T.O. 1F-86L-1

FLIGHT HANDBOOK

USAF SERIES
F-86L
AIRCRAFT

CONTRACT AF 04(606)-8533

TO 1F 86L-SF-1-3
25 July-61
TO 1F-86L-SF-1-4
25 Jan-62

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

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21 FEBRUARY 1958

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CURRENT FLIGHT CREW CHECKLIST

T.O. 1F-86L-CL1-1 DATED 27 OCTOBER 1961

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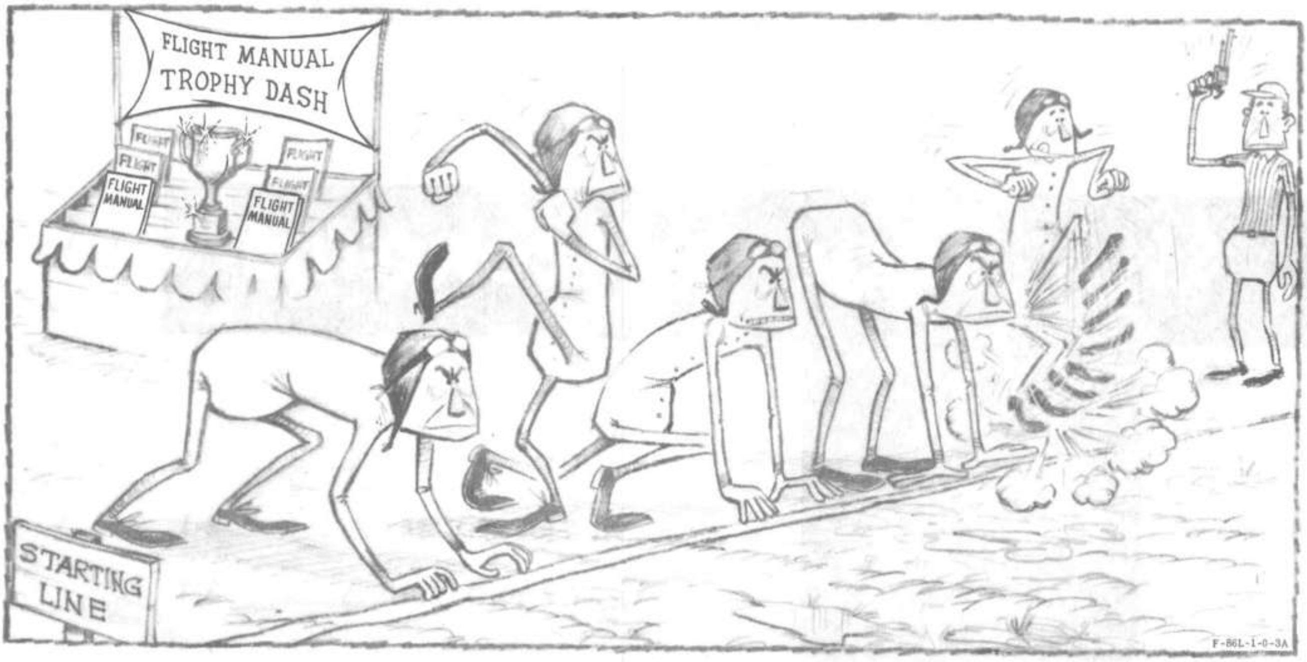


These pages tell you how to use the manual.

Scope. This manual contains the necessary information for safe and efficient operation of the F-86L. 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.

Sound Judgment. Instructions in this manual are for a pilot inexperienced in the operation of this airplane. 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 SMAMA 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 10 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.

Safety of Flight Supplements. Information involving safety will be promptly forwarded to you by Safety of Flight Supplements. Supplements covering loss of life will get to you in 48 hours by TWX, and those concerning serious damage to equipment within 10 days by mail. The current status of each Safety of Flight Supplement affecting your airplane can be determined by referring to the Weekly Index of Safety of Flight Supplements (T.O. 0-1-1A). The title page of the Flight Manual and the title block of each Safety of Flight Supplement should also be checked to determine the effect they may have on existing supplements. You must remain constantly aware of the status of all supplements—current supplements must be complied with but there is no point in restricting your operation by complying with a replaced or rescinded supplement.

Checklists. The Flight Manual contains only amplified checklists. Condensed checklists have been issued as separate technical orders. (Refer to back of the title page for the T.O. number and date of your latest checklist.) Line items in the Flight Manual and checklists are identical with respect to arrangement and item number. Whenever a Safety of Flight Supplement affects the condensed checklist, write in the applicable change on the affected checklist page.

How to Get Personal Copies. Each pilot is entitled to his personal copy of the Flight Manual, Safety of Flight Supplements, and checklists. The required quantities should be ordered before you need them to assure their prompt receipt. Check with your supply personnel; it is their job to fulfill your Technical Order requests. Basically, you must order the required quantities on the Publication Requirements Table (T.O. 0-3-1). Technical Orders 00-5-1 and 00-5-2 give detailed information for properly ordering these publications. Make sure a system is established at your base to deliver these publications to the flight crews immediately upon receipt.

Flight Manual and Checklist Binders. Loose leaf binders and sectionalized tabs are available for use with your manual. These are obtained through local purchase procedures and are listed in the Federal Supply schedule (FSC Group 75, Office Supplies, Part 1). Binders are also available for carrying your condensed checklist. These binders contain plastic envelopes into which individual checklist pages are inserted. They are available in three capacities and are obtained through normal Air Force supply under the following stock list numbers: 7510-766-4268, -4269, and -4270 for 15, 25, and 40 envelope binders, respectively. Check with your supply personnel for assistance in securing these items.

MB-8 Flight Computer. An MB-8 Flight Computer is available for this airplane. This pocket size computer provides pilots with compact performance data to aid in preparing flight plans, in-flight cruise control, and emergency replanning. The computer data discs, which contains specific performance data for this airplane, are distributed automatically to all bases having this airplane. New or revised discs are issued each time the performance data in this manual is revised. Operation of the computer is explained in the Appendix of this manual. If you have not received your computer, see your Base Operations Officer or T.O. 5F5-1-1.

Warnings, Cautions, and Notes. The following definitions apply to "Warnings," "Cautions," and "Notes" found throughout the manual.

WARNING

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

CAUTION

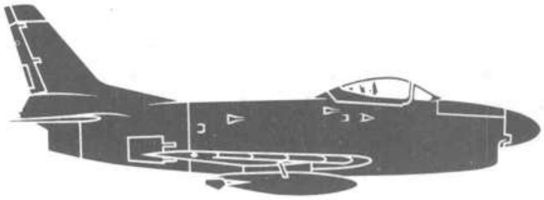
Operating procedures, techniques, etc, which if not strictly observed will result in damage to equipment.

Note

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

Your Responsibility—To Let Us Know. Every effort is made to keep the Flight Manual current. Review conferences with operating personnel and a constant review of accident and flight test reports assure inclusion of the latest data in the manual. However, we cannot correct an error unless we know of its existence. In this regard, it is essential that you do your part. Comments, corrections, and questions regarding this manual or any phase of the Flight Manual program are welcomed. These should be forwarded through your Command Headquarters to Commander, Sacramento Air Materiel Area, McClellan AFB, California, Attention: SMNEWH.

F·86L



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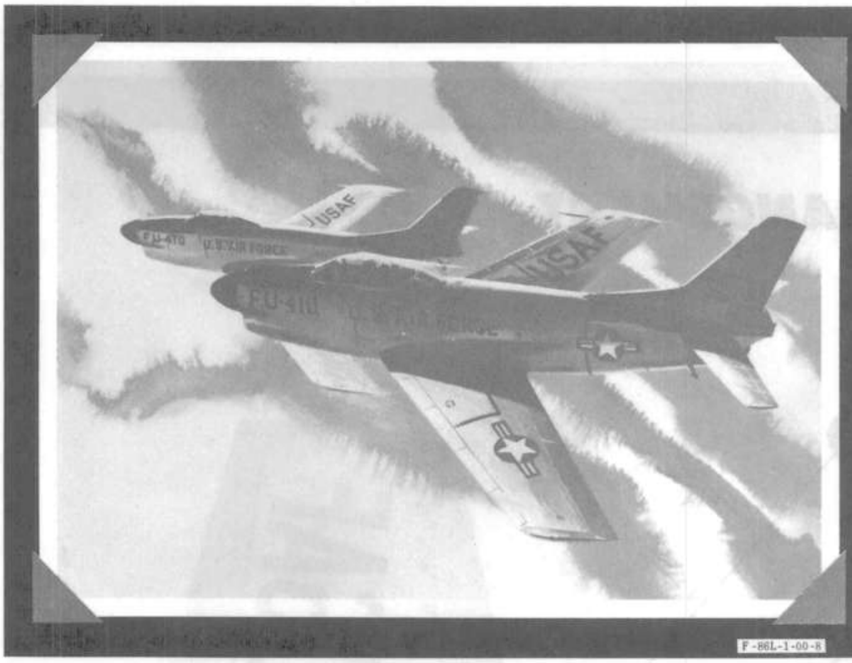

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Description

SECTION I

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AIRPLANE.

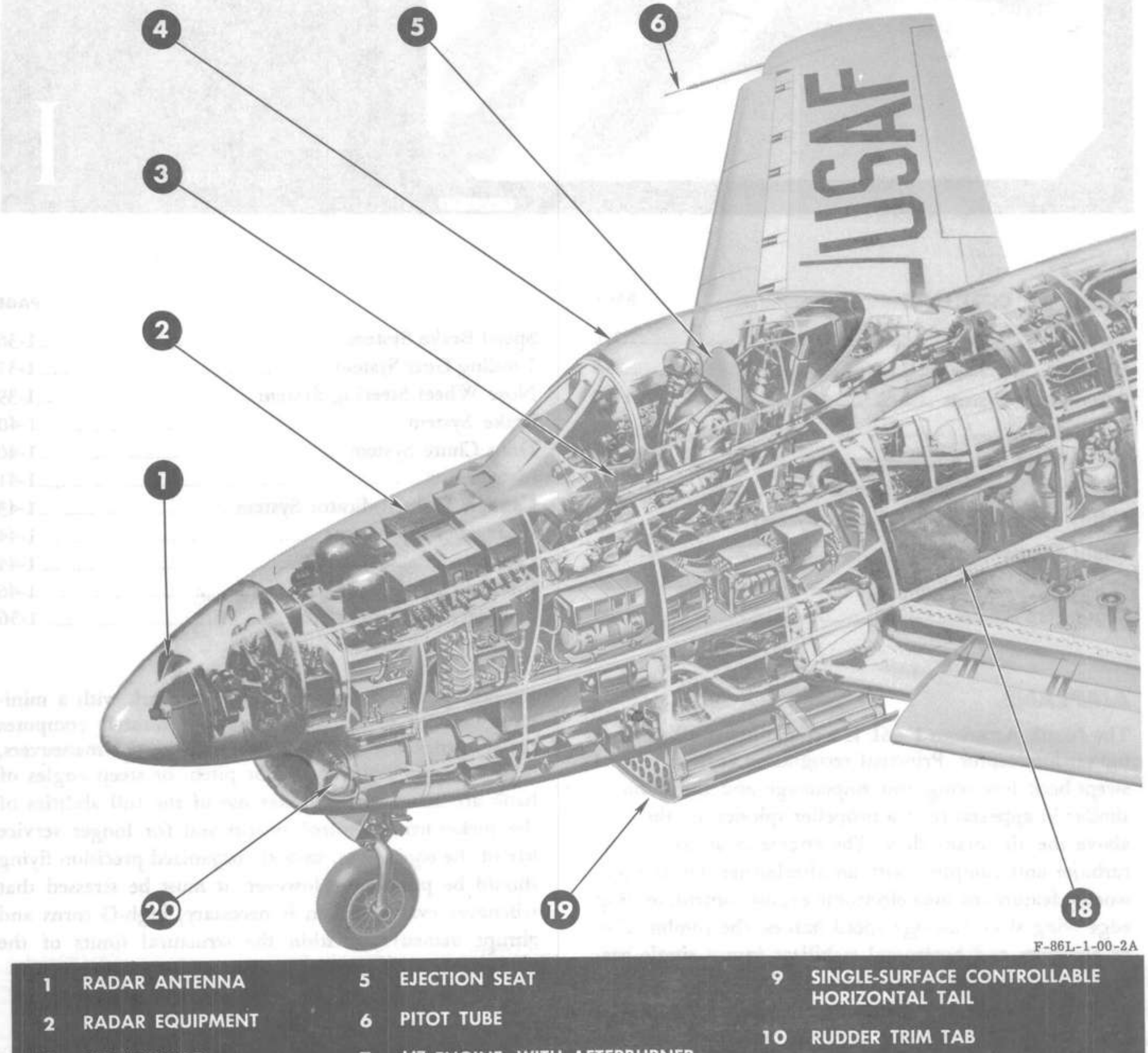
The North American F-86L is a single-place, all-weather fighter-interceptor. Principal recognition features are its swept-back low wing and empennage and the radome, similar in appearance to a propeller spinner, on the nose above the air intake duct. The engine is an axial-flow, turbojet unit equipped with an afterburner. Other noteworthy features include electronic engine control, leading edge wing slats, fuselage speed brakes, the combination of elevators and horizontal stabilizer into a single surface known as the controllable horizontal tail, and a drag chute. Designed chiefly as a high-altitude fighter-interceptor, the airplane is equipped with the latest and most advanced equipment (a large part of which is electronic) to accurately and effectively launch the rockets with which the airplane is armed. The rocket-firing control system computer tracks the target and indicates to the pilot the course to follow. This system requires precision flying in order to work with a minimum amount of error, as it more accurately computes the true rocket interception course if abrupt maneuvers, high G, rapid rates of roll or pitch, or steep angles of bank are avoided. For better use of the full abilities of the rocket-firing control system and for longer service life of the equipment, smooth, organized precision flying should be practiced. However, it must be stressed that whenever evasive action is necessary, high-G turns and abrupt maneuvers within the structural limits of the airplane are permissible.

AIRPLANE DIMENSIONS.

Over-all dimensions of the airplane are as follows:

Wing span	39.1 feet
Length	40.3 feet
Height	15.0 feet

GENERAL ARRANGEMENT



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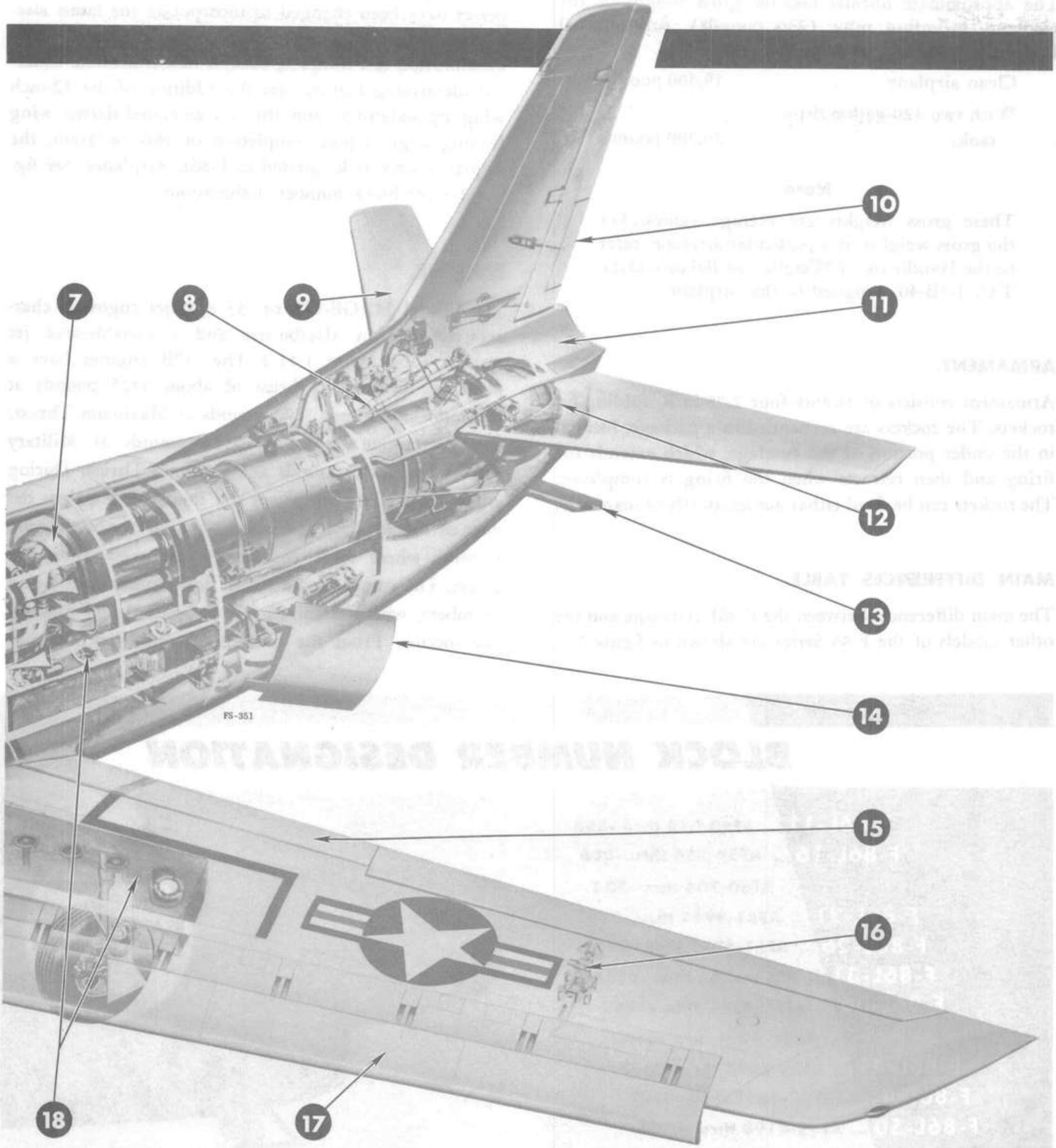
1 RADAR ANTENNA
2 RADAR EQUIPMENT
3 RADARSCOPE
4 ELECTRICALLY OPERATED, HINGED CANOPY
5 EJECTION SEAT
6 PITOT TUBE
7 J47 ENGINE WITH AFTERBURNER
8 CONTROLLABLE HORIZONTAL TAIL ACTUATING CYLINDER
9 SINGLE-SURFACE CONTROLLABLE HORIZONTAL TAIL
10 RUDDER TRIM TAB
11 DRAG CHUTE COMPARTMENT

Figure 1-1



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12	VARIABLE-AREA NOZZLE
13	FUEL TANK VENT BAYONET
14	SPEED BRAKE
15	WING FLAP
16	AILERON ACTUATING CYLINDER
17	WING SLATS
18	FUEL TANKS
19	ROCKET PACKAGE
20	RETRACTABLE LANDING AND TAXI LIGHT

AIRPLANE GROSS WEIGHT.

The approximate normal take-off gross weight of the airplane, including pilot (230 pounds), full internal fuel, and rockets, is as follows:

Clean airplane	18,400 pounds
With two 120-gallon drop tanks	20,200 pounds

Note

These gross weights are average values. For the gross weights of a particular airplane, refer to the Handbook of Weight and Balance Data, T.O. 1-1B-40, assigned to this airplane.

ARMAMENT.

Armament consists of twenty-four 2.75-inch, folding-fin rockets. The rockets are suspended in a package, located in the under portion of the fuselage, which extends for firing and then retracts when the firing is completed. The rockets can be fired either automatically or manually.

MAIN DIFFERENCES TABLE.

The main differences between the F-86L Airplane and the other models of the F-86 Series are shown in figure 1-3.

Under a modification program ("Project Follow-on"), some airplanes in the F-86D-11 through the F-86D-60 Series have been changed to incorporate the latest electronic equipment. The major identifying feature of this modification is a complete cockpit modernization. External identifying features are the addition of the 12-inch wing tip extension and the 6-3 extended-slatted wing leading edge. Upon completion of this program, the airplanes were redesignated as F-86L Airplanes. See figure 1-2 for block number designations.

ENGINE.

The Model J47-GE-17B or -33 turbojet engine is characterized by an afterburner and a variable-area jet nozzle. (See figure 1-11.) The -17B engines have a rated sea-level static thrust of about 5425 pounds at Military Thrust and 7500 pounds at Maximum Thrust; the -33 engine has about 5550 pounds at Military Thrust and 7650 pounds at Maximum Thrust. During engine operation, air enters the intake duct below the nose of the airplane and is routed to an axial-flow compressor, where it is compressed progressively in 12 stages. The compressed air then flows to the combustion chambers, where atomized fuel is injected and combustion occurs. From the combustion chambers, the hot

BLOCK NUMBER DESIGNATION

F-86L-11	... AF50-518 thru -553
F-86L-16	... AF50-554 thru -516
	AF50-704 thru -734
F-86L-21	... AF51-2944 thru -3131
F-86L-26	... AF51-5857 thru -5944
F-86L-31	... AF51-5945 thru -6144
F-86L-36	... AF51-6145 thru -6262
	AF51-8274 thru -8505
F-86L-41	... AF52-3598 thru -3897
F-86L-45	... AF52-3899 thru -4197
F-86L-50	... AF52-4198 thru -4304
	AF52-9983 thru -10176
F-86L-55	... AF53-557 thru -781
F-86L-60	... AF53-782 thru -1071
	AF53-3675 thru -3710
	AF53-4018 thru -4090

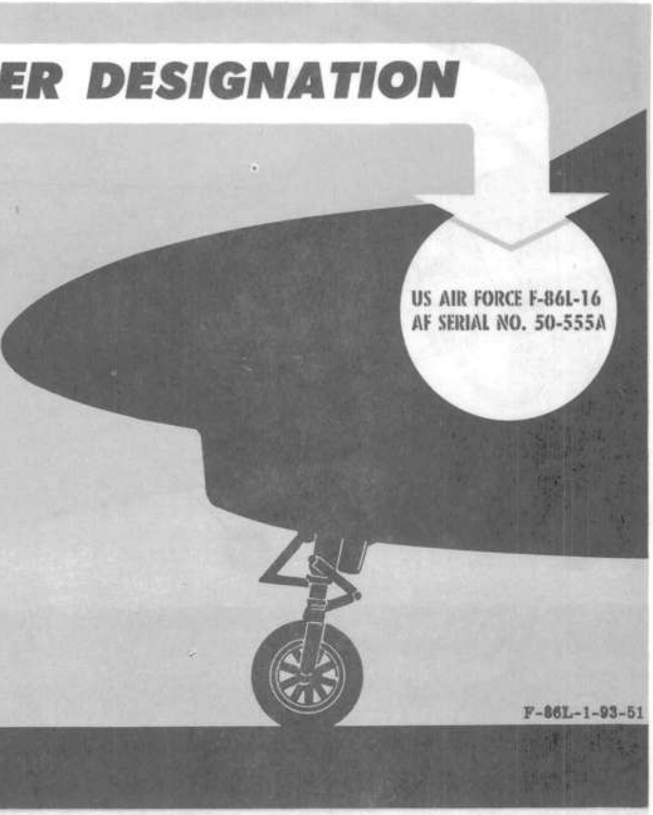

Figure 1-2

MAIN DIFFERENCES TABLE

ITEM	F86A	F86D	F86E	F86F	F86H	F86K	F86L
ENGINE	J47-GE-7 OR -13	J47-GE-17, -17B, OR -33	J47-GE-13	J47-GE-27	J73-GE-3	J47-GE-17B	J47-GE-17B OR -33
ENGINE AIR INTAKE DUCT	IN NOSE	BELOW RADOME IN NOSE	IN NOSE	IN NOSE	IN NOSE	BELOW RADOME IN NOSE	BELOW RADOME IN NOSE
DRAG CHUTE	NO	IN EMPENNAGE ABOVE EXHAUST NOZZLE AND BELOW RUDDER	NO	NO	NO	IN EMPENNAGE ABOVE EXHAUST NOZZLE AND BELOW RUDDER	IN EMPENNAGE ABOVE EXHAUST NOZZLE AND BELOW RUDDER
CANOPY	SLIDING	CLAMSHELL	SLIDING	SLIDING	CLAMSHELL	CLAMSHELL	CLAMSHELL
HORIZONTAL TAIL ACTION	CONVENTIONAL	STABILIZER AND ELEVATOR COMBINED INTO ONE MOVABLE SURFACE	CONTROLLABLE STABILIZER AND ELEVATOR	CONTROLLABLE STABILIZER AND ELEVATOR	CONTROLLABLE STABILIZER AND ELEVATOR	STABILIZER AND ELEVATOR COMBINED INTO ONE MOVABLE SURFACE	STABILIZER AND ELEVATOR COMBINED INTO ONE MOVABLE SURFACE
SURFACE CONTROLS	CONVENTIONAL WITH HYDRAULIC BOOST	COMPLETELY HYDRAULIC IRREVERSIBLE CONTROL	COMPLETELY HYDRAULIC IRREVERSIBLE CONTROL	COMPLETELY HYDRAULIC IRREVERSIBLE CONTROL	COMPLETELY HYDRAULIC IRREVERSIBLE CONTROL	COMPLETELY HYDRAULIC IRREVERSIBLE CONTROL	COMPLETELY HYDRAULIC IRREVERSIBLE CONTROL
ENGINE CONTROLS	CONVENTIONAL (MECHANICAL LINKAGE)	ELECTRONIC	CONVENTIONAL (MECHANICAL LINKAGE)	CONVENTIONAL (MECHANICAL LINKAGE)	HYDROMECHANICAL	ELECTRONIC	ELECTRONIC
AUTOMATIC PILOT	NO	YES	NO	NO	NO	YES	YES
ARTIFICIAL FEEL	NO	YES	YES	YES	YES	YES	YES
SIGHT	A-1B, A-1CM, OR MARK 18	E-3 FIRE CONTROL E-4 FIRE CONTROL N-9-1 (STAND-BY)	A-1CM OR A-4	A-1CM OR A-4	A-4	MG-4 FIRE CONTROL (WITH A-4 SIGHT)	E-4 FIRE CONTROL NAFFARS (STAND-BY)
ARMAMENT	GUNS AND EXTERNALLY MOUNTED BOMBS, ROCKETS, OR CHEMICAL TANKS	ROCKETS MOUNTED IN RETRACTABLE PACKAGE	GUNS AND EXTERNALLY MOUNTED BOMBS, ROCKETS, OR CHEMICAL TANKS	GUNS AND EXTERNALLY MOUNTED BOMBS, ROCKETS, OR CHEMICAL TANKS	MACHINE GUNS, BOMBS, ROCKETS, OR SPECIAL STORES	20 MM RAPID-FIRING GUNS	ROCKETS MOUNTED IN RETRACTABLE PACKAGE

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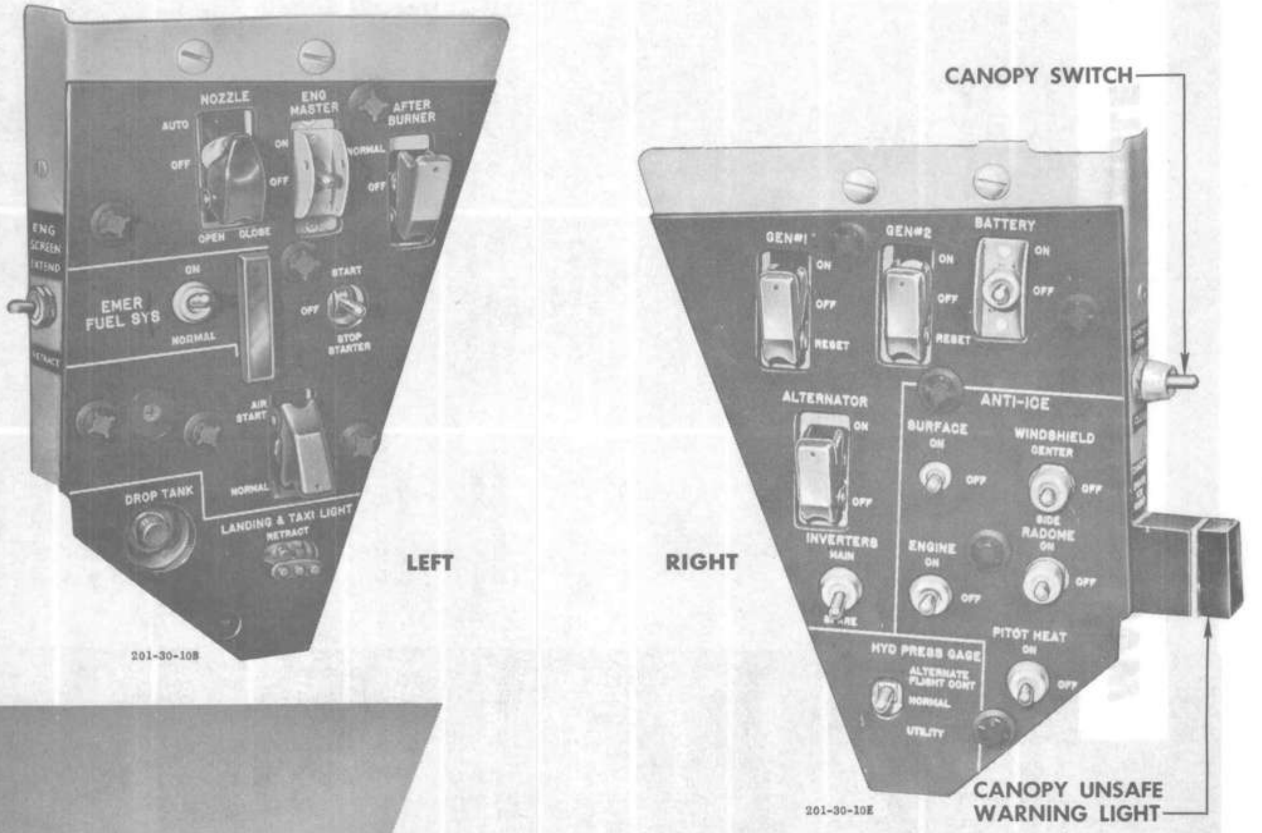
Figure 1-3

exhaust gas passes through a turbine and out the tail pipe in gradually expanding form to provide the high-velocity jet and reaction thrust. The turbine, which is rotated by the exhaust gas passing through it, is directly connected to, and drives, the compressor. When maximum performance for short periods is desired, the exhaust gas may be reheated by the injection of fuel into the tail pipe aft of the turbine. The burning of this injected fuel, providing added thrust, is called afterburning. An automatically controlled, variable-area nozzle on the end of the tail pipe provides correct nozzle conditions for most favorable performance, with or without afterburner operating. A ceramic-coated inner liner is installed in the tail pipe to prevent the high temperatures from damaging the exhaust nozzle and aft fuselage section. The main features of the -17B engine include an improved emergency fuel system regulator that incorporates an altitude schedule setting that reduces the possibility of overspeed on climb-out; a new main fuel valve and main amplifier that allows for better altitude performance, faster engine acceleration, better recovery from emergency test operation, and a lower rpm for initiation of afterburning; an improved flame holder and flame dome in the afterburning section to give more rigidity and strength; and a ceramic liner in the tail pipe for better insulation of exhaust temperatures. Operating procedures for the J47-GE-33 engine are the same as for the -17B engine. The main features changed on the -33 engine are as follows: The air inlet guide vanes are changed from a 3-degree pitch angle to 6 degrees to allow a greater amount of intake air and increase the thrust about 200 pounds. The variable-position exhaust nozzle is capable of a 4 percent larger opening. Both engines incorporate a floating turbine shroud ring to aid in keeping a more even and constant clearance between the turbine blades and shroud ring. It is designed to eliminate shroud ring warpage and

INSTRUMENT SUBPANELS



LEFT

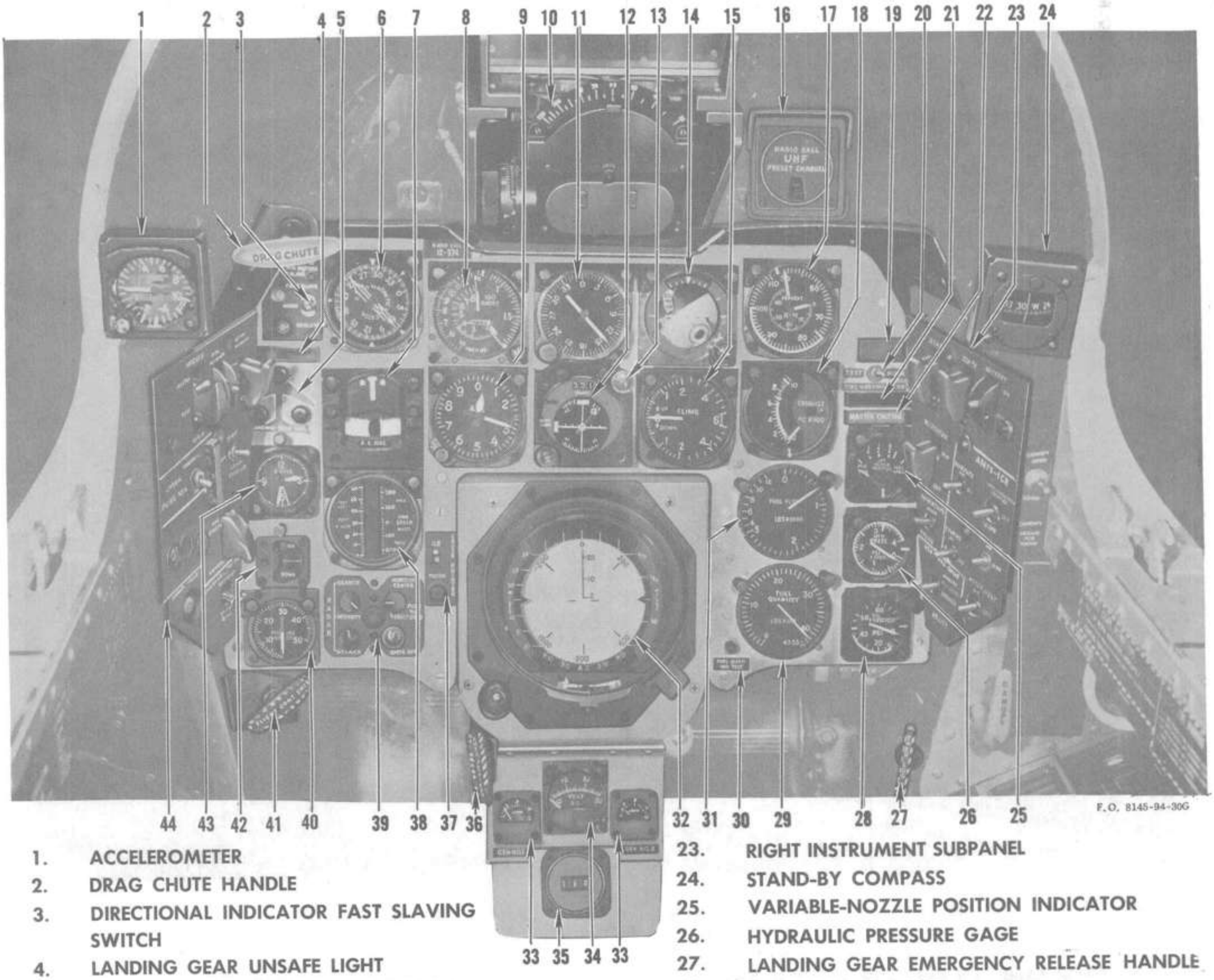
RIGHT

CANOPY SWITCH

CANOPY UNSAFE WARNING LIGHT

F-86L-1-30-1A

Figure 1-4



1. ACCELEROMETER
2. DRAG CHUTE HANDLE
3. DIRECTIONAL INDICATOR FAST SLAVING SWITCH
4. LANDING GEAR UNSAFE LIGHT
5. LANDING GEAR POSITION INDICATORS
6. RADIO MAGNETIC INDICATOR
7. TURN-AND-SLIP INDICATOR
8. AIRSPEED AND MACH NUMBER INDICATOR
9. ALTIMETER
10. NAFFARS SIGHT HEAD
11. DIRECTIONAL INDICATOR (SLAVED)
12. VOR APPROACH-COURSE INDICATOR
13. MARKER BEACON INDICATOR LIGHT
14. ATTITUDE INDICATOR
15. VERTICAL VELOCITY INDICATOR
16. COMMAND RADIO REMOTE CHANNEL INDICATOR
17. TACHOMETER
18. EXHAUST TEMPERATURE GAGE
19. FORWARD FIRE-WARNING LIGHT
20. FIRE-WARNING LIGHT TEST SWITCH
21. AFT FIRE-WARNING LIGHT
22. MASTER CAUTION LIGHT
23. RIGHT INSTRUMENT SUBPANEL
24. STAND-BY COMPASS
25. VARIABLE-NOZZLE POSITION INDICATOR
26. HYDRAULIC PRESSURE GAGE
27. LANDING GEAR EMERGENCY RELEASE HANDLE
28. OIL PRESSURE GAGE
29. FUEL QUANTITY GAGE
30. FUEL QUANTITY GAGE TEST SWITCH
31. FUEL FLOWMETER
32. RADARSCOPE
33. LOADMETERS (GENERATORS NO. 1 AND 2)
34. VOLTMETER
35. TACAN DISTANCE INDICATOR*
36. DROP TANK EMERGENCY JETTISON HANDLE
37. ILS-TACAN SWITCH
38. COMMAND SPEED-ALTITUDE INDICATOR
39. RADARSCOPE PRESENTATION INTENSITY CONTROL PANEL
40. COCKPIT ALTIMETER
41. FLIGHT CONTROL EMERGENCY HANDLE
42. PITCH TRIM INDICATOR
43. CLOCK
44. LEFT INSTRUMENT SUBPANEL (ENGINE CONTROL PANEL)

*Some airplanes. (Refer to applicable text.)

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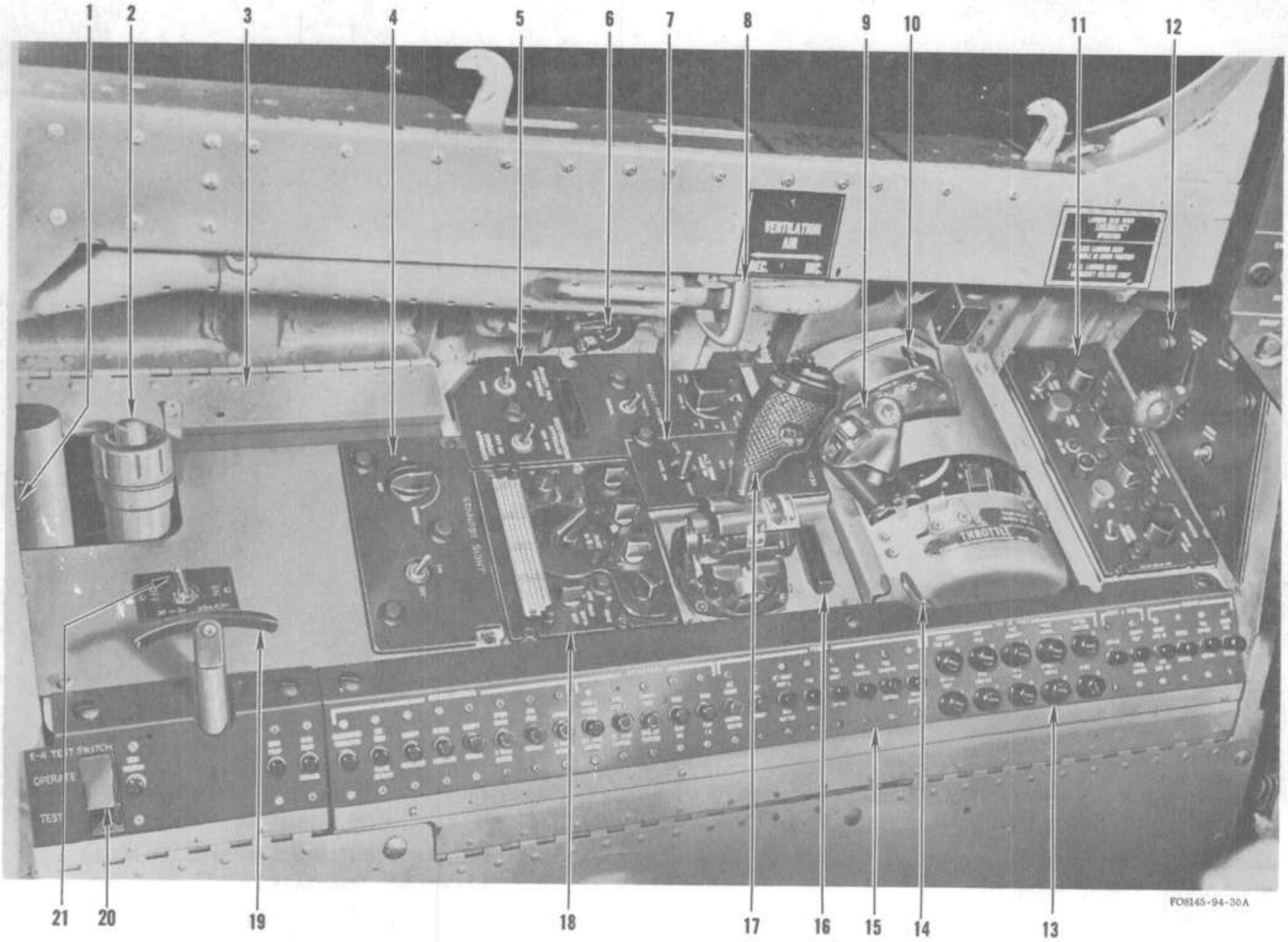
COCKPIT—FORWARD VIEW

Figure 1-5



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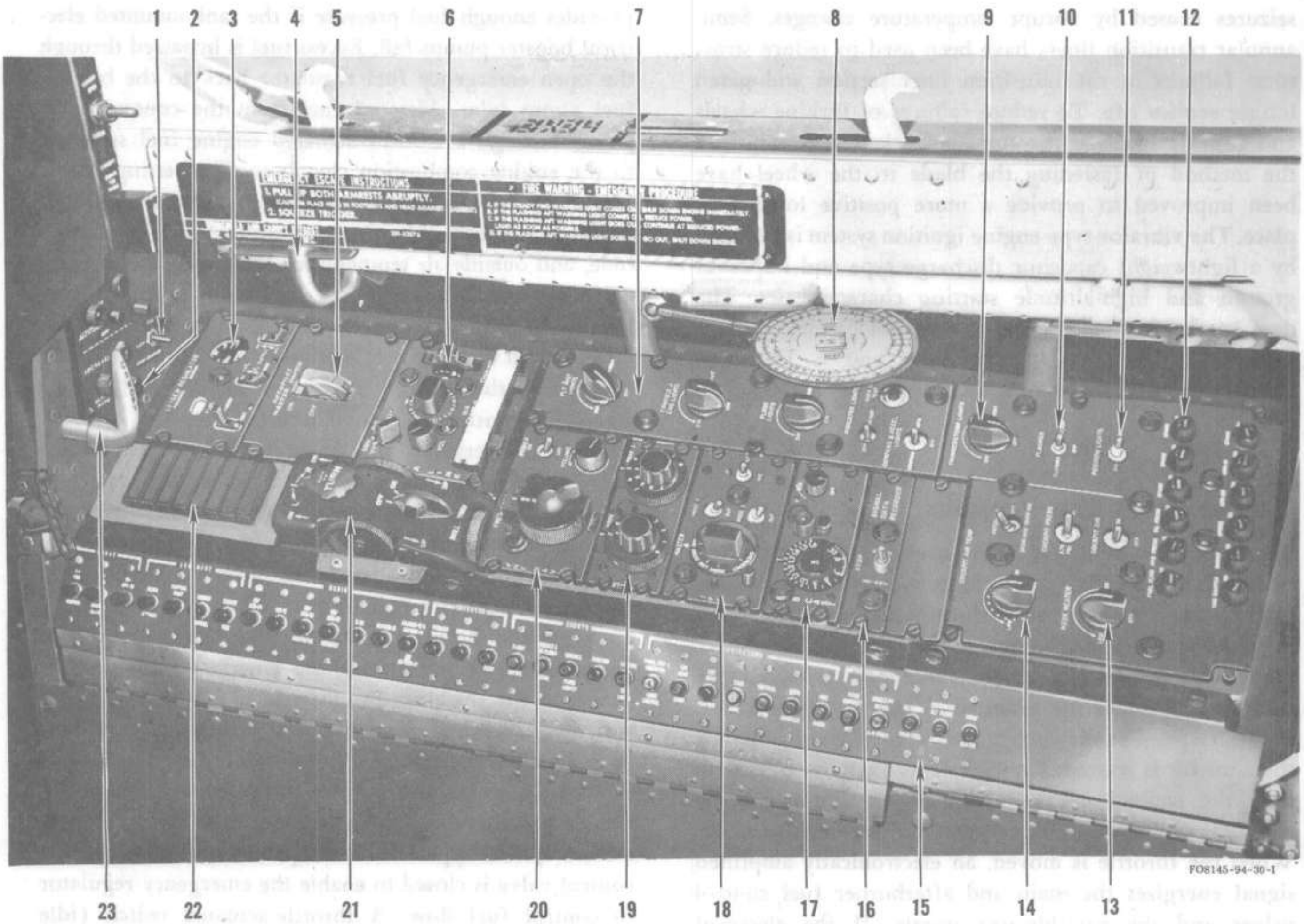
1. DROP TANK AIR PRESSURE SHUTOFF VALVE
2. ANTI-G SUIT PRESSURE REGULATOR VALVE
3. MAP CASE
4. STAND-BY SIGHT CONTROL PANEL
5. ARMAMENT CONTROL PANEL
6. MANUAL RAM-AIR LEVER
7. FLIGHT CONTROL PANEL
8. VENTILATION AIR LEVER
9. THROTTLE GRIP
10. WING FLAP HANDLE
11. E-4 RADAR CONTROL PANEL
12. LANDING GEAR CONTROL PANEL
13. FUSE PANEL
14. THROTTLE FRICTION LEVER
15. CIRCUIT-BREAKER PANEL
16. TRIMMED FOR TAKE-OFF LIGHT
17. RADAR ANTENNA HAND CONTROL
18. COMMAND RADIO CONTROL PANEL
19. RUDDER LOCK HANDLE
20. E-4 TEST SWITCH
21. VENTILATING SUIT SWITCH

COCKPIT—LEFT SIDE

F-86L-1-30-3C

Figure 1-6



1. YAW DAMPER SWITCH
2. AUTOMATIC APPROACH COUPLER CONTROLLER
3. OXYGEN REGULATOR PANEL
4. WINDSHIELD AND CANOPY DEFROST LEVER
5. AUTOPILOT POWER SWITCH
6. DATA LINK CONTROL PANEL
7. LIGHTING CONTROL PANEL
8. NAVIGATIONAL COMPUTER
9. THUNDERSTORM LIGHT RHEOSTAT
10. LIGHT FLASHER SWITCH
11. POSITION LIGHTS SWITCH
12. FUSE PANEL
13. MASK HEATER RHEOSTAT
14. COCKPIT AIR CONTROL PANEL
15. CIRCUIT-BREAKER PANEL
16. NADAR RECORDER SWITCH
17. R-22 CONTROL PANEL
18. AN/APX-6A CONTROL PANEL
19. AN/APX-25 CONTROL PANEL
20. AN/ARN-14 CONTROL PANEL
21. AUTOMATIC PILOT FLIGHT CONTROLLER
22. CAUTION LIGHT PANEL
23. CANOPY LOCK HANDLE

COCKPIT—RIGHT SIDE

F-86L-1-30-4B

Figure 1-7

seizures caused by abrupt temperature changes. Semi-annular transition liners have been used to reduce structural failures in the transition liner section and given longer service life. To reduce failures of turbine wheels and turbine buckets, the turbine bucket mounting and the method of fastening the blade to the wheel have been improved to provide a more positive locking in place. The vibrator-type engine ignition system is replaced by a lightweight capacitor discharge type and improves ground and high-altitude starting characteristics. The dual spark plug installation is replaced by single plugs installed in combustion chambers 3 and 7. This new ignition system results in a weight saving of about 20 pounds.

ELECTRONIC ENGINE CONTROL.

The airplane is equipped with an electronic engine control, with the main advantage of extremely rapid response of the engine to changes in throttle setting. Also, starting and operating technique is considerably simplified. Flame-outs and compressor stalls due to excessively rapid throttle movement are eliminated because the controls always respond at the correct rate, regardless of how fast the throttle is moved. Control of the engine is tied in with the control of the variable-area nozzle, thereby automatically maintaining correct tail-pipe temperature. When the throttle is moved, an electronically amplified signal energizes the main and afterburner fuel control valves and the variable-area nozzle. If the electrical inverters do not work properly when external power is applied for a start, the electronic power control will be inoperative. Inverter-out caution lights should be checked and all circuit breakers pushed in when external power has been applied before an engine start is attempted. Before an automatic start, check that the engine control lockup light is out. Otherwise, a hot start may result. The starting circuit will not be energized if ac power is not available from the inverters. Refer to Section VII for further information on the electronic engine control and its characteristics.

ENGINE FUEL CONTROL SYSTEM.

Engine fuel control is provided by a main fuel control valve and an emergency fuel regulator, controlled by a two-position emergency fuel switch. (See figure 1-9.) A throttle-actuated, spring-loaded, idle detent plunger and switch are installed on the throttle quadrant to allow the pilot to abort take-off if the electronic engine control locks up during take-off roll. An engine-driven dual fuel pump and tank-mounted booster pumps supply fuel to the main control valve, which meters the amount of fuel required by the engine. The engine-driven pump provides enough fuel pressure if the tank-mounted electrical booster pumps fail. Excess fuel is bypassed through the open emergency fuel regulator back to the booster fuel pump inlet. Metered fuel from the control valve passes through a throttle-actuated engine fuel stopcock to the engine combustion chambers. The setting of the fuel control valves is determined electronically by throttle position, airspeed, exhaust temperature, engine rpm, altitude, and outside air temperature. The main fuel control valve automatically regulates fuel flow to the engine during starting; the correct fuel flow is provided for ignition and then for acceleration to the speed previously selected by the throttle. In case of failure of the electronically controlled main control valve, the throttle-controlled emergency fuel regulator takes over engine fuel control when the emergency fuel system switch is positioned at ON. The emergency regulator limits the amount of bypassed fuel in accordance with throttle setting, airspeed, and altitude. In normal operation, the emergency regulator is held in a full bypass position by an energized holdout solenoid. The solenoid may be de-energized by positioning the emergency fuel system switch to ON, enabling the throttle to mechanically control the emergency regulator. The emergency regulator, at a position determined by the throttle, forces fuel around the main control valve to the combustion chambers. When control by the emergency regulator is selected, a main system bypass valve is opened and the main fuel control valve is closed to enable the emergency regulator to control fuel flow. A throttle-actuated switch (idle detent switch) also allows engine control to be converted to the emergency fuel system if the engine controls lock up at Take-off Thrust on the main fuel system and it is desired to abort the take-off. The idle detent switch is actuated by rapidly retarding the throttle to START IDLE with about 30 to 40 pounds force. This switch when actuated electrically opens the main fuel system bypass valve and permits the emergency fuel system to assume engine control; however, it does not unlock the electronic engine controls. A complete loss of electrical power to the primary bus, or movement of the battery and generator switches to OFF during engine operation will also cause the holdout solenoid to be de-energized and the main system bypass valve to open. This allows the emergency fuel system to take over fuel control, regardless of the position of the emergency fuel system switch and without the emergency fuel system indicator light coming on. The emergency regulator is set to deliver normally a slightly lower fuel pressure than the main fuel control valve. The emergency regulator does not provide automatic fuel control in starts, accelerations, and decelerations; therefore, with the engine operating below 85% rpm, any rapid throttle movement with the emergency regulator operating would supply too much fuel to the

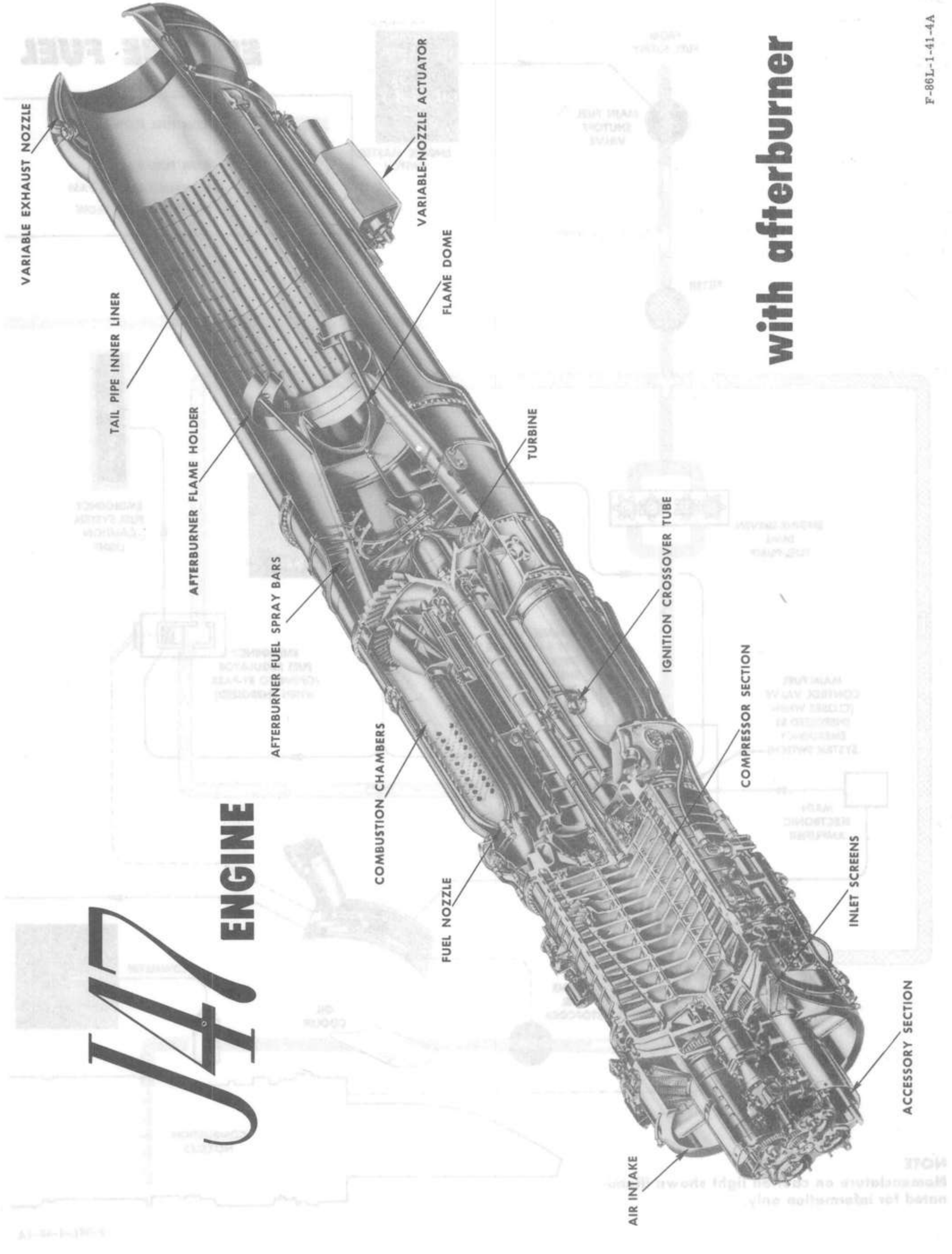
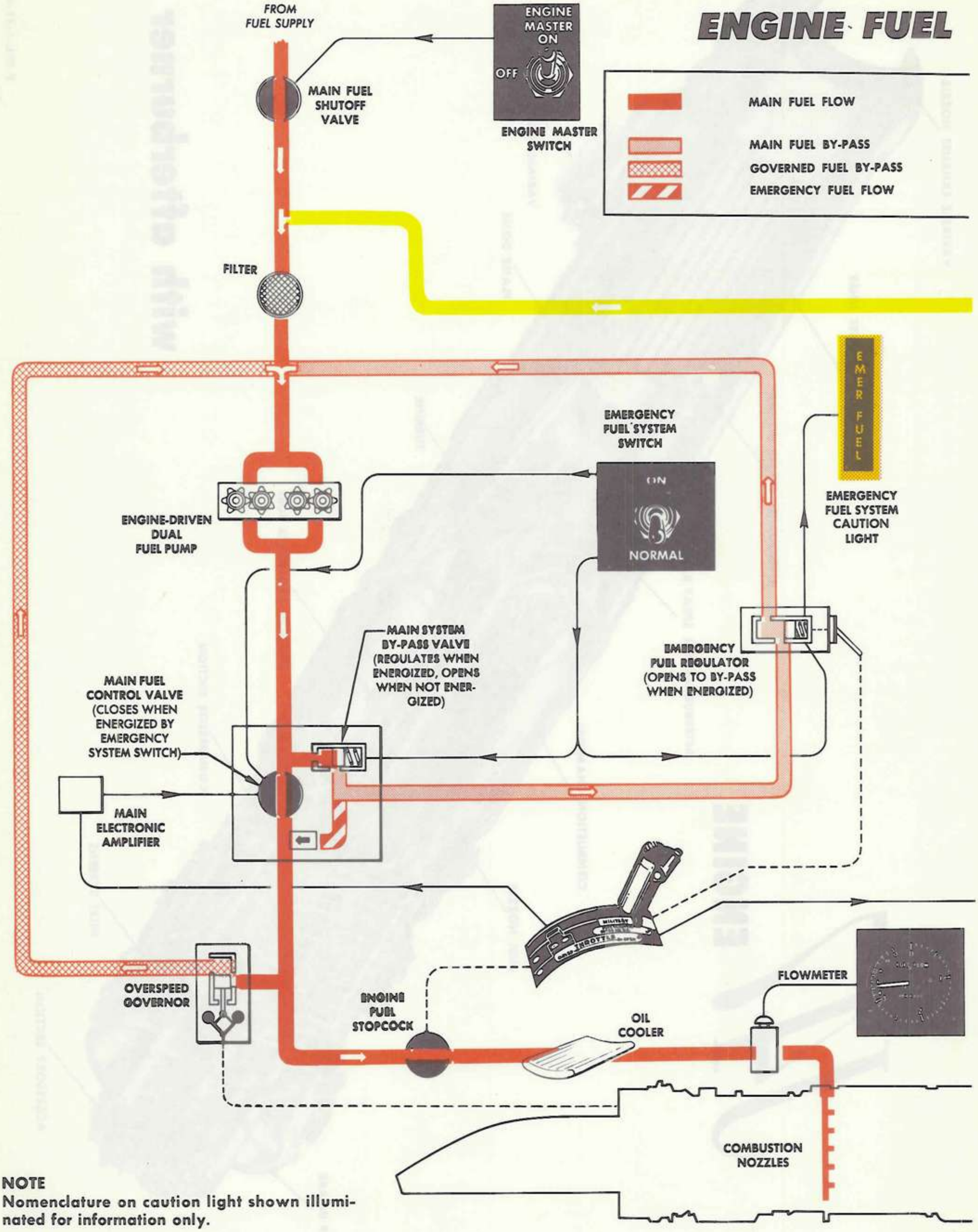

J47 ENGINE
with afterburner
VARIABLE EXHAUST NOZZLE
VARIABLE-NOZZLE ACTUATOR
TAIL PIPE INNER LINER
FLAME DOME
AFTERBURNER FLAME HOLDER
TURBINE
AFTERBURNER FUEL SPRAY BARS
IGNITION CROSSOVER TUBE
COMBUSTION CHAMBERS
COMPRESSOR SECTION
FUEL NOZZLE
INLET SCREENS
ACCESSORY SECTION
AIR INTAKE
F-86L-1-41-4A

Figure 1-8

ENGINE FUEL

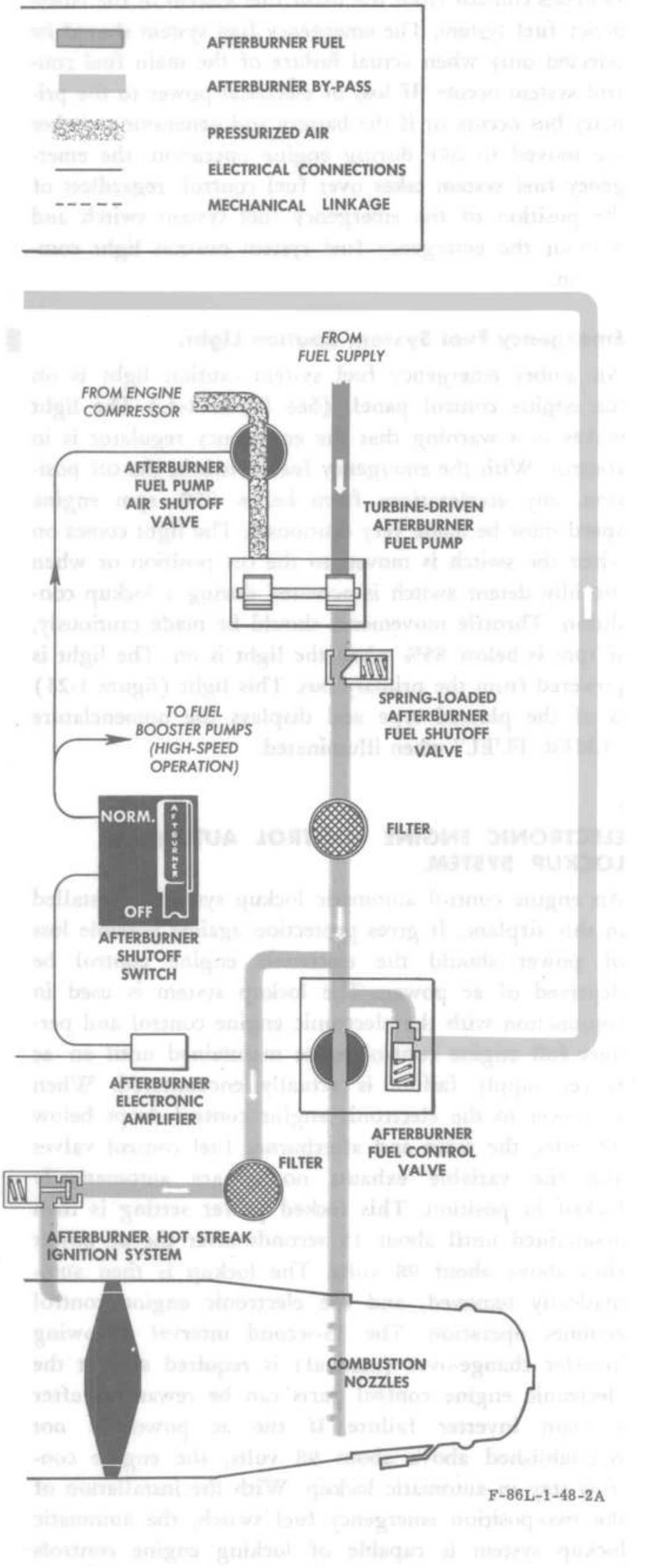


NOTE
Nomenclature on caution light shown illuminated for information only.

F-86L-1-48-1A

Figure 1-9

CONTROL SYSTEM



F-86L-1-48-2A

engine, causing flame-out, stall, or excess temperatures. A mechanical overspeed governor is installed downstream of the main control valve and emergency regulator. The governor bypasses excess fuel if the engine tends to overspeed. Refer to Section VII for additional information on the emergency fuel system.

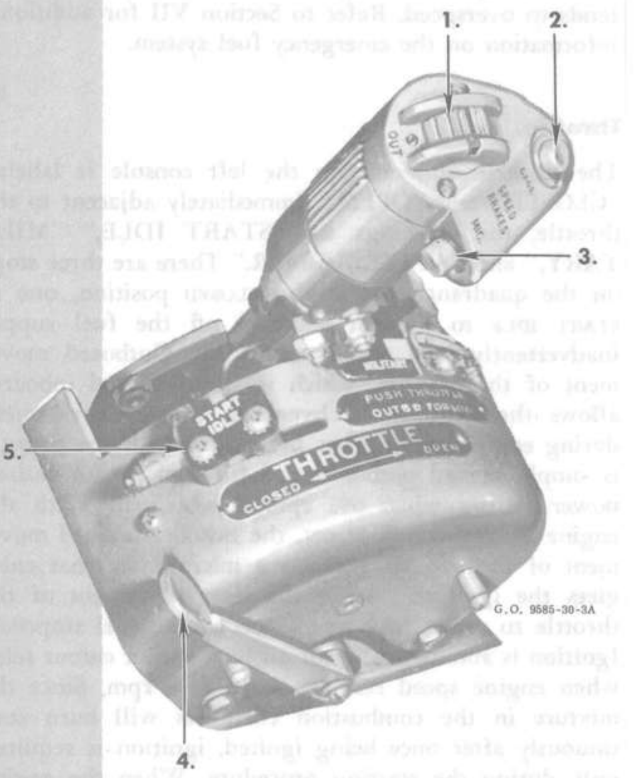
Throttle.

The throttle quadrant on the left console is labeled "CLOSED" and "OPEN." Immediately adjacent to the throttle, the markings are "START IDLE," "MILITARY," and "AFTERBURNER." There are three stops on the quadrant: one at the CLOSED position, one at START IDLE to prevent shutting off the fuel supply inadvertently, and one at MILITARY. Outboard movement of the throttle, which is spring-loaded inboard, allows the stops to be bypassed. Throttle movement during engine starting has been simplified; the throttle is simply moved outboard and forward to the desired power setting when 6% rpm is obtained. With the engine master switch at ON, the initial outboard movement of the throttle actuates a microswitch that energizes the ignition system; the later movement of the throttle to START IDLE opens the engine fuel stopcock. Ignition is automatically cut off by a starter cutout relay when engine speed reaches about 23% rpm. Since the mixture in the combustion chambers will burn continuously after once being ignited, ignition is required only during the starting procedure. When the engine is running, movement of the throttle in the normal operating range changes engine rpm by electronically changing the setting of the main fuel control valve. The throttle setting in conjunction with the temperature limiting control circuitry determines the position of the variable-area nozzle which maintains the most favorable exhaust temperatures. When the throttle is moved past the stop at MILITARY, compressor air is supplied for afterburner fuel pump turbine operation and the afterburner fuel shutoff valve is opened. In the afterburner operating range, the afterburner fuel control valve is electronically controlled by movement of the throttle to obtain various afterburner settings. Afterburning continues until the throttle is retarded from the AFTERBURNER range. A throttle-actuated switch, mounted on the quadrant at the START IDLE position, permits conversion to the emergency fuel system only in the event of engine control lockup. This idle detent switch is actuated by retarding the throttle to the START IDLE position with enough force to depress a spring-loaded plunger. The throttle grip (figure 1-10) contains a microphone button and a speed brake switch.

Engine Master Switch.

An engine master switch is on the engine control panel (figure 1-4) on the left instrument subpanel. Turning the master switch to ON opens the main fuel shutoff

THROTTLE GRIP CONTROLS



1. SPEED BRAKE SWITCH
2. SIGHT ELECTRICAL CAGING BUTTON
3. MICROPHONE BUTTON
4. THROTTLE FRICTION LEVER
5. IDLE-DETENT SWITCH

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Figure 1-10

valve, starts the fuel booster pumps, and completes circuits to the throttle-actuated microswitch, which provides ignition during starting. The circuit to the air start switch is also energized. The engine master switch is powered from the primary bus.

Emergency Fuel System Switch.

The proper engine fuel control can be selected by a switch (figure 1-4) on the engine control panel. This switch has two positions, ON and NORMAL, and is powered by the primary bus. With the switch in the ON position, engine control is provided by the emergency fuel system, and the emergency fuel system caution light comes on to provide a warning that rapid throttle movements should not be made when engine rpm is below 85%; otherwise, a compressor stall or flame-out may result. The switch is to be set at the NORMAL position for take-off and all normal operation. If automatic lockup occurs during take-off and it is desired to abort the take-off, the throttle is moved to the START IDLE position with enough effort to push in the idle detent plunger. This actuates the idle detent switch and immediately switches control from the main fuel system to the emergency fuel system. The emergency fuel system should be selected only when actual failure of the main fuel control system occurs. If loss of electrical power to the primary bus occurs or if the battery and generator switches are moved to OFF during engine operation, the emergency fuel system takes over fuel control, regardless of the position of the emergency fuel system switch and without the emergency fuel system caution light coming on.

Emergency Fuel System Caution Light.

An amber emergency fuel system caution light is on the engine control panel. (See figure 1-4.) The light serves as a warning that the emergency regulator is in control. With the emergency fuel switch in the ON position, any accelerations from below 85% rpm engine speed must be made very cautiously. The light comes on when the switch is moved to the ON position or when the idle detent switch is actuated during a lockup condition. Throttle movements should be made cautiously, if rpm is below 85% when the light is on. The light is powered from the primary bus. This light (figure 1-25) is of the placard type and displays the nomenclature "EMER. FUEL" when illuminated.

ELECTRONIC ENGINE CONTROL AUTOMATIC LOCKUP SYSTEM.

An engine control automatic lockup system is installed in this airplane. It gives protection against possible loss of power should the electronic engine control be deprived of ac power. The lockup system is used in conjunction with the electronic engine control and permits full engine control to be maintained until an ac power supply failure is actually encountered. When ac power to the electronic engine control drops below 92 volts, the main and afterburner fuel control valves and the variable exhaust nozzle are automatically locked in position. This locked power setting is then maintained until about 15 seconds after the ac power rises above about 98 volts. The lockup is then automatically removed, and the electronic engine control resumes operation. The 15-second interval following inverter change-over (manual) is required so that the electronic engine control parts can be rewarmed after a main inverter failure. If the ac power is not re-established above about 98 volts, the engine controls stay in automatic lockup. With the installation of the two-position emergency fuel switch, the automatic lockup system is capable of locking engine controls during an automatic start. (Refer to "Automatic Start" in Section II.) After the engine is operating, the automatic lockup system remains operable during normal operation with the emergency fuel system in the NORMAL position. If automatic lockup occurs during take-off roll, with the emergency fuel switch at NORMAL, the take-off can be aborted if desired, by rapidly retarding the throttle to START IDLE. The throttle is retarded rapidly to prevent engine overspeed because back pressure on the turbine wheel is decreased as afterburner operation ceases. This throttle action actuates the idle detent switch, which transfers engine operation to the emergency fuel system during a lockup condition only.

Note

> Actuation of the idle detent switch converts engine control to the emergency fuel system only during a lockup condition. Moving the emergency fuel system switch to ON or actuating the idle detent switch when the engine controls are locked up does not unlock the exhaust nozzle.

The emergency fuel system remains in control until the engine control lockup light goes out and until the emergency fuel switch is cycled to ON and returned to NORMAL. For taxiing after take-off is aborted and before the throttle is readvanced, position the emergency fuel system switch to ON. If it is desired, the take-off can be continued in the lockup condition. After a safe altitude is reached (if engine controls do not unlock automatically, or if engine controls do not unlock within 30 seconds after manually selecting the secondary inverter), the emergency fuel system should be manually selected by moving emergency fuel switch on ON, and a landing made using the emergency fuel system for engine operation.

Engine Control Lockup Indicator Light.

An amber engine control placard-type caution light on the caution light panel (figure 1-25), on the right console, displays the nomenclature "ENG CONT LOCK-UP" when the electronic engine controls are in lockup. The light is powered by the primary bus. When ac power loss occurs, causing the electronic engine controls to be locked in position, this light comes on. This light remains on until ac power is restored and the electronic engine controls have been automatically released from automatic lockup. Therefore, during operation of the main fuel control system, this light serves as a warning that power settings should not be changed as long as the light remains on. If it is necessary to operate on the emergency fuel system, engine operation on the emergency fuel system has no effect on the illumination of the light. The light remains on as long as ac power is not available. Switching the emergency fuel system switch from the ON position to the NORMAL position must not be attempted while the lockup indicator light is on. For example, if lockup occurs when operating at Military Thrust and throttle reductions are made while transferred to the emergency fuel system, and then the emergency fuel system switch is moved back to NORMAL, the sudden surge of fuel fed through the locked-up open main fuel control valve will cause a dangerous overtemperature condition. The engine control lockup light may go on momentarily during an automatic start; however, the start should be continued in normal sequence as lockup protection is provided during automatic starts. If the light does not go out within 30 seconds after the start is initiated, the engine should be shut down and the trouble investigated before another start attempt.

VARIABLE-AREA NOZZLE.

Two clamshell-type doors form the variable nozzle (figure 1-11) at the end of the tail pipe. The electrically actuated nozzle is electronically controlled by throttle position and exhaust temperature to maintain correct nozzle temperature for most favorable performance. The nozzle may also be manually actuated. When the variable-area nozzle is full open, its area is about 160 percent that of a fixed nozzle (Military Thrust area on a standard NACA day); when the variable-area nozzle is fully closed, its area is 95 percent that of a fixed nozzle. When automatically controlled, the nozzle is scheduled to close from about ½ position on some airplanes at idle rpm (¾ position on others) to about ⅛ position at Military Thrust. The nozzle gradually closes to follow the scheduled throttle position if the throttle is slowly advanced. On a throttle burst, the nozzle locks at the lower power position until the engine rpm is within 2% to 7% of the higher power rpm. The nozzle then rapidly closes to the scheduled position. If this scheduled nozzle position, at steady-state operation, is such that it causes the exhaust temperature to exceed 685°C, the nozzle is driven open to the position necessary to maintain 685°C by the exhaust temperature control circuitry. During normal afterburner operation, the nozzle position is controlled mainly by exhaust temperature; that is, the nozzle is moved to whatever position is necessary to maintain 685°C. If, in an effort to maintain the correct exhaust temperature, the nozzle is driven full open and exhaust temperature still tends to exceed 685°C, the electronic engine control automatically decreases afterburner fuel flow to prevent excessive exhaust temperatures. The afterburner fuel flow is also cut back in case the nozzle jams at a position which would normally result in overtemperature operation; or if the nozzle is manually jogged closed during afterburner operation, the after-

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Figure 1-11

burner fuel flow automatically decreases as nozzle area decreases.

WARNING

> It is recommended that the variable-nozzle switch be left in the AUTO position during landing approach and ground run. If the nozzle has been jogged open, enough thrust will not be available for a go-around unless the nozzle is jogged closed or the switch is returned to AUTO position.

Note

> With the variable-nozzle switch in the AUTO position, the nozzle is automatically controlled to give most favorable engine performance. Opening the nozzle has a negligible effect on the landing roll, because thrust loss is a very small percentage of the total available braking force during a landing. This force is about 4000 pounds, and idle thrust is reduced only 100 pounds by opening the nozzle.

Variable-nozzle Switch.

For automatic operation of the variable nozzle through the electronic engine control, a variable-nozzle switch, on the engine control panel (figure 1-4), is placed in the guarded AUTO position. When the switch is turned OFF, automatic control is cut off and, if the switch is left at OFF during normal operation, engine control will be limited, allowing possible overspeed and/or overtemperature to occur. If the automatic controls fail or are to be overridden, the nozzle may be actuated by movement of the switch from OFF to either of the spring-loaded positions, OPEN or CLOSE. The nozzle moves more slowly when actuated by means of the switch than when automatically controlled. The switch is powered from the primary bus. However, when switch is at AUTO, ac power must be available for automatic operation of the variable nozzle.

Variable-nozzle Position Indicator.

A position indicator (25, figure 1-5) for the variable nozzle is on the main instrument panel. The indicator dial is calibrated in quarters from minimum to maximum nozzle area. On engines with an early-type thrust selector, the indicator shows about ½ position at idle rpm; on engines with a late-type thrust selector, it shows about ¾ position at idle rpm. Power for operation of the position indicator is supplied from the primary bus.

IGNITION SYSTEM.

The ignition system, providing ignition through two spark plugs, functions only during ground starts and windmilling air starts. For ground starts, with the battery switch and engine master switch ON and the starter switch in the momentary START position, the initial outboard movement of the throttle (to pass the START IDLE stop) actuates a microswitch that supplies dc power to the ignition units. This dc power is converted by the ignition unit into high-voltage alternating current and is fed to the spark plugs in the No. 3 and No. 7 burners. After ignition occurs and the engine has accelerated to about 23% rpm, the ignition system is de-energized by the action of the automatic starter drop-out relay. During windmilling air starts, the main ignition system is energized through the AIR START (up) position of the air start switch and the throttle microswitch as in ground starts. After an air start, it is necessary to return the air start switch to NORMAL (down) to de-energize the main ignition system. Afterburner ignition is accomplished by a hot-streak ignition system. Fuel is bled from the inlet side of the afterburner fuel control valve through the hot-streak ignition valve, which permits a metered amount of fuel to flow through the turbine wheel. The metered fuel is ignited aft of the turbine wheel by hot gases or spontaneous combustion and streaks down to ignite fuel discharged from the afterburner fuel spray bars. The hot-streak ignition system is automatically cut off after a short time interval and will be recharged automatically only when the throttle is moved from AFTERBURNER range.

Engine Master Switch.

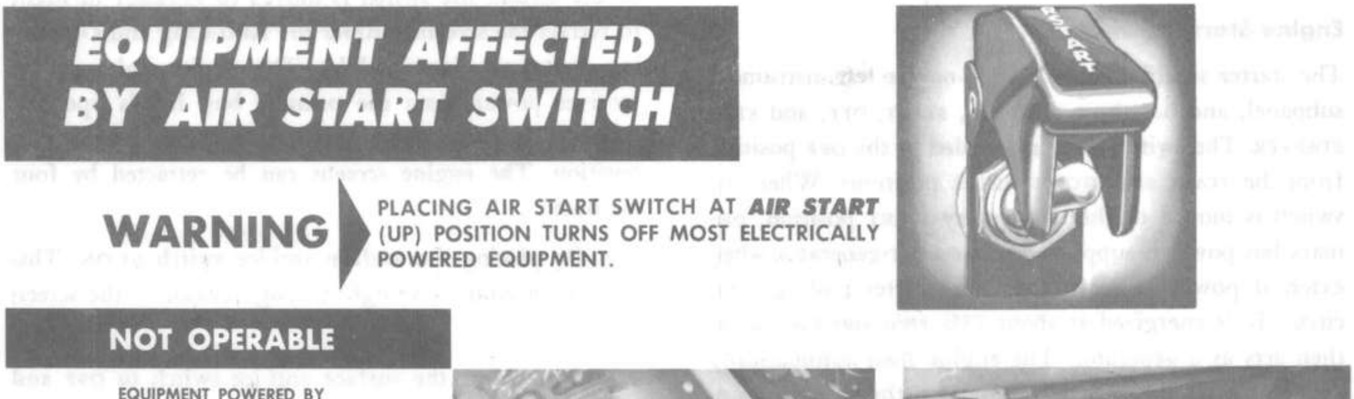
Refer to "Engine Fuel Control System" in this section.

Air Start Switch.

To provide ignition for restarting the engine in flight, a two-position switch is installed on the engine control panel. (See figure 1-4.) When the switch is moved from the guarded NORMAL (down) position to the AIR START (up) position, current is supplied for engine ignition; however, the throttle also must be moved outboard to complete the ignition circuit. At the same time, an inverter for the fuel flowmeter is energized and all electrical equipment powered by the secondary bus, monitored bus No. 1, monitored bus No. 2, monitored bus No. 3, and the ac bus is automatically turned off to temporarily decrease the load on the battery. The air start switch is powered from the primary bus. (See figure 1-15.) When the air start switch is returned to the NORMAL (down) position, after the start is completed and the generators are again operating, ignition shuts off and electrical equipment returns to normal operation. The emergency fuel system switch should not be returned to NORMAL before the engine control lockup light goes out because the inverters and electronic engine controls will not have enough time to warm up to proper operating temperatures.

CAUTION

Continuous operation of the air start ignition circuit is limited to a maximum of 3 minutes per start. Longer periods of use will damage the ignition vibrator units.



EQUIPMENT AFFECTED BY AIR START SWITCH

WARNING: PLACING AIR START SWITCH AT ***AIR START*** (UP) POSITION TURNS OFF MOST ELECTRICALLY POWERED EQUIPMENT.

NOT OPERABLE

EQUIPMENT POWERED BY

SECONDARY BUS
MONITORED NO. 1 BUS
MONITORED NO. 2 BUS
MONITORED NO. 3 BUS
A-C BUS

WHICH INCLUDES....

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Figure 1-12

STARTER SYSTEM.

A combination starter-generator works as a starter until engine speed reaches about 23% rpm, and thereafter works as a generator. The starter can be energized only when an external power source is connected to the airplane, because the airplane batteries are automatically disconnected from the electrical system during ground starts. Starter operation is entirely automatic after the starter switch is momentarily moved to the START position. Should the engine fail to start, the starter is de-energized if the stop-starter position is selected.

Note

An external power source capable of 28 volts, 1200 amperes surge and a continuous operating current of 500 amperes must be connected to both external power receptacles for starting.

Engine Starter Switch.

The starter switch (figure 1-4) is on the left instrument subpanel, and has three positions, START, OFF, and STOP STARTER. The switch is spring-loaded to the OFF position from the START and STOP STARTER positions. When the switch is moved to the momentary START position, primary bus power is supplied to the starter-generator when external power is connected. The starter and ignition circuit is de-energized at about 23% rpm and the starter then acts as a generator. The engine then automatically accelerates to the speed selected by throttle position. The start cycle can be interrupted by placing the switch at STOP STARTER momentarily. Since the starting and ignition circuit is automatically de-energized during starts, it is unnecessary to use the STOP STARTER position except in case of a false start.

Battery Switch.

The battery switch (figure 1-4) on the right instrument subpanel has two positions, ON and OFF. When the switch is at OFF, battery power is supplied only to the battery bus; with the switch in the ON position, battery power is supplied to the primary bus, secondary bus, and monitored bus No. 1, when external power is not applied. (See figure 1-15.)

ENGINE AIR INLET.

The engine inlet air is routed from the air inlet opening, at the nose of the airplane, under the radome, to the engine by a duct designed to provide maximum airflow to the engine under all flight conditions. Foreign objects entering the duct during take-off or landing are prevented from entering the engine by retractable engine screens. Position of this screen is manually controlled by movement of an inlet switch to the desired position, if the surface anti-ice switch is OFF. (Refer to "Anti-icing Systems" in Section IV.) A glide path antenna is on the leading edge of the lower part of the air inlet opening.

Engine Inlet Screen Switch.

The movable engine inlet screen, which protects the engine from foreign objects, is controlled by a two-position switch on the left instrument subpanel. (See figure 1-4.) The switch is normally at EXTEND on the ground and during take-off, so that the screen covers the inlet. To maintain maximum airflow and to prevent icing of the screen, the switch is moved to RETRACT in flight to retract the screens. (Refer to "Anti-icing and Defrosting Systems," Section IV.) The engine inlet switch receives power from the primary bus, but is operable only when the surface anti-ice switch is in the OFF position. The engine screens can be retracted by four methods:

a. By placing the surface anti-ice switch to ON. This method provides a straight-through circuit to the screen actuator.

b. By placing the surface anti-ice switch to OFF and the engine inlet screen switch to RETRACT.

c. By placing the surface and engine anti-ice switches at OFF and the engine inlet screen switch at RETRACT. The screens can only be extended when the anti-icing switches are at OFF.

d. By placing the engine and anti-ice switch at ON.

ENGINE INDICATORS.

Exhaust Temperature Gage.

An exhaust temperature gage, calibrated in 25-degree increments from 0°C to 1000°C (18, figure 1-5), is on the instrument panel. It provides a visual indication of engine operating condition, so that accurate power settings can be obtained. The gage is a self-generated electrical unit. It does not require power from the electrical system of the airplane for operation. For exhaust temperature gage limitations markings, see figure 5-1.

(Deleted)

Tachometer.

The tachometer, calibrated from 0% to 110% rpm (17, figure 1-5), is on the instrument panel. It indicates engine speed in percentage of maximum rated rpm (7950). This indicator, used in conjunction with the exhaust temperature gage, enables engine power to be accurately set without exceeding engine limitations. The tachometer is not powered from the electrical system of the airplane. It is supplied by the tachometer generator, which generates a voltage proportional to engine speed. For tachometer markings, see figure 5-1.

Fuel Flowmeter.

A fuel flowmeter, calibrated from 0 to 12,000 pounds per hour fuel flow (31, figure 1-5), is on the lower right side of the instrument panel. It gives the rate of fuel flow in pounds per hour. The indicator dial has the 0- to 3000-pound-per-hour position expanded, thus enabling more accurate readings within this range. The fuel flowmeter does not show rate of afterburner fuel flow. The flowmeter is powered from the ac bus; however, in case normal ac power is not available (when air start switch is actuated), a special inverter, powered by the primary bus, supplies ac power only for the flowmeter.

Oil Pressure Gage.

The oil pressure gage (28, figure 1-5), calibrated from 0 to 100 psi and mounted on the instrument panel, shows the pressure of oil within the engine. The gage is an electrical instrument powered from the ac bus of the airplane. For oil pressure gage limitation markings, see figure 5-1.

AFTERBURNER SYSTEM.

For Maximum Thrust for short periods, fuel discharged from nozzles aft of the turbine wheel is burned in the tail pipe. In this manner, the engine exhaust gas is reheated and provides added thrust. Fuel to the afterburner fuel spray bars is controlled by an afterburner fuel control valve. (See figure 1-9.) Throttle position, altitude, airspeed, engine rpm, and exhaust temperature electronically determine the afterburner fuel control valve setting. An afterburner fuel pump, driven by engine compressor air, supplies fuel to the afterburner fuel control valve. The afterburner fuel pump is tank-mounted and discharges enough fuel for afterburning operation without using the booster pumps. Bypass fuel from the tank-mounted unit is routed back to the forward fuselage tank.

CAUTION

- If afterburner blowout occurs with less than 1300 pounds of fuel remaining, do not attempt further afterburner operation unless dictated by emergency or combat conditions.
- This precaution does not form an operating limitation, but rather a measure for protection of the afterburner turbine-driven pump if the aft fuselage tank transfer pump fails.

Afterburning can be obtained by further advancing the throttle past the MILITARY stop to the AFTERBURNER range. This action causes an afterburner fuel pump air shutoff valve to be opened. The fuel pump air shutoff valve supplies compressor air to the afterburner fuel pump turbine, which begins operating. The fuel pressure of the pump output then opens the afterburner fuel shutoff valve and allows flow to the afterburner fuel control valve. As afterburner fuel flow is increased, the variable nozzle is automatically opened to prevent excessive exhaust temperatures. When the variable nozzle is fully open, afterburner fuel flow is limited by control valve position as required to prevent excessive exhaust temperatures, regardless of throttle position. The afterburner is shut off when the throttle is retarded from the AFTERBURNER range. The afterburner fuel control valve has a mechanical stop to prevent the fuel flow from exceeding desired maximum limit. A ceramic-coated inner liner is installed in the tail pipe to prevent high temperatures from damaging the tail pipe and aft fuselage. The inner liner, made of corrugated metal sprayed with heat-resistant ceramic compound, fits around the inner circumference of the tail pipe. The tail pipe should be checked for the inner-liner installation before flight. (Refer to Section VII for additional information on the afterburner system.)

Warning

Use of afterburner is recommended for take-off. However, take-off at military thrust is satisfactory although the take-off run is approximately 50% greater under standard conditions.

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Afterburner Shutoff Switch.

A guarded switch (figure 1-4) is on the left engine sub-panel and is powered by the primary bus. It provides an emergency means of cutting off afterburner operation. The switch has two positions: NORMAL and OFF. For afterburner operation, the switch must be in the NORMAL position. Movement of the switch to OFF closes the air valve to the air-turbine-driven afterburner fuel pump, thus shutting off afterburner operation.

OIL SYSTEM.

Lubrication of the various gears and bearings of the engine is accomplished by means of a pressure-type oil system and a scavenge pump return. The oil serves both for lubricating and cooling and is a completely automatic system requiring no control action by the pilot. Oil is routed to the different sections of the engine, where it lubricates and cools, and then through a scavenge pump that transfers the oil back to the oil supply tank. If the oil has been heated above the preset temperature of the oil temperature control valve, it is automatically routed through the oil cooler before being returned to the oil supply tank. The oil system uses 3 US gallons of oil in a 4½ US gallon tank (1½ gallons expansion space). The tank is located high on the right side of the fuselage, aft and above the trailing edge of the wing. Inverted operation is limited because of inability of scavenge pumps to return oil from sumps to oil supply tank. (See figure 1-29 for oil specifications.)

FUEL SYSTEM.

Four fuel tanks are installed in the airplane: two in the fuselage, and one in each wing outer panel. (See figure 1-13.) Fuel is supplied to the engine from the forward fuselage tank by electric booster pumps. On F-86L-11 through F-86L-41 Airplanes, the afterburner fuel pump is mounted on the underside of the dual booster pump flange, under the center wing fuel cell. On F-86L-45 and later airplanes, the afterburner fuel pump is tank-mounted with its own integral boost pump unit and supplies enough afterburner fuel without using the other existing booster pumps for afterburner operation. The forward fuselage tank consists of two cells. The lower one, in the wing center section, receives fuel by gravity feed from the upper cell and from the outer wing tanks. Fuel is transferred from the aft fuselage tank to the forward fuselage tank (lower cell) under pressure by an electric transfer pump that operates automatically when the fuel quantity in the forward tank drops below a preset value. Fuel transfer is made when about 30 gallons has been consumed from the forward fuselage tank. If drop tanks are carried, aft fuselage tank fuel transfer is made after all the drop tank fuel is consumed. The transfer pump is powered by monitored bus No. 2 and automatically operates at a higher speed during afterburner operation. Also fuel flow to the engine is obtainable from the forward fuselage tank and from the aft fuselage tank by suction flow, if the electric booster pumps fail. There are individual filler points for each tank. Also, a single-point refueling nozzle receptacle and line system are provided. The nozzle receptacle is in the left side of the fuselage, next to the aft fuselage fuel tank. Single-point refueling time is about 3 minutes. The refueling equipment should be capable of delivering fuel at the rate of about 200 gpm with a refueling nozzle pressure of 50 (±5) psi (50 psi is recommended for maximum filling). If a nozzle pressure of less than 40 psi is used, incomplete filling of the system will result, and a nozzle pressure greater than 60 psi may be detrimental to the equipment. The refueling flow is automatically shut off when the airplane system is full; this is shown by a rise on the nozzle pressure gage and a zero flow indication. When the airplane is refueled by means of the individual filler points, the forward fuselage tank must be filled first in order to use full fuel capacity; if the wing tanks or aft fuselage tank is filled first, fuel from these tanks will drain into the forward fuselage tank lower cell while the forward fuselage tank is being serviced. (See figure

AIRPLANE FUEL SYSTEM

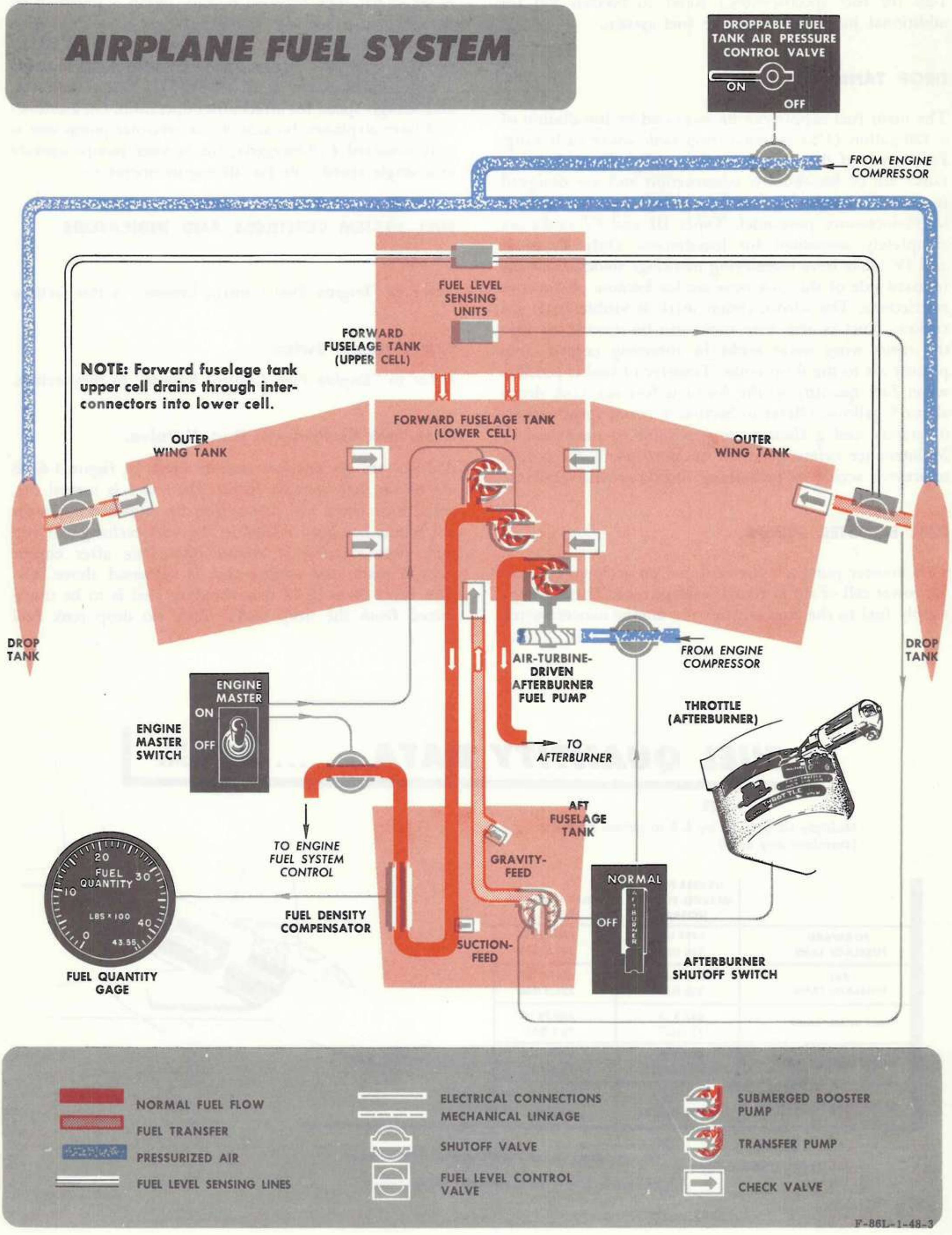


Figure 1-13

1-29 for fuel specification.) Refer to Section VII for additional information on the fuel system.

DROP TANKS.

The main fuel supply can be increased by installation of a 120-gallon (US) external drop tank under each wing. Four types of drop tanks can be carried. Types I and II tanks are of knockdown construction and are designed so that final assembly can be accomplished in the field by maintenance personnel. Types III and IV tanks are completely assembled for installation. Only Types II and IV tanks have identifying markings stenciled on the inboard side of the tank nose section because of the tank restrictions. The identification mark is visible from the cockpit. Fuel in the drop tanks can be transferred into the main wing outer tanks by directing engine compressor air to the drop tanks. Transfer of fuel is possible when fuel quantity in the forward fuselage tank drops about 5 gallons. (Refer to Section V for airspeed center-of-gravity and g limitations applicable to drop tanks.) Maintenance safety pins can be installed in the pylons to prevent accidental jettisoning during ground servicing.

FUEL BOOSTER PUMPS.

Two booster pumps, a forward and an aft pump, are in the lower cell of the forward fuselage tank. These pumps supply fuel to the engine when the engine master switch is set at ON. The forward booster pump is powered by the monitored bus No. 2, while the aft booster pump is powered by primary bus. (See figure 1-13.) On F-86L-11 through F-86L-41 Airplanes, the booster pumps operate at two speeds: at low speed for Military Thrust or lower, and at high speed for afterburner operation. On F-86L-45 and later airplanes, because the afterburner pump unit is tank-mounted (submerged), the booster pumps operate at a single speed only for all engine operation.

FUEL SYSTEM CONTROLS AND INDICATORS.

Throttle.

Refer to "Engine Fuel Control System" in this section.

Engine Master Switch.

Refer to "Engine Fuel Control System" in this section.

Drop Tank Air Pressure Shutoff Valve.

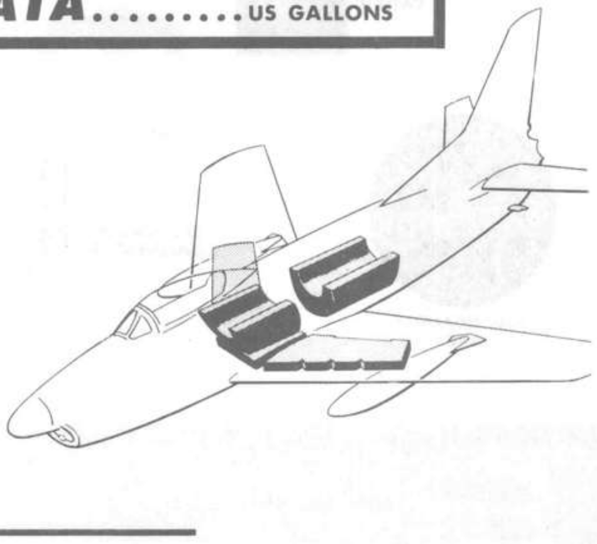
A drop tank air pressure shutoff valve (1, figure 1-6) is aft of the left console. When the valve is turned ON, both drop tanks are pressurized by engine compressor air, which has been cooled in the heat exchanger. Drop tank pressurization is almost immediate after engine start is made and engine rpm is increased above idle. The valve must be at ON whenever fuel is to be transferred from the drop tanks. Since no drop tank fuel

FUEL QUANTITY DATA........ POUNDS OR US GALLONS

NOTE

Multiply US gallons by 6.5 to obtain pounds (standard day only).

	USABLE FUEL IN LEVEL FLIGHT (TOTAL)	FULLY SERVICED (TOTAL)
FORWARD FUSELAGE TANK	1495 LB 230 GAL	1504.75 LB 231.5 GAL
AFT FUSELAGE TANK	1495 LB 230 GAL	1501.5 LB 231.0 GAL
LEFT WING TANK	487.5 LB 75 GAL	490.75 LB 75.5 GAL
RIGHT WING TANK	487.5 LB 75 GAL	490.75 LB 75.5 GAL
DROP TANKS (TWO)	1560 LB 240 GAL	1560 LB 240 GAL



TOTAL USABLE FUEL
Without drop tanks 3965 pounds, 610 gallons.
With drop tanks 5525 pounds, 850 gallons.

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Figure 1-14

quantity gage is provided, fuel transfer from the drop tanks during operation at high-altitude cruise is shown by a constant airplane fuel quantity gage reading during the transfer. The fuel quantity gage shows about full during the transfer. During afterburner operation (high fuel consumption rate), fuel transfer from the drop tanks may be insufficient to maintain a constant reading on the fuel quantity gage. In this case, fuel transfer is indicated by a relatively low rate of fuel quantity reduction. The valve should be set at ON at all times in flight, when drop tanks are installed, to prevent possible drop tank collapse during rapid descents. Uneven feeding from the drop tanks does not affect the flying qualities of the airplane.

Drop Tank Jettison Button.

Tanks can be jettisoned by pressing the drop tank jettison button on the engine control panel. (See figure 1-4.) Power for jettisoning the tanks is supplied by the battery bus.

WARNING

To prevent accidental explosion of drop tanks while on ground, they must not be installed, removed, or given an operational drop test (either manually or electrically) unless the airplane and drop tanks are electrostatically grounded.

Drop Tank Emergency Jettison Handle.

A manual drop tank emergency jettison handle (36, figure 1-5), located below and to the left of the radarscope, provides a means of jettisoning the drop tanks if the electrical system fails. When the handle is pulled to full extension, about 3 inches, the emergency jettison system releases the drop tanks; when the handle is released, it returns to its normal position.

Fuel Quantity Gage.

A fuel quantity gage (29, figure 1-5) is on the lower right side of the instrument panel. It shows total actual pounds of internal fuel regardless of temperature or type of fuel. The fuel quantity gage is powered from the ac bus of the airplane. No fuel quantity gage is provided for the drop tanks. Any abnormal fuel sequencing will not affect the fuel quantity indication.

Fuel Quantity Gage Test Switch.

A push-button switch (30, figure 1-5) on the instrument panel is provided to test the fuel quantity indicating system for proper operation. Pressing the test switch should cause the indicator needle to rotate counterclockwise. Upon release of the test button, the needle should return to its former position. Failure of the needle to respond shows a faulty indicating system.

ELECTRICAL POWER SUPPLY SYSTEM.

Electrical energy in this airplane is supplied through a 28-volt, direct-current system powered by two 400-ampere, engine-driven generators. (See figure 1-15.) One of the two generators is a combination starter-generator unit, acting as a starter up to about 23% rpm, and thereafter acting as a generator when engine rpm reaches about 37%. Two 24-volt, 24-ampere-hour storage batteries serve as a stand-by to supply current to the essential units if both generators fail. All ac operated equipment (except radar) is powered by a main inverter (single-phase). Power for the radar equipment is supplied by a secondary inverter (single-phase) and a single-phase engine-driven alternator. The secondary inverter supplies the radar with a regulated frequency and disconnects from the radar and assumes the ac load of the airplane when the inverter selector switch is positioned at SPARE. The alternator supplies the radar with an unregulated frequency. Loss of the unregulated frequency causes the radar to function improperly. Three-phase power is provided for the automatic pilot, attitude indicator, yaw damper, and directional indicator by four power converters which are normally powered by the main inverter.

ELECTRICALLY OPERATED EQUIPMENT.

See figure 1-15.

CAUTION

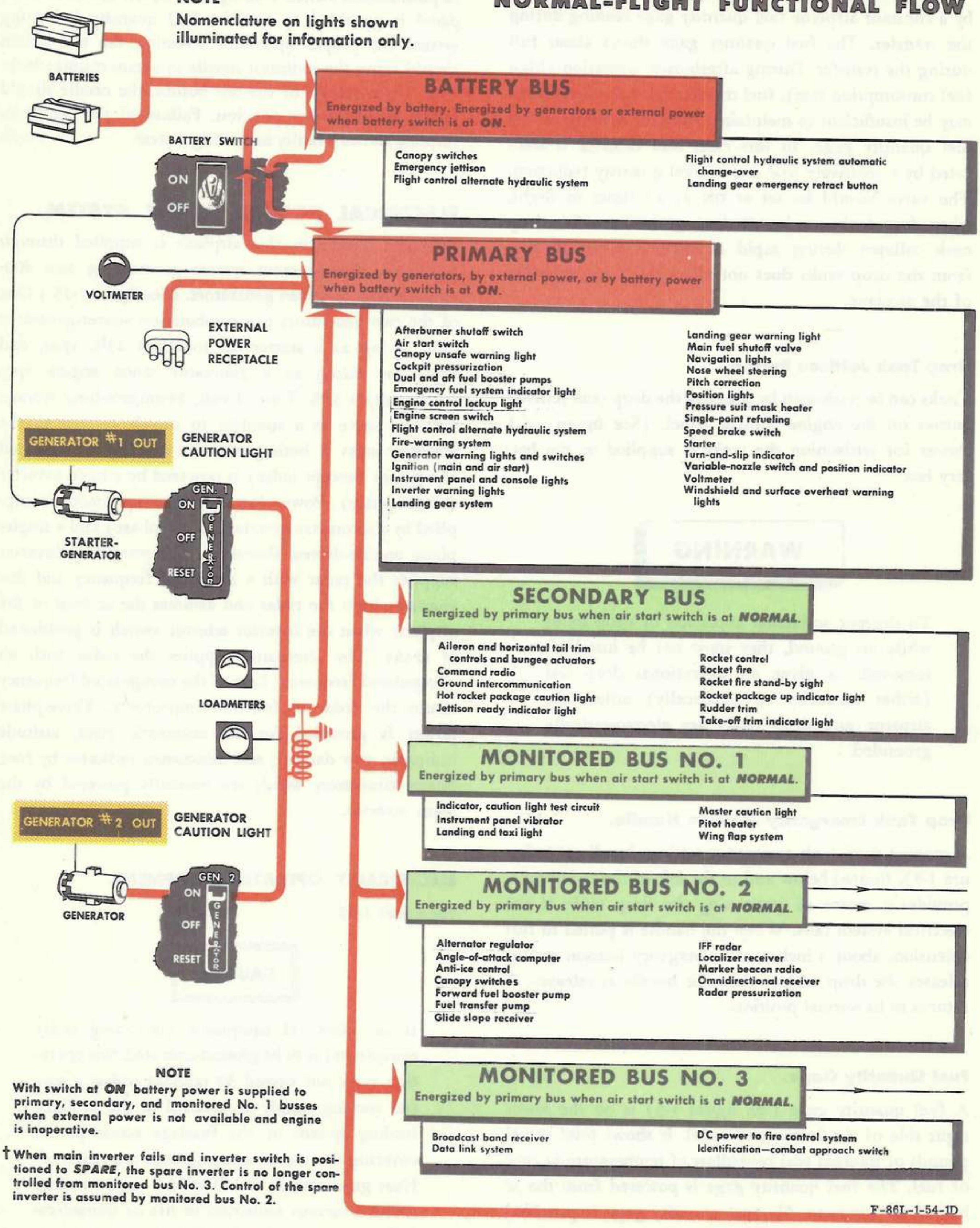
If the electrical equipment (including radar equipment) is to be ground-operated, this operation must not exceed 30 minutes unless a special cooling supply is attached to the in-flight cooling system or the fuselage access panels covering the electrical equipment are removed. Heat generated in the electrical compartments causes a serious reduction in life or immediate failure of equipment if adequate ventilation is not provided.

ELECTRICAL POWER

NORMAL-FLIGHT FUNCTIONAL FLOW

NOTE

Nomenclature on lights shown illuminated for information only.



BATTERY BUS

Energized by battery. Energized by generators or external power when battery switch is at **ON**.

- Canopy switches
- Emergency jettison
- Flight control alternate hydraulic system
- Flight control hydraulic system automatic change-over
- Landing gear emergency retract button

PRIMARY BUS

Energized by generators, by external power, or by battery power when battery switch is at **ON**.

- Afterburner shutoff switch
- Air start switch
- Canopy unsafe warning light
- Cockpit pressurization
- Dual and aft fuel booster pumps
- Emergency fuel system indicator light
- Engine control lockup light
- Engine screen switch
- Flight control alternate hydraulic system
- Fire-warning system
- Generator warning lights and switches
- Ignition (main and air start)
- Instrument panel and console lights
- Inverter warning lights
- Landing gear system
- Landing gear warning light
- Main fuel shutoff valve
- Navigation lights
- Nose wheel steering
- Pitch correction
- Position lights
- Pressure suit mask heater
- Single-point refueling
- Speed brake switch
- Starter
- Turn-and-slip indicator
- Variable-nozzle switch and position indicator
- Voltmeter
- Windshield and surface overheat warning lights

SECONDARY BUS

Energized by primary bus when air start switch is at ***NORMAL***.

- Aileron and horizontal tail trim controls and bungee actuators
- Command radio
- Ground intercommunication
- Hot rocket package caution light
- Jettison ready indicator light
- Rocket control
- Rocket fire
- Rocket fire stand-by sight
- Rocket package up indicator light
- Rudder trim
- Take-off trim indicator light

MONITORED BUS NO. 1

Energized by primary bus when air start switch is at ***NORMAL***.

- Indicator, caution light test circuit
- Instrument panel vibrator
- Landing and taxi light
- Master caution light
- Pitot heater
- Wing flap system

MONITORED BUS NO. 2

Energized by primary bus when air start switch is at ***NORMAL***.

- Alternator regulator
- Angle-of-attack computer
- Anti-ice control
- Canopy switches
- Forward fuel booster pump
- Fuel transfer pump
- Glide slope receiver
- IFF radar
- Localizer receiver
- Marker beacon radio
- Omnidirectional receiver
- Radar pressurization

MONITORED BUS NO. 3

Energized by primary bus when air start switch is at ***NORMAL***.

- Broadcast band receiver
- Data link system
- DC power to fire control system
- Identification—combat approach switch

NOTE

With switch at *ON* battery power is supplied to primary, secondary, and monitored No. 1 busses when external power is not available and engine is inoperative.

† When main inverter fails and inverter switch is positioned to *SPARE*, the spare inverter is no longer controlled from monitored bus No. 3. Control of the spare inverter is assumed by monitored bus No. 2.

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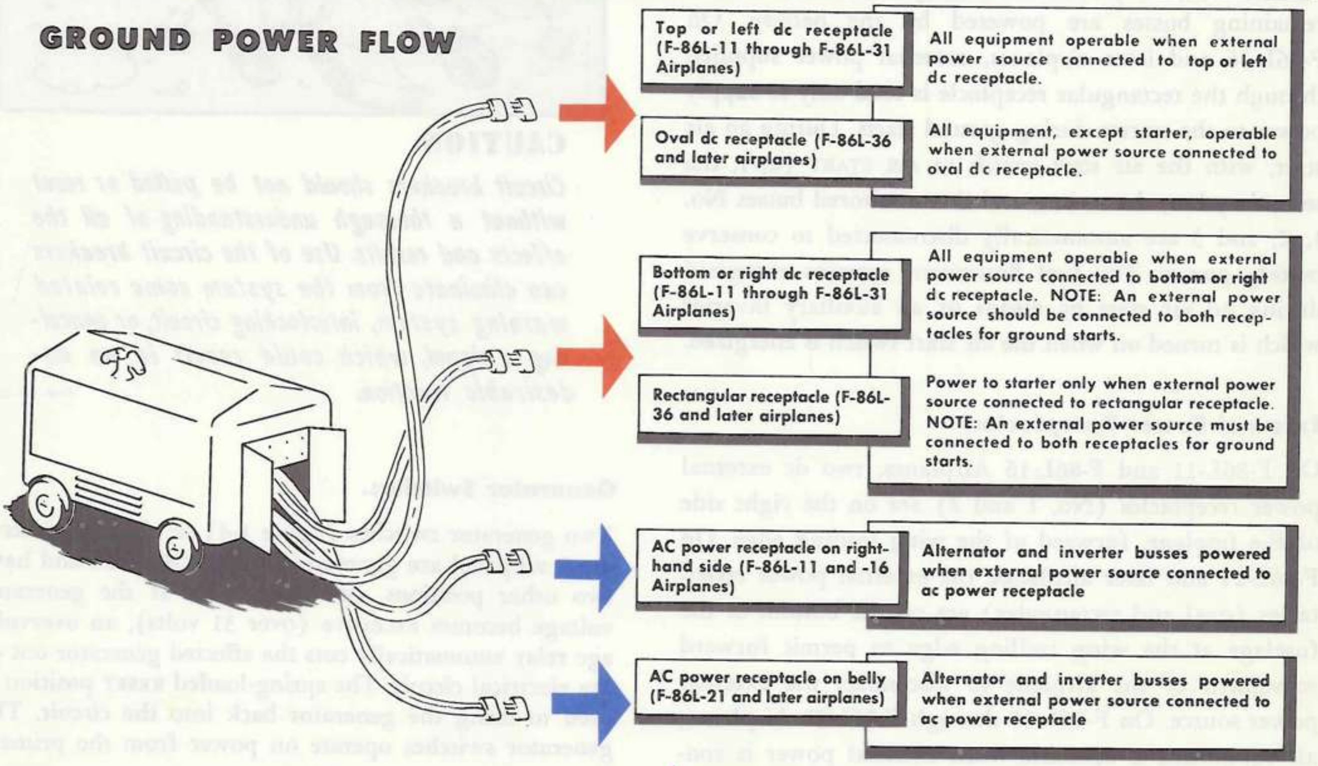
Figure 1-15

DISTRIBUTION

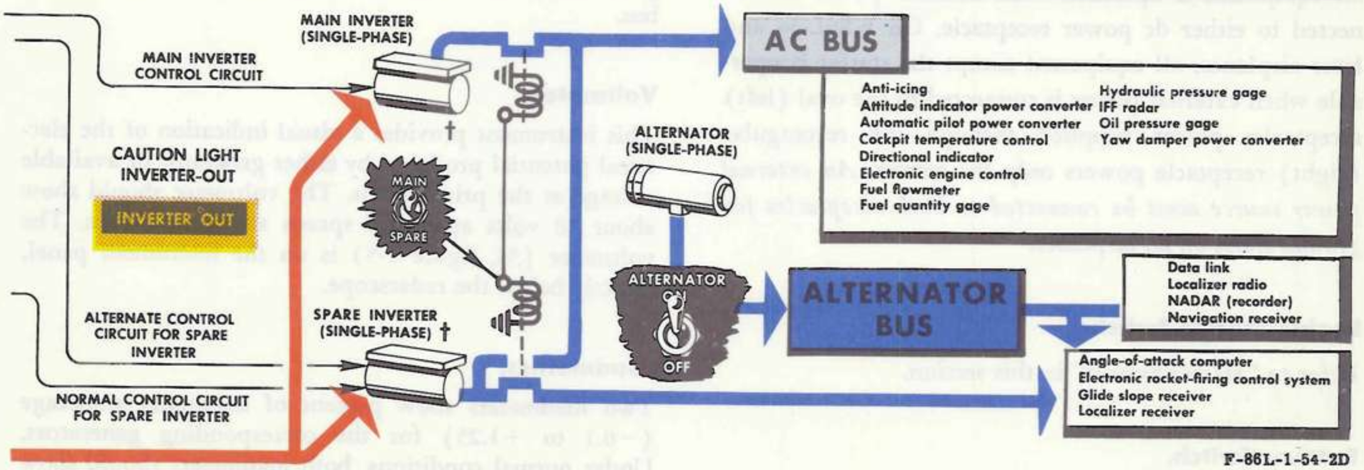
FLIGHT EMERGENCIES

EMERGENCY CONDITIONS	AIR START SWITCH AT *AIR START* (UP)	BOTH GENERATORS INOPERATIVE	ONE GENERATOR INOPERATIVE	BOTH INVERTERS INOPERATIVE	MAIN INVERTER INOPERATIVE (SPARE INVERTER MUST BE MANUALLY SELECTED.)
COLORED BUSSES OPERATIVE	🟥 BATTERY BUS	🟥 BATTERY BUS	🟥 BATTERY BUS	🟥 BATTERY BUS	🟥 BATTERY BUS
	🟥 PRIMARY BUS	🟥 PRIMARY BUS	🟥 PRIMARY BUS	🟥 PRIMARY BUS	🟥 PRIMARY BUS
	SECONDARY BUS	🟩 SECONDARY BUS	🟩 SECONDARY BUS	🟩 SECONDARY BUS	🟩 SECONDARY BUS
	MONITORED BUS NO. 1	🟩 MONITORED BUS NO. 1	🟩 MONITORED BUS NO. 1	🟩 MONITORED BUS NO. 1	🟩 MONITORED BUS NO. 1
	MONITORED BUS NO. 2	MONITORED BUS NO. 2	🟩 MONITORED BUS NO. 2	🟩 MONITORED BUS NO. 2	🟩 MONITORED BUS NO. 2
	MONITORED BUS NO. 3	MONITORED BUS NO. 3	MONITORED BUS NO. 3	🟩 MONITORED BUS NO. 3	🟩 MONITORED BUS NO. 3
	AC BUS	AC BUS	🟦 AC BUS	AC BUS	🟦 AC BUS

GROUND POWER FLOW



Top or left dc receptacle (F-86L-11 through F-86L-31 Airplanes)	All equipment operable when external power source connected to top or left dc receptacle.
Oval dc receptacle (F-86L-36 and later airplanes)	All equipment, except starter, operable when external power source connected to oval dc receptacle.
Bottom or right dc receptacle (F-86L-11 through F-86L-31 Airplanes)	All equipment operable when external power source connected to bottom or right dc receptacle. NOTE: An external power source should be connected to both receptacles for ground starts.
Rectangular receptacle (F-86L-36 and later airplanes)	Power to starter only when external power source connected to rectangular receptacle. NOTE: An external power source must be connected to both receptacles for ground starts.
AC power receptacle on right-hand side (F-86L-11 and -16 Airplanes)	Alternator and inverter busses powered when external power source connected to ac power receptacle
AC power receptacle on belly (F-86L-21 and later airplanes)	Alternator and inverter busses powered when external power source connected to ac power receptacle



AC BUS:

Anti-icing	Hydraulic pressure gage
Attitude indicator power converter	IFF radar
Automatic pilot power converter	Oil pressure gage
Cockpit temperature control	Yaw damper power converter
Directional indicator	
Electronic engine control	
Fuel flowmeter	
Fuel quantity gage	

ALTERNATOR BUS:

Data link
Localizer radio
NADAR (recorder)
Navigation receiver

Angle-of-attack computer
Electronic rocket-firing control system
Glide slope receiver
Localizer receiver

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DC ELECTRICAL POWER DISTRIBUTION.

The electrical power necessary for operation of the electrical units in the airplane is distributed by a group of six dc busses and two ac busses: a battery bus, a primary bus, a secondary bus, monitored busses No. 1, 2, and 3, an inverter bus, and an alternator bus. The battery bus is hot at all times, so that essential equipment, from the battery bus, is operable regardless of the position of the battery switch. On F-86L-11 through F-86L-31 Airplanes, when external power is supplied through either dc receptacle (oval receptacle on F-86L-36 and later airplanes) or when both generators are operating, all busses are energized through the primary bus. If one generator fails, monitored bus No. 3 is disconnected from the system. If both generators fail, monitored busses No. 2 and 3 are disconnected, and, with the battery switch at ON, the remaining busses are powered by the battery. On F-86L-36 and later airplanes, external power supplied through the rectangular receptacle is used only to supply power to the starter during ground starts. During an air start, with the air start switch in AIR START (up), the secondary bus, the ac bus, and the monitored busses No. 1, 2, and 3 are automatically disconnected to conserve battery power. The fuel flowmeter, remains energized during an air start by means of an auxiliary inverter which is turned on when the air start switch is energized.

External Power Receptacles.

On F-86L-11 and F-86L-16 Airplanes, two dc external power receptacles (No. 1 and 2) are on the right side of the fuselage, forward of the wing leading edge. On F-86L-21 and later airplanes, the external power receptacles (oval and rectangular) are on the bottom of the fuselage at the wing trailing edge to permit forward movement of the airplane to disconnect the external power source. On F-86L-11 through F-86L-31 Airplanes, all equipment is operable when external power is connected to either dc power receptacle. On F-86L-36 and later airplanes, all equipment except the starter is operable when external power is connected to the oval (left) receptacle; power supplied through the rectangular (right) receptacle powers only the starter. *An external power source must be connected to both receptacles for ground starts on all airplanes.*

Engine Starter Switch.

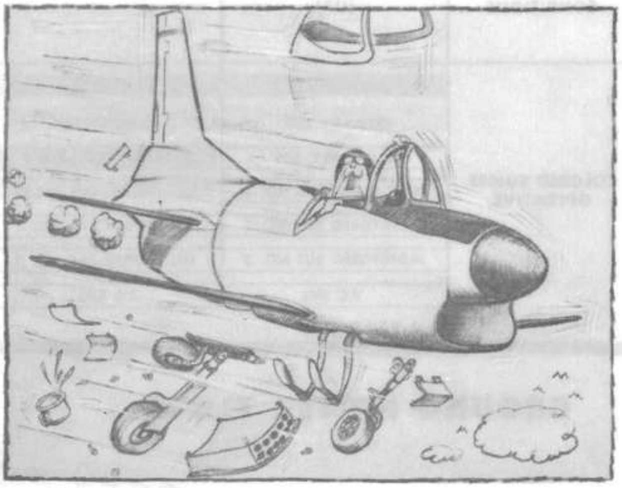
Refer to "Starter System" in this section.

Battery Switch.

Refer to "Starter System" in this section.

Circuit Breakers.

Most of the dc electrical circuits are protected by push-pull circuit breakers on panels on each side of the cockpit.



CAUTION

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

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Generator Switches.

Two generator switches (figure 1-4) on the right instrument subpanel are guarded in the ON position and have two other positions, OFF and RESET. If the generator voltage becomes excessive (over 31 volts), an overvoltage relay automatically cuts the affected generator out of the electrical circuit. The spring-loaded RESET position is used to bring the generator back into the circuit. The generator switches operate on power from the primary bus.

Voltmeter.

This instrument provides a visual indication of the electrical potential produced by either generator or available voltage at the primary bus. The voltmeter should show about 28 volts at engine speeds above 37% rpm. The voltmeter (34, figure 1-5) is on the instrument panel, directly below the radarscope.

Loadmeters.

Two loadmeters show percent of maximum amperage (−0.1 to +1.25) for the corresponding generators. Under normal conditions, both loadmeters should show about the same value (about +0.6). Both generator loadmeters (33, figure 1-5) are on the instrument panel, below the radarscope.

Generator Caution Lights.

Two amber generator caution lights (figure 1-25) illuminate to show that the respective generator has failed or has been disconnected because of overvoltage. Both lights are powered by the primary bus and come on during air starts. The placard-type indicator light for each generator on the caution light panel, displays "GENERATOR #1 OUT" and "GENERATOR #2 OUT" when illuminated.

AC ELECTRICAL POWER DISTRIBUTION.

The ac electrical power is distributed to the ac electrical equipment throughout the airplane by two busses: the ac bus and the alternator bus. The ac bus is powered by the main single-phase inverter and supplies power to all ac operated equipment except the radar. Power to the radar equipment is supplied by the secondary single-phase inverter and by an engine-driven alternator. Both inverters are powered by the primary bus. Control of the main inverter is powered from monitored bus No. 2; the main inverter will be cut out if power from monitored bus No. 2 is not available. Likewise, control of the secondary inverter is powered from monitored bus No. 3; the secondary inverter will not operate if monitored-bus No. 3 fails. If the main inverter fails during any flight with only one generator operating (monitored bus No. 3 and secondary inverter rendered inoperative), control of the secondary inverter must be manually transferred from monitored bus No. 3 to monitored bus No. 2. When the change-over is completed, the secondary inverter takes over the main inverter load when selected. The alternator bus supplies the radar with unregulated frequency.

Alternator.

For unregulated frequency ac power for the radar, an 8-kilovolt-ampere, 115-volt, single-phase alternator is provided. The alternator is engine-driven and connected directly to the radar. The radar itself has a means of preventing damage by overvoltage supply from the alternator. The alternator bus is supplied on the ground by a separate ac external power receptacle. The external power supply cannot be paralleled with the engine-driven alternator supply. The alternator voltage regulator is controlled by power from monitored bus No. 2.

AC External Power Receptacles.

A single receptacle for the connection of ac ground power is used to allow external inverter power and alternator power to be supplied for ground operational purposes only. On F-86L-11 and F-86L-16 Airplanes, the receptacle is on the right side of the fuselage, forward of the wing, and just below the two external dc power receptacles. On F-86L-21 and later airplanes, the receptacle is on the belly, just forward of the fuselage break point and between the two dc external power receptacles. (See figure 1-16.) External alternator power may be supplied, when the engine is not running, to provide power for ground operation of the radar; the power is furnished between 380 and 770 cycles per second. The airplane inverters are disconnected when the external power source is connected and the engine master switch is OFF, allowing for extended ground operation and to provide alert power for those units requiring ac power. If the engine master switch is ON, the external power source is automatically disconnected. To prevent damage to the plug connection when it is being disconnected, the engine master switch should be turned ON before the plug is removed.

AC Fuses.

Most of the ac circuits are protected by fuses which are replaceable in flight. The fuses are grouped together on panels on each side of the cockpit. One group is on the panel next to the throttle; the other group is on the aft end of the right console.

Inverter Selector Switch.

The inverter selector switch (figure 1-4) is used for manually selecting the main or spare inverter as power sources for the ac operated equipment. The switch has two fixed positions: MAIN, which is the position for all normal operation; and SPARE, for manually selecting the spare inverter as a power source if the main inverter fails. Normally, the main inverter supplies power for all ac operated equipment except radar, which is supplied by the secondary inverter and alternator. If the main inverter fails, the inverter selector switch must be placed at SPARE, causing the spare inverter to drop the radar equipment, and allowing spare inverter power to become available for the ac-operated equipment.

Alternator Switch.

A two-position switch for control of the alternator is located on the right instrument subpanel. (See figure 1-4.) When the switch is in the ON position, the alternator bus is provided with ac voltage from the engine-driven alternator or from an external power source. When an external source is supplying power to the alternator bus, it alone supplies the power until disconnected. The switch is powered by the monitored Bus No. 3 and should be ON at all times unless an alternator failure is shown by failure of the radarscope picture.

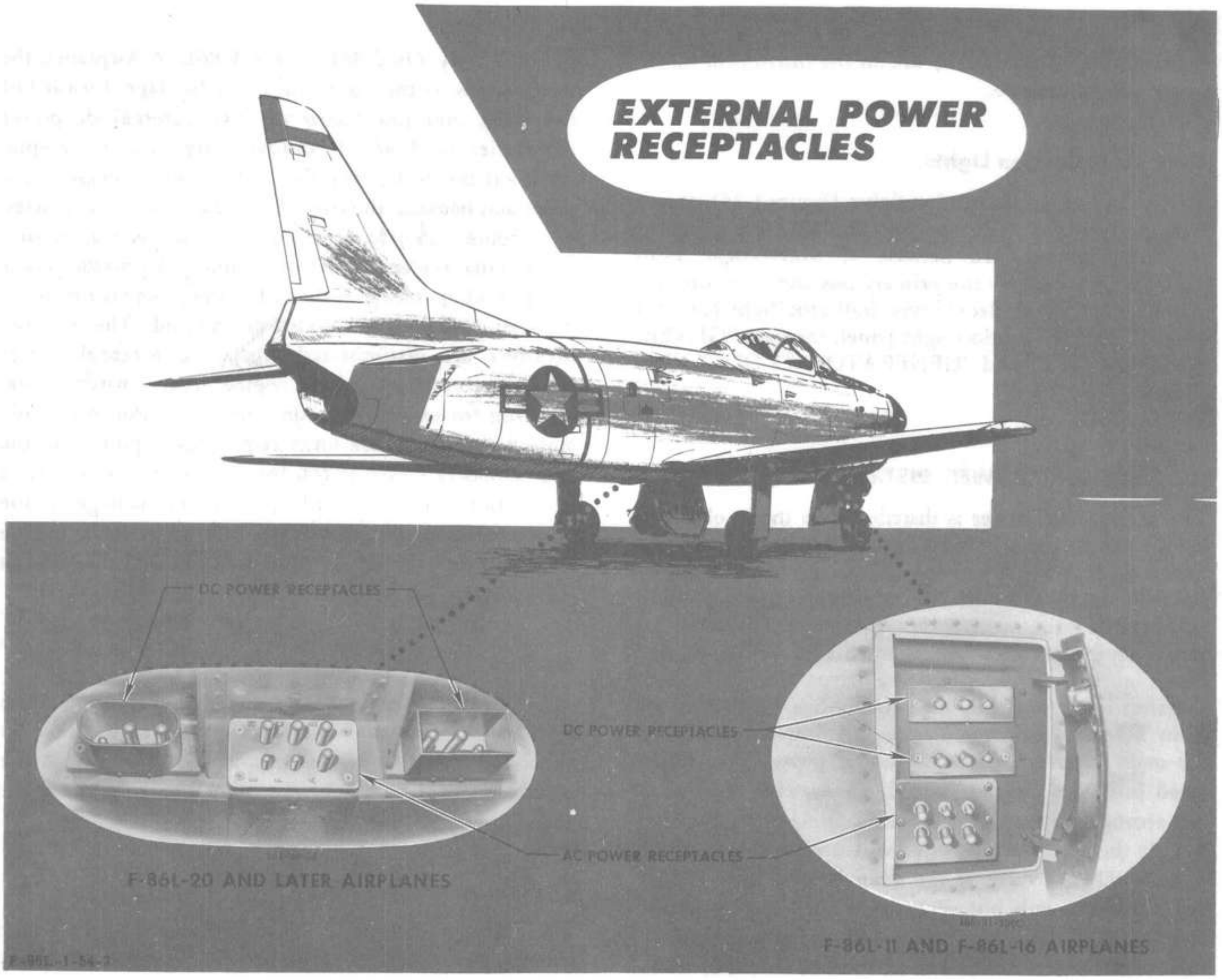


Figure 1-16

Inverter-out Caution Light.

Inverter failure is indicated by the illumination of a placard-type caution light on the caution light panel on the right console. (See figure 1-25.) When the light is lit, it shows "INVERTER OUT" and is amber in color. When this light comes on, the spare inverter should be selected by moving the inverter selector switch to the SPARE position. If the light remains on when the switch is placed at either the MAIN or SPARE position, both inverters have failed. The light is powered by the primary bus.

Note

The electronic engine controls will automatically lock up when an ac power failure occurs.

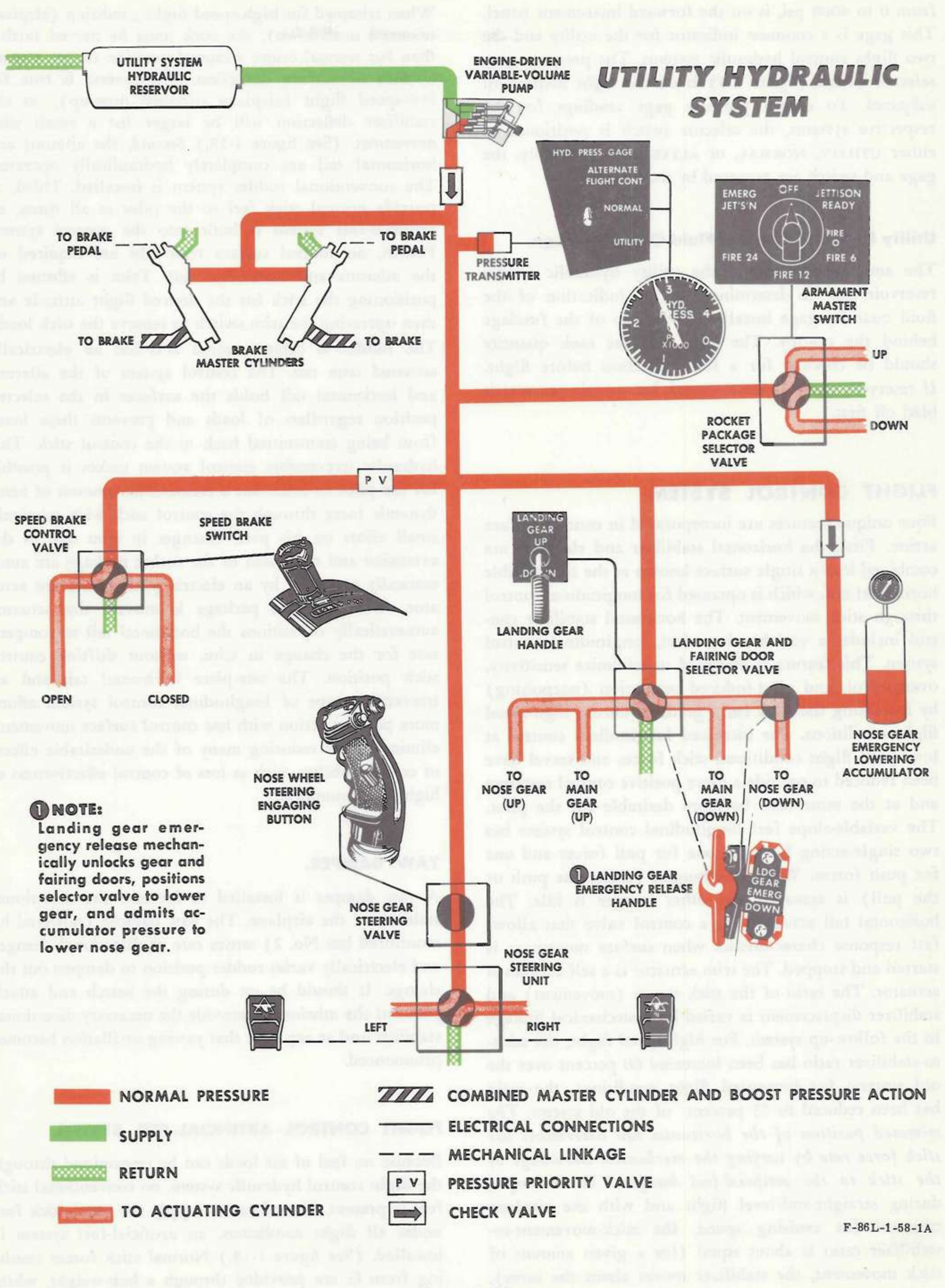
UTILITY HYDRAULIC POWER SUPPLY SYSTEM.

The utility hydraulic power supply system is a closed-center, constant-pressure type system with an engine-driven, variable-output pump. (See figure 1-17.) This system is completely independent of the flight control hydraulic systems. A pressure storage accumulator is provided for nose gear emergency extension. This system supplies hydraulic power for operation of the landing gear, speed brakes, nose wheel steering, wheel brakes, and rocket package operation. (See figure 1-29 for hydraulic fluid specification.)

UTILITY HYDRAULIC SYSTEM INDICATORS.

Hydraulic Pressure Gage and Pressure Gage Selector Switch.

The hydraulic pressure gage (26, figure 1-5), calibrated



① NOTE:
Landing gear emergency release mechanically unlocks gear and fairing doors, positions selector valve to lower gear, and admits accumulator pressure to lower nose gear.

Figure 1-17

from 0 to 4000 psi, is on the forward instrument panel. This gage is a common indicator for the utility and the two flight control hydraulic systems. The pressure gage selector switch (figure 1-4) is on the right instrument subpanel. To obtain pressure gage readings for the respective systems, the selector switch is positioned at either UTILITY, NORMAL, or ALTERNATE. Normally, the gage and switch are powered by the ac bus.

Utility Hydraulic System Fluid Quantity Gage.

The amount of fluid in the utility hydraulic system reservoir can be determined by the indication of the fluid quantity gage installed in the top of the fuselage behind the canopy. The gage and the tank quantity should be checked for a full indication before flight. If reservoir cap is to be removed, be sure air pressure is bled off first.

FLIGHT CONTROL SYSTEM.

Four unique features are incorporated in control surface action. First, the horizontal stabilizer and elevators are combined into a single surface known as the controllable horizontal tail, which is operated for longitudinal control through stick movement. The horizontal stabilizer control includes a variable-slope feel, longitudinal control system. This feature is designed to minimize sensitivity, overcontrol, and pilot-induced oscillation (porpoising) by increasing the stick force gradient during high-speed flight conditions. For increased longitudinal control at low-speed flight conditions, stick forces and travel have been reduced to provide a more positive control response and at the same time be more desirable for the pilot. The variable-slope feel longitudinal control system has two single-acting bungees, one for pull forces and one for push forces. When one bungee (either the push or the pull) is actuated, the other bungee is idle. The horizontal tail actuator has a control valve that allows fast response characteristics when surface movement is started and stopped. The trim actuator is a self-contained actuator. The ratio of the stick throw (movement) and stabilizer displacement is varied by a mechanical linkage in the follow-up system. For high-speed flight, the stick-to-stabilizer ratio has been increased 60 percent over the old system; for low-speed flight conditions, the ratio has been reduced to 75 percent of the old system. *The trimmed position of the horizontal tail determines the stick force rate by varying the mechanical advantage of the stick to the artificial-feel bungees.* For example, during straight-and-level flight and with the airplane trimmed for cruising speed, the stick-movement-to-stabilizer ratio is about equal (for a given amount of stick movement, the stabilizer moves about the same). When trimmed for high-speed flight condition (airplane trimmed nose-down), the stick must be moved farther than for normal cruise trimmed position to get a small amount of surface deflection. The reverse is true for low-speed flight (airplane trimmed nose-up), as the stabilizer deflection will be larger for a small stick movement. (See figure 1-18.) Second, the ailerons and horizontal tail are completely hydraulically operated. The conventional rudder system is installed. Third, to provide normal stick feel to the pilot at all times, an artificial-feel system is built into the control system. Fourth, no control surface trim tabs are required on the ailerons and horizontal tail. Trim is effected by positioning the stick for the desired flight attitude and then operating the trim switch to remove the stick loads. The rudder is cable-operated and has an electrically actuated trim tab. The control system of the ailerons and horizontal tail holds the surfaces in the selected position regardless of loads and prevents these loads from being transmitted back to the control stick. This hydraulic irreversible control system makes it possible for the pilot to overcome a tremendous amount of aerodynamic force through the control stick with relatively small effort on his part. Changes in trim due to the extension and retraction of the rocket package are automatically corrected by an electric pitch correction actuator. Whenever the package is moved, the actuator automatically repositions the horizontal tail to compensate for the change in trim, without shifting control stick position. The one-piece horizontal tail and an irreversible type of longitudinal control system afford more positive action with less control surface movement, eliminating or reducing many of the undesirable effects of compressibility, such as loss of control effectiveness at high Mach numbers.

YAW DAMPER.

A yaw damper is installed to increase the directional stability of the airplane. The yaw damper (powered by monitored bus No. 2) senses rate of directional changes and electrically varies rudder position to dampen out the change. It should be on during the search and attack phase of the mission, to provide the necessary directional stability, and at any time that yawing oscillation becomes pronounced.

FLIGHT CONTROL ARTIFICIAL-FEEL SYSTEM.

Because no feel of air loads can be transmitted through the flight control hydraulic system, no conventional stick feel is present. Therefore, to supply the usual stick feel under all flight conditions, an artificial-feel system is installed. (See figure 1-18.) Normal stick forces resulting from G are provided through a bob-weight, while

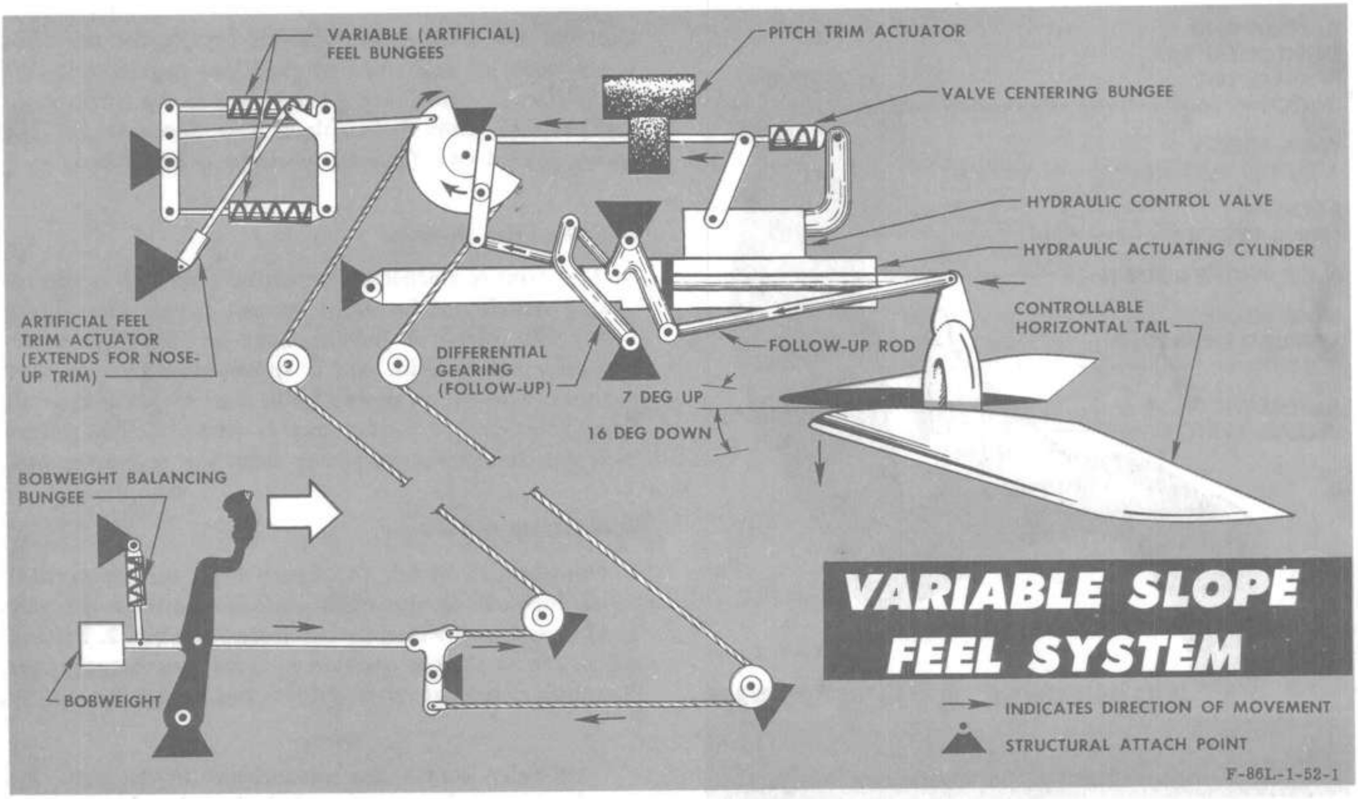


Figure 1-18

stick forces resulting from control surface air loads are simulated through spring bungees. The normal and alternate trim switches control the position of the bungees so that the control stick no-load position is changed and desired trim is obtained.

FLIGHT CONTROLS AND INDICATOR.

Control Stick.

The control stick grip (figure 1-19) has an aileron and horizontal tail normal trim switch, a camera and rocket-firing trigger, a nose wheel steering engaging button, a microphone button, a tank-rocket jettison button, and an automatic pilot release switch.

Rudder Pedals.

The angle of the rudder pedals is adjustable on the ground. The pedals can also be individually adjusted fore and aft by adjustment levers outboard of each pedal. When the lever is held out with the foot, the pedal can be moved to one of five neutral positions; the pedal position locks as selected when the lever is released.

Control Lock.

The control surfaces, except the rudder, are locked against external loads at all times because of the irreversible hydraulic system. The rudder lock handle (19, figure 1-6) is on the left aft console. When the handle is pulled up, a mechanical lock is set to engage when the rudder pedals are neutralized. To unlock the rudder, the lock handle is pivoted to release an incorporated catch, then pushed down.

CAUTION

> Do not twist the rudder lock handle. This could cause the locking system to function incorrectly.

Normal Trim Switch.

Normal trim of the horizontal tail or of the ailerons is provided through a five-position switch on top of control stick grip. (See figure 1-19.) This switch is powered by the secondary bus and is spring-loaded to the center position. Trim is effected by setting the stick for the desired flight attitude and then operating the normal trim switch to remove the stick loads. Holding the normal trim switch to either side causes the corresponding wing to be trimmed down. Holding the normal trim switch forward trims the airplane nose down; holding it aft trims the nose up. When the switch is

CONTROL STICK GRIP

Figure 1-19

released, it automatically returns to the center (OFF) position and trim action stops.

WARNING

- The normal trim switch is subject to sticking in any or all of the actuated positions, resulting in application of extreme trim. If this condition occurs during preflight check and the switch does not return automatically to the center (OFF) position, enter this fact in the Form 781 with a red cross and do not fly the airplane.
- If the normal trim switch sticks in any actuated position during flight, the switch must be returned manually to the center (OFF) position after the desired amount of trim is obtained.

Alternate Trim Switch.

A five-position toggle switch (figure 1-20), on the flight control panel, provides an alternate trim circuit for the ailerons and horizontal tail and is powered from the secondary bus. There are four marked positions. LEFT and RIGHT positions provide aileron trim for the corresponding wing. Placing the switch to LEFT position will trim the left wing down, and the reverse for the right wing. NOSE DN and NOSE UP positions provide trim for the horizontal tail. Placing the switch in the corresponding position trims the airplane nose down or up. The spring-loaded OFF (center) position is unmarked.

Rudder Trim Switch.

Rudder trim is electrically controlled through a spring-loaded switch on the flight control panel. (See figure 1-20.) The switch is held to LEFT or RIGHT for corresponding rudder trim and is spring-loaded to the OFF position. The switch should be in the OFF position at all times after desired rudder trim is obtained. The rudder trim switch receives its power from the secondary bus.

Yaw Damper Switch.

A two-position switch (1, figure 1-7), on the vertical panel forward of the right console, controls the yaw damper and is powered by monitored bus No. 2. Placing the switch in the ON position puts the yaw damper into operation if the automatic pilot is not engaged.

Note

To fully utilize the advantages of the yaw damper, it is recommended that the damper be turned on during climb-out and turned off during the before landing check.

Take-off (Trim) Position Indicator Light.

A placard-type indicator light (16, figure 1-6) shows when the ailerons, horizontal tail, and rudder are in take-off trim position. When the lights comes on, the words "TRIMMED FOR TAKE-OFF" is shown. The light is green and is powered by the secondary bus. It comes on when any one of the surfaces is trimmed to the take-off position and goes out when the trim switch is released to the OFF position. Aileron and rudder take-off trim positions are neutral; the horizontal tail take-off trim position is set for an airplane nose-up condition.

Note

- The take-off trim position indicator light does not come on when surfaces are being trimmed with the automatic pilot master switch ON.
- The take-off trim setting of the horizontal stabilizer is identified by a white triangle painted on the left side of the fuselage, just forward of the stabilizer. During preflight check of trim system, have ground crew check that leading edge of stabilizer is aligned with aft apex of triangle when take-off trim is obtained.

FLIGHT CONTROL HYDRAULIC SYSTEMS.

A constant-pressure hydraulic system supplies power for operation of ailerons and horizontal tail. (See figure

1-21.) An alternate constant-pressure hydraulic system is provided in case the normal system fails. Change-over from the normal to the alternate system is usually accomplished automatically when normal system pressure fails. A manual method of change-over, however, is provided by a control handle in the cockpit. A flight control switch is provided to test the alternate system

FLIGHT CONTROL PANEL

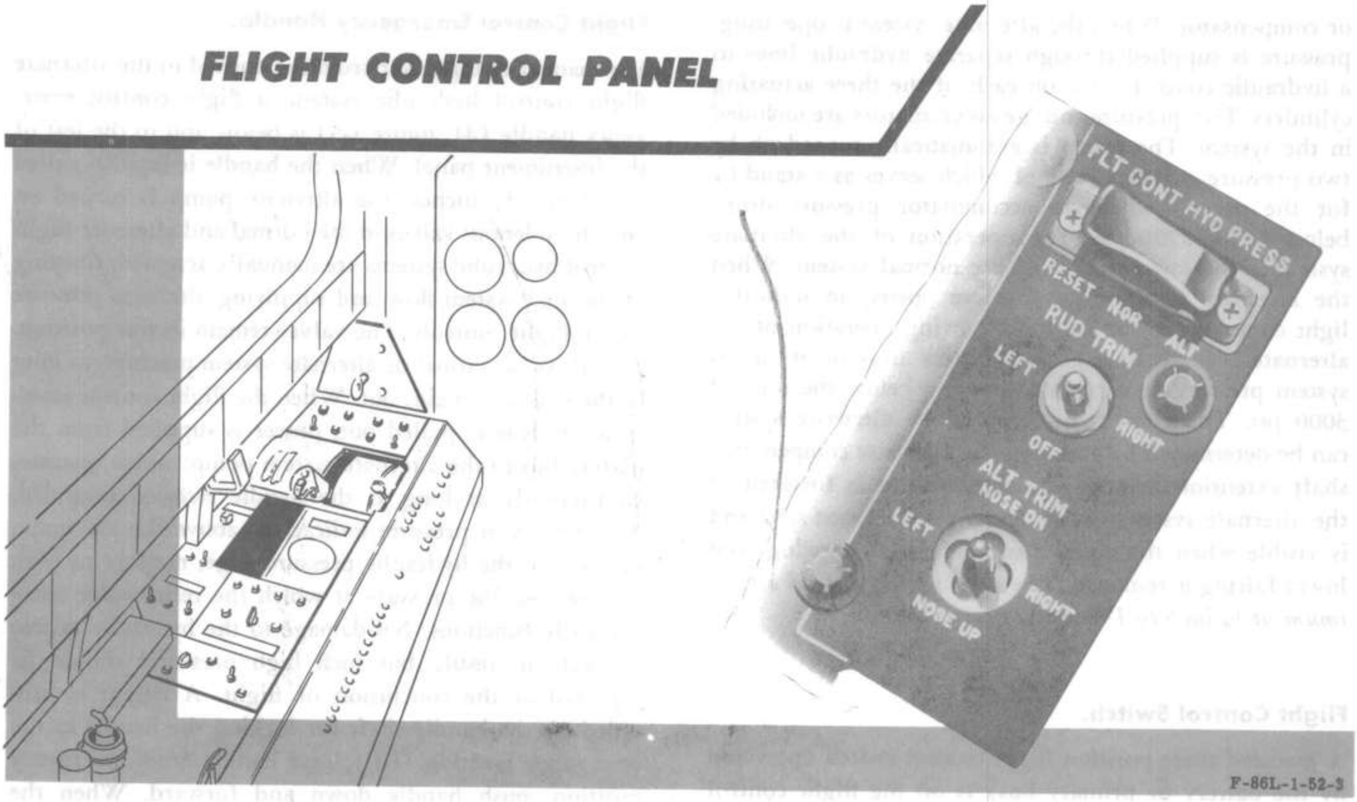


Figure 1-20

by simulating a failure of the normal system. When normal system pressure falls to about 650 psi, two pressure switches close (one of which serves as stand-by for the other), energizing two solenoid-operated shutoff valves. One valve shuts off the pressure supply in the normal system; the other opens to allow operation of the alternate system. However, if alternate system pressure is also below 650 psi, a second pair of pressure switches, in the alternate system lines, remain open; the circuits to the solenoid valves are not completed, and the valves remain in the positions to use normal system pressure. Therefore, automatic transfer to the alternate system is prevented if alternate pressure is below a usable amount. (See figure 1-29 for fluid specification.) Refer to "Hydraulic Systems" in Section VII for additional information.

Flight Control Normal Hydraulic System.

The system is pressurized by a variable-volume, engine-driven pump which receives fluid from the normal system reservoir or compensator. The pump is supplemented by an accumulator for instantaneous high rates of demand. The accumulator air pressure gage, behind the same access door as the oil filler point, should be checked before flight for about 650 psi air precharge when hydraulic pressure is depleted. The pressure is applied to three hydraulically operated dual actuating cylinders, one for the horizontal tail and one for each aileron. Each actuating cylinder is, in effect, two independent actuating cylinders and contains one normal and one alternate control valve. The normal and the alternate control valves on the actuating cylinder operate entirely independent of each other; malfunction or loss of fluid in one valve or cylinder will not affect operation of the other in any way. The amount of fluid in the system can be determined by the fluid quantity indicator pin which protrudes from the compensator. The pin is seen by removal of the access door just forward of the flight control normal hydraulic system filling point. The pin should protrude a minimum of ¼ inch to 1¼ inches maximum and should be checked before flight. Movement of the control stick, which is mechanically linked to the control valves, directs system pressure through the valves to the actuating cylinders, which cause movement of the corresponding control surface. As the control system for the ailerons is designed to hold against air loads up to the structural design limits of the airplane, and the control system for the horizontal tail is designed to hold against any amount of outside force, air loads on the control surfaces are not transmitted to the pilot through the control stick.

Flight Control Alternate Hydraulic System.

The system is pressurized by an electric-motor-driven pump, which receives fluid from an alternate reservoir or compensator. When the alternate system is operating, pressure is supplied through separate hydraulic lines to a hydraulic control valve on each of the three actuating cylinders. Two pressure storage accumulators are included in the system. The pump is automatically turned on by two pressure switches (one of which serves as a stand-by for the other) whenever accumulator pressure drops below about 2700 psi. The operation of the alternate system is the same as that of the normal system. When the alternate system shutoff valve opens, an indicator light comes on in the cockpit, showing operation of the alternate system. Rapid control stick movement causes system pressure to drop considerably below the normal 3000 psi. The amount of fluid in the alternate system can be determined by checking the alternate compensator shaft extension length. The compensator is forward of the alternate system accumulators on the front spar and is visible when the access panel at the right wing root lower fairing is removed. *The shaft should extend a minimum of 1/4 inch to 1 1/4 inches maximum.*

Flight Control Switch.

A guarded three-position flight control switch (powered by the battery or primary bus) is on the flight control panel (figure 1-20) aft of the throttle. It provides a selective means of changing from the normal to the alternate flight control hydraulic system for test purposes. The three positions are ALT, guarded NOR, and RESET. With the switch in the NOR position (engine running), the normal system supplies pressure to the flight controls, and the alternate system cuts in automatically should the normal system fail. With the switch in the NOR or ALT position, two solenoid valves are energized, shutting off normal system pressure and supplying alternate system pressure to the flight controls. If alternate system pressure is below 650 psi, however, the alternate system valve will not be energized even though the switch is at NOR or ALT. To return control to the normal system, the switch must be moved to the RESET position momentarily before it is returned to NOR. With the switch at RESET, the normal system shutoff valve is opened and the alternate system valve is closed. However, when the switch is moved from RESET to NOR if normal system pressure is below 650 psi, the valves automatically transfer again and the alternate system returns to operation. If the switch is positioned at NOR without first being moved to the RESET position, the alternate system continues to operate. Regardless of switch position, the normal system will not operate as long as the engine is not running. The alternate system may be checked without the engine running, by use of an external electrical power source; to check transfer of the normal system to the alternate system, the engine must be running or a ground hydraulic power source connected to the systems.

Flight Control Emergency Handle.

For manual change-over from the normal to the alternate flight control hydraulic system, a flight control emergency handle (41, figure 1-5) is below and to the left of the instrument panel. When the handle is rapidly pulled aft about 2½ inches, the alternate pump is turned on and the solenoid valves in the normal and alternate flight control hydraulic systems are manually actuated, shutting off normal system flow and supplying alternate pressure to the flight controls. The valves remain in this position, regardless of normal or alternate system pressure, as long as the handle remains out. When the flight control emergency handle is pulled out, power is supplied from the battery bus to the alternate system pump, which operates continuously as long as the handle remains extended. This results in pressure indications above the maximum marked on the hydraulic pressure gage, ranging as high as 4000 psi, the pressure at which the relief valve automatically functions. No damage to the hydraulic system is likely to result, but such high pressures should be reported at the conclusion of flight. A detent is provided on the handle shaft for locking the handle in the emergency position. To release handle from emergency position, push handle down and forward. When the emergency handle is returned to the normal position, the alternate system continues to operate until the flight control switch is momentarily positioned to RESET and then placed at NOR.

Hydraulic System Pressure Gage and Pressure Gage Selector Switch.

Refer to "Utility Hydraulic Power Supply System" in this section.

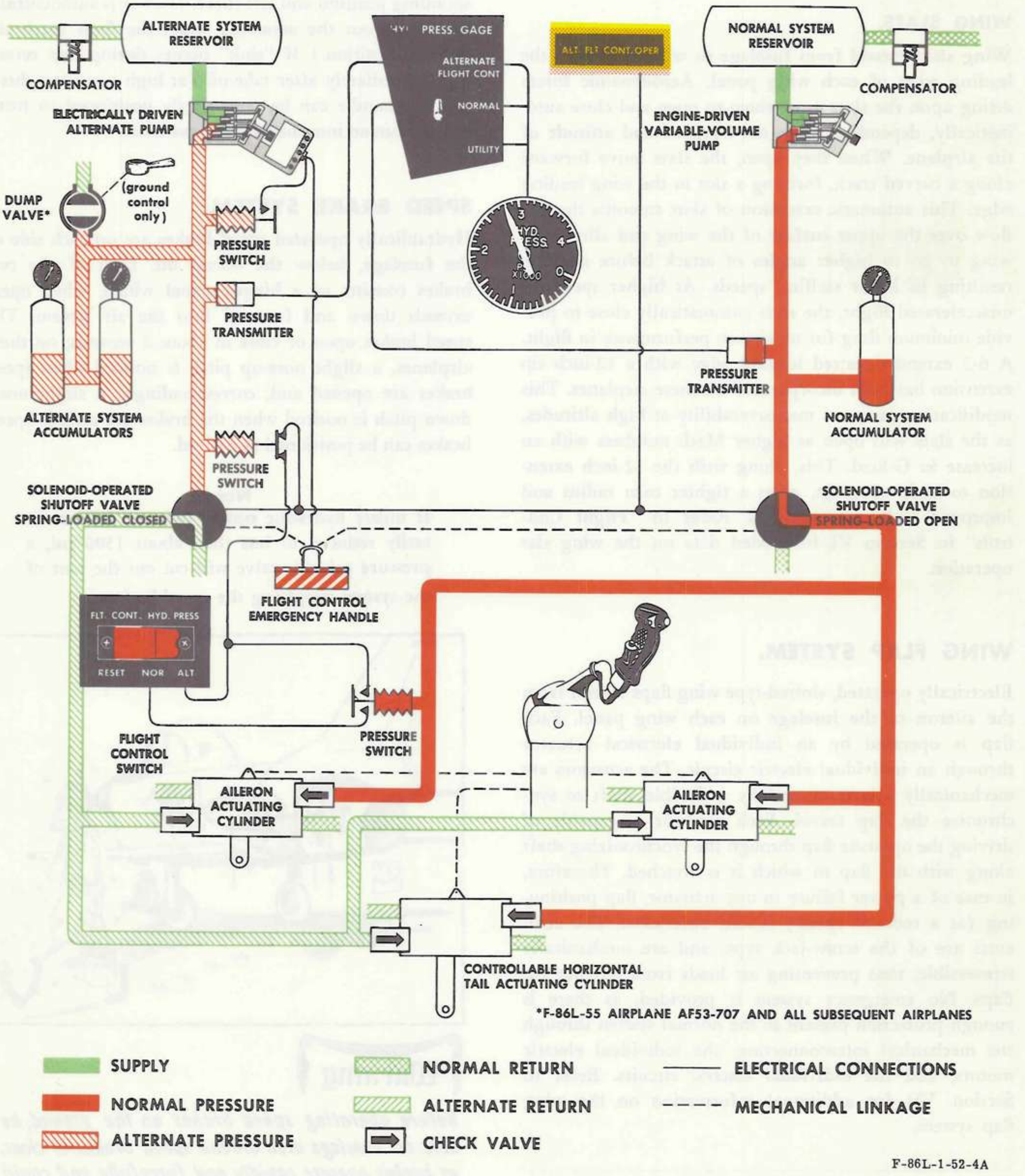
Flight Control Alternate System Caution Light.

A placard-type caution light (figure 1-25) indicates whenever the flight control alternate system is operating. The light is powered by the monitored bus No. 1 and shows "ALT. FLT. CONT. OPER." when illuminated.

Flight Control Alternate System Accumulator Air Pressure Gages.

Two accumulator air pressure gages and filler valves are behind an access door in the right wing root lower fairing. The gages should be checked before flight for a precharge air pressure of about 650 psi with the alternate system hydraulic pressure depleted. The pressure is depleted by disconnecting the external electrical power, disconnecting the batteries, pulling the flight control emergency handle, and moving the control stick until

FLIGHT CONTROL HYDRAULIC SYSTEM



*F-86L-55 AIRPLANE AF53-707 AND ALL SUBSEQUENT AIRPLANES

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Figure 1-21

the controls no longer move. On late airplanes,* the pressure is depleted by opening a dump valve, located in the same recess as the accumulator air pressure gages. Opening the dump valve allows pressure to be routed to return.

WING SLATS.

Wing slats extend from fuselage to wing tip along the leading edge of each wing panel. Aerodynamic forces acting upon the slats cause them to open and close automatically, depending upon the airspeed and attitude of the airplane. When they open, the slats move forward along a curved track, forming a slot in the wing leading edge. This automatic extension of slats smooths the airflow over the upper surface of the wing and allows the wing to go to higher angles of attack before stalling, resulting in lower stalling speeds. At higher speed, in unaccelerated flight, the slats automatically close to provide minimum drag for maximum performance in flight. A 6-3 extended-slatted leading edge with a 12-inch tip extension has been incorporated on these airplanes. This modification increases maneuverability at high altitudes, as the slats will open at higher Mach numbers with an increase in G-load. This, along wtih the 12-inch extension to each wing tip, gives a tighter turn radius and improved stall characteristics. Refer to "Flight Controls" in Section VI for added data on the wing slat operation.

WING FLAP SYSTEM.

Electrically operated, slotted-type wing flaps extend from the aileron to the fuselage on each wing panel. Each flap is operated by an individual electrical actuator through an individual electric circuit. The actuators are mechanically interconnected by a flexible shaft to synchronize the flap travel. Each actuator is capable of driving the opposite flap through the synchronizing shaft along with the flap to which it is attached. Therefore, in case of a power failure to one actuator, flap positioning (at a reduced speed) is still obtainable. The actuators are of the screw-jack type, and are mechanically irreversible, thus preventing air loads from moving the flaps. No emergency system is provided, as there is enough protection present in the normal system through the mechanical interconnection, the individual electric motors, and the individual electric circuits. Refer to Section VII for additional information on the wing flap system.

WING FLAP HANDLE.

The wing flap handle (10, figure 1-6) is outboard of the throttle. It moves on a quadrant marked "UP," "HOLD," and "DOWN." The wing flap handle receives its power from the monitored bus No. 1. To position the flaps full up or down, the flap handle is moved to the corresponding position and left there. (Power is automatically removed from the actuators when the flaps reach the extreme position.) If "sink" occurs during flap retraction immediately after take-off (at high gross weights), the flap handle can be temporarily positioned to HOLD to maintain an intermediate flap position.

SPEED BRAKE SYSTEM.

Hydraulically operated speed brakes are on each side of the fuselage, below the dorsal fin. Each of the two brakes consists of a hinged panel which, when open, extends down and forward into the air stream. The speed brakes open or close in about 2 seconds; on these airplanes, a slight nose-up pitch is noticed when speed brakes are opened and, correspondingly, a slight nose-down pitch is noticed when the brakes are closed. Speed brakes can be positioned as desired.

Note

If utility hydraulic system pressure is momentarily reduced to less than about 1500 psi, a pressure priority valve will cut out the part of the system supplying the speed brakes.

Warning

Before operating speed brakes on the ground, be sure aft fuselage area around speed brakes is clear, as brakes operate rapidly and forcefully and could injure any personnel near the brakes.

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***F-86L-55 Airplane AF53-707 and all later airplanes**

SPEED BRAKE SWITCH.

A serrated toggle switch, on top of the throttle grip (figure 1-10), controls the speed brake hydraulic control valve. The switch is powered by the primary bus and has three fixed positions: IN, OUT, and a neutral position, which is shown by a white mark on the switch guide. The brakes can be stopped in any position by movement of the switch to neutral. After the brakes have been opened or closed, the switch is normally returned to neutral (center position).

CAUTION

- Since the speed brake hydraulic lines are routed near the engine, it is important that the speed brake switch be kept in the neutral position to cut off pump pressure to the lines and minimize the fire hazard in case of a damaged line.
- If the speed brakes do not open when the control switch is set to OUT, return switch to neutral position. The switch should not be cycled to IN and OUT, as additional fluid is lost with each cycle if the malfunction is caused by a broken line.

LANDING GEAR SYSTEM.

The landing gear and wheel fairing doors are hydraulically actuated and electrically (dc power) controlled and sequenced. An accumulator supplies pressure for emergency lowering of the nose gear. The accumulator air pressure may be checked by operating the nose gear accumulator dump valve in the nose wheel well. The air pressure should be 1200 (±50) psi with hydraulic pressure exhausted. The steerable nose gear retracts aft into the fuselage, pivoting to lie parallel with the bottom of the airplane. The main gear retracts inboard into the wing panels and fuselage. Hydraulic brakes are provided on the main wheels.

LANDING GEAR HANDLE.

A handle, on the landing gear control panel (figure 1-22) above the left forward console, electrically controls the landing gear and gear door selector valves. The gear handle has two positions, UP and DOWN. The gear handle is powered by the primary bus. When the gear is down and locked and the weight of the airplane is on the gear, a ground safety switch prevents gear retraction if the gear handle is inadvertently moved to UP. The fairing doors are not controlled by this switch and follow their normal sequence, opening when the gear handle is moved to UP. Gear retraction time is about 7 seconds; extension time is about 10 seconds.

CAUTION

Although the ground safety switch will not allow the gear to retract even though the gear handle is moved to UP while the weight of the airplane is on the gear, subsequent taxiing on rough ground might allow enough strut extension to open the safety switch and allow the gear to retract.

LANDING GEAR EMERGENCY RETRACT BUTTON.

WARNING

To prevent damage to airplane and to prevent possible pilot injury, do not use landing gear emergency retract button.

A guarded emergency retract push-button switch is above the gear handle on the landing gear control panel. (See figure 1-22.) When the gear handle is at UP and the emergency retract button is pressed and held, the ground safety switch is bypassed and the gear can be retracted on the ground.

CAUTION

Do not use the landing gear emergency retract button in flight to raise the gear. Damage to gear doors and gear lowering mechanism may result.

LANDING GEAR EMERGENCY RELEASE HANDLE.

Should failure of the utility hydraulic system or electrical system occur, the gear may be lowered by use of the landing gear emergency release handle. When the landing gear emergency release handle (27, figure 1-5), below the instrument panel on the right, is pulled to full extension (to about 14 inches and with a force of about 65 pounds), all fairing doors and the main gear uplocks are mechanically unlocked, gear and door hydraulic selector valves are set to lower the gear, and a special nose gear accumulator provides pressure to extend the nose gear. The main gear falls by gravity to the down-and-locked position. Once the gear has been lowered by the emergency release handle, the nose gear cannot be retracted until the nose gear portion of the emergency release system has been reset on the ground. A red rod protrudes through the right side of the fuselage, just above the nose gear door, when the landing gear emergency release handle is pulled. The nose gear portion of the emergency release system is reset when this rod is pushed until it is again flush with the fuselage.

CAUTION

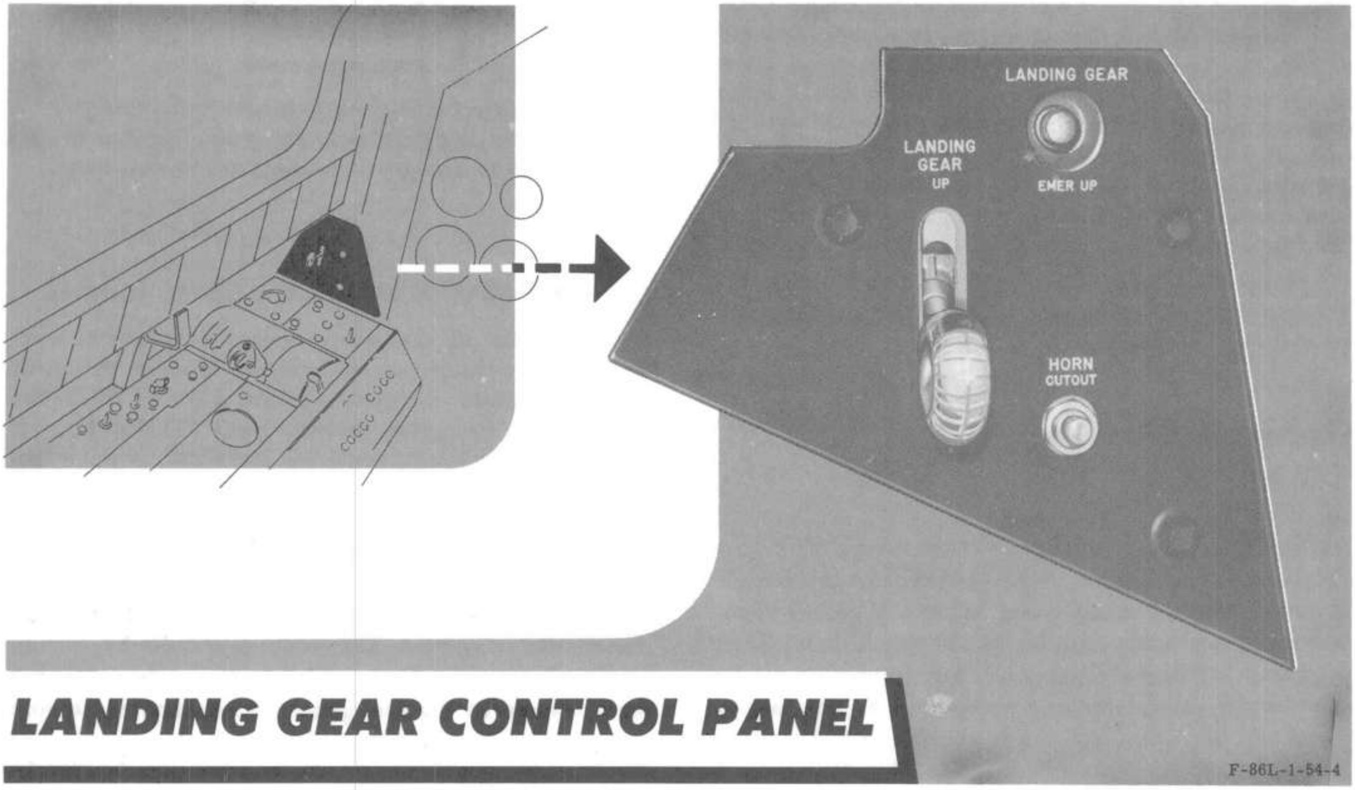
- The emergency release handle must be pulled to full extension to ensure release of all uplocks and proper positioning of hydraulic selector valves. The handle should be held in the full extended position until landing gear indicators show a safe landing gear position.
- To prevent damage to the surrounding equipment, manually replace handle to the stowed position.

LANDING GEAR DOOR GROUND CONTROL SWITCH.

A switch (primary bus powered) is in the recess well for the retractable step on the left forward fuselage, to open the landing gear wheel well doors for ground maintenance. The switch has two positions, OPEN and CLOSE. The switch should be checked before flight to ensure that it has been placed in the CLOSE position. The only safe method for opening the landing gear doors for ground maintenance is by operation of this switch. Any other method of opening the doors for maintenance is unsafe, with the exception that if after the switch has been moved to OPEN, but because of lack of hydraulic pressure the doors will not open. Then, with the switch in the OPEN position, the landing gear emergency release handle can be pulled to open the doors. If the emergency release is used to open the doors, the nose gear valve must be reset before the next flight.

LANDING GEAR SYSTEM INDICATORS.

Three green landing gear position indicator lights (5, figure 1-5) are on the left side of the instrument panel. The lights are placed in a position representing the nose and main gears. Each light comes on when the respective gear is down and locked. The two red unsafe warning lights come on any time the landing gear is in a position not corresponding to the landing gear handle position. One warning light is in the landing gear handle, and the other, a placard-type, is mounted on the instrument panel above the position indicator lights. This warning light shows "LANDING GEAR UNSAFE" when illuminated. The landing gear unsafe warning



LANDING GEAR CONTROL PANEL

Figure 1-22

horn, in the cockpit, sounds when the gear is in any position other than down and locked and the throttle is retarded. The warning horn can be silenced by pressing the horn cutout button (figure 1-22) or by advancing the throttle. Power for the position indicators lights, unsafe warning lights, and warning horn is supplied by the primary bus. The intensity of the lights is controlled by the indicator light dimmer switch on the right console. These lights may be tested by the indicator light push-to-test button on the right console.

NOSE WHEEL STEERING SYSTEM.

Utility hydraulic system pressure is supplied to the nose wheel steering unit through a shutoff valve actuated by a push-button switch on the control stick grip. (See figure 1-19.) The nose wheel may be turned about 27 degrees either side of center by pressure on the corresponding rudder pedal while the steering system is engaged. The nose wheel steering unit acts as a shimmy damper when not being used for steering.

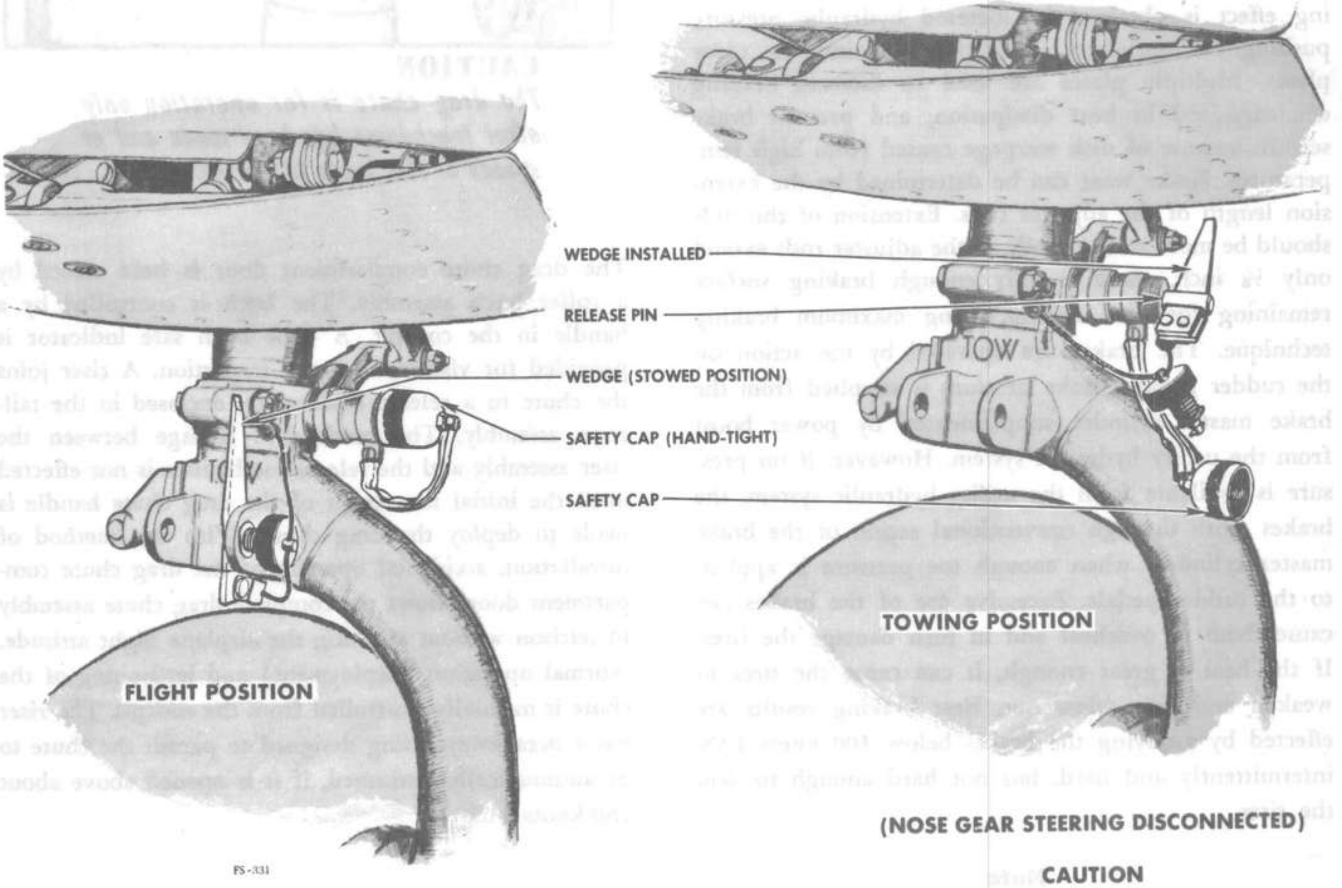
NOSE WHEEL STEERING RELEASE PIN.

A nose wheel steering release pin is on the left side of the nose gear assembly just above the wheel. It is disengaged to disconnect the nose wheel steering unit from the nose wheel for towing the airplane. It is held disengaged by inserting a tow-pin wedge in the release pin. (See figure 1-23.)

CAUTION

It is important to check before flight to make sure the safety cap is on and tight; this ensures

NOSE WHEEL STEERING RELEASE PIN



CAUTION

Before taxiing, the wedge must be stowed and the safety cap installed hand-tight.

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Figure 1-23

that the release pin is engaged and that nose gear will retract properly. Make sure that tow-pin wedge is properly stowed.

NOSE WHEEL STEERING ENGAGING BUTTON.

An engaging button, on the control stick grip (figure 1-19), is pressed to operate the nose wheel steering system. To engage the nose wheel steering unit, the switch must be pressed and the rudder pedals aligned in the direction the nose wheel is turned. When the nose wheel and the rudder pedals are coordinated in this manner, the nose wheel steering unit remains engaged as long as the switch is pressed. The nose wheel steering engaging button is powered by the primary bus and is operable only when the airplane is on the ground.

BRAKE SYSTEM.

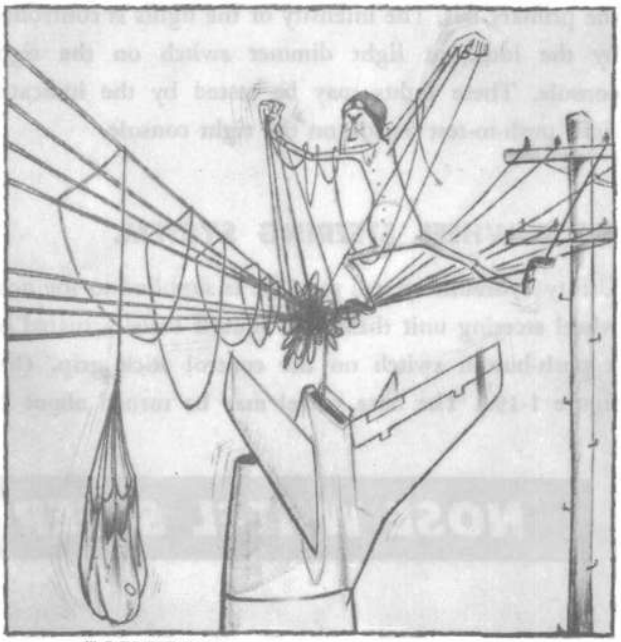
The hydraulic brake system is of the segmented rotor-disk type unit, incorporating boost-type brake master cylinders. The braking units, on each main landing gear wheel, consist of rotor and stator plate assemblies. Braking effect is obtained by metered hydraulic pressure pushing the stationary stator plates against the rotor plates. Multiple plates are used to increase braking efficiency, aid in heat dissipation, and prevent brake seizure because of disk warpage caused from high temperatures. Brake wear can be determined by the extension length of the adjuster rods. Extension of the rods should be more than ⅛ inch. If the adjuster rods extend only ⅛ inch, there is only enough braking surface remaining for one landing, using maximum braking technique. The brakes are operated by toe action on the rudder pedals. Brake pressure is supplied from the brake master cylinder supplemented by power boost from the utility hydraulic system. However, if no pressure is available from the utility hydraulic system, the brakes work through conventional action of the brake master cylinders when enough toe pressure is applied to the rudder pedals. Excessive use of the brakes can cause them to overheat and in turn damage the tires. If the heat is great enough, it can cause the tires to weaken and later blow out. Best braking results are effected by applying the brakes below 100 knots IAS, intermittently and hard, but not hard enough to skid the tires.

Note

This airplane is not equipped with parking brakes. Refer to Section VII for additional information on the wheel brake system.

DRAG CHUTE SYSTEM.

The 16-foot, ring-slot type drag chute, packaged in a deployment bag and stowed in a compartment below the rudder and above the exhaust nozzle, is provided to reduce landing distances.



CAUTION

The drag chute is for operation only after touchdown has been made and at speeds of 150 knots IAS or below.

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The drag chute compartment door is held closed by a roller latch assembly. The latch is controlled by a handle in the cockpit. A door latch safe indicator is provided for visual and touch inspection. A riser joins the chute to a release mechanism, enclosed in the tail-cone assembly. The mechanical linkage between the riser assembly and the release mechanism is not effected until the initial movement of the drag chute handle is made to deploy the drag chute. With this method of installation, accidental opening of the drag chute compartment door allows the complete drag chute assembly to jettison without affecting the airplane flight attitude. Normal operation (deployment) and jettisoning of the chute is manually controlled from the cockpit. The riser has a breakaway fitting designed to permit the chute to be automatically jettisoned, if it is opened above about 160 knots IAS.

DRAG CHUTE HANDLE.

The drag chute handle (2, figure 1-5) is in a bracket directly above the upper left corner of the instrument panel. Pulling the drag chute handle aft to the first stop position (about 2 inches) releases the compartment door, allowing the pilot chute to be deployed and in turn open the drag chute. For controlled jettisoning of the chute after deployment, the handle must be rotated 90 degrees counterclockwise and pulled full aft (about 3 additional inches). This releases the locking assembly and allows the chute to be jettisoned.

DRAG CHUTE DOOR LATCH SAFE INDICATOR.

The latch indicator is directly below the drag chute compartment door and to the left of the door latch. The indicator is a square pin that protrudes from a hole next to the latch to show that the latch is securely locked. The indicator pin must extend at least 1⅜ inches (as determined by a latch indicator gage, riveted alongside the indicator pin), and must be checked for a safe indication before flight. If the indicator does not protrude at least as far as the indicator gage, the latch is insecure.

INSTRUMENTS.

Most of the instruments are electrically operated by power from the electrical system. (See figure 1-15.) The tachometer and exhaust temperature gage are self-generated electrical instruments and are not powered by the electrical system.

Note

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

PITOT-STATIC BOOM.

Pitot and static pressures for various flight instruments are obtained from the pitot-static boom, which extends from the right wing tip. Pitot-head anti-icing protection is afforded by electrical heating elements. (Refer to "Anti-icing and Defrosting Systems" in Section IV.)

AIRSPEED AND MACH NUMBER INDICATOR.

The combination airspeed and Mach number indicator (8, figure 1-5) on the instrument panel incorporates the following features: A conventional needle hand is used to indicate airspeed through a range of 80 to 850 knots. A knurled knob, at the lower right corner of the instrument ring, allows the setting of the landing speed index marker to the recommended landing speed for various configurations. (The landing speed index marker moves along the right perimeter of the dial.) The adjustment of this landing speed index marker can be made within a range of 110 to 200 knots IAS. In the left half of the instrument dial is a movable Mach scale (with a range from Mach .5 to Mach 2.2) that rotates with altitude changes to show the Mach number that is equivalent to indicated airspeed for the particular flight altitude. For example, at sea level, the Mach 1.0 graduation on the Mach scale might be opposite the 650-knot graduation of the IAS dial. If a climb were made to 40,000 feet, the Mach dial would rotate counterclockwise so that the Mach 1.0 graduation would then be opposite the 312-knot graduation. A movable red and black limiting hand automatically indicates, in terms of IAS, the maximum allowable equivalent airspeed (EAS) of the airplane in a clean configuration.

Note

> Equivalent airspeed (EAS) is calibrated airspeed (CAS) corrected for errors induced by compressibility. Calibrated airspeed is indicated airspeed (IAS) corrected for installation error.

As altitude is increased, changes in outside air density cause the limiting hand to move to a higher IAS reading. If, for example, the limiting hand is set for 610 knots EAS at sea level, at 20,000 feet the hand will move to about 654 knots IAS. In effect, this movable limiting hand replaces the fixed red limitation mark used on previous airspeed indicators which deprives the airplane of additional allowable speed at altitude. For airspeed and Mach Number indicator markings, see figuse 5-1.

ACCELEROMETER.

A three-pointer accelerometer, (1, figure 1-5) on the left side of the windshield bow, indicates positive- and negative-G loads. In addition to the conventional indicating pointer, there are two recording pointers (one for positive-G loads and one for negative-G loads) which follow the indicating pointer to its maximum travel. The recording pointers remain at the maximum travel positions reached by the indicating pointer, giving a record of maximum G-loads encountered. To return the recording pointers to the normal (1 G) position, it is necessary to press the knob on the lower left corner of the instrument ring. For accelerometer gage markings, see figure 5-1.

ALTIMETER.

Some airplanes have a conventional-type altimeter (9, figure 1-5). Other airplanes are equipped with a modified

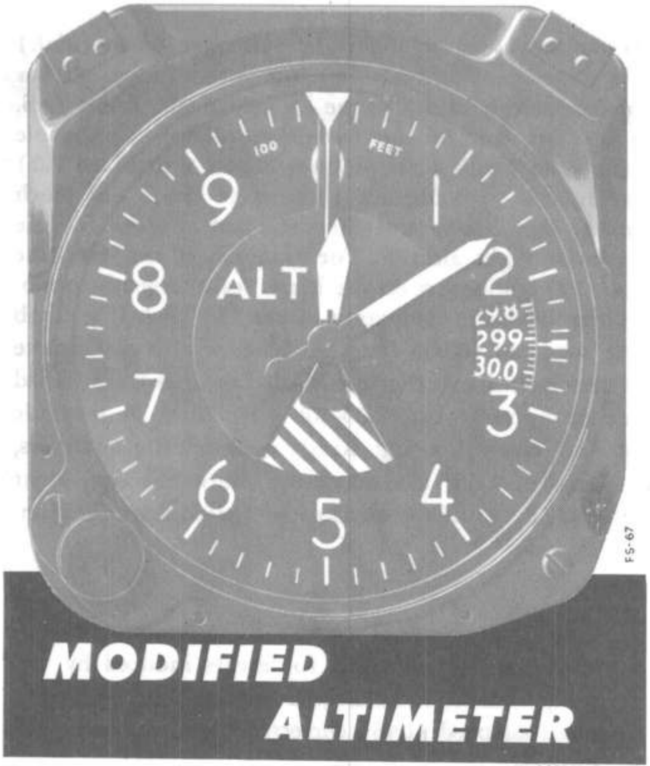

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Figure 1-24

altimeter (figure 1-24) which in addition to the standard 1000- and 100-foot pointers, incorporates a new 10,000-foot pointer (notched disk with an extension pointer), which serves a second function as a warning indicator. The warning indicator is a striped section which appears through the notched disk at altitudes below 16,000 feet. This altimeter offers improved readability and gives visual warning when an altitude of less than 16,000 feet is entered.

DIRECTIONAL INDICATOR (SLAVED).

Refer to "Navigation Equipment" in Section IV.

STAND-BY COMPASS.

A conventional magnetic compass (24, figure 1-5), on the windshield bow to the right of the instrument panel, is furnished for navigation if the instrument or electrical system fails. Lighting of the stand-by compass is controlled by a switch on the lighting control panel (figure 4-8). A compass correction card is on the right side of the canopy frame.

MM-2 ATTITUDE INDICATOR.

The MM-2 attitude indicator (14, figure 1-5), on the instrument panel, is a remote reference, pictorial-type instrument. Attitude signals are electrically supplied to the indicator by a remotely located K-4B controller which uses both dc and three-phase ac power. The system is automatically put into operation after dc power and three phase ac power are on. After about 2½ minutes, the "OFF" flag on the upper left section of the indicator face retracts. This completely automatic operation eliminates manual caging. Failure of either dc or three-phase ac power causes the "OFF" flag to reappear.

WARNING

Failure of certain components in the K-4B assembly does not cause the "OFF" flag to appear even though the instrument is not functioning properly. Therefore, periodically in flight, the attitude indications given by the MM-2 should be checked against other flight instruments, such as the stand-by magnetic compass or the turn-and-slip and vertical velocity indicators.

Pitch and roll attitudes are shown by the circular motion of a universally mounted sphere displayed as the background for a miniature reference airplane. The miniature reference airplane is always in proper physical relationship to the simulated earth, horizon, and sky areas of the background sphere. The horizon is represented on the sphere as a solid fluorescent line, with the sky indicated by a light gray area and the earth by a dull black area. Horizontal markings with 5 degrees of separation on the face of the sphere show accurate airplane attitudes up to 85 degrees of climb or dive. The 5-degree scale is slightly expanded for greater accuracy. This provides quick readability to within one degree of climb or dive. Used for this purpose, the attitude indicator is an accurate aid in GCA and ILS approaches. Bank angles are read on a semicircular bank scale on the upper half of the instrument. The adjustment knob, on the lower right side of the instrument, electrically rotates the sphere on the proper position in relation to the fixed miniature airplane to correct for pitch attitude changes. This adjustment is necessary, since the level-flight attitude of the airplane varies with weight and speed. The gyros, in the K-4B controller, have 360 degrees of freedom in roll and ±85 degrees in pitch. Turn error is eliminated by the pitch-bank erection system, also in the K-4B controller. The instrument is capable of near errorless performance in all pitch flight attitudes up to ±85 degrees. A slight amount of pitch error results from acceleration or deceleration. This is especially noticeable on take-off. There is very little error accumulation during multiple rolls or loops. All acrobatic maneuvers that the airplane is capable of performing are well within the performance capabilities of the system. When the airplane climbs and exceeds +85 degrees in pitch, the sphere rolls 180 degrees and presents to the pilot a series of concentric circles on a gray, or simulated solid-sky background. When the airplane dives and exceeds −85 degrees in pitch, the sphere rolls 180 degrees and presents a series of concentric circles on a black, or simulated solid-earth background. When the airplane reaches an inverted position, the instrument reads the reverse of straight-and-level flight, that is, the horizon line shows, but the earth and sky are transposed. As the airplane continues to ±270 degrees in pitch, the sphere again rolls 180 degrees, displays the series of concentric circles, and then remains fixed as the airplane flies around it and once more presents to the pilot a normal horizon with sky (gray) and earth (black) in their proper relationship. The gyro is not likely to tumble, even during extreme maneuvers. However, should the gyro tumble, it erects in about 2½ minutes if the circuit breaker labeled "ATTITUDE GYRO," on the right console circuit-breaker panel, is momentarily pulled out and then pushed back in. Any additional time required for the instrument to completely settle down to a steady presentation and for the flag to disappear should be reported in the Form 781. If the circuit breaker is not reset, the gyro requires about 15 minutes to erect through each 45 degrees. Indication error is less than ½ degree in level flight, and, up to a turn rate of 40 degrees per minute, the indication error compares to that of a conventional gyro. In turns of 40 degrees or more per minute, a compensating mechanism in the instrument limits turn error to 2 degrees.

WARNING

A slight amount of pitch error in the indication of the Type MM-2 attitude indicator results from accelerations or decelerations. It appears as a slight climb indication after a forward acceleration and as a slight dive indication after deceleration when the airplane is flying straight and level. This error is most noticeable at the time the airplane breaks ground during the take-off run. At this time, a climb indication error of about 1½ bar widths is normally noticed; however, the exact amount of error depends upon the acceleration and elapsed time of each individual take-off. The erection system automatically removes the error after the acceleration ceases.

TURN-AND-SLIP INDICATOR.

The conventional turn-and-slip indicator (7, figure 1-5) is on the instrument panel. It is electrically driven by power from the primary bus. The instrument is calibrated so that one standard needle-width turn will accomplish a 360-degree turn in 4 minutes (1½-degree-per-second rate of turn). The turn indicator is not normally used in banks exceeding 30 degrees.

CAUTION LIGHT INDICATOR SYSTEM.

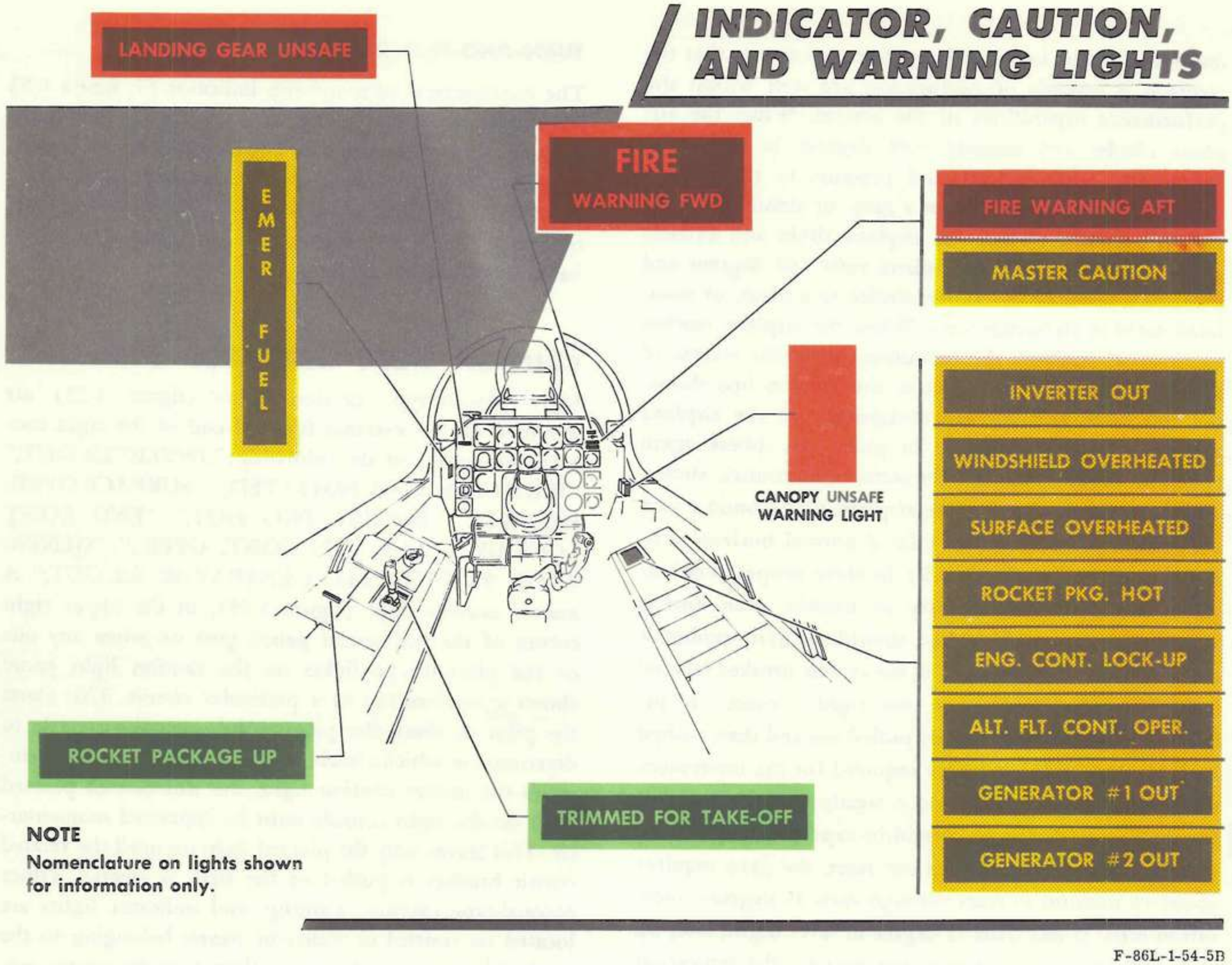
Eight placard-type caution lights (figure 1-25) are mounted on the extreme forward end of the right console, and consist of the following: "INVERTER OUT," "WINDSHIELD OVERHEATED," "SURFACE OVERHEATED," "ROCKET PKG HOT," "ENG CONT LOCK-UP," "ALT. FLT. CONT. OPER.," "GENERATOR #1 OUT," and "GENERATOR #2 OUT." A master caution light (figure 1-25), in the upper right corner of the instrument panel, goes on when any one of the placard-type lights on the caution light panel shows a malfunction in a particular circuit. This alerts the pilot to check the placard lights on the console to determine in which circuit trouble is occurring. To extinguish the master caution light, the illuminated placard light on the right console must be depressed momentarily. This leaves only the placard light on until the related circuit breaker is pulled or the fault is cleared. Other placard-type caution, warning, and indicator lights are located on control or indicator panels belonging to the applicable system and do not illuminate the master caution light. They are "TRIMMED FOR TAKE-OFF," "ROCKET PACKAGE UP," "EMERGENCY FUEL," and "LANDING GEAR UNSAFE."

INDICATOR LIGHT TEST BUTTON.

All caution lights, except the fire-warning and canopy-unsafe lights, can be tested by depressing a push-to-test button (figure 4-8)which is powered from monitored bus No. 1 and located on the lighting control panel on the right console. The fire-warning lights have a separate test switch. The canopy-unsafe light cannot be dimmed or tested.

INDICATOR LIGHT DIMMER SWITCH.

The brilliancy of the indicator, caution, and warning lights can be selected by the two-position (DIM and BRIGHT) indicator light dimmer switch. This switch, powered by the monitored bus No. 1, is on the lighting control panel on the right console (figure 4-8). The indicator lights may be dimmed only when the flight instrument light switch is ON.



INDICATOR, CAUTION, AND WARNING LIGHTS

NOTE

Nomenclature on lights shown for information only.

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Figure 1-25

EMERGENCY EQUIPMENT.

ENGINE FIRE-WARNING SYSTEM.

Two fire detector systems are provided to detect and show fire in the forward section of the engine compartment and an overtemperature condition or fire in the aft section. A stainless-steel fire wall divides the engine compartment immediately aft of the compressor. Therefore, the forward section includes the compressor and the accessory section, and the main wheel wells; the aft section, the combustion chambers and tail pipe. Each system consists of fire detector units throughout the engine compartments and warning lights in the cockpit. A red placard-type "FIRE WARNING AFT" light (figure 1-25), on the upper right corner of the instrument panel, is connected to a flasher unit. When a fire or overheat condition occurs in the aft section, a flashing red light is seen. The "FIRE WARNING FORWARD" light (figure 1-25), on the upper right corner of the instrument panel, also of the placard type, will remain a steady red when a fire occurs in the forward section. Both warnlight lights are powered from the primary bus, and the continuity of the fire detector circuits can be tested by the test switch (20, figure 1-5) on the instrument panel.

CANOPY.

The electrically actuated, clamshell-type canopy opens and closes by rotating about a hinge point at the rear. The airplane may be taxied at speeds up to 50 knots IAS with the canopy in any position from fully closed to fully open. The canopy is closed by an electrically powered actuator and is locked by manually operated latches on the canopy rails. When the landing gear leaves the ground, a hook at the canopy hinge point automatically disengages, releasing the canopy from the actuator. The canopy is then secured by the mechanical latches in readiness for emergency ejection. When the landing gear again touches the ground, the hook engages, and, when the mechanical latches are released, the canopy may be opened by the actuator. Emergency ejection of the canopy during flight is made when either the right or left ejection seat armrest is raised, which fires the canopy initiator and its gas charge fires the canopy ejector. The ejection seat armrests are interconnected. Raising either armrest raises the opposite armrest. Actuation of the ejection seat catapult firing mechanism is not dependent upon canopy jettisoning or operation, as there is no seat catapult firing mechanism safety pin to be pulled by the canopy as it leaves the airplane. Thus, if canopy fails to leave the airplane, the ejection seat may be ejected through the canopy as a last resort. However, either armrest must be raised to the full up position in order to squeeze its trigger and eject through the canopy.

GROUND AND MAINTENANCE SAFETY PINS.

The canopy jettison system is safetied by inserting a ground safety pin (figure 1-27) through a block on the front of the seat and across the trigger in the right seat armrest. This pin prevents raising the seat armrest and inadvertently firing the canopy. This ground safety pin is to be removed before flight and replaced immediately after flight. When the safety pin is removed, the canopy and seat catapults are armed. A maintenance safety pin (figure 1-27) for the canopy initiator is also provided. The initiator is located between the right console and the seat armrest.

WARNING

> The canopy initiator may be safetied during ground maintenance by a safety pin. This maintenance safety pin should not be inserted in the initiator for normal ground operations, but if installed must be removed before flight.

CANOPY SEAL.

An inflatable canopy seal is provided to seal the canopy in the closed position. Pressure for inflation of the seal is provided by the engine compressor and is automatically controlled by a pressure regulator when the engine is operating. The seal is automatically inflated whenever the canopy is fully latched and is deflated whenever the canopy is unlatched.

CANOPY OPERATING BUTTONS (EXTERNAL).

The canopy is operated externally by means of two electrical spring-loaded push buttons, on the left side of the fuselage, about 2 feet below and in line with the windshield. One button is marked "OPEN"; the other, "CLOSE." These operating buttons receive their power from monitored bus No. 2 when this bus is energized. If this bus is not energized, the battery bus supplies these buttons with power.

CANOPY EXTERNAL EMERGENCY RELEASE HANDLE.

A canopy external emergency release handle can be reached through an access door on the left side of the fuselage, about 3½ feet below the canopy frame and slightly forward of the windshield bow line. When the door is opened, the canopy hook is electrically released. Pulling the external emergency release handle unlocks the canopy latches so that the canopy can be lifted. If electrical power is not available, the canopy hook may be disengaged by a handle beneath a small access door directly behind the canopy on the top of the fuselage.

CANOPY SWITCH.

From within the cockpit, the canopy is controlled by a three-position toggle switch on the right instrument subpanel. (See figure 1-26.) To operate the canopy, the switch must be held at either of the spring-loaded positions, OPEN or CLOSED. When the canopy has fully opened or closed, power to the canopy actuator is automatically cut off. When the switch is released, it returns to the center OFF position and the canopy remains in the selected position. The canopy switch is powered by monitored bus No. 2 when this bus is energized and from the battery bus when monitored bus No. 2 is not energized. The circuit to the switch is opened whenever the canopy latches are in the locked position.

CAUTION

> When the canopy is being closed, the canopy switch should be held at CLOSED until the canopy actuator automatically cuts off. If the switch is released before the actuator cuts off, the hook at the canopy hinge point may not disengage. Emergency canopy ejection is still possible if the hook fails to disengage, but structural damage to the fuselage may result.

CANOPY SWITCH AND WARNING LIGHT

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Figure 1-26

Note

Operation of either external button overrides the selection of the cockpit switch.

CANOPY LOCK HANDLE.

The canopy, when closed, is locked or unlocked by means of a push-pull type canopy lock handle 23, (figure 1-7), extending through the vertical panel forward of the right console. When the handle is pushed full forward, the latches are engaged and the canopy is locked. When the canopy is fully locked, the canopy switch circuit is opened and the canopy unsafe warning light goes out. Pulling the handle aft unlocks the latches and activates the canopy switch circuit, and the canopy unsafe warning light comes on.

CANOPY EMERGENCY RELEASE (SEAT ARMREST).

The latches are released and the canopy ejector is fired when either armrest or the ejection seat (figure 1-27) is pulled full up in preparation for seat ejection.

CANOPY UNSAFE WARNING LIGHT.

A red canopy unsafe warning light (figure 1-25) is on the right instrument subpanel. The light is powered by the primary bus and comes on and remains on as long as the canopy latches are unlocked. The light goes out when the latches are locked. A yellow stripe is painted on the forward canopy latches so that a visual check may be made to ensure, when the canopy unsafe warning light is out, that the canopy latches are in the fully locked position. This added visual check can be made by leaning forward and looking, right or left, through the forward latch rig pin hole. If the yellow stripe is not readily visible, repeat locking procedure until yellow stripe is apparent, to ensure that latches are fully locked.

EJECTION SEAT.

An ejection seat (figure 1-27) is provided which will catapult the seat clear of the tail surfaces, thus making ejection possible at any speed. A catapult (explosive cartridge with telescoping tubes) aft of the seat supplies the propelling force to eject seat and pilot from the cockpit. A gas initiator system is used to fire the seat catapult. The seat may be adjusted up and forward, but the footrests remain in a fixed position. If added height in seat is needed, use a solid filler block, if the frontal height does not exceed 5 inches. When a C-2A raft is carried, *a filler block may be used in the modified zipper compartment on the bottom of the pack provided the frontal height of the entire pack does not exceed 5 inches.* The armrests are hinged to actuate the ejection sequence. When the seat is ejected, the anti-G suit, oxygen hose, and microphone and headset connections automatically disconnect at a single fitting attached to the seat between the footrests. A radio headset plug-in is just above the left armrest of the seat. On airplanes changed by T.O. 1F-86-563, the seat is equipped with an electric, motor-driven blower, lines, and fittings. This additional equipment will enable the pilot to use the MA-2 ventilated suit during flight and stand-by operation before engine start.

EJECTION SEAT and CANOPY EJECTOR

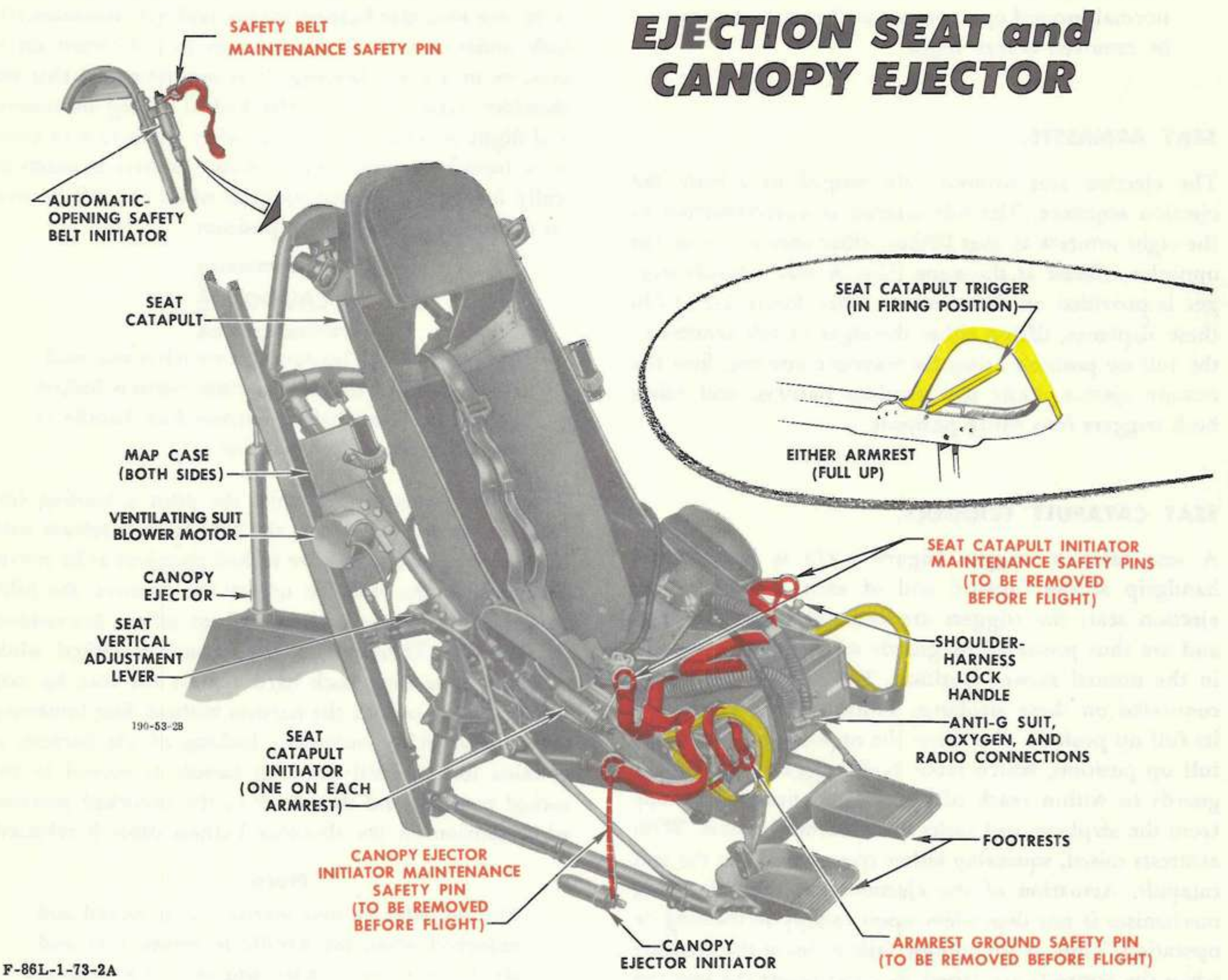

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Figure 1-27

WARNING

- Do not use the A-5 seat cushion, or any similar sponge rubber cushion, when equipped with a one-man life raft or survival kit. If ejection is necessary, serious spinal injuries can result when the ejection force compresses the cushion and enables the seat to gain considerable momentum before exerting a direct force on the pilot. The chance of injury during a crash landing is also increased.
- No cushion, life raft pack, or survival kit should be used that has a frontal height greater than 5 inches; otherwise, there may be interference between control stick and kit when seat is raised to its top position.

GROUND AND MAINTENANCE SAFETY PINS.

To prevent inadvertent firing of the ejection seat catapult while on the ground, a ground safety pin (figure 1-27) is inserted through a block on the front of the seat and across the trigger in the right seat armrest. The ground safety pin prevents raising the seat armrest, and prevents firing the canopy and positioning the ejection seat firing triggers. This ground safety pin is to be removed before flight and replaced immediately after flight. When the safety pin is removed, the canopy and seat catapults are armed.

WARNING

The seat catapult initiators may be safetied during ground maintenance by initiator safety pins at each armrest. These maintenance safety pins should not be inserted in the initiators for normal ground operations, but if installed must be removed before flight.

SEAT ARMRESTS.

The ejection seat armrests are hinged to actuate the ejection sequence. The left armrest is interconnected to the right armrest so that lifting either armrest raises the opposite armrest at the same time. A seat catapult trigger is provided on each armrest. (See figure 1-27.) On these airplanes, lifting either the right or left armrest to the full up position raises the opposite armrest, fires the canopy ejector, locks the shoulder harness, and raises both triggers into firing position.

SEAT CATAPULT TRIGGERS.

A seat catapult trigger (figure 1-27) is beneath the handgrip at the forward end of each armrest of the ejection seat; the triggers are recessed in the armrests and are thus protected by guards when the armrests are in the normal stowed position. The armrests are interconnected on these airplanes. Pulling either armrest to its full up position also raises the opposite armrest to its full up position, which raises both triggers out of their guards to within reach of the fingers, fires the canopy from the airplane, and locks the shoulder harness. With armrests raised, squeezing either trigger will fire the seat catapult. Actuation of the ejection seat catapult firing mechanism is not dependent upon canopy jettisoning or operation. Thus, if the canopy fails to leave the airplane when the armrests are raised, as a last resort the seat can be ejected through the canopy when either trigger is squeezed.

SEAT VERTICAL ADJUSTMENT LEVER.

Vertical seat adjustment is accomplished mechanically by operation of the seat vertical adjustment lever, on the right side of the ejection seat. (See figure 1-27.) Pulling the lever forward and up releases the seat for adjustment. A handle on the left bow of the windshield helps relieve weight of the pilot on the seat during adjustment. The seat adjusts up and forward. The foot-rests are stationary and may be used to assist in adjusting the seat. After any seat adjustment is made, make sure seat is securely locked in position.

SHOULDER HARNESS LOCK HANDLE.

The shoulder harness lock handle, on the left armrest of the ejection seat (figure 1-27), is conventionally operated for manually locking and unlocking the shoulder harness. Also, the shoulder harness inertia reel will automatically lock under 2 to 3 G deceleration in a forward direction, as in a crash landing. It is recommended that the shoulder harness be manually locked during maneuvers and flight in rough air, or as a safety precaution in event of a forced landing. The shoulder harness is automatically locked before seat ejection when the left armrest on the seat is in the full up position.

CAUTION

Before a forced landing, all switches not readily accessible with the shoulder harness locked should be "cut" before harness lock handle is moved to the locked position.

If the harness is locked while the pilot is leaning forward, as he straightens up, the harness will retract with him, 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 the 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 the harness. After automatic locking of the harness, it remains locked until the lock handle is moved to the locked position and then back to the unlocked position while tension on the shoulder harness cable is released.

Note

The shoulder harness inertia reel is locked and unlocked when the handle is moved fore and aft. Forward is LOCKED, and aft is UNLOCKED.

AUTOMATIC-OPENING SAFETY BELT.

The ejection seat has either the MA-1, MA-3, or MA-6 automatic-opening safety belt. In high-altitude ejections (above 15,000 feet), use of the automatic belt, *in conjunction with the automatic-opening parachute,* avoids parachute deployment at an altitude where sufficient oxygen would not be available to permit safe parachute descent. In a low-altitude ejection, use of the automatic belt greatly reduces the time required for separation from the seat and full parachute deployment. *Under no circumstances should the automatic belt be manually opened before ejection, regardless of altitude.* (The M-12 automatic belt initiator opens the belt one second after ejection.) Since the drag-to-weight ratio of the seat is considerably greater than that of the pilot, immediate separation would result if the belt were opened manually before ejection. This could result in the parachute pack accidentally blowing open, and the high opening shock of the parachute could cause serious or fatal injuries.

MA-1 AUTOMATIC-OPENING SAFETY BELT

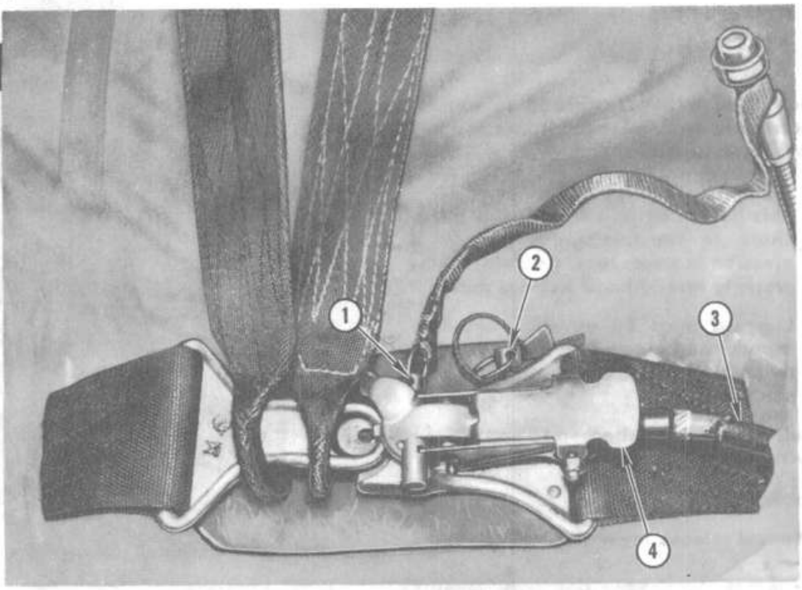
LOCKED

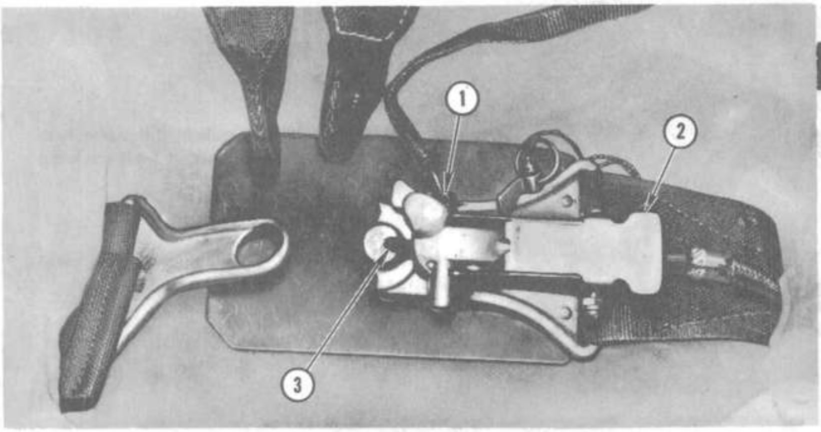
1. Belt locking key (attached to automatic parachute arming lanyard) inserted in belt locking mechanism.

   WARNING

   - This key must be used for the parachute to function automatically if ejection is necessary. Be sure key is properly inserted and will not pull out.
   - Lanyard must be outside parachute harness and not fouled on any equipment, to permit clean separation from seat.

2. Belt locking key (attached to belt). Not used with automatic parachute.
3. Initiator hose.
4. Manual release lever closed (shown with NAA type handle extension).





AUTOMATICALLY OPENED

1. Belt locking key (from automatic parachute arming lanyard) retained in belt locking mechanism.
2. Manual release lever closed.
3. Belt latch opened by gas pressure from initiator.

MANUALLY OPENED

1. Belt locking key ejected from locking mechanism when manual release lever is opened.

   WARNING

   If the belt is manually opened during ejection, the parachute will not open automatically upon separation from the seat.

2. Manual release lever opened.
3. Belt latch opened by manual release lever.

   NOTE

   Manual release lever can be used to unlock belt at any time, even if automatic-opening sequence already has been initiated.

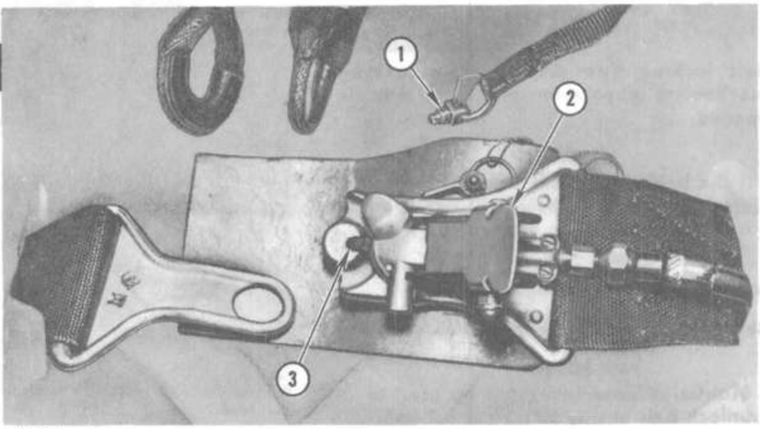


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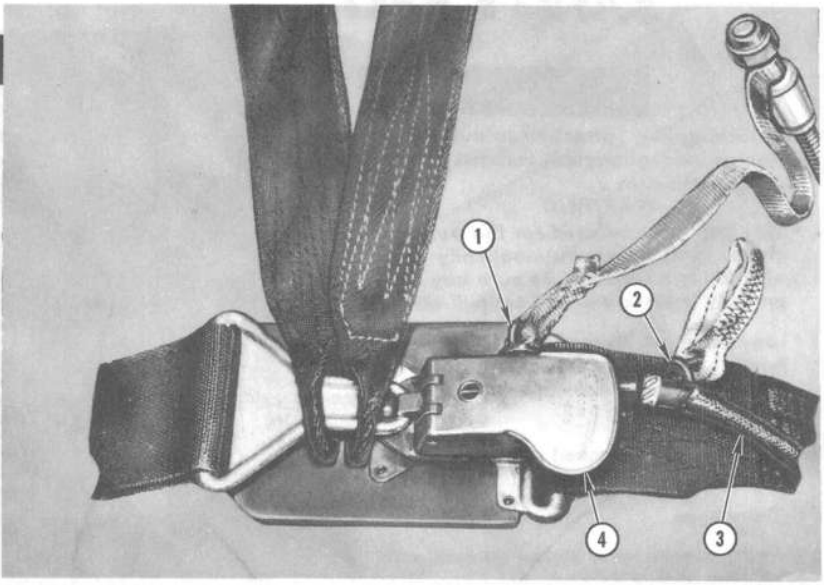
Figure 1-28 (Sheet 1 of 3)

MA-3 AUTOMATIC-OPENING SAFETY BELT



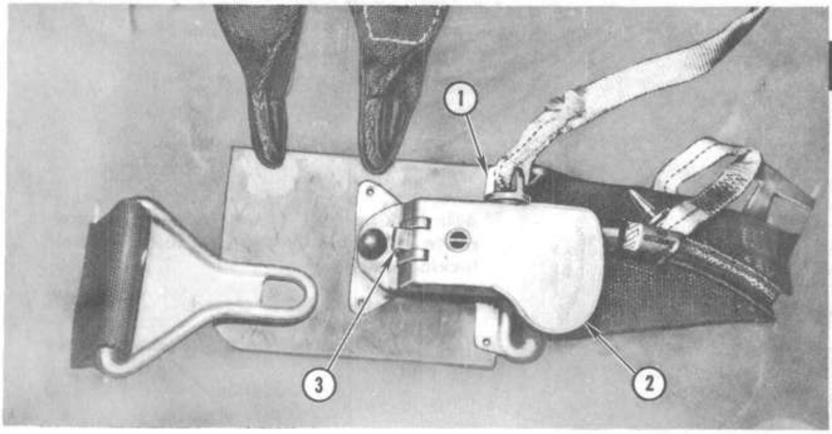
LOCKED

1. Belt locking key (attached to automatic parachute arming lanyard) inserted in belt locking mechanism.

   WARNING

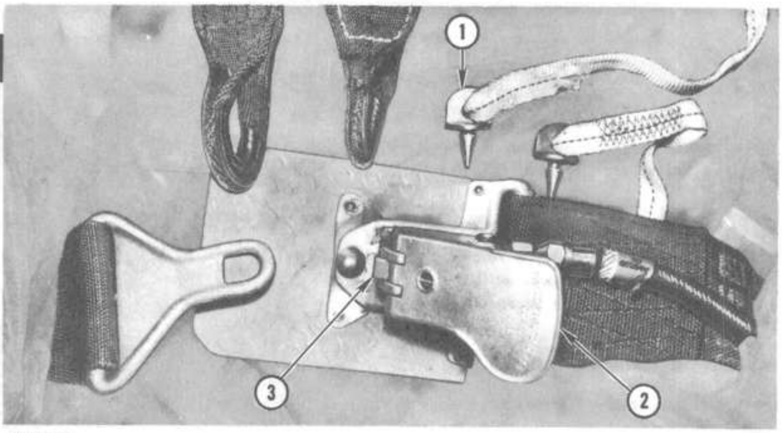
   - This key must be used for the parachute to function automatically if ejection is necessary. Be sure key is properly inserted and will not pull out.
   - Lanyard must be outside parachute harness and not fouled on any equipment, to permit clean separation from seat.

2. Belt locking key (attached to belt). Not used with automatic parachute.
3. Initiator hose.
4. Manual release lever closed.



AUTOMATICALLY OPENED

1. Belt locking key (from automatic parachute arming lanyard) retained in belt locking mechanism.
2. Manual release lever closed.
3. Belt latch opened by gas pressure from initiator.



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MANUALLY OPENED

1. Belt locking key ejected from locking mechanism when manual release lever is opened.

   WARNING

   If the belt is manually opened during ejection, the parachute will not open automatically upon separation from the seat.

2. Manual release lever opened.
3. Belt latch opened by manual release lever.

   NOTE

   Manual release lever can be used to unlock belt at any time, even if automatic-opening sequence already has been initiated.

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Figure 1-28 (Sheet 2 of 3)

MA-6 AUTOMATIC-OPENING SAFETY BELT

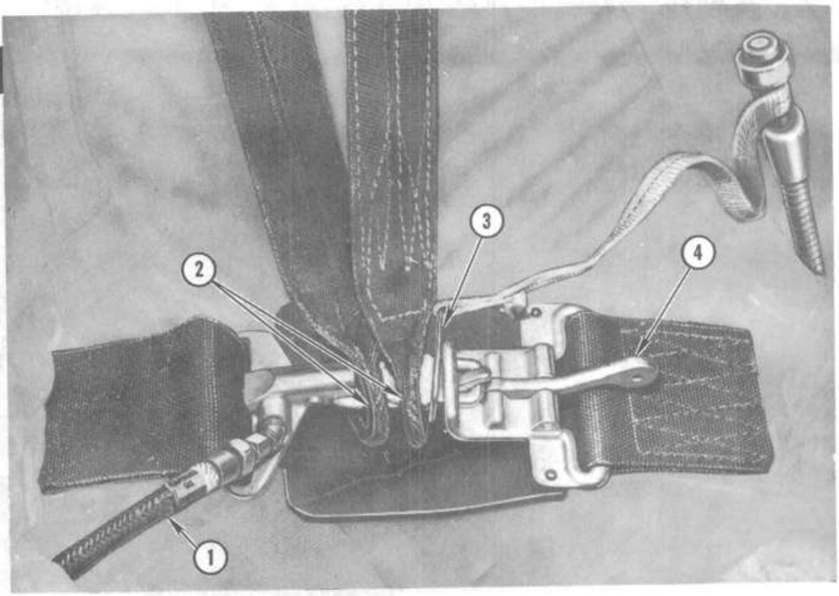
LOCKED

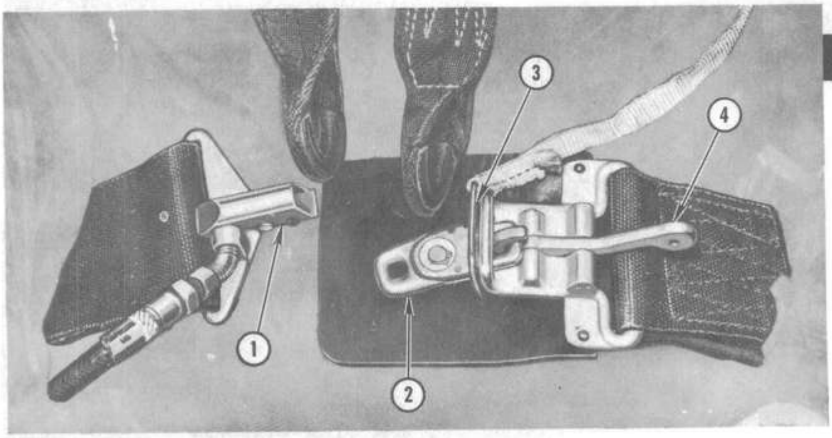
1. Initiator hose to automatic release mechanism.
2. Shoulder harness loops over swivel link.
3. Anchor (from automatic parachute arming lanyard) slipped over swivel link.

WARNING

- Although not necessary for closing the belt, the anchor must be installed, so that the parachute will function automatically if ejection is necessary.
- Lanyard must be outside parachute harness and not fouled on any equipment, to permit clean separation from seat.

4. Manual release lever closed.





AUTOMATICALLY OPENED

1. Automatic release mechanism actuated by gas pressure from initiator, detaching swivel link on automatic release side.
2. Swivel link retained by manual release lever.
3. Anchor (from automatic parachute arming lanyard) retained by swivel link.
4. Manual release lever closed.

MANUALLY OPENED

1. Swivel link released by manual release lever (automatic release mechanism not actuated).
2. Anchor (from automatic parachute arming lanyard) freed from swivel link.

WARNING

If belt is manually opened during ejection, parachute will not open automatically upon separation from seat.

3. Manual release lever opened.

NOTE

Manual release lever can be used to unlock belt at any time, even if automatic-opening sequence has been initiated.

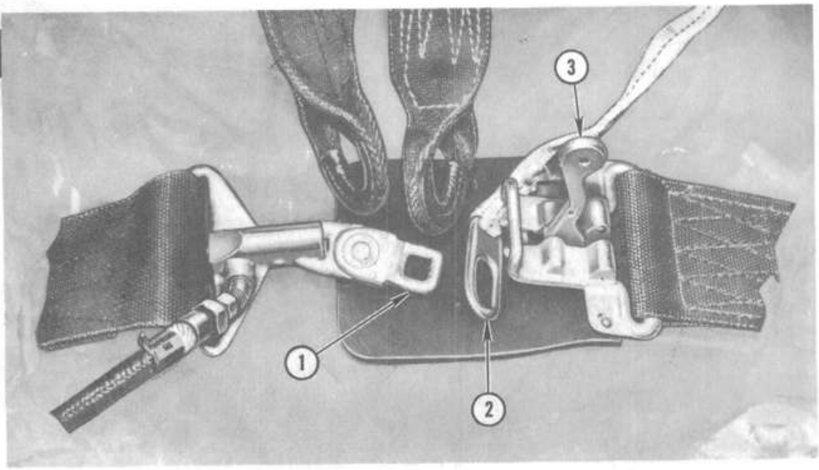


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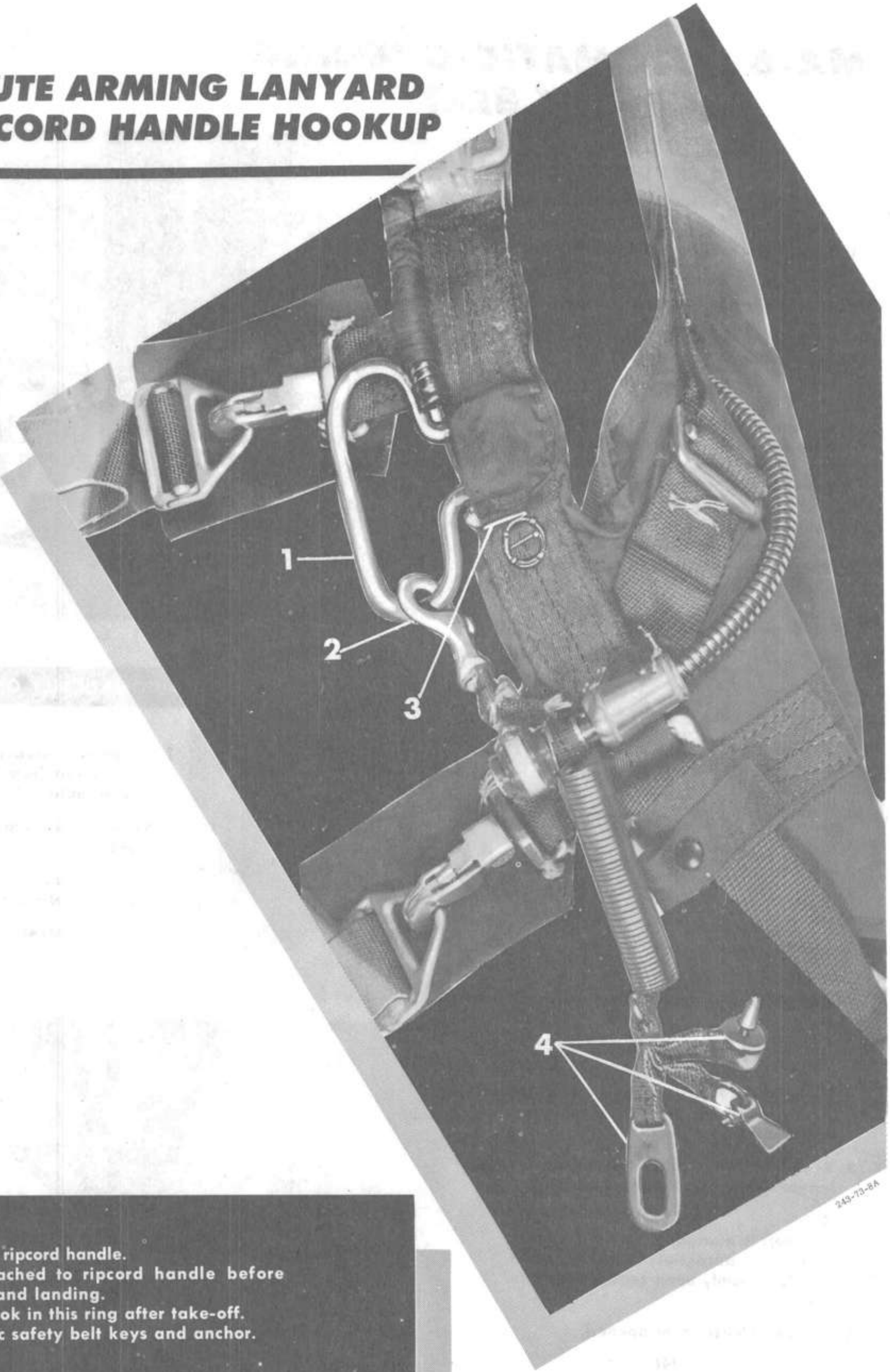
Figure 1-28 (Sheet 3 of 3)

PARACHUTE ARMING LANYARD AND RIPCORD HANDLE HOOKUP



1. Parachute ripcord handle.
2. Hook attached to ripcord handle before take-off and landing.
3. Retain hook in this ring after take-off.
4. Automatic safety belt keys and anchor.

F-86L-1-73-16A

Figure 1-28A

MA-3 Automatic-opening Safety Belt.

The MA-3 automatic-opening safety belt is a cartridge-operated device. Release of the MA-3 belt is accomplished either by manual operation by the pilot, or by gas pressure from a separate automatically controlled source (the M-12 initiator). The initiator supplies gas pressure through a high-pressure hose which actuates the release mechanism inside the belt. The release incorporates a key which is attached to a lanyard leading to the automatic ripcord release. The key provides an anchor for the static line to the timer of the automatic parachute. The release is designed so that the belt cannot be locked until the key is first inserted into the belt locking mechanism. The key is necessary for proper operation of the automatic belt. The key attached to the parachute lanyard is inserted into the belt locking mechanism. When the belt is manually opened, the key is ejected automatically so that inadvertent actuation of the automatic parachute will not occur. During automatic operation of the safety belt, the key remains firmly locked in the belt release, thereby arming the automatic parachute aneroid-timer as the pilot separates from the seat. Manual operation of the automatic belt can override the automatic function at any time. For example, it is possible to manually open the belt even though initiator action has started. The parachute automatic feature may likewise be overridden by manually pulling the parachute ripcord handle, even though the automatic parachute ripcord release has been actuated.

WARNING

If the safety belt is opened manually, the parachute *must* be opened manually. The aneroid-timer arming lanyard should be pulled to open the parachute, if above 14,000 feet.

Figure 1-28 shows the automatic belts closed with shoulder harness attached, automatically opened, and manually opened.

MA-6 Automatic-opening Safety Belt.

The MA-6 automatic safety belt (figure 1-28) is a cartridge-operated device. Release of the MA-6 belt is accomplished either by manual operation by the pilot, or by gas pressure from a separate automatically controlled source (the M-12 initiator). The initiator supplies gas pressure through a high-pressure hose which actuates the release mechanism inside the belt. The MA-6 belt is equipped with a swivel link which is designed to retain a ring-type anchor for actuating the automatic parachute. When the belt is fully locked, the swivel link is attached on one end to the manual release lever and on the other end to the automatic release. The swivel link is detached from the automatic release by actuation of the automatic release initiator. It is not mechanically necessary that the anchor, which slips over the manual release end of the swivel link, be used to close the belt. However, when the MA-6 belt is used in conjunction with an automatic parachute, the ring-type anchor *must* be attached to the parachute arming lanyard and then slipped over the swivel link in order for the parachute to function automatically when ejection is necessary. Figure 1-28 shows the MA-6 belt closed with shoulder harness and automatic parachute anchor attached, automatically opened, and manually opened. Manual operation of the automatic belt can override the automatic function at any time. For example, it is possible to manually open the belt even though initiator action has started. The parachute automatic feature may likewise be overridden by manually pulling the parachute ripcord handle, even though the automatic parachute ripcord release has been actuated.

WARNING

If the safety belt is opened manually, the parachute *must* be opened manually. The aneroid-timer arming lanyard should be pulled to open the parachute if above 14,000 feet.

LOW-ALTITUDE ESCAPE EQUIPMENT.

To provide an improved low-altitude escape capability, a system has been developed which incorporates a one-second delay safety-belt initiator and a zero-delay parachute arming lanyard (1-0 system) attached to the parachute ripcord handle. (See figure 1-28A.) The 1-0 system makes use of a detachable hook and lanyard that connects the parachute timer lanyard to the parachute ripcord handle. At very low altitude and airspeeds, the hook must be connected to the ripcord handle, thus providing parachute actuation immediately after separation from the ejection seat. At other altitudes and airspeeds, the hook must be disconnected from the ripcord handle, thus allowing the parachute timer to actuate the parachute below the parachute timer altitude setting. A ring, attached to the parachute harness, is provided for stowage of the hook when it is not connected to the ripcord handle. This "hookup" must be done manually. The hook configuration shown in figure 1-28A is one of several which will be in service use. Although each configuration differs in appearance, the attaching positions are the same. Refer to "Ejection" in Section III for maximum safe ejection speeds and emergency minimum ejection altitudes for ejection equipment. Figures 3-4 and 3-4A show ejection procedure and zero-delay lanyard connection requirements.

SERVICING DIAGRAM

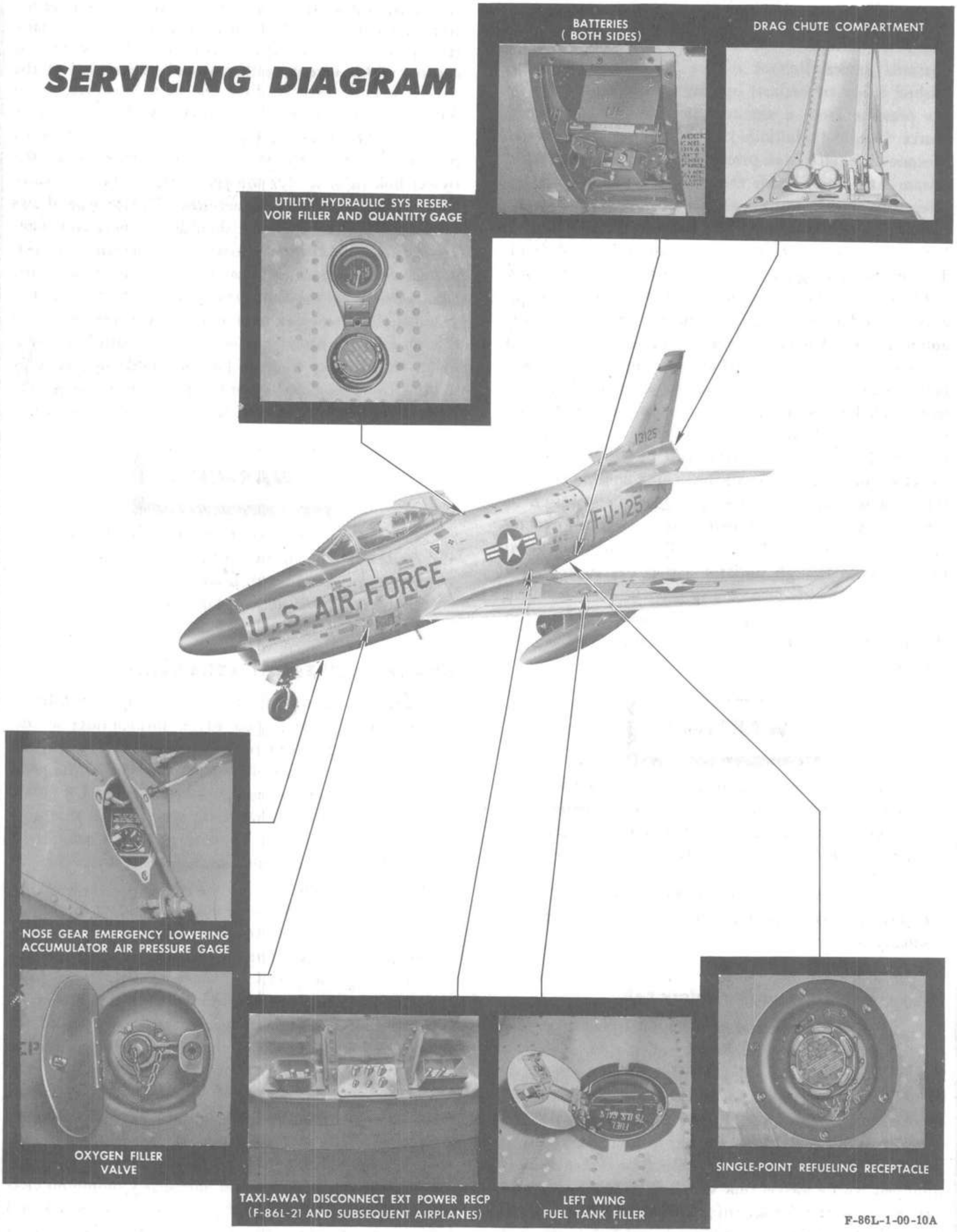


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Figure 1-29

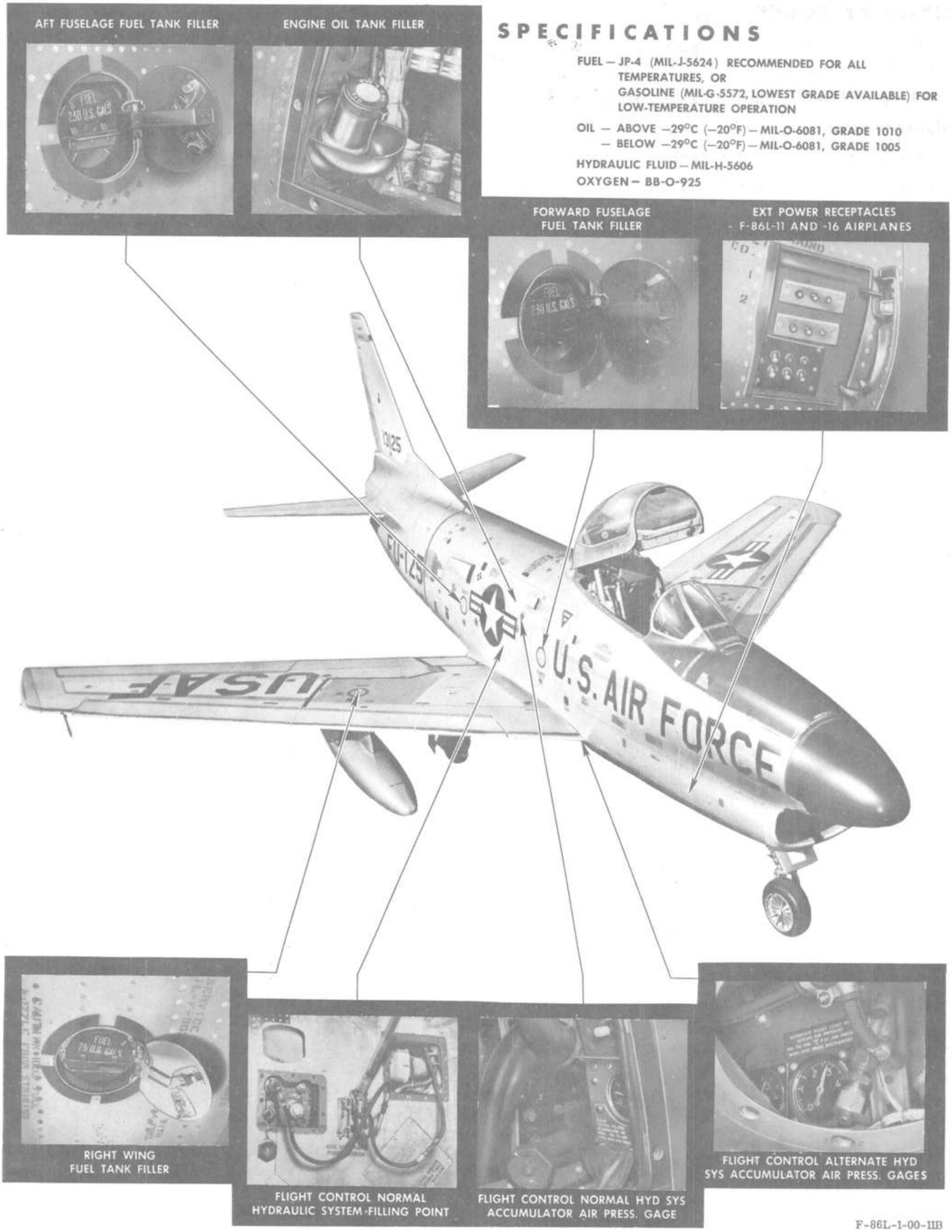
SPECIFICATIONS

FUEL — JP-4 (MIL-J-5624) RECOMMENDED FOR ALL TEMPERATURES, OR
GASOLINE (MIL-G-5572, LOWEST GRADE AVAILABLE) FOR LOW-TEMPERATURE OPERATION

OIL — ABOVE −29°C (−20°F) — MIL-O-6081, GRADE 1010
— BELOW −29°C (−20°F) — MIL-O-6081, GRADE 1005

HYDRAULIC FLUID — MIL-H-5606

OXYGEN — BB-O-925



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AUXILIARY EQUIPMENT.

The following auxiliary equipment is described in Section IV.

- Cockpit Air Conditioning and Pressurization System
- Radar Pressurization
- Anti-icing and Defrosting System
- Communication and Associated Electronic Equipment
- Lighting Equipment
- Oxygen System
- Autopilot
- Navigation Equipment
- Armament
- Fire Control System
- Miscellaneous Equipment

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Normal Procedures

SECTION II

TABLE OF CONTENTS PAGE

PREPARATION FOR FLIGHT.

FLIGHT RESTRICTIONS.

Refer to Section V for detailed airplane and engine operating limitations.

FLIGHT PLANNING.

The performance data in Appendix I is provided to determine fuel consumption and correct airspeed, power setting, and altitude necessary to complete the proposed mission.

TAKE-OFF AND LANDING DATA CARDS.

Refer to Appendix I for information necessary to fill out the Take-off and Landing Data Cards in T.O. 1F-86L-(CL)1-1, before each flight.

WEIGHT AND BALANCE.

Refer to Section V for weight and balance limitations. For loading information, refer to Weight and Balance Technical Manual, T.O. 1-1B-40. Before each flight, check the following.

1. Weight and balance—Check.

   Check take-off and anticipated landing gross weight and balance. Check Form 365F for weight and balance clearance. Make sure airplane is properly loaded with tanks and rockets for intended mission.

CHECK LISTS.

Refer to page iii for additional information on this subject. AFR 62-2 requires each flight crew member to refer directly to the check list during ground and flight operation except during taxi, take-off, landing, or critical emergencies. For these exceptions, the check list will be reviewed before the operation or afterward for "cleanup."

ENTRANCE.

After the canopy is opened by use of the external canopy button on the left side of the fuselage, the cockpit

EXTERIOR INSPECTION

Check all surfaces for crucks, distortion, loose rivets, and signs of damage; check for signs of hydraulic fluid, fuel, and oil leaks; check all access doors and panels and fuel filler cap secured; check tires for general condition, slippage, and proper inflation; and check position of gear doors, gear strut extension, and condition of the wheels.

Accumulator gage pressures (given on placards next to gage) are for 70°F. Pressures will be higher on hot days.

Starting at nose of airplane, make following checks:

*You may rely on your crew chief to check these items, if you desire. However, if preflight inspection or servicing was performed at a base where ground personnel are not completely familiar with your air plane, then you should check these items yourself.

1. NOSE
- Landing gear ground control switch **CLOSED**
- Rocket system ground switches **NORMAL** (if applicable)
- Radar access door secure (under fairing)
- Access panels secure (left side)
- Radome for condition and security
- Intake duct clear, except nose screen installed
- Landing light retracted
- Tow pin safety cap on hand-tight, wedge secure
- Oleo extension (4-5/16 inch at scissors)
- Nose gear steering unit for condition and security
- Nose gear tire for inflation, condition, and slippage
- Nose wheel chock removed
- Nose gear door switch and uplock
- Nose gear ground safety lock removed.
- Nose gear emergency extension accumulator air pressure [1200 (±50) psi] *
- Nose gear emergency selector valve reset *
- Access panels secure (right side)

2. WING CENTER SECTION AND RIGHT WHEEL WELL
- Alternate flight control accumulator air pressure [600 (+50, −0) psi]
- Alternate flight control compensator pin extension (1/4 inch to 1-1/4 inch)
- Brake pins for wear (1/8 inch minimum length) *
- Tire for inflation, condition, and slippage
- Brake disk for clearance
- Oleo extension (4-7/8 inch at scissors)
- Hydraulic leaks
- Gear uplock and door switch for condition
- Engine access door for security

3. TOP CENTER FUSELAGE
- Forward fuselage fuel tank cap secured, cover latched
- Utility hydraulic system quantity (in green), filler cap for security. (Caution—do not remove cap.) *
- Normal flight control accumulator air pressure [600 (+50, −0) psi]
- Oil quantity (tank cap and dip stick secure)
- Circuit breakers in (inside engine access door)
- Normal flight control compensator pin extension (1/4 inch to 1-1/4 inch)
- Access panels secure

4. RIGHT WING
- Wing fuel tank cap secure, cover latched
- Wing slats for freedom of movement
- Drop tank maintenance safety pin removed.
- Drop tank sway brace secure (if installed)
- Pitot cover removed
- Position light for damage
- Aileron and wing flap for damage
- Right drop tank fuel quantity, cap secure
- Wing skin condition

5. RIGHT AFT FUSELAGE
- Aft fuselage fuel tank cap secure, cover latched
- Battery connected *
- Speed brake for damage and hydraulic leaks
- Access panels secure

6. EMPENNAGE
- Control surfaces for any visual obstruction to movement
- Drag chute door secure, fly latched and indicator pin extended as far as indicator
- Position lights for damage
- Tail pipe and inner liner for cracks, distortion, and clearance
- Variable-nozzle, afterburner ring, and turbine wheel for condition

7. LEFT AFT FUSELAGE
- Fuel bayonet drain clear
- Speed brake for damage and hydraulic leaks
- Battery connected *
- Single-point refueling access panel secure
- Access panels secure

8. LEFT WHEEL WELL
- Brake pins for wear (1/8 inch minimum length) *
- Tire for inflation, condition, and slippage
- Brake disk for clearance
- Oleo extension (4-7/8 inch at scissors)
- Hydraulic leaks
- Gear uplock and door switch for condition
- Engine access door for security

9. LEFT WING
- Wing flap and aileron for damage
- Left drop tank fuel quantity, cap secure
- Position light for damage
- Wing slats for freedom of movement
- Drop tank sway brace secure (if installed)
- Drop tank maintenance safety pin removed.
- Wing fuel tank cap secure, cover latched
- Wing skin condition

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Figure 2-1

can be entered from either side of the airplane. A tubular metal ladder hooks over the cockpit ledge for normal entry into the cockpit. If a ladder is not available, the cockpit can be entered from the left side of the airplane by a telescoping step (released by a push latch) and two combination handhold and kickin steps. (See figure 2-2.)

Note

> After pilot entry, the ground crew manually stows the telescoping step.

PREFLIGHT CHECK.

BEFORE EXTERIOR INSPECTION.

1. Form 781—Check.
   Check Form 781 for engineering status, and make sure airplane has been serviced with required amounts of fuel, oil, hydraulic fluid, oxygen, and a drag chute for the mission. For servicing points, see figure 1-29.
2. Personal gear—Check.
   Make sure that personal equipment, parachute harness, anti-G suit, oxygen mask, helmet, and survival equipment is in good condition.

EXTERIOR INSPECTION.

Perform exterior inspection as outlined in figure 2-1.

CANOPY AND EJECTION SEAT CHECK.

Before entering cockpit, check canopy and ejection seat as follows:

1. Radar access panel—Check.
   Check that locking latches are down and locked.

ENTERING COCKPIT

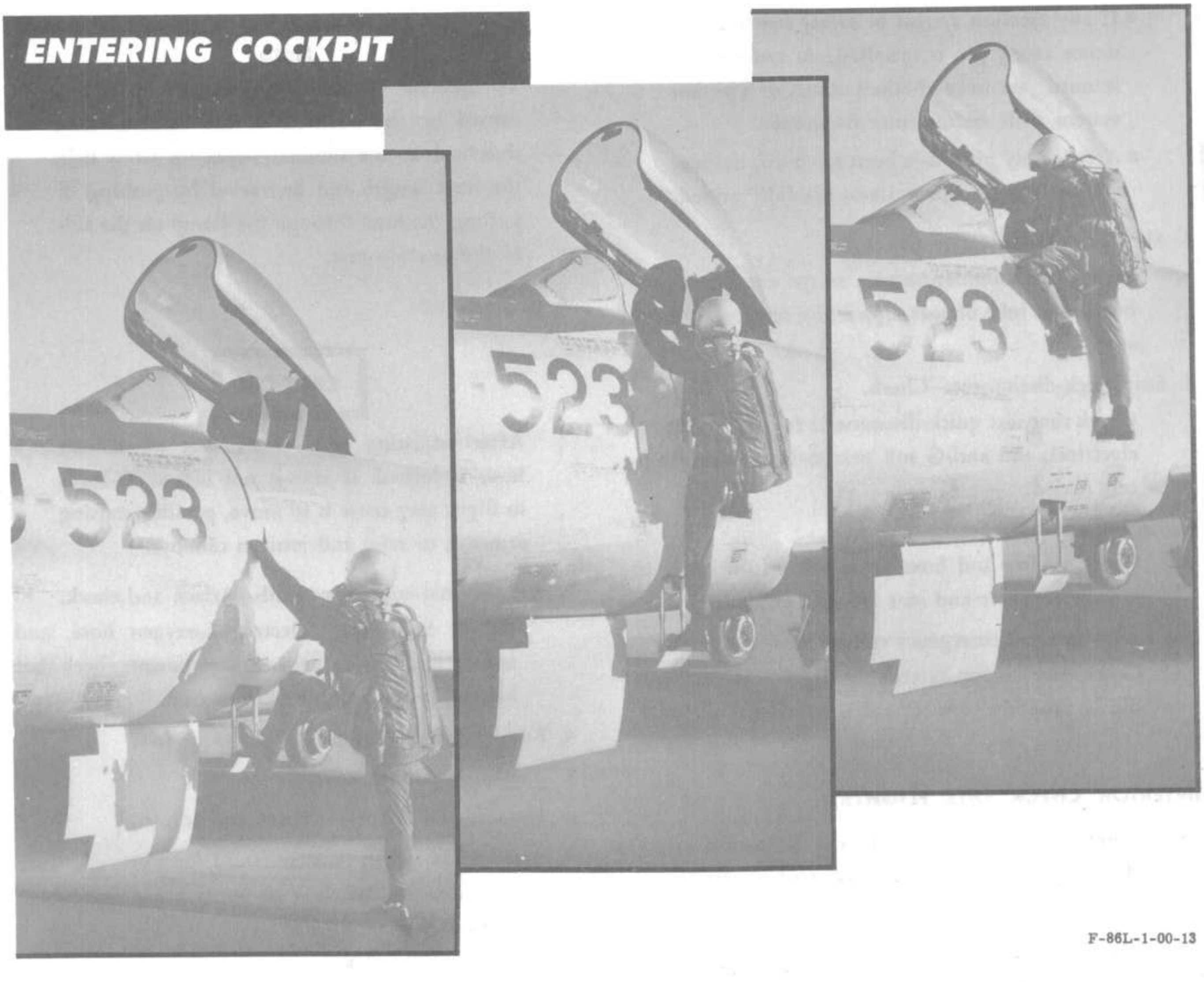

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Figure 2-2

1A. Handgrips and triggers—Check.

Check that seat handgrips are full down and latched.

2. Safety pins—Check.

Check that ground safety pin is installed in right seat armrest across trigger. Check that maintenance safety pin of canopy ejector initiator, on right side of cockpit below right console, has been removed. Check that maintenance safety pins of seat catapult initiators, on outboard side of seat under each armrest, have been removed. Check that maintenance safety pin has been removed from automatic-opening safety belt initiator, on aft upper left corner of seat tubular frame.

WARNING

- If any ejection system or safety belt maintenance safety pin is installed, do not remove it until you have checked status of ejection system with maintenance personnel.
- After safety pins have been removed, the seat and canopy ejection systems are fully armed.

3. Shoulder-harness strap—Check.

Make sure shoulder-harness straps are over upper horizontal tube of seat supporting structure behind seat.

4. Seat quick-disconnects—Check.

Check that seat quick-disconnects for oxygen, radio, electrical, and anti-G suit personal leads are properly mated.

5. Tubing and hose fitting—Check.

Check tubing and hose fittings from initiators to canopy remover and seat ejection catapult.

6. Canopy external emergency release handle—Check.

Check that canopy external emergency release handle is properly stowed and access door is closed.

INTERIOR CHECK (ALL FLIGHTS).

After entering the cockpit, make the following safety checks before making the left-to-right cockpit check.

Note

- The take-off and landing check lists are above the left and right consoles.
- The airplane is equipped with a ground crew intercom receptacle, on the left side of the fuselage, near the telescoping step.

1. Safety belt (shoulder harness and lanyard to safety belt), and zero-delay lanyard hook—Secured (inertia-reel handle UNLOCKED).

CAUTION

Make sure that the automatic-opening safety belt is properly fastened, chute arming lanyard is properly attached to the safety belt latching mechanism, and zero-delay lanyard hook is attached to the ripcord handle to ensure proper operation of this equipment if ejection is necessary. Refer to "Automatic-opening Safety Belt" in Section I for proper procedures for the various types of belts.

Note

To prevent possible interference problems caused by the position of the initiator hose that leads to the automatic-opening safety belt, the hose length can be varied by pushing or pulling the hose through the clamp on the side of the ejection seat.

2. Seat—Adjust.

CAUTION

After adjusting seat, check that adjustment lever is locked. If seat is not locked, G-loads in flight may cause it to move, possibly causing armrests to raise and jettison canopy.

3. All personal equipment leads—Attach and check.

Attach radio lead, electrical, oxygen hose, and anti-G suit hose to personal equipment; check that bail-out oxygen bottle is connected.

4. Rudder pedals—Adjust.
5. Armament master switch—OFF.
6. Throttle and friction—CLOSED and adjust.
7. Speed brake switch—Center (OFF) position.

(Speed brake switch at IN position for "scramble" take-offs.)

8. Engine master switch—OFF.
9. Battery switch—OFF.

10. Circuit breakers—IN.

Note

For "scramble" take-offs, make sure the areas around the speed brakes and wing flaps are clear of equipment and personnel before external power is plugged in and engine is started.

11. External electrical power source—Plugged in.
    Make sure that power source is capable of 28-volt, 1200-ampere surge and a continuous current of 500 amperes. Connect to both dc receptacles for starting or to both dc receptacles and the ac receptacle for starting and ground operation of radar equipment.

Note

External power units suitable for use on this airplane are the A3, A4, C-22, C-26, and V-1 (if they have been maintained to produce their rated output). However, the A4 and V-1 require a separate source for supplying ac power.

After completing the afore-mentioned safety checks, make a left-to-right check around cockpit on the following items.

12. Interior and exterior lighting—Check as required.
13. Drop tank air pressure shutoff valve—Check.
    Drop tank air pressure shutoff valve ON if tanks are installed; OFF if tanks are not installed.
14. Anti-G suit pressure regulating valve—As desired.
15. E-4 test switch—OPERATE.

15A. Ventilating suit switch—As desired.
    The ventilating suit switch is installed on airplanes changed by T.O. 1F-86-563.

16. Map case—Check.
    Flight Handbook, Radio Facilities Charts, Pilot's Handbooks—Jet, and other necessary publications and charts available for intended mission.
17. Rudder control lock handle—Check.
    Rudder control lock handle unlocked (push down).

CAUTION

Do not twist rudder control lock handle, as this could cause damage or cause a malfunction of the locking system.

18. Stand-by sight switch—OFF.
19. Stand-by sight rheostat—OFF.
20. Command radio (UHF)—OFF.
21. Identification-combat approach switch—COMBAT.
22. Rocket package override switch—Center (OFF) position.

    Turn armament master switch to FIRE 0. If rocket package is up and locked, the rocket-package-up indicator light will come on. Return armament master switch to OFF.
23. Manual ram-air valve—CLOSED.
    Make sure that lever is fully locked closed.
24. Ventilation air control—As desired.
25. Alternate trim switch—Check.
    Check for operation and check that switch returns to OFF (center).
26. Normal trim system—Check.

    Check rudder trim tab movement visually and return switch to OFF position. Using normal trim switch (on stick grip), check horizontal tail and ailerons for normal operation. As the ailerons or horizontal tail artificial feel spring bungees are repositioned, the control stick moves, resulting in corresponding movement of the ailerons or horizontal tail.
27. Flight control switch—NOR.

Note

Only the flight control alternate hydraulic system operates until after the engine has been started and the flight control switch momentarily placed at RESET and released to NORMAL.

28. Rocket firing switch—AUTOMATIC.
29. Wing flap handle—UP. (Wing flap handle DOWN for scramble take-off.)
30. Radar master siwtch—DISCONN.
31. Landing gear handle—DOWN.
    Depress horn cutout button to check warning light in gear handle and unsafe warning light placard.
32. Landing gear indicators—Check.
33. Variable-nozzle switch—AUTO.
    Check nozzle through operating range. Set nozzle at ¾ and then select AUTO.

34. Afterburner shutoff switch—NORMAL.
35. Emergency fuel system switch—NORMAL.
36. Engine screen switch—EXTEND.
37. Air start switch—NORMAL.
38. Landing and taxi light switch—Center (OFF) position.
39. Accelerometer—Reset.
40. Drag chute handle stowed—Full in.
41. Directional indicator fast slave switch—NORMAL.
42. Airspeed and Mach number indicator—Check and set.

    Set airspeed and Mach number indicator landing speed index.
43. Directional indicator—Check.

    Check for stabilization of needle and make sure that a 180-degree error in reading against the stand-by compass does not appear 3 to 4 minutes after power is applied.
44. Attitude indicator—Check.

    Check erection and retraction of warning "OFF" flag.
45. Fire-warning circuits—Check.
46. Vertical velocity indicator—Check at zero.
47. Marker beacon light—Check.
48. Altimeter—Set to field elevation.
49. Clock—Check and set.
50. "ILS-TACAN" switch—ILS.
51. Fuel quantity—Check.
52. Fuel quantity gage test switch—Check.
53. Radarscope intensity controls—Check.

    Turn intensity controls down and check transmitter-off light.
54. Flight control emergency handle—Fully in.
55. Drop tank emergency jettison handle—Fully in.
56. Landing gear emergency release handle—Fully in.
57. Generator switches—ON.
58. Windshield and radome anti-ice switches—OFF.
59. Surface and engine anti-ice switches—OFF.
60. Alternator switch—ON.
61. Inverter selector switch—SPARE.
62. Hydraulic pressure gage selector switch—ALTERNATE.
63. Pitot heat switch—ON, then OFF.

    Check operation with crew chief.

WARNING

Warm-up time for the pitot heater is about one minute at 32°F. Allow sufficient heating time if taking off into freezing rain or other visible moisture with surface temperature at or near freezing.

64. Stand-by compass—Check.
65. Windshield and canopy defrost lever—DEC.
66. Stand-by compass and accelerometer light switch—As desired.
67. Yaw damper switch—OFF.
68. Automatic approach coupler controls—OFF.
69. Oxygen system—Check.

    Oxygen regulator supply lever safetied at ON and pressure at 400 psi, diluter lever at NORMAL OXYGEN, and emergency lever at center (OFF) position. Check system operation. (Refer to "Oxygen System Preflight Check" in Section IV.)

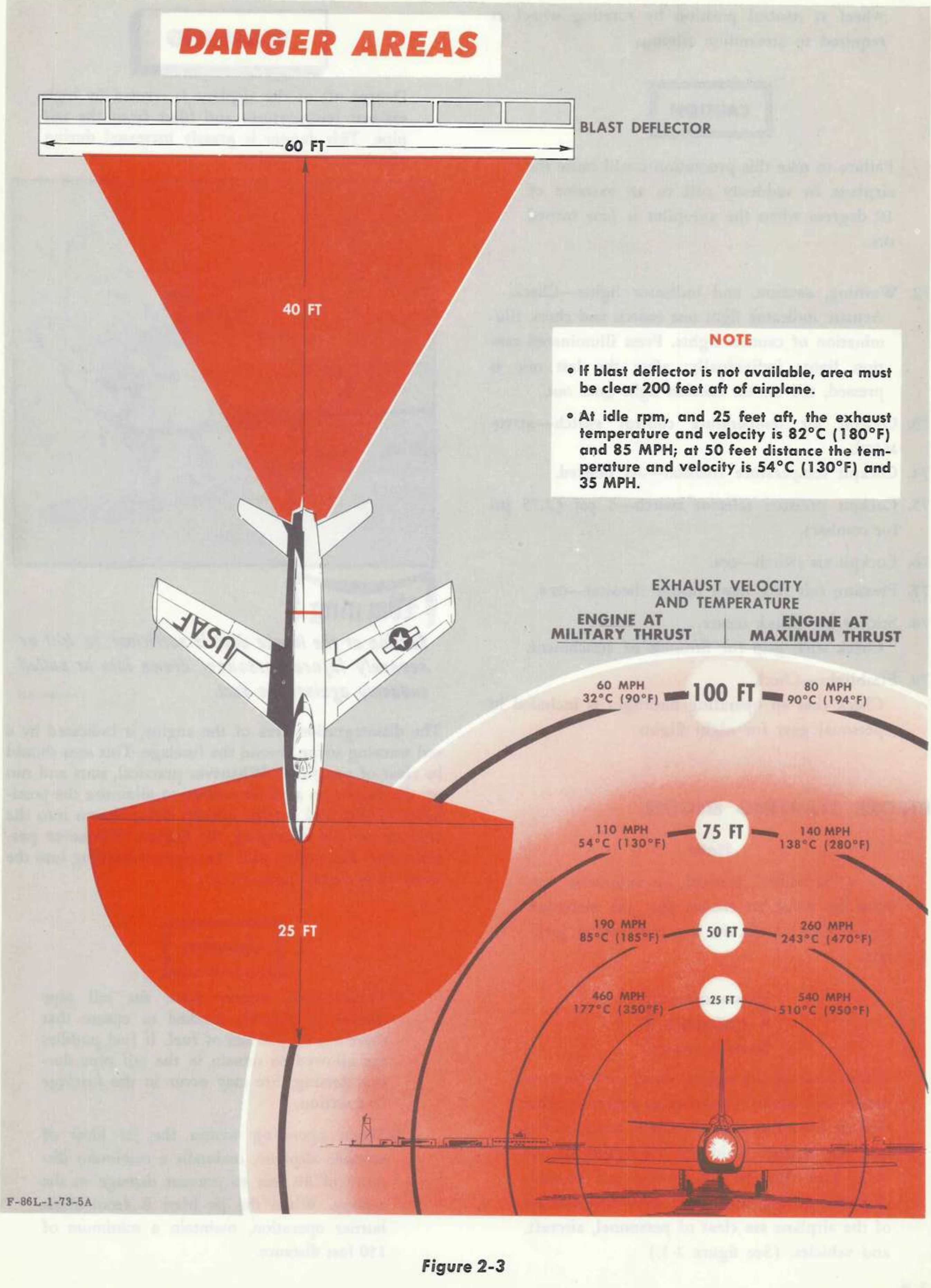
WARNING

If the airplane is to be operated on the ground under possible conditions of carbon monoxide contamination, such as taxiing directly behind another operating jet airplane or during operation with tail into wind, use oxygen with the regulator diluter at 100% OXYGEN.

70. Navigation and communication equipment—Check, then turn OFF.

    Check tower, approach control, GCI, GCA, and FAA radio frequencies. Set omni radio to first station en route.
71. Automatic pilot system—Check.

    Place autopilot power switch ON; then, with autopilot engaging switch ON, set autopilot roll trim



DANGER AREAS

NOTE

- **If blast deflector is not available, area must be clear 200 feet aft of airplane.**
- **At idle rpm, and 25 feet aft, the exhaust temperature and velocity is 82°C (180°F) and 85 MPH; at 50 feet distance the temperature and velocity is 54°C (130°F) and 35 MPH.**

Figure 2-3

wheel at neutral position by rotating wheel as required to streamline ailerons.

CAUTION

Failure to take this precaution could cause the airplane to suddenly roll to an extreme of 10 degrees when the autopilot is first turned ON.

72. Warning, caution, and indicator lights—Check.
    Actuate indicator light test switch and check illumination of caution lights. Press illuminated caution lights individually; after the last one is pressed, the master caution light goes out.
73. Cockpit air temperature control switch—AUTOMATIC.
74. Cockpit temperature rheostat—As desired.
75. Cockpit pressure selector switch—5 psi (2.75 psi for combat).
76. Cockpit air switch—ON.
77. Pressure suit face mask heater rheostat—OFF.
78. Stick grip—Check secure.
    Check stick grip for firmness of attachment.
79. Flashlight—Check.
    Check that an operating flashlight is included in personal gear for night flights.

BEFORE STARTING ENGINE.

Note

For a "scramble" take-off, an automatic start must be made to ensure that the electronic engine control circuits are functioning properly.

CAUTION

Before starting the engine, make sure the nose intake duct screen is installed to prevent engine damage caused by foreign objects being sucked into the engine. Hold the toe brakes on, or make sure that the main wheels are securely chocked and that all danger areas fore and aft of the airplane are clear of personnel, aircraft, and vehicles. (See figure 2-3.)

WARNING

Danger aft of the airplane is created by high exhaust temperatures and blast from the tail pipe. This danger is greatly increased during afterburner operation.

Warning

Suction at the intake duct is sufficient to kill or severely injure personnel drawn into or pulled suddenly against the duct.

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The disintegration area of the engine is indicated by a red warning stripe around the fuselage. This area should be clear of personnel. Whenever practical, start and run up the engine on a paved surface to minimize the possibility of dirt and foreign objects being drawn into the compressor and damaging the engine. Whenever possible, start the engine with the airplane heading into the wind or at right angles to it.

CAUTION

- Before every engine start, the tail pipe should be visually checked to ensure that there are no puddles of fuel. If fuel puddles are allowed to remain in the tail pipe during starting, fire may occur in the fuselage rear section.
- When operating within the jet blast of another airplane, maintain a minimum distance of 80 feet to prevent damage to the canopy. When the jet blast is from afterburner operation, maintain a minimum of 150 feet distance.

STARTING ENGINE.

AUTOMATIC START.

Note

- The automatic start procedure is normally used for all operational and training missions.
- The spare inverter will be used during engine starting to reduce ground operational check-out time. This will provide a check of the spare inverter and simplify the automatic lockup check procedure.

Start the engine as follows:

Note

See figure 5-1 for exhaust temperature limits.

1. Recheck throttle—CLOSED.
1. Battery switch—ON.
3. Inverter circuit breakers in, inverter caution light out—Check.

    The starting circuit is held open if inverter power is not available.

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4. Variable-nozzle switch—AUTO.

   Check through operating range, set at ¾ position, then back to AUTO.

Note

When the variable-nozzle switch is held in the OPEN or CLOSE position until the nozzle is either full open or full closed and then released, the indicating needle will experience a spring-back because of a design characteristic of the instrument.

5. Engine master switch—ON.

5A. Engine control lockup light—Out.

   Check that lockup light is out to ensure that electronic fuel control has warmed up.

5B. Emergency fuel system switch—ON.

   Check for 10°C to 100°C drop on exhaust temperature gage.

5C. Emergency fuel system switch—NORMAL.

   Check for 10°C to 100°C rise on exhaust temperature gage.

CAUTION

If no fluctuation of the exhaust temperature gage is noted during steps 5B and 5C, the temperature sensing circuit is not functioning properly. Therefore, do not attempt a start. This check confirms proper functioning of the start circuit portion of the main fuel amplifier. However, it will still be essential to monitor the fuel flowmeter very closely to ensure that the start temperatures will remain within limits.

6. Starter switch—Hold momentarily at START position, and then release to OFF.

CAUTION

- If the engine control lockup caution light comes on as the starter is energized, continue the automatic start by advancing the throttle to START IDLE at 6% rpm, as usual, because lockup protection is now provided during automatic starting.
- If the lockup caution light comes on at any time during an automatic start and does not go out within about 30 seconds, retard the throttle to CLOSED and investigate before making another start attempt.
- The high current required for starting will burn out the starter in a matter of seconds if the engine doesn't "turn over" as soon as the starter is energized. If there are no audible indications of engine rotation, or if there is no response on the tachometer within a few seconds, move the starter switch to STOP STARTER immediately.

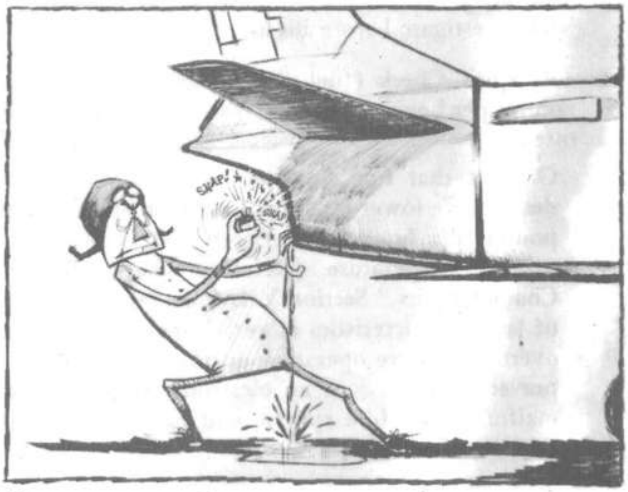
7. 5% rpm—Check for minimum of 18 volts.

7A. Oil pressure—Check.

   If there is no visible indication of oil pressure shut down and investigate.

8. 6% rpm—Advance throttle rapidly to START IDLE.

   The fuel flow rises to about 900 to 1000 pounds per hour and stabilizes at about 600 pounds per hour. Exhaust temperature rises and stabilizes at about 600°C (700°C on -33 engines).



Warning

If ignition does not occur within 15 seconds, close throttle and move starter switch to stop start position. Wait 3 minutes, to allow drainage of fuel from combustion chambers and tailpipe, before attempting restart.

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Note

During automatic starts, the fuel flow indication in the cockpit precedes the exhaust gas temperature indication by about 3 seconds. For this reason, the fuel flow indication gives a more rapid indication of the engine start than does the exhaust temperature. Using the fuel flowmeter as a primary instrument and observing the exhaust temperature allows a start to be aborted before an overtemperature condition can take place.

9. 12% rpm—Exhaust temperature should decline slightly.

   The fuel flow will remain steady.

10. 14% rpm—Fuel flow and exhaust temperature start to rise.

   Observe that fuel flow starts to rise to about 950 pounds per hour, and exhaust temperature starts to rise and will peak at about 815°C (maximum of 850°C).

11. 14% to 40% rpm—The fuel flow continues to rise slowly to about 1500 pounds per hour and exhaust temperature remains at about 815°C (with a possible momentary or maximum peak of 850°C).

CAUTION

The rise to 815°C exhaust temperature should occur before 18% rpm is reached; if it does not, chop the throttle to CLOSED immediately and investigate before flight.

12. 40% rpm—Check (fuel flow between 800 and 1300 pounds per hour, 400°C and 600°C exhaust temperature).

    Observe that fuel flow and exhaust temperature decline to a lower reading of between 800 and 1300 pounds per hour and between 400°C and 600°C exhaust temperature. (Refer to "Automatic Start Characteristics," Section VII. Complete knowledge of such characteristics is very important if engine overtemperature operation during starting is to be prevented in case of an electronic engine control malfunction.) Idle rpm should be about 40% on the main fuel system.

WARNING

- If cockpit indications depart from these normal trends (and continue to rise), retard throttle to CLOSED position, move stop-starter switch to STOP STARTER position, and investigate. Failure to accomplish a satisfactory automatic start shows a control system malfunction, and the airplane should not be flown until an investigation is made to isolate and replace the faulty component. The inability to accomplish an automatic start does not necessarily mean that the faulty component is used only during the starting cycle, nor does it mean a "hot start" need occur.

WARNING

- During engine starts up to idle rpm (within 2 minutes), exhaust temperatures of 950°C or above for 2 seconds or more constitute an overtemperature operation and require engine removal.
- For all engine operations (except starting), exhaust temperatures of 690°C to 750°C for 40 seconds or more, temperatures of 750°C to 800°C for 10 seconds or more, and temperatures above 800°C for 2 seconds or more constitute overtemperature operation.
- The duration and degree of all overtemperature must be entered in the Form 781.

Note

On throttle bursts from about 90% rpm to Military Thrust, exhaust temperature encountered during the transient condition may be higher than that experienced during throttle bursts from lower thrust settings. However, check that exhaust temperature limits are not exceeded.

WARNING

- The starter is limited to three consecutive starts of one minute duration per start, with a 3-minute cooling period between starts. If more than three starts are required, allow the starter to cool 30 minutes before using it again.
- If the engine speed does not reach 25% rpm in one minute, shut down the engine and investigate the cause. Excessive operation below 25% engine rpm can cause extensive damage to the starter and engine.
- If the starter should become de-energized before the engine reaches about 20% rpm, shut down the engine immediately. No attempt to accelerate the engine should be made.

Note

It is unnecessary to use the stop-starter switch to disengage the starter after starts, since the starter relay is designed to cut out automatically at about 25% rpm.

13. Oil pressure—Check (12 psi minimum).

    If there is no sign of oil pressure within 30 seconds, shut down engine and investigate.

14. Engine instruments—Check for desired readings.
15. External power—Disconnect.
16. Generator caution lights out—Check.

START ON EMERGENCY FUEL SYSTEM.

When it is necessary to use the emergency fuel system for engine start, observe the same cautions and warnings as during an automatic start. Start the engine as follows:

1. Recheck throttle—CLOSED.
2. Battery switch—ON.
3. Inverter circuit breakers in and inverter caution light off—Check.
4. Variable-nozzle switch—AUTO.
   Check through operating range, set at ¾ position then back to AUTO.
5. Engine master switch—ON.
6. Emergency fuel system switch—ON.

CAUTION

If the generator voltmeter reading drops below 15 volts during the start, immediately abort the start by actuating the stop-starter switch; otherwise, the relays in the starter-controller and generator circuits may be damaged. If the voltmeter reading does drop below 15 volts during the start, external power unit output is inadequate. Therefore, have the external power unit replaced by a suitable unit before a subsequent start attempt.

7. Starter switch—Hold momentarily at START, and then release to OFF.
8. At 6% rpm—Advance throttle about halfway to START IDLE.
9. As fuel flow rises—Observe ignition.
   Regulate throttle to maintain 400 to 500 pounds per hour fuel flow until ignition occurs, as shown by a rise in exhaust temperature.
10. When ignition occurs—Move throttle to START IDLE without exceeding 750°C.
    Use both hands to regulate throttle when moving it to START IDLE to maintain 700°C to 750°C exhaust temperature.

CAUTION

- Do not make excessively cool starts; try to maintain recommended temperatures. Cold starts prolong the starting period, put excessive loads on the starter-generator unit, and give a poor airflow through the combustion chambers at low rpm.
- When a hot start occurs, shut down the engine immediately. If smoking or fire persists, engage the starter with throttle closed for about 20 to 30 seconds to clear the engine of excess fuel.

11. Engine instruments—Check for desired readings.
12. External power—Disconnected.

CAUTION

After the start is made, check that the engine control lockup caution light is out, showing that the electronic engine control amplifiers are warmed up enough to permit operation on main fuel system.

13. Emergency fuel system switch—NORMAL.
    Engine should stabilize at about 40% rpm.

CAUTION

If the engine operates abnormally with the emergency fuel system switch at NORMAL, return the switch to ON and check for correct position of the power switches and circuit breakers.

GROUND OPERATION.

No engine warm-up is necessary. As soon as the engine stabilizes at idling speed with normal gage readings, the throttle may be opened to full power. Idle rpm should be about 40% on the main fuel system, but varies slightly with the setting of each individual airplane.

CAUTION

During any engine operation at idle rpm, check that the engine control lockup caution light and the emergency fuel system caution light are not on before throttle advancement. If the caution lights are on, cautiously advance the throttle to an rpm slightly above idle and wait for the engine control lockup caution lights to go out. Then move the emergency fuel system switch to ON and back to NORMAL to return the engine control to the main fuel control system.

Note

Be sure the wheels are firmly chocked and, also, hold the toe brakes on. This airplane is not equipped with parking brakes.

The following checks of the flight control and utility hydraulic systems are necessary to ensure proper operation of the systems:

GENERATOR LOADMETER DIFFERENTIAL CHECK.

1. Generators—Check at 55% rpm.

   Check that loadmeter differentials do not vary more than 10 percent from each other and that voltmeter shows about 28 volts (generators do not generate below about 37% rpm). The loadmeter reading should be about 0.6; if the indication is above this, the system should be checked before flight.

AUTOMATIC LOCKUP SYSTEM CHECK.

Before the first flight of the day, the operational check of the inverter change-over and the electronic engine control automatic lockup system may be made, using the following procedures:

1. Exhaust nozzle full open—Check.

   With variable-nozzle switch, jog exhaust nozzle full open. Leave switch at OFF.

2. Throttle—Advance to 55% rpm.
3. Inverter selector switch—MAIN.

   Lockup caution light should come on.

Note

Placing the inverter selector switch at MAIN de-energizes the spare inverter and transfers operation to the main inverter.

4. (Deleted)
5. Throttle—START IDLE.

CAUTION

When retarding throttle to START IDLE, be careful not to actuate the idle-detent switch, thus preventing energizing the emergency fuel system.

6. Variable-nozzle switch—AUTO.

   Note that rpm and variable-nozzle position remain constant, indicating engine controls are in lockup condition.

7. Note time for recovery of engine controls—Check.

   With throttle at START IDLE, the lockup caution light should go out approximately 10 to 25 seconds after the inverter caution light goes out. When the lockup caution light goes out, an abrupt reduction in rpm (to about 40%) and the automatic closing of the variable-nozzle to one-half position (about the three-quarter position on some airplanes) takes place. Engine control is restored by the automatic lockup system when the main inverter again supplies power to the electronic engine controls.

Note

The exhaust nozzle should close from full open to the one-half position (or three-quarter position on some airplanes) within 3 seconds after the lockup caution light goes out.

8. Radar master switch—STDBY.

FLIGHT CONTROL HYDRAULIC SYSTEM CHECK.

Note

The flight control alternate hydraulic system becomes operative automatically when external power is applied. It remains engaged until the flight control normal hydraulic system is manually selected after the engine is started.

1. Throttle—START IDLE.
2. Hydraulic pressure gage selector switch—NORMAL.
3. Flight control switch—RESET.

   Engage flight control normal hydraulic system by holding flight control switch at RESET momentarily. Check that alternate system caution light is out.

CAUTION

When checking the control surface movement on both normal and alternate systems, check the rate of travel of the control stick by rapid, full-travel movements of the stick. If the rate is slower than normal, as determined by experience, have the ground personnel check the systems to determine the malfunction. (Refer to "Hydraulic Systems," Section VII.)

4. Flight control normal hydraulic system—Check.
   a. Flight control switch—NOR.
   b. Control stick—Move.
   Visually check for proper surface movement.
   c. Pressure—After 5 seconds, 2850 to 3200 psi (control stick not in motion).
5. Flight control alternate hydraulic system—Check.
   a. Flight control switch—ALT.
   b. Alternate system caution light—ON.
   c. Hydraulic pressure gage selector switch—ALTERNATE FLIGHT CONT.
   d. Control stick—Move, and check pressure drop on alternate system.
   Visually check for proper control surface movement.
   e. Pressure—2550 to 3200 psi (control stick not in motion).

Note

The alternate system pressure should slowly fluctuate between the maximum limits of 2550 and 3200 psi, because of the designed leakage in the flight control actuators causing the alternate system hydraulic pump to cycle on and off.

   f. Flight control switch—RESET.
   Momentarily hold flight control switch at RESET

and then release. Check that alternate system caution light is out.

6. Flight control system manual emergency (override) system—Check.

Note

The following check is to be made before the first flight of the day and when advised by ground personnel that maintenance has been performed on the flight control alternate hydraulic system.

a. Flight control switch—Hold at RESET.

b. Flight control emergency handle—Pull to full extension (about 2½ inches).

Holding the flight control switch at the RESET position opens the electrical circuit to the flight control system transfer valves. This ensures that the normal system transfer is held in the closed position and that the alternate system transfer valve is held in the open position by the mechanical flight control manual emergency control only. The alternate caution light should not be on.

Note

With the flight control emergency override handle pulled out, the gage pressure should not change when the flight control switch is positioned at RESET or released to NORMAL.

c. Control stick—Move, and check pressure drop on alternate system.

Visually check for proper control surface movement while holding switch at RESET.

d. Flight control switch—NOR.

e. Alternate system caution light—ON (indicating electrical circuit complete).

f. Pressure—3050 to 4000 psi.

Pressure should remain constant (except for momentary surges) at a value between the maximum limits of 3050 and 4000 psi (control stick not in motion).

7. Flight control emergency handle—In.
8. Pressure—2550 to 3200 psi (control stick not in motion).

Note

Because of the tolerances of the alternate system relief valves and the pressure indicating system, the pressure may exceed the red limit value (3200 psi) and may even reach 4000 psi when the manual emergency handle is actuated. These pressures are considered normal for this part of the alternate system operation.

9. Automatic return to flight control normal system—Check.

a. Control stick—Move rapidly.

b. Alternate system caution light—Out.

Check that light goes out within range of 575 to 775 psi, indicating that normal system is again in control.

c. Hydraulic pressure gage selector switch—NORMAL.

d. Pressure—2850 to 3200 psi (control stick not in motion).

UTILITY HYDRAULIC SYSTEM CHECK.

1. Hydraulic pressure gage selector switch—UTILITY.

Check pressure indicator on gage.

2. Speed brakes—Check.

Run speed brakes through one complete cycle. Close speed brakes and return switch to NEUTRAL position. Have ground crew check for proper operations.

WARNING

Before operating the speed brakes, be sure the fuselage rear section around the speed brakes is clear, because the brakes operate rapidly and forcefully and could injure any personnel near the brakes.

3. Pressure—Approximately 3000 psi.
4. Hydraulic pressure gage selector switch—NORMAL.

Switch should be maintained at NORMAL except when pressure checks of the other hydraulic systems are made or when monitoring another system because of a suspected or known malfunction.

(Deleted)

TRIMMED FOR TAKE-OFF INDICATOR LIGHT CHECK.

1. Take-off trim—Check.

Horizontal tail, ailerons, and rudder trimmed individually until take-off position indicator light comes on.

Note

The ground crew check of the horizontal stabilizer is facilitated by a white triangle painted on the left side of the fuselage. When the stabilizer is at the proper take-off trim setting, the leading edge is aligned with the aft apex of the triangle.

WING FLAP CHECK.

1. Wing flap handle—DOWN.

BEFORE TAXIING.

CAUTION

Before taxiing, the radar master switch will be placed in the STBY or OPER position for a period of not less than 2 minutes to prevent damage to the gyro suspension points.

1. Altimeter—Set to field pressure.

Check that 10,000-foot pointer is correctly set and note error against field elevation; consider this when resetting altimeter in flight.

WARNING

If altimeter error is more than 75 feet, do not accept the airplane.

1A. Communication and navigation equipment—ON.

2. Anti-icing switches—ON (as required).

Note

With the surface anti-icing system on, the engine anti-icing is in operation and the intake screens are automatically retracted.

3. Pitot heat switch—ON (as required).

4. Safety belt and shoulder harness—Secured; inertia reel handle UNLOCKED.
5. Ground safety pin—Remove.

WARNING

After the ground safety pin has been removed, the seat and canopy ejection systems are fully armed.

6. Main wheel chocks—Removed.
7. IFF master switch—STDBY.

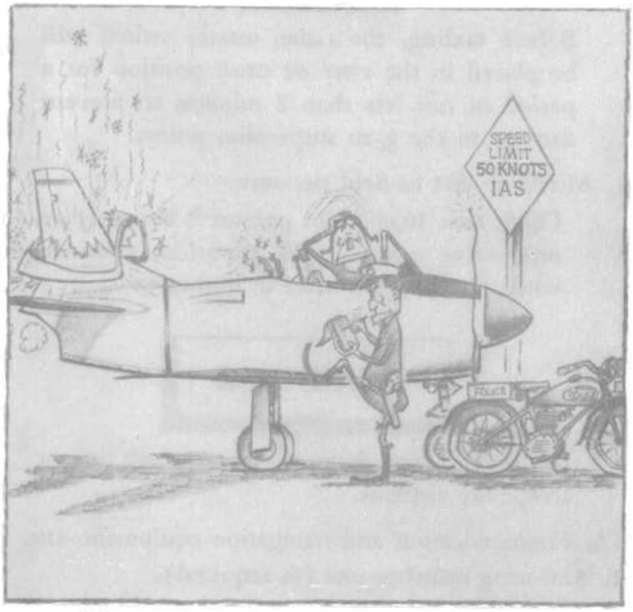
TAXIING.

Observe the following rules for taxiing:

WARNING

Maintain a minimum distance of 80 feet from the exhaust blast of any other airplane that is operating at Military Thrust, to prevent damage to canopy. When the blast is from afterburner operation, the minimum distance should be 150 feet.

1. Taxi at lowest practical rpm.
   Once the airplane is moving, it can be taxied with the throttle in the START IDLE position (about 40% rpm) on a hard surface. This setting provides enough cooling air for the generators.



CAUTION

Do not exceed canopy-open speed limit of 50 knots IAS while taxiing; otherwise damage to canopy mechanism may result. F-86L-1-0-8

2. Nose wheel steering—Engage.
   Maintain directional control through steerable nose wheel by use of rudder pedals; hold steering button depressed to obtain nose wheel steering action. The nose wheel and rudder pedal position must be coordinated before the steering mechanism can engage if the nose wheel is not centered.

CAUTION

If the turn must be made tighter than the nose wheel steering permits, disengage the nose wheel steering and continue the turn using the brakes only.

3. Taxi time—Minimize.
   Airplane range is considerably decreased by high fuel consumption during taxiing. Fuel consumption during taxi is about 3 gallons per minute (20 pounds per minute) with engine at 40% rpm.
4. Oxygen regulator diluter lever—As required.
   If airplane is to be operated on the ground under possible conditions of carbon monoxide contamination, such as taxiing directly behind another jet airplane or during operation with tail into the wind, use oxygen with diluter lever at 100% OXYGEN.
5. Flight indicators—Check.
   Perform operational check of all flight (gyro) indicators during taxiing.

BEFORE TAKE-OFF.

SCRAMBLE TAKE-OFF CHECK.

An automatic start must be made for a scramble take-off. The following checks are the only ones that are mandatory before take-off:

1. Flight control switch—ALT.
   Check for proper movement on alternate system.
2. Flight control switch—Hold at RESET momentarily.
3. Flight controls—Check for proper response on normal system.
4. Canopy—Closed and locked.
5. Position—Lined up for take-off.
6. Throttle—Advance rapidly to MILITARY (throttle burst).
7. Emergency fuel system—Check.
8. Afterburner—Check that engine stabilizes normally in afterburner before releasing brakes.

PREFLIGHT AIRPLANE CHECK.

This check is unnecessary for a scramble take-off. After taxiing to the take-off area, complete the following checks:

1. Intake duct nose screen—Remove.

WARNING

The intake duct nose screen must be removed before the preflight engine check and with the engine at idle rpm. Ground personnel removing the screen must not wear articles of loose clothing or carry equipment likely to be drawn into the intake duct.

2. Rocket package—Check up and locked.

   Turn armament master switch to FIRE 0. If rocket package is up and locked, the rocket-package-up indicator light comes on. Return armament master switch to OFF.

3. Flight controls—Check.

   Check flight controls for correct operation and freedom of movement. Make sure oxygen and anti-G suit hoses do not interfere with stick travel.

4. Canopy—Closed and locked.

   Check canopy locking handle in full forward position, canopy unsafe warning light out, and canopy latches visually (yellow stripe visible through rig pin hole).

CAUTION

When the canopy is being closed, the canopy switch should be held at CLOSED until the canopy actuator automatically cuts off. If the switch is released before the actuator cuts off, the hook at the canopy hinge point may not disengage when becoming air-borne. Emergency canopy ejection is still possible if the hook fails to disengage, but structural damage to the fuselage may result.

5. Automatic pilot engaging switch—OFF.
6. Oxygen regulator diluter lever—NORMAL OXYGEN.

   If contamination is suspected, use 100% OXYGEN.

7. Take-off position.

   Make sure airplane is lined up on runway, and nose wheel is centered. Hold airplane with brakes.

PREFLIGHT ENGINE CHECK.

For a scramble take-off, items 1 and 4 of this check do not have to be done.

Perform preflight engine check as follows:

CAUTION

The engine screens should not be cycled if foreign objects are believed to be present. Instead, the airplane should be returned and the preflight inspection for foreign objects repeated.

1. Engine screen—RETRACT; then EXTEND.

   With engine at idle rpm, operate engine screens through one cycle; then leave engine screen switch at EXTEND.

Note

This check allows any foreign matter caught on the edge of the engine screens to be dumped into the engine while the airplane is on the ground, before flight safety is involved. It requires about 10 seconds to cycle the screens.

2. Emergency fuel control system—Check.

   a. Throttle—Advance rapidly from START IDLE to MILITARY stop.

      Allow engine to stabilize. Normal stabilized exhaust temperature should be 685°C (+5°C, −10°C) at 100% rpm (+0%, −2% rpm).

   b. Engine instruments—Check for desired readings.

CAUTION

When operating within the jet blast of another airplane, maintain a minimum distance of 80 feet to prevent damage to the canopy. When the jet blast is from afterburner operation, maintain a minimum distance of 150 feet.

   c. Emergency fuel switch—ON.

      Exhaust temperature and rpm should be in accordance with chart in figure 2-4.

CAUTION

When moving the emergency fuel system switch to ON, be prepared to retard the throttle immediately to minimize the engine overspeed in case of maladjustment or malfunction of the emergency fuel regulator.

EMERGENCY FUEL REGULATOR CHECK

SUMMER OPERATION
+40°F TO +100°F

OUTSIDE AIR TEMPERATURE °F	% RPM	EXHAUST TEMPERATURE °C
100	96.0	685 (+5, −15)
90	94.0	685 (+5, −15)
80	92.5	680 (+10, −15)
70	91.5	665 (±15)
60	91.0	655 (±15)
50	90.5	645 (±15)
40	90.0	635 (±15)

WINTER OPERATION
0°F TO +60°F

OUTSIDE AIR TEMPERATURE °F	% RPM	EXHAUST TEMPERATURE °C
60	96.0	685 (+5, −15)
50	94.0	685 (+5, −15)
40	92.5	680 (+10, −15)
30	91.5	665 (±15)
20	91.0	655 (±15)
10	90.5	645 (±15)
0	90.0	635 (±15)

EXTREME WINTER OPERATION
-60°F TO +20°F

OUTSIDE AIR TEMPERATURE °F	% RPM	EXHAUST TEMPERATURE °C
20	96.0	685 (+5, −15)
10	94.0	685 (+5, −15)
0	92.5	680 (+10, −15)
-10	91.5	665 (±15)
-20	91.0	655 (±15)
-30	90.5	645 (±15)
-40	90.0	635 (±15)
-50	89.5	620 (±15)
-60	89.0	610 (±15)

ALLOWABLE VARIATIONS 1. RPM ±2%

Select correct table for emergency fuel schedule setting temperature range. The exhaust temperature and rpm should read, within the allowable variations as shown. If reading is other than given in table, the scheduled emergency fuel system performance will not be realized, and a check of the emergency fuel regulator is desirable.

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Figure 2-4

d. Throttle—Retard to 85%.

CAUTION

The throttle should be retarded to approximately 85% rpm before switching back to the NORMAL position because an overtemperature could result due to the drop-off in rpm which would occur if the throttle were left in the MILITARY position. If an overtemperature condition does occur, the duration and degree of the overtemperature must be entered in Form 781 and appropriate corrective maintenance must be accomplished.

e. Emergency fuel switch—NORMAL.

CAUTION

Engine rpm may drop momentarily to about 70% rpm. Do not return the switch to ON during this rpm drop unless the throttle is first retarded to START IDLE, because overtemperature or compressor stall could occur.

f. Throttle—Advance steadily and rapidly past MILITARY stop to full forward position.

It is not necessary to stabilize at MILITARY THRUST before advancing the throttle into afterburner range.

3. Afterburner ignition—Check.

Observe that afterburner ignition occurs within 5 seconds, shown by definite increase in thrust and an increase in variable-nozzle area. Exhaust temperature should not exceed temperature limits. Normal stabilized temperature should be 685°C (+5°C, −10°C). Engine speed should stabilize between 98% and 100% rpm.

CAUTION

- Engine shutdown is required if the exhaust temperature limit is exceeded. The temperature and duration must be enerted in Form 781.
- Should the engine overspeed exceed 104% rpm, either with or without an overtemperature condition, shut down engine as this necessitates turbine wheel replacement. For overspeeds in excess of 108% rpm, the engine must be removed for overhaul.

4. Afterburner fuel control valve—Check.

After engine stabilizes, retard throttle slowly and carefully about one-half the afterburner range. Note that exhaust nozzle area decreases and exhaust temperature stays constant. Readvance throttle.

CAUTION

If the exhaust nozzle area does not decrease as the throttle is retarded, the afterburner fuel control valve is not operating properly. Shut down afterburner operation by retarding the throttle to MILITARY position or below. The electronic engine controls should be checked before the throttle is readvanced to the afterburner range.

5. Engine instruments—Check.

Check engine instruments for proper readings.

6. IFF—NORMAL (mode and code as briefed).

TAKE-OFF.

NORMAL TAKE-OFF.

Before the take-off roll is started, check that the exhaust temperature and variable-nozzle position are stabilized. Monitor these instruments closely during take-off with maximum power to detect accidental nozzle closure. Engine failure can occur in a relatively short time if nozzle closure occurs during afterburner operation. The normal take-off procedure produces results as shown in the take-off charts. (See figures A-3 through A-7.) During the early phase of the take-off, after the wheel brakes are released, maintain directional control with the nose wheel steering. Do not use the wheel brakes to maintain directional control during take-off as the use of the brakes slows the airplane and lengthens the take-off run. The rudder control becomes effective at approximately 60 knots IAS. As take-off speed reaches 110 knots with no external load (115 knots IAS with drop tanks), pull the stick back firmly to lift the airplane nose to take-off attitude. If the take-off is being made on rough terrain, it is advisable to lift the nose wheel as soon as possible to minimize the shock loads to the nose gear assembly. Hold the nose wheel just off the runway until the nose wheel lift-off speeds are attained, and then lift the nose to take-off attitude. During the take-off run, maintain a nose-high attitude. As the airplane leaves the ground, it assumes a more normal attitude as the airspeed increases and the wing flaps are raised. The normal lift-off speed is 125 knots IAS at normal take-off gross weight (with rockets). With full drop tanks installed, the lift-off speed is increased to 130 knots.

WARNING

After an aborted take-off, regardless of the reason, the airplane must be taxied back to the parking area, the engine shut down, and the brakes allowed to cool enough so that they can be touched by hand before further flight. Do not park the airplane in a crowded parking area because of the danger of fire and explosion from overheated brakes.

Note
Extensive use of afterburner materially reduces flight range and operational time.

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MINIMUM-RUN TAKE-OFF.

A minimum-run take-off is a maximum-performance maneuver, with the airplane lifting off near the stalling speed, and should be attempted only when using afterburner. It is closely related to slow flying with the airplane in a high angle-of-attack attitude. Therefore, you should be familiar with the characteristics of this maneuver to be able to maintain the necessary safe margin above the stall. The same trim settings should be used as for a normal take-off, and the initial take-off run is the same. As the take-off run progresses, the stick should be pulled back firmly at about 105 knots IAS with no external load, or at about 110 knots IAS with drop tanks. As the nose wheel lifts off, a steady rotation of the airplane to take-off attitude occurs, with the airplane lifting off at about 120 knots IAS with no external load or at about 125 knots IAS with drop tanks. As the airplane lifts off, reduce the back pressure enough to maintain minimum airspeed build-up and maximum climb angle to effect the shortest air run that will clear all obstacles. The landing gear should not be retracted until the airplane accelerates to the normal take-off speeds, i.e., at least 5 knots faster than minimum-run take-off speeds. After all obstacles are cleared, retrim the airplane and accelerate to best climb speed.

WARNING

When the airplane is very close to stall speed, retracting the gear may cause a nose-up pitch sufficient to cause a stall. Waiting until normal take-off speeds are reached or exceeded eliminates this hazard.

CROSS-WIND TAKE-OFF.

During a cross-wind take-off, use the same procedures as for normal take-offs. However, a higher nose wheel lift-off speed is recommended to improve airplane controllability. Be prepared to apply rudder pressure after nose wheel lift-off to keep the take-off roll straight down the runway until air-borne. After breaking ground, be prepared to counteract the airplane drift.

Note

Refer to Appendix I for data regarding cross-wind take-off components. (See figure A-2.)

AFTER TAKE-OFF—CLIMB.

When the airplane is definitely air-borne, do the following.

Note

Binding and/or jerky control operation can be caused by malfunction of either the flight control system or the autopilot system. It is possible for the autopilot system to become partially engaged with the flight controller switch at OFF. Therefore, to eliminate the possibility of autopilot system malfunction when abnormal control operation occurs, place the autopilot master switch at OFF.

1. Landing gear handle—UP.
   Check gear position indicator lights.
2. Wing flap handle—UP.
   Wing flaps up above 155 IAS. Normally, no "sink" occurs because of the rapid acceleration of the airplane. However, if "sink" does occur (at high gross weight), the flap control can be temporarily set to HOLD to maintain intermediate flap position. After flaps are fully retracted, leave wing flap handle at UP.

CAUTION

- Do not retract the landing gear while yawing or slipping, as damage to the gear doors may result.
- Raise the landing gear and flaps below limit airspeeds; otherwise, excessive air loads may

CAUTION

When the landing light is used for take-off, it should be retracted before the landing light airspeed limit is reached, to prevent damage by heavy air loads to the operating mechanism.

4. Engine screen switch—RETRACT.
5. Trim longitudinally—As required.

Note

The slats close at about 240 knots IAS on a clean airplane, and at about 265 knots IAS when carrying two 120-gallon drop tanks.

6. Hold constant altitude—Set up climb speed.

   Start climb about 20 knots IAS before reaching best climb speed for that particular altitude to stabilize on desired climb schedule as quickly as possible. Maintain best climb speed for minimum time to altitude. Refer to Appendix I for further information.

6A. Zero-delay lanyard hook—Detach from ripcord handle and attach to stowage ring.

   Zero-delay lanyard hook should be stowed after reaching 2000 feet above the terrain.

WARNING

The lanyard must be disconnected whenever the airplane is operated outside the operational area in order that the safety delay provided by the parachute timer aneroid will not be overridden.

7. Armament master switch—As required.
8. Yaw damper switch—ON.
9. Throttle—Retard to shut down afterburner.

   To provide a minimum safe altitude for taking corrective action in case of power loss, do not shut off afterburner until a minimum altitude of at least 1000 feet above the terrain is obtained. When added thrust is no longer needed, shut off afterburner by retarding throttle past MILITARY stop to desired setting.

Note

A momentary surge to 101% rpm is often experienced when coming out of afterburner operating range. These momentary surges are not harmful to the engine.

10. Oxygen diluter lever—NORMAL OXYGEN.

   If 100% OXYGEN was used for take-off, return oxygen regulator diluter lever to NORMAL OXYGEN, unless carbon monoxide contamination is suspected. If contamination is suspected, continue use of 100 percent oxygen as long as considered necessary.

WARNING

The oxygen diluter lever must be returned to NORMAL OXYGEN as soon as possible, because use of 100 percent oxygen so depletes the oxygen supply as to be hazardous.

11. IFF—Checked.

   If positive operation of the normal mode of IFF has not been established during departure with an air traffic control facility, a check should be made with such a facility as soon after take-off as flight conditions will permit. This check must be made before entering a radar advisory area. If IFF is inoperative, consult the appropriate navigation publication.

12. Reset altimeter when climbing through 23,500 feet —29.92 in. Hg or as required.

CLIMB.

Military Thrust is recommended for climb for maximum range conditions when minimum time to altitude is not important. For minimum time to altitude, such as in a point interception mission, Maximum Thrust is required. Refer to climb charts in Appendix I for recommended indicated airspeeds to be used during climb and for estimated rates of climb and fuel consumption.

CAUTION

If an in-flight seat adjustment is made, check that seat vertical adjustment lever is locked and seat is locked in position. If seat is not locked, G-loads may cause it to move and possibly cause armrests to raise and jettison the canopy.

CRUISE.

For cruise data, refer to Appendix I.

AFTERBURNER OPERATION DURING FLIGHT.

Note

- The afterburner should be used only when maximum thrust is essential, and it should be shut off when this need has passed, because of the greatly increased fuel consumption.
- In steady-state operation, if the exhaust temperature rises above 685°C (+5°C, −10°C) or if the nozzle operation becomes erratic, a malfunction of the engine control or thermocouples is indicated. Reduce power and land as soon as possible. Do not go into or return

to afterburner after such a condition has existed.

CAUTION

- If an afterburner blowout occurs with less than 1300 pounds of fuel remaining, do not attempt further afterburner operation unless required by emergency or combat conditions. This precaution does not constitute an operating limitation, but rather a measure to reduce the possibility of afterburner fuel pump overspeed if the fuselage rear tank transfer pump fails.
- No attempt is to be made to ignite the afterburner when the engine is operating on emergency fuel system.

Follow this procedure for afterburner operation while in flight:

1. Variable-nozzle switch—AUTO.
2. Throttle—Full forward position.

   From any intermediate power setting, advance throttle steadily and rapidly past MILITARY stop to full forward position. Afterburner ignition is possible by movement to the afterburner range from any throttle position. Ignition is indicated by an increase in thrust and variable-nozzle area.

Note

Ten seconds may be required to effect afterburner light-up in flight. The time necessary for afterburner light-up normally increases as the altitude is increased.

3. Afterburner—OFF.

   When added thrust is no longer needed, shut off afterburner by retarding throttle past MILITARY stop to desired setting.

FLIGHT CHARACTERISTICS.

Refer to Section VI for information regarding flight characteristics.

DESCENT.

Circumstances may arise which require a descent from high altitude in the shortest possible time. Rates of descent as high as 55,000 feet per minute can be obtained with this airplane. For a typical descent, refer to descent charts (figures A-24 and A-25). For exhaust temperature limitations during descent, refer to Section V.

Note

The windshield and canopy defrost system provides enough heating of the transparent surfaces to effectively prevent the formation of frost or fog during descent.

1. IFF—Checked.

   Within one hour before estimated time of landing, a positive IFF check should be made with an Air Traffic Control Facility.
2. Reset altimeter when descending through flight level 240—Altimeter setting at point of descent.

BEFORE LANDING.

During approach to the field, make the following checks:

1. Armament master switch—OFF.

1A. Circuit breakers—Check.

2. Radar master switch—STDBY.

CAUTION

To prevent landing shock loads from damaging the fire control system gyro, wait until landing has been made and taxiing is completed before turning the radar off.

3. Fuel quantity—Check.
4. Hydraulic pressure—Check.
5. Safety belt, shoulder harness, and zero-delay lanyard hook—Secured.

   Zero-delay lanyard hook must be attached to ripcord handle before descending below 2000 feet above the terrain.
6. Shoulder harness inertia reel handle—UNLOCKED.
7. Yaw damper switch—OFF.
8. Windshield anti-icing switch—As desired.

   If vision is impaired by rain during landing approach, select either CENTER or SIDE position, as desired.

Note

- Enough anti-icing airflow is available over the windshield to improve the visibility effectively if a minimum of 75% engine rpm is maintained. If rain is still encountered as the power is reduced for landing, vision through the windshield side panels may be necessary. Turn the anti-icing switch OFF after touchdown if the windshield caution light has not come on. If the light comes on, leave the switch on; reduced engine power on the ground or selecting manual ram air allows gradual cooling of the windshield and helps prevent cracking of the glass by sudden temperature changes.
- Illumination of the light shows that the design limit of the air supply in the system has been reached, but does not necessarily mean that the windshield has reached the same temperature. In addition to reducing

engine power to lower the anti-ice air temperature, selecting manual ram air reduces the amount of air to be cooled in the heat exchanger, thus reducing the temperature.

- It is recommended that manual ram air be used in conjunction with the anti-ice system only during taxiing, take-off, or landings, because unsatisfactory cockpit temperatures could result if the windshield anti-icing is used extensively during flight.

9. Speed brake switch—OUT.
   Return switch to neutral when brakes extend fully.
10. Landing gear handle—DOWN.
    Lower gear below 185 knots IAS and check position indicators.
11. Pattern—Fly at 160 to 185 knots IAS, using power for level flight.
12. Wing flap handle—DOWN.
13. Check instruments—In desired range.
14. Final approach—Fly at 140 knots IAS.
    Use this as minimum flare speed.
15. Throttle—Retard to START IDLE at touchdown.
    Do not chop throttle earlier because of high rate of descent with power off. Touch main wheels first, wings level, tail well down; lower nose wheel slowly and deploy drag chute to shorten landing roll and minimize brake wear.

Note

The drag chute is designed to be deployed at speeds of 150 knots IAS or below and after touchdown. The drag chute will automatically break away if deployed at speeds above 160 knots IAS.

While following the procedure outlined in figure 2-5 for making a normal approach and landing, observe the following precautions.

CAUTION

- Do not lower the landing gear in accelerated turns or pull-ups, because the G encountered may damage the landing gear operating mechanism. Also, if the gear is lowered above the gear-down limit airspeed of 185 knots IAS, the air loads may damage the landing gear doors or fairings.
- To prevent possible damage to the gear doors, the landing gear should not be extended or retracted while the airplane is in a slipping or yawing attitude.

In addition to improving deceleration and shortening ground roll, extending the speed brakes permits the use of higher engine rpm during a normal approach. This is a definite advantage if a go-around is required.

Note

The speed brakes are made inoperative automatically if the utility hydraulic system pressure falls below about 1500 psi.

Flying the landing pattern at 160 to 185 knots IAS, using power for level flight, results in about the same amount of thrust as that produced at much lower rpm in airplanes with fixed nozzles. Rapid increases in thrust are possible only above about 75% rpm, Military Thrust being reached in 3.5 seconds from this setting. Therefore, to ensure adequate acceleration, use full flaps, speed brakes, and high engine rpm on the approach, if required.

LANDING.

NORMAL LANDING.

The procedure set forth produces the results shown in the landing chart in Appendix I. While following the procedure outlined in figure 2-5 for completing a normal landing, observe the following precautions:

Note

The full length of the runway should be used during the landing roll, so that the brakes can be used as little and as lightly as possible for stopping.

Speed brakes may be used optionally in the traffic pattern, although the recommended approach procedure is to have the speed brakes open to allow carrying a higher power setting in case of a go-around. To avoid high rate of sink, a power setting of 75% to 85% rpm is necessary to hold the rate of descent on final approach, to less than 1500 feet per minute at the recommended final approach speed.

WARNING

The variable-nozzle should be left at AUTO during the landing approach and ground run. If the nozzle has been "jogged" open, enough thrust will not be available for a go-around unless the nozzle is "jogged" closed or the switch is returned to AUTO.

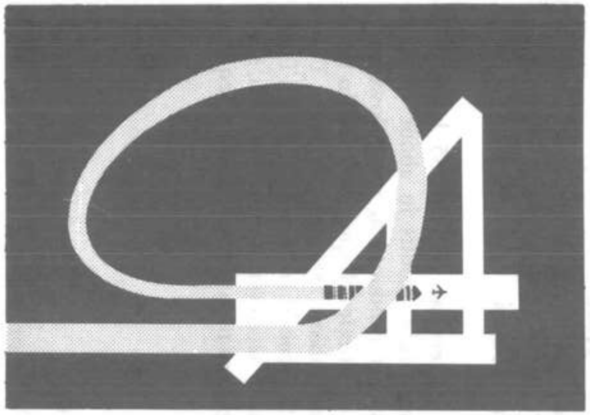
Note

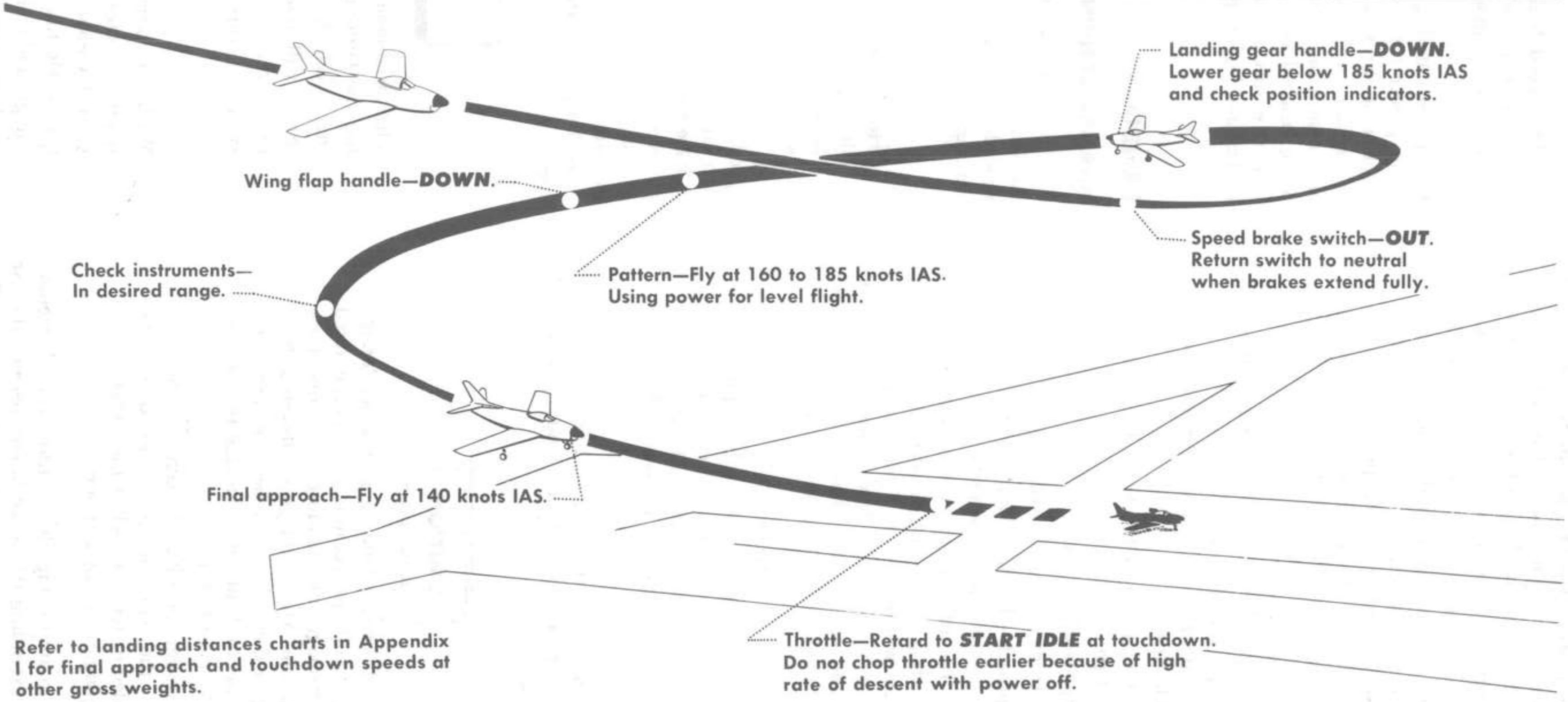
With the variable-nozzle switch at AUTO, the nozzle is automatically controlled to give the most favorable engine performance. Opening the nozzle has a negligible effect on the landing ground roll, because the thrust loss is a very small percentage of the total available braking force during a landing. The total available

NORMAL APPROACH AND LANDING

(TYPICAL)

FOR NORMAL LANDING GROSS WEIGHT OF 15,000 POUNDS (1000 POUNDS FUEL RESERVE)





Landing gear handle—**DOWN**. Lower gear below 185 knots IAS and check position indicators.

Speed brake switch—**OUT**. Return switch to neutral when brakes extend fully.

Wing flap handle—**DOWN**.

Pattern—Fly at 160 to 185 knots IAS. Using power for level flight.

Check instruments—In desired range.

Final approach—Fly at 140 knots IAS.

Throttle—Retard to ***START IDLE*** at touchdown. Do not chop throttle earlier because of high rate of descent with power off.

Refer to landing distances charts in Appendix I for final approach and touchdown speeds at other gross weights.

Precautions to be observed in following this procedure are contained in the paragraphs titled BEFORE LANDING and NORMAL LANDING.

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Figure 2-5

braking force is about 4000 pounds, and idle thrust is reduced only 100 pounds by opening the nozzle.

Do not attempt a full-stall landing, since the angle of attack at the stall is so high that the tail will drag the ground. Maintain directional control during the landing roll by use of rudder and differential braking.

CROSS-WIND LANDING.

Note

Refer to Appendix I for data regarding cross-wind landings. (See figure A-2.)

Cross-wind landings may be easily performed in this airplane by using the normal landing procedures. However, while using normal approach speeds, crab or lower the wing into the wind to keep the airplane lined up with the runway. The normal approach speed is used for flare-out; if crabbed or wing low, align the airplane with the runway just before touchdown. After touchdown, lower the nose wheel smoothly to the runway as soon as practical and deploy the drag chute if necessary. The drag chute is for use only after touchdown and at speeds of 150 knots IAS or below.

CAUTION

- The drag chute should not be deployed in 90-degree cross winds exceeding 20 knots or in 45-degree cross winds exceeding 30 knots, because of weathercocking tendencies of the airplane with the chute deployed.
- However, in an emergency, the drag chute may be deployed during strong cross winds to provide fast deceleration. The drag chute should be deployed immediately after the nose wheel touches, to obtain optimum deceleration effects; then jettison the chute as soon as practical if excessive yaw develops. Be prepared to use brakes, rudder, and/or nose wheel steering to maintain directional control. Use enough aileron to prevent the cross wind from lifting the wing but not so much that the wing will start down.
- If possible, be sure that drag chute will clear the following airplanes if it becomes necessary to jettison the chute to maintain straight landing roll.

MINIMUM-RUN LANDING.

To make a minimum-run or short-field landing with this airplane, you should be thoroughly familiar with the slow speed flight and stall characteristics of the airplane. In planning the approach, hold 160 knots IAS in turn onto the final approach, and then reduce the power to maintain 120 to 130 knots IAS on the final approach. Control the final approach airspeed with the throttle, flaps, and speed brakes and plan to touch down as near the end of the runway as possible. Immediately after touchdown, deploy the drag chute and, as soon as the chute opens, lower the nose smoothly and quickly to the runway to permit brake application. Begin maximum braking when the speed falls below 100 knots IAS being careful not to slide the tires. Use the brakes intermittently and hard (apply the brakes for about 2 to 3 seconds; allow one second release intervals between applications).

Note

Although the drag chute is not designed for in-flight use, it does not adversely affect the airplane flight characteristics if it is inadvertently opened just before touchdown and the proper flare-out has been initiated.

CAUTION

- Braking is permissible above 100 knots IAS; however, caution should be used to prevent the wheels from sliding, because brake action is extremely difficult to feel above this speed.
- Excessive use of the brakes can cause them to overheat, causing damaging effects on the tires. If the heat is great enough, it can cause the tires to weaken and later blow out. If the brakes are used excessively during taxiing, landings, or aborted take-offs, for any reason, the airplane must be taxied back to the line, the engine must be shut down, and the brakes must be allowed to cool enough to touch by hand before starting another flight. Do not park the airplane in a crowded parking area because of the danger of fire or explosion from overheated brakes.
- The drag chute should be jettisoned before taxiing downwind in winds exceeding 15 knots, because of the possibility of the chute collapsing and risers burning by contact on hot areas of the exhaust nozzle.

HEAVY-WEIGHT LANDING.

The same technique for normal landing applies for the heavy-weight landing (near maximum take-off gross weight), except for necessary increases in power settings. As gross weight increases, approach and touchdown speed should be increased accordingly. (See figures A-26 and A-27.) For example, if the take-off is made with full internal fuel, full 120-gallon drop tanks, and full rocket load, and a landing has to be made before any excess fuel and the rocket load can be expended, the landing weight is about 19,500 pounds. With this landing weight, the recommended final approach and flare speed is 158 knots IAS, to provide adequate flare characteristics. A stall landing should be avoided, if at all possible, in an attempt to keep the G to a minimum at point of touchdown.

Note

- If necessary, the drag chute may be deployed to provide maximum deceleration after touchdown.
- If a heavy-weight landing is made, the airplane should be checked for signs of overstress before the next flight.

SLIPPERY RUNWAY LANDINGS.

When landing on a slippery runway (wet or icy), use the normal landing pattern and procedures. However, the condition of the runway (degree of slipperiness) must be determined by ground personnel and the pilot must be advised accordingly so that proper technique can be used. On rough ice or a wet rough surface, deploy the drag chute upon touchdown, lower the nose immediately, and apply heavy intermittent braking as necessary. On smooth ice or a wet smooth surface, upon touchdown deploy drag chute and maintain a nose-high attitude after touchdown with full flaps to provide aerodynamic braking. Care must be taken not to become airborne again at the higher speeds. As the speed is reduced and after the nose wheel touches, attempt to obtain braking with wheel brakes. As the braking coefficient is greatly reduced on slippery runways (especially on the first portion of the landing roll), the landing roll is increased. In each case, use of the drag chute is imperative to give maximum deceleration. Careful braking action is necessary to prevent locking of the wheel brakes (which causes skidding and loss of directional control). Braking should be intermittent to retain directional control, as nose-wheel steering under these conditions is relatively ineffective. Rudder should be used also for directional control, and it will be effective down to about 60 knots IAS. Make every effort to remain on the runway in case a barrier engagement becomes necessary. When taxiing, care must be taken, as directional control on a slippery runway is difficult. (See landing distance chart in Appendix I for approach and touchdown speeds and landing distances.)

TOUCH-AND-GO LANDING.

When a touch-and-go landing is made, perform a normal approach and landing, except do not use the drag chute. Lower the nose wheel onto the runway as soon as possible after touchdown and simultaneously close the speed brakes and advance the throttle to Maximum Thrust.

Note

- Do not perform a touch-and-go landing with less than 1000 pounds of fuel.
- Do not use Maximum Thrust if fuel level is below 1300 pounds.

Complete a normal take-off, observing the recommended nose wheel lift-off speeds. Retract landing gear and wing flaps as in a normal take-off. Where a series of touch-and-go landings are to be made, the normal before landing check must be accomplished for the initial landing. After the final touch-and-go landing, if the flight is to be continued, the normal after take-off—climb check must be made.

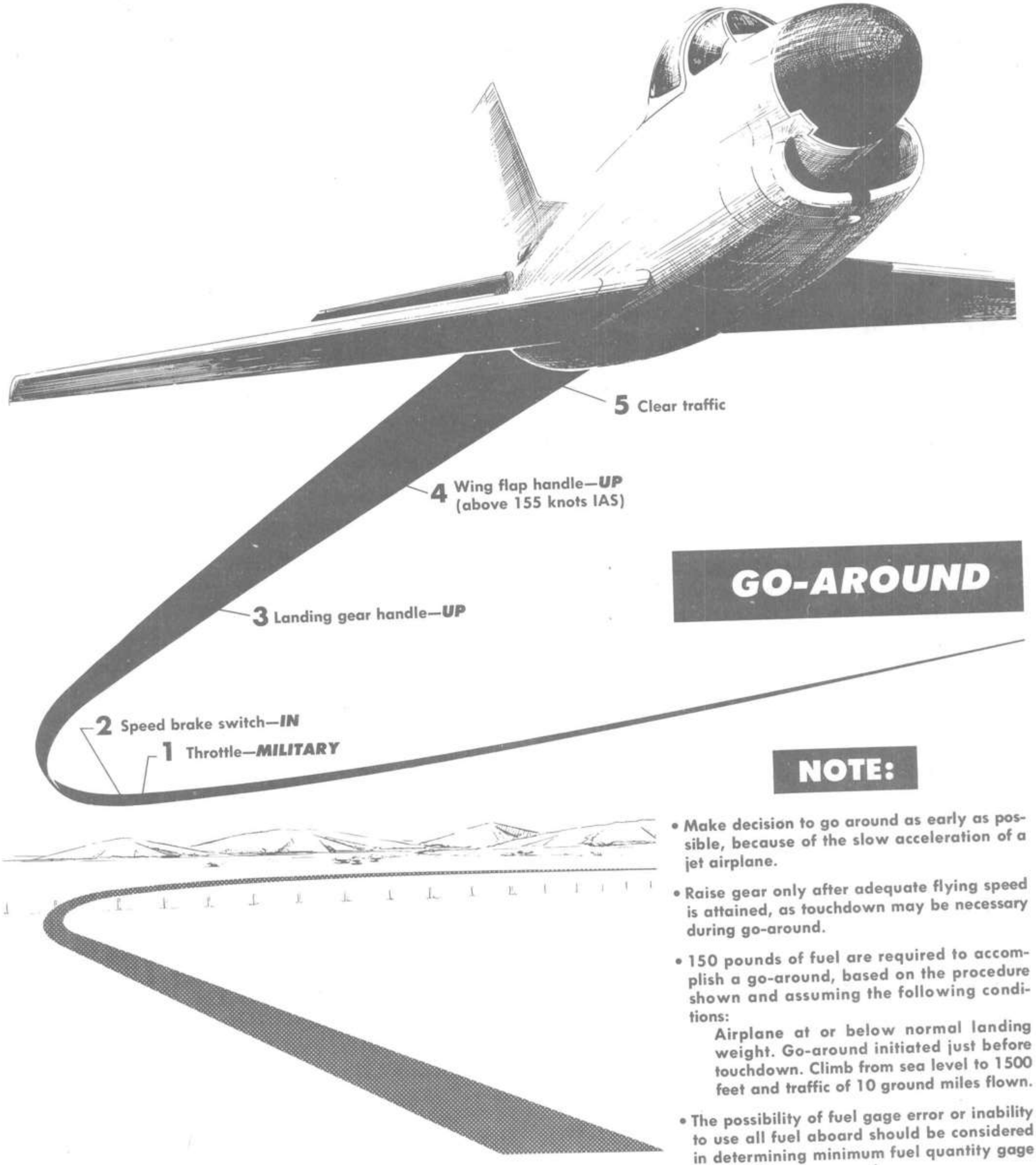
GO-AROUND.

While following the procedure outlined in figure 2-6 for making a go-around from an aborted landing approach, observe the following precautions:

WARNING

- Make decisions to go around as early as possible. The low-altitude acceleration characteristics of a jet-propelled airplane are definitely inferior to those of a propeller-driven airplane.
- During a go-around, if the engine does not respond to throttle advancement on the first attempt, as shown by engine instruments, retard the throttle to START IDLE (if rpm drops below 85%), position the emergency fuel system switch to ON, and cautiously readvance the throttle.
- If the main fuel system has failed during flight, the emergency fuel system switch should be ON, and if the variable-nozzle is inoperative, the variable-nozzle switch should

GO-AROUND



NOTE:

- Make decision to go around as early as possible, because of the slow acceleration of a jet airplane.
- Raise gear only after adequate flying speed is attained, as touchdown may be necessary during go-around.
- 150 pounds of fuel are required to accomplish a go-around, based on the procedure shown and assuming the following conditions:
  Airplane at or below normal landing weight. Go-around initiated just before touchdown. Climb from sea level to 1500 feet and traffic of 10 ground miles flown.
- The possibility of fuel gage error or inability to use all fuel aboard should be considered in determining minimum fuel quantity gage reading for a go-around.

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Figure 2-6

be OFF (nozzle closed). Under these conditions, the acceleration characteristics of the airplane are extremely poor. Also, advancement of the throttle must be done with caution to prevent flame-out or dangerous overtemperature.

Afterburning should not be used if the emergency regulator is controlling the fuel flow, since the emergency regulator does not have the safety features of the main fuel control valve.

CAUTION

To prevent damage from air loads, the landing lights should be retracted before the light-down limit airspeed is reached.

AFTER LANDING.

Maintain directional control during landing roll by use of rudder and differential braking.

After completion of the landing roll:

1. Engine screen switch—EXTEND.

   Engine inlet screens should be extended after completion of landing roll and before turning off runway.
2. Windshield and canopy defrost lever—DEC.
3. Speed brake switch—OFF (center).
4. Nose wheel steering—Engage.

   Engage nose wheel steering when slow taxiing becomes necessary.
5. Drag chute—JETTISON (on taxiway).

CAUTION

- To obtain the best drag chute service life, it is recommended that the drag chute be jettisoned, at the lowest possible taxi speed, immediately after taxiing off the runway onto the taxiway and while the drag chute is still inflated.
- Do not stop during taxiing, or the nylon riser will be severely damaged by exhaust heat. Use extreme care when taxiing for long distances with the drag chute deployed to prevent it from dragging on the ground or touching the hot exhaust nozzle area.
- Do not make sharp turns during taxiing with the drag chute deployed to prevent the chute from collapsing and damaging the chute and the chute compartment.

6. Speed brake switch—IN.
7. Wing flap handle—UP.
8. Anti-ice and pitot heat switches—OFF.
9. IFF and omni switches—OFF.

   Turn IFF off as soon after landing as possible. This will eliminate signals from taxiing or parked airplanes, which would otherwise block the controller's scope and interfere with the control of air-borne airplanes.
10. Trim—Take-off setting.

ENGINE SHUTDOWN.

This shutdown procedure permits engine stabilization at the lowest temperature, which minimizes the possibility of shroud ring rub. If required by emergency conditions, the engine may be shut down immediately.

Note

When operating under local command procedures for checking coast-down time of engine rotor with a locked-open nozzle, the temperature should be stabilized at the lowest level consistent with the locked-open nozzle setting before shutdown.

1. Wheel brakes—ON.
2. Throttle—65% to 70% rpm.

   The engine should be operated at 65% to 70% rpm for about 2 minutes.
3. Throttle—CLOSED.

   Close throttle sharply.

Note

When the ac power stops during engine shutdown as rpm decreases, the ac powered fuel flow, oil pressure, and hydraulic pressure gages may deceptively change indications. Therefore, during this period, do not rely upon these indications.

4. Engine master switch—OFF.

   Turn master switch OFF below 10% rpm, and wait a few seconds before turning battery switch OFF.
5. Battery switch—OFF.
6. All electrical switches—OFF.

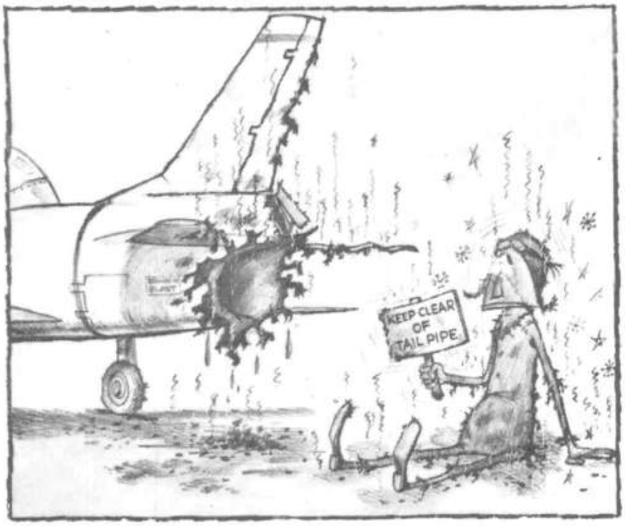
   Turn all switches OFF except generator and alternator.
7. Control stick—Cycle.

   With engine rpm at zero, cycle control stick full fore and aft until it "freezes" to dump flight control normal hydraulic system pressure. This helps prevent damage to "O" rings in the normal system accumulator.
8. Flight control emergency handle—OUT (aft).
9. Control stick—Cycle.

   Move control stick as rapidly as possible full fore and aft through two complete cycles to dump flight control alternate hydraulic system pressure. This helps prevent damage to "O" rings in the alternate system accumulators.
10. Flight control emergency handle—IN (forward).

    Push flight control emergency handle full in immediately after control stick cycling is completed.

If handle is not pushed in immediately after stick cycling is completed, alternate system pressure builds up again.



Warning

Keep clear of tail pipe and do not move airplane into hangar for at least 15 minutes after shutdown, because of the possibility of accumulating fuel vapors exploding.

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BEFORE LEAVING AIRPLANE.

Make the following checks before leaving the airplane:

1. Armrests full down and latched—Check.
2. Ejection seat ground safety pin—Install in right armrest (across the trigger).
3. Drop tank air pressure shutoff valve—OFF.
4. Rudder—Lock.

CAUTION

If wearing an automatic-opening, aneroid-type parachute that has a key attached to the aneroid arming lanyard, make sure key does not foul when leaving cockpit, to prevent chute from being opened accidentally.

5. Main wheels—Chocked.
6. Form 781—Complete.

CAUTION

Make appropriate entries in the DD Form 781 covering any limits in the Flight Handbook that have been exceeded during the flight. Entries must also be made when, in the pilot's judgment, the airplane has been exposed to unusual or excessive operations such as hard landings, excessive braking action during aborted take-offs, long and fast landings, and long taxi runs at high speeds, etc.

CONDENSED CHECK LIST.

Your normal condensed check list is now contained in T.O. 1F-86L-(CL)1-1.

(Pages 2-29 through 2-46 deleted)

Emergency Procedures

SECTION III

TABLE OF CONTENTS

ENGINE FAILURE.

Complete engine failures are rarely experienced on this airplane. Engine flame-outs and malfunctions of various types do, however, occur from time to time. These malfunctions are usually the result of improper fuel scheduling caused by a malfunction of the integrated electronic engine control or of one of its components, or by incorrect techniques during critical flight conditions. (Refer to "Main Fuel Control System Failure" in this section.) When time and altitude permit, air starts can usually be accomplished if engine failure is due to malfunction of the main fuel control system. Signs of failure of the main fuel control system are often shown by the engine instruments. Air starts should never be attempted if engine failure can be attributed to some obvious mechanical failure with the engine proper.

ENGINE FAILURE DURING TAKE-OFF RUN (NO RUNWAY OVERRUN BARRIER).

WARNING

Do not attempt to use the landing gear up button. The nose gear will retract immediatey, and the airplane will go down on its nose. One main gear will probably fold before the other, and severe structural damage and possible pilot injury can result.

Note

- For procedure when using a runway equipped with runway overrun barrier, refer to "Engaging Runway Overrun Barrier" in this section.

- It is desirable to leave the gear extended to absorb impact loads especially if the terrain is rough beyond the end of the runway.

If a power loss occurs after take-off is committed, proceed with step one and continue take-off. If step one cannot be accomplished because of an excessive rpm drop or if a take-off is aborted before committed to take off and insufficient runway remains for a normal stop, proceed with step 2.

1. Emergency fuel switch—ON (if engine rpm is above 85% and committed to take-off).

   If engine power loss is indicated by rpm or exhaust temperature drop but rpm has not fallen below 85%, move emergency fuel switch to ON.

WARNING

If engine rpm has fallen below 85%, abort take-off. There would not be enough time to retard throttle to START IDLE, switch emergency fuel switch to ON, and then readvance throttle.

Note

If engine does not immediately recover sufficient power to continue take-off when emergency fuel switch is moved to ON, proceed to step 2.

2. Abort.

   Refer to "Abort" under "Take-off and Landing Emergencies" in this section.

3 through 9. (Deleted)

ENGINE FAILURE DURING TAKE-OFF (AIRPLANE AIR-BORNE).

If engine failure occurs on take-off after airplane is air-borne, prepare for an emergency landing, accomplishing as much of the following as time permits:

1. Emergency fuel switch—ON (if engine rpm is above 85%).

   If engine power loss is indicated by rpm or exhaust temperature drop but rpm has not fallen below 85%, move emergency fuel switch to ON.

WARNING

If engine rpm has fallen below 85%, there would not be enough time to retard throttle to START IDLE, switch emergency fuel switch to ON, and then readvance throttle. Therefore, proceed to steps 2 through 9.

2. Drop tank jettison button—Depress (or emergency jettison handle—Pull).
3. Armament master switch—EMERG. JET'SN (if time permits).

   Jettison rocket package if rockets are installed.

Note

If engine does not immediately recover sufficient power to sustain flight when the emergency fuel switch is moved to ON, proceed to step 4.

4. Throttle—CLOSED.
5. Canopy handle—Pull.

   Manually unlocking the canopy allows the airstream to carry the canopy away from the fuselage.

Note

Pull helmet visor down before unlocking canopy.

WARNING

If canopy has not been released and if spilled fuel is in vicinity of airplane, use mechanical or electrical means to remove canopy, if time permits. If these systems fail, the canopy jettison system may be used; however, a fire may result from a hot powder spark when the canopy catapult is actuated.

6. Landing gear handle—DOWN.
7. Wing flap handle—DOWN.
8. Engine master, generator, and battery switches—OFF.

Note

Turn engine master switch OFF while battery switch is still at ON, so that power will still be available to close fuel shutoff valve.

9. Shoulder harness lock handle—LOCKED.
10. Land straight ahead.

    Change course only enough to miss obstacles.
11. Drag chute handle—Pull (after touchdown).

Note

If drag chute is deployed at speeds above about 160 knots IAS, it automatically jettisons.

ENGINE FAILURE DURING FLIGHT.

If engine failure occurs during flight, follow this procedure:

Note

Before closing the throttle, check fuel flow (600 pph minimum) and exhaust temperature indication. If engine has not flamed out, do not close throttle.

1. Attempt air start immediately (if mechanical malfunction is not apparent).

   Refer to "Engine Air Start" in this section.

Note

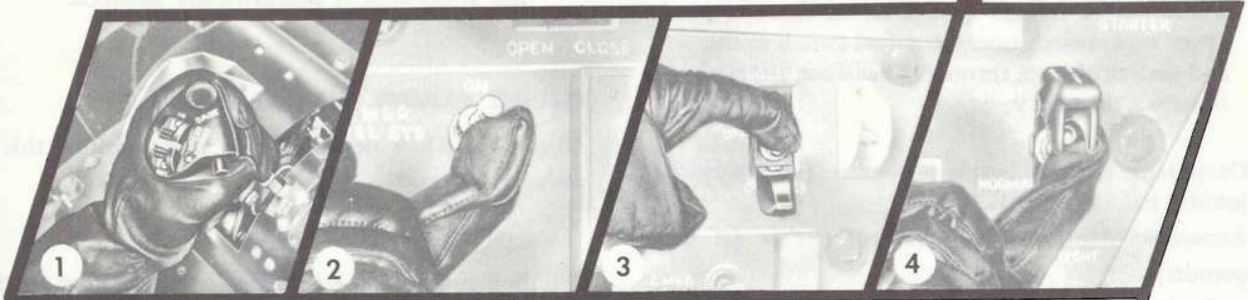
The actuation of the air start switch automatically shuts off electrical equipment not essential when making an air start. However, after the air start is made, turn off any electrical equipment not required.

If engine does not start before airspeed decreases to about 200 knots IAS, establish glide at 200 knots IAS with landing gear and wing flaps up and speed brakes closed for maximum glide distance. (See figure 3-2.)

2. Repeat air start procedure, if necessary.

If engine failure necessitates a forced landing, maximum gliding distance can be obtained by establishing a glide of 200 knots IAS, with landing gear and wing flaps up and speed brakes closed. Unless the engine is damaged, it windmills at enough speed to operate all hydraulic controls, including the flight control normal hydraulic system. However, engine windmilling is inadequate to provide generator power at any normal gliding speed. Operation of the landing gear, wing flaps, and speed brakes is considerably slower than normal. Because electrical power is being derived only from the battery, such power is available for about 25 to 28 minutes with all unnecessary electrical equipment turned off, unless a failure of the flight control normal hydraulic system accompanies the engine failure. If this is the case, electrical power is available for about 20 minutes only, and alternate system hydraulic accumulator pressure should be conserved by minimum movement of the control surfaces. Operation from localities with low prevailing out-

ENGINE AIR START PROCEDURE



1. **Throttle CLOSED.** To prevent flooding the engine with fuel.
2. **Emergency fuel system switch ON.** The electronic engine control is inoperative with air start switch in ***AIR START*** (up).
3. **Variable nozzle closed.** To aid in making an easier air start
4. **Air start switch to *AIR START* (up).** To reduce electrical load, providing maximum battery life.

⑤ **Hold airplane as level as possible for at least 5 seconds to drain any fuel that may have accumulated in the engine. Attempt air start as soon as possible. However, starts are more readily obtained below 40,000 feet.**

WARNING

WHEN AIR START SWITCH IS IN *AIR START* (UP) POSITION, EQUIPMENT POWERED BY THESE BUSSES IS INOPERATIVE:

SECONDARY BUS
MONITORED NO. 1 BUS
MONITORED NO. 2 BUS
MONITORED NO. 3 BUS
AC BUS
WHICH INCLUDES
RADAR EQUIPMENT
RADIO EQUIPMENT
WING FLAP CONTROL
ELECTRONIC ENGINE CONTROLS

CAUTION

With air start switch at *AIR START* (up), do not move the battery switch out of *ON*, as a complete loss of fuel pump and ignition power could result.

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side temperature causes more rapid loss of battery power. (See figure 1-15 for list of equipment powered by battery when battery switch is at BATTERY and both generators are inoperative.)

Engine Failure During Flight at Low Altitude.

If engine failure occurs 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 (air start, establishing forced-landing pattern, ejection, etc).

Note

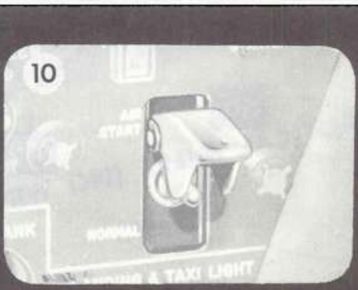
The point at which climb should be terminated will depend on whether the pilot intends to eject or whether he intends to continue attempting air starts, establish forced landing pattern, etc. In any event, it is recommended that air start be attempted immediately upon detection of engine flame-out and 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. For this condition, the optimum zoom-up technique is to pull the air-

Engine speed—20% to 40% rpm windmilling.
Restart at 40,000 feet or below.

Throttle—Advance.
Fuel flow of 250 pounds per hour (at high altitude) to 750 pounds per hour (at low altitude).

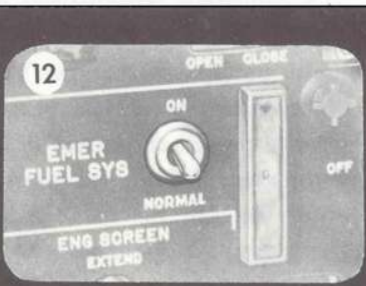
Exhaust temperature—Regulate throttle to maintain about 400°C.
Very cautiously regulate throttle until engine speed stabilizes.

Throttle—Advance to desired power setting.
Keep exhaust temperature below 750° C.



Air start switch—***NORMAL***.
After reaching 37% rpm or above, so that generators are again operating.

Variable-nozzle switch—***AUTO***.
After lockup indicator light is extinguished.



Emergency fuel switch—***NORMAL***.

CAUTION

If a sufficient warm-up period is not allowed before the emergency fuel system switch is moved to *NORMAL* , another flame - out may result. However, if main fuel system failure is suspected, leave emergency fuel system switch at *ON* and land as soon as practicable.

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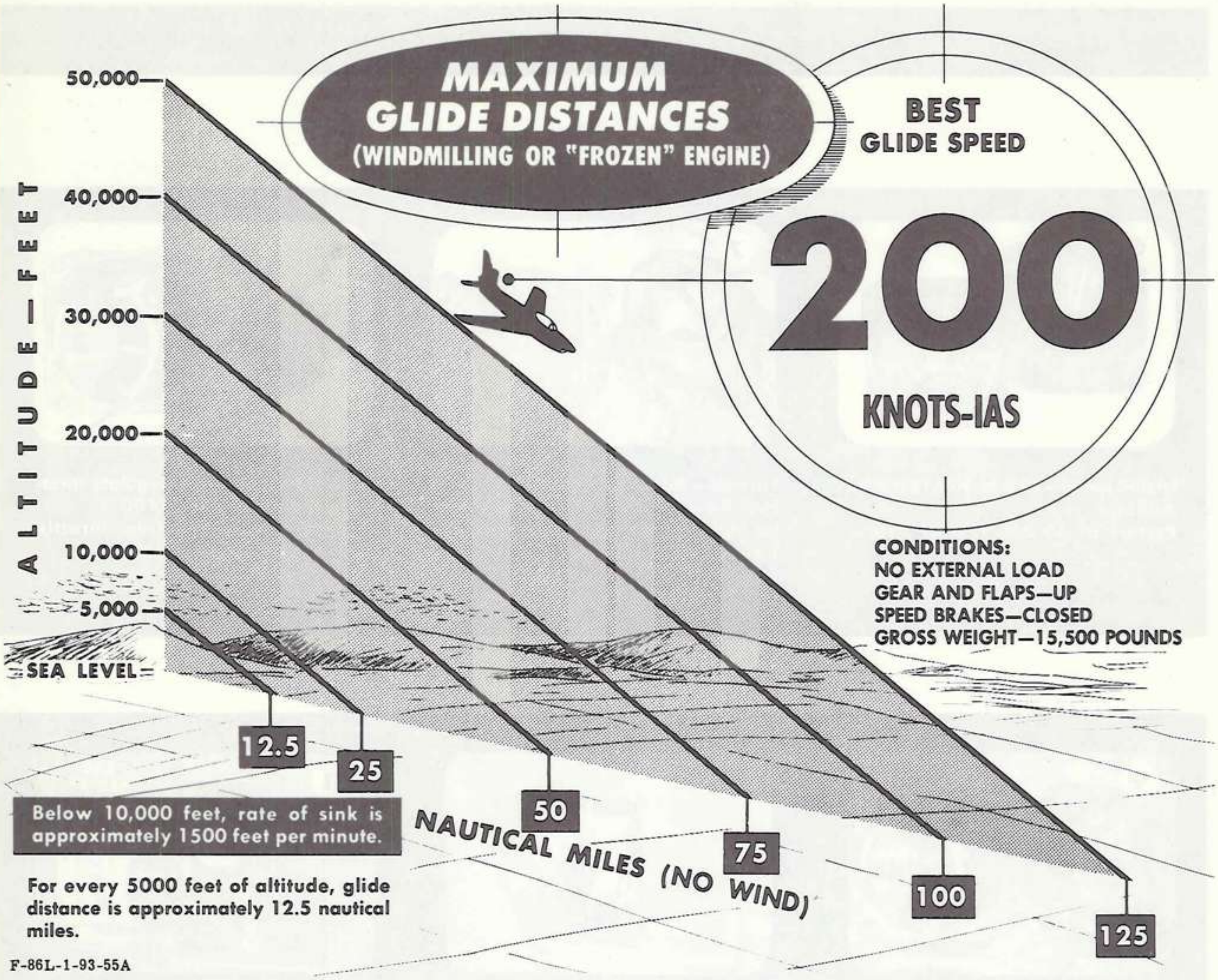
Figure 3-1


MAXIMUM GLIDE DISTANCES
(WINDMILLING OR "FROZEN" ENGINE)

BEST GLIDE SPEED 200 KNOTS-IAS

CONDITIONS:
NO EXTERNAL LOAD
GEAR AND FLAPS—UP
SPEED BRAKES—CLOSED
GROSS WEIGHT—15,500 POUNDS

Below 10,000 feet, rate of sink is approximately 1500 feet per minute.

For every 5000 feet of altitude, glide distance is approximately 12.5 nautical miles.

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Figure 3-2

plane up with wings level until light buffet is encountered. Hold this condition until the speed drops to 120 knots IAS or the rate of climb approaches zero; then eject. If the decision is to continue attempting air starts, the climb should be terminated prior to dropping below best glide speed, in order to obtain maximum glide distance and maintain adequate engine windmilling rpm for air start.

Maximum altitude can be achieved by jettisoning external loads prior to zoom-up. The further up the climbing flight path that external loads are jettisoned, the less additional altitude will be gained. However, when jettisoning external loads, consideration must be given to such factors as: sufficient airspeed to allow time for pilot reaction and jettisoning external loads; terrain where external loads will fall (populated areas, friendly or enemy territory, etc); type of stores to be jettisoned (full or empty drop tanks, etc); controllability of the airplane if one or more stores fail to release, resulting in a dangerous asymmetrical condition at low altitude. Also of prime importance are the external load release limits outlined in Section V. These limits should be observed to prevent damage to the airplane. It is impossible to predict the extent of damage which may occur if the external loads are released outside the established limits because of the number of factors involved. Depending on the emergency, it may be advisable to jettison the external loads outside the release limits and risk some damage to the airplane in order to increase the probability of being able to accomplish subsequent emergency procedures. In any event, the decision to jettison or retain external loads must be made by the pilot on the basis of his evaluation of the factors mentioned and conditions existing at the time of the emergency.

ENGINE AIR START.

Although engine air starts are more readily obtainable below 40,000 feet, the air start should be attempted as soon as possible after flame-out. (See figure 3-1.) During restart, if ignition does not occur within 20 seconds after throttle is opened, slowly retard throttle to CLOSED and then readvance throttle until a higher fuel flow is reached. Repeat this procedure until ignition occurs or until one minute has elapsed, because a 5-second fuel accumulation drainage period should be allowed after each one-minute restart attempt. On some altitude restarts, the engine may be on the verge of compressor stall with the throttle at START IDLE, and any attempt to advance the throttle will cause a complete stall. If this occurs, retard throttle below initial position and then readvance it slowly, keeping exhaust temperature well within limits. If, after several attempts have been made, ignition does not occur before airplane has descended to an altitude of 10,000 feet above the ground and a forced landing is to be made, return air start switch to NORMAL so that radio contact for a forced landing can be re-established. Refer to "Forced Landing (Windmilling or Frozen Engine)" for a forced landing, or refer to "Ejection" if engine failure necessitates bail-out.

LOW-ALTITUDE AIR START.

The altitude and/or airspeed at time of flame out, plus pilot proficiency and experience, will dictate whether a low-altitude air start, ejection, or forced landing will be performed. The low-altitude air start procedure should be accomplished immediately after the flame-out, even to the extent of overspeeding or overheating the engine. If flame-out occurs with sufficient air speed available (300 knots IAS or more), the airplane should be pulled up (zoom-up) to exchange air speed for altitude while initiating the low altitude air start procedure. The following air start procedure is to be used if flame out occurs at 5000 feet or less above the terrain.

1. Throttle—Retard to mid-quadrant range.
2. Air start switch—AIR START (up).
3. Emergency fuel switch—ON.
4. Throttle—Advance to desired thrust position.

If restart does not occur immediately, as evidenced by an increase in exhaust gas temperature and engine rpm, prepare for an ejection or forced landing.

MAXIMUM GLIDE.

For maximum gliding distance, the most favorable gliding speed is 200 knots IAS with gear and flaps up, 160 knots IAS with gear down, and 140 knots IAS with gear and flaps down. These speeds apply with speed brakes closed and no external load. (See figure 3-2.)

EJECTION VS FORCED LANDING.

Normally, ejection is the best course of action in the event of complete engine flame-out (windmilling or frozen), or when positive control of the airplane cannot be maintained. Because of the many variables encountered, the final decision to attempt a flame-out 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 in the following list, combined with the pilot's analysis of the airplane condition, type of emergency, and his proficiency are of prime importance in determining whether to attempt a flame-out landing, or to eject. These variables make a quick and accurate decision difficult. If the decision is made to eject, the pilot should attempt to turn the airplane toward an area where injury or damage to persons or property on the ground or water is least likely to occur. Before a decision is made to attempt a flame-out landing, the following basic conditions should exist.

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

b. Flame-out landings should only be attempted on a prepared or designated suitable surface.

c. Approaches to the runway should be clear and should not present a problem during the flame-out approach.

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, the pilot should attempt to turn the airplane toward an area where injury or damage to persons or property on the ground or water is least likely to occur.

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

Note

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

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

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

FORCED LANDING (WINDMILLING) OR FROZEN ENGINE).

If engine failure during flight necessitates a forced landing, a maximum gliding distance can be obtained by establishing a glide of 200 knots IAS, with landing gear and wing flaps up, speed brakes closed.

Note

Braking action is difficult to feel between normal recommended touchdown airspeed of 120 knots IAS and when decelerating to 100 knots IAS. Maximum braking technique should be used immediately after touchdown by rapid on-off applications on brake pedals (about one second on, one second off), this pressure being applied very lightly at higher indicated airspeeds, with heavier pressure being applied as the airplane decelerates under 100 knots IAS. With the utility hydraulic system pressure low or inoperative, brake boost pressures drop with continued brake application. Braking action is still possible, but pedal pressures are extremely high.

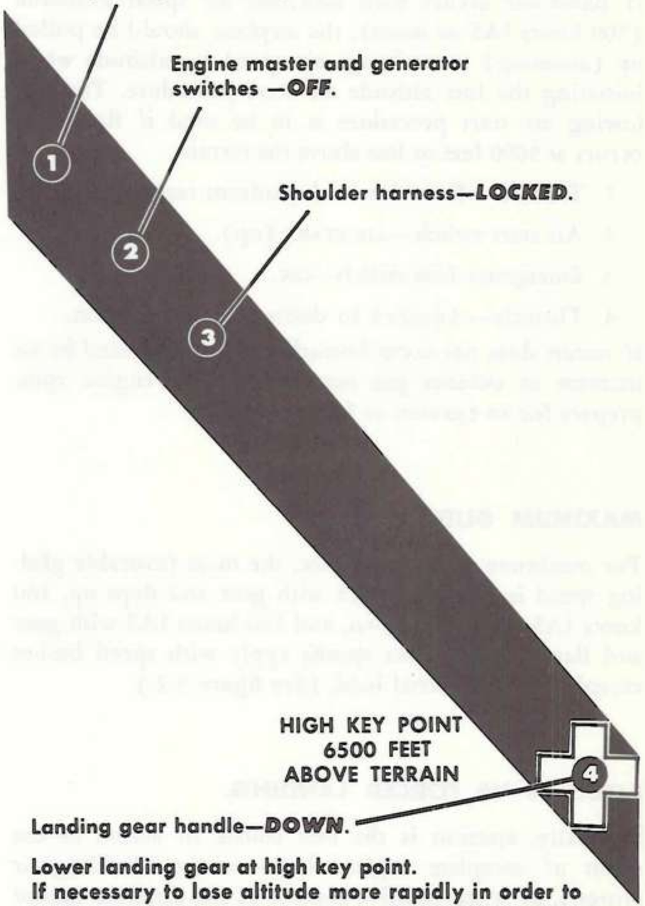
The procedure outlined in figure 3-3. is recommended for a forced landing.

SIMULATED FORCED LANDING.

The normal concept of retarding the throttle to idle to practice flame-out forced landings does not apply with jet airplanes. With the throttle at START IDLE, the engine produces about 400 pounds of thrust, whereas a flame-out and windmilling engine creates drag. Thus, with the engine at idle power or a minimum of 300°C exhaust temperature, the rate of descent would be less and the glide distance would be greater than during an actual flame-out forced landing. To simulate the drag of a flame-out and windmilling engine, extended speed brakes are used. However, as the drag produced when the speed brakes are extended is greater than that of a windmilling engine, certain engine power has to be maintained. In the final approach, under actual forced landing conditions, it may be desired to extend the speed brakes to prevent possible overshooting. This increased drag effect of speed brake extension can be simulated during a practice forced landing by removing engine power by retarding the throttle to START IDLE or a minimum of 300°C exhaust temperature. Because the idling engine still produces some thrust, touchdown is slightly farther down the runway than during an actual flame-out landing. Familiarization with forced-landing techniques and procedures, as shown in figure 3-3, can be attained by accurately practicing forced landings, using the recommended engine power (established by extensive flight tests) and extended speed brakes to simulate a flame-out engine condition. Rate of descent, glide distance, and flight characteristics with the engine windmilling can be simulated above 12,000 feet by reducing the engine rpm to 74% (78% rpm for airplanes incorporating the new-type thrust selector), opening speed brakes, and establishing a glide speed of 200 knots IAS. The landing gear should be lowered at 12,000 feet, and a glide speed of 170 knots IAS initiated, still using the same rpm setting. If approach during practice forced landing is not as desired, make a normal go-around and repeat forced landing until desired efficiency is attained. If the engine seizes (rotor locked), the airplane characteristics in actual forced landings are not noticeably changed. Actually, the drag of the airplane with the engine rotor locked is slightly less than with a windmilling engine. Although the decreased drag results in a decreased rate of descent, the difference will not be easily discerned. Thus, the techniques developed for forced landings with a windmilling engine are also applicable for forced landings with engine in the rotor-locked condition.

FORCED LANDING

WINDMILLING OR "FROZEN" ENGINE



External load—Jettison (rocket package if loaded).

Engine master and generator switches —*OFF*.

Shoulder harness—*LOCKED*.

HIGH KEY POINT
6500 FEET
ABOVE TERRAIN

Landing gear handle—*DOWN*.

Lower landing gear at high key point.
If necessary to lose altitude more rapidly in order to reach the high key point, gear may be lowered earlier. If altitude is too low to enter pattern at high key point, leave gear up until a subsequent key point can be reached.

WARNING

Do not leave gear up for landing. Investigation has shown that emergency landing with gear down minimizes pilot injury and damage to airplane.

NOTE

If engine is frozen, lower gear by means of landing gear emergency lowering handle, because utility hydraulic pressure will not be available (gear cannot be retracted).

WARNING

- **Speed brake extension will be slower than normal.**
- **Speed brakes will be rendered inoperative automatically if utility hydraulic system pressure is below about 1500 psi.**
- **If terrain is unknown or unsuitable for a forced landing, eject.**
- **If engine is "frozen," nose wheel steering is inoperative.**

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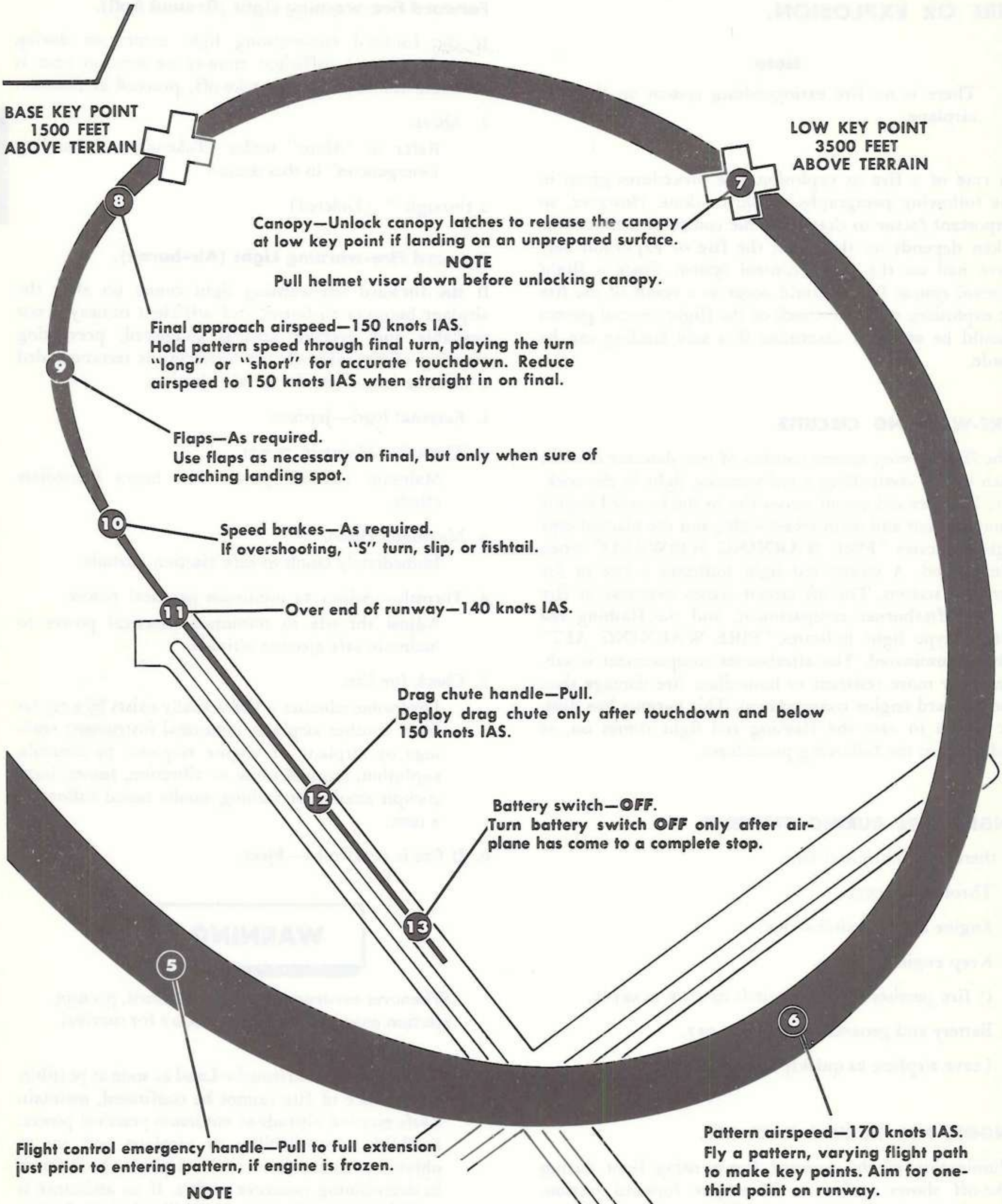

BASE KEY POINT
1500 FEET
ABOVE TERRAIN

LOW KEY POINT
3500 FEET
ABOVE TERRAIN

Canopy—Unlock canopy latches to release the canopy at low key point if landing on an unprepared surface.

NOTE

Pull helmet visor down before unlocking canopy.

Final approach airspeed—150 knots IAS.
Hold pattern speed through final turn, playing the turn "long" or "short" for accurate touchdown. Reduce airspeed to 150 knots IAS when straight in on final.

Flaps—As required.
Use flaps as necessary on final, but only when sure of reaching landing spot.

Speed brakes—As required.
If overshooting, "S" turn, slip, or fishtail.

Over end of runway—140 knots IAS.

Drag chute handle—Pull.
Deploy drag chute only after touchdown and below 150 knots IAS.

Battery switch—OFF.
Turn battery switch OFF only after airplane has come to a complete stop.

Flight control emergency handle—Pull to full extension just prior to entering pattern, if engine is frozen.

NOTE

This will ensure positive continuous engagement of the flight control alternate hydraulic system during the landing phase.

Pattern airspeed—170 knots IAS.
Fly a pattern, varying flight path to make key points. Aim for one-third point on runway.

SPEEDS GIVEN ARE APPLICABLE FOR ANY CLEAN AIRPLANE WEIGHT CONDITION

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Figure 3-3

FIRE OR EXPLOSION.

Note

There is no fire extinguishing system on this airplane.

In case of a fire or explosion, the procedures given in the following paragraphs should be done. However, an important factor to determine the course of action to be taken depends on the effect the fire or explosion may have had on the flight control system. Since a flight control system failure could occur as a result of the fire or explosion, a careful check of the flight control system should be made to determine if a safe landing can be made.

FIRE-WARNING CIRCUITS.

The fire-warning system consists of two detector circuits, each circuit controlling a red warning light in the cockpit. The forward circuit senses fire in the forward engine compartment and main wheel wells, and the placard-type light indicates "FIRE WARNING FORWARD" when illuminated. A steady red light indicates a fire in the forward section. The aft circuit senses overheat or fire in the afterburner compartment, and the flashing red placard-type light indicates "FIRE WARNING AFT" when illuminated. The afterburner compartment is substantially more resistant to immediate fire damage than the forward engine compartment. This permits less drastic action in case the flashing red light comes on, as indicated in the following procedures.

ENGINE FIRE DURING STARTING.

If there is indication of fire:

1. Throttle—CLOSED.
2. Engine master switch—OFF.
3. Keep engine turning.
4. If fire persists—Starter switch to STOP STARTER.
5. Battery and generator switches—OFF.
6. Leave airplane as quickly as possible.

ENGINE FIRE DURING TAKE-OFF.

Illumination of the forward fire-warning light during take-off shows a fire in the engine forward section, necessitating immediate action. The exact procedure to follow varies with each set of circumstances and depends upon altitude, airspeed, length of runway and overrun clearance remaining, location of populated areas, etc. The decision you make depends on these factors. To help you decide, the following procedures are presented for your information.

Forward Fire-warning Light (Ground Roll).

If the forward fire-warning light comes on during ground roll and sufficient runway or overrun area is available for aborting the take-off, proceed as follows:

1. Abort.
   Refer to "Abort" under "Take-off and Landing Emergencies" in this section.

2 through 7. (Deleted)

Forward Fire-warning Light (Air-borne).

If the forward fire-warning light comes on after the airplane becomes air-borne, and sufficient runway is not available and overrun area is congested, preventing aborting of the take-off, the following is recommended if altitude is too low for a safe ejection.

1. External load—Jettison.
2. Throttle—Maintain power.
   Maintain take-off power and begin immediate climb.
3. Maximum climb.
   Immediately climb to safe ejection altitude.
4. Throttle—Adjust to minimum practical power.
   Adjust throttle to minimum practical power to maintain safe ejection altitude.
5. Check for fire.
   Determine whether a fire actually exists by a report from another airplane, abnormal instrument readings or airplane or engine response to controls, explosion, unusual noise or vibration, fumes, heat, cockpit smoke, or trailing smoke noted following a turn.
6. If fire is confirmed—Eject.

WARNING

Whenever existence of fire is confirmed, prompt ejection ensures the greatest chance for survival.

7. If fire cannot be confirmed—Land as soon as possible.
   If existence of fire cannot be confirmed, maintain a safe ejection altitude at minimum practical power. Establish controllability of airplane and try to obtain assistance from other airplanes in the area in determining existence of fire. If no assistance is available, reconfirm controllability before descent below safe ejection altitude, and land as soon as possible.

Aft Fire-Warning Light (Ground Roll).

If the aft fire-warning light comes on during ground roll and sufficient runway and overrun area is available to abort the take-off, proceed as follows:

1. Abort.

    Refer to "Abort" Take-off and Landing Emergencies" in this section.

2 through 7. (Deleted)

Aft Fire-warning Light (Air-borne).

If the aft fire-warning light comes on after becoming airborne and take-off cannot be safely aborted, proceed as follows:

1. Throttle—Reduce power.

    Retard throttle from AFTERBURNER range to Military Thrust and continue to climb-out.

2. Warning light—Check.

    a. If light goes out—Continue flight at reduced power and land as soon as possible.

        It is remotely possible that fire may have damaged the fire detector circuit. To test circuit, hold fire warning system test switch at TEST. If the light comes on while the switch is at TEST, the circuit is still operative.

    b. If light stays on—Continue climb.

        With reduced power, maintain climb and check for other signs of fire, such as trailing smoke, long exhaust flames, etc.

3. Visual indications of fire—Check.

    a. If no fire is apparent—Continue flight at reduced power and land as soon as possible.

    b. If fire exists—Eject.

        If positive signs of fire exist, maintain power and immediately climb to a minimum safe ejection altitude, and eject. (See figure 3-4 for minimum safe ejection altitude.)

ENGINE FIRE DURING FLIGHT.

Forward Fire-warning Light.

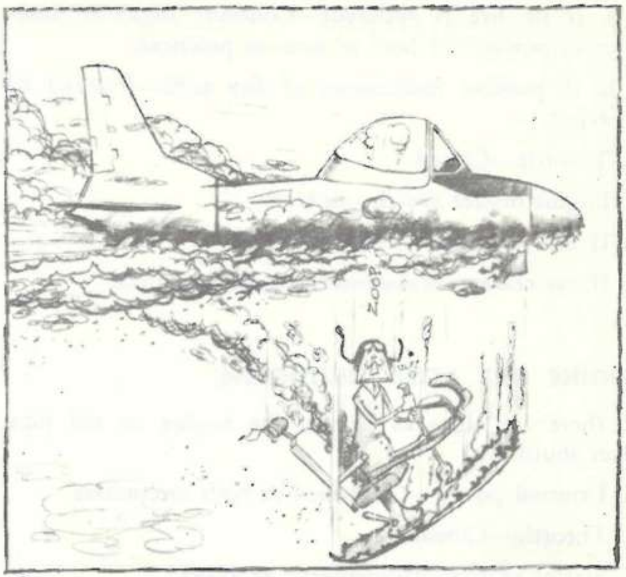
If the forward fire-warning light comes on, proceed as follows:

1. Throttle—Adjust to minimum practical power, maintaining safe ejection attitude.

2. Check if fire exists.

    Determine whether a fire actually exists by a report from another airplane, by abnormal instrument readings, or airplane or engine response to controls, explosion, unusual noise, vibration, fumes, heat, cockpit smoke, or trailed smoke noted following a turn.

3. If existence of fire is confirmed—Eject.



Warning

Whenever existence of fire is confirmed, prompt ejection will assure greater chance of survival.

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4. If fire cannot be confirmed—Land as soon as possible.

    If existence of fire cannot be confirmed, maintain a safe ejection altitude at the minimum practical power, and proceed toward nearest available base establishing controllability of airplane en route. Reconfirm controllability before descent below safe ejection altitude, and land as soon as possible.

Aft Fire-warning Light.

Illumination of the aft fire-warning light (intermittent flashing red light) shows on overheat condition or possible fire in the aft section, necessitating action as follows:

1. Warning light—Check.

    a. Reduce power in attempt to extinguish light.

    b. If light goes out—Continue flight at reduced power, and land as soon as practical..

        It is remotely possible that fire may have damaged the fire detector circuit. To test circuit, hold fire-warning system test switch at TEST. If the light comes on while the switch is at TEST, the circuit is still operative.

    c. If light remains on with throttle retarded to START IDLE, indicating possible fire rather than overheat—Proceed to step 2.

2. Check for other indications of fire, such as trailing smoke, engine noise, verification from another airplane, etc.

a. If no fire is apparent—Continue flight at minimum power and land as soon as practical.

b. If positive indications of fire exist—Proceed to step 3.

3. Throttle—Closed.
4. Engine master switch—OFF.
5. If fire continues—Eject.
6. If fire ceases—Make forced landing or eject.

ENGINE FIRE AFTER SHUTDOWN.

If there are signs of fire in the engine or tail pipe after shutdown:

1. External power—Connected to both receptacles.
2. Throttle—Closed.
3. Starter switch—Momentarily at START.
4. As starter is engaged—Audibly check that engine begins to turn, or note tachometer indication.
5. Engine rpm—Approximately 9% (one minute maximum).
6. Stop-starter switch—Momentarily hold at STOP STARTER position.

ELECTRICAL FIRE.

Circuit breakers or fuses protect most of the electrical circuits to minimize the probability of electrical fires. However, if an electrical fire does occur, proceed as follows:

1. Battery and generator switches—OFF.

   The fuel booster and transfer pumps are inoperative when all electrical power is shut off, and the possibility of an engine flame-out is greatly increased when these pumps become inoperative.

1A. Emergency fuel switch—ON.

CAUTION

If it becomes necessary to move the battery and the generator switches to OFF, the emergency fuel system takes over fuel control, regardless of the position of the emergency fuel system switch and without illuminating the emergency fuel system caution light. Thus, all later throttle movements must be made cautiously to prevent compressor stall or flame-out.

2. Land as soon as practical.

Note

Battery power lasts from 25 to 28 minutes unless the flight control normal hydraulic system fails. If the flight control alternate hydraulic system must be used, battery power lasts only about 20 minutes and alternate hydraulic accumulator pressure should be conserved by minimum movement of control surfaces. Operation from bases with low prevailing outside temperatures make loss of battery power even more rapid.

ELIMINATION OF SMOKE OR FUMES.

If smoke or fuel fumes enter the cockpit, proceed as follows:

Note

When necessary to depressurize cockpit at high altitude, first descend to 20,000 feet or less; then depressurize cockpit.

1. Oxygen regulator diluter lever—100% OXYGEN.
2. Oxygen regulator emergency toggle lever—EMERGENCY.
3. Manual ram-air valve—OPEN.
4. If preceding steps are not successful—Pull canopy handle.

EJECTION.

If the decision has been made to abandon the airplane in flight, escape should be made with the ejection seat. The basic ejection procedure is shown in figure 3-4. Connection requirements for the zero-delay lanyard are shown in figure 3-4A.

WARNING

If overwater ejection is made, remove oxygen mask before hitting water, to prevent sucking water into mask.

Note

Refer to "Ejection VS Forced Landing" in this section for additional information.

The following information should be observed, when ejection must be accomplished:

a. Under level-flight conditions, eject at least 2000 feet above the terrain if possible.

b. Eject at the lowest practical airspeed at which level flight can be maintained.

c. If recovery from a spin has not been completed by the time the airplane passes through 7000 feet above the terrain, or ejection must be accomplished during an uncontrollable dive, eject 7000 feet above the terrain, if possible.

d. If the airplane is not controllable, ejection must be accomplished at whatever speed exists, as this offers the only opportunity of survival. At sea level, wind blast will exert minor forces on the body up to about 525 knots IAS, appreciable forces from about 525 to 600 knots IAS, and excessive forces above about 600 knots IAS. As altitude is increased, these speed ranges will be proportionately slightly lower.

e. The automatic safety belt must not be opened manually before ejection, regardless of altitude, for several reasons. If the automatic seat belt is opened manually, the automatic-opening feature of the parachute is eliminated and seat separation will be too rapid at high speed.

LOW-ALTITUDE EJECTION.

The following are emergency minimum ejection altitudes, based on use of the BA-15 or BA-18 parachute in level flight:

Zero-delay lanyard connected—100 feet above the terrain.

Zero-delay lanyard not connected—200 feet above the terrain.

WARNING

Emergency minimum ejection altitudes quoted were determined through extensive flight tests and are based on distance above terrain on initiation of seat ejection (i.e., time seat is fixed). These figures do not provide any safety factor for such matters as equipment malfunction, delays in separating from the seat, etc. These figures are quoted only to show the minimum altitude that must be achieved in the event of such low-altitude emergencies as fire on takeoff. They must not be used as the basis for delaying ejection when above 2000 feet, since accident statistics show a progressive decrease in successful ejections as altitude decreases below 2000 feet. Therefore, whenever possible, eject above 2000 feet.

EJECTION SEAT OPERATION

Figure 3-4

During any low-altitude ejection (below 2000 feet above the terrain), the chances for successful ejection can be greatly increased by zooming the airplane (if airspeed permits) to exchange airspeed for altitude. Ejection should be accomplished while the airplane is in a positive climb. This will result in a more nearly vertical trajectory for the seat and pilot, thus providing more altitude and time for seat separation and parachute deployment. (Refer to "Engine Failure During Flight at Low Altitude" in this section for information on the zoom-up maneuver.)

FAILURE OF SEAT TO EJECT.

If the seat does not eject when the triggers are squeezed, proceed as follows:

1. Speed brakes—Closed.
2. Safety belt—Unfasten.
3. Bail-out bottle—Actuate, if necessary.
4. Personal leads (oxygen, radio, and anti-G suit)—Disconnect.
5. Invert airplane and then push free of seat or bail out

2

SQUEEZE EITHER TRIGGER TO EJECT SEAT

IF CANOPY FAILS TO JETTISON

SQUEEZE EITHER TRIGGER TO EJECT SEAT THROUGH CANOPY.

EJECTION

Steps 1 and 2 are all that is necessary to eject. If time and conditions permit, do as much of the following as possible.

- Stow all loose equipment.
- Actuate bail-out bottle.
- Stopcock throttle.
- Lower helmet visor.
- Brace for ejection:
  - Heels hooked firmly in footrests.
  - Arms braced in armrests.
  - Body erect.
  - Head hard against headrest.

AFTER SEAT EJECTS....BELT WILL OPEN IN ONE SECOND

- Immediately after ejection, attempt to manually open the safety belt, as a precaution against the belt failing to open automatically.
- As soon as the belt releases, a determined effort must be made to separate from the seat. This will result in maximum terrain clearance and maximum available time for parachute deployment. This is extremely important for low-altitude ejections.
- If the safety belt has been opened manually during ejections above 14,000 feet, immediately pull parachute arming lanyard to permit automatic opening of the parachute at the preset altitude.
- Manually pull the parachute ripcord handle for all ejections below 14,000 feet.

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over the right side (to avoid hitting the fuel vent bayonet).

If you have control of the airplane, trim nose down and pull stick back to slow airplane as much as possible; then invert airplane. Maintain positive G-load until inverted; then sharply release stick and push free of seat. If you do not have control of the airplane, slow airplane as much as possible, then bail out over the right side.

6. Parachute arming lanyard—Pull.

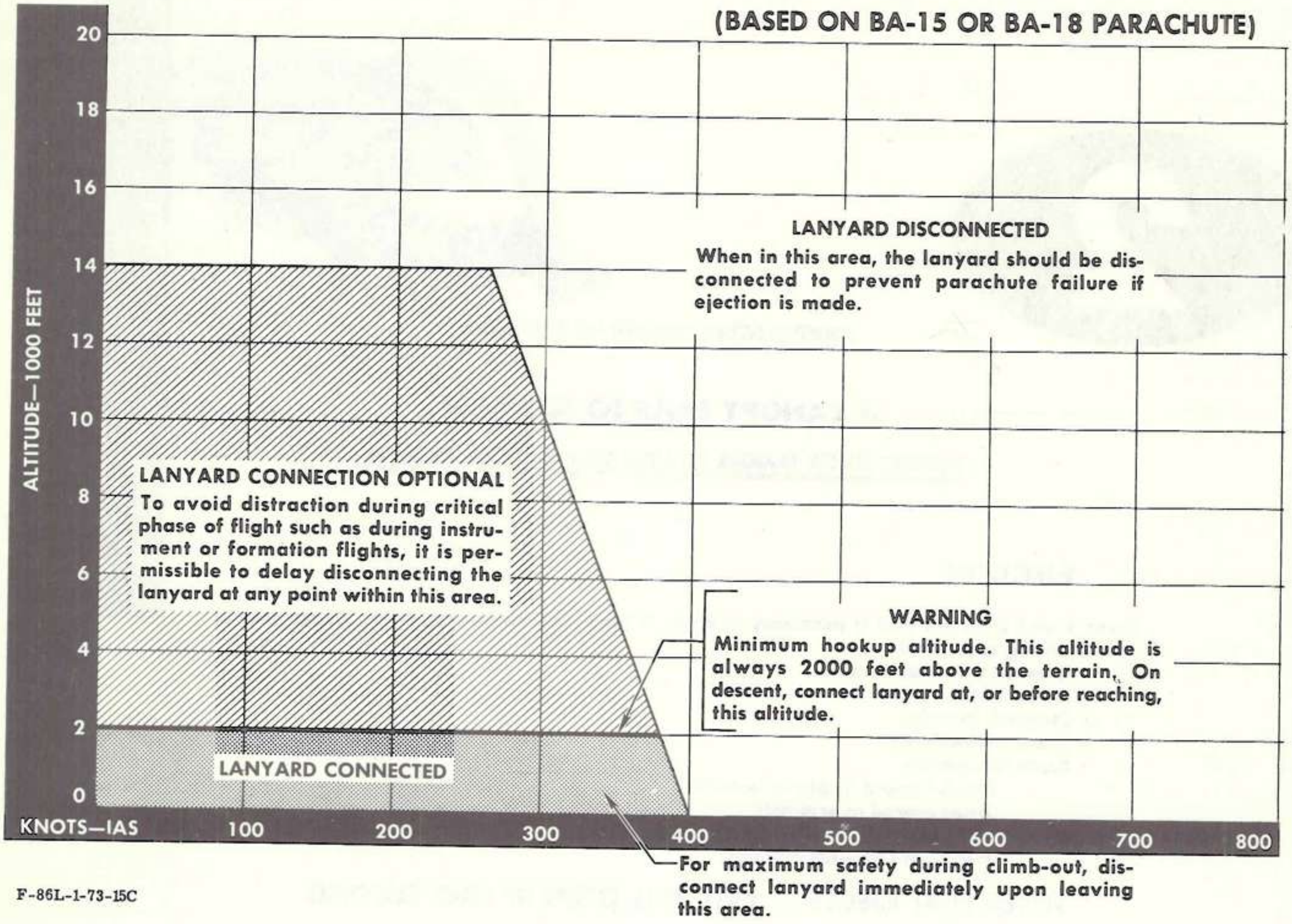
WARNING

If bail-out occurs below 14,000 feet, pull ripcord handle immediately.

Note

If you lose your oxygen mask and you do not have an automatic parachute, you should "free-fall" to 14,000 feet if possible, and then pull

ZERO-DELAY LANYARD CONNECTION REQUIREMENTS



(BASED ON BA-15 OR BA-18 PARACHUTE)

LANYARD DISCONNECTED
When in this area, the lanyard should be disconnected to prevent parachute failure if ejection is made.

LANYARD CONNECTION OPTIONAL
To avoid distraction during critical phase of flight such as during instrument or formation flights, it is permissible to delay disconnecting the lanyard at any point within this area.

WARNING
Minimum hookup altitude. This altitude is always 2000 feet above the terrain. On descent, connect lanyard at, or before reaching, this altitude.

For maximum safety during climb-out, disconnect lanyard immediately upon leaving this area.

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Figure 3-4A

ripcord handle. The length of time you can "free-fall" before anoxia prevents you from pulling ripcord handle depends upon your physical condition and bail-out altitude.

TAKE-OFF AND LANDING EMERGENCIES.

ABORT.

WARNING

Do not attempt to use the landing gear emergency up button. The nose gear will retract immediately, and the airplane will go down on its nose. One main gear will probably fold before the other, and structural damage and possible pilot injury can result.

The procedure for aborting is basically the same for any take-off emergency. Depending upon the severity of the situation, do as many of the following steps as necessary:

1. Throttle—Closed.

Note

In case of an engine control lockup, the throttle has to be retarded with enough force to actuate the idle detent switch to convert engine control to the emergency fuel system.

2. Drag chute handle—Pull.

CAUTION

Use care after deploying drag chute in cross winds of 45 to 90 degrees because of the weather-cocking tendencies of the airplane with chute deployed. Be ready to use brakes, rudder, and/or nose wheel steering to maintain directional control.

3. Brakes—Apply as necessary.

WARNING

- The heat generated in the brakes during an aborted take-off continues to build up during taxiing operation back to the line. This heat is transmitted to the wheel and into the tire itself. This heat in the tire melts the rubber and weakens the cords until the casing blows out.
- After an aborted take-off for any reason, the airplane must be taxied back to the line. Shut down engine. Make sure brake assembly is cool enough to touch by hand before further flight.

4. Drop tank jettison button—Depress (or emergency jettison handle—Pull).

WARNING

Rockets cannot be jettisoned by actuation of the stick grip jettison button when the weight of the airplane is on the gear.

5. Seat armrest—Raise.

   Raise armrest to jettison canopy, and lock shoulder harness before coming to a complete stop.

WARNING

If armrest has not been raised and if spilled fuel is in the vicinity of the airplane, use the mechanical or electrical means to remove the canopy if time permits. If these systems fail, the canopy jettison mechanism may be used; however, a fire may result from a hot powder spark when the canopy catapult is actuated.

6. Engine master and battery-starter switches—OFF.

CAUTION

Turn engine master switch to OFF while battery-starter switch is at BATTERY, so that power will still be available to close fuel shutoff valve.

7. Generator switches—OFF (if time permits).

ENGAGING RUNWAY OVERRUN BARRIER.

WARNING

- Do not attempt to use the landing gear emergency up button. The nose gear will retract immediately, and the airplane will go down on its nose. One main gear will probably fold before the other, and severe structural damage and possible pilot injury can result.
- If the canopy has been removed and a barrier engagement is imminent, with any landing gear configuration other than all gear down and locked, there is a possibility of the upper barrier strap entering the cockpit. To prevent injury if this should occur lean as far forward as possible, so that the windshield covers the head and shoulders.

In this airplane, successful engagements have been made with the nylon net runway overrun barrier up to 130 knots ground speed. The speed range where drop tanks are beneficial to barrier engagement is extremely small (40 to 60 knots). In an emergency, it is impractical to retain the drop tanks and attempt to control the airplane speed for barrier engagement within this speed range. Therefore, when an engagement is imminent, jettison the drop tanks. Barrier engagements should be made as close to the center of the barrier as possible. Off-center engagements can be made successfully, but the airplane swerves as a result of the webbing pulling unevenly on the nose wheel. If for any reason you are unable to bring the airplane to a stop or to a safe taxiing speed after a landing before reaching the end of the runway, and if the runway is equipped with a nylon net overrun barrier, do the following:

WARNING

- Make decision to jettison drop tanks as early as possible to ensure greatest possible separation of tanks and airplane and to minimize the possibility of tanks sliding ahead of the airplane and prematurely tripping the barrier.
- If barrier engagement is anticipated while still air-borne, jettison external load over an open area.

1. Drop tanks—JETTISON.

1A. Drag chute—Deploy.

2. Throttle—CLOSED.
3. Aim for center of barrier and contact it as close to 90 degrees as possible.
4. Brakes—Avoid excessive use during engagement to barrier, to prevent tire blowouts.
5. Engine master, generator, and battery switches—OFF.
6. Engage barrier.

CAUTION

Do not turn battery switch off until engine master switch has been turned off, so that power will be available to close fuel shutoff valve.

TIRE FAILURE.

Tire failure on take-off may present more problems than a tire failure on landing. Directional control is more difficult at the higher gross weights during take-off abort; therefore, if speed is at or near take-off speed, continue take-off and burn fuel down before landing.

Nose Gear Tire Failure On Take-off.

If the nose gear tire fails during take-off run and speed is too slow to continue take-off, the take-off should be aborted. (Refer to "Abort" under "Take-off and Landing Emergencies" in this section.)

Note

- If nose gear tire failure occurs at or near nose wheel lift-off speed, the pilot may elect to continue the take-off in order to reduce the gross weight of the airplane. Control on the ground is much easier at lighter gross weights.
- Even though heavy braking increases the load on the nose gear, it is considered more important that the airplane be stopped as quickly as possible than to attempt to lighten nose wheel loading at the expense of a longer roll.

Nose Gear Tire Failure On Landing.

When a landing is to be made with nose gear tire flat, lower landing gear in normal manner, and proceed as follows:

1. Touchdown—Hold nose gear off runway as long as possible.
2. Drag chute—Deploy.
3. Nose wheel steering—Engage.

   After nose wheel touchdown, use combination of braking and nose wheel steering.

Main Gear Tire Failure On Take-off.

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

1. If speed is greater than 110 knots IAS—Jettison drop tanks and continue take-off.
2. If speed is less than 110 knots IAS—Abort take-off. Retain external loads unless barrier engagement is anticipated (Refer to "Abort" under "Take-off and Landing Emergencies" in this section.)

WARNING

If take-off is continued, the landing gear should not be retracted if tire has failed or is suspected to have failed. Tire fragments may damage equipment in the wheel well.

CAUTION

- Avoid extreme rudder pedal deflections when nose wheel steering is engaged, since this may cause nose wheel to skid or skip sideways, and steering effectiveness will be lost.
- Deliberately blowing the good tire may not be helpful in keeping the airplane on the runway. The airplane will tend to roll straighter with both main gear tires blown, but it is very difficult to turn under this condition. Braking efficiency is greatly reduced when both the main gear tires are blown.

Main Gear Tire Failure On Landing.

When a landing is to be made with a main gear tire flat, lower landing gear in normal manner, and proceed as follows:

1. Touchdown—Land on side of runway away from flat tire.

   Note

   This is necessary to minimize the amount of differential braking required if the airplane pulls toward the flat tire.

2. Drag chute—Deploy.
3. Nose wheel steering—Engage.

   After nose wheel touchdown, use a combination of differential braking and nose wheel steering.

BELLY LANDING.

If a belly landing is unavoidable, proceed as follows:

1. Canopy—Unlock.

   Unlock latches manually after turning final to allow airstream to break canopy away from fuselage.

   Note

   Pull helmet visor down before unlocking canopy.

   WARNING

   - The canopy should be released before landing, to prevent the possibility of being trapped in the cockpit if the fuselage warps and the canopy jams in the closed position.
   - Jettisoning the canopy after a belly landing during which the fuel tanks have ruptured can cause spilled fuel to ignite.

2. Rocket package—Jettison if loaded; retain if empty.
3. Drop tanks—Jettison if they contain fuel.

   WARNING

   Empty drop tanks should be retained to reduce possible pilot injury, impact damage, and fire hazard.

4. Make normal approach.
5. Wing flap handle—DOWN, for final approach.
6. Speed brake switch—OUT.
7. Landing gear handle—UP.
8. Throttle—CLOSED, when landing is ensured.
9. Engine master, generator, and battery switches—OFF.

   Just before touchdown, turn engine master, generator, and battery switches OFF. Battery switch should be turned off last, so that power is available to close the fuel shutoff valve when the engine master switch is turned OFF.

10. Shoulder harness lock handle—LOCKED.
11. Touch down in normal landing attitude.
12. Drag chute—Deploy immediately after touchdown.

    WARNING

    If the drag chute is deployed at speeds in excess of approximately 160 knots IAS, it automatically jettisons.

    Note

    Flight tests have shown that a properly packed chute has the least compartment pull-out resistance and deploys at speeds as low as 60 knots IAS in about 4 seconds. However, to ensure consistent and proper operation, it is recommended that the chute be deployed above 75 knots IAS.

13. Leave airplane immediately after it stops.

LANDING GEAR UNSAFE INDICATIONS.

If an unsafe gear down indication still exists after the emergency lowering procedure (figure 3-6) has been accomplished, attempt to obtain from the tower or chase plane, a positive confirmation of the gear condition. Either of two courses of action will be followed, depending upon the gear condition. If an unsafe main gear condition is *positively* confirmed, follow the procedures under "Main Gear-up Landing (Prepared Surface Only)." If no positive confirmation can be obtained, then follow the procedure given under "Any One Gear Up or Unlocked."

Main Gear-up Landing (Prepared Surface Only).

When one or both main gear cannot be extended (and utility hydraulic pressure is available), the main gear should be retracted and a landing made on the nose gear and aft fuselage (or empty drop tanks) rather than landing on only one main and nose gear. This should not be done unless the tower or chase plane can *positively* confirm that one or both main gear are not fully extended. If the main gear cannot be retracted, a landing with asymmetrical gear configuration may be made.

Note

Whenever the gear cannot be extended by the normal system, the emergency procedure will be used. (See figure 3-6.) However, once the emergency lowering procedure is used, the nose gear is extended and locked down and cannot be retracted.

If an unsafe condition is confirmed for the main gear after using the emergency lowering procedure, the following procedure should be used:

1. Landing gear handle—UP.

   Retract main gear so that landing can be made on nose gear and aft fuselage (or empty drop tanks).

2. Canopy—Unlocked.

   Unlock latches manually after turning final approach to allow airstream to break canopy away from fuselage.

Note

Pull helmet visor down before unlocking canopy.

WARNING

- The canopy should be released before landing to prevent the possibility of being trapped in the cockpit if the fuselage warps and the canopy jams in the closed position.
- Jettisoning the canopy after a landing during which the fuel tanks have ruptured can cause spilled fuel to ignite from a hot powder spark when the canopy catapult is actuated.

3. Rocket package—Jettison if loaded; retain if empty.
4. Drop tanks—Jettison if they contain fuel.

WARNING

Empty drop tanks should be retained to reduce possible pilot injury, impact damage, and fire hazard.

5. Plan approach to touch down as near end of runway as possible.
6. Wing flap handle—DOWN on final approach.
7. Speed brake switch—OUT.
8. Throttle—CLOSED just before touchdown.
9. Engine master switch—OFF.
10. Battery switch—OFF.

    Wait one second to allow fuel shutoff valve to close; then move battery switch to OFF.
11. Generator switches—OFF.
12. Shoulder harness lock handle—LOCKED.
13. Touchdown—Attempt to touch down on nose gear and aft fuselage simultaneously.
14. Drag chute—Deploy immediately after touchdown.

Note

The drag chute is designed to automatically jettison at speeds above approximately 160 knots IAS.

15. Leave airplane immediately after stopping.

ANY ONE GEAR UP OR UNLOCKED.

If any one gear will not extend or lock down, leave remaining gear down and proceed as follows:

1. Canopy—Unlock.

    Unlock latches manually after turning final approach to allow airstream to break canopy away from fuselage.

Note

Pull helmet visor down before unlocking canopy.

WARNING

- The canopy should be released before landing, to prevent the possibility of being trapped in the cockpit if the fuselage warps and the canopy jams in the closed position.
- Jettisoning the canopy after a belly landing during which the fuel tanks have ruptured can cause spilled fuel to ignite from a hot powder spark when the canopy catapult is actuated.

2. Rocket package—Jettison if loaded; retain if empty.
3. Drop tanks—Jettison if they contain fuel.

WARNING

Empty drop tanks should be retained to reduce possible pilot injury, impact damage, and fire hazard.

4. Plan approach to touch down as near end of runway as possible.
5. Wing flap handle—DOWN, on final approach.
6. Speed brake switch—OUT.

Note

If nose gear is down but not locked, you can attempt to snap it down and locked by making a touch-and-go landing. Attempt this procedure only after all other emergency measures have failed.

7. Throttle—CLOSED, just before touchdown.
8. Engine master switch—OFF.
9. Battery switch—OFF.

    Wait one second to allow fuel shutoff valve to close, then move battery switch to OFF.
10. Generator switches—OFF, if time permits.
11. Shoulder harness lock handle—LOCKED.
12. After touchdown—Hold unsafe gear off runway as long as possible.

    After touchdown, hold unsafe gear off runway as long as possible, easing it down before flight controls become ineffective.

13. Drag chute—Deploy immediately after touchdown.

WARNING

If the chute is deployed at speeds above about 160 knots IAS, the chute automatically jettisons.

14. Brakes—Do not use if stop can be made without them.
15. Leave airplane immediately after stopping.

LANDINGS ON UNPREPARED SURFACES.

Landings on unprepared surfaces are not recommended. However, if an emergency landing on an unprepared surface is unavoidable, it must be made with as many landing gear down as possible. Investigation has shown that landings made on unprepared surfaces with the landing gear down have resulted in less pilot injury and less damage to the airplane than those made with gear up. Empty drop tanks should be retained to cushion impact loads and minimize airplane damage as much as possible.

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NO-FLAP LANDING.

No special technique is required for landing without wing flaps. Speed during final approach and touchdown should be increased 10 percent over recommended speeds for load and configuration.

LOSS OF CANOPY.

The flight characteristics with or without the canopy are the same. Stall speeds with or without the canopy are the same, and the stall warning of general airframe buffet remains unchanged. At about 5 to 10 knots IAS above stall, turbulence around the empennage causes a directional oscillation with accompanying roll. Without the canopy, the noise level caused from airflow over the open cockpit is extremely disturbing, but not considered dangerous. If the canopy should come off during the take-off roll and there is not enough runway remaining to abort the take-off, it is recommended that the take-off be completed. Use higher power settings and maintain normal approach speed during landing. The normal approach speed is 30 knots IAS above stall speed; however, it should be remembered that, if a landing is made immediately after take-off, the airplane weight will be higher than normal and therefore the approach and touchdown speeds will be higher. The stall speeds and the recommended approach and touchdown speeds for various conditions are shown in the appendix.

EMERGENCY ENTRANCE.

See figure 3-5.

DITCHING.

Note

Inspect emergency equipment, parachute, life vest, and raft pack before each overwater flight.

Ditch only as a last resort. All emergency survival equipment is carried by the pilot; therefore, there is no advantage in riding the airplane down. However, if altitude is not sufficient for emergency exit, and ditching is unavoidable, proceed as follows:

1. Follow radio distress procedure.
2. Jettison (salvo) button—Depress (or emergency jettison handle—Pull).

   Drop tanks must be jettisoned regardless of amount of fuel contained. The tanks cause the airplane to dive violently upon contact with the water.
3. Rocket package—Jettison.
4. Personal equipment—Disconnect.

   Check that leads will not foul when leaving cockpit (leave oxygen connected).
5. Oxygen regulator diluter lever—100% OXYGEN.

Note

In the event of ditching and sinking in water where you find yourself unable to immediately escape due to any number of factors, it is possible for you to survive under water with your oxygen equipment until you can free yourself and escape. The A-14 or A-13A pressure-demand type oxygen mask and the diluter-demand oxygen regulator is suitable for an underwater breathing device when the regulator is set at 100% OXYGEN. It is essential that the mask be in place and tightly strapped, and that the regulator be set at 100% OXYGEN. The bail-out bottle cannot be used under water.

6. Landing gear handle—UP.
7. Speed brake switch—IN.
8. Canopy—Unlock.

   Allow airstream to carry canopy away.

Note

Pull helmet visor down before unlocking canopy.

9. Throttle—CLOSED.
10. Wing flap handle—DOWN.

    Flaps collapse on impact and do not tend to make airplane dive.
11. Engine master, generator, and battery switches—OFF.

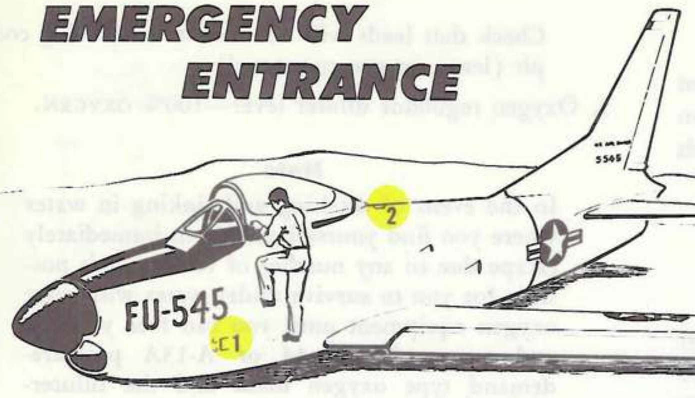
    Turn battery switch OFF last, so that power will be available to close fuel shutoff valve when engine master switch is turned OFF.
12. Safety belt and shoulder harness—Tighten.
13. Shoulder harness lock handle—LOCKED.
14. Surface conditions—Check.

    Unless wind is high or sea is rough, plan approach heading parallel to any uniform swell pattern and try to touch down along wave crest or just after crest passes. If wind is as high as 25 knots or surface is irregular, the best procedure is to approach into the wind and touch down on the falling side of a wave.
15. Approach and flare—Normal.
16. Touchdown—Keep nose high, and attempt to touch down at minimum flying speed.

WARNING

If airplane is ditched in a near-level altitude, it will dive violently soon after contact.

EMERGENCY ENTRANCE



NOTE:
If canopy cannot be readily lifted off, emergency entrance must be made forcibly.

WARNING

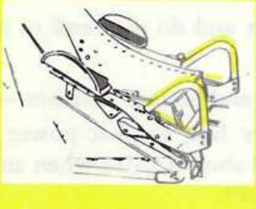
When canopy has been jettisoned, the ejection seat is armed.

CANOPY EMERGENCY RELEASE

CANOPY HOOK RELEASE

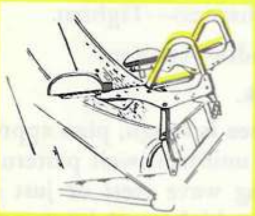
1 **Pull canopy emergency release handle to release canopy latches. Then, to complete canopy opening electrical circuit, close access door or hold switch depressed with finger while opening canopy electrically by pushing external control button marked "OPEN." Hold button fully depressed until canopy is completely open.**

2 **If the canopy will not open, lift canopy with handholds in canopy frame and remove canopy from airplane. It may be necessary to pull and hold extended (or secure in extended position) the canopy hook release in order to free canopy.**



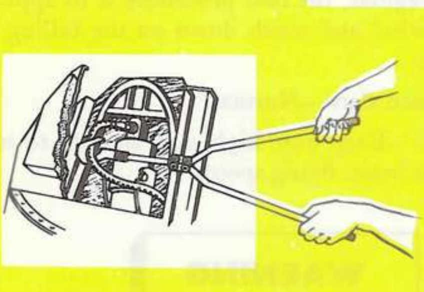
3 **Determine position of seat armrests.**

A. If both seat armrests are in normal down or stowed position, complete rescue operation, being sure to keep clear of armrests at all times.



WARNING

Avoid unnecessary handling of any portion of seat and canopy firing mechanisms at all times and stay clear of line of canopy ejection.



B. If either armrest is raised, disarm catapult by cutting or disconnecting* hose leading from seat catapult to "T" fitting on back of seat. Cut hose, using cutter as shown, as close to seat catapult as possible. Make sure that loose hose ends are not aligned; otherwise, if seat initiators fire accidentally, expanding gases may actuate catapult exactor and cause seat to fire.

***Use 9/16-inch open-end wrench.**

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Figure 3-5

17. Oxygen mask—Remove.

18. Leave airplane.

DROP TANK AND ROCKET PACKAGE EMERGENCY JETTISON IN FLIGHT.

To release drop tanks, press drop tank jettison button on left instrument subpanel. The drop tanks can also be released manually when the drop tank emergency jettison handle is pulled to its full extension (about 3 inches). To release rocket package, turn armament master switch to EMERG JET'SN.

Note

> Refer to "Drop Tank Release Speed" in Section V for release speeds with various types of drop tanks. (See figure 5-1.)

AFTERBURNER FAILURE.

LOSS OF AFTERBURNER DURING TAKE-OFF.

If the afterburner fails during take-off, there will be a noticeable loss of thrust and a decrease in noise level. If the failure occurs before committed to take-off, abort the take-off. [Refer to "Engine Failure During Take-off Run (No Runway Overrun Barrier)" in this section.]

LOSS OF AFTERBURNER DURING CLIMB-OUT.

If afterburner fails after airplane is air-borne and take-off is to be continued, proceed as follows:

1. Variable-nozzle will automatically go to closed position.

   Automatic closing of the variable-nozzle should restore operation to Military Thrust in about 2 seconds.

Note

> If proper response to automatic closing of nozzle is not obtained, manually close nozzle to desired position.

2. Throttle—MILITARY.

3 through 6. (Deleted)

7. Landing gear—Retract immediately.

8. Wing flap handle—UP, as soon as a safe airspeed is reached.

9 and 10. (Deleted)

LOSS OF AFTERBURNER DURING FLIGHT.

Note

> In steady-state operation, if exhaust temperature climbs over 685°C or if nozzle operation becomes erratic, a malfunction of the electronic engine controls or thermocouples is indicated. Reduce power and land as soon as possible. Do not go into or return to afterburner after such a condition has existed.

When loss of afterburner occurs during flight, proceed as follows:

1. Variable-nozzle will automatically go to closed position.

   Automatic closing of the variable-nozzle should restore operation to Military Thrust in about 2 seconds.

2. Throttle—MILITARY.

3. Attempt to relight afterburner—Watch for signs of abnormal operation.

   If all cockpit indications of afterburner operation are normal on the relight, continue afterburner operation.

AFTERBURNER SHUTOFF FAILURE.

If retarding the throttle below MILITARY stop does not shut off the afterburner, move the afterburner shutoff switch to OFF. This changes the forward and aft fuel booster pumps and dual pumps to low speed and shuts off the afterburner turbine-driven fuel pump, which allows the afterburner fuel shutoff valve to close.

VARIABLE-AREA NOZZLE AUTOMATIC CONTROL FAILURE.

A malfunction of the automatic control of the variable-area nozzle is shown by improper response of the nozzle to throttle movement, or inability to hold engine exhaust temperature near the Military Thrust limit. To manually control the variable-area nozzle, proceed as follows:

1. Variable-nozzle switch—OPEN or CLOSE, as necessary.

CAUTION

- Do not attempt to light afterburner with variable-nozzle switch at OFF as this could result in an engine overtemperature condition.
- Do not move variable-nozzle switch from AUTO unless failure of nozzle automatic control is shown, or unless emergency fuel switch is moved to ON during a lockup condition, as this could result in an engine overtemperature condition.

Note

The variable-nozzle moves more slowly when actuated by means of the nozzle switch than when automatically controlled.

INADVERTENT NOZZLE CLOSURE.

Failure of the temperature sensing system permits inadvertent exhaust nozzle closure and creates an extremely dangerous engine operating condition and complete engine failure in a relatively short time. The first step in this emergency procedure is to bring the throttle out of the afterburner range; at which time, the exhaust nozzle position is controlled directly by the engine thrust selector, and all engine operation up to Military Thrust will be nearly normal. However, the exhaust gas temperature should be closely monitored, as it is possible to obtain a slight overtemperature in the full Military Thrust position. When this procedure is followed, the pilot will have Maximum Power (Military Thrust) and faster engine acceleration in the event of a go-around. Also during the landing phase, the exhaust nozzle will open (approximately one-half position) and minimum thrust is provided (400 pounds) which will require the least amount of braking. If nozzle closure is evident, proceed as follows:

1. Discontinue afterburner operation immediately.
   Do not relight afterburner at any time.
2. Retard throttle—Maintain exhaust temperature at 685°C maximum.
3. Land as soon as possible.

INADVERTENT NOZZLE OPENING.

There are certain critical phases of flight such as during and immediately following take-off when an inadvertent nozzle-opening will require pilot action, the urgency of which will depend on conditions at the time of the emergency. If such a failure should occur before becoming committed to take-off, the take-off should be aborted. If nozzle opening should occur after becoming committed to take-off, maintain Maximum Thrust (or advance throttle to Maximum Thrust afterburner range) and climb until a safe altitude is reached. If the nozzle-opening occurs when the throttle is retarded from the afterburner range to the Military Thrust position following take-off, proceed as follows:

1. Variable nozzle—Manually close to ¼ position.
2. Throttle—Retain at Military Thrust position.

Note

If thrust (acceleration) is not considered adequate, it may be necessary to jettison drop tanks, if installed.

3. Variable nozzle—Adjust to maintain exhaust temperature at approximately 685°C.

Note

The primary concern is to maintain sufficient thrust to perform a subsequent landing; therefore, maintaining exact exhaust gas temperature within limits is of secondary importance.

4. Land as soon as possible.

OIL SYSTEM FAILURE.

In case of an oil system malfunction, causing either high or low oil pressure, possible oil starvation accompanied by failure of one or more of the main bearings may occur. If the engine rpm is reduced after oil starvation of one or more main bearings, it is possible that the resistance to rotation offered by a "failed" bearing will be great enough to cause further deceleration of the engine. Engine seizure would probably occur regardless of the fact that the throttle may be advanced after the engine has begun to decelerate. The engine may possibly operate for a longer period of time, with one or more "failed" main bearings, if the rpm is increased immediately after oil system malfunction is detected. In case of high or low oil pressure, the following procedures should be used.

1. If power setting is above 80% rpm, do not move throttle until landing is ensured.
2. If power setting is below 80% rpm, advance throttle until engine rpm is 80% or more, and do not move throttle until landing is ensured.

and a decrease in exhaust temperature) and immediately move the emergency fuel switch to ON. In view of the different circumstances and conditions that may be encountered at time of failure, such as runway length, speed, field elevation, and stage of take-off at which failure occurs, the emergency procedures are prescribed in three phases:

- Main fuel system control failure before committed to take-off. Abort the take-off. Refer to "Engine Failure During Take-off Run (No Runway Overrun Barrier)," in this section.
- Main fuel system control failure after committed to take-off and before rpm drops below 85%. Position emergency fuel switch to ON and continue take-off.
- Main fuel system control failure after committed to take-off and rpm is inadvertently allowed to drop below 85% rpm. Refer to "Engine Failure During Take-off (Airplane Air-borne)," in this section.

MAIN FUEL CONTROL SYSTEM FAILURE DURING CLIMB.

It is necessary for the pilot to recognize a main fuel control system failure (shown by rpm drop and decrease in exhaust temperature) and immediately move the emergency fuel system control switch to ON. If the engine speed is inadvertently allowed to drop below 85% rpm before the emergency fuel system switch is moved to ON, the throttle should be retarded to START IDLE before the switch is placed to ON, to prevent an overtemperature condition. During take-off and climb to altitude, failure of the main fuel control system, which results in locking of the main fuel control valve, may not be detected until the lower fuel requirements of increased altitude produce a gradual increase in engine rpm or until the throttle is retarded after take-off and there is no response. When failure occurs, proceed as follows:

1. Emergency fuel switch—ON (as soon as failure is detected).

CAUTION

If engine speed is allowed to drop below 85% rpm before switch is moved to the ON position, retard throttle to START IDLE; then move switch to ON. Cautiously readvance throttle to prevent an overtemperature condition.

2. Throttle—Retard rapidly from AFTERBURNER to START IDLE.
3. Variable-nozzle switch—CLOSE, then OFF (only if the automatic feature of the variable nozzle should fail).
4. Throttle—Cautiously advance to MILITARY (avoid overtemperature condition).

MAIN FUEL CONTROL SYSTEM FAILURE DURING FLIGHT.

WARNING

If the main fuel control system fails during flight, a landing must be made using the emergency fuel system. The throttle should not be retarded to START IDLE during a landing approach if the emergency fuel system is used, since the time required to accelerate the engine from speeds below 40% rpm may be excessive if a go-around is necessary. Therefore, caution must be exercised to maintain the rpm at 75% when operating on the emergency fuel system during an approach.

Failure of the main fuel control system, with a resulting excessively open position of the main fuel control valve, will be evidenced by engine overspeeding to the overspeed governor setting and/or compressor stalling. Should such a failure occur, the emergency fuel system switch should be moved immediately to ON. Sudden loss of fuel flow, and any decrease in engine rpm during flight, show failure of the main fuel control system (unless fuel starvation has occurred) and necessitate operation on the emergency fuel regulator. To recover power following failure of the main fuel control system:

1. Retard throttle—START IDLE position (if rpm drops below 85%).
2. Emergency fuel system switch—ON.
3. Slowly readvance throttle.

CAUTION

When the emergency fuel system is in operation, throttle movement must be slow and smooth to avoid flame-out or engine overtemperature, particularly at high altitudes.

4. Variable-nozzle—"Jog" to desired position if automatic system fails.

   Jog nozzle to obtain desired exhaust temperature.
5. If engine flame-out occurs before throttle is readvanced, attempt an air start. (Refer to "Engine Air Start.")

ELECTRICAL SYSTEM EMERGENCY OPERATION.

FAILURE OF ONE GENERATOR.

If a generator warning light comes on, showing that one generator has failed or has been disconnected because of overvoltage, the equipment powered by the monitored bus No. 3, secondary inverter, and alternator, which includes radar and localizer receiver, will be automatically shut off. The glide slope will continue to operate in the event of a generator failure. Try to bring the generator back into the circuit as follows:

1. Warning light—Indicates the "failed" generator.
2. Master caution light—Automatically comes on.
3. "Failed" generator warning light—Press.

   Pressing the generator warning light turns off the master caution light, resetting it for any additional failures.
4. Momentarily hold related generator switch—RESET.
5. Generator switch—ON.

   If warning light remains out it shows that the overvoltage was temporary.
6. If warning light comes on again, move generator switch to OFF.

FAILURE OF BOTH GENERATORS.

If both generator warning lights come on, showing that both generators are out, equipment powered by monitored busses No. 2 and 3 and dc gyro power are shut off. This results in loss of power from the primary inverter to the ac bus.

CAUTION

The electronic engine control is inoperative when ac power is cut off. To provide later engine control on the emergency fuel system, the emergency fuel system switch should be immediately placed to ON. All later throttle movements must be made cautiously to prevent compressor stall or flame-out.

With ac power removed, the fuel flowmeter, fuel quantity, oil pressure, and hydraulic pressure gages will be inoperative. These instruments, while inoperative, will deceptively continue to show the condition that existed at any time of power failure. Try to bring generators back into circuit as follows:

1. Emergency fuel system switch—ON.
2. All nonessential electrical equipment—OFF.

Note

Failure of both generators does not automatically turn off all nonessential equipment. To effectively prolong battery life, you must turn off equipment you do not absolutely need.

3. Momentarily hold one generator switch at—RESET.
4. Generator switch—ON.

   If related caution light does not go out, turn generator switch OFF and try to reset other generator.
5. If related caution light goes out—Make a single attempt to reset other generator.

CAUTION

Repeated attempts to reset the inoperative generator may result in disconnecting the operative generator. If this occurs, leave inoperable generator switch OFF and again reset operable generator.

6. When at least one generator is operating:
   a. Wait 2 minutes—Allow electronic engine control to warm up (lockup light out).
   b. Emergency fuel switch—NORMAL.

COMPLETE ELECTRICAL FAILURE.

If a complete electrical failure should occur, or if for any reason it becomes necessary to move both battery and generator switches to OFF, remember that most equipment and controls will be inoperative without electrical power. See figure 1-15 for equipment powered by battery bus.

CAUTION

If a complete electrical power failure occurs, or if it becomes necessary to move the battery and generator switches to OFF, the emergency fuel system caution light. Thus, all later throttle of the position of the emergency fuel system switch and without illuminating the emergency fuel system caution light. Thus, all later throttle movements must be made cautiously to prevent compressor stall or flame-out.

Flight under these conditions is limited, and the following precautionary measures should be observed:

1. Reduce airspeed—Readjust trim.

   After power is turned off, trim is not available.
2. Reduce altitude and engine rpm to maintain satisfactory engine operation, if necessary.

The fuel booster and transfer pumps are inoperative when electrical power is shut off. It is possible to have an engine flame-out even with 1200 to 1700 pounds of fuel remaining, as the fuel supply to the engine will be suction feed only.

3. Land as soon as possible using forced landing pattern. (See figure 3-3.)

WARNING

Avoid extreme pitch attitudes and rapid airplane acceleration or deceleration to minimize the possibility of engine flame-out.

Note

Use landing gear emergency lowering system to ensure that gear lowers and locks. (Refer to "Landing Gear Emergency Lowering" in this section.) When electrical power is not available to the primary bus, the landing gear position indicators are inoperative and continuously show an unsafe condition.

INVERTER FAILURE (AUTOMATIC LOCKUP SYSTEM).

When failure of the main or spare inverter occurs, the inverter-out caution light comes on. Should the main inverter fail, the inverter out, engine control lockup, and master caution lights come on. When this occurs, the electronic engine controls are automatically locked up. When the main inverter fails, place inverter selector switch at SPARE. This transfers operation to the spare inverter and it assumes the load of the "failed" inverter. When the spare inverter comes up to speed and stabilizes, the inverter-out caution light should go out and approximately 10 to 25 seconds later the engine control lockup caution lights should go out, indicating the electronic engine controls are again in operation. The spare inverter normally powers the radar fire control system and is energized when the radar master switch is on or when the inverter selector switch is placed at SPARE. If a main inverter failure occurs when the radar is in operation, the selection of the spare inverter automatically transfers power from the radar fire control system to systems normally powered by the main inverter. The recovery time for electronic engine controls (indicated when the engine control lockup caution light goes out) is practically immediate, as the spare inverter is already up to speed and stabilized.

Inverter Failure During Take-off Roll (Continued Take-off).

During the take-off roll, if the main inverter fails (shown by inverter-out caution light coming on) and the engine controls automatically lock up (shown by the engine control lockup caution light coming on) and it is desired to continue the take-off in a locked-up condition, follow this procedure:

1. Continue take-off.
   Climb to a safe altitude, leaving throttle set at Maximum Thrust.
2. Inverter selector switch—SPARE position.

Note

The engine controls automatically unlock when ac power is restored (above about 98 volts) and the electronic engine control again takes over engine operation.

3. If lockup caution light does not go out within 30 seconds:
   a. Throttle—Rapidly retard to START IDLE.
   b. Emergency fuel switch—ON.
      Immediately move emergency fuel switch to ON as soon as throttle is retarded.
   c. Variable nozzle—Jog to desired position.
      Jog nozzle to obtain desired exhaust temperature.
   d. Cautiously readvance throttle to desired power setting.
4. Land as soon as practical.

Inverter Failure During Take-off Roll (Aborted Take-off).

During the take-off roll, if the main inverter fails (shown by inverter-out caution light coming on) and the engine controls automatically lock up (shown by the engine control lockup caution light coming on), do the following:

1. Abort.
   Refer to "Abort" under "Take-off and Landing Emergencies" in this section.

2 through 8. (Deleted.)

Inverter Failure During Flight.

During flight, if the engine control lock-up and master caution light comes on (showing that ac power has failed and the electronic engine control is in automatic lockup), maintain altitude and power settings. If conditions arise that require power readjustment before automatic unlocking of the engine electronic controls (which occurs when the inverter selector switch is manually moved to SPARE inverter), it will be necessary to change to the emergency fuel system to restore engine control. The switchover to the emergency fuel system is accomplished as follows:

1. Throttle—Rapidly retard to START IDLE.

2. Emergency fuel system switch—ON.
   Immediately move emergency fuel switch to ON as soon as throttle is retarded.
3. Variable nozzle—Close to desired position.
   Return variable-nozzle switch to OFF to lock nozzle in position.
4. Throttle—Advance cautiously to desired power setting.
5. Inverter selector switch—SPARE.
   Placing the inverter selector switch at SPARE selects the secondary inverter as the electronic engine control power source. When power is restored, the lockup system requires about 10 to 25 seconds to release the lockup condition.

If automatic electronic engine control lockup occurs during approach or landing, position throttle at about the mid-throttle position before moving emergency fuel system switch to ON.

LANDING GEAR EMERGENCY OPERATION.

(Deleted)

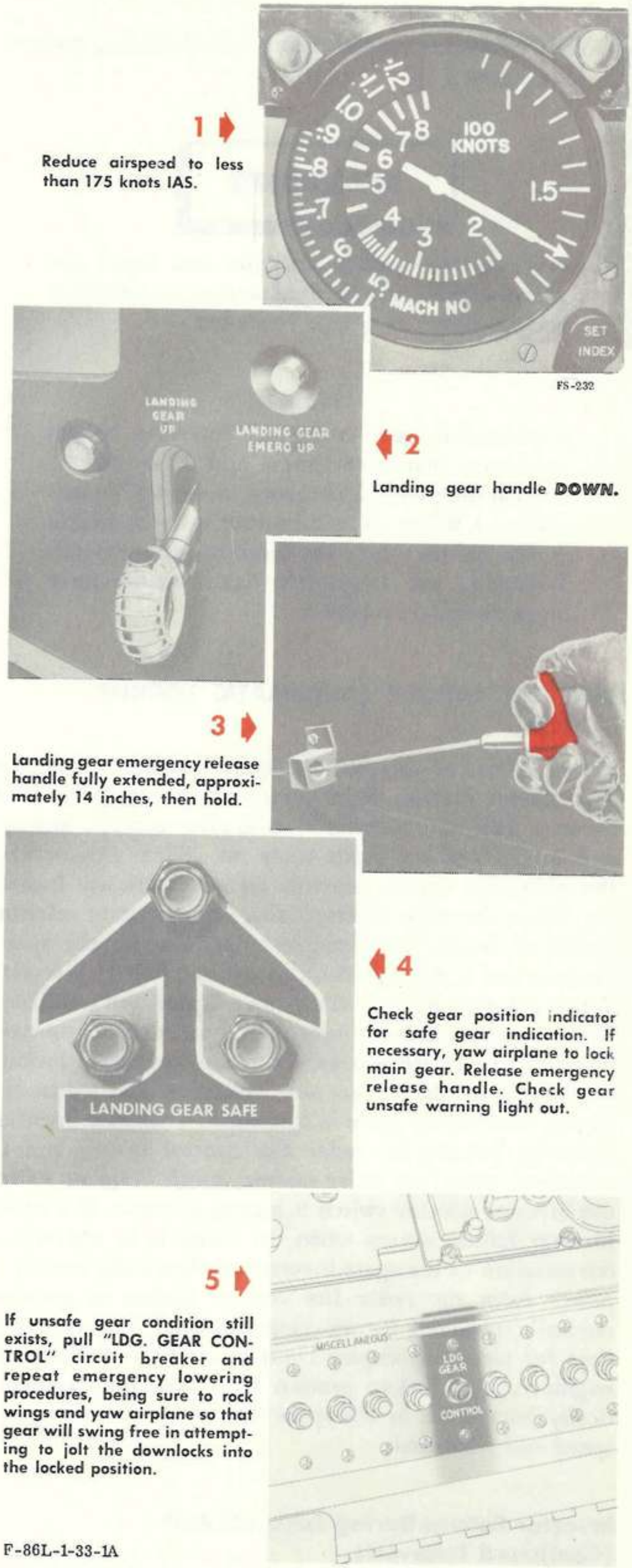
LANDING GEAR IN-FLIGHT EMERGENCY RETRACTION.

During flight, the following condition may be encountered. The landing gear red unsafe warning light may remain on after the landing gear handle is placed at UP. This does not necessarily constitute an emergency condition, but, under certain conditions, air loads on the landing gear doors can prevent the gear from retracting. This would be shown by a safe "down" indication on all three gears, with the unsafe warning light on and the handle at UP. If such a condition occurs, proceed as follows:

1. Leave landing gear handle—UP.
2. Maintain straight flight path—Minimize G and eliminate yaw.
3. Reduce speed to below 185 knots IAS.
   155 to 160 knots IAS is recommended to minimize air loads on doors.
   a. If a safe indication is obtained—Continue flight.
   b. If unsafe condition exists—Extend gear.
   c. When a safe gear-down indication is obtained—Return for landing.

If mission is of importance, maintain straight flight path to minimize G and eliminate yaw, hold airspeed below 185 knots IAS (155 to 160 knots IAS is recommended), and cycle gear down and up. If unsafe warning light goes out, continue mission; if unsafe light remains on, extend gear and land as soon as practical.

LANDING GEAR EMERGENCY LOWERING



1 Reduce airspeed to less than 175 knots IAS.

2 Landing gear handle **DOWN.**

3 Landing gear emergency release handle fully extended, approximately 14 inches, then hold.

4 Check gear position indicator for safe gear indication. If necessary, yaw airplane to lock main gear. Release emergency release handle. Check gear unsafe warning light out.

5 If unsafe gear condition still exists, pull "LDG. GEAR CONTROL" circuit breaker and repeat emergency lowering procedures, being sure to rock wings and yaw airplane so that gear will swing free in attempting to jolt the downlocks into the locked position.

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Figure 3-6

LANDING GEAR EMERGENCY LOWERING.

If a safe landing gear-down indication is not obtained after several attempts of using the normal procedure, the landing gear emergency procedure as shown in figure 3-6 should be used. If, after the emergency lowering procedure is used, there is still an unsafe gear indication on either or both main gear, pull the "LANDING GEAR CONT." circuit breaker and repeat the emergency lowering procedure, making sure to rock the wings and yaw the airplane so the gear will swing free in attempting to jolt the downlocks into the locked position.

Note

The nose gear does not retract if the landing gear has been lowered by means of the emergency lowering system.

FLIGHT CONTROL HYDRAULIC SYSTEM FAILURE.

If flight control normal hydraulic system pressure drops below about 650 psi, the flight control alternate system is automatically engaged if alternate system pressure is available. The alternate system will supply pressure for all normal flight requirements.

WARNING

In case of failure of the flight control normal hydraulic system, do not fly close formation, perform aerobatics, or engage in unnecessary low-altitude flying.

If the flight control normal system fails, use the following procedure:

1. Flight control alternate system indicator light on—Check.
2. Hydraulic pressure gage selector switch—ALTERNATE FLIGHT CONT.

   Constantly check alternate system pressure.
3. Do not prolong flight; land as soon as practical.
4. Flight control emergency handle—Pull.
   a. Before entering traffic pattern—Pull handle.

   Note

   This will ensure positive continuous engagement of flight control alternate hydraulic system during the landing phase.

   b. If automatic transfer to flight control alternate system does not occur—Pull handle.

CAUTION

Pull emergency handle only if automatic transfer to alternate system does not occur; otherwise, the alternate system pump will operate continuously and drain the battery power (if generators are inoperative).

WARNING

If the flight control normal and alternate hydraulic systems fail, movement of the control stick will not cause corresponding surface movement, except to allow the surface to streamline under air loads. Reduce airspeed to about 200 knots IAS and try to maintain control by varying power settings and applying steady push and pull forces on stick, allowing air loads to streamline control surfaces. If control cannot be maintained, eject. If some control is possible, however, and if altitude permits, try to recover and return to a suitable area; then eject, because landing with these high stick forces should not be attempted under any circumstances.

FLIGHT CONTROL ARTIFICIAL FEEL SYSTEM FAILURE.

Artificial feel system failure can be indicated by a lightening of stick forces (resulting in overcontrol), lack of trim response, and poor stick-centering characteristics. Failure of the flight control artificial feel control system results in loss of adequate control. Reduction of engine power may relieve severe oscillation of the airplane; however, when such a failure occurs, ejection is recommended.

HORIZONTAL TAIL NORMAL TRIM FAILURE.

If a failure of the normal trim control for the controllable horizontal tail occurs, the controllable horizontal tail can be trimmed through use of the alternate longitudinal trim switch on the left side of the cockpit.

AILERON NORMAL TRIM FAILURE.

If the normal aileron trim control fails, the ailerons can be trimmed through use of the alternate lateral trim switch on the left console, aft of the throttle.

CONDENSED CHECK LIST.

Your emergency condensed check list is now contained in T.O. 1F-86L-(CL)1-1.

(Pages 3-27 through 3-40 deleted)

CUT ON SOLID LINE

EMERGENCY PROCEDURES
F-86L CONDENSED CHECK LIST

NOTE

The following check list is a condensed version of the procedures presented in Section III. These pages are arranged so that you may remove them from your Flight Handbook and insert them into a flip pad for convenient use. They are arranged so that each action is in sequence with the expanded procedure given in Section III. Presentation of the condensed check list does not imply that you need not read and thoroughly understand the expanded versions. To fly the airplane safely and efficiently, you must know the reason why each step is performed and why the steps occur in certain sequences.

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CUT ON SOLID LINE

ENGINE FAILURE.

ENGINE FAILURE DURING TAKE-OFF RUN. (NO RUNWAY BARRIER).

1. Emergency fuel switch—ON (if engine rpm is above 85% and committed to take-off).
2. Drop tank jettison button—Depress (or emergency jettison handle—Pull).
3. Drag chute handle—Pull.
4. Throttle—CLOSED.
5. Brakes —Apply as necessary.
6. Landing gear handle—UP (if conditions warrant); then landing gear emergency-up button—Depress and hold.
7. Seat armrests—Raise.
8. Engine master and battery switches—OFF.
9. Generator switches—OFF (if time permits).

ENGINE FAILURE DURING TAKE-OFF (AIRPLANE AIR-BORNE).

1. Emergency fuel switch—ON (if engine rpm is above 85%).
2. Drop tank jettison button—Depress (or emergency jettison handle—Pull).
3. Armament master switch—EMERG. JET'SN (if time permits).
4. Throttle—CLOSED.
5. Canopy handle—Pull.
6. Landing gear handle—DOWN.
7. Wing flap handle—DOWN.
8. Engine master, generator, and battery switches—OFF.
9. Shoulder harness lock handle—LOCKED.
10. Land straight ahead.
11. Drag chute handle—Pull (after touchdown).

ENGINE FAILURE DURING FLIGHT.

1. Attempt air start immediately (if mechanical malfunction is not apparent).
2. Repeat air start procedure, if necessary.

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ENGINE AIR START.

When Flame-out Occurs.

1. Throttle closed.
2. Emergency fuel system switch— ON.
3. Variable nozzle—Closed.
4. Air start switch—AIR START (up).
5. Airplane—Hold level.

Restarting.

1. Engine speed— 20% to 40% rpm windmilling.
2. Throttle—Advance.
3. Exhaust temperature—Regulate throttle to maintain about 400°C.
4. Throttle—Advance to desired power setting.
5. Air start switch—NORMAL.
6. Variable-nozzle switch—AUTO.
7. Emergency fuel switch—NORMAL.

FORCED LANDING (WINDMILLING OR FROZEN ENGINE).

1. External load—Jettison (rocket package if loaded).
2. Engine master and generator switches—OFF.
3. Shoulder harness—LOCKED.
4. Landing gear handle—DOWN.
5. Flight control emergency handle—Pull to full extension just prior to entering pattern, if engine is frozen.
6. Pattern airspeed—170 knots IAS.
7. Canopy—Unlock canopy latches to release the canopy at low key point if landing on an unprepared surface.
8. Final approach airspeed—150 knots IAS.
9. Flaps—As required.
10. Speed brakes—As required.
11. Over end of runway—140 knots IAS.
12. Drag chute handle—Pull.
13. Battery switch—OFF.

CUT ON SOLID LINE

FIRE OR EXPLOSION.

ENGINE FIRE DURING STARTING.

1. Throttle—CLOSED.
2. Engine master switch—OFF.
3. Keep engine turning.
4. If fire persists—Starter switch to STOP STARTER.
5. Battery and generator switches—OFF.
6. Leave airplane as quickly as possible.

ENGINE FIRE DURING TAKE-OFF.

Forward Fire-warning Light (Ground Roll).

1. Throttle—CLOSED.
2. External load—Jettison.
3. Drag chute—Deploy if necessary.
4. Use maximum braking (if necessary).
5. Landing gear handle—Up.
6. Landing gear emergency-up button—Depress and hold (if necessary to retract gear).
7. Abandon airplane immediately upon stopping, if fire is apparent.

Forward Fire-warning Light (Air-borne).

1. External load—Jettison.
2. Throttle—Maintain power.
3. Maximum climb.
4. Throttle—Adjust to minimum practical power.
5. Check for fire.
6. If fire is confirmed—Eject.
7. If fire cannot be confirmed—Land as soon as possible.

Aft Fire-warning Light (Ground Roll).

1. Throttle—CLOSED.
2. External load—Jettison.
3. Drag chute—Deploy if necessary.
4. Use maximum braking if necessary.
5. Landing gear handle—UP (if necessary).

CUT ON SOLID LINE

6. Landing gear emergency up button—Depress and hold (if necessary to retract gear).
7. Abandon airplane immediately upon stopping, if fire is apparent.

Aft Fire-warning Light (Air-borne).

1. Throttle—Reduce power.
2. Warning light—Check.
   a. If light goes out—Continue flight at reduced power and land as soon as possible.
   b. If light stays on—Continue climb.
3. Visual indications of fire—Check.
   a. If no fire is apparent—Continue flight at reduced power and land as soon as possible.
   b. If fire exists—Eject.

ENGINE FIRE DURING FLIGHT.

Forward Fire-warning Light.

1. Throttle—Adjust to minimum practical power, maintaining safe ejection altitude.
2. Check if fire exists.
3. If existence of fire can be confirmed—Eject.
4. If fire cannot be confirmed—Land as soon as possible.

Aft Fire-warning Light.

1. Warning light—Check.
   a. Reduce power in attempt to extinguish light.
   b. If light goes out—Continue flight at reduced power, and land as soon as practical.
   c. If light remains on with throttle retarded to START IDLE, indicating possible fire rather than overheat—Proceed to step 2.

CUT ON SOLID LINE

2. Check for other indications of fire, such as trailing smoke, engine noise, verification from another airplane, etc.
   a. If no fire is apparent—Continue flight at minimum power and land as soon as practical.
   b. If positive indications of fire exist—Proceed to step 3.
3. Throttle—Closed.
4. Engine master switch—OFF.
5. If fire continues—Eject.
6. If fire ceases—Make forced landing or eject.

ENGINE FIRE AFTER SHUTDOWN.

1. External power—Connected to both receptacles.
2. Throttle—Closed.
3. Starter switch—Momentarily at START.
4. As starter is engaged—Audibly check that engine begins to turn, or note tachometer indication.
5. Engine rpm—Approximately 9% (one minute maximum).
6. Stop-starter switch—Momentarily hold at STOP STARTER position.

ELECTRICAL FIRE.

1. Battery and generator switches—OFF.

1A. Emergency fuel switch—ON.

2. Land as soon as practical.

ELIMINATION OF SMOKE OR FUMES.

1. Oxygen regulator diluter lever—100% OXYGEN.
2. Oxygen regulator emergency toggle lever—EMERGENCY.
3. Manual ram-air valve—OPEN.
4. If preceding steps are not successful—Pull canopy handle.

CUT ON SOLID LINE

EJECTION.

EJECTION SEAT OPERATION.

1. Raise either armrest to full up position to jettison canopy and to lock shoulder harness (armrest interconnected).
2. Squeeze either trigger to eject seat.

FAILURE OF SEAT TO EJECT.

1. Speed brakes—Closed.
2. Safety belt—Unfasten.
3. Bail-out bottle—Actuate, if necessary.
4. Personal leads (oxygen, radio, and anti-G suit)—Disconnect.
5. Invert airplane and then push free of seat, or bail out over the right side.
6. Parachute—Arming lanyard (automatic parachute), or "D" ring (manual parachute)—Pull.

TAKE-OFF AND LANDING EMERGENCIES.

ENGAGING RUNWAY OVERRUN BARRIER.

1. Drop tanks—JETTISON.

1A. Drag chute—Deploy.

2. Throttle—CLOSED.
3. Aim for center of barrier and contact it as close to 90 degrees as possible.
4. Brakes—Avoid excessive use during engagement to barrier, to prevent tire blowouts.
5. Engine master, generator, and battery switches—OFF.
6. Engage barrier—At recommended speed.

CUT ON SOLID LINE

BELLY LANDING.

1. Canopy—Unlock.
2. Rocket package—Jettison if loaded, retain if empty.
3. Drop tanks—Jettison if they contain fuel.
4. Make normal approach.
5. Wing flap handle—DOWN, for final approach.
6. Speed brake switch—OUT.
7. Landing gear handle—UP.
8. Throttle—CLOSED, when landing is ensured.
9. Engine master, generator, and battery switches—OFF.
10. Shoulder harness lock handle—LOCKED.
11. Touch down in normal landing attitude.
12. Drag chute—Deploy immediately after touchdown.
13. Leave airplane immediately after it stops.

Main Gear-up Landing (Prepared Surface Only).

1. Landing gear handle—UP.
2. Canopy—Unlocked.
3. Rocket package—Jettison if loaded; retain if empty.
4. Drop tanks—Jettison if they contain fuel.
5. Plan approach to touch down as near end of runway as possible.
6. Wing flap handle—DOWN on final approach.
7. Speed brake switch—OUT.
8. Throttle—CLOSED just before touchdown.
9. Engine master switch—OFF.
10. Battery switch—OFF.
11. Generator switches—OFF.
12. Shoulder harness lock handle—LOCKED.
13. Touchdown—Attempt to touchdown on nose gear and aft fuselage simultaneously.
14. Drag Chute—Deploy immediately after touchdown.
15. Leave airplane immediately after stopping.

CUT ON SOLID LINE

ANY ONE GEAR UP OR UNLOCKED.

1. Canopy—Unlock.
2. Rocket package—Jettison if loaded; retain if empty.
3. Drop tanks—Jettison if they contain fuel.
4. Plan approach to touch down as near end of runway as possible.
5. Wing flap handle—DOWN, on final approach.
6. Speed brake switch—OUT.
7. Throttle—CLOSED, just before touchdown.
8. Engine master switch—OFF.
9. Battery switch—OFF.
10. Generator switches—OFF, if time permits.
11. Shoulder harness lock handle—LOCKED.
12. After touchdown—Hold unsafe gear off runway as long as possible.
13. Drag chute—Deploy immediately after touchdown.
14. Brakes—Do not use if stop can be made without them.
15. Leave airplane immediately after stopping.

LANDING WITH FLAT TIRE.

Nose Gear Tire Flat.

1. Touchdown—Hold nose gear off runway as long as possible.

1A. Drag chute—Deploy.

2. Nose wheel steering—Engage.

Main Gear Tire Flat.

1. Touchdown—Land on side of runway away from flat tire.

1A. Drag chute—Deploy.

2. Nose wheel steering—Engaged.

CUT ON SOLID LINE

DITCHING.

1. Follow radio distress procedure.
2. Jettison (salvo) button—Depress (or emergency jettison handle—Pull).
3. Rocket package—Jettison.
4. Personal equipment—Disconnect.
5. Oxygen regulator diluter lever—100% OXYGEN.
6. Landing gear handle—UP.
7. Speed brake switch—IN.
8. Canopy—Unlock.
9. Throttle—CLOSED.
10. Wing flap handle—DOWN.
11. Engine master, generator, and battery switches—OFF.
12. Safety belt and shoulder harness—Tighten.
13. Shoulder harness lock handle—LOCKED.
14. Surface conditions—Check.
15. Approach and flare—Normal.
16. Touchdown—Keep nose high, and attempt to touch down at minimum flying speed.
17. Oxygen mask—Remove.
18. Leave airplane.

AFTERBURNER FAILURE.

LOSS OF AFTERBURNER DURING CLIMB-OUT.

1. Variable-nozzle will automatically go to closed position.
2. Throttle—MILITARY.

3 through 6. (Deleted)

7. Landing gear—Retract immediately.
8. Wing flap handle—UP, as soon as a safe airspeed is reached.

9 and 10. (Deleted)

LOSS OF AFTERBURNER DURING FLIGHT.

1. Variable-nozzle will automatically go to closed position.
2. Throttle—MILITARY.
3. Attempt to relight afterburner—Watch for signs of abnormal operation.

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CUT ON SOLID LINE

VARIABLE-AREA NOZZLE AUTOMATIC CONTROL FAILURE.

1. Variable-nozzle switch—OPEN or CLOSE, as necessary.

INADVERTENT NOZZLE CLOSURE.

1. Discontinue afterburner operation immediately.
2. Retard throttle—Maintain exhaust temperature at 685°C maximum.
3. Land as soon as possible.

OIL SYSTEM FAILURE.

1. If power setting is above 80% rpm, do not move throttle until landing is ensured.
2. If power setting is below 80% rpm, advance throttle until engine rpm is 80% or more, and do not move throttle until landing is ensured.
3. Land as soon as possible using recommended flame-out landing pattern to ensure landing in case of complete power failure.

MAIN FUEL CONTROL SYSTEM FAILURE.

MAIN FUEL CONTROL SYSTEM FAILURE DURING CLIMB.

1. Emergency fuel switch—ON (as soon as failure is detected).
2. Throttle—Retarded rapidly from AFTERBURNER to START IDLE.
3. Variable-nozzle switch—Close, then OFF (only if the automatic feature of the variable nozzle should fail).
4. Throttle—Cautiously advance to MILITARY (avoid overtemperature condition).

CUT ON SOLID LINE

MAIN FUEL CONTROL SYSTEM FAILURE DURING FLIGHT.

1. Retard throttle—START IDLE position (if rpm drops below 85%).
2. Emergency fuel system switch—ON.
3. Slowly readvance throttle.
4. Variable-nozzle—"Jog" to desired position if automatic system fails.
5. If engine flame-out occurs before throttle is readvanced, attempt an air start.

ELECTRICAL SYSTEM EMERGENCY OPERATION.

FAILURE OF ONE GENERATOR.

1. Warning light—Indicates the "failed" generator.
2. Master caution light—Automatically comes on.
3. "Failed" generator warning light—Press.
4. Momentarily hold related generator switch—RESET.
5. Generator switch—ON.
6. If warning light comes on again, move generator switch to OFF.

FAILURE OF BOTH GENERATORS.

1. Emergency fuel system switch—ON.
2. All nonessential electrical equipment—OFF.
3. Momentarily hold one generator switch at—RESET.
4. Generator switch—ON.
5. If related caution light does go out—Make a single attempt to reset other generator.
6. When at least one generator is operating:
   a. Wait 2 minutes—Allow electronic engine control to warm up (lockup light out).
   b. Emergency fuel system switch—NORMAL.

COMPLETE ELECTRICAL FAILURE.

1. Reduce airspeed—Readjust trim.
2. Reduce altitude and engage rpm to maintain satisfactory engine operation. if necessary.
3. Land as soon as possible.

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CUT ON SOLID LINE

INVERTER FAILURE (AUTOMATIC LOCKUP SYSTEM).

Inverter Failure During Take-off Roll (Continued Take-off).

1. Continue take-off.
2. Inverter selector switch—SPARE position.
3. If lockup caution light does not go out within 30 seconds:
   a. Retard throttle to START IDLE.
   b. Emergency fuel switch—ON.
   c. Variable-nozzle—"Jog" to desired position.
   d. Cautiously readvance to desired power setting.
4. Land as soon as practical.

Inverter Failure During Take-off Roll (Aborted Take-off).

1. Throttle—Rapidly retard to START IDLE.
2. Brakes—Apply as necessary.
3. Drag chute—Deploy (if necessary).
4. Emergency fuel system switch—ON (before readvancing the throttle).
5. Inverter selector switch—SPARE.
6. Throttle—Readvance as desired for taxiing.
7. Electronic engine control lockup—Check.
8. Emergency fuel system—NORMAL.

Inverter Failure During Flight.

1. Throttle—Rapidly retard to START IDLE.
2. Emergency fuel system switch—ON.
3. Variable nozzle—Closed to desired position.
4. Throttle—Advance cautiously to desired power setting.
5. Inverter selector switch—SPARE.

CUT ON SOLID LINE

LANDING GEAR EMERGENCY OPERATION.

LANDING GEAR EMERGENCY RETRACTION.

Landing Gear In-flight Retraction Emergency.

1. Leave landing gear handle—UP.
2. Maintain straight flight path—Minimize G and eliminate yaw.
3. Reduce speed to below 185 knots IAS.
   a. If a safe indication is obtained—Continue flight.
   b. If unsafe condition still exists—Extend gear.
   c. When a safe gear-down indication is obtained—Return for landing.

LANDING GEAR EMERGENCY LOWERING.

1. Reduce airspeed to less than 175 knots IAS.
2. Landing gear handle—DOWN.
3. Landing gear emergency release handle fully extended, approximately 14 inches, and hold.
4. Check gear position indicator for safe gear indication. If necessary, yaw airplane to lock main gear. Release emergency release handle and check gear unsafe warning light out.

FLIGHT CONTROL HYDRAULIC SYSTEM FAILURE.

1. Flight control alternate system indicator light on—Check.
2. Hydraulic pressure gage selector switch—ALTERNATE FLIGHT CONT.
3. Do not prolong flight; land as soon as practical.
4. Flight control emergency handle—Pull.
   a. Before entering traffic pattern—Pull handle.
   b. If automatic transfer to flight control alternate system does not occur—Pull handle.

T.O. 1F-86L-1
Changed 16 October 1959 **14**

F-86L-1-00-18A

Auxiliary Equipment

SECTION IV

TABLE OF CONTENTS

COCKPIT AIR CONDITIONING AND PRESSURIZATION SYSTEM.

The air conditioning system is designed to supply air for pressurization and heating or cooling of the cockpit. (See figure 4-1.) Hot air taken from the engine compressor section is passed through an air-cooling radiator. A bypass valve diverts an automatically selected amount of this air through a cooling turbine. This refrigerated air then mixes with bypass warm air and enters the cockpit at a preselected temperature. Air outlets are provided along each side of the cockpit above the consoles and in the area just forward of the pilot's feet. The cockpit is nonpressurized from sea level to 12,500 feet. Above this altitude, a cockpit altitude of 12,500 feet is maintained until the selected cockpit pressure is reached. Pressure schedules for either 2.75 psi or 5.00 psi differential may be selected. A pressure dump valve releases all cockpit pressure when operated by the pilot or automatically relieves any excess pressure if the pressure regulator fails. All air conditioning and pressurization controls are powered from the primary bus.

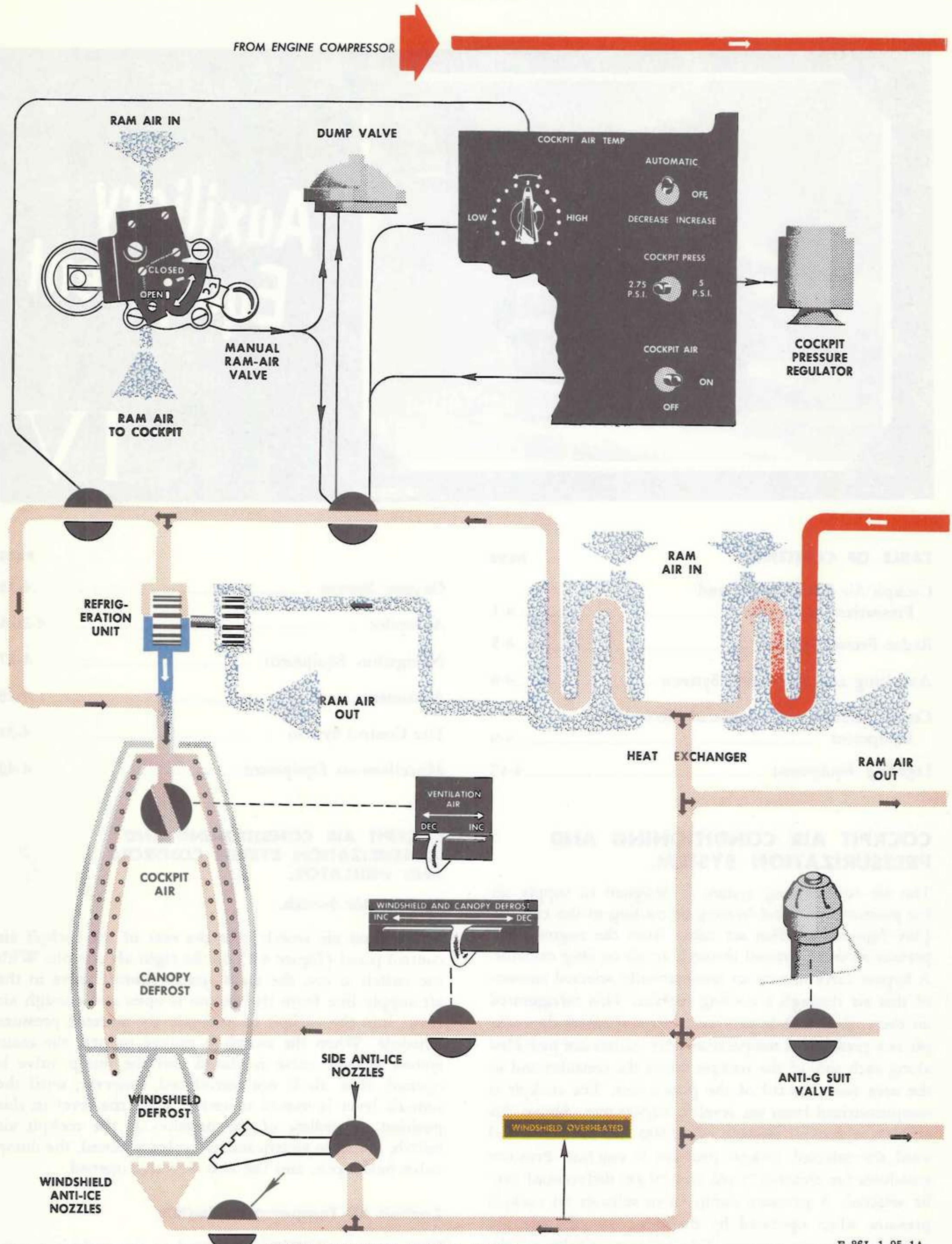
COCKPIT AIR CONDITIONING AND PRESSURIZATION SYSTEM CONTROLS AND INDICATOR.

Cockpit Air Switch.

The cockpit air switch is at the rear of the cockpit air control panel (figure 4-2) on the right aft console. With the switch at ON, the main system shutoff valve in the air supply line from the engine is open and enough air flows into the cockpit to maintain the selected pressure schedule. When the switch is moved to OFF, the main system shutoff valve is closed and the dump valve is opened. Ram air is not introduced, however, until the ram-air lever is moved to OPEN. With the lever in this position, regardless of the position of the cockpit air switch, the main system shutoff valve is closed, the dump valve held open, and the ram-air valve opened.

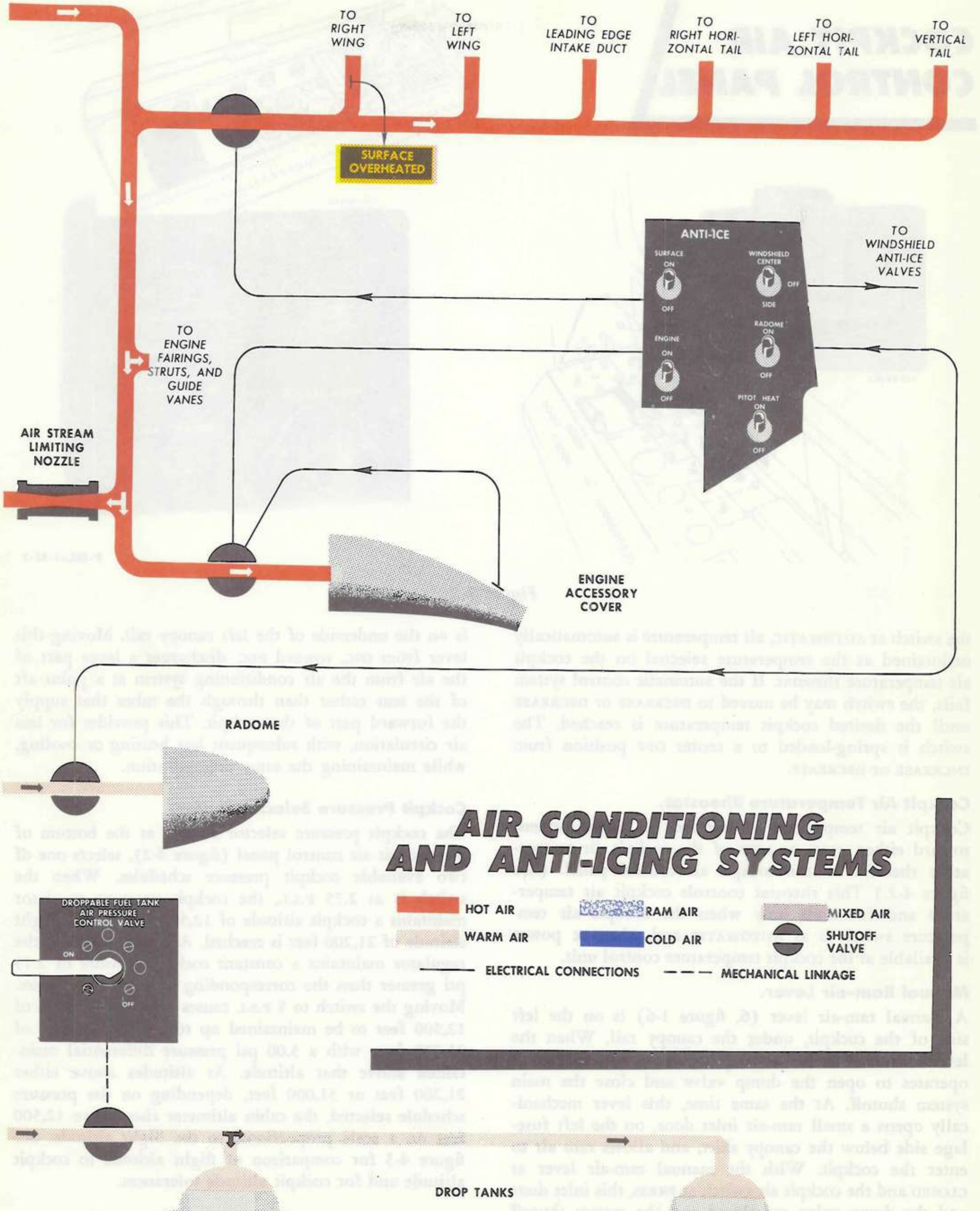
Cockpit Air Temperature Switch.

Temperature of the air admitted to the cockpit is controlled by a four-position temperature control switch, on the cockpit air control panel. (See figure 4-2.) With



F-86L-1-95-1A

Figure 4-1



AIR CONDITIONING AND ANTI-ICING SYSTEMS

F-86L-1-95-2A

COCKPIT AIR CONTROL PANEL

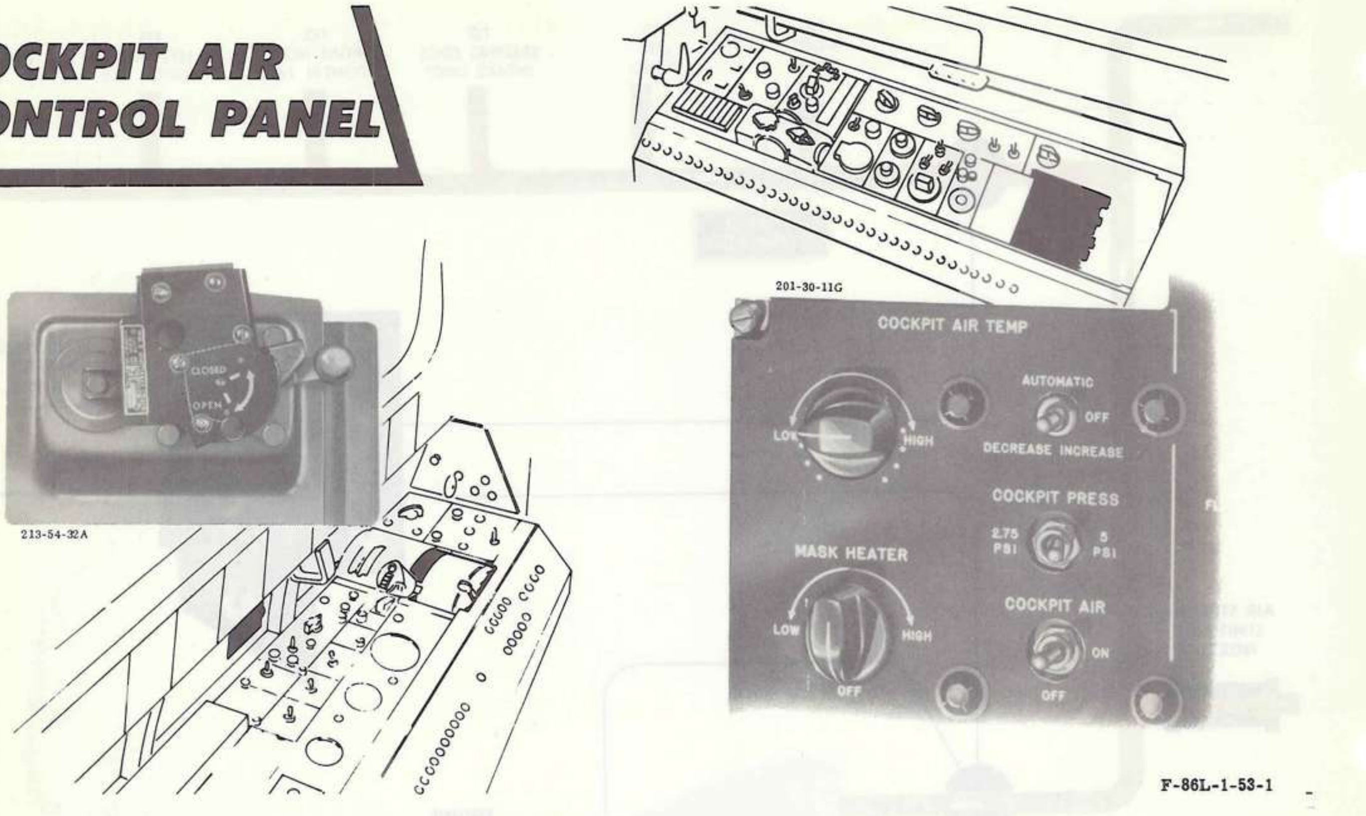


Figure 4-2

the switch at AUTOMATIC, air temperature is automatically maintained at the temperature selected on the cockpit air temperature rheostat. If the automatic control system fails, the switch may be moved to INCREASE or DECREASE until the desired cockpit temperature is reached. The switch is spring-loaded to a center OFF position from INCREASE or DECREASE.

Cockpit Air Temperature Rheostat.

Cockpit air temperature is selected by an adjustment toward either HIGH or LOW of the cockpit air temperature rheostat on the cockpit air control panel. (See figure 4-2.) This rheostat controls cockpit air temperature and functions only when the cockpit air temperature switch is at AUTOMATIC and when ac power is available at the cockpit temperature control unit.

Manual Ram-air Lever.

A manual ram-air lever (6, figure 1-6) is on the left side of the cockpit, under the canopy rail. When the lever is moved to the OPEN position, an electric switch operates to open the dump valve and close the main system shutoff. At the same time, this lever mechanically opens a small ram-air inlet door, on the left fuselage side below the canopy skirt, and allows ram air to enter the cockpit. With the manual ram-air lever at CLOSED and the cockpit air switch at PRESS, this inlet door and the dump valve are closed and the system shutoff valve is opened.

Ventilation Air Lever.

A manually operated ventilation air lever (8, figure 1-6) is on the underside of the left canopy rail. Moving this lever from INC. toward DEC. discharges a large part of the air from the air conditioning system at a point aft of the seat rather than through the tubes that supply the forward part of the cockpit. This provides for less air circulation, with subsequent less heating or cooling, while maintaining the same pressurization.

Cockpit Pressure Selector Switch.

The cockpit pressure selector switch, at the bottom of the cockpit air control panel (figure 4-2), selects one of two available cockpit pressure schedules. When the switch is at 2.75 P.S.I., the cockpit pressure regulator maintains a cockpit altitude of 12,500 feet until a flight altitude of 21,200 feet is reached. Above 21,200 feet, the regulator maintains a constant cockpit pressure of 2.75 psi greater than the corresponding outside air pressure. Moving the switch to 5 P.S.I. causes a cockpit altitude of 12,500 feet to be maintained up to a flight altitude of 31,000 feet, with a 5.00 psi pressure differential maintained above that altitude. At altitudes above either 21,200 feet or 31,000 feet, depending on the pressure schedule selected, the cabin altimeter rises above 12,500 feet on a scale proportional to the flight altitude. See figure 4-3 for comparison of flight altitude to cockpit altitude and for cockpit altitude tolerances.

Cockpit Altimeter.

This airplane is provided with a Specification MIL-I-5099 cockpit altimeter. This instrument has one pointer and shows cockpit pressure altitude.

NORMAL OPERATION OF COCKPIT AIR CONDITIONING AND PRESSURIZATION SYSTEM.

1. Cockpit air switch ON.
2. Cockpit pressure selector switch at either 2.75 P.S.I. or 5 P.S.I.
3. Cockpit air temperature switch AUTOMATIC.
4. Cockpit air temperature rheostat set for desired temperature.
5. Ventilation air lever adjusted as desired.

WARNING

To minimize danger resulting from sudden decompression, the cockpit pressure selector switch should be set at 2.75 P.S.I. during combat.

EMERGENCY OPERATION OF PRESSURIZATION SYSTEM.

Should sudden depressurization of the cockpit be necessary:

1. If at high altitude, and if circumstances permit, immediately descend to 20,000 feet or less.

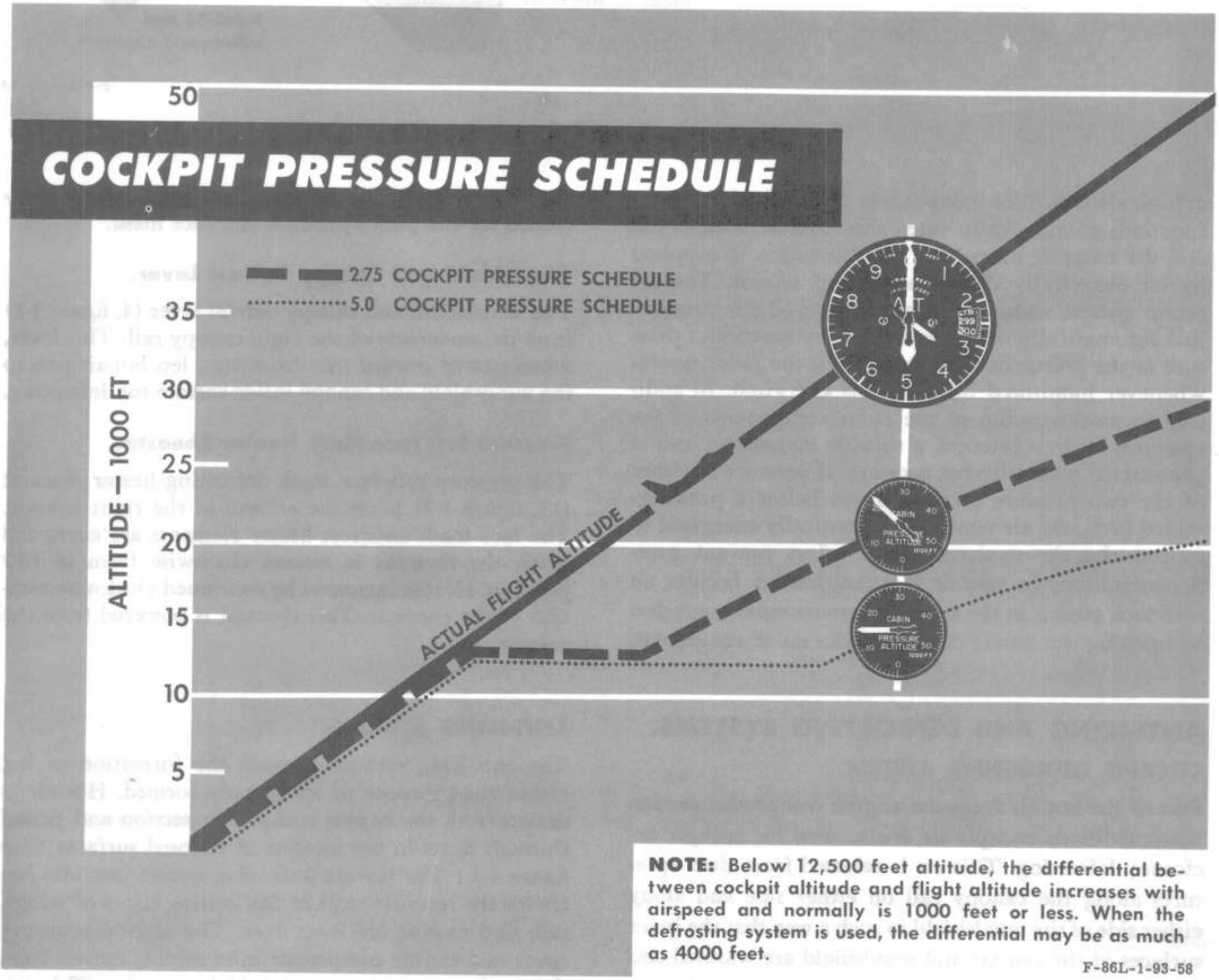
Note

Following sudden cockpit depressurization at altitude, check oxygen mask for proper fit and oxygen flow.

2. To dump pressure without admitting ram air, move cockpit air switch to OFF. If introduction of ram air is desired, position manual ram-air lever to OPEN.

RADAR PRESSURIZATION.

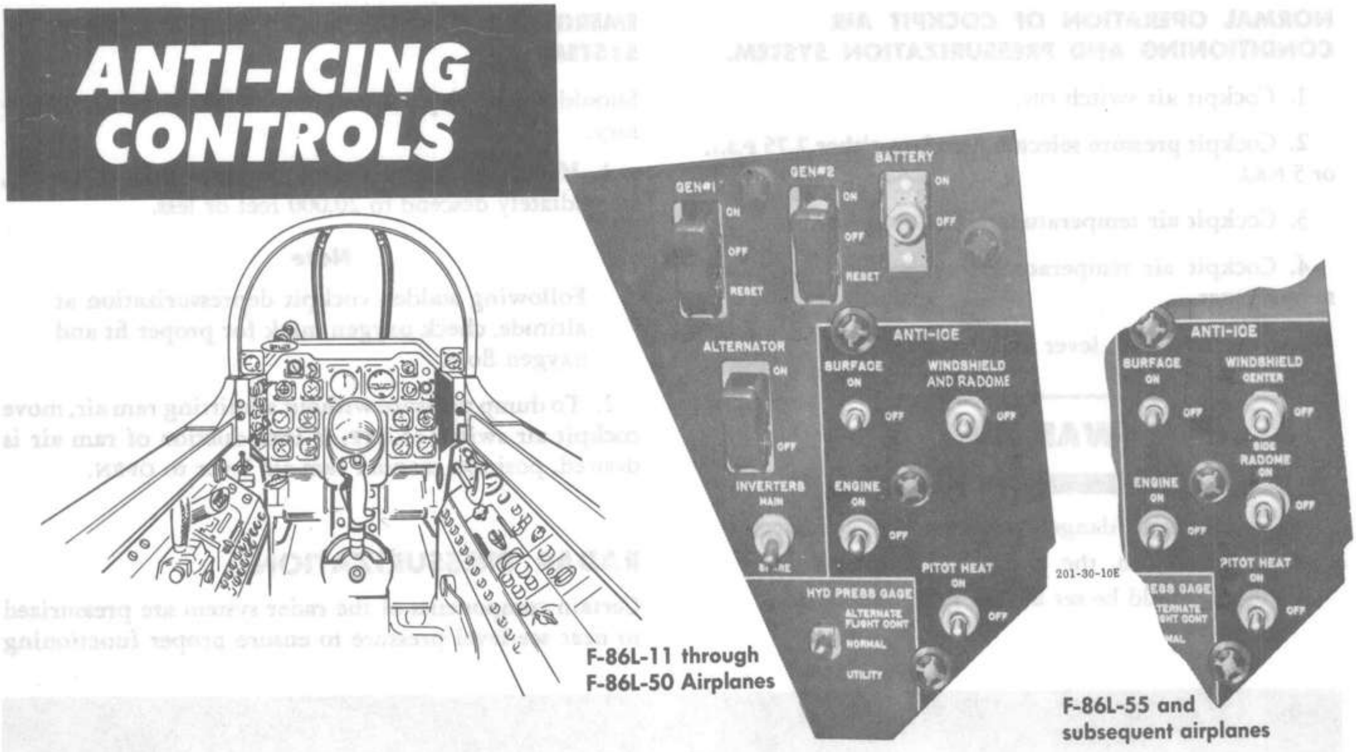
Certain components of the radar system are pressurized to near sea-level pressure to ensure proper functioning



NOTE: Below 12,500 feet altitude, the differential between cockpit altitude and flight altitude increases with airspeed and normally is 1000 feet or less. When the defrosting system is used, the differential may be as much as 4000 feet.

F-86L-1-93-58

Figure 4-3



F-86L-1-53-2A

Figure 4-4

at high altitude. The independent pressurization system functions automatically when the airplane is air-borne and the radar is turned on. Pressurization is supplied by an electrically driven air pump system. The air pump system, using air from the anti-G suit pressure line automatically regulates and maintains correct pressure in the pressurized components of the radar system whenever monitored bus No. 2 is energized. In addition to pressurization of the radar components of the system with low pressure, a tunable magnetron unit is pressurized with a higher pressure. If pressure in either of the two pressure sections drops below a predetermined level, the air pump is automatically energized to repressurize the sections. Relief valves prevent overpressurization. In case of a pressurization failure, an interlock switch in the system prevents radar operation by opening the power circuits to the radar equipment.

ANTI-ICING AND DEFROSTING SYSTEMS.

COCKPIT DEFROSTING SYSTEM.

Part of the hot air from the engine compressor section that conditions cockpit air is also used for cockpit enclosure defrosting. This air is released from duct apertures along the canopy rail on either side and along either side of the windshield in such a way that the inner surfaces of the canopy and windshield are warmed and defrosted. This interior defrosting system can be operated independently or in conjunction with the exterior anti-icing system. An electrical antifrost system is included for the pilot's pressure suit face mask.

Windshield and Canopy Defrost Lever.

The windshield and canopy defrost lever (4, figure 1-7) is on the underside of the right canopy rail. This lever, when moved toward INC. from DEC., lets hot air pass to the windshield and canopy inside surface for defrosting.

Pressure Suit Face Mask Heater Rheostat.

The pressure suit face mask defrosting heater rheostat (13, figure 1-7) is on the aft end of the right console. The face mask antifrost heater elements are energized when the rheostat is rotated clockwise from its OFF position. Heat is increased by continued clockwise rotation of the rheostat. This rheostat is powered from the primary bus.

ANTI-ICING SYSTEMS.

The anti-icing systems prevent the formation of ice, rather than dispose of ice already formed. Hot air is drawn from the engine compressor section and passed through ducts in the interior of exposed surfaces. (See figure 4-1.) The surface anti-icing system provides hot air for the interior areas of the leading edges of wings, tail, and engine air inlet duct. The engine accessory cover and engine compressor inlet receive hot air from the engine accessory cover anti-icing system. This system always operates simultaneously with the surface anti-icing system when the surface anti-ice switch is turned ON. The engine accessory cover anti-icing system does, however, have its own individual control by which it can be set in operation without actuating the surface anti-icing system. The interior windshield defrosting system and radome anti-icing system can operate simultaneously or independently of each other. In the windshield and radome anti-icing system, hot air is injected into the radome and is also discharged at the outside base of the windshield. The only unit that is electrically heated to prevent icing is the pitot head on the right wing tip.

Surface Anti-ice Switch.

The two-position surface anti-ice switch is mounted on the right instrument subpanel. (See figure 4-4.) This switch is powered from monitored bus No. 2, provided ac power is available. When the switch is placed at ON, hot air is made available for both the surface anti-icing and the engine accessory cover anti-icing systems, and the engine inlet screen is automatically retracted.

Engine Screen Switch.

The two-position engine screen switch is mounted on the left instrument subpanel. (See figure 1-4.) Power for the engine screen actuator reaches this switch from the primary bus only when the surface anti-ice and engine anti-ice switches are at OFF. However, the engine inlet screens retract when the surface anti-ice switch is placed at ON or the engine anti-ice switch is placed at ON. Placing the engine screen switch at EXTEND extends the screen into position to prevent foreign objects from entering the engine compressor section. Moving the switch to RETRACT retracts the screen to allow maximum airflow and to prevent ice accumulation. (Refer to "Engine Inlet Screen Switch" in Section I.)

Engine Anti-ice Switch.

The two-position engine anti-ice switch is mounted on the right instrument subpanel. (See figure 4-4.) This switch is powered from the primary bus and is energized only when the surface anti-ice switch is placed at OFF. Power for the engine accessory cover anti-icing system reaches the engine anti-ice switch from monitored bus No. 2, provided the surface anti-ice switch is at OFF.

Windshield and Radome Anti-ice Switch.

On F-86L-11 through F-86L-50 Airplanes, a two-position windshield and radome anti-ice switch, on the right instrument subpanel and powered by monitored bus No. 2, lets hot air pass to the windshield and radome for anti-icing when the switch is placed at ON.

Windshield Anti-ice Switch.

On F-86L-55 and later airplanes, the windshield anti-ice switch (figure 4-4) has three positions, CENTER, OFF, and SIDE, and is powered from monitored bus No. 2. The CENTER and SIDE positions allow selection of either of two windshield areas to be anti-iced. The SIDE position is provided to give improved visibility through the left windshield panel during landing approaches in rain or icing conditions. The windshield anti-icing should be used sparingly during ground operation to prevent cracking the windshield.

Radome Anti-ice Switch.

On F-86L-55 and later airplanes, the two-position radome anti-ice switch (figure 4-4) is on the right instrument subpanel and is powered by monitored bus No. 2. Selecting the ON position allows engine compressor air to be directed to the radome and the center area of the windshield for anti-icing. The radome anti-ice switch controls windshield anti-ice airflow *if* the windshield anti-ice switch is in the SIDE or OFF position. Hot air for the side windshield can be furnished only when the radome anti-ice switch is at OFF; therefore, if the windshield anti-ice switch has been positioned at SIDE, and the radome anti-ice switch is turned ON, the windshield side panel air is cut off and the windshield center panel air is turned on automatically.

Pitot Heat Switch.

The pitot heat switch, on the right instrument subpanel (figure 4-4), receives power from monitored bus No. 1. Moving the switch to ON causes the pitot head to be electrically heated.

Surface Anti-ice Overheat Caution Light.

A surface anti-icing overheat caution light is on the caution light panel (figure 1-25). The light comes on when there is excess temperature in the surface anti-icing system. Power for this light comes from the primary bus, and the light displays "SURFACE OVERHEATED" when on. The light will come on when the temperature of the air reaches 350°F (177°C).

Windshield and Radome Anti-ice Overheat Caution Light.

A windshield and radome anti-ice air overheat caution light is on the caution light panel (figure 1-25). When illuminated, it shows that air temperature in the windshield and radome anti-icing system has reached or exceeded the design limit of 135°C (275°F); it does not necessarily mean an immediate overheat condition, as windshield temperature depends largely on outside air temperature. This light is powered from the primary bus and displays "WINDSHIELD OVERHEATED" when on. The light will come on when the temperature of the air reaches 275°F (135°C).

NORMAL OPERATION OF ANTI-ICING AND DEFROSTING SYSTEMS.

1. Surface anti-ice switch ON.

2. Radome anti-ice switch ON; windshield anti-ice switch to SIDE position.

Note

- With the radome anti-ice switch ON the windshield center panel will automatically be on, even though the windshield anti-ice switch is at SIDE. However, on landing, if side panel anti-icing is necessary, moving radome anti-ice switch to OFF will then permit the side panel to anti-ice.
- The windshield and canopy defrost system provides enough heating of the transparent surfaces to effectively eliminate the formation of frost or fog during descent.

3. Adjust windshield and canopy defrost lever toward INC. as desired.

4. Pitot heat switch ON.

Rain Removal System.

The air blast from the windshield anti-icing system can be used for rain removal. The windshield anti-ice control should be placed at CENTER or SIDE as desired, and the radome anti-ice switch should be turned OFF. Turning off the radome anti-ice system and other systems using engine bleed air reduces the likelihood of windshield glass cracking due to overheat. A windshield overheat indication may be observed during some landing approaches, take-offs, and low-speed flight conditions. This condition should not be considered an immediate overheat of the windshield, since the indicator senses the temperature of the anti-ice air (design limit 275°F) in the windshield nozzle. The actual temperature of the glass is less than that of the nozzle air because of the conditions of rain, ice, outside air temperature, and airflow over the windshield. Therefore, the system need not be shut off during flight requiring maximum available visibility, since windshield cracking would not necessarily result for at least 30 seconds. Flight safety considerations are more important than the prevention of windshield cracking. The following procedures prevent, or reduce the severity of, windshield overheat if flight conditions preclude turning the system off.

Landing and Take-off.

1. Place manual ram-air lever to OPEN.

2. Reduce cockpit defrost airflow to minimum practicable. During landing or take-off, if the overheat caution light comes on, the windshield anti-ice system should not be shut off.

Ground Run.

1. With caution light on, leave windshield anti-ice switch at CENTER.

2. Place manual ram-air lever to OPEN.

3. Reduce cockpit defrost airflow to minimum practicable.

4. Reduce engine rpm until light goes off (about 80% rpm).

Level Flight.

1. Increase or decrease airspeed about 30 to 50 knots.

2. Reduce cockpit defrost airflow to minimum practicable.

CAUTION

It is recommended that the OPEN position of the manual ram-air lever be used in conjunction with the anti-ice system only during landing, take-off, or taxiing, because unsatisfactory cockpit temperatures could result if it were used extensively during flight. The rain removal feature of the windshield anti-ice system is limited by engine power and the intensity of the rain.

EMERGENCY OPERATION OF ANTI-ICING SYSTEMS.

Overheating of Windshield and Radome Anti-icing System.

If the windshield and radome anti-ice overheat caution light comes on, indicating an overheated condition in the windshield and radome anti-icing system, proceed as follows:

During Ground Run.

1. With caution light on, leave windshield anti-ice switch ON.

2. Place manual ram-air lever to OPEN.

3. Reduce cockpit defrost airflow to minimum practicable.

4. Reduce engine rpm until light goes off (about 80% rpm).

During Landing and Take-off.

1. Place manual ram-air lever to OPEN.

2. Reduce cockpit defrost airflow to minimum practicable.

During Level Flight.

1. Increase or decrease airspeed about 30 to 50 knots.

2. Reduce cockpit defrost airflow to minimum practicable.

CAUTION

> It is recommended that the OPEN position of the manual ram-air lever be used in conjunction with the anti-ice system only during landing, take-off, or taxiing, because unsatisfactory cockpit temperatures could result if it were used extensively during flight. The rain removal feature of the windshield anti-ice system is limited by engine power and the intensity of the rain.

Overheating of Surface Anti-icing System.

If the surface anti-ice overheat caution light illuminates, indicating an overheated condition in the surface anti-icing system, proceed as follows:

1. Cycle surface anti-ice switch OFF and ON to try to maintain a temperature below maximum necessary to illuminate caution light. Any momentary malfunction may be eliminated during this switch cycling.

Note

> If the surface anti-ice overheat warning light remains on after the switch has been cycled, it may be necessary to reduce engine power to lower the temperature of the air supply.

2. If a power reduction is impractical or if it fails to lower air supply temperature below the maximum necessary to illuminate the caution light, place surface anti-ice switch at OFF.

COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT.

INTERCOMMUNICATION SYSTEM—AN/AIC-10.

This system provides a means of communication between the interphone station (ground crew) and the cockpit; it also maintains a suitable audio level to the pilot's headset for all receivers, at all altitudes. The interphone receptacle is powered from the secondary bus; it is on the lower left side of the fuselage, forward of the pilot's step. When ground personnel connect an interphone to the receptacle, the pilot's microphone is "hot"; he need not depress the microphone button to talk to ground personnel.

Operation of Intercommunication System—AN/AIC-10.

The intercommunication system (AN/AIC-10) is operable any time 28-volt dc is applied to the electrical system of the airplane. Electrical power can be supplied by the airplane batteries or generators, or by external power. Pilot and ground crew intercommuncation is possible when the ground crew communication line is plugged into the jack on the left forward fuselage.

BROADCAST BAND RECEIVER—R-22.

The R-22 broadcast band receiver provides the pilot with broadcast reception over the standard broadcast band from 550 to 1600 kilocycles; it is controlled from the panel on the right console. (See figure 4-7.) The receiver, which is powered from monitored bus No. 3, has its antenna in the canopy. (See figure 4-6.) The receiver is not intended for navigational use, but only for monitoring the broadcast band.

Operation of Broadcast Band Receiver—R-22.

1. Rotate volume knob clockwise to turn radio on. (Allow enough time for set to reach operating temperature.)

2. Rotate tuning handle to obtain desired station frequency.

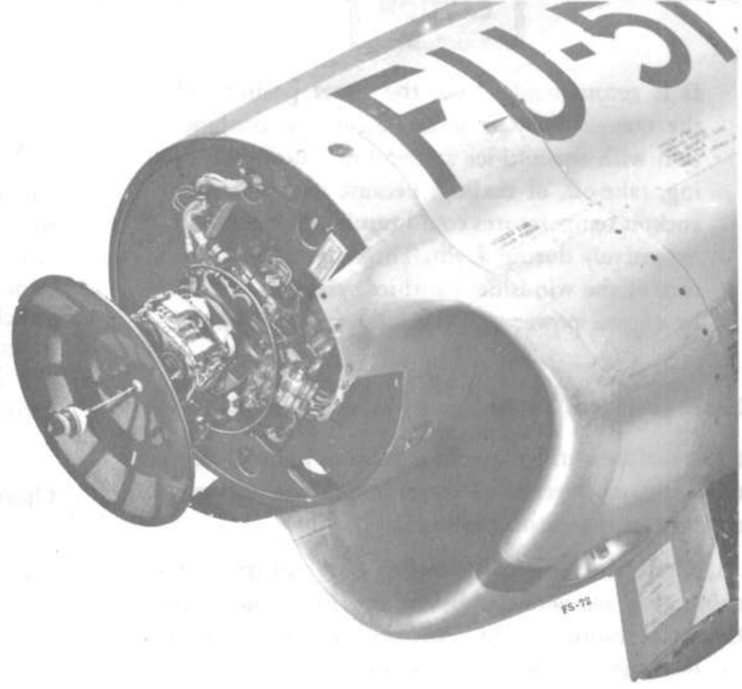
3. Adjust volume as desired.

4. To turn radio off, rotate volume control knob counterclockwise to OFF.

UHF COMMAND RADIO—AN/ARC-34.

The AN/ARC-34 command radio equipment (figure 4-7) provides two-way AM radiotelephone communications on 1750 different channels in the radio-frequency range of 225.0 through 399.9 megacycles on frequencies spaced 0.1 megacycle apart. It has provisions for presetting 20 channels on the receiver unit at any one time, and any of the preset channels may be selected as desired. The guard channel receiver (a separate integral component) is capable of covering the frequency range of 238.0 through 248.0 megacycles. The normal guard channel frequency is 243.0 megacycles. The controls for the unit are the main control switch, which has four positions, OFF (turns set off), MAIN (allows transmission and reception on main selected channels only), BOTH (allows transmission and reception on main selected channels and reception only on the guard frequency), and ADF (which has no function at the present time); the channel selector (a rotary selector switch for selection of the preset channels); the "MANUAL-PRESET-GUARD" selector control (MANUAL position for manual selection of a desired

COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT



WARNING
RADAR GROUND CHECKS MUST NOT BE MADE WITHIN 50 FEET OF OPERATIONS INVOLVING FUEL.

TYPE	DESIGNATION	USE	RANGE
COMMUNICATION AMPLIFIER	AN/AIC-10	AMPLIFIES RADIO SIGNALS	
BROADCAST BAND RECEIVER	R-22	MONITORING BROADCAST BAND	LINE OF SIGHT
UHF COMMAND RADIO	AN/ARC-34	TWO-WAY VOICE COMMUNICATION	LINE OF SIGHT
IFF	AN/APX-6A	AUTOMATIC IDENTIFICATION	LINE OF SIGHT
SIF	AN/APX-25	AUTOMATIC IDENTIFICATION (USED WITH AN/APX-6A)	LINE OF SIGHT
OMNIDIRECTIONAL RECEIVER	AN/ARN-14	RECEIVES VOR SIGNALS	LINE OF SIGHT
NAVIGATION EQUIPMENT*	AN/ARN-21	TACTICAL AIR NAVIGATION	LINE OF SIGHT (195 MILES)
GLIDE SLOPE RECEIVER	AN/ARN-31	INSTRUMENT APPROACH	15 MILES
MARKER BEACON	AN/ARN-12	VISUAL RECEPTION OF MARKER BEACON SIGNALS	VERTICAL
DATA LINK	AN/ARR-39	GCI INFORMATION	LINE OF SIGHT

* Airplanes changed by T.O. 1F-86L-531

F-86L-1-71-1B

Figure 4-5

RADIO AND RADAR ANTENNA
LOCATIONS

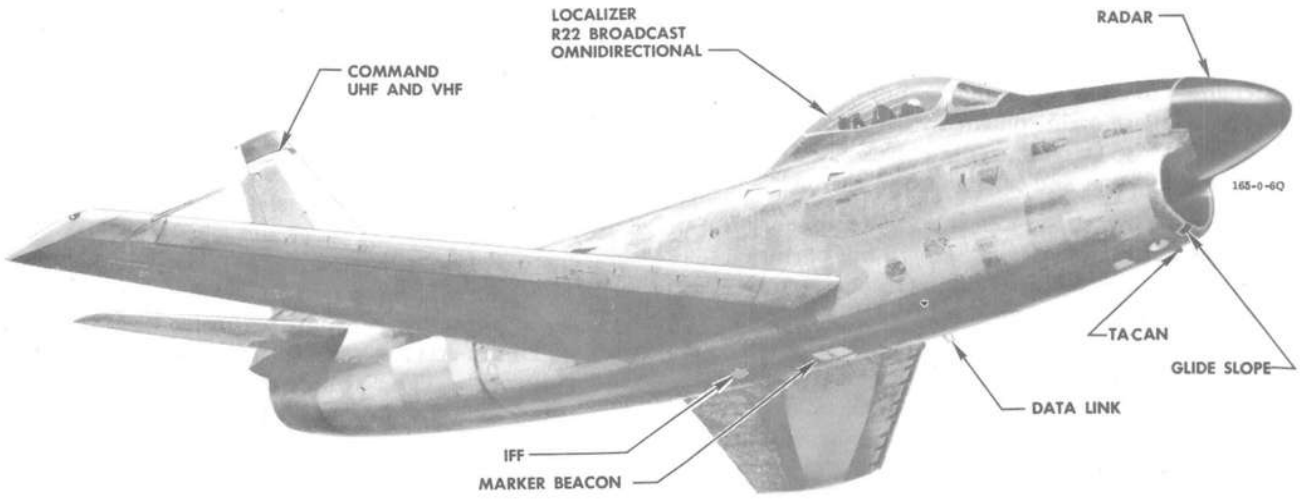


Figure 4-6

frequency from 225.0 to 399.9 megacycles by use of the four frequency selection knobs at the top of the control panel, PRESET position for use with the channel selector and the 20 preset frequencies, and GUARD position for monitoring the emergency guard frequency); a volume control for manual adjustment of volume; and a tone button for sending a continuous tone to aid in obtaining a direction finding bearing. A placard, at the bottom of the control panel, lists the frequencies selected for the 20 preset channels. There is a remote channel indicator (16, figure 1-5) on the instrument panel shroud to the right of the sight head. This indicator has been installed so that attention will not be diverted from the instrument panel when changing channels.

Operation of Command Radio—AN/ARC-34.

1. Select PRESET position with the selector control ("MANUAL-PRESET-GUARD" control).

2. Rotate main control switch to BOTH position and allow about 2 minutes for warm-up of main and guard receiver units.

3. Place channel selector control to a channel other than desired channel. Allow tuning cycle to be completed; then return to desired channel. Check remote channel indicator for same channel indication.

Note

- No transmission is made on emergency (distress) frequency channels except for emergency purposes. For test, demonstration, or drill purposes, the radio equipment is operated in a shielded room to prevent transmission of messages that could be construed as actual emergency messages.
- An inherent characteristic of the radio set reduces the reception and transmission qualities of the set if step 3 is not observed. If the first selection is retained, full power for reception and transmission is not obtainable.

4. Adjust volume control for desired audio level.

5. For manual selection of a frequency not included in preset channels, set selector control to MANUAL. The four windows across the top of the panel should now be open. Use the four knobs across top of panel to select desired frequency. The digits that appear in the windows indicate the operating frequency. (The main control switch must be at MAIN or BOTH for manual operation.)

Note

- This procedure places the equipment in the "receive" condition. Transmission of the same frequency is obtained by depressing the microphone button; however, if it is desired to change the transmitter frequency, the microphone button should be released before the frequency is changed. About 4 seconds should elapse before transmission is begun on the new frequency.

- A thermal time-delay relay cuts out and stops the drive motor after 50 to 125 seconds of continuous operation (switching from one channel to another without stopping). If this occurs, place main control switch to OFF and allow a 30-second cooling period. Then switch to BOTH and select desired channel.
- Do not try to tune receiver to any frequency below 225 megacycles, as set will not operate in this range and continuous operation of channeling drive motor results.

6. For transmission and reception on guard frequency, move selector control to GUARD. This tunes the receiver and transmitter to the guard frequency and cuts out the main units.

7. To turn set off, rotate main control switch to OFF.

STAND-BY RADIO RECEIVER.

The AN/ARR-39 data link receiver may be used as a stand-by receiver in case of a malfunction of the AN/ARC-34 command radio receiver. For complete information and operation of the AN/ARR-39 data link, refer to "AN/ARR-39 Data Link System" in this section.

Operation of Stand-by Radio Receiver.

When using the AN/ARR-39 data link receiver as a command radio stand-by receiver, proceed as follows:

1. Move function switch to STBY.

2. Select desired channel on channel selector. Select a frequency from channel-frequency card (on AN/ARR-39 control panel).

3. Adjust volume as desired.

4. Using AN/ARC-34 transmitter, call ground radio control and request that transmission to your airplane be made on frequency selected in step 2.

IDENTIFICATION RADAR—AN/APX-6A.

The AN/APX-6A identification radar set (IFF) is used to identify automatically the airplane in which it is installed whenever it is properly challenged by suitably equipped air or surface forces. The set also has provisions for identifying the airplane in which it is installed as a specific friendly airplane within a group of other airplanes. It has means of transmitting a special distress code when challenged. This set receives challenges and transmits replies to the source of the challenges. These replies are displayed, together with the associated radar targets, on the radar indicators of the challengers. When a radar target is accompanied by a proper reply from the IFF set, the target is considered friendly. Controls for the set are on the C-1158/APX IFF control panel (figure 4-7) on the right console. These controls consist of a rotary-type master switch, two mode switches, and an "I/P-MIC" switch. The master switch has five positions: EMERGENCY, NORM, LOW, STBY, and OFF. The upper mode switch has two positions, MODE 2 and OUT. The lower mode switch has two positions, MODE 3 and OUT. The "I/P-MIC" switch has three positions, I/P, OUT, and MIC. An AN/APX-25 SIF (selective identification feature) is formed when a coder and an SIF control panel are connected to the AN/APX-6A system. Since the transponder is the main unit of both the IFF and SIF systems, the transponder must be adapted to the system in use. This is accomplished by a two-position switch in the transponder. The switch positions are NORM and MOD. The switch determines whether or not the coder and the SIF control panel are connected into the transponder. When the switch is at NORM, the system operates as an AN/APX-6A system. When the switch is at MOD, the system operates as an SIF system. Refer to "Identification Radar—AN/APX-25" in this section. The AN/APX-6A system is powered by the ac bus.

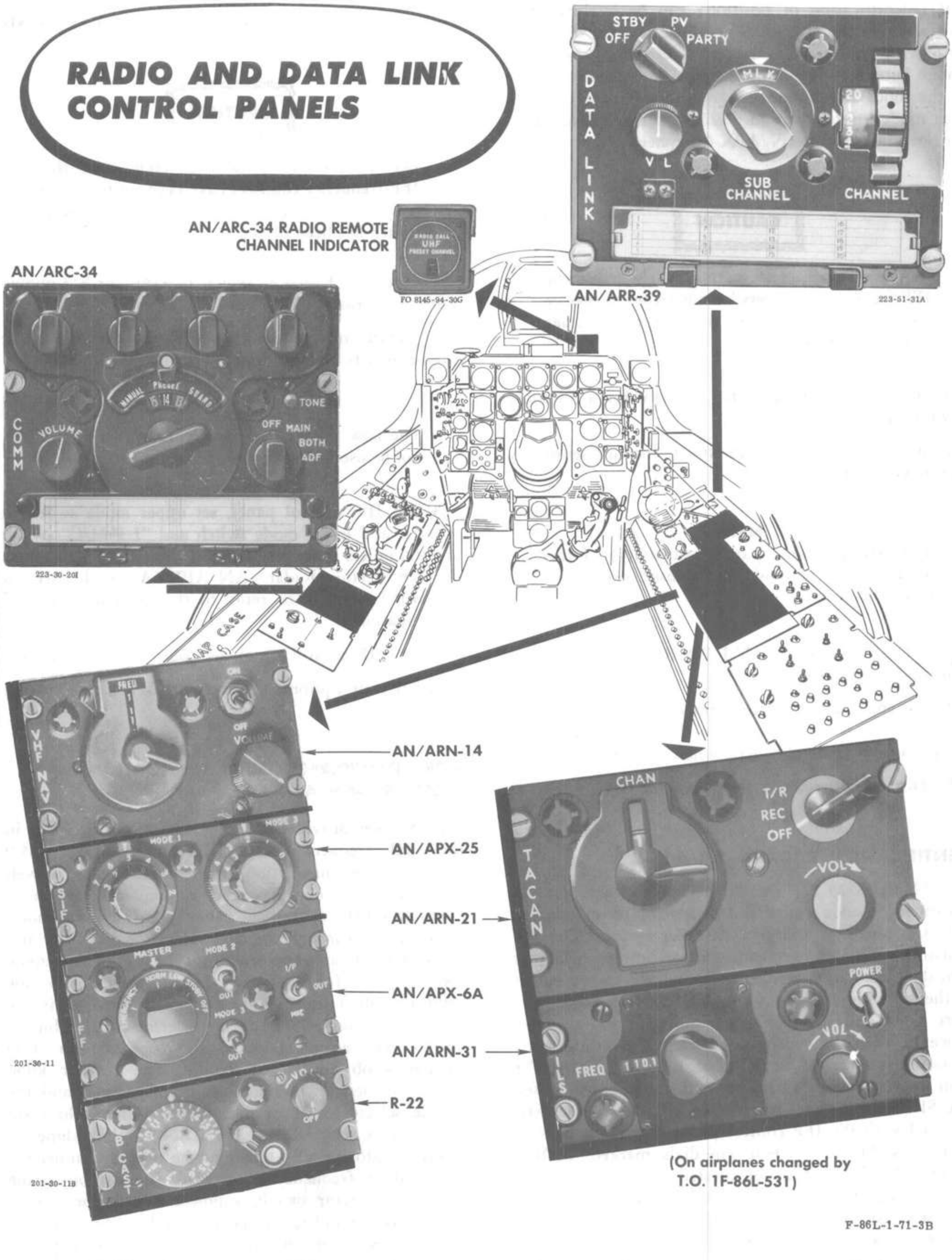
Operation of Identification Radar—AN/APX-6A.

IFF replies are specific to the limit of replying to any of three modes of interrogation. Mode 1 operation is established when the master switch is at either LOW or NORM and both mode switches and the "I/P-MIC" switches are at OUT. In the LOW position, the sensitivity of the receiver is reduced and it replies only to strong interrogation from nearby equipment. Full sensitivity is established with the master switch at NORM. Mode and "I/P-MIC" switch positions for replying to the possible modes of interrogation are as follows:

SWITCH	POSITION	MODE OF OPERATION
All	OUT	1
Upper mode	MODE 2	
Lower mode	OUT	1 and 2
"I/P-MIC"	OUT	
Lower mode	MODE 3	
Upper mode	OUT	1 and 3
"I/P-MIC"	OUT	
Upper mode	MODE 2	
Lower mode	MODE 3	1, 2, and 3
"I/P-MIC"	OUT	

The "I/P-MIC" switch allows ground control to single out, by radio request for identification, an individual

RADIO AND DATA LINK CONTROL PANELS



(On airplanes changed by T.O. 1F-86L-531)

Figure 4-7

airplane from a high air traffic density. Operation on I/P (identification of position) can be established in two ways: by moving the "I/P-MIC" switch to I/P, or by moving the switch to MIC and depressing the microphone button on the throttle. The I/P reply is the same as the mode 2 reply and is transmitted in response to each mode 2 interrogation. Perform the following steps for operation of the AN/APX-6A system.

CAUTION

Before take-off, check with crew chief that the IFF frequency counters have been set to proper frequency channels, and that the transponder switch is at NORM.

1. Rotate IFF master switch to STBY for a 3-minute warm-up period.
2. Rotate master switch to NORM, for full sensitivity and maximum performance.

Note

The LOW position (partial sensitivity) of the master switch should not be used except on proper authorization.

3. Set mode switches and "I/P-MIC" switches at OUT, unless otherwise directed.
4. For emergency operation, press dial stop and rotate master switch to EMERGENCY, so that set will automatically transmit distress signals when challenged.
5. Turn set off, rotate master switch to OFF.

IDENTIFICATION RADAR—AN/APX-25.

The AN/APX-25 SIF (selective identification feature) is formed when a coder and a control panel, marked SIF, are added to the AN/APX-6A system. The SIF system has more comprehensive identification capability than does the IFF system. It is through an improvement of the replying code that the AN/APX-25 provides a more rapid and absolute identification of the airplane. However, with the exception of the reply coding, their operation is similar. The SIF control panel (figure 4-7) is on the right console adjacent to the IFF control panel. The SIF control panel has two coder dials. These dials are used with the IFF control panel to provide control of the AN/APX-6A system. The dials, marked "MODE 1" and "MODE 3," can be rotated to set in the reply code for the respective modes of operation that have been selected on the IFF control panel. The SIF system operates when the transponder switch is at MOD. The SIF system is powered by the ac bus and monitored bus No. 2.

Operation of Identification Radar—AN/APX-25.

Perform the following steps for operation of the SIF system:

CAUTION

Before take-off, check with crew chief that IFF frequency counters have been set to proper frequency channels and that the transponder switch has been placed at MOD.

1. Rotate IFF master switch to STBY for a 3-minute warm-up period.
2. Rotate master switch on IFF panel to NORM for full sensitivity and maximum performance.

Note

The LOW position of the master switch should not be used except on proper authorization.

3. On IFF control panel, set upper mode switch at MODE 2 and lower mode switch and "I/P-MIC" switch at OUT, unless otherwise directed. (Refer to "Operation of Identification Radar—AN/APX-6A" in this section for switch settings in reply to the possible modes of interrogation.)
4. On SIF control panel, set coder dials as required.
5. To turn equipment off, rotate IFF master switch to OFF.

VOR (OMNIDIRECTIONAL) NAVIGATION RECEIVER—AN/ARN-14.

This receiver provides the pilot with navigation aids in the VHF frequency range between 108.0 and 135.9 megacycles. All navigation information is visual as well as aural, and may be observed on indicator units mounted on the instrument panel. The receiver is monitored aurally through the communication amplifier and is powered from monitored bus No. 2. The remote control panel for operating the equipment is on the right console (figure 4-7). Frequency selection is obtained by the use of a frequency selector switch which is on the remote-control panel, and consists of a large circular knob and small handle. The circular knob selects frequencies in hundreds of megacycles and the handle selects tenths of megacycles. When a localizer frequency is selected, the AN/ARN-31 glide slope receiver is automatically tuned to the proper channel for the localizer frequency being used. In addition to the frequency selector switch, a power switch, for control of the receiver and related circuits, and a volume control are provided on the remote-control panel. On airplanes changed by T.O. 1F-86L-531, the AN/ARN-14 equipment is removed.

VOR NAVIGATION RECEIVER INDICATORS.

VOR Course (Approach) Indicator.

The course indicator (11, figure 1-5) is mounted on the instrument panel. Signals from the VHF navigation receiver are directed into the indicator to operate the vertical needle for course guidance. A small background needle provides course deviation information 45 degrees to the right and left of the course selected, both "to" and "from" the selected station. The main vertical needle has a maximum deflection of about 10 degrees either side of the course centerline. A "SET" knob on the lower left corner of the instrument is used to select a desired course, the magnetic value of which appears in a window at the top of the instrument. The horizontal needle is operated by the glide slope receiver for descent guidance during ILS operations. A window in the upper left corner of the instrument displays "TO" and "FROM" indication, which signifies whether the selected course is inbound to the station tuned in or the outbound reciprocal in relation to the airplane position. The indicator is provided with flag alarms which become visible at any time a received signal is unreliable, and when the equipment is shut off, either intentionally or because of electrical power failure. A marker beacon light is in the upper right corner of the instrument. This light is connected to the marker beacon receiver and it comes on whenever the marker beacon receiver detects a 75-megacycle signal. It incorporates a press-to-test feature for checking bulb condition, as well as a light brilliance control.

Radio Magnetic Indicator.

The radio magnetic indicator (6, figure 1-5) is on the instrument panel. This is a dual-pointer instrument into which is directed heading information from the J-4 directional indicator system. This results in the operation of a rotating compass card, providing magnetic heading displayed against a fixed reference marker at the 12-o'clock position on the dial. Signals from the AN/ARN-14 navigation receiver (or AN/ARN-21 navigational receiver on airplanes changed by T.O. 1F-86L-531) are fed into the instrument to drive the double-barred (No. 2) pointer, providing radio bearing information which is read directly from the instrument as magnetic bearing to the station. The narrow single-barred (No. 1) pointer is not used on this airplane.

Note

> When the AN/ARN-14 VOR navigation receiver is inoperative or not in use, the double-barred pointer rotates freely.

Operation of VOR Navigation Receiver—AN/ARN-14.

1. Turn power switch to ON.
2. Position frequency selector to desired frequency setting. Identify station from coded signal in headset.

CAUTION

The flag alarm for the vertical needle on the

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course indicator must be out of sight before the vertical needle can be relied upon.

3. Set desired magnetic course heading in course window of course indicator.

4. Adjust volume as desired.

NAVIGATION RADIO AN/ARN-21.

The AN/ARN-21 radio is a navigational aid capable of giving the pilot bearing and slant distance to a surface beacon. The controls and indicators in the cockpit for this equipment consist of: a control panel on the right console, aft of the autopilot control (installed when the AN/ARN-14 control panel is removed); a distance indicator mounted on the lower center section of the instrument panel (35, figure 1-5); and a bearing indicator utilizing the radio magnetic indicator already installed in the upper left corner of the instrument panel (6, figure 1-5). There are 126 channels that may be selected by the pilot for transmitting and receiving. In operation, the AN/ARN-21 transmits an interrogation signal from the airplane to the surface beacon which receives the same signal and retransmits it back to the airplane. The equipment in the airplane only accepts the answer to its own interrogation signal. By an electronic measurement of the elapsed time, the distance information is interpreted and shown on the distance indicator. The distance is given as slant distance (nautical miles from the airplane down to the surface beacon). The surface beacon also transmits a Morse code identification tone each 38 seconds. The AN/ARN-21 has a range of about 195 miles in line of sight. If the range of 195 miles is exceeded, a red bar drops across the figures of the distance indicator. However, the relative bearing to the surface beacon is still shown on the bearing indicator if the airplane is below the 40-degree angle limit. The bearing indicator is locked on the surface beacon at all times, provided the airplane is not above the 40-degree angle limit from the surface beacon. If loss of bearing indication occurs, the bearing indicator needle rotates counterclockwise continuously until the airplane is back within limits. At this time, the distance indicator gives the slant distance to the surface beacon if it is within range.

AN/ARN-21 Controls and Indicators.

Function Switch. The function switch on the left of the AN/ARN-21 control panel is powered by the monitored bus No. 2. This switch has three positions: T/R, REC, and OFF. When the function switch is at T/R, the AN/ARN-21 starts transmitting an interrogation signal to the surface beacon for distance information and also receives bearing information from the surface beacon. Moving the function switch to REC stops the transmitting of the interrogation signal and only bearing information is received from the surface beacon. The distance indicator is inoperative and a red bar drops across the figures when the function switch is moved to OFF and the AN/ARN-21 equipment is shut off.

Channel Selection Switch. The channel selection switch and handle on the control panel permit selection of any one of the 126 channels for air-to-ground transmissions. These channels cover 1025 mcs to 1150 mcs with a one mc separation. The circular knob selects the first two digits, and the handle selects the third digit of the desired channel. By using the knob and handle, any combination of figures up to 126 can be set up in the channel window.

Note

Allow about 12 seconds after channel selection for the bearing indicator and the distance indicator to indicate the new information.

Volume Control Knob. The volume control knob marked "VOL," on the right of the control panel, adjusts the loudness of the surface beacon identification tone. Rotate knob clockwise to increase loudness.

Bearing Indicator. The bearing indicator, on the instrument panel, indicates the relative bearing to the surface beacon from your position. The indicator has degree markings around its edge, with figures at each 30-degree point. Signals from the AN/ARN-21 navigation receiver are fed into the instrument to drive the double-barred (No. 2) pointer, providing radio bearing information which is read directly from the instrument as magnetic bearing to the station. The indicator operates when the function switch is at either REC or T/R. If the bearing signal is lost or interfered with, such as a steep bank putting the antenna away from the surface beacon, a memory circuit in the receiver maintains the last bearing received for about 3 seconds. If the signal is still disrupted after the time limit, the bearing indicator needle spins counterclockwise until the signal is picked up again. If the airplane is above a 40-degree angle from the surface beacon, the bearing indicator needle keeps on spinning around the dial until the airplane is back within this limit. During a channel change or when the equipment is first turned on, the bearing needle may falsely lock on momentarily before indicating the correct heading. Therefore, wait a few seconds after a lock-on before relying on the bearing indicated.

Distance Indicator. The distance (range) indicator (35, figure 1-5), on the instrument panel, shows the slant distance in nautical miles from the airplane to the surface beacon by means of figures displayed in a small window in the center of the instrument. The indicator utilizes monitored bus No. 2 and ac power and operates only when the function switch is at T/R. When the indicator is inoperative or the channel is being changed, a red bar drops down and covers the figures. If the return signal from the surface beacon is lost either because of interference (as during a steep bank that puts the antenna away from the surface beacon) or being out beyond the 195-mile range of the equipment, a memory circuit retains the last distance before the interruption for about 10 seconds, then the red bar drops across the figures. When the airplane is back within range, the distance indicator corrects itself and the red bar disappears automatically. There may be a momentary false indication when the equipment is first turned on or when changing channels. However, wait a few seconds to ensure that the indication can be relied upon.

ILS-TACAN Switch.

The "ILS-TACAN" switch (36, figure 1-5), on the instrument panel, permits selection of either ILS or TACAN for control of the vertical deviation needle on the course indicator. This switch should be left in the ILS position until the "TACAN SWITCH INOPERATIVE" decal is removed from beside the switch when TACAN replaces the omnidirectional receiving system.

Operation of AN/ARN-21 Radio (Homing).

To operate the AN/ARN-21 radio, proceed as follows:

1. "ILS-TACAN" switch—TACAN.

1A. Rotate channel selector knobs to surface beacon channel desired.

2. Move function switch to either REC or T/R and allow about 2 minutes for warm-up, or until bearing indicator stops spinning.

Note

A false lock-on may occur momentarily; however, the bearing needle will release and go to the magnetic bearing of the surface beacon.

3. To home on surface beacon, proceed as follows:
   a. Turn airplane until directional indicator indicates heading given on bearing indicator.
   b. Rotate "SET" knob on course indicator to select desired course.
   c. Read slant distance to station on distance indicator.

Note

If the function switch is at T/R, the distance indicator shows a reduction in mileage as you approach the surface beacon, and shows an increase in mileage as you fly away from it.

4. To turn equipment off, move function switch to OFF.

Note

After the AN/ARN-21 is turned off, the No. 2 pointer of the radio magnetic indicator rotates freely.

GLIDE SLOPE AND LOCALIZER RECEIVER—AN/ARN-31.

The glide slope receiver, AN/ARN-31-R-626, operates in conjunction with, and is controlled by, the omnidirectional receiver control panel AN/ARN-14 marked "VHF NAV." The glide slope antenna is located in the lower lip of the air intake duct. The AN/ARN-31 system is powered from monitored bus No. 2 on dc power, and from the alternator bus for ac power. The AN/ARN-31 will continue to operate in the event of a single generator failure. It forms a dual 20-channel receiving set designed to receive glide slope frequencies, spaced 0.3 megacycles apart, from 329.3 to 335.0 megacycles inclusive, in order to produce vertical guidance during airplane landing operations. The omnidirectional receiver AN/ARN-14 provides lateral guidance. Provisions are made for installation of the AN/ARN-21 TACAN (tactical air navigation) system. When this system is installed on airplanes changed by T.O. 1F-86L-531, the AN/ARN-14 omnidirectional receiving system and the AN/ARN-12 marker beacon system are removed. The units installed in the airplane are: an "ILS-TACAN" switch, on the instrument panel, and a separate AN/ARN-31-R-625 localizer receiver with a control panel.

Glide Slope and Localizer Receiver (AN/ARN-31) Control Panel (ILS).

The AN/ARN-31 (ILS) control panel (figure 4-7) is installed when TACAN is installed. The ILS frequency is selected by rotating the frequency selector knob on the ILS control panel until the desired localizer frequency appears in the indicator window to the left of the selector knob. The selector knob may be rotated in either direction. The volume control knob regulates the volume of the audible signal. The power switch controls power to the system.

Operation of Glide Slope and Localizer Receiver—AN/ARN-31 (Airplanes Equipped with OMNI).

1. Set frequency selector to desired ILS frequency.
2. Move power switch on AN/ARN-14 radio to ON.

Note

Energizing the AN/ARN-14 radio energizes the AN/ARN-31 radio at the same time. Selection of the desired frequency on the

AN/ARN-14 radio also selects the corresponding frequency for the AN/ARN-31 radio.

CAUTION

The flag alarms for both the vertical and horizontal needles of the course indicator must be out of sight before the indicator can be relied on.

3. Adjust volume control as desired.
4. Fly airplane to intersect glide slope and localizer beam.
5. After instrument landing is completed, turn power switch OFF.

Operation of Glide Slope and Localizer Receiver—AN/ARN-31 (Airplanes Equipped with TACAN).

To operate the ILS system, proceed as follows:

1. "ILS-TACAN" switch—ILS.
2. Power switch—ON.
3. Select desired ILS frequency on ILS control panel.
4. Volume control—As desired.
5. Observe deflections of cross pointers on course indicator. At the start of an ILS approach where the vertical needle warning "OFF" flag has disappeared but the horizontal needle warning "OFF" flag is still visible, or at a check point as locally prescribed, a check to determine whether power loss to the relays has occurred can be made by momentarily turning off TACAN equipment. If a power failure has occurred, the following will occur:

   a. If the vertical needle warning "OFF" flag does not appear immediately, it can be considered that the vertical needle is receiving information from the localizer, and the TACAN equipment can be switched back on.

   b. If the vertical needle warning "OFF" flag appears immediately, it can be assumed that the signal to the vertical needle was being received from a TACAN station and not the localizer and, therefore, the system is no longer reliable for an ILS approach.

   c. During an ILS approach (after both warning "OFF" flags have disappeared), a power loss will be detected by the horizontal needle warning "OFF" flag appearing, and the horizontal needle will center itself and remain centered regardless of airplane movement.

CAUTION

Check that the red "OFF" flags for both the vertical and horizontal bar disappear; the flag must be out of sight before the indications are reliable.

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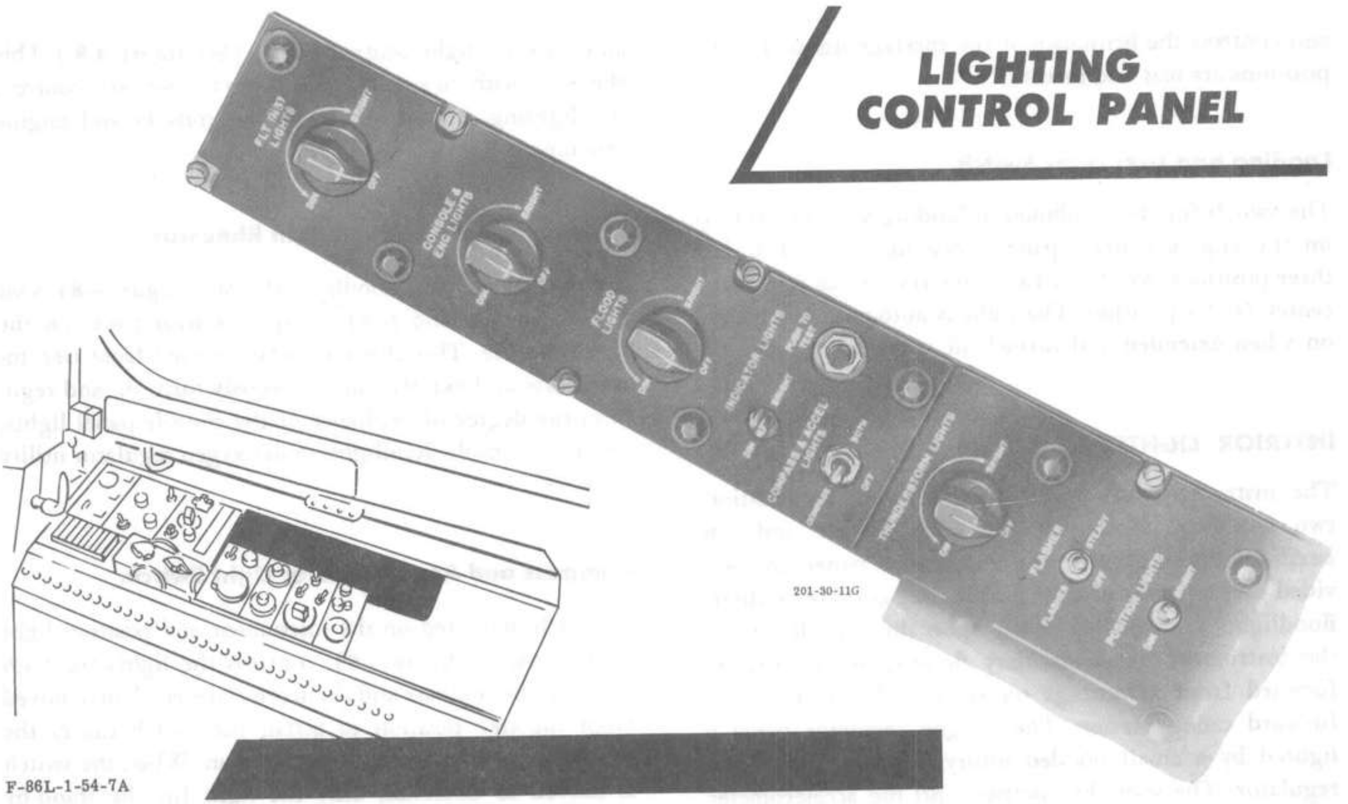

Figure 4-8

6. Fly airplane to center both cross pointers.
7. Turn power switch OFF to de-energize system.

MARKER BEACON RADIO—AN/ARN-12.

The marker beacon radio is automatically turned on when power is supplied to the electrical system of the airplane. The marker beacon indicator light (12, figure 1-5) is on the approach indicator. This radio is powered through monitored bus No. 2. When the AN/ARN-21 (TACAN) system is installed, the AN/ARN-12 system is removed.

LIGHTING EQUIPMENT.

EXTERIOR LIGHTING.

Exterior lighting consists of four position lights on wing tips and tail, three fuselage lights, and a combination landing and taxi light. One fuselage light is in the top of the fuselage, just aft of the cockpit; the others are on the bottom of the fuselage, directly aft and on each side of the rocket package recess. Each fuselage light contains one large lamp and one small lamp. The retractable landing and taxi light, mounted on the bottom of the engine air intake duct just forward of the nose wheel strut, extends downward. The landing light beam is directed forward and down from the nose of the airplane for illumination during approach and landing. In the landing position, the light beam extends downward 12.5 degrees below the longitudinal axis of the airplane. When the weight of the airplane is on the nose gear, the light extends further, until the angle of the beam is one degree above the longitudinal axis of the airplane, for taxiing. When used during night takeoff, the beam is high until the airplane "breaks ground"; then it returns to the beam-low position, where it remains until retracted manually. All exterior lighting controls are powered from the primary bus except the landing and taxi light switch; it is powered from monitored bus No. 1.

Exterior Lighting Flasher Switch.

The flasher switch, mounted on the instrument and position light control panel (figure 4-8) on the right aft console, controls the position lights. From the OFF position, the switch can be moved to STEADY, which will cause all four position lights to burn steadily, or it can be moved to FLASH, giving a repeated regular-interval flashing.

Position Light Dimmer Switch.

The position light dimmer switch, on the instrument and position light control panel (figure 4-8), regulates the brilliance of the wing tip and tail position lights, and controls the brilliance of the fuselage lights. Its two positions are DIM and BRIGHT.

Landing and Taxi Light Switch.

The switch for the combination landing and taxi light is on the engine control panel. (See figure 1-4.) It has three positions: RETRACT, EXTEND & ON and an unmarked center (OFF) position. The light is automatically turned on when extended and turned off when retracted.

INTERIOR LIGHTING.

The instruments are individually lighted. In addition, two auxiliary floodlights for each console and one auxiliary floodlight for the instrument panel are provided on each side of the cockpit. The console auxiliary floodlights are directed down upon the consoles, while the instrument panel auxiliary floodlights are directed forward from mountings on either side of the lower forward canopy frame. The oxygen regulator panel is lighted by a small hooded utility light just above the regulator. The stand-by compass and the accelerometer, mounted at the base of the windshield bow on each side of the main instrument panel, are individually lighted. The stand-by compass light is built into the instrument, while the accelerometer lights are enclosed in an instrument lighting fixture attached to the face of the instrument. An extension light on the right aft side of the cockpit has a spring-coiled cord; the light can be disengaged and held by hand, or it can be remounted in another socket-type mounting on the lower right forward canopy frame for maximum flexibility. Two thunderstorm lights (one on either side of the seat headrest) are provided to supply a constant white light so that vision is protected against lightning flashes during any thunderstorm operation. All interior lighting controls are powered from the primary bus. When no external power is being supplied and generators are inoperative, all lighting is made operable when the battery switch is turned to ON.

Flight Instrument Light Rheostat.

The flight instrument light rheostat is mounted at the top of the instrument and position light control panel (figure 4-8) on the right aft console. When moved from OFF to DIM or BRIGHT, this rheostat turns on and controls the brilliance of the flight instrument lights.

Console and Engine Instrument Light Rheostat.

The console and engine instrument light rheostat is aft of the flight instrument light rheostat on the instrument and position light control panel. (See figure 4-8.) This rheostat, with OFF, DIM, and BRIGHT positions, controls the lighting and brilliance of the console and engine instrument lights.

Console Panel and Floodlight Rheostat.

A console panel and floodlight rheostat (figure 4-8) is on the instrument and position light control panel on the right console. This rheostat, when moved from OFF toward DIM and BRIGHT, simultaneously turns on and regulates the degree of brilliance of the console panel lights, auxiliary console floodlights, and oxygen regulator utility light.

Compass and Accelerometer Light Switch.

A switch, mounted on the instrument and position light control panel (figure 4-8), controls the lights for both the stand-by compass and the accelerometer. When moved from the OFF position to BOTH, the switch causes the lights for both instruments to come on. When the switch is moved to COMPASS, only the light for the stand-by compass is turned on. The brilliance of the compass and accelerometer lights is controlled by the flight instrument light rheostat.

Thunderstorm Light Rheostat.

The thunderstorm light rheostat (figure 4-8) is on the instrument and position light control panel. This rheostat, when moved from OFF to DIM or BRIGHT, turns on and controls the brilliance of the two thunderstorm lights mounted on each side of the ejection seat headrest.

OXYGEN SYSTEM.

The airplane is equipped with a gaseous oxygen system. Oxygen is supplied by two Type D-2 cylinders and a smaller Type B-3 cylinder through an MD-1 type regulator. The system has an operating pressure of 400 psi. For combat safety, the cylinders supply the regulator through two distribution lines joined at a check valve near the regulator. The complete oxygen system can be serviced at a single filler valve accessible through an access door on the lower left side of the fuselage forward of the wing. (See figure 1-29.) A pressure gage and flow indicator is incorporated in the regulator. This regulator automatically supplies a proper mixture of oxygen and air at all altitudes. At high altitudes, the regulator automatically supplies positive pressure breathing. The delivery pressure varies automatically with changes in altitude. Regardless of how much oxygen is

OXYGEN DURATION – HOURS

CABIN ALT FEET	GAGE PRESSURE—PSI							
	400	350	300	250	200	150	100	BELOW 100
35,000 AND ABOVE	3.6 (3.6)	3.1 (3.1)	2.7 (2.7)	2.2 (2.2)	1.8 (1.8)	1.3 (1.3)	0.9 (0.9)	EMERGENCY – DESCEND TO ALTITUDE NOT REQUIRING OXYGEN
30,000	2.7 (2.6)	2.4 (2.3)	2.0 (1.9)	1.7 (1.6)	1.3 (1.3)	1.0 (1.0)	0.7 (0.6)	
25,000	2.5 (2.0)	2.2 (1.7)	1.9 (1.5)	1.6 (1.3)	1.3 (1.0)	0.9 (0.8)	0.6 (0.5)	
20,000	2.8 (1.5)	2.4 (1.3)	2.1 (1.1)	1.7 (0.9)	1.4 (0.8)	1.0 (0.6)	0.7 (0.4)	
15,000	3.4 (1.2)	3.0 (1.0)	2.5 (0.9)	2.1 (0.8)	1.7 (0.6)	1.3 (0.5)	0.9 (0.3)	
10,000	3.4 (1.0)	3.0 (0.9)	2.5 (0.7)	2.1 (0.6)	1.7 (0.5)	1.3 (0.4)	0.9 (0.3)	
5,000	3.4 (0.8)	3.0 (0.7)	2.5 (0.6)	2.1 (0.5)	1.7 (0.4)	1.3 (0.3)	0.9 (0.2)	
SEA LEVEL	3.4 (0.6)	3.0 (0.5)	2.5 (0.4)	2.1 (0.4)	1.7 (0.3)	1.3 (0.2)	0.9 (0.1)	

CYLINDERS: TWO TYPE D-2 AND ONE TYPE B-3.

BLACK FIGURES INDICATE DILUTER LEVER ***NORMAL OXYGEN.*** FIGURES IN PARENTHESES INDICATE DILUTER LEVER ***100% OXYGEN.***

F-86L-1-73-10A

Figure 4-9

being used, the pressure will always be the amount required for any specific altitude. A pressure relief valve on the outlet side of the regulator relieves excess pressures. Only a pressure-demand oxygen mask should be used. The approximate duration of the oxygen supply is given in figure 4-9. To prevent damage to oxygen hose when it is not in use, the hose may be clipped to the webbing provided below the right side of the instrument panel.

OXYGEN SYSTEM CONTROLS.

Regulator Diluter Lever.

An oxygen regulator diluter lever is provided in the top right corner of the oxygen regulator panel (figure 4-10), to select NORMAL OXYGEN for all normal usage or 100% OXYGEN for emergency use.

Regulator Supply Lever.

The oxygen regulator supply lever, at the bottom of the oxygen regulator panel (figure 4-10), should be safety-wired to the ON position at all times during normal operation, to prevent inadvertent closing off of the oxygen supply. If desired, because of regulator malfunction or emergency conditions, the safety wire can easily be broken and the supply lever can be positioned at OFF.

Regulator Emergency Toggle Lever.

The oxygen regulator emergency toggle lever, on the oxygen regulator panel (figure 4-10), should be in the center position at all times unless an unscheduled pressure increase is desired. Moving the toggle lever either way from its unmarked center OFF position provides continuous positive pressure to the oxygen mask for emergency. The emergency toggle lever has three positions: the center OFF position, the forward EMERGENCY position for emergency oxygen flow, and the aft TEST position for testing system and mask leaks.

CAUTION

When positive pressures are required, it is mandatory that the oxygen mask be well fitted to the face. Unless special precautions are taken to ensure no leakage, the continued use of positive pressure under these conditions results in the rapid depletion of the oxygen supply.

OXYGEN SYSTEM INDICATORS.

Pressure Gage and Flow Indicator.

The pressure gage and flow indicator are on the oxygen regulator panel (figure 4-10). The pressure gage shows

OXYGEN REGULATOR CONTROL PANEL

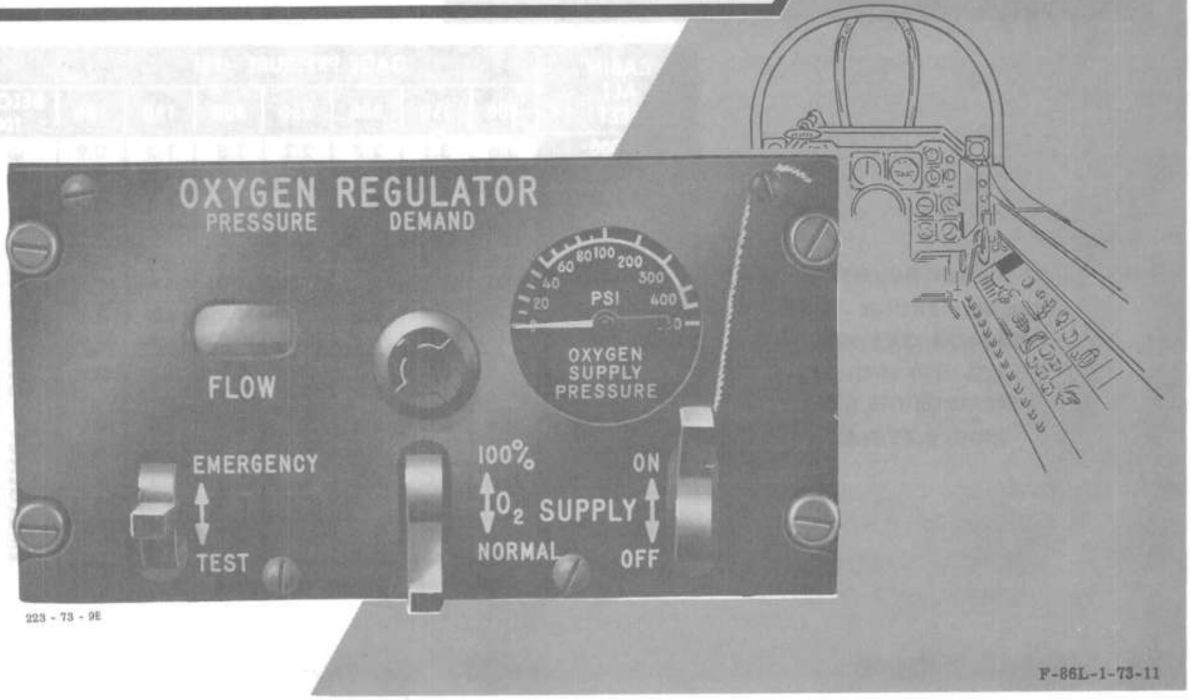

Figure 4-10

the amount of oxygen in the cylinders. The flow indicator (blinker) consists of an oblong opening in the face of the regulator panel, and shows black and white alternately during the breathing cycle.

Note

> As the airplane ascends to high altitudes and low temperatures, the oxygen cylinders become chilled. As the cylinders become cooled, the oxygen gage pressure indication is reduced, sometimes rather rapidly. With a 100°F decrease in temperature in the cylinders, the gage pressure can be expected to drop 20 percent. This rapid fall in pressure is occasionally a cause for unnecessary alarm. All the oxygen is still there, and as the airplane descends to warmer altitudes, the pressure tends to rise again, so that the rate of oxygen usage may appear to be slower than normal. A rapid fall in oxygen pressure while the airplane is in level flight, or while it is descending, is not ordinarily due to falling temperature. When this happens, leakage or loss of oxygen must be suspected.

OXYGEN SYSTEM PREFLIGHT CHECK.

Before take-off, the oxygen system should be checked as follows:

Note

> Above 30,000 feet, you may sometimes notice a vibration, or wheezing sound, in the pressure-demand mask. This condition does not indicate a malfunction and can be overlooked.

1. Check that personal leads are properly mated at ejection seat fitting. Note oxygen pressure gage indication (400 psi minimum). See figure 4-11 for oxygen hose hookup.

2. Check oxygen regulator with diluter lever first at NORMAL OXYGEN and then at the 100% OXYGEN position as follows: Remove mask and blow gently into end of oxygen regulator hose as during normal exhalation. There should be resistance to blowing. Little or no resistance to blowing indicates a leak or faulty operation.

3. With regulator supply valve ON, oxygen mask connected to regulator, and diluter lever in 100% OXYGEN position, breathe normally into mask and conduct the following checks:

   a. Observe blinker for proper operation.

   b. Deflect emergency toggle fore and aft. A positive pressure should be supplied to the mask. Hold breath to determine whether there is leakage around mask. Return emergency toggle to center position. Positive pressure should cease.

4. Return diluter lever to NORMAL OXYGEN.

OXYGEN SYSTEM NORMAL OPERATION.

1. Before each flight, be sure oxygen pressure gage reads at least 400 psi. If pressure is below this minimum, have the oxygen system charged to capacity before take-off.

2. Oxygen regulator diluter lever NORMAL OXYGEN.

3. Oxygen regulator supply lever ON.

OXYGEN SYSTEM EMERGENCY OPERATION.

With development of anoxia symptoms, proceed as follows:

1. Oxygen regulator diluter lever—100% OXYGEN.

2. Push oxygen regulator emergency toggle lever either way from center. If oxygen regulator becomes inoperative, pull ball handle on H-2 emergency oxygen bail-out bottle and descend to a cockpit altitude below 10,000 feet as soon as possible.

AUTOPILOT.

The F-5 automatic pilot is an electronic flight control equipped with an automatic horizontal tail trim unit. This automatic pilot will hold the airplane on any preselected course that may be desired, change the course at will with a coordinated turn, or maintain the airplane laterally level and in any desired angle or climb or dive up to 40 degrees from level flight. Automatic control starts in the gyro and amplifier control unit, which includes ac powered directional and vertical gyros as references. The directional gyro establishes a reference for the azimuth heading of the airplane; the vertical gyro establishes a flight reference about the lateral and longitudinal axis of the airplane. The automatic horizontal tail trim unit automatically operates the horizontal tail trim actuator to maintain the airplane in proper longitudinal trim while the automatic pilot is engaged. The horizontal trim portion of the normal trim switch on the control stick is inoperative while the automatic pilot is engaged, to prevent manual operation of the horizontal tail trim in opposition to the automatic function. Disengaging the automatic pilot will automatically restore the horizontal tail trim function to the normal trim switch. The automatic pilot can be overpowered at any time or can be immediately disengaged by use of the automatic pilot release switch on the control stick or the automatic pilot engaging switch on the flight controller. If the automatic pilot is engaged during a wing-level dive or climb, the airplane will continue on course in the dive or climb. However, if the automatic pilot is engaged while the airplane is in a level, climbing, or diving turn, the wings will return abruptly to about level attitude.

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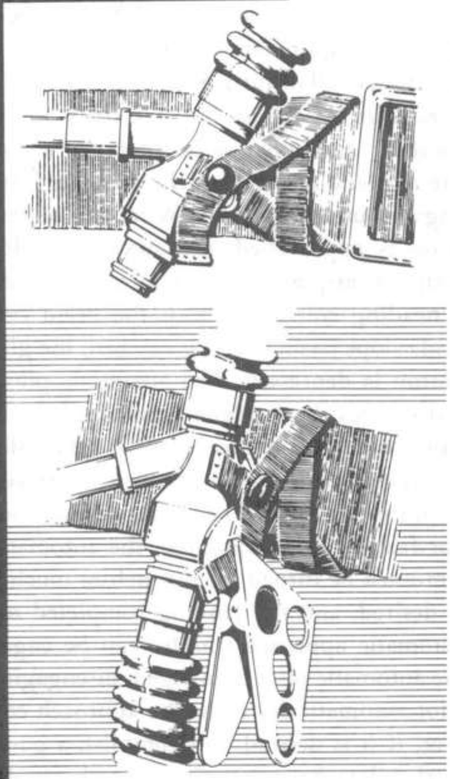
OXYGEN HOSE HOOKUP

MC-3A



1 Attach oxygen mask hose (male connector) to parachute harness chest strap by wrapping mask connector tie-down strap underneath and up behind chest strap harness twice, then snapping.

WARNING

Failure to double-loop tie-down strap around chest strap may permit tie-down strap to slip into and open the chest strap snap during ejection.

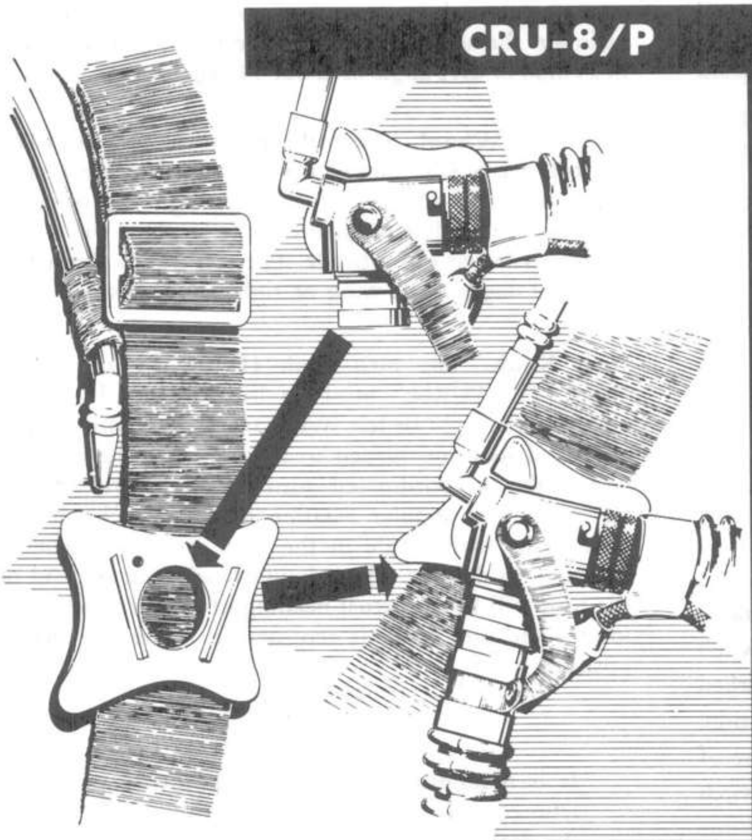
2 Attach seat oxygen hose to oxygen mask hose. Listen for click and visually check (or feel) that sealing gasket is only half exposed.

3 Fasten alligator clip as close to snap on tie-down strap as possible.

WARNING

Do not attach clip to harness as this may prevent quick separation from seat during ejection. The force required to pull clip from harness is more than from strap.

CRU-8/P



1 Insert connector into connector mounting plate attached to parachute harness. Check that connector is firmly attached and that lockpin is locked.

2 Insert male bayonet connector, on end of oxygen mask hose, into female receiving port of connector, and turn connector to lock its prongs into recesses in lip of receiving port.

3 Couple seat oxygen hose to lower port of connector.

4 Snap strap attached to seat oxygen hose onto connector.

WARNING

The seat hose should not have an alligator clip. If there is a clip, it should not be used, as possible interference may occur during ejection.

5 Attach bail-out bottle hose to swiveling port of connector by inserting male coupling of bail-out bottle hose and turning it clockwise against spring-loaded collar.

F-86L-1-95-3A

Figure 4-11

The automatic pilot uses signals from the automatic approach coupler to guide the airplane during instrument approaches on the radio signals received from the instrument landing transmitters. The automatic approach coupler equipment is controlled by engage buttons on the automatic approach coupler controller on the vertical panel forward of the right console. Indicator lights, incorporated in the engage buttons, come on to show when the localizer and glide slope channels are engaged. When the airplane approaches the localizer beam, the localizer engage button is pressed. When the center of the localizer beam is approached, the automatic pilot automatically turns the airplane into the localizer beam and establishes a heading coincident with the beam center. When the glide slope beam center is reached, the glide slope engage button is depressed. The automatic pilot then automatically noses the airplane down until the flight path coincides with the center of the glide slope beam. The automatic pilot automatically compensates the airplane for normal cross-wind conditions. Since no automatic flare out feature is incorporated, the automatic approach system must be turned off just before touchdown, or sooner if desired, and the landing completed manually. As the automatic approach coupler can be engaged only while the automatic pilot is engaged, disengaging the automatic pilot automatically turns the approach coupler off. However, if it is desired to accomplish a go-around on automatic pilot, the automatic approach coupler can be turned off without disengaging the automatic pilot, by lifting the turn knob on the flight controller out of the detent position and dropping it back again into the detent position. All automatic pilot controls are powered from the ac busses.

Note

Maximum use of the autopilot on all missions is recommended, because flight familiarization and repeated practice improve proficiency and instill confidence in the equipment.

AUTOPILOT CONTROLS AND INDICATORS.

Autopilot Master Switch.

AC and dc power to the autopilot gyros and associated equipment is controlled by a guarded two-position switch (5, figure 1-7) on the right console. The switch is marked "ON" and "OFF" and is guarded in the ON position. The switch should only be positioned to OFF in case of emergency, to disengage the autopilot. Should this switch be positioned to OFF during flight, it will not be possible to engage the autopilot until about 3 minutes after the switch has been returned to the ON position.

Autopilot Release Switch.

An automatic pilot release switch is on the control stick (figure 1-19), just below the stick grip. The switch is actuated by squeezing the grip that covers it. Actuation of the switch disengages the automatic pilot and causes the automatic pilot engaging switch on the flight controller to return automatically to the OFF position.

Autopilot Flight Controller.

All flight control functions of the automatic pilot are centered in the flight controller (figure 4-12), on the right console. The flight controller incorporates the engaging switch, the roll trim wheel, the pitch trim wheels, and the turn knob.

Engaging Switch. The automatic pilot engaging switch (figure 4-12) is a rotary switch with an OFF and an ON position. Placing the switch at ON electrically connects the automatic pilot to the flight control system. The switch is automatically locked in the OFF position until a time delay of 3 minutes has elapsed from the time the power is supplied to the primary bus, or whenever the turn knob is not in the neutral detent position.

Pitch Trim Wheels. The pitch trim wheels (figure 4-12) control the nose-up or nose-down position of the airplane. If the pitch trim wheels are rotated aft for nose-up trim or forward for nose-down trim, the airplane will maintain the selected attitude. The pitch trim is limited to a climb or dive angle of about 40 degrees.

Roll Trim Wheel. The roll trim wheel (figure 4-12) controls the lateral trim of the airplane. If the roll trim wheel is rotated clockwise for right wing down or counterclockwise for left wing down, the airplane will maintain the selected roll attitude. The roll trim is limited to about 10 degrees left wing or right wing down.

Turn Knob. The turn knob (figure 4-12), marked "LIFT TO TURN," must be lifted before it can be turned to the right or left. When the knob is lifted out of neutral detent and turned to right or left, the airplane will make a coordinated turn in the corresponding direction. The angular rotation of the turn knob will govern the bank angle in the turn up to a maximum of about 50 degrees. The azimuth heading at the end of the turn will be the actual heading of the airplane at the instant the turn knob is returned to its neutral detent position.

Note

It is necessary to introduce appropriate pitch trim corrections with the pitch trim wheels on the flight controller if it is desired to maintain altitude during, or at the completion of, a turn maneuver.

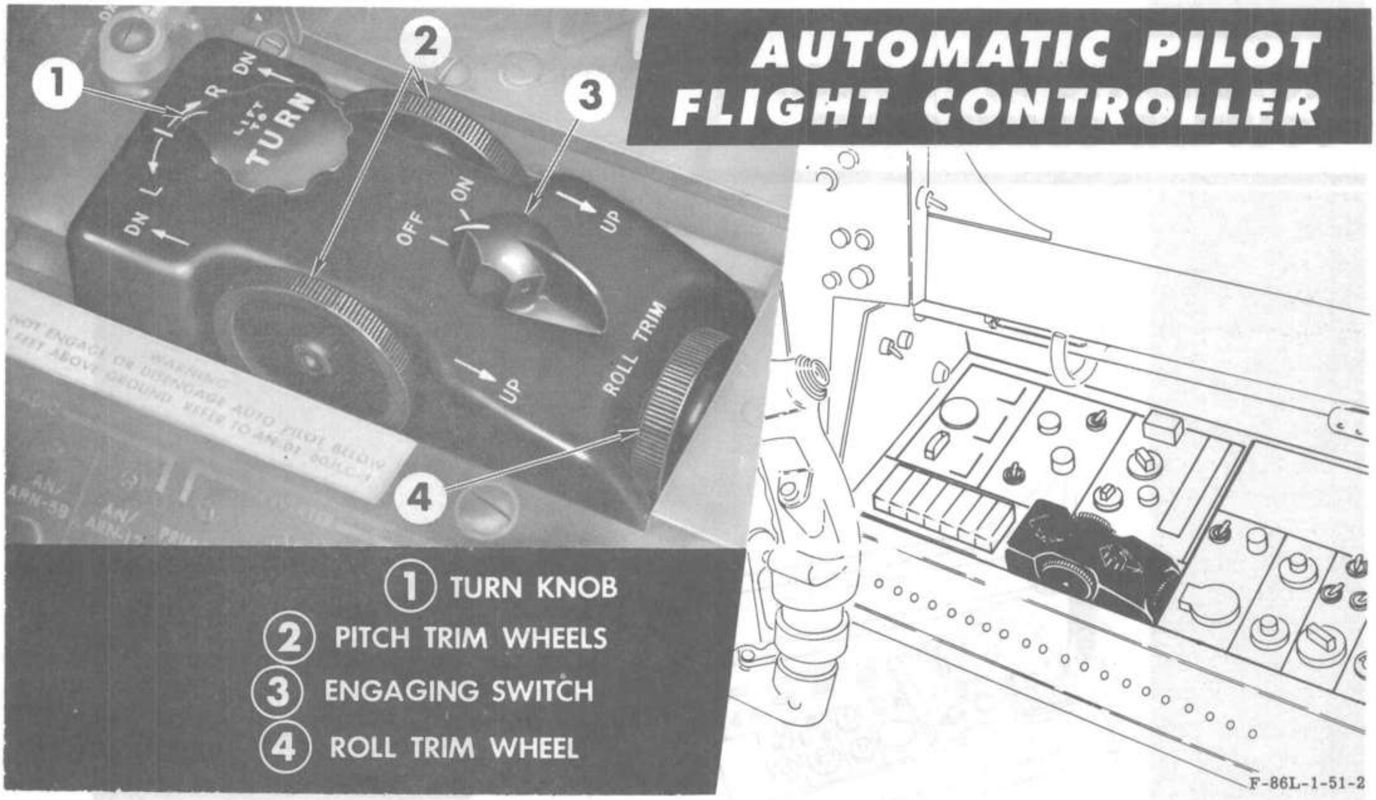


Figure 4-12

Automatic Approach Coupler Controller.

The automatic approach coupler controls are grouped on the approach coupler controller (figure 4-13), on the vertical panel forward of the right console. The controller incorporates three combination push-button and indicator light switches, marked "LOCALIZER," "GLIDE PATH," and "ALTITUDE," and an altitude off push-button switch. The localizer and glide path switches are used to engage the automatic approach coupler to the automatic pilot. Pressing the altitude switch (not connected at present) engages a barometric pressure control to the automatic pilot, which automatically maintains the airplane at the specific altitude at which it was engaged. The altitude off switch (not connected at present) is used to disengage the altitude control.

Localizer Engage Button and Indicator Light. A combination push-button switch and indicator light, marked "LOCALIZER," is provided on the automatic approach coupler controller (figure 4-13) to connect the localizer receiver signals to the automatic pilot. As the airplane approaches the localizer beam, depressing the localizer button allows the automatic pilot to use the proper maneuvering signals from the localizer receiver and automatically turn the airplane to intercept and establish a heading along the center of the localizer beam. Illumination of the indicator light, within the engage button, shows that the localizer channel is connected to the automatic pilot.

Glide Path Engage Button and Indicator Light. A combination push-button switch and indicator light, marked "GLIDE PATH" and located on the automatic approach coupler controller (figure 4-13), is used to connect the glide slope receiver signals to the automatic pilot as the airplane reaches the center of the glide slope beam. Depressing the glide path button when the airplane reaches the center of the glide slope beam connects the maneuvering signals from the glide slope receiver to the automatic pilot, which uses these signals to nose the airplane down to intercept and establish a descent along the center of the glide slope. A safety interlock prevents engagement of the glide sloap receiver to the automatic pilot until after the localizer signals are first connected to the automatic pilot. Illumination of the indicator light, within the engage button, shows that the glide slope channel is connected to the automatic pilot.

Altitude Engage Button and Indicator Light. A combination push-button and indicator light, marked "ALTITUDE" and located on the automatic approach coupler controller (figure 4-13), is used to maintain altitude control during automatic approaches. At present, this button is *not connected* and is therefore *inoperable.*

Altitude Off Button. The altitude off button, on the automatic approach coupler controller (figure 4-13), is used to disengage the altitude control. As the altitude control is not connected, this button is *not operable.*

AUTOMATIC APPROACH COUPLER CONTROLLER

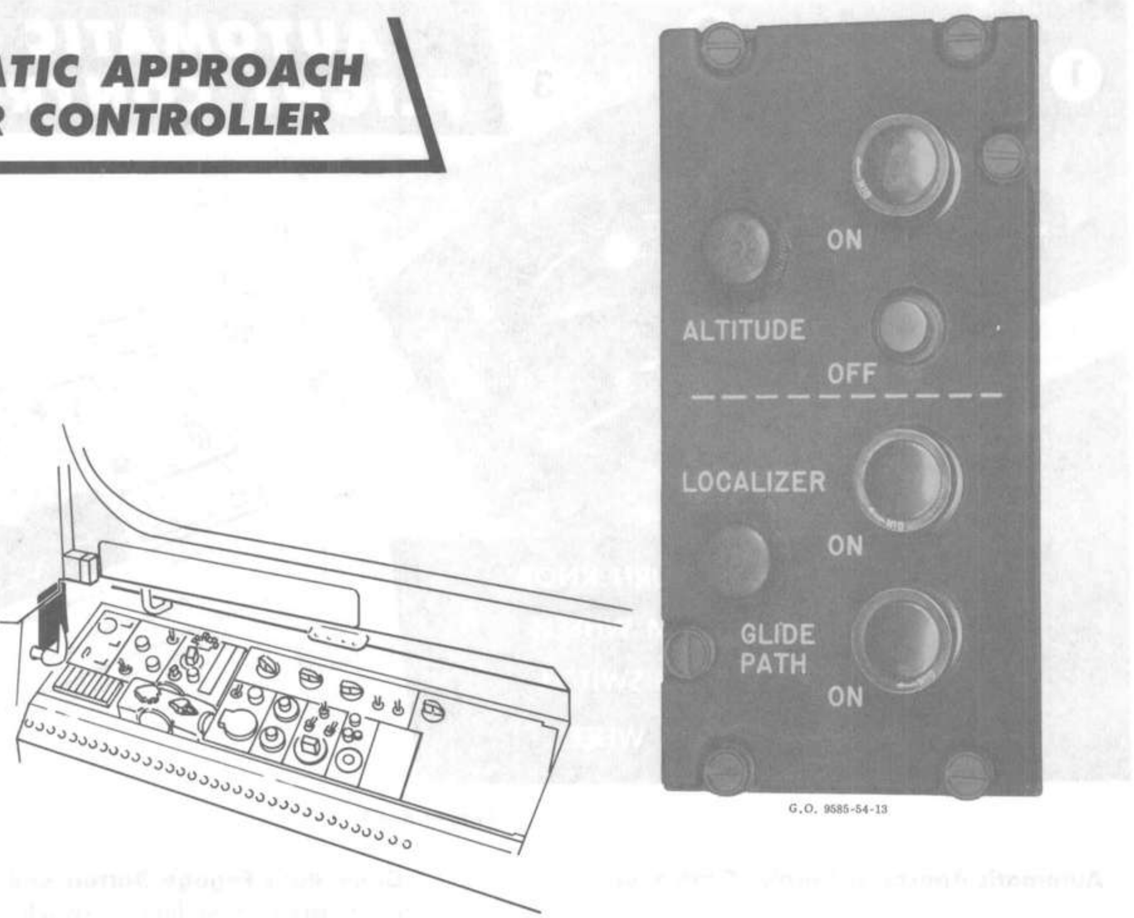


Figure 4-13

Automatic Pilot Pitch Trim Indicator.

A pitch trim indicator (38, figure 1-5), on the left side of the instrument panel, shows the pitch trim of the airplane while it is operating on automatic pilot. Position of the needle allows the pilot to anticipate an airplane out-of-trim condition upon disengagement of the automatic pilot, if the automatic pitch trim should not function correctly. This indicator is powered by signals received from the automatic pilot horizontal tail servo and operates only when the automatic pilot engaging switch is at ON. Needle displacement toward either "UP" or "DOWN" shows that the airplane is trimmed for that flight attitude.

AUTOMATIC PILOT NORMAL OPERATION.

Ground Tests.

The automatic pilot should be ground-checked before each flight as follows:

1. With flight controls in neutral and turn knob in the neutral detent, turn engaging switch to ON.

Note

Engaging switch is automatically locked OFF until primary bus has been energized for about 3 minutes.

2. Rotate roll trim wheel in each direction and check control stick for corresponding movement. Return roll trim wheel to neutral position by rotating it as required to streamline ailerons.

3. Lift turn knob out of neutral detent; turn knob in each direction and check control stick for corresponding movement. Rudder pedals will momentarily move to coordinate with control stick. Return turn knob to neutral detent. Control stick will return to neutral, but rudder pedals will not.

4. Rotate pitch trim wheels in each direction and check control stick for corresponding movement. Return control stick to neutral, using pitch trim wheels.

5. On airplanes equipped with automatic approach coupler, perform the following:

a. With instrument approach radio receivers on (refer to "Glide Slope and Localizer Receiver—AN/ARN-31"), press localizer engage button and see that indicator light comes on. Control stick should move to show turn in direction of deflection of localizer needle on course indicator.

b. Depress glide path engage button and see that indicator light comes on. Control stick should move back for an upward deflection of the glide slope needle.

c. Lift turn knob on flight controller to disengage automatic approach coupler from automatic pilot. See that localizer and glide path indicator lights go out.

6. Recheck roll and pitch trim wheels for neutral setting.

7. Squeeze release switch on control stick to disengage automatic pilot. Engaging switch on flight controller should return to OFF. Manually check flight controls for correct operation and freedom of movement.

In-flight Operation.

1. Manually trim airplane for wing-level flight on desired course and pitch attitude.

2. Turn engaging switch to ON.

CAUTION

When automatic pilot is being engaged, hold control stick firmly to prevent any abrupt resultant maneuver that may occur should automatic pilot not function properly.

Note

- Failure to return roll trim wheel to neutral before take-off can cause the airplane to roll suddenly either right or left to an extreme of 10 degrees when the automatic pilot is engaged.
- Engaging switch cannot be turned ON unless turn knob is in the neutral detent.
- There are no indices to be lined up before automatic pilot engagement.

3. Adjust roll trim wheel as necessary to maintain wings level.

4. Perform turns and changes in pitch attitude as desired by operation of appropriate controls on flight controller. Climbing or diving turns can be accomplished by simultaneous use of pitch trim wheels and the turn knob. It is recommended that the autopilot be engaged during IFR conditions, to assist the pilot in retaining the desired flight attitude. If the autopilot is engaged while the pilot still has valid attitude indication from the flight instruments, it may preclude difficulties arising as a result of losing such indication.

Note

Use of the autopilot for recovery from unusual flight attitudes is not recommended. While successful recovery is likely in most instances, certain critical attitudes, airspeeds, and altitudes make such a procedure inadvisable.

WARNING

Maintain close supervision of the automatic pilot, particularly below 5000 feet, to reduce effect should automatic pilot not function correctly.

Note

Any time binding and/or jerky control operation is experienced, the automatic pilot power switch should be moved to OFF to eliminate this problem.

5. When automatic pilot run is completed, squeeze release switch on control stick to disengage automatic pilot, or turn engaging switch on flight controller to OFF. The pitch trim indicator may be checked for proper alignment. Observation of a misalignment allows the pilot to anticipate a respective airplane out-of-trim condition upon disengagement of the automatic pilot.

CAUTION

When automatic pilot is being disengaged, hold control stick firmly to prevent any abrupt maneuver that may occur should the automatic pilot not function properly.

Automatic Approach Operation.

Familiarity with ILS beam is necessary in order to properly make an acceptable automatic approach. During automatic approach, the airplane will follow a course shown by the course indicator. An automatic approach may be accomplished as follows:

1. Turn on instrument approach radio receivers according to directions in this section.

Note

The power switch on the VHF navigation radio panel must be ON and frequency selector set to the desired channel about 20 minutes before arrival at destination.

2. With automatic pilot turn knob in neutral detent, turn automatic pilot engaging switch ON.

CAUTION

When automatic pilot is being engaged, hold control stick firmly to prevent any abrupt resultant maneuver that may occur should automatic pilot not function properly.

3. Approach localizer beam heading at the specific minimum approach altitude, or any altitude above the minimum so long as it is well below the glide path beam, and at a maximum airspeed of 180 to 200 knots IAS. Intercept localizer beam at any angle up to 90 degrees of the beam heading (smaller intercept angles give less overshoot and are preferable) and not less than 10 miles from the runway (transmitter station). The greater the intercept angle, the greater must be the distance of beam intercept from the runway. Entry into the beam should be at a minimum of 15 miles from the end of the runway when the intercept angle is 90 degrees.

4. When the localizer needle on the course indicator starts a steady movement toward center (between one and two dots needle deflection), depress localizer button on approach coupler controller. The indicator light will come on when the approach coupler is engaged. Maintain altitude during turn-on and until glide path is intercepted, by introducing necessary pitch corrections using pitch trim wheels on flight controller.

Note

When the airplane rolls into a bank during automatic turn-on to the localizer, the nose will drop. Introduce nose-up trim by using pitch trim wheels on flight controller to hold level flight. When the airplane rolls out of a bank on the localizer beam, the airplane will climb. Introduce nose-down trim in the same manner to hold level flight.

5. After airplane has automatically turned and is stabilized on center of beam heading (vertical needle centered), and before glide path needle starts its downward movement, lower landing gear and flaps (below 185 knots IAS) and extend speed brakes as desired.

Note

- When flaps are lowered, the airplane will start to climb immediately. Introduce nose-down trim, using pitch trim wheels and flight controller to hold level flight.
- A more stable glide path control is obtained if full flaps are used.

6. Reduce and stabilize airspeed to 160 knots IAS before intercepting glide path. Power settings should be the same as for a normal approach pattern.

7. When glide slope needle on course indicator reaches mid-position, depress glide path button. The indicator light will come on when approach coupler is engaged.

Note

It is permissible to use the pitch trim wheels to assist the approach coupler if it should be necessary to correct for a large glide slope error signal in a relatively short time.

8. During descent on glide path, changes in airspeed, power, and configuration should be held at a minimum to minimize deviations from glide path beam.

9. Automatic pilot pitch trim indicator may be checked for proper alignment. This allows the pilot to anticipate an airplane out-of-trim condition upon disengagement of the automatic pilot, should the automatic pitch trim not function correctly.

10. Just before touchdown, or sooner if desired, squeeze automatic pilot override switch on control stick (disengaging automatic pilot and automatic approach coupler) and complete landing manually.

CAUTION

When automatic pilot is being disengaged, hold control stick firmly to prevent any abrupt maneuver that may occur should the automatic pilot not function properly.

Note

- If it is necessary for an automatic go-around, the automatic approach coupler may be disengaged from the automatic pilot by lifting the automatic pilot turn knob in the detent position and dropping it again. This leaves the automatic pilot in control, and a go-around may be made on automatic pilot. If a manual go-around is desired, squeeze automatic pilot override switch on control stick or turn engaging switch on automatic pilot to OFF to remove both automatic approach coupler and automatic pilot from control of airplane.
- Complete failure of instrument approach equipment will cause the airplane to continue at the attitude previously maintained at time of equipment failure.

AUTOMATIC PILOT EMERGENCY OPERATION.

In any emergency, the automatic pilot may be disengaged by either the control stick release switch or the flight controller. If the switches do not function, electrical power to the system may be removed by moving the autopilot power switch from ON to OFF. The switch is on the right console. (See 5, figure 1-7.) The autopilot can be overpowered when engaged, and the stick forces will not be excessively high. Rudder forces, however, may require maximum pilot effort.

AUTOMATIC PILOT EMERGENCY DISCONNECT.

Binding and/or jerky control operation can be caused by malfunction of either the flight control system or the autopilot system. It is possible for the autopilot system to become partially engaged with the flight controller switch in the OFF position. Therefore, to eliminate the possibility of autopilot system malfunction when abnormal control operation occurs, one of the following actions, listed in order of preference, should be taken:

1. Place autopilot master switch at OFF.
2. Pull autopilot circuit breaker on left circuit-breaker panel.
3. Remove autopilot ac fuse on left fuse panel.

NAVIGATION EQUIPMENT.

STAND-BY COMPASS.

Refer to "Instruments" in Section I.

DIRECTIONAL INDICATOR (SLAVED).

The directional indicator (slaved gyro magnetic compass) (11, figure 1-5) is basically a directional gyro that is automatically kept on the magnetic heading of the airplane by a flux valve in the left wing, inboard of the tip. The flux valve "senses" the south-north flow of the earth's magnetic flux and shows magnetic heading without northerly turning error, oscillation, or swinging. Errors will result in the J-2 compass during turns, banks, or rolls, and the fast-slaving switch may be actuated after the maneuvers are completed so as to correct the heading indication at the fastest possible rate. Electrical power for the directional indicator is provided only when dc power and 400-cycle, three phase ac power is available.

Note

Should either the ac or the dc power supply fail, the directional indicator system is automatically disconnected from all electrical power.

The gyro is energized when external power or generator power is applied to the airplane, and is on a fast-slaving cycle for the first 2 to 3 minutes of operation, during which it should align with the magnetic heading. The gyro then begins a slow slaving cycle. A switch is provided to energize the fast slaving circuit for faster recovery during flight.

Note

After the gyro reaches operating speed, the needle should be checked against the stand-by compass indication to make sure it does not show a 180-degree ambiguity. If such ambiguity exists, the directional indicator is not operating properly.

A knob on the lower left of the directional indicator permits the compass card to be rotated to a preselected heading. Indicator readings will be incorrect if the airplane exceeds 85 degrees of climb or dive or if it banks left or right more than 85 degrees.

Directional Indicator Fast-Slaving Switch.

A fast-slaving cycle of the directional indicator can be selected by means of a three-position switch (3, figure 1-5) on the top left of the instrument panel. The three positions are marked FAST SLAVE, NORMAL and DESLAVE. Momentary actuation of the switch in the FAST SLAVE position interrupts dc power to the slaved gyro. This power interruption automatically de-energizes the slow-slaving cycle and engages the fast-slaving cycle, as during an initial start, permitting faster gyro recovery to the true heading.

CAUTION

Do not hold switch in the FAST SLAVE position over 2 seconds, and allow a minimum of 10 minutes before reslaving. Excessive use can damage the slaving torque motor.

When in DESLAVE position, the switch applies dc power to a relay in the amplifier unit to open the circuit that slaves the control gyro to the flux valve transmitter. This position is used in polar regions where the excessive dip in the earth's magnetic lines of force causes compass indications to become inaccurate. With the switch in DESLAVE position, the gyro compass system will be used as a directional gyro, and conventional procedures for making gyro drift corrections should be employed. Except for the special circumstances noted, the switch should always be in NORMAL position.

NAVIGATIONAL COMPUTER.

The navigational computer (8, figure 1-7) is a manually operated navigation device which allows the pilot to solve simple problems of time, rate, and distance, true airspeed and density altitude, and more complex problems involving wind angles and drift. The computer is 4 inches in diameter and is permanently mounted on a swivel arm above the cockpit right console. It consists of an inner and an outer stationary disk, and an intermediate movable disk. Graduations are cut into the disks, and values are determined by rotating the intermediate disk in a conventional manner. The computer is constructed in such a way that either side may be used (depending on the problem being solved); it is completely operable with one hand. When not in use, the computer can be stowed under the canopy sill.

ARMAMENT.

The airplane is equipped with a hydraulically operated rocket package containing twenty-four 2.75-inch rockets. The package is in the under portion of the fuselage and is automatically extended and retracted for rocket firing. The fire control computer automatically triggers the firing circuit, which lowers the rocket package, and then commences firing rockets. This sequence requires ½ second. Two-tenths of a second is required to fire 24 rockets, after which the package is retracted, in 3.3 seconds. Thus, the total firing sequence requires 4 seconds for a complete cycle. The entire rocket package can be jettisoned in an emergency. If any firing malfunction occurs, the package will remain extended and can be retracted in the air by the following method: place the armament master switch at FIRE 0, and the rocket package override switch at UP. The remaining rockets can be fired automatically or manually through the fire control system. For manual rocket firing, a NAFFARS (North American folding-fin aircraft rocket sight) lead-computing gyroscopic sighting system projects a fixed or moving reticle image onto the reflector glass for sighting purposes. This provides an alternate sight for use under visual attack conditions in case the E-4 fire control system should fail.

ARMAMENT CONTROLS.

Rocket-firing Switch.

A two-position rocket-firing switch is on the armament master control panel (figure 4-14) on the left console, aft of the throttle. Power for this switch is derived from the secondary bus. The switch has an AUTOMATIC position for automatic firing and a MANUAL position for manual firing.

Armament Master Switch.

A rotary, seven-position armament master switch is on the armament master control panel. (See figure 4-14.) The switch is powered from the secondary bus, except for the EMERG JET'SN position, which gets power directly from the battery. The switch positions are OFF, FIRE 0, FIRE 6, FIRE 12, FIRE 24, and EMERG JET'SN. Selection of FIRE 0 position allows the rocket package to cycle open and closed when the trigger is held depressed, if the weight of the airplane is not on the landing gear and if the rocket-firing switch is in MANUAL position. Turning the switch to rocket selector positions selects the number of rockets to be fired with one depression of the trigger. Raising the knob enables the switch to be turned to EMERG JET'SN. This action immediately jettisons the rocket package, if the weight of the airplane is not on the landing gear. The normal position for the armament master switch during take-off and landing is OFF.

WARNING

To prevent inadvertent release of drop tanks and/or rocket package, do not depress trigger when armament master switch is being moved.

Rocket-firing Trigger.

A trigger on the control stick (figure 1-19) has two stages of travel easily discernible through trigger feel. The first stage of trigger travel is not used. The second stage of trigger travel, or fully depressed trigger position, causes operation of the rocket package. For automatic rocket firing, the trigger is fully depressed at the first radarscope indication that 20 seconds or less remains until firing time. The trigger must be held down throughout the firing run until breakaway is displayed on the radarscope. Because of the possibility that some

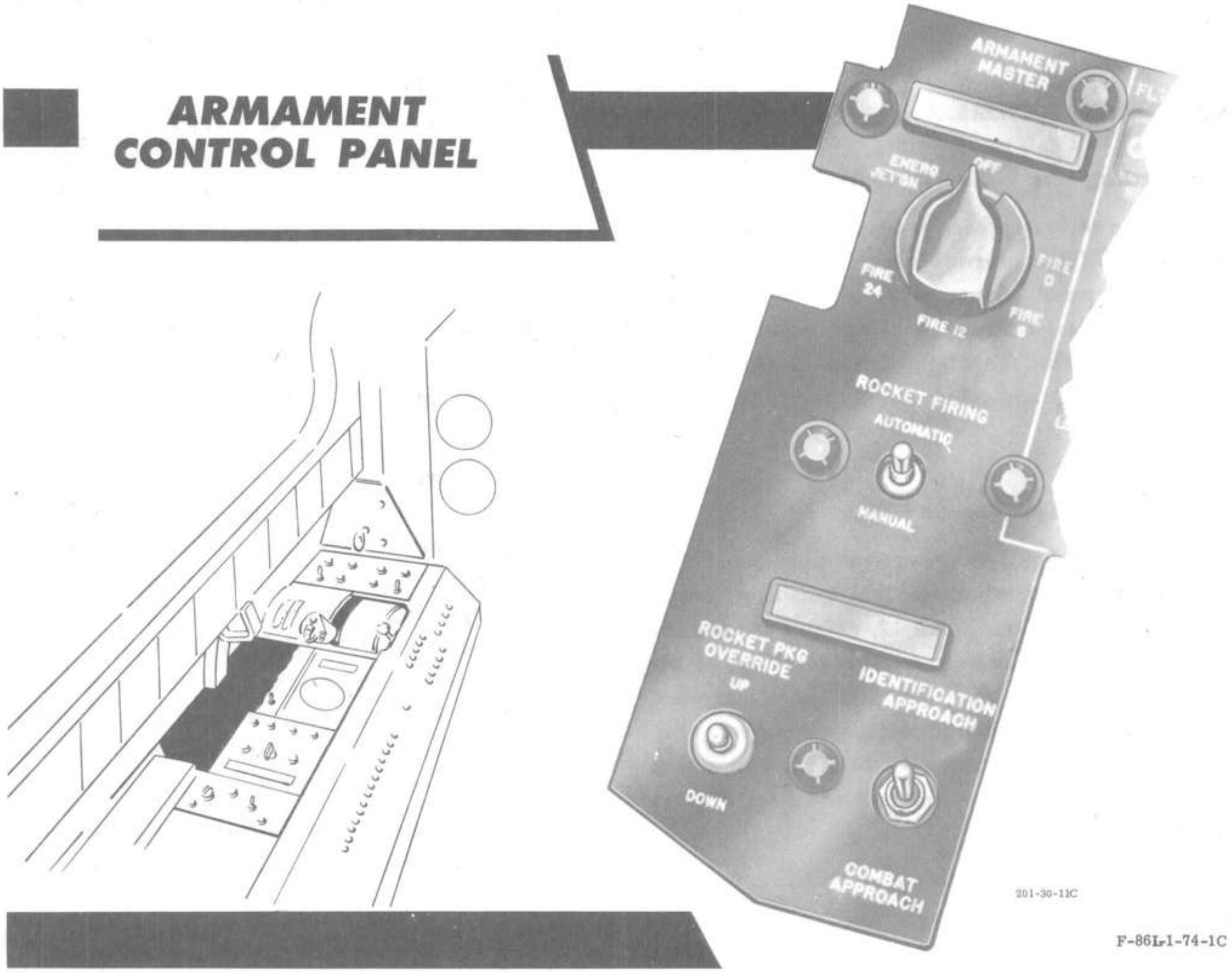


Figure 4-14

Tank-Rocket Jettison Button.

A tank-rocket jettison button is on the control stick. (See figure 1-19.) However, because the jettison-ready position is removed from the armament master switch, this button is not operable. The drop tank jettison button on the left instrument subpanel (figure 1-4) is for jettisoning the drop tanks and the emergency jettison position of the armament master switch is for jettisoning the rockets. The drop tanks can be released by pressing the drop tank release button or pulling the drop tank emergency jettison handle.

Rocket External Loading Switch.

A three-position rocket-ground-loading switch, powered by the secondary bus, is under an access door on the lower left side of the nose section, just aft of the nose gear. This switch has three positions: EXTEND, NORMAL, and RETRACT (spring-loaded from the RETRACT to the NORMAL position), and is used for ground operation of the rocket pod.

Rocket Pod External Jettisoning Switch.

A rocket pod external jettisoning switch, for releasing the rocket pod while the airplane is on the ground, is under an access door on the lower left side of the nose section, just aft of the nose gear. This switch is powered by the secondary bus and has two positions, NORMAL and JETTISON. The switch is guarded in the NORMAL position.

ARMAMENT INDICATORS.

Rocket-package-up Indicator Light.

Whenever the rocket package is up and locked, a green light forward of the override switch on the armament master control panel (figure 4-14) comes on, provided the armament master switch is at any position except OFF or EMERG JET'SN. This light derives its power from the secondary bus, and when lit, displays "ROCKET PACKAGE UP."

Hot-rocket-package Caution Light.

An amber caution light, on the caution light panel (figure 1-25), comes on whenever the armament master switch is placed at FIRE 6, FIRE 12, or FIRE 24 and the trigger is depressed. The light remains on if any of the selected rockets fail to fire. The light goes out when the armament master switch is placed at any other position than FIRE 6, FIRE 12, or FIRE 24. This indicator is powered from the secondary bus and when on, displays "ROCKET PACKAGE HOT."

(Deleted)

ARMAMENT INDICATOR LIGHT OPERATION.

Sequence of Operation.

The sequence of operation for the armament indicator lights during an automatic or manual rocket-firing mission is as follows:

a. When the armament master switch is set to select the number of rockets to be fired in a single salvo (i.e., FIRE 6, FIRE 12, or FIRE 24), the "ROCKET PACKAGE UP" light comes on. This indicates the package is fully retracted.

b. After the rocket-firing trigger switch is depressed manually or the trigger circuit is closed automatically, the rocket package is extended and the "ROCKET PACKAGE UP" light goes off; then the "ROCKET PACKAGE HOT" light and the "MASTER CAUTION" light come on.

c. The "ROCKET PACKAGE HOT" light and "MASTER CAUTION" light remain on until all of the selected rockets are fired. The package is then automatically retracted and the "ROCKET PACKAGE HOT" light and "MASTER CAUTION" light go out. When the package is fully retracted, the "ROCKET PACKAGE UP" light comes on again.

d. If any of the selected rockets fail to fire, the "ROCKET PACKAGE HOT" and "MASTER CAUTION" light remain on until the package is retracted manually.

ROCKET PACKAGE EMERGENCY OPERATION.

Hot-rocket Package.

If the amber hot-rocket-package caution light remains on after rockets are fired, indicating that one or more rockets have failed to fire and rocket package is still extended, either jettison rocket package or turn armament master switch to OFF and, after a safe interval (about 3 minutes), retract rocket package by moving rocket package override switch to UP. If the rocket package is manually retracted, the remaining rockets may be selected and fired by either procedure 1 or procedure 2; however, if the armament master switch has been turned OFF, any previously selected rockets cannot be fired.

1. Turn armament master switch to previously set position and pull trigger once for each remaining group of rockets.

2. Turn armament master switch to FIRE 24 position and squeeze trigger once, thereby salvoing all remaining rockets.

3. If, after completion of step 1 or 2, hot-rocket-package warning light is still on, jettison or retract package as described.

Rockets Fail to Fire.

Before any rocket-firing run, check that all respective circuit breakers are fully pushed in to ensure correct rocket-firing operations. If the rockets fail to fire on a rocket-firing run, do not push the circuit breakers in until a safe area of the firing range is reached because the package may extend and fire rockets when the circuit breaker is pushed in. Turn the armament master switch to FIRE 0 before pushing in the rocket-fire and rocket-package circuit breakers.

Jettisoning Rocket Package.

To jettison rocket package, turn armament master switch to EMERG JET'SN.

E-4 Test Switch.

An E-4 test switch (20, figure 1-6), in the cockpit, permits in-flight or ground operational check of the E-4 fire control system attack presentation. This switch permits checks to determine if certain malfunctions exist which could place the airplane on a collision course. The switch is a guarded two-position, TEST and OPERATE, switch located on the aft end of the left circuit-breaker panel.

FIRE CONTROL SYSTEM.

An all-weather rocket-firing control system is incorporated to provide position information that enables the pilot to locate an air-borne target, maneuver the airplane to launch an attack, and accurately fire rockets. The electronic fire control system operates automatically to fire rockets at the proper release point while the trigger is held depressed and if the rocket-firing switch is in AUTOMATIC position. However, a selected number of rockets (6, 12, or 24) may be fired manually by momentarily depressing the trigger for each firing cycle. The radarscope (flight indicator) (32, figure 1-5), in the center of the instrument panel, furnishes the pilot with a visual presentation of the interception. Because of the classified nature of this equipment, only elementary information on it is supplied in this publication. In case the electronic rocket-firing control systems fails, the stand-by sight can be used. [Refer to "NAFFARS (Stand-by Sight") in this section.] A radarscope camera connector plug is installed just above the lower edge and behind the right side of the instrument panel. A decal, "RADARSCOPE CAMERA CONNECTOR," next to the plug also identifies it. A radarscope camera may be installed. The purpose of this camera is to record the attack phase of the rocket-firing mission and to provide a visual record for study as a training aid. An elevation bias in the fire control system computer on some airplanes precludes the possibility of scoring hits on target aircraft during training missions. A placard mounted on the forward instrument panel reads: "THIS AIRCRAFT IS EQUIPPED WITH ELEVATION BIAS INCORPORATED IN THE FIRE CONTROL SYSTEM." On airplanes delivered with the elevation bias in the fire control system computer connected in the combat position, the placard reads: "THE FIRE CONTROL COMPUTER IN THIS AIRPLANE IS CONNECTED FOR COMBAT USE." The fire control system should be checked each time a replacement is made, to determine whether elevation bias is in or out, and whether the placard is installed accordingly. A magnetic tape recorder (NADAR) is installed in conjunction with the E-4 fire control system. This unit automatically records the attack phase of the intercept from lock-on to pull-out. The tape recordings are reproducible after each flight or as necessary for the purpose of studying pilot technique as a training aid. The recorder is mounted in the aft end of the canopy. On airplanes changed by T.O. 1F-86-549, a switch has been added on the right console that permits pilot control of the NADAR (radarscope) recorder. It permits full use of the recorder throughout the complete attack phase, if the pilot so desires. The switch has three positions: START, STOP, and AUTO. The switch is powered by the secondary bus.

RADAR AND ROCKET-FIRING SYSTEM CONTROLS.

A radar power control panel is forward of the throttle. The scope presentation intensity control panel is on the lower left of the instrument panel, and the antenna hand control is aft of the throttle. (See figure 4-15.) The E-4 system is powered from monitored bus No. 3, and depends upon availability of ac power.

Radar Control Panel.

Master Power Switch. The master power switch, on the radar control panel (figure 4-15), is a rotary-type switch that controls electrical power to the fire control system. It has four positions: DISCONN, STBY, OPER, and EMER. The DISCONN position is used only when it is desired to disconnect power to the system or in case of a failure or malfunction. To select the DISCONN position, the pilot must raise the switch; this releases a lock and enables the switch to rotate. With the switch in the STBY position, power is applied to the system to allow for a warm-up period of about 4½ minutes before the switch is positioned at OPER. It also offers a means of discontinuing operation while the system remains in a stand-by condition for immediate use. The OPER position permits system operation after a protective time delay of about 4½ minutes or immediately if the switch has been in STBY for a minimum of 4½ minutes. The switch may be positioned directly to OPER; however, the system is still protected by the time delay.

Note

Provisions have been made to energize the erection rate relay two minutes after the master switch has been placed in STBY or OPER, thereby ensuring that the roll and pitch control will be uncaged and in the proper position before the airplane is air-borne.

The EMER position is used only for an emergency situation that requires immediate use of the radar without benefit of the warm-up time delay. To select the EMER position, it is necessary to raise the switch; this releases a lock and allows the switch to rotate. The EMER position of the master power switch places the equipment in emergency operation about 45 seconds after the system is turned on.

allows the switch to rotate. The EMER position of the master power switch places the equipment in emergency operation about 45 seconds after the system is turned on.

CAUTION

- Do not use EMER position of master power switch except in emergencies. Indiscriminate use of the EMER position to shorten the normal 4½-minute delay period will probably damage units of the system.
- A 2-minute warm-up period is required before taxi or take-off, to permit the radar gyro to acquire enough speed to prevent damage to the suspension points. However, the 4½ minute warm-up (computer light on) is required before the system is fully operational.
- The DISCONN position should not be used while the airplane is performing flight maneuvers or landing, unless 3½ minutes is allowed in level flight for the roll-and-pitch gyro to come to a stop, thus preventing damage to the suspension points.

Elevation Scan Switch. The "EL SCAN" switch of the E-4 fire control system provides means for tilting the antenna radiation pattern up or down. This rotary-type switch, on the radar control panel (figure 4-15), is continuous from UP to DOWN, with a detent in the HORIZON position. During search operation with the switch in the HORIZON position, the antenna sweeps an area covering about 3 degrees above and 3 degrees below the horizon. During ground map and beacon interrogation with the switch set at HORIZON, the antenna sweeps an area about 6 degrees in height, centered 6 degrees below the horizon. When the switch is in the UP position with the airplane in level flight, the upper sweep of the antenna is 33.5 degrees above the center of the scan beam; with the switch in the DOWN position, the lower sweep of the antenna is 13.5 degrees below the center of the scan beam. The UP and DOWN positions of the "EL SCAN" switch provide variable, rather than preset, scanning positions. Rotation of the switch adjusts the scanning area to the elevation desired for best coverage.

Azimuth Scan Switch. The E-4 fire control system "AZ SCAN" switch, to the right of the "EL SCAN" switch on the radar control panel (figure 4-15), is a four-position rotary switch, labeled "NARROW," "BROAD," "LEFT," and "RIGHT." It provides a maximum radar azimuth coverage of 68.5 degrees left and right of center in the BROAD position and a minimum of 41 degrees left and right of center in the NARROW position. Selection of the LEFT position gives an azimuth coverage of 68.5 degrees left and 11 degrees right. With the switch in the RIGHT position, the antenna sweeps an area of 68.5 degrees right and 11 degrees left. When the "AZ SCAN" switch is placed in the BROAD position, the antenna completes one scan pattern cycle in about 3½ seconds. With the switch in either of the three other positions, a scan pattern cycle is completed in about 2 seconds. When the elevation and azimuth controls are used correctly, the antenna will search any area in front of the airplane, above and below the horizon.

Operation Switch. Three operational modes are initiated with the four-position rotary "OPERATION" switch on the radar control panel (figure 4-15), to the right of the azimuth scan control. The positions for the three modes are SEARCH, GROUND MAP, and BEACON. In the search mode, a choice of two presentations is offered, LONG PULSE or SHORT PULSE. When the switch is in the LONG PULSE position, maximum power is used over a longer period to give maximum target detection ranges up to 30 nautical miles; the SHORT PULSE position provides a short pulse of higher pulse-repetition frequency for better echo returns at short range. With the switch in the GROUND MAP position, the antenna searches the terrain below and ahead of the airplane to a maximum range of 200 nautical miles. With the switch in the BEACON position, radar beacon code numbers appear on the scope as a series of horizontal bars positioned to show relative range and bearing. These assist the pilot in locating and identifying his position with respect to the beacon station. The beacon mode also has a maximum range of 200 nautical miles.

Scale Illumination Switch. The scale illumination switch, on the radar control panel (figure 4-15), has HIGH, LOW, and MED positions. It controls the intensity of the lights illuminating the scales on the radarscope.

Beacon and Ground Map Expand Control Knob. The "BCN & GROUND MAP EXPAND" control knob is on the radar control panel. (See figure 4-15.) During ground map operation, depressing the switch permits expansion of any 20-mile zone of the range sweep trace selected by the pilot to cover the entire scope display. This allows a more detailed presentation. During beacon operation, positioning the range marker strobe just below the lowest marker of the beacon return signal and depressing the "BCN & GROUND MAP EXPAND" knob, causes the beacon indications to be expanded, and the coding can be more easily interpreted.

Anti-jam Switch. Operation of the anti-jam pushbutton switch, on the radar control panel (figure 4-15), varies the frequency of the radar transmitter-receiver to counteract jamming or other interference.

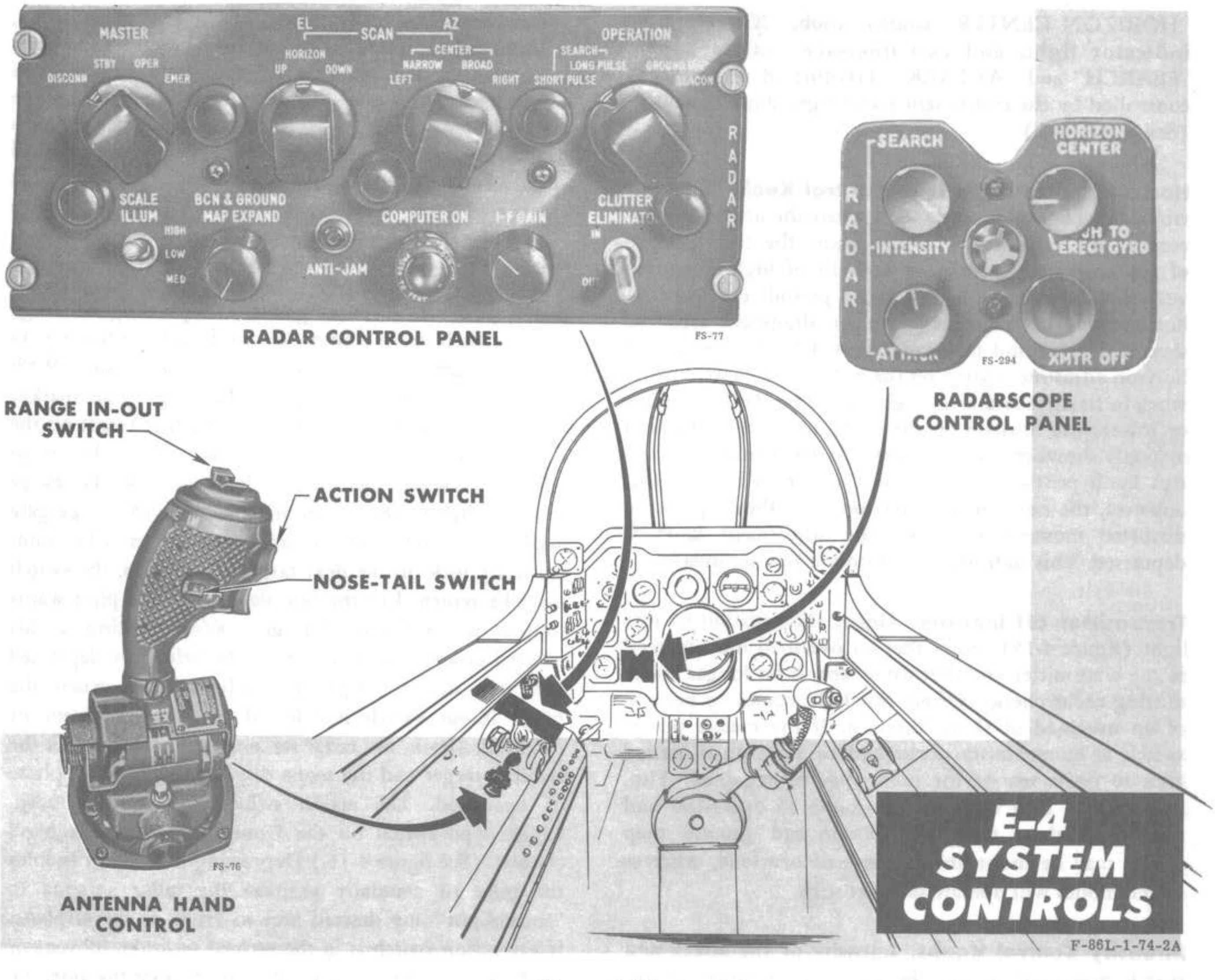


Figure 4-15

The switch is operative only in systems employing a radar transmitter-receiver with a tunable magnetron. To operate, hold button depressed until jamming is eliminated.

Computer-on Light. A computer-on light (figure 4-15) is installed on the radar control panel to the right of the anti-jam switch. The light shows when the computer is operating. The computer-on light comes on after the 4½-minute warm-up delay.

Note

> The computer is reliable only after the computer-on light comes on (approximately 4½ minutes). During extreme cold weather, the warm-up time increases.

Intermediate Frequency (I-F) Gain Control Knob. This rotary-type control knob, on the radar control panel (figure 4-15), governs the amplification of signal returns by adjusting the sensitivity of the radar receiver. For fire control operation, the control should be turned to the full clockwise position. It may be necessary to adjust the control during search, ground map, and beacon operation, and in cases where jamming or clutter is evident. Small adjustments may provide a clearer presentation on the radarscope and eliminate inherent instability in the radar response from different reflecting surfaces.

Clutter Eliminator Switch. This two-position switch, with labeled positions "IN" and "OUT," is on the radar control panel. (See figure 4-15.) In automatic search operation, the "CLUTTER ELIMINATOR" switch may be used to eliminate long, formless trains of cloud, ground, or sea return echos to improve the radarscope presentation.

Radarscope Control Panel.

The radarscope control panel (figure 4-15) is on the lower left instrument panel. It is flush-mounted and has three control knobs and one indicator light. These are the

"HORIZON CENTER" control knob, "XMTR OFF" indicator light, and two intensity control knobs, "SEARCH" and "ATTACK." Lighting of this panel is controlled by the instrument panel light dimmer switch. (See figure 4-8.)

Horizon Center Gyro Erect Control Knob. This control knob (figure 4-15) is used when the artificial horizon on the radarscope fails to show the true attitude of the airplane. At times, as a result of high-G maneuvers that occur over a prolonged period, the artificial horizon on the scope develops an alignment error of several degrees and may be corrected by depressing the horizon adjustment knob on the radarscope control panel when in straight-and-level flight. Rotating the knob raises or lowers the horizon on the scope until the indication correctly shows the airplane attitude. Depressing the control knob provides fast erection of the roll and pitch; however, the horizon line may move off the scope or be distorted momentarily when the adjustment knob is depressed. This indication lasts only a few seconds.

Transmitter-off Indicator Light. Illumination of this light (figure 4-15) shows that an overload has occurred in the transmitter and that the system is no longer transmitting radar energy. Often, this light comes on because of an overload of short duration. If the master power switch is momentarily positioned to STBY, then turned back to OPER, use of the radar may be regained. Also, an overload may exist in one mode of operation and not in another; therefore, beacon and ground map modes may be inoperable because of overload, whereas search modes will operate satisfactorily.

Intensity Control Knobs. Intensity of the attack and search presentations may be varied by rotation of the "ATTACK" and "SEARCH" control knobs on the radarscope control panel. (See figure 4-15.) Rotation of the "SEARCH" control knob varies the contrast between the target presentation and the background; rotating the "ATTACK" control knob increases or decreases the intensity of the rest of the display on the radarscope.

Radar Antenna Hand Control.

The antenna hand control for the E-4 fire control system (figure 4-15), mounted aft of the throttle quadrant, is used when manual control of the radar antenna is desired. Antenna hand control movement has the same effect on antenna action as control stick movement does on airplane controls, forward-and-back action for vertical movement of the antenna and side-to-side action for lateral movement of the antenna. On the top of the control is a range in-out switch. The front part of the hand control incorporates an action switch for placing the antenna in manual search. When the antenna hand control is momentarily moved to the full aft position, a limit switch, in the base of the antenna hand control, returns the antenna to automatic search from either manual search or radar track operation. The range in-out switch provides the pilot with a means of positioning the range gate marker over the selected target on the range trace to effect a lock-on. The switch is a five-position, rocker-type switch, actuated by depressing with the left thumb. When the action switch on the front of the antenna hand control is depressed, the range gate marker (a small blip) appears at the 5-mile position on the range trace. Depressing the range in-out switch to the first or second detent position moves the range gate marker up or down the range trace. With the switch in the first detent, the range gate marker stops the radar set and locks it on the first target on the range trace that it comes to. If the radar locks on an undesired target, momentary depression of the range in-out switch to the second detent causes the range gate marker to jump past this undesired target. (To automatically lock on the next target it comes to, the switch must be returned to the first detent.) If the pilot wants to pass through several targets before locking on his selected target, the switch should be held fully depressed until the desired target is reached. Then, when the range in-out switch is released to the first detent or neutral position, the radar set automatically locks on the selected target and the scope displays the tracking phase of operation. The action switch is a spring-loaded, trigger-type switch on the front of the antenna hand control. (See figure 4-15.) Depressing this switch enables the pilot to manually position the radar antenna to "searchlight" any desired area in front of the airplane. If the action switch is in the normal position, movement of the antenna hand control has no effect on the antenna. Release of the action switch is necessary after range lock-on to get an attack presentation and a track lock-on. The switch labeled "NOSE-TAIL," is a two-position sliding switch operated by the thumb. This switch provides a method of segregating multiple targets when they appear on the scope as a single large blip. Sliding the switch forward to NOSE selects the nearest target, and the TAIL position selects the farthest target.

RADARSCOPE PRESENTATION.

Azimuth Scale.

Short vertical lines at the top and bottom of the scope face show 30-degree intervals on either side of center to +60 degrees and −60 degrees and provide azimuth reference (figure 4-16) during search display. The symbol "AZ" is engraved below the bottom series of lines at the zero degree or dead-ahead position. The azimuth scale is lighted during all modes of operation except automatic track.

RADARSCOPE DISPLAY

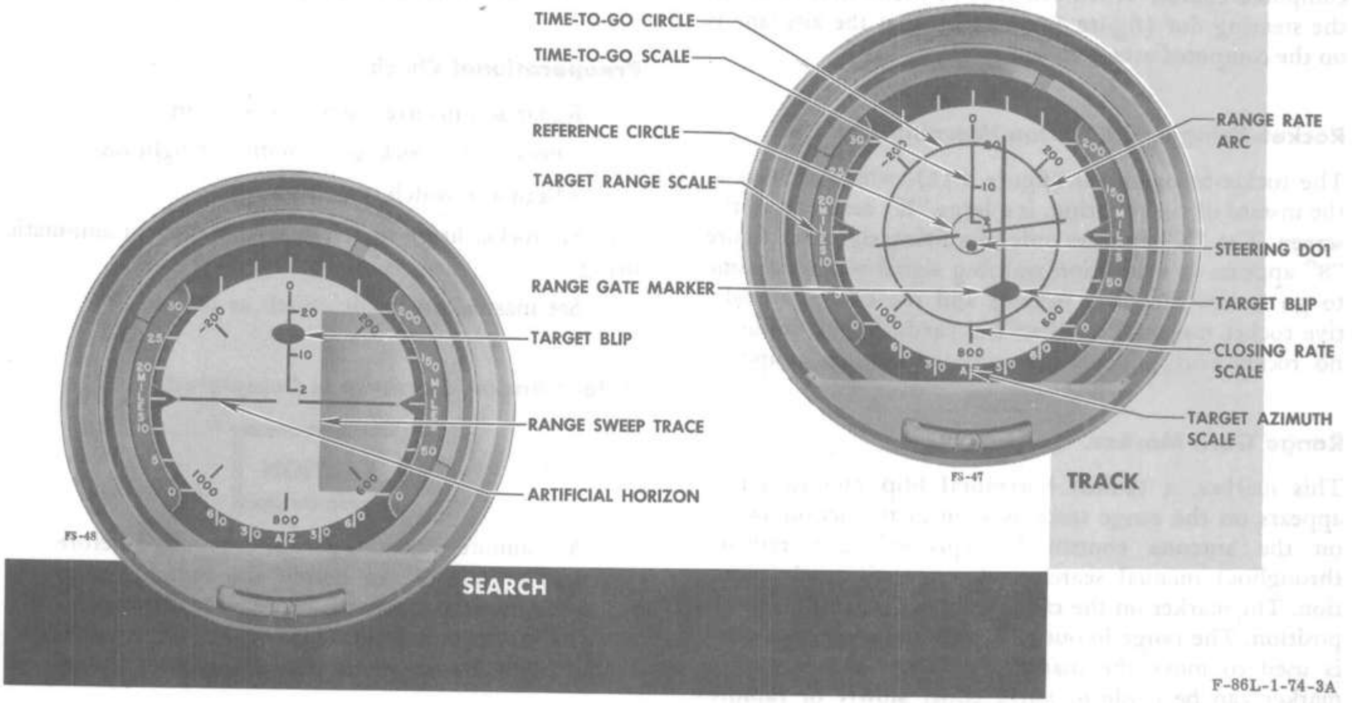


Figure 4-16

Range Scales.

These scales (figure 4-16) consist of short horizontal lines along the right and left edges of the scope and show the range of the search display in nautical miles. The left scale, used during automatic search, manual search, and automatic track, is calibrated in 5-nautical-mile intervals from zero to 30 miles maximum range. The right scale, used during beacon and ground map, is calibrated in 50-nautical-mile intervals from zero to 200 miles maximum range.

Artificial Horizon Reference.

There is a V-shaped mark (figure 4-16) at each side of the horizontal diameter of the tube face. These marks determine the roll and pitch attitude of the artificial horizon during flight.

Time-to-go Scale.

Illuminated during automatic track operation, this scale is calibrated at 2, 10, and 20 seconds on a vertical line extending upward above the center of the scope. The scale provides a time reference for the time-to-go circle (figure 4-16).

Range Rate Scale.

Closing rates on a target to a maximum of 1000 knots are calibrated from the 12 o'clock position in a clockwise direction. Opening rates to a maximum of 200 knots read in a counterclockwise direction and are provided by the range rate scale on the face of the scope. Closing and opening rates are read from the range rate arc in the time-to-go circle, as it closes toward the center of the scope (figure 4-16).

Range Rate Arc.

The range rate or relative speed between interceptor and target is shown by a small blanked segment (figure 4-16) of the time-to-go circle. Closing or opening range rates may be read directly from the range rate scale. With a zero range rate, the segment is at the 12 o'clock position.

Reference Circle.

The reference circle (figure 4-16) is a circular trace centered in the attack display. Basically it serves as the position reference for the steering dot. It also shows the particular phase of automatic track in which the system is operating. In Phase I, the reference circle has a diameter of one inch. In Phase II, the diameter is ¼ inch. At the start of Phase III, the circle collapses to a ¼-inch horizontal line.

Steering Dot.

A bright spot on the scope display is the primary reference for pilot guidance. It is displaced from the center of the reference circle during the attack display in proportion to the angle that the airplane deviates from the computed course. When centered in the reference circle, the steering dot (figure 4-16) shows that the airplane is on the computed attack course.

Rocket-firing and Collision Warning Signals.

The rocket-firing signal (figure 4-17), which appears at the instant of rocket firing, is a large "X" centered on the screen. The "X" appears only as a firing signal. A figure "8" appears as a collision warning signal when the time to go is less than 4½ seconds and the computed relative rocket travel is less than 260 yards. In this instance, no rocket-firing signals are initiated by the computer.

Range Gate Marker.

This marker, a ⅛-inch horizontal blip (figure 4-16), appears on the range trace as soon as the action switch on the antenna control is depressed, and remains throughout manual search and automatic track operation. The marker on the range trace is first at the 10-mile position. The range in-out switch on the antenna control is used to move the marker in or out in range. The marker can be made to move either slowly or rapidly, depending upon whether the switch is partially depressed or fully depressed. When the range gate marker is moved to coincide with the target blip and then the action trigger released, the automatic track display appears.

NORMAL OPERATION OF E-4 FIRE CONTROL SYSTEM.

WARNING

Radar ground checks must not be made within 50 feet of operations involving fuel or other flammable liquids. Tests indicate that electrical energy from radar equipment may ground through steel tools, common pencils, etc, causing ignition of fuel vapors.

Note

- Radar tracking and rocket firing should be accomplished at speeds above .78 Mach number to ensure accurate fire control system computing. At speeds below .78 Mach number, the angle-of-attack output for the computer becomes fixed and therefore does not give accurate elevation steering information.
- If an attack presentation on the radarscope is to be obtained, the rocket-firing switch on the armament control panel must be in the AUTOMATIC position.
- Rockets cannot be fired if the nose gear and nose gear doors are not up and locked or if the rocket package is not fully extended.

Preoperational Check.

1. Radar and inverter circuit breakers in.
2. Check rocket-package-up indicator light on.
3. Alternator switch ON.
4. Set rocket-firing switch to AUTOMATIC for automatic firing.
5. Set master armament switch as desired.

Before Radar Warm-up Is Completed.

CAUTION

A 2-minute warm-up period is required before taxi or take-off, to permit the radar gyro to acquire enough speed to prevent damage to the suspension points. However, 4½ minutes is necessary before the set is fully operational.

1. Set master power switch to STBY.
2. Set elevation scan switch to HORIZON.
3. Set azimuth scan switch to BROAD.
4. Set operation switch to SHORT PULSE.
5. Set clutter eliminator switch to OUT.
6. Turn I-F gain control knob fully clockwise.
7. Set scale illumination switch as desired.
8. Depress transmitter-off indicator light to check bulb.

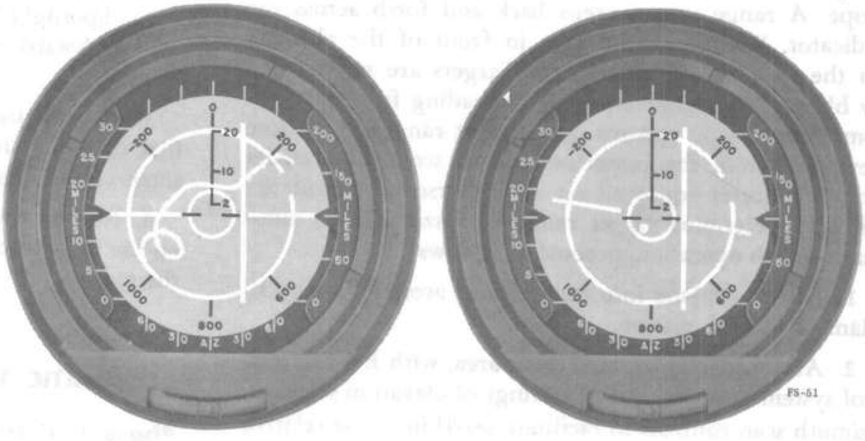
After Warm-up Is Completed.

1. Set master power switch to OPER.
2. Observe appearance of range sweep trace and artificial horizon.
3. Turn I-F gain control knob fully counterclockwise.
4. Reduce search intensity until range sweep trace is just barely visible.
5. Restore I-F gain; turn I-F gain control knob fully clockwise.
6. Reduce attack intensity for best legibility of artificial horizon.
7. Yaw damper switch ON.

AUTOMATIC SEARCH.

On the E-4 fire control system, during automatic search, the antenna automatically scans any one of several sectors ahead of the airplane in a rectangular scan pattern,

RADARSCOPE ATTACK DISPLAY



1 LOCK-ON ATTACK HAS BEGUN. **2** CORRECT TO CENTER STEERING DOT.

3 20 SECONDS TO GO **4** 10 SECONDS TO GO **5** 4-1/2 SECONDS TO GO PHASE III

6 MAINTAIN LEVEL FLIGHT **7** RX FIRED SIGNAL—PULL-OUT **8** COLLISION WARNING SIGNAL

Figure 4-17

determined by the settings on the radar set controls. Target information is supplied to the pilot on the radarscope. A range trace sweeps back and forth across the indicator, "painting" the area in front of the airplane on the face of the radarscope. Targets are represented by blips whose relative positions, reading from the bottom of the scope upward, give target range, and whose deviation from the centerline of the scope give target azimuth. Scales engraved on the radarscope permit the pilot to determine target range and azimuth. In automatic search operation, proceed as follows:

1. Direct airplane into interception area, according to plans of tactical mission.

2. At approach of interception area, with E-4 fire control system installed, adjust settings of elevation scan and azimuth scan controls to facilitate searching zone relative to anticipated position of target.

Note

If approximate altitude of target is unknown, use azimuth scan and elevation scan controls to the fullest extent on E-4 fire control system to obtain maximum space coverage. When target is detected, adjust elevation scan control for desired elevation angle.

3. Watch search display on radarscope as target range approaches 15 miles. The target will appear as a bright blip.

4. Monitor target position closely to determine range and azimuth data.

5. To place system in manual search in preparation for lock-on, depress action switch on antenna hand control.

MANUAL SEARCH.

After the pilot selects a target, he takes over manual control of the antenna by depressing the action switch on the front of the antenna hand control. He then manipulates this control to place the range sweep trace over the blip representing the target he has selected. The range-gate marker, which normally appears at the 10-mile mark on the range sweep trace, is then moved up or down on the range sweep trace by the left or right side of the range in-out switch. When the range-gate marker, on the E-4 fire control system, is moved to cover the target blip on the scope, the radar automatically locks on the target selected; when the action switch is released, the radar goes into automatic track operation. In manual search operation, proceed as follows:

1. While squeezing the action switch, manipulate antenna hand control so that position of range-sweep trace on radarscope indicator coincides with azimuth position of target.

2. "Spotlight" target by moving antenna hand control backward and forward until target blip appears brightest.

3. Depress IN or OUT side of range in-out switch to first detent position to move range-gate marker to indicated target range.

4. Release action switch. The attack display will appear on the radarscope; then the radar will automatically track the target.

AUTOMATIC TRACK.

Phase I. Phase I of the automatic track operation is that part of the attack operation from lock-on until 20 seconds to go. Phase I enables the pilot to make the maneuvers necessary to bring the airplane onto the lead-collision course. Only approximate steering is necessary, and the pilot need only keep the steering dot within the one-inch reference circle. If extreme maneuvers are called for, they should be made in Phase I and performed as easily as possible.

Phase II. The beginning of Phase II is defined as 20 seconds to go, the time at which the time-to-go circle begins to shrink. Phase II enables the pilot to perform the more precise steering that is necessary as the airplane approaches the target. During this phase, the pilot is required to steer so as to keep the steering dot centered within the ¼-inch reference circle.

Phase III. If the system goes into Phase III operation, the reference circle flattens into a ¼-inch horizontal line at 4½ seconds to go. Phase III enables the pilot to perform the most precise steering possible during the final stages of side attacks. Rocket firing and the appearance of the pull-out warning signal occur at the instant when there is the greatest probability of scoring a hit on the target. During Phase III, the time of firing depends essentially upon three factors: (1) the point of intersection of target and attacking aircraft paths; (2) the time until the target reaches the intersection; (3) the time required for the rockets to travel to the intersection. At 2½ seconds to go, the circuits in the firing section of the computer are readied, and when the computer calculates that the target and the rockets will arrive at the intersection simultaneously, electrical firing signals are initiated. Just before the firing signals, the computer initiates an electrical signal to lower the rocket pod. In Phase III, the computer compensates for an azimuth steering error by recalculation of the problem based on the new conditions brought about by the error. Azimuth excursion of the steering dot shows bank angle only; thus the pilot may concentrate on vertical steering and keeping the airplane wings level.

IDENTIFICATION-COMBAT APPROACH.

The identification-combat approach switch (figure 4-14) on the left console, permits selection of a normal E-4 combat approach or an identification approach. This switch is powered by the monitored bus No. 3. The IDENTIFICATION APPROACH position provides a modified E-4 radarscope presentation which allows for tracking and overtaking of the target for identification. If a lock-on has been obtained, the switch may be moved to either position without breaking the lock-on. The modified radarscope presentation displays the following features for the identification approach:

a. Closure rate—this is the value displayed by the range rate arc divided by 4. This equals the closure rate in knots (TAS).

b. Slant range—this is shown by a horizontal bar intersecting the central scale (time-to-go) for the range in 100's of yards.

c. Azimuth and elevation—the bearing of the unknown is shown by the position of the steering dot.

d. Artificial horizon—the true horizon is represented by two horizontal segments on either side of the radarscope center and is referenced by the displacement of these segments from the two side-mounted V-shaped marks.

When making an identification approach, the steering dot should be held to one side of the center of the scope so that the interceptor will not be drawn into a tail-chase position. Upon completion of the unknown identification, the switch may be placed in the COMBAT APPROACH position for continuation of the attack phase or for break-off in preparation for other search phases.

Typical Identification Approach.

After being directed to the target area by GCI and lock-on has been established, the identification-combat approach switch is placed at IDENTIFICATION APPROACH. Since the range rate arc just after lock-on may be greater than can be indicated on the scope (maximum rate of closure as shown on the scope is 300 knots at the 9 o'clock position), higher range rates may be obtained to help in speed control in the overtake by momentarily switching to the COMBAT APPROACH mode where the range rate scale is four times less sensitive (1200 knots at the 9 o'clock position). When lock-on is made, center the steering dot on the scope to fly a true pursuit course. Range separation should be about 4 miles before following the pursuit course, to eliminate an extended tail chase and excessive bank angles. (See figure 4-18 for a typical identification approach.)

Note

In the identification approach mode, the steering dot indicates target position only and not a computed course. Therefore, the dot has a much lower sensitivity than in the combat-approach mode.

As the interceptor approaches the target, the closure rate is shown by the location of the range rate arc in the time circle in much the same manner as in the attack phase, except that the closure rate shown must be divided by 4, i.e., if the range rate arc is at the 800-knot position (divide by 4) the closure rate is 200 knots (TAS). The closure rate may be controlled by the use of speed brakes and throttle for making identification passes on slower airplanes. The following speeds are recommended for closing rates:

RANGE TO TARGET	APPROXIMATE CLOSURE RATE
2000 yards	25 knots
1000 yards	15 knots
200 yards	0-10 knots

At a range of 2000 yards, displace the steering dot from the center of the scope up to the 200-yard range mark and an equal distance to the right or left of the center of the scope, depending on which side of the target the pass is made from (this will set the interceptor approximately 100 feet below and to the right or left of the target when it reaches minimum range).

WARNING

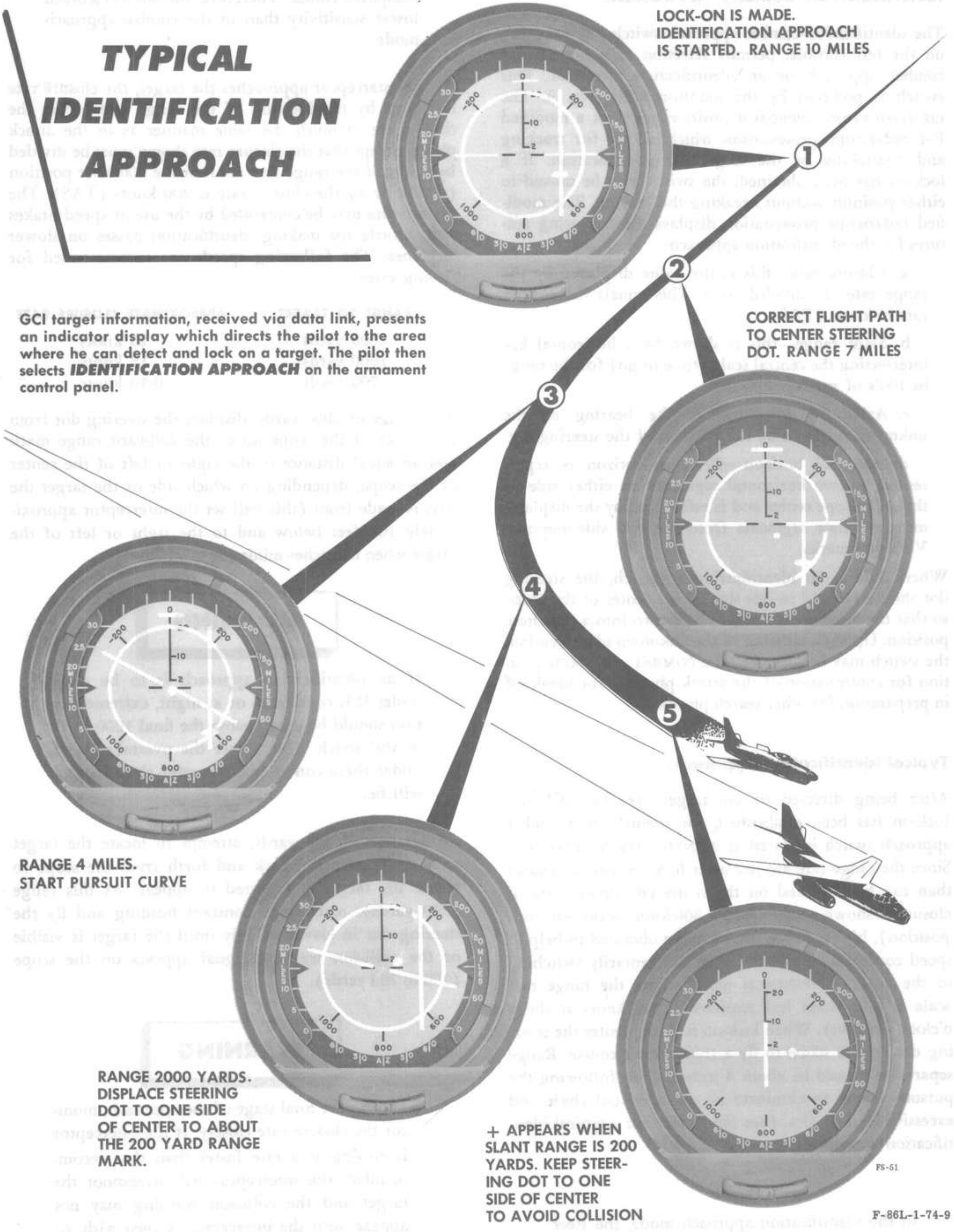
If an identification approach is to be made under IFR conditions or at night, extreme caution should be used during the final 1000 yards of the attack. The slower the overtake speed, under these conditions, the safer the approach will be.

At a range of 500 yards, attempt to locate the target visually by glancing back and forth from the scope to where the target is expected to appear. At this range (500 yards), maintain a constant heading and fly the steering dot in elevation only until the target is visible or the collision warning signal appears on the scope (200 to 260 yards).

WARNING

- During the final stage of the approach, monitor the closure rate closely. If the interceptor is closing at a rate faster than that recommended, the interceptor will overshoot the target and the collision warning may not appear until the interceptor is even with, or slightly ahead of the target depending on the

TYPICAL IDENTIFICATION APPROACH



LOCK-ON IS MADE. IDENTIFICATION APPROACH IS STARTED. RANGE 10 MILES

CORRECT FLIGHT PATH TO CENTER STEERING DOT. RANGE 7 MILES

GCI target information, received via data link, presents an indicator display which directs the pilot to the area where he can detect and lock on a target. The pilot then selects *IDENTIFICATION APPROACH* on the armament control panel.

RANGE 4 MILES. START PURSUIT CURVE

RANGE 2000 YARDS. DISPLACE STEERING DOT TO ONE SIDE OF CENTER TO ABOUT THE 200 YARD RANGE MARK.

+ APPEARS WHEN SLANT RANGE IS 200 YARDS. KEEP STEERING DOT TO ONE SIDE OF CENTER TO AVOID COLLISION

F-86L-1-74-9

Figure 4-18

speed of the interceptor. For this reason, be sure to displace the steering dot from the center of the scope at the 2000-yard range mark. At the 200-yard range, the steering dot should be positioned at the 30-40 degree azimuth mark to provide sufficient lateral clearance with the target.

- The target the radar set is locked on may be one of a group of targets flying in formation. Therefore, extreme caution should be exercised during the final stages of the approach.

If the target is not visible at a range of 200 yards, break off the identification pass or decrease range rate and fall back behind the target until conditions will allow a visual identification. The steering dot will continue to indicate target position after the collision warning signal appears. If the range between interceptor and target is increased after the collision warning signal appears, the system will continue tracking the target and the collision warning signal will disappear.

OPERATIONAL CHARACTERISTICS.

Certain characteristics of the fire control system have developed which should be explained, to enable the pilot to receive maximum benefit from this system.

Rocket Drop.

If the rockets are launched in a horizontal direction (angle of attack of zero degrees), they will drop a short distance because of gravity before hitting the target. The computer allows for this drop by computing an attack course which passes above the target path by the amount of the drop.

Angle of Attack.

If the rockets are launched in an upward direction (positive angle of attack), they will rise above the attack course before weather-cocking into the air stream. This effectively reduces the distance of rocket drop from airplane to target. The computer considers both factors and computes an attack course which passes above the target path by a distance less than the normal rocket drop.

Bank Angle.

The airplane wings should be within about 10 degrees of horizontal during Phase III. If they are not, the probability of scoring a hit is reduced. For example: if the airplane remains in a 30-degree bank during Phase III, the probability of scoring a hit is reduced about 25 percent.

Undesired Echoes.

At low altitudes over mountainous terrain or water, continuous undesired echoes known as ground clutter may produce images on the scope. These images may induce lock-on; however, they are generally extensive and diffused, making them readily identifiable.

Multiple Targets.

When a formation of two or more airplanes appears on the radarscope, the airplanes may appear as closely grouped blips or one large blip, depending on the tightness of the formation, so the problem of separating them into single targets becomes apparent. Single-target lock-on separation requires about 100 yards difference in the range of two targets at the same azimuth, or a 4-degree difference in azimuth of two targets at the same range. If an elongated blip representing two targets appears on the scope, it is possible to lock on one end of the elongated blip by moving the range sweep trace onto the extreme end of the blip desired, and then moving the range-gate marker into position on the trace. A lock-on should occur if the targets are more than 4 degrees apart in azimuth. If the two targets are so closely spaced that the radar cannot distinguish between them, the radar will lock on the two targets as one and continue to track both as long as they remain together. Should the targets separate enough, the radar will remain on one target, generally the larger of the two, or if they are of the same size, the lock-on occurs on the nearer target.

Altitude Mark.

Radar echoes from the ground appear on the scope as a narrow horizontal line, known as the altitude mark. When the distance from the interceptor to the target is equal to the distance from the interceptor to the ground, the echoes from the ground and the target appear at the same position on the scope display. When this happens, the radar can lock on either the target or the altitude mark. If the radar locks onto the altitude mark, the range circle closing rate segment goes to zero and the steering dot becomes erratic. The pilot must then maintain his course while he again locks his radar on the target. With a little experience, the pilot can anticipate the lock on the altitude mark and can quickly relock on the target by use of the range in-out switch alone after the target has passed through the altitude mark.

Attack Geometry.

The use of air-to-air rockets has permitted a change in the type of an attack employed by a fighter-type airplane. For the fighter equipped with guns, a curved pursuit course is used because the guns must be on target at least several seconds to ensure enough hits for a kill. The interceptor armed with rockets makes use of an essentially straight-line course, since the full armament load can be fired in roughly two tenths of a second. Thus, the interceptor flies a lead collision course which allows for distance of rocket travel relative to interceptor. The fire control system computer furnishes the necessary steering data for the pilot to fly this lead collision course and automatically fires the rockets at the split second required for a hit. The interceptor makes this straight-line run-in on target regardless of whether he is on a beam approach or stern approach. It is recommended that near-beam approaches be made and that GCI and the interceptor pilots train to this end. The beam attack provides the largest target profile, thus increasing the hit probability. Figure 4-19 illustrates a stern attack and a beam attack.

Distance of Closest Approach—During Attack.

In flying the lead collision course, it must be remembered that the interceptor is carrying the rockets to a firing point where the rockets will be fired on a true collision course with the target, thus allowing the rockets to travel several hundred yards ahead of the interceptor. This means that the target will cross in front of the interceptor at the time of impact. This distance of relative rocket run is about 500 yards. The actual clearance then depends on the relationship of the interceptor and target courses and the ratio of their respective speeds. Figure 4-20 assumes that the interceptor is making a 90-degree beam attack and the ratio of interceptor speed to the target speed is 3 to 1. The distance of closest approach is about 150 yards. This, of course, is true only when the interceptor continues on the attack course; if you break away at the firing signal, the interceptor will miss the target by a larger distance.

GROUND MAP OPERATION.

Ground map function may be used for navigation purposes by properly setting the switches on the radar control panel. (See figure 4-15.) During ground map operation, the antenna scans a selected area ahead of the airplane and projects the ground return on the radarscope. During ground map operation, range is shown on the right side of the scope from a distance of 0 to 200 nautical miles in front of the airplane. Any 20-mile sector of the scope presentation (beyond 5 miles) may be expanded for easier interpretation by use of the "BCN & GROUND MAP EXPAND" control knob. The strobe line on the scope, indicated by a marker on the range trace, should be moved up just below the area to be expanded, by rotation of the "BCN & GROUND MAP EXPAND" control knob. When the control knob is depressed, the 20-mile zone selected is expanded to cover the entire area of the scope.

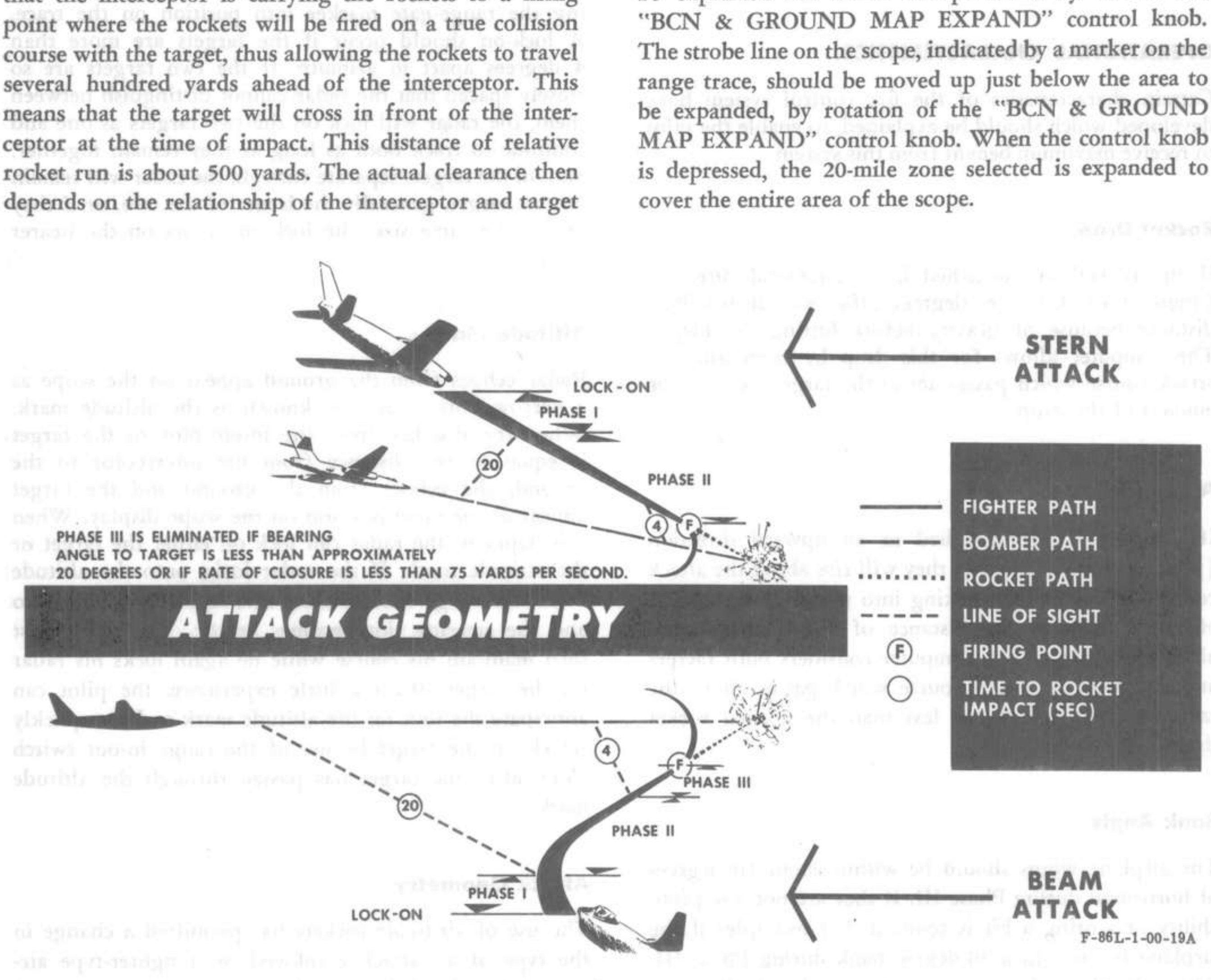
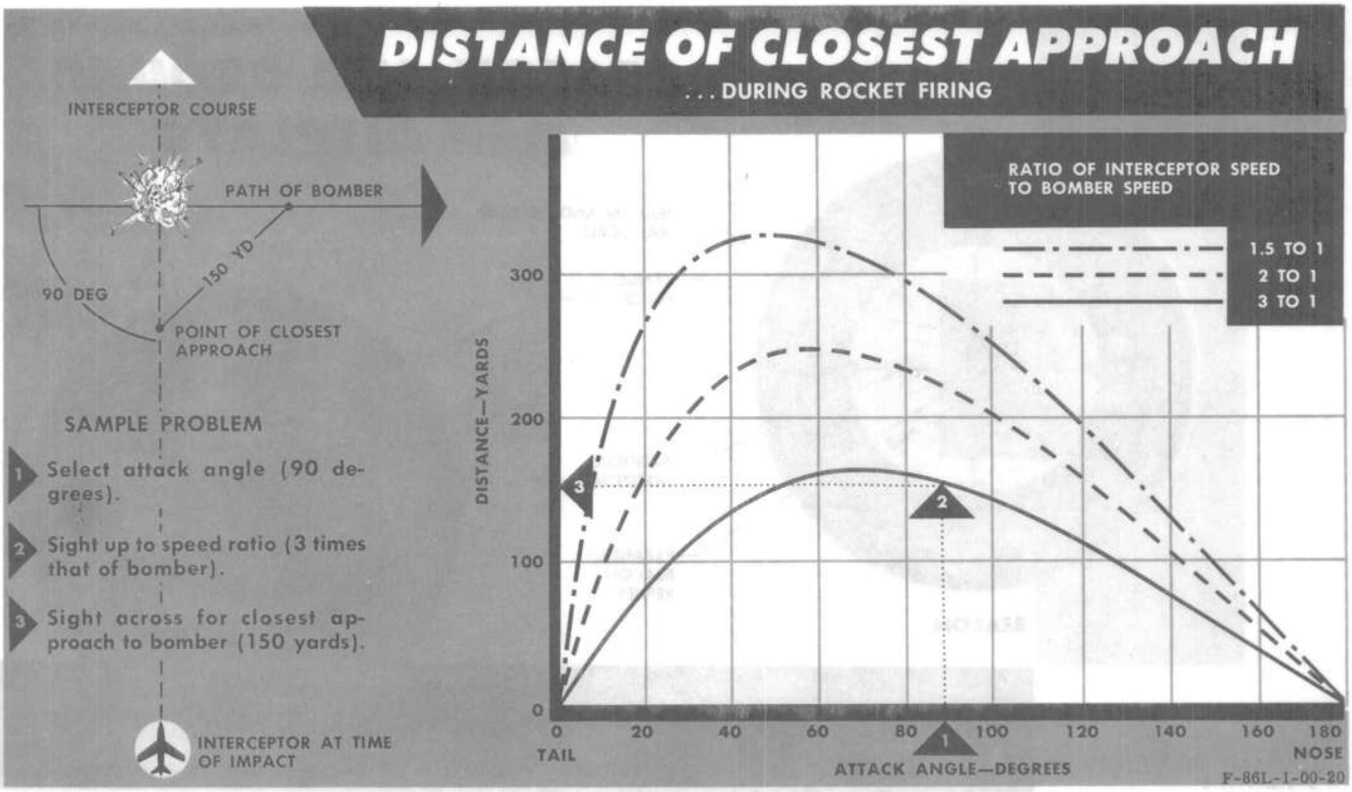


Figure 4-19



SAMPLE PROBLEM

1. Select attack angle (90 degrees).
2. Sight up to speed ratio (3 times that of bomber).
3. Sight across for closest approach to bomber (150 yards).

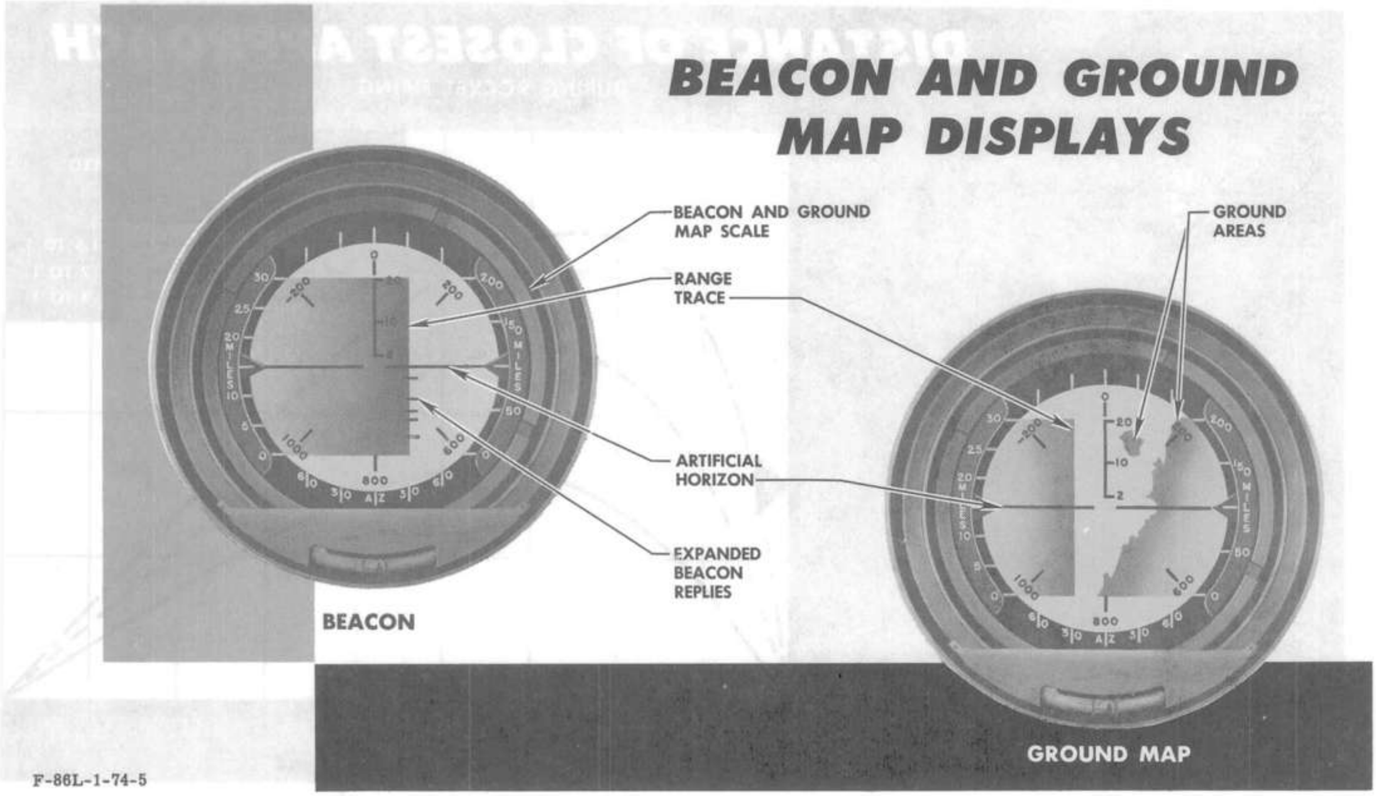
Figure 4-20

BEACON OPERATION.

With the controls on the radar control panel (figure 4-15) set for beacon operation, radar beacons may be used as an aid in navigation. Radar beacon signals appear on the radarscope indicator as short horizontal bars. Range to the station and azimuth location may be read from the scales on the right and bottom side of the indicator. The bottom bar represents the range to the station. The presentation may be expanded for easier operation by use of the "BCN & GROUND MAP EXPAND" control knob as in ground map operation. Depressing the knob with the strobe marker below the bottom mark of the beacon return will expand the bars for easier reading of the coded reply to identify the radar station.

AN/ARR-39 DATA LINK SYSTEM.

The data link system (figure 4-7) is a method of supplying search and attack data to the pilot from ground-controlled radar units. The entire system is powered from the monitored bus No. 3. The primary function is to put the interceptor in an attack position. The data is visually displayed to the pilot on the E-4 radarscope and the data link altitude-speed indicator mounted on the instrument panel. The data presented on the scope consists of command heading, attack heading, target range, target bearing, and time-to-go circle. The time-to-go circle is a circle about 3 inches in diameter and centered on the E-4 scope. The circle appears when the data link mode is selected and remains at maximum diameter until the time-to-go offset point is approximately equal to 20 minutes, at which time the diameter of the circle decreases until it disappears at the offset point. Command altitude and speed are presented on a data link altitude-speed indicator (38, figure 1-5). When the data link receives information from ground control, the white flag disappears from the face of the altitude-speed indicator; this flag reappears when ground control is no longer supplying information to the interceptor. The command heading is presented on the radarscope in the form of a steering dot which the pilot centers by steering the airplane into the dot. The steering dot moves across the scope in a horizontal plane but does not rise or lower from the artificial horizon. The steering dot should be kept in the center of the scope until the time-to-go circle also becomes a dot and disappears. The interceptor is now at a position called the "offset point." At this point, the steering dot normally jumps to one side of center. This indicates that it is time to turn onto the attack heading, which is done by again flying into the steering dot until it becomes centered in the scope. A circle about ⅞ inch in diameter, called the target marker circle, appears at one side of the scope at the beginning of the command heading presentation and remains on the scope until a lock-on is achieved by the E-4 system. This circle is for target reference in distance and azimuth relative to the interceptor. After turn to attack heading



BEACON AND GROUND MAP DISPLAYS

Figure 4-21

is made and at about a 10-mile target range, manually move range trace until it is superimposed upon target in center of ⅞-inch target marker circle; then move range gate up the trace until automatic lock-on is achieved. At this time, the data link automatically disconnects and an E-4 attack display is presented on the scope.

Data Link System Controls and Indicator.

The data link control panel, mounted on the right console, has four controls: a function switch, a channel selector, a subchannel selector, and a volume control. The power switch is a four-position, rotary control with OFF, STBY, PVT, and PARTY positions. The STBY position allows the equipment to warm up and be held in a stand-by condition until operation is desired. The PVT position allows only messages addressed to the particular airplane to be heard. PARTY position allows all messages, on the particular UHF channel selected, to be heard. The data link altitude-speed indicator (38, figure 1-5) is on the left side of the instrument panel. This instrument shows command altitude and airspeed change to be made to put the interceptor in an attack position. A white flag indicates when the data link is no longer receiving information.

Operation of AN/ARR-39 Data Link System.

1. Set function switch as desired.

Note

Before turning on the data link system, make sure the E-4 fire control system is turned on. This prevents an overvoltage condition in the data link power and receiver supply.

2. Set channel and subchannel selectors to channels prearranged with data link ground control.
3. Adjust volume as desired.
4. Continue flight by reference to visual data link radarscope display and command altitude and airspeed.

Note

- Upon completion of the attack, the data link will automatically be recoupled to the radarscope, and homing information may be presented.
- If data link switch is ON and alternator is not delivering normal output (engine not running at normal rpm), a thermal overload relay will remove dc power and cause the data link system to become inoperative after approximately 70 seconds. If this occurs, turn

data link switch OFF, then back to ON to recycle the relay and reapply dc voltage.

SHUTDOWN PROCEDURE.

For shutdown of fire control system, turn radar power and armament master switches OFF.

CAUTION

To avoid damage to the radar gyro, leave radar on or in stand-by until parked.

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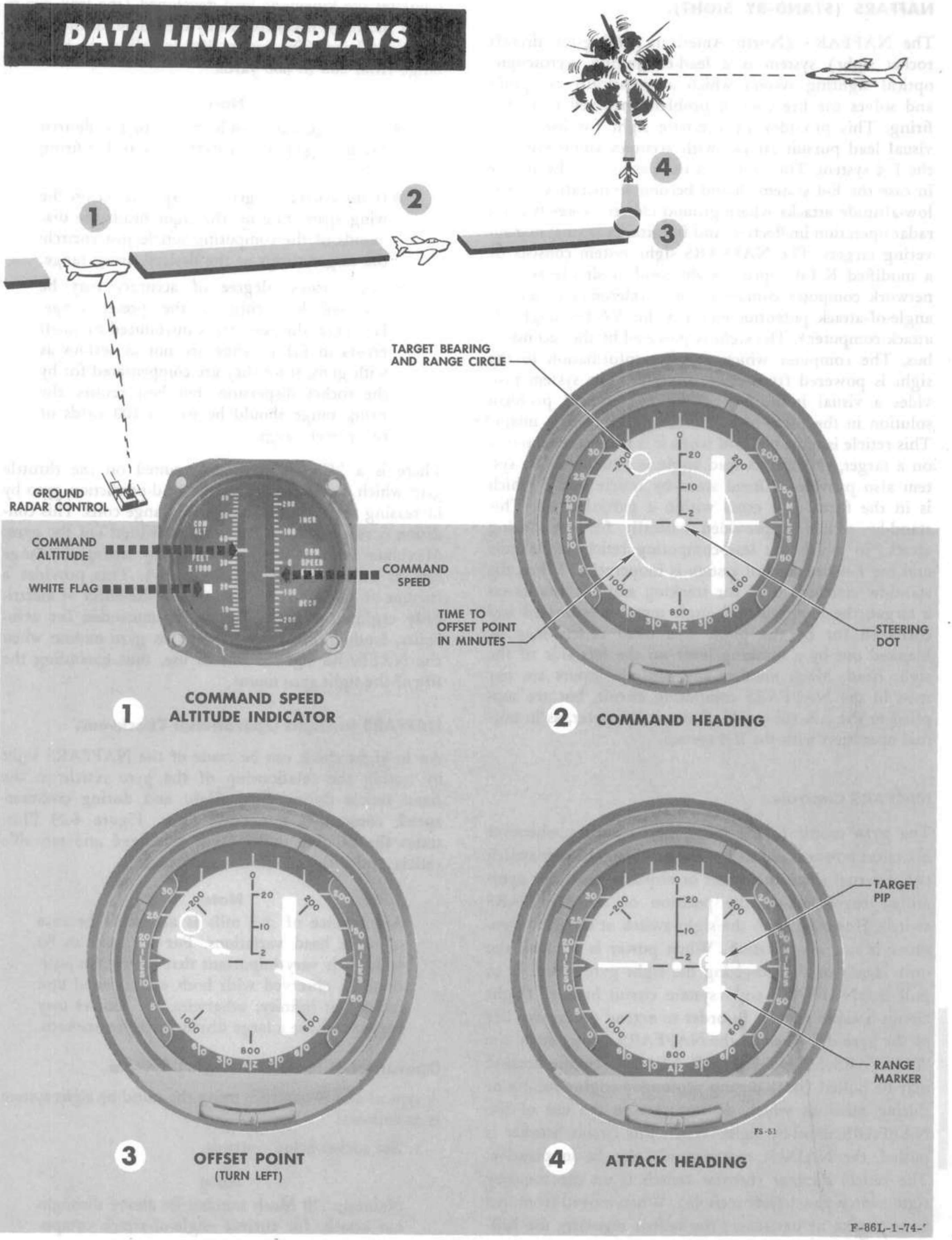
DATA LINK DISPLAYS
1
2
3
4
GROUND
RADAR CONTROL
TARGET BEARING
AND RANGE CIRCLE
COMMAND
ALTITUDE
WHITE FLAG
COMMAND
SPEED
TIME TO
OFFSET POINT
IN MINUTES
STEERING
DOT
TARGET
PIP
RANGE
MARKER
1 COMMAND SPEED
ALTITUDE INDICATOR
2 COMMAND HEADING
3 OFFSET POINT
(TURN LEFT)
4 ATTACK HEADING
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F-86L-1-74-

Figure 4-22

NAFFARS (STAND-BY SIGHT).

The NAFFARS (North American folding-fin aircraft rocket sight) system is a lead-computing, gyroscopic, optical sighting system which automatically computes and solves the fire control problem involved in rocket firing. This provides an alternate sight for use under visual lead pursuit attacks with accuracy comparable to the E-4 system. This system is used as a stand-by system in case the E-4 system should become inoperative or for low-altitude attacks where ground clutter makes the E-4 radar operation ineffective, and for attacks against maneuvering targets. The NAFFARS sight system consists of a modified K-14C optical sight head, a simple resistor network computer containing an accelerometer, and an angle-of-attack potentiometer (in the AA-106 angle-of-attack computer). The sight is powered by the secondary bus. The computer which supplies information to the sight is powered from either inverter. The system provides a visual indication of the fire control problem solution in the form of a lead-computing reticle image. This reticle is movable, and when it is held superimposed on a target, the correct lead angle is obtained. The system also provides a fixed stand-by reticle image which is in the form of a cross within a partial circle. This stand-by reticle is provided basically for use during attacks in which the lead-computing reticle circle fails and the E-4 fire control system is inoperative. When the stand-by reticle is used for tracking and for attacks on a target, the required lead angle must be estimated and corrected for by the pilot. The fixed reticle may be blanked out by a masking lever on the left side of the sight head. Mach number and altitude inputs are not used in the NAFFARS computing circuit, but are supplied to the AA-106 angle-of-attack computer, as in normal operation with the E-4 system.

NAFFARS Controls.

The gyro motor in the sight head operates whenever electrical power is applied to the airplane (battery switch ON, external electrical power or airplane generator operating) regardless of the position of the NAFFARS switch. However, with the sight switch at OFF, the computer is not in operation. When power is applied, the only means of de-energizing the sight gyro motor is to pull the NAFFARS sight system circuit breaker (right circuit-breaker panel). In order to extend the service life of the gyro drive belt of the NAFFARS sight system, the "NAFFARS SIGHT-NADAR START" circuit breaker may be pulled (out) during prolonged engine run-up or during missions which do not require the use of the NAFFARS stand-by sight. When this circuit breaker is pulled, the NADAR recorder will also be inoperative. The reticle dimmer rheostat switch is on the stand-by sight switch panel (left console). When moved from OFF to INCREASE or DECREASE, the switch regulates the brilliance of the reticle image. The sensitivity current, which regulates the kinematic lead developed (the lead due to target motion), is controlled by the range on the side of the sight head. The range dial is calibrated in firing range from 200 to 800 yards.

Note

- The range dial should be set to the desired firing range before entering the rocket-firing pass.
- If the correct target wing span is set on the wing span scale on the sight head, the diamonds of the computing reticle just encircle the target wings at the desired firing range.
- The greatest degree of accuracy may be obtained by firing at the preset range. However, the aim errors introduced by small errors in firing range are not as serious as with guns, since they are compensated for by the rocket dispersion. For best results, the firing range should be within 100 yards of the preset range.

There is a "CAGE" button mounted on the throttle grip which electrically cages the lead-prediction gyro by increasing the current through the range coils. This condition is referred to as "maximum stiffness" of the gyro. Maximum stiffness is also obtained by setting the range dial at minimum range (200 yards). This provides a current of 260 milliamperes and has the effect of electrically caging the gyro. This is recommended for aerobatics, landing, or taxiing to restrain gyro motion when the NAFFARS sight is not in use, thus extending the life of the sight gyro motor.

NAFFARS In-flight Operational Check-out.

An in-flight check can be made of the NAFFARS sight by noting the relationship of the gyro reticle to the fixed reticle during level flight and during constant-speed, constant-G horizontal turns. Figure 4-23 illustrates the relative positions of the fixed and movable reticle under the conditions indicated.

Note

A tolerance of ±3 mils is allowable because of sight head variations. For the tests to be valid, it is very important that the reticle positions be observed with both eyes opened and focused at infinity; otherwise, the reticles may appear to have a large displacement in azimuth.

Operation of NAFFARS (Sight) System.

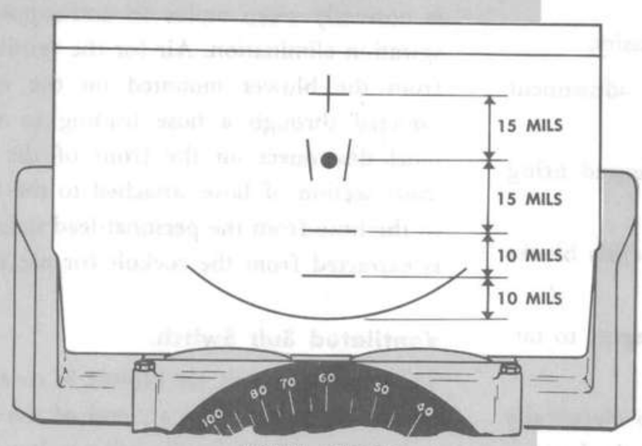
A typical attack sequence using the stand-by sight system is as follows:

1. Set rocket-firing controls.

Note

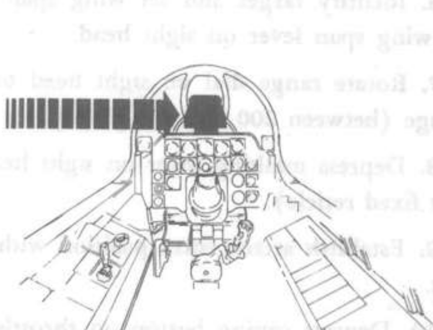
Maintain .78 Mach number or above throughout attack, for correct angle-of-attack computations.

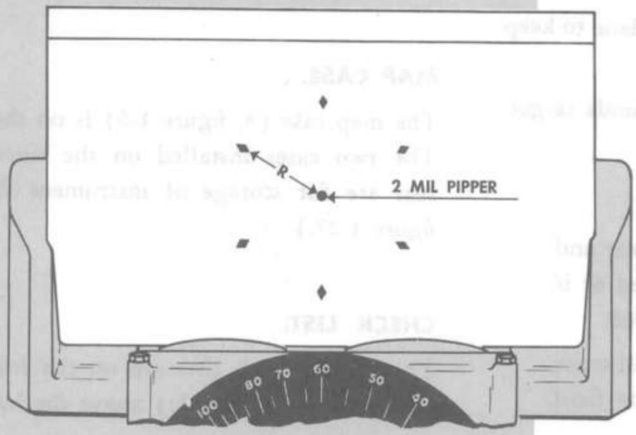
NAFFARS IN-FLIGHT OPERATIONAL CHECK-OUT



FIXED RETICLE

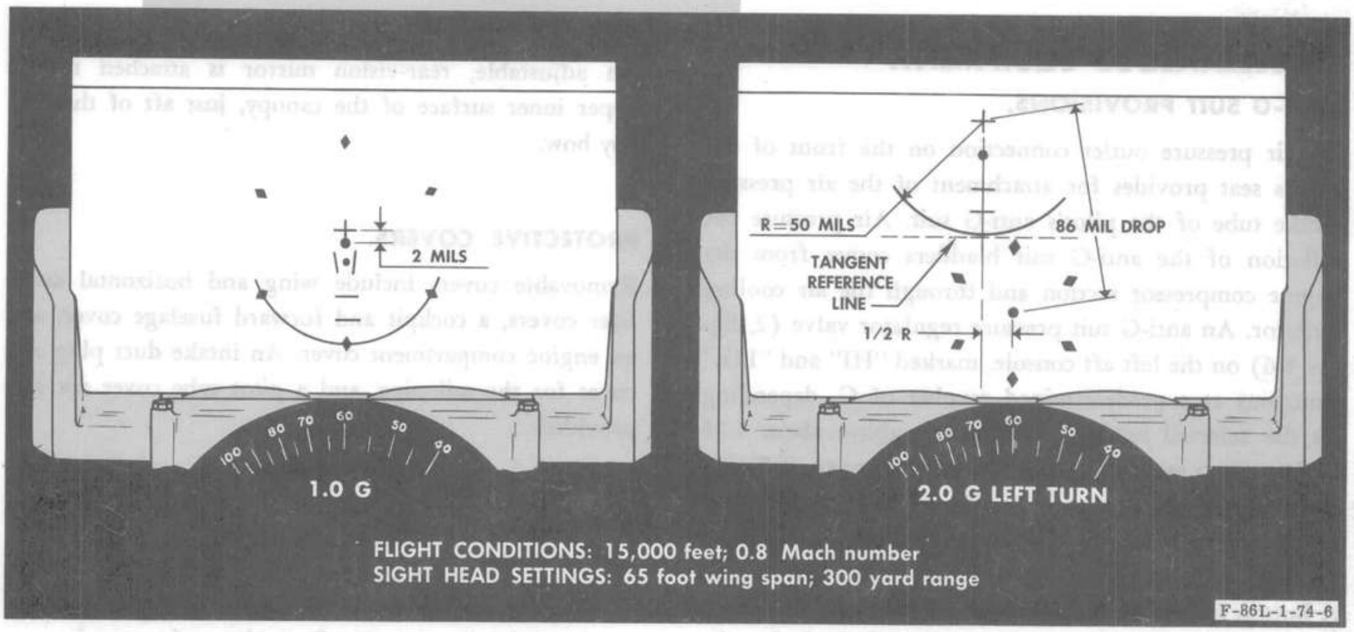
RETICLE DISPLAY





GYRO RETICLE

Radius (R) is controlled by range input and wing span setting.



FLIGHT CONDITIONS: 15,000 feet; 0.8 Mach number
SIGHT HEAD SETTINGS: 65 foot wing span; 300 yard range

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Figure 4-23

2. Set rocket-firing switch for manual operation.

3. Set armament master switch to desired number of rockets to be fired.

4. Turn stand-by sight switch to ON.

5. Adjust reticle brilliance to desired intensity.

6. Identify target and set wing span by adjustment of wing span lever on sight head.

7. Rotate range dial on sight head to desired firing range (between 200 and 800 yards).

8. Depress masking lever on sight head (this blanks out fixed reticle).

9. Establish attack entry position with respect to target.

10. Depress caging button on throttle to electrically cage sight gyro, and place sight reticle ahead of target by a distance equal to the estimated lead required.

11. Release cage switch and maneuver airplane to keep reticle image superimposed on target.

12. When reticle image completely surrounds target, fire rockets and execute pull-out.

Note

- Rockets cannot be fired if the nose gear and nose gear doors are not up and locked or if the rocket package is not fully extended.
- Each later depression of the trigger will cause the selected number of rockets to be fired until the package is empty.

MISCELLANEOUS EQUIPMENT.

ANTI-G SUIT PROVISIONS.

An air pressure outlet connection on the front of the pilot's seat provides for attachment of the air pressure intake tube of the pilot's anti-G suit. Air pressure for inflation of the anti-G suit bladders comes from the engine compressor section and through the air cooling radiator. An anti-G suit pressure regulator valve (2, figure 1-6) on the left aft console, marked "HI" and "LO," functions at a predetermined number of G, depending on the selected setting. Acceleration above about 1.75 G (HI or LO setting) causes the valve to open, inflating the anti-G suit. For each additional 1 G acceleration force, a corresponding one psi (LO setting) or 1.5 psi (HI setting) air pressure is exerted in the anti-G suit. A button on top of the valve can be manually depressed to inflate the suit momentarily when desired, for the purpose of lessening fatigue during prolonged flight.

VENTILATED SUIT PROVISIONS.

On airplanes changed by T.O. 1F-86-563, provisions for the use of a ventilated suit are installed. The ventilated suit provides air circulation around the pilot's body and is normally worn under an anti-exposure suit for perspiration elimination. Air for the ventilated suit is taken from the blower mounted on the ejection seat and directed through a hose leading to the personal-lead quick-disconnect on the front of the ejection seat. A short section of hose, attached to the suit, is connected to the hose from the personal-lead quick-disconnect. Air is extracted from the cockpit for use in the suit.

Ventilated Suit Switch.

The ventilated suit air blower is controlled by a two-position switch on the aft end of the left console. The switch is powered by the primary bus and when moved to ON, energizes the air blower on the ejection seat.

MAP CASE.

The map case (3, figure 1-6) is on the aft left console. The two cases installed on the sides of the ejection seat are for storage of instrument flight charts. (See figure 1-27.)

CHECK LIST.

The pilot's check lists are on the inboard face of the cockpit ledge (left side) above the left console.

REAR-VISION MIRROR.

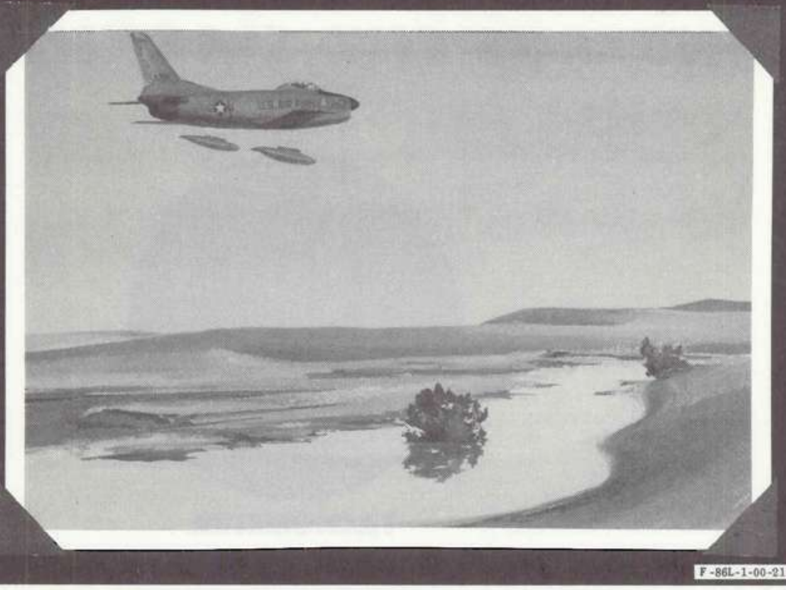
An adjustable, rear-vision mirror is attached to the upper inner surface of the canopy, just aft of the canopy bow.

PROTECTIVE COVERS.

Removable covers include wing and horizontal stabilizer covers, a cockpit and forward fuselage cover, and an engine compartment cover. An intake duct plug and cover for the tail pipe, and a pitot tube cover are also provided.

CAUTION

The air intake duct plug and tail pipe cover should not be installed until the engine has cooled, to prevent formation of excessive moisture.



F-86L-1-00-21

Operating Limitations

SECTION V

INSTRUMENT MARKINGS.

The limitation markings as shown on the instruments (figure 5-1) and noted in the captions are not necessarily repeated in the text of this or other sections.

ENGINE LIMITATIONS.

All normal engine limitations are shown in figure 5-1. The definition of thrust settings for the airplane are as follows:

Maximum Thrust is defined as the thrust obtained at 100% rpm and 685°C exhaust temperature with full afterburner.

Military Thrust is defined as the thrust obtained at 100% rpm and 685°C exhaust temperature without afterburner.

Maximum Continuous Thrust is defined as the thrust obtained at 635°C exhaust temperature.

Note

There is no time limit for any power setting.

ENGINE OVERSPEED.

All engine overspeeds of more than 104% rpm up to and including 108% rpm, with or without an overtemperature condition, necessitate turbine wheel replacement. For overspeeds in excess of 108% rpm, regardless of temperature, the engine will be removed for overhaul.

ENGINE OIL SYSTEM.

A maximum oil pressure fluctuation of plus 3 psi to minus 3 psi from the steady-state pressure is permissible. During flight, if fluctuations exceed the ±3 psi, a landing should be made as soon as possible. During ground operation, if fluctuations exceed ±3 psi, entry should be made in DD From 781 and the cause investigated prior to flight.

COMPRESSOR STALLS.

All compressor stalls, inclusive of the duration, exhaust temperature, severity, altitude, airspeed, rpm, and throttle action (advancing, retarding, or static) accompanying the stall, must be recorded in the DD Form 781.

ENGINE EXHAUST TEMPERATURE.

Engine Start.

During engine starts up to idle rpm (within 2 minutes), exhaust temperatures of 950°C or above for 2 seconds or more constitute overtemperature operation.

INSTRUMENT MARKINGS

OIL PRESSURE

🟥	12 psi	minimum
🟨	12-25 psi	permissible only below military rpm (98% to 100%)

CAUTION

At military rpm (98% to 100%), oil pressure must be between 25 and 45 psi.

🟩	25-45 psi	continuous operation at all rpm
🟥	50 psi	maximum*

* During cold-weather starting (pressure will return to normal after a short period of operation).

TACHOMETER

🟥	75% minimum cruise
🟩	75%-100% continuous
🟥	100% maximum (+0, −2% rpm)

HYDRAULIC PRESSURE

	UTILITY HYDRAULIC SYSTEM	FLIGHT CONTROL NORMAL HYDRAULIC SYSTEM	FLIGHT CONTROL ALTERNATE HYDRAULIC SYSTEM
🟨 650-2550 psi	Malfunction within system–unit operation sluggish		Normal only if system is engaged and controls operating
🟩 2550-3200 psi	Normal– when systems are in operation.*		Normal when controls are not in use
🟥 3200 psi	Maximum		Maximum when NOT using emergency override handle for alternate system operation
🟨 3200-4000 psi	Engine-driven pump compensator failure		Normal only if emergency override handle is pulled

*For static (no-flow) conditions, gage pressure should be 2850 to 3200 psi.

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Figure 5-1

BASED ON ALL GRADES OF FUEL

AIRSPEED AND MACH NUMBER INDICATOR

🟥 610 knots IAS max or speed where wing roll becomes excessive*

🟨 185 knots IAS gear-down limit airspeed

(195 knots IAS flap-down limit airspeed)

* The black and red pointer will move with altitude to give the limiting indicated airspeed (IAS) that corresponds to the equivalent airspeed (EAS) of 610 knots.

NOTE

WITH DROP TANKS INSTALLED, AIRSPEED LIMITS ARE:

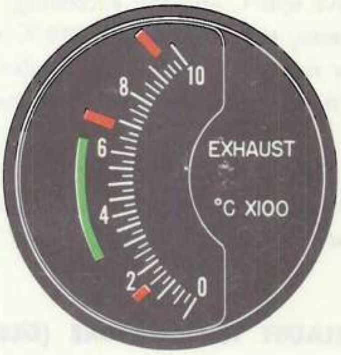
Types I and III

🟨🟥🟨🟥 Below 15,000 ft 555 knots IAS or .9 Mach number, whichever is less

Above 15,000 ft same as with no external load

Types II and IV

500 knots IAS or .9 Mach number, whichever is less



EXHAUST TEMPERATURE

🟥	150°C	minimum (for ground operation)
🟩	300°C-635°C	continuous
🟥	685°C	maximum (stabilized) at Maximum Thrust or Military Thrust
🟥	950°C	maximum during start (within 2 min)*

*Refer to applicable text in this section.

ACCELEROMETER

🟥 5.6 G max with no external load

🟥 5.0 G max with Types I and III 120-gallon drop tanks (4.0 G max with Types II and IV 120-gallon drop tanks)

🟥 -2.0 G max for all configurations

Max G allowable for operation of rocket package above 560 knots is 3.5 G.

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Engine Operation.

For all engine operation (except starting), exhaust temperatures above 690°C and not exceeding 750°C for 40 seconds or more, temperatures of 750°C to 800°C for 10 seconds or more, and temperatures above 800°C for 2 seconds or more constitute overtemperature operation.

Note

> The duration and degree of all overtemperature must be entered in the DD Form 781.

ENGINE EXHAUST TEMPERATURE (DESCENT).

The following minimum exhaust temperatures must be observed during any descent:

- At any altitude, when using Maximum Continuous Thrust or below, maintain 300°C minimum during descent.
- Above 25,000 feet altitude, when using Maximum or Military Thrust, maintain 600°C for about 2 minutes. After about 2 minutes at 600°C or when descending through 25,000 feet altitude, the throttle may be retarded further to maintain a minimum of 300°C for the remainder of the descent.
- At or below 25,000 feet altitude, retard throttle to maintain a minimum of 300°C throughout descent.

AIRSPEED LIMITATIONS.

LANDING GEAR LOWERING SPEEDS.

Limit airspeed for landing gear lowering is 185 knots IAS. If the landing gear is lowered at speeds above this value, the air loads may damage the fairing doors, or operating mechanism.

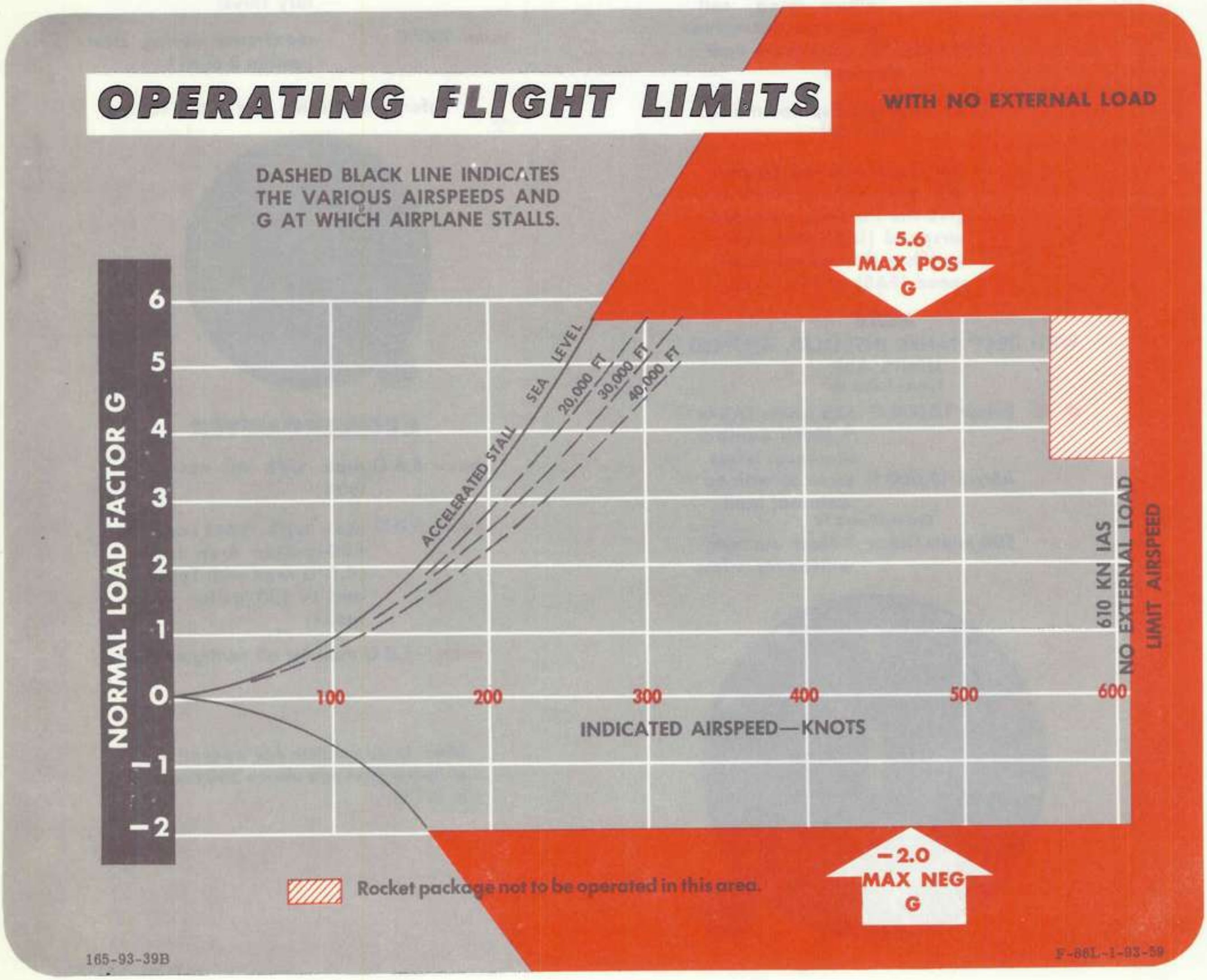


Figure 5-2

WING FLAP LOWERING SPEED.

The limiting airspeed for lowering of the wing flaps is 195 knots IAS. If the wing flaps are lowered above this limiting airspeed, the fairing or operating mechanisms may be damaged.

LANDING LIGHT LOWERING SPEED.

The landing light is designed to be lowered after the landing gear is extended. The limit airspeed for lowering the landing light is 185 knots IAS.

CANOPY OPENING SPEED.

The canopy is not to be opened in flight. On the ground, while taxiing, the canopy may be operated at airspeeds not exceeding 50 knots IAS. If the canopy is operated at airspeeds above this value, damage to the canopy and the canopy operating mechanism will result.

ROCKET PACKAGE OPERATION SPEED.

Rocket package operation under normal conditions imposes no airspeed limitations. However, at airspeeds above 560 knots IAS, the rocket package must not be operated during normal accelerations greater than 3.5 G.

DROP TANK RELEASE SPEED.

The drop tank release limits for all types (I, II, III, and IV) of tanks are as follows (maximum airspeed and G-limitations must be observed):

Full tanks	drop at any speed.
Empty or partially full	drop at any speed above 220 knots IAS.

Note

- All drops should be made in wings-level (no-roll) flight at 1.0 G.
- In an emergency, drops may be made at any flight attitude. However, the airplane may suffer minor damage to the wing, or the pitot boom may be lost.

DRAG CHUTE OPERATING SPEED.

The drag chute is designed to be deployed at speeds of 150 knots IAS or below and *only after touchdown.* The drag chute is automatically released from the airplane if deployed at speeds above about 160 knots IAS. If the chute is deployed at speeds above 150 knots IAS, the breakaway fitting tension element must be visually inspected before further flight and replaced if found deformed. The drag chute should not be deployed in a 90-degree cross wind which exceeds 20 knots nor in a 45-degree cross wind which exceeds 30 knots, except in an emergency. Flight tests have shown that a properly packed chute has the least compartment pull-out resistance and will deploy at speeds as low as 60 knots IAS in about 4 seconds. However, to ensure consistent and proper operation, it is recommended that the chute be deployed above 75 knots IAS.

Note

> Although the drag chute is not designed for in-flight use, it will not adversely affect the airplane flight characteristics if it is inadvertently deployed just before touchdown and the proper flare-out has been initiated.

MAXIMUM ALLOWABLE AIRSPEED.

No External Load.

No Mach number limitation is imposed on the airplane with no external load. However, the airspeed limitation at any altitude is 610 knots IAS, or airspeed where wing roll becomes excessive.

External Drop Tanks Installed.

For maximum allowable airspeeds with 120-gallon external drop tanks installed, see figure 5-1.

PROHIBITED MANEUVERS.

INVERTED FLIGHT.

Inverted flying, or any maneuver resulting in negative acceleration, must not be performed with the afterburner operating.

Note

> Inverted flight with afterburner operating is prohibited. Inverted flight without the afterburner operating must be limited to 10 seconds duration, as there is no means of ensuring a continuous flow of fuel or oil in this attitude.

INTENTIONAL SPINS.

With 120-gallon external drop tanks installed, intentional spins are prohibited.

(Deleted)

OTHER MANEUVERS.

Snap rolls or any other snap maneuvers are prohibited at all times. When Types II or IV 120-gallon external drop tanks are installed and are empty, rate of roll is limited to 90 degrees per second.

ROCKET-FIRING LIMITATION.

Do not fire MK II 2.75-inch rockets above 20,000 feet, except in an emergency. Below 20,000 feet, not more than six MK II 2.75-inch rockets may be fired per salvo.

CAUTION

Firing of MK II rockets above 20,000 feet could cause engine compressor stall and flame-out.

ACCELERATION LIMITATIONS.

MAXIMUM ACCELERATION.

For maximum allowable G for wings-level (no-roll) pull-outs, see figure 5-1. The operating flight limit diagram (figure 5-2) graphically illustrates wings-level (no-roll) G-limits with no external load. Maximum allowable positive G for rolling pull-outs with no external load is 3.7 G. Maximum allowable positive G for rolling pull-outs with Types I and III 120-gallon external drop tanks installed is 3.3 G; for Types II and IV drop tanks, 2.6 G. Maximum allowable negative G during rolls is −1.0 G in any configuration.

ENGINE.

If the engine has been subjected to a load factor in excess of 10 G, it must be removed and a special inspection performed.

CENTER-OF-GRAVITY LIMITATIONS.

The center-of-gravity position of the airplane is chiefly affected by the distribution of the fuel load carried and by whether or not the 2.75-inch rockets are aboard. External 120-gallon drop tanks do not greatly change the airplane center of gravity, although the airplane weight is increased. Since there is no in-flight control of CG position other than the normal expenditure of rockets and release of external loads, major factors affecting CG position must be checked before flight. Refer to Handbook of Weight and Balance Data, T.O. 1-1B-40.

WEIGHT LIMITATIONS.

The design of the airplane prevents the possibility of overloading; therefore, there are no weight limitations to be watched so long as standard drop tanks are carried. If a hard landing is made with the airplane near take-off gross weight, the airplane should be inspected for signs of structural damage before the next flight.

F-86L-1-00-22

Flight Characteristics

SECTION VI

GENERAL.

Note

> The information in this section applies only to the airplane with no external load, unless otherwise noted.

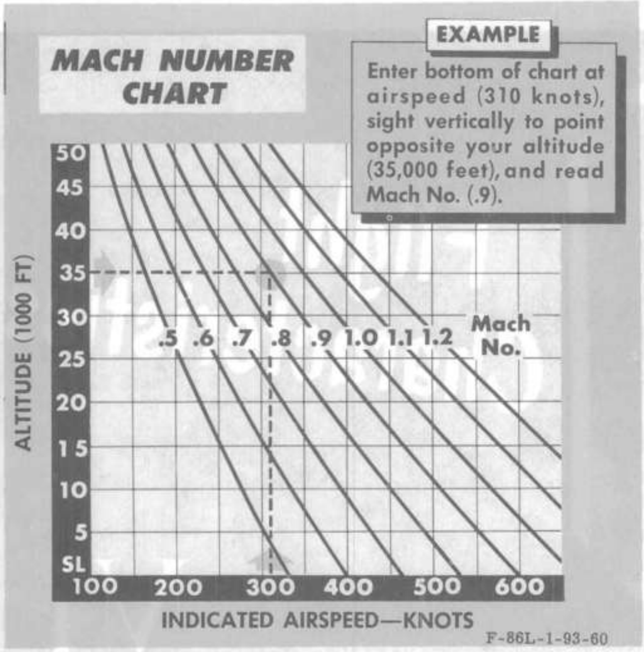
The stability and control characteristics of the airplane are excellent throughout its entire speed range. These characteristics are made possible by incorporation of the controllable horizontal tail as the primary longitudinal control and the adoption of the completely hydraulic flight control system. Use of this type control system provides comfortable stick forces and superior handling qualities, particularly in regions of high Mach numbers. Wing slats and speed brakes are provided to further improve flight control. The extended, slatted wing leading edge and a 12-inch wing tip extension increase maneuverability at high altitudes.

MACH NUMBER.

Note

> Mach number represents a percentage of the speed of sound. For example, if you are flying at Mach .75 at any altitude, your speed is 75 percent of the speed of sound at that altitude.

For easier association, the speeds in this section are given in terms of Mach number rather than indicated airspeeds. In order to relate a flight characteristic to airspeed, you would need to know a different airspeed at which that characteristic occurred for every altitude. However, if a flight characteristic is related to Mach number, the flight characteristic will occur at the same Mach number at any altitude and will vary only in intensity, depending upon the altitude. At low altitude, the indicated airspeed for a given Mach number will be higher than at high altitude, and, hence, pressures on



EXAMPLE

Enter bottom of chart at airspeed (310 knots), sight vertically to point opposite your altitude (35,000 feet), and read Mach No. (.9).

F-86L-1-93-60

Figure 6-1

the airplane will be greater than at high altitude. Therefore, you will notice that, although the same handling characteristics will occur at the same Mach number at any altitude, the effect on the airplane and on the controls will be more pronounced, and possibly limiting, at low altitude. A Mach number chart (figure 6-1) illustrates the variation of airspeed with altitude for given Mach numbers.

Note

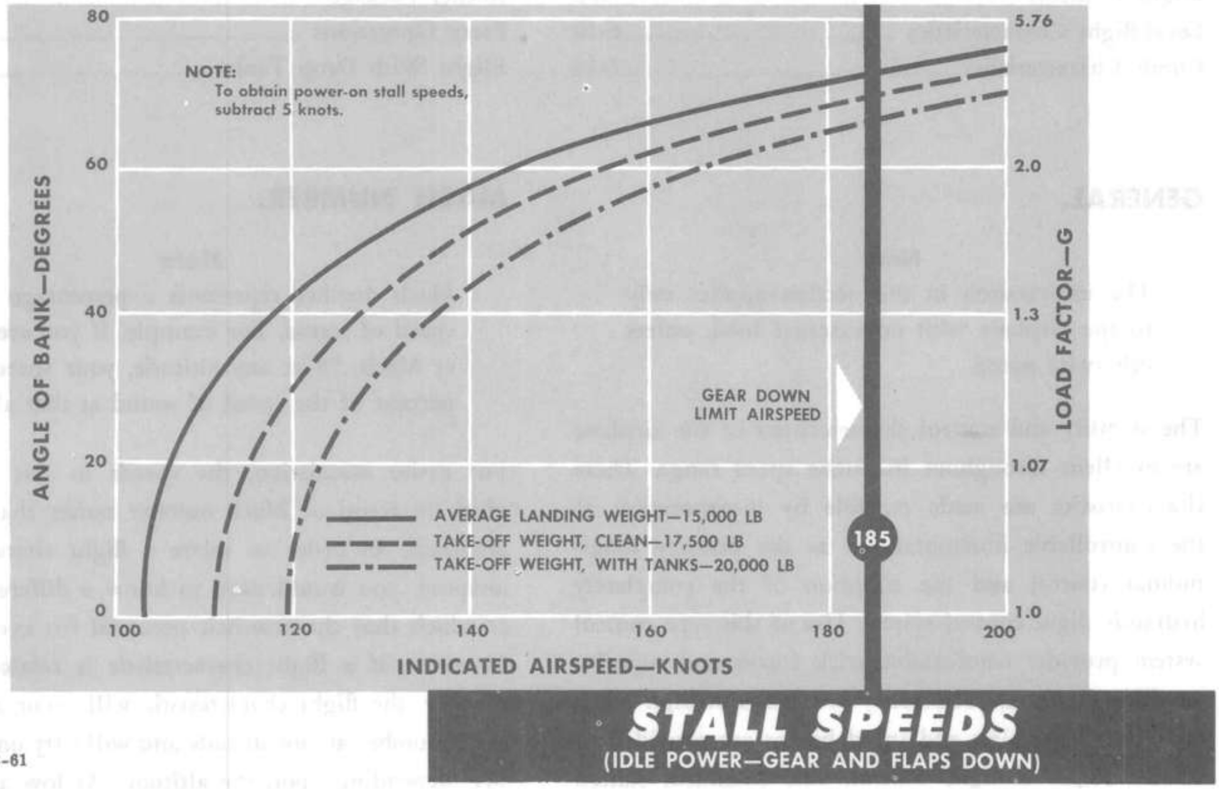
> Refer to Appendix I for airspeed conversion data. (See figure A-1.)

STALLS.

Stall characteristics of the airplane are typical for a swept-wing fighter, which has a higher angle of attack at the stall point than straight-wing fighters. There is no severe rolling or yawing tendency, and positive aileron control is available through the stall and during recovery. The airplane has good stall warning characteristics in all attitudes. Entry into the stall speed range is shown by a medium to heavy general airframe buffet, depending upon the configuration and the G-load imposed.

UNACCELERATED STALLS.

Unaccelerated stalls (stalls at 1 G), with the landing gear and wing flaps down and power off, are preceded by stall warning in the form of mild airframe buffet. The actual stall is straight ahead with a slight pitching motion. Stalls in the same configuration with power on have the same stall warning, but power-on stalls are not recommended with the afterburner on since the



NOTE: To obtain power-on stall speeds, subtract 5 knots.

STALL SPEEDS

(IDLE POWER—GEAR AND FLAPS DOWN)

F-86L-1-93-61

Figure 6-2

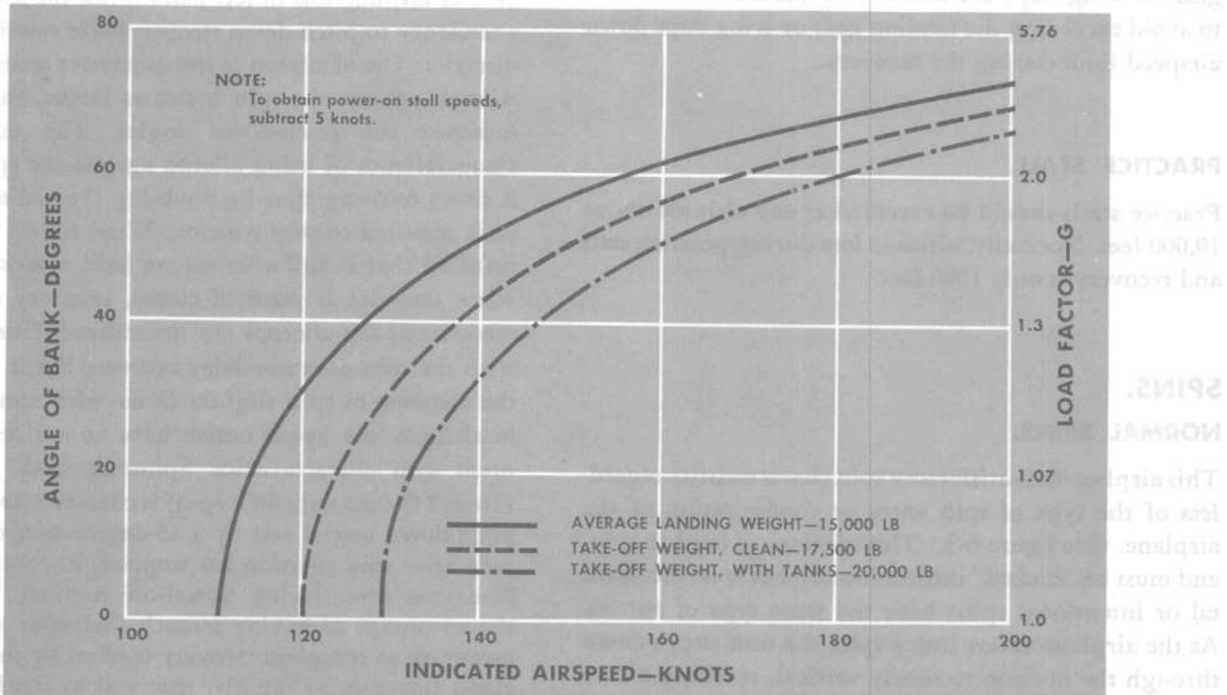
airplane attains a very nose-high attitude accompanied by considerable pitch, roll, and yaw. Unaccelerated stalls with the landing gear and wing flaps retracted and with power on or off occur at speeds of 5 to 10 knots higher than those with the landing gear and wing flaps down. The stall warning is a light airframe buffet, which becomes heavier just before the stall. The nose drops through the horizon and the airplane may roll in either direction.

ACCELERATED STALLS.

Accelerated stalls (stalls at more than 1 G) are sometimes referred to as high-speed stalls because they occur above the unaccelerated stall speeds. Applying G on an airplane raises its stalling speed; for example, the application of 2 G doubles the weight of the airplane and wing lift is not always sufficient to support this weight. All accelerated stalls are preceded by heavy buffet and the higher the stall speed the heavier the buffet.

Low-speed Accelerated Stalls.

Low-speed accelerated stalls, in any configuration with power on or off, provide adequate stall warning with a medium to heavy airframe buffet. Accelerated stalls at low speeds usually occur when too tight a turn is made. At the stall, the nose drops out of a turn. When warned of an approaching stall, you can avoid stalling the airplane by releasing back pressure on the stick. The effect of the angle of bank upon accelerated stall speeds is shown in figure 6-2 for 15,000, 17,500, and 20,000 pounds. The curve for a 20,000-pound airplane represents the take-off weight with drop tanks, and the 15,000-pound curve represents average weight on an approach at completion of a flight. The 17,500-pound curve represents take-off clean or maneuvering weight with the drop tanks. The stall speeds shown are based on landing gear and wing flaps down or up with power off. As the engine thrust is increased, the stall speed will be slightly decreased at a given angle of bank. As the speed is decreased during approach, the amount of bank angle or G-load that can be imposed before stalling also decreases. For example, using figure 6-2, during a final approach at 140 knots IAS weighing 15,000 pounds, a stall will not occur until an angle of bank of 58 degrees and 1.8 G are imposed on the airplane. Therefore, considerable maneuvering can be accomplished in the traffic pattern without stalling. For an additional example, suppose you must land immediately after take-off with a maximum gross weight of 20,000 pounds. At the recommended final approach speed of 160 knots IAS for the 20,000-pound weight, stall will occur at an angle of bank of 57 degrees and 1.7 G. This permits a good margin of maneuverability before stall is reached.



NOTE:
To obtain power-on stall speeds, subtract 5 knots.

F-86L-1-93-62

STALL SPEEDS

(IDLE POWER—GEAR AND FLAPS UP)

High-speed Accelerated Stalls.

WARNING

An accelerated, high-speed stall at low altitude can damage the airplane or cause you to black out and possibly lose control.

The extended, slatted wing leading edge and wing tip extensions on this airplane result in reduced buffet when pulling G at high altitudes and high Mach numbers. When pulling G at approximately .9 Mach number, the airplane will experience a mild buffet prior to slat opening, followed by a reduction in buffet as more G is pulled and the slats open. When pulling maximum available G between .65 and .9 Mach number, the airplane will have only a mild pitch-up tendency which is controllable. The extended, slatted wing leading edge and wing tip extensions permit higher G-loads at high altitude and high Mach numbers before stall occurs. Figure 5-2 shows the G-loads attainable at various altitudes and airspeeds.

STALL RECOVERY.

Stall recovery is made in the normal manner by applying forward stick and increasing power. If the landing gear or wing flaps are down, care should be exercised to avoid exceeding the landing gear or wing flaps down airspeed limit during the recovery.

PRACTICE STALL.

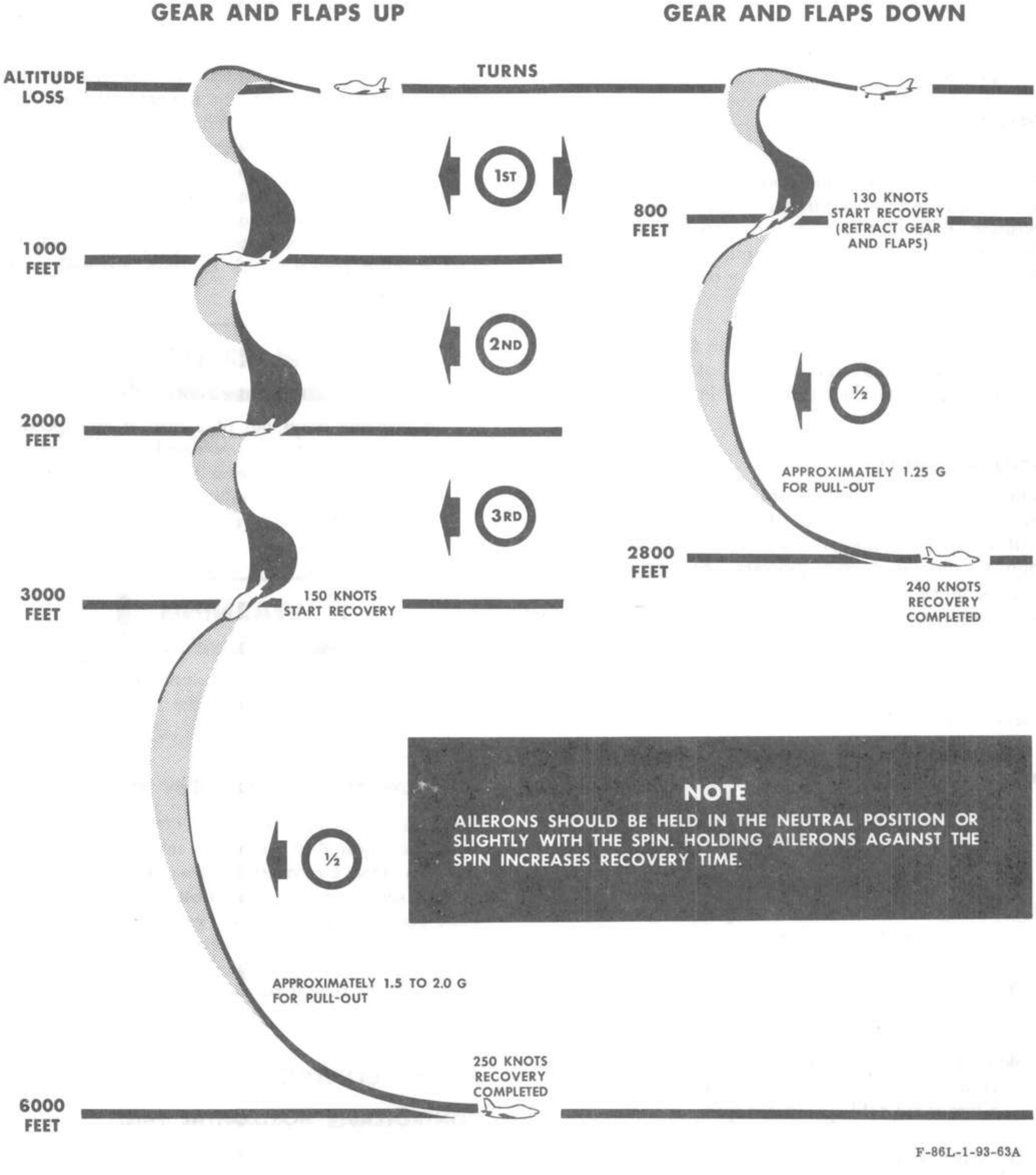
Practice stalls should be executed at any altitude above 10,000 feet. Normally, altitude loss during practice stall and recovery is only 1000 feet.

SPINS.

NORMAL SPINS.

This airplane has satisfactory spin characteristics regardless of the type of spin entry or configuration of the airplane. (See figure 6-3.) This airplane is hard to spin, and must be "kicked" into an intentional spin. Accidental or intentional spins have the same type of entries. As the airplane enters into a spin, the nose drops down through the horizon to nearly vertical, reaching a dive angle of 50 to 75 degrees about one-half way through the first turn of the spin. During the first half of this turn, the airplane begins its spin rotation gradually; but as the nose drops steeply, the rotation rate speeds up to a point where you sense the airplane suddenly whipping down to the vertical. At the completion of about the first half turn of the spin, the rapid rate of rotation decreases almost as suddenly as it began; as the second half of the turn progresses, the nose pitches up and the spin rotation slows to a point where it appears to stop. At this point the nose will come almost up to the horizon with the wings level, and the first turn of the spin is complete. On the average, 8 seconds will be required to complete the first turn with a loss in altitude of 500 or 600 feet. As the airplane rolls into the second turn of the spin, it follows the same pattern of an increased rate of spin rotation as the airplane pitches down and a slowing rotation accompanied by the nose rising toward the horizon again as the second turn is completed. However, the second as well as any continuing turns are characterized by the airplane pitching down steeper to the 80- or 90-degree dive angle at about the half turn point, and by a smaller amount of pitch-up of the nose toward the horizon as each turn is completed. By the completion of the third or fourth turn, the nose is only coming up to within 50 or 60 degrees of the horizon in contrast to the return of within 10 to 15 degrees during the first turn. Each turn of spin is completed about a second quicker than the preceding turn until a minimum of about 3 seconds is reached. Altitude losses during later turns require 1000 feet per turn on the average. The airplane spins faster to the right than to the left, but requires less altitude to complete. In addition to the greater altitude loss in left-hand spins, the airplane has a tendency to pitch down steeper while rotating in this direction. Use of aileron in the spin is not recommended. Aileron against the spin increases buffet, and slightly increases the pitch-down angles. The outstanding characteristics of using aileron against the spin is that it slows recovery time by doubling the ordinary 3 seconds required to stop rotation. Wind tunnel tests have revealed that if full ailerons are held against the spin when one slat is jammed closed, recovery cannot be made until the ailerons are neutralized. Using aileron with the spin does not delay recovery but it may cause the airplane to spin slightly faster with some increase in altitude loss. Speed brakes have no noticeable effect upon spin characteristics. Spinning with power on (from 2 G turn with 80% rpm) is characterized by lesser pitch-down angles and by a 45-degree nose-down attitude after spin rotation has stopped, in contrast to the 90-degree dive during power-off recovery. However, the advantage of having a much shallower angle with power on to complete recovery is offset by the fact that speed increases so rapidly, that just as much or more altitude is lost in comparison to the 90-degree, power-off recovery completion. If you inadvertently spin with the landing gear and wing flaps down, the airspeed during recovery will exceed placard limits. Retract the landing gear and wing flaps immediately to avoid structural

TYPICAL SPIN CHARACTERISTICS



NOTE

AILERONS SHOULD BE HELD IN THE NEUTRAL POSITION OR SLIGHTLY WITH THE SPIN. HOLDING AILERONS AGAINST THE SPIN INCREASES RECOVERY TIME.

Figure 6-3

damage. Spins in the landing configuration are characterized by slightly less altitude loss during the first turn.

WARNING

> Spins with drop tanks installed are prohibited. If a spin is inadvertently entered when drop tanks are installed, use normal recovery procedure. If spin does not stop immediately, jettison drop tanks and repeat normal recovery procedure.

INVERTED SPINS.

Inverted spins are characterized by a roll upright into a 45-degree dive attitude about every three-fourths of a turn and are followed by a roll again into the inverted position. Each turn takes about 6 seconds. Recovery can be initiated at any time by neutralizing the controls and dropping the nose as the airplane rolls upright.

Note

> Flame-outs can occur during an inverted spin, because of interrupted flow of fuel to the engine while the airplane is in the inverted position.

SPIN RECOVERY.

This airplane has excellent spin recovery characteristics in that rotation can be quickly stopped in about one-half turn, using normal recovery techniques. In addition to the rapid spin recovery characteristics, using normal procedure, the airplane will recover from a spin itself, once you release the controls, It will require about two turns to recover "hands off." To recover from a spin, proceed as follows:

1. Retard throttle to IDLE upon spin entry to prevent excessive altitude loss.

2. Apply full opposite rudder followed immediately by neutralizing the stick.

WARNING

- Do not hold stick back during recovery, as this may cause a spin in the opposite direction when the turn is stopped.
- Hold ailerons neutral during all spin recoveries, since recovery may be delayed by improper use of ailerons.
- If slats are asymmetrical (one slat jammed closed), spin recovery will be prevented if full ailerons are held against the spin.

3. After spin rotation has been stopped, neutralize rudder and regain flying speed before opening speed brakes or starting pull-out.

WARNING

> Failure to hold nose down to regain flying speed before opening speed brakes or beginning pull-out may cause the airplane to stall and snap into a secondary spin. However, full-forward stick is not recommended, because an excessively steep recovery attitude may result.

Spin recovery is completed about one-half turn after recovery control is initiated. As recovery control is applied, the spin speeds up momentarily just before the airplane stops rotating. Therefore, do not be misled into thinking your recovery technique is ineffective. Flight tests show that speed brakes have no adverse effect on the spin characteristics or recovery. Therefore, if the speed brakes are open when a spin is entered, complete recovery with them open, if desired, being sure to hold forward stick to allow airspeed to build up above stall speed.

WARNING

> If airplane snaps out of a turn at any speed, enters a spin from a low-speed, straight-ahead stall, or enters any form of spin-type maneuver, apply opposite rudder and simultaneously neutralize the stick to effect immediate recovery.

WARNING

> Do not trim into a turn, since the stick may not return to neutral if the controls are released for recovery.

MINIMUM ALTITUDE FOR SPIN RECOVERY.

Flight test data indicates that 7000 feet is the terrain clearance required to complete a recovery from a normal spin. To effect a recovery from a one-turn spin (using a normal spin recovery), the altitude loss will be about 6500 feet. Therefore, if you get into a spin with less than the required 7000-foot terrain clearance, eject, since the margin of safety is too small to attempt recovery. Practice spins should be entered about 30,000 to 35,000 feet.

FLIGHT CONTROLS.

CONTROLLABLE HORIZONTAL TAIL.

The controllable horizontal tail provides extremely effective longitudinal control because of the increased movable surface area and improved surface effective-

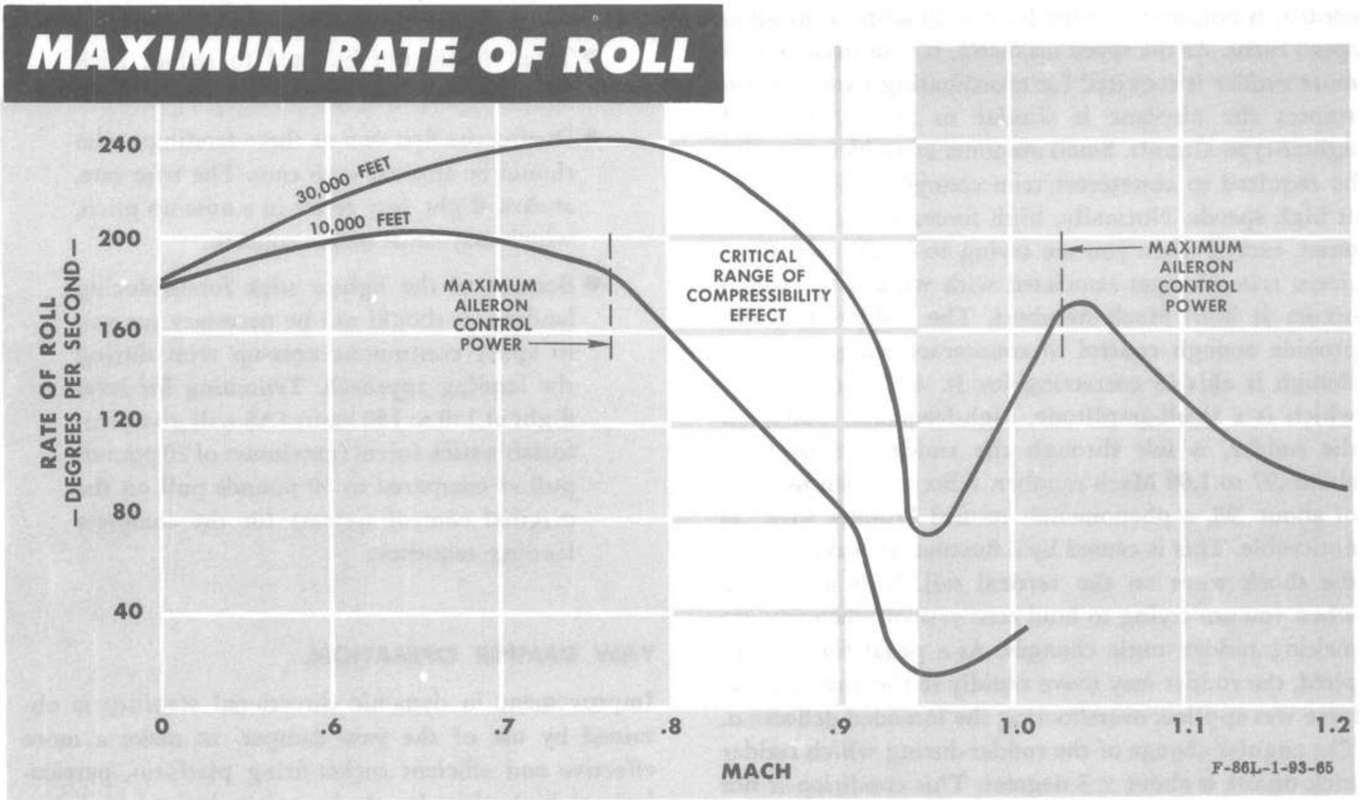


Figure 6-4

ness. Therefore, use of this control requires considerably less applied pilot force in maneuvering flight than a conventional stabilizer-elevator configuration. Similarly, the amount of stick travel required to perform a given maneuver is reduced. This control improvement is most noticeable at high speeds at low altitudes, and care should be exercised to avoid application of excessive G by overcontrolling. This means that until you gain enough experience to anticipate the approximate response of the airplane, you should not attempt close-formation flight or large, abrupt stabilizer motions. While flying in rough air or jet wash of another airplane, the safety belt and shoulder harness should be kept tight and the stick held in a loose grip to prevent an induced oscillation. If an oscillation should occur, release the stick or make a steady pull-up.

AILERON CONTROL.

The rate of roll produced through use of the ailerons is very high. Extreme caution should be exercised in aileron use until you are thoroughly familiar with aileron effectiveness. Figure 6-4 shows the maximum rate of roll of the airplane at 10,000 and 30,000 feet throughout its entire speed range. Note that at high altitude, aileron effectiveness is reduced at high Mach numbers (.8 to .95) because of compressibility effects and then returns until the maximum aileron power output is reached at Mach 1. At low altitudes, the loads on the ailerons become very high and the maximum aileron power is reached at a much lower Mach number (about .78), sharply reducing the rate of roll above Mach .9, to a point where aileron control power is very low. The hazard of low aileron control power at low altitude and high Mach number should be recognized, and a reduction in speed should be made to satisfactorily control this condition. The maximum aileron power output is a safety factor to prevent possible damage to the structure when extremely high loads are placed on the aileron.

RUDDER CONTROL.

Rudder control is satisfactory and very effective at low and intermediate airspeeds. Very little rudder action is necessary to execute all normal maneuvers. Sufficient control is provided to trim the airplane to straight-wing and level flight and to make coordinated turns properly. At high airspeeds, the increasing rudder deflections required for sideslips, and the corresponding increase in pedal forces, show that rudder effectiveness is decreasing. This is a normal phenomenon due to the occurrence of shock waves on the vertical tail in the transonic Mach number range. The effect of shock wave formation results in boundary layer separation and an increased wake effect, decreasing the effectiveness of the control surface. However, very little sideslip control is normally needed for coordinating into high-speed turns. As the speed decreases, it is noticeable that more rudder is required for coordinating turns. In this respect the airplane is similar to all conventional fighter-type aircraft. Small amounts of rudder may also be required to counteract trim changes due to power at high speeds. Normally, high forces are not encountered, except when you are trying to counteract directional trim changes associated with wing drop, which occurs at high Mach numbers. The rudder does not provide enough control to counteract wing drop, although it aids in correcting for it. A "rudder buzz," which is a small-amplitude, high-frequency buffet on the rudder, is felt through the rudder pedals from about .97 to 1.05 Mach number. Also, at Mach number of about .98, a phenomenon termed "rudder kick" is noticeable. This is caused by a fluctuating wake behind the shock wave on the vertical tail. It is noticeable when you are trying to hold zero yaw or when you are making rudder angle changes. As a pedal force is applied, the rudder may move rapidly in the direction the force was applied, overshooting the intended deflection. The angular change of the rudder during which rudder kick occurs is about ±3 degrees. This condition is not dangerous unless aggravated by a loose rudder trim tab.

FLIGHT TRIM CHARACTERISTICS.

No trim tabs are provided on the horizontal tail or ailerons. These surfaces are trimmed by changing the no-load (neutral) position of the stick. Rudder trim is obtained by an electrically actuated trim tab. The pitching action that normally occurs during operation of the rocket package is automatically corrected by an electrically operated pitch corrector actuator: thus, little or no corrective action is necessary by the pilot. The actuator repositions the horizontal tail without changing control stick position. A slight, easily controlled, nose-up pitch will be noticed when the speed brakes are extended; correspondingly, a slight nose-down pitch will be noticed when speed brakes are retracted. Opening the speed brakes without correcting the resulting pitch-up with stick action results in a maximum of about 1½ additional G being imposed on the airplane at high speeds. The longitudinal trim characteristics are improved by incorporation of the variable-slope feel control system. This new system markedly reduces the trim lag at all speeds, giving immediate pilot trim response. The trim rate has also been increased; however, in the high-speed range, it will not be as noticeable as in the low-speed range. For example, in the landing condition, the trim rate has been approximately doubled over that of the original trim system.

Note

- Trim should not be used to reduce stick forces to zero during aerobatic maneuvers.
- During the first two or three landings, trim should be applied with care. The trim rate, at slow flight, may result in a nose-up pitch, which may cause undue concern.
- Because of the lighter stick forces during landing, it should not be necessary for you to apply continuous nose-up trim during the landing approach. Trimming for level flight at 150 to 180 knots IAS will give comfortable stick forces (maximum of 20 pounds pull as compared to 50 pounds pull on the original control system) for the complete landing sequence.

YAW DAMPER OPERATION.

Improvement in dynamic directional stability is obtained by use of the yaw damper, to make a more effective and efficient rocket-firing platform, particularly at high altitudes. At low altitudes and high airspeeds, the inherent dynamic directional stability is satisfactory, and damper action is not necessary. It is recommended that it be used during the search and tracking phases of the attack, to obtain maximum hit probabilities. However, to avoid forgetting to turn the yaw damper on, it is suggested that it be turned on during the climb to altitude. The yaw damper consists of a rate gyro, a "washout" circuit, and a servomechanism. The rate gyro senses turning rate, which is then fed through the washout circuit to the servomechanism, which moves the rudder in such a way as to decrease airplane yaw oscillations. While the yawing oscillation may be of such a small degree that you will not be able to visually detect it, it could reduce the kill probability considerably, unless the yaw damper was turned on. This yawing motion could be induced by your applying any correction during tracking, either by rudder or aileron deflections. This corrective rudder is in a direction to resist the yawing motion of the airplane. The washout circuit eliminates any effect of the yaw damper, once a steady rate of turn is established. This action prevents the yaw damper from opposing pilot control during steady turns. Thus the yaw damper will only operate when the turning rate is building up or decreasing. Figure 6-5 illustrates the improvement in the dynamic direction characteristics. The difference in damping time is shown by the two curves which show airplane response to a release from a steady sideslip with the yaw damper "on" and "off." These particular data, taken at an altitude of 40,000 feet and

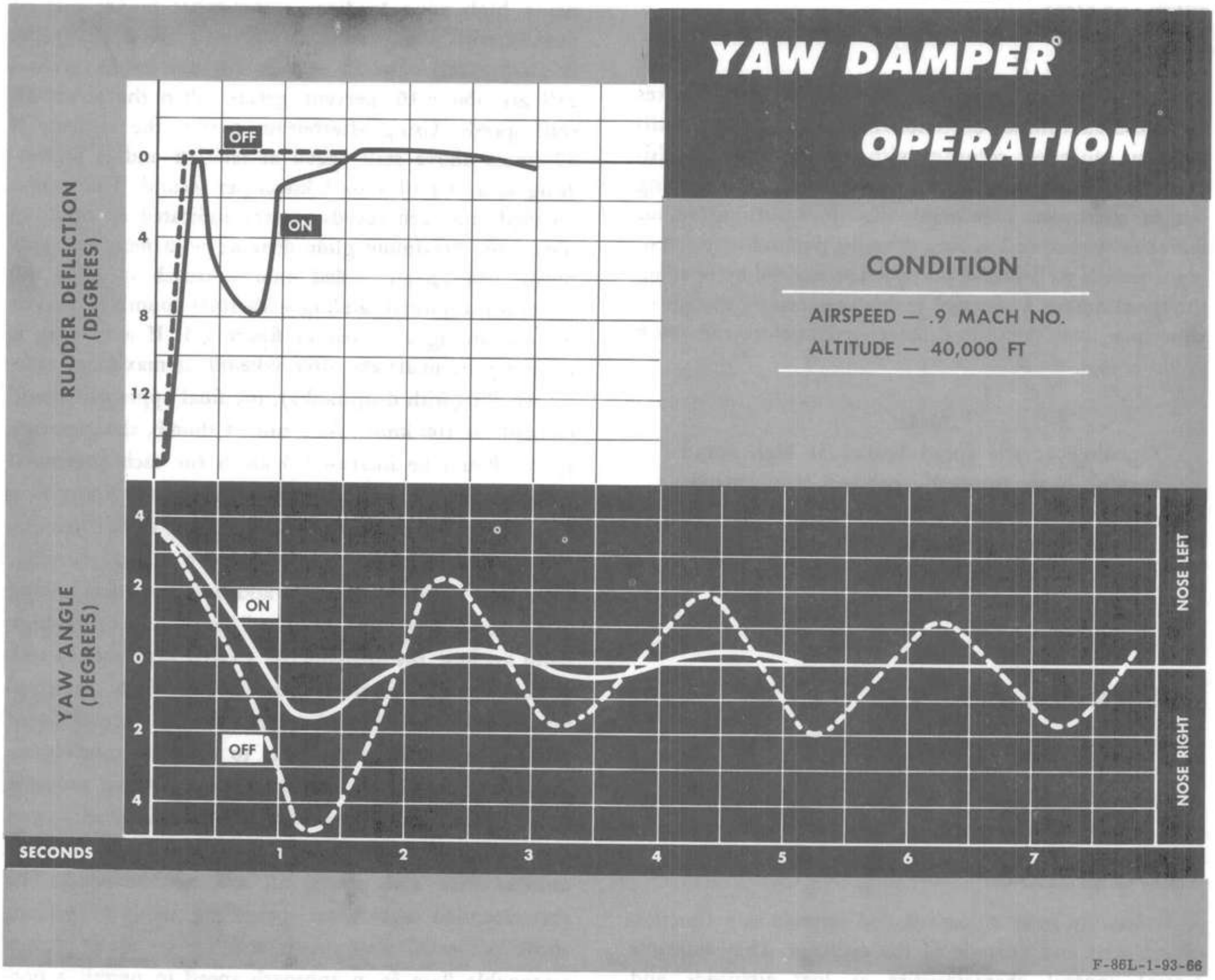


Figure 6-5

Mach .9, are typical of high-altitude directional characteristics. From these data, it can be seen that the yaw damper is an essential device to make this airplane a more effective and efficient rocket-firing platform. During an entry into a turn, when a turning rate is being built up, the rudder will kick back if your feet are on the rudder pedals, since rudder action is in such a direction as to resist rapid direction changes. It is recommended that your feet remain on the rudder pedals, but do not resist the yaw damper action. The magnitude of this kickback force is about 50 percent of the force that you apply. In the event of a damper failure, the maximum override force required to hold the rudder control is 180 pounds, which can be easily controlled until the yaw damper is turned off. The yaw damper should be turned "off" during pre-traffic-pattern check. Specific operational characteristics applicable for the manual rudder and powered rudder are given in the following paragraphs.

RUDDER OPERATION.

During normal damper operation in straight-and-level flight, pilot override rudder pedal forces will vary from 0 to 90 pounds. The magnitude of force required will depend upon the flight condition and the air turbulence. It is recommended that your feet remain on the pedals, but avoid interfering with the damper operation, as your force will decrease the damper effectiveness. In a turning maneuver, damper action will last ½ second or less. Within this time, the override force can build up to 180 pounds at the pedals. For this reason, it is recommended that the damper be inoperative during landing procedures. In the event of a yaw damper hard-over failure (electrical short), the maximum override force required to obtain rudder control would be 180 pounds at the pedals until the yaw damper is turned off. This type of yaw damper failure is not of sufficient magnitude to cause any structural damage to the airplane even if you do nothing to keep the airplane from yawing.

SPEED BRAKES.

Deceleration.

At any time that deceleration is desired, speed brakes may be used without objectionable buffeting. In a pullout, you can effect recovery with minimum loss of altitude by first opening speed brakes and then pulling out at maximum permissible G. Since turning radius increases with speed, a very effective method of tightening a turn is to decrease the speed as desired by opening the speed brakes. Use speed brakes as necessary to tighten your turn, and then close them again before too much speed is lost.

Note

> Opening of the speed brakes at high speed results in an automatic nose-up trim change, and an increase of approximately 1½ to 2 G. Correspondingly, retraction of the speed brakes results in a similar nose-down trim change and a decrease in G.

Tactical Maneuvers.

Speed brakes may be used to an advantage during tactical maneuvers whenever steep angles of approach are desired.

SLAT OPERATION.

The slats are fully automatic and operate as a function of airspeed and attitude of the airplane. They improve lateral control characteristics at low airspeeds and reduce the stalling speed. In level unaccelerated flight with no external load, the slats are cracked open at approximately 240 knots IAS and are fully open at approximately 165 knots IAS. The slats are designed to open under G-loads at speeds in excess of .65 Mach number. This results in increased lift potential and consequently higher available G at high altitudes and high Mach numbers.

LEVEL-FLIGHT CHARACTERISTICS.

LOW SPEED.

The stalling characteristics and handling qualities at low speed are very good. They are quite similar to those of a straight-wing fighter airplane, the only exception being that a higher angle of attack is required for take-off and landing, which is typical for a swept-wing airplane. When the afterburner is used, a much faster acceleration will be apparent because of the increased thrust. The rate of roll is very high, and aileron control is effective down through the stall. Since the airplane has a high wing loading, a somewhat higher rate of descent will be noticed at any given approach airspeed. Recommended take-off speeds for minimum ground roll are about 10 percent greater than the power-off stall speeds. Using afterburner power, the airplane is 17 knots above stall speed at take-off and is accelerating at a rate of 4 to 5 knots per second. The recommended approach speeds are the indicated airspeeds to obtain the maximum glide distance with flaps and gear down. The recommended final approach speed is 140 knots for a normal landing with 1000 pounds of fuel or less remaining as noted in figure 2-5. If a landing is necessary immediately after take-off at maximum take-off weight (with drop tanks), the final approach should be made at 160 knots. As a rule of thumb, the approach speed should be increased 5 knots for each additional 1000 pounds of fuel remaining, using 140 knots as a base point. For example, if 3000 pounds of fuel remain, this is 2000 pounds more than for a normal landing; therefore, 10 knots should be added to 140 knots, giving an approach speed of 150 knots IAS. Because of the high wing loading, the airplane has a fairly high rate of sink at low speed; therefore, caution should be exercised not to allow the airspeed to get too low, since sufficient airspeed will not be available to flare for touchdown. This will result in an extremely hard landing unless it is anticipated and is avoided by an application of power. For best landing results, power approaches with a simultaneous flare and power cut are recommended. The recommended touchdown speeds are about 17 percent above power-off stall speeds and are set up to give a reasonable flare from approach speed to permit a normal landing without touching down too hard.

CRUISE SPEED.

At medium to high speeds, maximum lift capabilities of the airplane, thrust-drag ratio, handling characteristics, and control effectiveness are excellent. These qualities ensure good maneuverability and combat performance. The controllable horizontal tail is very effective in the cruise Mach number range; until you have become accustomed to it, the fast response of the airplane to small stick movements may cause you to feel that the airplane is too sensitive. Thus, it is advisable to become thoroughly familiar with the airplane before attempting close formation flight.

HIGH SPEED.

This airplane is capable of speeds into the transonic speed range. The combat allowance chart in Appendix I

MANEUVERING STICK FORCES

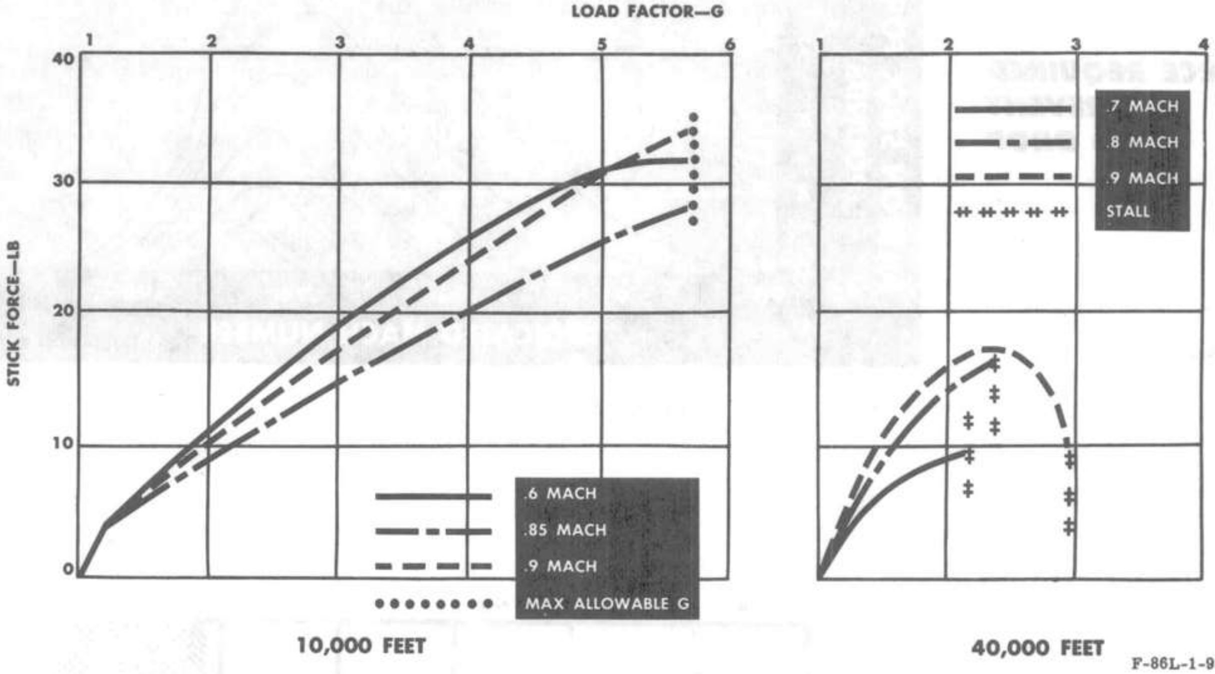


Figure 6-6

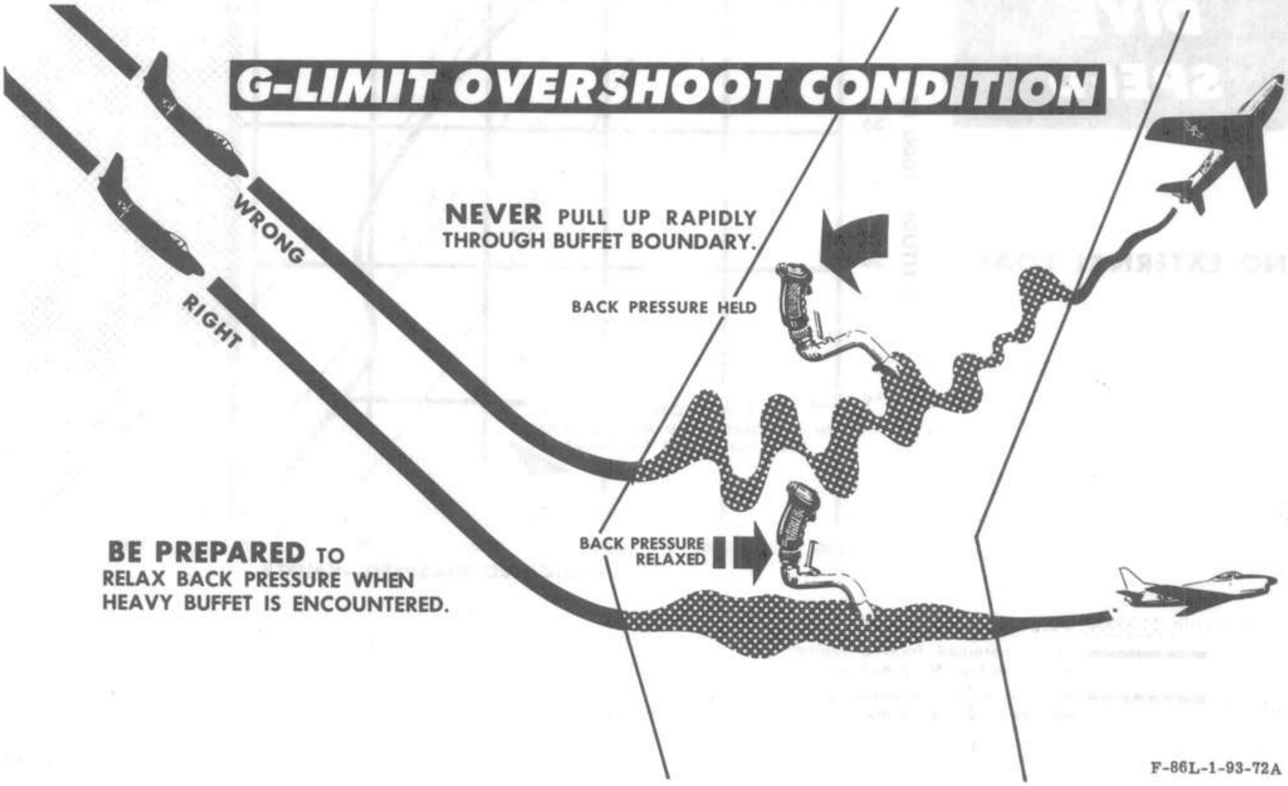
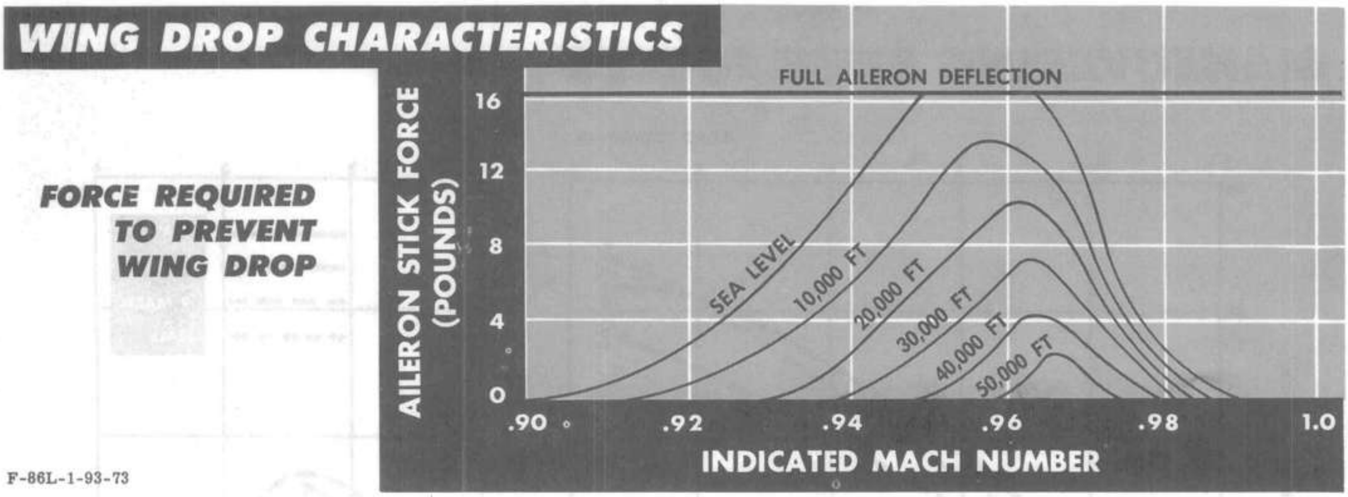


Figure 6-7



WING DROP CHARACTERISTICS

FORCE REQUIRED TO PREVENT WING DROP

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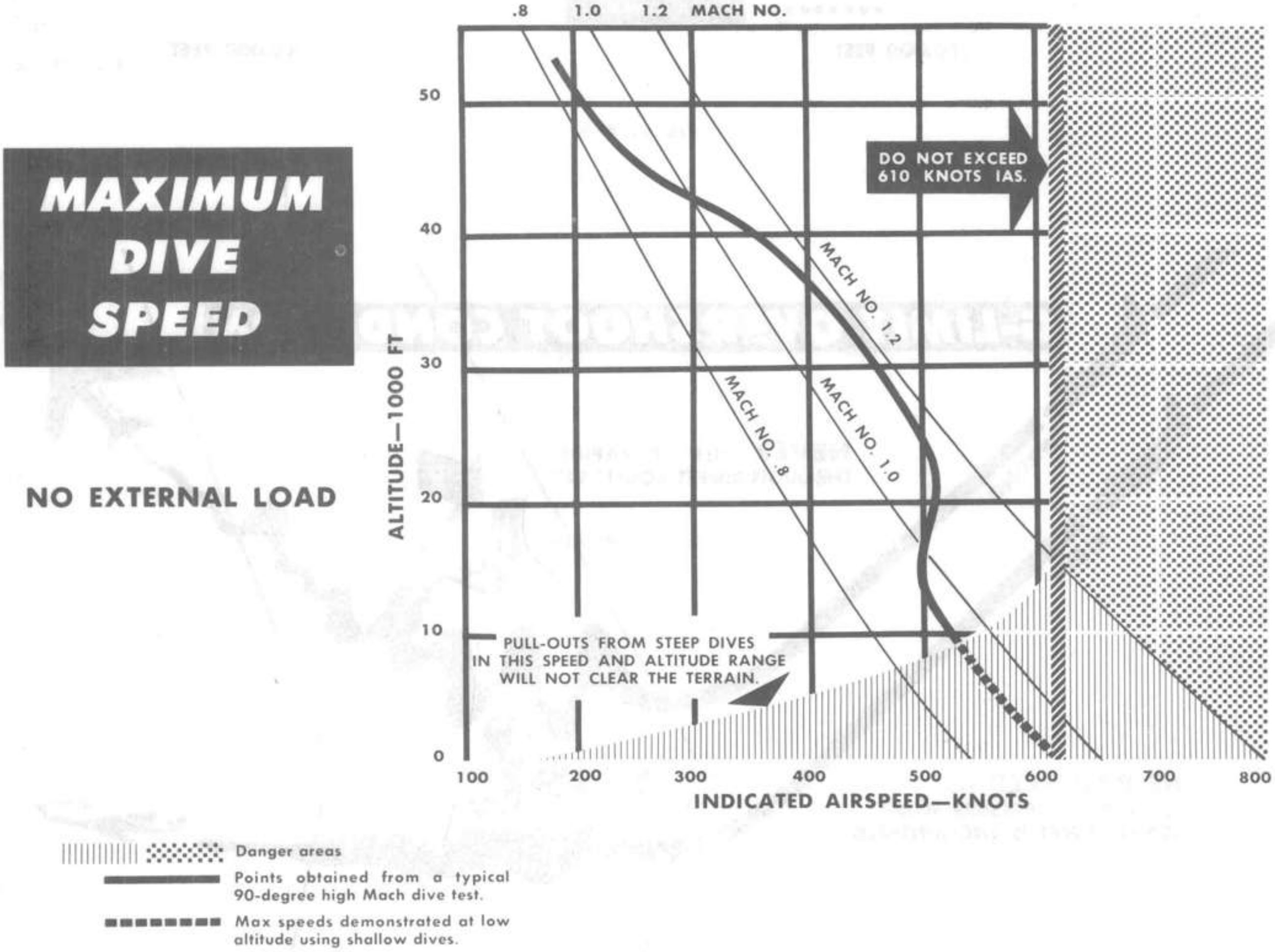
Figure 6-8



MAXIMUM DIVE SPEED

NO EXTERNAL LOAD

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Figure 6-9

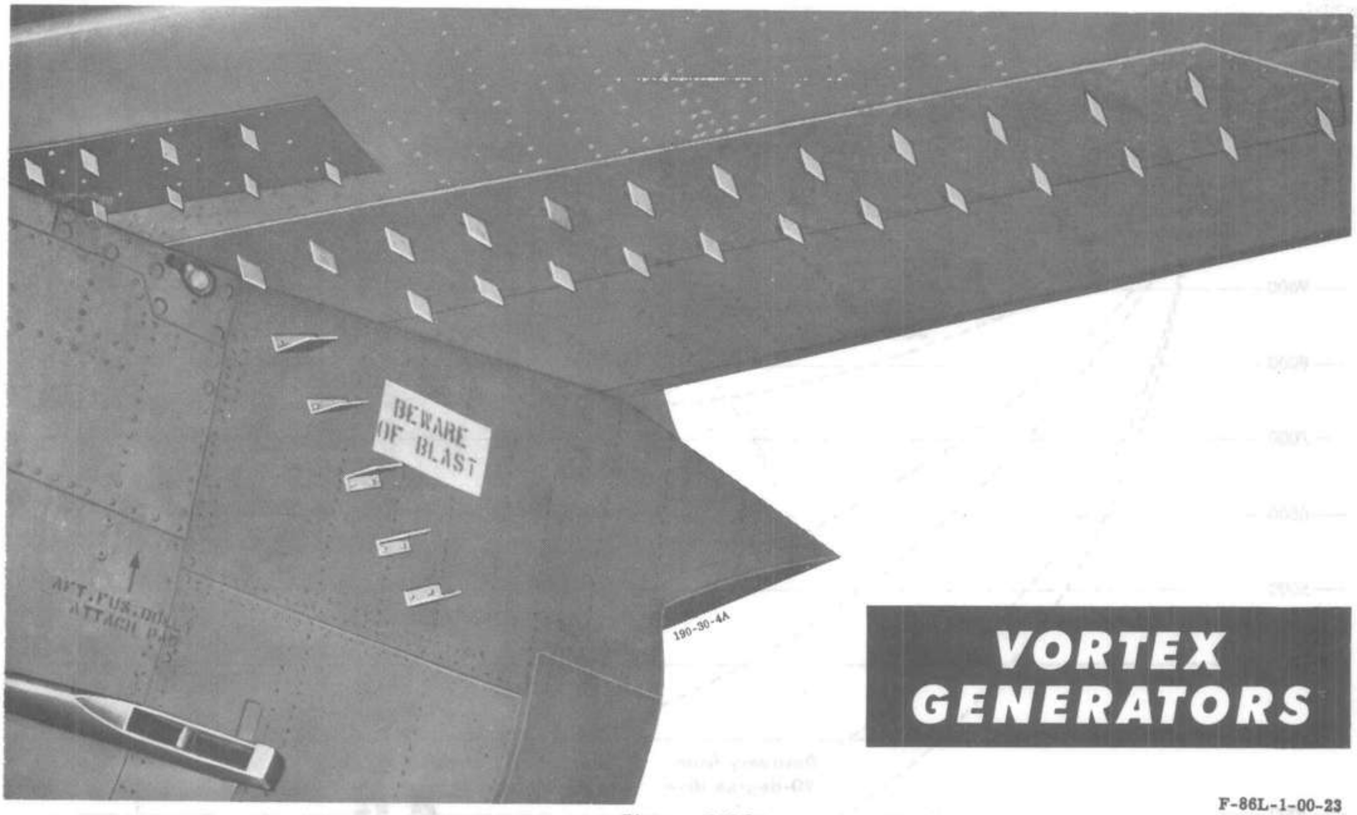

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Figure 6-10

shows the maximum level-flight Mach number capabilities of a clean airplane and an airplane carrying 120-gallon drop tanks, using Military and Maximum Thrust. Certain portions of the drop tank Maximum Thrust curve exceed the placard limit. (Refer to Section V.) These Mach numbers represent level-flight stabilized speeds. The airplane is easily controlled through the transonic speed range to the maximum capabilities of the airplane. Stability and control are essentially unaffected up to about Mach .95. However, you may notice a reduction in the rate of stick force change between Mach .8 and .9 when flying at one G. As the speed is increased above Mach .9, the stick push forces will steadily increase (airplane "tucks up," showing positive stability), but will never become uncomfortably high. The controllable horizontal tail is very effective at high indicated airspeeds and particularly between Mach .8 and .9. Since pilot feel is achieved through a spring bungee, the resultant effect of these trim changes is relatively mild, in that stabilizer stick forces increase only about 20 pounds in the "tuck-up" region. At low altitudes, progressive wing heaviness may develop on some airplanes with increasing airspeed; therefore, airplane operation should be at airspeeds where enough aileron control is available to control this characteristic. If an uncontrollable wing heaviness or wing drop is encountered, slow up by making a gentle pull-up, by opening speed brakes, or by reducing power. It is possible to alleviate the tendency toward wing heaviness at low altitude by rigging the wing flaps to counteract the basic roll tendency. Rigging must be within accepted limits. On most airplanes, the maximum level-flight speed is below the speed where wing drop is encountered. Rate of roll is high for fighter-type airplanes, particularly in the combat Mach number range.

VORTEX GENERATORS.

To minimize buffet caused by shock waves between Mach .81 and .92, a series of small vanes (figure 6-10) are installed on the underside of the horizontal tail and on the fuselage below the horizontal tail. Installation of these vanes eliminates the turbulent airflow which produces the buffet, and, with the elimination of the turbulent airflow, the airplane drag is also reduced. These vanes are termed "vortex generators," as they create small whirlpools of air, commonly called vortices. These vortices stir up the slow-moving air found close to the fuselage, thus allowing the smooth flow of air to continue farther aft on the fuselage before becoming turbulent.

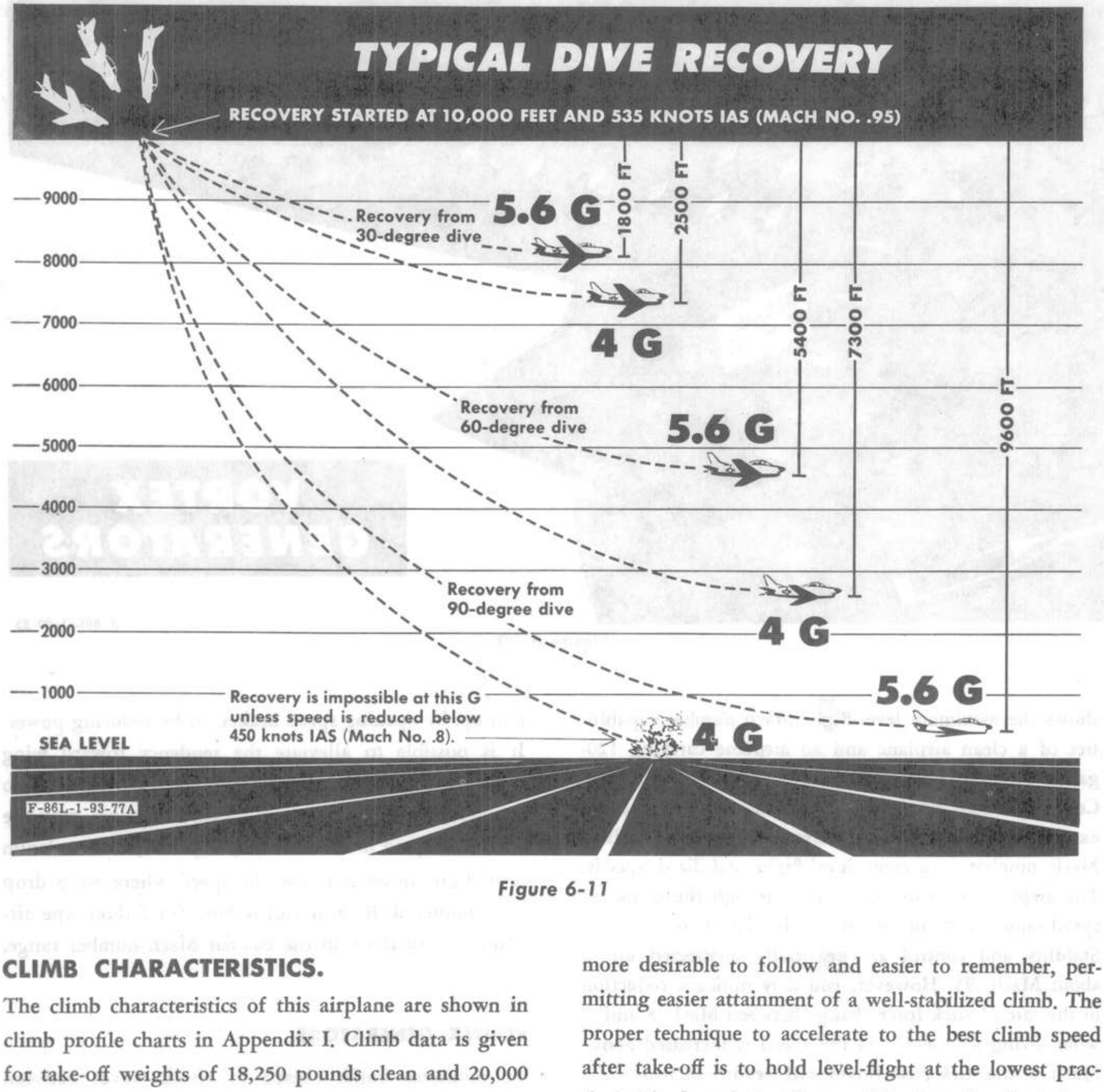


Figure 6-11

CLIMB CHARACTERISTICS.

The climb characteristics of this airplane are shown in climb profile charts in Appendix I. Climb data is given for take-off weights of 18,250 pounds clean and 20,000 pounds with 120-gallon drop tanks installed. In all cases, the fuel used (or weight reduction) during ground operation, take-off, and climb is accounted for. Fuel allowed for ground operation and accelerating to climb speed is about 600 to 800 pounds. Anticipate a slightly higher fuel consumption during afterburner operation for airplanes using the J47-GE-33 engine.

CLIMB SPEEDS.

The climb speed schedules are shown in terms of Mach number. A Mach number schedule is considered much more desirable to follow and easier to remember, permitting easier attainment of a well-stabilized climb. The proper technique to accelerate to the best climb speed after take-off is to hold level-flight at the lowest practical altitude and start the transition into the climb about .03 Mach number below the desired climb schedule (.06 for Maximum Thrust clean), picking up the stabilized climb schedule about 5000 to 10,000 feet above the ground. This transition is shown on the climb speed chart.

TIME TO CLIMB.

These climb schedules have been determined to give the shortest time to any altitude for Maximum Thrust and the longest range for Military Thrust. Time required to accelerate to climb speed from brake release at take-off and time required to accelerate from climb speed at end altitude to combat speed have been considered in these climb schedules. If minimum time to altitude is the primary objective, a Maximum Thrust climb should be used. If the consideration is maximum range, a Military Thrust climb should be used.

MANEUVERING-FLIGHT CHARACTERISTICS.

MANEUVERABILITY.

At all Mach numbers and airspeeds, maneuvers may be accomplished with relative ease. The flight capabilities achieved through use of the swept wing, the horizontal tail as the direct longitudinal control, and the completely hydraulic flight control system are especially noticed during maneuvers at high Mach numbers. Very little rudder action is necessary in performing maneuvers. Stick forces during maneuvering flight (figure 6-6) are moderate and relatively uniform over the entire speed and altitude range. The stick force required to pull G does not decrease at high altitudes and at low indicated airspeeds. Instead, there is a slight increase in stick force required to pull G as the indicated airspeed is decreased. This occurs because the artificial feel system is based on stabilizer deflection alone, rather than on stabilizer deflection and indicated airspeed. This may seem unnatural at first, but you will soon become accustomed to this type of variation. You will find that the reduced stick forces and increased maneuverability resulting at high Mach numbers and high indicated airspeeds greatly improve the tactical capabilities of the airplane. The increase in stick force required to pull G at high altitudes effectively results in a more stable and comfortable airplane to fly at altitudes where most airplanes become very "sloppy." At high altitudes during pull-ups into the buffet region, or at intermediate altitudes and low Mach numbers, you may notice a slight decrease in stick force just before the stall. This characteristic is particularly noticeable at high altitudes near Mach .9. This condition is termed "dig-in."

G-LIMIT OVERSHOOT.

When G is increased to a certain value above the G at which buffet begins, the airplane will feel less stable in pitch and may dig in. As the airplane digs in, thus tending to increase G automatically, the intended G—and in some cases the maximum allowable G—may be exceeded. This condition is termed "overshoot." This overshoot is caused by a basic instability characteristic of the airplane which exists when the wing is near stall. Overshoot is most likely to be encountered when the airplane is well into the buffet region. Therefore, the start of general airplane buffet is a warning that you are approaching the overshoot region. Although overshoot can cause the maximum allowable G-limit to be exceeded and possibly damage the airplane, the control power available, because of the completely hydraulic flight control system and the one-piece horizontal tail, enables you to apply immediate and effective recovery action before the airplane exceeds the G-limit. Since the buffet boundary automatically accounts for changes in altitude, Mach number, and gross weight, use the buffet region as a sign of possible overshoot conditions. Always remember that the airplane is limited to 5.6 G clean and 5.0 G with drop tanks installed. When encountering the buffet boundary, slow your rate of pull-up and be prepared to apply immediate recovery control to prevent overshoot and possible damage to the airplane. (See figure 6-7.)

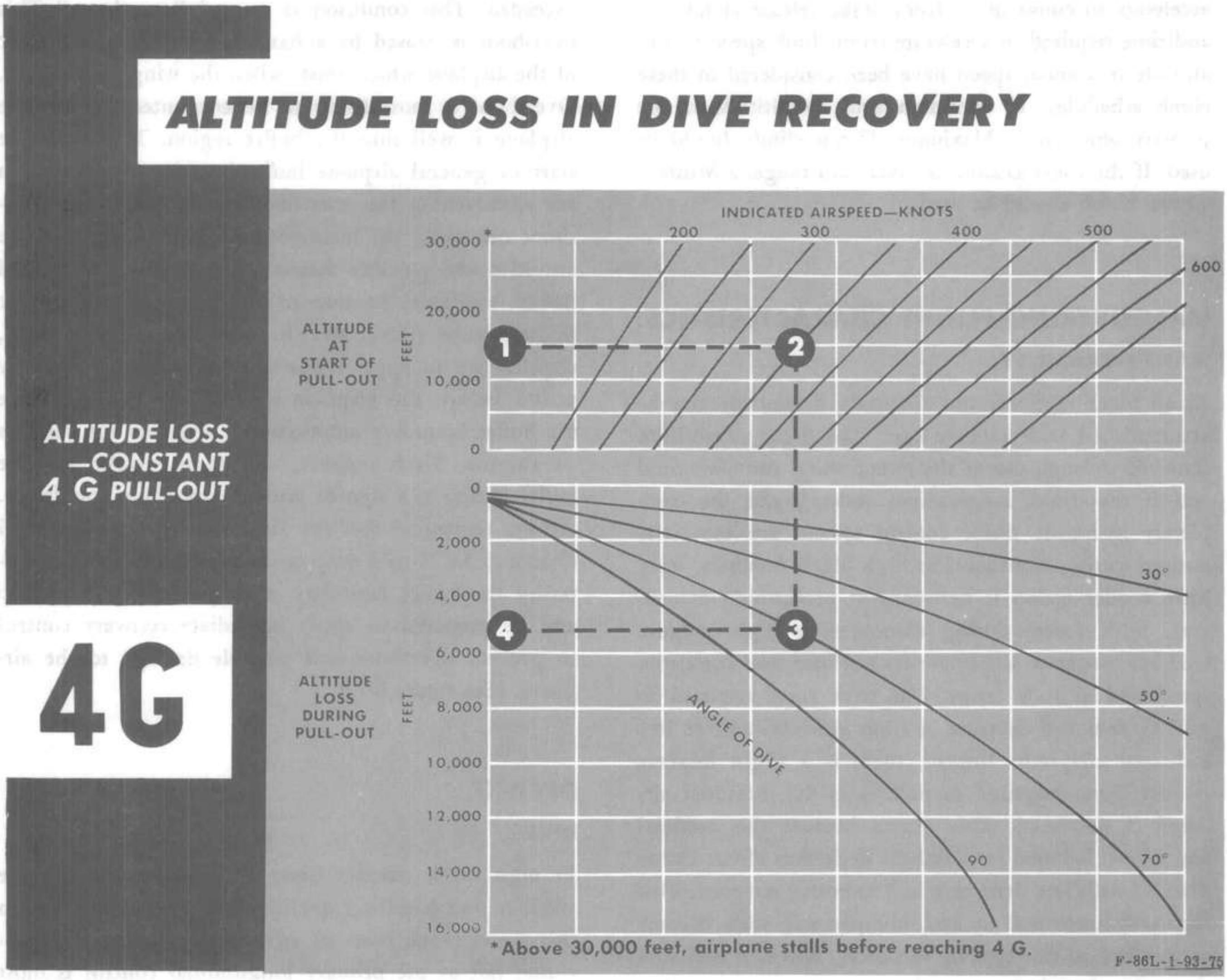
DIVING.

DIVES.

In high Mach number dives and maneuvers, airplane stability and handling qualities are very good. It is in this speed range that the advantage of using the horizontal tail as the primary longitudinal control is most apparent. The stick forces remain at a comfortable level, and the airplane is easily controlled at all Mach numbers. In the transonic speed range between Mach .96 and 1.0, a wing drop and a slight yawing characteristic are encountered. The wing drop is a rather abrupt roll but may be controlled by application of corrective aileron and rudder. The airplane handles very smoothly with no uncontrollable or erratic motions up to maximum possible dive speeds. The severity of the wing drop is greater at low altitudes than at high altitudes. This is shown by figure 6-8, which presents stick force to control the wing drop for various altitudes.

FLIGHT TEST DIVES.

During the flight testing of this airplane, many high Mach number dives were conducted. A sample of these dives is shown in figure 6-9 for a 90-degree dive, using Maximum Thrust. For example, the highest true Mach number obtained was 1.17 Mach number shown between



*Above 30,000 feet, airplane stalls before reaching 4 G.

Figure 6-12

35,000 and 30,000 feet with the dive started from service ceiling. No undesirable flight characteristics are encountered during high Mach dives other than wing drop which is easily corrected. The speeds shown in figure 6-9 below 15,000 feet were not obtained at 90-degree dives. Mach numbers attained in this range are lower because of reduced dive angles, the more severe wing drop tendency, and the altitude required to perform a safe pull-out.

DIVE RECOVERY.

Dive recovery (figure 6-11) is accomplished by application of necessary stick back pressure to effect the desired pull-out. Speed brakes may be used to reduce airspeed during pull-outs. Stabilizer stick forces to accomplish pull-outs are satisfactory and do not increase rapidly. During pull-outs from dives or in accelerated turns, the stabilizer develops sufficient control power to enable the maximum allowable G or stall to be reached throughout the speed and altitude range. Take care that you do not damage the airplane by overcontrol before you become accustomed to the rapid response of the airplane to control stick movement.

Altitude Loss in Dive Recovery.

The altitude lost during dive recovery is determined by four interdependent factors: (1) angle of dive, (2) altitude at start of pull-out, (3) airspeed at start of pull-out, and (4) the G maintained during pull-out. Because these factors must be considered collectively in estimating altitude required for recovery from any dive, their relationship is best presented in chart form as shown in figure 6-12. Note that one of the charts is based on

HOW TO USE CHARTS

Select appropriate chart depending upon acceleration (4 G or 5.6 G) to be held in pull-out; then

① Enter chart at altitude line nearest actual altitude at start of pull-out (for example, 15,000 feet).

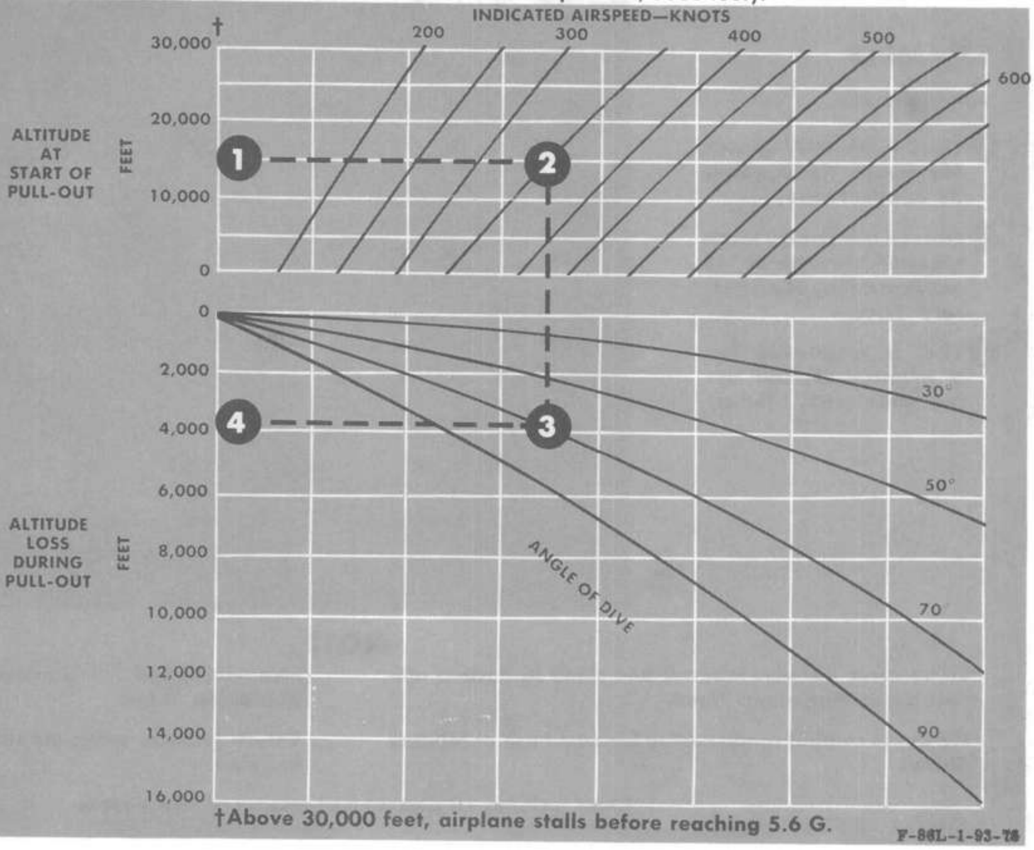
② On scale along altitude line, select point nearest the IAS at which pull-out is started (350 knots IAS).

③ Sight vertically down to point on curve of dive angle (70°) directly below airspeed.

④ Sight back horizontally to scale at left to read altitude lost during pull-out (constant 4 G pull-out, 5000 feet; constant 5.6 G pull-out, 3800 feet).

ALTITUDE LOSS —CONSTANT 5.6 G PULL-OUT

5.6G



†Above 30,000 feet, airplane stalls before reaching 5.6 G.

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a 4-G pull-out, and the other on a 5.6-G pull-out. Compare the altitude lost during recovery from a 4-G pull-out with that lost during recovery from a 5.6-G pull-out; also compare the effects of variations in the other three factors. Remember that a value obtained from either chart is the altitude lost during recovery—not the altitude at which recovery is completed. Therefore, in planning maneuvers that involve dives, consider first the altitude of the terrain and then use the charts to determine the altitude at which recovery must be started for pull-out with adequate terrain clearance. In using the charts, you should allow for the fact that, without considerable experience in this airplane, you cannot determine exactly what your dive angle and speed are going to be at the start of the pull-out. If you come out of a split "S" or other high-speed maneuver in a near-vertical dive, speed builds up rapidly. Therefore, until you know the airplane well, go into the chart at the highest speed and dive angle you might expect to reach after completing your maneuvers. If, for instance, you are in a 90-degree dive at an airspeed above Mach .8 and you wait until 10,000 feet to start your pull-out, you would have to make a 5.6-G pull-out; a 4-G pull-out would not clear the terrain. (See figure 6-12.) Maneuvers should be planned so that if they terminate in a near-vertical dive, the airplane may be pulled on through to a shallower dive angle before the speed becomes excessive or before too low an altitude is reached.

Note

It is a good idea to memorize a few specific conditions from the dive charts so that you have a basis for judgment on pull-outs.

COMBAT TIME AVAILABLE

(NO EXTERNAL LOAD)

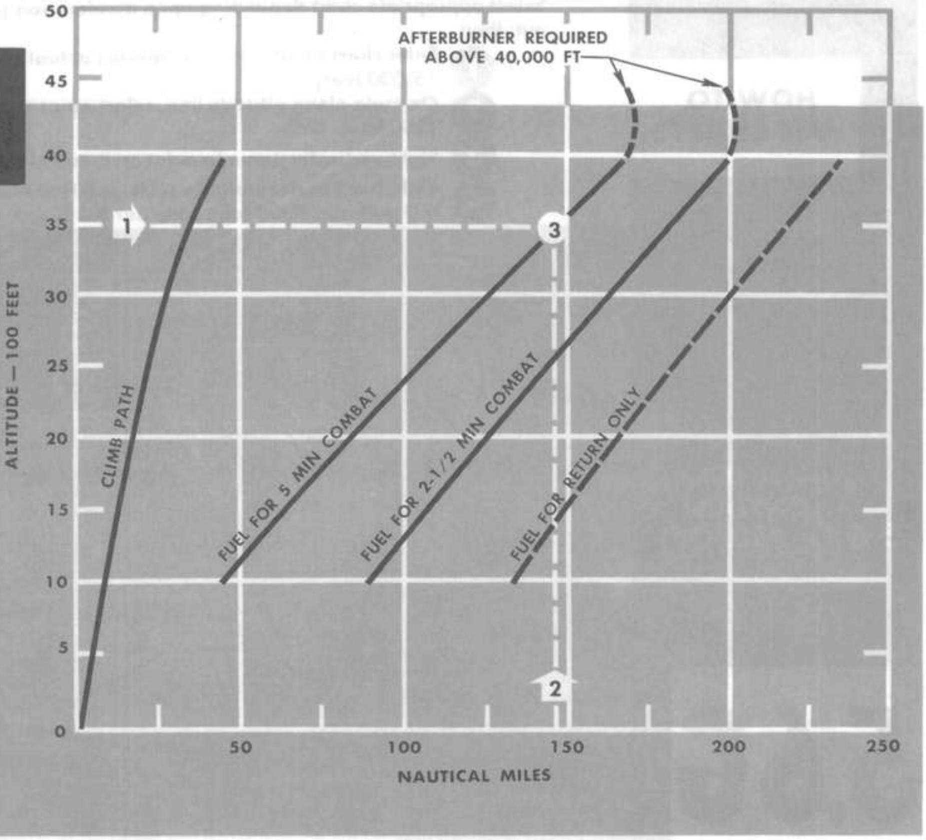
EXAMPLE

After take-off:

① Climb to 35,000 feet with Maximum Thrust, range 35 nautical miles.

② Proceed to intercept target reported at range of 145 nautical miles, using Military Thrust.

③ Fuel is available for 5 minutes combat using Maximum Thrust.



NOTE

Climb curve includes take-off and climb to desired altitude using Maximum Thrust.

Fly-out to combat range curves based on use of Military Thrust.

Five minute and 2-1/2 minute combat curves based on Maximum Thrust.

Return to base, using maximum range data from Appendix I.

Chart includes 10 percent fuel reserve of 400 pounds.

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Figure 6-13

EFFECTS OF GUSTS.

The gust load imposed on the airplane increases directly with the speed; if the speed is doubled, the gust load will double. At high speeds in extremely turbulent air, gust loads may be as high as 4 G. If the gusts occur during high-speed maneuvering flight, they can cause the limit load factor of the airplane to be exceeded. Therefore, if it is necessary to fly in turbulent air, reduce your speed, and refrain from intentionally pulling more than 2 G. (Refer to "Turbulence and Thunderstorms" in Section IX for a comfortable speed for penetrating an area of turbulent air.)

ROCKET PACKAGE.

As the rocket package is installed in the underside of the airplane, there are no changes in flight characteristics when rockets are carried. Therefore, no limiting Mach number or airspeed is required. However, the limitations on rocket package operation during normal accelerations are shown in Section V.

FERRY OPERATIONS.

To obtain maximum range with this airplane, a number of important techniques or flight conditions are necessary. The proper cruise technique is as follows: (1) Climb with Military Thrust to cruise altitude. The cruise altitude is defined as the altitude where the rate of climb is about 500 fpm. (This altitude rather than a fixed altitude is used because of variations in engine thrust between one engine and another.) (2) Level out and accelerate to the proper cruise Mach number, using Military Thrust. To aid in reaching the cruise Mach

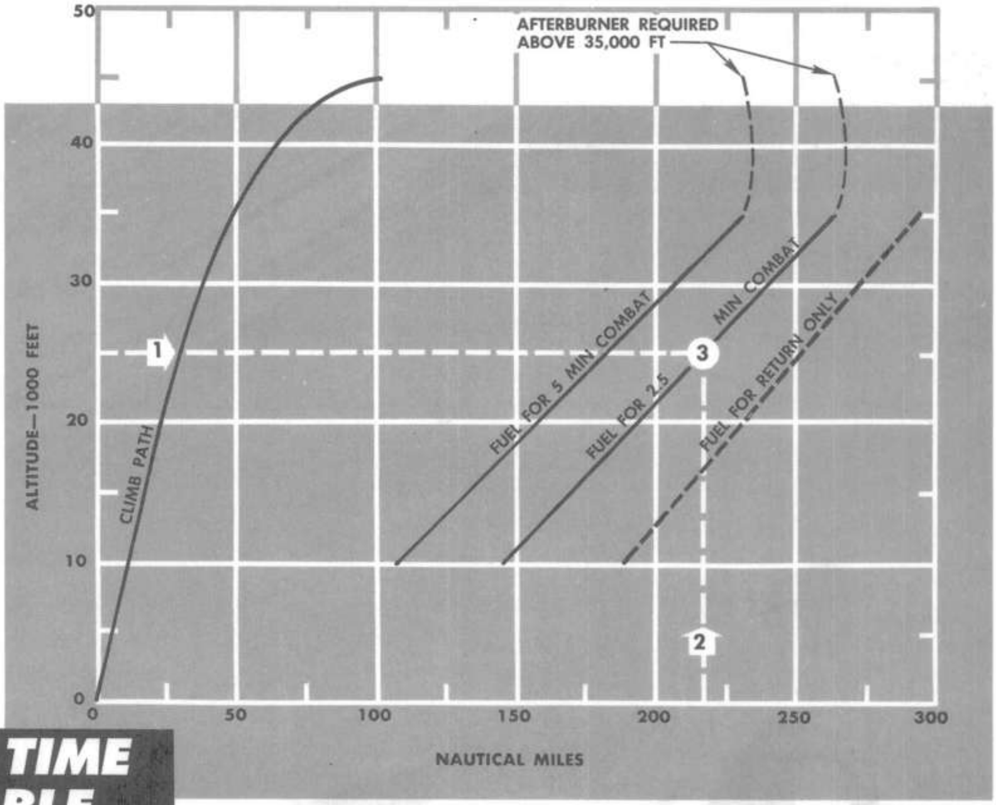
EXAMPLE

After take-off:

① Climb to 25,000 feet with Maximum Thrust, range 30 nautical miles.

② Proceed to intercept target reported at range of 215 nautical miles. Use Military Thrust.

③ Fuel is available for 2.5 minutes combat, using Maximum Thrust.



COMBAT TIME AVAILABLE

(WITH DROP TANKS)

NOTE

Climb curve includes take-off and climb to desired altitude, using Maximum Thrust.

Fly-out to combat range curves based on use of Military Thrust.

Five-minute and 2.5-minute combat curves based on Maximum Thrust.

Return to base, using maximum range data from Appendix I.

Chart includes 10 percent fuel reserve of 550 pounds.

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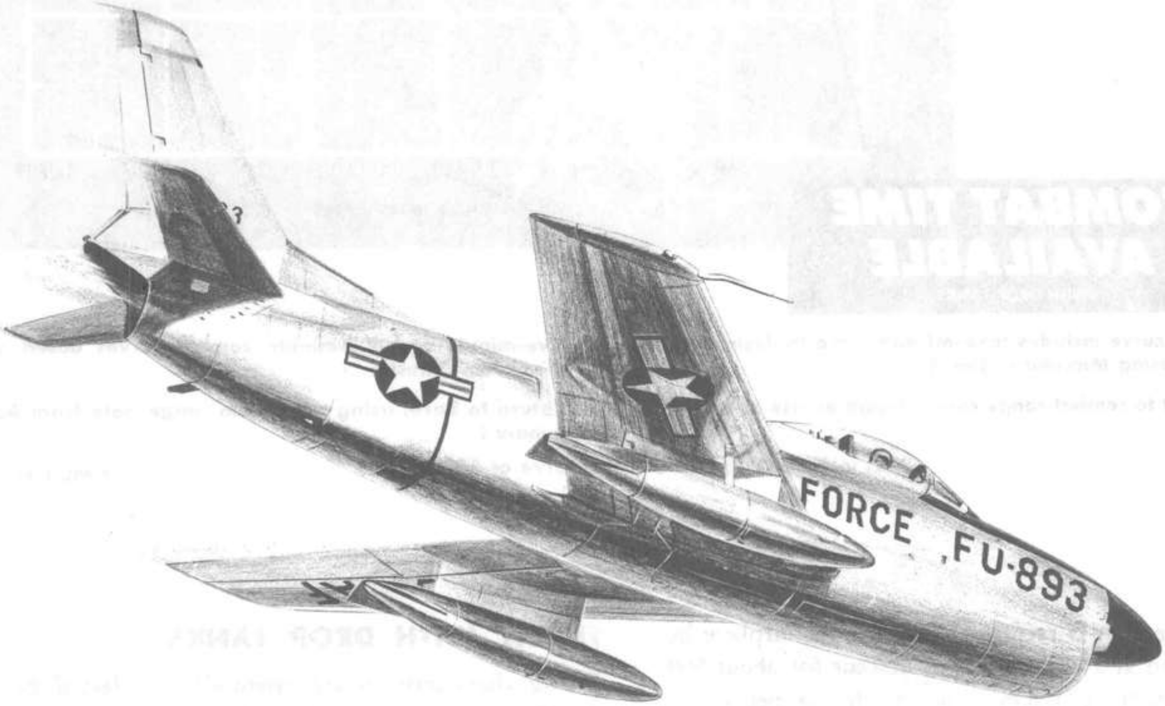
number sooner, it is recommended that the airplane be shallow-dived at 250 fpm rate of descent for about 500 feet of altitude. (3) Level out at the proper cruise speed and set up the engine power to 635°C tail-pipe temperature. Maintain these conditions, and let the airplane seek the proper altitude. With this power and speed, the airplane will climb as fuel is used. (4) Make a letdown at the highest comfortable Mach number, observing the exhaust temperature limits for descents, with speed brakes full open.

FLIGHT WITH DROP TANKS.

Flying characteristics are essentially unaffected by the installation of the 120-gallon drop tanks. Do not exceed airspeed limitations when drop tanks are installed. (See figure 5-1.) As a result of the increased drag and weight, take-off distances will naturally be greater and the rate of climb reduced. If tanks are to be dropped, refer to "Drop Tank Release Speed" in Section V for acceptable drop speeds.



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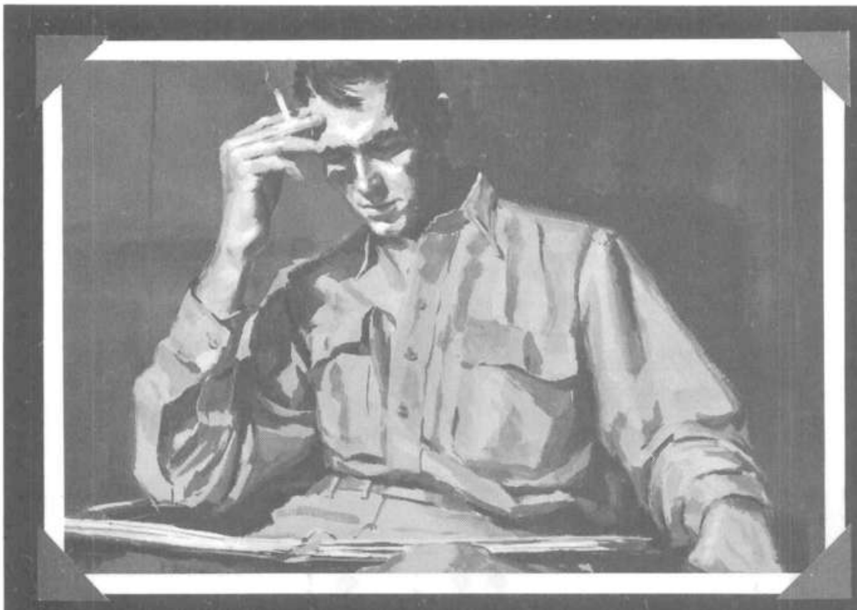


Systems Operations

SECTION VII

TABLE OF CONTENTS

ELECTRONIC ENGINE CONTROL.

The jet engine of this fighter-interceptor is controlled through an integrated electronic control from a single throttle. The throttle gives complete, correct control of engine fuel, variable-area nozzle, and afterburner fuel at all times. The control system (figure 7-1) is basically an engine speed and engine temperature regulator, in which variables are under control at all times. In relation to throttle position, the thrust selector sets engine speed, variable-nozzle area, and afterburner fuel flow and transmits these signals electrically to the amplifiers. The amplifiers also receive signals of engine speed, compressor inlet temperature, compressor discharge pressure, and turbine discharge temperature. The composite output of the amplifiers, resulting from the joining of these signals, controls the settings of the main fuel valve, the afterburner fuel valve, and the variable-area nozzle actuator. Outstanding features of this control system are strict control over engine speed and exhaust gas temperature throughout the operating range under all normal flight conditions; direct relationship between throttle position and engine thrust output; realization of near-optimum engine conditions at each power setting; automatic ground starting; automatic engine and afterburner flame-out protection under all flight conditions; high rate of engine acceleration, automatically controlled; and freedom from compressor stall and engine overtemperature (excluding the momentary condition following the switching from emergency to the main fuel system).

THRUST SELECTOR.

The thrust selector is in the left equipment bay. It converts throttle movement into electrical signals. There are three potentiometers within the thrust selector housing: one for engine speed signals, one for variable-nozzle position signals, and one for afterburner fuel scheduling signals. There are two types of thrust selectors presently in use. Both thrust selectors operate in the same manner and are interchangeable, the main difference being in the variable-nozzle position when at idle engine speed. With the throttle in the START IDLE position, the new thrust selector calls for a nozzle position of about three-fourths open instead of the one-half open position on the older type. In addition, throttle sensitivity is decreased at high power settings and increased at low power set-

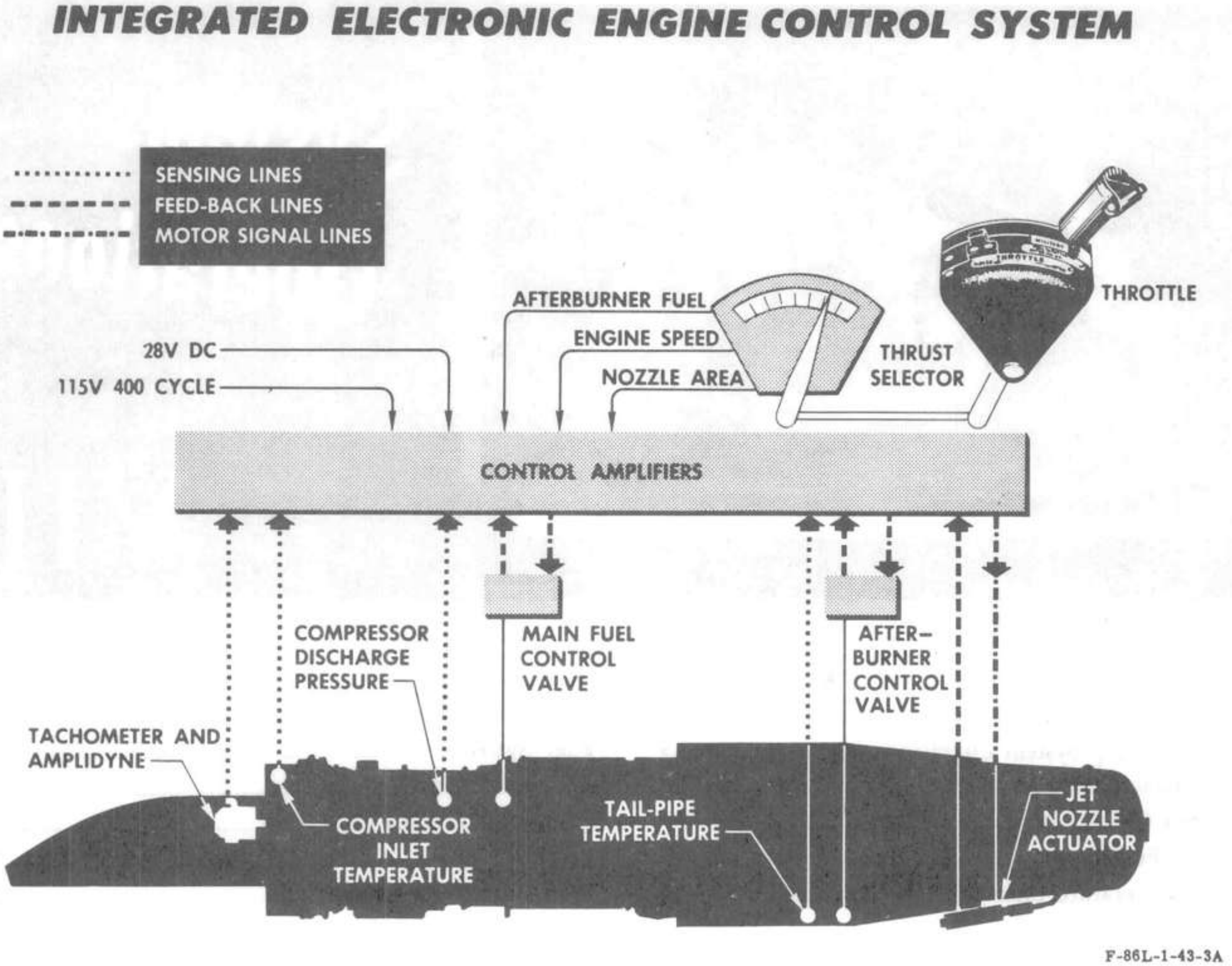


Figure 7-1

tings. Also, at high power settings, a given exhaust temperature can be selected easier, and the engine will maintain 100% rpm through a greater arc of throttle travel. At low power settings, engine rpm and thrust will respond more for a given throttle movement. This new thrust selector will also decrease acceleration time on throttle bursts from idle rpm, decrease thrust faster on a throttle chop, and give cooler engine shutdowns.

AUTOMATIC START CHARACTERISTICS.

The automatic starting system of the integrated electronic engine control has greatly simplified starting procedures and has virtually eliminated overtemperature operation associated with jet-engine starting. If, however, a malfunction occurs during an automatic start, it is important that the pilot be familiar with the exhaust gas temperature and fuel flow characteristics during ignition and acceleration to idle, so that proper action can be taken to prevent any possibility of later engine overtemperature operation. Full use of the automatic starting provisions of the electronic engine control by the contractor has proved the system to be very reliable. Exhaust gas temperature is a direct function of the amount of fuel being supplied to the engine, and the exhaust temperature indications will be very similar to the general pattern of the fuel flow. Pilot and crew chief familiarity with the starting fuel pressure and fuel flow pattern (figure 7-2) will make it obvious when an overtemperature condition will occur and allow enough time to retard the throttle to the CLOSED position to prevent an engine overtemperature condition. A start using the automatic starting system is recommended because starting is much easier and safer and less throttle manipulation is required to keep the exhaust gas temperatures within the required limits. Also, an automatic start will give an early indication of the operability of the engine control since inability to accomplish an automatic start indicates a control or fuel system failure. If, for any reason, it is suspected that the engine control system may not function properly during engine starting (especially after the airplane has been exposed to heavy rainfall), it is recommended that the engine be first started using the manual start procedure. After the engine has been started and checked as satisfactory, then shut down and perform an automatic start. If an automatic start cannot be accomplished, it is recommended that the airplane not be flown until an investigation is made to isolate and replace the faulty part. There are three functional ground checks which the pilot can use to determine whether the electronic engine control is operating:

a. Automatic start capabilities.

b. Stall-free throttle bursts from idle to Military Thrust (emergency fuel switch in NORMAL).

c. Temperature control during afterburner light-up.

Omission of any one of these checks before take-off decreases the possibility of detecting improper engine control.

When the throttle is advanced directly to START IDLE at 6% rpm, the fuel flow will build up to about 600 pounds per hour. (A characteristic of the fuel flowmeter indicating system is that when the throttle is moved to START IDLE, the fuel stopcock opening allows the fuel flow to rise very abruptly to about 900 to 1000 pounds per hour, and then rapidly fall to about 600 pounds per hour. This "blip" in the indicated fuel flow is momentary and should not be mistaken as a failure in the fuel control system.) When ignition occurs, exhaust temperature will rise and peak at about 600°C (700°C on the -33 engine). As engine speed increases, fuel flow will remain steady at 600 pounds per hour, and exhaust temperature will decline slightly. At about 14% rpm, fuel flow will again rise rather sharply until it reaches a peak of about 950 pounds per hour. The exhaust temperature will increase correspondingly and peak at about 815°C. As engine rpm increases above 14%, the fuel flow will gradually climb to about 1500 pounds per hour and as the engine stabilizes at the idle rpm, the fuel flow and exhaust gas temperature will slowly decline to some lower value (between 800 and 1300 pounds per hour and between 400°C and 600°C). If cockpit indications during an automatic start depart from these trends (figure 7-2), shut down engine immediately by chopping throttle to CLOSED to prevent overtemperature. If the fuel flow builds up too rapidly and does not level off at about 600 pounds per hour at 6% rpm, it is an indication of a *shorted thermocouple* or some other control system failure. Under this condition, exhaust temperature will rise at a rapid rate until 950°C is exceeded. Overtemperature caused by an *open thermocouple* is indicated by the fuel flow and exhaust temperature remaining at the initial peak level until 14% rpm is exceeded, at which time the fuel flow and exhaust temperature will increase very rapidly until 950°C temperature is exceeded. Knowledge of engine start characteristics will help to *anticipate* and *prevent* hot starts, and will help extend the engine service time to the normal engine overhaul time limit.

AUTOMATIC LOCKUP SYSTEM CHARACTERISTICS.

The lockup system was devised to immobilize the main fuel valve, afterburner fuel valve, and variable-area nozzle to prevent any erratic engine operation that may accompany an ac power supply loss or recovery. To further simplify pilot operating procedures during such an ac power supply loss, the lockup system was made to operate automatically. This permits full engine control to be maintained until an ac power supply failure is actually encountered. A voltage sensitometer unit, incorporated in the lockup system, senses voltage changes and, whenever ac voltage drops below about 92 volts, automatically locks the electronic engine controls in position. It also illuminates an "ENG CONT LOCKUP" light in the cockpit to show that the electronic engine controls are in the locked condition. When it is desirable to remain in lockup, during the critical take-off period or in anticipation of automatic unlocking, continue flying to a safe altitude and level off. When automatic unlocking occurs, a change in thrust may be expected. However, any power surges that may develop will be controlled electronically within the engine limits. If power readjustments are required when operating within the afterburner range while the engine control lockup caution light is on, engine operation on the emergency fuel system must be manually selected by rapidly retarding the throttle to START-IDLE and immediately selecting the emergency fuel system.

Note

- When retarding the throttle under these conditions, it must be retarded to START-IDLE to prevent dangerous overspeeding of the engine. In this case, the nozzles are locked at the three-fourths position, and there is very little back pressure on the turbine wheel. This will result in a dangerous overspeed condition if the throttle is left at MILITARY on the emergency fuel system. After retarding the throttle to START-IDLE and switching to emergency fuel system, the nozzles should be closed manually to one fourth open, and the throttle should be readvanced cautiously for desired thrust.
- During engine lockup, moving the emergency fuel system switch to ON, or actuating

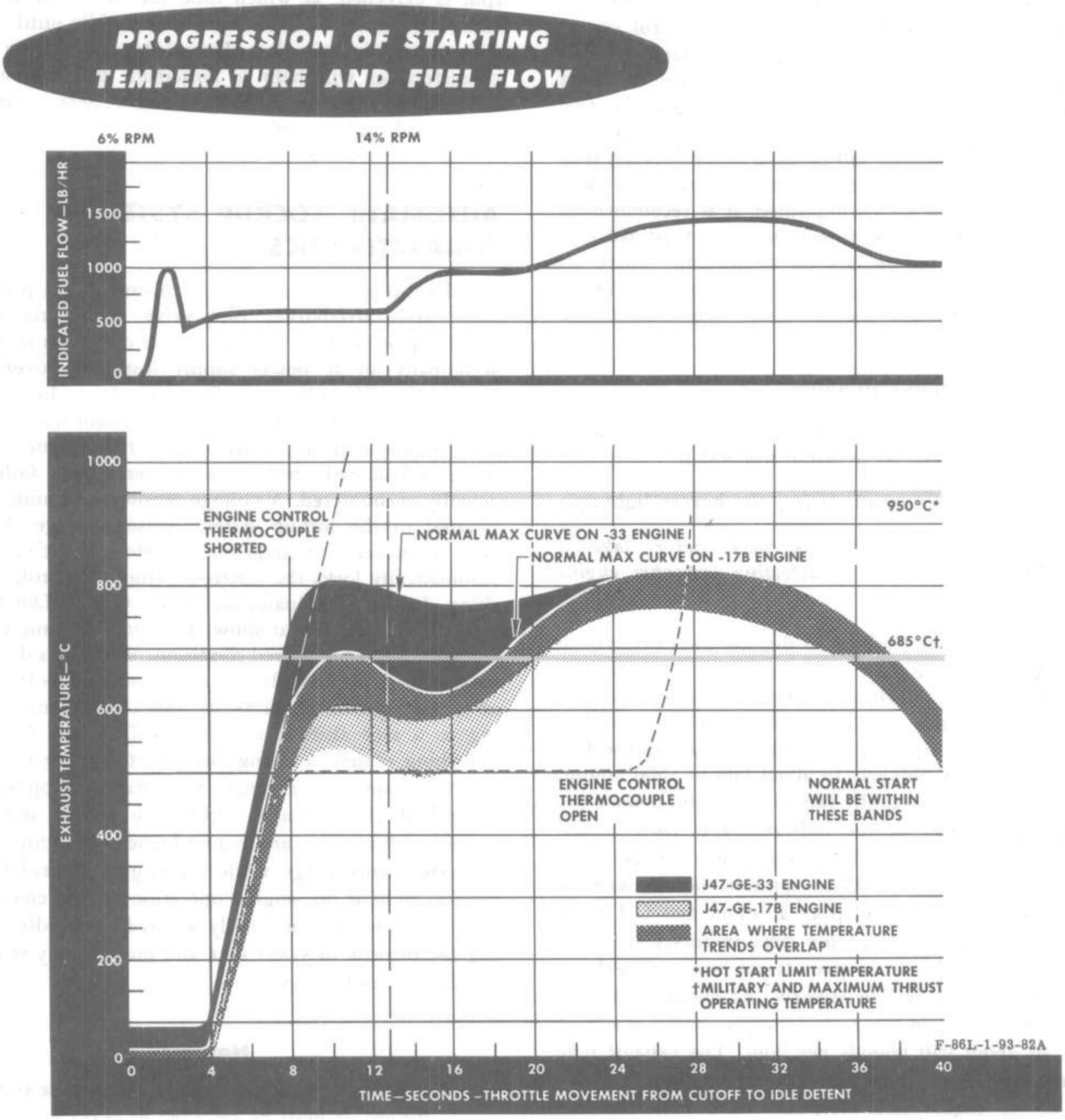


Figure 7-2

the idle detent plunger will not unlock the exhaust nozzle. When the engine is in lockup, the exhaust nozzle must be jogged to desired position.

EMERGENCY FUEL SWITCH CHARACTERISTICS.

It is *not* necessary to "arm" the automatic lockup system after an engine start on airplanes with the two-position emergency fuel system switch, since lockup protection is now provided during the engine start. It remains operable during all normal operation whenever the emergency fuel switch is at NORMAL position. If the ac power supply loss is momentary, the sensitometer maintains electronic engine controls in the locked condition until about 15 seconds after the ac voltage supply rises above about 98 volts. This 15-second interval, following an ac power supply build-up, is required so that the electronic engine control components can be rewarmed after an ac power failure. However, if the ac power supply is not re-established above about 98 volts, the electronic engine controls remain locked. It is important that power settings not be changed when operating on the main fuel system while the indicator light is on, as engine overtemperature and surging may result when lockup is removed. Although automatic lockup of the main and afterburner fuel valves cannot be broken as long as the power failure exists, engine control and thrust can be maintained by switching to the emergency fuel system and by controlling the nozzle manually. After selecting the emergency fuel system, no attempt should be made to return to the main fuel system while the engine control system lockup light remains on. With the fuel valves still locked in the original position and the nozzle still locked either in the original or selected position, excess fuel will flow into the combustion chambers in which there is no control over fuel flow or temperatures. This could cause possible violent engine surge and overtemperature.

If the lockup light comes on during the take-off roll and it is desired to abort the take-off, chop the throttle to the idle detent with enough effort to depress an idle detent plunger which actuates a detent switch and reverts engine control to the emergency fuel system (during lockup only). The emergency fuel system will then remain in control until the engine control lockup light goes out *and* until the emergency fuel system switch is cycled to ON and returned to NORMAL. It is necessary to manually reposition the exhaust nozzle when operating on the emergency fuel system during engine lockup. Positioning the emergency fuel system switch to ON during engine lockup does not unlock the exhaust nozzle.

Note

> During engine lockup, moving the emergency fuel system switch to ON, or actuating the idle detent plunger will not unlock the exhaust nozzle. When the engine is in lockup, the exhaust nozzle must be jogged to desired position.

ENGINE CHARACTERISTICS.

ABNORMALLY SLOW ENGINE ACCELERATIONS.

At altitudes above 25,000 feet, if the fuel schedule of the electronic engine control has not been properly set, there will be a drop-off in maximum rpm and exhaust temperatures as altitude is increased. Should this condition exist, it is very likely that engine accelerations will be extremely slow. It is possible, however, to have abnormally slow accelerations without having a drop-off from maximum rpm. Both conditions are the result of improper fuel scheduling, but to different extents. When the conditions are extreme, the engine cannot accelerate to obtain 100% rpm at intermediate altitudes, and the airplane cannot climb to operational ceiling. These conditions can be corrected by proper ground adjustment procedures.

LACK OF RESPONSE TO THROTTLE MOVEMENT.

Actuation of the automatic lockup system is first evidenced by a lack of engine response to throttle movement and illumination of the lockup light. Should a condition arise where the engine fails to respond to a change in throttle position, it is probably caused by power failure either in the airplane electrical supply system or in the ac supply system, as shown by the engine control lockup caution light coming on. This condition could be caused by the failure of certain tubes in the electronic engine control amplifiers that control the main system and afterburner fuel valves. This lack of response to throttle movement is incorporated in an electronic engine control system as a safety device and shows a failure. Therefore, a failure of this type causes the system to remain locked in the position at which the electrical power failed. The obvious solution is to switch to the emergency fuel system. For example, if, during flight at 80% rpm, the throttle is advanced to MILITARY with no corresponding increase in rpm, first return the throttle to the previous position, or below; then switch to the emergency fuel system. Remember that severe engine transitions and compressor stall can occur during transfer to the emergency fuel system if the throttle has not been returned to the position that it was in when the main system failed, as the emergency fuel system takes into account only altitude, airplane speed, and throttle position.

COMPRESSOR STALL.

The integrated electronic engine control in this airplane has been designed to eliminate the possibility of compressor stall. The integrated electronic engine control properly and accurately provides fuel in the correct proportion to the engine under any rapid throttle advancement. *However, when an electronic engine control is improperly adjusted, or when the emergency fuel system is in operation, a compressor stall may occur after any rapid advancement of the throttle.* Rapid throttle advancement injects more fuel into the combustion chambers than the engine can use for acceleration at the existing rpm. The burning of this additional fuel increases combustion pressures. Increase of these pressures creates a corresponding increase in the pressure against the compressor discharge air. This increase of pressure against the compressor discharge air results in a breakdown of airflow through the last stages of the compressor. This is known as a compressor stall. As a result of the stall, the mass airflow through the compressor is reduced, causing a reduction in the airflow through the turbine; thus, the energy available to the turbine wheel is decreased, causing loss in engine speed. If the engine is allowed to continue operation in a stalled condition, the temperature of the burning gases will increase until serious damage to the turbine section of the engine occurs, resulting in engine failure. A roaring, pulsating noise accompanies compressor stall and may precede any engine instrument indication of changing engine conditions. If the roaring noise is heard after a rapid engine acceleration, immediately retarding the throttle will eliminate the compressor stall. If exhaust temperature stabilizes at a normal value, the throttle should be readvanced slowly. Exhaust temperature rise should be normal during throttle advancement. However, if the temperature continues to drop after the throttle is retarded, flame-out has occurred and an air start should be attempted. (Refer to "Engine Air Start," Section III.) In addition to the roaring, pulsating noise, other indications of a compressor stall are a rapidly rising exhaust temperature, steady or decreasing rpm, a long flame from the tail pipe, loss of thrust, and heavy engine vibration. In general, injection of excessive fuel into the engine at altitudes below 25,000 feet tends to cause compressor stall. Above this altitude, flame-out usually results.

NORMAL ENGINE CHARACTERISTIC RESEMBLING COMPRESSOR STALL.

During acceleration from a very low power setting, as in a go-around from an aborted landing, the engine noise may change from a high-pitched whine to a low-pitched rumble, similar to that obtained in the first stage of compressor stall. As the throttle is advanced and the engine begins to accelerate through the low, inefficient operating rpm range, the fuel control valve supplies the engine with an excessive amount of fuel, which causes the exhaust temperature to rise rapidly. The rate of fuel injection is then reduced by the control valve, allowing the exhaust temperature to peak and then drop off slightly. As the engine speed increases into the intermediate and more efficient operating rpm range, the high-pitched whine decreases and the low-pitched rumble increases in intensity as the engine accelerates toward the desired rpm. As the higher operating rpm range is reached, the low-pitched rumble gradually decreases. When the desired rpm is reached, the exhaust temperature stabilizes at a lower value than that obtained during the acceleration. Engine noise then becomes steady. These phenomena are more noticeable at low altitude under low-ram flight conditions than at high altitude. The sound indications may be initially construed as symptoms of compressor stall. However, the only true indications of compressor stall or failure of engine to accelerate are the readings of the engine instruments. Compressor stall is characterized by rapid rise in exhaust temperature accompanied by a roaring noise and heavy vibration and followed by loss in engine speed.

FLAME-OUT.

Flame-out is just what the name implies and can occur during rapid accelerations or decelerations of the engine. *Acceleration* flame-out, like compressor stall, occurs when more fuel is injected into the combustion chambers than the engine can use for acceleration at the existing rpm. But, unlike the fuel-air mixture that causes compressor stall, this mixture is so excessively rich that it cannot burn, so the flame goes out. Flame-out during rapid engine *deceleration* will result whenever the amount of fuel injected into the combustion chambers is reduced to a level too low to sustain combustion at the existing rpm. Flame-outs are indicated by loss in thrust, drop in exhaust temperature, and possibly by a loud noise similar to engine backfire. During a partial flame-out, some of the combustion chambers may still maintain combustion if the exhaust temperature does not drop below 150°C. The throttle should be retarded to idle and readvanced slowly in an attempt to relight the other chambers. If exhaust temperature continues to decrease below 150°C, the flame-out is complete and an air start is necessary. During any rapid throttle movement above about 25,000 feet, flame-outs may occur if the electronic engine control does not function properly or is improperly scheduled, or if the emergency fuel system is in operation. A normal air start may be accomplished after a flame-out; however, caution should be exercised. The air start should be attempted as soon after a flame-out as possible. However, air starts are more readily attained below 40,000 feet.

ENGINE NOISE AND ROUGHNESS.

Thermal expansion and pressure surge occasionally occur in the pressurization system during flight, resulting in a number of abnormal sounds. Therefore, when any unusual noise appears, dump cabin pressure for a few minutes. If the noise continues, have the engine checked during shutdown after landing. During normal operation, the engine may seem to run rougher than other engines in jet-type airplanes. The reason is that it is equipped with an afterburner, which tends to make any normal vibration more apparent. The vibrations or roughness may tend to cause some concern until the pilot becomes familiar with the airplane and its characteristics. (Refer to "Afterburner Roughness" in this section.) Engine roughness may occur in flight, especially during operation at high power above 15,000 feet. Usually this roughness can be eliminated by a change of rpm. However, if engine roughness occurs at all altitudes or engine speeds, it indicates some mechanical failure, and an immediate landing should be made.

TURBINE NOISE DURING SHUTDOWN.

The light scraping or squealing noise which may be heard during engine shutdown results from interference between the turbine buckets and the turbine shroud. Contact of the two parts is due to the tendency of the shroud to shift and distort under varying temperature conditions, such as are induced by engine shutdown. The scraping, while undesirable, does not damage either part; however, in order to minimize it, idle the engine for at least 2 minutes at minimum temperature obtainable with the rpm at about 65% to 70% before shutdown after any high-power operation (either flight or ground). If, despite this precaution, heavy scraping does occur on shutdown, do not try to restart engine until turbine temperature has dropped enough to provide adequate clearance between the buckets and shroud, since a starting attempt might result in destruction of the starter. If a start must be made when interference is suspected, be particularly alert for engine response. If there is no audible indication of engine rotation, or if there is no response on the tachometer within a few seconds, hold starter switch at STOP STARTER position momentarily.

SMOKE FROM TURBINE DURING SHUTDOWN.

White Smoke.

When the engine is shut down, fuel may accumulate in the turbine housing where heat of the turbine section of the engine causes the fuel to boil. (Although a turbine housing drain is provided, the drain may not prevent accumulations of some fuel.) Presence of this residual fuel in the engine will be shown by emission of fuel vapor or smoke from the tail pipe or inlet duct. Boiling fuel, indicated by appearance of white fuel vapor, does not damage the engine, but does create a hazard to personnel because of the possibility of ignition with explosive violence if the vapor is allowed to accumulate in the engine and fuselage. Therefore, all personnel should keep clear of tail pipe and intake duct for 15 minutes after shutdown and at all times when smoke or vapors issue from tail pipe.

Black Smoke.

The appearance of black smoke from the tail pipe after shutdown indicates burning fuel, which will damage the engine and should be cleared immediately as follows:

1. External power source connected to both receptacles.
2. Engine master switch—OFF.
3. Throttle closed.
4. Battery-starter switch momentarily at STARTER.
5. Allow engine to crank to about 9% rpm (one minute maximum); then hold starter switch at STOP STARTER position momentarily.

While following this procedure, keep in mind that the high current required for starting will burn out the starter in a matter of seconds if the engine doesn't turn over as soon as the starter is energized. If there is no audible indication of engine rotation or if there is no response on the tachometer within a few seconds, depress the stop-starter button immediately.

TACHOMETER INDICATION.

If a tachometer failure is shown by a drop in rpm, check oil pressure gage for a pressure indication, as both the tachometer and oil pump are driven from the same accessory drive. If loss of oil pressure is also shown, a landing should be made as soon as practicable.

AFTERBURNER CHARACTERISTICS.

AFTERBURNER BLOWOUT.

A severe loss of thrust while on afterburner usually means only an afterburner blowout. This can be caused by a rare combustion phenomenon which will probably occur only at extremely high altitude. Afterburner failure may also result from the failure of the afterburner air-turbine fuel pump, from the failure and closing of the afterburner air-turbine air-supply shutoff valve, from a negative-G maneuver, or from a control system failure. If the airplane is at a safe altitude when a failure occurs, the results are probably more bothersome than serious, as the automatic closing of the nozzle will restore full Military Thrust in about 2 seconds and any engine overspeed encountered will be controlled by the electronic engine control and by the hydraulic overspeed governor to prevent destructive overspeeding of the engine.

CAUTION

- If afterburner blowout occurs with less than 1300 pounds of fuel remaining, do not attempt further afterburner operation unless dictated by emergency or combat conditions.

- This precaution does not constitute an operating limitation, but rather a measure for protection of the afterburner turbine-driven pump in the event of fuselage rear section tank transfer pump failure.

AFTERBURNER ROUGHNESS.

Reports of afterburner roughness at altitude have been received from pilots flying airplanes with the J47-GE-33 engine installed. This roughness, existing primarily at an altitude range of 25,000 to 35,000 feet, is exhibited to the pilot in the form of vibration on the rudder pedals and the control stick. Its frequency is not as high or constant as a bearing failure, and is felt in varying intensity between the altitudes quoted, reaching maximum intensity at a specific altitude. This afterburner roughness is the result of a poor spray pattern from the large-slot spray bars when the afterburner fuel pressure decreases (as fuel flow is decreased by increasing altitude) to a value approaching the cutout point of the afterburner fuel flow divider. This poor spray pattern causes partial and erratic burning of large-slot fuel in the afterburner. Flight tests, conducted with the aid of a simulated CDP (compressor discharge pressure) control in the cockpit, revealed that raising or lowering of the afterburner fuel schedule raised or lowered, respectively, the effective altitude of the roughness. Thus, the altitude at which the pilot feels the afterburner roughness will be higher with the "flattop" fuel schedule than with the old, lower fuel schedule. If you should encounter engine roughness, remember the following points for properly diagnosing this afterburner roughness.

a. Afterburner roughness exists primarily at altitudes from 25,000 to 35,000 feet.

b. Intensity of afterburner roughness will reach maximum at a specific altitude and will diminish at either side of that altitude.

c. The frequency of the vibration felt on the stick and rudder pedals is not as high or constant as that of a bearing failure (133 cycles per second). The magnitude of the roughness will be more comparable to the tail buffet encountered with the drag chute aspirator than with the vibration accompanying either bearing or turbine wheel failure.

d. The roughness will not necessarily be accompanied by any noticeable change in engine instrument readings.

e. This condition will not contribute to activation of the fire-warning system.

f. Manufacturing and Air Force personnel agree that this roughness, although not desirable, is not a hazard.

ENGINE OVERSPEED DURING AFTERBURNER SHUTDOWN.

Emergency Fuel System Switch at NORMAL.

Excessive damping of the main fuel control valve by means of an improperly set stability adjustment could cause an overspeed condition when coming out of afterburning. If this adjustment is set too high, the main fuel valve will not reduce the fuel flow fast enough to prevent engine overspeeding before the nozzle has a chance to close. The amount of overspeeding will depend upon how far the control is out of adjustment. This condition can be minimized by retarding the throttle slowly whenever coming out of afterburner. This procedure permits the nozzle to close progressively while the engine is still using the gradually decreasing amount of afterburning. Thus, the nozzle will be nearly closed at the time the afterburner goes out. Protection against destructive engine overspeeding is still provided by the hydraulic overspeed governor.

EMERGENCY FUEL SYSTEM.

EMERGENCY FUEL SYSTEM LIMITATIONS.

It should be remembered that the emergency fuel system is strictly an emergency system designed to enable the pilot to return the airplane to base if the main fuel system fails. The emergency system was never intended or designed to be used as an alternate fuel system. For a given throttle position, the emergency fuel regulator senses only fuel pressure and compressor inlet pressure changes. From these two parameters, a bypass fuel *flow* through the regulator is established thus scheduling a fuel pressure to the engine. Since the emergency regulator does not sense engine rpm or compressor inlet temperature, for a given compressor inlet pressure, the unit will schedule a specific bypass flow (corrected by sensing pressure) regardless of engine rpm, compressor inlet temperature, exhaust gas temperature, or any other parameter. This is the reason for needing the three emergency fuel regulator schedules—summer, winter, and extreme-winter—so that the unit can be adjusted for changes in ambient air temperature to a reasonable degree. Since all control parameters are not sensed and are, therefore, not compensated for by the ED-4 regulator, it should be expected that engine rpm with the emergency system in operation can vary over a relatively large range with changes in altitude, airplane airspeed, and the angle of attack of the air inlet duct with respect to the airstream flowing past the airplane. In the winter, the emergency fuel regulator schedule is set higher to bring the engine rpm up to normal. When the airplane is flown at high altitudes, the fuel schedule is too high and engine overspeed becomes a good possibility if the throttle is set in the MILITARY position. This phenomenon is more noticeable in the winter than in the summer. The reason for this is that ambient air temperature changes vary greatly on the ground from one season to another while the ambient air temperature at extremely high altitudes remains very nearly constant year around. When switching to the emergency system at altitude, the throttle should be retarded to prevent engine overspeed. However, the overspeed governor should prevent any serious overspeed, and the pilot needs only to monitor the throttle at these high altitudes to maintain 100% rpm or less. The emergency system was designed to operate only to 30,000 feet. From 6,000 to 30,000 feet, the emergency fuel system is only required to furnish a minimum of 85% of the normal thrust for a specific altitude on a normal 59°F day (no maximum). Therefore, an emergency fuel system check at some altitude from 6,000 to 30,000 feet will merely inform the pilot whether the emergency fuel system is operating properly, and no stringent performance requirements should be expected.

EMERGENCY FUEL SYSTEM OPERATION.

During operation on this system, the scheduling of the emergency fuel regulator makes it necessary for the pilot to open the throttle farther to maintain a specified power setting than would be necessary during operation on the main fuel system. This is because the emergency fuel regulator scheduling is normally set lower than that of the main fuel system to prevent overspeeding and overtemperature of the engine when switching from main to emergency. Therefore, while the engine is operating on the emergency fuel system, the lower portion of the throttle travel usually becomes less effective, and available power at full throttle is reduced as altitude is increased, varying considerably with altitude above 20,000 feet. Therefore, during operation on the emergency fuel system, it is necessary not only that all throttle movements be made cautiously, but also that the throttle be advanced farther than is necessary on the main fuel system for a specified power setting, the amount of advancement increasing with the altitude.

CAUTION

- If engine speed is inadvertently allowed to drop below 85% rpm before emergency fuel system switch is moved to the ON position, the throttle should be retarded to START IDLE before the switch is placed ON, to prevent an overtemperature condition.
- Extremely low engine rpm should be avoided, when operating on the emergency system, because of excessive slow acceleration characteristics from engine speeds below 40% rpm.

EXHAUST TEMPERATURE CHARACTERISTICS.

OVERTEMPERATURE VS ENGINE LIFE.

The useful life of any jet engine is greatly shortened by operation at high rpm and temperature. Jet engine hot section parts are required to operate at temperatures near their safe structural limit when maximum performance is required of the engine. The turbine wheel, in particular, which operates with a rim temperature close to the peak of tolerance for the metal from which it is manufactured, is subject to early failure when subjected to serious overtemperatures, or to repeated "minor" overtemperatures. The J-47 turbine wheel can be expected to operate satisfactorily for at least 1000 hours at a steady state EGT of 685°C if not subjected to overtemperatures. However, a 15°C increase in steady state EGT will reduce the turbine wheel life by approximately 55%, and transient temperatures that exceed 950°C for as little as two seconds can render the turbine wheel unserviceable. Thus it can be seen that "minor" overtemperatures are not minor at all, but a definite hazard to flight safety. The careful monitoring of EGT by the pilot, and the recording of all overtemperature operation is imperative. Particularly during starting and afterburner operation the pilot should, with a clear understanding of fuel flow characteristics and their relation to EGT, be alert for an incipient overtemperature condition and recognize it in time to take rapid corrective action. All operating personnel should be thoroughly familiar with the exhaust temperature limits given in Section V. When the engine is properly adjusted, the EGT system properly calibrated, and the engine controls are properly handled, all operating temperatures including transient temperatures will fall within the serviceability limits established for the engine. Careful monitoring of EGT will detect any maladjustment or malfunction. The importance of such monitoring cannot be overemphasized.

SPEED AND EXHAUST TEMPERATURE FLUCTUATION.

Minor fluctuations of the engine speed or exhaust temperature can be caused by a number of factors. The stability adjustment, if set too high, will cause the engine to take an unusual length of time to stabilize at a new power setting, as called for by the throttle position. In this case, the engine responds normally up to some rpm or temperature close to the value desired; however, when that point is reached, the whole process slows down and the final stabilized value may not be reached until 5 to 20 seconds later. The stability adjustment, if set too low, will cause the control system to overshoot and undershoot, not too rapidly, but to the extent that it is apparent that some instability exists. In this case, the engine speed or exhaust temperature fluctuates, or hunts, in a manner similar to that which would be obtained with a slow-moving hydraulic engine control governor. The stability and transient temperature control may be adjusted to correct these fluctuations. More violent fluctuations would be cause for transferring to the emergency fuel system.

CONTROL OF EXHAUST TEMPERATURE.

A variable-area nozzle is used on this engine to aid in maintaining exhaust temperature at the proper level, regardless of altitude or airspeed. The temperature depends upon the nozzle schedule adjustment, temperature control circuit, and thermocouple voltage. If, during a Military Thrust climb, the exhaust temperature falls off from 685°C to some lower value and the nozzle does not move to hold the exhaust temperature at 685°C, the nozzle schedule settings are possibly at fault and should be checked. The variable-area nozzle should, within the limits of its range of operation, be able to correct any wandering of the exhaust temperature that is exhibited by most fixed-nozzle jet airplanes.

INVERTER CHANGE-OVER CHARACTERISTICS.

The main inverter is normally the primary source of ac power. The secondary inverter normally supplies only the ac power for radar operation. With the main inverter selected and the radar turned on, both inverters will be operating. Should the main inverter fail, the inverter caution light on the caution light panel (see figure 1-25), will illuminate. To switch the secondary inverter to the main ac bus, the inverter selector switch on the right instrument subpanel (see figure 1-4) must be positioned to SPARE. At this time the secondary inverter will be disconnected from the radar load and connected to the main ac bus, and the inverter-out caution light will go out. If the secondary inverter is not operating (radar turned off), positioning the inverter selector switch to SPARE will turn on the secondary inverter and connect it to the main ac bus. The inverter caution light will only show failure of the selected inverter.

FUEL SYSTEM.

Operation of the fuel system is essentially automatic, requiring no action from the pilot during flight. However, it is essential that the pilot keep the following precautions in mind.

1. Emergency fuel system switch at NORMAL for all normal operation, including take-off and climb.

2. When drop tanks are carried, leave drop tank air pressure shutoff valve ON at all times during flight, to prevent possible collapse of drop tanks during rapid descents.

Note

Uneven feeding from the drop tanks does not affect the flight characteristics of the airplane.

FUEL SYSTEM OPERATION WITH INOPERATIVE AFT TRANSFER PUMP.

The fuel system provides for automatic fuel transfer from the aft fuselage tank by an electrically driven fuel transfer pump controlled by a fuel float switch. During engine operation with the aft fuselage tank transfer pump inoperative, fuel is transferred by gravity to the center wing fuel tank through the aft fuselage tank transfer line. Transfer of fuel continues until the fuel level in the aft fuselage tank drops below the level of the aft fuselage tank transfer line. Fuel is then drawn to the engine by the engine pump suction through the aft fuselage tank suction-feed outlet. However, a check valve incorporated in the suction-feed outlet prevents suction feed from the aft tank as long as there is fuel available at the fuel boost pump in the center wing tank. As a result, suction feed from the aft tank will not occur until all fuel in the center wing has been used.

Note

Afterburner operation with aft fuselage tank transfer pump inoperative will deplete the fuel in the center wing fuel tank faster than it can be replenished from the aft fuselage fuel tank by gravity feed. As a result, afterburner blowout can occur because of fuel starvation. If afterburner blowout occurs with less than 1300 pounds of fuel remaining, do not attempt further afterburner operation unless combat or emergency conditions dictate.

HYDRAULIC SYSTEMS.

Check hydraulic systems periodically during flight as follows:

1. Hold pressure gage selector switch at UTILITY and read gage for proper utility system pressure.

2. Fly straight and level for 5 seconds and then, with gage selector switch at NORMAL, read pressure gage for flight control normal system pressure.

3. Without moving control stick and with gage selector switch at ALTER, read gage for flight control alternate system pressure.

On conventional flight control systems, intermediate rates and maximum rate of control movements were both directly proportional to pilot effort. In constant-pressure, irreversible hydraulic systems, such as on this airplane, the rate of control movement will vary with effort only until the actuator valve is completely open. Any additional effort by the pilot will not result in a further increase in rate of movement. Thus, the maximum rate obtainable is not determined as much by pilot effort as by the hydraulics and kinematics of the system. With a conventional system, almost any malfunction which could occur that would limit maximum rate of control movement would also be readily apparent at some lesser rate. It would be difficult for it to continue undetected. The same is not true of irreversible systems. Should there be some restriction in the rate of flow of hydraulic fluid in the irreversible system, it will not be apparent until an attempt is made to move the controls faster than the restriction will permit. Also, the rate of movement imposed by the restriction will be maximum regardless of pilot effort. Inability to lift the nose wheel during take-off can result if the stabilizer actuator control valves of the normal and alternate systems are not properly synchronized. If the valves are not synchronized, available control valve displacement is reduced, resulting in a corresponding reduction in maximum rate of control movement. This reduced rate would obviously restrict airplane response. This same effect would occur if restriction in hydraulic flow were caused, for example, by improper attachment of quick-disconnect fittings. Experience shows that this reduction in rate of control movement can mislead the pilot and at the same time escape detection by maintenance personnel. Whether the pilot encounters or notices the malfunction depends upon individual technique and whether the pilot desires to move the controls at a rate faster than the malfunction would permit. It is during take-off and landing that full stick deflection is most often necessary. Should the stick fail to move at the normal rate, the pilot may apply greater than normal pressure and gain the impression that he had full stick deflection. Because of the short time involved and the surprise element, the pilot may have an erroneous impression of how far the stick moved. Since a ground check will show that full stick deflection occurs (ignoring the fact that it can be moved only at a slower than normal rate), the nature of the malfunction remains undetected. Another pilot using a slower technique and not having occasion to move the stick at rapid rates will not notice the failure. During nose wheel lift-off on take-off, during misjudged and consequently late flare-out on landing, and in the technique of "feeling for the runway," a pilot may assume he is getting the desired stick deflection, whereas restriction of hydraulic fluid flow for any of the reasons mentioned may actually be limiting the rate and consequently the amount of immediate stick deflection. These examples are based on use of the horizontal stabilizer, but other difficulties could also result from similar malfunctions affecting aileron control. It is important to check rate of control surface movement before flight. If the rate is slower than normal, based on experience in other F-86L Airplanes, the previously described malfunction of the flight control system should be suspected.

WING FLAP HANDLE OPERATION.

The original design, use, and purpose of the HOLD position of the flap handle was to allow varying degrees of flap extension to prevent "sink," if it should occur during high gross weight take-offs.

CAUTION

> The flap actuating mechanism may be damaged if the flap handle is left in the HOLD position for an extended length of time and the flaps have not been fully retracted.

After airspeed has built up enough for complete flap retraction, the flap handle should be moved to UP and left there until flaps are needed again. For landings, the flap handle is moved firmly to the full DOWN stop.

LANDING GEAR.

If the landing gear unsafe warning light comes on during flight, indicating an unsafe landing gear condition, airspeed should be reduced to below 185 knots IAS before cycling the gear. If the unsafe warning light does not go out after the gear is cycled several times, land as soon as practicable.

WHEEL BRAKE OPERATION.

To reduce maintenance difficulties and accidents due to brake failure, it is important that wheel brakes be used properly. Frequently, operating personnel attempt to stop the airplane as quickly as possible, regardless of the length of runway. They also use the brakes consistently for speeding up turns and drag the brakes while taxiing.

a. In order that brakes can be used as little and as lightly as possible, take full advantage of the length of the runway, utilizing aerodynamic braking to stop the airplane.

b. Use extreme care when applying brakes immediately after touchdown, or at any time there is considerable lift on the wings, to prevent skidding the tires. Heavy brake pressure will lock the wheels more easily immediately after touchdown than when 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 wheels 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.

c. If maximum wheel braking is required, lift should be decreased as much as possible by lowering the nose gear and raising the flaps before applying the brakes. This procedure will improve braking action since the load on the tires will be increased, thus increasing the frictional force between the tires and the runway.

d. When a short landing roll is required, a single smooth application of the brakes with constantly increasing pedal pressure will result in optimum braking.

e. During a series of successive landings, a minimum of 15 minutes should elapse between landings where the landing gear remains in the slip stream, and a minimum of 30 minutes with the landing gear retracted between landings, to allow adequate cooling time between brake applications. This time restriction is not applicable to touch-and-go type landings when no brake application is involved.

f. The brakes should not be dragged while taxiing, and should be used as little as possible for turning the airplane on the ground.

g. 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 and the parking brakes should not be set. Overheated wheels and brakes must be cooled before the airplane is subsequently towed or taxied. Peak temperatures in the wheel and brake assembly are not attained until 5 to 15 minutes after a maximum braking operation is completed. In extreme cases, heat build-up 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 build-up.

Section VIII

CREW DUTIES

Not applicable to this airplane

All-weather Operation

SECTION IX

TABLE OF CONTENTS

Except for some repetition necessary for emphasis or continuity of thought, this section contains only those procedures that differ from, or are in addition to, the normal operating procedures in Section II.

INSTRUMENT FLIGHT PROCEDURES

This airplane has satisfactory stability and excellent handling characteristics while being flown entirely by reference to instruments. The control feel is somewhat different at low speeds than at high speeds in that relatively large stick movements are required and somewhat greater stick forces are present, which will be absent in the higher speed ranges. Certain phases of instrument flight operations may result in overcontrolling and resulting pilot-induced oscillations, which should be dampened out by releasing the stick momentarily. Under absolutely no circumstances, except in the case of military necessity, should this plane be flown entirely by reference to instruments unless you are a qualified instrument pilot and a holder of the AF Form 8A (Green) or AF Form 8 (White) Instrument Certificate. The airplane is equipped with the latest radio navigational aids, and a complete deicing system that will enable you to fly in all kinds of weather with such ease and accuracy to approach the precision of an automatic pilot, which is also installed on the airplane. As certain phases of instrument flying may require delays in departures and additional time for approach procedures which are often made at low altitudes, the endurance factor is critical. Consult the appendix for flight planning information, and use particular care in planning an alternate and fuel consumption. It is necessary that your flight planning be accurate with special attention to the traffic density and the type of approaches available at your destination. The effect of a go-around on fuel reserve (because of a missed approach or traffic control emergencies) must be considered. You will be able to make omni, GCA, and ILS approaches in this airplane.

BEFORE INSTRUMENT TAKE-OFF.

The course index of the directional indicator should be rotated to align the runway heading with the top of the dial.

Note

> Instrument take-offs can be made satisfactorily without the afterburner. However, the afterburner is strongly recommended to shorten take-off roll for very low visibility conditions or to aid acceleration with water or snow on the runway.

INSTRUMENT TAKE-OFF AND CLIMB.

1. Recheck all instruments quickly and release brakes.
2. Maintain heading, using nose wheel steering until rudder becomes effective at about 60 knots IAS. Maintain visual reference to runway if possible. If visual reference is lost or deteriorates until it becomes difficult to maintain your heading, go on instruments immediately, using your heading indicator as your primary instrument.

WARNING

> Use of brakes for directional control lengthens runway roll and reduces acceleration during take-off. With the end of runway obscured, it is possible to use excessive distance to accelerate without realizing there is not enough runway remaining to take off.

3. Take off at normal VFR speeds.
4. Immediately establish an initial climb attitude on instruments, with vertical velocity indicator as primary instrument, at 500 fpm.
5. Landing gear handle UP as soon as altimeter shows an increase in altitude.
6. Establish 160 knots IAS climb until a 1500 fpm climb is indicated; then retract wing flaps.
7. Holding 1500 fpm on the vertical velocity indicator, accelerate to best VFR climbing speed.

WARNING

> Care should be used in making turns and beginning accelerations to best climb speeds after take-off by taking into consideration terrain obstructions and minimum altitudes at the point of departure.

8. Engine screen switch at RETRACT.

Note

> When in areas of known or suspected icing conditions, use anti-ice systems to prevent ice formation.

INSTRUMENT CRUISING FLIGHT.

The airplane has excellent handling characteristics throughout its normal speed range if properly trimmed and flown by reference to the attitude flight instruments. The autopilot greatly simplifies the task of the all-weather pilot by enabling you to read charts and navigate without the responsibility of control of the airplane.

INSTRUMENT DESCENTS.

WARNING

> It is imperative during descents that the altimeter be accurately read, with particular attention given to the 1000- and 10,000-foot pointers.

The best power setting for conservation of fuel during descents is START IDLE. However, 80% rpm will provide desired rate of descent and exhaust temperatures. Speed brakes should be opened, to limit airspeed and distance covered. The landing gear and wing flaps should be retracted. The autopilot is recommended for all types of instrument penetrations to enable you to maintain precision control over airspeed and pitch control during the descent. Descending turns on the autopilot present no problem because they are easily accomplished with the turn-knob control. If icing conditions exist or are anticipated, or if it is raining, maintain at least 75% rpm in descents to be assured that enough hot air will be available for deicing and rain removal. To aid in controlling air temperature to the windshield during a descent in rain (if rain removal air is used), ram air should be selected for cockpit cooling. Selecting ram air will reduce the temperature of the air going to the windshield, thus preventing windshield cracking from sudden temperature changes.

Note

> The windshield and canopy defrost system provides sufficient heating of the transparent sur-

faces to effectively eliminate the formation of frost or fog during descent.

WARNING

When power is reduced below 75% rpm during an approach to the runway in a rainstorm, forward visibility will be obscured immediately, as hot air is no longer available for rain removal. Touch down by looking out of the windshield side panels, which will remain fairly clear at all times. Turn system off after touchdown if windshield overheat warning light has not illuminated. If light is on, leave system on and select ram air for cockpit cooling, which allows a gradual reduction of air temperature to windshield.

JET PENETRATIONS.

Jet penetrations have been set up to provide a high-speed and high rate-of-descent letdown from cruising altitude to a point where VFR approach or an instrument approach (such as GCA, omnirange, or ILS) can be made. Penetration procedures for specific fields are given on JAL (jet approach and landing) charts. The Pilot's Handbook—Jet, in two parts for the eastern and western United States, has the JAL charts for all fields where jet penetration procedures have been established. Figure 9-1 shows a typical jet penetration accomplished by beginning a letdown at the penetration cone (cruising altitude) on the heading specified in the JAL chart. The initial phase of the penetration is set up to avoid interference with altitudes occupied by other airplanes. After the high cone is crossed, a conventional instrument approach is begun. A typical penetration with VFR approach is shown in figure 9-2. In such penetrations, if you are not VFR at low-cone altitude, an instrument approach must be made. The conditions set up in the JAL charts should be given careful consideration during flight planning. Availability of GCA, alternates, and operational problems in high-density traffic areas should be analyzed.

Note

Flight paths illustrated in figures 9-1 and 9-2 can be used on both types of penetrations and low approaches. Check the current JAL chart for your destination. The recommendations set up in the JAL charts should be given careful consideration during flight planning. Availability of radio aids, field alternates, and the operational problems in high-density traffic areas should be analyzed.

RADAR RECOVERY.

Radar letdowns with GCA landings are optimum for conserving fuel under instrument conditions. For a typical letdown, see figure 9-3. When planning the use of this aid upon an IFR arrival, remember that heavy precipitation can seriously reduce the capabilities of the controller to bring you in.

Note

To ensure a satisfactory radar recovery, the IFF should be turned on to aid the controller in seeing your airplane.

INSTRUMENT APPROACHES.

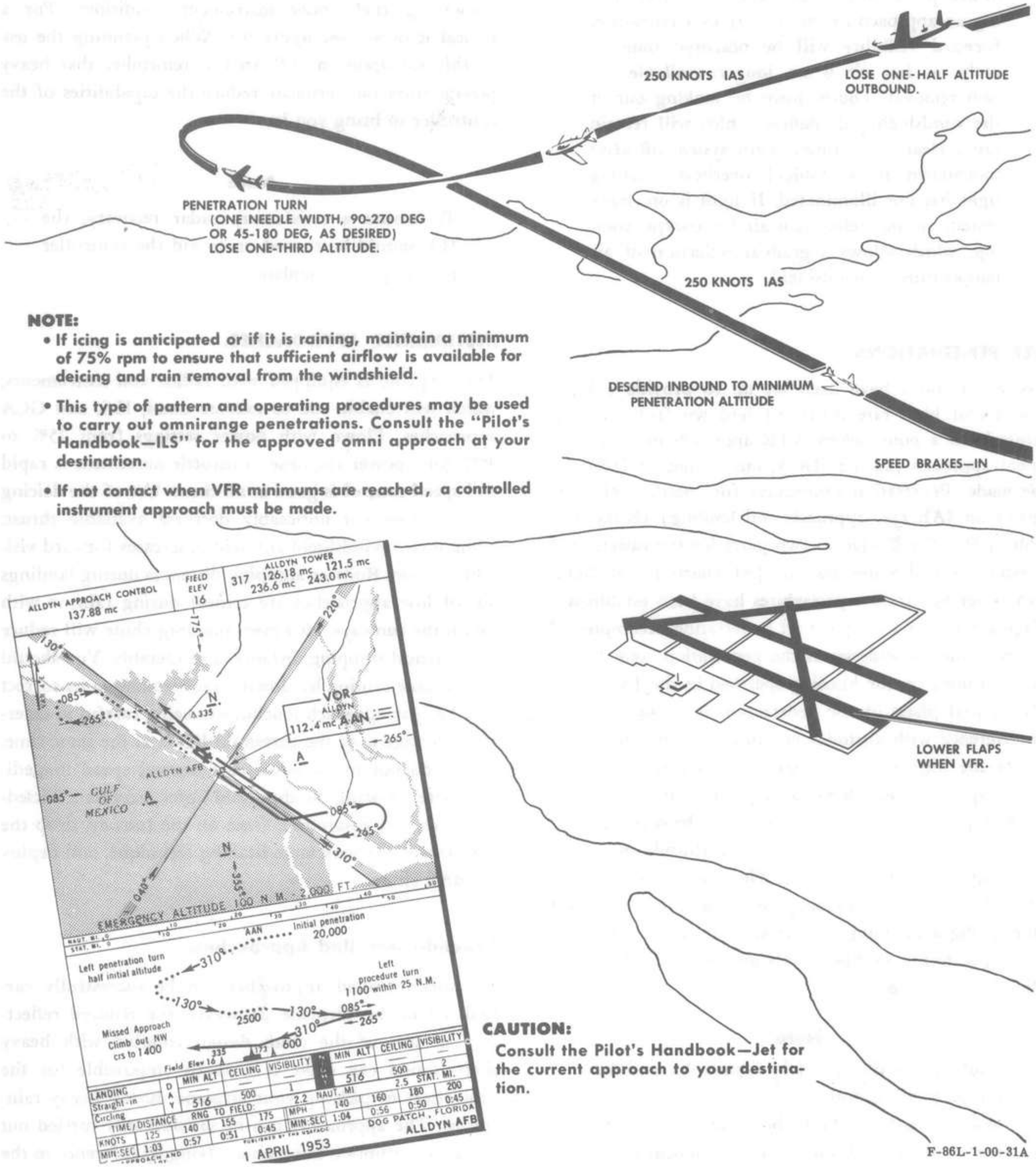
This airplane is equipped with radios and instruments, which will enable you to execute omni, ILS, and GCA approaches. Flown with power settings from 75% to 85% rpm, power response to throttle movement is rapid and speed control is good at all times. Use of the deicing systems does not noticeably decrease available thrust, while use of windshield anti-icing increases forward visibility in rain. Runway stopping distances during landings out of low approaches are critical during rain or with ice on the runways. However, the drag chute will reduce these critical stopping distances considerably. You should use extreme caution by slowing the airplane to its correct speed as you approach touchdown, being careful to determine passage over the threshold lights at the same time. If you do not touch down at a normal speed immediately after crossing the threshold lights, execute a missed-approach and go-around. Once on the runway, drop the nose wheel, use maximum braking technique, and deploy the drag chute.

Ground-controlled Approaches.

Ground-controlled approaches can be successfully carried out in this airplane. However, the reduced reflecting surfaces of the clean design coupled with heavy precipitation can make it virtually impossible for the controllers to pick up your airplane during heavy rainstorms. The approaches can be satisfactorily carried out using the autopilot, but manual flying by reference to the flight instruments is considered more satisfactory. A typical approach is shown in figure 9-6. The runway distances

JET PENETRATION AND LOW APPROACH

(TYPICAL)



NOTE:

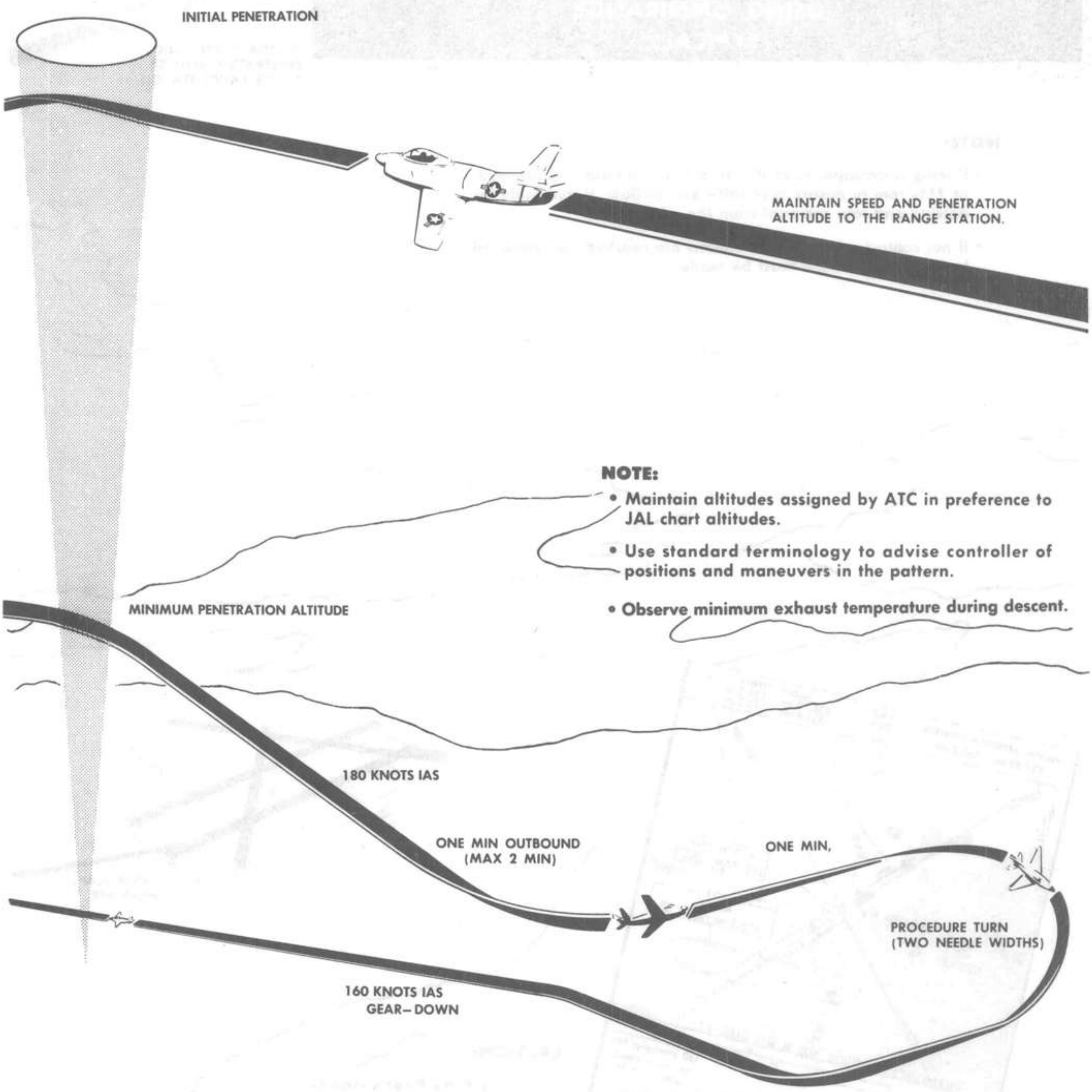
- If icing is anticipated or if it is raining, maintain a minimum of 75% rpm to ensure that sufficient airflow is available for deicing and rain removal from the windshield.
- This type of pattern and operating procedures may be used to carry out omnirange penetrations. Consult the "Pilot's Handbook—ILS" for the approved omni approach at your destination.
- If not contact when VFR minimums are reached, a controlled instrument approach must be made.

CAUTION:

Consult the Pilot's Handbook—Jet for the current approach to your destination.

F-86L-1-00-31A

Figure 9-1



NOTE:

- Maintain altitudes assigned by ATC in preference to JAL chart altitudes.
- Use standard terminology to advise controller of positions and maneuvers in the pattern.
- Observe minimum exhaust temperature during descent.

F-86L-1-00-33A

JET PENETRATION AND LOW APPROACH

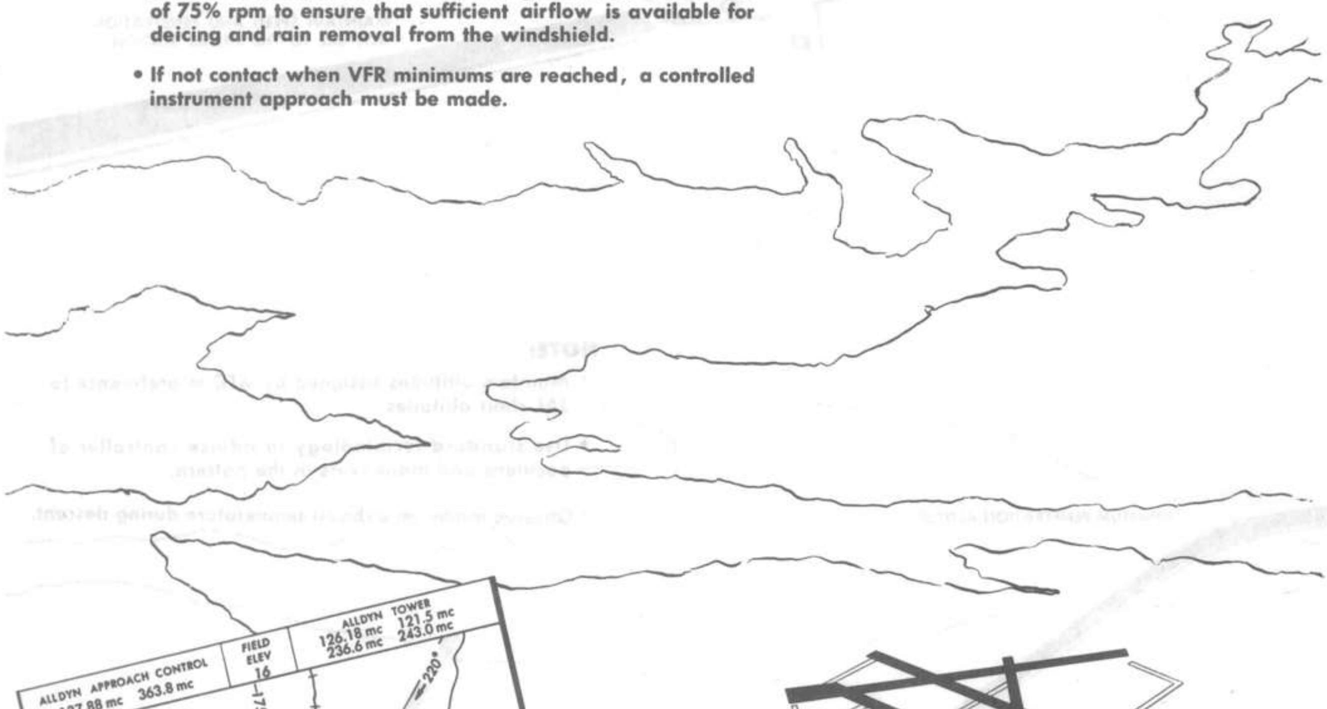
USING OMNIRANGE

(TYPICAL)

MAINTAIN SPEED AND PENETRATION ALTITUDE TO THE RANGE STATION.

NOTE:

- If icing is anticipated or if it is raining, maintain a minimum of 75% rpm to ensure that sufficient airflow is available for deicing and rain removal from the windshield.
- If not contact when VFR minimums are reached, a controlled instrument approach must be made.



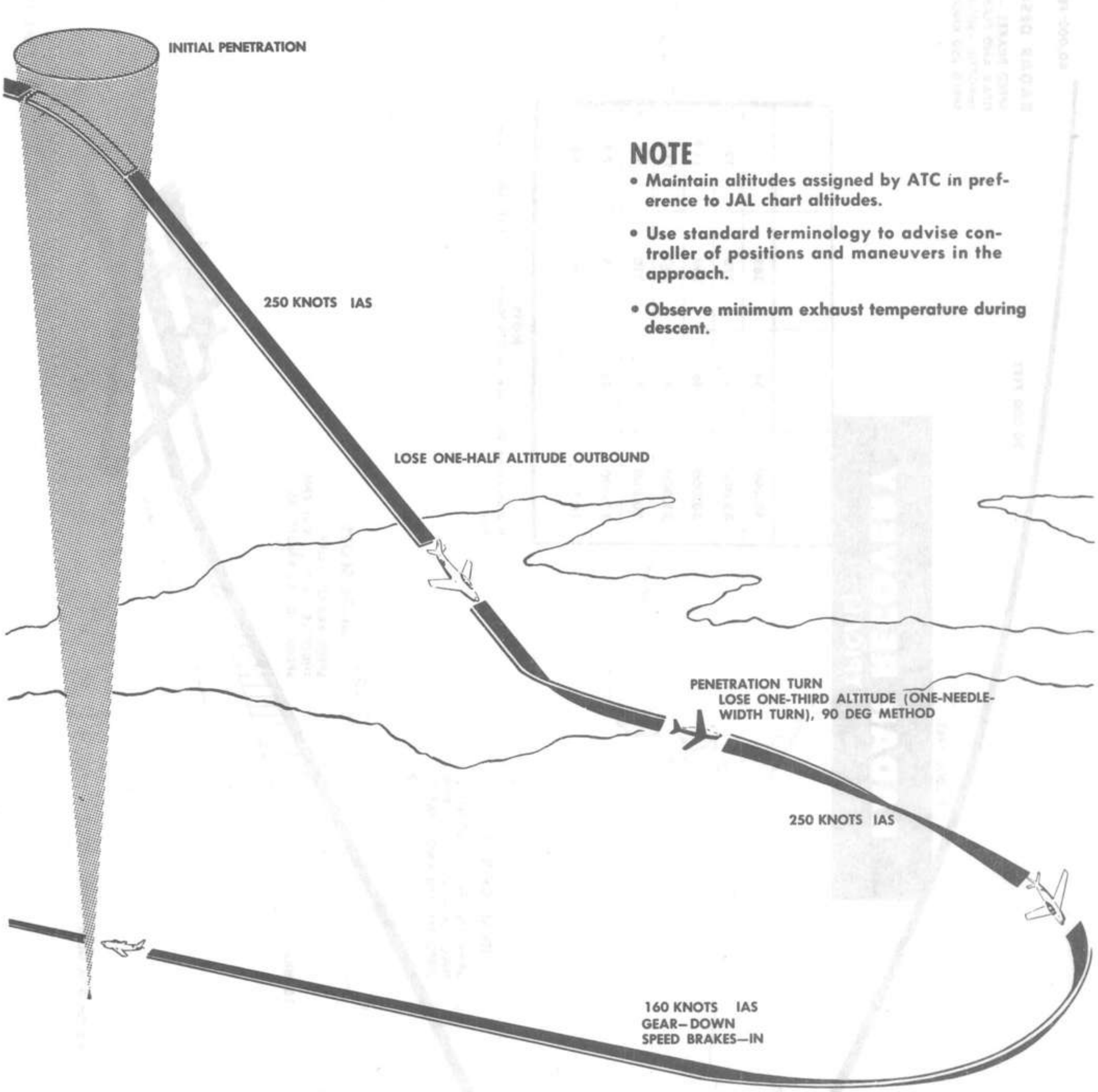
LOWER FLAPS WHEN VFR

CAUTION:

Consult the Pilot's Handbook—Jet for the current approach to your destination.

F-86L-1-00-34A

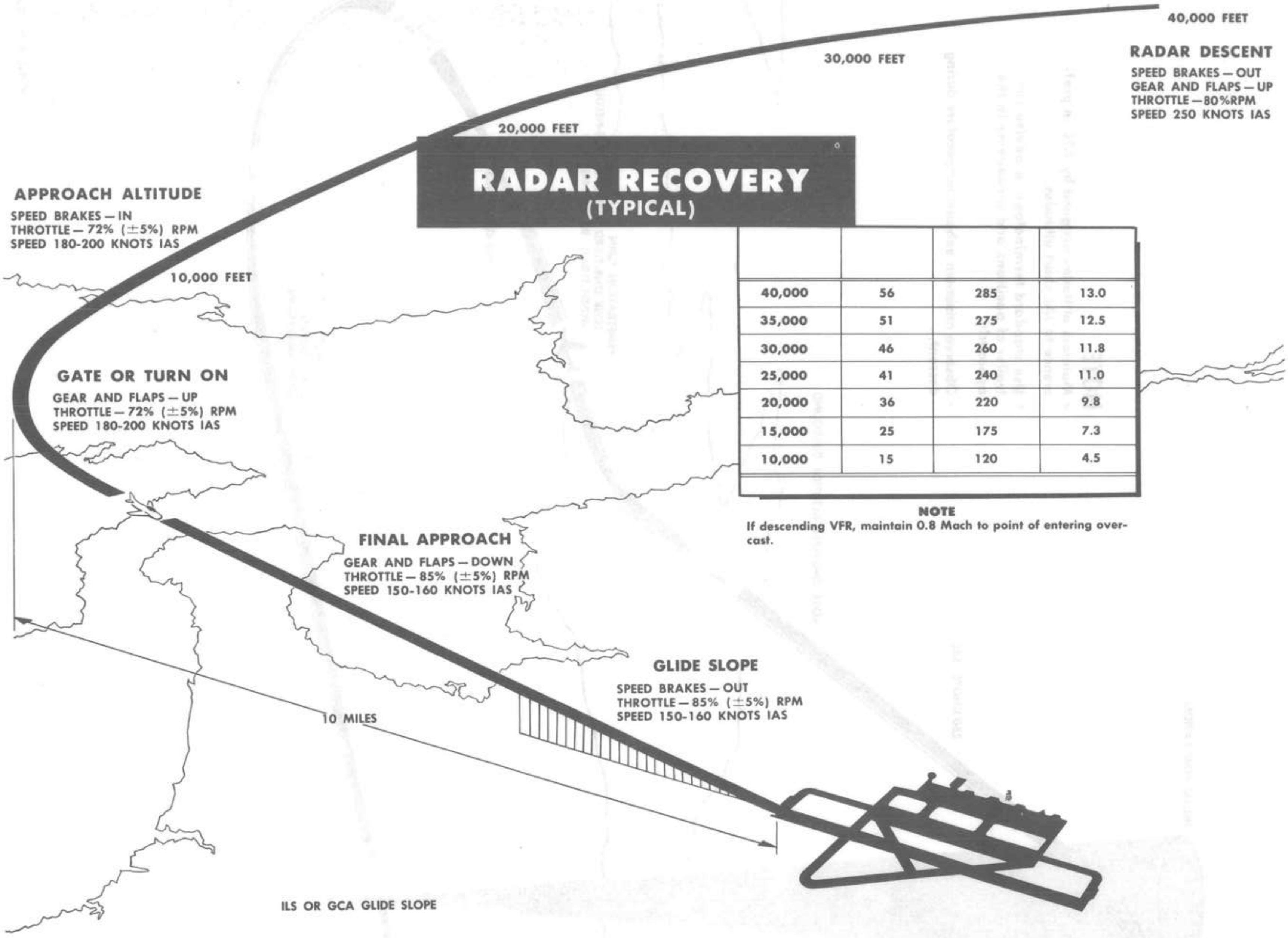
Figure 9-2



NOTE

- Maintain altitudes assigned by ATC in preference to JAL chart altitudes.
- Use standard terminology to advise controller of positions and maneuvers in the approach.
- Observe minimum exhaust temperature during descent.

F-86L-1-00-32A



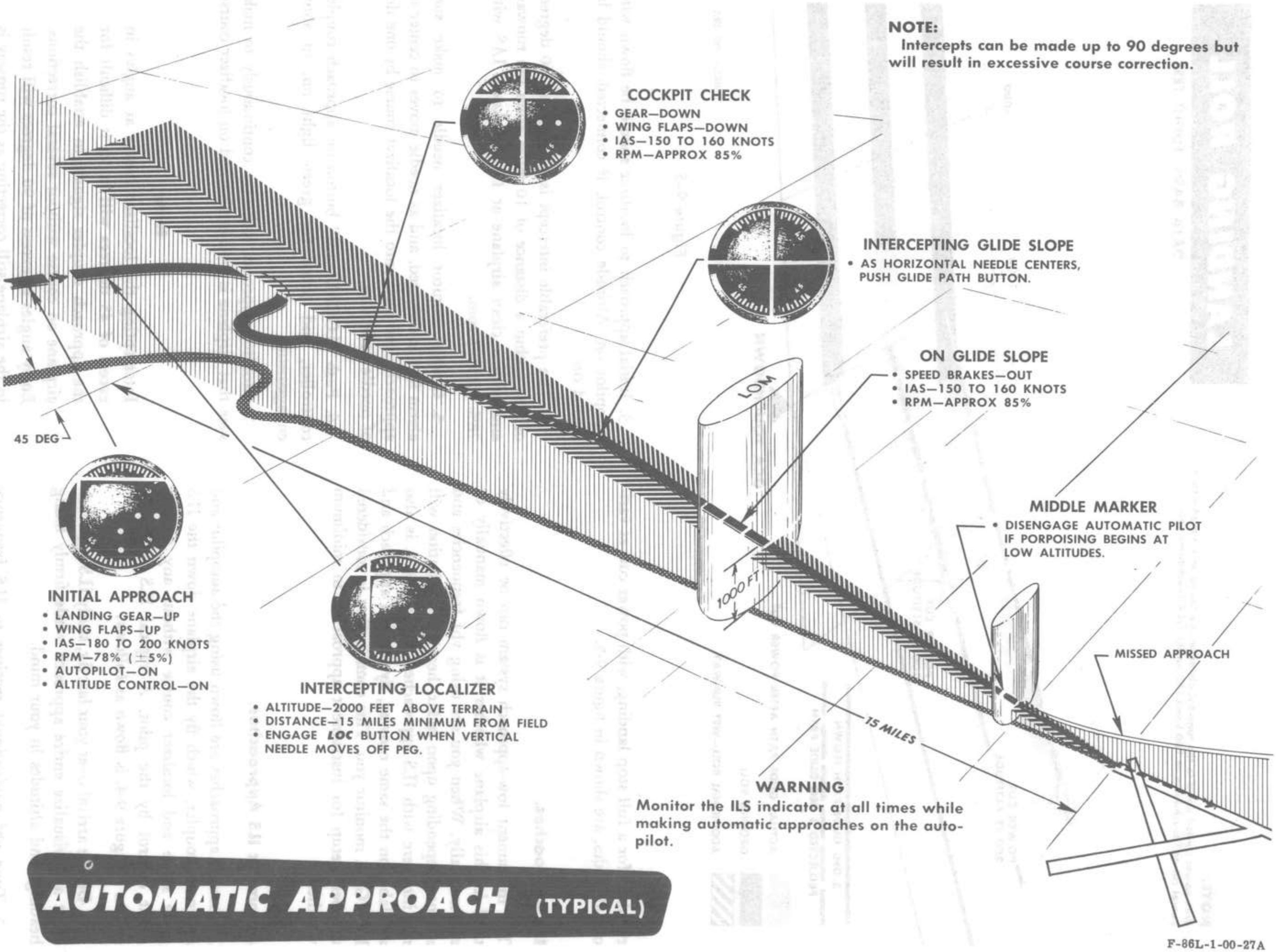
RADAR RECOVERY
(TYPICAL)

40,000	56	285	13.0
35,000	51	275	12.5
30,000	46	260	11.8
25,000	41	240	11.0
20,000	36	220	9.8
15,000	25	175	7.3
10,000	15	120	4.5

NOTE

If descending VFR, maintain 0.8 Mach to point of entering overcast.

Figure 9-3



NOTE:
Intercepts can be made up to 90 degrees but will result in excessive course correction.

COCKPIT CHECK
- GEAR—DOWN
- WING FLAPS—DOWN
- IAS—150 TO 160 KNOTS
- RPM—APPROX 85%

INTERCEPTING GLIDE SLOPE
- AS HORIZONTAL NEEDLE CENTERS, PUSH GLIDE PATH BUTTON.

ON GLIDE SLOPE
- SPEED BRAKES—OUT
- IAS—150 TO 160 KNOTS
- RPM—APPROX 85%

MIDDLE MARKER
- DISENGAGE AUTOMATIC PILOT IF PORPOISING BEGINS AT LOW ALTITUDES.

INITIAL APPROACH
- LANDING GEAR—UP
- WING FLAPS—UP
- IAS—180 TO 200 KNOTS
- RPM—78% (±5%)
- AUTOPILOT—ON
- ALTITUDE CONTROL—ON

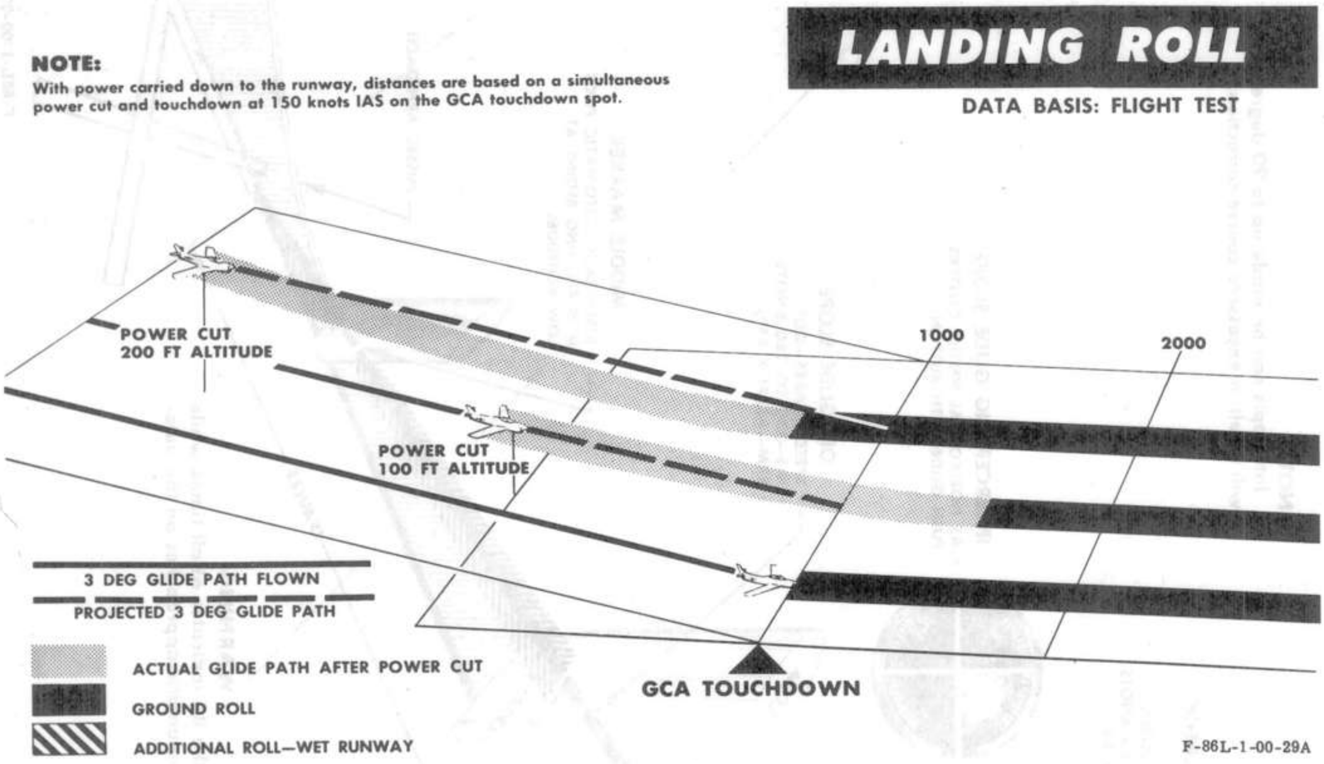
INTERCEPTING LOCALIZER
- ALTITUDE—2000 FEET ABOVE TERRAIN
- DISTANCE—15 MILES MINIMUM FROM FIELD
- ENGAGE ***LOC*** BUTTON WHEN VERTICAL NEEDLE MOVES OFF PEG.

WARNING
Monitor the ILS indicator at all times while making automatic approaches on the autopilot.

AUTOMATIC APPROACH (TYPICAL)

F-86L-1-00-27A

Figure 9-4



NOTE:
With power carried down to the runway, distances are based on a simultaneous power cut and touchdown at 150 knots IAS on the GCA touchdown spot.

Figure 9-5

required for a full stop landing, with power cuts at various altitudes, are shown in figure 9-5.

ILS Approaches.

The instrument low-approach system can be effectively used in this airplane whether it is flown manually or automatically. When you are using vhf frequencies and are not depending upon radar, heavy precipitation will not interfere with ILS approaches. Where GCA is also available on the same runway, fly the ILS approach and have GCA monitor you. This combination is considered the best setup for instrument approaches in minimum weather.

Automatic ILS Approaches.

Automatic approaches are flown using the autopilot and approach coupler, which fly the airplane down the ILS glide slope and localizer course without any manual flight control by the pilot. A typical ILS approach, shown in figure 9-4, is flown as follows:

1. Before arrival over your last fix, study ILS approach chart and visualize entire approach while firmly fixing headings and altitudes in your mind.

2. Tune vhf navigational receiver to ILS frequency and identify it.

3. Initial approach to localizer should be flown with autopilot on. Altitude control, if connected, should be turned ON.

4. The preferable intercept is an angle of 60 degrees or less within a distance of 10 miles from the runway, and with a clean airplane at 180-200 knots IAS with 78% (±5%) rpm.

5. Closely monitor localizer needle to make sure alarm flag is retracted, and as needle moves to center of approach, lead turn onto the localizer course by one dot of needle deflection.

6. Push "LOCALIZER" button on approach coupler controller, and check for green light on, to show engagement.

7. Monitor approach indicator continuously to make sure that airplane is well established on localizer course.

Note

Intercepting the localizer course at angles in excess of 45 degrees will make it difficult for the approach coupler signals to establish the airplane on course without several corrections. Entry angles in excess of 90 degrees will result in the airplane still correcting as the runway is approached.

DISTANCES FROM GCA TOUCHDOWN (TYPICAL)

FLIGHT CONDITIONS

AIRPLANE: CLEAN AIRPLANE
FUEL RESERVE ON LANDING 1000 POUNDS
NO DRAG CHUTE

WEATHER: WIND CALM, TEMPERATURE 59°F

FIELD ELEVATION: SEA LEVEL

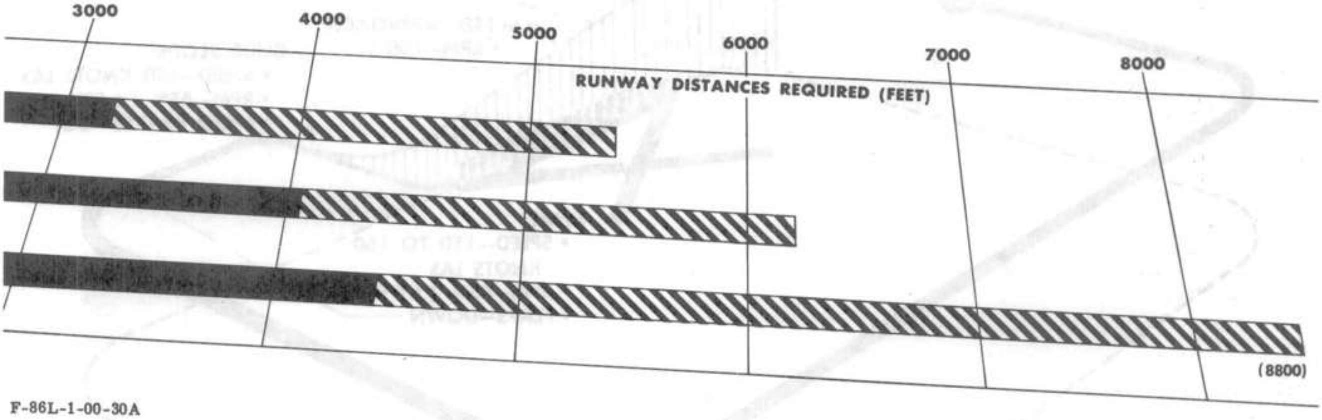
RUNWAY CONDITION: DRY OR WET

RUNWAY CONSTRUCTION: CONCRETE

TECHNIQUE: MAXIMUM PRACTICAL BRAKING

APPROACH SPEED: 150 KNOTS IAS

TOUCHDOWN SPEED: 120 KNOTS IAS



F-86L-1-00-30A

8. When turn on is complete, perform landing cockpit check, reducing speed to 150-160 knots IAS at 85% (±5%) rpm with landing gear and wing flaps down.

9. Approaching glide slope, push glide slope button as horizontal needle moves down and reaches center of approach indicator.

10. Speed brake switch—OUT. Return switch to neutral after extension.

11. Assume manual control when definitely VFR or when glide slope porpoising occurs by raising turn knob on the flight controller or squeezing automatic pilot release switch on the stick. Automatic control should be effective down to 200 feet altitude.

12. Execute missed approach upon reaching ILS minimums by disengaging approach coupler and pulling up manually.

Holding On Omni.

For holding over omni stations or fixes in "race track" type patterns, when in the clean or tank configurations, either a "loiter" type speed or a maximum-range type speed may be used. When no icing conditions prevail, the lower speed may be used. When in icing conditions, it is desirable to keep the slats closed so as to maintain anti-ice protection. In this case, the higher speed should be used. Speeds and approximate rpms for the different configurations, altitudes, and icing conditions are shown below. The 180-degree turns in the holding pattern require more power than the 2- or 3-minute legs; therefore, hold constant power setting for the listed speed in the turn. The use of the autopilot is recommended for holding. The optimum altitude for holding is 30,000 feet.

	CLEAN		WITH DROP TANKS	
ALTITUDE (FEET)	KNOTS IAS	RPM	KNOTS IAS	RPM
	NO ICING CONDITIONS			
10,000	190	83	170	85
20,000	190	86	175	88
30,000	190	89	180	91
	ICING CONDITIONS			
10,000	275	86	255	86
20,000	255	88	250	89
30,000	240	91	245	94

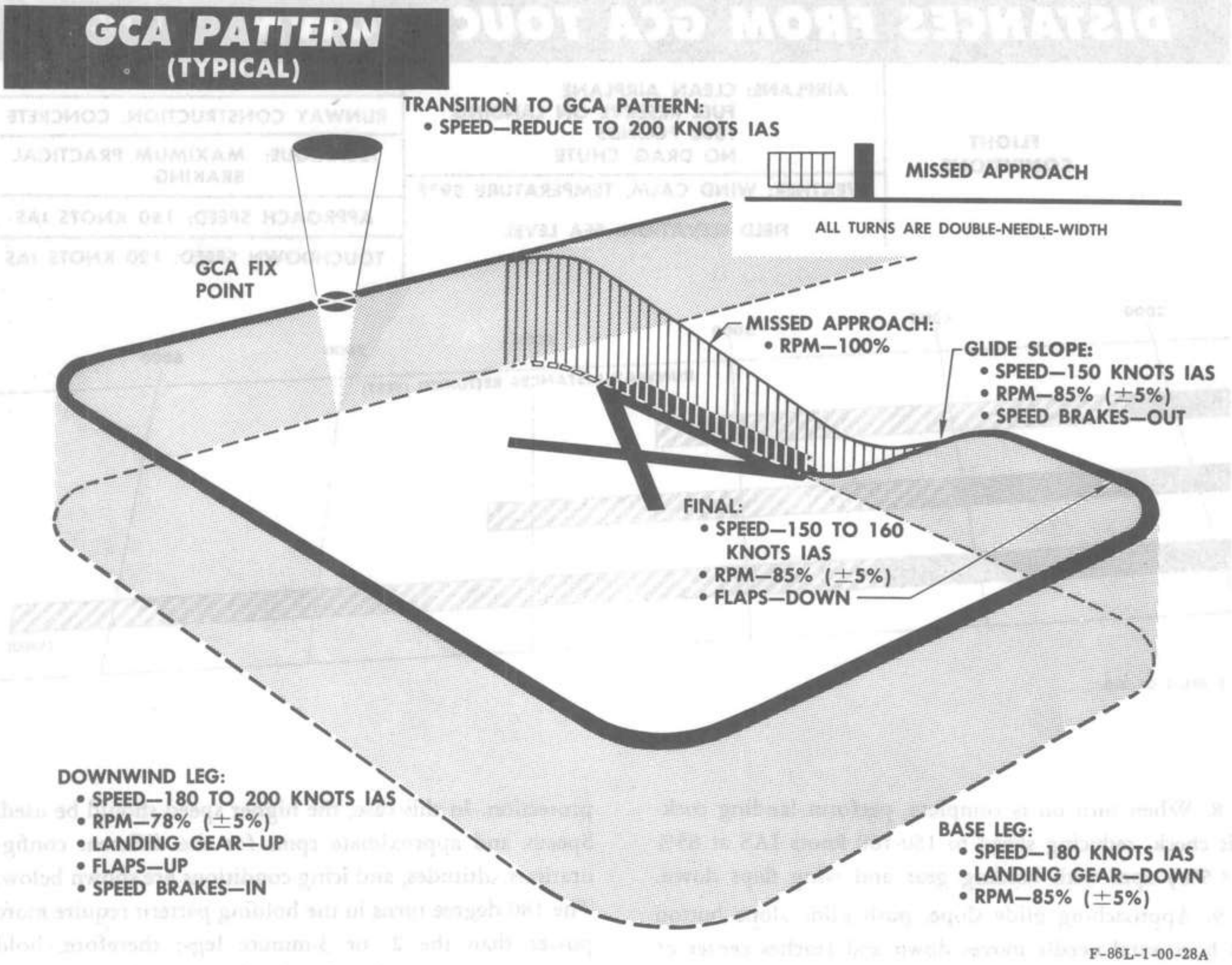

GCA PATTERN
(TYPICAL)
TRANSITION TO GCA PATTERN:
• SPEED—REDUCE TO 200 KNOTS IAS
MISSED APPROACH
ALL TURNS ARE DOUBLE-NEEDLE-WIDTH
GCA FIX POINT
MISSED APPROACH:
• RPM—100%
GLIDE SLOPE:
• SPEED—150 KNOTS IAS
• RPM—85% (±5%)
• SPEED BRAKES—OUT
FINAL:
• SPEED—150 TO 160 KNOTS IAS
• RPM—85% (±5%)
• FLAPS—DOWN
DOWNWIND LEG:
• SPEED—180 TO 200 KNOTS IAS
• RPM—78% (±5%)
• LANDING GEAR—UP
• FLAPS—UP
• SPEED BRAKES—IN
BASE LEG:
• SPEED—180 KNOTS IAS
• LANDING GEAR—DOWN
• RPM—85% (±5%)
F-86L-1-00-28A

Figure 9-6

ICE AND RAIN

When flying on instruments, the possibility of engine or airfoil icing is often present. However, this airplane will normally operate above serious icing levels, and its high performance makes it possible to fly out of dangerous icing altitudes. If the airplane does ice up, remember the two most serious aspects. First, engine ice can result in serious engine damage. Second, regardless of amount, airfoil ice destroys lift and creates drag. This in turn raises stalling speeds abnormally high, requiring careful airspeed control on landing.

ENGINE ICING.

WARNING

- If areas of known icing have been flown through, or if engine icing is suspected to have occurred, it is recommended that engine screens be extended to minimize engine damage caused by large chunks of ice being ingested into the engine.
- Because of the features of the electronic engine controls, there has been no positive way established for detecting engine icing by reference to the engine instruments during operation on the main fuel system. Use of airplane anti-ice equipment is recommended when flying in areas of known icing.

WING ICING.

Even in the most severe icing conditions, simultaneous operation of all anti-icing systems will keep all heated surfaces clear of ice without noticeable loss of engine thrust. The surface anti-icing system is very effective in deicing the airplane if ice is allowed to accumulate on wings and tail. *However, the purpose of the anti-icing systems is to prevent formation of ice rather than to dispose of ice already formed.* Therefore, use all anti-icing systems continuously whenever conditions show there is a possibility of icing. Maintain a minimum of 75% rpm to allow the system to operate at full efficiency.

WARNING

- Ice around the leading edges of the air inlet duct, the accessory cover, the inlet screens, and around the engine compressor inlet can be extremely hazardous. Also, if windshield and radome heat is not used in icing conditions, it is possible for a considerable amount of ice to accumulate on the radome. Therefore, operation of the surface anti-icing system is recommended when in icing conditions.
- If any well-formed ice formation erodes or melts off and blows back into the intake duct and compressor section, possible engine damage may occur. Therefore, it is unsafe to fly in icing conditions unless all of the anti-icing systems are in operation.

USE OF ANTI-ICE SYSTEMS.

Place the engine screen switch in the RETRACT position as a precautionary measure during all flights in weather regardless of icing probability. (Refer to "Anti-icing and Defrosting Systems," Section IV.) All systems may be used simultaneously during take-off and instrument approaches without noticeable loss in thrust. Therefore, if taking off in conditions of freezing rain or severe icing, all systems should be operated. *Wing leading edge anti-icing is not at maximum efficiency when the leading edge slats are partially or fully opened.*

TURBULENCE AND THUNDERSTORMS


F-86L-1-00-38

Note

A comfortable penetration speed for entering a zone of turbulent air is 250 knots IAS.

F-86L-1-0-2A

It is imperative that you prepare the airplane before entering a zone of turbulent air. If the storm cannot be seen visually, its proximity may be detected by radio static intensity. The radarscope can be used to detect "soft" spots in the storm. Adjust your throttle as necessary to obtain a safe penetration speed before entering the storm.

CAUTION

Do not lower gear or flaps in the storm, because they decrease the aerodynamic efficiency of the airplane.

ENGINE SURGE AND FLAME-OUT CAUSED BY ADVERSE WEATHER CONDITIONS.

The following factors, singly or in combination, can cause engine flameout:

a. Penetration of cumulus build-ups with associated high liquid content.

b. Engine icing of either nose accessory section cover or inlet guide vanes.

c. Turbulence associated with penetration can result in excessive nose-up angles of attack, causing marginal engine performance.

d. Above 40,000 feet, the surge margin of the engine is reduced and there is poor air distribution across the face of the compressor.

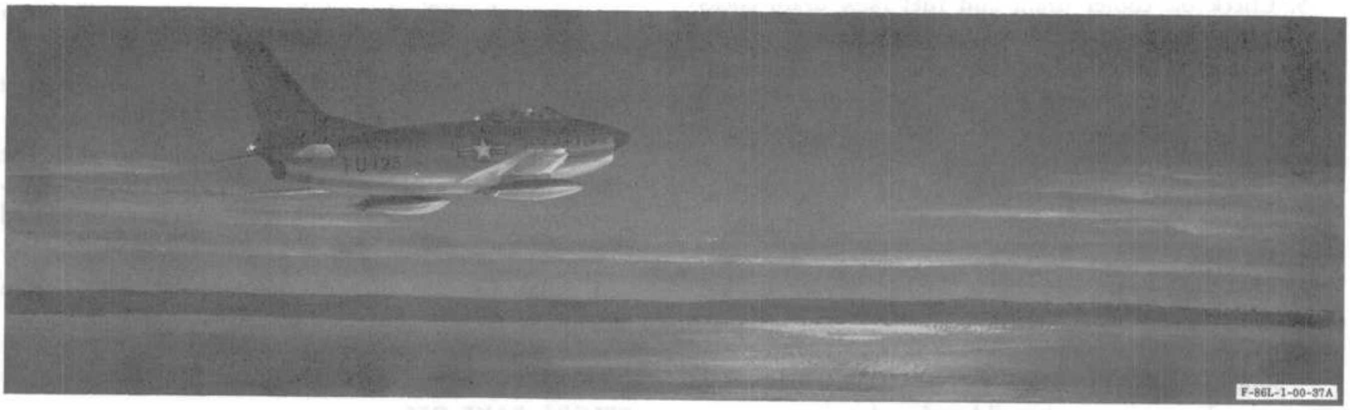
CAUTION

Flying in turbulence or hail may increase inlet duct distortion. At higher altitudes, this distortion can result in engine surge and possible flame-out. However, normal air starts may be accomplished, as outlined in Section III.

Areas of turbulent air, hail storms, or thunderstorms should be avoided whenever possible, because of the increased danger of engine flame-out.

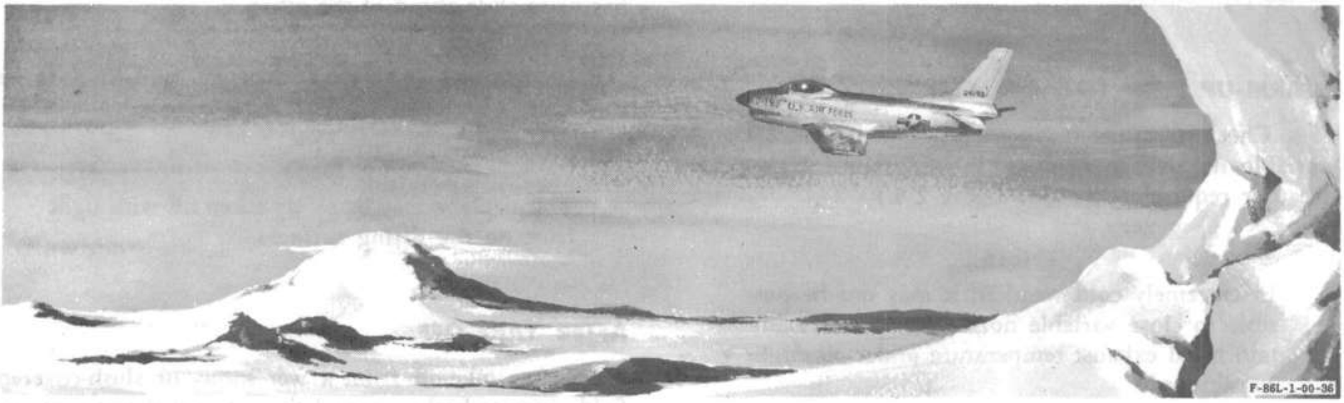
If these areas cannot be avoided, the engine anti-icing system should be turned on prior to weather penetration. Exhaust temperature gage should be monitored continuously during weather penetration. *Exhaust temperature indication alone may come too late to enable the pilot to take timely corrective action.* The engine anti-icing system prevents the formation of ice and is not a deicer. Whenever possible, icing conditions should be anticipated in advance, and the anti-icing system should be turned on to warm up the engine air inlet. If ice has already begun to build up before the anti-icing system is turned on, reduce the throttle setting to minimize the danger of internal engine damage until all ice has broken off and been ingested by the engine. When the presence of ice is no longer evident, check the engine at idle rpm; then advance the throttle to any desired setting.

NIGHT FLYING



There are no specific techniques for flying this airplane at night which differ from those required for daylight operation.

COLD-WEATHER PROCEDURES



Icing conditions are covered under "Ice and Rain" in this section. While still a factor for successful cold-weather operation, generally cold-weather postflight preparation is not as critical in jet-powered airplane operation as in reciprocating-engine airplane operation, because there is no need for oil dilution, etc. To expedite preflight inspection and ensure satisfactory flight during cold-weather operation, adhere to the normal operating procedures outlined in Section II, with the following additions and exceptions.

BEFORE ENTERING COCKPIT.

1. At temperatures below −26°C (−15°F), have preheat used in cockpit and on canopy seal.

2. Check that the airplane—including surfaces, controls, ducts, shock struts, drains, etc—has been cleared of all snow and ice.

WARNING

A take-off should not be attempted with snow and ice on the airplane surfaces. Snow and ice on the airplane surfaces causes a loss of lift and creates dangerous stalling characteristics.

3. Be sure that wing slats move freely and that they can be closed manually.

CAUTION

Slat retaining straps are provided to hold wing slats in a closed position during preheating of flight surfaces. Check that these straps are removed before flight.

4. Make sure shock struts and actuating cylinders are clear of ice and dirt.

5. Check oil cooler drain and fuel tank drain cocks for ice and for drain condensate.

6. Inspect pitot tube, fuel tank vent, and oil tank vent, and have any ice removed.

7. Inspect lower portion of engine compressor section for evidence of ice formation on forward stator and rotor blades. If accumulation of ice can be seen or is suspected in the area of the compressor or turbine sections, check engine for freedom of rotation.

Note

External heat must be applied to forward section of engine to remove ice. Engine should be started as soon as possible after heating, to prevent moisture from refreezing.

8. Have preheat used on engine accessory section. If necessary, ground heating equipment can be connected to the engine air intake duct, cockpit air conditioning and pressurization system, rocket package, or tail-pipe nozzle.

WARM-UP AND GROUND CHECK.

1. Check to ensure that emergency fuel regulator and variable nozzle are adjusted in accordance with cold-weather requirements. (See figure 2-4.)

Note

In extremely cold weather, it may not be possible to close variable nozzle enough to maintain rated exhaust temperature under all flight conditions.

WARNING

This airplane is not equipped with parking brakes. Use firmly anchored wheel chocks for engine run-ups. Make sure the airplane is tied down securely before attempting a full-power run-up. During low outside air temperatures, the thrust developed at all engine speeds is noticeably greater.

2. Turn on cockpit air conditioning system and windshield and canopy defrosting system as required, immediately after engine start.

CAUTION

Make sure all instruments have been sufficiently warmed up to ensure normal operation. Check for sluggish instruments during taxiing.

TAXIING.

1. Avoid taxiing in deep snow, as taxiing and steering are extremely difficult and frozen brakes are likely to result.

2. To conserve battery life while taxiing at low engine speeds, use only essential electrical equipment.

3. Increase space between airplanes while taxiing at subfreezing temperatures, to ensure safe stopping distance and to prevent icing of airplane surfaces by melted snow and ice in the jet blast of a preceding airplane.

4. Minimize taxi time to conserve fuel and reduce amount of ice fog generated by jet engines.

BEFORE TAKE-OFF.

1. Make normal full-power check if on a dry, clear runway; however, if take-off is started on ice or snow, make check during the initial part of the take-off roll. Do not attempt to hold the brakes while the engine is accelerating and the take-off roll is beginning, as you are likely to lose control of the airplane if one wheel begins to slide ahead of the other.

2. Pitot heater switch—ON.

3. Retract engine screens whenever take-off is to be made into known, or possible, icing conditions.

Note

The airplane may be safely taken off with light frost on the lifting surfaces.

AFTER TAKE-OFF.

1. After take-off from a wet snow- or slush-covered field, operate brakes several times to expel wet snow or slush, and operate landing gear and wing flaps through several complete cycles to prevent their freezing in retracted position. (Expect considerably slower operation of the landing gear in cold weather, due to stiffening of all lubricants.)

CAUTION

Do not exceed the landing gear and wing flap down limit airspeed during the operation.

2. Check instruments. At extremely low outside air temperatures, instruments should be sufficiently warmed up to ensure reliable operation.

DURING FLIGHT.

1. Use cockpit air conditioning system as required.

2. Use anti-icing and defrosting systems continuously whenever conditions indicate possible icing.

CAUTION

Care should be taken when flying in known icing conditions with the slats open, as ice removal is very slow at or around the slats.

DESCENT.

1. Operate windshield and canopy defrost system to clear windshield armor glass of frost usually formed during rapid descent from altitude.

Note

The windshield and canopy defrost system provides sufficient heating of the transparent surfaces to effectively eliminate the formation of frost or fog during descent.

2. Check engine operating temperatures during descents and in traffic pattern, as low temperatures are common at low altitudes because of frequent temperature inversions.

3. If icing conditions exist, use at least 75% rpm, which is required to operate the anti-icing system.

APPROACH.

WARNING

Heavy ice accumulation will greatly increase stalling speed; therefore, extreme caution must be used when landing under such conditions.

1. Make normal pattern and landing, but allow for flatter guide due to increased thrust caused by extremely low surrounding air temperatures.

2. Pump brake pedals several times to free any accumulated ice.

AFTER LANDING.

1. Deploy drag chute below 150 knots IAS.

CAUTION

The drag chute should not be deployed in 90-degree cross winds exceeding 20 knots or in 45-degree cross winds exceeding 30 knots because of weather cocking tendencies of the airplane with the chute deployed.

CAUTION

- In an emergency, however, the drag chute may be deployed during cross-wind landing to provide fast decelerations, but only after the nose wheel is on the ground; then jettison the chute as soon as practical if excessive yaw develops. Be prepared to use brakes, rudder, and/or nose wheel steering to maintain directional control. (On wet or icy runways, brakes and nose wheel steering are relatively ineffective.)
- Caution should be used if possible, to be sure that the drag chute will clear other airplanes if it becomes necessary to jettison the chute to maintain control after touchdown.

2. If snow and ice tires are installed on airplane, apply brakes intermittently and carefully to keep treads from filling and glazing over.

Note

Hard braking on icy or wet runways may result in dangerous skidding or fishtailing.

3. If conditions permit, taxi with enough rpm to cut in the generator, as low temperatures decrease battery output.

4. Turn pitot heater switch OFF.

CAUTION

The drag chute should be jettisoned before taxiing downwind in winds exceeding 15 knots because of the possibility of the chute collapsing and risers burning by contact on hot areas of exhaust nozzle.

BEFORE LEAVING AIRPLANE.

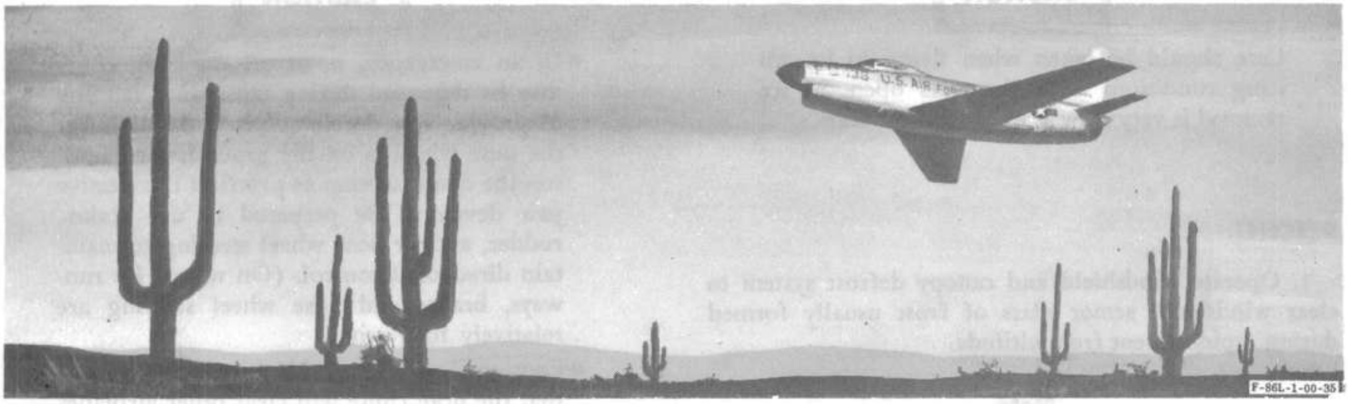
1. If it is not snowing or raining, leave canopy partly open to allow circulation within cockpit, to prevent canopy cracking from differential contraction, and to decrease windshield and canopy frosting.

2. Check that protective covers are installed on canopy and pitot head. Allow 15 minutes after engine shutdown before installing intake and exhaust duct covers.

3. Whenever possible, leave airplane parked with full fuel tanks. Every effort should be made during servicing to prevent moisture from entering the fuel system.

4. Check that batteries are removed when airplane is parked outside at temperatures below −29°C (−20°F) for more than 4 hours.

HOT-WEATHER AND DESERT PROCEDURES



BEFORE TAKE-OFF.

The emergency fuel regulator is set to give 96% rpm on a 100°F day, and does not compensate for temperature changes. If the emergency fuel system is turned on at maximum rpm when temperature is above 100°F, the engine may overspeed.

CAUTION

> If the airplane is based at a field where normal temperature range is above 100°F, the emergency regulator should be reset as soon as possible to give the 100°F day setting (figure 2-4) at the maximum outside air temperature.

If the emergency regulator has been reset, the normal preflight fuel control system tests may be performed and the normal take-off procedure may be followed. If outside air temperatures are excessively high and the emergency fuel regulator has not been reset to the higher outside air temperature, test the fuel control system as follows:

1. With emergency fuel system switch at NORM, advance throttle to 80% to 85% rpm and move emergency fuel system switch to ON. A slight increase in engine speed verifies that the emergency regulator is controlling fuel flow and is set for a lower temperature. Return emergency fuel system switch to NORM.

CAUTION

> No other fuel control system test should be performed at outside air temperatures of more than 100°F because of possible engine overspeed on the emergency regulator.

WARNING

> With the emergency fuel system switch at NORM, the emergency regulator cannot take over the fuel control. Consequently, if the main fuel control valve fails and rpm drops below 85%, the throttle must be immediately retarded to START IDLE and the emergency fuel system switch placed ON to prevent engine failure. The throttle must then be cautiously advanced to obtain the desired power.

Note

> Do not attempt to take off in a sandstorm or dust storm. Park the airplane cross-wind and shut down engine to prevent sand or dirt from damaging engine.

TAKE-OFF.

The increase in required take-off distances commonly associated with hot-weather operation of any airplane is even greater when the airplane is powered by jet engines. (See figures A-5 and A-6 for take-off distances at various temperatures.)

APPROACH AND LANDING.

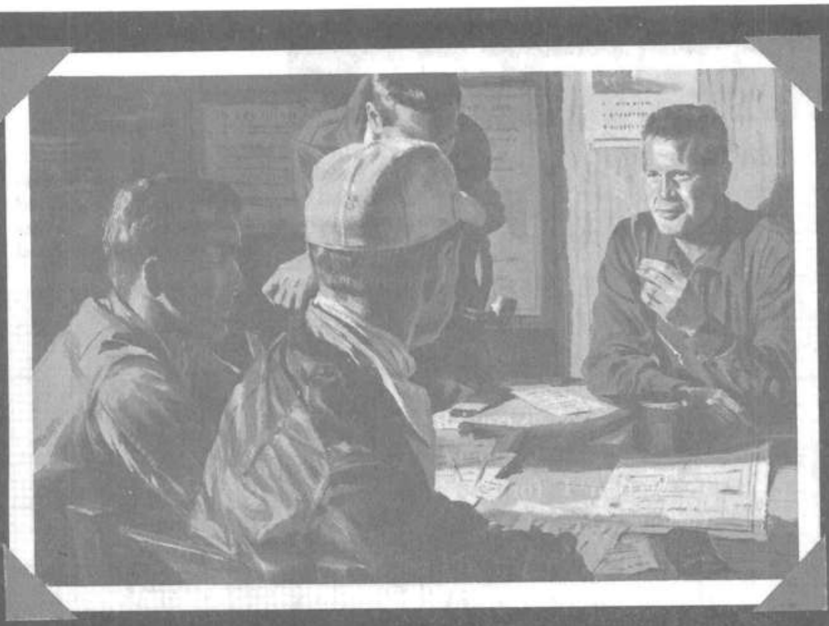
1. Maintain recommended indicated approach and touchdown speeds. Because of high outside air temperatures, speed relative to the ground will be higher than normal.

2. Expect a longer landing roll due to higher ground speed at touchdown.

BEFORE LEAVING AIRPLANE.

1. If sand or dust is not blowing, leave canopy slightly open to permit air circulation within cockpit.

2. Check that protective covers are installed on pitot head, canopy, and intake and exhaust ducts.



F-86L-1-00-3

Performance Data

APPENDIX I

TABLE OF CONTENTS PAGE

INTRODUCTION.

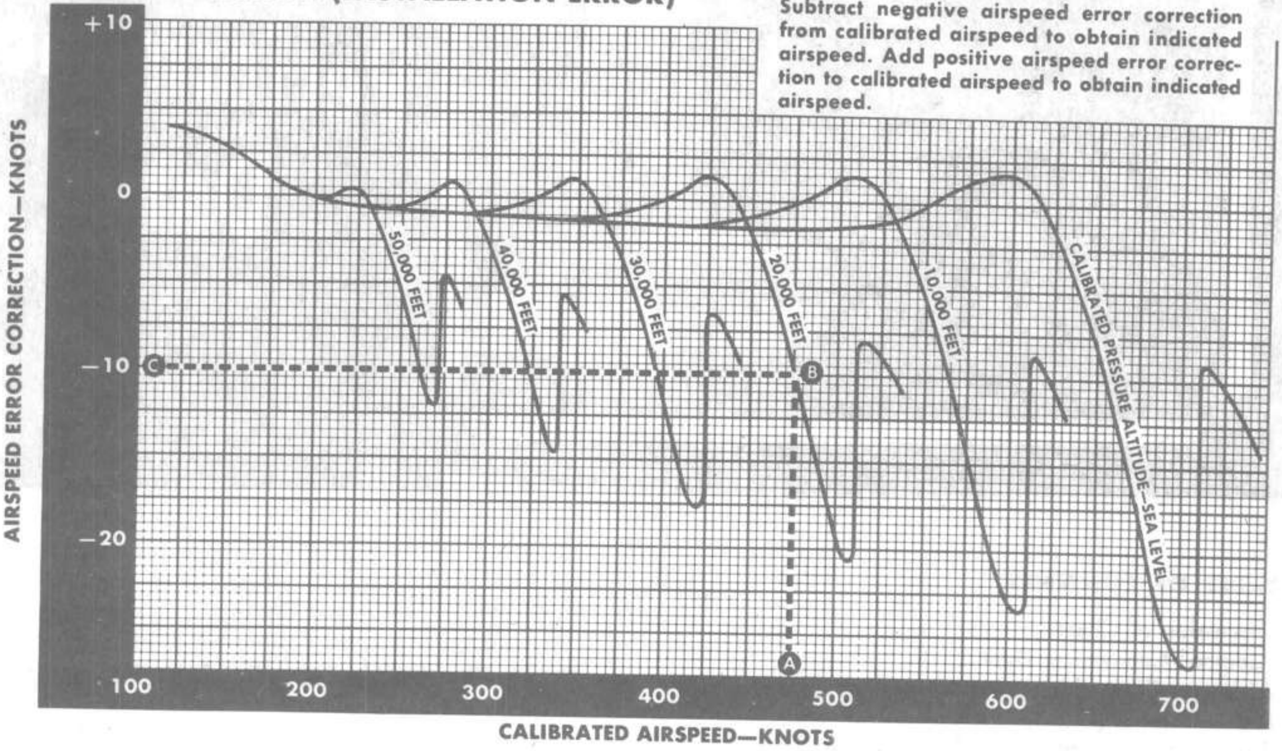
The flight performance charts in this section provide the pilot with data for flight planning purposes. Two types of charts are included: (1) Profile-type charts for maximum range, endurance, and Maximum Continuous Thrust operation, and (2) graphical charts for take-off, climb, nautical miles per pound of fuel, descents, and landings. The profile-type charts are a supplement to the graphical data and help flight planning by reducing the computations that must be made. These charts are based on the recommended climb and cruise settings shown on the profile for the particular load configuration of the airplane, and the decrease in weight has been accounted for as fuel is consumed. This type of presentation gives a direct indication of the fuel and time required to cover a given distance, if the recommended settings are maintained. For cruise at Mach numbers other than those given on the profile charts, the graphical charts should be used for flight planning. The graphical charts supply cruise performance data throughout the operating speed range of the airplane. For flight planning where accurate results are necessary, the graphical data should be used.

Note

> Weight variations between aircraft may occur due to production changes and field modifications. Therefore, a take-off gross weight range is presented on each profile within which the chart data are valid. If the weight of your particular aircraft lies outside of this weight range, the graphical charts for climb and nautical miles per pound of fuel should be used for the most accurate performance data.

airspeed conversion data

AIRSPEED CORRECTION (INSTALLATION ERROR)



NOTE

Subtract negative airspeed error correction from calibrated airspeed to obtain indicated airspeed. Add positive airspeed error correction to calibrated airspeed to obtain indicated airspeed.

EXAMPLE:

Ⓐ is calibrated airspeed (475 knots).

Ⓑ is calibrated pressure altitude (20,000 feet).

Ⓒ is airspeed error correction (−10 knots).

Ⓐ-Ⓒ is indicated airspeed (465 knots).

COMPRESSIBILITY CORRECTION

SUBTRACT CORRECTION FROM CALIBRATED AIRSPEED TO OBTAIN EQUIVALENT AIRSPEED

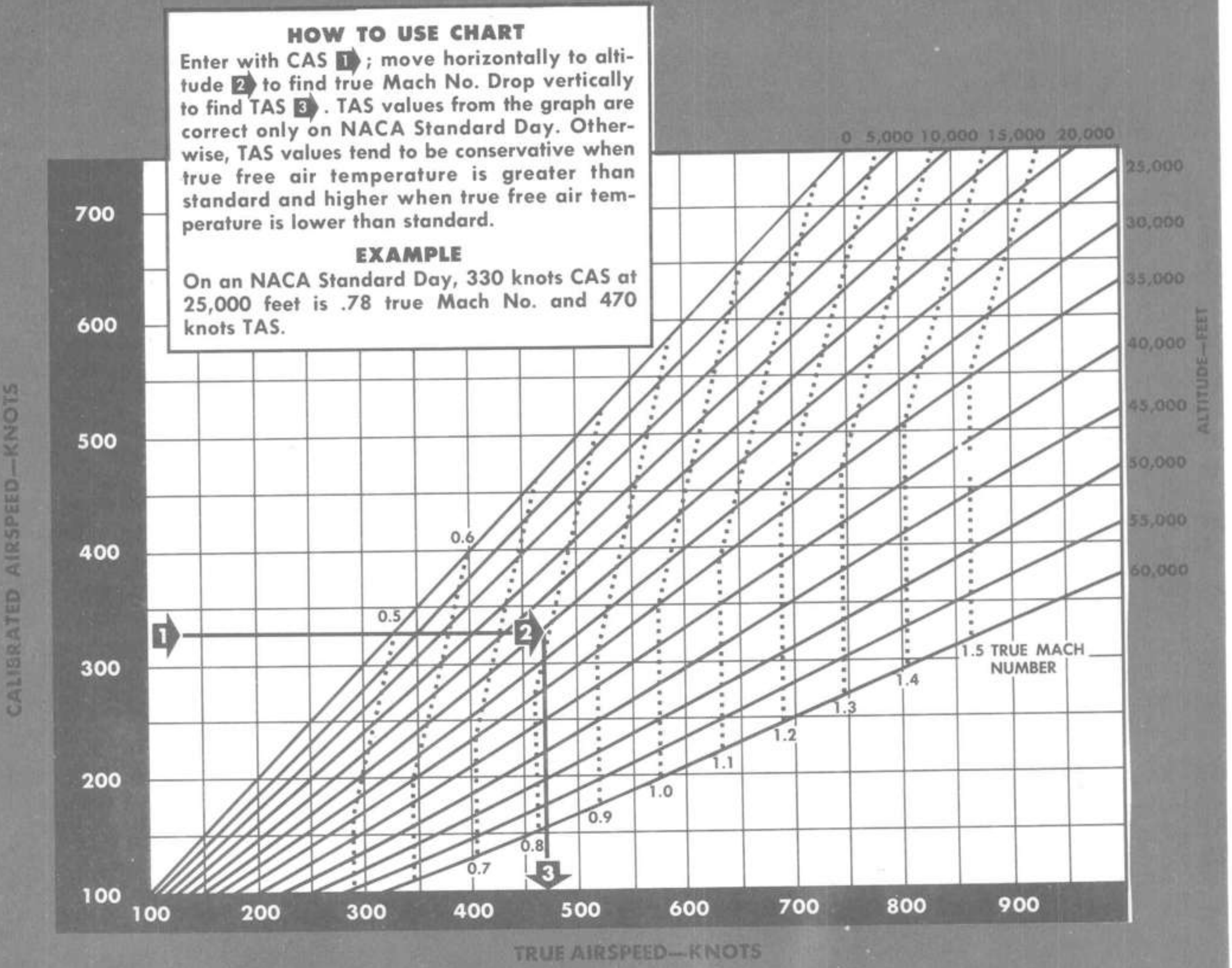
PRESSURE ALTITUDE—FEET	150	200	250	300	350	400	450	500	550	600
5,000	0	0	1	2	2	3	5	6	8	10
10,000	0	1	2	3	5	7	10	13	17	21
15,000	1	2	3	5	8	12	16	21	27	
20,000	1	3	5	8	12	17	23	31		
25,000	2	4	7	11	17	24	32			
30,000	2	5	9	15	23	32				
35,000	3	7	12	20	29					
40,000	4	9	16	25						

CAS—KNOTS

F-86L-1-93-2B

Figure A-1

AIRSPEED CONVERSION



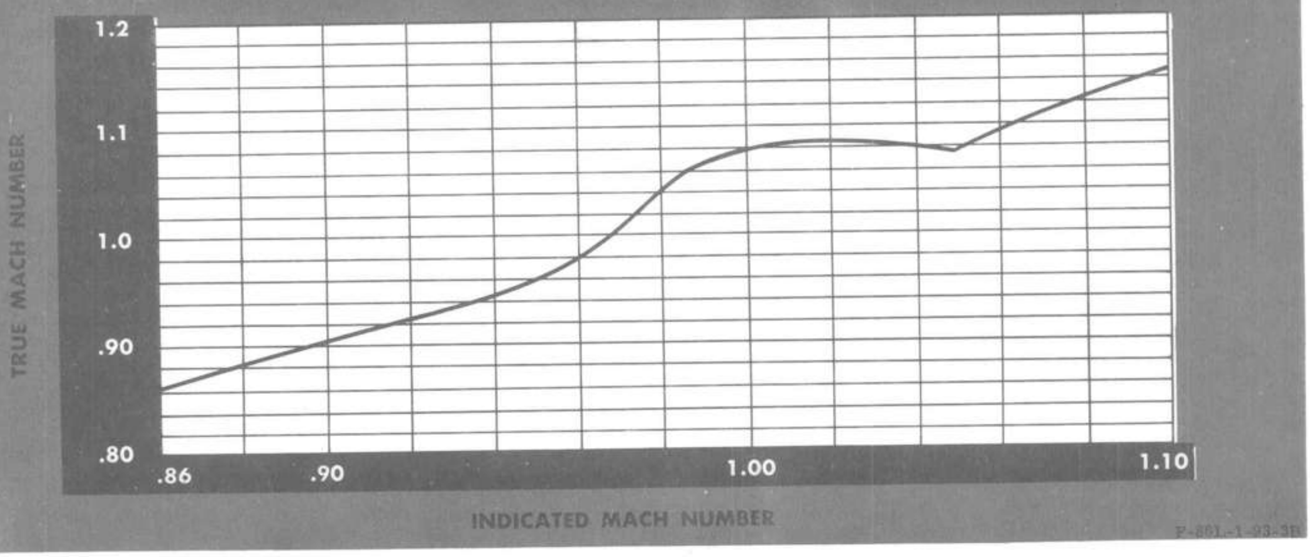
HOW TO USE CHART

Enter with CAS 1; move horizontally to altitude 2 to find true Mach No. Drop vertically to find TAS 3. TAS values from the graph are correct only on NACA Standard Day. Otherwise, TAS values tend to be conservative when true free air temperature is greater than standard and higher when true free air temperature is lower than standard.

EXAMPLE

On an NACA Standard Day, 330 knots CAS at 25,000 feet is .78 true Mach No. and 470 knots TAS.

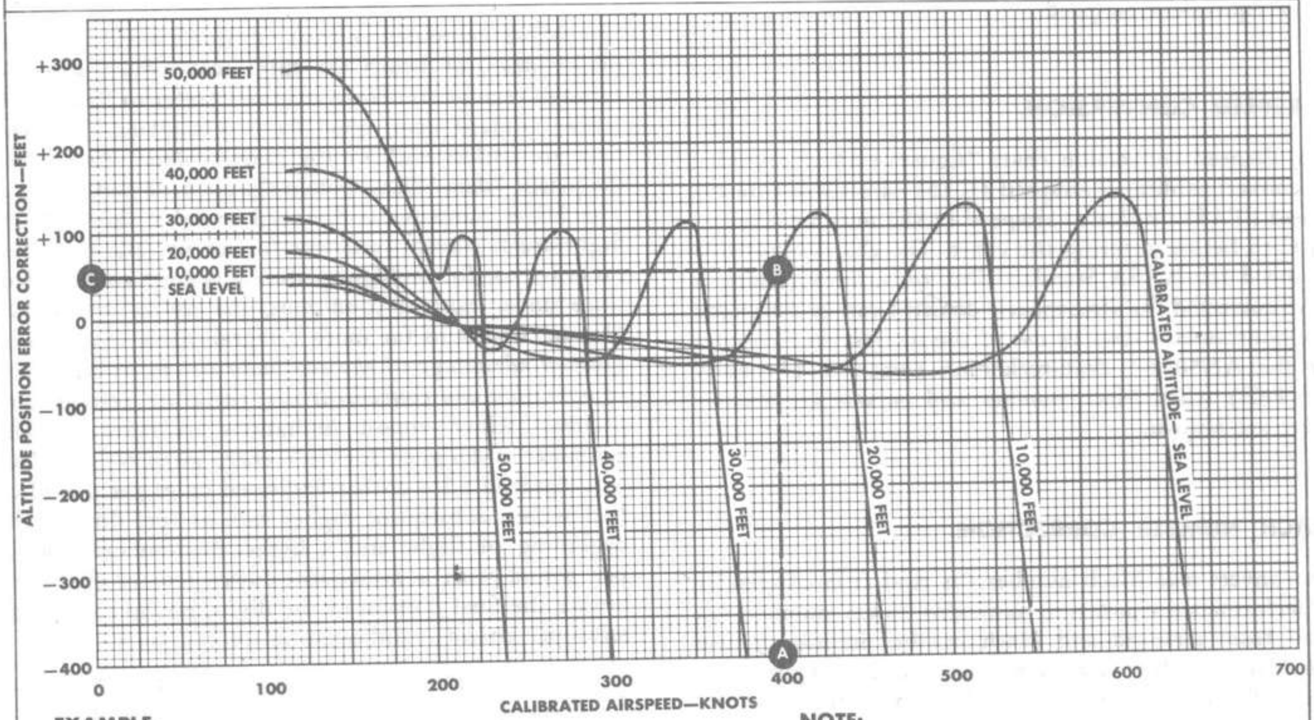
MACH NUMBER CORRECTION



DATA AS OF: 7 MAY 1957
BASED ON: FLIGHT TEST

ALTIMETER CORRECTION

MODEL: F-86 L
ENGINE: J47-17B or - 33



EXAMPLE:

- Ⓐ is calibrated airspeed (400 knots).
- Ⓑ is calibrated pressure altitude (20,000 feet).
- Ⓒ is altitude error correction (+ 50 feet).
- Ⓑ+Ⓒ is indicated pressure altitude (20,050 feet).

NOTE:

- Subtract negative correction from calibrated pressure altitude to obtain indicated pressure altitude. Add positive correction to calibrated pressure altitude to obtain indicated pressure altitude.
- Calibrated and true pressure altitude are identical.

F-86L-1-93-90

Figure A-1A

All charts are based on NASA Standard Day conditions. Airplanes equipped with J47-GE-33 engines have an improved Maximum Thrust climb performance.

Note

> The performance data in this section is based on the thrust of an average engine; however, it has been found that actual thrust between engines varies widely and can cause a variance in performance by as much as + or − 7%.

AIRSPEED CORRECTIONS.

IAS—Indicated airspeed is the reading taken from the airspeed indicator.

CAS—Calibrated airspeed is indicated airspeed corrected for installation effects.

EAS—Equivalent airspeed is calibrated airspeed corrected for compressibility effects.

TAS—True airspeed is equivalent airspeed corrected for atmospheric density.

GS—Ground speed is true airspeed corrected for wind.

INSTALLATION CORRECTION.

Because of the position of the pitot-static boom and the installation error of the other units of the airspeed indicating system, an airspeed correction must be made. The airspeed installation error at or near stall speeds causes the indicated airspeed (IAS) to be approximately 3 knots higher than the calibrated airspeed (CAS). At all other speeds, except those exceeding .95 Mach number, the airspeed installation error is less than 2 knots. The correction to be applied to CAS to obtain IAS is shown in figure A-1.

COMPRESSIBILITY CORRECTION.

Equivalent airspeed (EAS) is calibrated airspeed (CAS) corrected for compressibility effects. Though the difference between EAS and CAS is negligible at low speeds and low altitudes, impact pressure upon the pitot tube at high speeds increases, causing the airspeed indicator to show values above normal. The correction factors shown in the compressibility correction table (figure A-1) should be subtracted from calibrated airspeed to determine equivalent airspeed.

AIRSPEED CONVERSION.

An airspeed conversion chart (figure A-1) is provided to convert calibrated airspeed (CAS) directly to true airspeed (TAS). Indicated airspeed (IAS) must be changed to CAS before entering the chart. The chart shows true airspeed for NASA Standard Day only. TAS (which is EAS corrected for atmospheric density) can be computed for nonstandard days by use of the navigation computer or the AN5834-1 dead-reckoning computer (formerly the E6B) when Mach number and outside air temperature are known.

MACH NUMBER CORRECTION.

To convert *true* Mach number (as read from Appendix I performance charts) to *indicated* Mach number (as read from airspeed and Mach number indicator), use the Mach number correction chart shown in figure A-1. The difference between *indicated* Mach number and *true* Mach number at speeds below .86 Mach is negligible.

ALTIMETER CORRECTION.

Because of the position of the altimeter static-pressure source, a correction must be applied to the pressure altitude (given on the performance charts) to obtain indicated pressure altitude. This correction should be made by use of the chart in figure A-1A. Where the correction is negative, it must be subtracted from the pressure altitude to obtain indicated altitude. Where the correction is positive, it must be added to the pressure altitude to obtain indicated altitude.

Note

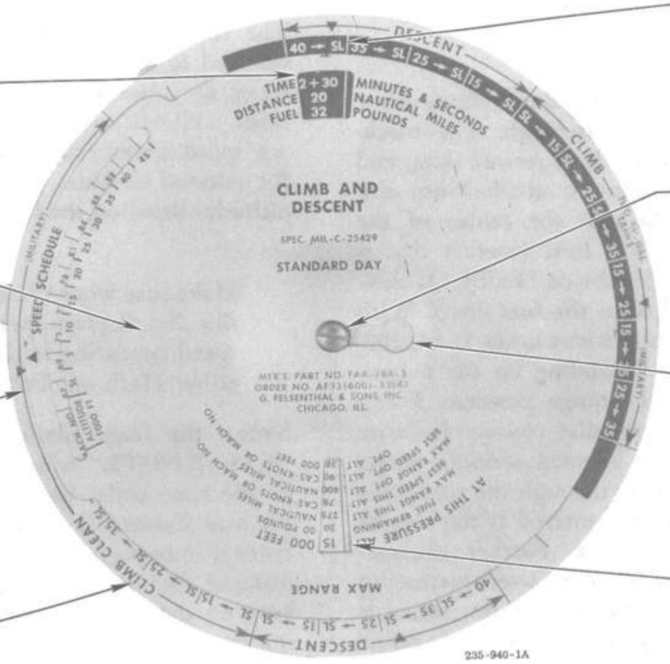
The altitude given on the charts is true or calibrated pressure altitude.

MB-8 COMPUTER.

The MB-8 computer consists of three metal and two plastic discs, of which the three metal discs, supplied through regular Air Force channels (refer to foreword), are a standard item, good for any airplane; however, they are useless without the plastic "data" discs, since the plastic "data" discs contain the airplane performance. The MB-8 computer is designed to solve simple level-flight cruise control problems for jet aircraft. However, exclusive use for preflight planning is not recommended, since under normal conditions, the use of the Flight Manual results in far more comprehensive results. *The greatest advantage of the computer lies in its simplicity of operation and convenient size*; therefore, certain compromises which impose limitations are involved. The computer is designed for an *average* gross weight. This will result in a lower-than-indicated miles per pound of fuel with a subsequent higher rate of fuel flow at the beginning of flight and a higher-than-indicated miles per pound with a subsequent lower rate of fuel flow during the final portion of the flight, giving an average miles per pound as indicated on the computer.

The back or "tabulator side" (figure A1-B) of the MB-8 computer shows the cruise data in the "MAX RANGE" window, listing combinations of fuel remaining at selected pressure altitude. This data can be used as a quick range check for various quantities of fuel remaining at altitude. Range data for both optimum cruise and cruise at constant altitude is given, thereby providing a quick and yet fairly comprehensive picture of the range potential. This data is very similar to the information given in the optimum return profile of the Flight Manual. A second window displays the time, fuel, and distance required for climb or descent, while a third window frames the recommended altitude-speed schedule for these maneuvers. Notice that a black background is used for one configuration, while the other has a white background.

MB-8 COMPUTER



CLIMB AND DESCENT TABULATOR WINDOW

CLIMB AND DESCENT METAL DISC (ONE OF THE THREE STANDARD METAL DISCS)

LINE UP THESE TRIANGLES TO OBTAIN RECOMMENDED SPEED SCHEDULE

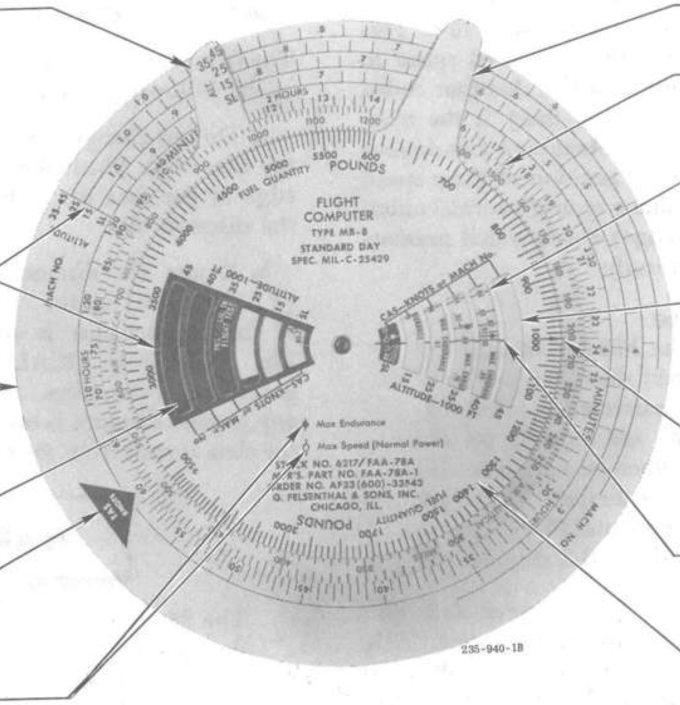
CLIMB AND DESCENT PLASTIC DISC (ONE OF THE TWO PLASTIC DATA DISCS) MAKE SURE YOU INSTALL IT WITH THE PROPER CONFIGURATION SHOWING

PLACE DESIRED CLIMB OR DESCENT ALTITUDES OVER THE TABULATOR WINDOW. CHECK ARROWS TO DETERMINE CLIMB OR DESCENT.

DO NOT USE SCREWDRIVER IN DISC ASSEMBLY GUIDE GROOVE.

LINE UP SLOT WITH GROOVE ON PIN, AND SLIDE DISC TO DISASSEMBLE.

"MAX RANGE" TABULATOR WINDOW



DISTANCE DISC CURSOR

WHEN YOU ASSEMBLE THE COMPUTER, MAKE SURE THAT:

- THE DISC FOR THE RIGHT CONFIGURATION IS USED.
- THE SPEEDS ON THE OUTSIDE DISC AGREE WITH THE SPEEDS SHOWING THROUGH THE WINDOWS, MACH NO. WITH MACH NO. OR CAS WITH CAS.

TIME DISC (ONE OF THE THREE STANDARD METAL DISCS)

THIS WINDOW IS FOR THE CONFIGURATION WITH THE BLACK BACKGROUND AND WHITE PRINTING.

TAS TRIANGLE

REMEMBER THESE SYMBOLS WHEN SETTING A SPEED IN THE WINDOWS.

FUEL DISC TAB

DISTANCE DISC (ONE OF THE TWO PLASTIC DATA DISCS)

SPEED (MIN) LINES INCREASE COUNTERCLOCKWISE

ALTITUDE WINDOWS (MATCH THE ALTITUDES SHOWN ON THE DISTANCE DISC CURSOR)

READ NAUTICAL MILES PER 1000 POUNDS OF FUEL OPPOSITE THIS LITTLE ARROW.

INDEX LINE (LINE IT UP WITH THE DESIRED CRUISE MACH NUMBER.)

FUEL DISC (ONE OF THE THREE STANDARD METAL DISCS)

F-86L-1-93-89

Figure A-1B

Turn to the front or "working side" of the computer and begin at the center, working toward the outer edge. *Keep in mind the six factors of range*:

1. Speed (Mach number)
2. Altitude
3. Fuel
4. Distance
5. Time
6. Wind

Notice the opposing "pie-shaped" windows which allow the center plastic discs to show through. The black-bordered window is for the black background data, and vice versa. Notice that the window is divided into *altitudes*, with an index line through the center of the windows. The outer edge of this first (metal) disc is divided into a logarithmic scale labeled "FUEL QUANTITY—POUNDS" (referred to as the fuel disc). With this type of scale, the "1000" mark can mean 1, 10, 100, 1000, or 10,000 pounds, etc, depending on the magnitude of the other factors in the range problem. Using the tab provided, rotate the fuel disc *counterclockwise* so that the index line for any selected *altitude* passes across the *speed* lines which show through the respective window. The first speed line encountered is the *recommended* speed for maximum range. Further counterclockwise rotation results in passing over increasing speeds until the maximum speed line in the series is reached. In progressing from speed for maximum range to maximum speed, the index passes over a speed line coded as a solid dot with a vertical line passing through it. This is the computer setting for maximum endurance. The speed for maximum endurance is quoted at the extreme right of the *maximum range* speed line. This coded point is used together with the quoted speed to obtain maximum endurance information. Another coded speed line (diamond with a vertical line) is the maximum speed for Normal Power (Maximum Continuous Thrust). To help understand the position of these speed points on the computer, examine a typical nautical-miles-per-pound-of-fuel (specific range) curve which presents these same speed points graphically.

Note

> The speeds shown on the MB-8 computer are CAS or true Mach number; therefore, any indicated speeds should be corrected for installation error before speeds are entered on the computer. Because of numerous variables and possible modification of the airspeed indicating system, the indicated airspeed and Mach number are not incorporated in the MB-8 computer.

The second disc (plastic) is a performance data disc around which is placed a logarithmic scale labeled "AIR NAUTICAL MILES." Refer to this disc as the "distance disc." The placement of the speed lines previously described maintains the proper relationship between the *distance* and *fuel* discs. Note that any specific relationship between the fuel and distance discs for a selected speed and altitude will give the specific range or nautical air miles per pound of fuel; i.e., the air miles at the 1000-pound mark are actually nautical air miles per 1000 pounds of fuel. The tab on the distance disc is a special shape with the straight edge of the tab acting as a "wiper" or cursor on the third (metal) disc. Mention will be made of this cursor in the discussion of the "time" disc.

The third disc of the front face of the computer is referred to as the "time disc." On this disc is printed a series of concentric scales, of which the inner scale is label "HOURS—MINUTES." The succeeding scales are speed scales (Mach number or calibrated airspeed) for selected altitudes, i.e., altitudes corresponding to the altitudes listed on the fuel disc.

Note

> Make sure when the computer is assembled that this disc displays speed in the same terms as the speed appearing in the window of the fuel disc: either Mach number or CAS.

Notice the large black triangle on this disc, labeled "TAS—KNOTS," with the apex at the 60-minute mark of the time scale. For standard atmosphere conditions, the *true* airspeed in knots may be obtained from the distance disc opposite this TAS triangle. That is, when the distance disc cursor is aligned with a speed (Mach number) on the time disc, at some altitude, the corresponding *true* airspeed is indicated by the TAS triangle (using the distance scale as a speed scale). This conversion feature is useful in making corrections for wind.

WIND CORRECTIONS.

The front face of the computer can be adjusted for wind in the following manner:

a. Do not change the relationship of the fuel disc and the time disc. Pinch the fuel disc tab against the outer edge of the time disc. This will still permit rotation of the distance disc.

b. Rotate the distance disc until the ground speed (TAS + wind) on the "AIR NAUTICAL MILES" scale of the distance disc is aligned with the TAS triangle. The "AIR NAUTICAL MILES" scale then becomes ground nautical miles, and the fuel required to travel any ground distance is obtained from the fuel disc, while the time is read from the time disc.

WARNING

> The Mach numbers now appearing in the window of the fuel disc and on the time disc under the index cursor no longer apply. The *original Mach number must be maintained in flight.*

c. To determine the winds while in flight, a system of check points can be utilized. Rotate the distance disc until the distance between check points is aligned with the elapsed time on the "MINUTES" scale of the time disc. The ground speed is then read on the distance disc opposite the TAS triangle. The fuel required to travel any selected ground distance is obtained from the time disc. The Mach numbers appearing in the window of the fuel disc no longer apply and should be ignored. The *original Mach number must be maintained.*

FUEL FLOW CORRECTIONS.

Variations in the fuel consumption characteristics due to battle damage, small changes in configurations, differences in engines, formation flight, etc, may be accounted for in the following manner:

a. Determine the fuel flow from the flowmeter.

b. Do not change the relationship of the distance disc and the time disc (set from ground speed).

c. Rotate the fuel disc until the rate of fuel flow, read from the flowmeter, is aligned with the TAS triangle.

d. Determine distance and time for selected fuel quantities from the respective discs.

SUMMARY.

Variations in rate of fuel flow of an average magnitude of +5 percent of that indicated on the computer can be expected on the initial portion of the flight and −5 percent on the final portion when flying at the Mach number recommended for maximum range. These variations show up plainly when the maximum range shown on the tabulator side of the computer is compared with the range obtained on the fuel-distance side. The tabulator side will indicate a greater distance because this data considers the change in airplane gross weight as fuel is consumed, whereas the indicated specific range on the fuel-distance side of the computer is an average value and results in a slightly conservative distance. The true airspeeds presented on the computer are based on standard atmospheric conditions. An allowance for the difference in this true airspeed and the true airspeed for the actual atmospheric condition can be made by the wind correction method described previously. The rate of fuel flow is also based on standard atmospheric conditions. However, the difference in fuel flow need not be corrected, since the air range calculated on the flight computer is normally independent of air temperature when the Mach number is properly indexed.

CROSS-WIND CHART.

The cross-wind chart (figure A-2) is used to obtain the equivalent head wind for cross winds from 0 to 60 knots and up to 90 degrees from airplane heading. The equivalent head wind is used in the take-off and landing charts to determine distances with wind. Refer to Section II for recommendations and suggested techniques for take-off and landing with a cross wind.

TAKE-OFF.

Take-off performance is affected by a large number of variables, i.e., temperature, altitude, gross weight, and wind, as well as runway surface, use of brakes for directional control, and engine condition. Charts including these variables are provided for take-off distance, acceleration distance, and speed, and stopping distance or refusal speed. Increases in any of these variables except wind tend to increase take-off ground roll to a point where a take-off in which normal techniques are used may not be successfully accomplished in the available runway length. The last point at which a decision to stop or take off can be made is called the go, no-go distance point and can be determined by the combined use of the take-off and acceleration distance charts with the refusal speed chart. When used separately, the take-off chart shows distances for ground roll as well as total distance required to clear a 50-foot obstacle; the take-off acceleration chart shows the speed-distance relationship during the ground roll portion of take-off; and the refusal speed chart shows the combined distance traveled in acceleration to any given refusal speed and the distance required for a full stop.

TAKE-OFF SPEEDS.

The indicated airspeeds (IAS) for nose wheel lift-off, take-off, and the initial stall warning speeds versus gross weight are shown on figure A-3.

TAKE-OFF DISTANCES.

Ground-run distance and total distances to clear a 50-foot obstacle with Maximum or Military Thrust are plotted in the take-off distance charts (figures A-4 and A-5). The distances shown are for normal take-off technique on a dry, hard-surface runway. These charts may be used for any configuration if the gross weight at take-off is considered. Use of the chart is explained by a sample problem.

Note

> It is difficult to obtain accurate results with an accumulative error of less than 300 feet when computing take-off and landing distances. Therefore, follow the grid and guide lines carefully to keep the error to a minimum.

TAKE-OFF ACCELERATION.

The take-off acceleration charts (figures A-6 and A-7) give ground roll distances required to accelerate to any desired indicated airspeed using Maximum or Military Thrust. Also, check-point speeds may be determined for specific ground roll distances for prevailing take-off conditions. Use of the charts is explained by a sample problem.

REFUSAL SPEEDS.

The highest indicated airspeed to which the airplane can accelerate and then stop in the available runway length is called the refusal speed. This speed is obtained from the refusal speed charts (figures A-8 and A-9) for the prevailing take-off conditions and runway length. The refusal speeds charts are based on a Maximum or Military Thrust acceleration to the refusal speed, and then normal braking to a stop on a dry, hard-surface runway, without use of drag chute or speed brake. The drag chute and the speed brakes will reduce the distance required to stop and should be used if possible. The ground roll distance required to accelerate to refusal speed can be found on the take-off acceleration charts (figures A-6 and A-7). Use of the charts is explained by a sample problem.

GO, NO-GO SPEED AND DISTANCE.

The go, no-go distance and the corresponding go, no-go speed form the maximum allowable ground roll and minimum-speed combination that will permit either a take-off or a complete stop in the remaining runway length. For example, if the indicated airspeed (IAS) falls below the go, no-go speed at the go, no-go distance point, the take-off should be discontinued. If the IAS is above the go, no-go speed, the take-off may be continued.

Obtain go, no-go speed and distance as follows:

a. With available runway length and effective wind, enter the ground roll distance scale on the take-off distance chart at the point where wind and ground roll distance intersect; follow the wind guide lines to the wind base line. Proceed to gross weight, and then to field pressure altitude. Note the temperature on temperature scale. This procedure assumes that the take-off would be made in exactly the available runway length. Obviously, obstacles at the end of the runway should be considered when establishing the available runway length. If step a. results in a temperature beyond the charts limits, it is an indication that the available runway length is in excess of the distance required to take off even under the most adverse conditions. To obtain the desired information, select highest temperature shown for the field pressure altitude and proceed with steps b. and c.

b. Use maximum temperature obtained from step a. to enter refusal speed chart and obtain a refusal speed corresponding to available runway length used in step a. This is the speed to which the airplane can accelerate and still stop in the available runway length. To determine the maximum distance down the runway that this speed can occur, proceed to step c.

c. With temperature obtained from step a. and speed from step b., obtain ground roll required to accelerate to desired speed from take-off acceleration chart. This, then, is the go, no-go distance point. Acceleration checkpoint distance can be determined by following the guide line to intersections with lower speeds and obtain the corresponding check-point distances.

Note

This procedure shows how the charts are used to obtain the go, no-go distance and speed for a minimum-acceleration condition. Normal conditions permit take-offs in shorter distances at improved acceleration rates which give higher go, no-go speeds. These values may be extracted from the refusal speed charts, while auxiliary check-point distances and speeds can be obtained from the take-off acceleration chart, using the exact runway temperature and altitude.

RUNWAY DISTANCE MARKING SYSTEM.

The numbering and placement of runway distance markers reflects the distance remaining to the end of the runway. The following procedure is recommended for use of runway distance markers in checking take-off performance.

a. Determine go, no-go speed and distance.

b. Obtain distance remaining between refusal point and end of runway by subtracting go, no-go distance from runway available.

c. Establish go, no-go marker as marker from which at least this distance remains to end of runway. (In accordance with the new marker system on an odd length runway, one half of the odd figure over exact thousands of feet must be added to the distances shown on the markers to determine the actual distance remaining.)

d. Use take-off acceleration chart to determine acceleration check speed. Since the acceleration check marker is two markers short of the go, no-go marker, the acceleration check speed is determined at a distance 2000 feet less than the go, no-go distance.

NONSTANDARD DAY TEMPERATURE.

When the free air temperature is higher than standard, the airplane will perform as if it weighs more than it actually does. When the free air temperature is lower than standard, the airplane will perform as if it weighs less than it actually does. Where cruise is performed at the cruise ceiling (limited by Maximum Continuous Thrust) on a hot day, the altitude will be decreased because at any particular thrust setting the thrust is decreased. If cruise is performed below the cruise ceiling, the maximum cruise thrust is not being used. Actually, an excess of thrust is available on a Standard Day. The thrust loss due to an increase in ambient temperature has only the effect of requiring a higher cruise engine speed and a slightly higher specific fuel consumption. Use of an equivalent weight permits utilization of the Standard Day charts under nonstandard temperature conditions. Equivalent weight is obtained by applying a weight increment to actual airplane gross weight. The equivalent weight is used only to determine the nonstandard climb performance and cruise ceiling. For each 10°C rise in air temperature above Standard Day conditions, increase actual gross weight, as shown on the individual chart before entering the climb chart. For each 10°C below Standard Day conditions, apply correction in the opposite direction. Cruise performance is determined for the actual airplane gross weight.

CRUISE.

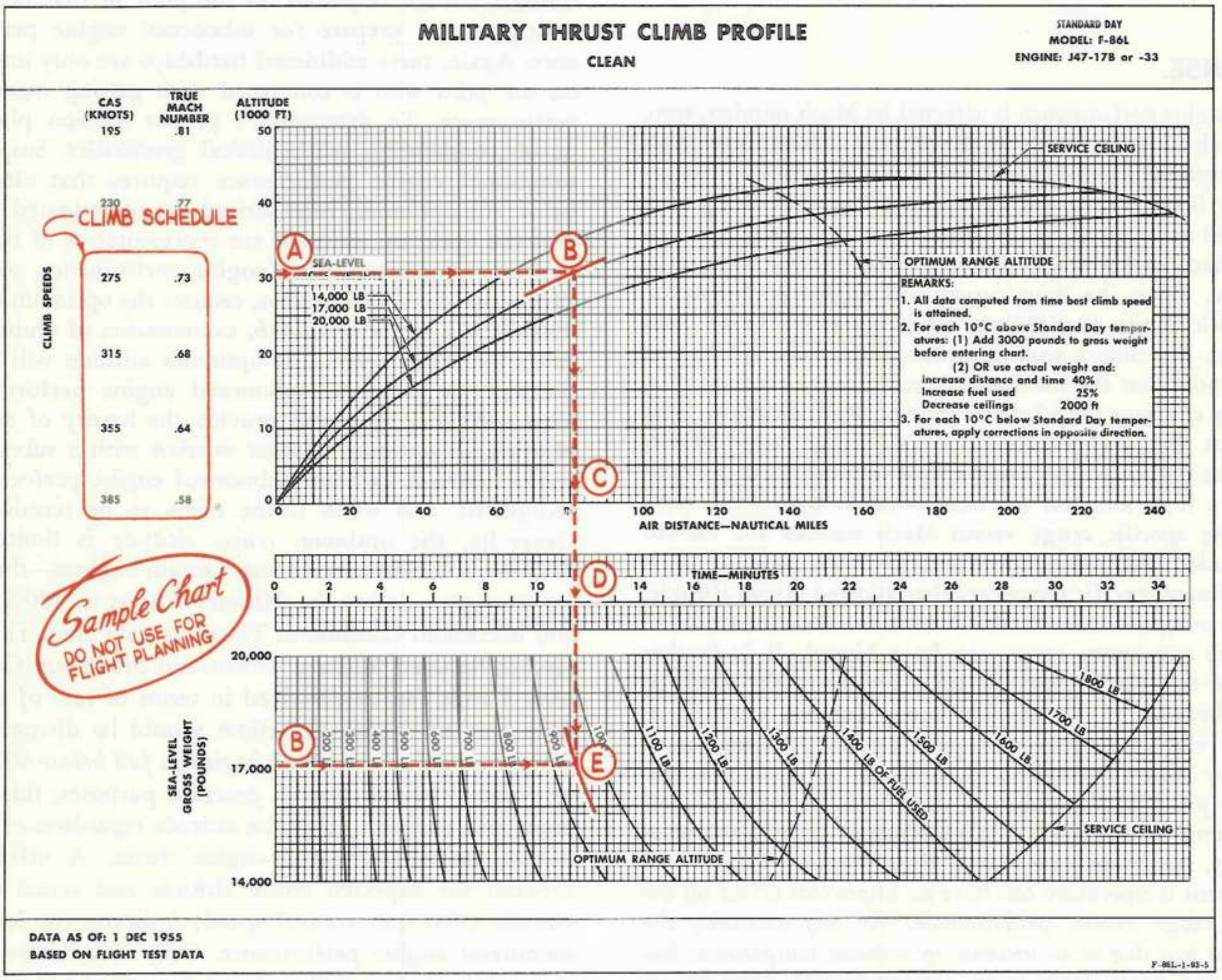
As engine performance is affected by Mach number, rpm, and altitude, the drag curve indicates flexibility in both the optimum cruise Mach number and altitude. Therefore, instead of these optimum parameters being presented as points in space, there is a definite range or span of Mach and altitude that will produce near maximum range. From the drag curves and engine performance, specific range at different Mach numbers can be computed. Examine a nautical-miles-per-pound-of-fuel chart and note that the maximum specific range remains relatively constant for a broad range of Mach numbers. This means that without compromising range, wind effects can be optimized (by using a slow airspeed for tail winds, and a high airspeed for head winds). By further computing specific range versus Mach number for various altitudes, the same characteristics hold true. If these maximum specific ranges are then plotted versus altitude, it is seen that there is also a considerable altitude band where maximum range can be achieved. It is further noted that the heavier the gross weight of the airplane, the broader is the altitude band. For the operational pilot who is plagued with poor engine performance or traffic control problems, these bands of Mach and altitude provide the luxury of *still* being capable of performing an optimum combat mission, or, more expressively, *maximum operational effectiveness.* Variations of ambient temperature can have an important effect on the long-range cruise performance. At any altitude, the thrust loss due to an increase in ambient temperature has only the small effect of requiring a higher cruise engine speed and perhaps a slightly higher specific fuel consumption. However, increased ambient temperature also increases the true airspeed at a constant Mach number; consequently, specific range is not seriously affected. Remember that *Mach number* is the choice parameter for precise cruise control. If the cruise were to be performed at the optimum cruise altitude and the optimum altitude were thrust-limited on a Standard Day, then ambient temperatures above standard would certainly reduce the range by reducing the altitude for cruise. If the optimum cruise altitude is thrust-limited on a Standard Day, there may be a hot-day speed and altitude reduction and an associated loss in specific range along the optimum long-range path. Fortunately, most present-day high-performance airplanes are not compromised in cruise by thrust limitations. However, the addition of external stores does to some extent limit the cruise because of thrust.

Airplane performance is critically affected by variations in thrust and drag; namely, those performance items which describe limits, i.e., maximum speed, ceiling, etc. While Flight Handbook performance data are based on a theoretical engine, experience has shown that logistics and maintenance play an important part in the extent to which an engine can be kept up to standard. As a rule, the pilot is not readily able to evaluate the level of engine performance before flight. Consequently, an additional burden is placed on the pilot in that he must anticipate and prepare for subnormal engine performance. Again, these additional hardships are only imposed on the pilot who is concerned with getting maximum performance. To determine a precise mission plan requires considerable mathematical gymnastics. Suspected subnormal engine performance requires that altitudes below the optimum cruise altitude be investigated. Note that the optimum altitudes are representative of normal engine performance. Poor engine performance, such as that experienced on hot days, reduces the optimum cruise altitude. As a *rule of thumb*, examination of cruise altitudes *3000 feet* below the optimum altitude will cover the extreme range of subnormal engine performance. This additional step will provide the luxury of accomplishing an *optimum combat mission* with a subnormal engine. How is in-flight subnormal engine performance recognized, and when is the climb to be terminated? Generally, the optimum cruise altitude is limited by Maximum Continuous Thrust. Certain engines—the J47, for example—define the Military Thrust as 100% rpm, and Maximum Continuous Thrust as 96% rpm. The difference between Military Thrust and Maximum Continuous Thrust can be described in terms of *rate of climb.* As a rule of thumb, the climb should be discontinued when the vertical speed *just begins to fall below 600 fpm* in Military Thrust. For all practical purposes, this technique will establish the cruise altitude regardless of what factors are affecting the engine thrust. A difference between the expected cruise altitude and actual cruise altitude (600 fpm vertical speed) indicates the level of subnormal engine performance. Only if a deviation in cruise altitude is anticipated and accounted for will the mission initiate and progress in an optimum manner. Anticipated subnormal engine performance can be reckoned with for the precise plan by (1) examining airplane performance *3000 feet* below the optimum cruise altitudes, and (2) discontinuing the climb when the vertical speed just falls below 600 fpm. Optimum cruise control is conducted by establishing Mach number (optimized for wind, etc) and by monitoring engine thrust by means of rpm, exhaust temperature, etc. Recognition and use of these in-flight rules of thumb will provide the link between the preflight plan and the successful accomplishment of the combat mission and should prove invaluable in increasing the combat effectiveness of the airplane.

CLIMB PROFILE

DESCRIPTION

The climb profile charts give time required, distance traveled, and fuel used (based on the recommended climb speed schedule) for a military thrust climb from sea level for several gross weights. The reduction in weight due to fuel used during climb is taken into account. Approximate climb data for climbs between two specific altitudes may be obtained from these profile charts, but it is recommended that the graphical climb charts be used for such in-flight climb data.



REMARKS:
1. All data computed from time best climb speed is attained.
2. For each 10°C above Standard Day temperatures: (1) Add 3000 pounds to gross weight before entering chart.
   (2) OR use actual weight and:
   Increase distance and time 40%
   Increase fuel used 25%
   Decrease ceilings 2000 ft
3. For each 10°C below Standard Day temperatures, apply corrections in opposite direction.

DATA AS OF: 1 DEC 1955
BASED ON FLIGHT TEST DATA

USE

Enter the chart at the altitude at end of climb and the gross weight at start of climb (sea level). From this point, read the distance traveled and time required to climb. To obtain the fuel used during climb, project the point down to the sea-level gross weight in the lower portion of the chart and interpolate for fuel used. The gross weight at the end of climb is the sea-level gross weight minus fuel required to climb. For temperatures other than Standard Day, apply the corrections, shown on each graph, to gross weight.

The example shown is for a Military Thrust climb from sea level to 30,000 feet with a gross weight of 17,000 pounds in the clean configuration.

A is altitude at end of climb........................30,000 ft
B is gross weight at start of climb (sea level)........................17,000 lb
C is distance traveled in climb........................81 n mi
D is time required to climb........................11.5 min
E is fuel used during climb........................940 lb
B minus E is gross weight at end of climb......16,060 lb

CLIMB GRAPHICAL

DESCRIPTION

Climb charts for Maximum, Military, and Maximum Continuous Thrust operations, based on a recommended climb speed schedule, are shown for each configuration. Time and distance are plotted against gross weight with guide lines to show the reduction in gross weight during climb due to the fuel used. Service ceiling (100 fpm), combat ceiling (500 fpm), and optimum range altitude (constant Mach cruise-climb) are superimposed on the graph.

EXAMPLE:

A_w is initial gross weight
(16,550 LB)

A_h is initial altitude
(15,000 FT)

A_d is initial distance
(29 Naut. Miles)

A_t is initial time
(4.0 Min.)

B_h is final altitude
(40,000 FT)

B_d is final distance
(180 Naut. Miles)

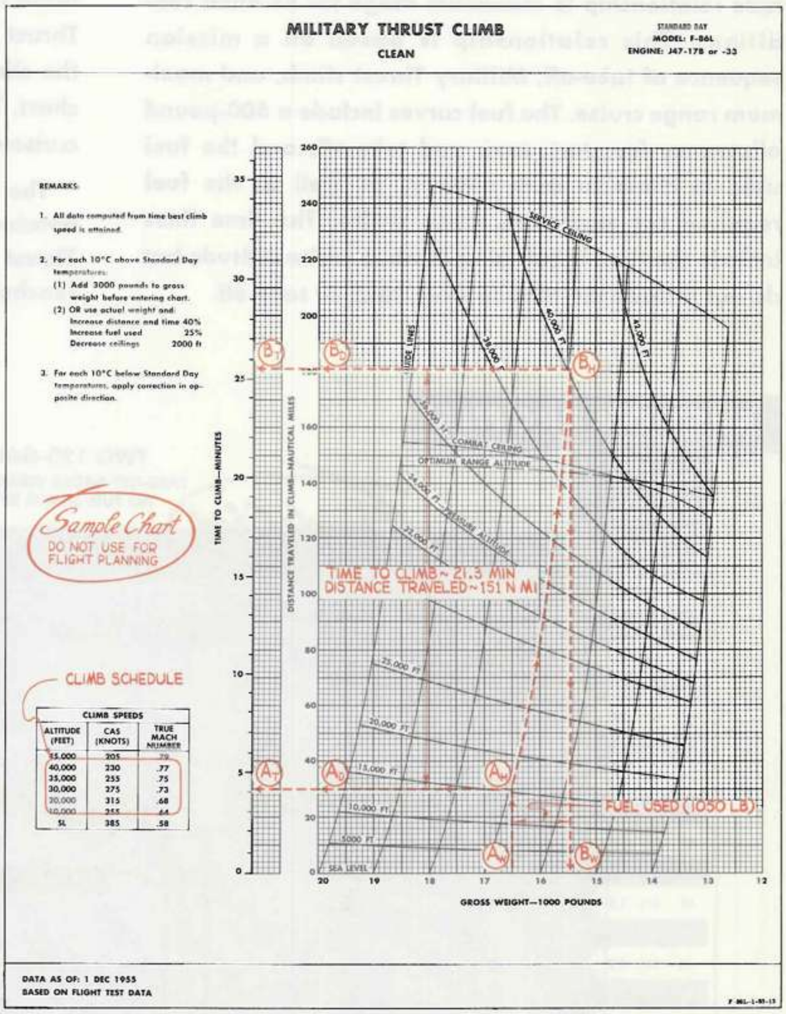
B_t is final time
(25.3 Min.)

B_w is final gross weight
(15,500 LB)

A_w minus B_w is fuel used
(1050 LB)

B_d minus A_d is distance traveled
(151 Naut. Miles)

B_t minus A_t is time to climb
(21.3 Min.)



REMARKS:

1. All data computed from time best climb speed is attained.
2. For each 10°C above Standard Day temperatures:
   (1) Add 3000 pounds to gross weight before entering chart.
   (2) OR use actual weight and:
   Increase distance and time 40%
   Increase fuel used 25%
   Decrease ceilings 2000 ft
3. For each 10°C below Standard Day temperatures, apply correction in opposite direction.

CLIMB SPEEDS		
ALTITUDE (FEET)	CAS (KNOTS)	TRUE MACH NUMBER
45,000	205	.79
40,000	230	.77
35,000	255	.75
30,000	275	.73
20,000	315	.68
10,000	355	.64
SL	385	.58

DATA AS OF: 1 DEC 1955
BASED ON FLIGHT TEST DATA

USE

To obtain the climb data desired, enter the proper climb chart at the gross weight and altitude at start of climb. Note the time and distance at this point. From this initial altitude point, trace a curve parallel to the guide lines until it intersects the desired altitude at end of climb. Note the time, distance, and gross weight at this intersection. The difference between the initial and final time is the time required to climb. The difference between initial and final values for distance and for gross weight gives, respectively, the distance traveled and fuel used to climb. Since time and distance are zero at sea level, the time required and distance traveled may be read directly for climbs starting at sea level. Fuel used, however, must still be determined by the difference in gross weights.

The effect of temperature on time, fuel, and distance to climb is accounted for by using a corrected gross weight at start of climb (increased at temperatures above standard; decreased at temperatures below standard). Instructions for temperature correction are given on each climb chart.

The example shows the fuel used, distance traveled, and time to climb from 15,000 feet to 40,000 feet, using Military Thrust, clean airplane, with an initial gross weight of 16,550 pounds at start of climb.

MISSION PROFILE

DESCRIPTION

These charts give the time, fuel, distance, and altitude relationship to maximum range for no-wind conditions. This relationship is based on a mission sequence of take-off, Military Thrust climb, and maximum range cruise. The fuel curves include a 600-pound allowance for start, taxi, and take-off, and the fuel used in climb to each altitude, as well as the fuel required for maximum range cruise. The time lines include the time required to climb to cruise altitude but do not include the time to start, taxi, or take off.

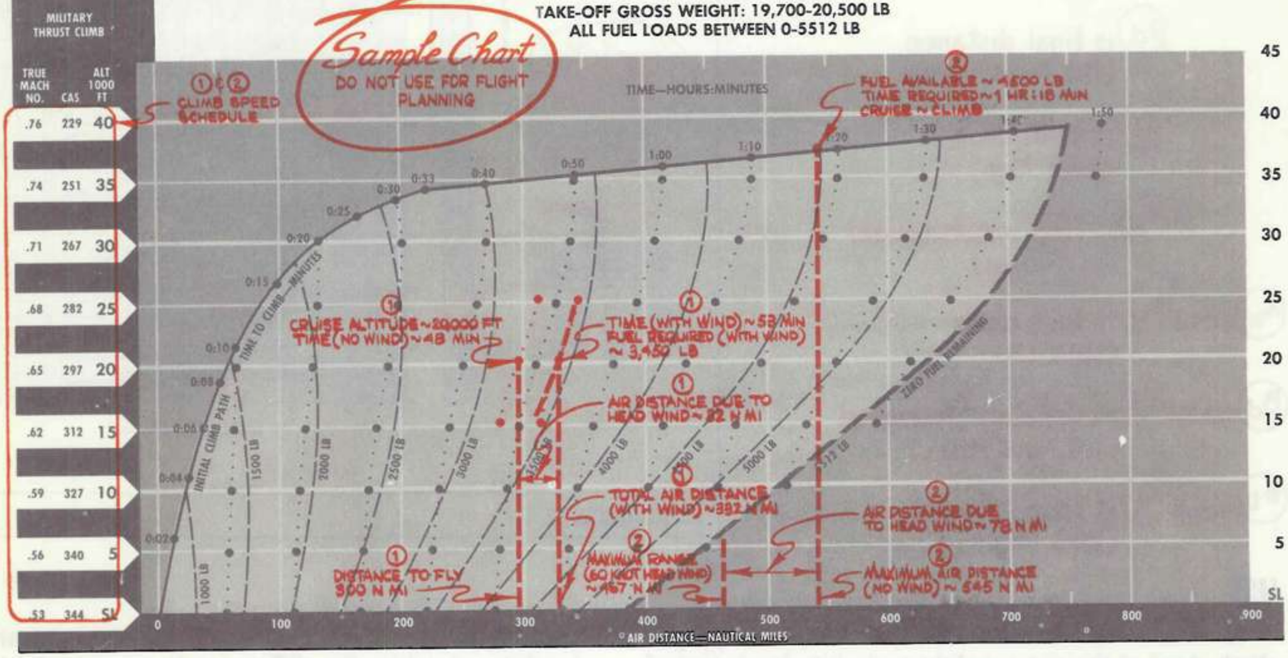
The line labeled "Initial Climb Path" shows the distance traveled and time consumed during the Military Thrust climb from sea level to cruising altitude, using the climb speed schedule tabulated at the left of the chart. The continuation of the initial climb path is the cruise-climb path based on a constant Mach number.

The approximate best cruise-climb altitude can be obtained by climbing at the recommended Military Thrust climb schedule until the proper altitude is reached. Level off and set up the thrust setting and

MISSION PROFILE

STANDARD DAY
Model: F-86L
Engine: J47-17B or -33

TWO 120-GALLON TANKS
TAKE-OFF GROSS WEIGHT: 19,700-20,500 LB
ALL FUEL LOADS BETWEEN 0-5512 LB



REMARKS:

1. 600-pound fuel allowance for start, taxi, take-off, and acceleration to climb schedule.
2. No allowance or reserve for loiter, descent, or landing.
3. Use Military Thrust for climb. (See Military Thrust climb chart for detailed information.)
4. Cruise at recommended Mach number.
5. For cruise-climb procedure, use Maximum Continuous Thrust.

LEGEND

— — — Fuel consumed
——— Maximum Continuous Thrust cruise-climb path
●· · · ●· · · ● Time (start, taxi, and take-off not included)

CRUISE—TWO 120-GALLON TANKS

② CRUISE SETTINGS

① CRUISE SETTINGS

ALTITUDE FEET	TRUE* MACH NO.	APPROXIMATE			
		CAS	TAS	LB/HR	% RPM
* CRUISE-CLIMB	.76	—	440	2550-2150	100
35,000	.76	255	440	2500-2300	100-98
30,000	.70	265	410	2500-2300	98-95
25,000	.65	270	390	2600-2400	96-93
20,000	.60	275	370	2750-2600	93-91
15,000	.56	285	350	2950-2800	91-89
10,000	.53	295	340	3300-3100	90-89
5,000	.51	310	330	3700-3500	90-89
SEA LEVEL	.50	330	330	4300-4150	90-89

* Maximum Continuous Thrust, 100% rpm, 635°C EGT

Data as of: 25 Dec. 1957. Based on flight test data.

F-86L-1-93-6A

Mach number given for cruise-climb procedure; the airplane will automatically seek the cruise-climb altitude for it's particular gross weight. Maintain the initial thrust setting throughout the remainder of cruise-climb. For cruise at a constant altitude, set up the recommended Mach number at the intersection of the climb path and the cruise altitude. As the flight progresses, the thrust setting must be decreased gradually as fuel is consumed, to maintain the recommended Mach number.

A cruise table gives recommended Mach numbers and approximate operating conditions for both cruise-climb procedure and for cruise at constant altitude. (Cruise-at-constant-altitude data is given for each 5000 feet.)

USE

The chart may be entered with one or more of the four range factors: time, fuel, distance, and altitude. By entering the chart with the known factors, the others may readily be determined. This is for a no-wind condition.

To determine wind effect upon time, fuel, and distance, compute air distance due to wind (time × wind velocity), and apply to the no-wind distance to obtain the total air distance with wind. Re-enter the profile with the air distance (with wind) and move to the cruise altitude to obtain the fuel and time required with wind.

SAMPLE PROBLEM 1

Using the example shown, find the fuel required, time, necessary speed, and thrust setting to cruise 300 nautical miles at 20,000 feet with a head wind of 40 knots in the two 120-gallon tank configuration.

a. Enter at 300 nautical miles and 20,000 feet to obtain time (no wind) .... 48 min (0.80 hr)

b. Air distance due to wind (40 × 0.80) .... 32 naut mi

c. Total air distance with head wind (300 + 32) .... 332 naut mi

d. Re-enter profile with air distance (with wind) and move to cruise altitude (20,000 ft) to obtain fuel required with wind .... 3450 lb
and time required with wind .... 53 min (.92 hr)

e. Determine cruise speed from table .... .60 Mach No

f. Determine cruise thrust setting (% rpm) from table .... 93% to 91% rpm
(Thrust setting decreases with gross weight.)

Note that if this flight had been made between 30,000 and 35,000 feet cruising altitude the time and fuel required would have been slightly less.

SAMPLE PROBLEM 2

Determine the maximum distance flyable, using the two 120-gallon tank configuration with 4500 pounds of fuel and a 60-knot head wind.

(Hint: Use cruise climb for maximum range.)

a. Enter at 4500 pounds of fuel and obtain maximum air distance at cruise climb (no wind) .... 545 n mi

b. Time (no wind) .... 1 hr 18 min (1.3hr)

c. Air distance due to head wind (1.3 × 60) .... 78 n mi

d. Maximum range with head wind (545 − 78) .... 467 n mi

e. Determine cruise-climb speed from table .... .76 Mach No

f. Determine cruise thrust setting (% rpm) from table .... 100% rpm 635°C egt

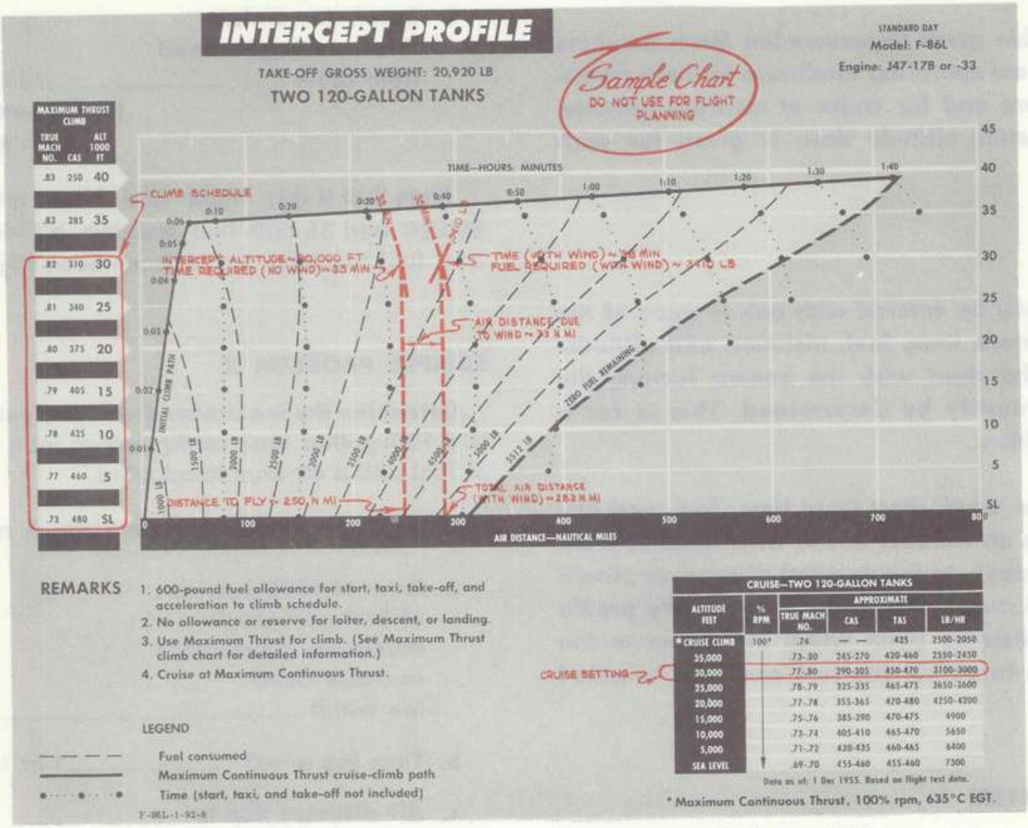
F-86L-1-93-7B

INTERCEPT PROFILE

DESCRIPTION

The intercept profile is used to obtain the fuel necessary to fly to a given distance and altitude in a minimum amount of time, using a Maximum Thrust climb to altitude and Normal Thrust (Maximum Continuous Thrust) for cruise. The intercept profile is similar to the mission profile in use; however, the intercept profile should be restricted to flights where time is the important factor, while the mission profile is employed for maximum range flights.

A cruise table gives approximate operating conditions along with the true Mach numbers for both cruise-climb procedure and for cruise at constant altitude (cruise-at-constant-altitude data is given for each 5000 feet).



MAXIMUM THRUST CLIMB		
TRUE MACH NO.	CAS	ALT 1000 FT
.83	250	40
.83	285	35
.82	310	30
.81	340	25
.80	375	20
.79	405	15
.78	435	10
.77	460	5
.73	480	SL

REMARKS
1. 600-pound fuel allowance for start, taxi, take-off, and acceleration to climb schedule.
2. No allowance or reserve for loiter, descent, or landing.
3. Use Maximum Thrust for climb. (See Maximum Thrust climb chart for detailed information.)
4. Cruise at Maximum Continuous Thrust.

LEGEND
— — — Fuel consumed
——— Maximum Continuous Thrust cruise-climb path
•···•···• Time (start, taxi, and take-off not included)

CRUISE—TWO 120-GALLON TANKS

ALTITUDE FEET	% RPM	APPROXIMATE			
		TRUE MACH NO.	CAS	TAS	LB/HR
* CRUISE CLIMB	100*	.74	— —	425	2500-2050
35,000		.73-.80	245-270	420-460	2550-2450
30,000		.77-.80	290-305	450-470	3100-3000
25,000		.78-.79	325-335	465-475	3650-3600
20,000		.77-.78	355-365	470-480	4250-4200
15,000		.75-.76	385-390	470-475	4900
10,000		.73-.74	405-410	465-470	5650
5,000		.71-.72	420-435	460-465	6400
SEA LEVEL		.69-.70	455-460	455-460	7300

Data as of: 1 Dec 1955. Based on flight test data.

* Maximum Continuous Thrust, 100% rpm, 635°C EGT.

USE

Like the mission profile, the chart may be entered with one or more of the four range factors: time, fuel, distance, and altitude. By entering the chart with the known factors, the others may readily be determined. This is for a no-wind condition.

To determine wind effect upon time, fuel, and distance, compute air distance due to wind (time × wind velocity), and apply to the no-wind distance to obtain the total air distance with wind. Re-enter the profile with the air distance (with wind) and move to the cruise altitude to obtain the fuel and time required with wind.

SAMPLE PROBLEM

Using the example shown, find the time and fuel required to reach a point of interception 250 nautical miles away at an altitude of 30,000 feet with a head wind to 60 knots in the two 120-gallon tank configuration.

a. Enter at 250 nautical miles and 30,000 feet to determine the time required (no wind) .... 33 min (.55 hr)

b. Air distance due to wind (.55 × 60) .... 33 naut mi

c. Total air distance with head wind (250 + 33) .... 283 naut mi

d. Re-enter the profile with air distance (with wind) and move to the cruise altitude (30,000 ft) to obtain the fuel required with wind .... 3410 lb

and the time required with wind .... 38 min

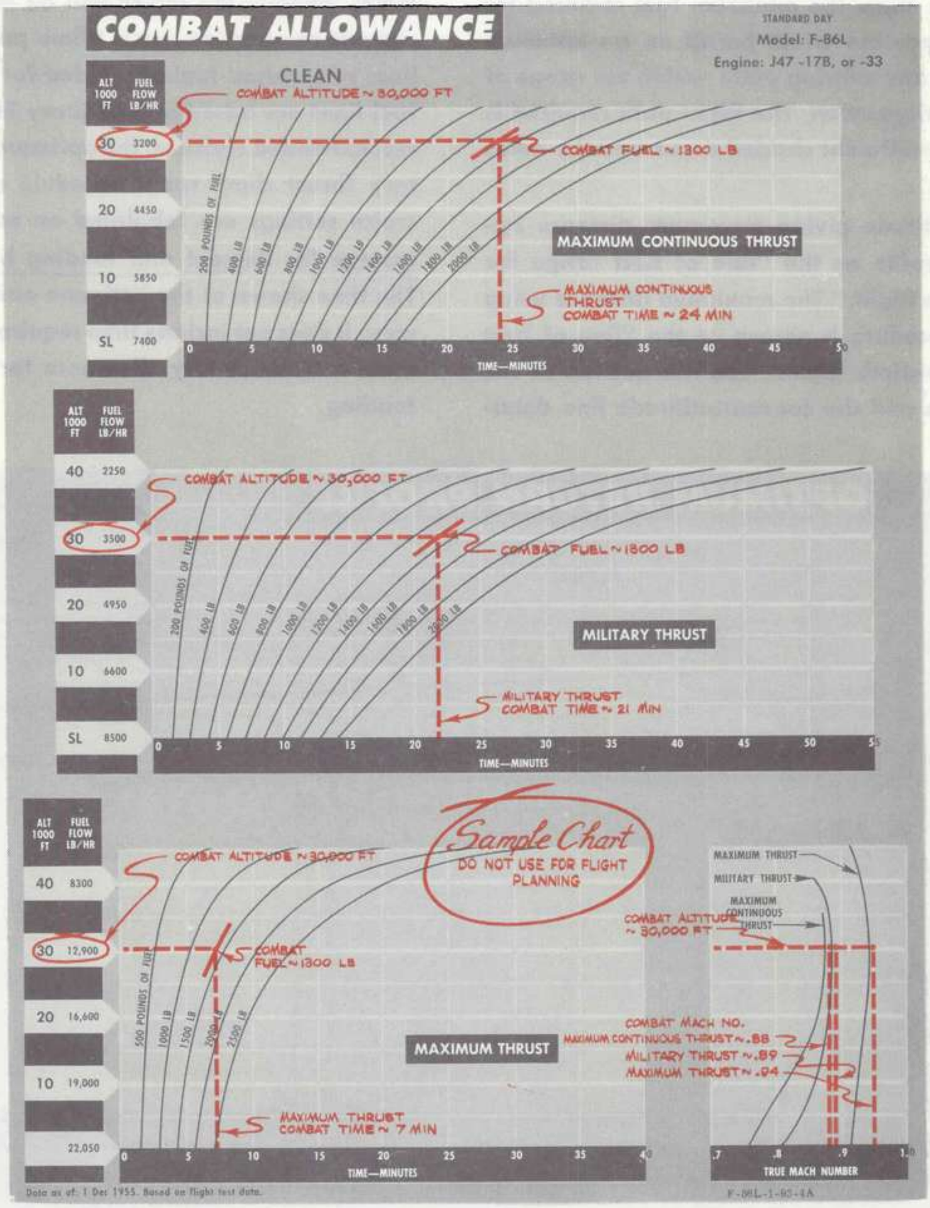
e. Determine cruise speed from table .... .77 to .80 Mach No.

f. Determine cruise power setting (% rpm) from table .... 100% rpm, 635°C egt

COMBAT ALLOWANCE

DESCRIPTION

The combat allowance chart shows the relationship between time and fuel with changes in altitude, at Maximum, Military, and Maximum Continuous Thrust settings. Maximum speeds for the respective thrust settings are also shown, based on an average combat gross weight. Combat time or fuel may be determined from these charts for a given thrust setting.



Data as of: 1 Dec 1955. Based on flight test data.

F-86L-1-93-4A

USE

Enter the chart at the combat altitude and the fuel quantity to be used for combat to obtain the time available. Enter at the altitude and time available for combat to obtain the fuel required.

Using the example shown for the clean configuration, obtain the time available for a combat fuel allowance of 1300 pounds at 30,000 feet, using Maximum, Military, and Maximum Continuous Thrust. Also obtain the maximum level-flight Mach number for the altitude and thrust setting.

	TIME AVAILABLE	MACH NO.
Maximum Thrust	7.0 min	.94
Military Thrust	21.0 min	.89
Max Cont Thrust	24.0 min	.88

OPTIMUM RETURN PROFILE

DESCRIPTION

These profiles show the minimum fuel required for maximum distance (no wind) based on an optimum flight path from any starting point within the range of the airplane configuration. The flight path required is indicated by the different shaded areas and the notes relative to them.

The cruise altitude giving maximum distance appears on the profile as the "line of best range for constant-altitude flight." The maximum distance using cruise-climb procedure is shown as the "line of best range for cruise-climb flight." The intersection of the cruise-climb line and the constant-altitude line determines whether the return will be made at a constant altitude or at cruise-climb. Climb path guide lines and lines of constant fuel are added for interpolation. The fuel lines are based on a Military Thrust climb to, and recommended cruise at, the optimum altitude. The Military Thrust climb speed schedule and recommended cruise settings are tabulated on each chart. No fuel reserve for descent and landing has been included. The time shown at the optimum altitude is cruise time only; it does not include time required for climb to optimum altitude or any allowance for descent, loiter, or landing.

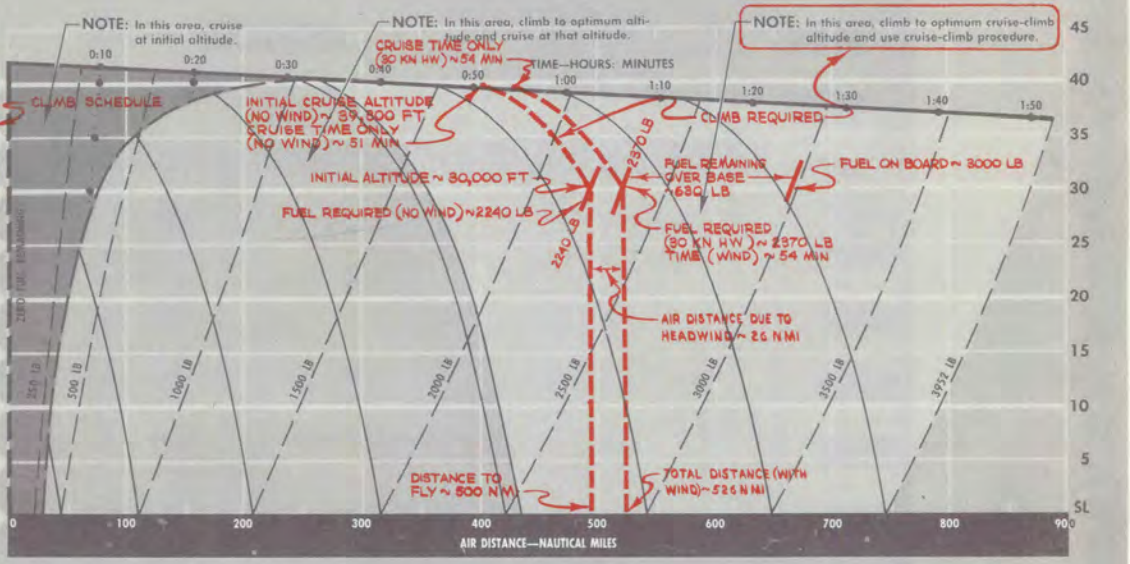
OPTIMUM RETURN PROFILE

STANDARD DAY
Model: F-86L
Engine: J47-17B or -33

GROSS WEIGHT: 15,168-19,120 LB

CLEAN

MILITARY THRUST CLIMB TRUE MACH NO.	CAS	ALT 1000 FT
.77	230	40
.75	255	35
.73	275	30
.71	295	25
.68	315	20
.66	335	15
.64	355	10
.62	375	5
.58	385	SL



REMARKS

1. Fuel required at any point includes Military Thrust climb to flight altitude (if below that flight altitude).
2. No allowance or reserve for loiter, descent, or landing.
3. Best cruise condition determined by intersection of climb path guide lines and lines of best range.
4. Cruise at recommended Mach number.
5. For cruise-climb procedure, maintain constant Mach number. Use Maximum Continuous Thrust.

LEGEND

— — — Fuel required
——— Climb path guide lines
—— — —— Line of best range for constant-altitude flight
——— Line of best range for cruise-climb flight
● · · · ● · · · ● Time at cruising altitude

Sample Chart
DO NOT USE FOR FLIGHT PLANNING

CRUISE SETTINGS

CRUISE - CLEAN

ALTITUDE FEET	TRUE MACH NO.	APPROXIMATE			
		CAS	TAS	LB/HR	% RPM
*CRUISE-CLIMB	.83	—	475	2100-1900	100*
35,000	.78	265	445	2100-2000	97-93
30,000	.70	265	415	2200-2100	94-91
25,000	.66	270	395	2350-2200	92-89
20,000	.62	280	375	2500-2400	91-88
15,000	.58	290	360	2800-2700	89-87
10,000	.55	305	350	3100-3000	89-87
5,000	.53	320	340	3600-3500	89-87
SEA LEVEL	.51	335	335	4100-4000	89-87

Data as of: 1 Dec 1955. Based on flight test data.

* Maximum Continuous Thrust, 100% rpm, 635°C EGT.

F-86L-1-93-9

USE

The chart may be entered at the initial altitude with either the fuel on board (to determine the distance available) or with the distance to be flown (to determine the fuel required). The shaded area in which the initial point falls establishes the cruising procedure to be used, as stated in the note relative to the area.

The total time required to fly the distance is the time at cruise altitude (obtain from profile), plus the time required to climb (obtained from the graphical Military Thrust climb chart). To simplify the calculation of distance and/or fuel with wind, however, the time to climb may be omitted and the profile cruise time used to determine the average return speed. If greater accuracy is desired, the graphical data should be used.

The effect of wind must be applied to obtain the actual fuel and time to fly the distance. A close approximation can be obtained by considering the head or tail wind for the time required to complete the flight (neglecting the difference in wind at the lower altitudes, since comparatively little time is spent in the climb phase).

SAMPLE PROBLEM

From the example shown, determine the fuel and time required to return to a base 500 nautical miles away. The airplane is at 30,000 feet with 3000 pounds of fuel on board in the clean configuration. A 30-knot head wind is assumed.

a. Enter profile at 500 nautical miles and 30,000 feet to establish starting point. Fuel required (no wind) .... 2240 lb
(In this area, note that a climb is required and a cruise-climb procedure is followed.)

b. By following the climb guide lines, the initial cruise-climb altitude is .... 39,300 ft

c. Cruise time* (no wind) .... 51 min (0.85 hr)

d. Air distance due to head wind (.85 × 30) .... 26 naut mi

e. Total air distance with wind (500 + 26) .... 526 naut mi

f. Re-enter the profile at the air distance (e) and move to the initial altitude (30,000 ft) to obtain the fuel required with wind .... 2370 lb
and time with wind .... 54 min
(Use the flight path originally determined for no wind.)

g. Fuel remaining over base at altitude (3000 − 2370) .... 630 lb

Note: It is recommended that sufficient reserve be considered for a normal landing operation when determining maximum distance obtainable, unless, however, an emergency condition prevails.

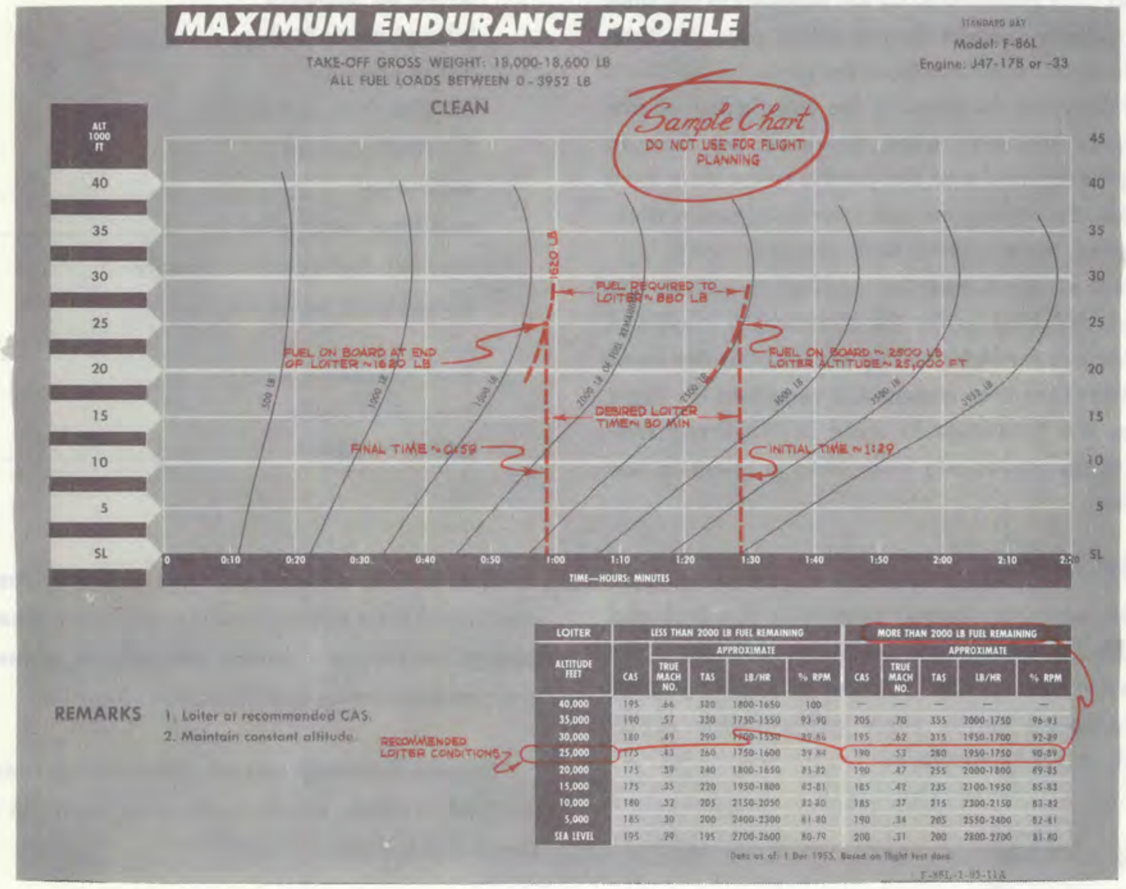
*Greater accuracy can be obtained by considering the time to climb, which is obtained from the Military Thrust climb chart.

MAXIMUM ENDURANCE PROFILE

DESCRIPTION

These profiles show the maximum time available for the fuel on board when loitering at a constant altitude.

The recommended calibrated airspeed (CAS) and the approximate operating conditions are tabulated on each chart for several fuel quantities.



LOITER	LESS THAN 2000 LB FUEL REMAINING					MORE THAN 2000 LB FUEL REMAINING				
		APPROXIMATE					APPROXIMATE			
ALTITUDE FEET	CAS	TRUE MACH NO.	TAS	LB/HR	% RPM	CAS	TRUE MACH NO.	TAS	LB/HR	% RPM
40,000	195	.66	380	1800-1650	100	—	—	—	—	—
35,000	190	.57	330	1750-1550	93-90	205	.70	355	2000-1750	96-93
30,000	180	.49	290	1700-1550	89-86	195	.62	315	1950-1700	92-89
25,000	175	.43	260	1750-1600	89-84	190	.53	280	1950-1750	90-89
20,000	175	.39	240	1800-1650	85-82	190	.47	255	2000-1800	89-85
15,000	175	.35	220	1950-1800	83-81	185	.42	235	2100-1950	85-83
10,000	180	.32	205	2150-2050	82-80	185	.37	215	2300-2150	83-82
5,000	185	.30	200	2400-2300	81-80	190	.34	205	2550-2400	82-81
SEA LEVEL	195	.29	195	2700-2600	80-79	200	.31	200	2800-2700	81-80

Data as of: 1 Dec 1955. Based on flight test data.

F-86L-1-93-11A

REMARKS

1. Loiter at recommended CAS.
2. Maintain constant altitude.

USE

To determine the time available for a given amount of fuel, enter the chart at the amount of fuel on board at the start of loiter and the flight altitude; note the initial time. Re-enter the chart at the amount of fuel on board at the end of the endurance flight (initial fuel on board less fuel to be used) and read the final time. The difference between the initial and final time is the time available to loiter at constant altitude.

To obtain the fuel required to loiter a given time, enter the chart at the amount of fuel on board at the start of loiter and flight altitude; note the initial time. Re-enter the chart at the time at the end of loiter (initial time less time to loiter) and read final fuel on board. The difference between the initial and final fuel on board is the fuel required to loiter.

From the example shown, determine the fuel required to loiter at 25,000 feet with clean airplane for 30 minutes. The fuel on board at start of loiter is 2500 pounds.

a. Initial time at 2500 pounds and 25,000 feet......................1 hr 29 min

b. Final time (1:29 — 0:30) ....59 min

c. Fuel on board at end of loiter (0:59 at 25,000 feet) ....1620 lb

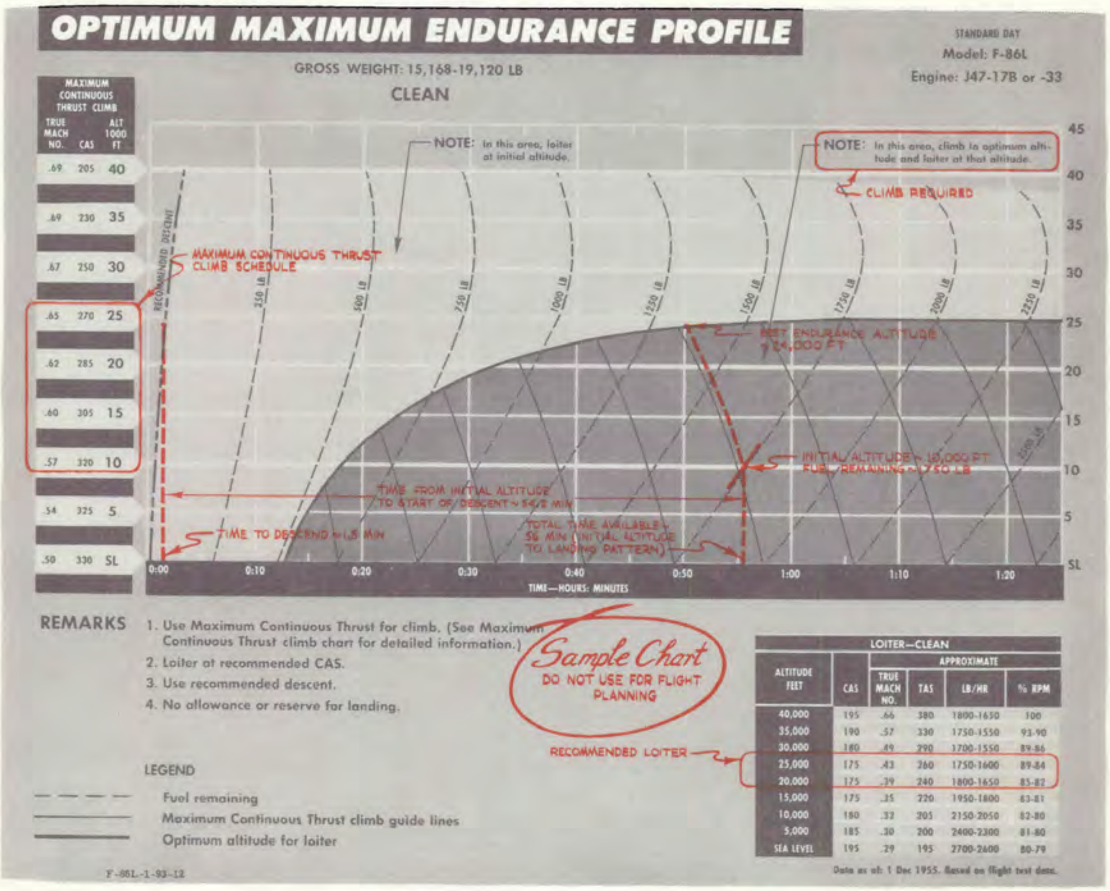
d. Fuel required to loiter (2500 — 1620) ....880 lb

e. Recommended loiter (CAS) ....190 kn

OPTIMUM MAXIMUM ENDURANCE PROFILE

DESCRIPTION

These profiles give the maximum time in the air for the fuel remaining, based on an optimum flight path, from any starting altitude. The flight path required is indicated by the different shaded areas and the notes relative to them. Time and fuel lines shown are based on a Maximum Continuous Thrust climb to best endurance altitude, loiter at the altitude, and recommended descent to sea level (no reserve for landing). The climb speed schedule is tabulated at the left of the chart; the loiter speed schedule is tabulated below the chart.



MAXIMUM CONTINUOUS THRUST CLIMB

TRUE MACH NO.	CAS	ALT 1000 FT
.69	205	40
.69	230	35
.67	250	30
.65	270	25
.62	285	20
.60	305	15
.57	320	10
.54	325	5
.50	330	SL

REMARKS

1. Use Maximum Continuous Thrust for climb. (See Maximum Continuous Thrust climb chart for detailed information.)
2. Loiter at recommended CAS.
3. Use recommended descent.
4. No allowance or reserve for landing.

LEGEND

— — — — Fuel remaining
──── Maximum Continuous Thrust climb guide lines
━━━━ Optimum altitude for loiter

LOITER—CLEAN

ALTITUDE FEET	CAS	APPROXIMATE			
		TRUE MACH NO.	TAS	LB/HR	% RPM
40,000	195	.66	380	1800-1650	100
35,000	190	.57	330	1750-1550	93-90
30,000	180	.49	290	1700-1550	89-86
25,000	175	.43	260	1750-1600	89-84
20,000	175	.39	240	1800-1650	85-82
15,000	175	.35	220	1950-1800	83-81
10,000	180	.32	205	2150-2050	82-80
5,000	185	.30	200	2400-2300	81-80
SEA LEVEL	195	.29	195	2700-2600	80-79

Data as of: 1 Dec 1955. Based on flight test data.

F-86L-1-93-12

USE

The chart may be entered at the initial altitude with either the fuel remaining (to determine the time available) or the time desired (to determine the fuel requirement). The shaded area in which the initial point falls establishes the flight path to be used, as stated in the note relative to the area.

From the example shown, determine the time available and necessary flight path to remain aloft with 1750 pounds of fuel remaining at 10,000 feet in the clean configuration.

a. Enter profile at 10,000 feet and 1750 pounds of fuel remaining to establish starting point. Total time available........................56 min (In this area, note that a climb is required.)

b. By following the climb guide lines, the best endurance altitude is..................24,000 ft

c. Descent time from 24,000 feet to sea level ....1.5 min

d. Elapsed time from start of climb to start of descent (0:56 — 0:015) ....54.5 min

Suppose a reserve of 500 pounds of fuel had been desired for landing; then enter the profile at 1250 pounds of fuel (1750 — 500) and proceed as outlined in steps a. through d.

Time available ....35 min

Endurance altitude ....21,000 ft

Descent time ....1.3 min

Elapsed time ....33.7 min

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DESCENTS.

The descent charts are based on the use of speed brakes to provide high rates of descent with idle thrust to minimize fuel consumption. Minimum exhaust temperature limits should be observed during all descents. {Refer to "Engine Exhaust Temperature (Descent)" in Section V.} Distance, time, fuel consumed, and rate of descent are shown in figures A-24 and A-25. Descent speed schedules are also included.

LANDING DISTANCES.

Landing ground roll distances and total distances to clear a 50-foot obstacle, with or without the drag chute, are shown in figures A-26 and A-27. In both charts, the distances are computed for the speed brakes extended and full flaps. The following conditions are also considered: dry, hard-surface runway; temperature, 0°F through 140°F; pressure altitude, sea level through 6000 feet; gross weight, 14,000 through 20,000 pounds; and 20-knot tail winds, through 60-knot head winds. The recommended indicated airspeeds for the approach, touchdown, and initial stall warning are shown for all gross weights on the charts. Use of the charts is explained by a sample problem on each.

NAUTICAL MILES PER POUND OF FUEL.

Cruise data (zero wind) throughout the speed range from maximum endurance to Military Thrust are shown on the nautical-miles-per-pound-of-fuel charts. (See figures A-34 through A-38.) Several weights for each configuration are given at altitudes of sea level, 15,000, 25,000, 35,000, and 40,000 feet. Each chart includes specific range (nautical miles per pound), fuel flow, and power settings (% rpm). Also included are curves of recommended cruise true Mach number, maximum endurance, and Maximum Continuous and Military Thrust. Specific range is plotted versus true Mach number, with subscales of calibrated airspeed (CAS) and true airspeed (TAS). Cruising range is the product of specific range multiplied by pounds of fuel available for cruise.

$$\text{Range} = \frac{\text{Naut Mi}}{\text{Lb}} \times \text{Lb of Fuel}$$

For greatest accuracy in determining cruising range, consider small amounts of fuel at a time rather than the total fuel available. By this method, the total cruising range is the sum of the individual ranges obtained for each amount of fuel. To obtain the cruising range for a given amount of fuel, use the following steps:

a. Select proper chart for airplane configuration and altitude.

b. Determine average weight of airplane for amount of fuel being considered.

c. Enter chart at this average weight and desired true Mach number, or desired thrust setting, to obtain specific range (nautical miles per 1000 pounds of fuel).

Note

When there is a wind to be considered, multiply the specific range found in step c. by the range factor (ground speed divided by true airspeed) to obtain the specific range for wind. Proceed with steps d. and e. to complete the problem.

d. To obtain cruising range, multiply specific range by amount of fuel.

e. Interpolate approximate fuel flow and power setting at true Mach number and average weight.

For temperatures other than Standard Day, apply the corrections shown on each chart to true airspeed and fuel flow. Do not change the nautical miles per pound of fuel, true Mach number, or thrust setting.

Note

It will be noted that the curves for the 120-gallon tank configuration have noticeably different shapes than those for the clean configuration. The reason for this change is that the slats start to open as speed is reduced through the normal cruise range. This causes a drag increase as slat opening progresses up to about 25 percent open. Beyond this opening, the increase in drag dissipates and returns to normal. Because of the drag increase, a lowering of the curves is created, thus necessitating higher cruise speeds at high altitudes to remain above the slat opening speeds. The specific ranges at the recommended cruise speeds remain about the same; however, the clean airplane performance remains unaffected because the cruise speeds are basically higher, and the absence of tanks will delay slat opening to lower speeds. These two reasons give a significant speed interval between slat opening and the recommended cruise speed.

SUMMARY.

Check your flight plan during the actual flight to determine whatever deviations exist. These deviations may be applied to the reserve expected at the destination. The most important factors to consider are:

a. Fuel used during start, taxi, and take-off. (The mission and intercept profiles allow 600 pounds for this phase.)

b. Wind effect.

c. Deviation from the recommended climb schedule.

d. Deviation from the recommended cruise settings.

e. Variation in engine performance.

f. Navigational errors, formation flight, and fuel actually aboard at take-off.

SAMPLE PROBLEM.

This sample problem combines the use of the charts and graphs in this section to plan a mission.

An intercept mission is to be flown using two 120-gallon drop tanks which are to be dropped before combat.

Prepare a flight plan based on the following data:

a. Distance to combat area .... 200 naut mi
b. Assigned altitudes:
  Inbound to combat
  (constant altitude) .... 30,000 ft
  Outbound from combat .... 35,000 ft and above
c. Combat—35,000 feet
  (Military Thrust) .... 10 min
d. Combat—35,000 feet
  (Maximum Thrust) .... 5 min
e. Weather (assume Standard Day
  temperature throughout) .... CAVU
  Winds aloft:
  Inbound (30,000 feet) .... 30 kn head wind
  Outbound (35,000 feet
  and above) .... 45 kn tail wind
  Field elevation .... 1500 ft
  Runway length .... 4700 ft
f. Airplane gross weight:
  Basic (includes trapped oil
  and internal fuel, and
  miscellaneous equipment) .... 13,599 lb
  Pilot .... 200 lb
  Two 120-gallon drop tanks
  (empty weight) .... 232 lb
  Rockets (24) .... 432 lb
  Maximum usable fuel (internal)
  and drop tanks (848 gallons) .... 5,512 lb
  Total gross weight .... 19,975 lb

TAKE-OFF.

Obtain the take-off distance from the Maximum Thrust take-off distance chart, figure A-4. Obtain take-off and nose wheel lift-off speed from take-off speeds chart in figure A-3. (Standard Day temperature at 1500 feet is 54°F.) Use zero wind.

Ground roll distance (19,975 pounds) .... 3000 ft
Total take-off distance over
50-foot obstacle .... 4500 ft
Take-off speed (IAS) .... 128 kn
Initial stall warning speed (IAS) .... 127 kn
Nose wheel lift-off speed .... 113 kn

GO, NO-GO SPEED AND DISTANCE.

Enter the maximum thrust, normal take-off distance chart (figure A-4) with the available runway length (4700 feet and zero wind) and obtain the maximum allowable take-off temperature.

Temperature (1500 feet and 19,975
pounds) .... 134°F

Obtain the refusal speed from figure A-8 using the temperature, gross weight, field elevation, wind, and runway length.

Go, no-go speed (IAS), 19,975 pounds
and 134°F .... 86 kn

Use the temperature and go, no-go speed to determine the acceleration ground roll distance from figure A-6.

Go, no-go speed distance (134°F and
1500 feet altitude) .... 2150 ft

LANDING IMMEDIATELY AFTER TAKE-OFF.

To complete the take-off data card, data for landing at take-off gross weight must be determined from the landing distance chart with drag chute deployed. Obtain the following data from figure A-26, using take-off conditions:

a. Ground-roll distance (19,975 pounds) .... 2100 ft
b. Total distance to clear 50-foot obstacle .... 3500 ft
c. Final approach speed (IAS) .... 160 kn
d. Touchdown speed (IAS) .... 132 kn
e. Initial stall warning speed (IAS) .... 127 kn

INBOUND TO COMBAT.

The inbound leg may be determined directly from the intercept profile chart for two 120-gallon drop tanks, figure A-18. The profile includes a 600-pound fuel allowance for start, taxi, and take-off, as well as the fuel required to climb and cruise at 30,000 feet.

a. Distance .... 200 naut mi
b. Time (no wind) from profile .... 26 min (.43 hr)
c. Air distance due to wind (.43 × 30) .... 13 naut mi
d. Total air distance with head wind
  (200 + 13) .... 213 naut mi
e. Fuel required (with wind)
  from profile .... 2930 lb
f. Time with wind from profile .... 28 min
g. Cruise speed (30,000 ft) .... .77 to .80 Mach No.
h. Cruise at Maximum Continuous
  Thrust .... 100% rpm, 635°C
i. Maximum Thrust climb speed
  schedule .... (See left side of profile.)
j. Gross weight at end of cruise
  (drop tanks released at end of
  cruise) 19,975 pounds minus (e)
  minus 232 lb .... 16,813 lb

CLIMB.

Military Thrust climb to combat altitude (35,000 feet), zero distance traveled. (Use Military Thrust climb chart, clean, figure A-29.)

a. Gross weight at start of climb from 30,000 feet .... 16,813 lb

b. Gross weight at end of climb to 35,000 feet .... 16,560 lb

c. Fuel used to climb (16,813 pounds minus 16,560 pounds) .... 253 lb

d. Time required to climb (17 min − 12 min).... 5 min

e. Military Thrust climb speed and power schedules .... (See figure A-29.)

COMBAT ALLOWANCE.

From the combat allowance chart—clean (figure A-23) obtain the fuel required for combat at 35,000 feet.

a. Combat, Military Thrust (10 minutes) .... 500 lb

b. Combat—Maximum Thrust (5 minutes) .... 770 lb

Total combat fuel .... 1270 lb

Gross weight at end of combat 16,560 pounds minus 1270 pounds (combat fuel) minus 432 pounds rockets .... 14,858 lb

Determine the fuel remaining at end of combat.

c. Take-off climb and cruise .... 2930 lb

d. Climb to combat altitude .... 253 lb

e. Combat .... 1270 lb

Total fuel used .... 4453 lb

f. Fuel remaining (5512 pounds minus 4453 pounds) .... 1059 lb

OUTBOUND FROM COMBAT (RETURN).

Assume return is started 200 nautical miles from base at an altitude of 35,000 feet. Enter the optimum return profile for the clean configuration (figure A-13) at the distance from base, and determine the fuel required and reserve with the existing tail wind.

a. Distance .... 200 naut mi

b. Fuel required (no wind) .... 880 lb

c. Recommended cruise altitude (constant) .... 38,500 ft

d. Cruise time (no wind) .... 21 min

e. Time to climb* (Military Thrust, clean) 35,000 feet to 38,500 feet, gross weight 14,858 pounds .... 3 min

f. Total time, no wind (d + e) .... (.40 hr) 24 min

g. Air distance due to wind (.40 × 45)...... 18 naut mi

h. Total air distance with tail wind (200 − 18) .... 182 naut mi

i. Fuel required (with wind) .... 800 lb

j. Cruise time, with wind from profile .... 19 min

k. Total time with wind (e + j) .... 22 min

l. Cruise speed (38,500 ft) .... .80 Mach No.

m. Thrust setting .... 99% to 97% rpm

n. Reserve over base at 38,500 feet (1059 pounds minus i) .... 259 lb

DESCENT.

Obtain the fuel required to descend to base from 38,500 ft—clean. (See figure A-24.)

a. Recommended descent fuel required (38,500 feet) .... 29 lb

b. Time to descend .... 3 min

c. Speed schedule, using idle thrust and speed brakes extended .... (See figure A-24.)

d. Fuel reserve for landing (259 pounds minus 29 pounds) .... 230 lb

e. Airplane gross weight for landing........ 14,029 lb

LANDING.

Obtain the landing distance from the landing distance chart (with drag chute deployed), figure A-26. Use 1500 feet, 54°F, and no wind.

a. Ground roll distance .... 1525 ft

b. Total distance over 50-foot obstacle .... 2700 ft

c. Final approach speed (IAS) .... 135 kn

d. Touchdown speed (IAS) .... 112 kn

e. Initial stall warning speed .... 109 kn

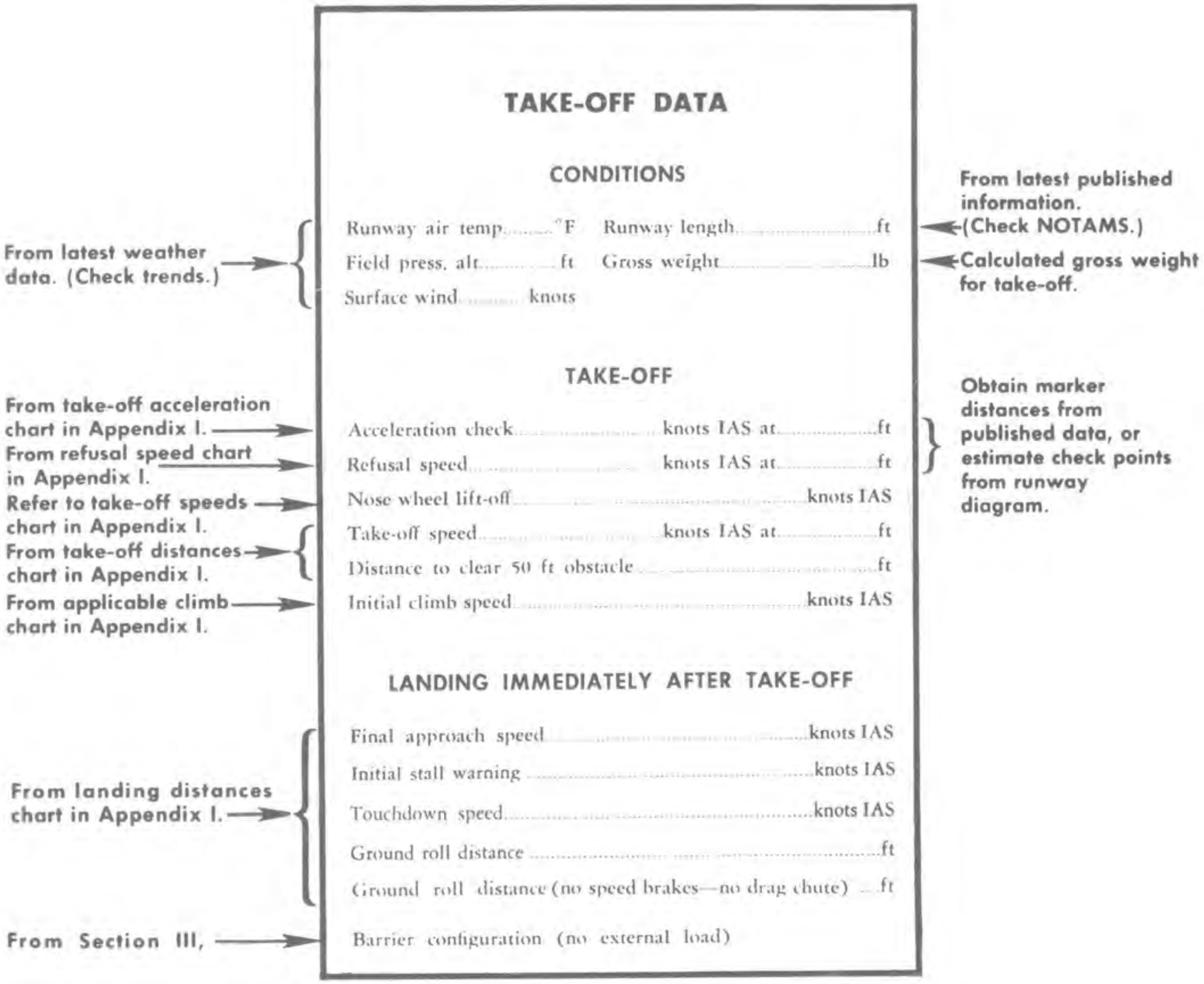
The sum of all the time required gives the time from take-off to landing* .... 1 hr 13 min

---

***Calculation of time to climb is not necessary unless an accurate time history is required. (See use of optimum return profile.)**

TAKE-OFF AND LANDING DATA CARDS.

Before take-off, the pilot will compute all data required to complete the take-off and landing data cards. Reproductions of these cards appear in the condensed check list T.O. 1F-86L-(CL)1-1. Each card should be filled out completely so that the information which the cards provide will be available as needed. The required data is computed from the appropriate charts in this Appendix. Interpretation of the data entered on the cards is subject to a number of variables with which the pilot should be familiar. For example, rapid changes in weather may produce marked variations between precomputed performance and actual performance. Such factors as braking during take-off, late afterburner light-up runway surface condition, etc, can seriously affect the performance which is precomputed and entered on the cards. However, the cards are very useful as a general guide to expected airplane performance, and will contribute substantially to flight safety when properly used. These two examples are provided as a guide for completion of the cards.



TAKE-OFF DATA

CONDITIONS

Runway air temp..........°F Runway length..........ft

Field press. alt..........ft Gross weight..........lb

Surface wind..........knots

TAKE-OFF

Acceleration check..........knots IAS at..........ft

Refusal speed..........knots IAS at..........ft

Nose wheel lift-off..........knots IAS

Take-off speed..........knots IAS at..........ft

Distance to clear 50 ft obstacle..........ft

Initial climb speed..........knots IAS

LANDING IMMEDIATELY AFTER TAKE-OFF

Final approach speed..........knots IAS

Initial stall warning..........knots IAS

Touchdown speed..........knots IAS

Ground roll distance..........ft

Ground roll distance (no speed brakes—no drag chute)..........ft

Barrier configuration (no external load)

From latest weather data. (Check trends.)

From take-off acceleration chart in Appendix I.

From refusal speed chart in Appendix I.

Refer to take-off speeds chart in Appendix I.

From take-off distances chart in Appendix I.

From applicable climb chart in Appendix I.

From landing distances chart in Appendix I.

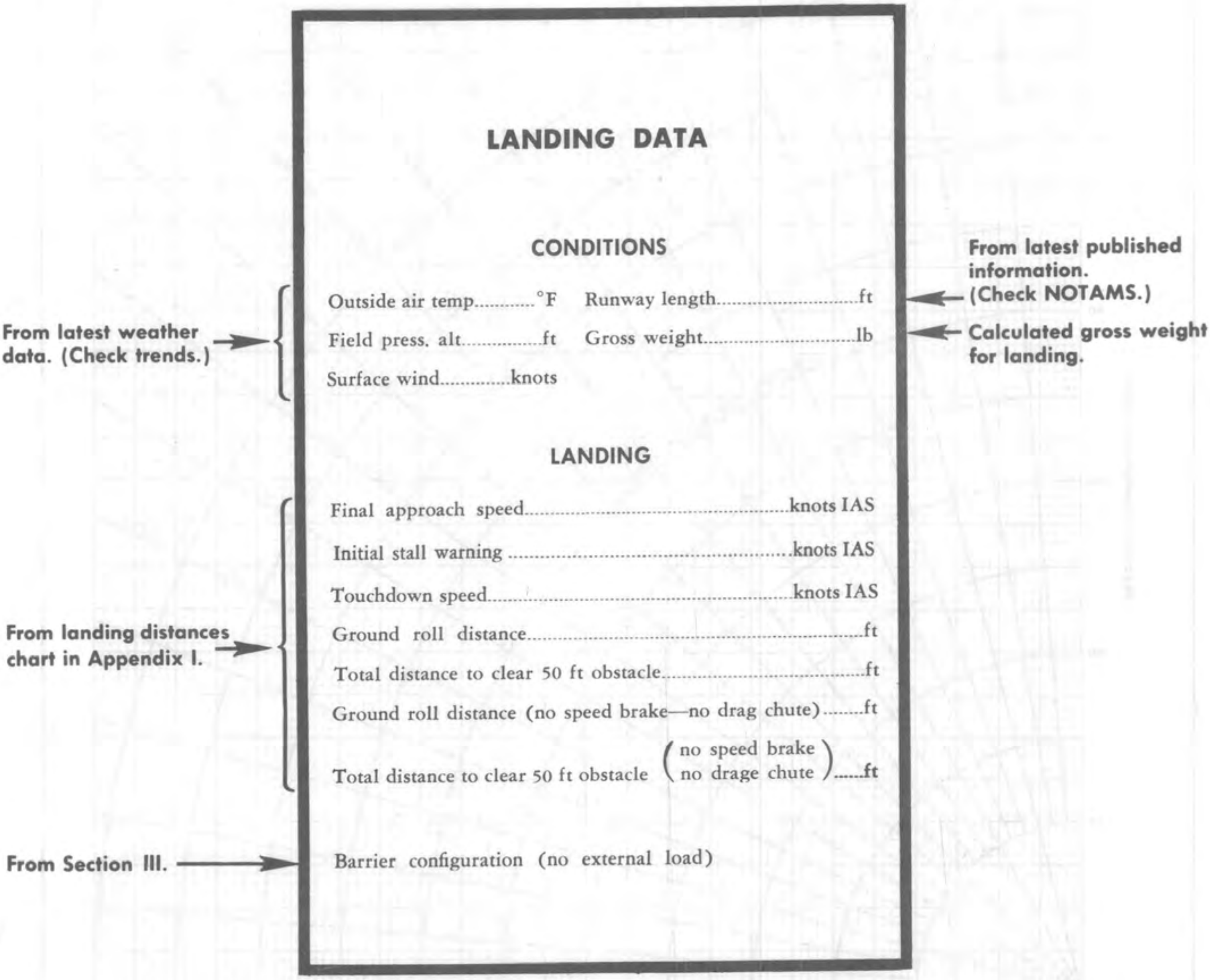
From Section III,

From latest published information. (Check NOTAMS.)

Calculated gross weight for take-off.

Obtain marker distances from published data, or estimate check points from runway diagram.

F-86L-1-93-83C



LANDING DATA

CONDITIONS

From latest weather data. (Check trends.)

Outside air temp............ °F

Field press. alt................ft

Surface wind..............knots

From latest published information. (Check NOTAMS.)

Runway length.............................ft

Calculated gross weight for landing.

Gross weight..............................lb

LANDING

From landing distances chart in Appendix I.

Final approach speed..knots IAS

Initial stall warning ....knots IAS

Touchdown speed..knots IAS

Ground roll distance..ft

Total distance to clear 50 ft obstacle...ft

Ground roll distance (no speed brake—no drag chute).........ft

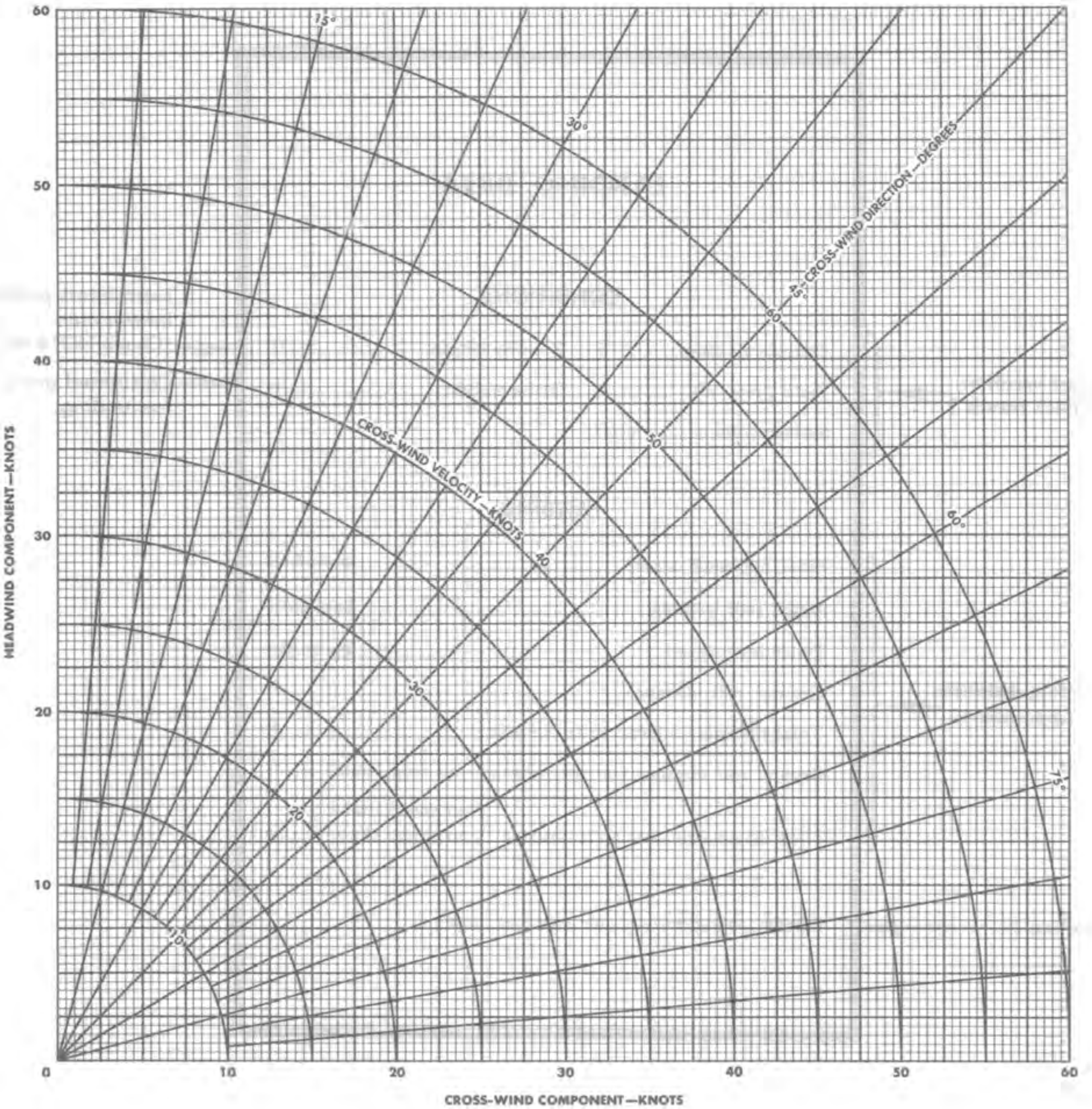
Total distance to clear 50 ft obstacle (no speed brake / no drage chute)......ft

From Section III.

Barrier configuration (no external load)

F-86L-1-93-84B

TAKE-OFF AND LANDING CROSS-WIND CHART

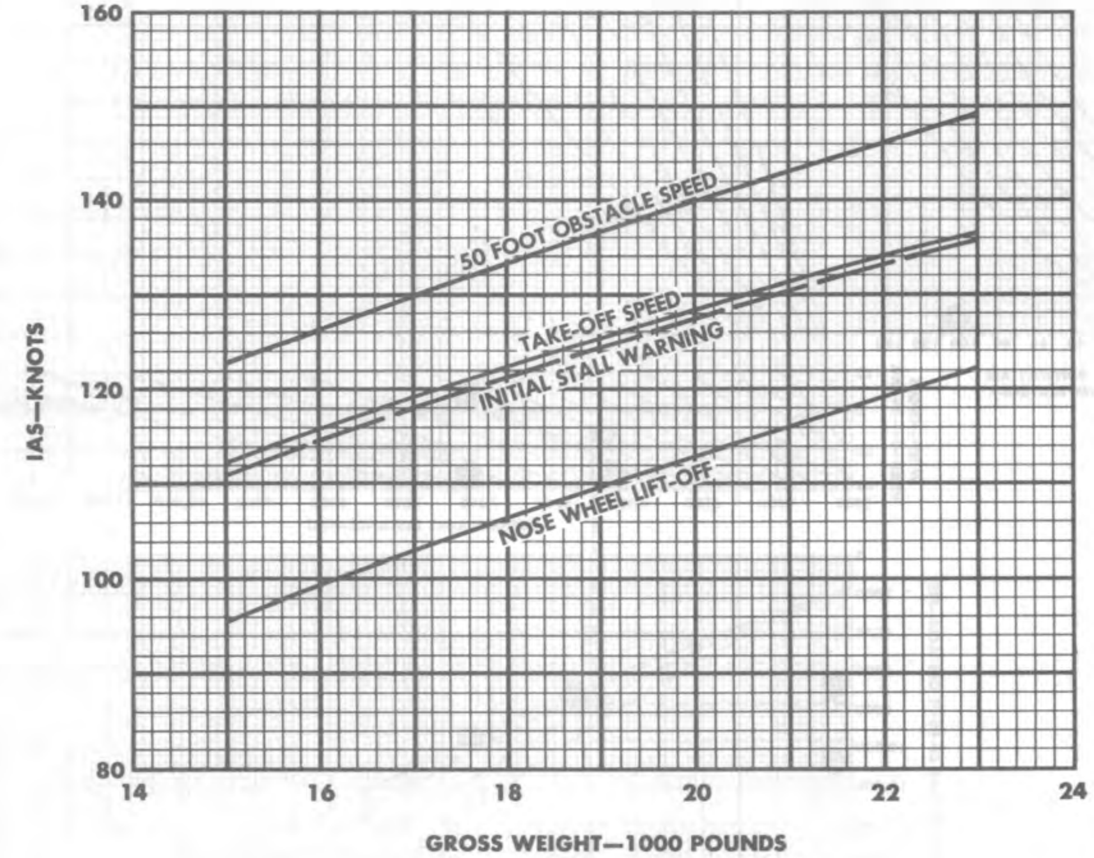


F-86L-1-03-87

Figure A-2

TAKE-OFF SPEEDS

STANDARD DAY
MODEL: F-86L
ENGINE: J47-17B or -33



DATA AS OF: 7 MAY 1957
BASED ON: FLIGHT TEST DATA

F-86L-1-93-88A

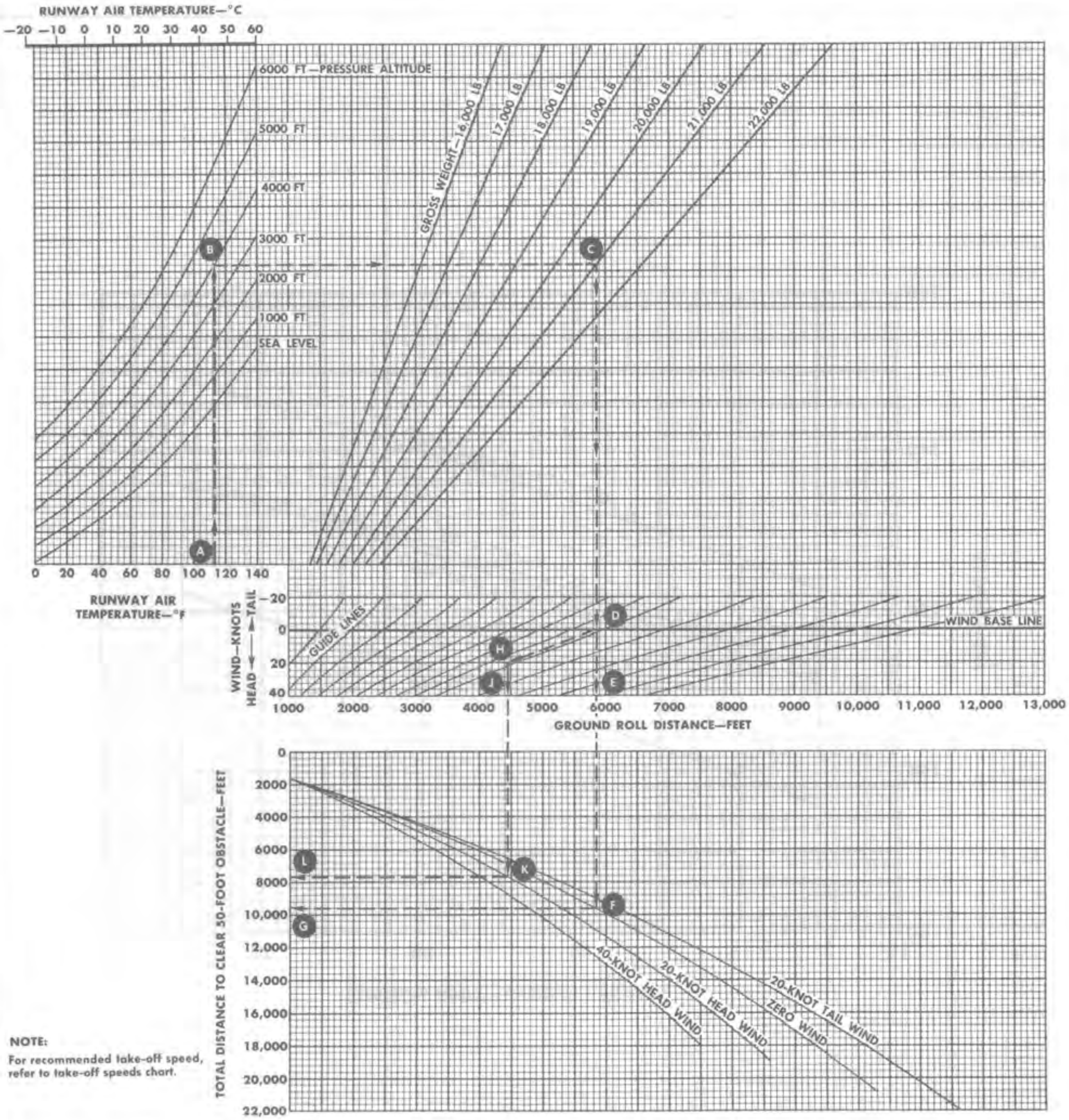
Figure A-3

FLAPS FULL DOWN

TAKE-OFF DISTANCES

MAXIMUM THRUST

HARD-SURFACE RUNWAY
MODEL: F-86L
ENGINE: J47-17B or -33



NOTE:
For recommended take-off speed, refer to take-off speeds chart.

EXAMPLE:

- Ⓐ is runway air temperature (113°F).
- Ⓑ is pressure altitude (4000 feet).
- Ⓒ is gross weight (21,000 pounds).
- Ⓓ is wind base line (zero).
- Ⓔ is ground roll with zero wind (5850 feet).
- Ⓕ is wind base line (zero).
- Ⓖ is total distance to clear 50-foot obstacle (9600 feet).
- Ⓗ is head wind (20 knots).
- Ⓙ is ground roll with 20-knot head wind (4450 feet).
- Ⓚ is head wind base line (20 knots).
- Ⓛ is total distance to clear 50-foot obstacle with 20-knot head wind (7600 feet).

DATA AS OF: 7 MAY 1957
BASED ON: FLIGHT TEST DATA

F-86L-1-93-14C

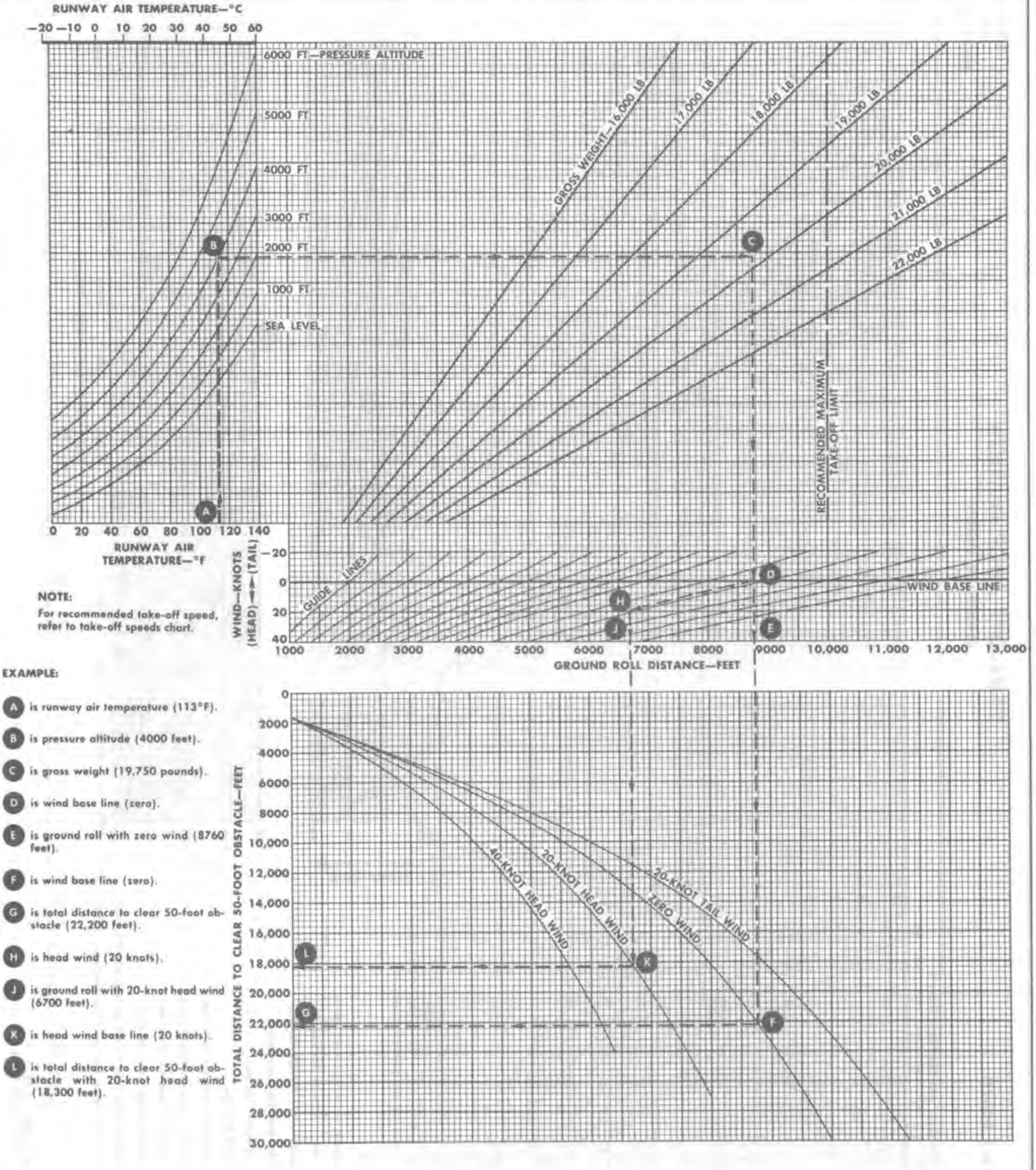
Figure A-4

FLAPS FULL DOWN

TAKE-OFF DISTANCES

MILITARY THRUST

HARD-SURFACE RUNWAY
MODEL: F-86L
ENGINE: J47-17B or -33



NOTE:
For recommended take-off speed, refer to take-off speeds chart.

EXAMPLE:

- Ⓐ is runway air temperature (113°F).
- Ⓑ is pressure altitude (4000 feet).
- Ⓒ is gross weight (19,750 pounds).
- Ⓓ is wind base line (zero).
- Ⓔ is ground roll with zero wind (8760 feet).
- Ⓕ is wind base line (zero).
- Ⓖ is total distance to clear 50-foot obstacle (22,200 feet).
- Ⓗ is head wind (20 knots).
- Ⓙ is ground roll with 20-knot head wind (6700 feet).
- Ⓚ is head wind base line (20 knots).
- Ⓛ is total distance to clear 50-foot obstacle with 20-knot head wind (18,300 feet).

DATA AS OF: 7 MAY 1957
BASED ON: FLIGHT TEST DATA

F-86L-1-93-15C

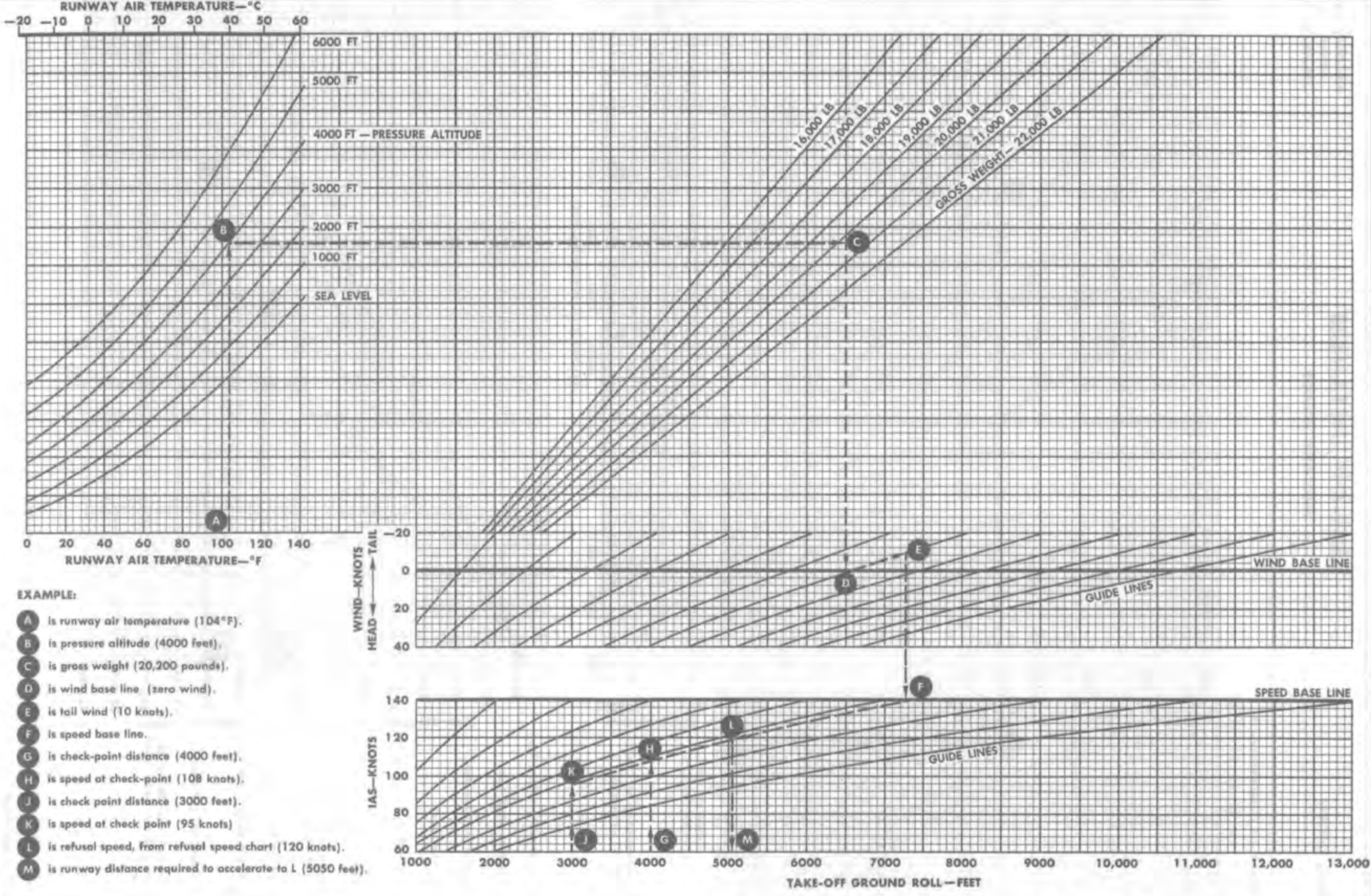
Figure A-5

FLAPS FULL DOWN

TAKE-OFF ACCELERATION

MAXIMUM THRUST

HARD-SURFACE RUNWAY
MODEL: F-86L
ENGINE: J47-17B, or -33



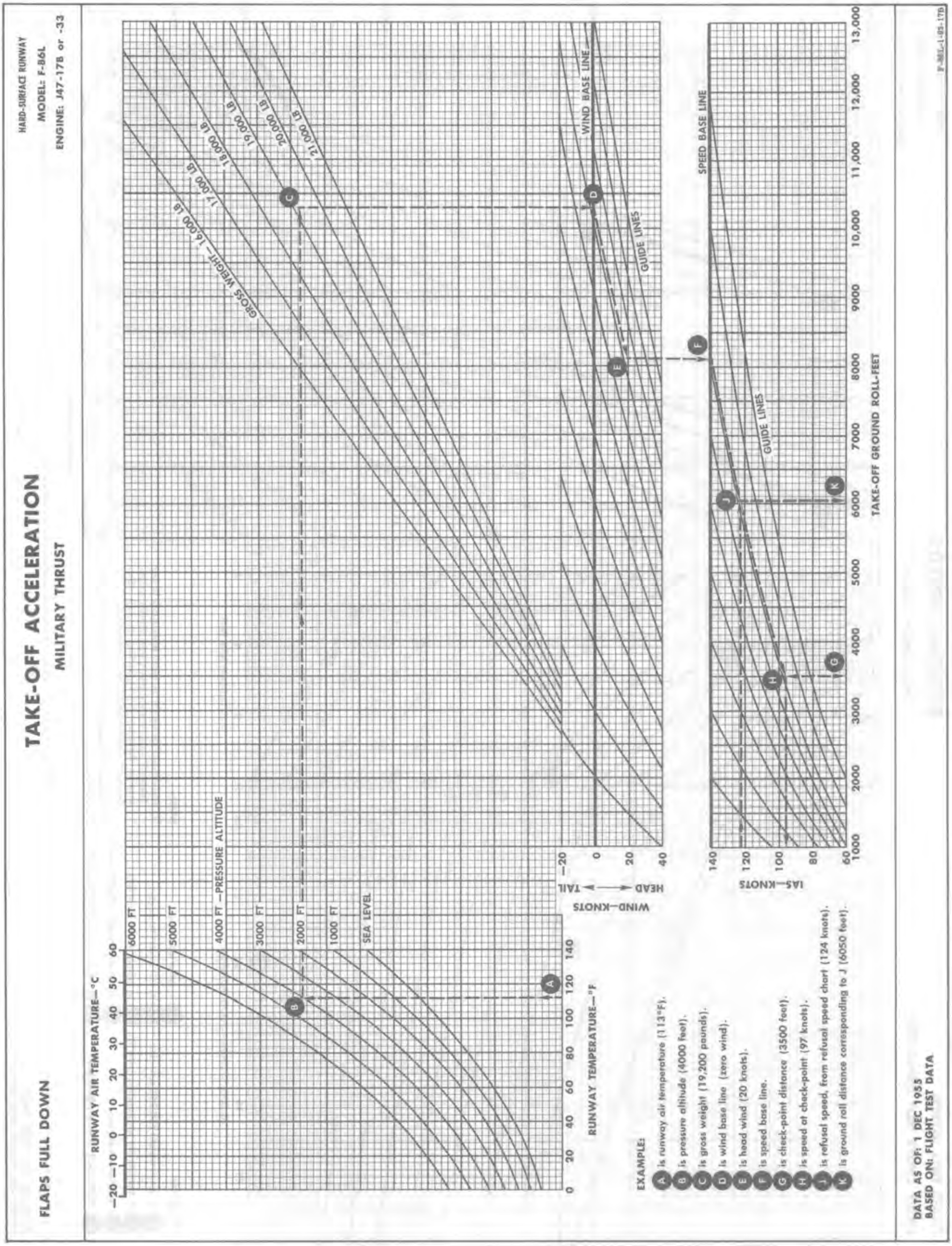
EXAMPLE:

- Ⓐ is runway air temperature (104°F).
- Ⓑ is pressure altitude (4000 feet).
- Ⓒ is gross weight (20,200 pounds).
- Ⓓ is wind base line (zero wind).
- Ⓔ is tail wind (10 knots).
- Ⓕ is speed base line.
- Ⓖ is check-point distance (4000 feet).
- Ⓗ is speed at check-point (108 knots).
- Ⓙ is check point distance (3000 feet).
- Ⓚ is speed at check point (95 knots)
- Ⓛ is refusal speed, from refusal speed chart (120 knots).
- Ⓜ is runway distance required to accelerate to L (5050 feet).

DATA AS OF: 1 DEC 1955
BASED ON: FLIGHT TEST DATA

F-86L-1-93-16A

Figure A-6



FLAPS FULL DOWN

TAKE-OFF ACCELERATION

MILITARY THRUST

HARD-SURFACE RUNWAY
MODEL: F-86L
ENGINE: J47-17B or -33

EXAMPLE:

- Ⓐ is runway air temperature (113°F).
- Ⓑ is pressure altitude (4000 feet).
- Ⓒ is gross weight (19,200 pounds).
- Ⓓ is wind base line (zero wind).
- Ⓔ is head wind (20 knots).
- Ⓕ is speed base line.
- Ⓖ is check-point distance (3500 feet).
- Ⓗ is speed at check-point (97 knots).
- Ⓙ is refusal speed, from refusal speed chart (124 knots).
- Ⓚ is ground roll distance corresponding to J (6050 feet).

DATA AS OF: 1 DEC 1955
BASED ON: FLIGHT TEST DATA

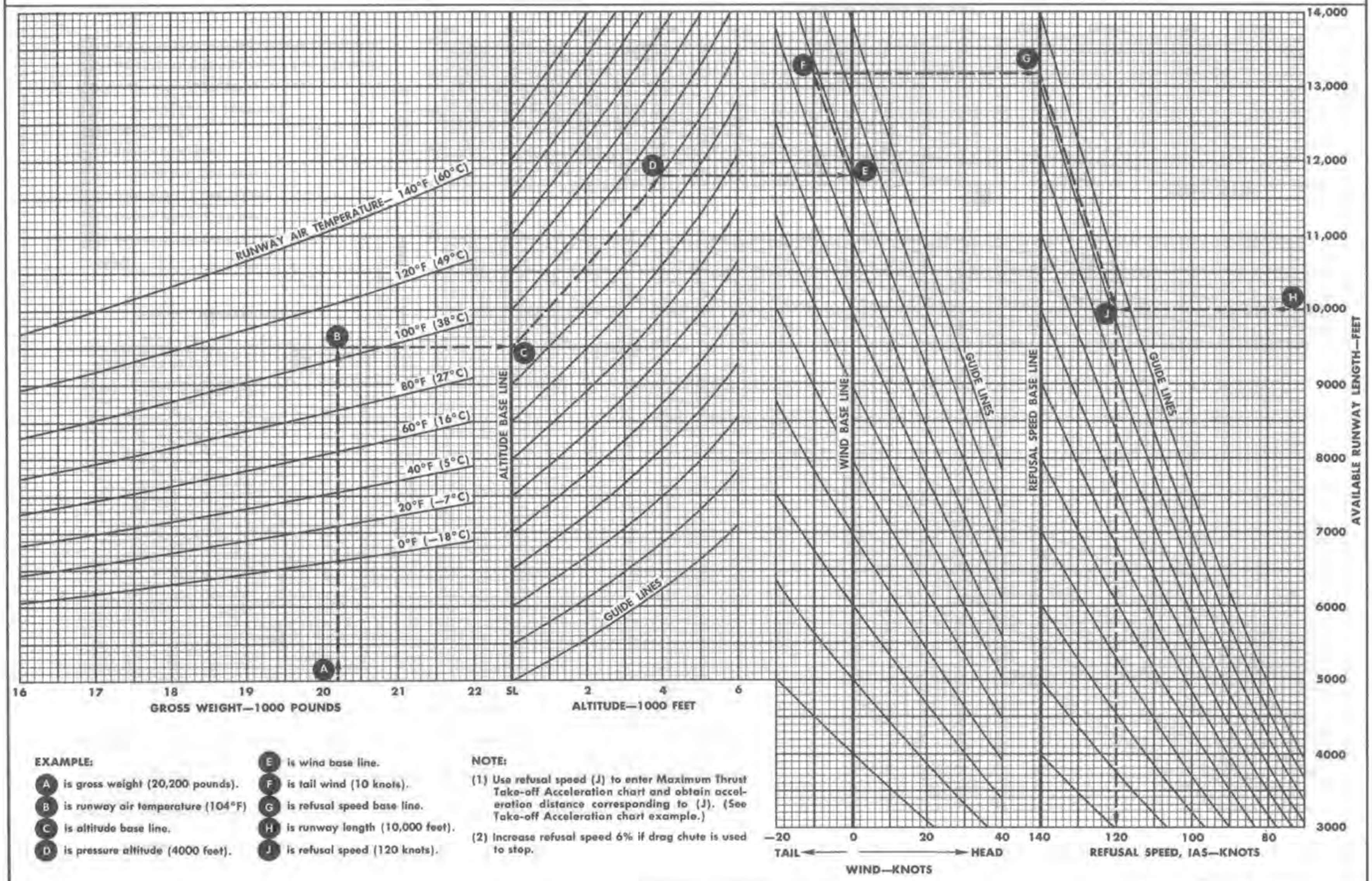
Figure A-7

FLAPS FULL DOWN
DRAG CHUTE NOT DEPLOYED

REFUSAL SPEEDS

MAXIMUM THRUST

HARD-SURFACE RUNWAY
MODEL: F-86L
ENGINE: J47-17B or -33



EXAMPLE:

- Ⓐ is gross weight (20,200 pounds).
- Ⓑ is runway air temperature (104°F)
- Ⓒ is altitude base line.
- Ⓓ is pressure altitude (4000 feet).
- Ⓔ is wind base line.
- Ⓕ is tail wind (10 knots).
- Ⓖ is refusal speed base line.
- Ⓗ is runway length (10,000 feet).
- Ⓙ is refusal speed (120 knots).

NOTE:

(1) Use refusal speed (J) to enter Maximum Thrust Take-off Acceleration chart and obtain acceleration distance corresponding to (J). (See Take-off Acceleration chart example.)

(2) Increase refusal speed 6% if drag chute is used to stop.

DATA AS OF: 1 DEC 1955
BASED ON: FLIGHT TEST DATA

F-86L-1-93-18

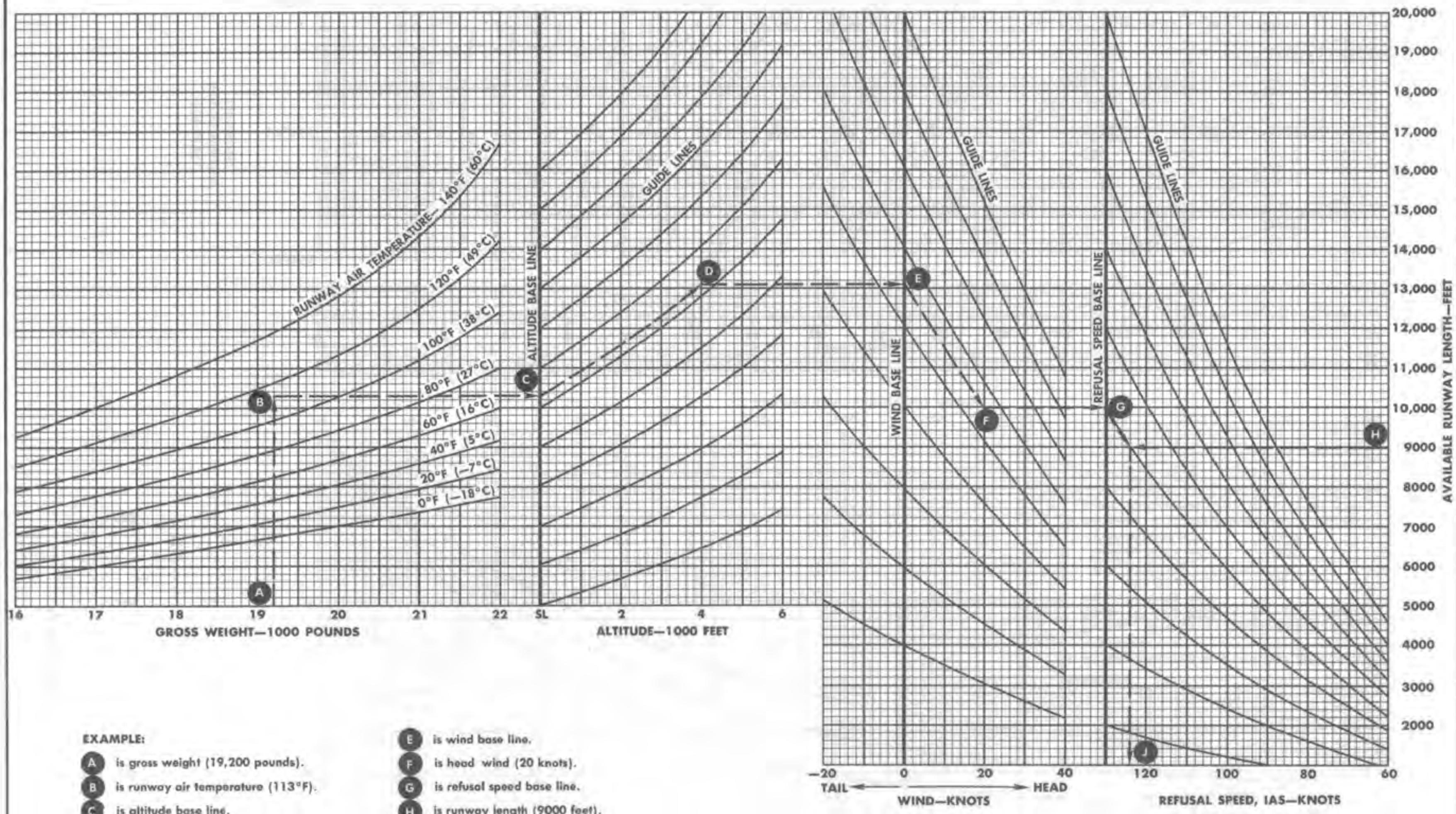
Figure A-8

FLAPS FULL DOWN
DRAG CHUTE NOT DEPLOYED

REFUSAL SPEEDS

MILITARY THRUST

HARD-SURFACE RUNWAY
MODEL: F-86L
ENGINE: J47-17B or -33



EXAMPLE:

- Ⓐ is gross weight (19,200 pounds).
- Ⓑ is runway air temperature (113°F).
- Ⓒ is altitude base line.
- Ⓓ is pressure altitude (4000 feet).
- Ⓔ is wind base line.
- Ⓕ is head wind (20 knots).
- Ⓖ is refusal speed base line.
- Ⓗ is runway length (9000 feet).
- Ⓙ is refusal speed (124 knots).

NOTE:

DATA AS OF: 1 DEC 1955
BASED ON: FLIGHT TEST DATA

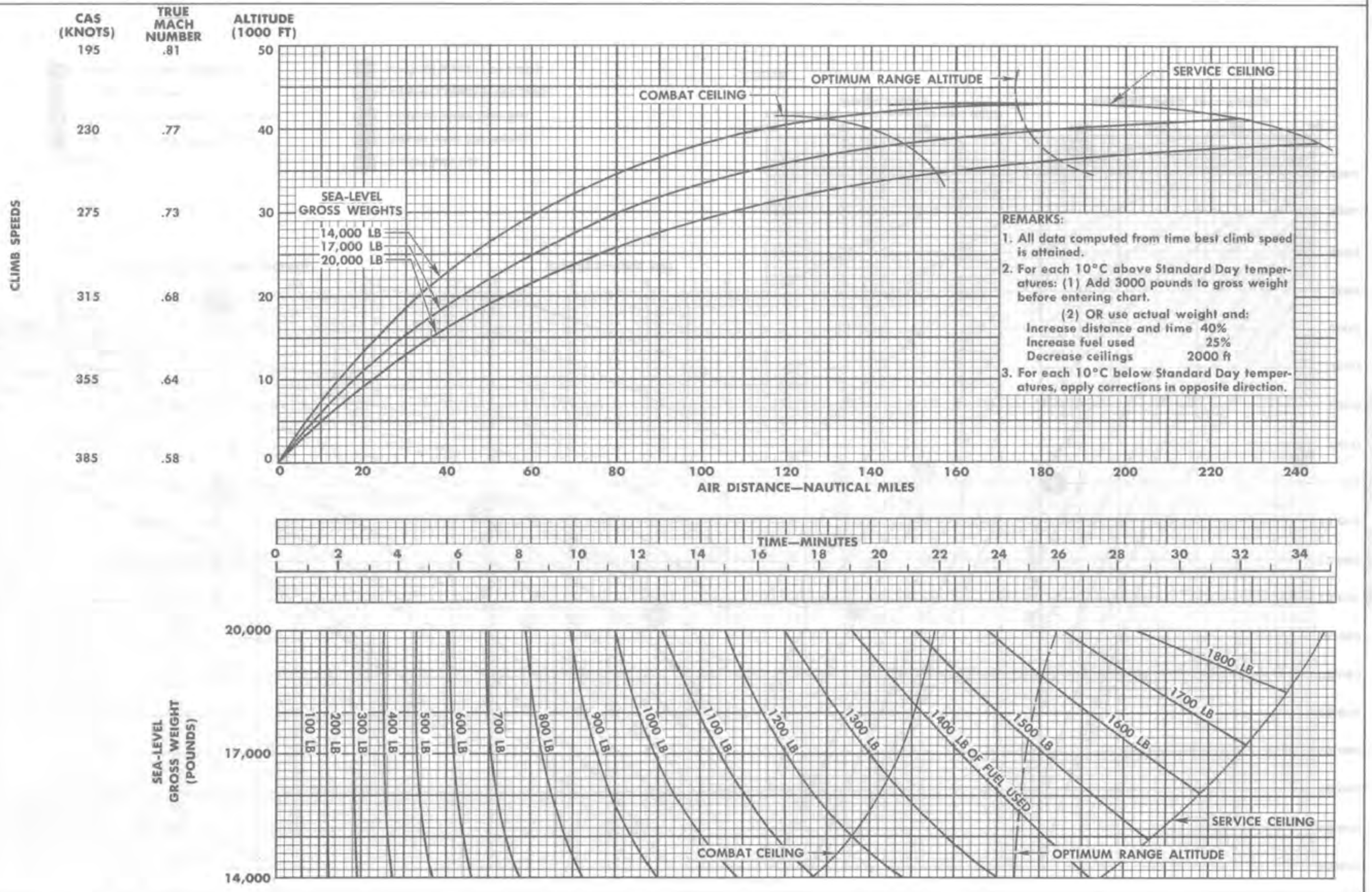
F-86L-1-93-18

Figure A-9

MILITARY THRUST CLIMB PROFILE

CLEAN

STANDARD DAY
MODEL: F-86L
ENGINE: J47-17B, or -33



REMARKS:

1. All data computed from time best climb speed is attained.
2. For each 10°C above Standard Day temperatures: (1) Add 3000 pounds to gross weight before entering chart.
   (2) OR use actual weight and:
   Increase distance and time 40%
   Increase fuel used 25%
   Decrease ceilings 2000 ft
3. For each 10°C below Standard Day temperatures, apply corrections in opposite direction.

DATA AS OF: 1 DEC 1955
BASED ON FLIGHT TEST DATA

F-86L-1-93-20A

Figure A-10

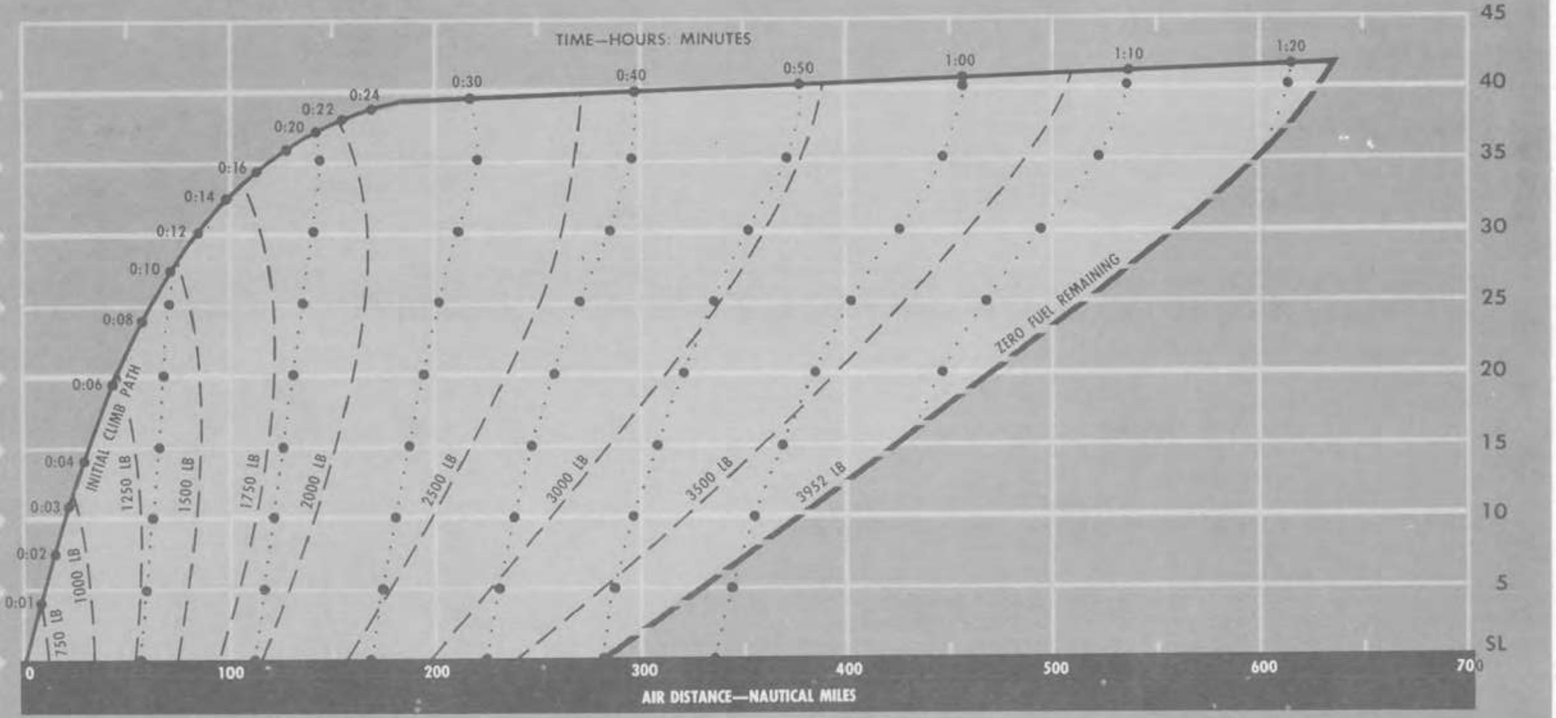
MISSION PROFILE

TAKE-OFF GROSS WEIGHT: 18,000-18,600 LB
ALL FUEL LOADS BETWEEN 0 - 3952 LB

CLEAN

STANDARD DAY
Model: F-86L
Engine: J47-17B or -33

MILITARY THRUST CLIMB		
TRUE MACH NO.	CAS	ALT 1000 FT
.77	230	40
.75	255	35
.73	275	30
.71	295	25
.68	315	20
.66	335	15
.64	355	10
.62	375	5
.58	385	SL



REMARKS

1. 600-pound fuel allowance for start, taxi, take-off, and acceleration to climb schedule.
2. No allowance or reserve for loiter, descent, or landing.
3. Use Military Thrust for climb. (See Military Thrust climb chart for detailed information.)
4. Cruise at recommended Mach number.
5. For cruise-climb procedure, maintain a constant rpm and Mach number.

LEGEND

— — — —	Fuel consumed
———	Maximum Continuous Thrust cruise-climb path
• · · · • · · · •	Time (start, taxi, and take-off not included)

CRUISE—CLEAN					
ALTITUDE FEET	TRUE MACH NO.	APPROXIMATE			
		CAS	TAS	LB/HR	% RPM
CRUISE CLIMB	.83	—	475	2100-1900	100*
35,000	.78	265	445	2100-2000	97-93
30,000	.70	265	415	2200-2100	94-91
25,000	.66	270	395	2350-2200	92-89
20,000	.62	280	375	2500-2400	91-88
15,000	.58	290	360	2800-2700	89-87
10,000	.55	305	350	3100-3000	89-87
5,000	.53	320	340	3600-3500	89-87
SEA LEVEL	.51	335	335	4100-4000	89-87

Data as of: 1 Dec 1955. Based on flight test data.

*Maximum Continuous Thrust, 100% rpm, 635°C EGT.

F-86L-1-93-21B

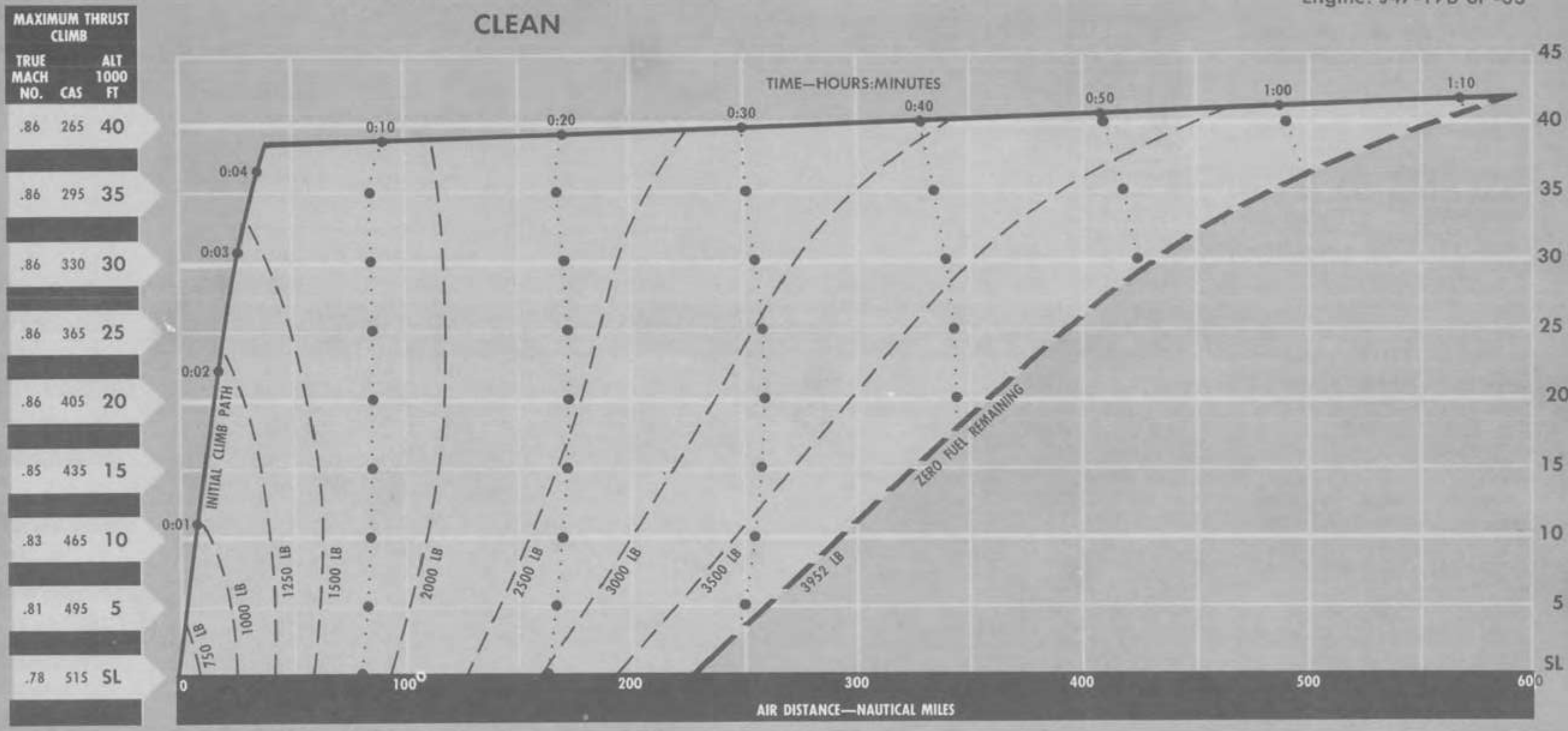
Figure A-11

INTERCEPT PROFILE

TAKE-OFF GROSS WEIGHT: 18,000-18,600 LB
ALL FUEL LOADS BETWEEN 0 - 3952 LB

CLEAN

STANDARD DAY
Model: F-86L
Engine: J47-17B or -33



MAXIMUM THRUST CLIMB		
TRUE MACH NO.	CAS	ALT 1000 FT
.86	265	40
.86	295	35
.86	330	30
.86	365	25
.86	405	20
.85	435	15
.83	465	10
.81	495	5
.78	515	SL

REMARKS

1. 600-pound fuel allowance for start, taxi, take-off, and acceleration to climb schedule.
2. Use Maximum Thrust for climb. (See Maximum Thrust climb chart for detailed information.)
3. Cruise at Maximum Continuous Thrust.
4. No allowance or reserve for loiter, descent, or landing.

LEGEND

— — —	Fuel consumed
———	Maximum Continuous Thrust cruise-climb path
●· · · ·●· · · ·●	Time (start, taxi, and take-off not included)

CRUISE—CLEAN					
ALTITUDE FEET	% RPM	APPROXIMATE			
		TRUE MACH NO.	CAS	TAS	LB/HR
* CRUISE CLIMB	100*	.83	—	475	2200-1900
35,000		.86-.87	295-300	495-500	2700
30,000		.86-.87	325-330	505-510	3200
25,000		.85-.86	360-365	510-515	3750
20,000		.84-.85	390-395	515-520	4250
15,000		.82-.83	420-425	510-515	4800
10,000		.79-.80	445-450	505-510	5500
5,000		.77-.78	470-475	500-505	6300
SEA LEVEL		.74-.75	490-495	490-495	7250

Data as of: 1 Dec 1955. Based on flight test data.

*Maximum Continuous Thrust, 100% rpm, 635°C EGT.

F-86L-1-93-22A

Figure A-12

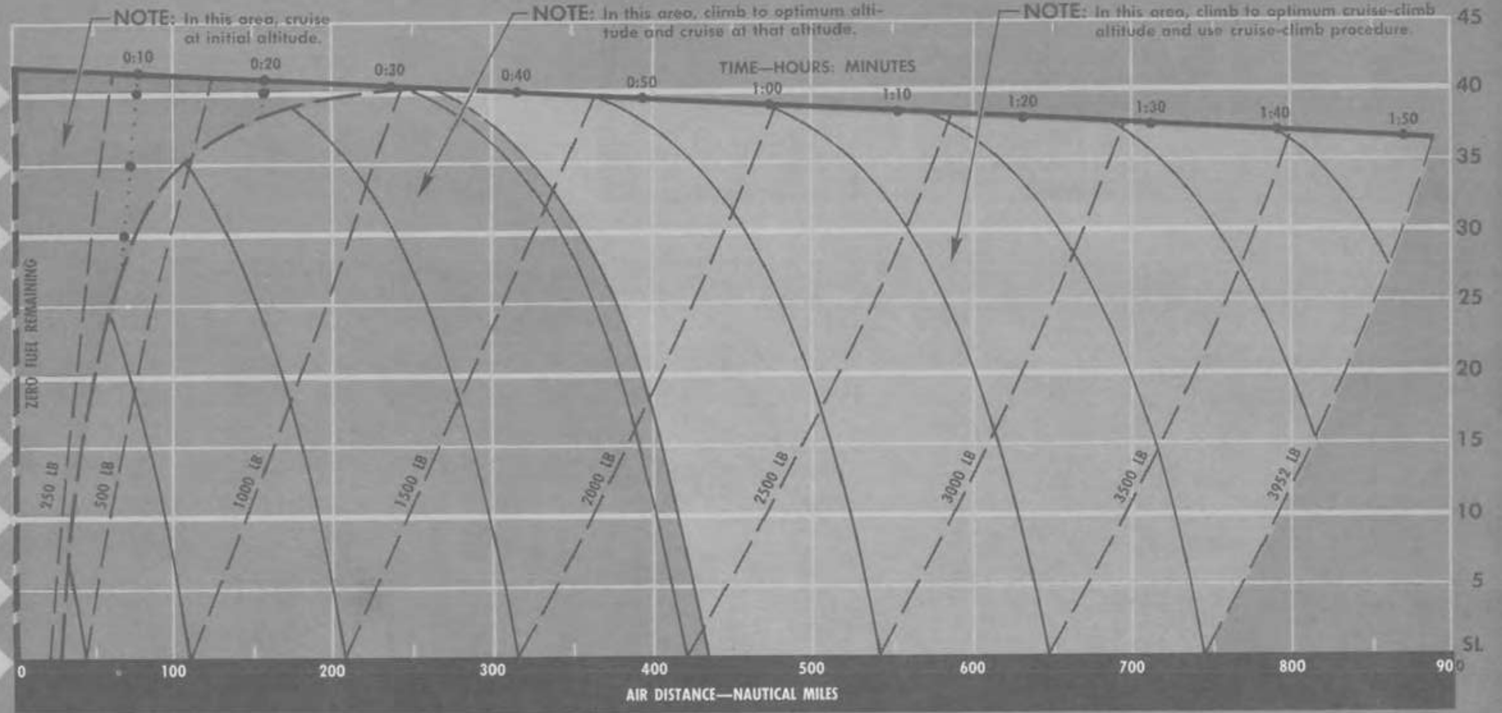
OPTIMUM RETURN PROFILE

STANDARD DAY
Model: F-86L
Engine: J47-17B or -33

TAKE-OFF GROSS WEIGHT: 18,000-18,600 LB
ALL FUEL LOADS BETWEEN 0 - 3952 LB

CLEAN

MILITARY THRUST CLIMB		
TRUE MACH NO.	CAS	ALT 1000 FT
.77	230	40
.75	255	35
.73	275	30
.71	295	25
.68	315	20
.66	335	15
.64	355	10
.62	375	5
.58	385	SL



NOTE: In this area, cruise at initial altitude.

NOTE: In this area, climb to optimum altitude and cruise at that altitude.

NOTE: In this area, climb to optimum cruise-climb altitude and use cruise-climb procedure.

REMARKS

1. Fuel required at any point includes Military Thrust climb to flight altitude (if below that flight altitude).
2. No allowance or reserve for loiter, descent, or landing.
3. Best cruise condition determined by intersection of climb path guide lines and lines of best range.
4. Cruise at recommended Mach number.
5. For cruise-climb procedure, maintain constant Mach number. Use Maximum Continuous Thrust.

LEGEND

— — —	Fuel required
———	Climb path guide lines
—— —— ——	Line of best range for constant-altitude flight
━━━	Line of best range for cruise-climb flight
● · · · ● · · · ●	Time at cruising altitude

CRUISE - CLEAN					
ALTITUDE FEET	TRUE MACH NO.	APPROXIMATE			
		CAS	TAS	LB/HR	% RPM
*CRUISE-CLIMB	.83	—	475	2100-1900	100*
35,000	.78	265	445	2100-2000	97-93
30,000	.70	265	415	2200-2100	94-91
25,000	.66	270	395	2350-2200	92-89
20,000	.62	280	375	2500-2400	91-88
15,000	.58	290	360	2800-2700	89-87
10,000	.55	305	350	3100-3000	89-87
5,000	.53	320	340	3600-3500	89-87
SEA LEVEL	.51	335	335	4100-4000	89-87

Data as of: 1 Dec 1955. Based on flight test data.

*Maximum Continuous Thrust, 100% rpm, 635°C EGT.

F-86L-1-93-23B

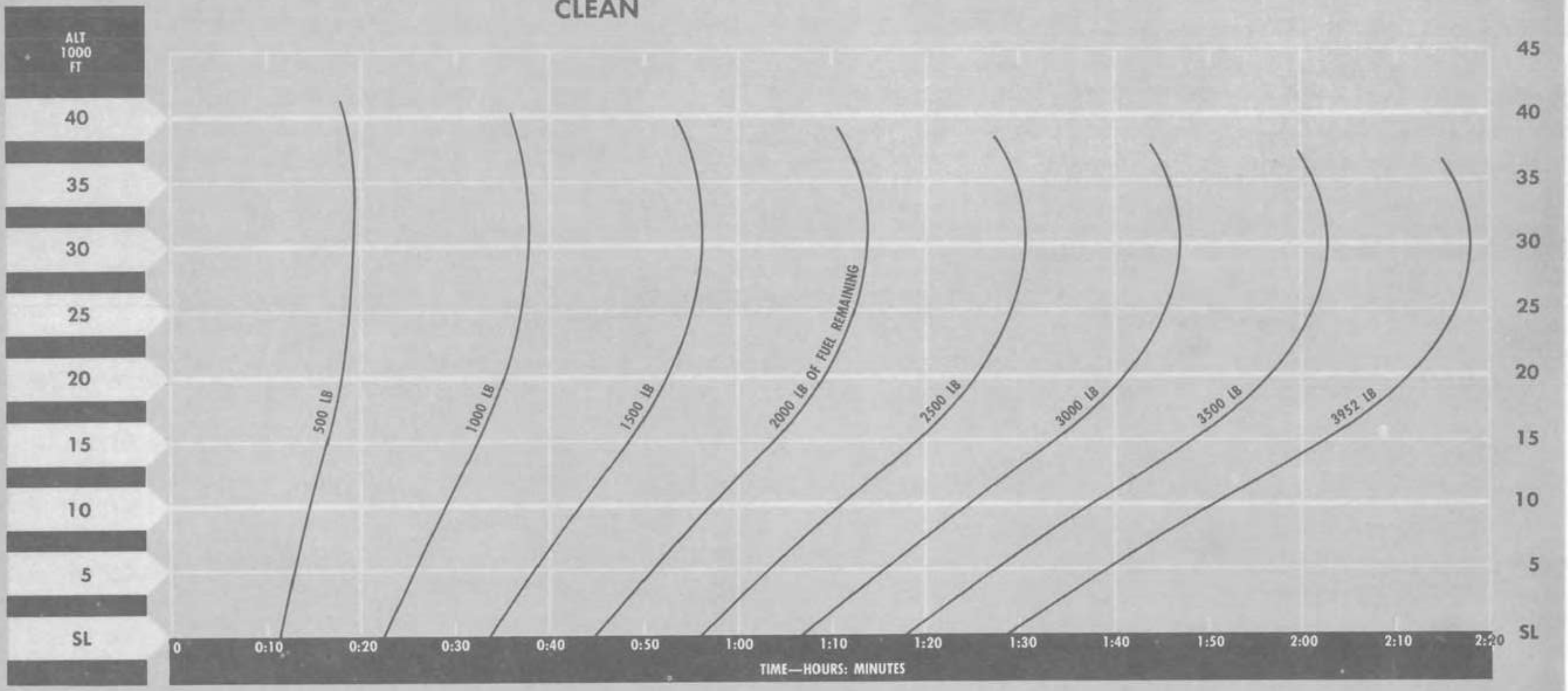
Figure A-13

MAXIMUM ENDURANCE PROFILE

STANDARD DAY
Model: F-86L
Engine: J47-17B or -33

TAKE-OFF GROSS WEIGHT: 18,000-18,600 LB
ALL FUEL LOADS BETWEEN 0 - 3952 LB

CLEAN



REMARKS
1. Loiter at recommended CAS.
2. Maintain constant altitude.

LOITER	LESS THAN 2000 LB FUEL REMAINING					MORE THAN 2000 LB FUEL REMAINING				
		APPROXIMATE					APPROXIMATE			
ALTITUDE FEET	CAS	TRUE MACH NO.	TAS	LB/HR	% RPM	CAS	TRUE MACH NO.	TAS	LB/HR	% RPM
40,000	195	.66	380	1800-1650	100	—	—	—	—	—
35,000	190	.57	330	1750-1550	93-90	205	.70	355	2000-1750	96-93
30,000	180	.49	290	1700-1550	89-86	195	.62	315	1950-1700	92-89
25,000	175	.43	260	1750-1600	89-84	190	.53	280	1950-1750	90-89
20,000	175	.39	240	1800-1650	85-82	190	.47	255	2000-1800	89-85
15,000	175	.35	220	1950-1800	83-81	185	.42	235	2100-1950	85-83
10,000	180	.32	205	2150-2050	82-80	185	.37	215	2300-2150	83-82
5,000	185	.30	200	2400-2300	81-80	190	.34	205	2550-2400	82-81
SEA LEVEL	195	.29	195	2700-2600	80-79	200	.31	200	2800-2700	81-80

Data as of: 1 Dec 1955. Based on flight test data.

F-86L-1-93-24A

Figure A-14

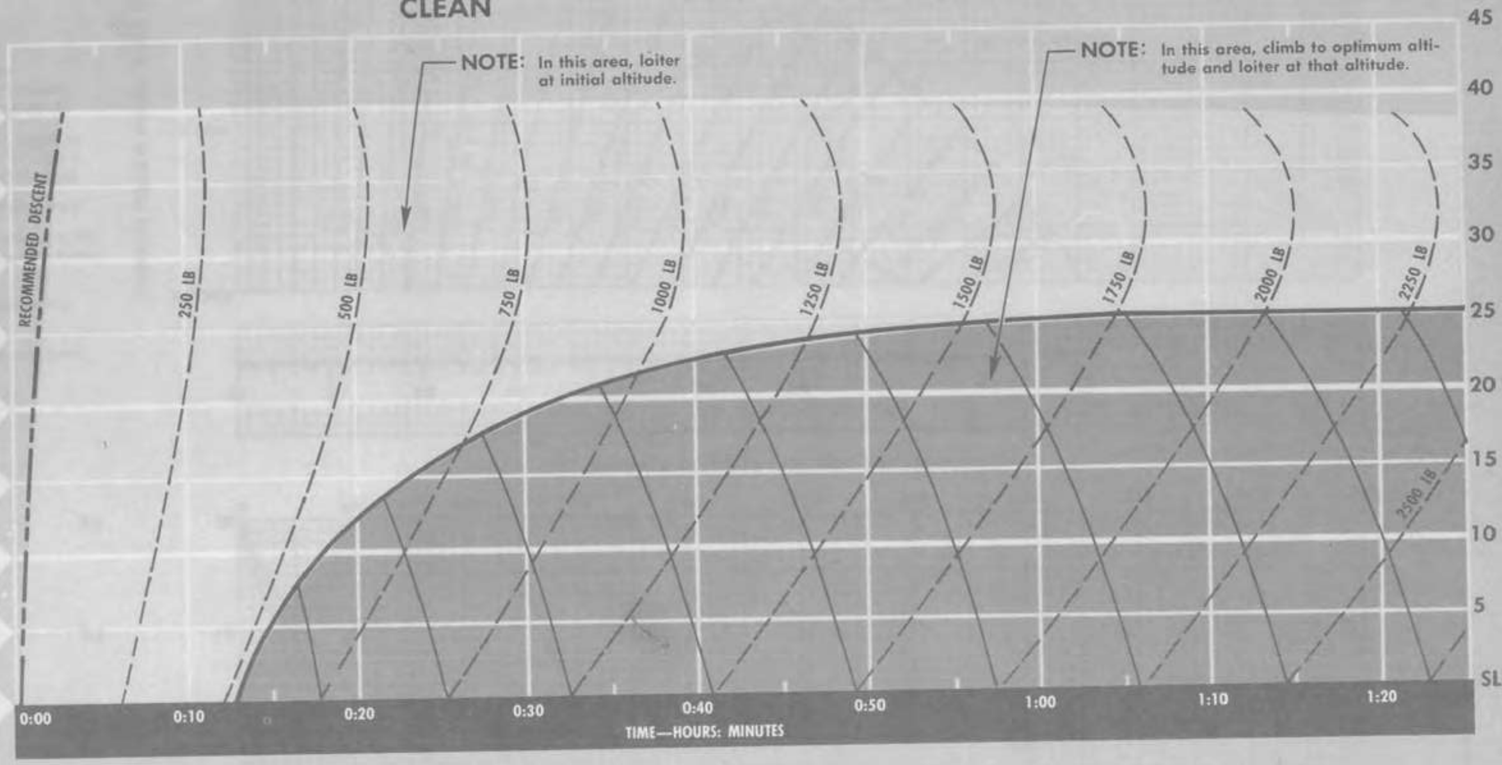
OPTIMUM MAXIMUM ENDURANCE PROFILE

STANDARD DAY
Model: F-86L
Engine: J47-17B or -33

TAKE-OFF GROSS WEIGHT: 18,000-18,600 LB
ALL FUEL LOADS BETWEEN 0 - 2500 LB

CLEAN

MAXIMUM CONTINUOUS THRUST CLIMB TRUE MACH NO.	CAS	ALT 1000 FT
.69	205	40
.69	230	35
.67	250	30
.65	270	25
.62	285	20
.60	305	15
.57	320	10
.54	325	5
.50	330	SL



NOTE: In this area, loiter at initial altitude.

NOTE: In this area, climb to optimum altitude and loiter at that altitude.

REMARKS

1. Use Maximum Continuous Thrust for climb. (See Maximum Continuous Thrust climb chart for detailed information.)
2. Loiter at recommended CAS.
3. Use recommended descent.
4. No allowance or reserve for landing.

LEGEND

— — — —	Fuel remaining
———	Maximum Continuous Thrust climb guide lines
▬▬▬	Optimum altitude for loiter

LOITER—CLEAN

ALTITUDE FEET	CAS	APPROXIMATE			
		TRUE MACH NO.	TAS	LB/HR	% RPM
40,000	195	66	380	1800-1650	100
35,000	190	.57	330	1750-1550	93-90
30,000	180	.49	290	1700-1550	89-86
25,000	175	.43	260	1750-1600	89-84
20,000	175	.39	240	1800-1650	85-82
15,000	175	.35	220	1950-1800	83-81
10,000	180	.32	205	2150-2050	82-80
5,000	185	.30	200	2400-2300	81-80
SEA LEVEL	195	.29	195	2700-2600	80-79

Data as of: 1 Dec 1955. Based on flight test data.

F-86L-1-93-25A

Figure A-15

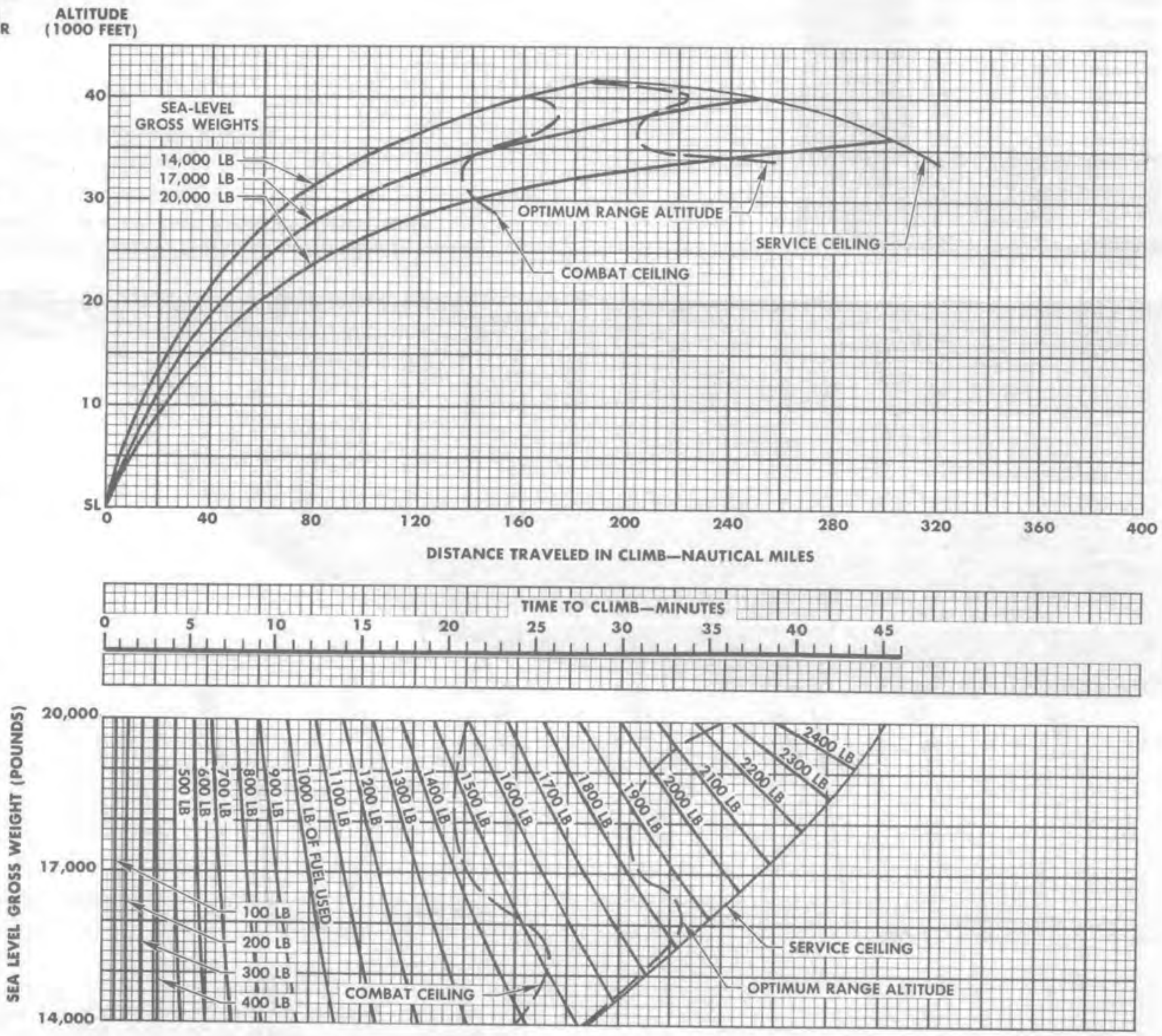
MILITARY THRUST CLIMB PROFILE

TWO 120-GALLON TANKS

STANDARD DAY
MODEL: F-86L
ENGINE: J47-17B or -33

CLIMB SPEEDS

CAS (KNOTS)	TRUE MACH NUMBER	ALTITUDE (1000 FEET)
229	.76	40
267	.71	30
297	.65	20
327	.59	10
344	.53	SL



REMARKS:

1. All data computed from time best climb speed is attained.
2. For each 10°C above Standard Day temperatures:

   (1) Add 3000 pounds to gross weight entering before chart.

   (2) OR use actual weight and:

Increase distance and time	40%
Increase fuel used	25%
Decrease ceilings	2000 ft

3. For each 10°C below Standard Day temperatures, apply correction in opposite direction.

DATA AS OF: 25 DEC 1957
BASED ON: FLIGHT TEST DATA

F-86L-1-93-26C

F-86K-1-93-123

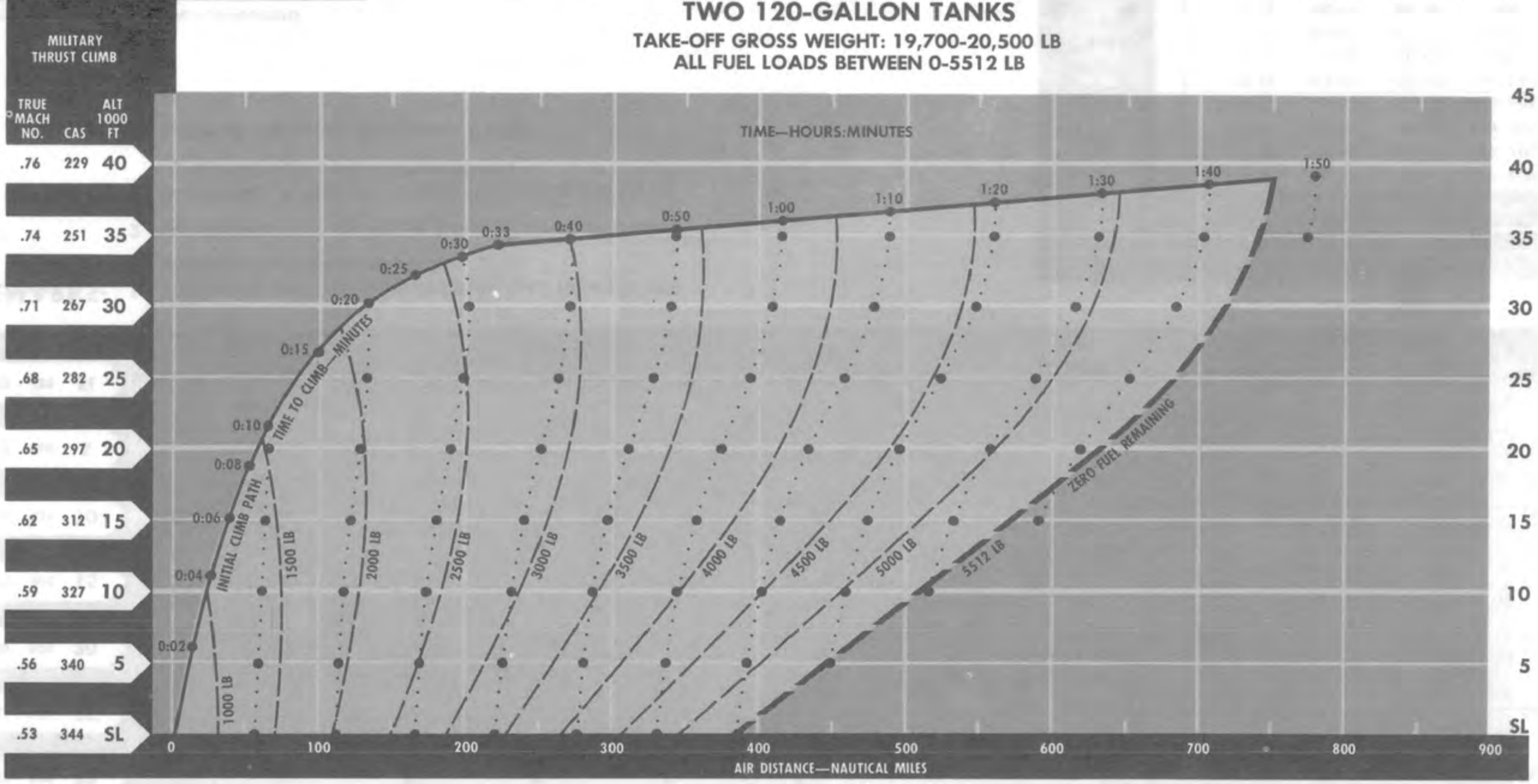
Figure A-16

MISSION PROFILE

STANDARD DAY
Model: F-86L
Engine: J47-17B or -33

TWO 120-GALLON TANKS

TAKE-OFF GROSS WEIGHT: 19,700-20,500 LB
ALL FUEL LOADS BETWEEN 0-5512 LB



TRUE MACH NO.	CAS	ALT 1000 FT
.76	229	40
.74	251	35
.71	267	30
.68	282	25
.65	297	20
.62	312	15
.59	327	10
.56	340	5
.53	344	SL

REMARKS:

1. 600-pound fuel allowance for start, taxi, take-off, and acceleration to climb schedule.
2. No allowance or reserve for loiter, descent, or landing.
3. Use Military Thrust for climb. (See Military Thrust climb chart for detailed information.)
4. Cruise at recommended Mach number.
5. For cruise-climb procedure, use Maximum Continuous Thrust.

LEGEND

— — — — Fuel consumed
——— Maximum Continuous Thrust cruise-climb path
●· · · ●· · · ● Time (start, taxi, and take-off not included)

CRUISE—TWO 120-GALLON TANKS

ALTITUDE FEET	TRUE MACH NO.	APPROXIMATE			
		CAS	TAS	LB/HR	% RPM
* CRUISE-CLIMB	.76	—	440	2550-2150	100
35,000	.76	255	440	2500-2300	100-98
30,000	.70	265	410	2500-2300	98-95
25,000	.65	270	390	2600-2400	96-93
20,000	.60	275	370	2750-2600	93-91
15,000	.56	285	350	2950-2800	91-89
10,000	.53	295	340	3300-3100	90-89
5,000	.51	310	330	3700-3500	90-89
SEA LEVEL	.50	330	330	4300-4150	90-89

* Maximum Continuous Thrust, 100% rpm, 635°C EGT.

F-86L-1-93-27C

Data as of: 25 Dec. 1957. Based on flight test data.

Figure A-17

INTERCEPT PROFILE

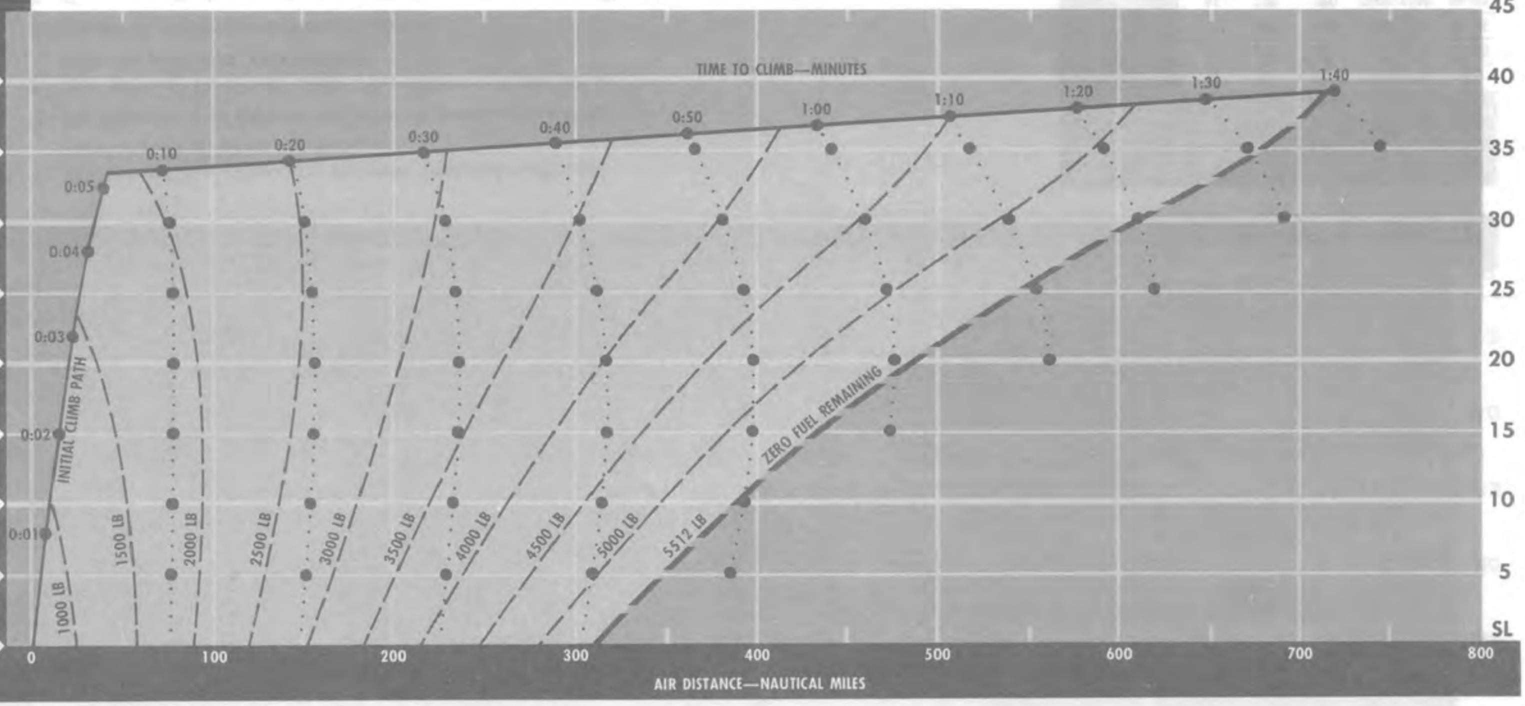
STANDARD DAY
Model: F-86L
Engine: J47-17B or -33

TAKE-OFF GROSS WEIGHT: 19,700-20,500 LB
ALL FUEL LOADS BETWEEN 0-5512 LB

TWO 120-GALLON TANKS

MAXIMUM THRUST CLIMB

TRUE MACH NO.	CAS	ALT 1000 FT
.83	250	40
.83	285	35
.82	310	30
.81	340	25
.80	375	20
.79	405	15
.78	435	10
.77	460	5
.73	480	SL



REMARKS:

1. 600-pound fuel allowance for start, taxi, take-off, and acceleration to climb schedule.
2. No allowance or reserve for loiter, descent, or landing.
3. Use Maximum Thrust for climb. (See Maximum Thrust climb chart for detailed information.)
4. Cruise at Maximum Continuous Thrust.

LEGEND

— — — —	Fuel consumed
———	Maximum Continuous Thrust cruise-climb path
●····●····●	Time (start, taxi, and take-off not included)

CRUISE— TWO 120-GALLON TANKS

ALTITUDE FEET	% RPM	APPROXIMATE			
		TRUE MACH NO.	CAS	TAS	LB/HR
* CRUISE-CLIMB	100	.76	— —	440	2550-2150
35,000	↓	.74-.80	250-270	425-460	2550-2500
30,000		.77-.80	290-305	450-470	3100-3000
25,000		.78-.79	325-335	465-475	3650-3600
20,000		.77-.78	355-365	470-480	4250-4200
15,000		.75-.76	385-390	470-475	4900
10,000		.73-.74	405-410	465-470	5650
5,000		.71-.72	430-435	460-465	6400
SEA LEVEL		.69-.70	455-460	455-460	7300

* Maximum Continuous Thrust, 100% rpm, 635°C EGT.

F-86L-1-93-28B

Data as of: 25 Dec. 1957. Based on flight test data.

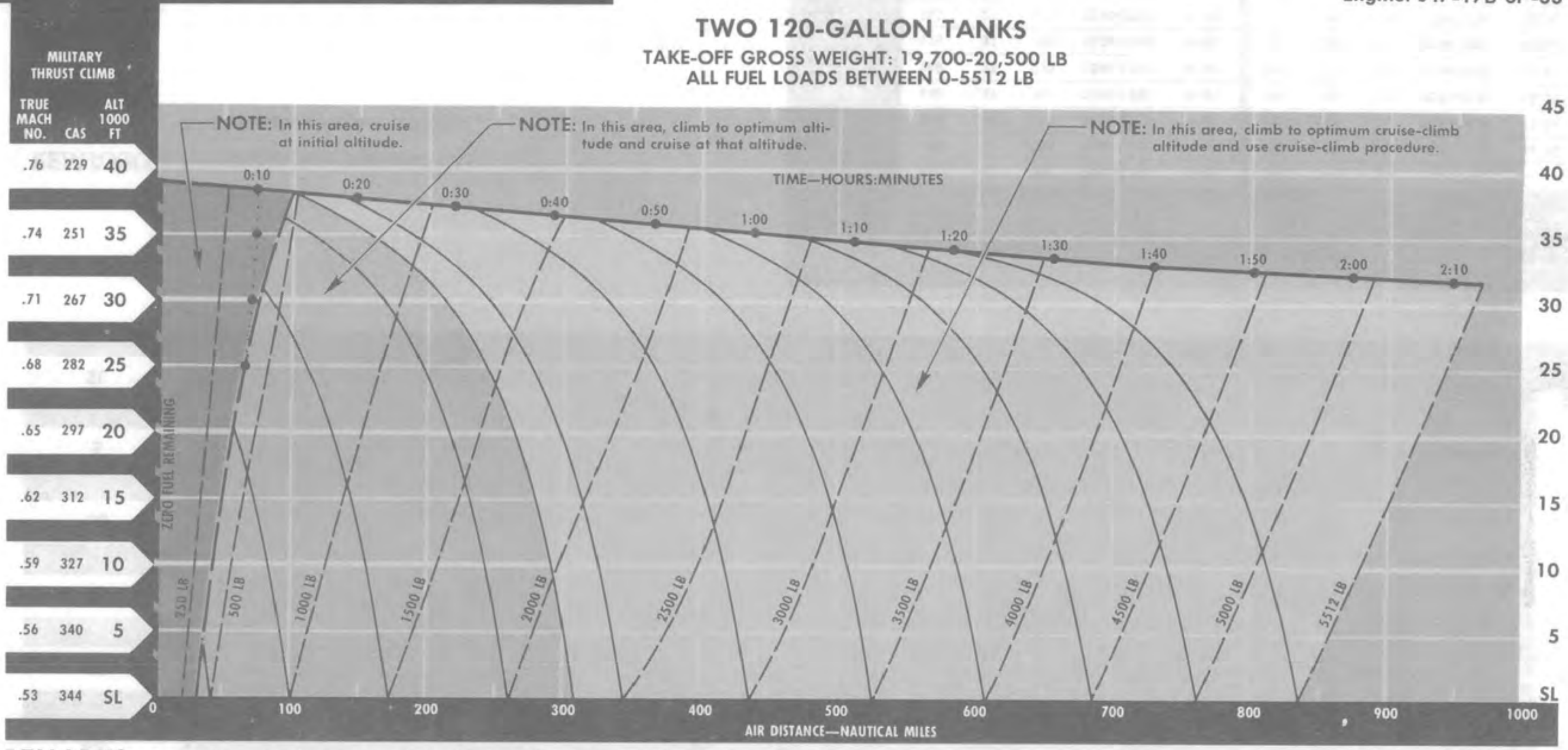
Figure A-18

OPTIMUM RETURN PROFILE

STANDARD DAY
Model: F-86L
Engine: J47-17B or -33

TWO 120-GALLON TANKS

TAKE-OFF GROSS WEIGHT: 19,700-20,500 LB
ALL FUEL LOADS BETWEEN 0-5512 LB



NOTE: In this area, cruise at initial altitude.

NOTE: In this area, climb to optimum altitude and cruise at that altitude.

NOTE: In this area, climb to optimum cruise-climb altitude and use cruise-climb procedure.

REMARKS:
1. Fuel required at any point includes Military Thrust climb to flight altitude (if below that flight altitude).
2. No allowance or reserve for loiter, descent, or landing.
3. Best cruise condition determined by intersection of climb path guide lines and lines of best range.
4. Cruise at recommended Mach number.
5. For cruise-climb procedure, maintain constant Mach number. Use Maximum Continuous Thrust.

LEGEND

— — — —	Fuel required
———	Climb path guide lines
—— — ——	Line of best range for constant-altitude flight
———	Line of best range for cruise-climb flight
●· · · ·●· · · ·●	Time at cruising altitude

CRUISE— TWO 120-GALLON TANKS					
ALTITUDE FEET	TRUE MACH NO.	APPROXIMATE			
		CAS	TAS	LB/HR	% RPM
* CRUISE-CLIMB	.76	—	440	2550-2150	100
35,000	.76	255	440	2500-2300	100-98
30,000	.70	265	410	2500-2300	98-95
25,000	.65	270	390	2600-2400	96-93
20,000	.60	275	370	2750-2600	93-91
15,000	.56	285	350	2950-2800	91-89
10,000	.53	295	340	3300-3100	90-89
5,000	.51	310	330	3700-3500	90-89
SEA LEVEL	.50	330	330	4300-4150	90-89

* Maximum Continuous Thrust, 100% rpm, 635°C EGT.

Data as of: 25 Dec. 1957. Based on flight test data.

F-86L-1-93-29D

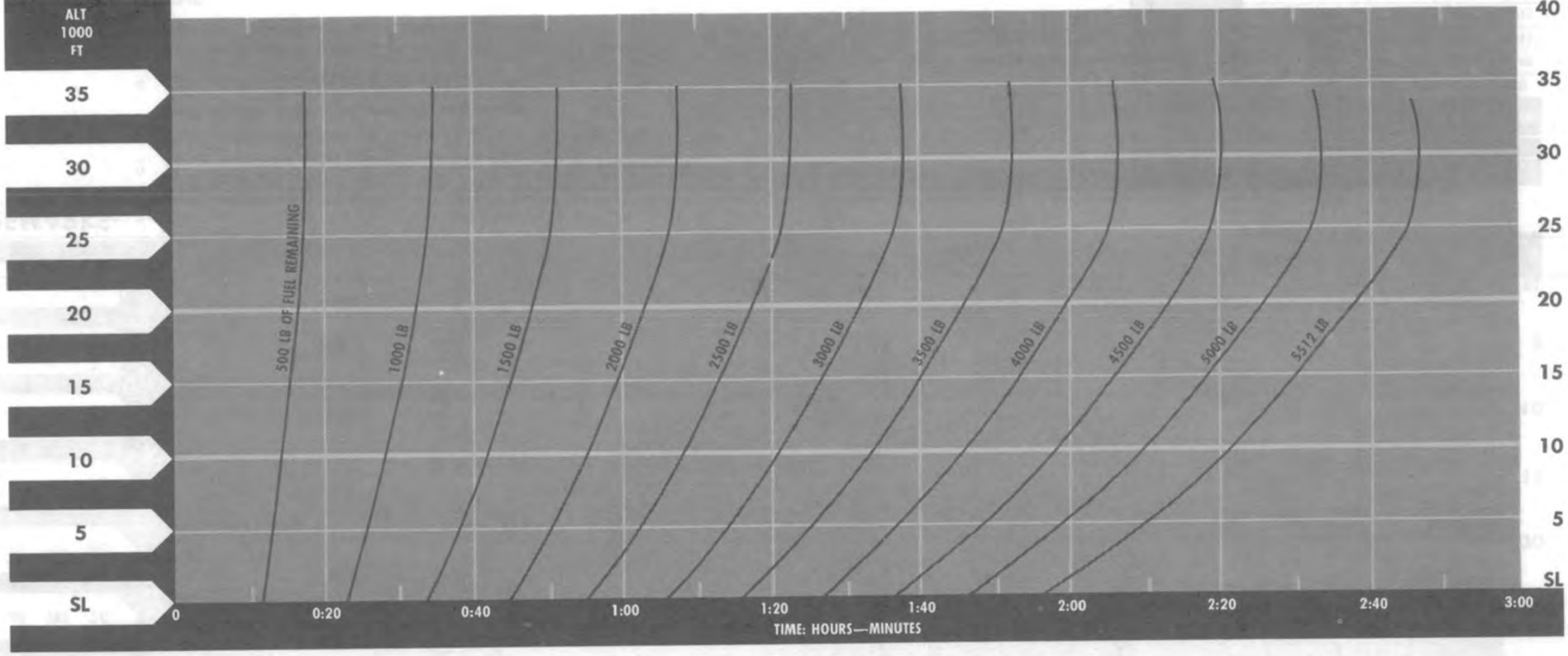
Figure A-19

MAXIMUM ENDURANCE PROFILE

STANDARD DAY
Model: F-86L
Engine: J47-17B or -33

TWO 120-GALLON TANKS

TAKE-OFF GROSS WEIGHT: 19,700-20,500 LB
ALL FUEL LOADS BETWEEN 0-5512 LB



LOITER	LESS THAN 3000 LB FUEL REMAINING					MORE THAN 3000 LB FUEL REMAINING				
		APPROXIMATE					APPROXIMATE			
ALTITUDE FEET	CAS	TRUE MACH NO.	TAS	LB/HR	% RPM	CAS	TRUE MACH NO.	TAS	LB/HR	% RPM
35,000	175	.53	307	2000-1700	96-91	—	—	—	— —	— —
30,000	180	.48	283	2000-1700	93-89	190	.52	305	2300-2000	96-93
25,000	180	.44	262	2000-1750	91-87	190	.47	280	2300-2000	95-91
20,000	180	.39	241	2100-1900	89-85	190	.42	258	2350-2100	93-89
15,000	180	.35	220	2200-1950	87-84	190	.38	236	2450-2200	91-87
10,000	175	.31	198	2350-2100	86-83	185	.33	213	2550-2350	89-86
5000	165	.27	175	2550-2350	84-82	175	.29	190	2750-2550	88-84
SEA LEVEL	155	.23	152	2850-2650	83-81	165	.25	165	3050-2850	86-83

REMARKS: 1. Loiter at recommended CAS.

2. Maintain constant altitude.

Data as of: 25 Dec. 1957. Based on flight test data.

F-86L-1-93-30C

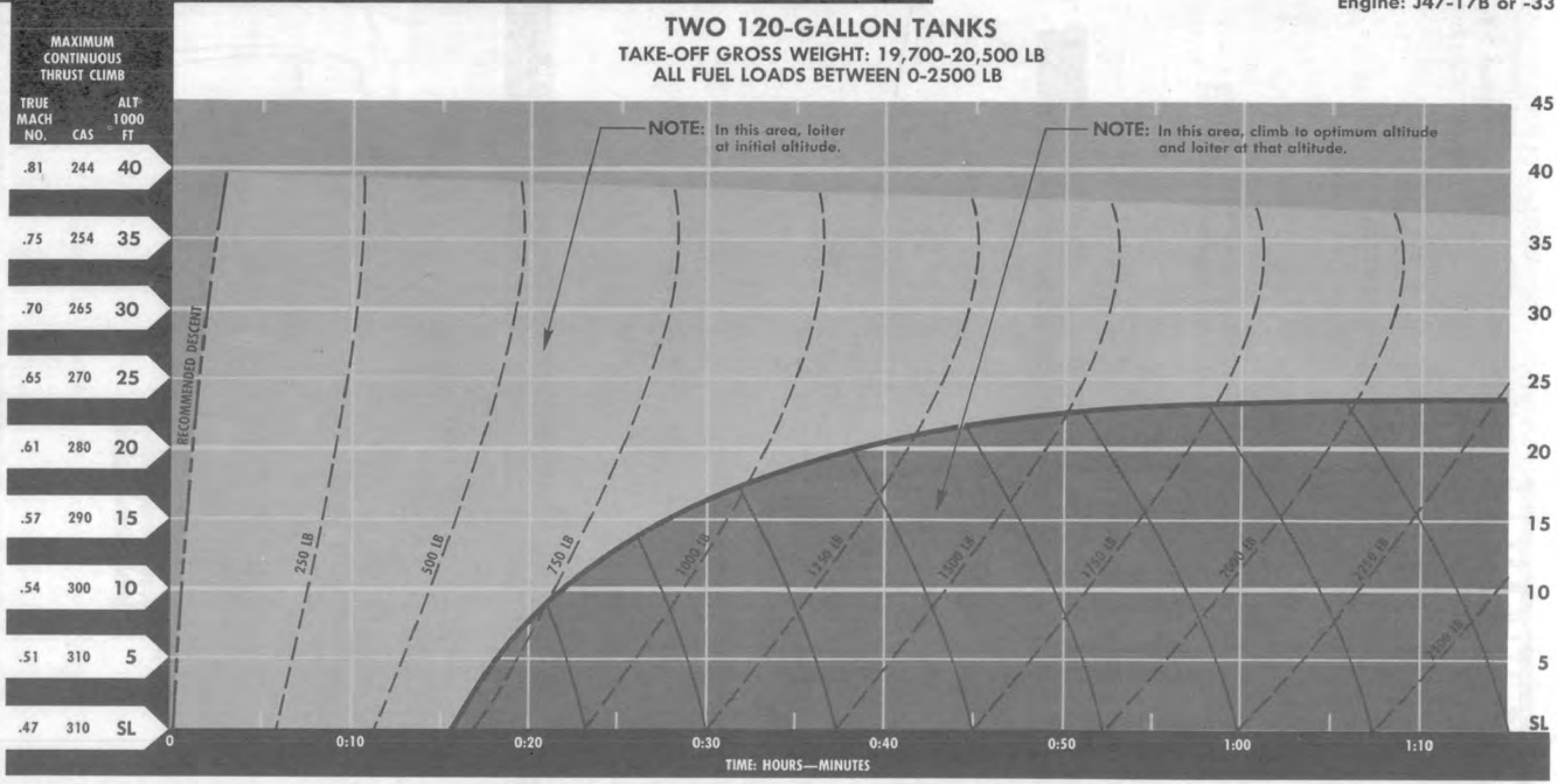
Figure A-20

OPTIMUM MAXIMUM ENDURANCE PROFILE

STANDARD DAY
Model: F-86L
Engine: J47-17B or -33

TWO 120-GALLON TANKS

TAKE-OFF GROSS WEIGHT: 19,700-20,500 LB
ALL FUEL LOADS BETWEEN 0-2500 LB



NOTE: In this area, loiter at initial altitude.

NOTE: In this area, climb to optimum altitude and loiter at that altitude.

REMARKS:

1. Use Maximum Continuous Thrust for climb. (See Maximum Continuous Thrust climb chart for detailed information.)
2. Loiter at recommended CAS.
3. Use recommended descent.
4. No allowance or reserve for landing.

LEGEND:

- ▬ Line of optimum altitude for loiter
- – – – Fuel remaining
- ─ Maximum Continuous Thrust climb guide lines

LOITER—TWO 120-GALLON DROP TANKS

ALTITUDE FEET	CAS	APPROXIMATE			
		TRUE MACH NO.	TAS	LB/HR	% RPM
35,000	175	.53	307	2000-1700	91-96
30,000	180	.48	283	2000-1700	89-93
25,000	180	.44	262	2000-1750	87-91
20,000	180	.39	241	2100-1900	85-89
15,000	180	.35	220	2200-1950	84-87
10,000	175	.31	198	2350-2100	83-86
5000	165	.27	175	2550-2350	82-84
SEA LEVEL	155	.23	152	2850-2650	81-83

Data as of: 25 Dec. 1957. Based on flight test data.

F-86L-1-93-31C

Figure A-21

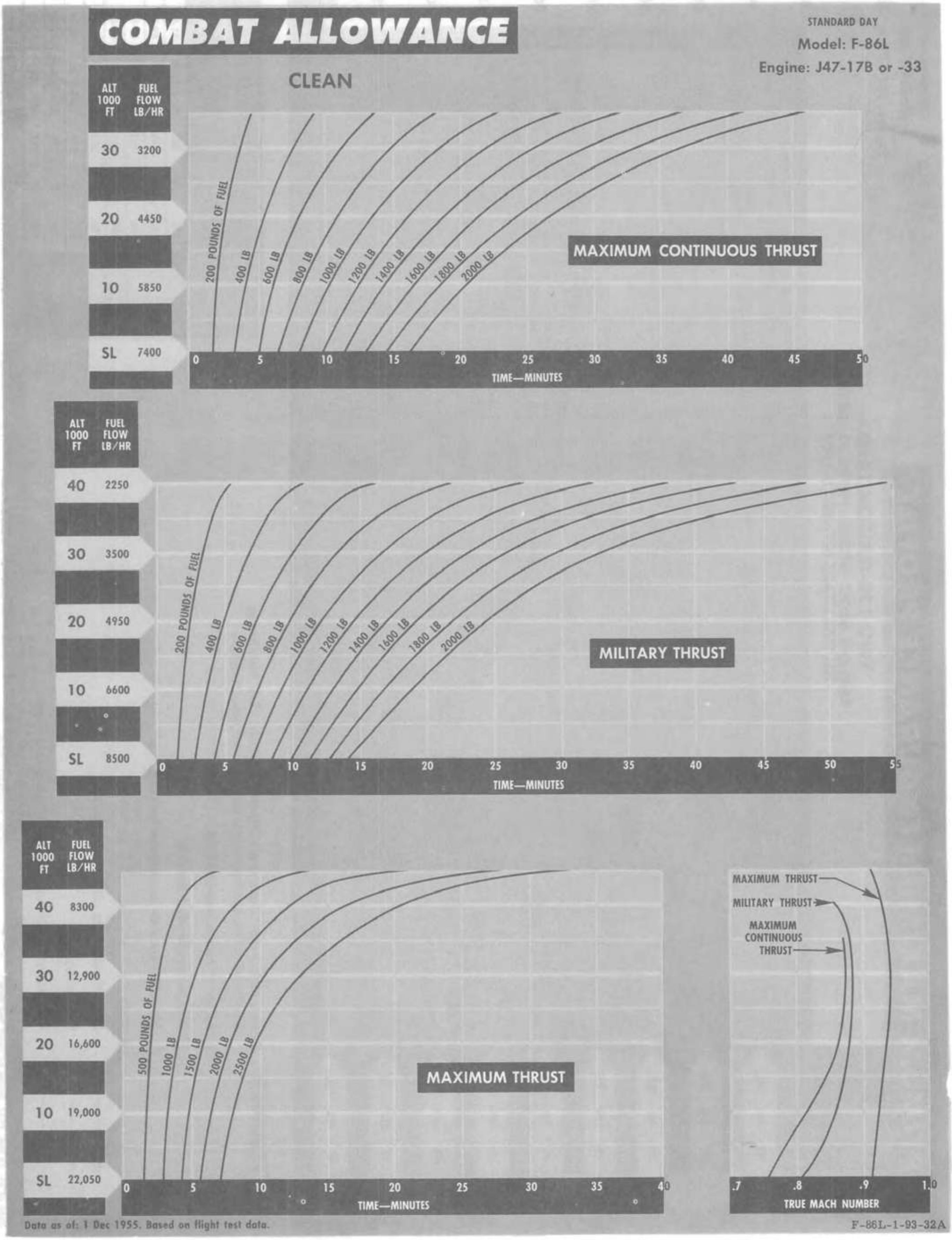

COMBAT ALLOWANCE
STANDARD DAY
Model: F-86L
Engine: J47-17B or -33
CLEAN
ALT 1000 FT
FUEL FLOW LB/HR
30 3200
20 4450
10 5850
SL 7400
200 POUNDS OF FUEL
400 LB
600 LB
800 LB
1000 LB
1200 LB
1400 LB
1600 LB
1800 LB
2000 LB
MAXIMUM CONTINUOUS THRUST
0 5 10 15 20 25 30 35 40 45 50
TIME—MINUTES
ALT 1000 FT
FUEL FLOW LB/HR
40 2250
30 3500
20 4950
10 6600
SL 8500
200 POUNDS OF FUEL
400 LB
600 LB
800 LB
1000 LB
1200 LB
1400 LB
1600 LB
1800 LB
2000 LB
MILITARY THRUST
0 5 10 15 20 25 30 35 40 45 50 55
TIME—MINUTES
ALT 1000 FT
FUEL FLOW LB/HR
40 8300
30 12,900
20 16,600
10 19,000
SL 22,050
500 POUNDS OF FUEL
1000 LB
1500 LB
2000 LB
2500 LB
MAXIMUM THRUST
0 5 10 15 20 25 30 35 40
TIME—MINUTES
MAXIMUM THRUST
MILITARY THRUST
MAXIMUM CONTINUOUS THRUST
.7 .8 .9 1.0
TRUE MACH NUMBER
Data as of: 1 Dec 1955. Based on flight test data.
F-86L-1-93-32A

Figure A-22

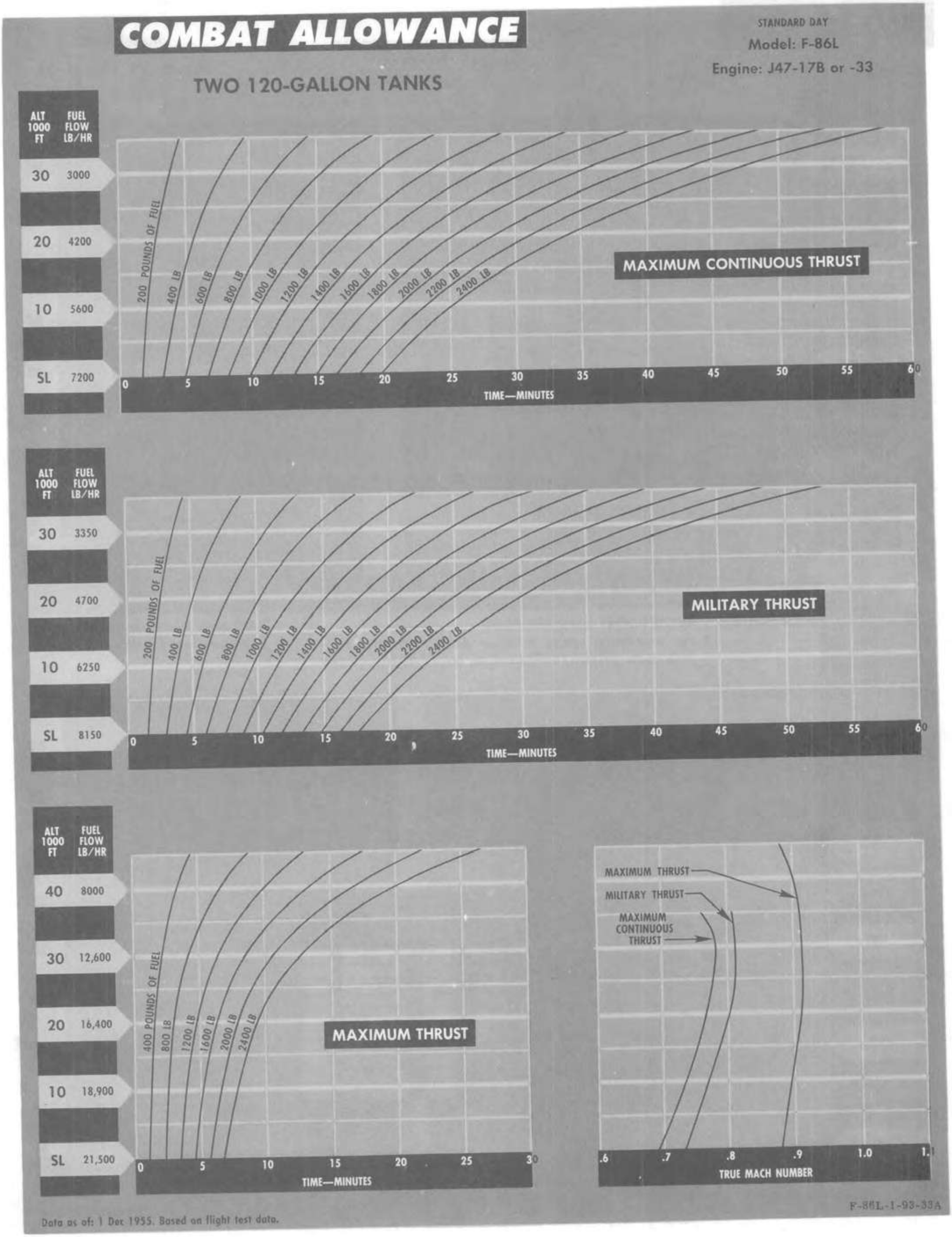

COMBAT ALLOWANCE
TWO 120-GALLON TANKS
STANDARD DAY
Model: F-86L
Engine: J47-17B or -33
ALT 1000 FT
FUEL FLOW LB/HR
30 3000
20 4200
10 5600
SL 7200
200 POUNDS OF FUEL
400 LB
600 LB
800 LB
1000 LB
1200 LB
1400 LB
1600 LB
1800 LB
2000 LB
2200 LB
2400 LB
MAXIMUM CONTINUOUS THRUST
0
5
10
15
20
25
30
35
40
45
50
55
60
TIME—MINUTES
ALT 1000 FT
FUEL FLOW LB/HR
30 3350
20 4700
10 6250
SL 8150
200 POUNDS OF FUEL
400 LB
600 LB
800 LB
1000 LB
1200 LB
1400 LB
1600 LB
1800 LB
2000 LB
2200 LB
2400 LB
MILITARY THRUST
0
5
10
15
20
25
30
35
40
45
50
55
60
TIME—MINUTES
ALT 1000 FT
FUEL FLOW LB/HR
40 8000
30 12,600
20 16,400
10 18,900
SL 21,500
400 POUNDS OF FUEL
800 LB
1200 LB
1600 LB
2000 LB
2400 LB
MAXIMUM THRUST
0
5
10
15
20
25
30
TIME—MINUTES
MAXIMUM THRUST
MILITARY THRUST
MAXIMUM CONTINUOUS THRUST
.6
.7
.8
.9
1.0
1.1
TRUE MACH NUMBER
F-86L-1-93-33A
Data as of: 1 Dec 1955. Based on flight test data.

Figure A-23

DESCENTS

STANDARD DAY

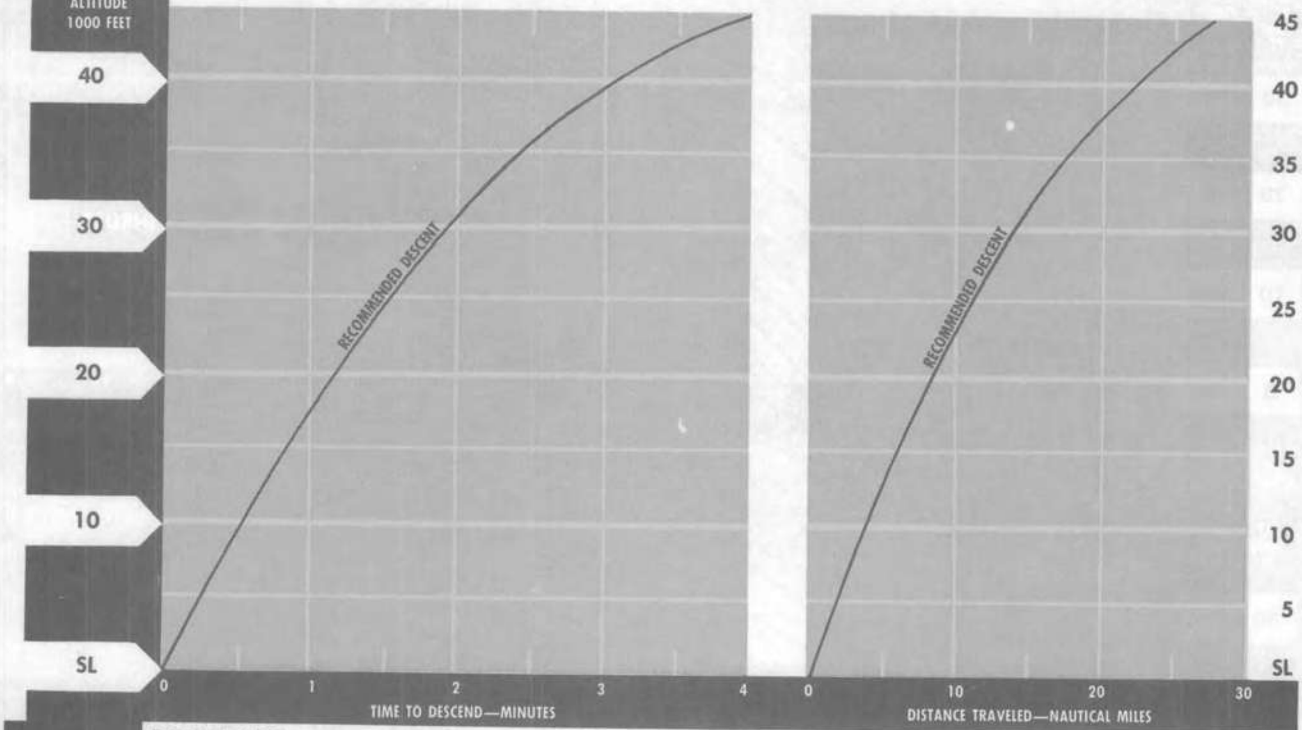
Model: F-86L

Engine: J47-17B, or -33

Data as of: 1 Dec. 1955
Based on FLIGHT TEST

GROSS WEIGHT: 15,000 LB

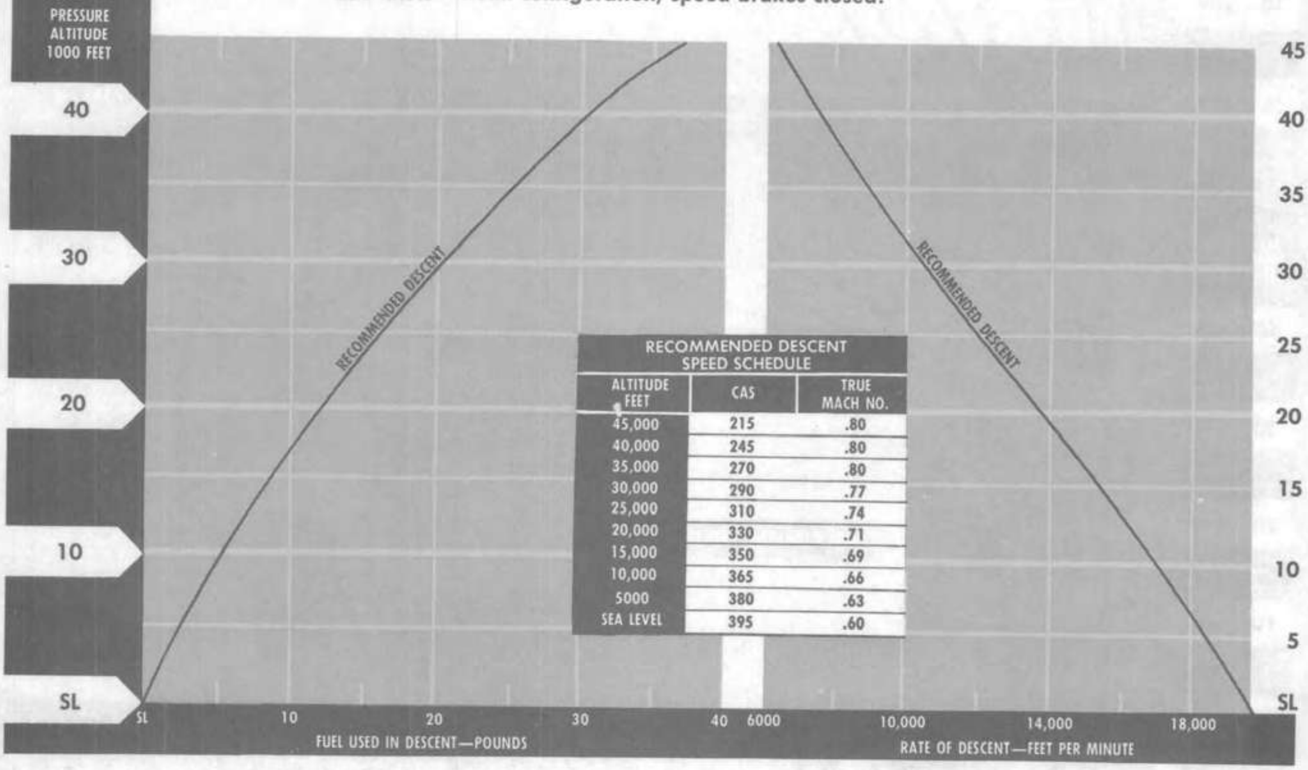
CLEAN



REMARKS: 1. Speed brakes open-Idle Thrust.

2. For maximum range without thrust, descend at 200 knots —clean configuration, speed brakes closed.

3. Observe minimum exhaust gas temperature for descent.



RECOMMENDED DESCENT SPEED SCHEDULE

ALTITUDE FEET	CAS	TRUE MACH NO.
45,000	215	.80
40,000	245	.80
35,000	270	.80
30,000	290	.77
25,000	310	.74
20,000	330	.71
15,000	350	.69
10,000	365	.66
5000	380	.63
SEA LEVEL	395	.60

F-86L-1-93-34B

Figure A-24

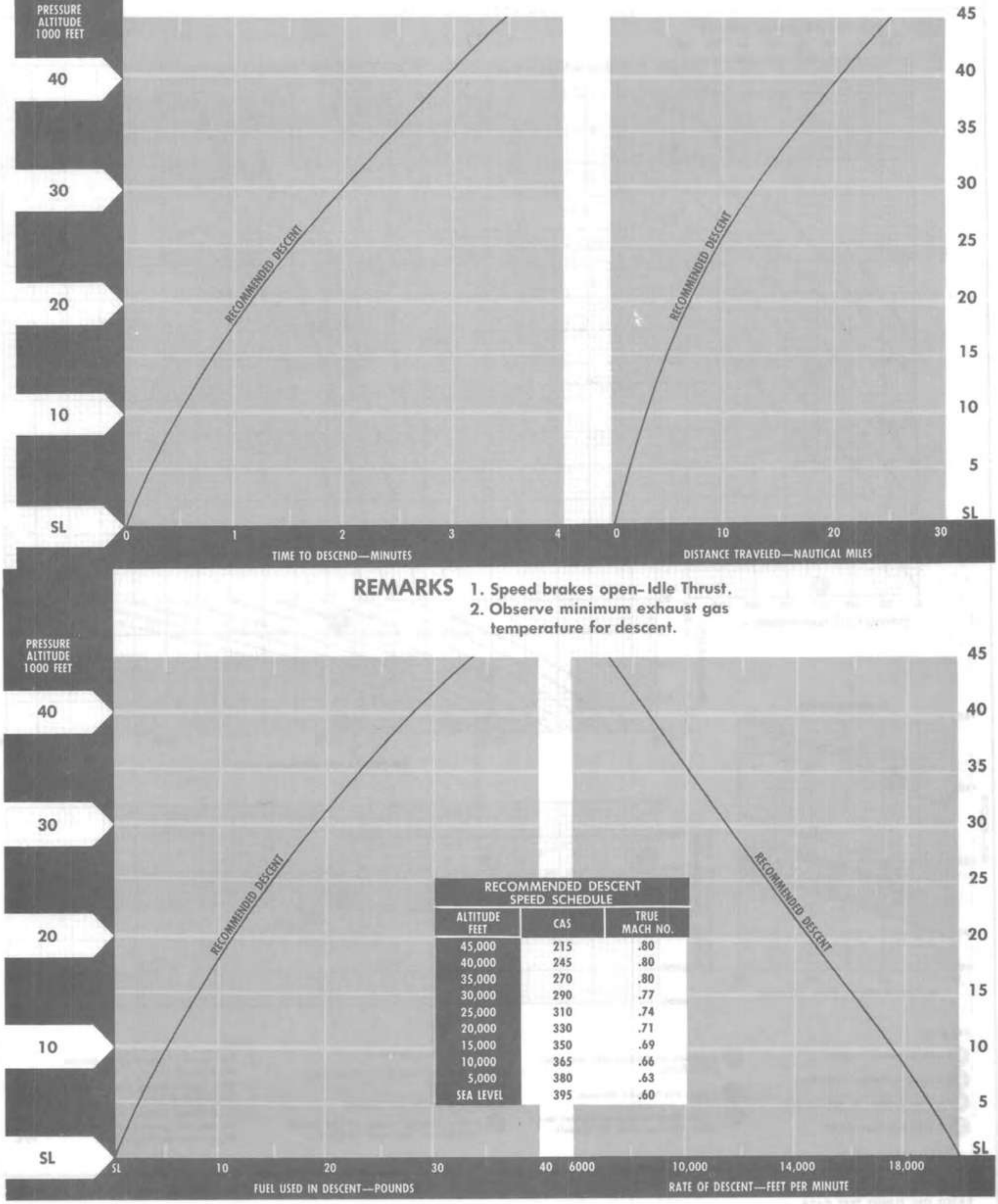
DESCENTS

STANDARD DAY
Model: F-86L
Engine: J47-17B, or -33

Data as of: 1 Dec 1955.
Based on FLIGHT TEST

GROSS WEIGHT: 15,500 LB

TWO 120-GALLON TANKS



REMARKS
1. Speed brakes open- Idle Thrust.
2. Observe minimum exhaust gas temperature for descent.

RECOMMENDED DESCENT SPEED SCHEDULE

ALTITUDE FEET	CAS	TRUE MACH NO.
45,000	215	.80
40,000	245	.80
35,000	270	.80
30,000	290	.77
25,000	310	.74
20,000	330	.71
15,000	350	.69
10,000	365	.66
5,000	380	.63
SEA LEVEL	395	.60

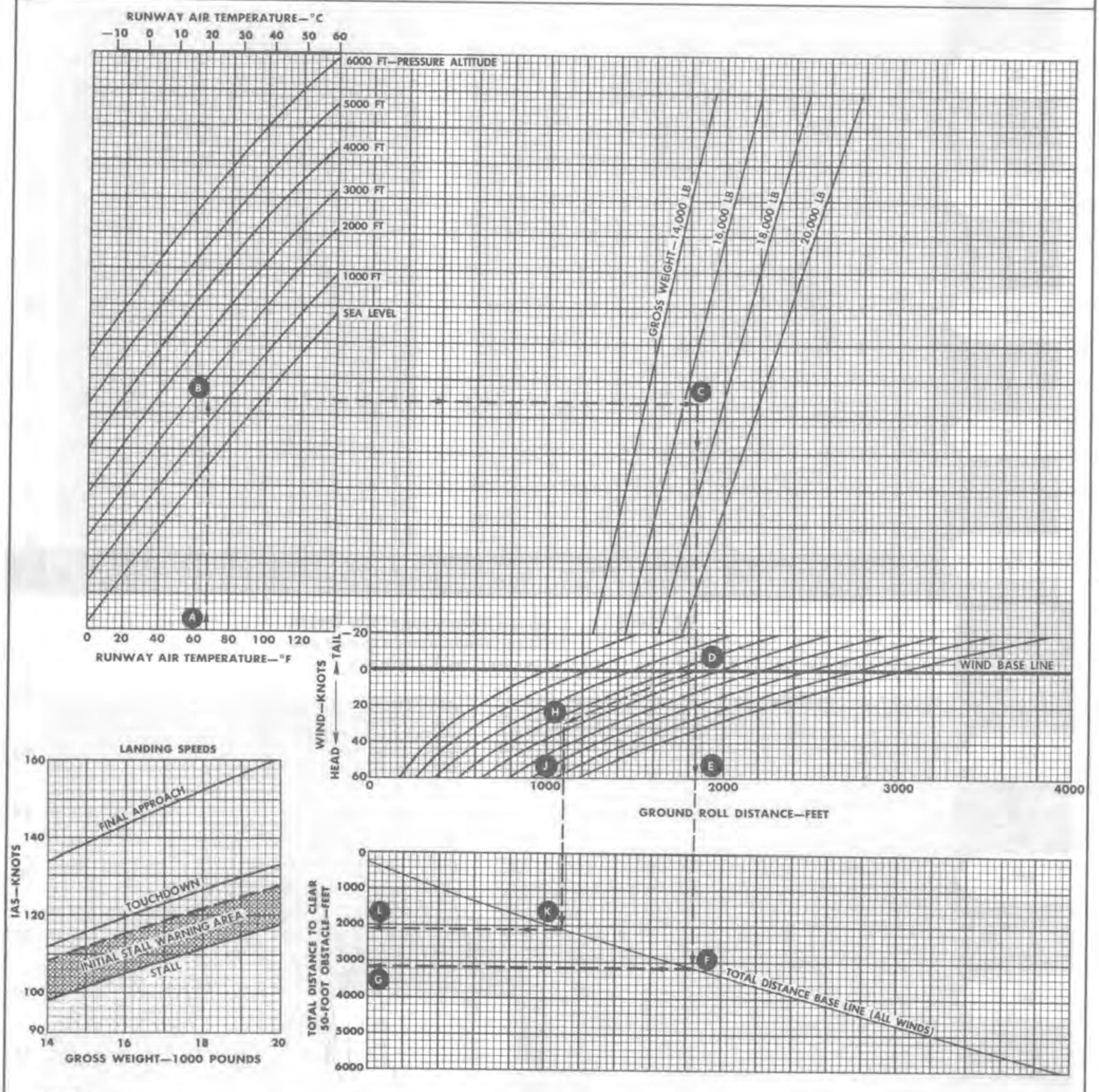
F-86L-1-93-35B

Figure A-25

DRAG CHUTE DEPLOYED
SPEED BRAKES OPEN
FLAPS FULL DOWN

LANDING DISTANCES

HARD-SURFACE RUNWAY
MODEL: F-86L
ENGINE: J47-17B or -33



EXAMPLE:

Ⓐ is air temperature (68° F).
Ⓑ is pressure altitude (1500 feet).
Ⓒ is gross weight (16,600 pounds).
Ⓓ is base line (zero wind).
Ⓔ is ground roll distance with zero wind (1840 feet).
Ⓕ is base line for total distance.
Ⓖ is total distance to clear 50-foot obstacle with zero wind (3150 feet).
Ⓗ is head wind (30 knots).
Ⓙ is ground roll with 30-knot head wind (1090 feet).
Ⓚ is base line for total distance.
Ⓛ is total distance to clear 50-foot obstacle with 30-knot head wind (2100feet).

NOTE:

1. Wet runways may increase ground roll as much as 50%
2. With speed brake closed, increase charted distances 5%
3. For landings without flaps
   (a) Increase ground roll distance 5%
   (b) Increase landing speeds 10%

DATA AS OF: 7 MAY 1957
BASED ON: FLIGHT TEST DATA

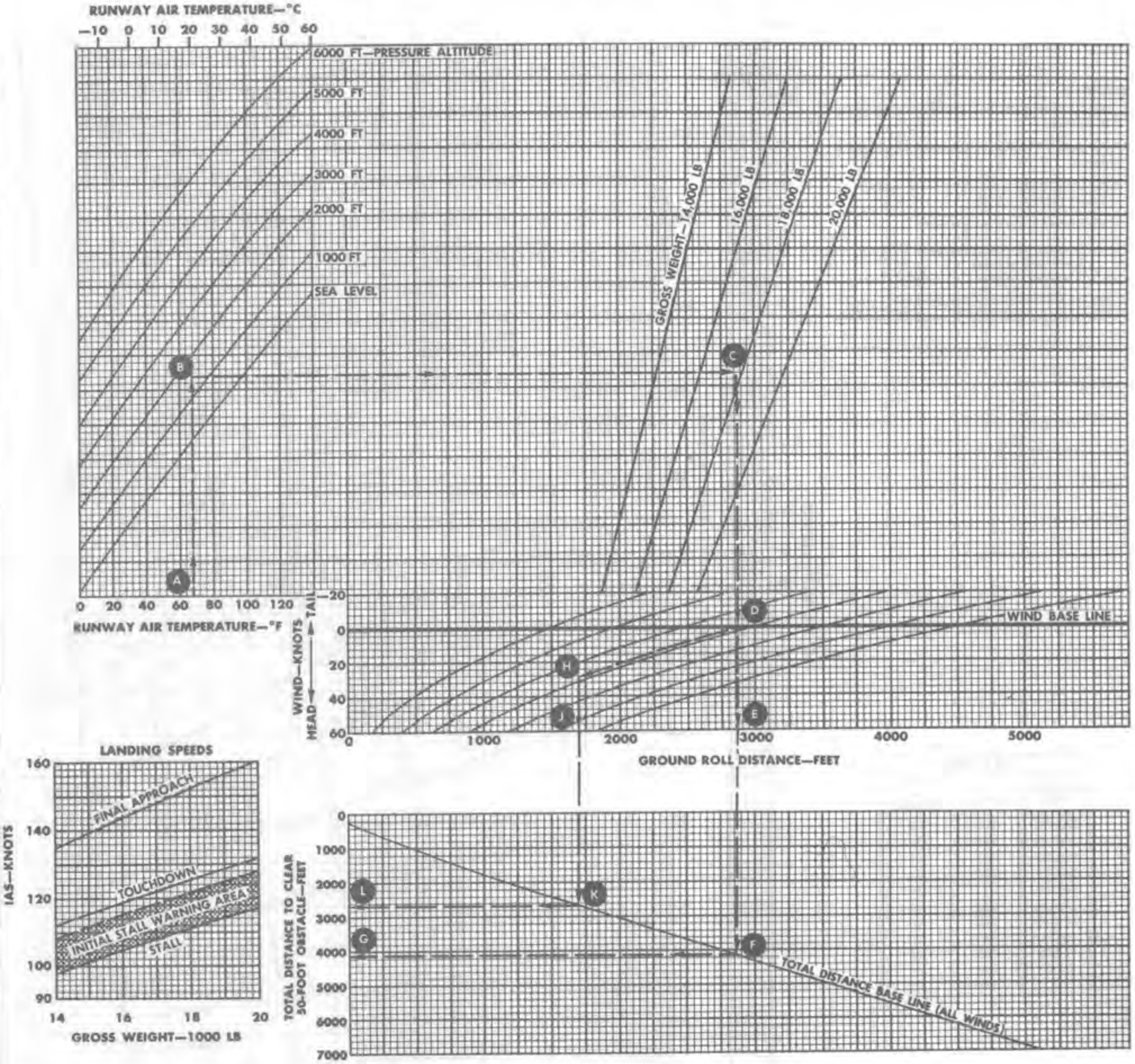
F-86L-1-93-36D

Figure A-26

DRAG CHUTE NOT DEPLOYED
SPEED BRAKES OPEN
FLAPS FULL DOWN

LANDING DISTANCES

HARD-SURFACE RUNWAY
MODEL: F-86L
ENGINE: J47-17B or -33



EXAMPLE:

Ⓐ is air temperature (68°F).

Ⓑ is pressure altitude (1500 feet).

Ⓒ is gross weight (17,600 pounds).

Ⓓ is base line (zero wind).

Ⓔ is ground roll distance with zero wind (2860 feet).

Ⓕ is base line for total distance.

Ⓖ is total distance to clear 50-foot obstacle with zero wind (4150 feet).

Ⓗ is head wind (30 knots).

Ⓙ is ground roll with 30-knot head wind (1700 feet).

Ⓚ is base line for total distance.

Ⓛ is total distance to clear 50-foot obstacle with 30-knot head wind (2700 feet).

NOTE:

1. Wet runways may increase ground roll distance as much as 100%
2. With speed brake closed, increase charted distances 5%
3. For landings without flaps
   (a) Increase ground roll distance 10%
   (b) Increase landing speeds 10%

DATA AS OF: 7 MAY 1957
BASED ON: FLIGHT TEST DATA

F-86L-1-83-37D

Figure A-27

MAXIMUM THRUST CLIMB

CLEAN

STANDARD DAY
MODEL: F-86L
ENGINE: J47-17B or -33

REMARKS:

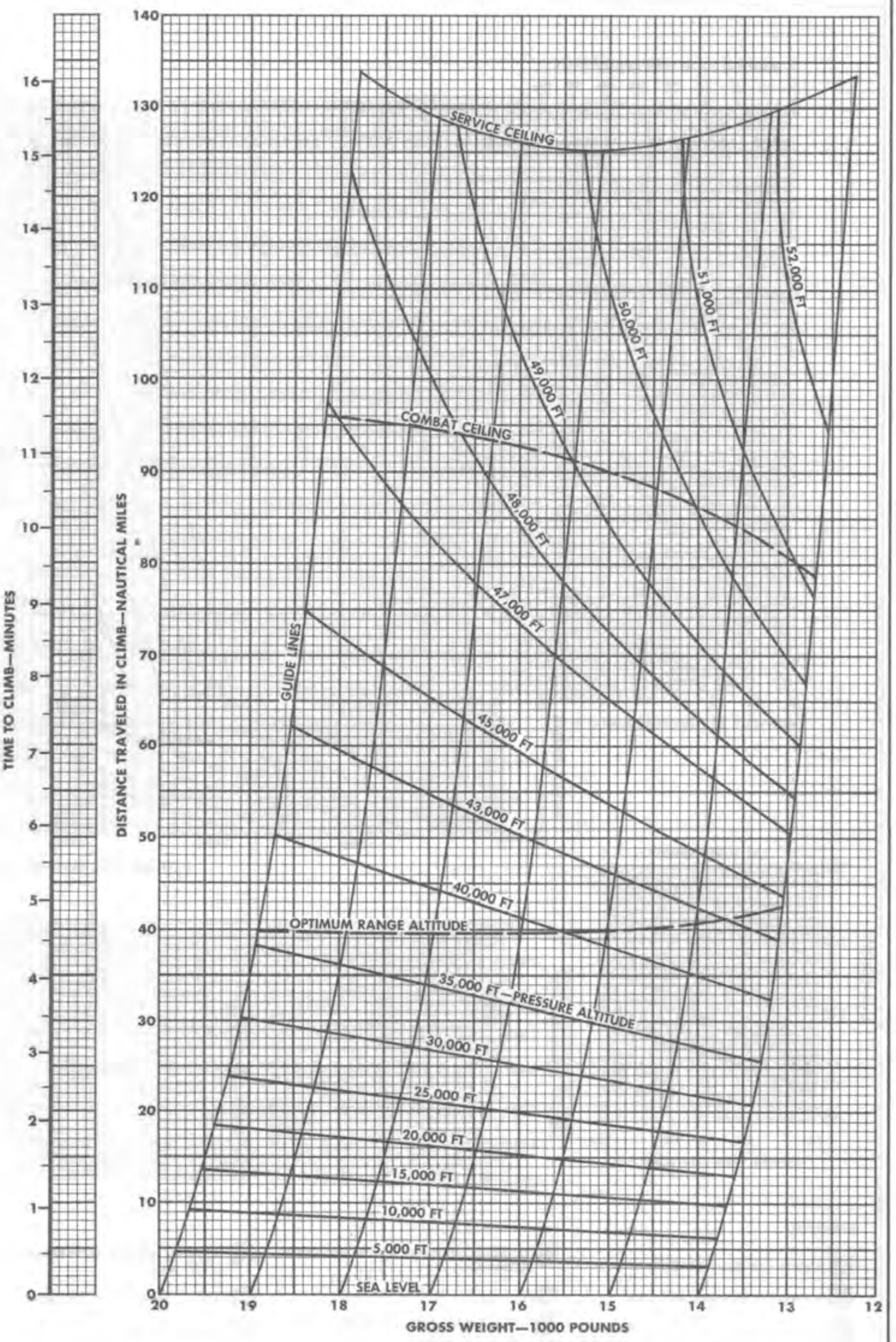
1. All data computed from time best climb speed is attained.
2. For each 10°C above Standard Day temperatures:

   (1) Add 3000 pounds to gross weight before entering chart.

   (2) OR use actual weight and:

   Increase distance and time 40%
   Increase fuel used 25%
   Decrease ceilings 2000 ft
3. For each 10°C below Standard Day temperatures, apply correction in opposite direction.

CLIMB SPEEDS		
ALTITUDE (FEET)	CAS (KNOTS)	TRUE MACH NUMBER
50,000	208	.86
45,000	234	.86
40,000	263	.86
35,000	294	.86
30,000	329	.86
25,000	365	.86
20,000	405	.86
15,000	435	.85
10,000	465	.83
5,000	495	.81
SL	515	.78



DATA AS OF: 1 DEC 1955
BASED ON FLIGHT TEST DATA

F-86L-1-93-38

Figure A-28

MILITARY THRUST CLIMB

CLEAN

STANDARD DAY
MODEL: F-86L
ENGINE: J47-17B, or -33

EXAMPLE:

Ⓐ is initial gross weight (17,500 pounds).

Ⓑ is final pressure altitude (30,000 feet).

Ⓒ is final gross weight (16,500 pounds).

Ⓐ minus Ⓒ is fuel to climb (1000 pounds).

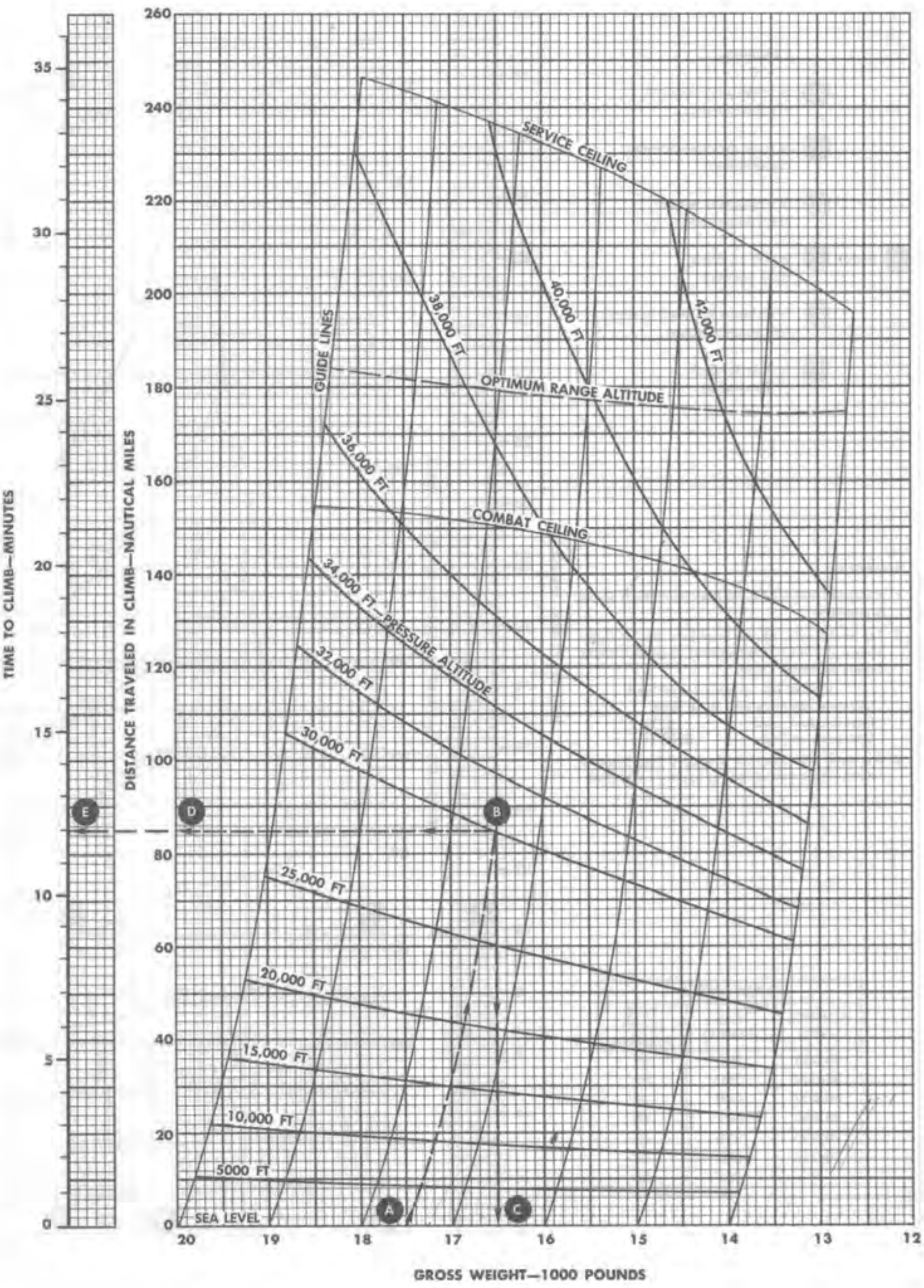
Ⓓ is distance traveled in climb (85 nautical miles).

Ⓔ is time to climb (12 minutes).

REMARKS:

1. All data computed from time best climb speed is attained.
2. For each 10°C above Standard Day temperatures: (1) Add 3000 pounds to gross weight before entering chart.
   (2) OR use actual weight and:
   Increase distance and time 40%
   Increase fuel used 25%
   Decrease ceilings 2000 ft
3. For each 10°C below Standard Day temperatures, apply corrections in opposite directions.

CLIMB SPEEDS		
ALTITUDE (FEET)	CAS (KNOTS)	TRUE MACH NUMBER
45,000	205	.79
40,000	230	.77
35,000	255	.75
30,000	275	.73
20,000	315	.68
10,000	355	.64
SL	385	.58



DATA AS OF: 1 DEC 1955
BASED ON FLIGHT TEST DATA

F-86L-1-93-40A

Figure A-29

MAXIMUM CONTINUOUS THRUST CLIMB

CLEAN

STANDARD DAY
MODEL: F-86L
ENGINE: J47-17B or -33

EXAMPLE:

Ⓐ is initial gross weight (17,500 pounds).

Ⓑ is final pressure altitude (25,000 feet).

Ⓒ is final gross weight (16,700 pounds).

Ⓐ minus Ⓒ is fuel to climb (800 pounds).

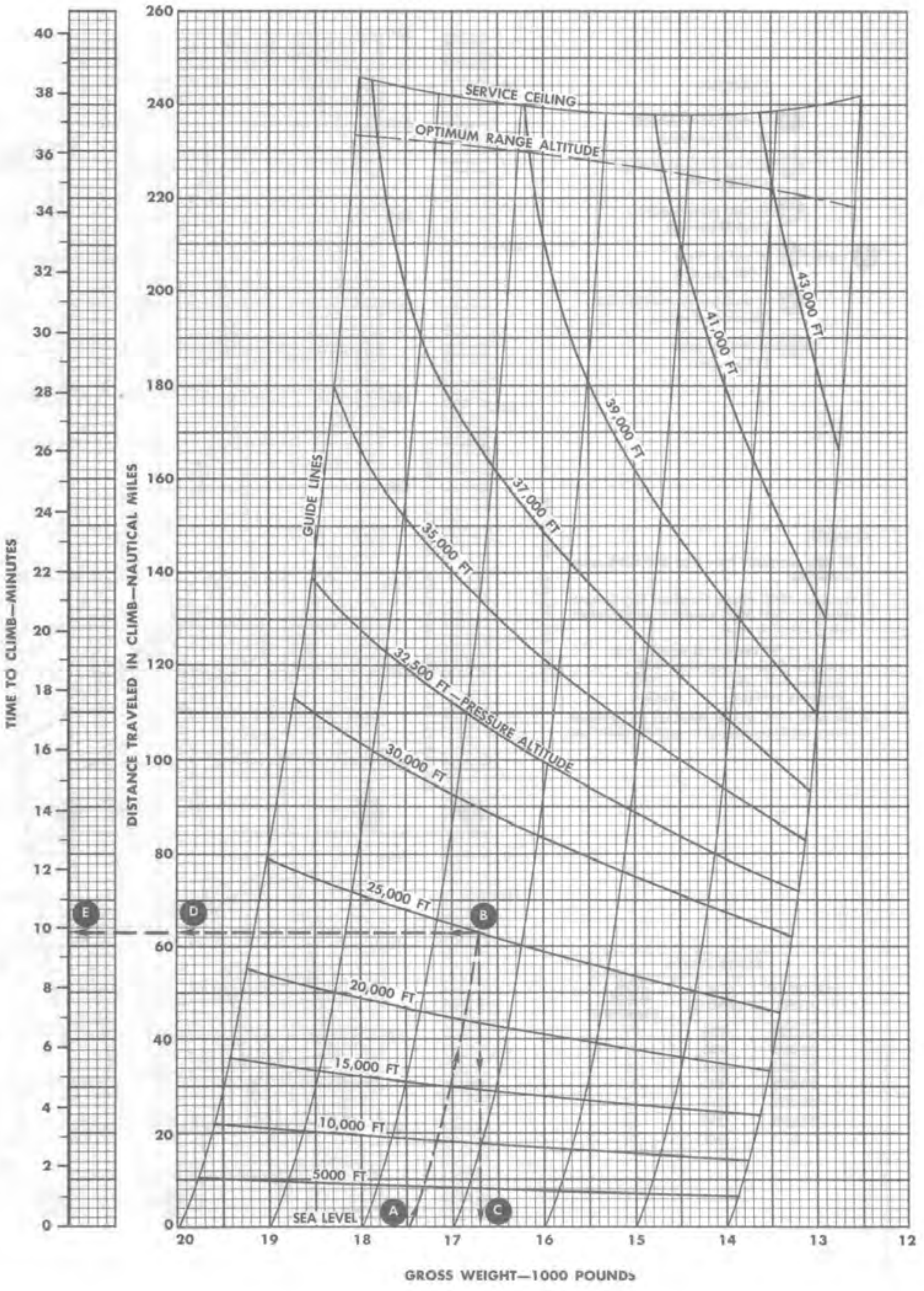
Ⓓ is distance traveled in climb (63 nautical miles).

Ⓔ is time to climb (9.8 minutes).

REMARKS:

1. All data computed from time best climb speed is attained.
2. For each 10°C above Standard Day temperatures: (1) Add 3000 pounds to gross weight before entering chart.
   (2) OR use actual weight and:
   Increase distance and time 40%
   Increase fuel used 25%
   Decrease ceilings 2000 ft
3. For each 10°C below Standard Day temperatures, apply corrections in opposite direction

CLIMB SPEEDS		
ALTITUDE (FEET)	CAS (KNOTS)	TRUE MACH NUMBER
40,000	205	.69
35,000	230	.69
30,000	250	.67
25,000	269	.65
20,000	286	.62
10,000	319	.58
SL	331	.50



DATA AS OF: 1 DEC 1955
BASED ON FLIGHT TEST DATA

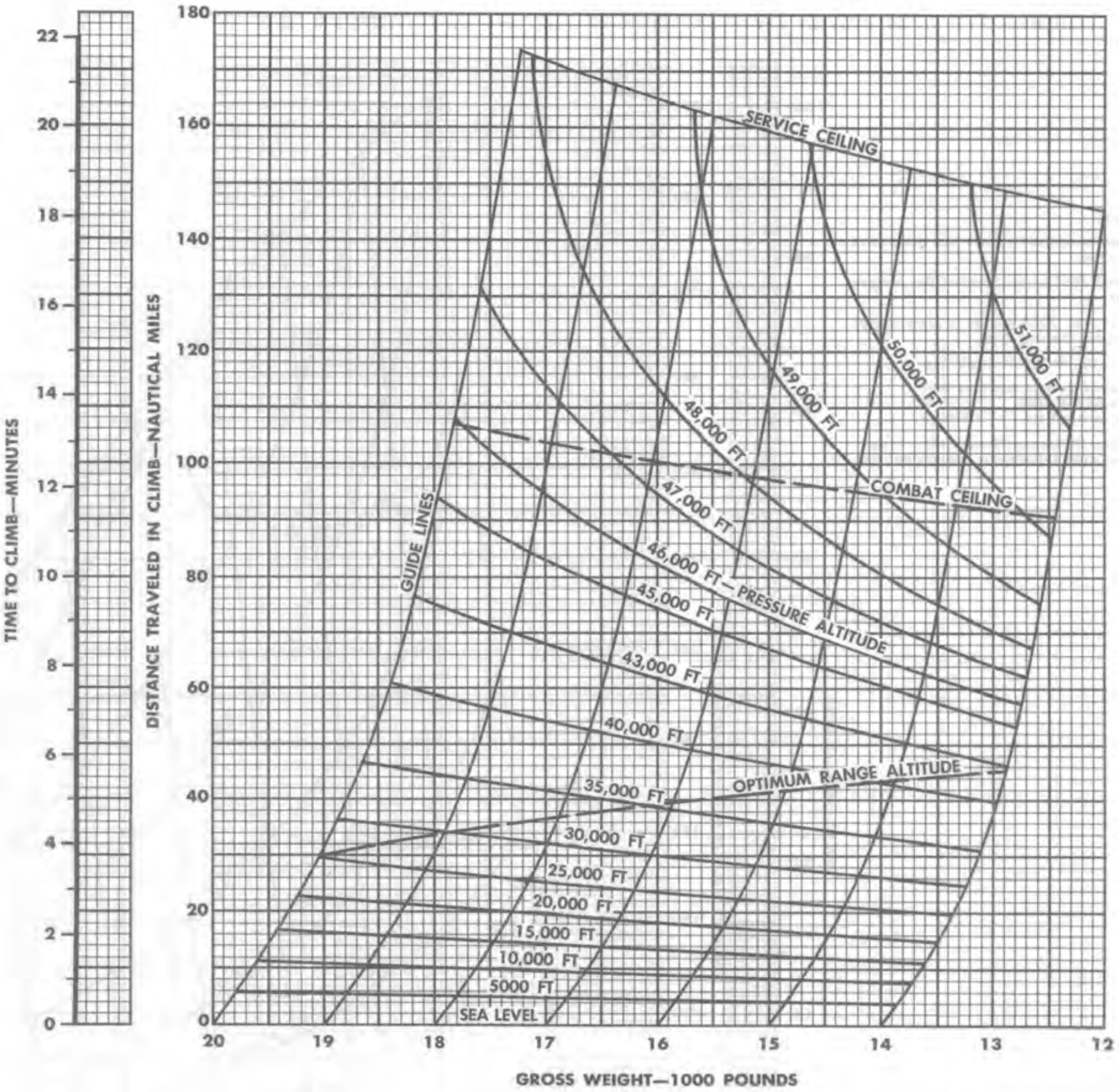
F-86L-1-93-41

Figure A-30

MAXIMUM THRUST CLIMB

TWO 120-GALLON TANKS

STANDARD DAY
MODEL: F-86L
ENGINE: J47-17B or -33



REMARKS:

1. All data computed from time best climb speed is attained.
2. For each 10°C above Standard Day temperatures:

   (1) Add 3000 pounds to gross weight before entering chart.

   (2) OR use actual weight and:

   Increase distance and time 40%
   Increase fuel used 25%
   Decrease ceilings 2000 ft
3. For each 10°C below Standard Day temperatures, apply correction in opposite direction.

CLIMB SPEEDS		
ALTITUDE (FEET)	CAS (KNOTS)	TRUE MACH NUMBER
50,000	200	.83
45,000	225	.83
40,000	252	.83
35,000	283	.83
30,000	312	.82
25,000	343	.81
20,000	373	.80
15,000	405	.79
10,000	436	.78
5000	461	.76
SL	482	.73

DATA AS OF: 1 DEC 1955
BASED ON FLIGHT TEST DATA

F-86L-1-93-42

Figure A-31

MILITARY THRUST CLIMB

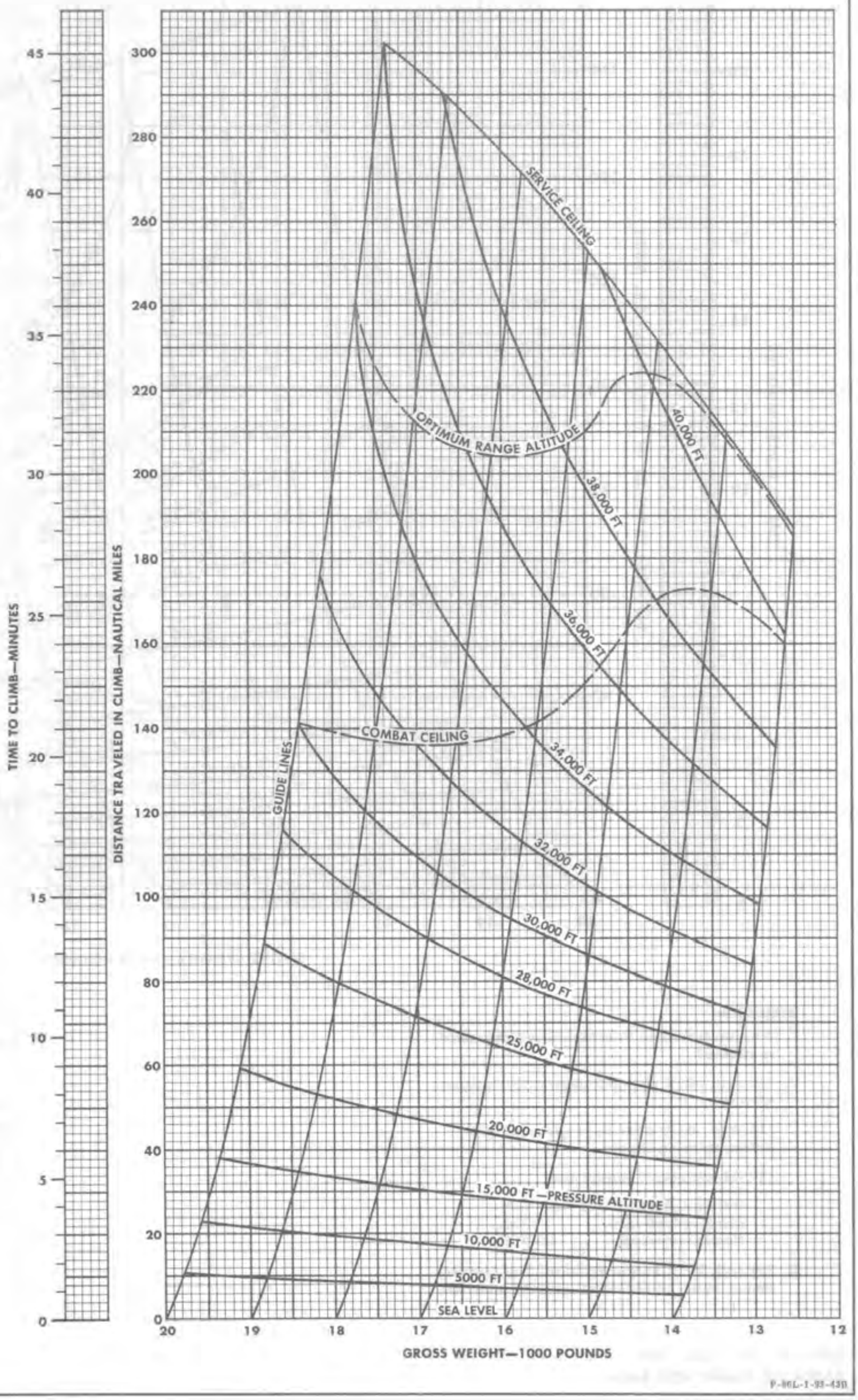
TWO 120-GALLON TANKS

STANDARD DAY
MODEL: F-86L
ENGINE: J47-17B or -33

REMARKS:

1. All data computed from time best climb speed is attained.
2. For each 10°C above Standard Day temperatures:
   - (1) Add 3000 pounds to gross weight before entering chart.
   - (2) OR use actual weight and:

     Increase distance and time 40%
     Increase fuel used 25%
     Decrease ceilings 2000 ft
3. For each 10°C below Standard Day temperatures, apply correction in opposite direction.



CLIMB SPEEDS

ALTITUDE (FEET)	CAS (KNOTS)	TRUE MACH NUMBER
40,000	229	.76
35,000	251	.74
30,000	267	.71
25,000	282	.68
20,000	297	.65
10,000	327	.59
SL	344	.53

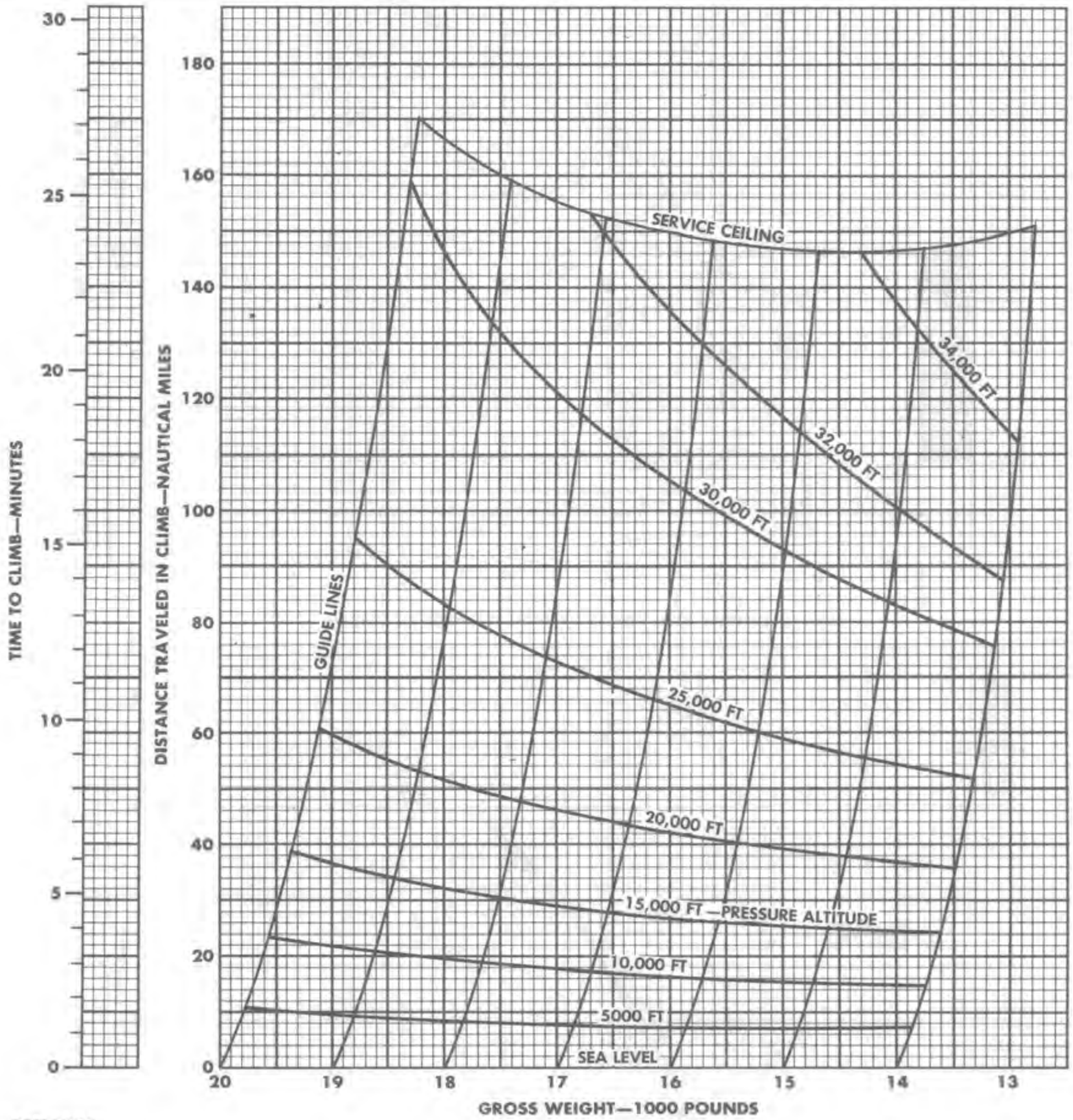
DATA AS OF: 25 DEC. 1957
BASED ON: FLIGHT TEST DATA

Figure A-32

MAXIMUM CONTINUOUS THRUST CLIMB

TWO 120-GALLON TANKS

STANDARD DAY
MODEL: F-86L
ENGINE: J47-17B or -33



REMARKS:

1. All data computed from time best climb speed is attained.
2. For each 10°C above Standard Day temperatures:
   (1) Add 3000 pounds to gross weight before entering chart.
   (2) OR use actual weight and:
   Increase distance and time 40%
   Increase fuel used 25%
   Decrease ceilings 2000 ft
3. For each 10°C below Standard Day temperatures, apply correction in opposite direction.

CLIMB SPEEDS		
ALTITUDE (FEET)	CAS (KNOTS)	TRUE MACH NUMBER
37,500	249	.78
35,000	254	.75
30,000	263	.70
25,000	273	.65
20,000	282	.61
10,000	300	.54
SL	311	.47

DATA AS OF: 25 DEC. 1957
BASED ON: FLIGHT TEST DATA

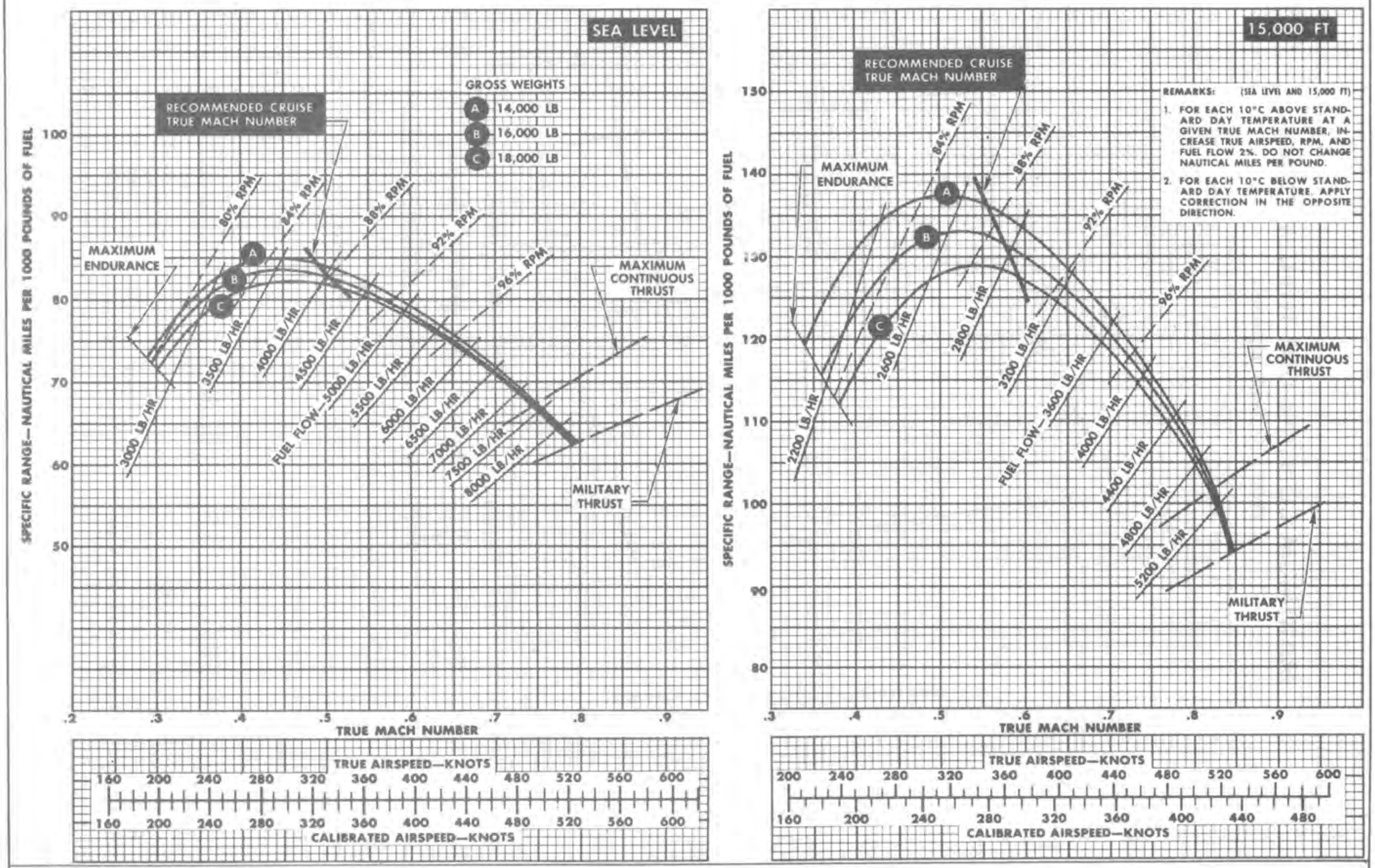
F-86L-1-93-44A

Figure A-33

NAUTICAL MILES PER POUND OF FUEL

CLEAN

STANDARD DAY
MODEL: F-86L
ENGINE: J47-17B or -33



REMARKS: (SEA LEVEL AND 15,000 FT)

1. FOR EACH 10°C ABOVE STANDARD DAY TEMPERATURE AT A GIVEN TRUE MACH NUMBER, INCREASE TRUE AIRSPEED, RPM, AND FUEL FLOW 2%. DO NOT CHANGE NAUTICAL MILES PER POUND.
2. FOR EACH 10°C BELOW STANDARD DAY TEMPERATURE, APPLY CORRECTION IN THE OPPOSITE DIRECTION.

DATA AS OF: 1 DEC 1955
BASED ON FLIGHT TEST DATA

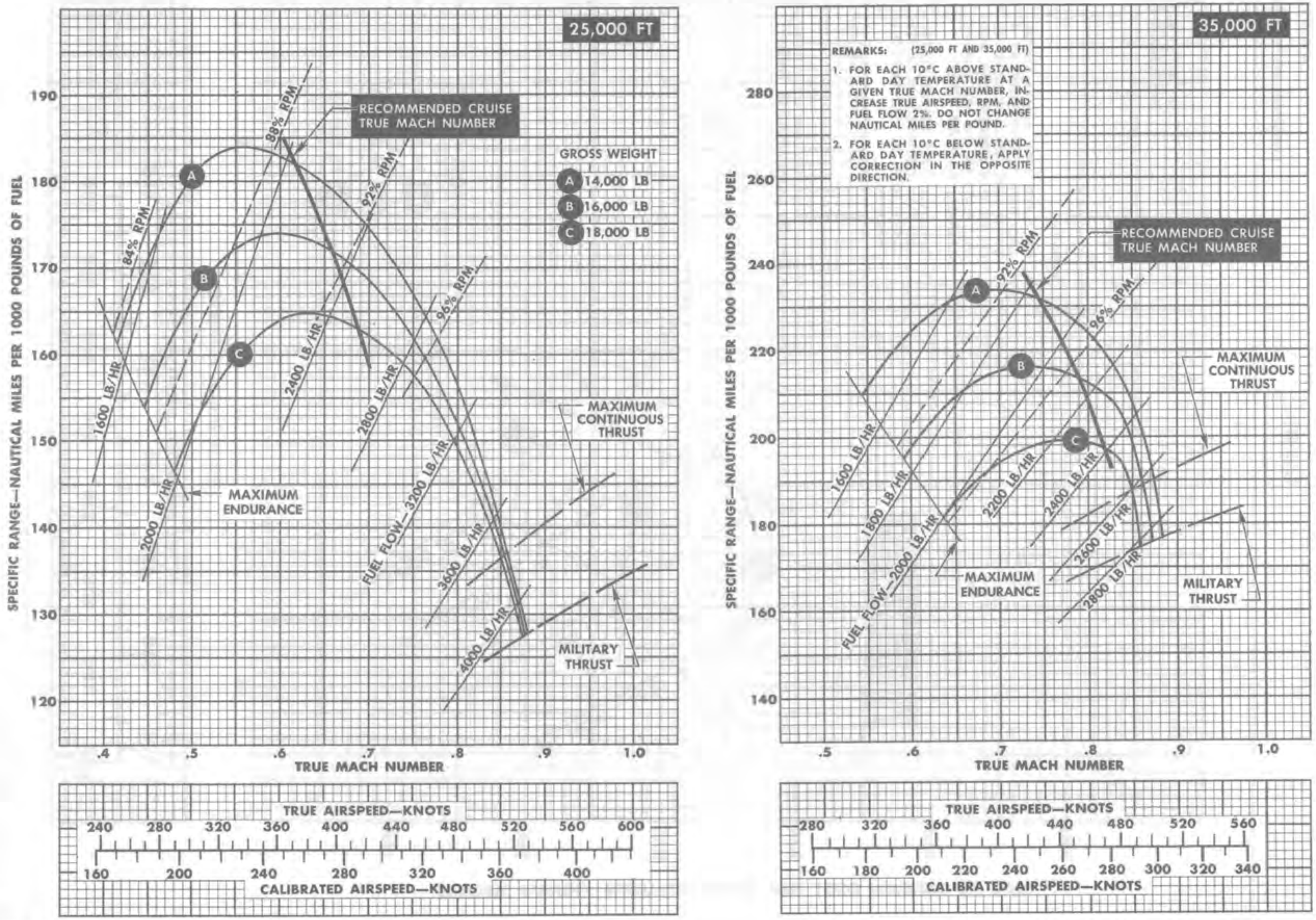
F-86L-1-93-46

Figure A-34

NAUTICAL MILES PER POUND OF FUEL

CLEAN

STANDARD DAY
MODEL: F-86L
ENGINE: J47-17B or -33



REMARKS: (25,000 FT AND 35,000 FT)

1. FOR EACH 10°C ABOVE STANDARD DAY TEMPERATURE AT A GIVEN TRUE MACH NUMBER, INCREASE TRUE AIRSPEED, RPM, AND FUEL FLOW 2%. DO NOT CHANGE NAUTICAL MILES PER POUND.
2. FOR EACH 10°C BELOW STANDARD DAY TEMPERATURE, APPLY CORRECTION IN THE OPPOSITE DIRECTION.

DATA AS OF: 1 DEC 1955
BASED ON FLIGHT TEST DATA

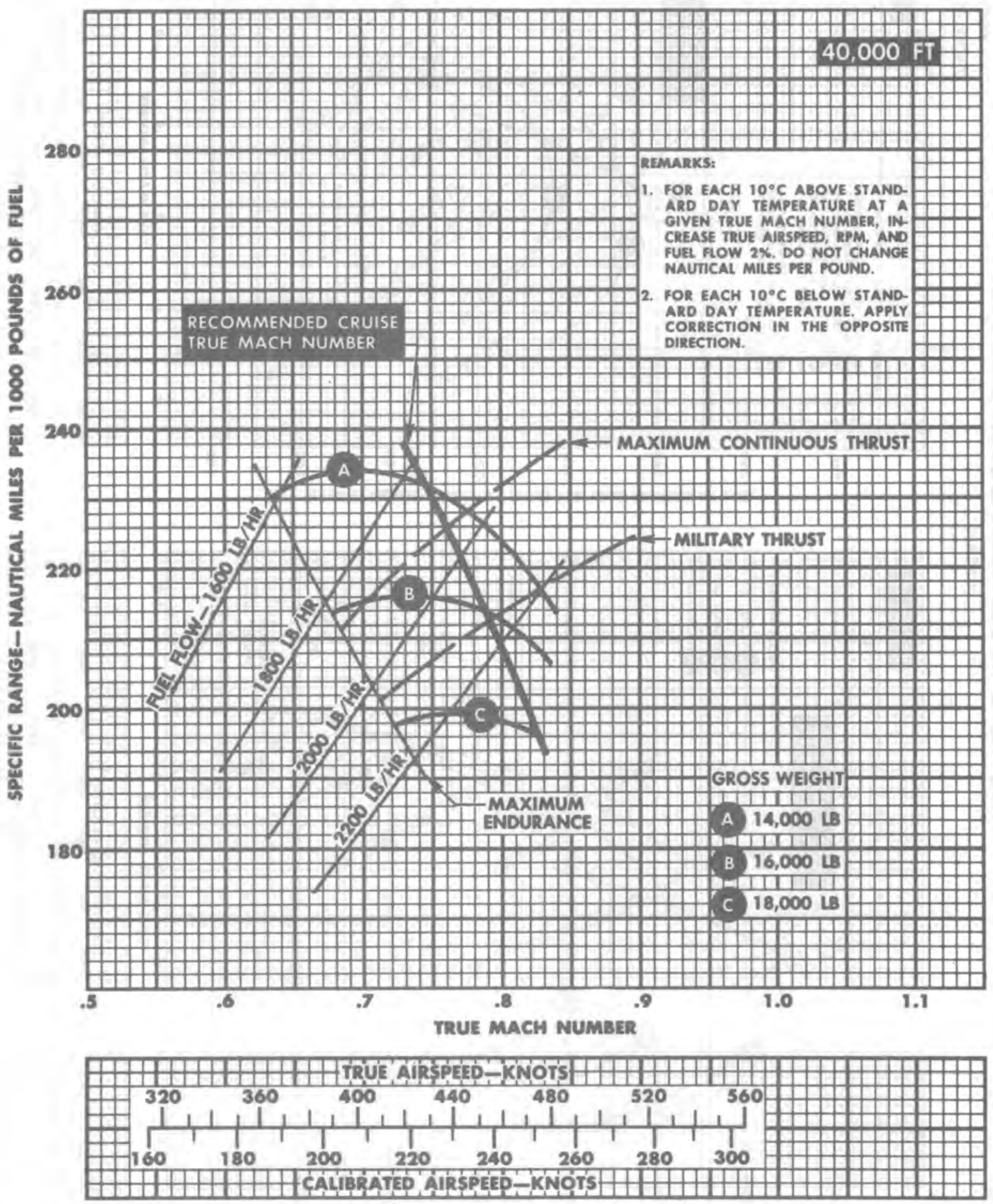
F-86L-1-93-46

Figure A-35

NAUTICAL MILES PER POUND OF FUEL

CLEAN

STANDARD DAY
MODEL: F-86L
ENGINE: J47-17B or -33



REMARKS:

1. FOR EACH 10°C ABOVE STANDARD DAY TEMPERATURE AT A GIVEN TRUE MACH NUMBER, INCREASE TRUE AIRSPEED, RPM, AND FUEL FLOW 2%. DO NOT CHANGE NAUTICAL MILES PER POUND.
2. FOR EACH 10°C BELOW STANDARD DAY TEMPERATURE. APPLY CORRECTION IN THE OPPOSITE DIRECTION.

DATA AS OF: 1 DEC 1955
BASED ON FLIGHT TEST DATA

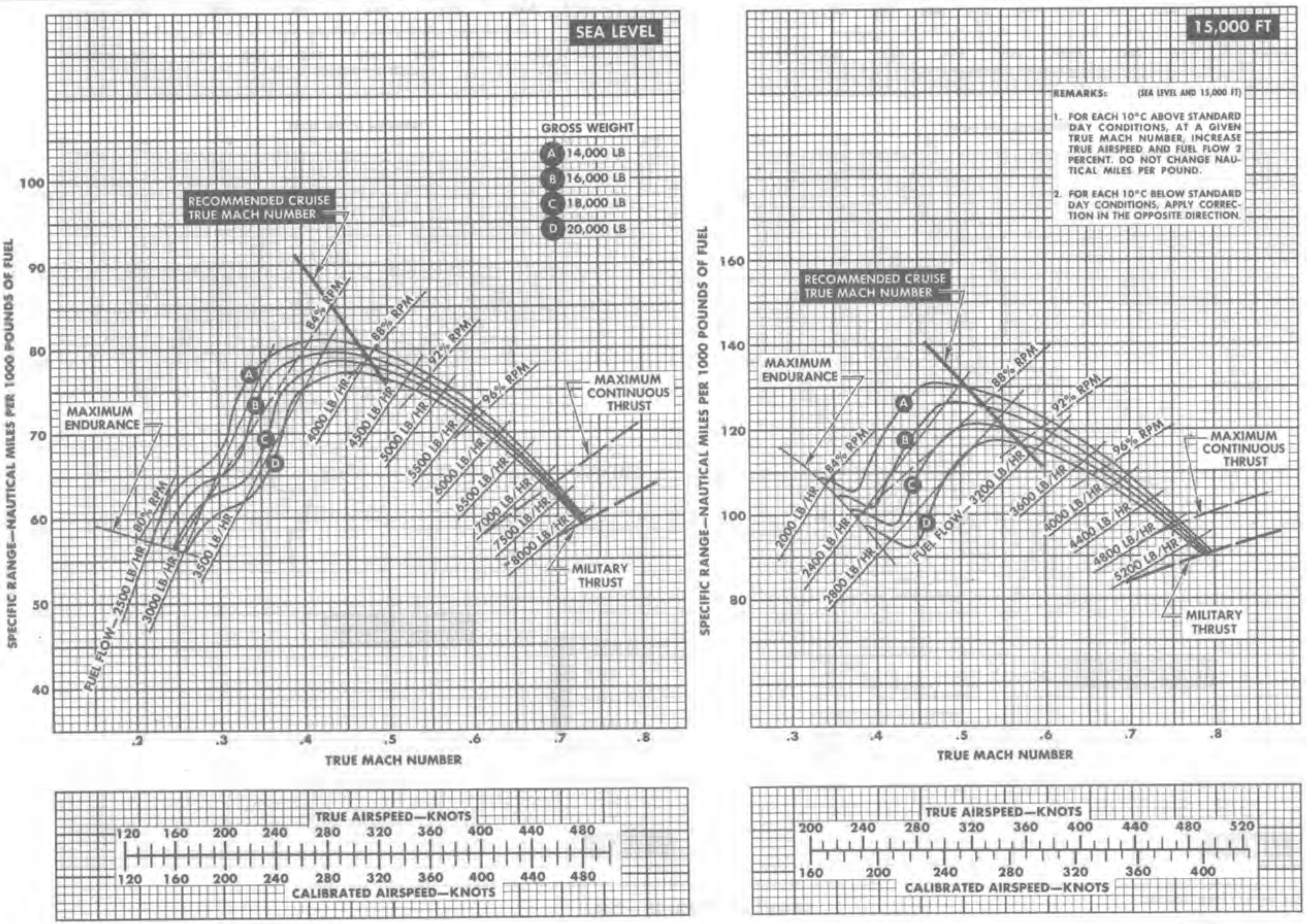
F-86L-1-93-47

Figure A-36

NAUTICAL MILES PER POUND OF FUEL

TWO 120-GALLON TANKS

STANDARD DAY
MODEL: F-86L
ENGINE: J47-17B or -33



REMARKS: (SEA LEVEL AND 15,000 FT)

1. FOR EACH 10°C ABOVE STANDARD DAY CONDITIONS, AT A GIVEN TRUE MACH NUMBER, INCREASE TRUE AIRSPEED AND FUEL FLOW 2 PERCENT. DO NOT CHANGE NAUTICAL MILES PER POUND.
2. FOR EACH 10°C BELOW STANDARD DAY CONDITIONS, APPLY CORRECTION IN THE OPPOSITE DIRECTION.

DATA AS OF: 25 DEC. 1957
BASED ON: FLIGHT TEST DATA

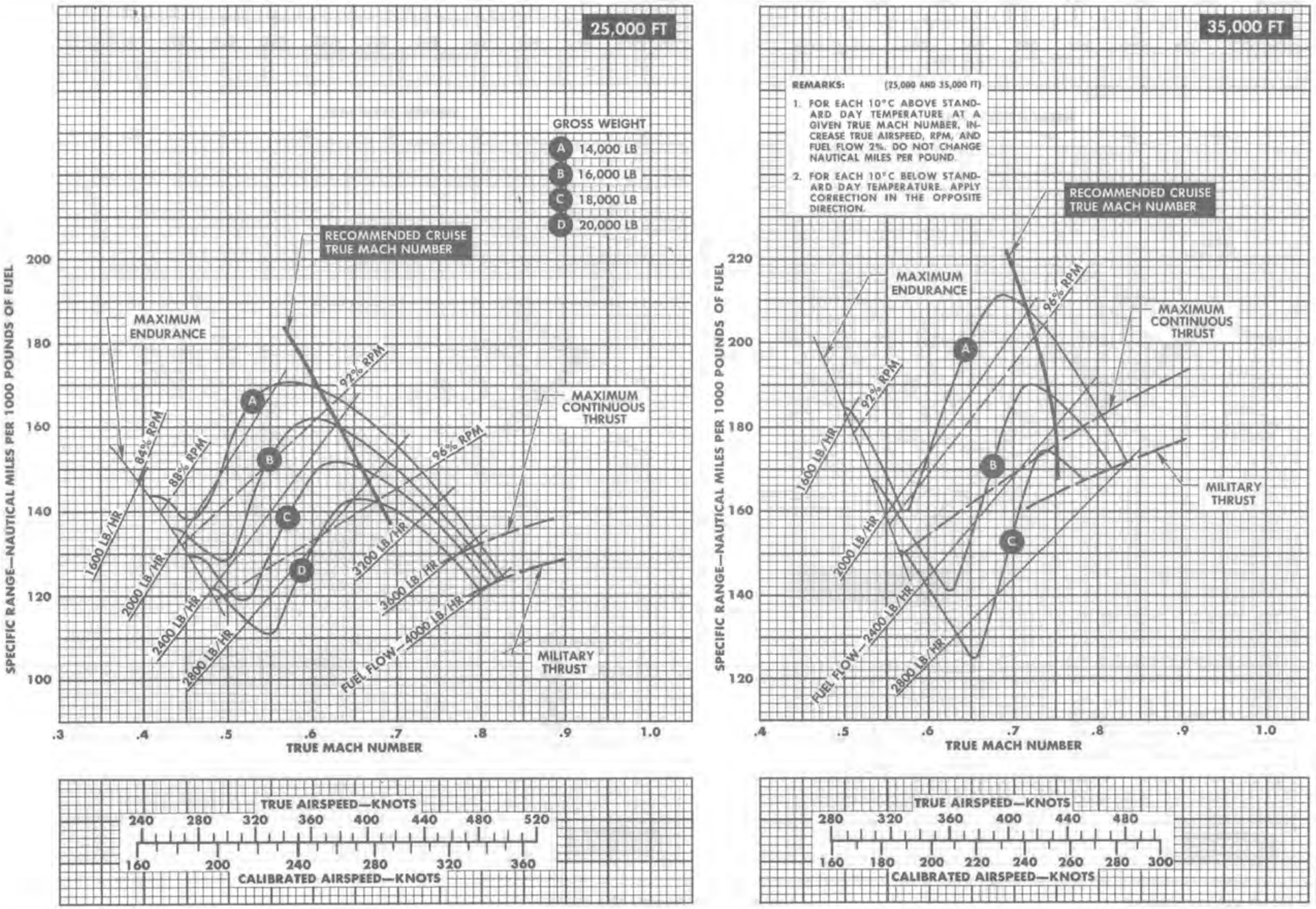
F-86L-1-93-48A

Figure A-37

NAUTICAL MILES PER POUND OF FUEL

TWO 120-GALLON TANKS

STANDARD DAY
MODEL: F-86L
ENGINE: J47-17B or -33



REMARKS: (25,000 AND 35,000 FT)

1. FOR EACH 10°C ABOVE STANDARD DAY TEMPERATURE AT A GIVEN TRUE MACH NUMBER, INCREASE TRUE AIRSPEED, RPM, AND FUEL FLOW 2%. DO NOT CHANGE NAUTICAL MILES PER POUND.
2. FOR EACH 10°C BELOW STANDARD DAY TEMPERATURE. APPLY CORRECTION IN THE OPPOSITE DIRECTION.

DATA AS OF: 25 DEC. 1957
BASED ON: FLIGHT TEST DATA

F-86L-1-93-49A

Figure A-38

Alphabetical Index

F-86L-1-00-40

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PAGE NUMBERS IN BOLDFACE DENOTE ILLUSTRATIONS

PAGE NUMBERS IN BOLDFACE DENOTE ILLUSTRATIONS

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