FLIGHT MANUAL

USAF SERIES

F-86K

AIRCRAFT

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

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This change replaces Safety of Flight Supplements (SF) 1-1 and 1-2. (The change dated 26 August 1960 replaced -1CU through -1CX.) See Basic Index, T.O. 0-1-1, and Weekly Index, T.O. 0-1-1A, for current status of Safety of Flight Supplements.

This publication is incomplete without Confidential Supplement T.O. 1F-86K-1A.

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30 JUNE 1958

CHANGED 30 DECEMBER 1960

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CURRENT FLIGHT CREW CHECK LIST
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DATED 30 DECEMBER 1960

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For listing of available material and details of distribution see Naval Aeronautics Publications Index NavAer 00-500.

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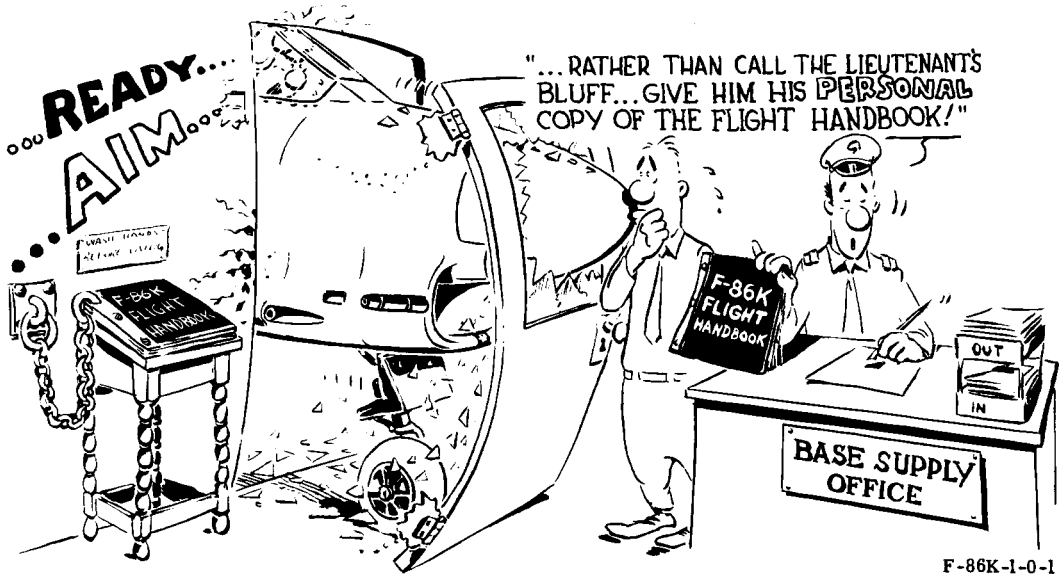


The intent of Air Force Regulation 5-13, dated 11 August 1953, is to entitle each pilot to his own copy of the Flight Handbook.

SCOPE. This manual contains all the information necessary for safe and efficient operation of the F-86K Airplane. These instructions do not teach basic flight principles, but are designed to provide you with a general knowledge of the airplane, its flight characteristics, and specific normal and emergency operating procedures. Your flying experience is recognized, and elementary instructions have been avoided.

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

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

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

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

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

TABS AND BINDERS. Flexible, loose-leaf tabs and binders have been provided to hold your personal copy of the Flight Manual. These good-looking, simulated-leather binders will make it much easier for you to revise your handbook as well as to keep it in good shape. These tabs and binders are secured through your local contracting officer.

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

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

Check Lists. The check lists previously included at the back of Sections II and III have been issued as a separate cardboard Technical Order. For the T.O. number and date of the check list applicable to this manual, refer to the "A" page under "Current Flight Check List." Procedures in this Flight Manual and its check list T.O. are identical with respect to arrangement of flight phases and step numbers. Order your cardboard check list T.O. as you would any Technical Order. The cardboard check list is designed for use with binders having plastic envelopes into which the cards are placed. These binders may be obtained through normal Air Force supply channels. Nomenclatures and stock numbers for the binders, with varying amounts of envelopes, are: Binder, USAF Flight Crew Check List, 15 envelopes—7510-766-4268; 25 envelopes, -4269; and 40 envelopes, -4270.

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

WARNING

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

CAUTION

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

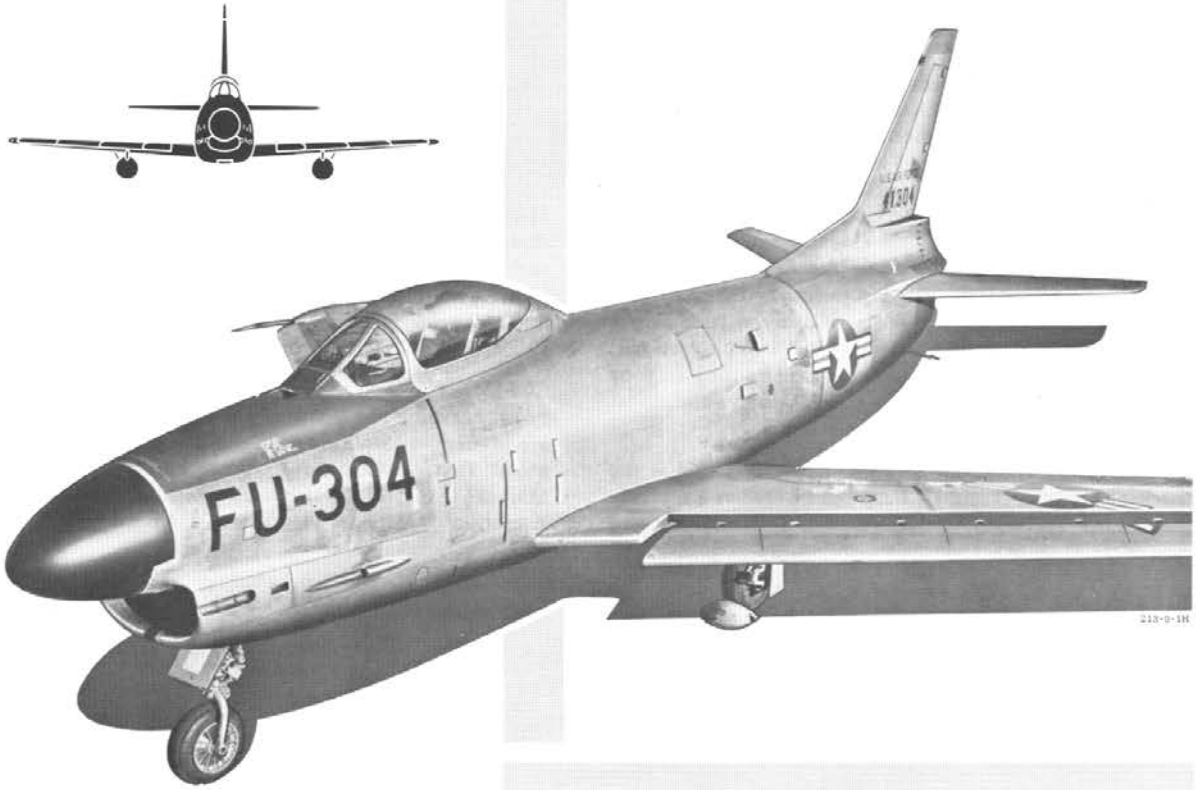
Note

Operating procedures, conditions, etc, which are essential to emphasize.

MAINTENANCE TECHNICAL MANUAL. One more thing. If you desire more detailed information on the various airplane systems and components than is provided within the scope of the Flight Manual, refer to the -2 Series Systems Maintenance Technical Manual (T.O. 1F-86K-2 series) for your airplane.

COMMENTS AND QUESTIONS. Comments and questions regarding any phase of the Flight Manual program are invited and should be forwarded through your Command Headquarters to Commander, Sacramento Air Materiel Area, McClellan AFB, McClellan, California, Attention: Weapons Engineering Division (SMNH).

F-86K



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Section I

DESCRIPTION

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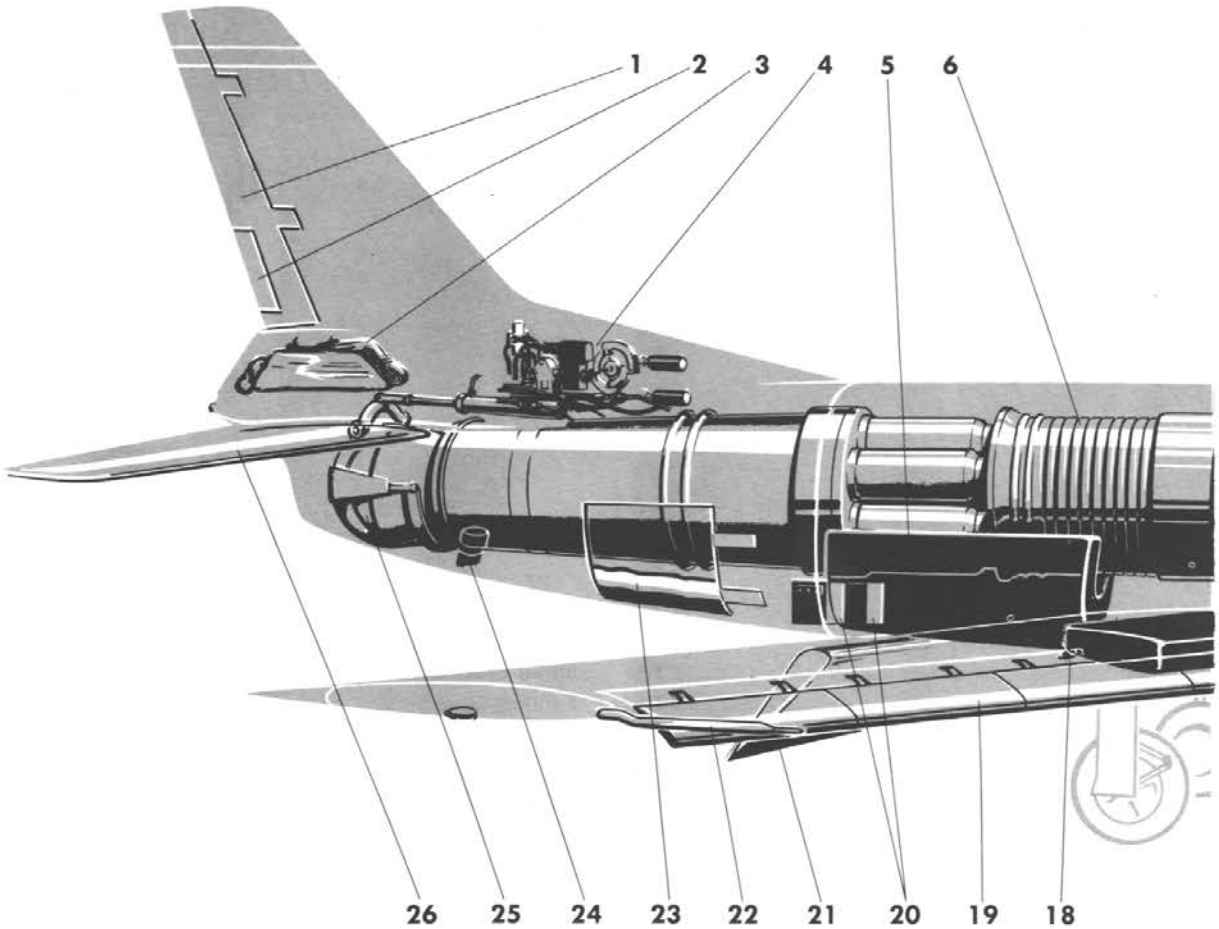
AIRPLANE.

The North American F-86K is a single-place, all-weather fighter-interceptor, with fully retractable tricycle landing gear. It is armed with four 20 mm cannons and missiles (airplanes changed by T.O.) utilizing the MG-4 fire control system. The F-86K has the same basic recognition features as all F-86 Series Airplanes, including the swept-back wings and empennage, and a radome, very similar in appearance to a propeller spinner, on the nose, above the air intake duct. The airplane is powered by an axial-flow, turbojet engine incorporating an afterburner and electronic engine controls. Other noteworthy features include the leading edge wing slats and fuselage speed brakes to increase handling characteristics, a drag chute for additional braking on landings, and a unit which combines the horizontal stabilizer and elevators into one surface known as the controllable horizontal stabilizer. The airplane is designed as a high-altitude, high-performance, all-weather interceptor capable of searching out, intercepting, and destroying enemy aircraft by using the latest and most advanced type of electronic equipment to effectively fire the four rapid-fire 20 mm cannons. The fire control system locates and indicates to the pilot the proper course to follow to intercept his target. This system requires precision flying to fully utilize the electronic fire control system with a minimum of error; however, if evasive tactics are required, high-G maneuvers and abrupt turns within structural limitations of the airplane are permissible.

AIRPLANE GROUP DESIGNATIONS.

Group numbers are used to identify airplanes in accordance with production changes that affect the airplane and/or its equipment. Airplanes within a given group are usually identical with respect to production changes. The group numbers and Air Force serial numbers



1. RUDDER
2. RUDDER TRIM TAB
3. DRAG CHUTE COMPARTMENT
4. VARIABLE-SLOPE FEEL FOR HORIZONTAL TAIL
5. AFT FUSELAGE FUEL TANK
6. J47-GE-17B JET ENGINE WITH AFTERBURNER
7. FORWARD FUSELAGE FUEL TANK
8. OXYGEN BOTTLES
9. ELECTRICALLY OPERATED HINGED CANOPY
10. RADARSCOPE
11. A-4 SIGHT
12. RADAR EQUIPMENT
13. RADAR ANTENNA

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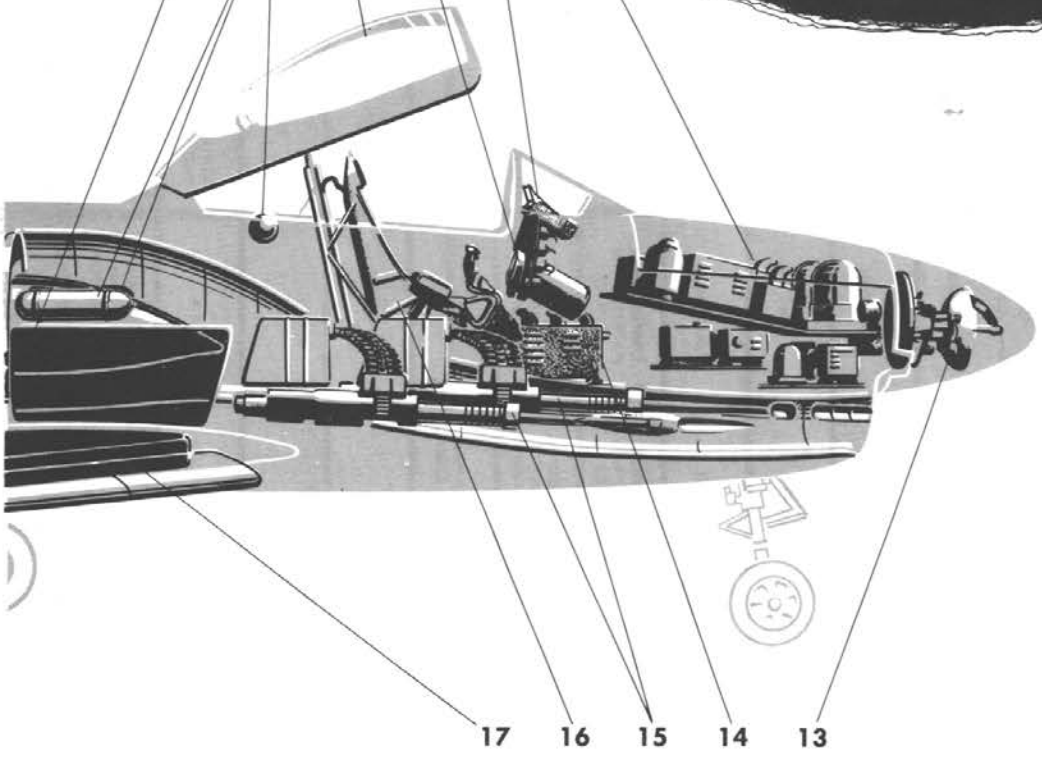
Figure 1-1

GENERAL ARRANGEMENT



14. ELECTRONIC ENGINE CONTROL AMPLIFIERS
15. 20 MM GUNS
16. EJECTION SEAT
17. WING FUEL TANK (TYPICAL BOTH SIDES)
18. EXTERNAL POWER RECEPTACLES
19. WING SLATS
20. BATTERIES
21. WING FLAP (TYPICAL BOTH SIDES)
22. PITOT TUBE (RIGHT-HAND WING ONLY)
23. SPEED BRAKE (BOTH SIDES)
24. FUEL VENT BAYONET (LEFT-HAND SIDE)
25. VARIABLE-AREA NOZZLE
26. CONTROLLABLE HORIZONTAL TAIL

F-86K-1-00-21

MAIN DIFFERENCES TABLE

ITEM	F86A	F86D	F86E	F-86F AND RF-86F	F86H	F-86K	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	MACHINE GUNS, BOMBS, ROCKETS, OR SPECIAL STORES * K-17 OR K-22 CAMERAS†	MACHINE GUNS, BOMBS, ROCKETS, OR SPECIAL STORES	20 MM RAPID-FIRING GUNS	ROCKETS MOUNTED IN RETRACTABLE PACKAGE

* F-86F Airplanes † RF-86F Airplanes

F-86K-1-93-110

Figure 1-2

assigned to the F-86K Airplanes, for coding purposes, are listed as follows:

GROUP NUMBERS	AF SERIAL NUMBERS
Group 1 (F-86K-1)	AF54-1231 through -1350
Group 2	AF55-4811 through -4880
Group 3	AF55-4881 through -4936
Group 4	AF56-4116 through -4160

Group 1 airplanes are also designated as F-86K-1 Airplanes.

AIRPLANE DIMENSIONS.

The principal dimensions of the airplane are as follows:

Wing span ..... 37.1 feet
Group 4 Airplanes ..... 39.1 feet
(and those changed by T.O.)
Length ..... 41.0 feet
Height (to top of fin) ..... 15.0 feet

Note

The increased wing span on Group 4 airplanes and those changed by T.O., is the result of adding a 12-inch extension to each wing tip.

AIRPLANE GROSS WEIGHT.

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

Groups 1, 2, and 3 Airplanes—
No external load ..... 18,400 pounds
With two 120-gallon drop tanks .... 20,200 pounds
With two 120-gallon drop tanks and two GAR-8 missiles ..... 20,700 pounds
Group 4 Airplanes—
No external load ..... 18,650 pounds
With two 120-gallon drop tanks .... 20,450 pounds
With two 120-gallon drop tanks and two GAR-8 missiles ..... 20,950 pounds

Refer to "Weight Limitations," Section V, for additional information.

Note

The preceding gross weights are average weights. For the gross weights of a particular airplane, refer to the Weight and Balance Technical Manual, T.O. 1-1B-40, that is assigned to the particular airplane.

ARMAMENT.

The armament consists of four 20 mm, combination blowback and gas-operated guns. The guns are located on the forward sides of the fuselage, two on each side of the cockpit. Ammunition is carried in removable ammunition boxes located above each gun. Missiles may be carried on launchers attached to the underside of the wing on airplanes changed by T.O. 1F-86K-546.

ENGINE.

The Model J47-GE-17B turbojet engine (figure 1-3) has an electronic engine control system, an afterburner, and a variable-area jet nozzle. The rated sea-level static thrust of the engine is about 5425 pounds at Military Power and 7500 pounds at Maximum Power (with afterburner operating). 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 exhaust gases pass 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 gases 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 the injected fuel providing additional thrust is called afterburning. An electronically controlled, variable-area nozzle on the end of the tail pipe provides correct nozzle conditions for optimum performance with or without afterburner operating. The engine has a "hot streak" ignition system for afterburner ignition, a flame dome and flame holder mounting to give rigidity and strength to the tail pipe, and a ceramic-coated inner liner in the tail pipe to give better insulation of exhaust temperatures.

ELECTRONIC ENGINE CONTROL.

The airplane is equipped with an electronic engine control (figure 7-1), the main advantage of which is the extremely rapid response of the engine to changes in throttle setting. In addition, starting and operating techniques are considerably simplified. Flame-outs and compressor stalls due to excessively rapid throttle movement are prevented, as 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 function properly when external power is applied for an engine start, the electronic power control will be inoperative. Inverter failure warning lights should be checked and all applicable circuit breakers pushed in when external power has been applied before an engine start is attempted. After external power has been connected to the airplane, an automatic start may be made after the engine control lockup light is out. This will

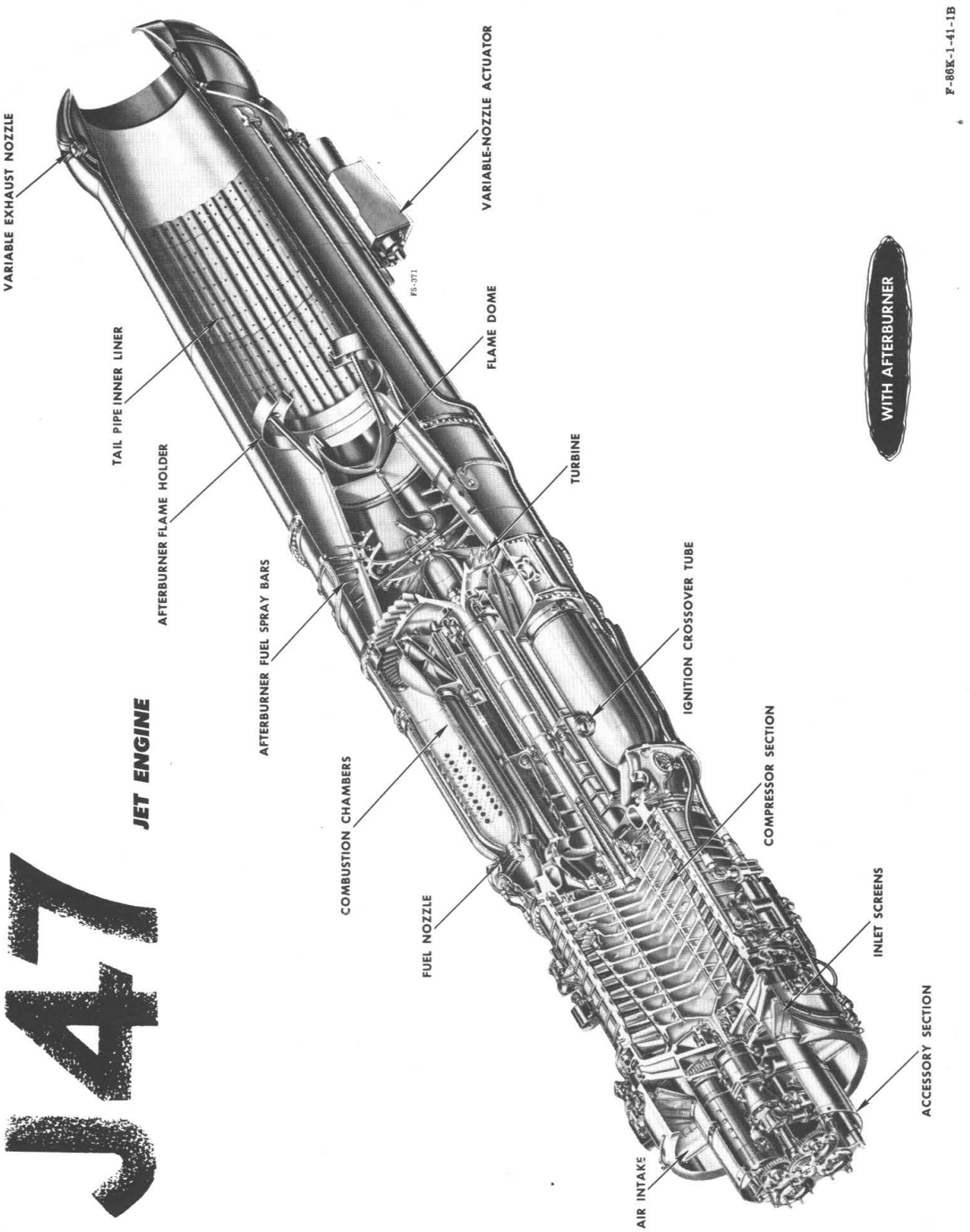

J47
JET ENGINE
WITH AFTERBURNER
F-86K-1-41-1B
FS-371
VARIABLE EXHAUST NOZZLE
VARIABLE-NOZZLE ACTUATOR
TAIL PIPE INNER LINER
FLAME DOME
AFTERBURNER FLAME HOLDER
TURBINE
AFTERBURNER FUEL SPRAY BARS
IGNITION CROSSOVER TUBE
COMBUSTION CHAMBERS
COMPRESSOR SECTION
FUEL NOZZLE
INLET SCREENS
ACCESSORY SECTION
AIR INTAKE

Figure 1-3

ensure that the amplifiers are warmed up enough for proper electronic control during the automatic start. 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 three-position emergency fuel system switch. (See figure 1-4.) On Group 3 and 4 airplanes and those changed by T.O., a two-position (NORM and ON) emergency fuel system switch is installed. The emergency fuel system has been changed to eliminate the chance of interaction between the main and emergency fuel control systems during take-off. It also eliminates confusion caused by two engine control systems being in use at the same time. This change *removes* the TAKE OFF position of the emergency fuel system switch and removes the emergency fuel system test button. A throttle-actuated, spring-loaded idle detent plunger and switch (replacing the 72-degree thrust selector switch) are added to the throttle quadrant to allow the pilot to abort a take-off if the electronic engine control locks up during the take-off roll. An engine-driven, dual fuel pump supplies fuel to the main fuel control valve, which meters the amount of fuel required by the engine. Excess fuel is bypassed through the open emergency fuel regulator back to the 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 TAKE OFF or ON (at the ON position on airplanes with the two-position emergency fuel switch). 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 TAKE OFF or ON (ON position for airplanes with two-position emergency fuel switch), enabling the throttle to mechanically control the emergency regulator. On airplanes with the three-position emergency fuel system switch, with the switch at TAKE OFF (the emergency regulator holdout solenoid is de-energized, alerting the emergency regulator to a stand-by condition) during 100% rpm operation, a drop in fuel pressure causes the emergency regulator to take over control of fuel flow at a pressure slightly below normal (depending on outside air temperature). 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 (72-degree switch incorporated in the thrust selector on airplanes with the three-position emergency fuel system switch, or the idle detent switch on airplanes incorporating the two-position emergency fuel system switch) also allows engine control to be converted to the emergency fuel system (with three-position emergency fuel system switch at TAKE OFF) 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 72-degree switch (about ¾ throttle position) or idle detent switch is actuated by rapidly retarding the throttle to START IDLE. 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-starter and generator switches to OFF during engine operation also causes 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 caution 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 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 (9, figure 1-6), on the left console, is labeled "CLOSED" and "OPEN." Immediately adjacent to the throttle, the markings are "START IDLE," "MILITARY," and "AFTERBURNER." There

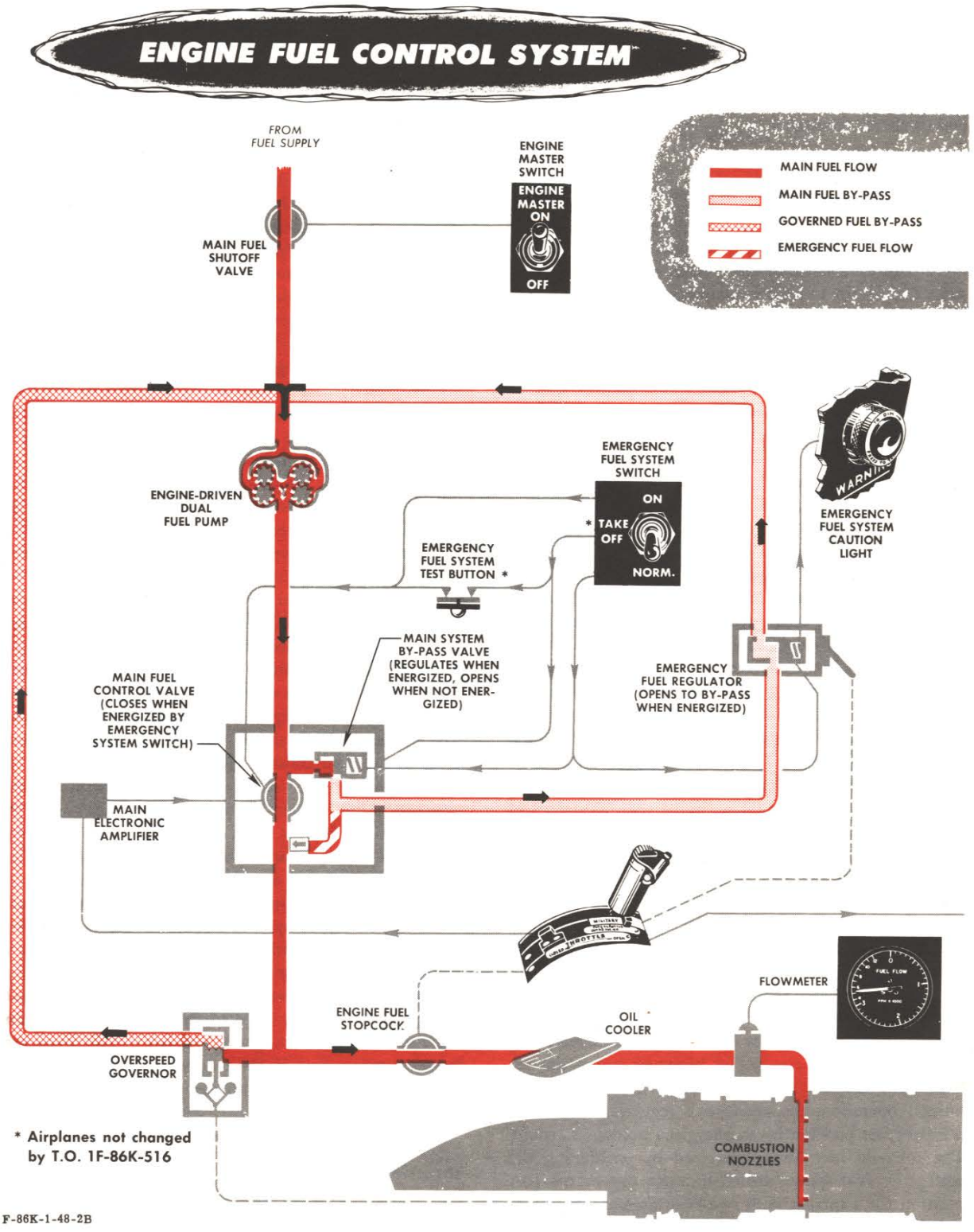
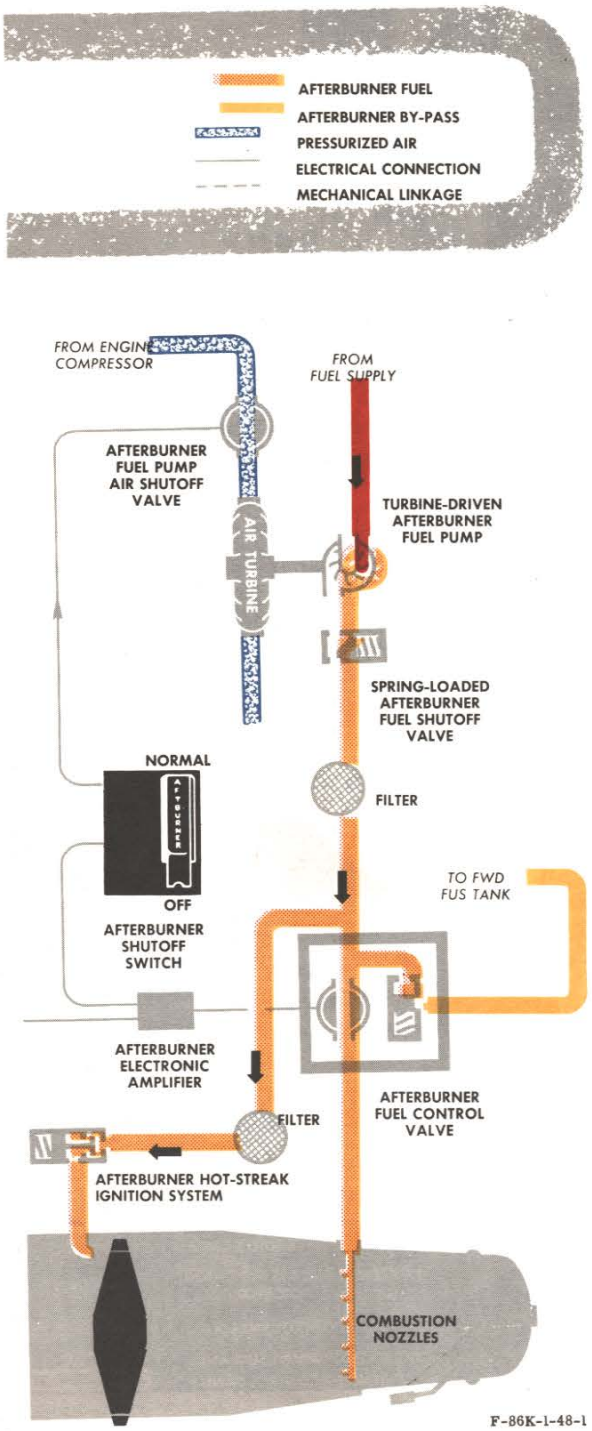

ENGINE FUEL CONTROL SYSTEM
FROM FUEL SUPPLY
ENGINE MASTER SWITCH
ENGINE MASTER ON
OFF
MAIN FUEL SHUTOFF VALVE
MAIN FUEL FLOW
MAIN FUEL BY-PASS
GOVERNED FUEL BY-PASS
EMERGENCY FUEL FLOW
ENGINE-DRIVEN DUAL FUEL PUMP
EMERGENCY FUEL SYSTEM SWITCH
ON
* TAKE OFF
NORM.
EMERGENCY FUEL SYSTEM TEST BUTTON *
WARNING
EMERGENCY FUEL SYSTEM CAUTION LIGHT
MAIN SYSTEM BY-PASS VALVE (REGULATES WHEN ENERGIZED, OPENS WHEN NOT ENERGIZED)
EMERGENCY FUEL REGULATOR (OPENS TO BY-PASS WHEN ENERGIZED)
MAIN FUEL CONTROL VALVE (CLOSES WHEN ENERGIZED BY EMERGENCY SYSTEM SWITCH)
MAIN ELECTRONIC AMPLIFIER
THROTTLE
FLOWMETER
FUEL FLOW
ENGINE FUEL STOPCOCK
OIL COOLER
OVERSPEED GOVERNOR
COMBUSTION NOZZLES
* Airplanes not changed by T.O. 1F-86K-516
F-86K-1-48-2B

Figure 1-4



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; subsequent 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, in turn, maintains optimum exhaust temperatures. When the throttle is advanced above the MILITARY stop, 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 power settings. Afterburning continues until the throttle is retarded below the AFTERBURNER range. The throttle grip (figure 1-9) contains a microphone button, a speed brake switch, and a target reject button for use with the MG-4 fire control system. Rotation of the grip provides manual ranging to supply range rate data.

Engine Master Switch.

An engine master switch is located on the engine control panel (figure 1-8) on the left instrument subpanel. Turning the master switch to the ON position opens the main fuel shutoff 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 (Three-position).

A means of selecting the proper fuel control for the engine is provided by a switch on the engine control panel. (See figure 1-8.) The switch has three positions, ON, TAKE OFF, and NORM, and is powered by the primary

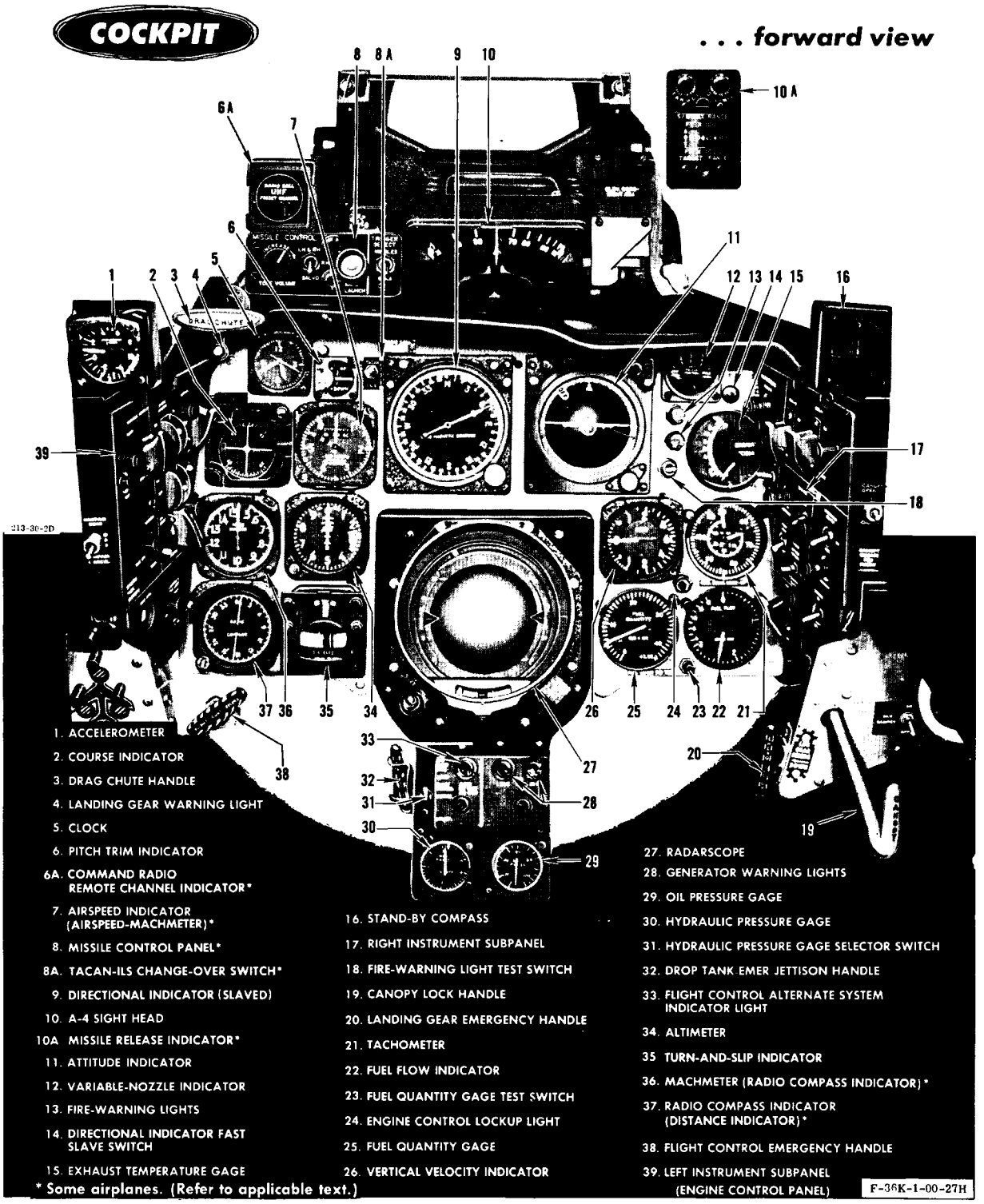

COCKPIT
. . . forward view
213-30-2D
1. ACCELEROMETER
2. COURSE INDICATOR
3. DRAG CHUTE HANDLE
4. LANDING GEAR WARNING LIGHT
5. CLOCK
6. PITCH TRIM INDICATOR
6A. COMMAND RADIO REMOTE CHANNEL INDICATOR*
7. AIRSPEED INDICATOR (AIRSPEED-MACHMETER)*
8. MISSILE CONTROL PANEL*
8A. TACAN-ILS CHANGE-OVER SWITCH*
9. DIRECTIONAL INDICATOR (SLAVED)
10. A-4 SIGHT HEAD
10A. MISSILE RELEASE INDICATOR*
11. ATTITUDE INDICATOR
12. VARIABLE-NOZZLE INDICATOR
13. FIRE-WARNING LIGHTS
14. DIRECTIONAL INDICATOR FAST SLAVE SWITCH
15. EXHAUST TEMPERATURE GAGE
16. STAND-BY COMPASS
17. RIGHT INSTRUMENT SUBPANEL
18. FIRE-WARNING LIGHT TEST SWITCH
19. CANOPY LOCK HANDLE
20. LANDING GEAR EMERGENCY HANDLE
21. TACHOMETER
22. FUEL FLOW INDICATOR
23. FUEL QUANTITY GAGE TEST SWITCH
24. ENGINE CONTROL LOCKUP LIGHT
25. FUEL QUANTITY GAGE
26. VERTICAL VELOCITY INDICATOR
27. RADARSCOPE
28. GENERATOR WARNING LIGHTS
29. OIL PRESSURE GAGE
30. HYDRAULIC PRESSURE GAGE
31. HYDRAULIC PRESSURE GAGE SELECTOR SWITCH
32. DROP TANK EMER JETTISON HANDLE
33. FLIGHT CONTROL ALTERNATE SYSTEM INDICATOR LIGHT
34. ALTIMETER
35. TURN-AND-SLIP INDICATOR
36. MACHMETER (RADIO COMPASS INDICATOR)*
37. RADIO COMPASS INDICATOR (DISTANCE INDICATOR)*
38. FLIGHT CONTROL EMERGENCY HANDLE
39. LEFT INSTRUMENT SUBPANEL (ENGINE CONTROL PANEL)
* Some airplanes. (Refer to applicable text.)
F-86K-1-00-27H

Figure 1-5

bus. The TAKE OFF position is used only during take-off and initial climb to safe altitude. When the switch is at TAKE OFF at 100% rpm, fuel flow to the engine is electronically controlled by the main fuel control valve, with the emergency regulator serving as a stand-by. With the switch in this position, the emergency fuel system caution light comes on as a warning that rapid throttle movements should not be made; otherwise, a compressor stall or flame-out may result. If the main fuel system pressure drops while the switch is at TAKE OFF, the emergency fuel regulator automatically takes over fuel control. However, if the main fuel control valve again becomes operative, it will serve as the primary control and the emergency fuel regulator will return to stand-by.

CAUTION

If it becomes necessary to reduce power when switch is at TAKE OFF, the throttle should be retarded to START IDLE and the emergency fuel system switch should be returned to NORM without hesitating in TAKE OFF position before the throttle is readvanced, to avoid undesirable power surges, possible compressor stall, or overtemperature condition.

When the emergency fuel system switch is at NORM, the main control valve controls fuel flow without the emergency regulator serving as a stand-by. The switch should normally be in this position for all flight conditions except take-off and initial climb. When the switch is moved to ON, the emergency regulator takes over fuel control, the main system by-pass valve is opened, and the main fuel control valve is closed. If loss of electrical power to the primary bus occurs, or if the battery-starter and generator switches are moved to OFF during engine operation, the emergency fuel system will take over fuel control without illuminating the emergency fuel system indicator light, regardless of the position of the emergency fuel system switch.

Emergency Fuel System Switch (Two-position).

A means of selecting the proper engine fuel control is provided by a switch (figure 1-8) on the engine control panel. The switch has two positions, ON and NORM, 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. This light is 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 should be set at the NORM position for take-off and all normal operations. 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 force to depress the idle detent switch. 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-starter 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 Test Button (Airplanes With Three-position Emergency Fuel System Switch).

Operation of the emergency fuel system may be checked by means of a test button adjacent to the emergency fuel system switch on the engine control panel. (See figure 1-8.) The emergency fuel system switch must be at TAKE OFF and the throttle at MILITARY power during the test. When the test button is depressed, completing the circuit from the primary bus, the main fuel control system is shut off by electrical closing of the main fuel control valve. A decrease in engine rpm to a lower stabilized value (figure 2-4) indicates that the emergency fuel regulator has taken over fuel control. When the test button is released, the main fuel control valve is allowed to regain fuel control, and the emergency fuel regulator is again at stand-by.

Emergency Fuel System Caution Light.

An amber emergency fuel system caution light, labeled "WARNING" is on the engine control panel. (See figure 1-8.) On airplanes with the three-position emergency fuel switch, the light comes on when the emergency fuel system switch is moved to ON or TAKE OFF. Illumination of the light is a warning that the emergency regulator is in control or in stand-by. With the emergency fuel system switch in the ON position, any accelerations from below-85%-rpm engine speeds must be made very cautiously. The throttle should never be readvanced when the switch is in TAKE OFF position because of the possibility of exhaust overtemperature. On airplanes with the two-position emergency fuel switch, 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.

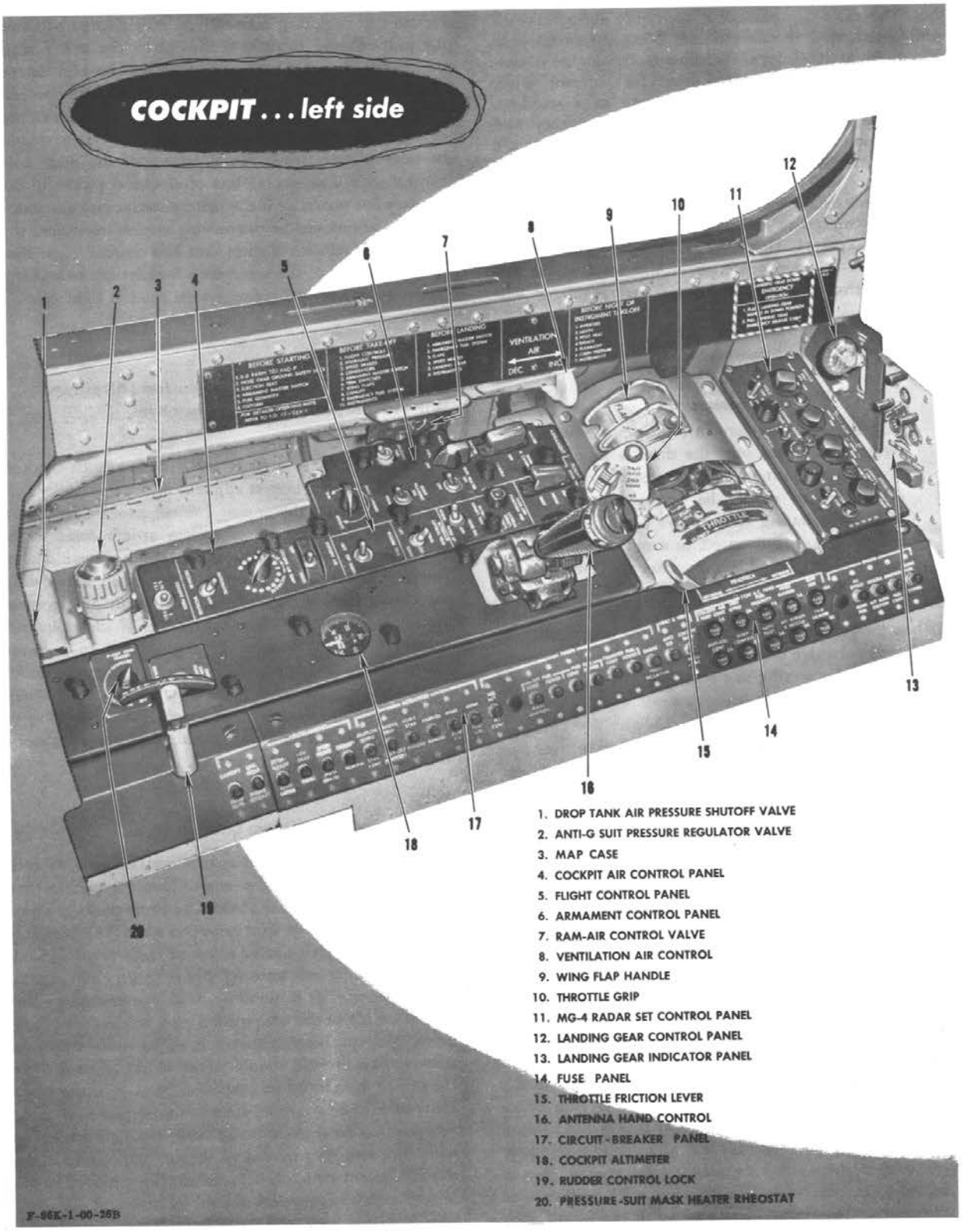

COCKPIT . . . left side
1. DROP TANK AIR PRESSURE SHUTOFF VALVE
2. ANTI-G SUIT PRESSURE REGULATOR VALVE
3. MAP CASE
4. COCKPIT AIR CONTROL PANEL
5. FLIGHT CONTROL PANEL
6. ARMAMENT CONTROL PANEL
7. RAM-AIR CONTROL VALVE
8. VENTILATION AIR CONTROL
9. WING FLAP HANDLE
10. THROTTLE GRIP
11. MG-4 RADAR SET CONTROL PANEL
12. LANDING GEAR CONTROL PANEL
13. LANDING GEAR INDICATOR PANEL
14. FUSE PANEL
15. THROTTLE FRICTION LEVER
16. ANTENNA HAND CONTROL
17. CIRCUIT-BREAKER PANEL
18. COCKPIT ALTIMETER
19. RUDDER CONTROL LOCK
20. PRESSURE-SUIT MASK HEATER RHEOSTAT
F-86K-1-00-26B

Figure 1-6

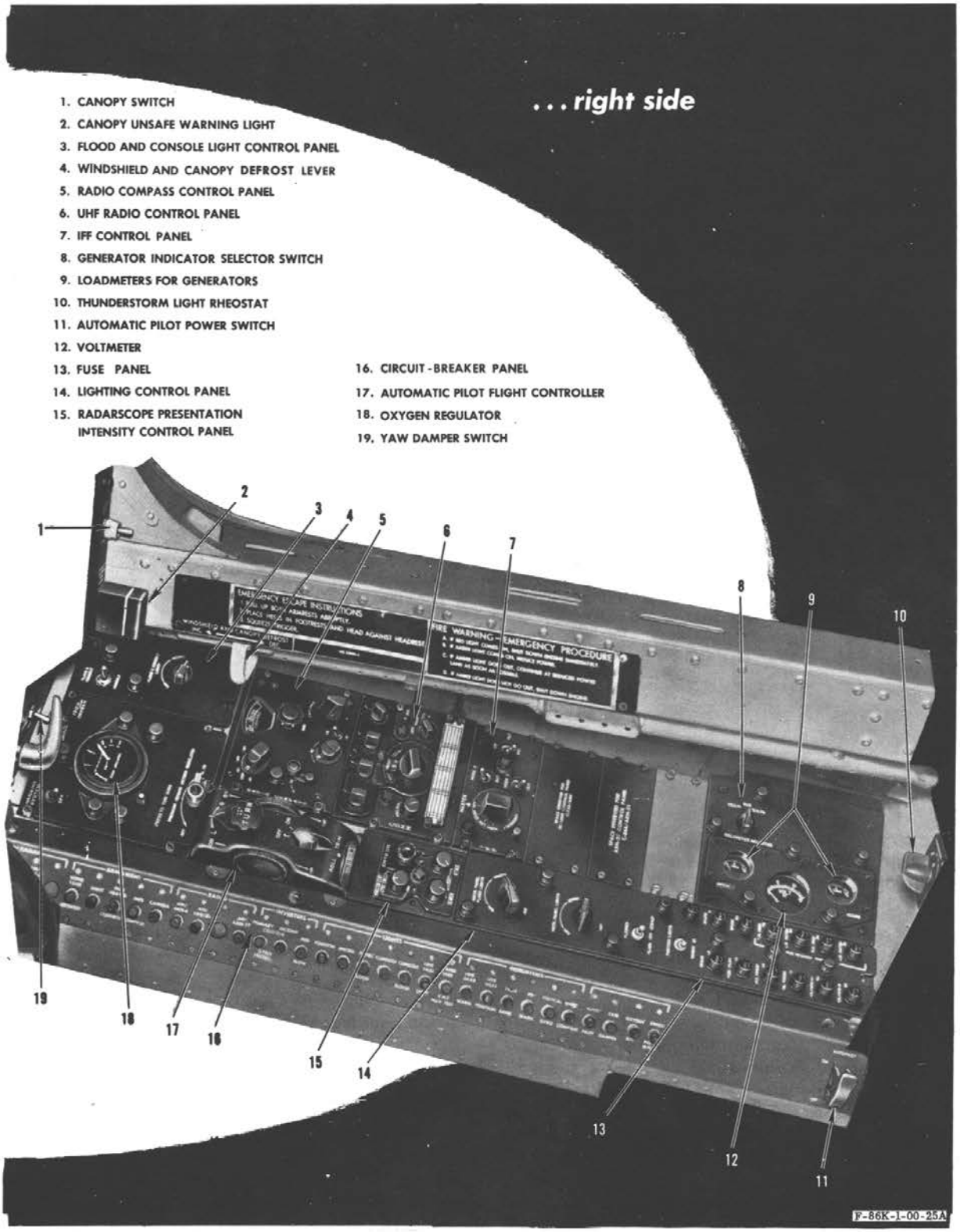
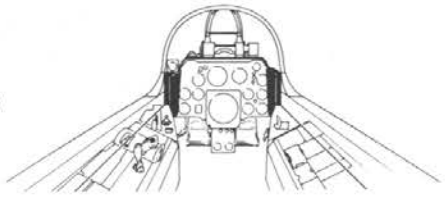

. . . right side
1. CANOPY SWITCH
2. CANOPY UNSAFE WARNING LIGHT
3. FLOOD AND CONSOLE LIGHT CONTROL PANEL
4. WINDSHIELD AND CANOPY DEFROST LEVER
5. RADIO COMPASS CONTROL PANEL
6. UHF RADIO CONTROL PANEL
7. IFF CONTROL PANEL
8. GENERATOR INDICATOR SELECTOR SWITCH
9. LOADMETERS FOR GENERATORS
10. THUNDERSTORM LIGHT RHEOSTAT
11. AUTOMATIC PILOT POWER SWITCH
12. VOLTMETER
13. FUSE PANEL
14. LIGHTING CONTROL PANEL
15. RADARSCOPE PRESENTATION INTENSITY CONTROL PANEL
16. CIRCUIT-BREAKER PANEL
17. AUTOMATIC PILOT FLIGHT CONTROLLER
18. OXYGEN REGULATOR
19. YAW DAMPER SWITCH
F-86K-1-00-25A

Figure 1-7

INSTRUMENT SUBPANELS



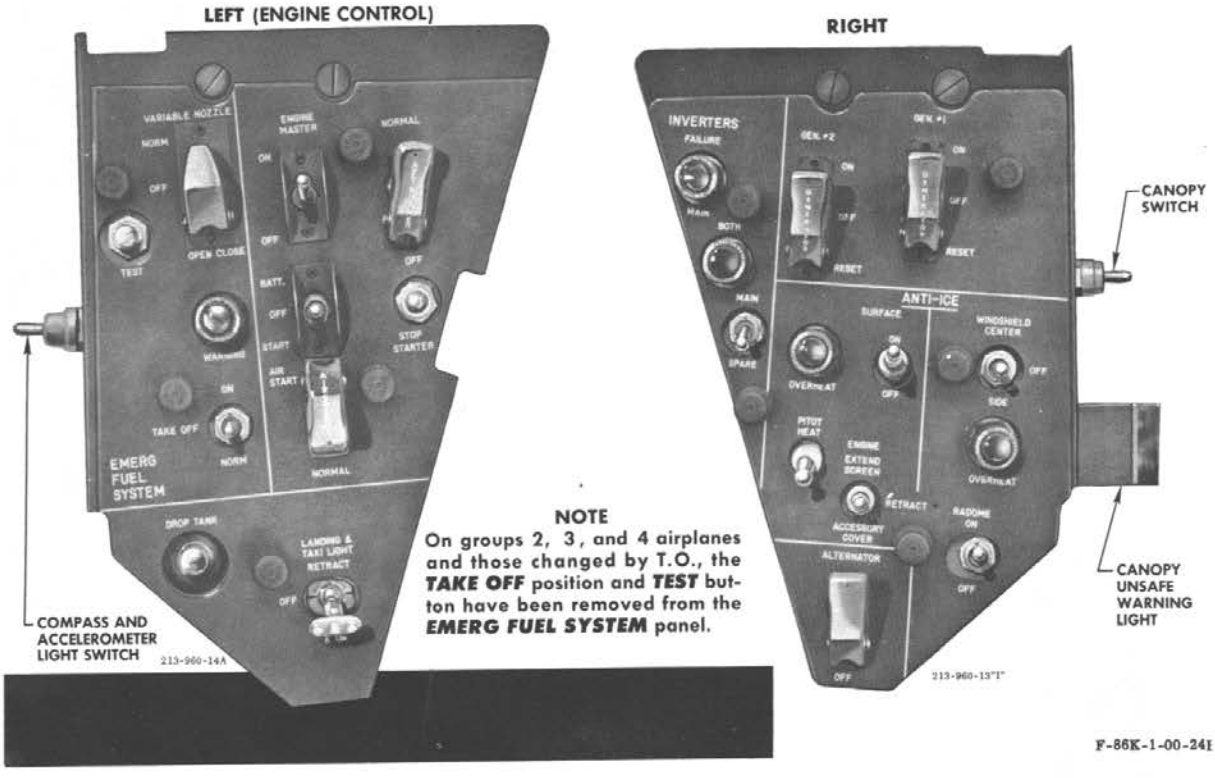


Figure 1-8

ELECTRONIC ENGINE CONTROL AUTOMATIC LOCKUP SYSTEM (AIRPLANES WITH THREE-POSITION EMERGENCY FUEL SYSTEM SWITCH).

An engine control automatic lockup system is installed in this airplane to provide protection against possible loss of thrust should the electronic engine control lose 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. Whenever the ac power supply to the electronic engine control falls below about 92 volts, the main and afterburner fuel control valves and the variable exhaust nozzle are automatically locked in their existing positions. This locked power setting is then maintained until about 15 seconds after the ac power supply 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 is required so that the electronic engine control components can be rewarmed after a main inverter failure. If the ac power supply is not re-established above about 98 volts, the electric engine controls will stay in automatic lockup. Engine control is recovered by converting to operation on the emergency fuel system. Power settings should not be changed when engine controls are in lockup, since engine overtemperature or surging may result when lockup is removed. During an engine start, the automatic lockup system is made ineffective when the battery-starter switch is momentarily positioned at START. *After the engine is operating, positioning the emergency fuel system switch to* ON *then back to* NORM *without hesitating at* TAKE OFF *makes the automatic lockup system operable.* It will then remain operable during all normal operation. If automatic lockup occurs during take-off roll, with the emergency fuel system switch at TAKE OFF, the take-off can be aborted 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 action

actuates the 72-degree switch in the thrust selector, which transfers engine operation to the emergency fuel system. For taxiing after take-off is aborted, before the throttle is readvanced, positioning the emergency fuel system switch to ON will eliminate any power surges that may occur when the throttle is readvanced. A lockup caution light, labeled "ENG. CONT. LOCK-UP," is provided to indicate when engine controls are in lockup. Refer to Section VII for added information on characteristics of the automatic lockup system.

ELECTRONIC ENGINE CONTROL AUTOMATIC LOCKUP SYSTEM (AIRPLANES WITH TWO-POSITION EMERGENCY FUEL SYSTEM SWITCH).

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 (automatic or 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 will 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 NORM position. If automatic lockup occurs during the take-off roll with the emergency fuel switch at NORM, the take-off can be aborted 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

Moving the emergency fuel switch to ON or actuating the idle detent switch when the engine controls are locked up does not unlock the exhaust nozzle. It must be controlled by the variable-nozzle switch.

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 NORM. For taxiing after a take-off is aborted and before the throttle is readvanced, the emergency fuel system switch should be positioned 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 the emergency fuel switch to ON, and a landing should be made using the emergency fuel system for engine operation.

Engine Control Lockup Caution Light.

An amber engine control caution light on the instrument panel (24, figure 1-5), labeled "ENG. CONT. LOCK-UP," is provided in the cockpit to indicate when the electronic engine controls are in lockup. The light is powered by the primary bus. Whenever ac power loss

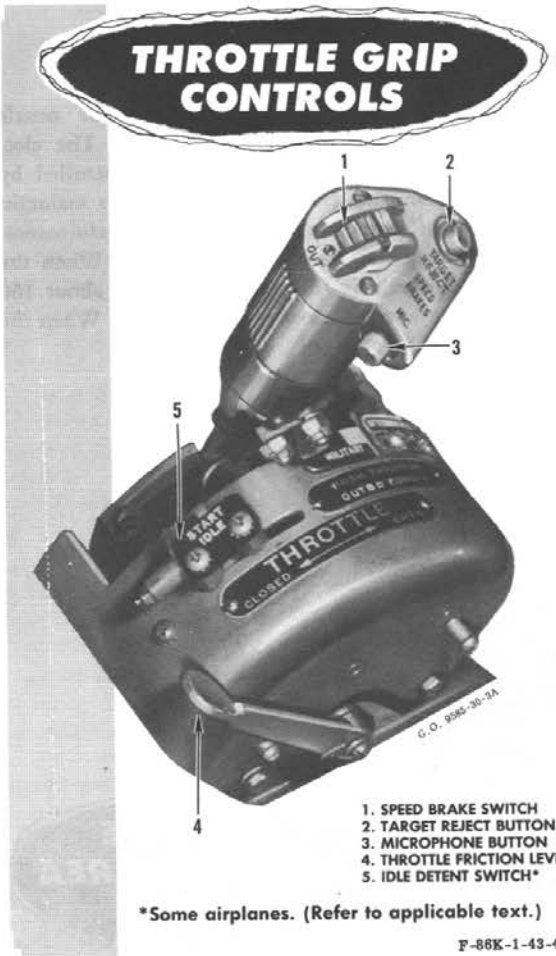


Figure 1-9

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. Consequently, 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, illumination of the light will not be affected. The light will remain on as long as ac power is not available. Switching the emergency fuel system switch from the ON position to the NORM position must not be attempted while the lockup caution light is on. For example, if lockup occurs when operating at Military Thrust and throttle reductions are made after transferring to the emergency fuel system, and then the emergency fuel switch is moved back to NORM, the sudden surge of fuel fed through the locked-open main fuel control valve will cause a dangerous overtemperature condition.

VARIABLE-AREA NOZZLE.

Two clamshell-type doors form the variable nozzle (figure 1-10) at the end of the tail pipe. The electrically actuated nozzle is electronically controlled by throttle position and exhaust temperature to maintain correct exhaust temperature for optimum performance. The nozzle may also be manually actuated. When the variable-area nozzle is full-open, its area is about 160 percent of the nozzle area at Military Thrust. When the nozzle is fully closed, its area is 95 percent of the Military Thrust nozzle area. Under automatic control, the nozzle gradually closes to follow the throttle-scheduled positions from about ¾ position (shown on the variable-nozzle indicator) at idle power to about ¼ position at Military Thrust. On a throttle burst, the nozzle locks at the lower power position until the engine rpm reaches from 2% to 7% of the higher power rpm. The nozzle then rapidly closes to scheduled position. This scheduled nozzle position, at steady-state operation, causes the exhaust temperature to exceed 685°C, and the nozzle will then be driven open from the scheduled position to the position necessary to maintain 685°C by the exhaust temperature control circuitry. During normal afterburner operation, the nozzle position is determined primarily 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 the exhaust temperature still tends to exceed 685°C, the electronic engine control will automatically decrease 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 afterburner fuel flow will be automatically decreased as nozzle area is decreased.

F-86K-1-40-1A

Figure 1-10

WARNING

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

Note

With the variable-nozzle switch in the NORM position, the nozzle is automatically controlled to give optimum 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 braking 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 1-8) is placed in the

guarded NORM 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 the possibility of engine overspeed and/or overtemperature operation. 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 the switch than when automatically controlled. However, when the switch is at NORM, ac power must be available for automatic operation of the variable nozzle. The switch is powered from the primary bus.

Variable-nozzle Position Indicator.

A position indicator (12, figure 1-5) for the variable nozzle is located on the main instrument panel. The indicator dial is calibrated in quarters from minimum to maximum nozzle area. Power for operation of the position indicator is supplied from the primary bus. During starts, with the variable-nozzle switch in the normal position, the indicator should show about ¾ position (with the new-type thrust selector) or ½ position (with the old-type thrust selector).

IGNITION SYSTEM.

The ignition system, providing ignition through four spark plugs, functions only during normal ground starts and windmilling air starts. For normal ground starts, with the engine master switch ON and the battery-starter switch moved to the START position momentarily, the initial outboard movement of the throttle (to pass the START IDLE stop) actuates a microswitch that supplies dc power to the ignition vibrator 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 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 normal 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 done by a "hot streak" ignition system. (See figure 1-4.) 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 retarded below 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 (figure 1-8) is installed on the left instrument subpanel. (See figure 1-11.) 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 1-14.) When the air-start switch is returned to the NORMAL (down) position, after the start is completed and the generators are again operating, the ignition shuts off and the electrical equipment returns to normal operation. If the emergency fuel system switch is returned to NORM before the engine control lockup light goes out, abnormal engine operation can occur, since the engine fuel control valve is still in a locked-up condition.

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.

STARTER SYSTEM.

A combination starter-generator functions as a starter until engine speed reaches about 23% rpm when it is automatically disconnected. At rpms above idle it functions as a generator. The starter can be energized only when an external power source is connected to the airplane, as the airplane batteries are automatically disconnected from the electrical system during ground starts. Starter operation is entirely automatic after the battery-starter switch is momentarily moved to the START position. Should the engine fail to start, the starter is de-energized if the "STOP STARTER" button is depressed.

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 dc external power receptacles for starting.

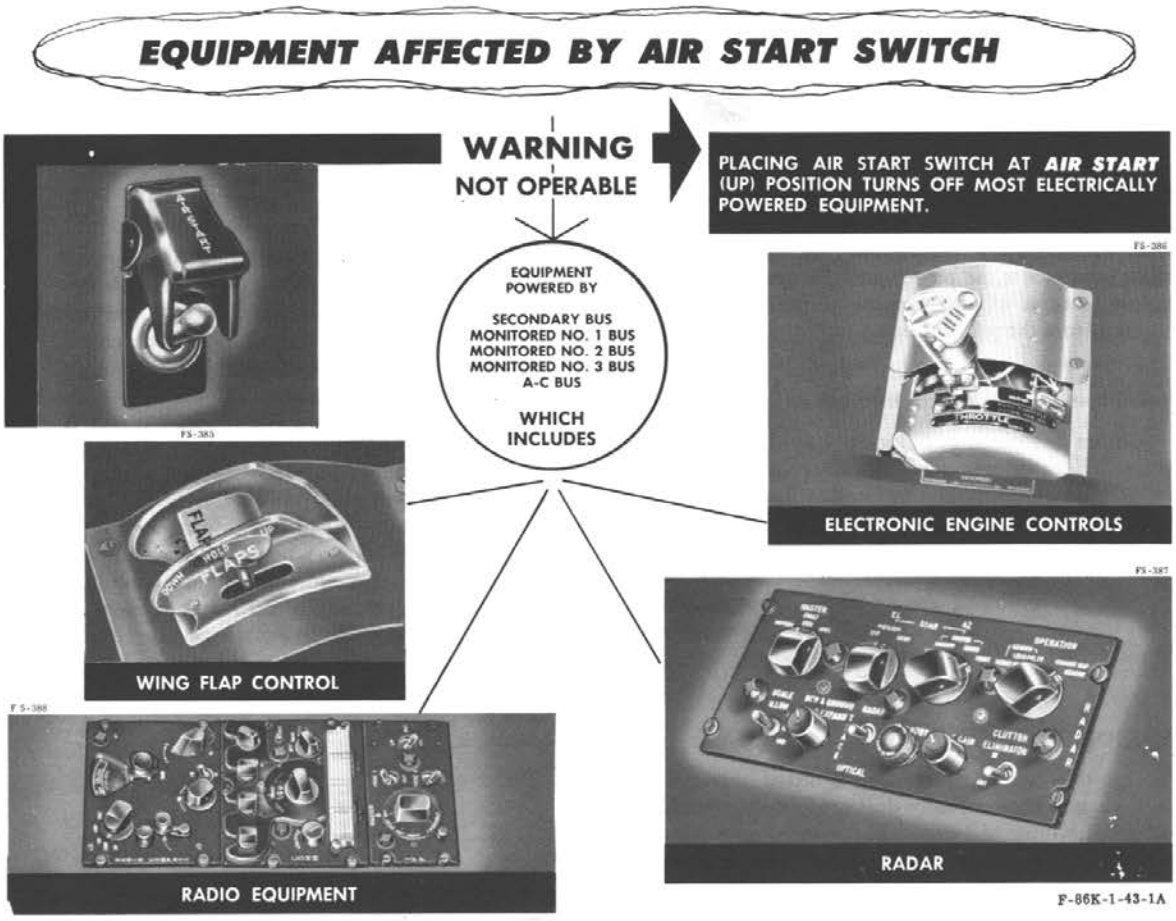


Figure 1-11

Battery-Starter Switch.

A guarded battery-starter switch on the engine control panel (figure 1-8) has two maintained positions, BATT. and OFF, and a spring-loaded START position for ground use only. When the switch is moved momentarily to START, power from the primary bus is supplied to the starter-generator when an external power source is connected. The starter-generator and ignition are automatically disconnected from the circuit at about 23% rpm. The engine automatically accelerates to the speed previously selected with the throttle. The switch returns to OFF from the START position and should be turned to BATT. for all normal operation. With the battery-starter switch at BATT., battery power is supplied to the primary bus. When the battery-starter switch is OFF, battery power is supplied only to the battery bus. (See figure 1-14.)

Stop-starter Button.

A stop-starter button, on the left instrument subpanel (figure 1-8), is for use in the event of a false start. When the button is depressed, current to the starter-generator and to the ignition system is cut off. Since the starter-generator is automatically disconnected from the circuit during engine starts, it is unnecessary to use the stop-starter button except in case of a false start.

ENGINE AIR INLET.

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 a retractable engine inlet screen. Position of this screen is manually controlled by movement of an inlet switch to the desired position, provided the surface anti-ice switch is OFF. (Refer to "Anti-icing Systems," in Section IV.) A glide-slope antenna is located on the leading edge of the lower part of the air inlet opening.

Engine Inlet Switch.

The movable engine inlet screen, which protects the engine from foreign objects, is controlled by a three-position switch on the right instrument subpanel. (See figure 1-8.) The switch is normally at EXTEND SCREEN on the ground and during take-off and landing, 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. The third position, ACCESSORY COVER, provides for anti-icing the accessory cover and retracting 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.

ENGINE INDICATORS.

Exhaust Temperature Gage.

An exhaust temperature gage, calibrated in 25-degree increments from 0°C to 1000°C (15, figure 1-5), mounted on the instrument panel, provides a visual indication of engine operating condition, so that accurate power settings can be obtained. The gage, being a self-generated electrical unit, does not require power from the electrical system of the airplane for operation. For exhaust temperature gage limitation markings, see figure 5-1.

Tachometer.

The tachometer, which is calibrated from 0% to 110% rpm (20, figure 1-5), and mounted on the main instrument panel, 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 (21, figure 1-5), is on the lower right side of the instrument panel and gives the rate of fuel flow in pounds per hour. The indicator dial has the 0 to 3000 pounds per hour sector expanded, thus enabling more accurate readings within this range. The fuel flowmeter does not indicate rate of afterburner fuel flow. The flowmeter is powered from the ac bus; however, in case normal ac power is not available (when the 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 on the instrument panel is calibrated from 0 to 100 psi (28, figure 1-5), and indicates 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, fuel discharged from the spray bars aft of the turbine wheel is burned in the tail pipe. In this manner, the engine exhaust gas is reheated and provides additional thrust. Fuel to the afterburner spray bars is controlled by an afterburner fuel control valve. (See figure 1-4.) 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 will discharge enough fuel for afterburning operation without utilizing 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 constitute an operating limitation, but rather a measure for protection of the afterburner turbine-driven pump in case of aft fuselage tank transfer pump failure.

Afterburning can be obtained by advancing the throttle above the MILITARY stop to the AFTERBURNER range. This action causes the afterburner air shutoff valve to be opened. This allows passage of compressor air to drive the afterburner fuel pump turbine. 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 the fuel control valve position as required to prevent excessive exhaust temperatures, regardless of throttle position. The afterburner is shut off when the throttle is retarded below the AFTERBURNER range. The afterburner fuel control valve incorporates a mechanical stop to prevent the fuel flow from exceeding the 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. There is no altitude restriction for afterburner operation. Refer to Section VII for additional information on the afterburner system.

Note

Extensive use of afterburner materially reduces flight range and operational time because of high fuel consumption.

AFTERBURNER EMERGENCY SHUTOFF SWITCH.

A guarded switch (figure 1-8), on the left engine subpanel and powered from the battery bus, 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 the OFF position will close the air shutoff valve to the air-turbine-driven afterburner fuel pump, thus shutting off the afterburner fuel pump operation.

OIL SYSTEM.

Lubrication of the various gears and bearings of the engine is done through a pressure-type oil system and a scavenge-pump return. The oil both lubricates and cools and the system is completely automatic, requiring no control action by the pilot. Oil is routed to the different sections of the engine and is then returned through a scavenge pump 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-gallon 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 the scavenge pumps are unable to return oil from the sumps to the oil supply tank. (See figure 1-26 for oil specification.)

FUEL SYSTEM.

Four fuel tanks are installed in the airplane: two in the fuselage, and one in each wing outer panel. (See figure 1-12.) Fuel is supplied to the engine from the forward fuselage tank by electric booster pumps. The afterburner turbine-driven fuel pump is tank-mounted with its own integral boost pump unit and provides enough afterburner fuel without utilizing the other 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 have 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. In addition, fuel flow to the engine is obtainable from the forward fuselage tank and from the aft fuselage tank by suction flow in case the electric booster pumps fail. There are individual filler points for each tank. When the airplane is refueled by means of the individual filler points, the forward fuselage tank must be filled first in order to utilize full fuel capacity; if the wing tanks or the 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. In addition, a single-point refueling-nozzle-receptacle-and-line system is provided. The nozzle receptacle is in the left side of the fuselage, adjacent 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 40 to 60 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. (See figure 1-26 for fuel specification.) Refer to Section VII for additional information on this system.

DROP TANKS.

The main fuel supply can be augmented 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

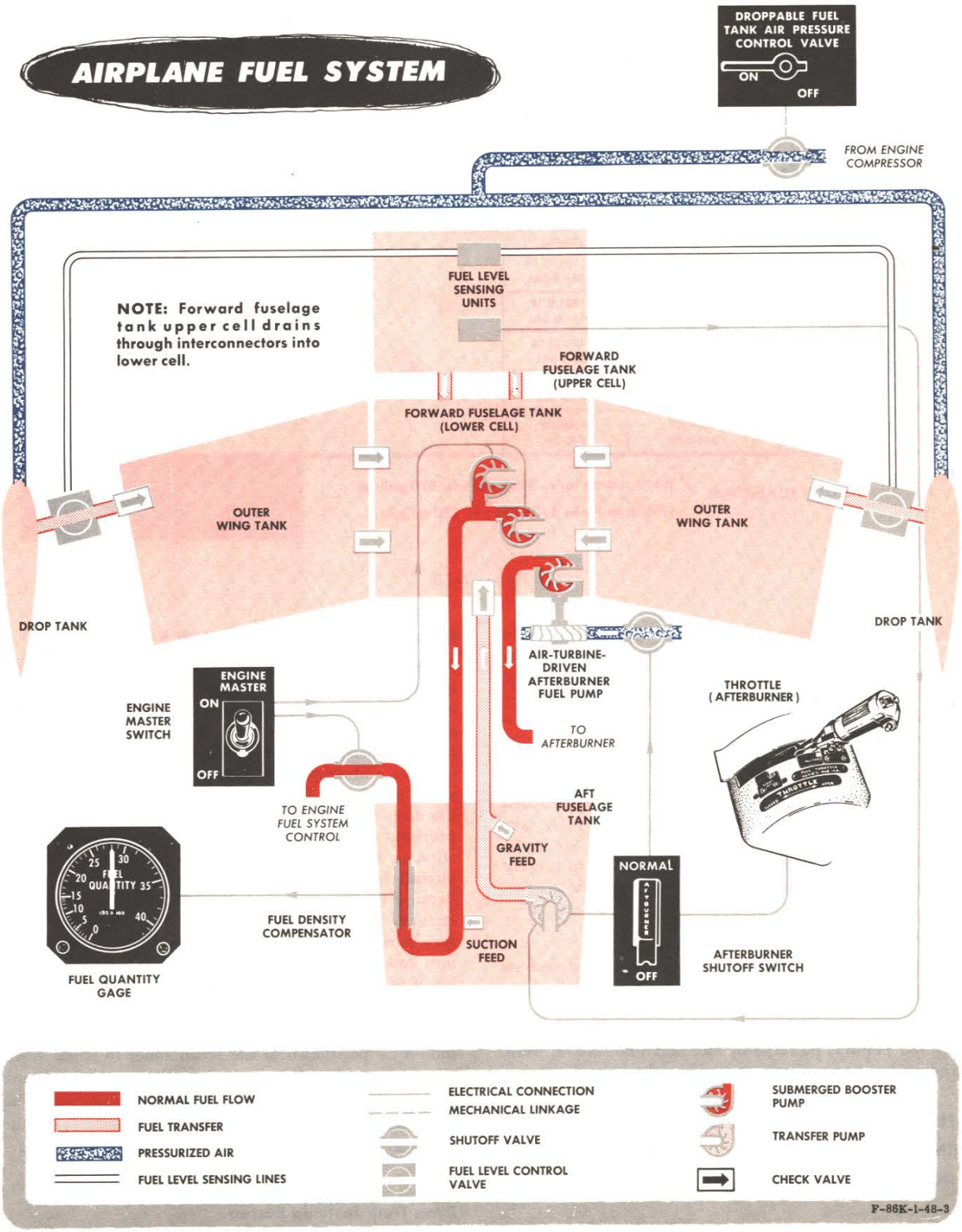

AIRPLANE FUEL SYSTEM
DROPPABLE FUEL TANK AIR PRESSURE CONTROL VALVE
ON
OFF
FROM ENGINE COMPRESSOR
NOTE: Forward fuselage tank upper cell drains through interconnectors into lower cell.
FUEL LEVEL SENSING UNITS
FORWARD FUSELAGE TANK (UPPER CELL)
FORWARD FUSELAGE TANK (LOWER CELL)
OUTER WING TANK
OUTER WING TANK
DROP TANK
DROP TANK
AIR-TURBINE-DRIVEN AFTERBURNER FUEL PUMP
TO AFTERBURNER
THROTTLE (AFTERBURNER)
ENGINE MASTER
ON
OFF
ENGINE MASTER SWITCH
TO ENGINE FUEL SYSTEM CONTROL
AFT FUSELAGE TANK
GRAVITY FEED
NORMAL
OFF
AFTERBURNER SHUTOFF SWITCH
FUEL QUANTITY
FUEL DENSITY COMPENSATOR
SUCTION FEED
FUEL QUANTITY GAGE
NORMAL FUEL FLOW
FUEL TRANSFER
PRESSURIZED AIR
FUEL LEVEL SENSING LINES
ELECTRICAL CONNECTION
MECHANICAL LINKAGE
SHUTOFF VALVE
FUEL LEVEL CONTROL VALVE
SUBMERGED BOOSTER PUMP
TRANSFER PUMP
CHECK VALVE
F-86K-1-48-3

Figure 1-12

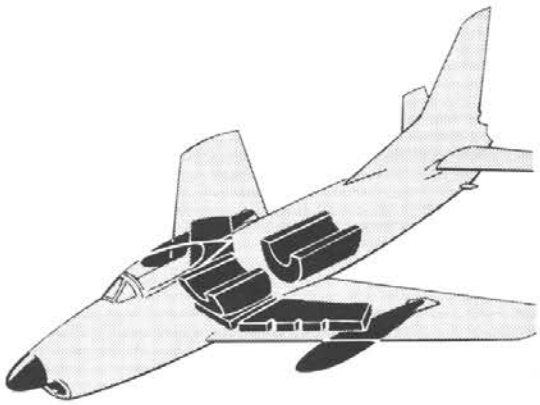
FUEL QUANTITY DATA

POUNDS OR US GALLONS

NOTE

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

TANKS	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



F-86K-1-93-26B

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

Figure 1-13

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 and G-limitations applicable to drop tanks.) On airplanes changed by T.O. 1F-86-590, provisions are incorporated for installing maintenance safety pins to prevent inadvertent release of the drop tanks during maintenance.

FUEL BOOSTER PUMPS.

Two constant-speed 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 positioned at ON. The forward booster pump is powered by monitored bus No. 2, while the aft booster pump is powered by the primary bus.

FUEL SYSTEM CONTROLS AND INDICATORS.

Throttle.

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

Engine Master Switch.

Refer to "Engine Fuel Control System," 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 ON whenever fuel is to be transferred from the drop tanks. Since no drop tank fuel quantity gage is provided, fuel transfer from the drop tanks during operation at high-altitude cruise is indicated by a constant aircraft fuel quantity gage reading during the transfer. Because of a change in fuel tank sequencing, the fuel quantity gage will indicate almost 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 positioned 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 depression of the drop tank jettison button on the left engine control panel. (See

figure 1-8.) 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 (31, figure 1-5), below and to the left of the radarscope, provides a means of jettisoning the drop tanks if the electrical (battery) 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 (24, figure 1-5) is on the lower right side of the instrument panel and indicates 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.

Fuel Quantity Gage Test Switch.

A push-button switch (22, figure 1-5) on the instrument panel is provided to test the fuel quantity indicating system for proper operation. Depressing 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 indicates a faulty indicating system. The switch is powered by the ac bus.

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 1-14.) 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. Two 24-volt, 24-ampere-hour storage batteries serve as a stand-by to supply current to the essential units in case failure of both generators occurs. 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, but will be disconnected from the radar and will assume the ac load of the airplane if the main inverter fails and the inverter switch on the right instrument subpanel is manually positioned at SPARE. The alternator supplies the radar with an unregulated frequency. Loss of the unregulated frequency will cause all ac and dc power to the radar to function improperly. Three-phase power is provided for the automatic pilot, vertical gyro, yaw damper, and directional indicator by four power converters which are normally powered by the main inverter.

ELECTRICALLY OPERATED EQUIPMENT.

See figure 1-14.

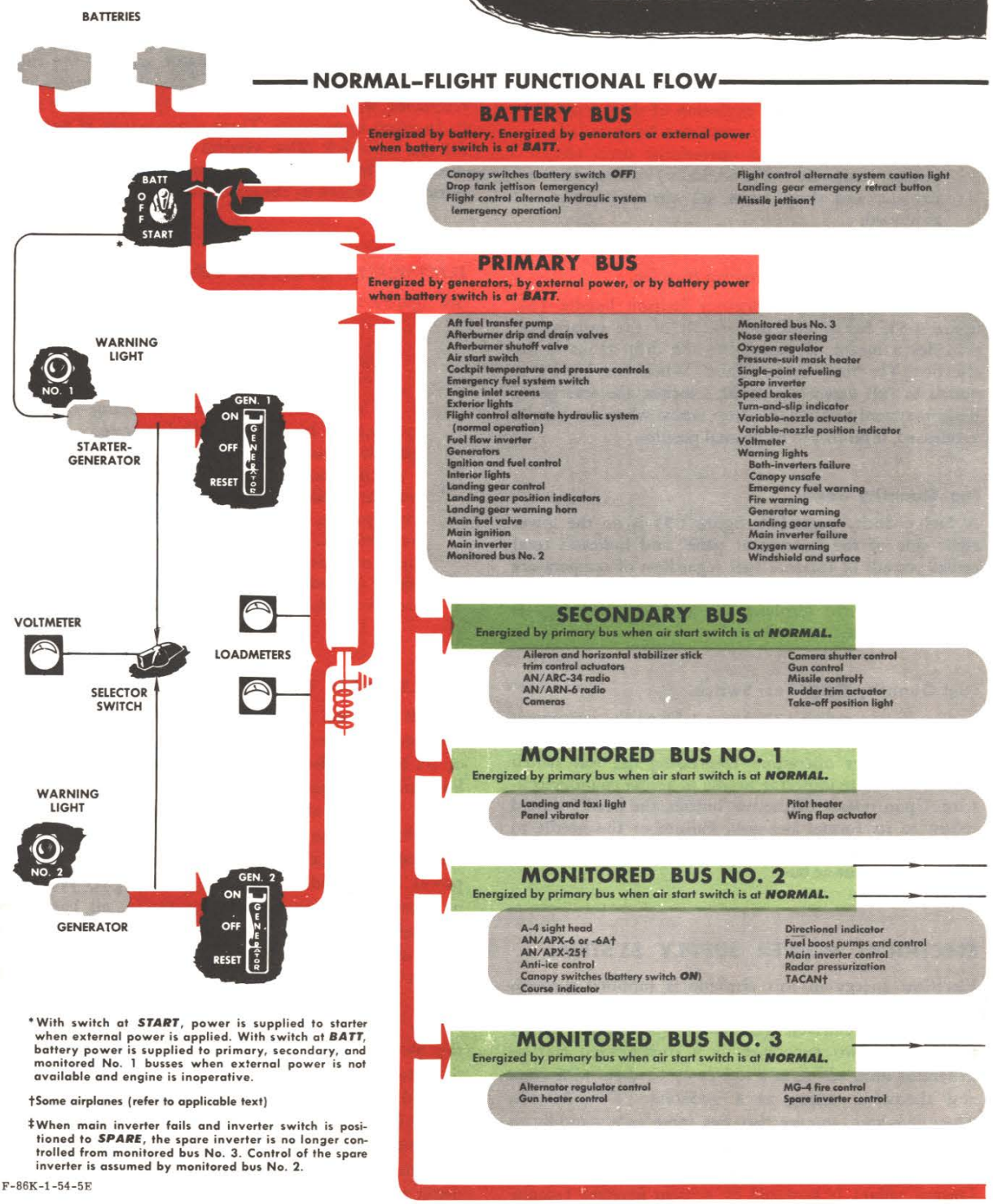
CAUTION

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

DC ELECTRICAL POWER DISTRIBUTION.

The dc electrical power necessary for operation of the electrical units in the airplane is distributed by a group of six busses: a battery bus, a primary bus, a secondary bus, and monitored busses No. 1, 2, and 3. The battery bus is "hot" at all times, so that essential equipment, powered from the battery bus, is operable regardless of the position of the battery-starter switch. When external power is supplied through the oval (right) receptacle 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-starter switch at BATT., the remaining busses are powered by the battery. The rectangular (left) receptacle is used only to supply external 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 monitored busses No. 1, 2, and 3 are automatically disconnected to conserve battery power. The fuel flowmeter remains energized during an air start by an auxiliary inverter which is turned on when the air-start switch is energized.

ELECTRICAL POWER



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

†Some airplanes (refer to applicable text)

‡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.

F-86K-1-54-5E

Figure 1-14

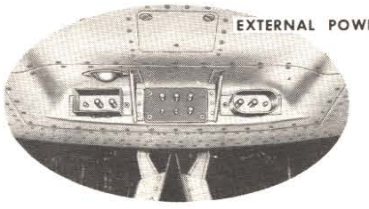
DISTRIBUTION

FLIGHT EMERGENCIES

COLORED BUSSES OPERATIVE

EMERGENCY CONDITIONS	AIR START SWITCH AT *AIR START* (UP)	BOTH GENERATORS INOPERATIVE	ONE GENERATOR INOPERATIVE	BOTH INVERTERS INOPERATIVE	MAIN INVERTER INOPERATIVE
	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
	A-C BUS	A-C BUS	A-C BUS	A-C BUS	A-C BUS

GROUND POWER FLOW

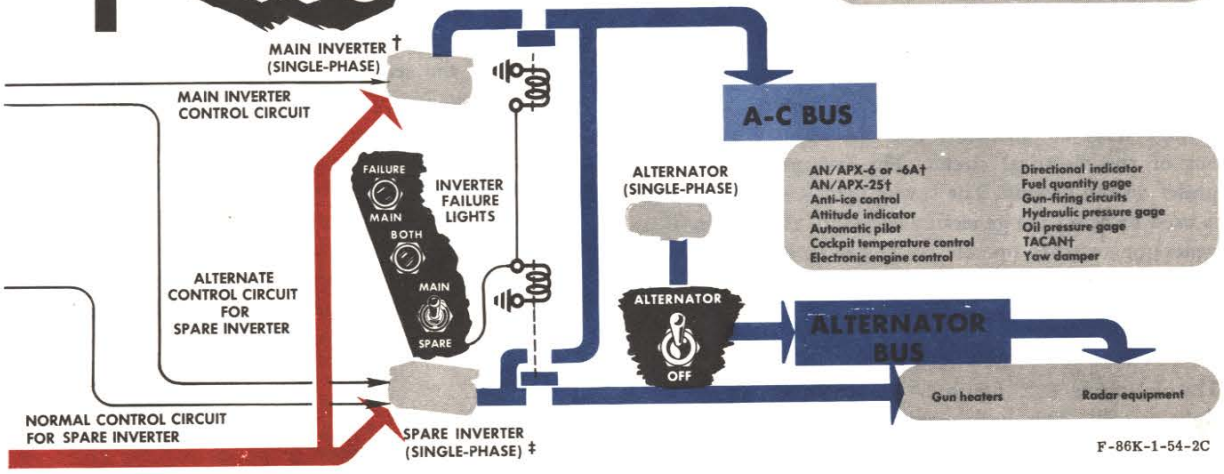


All equipment, except starter, operable when external power source connected to oval d-c receptacle.

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.

Alternator bus powered when external power source connected to a-c receptacle (alternator bus).

Inverter busses powered when external power source connected to inverter a-c power receptacle.



F-86K-1-54-2C

External Power Receptacles.

Two dc external power receptacles (figure 1-14) 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. All equipment is operable when external power is connected to both receptacles. The right dc receptacle is oval and the left is rectangular. All equipment except the starter is operable when external power is connected to the oval (right) receptacle; power supplied through the rectangular (left) receptacle is transmitted only to the starter. *An external power source must be connected to both receptacles for ground starts.*

Circuit Breakers.

Most of the dc electrical circuits are protected by push-pull circuit breakers mounted on panels (16, figure 1-6; 16, figure 1-7) 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 canceling signal, which could result in an undesirable reaction.

Battery-Starter Switch.

Refer to "Starter System" in this section.

Generator Switches.

Two generator switches on the right instrument subpanel (figure 1-8) 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 voltage regulator is preset on the ground. 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.

The voltmeter (12, figure 1-7) is mounted aft on the right console. This instrument provides a visual indication of the electrical potential produced by either generator or available at the primary bus. Above 37% rpm, the voltmeter should indicate about 28 volts.

Voltmeter Indicator Selector Switch.

A voltmeter indicator selector switch (8, figure 1-7) is aft on the right console. This switch may be moved to GEN. #1, GEN. #2, or BUS to produce voltage readings from either generator or from the primary bus.

Loadmeters.

Two loadmeters (9, figure 1-7) are aft on the right console. These instruments indicate percent of maximum amperage (−0.1 to +1.25) for the corresponding generators. Under normal conditions, both loadmeters should indicate about the same value (about +0.6).

Generator Warning Lights.

Two red generator warning lights (27, figure 1-5), one for each generator, are installed on the small subpanel mounted below the main instrument panel. Illumination of either warning light indicates 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.

AC ELECTRICAL POWER DISTRIBUTION.

AC electrical power (figure 1-14) is distributed to the ac electrical equipment throughout the airplane by two busses: the ac bus and the alternator bus. Power to all ac-operated equipment except radar is supplied through the ac bus by the single-phase main inverter. The radar equipment derives its power from the single-phase secondary inverter and from the 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 flight with only one generator operating (monitored bus No. 3 and secondary inverter inoperative), the control of the secondary inverter will automatically be transferred from monitored bus No. 3 to monitored bus No. 2. When the change-over is completed, the secondary inverter will automatically take over the main inverter load. The alternator bus powers only the radar and supplies it 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 incorporates a means of preventing damage by overvoltage supply from the alternator. The alternator bus is supplied power on the ground by a separate ac external power receptacle. The external power supply cannot be paralleled with the engine-driven alternator supply.

Alternator External Power Receptacle.

An ac external power receptacle (figure 1-14) is located between the two dc external power receptacles, on the bottom of the fuselage at the wing trailing edge. The ac receptacle may be used to furnish power, between 380 and 770 cycles per second, for ground operation of the radar.

Inverter External Power Receptacle.

The center electrical receptacle (figure 1-14), on the bottom of the fuselage, allows inverter power to be supplied by an external power source for ground purposes only. The center receptacle has been modified so that external power for the radar and electronic equipment can be supplied simultaneously. The inverters are disconnected when the external power source is connected and the engine master switch is OFF, allowing for extended ground operation providing 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 disconnecting, the engine master switch should be turned ON before removing the plug.

Inverter Selector Switch.

The inverter selector switch, on the right instrument subpanel (figure 1-8), is used for manually selecting the main or spare inverter as power sources for the ac-operated equipment. The switch (powered by monitored bus No. 2) has two fixed positions: MAIN, which is for all normal operation; and SPARE, for a secondary inverter power source in case of main inverter failure. 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 secondary inverter to drop its power supply to the radar equipment and making it available to the other ac-operated equipment.

Alternator Switch.

A guarded, two-position switch for control of the alternator is provided at the bottom of the right instrument subpanel. (See figure 1-8.) When the switch is in the ALTERNATOR 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 monitored bus No. 3 and should be at ALTERNATOR at all times unless an alternator failure is indicated by loss of radarscope picture.

Inverter Failure Warning Lights.

Failure of the main inverter is indicated by steady illumination of an amber warning light on the right instrument subpanel. (See figure 1-8.) Steady illumination of a red warning light, adjacent to the main inverter warning light, indicates failure of both inverters. Both of the inverter failure warning lights receive their power from the primary bus. Refer to Section VII for further information on inverter failure warning lights and their characteristics.

Note

The electronic engine controls (main fuel control valve, afterburner fuel control valve, and the exhaust nozzle control) will automatically lock up when ac power fails.

AC Fuses.

Most of the ac circuits are protected by fuses which are replaceable in flight. The fuses are grouped together on panels (13, figure 1-6; 13, figure 1-7) on each side of the cockpit. One group is on the panel next to the throttle; the other group is aft on the right console.

UTILITY HYDRAULIC POWER SUPPLY SYSTEM.

The utility hydraulic power supply system is a closed-center, constant-pressure type system incorporating an engine-driven, variable-output pump. (See figure 1-15.) 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 power for operation of the landing gear, speed brakes, nose wheel steering, and wheel brakes. (See figure 1-26 for hydraulic fluid specification.)

UTILITY HYDRAULIC SYSTEM INDICATORS.

Hydraulic Pressure Gage and Pressure Gage Selector Switch.

A pressure gage (29, figure 1-5) is on the small subpanel directly beneath the main instrument panel, with a pressure gage selector switch (30, figure 1-5) adjacent

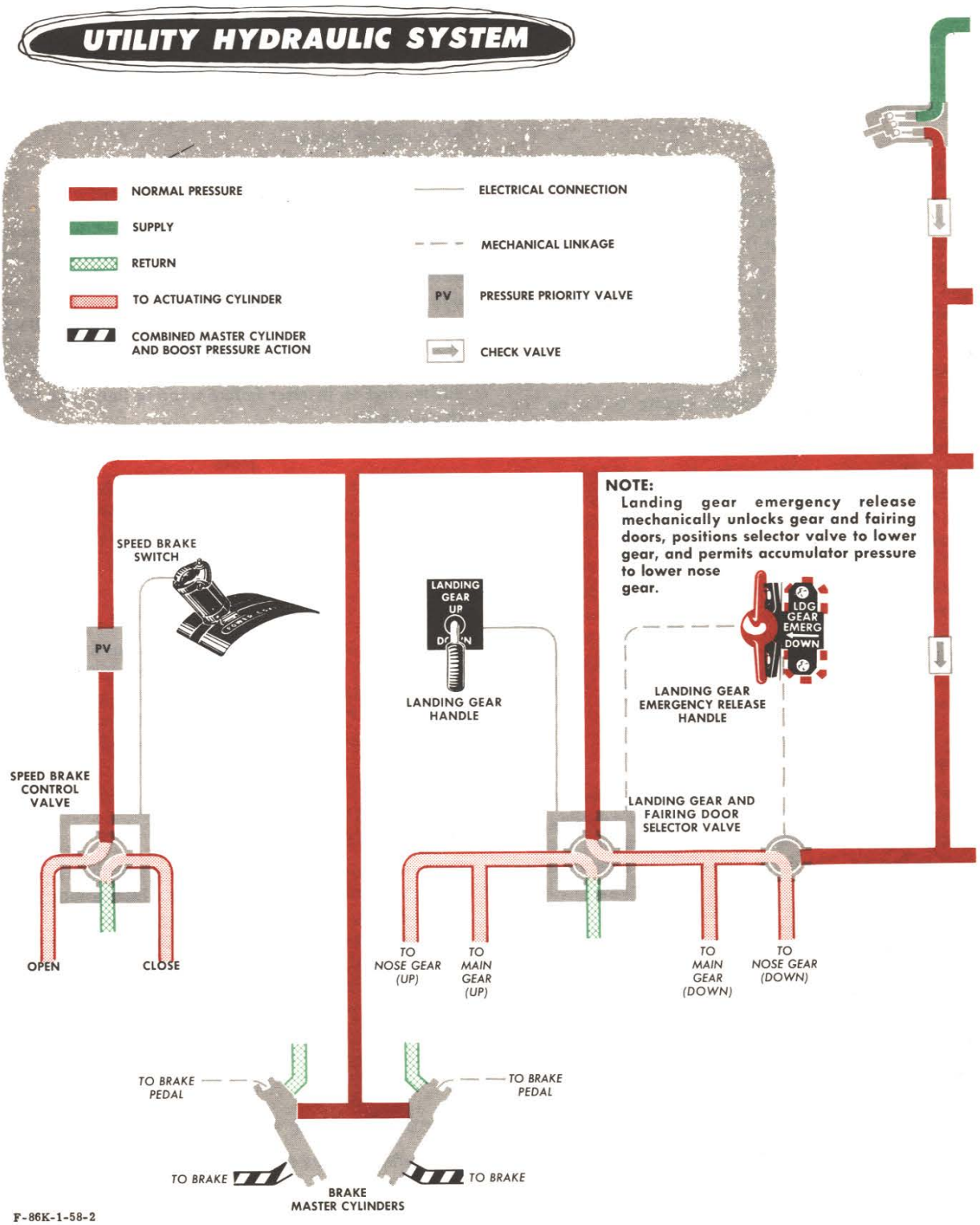
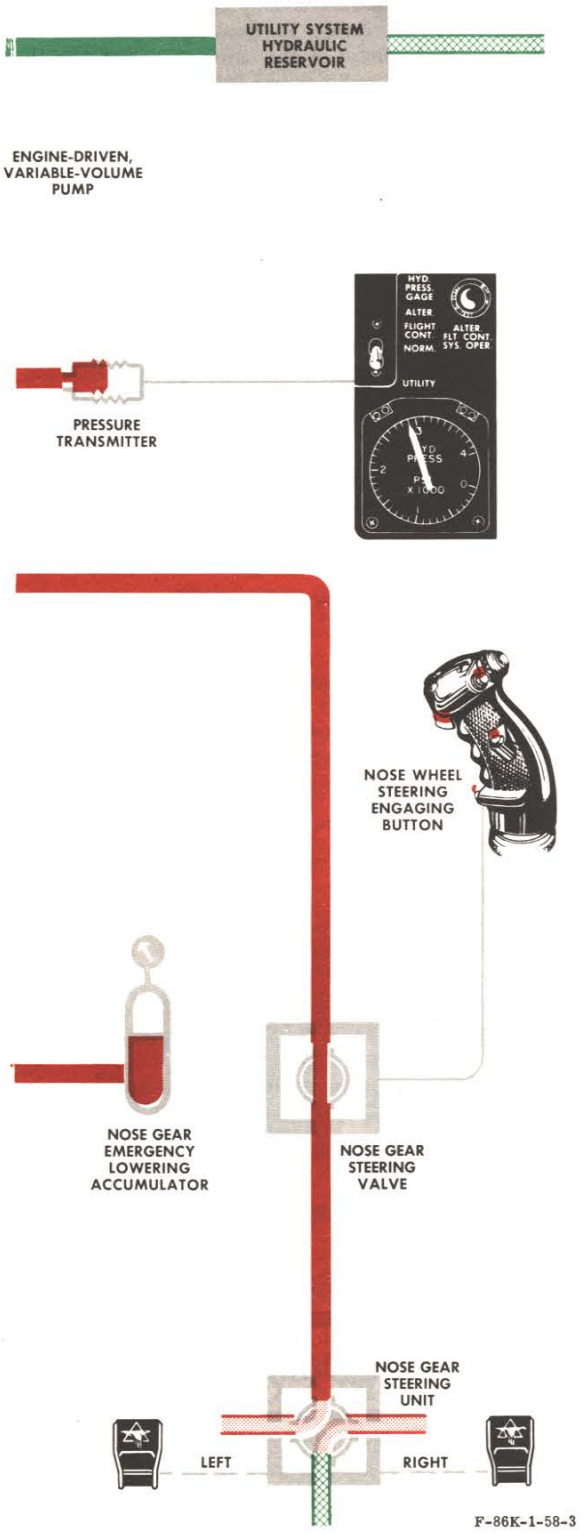

UTILITY HYDRAULIC SYSTEM
NORMAL PRESSURE
SUPPLY
RETURN
TO ACTUATING CYLINDER
COMBINED MASTER CYLINDER AND BOOST PRESSURE ACTION
ELECTRICAL CONNECTION
MECHANICAL LINKAGE
PV
PRESSURE PRIORITY VALVE
CHECK VALVE
NOTE:
Landing gear emergency release mechanically unlocks gear and fairing doors, positions selector valve to lower gear, and permits accumulator pressure to lower nose gear.
SPEED BRAKE SWITCH
PV
LANDING GEAR UP
LANDING GEAR HANDLE
LDG GEAR EMERG DOWN
LANDING GEAR EMERGENCY RELEASE HANDLE
SPEED BRAKE CONTROL VALVE
LANDING GEAR AND FAIRING DOOR SELECTOR VALVE
OPEN
CLOSE
TO NOSE GEAR (UP)
TO MAIN GEAR (UP)
TO MAIN GEAR (DOWN)
TO NOSE GEAR (DOWN)
TO BRAKE PEDAL
TO BRAKE PEDAL
TO BRAKE
TO BRAKE
BRAKE MASTER CYLINDERS
F-86K-1-58-2

Figure 1-15



to it. The switch is positioned to either UTILITY, NORMAL, or ALTER to obtain pressure gage readings for the respective systems. As the pressure gage is ac powered, it is operable, along with the pressure gage selector switch, when power is supplied by the ac bus. (Refer to figure 5-1 for the gage markings.)

Utility Hydraulic System Fluid Quantity Gage.

The amount of fluid in the utility hydraulic system reservoir is indicated by the fluid quantity gage (figure 1-26) in the top of the fuselage, behind the canopy. The gage should be checked for a full (in the green) indication before flight. If the tank cap is to be removed, bleed off the air pressure first.

FLIGHT CONTROL SYSTEM.

Four 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 incorporates a variable-slope feel, longitudinal control system. This feature is designed to minimize sensitivity and overcontrol by increasing the stick force gradient during high-speed flight conditions. For increased longitudinal control at low-speed flight conditions, stick forces and travel are reduced to provide a more positive control response and at the same time be more desirable for the pilot. Two single-acting bungees are installed: one for pull forces and one for push forces. When one bungee (either the push or pull) is actuated, the other bungee is idle. The horizontal tail has a control valve that allows quick response characteristics when surface movement is started and stopped. The ratio of the stick throw (movement) and stabilizer displacement is varied by a mechanical linkage in the follow-up 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 approximately equal (for a given amount of stick movement, the stabilizer moves approximately 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 slow-speed flight (airplane trimmed nose-up), as the stabilizer deflection will be larger for a small stick movement. (See figure 1-16.)

Second, the ailerons and horizontal tail are completely hydraulically operated. The conventional rudder system is installed. Movement of the control stick positions only the hydraulic control valves that direct pressure to the respective surface actuating cylinders. Third, to provide normal stick feel to the pilot at all times, an artificial feel system (spring-loaded bungees and a bobweight) is built into the control system. Fourth, no control surface trim tabs are required on the ailerons or 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 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. The one-piece horizontal tail affords 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 senses rate of directional changes and electrically varies rudder position to dampen out the change. It should be on during the search and attach 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, in order to supply the usual stick feel under all flight conditions, an artificial-feel system is installed. (See figure 1-16.) Normal stick forces resulting from G are provided through a bobweight, while 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 control stick no-load position is changed and desired trim is obtained.

FLIGHT CONTROLS AND INDICATOR.

Control Stick.

The control stick grip (figure 1-17) has an aileron and horizontal tail normal trim switch, a camera and gun firing trigger (which also fires the missiles on airplanes changed by T.O.), a nose wheel steering engaging button, a microphone button, and an automatic pilot release switch.

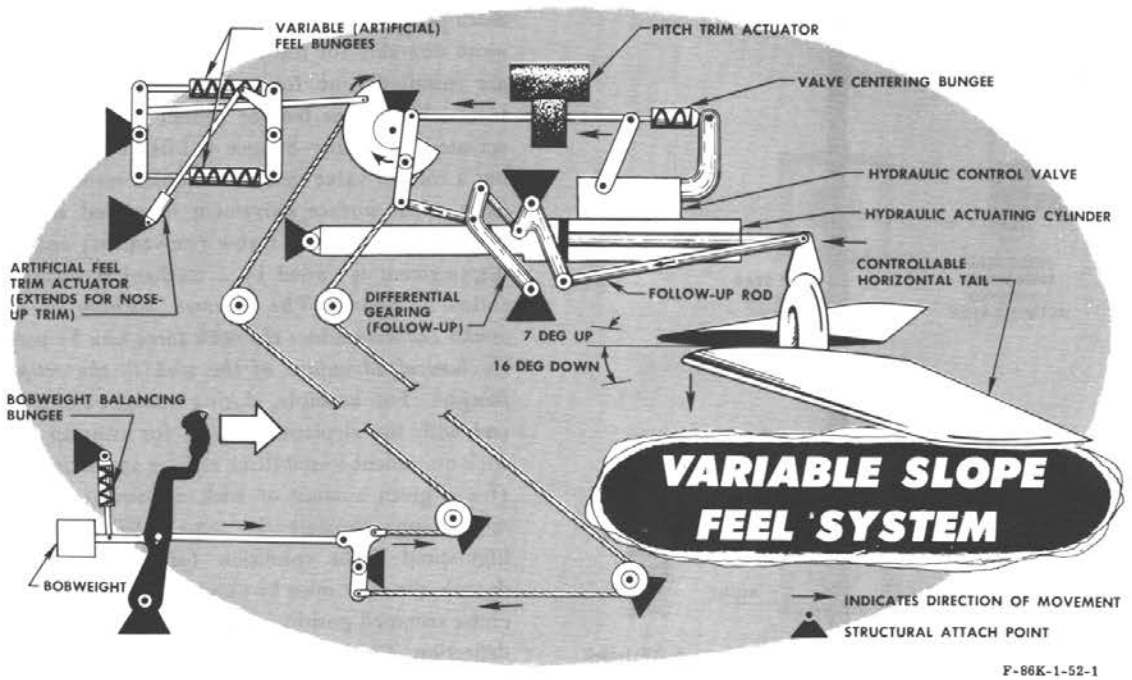


Figure 1-16

Figure 1-17

Rudder Pedals.

The angle of the rudder pedals is adjustable on the ground. The pedals can also be individually adjusted fore and aft by means of 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 will lock as selected when the lever is released.

Control Lock.

The control surfaces are locked against external loads at all times because of the irreversible hydraulic system. The rudder lock handle (18, figure 1-6) is aft on the left 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, as 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 1-17.) This switch is powered by the secondary bus and is spring-loaded to the center position. Trim is effected by positioning 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 nose down, while holding it aft trims the nose up. When the switch is 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 DD 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 Longitudinal Trim Switch.

A four-position switch, on the flight control panel (figure 1-18) on the left console, provides an alternate trim circuit for the horizontal tail. This switch accomplishes longitudinal trim at the same speed as the normal trim switch. The alternate longitudinal trim switch must be kept at NORM. if the normal trim switch (on the stick grip) is to be used for trimming. Moving the alternate longitudinal trim switch to OFF disconnects both the alternate and the normal trim circuits for the stabilizer, and prevents operation of the stabilizer automatic trim by the autopilot. Holding the switch at NOSE UP or NOSE DN overrides any malfunction of the normal trim switch and trims the airplane accordingly. The switch is powered by the secondary bus and is spring-loaded from NOSE UP or NOSE DN to OFF.

Alternate Lateral Trim Switch.

A four-position switch, on the flight control panel (figure 1-18), provides an alternate means of lateral trim. Trim by this switch is done at the same speed as by the normal trim switch. Ordinarily, this switch is kept at NORMAL, which allows use of the normal trim switch on the control stick. Placing the switch at OFF disconnects both normal and alternate aileron trim circuits; holding the switch at either LEFT or RIGHT overrides any mal-

function of the normal trim switch and will trim the corresponding wing down. The switch is powered by the secondary bus and is spring-loaded from LEFT or RIGHT to OFF.

Rudder Trim Switch.

Rudder trim is electrically controlled through a spring-loaded switch on the flight control panel. (See figure 1-18.) 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 (19, figure 1-7), located on the vertical panel forward of the right console and powered by the monitored bus No. 2, controls the yaw damper. Placing the switch in the ON position puts the yaw damper into operation, provided 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.

An amber light, on the flight control panel (figure 1-18), indicates the take-off trim position for the ailerons, horizontal tail, and rudder. The light is powered by the secondary bus; it comes on whenever any one of these surfaces is trimmed to the take-off position and goes out when the trim switch is released; it comes on again when the next surface is trimmed for take-off, etc. 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 the ailerons and the horizontal tail. (See

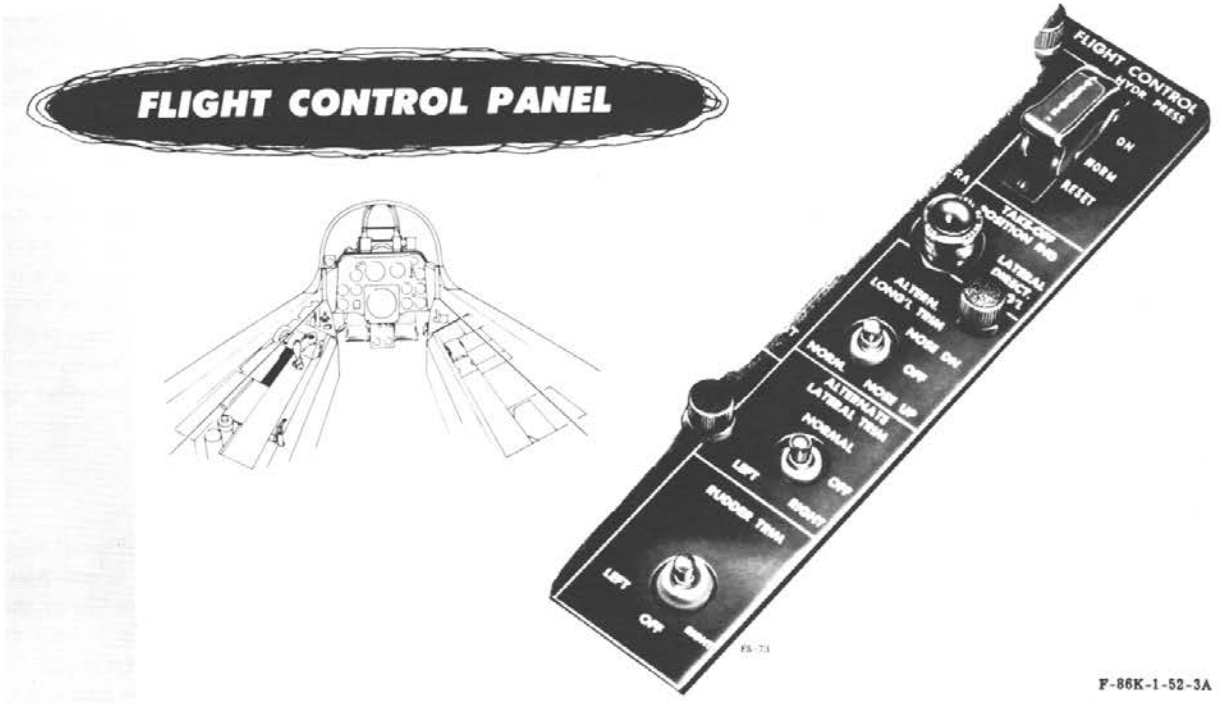


Figure 1-18

figure 1-19.) 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 automatic 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 tests the alternate system by simulating a failure of the normal system. When normal system pressure falls below 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 the alternate system pressure is also below 650 psi, a second pair of pressure switches in the alternate system lines will remain open; the circuits to the solenoid-operated valves will not be completed, and the valves will remain in the positions to utilize normal system pressure. Therefore, automatic transfer to the alternate system is prevented if alternate pressure is below a usable amount. (See figure 1-26 for fluid specification.) Refer to Section VII for additional information on these systems.

Flight Control Normal Hydraulic System.

The system is pressurized by a variable-volume, engine-driven pump which receives fluid from the normal system reservoir and compensator. The pump is supplemented by an accumulator for instantaneous high rates of demand. The accumulator air pressure gage (figure 1-26), behind the same access door as the engine oil filler point, should be checked before flight for 600 to 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 independently of each other; malfunction or loss of fluid in one valve or cylinder does 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 can be seen after 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 a maximum of 1¼ inches and should be checked before flight.* This flight control system is irreversible, in that movement of the control stick, which is mechanically linked to the control valves, directs system pressure through the valves to the actuating cylinders, moving the corresponding control surface. Thus, air loads on the control surfaces are not transmitted to the control stick. The ailerons are designed to hold against air loads up to the structural design limits of the airplane, and the horizontal tail is designed to withstand air loads exceeding these limits.

Flight Control Alternate Hydraulic System.

The system (figure 1-19) is pressurized by an electric-motor-driven pump, which receives fluid from an alternate reservoir and 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 the alternate system accumulator pressure drops below 2700 psi. The operation of the alternate system is identical to that of the normal system. Whenever the alternate system shutoff valve opens, an indicator light comes on in the cockpit, indicating 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 ¼ inch to a maximum of 1¼ inches.*

Flight Control Switch.

A three-position flight control switch, on the flight control panel (figure 1-18) aft of the throttle, provides selective changing from the normal to the alternate flight control hydraulic system for test purposes. The three positions are ON, guarded NORM, and spring-loaded RESET. With the switch in the NORM position (with engine running), the normal system supplies pressure to the flight controls, and the alternate system will cut in automatically should the normal system fail. With the switch in the ON 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 ON. To return control to the normal system, the switch must be moved to the spring-loaded RESET position momentarily before it is returned to NORM. With the switch at RESET, the normal system shutoff valve is opened and the alternate system valve is closed. However, when the switch is returned from RESET to NORM, if normal system pressure is below 650 psi, the valves will automatically transfer again and the alternate system will return to operation. If the switch is positioned at NORM without first being moved to RESET, the alternate system will continue to operate.

FLIGHT CONTROL HYDRAULIC SYSTEM

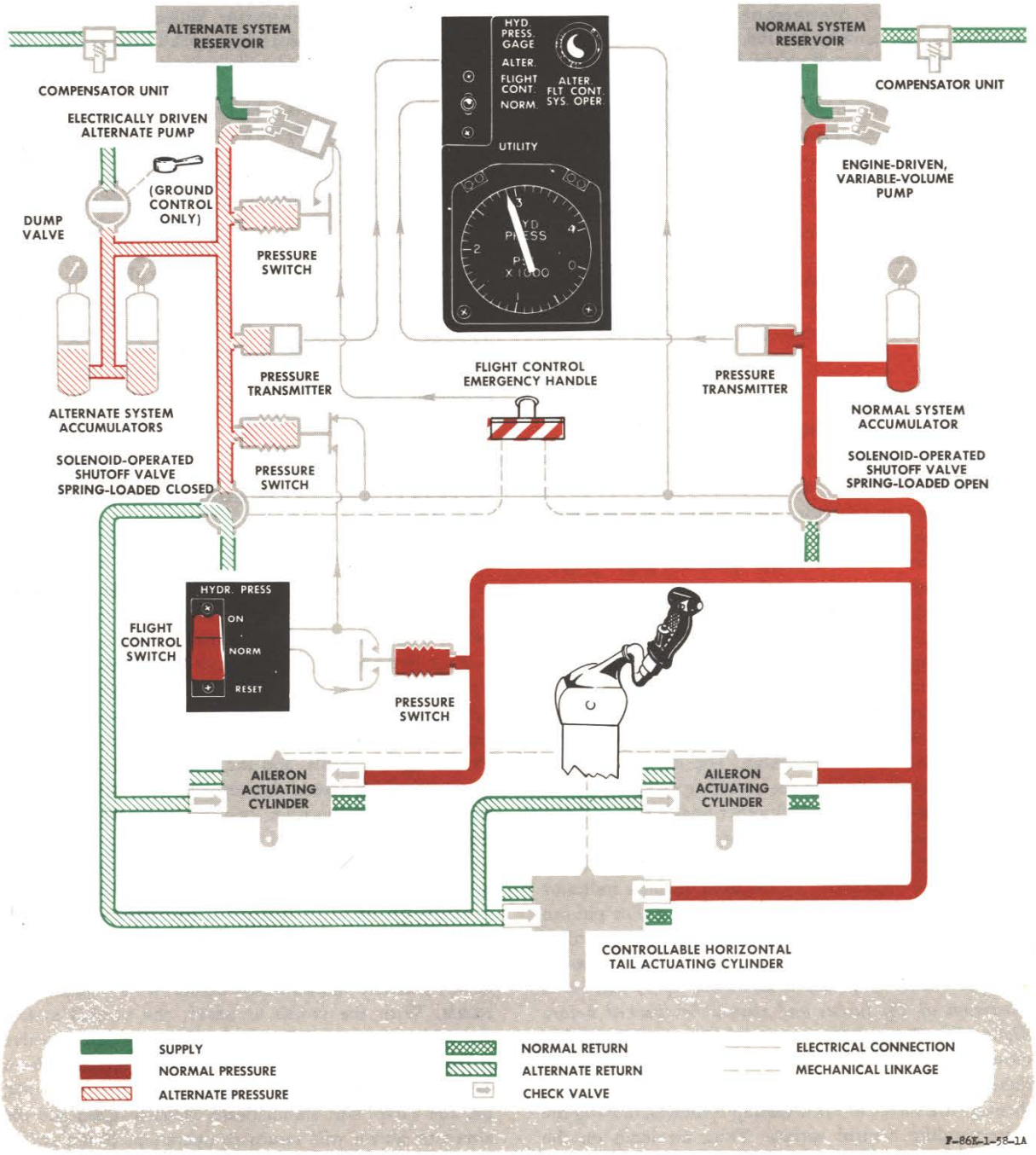


Figure 1-19

Regardless of switch position, the normal system will not operate if the engine is not running. The alternate system may be checked, however, without the engine running, by use of an external electrical power source; to check transfer of operation of the normal system to the alternate system, the engine must be running. The switch is normally powered by the primary bus; however, if the primary bus fails, the switch will automatically be powered by the battery bus.

Flight Control Emergency Handle.

For manual change-over of operation from the normal to the alternate flight control hydraulic system, a flight control emergency handle (37, figure 1-5) is located below and to the left of the main instrument panel. When the handle is pulled rapidly aft about 2½ inches, the alternate pump is turned on and the solenoid-operated valves in the normal and alternate flight control hydraulic systems are manually actuated, shutting off normal system flow and supplying alternate system pressure to the flight controls. The valves will 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 ranging as high as 4000 psi, which is above the maximum marked on the hydraulic pressure gage. This is also the pressure at which the alternate system 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 will continue to operate until the flight control switch is momentarily positioned to RESET and then placed at NORM.

CAUTION

The flight control alternate hydraulic system pump operates continuously as long as the manual emergency change-over handle is actuated. Decreased pump life may result from excessive periods of operation; also, drain on the battery in case of generator failure would appreciably shorten battery life. In addition, manual change-over to the alternate system may prevent return to the normal system if the change-over valve sticks. This would necessitate the duration of the flight to be performed on the alternate system. Therefore, do not actuate the manual emergency change-over handle in flight, except when the normal system fails and automatic (electrical) change-over to the alternate system does not occur, or just before entering the landing pattern when flying on the alternate system after normal system failure.

Hydraulic System Pressure Gage and Pressure Gage Selector Switch.

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

Flight Control Alternate System Indicator Light.

An amber light (32, figure 1-5), below the instrument panel, comes on whenever the flight control alternate hydraulic system is operating. Electrical power for this light is from the battery bus.

Flight Control Alternate System Accumulator Air Pressure Gages.

Two accumulator air pressure gages (figure 1-26) and the fluid and air 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 600 to 650 psi with the alternate system hydraulic pressure depleted. The pressure is depleted by opening a dump valve 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 (19, figure 1-1) 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. On Group 4 and airplanes changed by T.O., an improved wing leading edge and slat assembly has been installed. The new slat is known as the "6-3 slatted wing leading edge." The new slatted leading edge can be identified by a sharper leading edge and a thinner slat section. The purpose of the 6-3 leading edge is to give better high-altitude performance as well as good low-speed handling characteristics.

WING FLAP SYSTEM.

Electrically operated, slotted-type wing flaps (21, figure 1-1) 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 in the normal system through the mechanical interconnection, the individual electric motors, and the individual electric circuits.

WING FLAP HANDLE.

The wing flap handle (8, figure 1-6), outboard of the throttle, 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. However, after complete flap retraction is made, the handle should remain at UP. Refer to Section VII for additional information on this system.

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 will open or close in about 2 seconds. A slight nose-up pitch will be noticed when speed brakes are opened and, correspondingly, a slight nose-down pitch will be evident when the brakes are closed. Speed brakes can be positioned as desired.

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.

Note

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

SPEED BRAKE SWITCH.

A serrated toggle switch, on top of the throttle grip (figure 1-9), 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 indicated 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).

Note

- 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 fire hazard in case of a damaged line.
- If the speed brakes do not open when the control switch is positioned to OUT, return switch to the neutral position. The switch should not be cycled to IN and OUT, as additional fluid will be lost with each cycle if the malfunction is caused by a broken line.

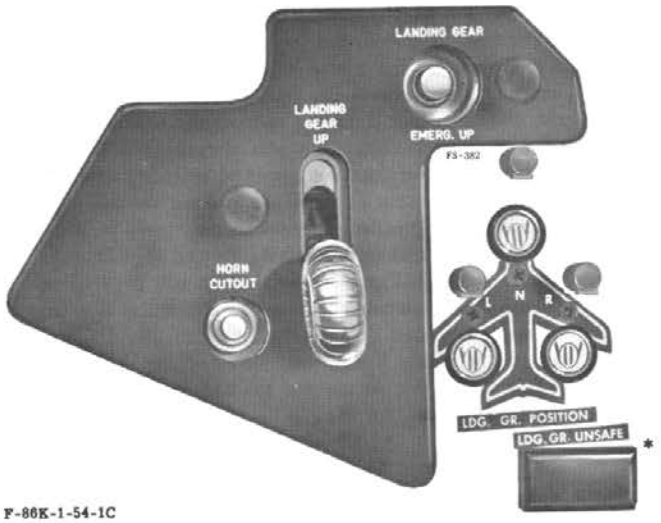
LANDING GEAR SYSTEM.

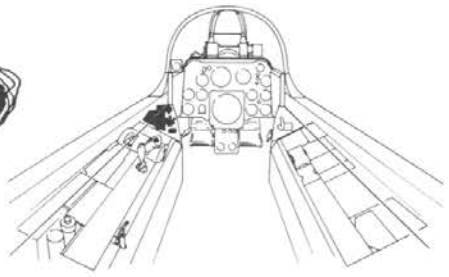
The landing gear and wheel fairing doors are hydraulically actuated and electrically (dc power) controlled and sequenced. An accumulator supplies pressure for emergency lowering of the nose gear. The accumulator air pressure may be checked by operating the nose gear accumulator dump valve in the nose wheel well. The air pressure should be 1200 (±50) psi with the 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 1-20) above and forward of the left console, electrically

LANDING GEAR CONTROL PANEL





NOTE

***Landing gear unsafe warning light is located on left side of instrument panel shroud on F-86K Airplane AF54-1251 and all subsequent airplanes. (Also those changed by T.O.)**

An additional warning light is located in the gear handle of all airplanes.

Figure 1-20

controls the landing gear and the gear-door selector valves. The gear handle has two positions, UP and DOWN. It receives its power from 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 will follow their normal sequence, opening when the gear handle is moved to UP.

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.

A guarded emergency-retract switch is above the gear handle on the landing gear control panel. (See figure 1-20.) When the gear handle is at UP and the emergency-retract button is depressed and held, the ground safety switch is bypassed and the gear can be retracted on the ground.

CAUTION

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

WARNING

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

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 (19, figure 1-5), below the instrument panel on the right, is pulled, with a force of about 65 pounds, to full extension (about 14 inches), all fairing doors and the main gear uplocks are mechanically unlocked, gear and door hydraulic selector

valves are positioned 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 emergency-lowering control valve is manually reset while the airplane is on the ground. The red control valve-reset shaft is pushed out during emergency nose gear lowering and protrudes from the right side of the fuselage just above the nose gear door. Pushing this reset rod in until it is again flush with the fuselage skin molding resets the nose gear emergency release system. 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 fully extended position until landing gear indicators show a safe landing gear position.

CAUTION

To prevent damage to the surrounding equipment, maintain a grip on the handle until it retracts to the stowed position.

LANDING GEAR DOOR GROUND CONTROL SWITCH.

A guarded switch is provided in the recess for the pilot's retractable step on the left forward side of the fuselage, to open the landing gear wheel well doors for ground maintenance. The switch has two positions, OPEN and CLOSE, and is powered by the primary bus. 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 one exception. If, after the switch has been moved to OPEN, the doors will not open because of lack of hydraulic pressure, then, with the switch still at OPEN, 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 emergency-lowering valve must be reset before the next flight.

LANDING GEAR SYSTEM INDICATORS.

Three landing gear position indicators (figure 1-20) are on the landing gear control panel to provide a visual indication of the condition of the gear and fairing doors. An unsafe gear warning light is in the landing gear control handle. On early airplanes* an additional gear unsafe warning light is located on the landing gear control panel. On later airplanes† and those changed by T.O., an additional gear unsafe warning light (4, figure 1-5) is on the upper left side of the instrument panel shroud. Each indicator shows red crosshatching if the related gear is in an unlocked condition, the word "UP" if the gear is up and locked, or a miniature wheel if the gear is down and locked. Red crosshatching will also appear if the electrical system is inoperative. The warning light comes on any time the landing gear or the door position does not correspond with the position of the gear handle, or when the throttle is retarded below minimum cruising rpm and gear is not down and locked. A warning horn in the cockpit sounds when the gear is in any position other than down and locked if the throttle is at less than cruising power. A warning horn cutout button (figure 1-20), beside the gear handle, is provided to silence the horn. Advancing the throttle silences the horn and resets the horn circuit. Both the unsafe warning light and the warning horn operate either in the air or on the ground whenever power is available. Power for the landing gear position indicators, unsafe warning light, and warning horn is received from the primary bus. The landing gear unsafe warning light is automatically dimmed when the instrument panel lights are turned on.

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 1-17.) 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, on the left side of the nose gear assembly just above the wheel (figure 1-21) 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.

CAUTION

It is important to check before flight to make sure that the safety cap is on and tight; this will ensure that the release pin is engaged and that nose gear will retract properly.

***F-86K Airplanes AF54-1231 through -1250**
†F-86K Airplane AF54-1251 and all later airplanes

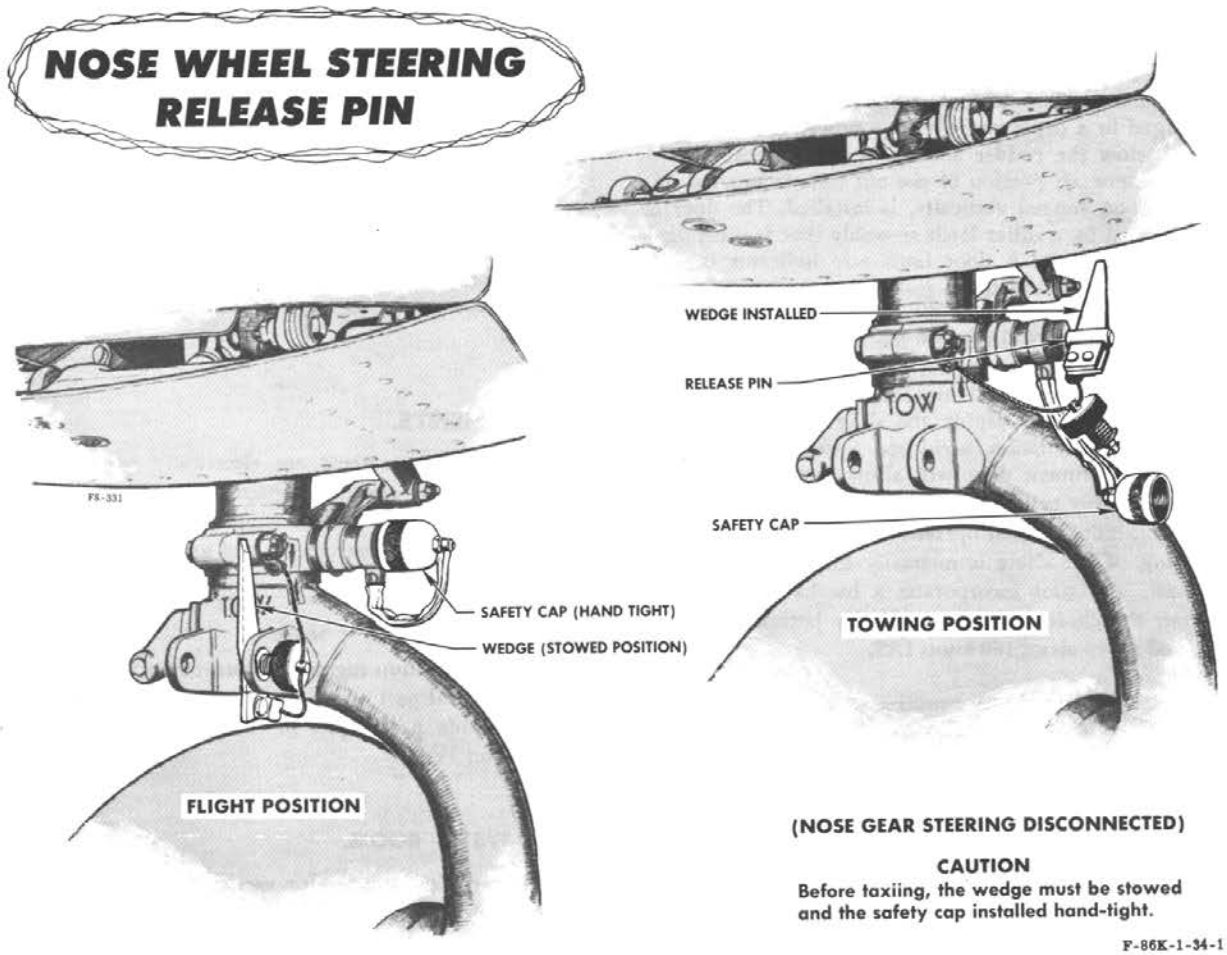


Figure 1-21

NOSE WHEEL STEERING ENGAGING BUTTON.

An engaging button, on the control stick grip (figure 1-17), is depressed to operate the nose wheel steering system. In order to engage the nose wheel steering unit, the switch must be depressed 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 will remain engaged as long as the switch is depressed. 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, 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 due to disk warpage resulting from high temperatures. 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 function through conventional action of the brake master cylinders when sufficient toe pressure is applied to the rudder pedals. Excessive use of the brakes can cause them to overheat and, in turn, cause detrimental effects upon the tires. If the heat is great enough, it can cause the tires to weaken and subsequently blow out. Best braking results are obtained by applying the brakes below 100 knots IAS, intermittently and hard, but not hard enough to stop wheel rotation.

Note

This airplane is not equipped with parking brakes.

DRAG CHUTE SYSTEM.

A drag chute (3, figure 1-1) is provided to reduce landing distances. The 16-foot, ring-slot type drag chute, packaged in a deployment bag, is stowed in a compartment below the rudder and above the exhaust nozzle. The extreme aft portion of the tail cone is squared off, and a door, hinged vertically, is installed. The door is held closed by a roller latch assembly that is controlled from 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. On some airplanes* mechanical linking of the riser assembly to the release mechanism is not accomplished 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 will allow 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 incorporates a breakaway fitting to permit the chute to be automatically jettisoned if it is opened above about 160 knots IAS.

CAUTION

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

DRAG CHUTE HANDLE.

The drag chute handle (3, figure 1-5) is in a bracket directly above the upper left corner of the instrument panel. Pulling the drag chute handle straight aft, without turning it, to the first stop position (about 2 inches) releases the compartment door, allowing the pilot chute to be deployed, which, in turn, opens 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 more inches). This releases the locking assembly and allows the chute to be jettisoned.

CAUTION

To prevent the drag chute from being jettisoned inadvertently when it is deployed, the drag chute handle should be actuated with a smooth, steady pull. Abrupt handle movement with excessive force may cause overrun of the operating linkage and jettisoning of the drag chute. (Do not use handle as handhold when entering or leaving the cockpit.)

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 adjacent to the latch to indicate 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 1-14.) 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 in 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. Boom anti-icing protection is afforded by electrical heating elements. (Refer to "Anti-icing and Defrosting Systems," in Section IV.)

AIRSPEED INDICATOR.

The airspeed indicator (7, figure 1-5) is essentially a conventional airspeed indicator with the addition of a maximum allowable airspeed pointer which indicates maximum airspeed for the airplane when it is equipped with drop tanks. The fluorescent pointer registers indicated airspeed. The striped pointer is used as a limit only when drop tanks are carried. This pointer is preset for the limit Mach number of the airplane with drop tanks, and it moves to show the airspeed corresponding to the limit Mach number or limit airspeed, whichever is less, during flight at 15,000 feet or below. Clockwise movement of the striped pointer will stop at the limiting airspeed at low altitude.

*F-86K Airplane AF54-1276 and all later airplanes

MACHMETER.

A Machmeter (35, figure 1-5) is provided for use in conjunction with the airspeed indicator. The Machmeter indicates the speed of the airplane in relation to the speed of sound.

AIRSPEED AND MACH NUMBER INDICATOR.*

This combination instrument (figure 5-1) replaces the individual airspeed and Machmeter indicators and 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, sets 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 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, then 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.

ALTIMETER.

Some airplanes have standard type altimeters, while other airplanes are equipped with a modified altimeter 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.

ACCELEROMETER.

An accelerometer (1, figure 1-5), installed at the bottom of the left windshield bow, indicates G (positive and negative). Reference to this instrument provides an indication of structural loads. In addition to the conventional indicating pointer, there are two recording pointers (one for positive and one for negative G-loads) which follow the indicating pointer to its maximum attained travel. The recording pointers remain at the maximum travel positions reached by the indicating pointer, thus giving a record of maximum G-load 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. Illumination of the accelerometer is controlled by a switch on the aft edge of the left instrument subpanel, and power is supplied by the primary bus.

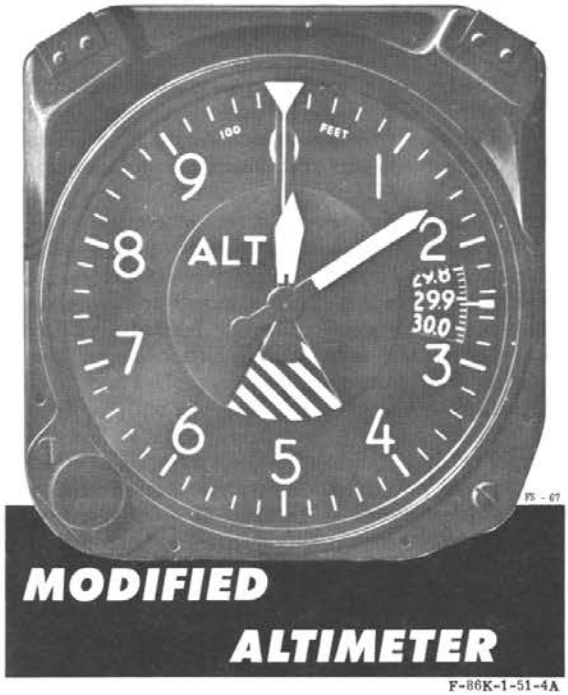


Figure 1-22

*F-86K Airplane AF54-1326 and all later airplanes

STAND-BY COMPASS.

A conventional magnetic compass (16, figure 1-5), mounted on the windshield bow to the right of the instrument panel, is furnished for navigation in the event of instrument or electrical system failure. Illumination of the stand-by compass is controlled by a switch, on the aft edge of the left instrument subpanel, and power is supplied by the primary bus.

DIRECTIONAL INDICATOR.

Refer to "Navigation Equipment," in Section IV.

ATTITUDE INDICATOR.

The Type B-1A attitude indicator (11, figure 1-5), on the instrument panel, indicates the attitude of the airplane in relation to the horizon. The indicator gyro is electrically driven and receives its power from the ac electrical bus. Erection of the indicator gyro requires about 2½ minutes after application of power and can be observed by disappearance of the "OFF" power-failure flag visible through the cover glass of the indicator. The "OFF" flag will appear in case of a complete ac or dc power failure. However, a slight reduction in ac or dc power, or failure of certain electrical components within the system, *will not* cause the "OFF" flag to appear, even though the system is not functioning properly.

WARNING

The "OFF" power-failure flag should not be relied upon as the sole means of determining malfunction of the attitude indicator. As an additional check, reference should be made to the turn-and-slip and directional indicators.

The instrument is operative through 360 degrees of roll, 82 degrees of climb, and 82 degrees of dive, and is not likely to tumble even during extreme maneuvers. However, should the gyro tumble, it will erect in about 2½ minutes if the circuit breaker labeled "VERTICAL GYRO," on the right console circuit-breaker panel, is momentarily pulled out and then pushed back in. If the circuit breaker is not used, the gyro will require about 15 minutes to erect. 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 the conventional indicator. In turns of 40 degrees or more per minute, a compensating mechanism in the instrument limits turn error to 2 degrees.

WARNING

A slight pitch error in the indication of the Type B-1A 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 bar-width error depends upon the acceleration and elapsed time of each individual take-off. The erection system automatically removes the error after the acceleration ceases.

The indicator does not have a manual caging handle. When electrical power is turned off, a snubber automatically grips the gimbal and keeps it from tumbling. When power is turned on, the snubber is released after a 15-second time delay. As the level-flight angle of attack of the airplane varies with different loadings and speeds, a pitch trim knob is provided on the indicator for the pilot to center the horizon bar after the airplane has been trimmed for level flight.

TURN-AND-SLIP INDICATOR.

The conventional turn-and-slip indicator (34, figure 1-5), on the instrument panel, is electrically driven by power from the primary bus. The instrument is calibrated so that a standard needle-width turn is equivalent to a 360-degree turn accomplished in 4 minutes (1½-degree-per-second rate of turn). Because of the excessive tilt required in the present installation of the turn-and-slip indicator, the instrument erroneously indicates a turn in the opposite direction during all entries into turns. The error increases with increased rate of roll. The turn needle indicates correctly only when there is no roll movement. When the attitude indicator is inoperative and the turn-and-slip indicator is being used as a primary flight instrument, the following instructions should be followed:

1. Avoid excessive rate of roll.
2. Maintain a constant angle of bank in a turn; the indicator then shows the correct rate and direction of turn.

EMERGENCY EQUIPMENT.

ENGINE FIRE-WARNING SYSTEM.

Two fire detector systems detect and indicate 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 each main landing gear wheel well*; the aft section, the combustion chambers and tail pipe. Each system consists of fire detector units mounted throughout the engine compartments and a warning light mounted in the cockpit. The warning lights (13, figure 1-5) are on the right side of the main instrument panel. Illumination of the red warning light, marked "FWD," indicates fire in the forward section of the engine compartment or in the wheel wells. Illumination of the amber warning light, marked "AFT," shows an excessive overtemperature condition or fire in the aft engine section. Operation of the warning system and lights can be checked by means of the system test switch next to the lights. When the switch is moved from NORM to the spring-loaded TEST position, the entire fire-warning circuit is energized and both warning lights should come on. The lights are powered by the primary bus and are of the push-to-test type, permitting check of bulb illumination independent of system operation.

CANOPY.

The electrically actuated clamshell-type canopy (9, figure 1-1) 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 jettison. 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 jettisoning of the canopy during flight is accomplished when either the right or left ejection seat armrest is raised to full-up position, which fires the canopy initiator and its gas charge fires the canopy ejector. The ejection seat armrests being 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 before the trigger can be squeezed and ejection through the canopy is possible.

GROUND AND MAINTENANCE SAFETY PINS.

The canopy jettison system is safetied by inserting a ground safety pin (figure 1-23) through a block on the front of the seat and across the trigger in the right seat armrest. This pin will prevent 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.

WARNING

The canopy ejector 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 seals 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 through 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 it is energized. If this bus is not energized, the battery bus supplies these buttons with power.

EXTERNAL CANOPY EMERGENCY RELEASE HANDLE.

An external canopy emergency release handle (figure 3-6) 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 in the top of the fuselage. See figure 3-6.

***F-86K Airplane AF54-1276 and all subsequent airplanes and those changed by T.O. 1F-86K-508**

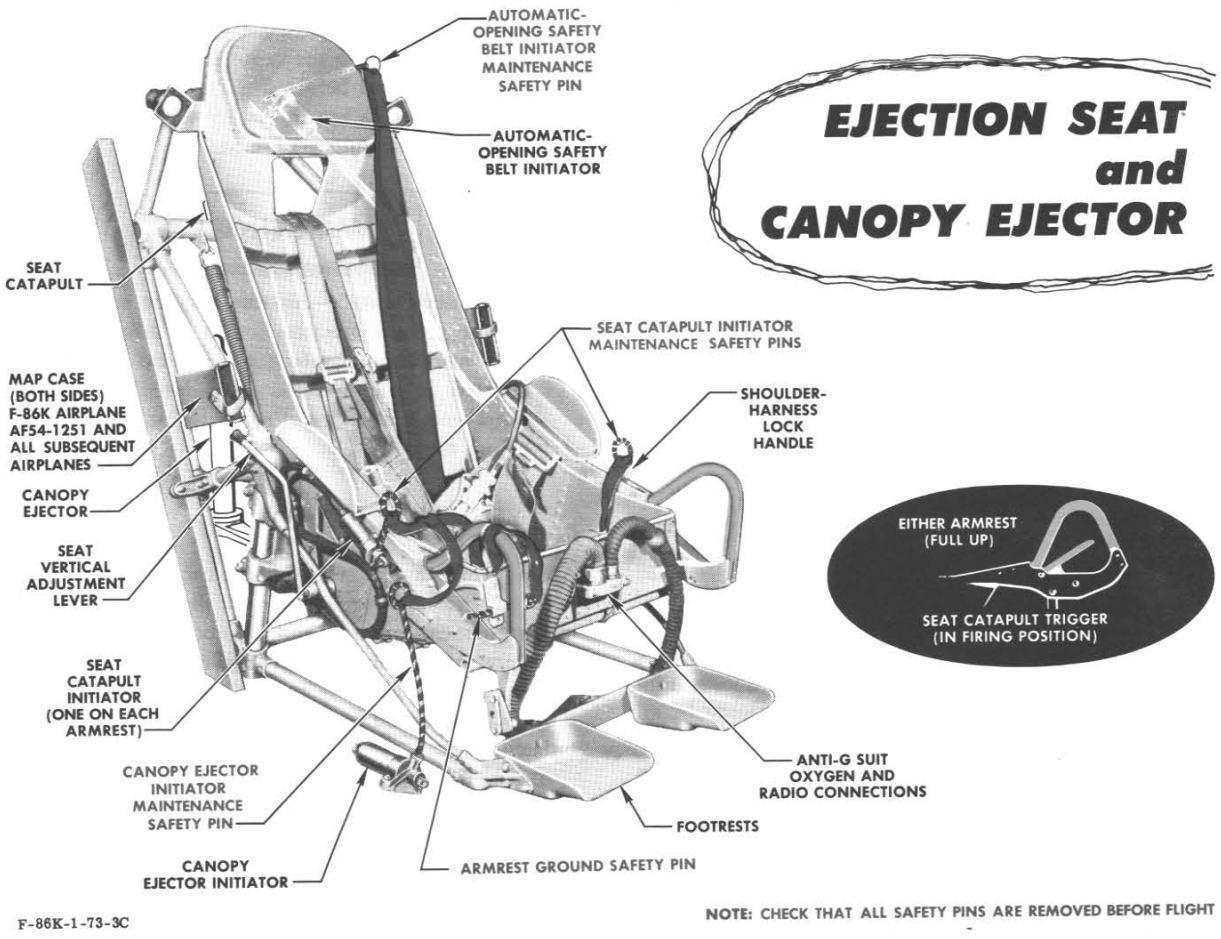


Figure 1-23

CANOPY SWITCH.

From within the cockpit, the canopy is controlled by a three-position toggle switch on the aft edge of the right instrument subpanel. (See figure 1-8.) To operate the canopy, the switch must be held at either of the spring-loaded positions, OPEN or CLOSE. 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.

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 (18, figure 1-5), 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. The latches are in the locked position when the yellow stripe on the latches is visible through the rig pin holes on the inboard face of the canopy frame. 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.

Note

During flight if it is desired to release the canopy without arming the ejection seat, the canopy may be released by manual unlocking and allowing the air stream to carry it away.

CANOPY EMERGENCY RELEASE (SEAT ARMREST).

The latches are released and the canopy ejector is fired when either armrest on the ejection seat (figure 1-23) is pulled full-up in preparation for seat ejection.

CANOPY UNSAFE WARNING LIGHT.

A canopy unsafe warning light (figure 1-8) is mounted on the aft edge of the right instrument subpanel. The light is powered by the primary bus and will come on and remain lighted 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 additional 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 1-23) 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.

WARNING

- When airplane is equipped with a one-man life raft or survival kit, the A-5 seat cushion, or any similar sponge rubber cushion should not be used. 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 PIN.

The seat ejection system is safetied by inserting a ground safety pin (figure 1-23) through a guide on the front of the seat and across the trigger in the right seat armrest. This pin locks the seat armrests in their stowed positions, thus preventing accidental firing of the canopy and positioning of the ejection seat firing triggers. The 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. These 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 (figure 1-23) are hinged to actuate the ejection sequence. The left armrest is interconnected to the right armrest so that lifting either armrest simultaneously raises the opposite armrest. A seat catapult trigger is provided on each armrest. Lifting either the right or the left armrest to the full-up position raises the opposite armrest, mechanically unlocks the canopy, fires the canopy ejector, locks the shoulder harness, and raises both triggers into firing position. Should the canopy ejector fail to fire when the armrests are raised, the air stream will carry the canopy away.

SEAT CATAPULT TRIGGERS.

A seat catapult trigger (figure 1-23) is beneath the handgrip at the forward end of each armrest of the ejection seat; the triggers are recessed in the armrests and thus protected by guards when the armrests are in the normal stowed position. As the armrests are interconnected, 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 for operation. Thus, if during emergency bail-out procedures 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. However, either armrest must be raised before the trigger can be squeezed and ejection through the canopy is possible.

SEAT VERTICAL ADJUSTMENT LEVER.

Vertical seat adjustment is done mechanically by operation of the seat vertical adjustment lever on the right side of the ejection seat. (See figure 1-23.) 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 footrests are stationary and may be used to assist in adjusting the seat.

CAUTION

After making air-borne or ground adjustment, be sure seat is locked in position, to prevent accidental firing of canopy caused by negative G forcing the unlocked seat to its top position hard enough to move the armrests upward.

SHOULDER HARNESS LOCK HANDLE.

The shoulder harness lock handle, on the left armrest of the ejection seat (figure 1-23), is conventionally operated for manually locking and unlocking the shoulder harness. In addition, 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, the harness will retract into successively 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 will remain 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.

SAFETY BELT.

The airplane is equipped with a B-18 manual-opening type safety belt, or an MA-1, MA-3 or MA-4, or an MA-5 or MA-6 automatic-opening type safety belt.

Automatic-opening Safety Belt.

The primary purpose of the automatic belt is to raise the maximum and lower the minimum altitudes at which escape may be successfully accomplished with the ejection seat. 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. If an automatic parachute is used in conjunction with the automatic belt, the time for full parachute deployment also is reduced. Consequently, use of the automatic belt and automatic parachute would lower the altitude required for safe ejection. Until you have become thoroughly familiar with the automatic belt and have been convinced that the automatic belt has been designed to save your life, you may have a tendency to distrust the automatic feature and feel that you can only be sure of its operation by manually operating it. However, the automatic belt has been thoroughly tested and is completely reliable. *Under no circumstances should the automatic belt be manually opened before ejection, regardless of altitude.* No matter how fast your reactions are, you cannot beat the automatic operation.

Before the use of automatic belts, instructions were issued that when ejection was necessary at less than 2000 feet above the terrain the conventional safety belt should be opened manually before ejection. However, manual release of automatic belts is not only undesirable but dangerous. The escape operation using the automatic feature is not only faster, since the belt automatically opens 2 seconds after ejection, but it also protects the pilot from severe injury at high speeds. (If the airplane is equipped with an M-12 automatic belt initiator, the belt opens 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 being blown open accidentally. The high opening shock of the parachute could cause serious or fatal injuries. So remember, *the automatic operation can't be beaten.*

MA-1, MA-3, and MA-4 Automatic Safety Belts. The Type MA-1, MA-3, or MA-4 automatic safety belt is a cartridge-operated device designed for use with the same webbing and fittings as used with the standard B-18 (manual) safety belt, but differs in the center section or release portion of the belt. Release of the MA-1, MA-3 or MA-4 belt is accomplished either by manual operation by the pilot or by gas pressure from a separate automatically controlled source, the M-4 (or M-12) initiator on the back of the seat. The initiator supplies approximately 1500 psi pressure through a high-pressure hose which actuates a piston inside the belt, retracting the latch tongue and releasing the link. The release incorporates a key which is attached to a lanyard leading to the automatic rip cord 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. This is a feature of the design so that the pilot will not neglect to tie the automatic parachute into the system. The key is necessary for proper operation of the automatic belt. If the automatic parachute is used, the key attached to the parachute lanyard is inserted into the belt locking mechanism. If the automatic parachute is not used, a spare key which is attached to the automatic belt must be inserted into the belt locking mechanism. (This spare key must not be removed from the belt.) 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 "D" ring, even though the automatic parachute rip cord release has been actuated.

WARNING

If the safety belt is opened manually, the parachute must be opened manually. (For automatic-opening parachutes, the aneroid-timer arming lanyard should be pulled to open parachute, if above 14,000 feet.

Figure 1-24 shows the automatic belts closed with shoulder harness attached, automatically opened, and manually opened.

MA-5 and MA-6 Automatic Safety Belts. The MA-5 and MA-6 automatic safety belts are similar in design and function to the MA-1, MA-3, and MA-4 belts. However, the MA-5 and MA-6 belts have a swivel link. When the belt is fully locked, the swivel 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. In addition, the MA-5 and MA-6 belts are designed to retain a ring-type anchor for actuating the automatic parachute, in place of a key. 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-5 or 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 1-24 shows the MA-5 and MA-6 belts closed with the 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 "D" ring, even though the automatic parachute rip cord release has been actuated.

WARNING

If the safety belt is opened manually, the parachute *must* be opened manually. (For automatic-opening parachutes, the aneroid-timer arming lanyard should be pulled to open the parachute, if above 14,000 feet.)

MA-1 AUTOMATIC-OPENING SAFETY BELT

LOCKED

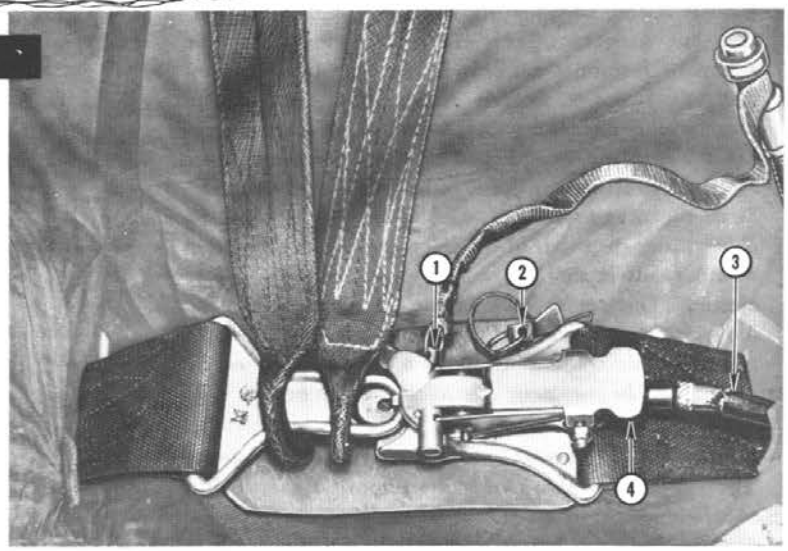
1. Belt locking key (attached to automatic parachute arming lanyard) inserted in belt locking mechanism.

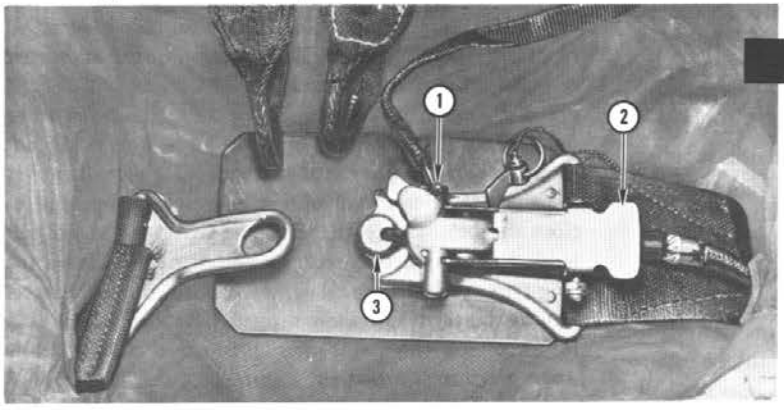
WARNING

This key must be used when an automatic parachute is worn, in order for the parachute to function automatically if ejection is necessary. Be sure the 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). Used to close belt only when automatic parachute is *not* worn.
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 automatic parachute is worn and belt is manually opened during ejection, parachute will *not* open automatically upon separation from 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.

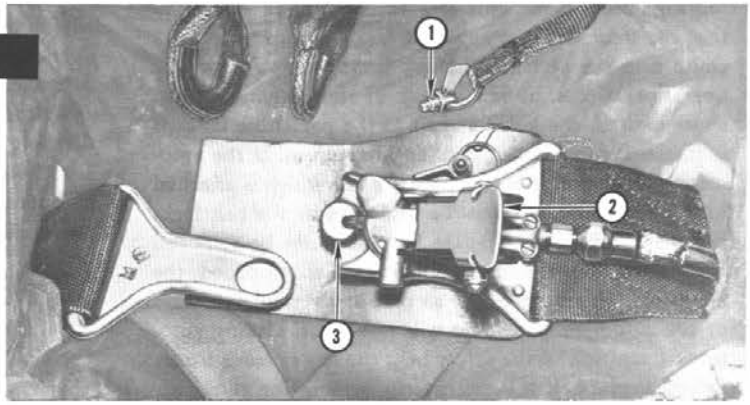


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Figure 1-24 (Sheet 1 of 3)

MA-3 AND -4 AUTOMATIC-OPENING SAFETY BELTS

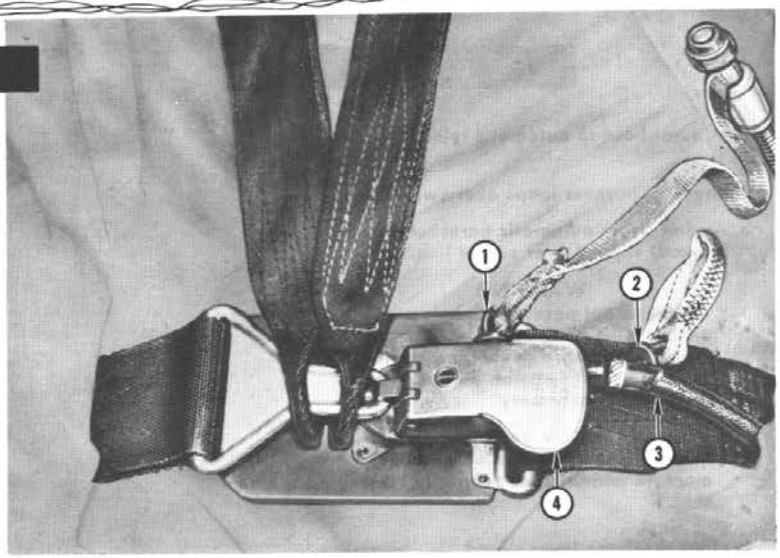
LOCKED

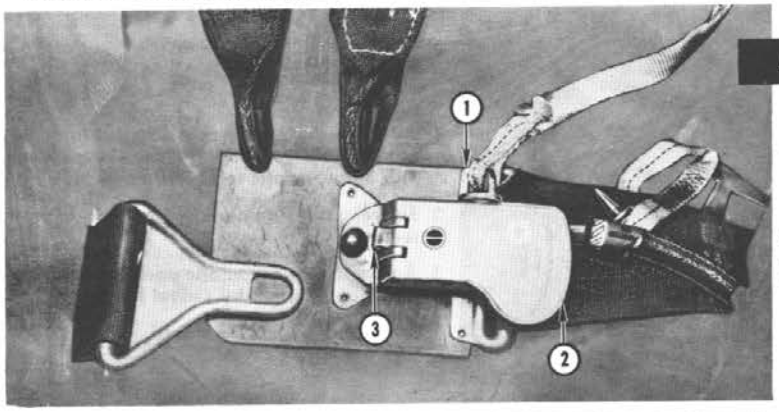
1. Belt locking key (attached to automatic parachute arming lanyard) inserted in belt locking mechanism.

WARNING

- This key must be used when an automatic parachute is worn, in order for the parachute to function automatically if ejection is necessary. Be sure key is inserted properly 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). Used to close belt only when automatic parachute is *not* worn.
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.

MANUALLY OPENED

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

WARNING

If automatic parachute is worn and belt is manually opened during ejection, parachute will *not* open automatically upon separation from 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.

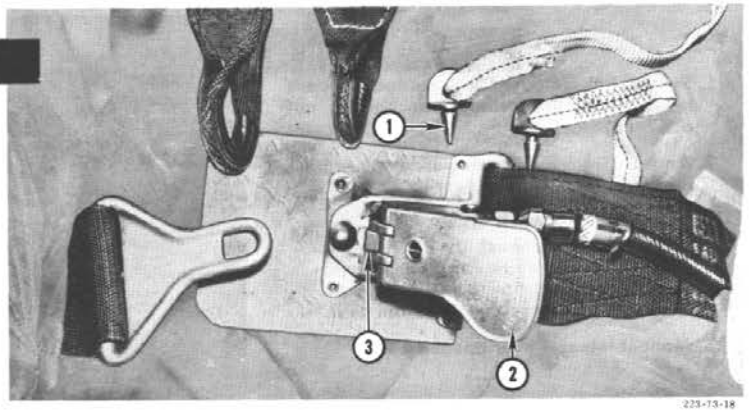


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Figure 1-24 (Sheet 2 of 3)

MA-5 AND -6 AUTOMATIC-OPENING SAFETY BELTS

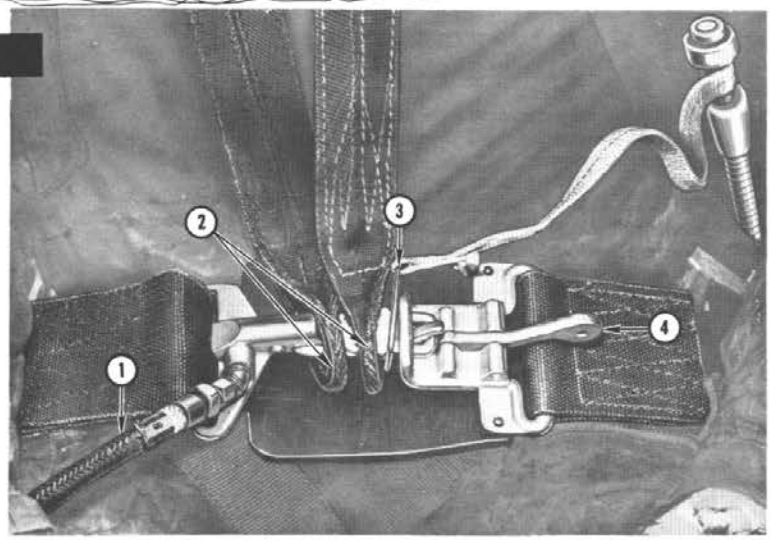
LOCKED

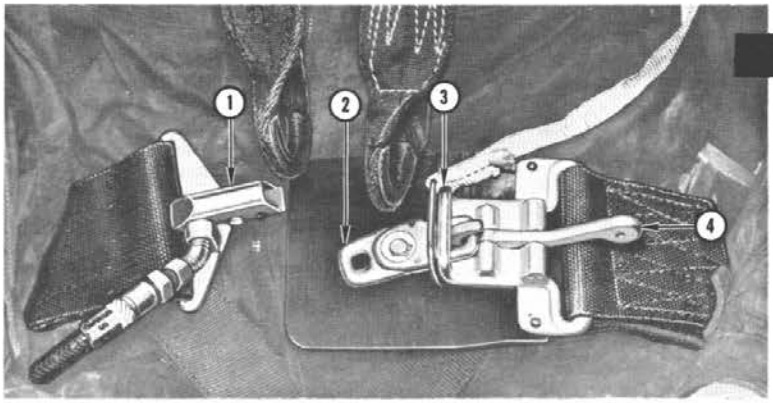
1. Initiator hose to automatic release mechanism.
2. Shoulder harness loops over swivel link.
3. Anchor (from automatic parachute arming lanyard) slipped over swivel link.

WARNING

- Although not necessary to close belt, anchor must be installed, when automatic parachute is worn, so that 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 automatic parachute is worn and 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.

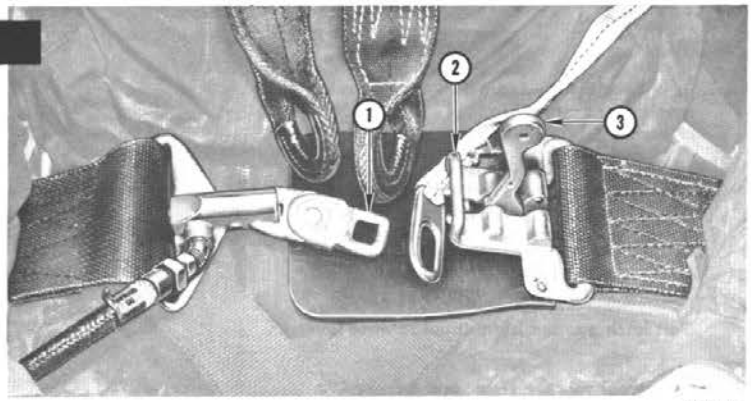


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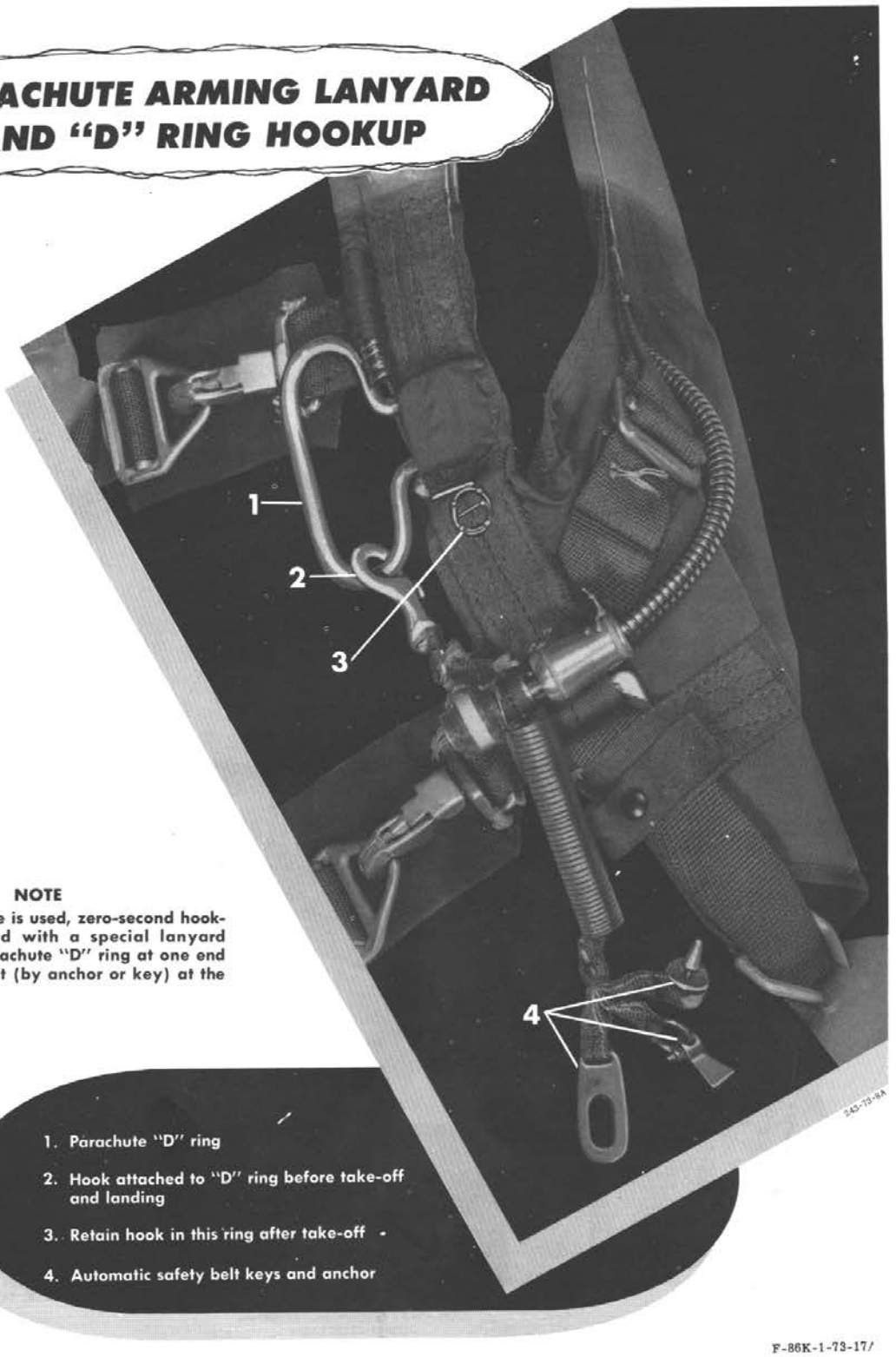
Figure 1-24 (Sheet 3 of 3)

PARACHUTE ARMING LANYARD AND "D" RING HOOKUP



NOTE

If manual parachute is used, zero-second hook-up is accomplished with a special lanyard which hooks to parachute "D" ring at one end and attaches to belt (by anchor or key) at the other end.

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

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Figure 1-25

SERVICING DIAGRAM

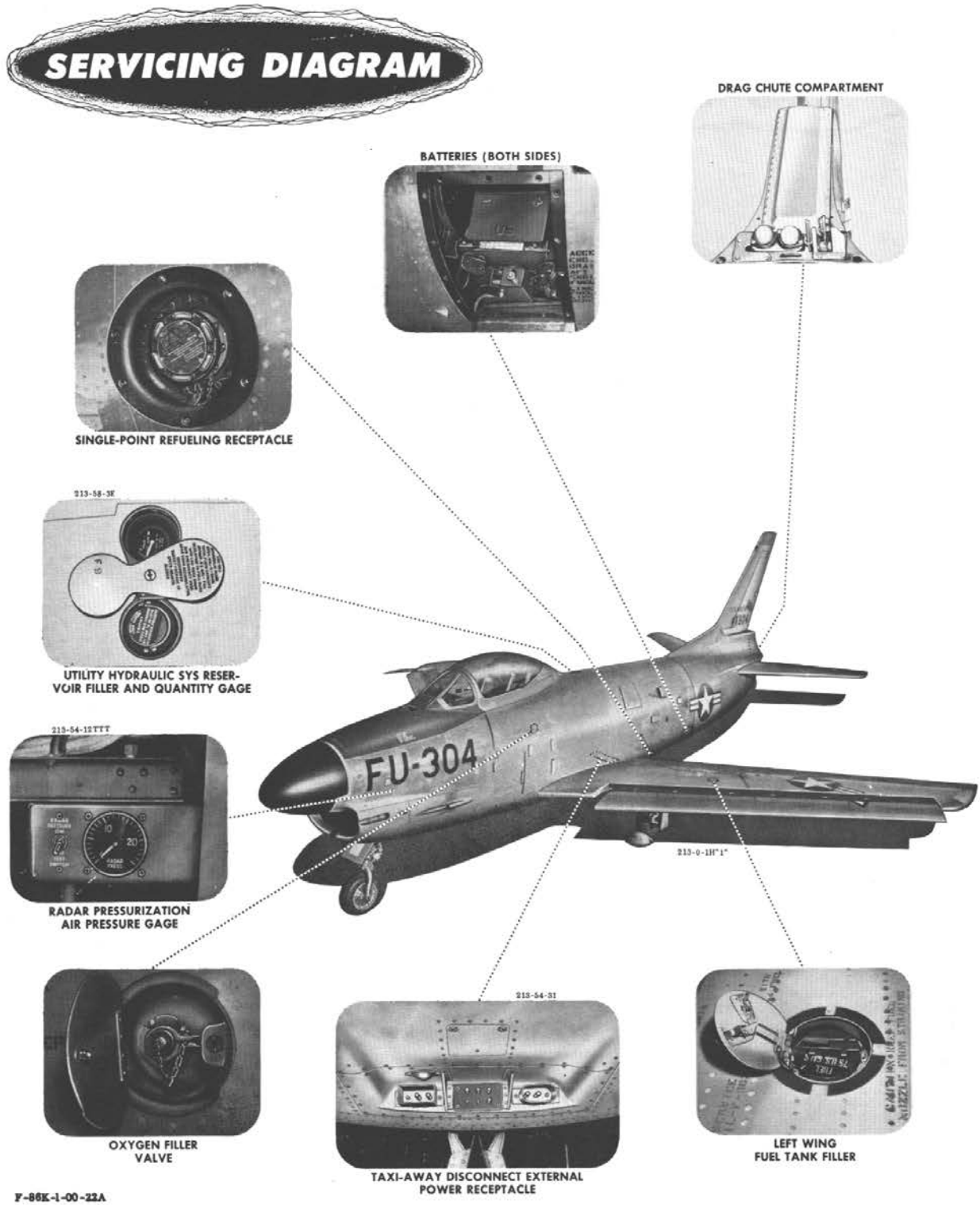
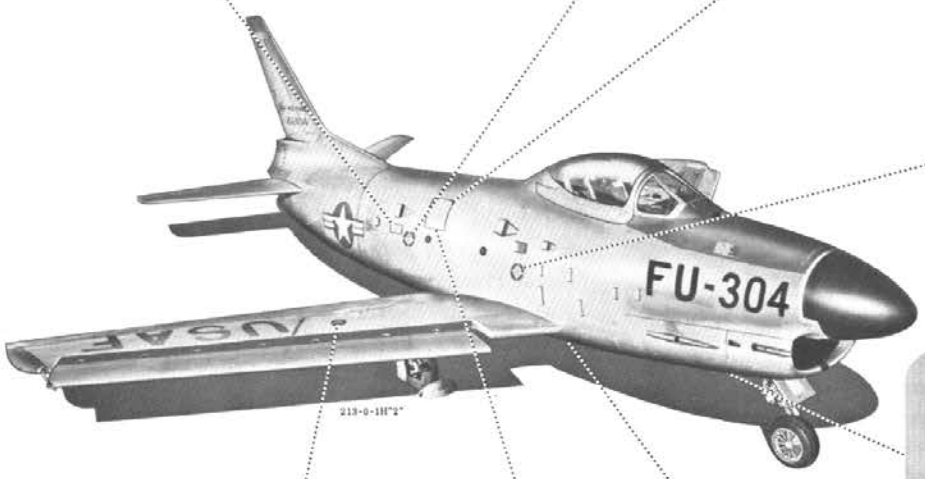
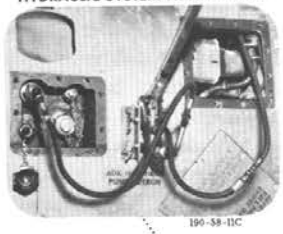


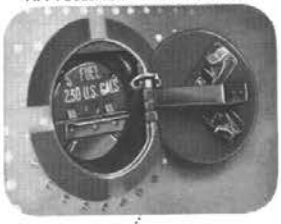
Figure 1-26



FLIGHT CONTROL NORMAL HYDRAULIC SYSTEM FILLING POINT



AFT FUSELAGE FUEL TANK FILLER



ENGINE OIL TANK FILLER

FORWARD FUSELAGE FUEL TANK FILLER

NOSE GEAR EMERGENCY LOWERING ACCUMULATOR AIR PRESSURE GAGE

FLIGHT CONTROL ALTERNATE HYD SYS ACCUMULATOR AIR PRESS. GAGE

RIGHT WING FUEL TANK FILLER

FLIGHT CONTROL NORMAL HYD SYS ACCUMULATOR AIR PRESS. GAGE

SPECIFICATIONS

FUEL — JP-4 (MIL-F-5264) RECOMMENDED FOR ALL TEMPERATURES, OR GASOLINE (MIL-F-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-O-5606

OXYGEN—BB-O-925

F-86K-1-00-23B

LOW-ALTITUDE ESCAPE EQUIPMENT.

To provide an improved low-altitude escape capability, a system incorporating a one-second safety belt initiator and a zero-second parachute (1-0 system) has been developed. The zero-second parachute delay is accomplished by means of a hook and lanyard which is attached to the parachute arming lanyard at one end and can be attached to the parachute "D" ring. (See figure 1-25.)

Note

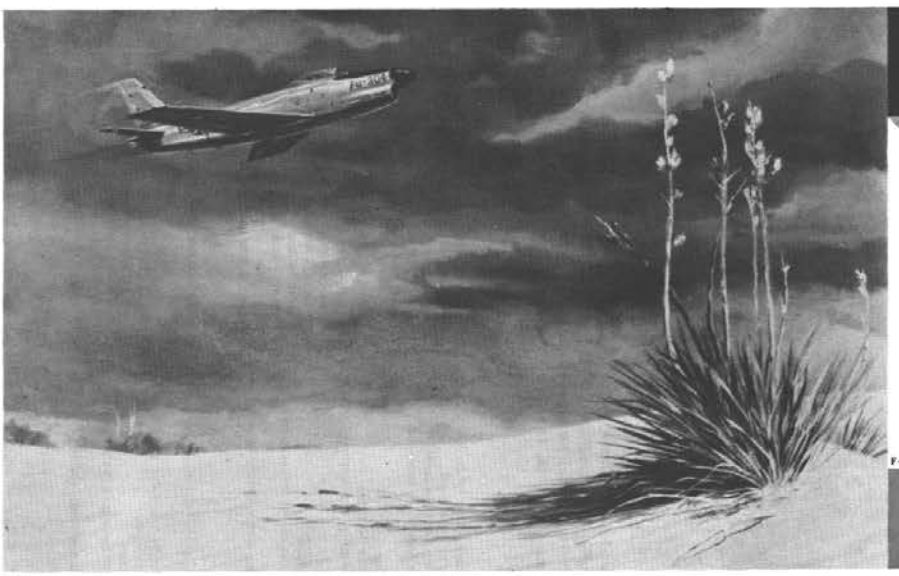
The "D" ring hook and lanyard may be installed on the parachute before the one-second safety belt initiator is installed on the airplane. This will temporarily provide a 2-0 system, with higher minimum safe ejection altitudes.

The 1-0 system makes use of a detachable hook and lanyard that connects the parachute timer lanyard to the parachute "D" ring. At very low altitude and airspeeds, the hook must be connected to the "D" ring, thus providing parachute actuation immediately after separation from the ejection seat. At other altitudes and airspeeds, the hook must be disconnected from the "D" ring, thus allowing the parachute timer to actuate the parachute below the critical parachute opening speed and 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 "D" ring. This "hookup" must be done manually. The hook configuration shown in figure 1-25 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 minimum safe ejection altitudes for various combinations of ejection equipment. Figure 3-5 shows a plot of three parameters: altitude, speed, and sequence time of the parachute automatic safety belt combination. The graph indicates safe ejection speeds with regard to parachute capability and body injury because of parachute opening shock. The sequence lines (slanting lines) indicate the limits above which the parachute will probably be damaged on opening or the pilot will probably be injured from deceleration effects. The lower chart of figure 3-5 shows the minimum altitude for a successful ejection with different combinations of automatic safety belt and automatic parachute timing sequence.

AUXILIARY EQUIPMENT.

The following auxiliary equipment is described in Section IV:

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



Section II

NORMAL PROCEDURES

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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 contained in T.O. 1F-86K-(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. If no gun or ammunition is installed, check for proper ballast installation.

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 clean-up.

ENTRANCE.

After the canopy is opened by using the external switch on the left side of the fuselage, the cockpit can be entered from either side of the airplane. A tubular metal ladder hooks over the cockpit ledge for normal entry

EXTERIOR INSPECTION

Check all surfaces for cracks, 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:

Figure 2-1

*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 airplane, then you should check these items yourself.

1. NOSE

- Landing gear ground control switch **CLOSED**
- Gun ports clear
- 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)
- 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 sway brace secure (if installed)
- Drop tank maintenance safety pin removed.
- 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 2-2

into the cockpit. If a ladder is not available, cockpit entry is gained from the left side of the airplane by a telescoping step (released by a push latch) and two combination handhold and kick-in steps. (See figure 2-2.)

Note

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

PREFLIGHT CHECK.

BEFORE EXTERIOR INSPECTION.

1. DD Form 781—Check.
   Check DD 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 1-26.
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 the cockpit, check canopy and ejection seat as follows:

1. Handgrips and triggers—Check.
   Check that seat handgrips are full down and latched.
2. Safety pin—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 the right console, has been removed. Check that maintenance safety pins of the seat catapult initiators, on the outboard side of the 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 the seat tubular frame.

CAUTION

- If any ejection system maintenance safety pin is installed, do not remove it until you have checked the status of the 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 closed.
7. Canopy ejector lead seal—Check.
   Check that lead seal on canopy ejector is not broken.

INTERIOR CHECK (ALL FLIGHTS).

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

Note

A pilot's check list is located above the left console.

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

CAUTION

Make sure automatic-opening safety belt is properly fastened, and if the automatic parachute is worn, that the chute arming lanyard is properly attached to the safety belt latching mechanism, and that zero-second parachute hook is attached to the "D" ring 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 leading 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. Ground fire switch—SAFE.
7. Throttle and friction—Closed and adjust.
8. Speed brake switch—Center (off) position.
9. Engine master switch—OFF.
10. Battery-starter switch—OFF.
11. Circuit breakers—IN.
12. 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 and the ac receptacles for starting and ground operation of radar equipment.

Note

External power units suitable for use on this airplane are the A3, A4, C22, C26, 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 to the airplane.

After completing the aforementioned safety checks, make a left-to-right check around the cockpit on the following items:

13. Interior and exterior lighting—Check as required.
14. Drop-tank air pressure shutoff valve—Check.
    Drop-tank air pressure shutoff valve ON if tanks are installed; OFF if tanks are not installed.
15. Anti-G suit pressure regulating valve—As desired.
16. Map case—Check.
    Flight Manual, Radio Facility Charts, Pilot's Handbooks—Jet, and other necessary publications and charts available for intended mission.
17. Pressure suit face mask heater rheostat—OFF.
18. Rudder control lock handle—Check.
    Rudder control lock handle unlocked (push down).

CAUTION

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

19. Cockpit pressure selector switch—5 PSI (2.75 psi for combat).
20. Cockpit air temperature control switch—Automatic (forward position).
21. Cockpit temperature rheostat—As desired.
22. Cockpit air switch—PRESS.
23. Manual ram-air valve—CLOSED.
    Make sure that lever is fully locked closed.
24. Alternate trim switches—Check.
    Check for operation and check that switches return to OFF (center); then return to NORMAL.
25. 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.

WARNING

The normal trim switch is subject to sticking in an actuated position, resulting in application of extreme trim. Therefore, operate normal trim switch in all four trim positions and check that it automatically returns to OFF (center) position when released. If switch sticks in any of the actuated positions, enter this fact with a red cross in Form 781 and do not fly airplane.

26. Landing gear handle—DOWN.
    Depress horn cutout button to check warning light in gear handle and unsafe warning light on the upper left corner of the instrument panel.
27. Landing gear indicators—Check.
28. Flight control switch—NORM.

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.

29. Ventilation air control—As desired.
30. Sight reticle dimmer rheostat—As desired.
31. Sight filament selector switch—PRIM.
32. Gun heater switch—As desired.
33. Wing flap handle—UP.
34. Radar master switch—OFF.
35. Flight control emergency handle—Fully in.
36. Afterburner shutoff switch—NORMAL.
37. Variable-nozzle switch—NORM.
38. Air start switch—NORMAL (guard cover down).
39. Emergency fuel system switch—NORM.
40. Landing and taxi light switch—Center (off) position.
41. Stand-by compass and accelerator light switch—As desired.
42. Drag chute handle—Stowed (full in).
43. Clock—Check and set.
44. Altimeter—Set to field elevation.

45. Accelerometer—Reset.
46. Airspeed and Mach number indicator—Check and set.
    Set airspeed and Mach number indicator landing speed index.
47. Fuel quantity—Check.
48. Fuel quantity gage test switch—Check.
49. Hydraulic pressure gage selector switch—ALTERNATE.
50. Generator switches—ON.
51. Inverter selector switch—SPARE.
52. Surface anti-ice switch—OFF.
53. Windshield and radome anti-ice switches—OFF.
54. 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.

55. Alternator switch—ON.
56. Engine screen switch—EXTEND SCREEN.
57. Yaw damper switch—OFF.
58. Landing gear emergency release handle—Fully in.
59. Oxygen system—Check.
    Oxygen regulator supply lever safetied on and pressure at 400 PSI; diluter lever NORMAL OXYGEN, and emergency lever at center position. Check oxygen 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 the wind, use 100% oxygen.

60. Navigation and communication equipment—Check; then turn OFF.
    Check tower, approach control, GCI, GCA, and CAA radio frequencies. Set omni radio to first station en route.
61. Automatic pilot system—Check.
    Place autopilot engaging switch on. Set autopilot roll trim wheel to 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.

62. Windshield and canopy defrost lever—DEC.
63. Voltmeter indicator selector switch—BUS.
64. Operation of A-4 sight—Check.
    (Refer to preflight check procedure for fire control system in Section IV.)
65. Warning, caution, and indicator lights—Check.
66. Stick grip—Check secure.
    Check stick grip for firmness of attachment.
67. Flashlight—Check.
    Check that an operating flashlight is included in the personal gear (night flights).

BEFORE STARTING ENGINE.

CAUTION

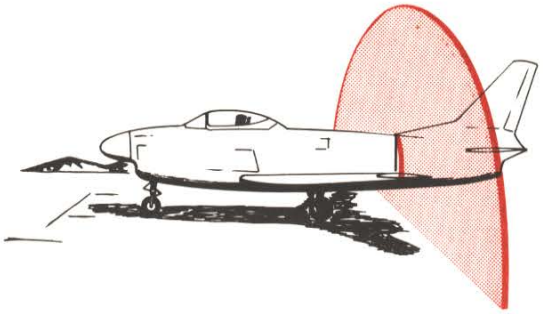
- Before starting engine, make sure nose intake duct screen is installed, to prevent engine damage caused by foreign objects being sucked into the engine. Hold toe brakes on or make sure that main wheels are securely chocked and that danger areas fore and aft of airplane are clear of personnel, airplanes,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

WARNING

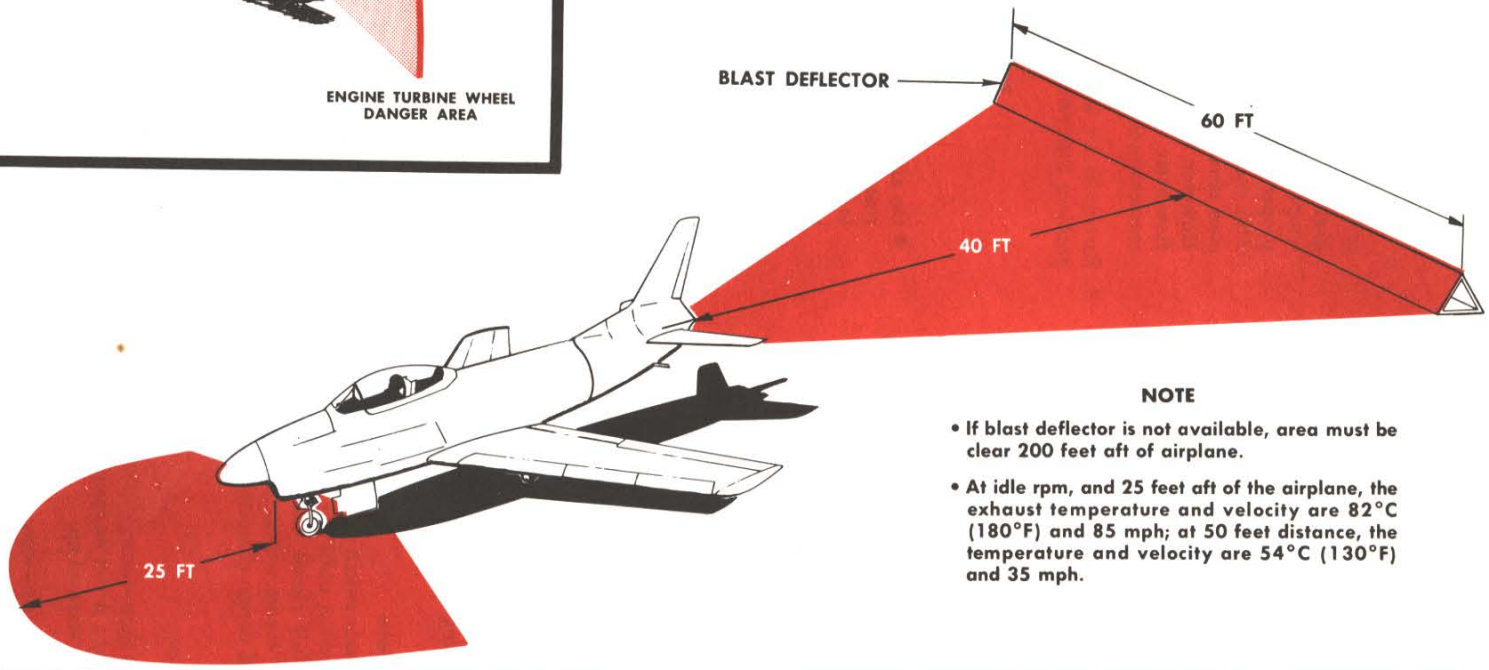
- Danger aft of the airplane is created by high exhaust temperatures and blast from the tail pipe. This danger is greatly increased during afterburner operation.
- Suction at the intake duct is sufficient to kill or severely injure personnel drawn into, or pulled suddenly against the duct.

The disintegration area of the engine is indicated by a red warning stripe around the fuselage. This area

DANGER AREAS



ENGINE TURBINE WHEEL DANGER AREA



NOTE

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

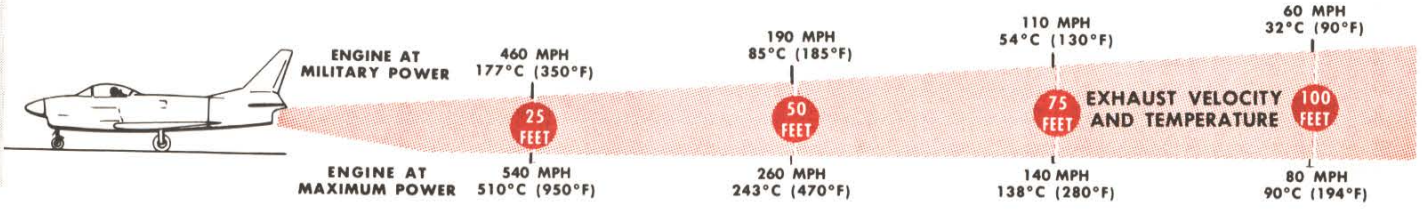


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Figure 2-3

should be clear of personnel. Whenever practical, start and run up engine on a paved surface to minimize possibility of dirt and foreign objects being drawn into compressor and damaging engine. Whenever possible, start engine with airplane heading into wind or at right angles to it. When operating within the jet blast of another airplane, maintain a minimum distance of 80 feet, to prevent damage to the canopy. When jet blast is from afterburner operation, maintain a minimum distance of 150 feet.

STARTING ENGINE.

AUTOMATIC START.

Note

- The automatic start procedure will normally be used for all operational and training missions.
- The spare inverter will be used during 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.
2. Inverter circuit breakers in, inverter caution light out—Check.

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

3. Variable-nozzle switch—NORM.
   Check through operating range; set at ¾ position; then back to NORM.

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 design characteristics of the instrument.

4. Engine master switch—ON.

4A. Engine control lockup light—OUT.
Check that lockup light is out to ensure that electronic fuel control has warmed up.

4B. Emergency fuel system switch—ON.
Check for 10°C to 100°C drop on exhaust temperature gage.

4C. 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 4B and 4B, 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 is still essential to monitor the fuel flowmeter very closely to ensure that the start temperatures will remain within limits.

5. Battery-starter switch—Hold momentarily at START position; then return switch to BATT.

CAUTION

- On airplanes equipped with the two-position emergency fuel switch, 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.
- On these airplanes, 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 prior to 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, depress stop-starter button immediately.

6. 5% rpm—Check for minimum of 18 volts.

6A. Oil pressure—Check.
If there is no visible indication of oil pressure, shut down engine and investigate.

7. 6% rpm—Advance the throttle rapidly to START IDLE. The fuel flow will rise to about 900 to 1000 pounds per hour and stabilize at about 600 pounds per hour. Exhaust temperature will rise and stabilize at about 600°C.

WARNING

If ignition does not occur within 15 seconds,

close throttle and depress stop-starter button. Wait 3 minutes, to allow drainage of fuel accumulation from combustion chamber and tail pipe, before attempting restart.

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 will give a more rapid indication of the engine start than will the exhaust temperature. Using the fuel flow gage as a primary instrument and observing the exhaust temperature will allow a start to be aborted before an overtemperature condition can take place.

8. 12% rpm—Exhaust temperature should decline slightly.
   The fuel flow will remain steady.
9. 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).
10. 14% to 40% rpm—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 of 815°C should occur before 18% rpm is reached; if it does not, chop throttle to CLOSED immediately and investigate before flight.

11. 40% rpm—Check (fuel flow between 800 and 1300 pounds per hour, exhaust temperature between 400°C and 600°C).
    Observe that fuel flow and exhaust temperature decline to lower readings 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 these characteristics is very important if engine overtemperature operation during starting is to be prevented in the event 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, press stop-starter button, 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.
- 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, 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, the exhaust temperature encountered during the transient condition may be higher than that experienced during throttle bursts from lower thrust settings. However, it should be noted that existing exhaust gas 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 starter to cool 30 minutes before using again.
- If engine speed does not reach 25% rpm in one minute, shut down and investigate the cause. Excessive operation below 25% engine rpm can cause extensive damage to starter and engine.
- If the starter should become de-energized before the engine reaches about 20% rpm, shut down engine immediately. No attempt to accelerate the engine should be made.

Note

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

12. Oil pressure—Check (12 psi minimum).
    If there is no sign of oil pressure within 30 seconds, shut down engine and investigate.
13. Engine instruments—Check for desired readings.
14. External power—Disconnect.
15. Generator caution lights out—Check.

START ON EMERGENCY FUEL SYSTEM.

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

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

CAUTION

If the generator voltmeter reading drops below 15 volts during the start, immediately abort the start by pressing the stop-starter button; 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.

6. Battery-starter switch—Hold momentarily at START; then return to BATT.
7. 5% rpm—Check for minimum of 18 volts.
8. 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 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 poor airflow through the combustion chambers at low rpm.
- When a hot start occurs, shut down engine immediately. If smoking or fire persists, engage starter with throttle closed for about 20 to 30 seconds, to clear engine of excess fuel.

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

CAUTION

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

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

CAUTION

If the engine operates abnormally with the emergency fuel system switch at NORM, 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 will vary 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 wheels are firmly chocked and hold toe brakes also. This airplane is not equipped with parking brakes.

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 inverter change-over and 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. Throttle—START IDLE.
5. Variable-nozzle switch—NORM.
   Note that rpm and variable-nozzle position remain constant, indicating engine controls are in lockup condition.
6. 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 (about 40%) and the automatic closing of the variable-nozzle to one-half position (about three-quarter position on some airplanes) takes place. Engine control is restored by the automatic lockup system when the primary inverter again supplies power to the electronic engine controls.

Note

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

7. Radar master switch—STBY.
   The radar should be on at least 2 minutes prior to taxi.

FLIGHT CONTROL HYDRAULIC SYSTEM CHECK.

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

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

4. Flight control normal hydraulic system—Check.
   a. Flight control switch—NORMAL.
   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—ON.
   b. Alternate system caution light—ON.
   c. Hydraulic pressure gage selector switch—ALTER.
   d. Control stick—Move and check for pressure drop.
      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.

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

   d. Flight control switch—NORM.

   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 pressure gage redline limit (3200 psi) and may even reach 4000 psi when the manual emergency handle is actuated. These pressures are considered normal for this phase of alternate hydraulic system operation.

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

   a. Control stick—Move rapidly.

   b. Alternate system caution light out—Check.

      Check that light goes out, indicating that normal system is again in control.

   c. Hydraulic pressure gage selector switch—NORM.

   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.

   Operate speed brakes through one complete cycle. Close speed brakes and return switch to neutral position. Have ground crew check for proper operation.

WARNING

Before operating speed brakes, be sure fuselage rear section around speed brakes is clear, as 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 other hydraulic systems are made or when another system is being monitored because of a suspected or known malfunction.

TRIMMED FOR TAKE-OFF INDICATOR LIGHT CHECK.

1. Take-off trim—Check.

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

Note

Under any load configuration, trimming to the light ensures a more comfortable feel for lifting the nose off during take-off and for holding the nose down during the transition phase of retracting gear and flaps after take-off.

WING FLAP CHECK.

1. Wing flap handle—Down.

BEFORE TAXIING.

1. 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. Altimeter—Set to field pressure.

   Check that 10,000-foot pointer is set correctly and note error against field elevation. This error should be considered when resetting altimeter during flight.

WARNING

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

8. IFF master switch—STBY.

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.

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.

PREFLIGHT AIRPLANE CHECK.

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. 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.

3. 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.

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

   If contamination is suspected, use 100% OXYGEN.

EMERGENCY FUEL REGULATOR CHECK

SUMMER OPERATION
+40 F TO +100 F

OUTSIDE AIR TEMP °F	% RPM	EXHAUST TEMP °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 TEMP °F	% RPM	EXHAUST TEMP °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 TEMP °F	% RPM	EXHAUST TEMP °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

6. Take-off position.
   Make sure airplane is lined up on runway, and nose wheel is centered. Hold airplane with brakes.

PREFLIGHT ENGINE CHECK.

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 SCREEN.

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. Three-position emergency fuel control system switch —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.
   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 jet blast is from afterburner operation, maintain a minimum distance of 150 feet.

c. Emergency fuel switch—TAKE OFF.

CAUTION

- When moving emergency fuel system switch to TAKE OFF, be prepared to retard throttle immediately to minimize engine overspeed in case of maladjustment or malfunction of emergency fuel regulator.
- When it becomes necessary to reduce power, retard throttle to START IDLE and move emergency fuel system switch to ON for about 2 seconds; then, without hesitating at TAKE OFF, return switch to NORM before readvancing throttle. This action is necessary to avoid undesirable power surges, possible compressor stall, or overtemperature conditions.

Note

Placing the emergency fuel system switch at TAKE OFF when the throttle is above three-fourths open position places the emergency fuel system in stand-by condition. When the throttle is below three-fourths open position, the engine is operating on the emergency fuel system. (Refer to "Automatic Lockup System Characteristics," Section VII.)

d. Variable-nozzle switch—NORM.

e. Emergency fuel system test button—Press.

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

f. Emergency fuel system test button—Release.

If recovery is slow or if rpm fails to recover to 100%, move emergency fuel switch to NORM. Retard throttle as necessary to assist rpm recovery. [Refer to "Nonrecovery Characteristic Following an Emergency Fuel System Test (Three-position Switch)" Section VII.]

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

It is not necessary to stabilize at Military Thrust before advancing throttle into afterburner range.

3. Two-position emergency fuel control system switch—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 jet blast is from afterburner operation, maintain a minimum of 150 feet distance.

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.

d. Throttle—Retard to 85% rpm.

CAUTION

The throttle should be retarded to approximately 85% rpm before switching back to the NORMAL position because an overtemperature could result from 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 DD Form 781 and the appropriate correction maintenance must be accomplished.

e. Emergency fuel switch—NORMAL.

CAUTION

Engine rpm may drop momentarily to about 70% rpm. Do not return switch to ON during

this rpm drop unless 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 throttle into afterburner range.

4. Afterburner ignition—Check.

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

CAUTION

- On airplanes equipped with the three-position emergency fuel switch, move switch to NORM before retarding throttle from AFTERBURNER. This will prevent engine overspeed.
- Engine shutdown is required if the exhaust temperature limit of any afterburner light-up on the ground is exceeded. Temperature and duration must be entered in DD 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.

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

6. Engine instruments—Check.

Check engine instruments for proper readings.

TAKE-OFF.

NORMAL TAKE-OFF.

Note

Refer to take-off distance charts in Appendix I for take-off distances and speeds. Make sure chart referred to is for applicable airplane, because Group 1, 2, and 3 airplanes use a different chart than Group 4 airplanes.

Before the take-off roll is started, check that the exhaust temperature and variable-nozzle positions are stabilized. Monitor these instruments closely during take-off with Maximum Thrust 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. 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 approxiately 60 knots IAS. At about 10 knots below take-off speed, pull the stick back firmly to rotate 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 slightly 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 rotate the nose to the 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.

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

The three-position emergency fuel switch should be in the TAKE OFF position for take-off. The two-position emergency fuel switch should be in the NORM position for all normal operation.

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 5 knots IAS below nose wheel lift-off speed. As the nose wheel lifts off, a steady rotation of the airplane to take-off attitude occurs with airplane lift-off occurring about 5 knots IAS below normal take-off speeds. 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.

Note

Refer to cross-wind take-off and landing chart in Appendix I for effect of varying cross winds.

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.

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 damage the gear doors or flap operating mechanism and prevent later operation.
- The wing flaps must be fully retracted to avoid failure of the flap actuating mechanism that may occur if the flaps are not supported against the up-stop (fully retracted) during accelerated maneuvers at high speed.

3. Landing and taxi light—RETRACT.

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

Slats close at about 180 to 200 knots IAS. On Group 4 airplanes, the slats close at about 240 knots IAS when no external load is carried;

when drop tanks are carried, the slats close at about 265 knots IAS.

6. Altitude—Hold constant and increase airspeed.
   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.

7. Emergency fuel switch (three-position)—NORM.
   When a safe altitude is reached, position emergency fuel switch (three-position) at NORM. The switch should be at NORM for all normal operations except take-off and initial climb.

Note

- If loss of engine power occurs when emergency fuel system switch is positioned at NORM, move switch to ON. If rpm decreases below 90%, shut off afterburner to prevent engine damage due to overheating the tail pipe.

- If engine speed is inadvertently allowed to drop below 85% rpm before the emergency fuel system switch is moved back to ON, the throttle should first be retarded to START IDLE before the switch is placed ON.

- Any time ambient air temperature causes the emergency fuel regulator setting to approach that of the main fuel system, and the emergency fuel system switch is at TAKE OFF, it is possible for the emergency fuel system to take over engine control and result in engine overspeed. Engine overspeeding during climb after take-off with emergency fuel system switch at TAKE OFF indicates the emergency fuel system has taken over engine control. When such an engine overspeed exists, an apparent loss of engine power will result when emergency fuel system switch is positioned at NORM. For further information, refer to "Emergency Fuel System Overriding Main Fuel System (Three-position Switch)," Section VII.

8. Zero-second parachute hook—Detach from parachute "D" ring and attach to stowage ring.
   Parachute 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 so that the safety delay provided by the parachute timer-aneroid will not be overridden.

9. Armament master and radar master switches—Desired position and STBY.
   Maintain wing-level flight during 4½-minute warm-up period.

10. Yaw damper switch—ON.

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

12. Oxygen diluter level—NORMAL OXYGEN.
    If 100% oxygen was used for take-off, return diluter to NORMAL OXYGEN, unless carbon monoxide contamination is suspected. If such is the case, continue use of 100 percent oxygen as long as considered necessary.

WARNING

Oxygen diluter lever must be returned to NORMAL OXYGEN as soon as possible, because use of 100% oxygen will so deplete the oxygen supply as to be hazardous.

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

14. 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 the IFF is inoperative, consult the appropriate navigation publication.

CLIMB.

Military Thrust is recommended for climb under 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 the 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 should be turned off when this need has passed, because of the greatly increased fuel consumption.
- In steady-state operation, if exhaust temperature climbs over 685°C (+5°C, −10°C), or if 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 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 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 whenever engine is operating on the 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.

CAUTION

To prevent engine damage due to overheating the tail pipe, do not operate continuously in afterburner with engine rpm below 90%.

Note

- There is no time limit for afterburner operation; however, extended or excessive use of the afterburner (Maximum Thrust) will rapidly decrease the fuel supply and seriously impair the range capabilities of the mission.
- Ten seconds may be required to effect afterburner light-up in flight. The time required for afterburner light-up will normally increase as 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 in Appendix I.

Note

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

1. IFF—Checked.
   This check should be performed within one hour before the estimated time of landing.

1A. 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. Ground fire switch—SAFE.
2. Armament master switch—OFF.
3. Radar master power switch—STBY.
4. Gun sight—Mechanically cage.

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 radar off.

4A. Circuit breakers—Check.

5. Fuel quantity—Check.
6. Hydraulic pressure—Check.
7. Safety belt, shoulder harness, and zero-second parachute hook—Secured.
   Parachute hook must be attached to "D" ring prior to descending below 2000 feet above the terrain.
8. Shoulder-harness inertia reel handle—Unlocked.
9. Yaw damper switch—OFF.
10. Windshield anti-icing switch—As desired.
    If vision is impaired by rain during landing approach, select either CENTER or SIDE, as desired.

Note

- Enough anti-icing airflow is available over windshield to improve visibility effectively if a minimum of 75% engine rpm is maintained. If rain is still encountered as power is reduced for landing, vision through windshield side panels may be necessary. Turn anti-icing switch OFF after touchdown, if windshield caution light has not come on. If light comes on, leave switch on; reduced engine power on the ground or selecting manual ram air will allow gradual cooling of windshield, and 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 anti-ice air temperature, selecting manual ram air will reduce 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 anti-ice system only during taxiing, take-off or landing, as unsatisfactory cockpit temperatures could result if windshield anti-icing is used extensively during flight.

11. Speed brake switch—OUT.
    Return switch to neutral when brakes extend fully.
12. Landing gear handle—DOWN.
    Lower gear below 185 knots IAS and check position indicators.
13. Pattern—Fly at 160 to 185 knots IAS, using power for level flight.
14. Wing flap handle—DOWN.
15. Check instruments—In desired range.
16. Final approach—Fly at 140 knots IAS.
    Use this as minimum flare speed.
17. 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. The drag chute is for use after touchdown at speeds of 150 knots IAS and below.

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 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.

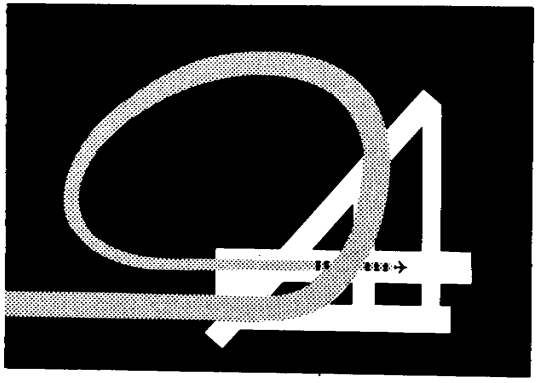
The procedure set forth produces the results shown in the landing charts in Appendix I. Refer to the proper chart for the applicable group of airplanes. While following the procedure outlined in figure 2-5 for completing a normal landing, observe the following precautions:

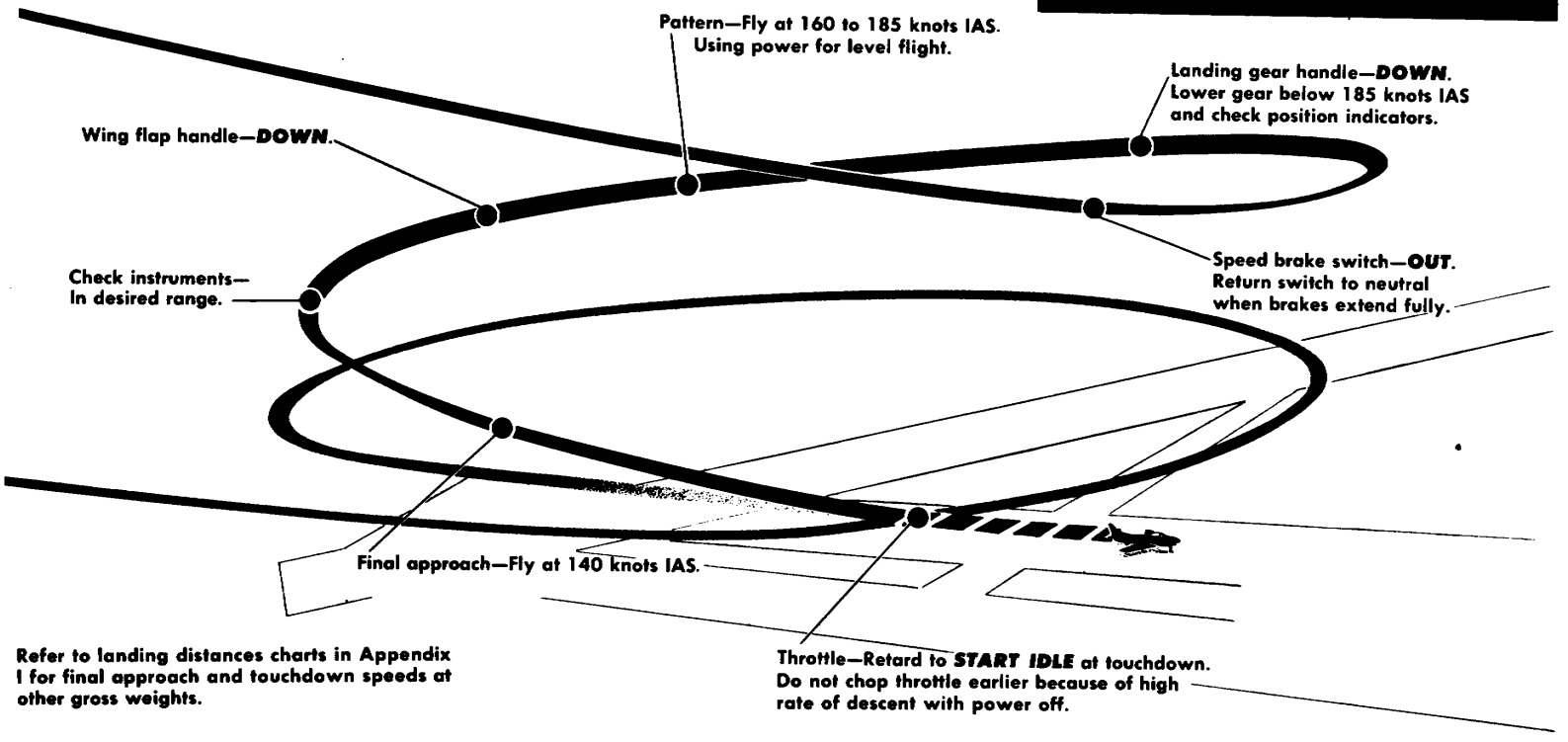
Note

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.

TYPICAL NORMAL APPROACH AND LANDING

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





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 LANDING.

Figure 2-5

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 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.

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.

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 in order to obtain maximum 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 a straight landing roll.
- Refer to cross-wind landing and take-off chart in Appendix I for effect of varying cross winds.

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 advertently 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 rea-

son, 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. 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 160 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 LANDING.

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 advised accordingly so that the proper technique can be used. On rough ice or a wet rough surface, upon touchdown, deploy the drag chute, and lower the nose immediately and apply heavy intermittent braking as necessary. On smooth ice or a wet smooth surface, 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 air-borne 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 cause 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. Refer to 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.

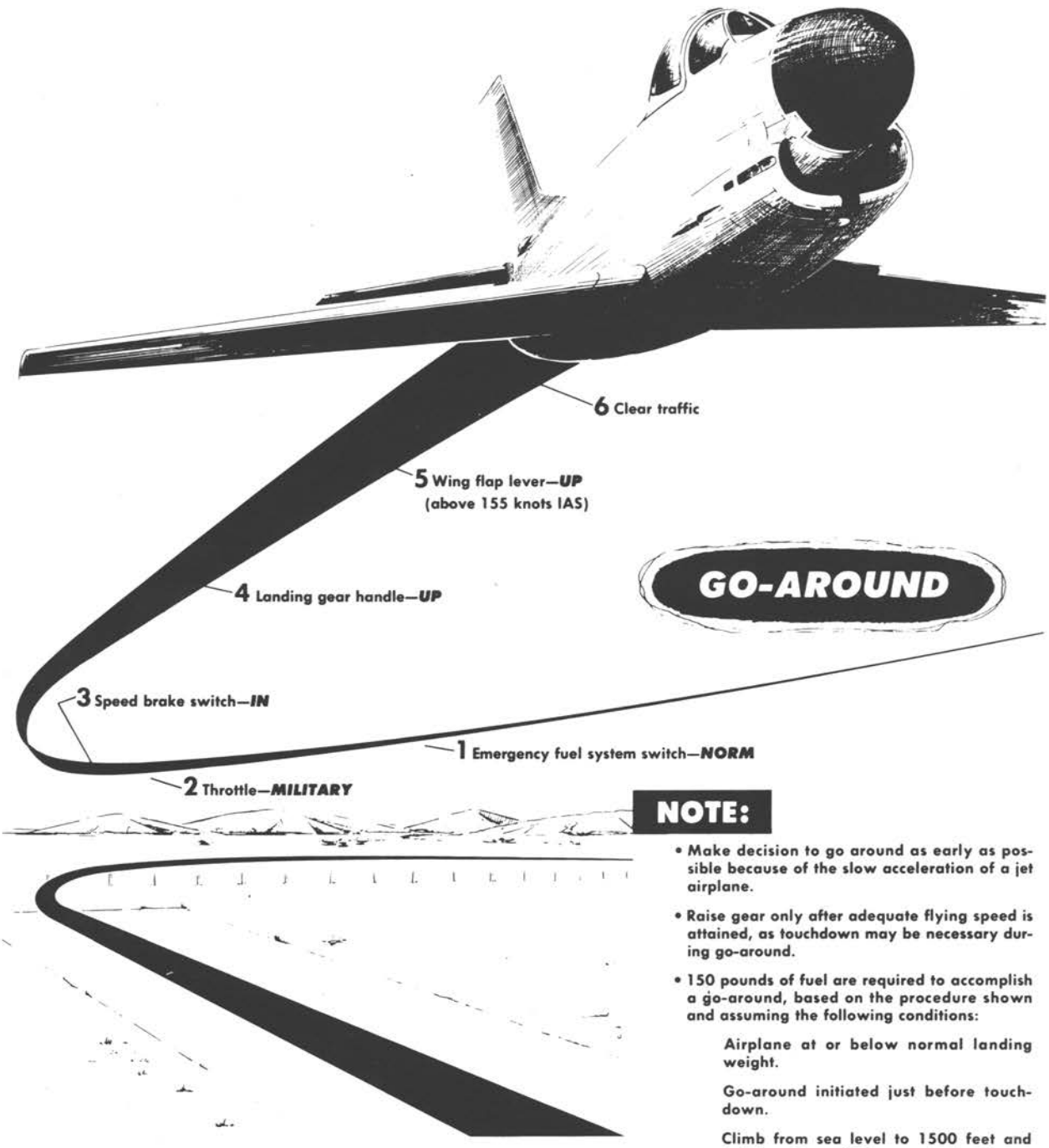
Complete a normal take-off, observing the recommended nose wheel lift-off speeds. Retract landing gear and wing flaps as in a normal take-off. Where a series of touch-and-go landings are to be made, the normal before landing check must be accomplished for the initial landing. After the final touch-and-go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

GO-AROUND.

While following the procedure outlined in figure 2-7 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 throttle to START IDLE (if rpm drops below 85%), position emergency fuel system switch to ON, and cautiously readvance throttle.
- If the main fuel system has failed during flight, the emergency fuel system switch



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 pattern 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

should be ON, and if the variable nozzle is inoperative, the variable-nozzle switch should 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 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.

After completion of the landing roll:

1. Engine screen switch—EXTEND SCREEN.
   Engine 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—Center (OFF) position.
4. Nose wheel steering—Engage.
   Engage nose wheel steering when slow taxiing becomes necessary.
5. Drag chute handle—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 ILS switches—OFF.
10. Trim—Set at take-off position.

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.

1. Wheel brakes—ON.
2. Throttle—65% to 70% rpm.
   The engine should be operated at 65% to 70% rpm for about 2 minutes.

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 nozzle setting before shutdown.

3. Throttle—CLOSED.
   Close throttle sharply.

Note

When 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, no reliance should be placed upon these indications.

4. Engine master switch—OFF.
   Turn master switch OFF below 10% rpm, and wait a few seconds before turning battery-starter switch OFF.
5. Battery-starter switch—OFF.
6. All electrical switches—OFF.
   Turn all switches OFF except generator and alternator.

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 accumulated fuel vapors exploding.

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.

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.

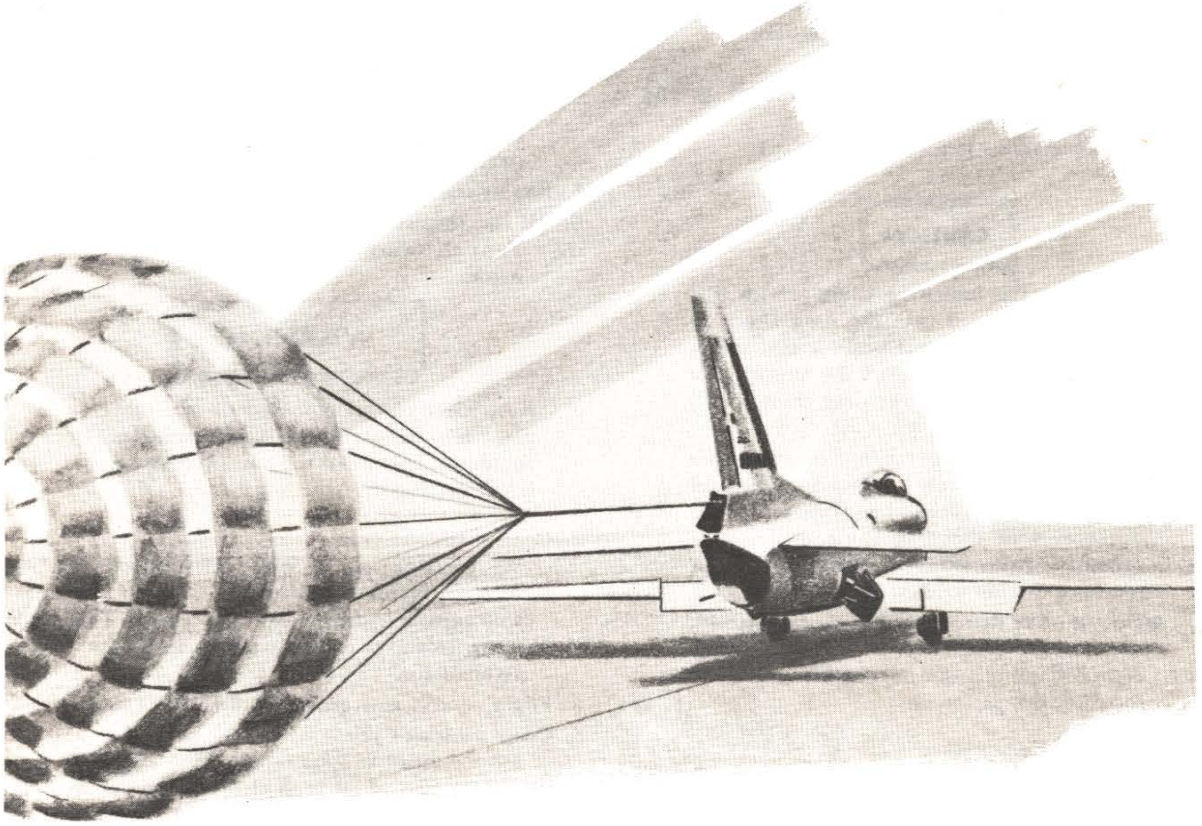
5. Main wheels—Chocked.
6. Form 781—Complete.

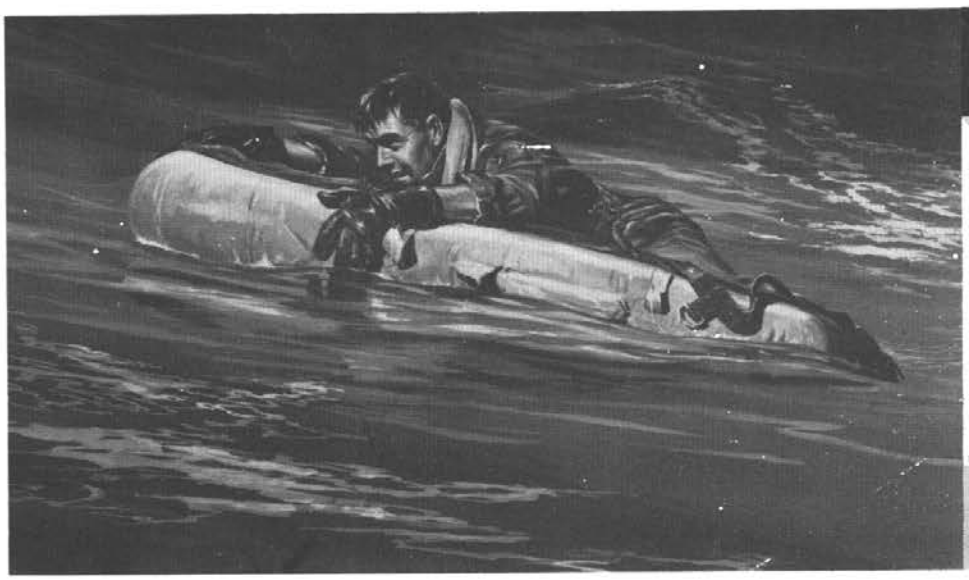
CAUTION

Make appropriate entries in Form 781 covering any limits in the Flight Manual 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 takeoffs, 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-86K-(CL)1-1.





Section III

EMERGENCY PROCEDURES

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ENGINE FAILURE.

Complete engine failures are rare on this airplane. However, engine flame-outs and malfunctions of various types do occur from time to time. These usually result from 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.") When time and altitude permit, air starts can usually be accomplished if engine failure is due to malfunction of the main fuel control system. Failure of the main fuel control system is often indicated by the engine instruments. Air starts should never be attempted if engine failure can be attributed to some obvious mechanical failure within the engine proper.

ENGINE OVERSPEED DURING TAKE-OFF.

On airplanes with the three-position emergency fuel switch installed, any time ambient air temperature causes the emergency fuel regulator setting to approach that of the main fuel system, it is possible for the emergency fuel system to take over engine control and result in engine overspeed during the climb after take-off. This overspeed is gradual and is a result of the emergency fuel system overriding the main fuel system, when the emergency fuel system switch is in the TAKE OFF position. If the emergency fuel system switch is positioned at NORM with the overspeed condition present, what appears to be a complete power loss will occur. (Refer to Section VII for further information.) If engine overspeed stabilizes at about 102% rpm, the climb may be continued without any power change being made. As altitude is increased, the engine speed will return to 100% rpm. However, before the emergency fuel system switch is positioned to NORM, the engine must be allowed to remain stabilized at 100% rpm for about 15 seconds. If engine overspeed tends to exceed 104% rpm during climb after take-off, while operating in afterburner range with the emergency fuel system switch at TAKE OFF, perform the following:

1. For airplanes equipped with the three-position emergency fuel system switch:
   a. Emergency fuel system switch—NORM.

b. Throttle—Retard immediately and rapidly to below MILITARY stop.

Note

When emergency fuel system switch is positioned to NORM, a loss in power results. For this reason, the throttle must be retarded from the AFTERBURNER range.

c. Throttle—Readvance to desired setting.
Engine will respond on main fuel system.

Note

This condition does not occur on airplanes incorporating the two-position emergency fuel switch, as the switch is in NORM position for take-off.

ENGINE FAILURE DURING TAKE-OFF RUN (NO 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.

Note

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

If the engine fails, or if a take-off is aborted before the airplane leaves the ground and insufficient runway remains for a normal stop, accomplish as much of the following as time permits:

1. For airplanes equipped with three-position emergency fuel switch.

a. Drag chute handle—Pull.

CAUTION

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

b. Throttle—CLOSED.

c. Brakes—Apply as necessary.

WARNING

- The heat generated in the brake during an aborted takeoff 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.

CAUTION

Do not retract gear if runway overrun barrier is present.

d. Drop tank jettison button—Depress (or emergency jettison handle—Pull) if drop tanks are installed.

e. (Deleted)

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

WARNING

If armrests have 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.

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

CAUTION

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

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

2. For airplanes equipped with two-position emergency fuel system switch.

a. Emergency fuel system 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 system 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 system switch to ON, and then readvance throttle.

b. Drop tank jettison button—Depress (or emergency jettison handle—Pull) if drop tanks are installed.

Note

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

c. Drag chute handle—Pull.

CAUTION

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

d. Throttle—CLOSED.

e. Brakes—Apply as necessary.

WARNING

- The heat generated in the brake during an aborted take-off continues to build up during taxiing operation back to take-off position. 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 taxiied back to the line. Shut down engine. Make sure brake assembly is cool enough to touch by hand before further flight.

f. (Deleted)

g. Seat armrests—Raise.

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

WARNING

If armrests have not been raised and if spilled fuel is in the vicinity of the airplane, use 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.

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

CAUTION

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

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

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

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

1. For airplanes equipped with three-position emergency fuel system switch.

a. Throttle—CLOSED.

b. Drop tank jettison button—Depress (if drop tanks are installed).

c. Canopy handle—Unlock.
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 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.

d. Landing gear handle—DOWN.

e. Wing flap handle—DOWN.

f. Engine master, generator, and battery-starter switches—OFF.

Note

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

g. Shoulder harness lock handle—LOCKED.

h. Land straight ahead.
Change course only enough to miss obstacles.

i. Drag chute handle—Pull (after touchdown).

Note

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

2. For airplanes equipped with the two-position emergency fuel system switch.

a. Emergency fuel system 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 system 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 system switch to ON, and then readvance throttle. Therefore, proceed to steps b. through h.

b. Drop tank jettison button—Depress (or emergency jettison handle—Pull) if drop tanks are installed.

Note

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

c. Throttle—CLOSED.

d. Canopy handle—Unlock.
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.

e. Landing gear handle—DOWN.

f. Wing flap handle—DOWN.

g. Engine master, generator, and battery-starter switches—OFF.

Note

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

h. Shoulder harness lock handle—LOCKED.

i. Land straight ahead.
Change course only enough to miss obstacles.

j. Drag chute handle—Pull (after touchdown).

Note

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

ENGINE FAILURE DURING FLIGHT.

If engine failure occurs during flight, follow this procedure.

Note

Before closing the throttle, check fuel flow (600 psi 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 185 knots IAS, establish glide at 185 knots IAS (200 knots on Group 4 airplanes and those changed by T.O.), 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 185 knots IAS (200 knots on Group 4 airplanes and those changed by T.O.), with landing gear and wing flaps up and speed brakes closed. Unless the engine is damaged, it will windmill at enough speed to operate all hydraulic controls, including the flight control normal hydraulic system. However, engine windmilling will be inadequate to provide generator power at any normal gliding speed. Operation of the landing gear, wing flaps, and speed brakes will be considerably slower than normal. Because electrical power is being derived only from the battery, such power will be 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 will be 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 outside temperature causes more rapid loss of battery power. (See figure 1-14 for list of equipment powered by battery when battery-starter 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 airplane up with wings level until light buffet is encountered. Hold this light buffet 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: 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 fails 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 starts during flight (figure 3-1) are more readily obtainable below 40,000 feet, the air start should be attempted as soon as possible after flame-out. During the 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, as 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 throttle at START IDLE, and any attempt to advance the throttle will cause a complete stall. If this occurs, retard the 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 (down) to re-establish radio communication and operation of landing gear, landing light, and flaps for landing. Refer to "Forced Landing (Windmilling or Frozen

Engine)" for a forced landing, or to "Ejection," if engine failure necessitates ejection.

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 airspeed available (300 knots IAS or more), the airplane should be pulled up (zoom-up) to exchange airspeed for altitude while the low-altitude air start procedure is being initiated. 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 glide distance, the optimum gliding speed is 185 knots IAS (200 knots IAS on Group 4 airplanes and those changed by T.O.) 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 with a windmilling or frozen engine, or failure of both flight control hydraulic systems. However, 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 listed, combined with the pilot's analysis of the condition of the airplane, 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, before ejection, if possible, 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 of at least 8000 feet.

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

Note

No attempt should be made to land a flamed-out airplane at any field whose approaches are over heavily populated areas, if a suitable area is available to abandon the airplane. If possible, before 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 185 knots IAS (200 knots IAS on Group 4 airplanes and those changed by T.O.), 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

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 switch—***CLOSE***

To aid in making an easier air start.

4 Air start switch—***AIR START*** (up)

To reduce electrical load, providing maximum battery life.

WARNING

When air start switch is on ***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
A-C 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-starter switch out of ***BATTERY***, as a complete loss of fuel pump and ignition power could result.

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 obtainable below 40,000 feet.

5 Airplane—Hold level

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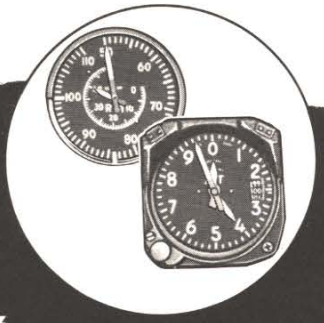
IAS. Maximum braking technique should be used immediately after touchdown by rapid on-off applications on brake pedals (about one second on, one second off), this pressure being applied very lightly at higher indicated airspeeds, with heavier pressure being applied as the airplane decelerates under 100 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 to 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, the rate of descent would be less

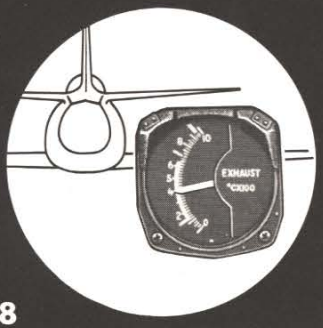


6

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

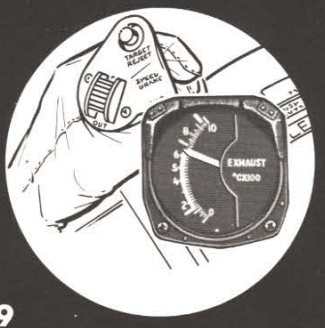
7

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



8

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



9

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

10

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

11

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

12

Emergency fuel switch—***NORM***.

CAUTION

If a sufficient warm-up period is not allowed before the emergency fuel system switch is moved to ***NORM***, 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 practical.

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Figure 3-1

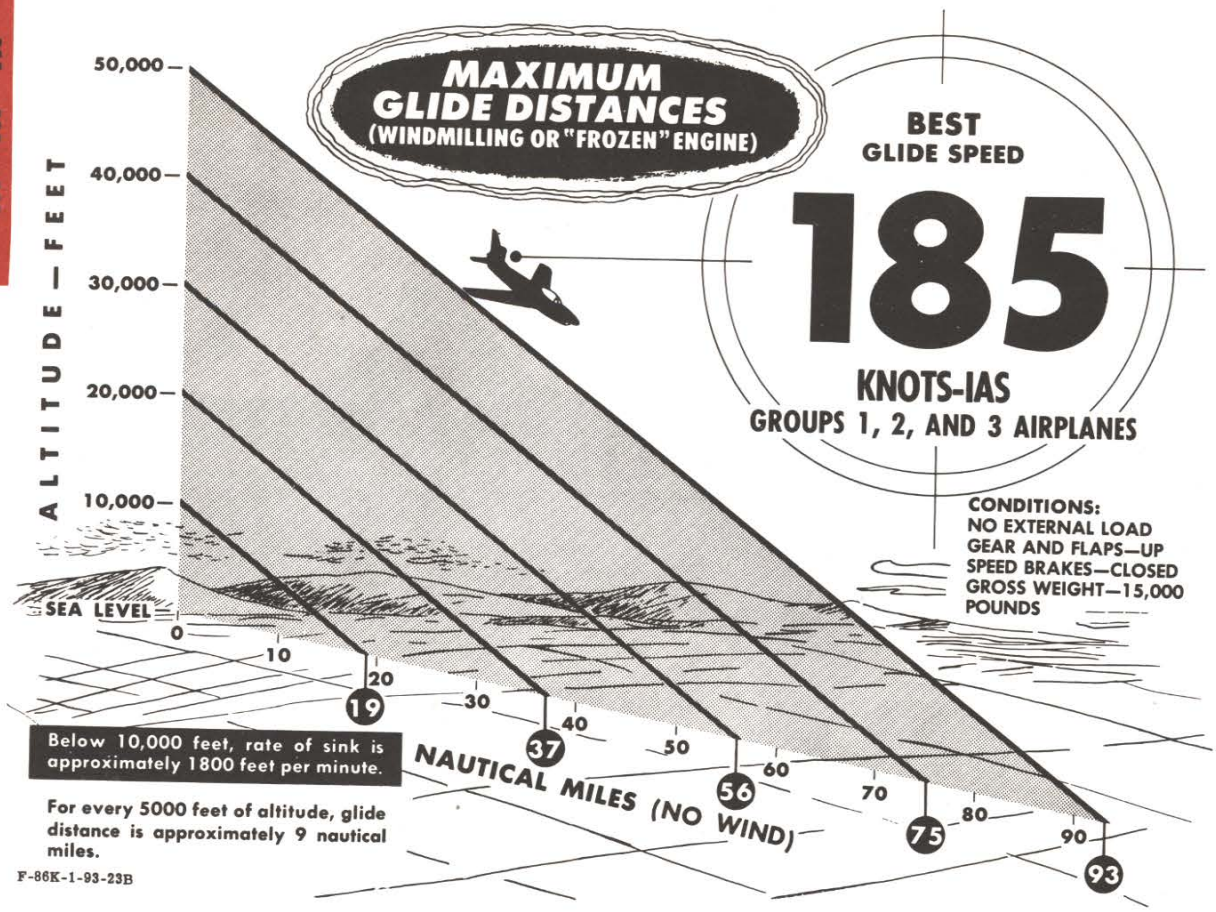
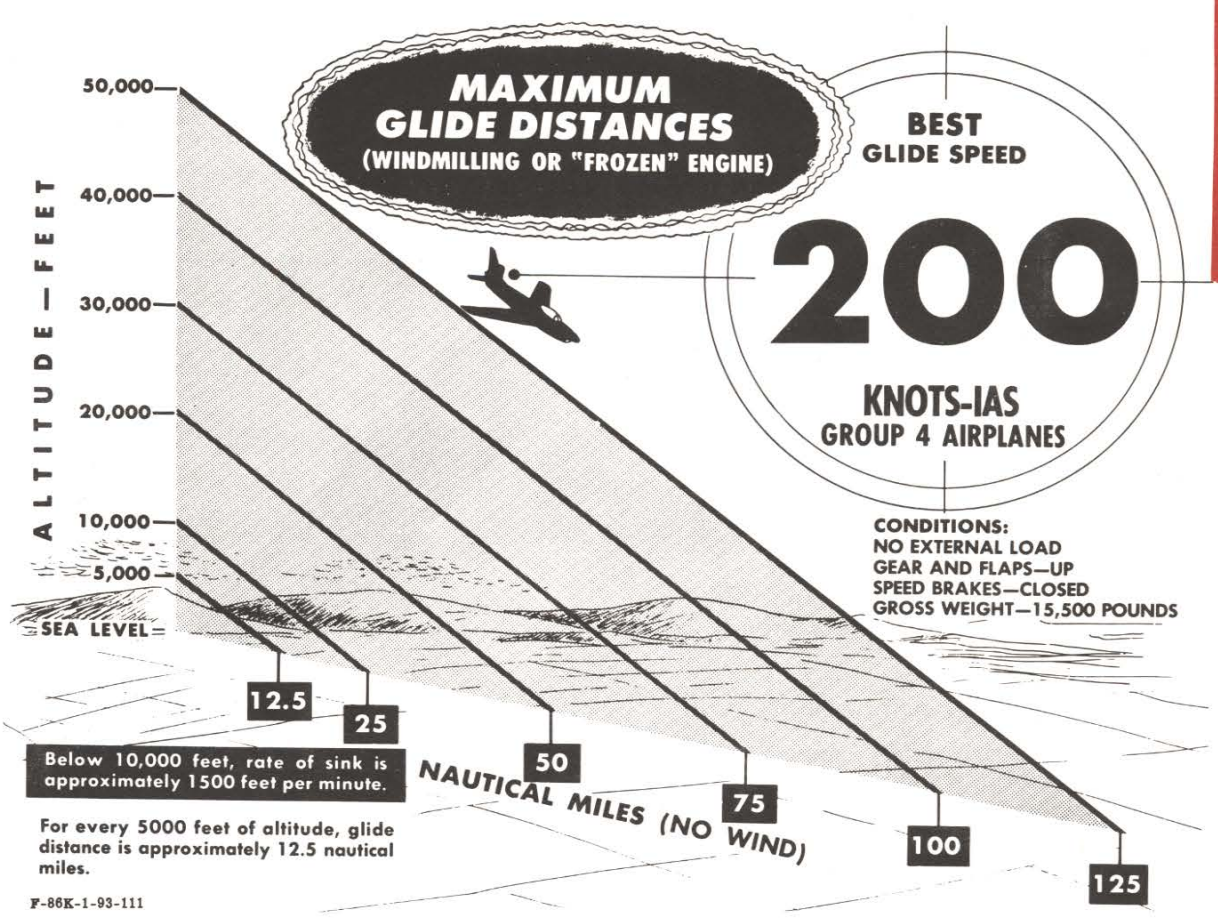


Figure 3-2

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 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 throttle to START IDLE. As the idling engine still produces some thrust, touchdown will be 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 78% (74% for airplanes incorporating the old-type thrust selector), opening speed brakes, and establishing a glide speed of 185 knots IAS (200 knots IAS on Group 4 airplanes and those changed by T.O.). 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 an engine in the rotor-locked condition.



FIRE OR EXPLOSION.

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 whether a safe landing can be made.

Note

This airplane is not equipped with a fire-extinguishing system.

FIRE-WARNING CIRCUITS.

The fire-warning system consists of two detector circuits, each circuit controlling a cockpit warning light. The forward circuit (a red indicating light) senses fire in the forward engine compartment and main wheel wells. The aft circuit (an amber indicating light) senses overheat or fire in the afterburner compartment. The afterburner compartment is substantially more resistant to immediate fire damage than the forward engine compartment. This permits less drastic action in case the amber warning 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—Press stop-starter button.
5. Battery-starter 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 will vary with each set of circumstances, and will depend upon altitude, airspeed, length of runway and overrun clearance remaining, location of populated areas, etc. The decision you make will depend 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 to allow for aborting the take-off, proceed as follows:

1. Throttle—CLOSED.
2. External load—Jettison.
3. Drag chute—Deploy if necessary.
4. Use maximum braking (if necessary).
5 and 6. (Deleted)
7. Abandon airplane immediately upon stopping, if fire is apparent.

Forward Fire-warning Light (Air-borne).

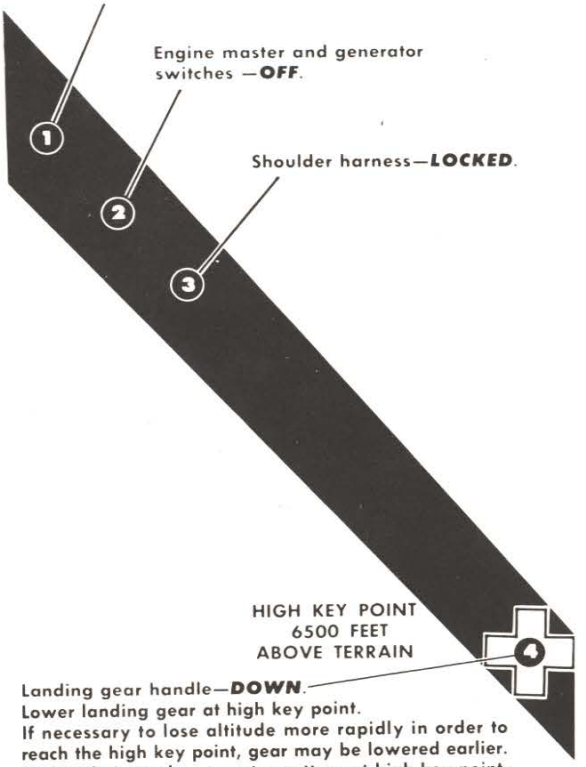
If the forward fire-warning light comes on after the airplane becomes air-borne, and sufficient runway is not available and overrun area is congested, preventing aborting of the take-off, the following is recommended if altitude is too low for a safe ejection.

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, 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 will ensure greatest chance for survival.

FORCED LANDING
WINDMILLING OR "FROZEN" ENGINE



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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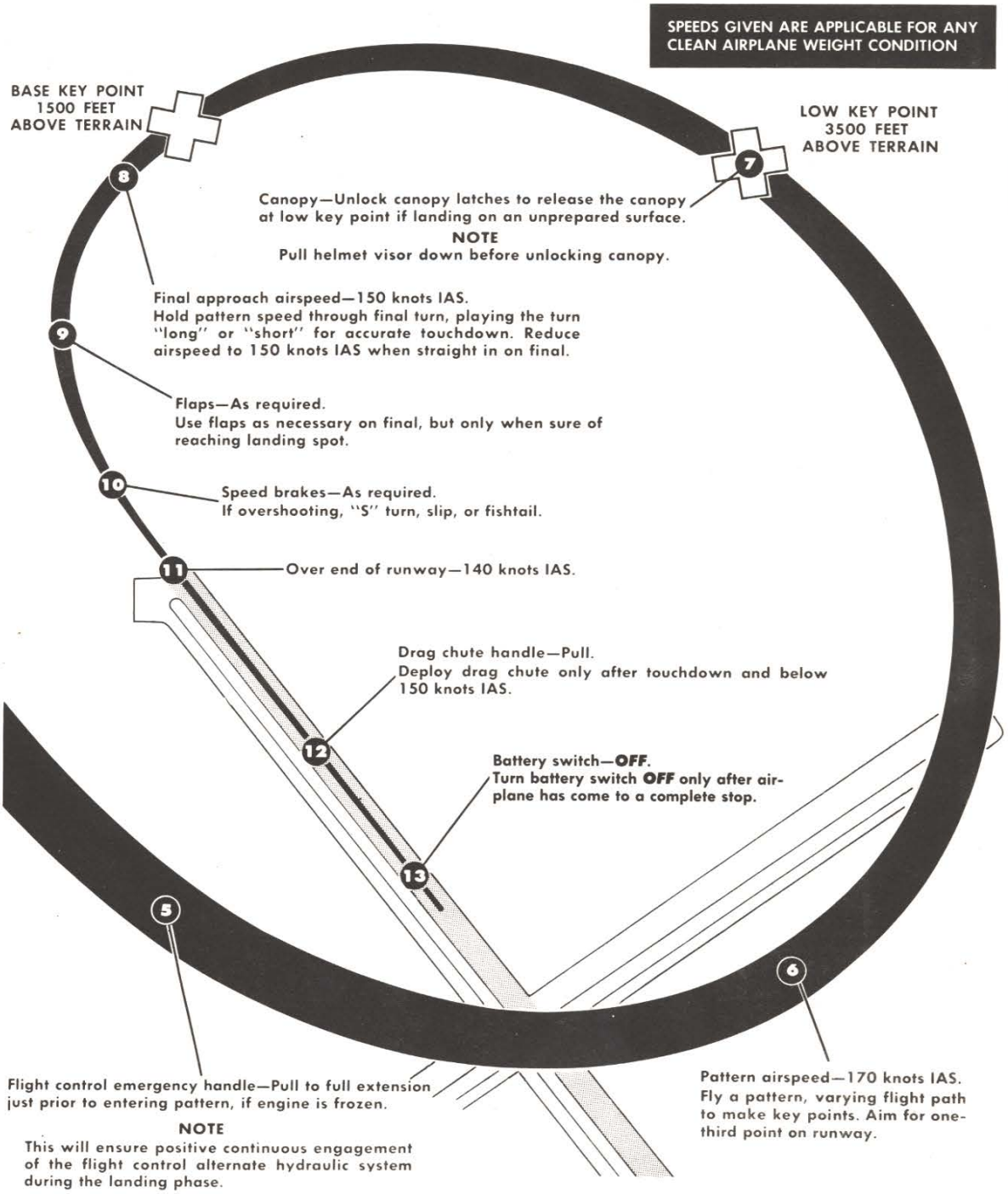
SPEEDS GIVEN ARE APPLICABLE FOR ANY CLEAN AIRPLANE WEIGHT CONDITION
BASE KEY POINT 1500 FEET ABOVE TERRAIN
LOW KEY POINT 3500 FEET ABOVE TERRAIN
7
8
Canopy—Unlock canopy latches to release the canopy at low key point if landing on an unprepared surface.
NOTE
Pull helmet visor down before unlocking canopy.
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.
9
Flaps—As required.
Use flaps as necessary on final, but only when sure of reaching landing spot.
10
Speed brakes—As required.
If overshooting, "S" turn, slip, or fishtail.
11
Over end of runway—140 knots IAS.
Drag chute handle—Pull.
Deploy drag chute only after touchdown and below 150 knots IAS.
12
Battery switch—OFF.
Turn battery switch OFF only after airplane has come to a complete stop.
13
5
6
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.
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Figure 3-3

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. Throttle—CLOSED.
2. External load—Jettison.
3. Use maximum braking (if necessary).
4. Drag chute—Deploy if necessary.
5. Warning light—Check.
   a. If light remains on after stopping—Leave airplane immediately.
   b. If light goes out—Engine master switch—OFF; then battery-starter switch—OFF.

Aft Fire-warning Light (Air-borne).

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

1. Throttle—Reduce power.
   Retard throttle from AFTERBURNER range to MILITARY and continue 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 flame, 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.
   Adjust throttle to minimum practical power to maintain safe ejection altitude.
2. Check for fire.
   Determine whether a fire actually exists by a report from another airplane, abnormal instrument readings, airplane or engine response to controls, explosion, unusual noise or vibration, fumes, heat, cockpit smoke, or trailing smoke noted following a turn.
3. If fire is confirmed—Eject.

WARNING

Whenever existence of fire is confirmed, prompt ejection will ensure greatest chance for survival.

4. 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 en route to nearest available base 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.

Illumination of the aft fire-warning light shows an 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 a fire in the engine or tail pipe after shutdown:

1. External power connected to both receptacles.
2. Throttle—CLOSED.
3. Battery-starter switch—Momentarily at STARTER.
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 button—Press.

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-starter 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-starter and generator switches to OFF, the emergency fuel system will take 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 will last from 25 to 28 minutes unless the flight control normal hydraulic system goes out. If the flight control alternate hydraulic system must be used, battery power will last 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 will 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.

Note

Pull helmet visor down before ejecting canopy.

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 parachute lanyard are shown in figure 3-5.

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

EJECTION SEAT OPERATION

Figure 3-4

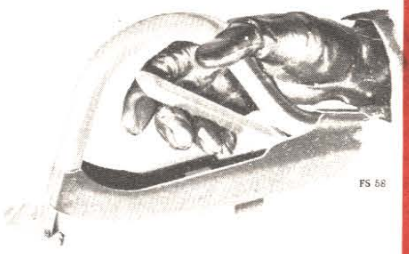
the only opportunity of survival. At sea level, wind blast will exert minor forces on the body up to about 525 knots IAS, appreciable forces from about 525 to 600 knots IAS, and excessive forces above about 600 knots IAS. As altitude is increased, these speed ranges will be proportionately slightly lower.

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 separations will be too rapid at high speeds.

LOW-ALTITUDE EJECTION.

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

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



2

IF CANOPY FAILS TO JETTISON

SQUEEZE EITHER TRIGGER TO EJECT SEAT THROUGH CANOPY.

IF TIME AND CONDITIONS PERMIT BEFORE EJECTION,

Steps 1 and 2 are all that are necessary for ejection. 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 EJECTION

- 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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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 fired). 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 take-off. 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.

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.)

(Deleted)

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 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 (automatic parachute), or "D" ring (manual parachute)—Pull.

WARNING

If bail-out occurs below 14,000 feet, pull "D" ring immediately whether parachute is automatic or manual type.

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, then pull "D" ring. The length of time you can "free-fall" before anoxia prevents you from pulling the "D" ring depends on your physical condition and bail-out altitude.

TAKE-OFF AND LANDING EMERGENCIES.

ENGAGING RUNWAY OVERRUN BARRIER.

WARNING

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.

Note

Barrier engagement is unlikely with the GAR-8 missiles or empty missile launchers installed.

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 engagement of the runway overrun barrier 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 engagement of the runway overrun barrier is imminent, jettison the drop tanks. If the runway overrun barrier is to be engaged, engage it 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:

1. Drop tanks—Jettison.

WARNING

Make decision to jettison drop tanks as early as posible, to ensure greatest possible separation of tanks and airplane and to minimize possibility of tanks sliding ahead of the airplane and prematurely tripping the barrier. In case of emergency, jettison external load over an open area.

1A. Drag chute—Deploy.

2. Throttle—CLOSED.
3. Aim for center of barrier and contact barrier as close to 90 degrees as possible.
4. Brakes—Avoid excessive use during engagement to barrier, to prevent tire blowouts and subsequent loss of directional control of airplane.

5. Engine master, generator, and battery-starter 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.

BELLY LANDING.

If a belly landing is unavoidable, and if time and terrain will allow, fire out all ammunition and expend excess fuel. (This will lighten the landing load, establish an aft CG condition, and minimize the danger of explosion or fire after landing.) 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. Drop tanks—Jettison if they contain fuel.

WARNING

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

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

   Just before touchdown, turn engine master, generator, and battery-starter switches OFF. Battery-starter 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.

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

WARNING

If 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 operations, it is recommended that the chute be deployed above 75 knots IAS.

12. Leave airplane immediately after it stops.

ZERO-SECOND LANYARD CONNECTION REQUIREMENTS

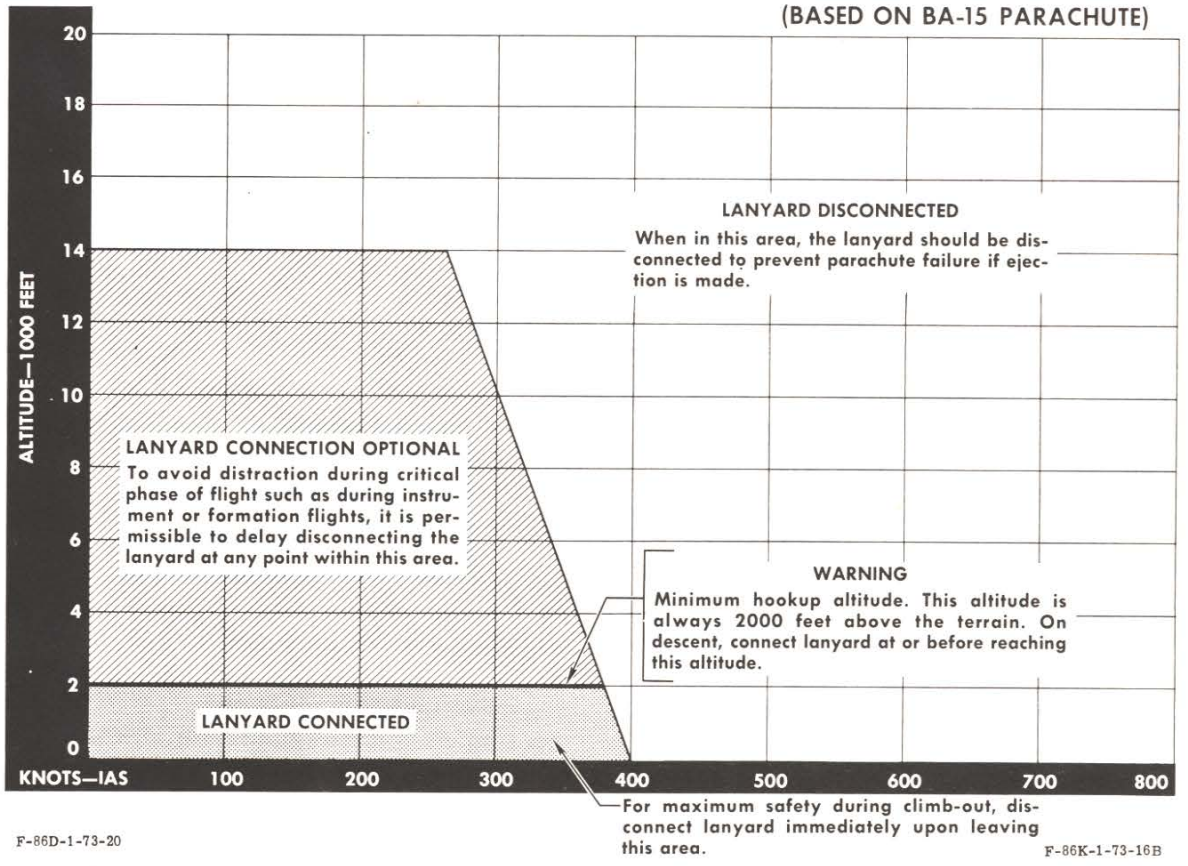


Figure 3-5

LANDING GEAR UNSAFE INDICATIONS.

If an unsafe gear-down indication still exists after the emergency lowering procedure (figure 3-7) 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 should 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 Surfaces 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 lowered (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 lowered by the normal system, the emergency procedure should be used. 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 air stream 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 jettison automatically 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. Ammunition—Expend.

   If time and terrain will allow, fire out all ammunition and expend excess fuel. This will lighten the landing load and establish an aft CG condition, and minimize the danger of explosion or fire after landing.

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-starter 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 should 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.

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 if speed is too slow to continue take-off, the take-off should be aborted.

Note

- If nose gear tire failure occurs at or near nose wheel lift-off speed, the pilot may elect to continue the take-off 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 the 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.

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.

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 3-6.

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. Personal equipment—Disconnect.

   Check that leads will not foul when leaving cockpit (leave oxygen connected).
4. 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.

5. Landing gear handle—UP.
6. Speed brake switch—IN.
7. Canopy—Unlock.

   Allow airstream to carry canopy away.

Note

Pull helmet visor down before unlocking canopy.

8. Throttle—CLOSED.
9. Wing flap handle—DOWN.

   Flaps collapse on impact and do not tend to make airplane dive.
10. Engine master, generator, and battery-starter switches —OFF.

    Turn battery-starter switch OFF last, so that power will be available to close fuel shutoff valve when engine master switch is turned OFF.
11. Safety belt and shoulder harness—Tighten.
12. Shoulder harness lock handle—LOCKED.
13. 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.
14. Approach and flare—Normal.
15. Touchdown—Keep nose high, and attempt to touch down at minimum flying speed.

WARNING

If airplane is ditched in a near-level attitude, it will dive violently soon after contact.

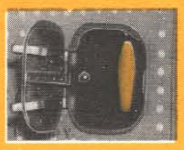
16. Oxygen mask—Remove.
17. Leave airplane.

DROP TANK EMERGENCY JETTISON IN FLIGHT.

To release drop tanks, depress drop tank jettison button on left instrument subpanel. The drop tanks can also be

EMERGENCY ENTRANCE

NOTE:
If canopy cannot be readily lifted off, emergency entrance must be made forcibly.



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 electrically by pushing external control button marked "OPEN." Hold button fully depressed until canopy is completely open.

2 If 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.

WARNING

When canopy has been jettisoned, the ejection seat is armed.

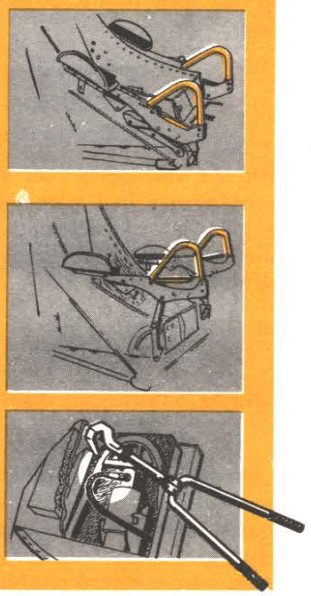
3 Determine position of seat armrests:
If both seat armrests are in normal down or stowed position, complete rescue operation, being sure to keep clear of armrests at all times.

WARNING

Avoid unnecessary handling of any portion of seat and canopy firing mechanisms at all times and stay clear of line of canopy ejection.

4 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 loose hose ends are not aligned; otherwise, if seat initiators fire accidentally, expanding gases may still actuate catapult exactor and cause seat to fire.

*Use 9/16-inch open-end wrench.



F-86K-1-31-1C

Figure 3-6

released manually when the drop tank emergency jettison handle is pulled to full extension, about 3 inches.

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.

CAUTION

With the emergency fuel system switch ON, the emergency fuel system is in control, and all throttle advancements must be slow, smooth, and gradual to prevent compressor stall or flame-out.

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, 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 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-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 roll 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 existing 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 ac 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.
3. Land as soon as possible using recommended flameout landing pattern to ensure landing in case of complete power failure.

WARNING

- Retarding the throttle at any time during an oil system malfunction may result in engine seizure and subsequent forced landing.
- In case of an oil system malfunction, switching to the emergency fuel system is not recommended unless malfunction of the main fuel controller is detected. Switching fuel systems will generally cause momentary engine deceleration and possible engine seizure.

MAIN FUEL CONTROL SYSTEM FAILURE.

MAIN FUEL CONTROL SYSTEM FAILURE DURING TAKE-OFF.

Three-position Emergency Fuel System Switch.

On airplanes equipped with the three-position emergency fuel system switch, take-off will be made with the switch in the TAKE-OFF position, thus putting the emergency fuel regulator in a stand-by condition. In the event of a main fuel regulator failure, there will be no indication except for a slight drop in rpm (4% to 10%) down to the emergency fuel system setting. If a slight rpm drop is detected during an early stage of take-off (before committed to take-off) and speed and distance permit, the take-off should be aborted. Refer to "Engine Failure During Take-off Run (No Runway Overrun Barrier)" in this section. If an rpm drop is detected after committed to a take-off, leave emergency fuel system switch at TAKE-OFF until safe altitude is reached, and then move switch to NORM. If any decrease

in rpm then occurs, failure of the main fuel control system is the probable cause in which case the emergency fuel control system switch should be immediately moved to ON.

Two-position Emergency Fuel System Switch.

The emergency fuel system switch is in the NORM position for take-off, climb, and all normal operation. In this case, the emergency fuel regulator will not be in a "stand-by condition"; therefore, it will be necessary for the pilot to recognize a main fuel control system failure (shown by a drop in rpm 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.

Three-position Emergency Fuel System Switch.

On airplanes equipped with the three-position emergency fuel switch, a main fuel control system failure during climb will not be shown, except for a slight drop in rpm (4% to 10%) down to the emergency fuel system setting, when the emergency fuel system switch is at TAKE-OFF position. However, when the emergency fuel system switch is moved from TAKE-OFF to NORM (after a safe altitude is reached) any failure will be evidenced by rapid decrease in engine speed or by no response when throttle is retarded. If any decrease in rpm is evident, showing failure of the main fuel control system, immediately move switch to ON. If engine speed is inadvertently allow to drop below 85% rpm before the emergency fuel system switch is moved to ON position, the throttle should be retarded to START IDLE before the switch is placed ON to prevent an overtemperature condition. If failure occurs proceed as follows:

1. Emergency fuel system switch—ON (when a safe altitude is reached).
2. Throttle—Retard from AFTERBURNER to START IDLE.
3. Variable-nozzle switch—CLOSE, then OFF (only if nozzle fails to work automatically).

   If the automatic control of the nozzle does not work properly, the nozzle can be closed manually. If the nozzle works automatically, it will move toward a closed position as the throttle is moved from AFTERBURNER to START IDLE, even if the emergency fuel system is controlling the engine.
4. Throttle—Cautiously advance to MILITARY (avoid overtemperature condition).

Two-position Emergency Fuel System Switch.

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 engine speed in inadvertently allowed to drop below 85% rpm before the 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. 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 system 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 nozzle fails to close automatically).
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 75% rpm may be too long if a go-around is necessary. Therefore, caution

must be exercised to maintain the rpm at 75% or above 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 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. Throttle—Retard to START IDLE (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.

   Return nozzle switch to OFF to lock nozzle in position.
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, equipment powered by the monitored bus No. 3, secondary inverter, alternator, and radar will be automatically shut off. Try to bring the generator back into the circuit as follows:

1. Voltmeter selector switch—Move to related generator position.
2. Momentarily hold related generator switch—RESET.
3. Generator switch—ON.

   If warning light remains out and voltmeter shows normal system voltage, it shows that the overvoltage was temporary.
4. If warning light comes on again, move generator switch to OFF.

FAILURE OF BOTH GENERATORS.

If both generator warning lights come on, indicating that both generators are out, equipment powered by monitored busses No. 2 and No. 3 and dc gyro power will be shut off. This will result 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 subsequent engine control on the emergency fuel system, the emergency fuel system switch should be immediately placed to ON. All subsequent throttle movements must be made cautiously to prevent compressor stall or flame-out.

With ac power removed, the fuel flowmeter, fuel quantity, fuel pressure, oil pressure, and hydraulic pressure gages will be inoperative. These instruments, while inoperative, will deceptively continue to indicate the condition that existed at the time of power failure. Attempt to bring the generators back into the 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. In order to effectively prolong battery life, you must turn off equipment you don't absolutely need.

3. Voltmeter selector switch—Move to related generator position.
4. Momentarily hold related generator switch at—RESET.
5. If related warning 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 the inoperable generator switch OFF and again reset the 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.

In the event of complete electrical failure, or if it is necessary to turn off the battery and generator switches, the fuel booster and transfer pumps will be inoperative. Under these conditions it is possible to have an engine flame-out with as much as 1200 to 1700 pounds of fuel remaining, since fuel will be supplied to the engine by suction feed only. With the booster pumps in the center wing cell inoperative and the aft fuselage tank empty or nearly empty, air will be drawn through the suction feed valve in the aft fuselage tank. This will result in intermittent fuel flow and possibly cause a flame-out. Under some conditions such as extreme pitch attitudes, rapid airplane acceleration or deceleration, and/or high thrust settings, a flame-out is possible even with more fuel remaining.

If complete electrical failure occurs, if it is necessary to turn off battery and generator switches, or if fluctuations of rpm, fuel flow, or exhaust temperature occur, proceed as follows:

1. Reduce altitude and engine rpm to maintain satisfactory engine operation.
2. Land as soon as possible using forced landing pattern.

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 failures of the main inverter or both inverters occur, such failures are shown by the inverter warning lights coming on. Should inverters fail while operating under electronic engine control, no manual emergency procedures are mandatory until power changes are required. The automatic lockup system automatically locks the electronic engine controls in position and illuminates the amber engine control lockup indicator light. (Refer to "Automatic Lockup System Characteristics" in Section VII.) Failure of the main inverter (with inverter selector switch at MAIN) causes both the "MAIN" and "BOTH" inverter failure warning lights to come on. The inverter selector switch must then be moved to SPARE; this will allow the secondary inverter to assume the load of the failed main inverter and extinguish the "BOTH" inverter failure warning light.

Inverter Failure During Take-off Roll (Continued Take-off).

If, during the take-off roll, the main inverter fails (shown by inverter failure warning light or lights 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.

Note

The engine controls will automatically unlock when ac power is restored (above about 98 volts) and the electronic engine control will then govern engine operation.

3. If lockup light does not go out within 30 seconds:
   a. Throttle—Rapidly retard to START IDLE.
   b. Emergency fuel switch—ON.
      Immediately switch to the emergency fuel system as the throttle is retarded to start IDLE.
   c. Variable nozzle—Jog closed.
   d. Throttle—Cautiously readvance 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 failure warning light or lights coming on) and the engine controls automatically lock up (shown by the engine control lockup caution light coming on),

and it is desired to abort the take-off, perform the following:

1. Throttle—Rapidly retard to START IDLE.

Note

On airplanes with the three-position emergency fuel system switch, this action automatically converts engine control to the emergency fuel system by actuation of the 72-degree thrust selector switch. On airplanes with the two-position emergency fuel system switch, the

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throttle has to be retarded with enough force to actuate the idle detent switch.

2. Brakes—Apply as necessary.
3. Drag chute—Deploy.

WARNING

- The heat generated in the brakes during an aborted take-off continues to build up during taxiing operation back to the take-off position. 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 flight.

4. Emergency fuel system switch—ON (before readvancing throttle).
5. Inverter selector switch—SPARE.
6. Throttle—Readvance as desired for taxiing.
   Keep in mind that all throttle movements must be made cautiously during operation on emergency fuel system.
7. Electronic engine control lockup—Removed.
   Engine control lockup caution light and inverter failure warning light or lights are no longer on.
8. Emergency fuel system switch—NORM.

Inverter Failure During Flight.

During flight, if the engine control lockup 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, it will be necessary to change to the emergency fuel system to restore engine control. The switch-over to the emergency fuel system is accomplished as follows:

1. Throttle—Rapidly retard to START IDLE.
   Immediately switch to the emergency fuel system as the throttle is retarded to START IDLE.
2. Emergency fuel system switch—ON.
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.

The inverter selector switch must be placed at SPARE before the lockup indicator light will go out. Placing the switch at SPARE selects the secondary inverter as the electronic engine control power source. When ac power is restored, the lockup system requires about 15 seconds to release the lockup condition. If automatic electronic engine control lockup occurs during approach or landing, position throttle at about 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 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 gear, 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 still 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.

If a safe landing gear down indication is not obtained after several attempts using the normal procedure, the landing gear emergency lowering procedure, as shown in figure 3-7, should be used. If, after using the emergency lowering procedure, an unsafe gear indication still exists on either or both main gear, pull the "LANDING GEAR CONTROL" circuit breaker and repeat the

emergency lowering procedure, making sure to rock the wings and yaw the airplane so that the gear will swing free in an attempt to jolt the downlocks into the locked position.

Note

The nose gear will 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. Do not attempt to reset to normal system even if pressure builds back up to operating range.

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).

Figure 3-7

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 will result 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.

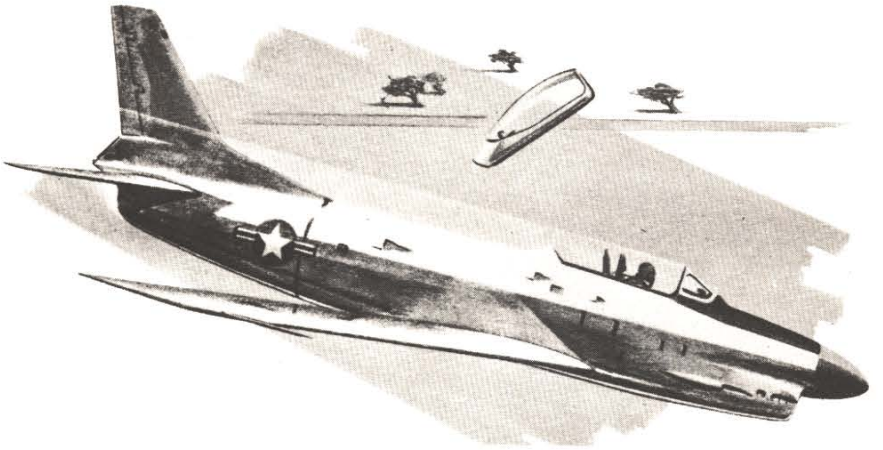
If a failure of the normal trim control for the controllable horizontal tail occurs, the controllable horizontal tail can be trimmed through use of the alternate longitudinal trim switch on the left side of the cockpit.

AILERON NORMAL TRIM FAILURE.

In event of failure of the normal aileron trim control, 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-86K-(CL)1-1.



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AUXILIARY EQUIPMENT

Section IV

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 4-3.) 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 failure of the pressure regulator occurs. All air conditioning and pressurization controls are powered from the primary bus.

COCKPIT AIR CONDITIONING AND PRESSURIZATION SYSTEM CONTROLS AND INDICATOR.

Cockpit Air Switch.

A two-position cockpit air switch is at the front of the cockpit air control panel (figure 4-2) aft on the left console. With the switch in the PRESS position, the main system shutoff valve in the air supply line from the engine is open and sufficient 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 admitted until the ram-air lever is moved to OPEN. With 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 the switch in the AUTOMATIC position, air temperature is automatically maintained at the temperature selected on the cockpit air temperature rheostat. In case 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 INCREASE or DECREASE of the cockpit air

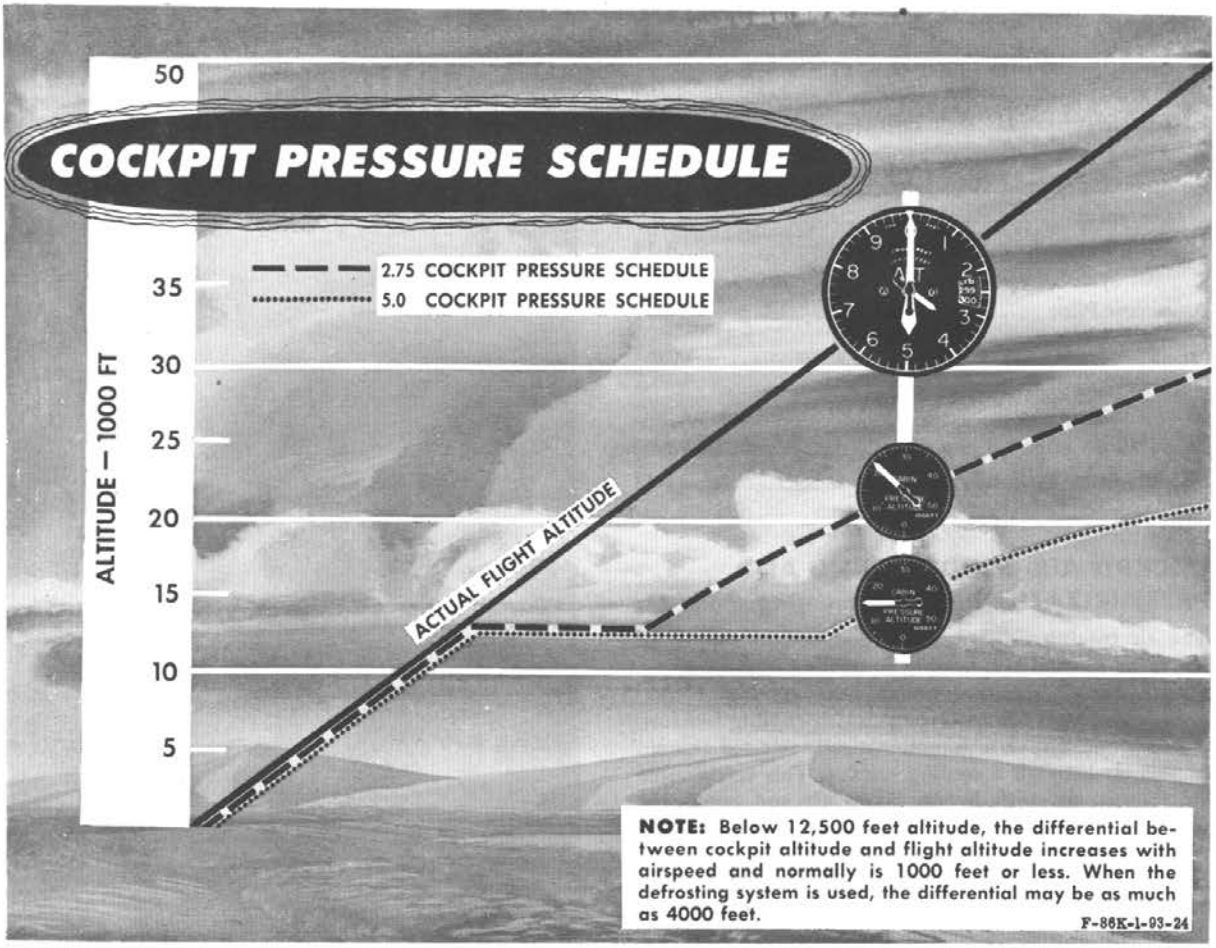


Figure 4-1

temperature rheostat on the cockpit air control panel. (See figure 4-2.) This rheostat controls cockpit air temperature 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 (figure 4-2) 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. Simultaneously, this lever mechanically opens a small ram-air inlet door on the left fuselage side below the canopy skirt, allowing ram air to enter the cockpit. With the manual ram-air lever in the CLOSED position and the cockpit air switch in the PRESS position, 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 (7, figure 1-6) is provided 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, resulting in 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 positioned 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

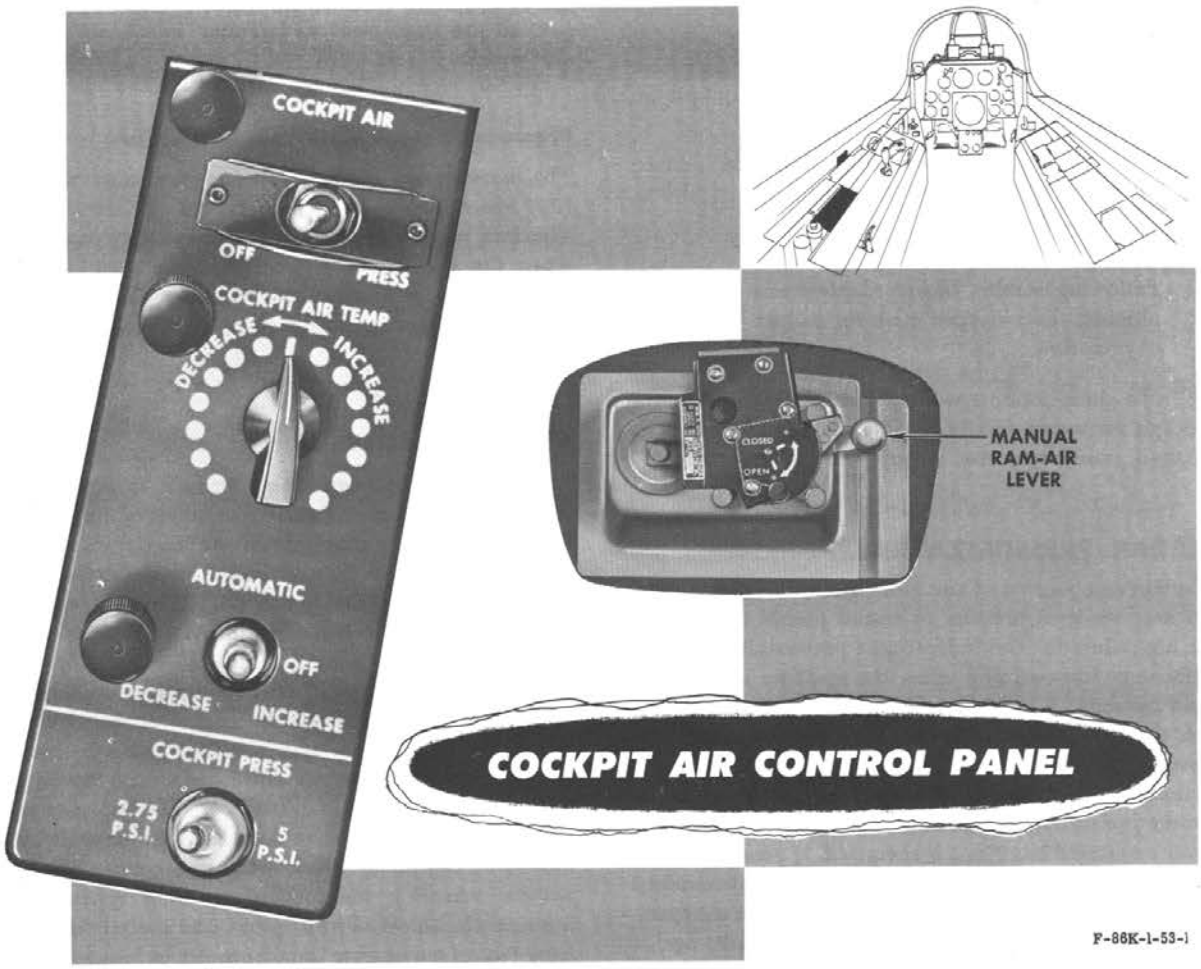


Figure 4-2

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 will rise above 12,500 feet on a scale proportional to the flight altitude. See figure 4-1 for comparison of flight altitude to cockpit altitude and for cockpit altitude tolerances.

Cockpit Altimeter.

The pressure altitude of the cockpit is indicated by the cabin pressure altimeter (17, figure 1-6) on the left console. The instrument has only one pointer and gives a direct cockpit pressure altitude.

NORMAL OPERATION OF COCKPIT AIR CONDITIONING AND PRESSURIZATION SYSTEM.

1. Cockpit air switch PRESS.
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 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 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 cockpit pressurized area, automatically regulates and maintains correct pressure in the pressurized components of the radar system whenever monitored bus No. 2 is energized. If pressure within the sections pressurized drops below a predetermined level, the air pump is automatically energized to repressurize the sections. If radar pressurization fails, use of the radarscope indicator is lost; however, optical mode operation with radar or manual ranging is possible.

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 on either side along the canopy rail 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., allows hot air to pass to the windshield and canopy inside surface for defrosting.

Pressure Suit Face Mask Heater Rheostat:

The pressure suit face mask defrosting heater rheostat (19, figure 1-6) is on the aft end of the left 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 purpose of the anti-icing systems is to prevent the formation of ice, rather than to 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 4-3.) The surface anti-icing system provides hot air for the interior areas of the leading edges of the 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 into operation without actuating the surface anti-icing system. The interior windshield defrost system and the radome anti-icing system can operate simultaneously or independently of each other. In the windshield defrost system 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 on the right instrument subpanel. (See figure 1-8.) This switch is powered from monitored bus No. 2, provided ac power is available. When the switch is placed in the ON position, 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 Inlet Switch.

The engine inlet switch, on the right instrument subpanel (figure 1-8), controls both the engine inlet screen and the engine accessory cover anti-icing system. With

the surface anti-ice switch at OFF, the engine inlet screen actuator is powered from the primary bus and the engine accessory cover anti-icing system from monitored bus No. 2. Placing the engine inlet switch at EXTEND SCREEN 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 Switch," Section I.) When the switch is moved to ACCESSORY COVER, the screen is retracted, and a thermal sensing unit controls anti-icing air for the engine accessory cover and forward compressor section, as required.

Windshield Anti-ice Switch.

The three-position windshield anti-ice switch, on the right instrument subpanel (figure 1-8), allows hot air to pass to the windshield for anti-icing when the switch is placed in the CENTER or SIDE position. The CENTER and SIDE positions permit selection of either of these two windshield areas to be anti-iced. The switch is powered from monitored bus No. 2.

Note

The windshield anti-icing system can also be used for rain removal purposes. Sufficient anti-icing airflow is available over the windshield to effectively improve vision if a minimum of 75% engine rpm is maintained.

Pitot Heat Switch.

The pitot heat switch is on the right instrument subpanel (figure 1-8) and receives power from monitored bus No. 1. Moving the switch ON causes the pitot head to be electrically heated.

Radome Anti-ice Switch.

The two-position radome anti-ice switch is on the right instrument subpanel. (See figure 1-8.) 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, powered by monitored bus No. 2, controls the 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 switch is in the OFF position; 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 will be cut off and windshield center panel air will be turned on automatically.

Surface Anti-ice Overheat Warning Light.

A surface anti-ice overheat warning light, beside the surface anti-ice switch on the right instrument subpanel (figure 1-8), comes on when there is excess heat in the surface anti-ice system. Power for this light is derived from the primary bus. The light will come on when the temperature of the air reaches 350°F (177°C).

Windshield and Radome Anti-ice Overheat Warning Light.

A windshield and radome anti-ice overheat warning light, on the right instrument subpanel (figure 1-8), indicates excess heat in the windshield and radome anti-ice system and receives power from the primary bus. The light will come on when the temperature of the air reaches 275°F (135°C).

Note

Illumination of the light indicates the design limit of the air temperature supplied to the anti-ice nozzle has been reached but does not necessarily indicate that the temperature of the windshield has reached the same limit. The temperature of the windshield depends on outside air temperature.

RAIN REMOVAL SYSTEM.

The air blast from the windshield anti-icing system can be used for rain removal purposes. To operate the rain removal system, the windshield anti-ice switch should be positioned 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 warning 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 glass temperature is less than that of the nozzle air because of the conditions of rain, ice, outside air temperature, and airflow over the windshield. Consequently, 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 should be followed to prevent, or reduce the severity of, windshield overheat if flight conditions preclude turning the system off.

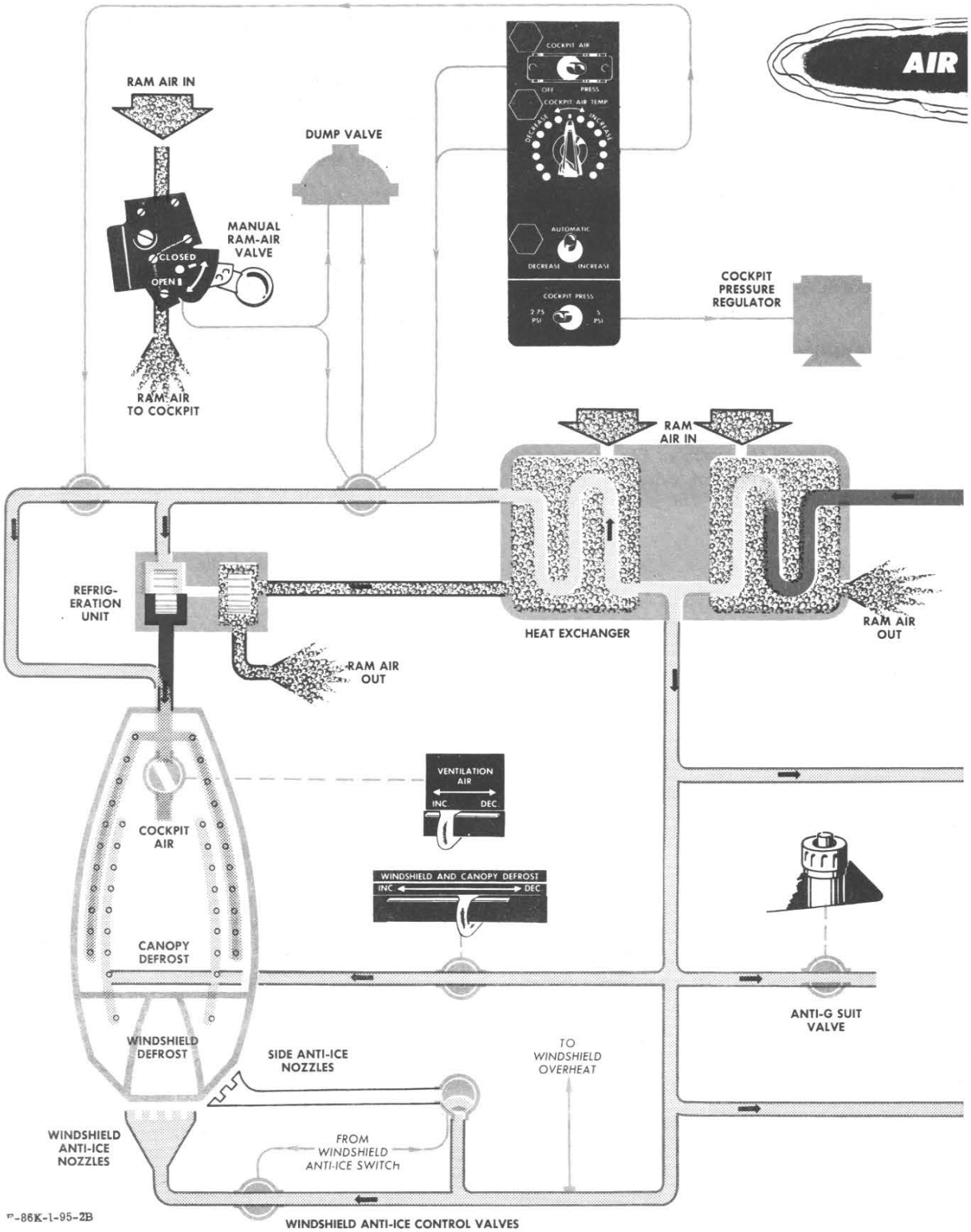
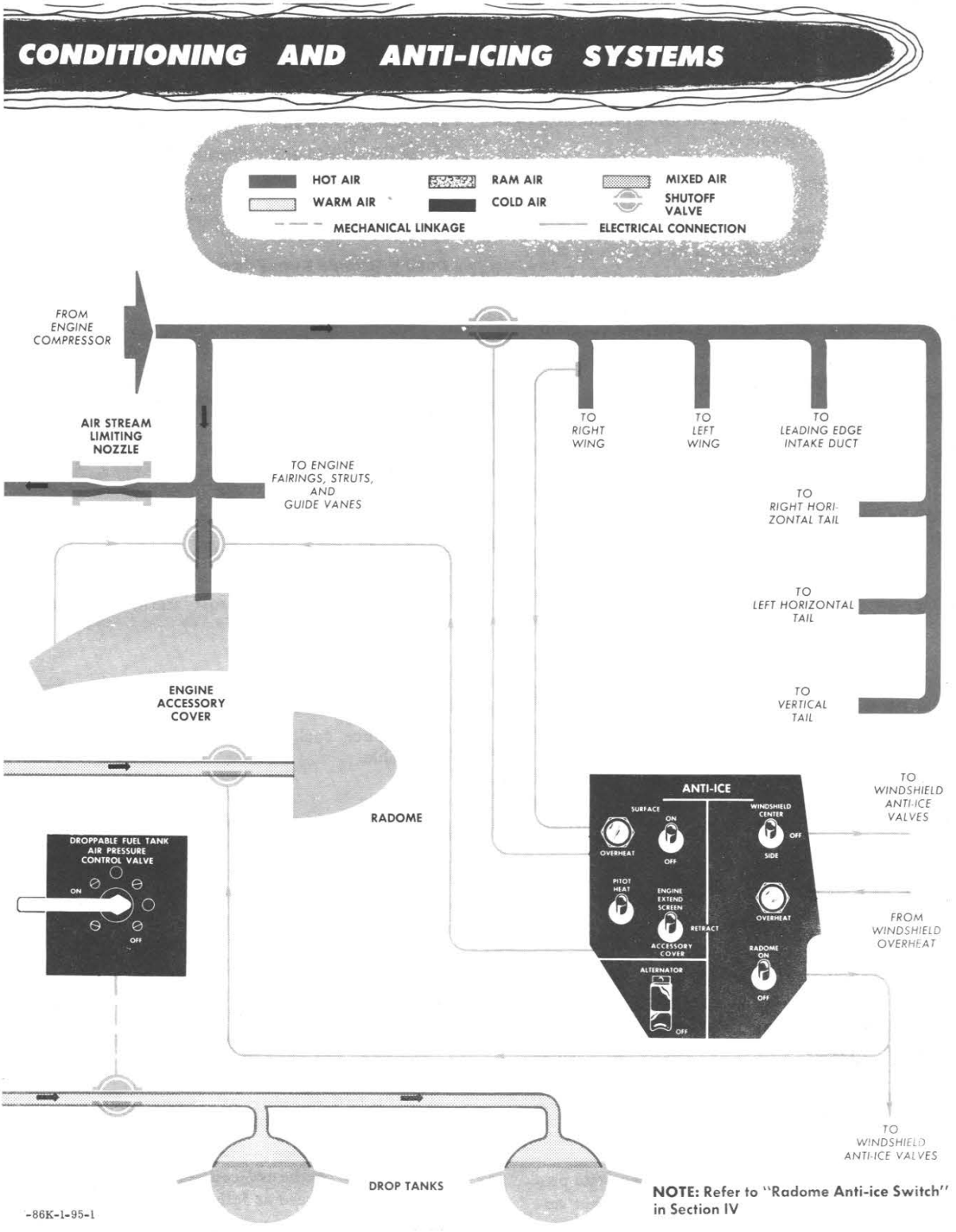

AIR
RAM AIR IN
DUMP VALVE
MANUAL RAM-AIR VALVE
CLOSED
OPEN
RAM AIR TO COCKPIT
COCKPIT AIR
OFF
PRESS
COCKPIT AIR TEMP
DECREASE
INCREASE
AUTOMATIC
DECREASE
INCREASE
COCKPIT PRESS
2.75 PSI
5 PSI
COCKPIT PRESSURE REGULATOR
RAM AIR IN
HEAT EXCHANGER
RAM AIR OUT
REFRIG-ERATION UNIT
RAM AIR OUT
VENTILATION AIR
INC
DEC
COCKPIT AIR
WINDSHIELD AND CANOPY DEFROST
INC
DEC
CANOPY DEFROST
ANTI-G SUIT VALVE
WINDSHIELD DEFROST
SIDE ANTI-ICE NOZZLES
TO WINDSHIELD OVERHEAT
WINDSHIELD ANTI-ICE NOZZLES
FROM WINDSHIELD ANTI-ICE SWITCH
WINDSHIELD ANTI-ICE CONTROL VALVES
F-86K-1-95-2B

Figure 4-3

CONDITIONING AND ANTI-ICING SYSTEMS



NOTE: Refer to "Radome Anti-ice Switch" in Section IV

Landing and Take-off.

1. Place cockpit air switch at OFF and move manual ram-air lever to OPEN.

2. Reduce cockpit defrost airflow to minimum practicable. During landing or take-off, if the windshield overheat warning light comes on, the windshield anti-ice system should not be shut off.

Ground Run.

1. With windshield overheat warning light on, leave windshield anti-ice switch at either CENTER or SIDE.

2. Place cockpit air switch at OFF and move 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.

NORMAL OPERATION OF ANTI-ICING AND DEFROSTING SYSTEMS.

1. Surface anti-ice switch ON.

2. Radome anti-ice switch ON. Windshield anti-ice switch may be positioned at CENTER or OFF position. (Refer to "Radome Anti-ice Switch" in this section.)

3. Adjust windshield and canopy defrost lever toward INC. as desired.

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.

4. Pitot heat switch ON (up position).

EMERGENCY OPERATION OF ANTI-ICING SYSTEMS.

Overheating of Windshield and Radome Anti-icing System.

If the windshield and radome anti-ice overheat warning light comes on, indicating an overheated condition in the windshield and radome anti-icing system, proceed as instructed in the following paragraphs.

During Ground Run. Proceed as follows:

1. With warning light on, leave windshield anti-ice switch ON.

2. Place cockpit air switch at OFF and 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. Proceed as follows:

1. Place cockpit air switch at OFF and manual ram-air lever to OPEN.

2. Reduce cockpit defrost airflow to minimum practicable.

During Level Flight. Proceed as follows:

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 warning light comes on, 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 the maximum necessary

to illuminate warning 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 warning light, place surface anti-ice switch at OFF.

COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT.

UHF COMMAND RADIO—AN/ARC-34.

The AN/ARC-34 command radio equipment (figure 4-4) provides two-way AM radio-telephone communication on 1750 different channels in the radio frequency range of 225.0 through 399.9 megacycles, on frequencies spaced 0.1 megacycle apart. It incorporates provisions for presetting 20 channels on the receiver unit at any one time, and any of the preset channels may be selected as desired. On airplanes changed by T.O. 1F-86K-550, a remote channel indicator is mounted on the left side of the instrument shroud. If the airplane is modified for missiles, the indicator is mounted on top of the missile control box. 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, a rotary channel selector switch for selection of the preset channels, the manual-preset-guard selector control, a volume control knob, and a tone button for sending a continuous tone to establish a direction-finding bearing. The main control switch has four positions: OFF, MAIN, BOTH, ADF. The radio set is turned off when the switch is at OFF. The MAIN position is for receiving and transmitting on the main selected channels only; the BOTH position allows, in addition, reception on the guard frequency. The ADF position is not operative at the present. Four frequency selection knobs at the top of the control panel are used for manual selection of a desired frequency between 225.0 to 399.9 megacycles when the manual-preset-guard selector switch is placed at MANUAL. When the switch is placed at PRESET, the 20 preset frequencies can be individually selected by using the rotary channel selector switch; if the switch is placed at GUARD, the guard frequency can be monitored for emergencies. A frequency card at the bottom of the control panel is used to list the frequencies selected for the 20 preset channels. Power for the AN/ARC-34 is furnished from the secondary bus.

Operation of Command Radio (AN/ARC-34).

1. Select PRESET position with manual-preset-guard control.

2. Rotate main control switch to BOTH position and allow about one minute for warm-up of main and guard receiver units.

Note

- A thermal time-delay relay cuts out and stops the channeling 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 position and allow a 30-second cooling period. Then switch to BOTH position and select desired channel.
- Do not attempt to tune receiver to any frequency below 225 megacycles, as set will not operate in this range and continuous operation of the channeling drive motor results.

3. Place channel selector control to a channel other than desired channel. Allow tuning cycle to be completed; then return to desired channel.

Note

An inherent characteristic of the radio set will reduce 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 cannot be obtained.

4. Adjust volume control to desired audio level.

5. Manual selection of a frequency not preset is made by moving the manual-preset-guard control to MANUAL position. Rotate the four frequency selection knobs for selection of desired frequency. The main control switch must be in either MAIN or BOTH position for manual operation.

Note

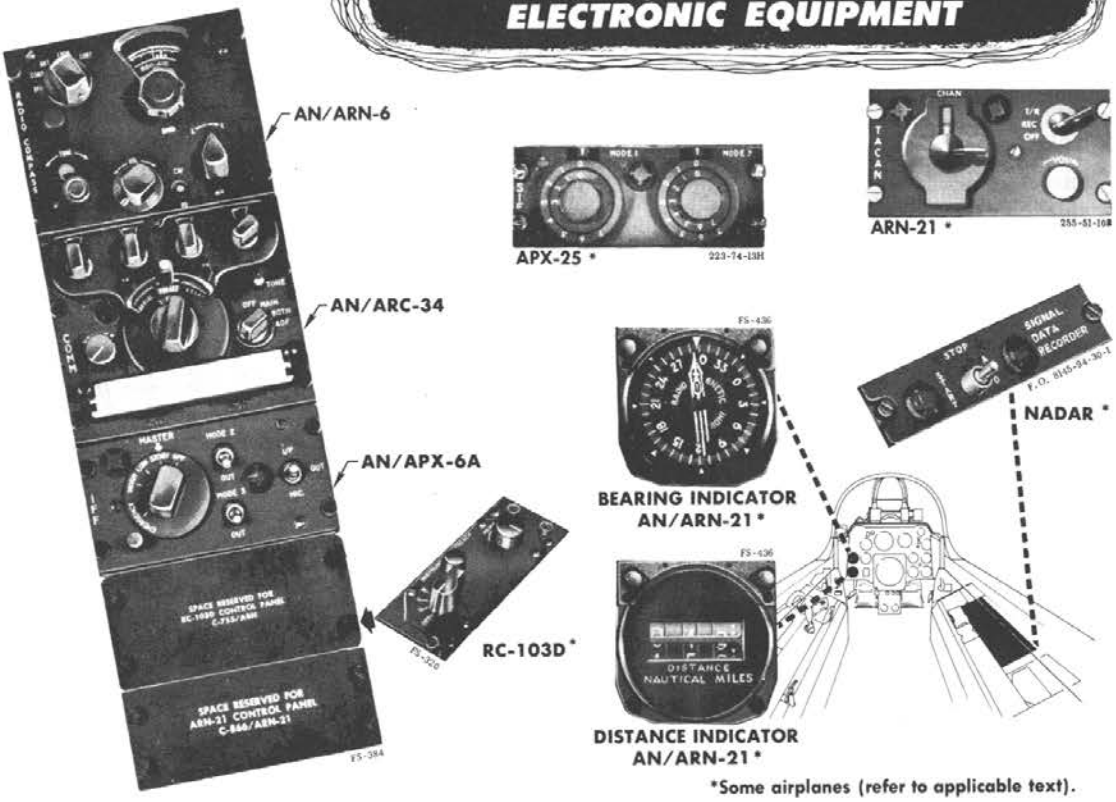
This procedure places the equipment in the receive condition. Transmission on the same frequency is done by depressing the microphone button; however, if it is desired to change the transmitter frequency, the microphone button should be released before the frequency is changed. About 4 seconds should elapse before transmission is begun on the new frequency.

6. To receive on guard frequency, move manual-preset-guard selector to GUARD. This tunes the receiver and transmitter to the guard frequency and cuts out the main units.

Note

No transmission will be made on emergency (distress) frequency channels except for emergency purposes. For test, demonstration, or

COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT



*Some airplanes (refer to applicable text).

TYPE	DESIGNATION	USE	RANGE
UHF COMMAND	AN/ARC-34	Two-way voice communication	75 to 100 miles
NAVIGATION EQUIPMENT	AN/ARN-21*	Tactical Air Navigation	Line of sight (195 miles)
RADIO COMPASS	AN/ARN-6	Reception of voice and code communication, position finding, homing.	20 to 200 miles
GLIDE SLOPE RECEIVER	AN/ARN-18*	Instrument Landing System	15 miles
LOCALIZER RECEIVER	RC-103-D	Instrument Landing System	25 to 50 miles
IFF	AN/APX-6 or 6A*	Automatic identification	Line of sight
SIF	AN/APX-25*	Selective Identification	Line of sight

F-86K-1-71-1E

Figure 4-4

drill purposes, the radio equipment must be operated in a shielded room to prevent transmission of messages that could be construed as actual emergency messages.

7. To turn set off, rotate main control switch to OFF.

NAVIGATIONAL RADIO—AN/ARN-21.

Airplanes changed by T.O. 1F-86K-549 are equipped with the AN/ARN-21 navigational radio. The AN/ARN-21 radio is a navigational aid capable of giving the pilot bearing and slant distance to a surface beacon. For this equipment, the controls and indicators in the cockpit consist of a control panel on the right console, a distance indicator on the instrument panel, a bearing indicator utilizing the radio compass indicator already installed on the instrument panel, and a course indicator on the instrument panel. 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 accepts only 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 minute. The AN/ARN-21 has a range of about 195 miles in line of sight and 40 degrees up from the surface beacon. 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 the 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 (figure 4-4), 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 Selector Switch. The channel selector switch (figure 4-4) marked "CHAN," in the center of the control panel, permits 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 switch consists of a large circular knob and a small handle. The knob selects the first two digits, and the handle selects the third digit of the desired channel. Thus, 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 (figure 4-4), marked "VOL," on the right of the control panel, adjusts the loudness of the surface beacon identification tone. Rotate knob clockwise to increase loudness.

TACAN-ILS Changeover Switch. The TACAN-ILS changeover switch (8A, figure 1-5), powered by the monitored bus No. 2, is on the instrument panel. The switch, labeled "TACAN-ILS," determines which of the two systems will furnish information to the course indicator and controls the visual presentation only. If electrical power to the TACAN-ILS selector switch relay is lost with the TACAN system ON and the TACAN-ILS switch at ILS, the following will occur:

a. The vertical needle of the course indicator automatically reverts to TACAN information, even though the TACAN-ILS switch is in the ILS position. There will be no indication during an ILS approach that the signal to the vertical needle is being derived from TACAN rather than from the localizer, because the "OFF" flag for the vertical needle will not appear. If electrical power to the relays was lost before the TACAN-ILS switch was moved to the ILS position, the needle will continue to indicate TACAN information.

b. The horizontal needle centers itself, and the horizontal needle warning "OFF" flag appears when electrical power to the relays is lost. However, if the ILS approach is started far enough out, the horizontal needle "OFF" flag may not have disappeared because of insufficient glide slope signal. The pilot will not know if the course indicator is receiving signals from the ILS transmitter or from TACAN, since the horizontal needle warning "OFF" flag is still visible

(either because of insufficient signal strength or because of power failure to the relays). Therefore, if during an ILS approach, the disappearance of the horizontal needle warning "OFF" flag is delayed beyond normal expectations, it may be an indication that electrical power to the relays is lost.

c. If the horizontal needle warning "OFF" flag has disappeared during an ILS approach (indicating glide slope signals are being received with sufficient strength) and subsequent power failure to the relays ocurs, the horizontal warning "OFF" flag will appear and the horizontal needle will center itself.

Bearing Indicator. The bearing indicator, on the instrument panel, indicates the relative bearing to the surface beacon from the airplane position. The indicator has degree markings around its edge, with figures at each 30-degree point. Signals from the AN/ARN-21 navigation receiver 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 the 40-degree angle limit, 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.

Course Indicator. Refer to "Instrument Landing System (ILS)" in this section.

Note

On airplanes equipped with TACAN, the "TO-FROM" indicator and the course selector knob are inoperative when ILS is used.

Distance Indicator. The distance indicator, 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 because of its being out beyond the 195-mile range of the equipment, a memory circuit retains for about 10 seconds the last distance before the interruption; 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. The airplane receives bearing and distance indications except when it is above the 40-degree angle limit from the surface beacon; above the 40-degree angle limit, it receives distance information only. 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.

Operation of AN/ARN-21 Radio (Homing).

To operate the AN/ARN-21 radio, proceed as follows:

1. Move TACAN-ILS switch to TACAN position.

1A. Rotate channel selector to surface beacon channel desired.

2. Move function switch to either REC or T/R and allow about 2 minutes for warm-up, or wait until bearing indicator stops spinning.

Note

A false lock-on may occur momentarily; however, the bearing needle will release and go to the true bearing of the surface beacon.

3. To home on surface beacon:

a. Turn airplane until directional indicator indicates heading given on bearing indicator.

b. Rotate "SET" knob on course selector to select desired course.

c. Read slant distance 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.

RADIO COMPASS—AN/ARN-6.

The AN/ARN-6 radio compass set (figure 4-4) is a visual and navigational aid used in conjunction with the radio compass indicator (37, figure 1-5) on the instrument panel. Four separate frequency bands are provided: band one, 100 to 200 kilocycles; band two, 200 to 410 kilocycles; band three, 410 to 850 kilocycles; and band four, 850 to 1750 kilocycles. Controls permit selection of automatic or manual direction finding. The radio compass loop is installed in the aft part of the canopy, and the "sense" antenna is incorporated in the upper arc of the canopy enclosure. (See figure 4-5.) The control switch on the radio compass control panel is powered from the secondary bus.

Operation of Radio Compass (AN/ARN-6).

1. Turn radio compass control switch on radio compass control panel (figure 4-4) to ANT.
2. Select desired frequency band with frequency selector switch on radio compass control panel, and tune desired station with the tuning crank.
3. Select type of operation, COMP. or LOOP.
4. Adjust volume control on radio compass control panel for desired output.
5. To turn radio off, rotate power switch to OFF.

INSTRUMENT LANDING SYSTEM (ILS).*

The ILS provides visual guidance during instrument approaches and landings. An AN/ARN-18 glide slope receiver and an RC-103-D localizer receiver are the principal components of the instrument landing and approach system radio. The two sets operate simultaneously, and each indicates the flight path of the airplane on a course indicator in the cockpit. Both receivers are controlled from a single panel. The system is powered from the monitored bus No. 2. On airplanes not changed by T.O., only wiring provisions for installation of the ILS equipment are incorporated. For information concerning autopilot function in the ILS, refer to "Automatic Pilot" in this section.

Course Indicator.

The course indicator (2, figure 1-5) is a dual-slope pointer instrument that responds to signals from the localizer and glide slope receivers. A horizontal pointer shows the position of the airplane relative to a runway glide path during ILS operations. A vertical pointer shows the position of the airplane relative to a radio beam projected from a localizer station. This pointer has a maximum deflection of about 10 degrees either side of the course centerline. A small background pointer provides course deviation information 45 degrees to the left or right of the course selected both "to" and "from" the selected station. A window in the upper left corner of the instrument displays a "TO" or "FROM" indication that signifies whether the selected course is inbound to the station tuned or is the reciprocal in relation to the airplane. A "SET" knob on the lower left corner of the instrument is used to select a desired magnetic course, the value of which appears in a window at the top of the indicator. The marker beacon light in the upper right corner of the instrument is inoperative on this installation. Two flag alarms, labeled "OFF," appear whenever a signal received is unreliable or when the equipment is shut off, either intentionally or because of electrical power failure.

ILS Control Panel.

The glide slope and localizer receivers are controlled from a single control panel. Frequencies are selected by a rotary-type switch on the control panel. The switch is marked in localizer frequencies. However, tuning the localizer receiver, as shown in the following table, automatically tunes the glide slope receiver to the required frequency. A volume control knob regulates the volume of the audible signal. The power switch, labeled "ON" and "OFF," controls power to the system.

LOCALIZER RECEIVER (RC-103-D)	GLIDE SLOPE RECEIVER (AN/ARN-18)
108.1 mc	334.4 mc
108.3 mc	335.0 mc
109.5 mc	332.6 mc
109.9 mc	333.8 mc
110.1 mc	334.4 mc
110.3 mc	335.0 mc

Note

The ILS control panel is not installed at present. Only provisions for installation of the panel are incorporated.

Normal Operation of ILS (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 pointer warning "OFF" flag has disappeared but the horizontal pointer 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 pointer warning "OFF" flag does not appear immediately, it can be considered that the vertical pointer is receiving information from the localizer, and the TACAN equipment can be switched back on.

b. If the vertical pointer warning "OFF" flag appears immediately, it can be assumed that the signal to the vertical pointer was being received from a TACAN

*Airplanes changed by T.O. 1F-86K-545.

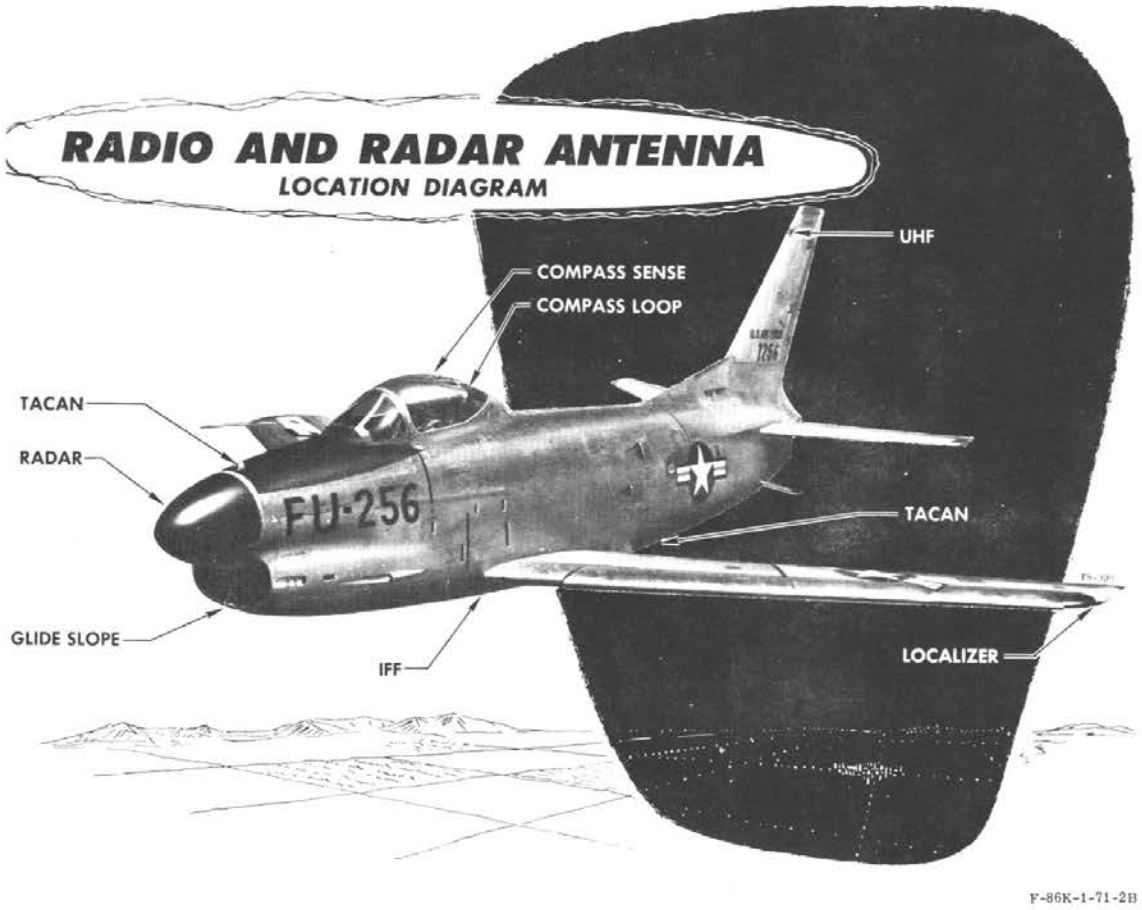


Figure 4-5

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 pointer warning "OFF" flag appearing, and the horizontal pointer 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.

6. Fly airplane to center both cross pointers.

7. Turn power switch OFF to de-energize system.

Emergency Operation of ILS.

There is no emergency operation of the ILS system. If the indications are erratic or otherwise unsatisfactory, check that "ILS-TACAN" switch is in ILS position.

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 IFF control panel (figure 4-4) 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, STDBY, 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 (Airplanes Changed by T.O. 1F-86K-548)" in this section. The AN/APX-6A system is powered by the monitored bus No. 2.

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 Lower mode "I/P-MIC"	MODE 2 OUT OUT	1 and 2
Lower mode Upper mode "I/P-MIC"	MODE 3 OUT OUT	1 and 3
Upper mode Lower mode "I/P-MIC"	MODE 2 MODE 3 OUT	1, 2, and 3

The "I/P-MIC" switch allows ground control to single out, by radio request for identification, an individual airplane from a high air traffic density. Operation on I/P can be established in two ways: by moving the "I/P-MIC" switch to I/P (identification position), 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, make sure that the IFF frequency counters have been set to proper frequency channels. Also, make sure that the transponder switch is at NORM.

1. Rotate master switch to STDBY for three-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. To turn set off, rotate master switch to OFF.

IDENTIFICATION RADAR—AN/APX-25 (AIRPLANES CHANGED BY T.O. 1F-86K-548).

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 4-4) 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 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 that IFF frequency counters have been set to proper frequency channels and that the transponder switch has been placed at MOD.

1. Rotate master switch to STDBY for three-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.
4. On SIF control panel, set coder dials as required.
5. To turn equipment off, rotate IFF master switch to OFF.

LIGHTING EQUIPMENT.

EXTERIOR LIGHTING.

Exterior lighting consists of four position lights on the wing tips and tail, two 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 other is directly below, in the bottom of the fuselage. 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, on the instrument and position light control panel (figure 4-6) aft on the right console, controls the position lights. From the OFF position, the switch can be moved to STEADY, causing all four position lights to burn steadily; or it can be moved to FLASH, effecting a repeated regular-interval flashing.

Position Light Dimmer Switch.

The position light dimmer switch, on the instrument and position light control panel (figure 4-6), regulates the brilliance of the wing tip and tail position lights and the fuselage lights. The switch has two positions, 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 1-8.) It has three positions: RETRACT, OFF, and EXTEND & ON. The light is automatically turned on when extended and turned on 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 either 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 lower forward side of the 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, at the base of the windshield bow on either 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 part of the canopy frame for maximum flexibility. Two thunderstorm lights (one on either side of the seat headrest) supply a constant white light so that vision is protected against lightning flashes during thunderstorm operation. All interior lighting controls are powered from the primary bus. When no external power is supplied and generators are inoperative, all lighting is made operable when the battery-starter switch is turned to BATT.

Instrument Panel Floodlight Rheostat.

An instrument panel floodlight rheostat is at the top of the instrument and position light control panel (figure 4-6) aft on the right console. When moved from OFF to DIM or BRIGHT, this rheostat turns on and controls the brilliance of the two auxiliary instrument panel floodlights.

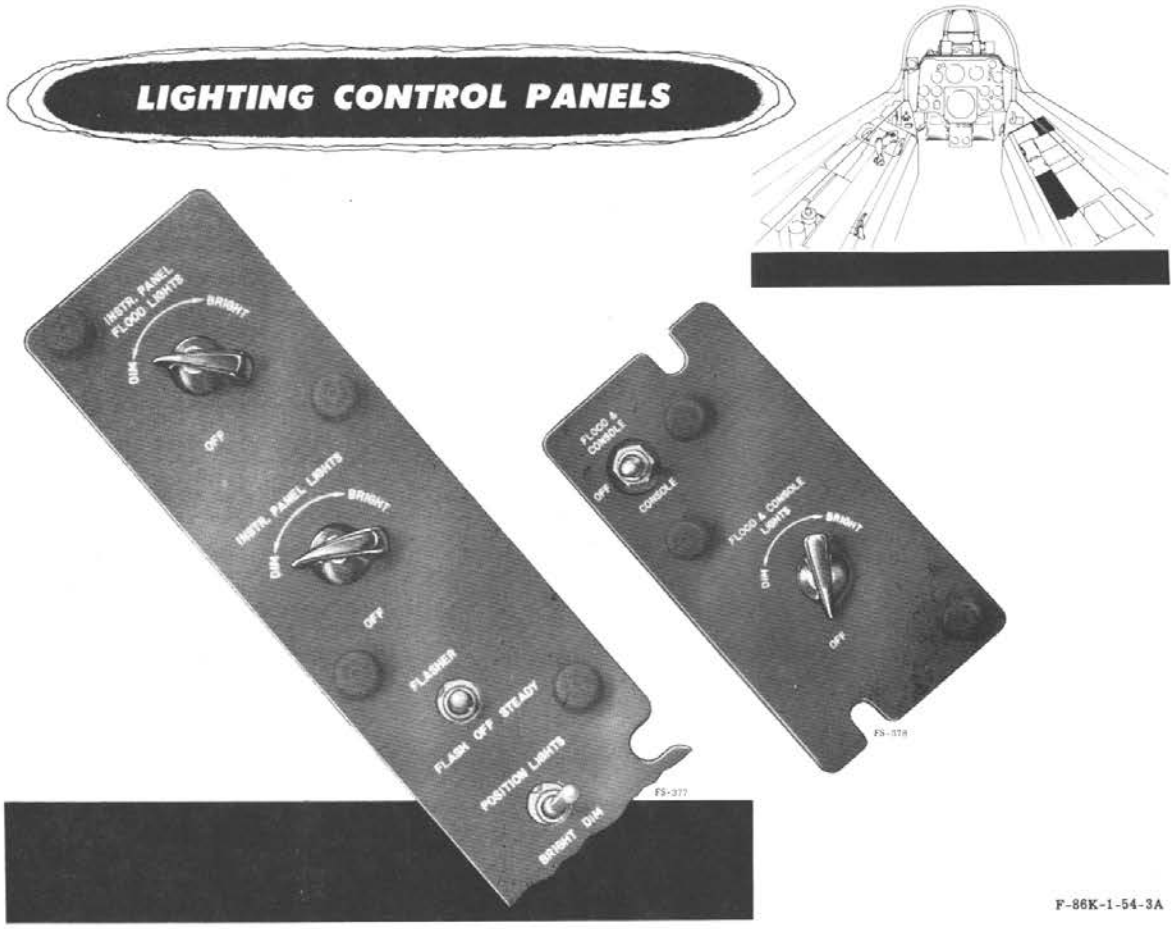


Figure 4-6

Instrument Panel Light Rheostat.

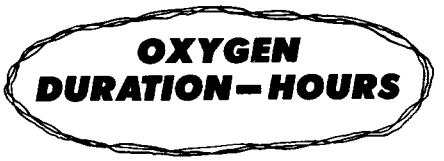
The instrument panel light rheostat is aft of the instrument panel floodlight rheostat on the instrument and position light control panel. (See figure 4-6.) This rheostat, with OFF, DIM, and BRIGHT positions, controls the illumination and brilliance of the instrument panel lights.

Console Panel and Floodlight Rheostat and Selector Switch.

A console panel and floodlight rheostat (figure 4-6), on the console light control panel, is outboard of the oxygen regulator on the right console. This rheostat, when moved from OFF to DIM and BRIGHT, simultaneously turns on and regulates the degree of brilliance of the console panel lights, the auxiliary console floodlights, and the oxygen regulator utility light. The console panel and floodlight selector switch (figure 4-6), also on the console light control panel, allows the selection of either CONSOLE or FLOOD & CONSOLE, or turns OFF all console panel lights and floodlights. Both the rheostat and the selector switch must be moved from the OFF position for the console panel lights and floodlights to be illuminated. Three lights which illuminate the landing gear control panel are also controlled from the rheostat.

Compass and Accelerometer Light Switch.

A switch (figure 1-8), mounted on the edge of the left instrument subpanel, below the accelerometer, controls the lights for both the stand-by compass and the accelerometer. When moved from the neutral OFF position to COMPASS & ACCEL, the switch turns on the lights for both instruments. When the switch is moved to COMPASS LIGHT, only the light for the stand-by compass is turned on. The brilliance of the compass and accelerometer lights is controlled by the instrument panel light rheostat.



BLACK FIGURES INDICATE DILUTER LEVER ***NORMAL OXYGEN.***

FIGURES IN PARENTHESIS INDICATE DILUTER LEVER ***100% OXYGEN.***

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.

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Figure 4-7

Thunderstorm Light Rheostat.

The thunderstorm light rheostat (10, figure 1-7) is on the vertical panel, aft of the right console. This rheostat, when moved from OFF to DIM or BRIGHT, turns on and controls the brilliance of the two thunderstorm lights.

OXYGEN SYSTEM.

The airplane is equipped with a gaseous oxygen system with two Type D-2 cylinders and one Type B-3 cylinder. 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. 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 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 4-7. To prevent damage to oxygen hose when it is not in use, it may be clipped to the webbing 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 4-8), to select NORMAL OXYGEN for all normal use or to select 100% OXYGEN for emergency use.

Regulator Supply Lever.

The oxygen regulator supply lever, at the bottom of the oxygen regulator panel (figure 4-8), 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, above the supply lever on the oxygen regulator panel (figure 4-8), 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

NOTE

The warning system switch is inoperative.

OXYGEN REGULATOR

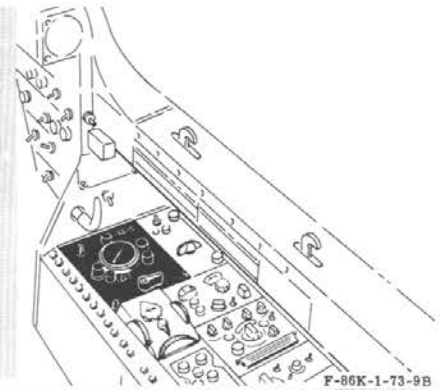


Figure 4-8

position provides continuous positive pressure to the oxygen mask for testing.

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 that there is no leakage, continued use of positive pressure under these conditions will result in the rapid depletion of the oxygen supply.

Regulator Warning Light Switch.

The oxygen regulator warning light switch (figure 4-8), on the oxygen regulator panel, should be at OFF at all times. The warning light has been removed and a placard installed above the switch to indicate that the warning light system is inoperative.

OXYGEN SYSTEM INDICATORS.

Pressure Gage and Flow Indicator.

The pressure gage and flow indicator on the oxygen regulator panel (figure 4-8) constitute a single instrument. The pressure gage indicates the amount of oxygen contained in the cylinders. The oxygen flow indicator consists of four small slots arranged symmetrically around the lower half of the gage dial face. These slots show alternately black and white with each breath of the user.

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 occasionally causes unnecessary alarm. All the oxygen is still there, however, and as the airplane descends to warmer altitudes, the pressure rises again, so that the rate of oxygen use 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 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

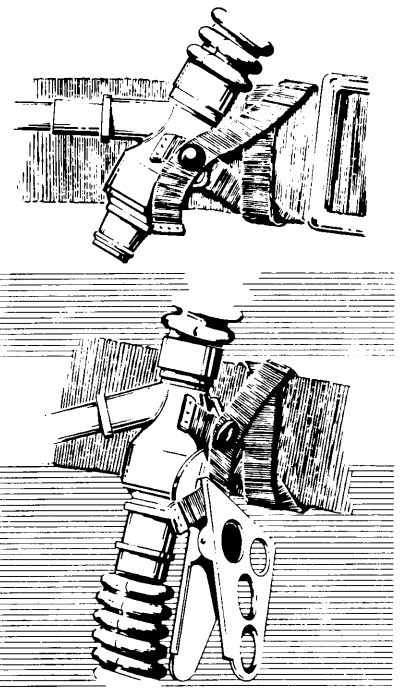
Failure to double-loop tie-down strap around chest strap may permit tie-down strap to slip into and open the chest strap snap during ejection.

2 Attach seat oxygen hose to oxygen mask hose. Listen for click and visually check (or feel) that sealing gasket is only half exposed.

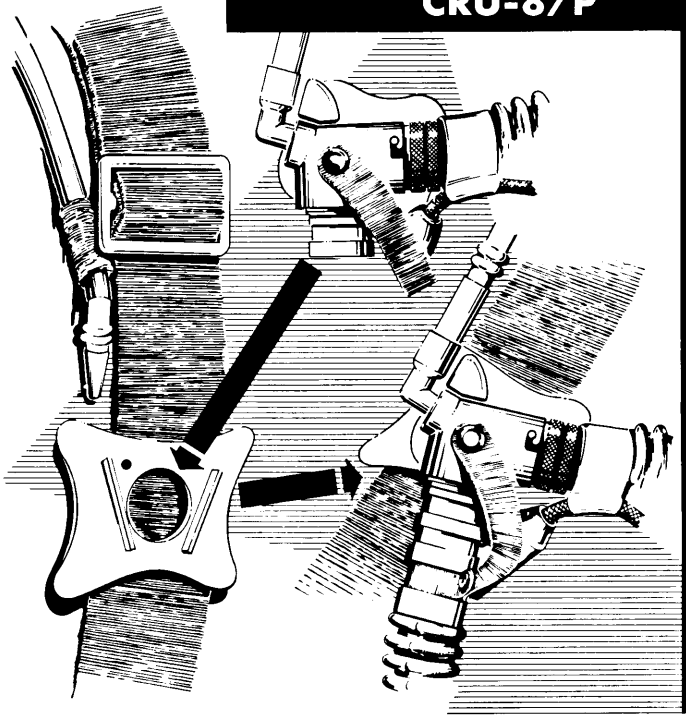
3 Fasten alligator clip as close to snap on tie-down strap as possible.

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.

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Figure 4-9

(Deleted)

OXYGEN SYSTEM PREFLIGHT CHECK.

Before take-off, the oxygen system should be checked as follows:

Note

This test procedure is applicable only for an initial preflight check of the system. In-flight tests, or repeated tests made within short periods, may produce false or misleading indications.

1. Check mask unit properly connected to oxygen hose and note oxygen pressure gage indication (400 psi minimum). See figure 4-9 for oxygen hose hook-up.

CAUTION

If the mask assembly is not connected, the oxygen regulator may be damaged by the full unrestricted flow during test of regulator warning system.

2. Check oxygen regulator with the diluter lever first at NORMAL OXYGEN position and then at 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 and the system should be checked before further flight.

3. With oxygen regulator supply lever ON, oxygen mask connected to regulator, and diluter lever in 100% OXYGEN position, breathe normally into mask and conduct following checks:

a. Observe blinker for proper operation.

b. Deflect regulator emergency toggle lever to right or left. A positive pressure should be supplied to mask. Hold breath to determine if there is leakage around mask. Return toggle lever 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 presure gage reads at least 400 psi. If pressure is below this minimum, have oxygen system charged to capacity before take-off.

2. Oxygen regulator diluter lever NORMAL OXYGEN.

3. Oxygen regulator supply lever ON.

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.

OXYGEN SYSTEM EMERGENCY OPERATION.

With development of hypoxia 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, as soon as possible, until cockpit altitude below 10,000 feet is indicated.

AUTOMATIC PILOT.

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 desired, change course with a coordinated turn, or maintain the airplane laterally level and in any desired angle of 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, and the vertical gyro establishes flight references about the lateral and longitudinal axes 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-tail 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 functions. Disengaging the automatic pilot automatically restores 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 continues 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 return abruptly to about level attitude. An automatic approach coupler is installed on airplanes changed by T.O. 1F-86K-545. The automatic pilot uses signals from the automatic approach coupler to guide the airplane during instrument approaches on the radio beams 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 path 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 path beam center is reached, the glide path engage button is depressed. The automatic pilot then automatically noses the airplane down until the flight path coincides with the center of the glide path 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. Three-phase ac current from the main inverter furnishes power for the automatic pilot.

Note

- The automatic pilot automatic trim will not function unless the alternate longitudinal trim switch is at NORM.
- Maximum utilization of the autopilot on all missions is recommended, because flight familiarization and repeated practice improve proficiency and instill confidence in the equipment.

AUTOMATIC PILOT CONTROLS AND INDICATORS.

Automatic Pilot Power Switch.

A guarded two-position automatic pilot power switch (11, figure 1-7) is on the aft end of the right console circuit-breaker panel. Moving the switch from the guarded ON position to the OFF position removes the source of ac and dc power to the automatic pilot gyros and associated equipment. This switch should normally be kept in the guarded ON position. However, if the mission to be flown will not require use of the automatic pilot, the switch can be positioned to the OFF position to save running time on the equipment. Should the switch be positioned at OFF during flight, it will not be possible to engage the automatic pilot until about 3 minutes after the switch has been returned to the ON position.

Automatic Pilot Release Switch.

An automatic pilot release switch is on the control stick (figure 1-17), just below the stick grip. The switch is

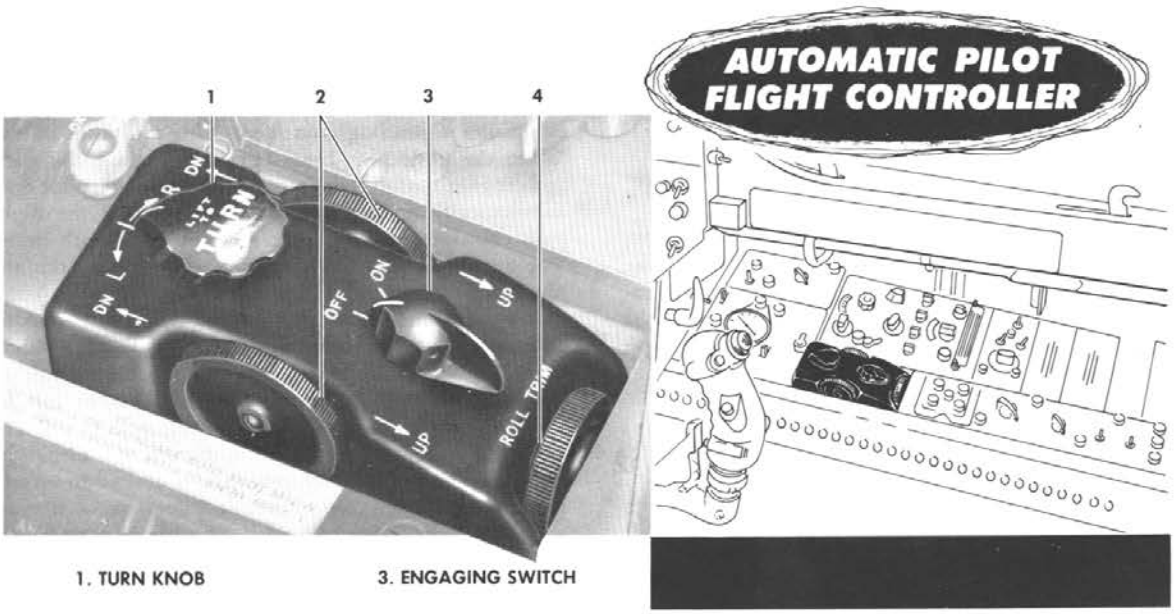


Figure 4-10

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.

Automatic Pilot Flight Controller.

All flight control functions of the automatic pilot are centered in the flight controller (figure 4-10) 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 4-10) is a two-position rotary switch having an OFF and an ON position. Placing the switch at ON electrically connects the automatic pilot to the flight control system. However, 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 4-10) control the nose-up or nose-down position of the airplane. If the pitch trim wheels are rotated aft for nose-up trim or rotated 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 4-10) 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 4-10), 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 degree of 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 will be 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.

Automatic Pilot Pitch Trim Indicator.

A pitch trim indicator (6, figure 1-6), on the upper left side of the main instrument panel, indicates the pitch

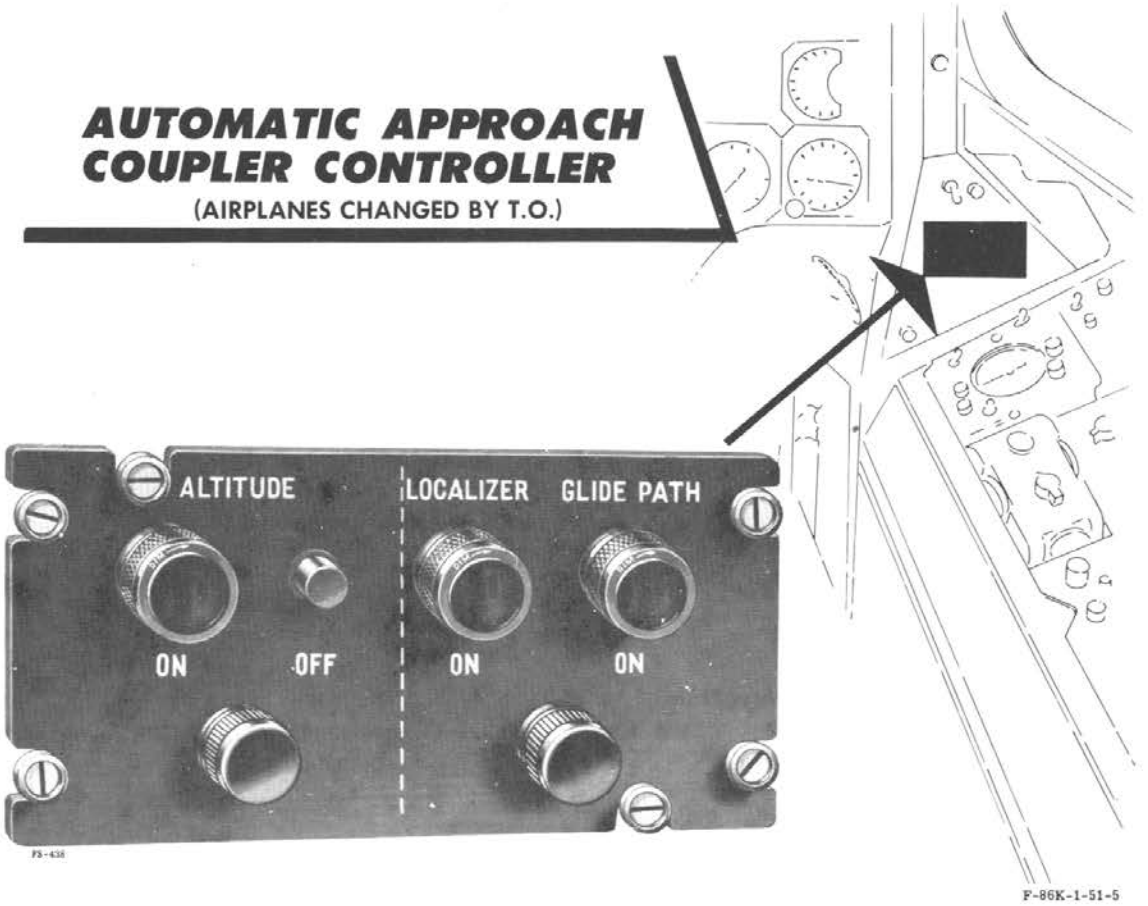


Figure 4-10A

trim of the airplane while it is operating on automatic pilot. The position of the needle allows the pilot to anticipate an airplane out-of-trim condition upon disengaging 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" indicates that the airplane is trimmed for that flight attitude.

Automatic Approach Coupler Controller.*

The automatic approach coupler controls are grouped on the approach coupler controller (figure 4-10A), 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) will engage a barometric pressure control to the automatic pilot, which will automatically maintain 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 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

*Airplanes changed by T.O. 1F-86K-545.

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, is used to connect the glide path receiver signals to the automatic pilot as the airplane reaches the center of the glide path beam. Depressing the glide path button when the airplane reaches the center of the glide path beam connects the maneuvering signals from the glide path 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 path beam. A safety interlock prevents engagement of the glide path 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 path 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, 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, is used to disengage the altitude control. As the altitude control is not connected, this button is *not operable.*

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 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 the 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. 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 with desired 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 along with altitude and airspeed considerations make such procedure inadvisable.

WARNING

Maintain close supervision of automatic pilot, particularly below 5000 feet, in case automatic pilot does not function correctly.

Note

At any time that binding and/or jerky control operation is experienced, the automatic pilot power switch must 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 an airplane out-of-trim condition on disengaging 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 the ILS beam is necessary to properly make an acceptable automatic approach. During automatic approach, the airplane will follow a course shown by the course indicator. On airplanes equipped with an automatic approach coupler, 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 ILS control panel must be ON and the frequency selector must be 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 pointer 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 pointer centered), and before glide path pointer 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 path pointer 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 path 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. The 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 the time of equipment failure.

AUTOMATIC PILOT EMERGENCY OPERATION.

In an emergency, the automatic pilot may be disengaged by either the control stick release switch or the engaging switch on the flight controller. If the switches do not function, all electrical power to the system may be removed by moving the autopilot power switch from the ON position to the OFF position. The switch is on the aft end of the right circuit-breaker panel. 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 when the flight controller switch is 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 guarded autopilot power switch in OFF position.
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.

RADIO COMPASS INDICATOR.

Refer to "Communication and Associated Electronic Equipment" in this section.

DIRECTIONAL INDICATOR (SLAVED).

The directional indicator (9, 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 indicates magnetic heading without oscillation, swinging, or northerly turning error. The magnetic heading is indicated by the needle on the directional indicator in the cockpit. Electrical power for the directional indicator is provided only when dc power and 400-cycle, three-phase ac power is available. Should either the ac or 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 indicator 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 push-button switch (14, figure 1-6) on the instrument panel. Momentary actuation of the switch 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 fast-slaving switch depressed over 2 seconds and allow a minimum of 10 minutes between depressions of the fast-slaving switch. Excessive use can damage the slaving torque motor.

ARMAMENT SYSTEM.

A gun bay containing two 20 mm automatic guns, mounted side by side, with removable ammunition cans, is on either side of the fuselage, outboard of the cockpit. The guns are combination blow-back, gas-operated guns, designed to fire electrically 20 mm ammunition at the rate of 700 to 800 rounds per minute. Above each gun is a removable rotary-feed mechanism which feeds belt-linked ammunition to the guns from removable ammunition cans mounted above the feed mechansm. Each ammunition can has a capacity of 132 rounds of ammunition. After the ammunition has been fired, the ejected casings and links are routed to expended-ammunition compartments below the guns. The guns are manually charged externally before flight. The 200-watt gun heaters controlled by the gun heater switch in the cockpit, are installed on each gun. The gun bays may be reached by removing the large doors covering each gun bay. Rubber plugs are installed in the forward end of each blast tube and in the muffler, to protect the guns from dirt and moisture. These plugs must be removed before flight. The guns are bore-sighted by use of the fuselage sighting equipment and a breech-type, boresight tool. A gun camera is installed in the leading edge of the left wing at the wing root, to record the results of the gun firing. Guns are fired by actuation of a trigger mounted on the control stick.

ARMAMENT CONTROLS.

Armament Master Switch.

An armament master switch is on the left console, outboard of the antenna hand control. (See figure 4-11.) The switch is a three-position guarded switch, marked "OFF," "CAMERA," and "GUNS & CAMERA," and is powered by the secondary bus. When the armament master switch is in the GUNS & CAMERA position and the airplane is air-borne, power is furnished from the secondary bus to the trigger control switch on the stick. A ground safety switch in the landing gear control handle circuit prevents the guns from being fired while the airplane is on the ground. With the master switch in the CAMERA position, only the camera circuit will be energized. With the switch in the OFF (center) position, power to the gun-firing controls is off and the firing circuit is inoperative.

Note

On airplanes changed by T.O., the trigger selector switch must be at GUNS when firing guns.

Trigger.

A gun trigger, powered by the secondary bus and located on the control stick (figure 1-17), fires the guns when the trigger is actuated by the pilot. The trigger has two detents, easily discernible by finger feel, each detent having a definite function with regard to the gun-firing system. Actuation of the trigger to the first detent, with the armament master switch in the GUNS & CAMERA position, energizes the camera. When the trigger is depressed to the second detent, a relay is closed and ac current, raised from 115 volts to 250-300 volts by transformers, passes through the circuit to the firing pins and the guns are fired. The camera has a 0- to 5-second time-delay overrun to record the hits after the guns cease firing. With the armament master switch in the CAMERA position, only the camera will operate when the trigger is depressed to either detent on the control stick.

Ground-fire Switch.

A ground-fire switch (figure 4-11), on the left console, aft of the armament master switch, is provided to test-fire the guns while the airplane is on the ground. This switch has two positions, SAFE and FIRE, and is powered by the secondary bus. Actuation of this switch allows current to by-pass the ground safety switch in the landing gear control handle circuit and permits the guns to be fired while the landing gear is extended.

Gun Heater Switch.

A gun heater switch (figure 4-11), powered by monitored bus No. 3, furnishes power to a gun heater relay, which in

Figure 4-11

turn connects 200-watt ac power to heaters installed on each gun and gun-feed mechanism. The two-position (ON and OFF) gun heater switch is on the left console, outboard of the antenna hand control.

GUN CAMERA.

An N-9 camera is in the leading edge of the left wing, at the wing root. The armament master switch, powered by the secondary bus, furnishes power for operation of the camera. Placing the armament master switch in either the CAMERA or GUNS & CAMERA position readies the camera for operation. When the trigger on the control stick is actuated to either the first or second detent, the camera begins to operate and continues to operate as long as the trigger is held depressed. When the trigger is released, the camera overrun control continues to operate the camera 0 to 5 seconds, depending on the setting of the overrun control.

Camera Lens Switch.

A rotary switch (figure 4-11), on the left console, with BRIGHT, HAZY, DULL, and OFF positions, is provided to adjust the lens opening of the N-9 gun camera. Positioning the switch at the desired setting adjusts the camera lens opening for the existing conditions.

RADARSCOPE RECORDER.

An N-6 camera is mounted on the radarscope shield for the purpose of recording scope presentations on film. The camera is powered from the secondary bus and can be manually controlled by the pilot by means of a switch mounted on top of the radarscope shield. The switch has three positions, MAN, AUTO, and OFF; however, the AUTO position is inoperative. Any phase of the radarscope presentation may be recorded on film at the pilot's discretion.

MISSILE CONTROL AND RELEASE INDICATOR PANELS

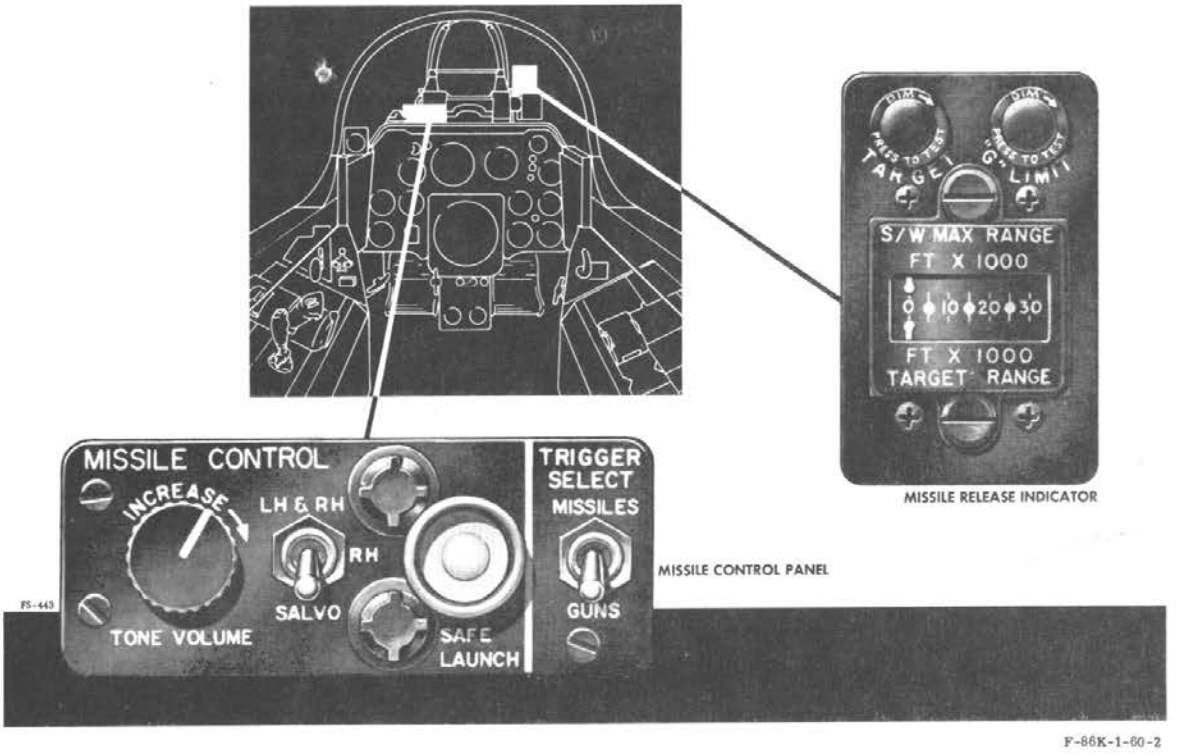


Figure 4-11A

MISSILE SYSTEM.*

For information concerning the GAR-8 missile, refer to the Confidential Supplement, T.O. 1F-86K-1A.

MG-4 FIRE CONTROL SYSTEM.

The MG-4 is an all-weather fire control system which offers the pilot a choice of two separate presentations and seven modes of operation, giving great versatility in methods of search, track, and navigational aid. Primarily designed to give an automatically computed lead-pursuit course, the MG-4 system has the advantage of putting the pilot into the best position for identification and, if necessary, to continue an attack without changing course or method of tracking. Search and track information is obtained from the radarscope (cathode-ray type), whereas the sight head presentation on the windshield gives track information only. Both the radarscope and the sight head may be used separately or in conjunction with each other. The radarscope presents the most information and should be used to obtain the range and azimuth of the target; however, under certain conditions, such as low-altitude flight or mountainous terrain, the sight head presentation would be more desirable as the radar becomes relatively ineffective at low altitude. At altitude, weather or flying conditions will generally dictate which method is preferable. When within firing range, as indicated by the presentation used, and with the armament master switch positioned to the GUNS & CAMERA position, the guns are manually fired by depressing the trigger on the control stick. On airplanes changed by T.O. 1F-86K-547, a magnetic tape recorder (NADAR) is installed in

*Airplanes changed by T.O. 1F-86K-546

conjunction with the MG-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. 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.

FIRE CONTROL SYSTEM CONTROLS AND INDICATORS.

Radar Control Panel.

The radar set control panel (figure 4-12) is on the left console forward of the throttle quadrant and contains the basic controls used to operate the system. The fire control system is powered by the alternator and a single-phase inverter controlled from monitored bus No. 3.

Master Power Switch. The master power switch (figure 4-12) is a rotary-type switch that controls the electrical power to the fire control system. It has three

positions, DISCONN, STBY, and OPER. The DISCONN position is used only when it is desired to disconnect power to the system under emergency conditions in flight, because of equipment failure. When the airplane is on the ground for maintenance, the STBY position is used to warm the set up before use. The OPER position permits system operation after a warm-up period of 4½ minutes, or immediately if the control has been in STBY for a minimum of 4½ minutes. The switch may be positioned directly from DISCONN to OPER if desired; however, the system is still protected by a 4½-minute time delay.

Stand-by Light. When the radar master power switch is moved from the DISCONN position, the stand-by light (figure 4-12) comes on. Illumination of the light indicates that the set is not sufficiently warmed up for operation. The light should go out after about a 4½-minute warm-up period, indicating the fire control system is then ready for operation.

Track Switch. The track switch (figure 4-12) is a two-position toggle switch marked "RADAR" and "OPTICAL." Positioning of this switch determines which mode of operation will be available to the pilot during an attack. With the track switch in the RADAR position, the normal presentation appears on the radarscope. During the tracking phase, the standard A-4 sight head presentation appears on the windshield. With the switch in the OPTICAL position, the radarscope will be blank and the pilot will use the standard A-4 sight head presentation for steering information.

Operation Switch. The rotary switch (figure 4-12), labeled "OPERATION," has three operational modes and four positions. The three modes are SEARCH, GROUND MAP, and BEACON. In the SEARCH mode a choice of LONG PULSE or SHORT PULSE is available. In SEARCH—LONG PULSE, maximum power is utilized to search out

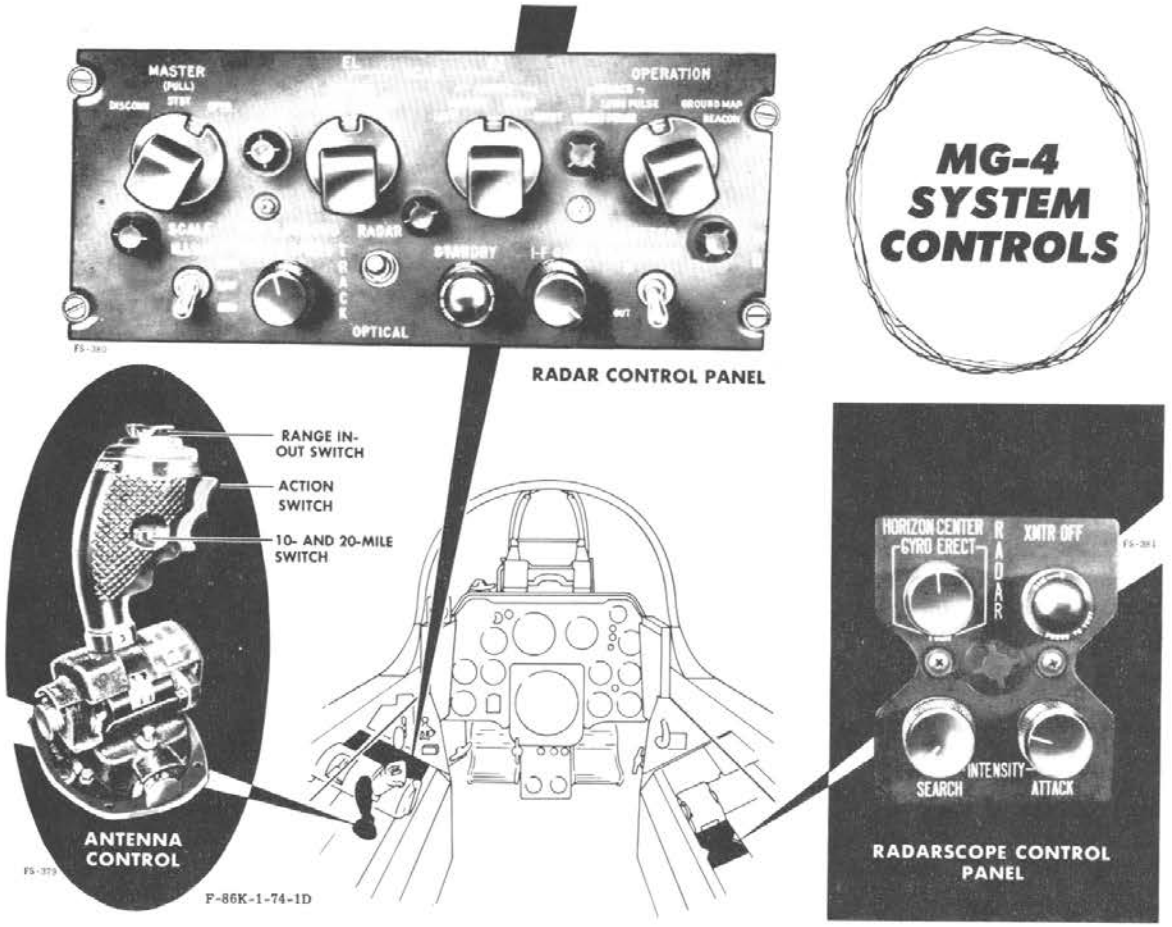


Figure 4-12

targets at a maximum range. In SEARCH—SHORT PULSE, better radar-echo returns are given for short ranges. In the GROUND MAP position, the antenna searches the terrain ahead of and below the airplane, and the scope presentations may be used for navigation. With the switch in the BEACON position, radar beacon station code numbers appear on the scope as a series of horizontal bars, to assist the pilot in locating and identifying his position with respect to the beacon station.

Scale Illumination Switch. The scale illumination switch (figure 4-12), with HIGH, LOW, and MED positions, controls the intensity of the lights illuminating the flight indicator scales.

Elevation Scan Control. The elevation-scan ("EL SCAN") control, a rotary switch (figure 4-12) with three positions, HORIZON, UP, and DOWN, is on the radar set control panel. Its purpose is to adjust the elevation-scan patterns to angles above, below, or on the horizon, as the pilot desires. With the selector set on the HORIZON position, the antenna beam sweeps an area about 8 degrees above, and 8 degrees below, the horizon. Moving the rotary control to the UP position causes the antenna to sweep the area above the horizon. When the DOWN position is selected, the antenna sweeps the area below the horizon. During ground map and beacon techniques, with the selector set at HORIZON position, the antenna sweeps an area about 9.5 degrees in height, centered 6 degrees below the horizon. The UP and DOWN positions on the radar set control panel are not preset scanning positions but are variable by rotating the knob, thus adjusting the scanning area to the elevation desired for best coverage.

Azimuth Scan Control. To the right of the elevation-scan ("AZ SCAN") control is a rotary azimuth-scan switch. (See figure 4-12.) The azimuth scan is a four-position switch labeled "NARROW," "BROAD," "LEFT," and "RIGHT." NARROW positions the antenna to sweep an area 41 degrees left and right of center, while BROAD positions the antenna to scan its maximum azimuth coverage of 70 degrees either side of center. Selection of the LEFT position gives an azimuth coverage of 70 degrees left and 11 degrees right. With the switch in the RIGHT position, the antenna sweeps an area 70 degrees right and 11 degrees left. By using the elevation and azimuth controls properly, the antenna will search any area in front of the airplane, above and below the horizon.

Intermediate Frequency (I-F) Gain Control. The normal position of the i-f gain control (figure 4-12) is full clockwise rotation; however, by rotating the i-f gain control counterclockwise, noise or interference may be reduced and target definition improved. It should be noted that a reduction in i-f gain results in a reduction in strength of signal returns.

Clutter Eliminator Switch. This two-position toggle switch (figure 4-12) has settings labeled "IN" and "OUT." With the switch at the IN position, undesirable returns from ground and sea are eliminated from the radarscope display. Normally the switch is left in the OUT position.

Beacon and Ground Map Expand Control. During ground map operation, the beacon and ground map expand control (figure 4-12) permits expansion of any 20-mile zone of the radarscope display, beyond 5 miles range. Rotating the expand control positions a strobe blip on the range trace. During beacon operation, when the strobe is positioned just below the lowest marker of the beacon return signal on the range trace, and the beacon and ground map expand knob is pulled out, the beacon indications are expanded and the coding can be more easily interpreted. The position of the strobe marks the range at which the 20-mile expansion will start.

Radarscope Indicator Control Panel.

The radarscope indicator control panel (figure 4-12) is on the right console just aft of the automatic pilot controls. It is flush-mounted and has three control knobs and one indicator. These are the "HORIZON CENTER GYRO ERECT" control, "XMTR OFF" indicator, and two intensity controls, "SEARCH" and "ATTACK." Illumination of the radarscope indicator control panel is controlled by the instrument panel light dimmer switch (figure 4-6).

Horizon Center Gyro Erect Control. This control (figure 4-12) is used when the artificial horizon on the radarscope fails to indicate 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 indicator control panel. Depressing the control knob provides fast erection of the roll and pitch control mechanism. The horizon line may jump momentarily when the adjustment knob is depressed; however, erection should take place within a few seconds. Rotating the knob raises or lowers the horizon on the scope until the indication correctly shows the airplane attitude.

Transmitter-off Indicator Light. Illumination of this "XMTR OFF" light (figure 4-12) indicates that an overload has occurred in the transmitter and that the system is no longer transmitting radar energy.

Note

The transmitter power light may flicker when switching between long-pulse mode of operation and short-pulse mode. Power is momentarily removed during the switching operation.

Intensity Controls. Intensity of the attack and search presentations may be varied by rotation of the "ATTACK" and "SEARCH" controls on the radarscope control panel. (See figure 4-12.) Rotation of the "SEARCH" control varies the contrast between the target presentation and the background, while rotating the "ATTACK" knob increases or decreases the intensity of the remainder of the display on the radarscope.

Antenna Hand Control.

The antenna hand control (figure 4-12), mounted aft of the throttle quadrant, is used in radar track when manual control of 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 for vertical movement of the antenna, and side-to-side action for lateral movement of the antenna. The sliding switch on the right side of the handle, labeled 10 and 20, permits selection of either a 10-mile range trace or a 20-mile range trace. In normal operation, the switch should be in the 20 position. If lock-on establishes that the target range is less than 10 miles, the switch can be moved to position 10. This will expand the range trace so that entire trace is covering only 10 miles, and gives a better target definition. On the top of the control grip is a range in-out switch and 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, incorporated in the base of the antenna hand control, returns the antenna to automatic search from radar track operation. To return to automatic search from manual search, release action switch. 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 four-position, rocket-type switch, actuated by depressing with the left thumb. Depressing the range in-out switch to the first or second detent moves the range-gate marker up or down the range trace. In the first detent, the range-gate marker stops and locks the radar set on the first target on the range trace that it comes to. If the radar locks on an undesired target, momentary actuation 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 desires 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, by releasing the range in-out switch to the first detent, or neutral position, the radar set will automatically lock on the selected target and the scope will display the tracking phase presentation. The action switch is a spring-loaded, trigger-type switch on the front of the antenna hand control. (See figure 4-12.) 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 (undepressed) position, or after automatic lock-on has been accomplished, movement of the antenna hand control will have no effect on the antenna.

Optical Track Ranging.

Manual Range Control. With the track switch in OPTICAL, the manual range control, incorporated in the throttle handle, controls the range signal to the fire control computers. When the throttle handle is turned clockwise past the detent, manual ranging is made available. Beyond the detent position, turning the throttle handle clockwise increases the reticle size, beginning at the minimum diameter. Radar ranging is not available in the optical modes.

Target Reject Switch. The target reject switch (figure 1-9) is a momentary-contact button, on the top of the throttle handle. In radar track, if the pilot desires to break lock-on on an undesired target, the button is depressed to deactivate the automatic range-tracking circuits. When the button is depressed, the sight head reticle moves to the center of the windshield and the radar returns to the automatic search mode. Releasing the target reject button allows the pilot to lock on the next target in the normal manner.

A-4 Sight Head Controls and Indicators.

Caging Lever. This lever is at the lower right side of the sight head. Before the sight head can be operated with the MG-4 fire control system, the caging lever must be placed at the UNCAGED position. With the lever in the CAGED position, the sight functions as a fixed sight.

Filament Switches. A two-position toggle switch (figure 4-11), at the middle of the left console, provides a means for energizing either of two filaments of the sight reticle bulb, in case one filament burns out. A similar filament switch is provided on the reference-circle projector for the reference-circle lamp.

reticle bulb, in case one filament burns out. A similar filament switch is provided on the reference-circle projector for the reference-circle lamp.

Reticle Dimmer Switch. The reticle dimmer switch provides adjustment for the illumination intensity of the reticle projected on the sight head display. This control is at the middle of the left console. (See figure 4-11.)

Wing Span Selector. The wing span selector lever is on the sight head. This lever is normally set at its maximum wing span position (120 feet) in radar track mode. In the optical track mode, the wing span selector should be manually set at the target wing span. Graduated markings (from 30 to 120) on the scale represent the size (in feet) of the target wing span. When the reticle size continues to correspond with the apparent target wing span, the correct range is being fed into the computer.

Sight Range Dial. Target range, in hundreds of feet, is indicated by the range dial, visible through a window on the left side of the sight head. The dial is graduated from 600 to 6000 feet and presents range distances as determined by radar or manual ranging.

Lock-on Indicator Light. The lock-on indicator light, on the left side of the sight head below the range dial, comes on when the radar has locked on the target during tracking. The indicator light housing may be rotated to control the light intensity.

RADARSCOPE DISPLAY.

Radarscope displays (26, figure 1-5) are presented by means of a cathode-ray tube enclosed in a pressurized cylindrical housing with a transparent window in the front. Various scales are etched on the transparent window to provide calibration for scope displays. A ball indicator is mounted at the bottom of the radarscope to assist the pilot in determining a coordinated maneuver during operation. Short vertical lines at the top and bottom of the scope window provide range trace azimuth indications in 30-degree increments from the center position to 60 degrees left or right of the airplane. Two range scales are provided, consisting of short horizontal lines along the right and left edges of the screen. The left scale, used during search and track, is calibrated in increments of 5 nautical miles from the zero base line to 20 nautical miles maximum range. The right scale, used during beacon and ground map operation, is calibrated in increments of 50 nautical miles from the zero

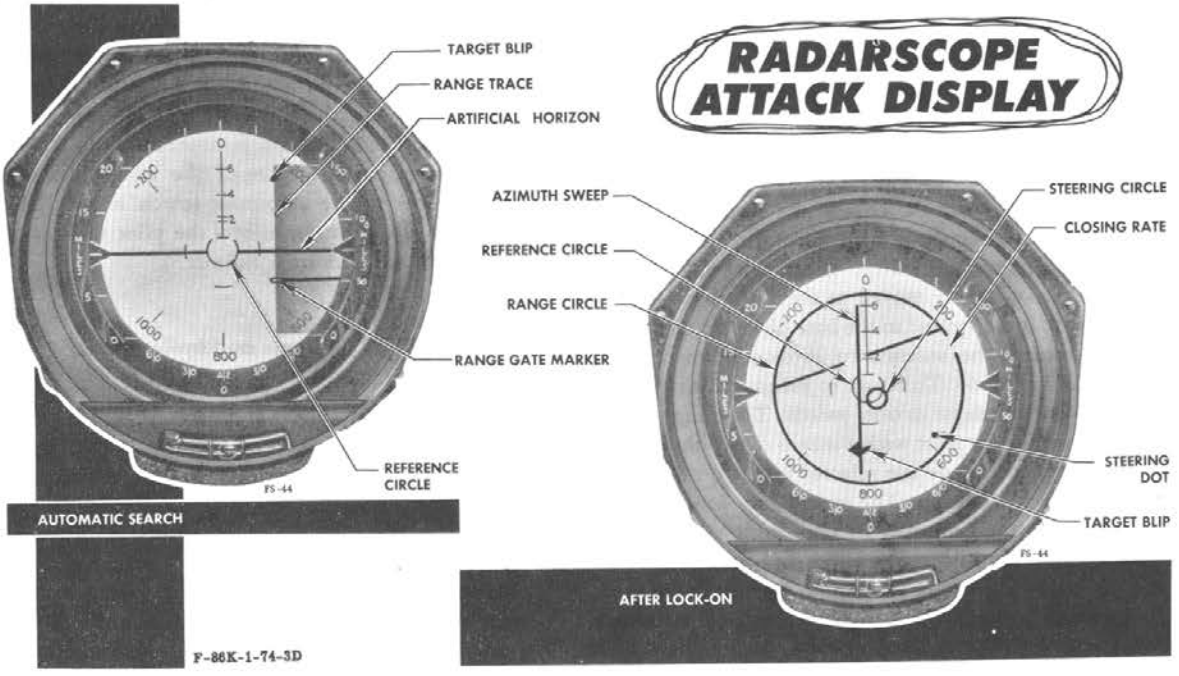


Figure 4-13

base line to 150 nautical miles maximum range. Two triangular marks at the outer edges of the horizontal diameter of the radarscope serve as a reference for comparison with the artificial horizon. The artificial horizon line and the reference marks appear in a straight line during level flight. The reference circle is etched on the scope window and remains in a fixed position and diameter. Unlike the scope reference circle, the steering circle, which is about ¼ inch in diameter, moves about the display in proportion to the error in flying the lead-pursuit course. The steering circle and steering dot appear on the radarscope display at the time of lock-on, but are not present during search. The range circle scale is a vertical line extending upward from the center of the scope. It is calibrated at 0.6, 2, 4, and 6 (× 1000) feet to provide range readings for the range circle. The range circle provides a convenient presentation of target range. After lock-on, the range circle begins to shrink as the range decreases below 6000 feet. Target range can be read directly, in thousands of feet, from the range circle scale engraved on the face of the indicator. When the range circle diameter coincides with marks etched on the scope at 2400 feet, maximum gun-firing range is indicated. At 600 feet the range circle is superimposed on the reference circle, indicating the suggested time for pull-out. The relative speed between the interceptor and the target is indicated by the position of the blanked portion of the range circle, and can be read from the closing rate scales in the 2, 4, 8, 10, and 12 o'clock positions on the inscribed portion of the indicator face. Positive closing rates, to a maximum of +1200 knots at the 9 o'clock position, are indicated by a clockwise rotation of the blanked portion of the range circle from the top zero position. Negative closure rates are indicated by a counterclockwise rotation from the top zero position.

OPERATING PROCEDURES.

Preflight Check.

1. Set armament master switch as desired.
2. Check airplane voltage for 28-volt dc output.
3. Alternator switch ON.
4. Check radar master power switch STBY. Stand-by light out.
5. Set elevation-scan switch at HORIZON.
6. Set azimuth-scan switch at BROAD.
7. Set operation switch at SEARCH—LONG PULSE.
8. Set clutter eliminator switch at OUT.
9. Check i-f gain control for maximum clockwise position.
10. Set track selector switch at RADAR.
11. Check manual range control on throttle in detent position.
12. Set wing span control on sight head at 120.
13. Set caging lever on sight head at UNCAGED.
14. Search intensity control at mid-position.
15. Attack intensity control at mid-position.

MODES OF OPERATION.

There are seven modes of operation: automatic search, manual search, visual acquisition, radar track, optical track, ground map, and beacon. The A-4 sight may be mechanically caged and used as a fixed sight in an emergency.

Automatic Search.

During automatic search, the antenna is space stabilized and automatically scans any one of several sectors ahead of the airplane in a rectangular scan pattern. Search patterns are determined by the settings on the radar set control panel. Target information is supplied to the pilot on the radarscope. A range-sweep trace moves back and forth across the indicator, "painting" the selected search area. Targets are shown as blips whose relative positions, read 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, adjust settings of elevation-scan and azimuth-scan controls to facilitate searching the zone relative to anticipated position of target.

Note

If target's approximate altitude is unknown, use azimuth-scan and elevation-scan controls to fullest extent, to obtain maximum space coverage. When target is detected, adjust elevation-scan control for desired elevation angle.

3. Observe search display on radarscope as target range approaches 10 miles. Target will appear as a bright blip.
4. Monitor target position closely to determine range and azimuth data, in order to plan the most effective attack run.

Manual Search and Lock-on.

When the target has been identified by the pilot, he assumes manual control of the antenna by pressing the action switch on the front of the antenna hand control. This control is then manipulated to place the range sweep trace over the blip representing the target 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 left or right actuation of the range in-out switch. When the range-gate marker is moved to cover the target blip on the scope, the radar automatically locks on the target selected and the antenna hand control no longer controls the action of the antenna.

In manual search operation, proceed as follows:

1. Manipulate antenna hand control so that position of the 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" side of range in-out switch to second detent position to move range-gate marker to indicated target range; then release switch to the first detent for lock-on.

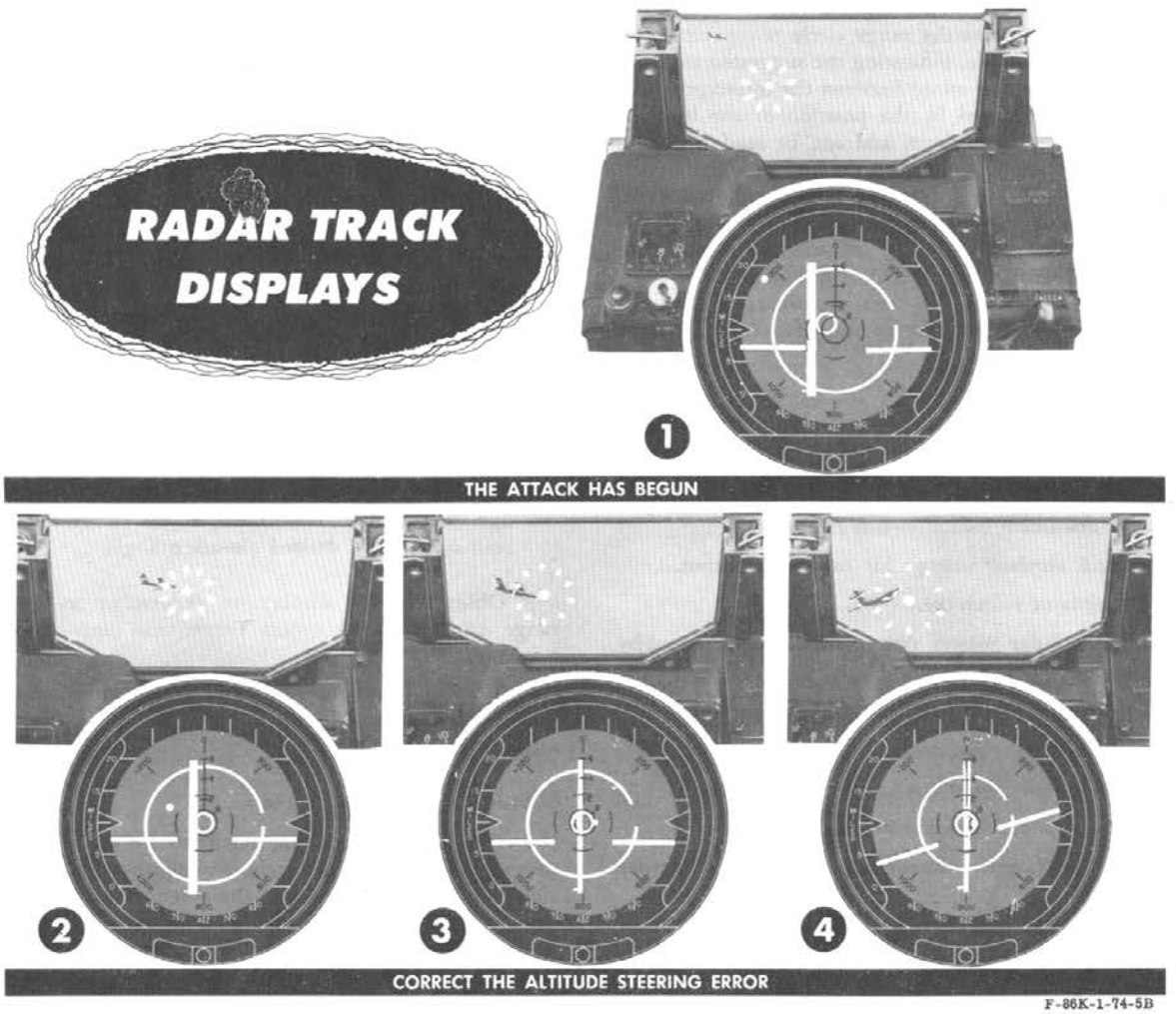
4. When range-gate marker coincides with target blip, observe that radar automatically tracks the target, as indicated by lighting of lock-on lamp on sight head and appearance of attack display on radarscope.

Visual Acquisition Mode.

During the automatic search mode, if the target is located visually through the windshield at a range less than 2 miles, two modes of operation are available: visual acquisition mode (radar) or optical mode. The radar mode should be used whenever possible. To make a visual acquisition mode lock-on, proceed as follows:

1. With the track switch in RADAR, rotate throttle grip clockwise out of detent. (The amount of rotation is not important.)

2. Steer interceptor to place sight head reticle over target aircraft.



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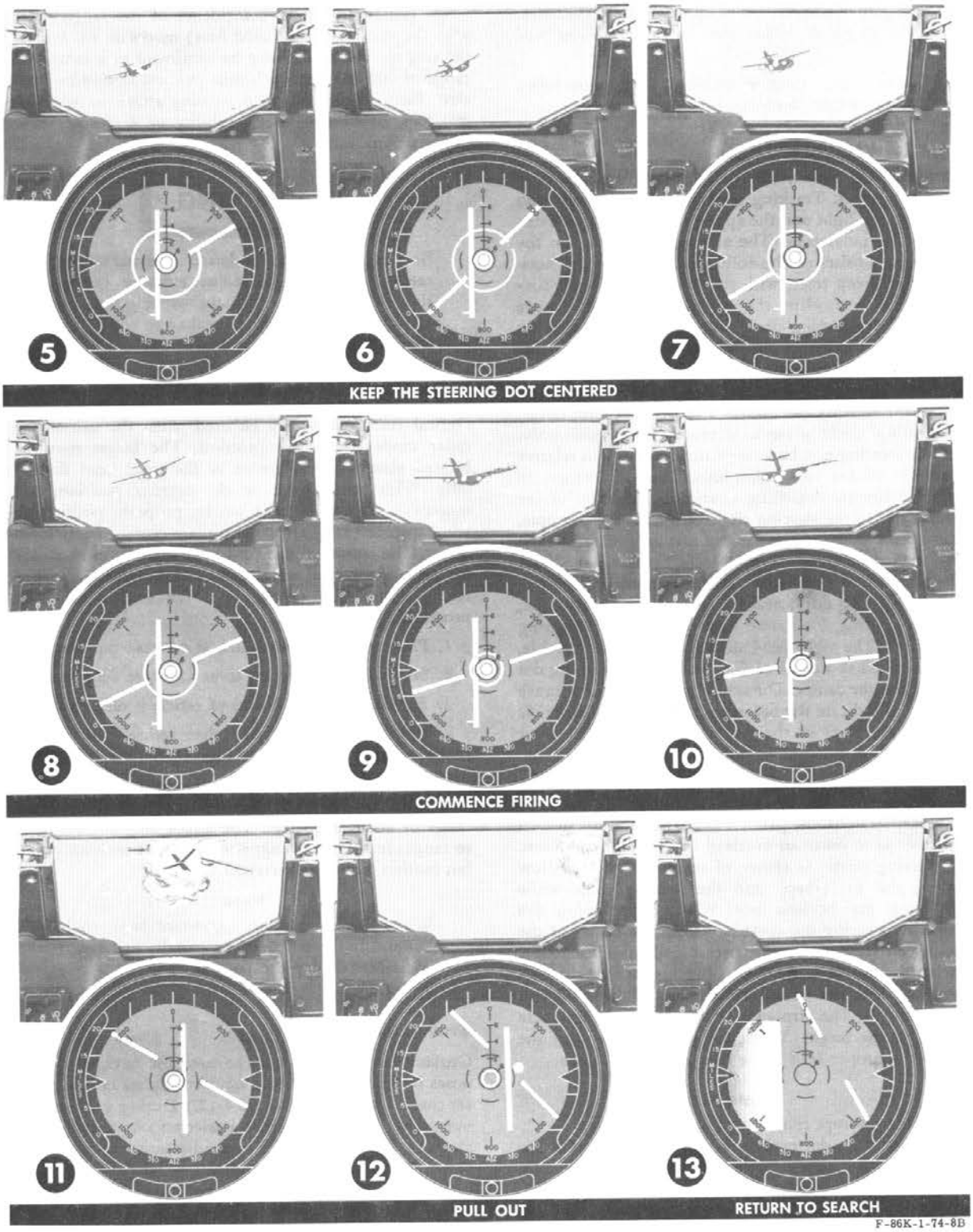
5
6
7
KEEP THE STEERING DOT CENTERED
8
9
10
COMMENCE FIRING
11
12
13
PULL OUT
RETURN TO SEARCH
F-86K-1-74-8B

Figure 4-14

3. The automatic range sweep generator will program the range gate to a maximum of approximately 1½ miles. When the target is within this range, a lock-on will occur.

4. Track target using windshield display to firing range, using method described under radar track.

Radar Track.

When lock-on occurs, the radar system automatically tracks the target. Tracking is indicated by illumination of the lock-on light and the appearance of the attack display on the radarscope. The attack presentation on the radarscope consists of the following: the artificial horizon, range-sweep trace, with the range-gate marker covering the target blip; the range and rate-of-closure circle; and the steering circle and steering dot, indicating the direction to steer to properly close on the target for firing. For long-range tracking, it is recommended that the steering circle be used as a steering guide in preference to the steering dot. When a target is at long range, the steering circle presents a more stable guide-point than the steering dot, because of the difference in relative movement of the two indications. These differences in characteristics are caused by a ratio of movement of the steering dot to the steering circle of 5 to 1. For example, a movement of the steering dot of one inch will cause the steering circle to move only ⅕ inch. Tracking operation will be easier if the steering circle is used for steering until the steering dot is near the center of the radarscope; then the steering dot should be used for "finer" steering corrections. The sight head display consists of a reticle, which appears as a circle of diamonds with a steering dot (pipper) in the center. The reticle and steering dot move together to indicate the necessary target lead. The reticle diameter decreases as the target range closes. In radar track operation, proceed as follows:

1. Establish the line of flight of the target by aligning the reference circle, steering circle, and steering dot in an imaginary straight line parallel to the horizon bar in such a manner as to cause an overlead or "cut-off" condition. Fly steering circle to center of reference circle. Allow steering dot to "creep" into the steering circle while paralleling the horizon bar. When approaching fire range, the steering dot must be within the center of the steering circle to obtain the correct lead angle for firing. During the attack, if the target becomes visible through the windshield, the windshield display may be utilized to finish the run. The airplane is flown to place the reticle pipper on the target. When the pipper is held on the target, the proper lead angle course is being flown.

Note

Sudden, abrupt control action will cause magnified steering dot excursions, especially through the roll axis. Any movement of the airplane, other than that required to maintain zero error at time of firing, will cause miss or widely dispersed lethal density pattern. Do not exceed 4.0 G at any time after lock-on.

2. The guns may be fired whenever the target is within range [indicated by the coincidence of the range circle with the vertical range (2400 foot) marks on the face of the scope]. The attack may be continued to a minimum range of 600 feet, at which time pull-out should be initiated. Exercise caution when pressing attack to less than 600 feet, because of the possibility of errors in radar presentations.

WARNING

Because it is difficult to determine exact closing rates from the radarscope, extreme caution should be exercised when approaching target to allow sufficient time for breakaway and transition to instrument flight after firing.

Optical Track—Radar Ranging.

Optical track mode may be used when the use of the radar mode becomes impractical. The target must be located visually by reference to the sight head display only. With track switch in the OPTICAL position, and target's known wing span set by properly positioning wing span lever, fly airplane to place center of reticle on target. The manual range control is rotated continuously to frame the target wing span. The range can be read from the range dial on the sight head. For optical track, proceed as follows:

1. Place track selector switch at OPTICAL position.

2. Set wing span selector lever at target wing span.

3. Fly airplane until center of reticle is on target.

4. Rotate throttle grip so that reticle continuously frames target and begins tracking.

5. Determine target range from sight head range dial. The guns may be fired whenever the target is within a range of about 2400 feet. The attack may be continued to ranges less than the suggested 600-foot pull-out point, but caution should be exercised.

Note

While firing, maintain a constant bank angle. Do not fly the reticle when actually firing, as it is disabled during this period.

(Deleted)

Ground Map Operation.

Ground map function may be used for navigation purposes by the proper setting of the switches on the radar set control panel. (See figure 4-12.) 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 will be indicated on the right side of the scope from a distance of 0 to 150 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

beacon and ground map expand switch. 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 beacon and ground map expand rotary switch. When the rotary switch is pulled out, the 20-mile zone selected is expanded to cover the entire area of the scope. (See figure 4-17.)

Beacon Operation.

With the controls on the radar set control panel (figure 4-12) 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, and azimuth location of, the station 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 reading of the code display by use of the beacon and ground map expand switch as in ground map operation. (See figure 4-17.)

MG-4 OPERATIONAL CHARACTERISTICS.

Certain characteristics of the MG-4 fire control system have developed which should be explained to enable the pilot to receive maximum benefit from this system.

Steering During Gunfire.

The steering circle and dot become inoperable during actual firing of the guns. To enable the pilot to continue tracking the target, a constant bank angle should be established before firing commences.

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. The clutter eliminator switch may be set to the IN position to reduce the effect of undesirable echoes.

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 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 sufficiently, 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. Under any flight conditions, the pilot may find the use of the sight head presentation preferable. If poor visibility rules out the use of the sight head presentation, the radarscope presentation can be used to select a single target.

Altitude Mark.

Radar echoes from the ground will 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 will appear at the same position on the scope display. When this happens, the radar may lock on either the target or the altitude mark. To avoid this condition, the pilot should, if possible, use a higher closing rate on the target. 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 after it has passed through the altitude mark.

Angle-off Target.

The interceptor should stay at as great an angle off the target as possible to remain out of the target airplane's zone of defense and still be in a position to launch a successful attack. Flying the steering circle in from long range will result in a tail chase approach and place the interceptor in a poor defensive position. Three variables determine the angle of attack. The first is the length of the approach, with as short a run as practical. The second is the ratio of the interceptor speed to that of the target (avoid a tail chase). The third is the initial angle off the target at the beginning of the approach. The optimum situation for an approach is: range 3 to 4 miles, the angle off near 90 degrees, and a closing rate of 200 knots or above.

EMERGENCY OPERATION.

Operation After Momentary Overload.

If a transmitter overload occurs momentarily, the transmitter will automatically operate at reduced power, and if the overload continues, the transmitter will cut off

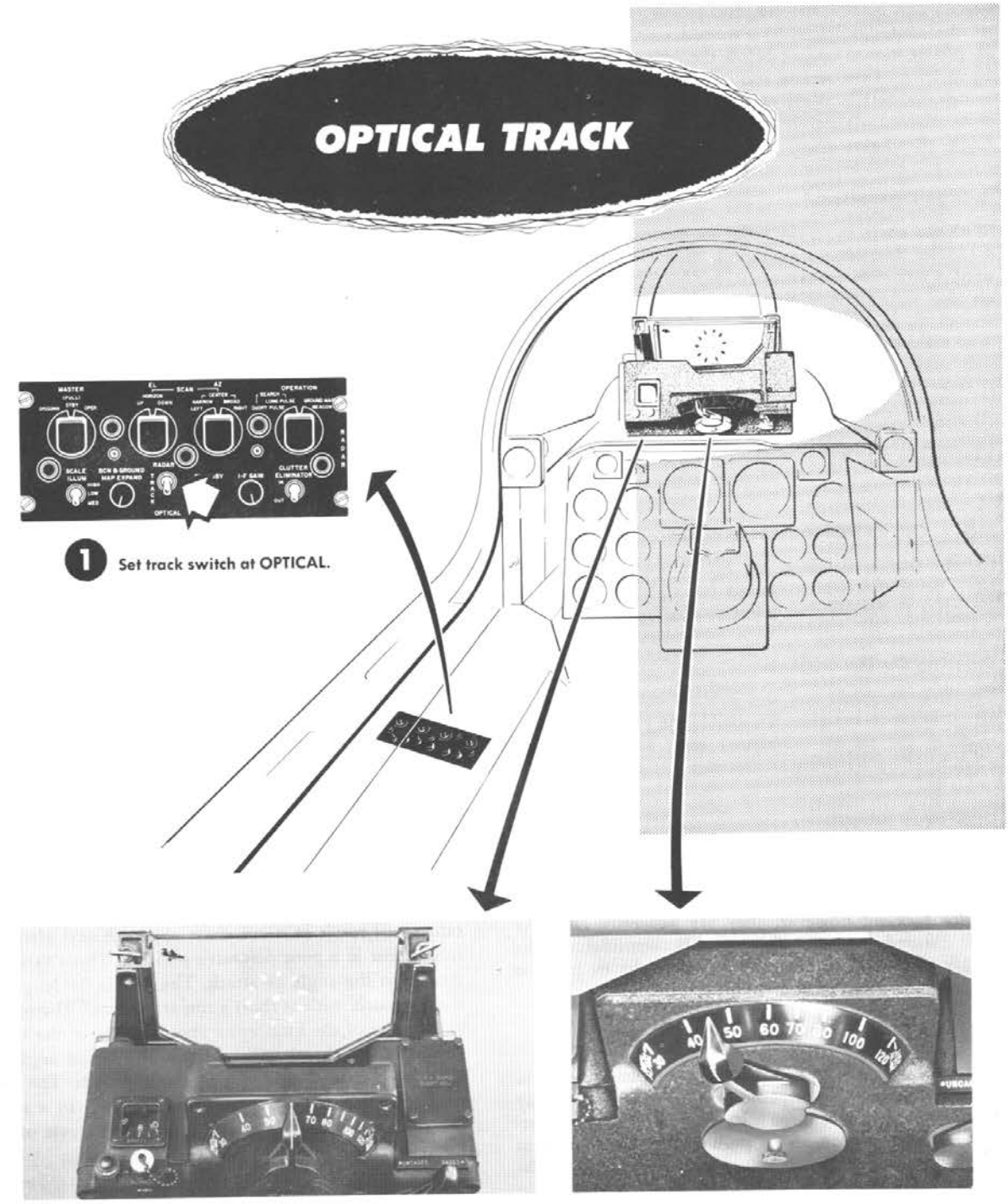

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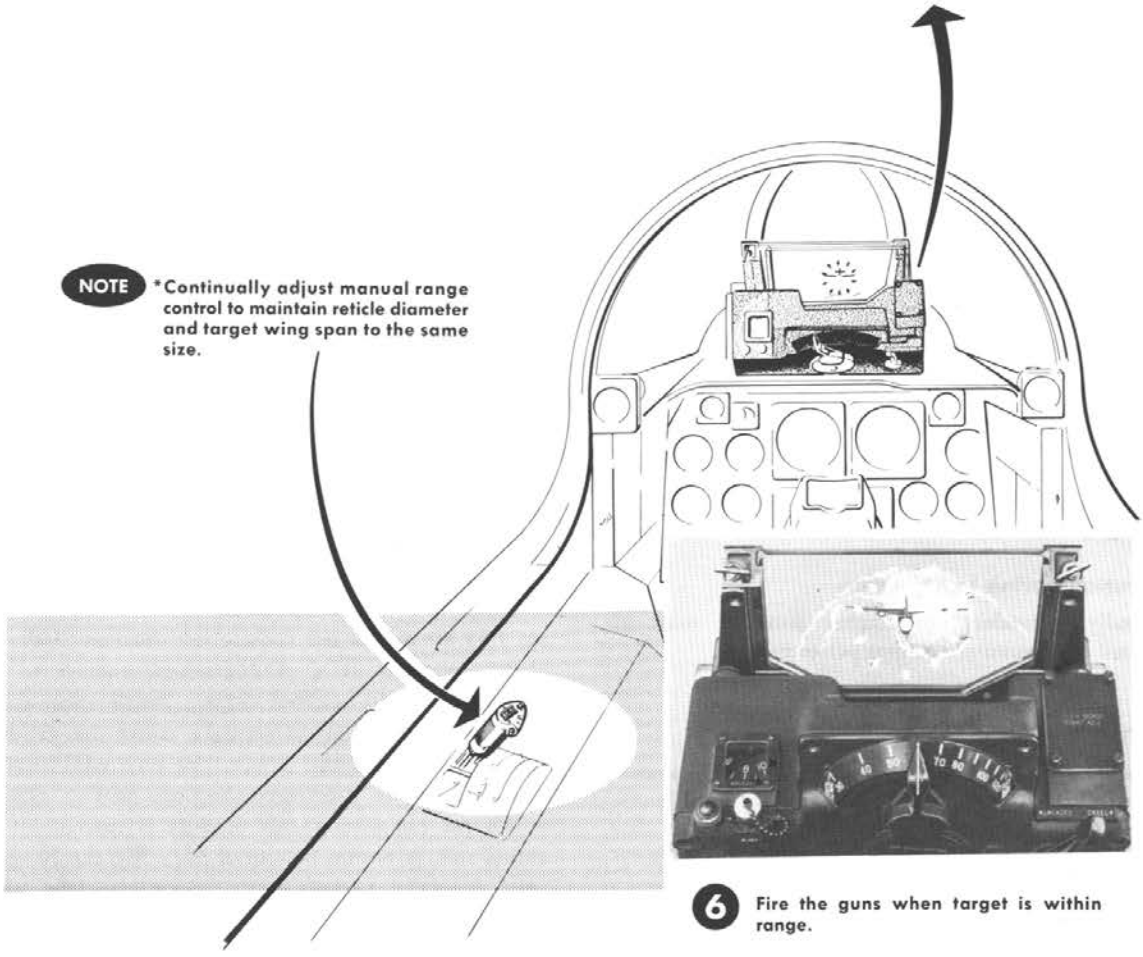
Figure 4-16

4 Steer interceptor to center target within reticle.

5 *Rotate manual range control until reticle diameter equals target wing span. (Refer to note below.)



NOTE *Continually adjust manual range control to maintain reticle diameter and target wing span to the same size.

6 Fire the guns when target is within range.

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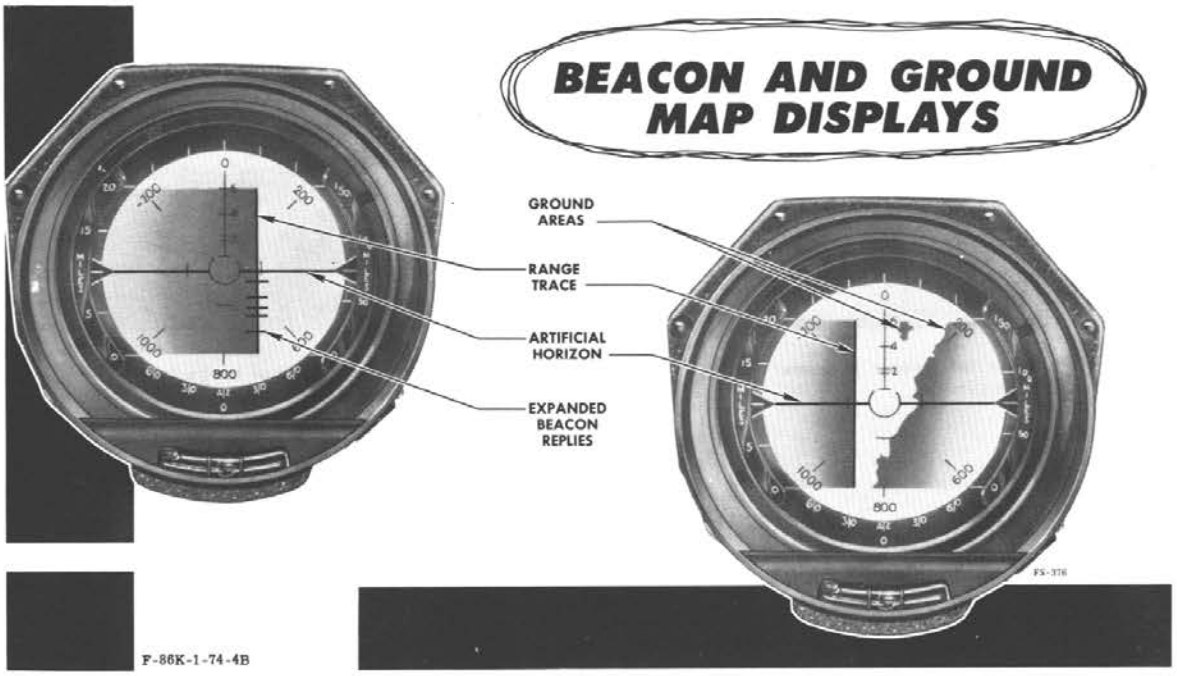


Figure 4-17

and the transmitter-off light will come on. If this should occur, turn operation switch to SEARCH—SHORT PULSE for lower power output, turn the radar master power switch to STBY and then back to OPER. This will reset the overload relays. If transmitter will not resume operation, turn track switch to OPTICAL and use manual ranging by rotation of throttle handle.

Operation During Interference.

Generally, procedures to combat jamming must be obtained from countermeasures personnel.

SHUTDOWN PROCEDURE.

For normal shutdown of equipment, place radar master power switch in STBY, manually cage sight head, armament master switch OFF, ground-fire switch SAFE. For emergency shutdown of equipment, place radar power master switch at DISCONN.

CAUTION

To avoid damage to radar gyro, turn radar off at least 6 minutes before landing, to allow sufficient time for gyro rotation to stop. However, if landing is made with radar on, taxi back to the line before turning radar master power switch to DISCONN.

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) aft on the left console, and 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 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.

MAP CASE.

The map case (2A, figure 1-6) is aft on the left console. Some airplanes have cases installed on the side of the ejection seat for storage of instrument flight charts. (See figure 1-23.)

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.

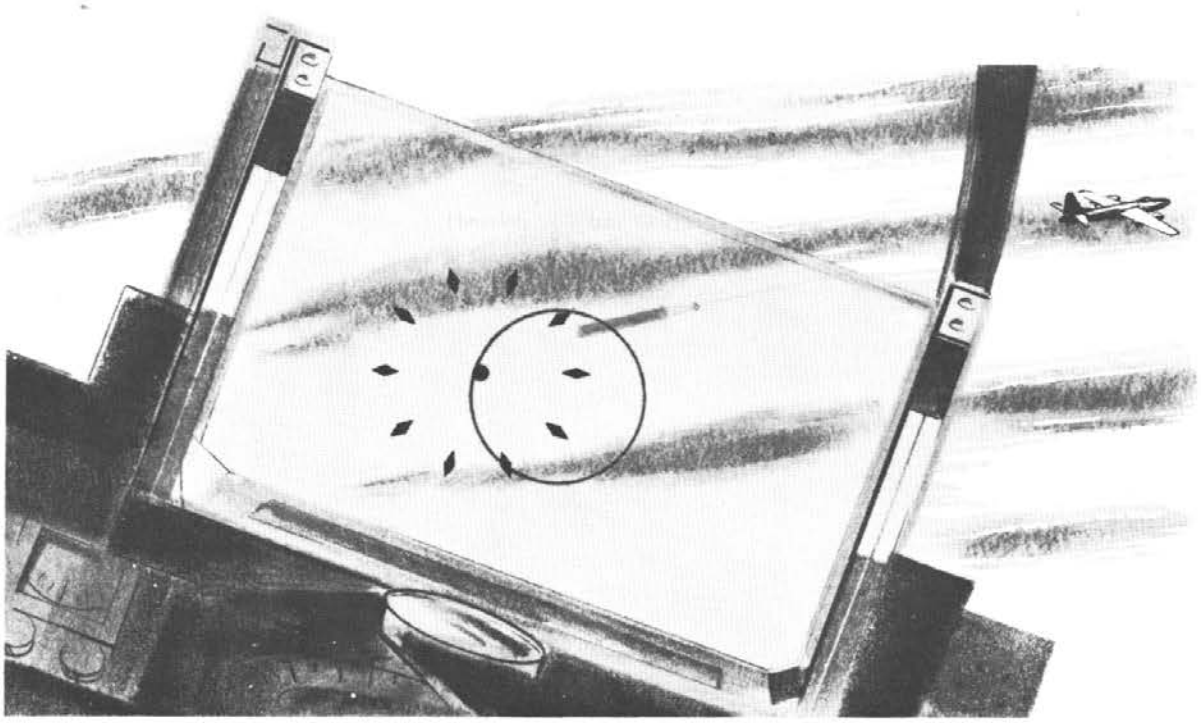
An adjustable, rear-vision mirror is attached to the upper, inner surface of the canopy, just aft of the canopy bow.

PROTECTIVE COVERS.

Removable covers are provided for the wing, horizontal stabilizer, engine compartment, tail pipe, gun ports, and the pitot tube. A plug is also provided for the intake duct.

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.



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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 and 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. All overspeed conditions must be entered in the Form 781.

COMPRESSOR STALLS.

All compressor stalls must be recorded in the Form 781. The entry includes the duration, exhaust temperature, severity, altitude, airspeed, rpm, and throttle conditions (advancing, retarding, or static) accompanying the stall.

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 Form 781 and the cause investigated prior to flight.

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 . . .

BASED ON ALL FUEL GRADES

HYDRAULIC PRESSURE GAGE

	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.

OIL PRESSURE GAGE

- 12 psi — minimum
- 12-25 psi — permissible only below military rpm (98 to 100%)

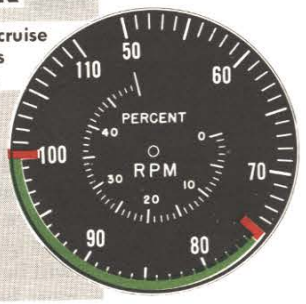
CAUTION
At military rpm (98% to 100%), oil pressure must be between 25-45 psi.

- 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



EXHAUST TEMPERATURE GAGE

- 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 minutes)

F-86K-1-51-2E

*Refer to applicable text, this section.

Figure 5-1

AIRSPEED INDICATOR

CLEAN OR WITH MISSILES ONLY:

- 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)

WITH DROP TANKS OR DROP TANKS PLUS MISSILES:

TYPES I AND III DROP TANKS

- 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 DROP TANKS

500 knots IAS or .9 Mach number, whichever is less

AIRSPEED AND MACH NUMBER INDICATOR

NOTE

- 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.

ACCELEROMETER

- 5.6 G max with no external load
- 5.0 G max with Types I and III 120-gallon drop tanks only, or missiles only. 4.5 G max with Types I and III 120-gallon drop tanks plus missiles. 4.0 G max with Types II and IV 120-gallon drop tanks.
- —2.0 G max for all configurations

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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 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.

MISSILE SAFE-LAUNCH SPEED.

The GAR-8 missile must be safe-launched within the limitations for the configuration involved.

LANDING GEAR LOWERING SPEED.

The limit airspeed for landing gear lowering is 185 knots IAS. If the landing gear is lowered at speeds above this value, resulting air loads may damage the fairing, doors, or operating mechanism.

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 flaps 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. It canopy is operated at airspeeds above this value, damage to canopy and canopy operating mechanism will result.

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 symmetrical (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. 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.

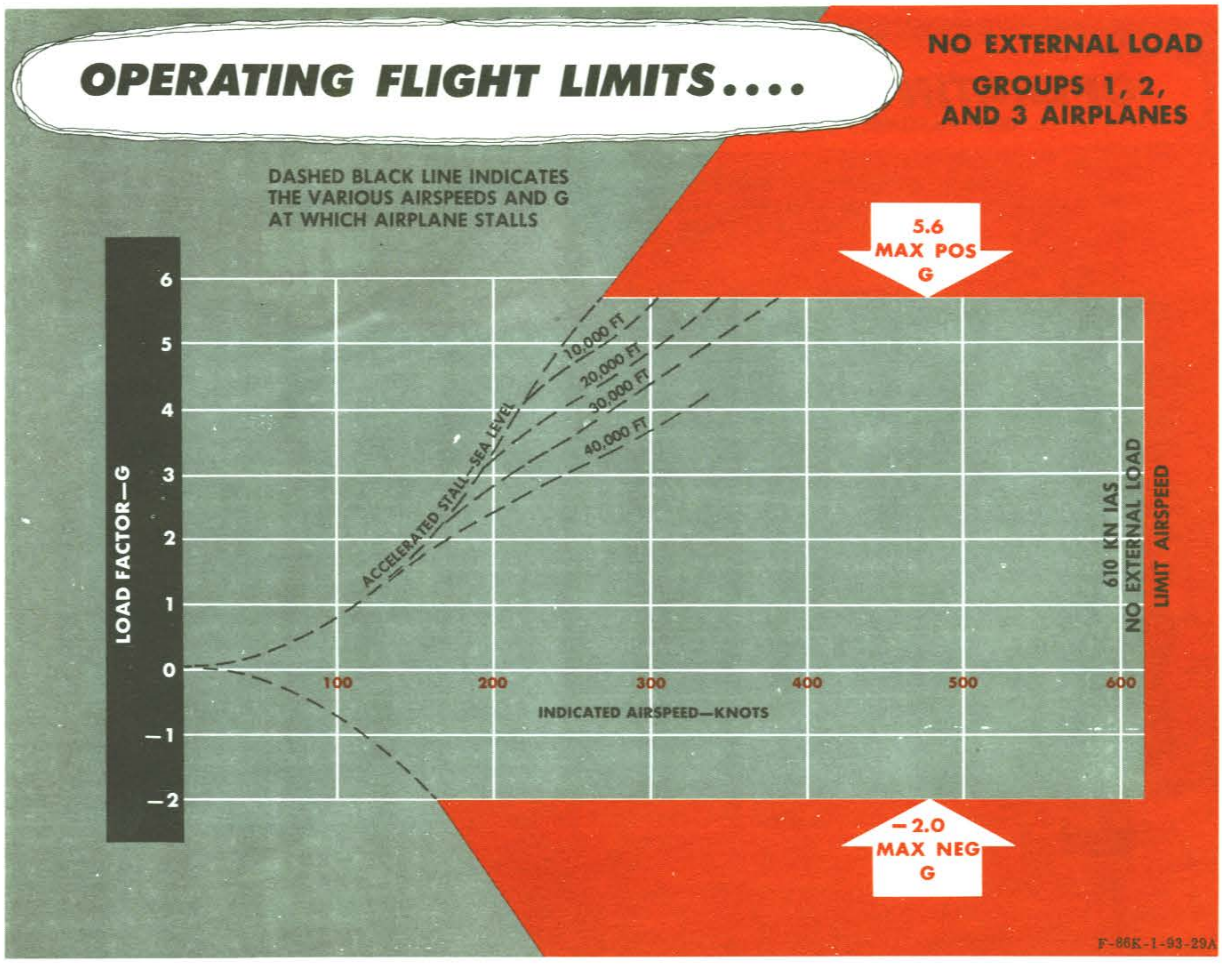

Figure 5-2

External Drop Tanks Installed.

For maximum allowable airspeeds with 120-gallon external drop tanks installed, see figure 5-1.

PROHIBITED MANEUVERS.

INTENTIONAL SPINS.

When 120-gallon external drop tanks are installed, intentional spins are prohibited.

INVERTED FLIGHT.

Inverted flying, or any maneuver resulting in negative acceleration, must not be performed when the afterburner is operating.

Note

Inverted flight with afterburner operating is prohibited. Without afterburner operation, inverted flight is limited to 10 seconds duration, as there is no means of ensuring a continuous flow of fuel or oil in this attitude.

(Deleted)

OTHER MANEUVERS.

Snap rolls or any other snap maneuvers are prohibited at all times. When Type II or IV 120-gallon external drop tanks are installed and are empty, rate of roll is limited to 90 degrees per second.

ACCELERATION LIMITATIONS.

MAXIMUM ACCELERATION.

For maximum allowable G for symmetrical (no-roll) pull-outs, see figure 5-1. The operating flight limits diagram (figure 5-2) graphically illustrates symmetrical (no-roll) G-limits with no external load. Maximum

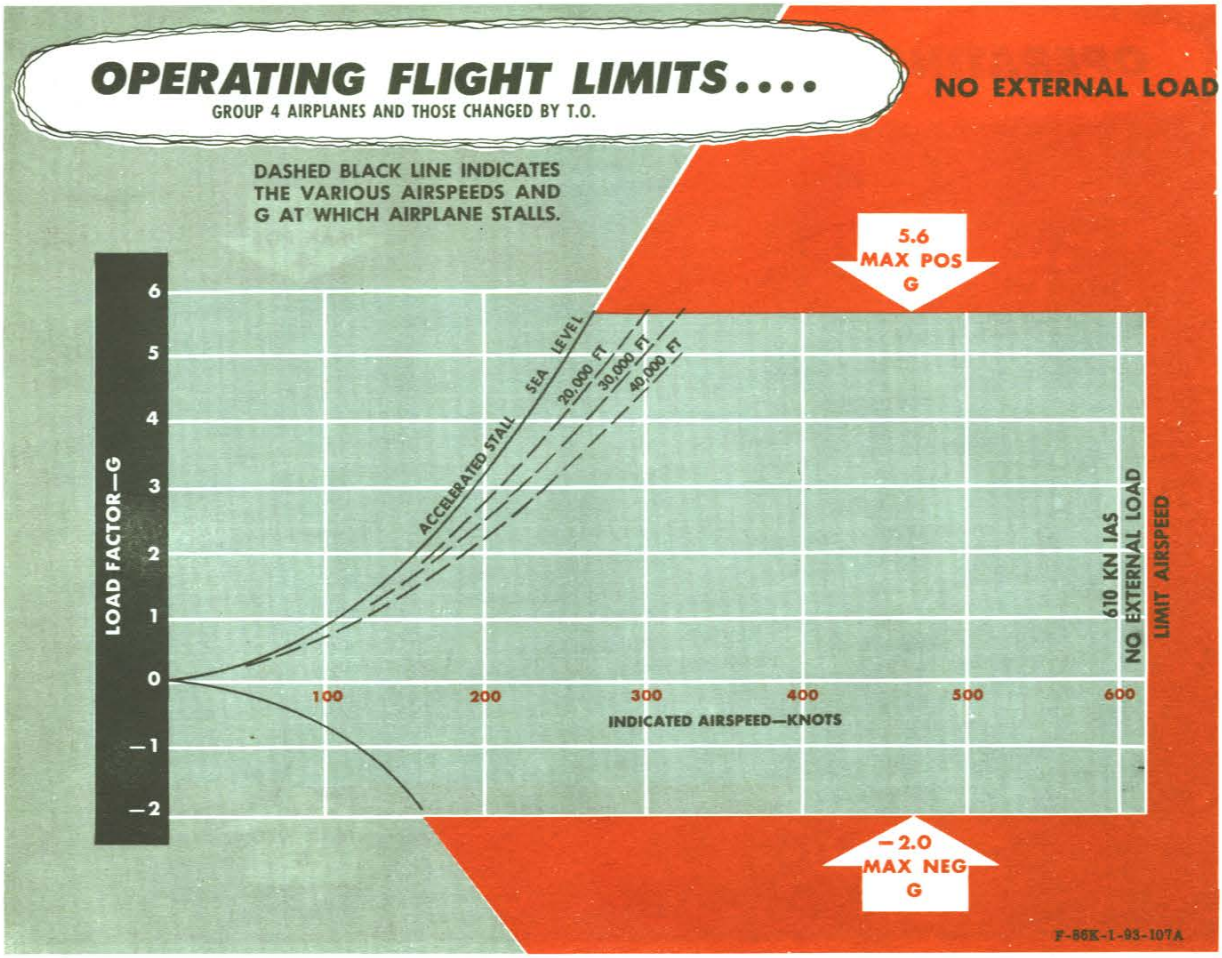

Figure 5-3

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 with 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 ammunition is aboard. External 120-gallon drop tanks do not greatly change the airplane center of gravity, although the airplane weight is increased. The location of equipment in the airplane has been closely controlled to provide a satisfactory airplane center-of-gravity position. Since there is no in-flight control of CG position other than the normal expenditure of ammunition and release of external loads, major factors affecting CG position must be checked before flight—for example, the installation of guns and ammunition. If any guns and/or ammunition are removed from the airplane, the ammunition boxes must be ballasted with an equivalent weight to maintain the CG within limits. Refer to Weight and Balance Technical Manual, T.O. 1-1B-40.

WEIGHT LIMITATIONS.

The design of the airplane precludes the possibility of overloading; consequently, there are no weight limitations to be observed 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.

Section VI

FLIGHT CHARACTERISTICS

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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.

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.

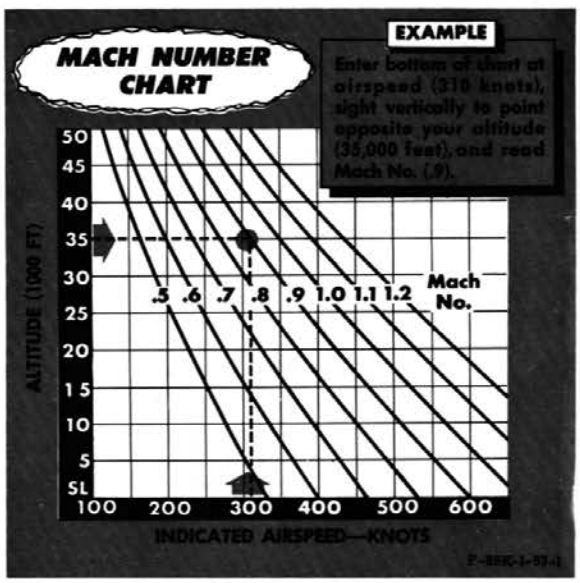
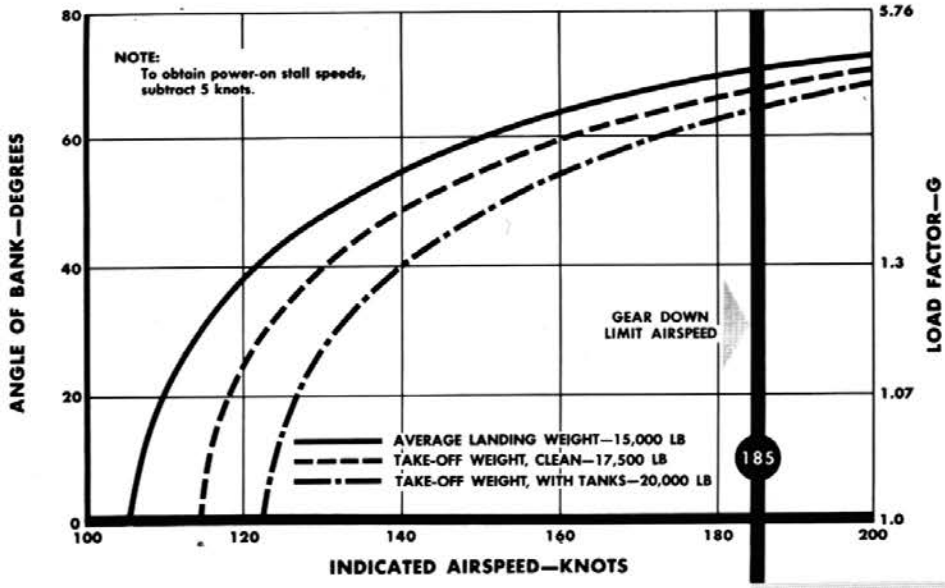


Figure 6-1

STALL SPEEDS
(IDLE POWER—GEAR AND FLAPS DOWN)

GROUPS 1, 2, AND 3 AIRPLANES



GROUP 4 AIRPLANES

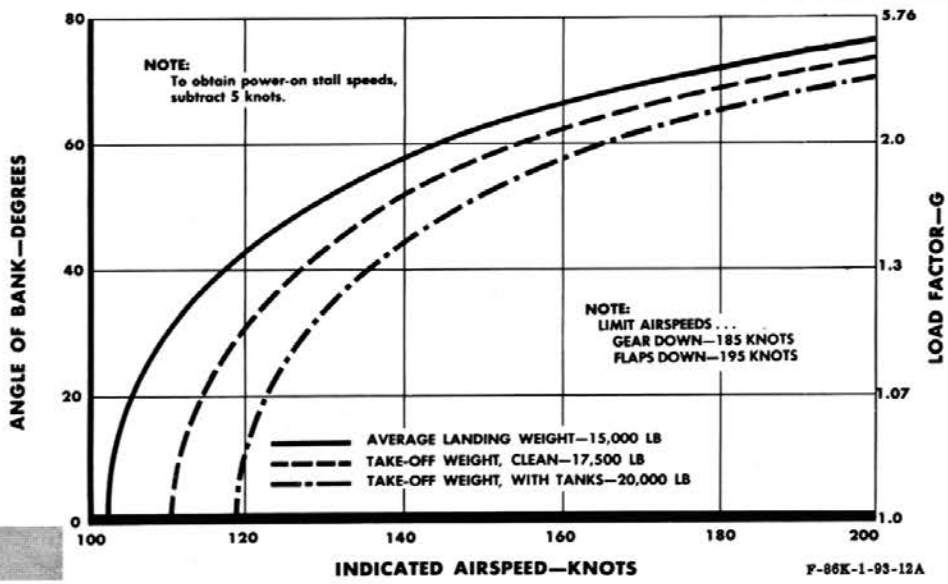
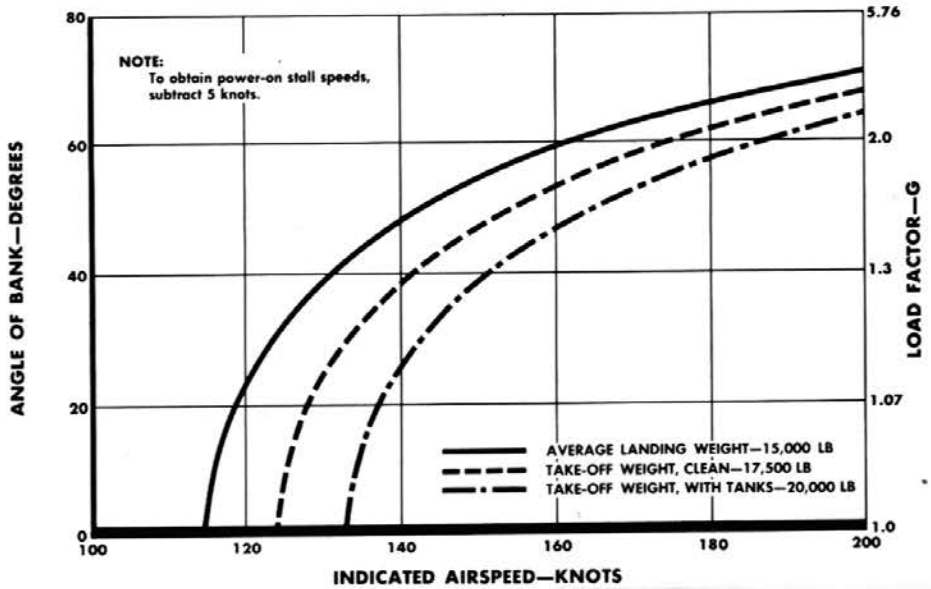


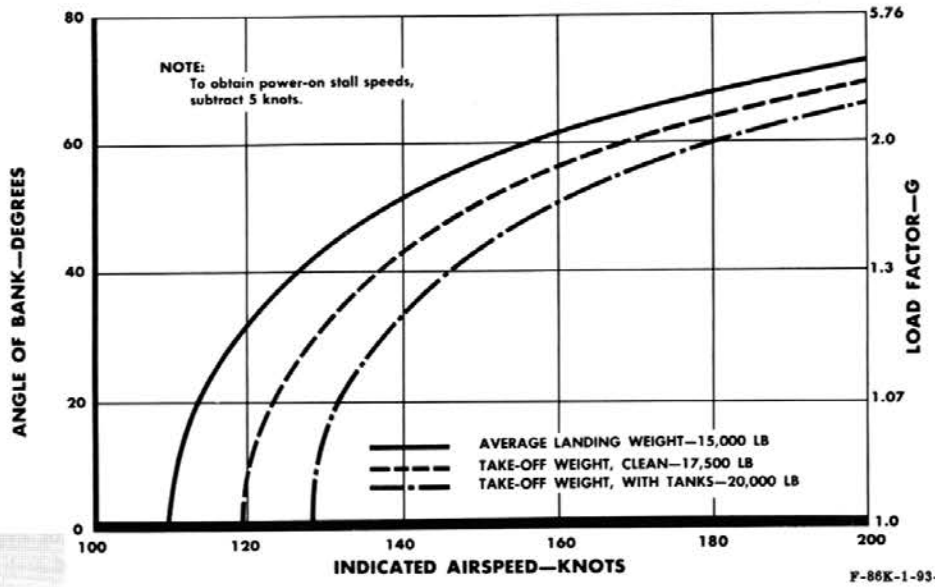
Figure 6-2

STALL SPEEDS
(IDLE POWER—GEAR AND FLAPS UP)

GROUPS 1, 2, AND 3 AIRPLANES



GROUP 4 AIRPLANES



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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 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.

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 indicated 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 medium 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 airplane attains a very nose-high attitude accompanied by considerable 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 and effective wing loading; 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. With the buffet as a warning of an approaching stall, you can avoid stalling the airplane by releasing back pressure on the stick and applying power. 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 weight, clean, or maneuvering weight with 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 is imposed on the airplane. Therefore, considerable maneuvering can be accomplished in the traffic pattern without stalling out. 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, allowing good maneuverability.

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.

On Groups 1, 2, and 3 airplanes, as the airplane approaches a high-speed stall, there will be considerable airplane buffet. Depending on the rapidity of the maneuver, the actual stall may be accompanied by G-overshoot and wing drop accompanied by heavy buffet. When you are approaching a high-speed stall, take the buffet as a warning and be prepared to relax stick back pressure or use push force to avoid the stall. On Group 4 airplanes

and those changed by T.O., because of the extended, slatted wing leading edge and wing tip extensions, an accelerated, high-speed stall results in reduced buffet when pulling G at high altitudes and high Mach numbers. When pulling G at about .9 Mach number, the airplane will experience a mild buffet before 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. Figures 5-2 and 5-3 show 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 STALLS.

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 spins or intentional spins have the same type of entries. As the airplane enters a spin, the nose drops through the horizon to nearly vertical, reaching a dive angle of 50 to 75 degrees about halfway through the first turn of the spin. During the first half of this turn, the airplane begins its spin rotation gradually; however, 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, and 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 comes almost up to the horizon with the wings level, and the first turn of the spin is complete. On the average, 8 seconds is 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-degree 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 comes up only to within 50 or 60 degrees of the horizon in contrast to the return to 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 subsequent turns require 1000 feet per turn on the average.

The airplane spin to the right is faster than that 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 characteristic of using aileron against the spin is that it slows recovery time by doubling the ordinary 3 seconds required to stop rotation. Aileron with the spin does not delay recovery, but it may cause the airplane to spin slightly faster with some increase in altitude loss. 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. 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 shallower angle with power on to make a recovery is offset by the fact that speed increases so rapidly that just as much, or more, altitude is lost as when making a 90-degree, power-off recovery. 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 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.

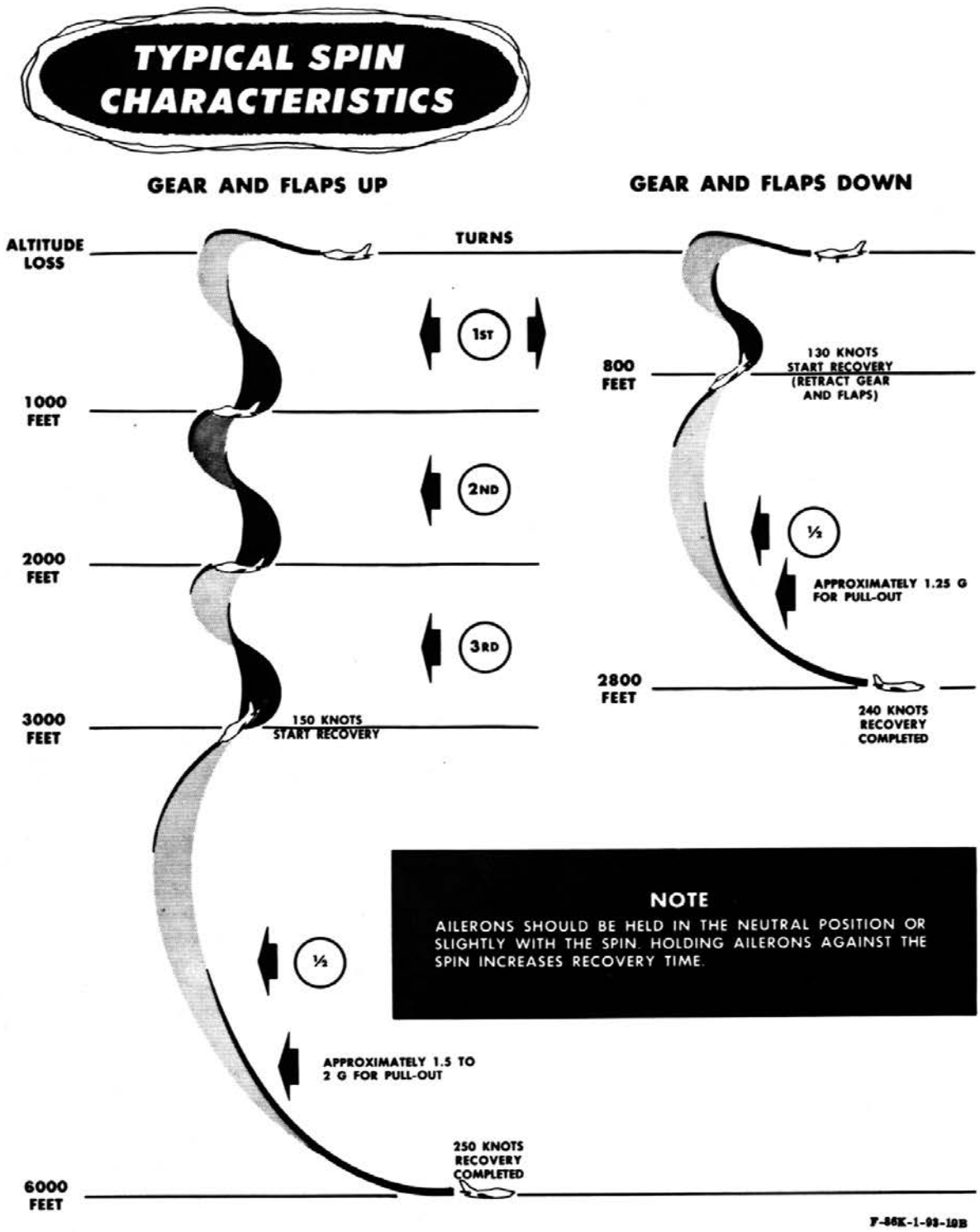
TYPICAL SPIN CHARACTERISTICS
GEAR AND FLAPS UP
GEAR AND FLAPS DOWN
ALTITUDE LOSS
TURNS
1ST
2ND
3RD
1000 FEET
2000 FEET
3000 FEET
150 KNOTS START RECOVERY
½
APPROXIMATELY 1.5 TO 2 G FOR PULL-OUT
250 KNOTS RECOVERY COMPLETED
6000 FEET
800 FEET
130 KNOTS START RECOVERY (RETRACT GEAR AND FLAPS)
½
APPROXIMATELY 1.25 G FOR PULL-OUT
2800 FEET
240 KNOTS RECOVERY COMPLETED
NOTE
AILERONS SHOULD BE HELD IN THE NEUTRAL POSITION OR SLIGHTLY WITH THE SPIN. HOLDING AILERONS AGAINST THE SPIN INCREASES RECOVERY TIME.
F-86K-1-93-10B

Figure 6-3

NONOSCILLATORY SPINS.

You may encounter a different kind of spin, a nonoscillatory-type, in which the normal rise and fall of the nose of the airplane through each turn does not occur. Instead, the airplane will spin rapidly with a steady pitch angle. The nonoscillatory spin can be encountered when the outboard or inboard ends of the slats stick closed while the other ends rack open. These spins usually require more turns for recovery after recovery controls are applied.

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 a half-turn, using normal recovery techniques. In addition to the rapid spin recovery characteristics, the airplane will recover from a spin itself, once you release the controls. It requires about two turns to recover "handsoff." Naturally this "hands off" technique is not recommended at low altitudes. To recover from a spin, proceed as follows:

1. Retard throttle to START 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 as the turn is stopped.
- Hold ailerons neutral during all spin recoveries, since recovery may be prolonged 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.
- If airplane snaps out of a turn at any speed, or enters a spin from a low-speed straight-ahead stall, or enters any form of spin-type manuever, apply opposite rudder and simultaneously move the stick abruptly forward to effect immediate recovery.
- 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 an extremely powerful longitudinal control because of the increased movable surface area and improved surface effectiveness. 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 over-controlling. This means that until you gain sufficient 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 in the jet wash of another airplane, the safety belt and shoulder harness should be kept tight and the stick should be held in a loose grip to prevent an induced oscillation. In the event an oscillation should occur, release the stick or make a steady pull up.

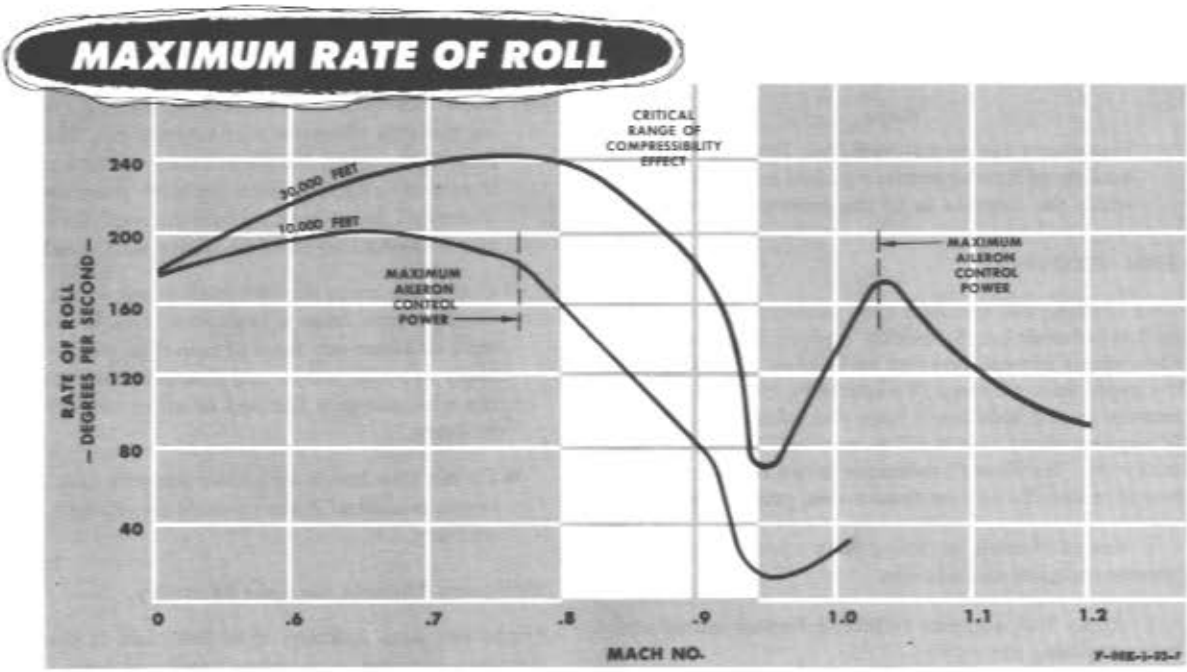

Figure 6-4

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 feet 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 wings-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 indicate 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 movement is required for coordinating turns. In this respect, the airplane is similar to all conventional fighter-type airplanes. Small amounts of rudder movement 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 sufficient 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. 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. The longitudinal trim characteristics are excellent, giving immediate pilot trim response.

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 could cause undue concern.
- Because of the light 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) for the complete landing sequence.

YAW DAMPER OPERATION.

The yaw damper improves dynamic directional stability by making the airplane a more effective gun-firing platform, particularly at high altitudes. At low altitudes and high airspeed, the inherent dynamic directional stability is satisfactory, and damper action is not necessary. It is recommended that damper action be used during the search and tracking phases of the attack to obtain maximum hit probabilities. However, so that use of the yaw damper may be remembered, 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. The servomechanism 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 it is not visually detectable, it nevertheless could reduce the kill probability considerably, unless the yaw damper is turned on. This yawing motion could be induced by your applying any correction during tracking, either by rudder or aileron deflections. This rudder correction 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 operate only 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 indicate airplane response to a release from a steady sideslip with the yaw damper on and off. During an entry into a turn, when a turning rate is being built up, the rudder will kick back because rudder action is in a direction to resist rapid direction changes. The magnitude of this kickback force is about 50 percent of the force that is applied. In the event of a damper failure, the maximum override force required to hold the rudder control is 180 pounds, a force which can be easily controlled until the yaw damper is turned off.

RUDDER OPERATION.

During normal damper operation in straight-and-level flight, the pilot override rudder pedal forces vary from 0 to 90 pounds. The magnitude of force required depends upon the flight condition and the air turbulence. It is recommended that your feet remain on the pedals, but avoid interfering with damper operation, as your force decreases damper effectiveness. In a turning maneuver, damper action lasts 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 pull-out, 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

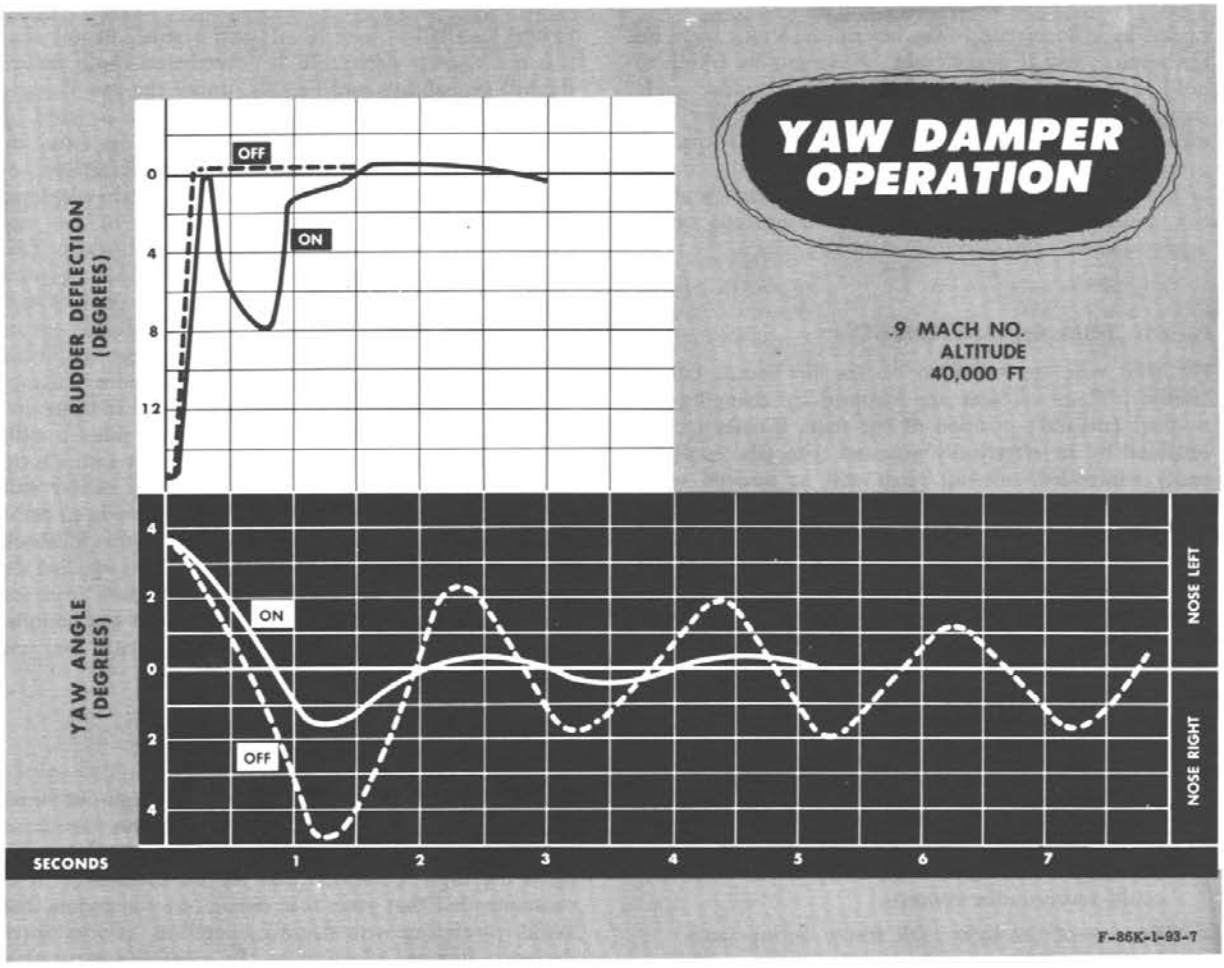

Figure 6-5

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 advantage during tactical maneuvers whenever steep angles of approach are desired.

SLAT OPERATION.

Leading edge wing slats are installed to improve lateral handling characteristics at low airspeed and to reduce the stalling speed. Whether open or closed, they do not appreciably change the handling qualities of the airplane. The slats are fully automatic and operate as a function of airspeed and attitude of the airplane, being full open at low speeds and full closed at cruising speeds and high speeds. For normal slat operation, on deceleration, the slats will begin to open at about 180 knots IAS and be fully opened at 160 knots IAS. On normal accelerations, the slats will begin closing at about 160 knots IAS and be fully closed at 180 to 200 knots IAS. On Group 4 airplanes and those changed by T.O., the slat operating speeds are different because of the improved 6-3 slatted wing leading edge. 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 number.

MANEUVERING STICK FORCES

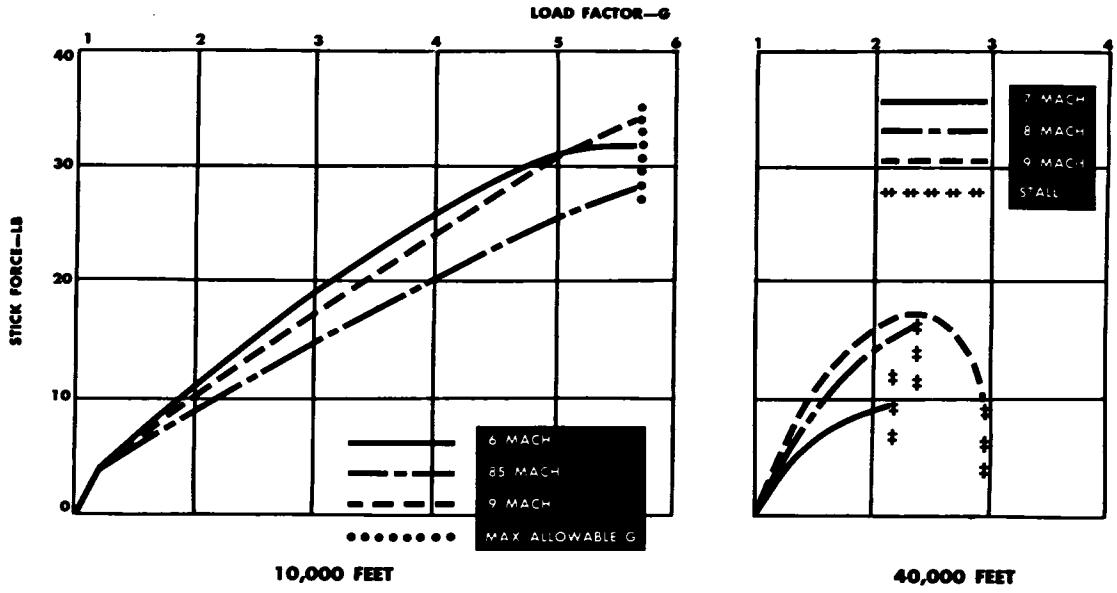

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Figure 6-6

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. 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, accelerating at a rate of 4 to 5 knots per second. 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. 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 remains, this would be 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; consequently, caution should be exercised not to allow the airspeed to get too low, since

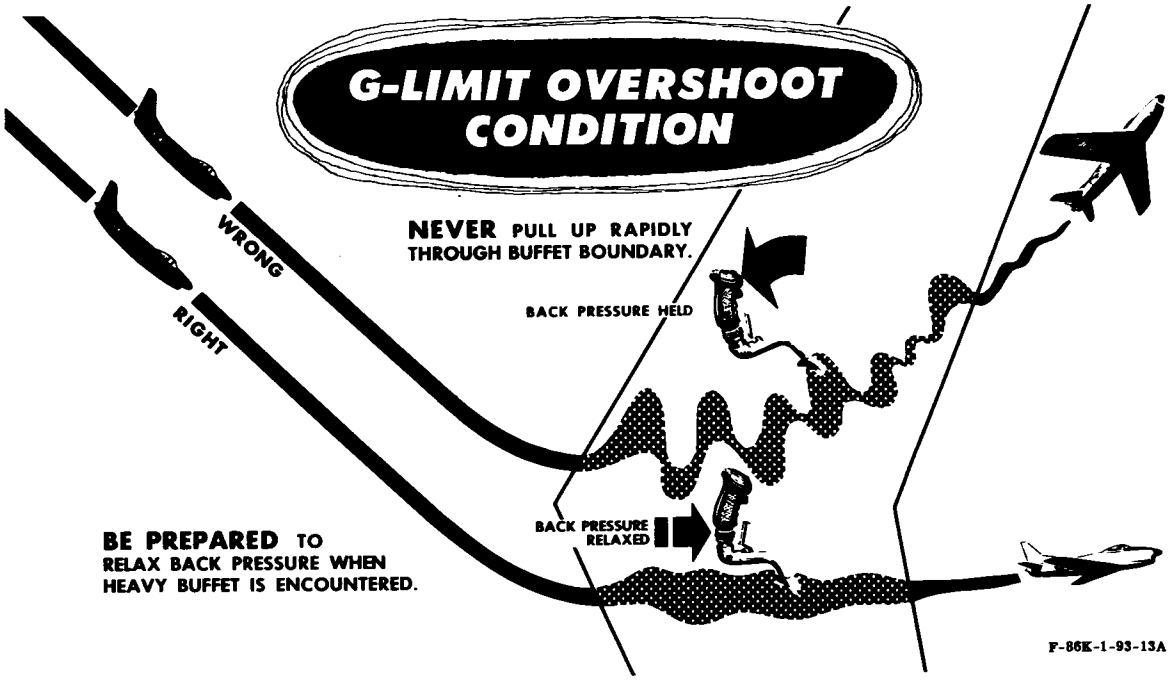


Figure 6-7

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 speed 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 shows the maximum level-flight Mach number capabilities of a clean airplane and an airplane carrying 120-gallon drop tanks, using Military Power and Maximum Power. Certain portions of the drop tank Maximum Power 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," indicating 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; consequently, airplane operation should be at airspeeds where sufficient 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. On most airplanes, the maximum level-

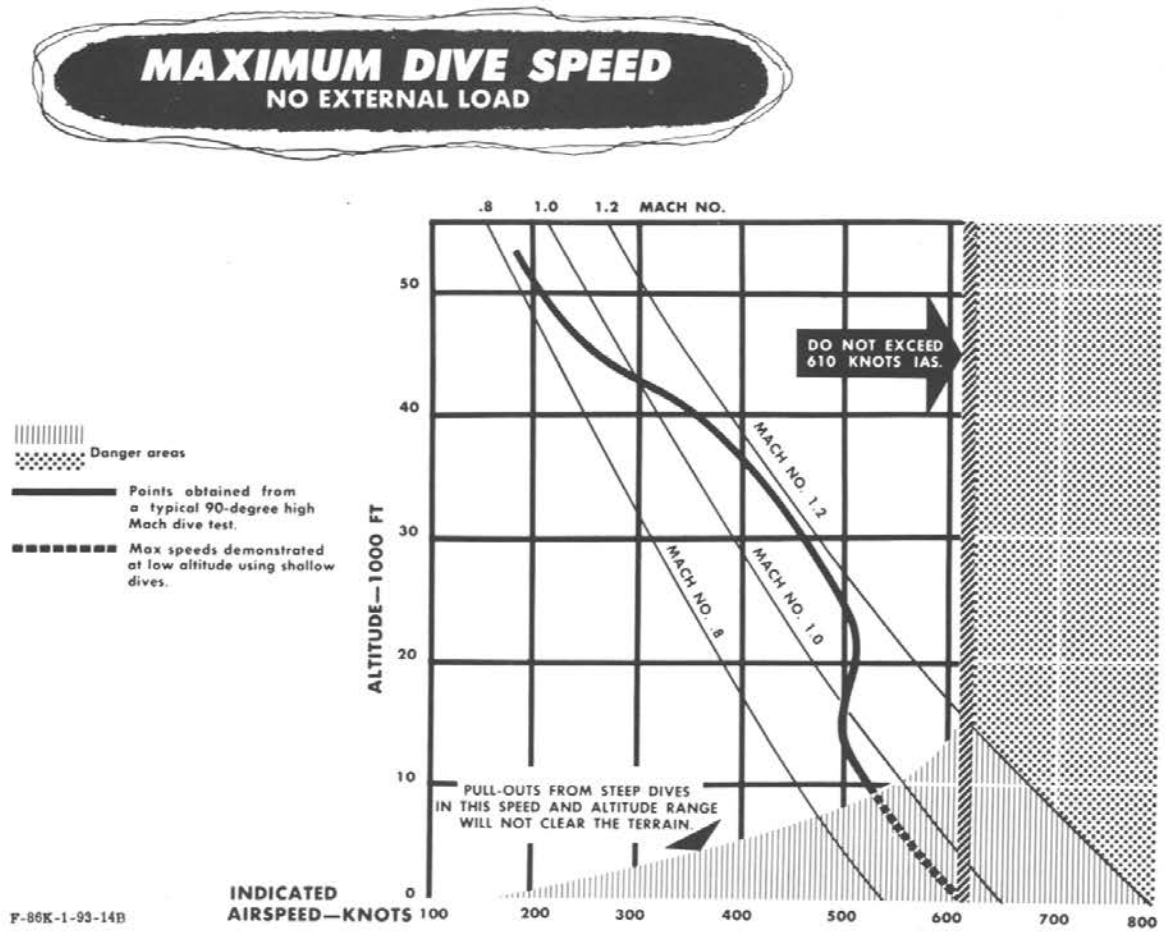


Figure 6-8

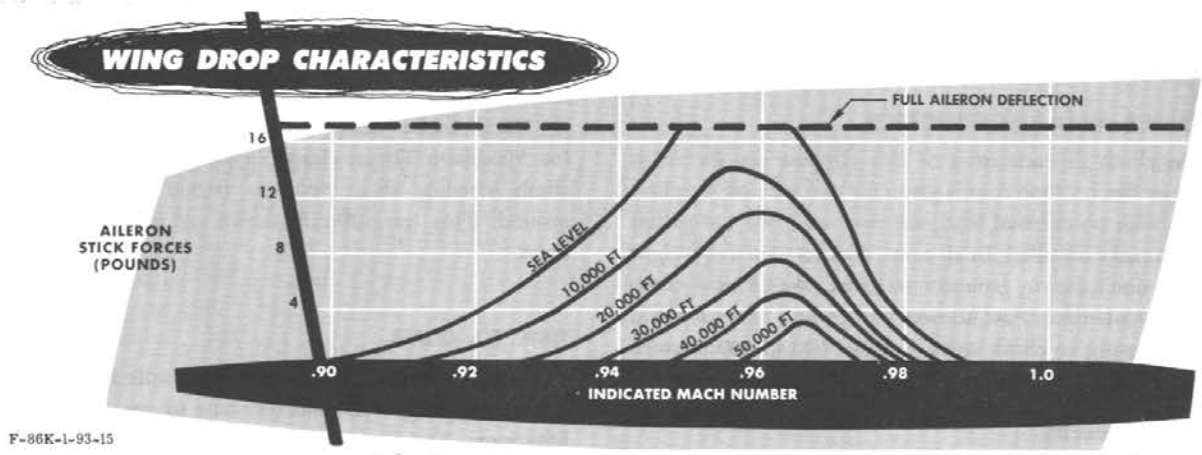


Figure 6-9

ALTITUDE LOSS IN DIVE RECOVERY

ALTITUDE LOSS —CONSTANT 4 G PULL-OUT

4G

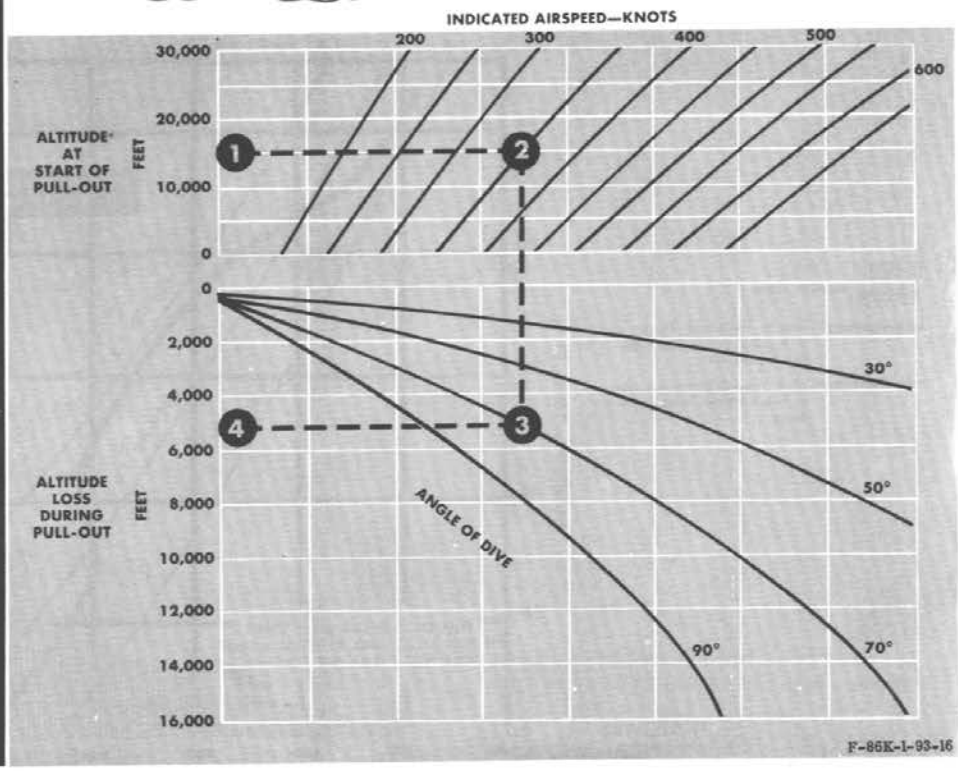


Figure 6-10

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.

CLIMB CHARACTERISTICS.

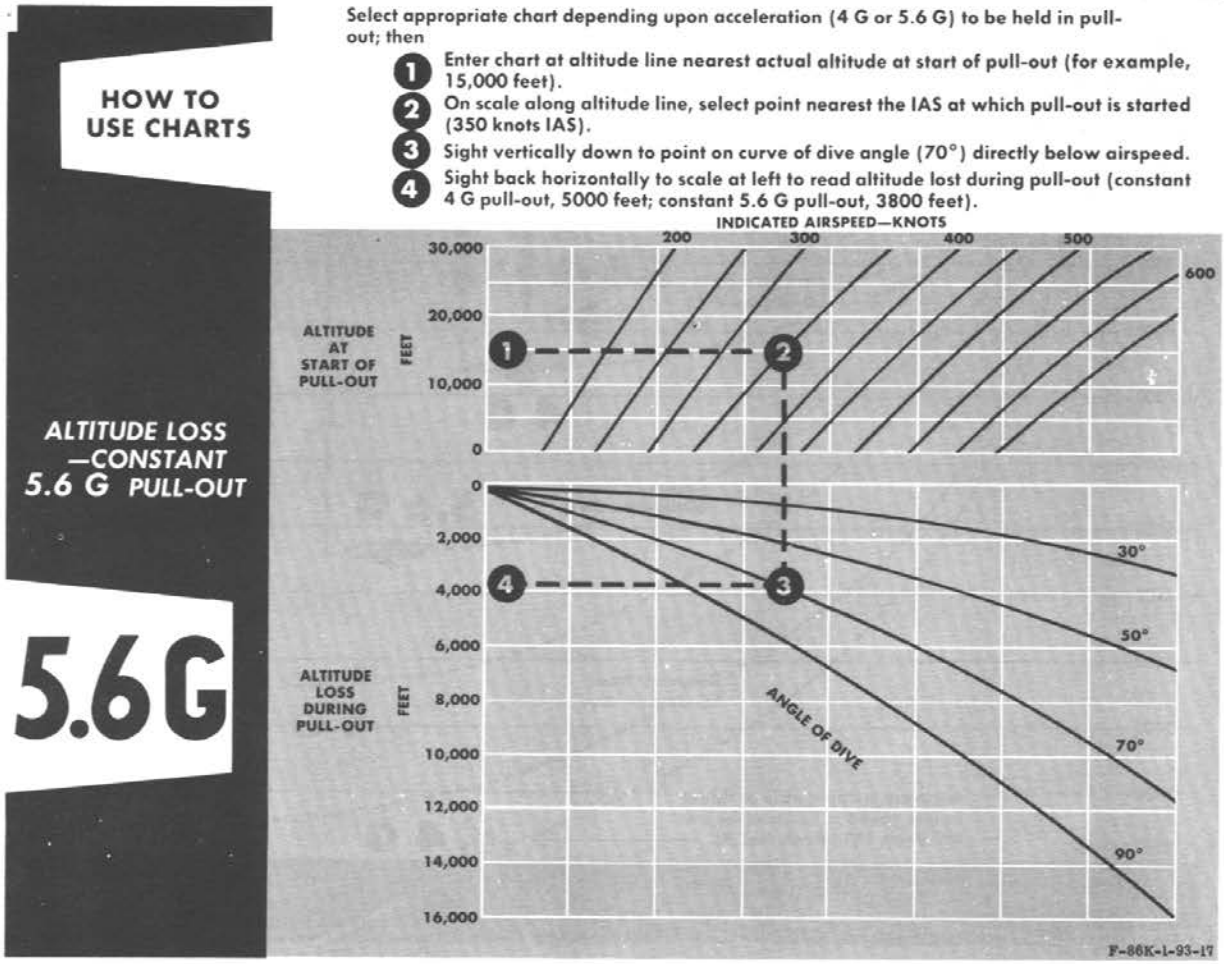
The climb characteristics of this airplane are shown in Appendix I. Climb data is given for two take-off weights: one with no external load, and one with two 120-gallon drop tanks installed. In all cases, the fuel used (or weight reduction) during ground operation, take-off, and climb is accounted for. Fuel allowed for ground operation and accelerating to climb speed is about 600 to 800 pounds.

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 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.

The climb schedules, as shown in Appendix I, have been determined to give the shortest time to any altitude for Maximum Thrust and the longest range for Military Thrust. The time required to accelerate to climb speed from brake release at take-off and the time required to



accelerate from climb speed at the desired altitude to combat speed have been considered in these climb schedules. If a 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 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

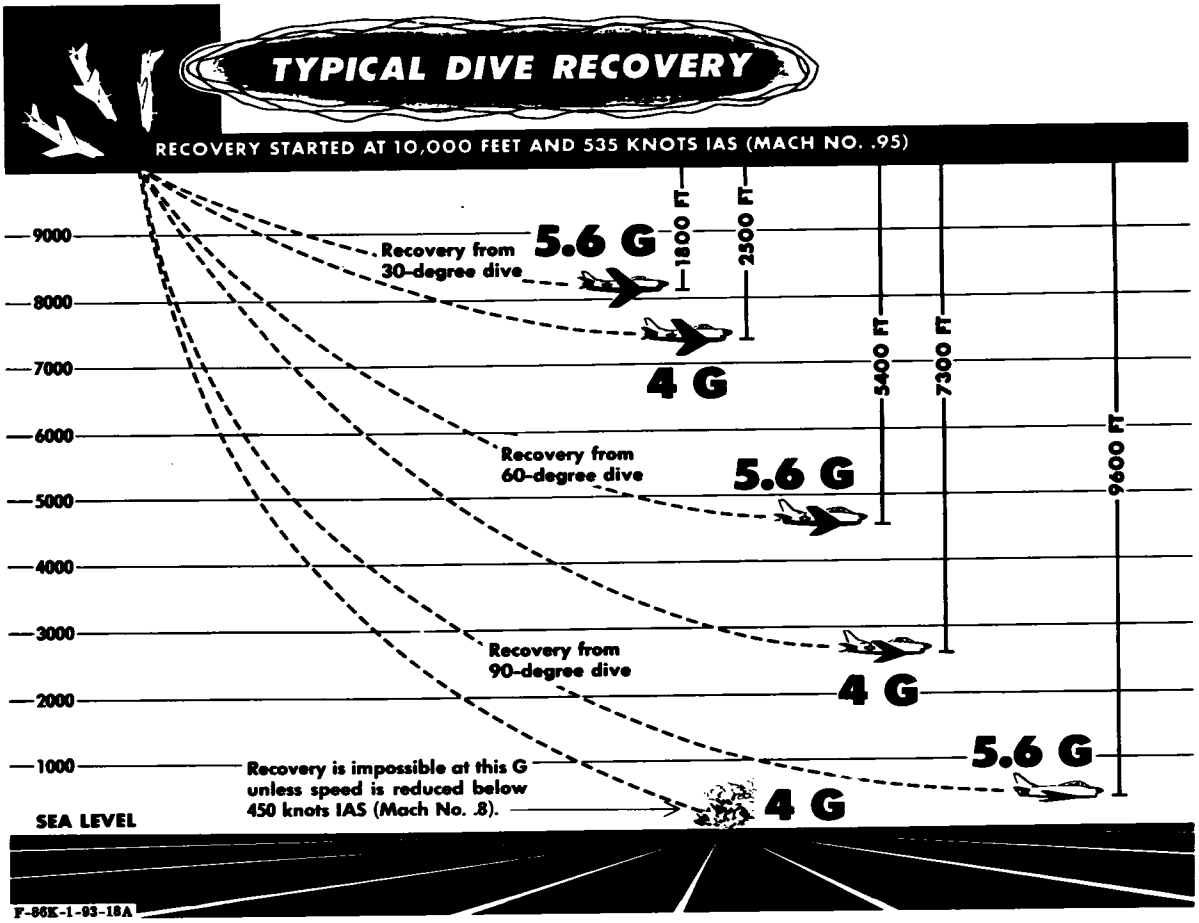


Figure 6-11

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 an indication 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.)

COMBAT TIME AVAILABLE
(NO EXTERNAL LOAD)

EXAMPLE
After take-off:

1. Climb to 35,000 feet with Maximum Power, range 35 nautical miles.
2. Proceed to intercept target reported at range of 145 nautical miles, using Military Power.
3. Fuel is available for 5 minutes combat using Maximum Power.

NOTE:
Climb curve includes take-off and climb to desired altitude using Maximum Power.
Fly-out to combat range curves based on use of Military Power.
Five-minute and 2½-minute combat curves based on Maximum Power.
Return to base, using maximum range data from Appendix 1.
Chart includes 10 percent fuel reserve of 450 pounds.

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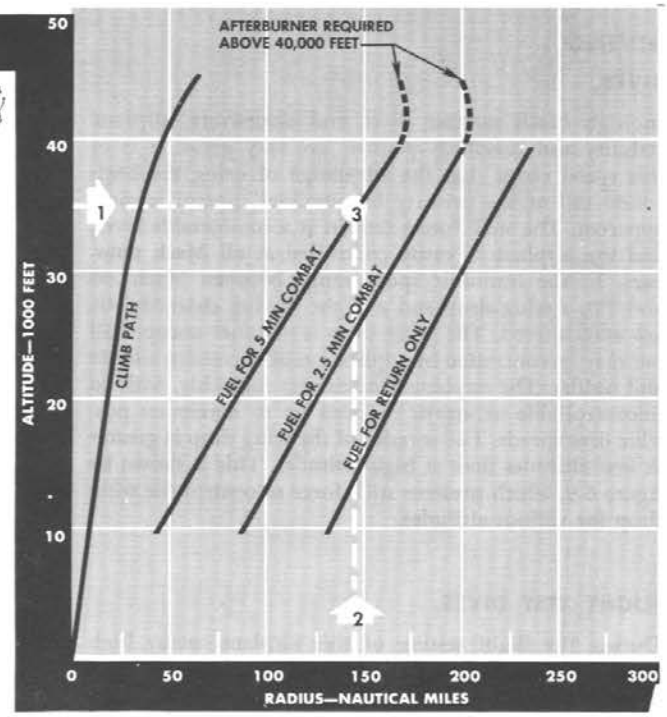

Figure 6-12

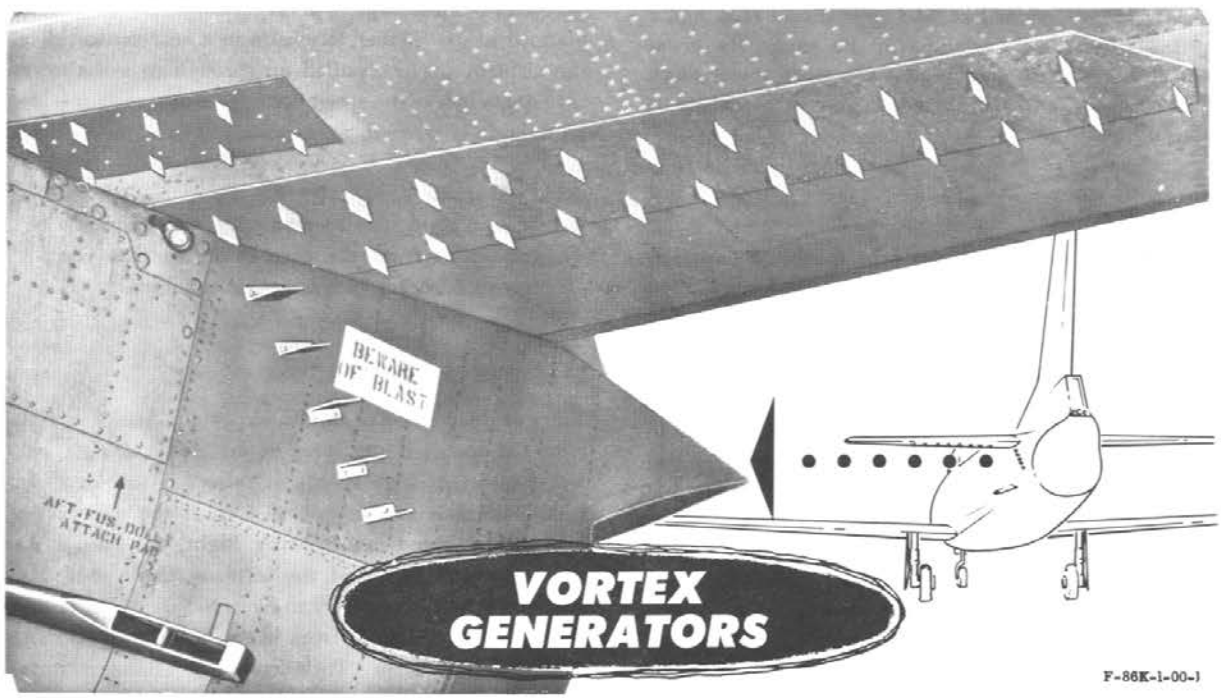

Figure 6-13

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 6-9, 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 6-8 for a 90-degree dive using Maximum Power. For example, the highest test Mach number obtained was 1.17 Mach number shown between 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 below 15,000 feet were not obtained at 90-degree dives. (See figure 6-8.) 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 if desired 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 6-10. Note that one of the charts is based on 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-outs 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. Consequently, 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 6-11.) 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 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 judgments on pull-outs.

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.)

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 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 using Idle Power with speed brakes full open, and observe exhaust limits for descents.

FLIGHT WITH DROP TANKS.

Flying characteristics are essentially unaffected by the installation of the 120-gallon drop tanks. Above 15,000 feet, there are no airspeed restrictions other than those for the clean airplane. However, below 15,000 feet with full or empty drop tanks installed, do not exceed 555 knots IAS or Mach .9, whichever is less. (See figure 5-1.) As a result of the increased drag and weight, take-off distances will be greater and the rate of climb reduced.

VORTEX GENERATORS.

To minimize buffet caused by shock waves between Mach .81 and .92, a series of small vanes (figure 6-13) 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.

WARNING

Section VII

SYSTEMS OPERATION

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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 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 integrating 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 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 over-temperature.

THRUST SELECTOR.

The thrust selector, mounted in the left equipment bay, converts throttle movement into electrical signals for engine control. 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 principal 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 settings. Also, at high power settings, a given exhaust temperature can be selected easier, and the engine will maintain 100% rpm through a

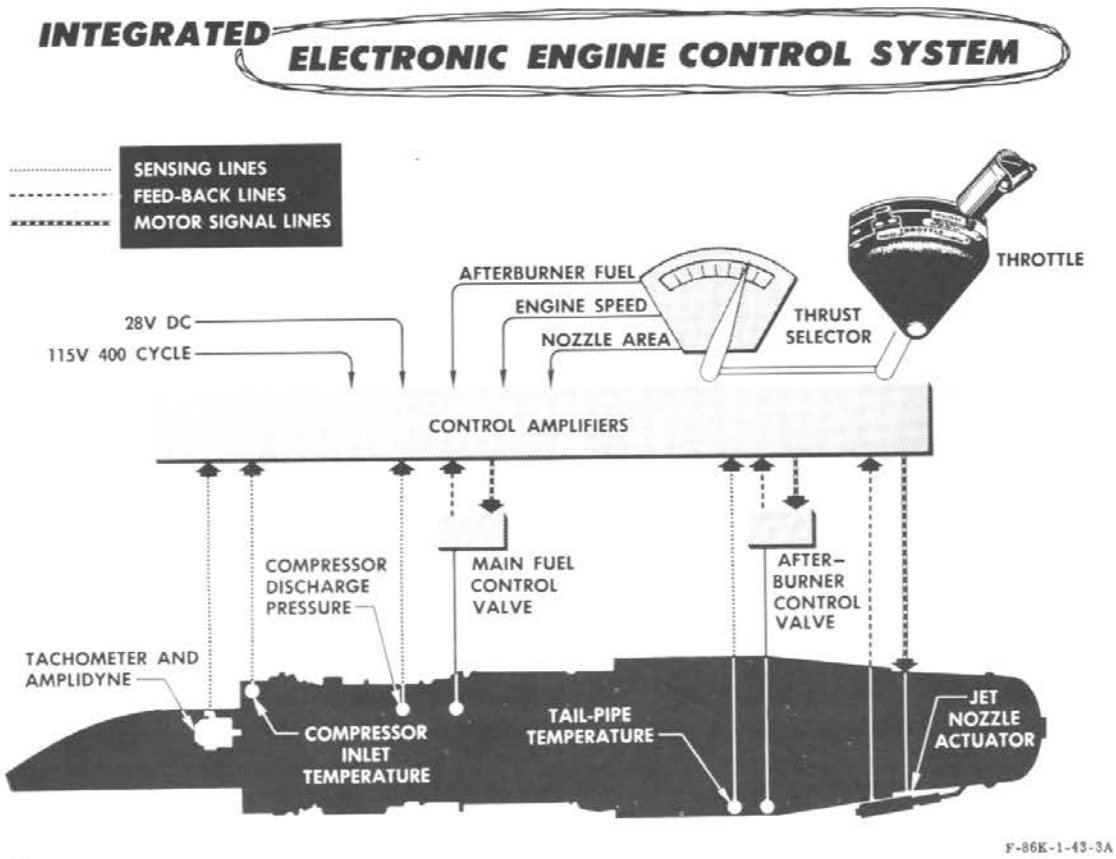


Figure 7-1

greater arc of throttle travel. At low power settings, engine rpm and thrust responds more for a given throttle movement. This new thrust selector also decreases acceleration time on throttle bursts from the idle rpm, decreases thrust faster on a throttle chop, and gives 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 rpm, so that proper action can be taken to prevent any possibility of subsequent 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; however, exhaust temperature will lag fuel flow indications about 2 to 3 seconds. Pilot and crew chief familiarity with the starting fuel flow pattern (figure 7-2) will make an overtemperature condition obvious when it will occur and allow enough time to retard the throttle to the CLOSED position to prevent an engine overtemperature. During operational and training missions, 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 gives an early indication of the operability of the engine control, since inability to accomplish an automatic start indicates a control or fuel system malfunction.

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 a heavy rain, it is recommended that the engine be first started using the manual start procedure. After the engine has started and checked satisfactory, 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 component.

Note

There are three functional ground checks which the pilot can use to determine the operability of the electronic engine control.

1. Automatic start capabilities.
2. Stall-free throttle bursts from Idle to Military Power (emergency fuel system switch in NORM).
3. Temperature control during afterburner light-up.

Omission of any one of these checks before take-off decreases the possibility of detecting improper engine control.

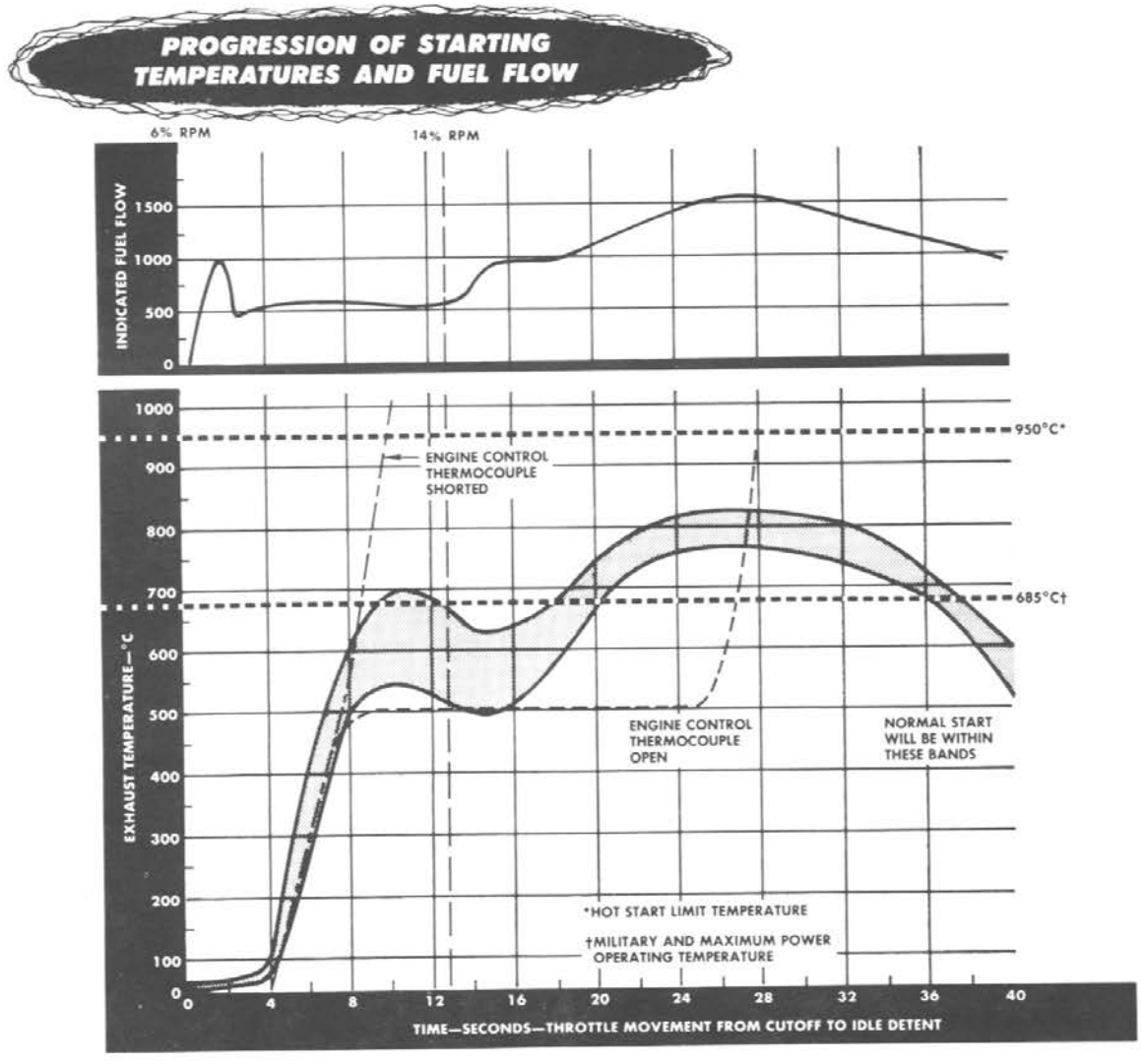


Figure 7-2

There are two check points designed and built into the automatic start circuit to forecast a control system malfunction and impending hot start. Check point No. 1 occurs at 6% rpm (immediately after advancing throttle to START IDLE), and check point No. 2 occurs at about 14% rpm. When the throttle is advanced directly to START IDLE at 6% rpm, the fuel flow builds up to about 600 pounds per hour. (A characteristic present in the fuel flowmeter indicating system is such 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 falls to about 600 pounds per hour. This "blip" in the indicated fuel flow is momentary and should not be mistaken as a malfunction in the fuel control system.) When ignition occurs, exhaust temperature rises and peaks at about 600°C. As engine speed increases, fuel flow remains steady at about 600 pounds per hour, and exhaust temperature declines slightly. At about 14% rpm, fuel flow again rises rather sharply until it reaches a peak of about 950 pounds per hour. The exhaust temperature increases correspondingly and peaks at 815°C.

CAUTION

These exhaust temperature and fuel flow peaks must occur before 18% rpm is reached. If they do not, chop throttle to CLOSED and investigate before flight.

As engine rpm increases above 14%, the fuel flow gradually climbs to about 1500 pounds per hour, and as the engine stabilizes at the idle rpm, the fuel flow and exhaust gas temperature slowly decline to some lower value (from 800 to 1300 pounds per hour and 400°C to 600°C). If cockpit indications during an automatic start depart from these trends (figure 7-2), shut down engine immediately by chopping throttle to OFF 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 malfunction. Under this condition, exhaust temperature rises 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 increases very rapidly until the 950°C temperature is exceeded. Knowledge of engine start characteristics helps to *anticipate* and *prevent* hot starts, and helps 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 amber 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 from the afterburner range to START-IDLE and immediately moving the emergency fuel system switch to ON.

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. A dangerous overspeed condition will result if the throttle is left at MILITARY on the emergency fuel system. After retarding the throttle to START-IDLE, the nozzles should be closed manually to one fourth open, and the throttle should be readvanced cautiously as required.
- During engine lockup, changing to the emergency fuel system will not unlock the exhaust nozzle. When the engine is in lockup, the exhaust nozzle must be jogged to the desired position.

THREE-POSITION EMERGENCY FUEL SWITCH CHARACTERISTICS.

The automatic lockup system is made effective after a normal engine start when the three-position emergency

fuel system switch is positioned at ON, then moved back to NORM without hesitating at TAKE OFF. It then remains operable during all normal operation whenever the emergency fuel system switch is positioned at either the TAKE OFF or the NORM 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 caution light is on, as engine overtemperature and surging may result when lockup is removed. Manual release of automatic lockup can be accomplished by converting to operation on the emergency fuel system. Subsequent to manual unlocking, no attempt should be made to return to the main fuel system for operation while the engine control lockup caution light is on, because while the emergency fuel switch is in the ON position, the controls are released from lockup. If the switch is returned to TAKE OFF or NORM position, the controls will lock up again in a position that may cause dangerous overtemperature or an rpm surge condition. A switch in the thrust selector at the 72-degree position (about ¾ throttle position) permits take-offs to be aborted if an automatic engine control lockup is encountered during the take-off roll. As the throttle is rapidly retarded to START IDLE, with the emergency fuel system switch at TAKE OFF, the 72-degree switch is actuated and de-energizes the main fuel system by-pass valve. This action opens the by-pass valve and permits the emergency fuel system to assume engine control; however, it does not unlock, or prevent locking of, the electronic engine controls. If the throttle is not retarded as rapidly as possible, when an afterburner take-off is to be aborted, engine overspeeding results.

TWO-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 lock-up protection is provided during the engine start. If ac power loss occurs, the results will be the same as those described under the three-position emergency fuel system switch characteristics. 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 NORM. 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 on airplanes incorporating the two-position switch.

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 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, when the emergency fuel system switch is inadvertently left in the* TAKE OFF *position, 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, if the emergency fuel switch is inadvertently left in the TAKE OFF position, 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 powers 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 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, depress the stop-starter button immediately.

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. Throttle closed.
3. Battery-starter switch momentarily at STARTER.
4. Allow engine to crank to about 9% rpm (one minute maximum); then depress stop-starter button and turn engine master switch OFF.

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 if the fuselage rear section tank transfer pump fails.

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 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.

1. Afterburner roughness exists primarily at altitudes from 25,000 to 35,000 feet.

2. Intensity of afterburner roughness will reach maximum at a specific altitude and will diminish at either side of that altitude.

3. 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.

4. The roughness will not necessarily be accompanied by any noticeable change in engine instrument readings.

5. This condition will not contribute to activation of the fire-warning system.

6. 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 NORM.

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 Switch at TAKE OFF (Three-position Switch).

On some occasions, when the throttle is retarded out of the afterburner range with the emergency fuel system switch inadvertently left in the TAKE OFF position, engine overspeed is experienced. This condition usually occurs on hot days and is not considered undesirable, as the maximum overspeed usually experienced is about 102% rpm. This condition will be corrected as the variable nozzle adjusts itself to the Military Thrust position. Normally, when the throttle is retarded from the afterburner range, an immediate decrease in the back pressure on the turbine wheel occurs, which allows the engine to momentarily overspeed. The electronic engine control, sensing this overspeed, immediately starts to close the main fuel valve. This reduces fuel flow to prevent further overspeeding, until the variable nozzle can assume the correct position and allow the exhaust temperature and back pressure to build up. However, on a hot day, with the emergency fuel system switch at TAKE OFF, the emergency fuel system is in stand-by, with a fuel scheduling very close to that of the main fuel system. Thus, when the main fuel valve closes to prevent overspeed, the emergency fuel regulator restricts the amount of by-pass fuel from the main fuel system. (See figure 1-4.) This restriction then forces the by-pass fuel around the main fuel valve and into the engine, and therefore prevents reduc-

tion of the fuel flow. As this condition can occur only when the emergency fuel system switch is in the TAKE OFF position, positioning the switch to NORM before retarding the throttle from afterburner range will prevent its occurrence.

EMERGENCY FUEL SYSTEM.

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 overriding the main system while on stand-by. 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.

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.

NONRECOVERY CHARACTERISTIC FOLLOWING AN EMERGENCY FUEL SYSTEM TEST (THREE-POSITION SWITCH).

On airplanes equipped with an old-type main fuel control valve, the inability of the engine to recover on the main fuel system following an emergency fuel system test is evidenced by failure of the engine rpm to fully recover to 100%. With the throttle at MILITARY stop and the emergency fuel system switch at TAKE OFF, depressing the emergency fuel system test button disables the main fuel system, causing the rpm to drop to the emergency fuel system value and the variable nozzle to go to the scheduled closed position. Releasing the test button returns engine control to the main fuel system, which

locks the variable nozzle. The variable nozzle is locked in position whenever throttle position calls for more than 3% increase in rpm. Usually there is adequate fuel flow provided to accelerate the engine from emergency fuel system rpm to approximately 97% rpm with the variable nozzle locked closed. When 97% rpm is reached, the variable nozzle is automatically unlocked; and as it opens, it allows the engine to continue acceleration to full speed. Occasionally, after an emergency fuel system test, there is not enough fuel flow provided by the main fuel system schedule to enable the engine to accelerate to 97% rpm with the nozzle positioned to a minimum area. When this occurs, the rpm stabilizes, or "hangs up," at some lower value. In order to assist rpm to recover to 100% on the main fuel system, the emergency fuel system switch should be moved to NORM and the throttle retarded sufficiently to provide a throttle schedule within 3% of actual rpm, thus allowing the nozzle to open and enabling the rpm to increase. As the engine starts to accelerate, the throttle can then be readvanced. On other airplanes, recovery of rpm after an emergency fuel system check will not be affected by retarding the throttle. Because of the characteristics of the later-type main fuel control valve, it may take about 20 seconds before rpm begins to increase.

EMERGENCY FUEL SYSTEM OVERRIDING MAIN FUEL SYSTEM (THREE-POSITION SWITCH).

Any time ambient air temperature causes the emergency fuel regulator setting to approach that of the main fuel system, it is possible for the engine to gradually overspeed (above 100% rpm) during the initial climb after take-off. This is a result of the emergency fuel system overriding the main fuel system when the emergency fuel system switch is in the TAKE OFF position. Normally, the engine overspeed will not exceed 102% rpm; however, it should be noted that short periods of operation between 100% and 104% rpm will not damage the engine. When emergency fuel system override occurs, what appears to be a complete power loss will be experienced if the emergency fuel system switch is positioned to NORM, with the overspeed condition present. This power loss occurs because the main fuel system, on sensing the overspeed condition, has closed the main fuel valve in an attempt to bring the engine speed down to 100% rpm. The main fuel system returns the main fuel valve to its open position when the emergency fuel system switch is positioned at NORM. However, the time required is dependent on the rate of response of the main fuel system. The overriding of the main fuel system by the emergency fuel system may be caused by improper adjustment of the electronic engine control, accumulation of mechanical tolerances in the emergency fuel system under ram conditions, or an atmospheric temperature inversion resulting in excessive outside air temperature as altitude is increased. If the engine fuel systems are checked and found to be within acceptable limits, the overriding by the emergency fuel system is acceptable and corrective action should be taken by the pilot. Engine overspeeding to 104% rpm when operating in afterburner can be corrected after a safe altitude is reached, by moving the emergency fuel system switch to NORM and immediately retarding the throttle from the afterburner range. The engine will respond on the main fuel system when the throttle is readvanced. If the engine overspeed condition stabilizes at about 102% rpm, climb may be continued without a power change. The altitude increase will cause the engine to return to 100% rpm. Wait 15 seconds after engine speed returns to 100% rpm before positioning emergency fuel system switch to NORM. The main fuel system will then take over engine control normally.

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 J47 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. On airplanes incorporating the three-position emergency fuel switch, the emergency fuel regulator may cause engine surges which occur when the switch is in the TAKE OFF position. The frequency of such surges is approximately one cycle per second.

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.

A "BOTH" inverter failure warning light (red) and a "MAIN" inverter failure warning light (amber) are provided in the cockpit. (See figure 7-3.) The illumination of the "MAIN" inverter failure warning light indicates failure of the main inverter. Illumination of the "BOTH" inverter failure warning light is controlled by the ac bus and indicates both inverters are inoperative. As there is no single indication of secondary inverter operating condition, it may be checked on the ground during the inverter change-over check. Positioning the inverter switch at SPARE fails the main inverter, which causes the "MAIN" inverter failure warning light to illuminate, indicating that the main inverter is inoperative. If the "BOTH" inverter failure warning light (red) remains out with the amber light on, the secondary inverter is, therefore, operable and has taken over the duties of the main inverter. During a ground check of the inverter change-over circuit or during flight after a main inverter failure, the "BOTH" inverter failure warning light (red) may come on momentarily. This momentary illumination must not be construed as failure of both inverters, as only steady illumination of the "BOTH" inverter failure warning light indicates both inverters have failed. The length of momentary illumination, or flash, of the "BOTH" inverter failure warning light will depend upon the position of the radar master power switch. With the radar power switch in any position but DISCONN (off), the secondary inverter will take over immediately after a main inverter failure.

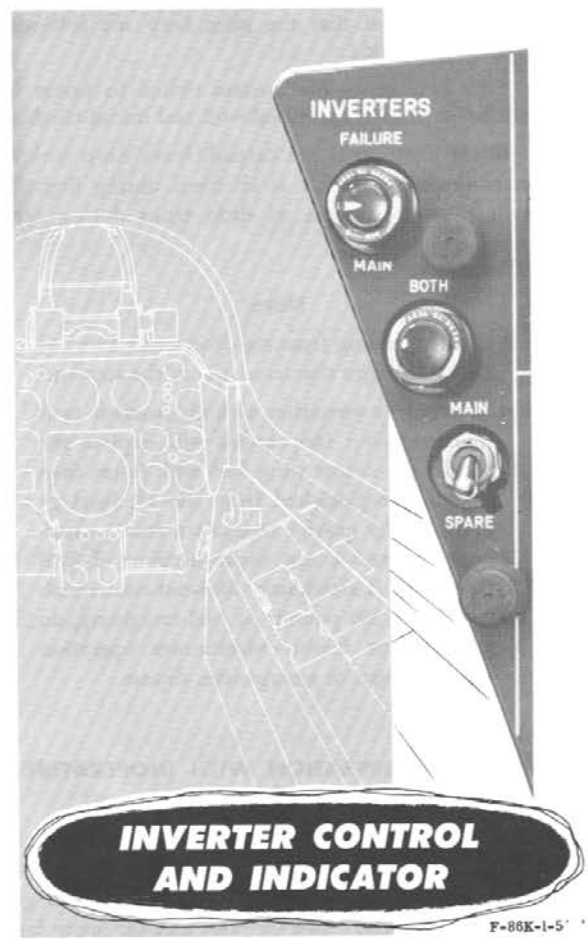


Figure 7-3

This immediate change-over may result in a flicker or flash of the "BOTH" inverter warning light. When the radar power switch is at DISCONN, the secondary inverter is not operating; for this reason, when inverter change-over is called for, the time necessary for change-over will be considerably lengthened because of the necessity of the secondary inverter to start operating and putting out ac power. Under this condition, therefore, the "BOTH" inverter failure warning light will come on and stay on for a short period of time until the secondary inverter can start operating and take over main inverter duties. This inverter change-over characteristic is very important to remember, as, in time of emergency, the momentary illumination of the "BOTH" inverter failure warning light might be construed as failure of both inverters instead of the time lag for the secondary inverter to take over.

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. Turn emergency fuel system switch to NORM for all normal operation except take-off and initial 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.
- 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 emergencies dictate.

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 tank 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 SYSTEM.

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; 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.

With conventional flight control systems, intermediate rates and maximum rate of control movements are both directly proportional to pilot effort. In constant-pressure irreversible hydraulic systems, such as on this airplane, the rate of control movement varies with pilot effort only until the actuator valve is completely open. Any additional effort by the pilot does not result in a further increase in rate of movement. Thus, the maximum rate obtainable is not determined so much by pilot effort as by the hydraulics and kinematics of the system. With a conventional system, almost any malfunction 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 is not apparent until an attempt is made to move the controls faster than the restriction permits. Also, the rate of movement imposed by the restriction

is maximum, regardless of pilot effort. Failure to lift the nose wheel during take-off can result from the fact that the stabilizer actuator control valves of the normal and alternate systems are not properly synchronized. If the valves are 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 permits. 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 encounter the malfunction. 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-86K Airplanes, malfunction of the flight control system as previously described 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 occurs during high gross weight take-offs. After airspeed has built up sufficiently for complete flap retraction, the flap handle should be positioned at UP until needed again. For landings, the flap handle is moved firmly to the full DOWN stop. The flap handle is built for normal use and does not require special gentle handling by the pilot during operation.

WARNING

The flap actuating mechanism may be damaged if the flap handle is left in the HOLD position for an extended length of time when the flaps are extended.

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 the gear is cycled. If the unsafe warning light does not go out after the gear is cycled several times, land as soon as practical.

WHEEL BRAKE OPERATION.

To reduce airplane accidents and maintenance problems caused by tire, wheel, and wheel brake failure, the following precautions should be observed insofar as practicable:

a. Take full advantage of the length of the runway, utilizing aerodynamic braking to stop the airplane, so that brakes can be used as little and as lightly as possible.

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 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. 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 landings when no brake application is involved.

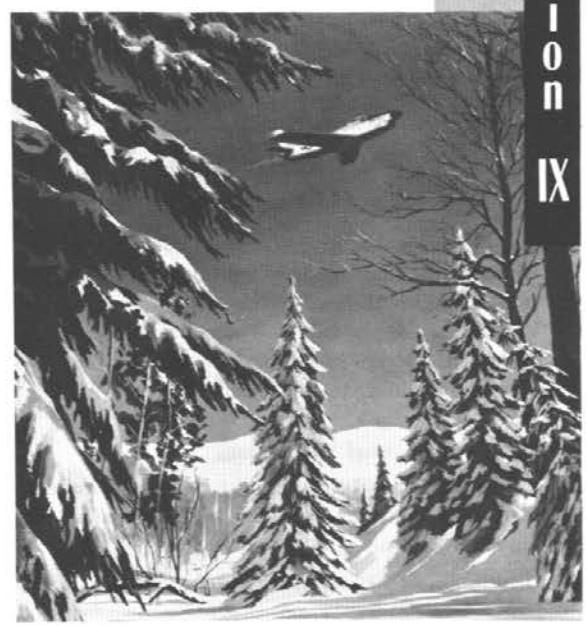
e. The brakes should not be dragged while taxiing, and should be used as little as possible for turning the airplane on the ground.

f. At the first indication of brake malfunction, or if brakes are suspected to be in an overheated condition after excessive use, the airplane should be maneuvered off the active runway and stopped. The airplane should not be taxied into a crowded parking area. Overheated wheels and brakes 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



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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 flight 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 and somewhat higher stick forces are present, which are absent in the higher speed ranges. Except in the case of military necessity, this airplane should not 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 radio navigational aids and a complete deicing system that will enable you to fly in all kinds of weather with ease and accuracy. 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, using particular care in planning your fuel consumption and alternate landing field. Therefore, 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 low-frequency range, ADF, and GCA 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 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 to a point where it becomes difficult to maintain your heading, go on instruments immediately, using your directional 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 sufficient runway remaining to complete 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 and 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.
- A slight pitch error in the indication of the Type B-1A 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 bar-width error depends upon the acceleration and elapsed time of each individual take-off. The erection system automatically removes the error after the acceleration ceases.

8. Engine inlet switch at RETRACT if surface anti-ice has not been used for take-off.

Note

When in areas of known or suspected icing condition, use anti-icing 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 aircraft.

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 allow the 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. Decending turns on the autopilot present no problem, because they are easily accomplished with the turn-knob control.

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.

If icing conditions exist or are anticipated or if it is raining, maintain 75% rpm in descents to be assured that adequate flow of hot air will be available for deicing and rain removal.

WARNING

When power is reduced below 75% rpm while approaching the runway during rain, forward visibility will be obscured somewhat as less hot air is available for rain removal. During touchdown, look out of the windshield side panels, which will remain fairly clear at all times. Turn system off after touchdown if warning light has not come on. If light is on, leave switch on; reduced engine power on the ground or moving manual ram-air lever to OPEN will allow gradual cooling of windshield, and thus prevent cracking of the glass by sudden temperature changes. Illumination of the light indicates the design limit of the air supply to the anti-icing nozzle has been reached but does not necessarily indicate that the temperature of the windshield has reached the same limit. The temperature of the windshield depends on outside air temperature. In addition to reducing engine power to reduce the temperature of the anti-ice air supply, moving the manual ram-air lever to the OPEN position will reduce the amount of air to be cooled in the heat exchanger, thus reducing the temperature. It is recommended that the OPEN position be used in conjunction with the anti-ice system only during landing, take-offs, or taxiing, because unsatisfactory cockpit temperatures could result if used extensively during flight. The rain removal feature of the windshield anti-ice system is limited by engine power and by the intensity of the rain.

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, low-frequency range, 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 with instrument approach, which is accomplished by beginning a letdown at the initial penetration (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 initial penetration, a conventional instrument approach is begun. A typical penetration with ADF approach is shown in figure 9-2. In such penetrations, if you are not VFR at minimum penetration altitude, an instrument approach must be made. The conditions set up in the JAL charts should be given careful considerations 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 letdown with GCA landings is 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.

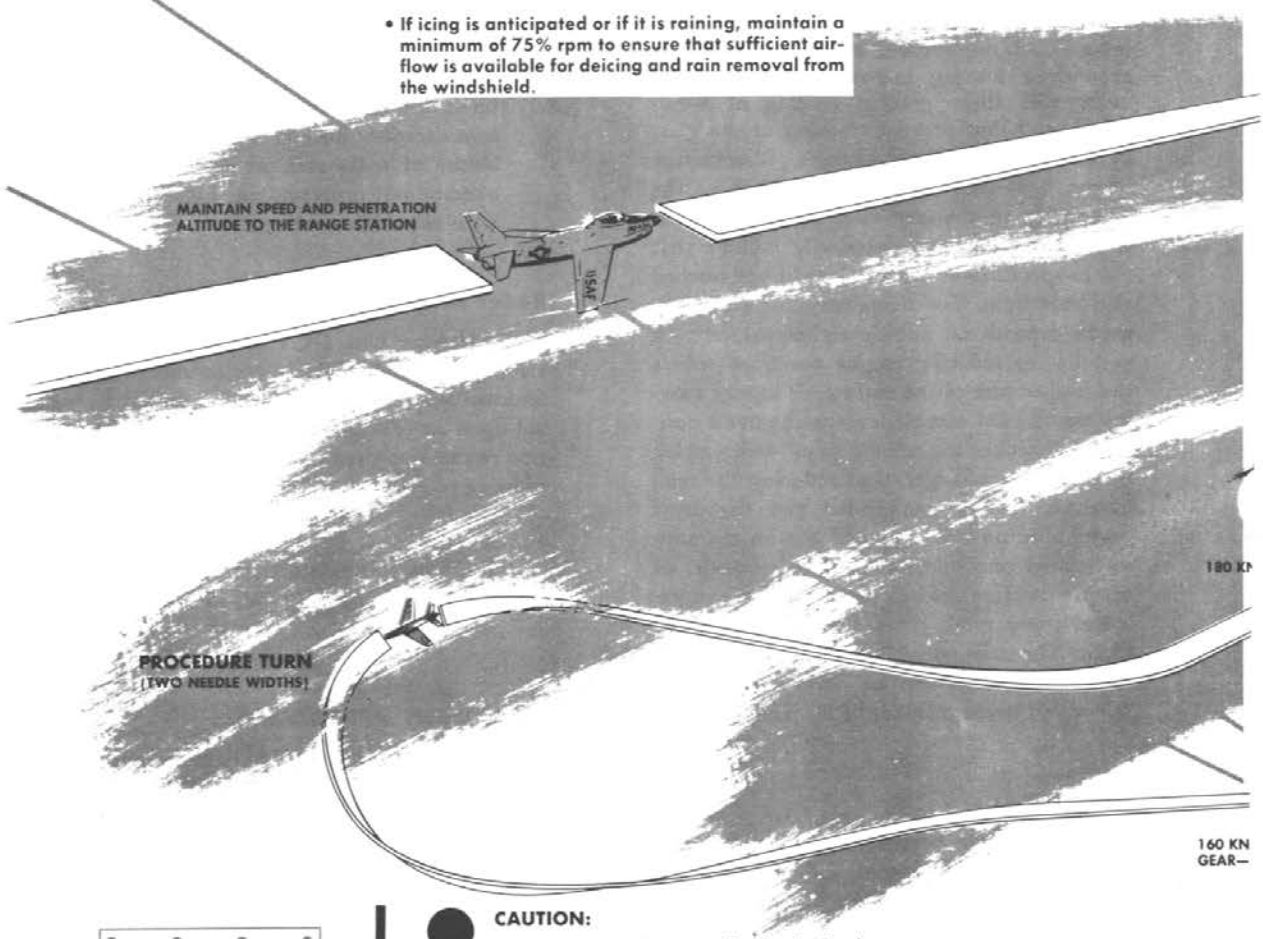
This airplane is equipped with radios and instruments, which will enable you to execute low-frequency range, GCA, and ADF type approaches. Flown with power settings from 75% to 85% rpm, power response to throttle movement is rapid and speed control is good at all times. Use of the deicing systems does not noticeably decrease available thrust, while use of windshield anti-icing aids forward visibility in rain. Runway stopping distances landing out of low approaches are critical during rain or with ice on the runways with this airplane. 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 and use maximum braking technique. (Refer to "Minimum-run Landing" in Section II.)

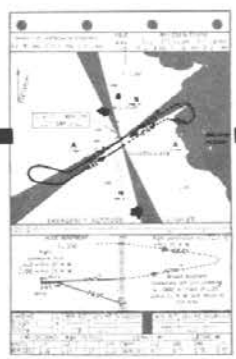
JET PENETRATION AND LOW APPROACH USING RADIO RANGE (TYPICAL)

INITIA'

TYPICAL WITH INSTRUMENT APPROACH

- 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.





CAUTION:

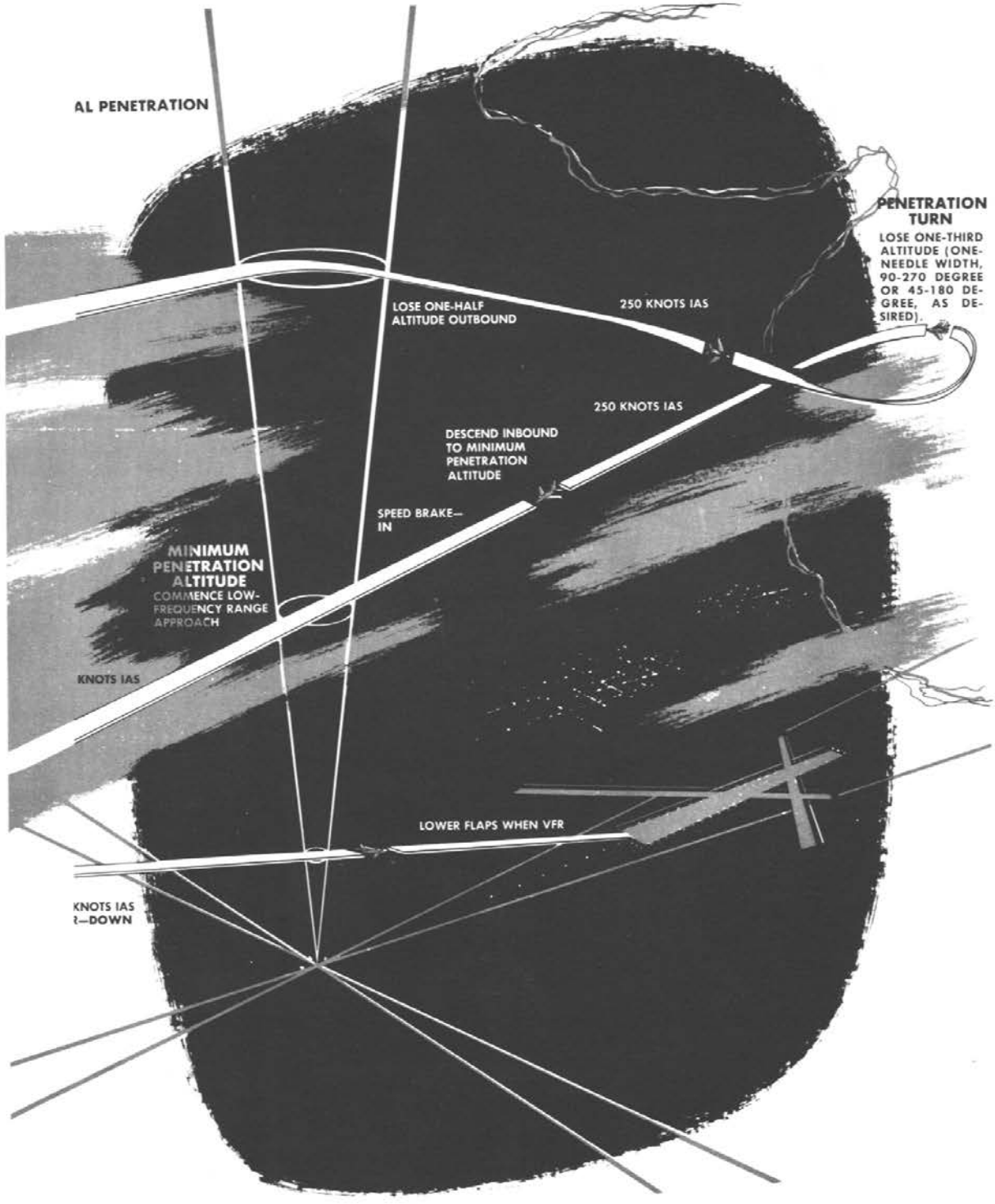
- Consult the Pilot's Handbook—Jet for the current approach to your destination.
- Observe minimum exhaust temperature during descent.

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.

F-86K-1-0D-39B

Figure 9-1


AL PENETRATION
PENETRATION TURN
LOSE ONE-THIRD ALTITUDE (ONE-NEEDLE WIDTH, 90-270 DEGREE OR 45-180 DEGREE, AS DESIRED).
LOSE ONE-HALF ALTITUDE OUTBOUND
250 KNOTS IAS
250 KNOTS IAS
DESCEND INBOUND TO MINIMUM PENETRATION ALTITUDE
SPEED BRAKE—IN
MINIMUM PENETRATION ALTITUDE
COMMENCE LOW-FREQUENCY RANGE APPROACH
KNOTS IAS
LOWER FLAPS WHEN VFR
KNOTS IAS
—DOWN

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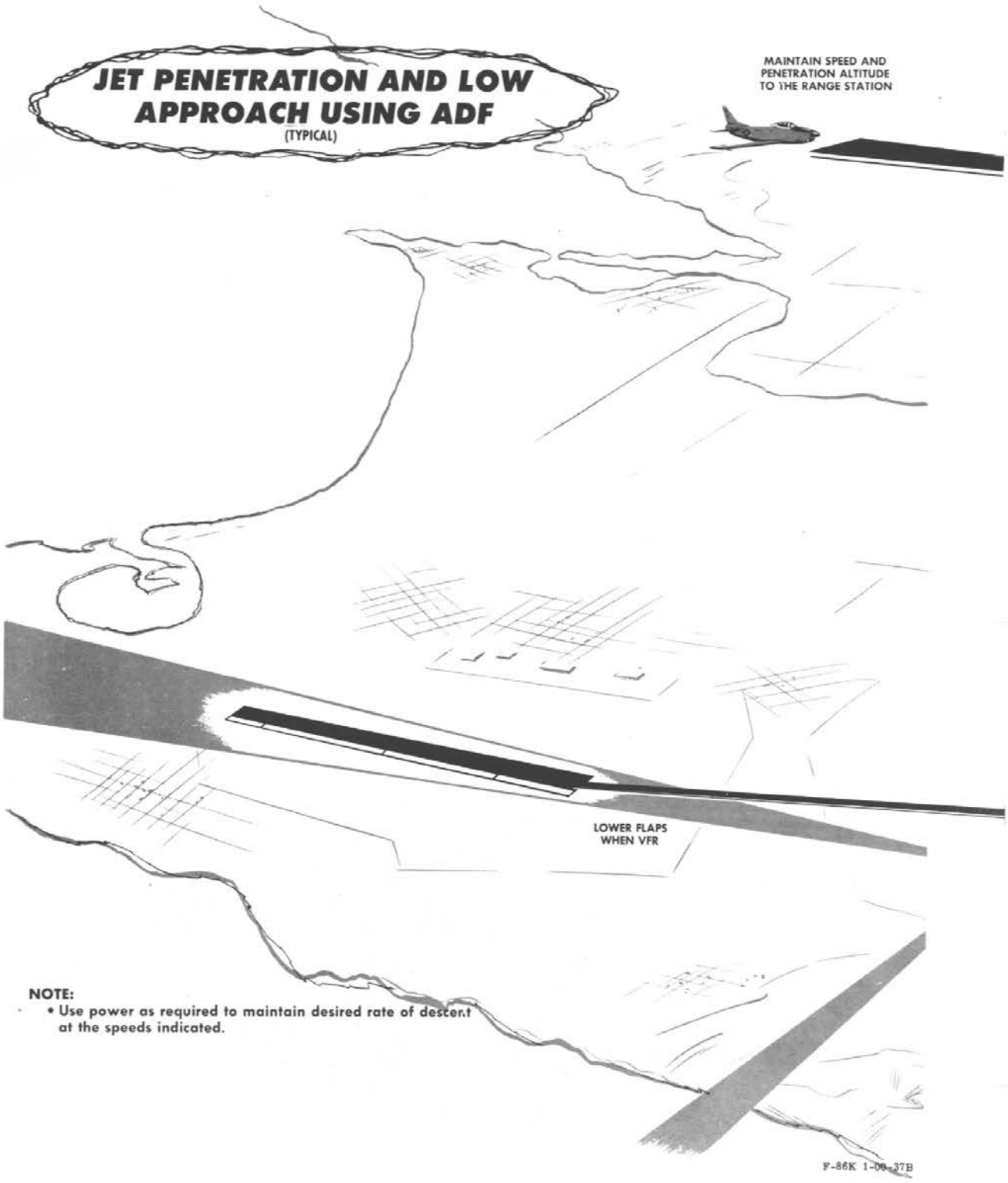
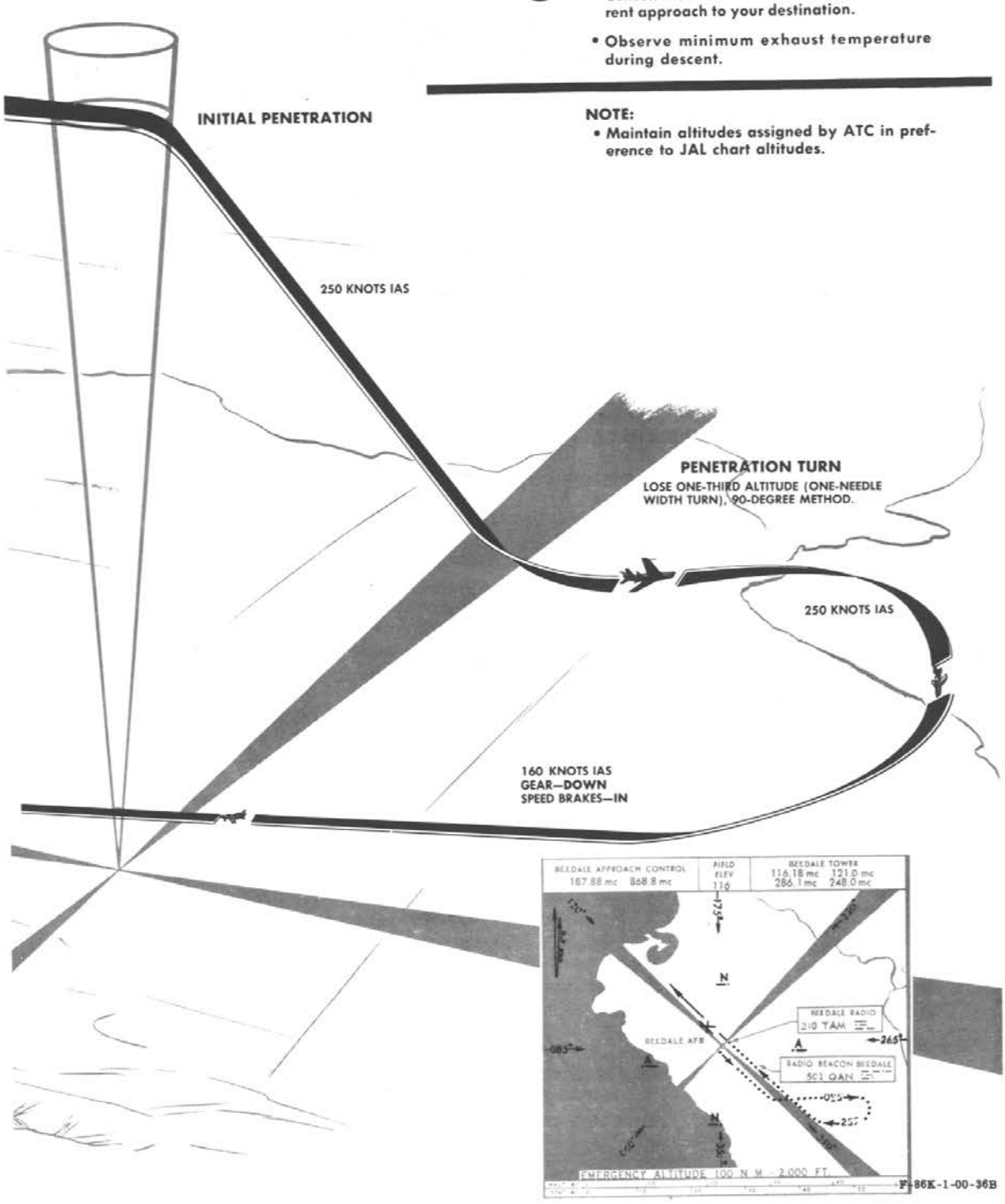

JET PENETRATION AND LOW APPROACH USING ADF
(TYPICAL)
MAINTAIN SPEED AND PENETRATION ALTITUDE TO THE RANGE STATION
LOWER FLAPS WHEN VFR
NOTE:
• Use power as required to maintain desired rate of descent at the speeds indicated.
F-86K 1-00-37B

Figure 9-2

CAUTION:
- Consult the Pilot's Handbook—Jet for the current approach to your destination.
- Observe minimum exhaust temperature during descent.

NOTE:
- Maintain altitudes assigned by ATC in preference to JAL chart altitudes.



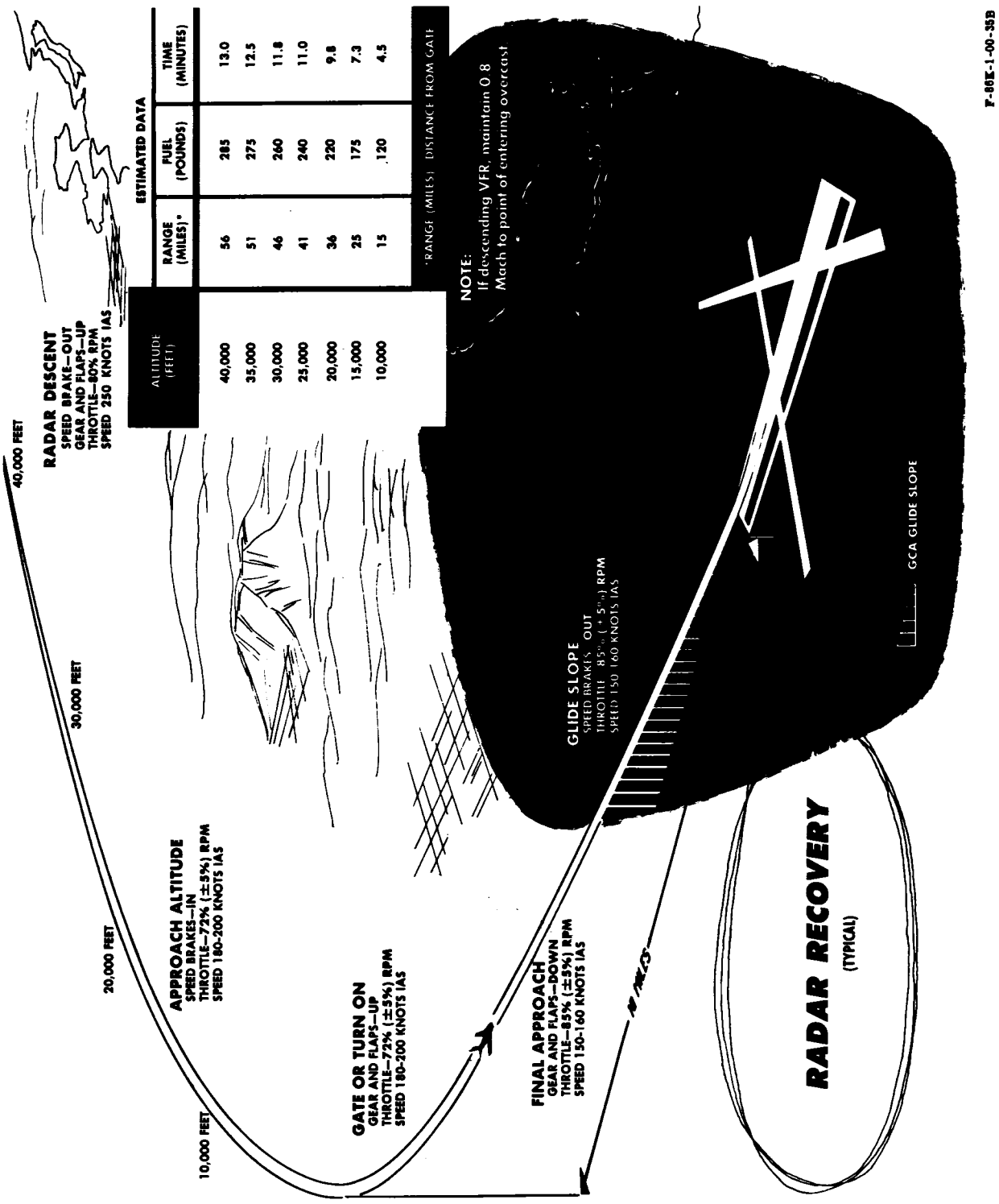

RADAR DESCENT
SPEED BRAKE—OUT
GEAR AND FLAPS—UP
THROTTLE—80% RPM
SPEED 250 KNOTS IAS
40,000 FEET
30,000 FEET
20,000 FEET
10,000 FEET
APPROACH ALTITUDE
SPEED BRAKES—IN
THROTTLE—72% (±5%) RPM
SPEED 180-200 KNOTS IAS
GATE OR TURN ON
GEAR AND FLAPS—UP
THROTTLE—72% (±5%) RPM
SPEED 180-200 KNOTS IAS
FINAL APPROACH
GEAR AND FLAPS—DOWN
THROTTLE—83% (±3%) RPM
SPEED 150-160 KNOTS IAS
GLIDE SLOPE
SPEED BRAKES—OUT
THROTTLE—85% (±5%) RPM
SPEED 150-160 KNOTS IAS
GCA GLIDE SLOPE
RADAR RECOVERY
(TYPICAL)
ESTIMATED DATA
ALTITUDE (FEET)
RANGE (MILES)*
FUEL (POUNDS)
TIME (MINUTES)
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
*RANGE (MILES) DISTANCE FROM GATE
NOTE:
If descending VFR, maintain 0.8 Mach to point of entering overcast
F-86E-1-00-35B

Figure 9-3

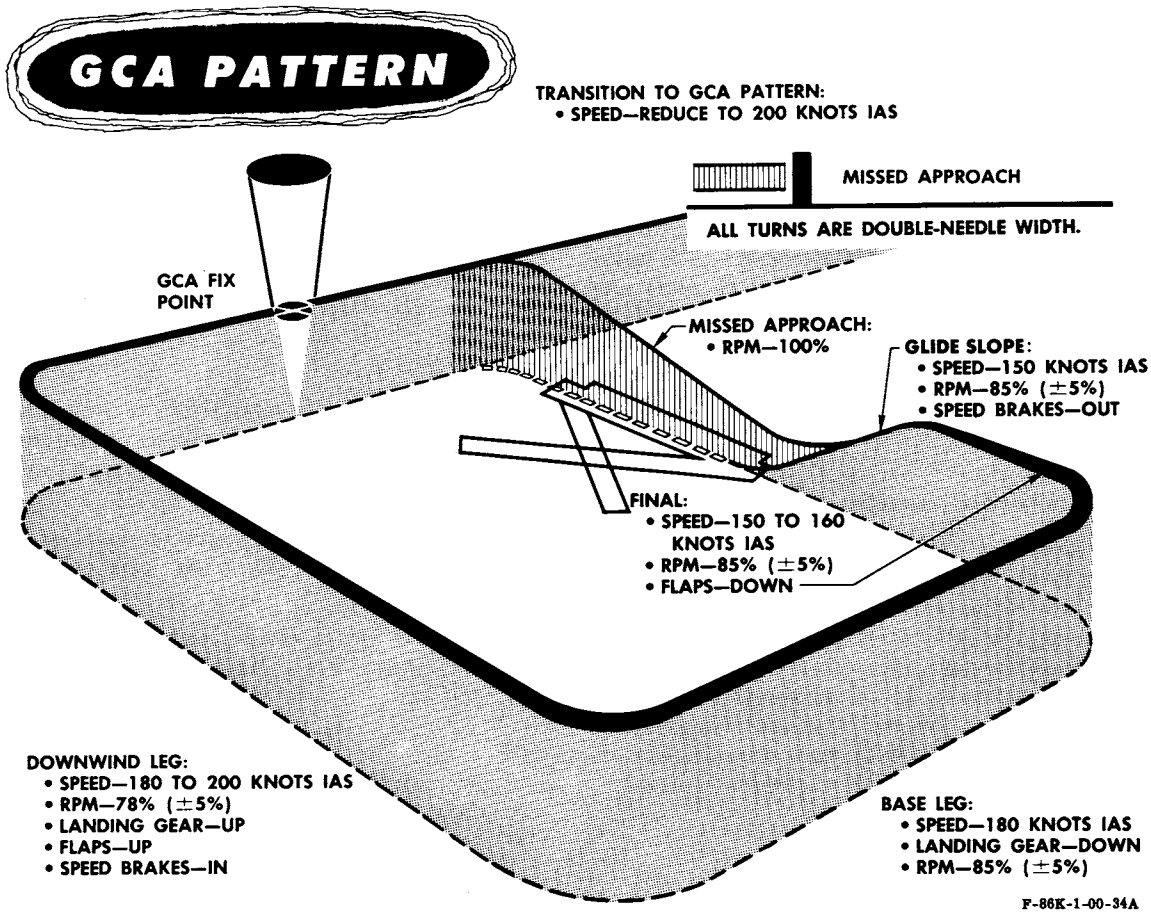


Figure 9-4

Holding on Low-frequency Ranges.

For holding over radio range or fixes in racetrack-type patterns in the clean configuration, maintain about 200 knots IAS, regardless of altitude. 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 turns. Use of the autopilot is recommended for holding. *The optimum altitude for holding, consistent with satisfactory handling characteristics and maximum fuel economy, is 30,000 feet.* The following table shows the approximate constant power settings required for holding:

	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

Low-frequency Range Approaches.

The normal low-frequency range approach as flown by conventional aircraft is seldom flown in this airplane. It will be flown as such if traffic control requires a standard jet penetration and you do not become VFR at the initial penetration. The low-freqenucy range approach procedure used by reciprocating engine airplanes may be used as part of a jet penetration with instrument approach, such as shown in figure 9-1. The range approach, in this case, is begun after reaching minimum penetration altitude. A jet penetration with ADF approach can be considered as combining the penetration and the low-frequency range approach in one maneuver, such as in figure 9-2.

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 control flying attitude by reference to the flight instruments is considered more satisfactory. A typical approach is shown in figure 9-4.

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 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 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. Set up your radio compass on outer compass locator or homer that will enable you to carry out transition to ILS localizer course.

3. Tune VHF navigational receiver to ILS frequency and identify it.

4. Initial approach to localizer should be flown with autopilot on. Altitude control, if installed, should be turned ON.

5. 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.

6. Closely monitor localizer pointer to make sure alarm flag is retracted, and as pointer moves to center of approach, lead turn onto the localizer course by one dot of pointer deflection.

7. Push "LOCALIZER" button on approach coupler controller, and check for green light on, to show engagement.

8. Monitor course 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.

9. 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.

10. Approaching glide slope, push glide slope button as horizontal pointer moves down and reaches center of course indicator.

11. Speed brake switch—OUT. Return switch to neutral after extension.

12. Assume manual control when definitely VFR or when glide slope porpoising occurs by raising turn knob on the flight controller or by squeezing automatic pilot release switch on the stick. Automatic control should be effective down to 200 feet altitude.

13. Execute missed approach upon reaching ILS minimums by disengaging approach coupler and pulling up manually.

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ICE AND RAIN

While operating on instruments, the possibility of engine or airfoil icing is often present. This airplane will ordinarily operate above serious icing levels, and its high performance should enable you to quickly move out of dangerous icing altitudes. If you do begin to ice up, remember its two most vicious aspects. First, engine ice can result in serious engine damage. Second, it's not how much ice you have on your airfoils, but the shape of it that destroys your lift and creates drag. This in turn raises your 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 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 indicate 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. In addition, if the 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 can be incurred. 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 inlet switch in the ACCESSORY COVER position as a precautionary measure during all flights in weather regardless of icing probability. (Refer to "Anti-icing and Defrosting Systems" in 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 placed in operation. The wing leading edge anti-icing is not at maximum efficiency when the leading edge slats are partially or fully opened.

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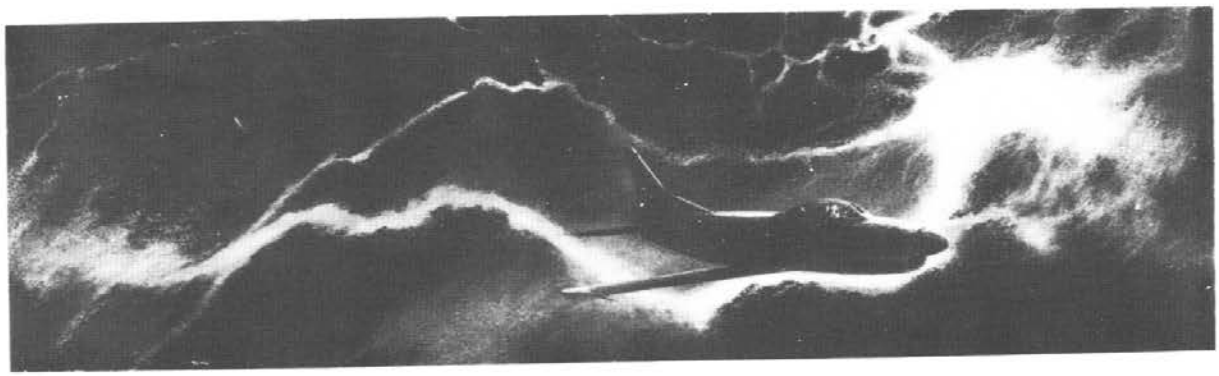


TURBULENCE AND THUNDERSTORMS

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.

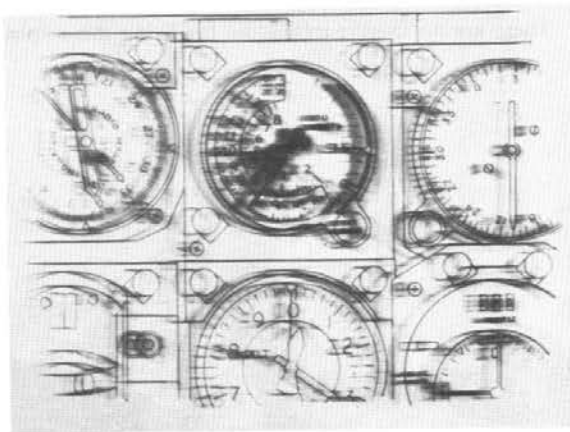
b. Engine icing of either nose accessory section cover or inlet guide vanes.

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.



Note

250 knots is a comfortable penetration speed for entering a zone of turbulent air.

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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 biuld 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 for daylight operation.

COLD-WEATHER PROCEDURES

Icing conditions are covered under ice and rain procedures 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 entire airplane for freedom from snow and ice. Check that all light snow or ice is removed. Do not permit ground crew to chip or scrape away ice, as this may damage airplane.

WARNING

The collection of snow and ice on the airplane surfaces constitutes one of the major flight hazards in low-temperature operation and can result in the loss of lift and treacherous stalling characteristics. A take-off should not be attempted under these conditions.

3. Be sure that wing slats move freely and that they can be moved manually into closed position.

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 is present or suspected, check engine for freedom of rotation.

CAUTION

External heat must be applied to forward section of engine to remove ice. The 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, 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 sufficiently to maintain rated exhaust temperature under all flight conditions.

2. Turn on cockpit air conditioning system and windshield and canopy defrosting system as required, immediately after engine start.

WARNING

- Make sure all instruments have been sufficiently warmed up to ensure normal operation. Check for sluggish instruments during taxiing.
- 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. Because of low outside air temperatures, the thrust developed at all engine speeds is noticeably greater.

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. Turn pitot heater switch ON (up).

3. Retract engine inlet 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 airspeeds 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 desired.

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 wing 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, for optimum benefits from the deicing 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 glide due to increased thrust caused by extremely low air temperatures.

2. Pump brake pedals several times to free any accumulated ice.

AFTER LANDING.

1. Deploy drag chute at 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.
- In an emergency, however, the drag chute may be deployed during cross-wind landing to provide fast deceleration. The drag chute should be deployed immediately after the nose wheel touches in order to obtain maximum deceleration effects; then jettison chute as soon as practical if excessive yaw occurs. Use enough aileron to prevent the cross wind from lifting the wing, but not so much that the wing will start down. 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 to be sure that the drag chute will clear other airplanes, if possible, 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 sufficient rpm to cut in the generator, as low temperatures decrease battery output.

CAUTION

The drag chute should be jettisoned before taxiing downwind in winds exceeding 15 knots because of the possibility of the chute collapsing and the risers burning by contact on hot areas of exhause nozzle.

4. Turn pitot heater switch OFF.

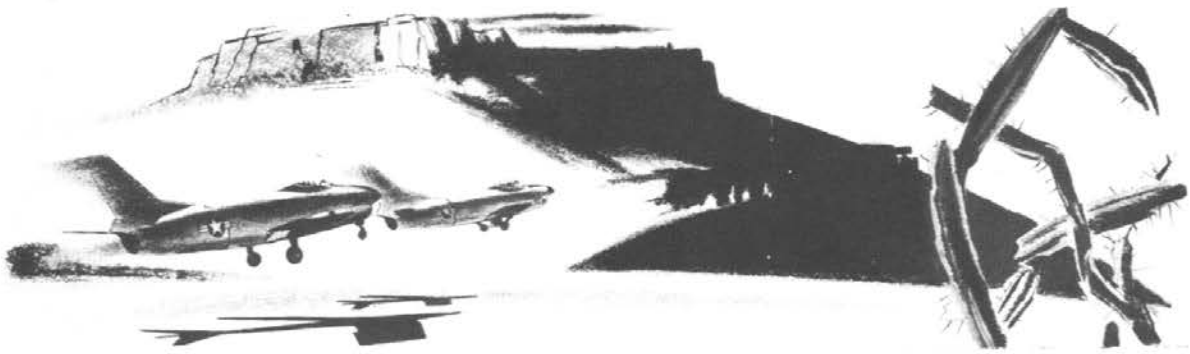
BEFORE LEAVING AIRPLANE.

1. If it is not snowing or raining, leave canopy partly open to allow circuiation within cockpit, to prevent canopy cracking because of differential contraction, and to decrease windshield and canopy frosting.

2. Check that protective covers are installed on pitot head and canopy. Allow at least 15 minutes cooling time 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: With emergency fuel system switch at NORM, advance throttle to 80%-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.

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. (Refer to Appendix I for take-off distances at various temperatures.)

APPROACH AND LANDING.

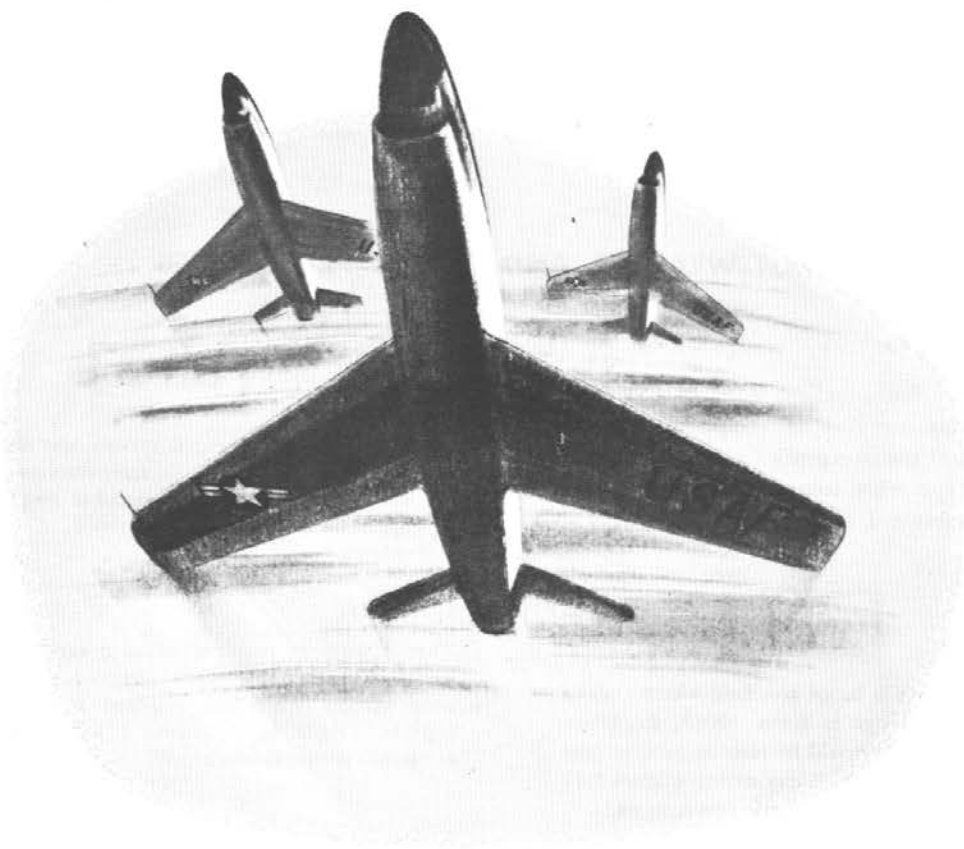
1. Maintain recommended indicated approach and touchdown speeds. Because of high outside air temperatures, speed relative to the ground will be higher than normal.

2. Expect a longer landing roll because of 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.



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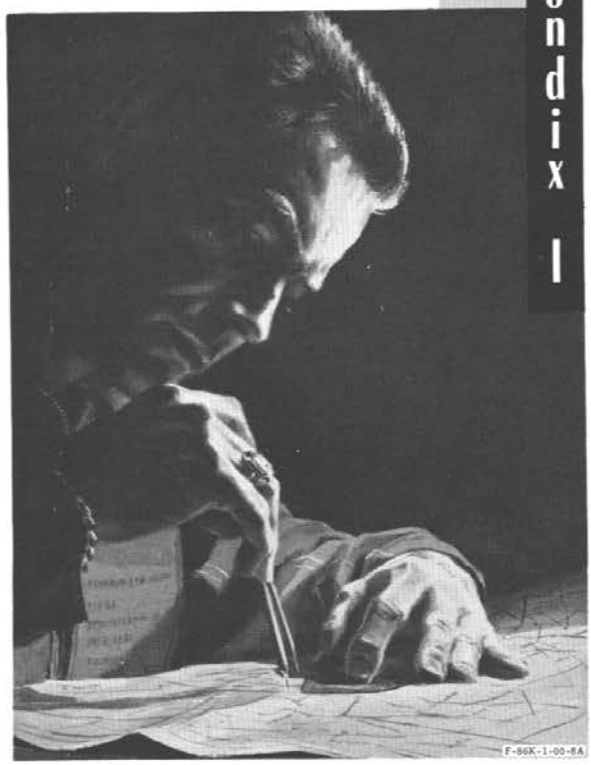
PERFORMANCE DATA

Appendix I



INTRODUCTION.

Performance charts are provided in this section for flight planning purposes. The charts that are identified by the notation "Group 4 airplanes Only" pertain to those airplanes equipped with the 6-3 extended-slatted wing leading edge and 12-inch wing tip extensions. Two types of charts are included for each set: (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 landing. 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.

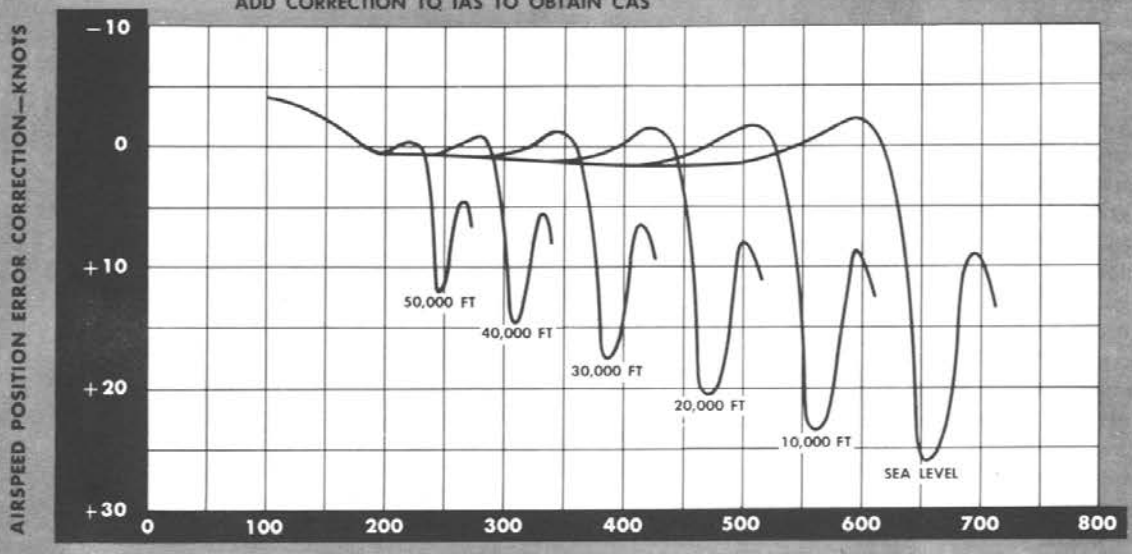
Note

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

AIRSPEED CONVERSION DATA

INSTALLATION CORRECTION

ADD CORRECTION TO IAS TO OBTAIN CAS



COMPRESSIBILITY CORRECTION

SUBTRACT CORRECTION FROM CALIBRATED AIRSPEED TO OBTAIN EQUIVALENT AIRSPEED

PRESSURE ALTITUDE—FEET

	CAS—KNOTS									
	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						

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Figure A-1

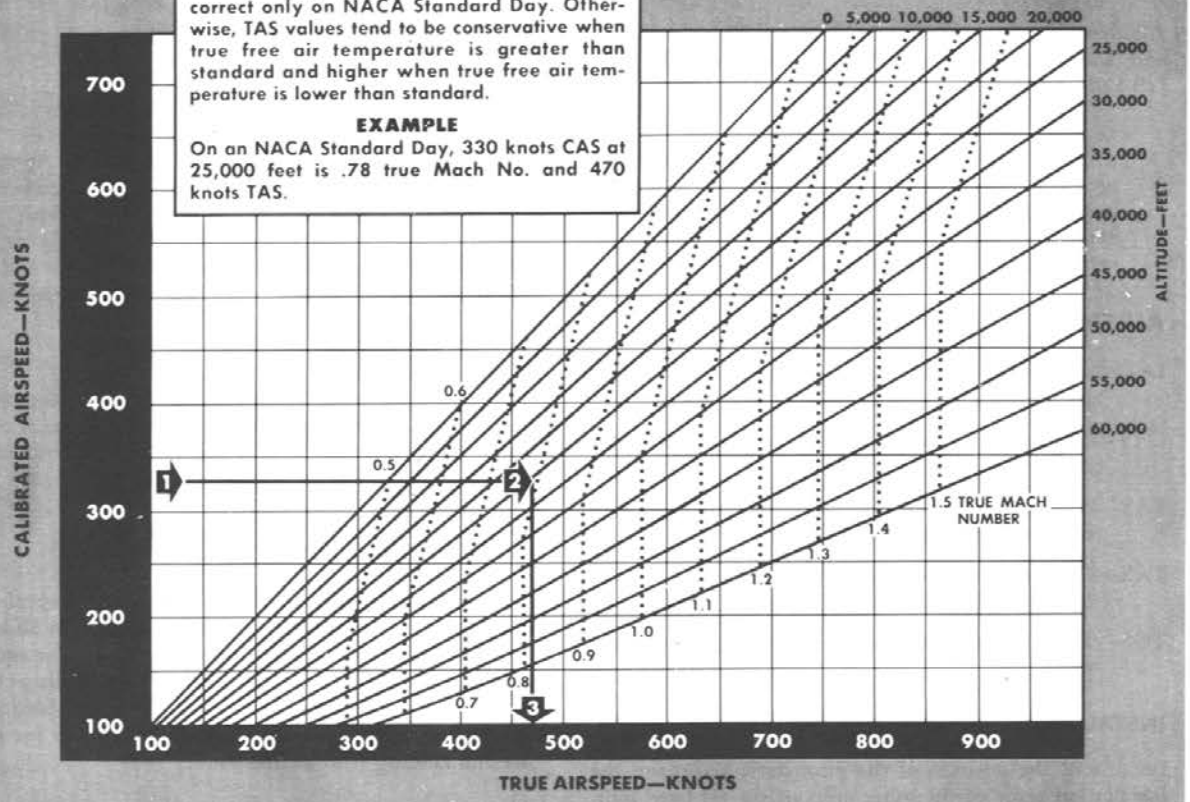
AIRSPEED CONVERSION

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

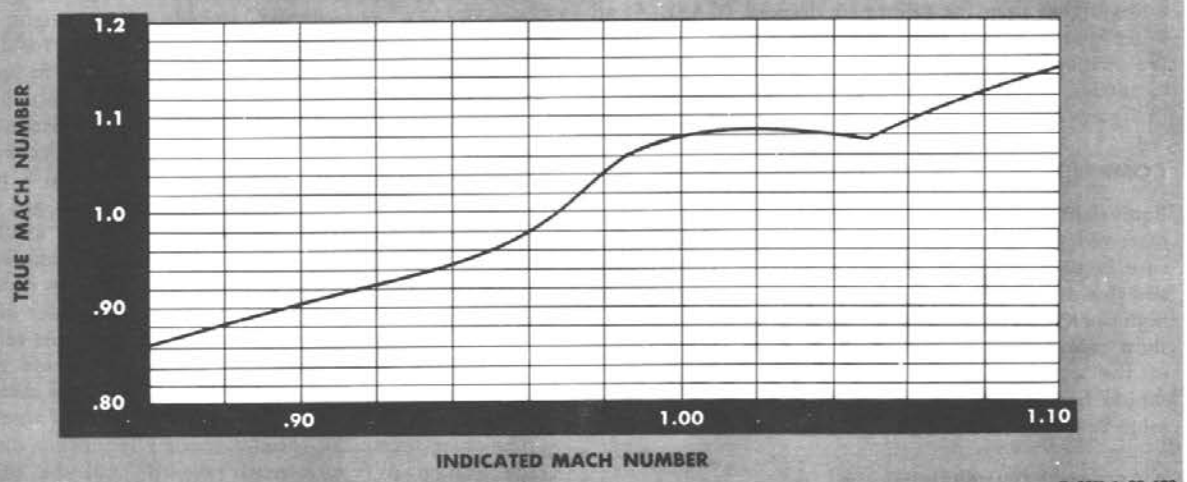


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chart data are valid. If the weight of your particular aircraft lies outside of this weight range, the graphical charts for climb and nautical miles per pound of fuel should be used for the most accurate performance data.

All charts are based on NASA Standard Day conditions, and show performance based on airplanes with J47-GE-17B engines.

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.

TGS—True 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 IAS to obtain CAS 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 NACA 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 ERROR.

The altimeter error is negligible through the entire speed and altitude capabilities of this airplane. A maximum altimeter error of plus 150 feet, for this airplane, occurs at 30,000 feet and maximum speed.

CROSS-WIND CHART.

The cross-wind chart (figure A-4) 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 50-foot obstacle clearance, plus the initial stall warning speeds versus gross weight are shown on figure A-5 for airplanes without wing tip extensions, and figure A-41 for airplanes with extended leading edges and tips.

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-6 and A-7 for airplanes without wing tip extensions and figures A-42 and A-43 for airplanes with the wing tip extensions). 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 error to a minimum.

TAKE-OFF ACCELERATION.

The take-off acceleration charts (figures A-8 and A-9) are the same for both wing configurations and 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 (for all airplane groups) from the refusal speed charts (figures A-10 and A-11) 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-8 and A-9). 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 check-point distances 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.

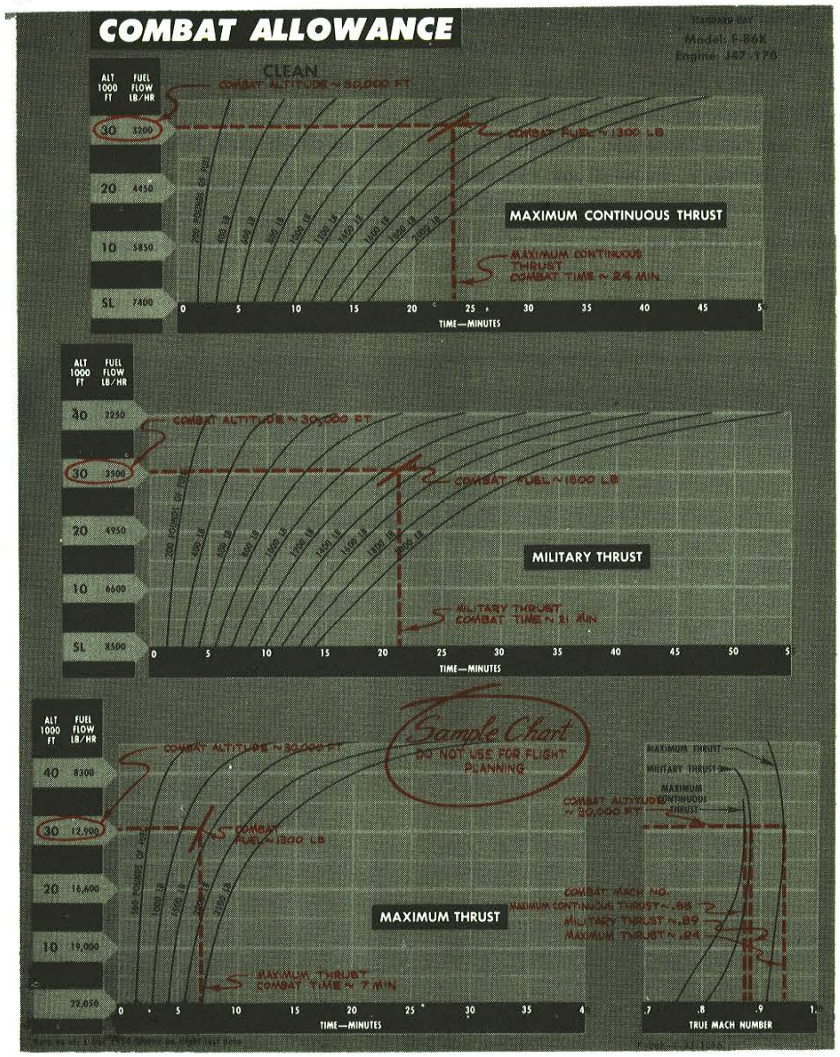
Airplane performance is critically affected by variations in thrust and drag; namely, those performance items which describe limits, i.e., maximum speed, ceiling, etc. While Flight Manual performance data are based on a theoretical engine, experience has shown that logistics and maintenance play an important 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. 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.

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.



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

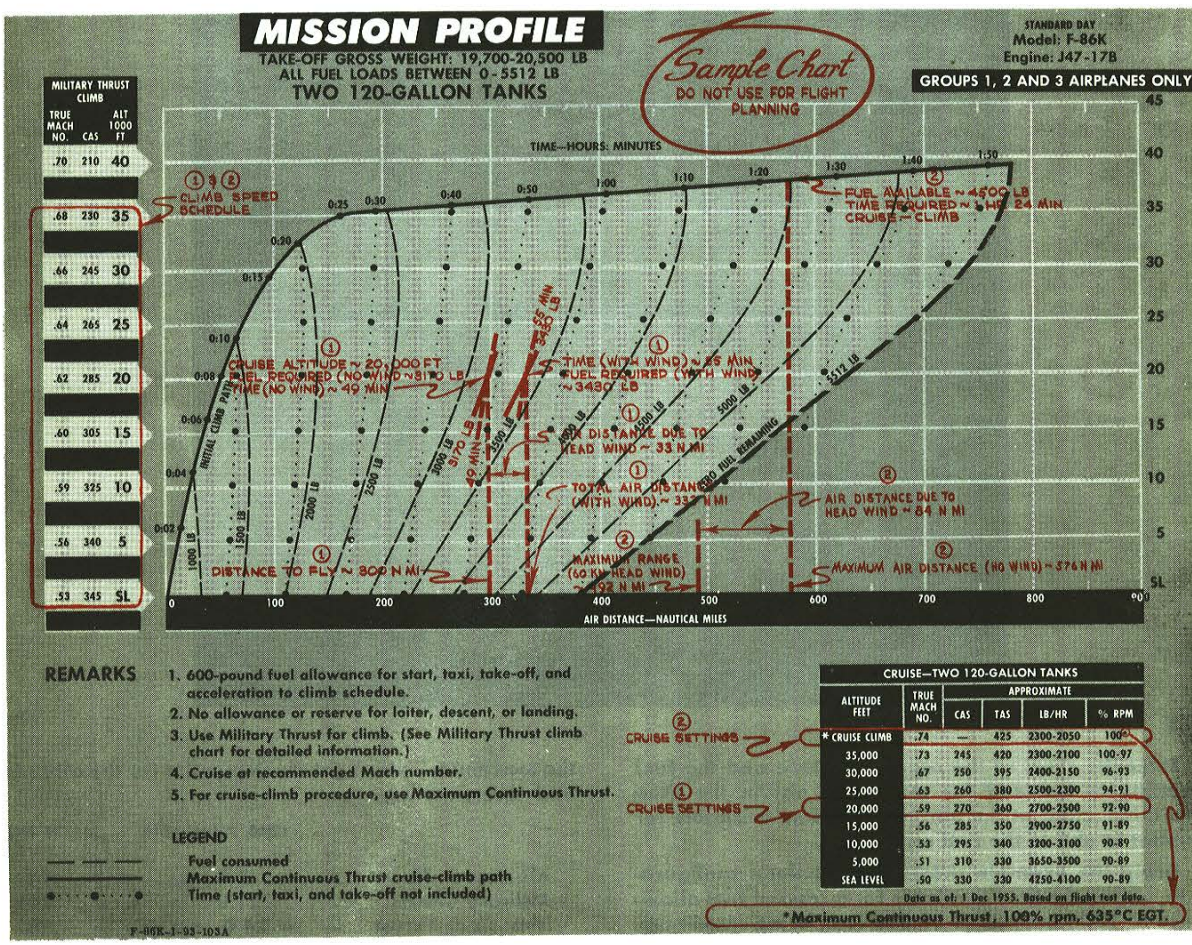
MISSION PROFILE

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



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
② CRUISE SETTINGS * CRUISE CLIMB	.74	—	425	2300-2050	100*
35,000	.73	245	420	2300-2100	100-97
30,000	.67	250	395	2400-2150	96-93
25,000	.63	260	380	2500-2300	94-91
① CRUISE SETTINGS 20,000	.59	270	360	2700-2500	92-90
15,000	.56	285	350	2900-2750	91-89
10,000	.53	295	340	3200-3100	90-89
5,000	.51	310	330	3650-3500	90-89
SEA LEVEL	.50	330	330	4250-4100	90-89

Data as of: 1 Dec 1955. Based on flight test data.

*Maximum Continuous Thrust, 100% rpm, 635°C EGT.

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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) ..... 49 min (0.82 hr)

b. Air distance due to wind (40 × 0.82) ..... 33 naut mi

c. Total air distance with head wind (300 + 33) ..... 333 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 ..... 3430 lb
and time required with wind ..... 55 min (.92 hr)

e. Determine cruise speed from table ..... .59 Mach No

f. Determine cruise thrust setting (% rpm) from table ..... 92% to 90% rpm
(Thrust setting decreases with gross weight.)

Note that if this flight had been made at approximately 32,000 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) ..... 576 n mi

b. Time (no wind) ..... 1 hr 24 min (1.4 hr)

c. Air distance due to head wind (1.4 × 60) ..... 84 n mi

d. Maximum range with head wind (576 − 84) ..... 492 n mi

e. Determine cruise-climb speed from table ..... .74 Mach No

f. Determine cruise thrust setting (% rpm) from table ..... 100% rpm 635°C egt

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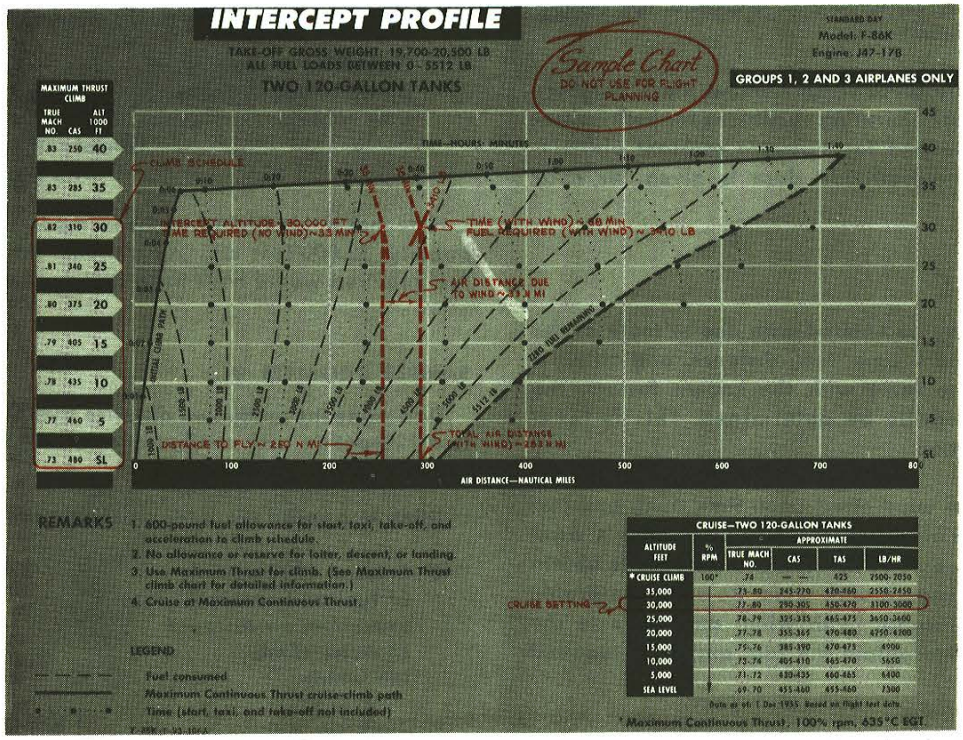
INTERCEPT PROFILE

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).



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

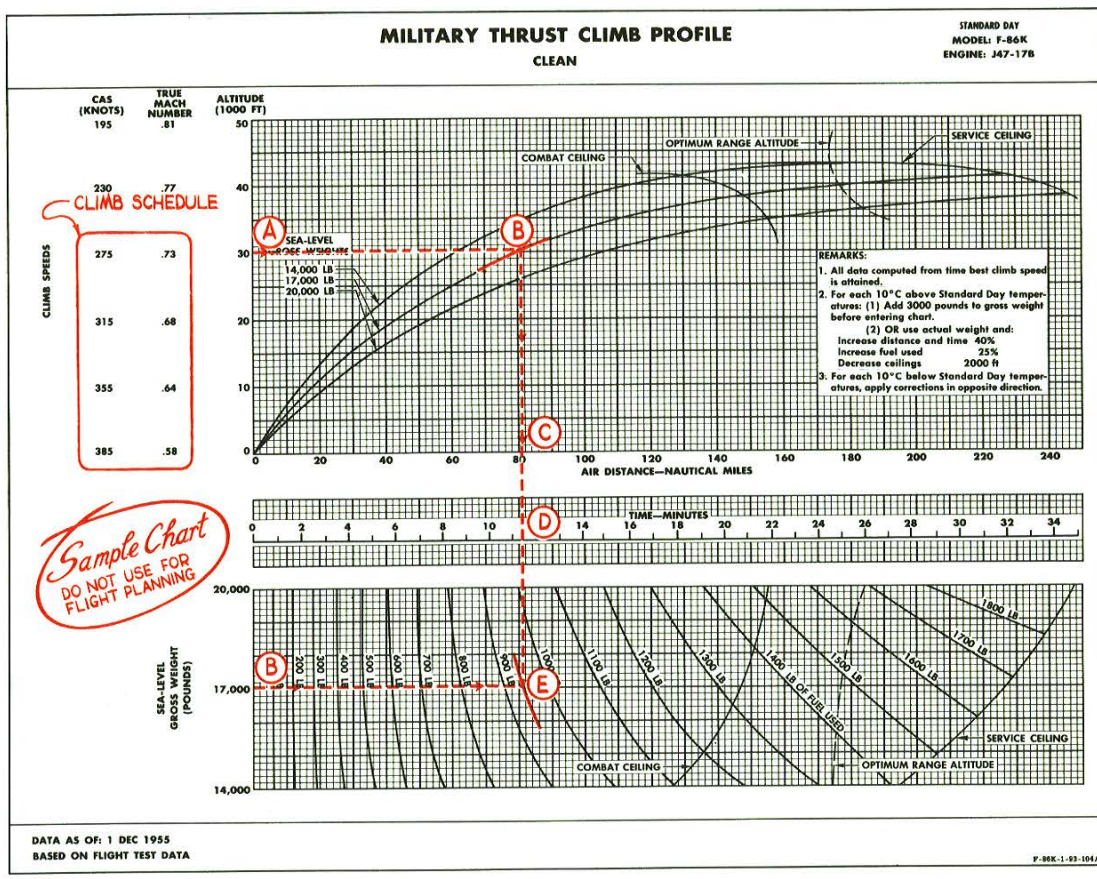
e. Determine cruise speed from table ..... .77 to .80 Mach No.

f. Determine cruise thrust setting (% rpm) from table ..... 100% rpm, 635°C egt

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.



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.

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

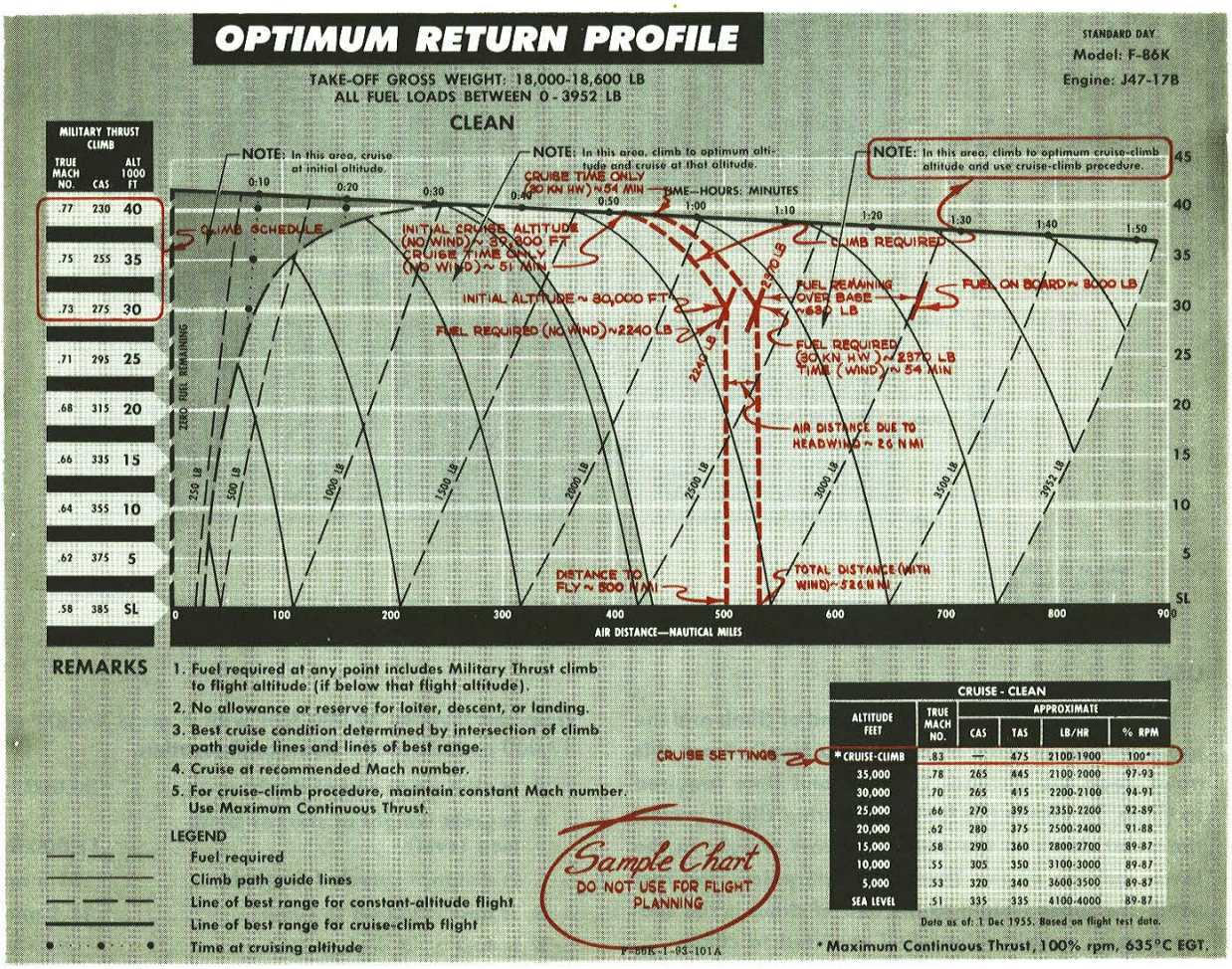
B minus E is gross weight at end of climb.....16,060 lb

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 ruise-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.



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 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.

Sample Chart
DO NOT USE FOR FLIGHT PLANNING

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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

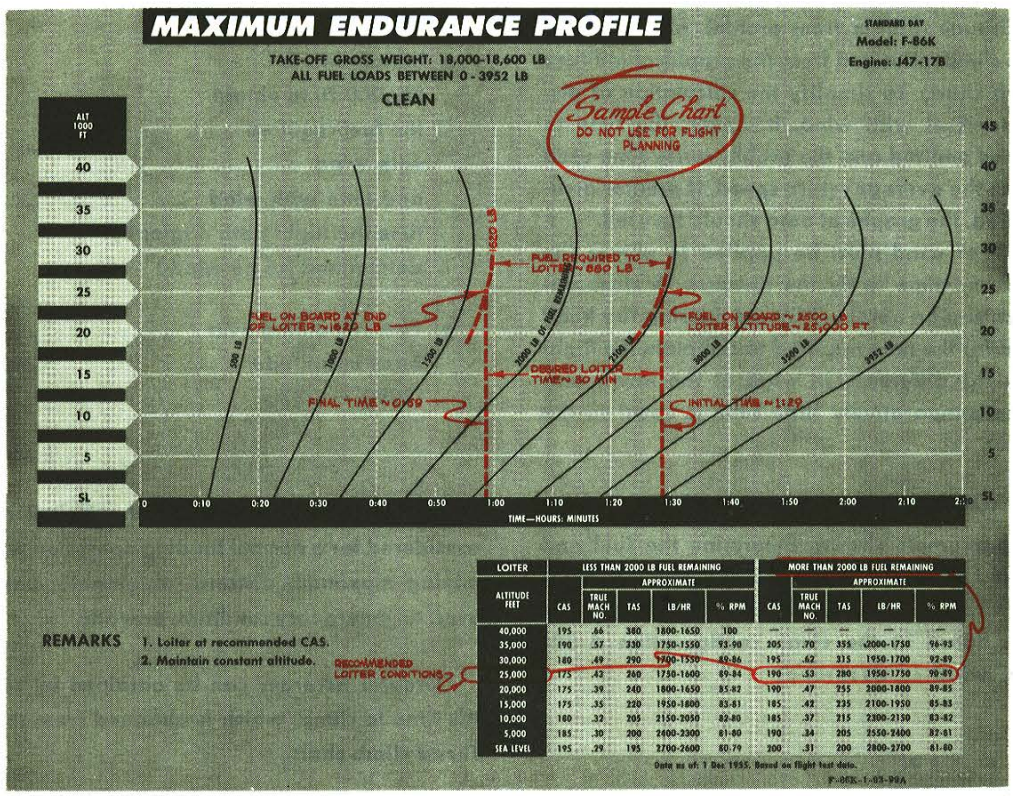
Note: It is recommended that sufficient reserve be considered for a normal landing operation when determining maximum distance obtainable, unless, however, an emergency condition prevails.

*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 ALTITUDE FEET	LESS THAN 2000 LB FUEL REMAINING					MORE THAN 2000 LB FUEL REMAINING				
	APPROXIMATE					APPROXIMATE				
	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	395	2000-1750	96-93
30,000	180	.49	290	1700-1550	89-86	195	.62	315	1950-1700	92-89
25,000	175	.42	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.

REMARKS
1. Loiter at recommended CAS.
2. Maintain constant altitude.

RECOMMENDED LOITER CONDITIONS

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.

Frǒm 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

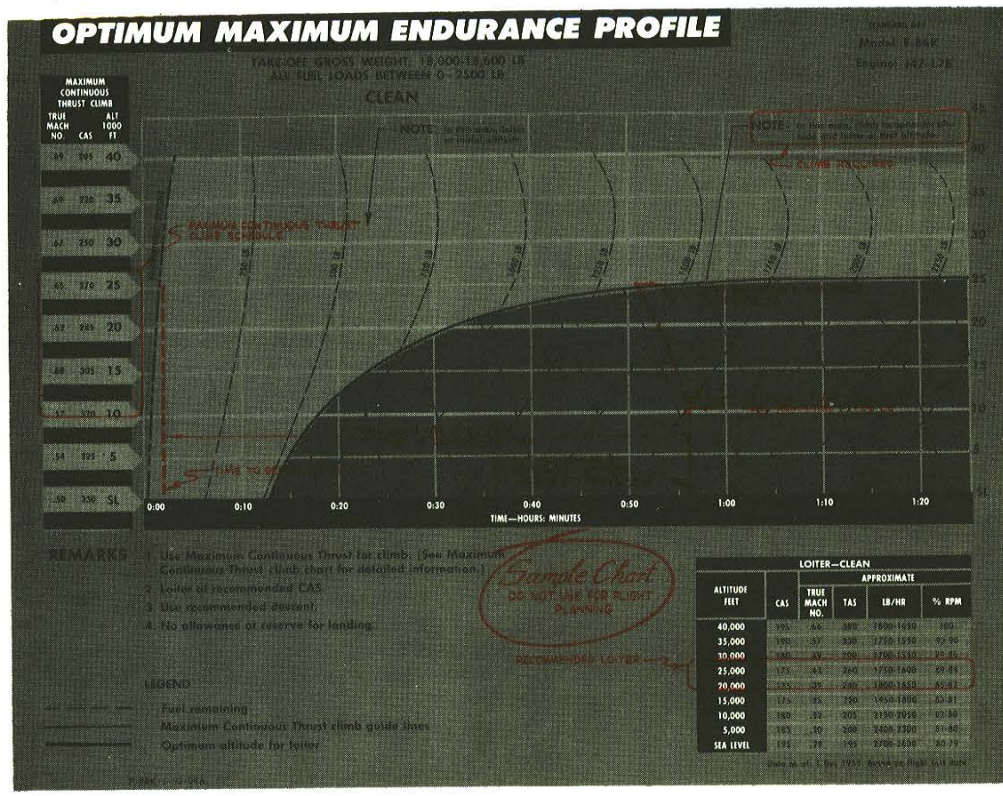
d. Fuel required to loiter (2500 — 1620) ..... 880 lb

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.



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

CLIMB GRAPHICAL

DESCRIPTION

Climb charts for Maximum, Military, and Maximum Continuous Thrust operation, 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)

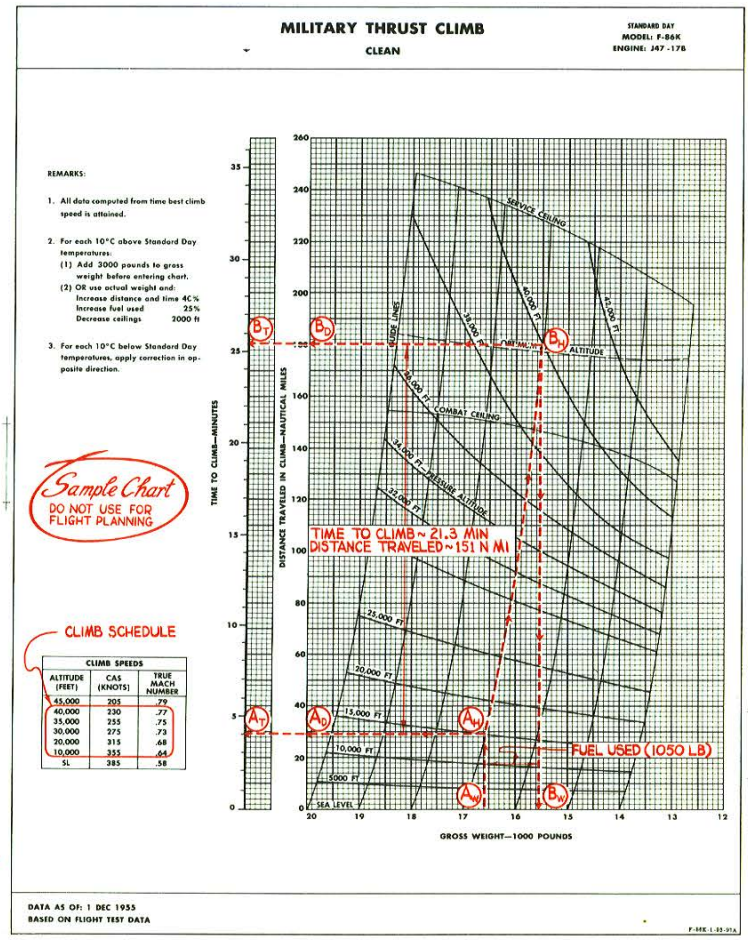
B_t is final time (25.3 Min.)

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.)



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.

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-28 and A-29. For maximum range descent in the clean configuration, an indicated airspeed of 185 knots is to be used for airplanes with the smaller wing area, and 200 knots for airplanes with the larger wing area (extended slatted-leading edges and wing tips). The recommended descent speed schedules are also included.

LANDING DISTANCES.

Total distances to clear a 50-foot obstacle and landing ground-roll distances, with or without the aid of the drag chute, are shown in figures A-12 and A-13, for airplanes without extended wing tips, and figures A-44 and A-45, for airplanes with wing tip extensions. Landing 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 each chart. 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-36 through A-38 for the clean configuration with or without wing tip extensions. Figures A-39 and A-40 show the nautical miles per pound of fuel for airplanes with two 120-gallon tanks installed, no wing tip extensions. Figures A-55 and A-56 show the nautical miles per pound of fuel for the 120-gallon tank configuration for airplanes with wing tip extensions installed.)

Note

It will be noted that the curves for the 120-gallon tank configuration with wing tip extensions have noticeably different shapes than those for the configurations without the extended leading edge and wing tip. 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 this drag increase, a reduction in specific range 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.

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 with this average weight at the 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.

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. Wing configuration.

b. Fuel used during start, taxi, and take-off. (The mission and intercept profiles allow 600 pounds for this phase.)

c. Wind effect.

d. Deviation from the recommended climb schedule.

e. Deviation from the recommended cruise settings.

f. Variation in engine performance.

g. 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 an airplane without extended wing tips and carrying two 120-gallon drop tanks which are to be dropped before combat.

Prepare a flight plan based on the following data:

a. Distance to intercept area ..... 200 naut mi

b. Assigned altitudes:
- Inbound to intercept (constant altitude) ..... 30,000 ft
- Outbound from intercept ..... 35,000 ft and above

c. Intercept—35,000 feet (Military Thrust) ..... 10 min

d. Intercept—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 ..... 5000 ft

f. Airplane gross weight:

Basic (includes trapped oil and internal fuel, armament, and miscellaneous equipment)	13,661 lb
Pilot	200 lb
Two 120-gallon drop tanks (empty weight)	232 lb
Ammunition (528 rounds)	370 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-6. Obtain take-off and nose wheel lift-off speed from take-off speeds chart in figure A-5. (Standard Day temperature at 1500 feet is 54°F.) Use zero wind.

- Ground-roll distance (19,975 pounds) ..... 3250 ft
- Total take-off distance over 50-foot obstacle ..... 4900 ft
- Take-off speed (IAS) ..... 134 kn
- Initial stall warning ..... 132 kn
- Nose wheel lift-off speed ..... 95 kn

GO, NO-GO SPEED AND DISTANCE.

Enter the Maximum Thrust, normal take-off distance chart (figure A-6) with the available runway length (5000 feet and zero wind) and obtain the maximum allowable take-off temperature.

- Temperature (1500 feet and 19,975 pounds) ..... 130°F

Obtain the refusal speed from figure A-10 using the temperature, gross weight, field elevation, wind, and runway length.

- Go, no-go speed (IAS), 19,975 pounds and 130°F ..... 90 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 (130°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-13, using take-off conditions:

a. Ground-roll distance (19,975 pounds) ..... 2350 ft

b. Final approach speed (IAS) ..... 159 kn

c. Touchdown speed (IAS) ..... 139 kn

d. Initial stall warning (IAS) ..... 132 kn

INBOUND TO COMBAT.

The inbound leg may be determined directly from the high speed profile chart for two 120-gallon drop tanks, figure A-22. 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 EGT
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 intercept altitude (35,000 feet), assume zero distance traveled. (Use Military Thrust climb chart, clean, figure A-31.)

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 table on chart.)

COMBAT ALLOWANCE.

From the combat allowance chart—clean (figure A-26) 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 370 pounds (ammunition) ..... 14,920 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

---

***Calculation of time to climb is not necessary unless an accurate time history is required. (See use of optimum return profile.)**

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-17) 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 14,920 pounds ..... 4 min
f. Total time, no wind (d + e) ..... (.42 hr) 25 min
g. Air distance due to wind (.42 × 45) ..... 19 naut mi
h. Total air distance with tail wind (200 − 19) ..... 181 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) ..... 23 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-28.)

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 table on chart.)
d. Fuel reserve for landing (259 pounds minus 29 pounds) ..... 230 lb
e. Airplane gross weight for landing ..... 14,091 lb

LANDING.

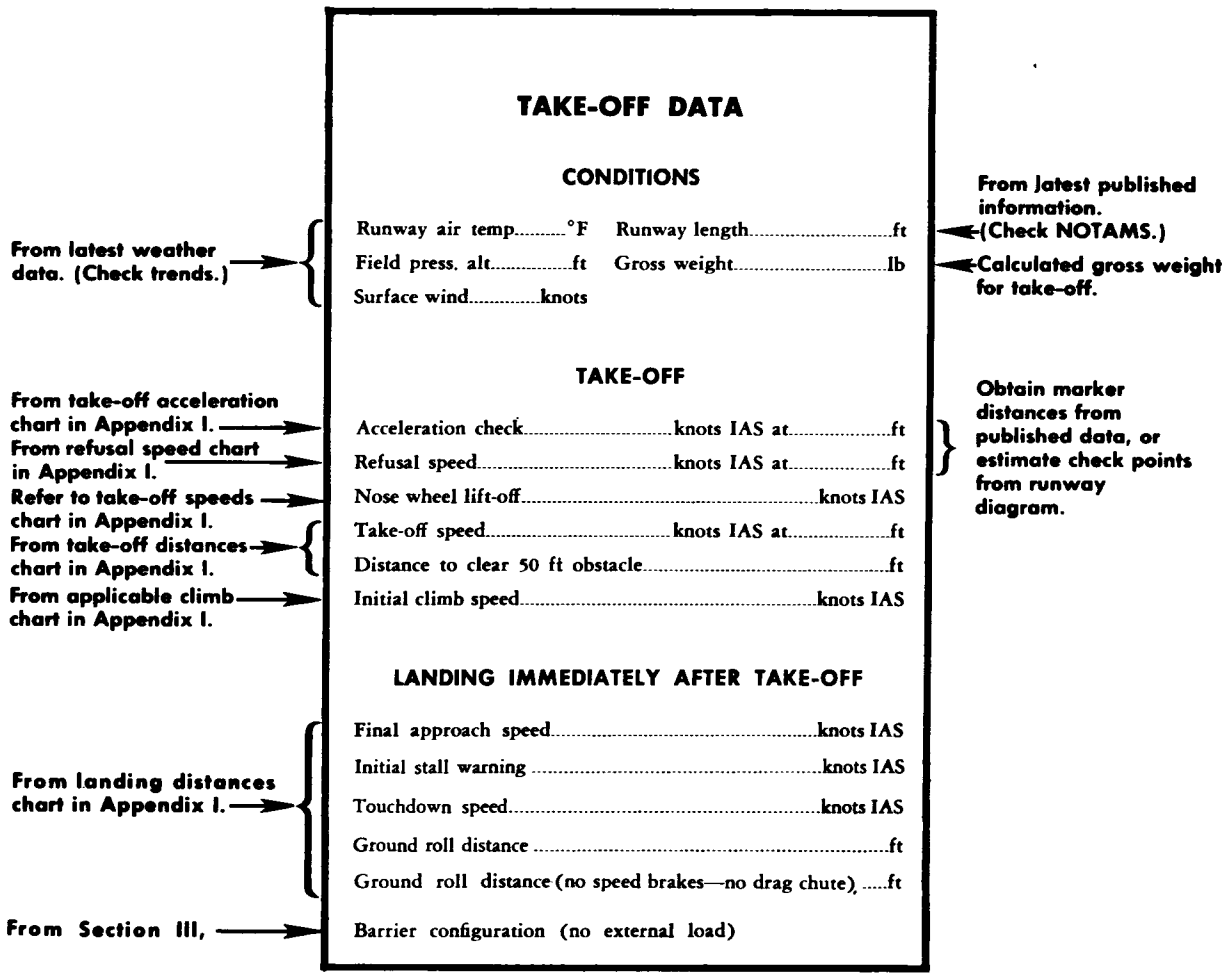
Obtain the landing distance from the landing distance chart (with drag chute deployed), figure A-12. Use 1500 feet, 54°F, and no wind.

a. Ground roll distance ..... 1700 ft
b. Total distance over 50-foot obstacle ..... 3000 ft
c. Approach speed (IAS) ..... 136 kn
d. Touchdown speed (IAS) ..... 116 kn
e. Initial stall warning speed ..... 113 kn

The sum of all the time required gives the time from take-off to landing* ..... 1 hr 14 min

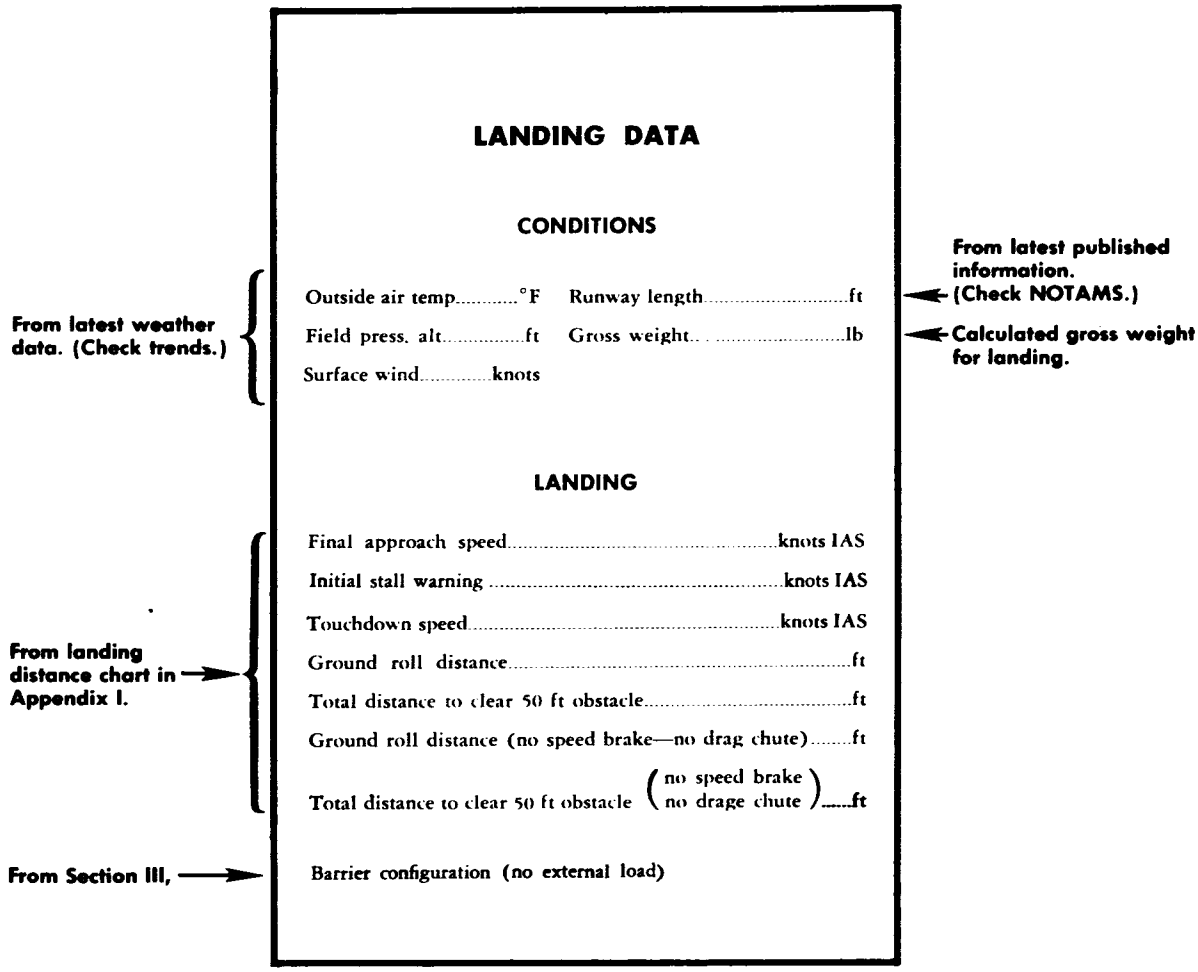
TAKE-OFF AND LANDING DATA CARDS.

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-86K-(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.



F-86K-1-93-130A

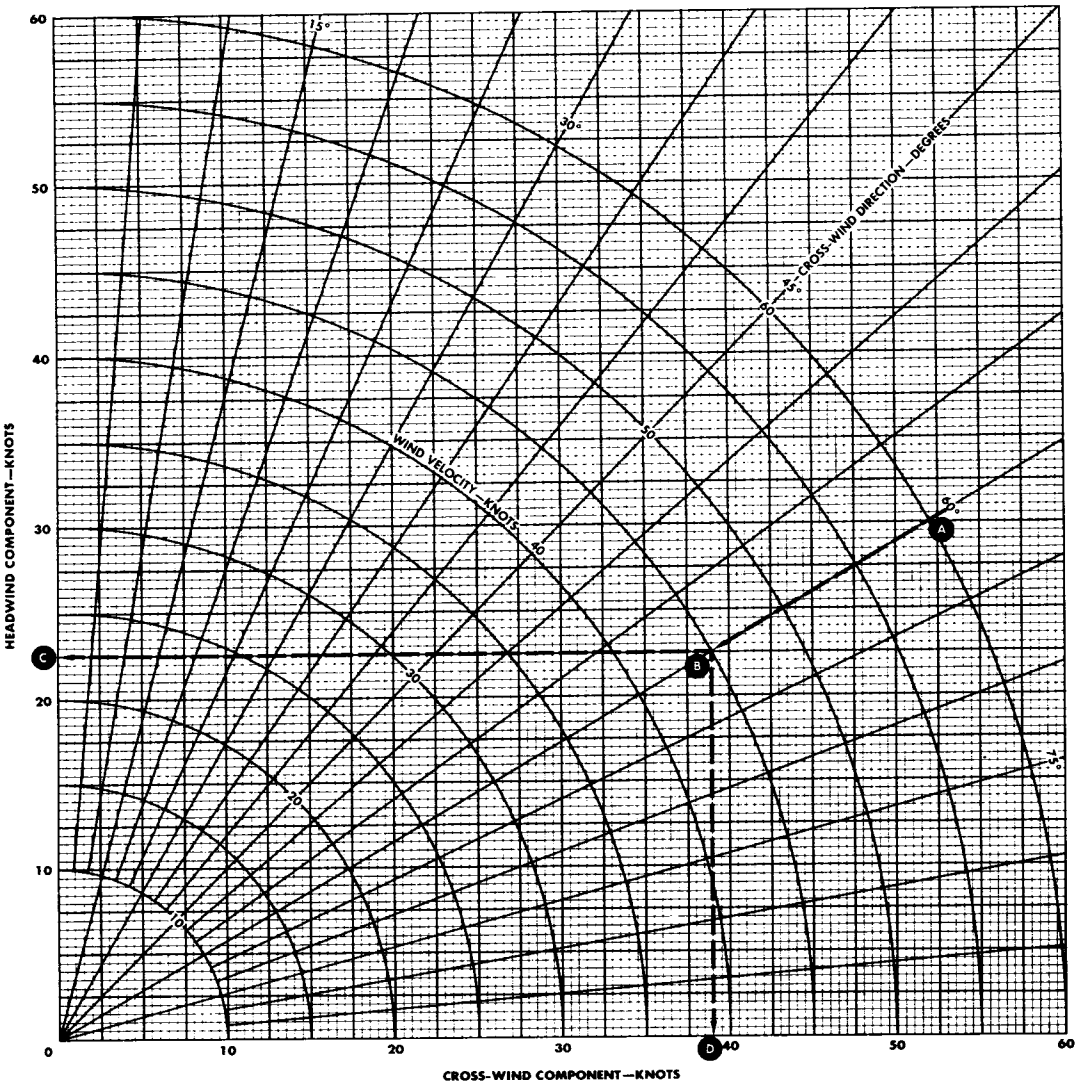
Figure A-2



F-86K-1-93-135

Figure A-3

TAKE-OFF AND LANDING CROSS-WIND CHART



NOTE:

To obtain tail-wind components, enter chart with direction of wind taken from reciprocal heading of airplane.

EXAMPLE:

- (A) is cross-wind direction, from airplane heading (60 degrees).
- (B) is wind velocity (45 knots).
- (C) is effective head wind (22.5 knots).
- (D) is effective 90-degree cross wind (39 knots).

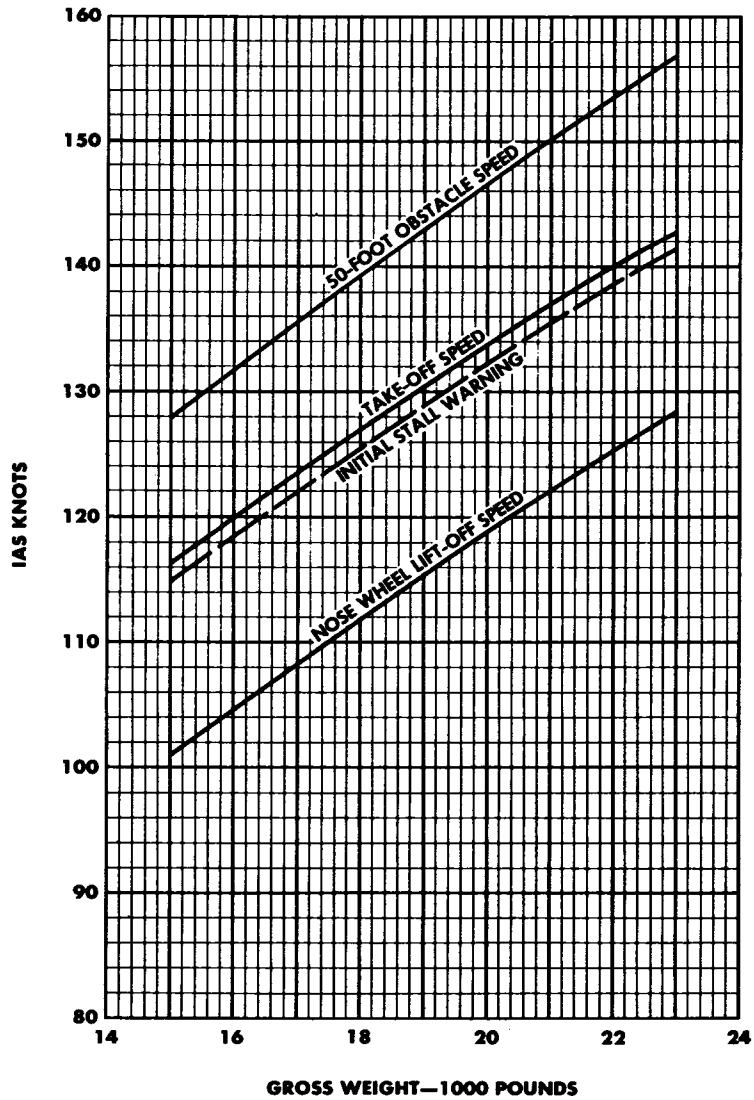
F-86K-1-93-131

Figure A-4

TAKE-OFF SPEEDS

STANDARD DAY
MODEL: F-86K
ENGINE: J47-17B

GROUPS 1, 2 AND 3 AIRPLANES ONLY



DATA AS OF: 1 DEC 1955
BASED ON: FLIGHT TEST DATA

F-86K-1-93-132

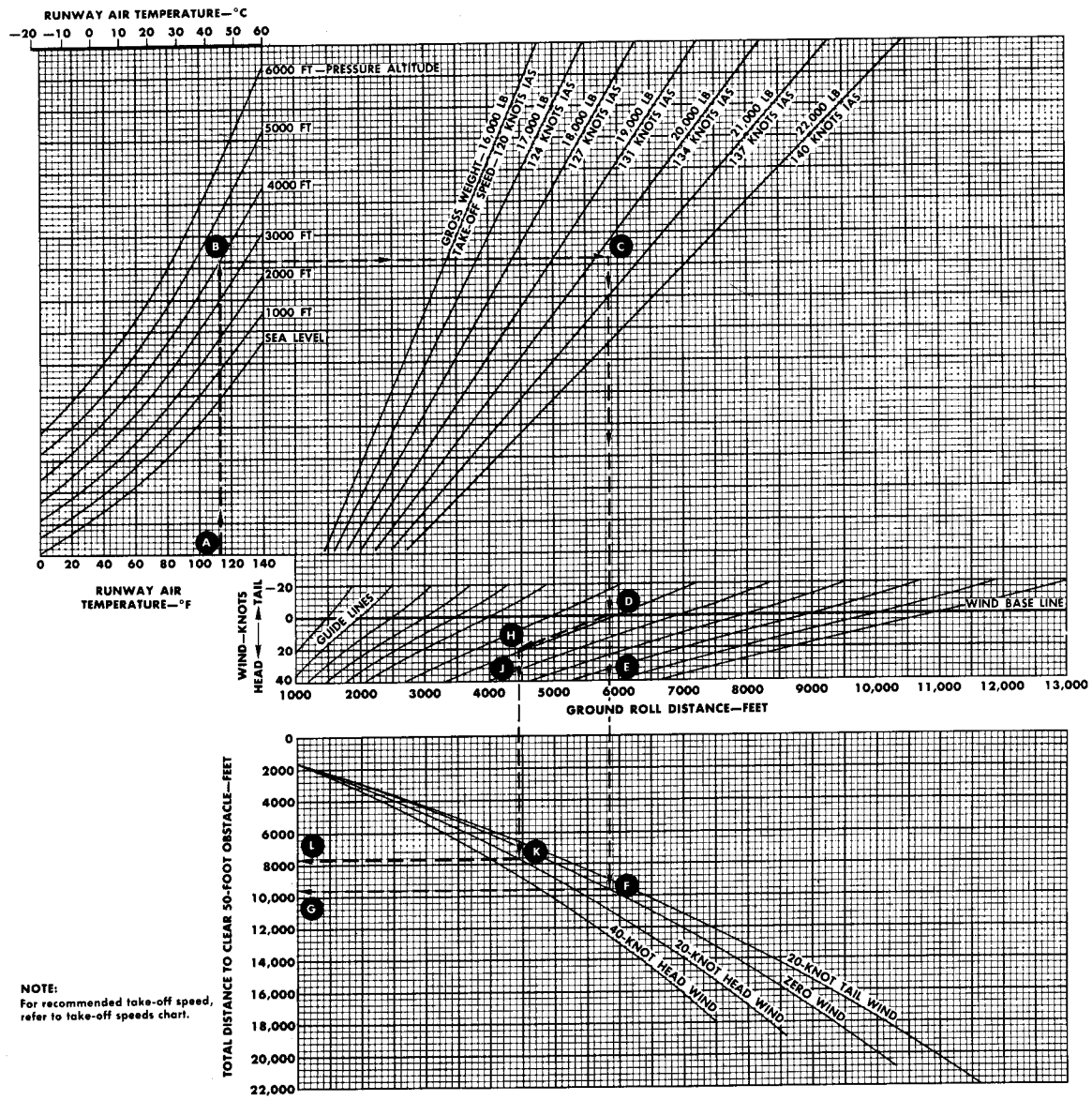
Figure A-5

FLAPS FULL DOWN

TAKE-OFF DISTANCES

MAXIMUM THRUST

HARD-SURFACE RUNWAY
MODEL: F-86K
ENGINE: J47-17B
GROUPS 1, 2 AND 3 AIRPLANES ONLY



NOTE:
For recommended take-off speed, refer to take-off speeds chart.

EXAMPLE:

- A is runway air temperature (113°F).
- B is pressure altitude (4000 feet).
- C is gross weight (20,200 pounds).
- D is wind base line (zero).
- E is ground roll with zero wind (5850 feet).
- F is wind base line (zero).
- G is total distance to clear 50-foot obstacle (9600 feet).
- H is head wind (20 knots).
- J is ground roll with 20-knot head wind (4450 feet).
- K is head wind base line (20 knots).
- L is total distance to clear 50-foot obstacle with 20-knot head wind (7600 feet).

DATA AS OF: 1 DEC 1955
BASED ON FLIGHT TEST DATA

F-86K 1-93-96B

Figure A-6

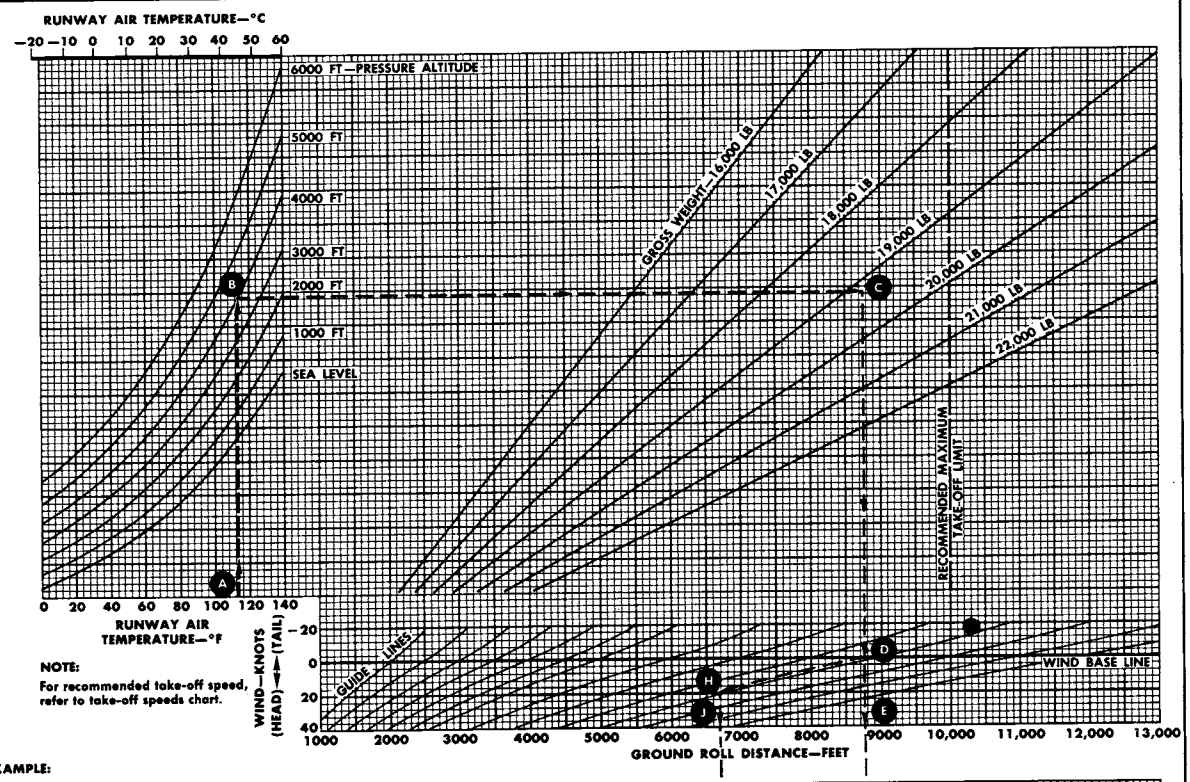
FLAPS FULL DOWN

TAKE-OFF DISTANCES

MILITARY THRUST

HARD-SURFACE RUNWAY
MODEL: F-86K
ENGINE: J47-17B

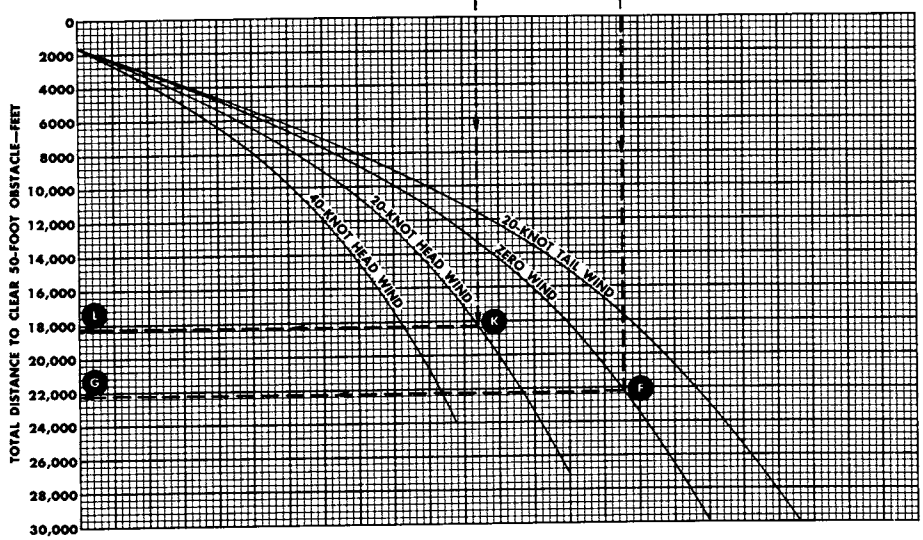
GROUPS 1, 2 AND 3 AIRPLANES ONLY



NOTE:
For recommended take-off speed, refer to take-off speeds chart.

EXAMPLE:

- (A) is runway air temperature (113°F).
- (B) is pressure altitude (4000 feet).
- (C) is gross weight (19,200 pounds).
- (D) is wind base line (zero).
- (E) is ground roll with zero wind (8760 feet).
- (F) is wind base line (zero).
- (G) is total distance to clear 50-foot obstacle (22,200 feet).
- (H) is head wind (20 knots).
- (J) is ground roll with 20-knot head wind (6700 feet).
- (K) is head wind base line (20 knots).
- (L) is total distance to clear 50-foot obstacle with 20-knot head wind (18,300 feet).



DATA AS OF: 1 DEC 1955
BASED ON FLIGHT TEST DATA

F-86K-1-93-95B

Figure A-7

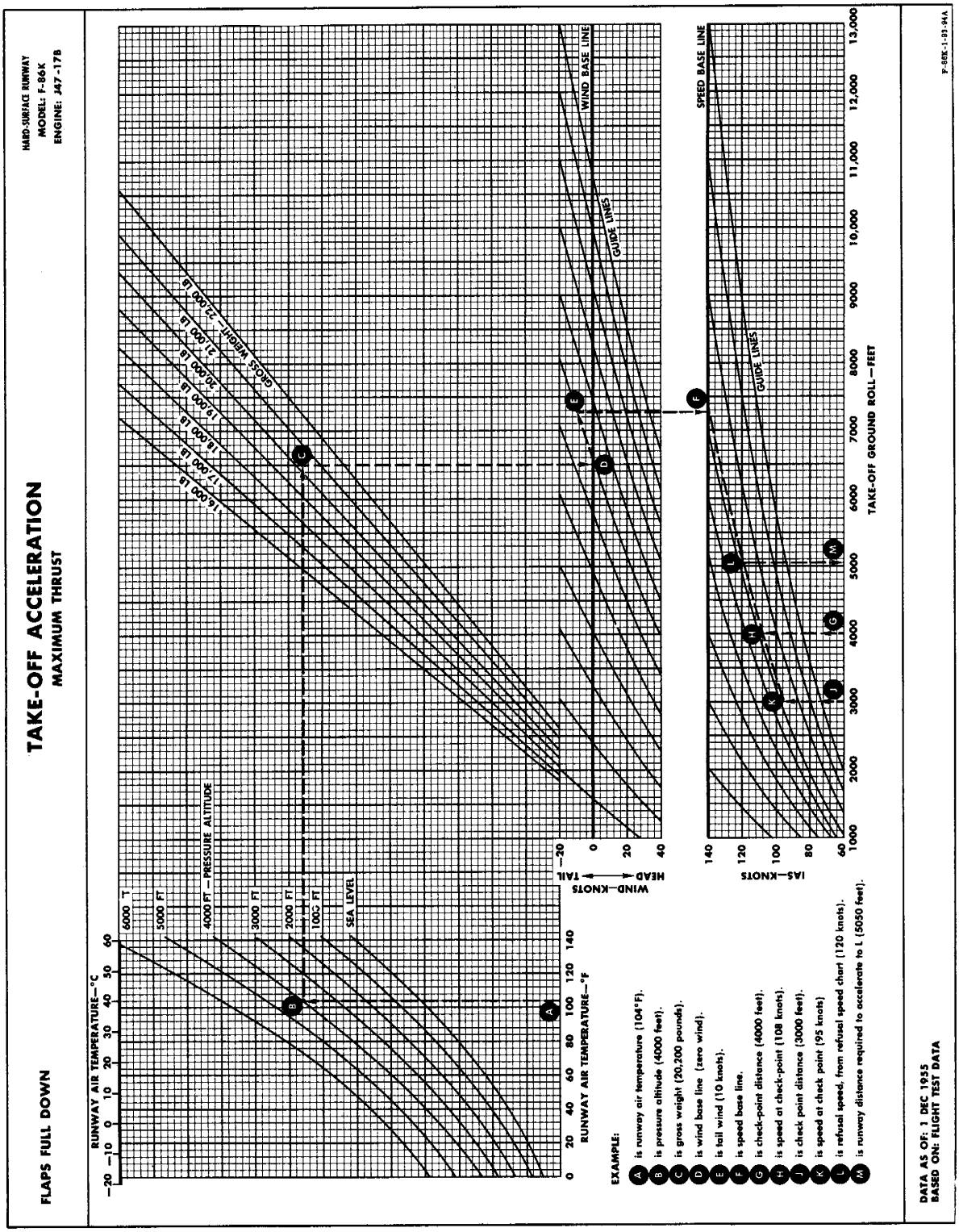

TAKE-OFF ACCELERATION
MAXIMUM THRUST
FLAPS FULL DOWN
HARD-SURFACE RUNWAY
MODEL: F-86K
ENGINE: J47-17B
RUNWAY AIR TEMPERATURE—°C
RUNWAY AIR TEMPERATURE—°F
PRESSURE ALTITUDE
SEA LEVEL
1000 FT
2000 FT
3000 FT
4000 FT
5000 FT
6000 FT
GROSS WEIGHT
16,000 LB
17,000 LB
18,000 LB
19,000 LB
20,000 LB
21,000 LB
22,000 LB
WIND—KNOTS
HEAD
TAIL
GUIDE LINES
WIND BASE LINE
IAS—KNOTS
SPEED BASE LINE
TAKE-OFF GROUND ROLL—FEET
EXAMPLE:
A is runway air temperature (104°F).
B is pressure altitude (4000 feet).
C is gross weight (20,200 pounds).
D is wind base line (zero wind).
E is tail wind (10 knots).
F is speed base line.
G is check-point distance (4000 feet).
H is speed at check-point (108 knots).
I is check point distance (3000 feet).
K is speed at check point (95 knots)
L is refusal speed, from refusal speed chart (120 knots).
M is runway distance required to accelerate to L (5050 feet).
DATA AS OF: 1 DEC 1955
BASED ON: FLIGHT TEST DATA
F-86K-1-03-94A

Figure A-8

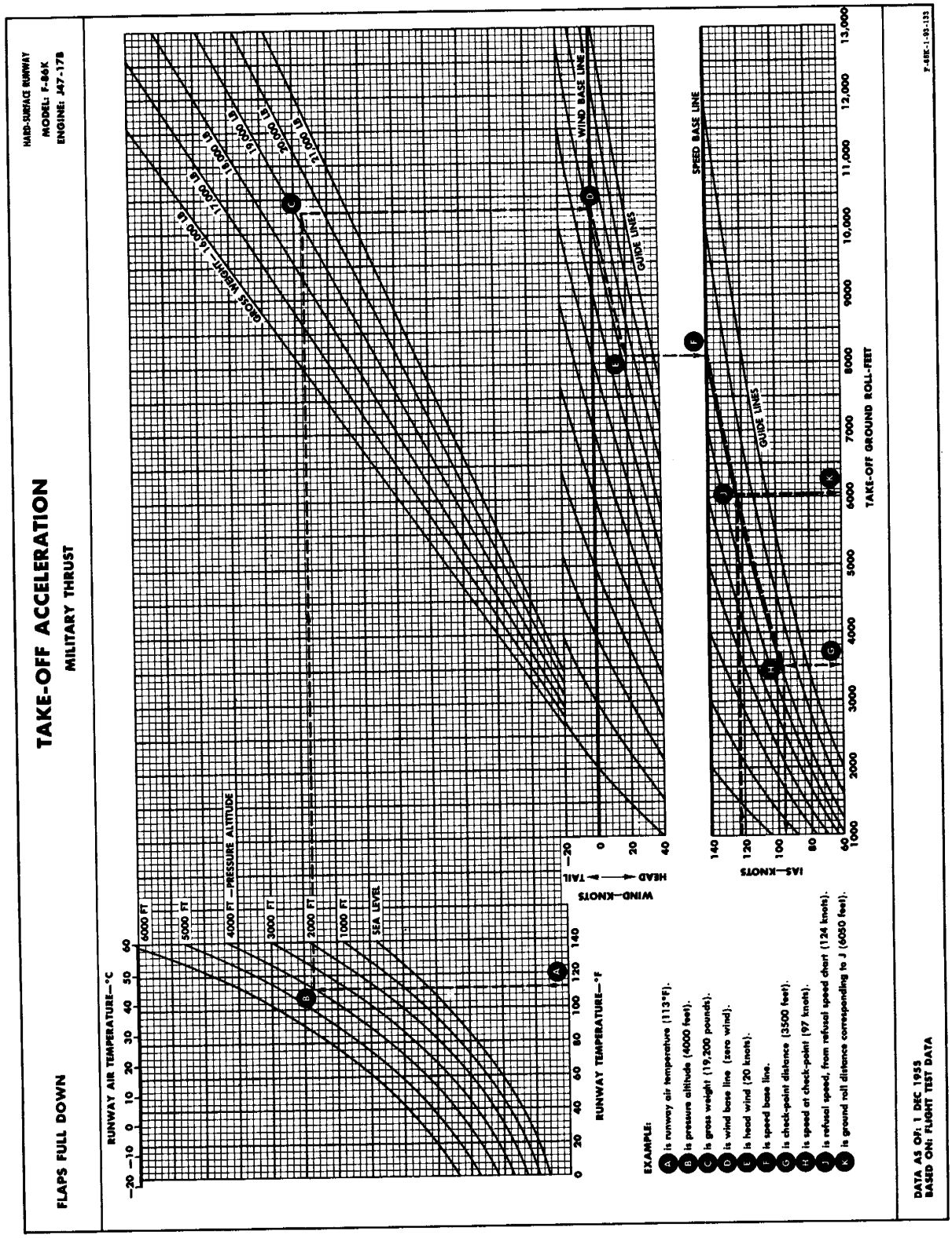

TAKE-OFF ACCELERATION
MILITARY THRUST
FLAPS FULL DOWN
HARD-SURFACE RUNWAY
MODEL: F-86K
ENGINE: J47-17B
RUNWAY AIR TEMPERATURE—°C
RUNWAY TEMPERATURE—°F
6000 FT
5000 FT
4000 FT — PRESSURE ALTITUDE
3000 FT
2000 FT
1000 FT
SEA LEVEL
GROSS WEIGHT—18,000 LB
17,000 LB
16,000 LB
15,000 LB
14,000 LB
13,000 LB
12,000 LB
WIND—KNOTS
HEAD ← → TAIL
WIND BASE LINE
GUIDE LINES
IAS—KNOTS
SPEED BASE LINE
GUIDE LINES
TAKE-OFF GROUND ROLL-FEET
EXAMPLE:
A is runway air temperature (113°F).
B is pressure altitude (4000 feet).
C is gross weight (19,200 pounds).
D is wind base line (zero wind).
E is head wind (20 knots).
F is speed base line.
G is check-point distance (3500 feet).
H is speed at check-point (97 knots).
J is refusal speed, from refusal speed chart (124 knots).
K is ground roll distance corresponding to J (6050 feet).
DATA AS OF: 1 DEC 1955
BASED ON: FLIGHT TEST DATA
F-86K-1-33-135

Figure A-9

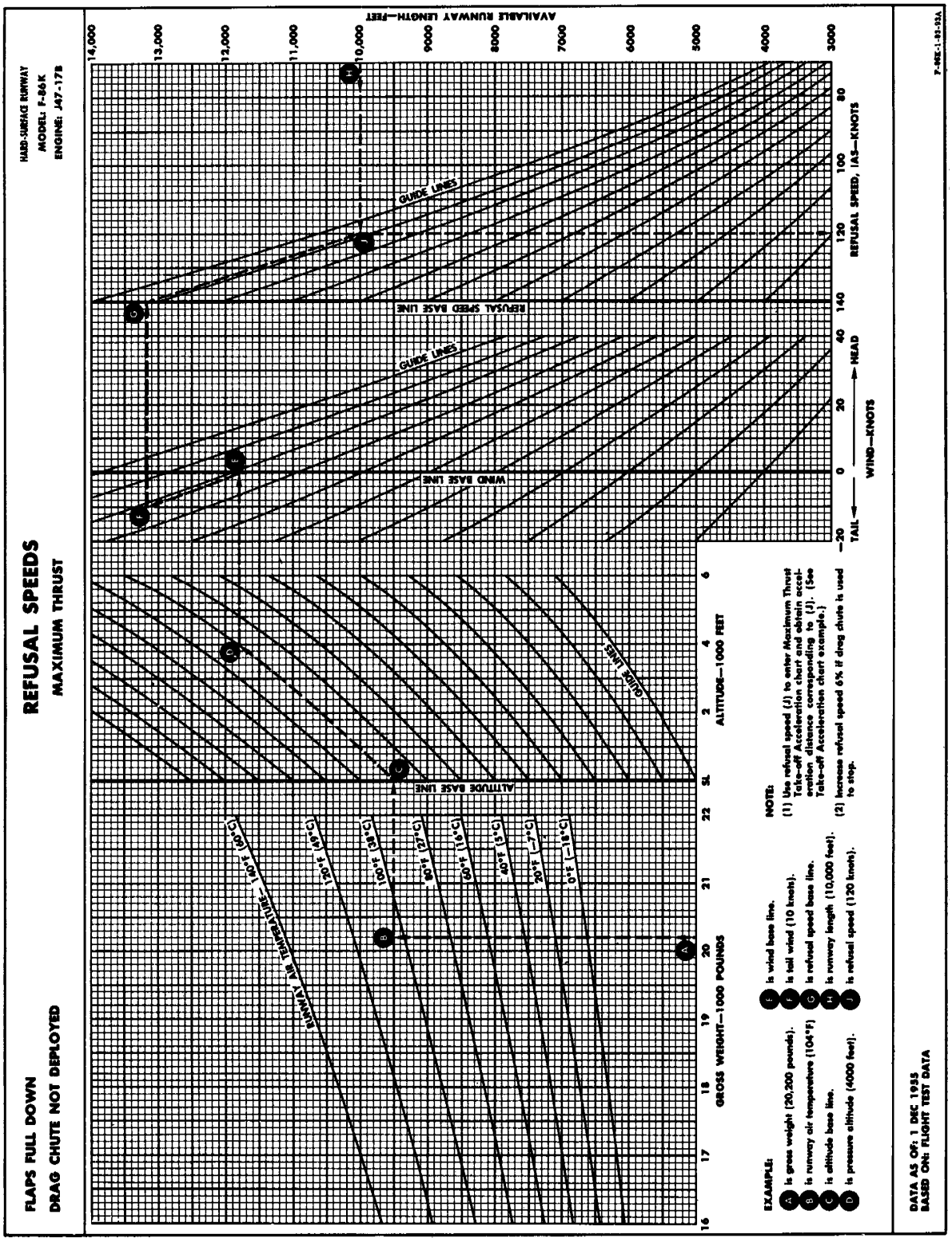

FLAPS FULL DOWN
DRAG CHUTE NOT DEPLOYED
REFUSAL SPEEDS
MAXIMUM THRUST
HARD-SURFACE RUNWAY
MODEL: F-86K
ENGINE: J47-17B
AVAILABLE RUNWAY LENGTH—FEET
14,000
13,000
12,000
11,000
10,000
9000
8000
7000
6000
5000
4000
3000
GUIDE LINES
REFUSAL SPEED BASE LINE
WIND BASE LINE
REFUSAL SPEED, IAS—KNOTS
140
120
100
80
WIND—KNOTS
TAIL
HEAD
−20
0
20
40
ALTITUDE BASE LINE
ALTITUDE—1000 FEET
SL
2
4
6
RUNWAY AIR TEMPERATURE—140°F (60°C)
120°F (49°C)
100°F (38°C)
80°F (27°C)
60°F (16°C)
40°F (5°C)
20°F (−7°C)
0°F (−18°C)
GROSS WEIGHT—1000 POUNDS
16
17
18
19
20
21
22
EXAMPLE:
A is gross weight (20,200 pounds).
B is runway air temperature (104°F)
C is altitude base line.
D is pressure altitude (4000 feet).
E is wind base line.
F is tail wind (10 knots).
G is refusal speed base line.
H is runway length (10,000 feet).
J 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-86K-1-93-93A

Figure A-10

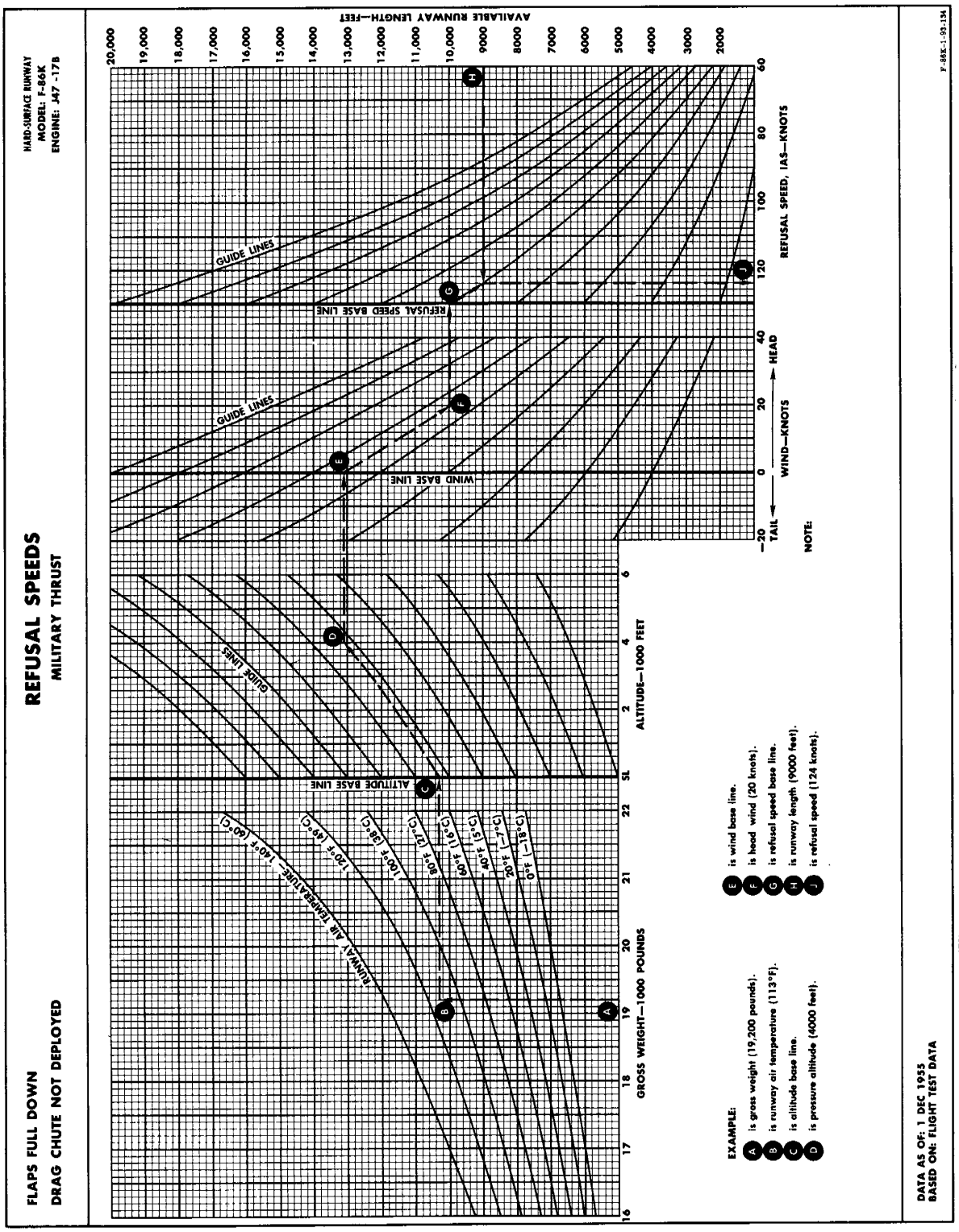
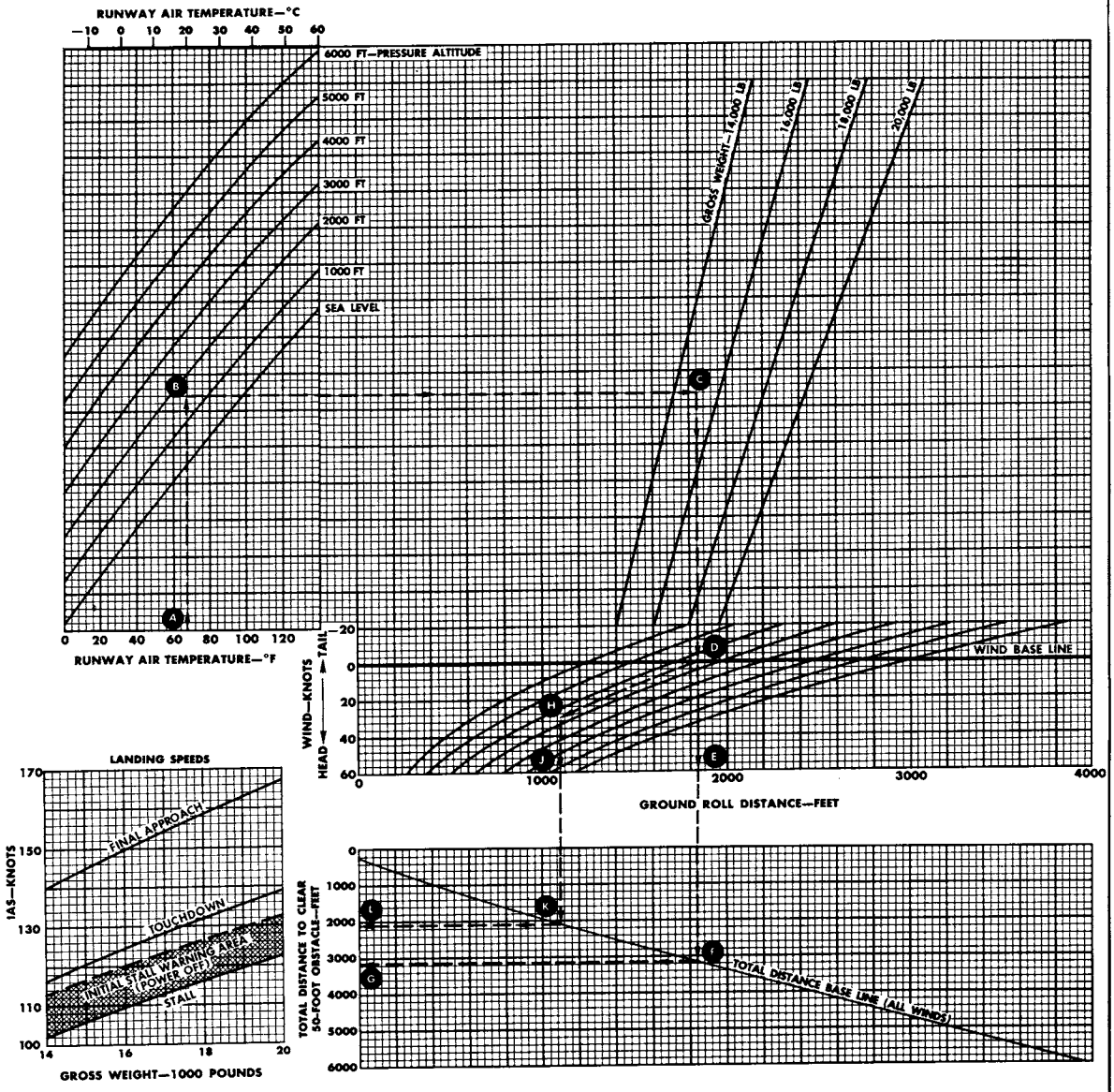

REFUSAL SPEEDS
MILITARY THRUST
FLAPS FULL DOWN
DRAG CHUTE NOT DEPLOYED
HARD-SURFACE RUNWAY
MODEL: F-86K
ENGINE: J47-17B
AVAILABLE RUNWAY LENGTH—FEET
20,000
19,000
18,000
17,000
16,000
15,000
14,000
13,000
12,000
11,000
10,000
9000
8000
7000
6000
5000
4000
3000
2000
GUIDE LINES
REFUSAL SPEED BASE LINE
GUIDE LINES
WIND BASE LINE
GUIDE LINES
ALTITUDE BASE LINE
RUNWAY AIR TEMPERATURE—
120°F (49°C)
100°F (38°C)
80°F (27°C)
60°F (16°C)
40°F (5°C)
20°F (-7°C)
0°F (-18°C)
-40°F (-40°C)
GROSS WEIGHT—1000 POUNDS
16
17
18
19
20
21
22
SL
2
4
6
ALTITUDE—1000 FEET
—20
0
20
40
TAIL
WIND—KNOTS
HEAD
60
80
100
120
REFUSAL SPEED, IAS—KNOTS
EXAMPLE:
A is gross weight (19,200 pounds).
B is runway air temperature (113°F).
C is altitude base line.
D is pressure altitude (4000 feet).
E is wind base line.
F is head wind (20 knots).
G is refusal speed base line.
H is runway length (9000 feet).
J is refusal speed (124 knots).
NOTE:
DATA AS OF: 1 DEC 1955
BASED ON: FLIGHT TEST DATA
F-86K-1-39-134

Figure A-11

DRAG CHUTE DEPLOYED
SPEED BRAKES OPEN
FLAPS FULL DOWN

LANDING DISTANCES

HARD-SURFACE RUNWAY
MODEL: F-86K
ENGINE: J47-17B
GROUPS 1, 2 AND 3 AIRPLANES ONLY



EXAMPLE:

- **A** is air temperature (68°F).
- **B** is pressure altitude (1500 feet).
- **C** is gross weight (15,000 pounds).
- **D** is base line (zero wind).
- **E** is ground roll distance with zero wind (1840 feet).
- **F** is base line for total distance.
- **G** is total distance to clear 50-foot obstacle with zero wind (3150 feet).
- **H** is head wind (30 knots).
- **J** is ground roll with 30-knot head wind (1090 feet).
- **K** is base line for total distance.
- **L** is total distance to clear 50-foot obstacle with 30-knot head wind (2100 feet).

NOTE:

1. Wet runways may increase ground roll distance 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: 1 DEC 1955
BASED ON FLIGHT TEST DATA

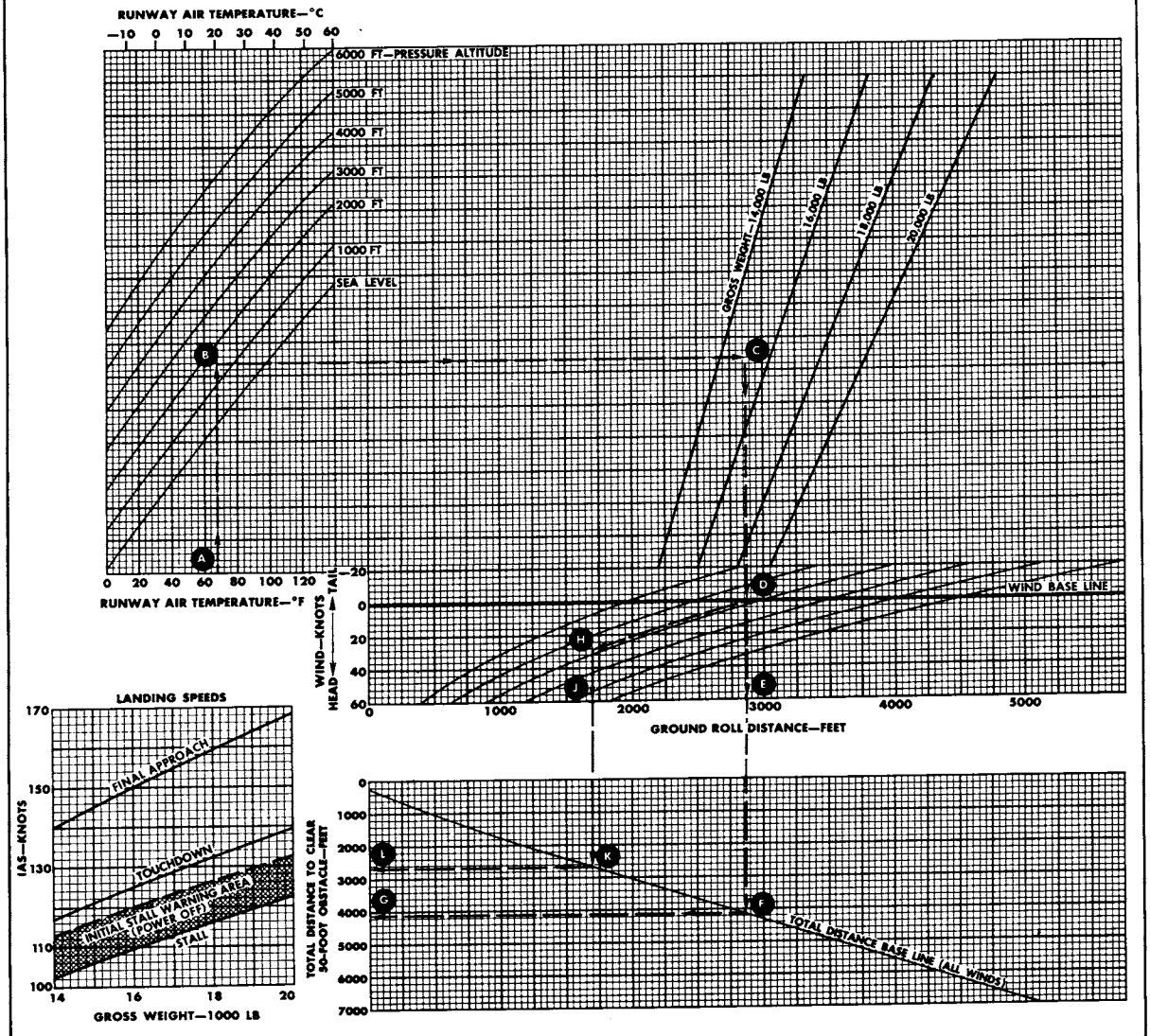
F-86K-1-93-78B

Figure A-12

DRAG CHUTE NOT DEPLOYED
SPEED BRAKES OPEN
FLAPS FULL DOWN

LANDING DISTANCES

HARD-SURFACE RUNWAY
MODEL: F-86K
ENGINE: J47-17B
GROUPS 1, 2 AND 3 AIRPLANES ONLY



EXAMPLE:

- (A) is air temperature (68°F).
- (B) is pressure altitude (1500 feet).
- (C) is gross weight (15,000 pounds).
- (D) is base line (zero wind).
- (E) is ground roll distance with zero wind (2860 feet).
- (F) is base line for total distance.
- (G) is total distance to clear 50-foot obstacle with zero wind (4150 feet).
- (H) is head wind (30 knots).
- (J) is ground roll with 30-knot head wind (1700 feet).
- (K) is base line for total distance.
- (L) 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: 1 DEC 1955
BASED ON FLIGHT TEST DATA

F-86K-1-93-77B

Figure A-13

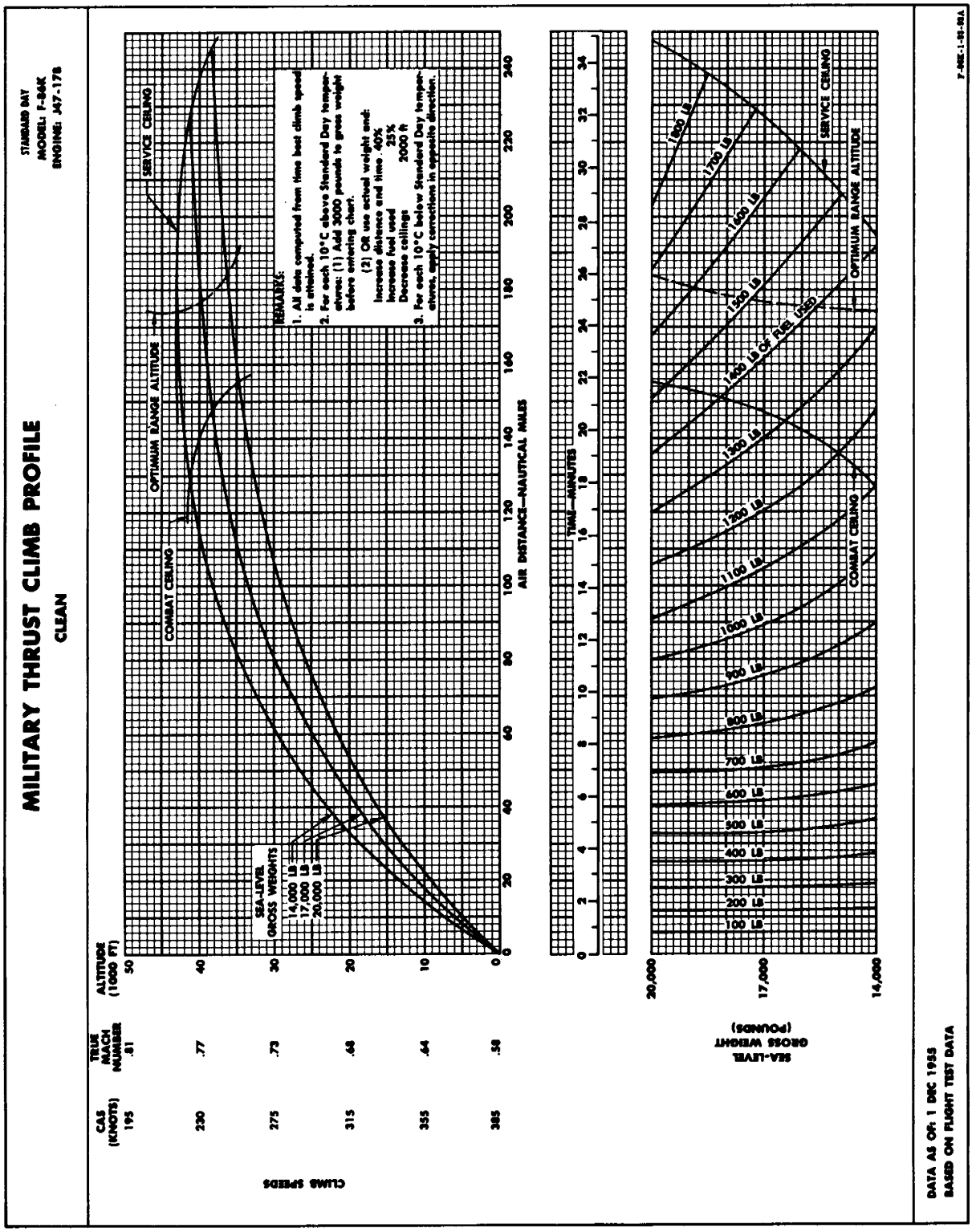

MILITARY THRUST CLIMB PROFILE
CLEAN
STANDARD DAY
MODEL: F-86K
ENGINE: J47-17B
CLIMB SPEEDS
CAS (KNOTS)
TRUE MACH NUMBER
ALTITUDE (1000 FT)
SEA-LEVEL GROSS WEIGHTS
14,000 LB
17,000 LB
20,000 LB
SERVICE CEILING
OPTIMUM RANGE ALTITUDE
COMBAT CEILING
AIR DISTANCE—NAUTICAL MILES
TIME—MINUTES
REMARKS:
1. All data computed from time best climb speed is attained.
2. For each 10°C above Standard Day temperature: (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 temperature, apply corrections in opposite direction.
SEA-LEVEL GROSS WEIGHT (POUNDS)
1800 LB
1700 LB
1600 LB
1500 LB
1400 LB OF FUEL (MAX)
1300 LB
1200 LB
1100 LB
1000 LB
900 LB
800 LB
700 LB
600 LB
500 LB
400 LB
300 LB
200 LB
100 LB
DATA AS OF: 1 DEC 1955
BASED ON FLIGHT TEST DATA
F-86K-1-31-30A

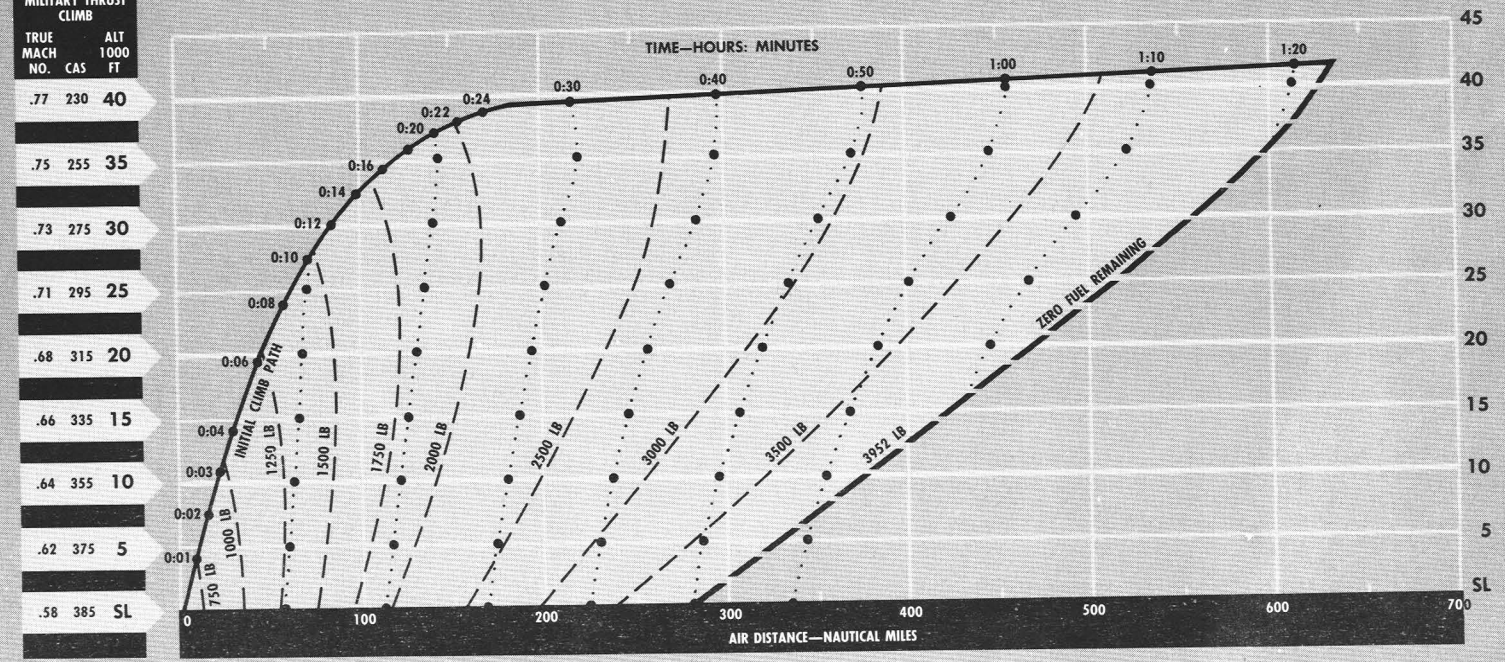
Figure A-14

MISSION PROFILE

STANDARD DAY
Model: F-86K
Engine: J47-17B

TAKE-OFF GROSS WEIGHT: 18,000-18,600 LB
ALL FUEL LOADS BETWEEN 0 - 3952 LB

CLEAN



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	APPROXIMATE TAS	APPROXIMATE LB/HR	APPROXIMATE % 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-86K-1-93-91A

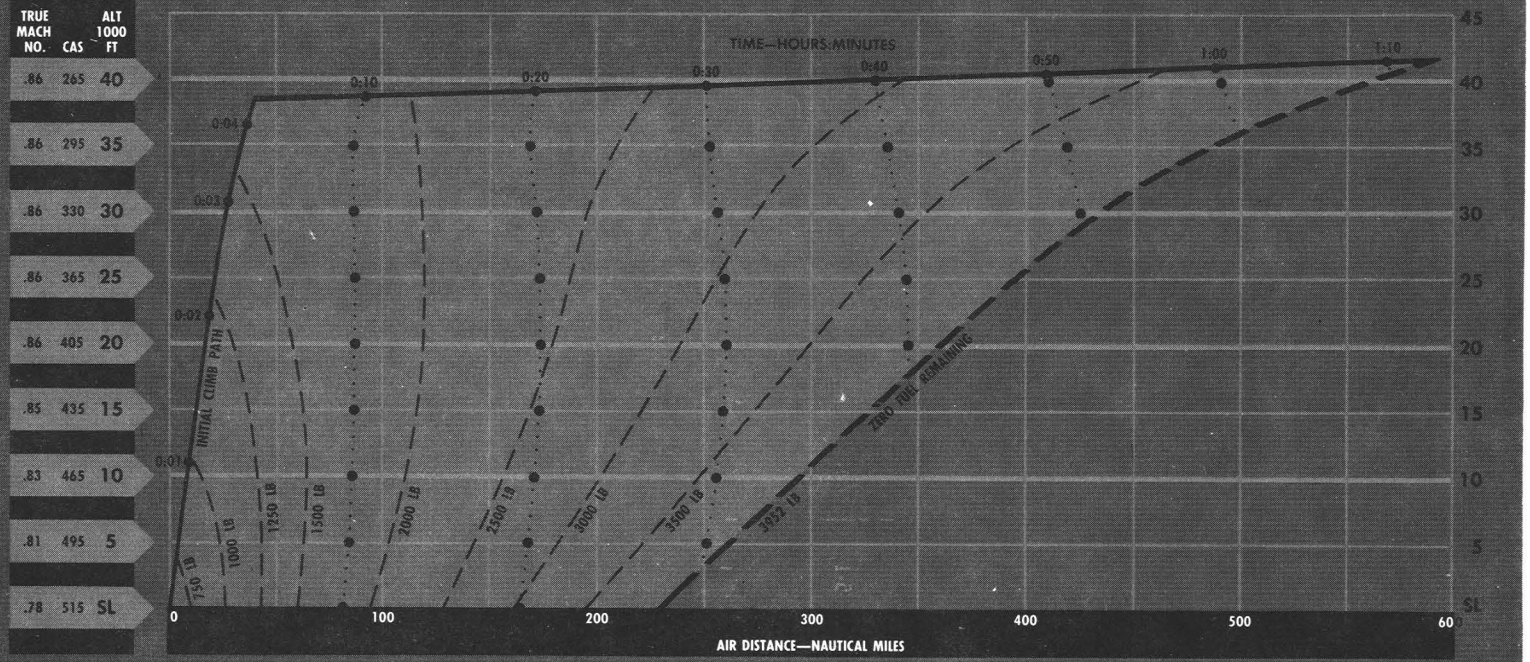
Figure A-15

INTERCEPT PROFILE

TAKE-OFF GROSS WEIGHT: 18,000-18,600 LB
ALL FUEL LOADS BETWEEN 0 - 3952 LB

STANDARD DAY
Model: F-86K
Engine: J47-17B

CLEAN



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.

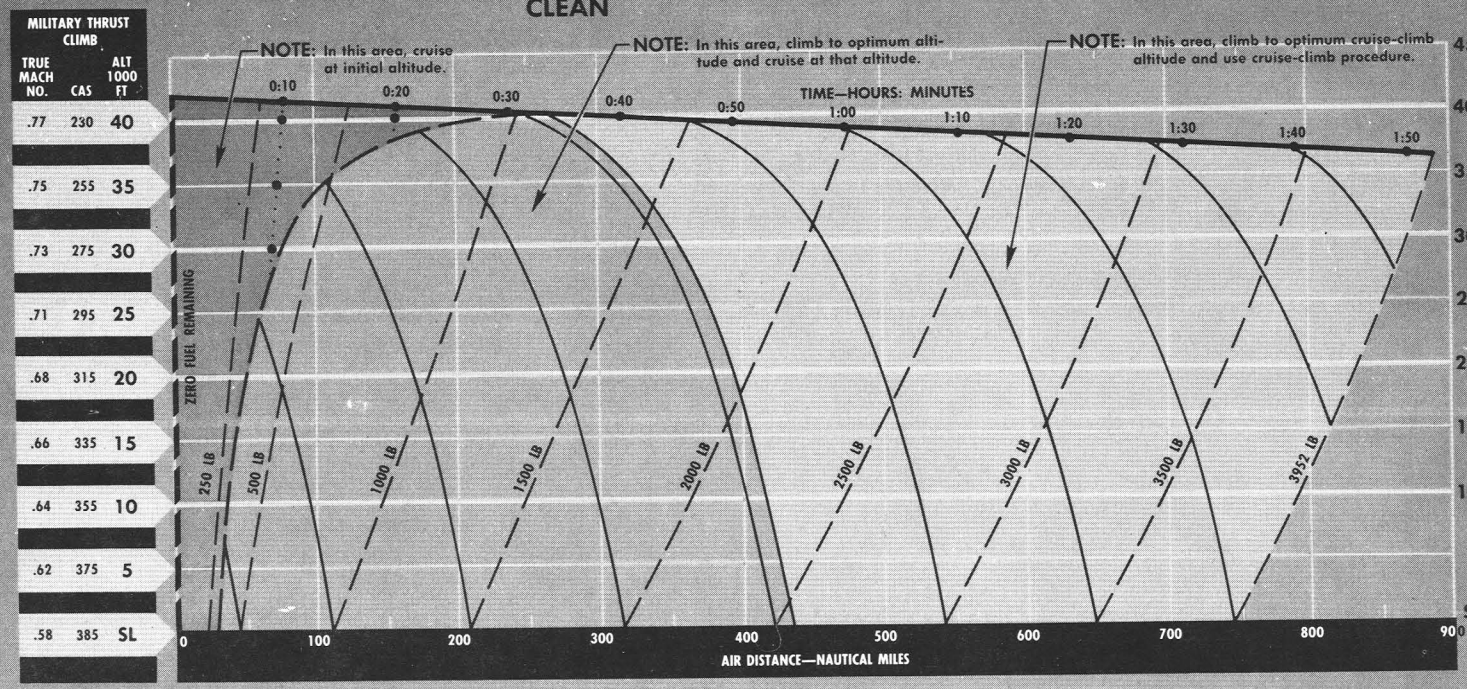
Figure A-16

OPTIMUM RETURN PROFILE

STANDARD DAY
Model: F-86K
Engine: J47-17B

TAKE-OFF GROSS WEIGHT: 18,000-18,600 LB
ALL FUEL LOADS BETWEEN 0 - 3952 LB

CLEAN



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-86K-1-93-89A

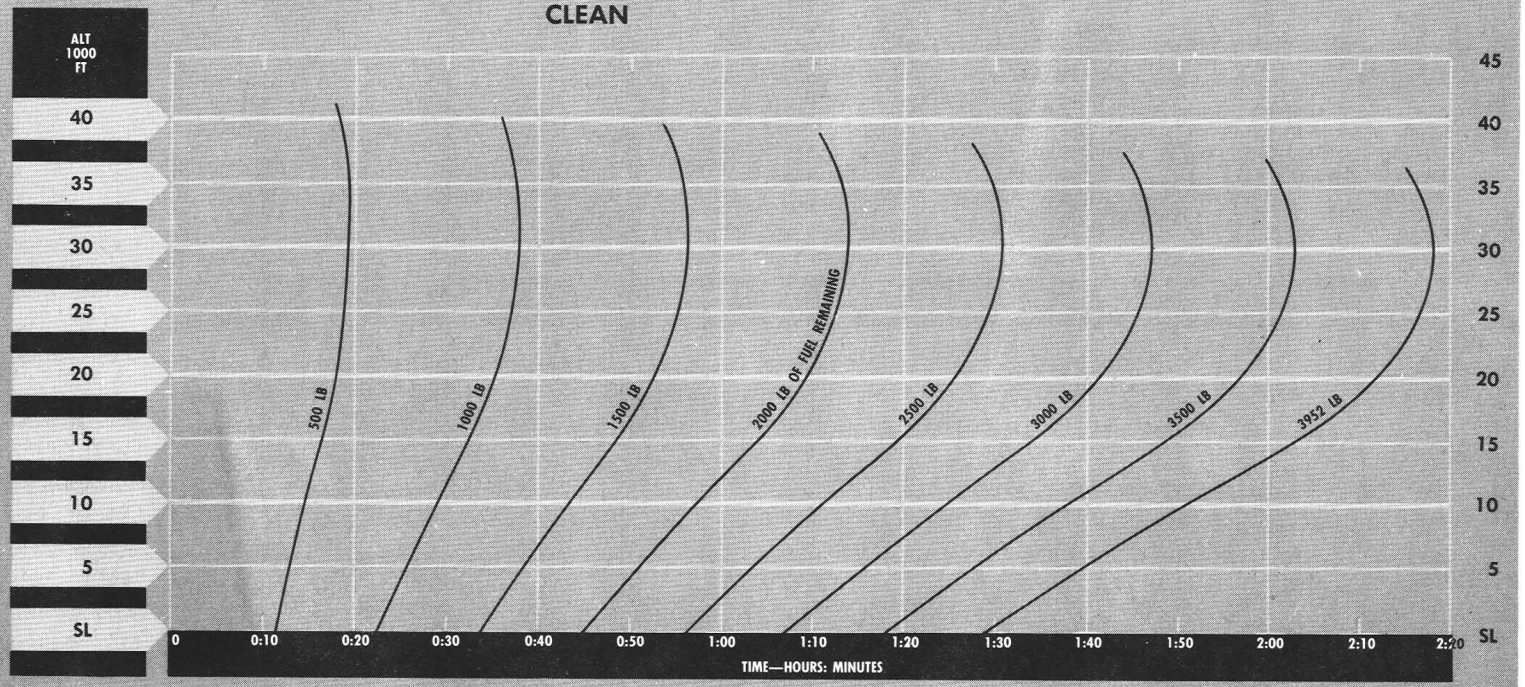
Figure A-17

MAXIMUM ENDURANCE PROFILE

STANDARD DAY
Model: F-86K
Engine: J47-17B

TAKE-OFF GROSS WEIGHT: 18,000-18,600 LB
ALL FUEL LOADS BETWEEN 0 - 3952 LB

CLEAN



LOITER	LESS THAN 2000 LB FUEL REMAINING					MORE THAN 2000 LB FUEL REMAINING				
ALTITUDE FEET	CAS	APPROXIMATE TRUE MACH NO.	APPROXIMATE TAS	APPROXIMATE LB/HR	APPROXIMATE % RPM	CAS	APPROXIMATE TRUE MACH NO.	APPROXIMATE TAS	APPROXIMATE LB/HR	APPROXIMATE % 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.

REMARKS

1. Loiter at recommended CAS.
2. Maintain constant altitude.

F-86K-1-93-88A

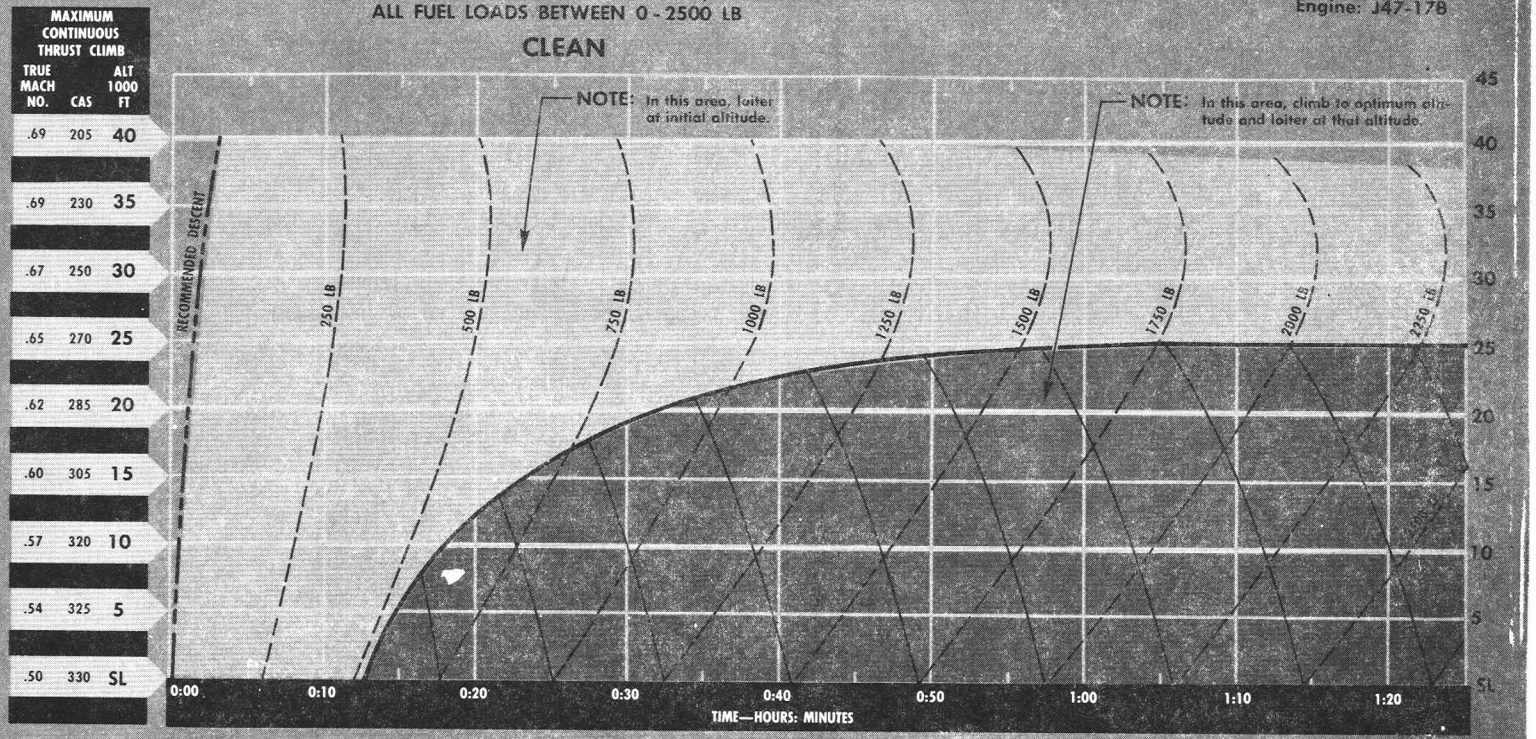
Figure A-18

OPTIMUM MAXIMUM ENDURANCE PROFILE

STANDARD DAY
Model: F-86K
Engine: J47-17B

TAKE-OFF GROSS WEIGHT: 18,000-18,600 LB
ALL FUEL LOADS BETWEEN 0 - 2500 LB

CLEAN



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.	APPROXIMATE TAS	APPROXIMATE LB/HR	APPROXIMATE % 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-86K-1-93-87A F-86K-1-93-98A

Figure A-19

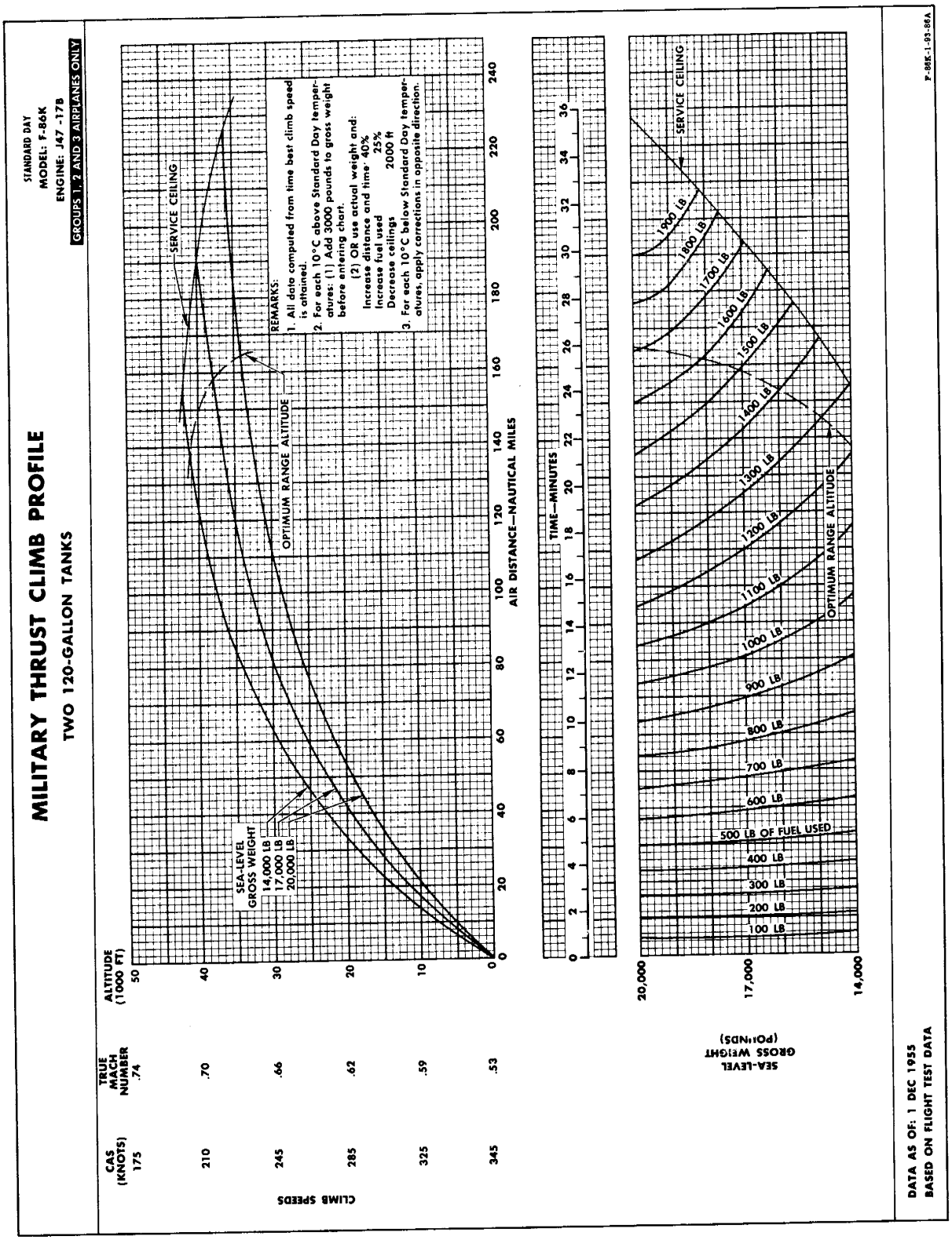

MILITARY THRUST CLIMB PROFILE
TWO 120-GALLON TANKS
STANDARD DAY
MODEL: F-86K
ENGINE: J47 -17B
GROUPS 1, 2 AND 3 AIRPLANES ONLY
CLIMB SPEEDS
CAS (KNOTS)
TRUE MACH NUMBER
ALTITUDE (1000 FT)
175 .74
210 .70
245 .66
285 .62
325 .59
345 .53
SERVICE CEILING
SEA-LEVEL GROSS WEIGHT
14,000 LB
17,000 LB
20,000 LB
OPTIMUM RANGE ALTITUDE
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.
AIR DISTANCE—NAUTICAL MILES
TIME—MINUTES
SEA-LEVEL GROSS WEIGHT (POUNDS)
1900 LB
1800 LB
1700 LB
1600 LB
1500 LB
1400 LB
1300 LB
1200 LB
1100 LB
1000 LB
900 LB
800 LB
700 LB
600 LB
500 LB OF FUEL USED
400 LB
300 LB
200 LB
100 LB
DATA AS OF: 1 DEC 1955
BASED ON FLIGHT TEST DATA
F-86K-1-93-86A

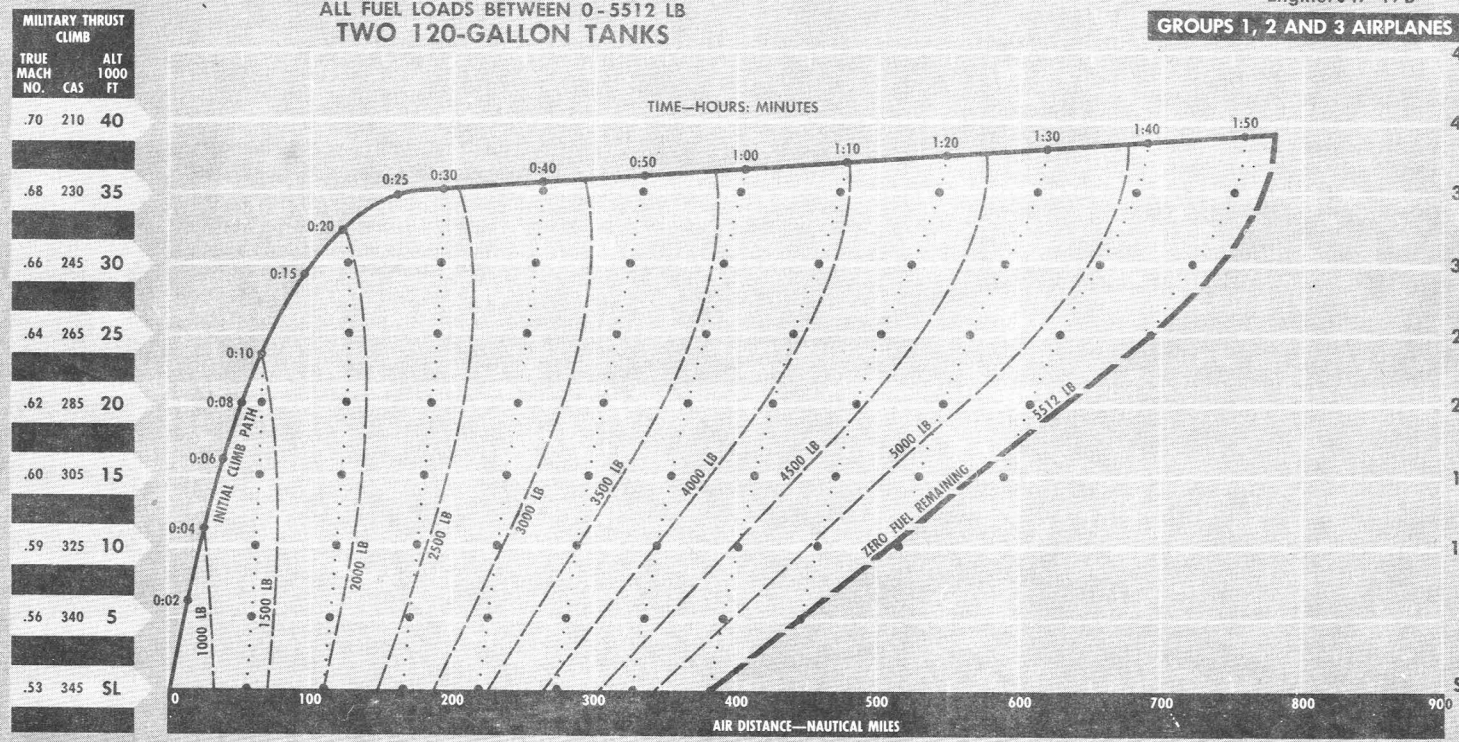
Figure A-20

MISSION PROFILE

TAKE-OFF GROSS WEIGHT: 19,700-20,500 LB
ALL FUEL LOADS BETWEEN 0-5512 LB
TWO 120-GALLON TANKS

STANDARD DAY
Model: F-86K
Engine: J47-17B

GROUPS 1, 2 AND 3 AIRPLANES ONLY



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	.74	—	425	2300-2050	100*
35,000	.73	245	420	2300-2100	100-97
30,000	.67	250	395	2400-2150	96-93
25,000	.63	260	380	2500-2300	94-91
20,000	.59	270	360	2700-2500	92-90
15,000	.56	285	350	2900-2750	91-89
10,000	.53	295	340	3200-3100	90-89
5,000	.51	310	330	3650-3500	90-89
SEA LEVEL	.50	330	330	4250-4100	90-89

Data as of: 1 Dec 1955. Based on flight test data.

*Maximum Continuous Thrust, 100% rpm, 635°C EGT.

F-86K-1-93-85A

Figure A-21

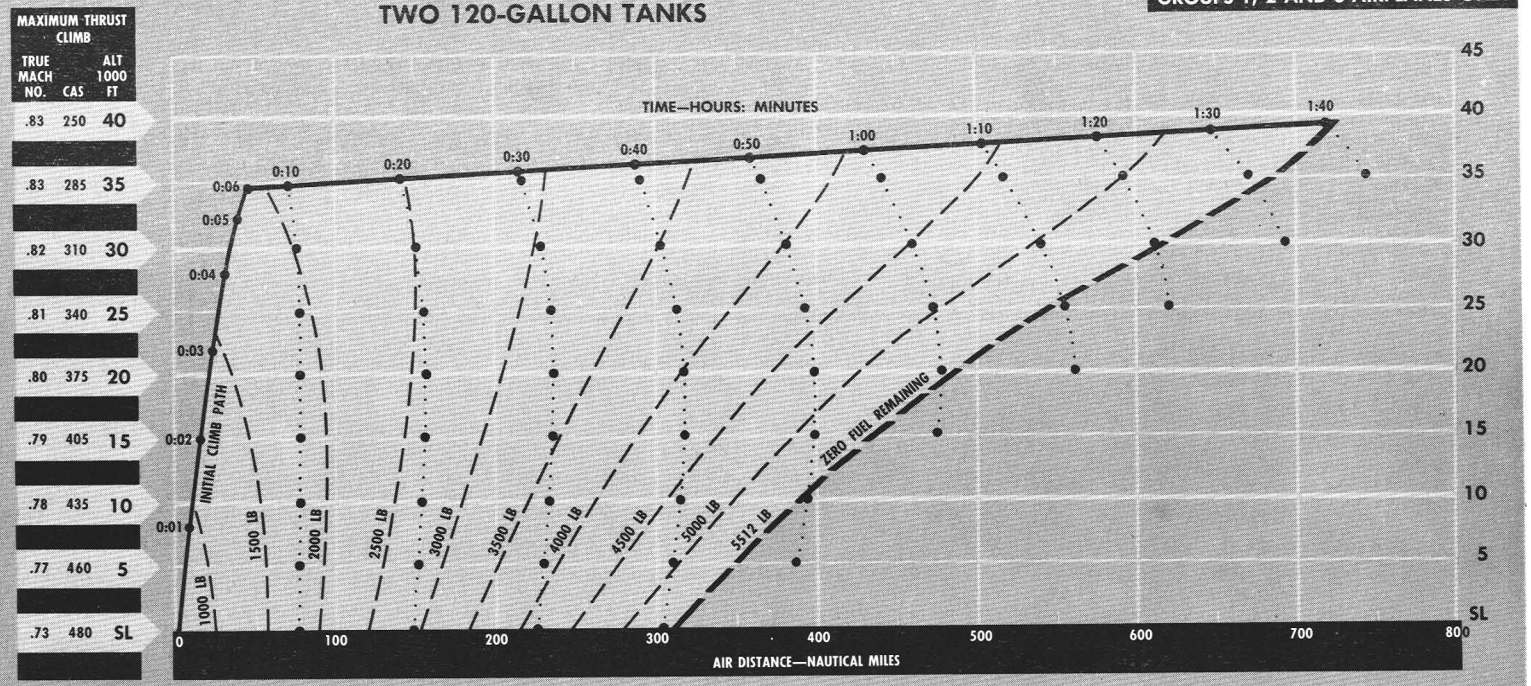
INTERCEPT PROFILE

STANDARD DAY
Model: F-86K
Engine: J47-17B

TAKE-OFF GROSS WEIGHT: 19,700-20,500 LB
ALL FUEL LOADS BETWEEN 0 - 5512 LB

TWO 120-GALLON TANKS

GROUPS 1, 2 AND 3 AIRPLANES ONLY



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	430-435	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.

F-86K-1-93-84A

Figure A-22

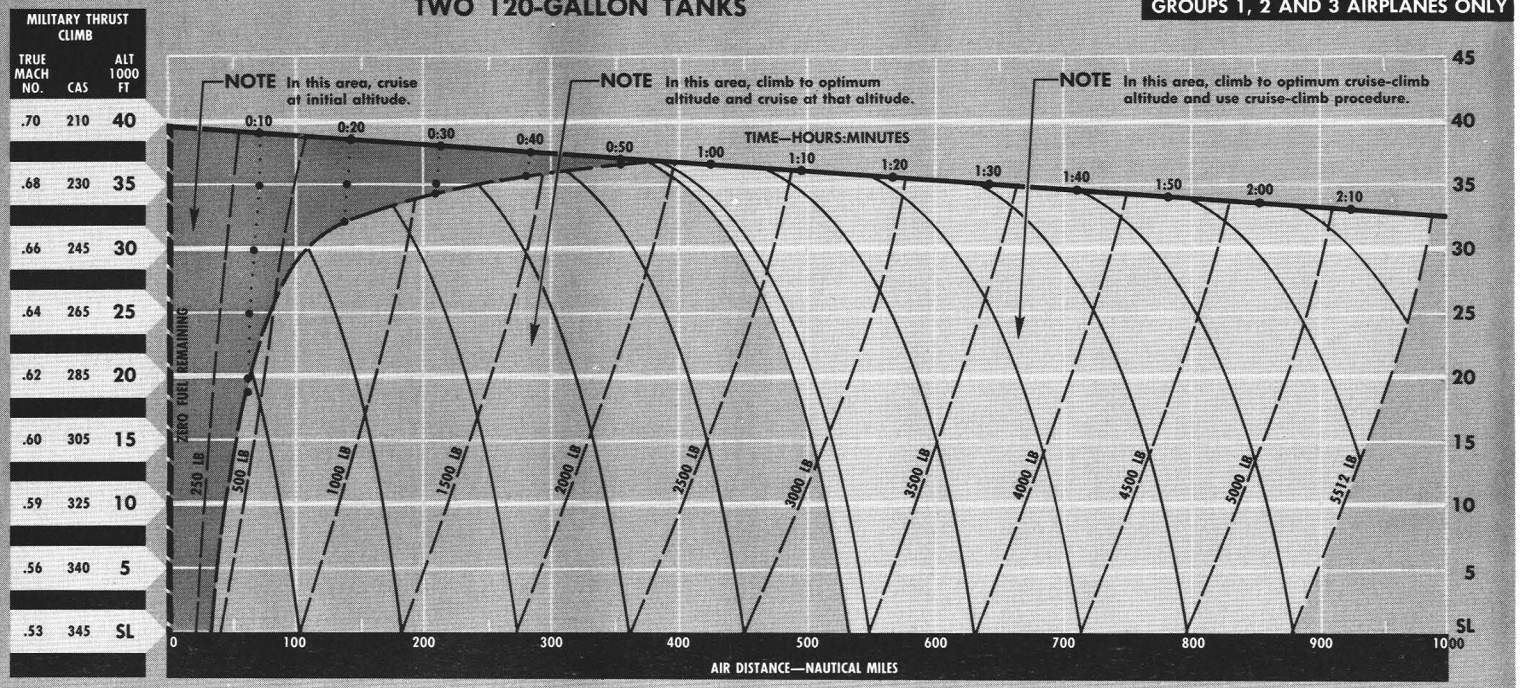
OPTIMUM RETURN PROFILE

STANDARD DAY
Model: F-86K
Engine: -17B

TAKE-OFF GROSS WEIGHT: 19,700-20,500 LB
ALL FUEL LOADS BETWEEN 0 - 5512 LB

TWO 120-GALLON TANKS

GROUPS 1, 2 AND 3 AIRPLANES ONLY



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	.74	240	425	2300-2050	100*
35,000	.73	245	420	2300-2100	100-97
30,000	.67	250	395	2400-2150	96-93
25,000	.63	260	380	2500-2300	94-91
20,000	.59	270	360	2700-2500	92-90
15,000	.56	285	350	2900-2750	91-89
10,000	.53	295	340	3200-3100	90-89
5,000	.51	310	330	3650-3500	90-89
SEA LEVEL	.50	330	330	4250-4100	90-89

Data as of: 1 Dec 1955. Based on flight test data.

*Maximum Continuous Thrust, 100% rpm, 635°C EGT.

F-86K-1-93-83A

Figure A-23

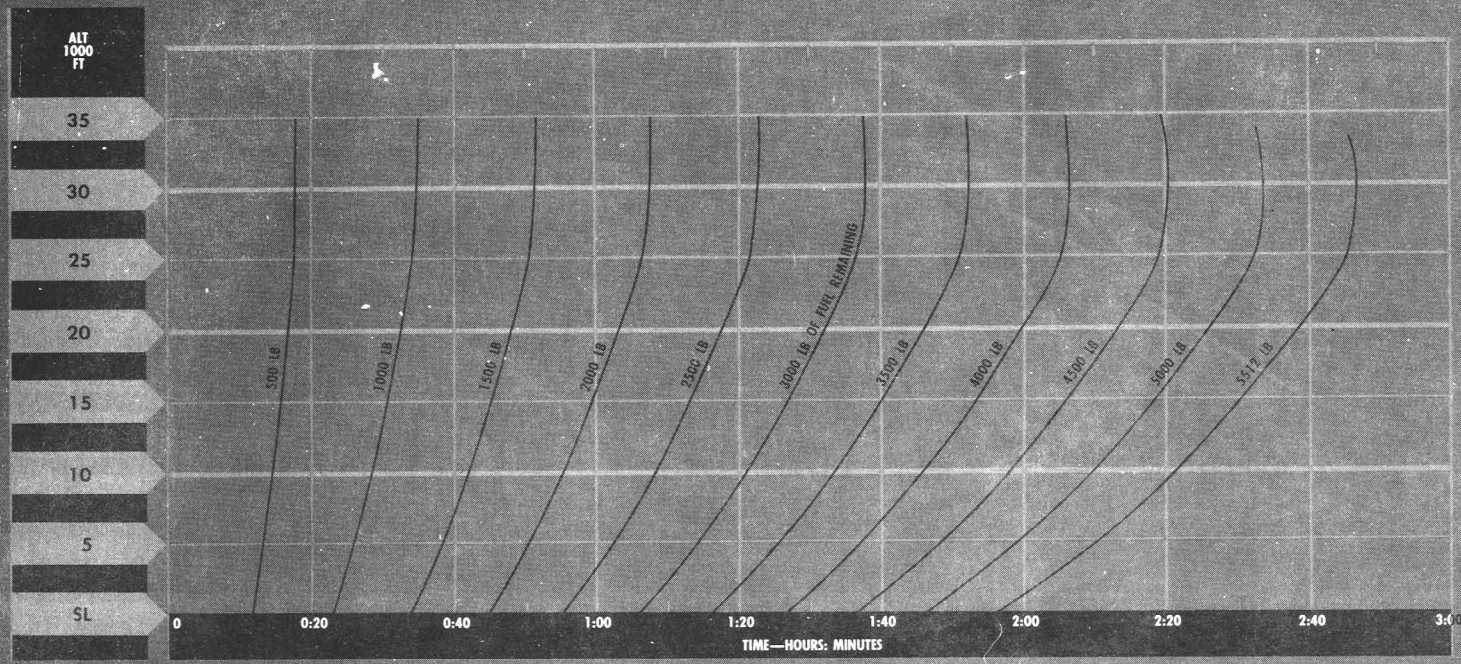
MAXIMUM ENDURANCE PROFILE

STANDARD DAY
Model: F-86K
Engine: J47-17B

TAKE-OFF GROSS WEIGHT: 19,700-20,500 LB
ALL FUEL LOADS BETWEEN 0 - 5512 LB

TWO 120-GALLON TANKS

GROUPS 1, 2 AND 3 AIRPLANES ONLY



LOITER	LESS THAN 2750 LB FUEL REMAINING					MORE THAN 2750 LB FUEL REMAINING				
ALTITUDE FEET	CAS	APPROXIMATE				CAS	APPROXIMATE			
		TRUE MACH NO.	TAS	LB/HR	% RPM		TRUE MACH NO.	TAS	LB/HR	% RPM
35,000	185	.56	325	2000-1700	95-91	200	.61	350	2300-2000	97-95
30,000	185	.50	290	2000-1700	92-89	195	.53	310	2300-2000	96-92
25,000	185	.45	275	2000-1750	90-86	195	.48	290	2300-2000	93-90
20,000	185	.41	250	2100-1900	87-84	200	.44	270	2350-2100	90-87
15,000	185	.37	235	2200-1950	85-82	200	.40	250	2450-2200	88-85
10,000	185	.34	215	2350-2100	84-81	205	.37	235	2550-2350	86-84
5,000	190	.31	200	2550-2350	83-80	205	.34	220	2750-2550	85-83
SEA LEVEL	190	.29	190	2850-2650	82-80	200	.31	200	3050-2850	84-82

Date as of: 1 Dec 1955. Based on flight test data.

REMARKS
1. Loiter at recommended CAS.
2. Maintain constant altitude.

F-86K-1-93-32A

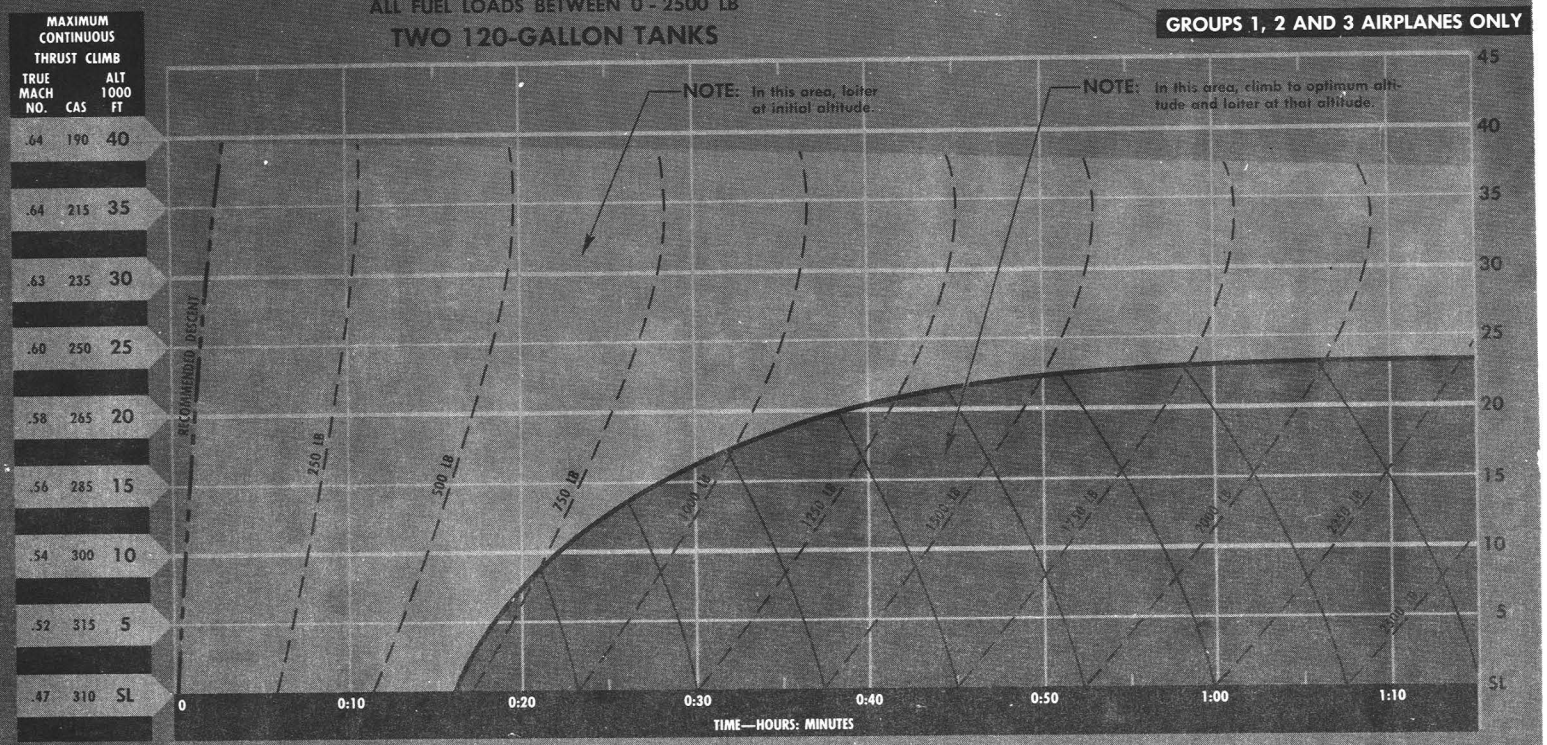
Figure A-24

OPTIMUM MAXIMUM ENDURANCE PROFILE

STANDARD DAY
Model: F-86K
Engine: J47-17B

TAKE-OFF GROSS WEIGHT: 19,700-20,500 LB
ALL FUEL LOADS BETWEEN 0 - 2500 LB
TWO 120-GALLON TANKS

GROUPS 1, 2 AND 3 AIRPLANES ONLY



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 TANKS

ALTITUDE FEET	CAS	APPROXIMATE TRUE MACH NO.	TAS	LB/HR	% RPM
35,000	185	.56	325	2000-1700	95-91
30,000	185	.50	290	2000-1700	92-89
25,000	185	.45	275	2000-1750	90-86
20,000	185	.41	250	2100-1900	87-84
15,000	185	.37	235	2200-1950	85-82
10,000	185	.34	215	2350-2100	84-81
5,000	190	.31	200	2550-2350	83-80
SEA LEVEL	190	.29	190	2850-2650	82-80

Data as of: 1 Dec 1955. Based on flight test data.

F-86K-1-83-81A

Figure A-25

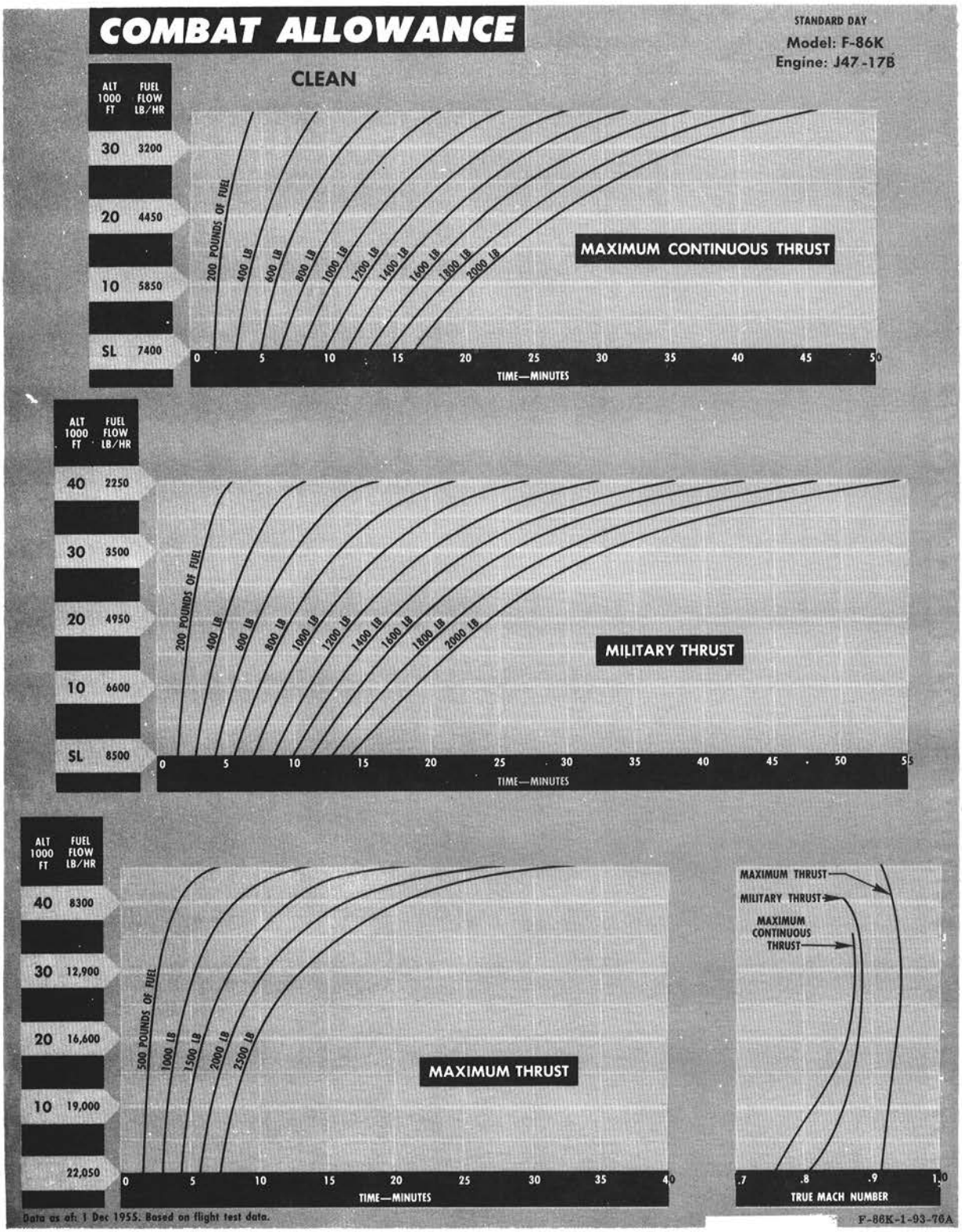

COMBAT ALLOWANCE
STANDARD DAY
Model: F-86K
Engine: J47-17B
CLEAN
ALT 1000 FT
FUEL FLOW LB/HR
30 3200
20 4450
10 5850
SL 7400
200 POUNDS OF FUEL
400 LB
600 LB
800 LB
1000 LB
1200 LB
1400 LB
1600 LB
1800 LB
2000 LB
MAXIMUM CONTINUOUS THRUST
0 5 10 15 20 25 30 35 40 45 50
TIME—MINUTES
ALT 1000 FT
FUEL FLOW 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
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-86K-1-93-76A

Figure A-26

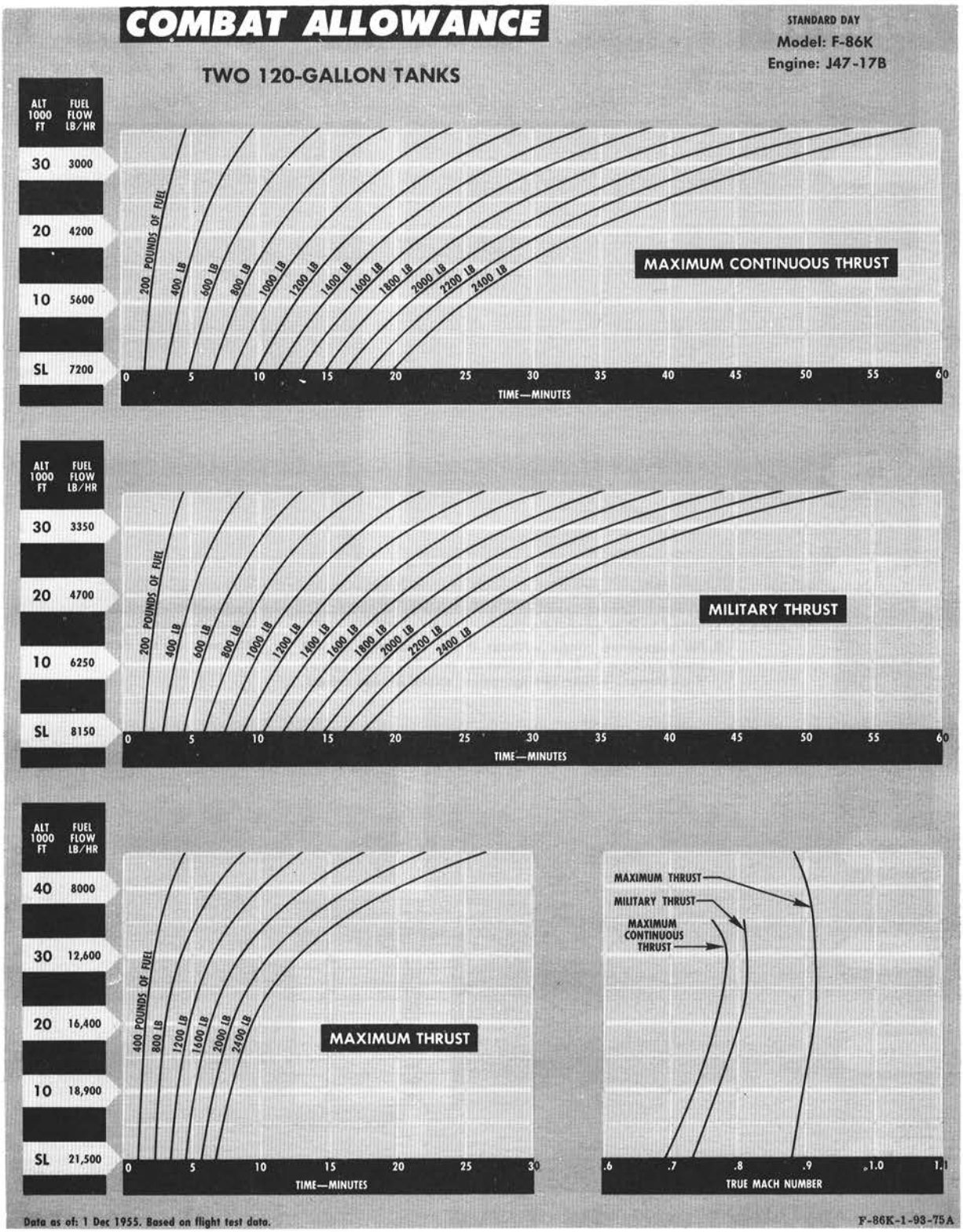

COMBAT ALLOWANCE
STANDARD DAY
Model: F-86K
Engine: J47-17B
TWO 120-GALLON TANKS
ALT 1000 FT
FUEL FLOW LB/HR
30 3000
20 4200
10 5600
SL 7200
200 POUNDS OF FUEL
400 LB
600 LB
800 LB
1000 LB
1200 LB
1400 LB
1600 LB
1800 LB
2000 LB
2200 LB
2400 LB
MAXIMUM CONTINUOUS THRUST
0 5 10 15 20 25 30 35 40 45 50 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
Data as of: 1 Dec 1955. Based on flight test data.
F-86K-1-93-75A

Figure A-27

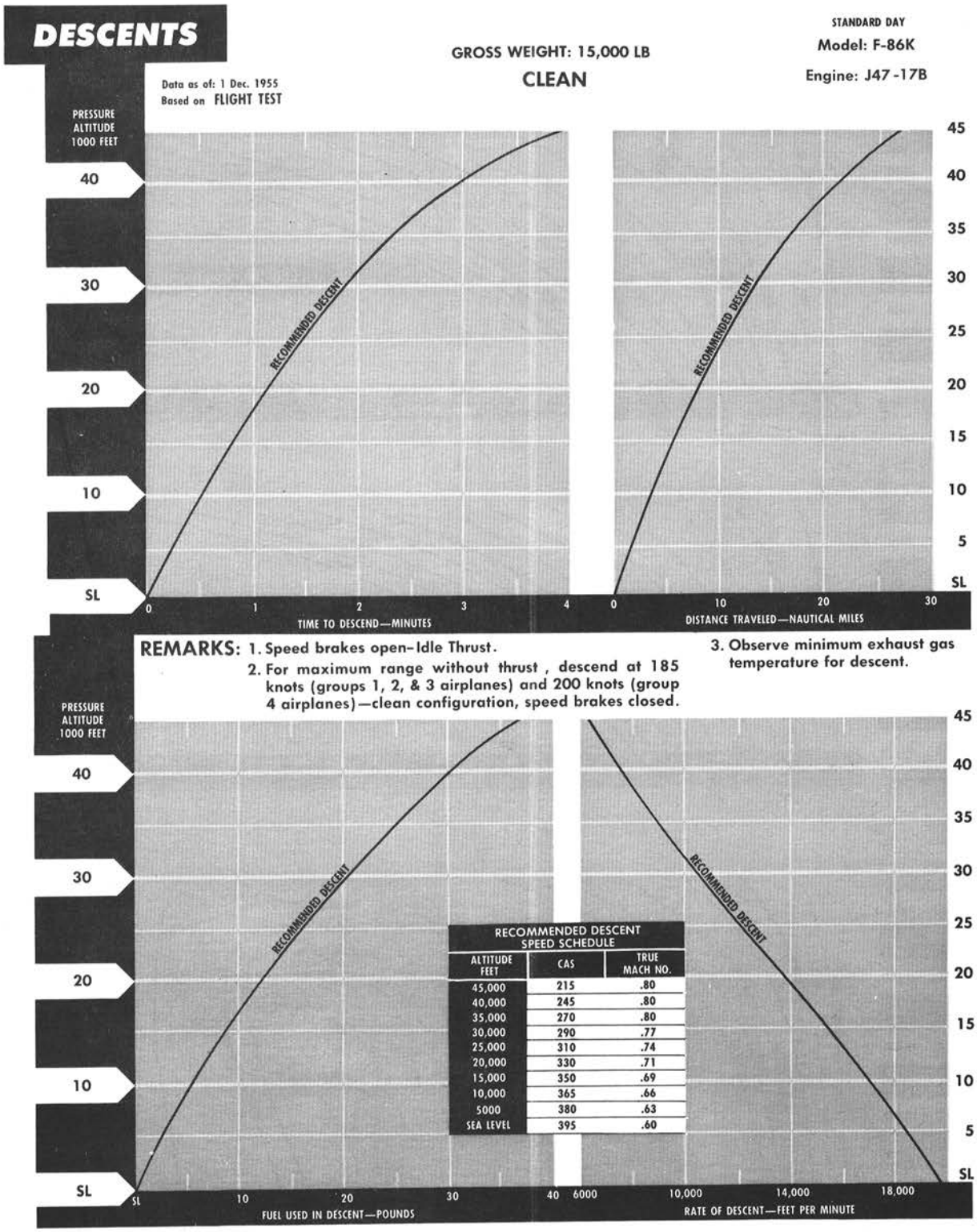

DESCENTS
STANDARD DAY
Model: F-86K
Engine: J47-17B
GROSS WEIGHT: 15,000 LB
CLEAN
Data as of: 1 Dec. 1955
Based on FLIGHT TEST
PRESSURE ALTITUDE 1000 FEET
40
30
20
10
SL
RECOMMENDED DESCENT
0 1 2 3 4
TIME TO DESCEND—MINUTES
0 10 20 30
DISTANCE TRAVELED—NAUTICAL MILES
45 40 35 30 25 20 15 10 5 SL
REMARKS: 1. Speed brakes open-Idle Thrust.
2. For maximum range without thrust, descend at 185 knots (groups 1, 2, & 3 airplanes) and 200 knots (group 4 airplanes)—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
SL 10 20 30 40 6000
FUEL USED IN DESCENT—POUNDS
10,000 14,000 18,000
RATE OF DESCENT—FEET PER MINUTE
F-86K-1-93-80C

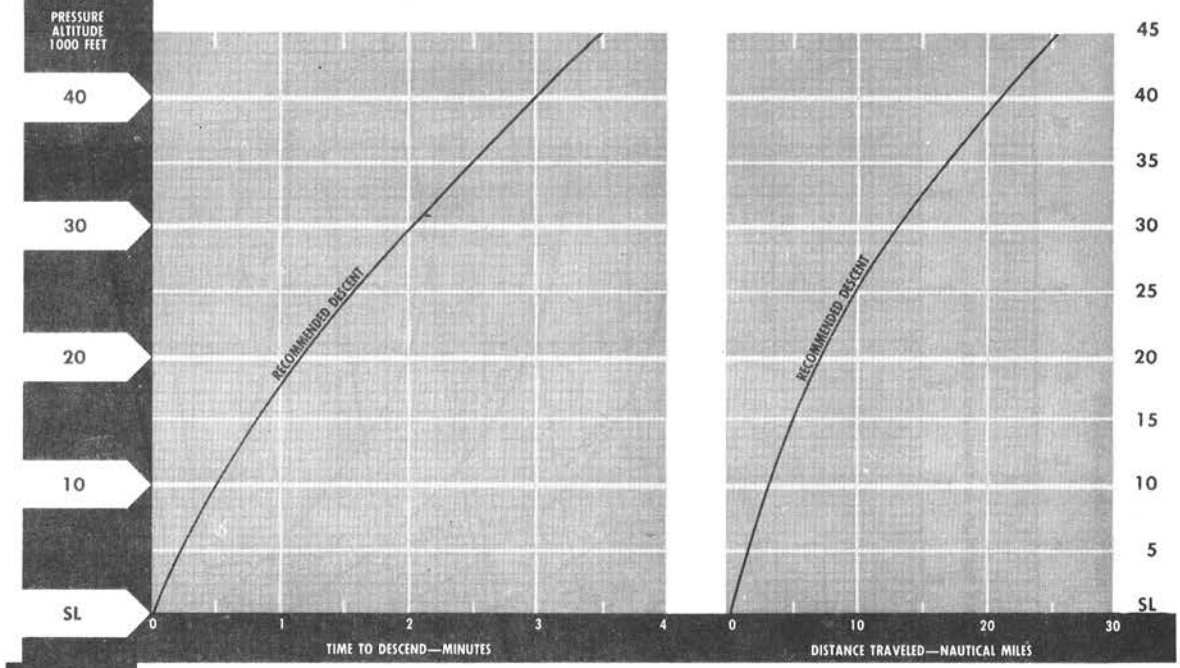
Figure A-28

DESCENTS

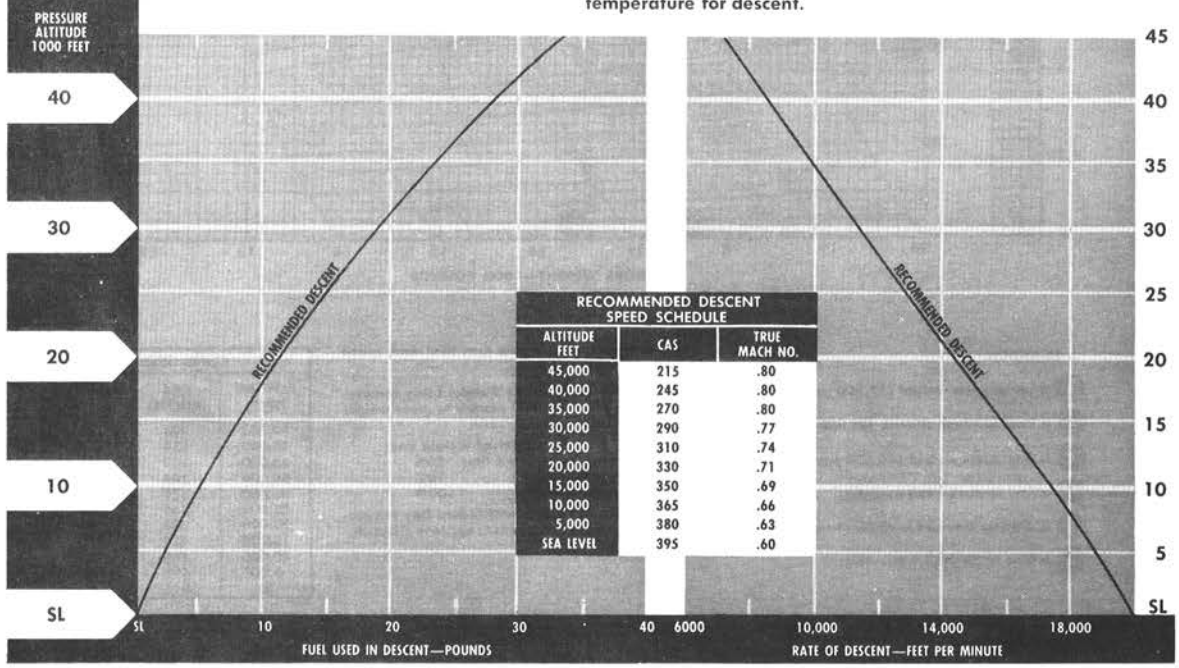
STANDARD DAY
Model: F-86K
Engine: J47-17B

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

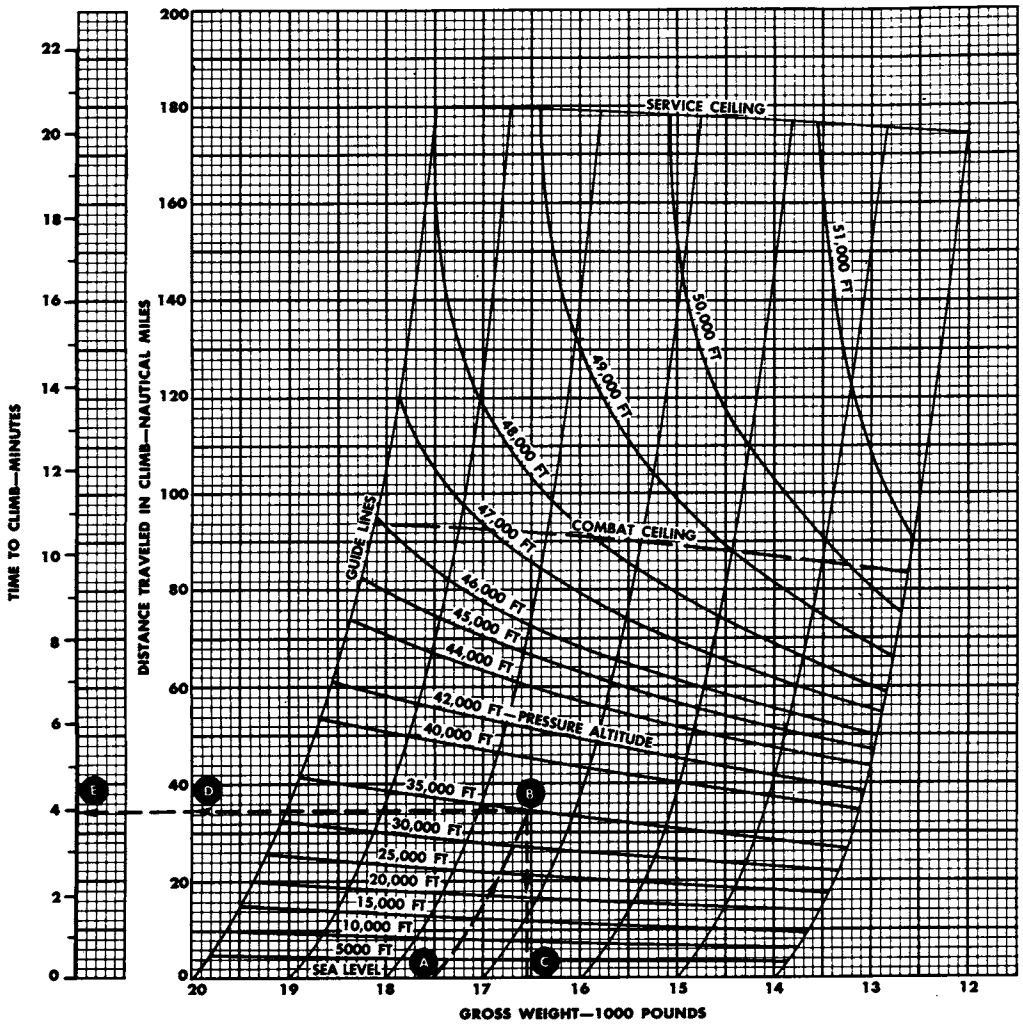
F-86K-1-93-79B

Figure A-29

MAXIMUM THRUST CLIMB

CLEAN

STANDARD DAY
MODEL: F-86K
ENGINE: J47-17B



EXAMPLE:

- (A) is initial gross weight (17,500 pounds).
- (B) is final pressure altitude (35,000 feet).
- (C) is final gross weight (16,550 pounds).
- (A) minus (C) is fuel to climb (950 pounds).
- (D) is distance traveled in climb (34 nautical miles).
- (E) is time to climb (3.9 minutes).

REMARKS:

1. All data computed from time best climb speed is attained.
2. For each 10°C above Standard Day temperatures: (1) Add 2000 pounds to gross weight before entering chart.
   (2) OR, use actual weight and:

Increase distance and time	20%
Increase fuel used	10%
Decrease ceilings	1500 ft

3. For each 10°C below Standard Day temperatures, apply corrections 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

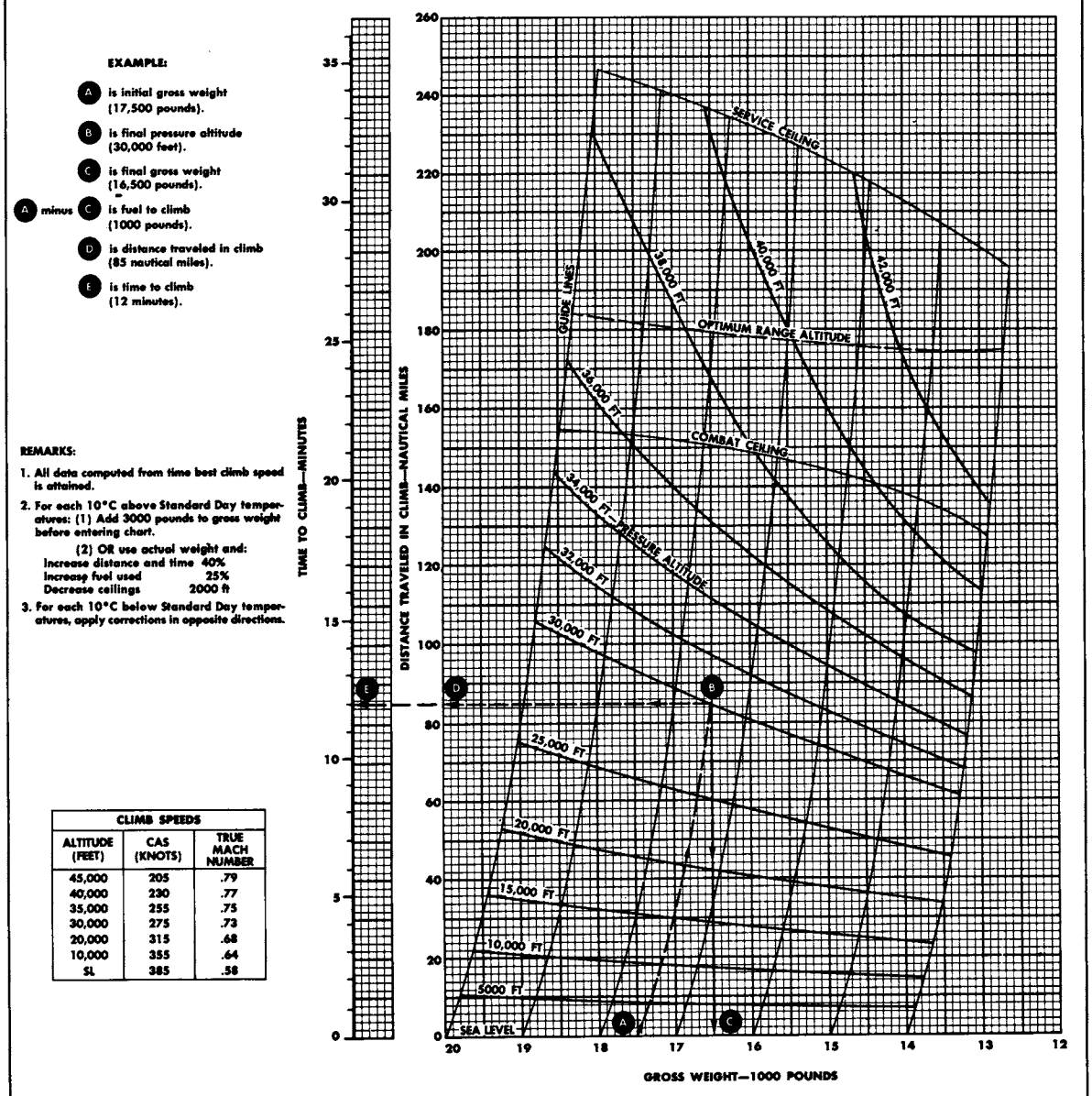
F-86K-1-93-74A

Figure A-30

MILITARY THRUST CLIMB

CLEAN

STANDARD DAY
MODEL: F-86K
ENGINE: J47-17B



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-86K-1-00-15A

Figure A-31

MAXIMUM CONTINUOUS THRUST CLIMB

CLEAN

STANDARD DAY
MODEL: F-86K
ENGINE: J47-17B

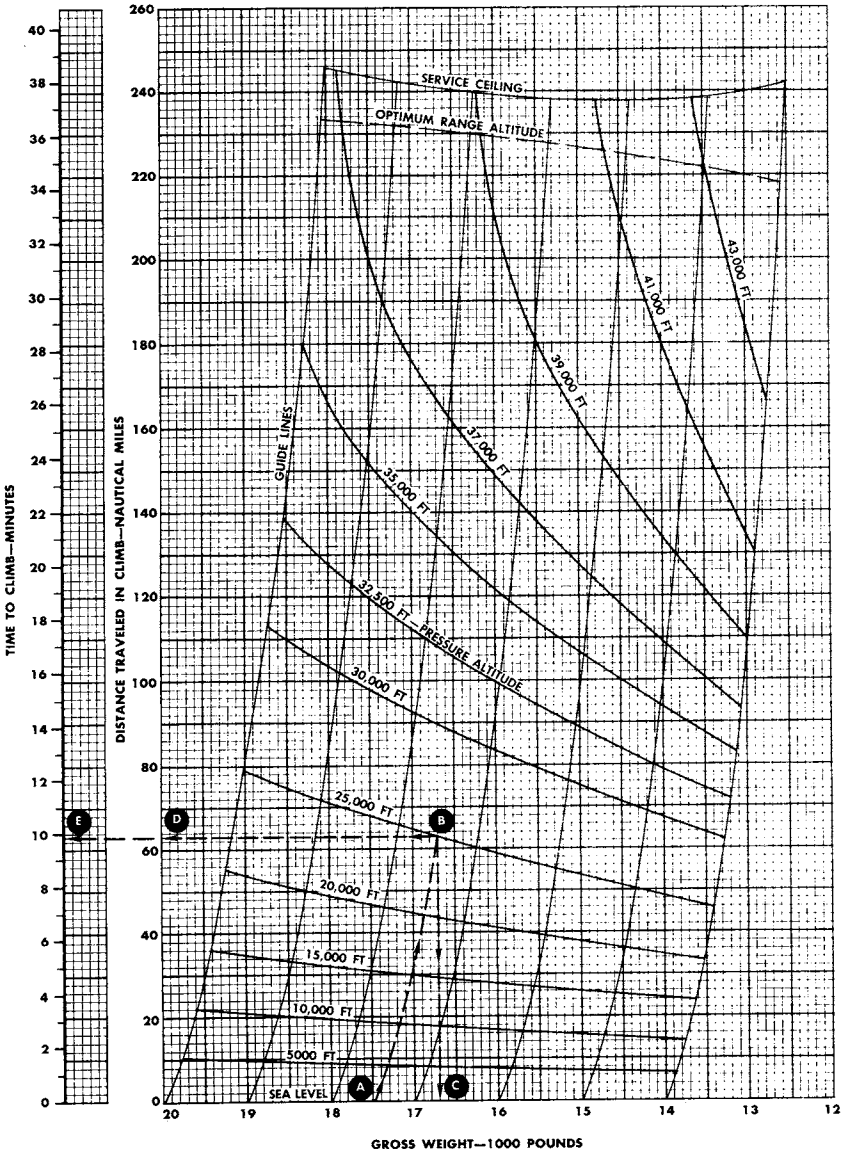
EXAMPLE:

- (A) is initial gross weight (17,500 pounds).
- (B) is final pressure altitude (25,000 feet).
- (C) is final gross weight (16,700 pounds).
- (A) minus (C) is fuel to climb (800 pounds).
- (D) is distance traveled in climb (63 nautical miles).
- (E) 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

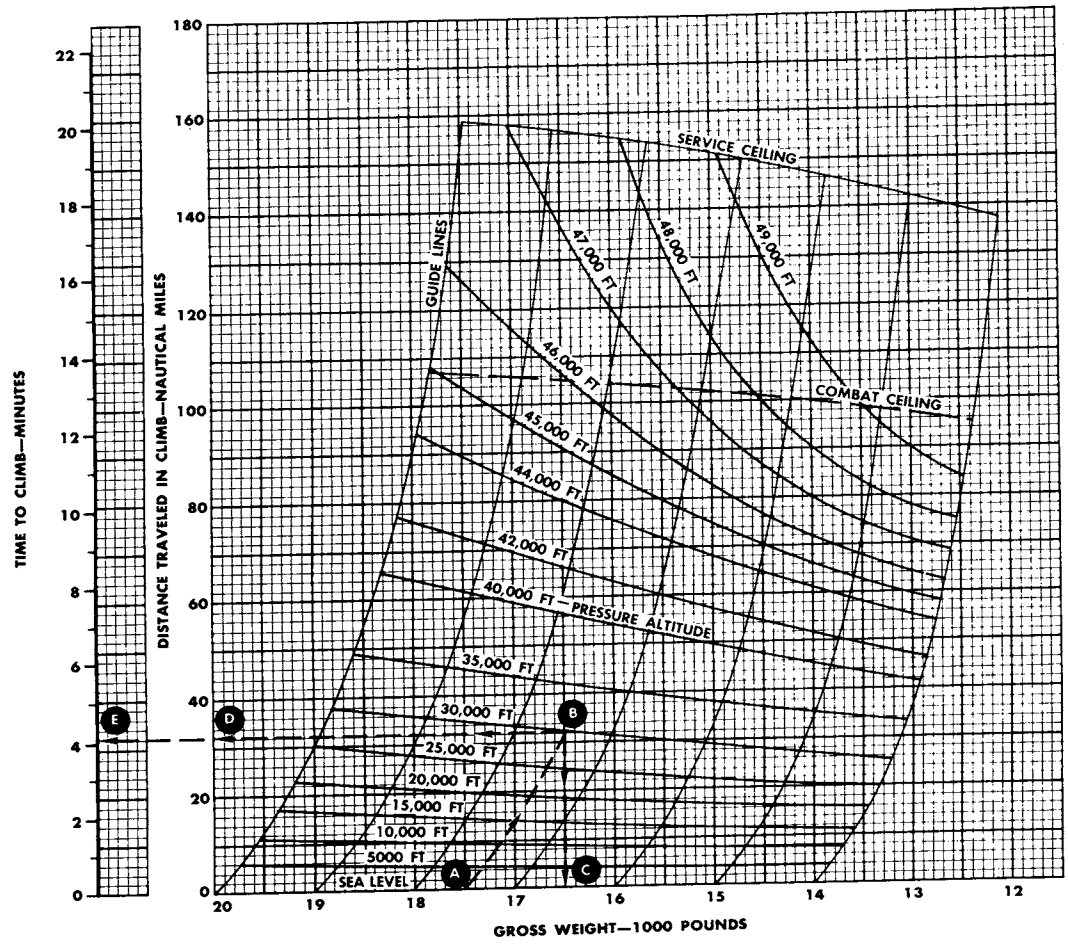
F-86K-1-93-72A

Figure A-32

MAXIMUM THRUST CLIMB

TWO 120-GALLON TANKS

STANDARD DAY
MODEL: F-86K
ENGINE: J47-17B
GROUPS 1, 2 AND 3 AIRPLANES ONLY



EXAMPLE:

- (A) is initial gross weight (17,500 pounds).
- (B) is final pressure altitude (30,000 feet).
- (C) is final gross weight (16,500 pounds).
- (A) minus (C) is fuel to climb (1000 pounds).
- (D) is distance traveled in climb (32 nautical miles).
- (E) is time to climb (4.1 minutes).

REMARKS:

1. All data computed from time best climb speed is attained.
2. For each 10°C above Standard Day temperatures: (1) Add 2000 pounds to gross weight before entering chart.
   (2) OR, use actual weight and:
   Increase distance and time 20%
   Increase fuel used 10%
   Decrease ceilings 1500 ft
3. For each 10°C below Standard Day temperatures, apply corrections 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
20,000	373	.80
10,000	436	.78
SL	482	.73

DATA AS OF: 1 DEC 1955
BASED ON FLIGHT TEST DATA

F-86K-1-93-71B

Figure A-33

MILITARY THRUST CLIMB

TWO 120-GALLON TANKS

STANDARD DAY
MODEL: F-86K
ENGINE: J47-17B
GROUPS 1, 2 AND 3 AIRPLANES ONLY

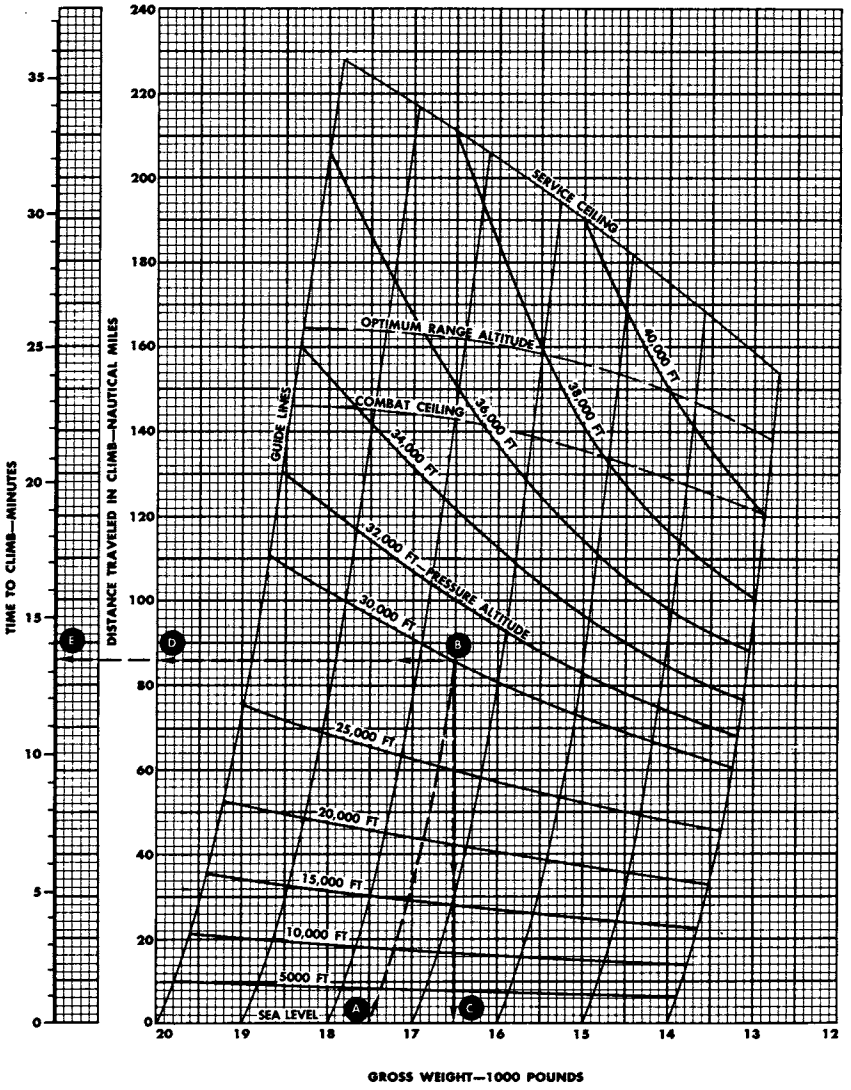
EXAMPLE:

- (A) is initial gross weight (17,500 pounds).
- (B) is final pressure altitude (30,000 feet).
- (C) is final gross weight (16,500 pounds).
- (A) minus (C) is fuel to climb (1000 pounds).
- (D) is distance traveled in climb (86 nautical miles).
- (E) is time to climb (13.4 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
40,000	210	.70
35,000	230	.68
30,000	245	.66
25,000	265	.64
20,000	285	.62
10,000	325	.59
SL	345	.53



DATA AS OF: 1 DEC 1955
BASED ON FLIGHT TEST DATA

F-86K-1-93-70A

Figure A-34

MAXIMUM CONTINUOUS THRUST CLIMB

TWO 120-GALLON TANKS

STANDARD DAY
MODEL: F-86K
ENGINE: J47-17B

GROUPS 1, 2 AND 3 AIRPLANES ONLY

EXAMPLE:

- (A) is initial gross weight (17,500 pounds).
- (B) is final pressure altitude (25,000 feet).
- (C) is final gross weight (16,600 pounds).
- (A) minus (C) is fuel to climb (900 pounds).
- (D) is distance traveled in climb (66 nautical miles).
- (E) is time to climb (11.0 minutes).

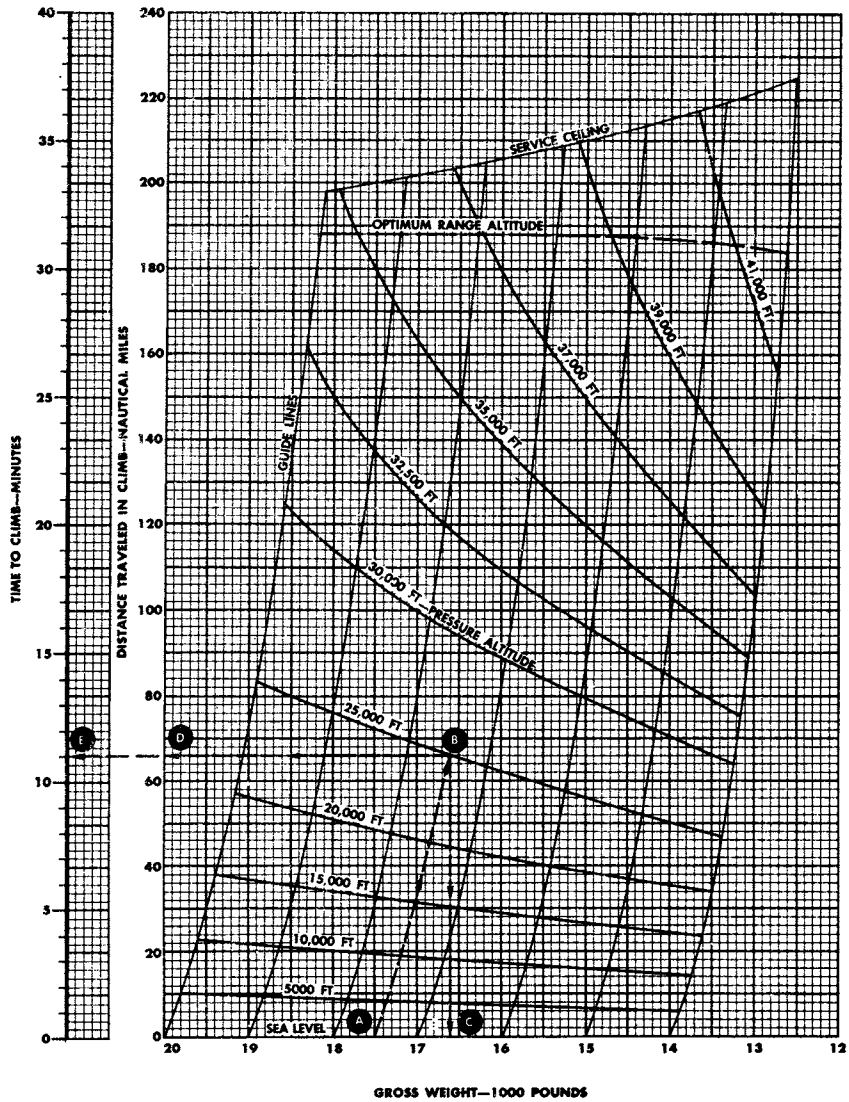
REMARKS:

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 correction in opposite direction.

CLIMB SPEEDS		
ALTITUDE (FEET)	CAS (KNOTS)	TRUE MACH NUMBER
40,000	191	.64
35,000	219	.64
30,000	233	.63
25,000	250	.60
20,000	267	.58
10,000	300	.54
SL	311	.47



DATA AS OF: 1 DEC 1955
BASED ON FLIGHT TEST DATA

F-86K-1-03-00A

Figure A-35

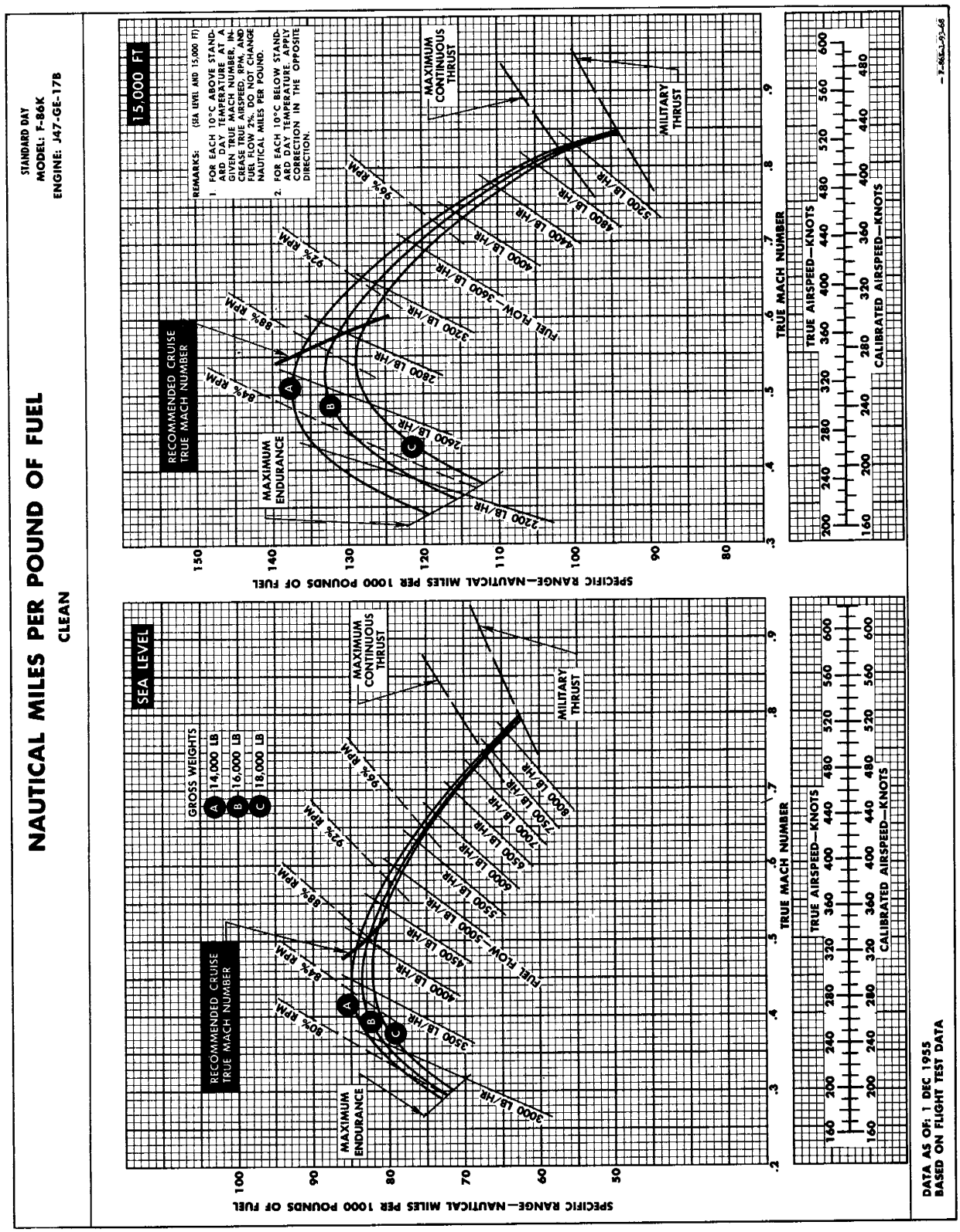

NAUTICAL MILES PER POUND OF FUEL
CLEAN
STANDARD DAY
MODEL: F-86K
ENGINE: J47-GE-17B
15,000 FT
REMARKS: (SEA LEVEL AND 15,000 FT)
1. FOR EACH 10°C ABOVE STANDARD DAY TEMPERATURE AT A GIVEN TRUE MACH NUMBER, INCREASE TRUE AIRSPEED, RPM, AND FUEL FLOW 2%. DO NOT CHANGE NAUTICAL MILES PER POUND.
2. FOR EACH 10°C BELOW STANDARD DAY TEMPERATURE, APPLY CORRECTION IN THE OPPOSITE DIRECTION.
MAXIMUM CONTINUOUS THRUST
MILITARY THRUST
RECOMMENDED CRUISE TRUE MACH NUMBER
MAXIMUM ENDURANCE
FUEL FLOW - 3600 LB/HR
SPECIFIC RANGE—NAUTICAL MILES PER 1000 POUNDS OF FUEL
TRUE MACH NUMBER
TRUE AIRSPEED—KNOTS
CALIBRATED AIRSPEED—KNOTS
SEA LEVEL
GROSS WEIGHTS
A 14,000 LB
B 16,000 LB
C 18,000 LB
FUEL FLOW - 5000 LB/HR
DATA AS OF: 1 DEC 1955
BASED ON FLIGHT TEST DATA

Figure A-36

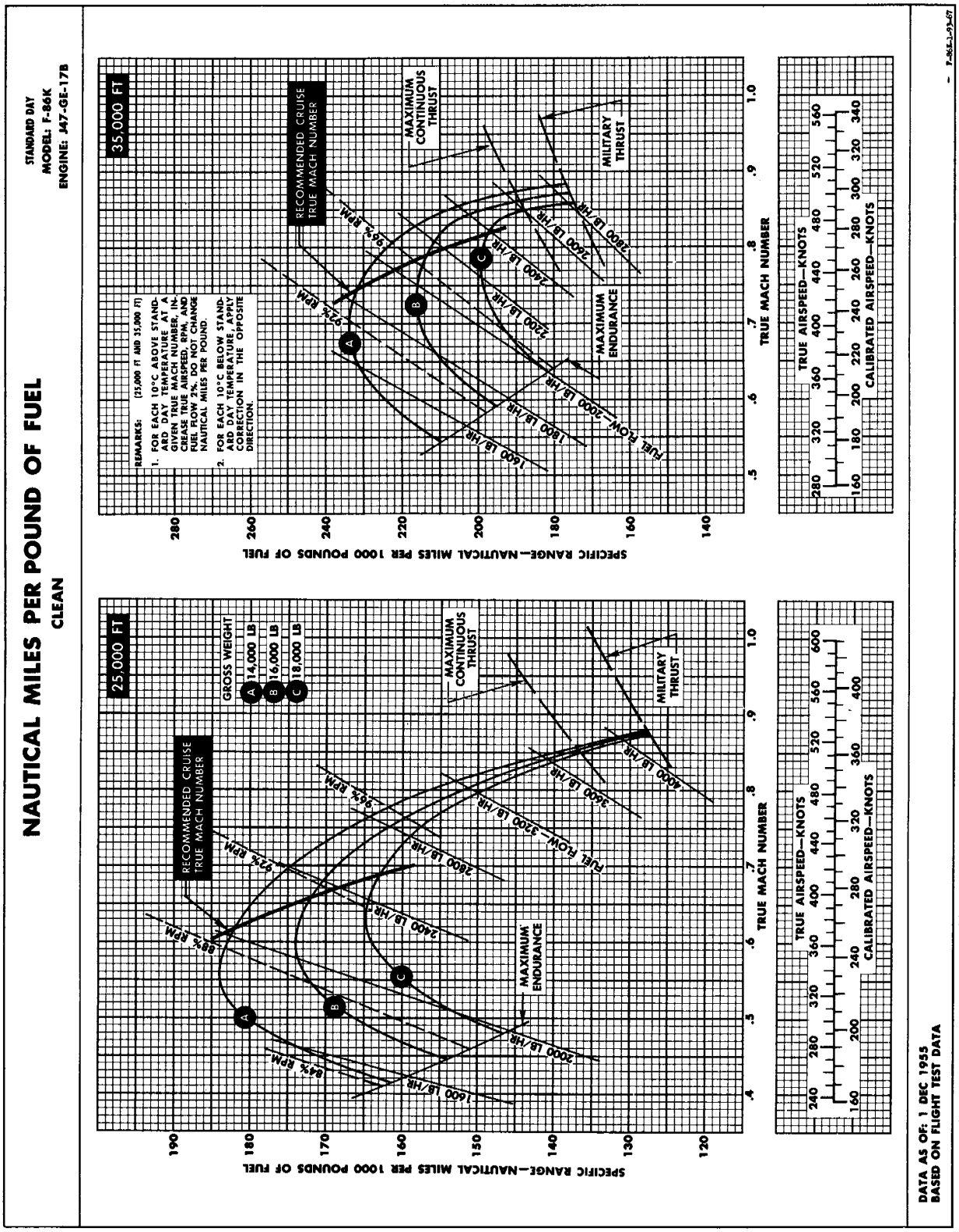
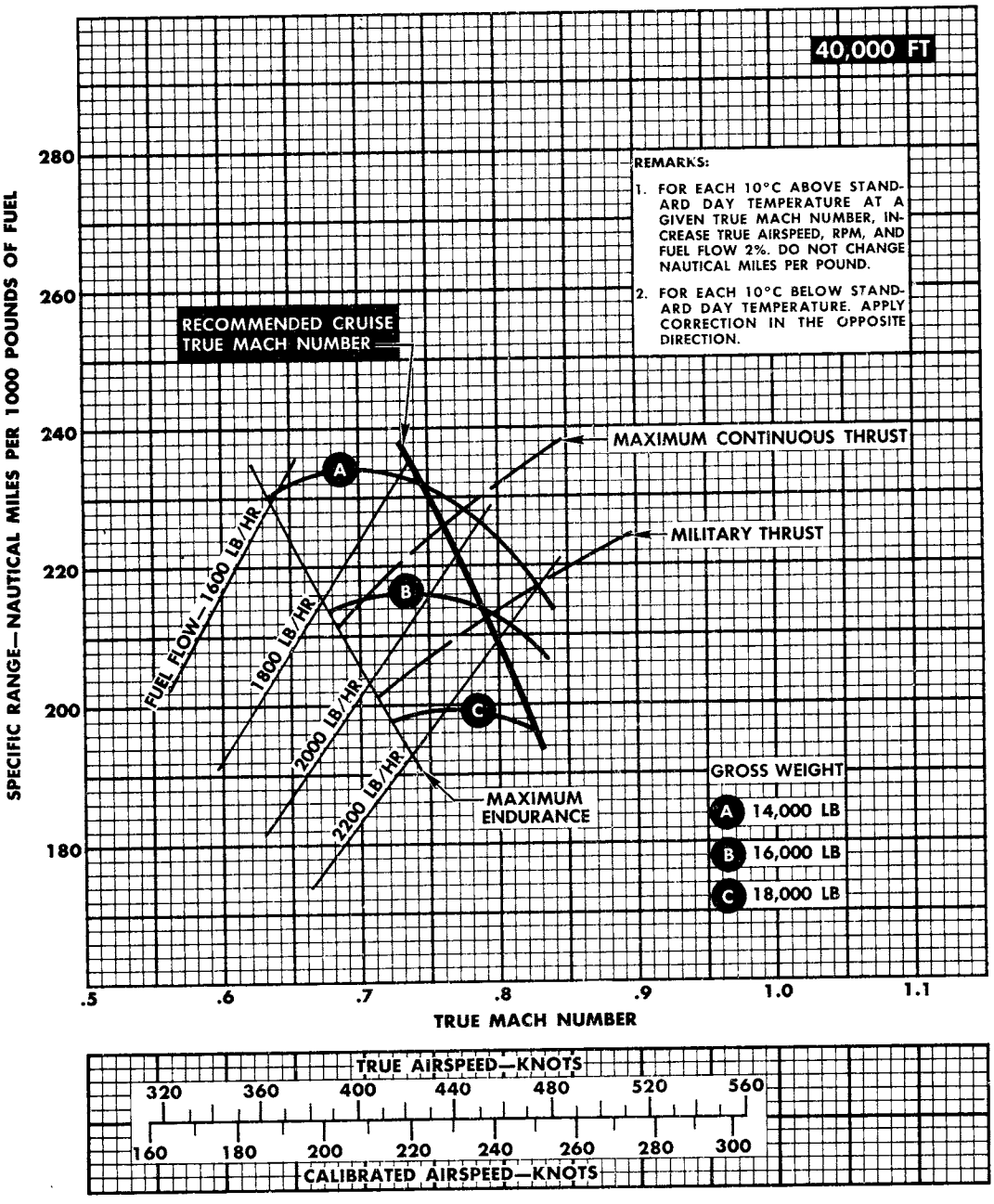

NAUTICAL MILES PER POUND OF FUEL
CLEAN
STANDARD DAY
MODEL: F-86K
ENGINE: J47-GE-17B
35,000 FT
25,000 FT
REMARKS: (25,000 FT AND 35,000 FT)
1. FOR EACH 10°C ABOVE STANDARD DAY TEMPERATURE AT A GIVEN TRUE MACH NUMBER, INCREASE TRUE AIRSPEED, RPM, AND FUEL FLOW 2%. DO NOT CHANGE NAUTICAL MILES PER POUND.
2. FOR EACH 10°C BELOW STANDARD DAY TEMPERATURE, APPLY CORRECTION IN THE OPPOSITE DIRECTION.
RECOMMENDED CRUISE TRUE MACH NUMBER
MAXIMUM CONTINUOUS THRUST
MILITARY THRUST
MAXIMUM ENDURANCE
GROSS WEIGHT
A 14,000 LB
B 16,000 LB
C 18,000 LB
FUEL FLOW—2000 LB/HR
FUEL FLOW—3200 LB/HR
1600 LB/HR
1800 LB/HR
2400 LB/HR
2600 LB/HR
3400 LB/HR
4000 LB/HR
95% RPM
97% RPM
88% RPM
92% RPM
85% RPM
SPECIFIC RANGE—NAUTICAL MILES PER 1000 POUNDS OF FUEL
TRUE MACH NUMBER
TRUE AIRSPEED—KNOTS
CALIBRATED AIRSPEED—KNOTS
DATA AS OF: 1 DEC 1955
BASED ON FLIGHT TEST DATA

Figure A-37

NAUTICAL MILES PER POUND OF FUEL

CLEAN

STANDARD DAY
MODEL: F-86K
ENGINE: J47-GE-17B



DATA AS OF: 1 DEC 1955
BASED ON FLIGHT TEST DATA

F-86K-1-93-66

Figure A-38

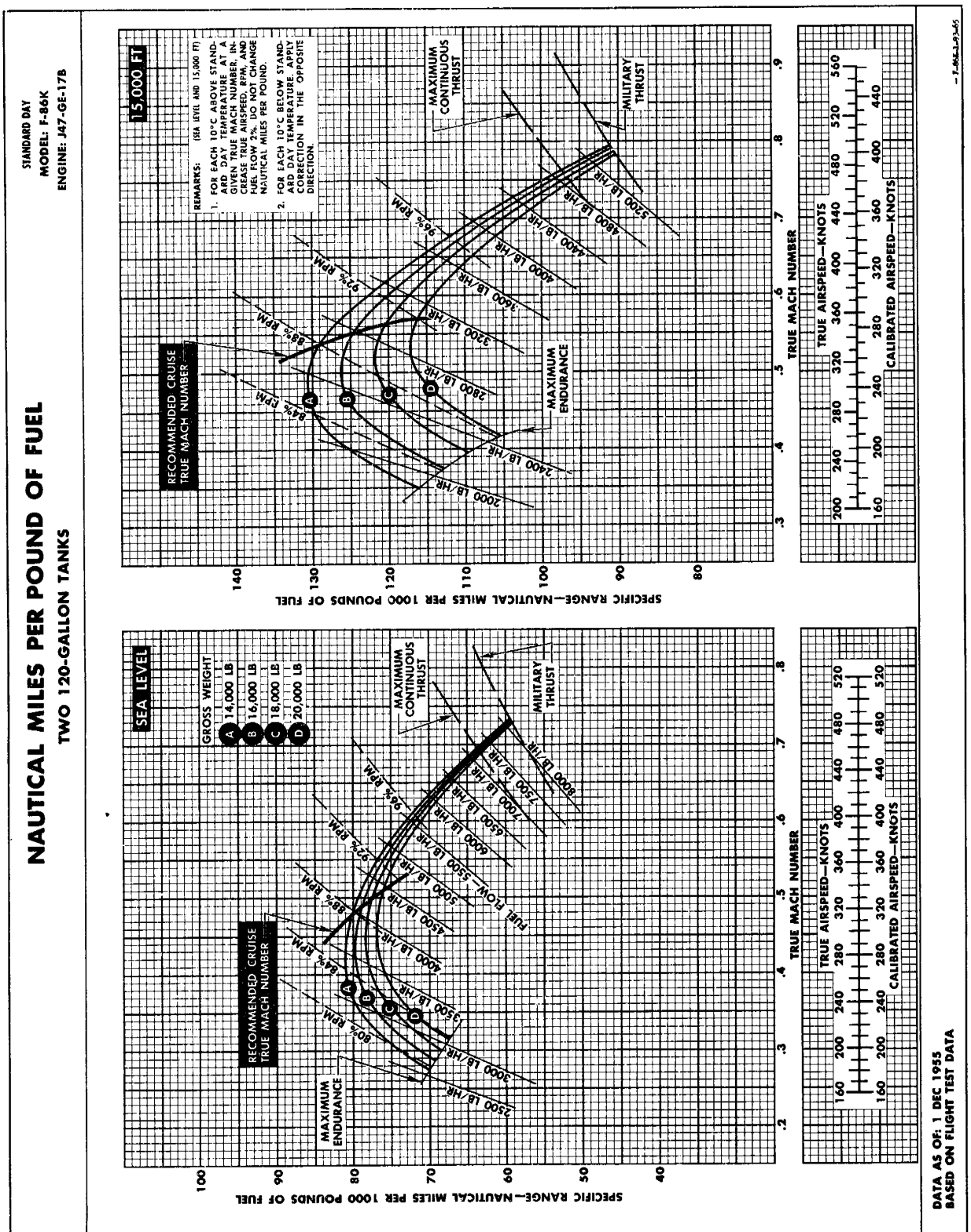

NAUTICAL MILES PER POUND OF FUEL
TWO 120-GALLON TANKS
STANDARD DAY
MODEL: F-86K
ENGINE: J47-GE-17B
SEA LEVEL
GROSS WEIGHT
A 14,000 LB
B 16,000 LB
C 18,000 LB
D 20,000 LB
RECOMMENDED CRUISE TRUE MACH NUMBER
MAXIMUM ENDURANCE
MAXIMUM CONTINUOUS THRUST
MILITARY THRUST
FUEL FLOW—5500 LB/HR
SPECIFIC RANGE—NAUTICAL MILES PER 1000 POUNDS OF FUEL
TRUE MACH NUMBER
TRUE AIRSPEED—KNOTS
CALIBRATED AIRSPEED—KNOTS
15,000 FT
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

Figure A-39

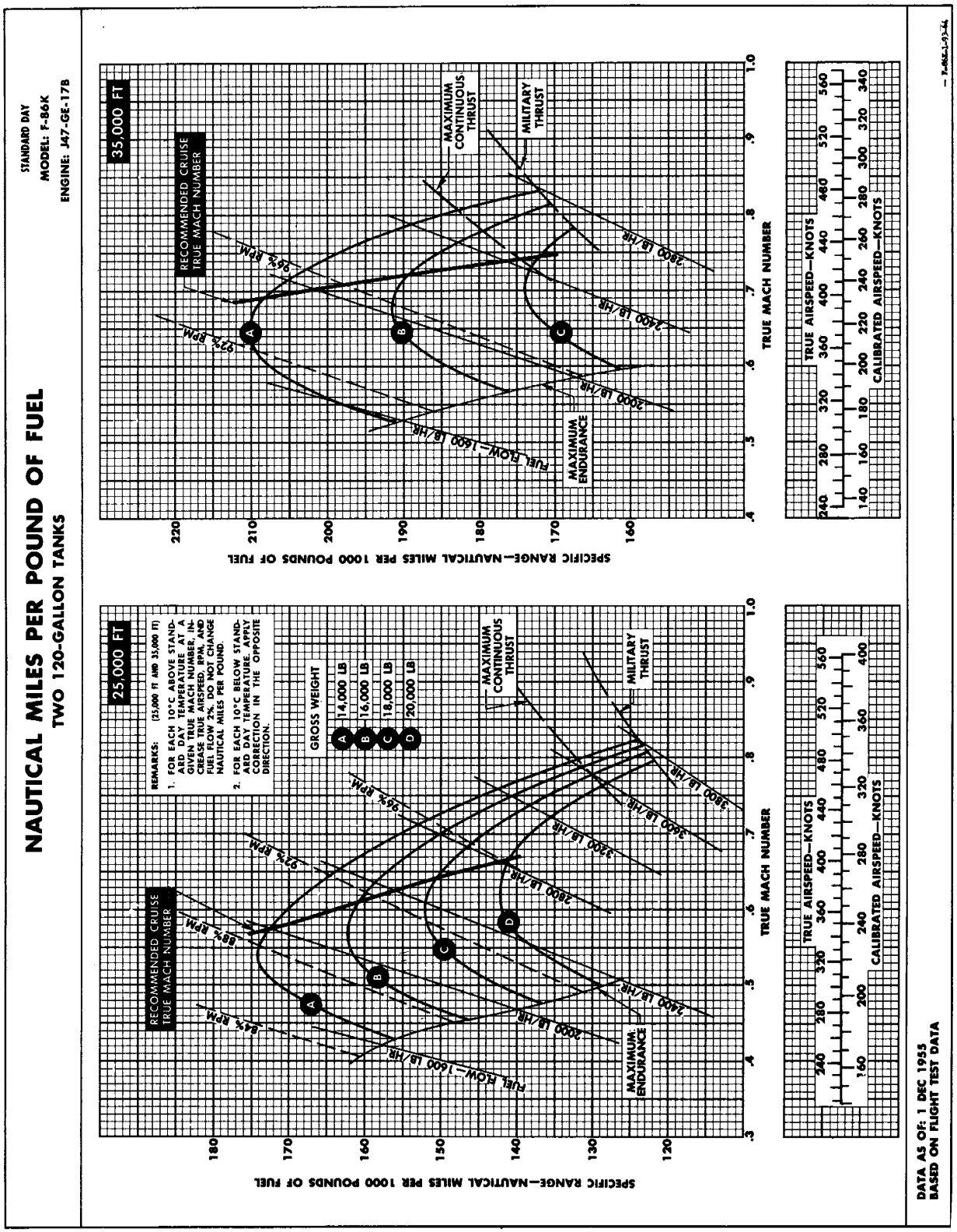
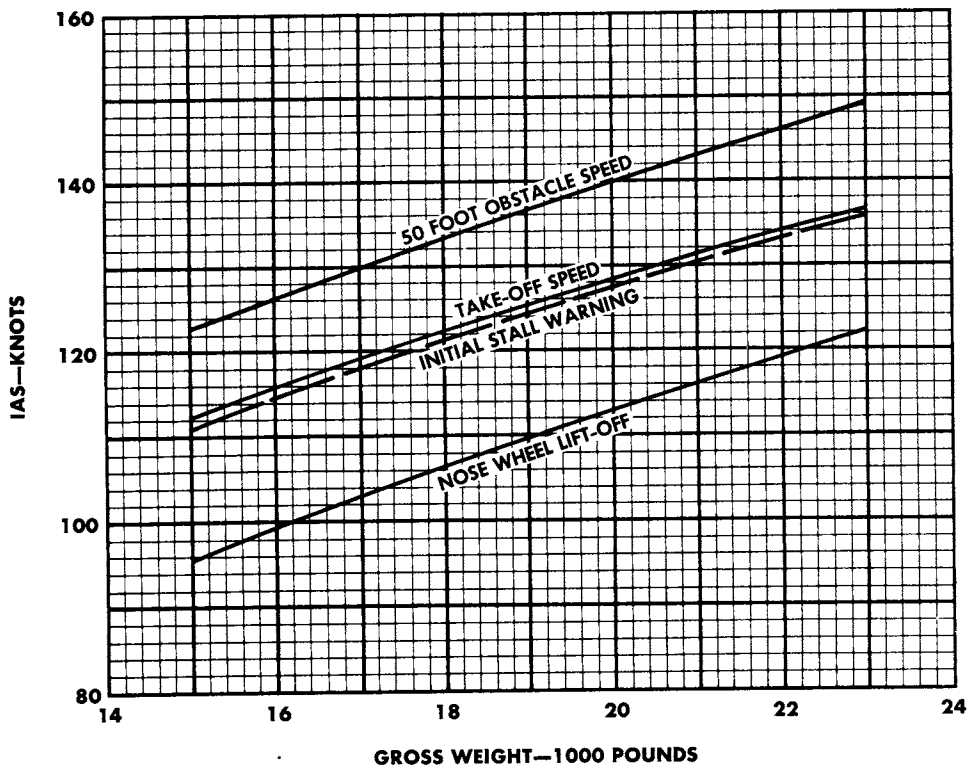

NAUTICAL MILES PER POUND OF FUEL
TWO 120-GALLON TANKS
STANDARD DAY
MODEL: F-86K
ENGINE: J47-GE-17B
35,000 FT
RECOMMENDED CRUISE
TRUE MACH NUMBER
97% RPM
96% RPM
MAXIMUM CONTINUOUS THRUST
MILITARY THRUST
MAXIMUM ENDURANCE
FUEL FLOW—1600 LB/HR
2800 LB/HR
2400 LB/HR
2000 LB/HR
SPECIFIC RANGE—NAUTICAL MILES PER 1000 POUNDS OF FUEL
TRUE MACH NUMBER
TRUE AIRSPEED—KNOTS
CALIBRATED AIRSPEED—KNOTS
25,000 FT
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 2% 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.
GROSS WEIGHT
A 14,000 LB
B 16,000 LB
C 18,000 LB
D 20,000 LB
88% RPM
94% RPM
3200 LB/HR
3600 LB/HR
DATA AS OF: 1 DEC 1955
BASED ON FLIGHT TEST DATA

Figure A-40

TAKE-OFF SPEEDS

STANDARD DAY
MODEL: F-86K
ENGINE: J47-17B

GROUP 4 AIRPLANES ONLY



DATA AS OF: 7 MAY 1957
BASED ON: FLIGHT TEST DATA

F-86K-1-93-127A

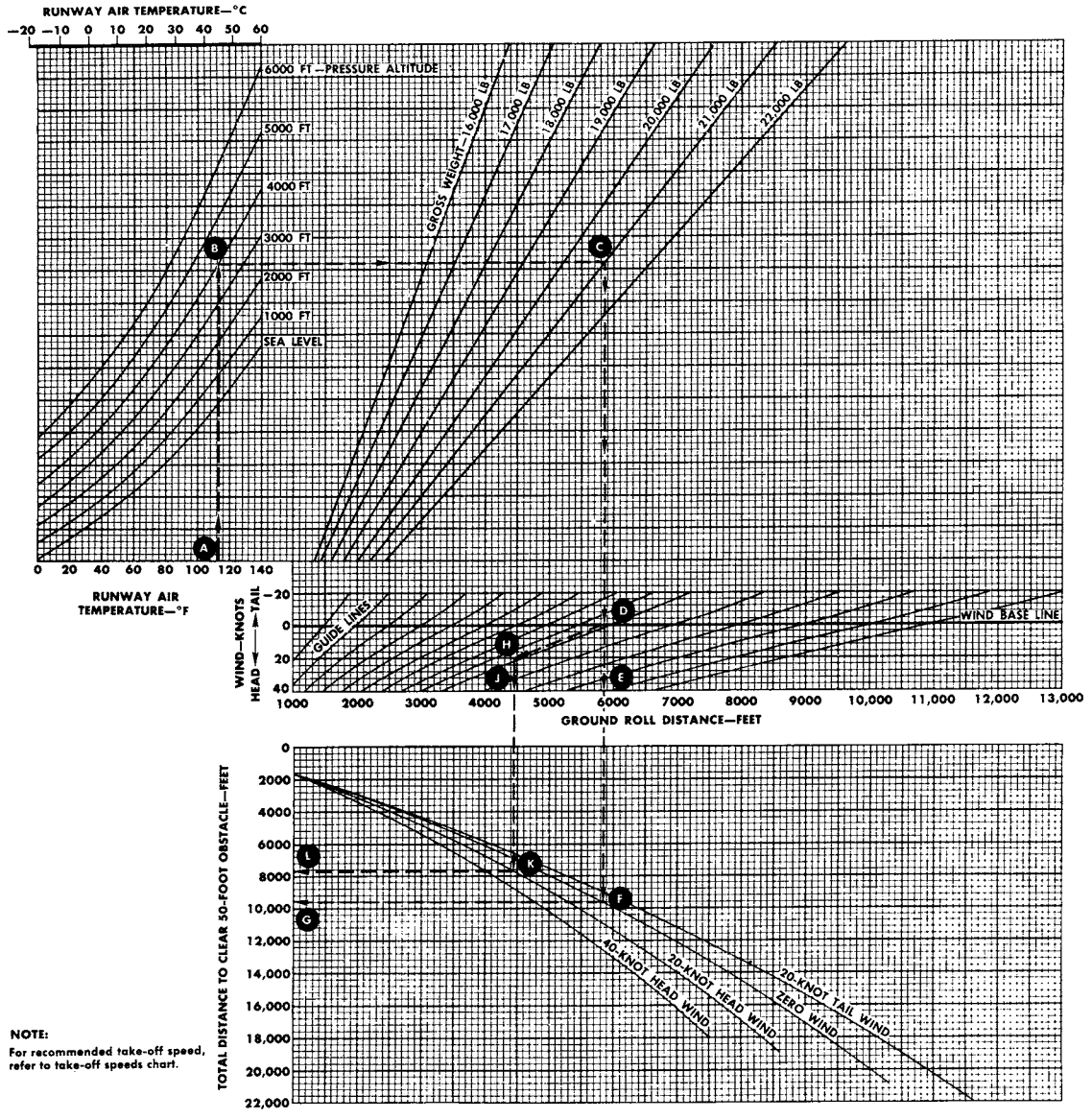
Figure A-41

FLAPS FULL DOWN

TAKE-OFF DISTANCES

MAXIMUM THRUST

HARD-SURFACE RUNWAY
MODEL: F-86K
ENGINE: J47 -17B
GROUP 4 AIRPLANES ONLY



NOTE:
For recommended take-off speed, refer to take-off speeds chart.

EXAMPLE:

- (A) is runway air temperature (113°F).
- (B) is pressure altitude (4000 feet).
- (C) is gross weight (21,000 pounds).
- (D) is wind base line (zero).
- (E) is ground roll with zero wind (5850 feet).
- (F) is wind base line (zero).
- (G) is total distance to clear 50-foot obstacle (9600 feet).
- (H) is head wind (20 knots).
- (J) is ground roll with 20-knot head wind (4450 feet).
- (K) is head wind base line (20 knots).
- (L) 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-86K-1-93-136A

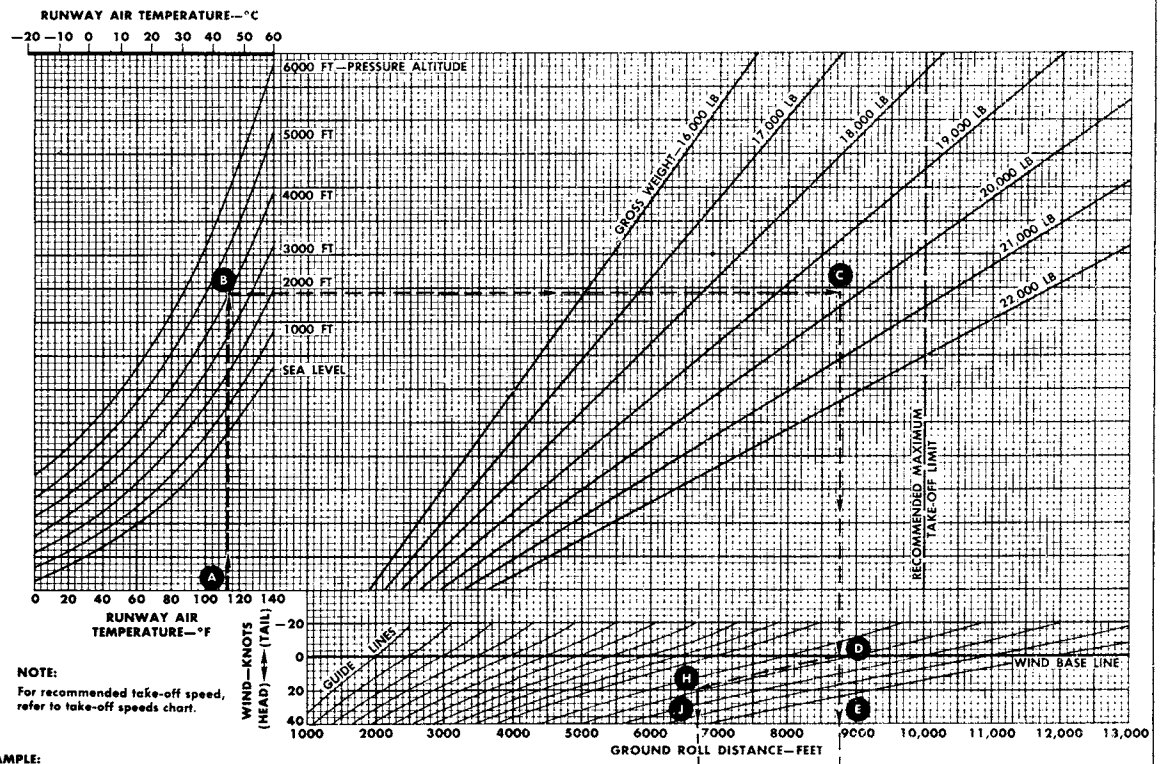
Figure A-42

FLAPS FULL DOWN

TAKE-OFF DISTANCES

MILITARY THRUST

HARD-SURFACE RUNWAY
MODEL: F-86K
ENGINE: J47-17B
GROUP 4 AIRPLANES ONLY

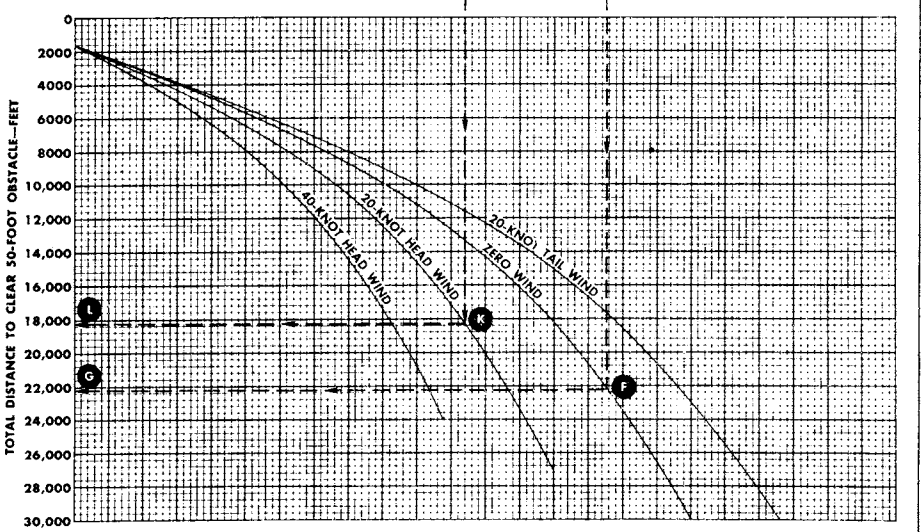


NOTE:

For recommended take-off speed, refer to take-off speeds chart.

EXAMPLE:

- **A** is runway air temperature (113°F).
- **B** is pressure altitude (4000 feet).
- **C** is gross weight (19,750 pounds).
- **D** is wind base line (zero).
- **E** is ground roll with zero wind (8760 feet).
- **F** is wind base line (zero).
- **G** is total distance to clear 50-foot obstacle (22,200 feet).
- **H** is head wind (20 knots).
- **J** is ground roll with 20-knot head wind (6700 feet).
- **K** is head wind base line (20 knots).
- **L** 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

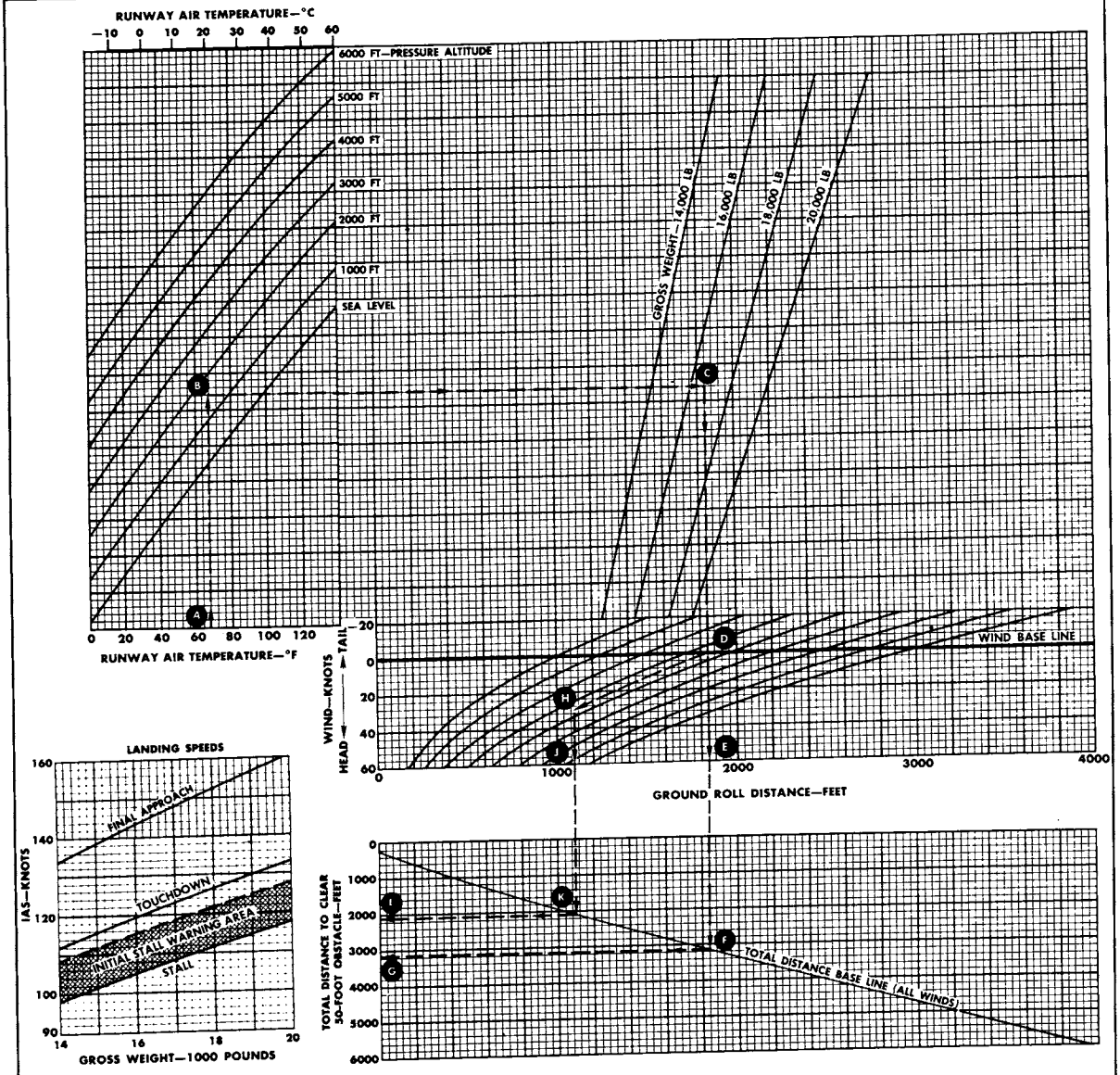
F-86K-1-93-126A

Figure A-43

DRAG CHUTE DEPLOYED
SPEED BRAKES OPEN
FLAPS FULL DOWN

LANDING DISTANCES

HARD-SURFACE RUNWAY
MODEL: F-86K
ENGINE: J47-17B
GROUP 4 AIRPLANES ONLY



EXAMPLE:

- **A** is air temperature (68°F).
- **B** is pressure altitude (1500 feet).
- **C** is gross weight (16,600 pounds).
- **D** is base line (zero wind).
- **E** is ground roll distance with zero wind (1840 feet).
- **F** is base line for total distance.
- **G** is total distance to clear 50-foot obstacle with zero wind (3150 feet).
- **H** is head wind (30 knots).
- **J** is ground roll with 30-knot head wind (1090 feet).
- **K** is base line for total distance.
- **L** is total distance to clear 50-foot obstacle with 30-knot head wind (2100 feet).

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-86K-1-93-125B

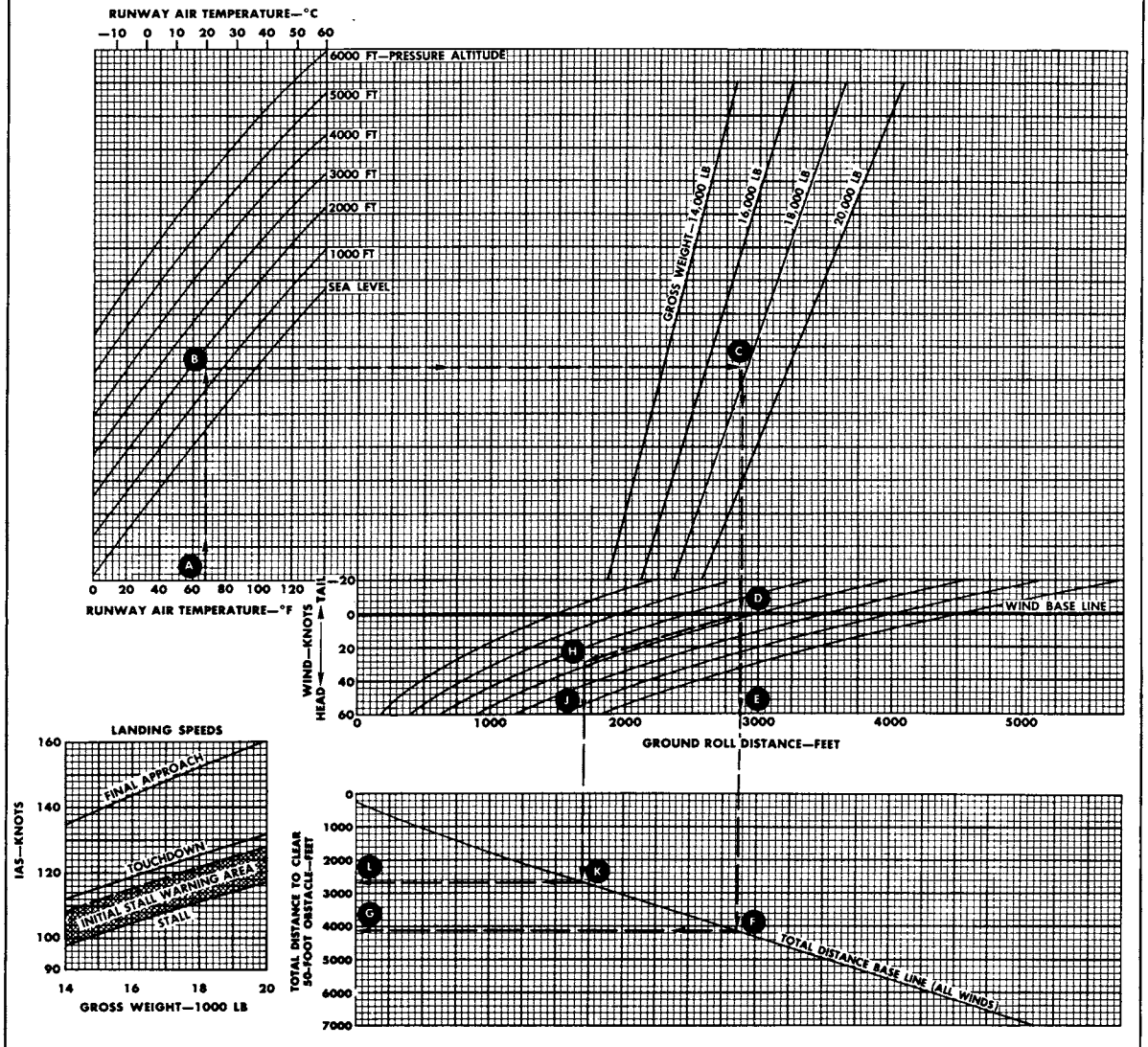
Figure A-44

Changed 16 January 1959

DRAG CHUTE NOT DEPLOYED
SPEED BRAKES OPEN
FLAPS FULL DOWN

LANDING DISTANCES

HARD-SURFACE RUNWAY
MODEL: F-86K
ENGINE: J47-17B
GROUP 4 AIRPLANES ONLY



EXAMPLE:

- (A) is air temperature (68°F).
- (B) is pressure altitude (1500 feet).
- (C) is gross weight (17,600 pounds).
- (D) is base line (zero wind).
- (E) is ground roll distance with zero wind (2860 feet).
- (F) is base line for total distance.
- (G) is total distance to clear 50-foot obstacle with zero wind (4150 feet).
- (H) is head wind (30 knots).
- (J) is ground roll with 30-knot head wind (1700 feet).
- (K) is base line for total distance.
- (L) 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-86K-1-93-124B

Figure A-45

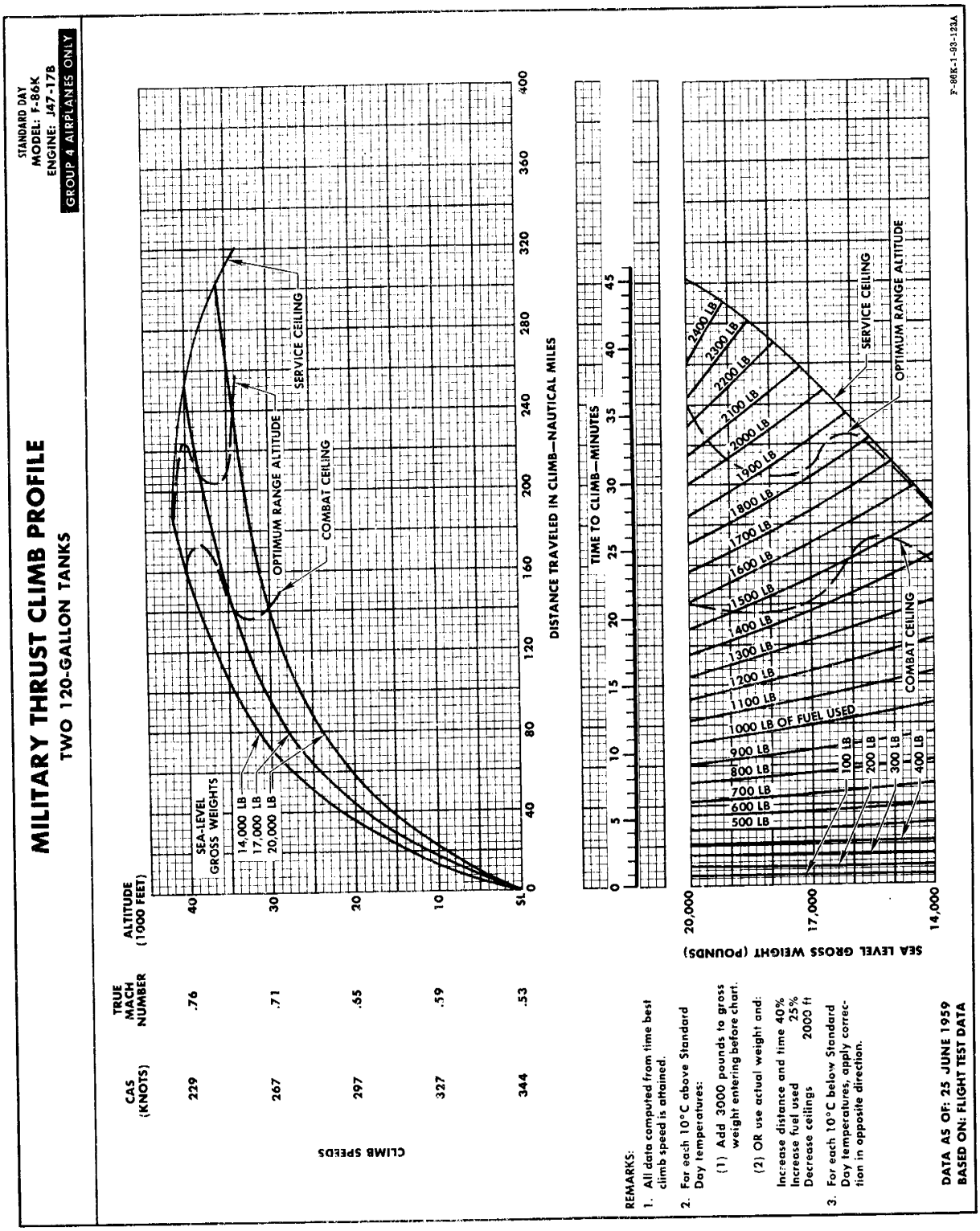

MILITARY THRUST CLIMB PROFILE
TWO 120-GALLON TANKS
STANDARD DAY
MODEL: F-86K
ENGINE: J47-17B
GROUP 4 AIRPLANES ONLY
CAS (KNOTS)
TRUE MACH NUMBER
ALTITUDE (1000 FEET)
229 .76
267 .71
297 .65
327 .59
344 .53
CLIMB SPEEDS
SEA-LEVEL GROSS WEIGHTS
14,000 LB
17,000 LB
20,000 LB
OPTIMUM RANGE ALTITUDE
SERVICE CEILING
COMBAT CEILING
DISTANCE TRAVELED IN CLIMB—NAUTICAL MILES
TIME TO CLIMB—MINUTES
SEA LEVEL GROSS WEIGHT (POUNDS)
2400 LB
2300 LB
2200 LB
2100 LB
2000 LB
1900 LB
1800 LB
1700 LB
1600 LB
1500 LB
1400 LB
1300 LB
1200 LB
1100 LB
1000 LB OF FUEL USED
900 LB
800 LB
700 LB
600 LB
500 LB
100 LB
200 LB
300 LB
400 LB
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 JUNE 1959
BASED ON: FLIGHT TEST DATA
F-86K-1-93-123A

Figure A-46

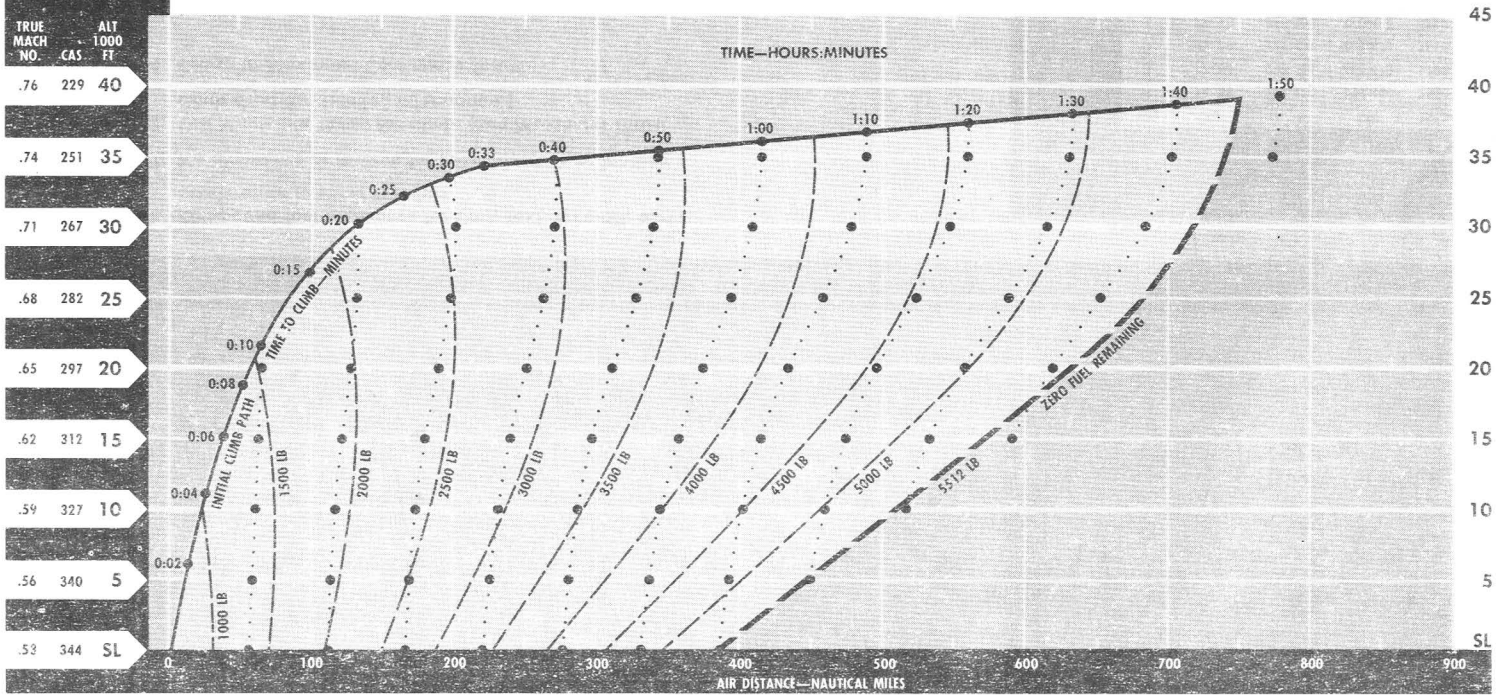
MISSION PROFILE

STANDARD DAY
Model: F-86K
Engine: J47-17B

GROUP 4 AIRPLANES ONLY

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 *					
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-86K-1-93-122

Figure A-47

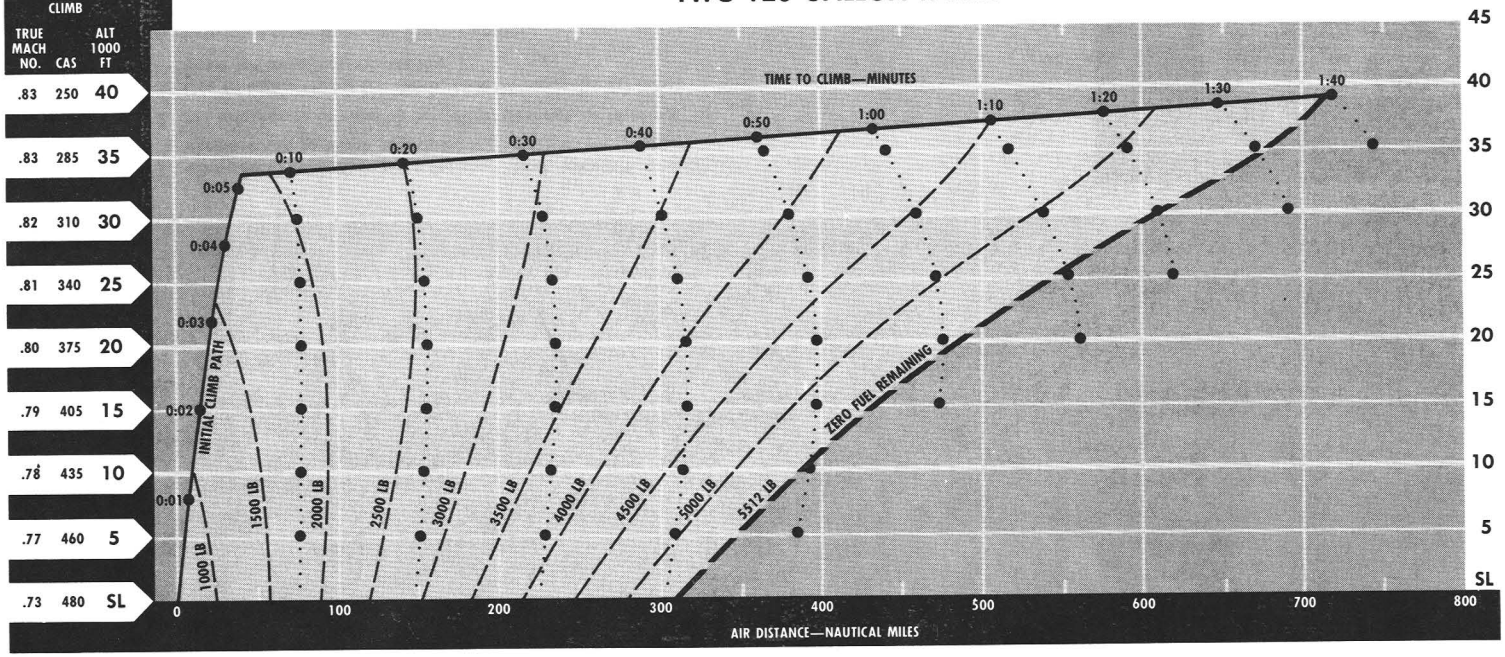
INTERCEPT PROFILE

STANDARD DAY
Model: F-86K
Engine: J47-17B

GROUP 4 AIRPLANES ONLY

TAKE-OFF GROSS WEIGHT: 19,700-20,500 LB
ALL FUEL LOADS BETWEEN 0-5512 LB

TWO 120-GALLON TANKS



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.

Data as of: 25 Dec. 1957. Based on flight test data.

F-86K-1-93-121

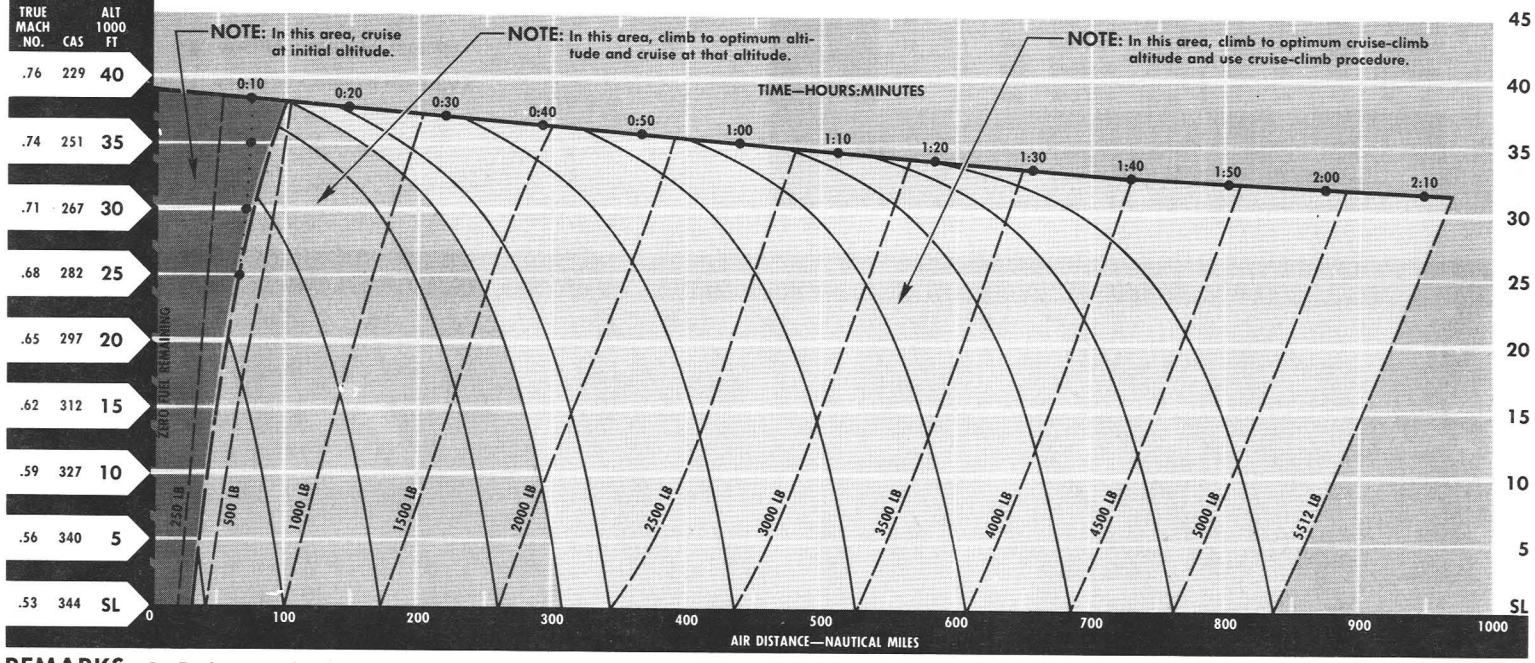
OPTIMUM RETURN PROFILE

STANDARD DAY
Model: F-86K
Engine: J47-17B

GROUP 4 AIRPLANES ONLY

TWO 120-GALLON TANKS

TAKE-OFF GROSS WEIGHT: 19,700-20,500 LB
ALL FUEL LOADS BETWEEN 0-5512 LB



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-86K-1-93-120

MAXIMUM ENDURANCE PROFILE

STANDARD DAY
Model: F-86K
Engine: J47-17B

GROUP 4 AIRPLANES ONLY

TWO 120-GALLON TANKS

TAKE-OFF GROSS WEIGHT: 19,700-20,500 LB
ALL FUEL LOADS BETWEEN 0-5512 LB

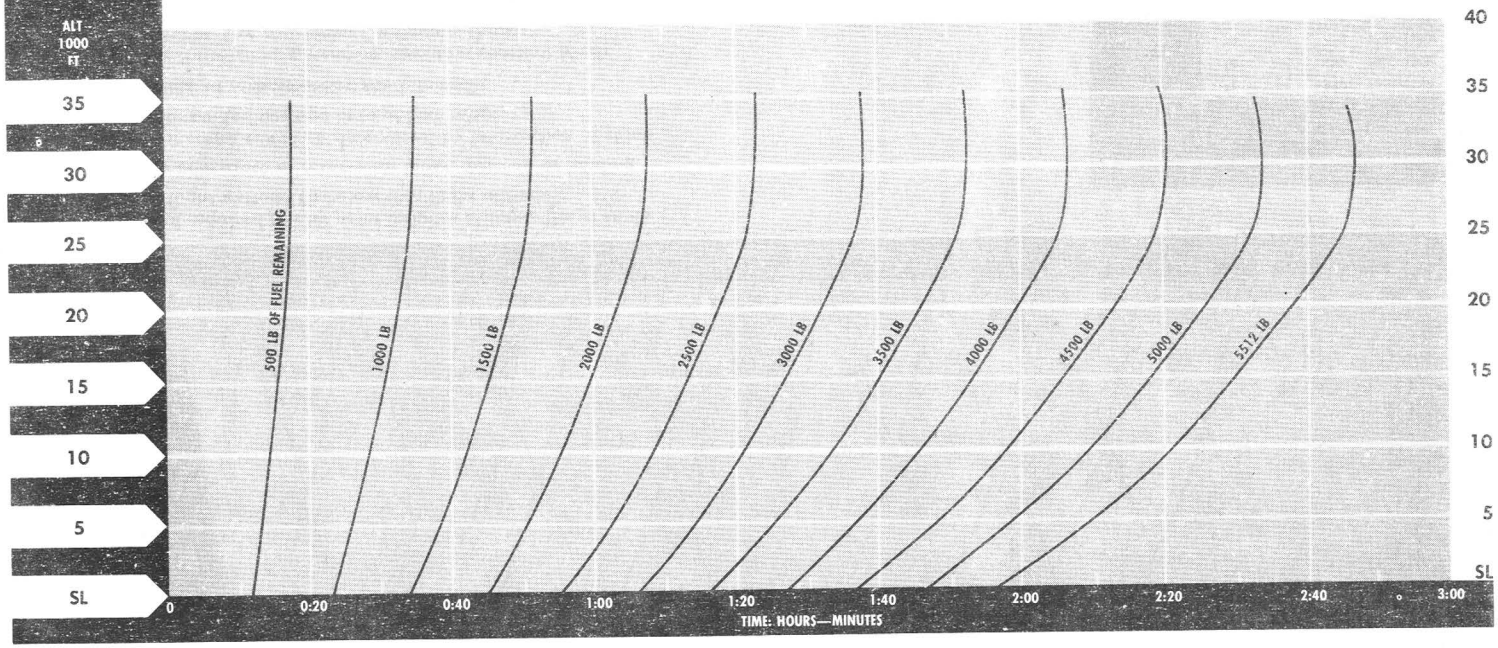


Figure A-50

LOITER	LESS THAN 3000 LB FUEL REMAINING					MORE THAN 3000 LB FUEL REMAINING				
ALTITUDE FEET	CAS	APPROXIMATE				CAS	APPROXIMATE			
		TRUE MACH NO.	TAS	LB/HR	% RPM		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-86K-1-93-119

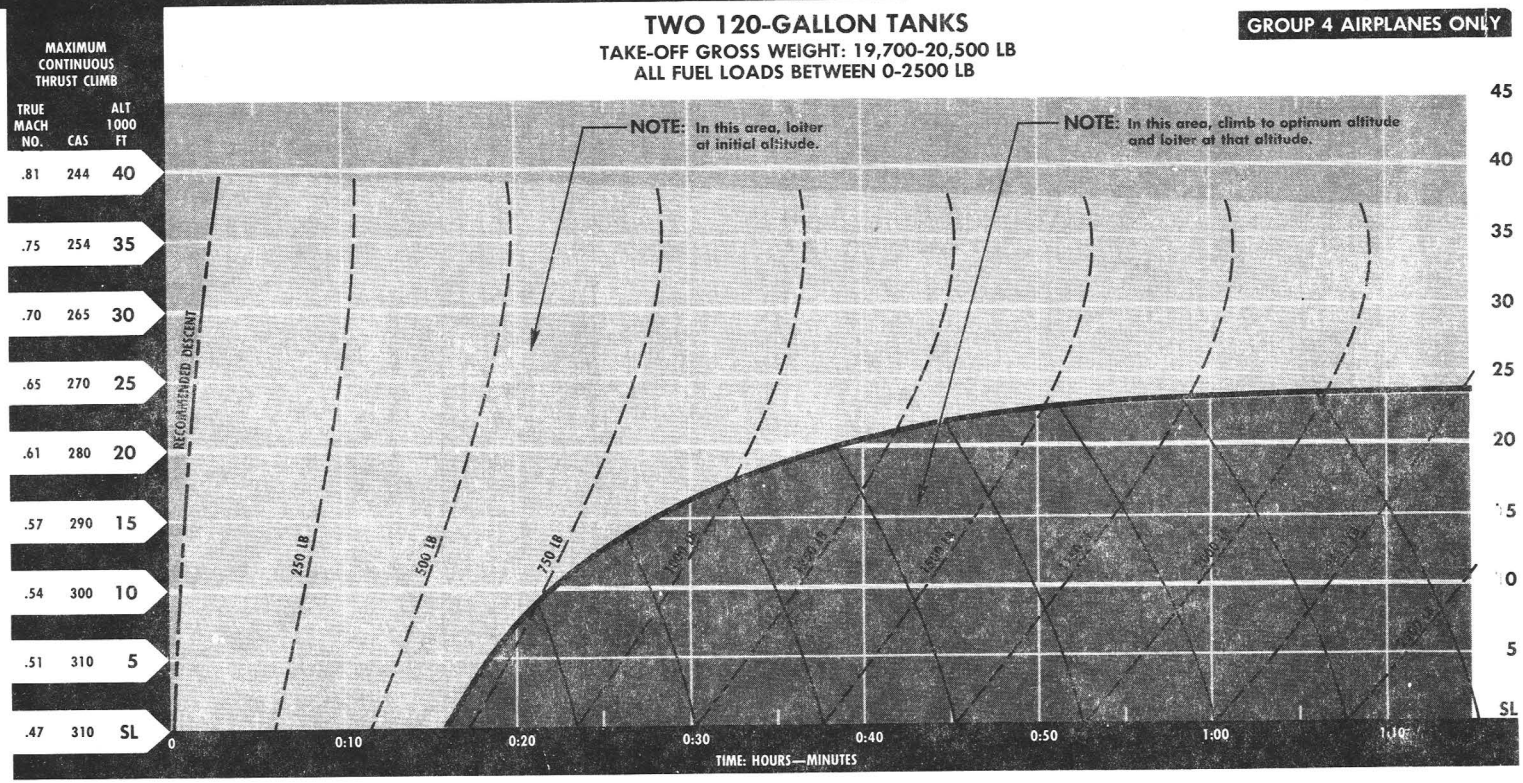
OPTIMUM MAXIMUM ENDURANCE PROFILE

STANDARD DAY
Model: F-86K
Engine: J47-17B

GROUP 4 AIRPLANES ONLY

TWO 120-GALLON TANKS

TAKE-OFF GROSS WEIGHT: 19,700-20,500 LB
ALL FUEL LOADS BETWEEN 0-2500 LB



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

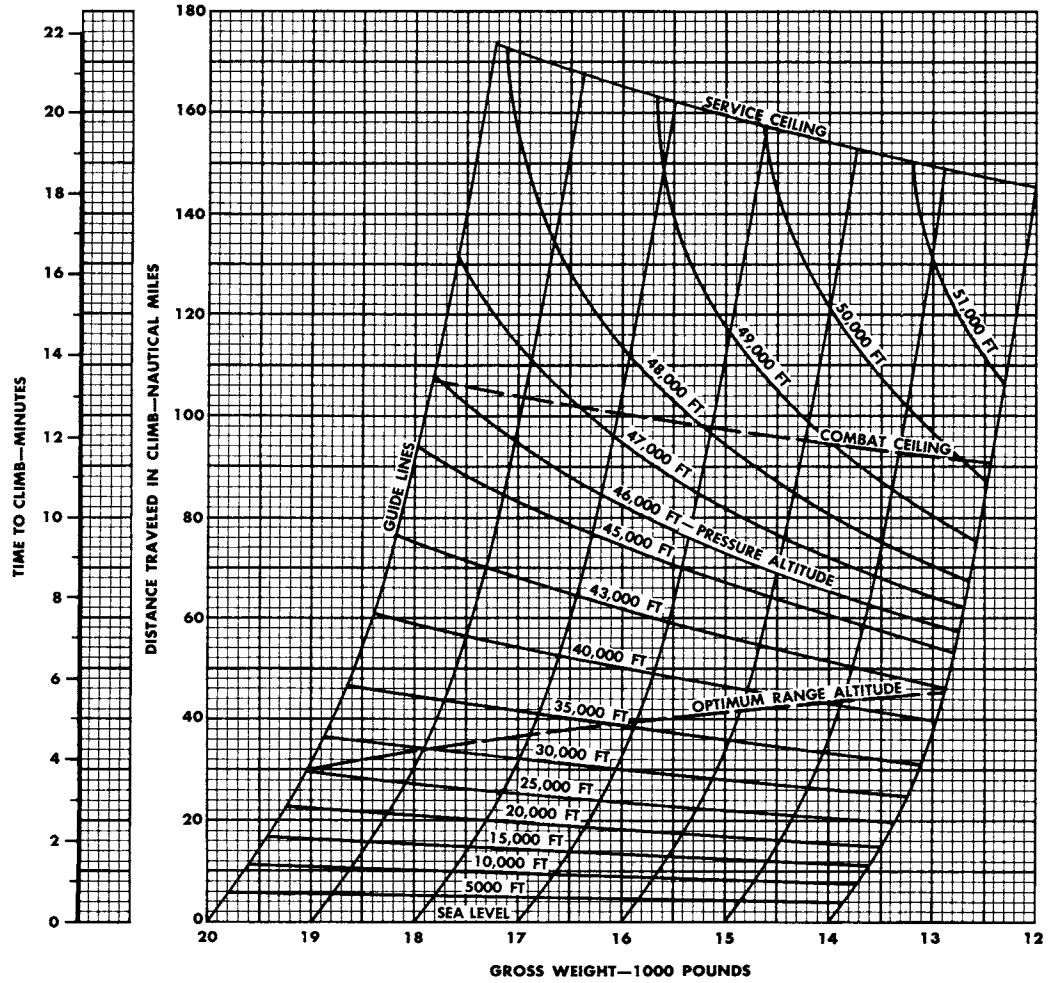
Data as of: 25 Dec. 1957. Based on flight test data.

F-86K-1-93-118

MAXIMUM THRUST CLIMB

TWO 120-GALLON TANKS

STANDARD DAY
MODEL: F-86K
ENGINE: J47-17B
GROUP 4 AIRPLANES ONLY



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-86K-1-93-117

Figure A-52

MILITARY THRUST CLIMB

TWO 120-GALLON TANKS

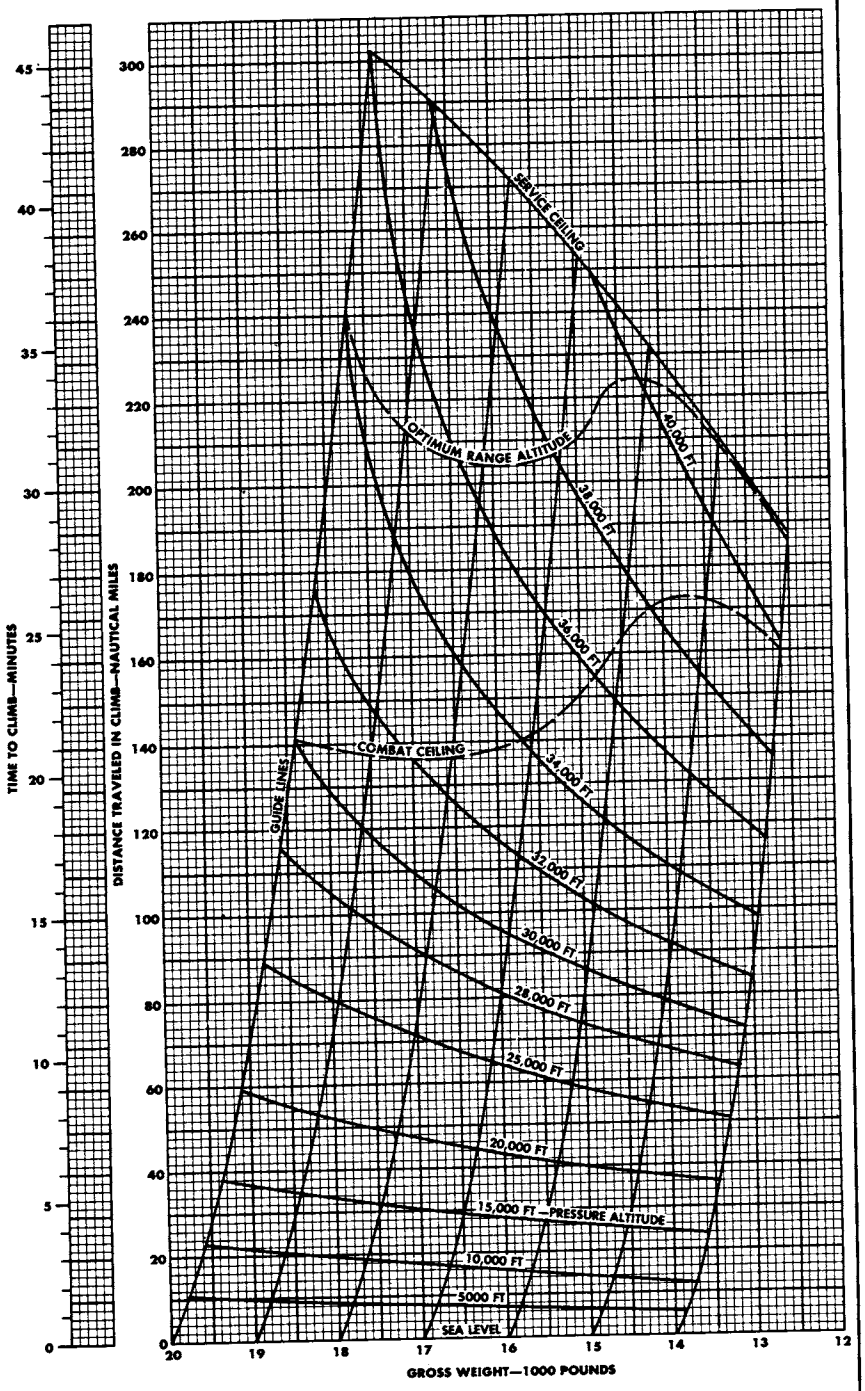
STANDARD DAY
MODEL: F-86K
ENGINE: J47-17B
GROUP 4 AIRPLANES ONLY

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

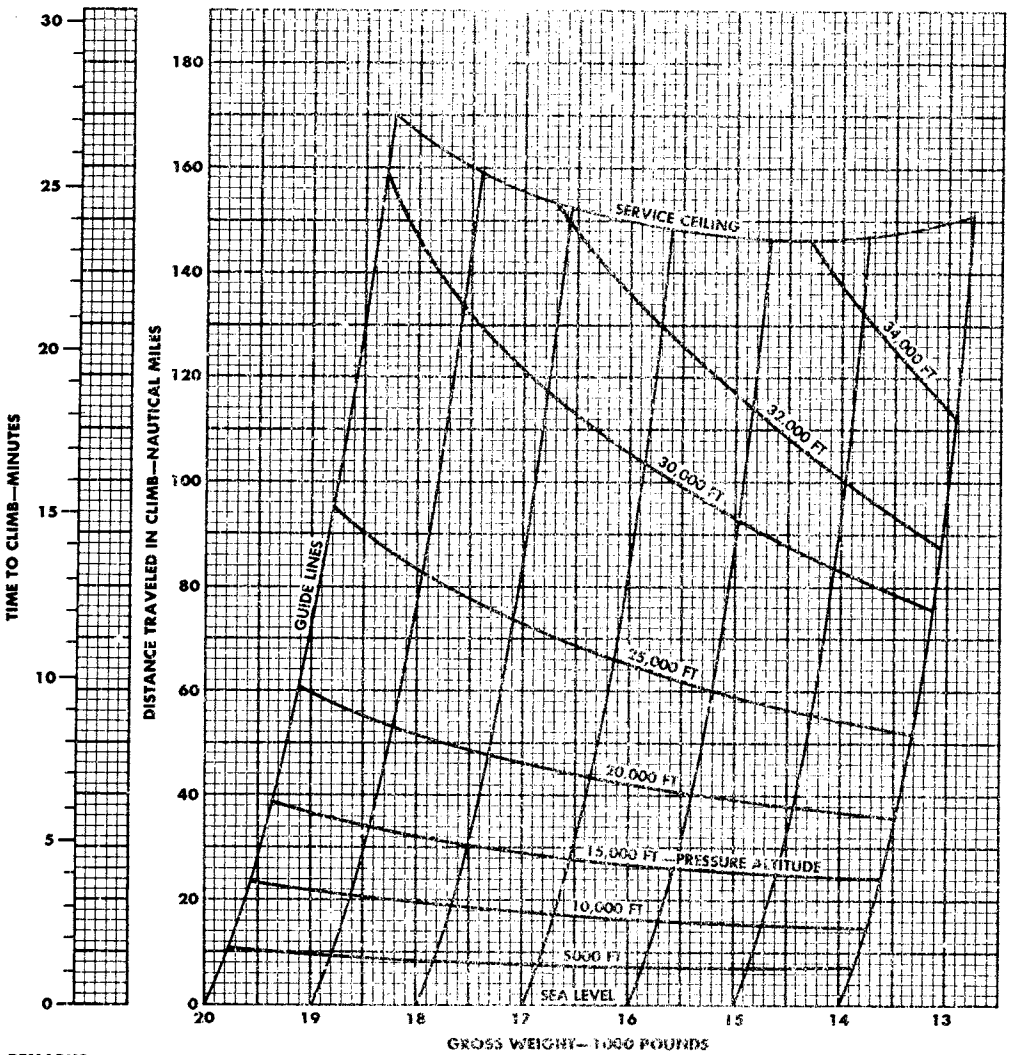
DATA AS OF: 25 DEC. 1957
BASED ON: FLIGHT TEST DATA

Figure A-53

MAXIMUM CONTINUOUS THRUST CLIMB

TWO 120-GALLON TANKS

STANDARD DAY
MODEL: F-86K
ENGINE: J47-17B
GROUP 4 AIRPLANES ONLY



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-86K-1-93-115

Figure A-54

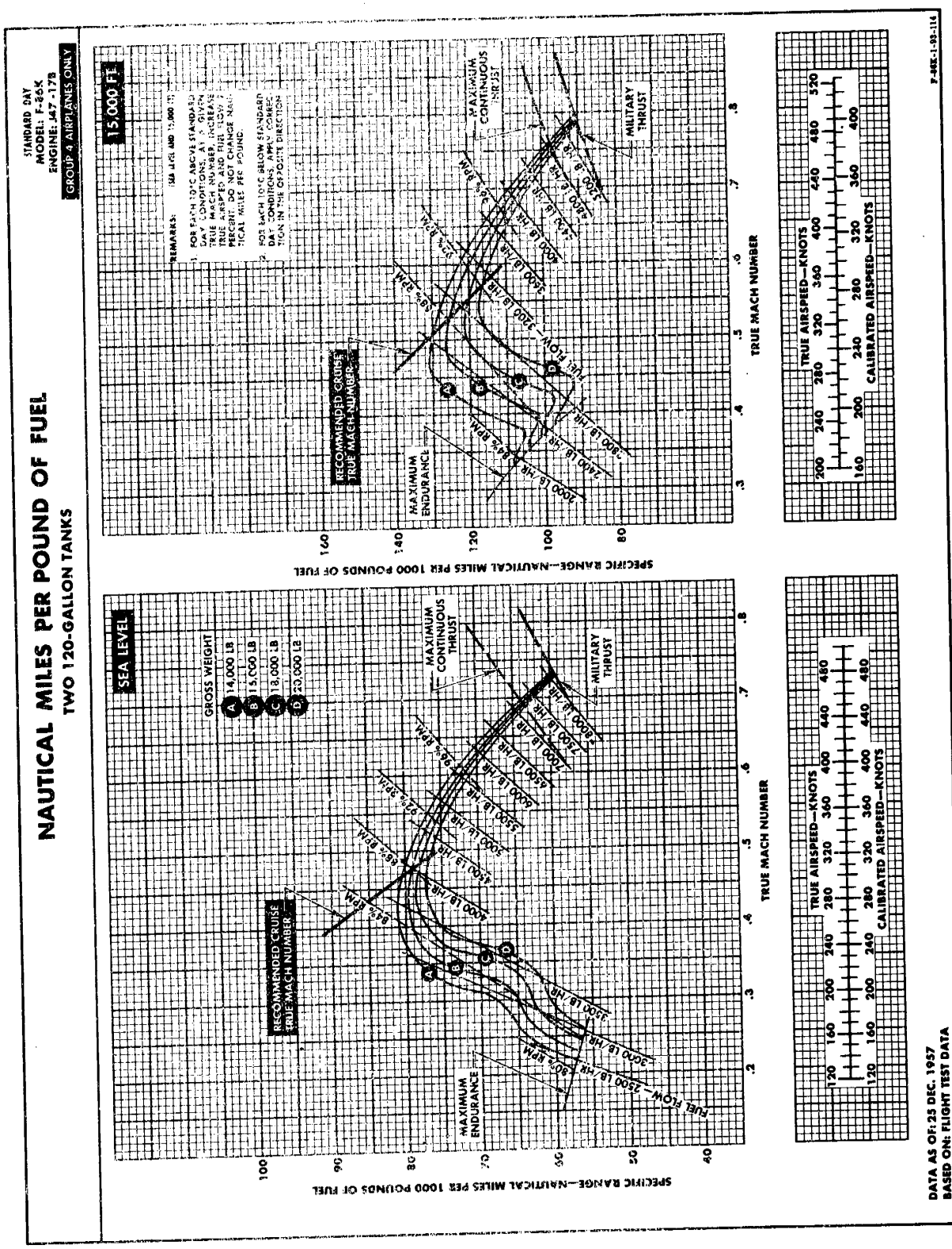

NAUTICAL MILES PER POUND OF FUEL
TWO 120-GALLON TANKS
STANDARD DAY
MODEL: F-86K
ENGINE: J47-17B
GROUP 4 AIRPLANES ONLY
SEA LEVEL
15,000 FT
GROSS WEIGHT
A 14,000 LB
B 15,000 LB
C 18,000 LB
D 20,000 LB
RECOMMENDED CRUISE TRUE MACH NUMBER
MAXIMUM ENDURANCE
MAXIMUM CONTINUOUS THRUST
MILITARY THRUST
FUEL FLOW — 1500 LB/HR
1400 LB/HR
1300 LB/HR
1200 LB/HR
1100 LB/HR
1000 LB/HR
900 LB/HR
800 LB/HR
700 LB/HR
600 LB/HR
500 LB/HR
SPECIFIC RANGE—NAUTICAL MILES PER 1000 POUNDS OF FUEL
TRUE MACH NUMBER
TRUE AIRSPEED—KNOTS
CALIBRATED AIRSPEED—KNOTS
REMARKS:
1. FOR EACH 10°C ABOVE STANDARD DAY CONDITIONS, AT A GIVEN TRUE MACH NUMBER, INCREASE TRUE AIRSPEED AND FUEL FLOW 2 PERCENT TO OBTAIN RANGE IN NAUTICAL MILES PER POUND.
2. FOR EACH 10°C BELOW STANDARD DAY CONDITIONS, APPLY CORRECTION IN THE OPPOSITE DIRECTION
DATA AS OF: 23 DEC. 1957
BASED ON: FLIGHT TEST DATA
F-86K-1-93-114

Figure A-55

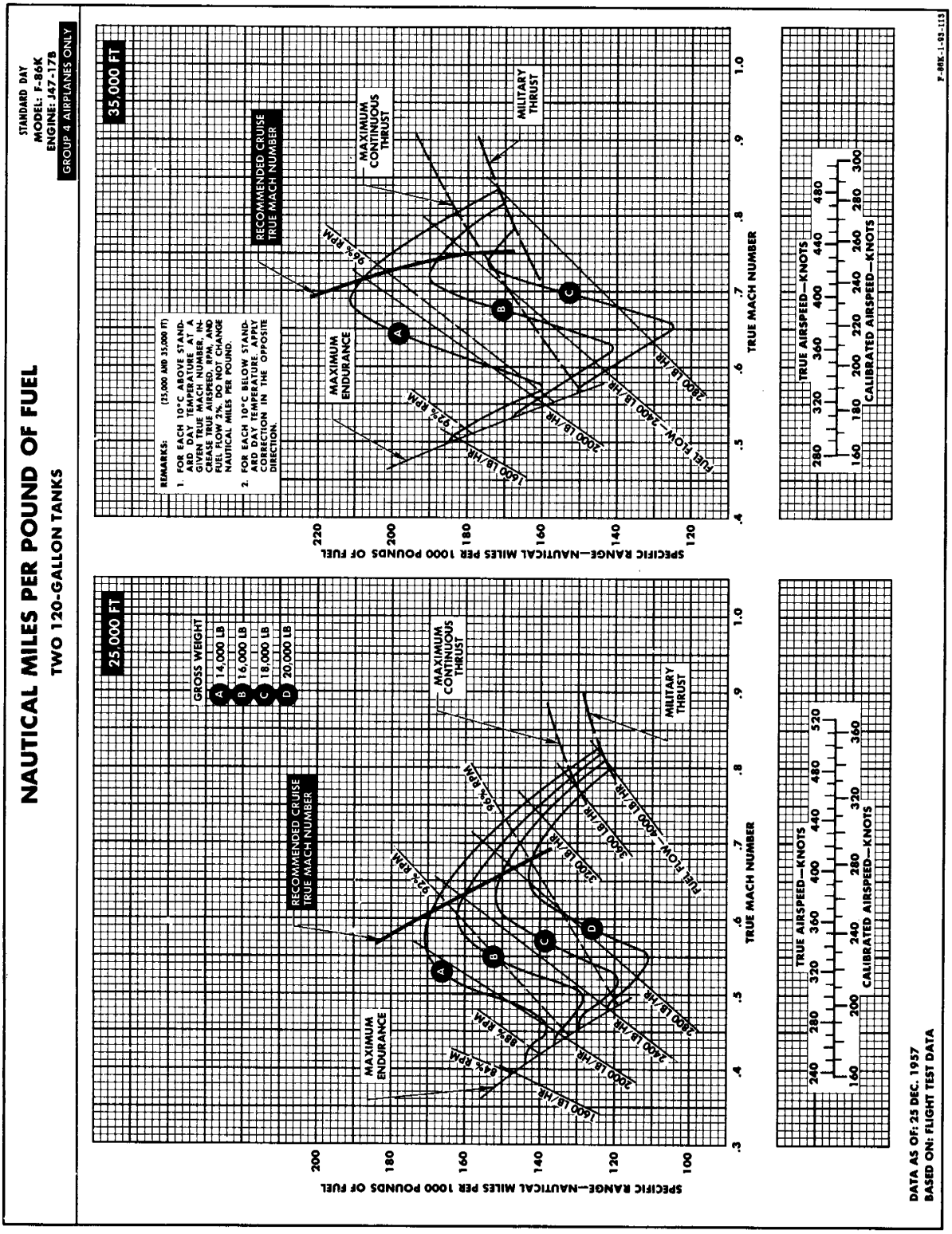

NAUTICAL MILES PER POUND OF FUEL
TWO 120-GALLON TANKS
STANDARD DAY
MODEL: F-86K
ENGINE: J47-17B
GROUP 4 AIRPLANES ONLY
35,000 FT
25,000 FT
REMARKS: (25,000 AND 35,000 FT)
1. FOR EACH 10°C ABOVE STANDARD DAY TEMPERATURE, AT A GIVEN TRUE MACH NUMBER, INCREASE TRUE AIRSPEED, RPM, AND FUEL FLOW 2%. DO NOT CHANGE NAUTICAL MILES PER POUND.
2. FOR EACH 10°C BELOW STANDARD DAY TEMPERATURE, APPLY CORRECTION IN THE OPPOSITE DIRECTION.
GROSS WEIGHT
A 14,000 LB
B 16,000 LB
C 18,000 LB
D 20,000 LB
RECOMMENDED CRUISE TRUE MACH NUMBER
MAXIMUM ENDURANCE
MAXIMUM CONTINUOUS THRUST
MILITARY THRUST
FUEL FLOW—1600 LB/HR
2000 LB/HR
2400 LB/HR
2800 LB/HR
3200 LB/HR
3600 LB/HR
4000 LB/HR
4400 LB/HR
SPECIFIC RANGE—NAUTICAL MILES PER 1000 POUNDS OF FUEL
TRUE MACH NUMBER
TRUE AIRSPEED—KNOTS
CALIBRATED AIRSPEED—KNOTS
DATA AS OF: 25 DEC. 1957
BASED ON: FLIGHT TEST DATA
F-86K-1-93-113

Figure A-56

ALPHABETICAL INDEX

F-86K-1-00-9A

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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	MACHINE GUNS, BOMBS, ROCKETS, OR SPECIAL STORES * K-17 OR K-22 CAMERAS†	MACHINE GUNS, BOMBS, ROCKETS, OR SPECIAL STORES	20 MM RAPID-FIRING GUNS	ROCKETS MOUNTED IN RETRACTABLE PACKAGE

* F-86F Airplanes † RF-86F Airplanes

F-86K-1-93-110

Figure 1-2

J47 JET ENGINE

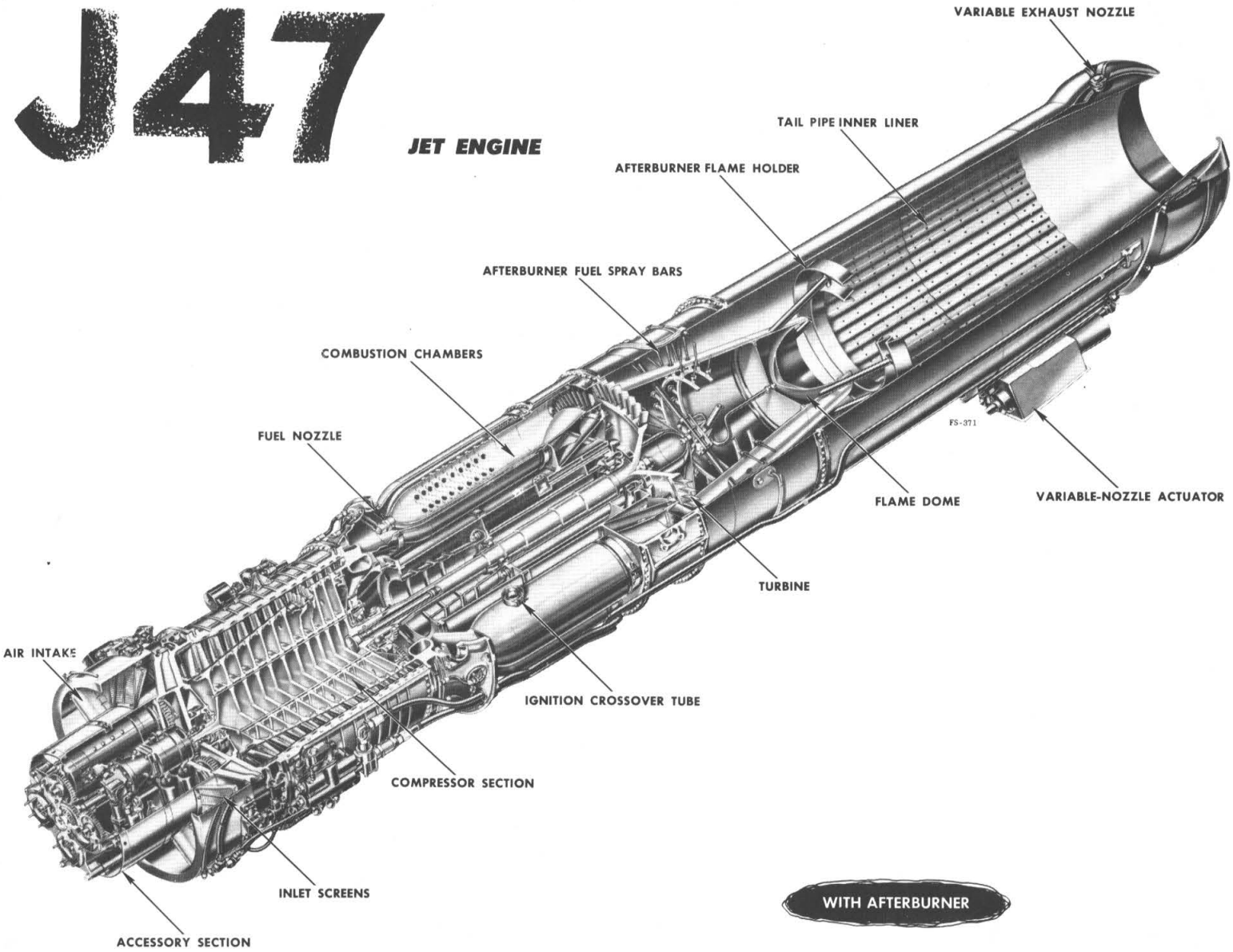


Figure 1-3

EXTERIOR INSPECTION

Check all surfaces for cracks, 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:

Figure 2-1

*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 airplane, then you should check these items yourself.

1. NOSE

- Landing gear ground control switch **CLOSED**
- Gun ports clear
- 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)
- 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 sway brace secure (if installed)
- Drop tank maintenance safety pin removed.
- 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

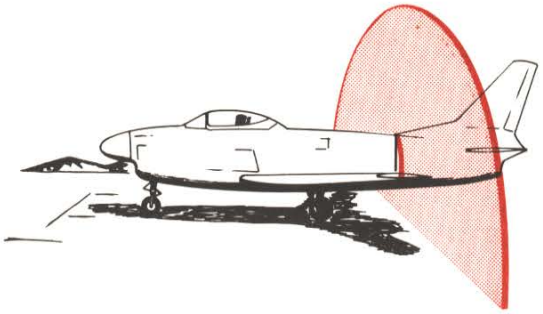
- Brake pins for wear (1/8 inch minimum length) *
- Tire for inflation, condition, and slippage
- Brake disk for clearance
- Oleo extension (4-7/8 inch at scissors)
- Hydraulic leaks
- Gear uplock and door switch for condition
- Engine access door for security

9. LEFT WING

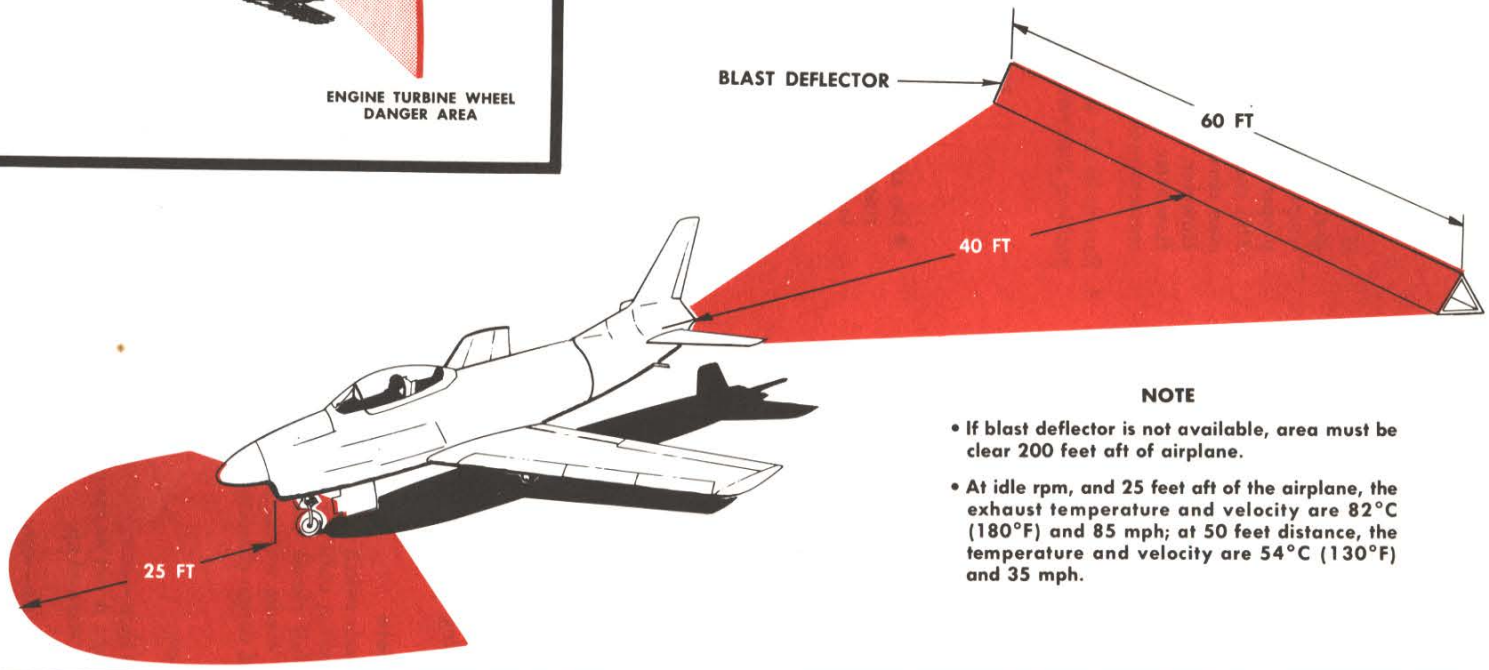
- Wing flap and aileron for damage
- Left drop tank fuel quantity, cap secure
- Position light for damage
- Wing slats for freedom of movement
- Drop tank sway brace secure (if installed)
- Drop tank maintenance safety pin removed.
- Wing fuel tank cap secure, cover latched
- Wing skin condition

F-86K-1-00-63C

DANGER AREAS

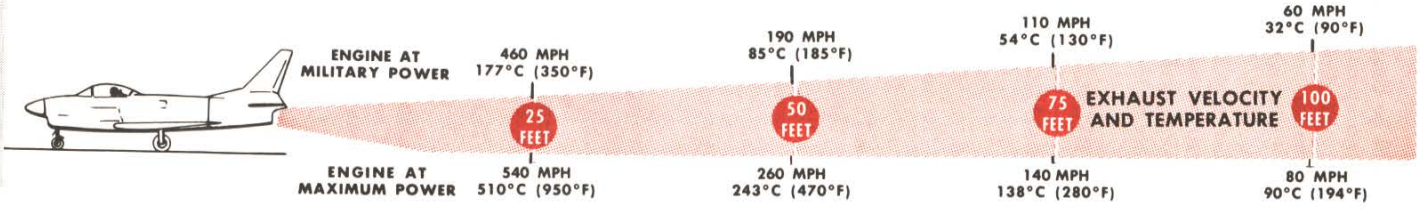


ENGINE TURBINE WHEEL DANGER AREA



NOTE

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

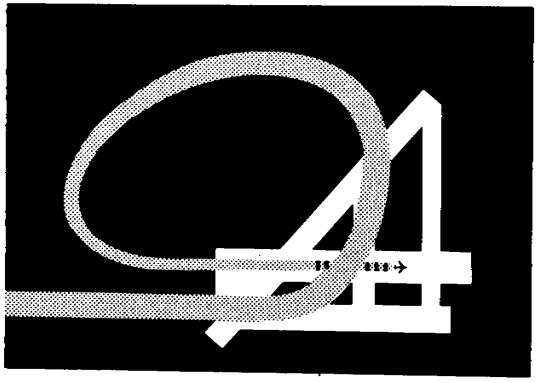


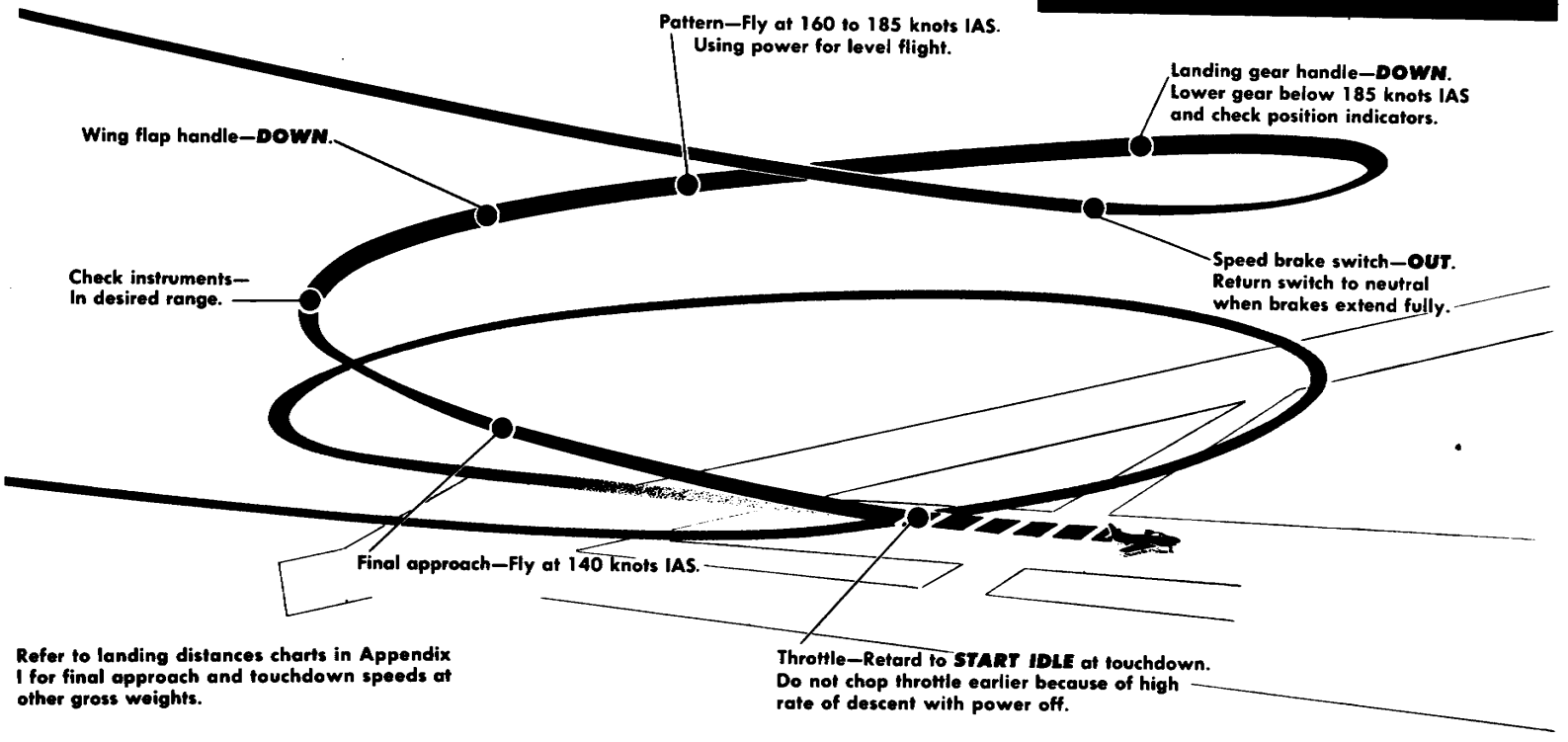
F-86K-1-73-8B

Figure 2-3

TYPICAL NORMAL APPROACH AND LANDING

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

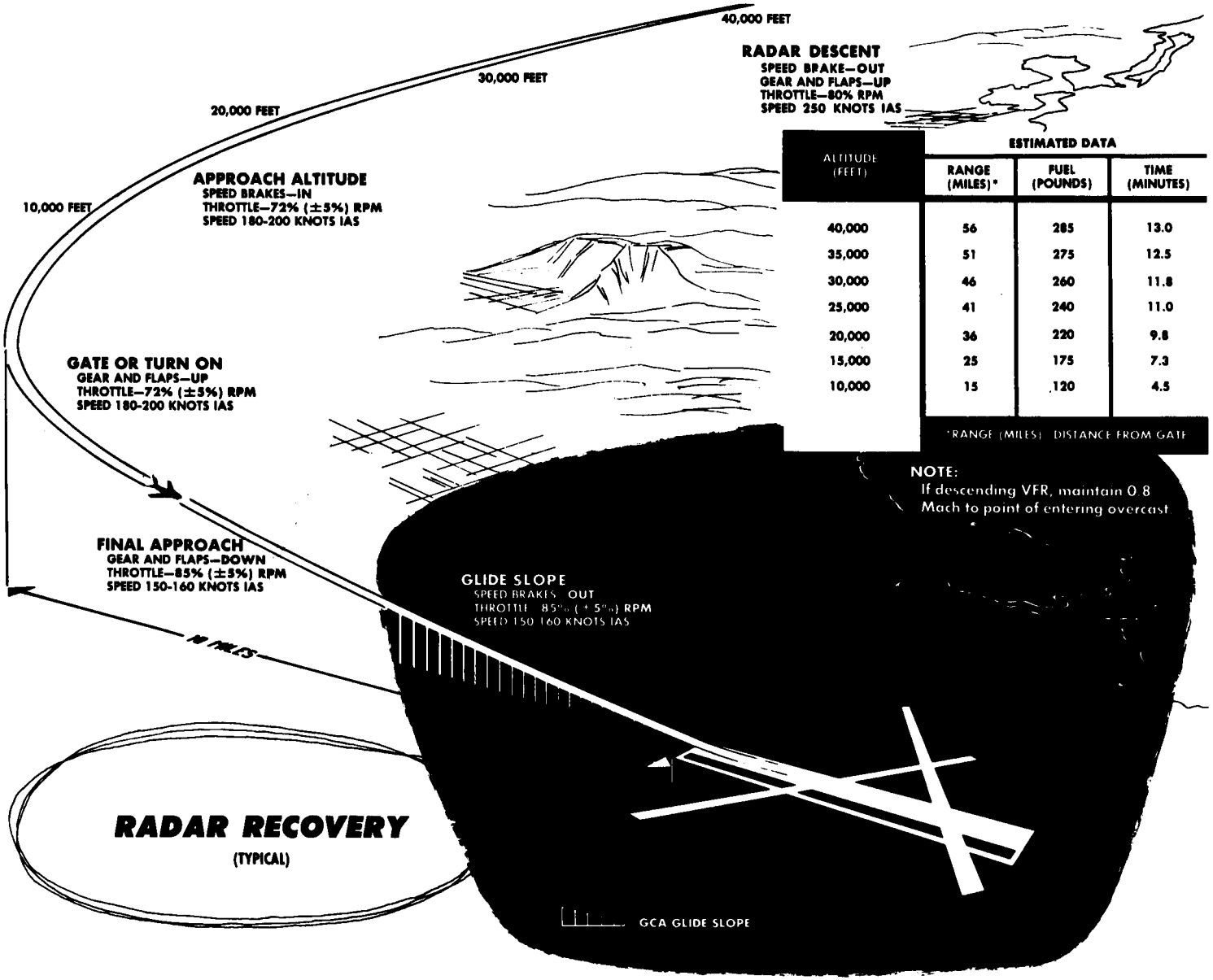




Refer to landing distances charts in Appendix I for final approach and touchdown speeds at other gross weights.

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

Figure 2-5



ALTITUDE (FEET)	ESTIMATED DATA		
	RANGE (MILES)*	FUEL (POUNDS)	TIME (MINUTES)
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

*RANGE (MILES) DISTANCE FROM GATE

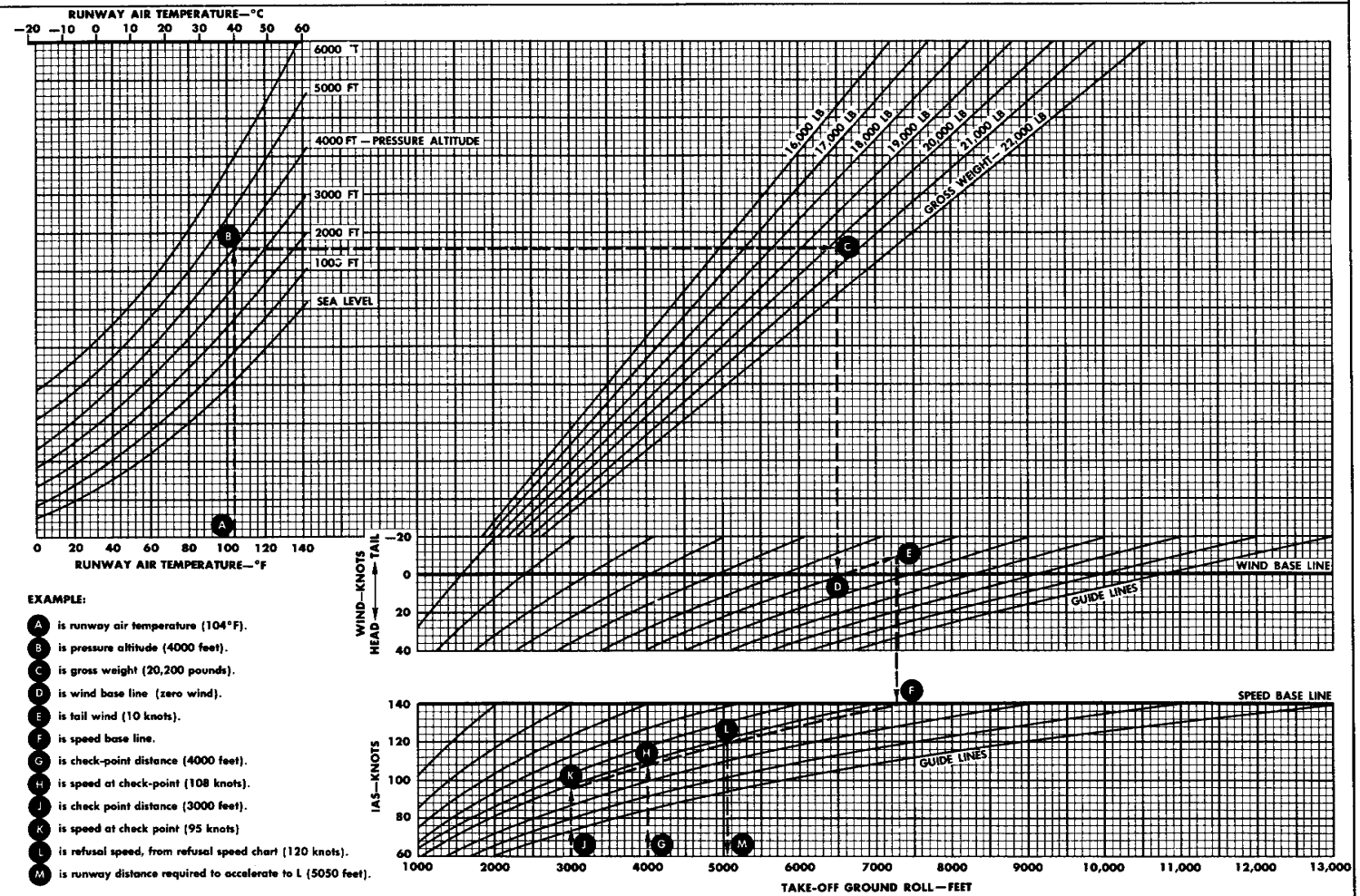
Figure 9-3

FLAPS FULL DOWN

TAKE-OFF ACCELERATION

MAXIMUM THRUST

HARD-SURFACE RUNWAY
MODEL: F-86K
ENGINE: J47-17B



EXAMPLE:

- (A) is runway air temperature (104°F).
- (B) is pressure altitude (4000 feet).
- (C) is gross weight (20,200 pounds).
- (D) is wind base line (zero wind).
- (E) is tail wind (10 knots).
- (F) is speed base line.
- (G) is check-point distance (4000 feet).
- (H) is speed at check-point (108 knots).
- (J) is check point distance (3000 feet).
- (K) is speed at check point (95 knots)
- (L) is refusal speed, from refusal speed chart (120 knots).
- (M) is runway distance required to accelerate to L (5050 feet).

DATA AS OF: 1 DEC 1955
BASED ON: FLIGHT TEST DATA

F-86K-1-83-94A

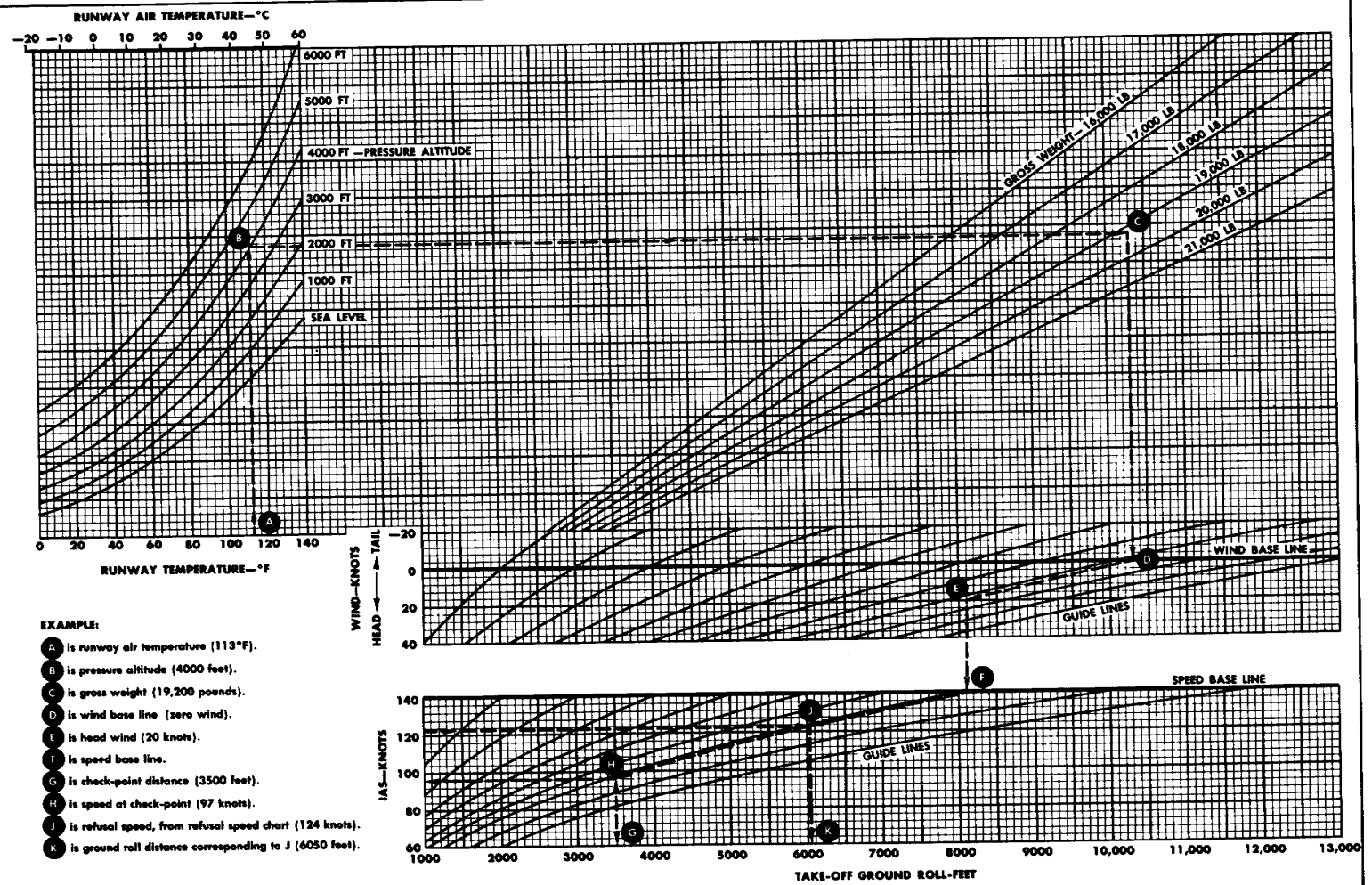
Figure A-8

TAKE-OFF ACCELERATION

FLAPS FULL DOWN

MILITARY THRUST

HARD-SURFACE RUNWAY
MODEL: F-86K
ENGINE: J47-17B



EXAMPLE:

- (A) is runway air temperature (113°F).
- (B) is pressure altitude (4000 feet).
- (C) is gross weight (19,200 pounds).
- (D) is wind base line (zero wind).
- (E) is head wind (20 knots).
- (F) is speed base line.
- (G) is check-point distance (3500 feet).
- (H) is speed at check-point (97 knots).
- (J) is refusal speed, from refusal speed chart (124 knots).
- (K) is ground roll distance corresponding to J (6050 feet).

DATA AS OF: 1 DEC 1955
BASED ON: FLIGHT TEST DATA

F-86K-1-95-133

Figure A-9

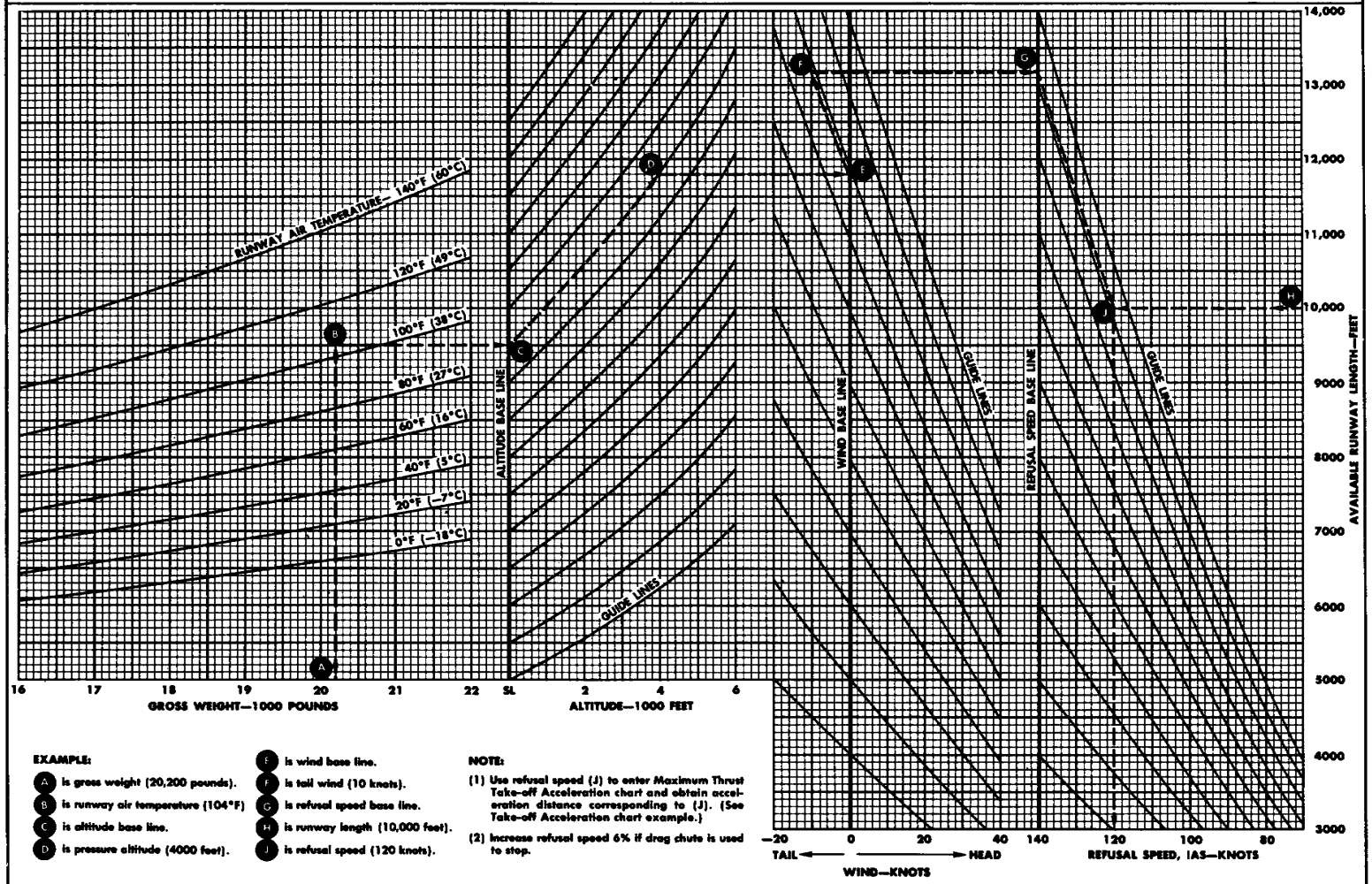
FLAPS FULL DOWN

DRAG CHUTE NOT DEPLOYED

REFUSAL SPEEDS

MAXIMUM THRUST

HARD-SURFACE RUNWAY
MODEL: F-86K
ENGINE: J47-17B



EXAMPLE:

- (A) is gross weight (20,200 pounds).
- (B) is runway air temperature (104°F)
- (C) is altitude base line.
- (D) is pressure altitude (4000 feet).
- (E) is wind base line.
- (F) is tail wind (10 knots).
- (G) is refusal speed base line.
- (H) is runway length (10,000 feet).
- (J) 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-86K-1-93-93A

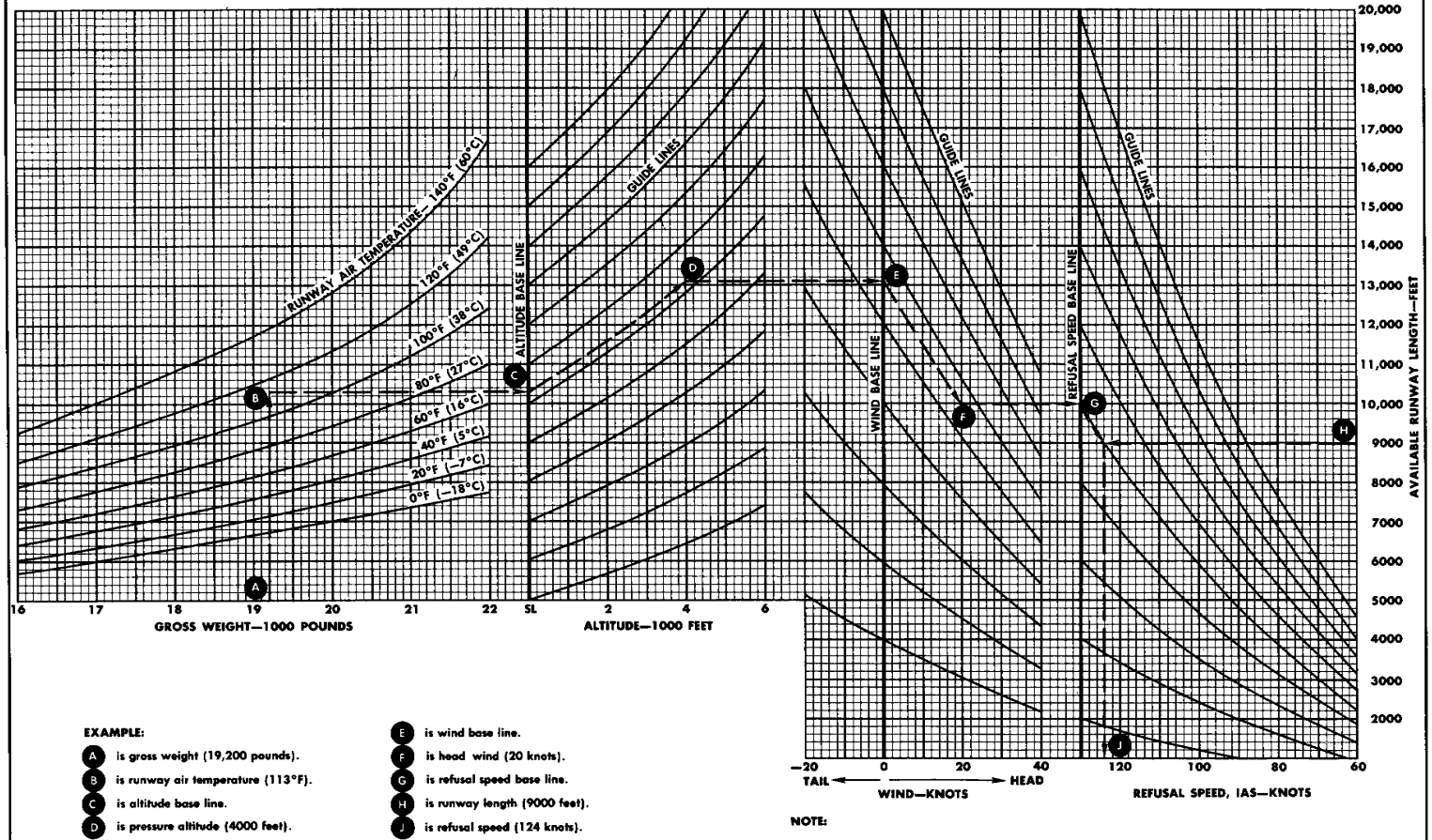
Figure A-10

FLAPS FULL DOWN
DRAG CHUTE NOT DEPLOYED

REFUSAL SPEEDS

MILITARY THRUST

HARD-SURFACE RUNWAY
MODEL: F-86K
ENGINE: J47 -17B



EXAMPLE:

- (A) is gross weight (19,200 pounds).
- (B) is runway air temperature (113°F).
- (C) is altitude base line.
- (D) is pressure altitude (4000 feet).
- (E) is wind base line.
- (F) is head wind (20 knots).
- (G) is refusal speed base line.
- (H) is runway length (9000 feet).
- (J) is refusal speed (124 knots).

NOTE:

DATA AS OF: 1 DEC 1955
BASED ON: FLIGHT TEST DATA

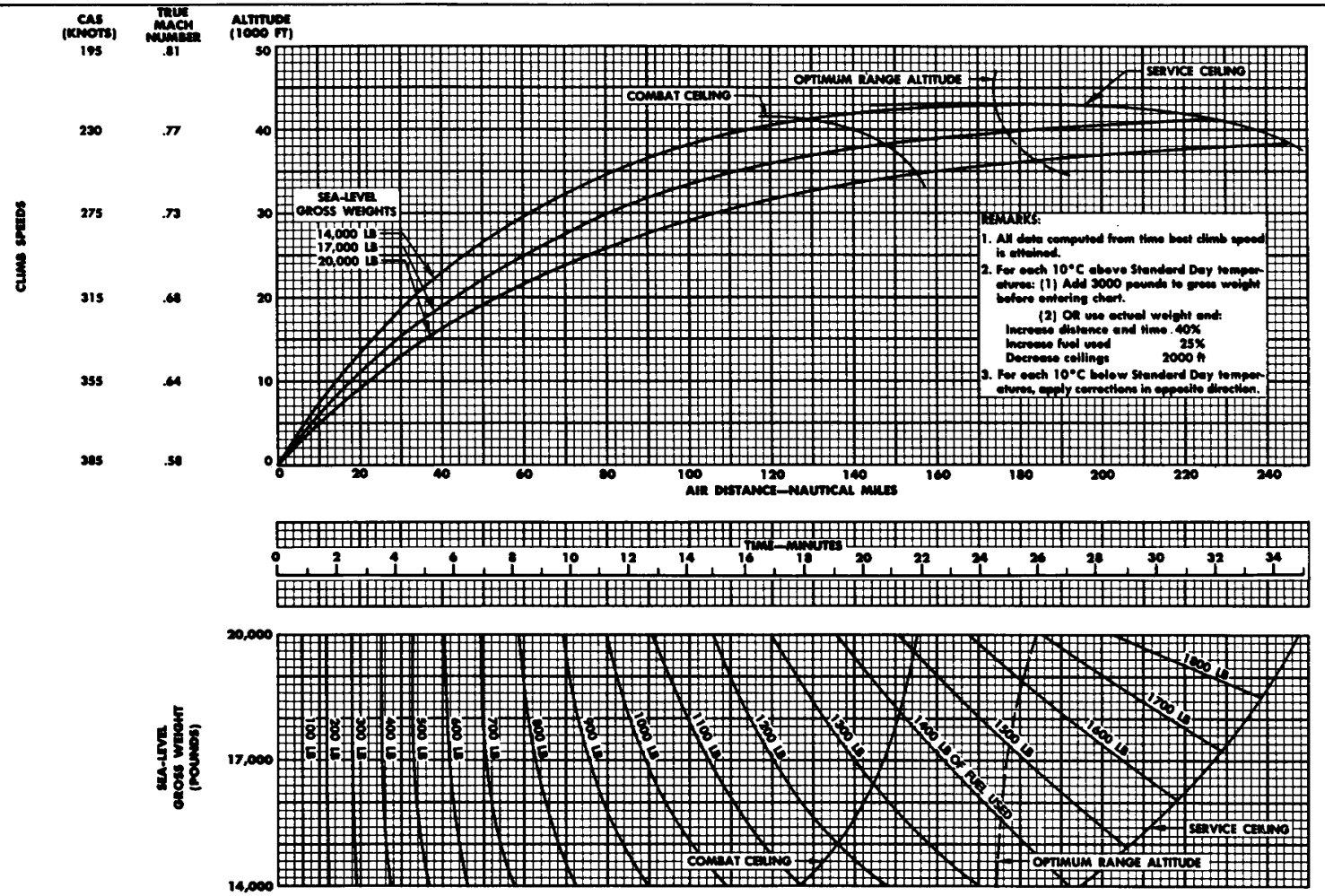
F-86K-1-93-134

Figure A-11

MILITARY THRUST CLIMB PROFILE

CLEAN

STANDARD DAY
MODEL: F-86K
ENGINE: J47-17B



DATA AS OF: 1 DEC 1955
BASED ON FLIGHT TEST DATA

F-86K-1-93-98A

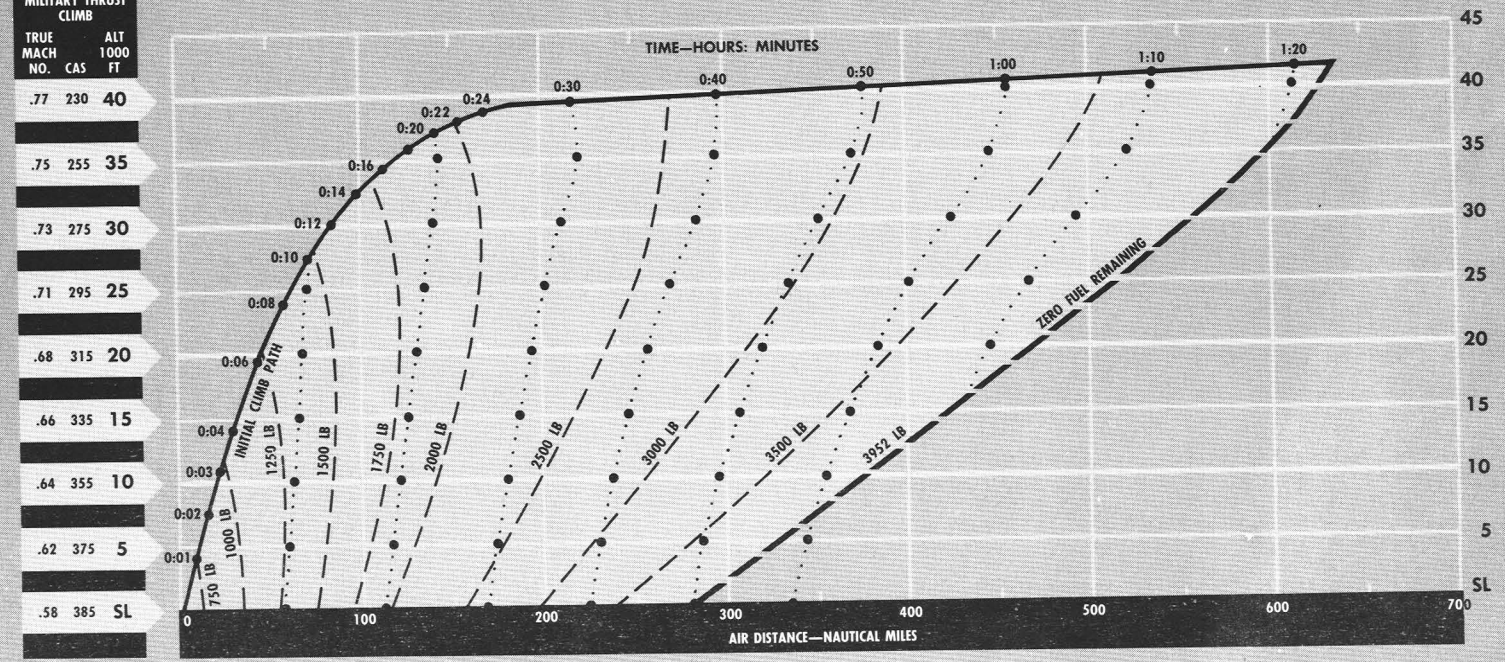
Figure A-14

MISSION PROFILE

STANDARD DAY
Model: F-86K
Engine: J47-17B

TAKE-OFF GROSS WEIGHT: 18,000-18,600 LB
ALL FUEL LOADS BETWEEN 0 - 3952 LB

CLEAN



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	APPROXIMATE TAS	APPROXIMATE LB/HR	APPROXIMATE % 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-86K-1-93-91A

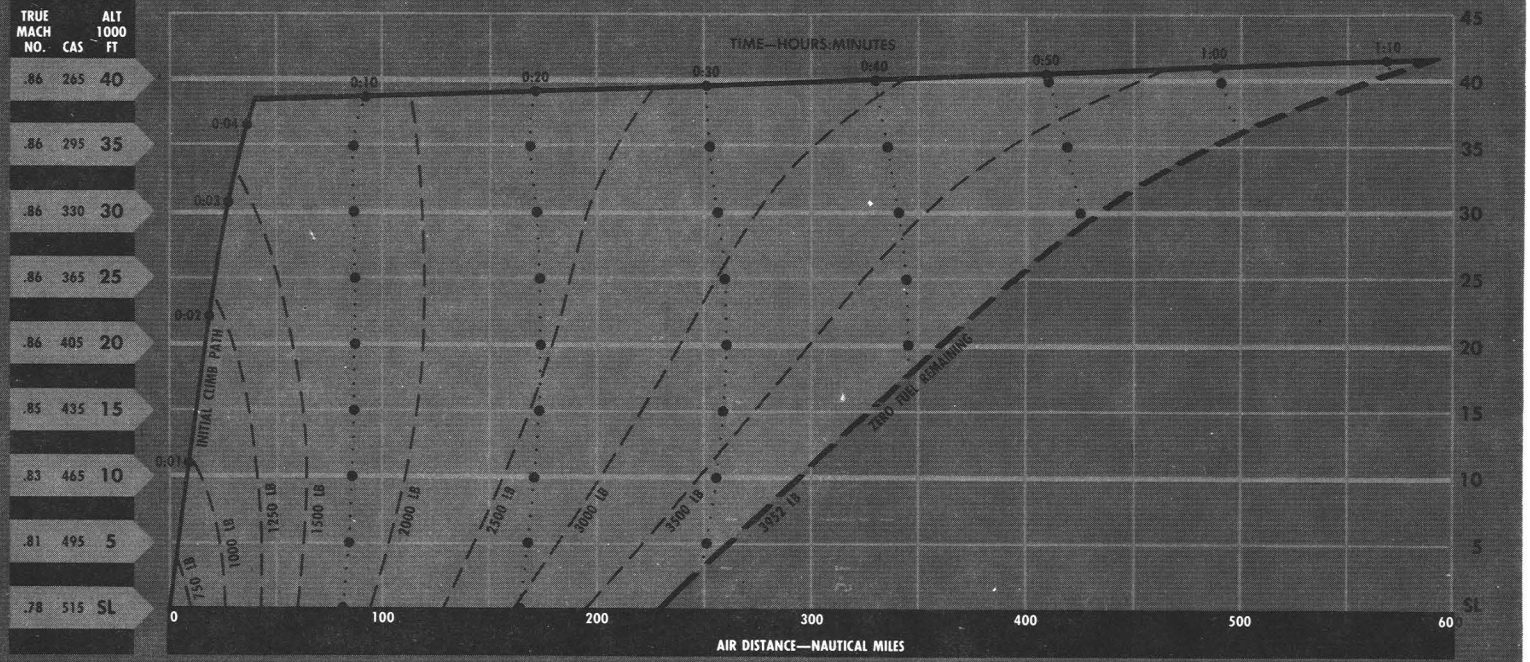
Figure A-15

INTERCEPT PROFILE

TAKE-OFF GROSS WEIGHT: 18,000-18,600 LB
ALL FUEL LOADS BETWEEN 0 - 3952 LB

STANDARD DAY
Model: F-86K
Engine: J47-17B

CLEAN



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.

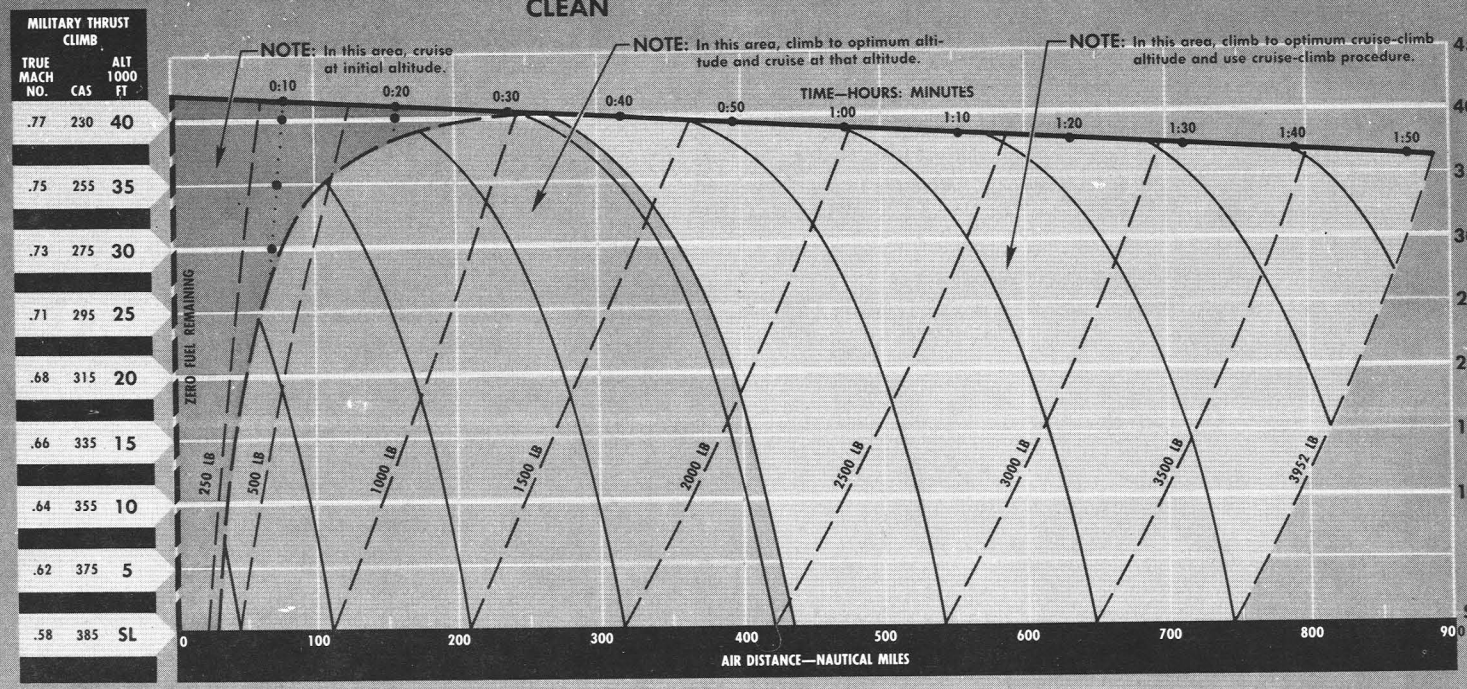
Figure A-16

OPTIMUM RETURN PROFILE

STANDARD DAY
Model: F-86K
Engine: J47-17B

TAKE-OFF GROSS WEIGHT: 18,000-18,600 LB
ALL FUEL LOADS BETWEEN 0 - 3952 LB

CLEAN



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-86K-1-93-89A

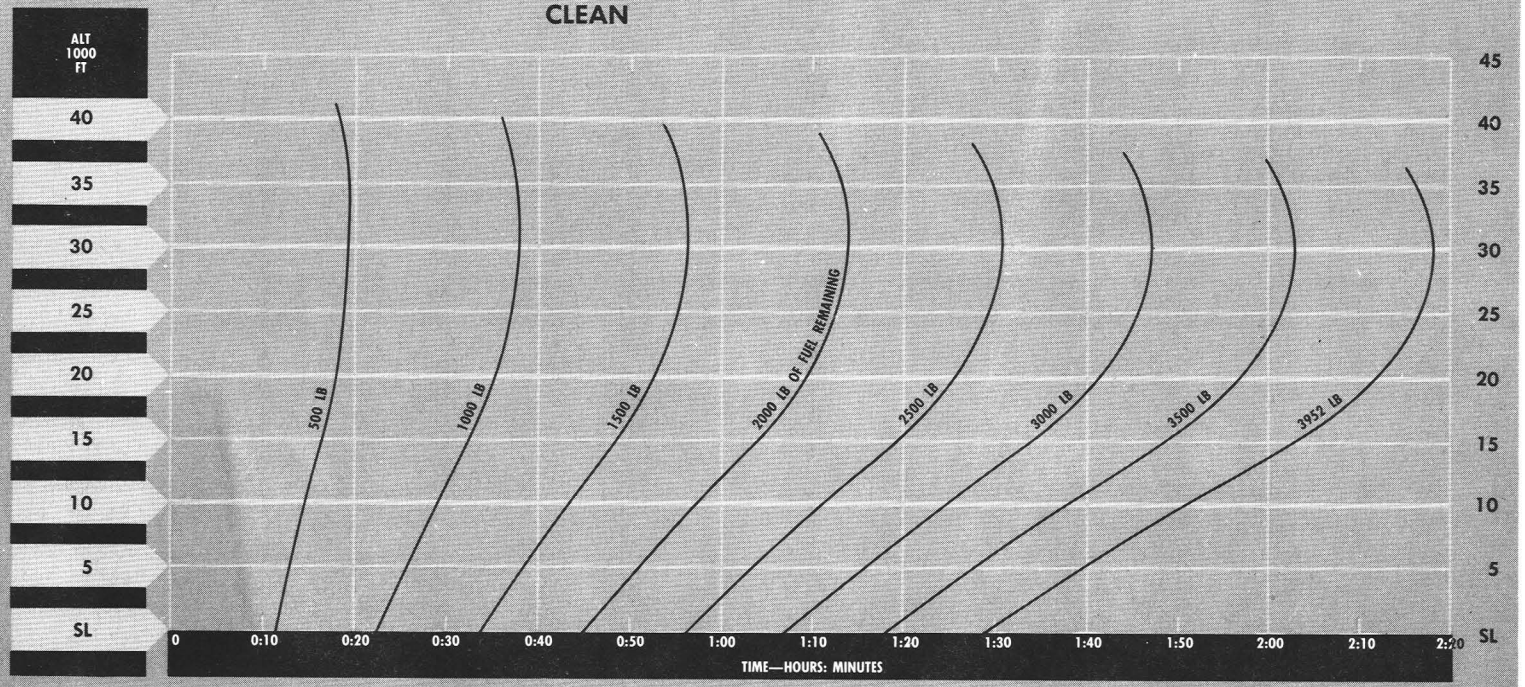
Figure A-17

MAXIMUM ENDURANCE PROFILE

STANDARD DAY
Model: F-86K
Engine: J47-17B

TAKE-OFF GROSS WEIGHT: 18,000-18,600 LB
ALL FUEL LOADS BETWEEN 0 - 3952 LB

CLEAN



LOITER	LESS THAN 2000 LB FUEL REMAINING					MORE THAN 2000 LB FUEL REMAINING				
ALTITUDE FEET	CAS	APPROXIMATE TRUE MACH NO.	APPROXIMATE TAS	APPROXIMATE LB/HR	APPROXIMATE % RPM	CAS	APPROXIMATE TRUE MACH NO.	APPROXIMATE TAS	APPROXIMATE LB/HR	APPROXIMATE % 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.

REMARKS

1. Loiter at recommended CAS.
2. Maintain constant altitude.

F-86K-1-93-88A

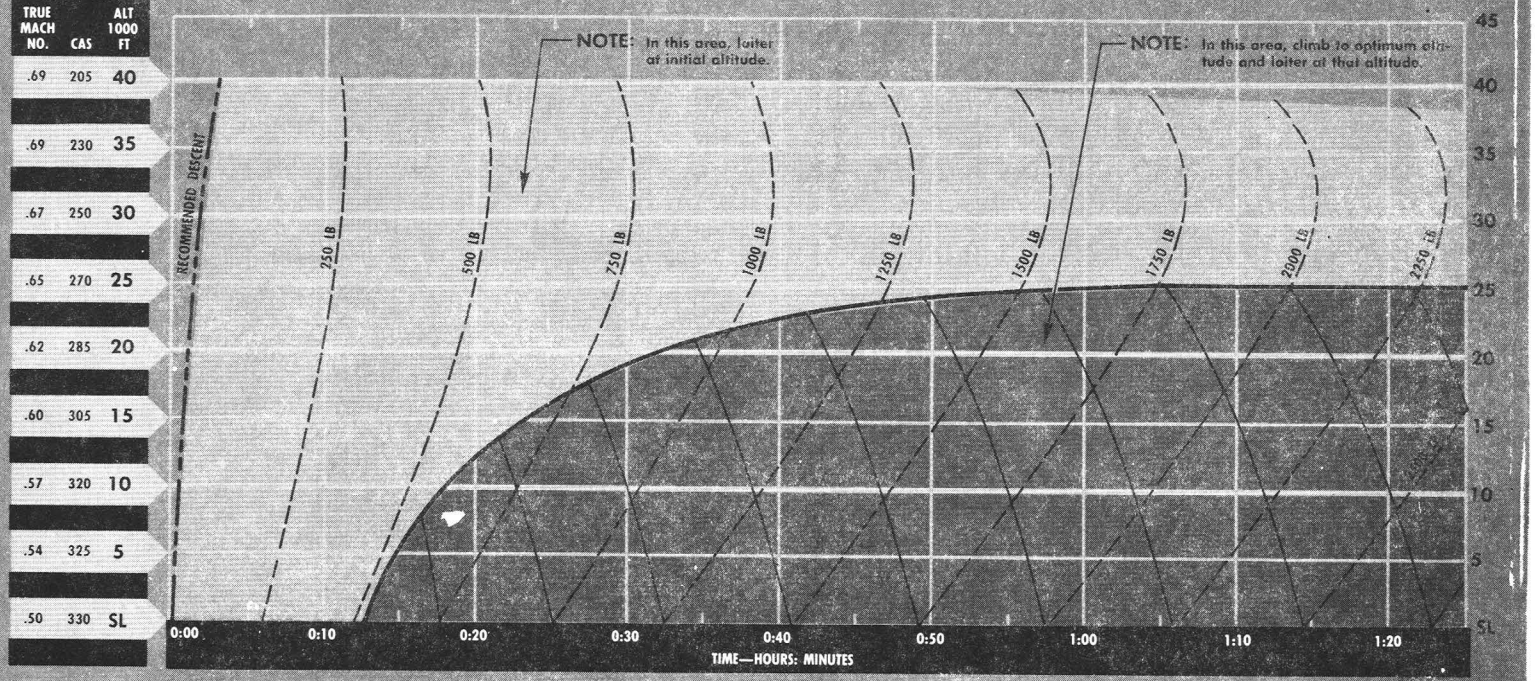
Figure A-18

OPTIMUM MAXIMUM ENDURANCE PROFILE

STANDARD DAY
Model: F-86K
Engine: J47-17B

TAKE-OFF GROSS WEIGHT: 18,000-18,600 LB
ALL FUEL LOADS BETWEEN 0 - 2500 LB

CLEAN



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.	APPROXIMATE TAS	APPROXIMATE LB/HR	APPROXIMATE % 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.

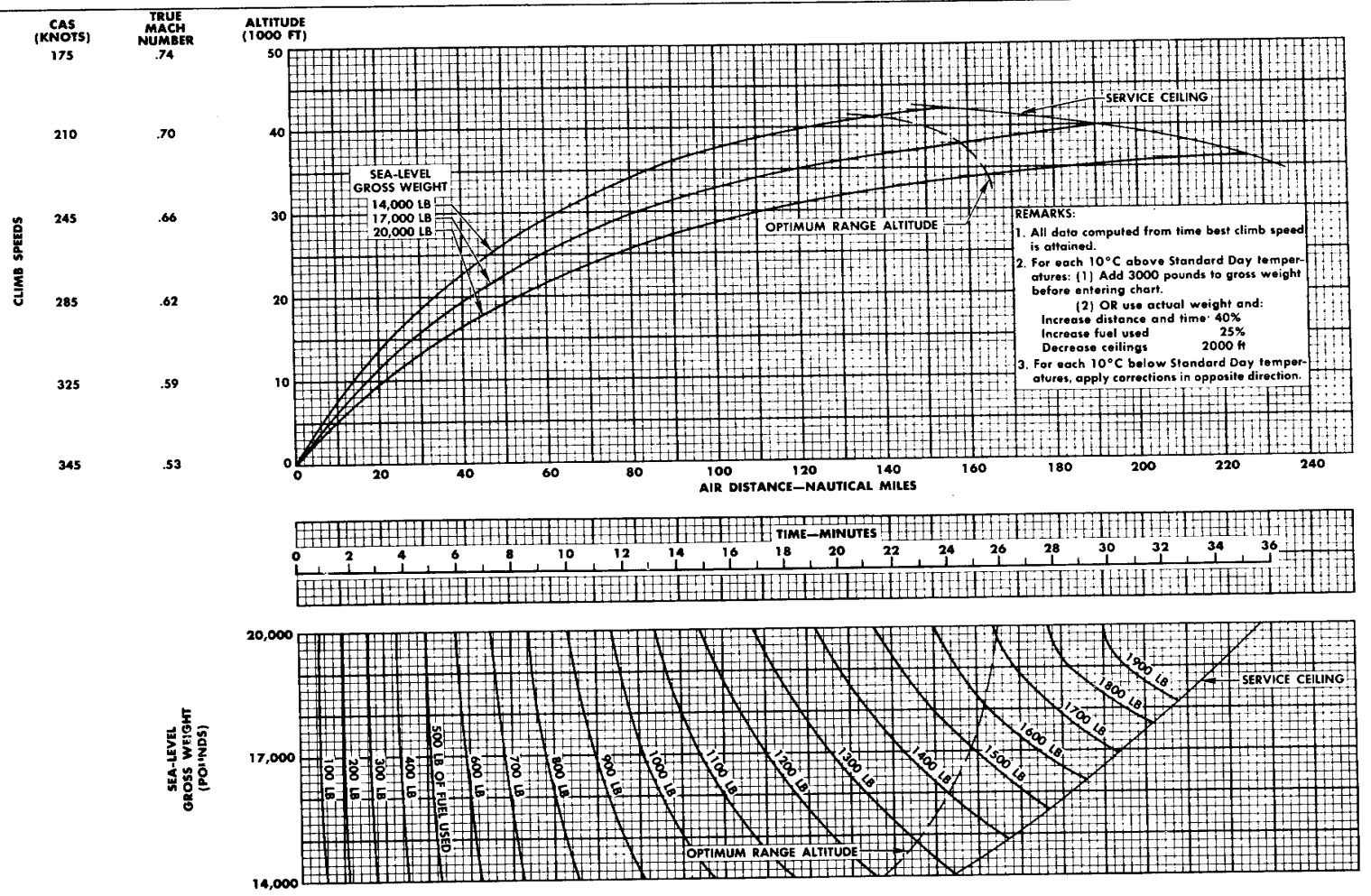
F-86K-1-93-87A F-86K-1-93-98A

Figure A-19

MILITARY THRUST CLIMB PROFILE

TWO 120-GALLON TANKS

STANDARD DAY
MODEL: F-86K
ENGINE: J47 -17B
GROUPS 1, 2 AND 3 AIRPLANES ONLY



DATA AS OF: 1 DEC 1955
BASED ON FLIGHT TEST DATA

F-86K-1-93-86A

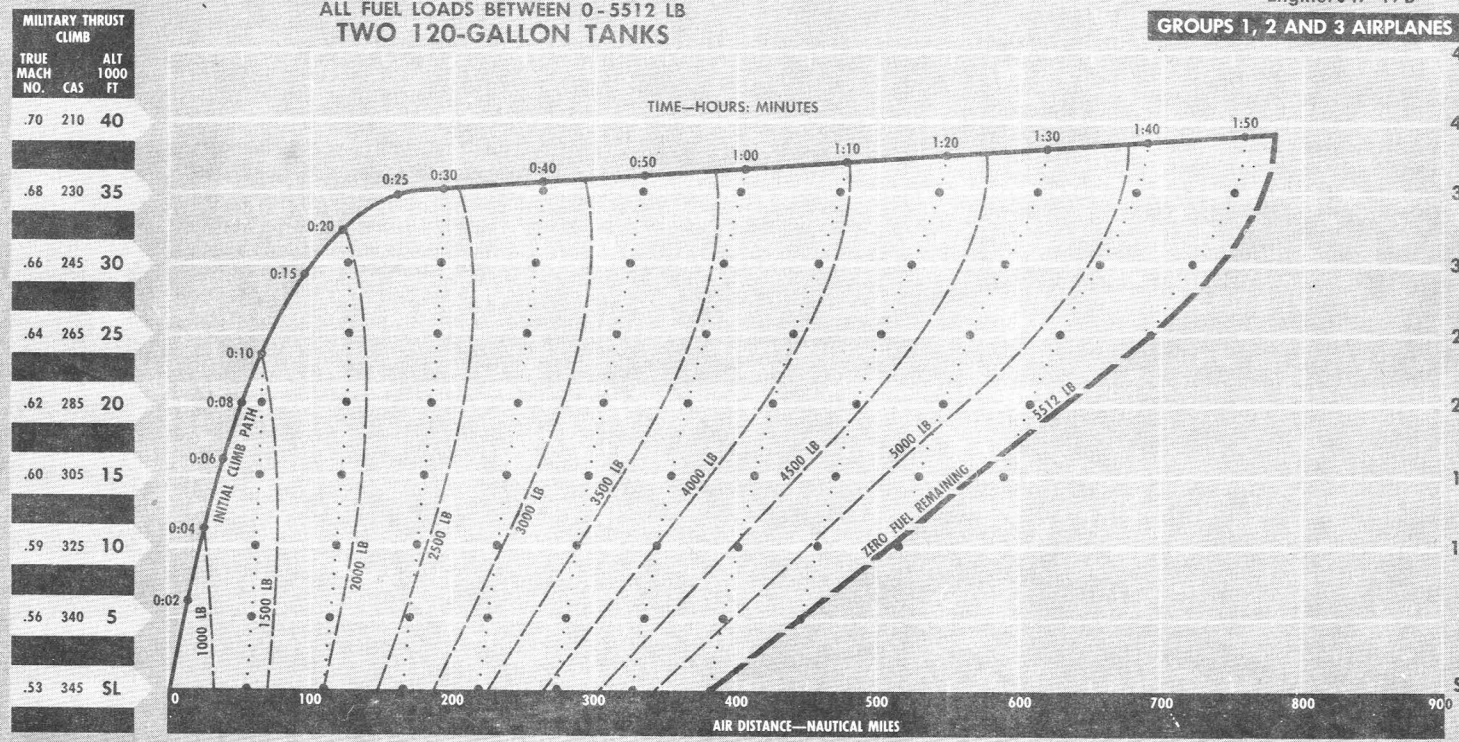
Figure A-20

MISSION PROFILE

TAKE-OFF GROSS WEIGHT: 19,700-20,500 LB
ALL FUEL LOADS BETWEEN 0-5512 LB
TWO 120-GALLON TANKS

STANDARD DAY
Model: F-86K
Engine: J47-17B

GROUPS 1, 2 AND 3 AIRPLANES ONLY



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	.74	—	425	2300-2050	100*
35,000	.73	245	420	2300-2100	100-97
30,000	.67	250	395	2400-2150	96-93
25,000	.63	260	380	2500-2300	94-91
20,000	.59	270	360	2700-2500	92-90
15,000	.56	285	350	2900-2750	91-89
10,000	.53	295	340	3200-3100	90-89
5,000	.51	310	330	3650-3500	90-89
SEA LEVEL	.50	330	330	4250-4100	90-89

Data as of: 1 Dec 1955. Based on flight test data.

*Maximum Continuous Thrust, 100% rpm, 635°C EGT.

F-86K-1-93-85A

Figure A-21

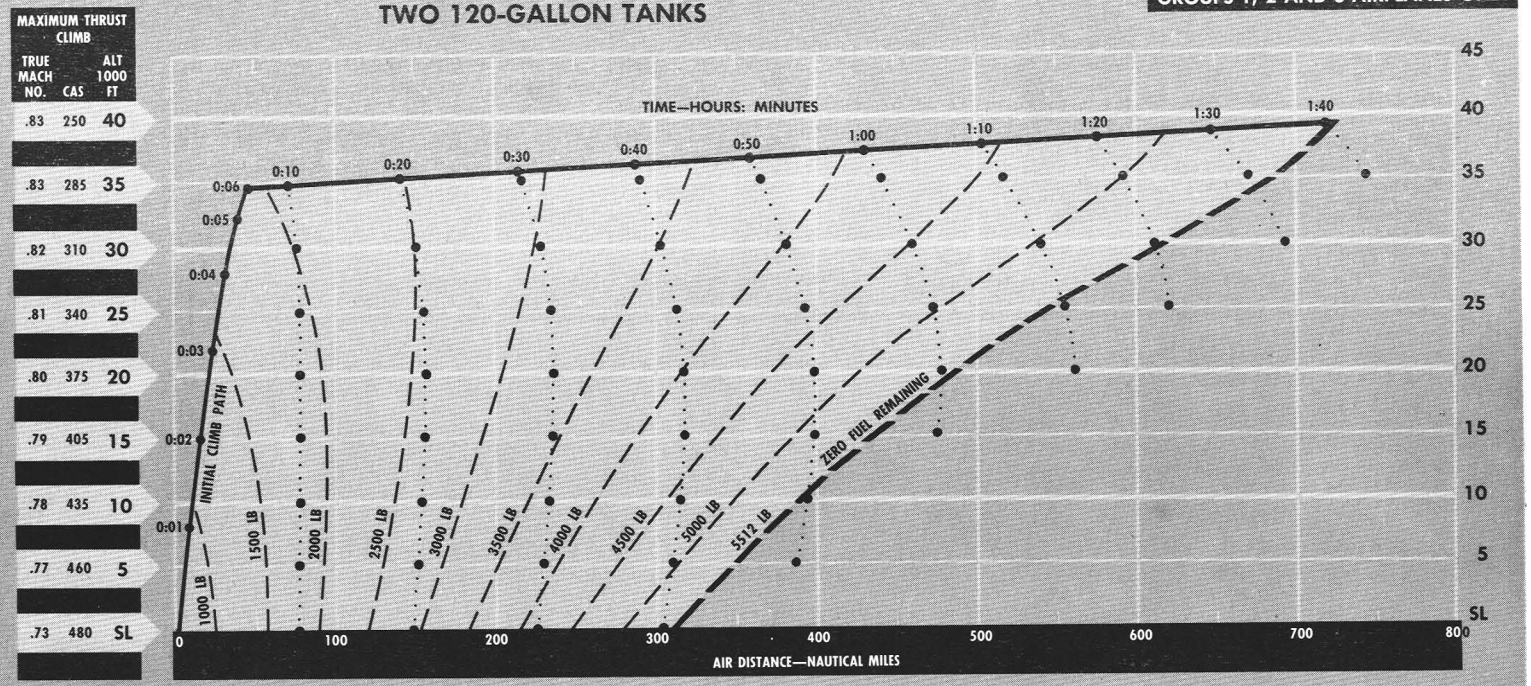
INTERCEPT PROFILE

STANDARD DAY
Model: F-86K
Engine: J47-17B

TAKE-OFF GROSS WEIGHT: 19,700-20,500 LB
ALL FUEL LOADS BETWEEN 0 - 5512 LB

TWO 120-GALLON TANKS

GROUPS 1, 2 AND 3 AIRPLANES ONLY



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	430-435	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.

F-86K-1-93-84A

Figure A-22

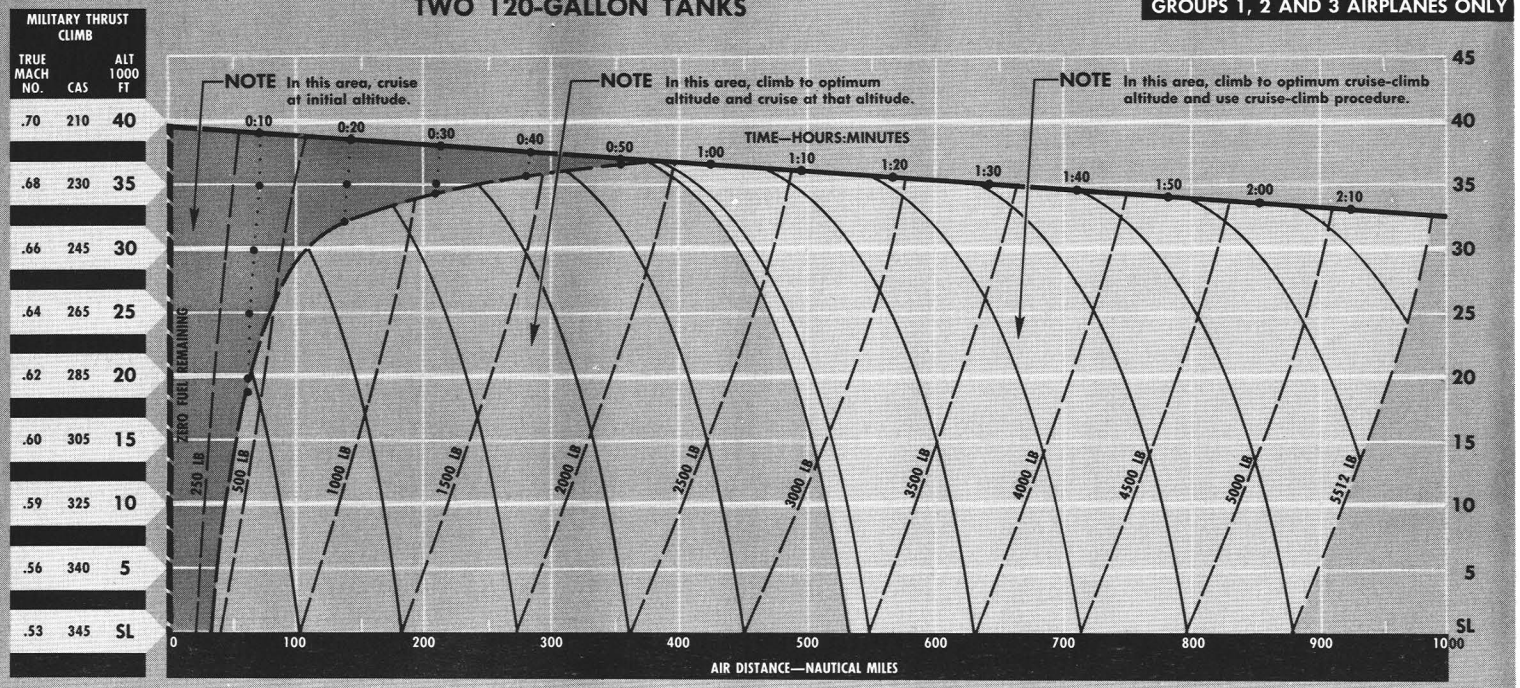
OPTIMUM RETURN PROFILE

STANDARD DAY
Model: F-86K
Engine: -17B

TAKE-OFF GROSS WEIGHT: 19,700-20,500 LB
ALL FUEL LOADS BETWEEN 0 - 5512 LB

TWO 120-GALLON TANKS

GROUPS 1, 2 AND 3 AIRPLANES ONLY



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	.74	240	425	2300-2050	100*
35,000	.73	245	420	2300-2100	100-97
30,000	.67	250	395	2400-2150	96-93
25,000	.63	260	380	2500-2300	94-91
20,000	.59	270	360	2700-2500	92-90
15,000	.56	285	350	2900-2750	91-89
10,000	.53	295	340	3200-3100	90-89
5,000	.51	310	330	3650-3500	90-89
SEA LEVEL	.50	330	330	4250-4100	90-89

Data as of: 1 Dec 1955. Based on flight test data.

*Maximum Continuous Thrust, 100% rpm, 635°C EGT.

F-86K-1-93-83A

Figure A-23

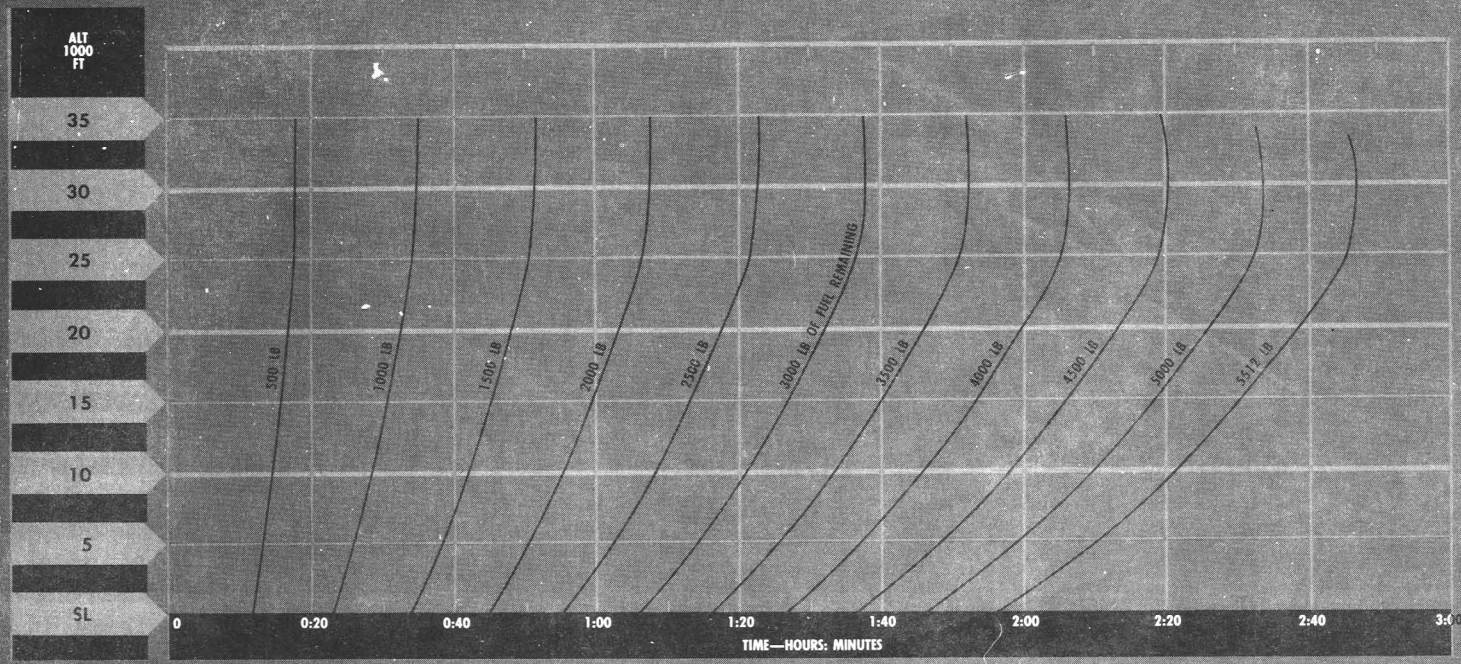
MAXIMUM ENDURANCE PROFILE

STANDARD DAY
Model: F-86K
Engine: J47-17B

TAKE-OFF GROSS WEIGHT: 19,700-20,500 LB
ALL FUEL LOADS BETWEEN 0 - 5512 LB

TWO 120-GALLON TANKS

GROUPS 1, 2 AND 3 AIRPLANES ONLY



LOITER	LESS THAN 2750 LB FUEL REMAINING					MORE THAN 2750 LB FUEL REMAINING				
ALTITUDE FEET	CAS	APPROXIMATE				CAS	APPROXIMATE			
		TRUE MACH NO.	TAS	LB/HR	% RPM		TRUE MACH NO.	TAS	LB/HR	% RPM
35,000	185	.56	325	2000-1700	95-91	200	.61	350	2300-2000	97-95
30,000	185	.50	290	2000-1700	92-89	195	.53	310	2300-2000	96-92
25,000	185	.45	275	2000-1750	90-86	195	.48	290	2300-2000	93-90
20,000	185	.41	250	2100-1900	87-84	200	.44	270	2350-2100	90-87
15,000	185	.37	235	2200-1950	85-82	200	.40	250	2450-2200	88-85
10,000	185	.34	215	2350-2100	84-81	205	.37	235	2550-2350	86-84
5,000	190	.31	200	2550-2350	83-80	205	.34	220	2750-2550	85-83
SEA LEVEL	190	.29	190	2850-2650	82-80	200	.31	200	3050-2850	84-82

Date as of: 1 Dec 1955. Based on flight test data.

REMARKS
1. Loiter at recommended CAS.
2. Maintain constant altitude.

F-86K-1-93-32A

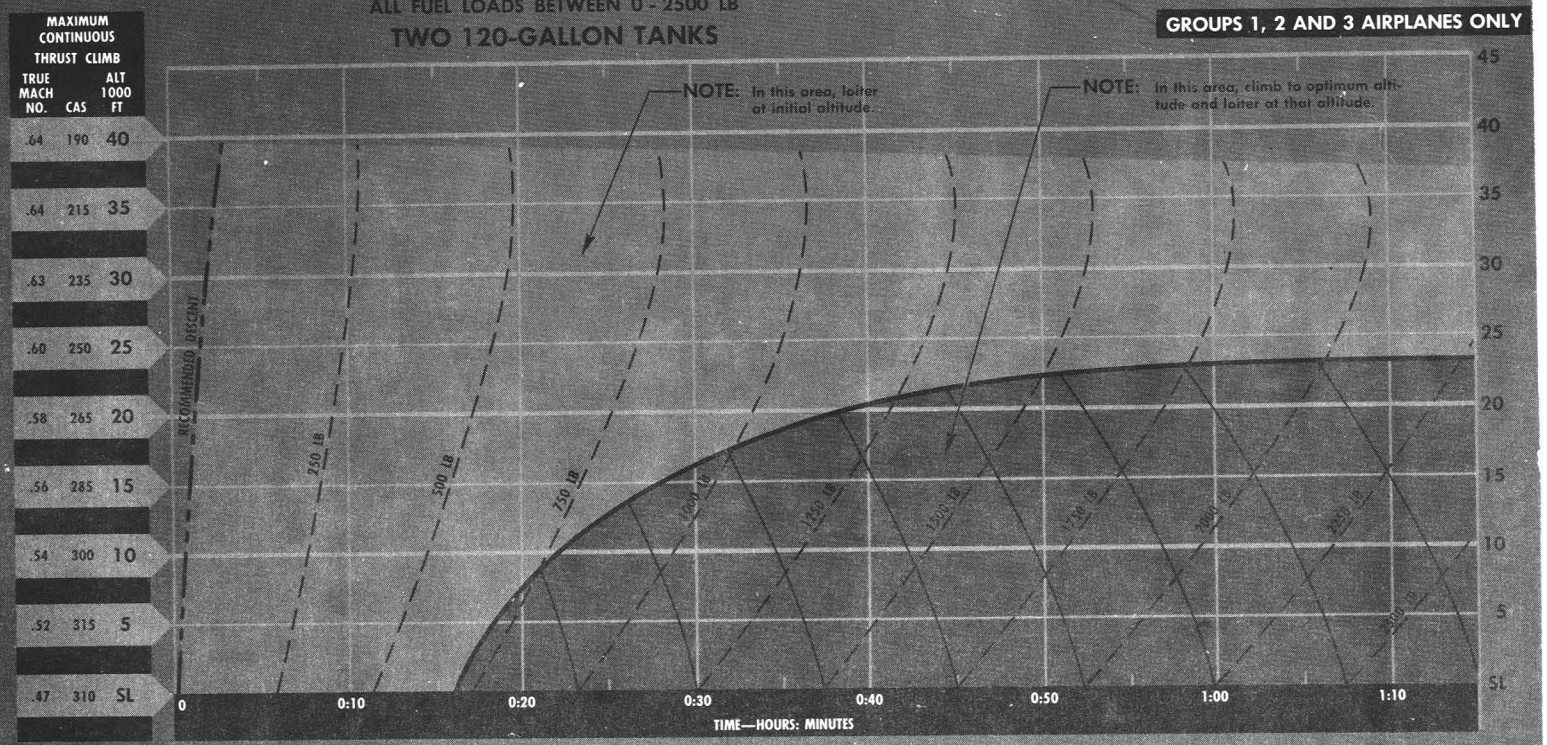
Figure A-24

OPTIMUM MAXIMUM ENDURANCE PROFILE

STANDARD DAY
Model: F-86K
Engine: J47-17B

TAKE-OFF GROSS WEIGHT: 19,700-20,500 LB
ALL FUEL LOADS BETWEEN 0 - 2500 LB
TWO 120-GALLON TANKS

GROUPS 1, 2 AND 3 AIRPLANES ONLY



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 TANKS

ALTITUDE FEET	CAS	APPROXIMATE TRUE MACH NO.	TAS	LB/HR	% RPM
35,000	185	.56	325	2000-1700	95-91
30,000	185	.50	290	2000-1700	92-89
25,000	185	.45	275	2000-1750	90-86
20,000	185	.41	250	2100-1900	87-84
15,000	185	.37	235	2200-1950	85-82
10,000	185	.34	215	2350-2100	84-81
5,000	190	.31	200	2550-2350	83-80
SEA LEVEL	190	.29	190	2850-2650	82-80

Data as of: 1 Dec 1955. Based on flight test data.

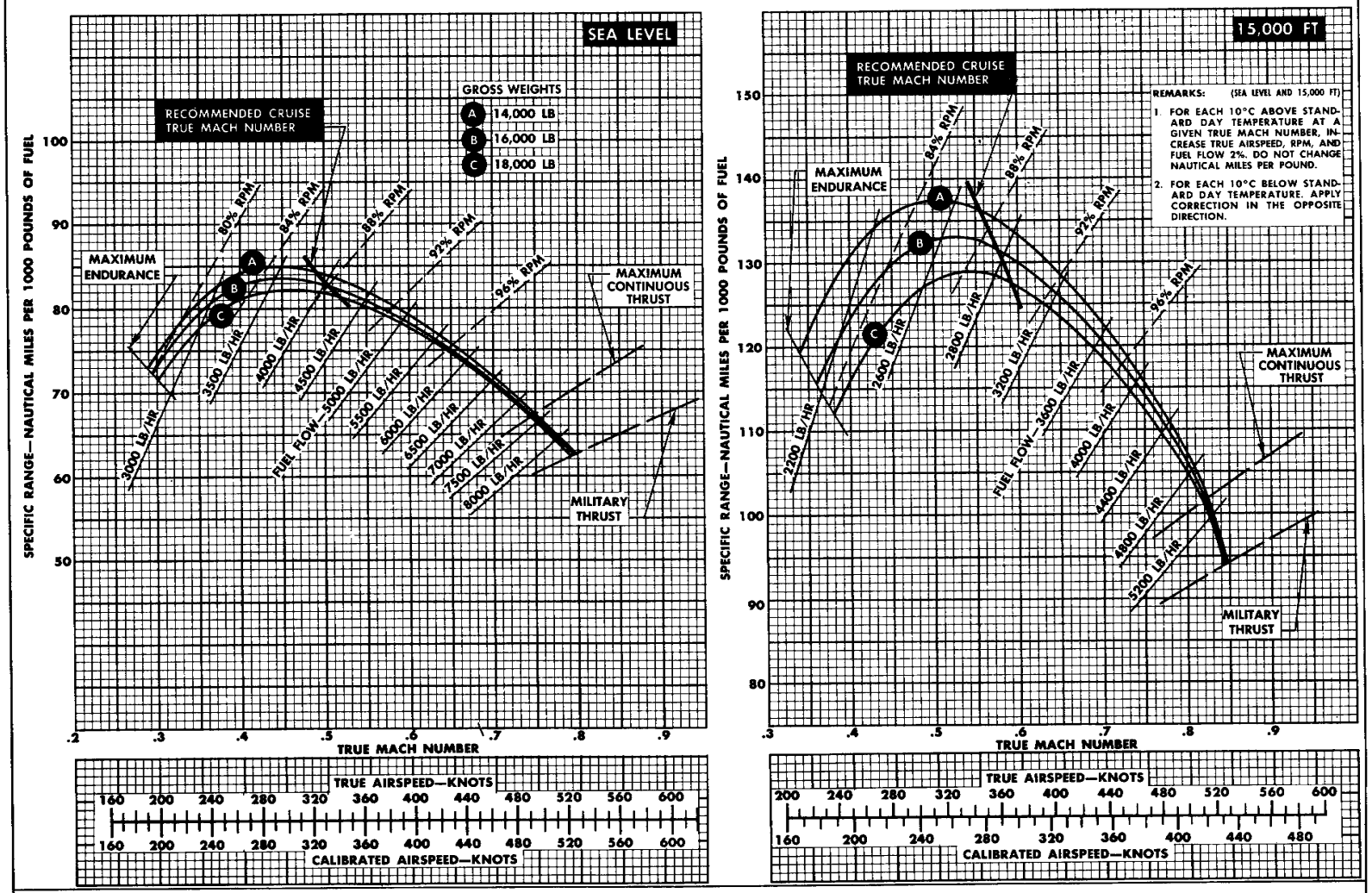
F-86K-1-83-81A

Figure A-25

NAUTICAL MILES PER POUND OF FUEL

CLEAN

STANDARD DAY
MODEL: F-86K
ENGINE: J47-GE-17B



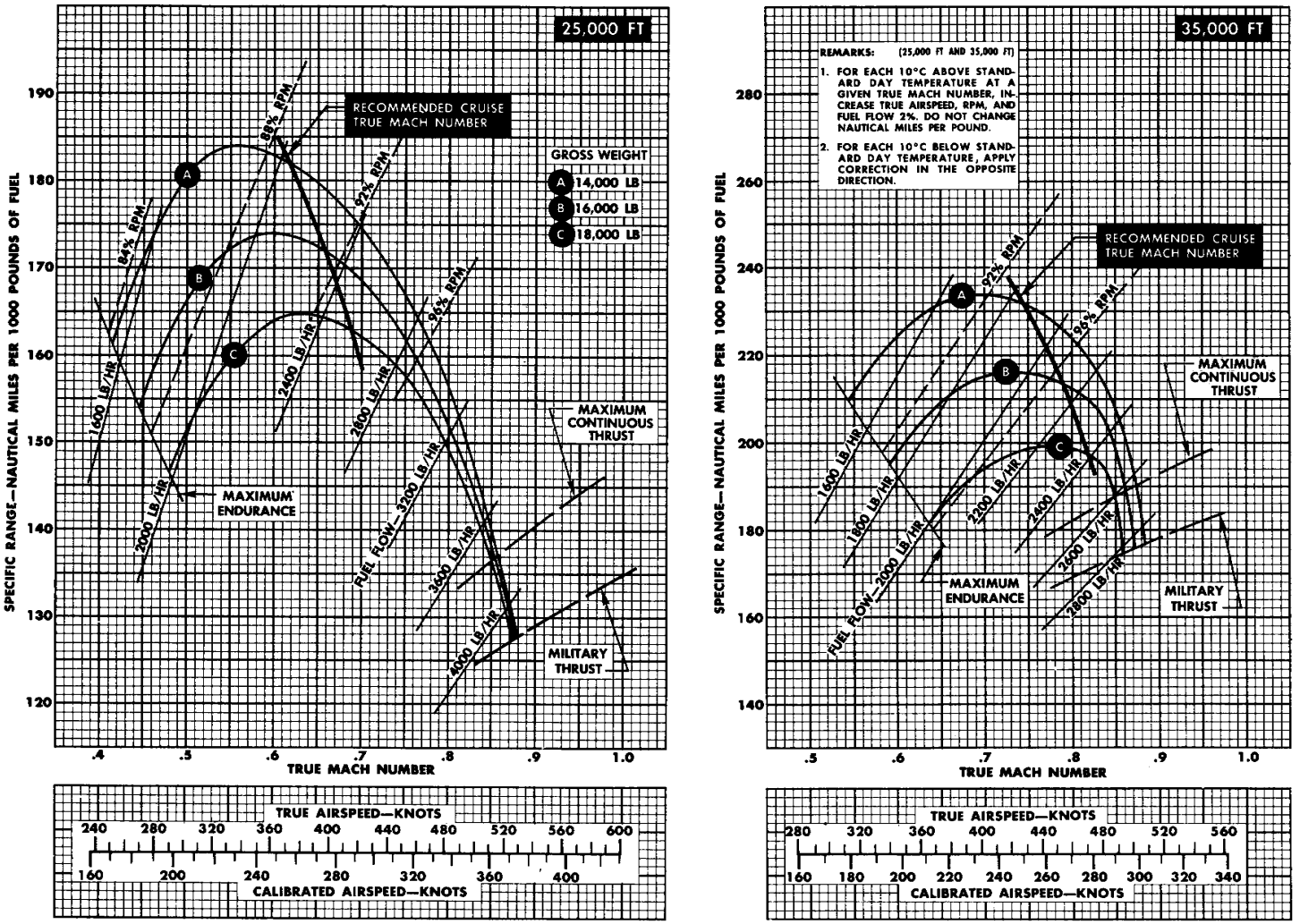
DATA AS OF: 1 DEC 1955
BASED ON FLIGHT TEST DATA

Figure A-36

NAUTICAL MILES PER POUND OF FUEL

CLEAN

STANDARD DAY
MODEL: F-86K
ENGINE: J47-GE-17B



DATA AS OF: 1 DEC 1955
BASED ON FLIGHT TEST DATA

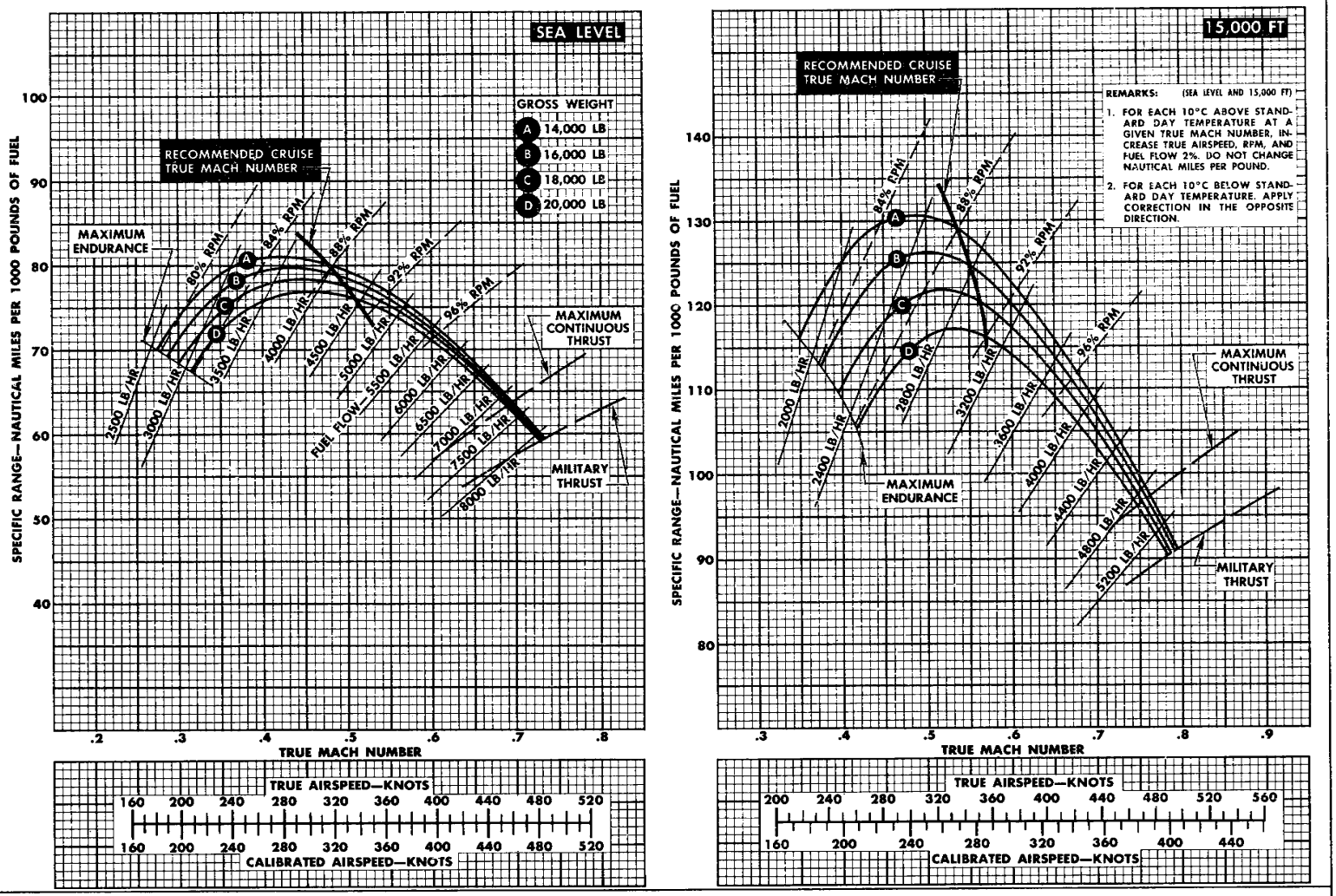
F-86K-1-93-67

Figure A-37

NAUTICAL MILES PER POUND OF FUEL

TWO 120-GALLON TANKS

STANDARD DAY
MODEL: F-86K
ENGINE: J47-GE-17B



DATA AS OF: 1 DEC 1955
BASED ON FLIGHT TEST DATA

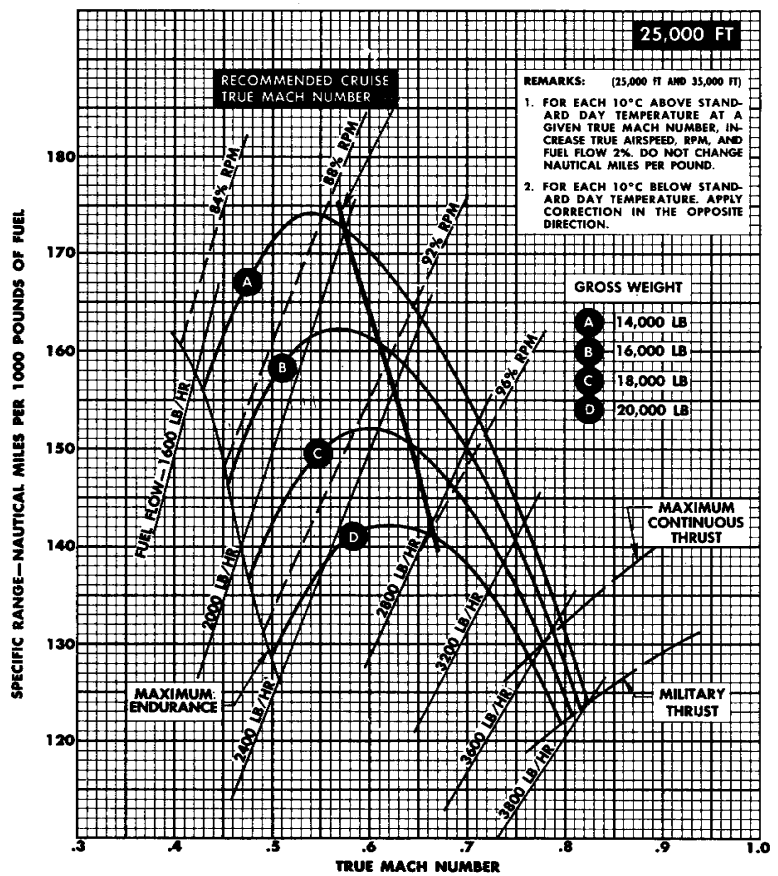
– F-86K-1-93-65

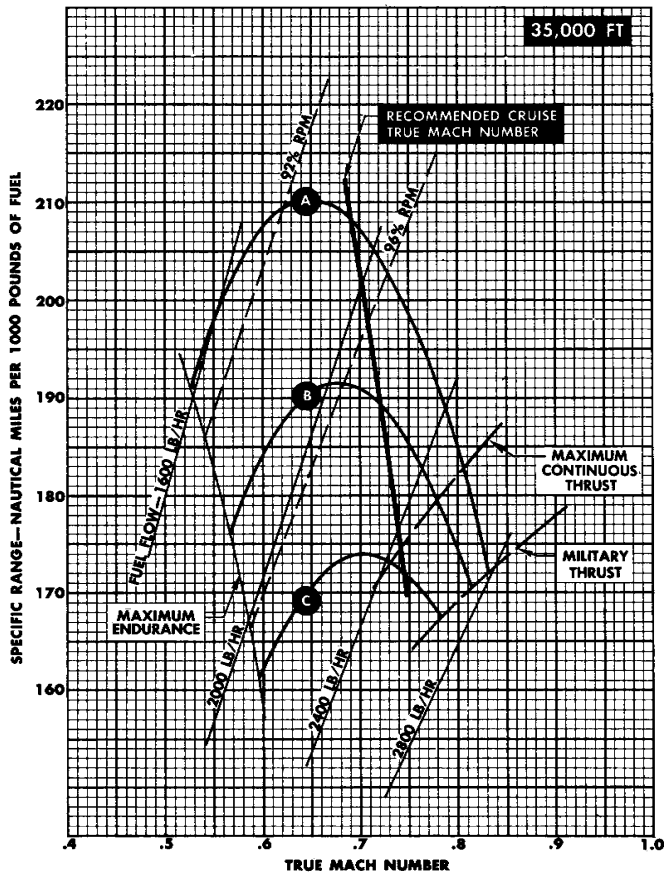
Figure A-39

NAUTICAL MILES PER POUND OF FUEL

TWO 120-GALLON TANKS

STANDARD DAY
MODEL: F-86K
ENGINE: J47-GE-17B





DATA AS OF: 1 DEC 1955
BASED ON FLIGHT TEST DATA

— F-86K-1-93-44

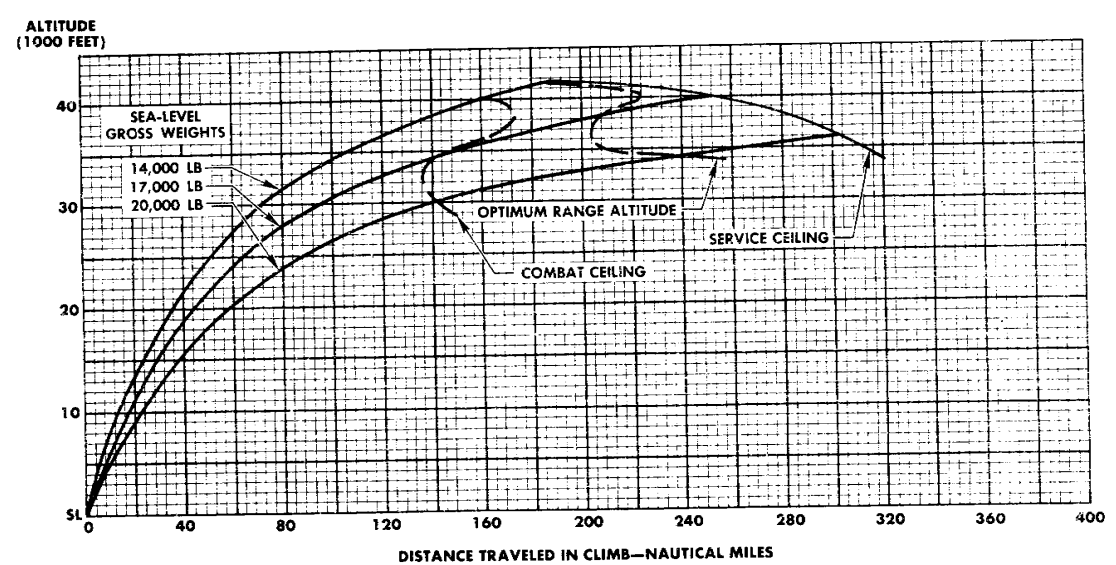
Figure A-40

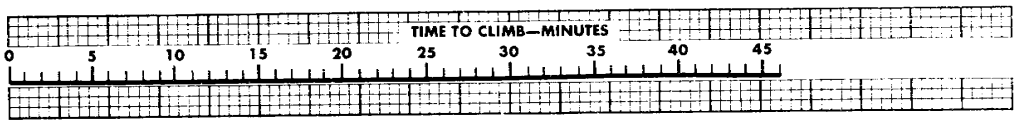
MILITARY THRUST CLIMB PROFILE

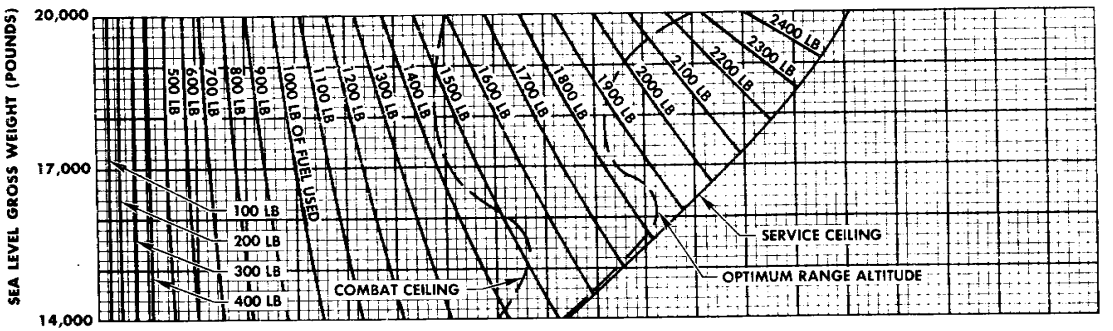
TWO 120-GALLON TANKS

STANDARD DAY
MODEL: F-86K
ENGINE: J47-17B
GROUP 4 AIRPLANES ONLY

CLIMB SPEEDS	CAS (KNOTS)	TRUE MACH NUMBER
	229	.76
	267	.71
	297	.65
	327	.59
	344	.53







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 JUNE 1959
BASED ON: FLIGHT TEST DATA

F-86K-1-93-123A

Figure A-46

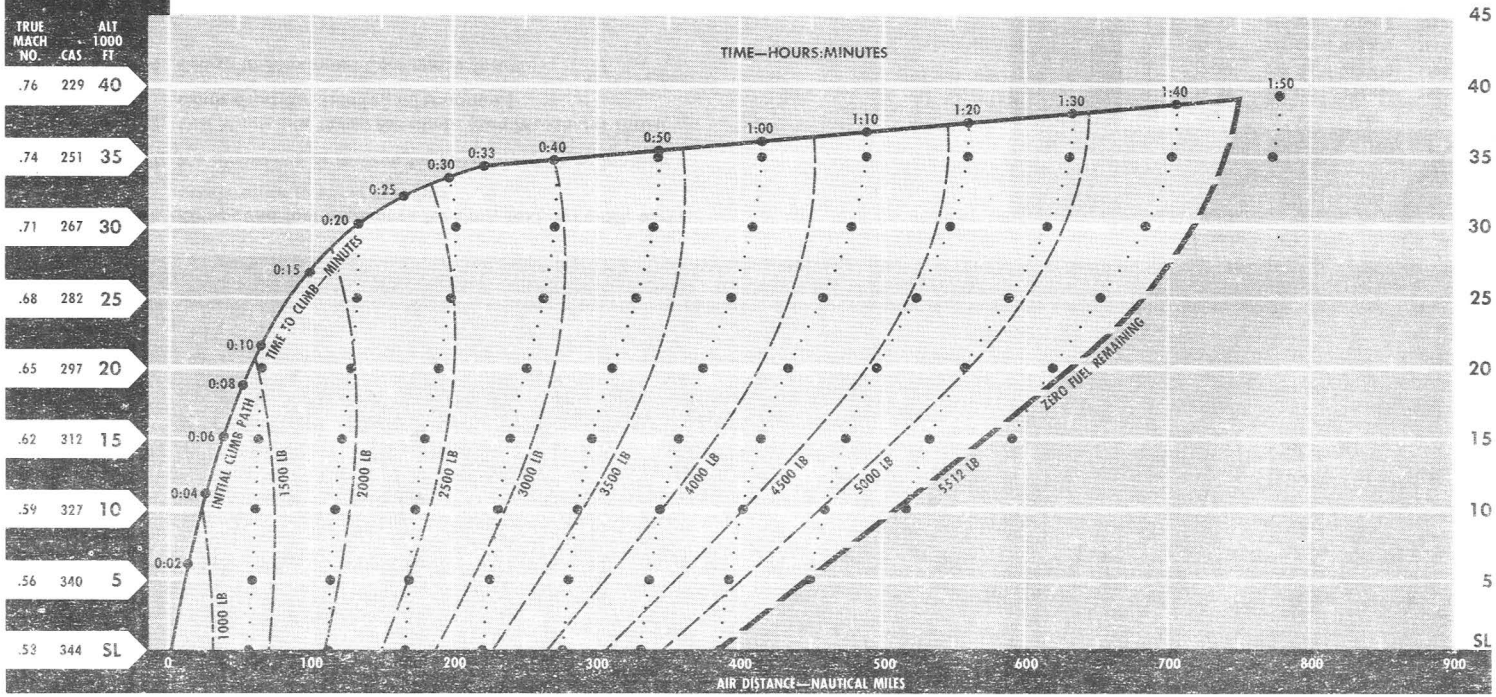
MISSION PROFILE

STANDARD DAY
Model: F-86K
Engine: J47-17B

GROUP 4 AIRPLANES ONLY

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 *					
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-86K-1-93-122

Figure A-47

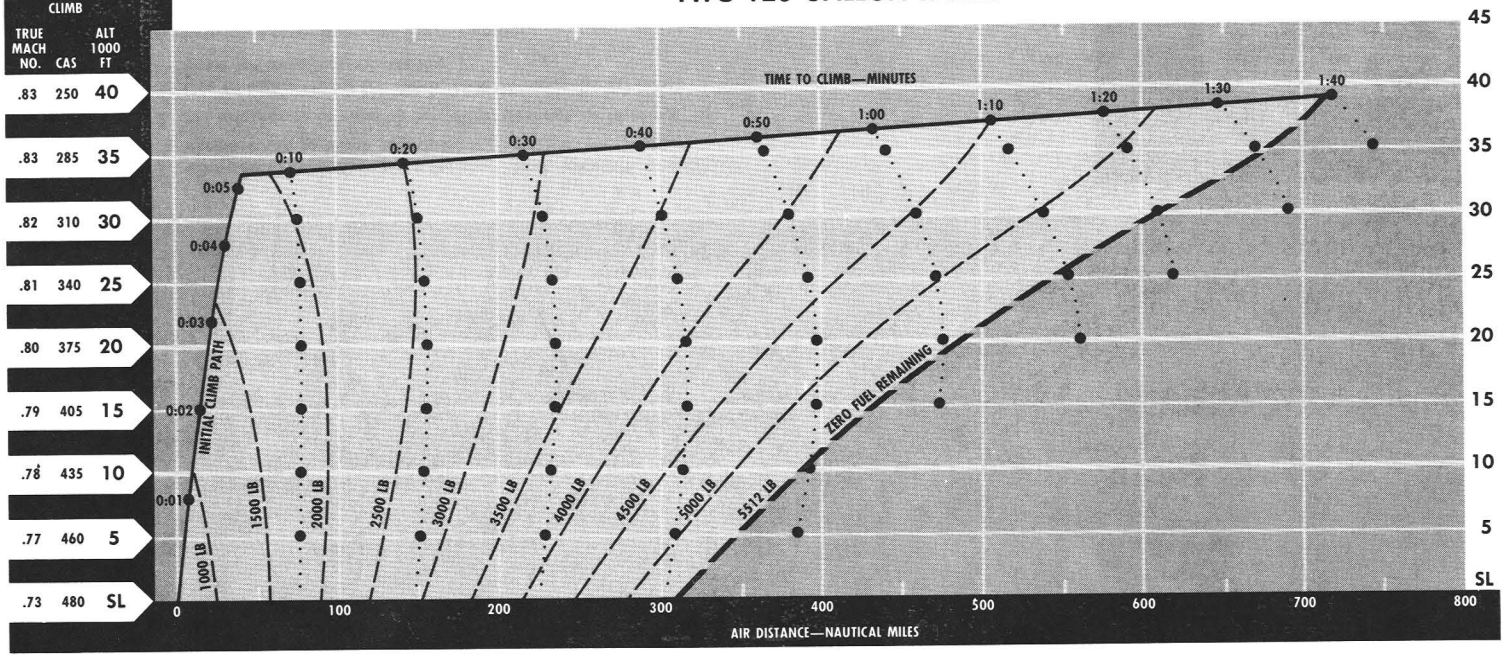
INTERCEPT PROFILE

STANDARD DAY
Model: F-86K
Engine: J47-17B

GROUP 4 AIRPLANES ONLY

TAKE-OFF GROSS WEIGHT: 19,700-20,500 LB
ALL FUEL LOADS BETWEEN 0-5512 LB

TWO 120-GALLON TANKS



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.

Data as of: 25 Dec. 1957. Based on flight test data.

F-86K-1-93-121

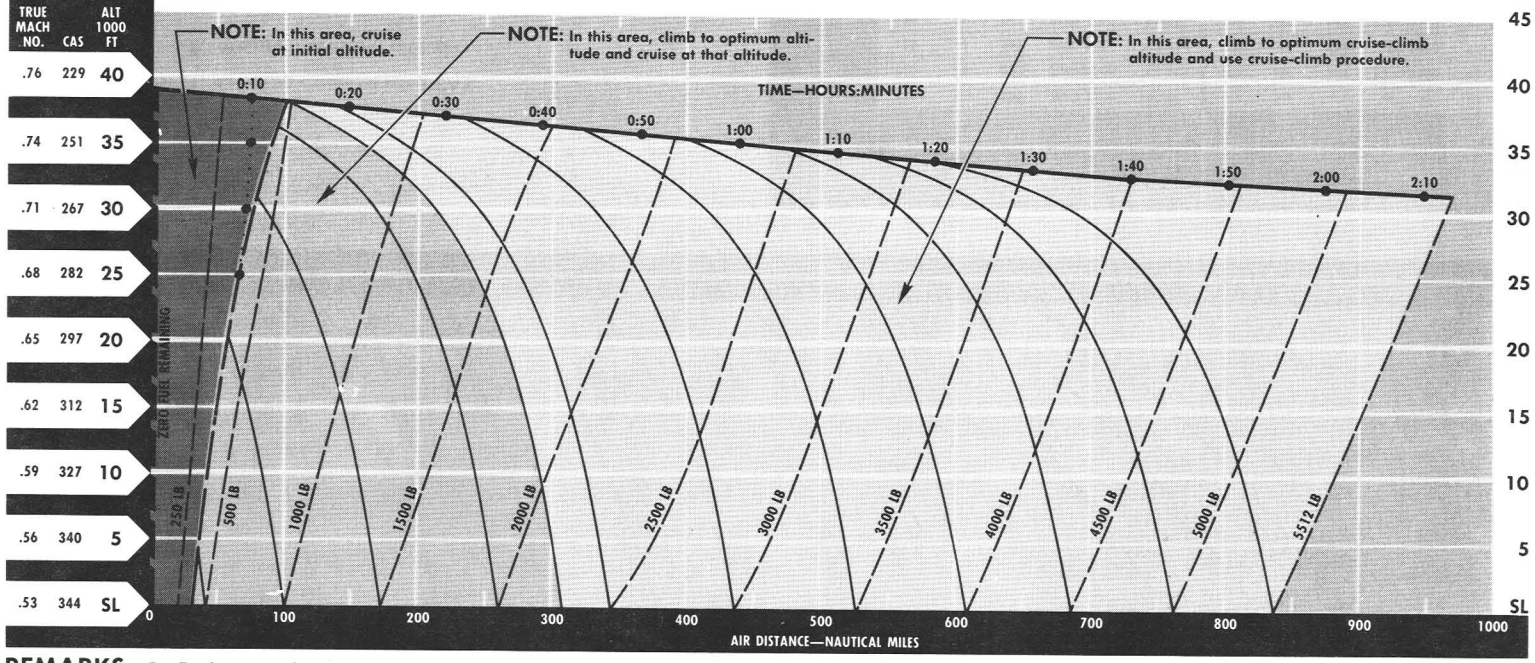
OPTIMUM RETURN PROFILE

STANDARD DAY
Model: F-86K
Engine: J47-17B

GROUP 4 AIRPLANES ONLY

TWO 120-GALLON TANKS

TAKE-OFF GROSS WEIGHT: 19,700-20,500 LB
ALL FUEL LOADS BETWEEN 0-5512 LB



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-86K-1-93-120

MAXIMUM ENDURANCE PROFILE

STANDARD DAY
Model: F-86K
Engine: J47-17B

GROUP 4 AIRPLANES ONLY

TWO 120-GALLON TANKS

TAKE-OFF GROSS WEIGHT: 19,700-20,500 LB
ALL FUEL LOADS BETWEEN 0-5512 LB

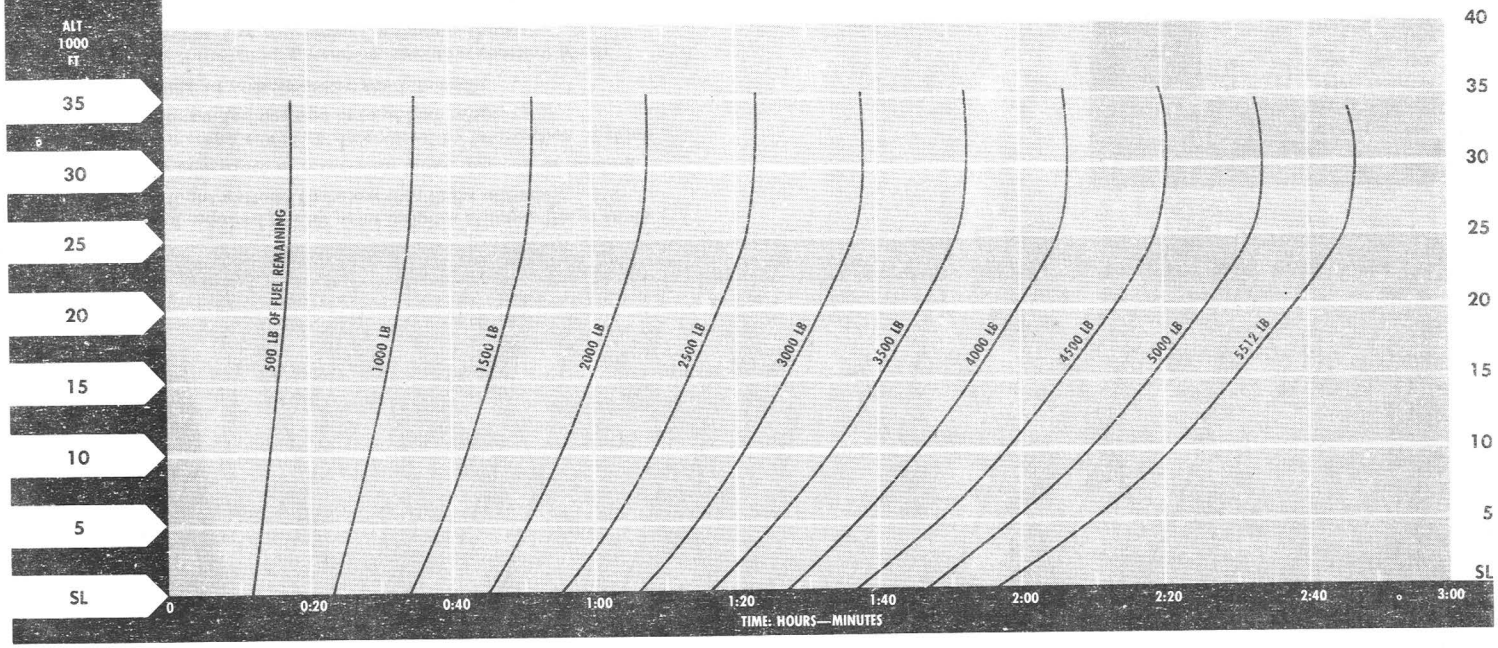


Figure A-50

LOITER	LESS THAN 3000 LB FUEL REMAINING					MORE THAN 3000 LB FUEL REMAINING				
ALTITUDE FEET	CAS	APPROXIMATE				CAS	APPROXIMATE			
		TRUE MACH NO.	TAS	LB/HR	% RPM		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-86K-1-93-119

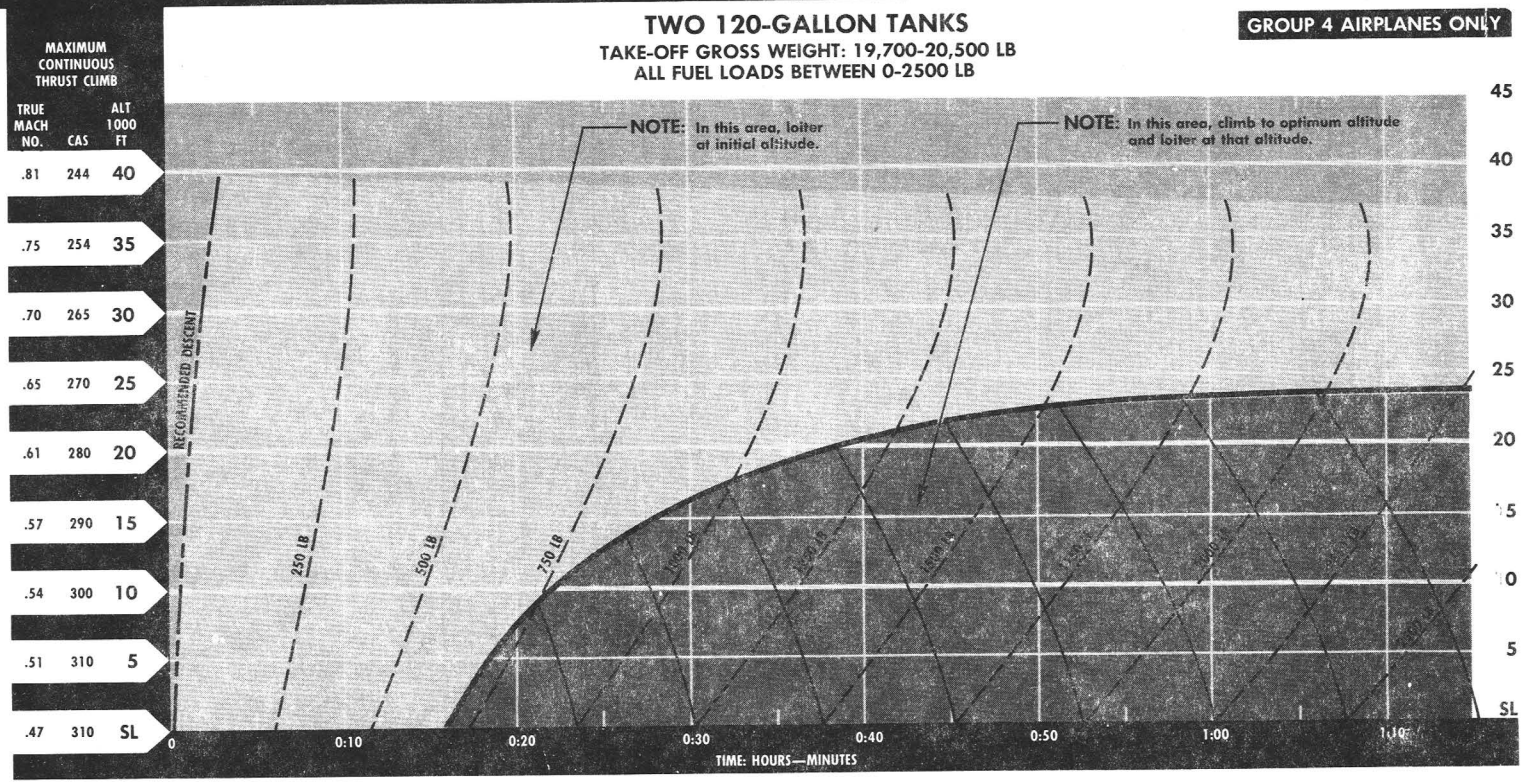
OPTIMUM MAXIMUM ENDURANCE PROFILE

STANDARD DAY
Model: F-86K
Engine: J47-17B

GROUP 4 AIRPLANES ONLY

TWO 120-GALLON TANKS

TAKE-OFF GROSS WEIGHT: 19,700-20,500 LB
ALL FUEL LOADS BETWEEN 0-2500 LB



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

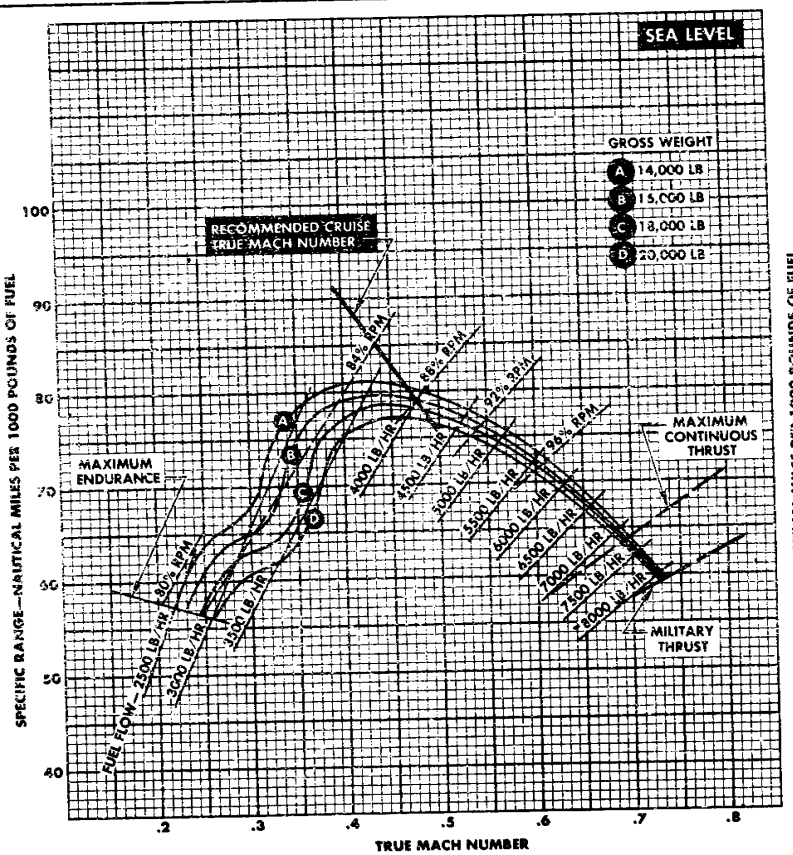
Data as of: 25 Dec. 1957. Based on flight test data.

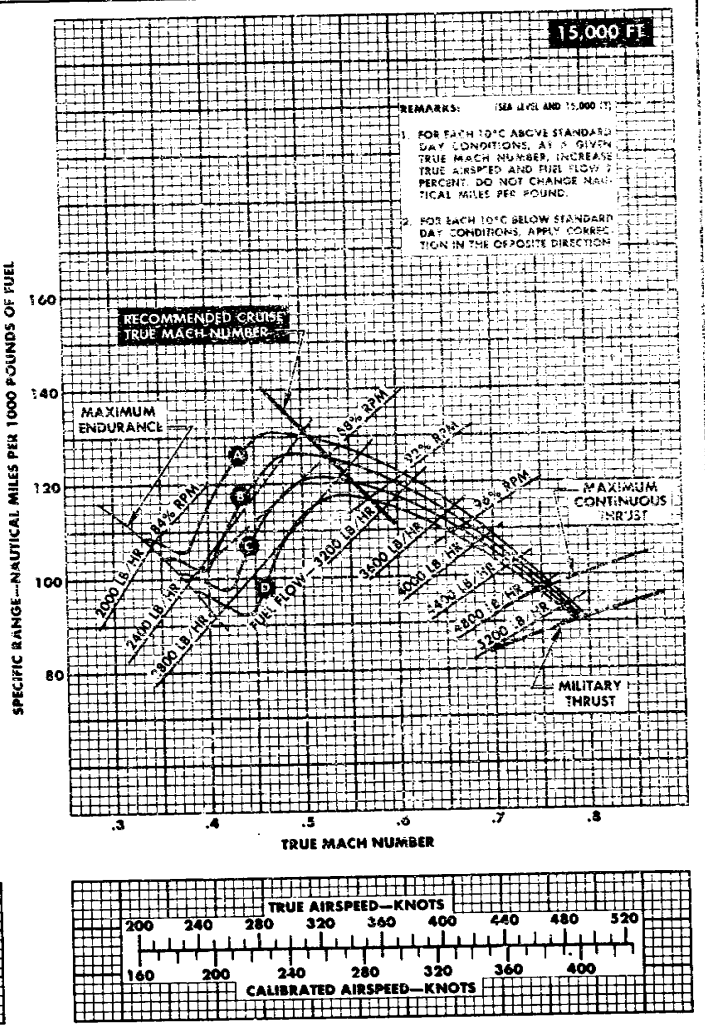
F-86K-1-93-118

NAUTICAL MILES PER POUND OF FUEL

TWO 120-GALLON TANKS

STANDARD DAY
MODEL: F-86K
ENGINE: J47 -17B
GROUP 4 AIRPLANES ONLY





DATA AS OF: 25 DEC. 1957
BASED ON: FLIGHT TEST DATA

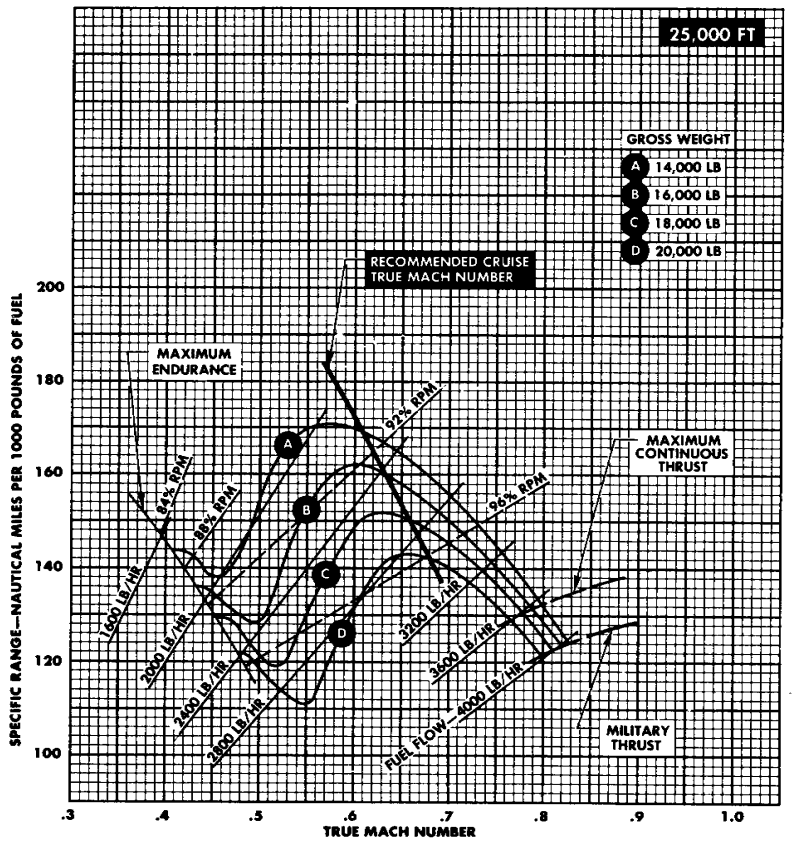
F-86K-1-93-114

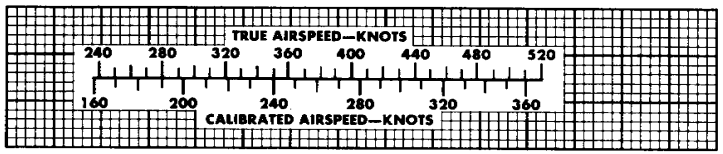
Figure A-55

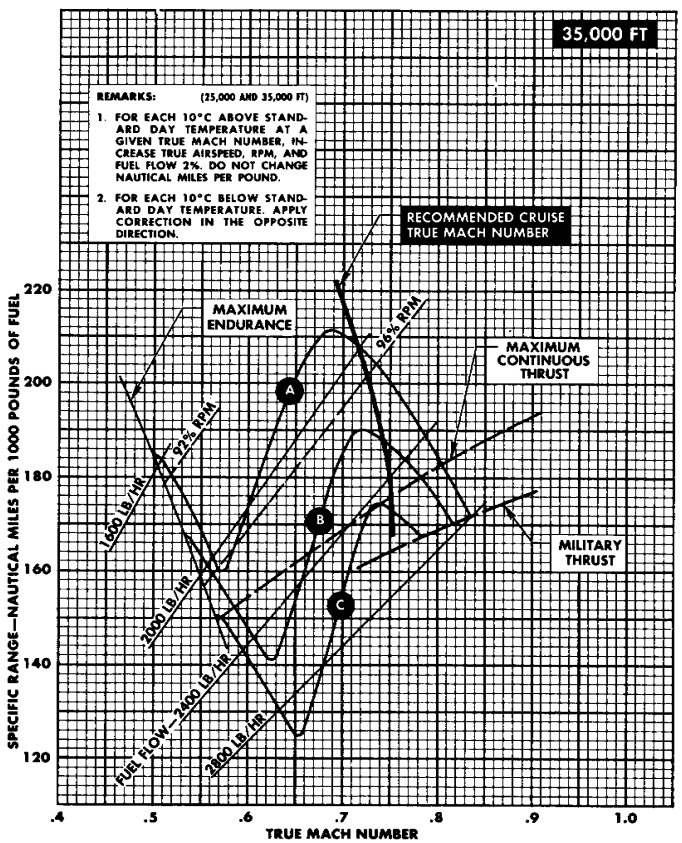
NAUTICAL MILES PER POUND OF FUEL

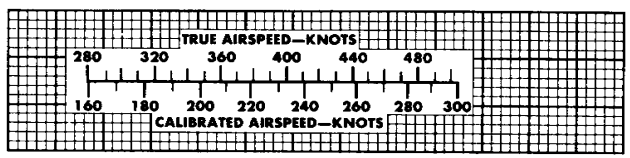
TWO 120-GALLON TANKS

STANDARD DAY
MODEL: F-86K
ENGINE: J47-17B
GROUP 4 AIRPLANES ONLY









DATA AS OF: 25 DEC. 1957
BASED ON: FLIGHT TEST DATA

F-86K-1-93-113

Figure A-56