# FLIGHT MANUAL

T.O. 1F-89H-1

USAF SERIES

# F-89H

AIRCRAFT

COMMANDERS ARE RESPONSIBLE FOR BRINGING THIS TECHNICAL PUBLICATION TO THE ATTENTION OF ALL AIR FORCE PERSONNEL CLEARED FOR OPERATION OF AFFECTED AIRCRAFT.

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THIS MANUAL IS NOT COMPLETE WITHOUT CONFIDENTIAL SUPPLEMENT T.O. 1F-89H-1A.



THIS CHANGE INCLUDES SAFETY OF FLIGHT SUPPLEMENTS THROUGH -1Y. SEE BASIC INDEX, T.O. 0-1-1, AND WEEKLY INDEX, T.O. 0-1-1A, FOR CURRENT STATUS OF SAFETY OF FLIGHT SUPPLEMENTS.

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H-1F

AIR FORCE, Kerr Litho, Culver City, Calif., 4/12/59—1450 (Northrop)

**31 OCTOBER 1958**

**CHANGED 13 FEBRUARY 1959**

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| *1-4 | 13 February 1959 |
| 1-5 | Original |
| *1-6 | 13 February 1959 |
| 1-7 through 1-66 | Original |
| 2-1 | Original |
| *2-2 through 2-5 | 13 February 1959 |
| 2-6 through 2-44 | Original |
| 3-1 through 3-2 | Original |
| *3-3 | 13 February 1959 |
| 3-4 through 3-11 | Original |
| *3-12 | 13 February 1959 |
| 3-13 through 3-18 | Original |
| *3-18A through 3-19 | 13 February 1959 |
| 3-20 through 3-28 | Original |
| *3-29 | 13 February 1959 |
| 3-30 through 3-38 | Original |
| 4-1 through 4-3 | Original |
| *4-4 | 13 February 1959 |
| 4-5 through 4-32 | Original |
| 5-1 through 5-16 | Original |
| 6-1 through 6-8 | Original |
| *6-9 | 13 February 1959 |
| 6-10 through 6-18 | Original |
| 7-1 through 7-6 | Original |
| *8-1 through 8-2 | 13 February 1959 |
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| 9-1 through 9-22 | Original |
| A-1 through A-110 | Original |
| 1 | Original |
| *2 | 13 February 1959 |
| 3 through 5 | Original |
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| 7 | Original |
| *8 | 13 February 1959 |
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* REFER TO T.O. 1F-89H-1A FOR ADDITIONAL INFORMATION.

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**BECAUSE OF THE RIGID REQUIREMENTS IMPOSED ON INTERCEPTOR CREWS OPERATING THE HIGH PERFORMANCE FIGHTERS OF THE JET AGE, LADY LUCK CANNOT BE RELIED UPON FOR COMPLETION OF A SUCCESSFUL MISSION. THEREFORE, IT IS MANDATORY THAT COMPLETE UNDERSTANDING OF FLIGHT CHARACTERISTICS AND OPERATING TECHNIQUES FOR THE HIGHLY COMPLEX SYSTEMS BE MAINTAINED AT THE HIGHEST LEVEL.**

## SCOPE

This manual contains all the information necessary for safe and efficient operation of the F-89H. These instructions do not teach basic flight principles, but are designed to provide you with a general knowledge of the airplane, its flight characteristics, and specific normal and emergency operating procedures. Your flying experience is recognized, and elementary instructions have been avoided.

## SOUND JUDGMENT

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

## PERMISSIBLE OPERATIONS

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

## STANDARDIZATION

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

## ARRANGEMENT

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

## YOUR RESPONSIBILITY

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

## PERSONAL COPIES, TABS, AND BINDERS

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

## HOW TO GET COPIES

If you want to be sure of getting your manuals on time, order them before you need them. Early ordering will assure that enough copies are printed to cover your requirements. Technical Order 0-5-2 explains how to order Flight Manuals so that you automatically will get all revisions, reissues, 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 flight crews once they are received on the base.

## SAFETY OF FLIGHT SUPPLEMENTS

Safety of Flight Supplements are used to get information to you in a hurry. Safety of Flight Supplements use the same number as your Flight Manual, except for the addition of a suffix letter. Supplements covering loss of life will get to you in 48 hours; those concerning serious damage to equipment will make it in 10 days. You can determine the status of Safety of Flight Supplements by referring to the Index of Technical Publications (T.O. 0-1-1) and 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 of Flight Supplement should also be checked to determine the effect 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 Publications Requirements Table, you automatically will receive all supplements pertaining to your airplane. Technical Order 0-5-1 covers some additional information regarding these supplements.

## WARNINGS, CAUTIONS, AND NOTES

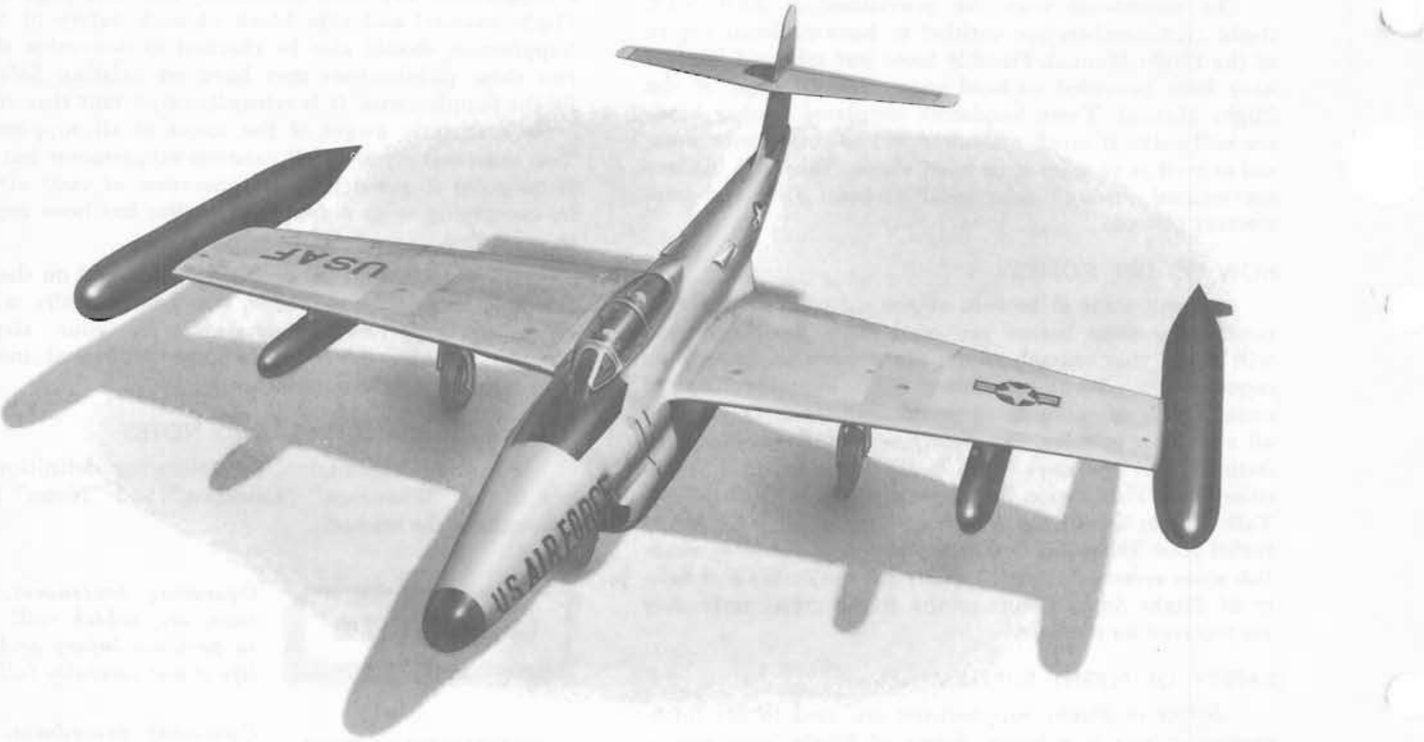
For your information, the following definitions apply to the "Warnings," "Cautions," and "Notes" found throughout the manual:

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

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

**Note** — *Operating procedures, conditions, etc, which it is essential to emphasize.*


**COMMENTS AND QUESTIONS REGARDING ANY PHASE OF THE FLIGHT MANUAL PROGRAM ARE INVITED AND SHOULD BE ADDRESSED TO COMMANDER, OGDEN AIR MATERIEL AREA, HILL AIR FORCE BASE, UTAH, ATTENTION: WCLOD-31D.**




# F-89H SCORPION


*Figure 1-1.*

# DESCRIPTION

SECTION I

HF-1B

## TABLE OF CONTENTS



## THE AIRPLANE.

The Northrop F-89H airplane is a two-place, mid-wing, jet-propelled, all-weather fighter interceptor designed to operate at high speeds and high altitudes. The airplane's function is to locate, intercept, and destroy enemy aircraft by day or night, under all conditions of weather. The crew consists of a pilot and a radar observer. For maximum efficiency, the radar equipment is operated by the observer, thus allowing the pilot to devote his full attention to flying. This division of duties results in higher combat effectiveness. The pilot and radar observer have individual cockpits with ejection seats and automatic heating and pressurizing facilities. The tandem cockpits are enclosed by a single jettisonable canopy. The airplane is powered by two turbojet engines with afterburners. The flight control surfaces are fully powered by two independent hydraulic systems. "Feel," which would otherwise be absent in a powered control system, is supplied artificially to the control stick and to the rudder pedals by springs. Additional elevator "feel" is supplied by a control force bellows system and a "G" operated bobweight. Another unusual feature not found on other combat airplanes is the combination of ailerons and speed brakes. Each aileron is composed of a leading edge section and two movable aft surfaces, one above the other, hinged at their forward edges. These two surfaces can be opened to any desired angle, up to an included angle of 120 degrees, to function as a speed brake. The left and right speed brakes operate simultaneously. Pylons under the wings carry jettisonable fuel tanks.

## AIRPLANE DIMENSIONS.

Refer to figure 1-2 for dimensions of this airplane.

## AIRPLANE GROSS WEIGHTS.

The design gross weight is approximately 39,500 pounds and the maximum gross weight is approximately 47,400 pounds. See figure 5-6 for exact gross weights.

## ARMAMENT.

Standard armament consists of 2.75 folding fin aerial rockets and GAR-1 missiles. For detailed information on armament, refer to T.O. 1F-89H-1A, a confidential supplement to this publication.

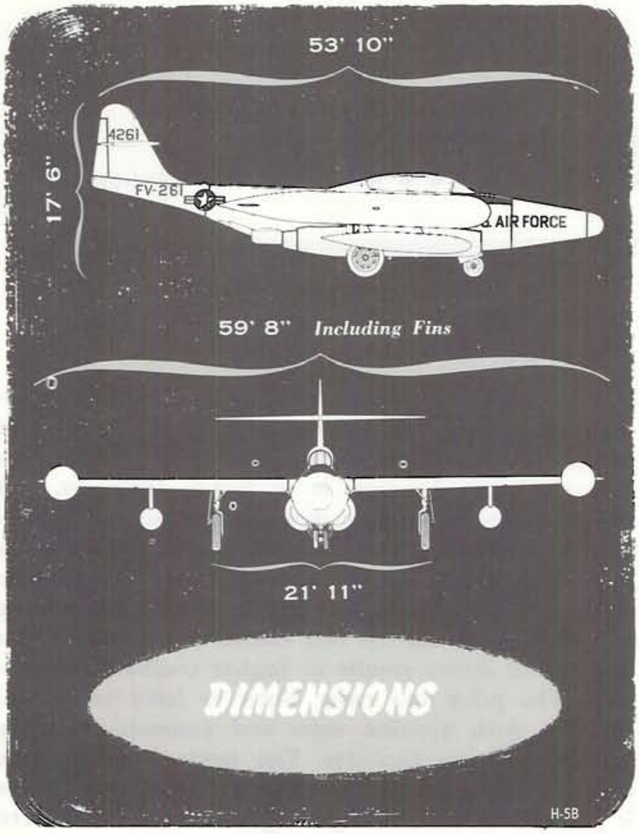



*Figure 1-2.*

## ENGINES.

The airplane is powered by two J35-35 axial-flow turbojet engines equipped with afterburners and retractable air inlet screens. Some airplanes have J35-47 inner combustion liners installed on J35-35 engines. Engines so modified have been reidentified as J35-35A by restamping the engine nameplate and making an appropriate notation in DD Form 781. On the front of each engine are mounted all accessories driven by the engine shaft, including engine fuel pump, oil pump, engine fuel control, hydraulic pump, starter generator, 28-volt d-c generator or alternator, and tachometer generator. Air enters through the engine airscoop and is progressively compressed through 11 stages in the axial-flow compressor. (See figure 1-5.) A portion of the eleventh stage compressor air is used to pressurize the pylon and wing tip fuel tanks and to operate the thermal anti-icing system, the afterburner fuel pump, the air-conditioning system, the canopy seal, and the anti "G" suit. The main flow of air from the compressor then enters the eight combustion chambers where fuel is sprayed under pressure and combustion occurs. The hot combustion gases rotate a turbine wheel which drives the compressor, both turbine wheel and compressor being mounted on the same shaft. From the turbine wheel, the gases travel through the exhaust cone and into the afterburner where additional fuel may be injected and burned to create more thrust if desired. The gases are then discharged from the tailpipe. The afterburner tailpipe nozzle is equipped with eyelids that open automatically during afterburning to increase tailpipe diameter, thus allowing additional thrust without excessive exhaust gas temperatures. The afterburner eyelids, in addition to opening during afterburning, will stay open during starting to prevent high temperatures, and during rapid acceleration to decrease acceleration time. Each engine at 100% rpm has a rated thrust of 5600 pounds without afterburning and 7400 pounds with afterburning. Acceleration from idle to 100% rpm requires approximately 12 seconds. For a detailed discussion of the eyelids, see Eyelid Operation, Section VII.

### ENGINE FUEL CONTROL SYSTEM.

Each engine has one gear-type, constant displacement, engine-driven fuel pump and one fuel control installed in the accessory section. The maximum output of each fuel pump is 26 gallons per minute. The engine-driven fuel pump incorporates two pumping elements. Should one element fail, the other element will maintain the required fuel pressure. Warning lights (figure 1-9), located on the pilot's left console, will indicate (on the ground only) that one of the pressure elements has failed. The fuel control automatically maintains the quantity of fuel supplied to the engine within a range that will prevent "rich blowout" during engine acceleration and "lean dieout" during deceleration, and bypasses any fuel in excess of that required by throttle setting, engine speed, and altitude. For engine starting and controlled acceleration during starting, the fuel is supplied to the combustion chambers in a wide-angle spray for ignition. This spray narrows its angle to distribute the combustion more evenly throughout the chamber as the engine accelerates. The change in spray characteristics is controlled within the nozzle by a spring-loaded valve which opens another set of orifices in the nozzle jet as fuel pressure builds up in the nozzle. A centrifugal governor in the fuel control varies the flow of fuel to the nozzles according to engine speed and throttle position. (See figure 1-6.) Refer to Section VII for additional information on engine operation.

#### Throttles.

Each of the two throttles (figure 1-7) on the pilot's left console mechanically regulates an engine fuel control. Markings on the throttle quadrant are CLOSED and OPEN. Mechanical stops at the IDLE position prevent inadvertent retarding of the throttle below the idle speed of the engines (49% to 51% rpm). The throttles can be retarded past the idle stops by raising the fingerlifts under the throttle knobs. This allows the throttles to be placed at CLOSED, stopping fuel flow to the engines. Each fingerlift connects to an afterburner demand switch that will start afterburning on the corresponding engine when the throttle is between the 90% and 100% rpm range. This is a mechanical

# MAIN DIFFERENCES TABLE


| ITEM | F-89 B AND C | F-89D | F-89H | F-89J |
|---|---|---|---|---|
| EXTERNAL POWER RECEPTACLES | THREE: *Some Group 1, 5, and 10 B airplanes*<br>FOUR: *Group 1, 5, and 10 B airplanes modified in accordance with T.O. 1F-89-256, some Group 15 B airplanes and some C airplanes*<br>FIVE: *Group 15 B airplanes modified in accordance with T.O. 1F-89-256; C airplanes modified in accordance with T.O. 1F-89-256* | FOUR: *Groups 1 through 25 airplanes*<br>THREE: *Group 30 and subsequent airplanes* | THREE | THREE |
| AUTOPILOT | NONE | *Group 35 and subsequent airplanes* | ALL AIRPLANES | ALL AIRPLANES |
| SINGLE-POINT FUELING | NONE | ALL AIRPLANES | ALL AIRPLANES | ALL AIRPLANES |
| ENGINES | J35-47 | J35-47: *Groups 1 through 20 airplanes*<br>J35-35 OR J35-35A: *Group 25 and subsequent airplanes* | J35-35 OR J35-35A | J35-35 OR J35-35A |
| ARMAMENT | SIX 20MM NOSE GUNS | ROCKETS | ROCKETS AND MISSILES | MB-1 ROCKETS<br>GAR-2A MISSILES<br>2.75 FFAR ROCKETS |
| WING TIP CONFIGURATION | FUEL TANKS | FUEL-ROCKET PODS | FUEL-ROCKET-MISSILE PODS | FUEL-ROCKET PODS OR 600-GALLON TIP TANKS |
| PYLON TANKS | NONE | ALL AIRPLANES | ALL AIRPLANES | TANKS OR MB-1 ROCKETS |
| NOSE FUEL TANK | NONE | ALL AIRPLANES | ALL AIRPLANES | ALL AIRPLANES |
| RADIO NAVIGATION EQUIPMENT | AN/ARN-6,-14,-18 | AN/ARN-6,-14,-18 | AN/ARN-6,-14,-18 | AN/ARN { -6,-14,-18 OR<br>-14,-18,-21 OR<br>-6,-21 } |

H-7C

Figure 1-3.

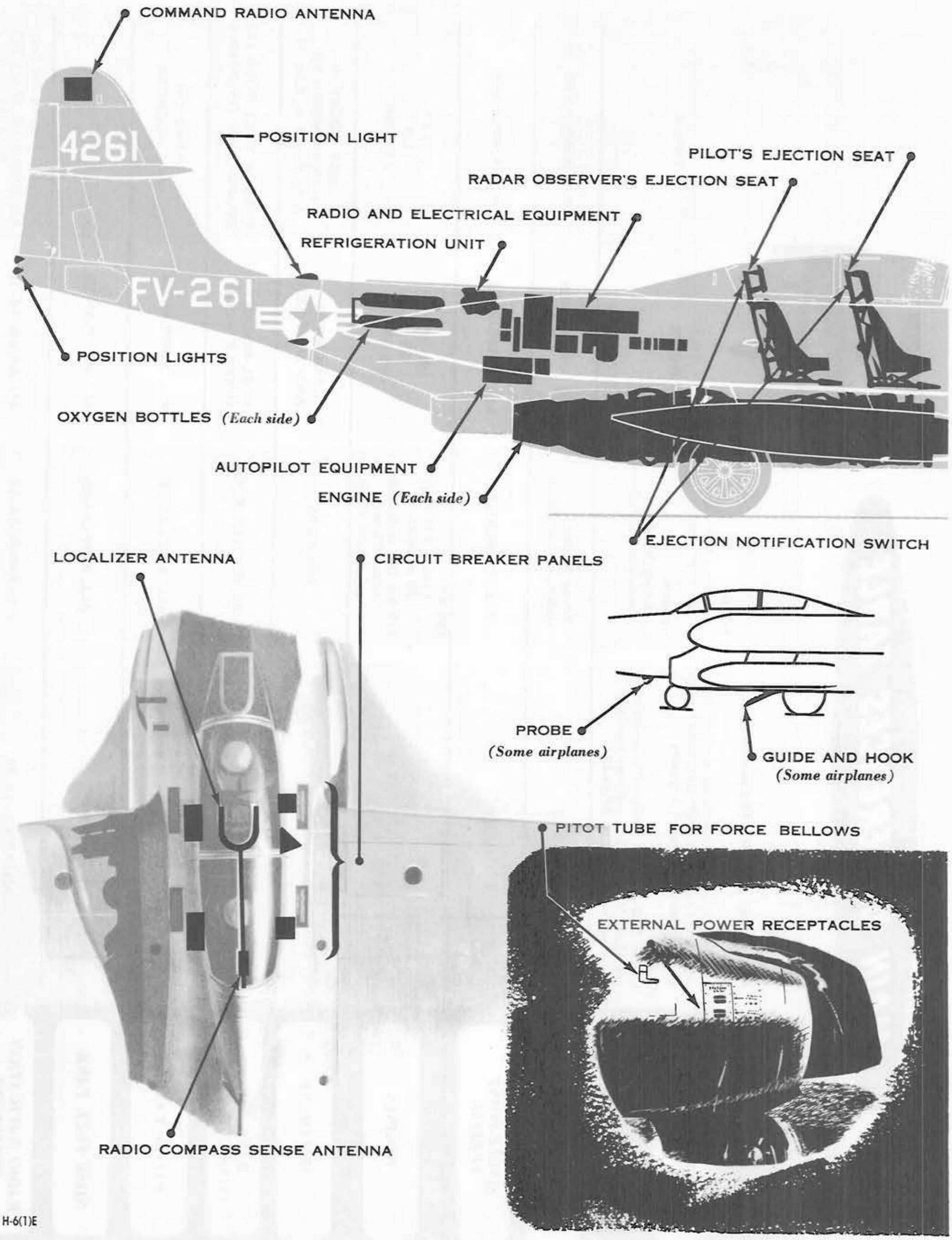
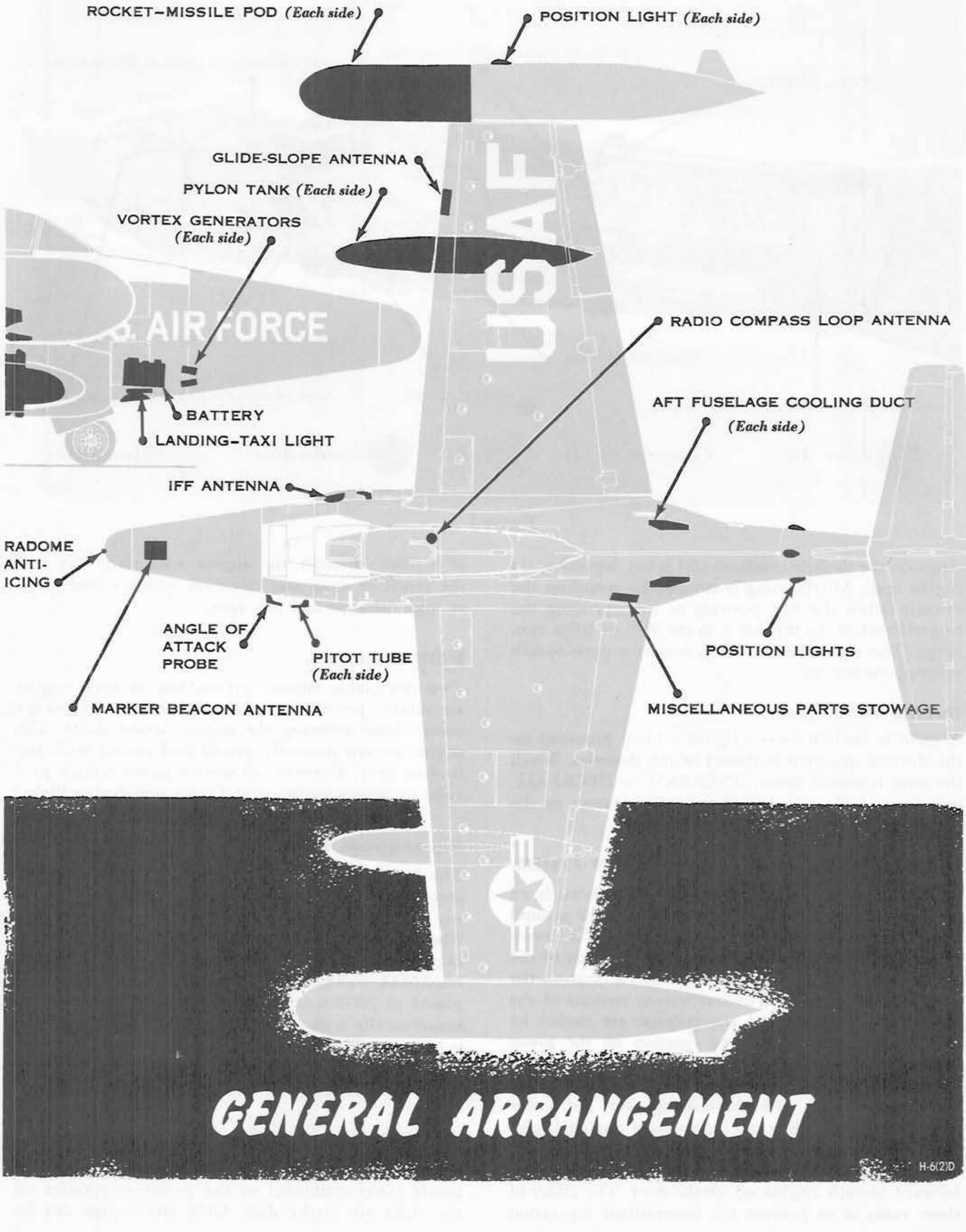

COMMAND RADIO ANTENNA
POSITION LIGHT
PILOT'S EJECTION SEAT
RADAR OBSERVER'S EJECTION SEAT
RADIO AND ELECTRICAL EQUIPMENT
REFRIGERATION UNIT
4261
FV-261
POSITION LIGHTS
OXYGEN BOTTLES (Each side)
AUTOPILOT EQUIPMENT
ENGINE (Each side)
EJECTION NOTIFICATION SWITCH
LOCALIZER ANTENNA
CIRCUIT BREAKER PANELS
PROBE
(Some airplanes)
GUIDE AND HOOK
(Some airplanes)
PITOT TUBE FOR FORCE BELLOWS
EXTERNAL POWER RECEPTACLES
RADIO COMPASS SENSE ANTENNA
H-6(1)E

Figure 1-4.


ROCKET-MISSILE POD (Each side)
POSITION LIGHT (Each side)
GLIDE-SLOPE ANTENNA
PYLON TANK (Each side)
VORTEX GENERATORS (Each side)
U.S. AIR FORCE
USAF
RADIO COMPASS LOOP ANTENNA
AFT FUSELAGE COOLING DUCT (Each side)
BATTERY
LANDING-TAXI LIGHT
IFF ANTENNA
RADOME ANTI-ICING
ANGLE OF ATTACK PROBE
PITOT TUBE (Each side)
POSITION LIGHTS
MARKER BEACON ANTENNA
MISCELLANEOUS PARTS STOWAGE
GENERAL ARRANGEMENT
H-6(2)D

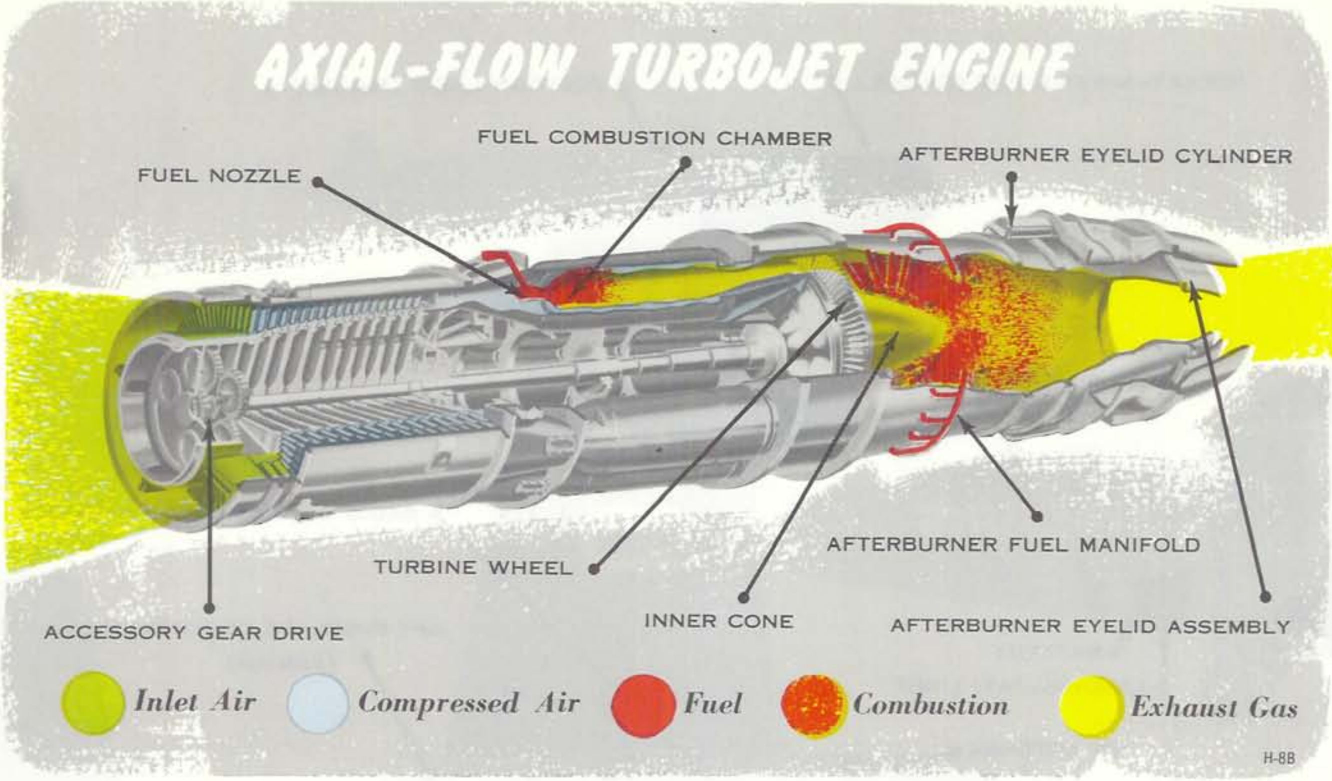



**Figure 1-5.**

range on the throttle quadrant and is not dependent on engine rpm. Afterburning is stopped by retarding the throttle below the 90% position or by depressing the fingerlift when the throttle is in the 90% to 100% rpm range. The right throttle knob houses a press-to-talk microphone button.

### Throttle Friction Lever.

A throttle friction lever (figure 1-7) is provided on the throttle quadrant outboard of the throttles. When the lever is moved toward INCREASE or DECREASE, resistance to throttle movement will increase or decrease accordingly.

## ENGINE COOLING AND AIR INDUCTION SYSTEM.

Engine cooling and induction air enters through an air intake at the front of each engine. On the ground and during takeoff, additional induction air is drawn through four intake doors on the outboard side of the engine forward door, and then through a door on the engine transition duct. The combustion sections of the engine compartment and the tailpipe are cooled by ram air supplied through an airscoop on the lower forward section of the engine's No. 3 and No. 4 doors. Retractable screens in the engine air intakes normally extend and retract with the landing gear, but under certain conditions they can be operated during flight. Vortex generators, in the form of two small air directing vanes, are installed approximately 40 inches forward of each engine air intake duct. The effect of these vanes is to prevent the intermittent separation of airflow through the engine transition duct and the resultant noise and vibration which would occur at high airspeed and low rpm.

## ENGINE SCREENS.

Two retractable engine screens, one in each engine air intake, provide a means for preventing foreign matter from entering the engine intake ducts. The engine screens normally extend and retract with the landing gear; however, an engine screen switch provides for screen extension and retraction during flight.

### Engine Screen Switch.

The 28-volt d-c engine screen switch (figure 4-4) on the anti-icing control panel provides a means for extending the engine screens during combat, or at other times when there is danger of foreign matter entering the engine intake ducts. The switch has two positions: NORMAL and EMERG EXTEN. When the switch is placed at NORMAL, the screens extend and retract automatically with the landing gear. When the switch is placed at EMER EXTEN, the screens extend; however, if the anti-icing system operation is selected, the screen control is overridden and the screens retract.

## STARTING AND IGNITION SYSTEM.

Power for starting is supplied by 28-volt d-c external power units connected to the power receptacles on the right air intake duct. Only one engine can be

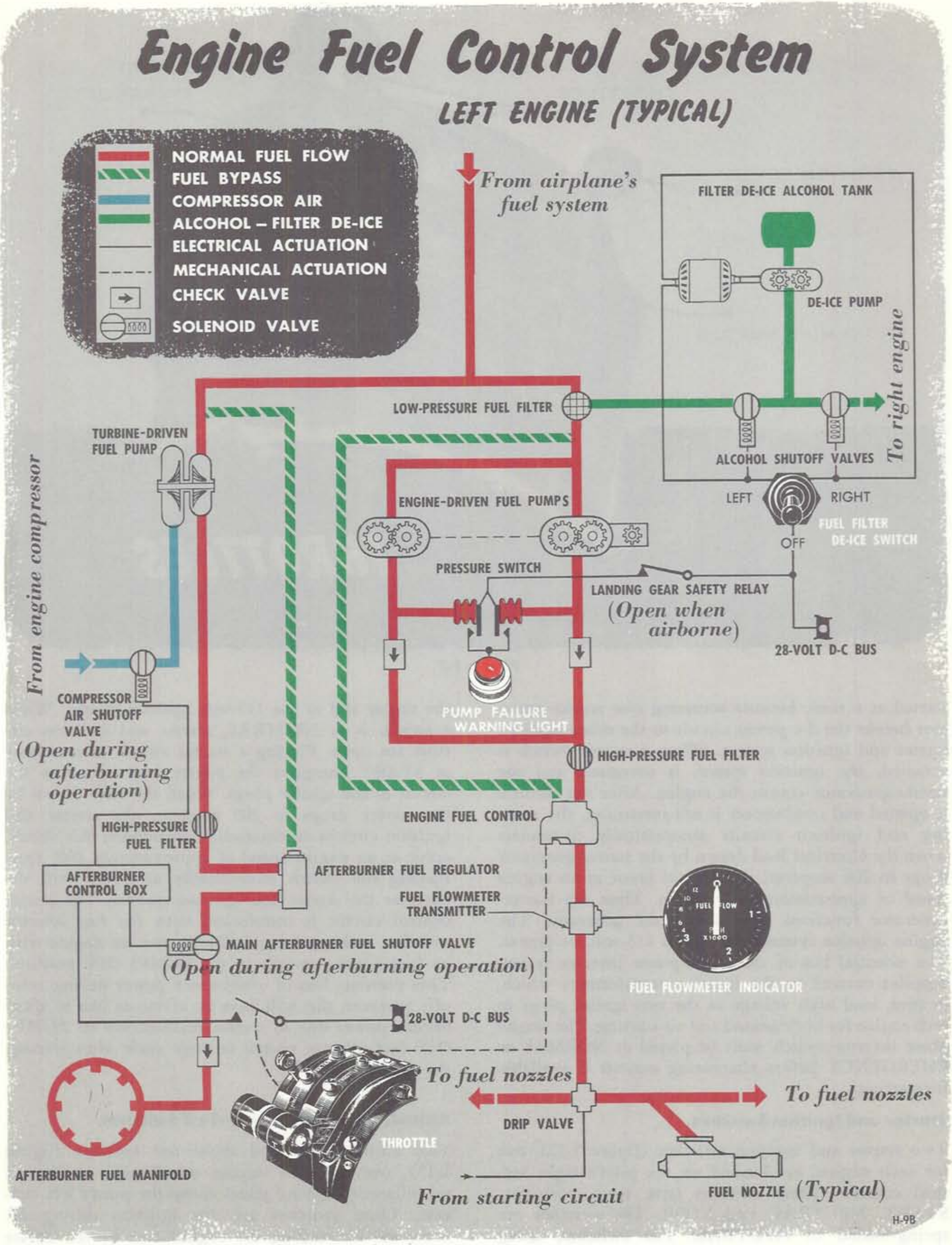

Engine Fuel Control System
LEFT ENGINE (TYPICAL)
NORMAL FUEL FLOW
FUEL BYPASS
COMPRESSOR AIR
ALCOHOL – FILTER DE-ICE
ELECTRICAL ACTUATION
MECHANICAL ACTUATION
CHECK VALVE
SOLENOID VALVE
From airplane's fuel system
FILTER DE-ICE ALCOHOL TANK
DE-ICE PUMP
To right engine
LOW-PRESSURE FUEL FILTER
ALCOHOL SHUTOFF VALVES
LEFT
RIGHT
OFF
FUEL FILTER DE-ICE SWITCH
TURBINE-DRIVEN FUEL PUMP
From engine compressor
ENGINE-DRIVEN FUEL PUMPS
PRESSURE SWITCH
LANDING GEAR SAFETY RELAY
(Open when airborne)
28-VOLT D-C BUS
PUMP FAILURE WARNING LIGHT
COMPRESSOR AIR SHUTOFF VALVE
(Open during afterburning operation)
HIGH-PRESSURE FUEL FILTER
ENGINE FUEL CONTROL
HIGH-PRESSURE FUEL FILTER
AFTERBURNER CONTROL BOX
AFTERBURNER FUEL REGULATOR
FUEL FLOWMETER TRANSMITTER
FUEL FLOW
X1000
FUEL FLOWMETER INDICATOR
MAIN AFTERBURNER FUEL SHUTOFF VALVE
(Open during afterburning operation)
28-VOLT D-C BUS
To fuel nozzles
To fuel nozzles
THROTTLE
DRIP VALVE
AFTERBURNER FUEL MANIFOLD
From starting circuit
FUEL NOZZLE (Typical)
H-9B

*Figure 1-6.*

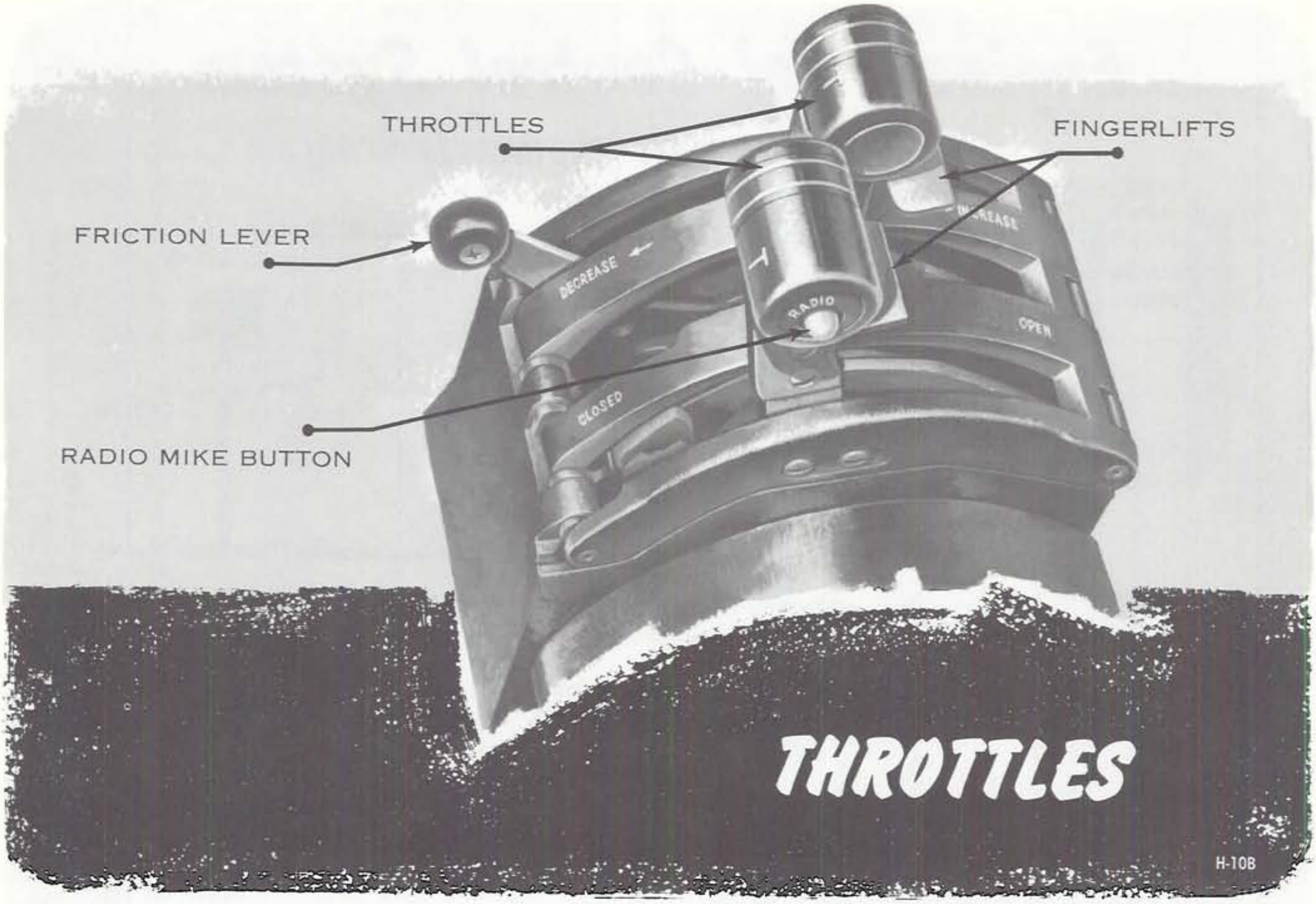



*Figure 1-7.*

started at a time, because actuating one starter-generator breaks the d-c power circuit to the other engine's starter and ignition system. When a starter switch is actuated, the ignition system is energized and the starter-generator cranks the engine. After the throttle is opened and combustion is self-sustaining, the starting and ignition circuits automatically disconnect when the electrical load drawn by the starter-generator drops to 200 amperes; this should occur at an engine speed of approximately 26% rpm. Then the starter-generator functions as a 28-volt d-c generator. The engine ignition system operates on 115-volt a-c power. The essential bus of the single-phase inverter system supplies current to the ignition transformers which, in turn, send high voltage to the two igniter plugs in each engine for both ground and air starting. The single-phase inverter switch must be placed at NORMAL or EMERGENCY before alternating current is available for starting.

**Starter and Ignition Switches.**

Two starter and ignition switches (figure 1-12), one for each engine, are located on the pilot's right vertical console. These switches have three positions: START, NEUTRAL, and STOP. The switches are spring-loaded to NEUTRAL. The switches, using 28-volt d-c power, control the electrical circuits to the starter and to the 115-volt ignition system. When a switch is at NEUTRAL, starter and ignition circuits are open. Placing a starter switch momentarily at START energizes the starter and completes the circuit to the igniter plugs. When the load drawn by the starter drops to 200 amperes, the starter and ignition circuits automatically disconnect; this should occur at an engine speed of approximately 26% rpm. Placing the switch momentarily at STOP will de-energize the starter and ignition circuits. The starter control circuit is interlocked with the fuel selector switches, making it impossible to start an engine with its fuel selector switch in the PUMPS OFF position. This prevents loss of afterburner power during take-off; however, this will have no effect on loss of afterburner power due to system malfunction or PUMPS OFF fuel selector switch settings made after starting the engines.

**Altitude Start and Starter-Test Switches.**

Two altitude start and starter-test switches (figure 1-17), one for each engine, are located on the aft miscellaneous control panel above the pilot's left console. These switches are for ignition during air starts and for turning the engine over by the starter without ignition. The switches have three positions:

TEST, NEUTRAL, and START; they are spring-loaded to NEUTRAL. The switches, using 28-volt d-c power, control separate electrical circuits to the 115-volt a-c ignition system and the 28-volt d-c starter. When a switch is at NEUTRAL, starting and ignition circuits are open. When an air start is required, placing the switch momentarily at START will supply ignition to the windmilling engine for 120 seconds through a time-delay unit. When the switch is held at TEST (for ground operation only), the starter will turn the engine over without ignition.

#### Starting Power Switch.

A guarded switch (figure 1-12) with two positions, EMERGENCY and NORMAL, is located on the pilot's right vertical console. This switch connects the 28-volt d-c primary bus to the starter bus for emergency starting when limited external power is available. When only one 28-volt d-c external power source is available (of at least 1000-amp rating), the one lead may be plugged into the lower d-c receptacle (with the battery switch at OFF) and the starting power switch placed at EMERGENCY.

**Note**

If only one external power unit is available for starting the airplane, it must be of at least 1000-amp capacity.

The engine then can be started with the starter switches. When the starting power switch is at NORMAL, the starter bus is disconnected from the 28-volt d-c primary bus.

**CAUTION**

For emergency starts, the 28-volt d-c generator switches must be at OFF. This is to prevent the left generator from overloading during the right engine start.

**Note**

This airplane cannot be started on the battery. External power is required.

### EXHAUST GAS TEMPERATURE GAGES.

Two exhaust gas temperature gages (figure 1-8), indicating exhaust temperature in degrees centigrade, are located on the pilot's instrument panel. The gages operate from thermocouples located in each engine exhaust cone and are independent of the airplane's electrical system. There is no direct control for regulating the exhaust temperatures by the pilot; however, limited control for these temperatures can be indirectly achieved by changing the throttle settings. See Section VII for a discussion of exhaust gas temperature versus runway temperature.

### TACHOMETERS.

Two tachometers (figure 1-8), indicating engine speed in % rpm, are located on the pilot's instrument panel. A tachometer generator is installed in the accessory section of each engine. The electrical power and frequency it produces for tachometer readings is proportional to engine rpm (100% engine speed is 8000 rpm).

### OIL PRESSURE GAGES.

Two oil pressure gages (figure 1-8), one for each engine, are located on the pilot's instrument panel and indicate oil pressure in pounds per square inch. The gages are operated by 115-volt ac from the single-phase inverter essential bus.

### FUEL FLOWMETER INDICATORS.

Two fuel flowmeter indicators (figure 1-8), one for each engine, are located on the pilot's instrument panel. The indicators show rate of flow in pounds per hour and use both 28-volt dc and 115-volt ac.

**Note**

When the afterburner is operating, a rise in fuel flow will be experienced; however, the fuel flowmeter indicators do not indicate fuel consumed by the afterburners.

**CAUTION**

The fuel flowmeter indicators are inaccurate for high rates of fuel flow. However, in the cruising range (3000 to 5000 pounds per hour), the indicators may be relied upon for cruise control.

### ENGINE-DRIVEN FUEL PUMP FAILURE WARNING LIGHTS.

Two 28-volt d-c fuel pump failure warning lights (figure 1-9), one for each engine, are located on the pilot's left console. The lights are provided to warn the pilot that one of the two elements of the engine-driven fuel pumps is inoperative. The lights are controlled by a pressure switch connected to the two pumping elements. If the fuel pressure drops at the outlet of one element, the switch closes and turns on the light. The lights will indicate an element failure during ground operation only. A switch on the left main landing gear prevents operation when the weight of the airplane is removed from the landing gear.

## AFTERBURNER SYSTEM.

Each engine has an afterburner which can be used to increase thrust when needed. The afterburner is a part of the tailpipe. As the gases travel through the exhaust cone and into the afterburner section, more fuel can be injected and burned if additional thrust is desired.

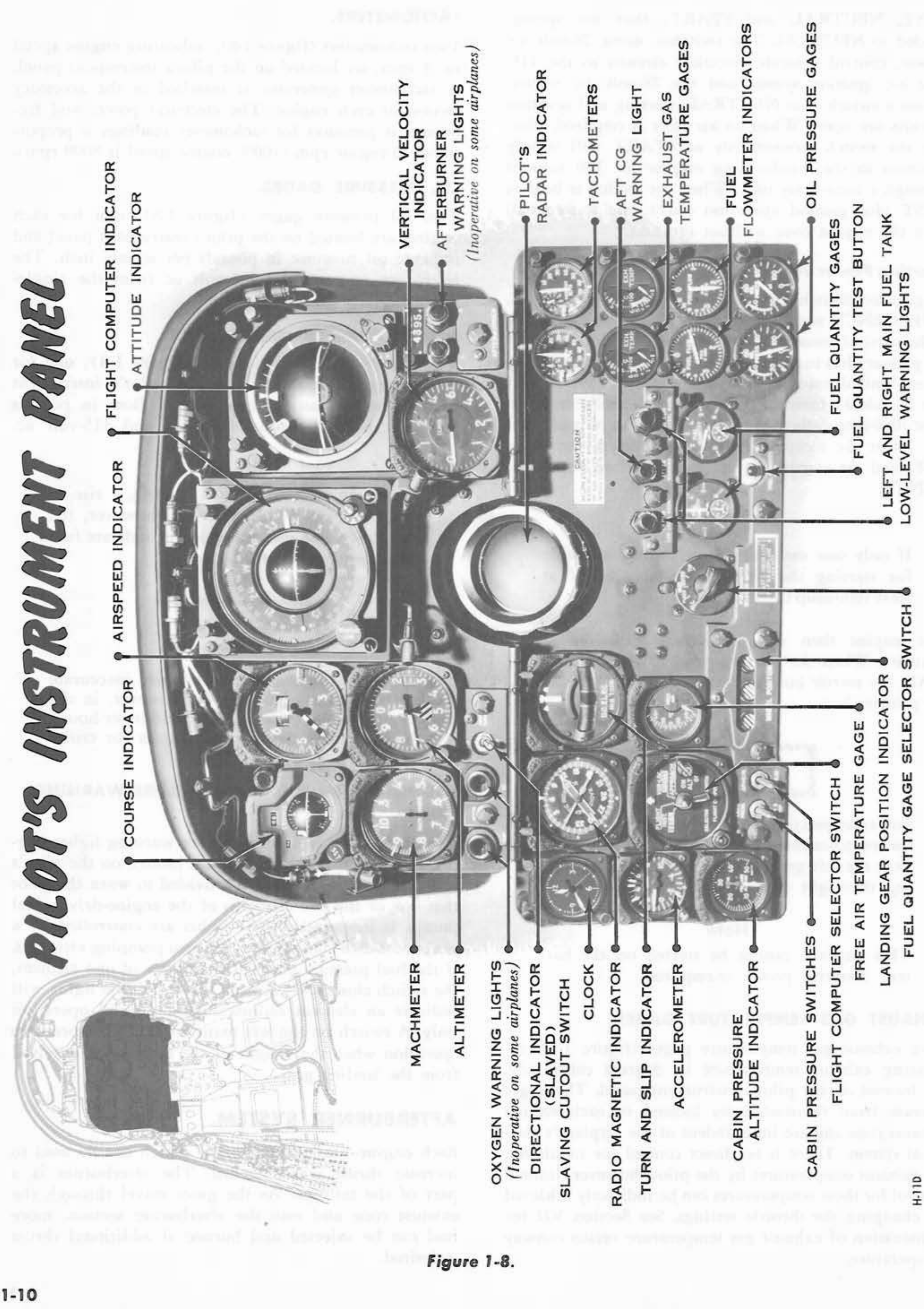

PILOT'S INSTRUMENT PANEL
COURSE INDICATOR
AIRSPEED INDICATOR
FLIGHT COMPUTER INDICATOR
ATTITUDE INDICATOR
VERTICAL VELOCITY INDICATOR
AFTERBURNER WARNING LIGHTS
(Inoperative on some airplanes)
PILOT'S RADAR INDICATOR
TACHOMETERS
AFT CG WARNING LIGHT
EXHAUST GAS TEMPERATURE GAGES
FUEL FLOWMETER INDICATORS
OIL PRESSURE GAGES
FUEL QUANTITY GAGES
FUEL QUANTITY TEST BUTTON
LEFT AND RIGHT MAIN FUEL TANK LOW-LEVEL WARNING LIGHTS
FUEL QUANTITY GAGE SELECTOR SWITCH
LANDING GEAR POSITION INDICATOR
FREE AIR TEMPERATURE GAGE
FLIGHT COMPUTER SELECTOR SWITCH
CABIN PRESSURE SWITCHES
CABIN PRESSURE ALTITUDE INDICATOR
ACCELEROMETER
TURN AND SLIP INDICATOR
RADIO MAGNETIC INDICATOR
CLOCK
SLAVING CUTOUT SWITCH
DIRECTIONAL INDICATOR (SLAVED)
OXYGEN WARNING LIGHTS
(Inoperative on some airplanes)
ALTIMETER
MACHMETER
H-11D

**Figure 1-8.**

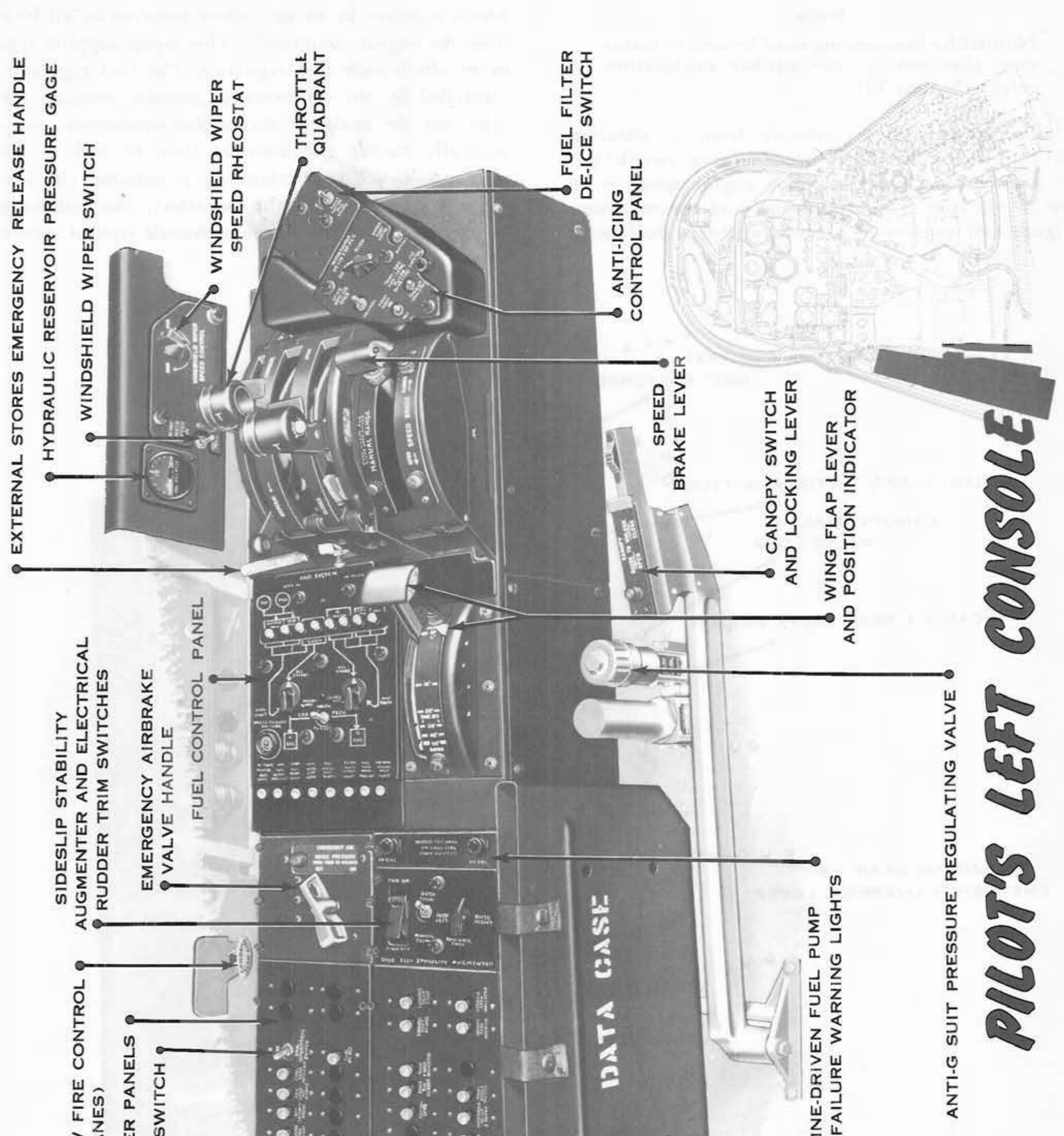

PILOT'S LEFT CONSOLE
EXTERNAL STORES EMERGENCY RELEASE HANDLE
HYDRAULIC RESERVOIR PRESSURE GAGE
WINDSHIELD WIPER SWITCH
WINDSHIELD WIPER SPEED RHEOSTAT
THROTTLE QUADRANT
FUEL FILTER DE-ICE SWITCH
ANTI-ICING CONTROL PANEL
SPEED BRAKE LEVER
CANOPY SWITCH AND LOCKING LEVER
WING FLAP LEVER AND POSITION INDICATOR
ANTI-G SUIT PRESSURE REGULATING VALVE
SIDESLIP STABILITY AUGMENTER AND ELECTRICAL RUDDER TRIM SWITCHES
EMERGENCY AIRBRAKE VALVE HANDLE
FUEL CONTROL PANEL
INTERNAL CANOPY SLOW FIRE CONTROL (SOME AIRPLANES)
CIRCUIT BREAKER PANELS
CANOPY CONTROL SWITCH
AFTERBURNER CONTROL SWITCH
DATA CASE
ENGINE-DRIVEN FUEL PUMP FAILURE WARNING LIGHTS
DATA CASE

*Figure 1-9.*

**Note**

Normal fuel sequencing must be used to maintain afterburning. For further explanation refer to Section VII.

Afterburning is best initiated from a stabilized full-throttle condition. A speed-sensing switch prevents afterburner ignition when engine speed is below 87.5% rpm. The afterburner fuel control system (figure 1-6) consists of a centrifugal-type fuel pump which is driven by an air turbine powered by air bled from the engine compressor. This pump supplies fuel to an afterburner fuel regulator. The fuel regulator, controlled by the difference in pressure between the inlet and the outlet of the engine compressor, automatically meters a continuous flow of fuel to the afterburner. When afterburning is initiated (by lifting the fingerlifts on the throttles), the following operations take place in the automatic control system

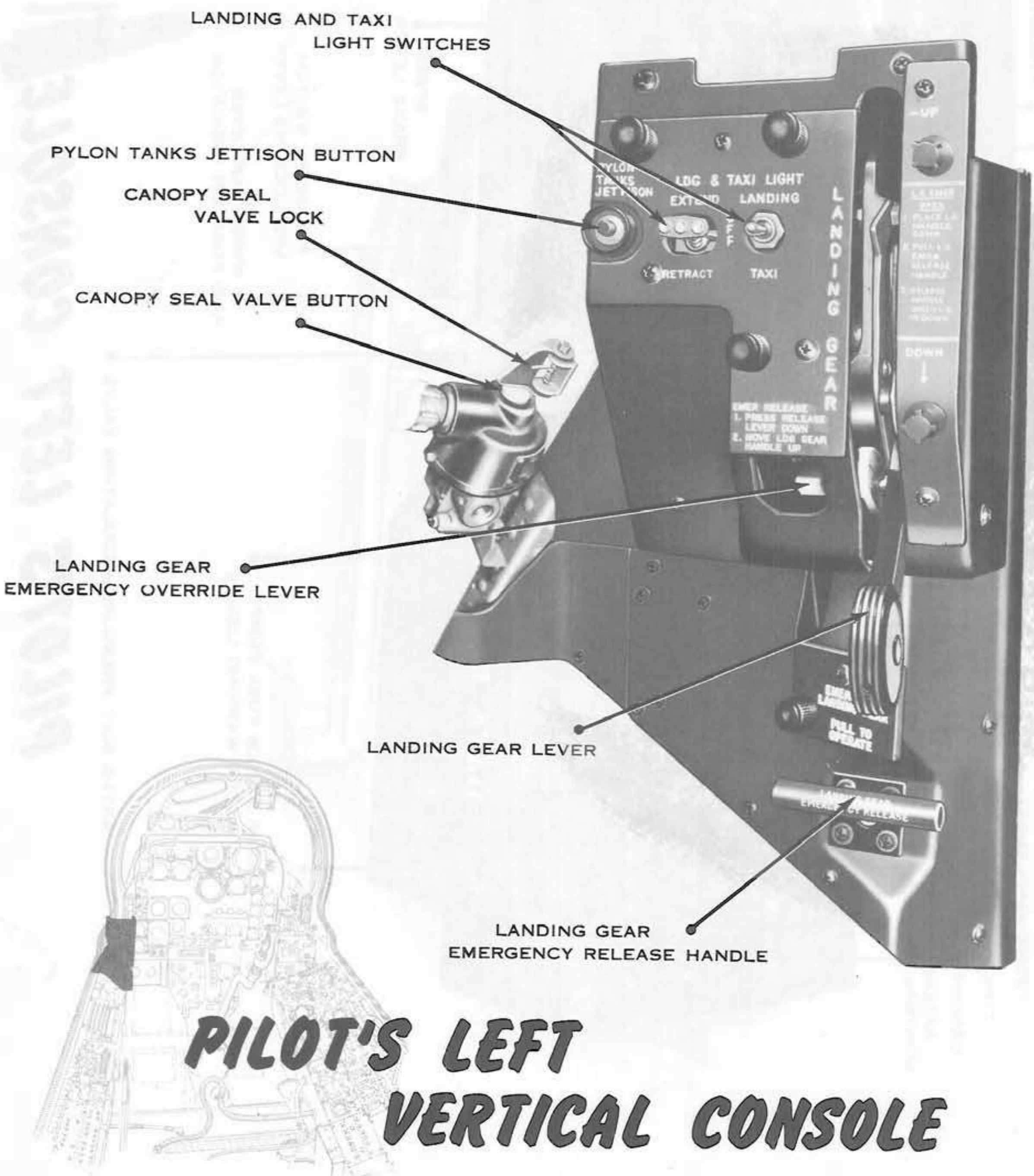
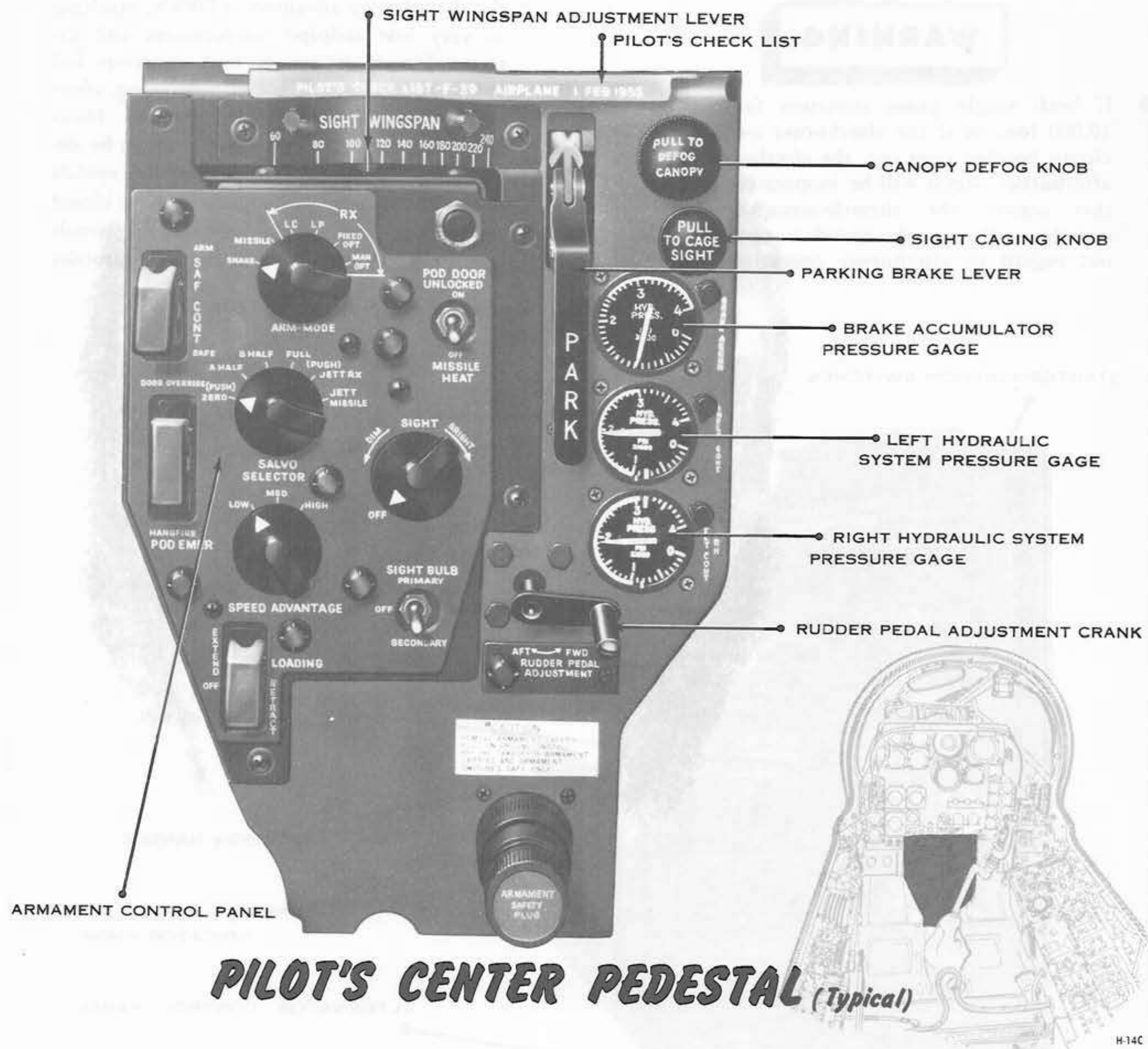



*Figure 1-10.*




## PILOT'S CENTER PEDESTAL (Typical)

*Figure 1-11.*

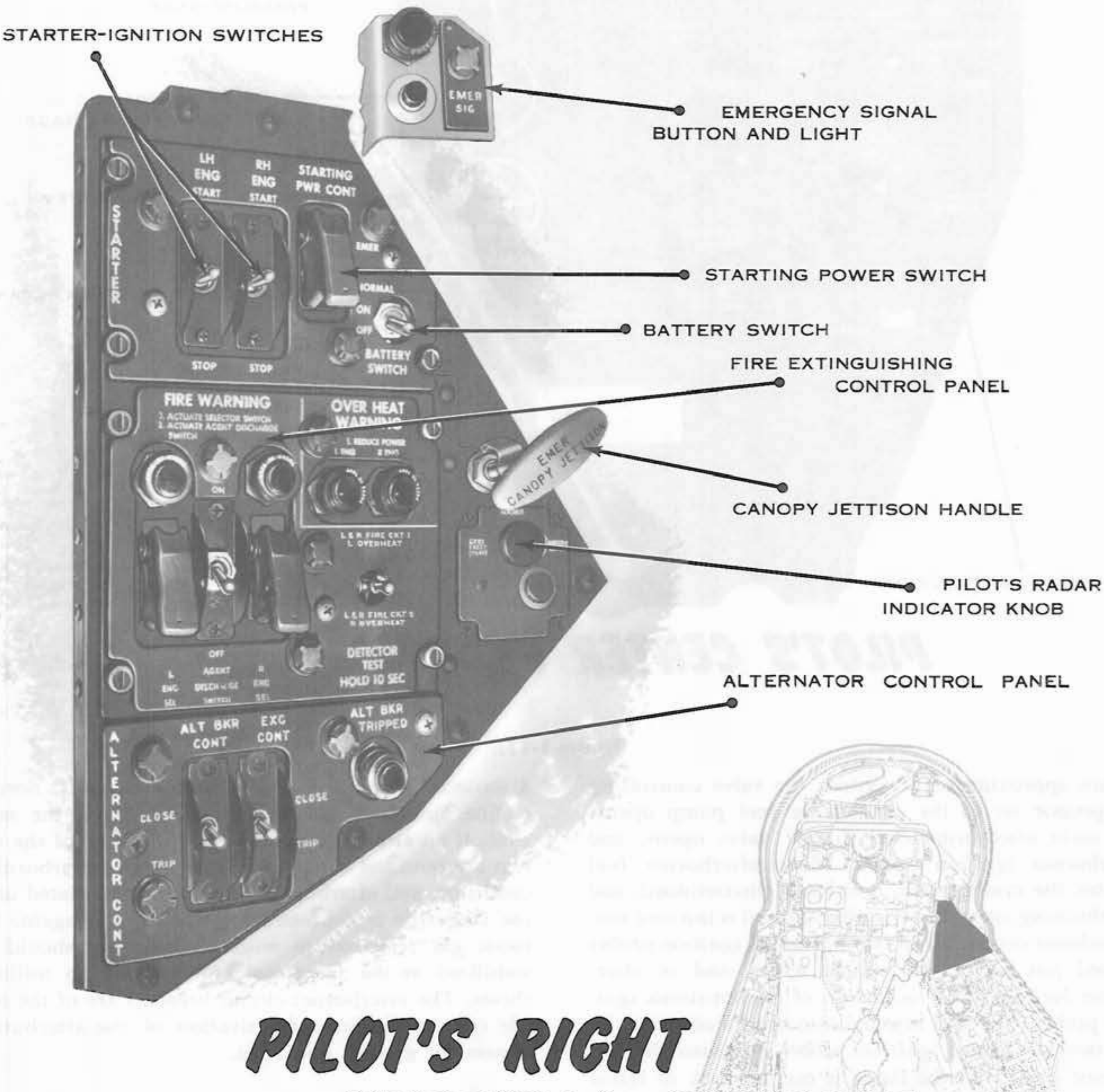
within approximately 1 second: the valve controlling compressor air to the afterburner fuel pump opens; the main afterburner fuel shutoff valve opens; and afterburner ignition occurs. When afterburner fuel ignites, the eyelids open, ignition is discontinued, and afterburning continues. Afterburner fuel is injected into the exhaust cone through two hot streak ignition probes located just aft of the turbine wheel, and an afterburner fuel manifold located aft of the hot streak ignition probes. The fuel injected into the exhaust cone by the two hot streak ignition probes is ignited by hot exhaust gases, and the flame is carried back to ignite the fuel injected into the exhaust cone by the afterburner fuel manifold. Initial afterburner combustion is normally accompanied by a momentary drop in engine speed and a momentary rise in exhaust gas temperature. Afterburning should be completely stabilized in 3 to 4 seconds. When the afterburner is shut off, normal engine operation should stabilize in about the same time. If an afterburner flames out, all units of the system are returned automatically to the nonafterburning condition, and afterburning cannot be reinitiated until the fingerlift is depressed and then raised again. Exhaust gas temperature with afterburning should be stabilized at the same temperature as with military thrust. The afterburner circuit breakers are of the toggle type to facilitate deactivation of the afterburner system for ground operation.

**Note**

When afterburners are shut down, a momentary increase in rpm will be experienced. Retarding the throttle to 98% or below will prevent engine overspeeding.

**WARNING**

- If both single phase inverters fail below 10,000 feet, or if the afterburner a-c control circuit breaker pops out, the afterburner and afterburner circuit will be inoperative. When this occurs, the throttle-actuated eyelid switches will cause the eyelids to open (without regard to afterburner operation) when the throttles are advanced to OPEN, resulting in very low tailpipe temperatures and extreme loss of thrust. If both inverters fail below 10,000 feet while in afterburning, afterburner operation will be unaffected. However, if the afterburners are shut down by depressing the throttle fingerlifts, the eyelids will remain open. The eyelids must be closed by moving the afterburner control circuit breakers to OFF or by retarding the throttles




# PILOT'S RIGHT VERTICAL CONSOLE

H-15B

*Figure 1-12.*

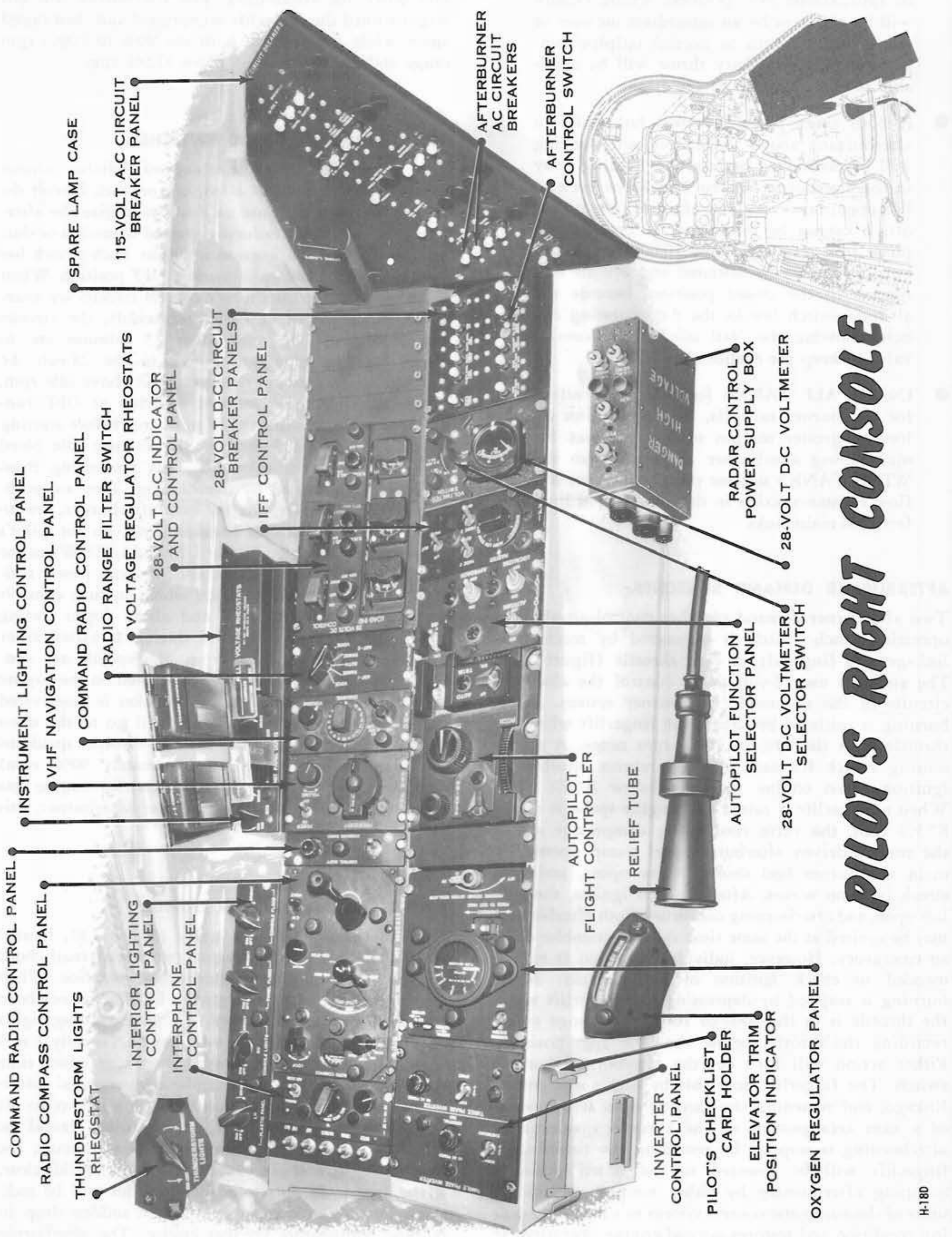

COMMAND RADIO CONTROL PANEL
RADIO COMPASS CONTROL PANEL
THUNDERSTORM LIGHTS RHEOSTAT
INTERIOR LIGHTING CONTROL PANEL
INTERPHONE CONTROL PANEL
INSTRUMENT LIGHTING CONTROL PANEL
VHF NAVIGATION CONTROL PANEL
COMMAND RADIO CONTROL PANEL
RADIO RANGE FILTER SWITCH
VOLTAGE REGULATOR RHEOSTATS
28-VOLT D-C INDICATOR AND CONTROL PANEL
IFF CONTROL PANEL
28-VOLT D-C CIRCUIT BREAKER PANELS
SPARE LAMP CASE
115-VOLT A-C CIRCUIT BREAKER PANEL
AFTERBURNER AC CIRCUIT BREAKERS
AFTERBURNER CONTROL SWITCH
RADAR CONTROL POWER SUPPLY BOX
28-VOLT D-C VOLTMETER
28-VOLT D-C VOLTMETER SELECTOR SWITCH
AUTOPILOT FUNCTION SELECTOR PANEL
AUTOPILOT FLIGHT CONTROLLER
RELIEF TUBE
INVERTER CONTROL PANEL
PILOT'S CHECKLIST CARD HOLDER
ELEVATOR TRIM POSITION INDICATOR
OXYGEN REGULATOR PANEL
PILOT'S RIGHT CONSOLE
H-180

*Figure 1-13.*

to approximate 90% position. Eyelid closure will be apparent by an immediate increase in thrust and a return to normal tailpipe temperature. Only military thrust will be available for the duration of the flight.

- If both single-phase inverters fail while in afterburning above 10,000 feet, afterburning will be unaffected because the holding relay in the afterburner control box keeps the eyelids open; however, once afterburning is shut off, it cannot be reinitiated. If both single-phase inverters fail above 10,000 feet, afterburning cannot be initiated and eyelids will remain in the closed position, because the altitude switch breaks the d-c operating circuit, allowing the "fail safe" eyelid control valve to keep the eyelids closed.
- Use the ALL TANKS fuel selector position for afterburner takeoffs, as this position affords a greater margin of fuel pressure for maintaining afterburner operation than the WING TANKS selector position because less flow resistance exists in the distribution lines from the main tanks.

## AFTERBURNER DEMAND SWITCHES.

Two afterburner demand switches control afterburner operation. Each switch is connected by mechanical linkage to a fingerlift on each throttle (figure 1-7). The switches use 28-volt dc to control the electrical circuits in the automatic afterburner system. Afterburning is initiated by lifting the fingerlift when the throttle is in the 90% to 100% rpm range. A speed-sensing switch for each engine prevents afterburner ignition when engine speed is below 87.5% rpm. When a fingerlift is raised and engine speed is above 87.5% rpm, the valve controlling compressor air to the turbine-driven afterburner fuel pump opens, the main afterburner fuel shutoff valve opens, and hot-streak ignition occurs. After the fuel ignites, the eyelids open, and afterburning continues. Both afterburners may be ignited at the same time during scrambles or in an emergency. However, individual ignition is recommended to check ignition of each burner. Afterburning is stopped by depressing the fingerlift when the throttle is in the 90% to 100% rpm range or by retarding the throttle below the 90% rpm position. Either action will turn off the afterburner demand switch. The fingerlift does this by direct mechanical linkage, and retarding the throttle does it by means of a cam arrangement in the throttle quadrant. If afterburning is stopped by retarding the throttle, the fingerlift will be lowered to the down position. Stopping afterburning by either method returns all units of the automatic control system to a nonafterburning condition and restores normal engine operation. If the afterburner flames out, the automatic control will shut down the afterburner. The afterburner will not reignite until the fingerlift is depressed and then raised again while the throttle is in the 90% to 100% rpm range and engine speed is above 87.5% rpm.

## AFTERBURNER CONTROL SWITCHES.

Two toggle-type afterburner control switches (circuit breakers figures 1-9 and 1-13), one on each 28-volt d-c circuit breaker panel, are used to deenergize the afterburner control circuits during ground operation or during afterburner malfunction in flight. Each switch has a placarded ON and an unmarked OFF position. When placed at ON, the afterburner control circuits are energized; when placed at OFF (unmarked), the circuits are deenergized. If more than 15 minutes are to elapse between supplying power to the 28-volt d-c bus and starting or operating engines above idle rpm, place the afterburner control switches at OFF (unmarked) and leave them OFF until just before starting engines. This will deenergize the altitude idle bleed and eyelid actuator solenoids, thus preventing them from being damaged by overheating. Two a-c push-pull circuit breakers, one for each afterburner, are located on the a-c circuit breaker panel on the pilot's right vertical console (figures 1-13 and 1-25). When the circuit breaker is set (pushed IN), inverter power activates the speed-sensing switch which in turn controls the eyelids at 87½% rpm and above (open during afterburner operation, closed during nonafterburner operation). Below 87½% rpm, the eyelids are controlled by the lower microswitch located on the engine throttle quadrant. If the circuit breaker is deactivated (pulled or pops out) the eyelids will go to the open position when the upper engine throttle quadrant microswitch is actuated (approximately 90% rpm) which will be denoted by a decrease in engine gas temperature and a loss of thrust. See Afterburner, this section.

## AFTERBURNER WARNING LIGHTS.

Two afterburner warning lights (figure 1-8), located on the pilot's instrument panel, provide a visual check of eyelid position during afterburner operation. When the engines are being operated at 87.5% rpm or above and afterburning is selected, the two warning lights will come on. These lights will stay on (usually 1 to 5 seconds) until afterburner eyelids open, at which time the lights will go off, indicating normal afterburner operation. If the warning lights fail to go off (indicating eyelids closed), afterburning should be discontinued. If an afterburner flameout occurs, the warning light will not come on until the eyelids close. If the eyelids do not close, the flameout will be indicated by the increase in rpm and a sudden drop in tailpipe temperature on that engine. The afterburner warning lights are inoperative on some airplanes.

## OIL SUPPLY SYSTEM.

Each engine has an independent dry sump, full scavenge oil supply system. See figure 1-14 for oil quantity data. Oil is gravity fed from the tank, mounted on the outboard side of the engine, to the main engine-driven pump. The main pump distributes the oil under pressure through a filter to the accessory gears and engine bearings. The scavenge side of this same pump returns oil from the accessory and forward engine bearing to the oil tank. A midframe scavenge pump scavenges oil from the mid, damper, and aft bearings, and returns it through a heat exchanger to the oil tank. The heat exchanger uses fuel flow to cool the scavenged oil. The operation of this system is entirely automatic. See figure 1-45 for oil specification and grade.

## FUEL SUPPLY SYSTEM.

The airplane has two independent fuel supply systems, left and right, with interconnecting lines and valves for crossfeeding (figure 1-16). Each system has a main fuselage tank, two multicelled wing tanks, a permanently installed tip tank, and a jettisonable pylon tank. The right system main tank is in the nose section; the left system main tank is in the aft fuselage. For fuel quantity data, see figure 1-15. During normal operation, fuel is pumped to the engines from the main tanks which are automatically replenished from the wing tanks. As wing tank fuel level is lowered, fuel from the pylon and tip tanks flows simultaneously into the wing tanks under air pressure from the engine compressors. Fluid level actuated valves within the wing tanks close when the tanks become full to prevent overfilling and pressurization. Pressurization of pylon and tip tanks is automatically regulated at approximately 6 psi and transfer of fuel from these tanks will continue until the pylon and tip tank fuel supply is exhausted or jettisoned. When a tip tank empties, a fluid level actuated shutoff valve within the tank closes the fuel line from the empty tank to the wing tanks. When a pylon tank empties, a float switch is actuated, causing a solenoid valve in the pylon air pressurization line to close. After the wing tanks become empty, the main tanks continue to supply fuel to the engines. When the main tank fuel level is lowered to the 100-gallon (650-pound) level, a low-level warning light on the pilot's instrument panel will glow red. For all normal operation, fuel flow sequence is completely automatic; however, wing tanks may be selected and fuel will be pumped directly from wing tanks to the engine. Crossfeed operation permits both engines to operate from either fuel system, or permits single-engine operation from either or both fuel systems. Fuel for afterburning is pumped from the main

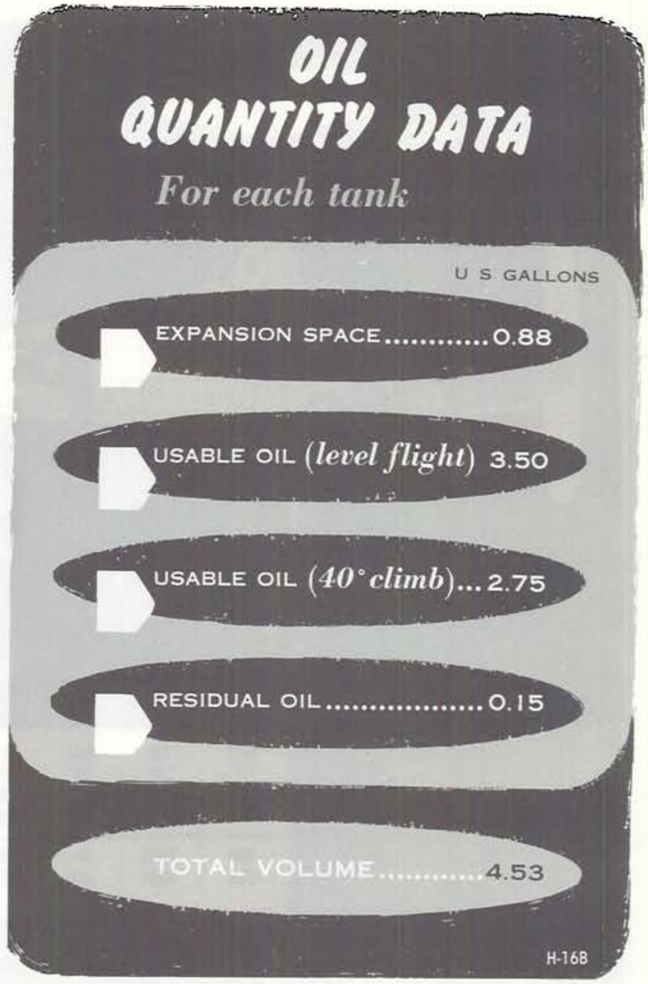



*Figure 1-14.*

fuel line to a turbine-driven pump on each engine, through the afterburner fuel regulators, and then to the afterburners. (For fuel specification and grade, see figure 1-45.)

### Booster Pumps.

Each of the two fuel systems has four 28-volt d-c booster pumps, one in each of the wing tanks and two in each main tank. During normal operation all booster pumps operate continuously. The pumps are designed for sustained operation wet or dry, and therefore may operate in an empty tank.

### Low Pressure Fuel Filter De-Icing System.

A low pressure fuel filter de-icing system is provided for the engines. Alcohol is injected at the pilot's discretion into the low-pressure filters to dissolve any ice accumulation in the filters or engine fuel controls. (For further description and operating procedure for this system, refer to Section IV. For alcohol specification, see figure 1-45.)

**FUEL QUANTITY DATA**

*Based on 6.5 lb per U S gallon (Standard Day)

*The weight of fuel required to fill tanks completely may differ from one filling to another because of the effect of temperature variation on fuel density.*

US GALLONS / *POUNDS (EACH TANK)

| | | TIP (2) GAL | TIP (2) LB | PYLON (2) GAL | PYLON (2) LB | OUTBD WING (2) GAL | OUTBD WING (2) LB | INBD WING (2) GAL | INBD WING (2) LB | RIGHT MAIN GAL | RIGHT MAIN LB | LEFT MAIN GAL | LEFT MAIN LB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| USABLE FUEL | EACH | 306 | 1989 | 300 | 1950 | 246 | 1599 | 104 | 676 | 261 | 1696 | 196 | 1274 |
| | TOTAL | 612 | 3978 | 600 | 3900 | 492 | 3198 | 208 | 1352 | 261 | 1696 | 196 | 1274 |
| FULLY SERVICED | EACH | 308 | 2002 | 301 | 1956 | 252 | 1638 | 106 | 689 | 263 | 1709 | 200 | 1300 |
| | TOTAL | 616 | 4004 | 602 | 3912 | 504 | 3276 | 212 | 1378 | 263 | 1709 | 200 | 1300 |

TOTAL USABLE
- With pylon tank fuel 2369 gallons (15,398 lb*)
- Without pylon tank fuel 1769 gallons (11,498 lb*)

DATA AS OF: *1 June 1955*
DATA BASIS: *Calibration*

H-17C

***Figure 1-15.***

**Pylon Tank Jettison System.**

The pylon tanks may be jettisoned electrically or, in an emergency, released manually. The ejection system in each tank pylon includes an ejector mechanism, consisting of an electrically ignited propellant charge. When the pylon tanks are ejected, 28-volt d-c power ignites the propellant charge which releases the attaching hooks and actuates an ejection piston which forcibly ejects the tanks clear of the airplane. When the tanks are manually released by pulling the external stores emergency release handle, they fall by gravity alone. Both tanks are jettisoned simultaneously.

**CAUTION**

If pylon tanks are manually released, minor damage to the airplane may occur.

**Tip Tank Fuel Dump System.**

Each tip tank has a 28-volt d-c motor-driven dump valve located in the tip tank tailcone. When these valves are opened, fuel is forced overboard under normal tip tank air pressure through an outlet in the tailcone at a rate that will normally empty a full tip tank in approximately 90 seconds. The valves are held open for approximately 2 minutes by a time-delay relay. Tip tank fuel will not be completely dumped during decelerations or dives; however, a new dumping cycle may be initiated if required.

**Note**

- Tip tank fuel cannot be dumped while the weight of the airplane is on the wheels, because the oleo strut ground safety switch breaks the tip tank fuel dump electrical circuit.
- The fuel gage selector switch should be placed at the TIP position prior to and during dumping of tip fuel. This will enable the pilot to

determine if the fuel in both tip tanks has been dumped and whether or not an unbalanced tip tank fuel condition exists.

**Single-Point Fueling System.**

For description and operation of the single point fueling system, refer to Section IV.

**FUEL SELECTOR SWITCHES.**

Two rotary 28-volt d-c selector switches (figure 1-18), one for each system, are located on the fuel control panel. Each switch has ALL TANKS, WING TANKS, and PUMPS OFF positions. When a selector switch is at ALL TANKS, all related booster pumps operate continuously and fuel sequencing is automatic: pylon and tip tanks feed the wing tanks, wing tanks feed the main tank, and the main tank feeds the engine. When a selector switch is at WING TANKS, only the wing tank booster pumps in that system operate and fuel is routed directly from wing tanks to the engine; however, pylon and tip tanks will continue to replenish the wing tanks. When a selector switch is at PUMPS OFF, all booster pumps in that system are shut down. The starter control circuit is interlocked with the fuel selector switches, making it impossible to start an engine with its fuel selector in the PUMPS OFF position. This modification prevents loss of afterburner power during takeoff but has no effect on loss of afterburner power due to system malfunction or PUMPS OFF power switch settings made after starting engines.

**Note**

Placing the selector switch at PUMPS OFF does not close the firewall fuel shutoff valve. This valve will close when the throttle is moved to the closed position or when the engine fire selector switch is actuated.

**CAUTION**

After positioning the fuel selector switch at any position, allow at least 3 seconds to elapse before selecting another position. This will preclude any possibility of the affected fuel system motor valves being reversed in midcycle, thus shortening valve life.

**CROSSFEED SWITCH.**

A 28-volt d-c crossfeed switch (figure 1-18), located on the fuel control panel, has OPEN and CLOSED positions. When the crossfeed switch is at OPEN, the main fuel lines of both systems are interconnected; both fuel systems may be used to operate one engine or both engines may be operated from either fuel system. Unbalanced lateral fuel loading (wing heaviness) may be corrected by feeding both engines from the system having more fuel. To balance fuel load, the crossfeed switch is placed at OPEN and the fuel selector switch for the system with less fuel is placed at PUMPS OFF. When fuel load is balanced, as indicated by lateral trim or fuel quantity gages, the selector switch is returned to ALL TANKS and the crossfeed switch to CLOSED.

**ENGINE FIRE SELECTOR SWITCHES.**

Two guarded 28-volt d-c engine fire selector switches (figure 1-39), one for each engine, are located on the pilot's right vertical console. Lifting the guard and placing either switch in the UP position arms the fire extinguishing agent discharge switch and closes those fuel shutoff valves which isolate the related engine from its fuel supply.

**THROTTLE-ACTUATED FUEL SHUTOFF SWITCHES.**

Two 28-volt d-c throttle-actuated fuel shutoff switches, one for each engine, are actuated when the throttles are moved to the closed position. Actuation of these switches closes the firewall fuel shutoff valves.

**Note**

If the right engine fuel selector switch is at WING TANKS, the related throttle-actuated fuel shutoff switch will not isolate the engine from its fuel supply.

**PYLON TANKS JETTISON BUTTON.**

A 28-volt d-c pushbutton (figure 1-10) marked PYLON TANKS JETTISON is located on the pilot's left vertical console. When the button is pressed, both pylon tanks are ejected simultaneously.

**EXTERNAL STORES EMERGENCY RELEASE HANDLE.**

An external stores emergency release handle (figure 1-9) is located on the pilot's left console. This emergency release handle is linked by cables and bellcranks to the bomb shackle release in each pylon. When the handle is pulled out approximately 7 inches with a force of approximately 50 pounds, both right and left bomb shackles will be tripped simultaneously and both pylon tanks will drop by gravity.

**CAUTION**

If pylon tanks are manually released, minor damage to the airplane may result.

**TIP TANK FUEL DUMP BUTTON.**

A 28-volt d-c pushbutton (figure 1-18) marked PRESS TO DUMP TIP TANK is located on the fuel control panel. When momentarily pressed, this switch operates

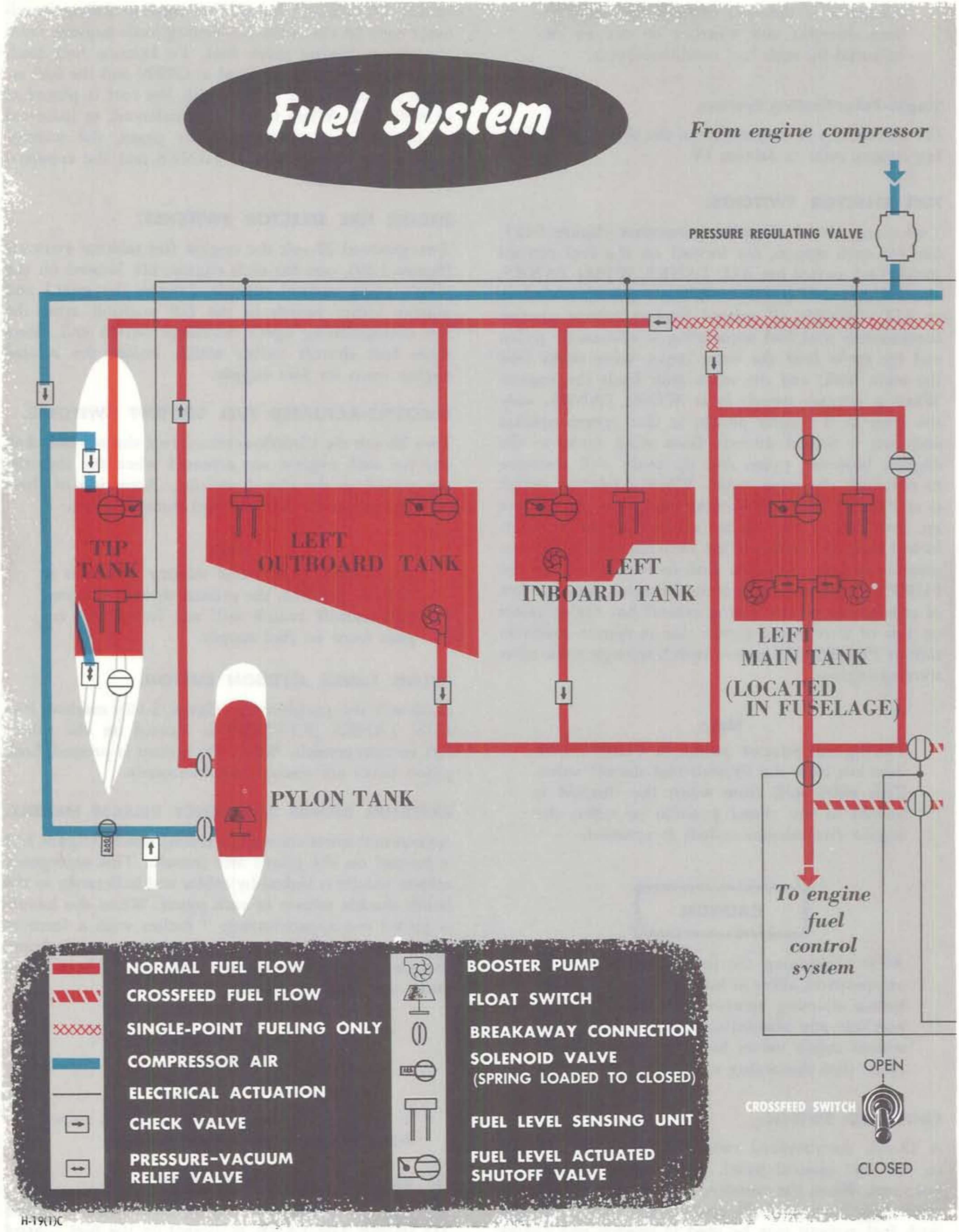
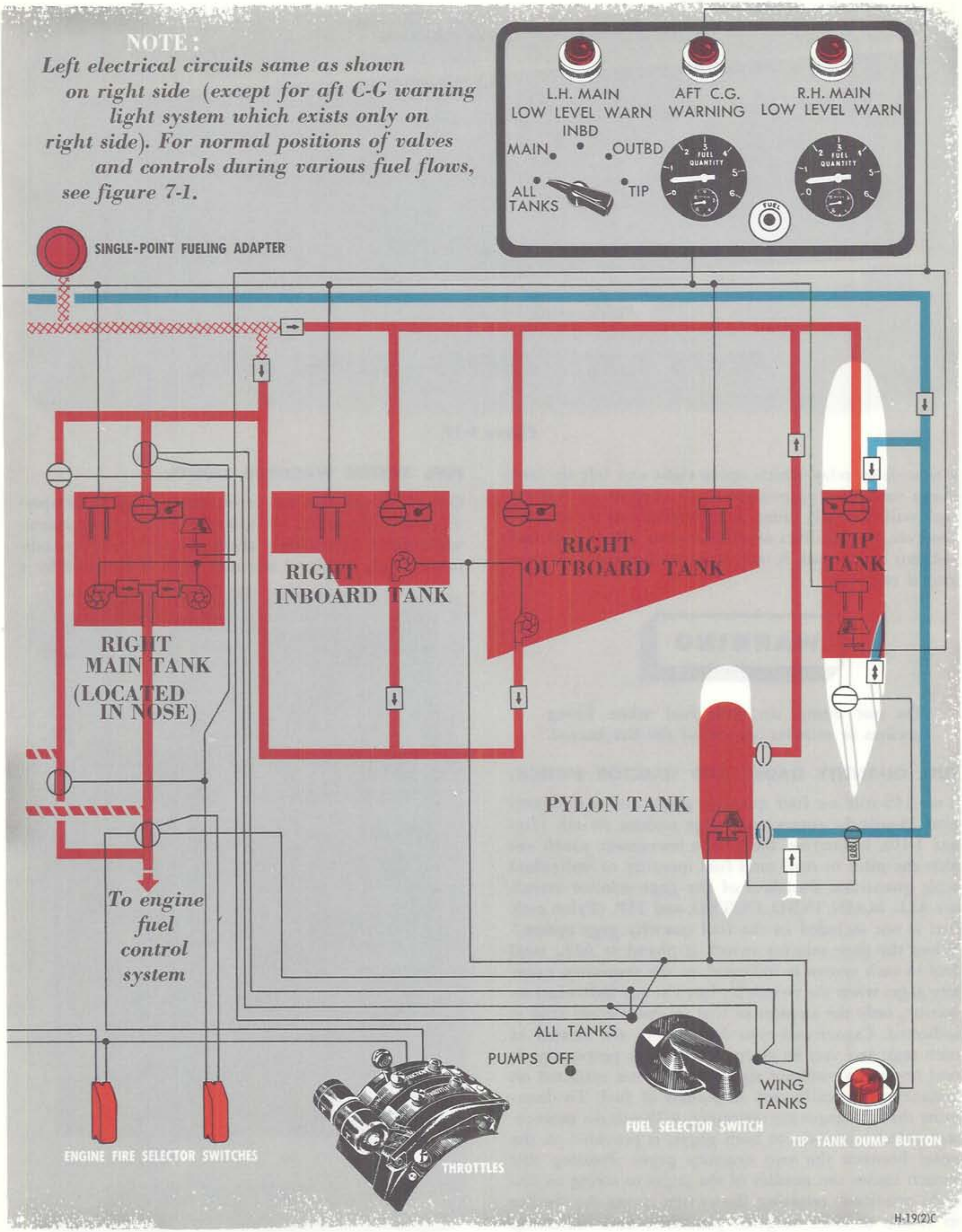

Fuel System
From engine compressor
PRESSURE REGULATING VALVE
TIP TANK
LEFT OUTBOARD TANK
LEFT INBOARD TANK
LEFT MAIN TANK (LOCATED IN FUSELAGE)
PYLON TANK
To engine fuel control system
OPEN
CROSSFEED SWITCH
CLOSED
NORMAL FUEL FLOW
CROSSFEED FUEL FLOW
SINGLE-POINT FUELING ONLY
COMPRESSOR AIR
ELECTRICAL ACTUATION
CHECK VALVE
PRESSURE-VACUUM RELIEF VALVE
BOOSTER PUMP
FLOAT SWITCH
BREAKAWAY CONNECTION
SOLENOID VALVE (SPRING LOADED TO CLOSED)
FUEL LEVEL SENSING UNIT
FUEL LEVEL ACTUATED SHUTOFF VALVE
H-19(1)C

Figure 1-16.


NOTE:
Left electrical circuits same as shown on right side (except for aft C-G warning light system which exists only on right side). For normal positions of valves and controls during various fuel flows, see figure 7-1.
L.H. MAIN LOW LEVEL WARN
AFT C.G. WARNING
R.H. MAIN LOW LEVEL WARN
INBD
MAIN
OUTBD
ALL TANKS
TIP
FUEL QUANTITY
FUEL
SINGLE-POINT FUELING ADAPTER
RIGHT MAIN TANK (LOCATED IN NOSE)
RIGHT INBOARD TANK
RIGHT OUTBOARD TANK
TIP TANK
PYLON TANK
To engine fuel control system
ALL TANKS
PUMPS OFF
WING TANKS
ENGINE FIRE SELECTOR SWITCHES
THROTTLES
FUEL SELECTOR SWITCH
TIP TANK DUMP BUTTON
H-19(2)C


PILOT'S MISCELLANEOUS CONTROL PANEL

**Figure 1-17.**

a time-delay relay which opens right and left tip tank dump valves for approximately 2 minutes. A full tip tank will normally dump in approximately 90 seconds; however, during dives or decelerations, all tip tank fuel will not be dumped. A new dumping cycle may be initiated if required.

**WARNING**

Do not dump tip tank fuel when firing rockets or missiles because of the fire hazard.

## FUEL QUANTITY GAGES AND SELECTOR SWITCH.

Two 115-volt a-c fuel quantity gages and a five-position 28-volt d-c rotary tank gage selector switch (figure 1-19), located on the pilot's instrument panel, enable the pilot to read total fuel quantity or individual tank quantities. Positions of the gage selector switch are ALL, MAIN, INBD, OUTBD, and TIP. (Pylon tank fuel is not included in the fuel quantity gage system.) When the gage selector switch is placed at ALL, total fuel in each system is indicated on the respective quantity gage; when the switch is placed at any individual selection, only the amount of fuel in the selected tank is indicated. Capacitance-type fuel probes are located in each tank and vary an electrical signal in proportion to fuel level; the resultant signal changes are reflected on quantity gages calibrated in pounds of fuel. To determine that the gages are operating, a 28-volt d-c press-to-test switch, common to both gages, is provided on the panel between the two quantity gages. Pressing this switch causes the needles of the gages to swing to off-scale positions; releasing the switch causes the needles to return to their original positions, thus indicating that the fuel quantity system is functioning.

## FUEL SYSTEM WARNING LIGHTS.

One aft cg and two low-level warning lights, all operating on 28-volt dc, are located on the pilot's instrument panel immediately above the fuel quantity indicators. Each low-level warning light is operated by a


FUEL CONTROL PANEL

**Figure 1-18.**


*Figure 1-19.*

float switch in each related main tank and will come on when main tank fuel is lowered to the 100-gallon (650-pound) level. The aft cg warning light is operated by, and in series with, two float switches, one located near the full level of the right main tank and one located near the empty level of the right tip tank. The aft cg warning light will come on when the main tank fuel level is lowered 50 gallons (325 pounds) from full with any fuel, above residual, remaining in the right tip tank. When the aft cg warning light comes on, airspeed must be reduced to Mach 0.65 or below. For discussion on center of gravity limitations, refer to Section V; for corrective action for aft cg warning, see Section III.

## ELECTRICAL POWER SUPPLY SYSTEMS.

One direct-current system and three alternating-current systems supply the electrical power. The 28-volt d-c system obtains power from three engine-driven generators, one on the left engine and two on the right engine. A 24-volt, 36 ampere-hour storage battery in the forward fuselage section serves as standby for emergency d-c circuits. The d-c generator on the left engine and one of the d-c generators on the right engine also function as starters. Full generator output is reached at 35% engine rpm. Alternating current is supplied by a constant frequency 115-volt a-c single-phase inverter system, a constant frequency 115-volt a-c three-phase inverter system, and a variable frequency 115/200-volt a-c three-phase alternator system. All inverters, two for each system, are powered by the primary 28-volt d-c bus. The alternator is engine-driven and is located on the left engine. External a-c power is required for ground operation and starting. External power receptacles for the 28-volt d-c system and 115/200-volt a-c alternator system are on the right engine air intake duct.

# ELECTRICAL SYSTEM LOAD DISTRIBUTION TABLE

| POWER SOURCE LOST | EQUIPMENT LOST | EQUIPMENT PICKED UP AUTOMATICALLY | EQUIPMENT PICKED UP MANUALLY | EQUIPMENT LOST PERMANENTLY |
|---|---|---|---|---|
| *INVERTERS:* | | | | |
| 1. POWER<br>a. 115-volt A C single-phase 2500-VA (main) | AFTERBURNER SPEED-SENSING SWITCH<br>AUTOPILOT<br>AUTOSYN INSTRUMENTS<br>CABIN TEMPERATURE CONTROL<br>ENGINE IGNITION<br>FUEL QUANTITY GAGE SYSTEM<br>GLIDE SLOPE RECEIVER<br>SIDESLIP STABILITY AUGMENTER<br>VHF NAVIGATION RECEIVER<br>WINDSHIELD DE-ICE AND DEFOG CONTROLLER<br>FLIGHT COMPUTER<br>DIRECTIONAL INDICATOR (SLAVED) | FLIGHT COMPUTER<br>DIRECTIONAL INDICATOR | *By manually selecting emergency operation, the spare inverter will supply power to all equipment normally powered by the main inverter.* | *Power to the Fire Control System will be cut off when power from the spare inverter is shifted to the Essential bus upon selecting emergency operation.* |
| b. 115-volt A C single-phase 2500-VA (spare) | FIRE CONTROL SYSTEM | NONE | NONE | FIRE CONTROL SYSTEM |
| 2. INSTRUMENT<br>115-volt A C three-phase 500-VA<br>a. main<br>b. spare | ATTITUDE INDICATOR | NONE | *Only one inverter, main or spare, operates at a time; if one fails, select the other.* | NONE |
| *ALTERNATOR:*<br>200/115-volt A C three-phase | FIRE CONTROL SYSTEM<br>FUEL VENT DE-ICE HEATERS<br>MISSILE HEATERS<br>NADAR HEATER<br>RADAR<br>RADOME ANTI-ICING FLUID HEATER<br>WINDSHIELD DE-ICE HEATER<br>FIGHTER IDENTIFICATION SYSTEM<br>WINDSHIELD DEFOG | FIGHTER IDENTIFICATION SYSTEM<br>WINDSHIELD DEFOG | NONE | FIRE CONTROL SYSTEM<br>FUEL VENT DE-ICE HEATERS<br>MISSILE HEATERS<br>NADAR HEATER<br>RADAR<br>RADOME ANTI-ICING FLUID HEATER<br>WINDSHIELD DE-ICE HEATER |
| *GENERATORS:*<br>28-volt D C generators (One on left engine and two on right engine) | NONE | *If one generator fails, the remaining two will carry the load.* | NONE | NONE |
| *BATTERY:*<br>24-volt, 36 ampere-hour storage | NONE<br>*(The battery serves as standby for D C circuit during flight.)* | NONE | NONE | NONE |

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Figure 1-20.

**Electrically Operated Equipment.**

For complete reference of power distribution to electrically operated equipment, see figure 1-21.

**External Power System.**

Two 28-volt d-c and one 115/200-volt three-phase a-c external power receptacles provide a means of starting the engines and operating all electrical equipment from external power. The three external power receptacles are located on the right engine air intake duct. The top receptacle is for 28-volt d-c starting power only. The center receptacle is for external power to the 28-volt d-c distribution bus. The lower receptacle is for external 115/200-volt three-phase 400-cycle power to the alternator and inverter buses. D-c loads are automatically assumed by the external power sources. To transfer a-c loads to external a-c power, the alternator breaker control switch must be momentarily placed at TRIP, the exciter control switch must be momentarily placed at CLOSE, the external power switch must be momentarily placed at CLOSE, then the single-phase inverter switch must be placed at NORMAL and the three-phase inverter switch placed at MAIN. External 115/200-volt three-phase a-c power is then connected to the alternator distribution bus; single-phase 115-volt a-c power is connected to the single-phase essential and secondary buses; and three-phase 115-volt a-c power is connected to the three-phase a-c bus. To transfer a-c loads from the external a-c power to the airplane's a-c power (after engines are running and two or more d-c generators and the alternator are operating), either the external power switch must be placed momentarily at TRIP or the alternator breaker switch placed momentarily at CLOSE. The airplane's a-c power system will then be in normal operation.

**Note**

- A-C loads will automatically transfer from external a-c power to the airplane's a-c power (inverter, alternator, and generator switches set for normal operation) when external a-c power is removed from the airplane. When a-c loads are being carried by an external power supply, the alternator circuit is open and the single-phase and three-phase inverters will not operate.
- If the three-phase inverter switch is placed at SPARE or the single-phase inverter switch at EMERGENCY, the external a-c power source will be automatically disconnected from the airplane.

**CAUTION**

Three-phase a-c external power must be used with this airplane. Single-phase a-c power will damage airplane equipment.

## 28-VOLT D-C SYSTEM.

The 28-volt d-c system obtains power from three engine-driven generators, one on the left engine and two on the right engine. The d-c generator on the left engine and one of the d-c generators on the right engine also function as starters. The two starter-generators crank the engines until the electrical load drops to about 200 amperes (approximately 26% rpm) and then all three generators cut in after engine speed reaches 28% rpm. Three bus bars provide for distribution of direct current; a battery bus, a primary bus, and a secondary bus. When the engines are being cranked, reverse-current relays disconnect the d-c generators from all but the starter bus. When the engines are operating, the three d-c generators supply both the primary bus and the secondary bus, and the two bus bars are interconnected by a bus-tie relay. Failure of any two generators will separate the two buses, and the remaining d-c generator will supply power to the primary bus only. A 24-volt 36 ampere-hour storage battery is connected in series to the main 28-volt d-c bus through the battery relay. If all three 28-volt d-c generators fail, the battery will operate emergency 28-volt d-c equipment for a limited time. If an emergency start is necessary, with one 28-volt d-c external power source available, an emergency bus-tie relay (through the starting power switch) connects the primary 28-volt d-c bus (energized by plugging external power into the lowest d-c receptacle) to the starter bus. With the exception of the battery switch on the pilot's right vertical console, all controls and indicators for the 28-volt d-c system are on the pilot's right console.

**Battery Switch.**

The battery switch (figure 1-12), located on the pilot's right vertical console, connects the battery bus with the 28-volt d-c primary bus and has ON and OFF positions. When the switch is at ON, the battery bus is connected to the 28-volt d-c primary bus. Whenever the 28-volt d-c system is operating and the battery switch is at ON, the battery is being charged. When the switch is at OFF, the circuit connecting the battery bus to the primary bus is broken.

**CAUTION**

The battery switch must not be at ON when the external 28-volt d-c starting power supply is being used to start the engines, as damage to the battery will result.

**28-Volt D-C Voltage Regulator Rheostats.**

Three voltage regulator rheostats (figure 1-13), one for each 28-volt d-c generator, are located under a hinged cover next to the 28-volt d-c indicator and control panel on the pilot's right console. The 28-volt

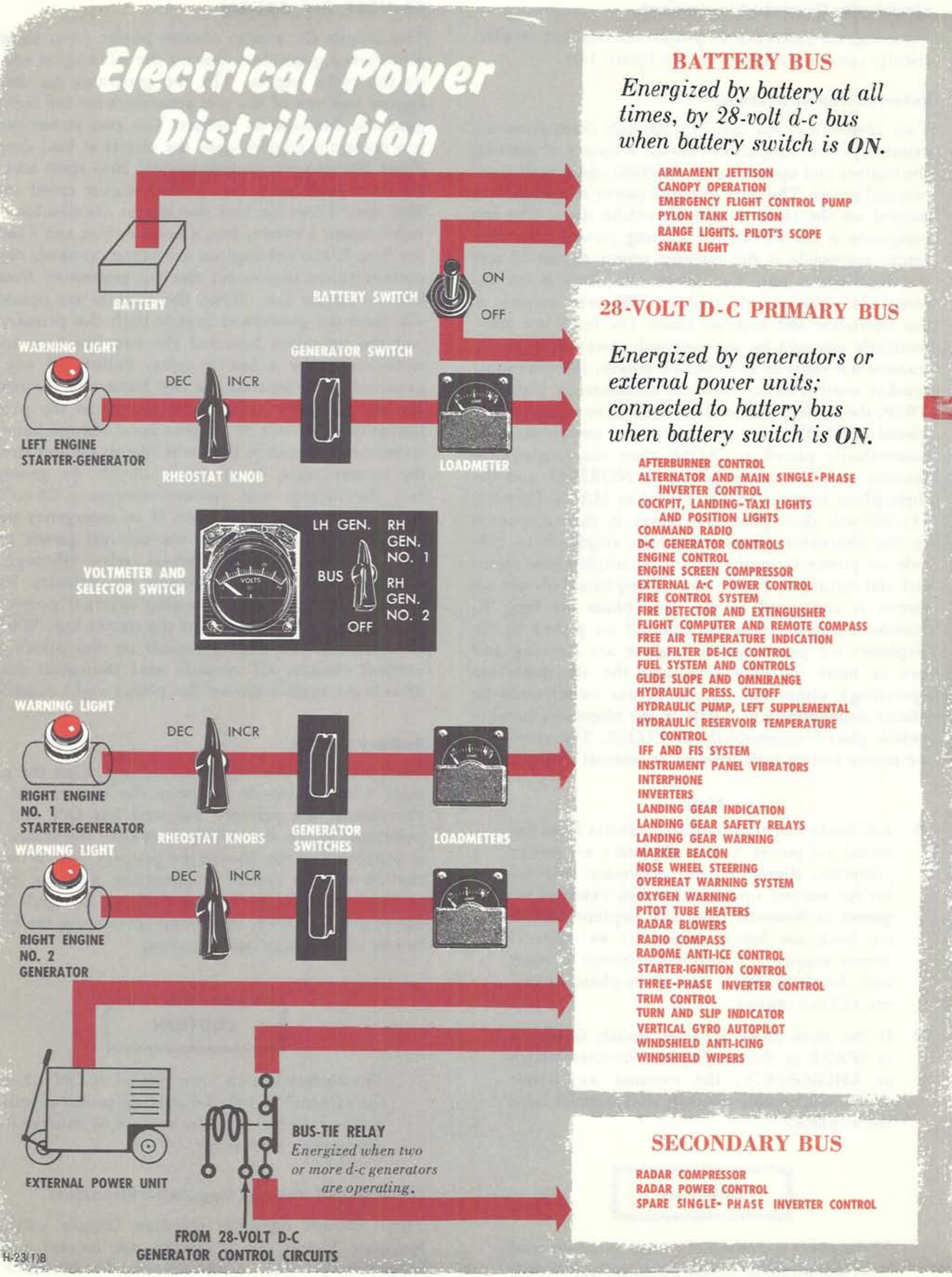
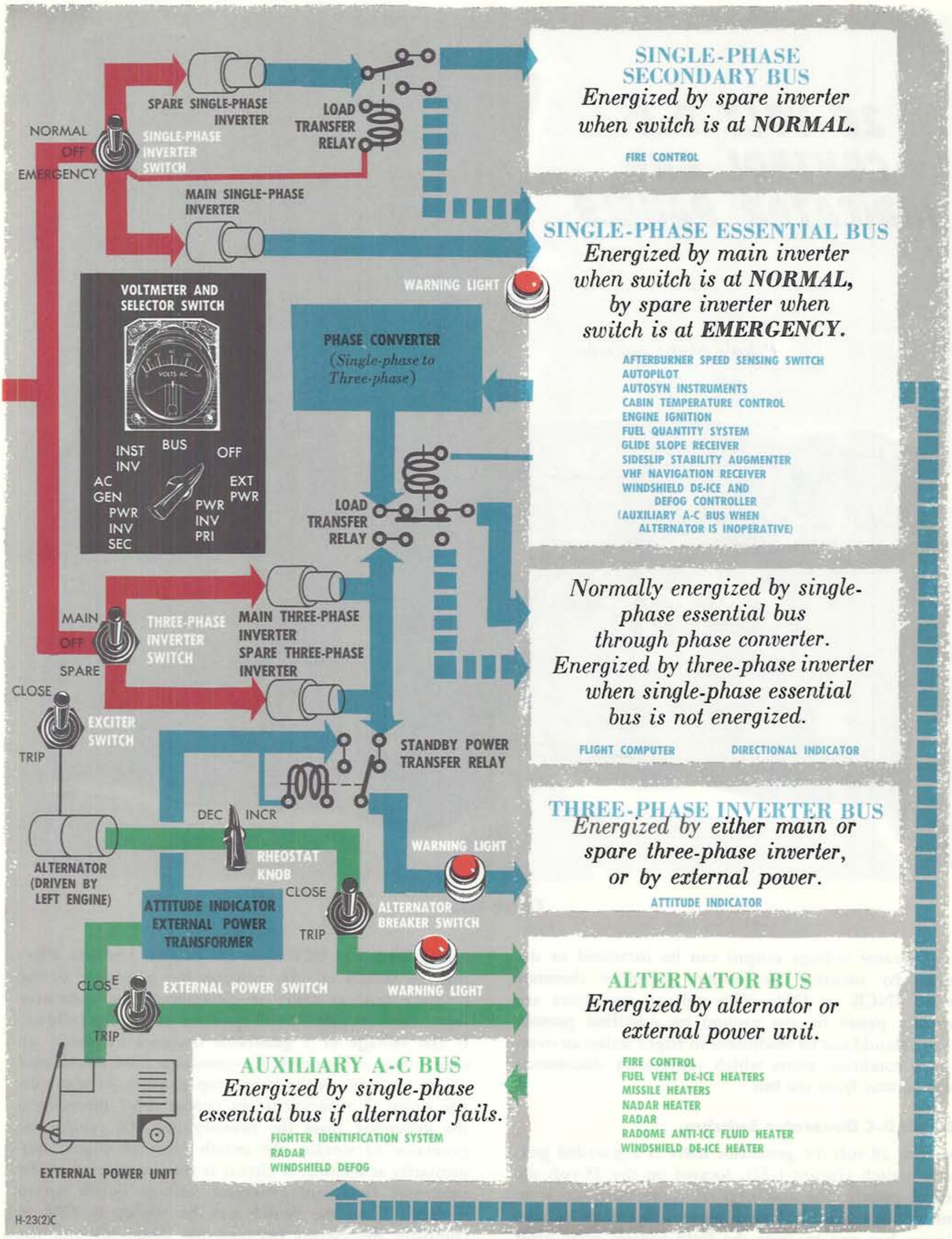

Electrical Power Distribution
BATTERY
BATTERY SWITCH
ON
OFF
WARNING LIGHT
GENERATOR SWITCH
DEC
INCR
LEFT ENGINE STARTER-GENERATOR
RHEOSTAT KNOB
LOADMETER
VOLTMETER AND SELECTOR SWITCH
LH GEN.
RH GEN. NO. 1
BUS
RH GEN. NO. 2
OFF
WARNING LIGHT
DEC
INCR
RIGHT ENGINE NO. 1 STARTER-GENERATOR
RHEOSTAT KNOBS
GENERATOR SWITCHES
LOADMETERS
WARNING LIGHT
DEC
INCR
RIGHT ENGINE NO. 2 GENERATOR
EXTERNAL POWER UNIT
BUS-TIE RELAY
Energized when two or more d-c generators are operating.
FROM 28-VOLT D-C GENERATOR CONTROL CIRCUITS
BATTERY BUS
Energized by battery at all times, by 28-volt d-c bus when battery switch is ON.
ARMAMENT JETTISON
CANOPY OPERATION
EMERGENCY FLIGHT CONTROL PUMP
PYLON TANK JETTISON
RANGE LIGHTS. PILOT'S SCOPE
SNAKE LIGHT
28-VOLT D-C PRIMARY BUS
Energized by generators or external power units; connected to battery bus when battery switch is ON.
AFTERBURNER CONTROL
ALTERNATOR AND MAIN SINGLE-PHASE INVERTER CONTROL
COCKPIT, LANDING-TAXI LIGHTS AND POSITION LIGHTS
COMMAND RADIO
D-C GENERATOR CONTROLS
ENGINE CONTROL
ENGINE SCREEN COMPRESSOR
EXTERNAL A-C POWER CONTROL
FIRE CONTROL SYSTEM
FIRE DETECTOR AND EXTINGUISHER
FLIGHT COMPUTER AND REMOTE COMPASS
FREE AIR TEMPERATURE INDICATION
FUEL FILTER DE-ICE CONTROL
FUEL SYSTEM AND CONTROLS
GLIDE SLOPE AND OMNIRANGE
HYDRAULIC PRESS. CUTOFF
HYDRAULIC PUMP, LEFT SUPPLEMENTAL
HYDRAULIC RESERVOIR TEMPERATURE CONTROL
IFF AND FIS SYSTEM
INSTRUMENT PANEL VIBRATORS
INTERPHONE
INVERTERS
LANDING GEAR INDICATION
LANDING GEAR SAFETY RELAYS
LANDING GEAR WARNING
MARKER BEACON
NOSE WHEEL STEERING
OVERHEAT WARNING SYSTEM
OXYGEN WARNING
PITOT TUBE HEATERS
RADAR BLOWERS
RADIO COMPASS
RADOME ANTI-ICE CONTROL
STARTER-IGNITION CONTROL
THREE-PHASE INVERTER CONTROL
TRIM CONTROL
TURN AND SLIP INDICATOR
VERTICAL GYRO AUTOPILOT
WINDSHIELD ANTI-ICING
WINDSHIELD WIPERS
SECONDARY BUS
RADAR COMPRESSOR
RADAR POWER CONTROL
SPARE SINGLE-PHASE INVERTER CONTROL
H-23(1)B

Figure 1-21.


SINGLE-PHASE SECONDARY BUS
Energized by spare inverter when switch is at NORMAL.
FIRE CONTROL
SPARE SINGLE-PHASE INVERTER
LOAD TRANSFER RELAY
NORMAL
OFF
EMERGENCY
SINGLE-PHASE INVERTER SWITCH
MAIN SINGLE-PHASE INVERTER
SINGLE-PHASE ESSENTIAL BUS
Energized by main inverter when switch is at NORMAL, by spare inverter when switch is at EMERGENCY.
AFTERBURNER SPEED SENSING SWITCH
AUTOPILOT
AUTOSYN INSTRUMENTS
CABIN TEMPERATURE CONTROL
ENGINE IGNITION
FUEL QUANTITY SYSTEM
GLIDE SLOPE RECEIVER
SIDESLIP STABILITY AUGMENTER
VHF NAVIGATION RECEIVER
WINDSHIELD DE-ICE AND DEFOG CONTROLLER
(AUXILIARY A-C BUS WHEN ALTERNATOR IS INOPERATIVE)
WARNING LIGHT
VOLTMETER AND SELECTOR SWITCH
VOLTS AC
BUS
INST INV
OFF
AC GEN
EXT PWR
PWR INV SEC
PWR INV PRI
PHASE CONVERTER
(Single-phase to Three-phase)
LOAD TRANSFER RELAY
Normally energized by single-phase essential bus through phase converter. Energized by three-phase inverter when single-phase essential bus is not energized.
FLIGHT COMPUTER
DIRECTIONAL INDICATOR
MAIN
OFF
SPARE
THREE-PHASE INVERTER SWITCH
MAIN THREE-PHASE INVERTER
SPARE THREE-PHASE INVERTER
CLOSE
TRIP
EXCITER SWITCH
STANDBY POWER TRANSFER RELAY
DEC
INCR
RHEOSTAT KNOB
THREE-PHASE INVERTER BUS
Energized by either main or spare three-phase inverter, or by external power.
ATTITUDE INDICATOR
WARNING LIGHT
ALTERNATOR (DRIVEN BY LEFT ENGINE)
ATTITUDE INDICATOR EXTERNAL POWER TRANSFORMER
CLOSE
TRIP
ALTERNATOR BREAKER SWITCH
WARNING LIGHT
ALTERNATOR BUS
Energized by alternator or external power unit.
FIRE CONTROL
FUEL VENT DE-ICE HEATERS
MISSILE HEATERS
NADAR HEATER
RADAR
RADOME ANTI-ICE FLUID HEATER
WINDSHIELD DE-ICE HEATER
CLOSE
TRIP
EXTERNAL POWER SWITCH
AUXILIARY A-C BUS
Energized by single-phase essential bus if alternator fails.
FIGHTER IDENTIFICATION SYSTEM
RADAR
WINDSHIELD DEFOG
EXTERNAL POWER UNIT
H-23(2)C

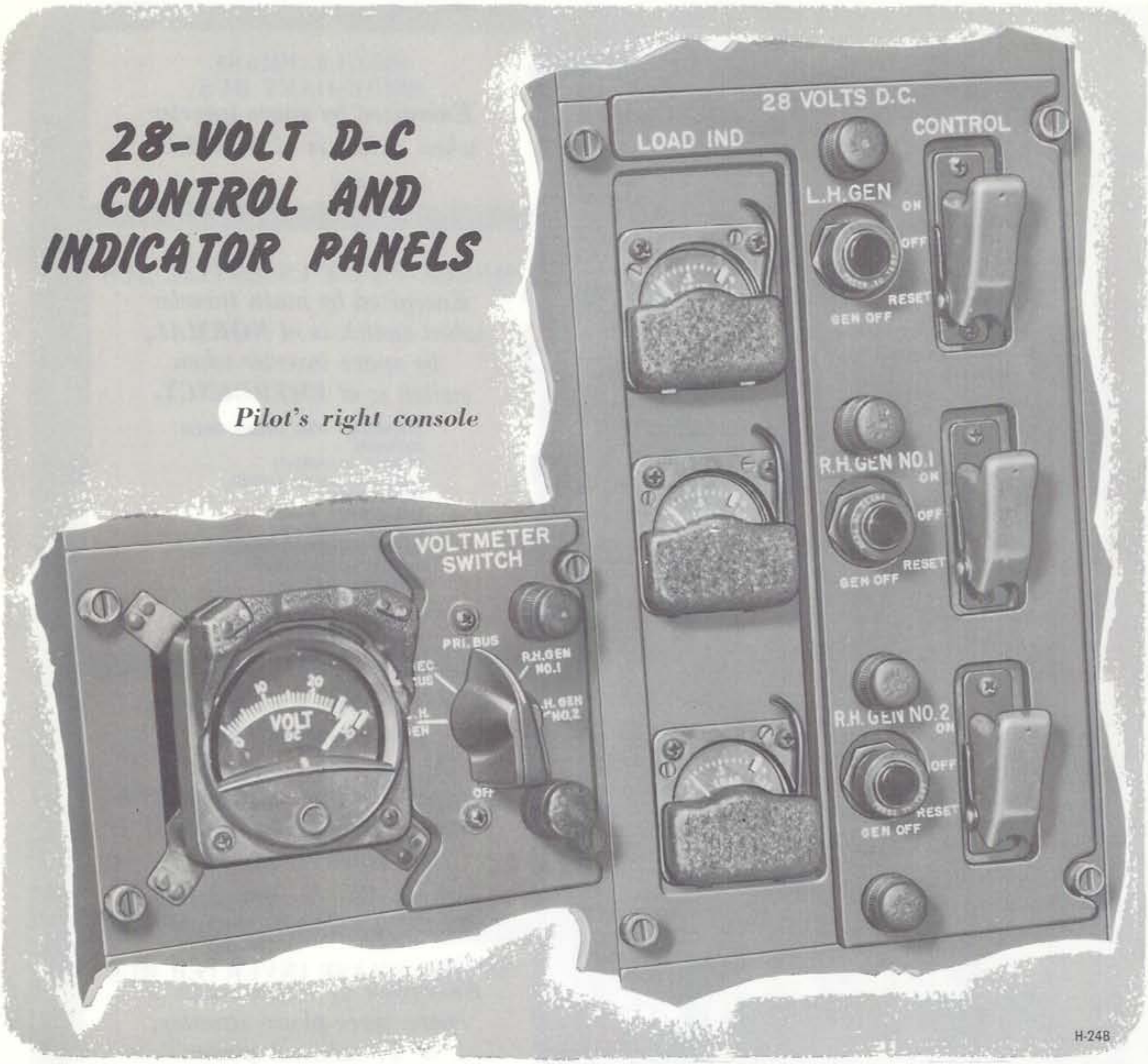



**Figure 1-22.**

d-c generator voltage output can be increased or decreased by turning the voltage regulator rheostats toward INCR or DEC. The voltage regulators are normally preset on the ground by qualified personnel and should not be readjusted in flight unless an overvoltage condition exists which continually disconnects the generator from the bus.

**28-Volt D-C Generator Switches.**

For each 28-volt d-c generator there is a guarded generator switch (figure 1-22), located on the 28-volt d-c control panel. The function of these switches is to connect the corresponding generator to the 28-volt d-c primary bus and to reset the field control relay after an overvoltage condition has occurred. The switch positions are ON, OFF, and RESET. The switch is spring-loaded to OFF from the RESET position. Placing the switch at ON connects the generator to the primary bus; at OFF, it disconnects the generator from the bus. The RESET position is used as follows: If the voltage of a generator becomes excessive, an overvoltage relay opens the generator field circuit and causes generator voltage to drop to zero. As the voltage drops, a reverse-current cutout relay disconnects the generator from the primary bus. To return the generator to service, the switch must be placed momentarily at RESET. A circuit is then completed to the generator field and generator voltage builds up to normal. Then the switch can be placed at ON to complete the circuit between the generator and the 28-volt d-c bus. If the overvoltage condition persists (as indicated by the generator warning light again coming on), voltage can be reduced to the correct value by first placing the generator switch at OFF, then turning the voltage regulator rheostat knob toward DEC (counterclockwise). Next, the generator switch must be placed momentarily at RESET, then returned to OFF. With the switch at OFF, the voltage regulator rheostat knob should be adjusted so that the voltmeter reads 28 volts. Then the generator switch can be placed at ON to put the generator back into service.

**28-Volt D-C Generator Warning Lights.**

Each generator has a 28-volt d-c generator-off warning light (figure 1-22) located on the 28-volt d-c control panel. These lights are marked GEN OFF. The lights come on to warn the pilot when the corresponding generator is disconnected from the 28-volt primary bus. The light will come on under the following conditions: before engines are started when the battery switch is turned ON or an external source of d-c power is applied to the airplane; when the engines are operating but the generator switch is at OFF; or if the generator has been automatically disconnected because of an overvoltage condition.

**28-Volt D-C Circuit Breakers.**

Most of the 28-volt d-c circuits (except emergency circuits) are protected by push-pull circuit breakers (figure 1-25) on five circuit breaker panels: two on the pilot's left console, one on the pilot's right console, and one each on the left and right sides of the radar observer's cockpit. Electrical overload within a circuit will cause the corresponding circuit breaker to pop out and open the overloaded circuit. The circuit may be closed again by pushing the circuit breaker IN, or the circuit can be opened manually by pulling the circuit breaker OUT.

**28-Volt D-C Loadmeters.**

Three loadmeters (figure 1-22), one for each generator, are located on the 28-volt d-c indicator panel on the pilot's right console. The loadmeters indicate the proportion of generator rated output being used.

**28-Volt D-C Voltmeter and Voltmeter Selector Switch.**

A voltmeter and a voltmeter selector switch (figure 1-22), on the 28-volt d-c indicator panel on the pilot's right console, provide a means of determining generator voltage output. The selector switch has LH GEN, RH GEN NO. 1, RH GEN NO. 2, PRI BUS, SEC BUS, and OFF positions. When the switch is turned to one of the three generator positions, the voltmeter indicates the output of the generator selected. When the switch is turned to PRI BUS or SEC BUS, the voltmeter indicates the voltage being supplied to the bus selected. When the switch is at OFF, the circuits to the voltmeter are open and the voltmeter reads zero.


*Figure 1-23.*

**Note**

Whenever the engines are operating, the voltmeter will indicate a voltage from each 28-volt d-c generator whether the generator switch is at ON or at OFF, unless the generator field circuit has been broken by action of the overvoltage relay or by generator failure. The loadmeter, however, will indicate load only when the generator switch is at ON and power is being supplied to the 28-volt d-c primary bus.

**INVERTER SYSTEMS.**

Alternating current is supplied by two 115-volt inverter systems: a single-phase system and a three-phase system. Each system has two inverters powered by 28-volt dc. In the single-phase inverter system, two 2500-va inverters (a main and spare) supply power to the essential and secondary buses (see figure 1-21). During normal operation, both single-phase inverters operate; the main inverter supplies power to the essential bus, and the spare inverter supplies power to the secondary bus. All single-phase inverter powered equipment is protected by circuit breakers on a panel (figure 1-25) located on the bulkhead at the right aft side of the pilot's seat. All inverters are powered by the 28-volt d-c essential bus; however, the control circuit for the


*Figure 1-24.*

spare single-phase inverter receives its power from the secondary 28-volt d-c bus, which is energized when two or more 28-volt d-c generators are operating. If the main single-phase inverter fails during normal operation, a red warning light will come on to indicate that the essential bus is not energized. Then emergency operation can be selected: the spare single-phase inverter, by means of a load transfer relay, will power the essential bus and the secondary bus will not be energized. If the spare inverter fails during normal operation, the main inverter will continue to supply power to the essential bus and the secondary bus will not be energized. The essential bus, in addition to carrying its normal load, also supplies power to the auxiliary bus (normally powered by the alternator) in case the alternator fails. In addition to equipment operated directly from the essential bus, the gyrosyn compass system and the flight computer are powered through a phase converter by the essential bus. The phase converter changes single-phase power to three-phase power. If the essential bus is not energized, as would occur if both single-phase inverters fail, a load-transfer relay will automatically shift the load of the gyrosyn compass system and the flight computer to the three-phase inverter system. The three-phase inverters, a main and a spare, are each rated at 500-va. Only one three-phase inverter (main or spare) operates at a time. Normally only the attitude indicator is powered by the three-phase inverter system. Operation of either main or spare three-phase inverter is manually selected. A red warning light will come on to warn of either three-phase inverter failure or an open attitude indicator circuit breaker. All controls and indicators, except the a-c voltmeter and voltmeter selector switch, for both three-phase and single-phase inverter systems are on one inverter control panel located on the pilot's right console. The voltmeter and voltmeter selector switch, which serve both inverter systems and the alternator system, are located in the radar observer's cockpit on the alternator control panel.

### Single-Phase Inverter Switch.

A 28-volt d-c switch (figure 1-23) on the upper portion of the inverter control panel has NORMAL, OFF, and EMERGENCY positions to control single-phase inverter operation. When the switch is at NORMAL, both single-phase inverters operate: the main inverter powers the

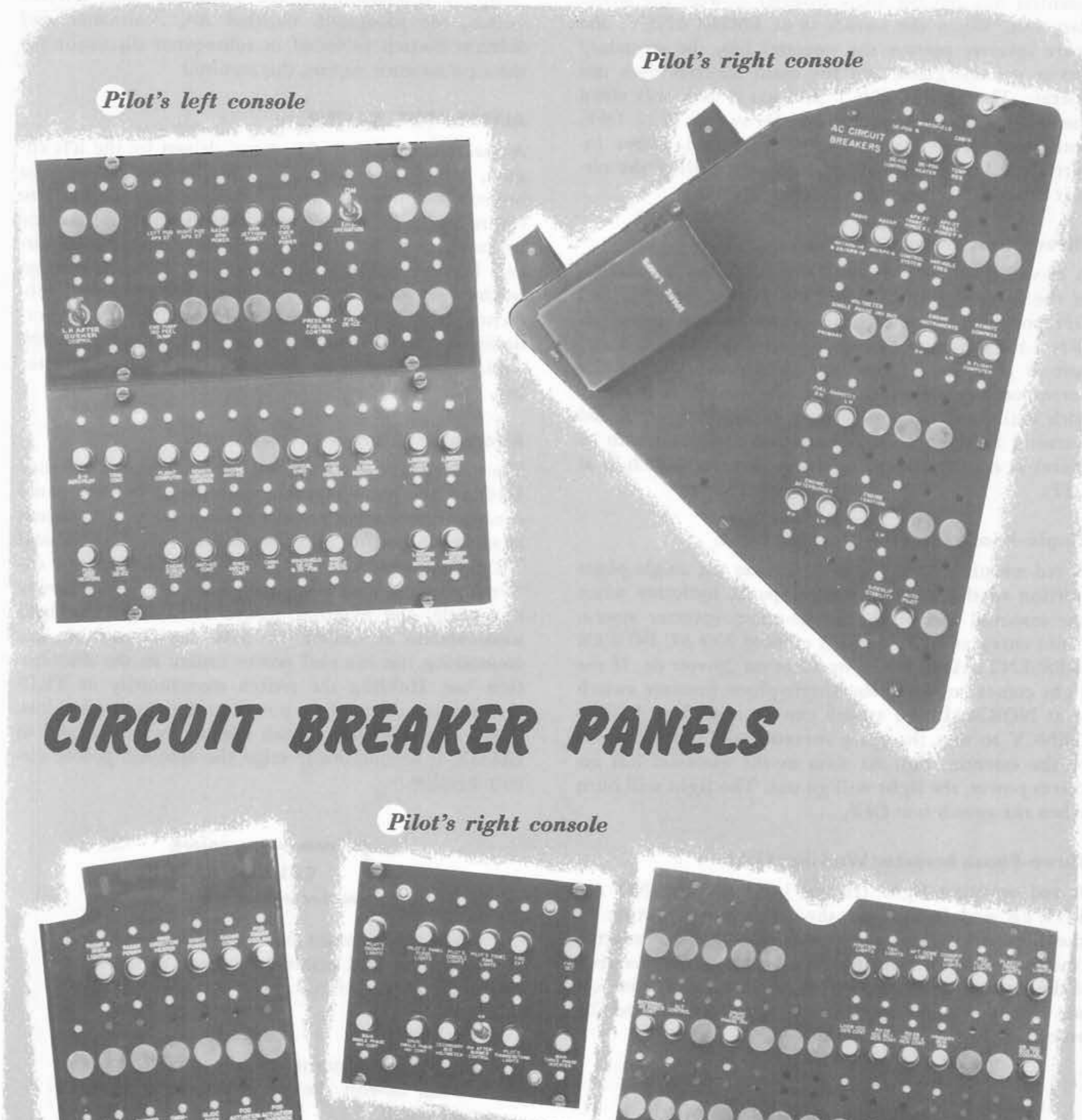

Pilot's left console
Pilot's right console
AC CIRCUIT BREAKERS
CIRCUIT BREAKER PANELS
Pilot's right console
Radar Observer's cockpit — right side
Radar Observer's cockpit — left side
H-115 B

Figure 1-25.

essential bus and the spare inverter powers the secondary bus. When the switch is at EMERGENCY, the spare inverter powers the essential bus, the secondary bus is not energized, and the main inverter does not operate. The EMERGENCY position is used only when the main inverter fails. When the switch is at OFF, both single-phase inverters are deenergized. Either inverter can be operated individually by pulling the circuit breaker for the other inverter.

#### Three-Phase Inverter Switch.

A 28-volt d-c switch (figure 1-23) on the upper portion of the inverter control panel has MAIN, SPARE, and OFF positions to control three-phase inverter operation. When the switch is placed at MAIN or SPARE, a circuit is completed from the 28-volt d-c bus to the corresponding inverter. When the switch is at OFF, both main and spare inverters are inoperative. A red warning light burns if the selected inverter (main or spare) is not operating, or if the inverter switch is at OFF.

#### Single-Phase Inverter Warning Light.

A red warning light (figure 1-23) on the single-phase portion of the inverter control panel indicates when the essential bus of the single-phase inverter system is not energized. The light is marked NO AC POWER —ESSENTIAL BUS and operates on 28-volt dc. If the light comes on while the single-phase inverter switch is at NORMAL, the switch can be moved to EMERGENCY so that the spare inverter will supply power to the essential bus. As soon as the essential bus receives power, the light will go out. The light will burn when the switch is at OFF.

#### Three-Phase Inverter Warning Light.

A red warning light (figure 1-23) marked NO AC POWER and located on the three-phase portion of the inverter control panel comes on if the selected (main or spare) three-phase inverter is inoperative, if the inverter switch is at OFF, or if the attitude indicator circuit breaker is open. The light operates on 28-volt dc.

**Note**

When the single-phase inverter switch is moved from NORMAL to EMERGENCY, the three-phase inverter light will flicker on momentarily. This is a result of the three-phase inverter momentarily picking up the gyrosyn compass system and flight computer load while the changeover is being made.

#### A-C Voltmeter and Selector Switch.

One voltmeter (figure 1-24) is provided for both the inverter systems and the alternator system. The voltmeter and its selector switch (figure 1-24) are located on the radar observer's alternator panel. (For a complete discussion on the voltmeter and selector switch, see paragraph entitled A-C Voltmeter and Selector Switch included in subsequent discussion on the a-c alternator system, this section.)

### ALTERNATOR SYSTEM.

A variable frequency alternator, driven by the left engine, supplies three-phase 115/200-volt ac to two buses: the alternator bus and the auxiliary a-c bus (see figure 1-21). An exciter switch turns on the alternator by energizing the alternator fields. An alternator circuit breaker connects the alternator, through a relay, to the two buses. Both switches must be placed momentarily at CLOSE to obtain alternator output. Alternator failure will cause a bus-tie relay to connect the auxiliary a-c bus to the essential single-phase inverter bus.

#### Alternator External Power Switch.

The three-position external power switch (figure 1-24) on the radar observer's alternator control panel controls the external power circuit breaker. The switch is spring-loaded to NEUTRAL from the CLOSE and TRIP positions. After a 115/200-volt 400-cycle a-c external power source is connected to the external power receptacle, the external power switch can be held momentarily at CLOSE to close the circuit breaker connecting the external power source to the distribution bus. Holding the switch momentarily at TRIP discontinues external a-c power to the distribution bus. When the alternator circuit breaker switch is held to CLOSE, it automatically trips the external power circuit breaker.

**CAUTION**

Operation of more than one alternator switch at a time will result in damage to the alternator control circuit.

**Note**

Before the external power switch can be closed, 28-volt d-c external power must be connected.

#### Alternator Exciter Switch.

Two three-position exciter switches (figure 1-24), one on the pilot's alternator control panel and one on the radar observer's alternator control panel, control 28-volt d-c circuits to the alternator exciter relay and provide a means for either crewmember to turn the alternator on and off. These switches are spring-loaded to NEUTRAL from the CLOSE and TRIP positions. When either switch is held momentarily at CLOSE, a circuit is completed from the 28-volt d-c bus to the exciter relay, which in turn closes and turns on the alternator. When the switch is held momentarily to TRIP, the circuit from the 28-volt d-c bus to the exciter relay is broken; the relay opens and cuts off alternator output.

CAUTION

Operation of more than one alternator switch at a time will result in damage to the alternator control circuit.

#### Alternator Circuit Breaker Switch and Indicator Light.

Two three-position circuit breaker switches (figure 1-24), one on the pilot's alternator control panel and one on the radar observer's control panel, close or trip the alternator circuit breaker. Each switch is spring-loaded to NEUTRAL from the CLOSE and TRIP positions. Holding the switch momentarily in the CLOSE position closes the circuit breaker connecting the alternator to the distribution bus and automatically trips the external power circuit breaker. Holding the switch momentarily in the TRIP position opens the circuit breaker, discontinuing alternator output to the distribution bus. The red indicator light (figure 1-24) to the right of the circuit breaker switch in each cockpit comes on when the alternator circuit breaker is in the tripped position.

CAUTION

Operation of more than one alternator switch at a time will result in damage to the alternator control circuit.

#### Alternator Voltage Rheostat.

A guarded voltage rheostat (figure 1-24) on the radar observer's alternator control panel can be used to adjust the voltage output of the alternator.

#### A-C Voltmeter and Selector Switch.

A voltmeter and selector switch (figure 1-24), located on the radar observer's alternator control panel, are used to check the voltage of all a-c power systems. The rotary selector switch has OFF, EXT PWR, PWR INV PRI, PWR INV SEC, AC GEN, INST INV, and BUS positions. When the switch is at EXT PWR, the voltmeter indicates external a-c power voltage before the external power switch is closed. When the switch is at PWR INV PRI or PWR INV SEC, the voltmeter indicates the voltage of the essential or secondary single-phase bus. When the switch is at AC GEN, the voltmeter indicates the voltage output of the alternator. When the switch is at INST INV, the voltage indicated is that of the selected three-phase inverter (main or spare). When the switch is at BUS, the alternator bus voltage is indicated.

## HYDRAULIC POWER SUPPLY SYSTEM.

The complete hydraulic power installation includes a left system and a right system, both powered by engine-driven pumps, with a supplemental electrically driven hydraulic pump tied into the left system. No interflow can occur between the left and right systems. The left and right systems operate at 3000 psi, and the supplemental hydraulic pump at 2500 psi. Each primary flight control has two actuating cylinders: one powered by the left system, and one powered by the right system. If either the left or right system fails, the remaining system provides adequate but limited flight control. If both the left and right systems fail, the left hydraulic system supplemental pump provides further limited flight control if the left hydraulic system has not failed through loss of hydraulic fluid. One pressurized hydraulic reservoir for the left system and one for the right system are in the forward fuselage section. The reservoirs are pressurized to prevent the fluid from foaming at altitude and to maintain a positive pressure on the inlet side of the engine-driven pumps. During engine starts, a purge valve, one in each system, bypasses hydraulic fluid from the pump back to the reservoir to reduce the load on the starter. After the engine starts, the pump puts out more fluid than the purge valve can bypass. The increase of pressure in the valve overcomes a spring tension and forces a piston over the return line to close the valve. System pressure then builds up to 3000 psi. During cold weather, for ground operation only, the hydraulic fluid in the left and right systems is maintained automatically at operating temperature. The weight of the airplane on the landing gear energizes a circuit to a thermoswitch. When the fluid temperature drops below a predetermined value, the thermoswitch actuates an electric shutoff valve and the fluid is routed through a restrictor which raises the temperature of the fluid until the correct temperature is obtained. (See figures 1-26, 1-27, 1-30, 1-33, 1-36, and 1-37 for hydraulically operated equipment. Refer to figure 1-45 for hydraulic fluid specification.

### LEFT HYDRAULIC SYSTEM.

Basic operating pressure for the left system comes from an engine-driven piston-type hydraulic pump on the left engine and an electrically driven supplemental hydraulic pump. This system powers one actuating cylinder on each flight control surface, the landing gear, main gear inboard doors, wheel brakes, wing flaps, speed brakes, missile extension mechanisms, and the nose wheel steering system. The left system includes a

# Hydraulic Power Supply Systems

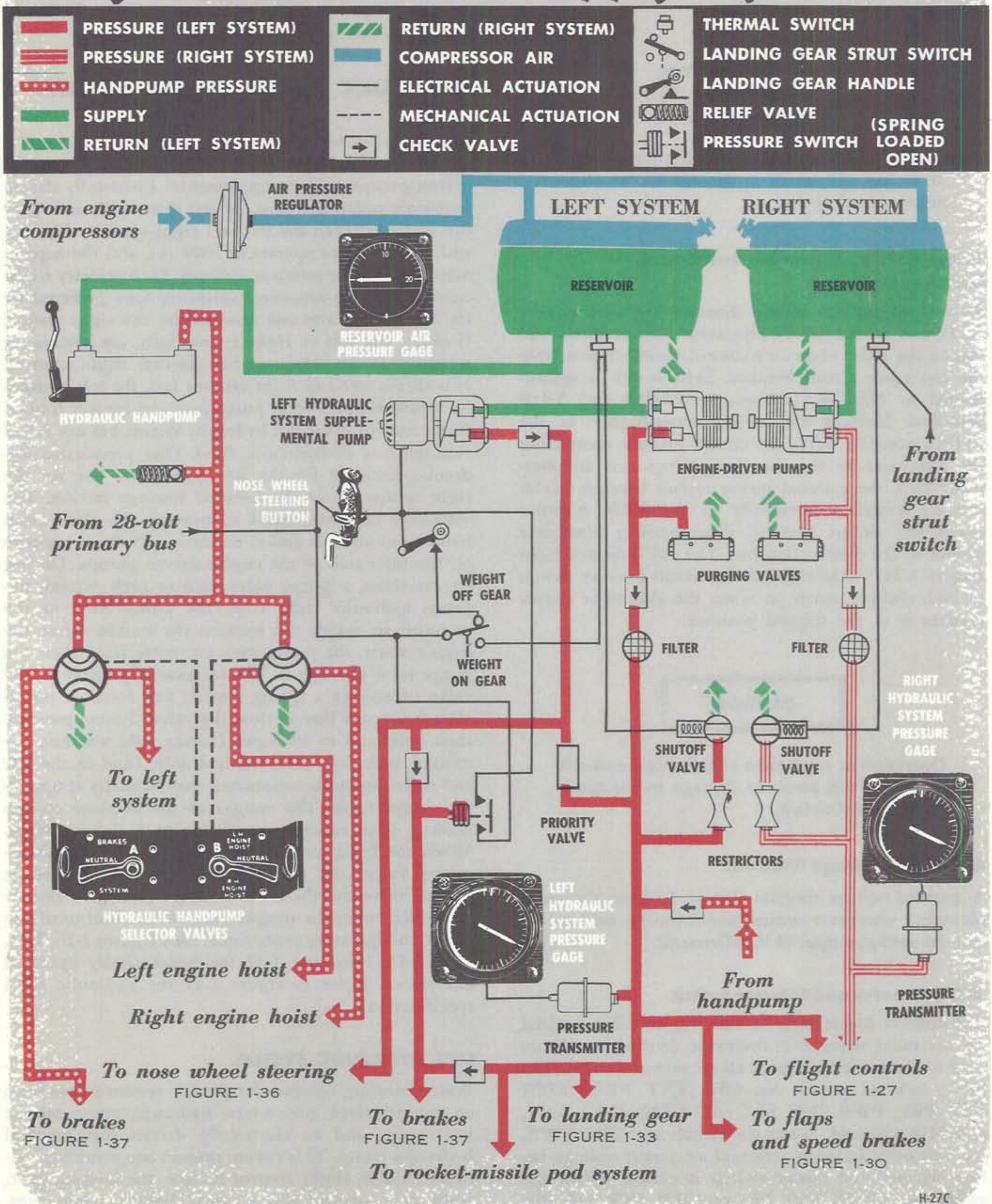



*Figure 1-26.*

pressurized reservoir in the left side of the forward fuselage section, a brake accumulator in the nose gear wheel well, and a handpump and two selector valves in the radar observer's cockpit. The handpump is ordinarily used to operate the hydraulic engine hoist system. In an emergency, the radar observer can recharge the brake hydraulic accumulator by placing the two selector valves at the proper placarded positions and then actuating the pump handle.

**Note**

The engine hoist system includes two hydraulic cylinders in the aft fuselage section, one of the two selector valves in the radar observer's cockpit, and needle control valves under the aft lower wing fillet doors. The hoist system is used by ground crew personnel when engine service is required. The handpump will not maintain sufficient hydraulic pressure for operation of the flight controls.

The left hydraulic system supplemental pump is started in three different ways. It starts automatically either in flight or on the ground whenever brake accumulator pressure drops below 1150 to 800 psi. A landing gear lever switch also starts the pump automatically when the landing gear lever is moved to the DOWN position in flight, to supply an additional volume of hydraulic flow to lower the gear. A strut switch cuts out the landing gear lever switch to prevent pump operation while the airplane's weight is on the gear. Normally, in flight and during taxi operations, the supplemental pump can be energized by depressing the nose wheel steering button, and deenergized by releasing the button. However, if the left hydraulic system pressure switch is automatically actuated, because of excessive use of the wheel brakes during taxiing, the supplemental pump will be automatically energized and continue to operate until the left hydraulic system pressure reaches 2200 to 2350 psi, regardless of the nose wheel steering button position. The steering and brake systems have first priority on supplemental pump flow and only the surplus flow enters the main left hydraulic system. This provides adequate flow on the ground for braking and steering regardless of other hydraulic system functions, even with the left engine inoperative. Since braking and steering are not used in the air, all the flow enters the left main system when the nose wheel steering button is depressed or the gear lowered, providing the brake accumulator is fully charged.

**Note**

In the event of a complete power failure, the battery switch must be ON to operate the supplemental pump.

**CAUTION**

- When a demand is made on the supplemental pump by operation of any left hydraulic system control, the supplemental pump must not be in operation for a period of more than 6 minutes, followed by a rest period of 15 minutes.
- When no demand is made on the supplemental pump by operation of any left hydraulic system control, the supplemental pump should not be in operation for more than 30 minutes.

### RIGHT HYDRAULIC SYSTEM.

Operating pressure for the right system is normally supplied by an engine-driven piston-type hydraulic pump on the right engine. This system powers one actuating cylinder of each basic flight control surface. The pressurized reservoir for the system is in the right side of the forward fuselage section.

### HYDRAULIC SYSTEM PRESSURE GAGES.

Both left and right systems and the brake accumulator system have autosyn pressure gages (figure 1-11) on the pilot's center pedestal. The gages operate on 115-volt ac from the main or spare single-phase inverter. A pressure gage (figure 1-9), showing the air pressure in both left and right system reservoirs, is located above the pilot's left console.

## FLIGHT CONTROL SYSTEM.

Hydraulic actuating cylinders controlled by servo valves operate the control surfaces of the airplane. The servo valves are in turn controlled by push-pull rods and cable linkages from the pilot's stick and rudder pedals. The rudder has a single set of control cables, and the elevator and ailerons have dual sets of control cables. All control surfaces have two independent sets of hydraulic actuators. One set receives hydraulic power from the right hydraulic system and the other from the left hydraulic system. Either system will give adequate control for safe flight. Surfaces other than the rudder operate on the 3000-psi system pressure. The rudder actuating cylinders operate on 700-psi pressure obtained through pressure reducers which reduce the normal 3000-psi system pressure. Since the flight control surfaces are fully powered, artificial "feel" has been provided because no forces are transmitted to the stick and the rudder pedals. A bobweight on the control force mechanism and a control force bellows, utilizing ram air pressure, provide additional "feel" for elevator operation. The irreversible surface control hydraulic system opposes surface movement when the airplane is not in use; however, the control

# Flight Control Hydraulic System

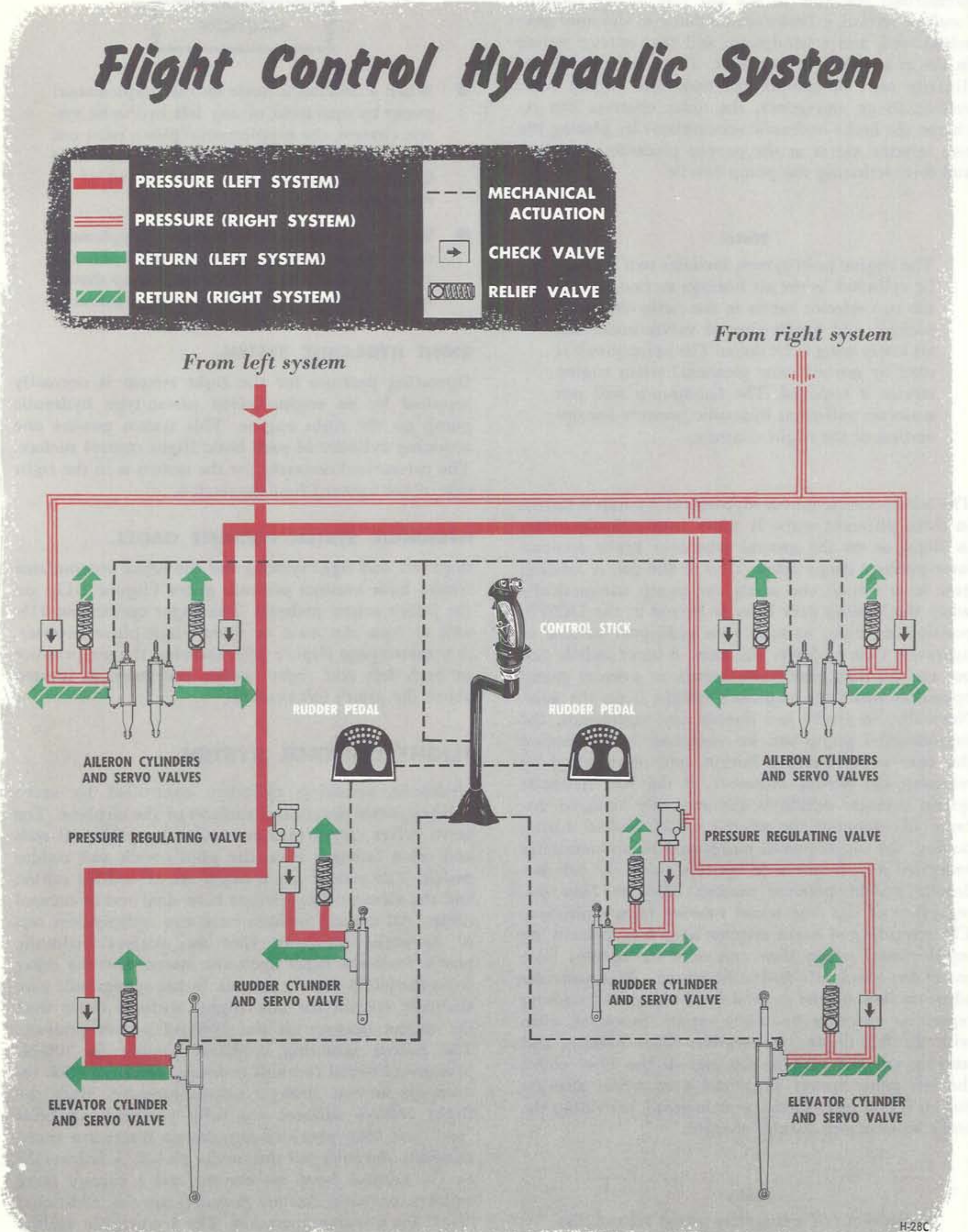



Figure 1-27.

surfaces will eventually droop after the airplane is parked without hydraulic pressure on the system. This is normal and should cause no alarm, as the control surfaces will return to their normal positions when hydraulic power is applied.

## CONTROL STICK.

The control stick (figure 1-28) is conventional with the following 28-volt d-c switches on the grip: aileron and elevator trim switch, pylon tanks and bombs release button (inoperative), rocket-missile firing trigger, radio mike button, autopilot emergency disconnect switch, and nose wheel steering button which also actuates the left system supplemental hydraulic pump.

## RUDDER PEDALS.

The rudder pedals are the conventional suspended type with toe-operated brake pedals. The pedals are adjustable to the desired position.

### Rudder Pedal Adjustment Crank.

A rudder pedal adjustment crank (figure 1-11) is on the pilot's center pedestal panel. Rotation of the crank moves both rudder pedals either forward or aft to the desired position.

## ELEVATOR FEEL SYSTEM.

A control force bellows in the elevator control mechanism lends "feel" for elevator movement in proportion to airspeed. A diaphragm in the bellows is attached so that a movement of the stick in either direction moves the diaphragm against ram-air pressure. In flight, ram air from the right pitot head creates the pressure on the diaphragm. This pressure increases with airspeed, increasing the resistance to control stick movement. When the airplane is not moving, there is no differential pressure in the bellows and no bellows resistance to control stick movement; however, elevator "feel" is provided by a spring within the bellows. Additional feel on the control stick comes from a bobweight attached to the stick mechanism. When "G" forces are applied to the airplane, the bobweight tends to move the stick toward the position of one "G" flight. The stick force increases as the "G" force becomes greater.

## FLIGHT CONTROL TRIM SYSTEM.

The control stick or pedal forces can be relieved by use of the trim system. The ailerons and elevator are trimmed by electric motors that mechanically change the relationship between the "feel" mechanism and the control system to reduce stick force to zero. The trim system operates directly on the control force


**Figure 1-28.**

producers and no trim tabs are used on the control surfaces. Aileron and elevator trim is accomplished by moving the aileron and elevator trim switch on the control stick grip. Limit switches are provided on the elevator trim mechanism to prevent serious overtrim if the switch should stick. Aileron trim travel is 6 degrees each way from neutral. Elevator trim travel is 11 degrees up and 10 degrees down. The rudder is normally trimmed automatically through the sideslip stability augmenter. The rudder may also be trimmed manually in emergencies by rotating the rudder trim knob either left or right. The rudder can be manually trimmed up to 5 degrees each way from neutral. Manual rudder trim should be used only when the sideslip stability augmenter system is inoperative.

### Aileron and Elevator Trim Switch.

The aileron and elevator trim switch (figure 1-28) on the pilot's control stick grip can be moved up or down for elevator trim and left or right for aileron trim. This switch, operating on 28-volt dc, controls electrical trim motors that reduce the stick force to zero, within trim limits, at a chosen aileron or elevator position.

**WARNING**

The aileron and elevator trim switch is spring-loaded to the NEUTRAL position; however, it should be returned to NEUTRAL manually to preclude the possibility of the switch sticking in the actuated position and causing a dangerous overtrim condition in case of malfunction of the limit switches.


**Figure 1-29.**

**Note**

The ailerons and elevator cannot be trimmed unless both hydraulic power and 28-volt d-c electrical power are available.

**Electrical Rudder Trim Knob.**

A rudder trim knob (figure 1-29), located on the sideslip stability augmenter control panel on the pilot's left console, provides a means of trimming the rudder manually. Hydraulic pressure, 115-volt single-phase ac, and 28-volt dc are required for effective use of the knob. The knob is safetied in the NEUTRAL position and is used only as an alternate means of trimming the rudder in case of malfunction of the autotrim feature of the sideslip stability augmenter. A rudder travel of 5 degrees in each direction can be obtained by rotation of the knob, which changes the position of the rudder servo with respect to the normal pedal position. When the rudder trim knob is rotated clockwise, the rudder deflects to the right. When the rudder trim knob is rotated counterclockwise, the rudder is deflected to the left. To use this trim knob, the rudder trim switch is moved to MANUAL TRIM position and the trim knob is rotated, to the right or left as required, with sufficient force to break the light safety wire.

**Rudder Trim Switch.**

A rudder trim switch (figure 1-29), on the sideslip stability augmenter control panel is for selecting either of two methods of trimming the airplane directionally through the sideslip stability augmenter system. This switch operates on 28-volt dc and has positions marked AUTO TRIM and MANUAL TRIM. When the switch is at AUTO TRIM, the airplane is automatically kept in directional trim. When the switch is moved to MANUAL TRIM position, directional trim is accomplished through a rudder trim potentiometer and the rudder centering mechanism by turning the rudder trim knob to the right or left as required.

**Note**

- The rudder cannot be trimmed unless hydraulic power, 28-volt d-c electrical power, and 115-volt essential bus power are available.
- At low indicated airspeeds, normally associated with takeoff, landing, and cruise at extreme altitudes, a pressure switch (in the landing gear warning system) overrides the

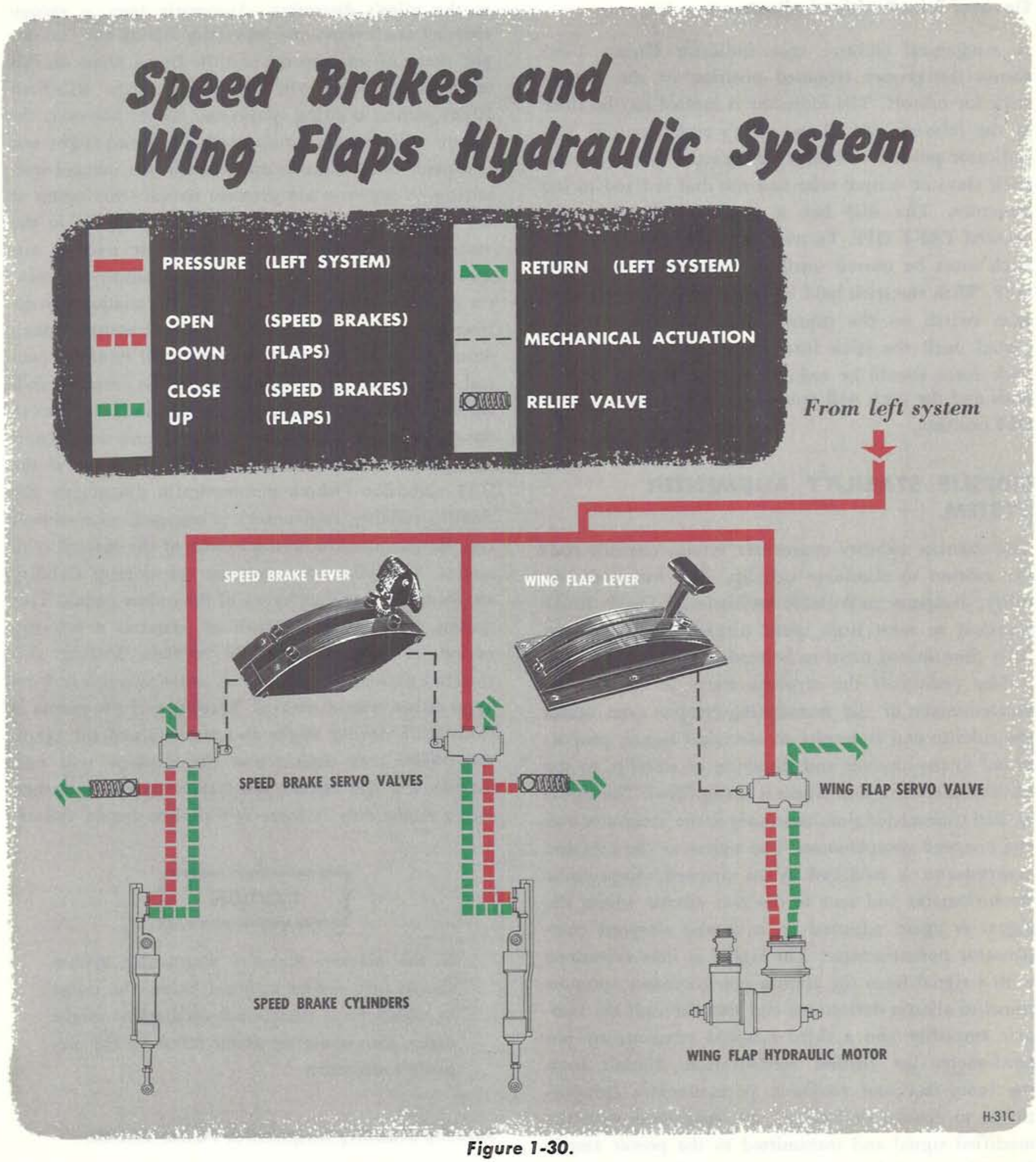



*Figure 1-30.*

AUTO TRIM position of the rudder trim switch. This action takes place automatically when the airspeed drops below 165 knots IAS; then the system returns to normal when the airspeed builds up to 180 knots IAS. The rudder trim switch itself does not move, as the pressure switch is in sequence with it. During the time that the autotrim feature is not in operation, electrical manual trim will be available through the sideslip stability augmenter system just as though the rudder trim switch were placed in MANUAL TRIM position. This automatic switching in and out of autotrim is to prevent undesirable oscillations that might occur with the autotrim feature operating at low indicated airspeeds.

### Elevator Trim Position Indicator.

A mechanical elevator trim indicator (figure 1-29) shows the proper trimmed position of the control stick for takeoff. The indicator is located on the floor at the inboard side of the pilot's right console. The indicator pointer is connected directly to the control stick elevator torque tube and the dial is fixed to the structure. The dial has a luminous circular spot marked TAKE OFF. To trim the stick for takeoff, the stick must be moved until the pointer is at TAKE OFF. With the stick held in this position, the elevator trim switch on the control stick grip must be actuated until the stick force is reduced to zero. The stick force should be reduced to zero within 10 seconds and the stick will remain at the indicated TAKE OFF position.

## SIDESLIP STABILITY AUGMENTER SYSTEM.

The sideslip stability augmenter system controls rudder motion to eliminate sideslip. This improves stability, dampens undesirable oscillations (Dutch Roll) common to most high speed airplanes, and permits fully coordinated turns to be made without use of the rudder pedals. If the airplane starts to sideslip, an accelerometer of the mass-spring-damper type senses the sideslip and transmits an electrical signal, proportional to the amount and direction of sideslip, to the electronic control unit where it is amplified. The signal is then transmitted simultaneously to the integrator and the airspeed compensator. The signal to the airspeed compensator is modified by an airspeed compensator potentiometer and sent to the rate circuit where the signal is again adjusted by a second airspeed compensator potentiometer. The signal is then combined with a signal from the aileron potentiometer (proportional to aileron deflection) and sent through the summer amplifier and a third airspeed compensator potentiometer for further modification. Signals from the integrator and feedback potentiometer (proportional to rudder deflection) are combined with the modified signal and transmitted to the power amplifier. The signal from the power amplifier controls an electrohydraulic valve, that in turn controls the rate and direction of hydraulic fluid flow to the rudder power cylinders. The power cylinders then move the rudder (without moving the rudder pedals) the amount required to counteract the lateral acceleration. The sideslip stability augmenter can be operated selectively either in automatic trim or in manual trim at the pilot's discretion. Automatic trim is recommended at all times and especially during the "on-target" stage of interception and the firing phase. In this setting the system will produce the most stabilized flight path at cruising speeds and above; however, the system will provide satisfactorily stabilized flight and is capable of continuous operation in the manual trim setting. A sensitive air pressure switch (that opens at 165 knots and closes at 180 knots) is included in the autotrim circuit, eliminating automatic trim at airspeeds below 165 knots. If the sideslip stability augmenter should fail completely in flight, the rudder may deflect as much as 5 degrees either side of neutral (maximum system authority). The rudder will return to neutral, however, within 60 seconds after the sideslip stability augmenter system is turned off. If a failure occurs in the automatic trim portion of the electronic control unit and power is still available to the system, or if the E-11 autopilot (which automatically disconnects the sideslip stability augmenter) is engaged, trim control may be obtained through selection of the manual trim system. The pilot may override the sideslip stability augmenter at any time by use of the rudder pedals. This system, powered by 115-volt ac, requires a warmup period of approximately 30 seconds. During this warmup period, the rudder may move as much as 5 degrees either side of neutral. Therefore, if the system is turned off during flight and then turned on again, the rudder may deflect and the airplane will yaw sharply. For this reason, the system should be turned off in flight only if there is complete system failure.

**CAUTION**

If the sideslip stability augmenter system should fail, reduce airspeed below the range in which large directional oscillations might occur, thus avoiding undue stress on the airplane's structure.

### Sideslip Stability Augmenter Power Switch.

A two-position PWR ON, PWR OFF switch (figure 1-29), located on the sideslip stability augmenter control panel, controls the single-phase a-c power that operates the sideslip stability augmenter system. The switch is guarded in the PWR ON position and should be left in that position at all times during flight unless the entire sideslip stability augmenter system fails. If this occurs, the switch should be placed at PWR OFF.


*Figure 1-31.*

## WING FLAP SYSTEM.

The slotted wing flaps operate on hydraulic power from the left hydraulic system (see figure 1-30). A wing flap lever on the pilot's left console is connected by cables to the wing flap servo valve mechanism which controls the direction of fluid flow to a hydraulic motor. Four jackscrew actuators, driven by the hydraulic motor through a series of torque tubes, move the flaps to the desired position. The flaps operate together. Flap travel is 50 degrees down from the wing reference plane. There is no emergency system for operating the wing flaps; however, with the supplemental hydraulic pump in operation, the flaps can be operated from this pressure source if the left engine-driven hydraulic pump fails.

### WING FLAP LEVER AND POSITION INDICATOR.

The wing flap lever and position indicator (figure 1-31) are located on the pilot's left console. The lever provides a means of moving the wing flaps to any desired position and can be pre-positioned at TAKE OFF (flap 30 degrees down), DOWN (flap 50 degrees fully down), and UP. As the wing flaps travel, the indicator gives visual indication of the flap position at any time during travel. Although the wing flaps can be pre-positioned only to the three detent positions, they can be placed at intermediate positions by holding the wing flap lever in the desired position until the indicator shows the flaps to be in that position. The lever can then be released and the flaps will remain in position until the lever is moved again. Retraction of wing flaps from the TAKE OFF to the UP position requires approximately 10 seconds.

## SPEED BRAKE SYSTEM.

The trailing section of each aileron splits through the chord line to form two surfaces. The two surfaces, hinged at the front, open to a V when used as a speed brake. Each speed brake is operated by a hydraulic cylinder powered by the left hydraulic system. Flow to the cylinders is regulated by the speed brake lever in the pilot's cockpit through cables and servo valves. Speed brakes may blow open if the airplane is parked in a tailwind when external speed brake locks have not been installed. There is no emergency system for operating the speed brakes; however, with the supplemental hydraulic pump in operation, the speed brakes can be operated from this pressure source if the left engine-driven hydraulic pump fails.

**SPEED BRAKE LEVER.**

The speed brake lever (figure 1-32), located on the pilot's left console, has OPEN and CLOSED positions and controls the position of the speed brakes. When the speed brake lever is moved, the speed brakes open together proportionally to lever movement. The lever can be stopped at any point between OPEN and CLOSED to give intermediate positioning of the speed brakes. At indicated airspeeds up to approximately 260 knots, the speed brakes can be fully opened (120 degrees included angle). At indicated airspeeds above 260 knots, the lever can be pre-positioned at any setting so long as the lever is moved toward a more fully open position, but the angle to which the speed brakes will open will be decreased in proportion to the increased airspeed. The speed brakes cannot be pre-positioned toward the CLOSED position. The speed brake lever must be pushed forward manually as the speed brakes close. If airspeed is above 260 knots, the airload on the speed brakes applies back pressure on the actuating cylinders in excess of the hydraulic system pressure and prevents full opening of the speed brakes. As airspeed is reduced, speed brakes will open to the position preset by the lever.

## LANDING GEAR SYSTEM.

The airplane has a tricycle landing gear which operates on power from the left hydraulic system and is controlled in normal operation by the landing gear lever in the pilot's cockpit. The main gear retracts inboard into the wing and the nose gear retracts vertically into the fuselage. A selector valve, a sequence valve, and actuating cylinders extend and retract the landing gear and the main landing gear inboard doors. The selector valve, attached by mechanical linkage to the pilot's landing gear lever, directs the flow of hydraulic fluid in the actuating cylinders to raise and lower the landing gear and operate the main landing gear inboard doors. The sequence valve reverses the action of the hydraulic pressure in the actuating cylinders of the inboard doors to synchronize the opening and closing of the inboard door with the retraction and extension of the main landing gear. If the pressure in the left hydraulic system drops below 1450 psi, a priority valve closes to give the flight control system priority over the landing gear system by shutting off the flow of fluid through the landing gear selector valve. Independent air bungee systems aid normal and emergency extension of the landing gear. Landing gear extension or retraction normally takes 6 seconds; however, when the engine rpm is below 80%, additional time may be required. The pilot can reverse the normal landing gear cycle at any time with a reverse movement of the landing gear lever. Hydraulic pressure is automatically relieved when all landing gear components are up and locked; a hydraulic shutoff valve, spring-loaded to open, operating on 28-volt dc, and controlled by microswitches, closes and shuts off the hydraulic pressure to the selector valve. Pressure is reapplied if any uplocks accidentally open during flight. On airplanes

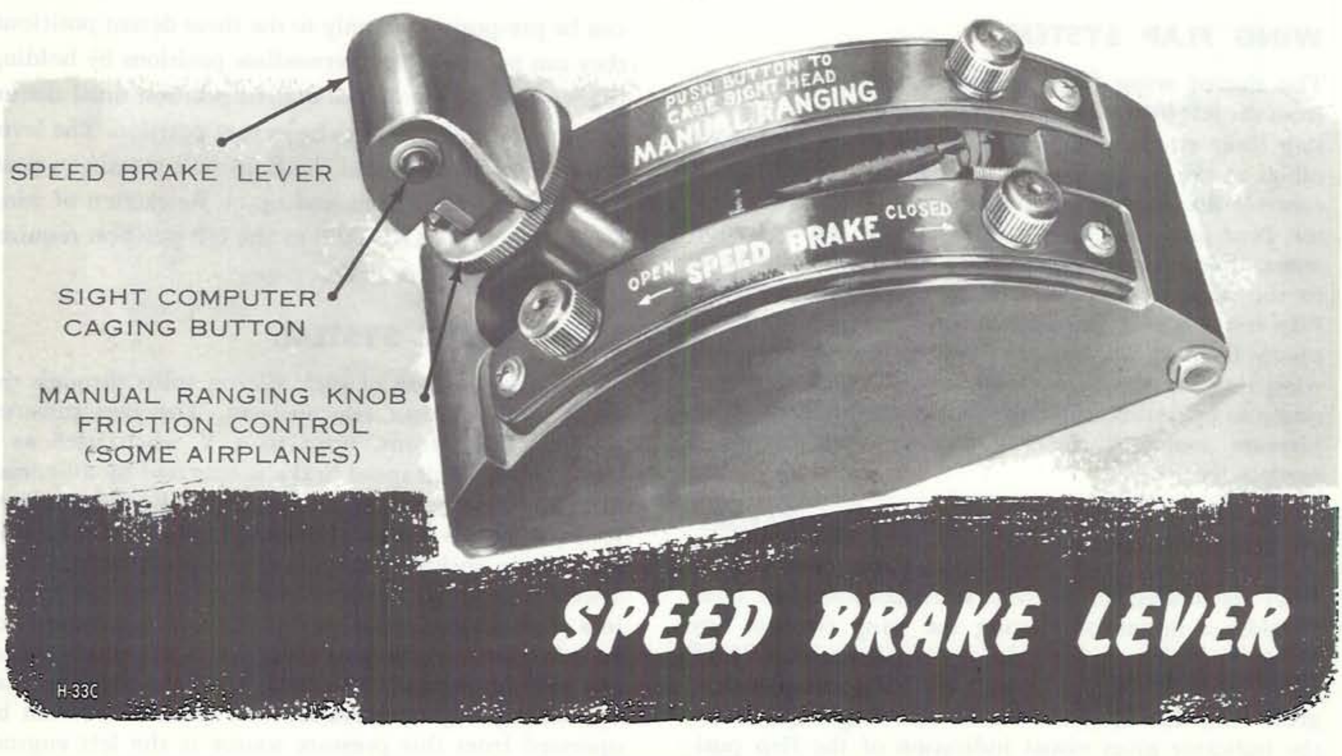



*Figure 1-32.*

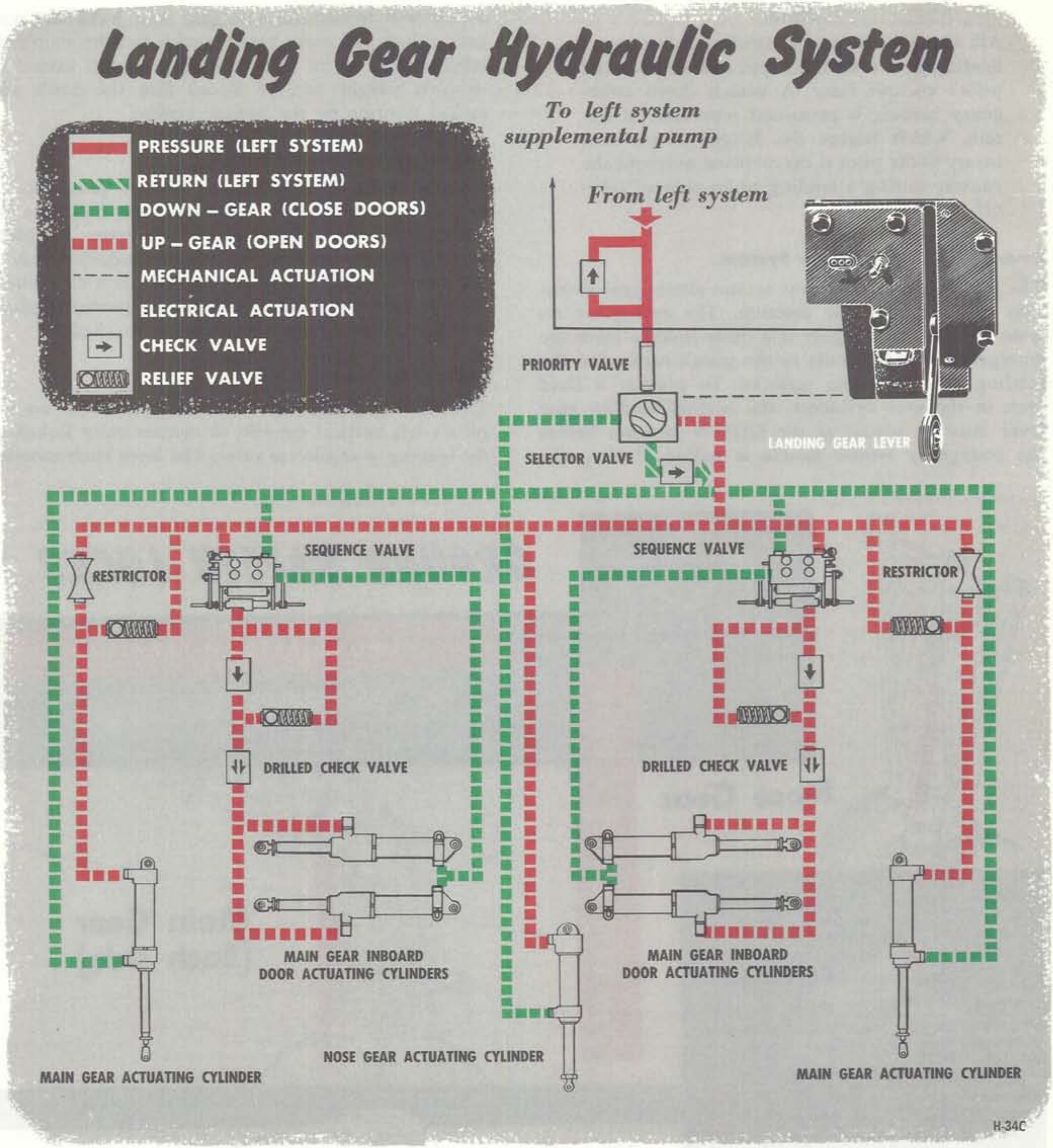



*Figure 1-33.*

modified in accordance with T.O. 1F-89-639, the landing gear system solenoid shutoff valve has been removed, allowing full system pressure to be applied to the main gear, nose gear, and main gear inboard doors at all times. This ensures that the inboard main landing gear doors are completely up and locked before the main landing gear indicators indicate an UP and locked position. When retracted, the landing gear is completely enclosed by doors. The nose gear doors are operated mechanically by the nose gear truss. Each main gear outboard door moves with the strut. Each main gear inboard door is operated hydraulically by two actuating cylinders and the sequence valve; the door closes and locks after the main gear is extended. If the landing gear lever is moved from one position to the other before completion of extension or retraction, a transfer piston on the sequence valve moves the sequence valve to keep the main landing gear inboard door open until the gear completes its movement in the changed direction.

**Note**

All airplanes have a controlled failure nose landing gear drag brace pin and a reinforced pilot's cockpit floor. A wheels down emergency landing is permitted regardless of terrain, which lessens the danger of personal injury to the pilot if the airplane overruns the runway during a landing or an aborted take-off.

**Emergency Landing Gear System.**

The emergency landing gear system allows gear extension without hydraulic pressure. The emergency release for the landing gear is a cable linkage from the emergency release handle in the pilot's cockpit to the landing gear and door uplocks. To prevent a fluid lock in the gear cylinders, the normal landing gear lever must be placed at the DOWN position before the emergency release handle is pulled. Pulling the handle will release the nose gear door locks, the nose gear uplock, the main gear uplocks, and the main gear inboard door locks. The landing gear will extend of its own weight and be forced into the down and locked position by the bungee system.

**Landing Gear Ground Locks.**

Ground safety locks (figure 1-34) are provided for the main landing gear. The main gear locks are installed between the hinge end of the lower side brace and the point where the actuating cylinder attaches to the strut. The nose gear ground lock is a clip which slips over the downlock cylinder and is pinned in place. All ground locks have red streamers attached.

**LANDING GEAR LEVER.**

The landing gear lever (figure 1-35), located on the pilot's left vertical console, is mechanically linked to the landing gear selector valve. The lever knob contains

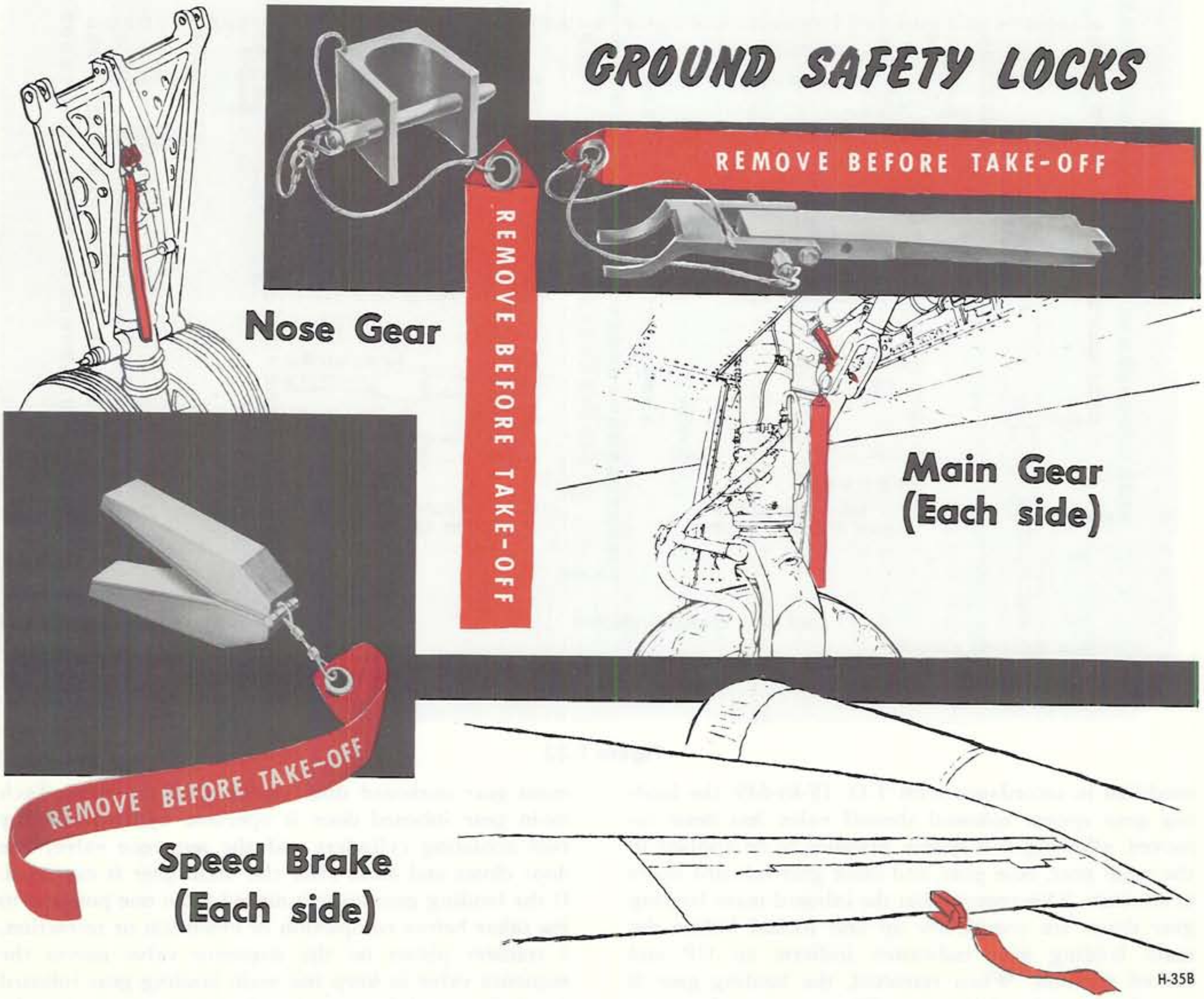



*Figure 1-34.*

# LANDING GEAR CONTROLS

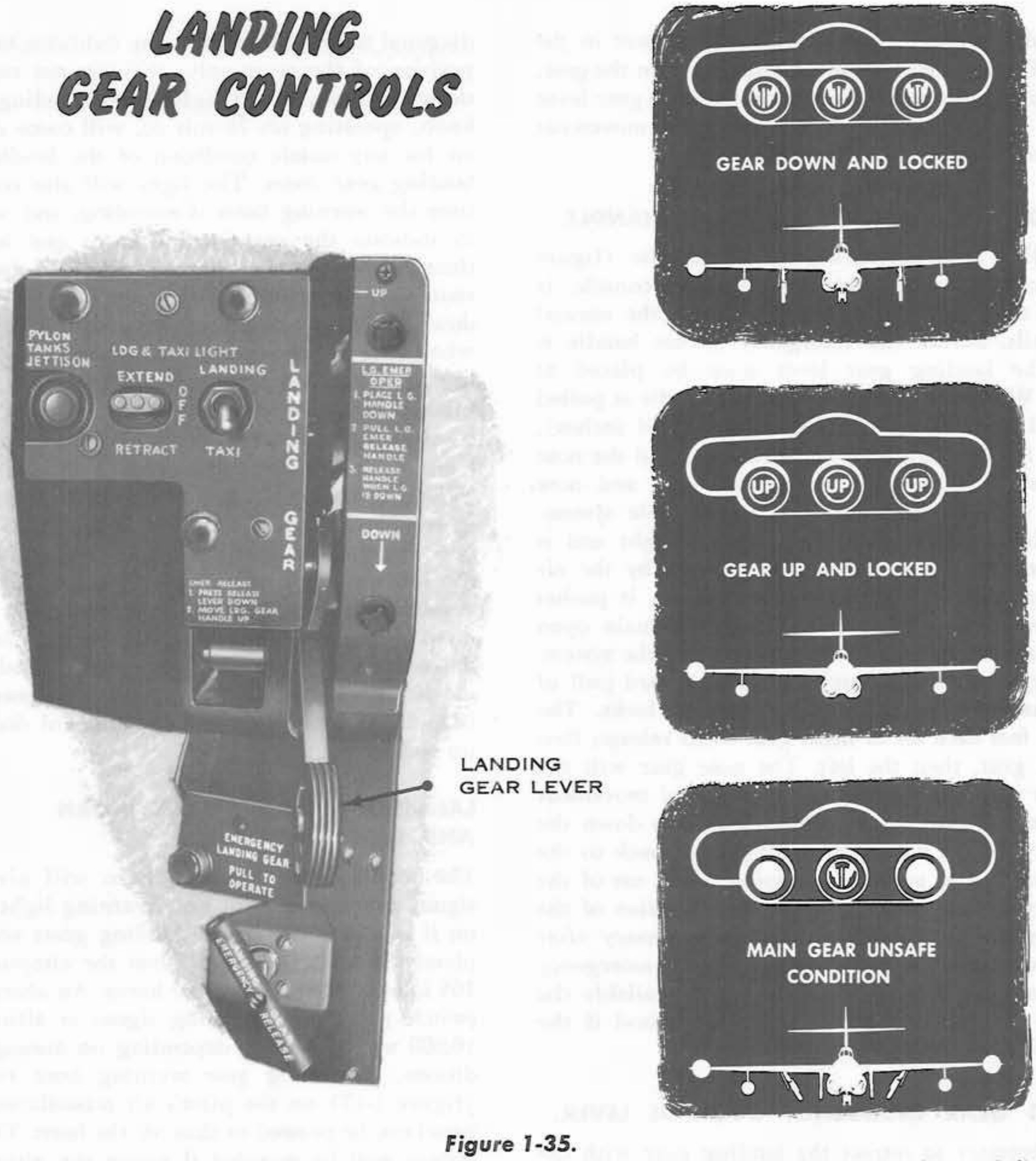



Figure 1-35.

a red light that indicates an open gear door or an unsafe gear position for landing. When the lever is moved to the DOWN position, the nose gear door locks are opened mechanically and slightly in advance of the nose gear uplock. The nose gear uplock switch for the electrically operated hydraulic shutoff valve opens the circuit to the shutoff valve. The valve opens and allows system pressure through to the priority valve and the selector valve. On airplanes modified in accordance with T.O. 1F-89-639, the hydraulic shutoff valve has been removed, allowing full system pressure to be applied to the main gear, nose gear, and main gear inboard doors at all times. Hydraulic power is supplied simultaneously to the actuating cylinders of the nose gear, main gear, and inboard doors. As the main landing gear inboard door cylinders are compressed, the door locks release and the door opens, releasing the outboard door locks. Final movement of the inboard doors releases main gear uplocks through a cable system. Final movement of the main gear actuates the sequence valves and reverses the flow of fluid to the inboard door actuating cylinders, causing the inboard door to close and lock. As the nose gear extends, the nose gear doors are moved to the open position. When the landing gear lever is moved to the UP position, the nose gear downlock releases. The inboard door cylinders compress, releasing inboard door locks and opening the doors. As the doors reach the open position, the main landing gear actuating cylinders release the main gear downlocks and all three landing gear actuating cylinders simultaneously retract the nose and main gears. As the nose gear retracts, the nose gear truss engages the nose gear door operating mechanism and the doors close and lock. The main gear outboard door is closed by the action of the main gear shock strut. As the main gear enters its uplocks, the sequence valve is actuated and reverses the flow of fluid to the inboard door actuating cylinders, closing and locking the doors. When all the doors lock, the microswitches for the hydraulic shutoff valve are actuated. The circuit is energized and the shutoff valve closes, relieving the pressure in the system. When the weight of the airplane is on the gear, a solenoid plunger safety lock in the landing gear lever quadrant automatically prevents accidental movement of the gear lever to the UP position.

### LANDING GEAR EMERGENCY RELEASE HANDLE.

The landing gear emergency release handle (figure 1-35), located on the pilot's left vertical console, is provided to lower the landing gear when the normal system fails. Before the emergency release handle is pulled, the landing gear lever must be placed at DOWN. When the emergency release handle is pulled to its full limit of travel (approximately 14 inches), the locks for the main gear inboard doors and the nose gear doors, and the uplocks for the main and nose gear are opened mechanically by the cable system. The landing gear extends of its own weight and is forced into the down and locked position by the air bungee systems. As the main gear extends, it pushes the inboard doors open, and the doors remain open until hydraulic pressure is again applied to the system. The emergency release handle requires a hard pull of approximately 80 pounds to release the locks. The pilot can feel each set of main gear locks release; first the right gear, then the left. The nose gear will not be felt as it is unlocked by the downward movement of the landing gear lever. After the gear is down the emergency release handle must be guided back to the stowed position to prevent whipping. Since use of the emergency system does not affect the operation of the normal system, no readjustments are necessary after the landing gear has been lowered by the emergency system; as soon as hydraulic pressure is available the gear may be operated by the normal method if the malfunction was temporary.

### LANDING GEAR EMERGENCY OVERRIDE LEVER.

If it is necessary to retract the landing gear with the airplane on the ground, or if the solenoid plunger safety lock fails, an emergency override lever (figure 1-35) releases the lock. When the airplane is on the ground, the safety lock holds the landing gear lever in the DOWN position to prevent accidental retraction of the landing gear. The lock is automatically retracted when the weight of the airplane is off the wheels. The gear lever can be released in an emergency by holding the override lever down while moving the gear lever up.

### LANDING GEAR POSITION INDICATORS.

A landing gear position indicator (figures 1-8 and 1-35) on the pilot's instrument panel shows the position of each gear. When a gear is down and locked, a wheel will show in a small window corresponding to that gear. When a gear is up and locked, UP will appear in a window. If a gear is unlocked or in an unsafe condition or if the 28-volt d-c power is off, red and cream diagonal stripes will show. The indicator tabs give the position of the gears only; they are not controlled by the gear doors. A red light in the landing gear lever knob, operating on 28-volt dc, will come on and stay on for any unsafe condition of the landing gear or landing gear doors. The light will also come on any time the warning horn is sounding, and will stay on to indicate the gear is not down and locked even though the warning horn is shut off by the reset switch. If the light is indicating that the gear is not down at low airspeed and low altitude, it will go off when either airspeed or altitude is increased. The landing gear lever warning light will remain on until the inboard main gear doors are retracted, even if the gear is safe. For this reason, the gear position indicators and a visual check for safe main gear should be relied upon following emergency gear drop. On airplanes modified in accordance with T.O. 1F-89-639, microswitches have been installed between the aft main gear door locks in the left and right gear wells to ensure that both inboard main landing gear doors are locked before the main landing gear indicators indicate an UP and locked position. On airplanes so modified an unsafe condition will be shown on the landing gear indicators if both the main gear and the inboard doors are not up and locked.

### LANDING GEAR WARNING HORN AND RESET BUTTON.

The landing gear warning horn will give a steady signal and the landing gear warning light will come on if one or more of the landing gears are not completely down and locked when the airspeed drops to 165 knots, plus or minus 10 knots. An altitude-sensing switch prevents a warning signal at altitudes above 10,000 to 13,000 feet, depending on atmospheric conditions. A landing gear warning horn reset button (figure 1-17) on the pilot's aft miscellaneous control panel can be pressed to shut off the horn. The warning system will be recycled if either the altitude or the airspeed is increased above the warning range or if the landing gear is extended. If the pilot does not use the reset button, the horn will stop blowing automatically when the airspeed reaches approximately 175 knots. On airplanes modified in accordance with T.O. 1F-89-627, the landing gear warning horn has been removed and replaced with an audible warning signal unit. If the landing gear has not extended and locked properly on airplanes so modified, a warning signal will be audible over the pilot's headset. Operation and control of the audible warning signal unit is the same as for the landing gear warning horn which it replaces.

**Note**

A quick check of the indicator light in the landing gear lever knob can be made when the gear is down and locked. Pressing the warning horn reset button will cause the indicator light to come on.

## NOSE WHEEL STEERING SYSTEM.

The dual nose wheel is equipped with a steering system controlled by rudder pedal action. (See figure 1-36.) The purpose of the system is to provide directional control during taxiing and takeoff only. Hydraulic pressure for the system is controlled by a solenoid shutoff valve operated by a button on the control stick grip. When the shutoff valve is open, a servo valve, mechanically controlled by the rudder pedals, directs pressure, according to the direction of rudder pedal displacement, to a vane-type actuator which turns the nose wheel strut. A mechanical followup device returns the servo valve to neutral when the nose wheel reaches the displacement dictated by rudder pedal deflection. The first 50 percent of rudder pedal displacement causes the nose wheel to rotate only 6 degrees from center. The remaining 50 percent of rudder pedal travel rotates the nose wheel through the remaining 40 degrees of angular displacement. When the nose wheel steering system is not being used (shutoff valve closed), a bypass valve is open to permit free flow of hydraulic fluid between both sides of the vane-type actuator, thus allowing the nose wheel to swivel. Both steering and swivel range of the nose wheel is 46 degrees each side of the centered position. A limit switch on the nose gear scissors closes the shutoff valve and opens the bypass valve when the weight of the airplane is taken off the nose gear strut, allowing it to extend. This allows the nose gear to swivel so that the centering cam will center the nose wheel for landing gear retraction and extension. Nose wheel steering may be selected at any time during taxiing and takeoff (assuming that the weight of the airplane is on the nose wheel regardless of the relative positions of the nose wheel and rudder pedals. If the nose wheel position does not correspond with the position of the rudder pedals when nose wheel steering is selected, the nose wheel will turn to correspond to the rudder pedal position. The system operates on pressure from the left hydraulic power supply system. Electrical components are powered by the 28-volt d-c bus.

### NOSE WHEEL STEERING AND SUPPLEMENTAL HYDRAULIC PUMP BUTTON.

A spring-loaded nose wheel steering button (figure 1-28) on the control stick grip controls the 28-volt d-c shutoff valve and the actuator bypass valve in the hydraulic steering system and the left hydraulic system supplemental pump. When the button is pressed, the shutoff valve opens, the bypass valve closes, the supplemental pump starts, and hydraulic pressure is supplied to the system. Subsequent movement of the rudder pedals will then turn the nose wheel in the direction and to the degree desired. The button must be held

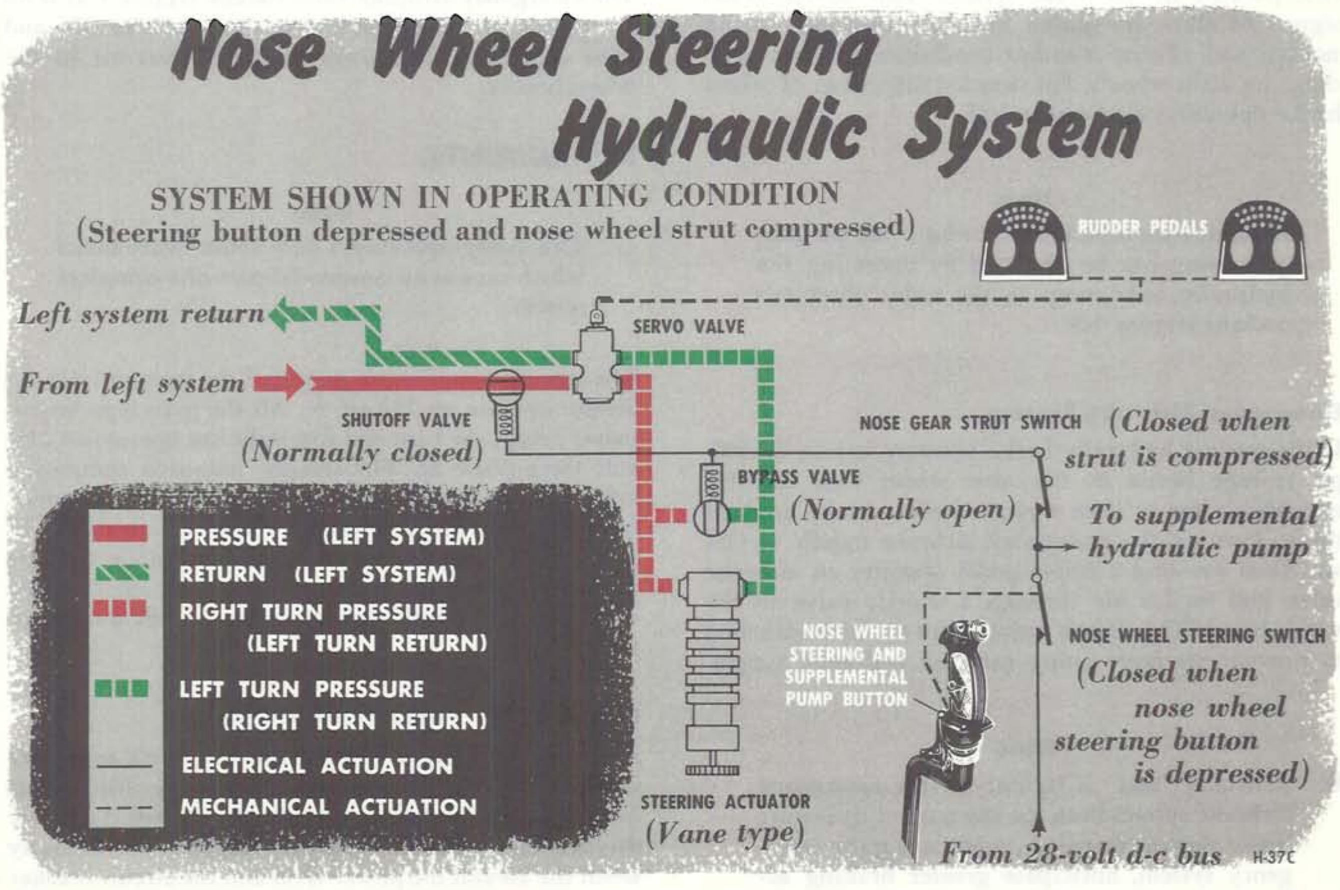



*Figure 1-36.*

depressed during nose wheel steering operation. When the button is released, the shutoff valve closes, the bypass valve opens, and the nose wheel swivels freely. A limit switch on the nose gear scissors overrides the steering button and prevents the steering system from operating when the weight of the airplane is not on the nose gear. However, pressing the button in flight will still start the supplemental pump to augment left hydraulic system pressure.

## BRAKE SYSTEM.

The main gear wheel brakes operate hydraulically using pressure from the left hydraulic system and brake accumulator which is pressurized by the left hydraulic system. The power brake valves, operated by depressing the brake pedals, individually meter fluid to the wheel brakes. If the left hydraulic system fails, brakes can be operated a limited number of times by the pressure in the brake accumulator. In an emergency when the accumulator pressure is gone, an emergency airbrake is available. (See figure 1-37.) A normally open pressure switch in the brake accumulator closes when pressure drops to between 1100 to 800 psi (or below). The switch starts the supplemental pump to replenish braking pressure. On airplanes modified in accordance with T.O. 1F-89H-522, an antiskid braking device is incorporated in the brake system. This device is designed to allow maximum braking efficiency during normal and adverse weather conditions without skidding the main wheels. For detailed discussion of wheel brake operation see Section VII.

**Note**

Enough hydraulic brake pressure for parking or towing can be obtained by operating the hydraulic handpump in the radar observer's cockpit (figure 4-8).

### Emergency Airbrake System.

If the normal hydraulic brake pressure is lost, a 1500-psi storage bottle in the nose wheel well contains enough air for at least three complete brake applications. Turning the emergency airbrake handle to ON and then pressing a brake pedal operates an airbrake valve and meters air through a shuttle valve to the wheel brake. The shuttle valve closes the hydraulic line to prevent air from going into the hydraulic system.

**Note**

- Artificial "feel" is lighter for the emergency airbrake system than for the normal hydraulic brake system; therefore, when using the emergency system, anticipate greater braking action for a given pedal pressure.
- If both emergency airbrake and brake accumulator pressures are applied to the system simultaneously, more pedal pressure will be required for the same amount of braking because the artificial "feel" for both systems must be overcome at the same time.

### BRAKE PEDALS.

The brake pedals are the conventional, toe-operated type. Each pedal controls a hydraulic power brake valve and an air power brake valve. When the pedals are pressed, all four valves open and either air or hydraulic pressure, or both, supply the braking action to the wheels. "Feel" will be absent unless pressure is available to one of the power brake valves. Application of both air and hydraulic pressure increases the pedal pressure required to obtain the same braking result.

### PARKING BRAKE LEVER.

The parking brake lever (figure 1-11) is located on the pilot's center pedestal. Pulling up on the parking brake lever while depressing the brake pedals sets the parking brakes. The parking brakes are released by manually releasing the parking brake lever slowly while depressing the brake pedals.

### EMERGENCY AIRBRAKE VALVE HANDLE.

The emergency airbrake valve handle (figure 1-9) is on the pilot's left console. Turning the handle to ON, and then depressing the brake pedals, meters air to the wheel brakes.

## INSTRUMENTS.

**Note**

This paragraph covers only those instruments which cannot be considered part of a complete system.

The free air temperature gage and the turn and slip indicator operate on 28-volt dc. All the gyro-type instruments except the turn and slip indicator operate on 115-volt three-phase ac. The standby magnetic compass, a self-contained unit of conventional type, is suspended from the windshield structure above and to the right of the pilot's instrument panel. This magnetic compass serves as a standby directional indicator in case the directional indicator (slaved) or the 28-volt d-c power fails.

### INSTRUMENT PANEL VIBRATORS.

An instrument panel vibrator on the pilot's and radar observer's instrument panels prevents the instruments from sticking. Each unit, a miniature 28-volt d-c motor driving an eccentric weight, operates continuously when the 28-volt d-c power is on and the circuit breaker is closed.

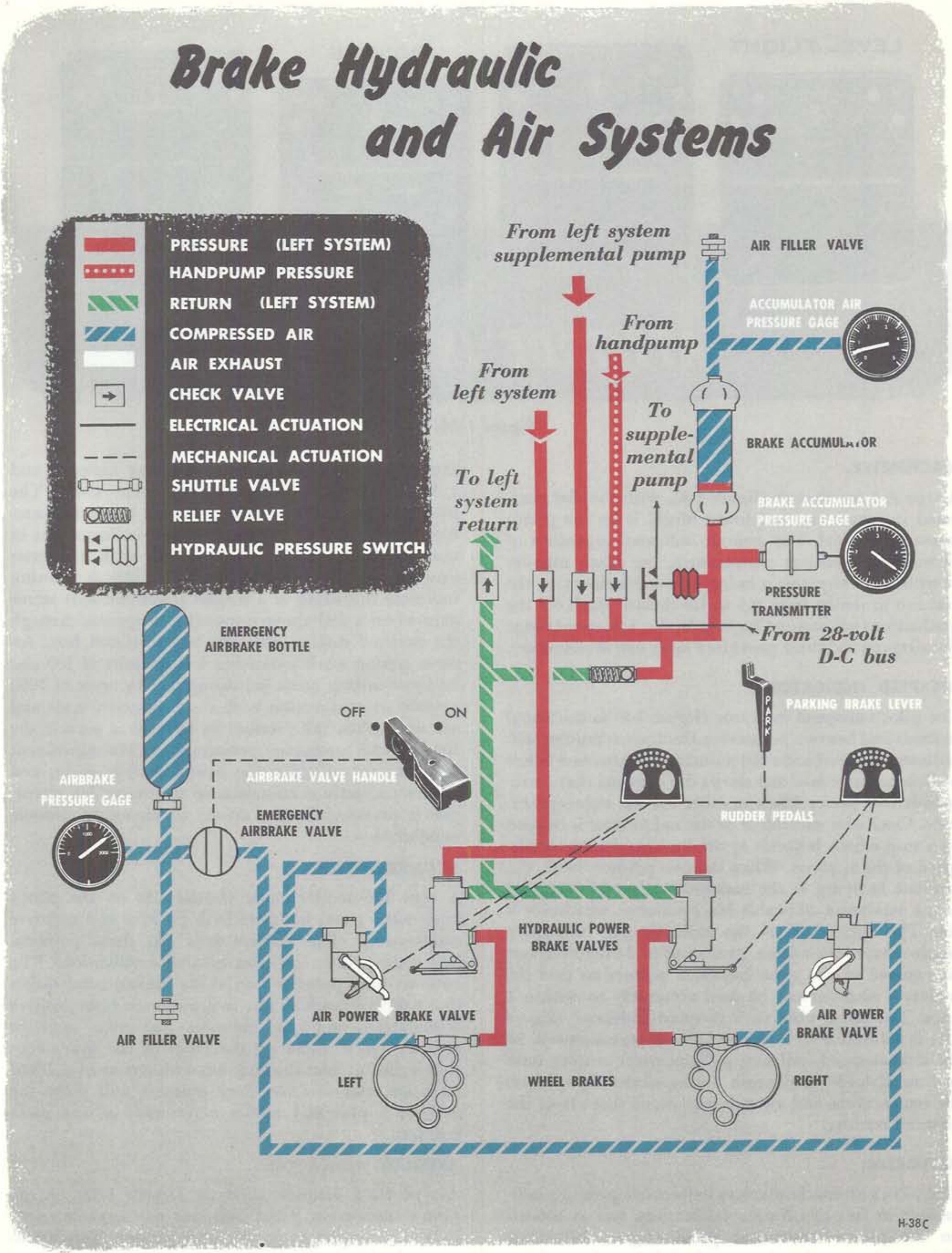

Brake Hydraulic and Air Systems
PRESSURE (LEFT SYSTEM)
HANDPUMP PRESSURE
RETURN (LEFT SYSTEM)
COMPRESSED AIR
AIR EXHAUST
CHECK VALVE
ELECTRICAL ACTUATION
MECHANICAL ACTUATION
SHUTTLE VALVE
RELIEF VALVE
HYDRAULIC PRESSURE SWITCH
From left system supplemental pump
AIR FILLER VALVE
ACCUMULATOR AIR PRESSURE GAGE
From handpump
From left system
To supple-mental pump
BRAKE ACCUMULATOR
To left system return
BRAKE ACCUMULATOR PRESSURE GAGE
PRESSURE TRANSMITTER
From 28-volt D-C bus
EMERGENCY AIRBRAKE BOTTLE
PARKING BRAKE LEVER
PARK
OFF
ON
AIRBRAKE VALVE HANDLE
AIRBRAKE PRESSURE GAGE
EMERGENCY AIRBRAKE VALVE
RUDDER PEDALS
HYDRAULIC POWER BRAKE VALVES
AIR POWER BRAKE VALVE
AIR FILLER VALVE
LEFT
WHEEL BRAKES
RIGHT
H-38C

Figure 1-37.

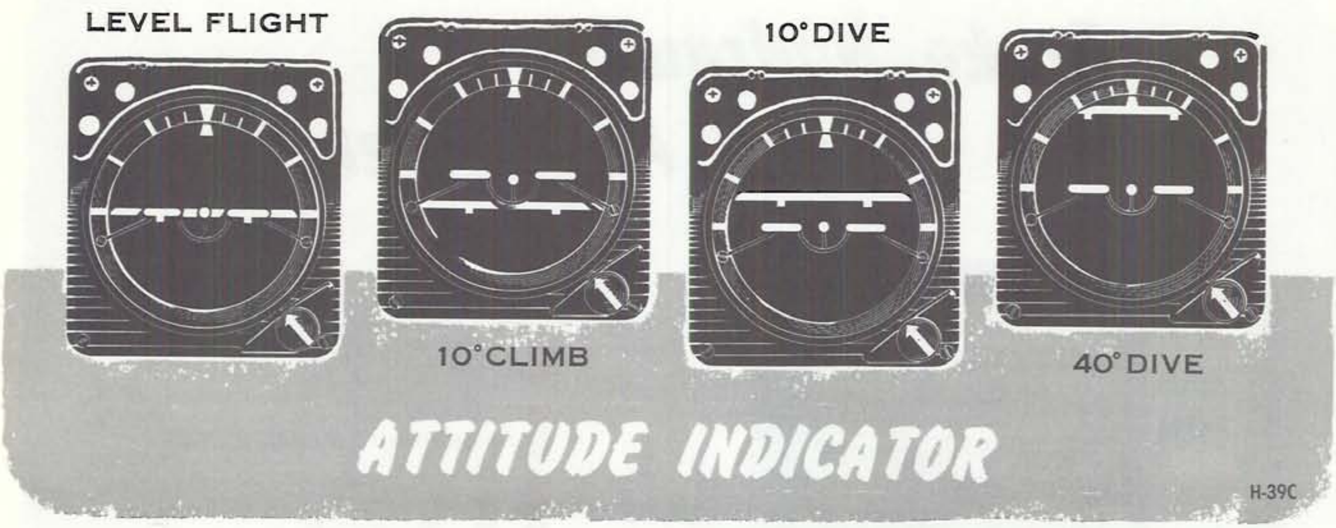



*Figure 1-38.*

## MACHMETER.

A type A-1 machmeter (figure 1-8), with the dial graduated in tenths and hundreths Mach, is on the pilot's instrument panel. The pointer indicates, regardless of altitude and ambient temperature, the Mach number at which the airplane is being flown. Numbers on the dial run in tenths from 0.3 to 1.0 (below Mach 0.3 the graduations are omitted because in this low-speed range the airspeed indicator provides a more useful reference).

## AIRSPEED INDICATORS.

The pilot's airspeed indicator (figure 1-8) is calibrated in knots and has two pointers: a fluorescent pointer that indicates airspeed and a red pointer with alternate bands of fluorescent white that shows the airspeed that corresponds to a preset Mach number for the existing altitude. Clockwise movement of the red pointer is limited by a stop which is preset at the limiting structural airspeed of the airplane. When the two pointers meet, the airplane is flying at the maximum allowable airspeed or the maximum allowable Mach number, whichever is less. The upper half of the indicator dial contains a window exposing a drum, graduated in 2-knot divisions and geared to the main indicator pointer so that the indicated airspeed can be read accurately to within 1 knot. The radar observer's airspeed indicator (figure 4-6) is calibrated in knots and shows true airspeed. In the true airspeed indicator a temperature-sensing bulb and an altitude diaphragm automatically compensate for temperature and altitude variations that affect the airspeed reading.

## ALTIMETER.

The pilot's altimeter displays barometric pressure indications in feet of altitude calibrations and is located on the pilot's instrument panel (figure 1-8). The altimeter has two hands, a notched disk with a pointer extension, two setting marks, a warning indicator and a barometric scale with an adjustment knob. The longer of the concentrically arranged hands indicates feet in units of 100, the shorter hand indicates feet in units of 1000, and the notched disk with a pointer extension indicates feet in units of 10,000. A warning indicator consisting of a striped (cross-hatched) sector painted on a dial above numeral five appears through the notched disk at altitudes below 16,000 feet. An outer setting mark indicating feet in units of 100 and an inner setting mark indicating feet in units of 1000 operate in conjunction with the barometric scale and are used when the pressure to be read is outside the limits of the barometric pressure scale. The adjustment knob is used to adjust the hands, setting marks, and barometric scale simultaneously to correct for atmospheric pressure changes caused by changing climatic conditions.

## ACCELEROMETER.

A type B-6 accelerometer (figure 1-8) on the pilot's instrument panel indicates both positive and negative accelerations. The accelerometer has three pointers. The main pointer indicates existing accelerations. The two auxiliary pointers stop at the highest acceleration that has been reached; one indicates maximum positive acceleration, and one indicates maximum negative acceleration. A knob on the front of the instrument case is used to reset the auxiliary pointers to zero. Until they are reset, the auxiliary pointers will show the maximum plus and minus movements of the main pointer.

## ATTITUDE INDICATOR.

A type B-1A attitude indicator (figure 1-38) on the pilot's instrument panel indicates the airplane's attitude with respect to an artificial horizon. The instrument obtains d-c power from the primary bus and a-c power from the instrument inverter. The B-1A indicator is noncaging and incorporates a zero-pitch trim knob that positions both the sphere and the horizon bar to the zero position. The pitch trim knob has a triangular mark for zero-pitch trim, three dots corresponding to a one-half inch deflection in the downward direction, and six dots corresponding to a 1-inch deflection in the upward direction. The indicator has a followup rate of 180 degrees per second in the pitch and bank axis. The indicator has a fast initial erection period, approximately 2 minutes ±30 seconds; but if the indicator tumbles in flight, erection may take 15 minutes. Included in the indicator is an electrically driven power warning flag that disappears from view when the indicator is up to full speed and the system is ready for operation. The 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 flag to appear, even though the system is not functioning properly. The instrument operates through 360 degrees of roll and through 164 degrees of pitch. The instrument is compensated for turn errors; however, the lower sensitivity limit of the turn-error compensating mechanism is 40 degrees per minute. Any turn made below 40 degrees per minute will result in turn errors common to other instruments. Turns made above 40 degrees per minute will be compensated for turn errors. In level flight, the maximum error in the indication of the airplane's attitude is less than one-half degree.

**WARNING**

- It is possible that a malfunction of the attitude indicator might be determined only by checking it with the directional indicator (slaved) and the turn and slip indicator.
- A slight amount of pitch error in the indication of the type B-1A attitude indicator will result from accelerations or decelerations. It will appear 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 will be most noticeable at the time the airplane breaks ground during the takeoff run. At this time a climb indication error of approximately one

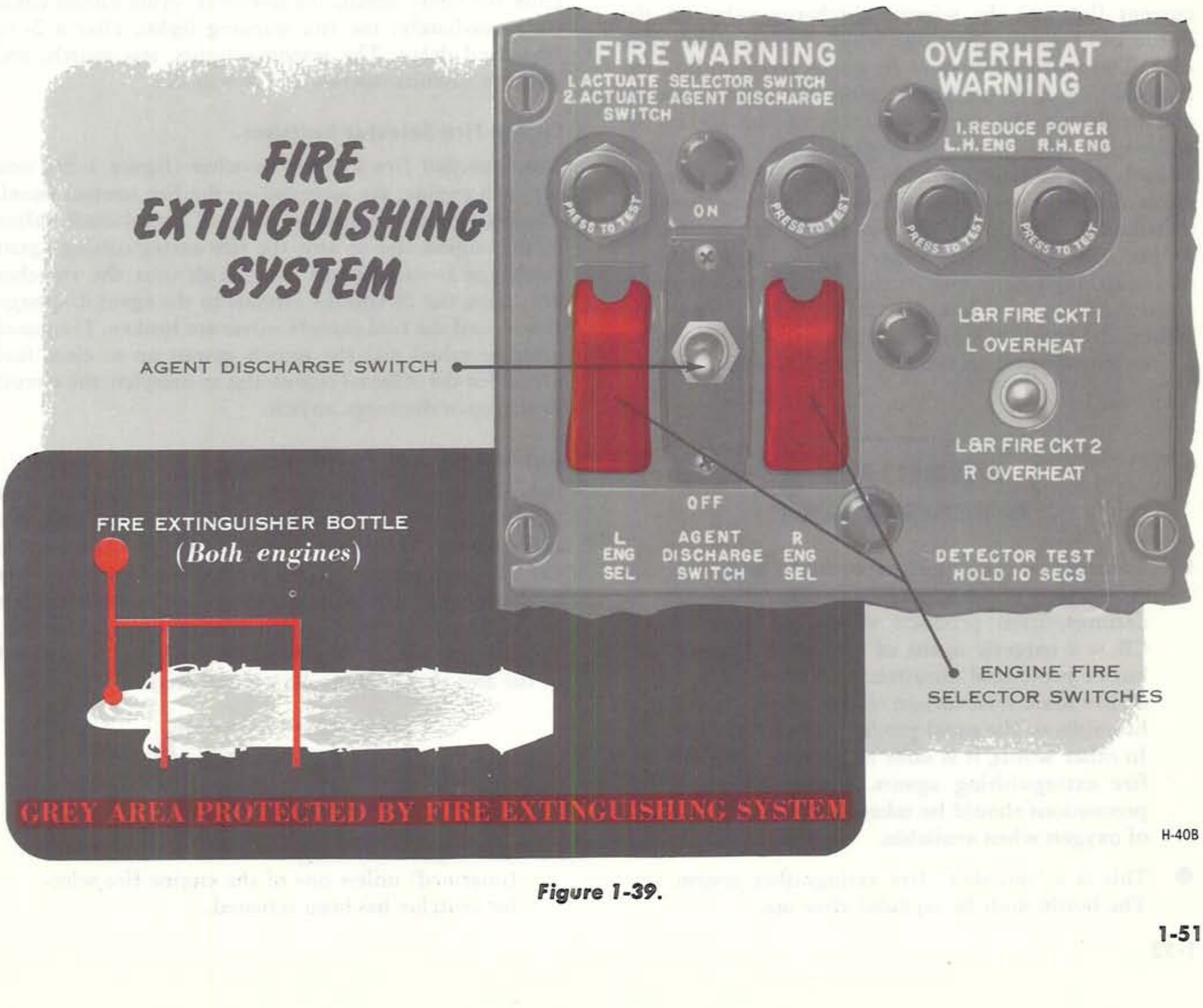



**Figure 1-39.**

and a half bar widths will normally be observed; however, the exact amount of error will depend upon the acceleration and elapsed time of each individual takeoff. The erection system will automatically remove the error after the acceleration ceases.

- If the power supply to the attitude indicator is interrupted, the instrument will be unreliable for 1 minute.

## EMERGENCY EQUIPMENT.

### FIRE EXTINGUISHING SYSTEM.

The fire extinguishing system has overheat detectors and fire detectors in each engine nacelle, and a single bromochloromethane extinguisher bottle in the nose wheel well with a discharge line to each engine. Two electrically fired, cartridge-operated, release valves and a pressure gage are assembled on the bottle. When either engine fire selector switch is placed in the up position, all fuel valves necessary to isolate the affected engine from its fuel supply close and the electrical circuit for the fire extinguishing system is armed. When the agent discharge switch is moved to ON, current flows to the selected discharge valve on the bottle and fires the cartridge which pierces a frangible disk. The bottle discharges its entire contents into the manifolding of the selected engine; the agent vaporizes and so dilutes the oxygen content of the air in the engine bay that it will no longer support combustion. If both fire selector switches are actuated before the agent discharge switch is actuated, the charge will be distributed to both engines but it will be insufficient to put out the fire in either engine. Both the fire extinguishing system and its controls operate on power from the 28-volt d-c bus. Overheat lights, fire warning lights, and controls for the extinguisher are located on a fire control panel on the pilot's right vertical console.

**WARNING**

- Repeated or prolonged exposure to high concentrations of bromochloromethane (CB) or decomposition products should be avoided. CB is a narcotic agent of moderate intensity but of prolonged duration. It is considered to be less toxic than carbon tetrachloride, methyl bromide, or the usual products of combustion. In other words, it is safer to use than previous fire extinguishing agents. However, normal precautions should be taken including the use of oxygen when available.
- This is a "one-shot" fire extinguisher system. The bottle must be replaced after use.

#### Fire and Overheat Warning Lights and Test Switch.

Two red fire warning lights (figure 1-39), one for each engine, are located on the fire control panel and will come on when a rapid temperature rise occurs in the engine area. Two amber overheat warning lights (figure 1-39), one for each engine, are on the fire control panel and will come on when the temperature in the engine bay rises above 178°C (350°F). A single detector test switch (figure 1-39), spring-loaded to an unmarked off position and with marked positions, L & R FIRE CKT 1 and L OVERHEAT, and L & R FIRE CKT 2 and R OVERHEAT, is for checking the two fire and two overheat warning circuits. When this switch is held at L & R FIRE CKT 1 and L OVERHEAT, both fire warning lights should come on indicating that fire warning circuit No. 1 is operative on both engines, and the left overheat warning light should come on indicating that the overheat detectors in the left engine bay are operative. When the switch is held at L & R FIRE CKT 2 and R OVERHEAT, both left and right fire warning lights again should come on indicating that fire warning circuit No. 2 is operative on both engines and the right engine overheat warning light should come on indicating that the overheat detectors in the right engine bay are operative. When the circuits are being tested, the overheat lights should come on immediately; the fire warning lights, after a 2- to 10-second delay. The warning lights, test switch, and detector circuits operate on 28-volt dc.

#### Engine Fire Selector Switches.

Two guarded fire selector switches (figure 1-39), one for each engine, are mounted on the fire control panel. These switches are used to turn off fuel shutoff valves to the engine and to arm the fire extinguishing agent discharge switch. When the guards over the switches are down, the 28-volt d-c circuits to the agent discharge switch and the fuel shutoff valves are broken. The guard must be raised and the switch moved up to close fuel valves for the affected engine and to complete the circuit to the agent discharge switch.

#### Agent Discharge Switch.

A spring-loaded agent discharge switch (figure 1-39) located on the fire control panel operates the fire extinguisher. When the switch is held momentarily to the ON position, the circuit is closed and current flows to the selected discharge valve on the fire extinguisher bottle. There, a cartridge is fired to pierce a sealing disk, and the full charge of extinguishing agent is directed to the area surrounding the selected engine.

**WARNING**

The agent discharge switch is ineffective (unarmed) unless one of the engine fire selector switches has been actuated.

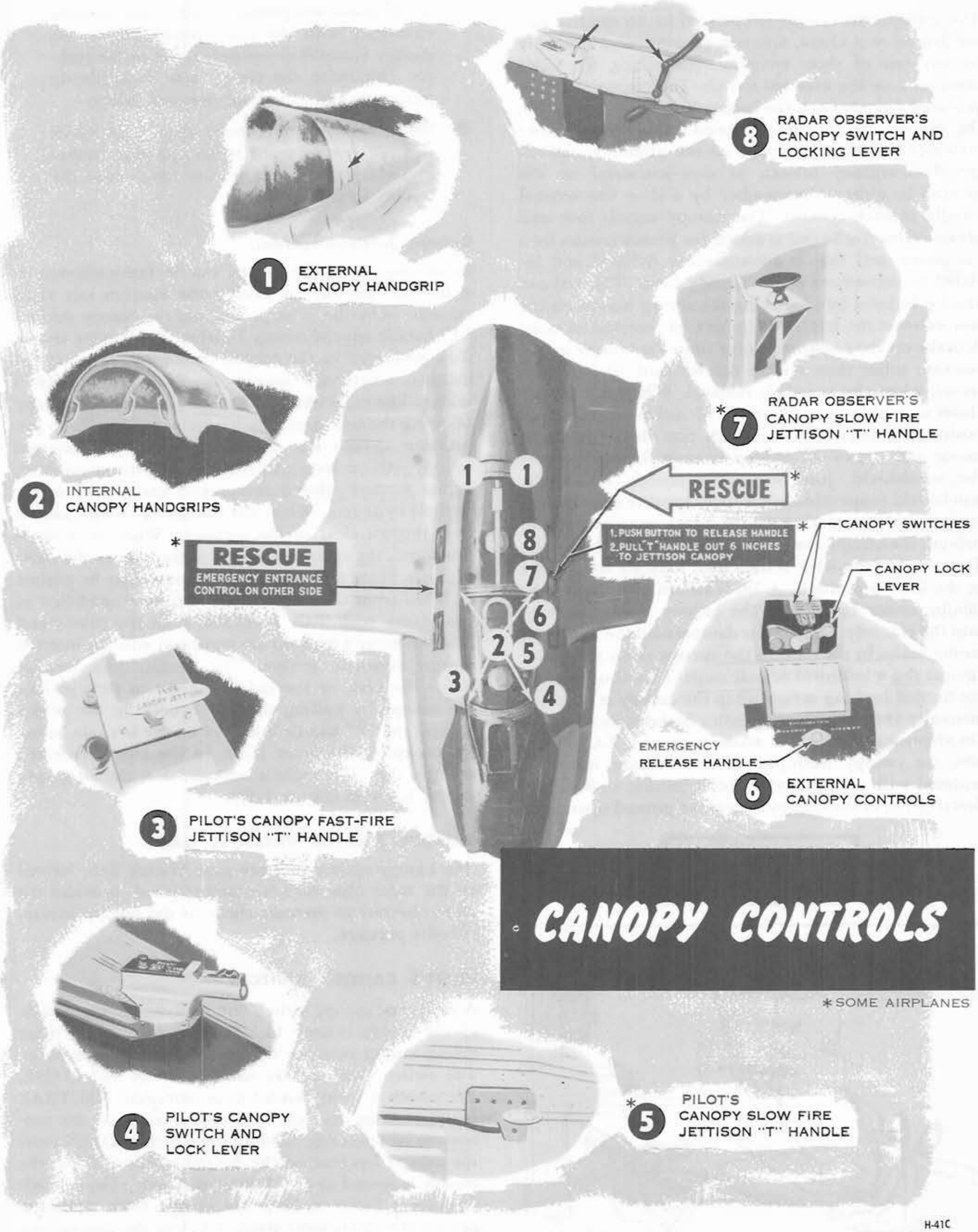
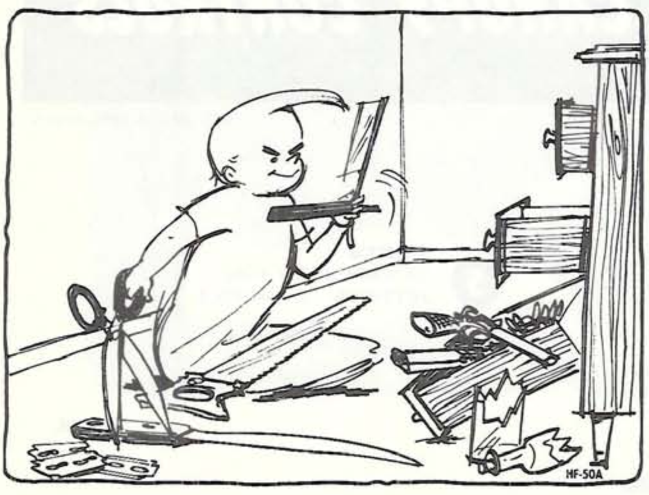

RADAR OBSERVER'S CANOPY SWITCH AND LOCKING LEVER
EXTERNAL CANOPY HANDGRIP
RADAR OBSERVER'S CANOPY SLOW FIRE JETTISON "T" HANDLE
INTERNAL CANOPY HANDGRIPS
RESCUE
EMERGENCY ENTRANCE CONTROL ON OTHER SIDE
RESCUE
1. PUSH BUTTON TO RELEASE HANDLE
2. PULL "T" HANDLE OUT 6 INCHES TO JETTISON CANOPY
CANOPY SWITCHES
CANOPY LOCK LEVER
EMERGENCY RELEASE HANDLE
EXTERNAL CANOPY CONTROLS
PILOT'S CANOPY FAST-FIRE JETTISON "T" HANDLE
CANOPY CONTROLS
* SOME AIRPLANES
PILOT'S CANOPY SWITCH AND LOCK LEVER
PILOT'S CANOPY SLOW FIRE JETTISON "T" HANDLE
H-41C

*Figure 1-40.*

## CANOPY.

The transparent canopy is operated by an electric motor geared to a chain, and can be controlled normally by any one of three switches: the pilot's, the radar observer's, or the external switch. The canopy motor is powered directly from the battery bus. In an emergency, the canopy can be fast-jettisoned in flight by either crewmember, slow-jettisoned on the ground by an external emergency release, or slow-jettisoned on the ground by either crewmember by a slow fire control handle in each cockpit. The canopy travels fore and aft on roller trucks and is sealed for pressurization by a pneumatic seal that is automatically deflated and inflated by movement of the canopy locks. The seal can also be deflated by depressing the spring button on the seal valve at the left of the pilot's left vertical console. A brake on the actuating motor stops the canopy in any position other than within the forward 10 inches of travel, when the switch is released. When the canopy closes to within approximately 10 inches of the closed position, it trips a microswitch that deenergizes the motor and allows the canopy to coast forward toward the windshield. Just before the canopy strikes the windshield (approximately 1 inch) another microswitch energizes the actuating motor brake momentarily to prevent the canopy from slamming into the windshield. The canopy lock lever is then used to bring the canopy to the locked position. A limit switch also brakes the canopy motor to prevent the canopy from slamming into the rear stops. Hydraulic dampers aid the actuating motor brake in preventing the canopy from slamming against the windshield or rear stops. This also provides the needed braking action when the canopy is operated manually and the actuating motor brake is inoperative. On airplanes modified in accordance with T.O. 1F-89-600, the canopy push-pull circuit breaker has been replaced with a toggle-type circuit breaker to facilitate deactivation of the canopy system for ground operation.

**WARNING**




- When leaving the airplane, make certain that no personal equipment, which could become entangled with the seat armrests when the canopy is closed or opened, is left in the cockpit. Otherwise, the canopy may be accidently jettisoned with attendant personal injury.
- When taxiing with canopy open, keep hands clear of canopy track when applying brakes as sudden brake application may cause the canopy to slam forward.

### Canopy Jettison System.

In an emergency, the canopy can be fast-jettisoned by either crewmember by raising the ejection seat right armrest, or by the pilot pulling out the canopy jettison "T" handle approximately 2 inches. The canopy can be slow-jettisoned by the ground crew by pulling out the external emergency release handle approximately 5 inches. The radar observer can slow-jettison the canopy by using the emergency hydraulic pump handle to put pressure against the cable attached to the external canopy jettison lever and the canopy jettison initiator. Either method releases compressed gas to the canopy jettison cylinders. When the canopy is fast-jettisoned, it is thrown clear of the airplane. When it is slow-jettisoned, the canopy is slowly pushed above the cockpit rails. From this position the canopy may be pushed or lifted from the airplane. On airplanes modified in accordance with T.O. 1F-89-586, both the pilot's and radar observer's cockpits are equipped with an internal canopy slow-fire jettison "T" handle. This enables either the pilot or the radar observer to slow-jettison the canopy by pulling the "T" handle. In the pilot's cockpit the "T" handle is located on the left side below the cockpit rail (figure 1-40). In the radar observer's cockpit, the "T" handle is located below the main spar on the left side (figure 1-40).

## CANOPY EJECTOR PRESSURE GAGE.

The canopy ejector pressure gage (figure 4-6), located on the radar observer's instrument panel, provides the radar observer an accurate check of the canopy jettison cylinder pressure.

## PILOT'S CANOPY SWITCH.

A slide-type canopy switch (figure 1-40) on the handle of the pilot's canopy lock lever is one of the three spring-loaded switches that control canopy operation. The switch positions are marked OPEN and CLOSE. The switch is spring-loaded to an unmarked NEUTRAL position. After the locks have been disengaged, the canopy can be opened by holding the switch at OPEN until the canopy has reached the desired position. When the canopy is opened to its full limit of travel, a limit switch operates a brake to keep the canopy from slamming against the mechanical stops. To close the canopy, the switch is held at CLOSE until the canopy stops moving and the lock lever is then pushed down to close and lock the canopy. The pilot's switch overrides the radar observer's switch, and the external switch overrides both cockpit switches. All canopy switches operate on 28-volt dc from the battery bus.

### RADAR OBSERVER'S CANOPY SWITCH.

A spring-loaded canopy switch (figure 1-40) on the left side of the radar observer's cockpit is marked OPEN and CLOSE and operates the canopy in the same manner as the pilot's canopy switch.

### EXTERNAL CANOPY SWITCHES.

To permit electrical actuation of the canopy from outside the cockpit, two battery-powered control switches (figure 1-40) are located inside a key-locked access door on the left side of the fuselage above the wing leading edge. The two push-type switches are marked OPEN and CLOSE. When either switch is held depressed, the canopy moves in the desired direction until the switch is released. The external canopy switches override the pilot's and radar observer's canopy switches.

**WARNING**

When opening the canopy with the external canopy switch, use caution to prevent the forward corner of the canopy from striking the operator's hand.

**Note**

If the canopy cannot be opened electrically, open canopy manually.

### CANOPY LOCK LEVERS AND INDICATOR LIGHT.

There are three canopy lock levers (figure 1-40): the pilot's, near the floor at the left of the pilot's seat; the radar observer's, on the left side of the cockpit; and the external lever, just below the left cockpit rail inside a key-locked external access door. Moving a lock lever forward, when the canopy is within 1 inch of full forward travel, fully closes and locks the canopy, and inflates the canopy pressure seal. Pulling a lock lever back releases the locks and a "canopy unlocked" 28-volt d-c red indicator light next to the left windshield defogging duct comes on.

**Note**

Prior to opening the canopy, place cabin air switch to RAM & DUMP position to deflate canopy seal.

The light goes out when the locks are engaged. The external lever must be disengaged and pushed into its clip for stowage.

### PILOT'S CANOPY HANDGRIPS.

If 28-volt d-c electrical power is not available, the canopy can be opened or closed manually. After release of the canopy locks, the canopy is free to roll. Two handgrips (figure 1-40) on the forward frame of the canopy are for the pilot's use in manual operation.

### RADAR OBSERVER'S CANOPY HANDGRIPS.

The radar observer can move the canopy manually by using U-shaped handgrips (figure 1-40) located on each canopy rail.

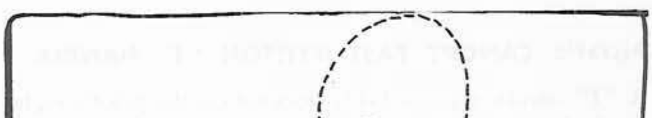
### EXTERNAL CANOPY HANDGRIPS.

Two external hinged handgrips (figure 1-40), one in each side of the aft structure of the canopy, can be used by personnel outside the cockpit to assist in manually moving the canopy.

### EXTERNAL EMERGENCY CANOPY RELEASE HANDLE.

The canopy can be slow-jettisoned by an external emergency release handle (figure 1-40) which is flush with the fuselage skin just below the access door for the external canopy switch. A button in the center of the handle must be pressed in to release the handle. Approximately 45 pounds of pull must be exerted to break the safety wire on the jettison valve and a constant pull must be maintained until the canopy breaks free and rises above the cockpit rails. When the handle is pulled out approximately 5 inches and held, compressed gas flows through a restrictor to the actuating cylinders and, in approximately 10 to 20 seconds, the canopy will be pushed above the cockpit rails. From this position it can be lifted or pushed from the airplane.

**WARNING**




The canopy should be jettisoned on the ground only in an emergency. To prevent accidental jettisoning of the canopy when the airplane is on the ground, safety pins must be installed in the canopy jettison components in both cockpits (as discussed in Ejection Seat Ground Safety Pins, this section).

**EJECTION SEAT RIGHT ARMREST.**

The right armrest of either ejection seat (figure 1-41) can be raised to fast-jettison the canopy. When either crewmember raises his right armrest, compressed gas under approximately 1800 psi flows to the actuating cylinders, the canopy locks release, and the canopy is thrown into the air.

**WARNING**

- The canopy goes straight up when it is jettisoned. Lack of airstream may cause it to fall back into the cockpit.
- If the canopy is to be jettisoned for reasons other than ejection (such as a forced landing), the pilot should not use the seat armrest, as this will also cause his seat to bottom, thus restricting vision. The canopy can be jettisoned by the pilot without bottoming the seat by pulling out the pilot's canopy jettison "T" handle.
- Keep hands and arms clear of canopy lock levers during canopy jettison. As the canopy is jettisoned, the radar observer's lock lever will rotate rapidly to the OPEN position and the pilot's lock lever will snap to the up (OPEN) position.

**PILOT'S CANOPY FAST-JETTISON "T" HANDLE.**

A "T" handle (figure 1-12), located on the pilot's right vertical console, enables the pilot to fast-jettison the canopy without using the ejection seat control. This handle is linked by a cable to a gas initiator located on the floor just forward of the right console. The cable also is linked to a microswitch in the 28-volt d-c circuit to the canopy retention solenoids. Pulling the handle out approximately 1 inch opens the microswitch and interrupts the circuit to the canopy retention solenoids; pulling the handle another inch (a total of approximately 2 inches) draws the firing pin from the initiator which in turn opens the shutoff valve to the canopy jettison cylinders. The retraction mechanism for stowing the radar observer's scope and console is then automatically actuated to the stowed position, and the jettison cylinders release the canopy locks and throw the canopy from the airplane. The pilot's canopy fast-jettison "T" handle should be used for all emergencies, other than ejection, requiring jettisoning of the canopy. To prevent inadvertent canopy jettisoning, a ground safety pin is provided for the canopy jettison gas initiator. This pin with its streamer is attached to the end of the pilot's ejection seat ground pin streamer. On Group 5 airplanes, a canopy jettison "T" handle guard and a large streamer are provided for additional safety.

## EJECTION SEATS.

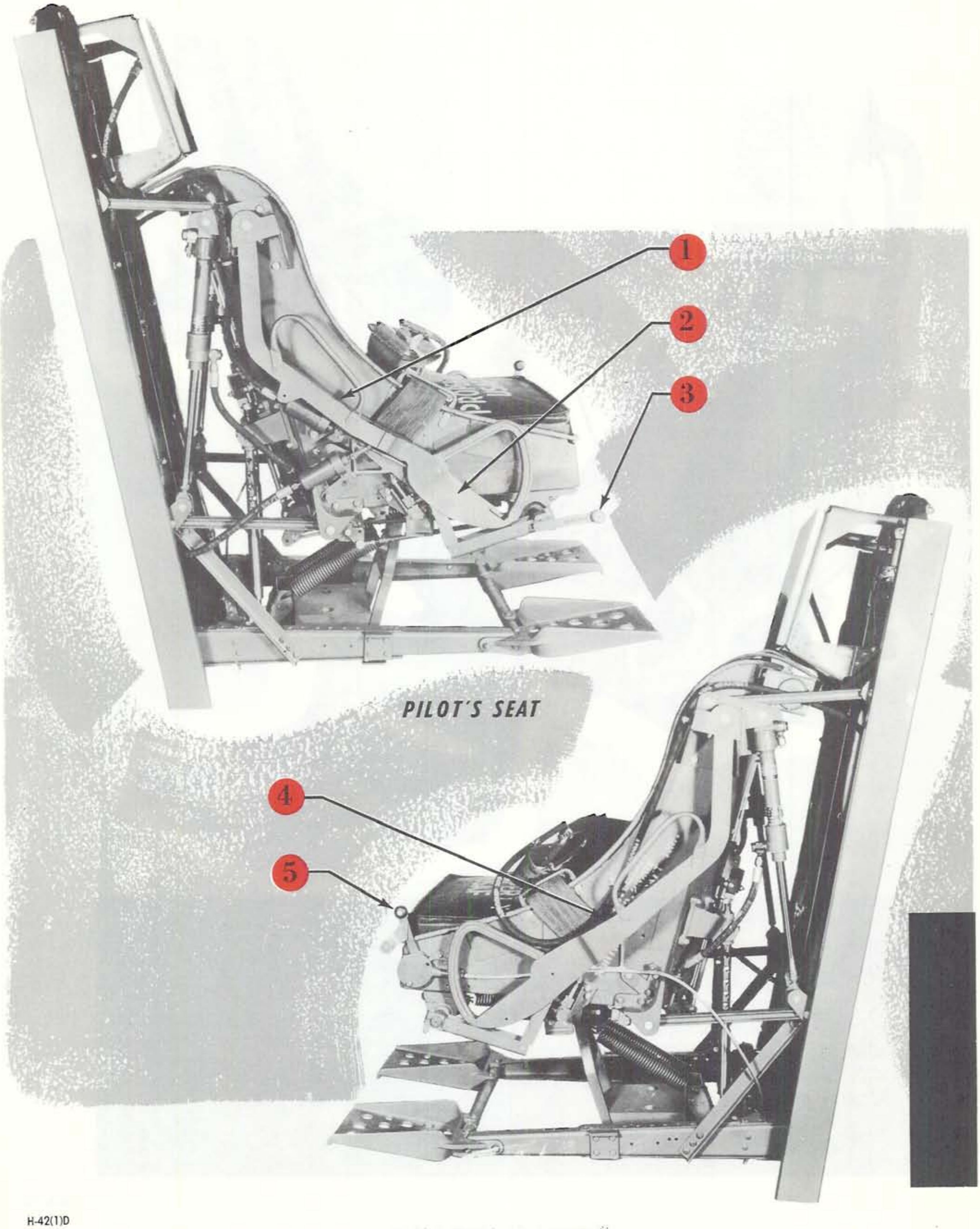
**WARNING**

If the C-2A life raft is being carried, the A-5 seat cushion should not be left on the seat. If both are used and it becomes necessary to eject or crash land, severe spinal injury may be caused by the excessive compressibility of the combination of life raft and cushion. If additional height in the seat is needed, a solid filler block may be used in conjunction with the life raft.

**Note**

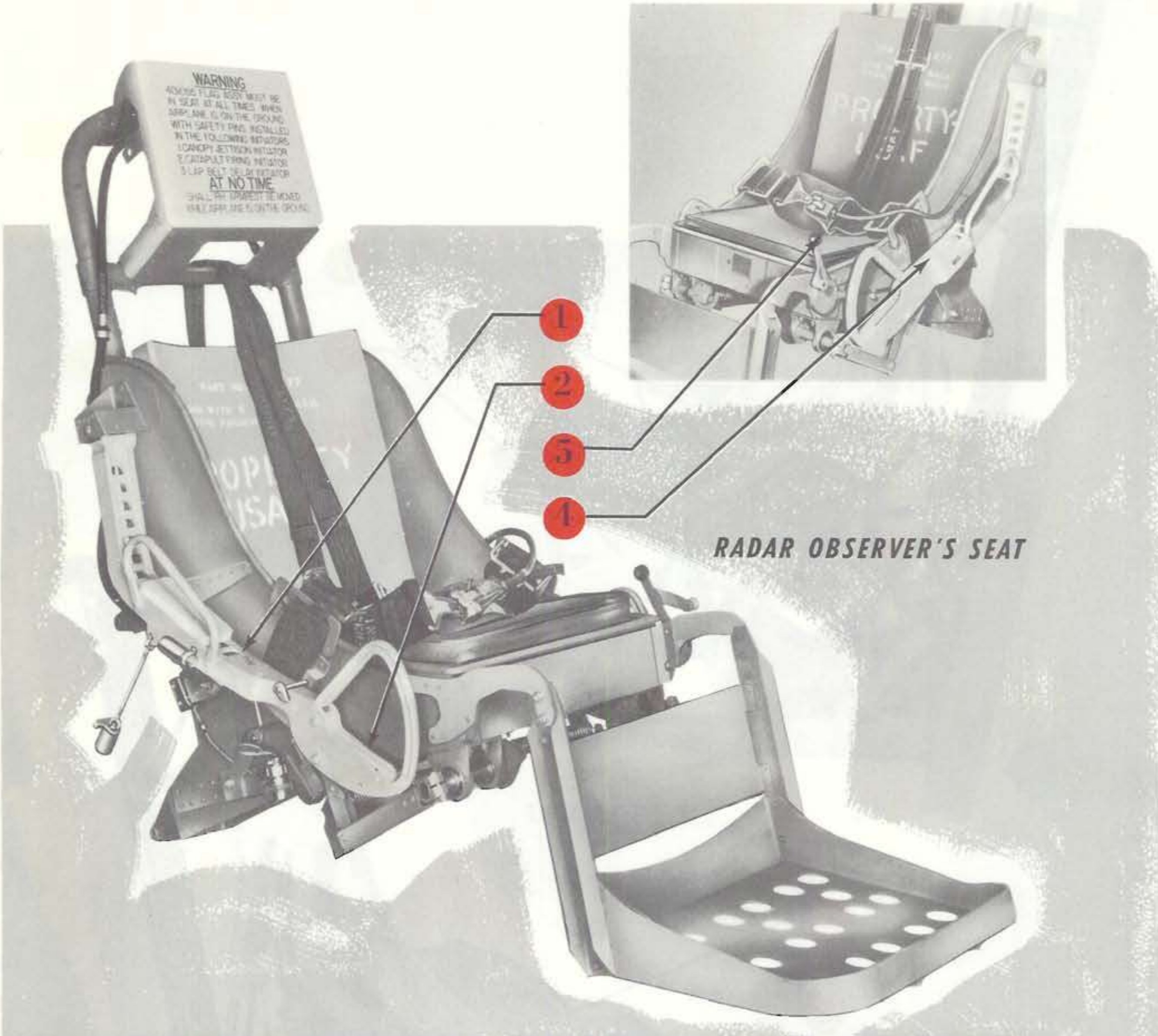
When the seat cushion is not used, the Type MD-1 contoured seat style survival kit container, stock number 2010-126602, with the MA-1 contoured cushion, stock number 2010-159100, should be used. The forward edge of the packed kit should not be thicker than 7 inches (consult T.O. 14S1-3-51, "Base Assembly, Use and Maintenance of Sustenance Kits" and T.O. 14S3-2-31, "One Man Life Raft, Type PK-2, Used with Survival Kit Container, Type MD-1"). The CA-2 one man life raft kit may be used if the MD-1 containers are not available.

The pilot's and radar observer's stations are equipped with catapult-type ejection seats (figure 1-41). A catapult aft of each seat contains an explosive charge that supplies the propelling force for seat ejection. The catapult is permanently safetied by two shear pins that are sheared during firing by gas pressure from the initiator. The headrest and footrests of each seat are fixed. The pilot's seat is adjustable in combination vertical-fore-and-aft directions. The radar observer's seat is not adjustable. Controls for the ejection sequence are the two armrests of each seat and the right handgrip firing trigger. Movement of these controls actuates a compressed air system that automatically lowers the pilot's seat to the full down position, locks the shoulder harness reel, fires the gas initiators which actuate the components that jettison the canopy, stows the radar




H-42(1)D

*Figure 1-41 (Sheet 1 of 2).*




## EJECTION SEATS

1. RIGHT ARMREST
2. RIGHT HANDGRIP AND FIRING TRIGGER
3. SEAT ADJUSTMENT LEVER
4. LEFT ARMREST
5. INERTIA REEL LOCK LEVER

H-42(2)D

*Figure 1-41 (Sheet 2 of 2).*

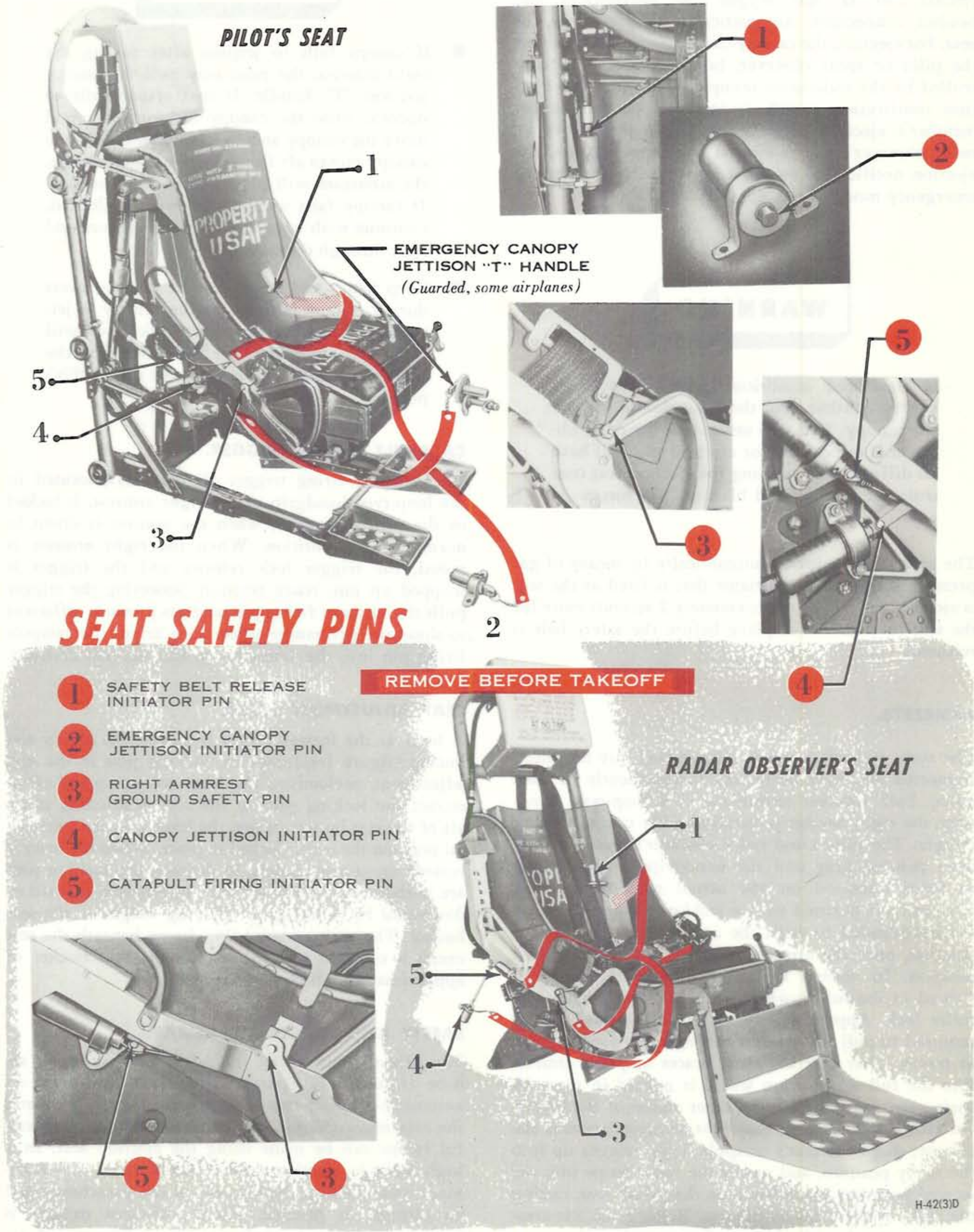

PILOT'S SEAT
EMERGENCY CANOPY
JETTISON "T" HANDLE
(Guarded, some airplanes)
1
2
3
4
5
SEAT SAFETY PINS
REMOVE BEFORE TAKEOFF
1 SAFETY BELT RELEASE INITIATOR PIN
2 EMERGENCY CANOPY JETTISON INITIATOR PIN
3 RIGHT ARMREST GROUND SAFETY PIN
4 CANOPY JETTISON INITIATOR PIN
5 CATAPULT FIRING INITIATOR PIN
RADAR OBSERVER'S SEAT
H-42(3)D

Figure 1-42.

observer's scope (stowed by raising right armrest of either seat), and fires the catapult. As the seat is ejected, anti "G" suit, oxygen hose, microphone, and headset connections automatically disconnect at the seat. For ejection, the canopy can be jettisoned by either the pilot or radar observer, but seat ejection is controlled by the individual occupying the seat. An ejection notification switch is installed on each crewmember's ejection seat. When either the pilot's or radar observer's seat is ejected from the airplane, the ejection notification switch automatically actuates the emergency mode of the AN/APX-6 IFF system.

**WARNING**

If time and conditions permit, the radar observer rather than the pilot should jettison the canopy. This will assure that the radar observer is in position for ejection and will have no difficulty in reaching the ejection seat controls due to the wind blast or "G" forces.

The safety belt releases automatically by means of gas pressure from a delay initiator that is fired as the seat is ejected, and allows approximately 2 seconds more for the seat to clear the airplane before the safety belt is released.

### ARMRESTS.

The right and left armrests (figure 1-41) are not interconnected and may be moved independently of each other. Each armrest terminates in a loop-type handgrip, the right handgrip containing the catapult firing trigger. The pilot's and radar observer's armrests have been painted gray and the handgrips orange-yellow to focus attention on the actual ejection controls. Each armrest is fitted with a jackknife-type brace that is spring-loaded to assist the armrest into the full up position, once the armrest is lifted free of its stowed position. In normal flying position each armrest is stowed in the full down position and held there by a roller lock. Approximately 20 pounds upward pull is required to pull the armrest through its first half inch of travel. After that the assist braces snap the armrest into the full up position where it is held in place by spring tension and the overcenter action of the braces. On either seat, raising the right armrest jettisons the canopy, snaps the seat's catapult firing trigger up into the ready position, and moves the radar scope into the stowed position; in addition, on the pilot's seat, raising the right armrest lowers the seat. Raising the left armrest locks the shoulder harness inertia reel.

**WARNING**

- If canopy fails to jettison after raising the right armrest, the pilot may pull the canopy jettison "T" handle. If that system fails to operate, raise the canopy locking lever and move the canopy switch to OPEN. When the canopy moves aft from the windshield frame, the airstream will blow it from the fuselage. If canopy fails to blow off when unlocked, continue with normal ejection procedure and eject through the canopy.
- Keep hands and arms clear of canopy levers during canopy jettison. As the canopy is jettisoned, the radar observer's lock lever will rotate rapidly to the OPEN position, and the pilot's lock lever will snap to the up (OPEN) position.

### CATAPULT FIRING TRIGGER.

The catapult firing trigger (figure 1-41), located in the loop-type handgrip of the right armrest, is locked in the stowed position when the armrest is down in normal flying position. When the right armrest is raised, the trigger lock releases and the trigger is snapped up into ready position. Squeezing the trigger pulls the initiator firing pin, and gas pressure sufficient to shear the permanent safety pins drives the catapult firing pin into the detonator to fire the seat catapult.

### SEAT ADJUSTMENT LEVER.

A lever at the forward right corner of the pilot's seat bucket (figure 1-41) controls locking pins in the seat adjustment mechanism. The lever rotates up and aft to retract the locking pins in the seat positioning struts aft of the seat bucket. When the lever is in the horizontal position the seat is locked in place. When the lever is rotated up approximately 15 degrees, the locking pins are withdrawn and the seat may be adjusted upward or downward by relieving or applying weight to the seat bucket. The spring-loaded "A" frame beneath the seat exerts a constant upward lift on the seat bucket of approximately half the weight of a pilot.

### SAFETY BELT AUTOMATIC RELEASE.

The primary purpose of the safety belt automatic release (figure 1-44), particularly when used with an automatic-opening aneroid-type parachute, is to extend the maximum and minimum altitudes at which successful escape can be made using the ejection seat. In a high altitude ejection (above 15,000 feet), the automatic system delays deployment of the parachute until an altitude is reached where sufficient oxygen is available to permit a safe parachute descent and air

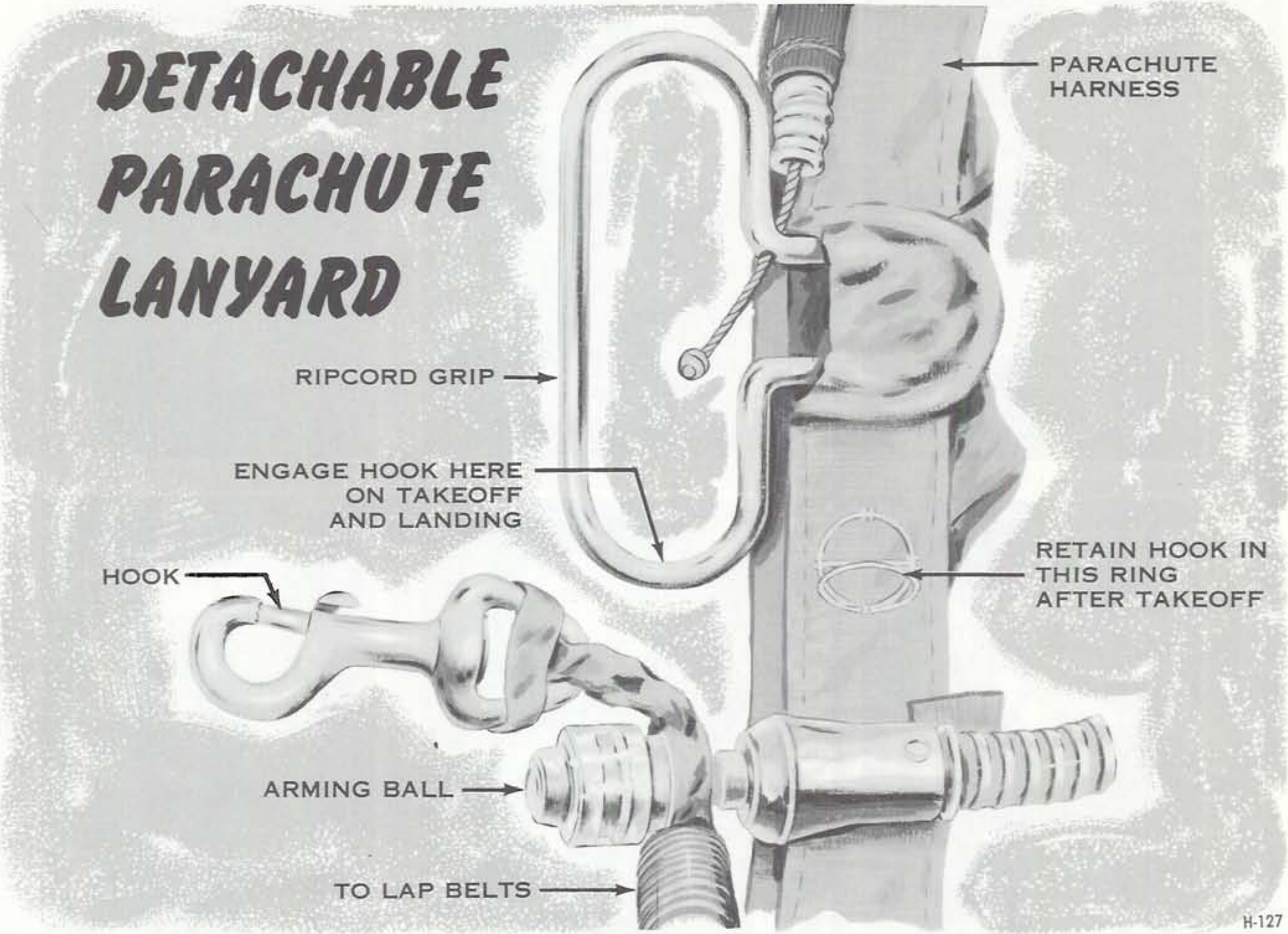



***Figure 1-43.***

density is great enough to reduce parachute opening shock. In a low altitude ejection, use of the automatic system greatly reduces the overall time required for separation from the seat and deployment of the parachute, and consequently reduces the altitude required for safe ejection. The various types of safety belt automatic releases have been thoroughly tested and are completely reliable. Under no circumstances should the automatic belt be manually opened before ejection, regardless of altitude. Human reaction cannot possibly beat the automatic operation of the release in opening the safety belt and arming the parachute, particularly under the stresses imposed by escape. The escape operation using the automatic release is not only faster, since it opens 2 seconds after ejection, but also protects the crewmember from severe injury at high speeds. Because the deceleration of a crewmember alone is considerably greater than that of the crewmember and seat together, immediate separation would result if the belt were manually opened just before ejection. This would not only cause greater "G" forces during deceleration, but could result in the parachute pack being blown open. The high opening shock of the parachute under these circumstances could cause fatal injuries. Currently, three types of safety belt automatic releases are in general use, the MA-1, the MA-2, -3, and -4, and the MA-5 and -6. (See figure 1-44.) Any of these various types may be found in the airplane. All three releases are designed to be locked and opened manually under normal usage, much the same as the standard manual safety belt, except that on the MA-1 through MA-4 models, a key that is attached to the parachute lanyard must be inserted into the release before it can be manually locked to ensure that the crewmember does not overlook the attachment of his parachute lanyard to the release. (If an automatic parachute is not used, the key attached to the release is used.) When the release is manually opened, the key drops out of the release to prevent inadvertently dumping the parachute. On the MA-5 and -6 automatic releases, a ring on the end of the parachute lanyard slips over the locking tongue of the release mechanism; when the release is manually opened, the ring slips free. However, on all three versions of the automatic release, the key (or ring) remains attached to the mechanism when the release is forced apart by gas pressure following an ejection, thus actuating the

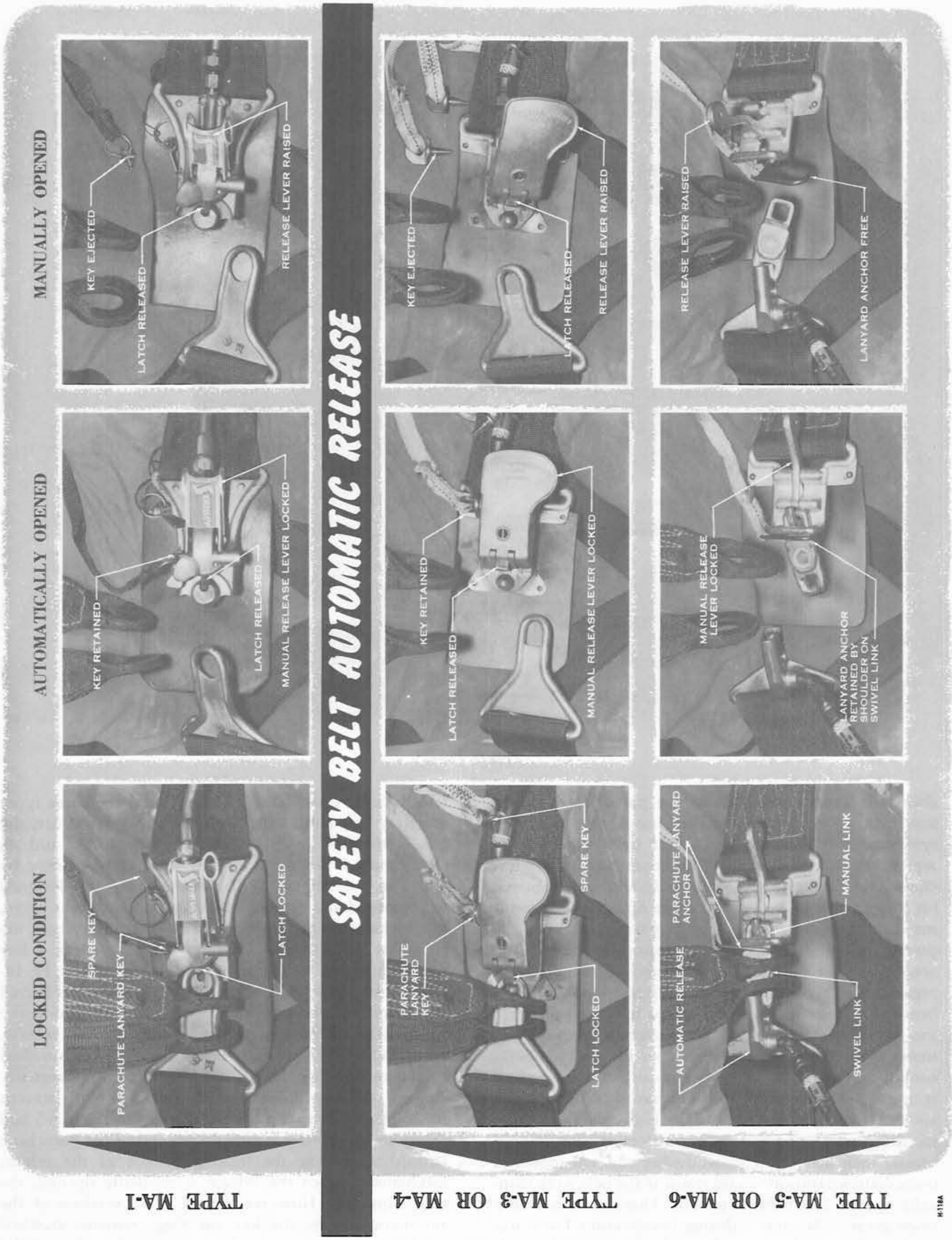

SAFETY BELT AUTOMATIC RELEASE
LOCKED CONDITION
AUTOMATICALLY OPENED
MANUALLY OPENED
TYPE MA-1
TYPE MA-3 OR MA-4
TYPE MA-5 OR MA-6
SPARE KEY
PARACHUTE LANYARD KEY
LATCH LOCKED
KEY RETAINED
LATCH RELEASED
MANUAL RELEASE LEVER LOCKED
KEY EJECTED
RELEASE LEVER RAISED
PARACHUTE LANYARD KEY
LANYARD ANCHOR FREE
MANUAL RELEASE LEVER LOCKED
LANYARD ANCHOR RETAINED BY SHOULDER ON SWIVEL LINK
AUTOMATIC RELEASE
PARACHUTE LANYARD ANCHOR
MANUAL LINK
SWIVEL LINK

Figure 1-44.

parachute mechanism when the crewmember separates from his seat. Manual operation of the system can override the automatic features at any time. For example, it is possible to manually open the safety belt even though initiator action has started. The parachute automatic features may also be overridden by manual operation even though the automatic parachute ripcord release has been actuated.

**WARNING**

- If the safety belt is opened manually, the parachute ripcord must be pulled manually.
- Improperly attaching the shoulder harness and safety belt tiedown straps to the automatic belt may prevent separation from the ejection seat after ejection. To make the attachment correctly, first place the right and left shoulder harness loops over the manual release end of the swivel link; second, place the automatic parachute lanyard anchor over the manual release end of the swivel link; then, fasten the safety belt by locking the manual release lever.
- The M-4 or M-12 safety belt initiator ground safety pin with warning streamer must be removed prior to flight. If the pin is not removed, automatic uncoupling of the safety belt will not occur if ejection becomes necessary. If pin is installed, maintenance personnel should be consulted on the status of the ejection system before occupying the seat.

## LOW ALTITUDE "ONE AND ZERO" EJECTION SYSTEM.

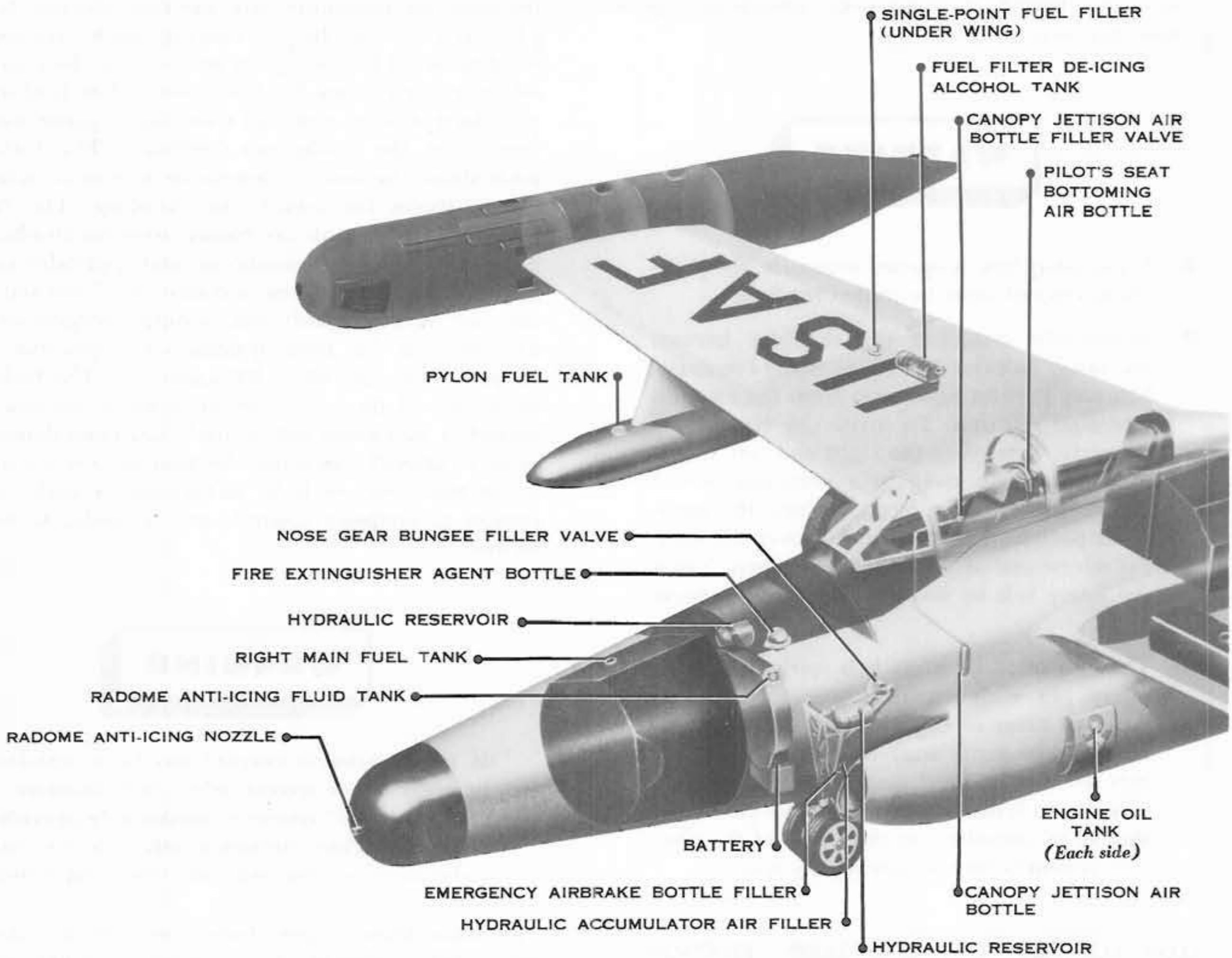
A system incorporating a one-second safety belt delay and a zero-second parachute delay ("one and zero") is provided (some airplanes) for ejection seat escape systems to improve low altitude escape capability. This system utilizes a detachable lanyard (figure 1-43) that connects the parachute timer knob to the parachute "D" ring. At very low altitudes and and at low airspeeds, the detachable lanyard must be connected to provide for parachute actuation immediately after separation of the aircrew member from the ejection seat. At higher altitudes and airspeeds, the detachable lanyard must be disconnected from the "D" ring, to allow 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 the stowage of the lanyard hook when it is not connected to the parachute "D" ring. The connecting (hookup) and disconnecting (unhooking) of the detachable lanyard and the parachute "D" ring must be done manually by each crewmember. Prior to takeoff, the static cord lanyard should be hooked up and the minimum safe ejection altitude determined. After takeoff, the lanyard must be unhooked and stowed by the crewmember after passing through the minimum safe ejection altitude for his particular system. Before landing, each crewmember must hook up lanyard prior to reaching the minimum safe ejection altitude for his system. After landing, the parachute may be removed from the airplane with the lanyard in the hooked-up condition. The following table should be used to determine minimum safe ejection altitudes for takeoff and landing. The figures presented in this table are conservative for climbs, optimistic for descending conditions and applicable to level flight attitudes. The "one and zero" and "two and zero" are used during takeoff and landing emergencies only, and the data for these systems are applicable to an airspeed range of 140 to 300 knots IAS. The following table should be used only as a guide because even though a minimum safe altitude has been determined prior to takeoff, the actual decision as to when to eject in an emergency will be influenced by such circumstances as airspeed, control, and attitude, as well as altitude.

**WARNING**

If the detachable lanyard has been installed before the one-second safety belt initiater, a "two and zero" system is temporarily provided wherein higher minimum safe ejection altitudes must be observed (see following table).

For nonautomatic parachutes used with automatic safety belts, lanyard, part number 67C6200, will be used. The minimum safe escape altitudes specified for one or two-second safety belt and zero second parachute settings apply when the lanyard is attached to the rip cord and safety belt.

| | *1-Second Automatic Lap Belt (M12 Initiator)* | *2-Second Automatic Lap Belt (M4 Initiator)* |
|---|---|---|
| 2-Second Parachute (F-1A Timer), B-4 or 5 Pack, C-9 Canopy | 350 FT | 550 FT |
| 2-Second Parachute (F-1A Timer), B-5 Pack C-11 Canopy | 400 FT | 600 FT |
| 1-Second Parachute (F-1B Timer), B4 or 5 Pack, C-9 Canopy | 200 FT | 350 FT |




## FLUID SPECIFICATIONS

**FUEL SPECIFICATION**

*RECOMMENDED*
MIL-F-5624A GRADE JP-4
*ALTERNATE*
MIL-F-5572 ANY GRADE

**RADOME ANTI-ICING FLUID By Volume**

60% ETHYLENE GLYCOL (MIL-E-9500)
40% DISTILLED WATER
0.1% WETTING AGENT (MIL-D-16791B)

**ENGINE OIL SPECIFICATION**

MIL-O-6081 GRADE 1010

**ALCOHOL SPECIFICATION**

MIL-A-6091

**HYDRAULIC FLUID SPECIFICATION**

MIL-O-5606

**FIRE EXTINGUISHING AGENT SPECIFICATION**

BROMOCHLOROMETHANE MIL-B-4394

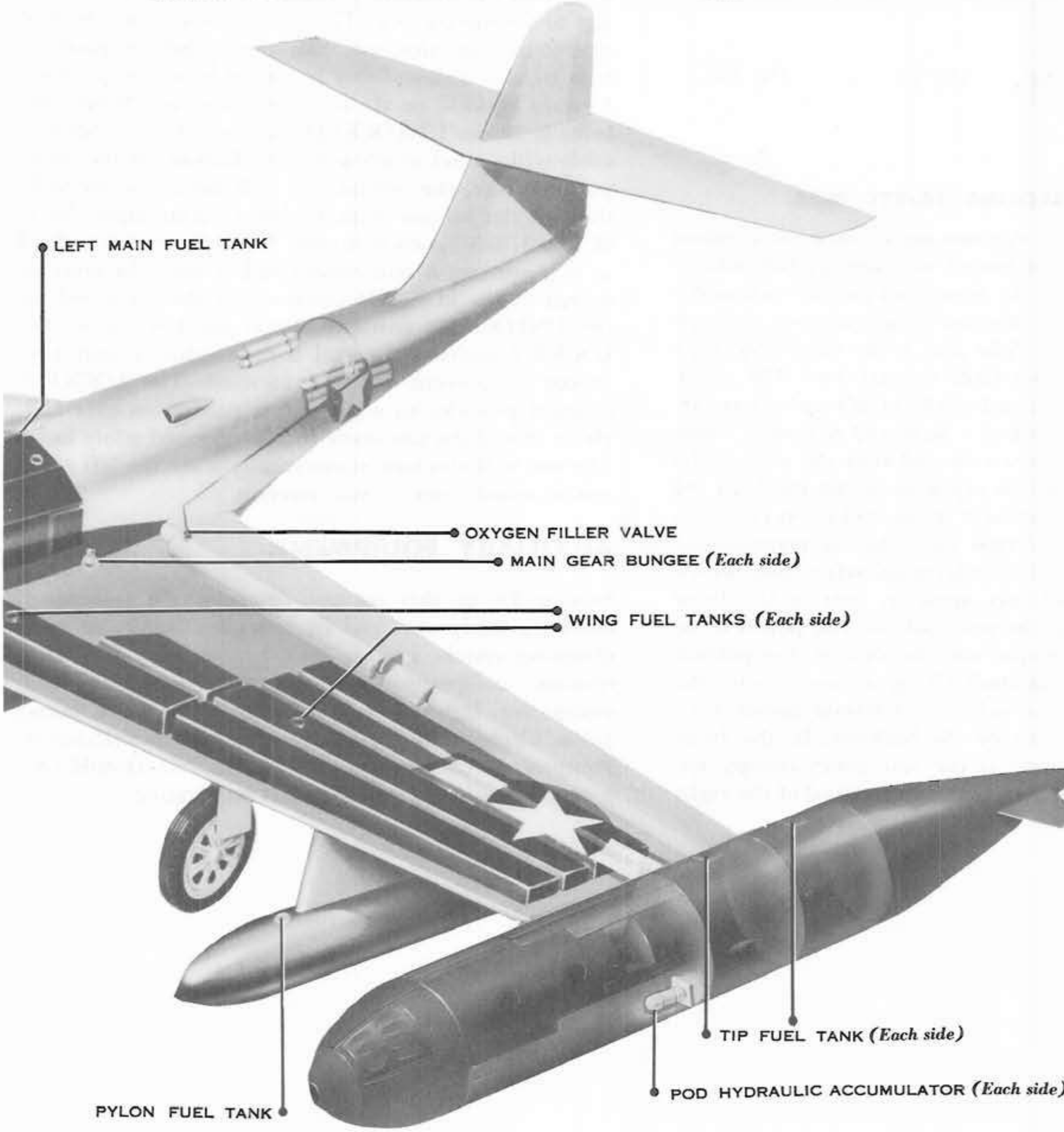
**OXYGEN SPECIFICATION**

MIL-BB-O-925

H-43(1)D

*Figure 1-45.*

# SERVICING DIAGRAM




H-43(2)C

| | | |
|---|---|---|
| 1-Second Parachute (F-1B Timer), B5 Pack, C-11 Canopy | 250 FT | 400 FT |
| 0-Second Parachute (Lanyard to "D" Ring), B4 or B5 Pack, C-9 Canopy | 100 FT | 200 FT |
| 0-Second Parachute (Lanyard to "D" Ring), B4 or B5 Pack, C-11 Canopy | 150 FT | 250 FT |

### EJECTION SEAT GROUND SAFETY PINS.

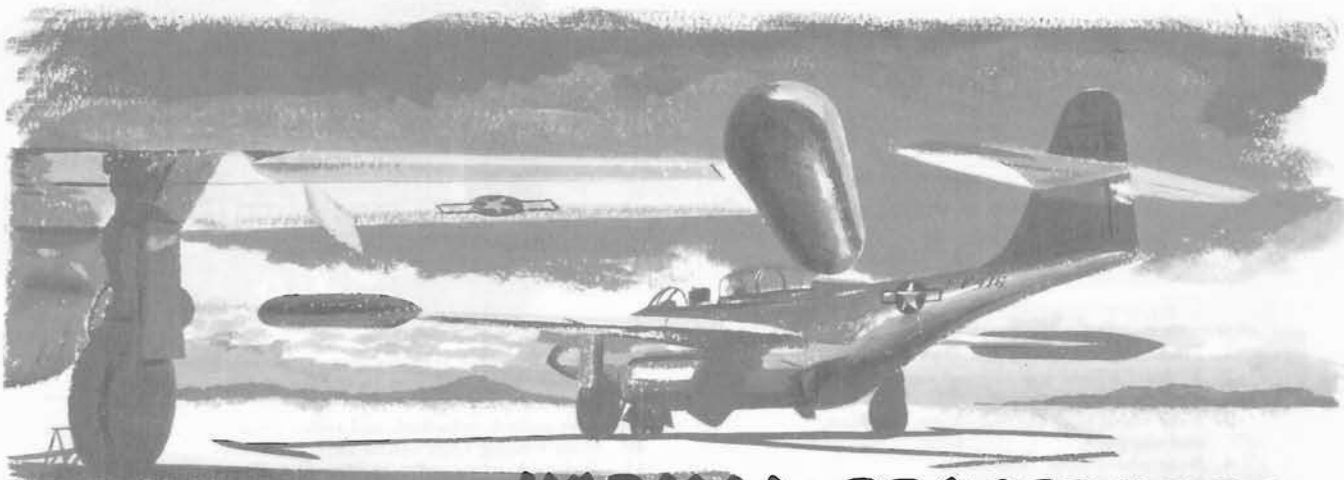
Ground safety for the ejection seats, when the airplane is on flight status, is achieved by a canopy fast-jettison "T" handle guard in the front cockpit and two safety pins, one in the radar observer's right armrest, and one in the pilot's armrest. The pin in the radar observer's cockpit is attached to a large red streamer. The safety pin and "T" handle guard in the pilot's cockpit are attached to opposite ends of a large red streamer. These pins and guard are to be removed after the safety belts are fastened and must be replaced before the belts are opened. They should remain in the cockpit at all times. Ground safety for ejection seats, during maintenance operation, is achieved by additional safety pins which are installed in each gas initiator, four in the front cockpit and three in the rear cockpit. The points to be safetied in each cockpit are the canopy fast-jettison valve initiator, the catapult firing initiator under the right armrest, and the safety belt release initiator on the left seat frame, aft of the backrest. In the front cockpit, a fourth point is the emergency canopy jettison initiator located on the floor forward of the right console. The large red streamers attached to these safety pins are fastened together with snaps. See figure 1-41.

### SHOULDER HARNESS INERTIA REEL LOCK LEVER.

A two-position LOCKED—UNLOCKED shoulder harness inertia reel lock lever (figure 1-41) is used to manually lock the shoulder harness reel or leave it free, subject to the inertia lock. The lever is located on the left side of each ejection seat. The lever is held in position by a friction disk and may be moved by a firm pressure forward to lock, or aft to unlock, the reel. When the lever is in the UNLOCKED position, the reel harness cable will extend to allow leaning forward in the cockpit; however, the inertia reel will automatically lock the shoulder harness tension cable when an impact force of 2 to 3 "G's" is encountered. When the reel is locked in this manner, it will remain locked until the lever is moved to the LOCKED position and then returned to the UNLOCKED position. When the lever is in the LOCKED position, the reel harness cable is manually locked to prevent bending forward. The LOCKED position provides an added safety precaution over and above that of the automatic inertia-operated safety lock. The reel will also lock automatically when the left armrest is raised prior to seat ejection.

## AUXILIARY EQUIPMENT.

Section IV of this manual describes the following auxiliary equipment and its operation: cabin air-conditioning system, canopy defogging system, anti-icing systems, communication and associated electronic equipment, lighting equipment, oxygen system, autopilot, single-point fueling system, and miscellaneous equipment. Armament is described in T.O. 1F-89H-1A, a confidential supplement to this publication.



SECTION II

# NORMAL PROCEDURES

HF-2B

### TABLE OF CONTENTS



Procedure steps in this section are followed by the symbols P, RO, or P—RO in parentheses to indicate whether the particular step is applicable to the pilot, radar observer, or both crewmembers.

## PREPARATION FOR FLIGHT.

### FLIGHT RESTRICTIONS.

Refer to Section V, Operating Limitations, for restrictions and limitations.

### FLIGHT PLANNING.

Prepare a complete flight plan to determine the required fuel, oil, oxygen, airspeed, power settings, and other items for the proposed mission. Use the operating data in Appendix I to assist you in planning.

### TAKEOFF AND LANDING DATA CARDS.

Fill out the takeoff and landing data cards using the operating data in Appendix I to assist you.

### WEIGHT AND BALANCE.

1. Check takeoff and anticipated landing gross weights and balance.
2. Make sure the airplane has been serviced and that the required armament and special equipment are loaded.
3. Refer to Section V for weight limitations.
4. Refer to Handbooks of Weight and Balance Data, T.O. 1-1B-40 and T.O. 1F-89H-5 for detailed loading information.
5. Check that the weight and balance clearance, DD Form 365 F, is satisfactory.

## PREFLIGHT CHECK.

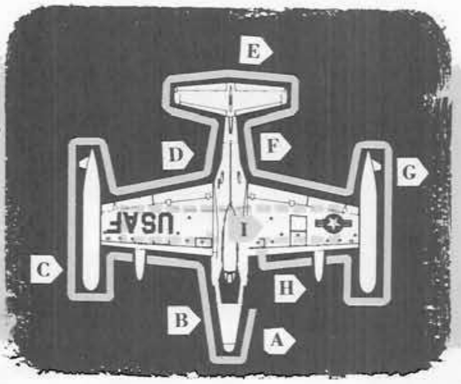
### BEFORE EXTERIOR INSPECTION.

Check DD Form 781 for the status of the airplane; make sure that the airplane has been properly serviced.

### EXTERIOR INSPECTION.

Conduct the exterior inspection as shown in figure 2-1.

# EXTERIOR INSPECTION




*When approaching the airplane, note the general overall appearance and then check the following items:*

## LEFT FORWARD SIDE

A
1. Pitot tube, static vents, and probe clear.
2. Hydraulic fluid and radome anti-icing fluid levels checked; caps secured.
3. Nose wheel tires for condition, inflation, and slippage.
4. Nose wheel door condition.
5. Nose wheel strut extension (approximately 3 inches); ground lock removed.
6. Static ground contact.
7. Fire extinguishing agent and bungee air pressures.
8. Landing-taxi light condition.
9. Battery access door—remove.
10. Radar pressure gages—check gages for pressure and crystals for proper color.
11. Engine screen pressure gages—check for pressure.
12. Brake accumulator gage—600–2500 psi.
13. Emergency airbrake pressure gage—1500 ± 50 psi.
14. Battery connected and secured.
15. All access doors secured.
16. Angle-of-attack computer probe cover removed; check freedom of movement.
17. Radar nose condition; anti-icing nozzle clear.

## RIGHT FORWARD SIDE

B
18. Power panel and electrical accessories access door; open and check all circuit breakers IN.
19. All access doors secured; right main tank filler cap secured.
20. Hydraulic fluid level checked; cap secured.
21. Pitot tube and static vents clear.
22. Cabin pressure regulator outlet clear.
23. Engine intake duct clear; screens and compressor blades aligned and undamaged; check screws inside intake and accessory section for security; check ground for foreign objects.
24. Evidence of fuel, oil, and hydraulic leaks.
25. Engine doors secured. Door lock bolt position indicators—locked position (some airplanes).
26. Engine air intake doors free; external engine inlet screens installed.
27. Check oil quantity; oil filler cap and dip stick cotter pin secured.
28. Eleventh-stage compressor bleed port clear.
29. Engine door No. 3 airscoop clear; inside door No. 3 airscoop—check for chafed fuel line. Engine door No. 4 airscoop clear.

## RIGHT WING

C
30. Wheel chocks in place; ground lock removed.
31. Tire condition, inflation, and slippage.
32. Brake disk for condition, pucks for proper clearance, and brake shuttle valve checked.
33. Jack lug pointing straight downward.
34. Landing gear outboard door condition; strut extension (approximately 6 inches between torque arm pivot points). Check outboard door locking arm for tension.
35. Wheel well lines for condition and leaks.
36. Inboard main gear door closed and locked.
37. Bungee air pressure.
38. Sequence valve transfer piston for condition and position (out), so that landing gear and door will sequence properly.
39. Gear uplock unlocked, and roller free.
40. Wing leading edge condition.
41. Underside of wing for condition, fuel and hydraulic leaks, tiedown ring flush, and fuel tank vent outlets free of obstructions.
42. Single-point refueling cap secured; refueling door locked.
43. Pylon tank for security.
44. Tank pylon for condition; pylon vent port clear.
45. Pylon tank fuel level and amount checked; filler cap secured.
46. Pylon tank pressure release valve closed (some tanks).
47. Pylon and tank for condition and leaks.
48. Pylon tank sway braces secured.
49. Missile Pod Launcher Accumulator pressure—check; access doors secured.
50. Anti-icing overboard duct clear.
51. Missile doors flush.
52. Frangible rocket tube covers installed.
53. Tip tank access doors secured.
54. Position light condition.
55. Tip pod fin for security of attachment.
56. Tip tank vent and fuel dump port clear.
57. Aileron and wing flap for condition and hydraulic leaks; aileron neutral, wing flap up. Speed brake external ground lock removed.

## RIGHT AFT FUSELAGE

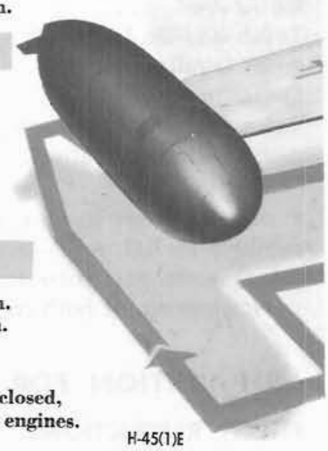
D
58. Tailpipe, fuel manifold, and flameholder condition.
59. Eyelids condition and position: closed, J35-35A engines; open, J35-35 engines.
60. Afterburner blastplate condition.
61. Refrigerator air intake and exhaust clear.
62. Aft fuselage access doors secured.
63. Fuselage position light condition.

## EMPENNAGE

E
64. General condition.
65. Drain ports for hydraulic leaks.
66. Position lights condition.
67. Access doors secured.
68. Rudder for approximate neutral position.

## LEFT AFT FUSELAGE

F
69. Fuselage position light condition.
70. Afterburner blastplate condition.
71. Tailpipe, fuel manifold, and flameholder condition.
72. Eyelids condition and position: closed, J35-35A engines; open, J35-35 engines.
73. Oxygen filler door secured.



H-45(1)E

*Figure 2-1.*

## LEFT WING

G
74. Aileron and wing flap for condition and hydraulic leaks; aileron neutral, wing flap up. Speed brake external ground lock removed.
75. Tip tank fuel dump port and vent clear.
76. Tip pod fin for security of attachment.
77. Position light condition.
78. Missile Pod Launcher Accumulator pressure—check; access doors secured.
79. Missile doors flush.
80. Frangible rocket tube covers installed.
81. Anti-icing overboard duct clear.
82. Wing access doors secured.
83. Underside of wing for condition, fuel and hydraulic leaks, tiedown ring flush, and fuel tank vent outlets free of obstructions.
84. Pylon tank fuel level and amount checked; filler cap secured.
85. Pylon tank pressure release valve closed (some tanks).
86. Pylon and tank for condition and leaks.
87. Pylon tank sway braces secured.
88. Pylon tank for security of attachment.
89. Tank pylon for condition; pylon vent port clear.
90. Wing leading edge condition.
91. Wheel chocks in place; ground lock removed.
92. Tire condition, inflation, and slippage.
93. Brake disk for condition, pucks for proper clearance, and brake shuttle valve checked.
94. Jack lug pointing straight downward.
95. Landing gear outboard door condition; strut extension (approximately 6 inches between torque arm pivot points). Check outboard door locking arm for tension.
96. Wheel well lines for condition and leaks.
97. Inboard main gear door closed and locked.
98. Bungee air pressure.
99. Sequence valve transfer piston for condition and position (out), so that landing gear and door will sequence properly.
100. Gear uplock unlocked, and roller free.

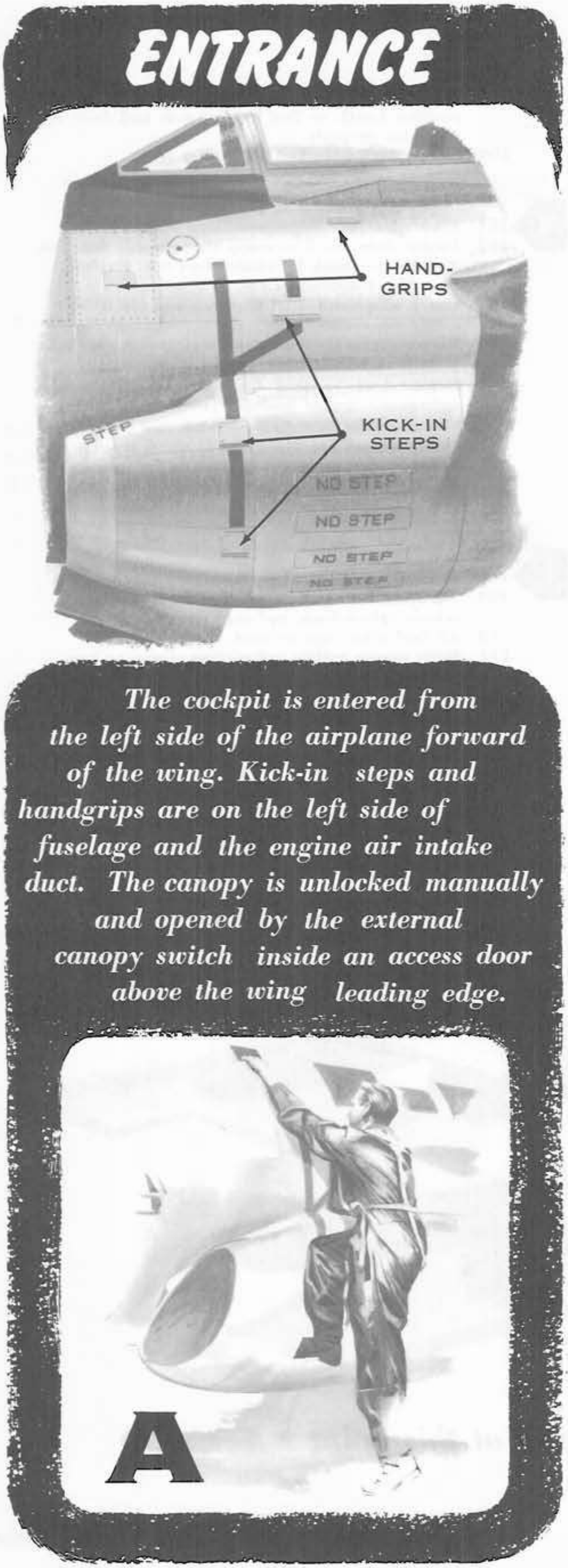
## LEFT SIDE

H
101. Eleventh-stage compressor bleed port clear.
102. Engine door No. 3 airscoop clear; inside door No. 3 airscoop—check for chafed fuel line. Engine door No. 4 airscoop clear.
103. Check oil quantity; oil filler cap and dip stick cotter pin secured.
104. Engine air intake doors free; external engine inlet screens installed.
105. Engine doors secured. Door lock bolt position indicators—locked position (some airplanes).
106. Engine intake duct clear; screens and compressor blades aligned and undamaged; check screws inside intake and accessory section for security; check ground for foreign objects.
107. Evidence of fuel, oil, and hydraulic leaks.

## UPPER WING AND FUSELAGE

I
108. General condition of surface.
109. Tip tanks for equal amounts of fuel, pressure release valves flush, and caps secured.
110. All fuel filler caps secured.
111. Static source outlets and cooling scoops on top of fuselage clear.
112. Fuselage position light condition.
113. Emergency flap reservoir filler cap secured (left wing).
114. Alcohol tank; check quantity and cap secured (right wing).
115. Canopy seal and windshield condition.
116. Windshield wiper condition.
117. Electrical access doors secured.
118. Canopy control door secured and emergency release handle stowed.


H-45(2)E




**CAUTION**

- Locate external power unit as far from the airplane as the power cable will permit, to reduce the hazard of fire from exhaust gas or hot components of the power unit.
- On some airplanes, two lockbolt position indicators on each engine nacelle door are provided to permit visual reference of their position when doors are being locked. When the small inspection door cover plates are removed, a movable lockbolt position indicator and a stationary reference indicator will be visible. These indicators must be aligned within 1/32 inch when the lockbolt is in locked position.

## ENTRANCE.

For the proper method of entering the cockpit, refer to figure 2-2.

## BEFORE ENTERING COCKPIT.

1. Canopy ejection pressure—Check (1500—2000 psi). (P—RO)
2. Ejection seats—Check. (P—RO)
   Armrests and trigger stowed; safety pins installed; safety belt initiator ground safety pin removed; seat air bottle pressure 1600—1800 psi; catapult file mark aligned.

**Note**

If the safety belt initiator ground safety pin is installed, consult maintenance personnel regarding the status of the ejection system before occupying the ejection seat.


*Figure 2-2.*

3. Circuit breakers—IN. (P—RO)
4. Armament switches—Check. (P)
   Safety control switch—SAFE; mode switch—SNAKE; salvo selector switch—ZERO.
5. Flashlight—Check operation. (P—RO)

## INTERIOR CHECK.

### Front Cockpit.

**Note**

A pilot's checklist (figure 1-11) is located above the center pedestal.

**WARNING**

If the C-2A life raft is being carried, the A-5 seat cushion should not be left on the seat. If both are used and it becomes necessary to eject or crash land, severe spinal injury may result because of the excessive compressibility of the combination of life raft and cushion. If additional height in the seat is needed, a solid filler block may be used in conjunction with the life raft.

1. Armament switches—SAFE; armament safety plug—Install. (P)
2. Safety belt and shoulder harness—Fasten; static cord lanyard and automatic-opening parachute lanyard—Connected; inertia reel operation—Check. (P—RO)

**WARNING**

The M-4 or M-12 safety belt initiator ground safety pin with warning streamer must be removed prior to flight. If the pin is not removed, automatic uncoupling of the safety belt will not occur if ejection becomes necessary. If pin is installed, maintenance personnel should be consulted on the status of the ejection system before occupying the seat.

3. Rudder pedals—Adjust. (P)
4. Battery switch—OFF. (P)
5. Throttles—Closed. (P)
6. 28-volt d-c external power—Connected (on right intake duct). (P)

**Note**

- If more than 15 minutes are to elapse between supplying power to the 28-volt d-c bus and starting or operating engines above idle rpm, place afterburner control switch (circuit breaker) at OFF (unmarked) and leave it OFF until just before starting engines. This will deenergize the eyelid and altitude idle bleed actuator solenoids, thus preventing them from being damaged by overheating.
- Check operation of all press-to-test lights on each control or indicator panel as the panel is checked.

7. 115/200-volt three-phase a-c external power—Connected. (P)
8. Exciter control switch—CLOSE momentarily. (P)
9. Alternator breaker control switch—TRIP momentarily. (P)
10. Three-phase inverter switch—MAIN. (P)
11. Single-phase inverter switch—Check EMERGENCY and NORMAL (leave on NORMAL). (P)
12. Alternator external power switch—CLOSE momentarily. (RO)
13. Left console circuit breakers—IN. (P)
14. Emergency airbrake valve handle—OFF. (P)
15. Sideslip stability augmenter power switch—PWR ON; rudder trim switch—AUTO TRIM; electrical rudder trim knob—Safetywired at center position. (P)
16. Single-point fueling light—OUT. (P)
17. Fuel control panel and fuel gages—Check. (P)
    Crossfeed switch—CLOSED; fuel selector switches—ALL TANKS; system circuit breakers—IN. Move fuel gage selector switch to each position and note readings of right and left indicators. Leave fuel gage selector at TIP so that tip tank feeding can be checked while taxiing out for takeoff.

**CAUTION**

After positioning the selector switch at any position, allow at least 3 seconds to elapse before selecting another position. This will preclude any possibility of the affected fuel system motor valves being reversed in mid-cycle, which will cause shorter valve life.

18. Wing flap lever—TAKE-OFF. (P)
19. Left hydraulic system supplemental pump—Check. (P)
    Depress nose wheel steering button and watch left hydraulic system pressure gage for pressure buildup to 2500 psi.

**CAUTION**

- When a demand is made on the supplemental pump by operation of any left hydraulic system control, the supplemental pump must not be in operation for a period of time greater than 6 minutes, followed by a rest period of 15 minutes.
- When no demand is made on it by operation of any left hydraulic system control, the supplemental pump should not be in operation for more than 30 minutes.

20. Speed brake—Check operation; leave closed. (P)

21. Operate all flight controls simultaneously. (P)
Visually check control surface operation.

22. Aileron and elevator trim switch—Check. (P)
Move the switch full travel to left, right, fore and aft positions to make sure that the switch automatically returns to NEUTRAL when released. If the switch sticks in any of the positions, enter this fact with a red cross on DD Form 781 and do not fly the airplane. During the check, stick force should be exerted against the trim to assure that the trim can be overpowered. Return the elevator trim to the TAKE-OFF position when check is completed. Check control grip for security.

**CAUTION**

In checking the control stick grip do not twist the grip as such action may cause the grip to become less secure.

23. Nose wheel steering button—Release. (P)

24. Left hydraulic system supplemental pump pressure switch—Check. (P)
Pump wheel brakes through several cycles to drop brake accumulator pressure to between 1100—800 psi. Supplemental pump should come on and brake accumulator pressure should start to rise to approximately 2100 to 2350 psi.

**CAUTION**

- When a demand is made on supplemental pump by operation of any left hydraulic system control, the supplemental pump must not be in operation for a period of time greater than 6 minutes, followed by a rest period of 15 minutes.
- When no demand is made on the supplemental pump by operation of any left hydraulic system control, the supplemental pump should not be in operation for more than 30 minutes.

25. Position light switches—As required. (P)

26. Landing gear warning horn reset button—Press. (P)
Landing gear lever light should come on.

27. Cabin temperature switch—AUTO. (P)

28. Cabin temperature rheostat—As required. (P)

29. Landing gear lever—Check DOWN. (P)
Check gear position indicators for safe gear indication. Emergency landing gear handle—Check IN (stowed position).

30. Canopy seal button—Released. (P)

31. Landing-taxi light switches—As required. (P)
Check operation of both the landing and taxi lamp beams after extending the light.

32. Windshield de-ice and defog knob—NORMAL. (P)

33. Windshield wiper switch—OFF. (P)

34. Windshield wiper speed rheostat—INC. (P)

35. Anti-ice switches—OFF. (P)

36. Engine screen switch—NORMAL. (P)

37. Pitot heat switch—Check. (P)
Turn pitot heat switch ON and check operation with crew chief. Leave on if necessary.

38. Canopy locking lever—UP. (P)

39. Cabin air switch—PRESSURE. (P)

40. Cabin differential pressure switch—5.00 PSI. (P)

41. Attitude indicator warning flag—Retracted. (P)

42. Flight computer—Check. (P)
Flight computer selector switch—FLIGHT INST; altitude switch—OFF; perform operational check of flight computer (see Section IV).

43. Directional indicator slaving cutout switch—IN. (P)

44. Altimeter and clock—Set. (P)
Cross-check with radar observer.

45. Parking brakes—Set. (P)

46. Canopy defog knob—IN. (P)

47. Fire and overheat warning circuits—Check operation. (P)
Hold detector test switch to L & R FIRE CKT 1 and L OVERHEAT; left and right fire warning lights and *left* overheat warning light should come on within 2 to 10 seconds. Hold to L & R FIRE CKT 2 and R OVERHEAT; left and right fire warning lights and *right* overheat warning light should come on.

48. Emergency signal button and light—Check. (P—RO)

49. Starting power switch—NORMAL. For emergency start—EMER (see caution under step 57). (P)

50. Canopy jettison "T" handle—IN (stowed position). (P)

51. Thunderstorm light rheostat knob—OFF. (P)

52. Interior and instrument lighting rheostats—As required. (P—RO)

53. Communication equipment—Check operation. (P—RO)
Canopy must be closed to check the ARN-6 and ARN-14. Radio compass—Check all positions and set to desired frequency; UHF command radio—Check all channels; VHF navigation set —Check and set to desired frequency; interphone—Check operation.

54. Oxygen equipment—Check operation. (P—RO)
Pressure gage—400 to 450 psi maximum; warning light switch—OFF; oxygen regulator diluter lever—NORMAL OXYGEN; oxygen regulator supply lever—ON; test system operation. (Refer to Oxygen System Preflight Check, Section IV, for detailed information.)

55. Autopilot switches—OFF; turn knob—Centered. (P)

56. IFF switch—OFF. (P)

57. Generator switches—ON. (P)

**CAUTION**

During emergency starts, one of the following procedures must be used. If generator switches are normally left in the OFF position they must be turned ON (following engine start) in the following order: left, right No. 2 and right No. 1. If generator switches are normally left in the ON position, the left generator switch only must be turned OFF, then turned ON after engines are started. Using other than the above procedures may result in the loss of the secondary bus and 2500 VA inverter, or the tripping of the bus-tie relay circuit breaker due to a current overload of the left generator during right engine start (external power connected). In either case the right No. 2 generator should be turned ON second, never first or third.

58. Right console circuit breakers—IN. (P)

59. Right vertical panel circuit breakers—IN. (P)

60. Make sure all required navigational publications are aboard. (P—RO)

## BEFORE STARTING ENGINES.

Whenever possible, start and run up engines on a concrete surface to prevent dirt and foreign objects from entering the compressors and damaging the engines. Avoid runup on macadam pavement; high exhaust temperatures may cause serious damage to the pavement aft of the airplane. If the airplane is to be operated under conditions of possible carbon monoxide contamination, such as runup or taxiing directly behind another airplane, or during runup with the tail into the wind, use the following procedure before starting engines: Put on oxygen mask, connect tube to oxygen regulator, and place diluter lever at 100% oxygen. After contamination is no longer suspected, place the diluter lever at NORMAL OXYGEN.

**WARNING**

- The oxygen diluter lever must be returned to NORMAL OXYGEN as soon as possible. Use of 100 percent oxygen could deplete the supply before the end of the mission.
- Before starting engines, make sure danger areas (figure 2-3) fore and aft of the engines are clear of personnel, airplanes, and vehicles. Suction at the intake ducts is sufficient to kill or seriously injure personnel if pulled against or drawn into the ducts. Danger aft of the engines is created by the high exhaust temperature and blast from the tailpipes.
- To reduce foreign object damage to the engines, external engine and side door air inlet screens will be installed for taxiing to or from takeoff and landing areas and for ground operations. The engines should be at idle rpm or stopped during installation or removal of screens as a safeguard to ground crews. Personnel installing or removing the screens shall approach from a 90-degree angle and to the rear of the inlet duct opening. One man shall stand at the wing tip of the airplane to signal the pilot or operator in case of accident.

**CAUTION**

Starting an engine by using the blast produced by another aircraft or engine is prohibited. This method of starting engines forces foreign objects into the intake of the engine compressor section and results in engine failure.

## STARTING ENGINES.

Start the left engine first, to supply hydraulic pressure to the brake accumulator.

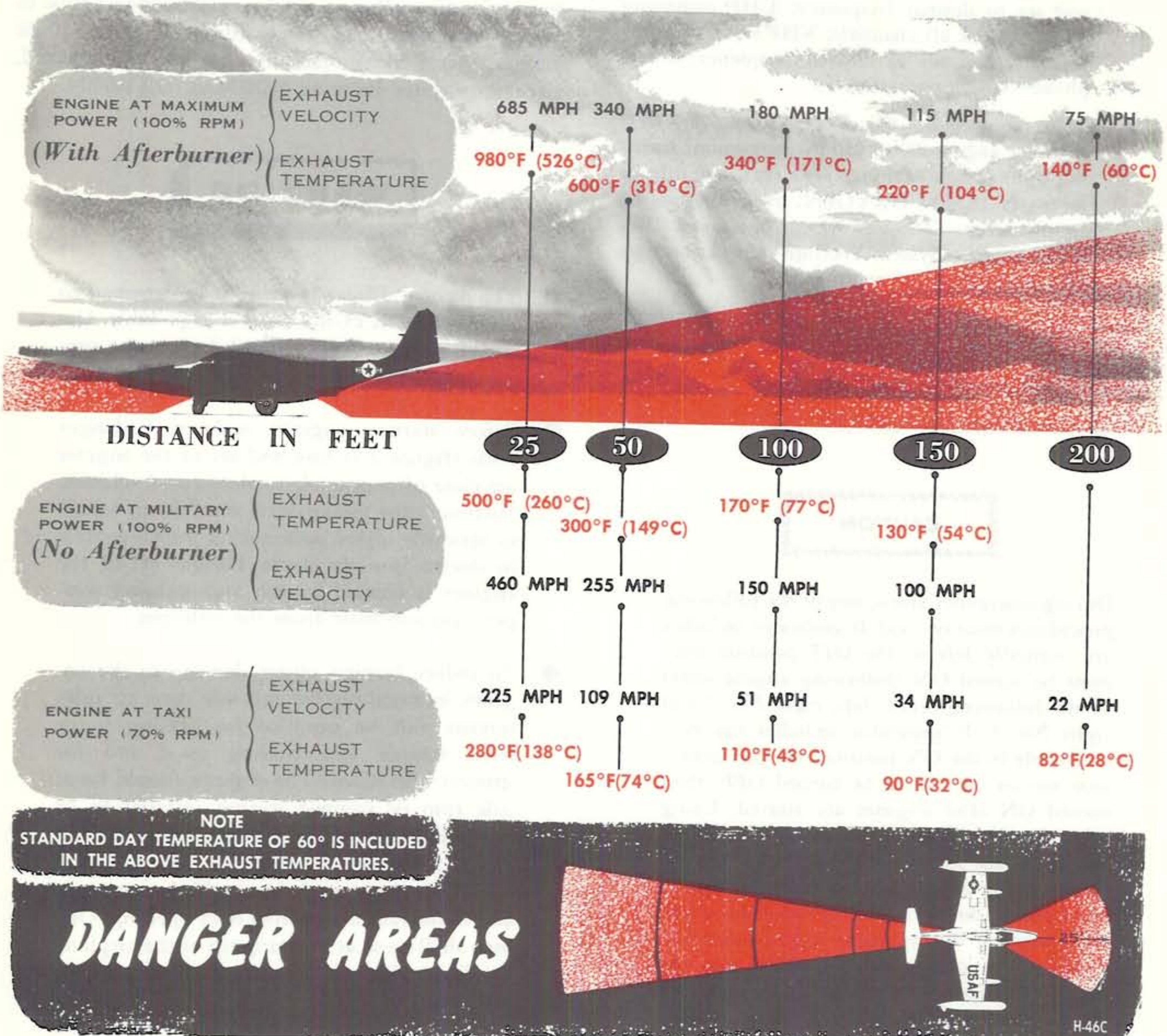



*Figure 2-3.*

**LEFT ENGINE.**

1. Fire guard posted. (P)
2. Throttles—CLOSED. (P)
3. Fuel selector switches—ALL TANKS; wing tank switches—ON; tip tank switches—ON; pylon tank switches—ON (if pylon fuel is carried). (P)
4. Crossfeed switch—CLOSED. (P)
5. Starter switch—START momentarily. (P)

   Check for rise in oil pressure. If there is no indication of oil pressure immediately after starting, shut down engine and investigate.

6. Throttle—IDLE when engine reaches 8 to 10% rpm. (P)

The starter circuit should automatically disconnect when load drawn by starter drops to 200 amperes (approximately 26% rpm). If ignition does not occur within 5 seconds after moving throttle to IDLE, close throttle and place starter switch momentarily at STOP. Do not operate the starter continuously for more than 1 minute. A second start may be attempted as soon as the engine stops rotating. A 3-minute interval must elapse after the second starting attempt and a 30-minute interval must elapse between each series of three starting attempts.

**CAUTION**

The starter is limited to three starts of 1-minute duration each; if more than three starts are required, allow starter to cool for 30 minutes before using again.

7. Exhaust gas temperature and rpm—Stabilized at idle (49 to 51% rpm) after ignition. (P)

**CAUTION**

A hot start is a start during which the exhaust gas temperature exceeds 915°C on J35-35 engines and 900°C on J35-35A engines. After any hot start during which the temperature reaches 1000°C or five hot starts during which the temperature is less than 1000°C, a "hot section" inspection of the engine must be accomplished. Exhaust gas temperatures between 750°C and 915°C inclusive on J35-35 engines and 735°C to 900°C on J35-35A engines are permissible for no more than 20 seconds. All hot starts must be entered in DD Form 781.

8. Hydraulic system pressure gage—Check while starting engine. (P)

When engine rpm is below 19% the pressure should not exceed 400 psi; between 19% and 38% rpm purge valve should open; when engine rpm is above 38% the pressure should be between 2800 and 3050 psi.

### RIGHT ENGINE.

9. Right engine—Start as for left engine. (P)
10. External power—Disconnected. (P)
11. Battery switch—ON. (P)
12. Fuel pump warning lights—Off. (P)
13. Engine instruments—Check. (P)

    Check for desired reading at idle rpm.

**Note**

When external power is disconnected, changeover to the airplane's 28-volt d-c system and all three a-c systems is automatic.

## ENGINE GROUND OPERATION.

No warmup period is necessary.

**CAUTION**

- During starting and accelerations, the maximum allowable exhaust gas temperature is 915°C on J35-35 engines and 900°C on J35-35A engines. Exhaust gas temperatures between 750°C and 915°C inclusive on J35-35 engines and 735°C to 900°C on J35-35A engines are permissible for no more than 20 seconds.
- Do not exceed maximum rpm. If engine rpm exceeds 104% momentarily or 103% stabilized, with or without overtemperature, the engine must be removed for overhaul. All overspeeding must be recorded in DD Form 781.

**Note**

See Section V for complete discussion on engine limitations.

## BEFORE TAXIING.

Hold control stick back during ground tests.

### VOLTAGE CHECK.

1. 28-volt generators—Check. (P)

   With engines above 50% rpm, output of each 28-volt generator should be 27.5 volts; loadmeters should show 0.2 maximum permissible difference.

2. Alternator—Check. (RO)

   With the left engine above 60% rpm, check the output of the 115/200-volt alternator.

3. Both single-phase inverter buses and three-phase inverter bus—Check output. (RO)

   All three buses should read 115 volts with voltmeter selector switch at PWR INV PRI, PWR INV SEC, INST INV.

4. Three-phase inverter switch—SPARE. (P)
5. Three-phase inverter bus—Check output. (RO)

   With voltmeter selector switch at INST INV, voltmeter should read 115 volts.

6. Three-phase inverter switch—MAIN. (P)
7. IFF switch—STDBY. (P)

### HYDRAULIC SYSTEM CHECK.

To check the left and right hydraulic flight control systems individually, the left system must be checked before starting the right engine.

1. Speed brakes—Check operation. (P)
2. Flight control surfaces—Check operation. (P)

   Operate all flight control surfaces simultaneously with both engines at idle rpm. Right hydraulic system pressure should not drop below 1500 psi.

### AUTOPILOT CHECK.

Perform the following autopilot check while taxiing to save time and fuel.

1. Autopilot power and autotrim switches—ON. (P)
   Leave these switches ON for the duration of the flight.
2. Turn knob—Check knob in DETENT position. (P)
3. Engaging switch—ENGAGE. (P)
   Move switch to ENGAGE after 1 1/2 to 2-minute warmup. The switch should remain at ENGAGE and the manual controls should resist movement.
4. Turn knob—Rotate clockwise and counterclockwise; pitch knob—Rotate fore and aft. (P)
   Stick should follow to right and left as turn knob is moved; stick should follow fore and aft as pitch knob is moved. Return knobs to DETENT position.
5. With nose wheel steering disengaged, yaw the airplane to the right, then to the left with brakes. (P)
   Left rudder pedal should move forward slightly when airplane is yawed to the right; right rudder pedal should move forward slightly when airplane is yawed to the left.
6. Check force required to override autopilot. (P)
   Operate the stick and the rudder pedals manually. Forces required to overpower the autopilot should not be excessive.
7. Autopilot emergency disconnect switch on control stick—Squeeze. (P)
   The engaging switch should return to the DISENGAGE position and the controls should be free.

## TAXIING.

Maintain directional control with the steerable nose wheel.

**CAUTION**

To reduce foreign object damage to the engines, external engine and side door air inlet screens will be installed for taxiing to or from takeoff and landing areas and for ground operations.

**WARNING**

The engines must be at idle rpm or stopped during installation or removal of screens as a safeguard to ground crews.

1. Ejection seat and canopy ground safety pins—Removed. (P—RO)
2. Brake accumulator pressure—Check. (P)
3. Wheel chocks—Signal ground crew to remove. (P)
4. Parking brakes—Release. (P)
5. Flight indicators—Check during taxiing. (P)
6. Perform autopilot check. (P)
7. Fuel gages—Check during taxiing for tip tank feeding. (P)
   Full tip tank fuel level indicates that tip tanks are not feeding.

**CAUTION**

- Use of wheel brakes in addition to nose wheel steering in turns will result in excessive stress on the nose gear and excessive nose wheel tire wear.
- Nose wheel tires will be severely damaged if maximum deflection turns are attempted at rolling speeds in excess of 10 knots.

Use 70% to 75% rpm to start the airplane rolling from a standing position and 50% to 55% rpm to keep it rolling. If taxiing with left engine only, a higher rpm is necessary. Maintain 60% to 70% rpm through turns at low speeds. This requires a large clear area aft of the tailpipes. A minimum of 115 feet of clear space ahead of the airplane is required to make a turn safely, starting from standstill. Minimize taxi time; flight range is considerably decreased by high fuel consumption during taxiing. In addition, aircraft tires are not designed to withstand extended durations of ground rolling operations. Long taxi periods will build up excessive temperatures and pressures in the tires, resulting in decreased margin of safety and service life of tires. Estimated fuel consumption for taxiing with two engines operating is 30 to 70 pounds per minute; therefore, 1 minute of taxi time costs from 3 to 8 nautical miles at long range cruising speed.

## BEFORE TAKEOFF.

### PREFLIGHT AIRPLANE CHECK.

After taxiing to takeoff position, complete the following check:

1. External engine and side door air inlet screens—Removed. (P)

**WARNING**

Obtain clearance from ground crew that screens have been removed. The engines must be at idle rpm as a safeguard for the ground crew.

2. Canopy—Closed and locked; warning light out. (P)
3. Flight controls—Check for free and correct movement. (P)
4. Elevator trim—Check for TAKE-OFF setting. (P)

**WARNING**

Be certain that airplane is trimmed properly for takeoff. Excessive trim will cause dangerous porpoising and possible stall.

5. Fuel selector switches—Check ALL TANKS. (P)

**WARNING**

Use of ALL TANKS fuel selector position for afterburner takeoff affords a greater margin of fuel pressure for maintaining afterburner operation than WING TANKS selector position because there is less flow resistance existing in the fuel distribution lines from the main tanks.

6. Safety belt—Tighten; shoulder harness—Adjust to fit snugly; inertia reel—UNLOCK; "L" shaped seat safety pin—Remove. (P—RO)
7. Anti "G" suit valve button—Press to check operation. (P—RO)
8. Wing flap lever—TAKE-OFF. (P)
9. Speed brake lever—CLOSED. (P)
10. Attitude indicator—Set. (P)
11. Hydraulic flight control, brake accumulator, and hydraulic reservoir pressure gages—Check. (P)
12. Autopilot power and autotrim switches—ON. (P)
13. Check radar observer prepared for takeoff. (P)
14. Engine screens—Extended (if any foreign objects are likely to enter engine intake ducts). (P)

## PREFLIGHT ENGINE CHECK.

Roll into takeoff position, center nose wheel, hold brakes, and perform the following checks:

1. Throttles—Full OPEN. (P)
   Allow engine rpm to stabilize at 98 to 100% rpm; observe exhaust gas temperature and check other instruments for desired ranges.

**Note**

Acceleration from idle to 100% rpm takes about 12 seconds for J35-35 engines and about 25 seconds for J35-35A engines.

**CAUTION**

Stabilized engine speeds greater than 103% rpm or a momentary rpm of 104% or more are prohibited, and engine must be removed for overhaul if this overspeeding occurs. The throttle must be reset if stabilized engine speed exceeds 102% rpm.

2. Fuel transfer—Check, with engines at military power. (P)
   Check fuel transfer by turning fuel selector switch to MAIN. Low main tank fuel level will indicate wing tanks not feeding. The aft CG and/or main low level warning lights coming on is further evidence that the wing tanks are not feeding. Leave selector on MAIN.
3. Left afterburner—ON. (P)
   Ignition will be indicated by thrust surge. Check exhaust gas temperature and rpm stabilized.
4. Right afterburner—ON. (P)
   Check exhaust gas temperature and rpm stabilized.

**Note**

Stabilization of rpm and exhaust gas temperature takes approximately 3 to 4 seconds after initiation of afterburning. The rise in exhaust gas temperature and drop in rpm indicate proper afterburner ignition. The subsequent rise of rpm to normal indicates the opening of the eyelids. Stabilization of exhaust gas temperature is the final indication of eyelid opening, afterburning, and airworthiness of the engine.

5. Engine exhaust gas temperature and rpm—Check. (P)

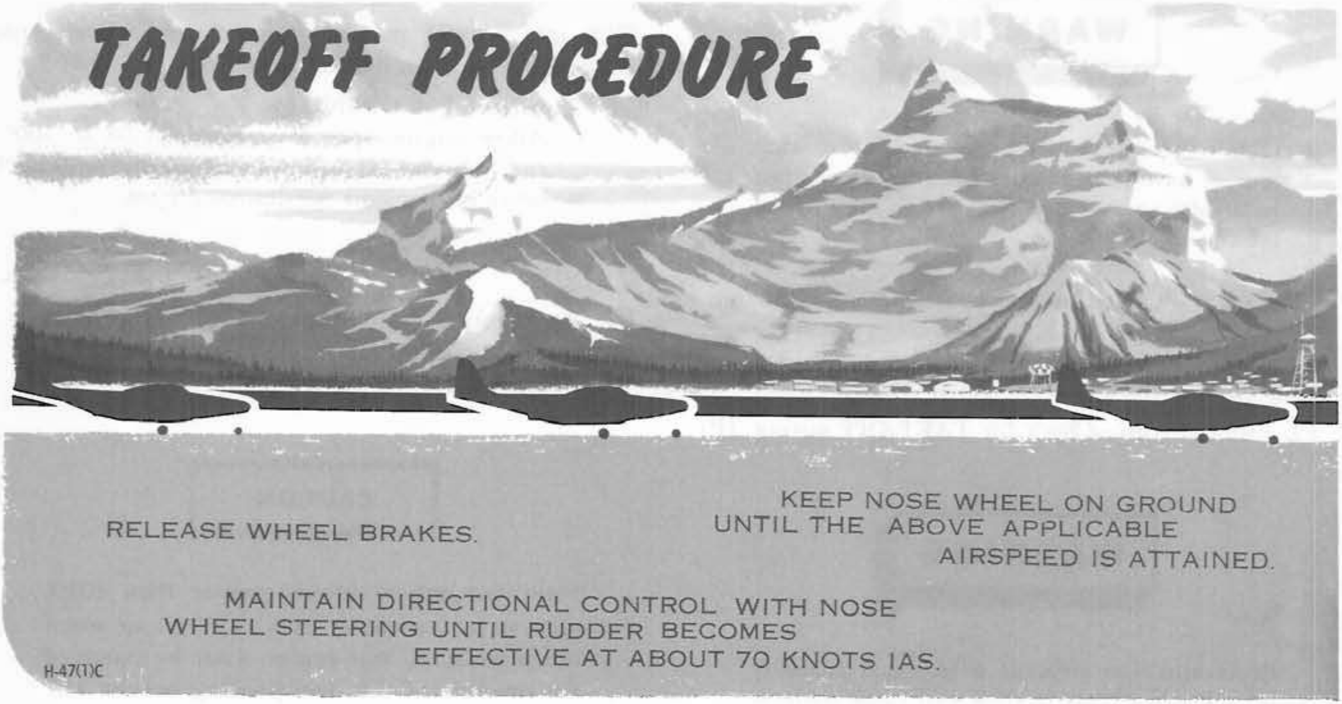



*Figure 2-4.*

**Note**

- Determine normal exhaust gas temperature (figure 5-2) for the existing runway temperature prior to takeoff. When engines have accelerated to 100% rpm and before beginning takeoff ground roll, check to ensure that exhaust gas temperature is within limits. Be sure to execute this check with the engine anti-icing system deactivated, as the engine anti-icing system, when actuated, may increase exhaust gas temperature by as much as 20°C (68°F). If the exhaust gas temperature is abnormally low, sufficient thrust may not be available for takeoff. Return to the line and enter this information in DD Form 781.
- Ambient air temperature does not affect peak temperature limits.

**CAUTION**

- If eyelids do not open, as indicated by the afterburner warning lights remaining on (some airplanes) and by excessive exhaust gas temperature and drop in rpm, shut down afterburner, retard throttles, and taxi back to line.
- Except in cases of emergency, the engines should never be shut down immediately after afterburner shutdown. This practice tends to permit accumulation of raw fuel in the afterburner, which may reignite upon contact with hot engine parts. For normal operation it is recommended that the engines be operated at from idle to 70%, whichever rpm gives lowest exhaust gas temperature, for at least 3 to 5 minutes after shutting down the afterburners. This procedure will eliminate shroud segment warpage, overheated bearings, and the possibility of raw fuel accumulating in the afterburners and igniting from hot engines.

## TAKEOFF.

### NORMAL TAKEOFF.

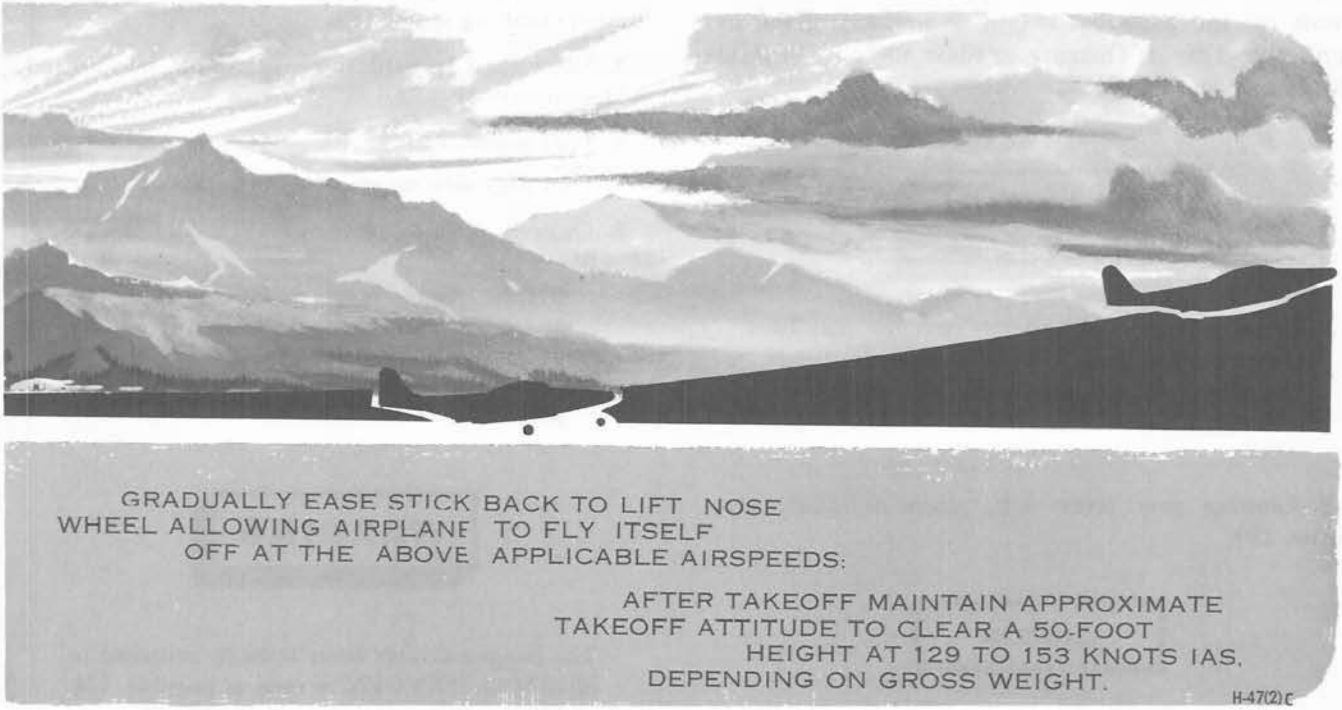
**Note**

The following procedure will produce the results stated in the Takeoff Distance Chart (figure A-6) in Appendix I.

When engines and afterburners are stabilized at 100% rpm, proceed with takeoff as shown in figure 2-4. See figure A-8 for refusal speed, and at checkpoint, check airspeed.

**WARNING**

Adhere closely to the recommended nose wheel liftoff and takeoff airspeeds to assure adequate lateral control and acceleration for takeoff.




**Note**

- Takeoff with military power is possible, but more distance is required. (See Takeoff Distance Chart, figure A-6, for military power takeoff distance.)
- Sustained low-altitude operation at maximum power can cause the rate of fuel consumption from the main tanks to exceed the rate of replenishment from the wing tanks. If the aft cg warning light comes on under these conditions, reduce power on the right engine or increase altitude.

### MINIMUM RUN TAKEOFF.

Strict adherence to takeoff procedure will result in minimum takeoff ground run. For length of ground run for various gross weights, see applicable Takeoff Distance Chart (figure A-6).

### OBSTACLE CLEARANCE TAKEOFF.

Follow normal takeoff procedure, using maximum power. After attaining the 50-foot height IAS (see After Takeoff—Climb, this section), maintain this IAS until obstacles are cleared, then continue with normal climb procedure.

### CROSSWIND TAKEOFF.

Follow normal takeoff procedure with the following exceptions: Use ailerons cautiously to maintain a wings level attitude. Lift off at higher speeds than normal, depending on wind velocity. Hold nose wheel on runway until reaching takeoff speed to get maximum benefit from nose wheel steering. This will greatly reduce wheel braking. To determine component headwind down the takeoff runway, and whether takeoff is recommended under crosswind conditions at the predicted minimum nose wheel liftoff speed, see Takeoff and Landing Crosswind Chart (figure A-5).

**CAUTION**

Crosswind takeoff ground run distance can be much greater than distances shown in the Takeoff Distance Charts, depending on wind velocity.

**Note**

Use of nose wheel steering will greatly facilitate directional control during crosswind takeoff and minimize use of brakes.

## AFTER TAKEOFF—CLIMB.

To gain altitude efficiently, first accelerate to the best climb speed at constant altitude, then climb, maintaining the best climb airspeed according to the type of climb desired. If a climb is started before reaching the best climb airspeed, total time and fuel consumption will be increased. The best power for climb depends on the performance required. Maximum thrust, military thrust, or normal thrust may be used. Optimum power settings for various performance requirements are described in the following paragraphs.

1. After takeoff, maintain approximate takeoff attitude to clear a 50-foot height at airspeeds given in applicable Takeoff Distance to Clear 50-Foot Obstacle chart in Appendix. (P)

**WARNING**

At takeoff airspeeds, aileron response may be somewhat less than at higher airspeeds. Takeoff airspeeds less than those recommended will aggravate this condition.

2. Landing gear lever—UP, when definitely airborne. (P)

**CAUTION**

Landing gear and landing gear doors should be up and locked and the light in the control handle out before exceeding the structural limit airspeed. Landing gear retraction at speeds in excess of structural limit airspeeds may result in partial gear retraction and possible loss of or damage to the main inboard landing gear doors. If "G" forces or sideslips are attempted during gear retraction, the maximum airspeed at which the landing gear will completely retract will be reduced.

**Note**

A priority valve in the hydraulic system gives priority to all flight controls over landing gear. Therefore, if the wing flaps are retracted before getting a safe uplock landing gear indication, the gear movement will be delayed until the flaps are up.

3. Wing flap lever—UP after attaining a safe gear and door UP indication and 160 knots IAS minimum (170 knots IAS if full pylon tanks are carried). (P)

**CAUTION**

Wing flaps must be fully retracted before reaching structural limit airspeed to avoid possibility of structural damage.

4. After reaching a safe altitude, increase airspeed to desired climbing speed. (P)

5. Static cord lanyard above minimum safe altitude—Disconnect. (P—RO)

6. Fuel gages—Check. (P)

7. Fuel gage selector switch—ALL. (P)

8. Oxygen diluter lever—NORMAL OXYGEN. (P—RO)

Return diluter lever to NORMAL OXYGEN as soon after takeoff as possible if takeoff was made using 100% OXYGEN because of suspected carbon monoxide contamination of cockpit.

**WARNING**

The oxygen diluter lever must be returned to NORMAL OXYGEN as soon as possible. Use of 100 percent oxygen could deplete the supply before the end of the mission.

9. IFF switch—As required. (P)

## CLIMB.

To gain altitude efficiently, first accelerate to the best climb speed at constant altitude, then climb, maintaining the best climb airspeed according to the type of climb desired. If a climb is started before reaching the best climb airspeed, total time and fuel consumption will be increased. The best power for climb depends on the performance required. Maximum thrust, military thrust, or normal thrust may be used. Optimum power settings for various performance requirements are described in the following paragraphs and will produce the results stated in the applicable Appendix Climb Charts. During climb the following should be accomplished at 5000 feet, 10,000 feet, and at level-off altitudes:

1. Oxygen—Check. (P—RO)

2. Altimeter and cabin altitude—Check for proper operation. (P—RO)

3. Engine instruments—Check operation. (P)

4. Wings and fuselage—Check. (P—RO)

### MAXIMUM RATE OF CLIMB.

To climb at the maximum rate (minimum time climb), use maximum power and maintain airspeed schedule shown in applicable Appendix Climb Charts.

### MINIMUM FUEL CLIMB.

To climb using minimum fuel without regard to distance gained, use military power at low altitudes and maximum power above 20,000-foot pressure altitude. Airspeeds shown in the applicable Appendix Climb Charts are suitable for this type of climb.

### MAXIMUM DISTANCE CLIMB.

To climb so that total distance covered, including cruise distance, is greatest for fuel consumed, use military power and maintain the airspeed shown in the applicable Appendix Climb Charts.

### MINIMUM DISTANCE CLIMB.

Depending on gross weight and power, minimum distance climb (maximum angle of climb) at low altitudes may be obtained at the airspeeds shown in figure A-10.

**Note**

- During locked throttle climb, engine rpm normally will not vary more than ±2%.
- Minimum distance climb is not a maximum rate of climb.

## CRUISE.

See Section VI and applicable Appendix charts for cruise characteristics of the airplane.

## FLIGHT CHARACTERISTICS.

See Section VI for flight characteristics of the airplane.

## DESCENT.

Any combination of power and speed brake position may be used during descent if the airspeed limitations in Section V are not exceeded. A normal descent provides a compromise in fuel, time, and distance and is ordinarily used during normal operation when loitering or while awaiting landing clearance. The descent is made at Mach 0.70 and idle power, maintaining the airspeeds specified in the Descent charts (figure A-28). With speed brakes fully open and engines at idle rpm, descents up to 30,000 fpm can be made without exceeding 350 knots IAS. Use the following procedure in making all descents:

1. Throttles and speed brakes—As required. (P)
2. Windshield defrosting system—As required. (P)
3. Canopy defogging system—As required. (P—RO)

Operate windshield defrosting system as required. Anticipate canopy fogging at low altitude and operate defogging system accordingly. Speed brakes can be used at any airspeed.

4. Altimeter—Set and cross-checked with radar observer prior to descent. (P)

## BEFORE LANDING.

Before entering traffic pattern, airspeed may be varied within wide limits with speed brakes. It is recommended that the pattern be entered at about 270 knots IAS with speed brakes closed, using 85% rpm. If an airspeed lower than 270 knots IAS is desired, open speed brakes in preference to reducing power.

**Note**

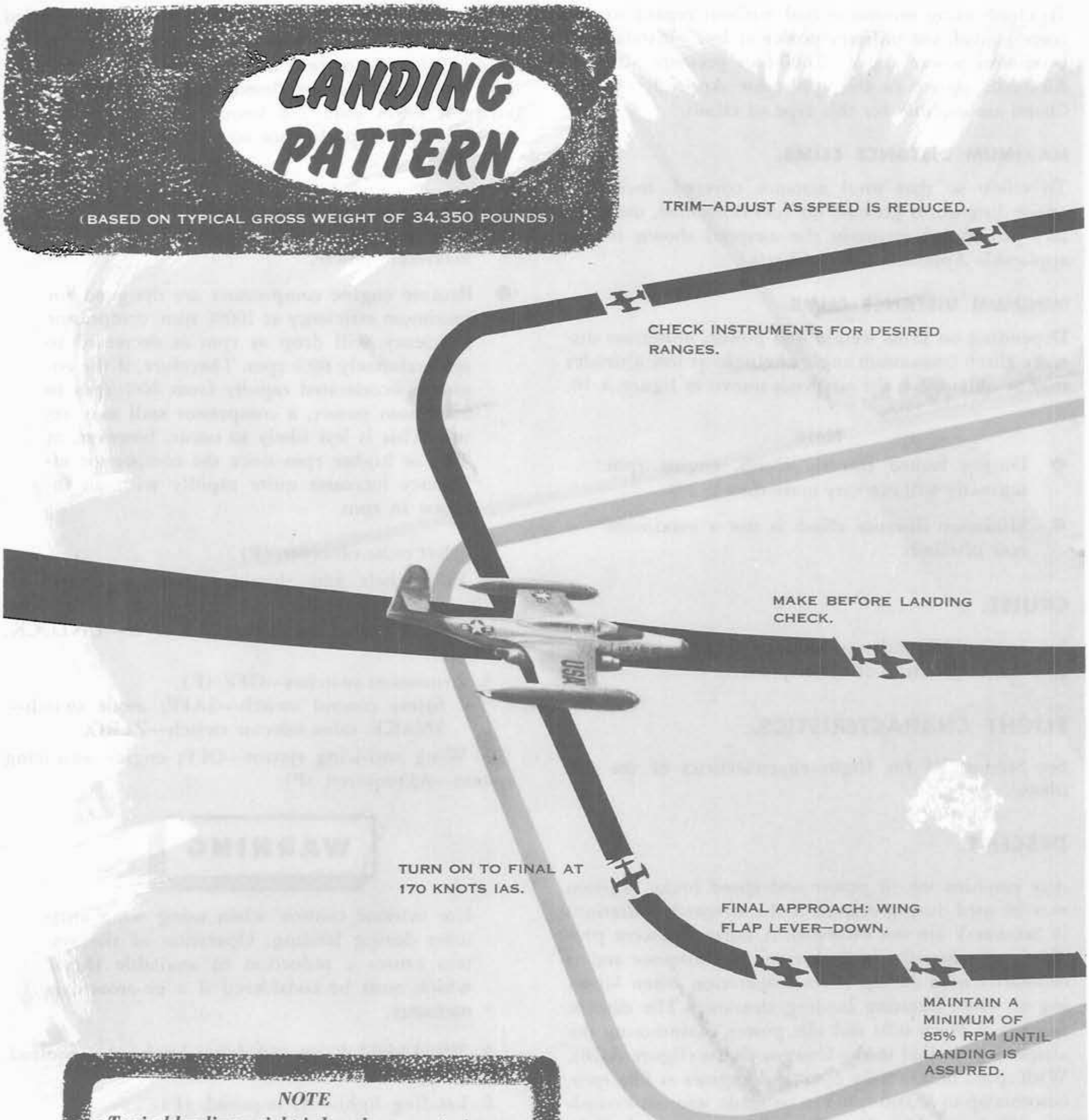
- When power is stabilized at 85% rpm, approximately 4 seconds are required to obtain maximum power.
- Because engine compressors are designed for maximum efficiency at 100% rpm, compressor efficiency will drop as rpm is decreased to approximately 80% rpm. Therefore, if the engine is accelerated rapidly from 80% rpm to maximum power, a compressor stall may result. This is less likely to occur, however, at 85% or higher rpm since the compressor efficiency increases quite rapidly with an increase in rpm.

1. Alert radar observer. (P)
2. Safety belt and shoulder harness—Tightened; static cord lanyard—Connect prior to reaching minimum safe altitude; inertia reel lock lever—UNLOCK. (P—RO)
3. Armament switches—OFF. (P)
   Safety control switch—SAFE; mode switch—SNAKE; salvo selector switch—ZERO.
4. Wing anti-icing system—OFF; engine anti-icing system—As required. (P)

**WARNING**

Use extreme caution when using wing anti-icing during landing. Operation of the system causes a reduction in available thrust which must be considered if a go-around is necessary.

5. Windshield de-ice and defog knob—As required. (P)
6. Landing light—As required. (P)
7. Brake accumulator and hydraulic pressure gages—Check. (P)
8. Engine screens—Extended. (P)
   Extend screens if any foreign objects are likely to enter engine intake ducts.
9. Enter traffic pattern at 270 knots IAS, using 85% rpm. (P)
10. Speed brake lever—OPEN. (P)
11. Airspeed 195 knots; speed brake lever—CLOSED. (P)
12. Landing gear lever—DOWN; check gear down. (P)




*NOTE*

- *Typical landing weight is based on a typical area intercept mission. Weight includes fuel for 20-minute loiter at sea level plus 5 percent total fuel and full armament.*
- *Increase landing speed 2 knots above speed cited on this landing chart for each additional 1000 pounds increase in gross weight.*

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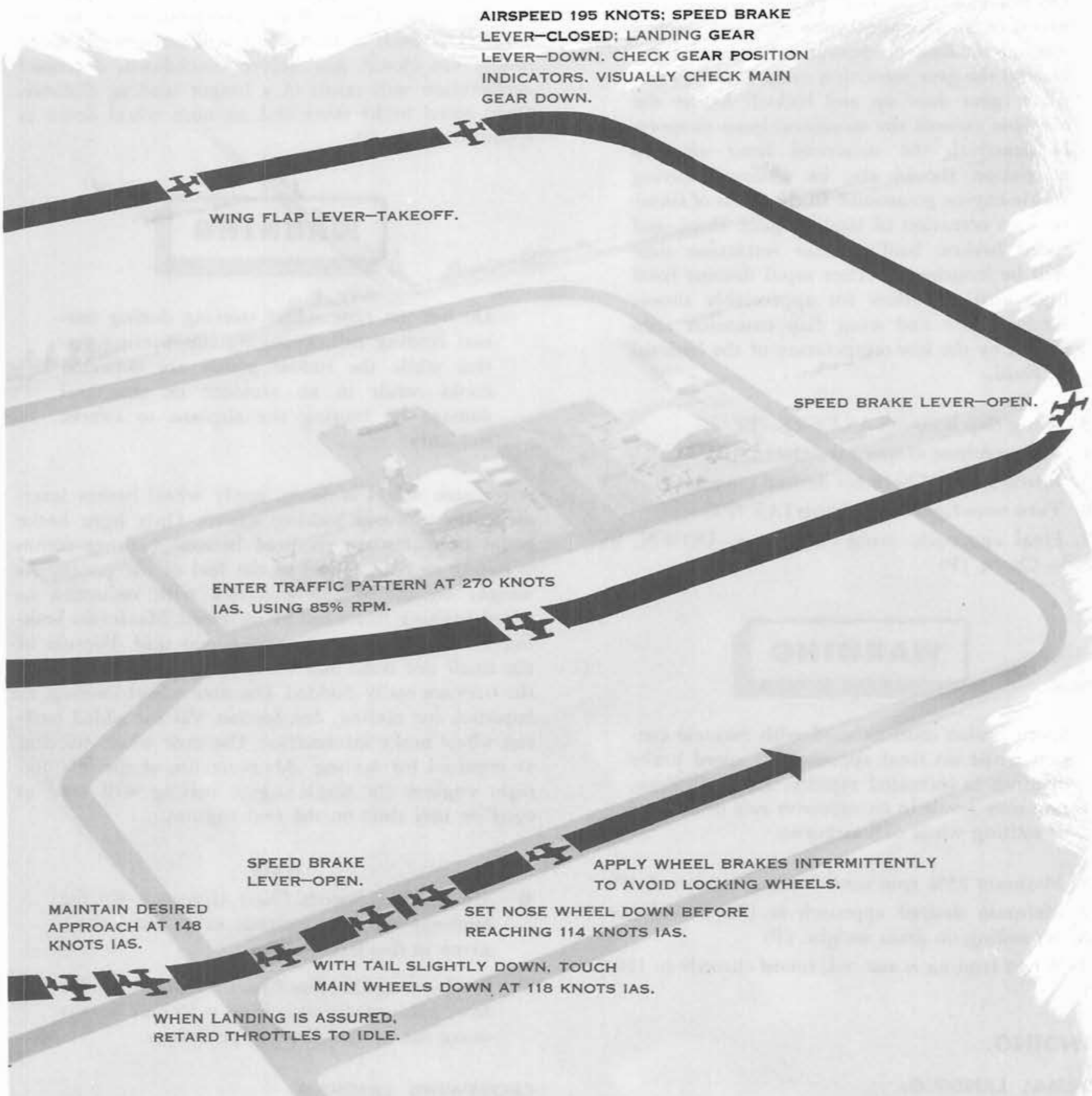
*Figure 2-5.*




***WARNING***

- *At higher gross weights, approach and touchdown speeds must be increased. See landing speeds chart in appendix for other weights and speeds.*

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**CAUTION**

Do not extend landing gear at airspeeds in excess of the structural limit airspeed. After a normal landing or during a two-engine go-around the gear retraction cycle must be complete (gear door up and locked) before the airplane exceeds the structural limit airspeed. If practical, the structural limit airspeed restriction should also be observed during single-engine go-around. In the event of simultaneous actuation of landing gear, flaps, and speed brakes, landing gear retraction time will be lengthened. After rapid descent from high altitude, allow for appreciably slower landing gear and wing flap extension rates caused by the low temperature of the hydraulic fluid.

13. Wing flap lever—TAKE-OFF. (P)
14. Trim—Adjust as speed is reduced. (P)
15. Instruments—Check for desired ranges. (P)
16. Turn onto final at 170 knots IAS. (P)
17. Final approach: wing flap lever—DOWN; airspeed—Check. (P)

**WARNING**

Speed brakes must be used with extreme caution while on final approach. If speed brake opening is increased rapidly, rapid deceleration may result in an excessive rate of descent or stalling while still airborne.

18. Maintain 85% rpm until landing is assured. (P)
19. Maintain desired approach at 131 to 156 knots IAS, depending on gross weight. (P)
20. When landing is assured, retard throttle to IDLE. (P)

## LANDING.

### NORMAL LANDING.

**Note**

The following procedure will produce the results stated in the applicable Landing Distance Chart (figure A-29) in the Appendix.

For the landing procedure refer to figure 2-5. Aside from the somewhat high stick force encountered during flareout, the airplane is easy to land. Tip and pylon tanks must be emptied before landing to prevent excessive loads in the tank attachment fittings. To avoid hard landings (touchdown at too high a rate of descent), do not open speed brakes fully until the airplane touches down. With tail slightly down, touch main gear down at applicable IAS given in Appendix Landing Speed Chart. Rapid deceleration of the airplane may result in stall while still airborne. If speed brakes are closed just before touchdown, decreased deceleration will result in a longer landing distance. Open speed brake lever and set nose wheel down at applicable airspeed.

**WARNING**

Do not use nose wheel steering during normal landing roll. Engaging the steering system while the rudder pedals are deflected could result in an accident or structural damage by causing the airplane to swerve suddenly.

After nose wheel is down, apply wheel brakes intermittently to avoid locking wheels. Only light brake pedal pressures are required because braking action is strong in comparison to the feel of the pedals. As weight on the wheels increases with reduction in speed, braking forces can be increased. Maximum braking occurs just before tires begin to skid. Because of the small tire tread and heavy weight of the airplane the tires are easily skidded. Use nose wheel steering, as required, for taxiing. See Section VII for added landing wheel brake information. Use nose wheel steering as required for taxiing. Alternate use of the left and right engines for single-engine taxiing will tend to equalize taxi time on the two engines.

**Note**

- See Landing Speeds Chart (figure A-30) for landings at gross weights other than those given in this section.
- See Landing Distance Chart (figure A-29) for total landing distance from a 50-foot height using the normal landing procedure.

### CROSSWIND LANDING.

Use normal landing procedure and correct for drift as necessary on approach and landing. To determine component headwind down the landing runway, and whether landing is recommended under crosswind conditions at the predicted minimum nose wheel touchdown speed, see Takeoff and Landing Crosswind Chart (figure A-5).

**Note**

Low aileron response will be experienced below 150 knots IAS.

**CAUTION**

Do not select more than 1/3 full speed brake opening prior to touchdown under crosswind landing conditions. Speed brake angles greater than 1/3 full open will impair lateral control as stall speed is approached.

### HEAVY WEIGHT LANDING.

Anticipate a higher airspeed on the final approach and also a greater ground speed and rolling distance with increased gross weight. Begin braking at the applicable speeds listed in the applicable Landing Distance Chart (figure A-29).

### MINIMUM RUN LANDING.

For a minimum ground run, normal landing procedure is followed with one exception: the right engine is shut down immediately after three-wheel contact. The thrust eliminated by shutting down the idling right engine will aid in reducing the landing roll. Leave the wing flaps extended to take advantage of aerodynamic braking on the landing roll. Exercise care in brake application before the full weight of the airplane is on the wheels, to avoid skidding.

### WET OR ICY RUNWAY LANDING.

Anticipate a 20 to 30 percent longer landing roll (considerably greater for an icy runway landing) than normal because of decreased braking friction. Use the normal landing technique of full flaps with full speed brakes immediately following touchdown and shut down the right engine immediately after three-wheel contact. Depend upon flap and speed brake drag for initial deceleration, and apply wheel brakes cautiously throughout the remainder of the landing roll to avoid skidding. Leave wing flaps fully extended until after turning off the runway. Open speed brakes after main gear touches down and leave extended until after turning off the runway.

## GO-AROUND.

Because of slow engine and airplane acceleration, make decision to go around as soon as possible. If a landing cannot be completed, use the go-around procedure shown below and in figure 2-6 as quickly as possible:

1. Throttles—OPEN (afterburners on if necessary). (P)
2. Speed brakes—CLOSED. (P)
3. Landing gear lever—UP (when definitely airborne). (P)
4. Wing flap lever—As required. (P)
   Gradually raise wing flaps as airspeed increases. See figure 6-2 for applicable stalling speeds.
5. Clear traffic as soon as adequate airspeed is attained. (P)

**CAUTION**

Landing gear and landing gear doors should be up and locked and the light in the control handle out before exceeding the structural limit airspeed.

## TOUCH-AND-GO LANDINGS.

Touch-and-go landings should be made only when authorized or directed by the major command concerned. Touch-and-go landings introduce a significant element of danger because of the many rapid actions which must be executed while rolling on the runway at high speed, or while flying in close proximity to the ground. This type landing can be safely accomplished with empty tip and pylon fuel tanks. Use caution in performing the cockpit procedures while maintaining directional control of the airplane. Use the following procedures in performing touch-and-go landings:

**Note**

- Prior to making touch-and-go landings, perform the Before Landing check.
- Maximum power should be used for all takeoffs.

### ON THE RUNWAY.

1. Throttles—Maximum power. (P)
2. Speed brakes—Closed. (P)
3. Wing flaps—Takeoff. (P)
4. Keep nose wheel on runway until nose wheel liftoff speed is attained. (P)
5. Gradually ease stick back to lift nose wheel, allowing airplane to fly itself off the runway at applicable airspeed. (P)

### AFTER TAKEOFF.

1. After takeoff maintain approximate takeoff attitude to clear a 50-foot obstacle at 129 to 154 knots IAS depending on gross weight. Trim airplane to eliminate excessive stick pressures. (P)

**WARNING**

- It is important to adhere to applicable airspeed since stalling will be approached at a lower airspeed, and takeoff distance will be increased appreciably at a higher airspeed.
- At takeoff airspeed, aileron response may be somewhat less than at higher airspeeds. Takeoff airspeeds less than those recommended will aggravate this condition.

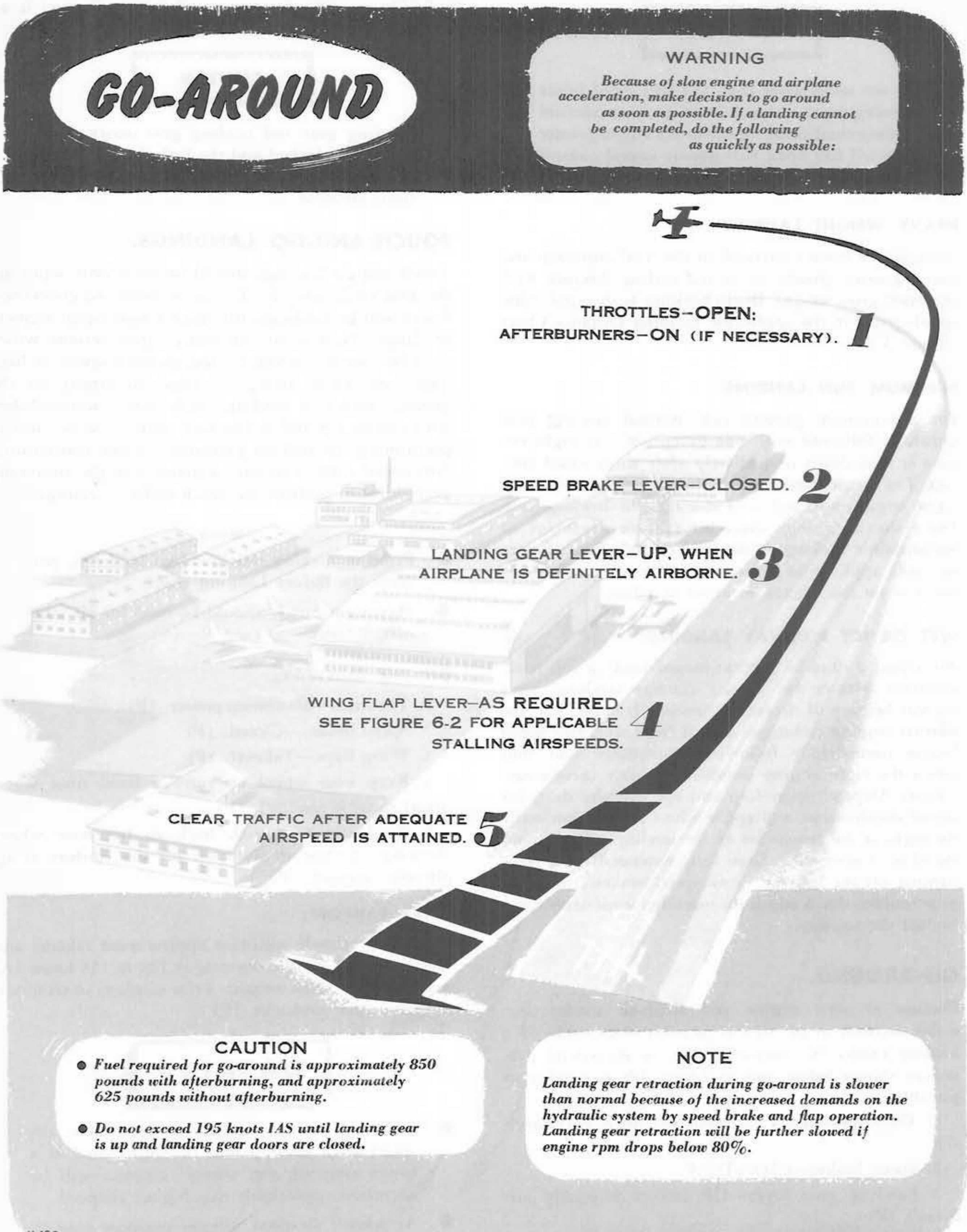
GO-AROUND
WARNING
Because of slow engine and airplane acceleration, make decision to go around as soon as possible. If a landing cannot be completed, do the following as quickly as possible:
THROTTLES–OPEN: AFTERBURNERS–ON (IF NECESSARY). 1
SPEED BRAKE LEVER–CLOSED. 2
LANDING GEAR LEVER–UP, WHEN AIRPLANE IS DEFINITELY AIRBORNE. 3
WING FLAP LEVER–AS REQUIRED. SEE FIGURE 6-2 FOR APPLICABLE STALLING AIRSPEEDS. 4
CLEAR TRAFFIC AFTER ADEQUATE AIRSPEED IS ATTAINED. 5
CAUTION
• Fuel required for go-around is approximately 850 pounds with afterburning, and approximately 625 pounds without afterburning.
• Do not exceed 195 knots IAS until landing gear is up and landing gear doors are closed.
NOTE
Landing gear retraction during go-around is slower than normal because of the increased demands on the hydraulic system by speed brake and flap operation. Landing gear retraction will be further slowed if engine rpm drops below 80%.
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*Figure 2-6.*

2. Landing lever—UP, when definitely airborne. (P)

CAUTION

Landing gear should be up and locked and the light in the control handle out before exceeding 195 knots IAS. Landing gear retraction at speeds in excess of 195 knots IAS may result in partial gear retraction and possible loss of or damage to the main gear landing gear doors. If "G" forces or sideslips are experienced during retraction the maximum airspeed at which the landing gear will completely retract will be reduced.

3. Wing flap lever—UP. (P)

CAUTION

Wing flaps must be fully retracted before reaching structural limit airspeed to avoid possibility of structural damage.

4. Fuel gages—Check. (P)

5. Throttles—As required to maintain desired altitude and airspeed. (P)

**BEFORE LANDING (AFTER TOUCH-AND-GO).**

When a series of touch-and-go landings are to be made, reenter traffic pattern as locally required. Enter the traffic pattern using 85% rpm and maintaining approximately 270 knots IAS with speed brakes closed. If an airspeed lower than 270 knots IAS is desired, open speed brakes in preference to reducing power. Do not extend landing gear at airspeeds in excess of 195 knots IAS. After a normal landing or during a two-engine go-around the gear retraction cycle must be complete (gear door up and locked) before the airplane exceeds 195 knots IAS. Prior to touch-and-go landing perform Before Landing check.

**Note**

After completion of last touch-and-go landing, perform the After Takeoff Climb of After Landing check as applicable.

## AFTER LANDING.

After nose wheel is down, apply wheel brakes intermittently to avoid locking wheels. Only light brake pedal pressures are required because braking action is strong in comparison to the feel of the pedals. As weight on the wheels increases with reduction in speed, braking forces can be increased. Maximum braking occurs just before tires begin to skid. Because of the small tire tread and heavy weight of the airplane the tires are easily skidded. Use nose wheel steering as required for taxiing. Alternate use of the left and right engines for single-engine taxiing will tend to equalize taxi time on the two engines.

CAUTION

- When a demand is made on the supplemental pump by operation of any left hydraulic system control, the supplemental pump must not be in operation for a period of time greater than 6 minutes, followed by a rest period of 15 minutes.
- When no demand is made on the supplemental pump by operation of any left hydraulic system control, the supplemental pump should not be in operation for more than 30 minutes.

WARNING

- If carbon monoxide contamination is anticipated during ground operation, oxygen should be used with the diluter lever at 100% OXYGEN.
- Do not use nose wheel steering during a normal landing. Engaging the steering system while the rudder pedals are deflected could result in an accident or structural damage by causing the airplane to swerve suddenly.

CAUTION

- Nose wheel tires will be severely damaged if maximum deflection turns are attempted at rolling speeds in excess of 10 knots.
- If the normal hydraulic brake pressure is lost, release brake pedals, turn the emergency airbrake handle to ON, and operate the brake pedals with *caution.* The emergency airbrake system will supply enough pressure for three complete brake applications.

**Note**

Adequate hydraulic pressure in the left system will be maintained during final approach through actuation of the supplemental pump by the landing gear lever switch. After touchdown, the pump will stop but will start again as brake accumulator pressure drops to between 1100 and 800 psi when the airplane is decelerated.

1. Turn off runway and come to a complete stop. (P)
2. Safety pins—Insert in ejection seat and canopy jettison mechanism. (P—RO)
3. Cabin air switch—RAM and DUMP (before opening canopy). (P)
4. Armament safety plug—Remove. (P)
5. With engines at *idle* have *external* engine screens installed. (P)
6. Wing flap lever—UP. (P)
7. Speed brake lever—CLOSED. (P)
8. Trim—Reset to TAKE-OFF. (P)
9. Anti-icing, windshield de-ice and defog and pitot heat switches—OFF. (P)
10. IFF—OFF. (P)
11. Taxi light—As required. (P)

## STOPPING ENGINES.

**WARNING**

To minimize the danger of explosion or fire due to fuel vapor, park the airplane into the wind when possible. Wait at least 15 minutes after engine operation (flight or ground) before going near the jet exhaust.

1. Parking brakes—Set. (P)
2. Canopy—Open. (P)
3. Flight controls—Neutral. (P)
4. Engines—Run up before shutdown. (P)
   If engines have been operating at normal rated thrust or above (with or without afterburning) for 5 minutes or more, either in flight or on the ground, operate the engines at idle to 70% rpm whichever rpm gives the lowest exhaust gas temperature for at least 3 to 5 minutes before shutting down, except in an emergency. During flight operation, approach and taxi time may be considered as part of this period.

**Note**

The preceding procedure will eliminate possible shroud ring segment warpage, overheated bearings, and the possibility of raw fuel accumulating in the afterburners and igniting from hot engines.

5. Throttles—CLOSED. (P)
   Move past IDLE stop to CLOSED by raising fingerlifts. Throttle friction lever—INCREASE.
6. Fuel selector switches—PUMPS OFF. (P)
7. All other switches—OFF except generator switches. (P—RO)

## BEFORE LEAVING AIRPLANE.

Surface control locks (except for speed brake locks) are not necessary because of the irreversible hydraulic control system.

1. Wheels—Chocked, and brakes released. (P)
2. All ground safety pins—Check installed. (P—RO)
3. Check that oxygen tube, radio cord, and personal equipment are properly stowed. (P—RO)

**WARNING**

- To prevent parachute from being opened inadvertently when wearing an automatic opening aneroid-type parachute that has a key attached to the aneroid arming lanyard, make sure the key does not foul when leaving cockpit.
- When leaving airplane, make certain that no personal equipment which could become entangled with the seat armrests when the canopy is closed or opened is left in the cockpit. Otherwise, the canopy may be accidentally jettisoned with attendant personnel injury.

4. Complete DD Form 781. (P)

**CAUTION**

To ensure inspection and maintenance of the airplane, make appropriate entries in the Form 781 covering any airplane limitations that have been exceeded during the flight. Entries must also be made when 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.

5. Check pitot covers on; landing gear ground locks installed. (P)

**CAUTION**

When leaving the airplane unattended, close and lock the canopy. This inflates the canopy seal, preventing moisture and dust from entering the cockpit.

**Note**

The following checklist is an abbreviated version of the procedures presented in the amplified checklists of Section II. This abbreviated checklist is arranged so you may remove it from your flight manual and insert it into a flip pad for convenient use. It is arranged so that each action is in sequence with the amplified procedure given in Section II. Presentation of the abbreviated checklist does not imply that you need not read and thoroughly understand the amplified version. To fly the airplane safely and efficiently you *must* know the reason why each step is performed and why the steps occur in certain sequence.

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SECTION III

# EMERGENCY PROCEDURES

HF-3B

TABLE OF CONTENTS



Procedure steps in this section are followed by the symbols P, RO, or P—RO in parentheses to indicate whether the particular step is applicable to the pilot, radar observer, or both crewmembers.

## ENGINE FAILURE.

### SINGLE-ENGINE FLIGHT CHARACTERISTICS.

Single-engine directional flight control characteristics are essentially the same as normal flight characteristics because of the proximity of the thrust lines to the centerline of the airplane. With one engine inoperative, very little rudder trim is required. Thus, good control is assured in the single-engine range. Minimum single-engine control speed is airspeed at stall. This airspeed varies with gross weight, wing flap setting, speed brake setting, and acceleration (such as that encountered in banks and pull-ups). An airspeed of 160 knots IAS (170 knots IAS if pylon tanks are full) is a safe minimum for all weights, all flap settings, all speed brake settings, and moderate accelerations. See figure 3-1 for single-engine service ceilings. In single-engine flight where only military power (100% rpm without afterburning) is available on the operating engine, there are certain airplane configurations in which level flight cannot be maintained. At a typical takeoff gross weight of 42,000 pounds (pylon tanks empty or dropped), one engine windmilling, flaps down 30 degrees or more, and with the landing gear *up* or *down*, it is impossible to maintain level flight. With the flaps *up* and the landing gear *up* or *down*, level flight is possible; however, until the landing gear is retracted or afterburning initiated, performance will be marginal and any turns or maneuvers may be accompanied by a loss of altitude.

### SINGLE-ENGINE PROCEDURE.

Immediately after experiencing engine failure in flight it is important to reduce drag to a minimum while maintaining IAS and directional control while investigating for the cause of the engine failure. If the cause of the malfunction cannot be determined, or if it is not safe to continue operation, the procedure given below should be followed for shutting down an engine in flight.

1. Throttle (inoperative engine)—CLOSED. (P)
2. Gear and flaps—Retract, if extended. (P)

**WARNING**

The throttle for the inoperative engine should be closed. If the throttle is left open, the throttle controlled fuel shutoff valve will be open allowing fuel to be metered through the engine.

3. Engine fire selector switch for inoperative engine—Raise guard and actuate switch. (P)

**Note**

If the right engine fire selector switch is actuated and the right engine fuel selector switch is at ALL TANKS, fuel from the right main tank only will be available for crossfeed operation. Wing tank fuel in the right system will not be available until the fuel selector switch is moved to WING TANKS.

4. Agent discharge switch—Actuate if necessary. (P)

**CAUTION**

Do not actuate agent discharge switch unless engine is on fire. This is a "one-shot" system, and until the extinguisher bottle has been replaced, there will be no further fire protection available.

5. Generator switch(es) (inoperative engine)—OFF. (P)
6. Inverter switches—As required. (P)
7. Unnecessary electrical equipment—Off. (P—RO)
8. Crossfeed switch—OPEN. (P)
9. Fuel selector switches—ALL TANKS. (P)

**WARNING**

If right engine is inoperative, do not operate speed brakes unless left engine rpm is at least 85% or the supplemental pump is operating. At lower rpm, the demand of speed brake operation on the hydraulic system causes limited aileron control unless supplemental pump pressure is available.

## SINGLE-ENGINE SERVICE CEILING

NOTE: *All altitudes are pressure altitudes in feet*

*Without pylon tanks*

| GROSS WEIGHT (Lb) | ALTITUDE STD DAY 59°F (15°C) AT SL — 96% RPM without AB | ALTITUDE STD DAY — 100% RPM without AB | ALTITUDE STD DAY — 100% RPM with AB | ALTITUDE HOT DAY 99°F (37°C) AT SL — 96% RPM without AB | ALTITUDE HOT DAY — 100% RPM without AB | ALTITUDE HOT DAY — 100% RPM with AB |
|---|---|---|---|---|---|---|
| 44,000 | 5900 | 9350 | 22,900 | —— | 6400 | 19,800 |
| 40,000 | 9500 | 11,900 | 26,000 | * 900 | 8900 | 23,000 |
| 36,000 | 13,000 | 14,800 | 29,700 | * 7900 | 11,800 | 26,200 |
| 32,000 | 16,700 | 18,300 | 32,900 | 13,900 | 14,850 | 29,600 |

DATA AS OF: *14 August 1957* DATA BASIS: *Flight test*

* WITH POWER REDUCED TO PREVENT EXCEEDING EXHAUST GAS TEMPERATURE LIMIT.

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*Figure 3-1.*


10. Power on good engine—Readjust. (P)
11. Trim for straight and level flight. (P)

## ENGINE FAILURE DURING TAKEOFF (BEFORE LEAVING GROUND).

### Takeoff Aborted.

If an engine fails before leaving the ground, continuing the takeoff depends upon length of runway, configuration, gross weight, airspeed at time of failure, field elevation, and ambient temperature. To help the pilot make a decision, single-engine takeoff distances for various gross weights, altitudes, and ambient temperatures are shown in the Appendix, figure A-6. This chart gives entire takeoff distance with one engine operating at maximum power, and is to be used only if an engine fails during the takeoff roll. If a decision to stop is made, use the following procedure:

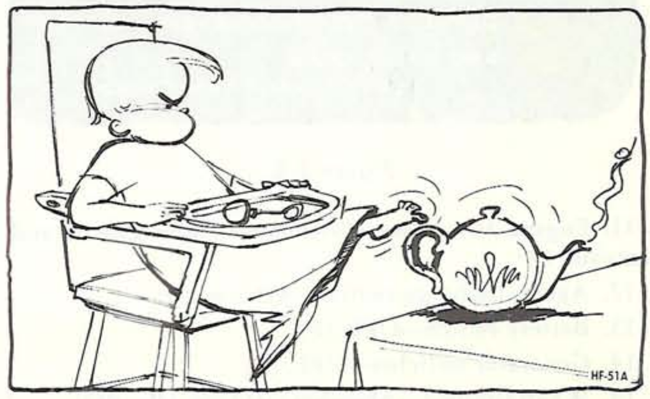
1. Alert radar observer. (P)
2. Throttles (both engines)—CLOSED. (P)
3. Nose wheel steering button—As required. (P)
4. Speed brake lever—OPEN. (P)
5. Wheel brakes—Apply (maximum braking occurs at a point just before tires skid). (P)

**WARNING**

If hydraulic pressure is insufficient for adequate braking, depress the nose wheel steering button. This energizes the 2500-psi supplemental pump which will provide adequate pressure for braking. If this should fail, use the emergency airbrake system.

6. Emergency airbrake system—As required. (P) If hydraulic pressure is insufficient for adequate braking, use the emergency airbrake system.

7. Canopy—Jettison with canopy jettison "T" handle. (P)
8. Inertia reel—Lock. (P—RO)




**Note**

All equipment should be set as required before locking inertia reel, as some smaller pilots may find it difficult to reach such items as the canopy fast jettison "T" handle after the inertia reel is locked.

9. Steer for smoothest terrain if remaining runway is insufficient for stopping. (P)
10. If necessary, raise landing gear by depressing the emergency override lever and simultaneously moving the landing gear lever to UP. (P)

**Note**

- Leave landing gear lever in DOWN position if runway is equipped with Type MA-1A runway overrun barrier and aircraft is modified to contain the necessary arresting gear equipment.
- If the left engine fails, depress the nose wheel steering button. This will energize the left hydraulic system supplemental pump which in turn will supply adequate hydraulic pressure to all units normally supplied by the left hydraulic system engine-driven pump.

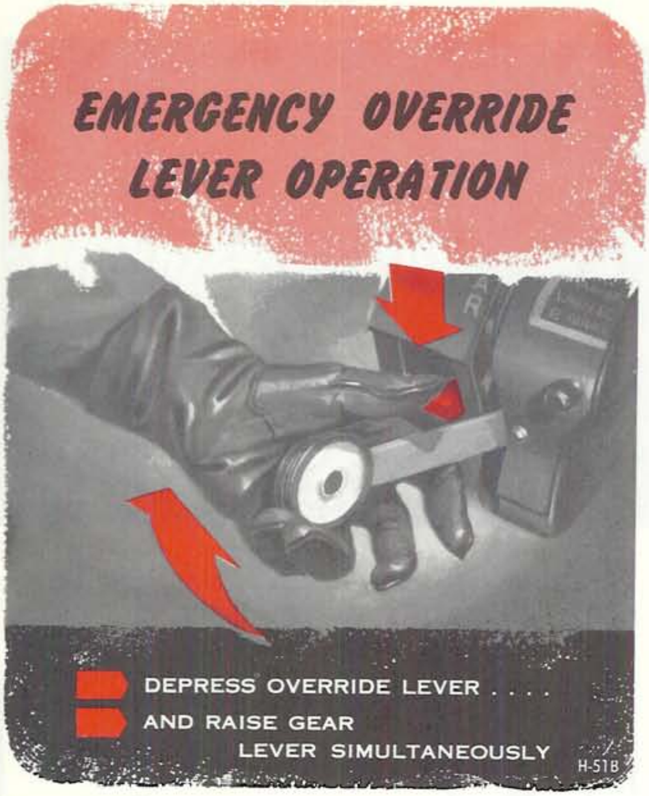



*Figure 3-2.*

11. Engine fire selector switches—Raise guards and actuate. (P)
12. Agent discharge switch—Actuate. (P)
13. Battery switch—OFF. (P)
14. Generator switches—OFF. (P)
15. When stopped—Abandon airplane. (P—RO)

**ENGINE FAILURE DURING TAKEOFF (AFTER LEAVING GROUND).**

If an engine fails immediately after takeoff, lateral and directional control of the airplane can be maintained if airspeed remains above stalling speed, but ability to maintain altitude or to climb depends upon gross weight, airplane configuration, and air density. Figure 3-3 shows the maximum gross weights at which a 100 feet-per-minute rate of climb can be maintained with landing gear down and flaps at takeoff for clean configuration and pylon tank configuration. For engine failure immediately after takeoff, use the following applicable procedure:

**Takeoff Continued.**

1. Warn radar observer of engine trouble. (P)
2. Landing gear and flaps—As required. (P)

**Note**

- If an immediate obstacle must be cleared, do not retract gear until obstacle is cleared. Retraction of the gear creates considerable additional drag. If the airplane is accelerating and no immediate obstacle must be cleared, the gear should be retracted.
- If the left engine fails, depress the nose wheel steering button. This will energize the left hydraulic system supplemental pump which in turn will supply adequate hydraulic pressure to all units normally supplied by the left hydraulic system engine-driven pump.

3. External stores—Jettison. (P)

**CAUTION**

When the pylon tanks are jettisoned manually (gravity drop), minor damage to the airplane may result.

4. Tip tank dump button—Press. (P)

**WARNING**

To completely dump full tip tanks will require approximately 90 seconds; therefore, the weight reduction will be gradual rather than instantaneous.

5. Throttle (inoperative engine)—CLOSED. (P)
6. Engine fire selector switch for inoperative engine—Raise guard and actuate. (P)
7. Agent discharge switch—As required. (P)
8. If obstacle must be cleared, hold airspeed at minimum safe value above stall to maintain best angle of climb. (P)
9. After obstacle is cleared, allow airspeed to increase to 160 knots. (P)
10. Wing flap lever—UP, at 160 knots. (P)

**WARNING**

Do not raise wing flaps below 160 knots IAS because maximum lift will be reduced, possibly below the minimum required to maintain altitude.

11. Electrical equipment (nonessential)—Off. (P—RO)

12. Trim—As required. (P)
13. Crossfeed switch—OPEN. (P)
14. Generator switch(es) for inoperative engine—OFF. (P)

**Continued Flight Impossible.**

1. Warn radar observer of impending forced landing. (P)
2. Lower nose to maintain flying speed. Prepare to land straight ahead if possible. Alter course only to miss obstacles. (P)
3. External stores—Jettison. (P)

**WARNING**

- Do not jettison armament unless area is suitable.
- Do not dump tip tank fuel as this will increase fire hazard.

4. Landing gear lever—DOWN. (P)

**WARNING**

GAR-1 missiles can be jettisoned only by firing them in an unarmed condition. Therefore, make certain area ahead of airplane is uninhabited.

5. Wing flaps—As required (if left engine or supplemental pump is operating). (P)
6. Speed brakes—As required. (P)
7. Throttles—CLOSED. (P)

**WARNING**

Do not dump wing tip fuel as this will increase fire hazard.

*Without pylon tanks*

***Weight in pounds at which 100 feet per minute rate of climb can be maintained with gear down, flaps in takeoff position, and maximum power.***

| FIELD ELEVATION (Feet) | AMBIENT TEMPERATURE -10°C (+14°F) | +10°C (+50°F) | +30°C (+86°F) | +50°C (+122°F) |
|---|---|---|---|---|
| 5000 | 40,100 | 37,050 | 31,920 | — |
| 4000 | 41,620 | 38,200 | 33,140 | — |
| 3000 | 43,175 | 39,760 | 34,350 | — |
| 2000 | 43,175 | 41,200 | 35,640 | 28,800 |
| 1000 | 43,175 | 42,780 | 36,980 | 29,850 |
| SEA LEVEL | 43,175 | 43,175 | 38,300 | 30,900 |

DATA AS OF: *14 August 1957*

DATA BASIS: *Flight Test*

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*Figure 3-3.*

8. Canopy—Jettison with canopy jettison "T" handle. (P)

9. Inertia reel lock lever—LOCKED. (P—RO)

10. Engine fire selector switches—Raise guards and actuate. (P)

11. Agent discharge switch—As required. (P)

12. Generator switches—OFF. (P)

13. Battery switch—OFF just before touchdown. (P)

**Note**

When the battery switch is placed at OFF, the left hydraulic system supplemental pump will be deenergized.

14. When stopped—Abandon airplane. (P—RO)

## ENGINE FAILURE DURING FLIGHT (LEFT OR RIGHT ENGINE).

If an engine fails during flight, investigate to determine the cause before attempting an air restart. It is recommended that the fuel system be checked first for proper operation. If the failure is caused by improper fuel system operation and the condition is corrected, restart the engine. (See Restarting Engine in Flight, this section.) If failure is caused by mechanical breakdown, as may be indicated by engine instruments or excessive vibration, the engine should be shut down. See figure 3-1 for single-engine service ceilings and applicable appendix charts for single-engine operating data. For procedure on shutting down engine in flight, see Single Engine Procedure, this section.

**Note**

If both engines fail and no restart is to be attempted, turn battery switch to OFF to conserve electrical power needed to operate the left hydraulic system supplemental pump for an emergency landing.

**WARNING**

If both engines fail, battery switch must be turned to ON again to operate supplemental pump.

## RESTARTING ENGINE IN FLIGHT.

For best starting conditions and wherever practical, attempt air starts at 20,000 feet or below.

**Note**

Before a restart is attempted and the igniter plugs are energized, fly the airplane in a nose high attitude (5 to 10 degrees above the horizontal) to drain excess fuel from engine.

A normal air restart can be made if the engine rpm is at least 12.5% and the airspeed is approximately 170 to 250 knots IAS. If both engines have failed, no attempt should be made to restart both engines at the same time. Battery power may be insufficient for simultaneous ignition of both engines; therefore it is recommended that only one engine be started at a time. Successful air starts after double flameout are dependent upon sufficient altitude and battery power. When above 20,000 feet, conserve battery power while descending to 20,000 feet or below, by turning fuel selector switches to OFF position, main power inverter to OFF position, and all other unnecessary electrical equipment off. Normally the left engine will be started first, unless there are known reasons for a hazardous or unlikely left engine restart. Place the fuel selector switch, for the engine to be restarted, in a position other than the position existing at the time of flameout, provided there is sufficient fuel in the new selection. This will cause relays and valves to recycle and may clear up the difficulty. Place the crossfeed switch at CLOSED and turn the power inverter to ON. Restart the selected engine and when rpm and exhaust gas temperature are stabilized, restart the other engine. If the second engine fails to start, place the crossfeed switch to OPEN and attempt another start. If a double flameout is experienced at low altitude, the fuel selection for the engine to be restarted first should be changed, provided there is sufficient fuel remaining in the new selection and time permits. The following procedure should be used for all air starts:

**CAUTION**

- Do not attempt to restart both engines at the same time.
- Failure to windmill at least 12.5% rpm indicates damage to an engine. Under this condition, do not attempt an air start.

1. Throttle—CLOSED. (P)

2. Fire selector switch—Check OFF. (P)

3. Fuel selector switch—Change tank selection provided there is fuel remaining in new selection. (P)

4. Crossfeed switch—CLOSED. (P)

5. Power inverter—ON. (P)

6. Altitude start switch—ALTITUDE START momentarily (for selected engine only). (P)

7. Throttle—IDLE (rpm and exhaust gas temperature stabilized) then advance to desired rpm. (P)


*Figure 3-4.*

8. If starting is unsuccessful, attempt another start at a lower altitude. In case of double flameout, reduce electrical load and attempt another start at lower altitude. (P)

**MAXIMUM GLIDE.**

For the distance this airplane will glide, power off, at various gross weights, refer to figure 3-4. During descent, the speed of the windmilling engines will be high enough to supply power to the hydraulic system for normal descent operation of the flight controls, provided that engine rpm on either engine does not drop below 10%. The supplemental pump should be used to ensure adequate control for landing; but to conserve battery power, the system should be left off until final approach. This can be done by turning off the battery switch before lowering the landing gear, lowering the landing gear with the emergency handle, and turning the battery switch on again when turning onto the final approach.

**CAUTION**

- Supplemental pump must not be in operation for more than 6 minutes, followed by a rest period of 15 minutes, when a demand is made on the pump by operation of any left hydraulic system control.
- Supplemental pump should not be in operation for more than 30 minutes when no demand is made on the pump by operation of any left hydraulic system control.

**WARNING**


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The battery will supply power for the operation of the supplemental hydraulic pump for a very limited time only, even with the electrical load reduced to a minimum.

## LANDING WITH ONE ENGINE INOPERATIVE.

If a landing with one engine is necessary, dump tip tank fuel and drop pylon tanks. Approach the airport at 250 knots IAS using no more than the following engine rpm:

| *Ambient Temperature* | *Engine RPM* |
|---|---|
| 50°C | 93% |
| 30°C | 92% |
| 10°C | 91% |

**WARNING**

If more than above power is required to sustain level flight at 250 knots IAS, gross weight must be reduced before landing; otherwise, reserve power may not be adequate to maintain desired approach path after landing gear and flaps are lowered.

**Note**

At airspeeds below 160 knots IAS, it may be necessary to lose altitude in order to increase airspeed. Bear this in mind if single-engine landing becomes necessary and there is the slightest chance that a go-around may be necessary.

The downwind leg of the pattern should be extended for a single-engine landing so that a lower than normal approach angle will be flown, thus allowing the use of higher engine rpm in case a go-around is necessary. Wing flaps are available with either or both engines inoperative. In the event of electrical failure, the radar observer can normally maintain brake accumulator pressure by pumping the hydraulic handpump so that the emergency airbrake system need not be used. If it becomes necessary to use the airbrakes during the landing roll, the pilot should apply the brakes carefully since they are very sensitive and effective. Do not pump the brakes because air is lost each time pedal pressure is released.

**WARNING**

Do not extend flaps below the takeoff position. If flaps are extended below takeoff position, they must be raised to at least the takeoff position in case of a go-around. Single engine go-around with flaps in full down position is impossible because level flight cannot be maintained.

### Right Engine Inoperative.

See Single-Engine Landing Pattern, figure 3-5.

1. Airspeed—Decelerate to 195 knots IAS on downwind leg. (P)
2. Landing gear lever—DOWN. (P)

**Note**

Lowering the landing gear by the emergency procedure will not affect subsequent normal operation.

3. Wing flap lever—TAKE OFF. (P)

**WARNING**

Do not extend flaps below the takeoff position. If flaps are extended below takeoff position, they must be raised to at least the takeoff position in case of a go-around. Single engine go-around with flaps in full down position is impossible because level flight cannot be maintained.

4. Airspeed—Stabilize at 180 knots IAS. (P)
5. Turn onto final and stabilize at 160 knots IAS. Fly a lower than normal approach angle so that high

rpm can be used. Use of high rpm will reduce the time needed to obtain maximum power should a go-around be necessary. (P)

6. Do not reduce airspeed below 160 knots IAS until landing is assured. (P)

7. Throttle—Retard to idle only when positive of landing. (P)

8. Speed brakes—OPEN, after touchdown to reduce ground roll. (P)

**Left Engine Inoperative.**

See Single-Engine Landing Pattern, figure 3-5.

1. Airspeed—Reduce to 195 knots IAS on downwind leg. (P)
2. Landing gear lever—DOWN. (P)
3. Landing gear emergency release handle—Pull. (P)
4. Landing gear position—Check. (P)
5. Emergency landing gear release handle—STOWED. (P)
6. Wing flap lever—TAKE OFF. (P)
7. Airspeed—Stabilize at 180 knots IAS. (P)
8. Turn onto final and maintain 160 knots IAS. Fly a lower than normal approach angle so that high rpm can be used. Use of high rpm will reduce the time needed to obtain maximum power should a go-around be necessary. (P)
9. Maintain 160 knots IAS until landing is assured. (P)
10. Throttle—Retard to IDLE when positive of landing. Speed brakes—OPEN after touchdown. (P)

## LANDING WITH BOTH ENGINES INOPERATIVE.

See Forced Landing, figure 3-6.

## SINGLE-ENGINE GO-AROUND.

The greater the speed when the decision is made to go around, the shorter the go-around distance. If doubt exists as to the landing, an immediate decision to go around will save considerable distance. When the go-around decision is made, complete the following steps in the order given:

1. Throttle (on operating engine)—OPEN. (P)
2. Afterburner (on operating engine)—ON (above 90% rpm). (P)
3. Speed brake lever—CLOSED. (P)
4. Wing flaps—20 degrees. (P)

**WARNING**

- Single-engine go-around with flaps in full down position must never be attempted because level flight cannot be maintained.
- During level flight accelerations at go-around airspeeds, greater acceleration will result with 20 degrees of flaps than with takeoff position of 30 degrees. Any flap setting lower than the takeoff setting should be reduced to at least the takeoff position immediately after decision to go around has been made.

5. Landing gear lever—UP. (P)

**Note**

- If an immediate obstacle must be cleared, do not retract gear until obstacle is cleared. Retraction of the gear creates considerable additional drag. If the airplane is accelerating and no immediate obstacle must be cleared, the gear should be retracted.
- Landing gear should be up and locked and the light in the control handle out before exceeding the structural limit airspeed.

6. Allow airplane to accelerate to 160 knots IAS before attempting climbout. If possible, stay close to the runway to take advantage of "ground effect." (P)

A loss in airspeed of 5 to 10 knots should be anticipated in leveling out. Should the airspeed be below 145 knots before roundout, the airplane should be allowed to touch down and accelerate on the runway. If a go-around must be made after airplane touchdown, accelerate to a minimum of 135 knots IAS before liftoff is attempted. If runway distance is available, attain more than 135 knots before liftoff. After takeoff and if conditions allow, take advantage of "ground effect" by holding the airplane close to runway.

## SINGLE-ENGINE TAKEOFF.

Single-engine takeoffs are not recommended for this airplane. A single-engine takeoff chart (figure A-6) is shown in the Appendix, but this chart is to be used only for reference if an engine fails during takeoff.

## SIMULATED SINGLE-ENGINE FLAMEOUT.

A single-engine flameout may be simulated by retarding the throttle (on simulated inoperative engine) to IDLE, opening the throttle on the operating engine as required, and placing the speed brake lever at 1/8 of quadrant travel (opening speed brakes 15 degrees).

## SIMULATED FORCED LANDING.

A two-engine flameout may be simulated for practicing forced landings by retarding the throttles to 85% rpm and opening the speed brake lever approximately 70 degrees (see figure 3-6).

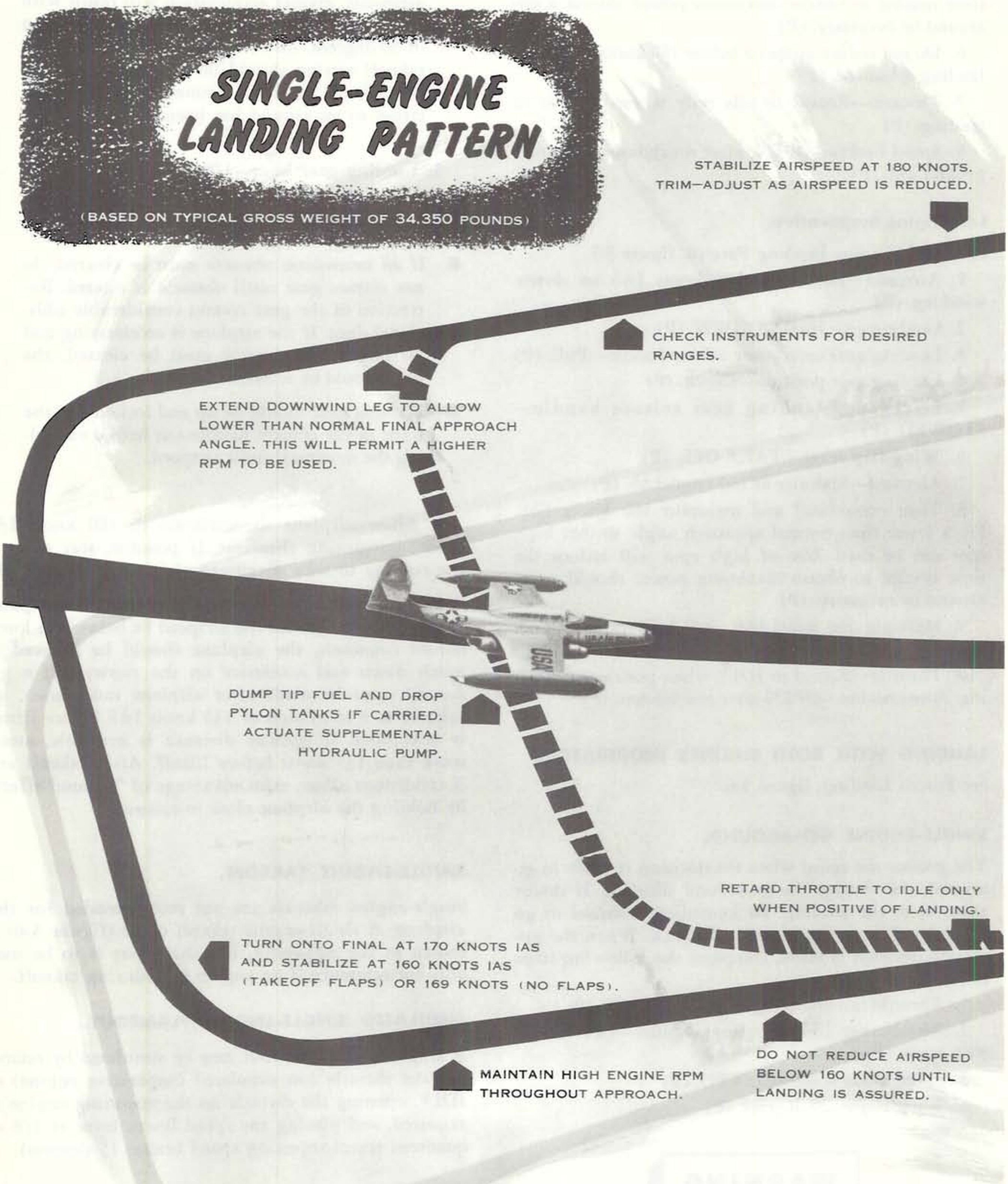


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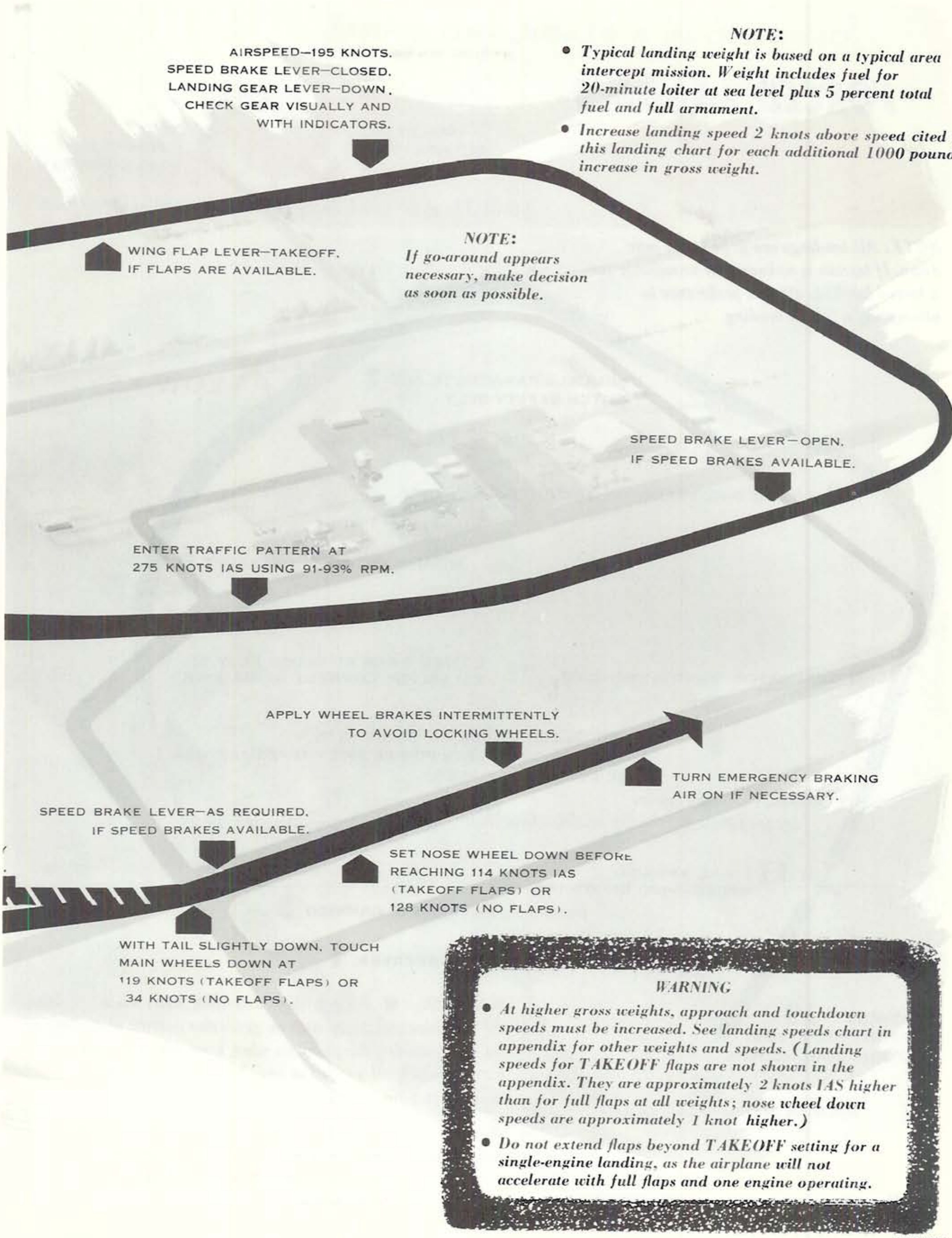
*Figure 3-5.*




*NOTE:*

- *Typical landing weight is based on a typical area intercept mission. Weight includes fuel for 20-minute loiter at sea level plus 5 percent total fuel and full armament.*
- *Increase landing speed 2 knots above speed cited on this landing chart for each additional 1000 pounds increase in gross weight.*

*NOTE:*
*If go-around appears necessary, make decision as soon as possible.*

*WARNING*

- *At higher gross weights, approach and touchdown speeds must be increased. See landing speeds chart in appendix for other weights and speeds. (Landing speeds for TAKEOFF flaps are not shown in the appendix. They are approximately 2 knots IAS higher than for full flaps at all weights; nose wheel down speeds are approximately 1 knot higher.)*
- *Do not extend flaps beyond TAKEOFF setting for a single-engine landing, as the airplane will not accelerate with full flaps and one engine operating.*

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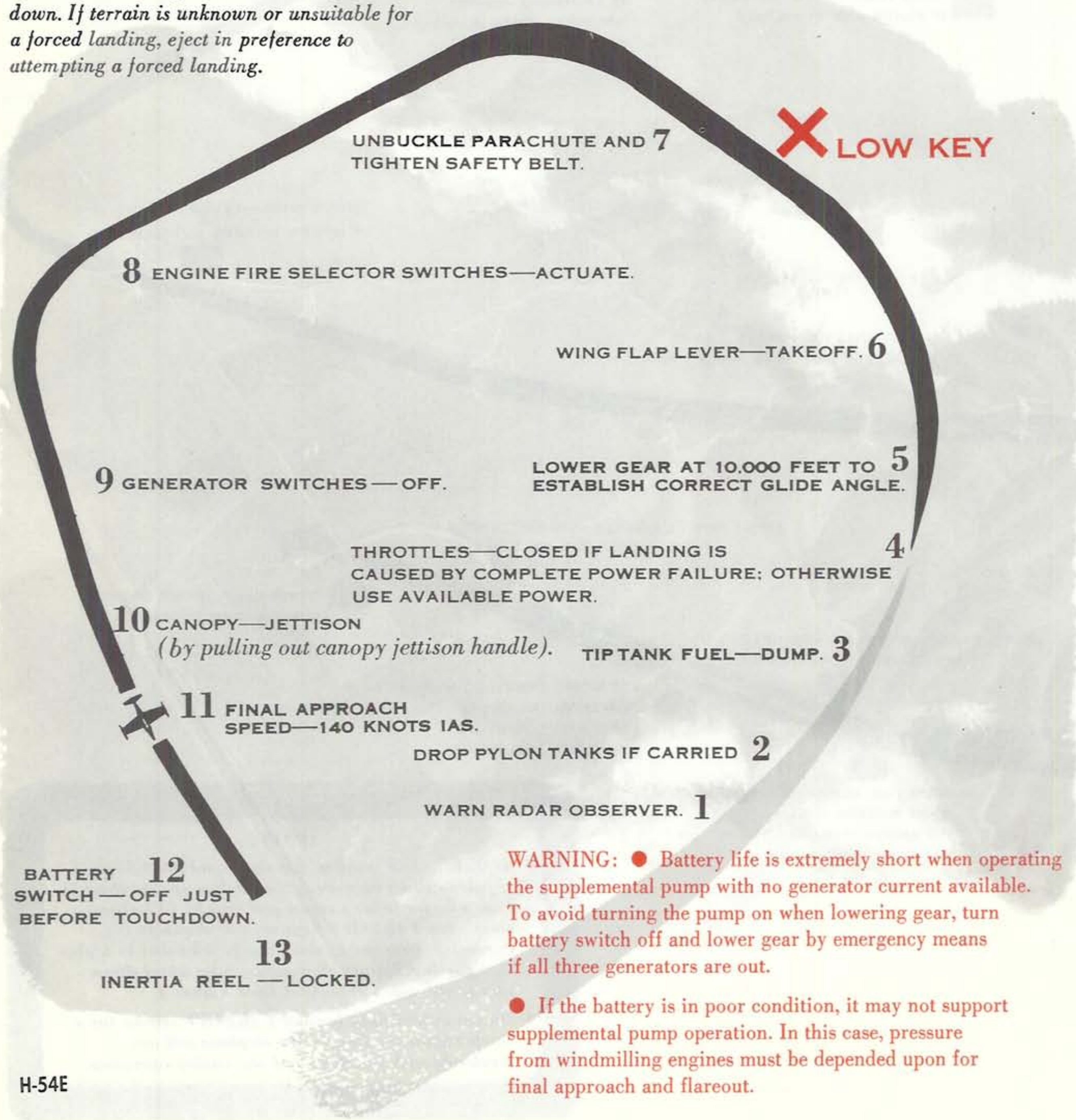
DESCEND IN A STABILIZED SPIRAL

# FORCED LANDING


*NOTE: The above speeds apply to all gross weights of the airplane.*

*NOTE: All landings are to be made gear down. If terrain is unknown or unsuitable for a forced landing, eject in preference to attempting a forced landing.*




WARNING:
- Battery life is extremely short when operating the supplemental pump with no generator current available. To avoid turning the pump on when lowering gear, turn battery switch off and lower gear by emergency means if all three generators are out.
- If the battery is in poor condition, it may not support supplemental pump operation. In this case, pressure from windmilling engines must be depended upon for final approach and flareout.

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*Figure 3-6.*

# FIRE.

## ENGINE FIRE DURING START.

If an engine overheat warning light comes on, close both throttles and keep affected engine windmilling with ground test switch. If the light does not go out, if an engine fire warning light comes on, or if there is any other indication of fire, proceed as follows:

1. Engine fire selector switch for engine on fire—Raise guard and actuate switch. (P)
2. Agent discharge switch—Actuate. (P)
3. Starter switch—STOP momentarily. (P)
4. Battery switch—OFF. (P)
5. Generator switch(es)—OFF. (P)
6. Radar observer—Warn to abandon airplane. (P)
7. Abandon airplane as quickly as possible. (P—RO)

**WARNING**

Do not restart engine until cause of fire or overheating has been determined and corrected. *Never* restart if agent discharge switch has been actuated; this is a "one-shot" system, and until the extinguishing agent bottle has been replaced, there will be no further fire protection available.

## ENGINE FIRE DURING FLIGHT.

If an engine overheat or fire warning light comes on, immediately retard the throttle on the affected engine. If the light then goes out, continue flight with reduced power and land as soon as possible. If either light stays on, or if there is any other indication of fire, proceed as follows:

1. Throttle—CLOSED (on inoperative engine). (P)
2. Engine fire selector switch (engine on fire)—Raise guard and actuate. (P)
3. Agent discharge switch—Actuate. (P)
4. Radar observer—Alert. (P)
5. Oxygen diluter lever—100% OXYGEN. (P—RO)
6. Oxygen regulator emergency lever—Actuate momentarily, to clear oxygen mask. (P—RO)

**WARNING**

Repeated or prolonged exposure to high concentrations of bromochloromethane (CB) or decomposition products should be avoided. CB is a narcotic agent of moderate intensity but of prolonged duration. It is considered to be less toxic than carbon tetrachloride, methylbromide, or the usual products of combustion. In other words, it is safer to use than previous fire extinguishing agents. However, normal precautions should be taken including the use of oxygen when available.

7. Generator switch(es) (for inoperative engine)—OFF. (P)
8. Do not attempt to restart engine. (P)
9. Land as soon as possible. (P)

**WARNING**

The "one-shot" fire extinguishing system delivers its entire charge when actuated and must be recharged before it is used again.

## FUSELAGE, WING, OR ELECTRICAL FIRE.

If fuselage, wing, or electrical fire occurs, perform the following immediately:

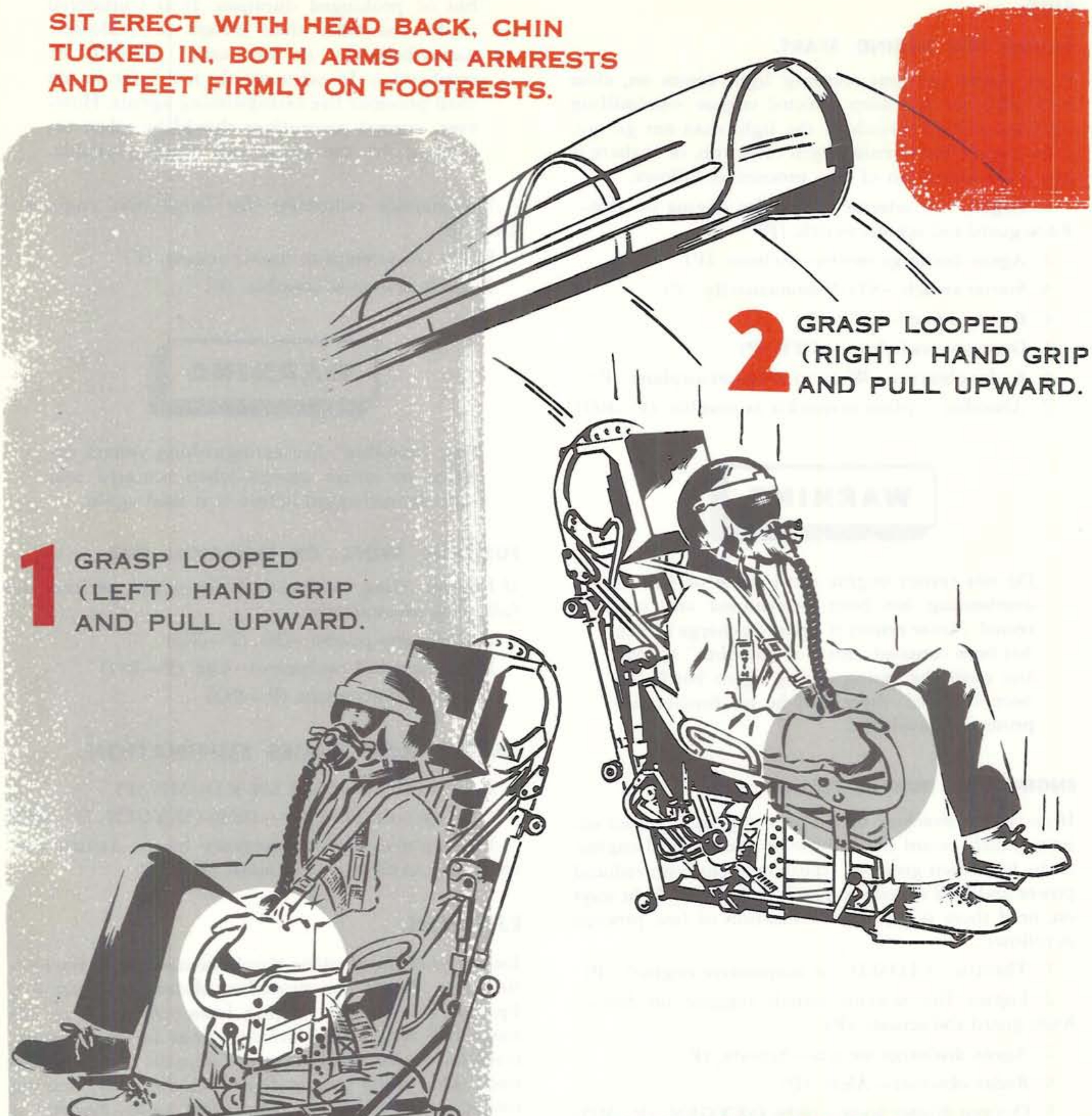
1. Radar equipment—Off. (P—RO)
2. All electrical equipment—Off. (P—RO)
3. Eject—If necessary. (P—RO)

# SMOKE AND FUMES ELIMINATION.

1. Cabin air switch—RAM & DUMP. (P)
2. Oxygen diluter lever—100% OXYGEN. (P—RO)
3. Oxygen regulator emergency lever—Actuate momentarily, to clear oxygen mask. (P—RO)

# EJECTION.

Escape from the airplane should be made with the ejection seat. Follow the procedure shown in figure 3-7. Ejection at airspeeds ranging from stall speed to 525 knots IAS results in relatively minor forces being exerted on the body. Ejection at airspeeds of 525 to 600 knots IAS exerts greater forces on the body, making escape more hazardous. Above 600 knots, ejection is extremely hazardous because of the excessive forces on the body. Ejection at low altitude is facilitated by pulling the nose of the airplane up above the horizon in a "zoom up" maneuver. Ejection seat velocity is small compared to the velocity of the airplane so that ejection accomplished when the airplane is flying horizontally results in the ejection seat following a nearly horizontal path. A "zoom up" maneuver will result in the ejection seat trajectory coming closer to the vertical, thus effecting an increase in altitude. This altitude gain will increase the time available for separation from the seat and deployment of the parachute. When emergencies necessitate ejections, slow the airplane




# WARNING

***Minimum safe level flight altitude for ejection is 2000 feet for manually operated safety belt and parachute; 1000 feet for automatic safety belt and manual parachute; 1000 feet with a manual belt opened before ejection and any type of parachute; and 500 feet with an automatic belt and automatic parachute (provided key attached to the parachute timer lanyard is inserted in the belt automatic release).***

Figure 3-7.

# EJECTION PROCEDURE
## PILOT AND RADAR OBSERVER

**3** SQUEEZE FIRING TRIGGER—RIGHT HAND GRIP.

AFTER SEAT CATAPULT FIRES—SEAT BELTS AND SHOULDER HARNESS ARE UNCOUPLED AUTOMATICALLY BY A DELAY INITIATOR.

**4** AFTER EJECTION (WITH SAFETY BELT RELEASED) KICK FREE OF SEAT.

## WARNING

***If time and conditions permit, the radar observer rather than the pilot shall jettison the canopy. This will assure that the radar observer is in position for ejection and will have no difficulty in reaching the ejection seat controls due to wind blast or "G" forces.***

## WARNING

***Keep hands and arms clear of canopy control levers during canopy jettison. As the canopy is jettisoned, the RO's control lever will rotate rapidly to the open position and the pilot's control lever will snap to the UP (open) position.***

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down as much as possible. Minimum safe ejection altitudes are 2000 feet with a manual belt and parachute, 1000 feet with an automatic belt and manual parachute, 1000 feet with a manual belt opened before ejection and any type of parachute, and 500 feet with an automatic belt and automatic parachute (if the key attached to the parachute timer lanyard is inserted in the belt automatic release).

**WARNING**

Ejection should not be delayed when the aircraft is in a descending attitude and cannot be leveled out. The chances of successful ejection at low altitudes under this condition are greatly reduced.

Minimum safe ejection altitudes for "one and zero" and "two and zero" systems for various combinations of equipment are listed below.

**WARNING**

If the detachable lanyard has been installed before the 1-second safety belt initiator, a "two and zero" system is temporarily provided wherein higher minimum safe ejection altitudes must be observed. (See following table.)

For nonautomatic parachutes used with automatic safety belts, lanyard, Part No. 57C6200, will be used. The minimum safe escape altitudes specified for 1- or 2-second safety belt and 0-second parachute setting apply when the lanyard is attached to the rip cord and safety belt.

| | *1-Second Automatic Lap Belt (M12 Initiator)* | *2-Second Automatic Lap Belt (M4 Initiator)* |
|---|---|---|
| 2-Second Parachute (F-1A Timer), B-4 or B-5 Pack, C-9 Canopy | 350 Feet | 550 Feet |
| 2-Second Parachute (F-1A Timer), B-5 Pack, C-11 Canopy | 400 Feet | 600 Feet |
| 1-Second Parachute (F-1B Timer), B-4 or B-5 Pack, C-9 Canopy | 200 Feet | 350 Feet |
| 1-Second Parachute (F-1B Timer), B-5 Pack, C-11 Canopy | 250 Feet | 400 Feet |
| 0-Second Parachute (Lanyard to "D" Ring), B-4 or B-5 Pack, C-9 Canopy | 100 Feet | 200 Feet |
| 0-Second Parachute (Lanyard to "D" Ring), B-4 or B-5 Pack, C-11 Canopy | 150 Feet | 250 Feet |

**BEFORE EJECTION.**

1. Reduce airspeed as much as possible and, if below 2000 feet, pull the nose up above the horizon to reduce airspeed ("zoom up" maneuver). (P)
2. Pull handle on bailout bottle if altitude necessitates. (P—RO)
3. Cabin air switch—RAM & DUMP. (P)
4. Loose equipment—Stow. (P—RO)
5. Automatic-opening parachute—Check. (P—RO) Make sure the key is attached to the automatic-opening safety belt and the lanyard is free.
6. Canopy—Jettison. (P—RO)

**WARNING**

Keep hands and arms clear of canopy lock levers during canopy jettison. As the canopy is jettisoned, the radar observer's lock lever will rotate rapidly to the open position, and the pilot's lock lever will snap to the up (open) position.

**EJECTION PROCEDURE.**

1. Left handgrip—Grasp and pull upward. (P—RO)
2. Right handgrip—Grasp and pull upward. (P—RO)
3. Firing trigger (on right handgrip)—Squeeze. (P—RO)
4. After ejection (with safety belt released)—Kick free of seat. (P—RO)

**FAILURE OF SEAT TO EJECT.**

If the ejection seat fails to operate, the following procedure may be used for leaving the airplane:

1. Reduce speed. (P)
2. Oxygen hose, radio equipment, and "G" suit lines —Disconnect. (P—RO)
3. Safety belt—Release. (P—RO)
4. Bailout—If possible roll airplane on its back and push clear. If it is not possible to roll the airplane over, bail out the side of cockpit toward the aft trailing edge of the wing. (P—RO)

### FAILURE OF CANOPY TO JETTISON.

1. Canopy jettison "T" handle—Pull. (P)

2. Canopy lock lever—Raise (if step *1* is ineffective). (P—RO)

3. Canopy switch—Move to OPEN (if step *1* is ineffective). (P—RO)

**Note**

As the canopy moves aft from the windshield frame, the airstream will blow it from the fuselage.

4. Continue with normal ejection procedure and eject through canopy (if steps *1, 2,* and *3* are ineffective). (P—RO)

### AFTER EJECTION.

1. After safety belt releases automatically, kick away from seat. (P—RO)

**Note**

If automatic release fails, release safety belt manually.

2. Conventional parachute—Delay opening to allow body to decelerate so that opening shock will be reduced. (P—RO)

**Note**

If ejection is at high altitude, free fall to normal breathing altitude will reduce the dangers of hypoxia and cold.

**WARNING**

- With a manual opening safety belt, open the belt before ejection under the following conditions: below 2000 feet if position in seat can be maintained, in a dive, or at high airspeeds up to 5000 feet. Opening the belt before ejection will facilitate pulling the D-ring, and parachute opening after ejection.
- At altitudes higher than 5000 feet do *not* open manually operated safety belt before ejection, especially at high airspeeds.
- With an automatic opening safety belt do *not* open the belt before ejection at any altitude. The automatic opening feature will give you the maximum safety factor under all conditions.
- In all ejections below 14,000 feet, manually pull the parachute D-ring immediately following separation from the ejection seat. This applies regardless of parachute type, manual or automatic.

## LANDING EMERGENCIES.

### LANDING WITH LATERAL UNBALANCE AND CRITICAL AFT CG.

When fuel remains in tip tanks, with no rockets or ballast in the nose of the rocket-missile pods, and with the right main tank nearly empty, a condition of critical aft cg may exist. If, in connection with this, a condition of lateral unbalance is suspected or known to exist, do not attempt rolling maneuvers, and use minimum bank turns only, in preparation for landing. Use the following procedure for landing with lateral unbalance and critical aft cg:

1. Tip tank fuel—Dump and burn off fuel unbalance as much as possible. (P)

2. Speed brakes—Use approximately 15 degrees for roll control. There will be no drag penalty and aileron effectiveness will be increased approximately 30 percent. (P)

3. Make straight-in approach. (P)

4. If time and fuel are available, test the airplane in the intended landing configuration at a minimum altitude of 12,000 feet to determine how slowly the airplane may be flown in a wings level attitude using a maximum of 1/2 aileron throw. Touchdown should be made at this speed. If adequate runway exists, plan to land without flaps for better aileron control. (P)

### LANDING WITH ONE TIP TANK CONTAINING FUEL.

If fuel from one tip tank cannot be dumped using normal and emergency fuel dumping procedures, the following procedure for landing with an asymmetrical tip fuel condition will be used:

1. Maintain sufficient airspeed to fly the airplane in wing-level attitude using maximum of one-half aileron throw. (P)

**WARNING**

To provide a margin of safety, aileron deflection should be limited to approximately one-half aileron throw to maintain wing-level flight. For minimum recommended approach airspeeds with asymmetrical tip fuel condition, see Asymmetrical Tip Fuel Condition VS Airspeed chart (figure 3-8).

2. Trim—Use trim switch to streamline ailerons with wings as an initial setting to indicate the amount of aileron control remaining. (P)

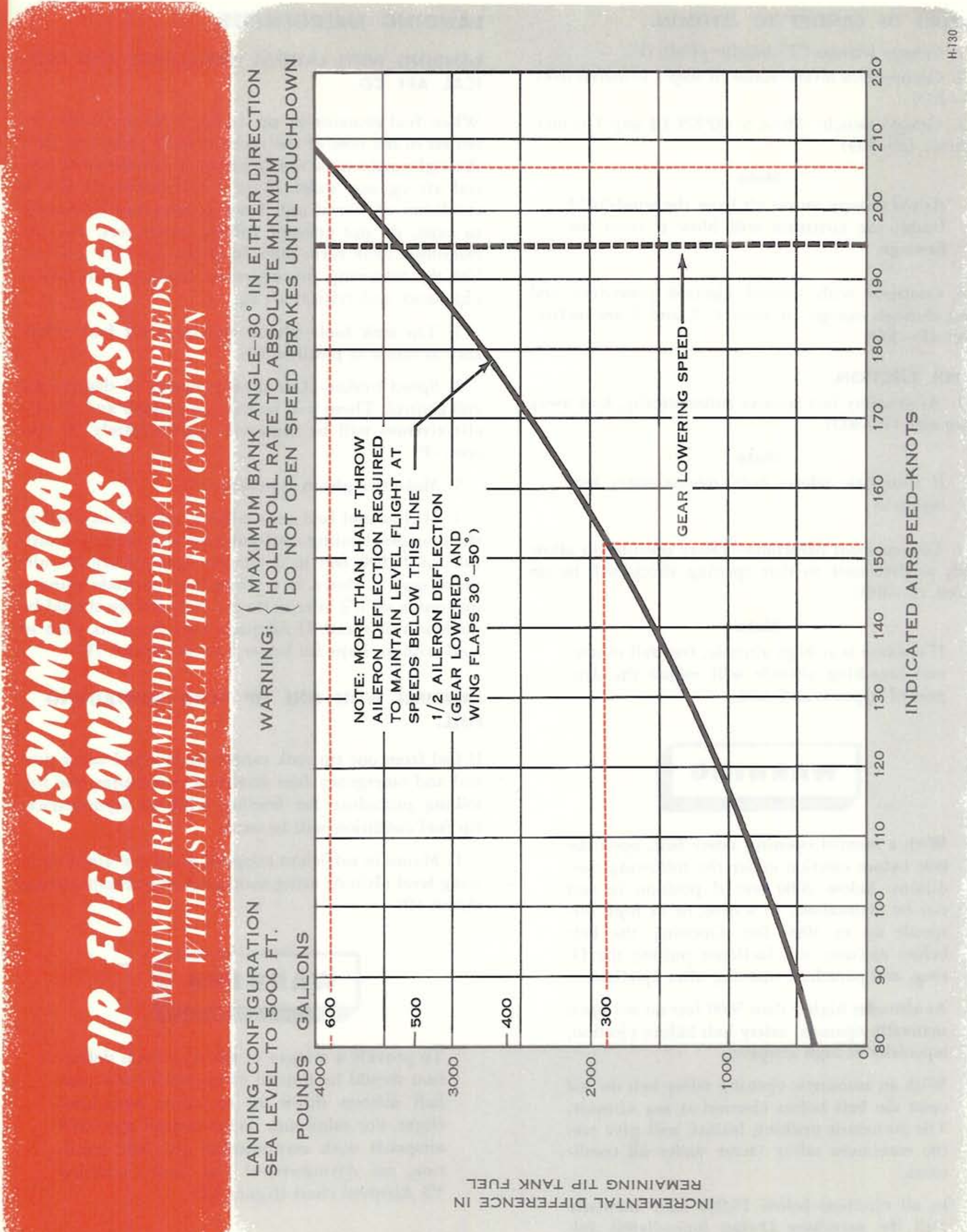
ASYMMETRICAL
TIP FUEL CONDITION VS AIRSPEED
MINIMUM RECOMMENDED APPROACH AIRSPEEDS
WITH ASYMMETRICAL TIP FUEL CONDITION
LANDING CONFIGURATION
SEA LEVEL TO 5000 FT.
WARNING: MAXIMUM BANK ANGLE–30° IN EITHER DIRECTION
HOLD ROLL RATE TO ABSOLUTE MINIMUM
DO NOT OPEN SPEED BRAKES UNTIL TOUCHDOWN
NOTE: MORE THAN HALF THROW AILERON DEFLECTION REQUIRED TO MAINTAIN LEVEL FLIGHT AT SPEEDS BELOW THIS LINE
1/2 AILERON DEFLECTION (GEAR LOWERED AND WING FLAPS 30°–50°)
GEAR LOWERING SPEED
POUNDS
GALLONS
4000
3000
2000
1000
0
600
500
400
300
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
INDICATED AIRSPEED–KNOTS
INCREMENTAL DIFFERENCE IN REMAINING TIP TANK FUEL
H-130

*Figure 3-8.*

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**WARNING**

- Aileron trim switch should be used only to streamline ailerons with wings as an initial setting.
- Avoid turning maneuvers as much as possible, holding roll rate to absolute minimum.
- Bank angle is limited to 30 degrees maximum in either direction; however, where possible, turns should be made to the side with the least fuel.

3. Pylon tanks—Jettison (if carried). (P)
4. Approach—Make straight in. (P)

### LANDING WITH FLAPS AND SPEED BRAKES RETRACTED.

If wing flaps and speed brakes are unavailable for landing, higher touchdown airspeeds must be used to compensate for the lack of extra lift normally supplied by the flaps. If both engines are operative, use speed brakes (if available) and maintain a minimum of 85% rpm throughout the final approach for rapid acceleration if a go-around is necessary. Lengthen the downwind leg to provide for a flat final approach and maintain engine rpm at as high a setting as possible. The airplane should be flown strictly by the airspeed indicator throughout the final approach and touchdown. Recommended final approach speeds are as follows:

| *Gross Weight—Lb* | *Approach IAS—Knots* |
|---|---|
| 30,000 | 160 |
| 34,000 | 169 |
| 38,700 | 179 |

**Note**

The preceding speeds are approximately 5 knots above the stall speed encountered under average gust conditions.

Touch the main wheels down at the following applicable airspeed:

| *Gross Weight—Lb* | *Landing IAS—Knots* |
|---|---|
| 30,000 | 125 |
| 34,000 | 133 |
| 38,700 | 142 |

Set the nose wheel down before the following applicable airspeed is reached:

| *Gross Weight—Lb* | *Nose Wheel Down IAS—Knots* |
|---|---|
| 30,000 | 119 |
| 34,000 | 127 |
| 38,700 | 140 |

Anticipate a landing roll 25 to 35 percent longer than normal for a dry hard-surfaced runway.

## RUNWAY OVERRUN BARRIER OPERATION (SOME AIRPLANES).

On some airplanes, a runway overrun barrier engagement modification is provided to prevent injury to crewmembers and damage to equipment. This modification prevents airplanes from overrunning runways if pilot should be unable to stop the airplane during landings or unsuccessful takeoffs. Airplanes so modified are equipped with a barrier triggering probe located just forward of the nose wheel gear well and a barrier guide and hook located just forward of the main landing gear. When the airplane overruns the end of the runway, the probe triggers the barrier, actuating barrier to an upright position. The guide then guides the barrier to the engaging hook which arrests the forward momentum of the airplane. A test program showed that the airplane could be successfully arrested at speeds ranging from 29 to 83 knots with all wheels making firm contact with the ground. This system is operable when the runway is equipped with Type MA-1A runway overrun barriers.

## RUNNING OFF RUNWAY ON LANDING.

During the landing roll, if the airplane leaves the runway due to failure of brakes, failure of arresting gear to engage the MA-1A runway overrun barrier on airplanes so equipped guide the airplane towards the smoothest terrain, if possible. The landing gear may be either raised or left extended. If desired, the landing gear can be raised by depressing the emergency override lever and simultaneously moving the landing gear lever to UP.

## FORCED LANDING.

If it is necessary to make a forced landing, accomplish as much of the procedure shown below and on figure 3-6 as possible. Land with the gear down regardless of the terrain, as statistics prove that less personal injury and damage to equipment are likely to result from a gear-down landing. Two-engine flameout landings should be considered only under most favorable or extenuating circumstances.

**Note**

If landing is to be made on a runway, leave landing gear lever in the DOWN position if the runway is equipped with Type MA-1A runway overrun barrier and the aircraft is modified to contain the necessary arresting gear equipment.

**WARNING**

- Battery life is extremely short when operating the supplemental pump with no generator current available. To avoid turning the pump on when lowering gear, turn battery switch off, if all three generators are out, and lower gear by emergency means.
- If battery is in poor condition, it may not support supplemental pump operation. In this case, pressure from windmilling engines must be depended upon for final approach and landing. Rapid movement of flight controls must be avoided.
- Do not raise the helmet visor prior to landing emergencies. Retaining the helmet visor in the lowered position will afford protection from impact injury, dislodged objects in the cockpit, flame and smoke, and from windblown objects if the canopy is jettisoned. The helmet visor is a protection device that should be worn in the lowered position in all landing emergencies.

**Note**

A two-engine flameout may be simulated for practicing forced landings by retarding the throttles to 85% rpm and opening the speed brake lever approximately 70 degrees (see figure 3-6).

1. Radar observer—Warn of impending forced landing. (P)
2. Pylon tanks—Jettison. (P)
3. Tip tank fuel—Dump. (P)
4. Throttles—CLOSED if power failure is complete; otherwise, use available power. (P)
5. Landing gear lever—DOWN at 10,000 feet. (P)

**Note**

If landing is to be made on a runway, leave landing gear lever in the DOWN position if the runway is equipped with Type MA-1A runway overrun barrier and the aircraft is modified to contain the necessary arresting gear equipment.

**WARNING**

Battery life is extremely short when operating the supplemental pump with no generator current available and may not last long enough to permit a two-engine flameout landing. To avoid turning the pump on when lowering gear, turn battery switch off and lower gear by emergency means.

6. Wing flap lever—TAKE OFF. (P)
7. Parachute—Unbuckle, and safety belt—Tighten. (P—RO)
8. Engine fire selector switches—Actuate. (P)
9. Generator switches—OFF. (P)
10. Canopy—Jettison with "T" handle. (P)
11. Final approach airspeed—140 knots IAS. (P)

**WARNING**

Airspeeds on final approach and flareout cannot be depended upon to windmill the engines at sufficient rpm to maintain hydraulic pressure for flight operation.

12. Battery switch—OFF. (P)
13. Inertia reel—LOCKED, just before touchdown. (P—RO)

**CAUTION**

When the shoulder harness inertia reel is locked, either by use of the inertia reel lock lever or by raising the left armrest, the pilot is prevented from bending forward; therefore, all controls not readily accessible should be positioned before the inertia reel is locked.

### LANDING WITH GEAR PARTIALLY EXTENDED.

If the landing gear fails to extend completely after both the normal and the emergency procedures have been used, leave as many wheels down as will extend, jettison canopy with "T" handle, and proceed with forced landing. Less damage will result with this procedure than with a gear-up landing.

### LANDING WITH FLAT TIRE.

Because of the comparatively large diameter wheels and small width of tires, directional control of the airplane is easily maintained with rudder and wheel brakes if a main gear tire blows out on landing. If the airplane is landed with one nose wheel tire flat, there will be a slight veering. If a landing is made with both nose wheel tires flat, sufficient up-elevator should be applied to take weight off the nose wheel, and use of wheel brakes should be minimized.

## EMERGENCY ENTRANCE.

If it is necessary to gain entrance to the cockpit in an emergency, first attempt to open the canopy by using the external lock lever and canopy switch, both located behind an access door on the left side of the fuselage above the wing leading edge. If the canopy switch fails to open the canopy after it is unlocked, attempt to open it manually using the external handgrips in the aft structure of the canopy. If this fails, slow-jettison the canopy by use of the external emergency canopy release handle, located flush with the fuselage skin just below the access door for the external canopy switch. Pushing the button in the center of the handle will release it. The handle must be pulled out (with a force of about 45 pounds) approximately 5 inches and held (from 10 to 20 seconds) until the canopy is raised above the cockpit rails. The canopy can then be lifted or pushed from the airplane. If all of the foregoing procedures fail, then, as a last resort, chop a hole in the canopy with an ax, using extreme caution not to injure crewmembers inside the cockpit. On airplanes modified in accordance with T.O. 1F-89-659, new rescue markings will be visible on either side of the cockpit. See figure 1-40.

## EMERGENCY EXIT ON GROUND.

If canopy cannot be opened by the normal procedure and immediate exit is necessary, in an emergency the radar observer can slow-jettison the canopy by using the emergency hydraulic pump handle to put pressure against the cable attached to the canopy external jettison lever and the canopy jettison initiator. When pressure is applied to the cable between the control lever and the initiator, the initiator is actuated and the canopy is slow-jettisoned. The cable is located in the forward left side of the radar observer's cockpit. If the canopy cannot be slow-jettisoned, fast-jettison the canopy by pulling the canopy jettison handle (on the pilot's right vertical console) or by raising the right armrest of either ejection seat. On airplanes modified in accordance with T.O. 1F-89-586, both the pilot's and radar observer's cockpits are equipped with an internal canopy slow fire jettison "T" handle. This enables either the pilot or the radar observer to slow-jettison the canopy by pulling the "T" handle.

**WARNING**

General direction of canopy movement when fast-jettisoned is straight up. Lack of airstream may cause it to fall back into the cockpit.

## DITCHING.

This airplane should never be ditched if there is sufficient altitude for safe ejection. Ditching is not recommended because it is assumed that the engine air intake ducts will cause the airplane to dive violently when it hits water. However, if altitude is insufficient for ejection, warn radar observer, then proceed as follows:

1. Tip tank fuel—Dump. (P)

**CAUTION**

Empty tip tanks do not contact the water until the airplane comes to rest, where they afford additional buoyancy. If the tip tanks contain fuel on ditching, they may plane through the water and create serious deceleration loads. Pylon tanks should be jettisoned whether or not they contain fuel.

2. IFF master control knob—EMERGENCY. (P)
3. External stores—Jettison. (P)
4. Canopy—Jettison with "T" handle. (P)
5. Landing gear lever—UP. (P)
6. Safety belt—Tighten. (P—RO)
7. Oxygen diluter lever—100%. (P—RO)
8. Nose wheel steering button—Depress. (P)
9. Wing flap lever—TAKE OFF. (P)
10. Throttles—CLOSED. (P)
11. Engine fire selector switches for both engines—Raise guards and actuate. (P)
12. Select a heading parallel to the wave crest if possible. Try to touch down along wave crest or just after crest passes. (P)
13. Make normal approach. (P)
14. Flare out to landing attitude, keeping the nose high. (P)
15. Generator switches—OFF. (P)
16. Battery switch—OFF, just before contact. (P)
17. Inertia reel—LOCKED. (P—RO)

**WARNING**

- After battery switch is turned OFF, supplemental pump will not operate.
- Do not attempt to ditch in a near level attitude. It is assumed that the airplane will dive violently when the intake ducts hit the water.

## OIL SYSTEM FAILURE.

If loss of oil is experienced, the airplane need not be abandoned immediately as a gas turbine engine will not fail immediately after loss of oil. An airplane gas turbine engine depends upon oil to cool the roller and ball bearings, so in the event of oil loss, reduce power to keep temperatures at a minimum. A J35 engine has operated for 27 minutes without oil before experiencing destructive engine failure. In most instances, ultimate failure of the engine will not occur within 10 minutes after loss of oil and will be characterized by a steadily increasing vibration. At this time engine shutdown should be made to prevent a destructive engine failure that would jeopardize a successful ejection or power off control of the airplane in a landing attempt. In most cases the airplane has remained controllable during its descent. When oil loss is experienced, the following procedure should be performed immediately:

1. Tip tank fuel—Dump. (P)
2. "G" forces—Minimize. (P)
3. Power setting (affected engine)—Minimum. (P)
4. Land at nearest airbase. (P)

## FUEL VENT SYSTEM MALFUNCTION.

Under certain conditions of fuel vent or transfer system malfunction, fuel may be lost overboard through a main tank vent. If fuel overboarding occurs, use the corrective procedures described in the following paragraphs.

### FUEL OVERBOARDING DURING CLIMB OR DIVE.

Overboarding of fuel during a climb or dive indicates mechanical failure of the left main tank dive valve in the open position. When this condition occurs, the airplane should be leveled immediately. If the fuel overboarding stops, malfunction of the dive valve is confirmed. If another climb or dive is made, and fuel overboarding starts again the airplane should be leveled immediately, and the inboard and outboard wing tank pump circuit breakers pulled out (deenergized) until the main tank low-level warning light illuminates. Both wing tank pump circuit breakers should then be pushed in (energized). If fuel overboarding continues, repeat the operation as necessary. If this procedure fails to stop fuel overboarding, wing tanks should be selected and the airplane landed as soon as possible.

**WARNING**

If fuel overboarding cannot be stopped, it is recommended that a no-flap landing be made because overboarding fuel could be drawn into the flap wells and drain into the hot engine bay, resulting in a fire or explosion.

**Note**

Since the vents for both the left and right main tanks are located adjacent to each other, the tank that is overboarding fuel cannot be determined.

### FUEL LEVEL CONTROL SHUTOFF VALVE MALFUNCTION.

If water freezes in a main tank fuel level control shutoff valve during normal fuel sequencing (ALL TANKS selection), the valve will not close fully when the main tank is full. As a result, fuel is forced overboard through the main tank vent line. (This condition will also exist if foreign matter other than ice accumulates in the main tank shutoff valve.) To correct this condition, the fuel selector switch for the left fuel system, then the right fuel system should be turned from ALL TANKS to WING TANKS and back to ALL TANKS. The resultant surges of fuel from the wing tanks may free the valve in the malfunctioning main tank. If the valve remains stuck, a wing tank selection should be made and the airplane landed as soon as possible.

**WARNING**

> If fuel overboarding cannot be stopped, it is recommended that a no-flap landing be made because overboarding fuel could be drawn into the flap wells and drain into the hot engine bay, resulting in a fire or explosion.

## FUEL SYSTEM EMERGENCY OPERATION.

### FUEL SYSTEM OPERATION FOLLOWING COMPLETE ELECTRICAL FAILURE.

Without electrical power, fuel is only available by gravity feed from the tank selected directly to the engine. Fuel will not transfer from the wing tank to the main tank without a booster pump. With battery power available for a limited time during complete electrical failure, the best fuel selection to ensure gravity feeding can be obtained using the following procedures:

1. Right fuel selector switch—ALL TANKS. Engine power settings when utilizing gravity feed should not exceed those required for maximum endurance as listed in the appendix. The maximum altitude at which the right main tank can maintain satisfactory engine operation on gravity feed is approximately 25,000 feet. (P)

**Note**

> If it becomes necessary to extend the flight beyond the limits of the fuel available in the right main (nose tank), the battery switch should be placed at ON and right fuel selector switch placed at WING TANKS. Fly the airplane in a level flight attitude.

2. Left fuel selector switch—WING TANKS (left wing tanks and main tanks will feed fuel to the engines simultaneously). The left wing should be elevated to ensure maximum fuel flow from the wing tanks. The maximum altitude at which the left main tank and wing tanks can maintain satisfactory engine operation on gravity feed is approximately 18,000 feet. (P)

**CAUTION**

> Attempts to gravity feed above the foregoing maximum gravity feed altitudes may cause damage to the engine-driven fuel pump which will result in fuel leakage.

3. Crossfeed switch—OFF. (P)

**WARNING**

> Crossfeed switch must be placed at CLOSED during gravity feed operation. This will prevent flameout of both engines due to one main tank emptying prior to the other.

### MAIN TANK BOOSTER PUMP FAILURE.

If one of the two main tank booster pumps fails, the remaining pump will continue to supply fuel to the engine and afterburner above 30,000 feet. Depending upon atmospheric conditions, one pump may or may not support afterburning below 30,000 feet.

### WING TANK BOOSTER PUMP FAILURE.

Wing tank booster pump failure will be evidenced by wing heaviness or main tank low-level warning light glowing.

**Note**

> Under some conditions of speed, altitude, and temperature, afterburning may not be available on WING TANKS selection below 10,000 feet; therefore WING TANKS selection is not recommended for takeoff. A WING TANKS selection will support afterburner operation above 10,000-foot altitude; however a wing tank booster pump failure will cause the related afterburner to shut down without warning when operating on WING TANKS selection below approximately 30,000-foot altitude.

If pump failure is caused by an electrical overload condition, the related circuit breaker on the fuel control panel (figure 1-18) will pop OUT, indicating which pump has failed. If no circuit breakers are OUT and a pump is believed to be inoperative as evidenced by wing heaviness or low-level warning light, place the fuel quantity selector switch for the system with the heavy wing alternately at INBD and OUTBD while observing the related fuel quantity gage; a large quantity of fuel existing in one wing tank after the other wing tank in the same system is empty or nearly empty, will indicate a pump failure in the tank with the most fuel. To use fuel from a wing tank with an inoperative pump, see Gravity Feed, this section.

**GRAVITY FEED.**

Each fuel system will gravity feed the related engine with sufficient fuel to maintain military power up to an approximate 6000-foot altitude. When fuel is being gravity fed from either or both wing tanks, the airplane must be flown at a 10-degree uncoordinated wing-high attitude for the system that is gravity feeding, so that the maximum amount of fuel can be drawn from the wing tanks. To gravity feed fuel from either wing tank, the booster pump in the other wing tank in the same system must be shut down by pulling the related circuit breaker. After fuel supply is exhausted from the wing tank during gravity feeding, press the circuit breaker IN.

**Note**

When gravity feeding from the right wing tanks with the fuel selector at WING TANKS, the right main tank is isolated from the system. Caution must be exercised to avoid flameout after the wing tanks become empty. Use the fuel quantity gage system to anticipate the wing tanks becoming empty; place the fuel selector at ALL TANKS before completely emptying the wing tanks.

**ONE TIP TANK NOT FEEDING.**

When fuel is not feeding from one of the tip tanks and an asymmetrical fuel condition is indicated, use the following procedure:

1. Fuel selector switch—ALL TANKS. (P)
2. Pylon tanks—Jettison (if carried). (P)

**Note**

If fuel is not being fed from a tip tank due to lack of pressurization, the pylon tank on the same side, in all probability, will not feed. Retaining the pylon tanks will aggravate the asymmetrical fuel condition.

3. If more than one-half aileron throw is required to maintain a wing-level attitude, increase airspeed as required to maintain level flight. Aileron trim should be used only to streamline aileron with wings as an initial setting to indicate the amount of aileron control remaining. (P)

**WARNING**

- To provide a margin of safety, aileron deflection should be limited to approximately one-half aileron throw to maintain wing-level flight. For minimum recommended approach airspeeds with asymmetrical tip fuel condition, see Asymmetrical Tip Fuel Condition VS Airspeed Chart (figure 3-8).
- Avoid turning maneuvers as much as possible, holding roll rate to absolute minimum.
- Bank angle is limited to 30 degrees maximum in either direction; however, where possible, turns should be made to the side with the least fuel.

4. Tip tank fuel—Dump by normal means if possible. If normal fuel dumping is unsuccessful, place the airplane in a moderate speed climb and dump the fuel by gravity. This is done by pressing the tip tank button which energizes both tip tank dump valves and holds them open for approximately 75 seconds by means of a time-delay relay. Several fuel dump cycles will be required to empty the tip tanks. Approximately 5 minutes are required to complete dumping tip tank fuel by gravity. (P)

**ENGINE-DRIVEN FUEL PUMP FAILURE.**

The engine-driven fuel pump has two individual pumping elements. If either pumping element fails, the remaining pumping element will continue to supply adequate fuel pressure to operate the engine at military power at any altitude. Failure of a pumping element in an engine-driven fuel pump will not affect afterburner operation. Fuel pressure for afterburning is supplied by the booster pumps and afterburner turbine-driven pump. Warning lights located on the pilot's left console (figure 1-9) will warn of a pump element failure during ground operation. During flight the warning lights are automatically disarmed by a switch on the left main landing gear.

**DAMAGED TANKS.**

If tanks are damaged or a severe leak is suspected, take corrective action as described in the following paragraphs.

**Damaged Main Tank.**

1. Main tank fuel—Use first. (P)
2. Fuel selector switch (for damaged fuel system)—ALL TANKS. (P)
3. Wing tank booster pump circuit breakers (on side where damage exists)—Pull. (P)
4. Wing tank booster pump circuit breakers (after main tank fuel is used)—IN. (P)
5. Fuel selector switch (for damaged fuel system)—WING TANKS. (P)

**WARNING**

Escaping fuel from a damaged right main tank may enter the air intake duct of an engine and cause the engine to explode.

**Damaged Tip or Pylon Tank.**

If a tip tank or pylon tank is damaged and pressure is lost, fuel from the tip and pylon tanks will not be usable. Jettison the pylon tanks and press the tip tank fuel dump button. Two or more dumping cycles may be required to dump fuel from unpressurized tip tanks. Any fuel remaining in the forward section of an unpressurized tip tank will not be dumped.

**Damaged Wing Tanks.**

If either wing tank is damaged and its booster pump is operative, use available fuel in the damaged tank first by pulling OUT the booster pump circuit breaker of the undamaged wing tank in the same system. If damage is such that escaping fuel causes an obvious fire hazard, shut down the engine on the damaged side.

### AFT CENTER-OF-GRAVITY FUEL MOVEMENT.

When fuel is in the tip tanks, weight of the right main tank fuel is essential to keep the airplane's center-of-gravity within allowable limits. If right main tank fuel is lowered 50 gallons (325 pounds) from full before tip tanks empty, an aft cg warning light on the pilot's instrument panel will come on to warn of an aft cg condition caused by insufficient fuel being transferred into the right main tank. If the aft cg warning light comes on, the pilot must reduce airspeed to Mach 0.65 or below and reduce power on the right engine. If the aft cg warning light stays on and the right main tank fuel level continues to drop as noted on the fuel quantity gages, immediately place the right fuel selector at WING TANKS. When all fuel is used from the tip tanks, as indicated by the fuel quantity gage system, use remaining fuel in wing and main tanks.

**Note**

- The aft cg warning light is disarmed by a float switch in the right tip tank when the tank becomes empty. This float switch is only to prevent the warning light from burning after all tip tank fuel is expended. To determine if any fuel remains in the tip tanks, use the fuel quantity gage system.
- Sustained low-altitude operation at maximum power can cause the rate of fuel consumption from the main tanks to exceed the rate of replenishment from the wing tanks. If the aft cg warning light comes on under these conditions, reduce power on the right engine or increase altitude.

## ELECTRICAL SYSTEM EMERGENCY OPERATION.

See figure 1-21 for equipment rendered inoperative because of failure of the 28-volt d-c system, the a-c alternator system, or the a-c inverter systems. In case of complete electrical failure, do not abandon airplane as control of the airplane can be maintained. Figure 3-9 covers 28-volt d-c generator malfunction for which corrective action may be taken by the pilot.

### GENERATOR OVERVOLTAGE.

If the voltage of a generator becomes excessive, an overvoltage relay will cut the generator out of the circuit and the generator warning light will come on. To return the generator to the circuit proceed as follows:

1. Generator switch—RESET momentarily, then return to ON. (P)

   If the generator warning light goes out and remains out, overvoltage was temporary.

2. Generator switch—OFF if generator warning light remains on. (P)
3. Voltage regulator rheostat—Turn toward DEC to reduce voltage. (P)
4. Generator switch—RESET momentarily, then return to OFF. (P)
5. Voltage selector switch—Turn to affected generator. (P)
6. Voltage regulator rheostat—Adjust until voltage is slightly above the voltage of the other generators. (P)
7. Generator switch—ON. (P)

### GENERATOR FAILURE.

If any one of the three 28-volt d-c generators fails, the remaining two can carry the entire load. If any two generators fail, the secondary bus is automatically disconnected from the electrical system. The remaining generator supplies power to the primary bus only. See figure 1-21 for power distribution. If all three 28-volt d-c generators fail, the following procedure is recommended:

1. Battery switch—OFF. (P)
2. Battery switch—ON and OFF as required to control the fuel system. (P)
3. All electrical switches not essential to emergency flight—OFF. (P—RO)
4. Tip tank fuel—Dump (if required). Place battery switch in the ON position, push tip tank dump button and hold for 5 seconds, then place the battery switch in the OFF position. (P)

   The tip tank dump valve will remain open until the battery switch is again placed in the ON position.

See figure 3-9 for procedure in case of 28-volt d-c malfunction.

# 28-VOLT D-C GENERATOR MALFUNCTION CHART

**NOTE**

*Only those failures for which specific corrective action can be taken in flight are shown. For failures other than those listed here, turn off malfunctioning generators and reduce load on operative generators.*

| | FIRST INDICATION OF MALFUNCTION | | VERIFICATION OF TYPE OF MALFUNCTION | |
|---|---|---|---|---|
| | MALFUNCTIONING GENERATOR | OTHER GENERATORS | MALFUNCTIONING GENERATOR | OTHER GENERATORS |
| OVERVOLTAGE | WARNING LIGHT ON; VOLTMETER 0-3 VOLTS; LOADMETER ZERO | LOADMETER ABOVE NORMAL | VOLTMETER OFF SCALE ON HIGH SIDE; LOADMETER ZERO* (READINGS OBTAINED WHILE MALFUNCTIONING GENERATOR RESET SWITCH IS HELD MOMENTARILY AT RESET.) | LOADMETER ABOVE NORMAL |
| IMPROPER PARALLELING | COND 1 HIGH LOADMETER READING | LOW LOADMETER READING | HIGH VOLTMETER READING; ZERO LOADMETER READING | LOADMETER ABOVE NORMAL |
| | COND 2 ZERO OR VERY LOW LOADMETER READING; WARNING LIGHT ON | LOADMETER ABOVE NORMAL | LOW VOLTMETER READING; ZERO LOADMETER READING (READINGS OBTAINED WHILE MALFUNCTIONING GENERATOR RESET SWITCH IS HELD MOMENTARILY AT RESET.) | LOADMETER ABOVE NORMAL |

## CORRECTIVE ACTION:

### OVERVOLTAGE

1. Place malfunctioning generator switch at ON and immediately return to OFF. This will allow overvoltage condition to trip the generator field control relay, thus preventing possible damage by deenergizing generator field circuits.


***NOTE**

*If voltage is normal when generator switch is placed at RESET, overvoltage was momentary and generator can be returned to service by placing switch at ON.*

### IMPROPER PARALLELING


1. Adjust voltage to 28 volts with voltage regulator rheostat.


2. Place generator switch at ON.


3. Check loadmeters for approximately equal load. If necessary, equalize load by adjusting the voltage regulator rheostats.

4. Frequently check operation of generator for evidence of further malfunctioning.

**NOTE**

*If generator malfunctioning cannot be corrected, turn generator off and reduce load on remaining generators by turning off nonessential equipment.*

Figure 3-9.

### ALTERNATOR FAILURE.

If the 115/200-volt alternator fails, all the components powered by it will be inoperative except the IFF and the windshield defog heat. These will be switched to the single-phase inverter system and will remain in operation. (See figure 1-21.)

### INVERTER FAILURE.

If the main single-phase inverter fails during normal operation, as indicated by the essential bus warning light coming on, place the single-phase inverter switch at EMERGENCY; the spare inverter will then assume the load of the essential bus and the secondary bus will not be energized. If the essential bus warning light comes on again, after emergency operation has been selected, failure of the spare inverter is indicated and the single-phase inverter switch should be placed at OFF.

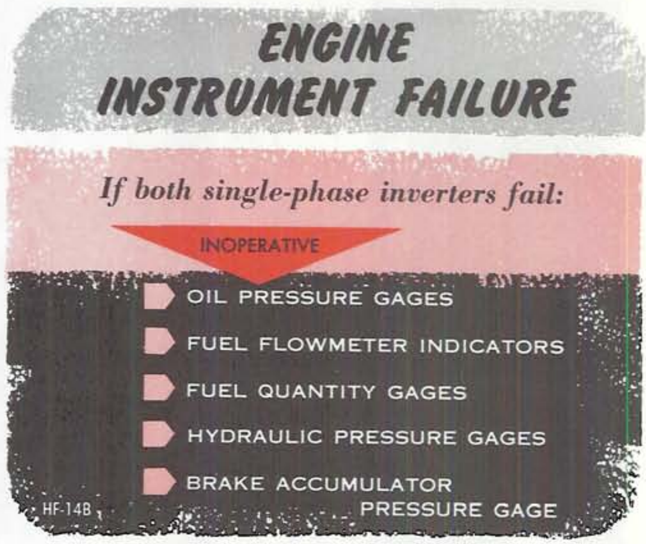
**WARNING**

- If both single-phase inverters fail below 10,000 feet, or if the afterburner ac control circuit breaker pops out, the afterburner and afterburner control circuits will be inoperative. When this occurs, the throttle-actuated eyelid switches will cause the eyelids to open (without regard to afterburner operation) when the throttles are advanced to OPEN, resulting in very low tailpipe temperatures and extreme loss of thrust. If both inverters fail below 10,000 feet while in afterburning, afterburner operation will be unaffected. However, if the afterburners are shut down by depressing the throttle fingerlifts, the eyelids will remain open. The eyelids must be closed by moving the afterburner control circuit breakers to OFF or by retarding throttles to approximately 90% rpm position. Eyelid closure will be apparent by an immediate increase in thrust and a return to normal tailpipe temperature. Only military power will be available for the duration of the flight.
- If both single-phase inverters fail while in afterburning above 10,000 feet, afterburning will be unaffected because the holding relay in the afterburner control box keeps the eyelids open; however, once afterburning is shut off, it cannot be reinitiated. If both single-phase inverters fail above 10,000 feet, afterburning cannot be initiated and eyelids will remain in closed position, because the altitude switch breaks dc operating circuit, allowing the fail-safe eyelid control valve to keep the eyelids closed.

If the selected (main or spare) three-phase inverter fails, as indicated by the three-phase inverter warning light coming on, place the three-phase inverter switch at the other position. If the light comes on again, indicating failure of both inverters, place the three-phase inverter switch at OFF. See figure 1-21 for equipment powered by the inverter systems.

### INSTRUMENT FAILURE.

#### Engine Instruments.




If both single-phase inverters fail, all engine instruments will become inoperative except the tachometers and exhaust gas temperature gages, both self-generating instruments. The pointers of the oil pressure gages, fuel pressure gages, fuel quantity gages, fuel flowmeter indicator, brake accumulator pressure gage, and left and right hydraulic pressure gages, all powered by the single-phase inverter system, will remain at the last setting indicated before inverter failure unless moved by vibration or shock.

#### Flight Instruments.

If all electrical systems fail, the following instruments will remain in operation: vertical velocity indicator, airspeed indicator, standby magnetic compass, and altimeter. The vertical velocity indicator, altimeter, and airspeed indicator will operate as long as the inlets on the pitot tube and static ports are not iced over. The turn and slip indicator depends on 28-volt d-c power for operation. If both three-phase inverters fail, the attitude indicator will tumble. The gyrosyn compass system and flight computer are powered through a phase converter by the single-phase essential bus. If both single-phase inverters fail, then the gyrosyn compass system and flight computer will receive power from the three-phase inverter system. See figure 1-21 for equipment powered by the inverter systems. If the 28-volt d-c system fails, the free air temperature gage needle will fall against the stop and all instruments depending upon power from either the single-phase or three-phase inverter system will be inoperative.

## HYDRAULIC SYSTEM EMERGENCY OPERATION.

If the right hydraulic system fails, all hydraulically operated units will operate by pressure from the left hydraulic system; however, flight control operation will be limited in degree and rate of surface movement. To increase the degree and rate of control surface movement during operation of other hydraulic units, depress the nose wheel steering button to start the left hydraulic system supplemental pump.

**WARNING**

> With right hydraulic system pressure unavailable, do not operate speed brakes unless the left engine rpm is at least 85% or the supplemental hydraulic pump is operating. At lower rpm, the demand on the left hydraulic system by speed brake operation results in limited aileron control unless supplemental pump pressure is available.

If the left hydraulic system fails through loss of fluid, the flight control system will operate on the right system pressure, but the degree and rate of surface movement will be limited. Speed brakes will be inoperative. The landing gear and wheel brakes (if accumulator pressure is not available) must be operated by emergency procedures. If the failure is caused by engine-driven pump failure only, system pressure can be maintained with the supplemental pump, and all units normally operated by the left system will be available, although rate of response may be somewhat less than normal. Operation of speed brakes, flaps, and gear in rapid sequence should be avoided. Use of nose wheel steering should be held to a minimum because of the high volume of fluid required. If partial failure occurs through the failure of an engine but the engine is still windmilling, pressure can be expected to vary between 700 and 2000 psi. Care should be taken not to allow the pressure to bleed below approximately 600 psi. This allows a slight margin above the purge valve setting of 300 psi. When this valve opens, pump flow is routed to the return line with the resultant loss of the system. The only means for closing the valve would be to increase engine rpm to about 38% or energize the supplemental pump. Engine windmill speeds to be expected are approximately 16%, 12%, and 9% rpm for 175, 140, and 100 knots IAS respectively. With hydraulic pressure available from one windmilling engine, and with extreme caution taken in *rate* of control movement, the following can be completed *independently:* extension of flaps partially or fully (if left engine is windmilling); correction for slight turbulence; 30-degree bank turns; and flareout for landings. If both hydraulic systems fail, flight controls can be operated with supplemental pump pressure if the left system has not failed through loss of fluid. In addition, all other hydraulic units can be operated, but discretion in their use should be exercised to avoid lowering system pressure excessively. The supplemental pump output is approximately equal to that of one engine-driven pump at idle rpm.

## FLIGHT CONTROL SYSTEM EMERGENCY OPERATION.

If the right or left hydraulic system fails, one 3000-psi hydraulic system is available for basic flight control. Normally, little difference will be noted with flight under such conditions. This includes flight at maximum level flight speed down to stall for the landing configuration. Due to limited elevator deflection, available load factor is lowered by approximately 0.3 "G." A limit in surface deflection occurs when there is a balance in elevator power and airloads (limiting elevator hinge movement). This means that the altitude lost during recovery from a dive is greater with only one hydraulic system operating. To be specific, maximum load factor obtainable at 0.85 true Mach number and 10,000-foot altitude is approximately 2.0 "G's"; with both systems operating about 2.3 "G's" are available. The limiting load factor, or "G" value, increases with any one or a combination of the following; decrease in Mach number, decrease in dynamic pressure, aft movement of the airplane center of gravity, and a decrease in horizontal stabilizer angle caused by manufacturing tolerances. Under 0.80 Mach number, longitudinal control to limit load factor or airplane buffet is available. Full basic control of the airplane is possible in flight using the supplemental pump. Control stick and rudder pedal actuating forces are comparable to those which occur with the normal system in operation. The replenishing rate of the supplemental pump is sufficient to maintain pressure during fast actuation of the control surfaces, as would occur during flight in turbulent air. Battery life when supporting the supplemental pump and limited use of the radios is short. For this reason it is suggested that the supplemental pump be used only when absolutely necessary if 28-volt generator power is unavailable. With only the hydraulic pressure of one windmilling engine available, a safe landing can be executed; however, it is necessary to exercise extreme caution in the rate of control movement so as not to open the purge valve. The engine-driven hydraulic pump replenishing rate at engine windmill speeds is low; but full control deflections applied at a slow rate, as necessary for a crosswind landing, are possible. During flight in moderate to heavy turbulence, basic stability should be depended upon to a great extent for maintaining the selected attitude.

**WARNING**

With right hydraulic system pressure unavailable, do not operate speed brakes, unless left engine rpm is at least 85% or the supplemental pump is operating. At lower rpm, the demand on the hydraulic system made by speed brake operation will result in limited aileron control unless supplemental pump pressure is available.

## SIDESLIP STABILITY AUGMENTER EMERGENCY OPERATION.

If the sideslip stability augmenter system fails, causing the airplane to oscillate violently, turn the sideslip stability augmenter switch to PWR OFF. Without stability augmentation, damping of the "Dutch Roll" oscillation is extremely light under many flight conditions, but these oscillations can be controlled by the pilot. Damping can be improved by descending to a lower altitude.

**Note**

If there is a malfunction of the electronic control unit, making the stability augmenter system inoperative with the rudder trim switch in AUTO TRIM position, move the switch to MANUAL TRIM. If the power amplifier is still operative, the system will continue to provide satisfactory damping of "Dutch Roll" oscillations but may require some manual adjustment of the rudder trim knob.

## WING FLAP SYSTEM EMERGENCY OPERATION.

If the left hydraulic system fails through some cause other than loss of hydraulic fluid, the wing flaps may be lowered by normal procedures after actuating the supplemental pump by depressing the nose wheel steering button. If complete electrical failure occurs, it is possible to lower the wing flaps if the left engine is windmilling and the airspeed is below 150 knots IAS; however, this procedure is not recommended because of the long extension time and the possibility of opening the purge valve with a resultant loss of the complete system. In the event the pre-positioning spring in the flap handle has broken, the flaps may be actuated by placing wing flap handle in desired position and moving the wing flap position indicator to extend or retract flaps as needed. Considerable pressure may be necessary to position the wing flap indicator using this method.

## SPEED BRAKE SYSTEM EMERGENCY OPERATION.

The speed brakes cannot be operated if the left hydraulic system fails; however, if the speed brakes are open at the time of failure, they will float back to the streamlined position when the speed brake lever is placed at CLOSED. If speed brakes fail and remain in the full open position, maximum power is required to maintain level flight up to 15,000 feet.

## LANDING GEAR SYSTEM EMERGENCY OPERATION.

If the normal landing gear lowering procedure fails to extend the gear to a safe condition, the pilot should first try to determine what is causing the malfunction, then execute the appropriate emergency procedure for lowering the landing gear to a safe landing condition. For example, the pilot can determine if there is flow in the landing gear system by recycling the landing gear lever from DOWN to UP and back to DOWN while watching the left hydraulic system pressure gage for fluctuations. If no fluctuations are indicated on the pressure gage during the check, indicating no flow in the landing gear system, it may be assumed that the landing gear position 4-way valve is stuck in the gear-up position. If this occurs, the only way the gear can be lowered is by reducing the left hydraulic system pressure to zero. In order to accomplish this, the left engine must be shut down, flaps partially lowered, speed brakes partially opened, and then the flaps retracted at the same time the speed brakes are closed. This will reduce the left hydraulic system pressure to the point that the system purge valve (figure 1-26) will open automatically (approximately 350 psi) and reduce the system pressure to zero. However, the safety relays circuit breaker in the radar observer's cockpit must be pulled prior to flap and speed brake operation to disarm the left hydraulic supplemental pump. After the system pressure has been reduced to zero, the landing gear emergency release handle may be pulled to lower the gear.

**CAUTION**

- The left engine must remain inoperative after the landing gear has been lowered by purging the system pressure. If the engine is restarted, left hydraulic system pressure will be restored to normal and the landing gear will retract.
- When using the landing gear emergency release handle, the pilot should make certain the handle is pulled to its full limit of travel (approximately 14 inches). This will assure that all landing gear uplocks have been unlocked. The handle should then be returned to its stowed position. Do not allow the handle to whip back to its stowed position, as damage to the cockpit equipment may result.

If any one or all of the landing gears fail to extend after the landing gear lever is placed in the DOWN position and the landing gear emergency release handle has been pulled, the pilot should execute a coordinated maneuver to pull positive "G's." This should be done with the landing gear lever at DOWN and the emergency release handle pulled and held to its full limit of travel. Care should be taken to avoid exceeding the maximum allowable "G's" for the altitude at which the maneuver is being executed.

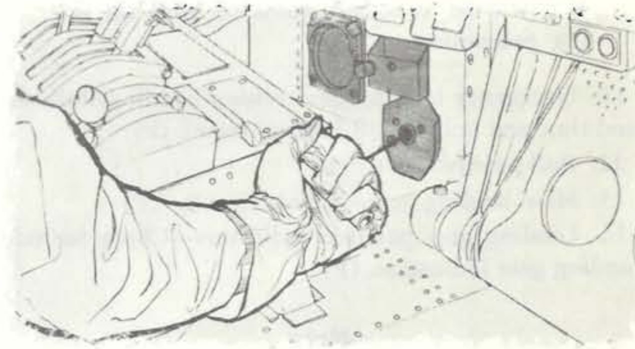
## GEAR FAILS TO EXTEND ON NORMAL PROCEDURE.

1. Airspeed—195 knots IAS or below. (P)
2. Landing gear lever—Check full DOWN. (P)

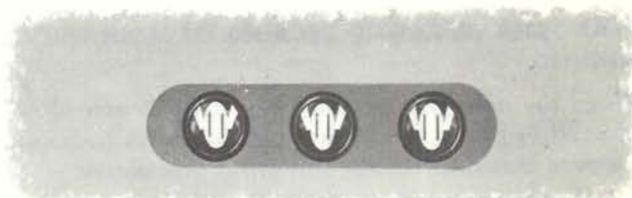
3. **Left hydraulic system pressure gage—2000 psi. (P)** If pressure is below 2000 psi and time and conditions permit, allow pressure to build up.
4. Landing gear emergency release handle—Pull to full limit of travel (14 inches). (Allow at least 30 seconds for gear to extend.) (P)

**CAUTION**

The landing gear emergency release handle should be guided back to its stowed position to prevent the handle from whipping back **and causing damage to cockpit equipment.**



5. **Main landing gear—Check visually. (P)**
6. Landing gear position indicators—Check for safe indication. (P)



## GEAR FAILS TO EXTEND ON EMERGENCY PROCEDURE.

1. Airspeed—195 knots IAS or below. (P)
2. Landing gear lever—Recycle, leave in DOWN position. (P)
3. Left hydraulic system pressure gage—Check for fluctuations. (P)

**Note**

If no fluctuations occur and the pilot is assured that no gears have moved, proceed with the emergency procedure by purging the left hydraulic system.

4. Left engine—Shut down. (P)
5. Safety relays circuit breaker—Pull. (RO)
6. Flaps—Lower partially. (P)
7. Speed brakes—Open partially. (P)
8. Flaps—Raise; speed brakes—Close simultaneously, to open the left hydraulic system purge valve. (P)
9. Left hydraulic system pressure gage—Check for 0 psi. (P)

10. Emergency landing gear release handle—Pull (allow at least 30 seconds for gear to extend). (P)

**CAUTION**

The landing gear emergency release handle should be guided back to its stowed position to prevent the handle from whipping back and causing damage to cockpit equipment.

**Note**

If gear fails to extend, continue with following procedures.

11. Emergency landing gear release handle—Pull second time and hold at full limit of travel. (P)
12. Pull positive "G's." (P)
13. Main landing gear—Check visually. (P)
14. Landing gear position indicators—Check for safe landing gear indication. (P)

**Note**

After a prolonged flight at high altitude (where temperature is low) emergency extension may be slower than normal.

## GEAR FAILS TO EXTEND BECAUSE OF MECHANICAL BINDING.

When the nose gear or main gear fails to extend because of suspected mechanical binding, with hydraulic pressure available, use the following procedures:

1. Landing gear lever—DOWN. (P)
2. Landing gear emergency release "T" handle—Pull to full limit of travel. (P)
3. Landing gear lever—UP, while maintaining tension on "T" handle in full out position. (P)
4. When gear has fully retracted, immediately place landing gear lever DOWN, while maintaining tension on "T" handle in full out position. After nose gear extends, guide "T" handle back to stowed position. (P)
5. Check gear down. (P)

**Note**

Lowering the landing gear by the emergency procedure will not affect subsequent normal operation. Each time the emergency gear extension system is used, the pilot should report it to ensure that the malfunction which necessitated the use of the emergency procedure is corrected.

## BRAKE SYSTEM EMERGENCY OPERATION.

If the left hydraulic system fails, the brakes can still be operated by the accumulator pressure. If necessary, the radar observer can charge the accumulator by placing the forward handpump selector valve (A) at BRAKES, the rear valve (B) at NEUTRAL (see figure 4-8) and pumping the hydraulic handpump. A normal ground roll stop can be made by using accumulator pressure only, provided there is 3000 psi pressure in the system. To stop the airplane using brake accumulator pressure, avoid too many applications which would deplete hydraulic pressure. If wheel brakes fail to respond to brake pedal pressure, release brakes, immediately turn the emergency airbrake handle to ON, then operate the brakes as usual. When applying airbrakes use caution as pedal resisting forces will be lighter than normally experienced. If both emergency airbrake and brake accumulator pressures are applied to the system simultaneously, more pedal pressure than normal will be required.

**CAUTION**

Do not turn emergency airbrake handle to ON while brakes are being applied; sudden increase in braking efficiency may result in a locked wheel and subsequent blowout.

**Note**

- The air bottle contains sufficient pressure for three complete applications of the brakes.
- Brakes must be bled after using the emergency airbrake system.

## LOSS OF CANOPY.

If the canopy is lost, the airplane should immediately be decelerated to 200 knots IAS or less. If no other emergency exists, the emergency signal system should be used, with prearranged signals, by the pilot and radar observer for intercommunication.

**Note**

The following checklist is an abbreviated version of the procedures presented in the amplified checklists of Section III. This abbreviated checklist is arranged so that you may remove it from your flight manual and insert it into a flip pad for convenient use. It is arranged so that each action is in sequence with the amplified procedures given in Section III. Presentation of the abbreviated checklist does not imply that you need not read and thoroughly understand the amplified version. To fly the airplane safely and efficiently you *must* know the reason why each step is performed and why the steps occur in certain sequence.

# AUXILIARY EQUIPMENT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## CABIN AIR-CONDITIONING SYSTEM.

Air for cabin air-conditioning and pressurizing and for canopy defogging is taken from the 11th stage of the engine compressors. It then flows through a shutoff valve in the supply duct to a bypass valve and refrigeration unit. An electronic temperature-sensing system automatically determines the settings of the bypass valve. Cooled air from the refrigeration unit mixes in the main duct with the hot air bypassing the unit and flows through floor outlets into the cabin. (See figure 4-2.) A cabin temperature rheostat regulates the temperature of the air entering the cabin, and an automatic pressure regulator controls the pressure. The cabin air-conditioning system is controlled by 28-volt d-c power, and the electronic temperature-sensing system is operated by 115-volt a-c power from the single-phase inverter system.

### Cabin Pressure Regulator.

The cabin is not pressurized below 12,500 feet. From 12,500 to 31,000 feet, the air pressure regulator maintains the cabin pressure at the 12,500-foot altitude pressure. Above 31,000 feet, the regulator normally maintains a constant differential pressure of 5.00 psi. For combat operation above 12,000 feet, an alternate differential pressure of 2.75 psi can be selected so that the drop in cabin pressure will not be explosive if the cabin is suddenly depressurized. If the cabin pressure regulator fails, a pressure-vacuum-relief valve relieves excessive pressure. When the airplane dives to an altitude where the outside pressure is greater than that in the cabin, the pressure-vacuum-relief valve opens to equalize the pressure.

### CABIN AIR SWITCH.

The 28-volt cabin air switch (figure 4-1) on the pilot's instrument panel controls cabin air and pressure. When the switch is at RAM & DUMP, ram air ventilates the cabin, the engine compressor air is shut off, and the cabin temperature control system is deenergized. When the switch is at PRESS, the ram air is shut off, the engine compressor air is turned on, and the cabin temperature control is energized.

### CABIN DIFFERENTIAL PRESSURE SWITCH.

The cabin differential pressure selector switch (figure 4-1), a 28-volt d-c switch on the pilot's instrument panel, provides a means of selecting either of two available cabin pressures. For all normal operations this switch should be at 5.00 psi so that from 12,500 feet the cabin pressure regulator will maintain the cabin pressure at the 12,500-foot level, and above 31,000 feet


**Figure 4-1.**

will maintain a constant differential pressure of 5.00 psi. For combat operations the switch should be moved to 2.75 psi to minimize any adverse effects if the cabin is suddenly depressurized. (See figure 4-3.)

### CABIN AIR TEMPERATURE SWITCH.

The cabin air temperature switch (figure 4-1) provides a means for lowering or raising cockpit temperature and is located on the pilot's aft miscellaneous panel. The cabin air temperature switch operates on 28-volt dc and has a center neutral position marked OFF; other positions are AUTO, MOM. INCR, and MOM. DECR. The switch is spring-loaded to OFF from the latter two positions. When the switch is at AUTO, the cabin temperature is maintained automatically according to the setting of the cabin temperature rheostat. When the switch is held at MOM. INCR or MOM. DECR the cabin temperature rheostat is cut out of the circuit and the cabin temperature increases or decreases in proportion to the length of time the switch is held. When the switch is released to OFF, the cabin temperature is not automatically controlled; the cooling unit bypass valve remains in the position it is in and the temperature of the air entering the cabin will remain constant if engine speed and airplane altitude remain constant. The cabin air temperature switch must be at AUTO when the pilot's canopy defog knob is pulled all the way out; then a sensing element, energized by the canopy defog knob, can override the cabin temperature rheostat and maintain a constant defogging air temperature of 79°C (175°F).

### CABIN TEMPERATURE RHEOSTAT.

The cabin temperature rheostat (figure 4-1) is a 28-volt d-c knob on the pilot's aft miscellaneous panel. When the cabin air temperature switch is at AUTO, the cabin temperature rheostat automatically controls the temperature of the air in the cabin. The rheostat can be rotated between COOLER and WARMER as desired to control the temperature in the cabin. The rheostat is out of the circuit when the cabin air temperature switch is not at AUTO.

### CABIN AIR-CONDITIONING SYSTEM NORMAL OPERATION.

1. Cabin air switch—PRESS.
2. Cabin air temperature switch—AUTO.
3. Cabin air temperature rheostat—As desired.
4. Cabin differential pressure switch—5.00 psi.

### CABIN AIR-CONDITIONING SYSTEM EMERGENCY OPERATION.

If the automatic temperature control fails, proceed as follows:

1. Cabin air temperature switch—Hold momentarily at MOM. INCR for warmer air or at MOM. DECR for cooler air.
2. Wait a few minutes for change to become evident; then repeat until desired temperature is attained.
3. If this fails, place cabin air switch at RAM & DUMP.

## CANOPY DEFOGGING SYSTEM.

Canopy defogging air is diverted from the cabin air-conditioning floor outlets and released through ducts along the canopy rail. The temperature of the air is maintained at 79°C (175°F) by a separate temperature-sensing unit. This sensing unit overrides the cabin temperature rheostat if the cabin temperature switch is set at AUTO and the pilot's canopy defog knob is pulled all the way out.

### CANOPY DEFOG KNOBS.

Two canopy defog knobs (figures 1-11 and 4-7), one on the pilot's center pedestal, and one on the left side of the radar observer's cockpit, are provided for canopy defogging. The defog knobs mechanically adjust valves which divert the cabin air from the floor outlets to the defogging ducts in the pilot's cockpit and torso comfort outlets in the radar observer's cockpit. Each crewmember controls canopy defogging for his cockpit,

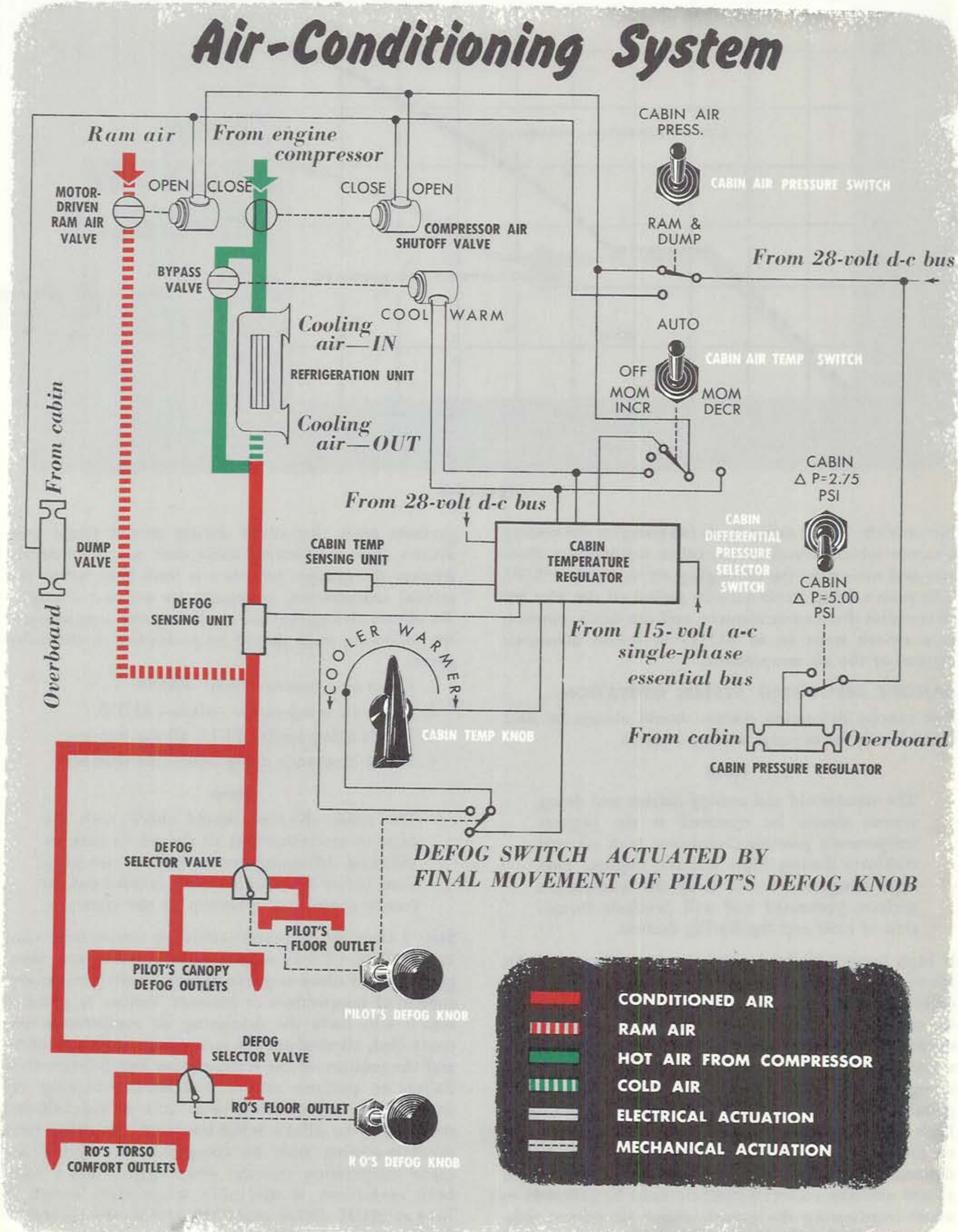

Air-Conditioning System
Ram air
From engine compressor
MOTOR-DRIVEN RAM AIR VALVE
OPEN
CLOSE
CLOSE
OPEN
COMPRESSOR AIR SHUTOFF VALVE
CABIN AIR PRESS.
CABIN AIR PRESSURE SWITCH
RAM & DUMP
From 28-volt d-c bus
BYPASS VALVE
COOL
WARM
Cooling air—IN
REFRIGERATION UNIT
Cooling air—OUT
AUTO
CABIN AIR TEMP SWITCH
OFF
MOM INCR
MOM DECR
From cabin
CABIN Δ P=2.75 PSI
CABIN DIFFERENTIAL PRESSURE SELECTOR SWITCH
CABIN Δ P=5.00 PSI
From 28-volt d-c bus
CABIN TEMP SENSING UNIT
CABIN TEMPERATURE REGULATOR
DUMP VALVE
Overboard
DEFOG SENSING UNIT
From 115-volt a-c single-phase essential bus
COOLER
WARMER
CABIN TEMP KNOB
From cabin
Overboard
CABIN PRESSURE REGULATOR
DEFOG SELECTOR VALVE
DEFOG SWITCH ACTUATED BY FINAL MOVEMENT OF PILOT'S DEFOG KNOB
PILOT'S FLOOR OUTLET
PILOT'S CANOPY DEFOG OUTLETS
PILOT'S DEFOG KNOB
DEFOG SELECTOR VALVE
RO'S FLOOR OUTLET
RO'S TORSO COMFORT OUTLETS
RO'S DEFOG KNOB
CONDITIONED AIR
RAM AIR
HOT AIR FROM COMPRESSOR
COLD AIR
ELECTRICAL ACTUATION
MECHANICAL ACTUATION
H-60B

Figure 4-2.

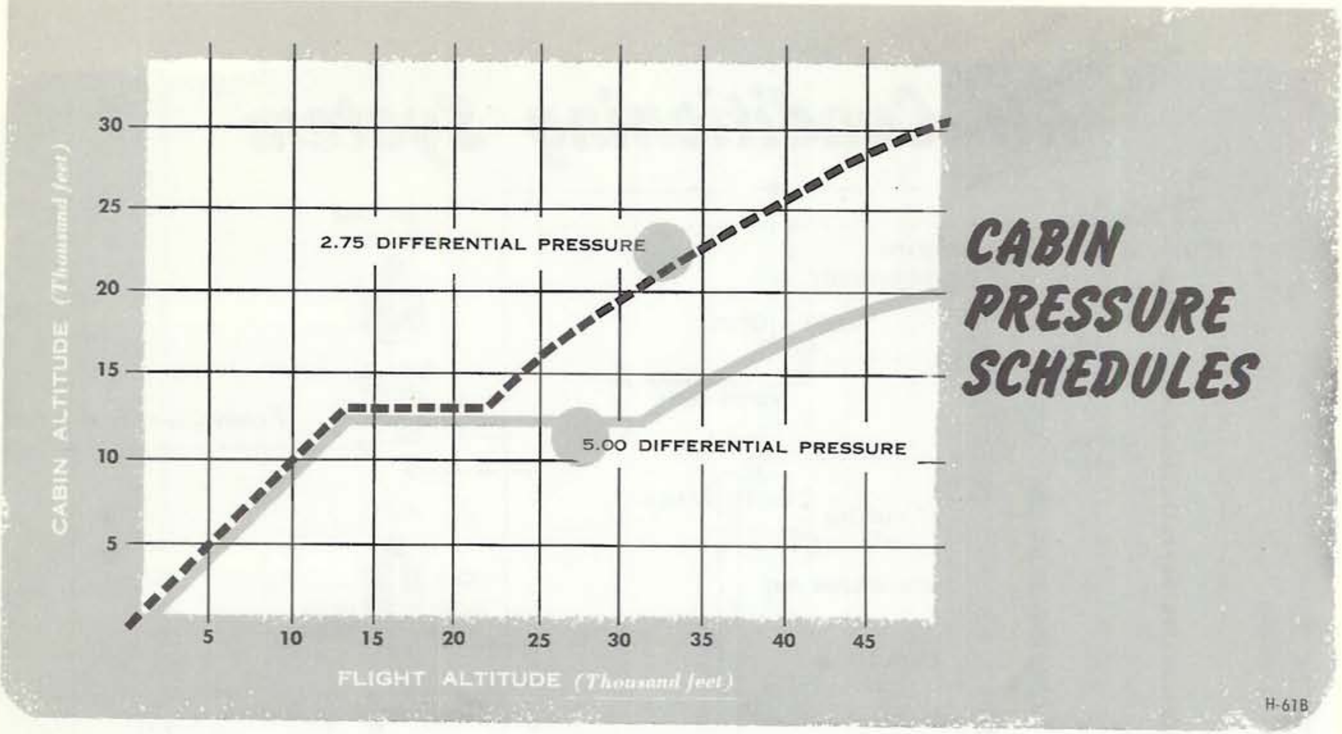



Figure 4-3.

but only the pilot's defog knob can energize the sensing element which overrides the cabin temperature rheostat and maintains the defogging air at 79°C (175°F). The pilot's defog knob must be pulled all the way out to energize the sensing element, and the cabin temperature switch must be at AUTO to insure automatic control of the air temperature.

**CANOPY DEFOGGING SYSTEM OPERATION.**

The canopy defogging system should always be used immediately before and during descents.

**Note**

The windshield and canopy defrost and defog system should be operated at the highest temperature possible (consistent with aircrew comfort) during high altitude flights. This high temperature will keep the transparent surfaces preheated and will preclude formation of frost and fog during descent.

If high humidities are known to exist at low altitudes (dewpoint over 60° F) the defogging system should be on for at least 30 minutes before descent to insure that the canopy does not fog over at low altitude. The windshield is electrically heated to prevent defogging; windshield heat should be used at all times. The canopy defogging system should be operated at the highest possible temperature consistent with comfort during high altitude flights, to preheat the canopy in order to prevent the formation of frost and fog during descents. When the canopy defogging system is used at low altitude, correct procedure must be followed to avoid overheating the canopy above its critical temperature of 88.6°C to 93.3°C (190°F to 200°F). At these temperatures it softens and can fail under the pressure loads that occur during certain flight conditions. The overheating itself does not permanently damage the canopy, for when it cools back below the critical temperature, it regains its original strength. To obtain defogging air at the correct temperature, the following steps should be performed in the order given:

1. Cabin air pressure switch—PRESS.
2. Cabin air temperature switch—AUTO.
3. Pilot's defog knob—PULL all the way out.
4. Radar observer's defog knob—As desired.

**Note**

The radar observer should check with the pilot to determine that all the pilot's controls affecting defogging are in their correct positions before he pulls his defog control out, to ensure controlled operation of the system.

Step *3* fixes the automatic cabin air temperature control at 79°C (175°F) only if steps *1* and *2* have been performed. Failure to perform step *1* will prevent any control of temperature or pressure. Failure to perform step *2* will leave the defogging air temperature uncontrolled, affected only by compressor air temperature and the position of the refrigeration unit bypass valve. Failure to perform step *3* will leave defogging air temperature uncontrolled, since only at the full out position of the pilot's defog knob will the defog temperature-sensing unit be energized to override the cabin temperature rheostat when steps *1* and *2* have been performed. If the cabin temperature switch is held at MOM. INCR or MOM. DECR, the automatic temperature control is overridden. If the pilot's or radar observer's defogging knob is pulled out when the switch is held at MOM. INCR, air at full compressor temperature is directed on the canopy and damage to the canopy may result. If either knob is pulled out when the switch is held at MOM. DECR, air at the lowest temperature available from the refrigeration unit is directed on the canopy. The use of the defog knobs at intermediate positions (not out far enough to energize the automatic temperature control) when the air-conditioning system is cooling the cockpits will greatly increase cooling effectiveness, since air from the defogging ducts will provide additional cooling to the upper part of the body. Caution must be exercised when the defog knobs are used in this manner since damage to the canopy will result if heating is turned on without returning the knobs to the full in position.

## ANTI-ICING SYSTEMS.

### THERMAL AND ELECTRICAL ANTI-ICING SYSTEMS.

For the thermal anti-icing system, hot air is extracted from the 11th stage of the engine compressor to anti-ice the leading edge of the wings, empennage, and engine air intake scoop. In normal operation, the hot air maintains a predetermined leading edge skin temperature. The air passes through a pneumatic safety valve and a modulating valve which is controlled by the skin normal thermistors and the pressure control. If the normal thermistors fail to control the modulating valve, and the surfaces of the leading edges overheat, a skin overheat thermistor will close the pneumatic safety valve to stop the flow of hot air to the surfaces. When the temperature drops below a predetermined value, the overheat thermistor will reopen the safety valve until the surfaces again overheat; then the cycle repeats. The engine inlet guide vanes, bullet nose, island fairings, and forward frame struts are heated by hot air bled directly from the 11th stage duct whenever the anti-icing system is in operation. Icing conditions are detected by means of a pressure-sensing icing probe located in each engine air inlet duct. When ice forms on either probe, a 28-volt d-c red warning light on the anti-icing control panel illuminates, the engine screen normal controls are overridden, and the engine screens are retracted. When the airplane is parked with the power on and the anti-icing switch is at OFF, the warning light will come on and remain on, whether ice is present or not, until the engines attain a speed of 62.5% rpm. Below 62.5% engine rpm the inlet air pressure is insufficient to actuate the pressure switch. Operation of the thermal anti-icing system causes a rise in exhaust gas temperature, an increase in specific fuel consumption, and a decrease in available thrust. The electrical controls for the system operate on 28-volt dc. In the electrical anti-icing systems, 28-volt d-c heating elements heat the pitot tubes and engine icing probes. The fuel tank vent heaters are energized by the 115/200-volt alternator. The anti-icing switch controls the circuits for all of these electrical heating units except the pitot heaters. When the airplane is on the ground, a ground safety switch on the main landing gear de-energizes all circuits except the pitot heating circuit.

**WARNING**

Do not use wing anti-icing during takeoff or landing as maximum available thrust will be reduced.

**Note**

The angle-of-attack probe heater is energized at all times when the landing gear is retracted.

#### Anti-Icing Switch.

The 28-volt d-c anti-icing switch (figure 4-4) on the anti-icing control panel controls the electrical circuits of the thermal and electrical anti-icing systems. When the red light warns that ice has formed on the icing probes, the switch can be turned to TAKEOFF for engine anti-icing or to FLIGHT for complete anti-icing. When the switch is at TAKEOFF or FLIGHT, the electric heaters for the icing probes and fuel vents operate when airborne; but while the airplane is on the ground, the ground safety strut switch breaks the circuits. When icing conditions no longer exist, the anti-icing switch should be turned to OFF to de-energize all anti-icing circuits.

#### Wing Anti-Icing Override Switch

The 28-volt d-c wing anti-icing override switch (figure 4-4) located on the anti-icing control panel, provides manual control of the flow modulating valve if the normal thermistor circuit fails. The switch has two positions: NORMAL and EMER. When the switch is placed at NORMAL, the modulating valve is controlled automatically by the normal thermistors and the pressure control. When the switch is placed at EMER, the modulating valve will open; however, if an over-pressure condition exists, the pressure control will prevent the valve from opening regardless of switch position. When the switch is at EMER, the overheat thermistor will continue to control the pneumatic safety valve.

#### Pitot Heat Switch.

Each pitot tube is heated by 28-volt d-c power. The pitot heat switch (figure 4-4) on the anti-icing control panel can be turned to OFF and ON to control the

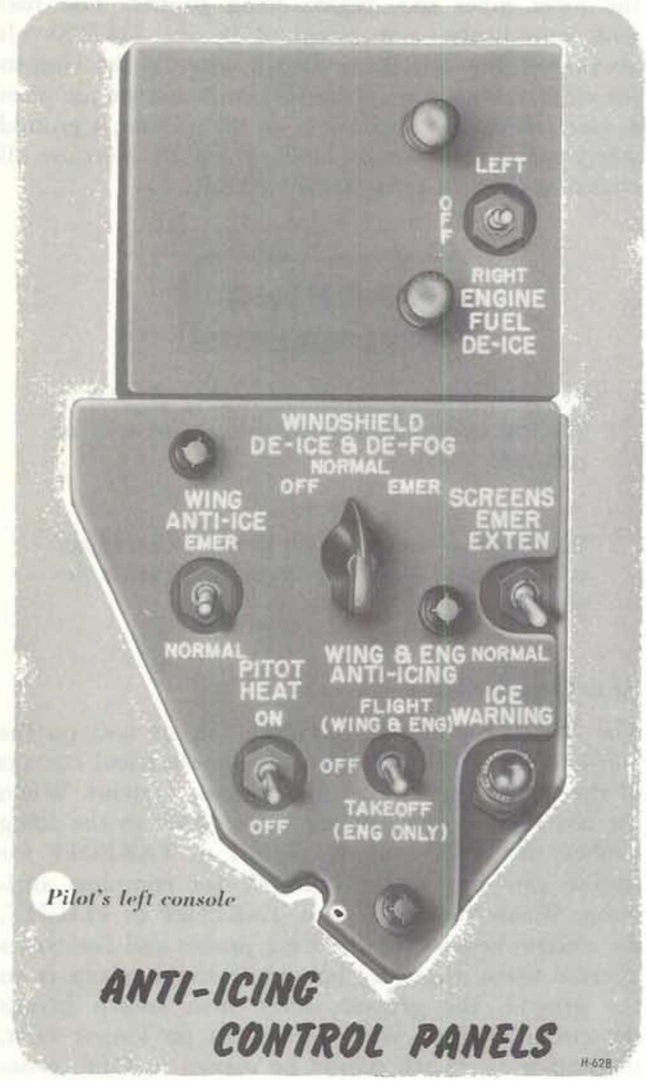



**Figure 4-4.**

operation of the pitot heaters. The pitot heat switch is not overridden by the ground safety switch and can be turned to ON at any time.

**Anti-Icing Warning Light.**

When ice forms on the icing probes, the 28-volt d-c anti-ice warning light (figure 4-4), located on the anti-icing control panel, comes on to indicate that the anti-icing system should be turned on. When the anti-icing switch is placed at TAKEOFF or FLIGHT, the light goes out and will not come on again while the system is energized. When the anti-icing switch is at TAKEOFF or FLIGHT the heating elements for the icing probes are energized when ice forms on the probes, and are automatically turned off when the ice is melted.

**Anti-Icing System Operation.**

The following operating procedures are recommended for use of the anti-icing system in conditions of known icing or when indicated by the ice warning light.

**Takeoff.** Select TAKEOFF position of anti-icing switch. This will retract the engine inlet screens and provide hot air anti-icing of the engine forward frame components.

**WARNING**

- **Unless the anti-icing switch is placed at TAKEOFF when taking off into icing conditions, the engine screens will remain extended until the airplane leaves the ground. In severe icing conditions the engine screens may become iced within a few seconds, resulting in dangerous loss of power.**
- **FLIGHT position of anti-icing switch is not to be used on takeoff, because complete airplane surface anti-icing increases the demand on the compressor hot air bleed and causes a much greater loss in thrust.**

**In Flight (Level Flight and Climb).** Select FLIGHT position of the anti-icing switch. This will retract the engine inlet screens if screen switch is in EMER EXTEN position, provide hot air anti-icing of the airframe leading edge surfaces and engine forward frame components, and provide electrical anti-icing of the fuel vents.

**Descent.** In making a descent from altitude through icing conditions, select FLIGHT position of anti-icing switch, maintain a minimum of 83% engine rpm and regulate airspeed and rate of descent as in normal descent. If ice then accumulates (additional hot air is required for anti-icing), increase the engine rpm without increasing airspeed.

**Landing.** Place the anti-icing switch in FLIGHT position before the final approach of a landing in icing conditions with one or both engines operating to provide ice protection for the wings and empennage. Use of the anti-icing system affords protection against icing conditions, but causes a decrease in available thrust. If a go-around is necessary, the anti-icing switch may remain in the FLIGHT position *only* if two engines with maximum thrust and afterburning are available. Place the anti-icing switch in TAKEOFF position during approach and landing under single-engine operation in light or moderate icing conditions to provide maximum thrust in case of a possible go-around. Adequate ice protection is available from one engine; however, available thrust may be dangerously reduced. In most cases moderate icing of the airfoil leading edges can be tolerated in preference to loss of engine thrust. When a go-around is necessary with both engines operating, but afterburners are inoperative, or when a single-engine go-around is necessary, place the anti-icing switch in the TAKEOFF position until a safe go-around altitude is obtained. After reaching a safe altitude, the anti-icing switch may be moved back to FLIGHT position. In single-engine operation excess thrust is low in landing and takeoff configurations. Therefore, it is imperative that flaps and landing gear are raised as soon as possible when making a single-engine go-around.

**Note**

> The hot air anti-icing systems use air from the engine compressor and thereby reduce the available thrust, increase the specific fuel consumption, and decrease the airspeed. The anti-icing systems should therefore be turned off when icing conditions no longer exist and should not be turned on in the absence of icing conditions.

## LOW PRESSURE FUEL FILTER DE-ICING SYSTEM.

A low pressure fuel filter de-icing system is provided for the engines. Alcohol can be injected into the fuel filter to dissolve ice particles in the fuel filter and engine fuel control. Fuel control icing will be evidenced by a drop in rpm, by overspeeding, or lack of throttle response in the affected engine. Overspeeding or drop in rpm in excess of 2% while operating at 100% throttle setting can be construed as an icing condition. Alcohol from a 3.9 (US) gallon tank, located in the right wing, affords approximately 3 minutes total de-icing time. A 28-volt d-c pump supplies pressure for operation of the low pressure fuel filter de-icing system. Two solenoid valves, one for each engine, control the flow of alcohol. Fuel filter or fuel control icing is not necessarily associated with other icing conditions, but will occur whenever water particles exist in the fuel and temperature of the fuel falls below 0°C (32°F).

### Low Pressure Fuel Filter De-Ice Switch.

A three-position 28-volt d-c switch, spring-loaded to OFF (center) with other positions RIGHT and LEFT (figure 4-4), is located on the anti-icing control panel. This switch controls power to a 28-volt d-c motor-driven de-icing pump, and opens either of two normally closed solenoid valves in the lines from the pump to the engine low pressure fuel filters. When engine fuel control icing is indicated by variation in engine rpm or lack of throttle response, the switch should be held to the position representing the affected engine (RIGHT or LEFT) until engine rpm ceases to fluctuate, indicating that fuel flow is back to normal. Normal flow should resume in 30 seconds or less. When the switch is released, the alcohol pump will stop operating and the solenoid valve in the line to the filter that was de-iced will return to its normally closed position. The alcohol supply will allow approximately 3 minutes of pump operation as the pump delivery rate averages slightly more than 1 gallon per minute.

**Note**

> If foreign matter other than ice restricts the flow of fuel through a filter, the corresponding engine will react as during icing. A filter clogged by foreign matter will be indicated if normal fuel flow does not resume after approximately 30 seconds of de-icing operation. This should not cause alarm. Before the fuel pressure drop across the low pressure filter becomes critical, a bypass valve will open and fuel will be routed around the filter. However, it is important to make sure that the filter is cleaned immediately after completion of flight.

## RADOME ANTI-ICING SYSTEM.

The radome anti-icing system prevents ice, which would cause radar interference, from forming on the nose of the airplane. Anti-icing fluid is supplied from a pressurized 3½ gallon tank to a nozzle which atomizes and sprays the fluid over the exterior surface of the radome. The tank is pressurized and the fluid is atomized by air from the 11th stage engine manifold. The compressor air is controlled by a solenoid valve actuated by switches in the pilot's and radar observer's cockpits. To prevent thickening at low temperatures, the fluid is maintained at about 40°F by a thermostatically controlled heater in the tank. For fluid specifications, see figure 1-45.

### Radome Anti-Icing Switches.

The system is actuated by placing the pilot's anti-icing switch (figure 4-4), located on the anti-icing control panel, at FLIGHT; however, the radar observer is provided with a 28-volt d-c override switch (figure 4-8), located on the right side of the cockpit, which gives him complete control over the system. The switch has three positions: NORMAL, OFF, and EMER. If the override switch is at NORMAL, the pilot's anti-icing switch controls the system. If the override switch is at OFF, the system is off regardless of the position of the pilot's anti-icing switch. If the override switch is at EMER, the system is on regardless of the position of the pilot's anti-icing switch.

**Note**

- The supply of anti-icing fluid will last approximately 1 hour if used continuously. This must be taken into consideration when planning interceptions under icing conditions.
- When anti-icing fluid has been used, a notation to this effect should be made in DD Form 781.

## WINDSHIELD HEAT SYSTEM.

The windshield is defrosted and de-iced by two transparent heat-conducting films within the windshield glass. The defrost system utilizes 28-volt dc and 115-volt single-phase inverter system ac for control and sensing circuits, and alternating current from the 115-volt alternator or from the single-phase inverter system for windshield heat. The temperature is automatically controlled by heat-sensing elements and temperature regulators.

### WINDSHIELD DE-ICE AND DEFOG KNOB.

A 28-volt d-c rotary windshield de-ice and defog knob (figure 4-4), on the anti-icing control panel has OFF, NORMAL, and EMER positions to control the windshield defrost and de-ice circuits. For defrosting, the knob is placed at NORMAL: full a-c power is supplied to the inner heat-conducting film and medium a-c power to the outer heat-conducting film. For de-icing, the knob is placed at EMER, and full a-c power is supplied to both heat-conducting films. The EMER position should be used only for heavy icing conditions, and the switch should be returned to NORMAL as soon as possible. The EMER position should never be used when the airplane is on the ground because the extreme heat applied to the outer film could damage the windshield. Primary power for windshield heat is supplied by the alternator; but if the alternator fails, the single-phase inverter system will supply power for the defrosting circuits.

**CAUTION**

To prevent possible bubbling of the heat-conducting film in the windshield glass, leave the windshield de-ice and defog knob at NORMAL for at least 1 minute before turning it to EMER. Only in heavy icing conditions should it be turned to EMER. Never operate the system on EMER longer than necessary.

## COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT.

### Interphone System AN/AIC-10

The interphone system, operating on 28-volt dc, provides the following facilities: speech communication within the airplane with or without the use of microphone switches, communication beyond the airplane by integration with its radio equipment, monitoring of received signals either individually or simultaneously, a call facility which permits transmission of urgent communication to both headsets regardless of individual control panel switch settings. On airplanes modified in accordance with T.O. 1F-89-627, the landing warning horn has been removed and replaced with an audible warning signal unit. If the landing gear has not extended and locked properly on airplanes so modified, a warning signal will be audible over the pilot's headset. Operation and control of the audible warning signal unit is the same as for the landing gear warning horn which it replaces. Receptacles in the right wheel well and in the aft radio and equipment section allow communication between the airplane crew and the ground crew.

### Interphone Control Panel AN/AIC-10.

An interphone control panel (figure 4-9) is located on the right console in each cockpit. Each panel has a volume control knob, five (toggle type) mixing switches, a rotary selector switch, and an auxiliary listen switch. The mixing switches, marked INTER, COMM, MARKER, ADF, and VHF NAV, enable the operator to monitor incoming signals from all five sources (interphone, command, marker beacon, radio compass or omnirange and localizer sets), or to select any combination. The rotary selector switch has positions COMM, COMM-INTER, INTER, and CALL, starting at the left and going clockwise. The switch's function is conventional. For example: with the switch at COMM-INTER or CALL, the microphone is open for interphone communication, but with the switch at either COMM or INTER, the operator must press a microphone button to talk or transmit. The auxiliary listen switch has NORMAL and AUX LISTEN positions. The toggle is safetied at NORMAL (up). When the switch is moved to AUX LISTEN any incoming signals bypass the interphone amplifier and come into the headset at line level (unamplified).

### ADF Filter Switch

The ADF filter switch panel (figure 1-13) is located on the pilot's right console. The filter switch is conventional in function, and has VOICE, RANGE, and BOTH positions to mix or filter voice and range signals when the radio compass is receiving on loop or antenna.

### Pilot's Microphone Switches.

Two microphone switches (figures 1-7 and 1-28), one located on the right engine throttle knob, and one on the control stick grip, can be pressed to transfer the microphone input from the interphone to the command transmitter.

### Radar Observer's Microphone Buttons.

One radar observer's microphone switch (figure 4-7) is located adjacent to the canopy defog knob and, when pressed, transfers the microphone input from the interphone to the command transmitter. A foot-operated switch located on the floor under the radar scope serves as a radio audio disconnect switch. When pressed, it prevents all incoming radio signals from reaching both the front and rear cockpits; however, the radar observer can talk to the pilot on the interphone. This arrangement permits the radar observer to shut out temporarily any distracting radio noises while concentrating on the radar scope.

# COMMUNICATIONS AND ASSOCIATED ELECTRONIC EQUIPMENT

| TYPE | DESIGNATION | FUNCTION | OPERATOR | RANGE | LOCATION OF CONTROLS |
|---|---|---|---|---|---|
| INTERPHONE | AN/AIC-10 | CREW INTERCOMMUNICATION | PILOT OR RO | COCKPIT | *Pilot's and RO'S right consoles* |
| UHF COMMAND | AN/ARC-27 | AIR-TO-AIR AND AIR-TO-GROUND COMMUNICATION | PILOT OR RO | LINE-OF-SIGHT | *Pilot's and RO'S right consoles* |
| RADIO COMPASS | AN/ARN-6 | VOICE RECEPTION, RADIO NAVIGATION | PILOT OR RO | 150 MILES UNDER AVERAGE CONDITIONS | *Pilot's and RO'S right consoles* |
| VHF NAVIGATION | AN/ARN-14 | VOR. VAR NAVIGATION, VOICE RECEPTION, LOCALIZER | PILOT | LINE-OF-SIGHT | *Pilot's instrument panel and right console* |
| GLIDE-SLOPE | AN/ARN-18 | INSTRUMENT APPROACH GLIDE-SLOPE | PILOT | 15 MILES | *Pilot's right console* |
| MARKER BEACON | AN/ARN-12 | RECEPTION OF MARKER BEACON SIGNALS ON RANGE AND LOCALIZER LEGS | PILOT | VERTICAL | *Pilot's instrument panel* |
| FLIGHT COMPUTER | A-2 | APPROACHING AND HOLDING PRE-SELECTED COURSE AND ALTITUDE | PILOT | LINE-OF-SIGHT | *Pilot's instrument panel* |
| IFF | AN/APX-6A | AUTOMATIC AIRCRAFT IDENTIFICATION | PILOT | LINE-OF-SIGHT | *Pilot's right console* |

H-63B

*Figure 4-5.*

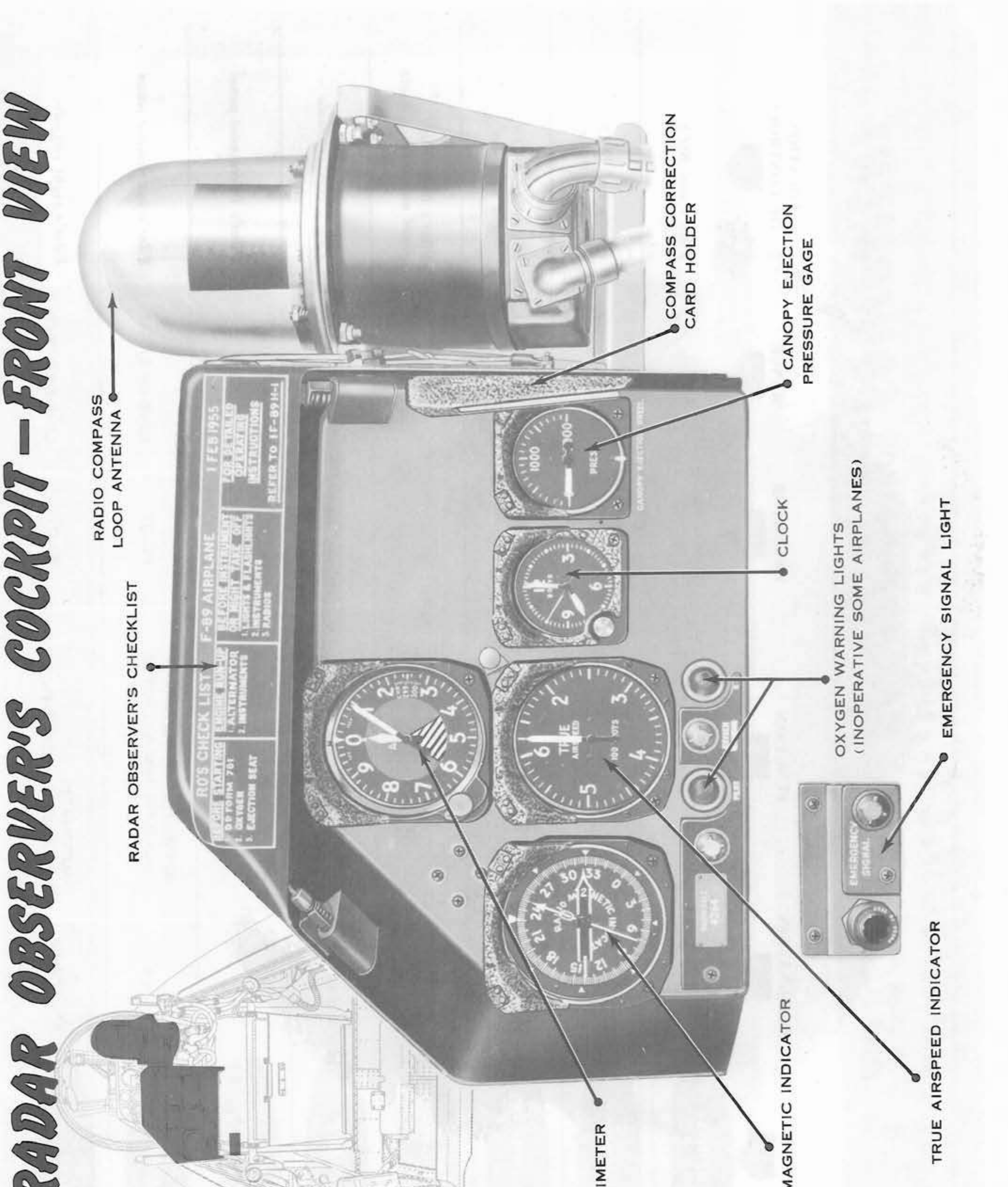

RADAR OBSERVER'S COCKPIT—FRONT VIEW
RADIO COMPASS LOOP ANTENNA
RADAR OBSERVER'S CHECKLIST
COMPASS CORRECTION CARD HOLDER
CANOPY EJECTION PRESSURE GAGE
CLOCK
OXYGEN WARNING LIGHTS (INOPERATIVE SOME AIRPLANES)
EMERGENCY SIGNAL LIGHT
TRUE AIRSPEED INDICATOR
RADIO MAGNETIC INDICATOR
ALTIMETER
RO'S CHECK LIST
F-89 AIRPLANE
1 FEB 1955
REFER TO 1F-89H-1
H-64C

*Figure 4-6.*

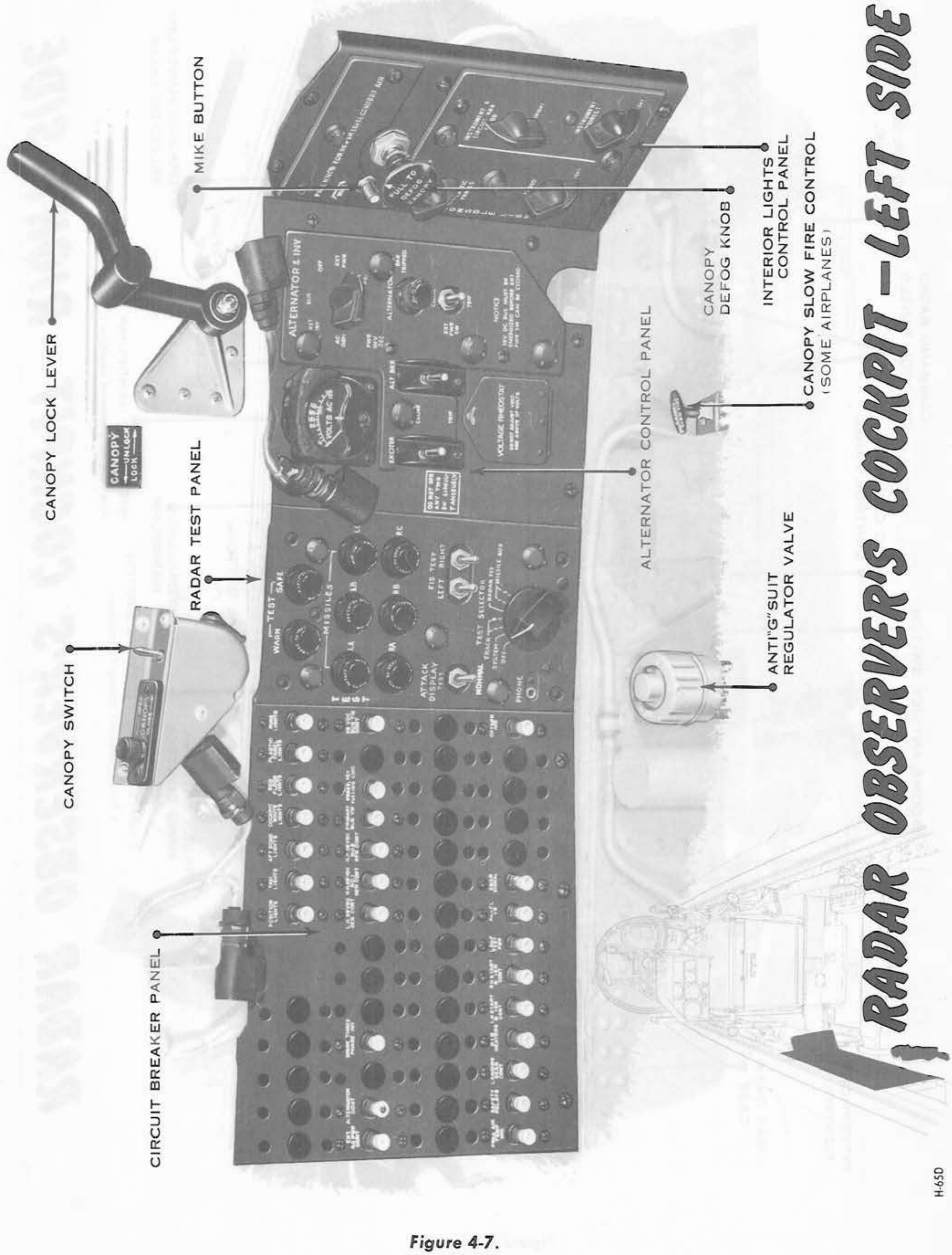

RADAR OBSERVER'S COCKPIT—LEFT SIDE
CANOPY LOCK LEVER
MIKE BUTTON
CANOPY SWITCH
RADAR TEST PANEL
CIRCUIT BREAKER PANEL
ALTERNATOR CONTROL PANEL
CANOPY DEFOG KNOB
INTERIOR LIGHTS CONTROL PANEL
CANOPY SLOW FIRE CONTROL (SOME AIRPLANES)
ANTI"G"SUIT REGULATOR VALVE
CANOPY ←UNLOCK LOCK→
H-65D

*Figure 4-7.*

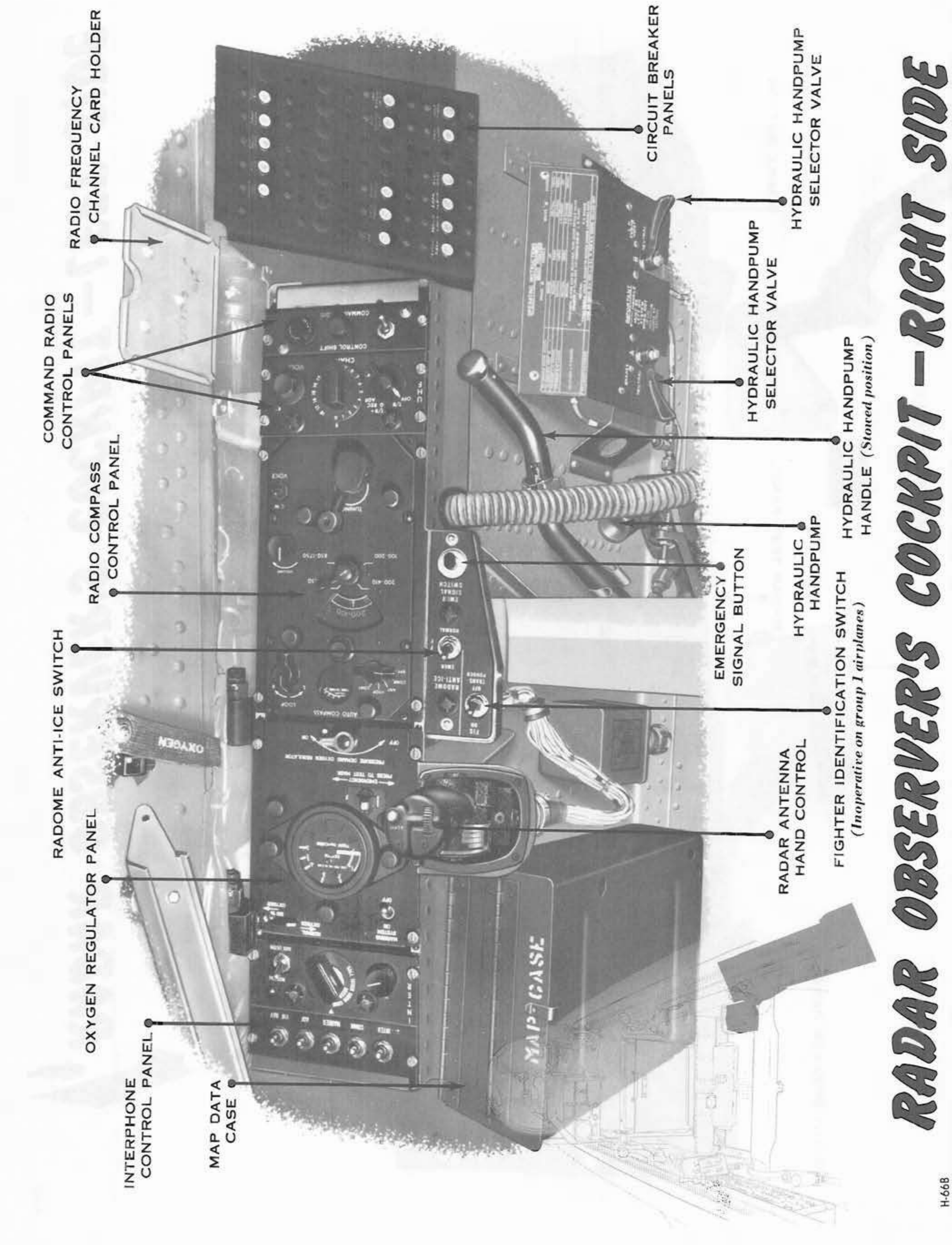

RADAR OBSERVER'S COCKPIT—RIGHT SIDE
RADIO FREQUENCY CHANNEL CARD HOLDER
COMMAND RADIO CONTROL PANELS
RADIO COMPASS CONTROL PANEL
RADOME ANTI-ICE SWITCH
OXYGEN REGULATOR PANEL
INTERPHONE CONTROL PANEL
MAP DATA CASE
CIRCUIT BREAKER PANELS
HYDRAULIC HANDPUMP SELECTOR VALVE
HYDRAULIC HANDPUMP SELECTOR VALVE
HYDRAULIC HANDPUMP HANDLE (Stowed position)
HYDRAULIC HANDPUMP HANDLE
HYDRAULIC HANDPUMP
EMERGENCY SIGNAL BUTTON
FIGHTER IDENTIFICATION SWITCH (Inoperative on group 1 airplanes)
RADAR ANTENNA HAND CONTROL
OXYGEN
MAP CASE
H-668

Figure 4-8.

### Interphone Operation.

1. Filter switch—BOTH.
2. Interphone selector switch—COMM-INTER.
3. Interphone toggle switch—INTER.
4. Auxiliary listen switch—NORMAL.
5. Volume control knob—Adjust as desired.


*Figure 4-9.*

**Note**

The interphone set is in operation whenever electrical power is on the airplane, unless the interphone circuit breakers (on the radar observer's circuit breaker panel) are pulled out.

## COMMAND RADIO AN/ARC-27.

The command radio set, operating on 28-volt dc, is used for airplane-to-airplane and airplane-to-ground communication. The range varies with the altitude and atmospheric conditions. A UHF channel identification holder is located on the forward right sliding canopy frame directly below the defog duct.

### Command Radio Controls.

Control panels for the command radio (figure 4-10) are on the pilot's right console and the radar observer's right console. Each control panel has a power control switch, channel selector switch, volume control knob, control-shift switch, and a green indicator light. The control-shift switches transfer control of the command radio to either cockpit, and the green light comes on in the cockpit having control. To transmit to the ground or to another airplane, a microphone switch must be depressed.

### Command Radio Operation.

1. Power control switch—T/R. Allow equipment to warm up for at least 1 minute.
2. Channel selector switch—Rotate to desired frequency channel. Set is now ready to transmit and receive.
3. Power control switch—T/R + G REC, if simultaneous reception on guard-frequency channel and another channel is desired.
4. Volume control knob—Adjust as desired.
5. Microphone button—Press to transmit.
6. Power control switch—OFF to turn set off.

**CAUTION**

- When the command radio set has been turned off, do not turn set on again for 1 minute. Allowing the condensors to discharge prevents an excessive power surge.
- To avoid damage to the selector mechanism, do not select another channel while set is in midcycle.

**Note**

No transmission will be made on emergency (distress) frequency channels except for emergency purposes. For test, demonstration, or drill purposes, the radio equipment will be operated in a shielded room to prevent transmission of messages that could be construed as actual emergency messages.


*Figure 4-10.*


**Figure 4-11.**

## RADIO COMPASS AN/ARN-6.

The radio compass, operating on 28-volt d-c power, indicates the direction to any selected transmitting station when the radio compass is set for homing operation of the loop antenna. The signal of this receiver is fed to the No. 1 needle of each radio magnetic indicator on the pilot's and radar observer's instrument panels.

### Radio Compass Controls.

Radio compass control panels (figure 4-11) are on the right console of each cockpit. Each control panel has a function switch, frequency band selector switch, loop L-R switch, volume control knob, CW-voice switch, and tuning crank. Either crewmember can gain control of the radio compass by turning the function switch to CONT.

### Radio Compass Operation.

1. Function switch—CONT momentarily to gain control; then turn to desired position. Allow at least 5 minutes for warmup.
2. Interphone selector switch—Any position.
3. Interphone ADF switch—ADF.
4. Frequency band selector switch—Turn to desired frequency.
5. Volume control knob—Adjust.
6. Function switch—OFF, to turn set off (both cockpits).

**Note**

- Operation of the E-9 fire control system causes mild to severe interference of the AN/ARN-6 radio compass, depending upon homing signal strength and frequency selected.
- The function switch in either the pilot's or radar observer's cockpit will turn the set off only when the function switch in the other cockpit is also in the OFF position.

## VHF NAVIGATION SET AN/ARN-14.

This equipment receives visual omnirange, visual-aural range, localizer, and communication signals in the high-frequency range of 108.0 to 135.9 megacycles. It employs 280 channels spaced 100 kilocycles apart, in the following categories:

FREQUENCY ALLOCATIONS

| *Frequency Band in Megacycles* | *Type of Service* |
|---|---|
| 108.0—111.9 | Runway Localizer |
| 108.3—110.3 | Visual-Aural Range (VAR) |
| 111.0—111.9 | Weather Broadcasts |


**Figure 4-12.**


Figure 4-13.

| *Frequency Band in Megacycles* | *Type of Service* |
|---|---|
| 112.0—117.9 | Visual Omnirange (VOR) |
| 118.0—121.9 | Tower |
| 122.0—135.9 | General Communications |

As the transmission in these bands is line-of-sight, reception varies from 3 miles unobstructed distance at sea level, to approximately 100 miles at 10,000 feet, and even greater distances at higher altitudes. The dynamotor operates on 28-volt dc; the indicators operate on 26-volt ac from the C-1 amplifier. For instructions covering use of this equipment for autopilot-controlled approach, see Automatic Approach Equipment, this section.

**VHF Navigation Set Controls.**

The VHF navigation control panel (figure 4-12) on the pilot's right console has a power switch, a frequency selector knob, and a volume control knob. The power switch is turned from OFF to ON to put the set into operation. The outer ring of the frequency selector dial rotates to show as a whole number, megacycles from 108 to 135 in the top three windows of the frequency selector dial. A center knob selects intervals of hundred-kilocycles which appear as decimal parts of a megacycle in the bottom window of the dial.

**VHF Navigation Set Indicators.**

Two indicators for this equipment are on the pilot's instrument panel. A course indicator registers VOR, VAR, localizer, and glide slope orientation. A radio magnetic indicator combines the functions of a directional indicator (slaved) with those of a dual radio compass. A duplicate radio magnetic indicator is on the radar observer's instrument panel.

**Radio Magnetic Indicator.** The radio magnetic indicator (figure 4-13) includes a rotating compass card and two needles. The rotating card is coupled to the gyrosyn compass system. The signals of the radio compass are fed to the No. 1 needle; the signals of the omnirange receiver are fed to the No. 2 needle when the receiver is tuned to a VOR transmitter. The angle between a needle and the index at the top of the instrument face will give the relative bearing; and the radio magnetic indicator will read, on the card under the point of the needle, the actual magnetic bearing to the station regardless of the heading of the airplane. Since the card will hold to magnetic north and the two needles will hold to the tuned radio stations, the card and the needles will appear to rotate as if fixed together whenever a tight turn is made at some distance from the stations.

**Course Indicator.** The course indicator (figure 4-14) has a marker beacon indicator light in one corner


Figure 4-14.

and a course set knob in the opposite corner. On the face of the instrument are: a course window which displays the number of the omnirange radial set up by the knob; a sensing window which indicates whether the radial course leads to or from the omnirange station; a relative heading needle which is coupled to the gyrosyn compass system; a vertical sliding bar and a horizontal sliding bar. When the receiver is tuned to a VOR station and the warning "off" flags have retracted from the face of the instrument, the instrument shows which of the 360 radials of the omnirange station has been selected (course window), whether that radial course leads to or from the station (sensing window), whether the radial lies right or left of the airplane (vertical bar indication), and whether the airplane is headed right or left of the selected course (relative heading needle). The horizontal bar does not respond to VOR signals; but when a glide-slope transmitter has been tuned in, the bar will show the position of the airplane with respect to the glide slope.

**VHF Navigation Set Ground Check.**

1. Single-phase inverter switch—NORMAL.
2. Three-phase inverter switch--MAIN.
3. Directional indicator slaving cutout switch—ON.
4. Interphone selector switch—Any position.
5. Interphone ADF switch—ADF.
6. Interphone VHF switch—VHF NAV.
7. VHF power switch—ON.
8. VHF frequency selector knob—Set on frequency of nearest omnirange station.
9. Radio compass function switch—CONT. When reaction of meter indicates that control has been obtained, turn to COMP.
10. Course indicator—Check that warning "off" flag has retracted from vertical bar after equipment has had a 2 to 5 minute warmup.
11. Radio magnetic indicator—Note that compass card reads the airplane heading and that No. 2 needle swings to bearing of omnirange station.
12. Course set knob—Rotate to set bearing to VOR station in course window. Note that vertical bar centers, and that sensing window reads TO. Note that relative heading needle is displaced to the same side of the station as the airplane's heading. Rotate course set knob to set up radials 7 degrees to right and 7 degrees to left, and note that vertical bar moves promptly and smoothly to full deflection on appropriate side. Continue rotating course set knob. When difference exceeds 90 degrees, note that the vertical bar crosses to the opposite side of instrument, and sensing window shows FROM. When reciprocal radial is reached, note that vertical bar comes to center.
13. VHF frequency selector knob—Tune to nearest VAR or localizer transmitter, if one is within receiving distance, and note that vertical bar makes correct response.
14. Radio compass frequency band selector switch—Tune to nearest suitable transmitter and note that No. 1 needle of radio magnetic indicator swings to proper bearing.
15. VHF power switch—OFF, to shut down receiver.
16. Radio compass function switch—OFF, to turn set off.

**VHF Navigation Set Operation.**

1. VHF power switch—ON.
2. VHF frequency selector knob—Rotate inner and outer ring of dial to select frequency.
3. VHF volume control knob—Adjust as desired.
4. VHF power switch—OFF, to turn set off.

**VHF Navigation Set—Operation With VOR.**

1. VHF power switch—ON.
2. VHF frequency selector knob—Set for desired VOR station. Allow 2 minutes for warning "off" flag to retract from vertical bar.
3. Course set knob—Rotate to center vertical bar. Read radial in course window and identify it as course to or from the station as indicated in sensing window. Read relative heading needle to determine whether aircraft is headed right or left of course. If reciprocal is desired, rotate course set knob to add or subtract 180 degrees; read course and sensing as now indicated. To fly on a radial other than the one the airplane is on, set up desired radial in course window. Vertical bar will then be deflected toward new radial. Fly toward vertical bar to arrive at desired radial, then turn onto course as bar centers. Adjust heading as necessary to compensate for drift. As long as vertical bar is centered, airplane is tracking along displayed radial, regardless of heading. Relative heading needle will indicate drift angle. When airplane crosses station while tracking along displayed radial, sensing will reverse with no changes in other indications of the instrument. When airplane is not tracking along displayed radial, vertical bar will be off center. In such a case, bar will swing to opposite side when airplane crosses displayed radial. To turn smoothly onto radial, steer to hold point of relative heading needle on vertical bar until both are centered. Sensing will reverse when airplane crosses the radial; that is, at 90 degrees to displayed radial.

**VHF Navigation Set—Operation With VAR.**

1. VHF power switch—ON.
2. VHF frequency selector knob—Set to desired VAR station. Allow 2 minutes for warning "off" flag to retract from vertical bar.

3. Note deflection of vertical bar. If bar deflects to left, airplane is in blue sector of range; if bar is to right, airplane is in yellow sector. Consult airways chart to identify sector.

**Note**

On VAR, the deflection of the vertical bar does not in itself indicate the direction in which to fly to get on course. It indicates merely the color sector in which the airplane is flying.

4. Identify signal in headphones as aural N or A, and consult airways chart to determine whether station is ahead or astern. If aural signals overlap to give a continuous dash, airplane is on aural leg at right angles to visual range.

5. Relative heading needle indicates heading relative to course selected.

**Note**

Blue and yellow sectors are assigned to opposite sides of the visual range in accordance with the course defined by the airway. At certain terminal airports, VAR is used in the absence of a localizer. In such cases, the sector orientation is the same as for an ILS localizer. That is, the blue sector is charted on the right and the yellow sector is charted on the left when the airplane is inbound on final approach, regardless of the course defined by the beam.

### VHF Navigation Set—Operation With Localizer.

1. VHF power switch—ON.
2. VHF frequency selector knob—Set to localizer station. Allow 2 minutes for warning "off" flag to retract from vertical bar.
3. Note deflection of vertical bar. If vertical bar is deflected to left, airplane is in blue sector of localizer range; if bar is to right, airplane is in yellow sector. Blue sector of a localizer is always charted to the right of the inbound course; therefore, a pilot on final approach can center on the beam by flying toward the bar.
4. Relative heading needle indicates required correction angle.

### VHF Navigation Set—Operation For Communications.

The receiver can be tuned to the appropriate transmitter to receive weather broadcasts, tower instructions, and general communications.

## GLIDE-SLOPE RECEIVER AN/ARN-18.

The glide slope gives vertical guidance to a pilot making an instrument approach to an airport equipped with a glide-slope transmitter. The receiver has no separate control panel. It is operated and tuned by the power switch and the frequency selector knob (figure 4-12) on the VHF navigation control panel, and its signals are fed automatically to the horizontal bar of the course indicator. When the set is tuned to a glide-slope transmitter and the signal is strong enough to retract the warning "off" flag from the horizontal bar, the pilot merely keeps the horizontal bar centered to follow the glide slope down to the runway. In brief, centering the two crossbars of the course indicator keeps the airplane on course and on glide slope for an instrument approach under adverse weather conditions. The set is powered by the single-phase inverter system.

## MARKER BEACON RECEIVING SET AN/ARN-12.

The marker beacon receiving set gives visual and aural coded signals whenever the airplane passes over a marker beacon transmitter, thus enabling the pilot to determine his exact position. The visual signal is given by an amber light (figure 4-14) on the pilot's course indicator, the aural signal through the interphone system whenever the interphone marker beacon switch is at MARKER and the interphone selector switch is on COMM-INTER. The set operates whenever the 28-volt d-c bus is energized.

## A-2 FLIGHT COMPUTER.

The A-2 flight computer electronically combines attitude, altitude, direction, and radio information on a single instrument. The flight computer may be used in flying a constant altitude compass course, in making ground-controlled approaches, in making instrument low approaches, and for go-arounds. The radio rate unit feeds into the computer a signal derived from the rate of change of the localizer signal as the airplane nears the runway, so that the pilot by keeping the vertical bar centered, can fly the localizer beam heading without correcting for wind drift on the heading indicator. This feature reduces the likelihood of over-correcting for wind drift during the latter stages of a low approach. The flight computer has a selector switch (figure 4-15) and a flight computer indicator (figure 4-16) on the pilot's instrument panel. The system is energized whenever the airplane's electrical power is on and the main or spare three-phase inverter is operating. If the main and spare three-phase inverters fail, the directional indicator on the flight computer will continue to operate; however, the horizontal and vertical bars will be inoperative.

### Flight Computer Selector Switch.

The flight computer selector switch (figure 4-15) on the pilot's instrument panel has LEFT, FLIGHT INST, VOR-LOC RIGHT, and APPROACH positions. When the selector switch is at FLIGHT INST, the flight computer indicator is used as a flight instrument independent of radio signals. When the selector

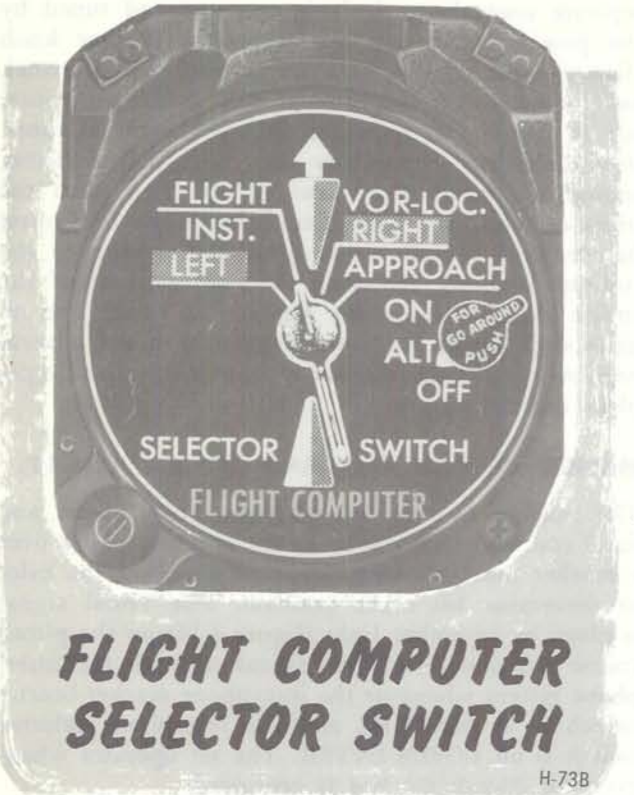



*Figure 4-15.*

switch is at any other position, radio signals are relayed into the flight computer indicator for localizer, approach, and landing purposes. When the selector switch is on any position but APPROACH and the airplane is flying at the desired flight altitude, an altitude control switch on the right side of the selector switch can be turned to ON. Altitude control signals will then be sent into the flight computer indicator and any deviation in altitude will cause the horizontal bar to move off zero. When the altitude control switch is turned to ON, the pitch-trim knob on the flight computer indicator becomes inoperative and the green light in the lower left corner of the selector switch goes out. When the selector switch is turned to APPROACH, the green light comes on to indicate that the altitude control has turned off automatically to prevent conflicting signals from going into the flight computer. When the selector switch is at APPROACH and a go-around is necessary, the pilot can press the altitude control switch and the horizontal bar will move to indicate the optimum climbout angle.

**Flight Computer Indicator.**

The flight computer indicator (figure 4-16) centered at the top of the pilot's instrument panel, has a course dial, a directional indicator, and two crossbars. A course set knob is on the lower left corner of the case and a pitch-trim knob on the lower right corner. Turning the course set knob rotates the course dial to bring the desired track figure under the course index at the top of the instrument face. The directional indicator rotates simultaneously to repeat the reading of the directional indicator of the gyrosyn compass system so that the magnetic heading of the airplane can be read continuously on the course dial under the heading pointer. The vertical bar deflects to give an appropriate "fly right" or "fly left" indication. When the pilot turns the airplane to zero the vertical bar, the directional indicator follows the heading of the airplane as it turns onto the new course. The vertical bar will not go past zero unless the airplane is overcontrolled in making the correction. When the airplane is on the selected course, the directional indicator and the vertical bars are centrally aligned with the course index. Deviations in pitch, altitude, and glide slope


*Figure 4-16.*

signals cause the horizontal bar to move up or down. The pitch-trim knob in the lower right corner adjusts the horizontal bar to compensate for changes in airplane pitch trim during flight. Clockwise rotation of the pitch-trim knob causes the horizontal bar to give a "fly up" indication.

**Flight Computer Operation.**

**Starting and Ground Check.**

1. Three-phase inverter switch—MAIN.
2. Directional indicator slaving cutout switch—ON.
3. Flight computer selector switch—FLIGHT INST.

4. Course set knob—Turn to make course dial read the direction shown by the directional indicator. When the flag disappears, indicating that the quick erector has completed its cycle, the vertical crossbar should be approximately at zero and the directional indicator should be aligned with the index.

5. Altitude control switch—ON. Horizontal bar should not move more than one needle width, if at all. Green light should be off when altitude control switch is ON.

6. Course set knob—Turn to rotate card to the right and then to the left; the vertical bar should signal "fly left" and "fly right" respectively. Turn course set knob to make course dial read the direction of the directional indicator. Vertical bar should zero and directional indicator should realign with the index.

7. Pitch-trim knob—Turn clockwise and counter-clockwise. Horizontal bar should move up and down respectively.

8. VHF power switch—ON.

9. VHF frequency selector knob—Turn for proper channel.

10. Flight computer selector switch—APPROACH. Vertical bar on the flight computer indicator should move to left or right, depending on position of airplane relative to the beam.

11. Altitude control switch—Push in to energize go-around circuit. Horizontal bar should indicate "fly up" and the orange flag should appear.

12. Flight computer selector switch—VOR-LOC RIGHT. Orange flag and "fly up" indication should disappear.

13. VHF power switch—OFF.

**Flying Compass Course at Constant Altitude.**

1. Selector switch—FLIGHT INST.

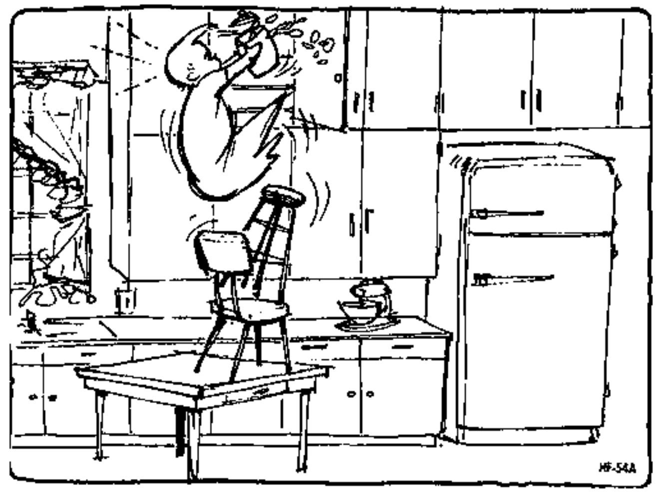
2. Course set knob—Rotate to bring desired track figure on course dial under the course index. Vertical bar will move to right or left.

3. Vertical bar—Note deflection and fly to rezero and to align directional indicator with course index.

4. Pitch-trim knob—Turn to zero horizontal bar at desired airplane pitch attitude.

5. Altitude control switch—ON when airplane reaches desired altitude. Green light on the selector switch should go out.

**CAUTION**



Whenever sudden altitude changes in excess of 500 feet are anticipated, the altitude control switch should be turned OFF to prevent damage to the altitude control unit.

6. Fly airplane to keep horizontal and vertical bars zeroed at all times.

**Note**

When changes in airplane trim are required, turn the altitude control switch to OFF until the new attitude is established.

**IFF AN/APX-6A.**

The purpose of the IFF equipment is to identify as friendly the airplane in which it is installed when challenged by an interrogator-responsor associated with friendly radars. When a radar target is accompanied by a proper IFF reply, that target is considered friendly. This system operates on 28-volt dc from the primary bus and 115-volt ac from the auxiliary a-c bus.

**IFF Controls.**

The master control knob and mode selector switches are on the IFF control panel (figure 4-17) located on the pilot's right console.

**IFF Normal Operation.**

Turn the IFF equipment on by placing the master control knob at STBY. The tactical situation or the communications officer will determine the ultimate


Figure 4-17.

position of the master control knob and mode switches for each mission. To turn the equipment off, place the master control knob at OFF.

#### IFF Emergency Operation.

For emergency operation, press dial stop and turn the master control knob to EMERGENCY. On airplanes modified in accordance with T.O. 1F-89-604 an ejection notification switch has been installed on each crewmember's ejection seat. When either pilot's or radar observer's seat is ejected from the aircraft, the ejection notification switch automatically actuates the emergency mode of the AN/APX-6 IFF system.

## LIGHTING EQUIPMENT.

### EXTERIOR LIGHTING.

#### Position Lights and Control Switches.

The position lights are conventional in color and arrangement and operate on 28-volt dc. The position light switch (figure 4-18) on the pilot's aft miscellaneous control panel has STEADY, OFF, and FLASH positions for controlling the operation of the lights. A switch to the right of the position light switch has DIM or BRIGHT positions to determine the intensity of the position lights. A flasher unit flashes the position lights at 40 cycles per minute; if the flasher unit fails, steady operation of the lights is automatic. The circuit breaker for the position lights is on the radar observer's circuit breaker panel.

#### Landing-Taxi Light and Control Switches.

The single retractable light, located on the under side of the fuselage nose section just forward of the nosewheel, serves for both landing and taxiing. The light is controlled by two switches (figure 4-18) on the left vertical console; an extension-retraction switch with EXTEND, RETRACT, and OFF positions; and a light switch with LANDING, TAXI, and OFF positions. The light is extended or retracted by placing the extension-retraction switch at EXTEND or RETRACT. The light may be stopped in any position along the arc of travel by placing the switch at OFF. Extension or retraction takes about 10 seconds. Limit switches automatically stop the extension-retraction motor when the light is fully extended or retracted. The light is turned on and off by the light switch. When the


Figure 4-18.

switch is placed at LANDING (with the extension-retraction switch at EXTEND), the light burns at maximum intensity and is positioned at the correct angle for landing or takeoff. When the switch is placed at TAXI with the extension-retraction switch at EXTEND, the light is positioned at the correct angle for taxiing (about 7 degrees higher beam than for landing) and the light beam widens and dims. The light can be turned on before extension if necessary so that the heat generated by the filament will de-ice the light assembly. After retraction, the light must be turned off by the light switch. The light and control switches are powered by the 28-volt d-c primary bus.

**CAUTION**

The landing-taxi light generates intense heat which may damage the light; therefore, do not use the light in the landing position longer than necessary. On the ground do not use the light in either position when the airplane is not moving.

**Note**

When changing from one position of the light (taxi or landing) to the other, the extension-retraction switch must be placed at EXTEND; otherwise the extension-retraction motor will not operate and the light will remain in the original position.

## INTERIOR LIGHTING.

### Pilot's Cockpit Lighting.

Red floodlights, operating on 28-volt dc, light the pilot's instrument panel and cockpit area. Two are on the movable section of the instrument panel glare shield; others are on the left and right sides of the cockpit structure. Three red floodlights, spaced evenly below the rail on each side of the cockpit, light the pilot's consoles. Red bulbs under individual ring-type, hinged lighting shields illuminate the flight instruments. The engine instruments and the fuel quantity gages are lighted by red floodlights. Indirect plastic panel lighting is used for all other panels, control position indicators, and markings. A C-4 cockpit light with a removable red filter can be swiveled or removed from the mount. Two rheostat-controlled thunderstorm lights, operating on 28-volt dc, are provided to counteract temporary blindness when eyes, adapted to the dark, are exposed to lightning flashes. These lights also provide interior illumination required for high altitude daytime flying. They consist of two white floodlights mounted one on each side of the pilot's cockpit approximately 4 inches above the left and right consoles and aligned so that their light beams converge on the lower center of the instrument panel. On the cockpit lighting control panel individual rheostats are provided to control the operation and intensity of the floodlights, instrument ring lights, and indirect lighting. A warning light dimming switch, located on the same panel, can be used to dim the warning lights during night operations. All lighting circuits for the pilot's cockpit are protected by circuit breakers on the pilot's circuit breaker panel. A stowage case for spare bulbs (figure 1-13) is attached to the bulkhead aft of the right console.

**Pilot's Cockpit Lighting Rheostats.** Seven 28-volt d-c rheostats (figure 1-13), located outboard of the pilot's right console, rotate from OFF to DIM to BRIGHT to control the pilot's cockpit lighting circuits. The first rheostat at the forward end of the pilot's cockpit lighting control panel controls the plastic panel lights; the second, the console lights; the third controls the instrument panel floodlighting, and the fourth, the console floodlighting. The fifth rheostat controls the lighting for the engine instruments; the sixth rheostat controls the lighting for the flight instruments. The thunderstorm light rheostat, mounted outboard of the pilot's right verticle console, rotates from OFF to DIM to BRIGHT to control both thunderstorm lights.

**Warning Lights Dimming Switch.** A 28-volt d-c warning light dimming switch (figure 1-13), located on the pilot's cockpit lighting control panel, provides a means of dimming, during night flying, all warning and indicator lights except the fire and over-heat warning lights, oxygen indicator, and inverter failure warning lights. The switch has DIM and BRIGHT positions and is spring-loaded to an unmarked NEUTRAL position. When the switch is momentarily placed at either position, the warning light intensity will be that of the selected position. The switch is interconnected with the flight instrument lighting rheostat and will not control warning light brightness if the rheostat is at OFF.

### Radar Observer's Cockpit Lighting.

Two 28-volt d-c red floodlights, mounted under the radar observer's glare shield, light the cockpit area. Two red bulbs under individual ring-type lighting shields illuminate each instrument on the instrument panel. The shields are hinged to permit replacement of the bulbs. All other panels have indirect or flood lamp lighting. A C-4 cockpit light can be swiveled or removed from its mount for either red or white lighting. Four rheostats control the operation and intensity of the instrument and circuit breaker floodlights, instrument indirect lights, console plastic panels, and console floodlights. The circuit breakers for the lights are on the radar observer's circuit breaker panel.

**Radar Observer's Cockpit Lighting Rheostats.** Four 28-volt d-c rheostats (figure 4-7) on the interior lights control panel located on left side of the cockpit, rotate from OFF to DIM to BRIGHT. The rheostat at the top left controls the plastic panels; the top right rheostat controls the instrument and circuit breaker floodlights; the bottom left rheostat controls the console floodlights; and the bottom right rheostat controls the instrument indirect lights.

### Pilot's and Radar Observer's C-4 Cockpit Lights.

A removable 28-volt d-c swivel mounted C-4 cockpit light with a red filter is mounted in each cockpit. The pilot's light is stowed on the left console with an alternate socket on the left windshield frame. The radar observer's light is stowed above the right console. A knob near the back of the light case turns the lamp on and off and controls its intensity. A white spring-loaded button on the back of the case can be pressed for momentary lighting. A small knob extending through a groove on the side of the case can be moved for spot- or floodlighting; tightening the knob screw locks the shield in any position. The red filter can be removed, if white light is desired.

## OXYGEN SYSTEM.

The airplane is equipped with a gaseous oxygen system having operating pressure of 400 to 450 psi. The oxygen is carried in four oxygen cylinders which are check-valved and installed in the aft fuselage for combat safety. Two of the cylinders supply oxygen to the pilot, and two supply the radar observer. Each crewmember's supply system is kept separate by the seated check valves at the filling manifold. When the check valves are unseated during filling, interflow between the four oxygen cylinders supplying the pilot and radar observer occurs. However, loss of pressure in one cylinder will result in the check valves being

| CABIN ALTITUDE (FEET) | GAGE PRESSURE (PSI) 400 | 350 | 300 | 250 | 200 | 150 | 100 | BELOW 100 |
|---|---|---|---|---|---|---|---|---|
| 35,000 & ABOVE | **5.7** 5.7 | **4.9** 4.9 | **4.0** 4.0 | **3.2** 3.2 | **2.4** 2.4 | **1.6** 1.6 | **0.8** 0.8 | EMERGENCY DESCEND TO ALTITUDE NOT REQUIRING OXYGEN |
| 30,000 | **4.1** 4.2 | **3.5** 3.6 | **2.9** 3.0 | **2.3** 2.4 | **1.8** 1.8 | **1.2** 1.2 | **0.6** 0.6 | |
| 25,000 | **3.2** 4.0 | **2.7** 3.4 | **2.3** 2.8 | **1.8** 2.3 | **1.4** 1.7 | **0.9** 1.1 | **0.5** 0.6 | |
| 20,000 | **2.4** 4.5 | **2.1** 3.8 | **1.7** 3.2 | **1.4** 2.6 | **1.0** 1.9 | **0.7** 1.3 | **0.3** 0.6 | |
| 15,000 | **2.0** 5.4 | **1.7** 4.7 | **1.4** 3.9 | **1.1** 3.1 | **0.9** 2.3 | **0.6** 1.6 | **0.3** 0.8 | |
| 10,000 | **2.0** 5.4 | **1.7** 4.7 | **1.4** 3.9 | **1.1** 3.1 | **0.9** 2.3 | **0.6** 1.6 | **0.3** 0.8 | |

*BOLD FACE (UPPER) FIGURES INDICATE DILUTER LEVER "100%."*
*LIGHT FACE (LOWER) FIGURES INDICATE DILUTER LEVER "NORMAL."*

**OXYGEN DURATION HOURS CHART**

CYLINDERS: 4 TYPE F2

CREW: 2

*The above figures apply whether one or two crewmembers are using oxygen, as each member's system is separate from the others.*

H-78C

Figure 4-19.

seated in the three remaining cylinders. The other tank in the system of the tank losing pressure is the only remaining source of oxygen to the crewmember being supplied by the system containing the damaged tank. On each crewmember's right console is an oxygen regulator panel which contains the oxygen system controls. A pressure-demand oxygen mask should be used with this system. The approximate duration of the oxygen supply at various altitudes is given in figure 4-19.

## OXYGEN REGULATOR.

A diluter-demand oxygen regulator control panel (figure 4-20) with a pressure gage and flow indicator is located on the right console of each cockpit. From sea level to 30,000 feet (cabin altitude) the regulator automatically varies the ratio of oxygen to air to supply the proper mixture to the crew. Above 30,000 feet (cabin altitude) the regulator delivers pure oxygen at maximum pressure. A relief valve in the regulator prevents excessive pressure in the oxygen mask.

### Regulator Supply Lever.

The oxygen supply lever (figure 4-20) on the regulator panel controls oxygen flow to the regulator. On airplanes equipped with the D-2 oxygen regulator, the shutoff valve is safetywired in the ON position in the pilot's cockpit to prevent accidental closing off of the oxygen supply during use at altitude. The radar observer's oxygen supply lever should be turned OFF whenever the radar observer's regulator is not being used. If it is left at ON, oxygen will be lost.

**Note**

> Because of the automatic pressure-breathing feature of the regulator, a continuous flow of oxygen at altitude will result if the regulator is not being used and the supply lever is left at ON. This condition causes a rapid loss of oxygen at altitude.

### Regulator Diluter Lever.

The diluter lever (figure 4-20) on the oxygen regulator panel has two positions: NORMAL OXYGEN and 100% OXYGEN. When the lever is at NORMAL OXYGEN, the regulator automatically varies the ratio of oxygen to air and supplies the proper mixture to the crew from sea level to 30,000 feet. Above 30,000 feet the regulator delivers pure oxygen. At any altitude, the diluter lever can be turned to 100% OXYGEN if pure oxygen is desired for emergencies.

### Regulator Emergency Lever.

The emergency toggle lever (figure 4-20) should remain in the center position at all times, unless an unscheduled pressure increase is required. Moving the toggle lever either way from its center position provides continuous positive pressure to the mask for


Figure 4-20.

emergency use. When the lever is depressed in the center position, it provides positive pressure to test the mask for leaks. Normally the lever should remain at the center OFF position.

**CAUTION**

When positive pressures are required, it is mandatory that the oxygen mask be well fitted to the face. Unless special precautions are taken to ensure no leakage, continued use of positive pressure under these conditions will result in rapid depletion of the oxygen supply.

### Regulator Warning System Switch and Indicator Lights (Some Airplanes).

The warning system switch (figure 4-20) on the oxygen regulator panel can be placed at ON or OFF to control the oxygen warning lights. Two warning lights (figures 1-8 and 4-6) are on the instrument panels in the pilot's and radar observer's cockpits. One light indicates breathing in the pilot's mask; the other indicates breathing in the radar observer's mask. When the warning system switch is ON, the light dims when oxygen is being used and glows brightly when oxygen is not being used. On airplanes modified in accordance with T.O. 1F-1-533 the warning system switch is placed in the OFF position, the lamps are removed from the warning lights, and the warning system is deactivated.

**Note**

At flight altitudes below 10,000 feet with the oxygen regulator operating and the mask being used, the lights may blink brightly. Since this can happen only at low altitudes, it should not cause undue concern. The oxygen regulator warning circuit may be turned off below 10,000-foot flight altitude since the possibility of hypoxia is critical only at higher altitudes.

### Oxygen System Pressure Gage And Flow Indicator.

A combination pressure gage and flow indicator (figure 4-20) on the oxygen regulator panel registers the pressure of the oxygen supply on the upper half of the dial. In the lower half of the dial, the slots in the flow indicator are luminous when oxygen is flowing through the regulator, dull black when it is not.

**Note**

As an airplane ascends to higher altitudes where the temperature normally is quite low, the oxygen cylinders become chilled. As the cylinders grow colder, the oxygen gage pressure is reduced, sometimes quite rapidly. With a 100°F decrease in cylinder temperature, the gage pressure can be expected to drop 20 percent. This rapid fall in pressure is occasionally a cause for unnecessary alarm. All the oxygen is still there, and as the airplane descends to warmer altitudes, the pressure will tend to rise again, so that the rate of oxygen usage may appear to be slower than normal. A rapid fall in oxygen pressure while the airplane is in level flight or while it is descending, is not ordinarily due to falling temperature, of course. When this happens, leakage or loss of oxygen must be suspected.

## OXYGEN SYSTEM PREFLIGHT CHECK.

1. Mask male connector attachment strap—Fasten to the parachute chest strap by routing the connector strap up under the chest strap as close to the center as possible, then down in front of the chest strap, and around again, then snap it to the connector.
2. Mask-to-regulator tubing female disconnect—Connect to the mask male connector, listen for the click and see that the sealing gasket is only half exposed.
3. Alligator clip—Attach to the end of the mask male connector strap. (See figure 4-21.)
4. Oxygen regulator—Check with diluter valve first at NORMAL OXYGEN and then at 100% OXYGEN by blowing gently into the end of the regulator tubing as during normal exhalation. If there is a resistance to blowing, the system is satisfactory. Little or no resistance to blowing indicates a leak or malfunction.
5. Oxygen warning light switches—ON (some airplanes). Warning light should emit a bright (steady or blinking) light. Move emergency toggle from center (OFF) to LEFT or RIGHT position. The warning light should change from a bright light to a filament glow and back to a bright light. Return emergency toggle to center (OFF) position.

**Note**

- Items pertaining to the oxygen warning system apply only to airplanes not modified in accordance with T.O. 1F-1-533.
- Conduct the following check with regulator supply valve at ON, oxygen mask connected to regulator, diluter lever at 100% OXYGEN, and normal breathing.

6. Blinker—Observe for proper operation. Warning light (some airplanes) should change from bright to a dim filament glow.
7. Emergency toggle—Deflect to RIGHT or LEFT. A positive pressure should be supplied to mask. Hold breath to determine if there is leakage around mask. Return emergency toggle to center (OFF) position; positive pressure should cease.
8. Diluter lever—Return to NORMAL OXYGEN.

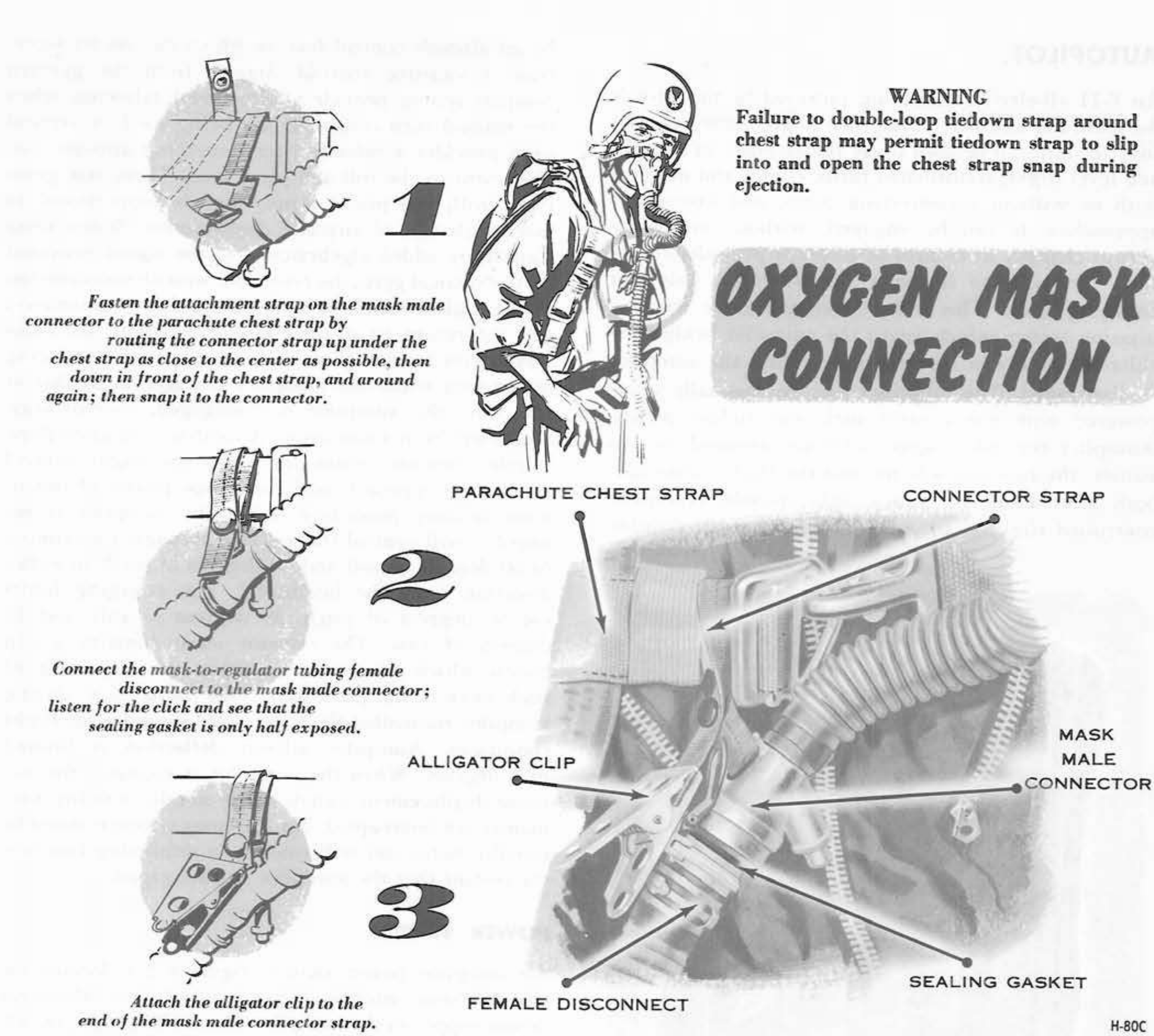



*Figure 4-21.*

## OXYGEN SYSTEM NORMAL OPERATION.

1. Regulator diluter lever—NORMAL OXYGEN.
2. Regulator supply lever—ON.
3. Regulator warning system switch—ON (on airplanes not modified in accordance with T.O. 1F-1-533).

## OXYGEN SYSTEM EMERGENCY OPERATION.

If either of the crew detects symptoms of hypoxia, or if smoke or fuel fumes enter the cabin:

1. Regulator diluter lever—100% OXYGEN.
2. Regulator emergency lever—Push IN and hold momentarily to clear mask.

**Note**

The duration of the oxygen supply for the pilot or radar observer is reduced when either turns to 100% OXYGEN or holds the oxygen emergency lever IN. The other member's supply will not be affected since the systems are independent.

3. Oxygen diluter lever—NORMAL OXYGEN after the emergency. If the oxygen regulator fails or if the mask develops a severe leak, push the regulator emergency lever to RIGHT or LEFT. If necessary, pull the cord of the bailout bottle.

**WARNING**

If either crewmember uses his bailout bottle, the airplane must immediately be flown to an altitude at which the crew does not require oxygen.

## AUTOPILOT.

An E-11 all-electric autopilot, powered by the 28-volt d-c main bus and the 115-volt a-c single-phase essential inverter bus, can be used to fly the airplane in straight and level flight, coordinated turns, climbs and descents with or without maneuvering turns, and instrument approaches. It can be engaged, without producing abrupt changes in control or airplane attitude, at any time the airplane is being flown within autopilot engaging limits. This is due to an automatic synchronization system which keeps the autopilot bridge circuits electrically in trim during the time the autopilot is disengaged. The autopilot can be manually overpowered with the control stick and rudder pedals. Autopilot controls (figure 4-22) are grouped in two panels; the function selector and the flight controller, both located on the pilot's right console. Autopilot controlled flight at constant altitude is made possible by an altitude control feature which derives its signal from a sensitive aneroid. Signals from the gyrosyn compass system provide a directional reference when the manual turn control is not being used. A vertical gyro provides a reference for measuring airplane displacement in the roll and pitch axes. Three rate gyros (yaw, roll, and pitch) supply signals proportional to rate of change of airplane displacement. When these signals are added algebraically to the signal provided by the vertical gyro, the result is a smooth coordination of the flight controls in both the starting of maneuvers and the return to straight and level flight. An automatic trim feature trims the elevator force-producing mechanism while the autopilot is engaged, so that at any time the autopilot is disengaged, control stick forces will be at a minimum. A localizer and glide-slope coupler provide means for automatic flight control during the approach and glide-slope phases of instrument landing procedure. After the autopilot is engaged it will control the airplane through a maximum of 60 degrees of roll and 50 degrees of pitch in either direction from the horizontal. The engaging limits are 50 degrees of pitch, 29 degrees of roll, and 10 degrees of yaw. The elevator servo contains a slip clutch which limits servo output to 13 pounds of stick force in the pitch axis. This limits "G's" during autopilot controlled flight to a safe value for all flight conditions. Autopilot aileron deflection is limited to 5 degrees. When the autopilot is engaged, the airplane displacement signals to the sideslip stability augmenter are interrupted, but the latter system remains in standby status and will resume its stabilizing function the instant that the autopilot is disengaged.


AUTOMATIC PILOT CONTROL PANEL

H-818

**Figure 4-22.**

### POWER SWITCH.

An autopilot power switch (figure 4-22), located on the function selector panel, controls the electrical power supply to the autopilot system. When the switch is placed at ON, power is supplied to the autopilot system. When the switch is placed at OFF, all electrical power to the autopilot is disconnected and the engaging switch, if at ENGAGE, snaps to OFF.

### ENGAGING SWITCH.

The autopilot engaging switch (figure 4-22) is located on the flight controller panel and has an ENGAGE and an unmarked OFF position. The switch is solenoid-held and will remain in the ENGAGE position only when the following conditions have been met: the autopilot circuit breakers are IN, the power switch has been at ON for 90 seconds or more, the turn knob on the flight controller is in detent, and the airplane is in an attitude within autopilot engaging limits. When the engaging switch is placed at OFF the autopilot disengages. The switch will snap to the OFF position if the power switch is turned to OFF or if the pilot's emergency disconnect switch is used to disengage the autopilot.

### EMERGENCY DISCONNECT SWITCH.

A 28-volt d-c, spring-loaded lever-type emergency disconnect switch (figure 1-28), located on the control stick grip, provides a means of instantaneous autopilot disengagement. If the autopilot is engaged, squeezing the emergency disconnect switch will disengage the autopilot and cause the engaging switch to snap to OFF. The autopilot power switch will remain at ON until manually moved to OFF. When the emergency disconnect switch is used to disengage the autopilot, any of the solenoid-held coupler switches that may be at ON at the time (altitude switch, localizer switch, or approach switch) will snap to OFF. Squeezing the emergency disconnect switch also will reset the autopilot engaging circuit.

### TURN KNOB.

A turn knob (figure 4-22), located on the flight controller panel, provides a means of making coordinated turns with the autopilot. The knob normally rests in a neutral detent (knob pointing forward). When the knob is in this position, directional signals from the airplane's gyrosyn compass system provide the autopilot with a heading or directional reference. Moving the turn control knob to the right or left out of the detent will result in an autopilot controlled coordinated turn in the direction that the knob is turned and at a bank angle proportional to the amount the knob is turned, up to a maximum bank angle of 60 degrees. When the turn knob is returned to the neutral detent, the airplane will roll smoothly out of the turn and continue to fly at the new compass heading. The autopilot will not engage with the turn knob out of detent.

### HEADING TRIM INDICATOR AND KNOB.

The heading trim indicator and knob (figure 4-22) on the flight controller are used to indicate and correct heading mistrim during autopilot controlled flight. To correct heading mistrim, rotate the heading knob in the direction of needle deflection: clockwise for right needle deflection, counterclockwise for left needle deflection.

**Note**

> The heading trim indicator will indicate a mistrim condition whenever the autopilot is engaged with the airplane in a bank. It will also indicate a mistrim condition whenever lateral trim conditions change during autopilot controlled flight. To eliminate the requirement for trimming after engagement it is recommended that the autopilot be engaged with the airplane in a coordinated zero-bank attitude.

### PITCH CONTROL KNOB.

A pitch control knob (figure 4-22), located on the flight controller, is used to trim for level flight and to control the airplane in climbs and descents when the altitude switch is not engaged. The pitch control knob may also be used in coordination with the turn knob for combined maneuvers. Rotating the pitch control knob forward lowers the nose, and rotating the knob aft raises the nose.

### ROLL TRIM KNOB.

A roll trim knob (figure 4-22) on the flight controller is used to center the ball on the turn and slip indicator after engagement of the autopilot. Rotate the knob clockwise for a ball-left condition, counterclockwise for a ball-right condition.

**Note**

> It will be necessary to use the roll trim knob only if the autopilot is engaged when the aircraft is flying in an uncoordinated manner. If the autopilot is engaged during uncoordinated flight, it is usually faster to disengage the autopilot, trim for coordinated flight manually, and reengage. The autopilot will synchronize with the new flight attitude automatically, thus eliminating the need for using the roll trim knob.

### AUTOTRIM SWITCH AND INDICATOR.

When the autopilot is engaged (autotrim switch must be ON), the elevator trim system is operated automatically to minimize stick force at disengagement. The elevator trim button on the control stick is deenergized when the autopilot is engaged. The autotrim indicator (figure 4-22), located on the flight controller panel, indicates correct operation or malfunction of the automatic trim system. When the autotrim system is operating properly, the trim indicator pointer will fluctuate to either side of center. If there is malfunction in the system the pointer will remain constantly deflected to one side. If this condition is noted, speed should be reduced before disengaging the autopilot; otherwise the airplane may pitch sharply upon disengagement, thus imposing excessive "G's."

### ALTITUDE SWITCH.

A solenoid-held altitude switch (figure 4-22) located on the function selector panel connects the altitude control to the autopilot elevator bridge circuits. When the switch is at ON, the autopilot will fly the airplane accurately at the pressure altitude at which it was flying when the switch was turned to ON. For a change in flight altitude, the switch is turned to OFF; the airplane flown to the new altitude and trimmed for level flight; and then the switch is placed at ON. The altitude switch snaps to OFF if the autopilot is disengaged or if the ILS approach switch is moved to ON.

**Note**

The altitude switch can provide limited trim; however, the airplane should be trimmed for approximately level flight before placing the altitude switch at ON. When large trim changes are required, it is necessary to retrim manually by means of the pitch control knob or by disengaging the autopilot, retrimming the aircraft, and reengaging the autopilot and altitude control.

## AUTOPILOT NORMAL OPERATION.

### Ground Tests.

During engine runup, turn on and engage autopilot and perform ground check as detailed in Section II.

### Normal Engaging Procedure.

The autopilot can be engaged whenever the airplane is flying within the autopilot engaging limits. Engage the autopilot as follows:

1. Power switch—ON (90-second warmup required).
2. Turn knob—Detent.
3. Autotrim switch—ON.
4. Trim the airplane for coordinated zero-bank attitude within ±50-degree pitch attitude.
5. Engaging switch—ENGAGE. Switch will hold in ENGAGE position if proper conditions for engagement have been met; otherwise switch will spring back when released.
6. Autotrim indicator—Check that needle of autotrim indicator is oscillating either side of center.

### Engaging Procedure In Turns Or Uncoordinated Flight.

When the autopilot is engaged in turns or in uncoordinated flight, it will be necessary to trim the autopilot as follows:

1. Center the ball on the turn and slip indicator using the roll trim knob. Rotate the knob clockwise for a ball left condition, counterclockwise for a ball right condition.
2. Center the needle on the heading trim indicator using the heading trim knob. Rotate the knob clockwise for a right needle condition, counterclockwise for a left needle condition. It is usually quicker and easier, however, to disengage the autopilot, trim the airplane for coordinated zero-bank attitude, and reengage the autopilot.

### Autopilot Trimming Procedure.

1. Trim the airplane manually after takeoff.
2. After engaging autopilot, check the turn and slip indicator. If a ball left or a ball right condition exists, center the ball by rotating the trim knob clockwise or counterclockwise respectively. Wings will level after this and the following steps are completed.
3. After centering the ball, check the heading trim indicator. If the needle is deflected, return it to approximate center by rotating the heading trim knob in the direction indicated by the needle.

If the airplane trim condition changes during flight on autopilot, always center the ball with the roll trim knob *before* centering the heading trim indicator needle. This procedure makes precise trimming of the autopilot possible in one operation and should always be used.

### Straight And Level Flight.

Fly to the desired altitude, trim the airplane for approximately level flight, and place the altitude switch ON. The autopilot will fly the airplane at the pressure altitude existing when the switch is placed ON. (If the altitude switch is OFF, the autopilot will maintain the airplane in the pitch attitude established by the pitch knob but will not necessarily maintain level flight.) When the turn control knob is in detent, the gyrosyn compass system establishes a heading reference to maintain the airplane in straight and level flight. If a lateral mistrim condition develops (such as would be caused by an unbalanced wing tip load) the autopilot will maintain the airplane laterally level and in straight flight but with heading mistrim in the direction of the heavy wing. To compensate for this condition, center the heading trim indicator needle using the heading trim knob.

### Maneuvering Flight.

Autopilot-controlled climbs and descents can be made using the pitch control knob. (Altitude switch should be OFF.) Rotate the pitch knob slowly and smoothly to change pitch attitude. If the pitch knob is rotated rapidly, thus calling for excessive "G's," the "G" limiting clutch in the elevator servo will slip, and the airplane will not respond. To correct this situation, disengage the autopilot, trim the airplane to the desired attitude, and reengage the autopilot. The autopilot will maintain the new attitude until changed by means of the pitch knob. Pull-ups from shallow dives may be made using the pitch knob, but pull-ups from steep dives must be made manually. Coordinated turns can be made using the turn knob. Bank angle (and corresponding turning rate) will be proportional to turn knob rotation. When the turn knob is returned to detent, the airplane will return to level, ending the turn. After a 5-second delay (which allows the airplane to stabilize on the new heading) the autopilot will fly the airplane on the compass heading existing at that instant. Combined maneuvers can be made by coordinated use of the turn and pitch knobs.

### Disengaging Procedure.

The autopilot may be disengaged in three ways: squeezing the disconnect switch on the control stick, moving the engaging switch to OFF, or moving the power switch to OFF. Squeezing the disconnect switch or moving the engaging switch to OFF leaves the autopilot in standby status (ready to operate as soon as it is reengaged). Moving the power switch to OFF turns off all electrical power to the autopilot, putting it completely out of operation. If it is left off for an appreciable length of time, a 90-second or more warmup will be required before the autopilot can be used again. Normally the power switch should be left at ON at all times during flight.

#### AUTOPILOT EMERGENCY OPERATION.

If the autopilot fails or functions erratically, disengage the autopilot and turn the power switch to OFF. When the autopilot is disengaged, the sideslip stability augmenter will resume its normal function of directionally stabilizing the airplane.

### AUTOMATIC APPROACH EQUIPMENT.

Automatic approach equipment is provided in the autopilot system. Localizer and approach couplers enable the autopilot to use signals from the localizer and glide-slope receivers of the VHF navigation set for reference in azimuth and elevation in autopilot controlled approaches. (The localizer coupler is not designed for autopilot controlled flight on omnirange and should not be used.) The signals fed to the localizer and glide-slope couplers are the same as those that move the vertical and horizontal bars on the ILS course indicator. The localizer and glide-slope couplers supply autopilot signals to maintain the airplane at the center of the localizer and glide beams respectively. This equipment can be disengaged instantly by squeezing the autopilot disconnect switch on the control stick.

#### LOCALIZER SWITCH.

A solenoid-held localizer switch (figure 4-22) on the function selector panel connects the localizer coupler to the autopilot. The switch has ON and OFF positions. When the switch is placed at ON (after the localizer beam has been intercepted according to standard ILS procedures), the coupler feeds signals to the autopilot to provide automatic bracketing and beam following. The localizer switch can be turned off manually, or will snap to OFF automatically when the approach switch (figure 4-22) is placed at ON, or when the autopilot is disengaged.

#### APPROACH SWITCH.

A solenoid-locked approach switch (figure 4-22) on the function selector connects the glide-slope coupler to the autopilot. The switch has ON and OFF positions. When the switch is placed at ON, the airplane noses down and follows the glide beam, and the localizer switch snaps to OFF. (The autopilot continues to receive localizer signals, however.) The approach switch cannot be turned to OFF manually. It snaps to OFF only when the autopilot is disengaged.

#### AUTOMATIC APPROACH EQUIPMENT OPERATION.

Refer to ILS—Autopilot-Controlled Approach, Section IX.

### ARMAMENT.

Information on this equipment is given in T.O. 1F-89H-1A, Confidential Supplement. The following figures, 4-23 through 4-25, are also contained in the supplement:

*Figure* 4-23 GENERAL ARRANGEMENT
*Figure* 4-24 ARMAMENT CONTROL PANEL
*Figure* 4-25 ARMAMENT SELECTION TABLE

### OPTICAL SIGHTHEAD (M169).

Information on this equipment is given in T.O. 1F-89H-1A, Confidential Supplement.

### E-9 FIRE CONTROL SYSTEM.

Information on this equipment is given in T.O. 1F-89H-1A, Confidential Supplement. The following figures, 4-26 through 4-31, are also contained in the supplement:

*Figure* 4-26 RADAR CONSOLE
*Figure* 4-27 ANTENNA HAND CONTROL
*Figure* 4-28 RADAR TEST PANEL
*Figure* 4-29 PILOT'S AND RADAR OBSERVER'S SCOPES
*Figure* 4-30 RADAR INDICATOR CONTROL
*Figure* 4-31 PILOT'S POWER-CONTROL BOX

### SINGLE-POINT FUELING SYSTEM.

All fuel tanks except the pylon tanks can be fueled through a single high-pressure fitting located on the lower side of the right wing, aft of the wheel well. To prevent overflowing and to prevent high fueling pressure from entering the tanks, a fluid level actuated shutoff valve in each tank closes as the tank becomes full. (See figure 4-32.) The system is designed to use a maximum of 55 psi during single-point operations. This airplane cannot be defueled through the use of the single-point fueling system.

#### SINGLE-POINT FUELING CONTROLS.

A 28-volt d-c tip tank control switch and a tank shutoff precheck switch (figure 4-33) are located in a

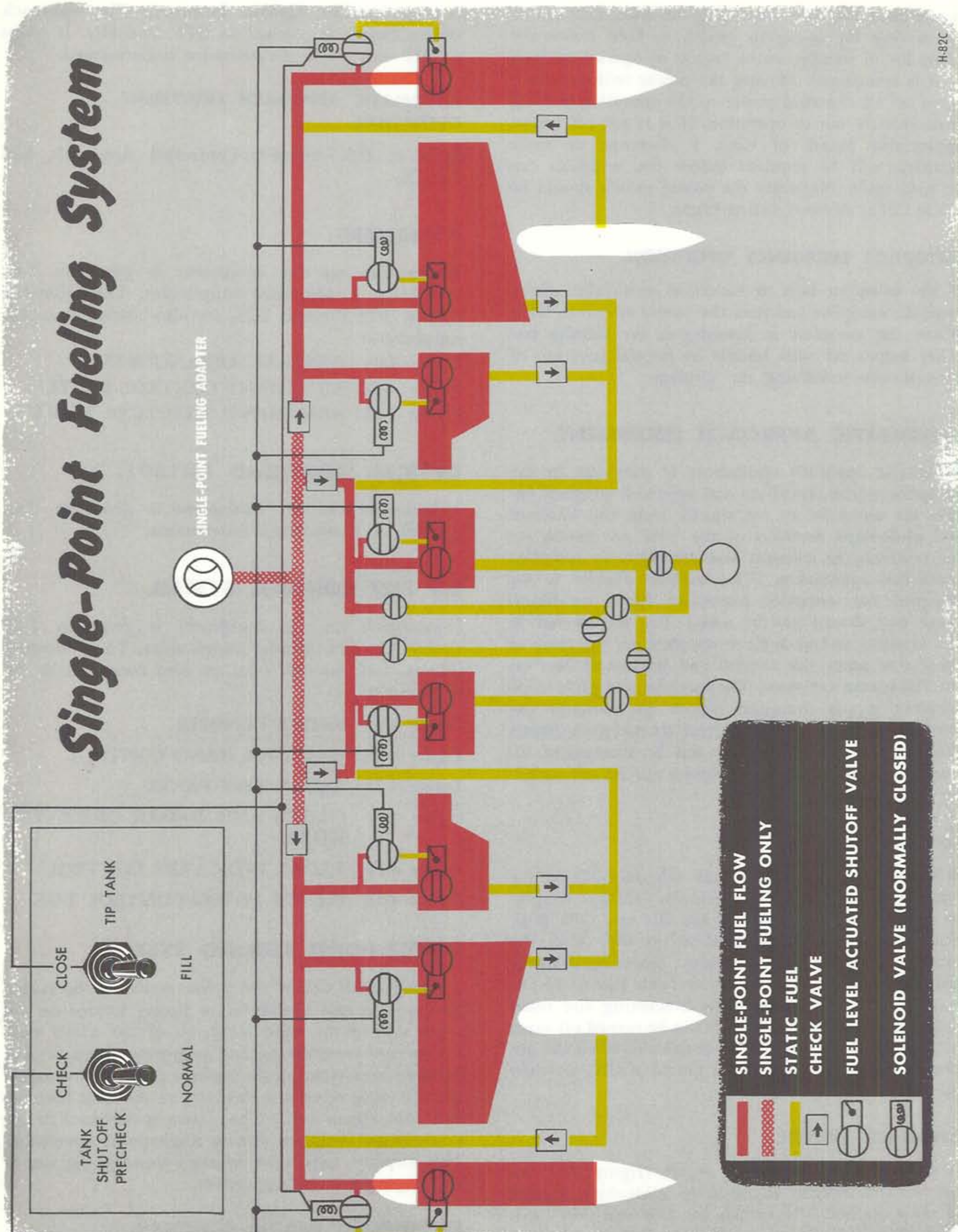

Single-Point Fueling System
SINGLE-POINT FUELING ADAPTER
TANK SHUTOFF PRECHECK
CHECK
NORMAL
CLOSE
FILL
TIP TANK
SINGLE-POINT FUEL FLOW
SINGLE-POINT FUELING ONLY
STATIC FUEL
CHECK VALVE
FUEL LEVEL ACTUATED SHUTOFF VALVE
SOLENOID VALVE (NORMALLY CLOSED)
H-82C

*Figure 4-32.*

switch box mounted in the right main landing gear wheel well. A 28-volt d-c circuit breaker located on the pilot's fuel control panel protects the single-point fueling system. The circuit breaker is left IN for all operations. The tip tank control switch has FILL and CLOSED positions. Placing the switch at FILL permits the tip tanks to fill during single-point fueling; placing the switch at CLOSE causes the tip tank shutoff valve to close and prevents fuel from entering the tip tanks during single-point fueling. The tank shutoff precheck switch has CHECK and NORMAL positions and is spring-loaded to NORMAL. Holding the switch at CHECK causes the tank shutoff valve in each tank to close under the same conditions that cause the valves to close when the tanks become full. While the precheck switch is held at CHECK, a rate of flow of approximately 40 gpm (noted on the single-point fueling equipment) indicates that all shutoff valves are functioning and that the system is safe for single-point fueling. Failure of any tank shutoff valve to close will be evidenced by a rate of flow in excess of 100 gpm, and single-point fueling must be stopped immediately. Releasing the tank shutoff precheck switch to NORMAL causes the tank shutoff valves to reopen and single-point fueling to continue. When the switch box cover is closed, the tip tank and tank shutoff precheck switches are automatically positioned for normal fuel system operation.

**CAUTION**

Fuel selector switches must be at ALL TANKS or PUMPS OFF during single-point fueling. A WING TANKS selection will allow fuel under high pressure to enter and damage low-pressure engine fuel components.

### SINGLE-POINT FUELING OPERATION.

1. Apply 28-volt d-c external power.
2. Connect fueling nozzle to single-point fueling adapter.
3. Pressure refueling circuit breaker—IN.
4. Fuel selector switches—ALL TANKS if engines are operating; PUMPS OFF if engines are shut down.
5. Tip tank control switch—FILL or CLOSED, as desired.
6. Single-point fueling nozzle valve—OPEN; then immediately hold precheck switch at CHECK. If rate of flow does not exceed approximately 40 gpm after 12 seconds, release tank shutoff precheck switch to NORMAL and allow airplane to be fueled; if rate of flow is 100 or more gpm after precheck switch is held at CHECK for 12 seconds, indicating a shutoff valve failure, stop single-point fueling immediately.


*Figure 4-33.*

**WARNING**

Under no circumstances must single-point fueling be continued if a tank shutoff valve fails to close during prechecking. Failure of a shutoff valve to close during single-point fueling will result in structural damage and a serious fire hazard.

**Note**

Failure of only one tank shutoff valve will result in a rate-of-flow greater than 100 gpm.

7. After airplane is fueled, turn fueling nozzle valve off, remove fueling nozzle, and close single-point fueling switch box door.

## MISCELLANEOUS EQUIPMENT.

### WINDSHIELD WIPER.

The windshield wiper operates on 28-volt d-c power. The windshield wiper switch (figure 1-9) turns the wiper on and off, and has ON, OFF, and PARK positions. The switch is adjacent to the speed rheostat (figure 1-9) which is located above the pilot's left console. The speed rheostat has INC and DEC positions for controlling the speed of the wiper motor. The speed rheostat must be at INC before the windshield wiper switch is turned to ON. If the wiper blade stops at an undesirable position when the switch is turned to OFF, the switch can be held momentarily to the spring-loaded PARK position; the blade will move to the right and stop automatically. If the wiper blade stops and cannot be started with the speed rheostat, the wiper should be turned off.

**CAUTION**

The speed rheostat should not be used to stop the wiper. Before either stopping or starting the wiper, the speed rheostat should be turned to INC.

## RELIEF TUBES.

The relief tube for the pilot is on the floor to the right of his seat; one for the radar observer is to the right of his seat, aft of the wing spar.

## MISCELLANEOUS PARTS STORAGE.

Fuselage and wing jack pads, mooring fittings, and microphones are stored in two bags in the radio and equipment section in the aft fuselage. The ground safety locks and the pitot tube covers are in a third bag near the floor to the left of the radar observer's seat.

## MAP AND DATA CASES.

A data case and flight report holder (figure 1-9) is beside the pilot's left console. A map data case (figure 4-8) is beside the right console in the radar observer's cockpit, and an airplane data case is in the aft radio and equipment section. Two spring clips are located on the upper right surface of the pilot's glare shield to be used as required for temporary storage of maps, computer, flight plan, etc. while the pilot is navigating.

## CHECKLISTS.

Each crewmember has a permanently installed metal checklist in his cockpit. The pilot's checklist (figure 1-11) slides out at the top of the center pedestal; the radar observer's checklist (figure 4-6) is above his instrument panel.

## REAR VIEW MIRRORS.

A mirror on the left frame of the windshield enables the pilot to see rearward. A mirror on the right side of the canopy frame allows the pilot and radar observer to see each other.

## EMERGENCY SIGNAL SYSTEM.

A red light and spring-loaded button-type switch in each cockpit provide a visual emergency system for the pilot and radar observer. In case of interphone failure or loss of the canopy, each crewmember can communicate with the other by means of code or prearranged signals. In the pilot's cockpit the button and signal light (figure 1-12) are mounted on a bracket directly below the right canopy defog duct. In the radar observer's cockpit the button (figure 4-8) is mounted on the inboard side of the right console and the signal light (figure 4-6) is located below the left side of the main instrument panel. The system is powered by the 28-volt d-c primary bus.

## BLIND FLYING CURTAIN ASSEMBLY.

Five orange acetate curtains can be snapped onto fasteners mounted in the pilot's cockpit to mask the windshield and forward canopy for simulated instrument flight. The curtains will not obstruct normal vision; but when the pilot wears blue goggles, he is unable to see through the curtains.

## ANTI "G" SUIT EQUIPMENT.

The pilot's and radar observer's anti "G" suits are inflated by air pressure from the engine compressors. An anti "G" suit intake tube attaches to an air pressure outlet on the front of each seat. A pressure regulator valve (figures 1-9 and 4-7) to the left of the pilot's and radar observer's seats is moved to LO and HI to control the pressure in the suit. Acceleration above 1.75 "G's" causes the valve to open, inflating the anti "G" suit; for each additional "G" acceleration, the suit is inflated 1.0 psi (LO setting) or 1.5 psi (HI setting). A button on top of the valve can be pressed to inflate the suit momentarily.

# OPERATING LIMITATIONS

SECTION V


## TABLE OF CONTENTS



## INTRODUCTION.

Cognizance must be taken of instrument markings shown on figure 5-1, since they represent limitations that are not necessarily repeated in the text.

## MINIMUM CREW REQUIREMENTS.

The minimum crew is a pilot for local day VFR flights. A radar observer or a qualified crew member will be added for cross country, night, or IFR flights, or at the discretion of the commander for other operations.

## ENGINE LIMITATIONS.

### STARTING (AIRPLANES EQUIPPED WITH J35-35 ENGINES).

During starting, the maximum allowable exhaust gas temperature is 915°C. Exhaust gas temperatures between 750°C and 915°C inclusive are permitted for no more than 20 seconds. On afterburner starts, if the exhaust gas temperature momentarily exceeds 915°C or if 5 seconds after the start the exhaust gas temperature exceeds 750°C, stop the afterburner.

### STARTING (AIRPLANES EQUIPPED WITH J35-35A ENGINES).

During starting, the maximum allowable exhaust gas temperature is 900°C. Exhaust gas temperatures between 735°C and 900°C are permissible for no more than 20 seconds. On afterburner starts, if the exhaust gas temperature momentarily exceeds 900°C or if 5 seconds after an afterburner start, the exhaust gas temperature exceeds 735°C, stop the afterburner. Normal power is 95.6% rpm; military power is 100% rpm without afterburning; and maximum power is 100% rpm with afterburning. There are no engine operating time limits.

### ACCELERATION (AIRPLANES EQUIPPED WITH J35-35 ENGINES).

During accelerations, the momentary exhaust gas temperature is not to exceed 915°C; but a peak temperature between 915° and 940°C is permitted for a maximum of 3 seconds at engine speeds below 75% rpm. Temperatures between 750°C and 915°C inclusive are permitted for no more than 20 seconds. The engine must be removed for overhaul if speed momentarily exceeds 104% rpm or 103% rpm stabilized with or without excessive exhaust gas temperature. Stabilized engine speeds greater than 103% rpm or 104% momentary rpm are prohibited and engine must be removed for overhaul if these limits are exceeded. The throttle must be reset if stabilized engine speed exceeds 102% rpm.

# INSTRUMENT MARKINGS

## AIRSPEED


195 KNOTS MAXIMUM FOR FULL FLAPS OR LANDING GEAR DOWN.

BELOW 20,000-FOOT PRESSURE ALTITUDE, THE AIRSPEED LIMITATION IS 470 KNOTS IAS OR MACH 0.90, WHICHEVER IS LESS.

THE INSTRUMENT SETTING IS SUCH THAT THE RED POINTER WILL MOVE TO INDICATE THE LIMITING STRUCTURAL AIRSPEED OR THE AIRSPEED REPRESENTING THE LIMITING MACH NUMBER, WHICHEVER IS LESS.

## ACCELEROMETER

−2.33 "G" MAX WITH EMPTY TIP AND PYLON TANKS AND WITH MISSILES RETRACTED ABOVE 12,000 FEET.

−1.67 "G" MAX WITH ANY AMOUNT OF TIP OR PYLON FUEL AND WITH MISSILES RETRACTED ABOVE 12,000 FEET.

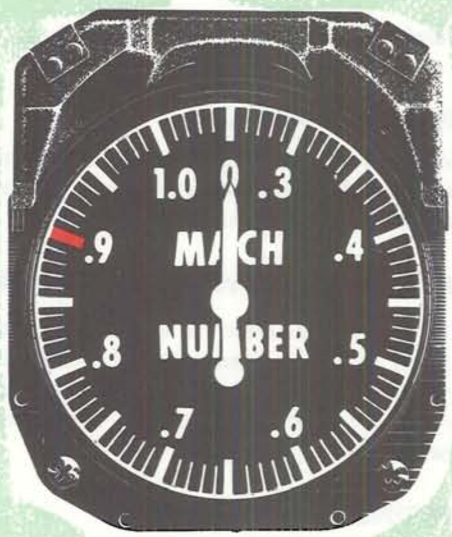
+3.67 "G" MAX WITH ANY AMOUNT OF TIP OR PYLON FUEL AND WITH MISSILES RETRACTED ABOVE 12,000 FEET.

+4.50 "G" MAX WITH EMPTY TIP AND PYLON TANKS AND WITH MISSILES EXTENDED ALL ALTITUDES.

+5.00 "G" MAX WITH EMPTY TIP AND PYLON TANKS AND WITH MISSILES RETRACTED BELOW 12,000 FEET.

+5.67 "G" MAX WITH EMPTY TIP AND PYLON TANKS AND WITH MISSILES RETRACTED ABOVE 12,000 FEET.


## MACHMETER




BELOW 20,000-FOOT PRESSURE ALTITUDE, THE AIRSPEED LIMITATION IS MACH 0.90 OR 470 KNOTS IAS, WHICHEVER IS LESS.

H-84(1)B

Figure 5-1 (Sheet 1 of 5).

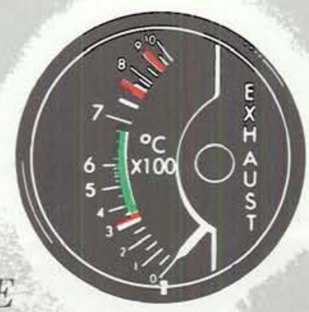

## ENGINE TACHOMETER

- RED: 49%–51% IDLE LIMITS
- GREEN: 80%–95% OPERATING RPM RANGE
- RED: 100% MAXIMUM

# Based on all fuel grades


## OIL PRESSURE

- RED: 15 PSI MINIMUM FOR FLIGHT
- GREEN: 25–45 PSI CONTINUOUS OPERATION
- RED: 45 PSI MAXIMUM FOR FLIGHT


## EXHAUST TEMPERATURE

| J35-35 A | | J35-35 |
|---|---|---|
| MINIMUM FOR FLIGHT 315°C | RED | 315°C MINIMUM FOR FLIGHT |
| CONTINUOUS OPERATION 315°–629°C | GREEN | 315°–680°C CONTINUOUS OPERATION |
| MAXIMUM FOR FLIGHT 735°C | RED | 750°C MAXIMUM FOR FLIGHT |
| MAXIMUM DURING STARTING AND ACCELERATION ONLY 900°C | RED | 915°C MAXIMUM DURING STARTING AND ACCELERATION ONLY |

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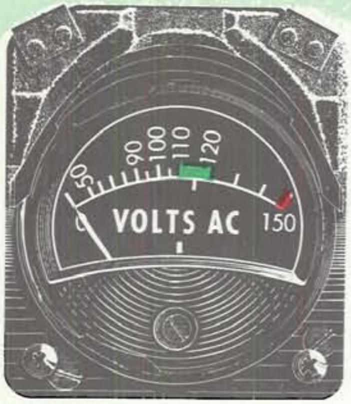
*Figure 5-1 (Sheet 2 of 5).*

# INSTRUMENT MARKINGS

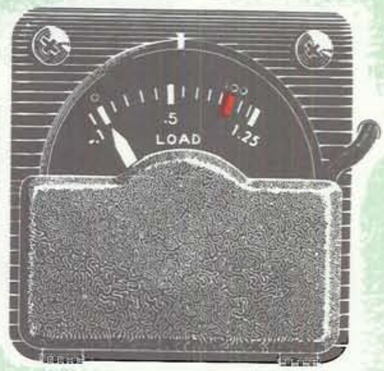



## VOLTMETER AC

110–120 VOLTS OPERATING RANGE

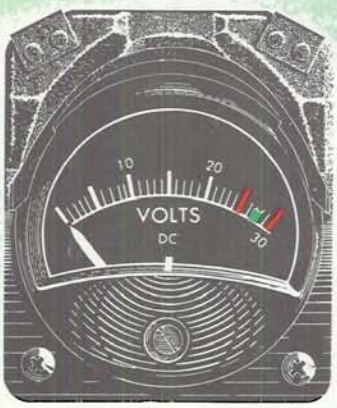
150 VOLTS MAXIMUM

## LOADMETER 28-VOLT DC




1.0 CONTINUOUS OPERATING LIMIT

## VOLTMETER DC

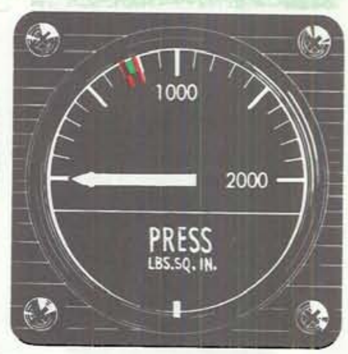



25 VOLTS MINIMUM

27.5 VOLTS DESIRED

30 VOLTS MAXIMUM

## NOSE GEAR BUNGEE PRESSURE

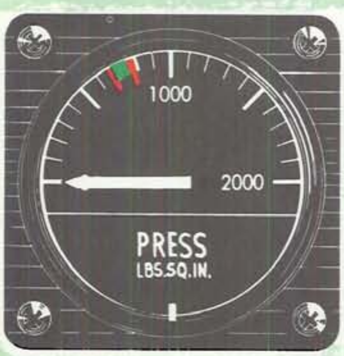



720 PSI MINIMUM

720–780 PSI OPERATING RANGE

780 PSI MAXIMUM

## MAIN GEAR BUNGEE PRESSURE



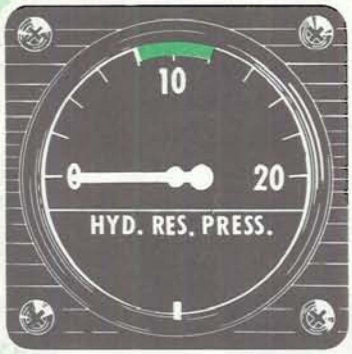

675 PSI MINIMUM

675–775 PSI OPERATING RANGE

775 PSI MAXIMUM

H-84(3)

*Figure 5-1 (Sheet 3 of 5).*



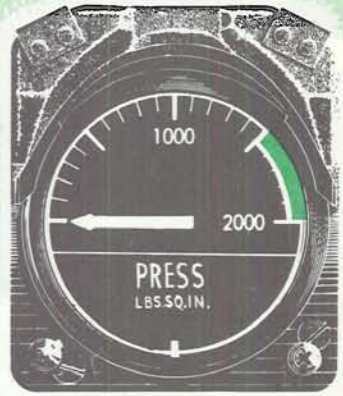

## HYDRAULIC RESERVOIR PRESSURE GAGE

8–12 PSI OPERATING RANGE


## PILOT'S SEAT PRESSURE GAGE

1600 PSI MINIMUM

1600–1800 PSI OPERATING RANGE




## CANOPY EJECTOR PRESSURE

1500–2000 PSI OPERATING RANGE

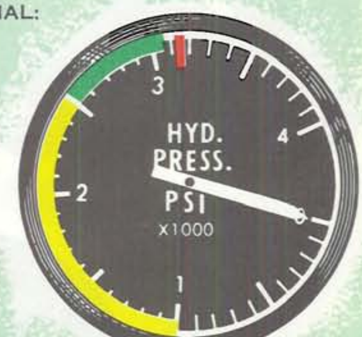

## BRAKE ACCUMULATOR

800 PSI ONE APPLICATION REMAINING

2500–3500 PSI NORMAL

3500–4100 PSI ABOVE NORMAL: ALLOWABLE

4100 PSI MAXIMUM

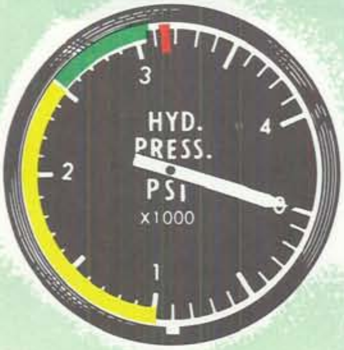



## LEFT HYDRAULIC SYSTEM

1000–2500 PSI MOMENTARY ALLOWABLE

2500–3050 PSI NORMAL

3150 PSI MAXIMUM




## RIGHT HYDRAULIC SYSTEM

1000–2500 PSI MOMENTARY ALLOWABLE

2500–3050 PSI NORMAL

3150 PSI MAXIMUM

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*Figure 5-1 (Sheet 4 of 5).*

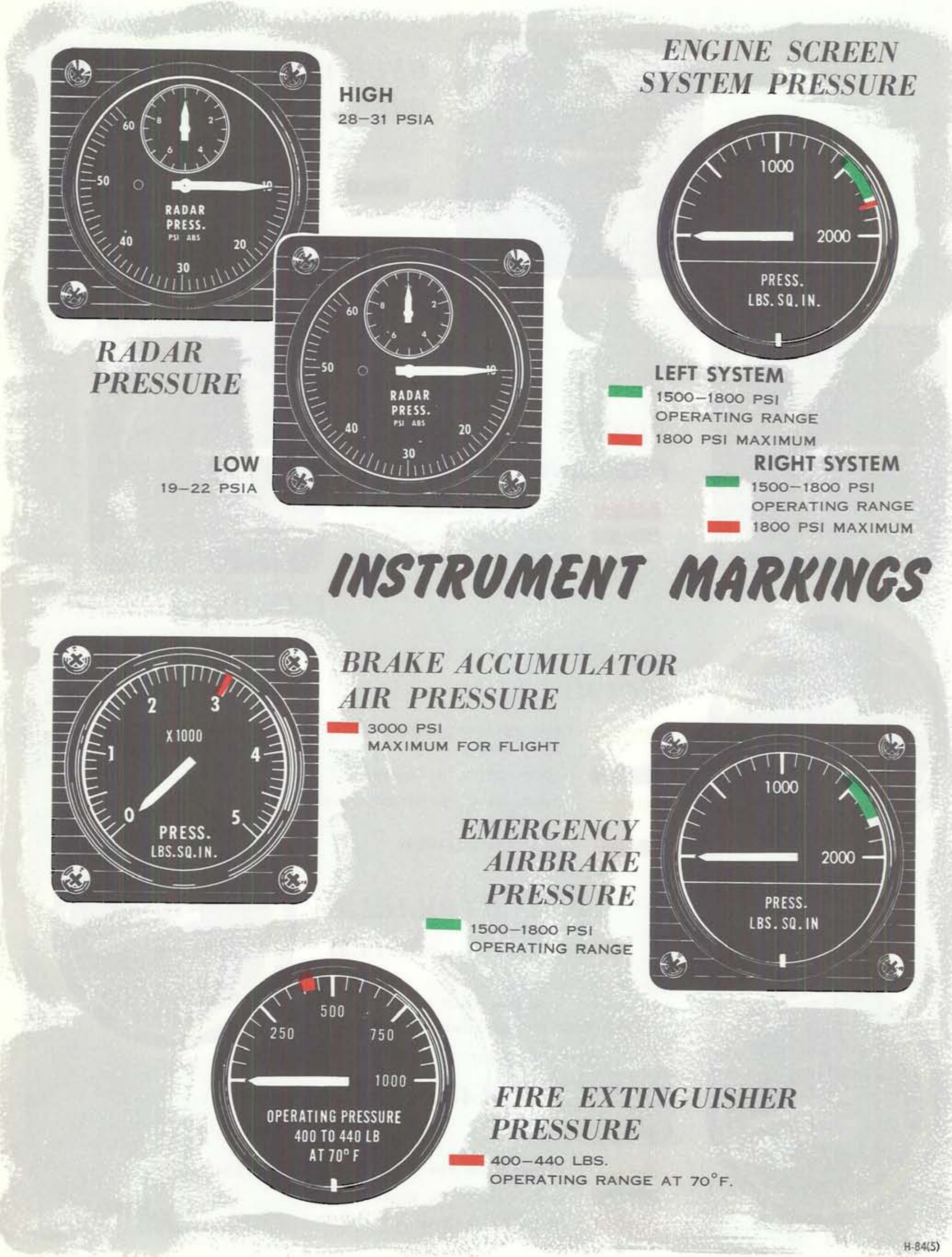



*Figure 5-1 (Sheet 5 of 5).*

# MISSILE LAUNCHER ACCUMULATOR AIR GAGE

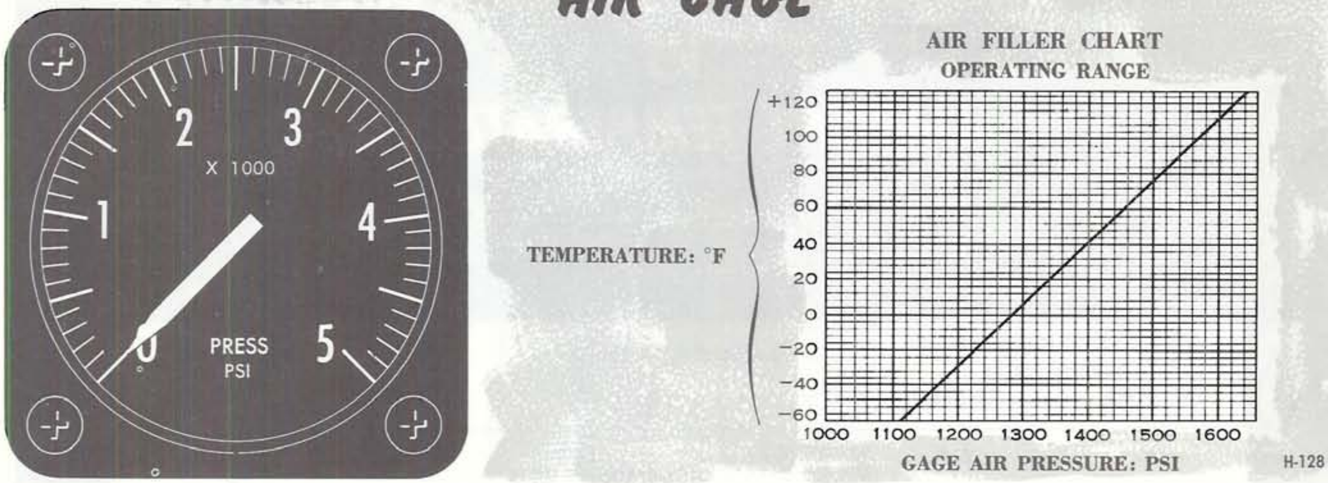



*Figure 5-2.*

### ACCELERATION (AIRPLANES EQUIPPED WITH J35-35A ENGINES).

The following J35-35A operating temperature limits must be observed: During accelerations, the momentary exhaust gas temperature is not to exceed 900°C, except that peak temperatures between 900°C and 925°C are permitted for a maximum of 3 seconds at engine speeds below 75% rpm. Temperatures between 735°C and 900°C are permissible for no more than 20 seconds. The engine must be removed for overhaul if speed momentarily exceeds 104% rpm or 103% rpm stabilized with or without excessive exhaust gas temperature. Engine speeds greater than 103% rpm are prohibited and engine must be removed for overhaul if this rpm is exceeded under stabilized conditions or 104% rpm is momentarily exceeded. Have the throttle reset if stabilized engine speed exceeds 102% rpm.

### EXHAUST GAS TEMPERATURE VERSUS AMBIENT TEMPERATURE.

Abnormally low exhaust gas temperatures for the existing ambient temperature will result in a loss of thrust. Available thrust may be insufficient for takeoff under this condition on a runway of limited length. Refer to figure 5-3 to ensure that exhaust gas temperatures and runway temperature are within limits which allow sufficient thrust for takeoff.

**Note**

Ambient temperature does not effect peak exhaust gas temperature limits.

### ALTERNATE FUEL LIMITATIONS.

If MIL-F-5572 aviation gasoline is used as an alternate fuel, the following limitations must be observed:

1. With ambient temperatures of 0°F (−18°C) and lower, do not exceed Mach 0.4 below 5000 feet with afterburners operating.

2. With sea level ambient temperatures exceeding 70°F (21°C), do not exceed 25,000-foot altitude.

These limitations are to prevent cavitation of the engine-driven and booster pumps.

## AIRSPEED LIMITATIONS.

Pending completion of static and flight tests, the airspeed limitations are as follows:

1. Below 20,000-foot pressure altitude, airspeed is restricted to 470 knots IAS or Mach 0.90, whichever is the lower indication. These limits are imposed to prevent excessive structural loads resulting from gusts. Above 20,000-foot pressure altitude, airspeed is unrestricted.

2. The preceding restrictions apply to *all fuel* and *armament* loading conditions with the following exception: with any amount of usable tip tank fuel, less than a full load of rockets (or approved dummy), *and* less than a full load of missiles do not exceed 400 knots indicated airspeed at any altitude. If a full complement of either type armament is aboard the airplane, the 400-knot indicated airspeed restriction does not apply.

**Note**

Cruising at 400 knots indicated airspeed instead of the airspeeds recommended in the Flight Operation Instruction Charts has negligible effect on range.

# EXHAUST GAS TEMPERATURES VS AMBIENT TEMPERATURES

*Air inlet screens extended*
*Without afterburning*

*NOTE: Afterburning lowers exhaust gas temperatures up to 5° C.*

| J35-35 ENGINES EXHAUST GAS TEMP 100% RPM °C MAX | °C MIN | AMBIENT TEMP °C | °F | J35-35A ENGINES EXHAUST GAS TEMP 100% RPM °C MAX | °C MIN |
|---|---|---|---|---|---|
| 749 | 729 | 38 | 100 | 735 | 715 |
| 749 | 729 | 32 | 90 | 735 | 715 |
| 743 | 723 | 27 | 80 | 729 | 709 |
| 736 | 716 | 21 | 70 | 721 | 701 |
| 728 | 708 | 16 | 60 | 713 | 693 |
| 719 | 699 | 10 | 50 | 705 | 685 |
| 711 | 691 | 4 | 40 | 697 | 677 |
| 702 | 682 | −1 | 30 | 687 | 667 |
| 692 | 672 | −7 | 20 | 678 | 658 |
| 683 | 663 | −12 | 10 | 669 | 649 |
| 673 | 653 | −18 | 0 | 659 | 639 |
| 663 | 643 | −23 | −10 | 649 | 629 |
| 653 | 633 | −29 | −20 | 639 | 619 |
| 645 | 625 | −34 | −30 | 632 | 612 |
| 638 | 618 | −40 | −40 | 623 | 603 |
| 631 | 611 | −46 | −50 | 616 | 596 |
| 626 | 606 | −51 | −60 | 611 | 591 |
| 98% RPM | | | | 98% RPM | |
| 748 | 728 | 43 | 110 | 733 | 713 |
| 749 | 729 | 49 | 120 | 735 | 715 |

H-126

**Figure 5-3.**

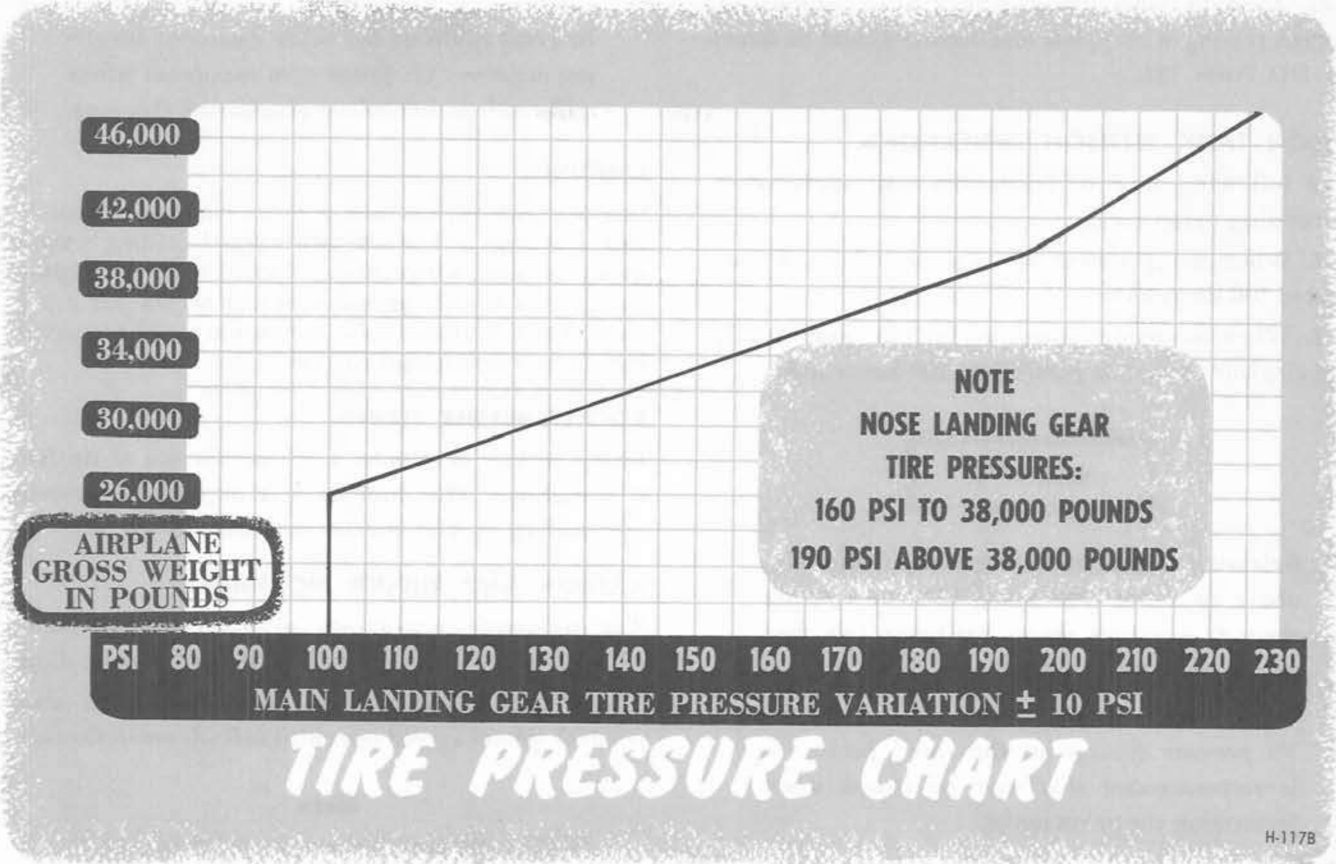



*Figure 5-4.*

3. With less than full armament and less than 400 pounds of fuel remaining in the main tanks, do not exceed 400 knots indicated airspeed.

## AUTOPILOT LIMITATIONS.

Autopilot-controlled flight below 25,000 feet pressure altitude is limited to 425 knots IAS or Mach 0.78, whichever is lower; however, the 400-knot IAS limitation described in the Airspeed Limitations paragraph must be observed.

## WING FLAP LIMITATIONS.

Do not exceed the following structural limit airspeed of the wing flaps, or the wing flaps may fail structurally:

| *Wing Flap Positions* | *IAS—Knots* |
|---|---|
| Wing flaps at takeoff (gear up) | 230 |
| Wing flaps full down (gear up or down) | 195 |

**Note**

A wing flaps full down and 195 knots IAS condition can occur only when the airplane is accelerated to 195 knots IAS after extending the flaps. Airloads prevent fully extending the flaps at or above this airspeed.

## LANDING GEAR LIMITATION.

With the wing flaps in any position, the structural limit airspeed of the landing gear and main landing gear doors is 195 knots IAS and 1.2 "G's" during retraction.

## TIRE LIMITATION.

Speed on the ground should not exceed 140 knots at takeoff or 122 knots at landing to obtain normal tire life. Exceeding these speeds on occasion will not necessarily result in tire failure; however, continual operation at excessive ground roll speeds will result in reducing tire life and premature failure. For tire pressures see figure 5-4.

## LANDING—TAXI LIGHT LIMITATION.

Do not extend landing light above 175 knots IAS. The light was designed for use only during final approach and landing. If this limitation is exceeded, the light may fail structurally.

## PYLON LIMITATIONS.

Overlimit stresses on the wing pylon racks may occur in flight: if a tank collapses; if the acceleration limit for the airplane with pylon fuel (1000 pounds or more) is exceeded; or if the airplane exceeds a roll rate of 90 degrees per second with 1000 pounds or more of pylon fuel. Landing with pylon tank fuel is prohibited. Rough taxiing with pylon fuel aboard should be noted on DD Form 781.

### PYLON TANK JETTISON LIMITATIONS.

The following airspeed limitations will apply when jettisoning pylon tanks:

1. When using power ejection procedure, do not exceed 300 knots IAS.
2. When releasing tanks to fall by gravity, fly the airplane as near as possible to 200 knots IAS.

**CAUTION**

- Releasing empty tanks at speeds substantially above or below 200 knots IAS, or ejecting them at airspeeds above 300 knots IAS may cause the tanks to tumble and strike the airplane.
- To prevent damage to the speed brakes, it is recommended that they be closed when jettisoning the pylon tanks.
- When the pylon tanks are jettisoned manually (gravity drop), minor damage to the airplane may result.

## CANOPY LIMITATIONS.

Speeds must not exceed 50 knots IAS when airplane is taxied with the canopy open.

## PROHIBITED MANEUVERS.

### SPINS.

Intentional spins, with or without external stores, are prohibited.

### ACROBATICS.

Acrobatics will not be performed below 12,000 feet.

### INVERTED FLIGHT.

Inverted flight can be maintained without afterburning for approximately 8 seconds at 20,000-foot pressure altitude, because of the limited amount of fuel available to the engines. At the time the airplane is inverted only that fuel already in the fuel lines, fuel pumps and fuel controller will be available for use; when that has been used flameout will occur. At lower altitudes this time will be considerably reduced because of increased fuel consumption.

**Note**

Inverted flight or any other maneuver involving negative "G" forces with maximum power will result in immediate afterburner flameout.

### LANDING.

Landing with any tip tank or pylon tank fuel is prohibited. Landings at heavier than normal landing weight should be made with caution. Normal landing weight is one half or less of internal fuel and no tip pod armament. These limitations are imposed to avoid overstressing the pod attachment fittings.

### ROCKET/MISSILE FIRING.

Firing rockets or missiles with any amount of tip fuel is prohibited. This limitation is imposed to prevent overloading tip pod attachment fittings.

### AILERON AND RUDDER MOVEMENT.

The following restrictions to aileron and rudder movement apply except during takeoff and landing:

1. With any pylon or tip tank fuel, other than residual, do not exceed one-third full aileron deflection.

**Note**

With no tip tank fuel and no pylon fuel (with or without empty pylon tanks), aileron deflection is unrestricted.

2. When pylon tanks (empty or full) are carried, or when any tip tank fuel is carried, abrupt rudder deflections are prohibited.

**Note**

Without pylon tanks or tip tank fuel, rudder deflection is unrestricted, except for fishtailing maneuvers.

## ACCELERATION LIMITATIONS.

A load factor envelope, shown on the Operating Flight Strength Diagram (figure 5-5), includes the operating gross weight and operating altitude ranges of the airplane. Lines on the left of the charts represent maximum lift limitations; top and bottom lines specify structural limit load factor; lines on the right indicate limit airspeeds or elevator control boundaries. The elevator control boundary lines show the necessity for careful regulation of airspeed during dive maneuvers because a small increase in IAS will result in a noticeable decrease in available load factor or ability to maneuver. This effect will be dangerous as speeds increase above the maximum level flight airspeed.

# FOR SYMMETRICAL FLIGHT IN SMOOTH AIR

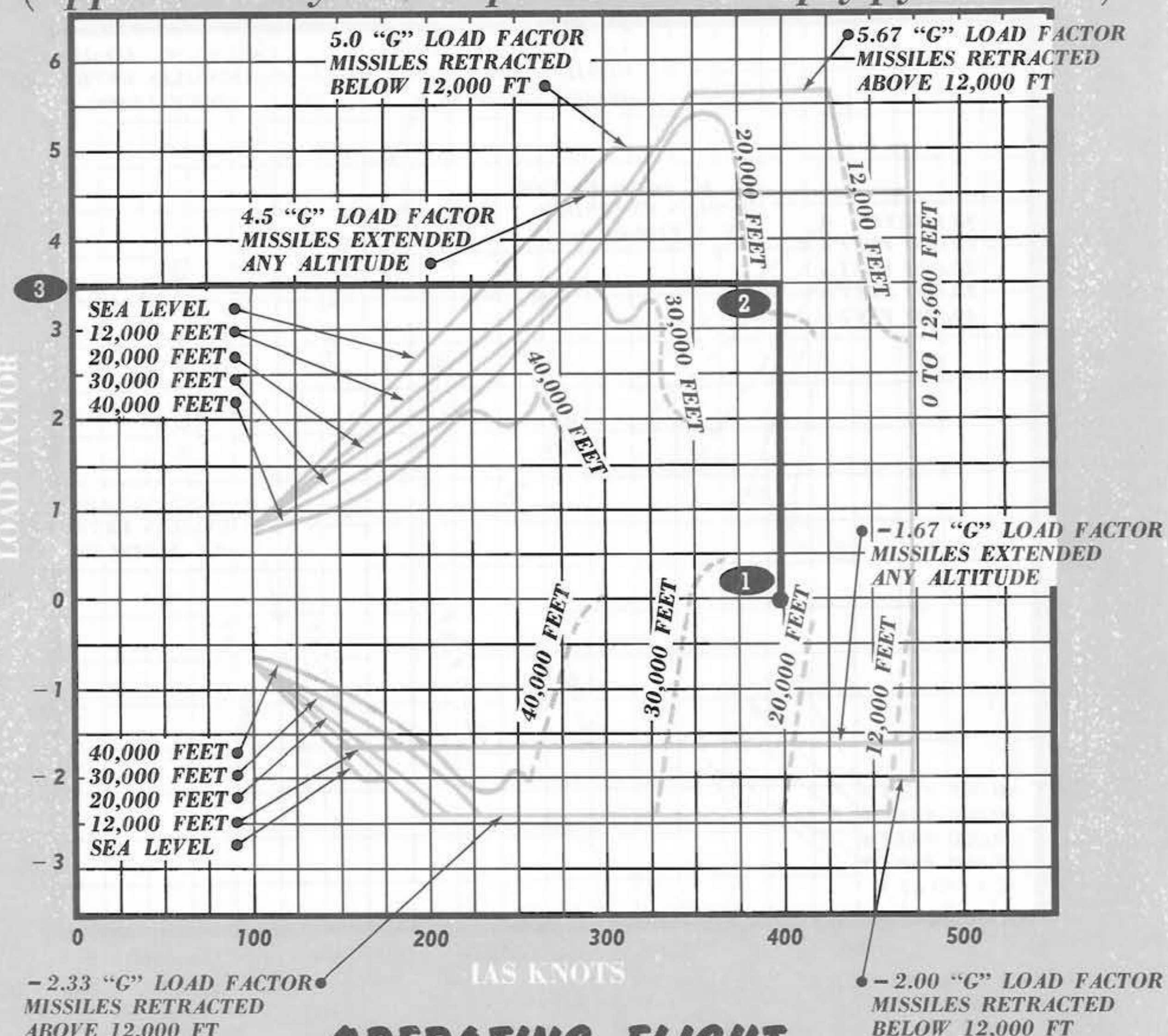
NO INTERNAL FUEL
NO TIP TANK FUEL
NO PYLON TANKS
FULL TIP POD ARMAMENT

APPROXIMATELY
**31,680**
POUNDS GROSS WEIGHT*

DATA AS OF: *14 August 1957*

DATA BASIS: *Flight test*

*(*Approximately 32,180 pounds with empty pylon tanks*)




## OPERATING FLIGHT STRENGTH DIAGRAM

## How to use charts......

SOLID LINES REPRESENT STALL LIMIT

BROKEN LINES REPRESENT ELEVATOR CONTROL POWER LIMITS

1. Select an indicated airspeed.
2. Move up the chart to a selected altitude (solid or broken line).
3. Move to the left to find the maximum number of "G's" you can pull at that airspeed and altitude.

H-88(1)C

Figure 5-5 (Sheet 1 of 3).

# FOR SYMMETRICAL FLIGHT IN SMOOTH AIR

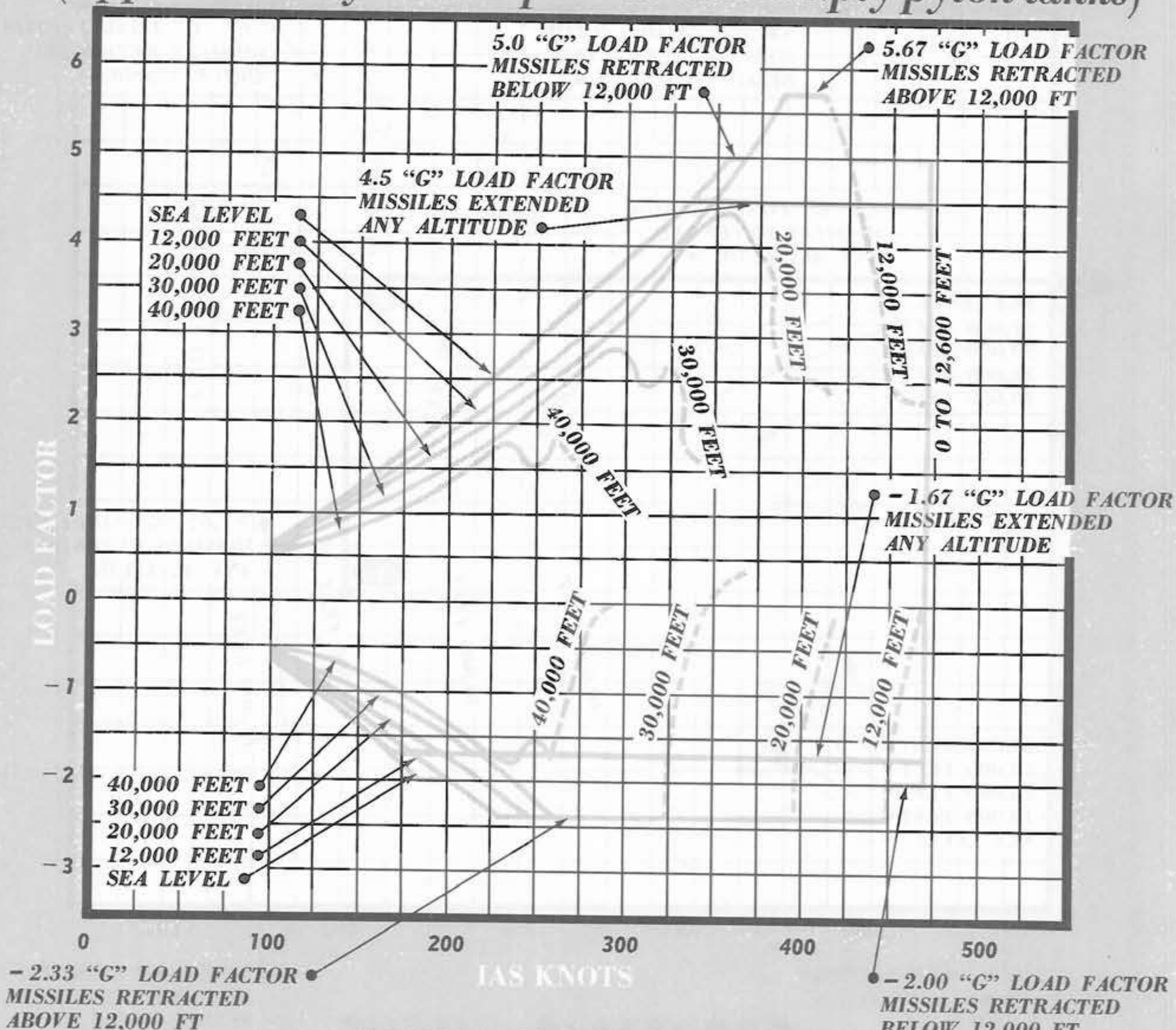
FULL INTERNAL FUEL
NO TIP TANK FUEL
NO PYLON TANKS
FULL TIP POD ARMAMENT

APPROXIMATELY
39,200
POUNDS GROSS WEIGHT *

DATA AS OF: *14 August 1957*

DATA BASIS: *Flight test*

*(Approximately 39,700 pounds with empty pylon tanks)*




## OPERATING FLIGHT STRENGTH DIAGRAM

## How to use charts.......

SOLID LINES REPRESENT STALL LIMIT

BROKEN LINES REPRESENT ELEVATOR CONTROL POWER LIMITS

1. Select an indicated airspeed.
2. Move up the chart to a selected altitude (solid or broken line).
3. Move to the left to find the maximum number of "G's" you can pull at that airspeed and altitude.

H-88(2)A

*Figure 5-5 (Sheet 2 of 3).*

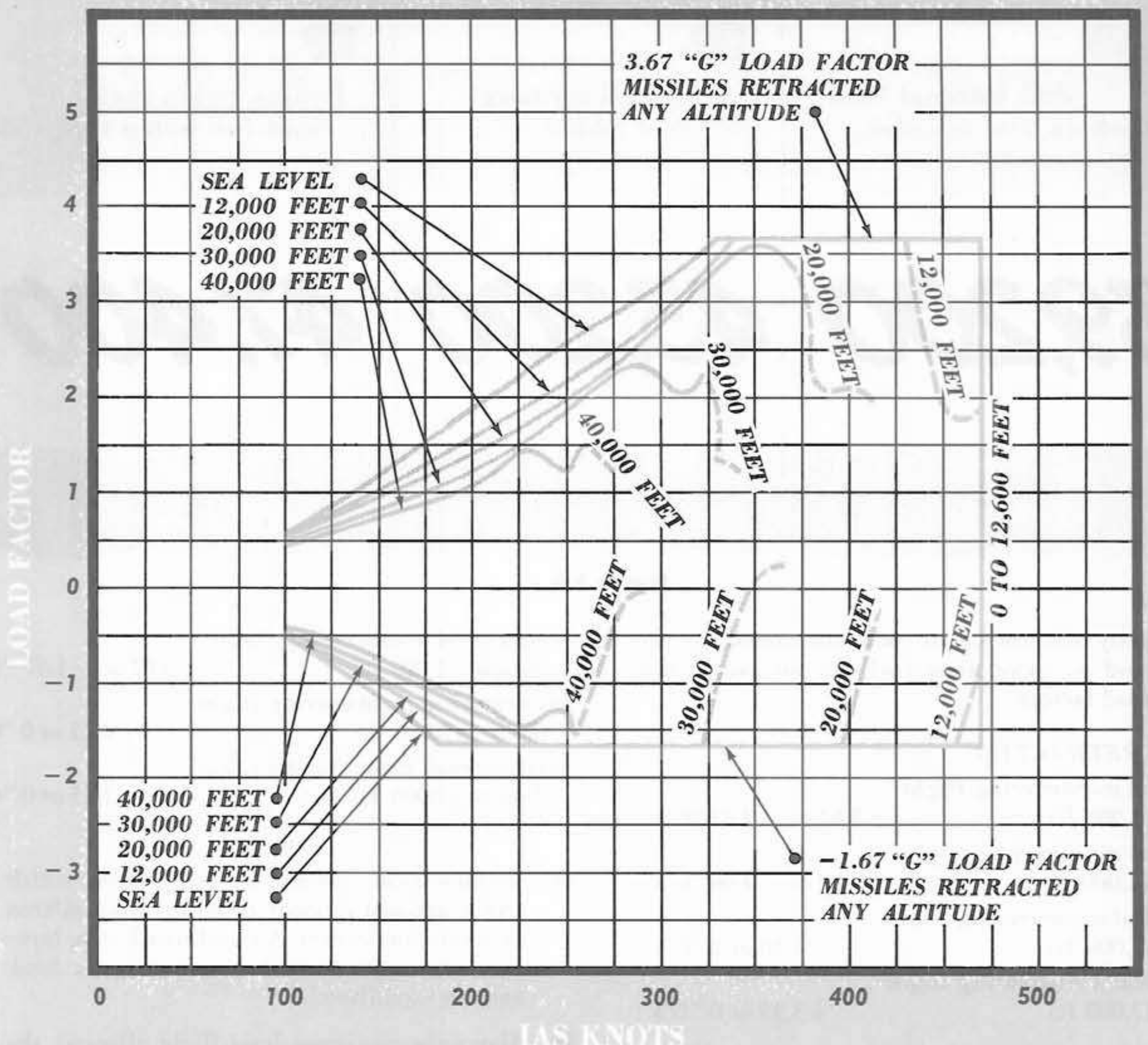
# FOR SYMMETRICAL FLIGHT IN SMOOTH AIR

FULL INTERNAL FUEL
FULL TIP TANK FUEL
FULL PYLON TANK FUEL
FULL TIP POD ARMAMENT

APPROXIMATELY
**47,360**
POUNDS GROSS WEIGHT

DATA AS OF: *14 August 1957*

DATA BASIS: *Flight test*




## OPERATING FLIGHT STRENGTH DIAGRAM

## How to use charts.......

SOLID LINES REPRESENT STALL LIMIT

BROKEN LINES REPRESENT ELEVATOR CONTROL POWER LIMITS

1. Select an indicated airspeed.
2. Move up the chart to a selected altitude (solid or broken line).
3. Move to the left to find the maximum number of "G's" you can pull at that airspeed and altitude.

H-88(3) A

Figure 5-5 (Sheet 3 of 3).

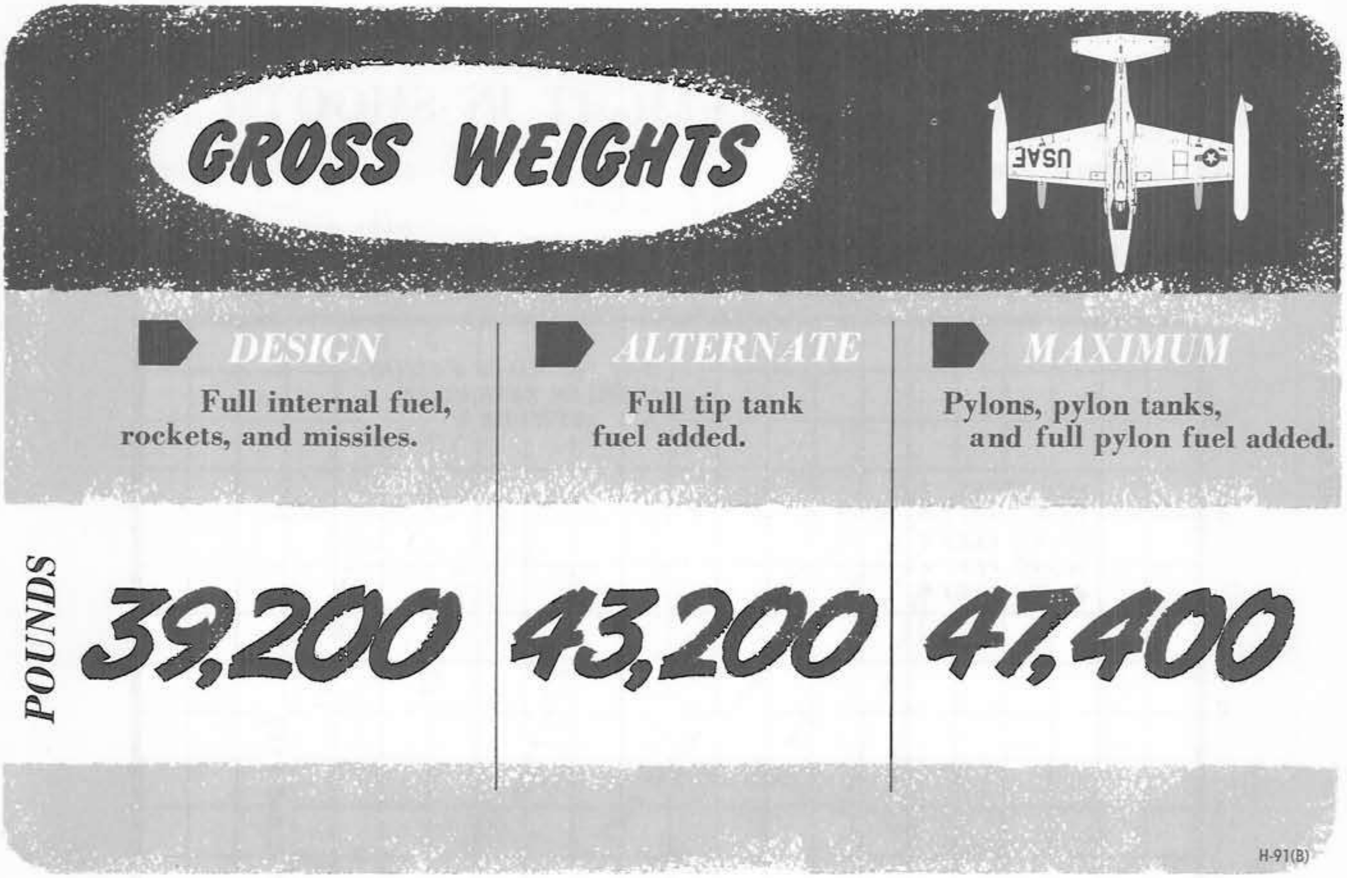



**Figure 5-6.**

1. With any amount of tip pod armament, no tip tank fuel, and no pylon tank fuel, do not exceed the following load factors:

*MISSILES RETRACTED*

Symmetrical maneuvering flight (above 12,000 ft) +5.67 or −2.33 "G's"

Symmetrical maneuveting flight (below 12,000 ft) +5.00 or −2.00 "G's"

Asymmetrical maneuvering flight (above 12,000 ft) +3.40 or 0 "G's"

Asymmetrical maneuvering flight (below 12,000 ft) +3.33 or 0 "G's"

*MISSILES EXTENDED*

*All Altitudes*

Symmetrical maneuvering flight +4.50 or −1.67 "G's"

Asymmetrical maneuvering flight +3.00 or 0 "G's"

2. With any amount of tip pod armament, full internal fuel, any amount of tip tank fuel, and any amount of pylon tank fuel, do not exceed the following load factors:

*MISSILES RETRACTED*

Symmetrical maneuvering flight (above 12,000 ft) +3.67 or −1.67 "G's"

Symmetrical maneuvering flight (below 12,000 ft) +3.67 or −1.67 "G's"

Asymmetrical maneuvering flight (above 12,000 ft) +2.45 or 0 "G's"

Asymmetrical maneuvering flight (below 12,000 ft) +2.45 or 0 "G's"

**Note**

- Asymmetrical maneuvers are those which create unequal airloads resulting from aileron or rudder deflection. A coordinated turn, however, is a symmetrical maneuver once bank angle is established.
- Above the maximum level flight airspeed, the maximum allowable negative load factor reduces as airspeed increases, reaching −1.00 "G" at maximum airspeed attainable.

**WARNING**

If airplane is trimmed for high speed flight at low altitude, airplane will nose down sharply if speed is reduced.

It is possible to overstress the tip tank attachment fittings and the pylon racks if a landing is made with fuel in these tanks; therefore, tip tanks must be emptied and pylon tanks must be emptied or jettisoned before landing. Not all of the tip tank fuel can be dumped during dives or deceleration because the fuel will shift and uncover the dump tube before the tank is emptied.

**WARNING**

Because of the fire hazard, do not fire armament while tip tank fuel is being dumped.

## CENTER-OF-GRAVITY LIMITATIONS.

The forward cg limit is at 20 percent of the Mean Aerodynamic Chord at 35,000 pounds gross weight or less, and 24 percent MAC at 48,000 pounds gross weight, varying linearly between these points. The normal operating aft limit is 25.8 percent MAC at 48,000 pounds gross weight and 27.7 percent MAC at 29,000 pounds gross weight; this limit varies linearly with gross weight. It is allowable for the aft cg limit to move 0.70 percent MAC aft of its normal position provided that a full load of fuel is carried (with or without pylon fuel tanks), and no tip pod rockets, approved dummy rockets, nor missiles are carried. For detailed instructions of weight and balance refer to T.O. 1-1B-40 and T.O. 1F-89H-5.

## WEIGHT LIMITATIONS.

There are no weight limitations. See figure 5-6 for design, alternate, and maximum gross weights.


HF-208


SECTION VI

# FLIGHT CHARACTERISTICS

HF-6B

## TABLE OF CONTENTS



## INTRODUCTION.

The airplane is a large, high speed, fast-climbing all-weather interceptor. The two-engine design increases dependability and permits high performance while carrying the heavy load of armament and equipment necessary for an intercept mission. All flight control surfaces are 100 percent hydraulically actuated. Full-powered controls permit accurate control of the airplane at airspeeds which would otherwise make control forces prohibitively high. They also prevent sudden airload changes on control surfaces from affecting the stick or rudder pedals. The wide range of speed control possible with split-aileron speed brakes increases combat effectiveness. The sideslip stability augmenter provides satisfactory damping of the high speed Dutch Roll, assists the pilot in making coordinated turns in combat maneuvers, and provides a stable firing platform at high speeds. Tip pod fins, in addition to decreasing wing twist and keeping the center of spanwise lift more nearly constant, add to the longitudinal stability and control characteristics of the airplane. The fins increase the stick force per "G", particularly for the aft cg conditions in the airspeed range where maneuvering stability is critical (from approximately 0.70 to 0.80 Mach number). Power response to throttle adjustment is slow, as in all jet airplanes because of the high inertia of the engine rotors. However, rapid changes of effective power are obtainable by stabilizing airspeed at a power setting higher than required by use of partially opened speed brakes, then quickly changing speed brake position as changes in effective power are required. Excess power is greatest at medium to high airspeeds. Consequently, to perform any maneuver involving altitude and airspeed changes, maintain medium to high airspeeds.

## STALLS.

The stall in this airplane is a mild pitch down, with drop off usually to the left. See figure 6-2 for stall speeds for clean landing and takeoff configurations. At low altitudes, power-on stall IAS is approximately 3 knots lower than power-off stall IAS for the configurations indicated in the Stall Speed Chart. The airspeeds shown in the chart for the landing and takeoff configurations are for idle power. Ailerons and rudder retain sufficient effectiveness to maintain adequate control during a stall. Recovery from a stall is made by lowering the nose slightly and adding power as may be required. The altitude lost in a stall will be approximately 500 feet. Landing gear position does not affect stall speed.

## MACH NUMBER CHART

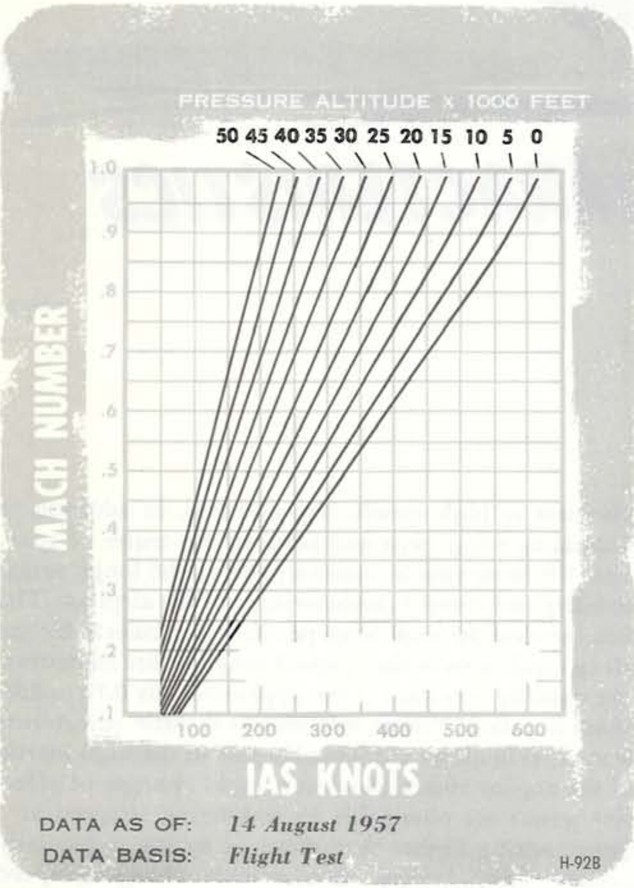



*Figure 6-1.*

Speed brake position affects stall speed as follows: with wing flaps up, stall IAS decreases as speed brake opening increases, reaching maximum decrease of 6 knots with speed brakes fully open. With wing flaps in the landing position, no change in stall IAS occurs until speed brakes are 30 degrees open; then stall IAS increases as speed brake opening increases, reaching a maximum increase of 7 knots with speed brakes fully open.

### ACCELERATED STALLS.

At airspeeds above Mach 0.25 the accelerated stall region (shown by the sloping lines on the left of the Operating Flight Strength Diagram, figure 5-5) is characterized by buffeting, pitching, and rolling, which increase as load factor increases. Any increase of load factor after buffet onset is accompanied by rapid loss of airspeed and extreme buffet. For this reason, the buffet region should not be penetrated beyond a mild buffet. It is recommended that accelerated stalls be practiced so that they may be anticipated by feel of the airplane.

### SPINS.

Intentional spins are prohibited. Damage to the airplane's heavy complement of electronic equipment may occur from the unusual loads developed in spins. The airplane will not spin inadvertently and has no dangerous inherent spin characteristics. However, because of the airplane's high wing loading, considerable altitude will be lost during a spin. Total altitude lost during spins varies from about 3000 feet between stall and complete recovery for a one-turn power-off spin in landing configuration, to about 12,000 feet for a three-turn spin with continuous power in clean configuration. A three-turn power-off spin in clean configuration generally requires about 10,000 feet total altitude. With the use of conventional spin recovery technique, recovery characteristics are normal. Recovery from a three-turn power-off spin in clean configuration requires between one-half and three-quarter turn, and recovery from a one-turn power-off spin in landing configuration requires from one-quarter to one-half turn. With power on, the rate of recovery is slightly slower. The conventional spin recovery technique of full opposite rudder followed by forward stick is normal and will produce satisfactory results; however, a faster recovery can be effected by neutralizing the stick at the same time opposite rudder is applied. This method also lessens the chance of inadvertently entering a secondary inverted spin while recovering from a normal spin. Aileron position during the spin, whether with the spin, neutral, or against the spin, has no effect on the recovery. Direction of spin has no pronounced influence on spin recovery characteristics. Raising flaps and closing speed brakes aid spin recovery.

### FLIGHT CONTROLS.

The full-powered irreversible flight control system gives the airplane good handling characteristics. Artificial stick feel provides a definite sense of control and is adequate under normal conditions. Control forces remain within moderate limits through a wide range of airspeeds.

### ELEVATOR.

Elevator control is satisfactory under normal operating conditions. However, between Mach 0.72 and 0.78 the elevator becomes extremely effective, and very small deflection is required to obtain an additional "G" of acceleration. Since the maximum power climb schedules are at these Mach numbers, more than normal effort may be necessary in turbulent air to hold to a close climb schedule. An elevator reversal occurs at Mach 0.80 to 0.83 and is characterized by slight nose

## STALL SPEED CHART

*With or without pylon tanks*

### GEAR UP OR DOWN — STALLING SPEED IAS KNOTS

| Wing Flap Position | Speed Brake Position | Angle of Bank | Pressure Altitude—Feet | Gross Weight—Pounds 30,000 | 34,000 | 38,000 | 42,000 | 47,400 | |
|---|---|---|---|---|---|---|---|---|---|
| 0° | CLOSED | 0° | 0 | 117 | 124 | 132 | 139 | 147 | POWER ON |
| 0° | CLOSED | 0° | 5,000 | 118 | 126 | 133 | 140 | 149 | POWER ON |
| 0° | CLOSED | 0° | 10,000 | 119 | 127 | 134 | 141 | 150 | POWER ON |
| 0° | CLOSED | 0° | 20,000 | 121 | 129 | 138 | 147 | 159 | POWER ON |
| 0° | CLOSED | 0° | 30,000 | 127 | 138 | 150 | 161 | 176 | POWER ON |
| 0° | CLOSED | 0° | 40,000 | 140 | 153 | 165 | 175 | 187 | POWER ON |
| 0° | CLOSED | 0° | 45,000 | 149 | 160 | 169 | 178 | 189 | POWER ON |
| 0° | CLOSED | 30° | 0 TO 5,000 | 124 | 132 | 140 | 147 | 157 | POWER ON |
| 0° | CLOSED | 45° | 0 TO 5,000 | 136 | 145 | 153 | 164 | 175 | POWER ON |
| 0° | CLOSED | 60° | 0 TO 5,000 | 162 | 175 | 188 | 201 | 220 | POWER ON |
| 30° | CLOSED | 0° | 0 TO 5,000 | 105 | 113 | 121 | 128 | 137 | IDLE POWER |
| 30° | CLOSED | 30° | 0 TO 5,000 | 113 | 120 | 128 | 136 | 146 | IDLE POWER |
| 30° | CLOSED | 45° | 0 TO 5,000 | 125 | 133 | 141 | 150 | 162 | IDLE POWER |
| 30° | CLOSED | 60° | 0 TO 5,000 | 150 | 162 | 171 | 180 | 191 | IDLE POWER |
| 50° | ½ OPEN | 0° | 0 TO 5,000 | 100 | 107 | 114 | 121 | 129 | IDLE POWER |
| 50° | ½ OPEN | 30° | 0 TO 5,000 | 106 | 114 | 122 | 130 | 140 | IDLE POWER |
| 50° | ½ OPEN | 45° | 0 TO 5,000 | 119 | 128 | 136 | 146 | 157 | IDLE POWER |
| 50° | ½ OPEN | 60° | 0 TO 5,000 | 146 | 159 | 170 | 179 | 190 | IDLE POWER |

DATA AS OF: *14 August 1957* DATA BASIS: *Flight test*

H-93B

**Figure 6-2.**

heaviness. This nose-down tendency can be trimmed out; however, if during a turn or other maneuver, the airspeed drops from 3 to 5 knots, the airplane will pitch up rather sharply. At high indicated airspeeds or at high Mach numbers, elevator control will be limited as shown on the Operating Flight Strength Diagram (figure 5-5). Under these conditions twisting and bending of the airplane structure, together with high Mach effects, cause elevator effectiveness to decrease rapidly, approaching zero at sea level at approximately Mach 0.925 (which is above the maximum airspeed restriction of the airplane). This is due to high dynamic pressures associated with high airspeeds at low altitude, and high Mach number effects at high altitude. The result is that the maximum load factor attainable at high airspeed at a given altitude will decrease as airspeed increases above about Mach 0.82. This means that the higher the airspeed, the fewer the available "G's." At speeds of Mach 0.86 and above, elevator effectiveness is so decreased that less than 2 degrees of elevator deflection are available with full stick deflection and less than 2 "G's" are available at Mach 0.98 at 35,000 feet (an important point to remember during a high Mach dive recovery).

**Note**

If airplane control should become sluggish at altitudes above 30,000 feet, check the hydraulic reservoir pressure. If pressure is below operating limits, reduce altitude until control response is again normal.

## "G" OVERSHOOT.

As positive or negative load factor develops on the airplane, an elevator force-feel bobweight tends to move the stick in the opposite direction opposing further stick application. For each "G" increase, the bobweight increases force against the stick 4.5 pounds. It must be remembered, however, that if the stick is moved abruptly, it is possible to obtain elevator position corresponding to high "G's" before the "G's" have built up on the airplane and have increased the stick force through the action of the bobweight. This is apparent particularly between Mach 0.65 and Mach 0.80. Once the "G" load starts to develop, the buildup to the point of failure can occur before corrective action becomes effective. Thus, by abruptly pulling back on the stick indiscriminately, it is possible to overshoot the "G" limit and pull the airplane apart. *When you're at low altitudes, do not attempt abrupt pull-ups.* Do not rely upon the "feel" of the stick to keep you out of trouble.

## AILERONS.

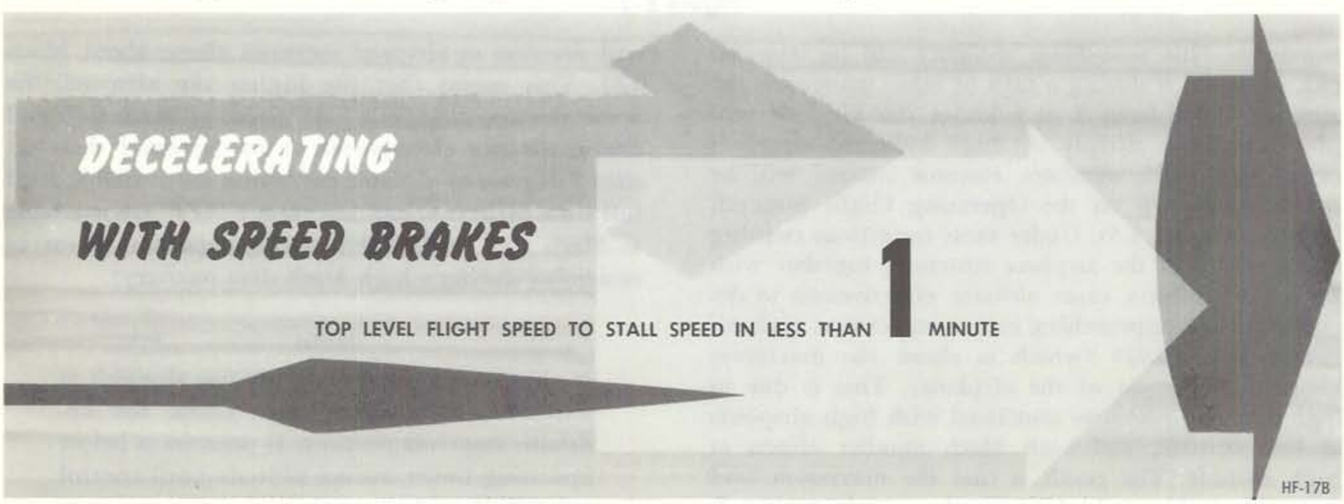
Aileron effectiveness is adequate under all conditions except in spins and at airspeeds above Mach 0.86 where aileron effectiveness decreases rapidly. At an indicated Mach number of 0.86, a slight aileron reversal occurs which may be compensated for by using ailerons in a direction opposite to normal. Sufficient lateral control for performing normal maneuvers at airspeeds above Mach 0.86 can be maintained with speed brakes opened approximately 7-1/2 degrees. Partially opening the speed brakes (from 10 to 20 degrees) also improves aileron effectiveness at medium airspeeds (above Mach 0.75). At low airspeeds near the ground (such as those used for takeoffs and landings), aileron response may be lower than normal, particularly in turbulent air. This condition may exist at any airplane gross weight but can be minimized by strict adherence to nose wheel liftoff, takeoff, approach, and landing airspeeds.

## RUDDER.

Rudder operation is satisfactory under all operating conditions. The slideslip stability augmenter should be turned on before takeoff and left on for the duration of the flight. This system operates automatically to damp out any sideslipping or rolling tendencies induced by high speed and altitude effects; also, through a signal derived from movement of the aileron controls, the system applies rudder in a turn in proportion to aileron deflection, thereby enabling the pilot to make coordinated turns with ailerons alone.

## SPEED BRAKES.

The split-aileron speed brakes provide a much larger drag surface than other types, making them highly effective under all operating conditions. Lateral control is improved at Mach numbers near cruise and above by sightly opened speed brakes. Since the speed brakes are symmetrical and are located almost in line with the airplane center of gravity, their use has little effect on trim. There is ample and positive control about all axes with speed brakes in any position. Pitch and yaw characteristics are not directly affected by their use. Letdowns up to 30,000 feet per minute can be made without exceeding 350 knots IAS. Altitude loss is reduced by using speed brakes in high speed dive recoveries; however, as the speed increases above Mach 0.90, speed brake effectiveness decreases. Above approximately 260 knots the speed brakes will not open fully. At Mach 0.90 they will open approximately 30 degrees only, and because of adverse compressibility effects, little drag may result from their use. Speed brakes are especially effective in controlling airspeed and altitude during approach. During landing, this airspeed control permits fast acceleration for go-arounds. Ground roll is reduced appreciably by moving the speed brakes to full open after touchdown. They give excellent airspeed control at constant throttle settings, thus permitting high rate of closure in combat while retaining maximum power for a fast breakaway. At high indicated airspeeds, sufficient lateral control for maneuvering can be maintained with speed brakes 5 to



10 degrees open without affecting airspeed. A 5-degree speed brake opening will also eliminate the natural rolloff tendency at high Mach numbers.

**Note**

By moving speed brake lever to the full open position and reducing power, the airplane can be decelerated in level flight from maximum level flight speed to stalling speed in less than 1 minute at any altitude.

### TRIM.

Longitudinal trim is not affected by lowering the landing gear during approach or by changes in thrust at high airspeed. However, when shutting down afterburners between approximately Mach 0.84 and Mach 0.88, the high speed can no longer be maintained (in level flight) and a push force on the stick is required as airspeed decreases, requiring retrimming at the lower airspeed. Nominal change in longitudinal trim is required when changes in thrust are made at low airspeeds. When speed brakes are opened, no immediate change in trim is required; however, as airspeed is reduced, longitudinal trim may be necessary. The aileron trim motor is independent of stick position. When trimming the elevator, the trim mechanism will not operate after the stick force is reduced to zero for any given stick position. Elevator trim will appear more sensitive at cruise speeds as less elevator is required to trim for a small change in speed in this region. Normal available rudder trim is 5 degrees left or right. Under normal flight conditions, the emergency rudder trim knob should not be used, as the sideslip stability augmenter system will be adversely affected.

### HIGH AIRSPEED OVERTRIM.

Stick forces vary with airspeed changes (see figure 6-3) and can be trimmed out for level flight. However, for flight at relatively low altitudes, extreme caution should be used in trimming out all the stick force. If all the push force required for level flight at relatively high airspeeds is trimmed out, and the airplane then slows down, it is possible for the pull force required for level flight (at the lower airspeed) to build up in magnitude faster than the pilot anticipates, causing the airplane to nose down sharply (an unsafe attitude with the airplane close to the ground).

**WARNING**

Do not trim out all stick force during low-level flight at high airspeeds as the airplane may dive sharply as airspeed is reduced.

## LEVEL FLIGHT CHARACTERISTICS.

At any operating altitude and at all airspeeds, except the range between Mach 0.80 and Mach 0.86, a push force on the stick is required as airspeed is increased if 1 "G" flight is to be maintained. As airspeed is increased from Mach 0.80 to Mach 0.86, 1 "G" flight can be maintained with less push force.

### LOW SPEED.

The handling characteristics of the airplane at low airspeeds are good, except that near 1 "G" stall, rolling response to aileron motion may be lower than normal.

**WARNING**


Adhere closely to nose wheel liftoff, takeoff, approach, and landing airspeeds, especially in turbulence or crosswinds, to assure adequate lateral control.

### CRUISING AND HIGH SPEED.

With the exception of the elevator stick force and position characteristics previously explained, no unusual characteristics will be experienced in the medium to high airspeed range. Figure 6-3 shows a typical variation of stick force with the airplane trimmed to fly

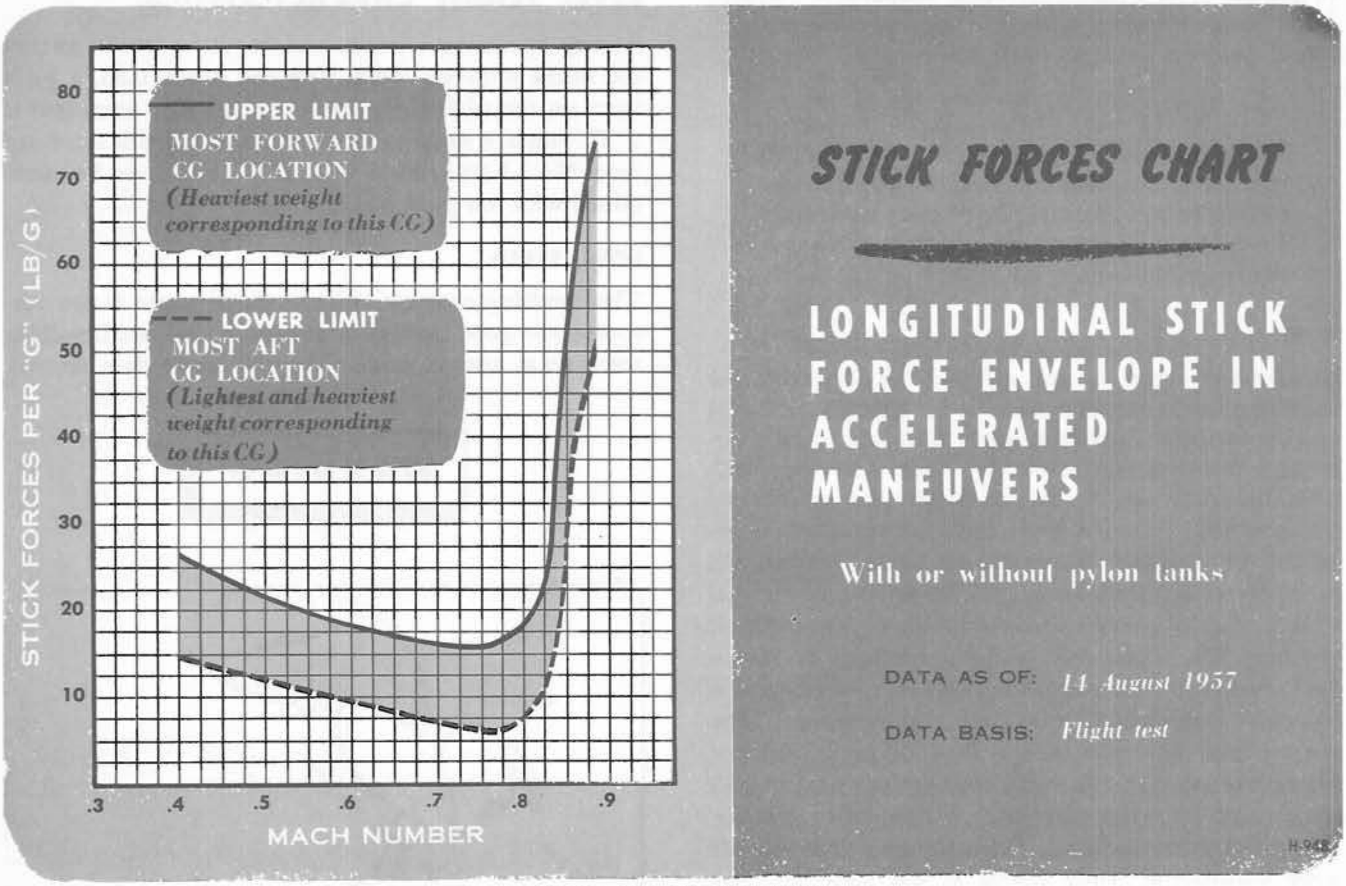



*Figure 6-3 (Sheet 1 of 2).*

"hands off" at cruise airspeed, and indicates the airspeed range of the mild reversal in normal stick force variation.

#### Buffet—1 "G" Flight.

During 1 "G" flight you will experience a mild compressibility buffet in the airspeed range from Mach 0.85 to Mach 0.90. This buffeting effect, which can be likened to driving a car along a washboard road, is not considered objectionable. The intensity of buffeting increases slightly with airspeed while in the buffet range, but practically disappears above Mach 0.90.

#### High Airspeed Wing Drop.

At airspeeds between Mach 0.85 and Mach 0.90 (the same range in which light buffeting is experienced in level flight) wing drop, common to many jet airplanes at high Mach numbers, is most likely to occur. Wing drop may be either to the right or left, but is usually to the left and can be eliminated by opening the speed brakes approximately 5 degrees.

## MANEUVERING FLIGHT.

### STICK FORCES.

In level flight, minimum stick forces per "G" will occur at airspeeds in the region of Mach 0.78 (see Stick Forces Chart, figure 6-3). Because of light stick forces, care must be exercised when maneuvering near this airspeed not to exceed the allowable load factor by overcontrol. If the airplane enters accelerated flight above Mach 0.80, the stick force necessary to pull load factor will be high, but may be partially trimmed out to a comfortable value. However, never trim out all of the stick force while in accelerated maneuvers. If enough stick force is applied and held, either by trim or pilot effort, to pull the desired load factor, the applied stick force will result in a rapid increase in load factor as airspeed drops. This can result in rapidly exceeding the design or even the ultimate load factor.

**WARNING**

Use no more elevator trim than necessary during maneuvers. Use extreme caution to avoid excessive "G's" as airspeed decreases during high speed maneuvers.

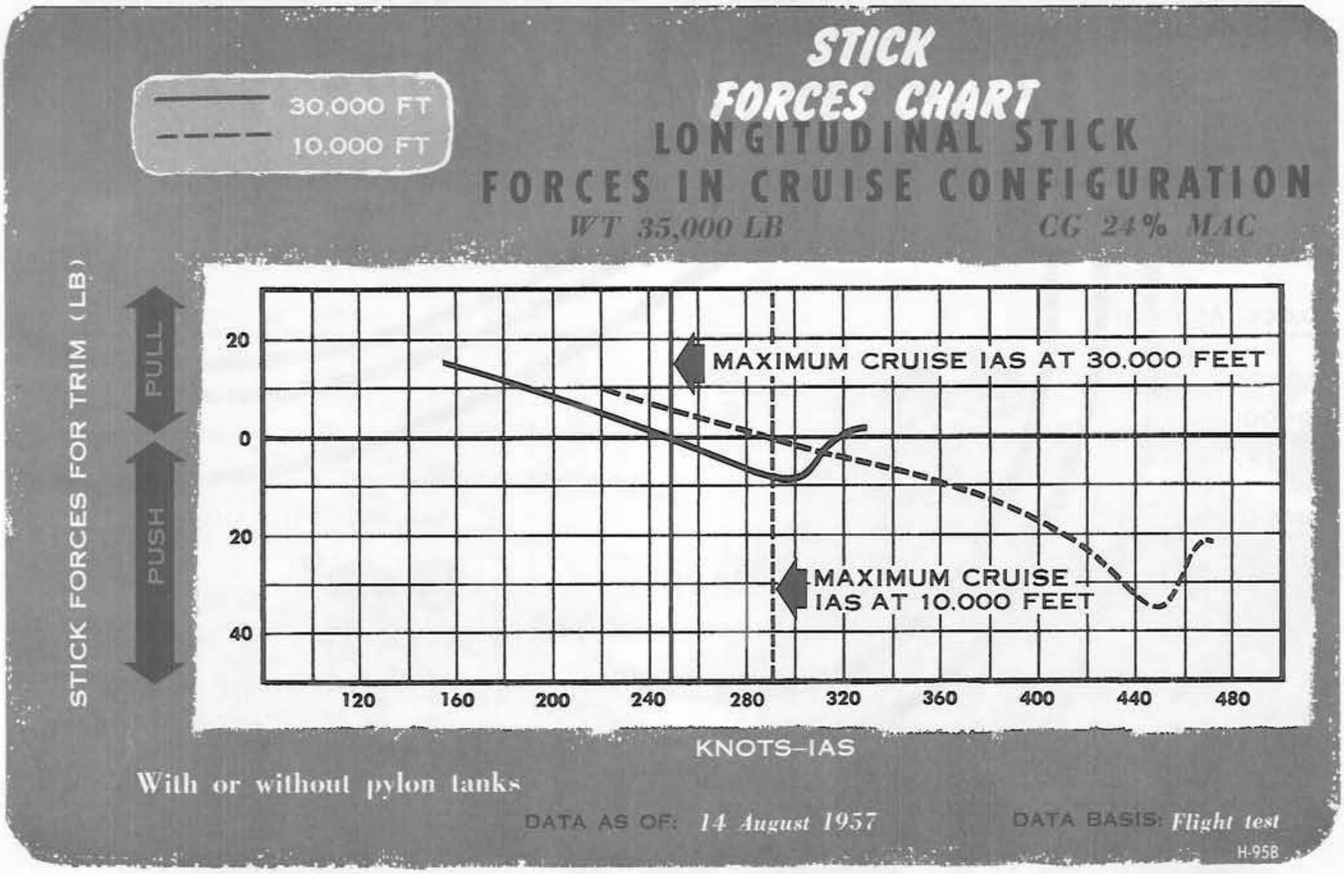



*Figure 6-3 (Sheet 2 of 2).*

## LOAD FACTORS.

The maximum permissible load factor of 5.67 is the highest allowable under any flight conditions. Above approximately 20,000 feet it is impossible to attain 5.67 load factor because the airplane will either be forced into an accelerated stall or the elevator control power limit will be reached. At these altitudes, the airplane is controllable at high Mach numbers and its flight characteristics are normal for a high performance airplane. At medium to high airspeeds at low altitudes, the airplane can be overstressed to the point of structural failure. Because of the possibility of excessive gust loads at low altitudes, the airplane is limited to a maximum load factor of 5.0 below 12,000 feet. Flying at high indicated airspeeds at low altitudes is dangerous because elevator effectiveness, or ability to develop load factor, can change within wide limits with relatively small changes in airspeed. Do not attempt abrupt pullups at low altitudes, and do not rely entirely on stick feel to keep you out of trouble. Be aware of the definite distinction between the structural strength of an interceptor and of a fighter-type designed for fighter versus fighter combat.

## DIVING.

At any gross weight, the altitude lost during recovery is dependent on the altitude at which recovery is started, the angle from which the recovery is made, airspeed during recovery, and the load factor ("G's") held during recovery. See figure 6-4 for examples of typical dive recovery flight paths.

**Note**

Altitude lost during dive recovery as shown in the Typical Dive Recovery illustration (figure 6-4) and Dive Recovery Charts (figure 6-5) does *not* include the altitude lost entering the dive. Dive recovery charts are based on a constant airspeed being held during entire recovery.

The Dive Recovery Charts (figure 6-5) show the interrelation between these variables. The charts should be studied collectively in order to understand the capabilities of the airplane and to be able to exercise proper

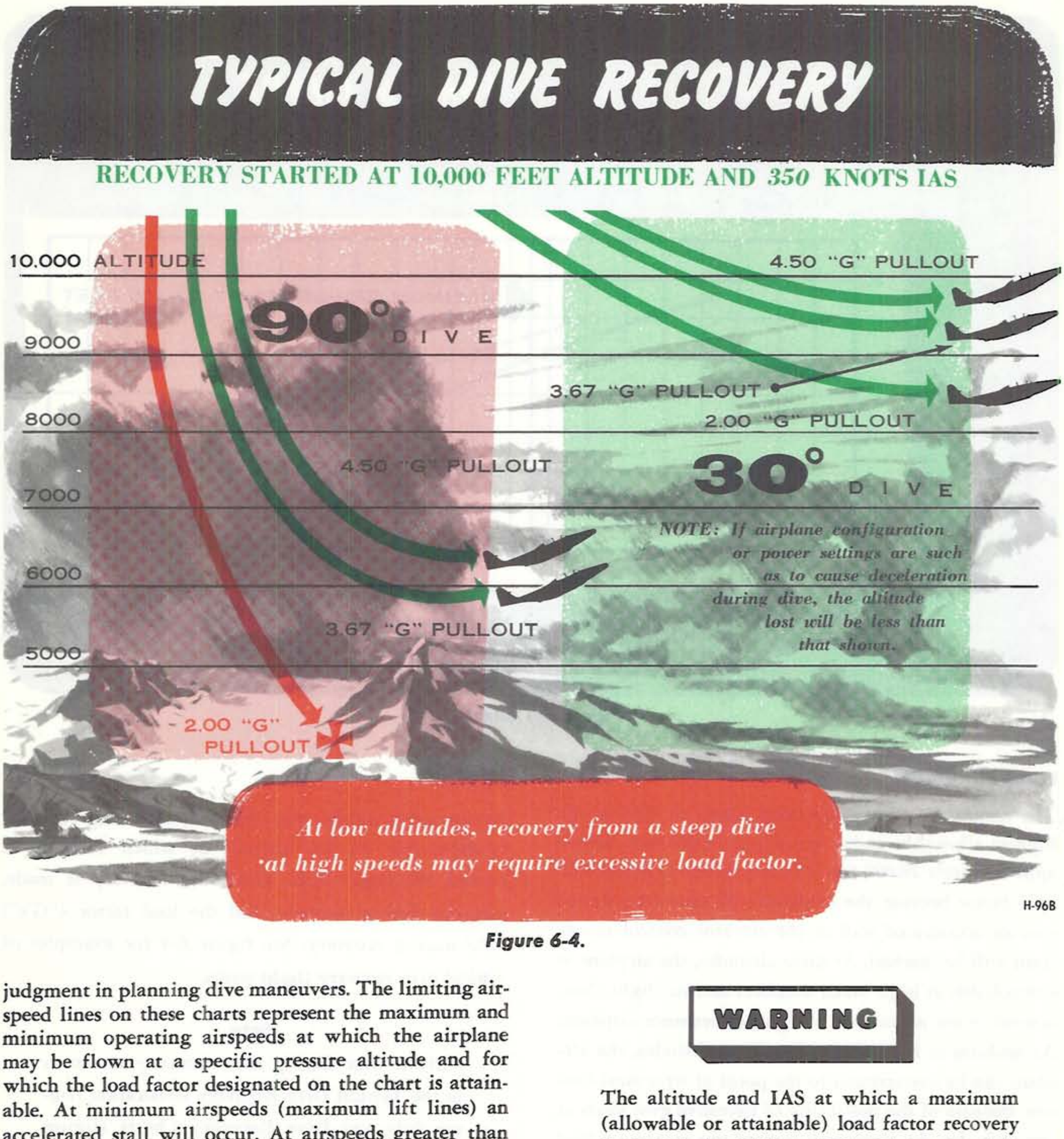



*Figure 6-4.*

judgment in planning dive maneuvers. The limiting airspeed lines on these charts represent the maximum and minimum operating airspeeds at which the airplane may be flown at a specific pressure altitude and for which the load factor designated on the chart is attainable. At minimum airspeeds (maximum lift lines) an accelerated stall will occur. At airspeeds greater than the maximum (elevator power limit lines), elevator control is limited by aeroelastic distortion of the airplane structure and by elevator control power to such an extent that the airplane can no longer develop the load factor shown on the chart. The resultant effect causes the maximum attainable load factor to decrease rapidly (and therefore increases the altitude lost during recovery) for a relatively small increase in IAS above the limiting value shown on the chart. See figure 6-5, sheet 1 of 6 sheets, for instructions on chart use.

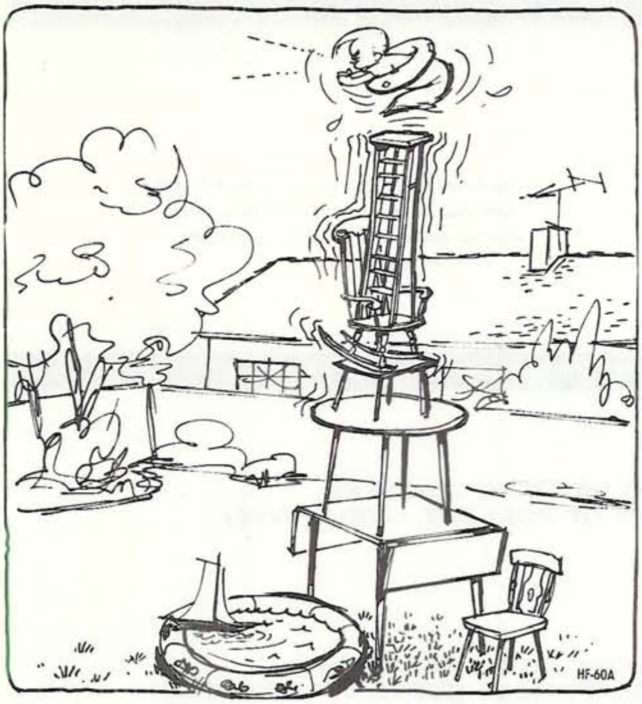
**WARNING**

The altitude and IAS at which a maximum (allowable or attainable) load factor recovery is started should be anticipated so as not to exceed airspeed restrictions (425 knots IAS or Mach 0.90, whichever is the lower) and to insure at least the minimum ground clearance.

### HIGH MACH DIVE.

Performing a high Mach dive at high altitude is the best way to become familiar with the high Mach characteristics of the airplane. This maneuver is useful in combat for a breakaway, as an evasive maneuver, or as an effective way to let down rapidly. Since the purpose of the high Mach dive is to lose altitude as rapidly as possible, enter the dive with maximum power and at high IAS and get into a 60-degree dive as soon as possible.

**WARNING**




Generally, the steeper you dive the greater the airspeed; however, if the angle of the dive is steepened beyond 60 degrees, the increase in speed is negligible. Dive angles steeper than 60 degrees result in far greater altitude loss during recovery. A vertical dive requires twice the altitude for recovery that a 60-degree dive requires. At speeds associated with high Mach dives (Mach 0.90 and above), elevator and speed brake effectiveness are greatly reduced. Because of the reduced elevator effectiveness at Mach 0.98 at 35,000 feet, less than 2 "G's" are available; therefore, until the airplane is slowed down, the elevator will have little effect for recovery. At speeds of Mach 0.90 and above, the speed brakes will open only 30 degrees or less, and because of adverse compressibility effects, little drag will result from their use. In a vertical or near vertical dive at high Mach numbers any delay in starting recovery, combined with the greatly reduced elevator and speed brake effectiveness, may result in such loss of altitude that recovery may be impossible. Therefore, use extreme caution in performing high Mach dives at angles greater than 60 degrees, and make certain that recovery from *any* high Mach dive is initiated no lower than 35,000 feet. The flight path for the 90 degree dive shown in figure 6-6 illustrates the excessive loss of altitude during vertical dive recovery.

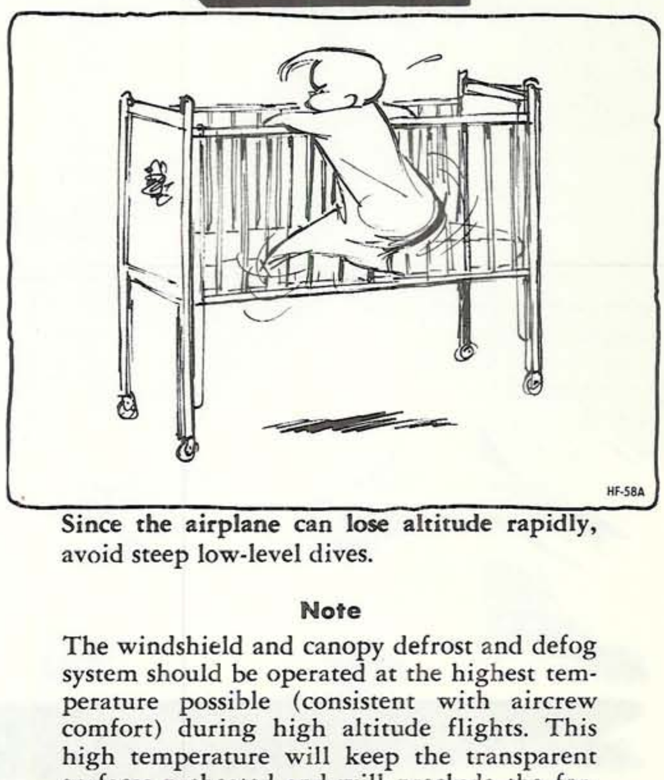
Enter the dive with a wingover. Maintain positive "G's" throughout the dive to prevent flameout. Since in a steep dive a high percentage of the airplane's momentum is caused by weight as compared to engine thrust, the speed of descent can be varied only within relatively narrow limits by throttle changes. Observe the effect of buffet as the airplane accelerates to high Mach numbers and again as it decelerates during pullout. The airplane has normal dive attitude and responds to a normal recovery technique. Begin normal recovery procedure at approximately 35,000 feet. See figure 6-6 for correct procedure.

**WARNING**

Do not use excessive elevator trim in recovering from a dive. When airplane slows down during pullout, elevators become more effective, and applied trim may result in pulling "G's" in excess of the load factor limit.

At approximately Mach 0.75, stick pressure is light and elevators are most sensitive. Exercise caution in this airspeed range so that design load factor is not exceeded. Because of elevator power limits you may be able to pull only approximately 1.3 "G's" at the beginning of recovery and about 2.5 "G's" maximum at the end of the pullout. The exact available load factor is, of course, dependent on Mach number and altitude.

**WARNING**




**Since the airplane can lose altitude rapidly,** avoid steep low-level dives.

**Note**

The windshield and canopy defrost and defog system should be operated at the highest temperature possible (consistent with aircrew comfort) during high altitude flights. This high temperature will keep the transparent surfaces preheated and will preclude the formation of frost or fog during descent.

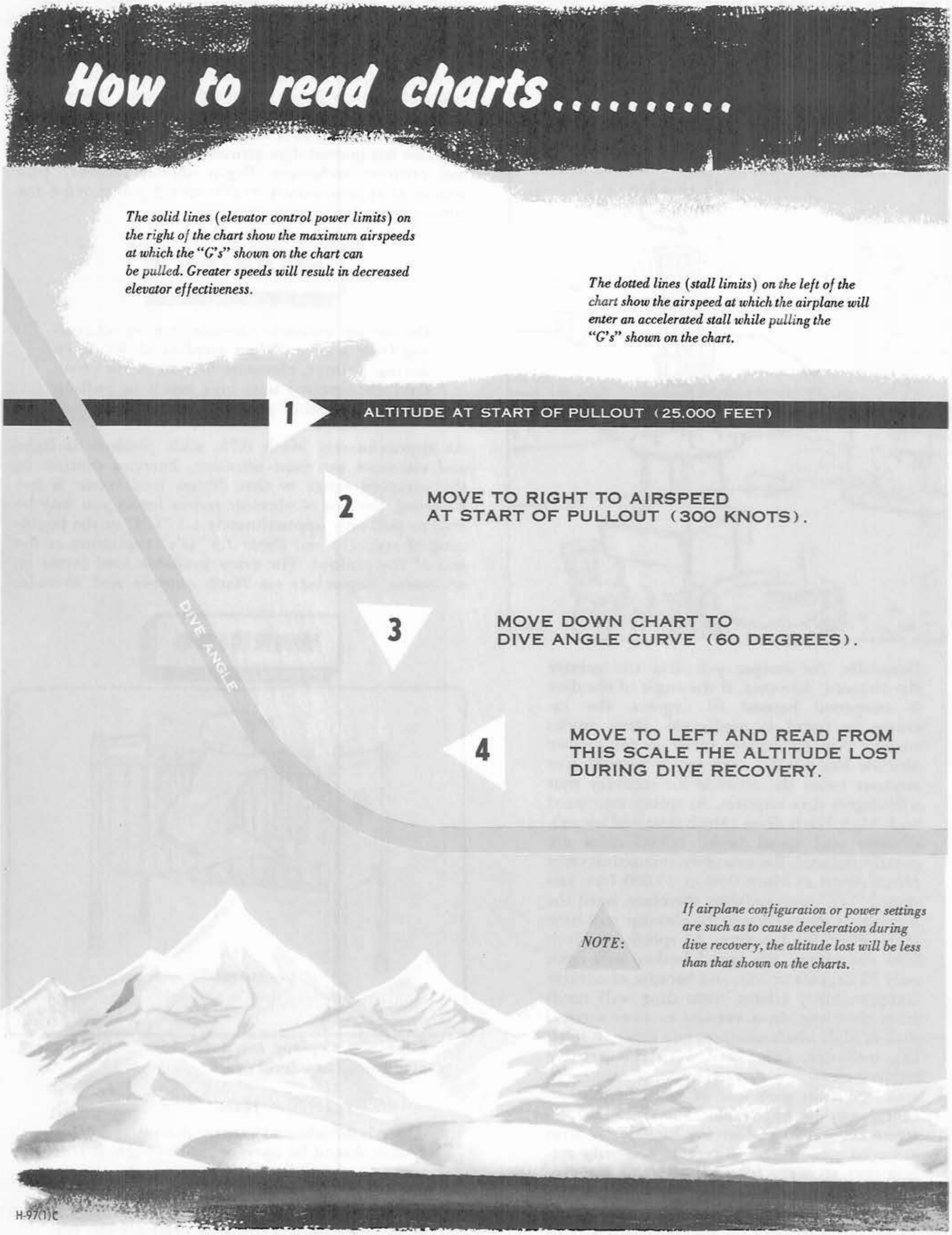



*Figure 6-5 (Sheet 1 of 6).*

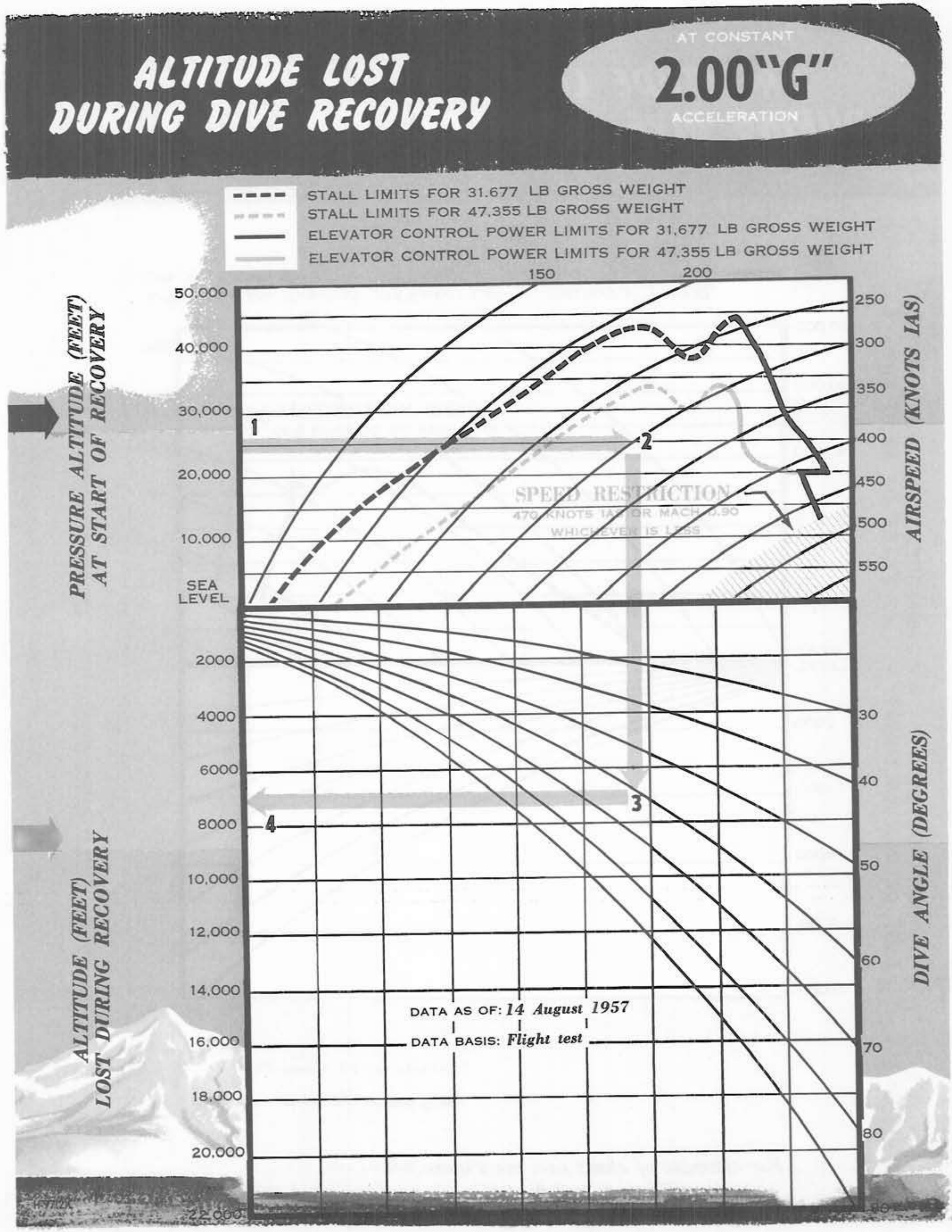
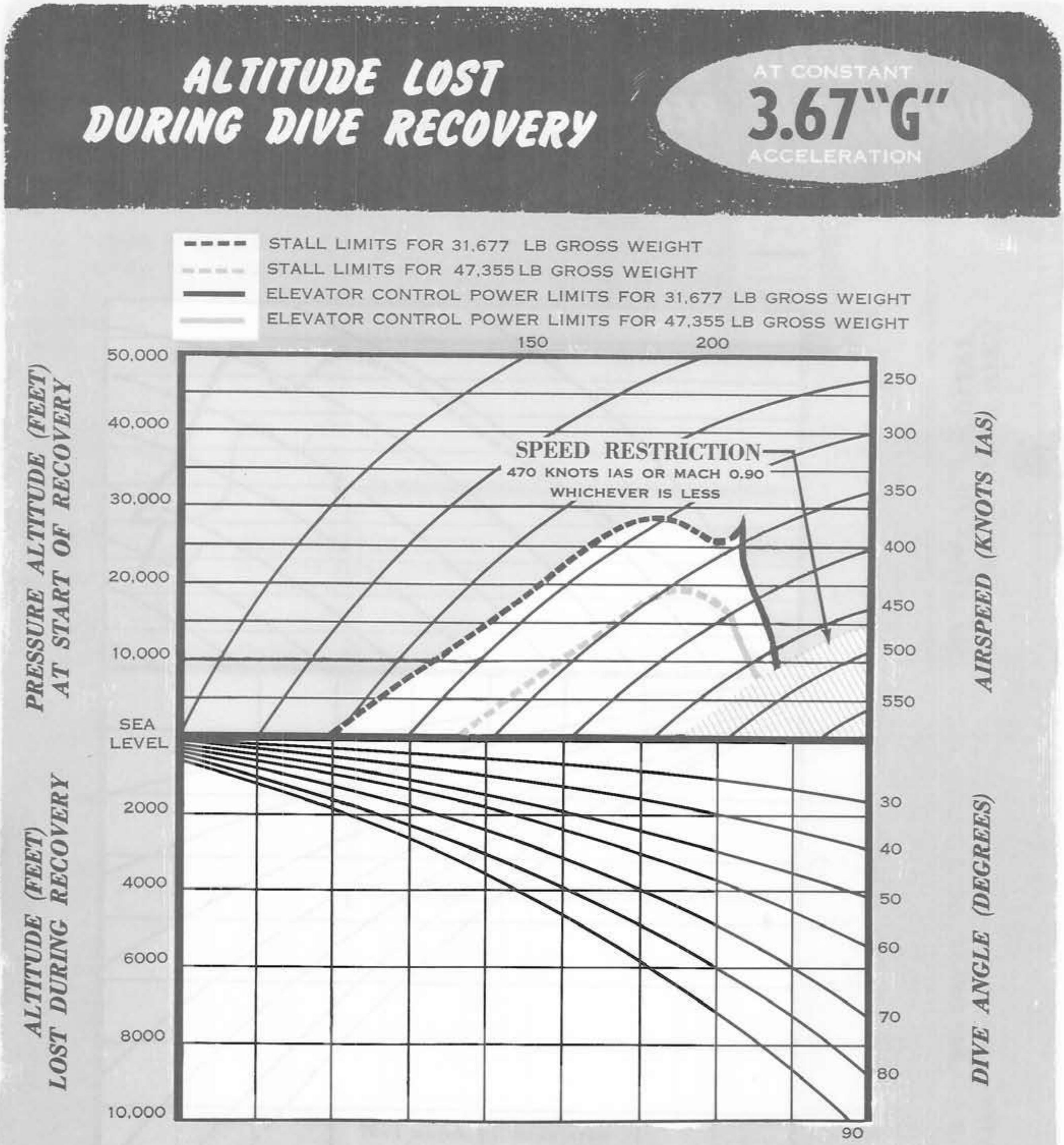



Figure 6-5 (Sheet 2 of 6).




DATA AS OF: *14 August 1957*

DATA BASIS: *Flight test*

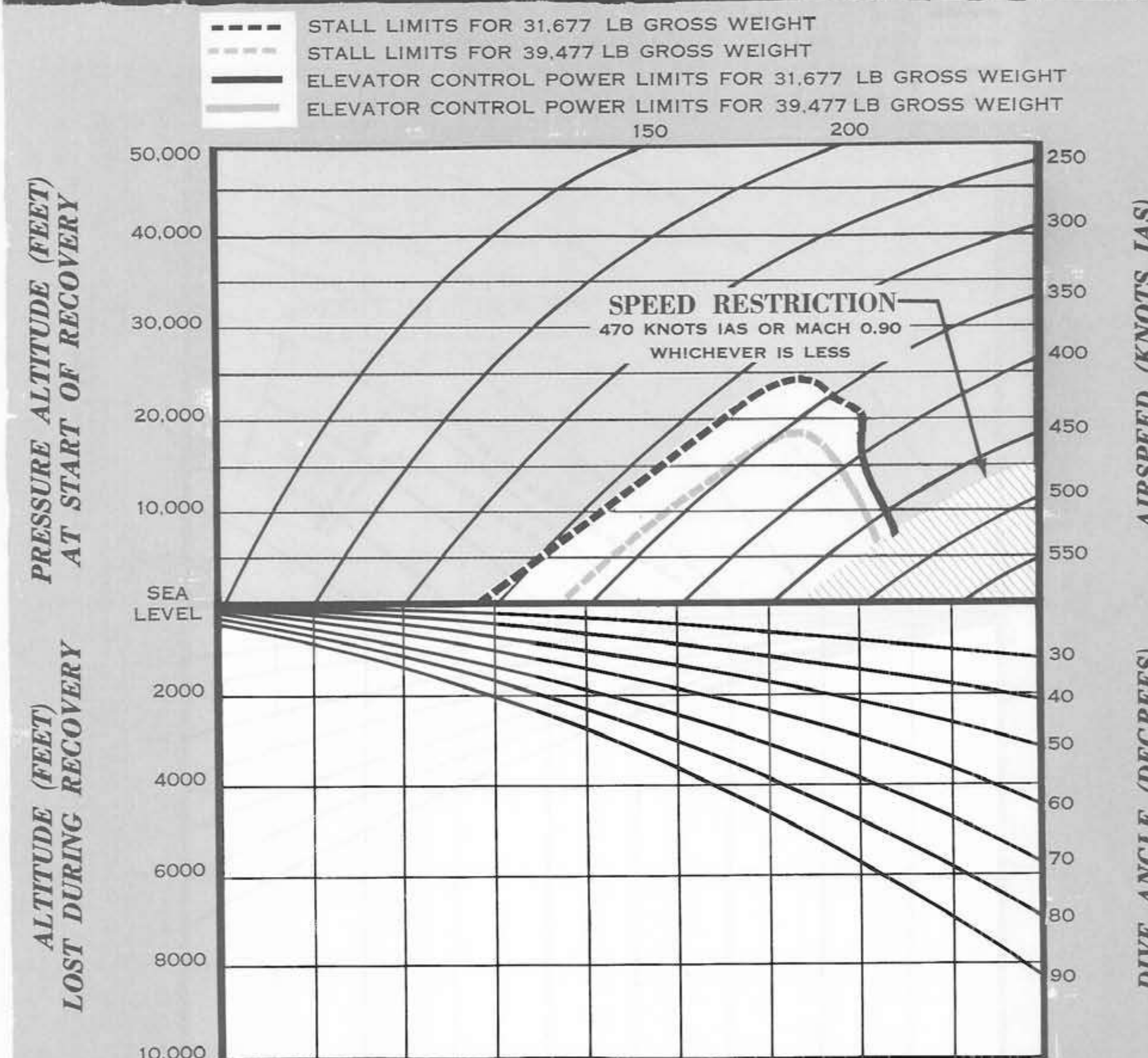
***For example of chart use, see Figure 6-6, Sheets 1 and 2 of 6.***

H-97(3) A

*Figure 6-5 (Sheet 3 of 6)*

# ALTITUDE LOST DURING DIVE RECOVERY

AT CONSTANT 4.50"G" ACCELERATION




DATA AS OF: *14 August 1957*

DATA BASIS: *Flight Test*

*For example of chart use, see Figure 6-6, Sheets 1 and 2 of 6.*

H-97(4) A

**Figure 6-5 (Sheet 4 of 6).**

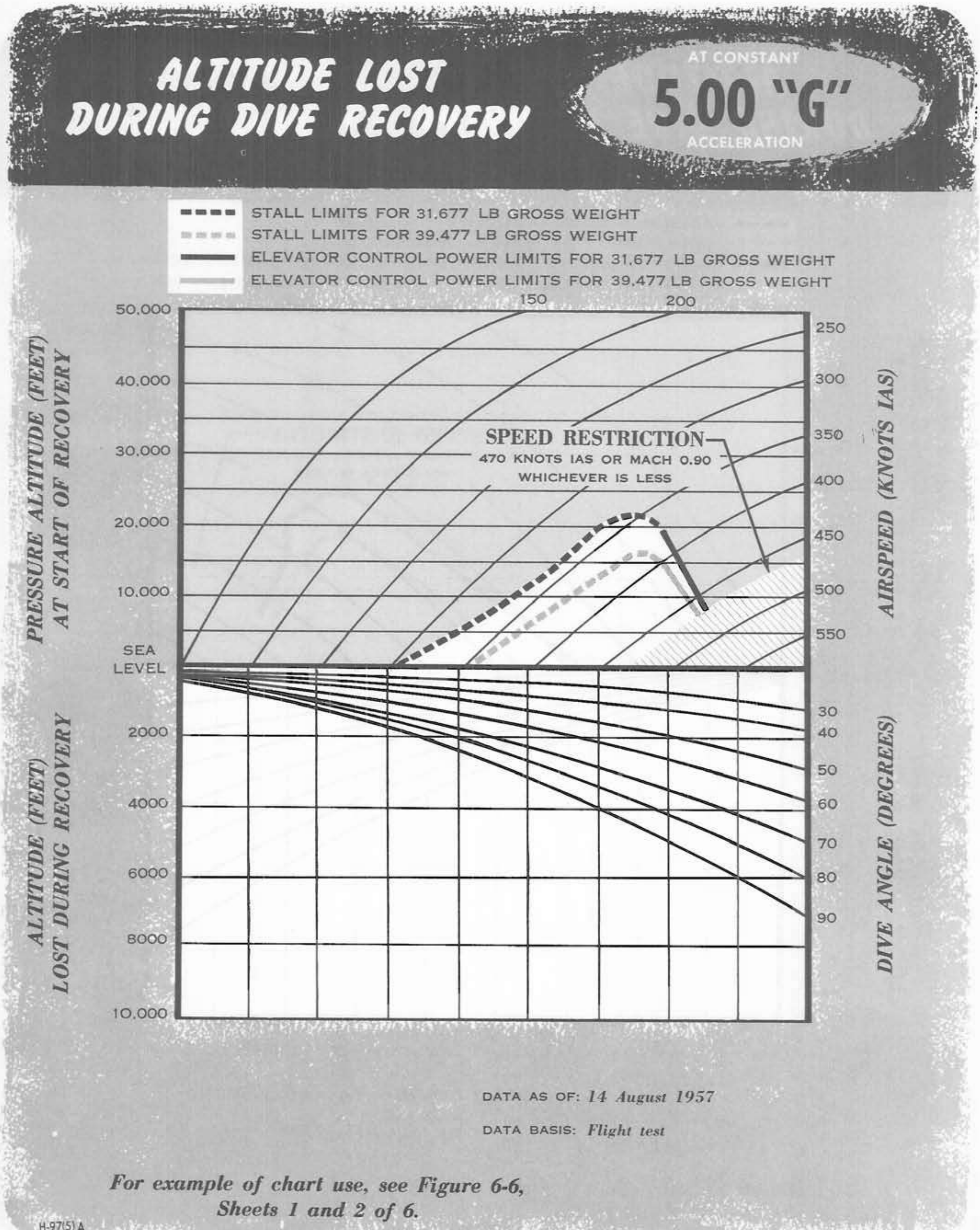



*Figure 6-5 (Sheet 5 of 6).*

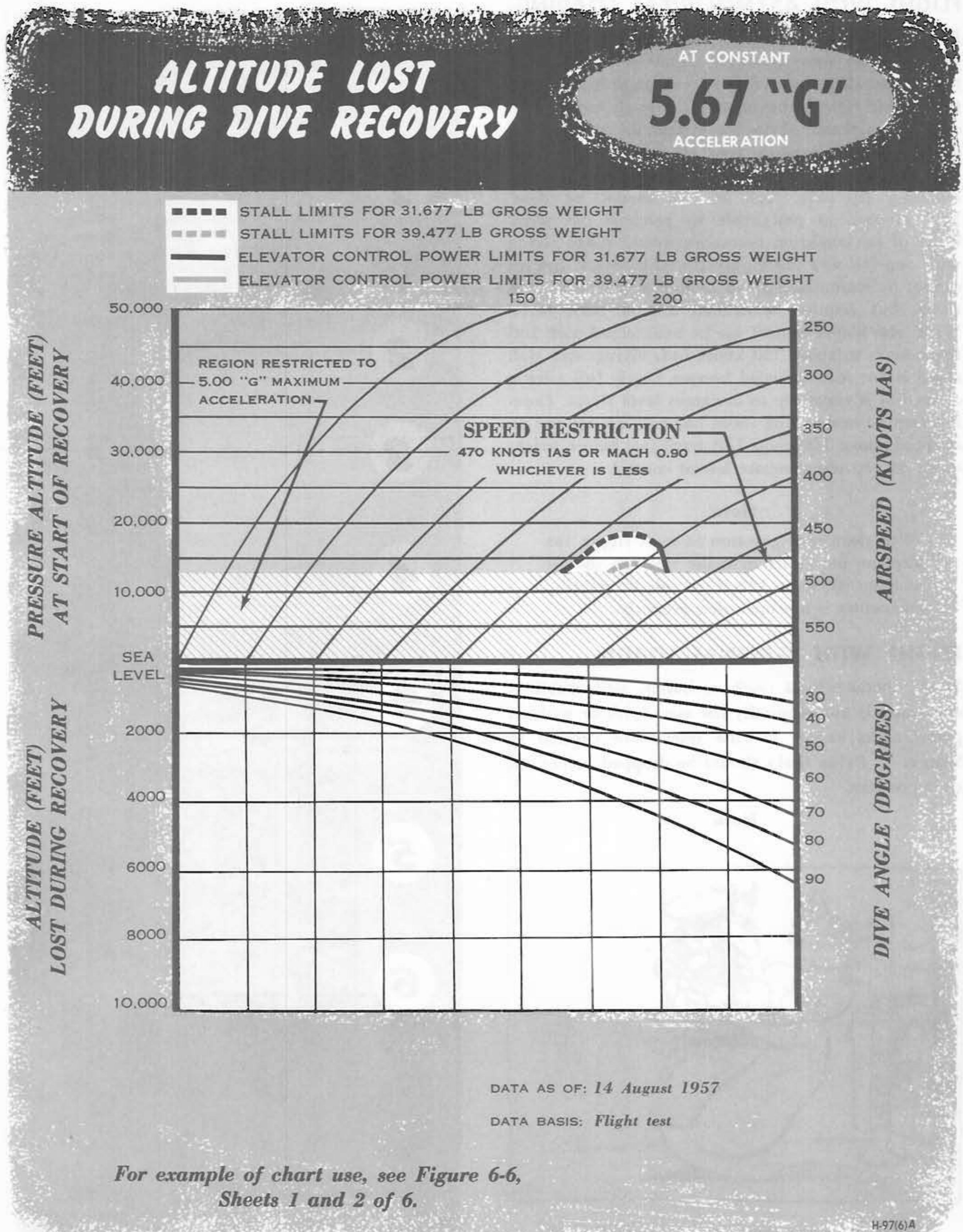



Figure 6-5 (Sheet 6 of 6).

## FLIGHT WITH ASYMMETRICAL LOADING.

Flights with asymmetrical loading should be avoided if possible. The most probable cause of asymmetrical loading would be uneven fuel consumption between the left and right fuel systems. If, through malfunction or mismanagement of the fuel system, an asymmetrical load condition develops, first attempt to correct the condition by balancing fuel load (see Section VII) or dumping tip tank fuel. If this cannot be done, land as soon as practicable to preclude the possibility of the condition becoming worse. When flying with one full and one empty tip tank, lateral control cannot be maintained down to stall speed using trim alone, but requires additional aileron stick force. With trim alone, control can be maintained with full flaps down to about 150 knots IAS. Flying near stall speed is not recommended because nearly full aileron deflection is necessary to maintain level flight. Landing may be made using about one-half aileron and an airspeed above 140 knots IAS until just before touchdown to provide adequate lateral control.

**Note**

With clean configuration in level flight, the airplane may start to snake through the air at about 280 knots IAS if the sideslip stability augmenter is not operating properly.

## FLIGHT WITH EXTERNAL LOADS.

Flight characteristics (such as buffet, stall, stability, and control) are essentially the same with or without pylon tanks except for the restrictions covered in Section V. Pylon tanks should be dropped before entering combat.

**Note**

HF-55A

External stores other than pylon tanks will not be carried.

**HIGH**

1 DOUBLE CHECK OPERATION OF ALL CONTROL SURFACES AND HYDRAULIC SYSTEMS. IT IS MANDATORY THAT BOTH SYSTEMS BE OPERATING AT NORMAL PRESSURE FOR SATISFACTORY CONTROL DURING A HIGH MACH DIVE AND RECOVERY.

2 AFTERBURNERS—ON.

3 OPEN SPEED BRAKES 5° TO PREVENT WING DROP.

4 ENTER 60° DIVE IN A DIVING TURN, MAINTAINING POSITIVE "G'S" TO PREVENT FLAMEOUT.

4 ENTER 90° DIVE WITH A HALF ROLL AND MAINTAIN MAXIMUM AVAILABLE "G'S" THROUGHOUT DIVE AND RECOVERY.

5 ESTABLISH ANGLE OF DIVE AS SOON AS POSSIBLE.

6 RETARD THROTTLES TO IDLE AND PLACE SPEED BRAKE LEVER AT FULL OPEN. PULL AND MAINTAIN MAXIMUM AVAILABLE LOAD FACTOR (LIMITED EITHER BY ELEVATOR POWER OR BUFFET). YOU CAN EXPECT TO PULL APPROXIMATELY 1.4 "G'S" AT THE BEGINNING OF THE PULLOUT.

H-100(1)B

# MACH DIVE

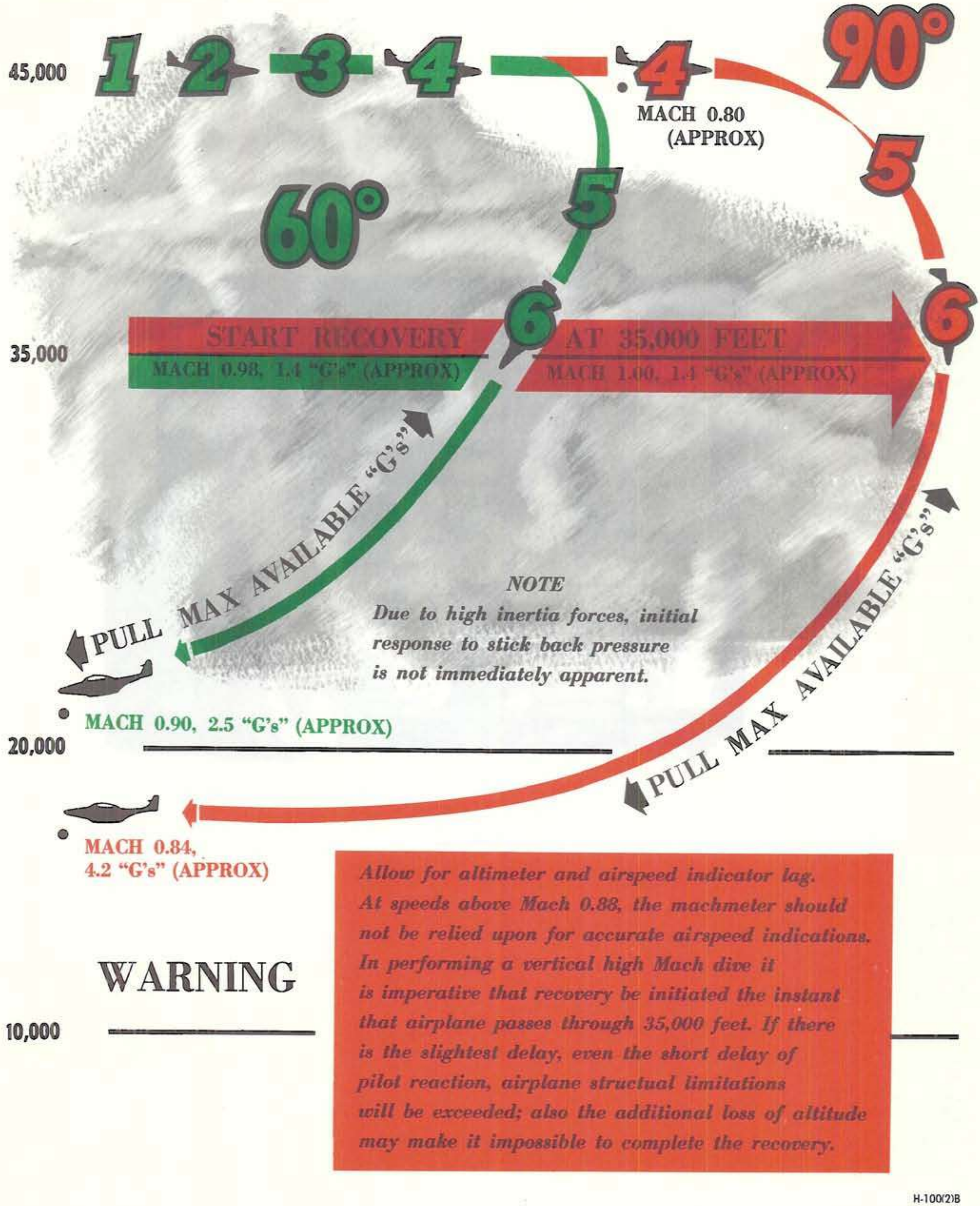
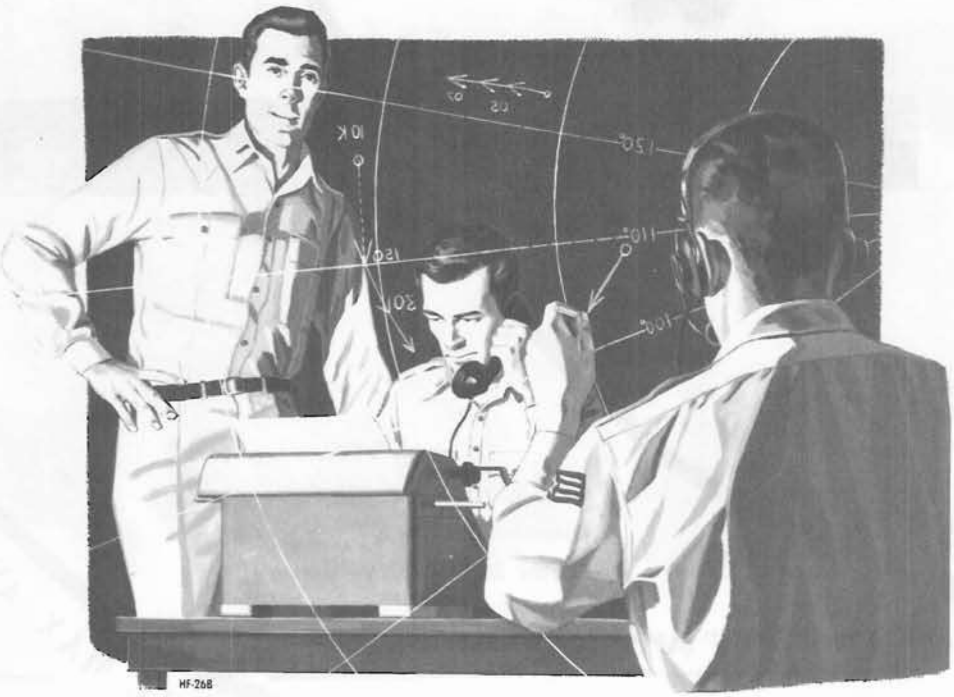



*Figure 6-6.*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## ENGINE.

### BURST ACCELERATION.

If conditions warrant, the engines can be burst accelerated by moving the throttles rapidly to OPEN. The engine fuel control will meter the fuel required by the engine, and normally will not pass sufficient fuel for excessive exhaust gas temperatures or for rpm above 100%.

**Note**

During a burst acceleration from 80% rpm to maximum power, a compressor stall may result. This will be noted by audible pulsation, lag in rpm, and increase in tailpipe temperature above limits.

### COMPRESSOR STALL.

Compressor stall may occur at times during engine acceleration and may be recognized by a loud rumble and vibration in the engine and rapid rise in exhaust gas temperature, accompanied by rpm stagnation or drop. Compressor stall is caused by a back pressure at the compressor outlet, which in turn is usually caused by an exceedingly rich fuel mixture. Under stall conditions, considerably greater than normal resistance to compressor rotation is encountered, resulting in the rumble or surge previously described. Compressor stall is most likely to be encountered under high ambient temperature conditions during accelerations from below 80% rpm to higher rpm, as compressor stall is a phenomena of acceleration only and will not occur at stabilized power settings. Since compressor stall is most likely to occur at approximately 80% rpm, it is recommended that engine rpm be maintained at 85% rpm or above on final approach until committed to landing. In addition, it is suggested that accelerations through the 80% rpm range be made with rapid advancement of the throttle to full open position, in order to obtain open eyelid conditions. If compressor stall is experienced, the throttle should be retarded to below the 80% rpm position and exhaust gas temperature should be allowed to drop to normal before advancing the throttle. If engine temperature exceeds the permissible limitation, notation of this fact should be made in DD Form 781 after landing so that an engine overheat inspection will be made.

### EXHAUST GAS TEMPERATURE VARIATION.

Because of the wide range of ambient air temperatures encountered at various bases where the aircraft is operated, familiarity with the corresponding variation in exhaust gas temperature is essential to avoid damage to the engine and assure flight safety. Abnormally low exhaust gas temperature for the existing ambient air temperature will result in a loss of thrust. This could be serious on takeoff under critical field length conditions. In cold weather, exhaust gas temperatures at 100% rpm are considerably lower than in hot weather. It is important to check the exhaust gas temperature against the rpm prior to takeoff. If the engines are operating at military power, the exhaust gas temperatures may decrease approximately 65°C as the altitude increases. Using maximum power, the exhaust gas temperatures drop a maximum of approximately 60°C between takeoff and absolute ceiling. There is no direct control for regulating the exhaust gas temperature; however, temperature can be indirectly controlled by throttle settings. Starting the afterburner causes a slight increase in exhaust gas temperature and a drop in engine rpm. This condition is temporary and both temperature and rpm soon stabilize. Refer to figure 5-3, Section V, for the runway temperatures and corresponding exhaust gas temperatures to be expected at 100% rpm.

## OVERTEMPERATURE VERSUS ENGINE LIFE.

The operational life of a jet engine is directly affected by the number of hot starts and high temperature and high rpm operations. At maximum and near maximum performance, hot section parts are exposed to temperatures requiring their functioning at near structural limits. The turbine wheel, in particular, is subject to early failure when subjected to serious overtemperatures or repeated slight overtemperatures because it operates with a rim temperature close to the peak of tolerance for the metal from which it is manufactured. The J35 turbine wheel has operated satisfactorily for as long as 2000 hours at normal expected steady exhaust gas temperature. However, an increase of as little as 15°C under the same conditions will appreciably reduce the turbine wheel life. Transient temperatures that exceed maximum allowable for as little as two seconds can render the turbine wheel unserviceable. Obviously, any overtemperatures, even momentary, beyond the limitations stipulated in Section V are serious and should be recorded accurately. When the engine is properly adjusted, the exhaust gas temperature indicating system properly calibrated, and the engine controls properly handled, all operating temperatures including transients will fall within the serviceability limits established for the engine. The careful monitoring of exhaust gas temperature by the pilot, and the recording of all overtemperature operation is imperative. Particularly during starting the pilot should, with a clear understanding of the fuel flow characteristics and their relation to exhaust temperature, be alert for an incipient overtemperature condition and recognize it in time to take rapid corrective action.

## ENGINE OVERSPEEDING AT ALTITUDE.

The engine will operate at sea level, with or without afterburning, within the limits preset on the engine fuel control. However, when operating at altitude, the fuel requirements without afterburning are somewhat reduced and there is a possibility that the engine may overspeed. Under most conditions the governor will prevent the engine from exceeding 100% rpm, but because of the inherent acceleration lag of the engine fuel control governors, a slight engine overspeeding in excess of 100% rpm may occur. In the event of overspeeding, retard the throttle to a setting that will prevent exceeding a stabilized rpm of 100%.

## EYELID OPERATION.

The eyelids are provided to increase the diameter of the tailpipe nozzle during afterburning. This is to permit an increase in thrust without operating at prohibitively high exhaust gas temperatures. In addition to opening in conjunction with afterburning, the eyelids will stay open during starting to prevent high temperatures, and during rapid acceleration to decrease acceleration time. An open-throttle switch and an idle switch, both operating on 28-volt dc, are in the No. 4 inlet duct island and are mechanically actuated by the throttle shaft. The idle switch is actuated when the throttle is at IDLE or below and causes the eyelids to stay open in this speed range. The open-throttle switch is actuated when the throttle is full open and causes the eyelids to open during burst accelerations, or when the throttle is opened faster than engine rpm rises; however, an engine speed-sensing switch will open, interrupting the open-throttle switch circuit when the engine rpm reaches 87.5% and causing the eyelids to close. If afterburning is selected during burst acceleration (by lifting the fingerlifts), the eyelids will stay open during the engine speed range from idle to 100% rpm (or from that rpm at which the burst acceleration is started). A pressure switch is in series with the idle switch and will open the idle switch circuit at 10,000-foot altitude and cause the eyelids to stay closed during high altitude idle. When the throttles are opened slowly, the eyelids will remain closed from idle to 100% rpm since the speed switch will be actuated in advance of the open-throttle switch to maintain closed eyelids during slow acceleration. Failure of the engine speed-sensing switch or loss of power from the primary a-c single-phase bus, will cause the eyelids to open during nonafterburning operation if the open-throttle switch is closed (throttle at 100% rpm position) and the airplane is below 10,000-foot pressure altitude (altitude switch closed). This will result in an extreme loss of thrust and low exhaust gas temperature. However, the eyelids can be closed by moving the afterburner control circuit breaker to the OFF position or, if trouble is caused by failure of a single-phase inverter, by moving the single-phase inverter switch to the EMER position.

The eyelids are operated by two pneumatic cylinders powered by air from the 11th stage engine compressor. The compressor air is directed to either side of the pneumatic cylinders by a solenoid valve which is controlled by a pressure-differential switch which senses pressure changes in the engine tailcone. If the eyelids fail to open when afterburning is selected, engine rpm will drop and exhaust gas temperature will rise. If this occurs, afterburning must be discontinued immediately to prevent excessive exhaust gas temperature. A failure of both single-phase inverters during afterburning will have no effect on engine and afterburner performance until the afterburners are shut down. If the airplane is below 10,000 feet and the throttles at 100% rpm, the eyelids will have to be closed by moving the afterburner control circuit breaker to the OFF position. Afterburning will not be available again until the single-phase power failure is corrected. Failure of the eyelids to close following afterburner operation will result in very low exhaust gas temperature and extreme loss of thrust.

## AFTERBURNER OPERATION.

### STARTING AFTERBURNERS AT HIGH ALTITUDE.

If difficulty is encountered when initiating afterburning at altitudes above 45,000 feet using the normal procedure, use the following procedure to decrease the time required to reach full afterburner operation.

1. Retard throttle to 95% rpm.
2. Lift throttle fingerlift, and simultaneously jab the throttle forward. Large jabs of more than 3% rpm are not recommended as they may result in overtemperature conditions.

## FUEL SYSTEM OPERATION.

See figure 7-1 for fuel flow during normal sequencing and figure 7-2 for fuel flow during manual selection of wing tanks and crossfeed operation.

### CROSSFEED OPERATION.

A 28-volt d-c crossfeed switch (figure 7-1), located on the fuel control panel, has OPEN and CLOSED positions. When the crossfeed switch is at OPEN, the main fuel lines of both systems are interconnected; both fuel systems may be used to operate one engine or both engines may be operated from either fuel system. Unbalanced lateral fuel loading (wing heaviness) may be corrected by feeding both engines from the system having more fuel. To balance fuel load, place the crossfeed switch at OPEN and the fuel selector switch for the system with less fuel at PUMPS OFF. When fuel load is balanced, as indicated by lateral trim and/or fuel quantity gages, return the selector switch to ALL TANKS, and the crossfeed switch to CLOSED. With one engine inoperative and the crossfeed switch at OPEN, fuel will be supplied to the operative engine from both fuel systems in either ALL TANKS or WING TANKS selection.

**WARNING**

The throttle for the inoperative engine should be closed. If the throttle is left open, the throttle controlled fuel shutoff valve will be open allowing fuel to be metered through the engine.

## BRAKE SYSTEM OPERATION.

Wheel brakes should be properly used and treated with respect to reduce maintenance difficulties and accidents due to wheel brake failure. Brakes should not be dragged when taxiing and should be used as little as possible for turning the airplane on the ground. Extreme care should be used to prevent locking a wheel and skidding the tires when applying brakes immediately after landing when there is considerable lift on the wings. Proper brake action does not occur until the tires are carrying heavy loads. Heavy brake pressure can result in a locked wheel far more easily if brakes are applied immediately after touchdown than if the same pressure is applied after the full weight of the airplane is on the wheels. Brakes can stop a wheel from turning, but stopping the airplane is dependent on the friction of the tires on the runway. Skidding resulting from improper braking tears off shreds of rubber that act as rollers between tire and runway; the heat generated by skidding melts tire rubber and the resultant molten rubber acts as a lubricant between tire and runway. The full landing roll should be utilized to minimize the use of wheel brakes and to take advantage of aerodynamic braking. Using either normal or emergency braking systems, short landing rolls (executed only when necessary) are accomplished by a single, smooth application of brakes with constantly increasing pedal pressure. To allow sufficient time for cooling between brake applications, a 15-minute interval is required between full stop landings where the landing gear remains extended in the slipstream and 30 minutes between full stop landings where gear has been retracted. If the brakes are used for steering or crosswind taxiing, or if a series of landings is performed, additional time for cooling is required. When the brakes are in a heated condition resulting from excessive use in an emergency stop, the airplane should not be taxied into a crowded area and the parking brake should not be set. Peak temperatures occur from 5 to 15 minutes after a maximum braking operation and proper brake-cooling procedure should be followed to prevent brake fire and possible wheel assembly explosion. On airplanes modified in accordance with T.O. 1F-89H-522, an antiskid braking device is incorporated in the brake system. This device is designed to allow maximum braking efficiency during normal and adverse weather conditions without skidding the main wheels.

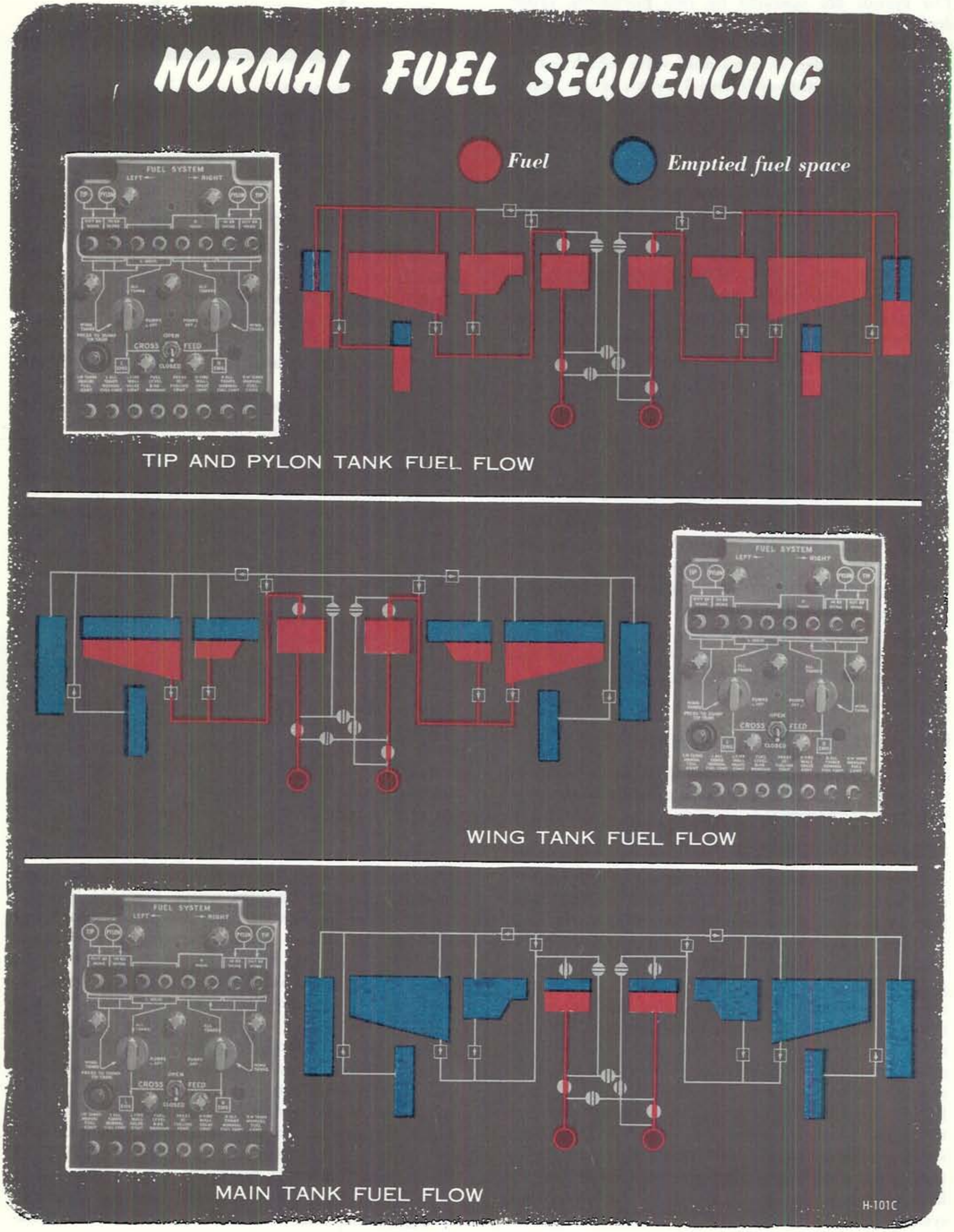
NORMAL FUEL SEQUENCING
Fuel
Emptied fuel space
FUEL SYSTEM
LEFT
RIGHT
CROSS FEED
OPEN
CLOSED
TIP AND PYLON TANK FUEL FLOW
WING TANK FUEL FLOW
MAIN TANK FUEL FLOW
H-101C

Figure 7-1.

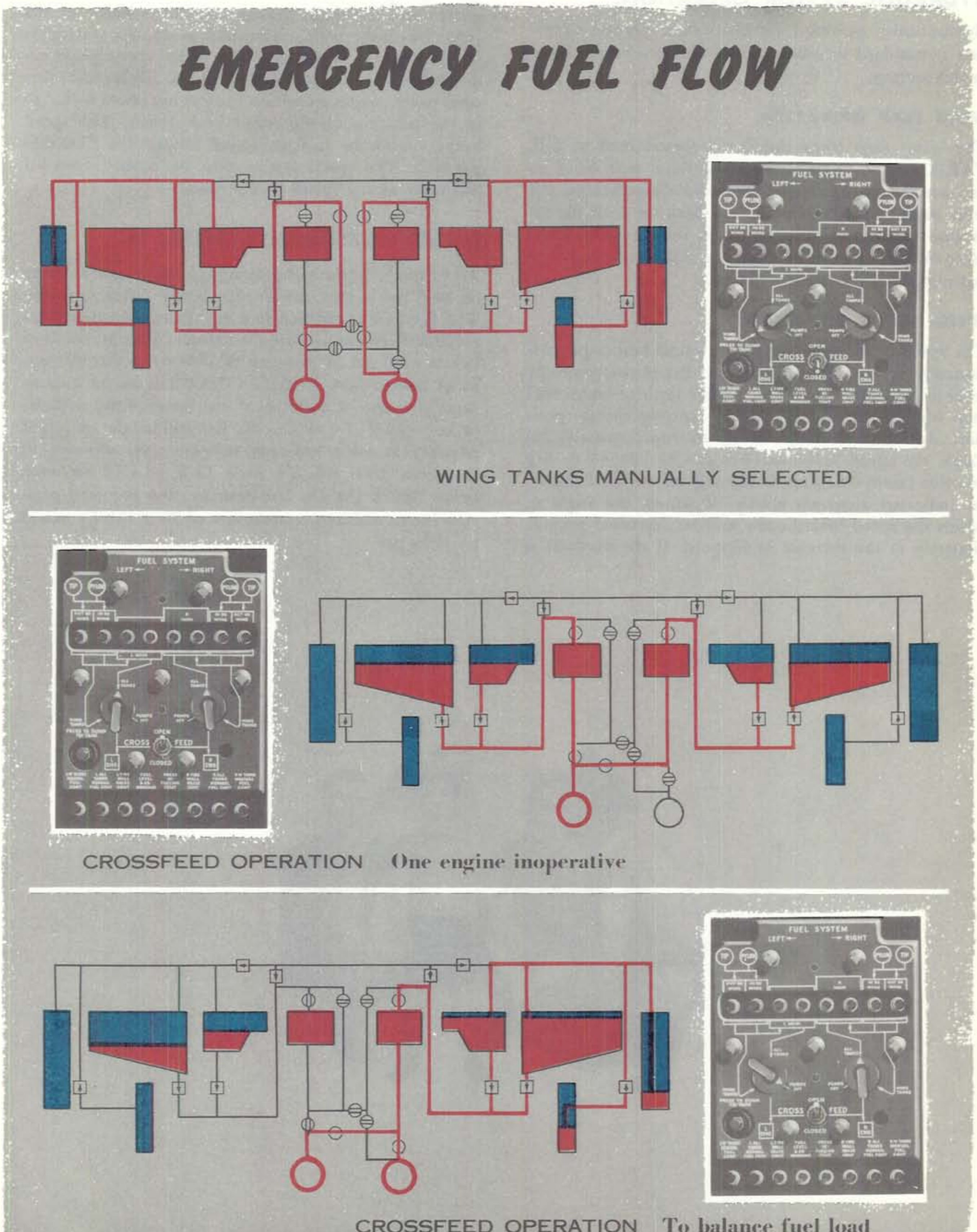
EMERGENCY FUEL FLOW
FUEL SYSTEM
WING TANKS MANUALLY SELECTED
CROSSFEED OPERATION One engine inoperative
CROSSFEED OPERATION To balance fuel load
H-102C

*Figure 7-2.*

## HYDRAULIC SYSTEM OPERATION.

Hydraulically powered systems whose normal operation is standard to most aircraft will not be discussed in this section.

### WING FLAP OPERATION.

The wing flap lever can be pre-positioned at UP, TAKEOFF, or DOWN; and the flaps will move to the selected position. For intermediate positions, the lever must be held at the desired position until the indicator shows the flaps to be in that position. The lever can then be released and the flaps will remain in position until the lever is moved.

### SPEED BRAKE OPERATION.

The speed brake lever opens the speed brakes proportionately to the lever movement. Pre-positioning the lever at any point toward the OPEN limit of travel will stop the speed brakes in the corresponding position. At indicated airspeeds up to approximately 260 knots, the speed brake surfaces can be opened to any position (from 0 degrees to 120 degrees included angle). At indicated airspeeds above 260 knots, the angle to which the speed brakes open will be decreased proportionately to the increase in airspeed. If the airspeed is great enough, the airflow creates a back pressure in the system and the speed brakes will "blow back" to the point where the back pressure on the actuating cylinders is equal to that of a relief valve in the speed brake hydraulic line. As the airspeed decreases, the speed brakes open to the original position if there has been no change in the position of the speed brake lever. The speed brake cannot be pre-positioned toward the CLOSED position. The speed brake must be pushed forward manually as the speed brakes close.

## CANOPY JETTISON SYSTEM.

To properly jettison the canopy, a minimum pressure of 1400 psi is required in the canopy jettison system. The decrease in temperature which accompanies high altitude flight may cause the cylinder pressure to drop below 1400 psi. A pressure of 1800 psi when the ambient temperature is 100°F (38°C) will assure a minimum pressure of 1400 psi if the temperature decreases to −50°F (−46°C). To determine the required pressure at other ambient temperatures, subtract 40 psi from 1800 psi for each 15°F (8.4°C) decrease below 100°F (38°C). For example, the required pressure for an ambient temperature of 70°F (21°C) would be 1720 psi.


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# CREW DUTIES

## PILOT'S DUTIES.

The duties of the pilot have been covered thoroughly in other sections of this handbook and will not be repeated here.

## RADAR OBSERVER'S DUTIES.

The radar observer's primary duty is to operate the radar equipment; therefore, he must be on every mission in which the radar equipment will be used. In addition to operating the radar equipment, he reads all checklists to the pilot and performs other important duties which are covered in the following paragraphs.

**Note**

For reasons of security classification, information concerning the E-9 fire control system and armament is not included in this manual. For information covering this equipment, consult T.O. 1F-89H-1A.

### EXTERIOR INSPECTION.

At the discretion of the pilot, the radar observer will assist in making the exterior inspection (figure 2-1).

**CAUTION**

On some airplanes, two lockbolt position indicators on each engine nacelle door are provided to permit visual reference of their position when doors are being locked. When the small inspection door cover plates are removed, a movable lockbolt position indicator and a stationary reference indicator will be visible. These indicators must be aligned within 1/32 inch when the lockbolt is in locked position.

### BEFORE ENTERING COCKPIT.

1. Ejection seat—Check:
   Armrests and trigger stowed; safety belt release initiator ground safety pin—Removed; safety pins installed; catapult file mark aligned.

**Note**

If the safety belt initiator ground safety pin is installed, consult maintenance personnel regarding the status of the ejection system before occupying the ejection seat.

2. Flashlight—Check operation.
3. Circuit breakers—In.

### ON ENTERING COCKPIT.

**Note**

A radar observer's checklist is located on the radar observer's instrument panel.

## INTERIOR CHECK.

### Rear Cockpit.

**WARNING**

If the C-2A life raft is being carried, the A-5 seat cushion should not be left on the seat. If both are used, and it becomes necessary to eject or crash land, severe spinal injury may result due to the excessive compressibility of the combination of life raft and cushion. If additional height in the seat is needed, a solid filler block may be used in conjunction with the life raft.

**Note**

When the seat cushion is not used, the Type MD-1 contoured seat style survival kit container, stock number 2010-126602, with the MA-1 contoured cushion, stock number 2010-159100, should be used. The forward edge of the packed kit should not be thicker than 7 inches (consult T. O. 14S1-3-51, "Base Assembly, Use and Maintenance of Sustenance Kits" and T.O. 14S3-2-31, "One Man Life Raft, Type PK-2, Used with Survival Kit Container, Type MD-1"). The CA-2 one-man life raft may be used if the MD-1 containers are not available.

1. Safety belt and shoulder harness—Fasten; inertia reel operation—Check; static cord lanyard—Connected; automatic-opening parachute lanyard—Connected.

**WARNING**

- If the safety belt is opened manually, the parachute ripcord must be pulled manually.
- Improperly attaching the shoulder harness and safety belt tie-down straps to the automatic belt will prevent separation from the ejection seat after ejection. To make the attachment correctly, first place the right and left shoulder harness loops over the manual release end of the swivel link; second, place the automatic parachute lanyard anchor over the manual release end of the swivel link; then, fasten the safety belt by locking the manual release lever.
- The M-4 or M-12 safety belt initiator ground safety pin with the warning streamer must be removed prior to flight. If the pin is not removed, automatic uncoupling of the safety belt will not occur if ejection becomes necessary. If pin is installed, maintenance personnel should be consulted on the status of the ejection system before the seat is occupied.

2. E-9 fire control test panel—Check (see T.O. 1F-89H-1A).
3. Alternator breaker control switch momentarily at TRIP; external power switch—CLOSE (after external power is connected).
4. Interphone amplifier switch—ON.
5. Interior light switches—As necessary.
6. Canopy defog knob—IN.
7. Altimeter and clock—Set and cross-checked with pilot.
8. Canopy jettison pressure gage—Check pressure.
9. Interphone selector switch—COMM INTER; interphone toggle switch—INTER.
10. Communications equipment—Check operation.
11. Emergency signal system—Check (with pilot).
12. Oxygen equipment—Check operation.
    Pressure gage 400 psi; oxygen regulator diluter lever NORMAL OXYGEN; oxygen regulator supply lever ON. (Refer to Oxygen System Preflight Check, Section IV, for detailed information.)
13. Hydraulic handpump system—Check.
    Engine hoist and brake selector valve handles positioned with aft handle (B) to NEUTRAL and forward handle (A) to SYSTEM; handpump handle stowed.

**Note**

For additional instructions regarding the radar observer's equipment, refer to T.O. 1F-89H-1A.

## GROUND TESTS.

1. 115-volt alternator system—Check.
   With left engine rpm above 60%, move alternator exciter switch and alternator circuit breaker switches to CLOSE momentarily. Check alternator voltmeter for 115 ± 1.5 volts.
2. Inverter buses—Check voltage.
   Check both single-phase inverter buses and three-phase bus for proper voltage; recheck voltage of three-phase bus when pilot selects spare instrument inverter.

## BEFORE TAKEOFF.

1. Ejection seat ground safety pins—Remove.
2. Safety belt—Tighten; shoulder harness—Adjust to fit snugly; inertia reel lock lever—LOCKED.
3. Anti "G" suit valve button—Press to check operation.

## AFTER TAKEOFF—CLIMB.

1. Static cord lanyard—Disconnected above minimum safe ejection altitude.

## DURING FLIGHT.

1. Adjust radar controls for set operation (see T.O. 1F-89H-1A).

## BEFORE LANDING.

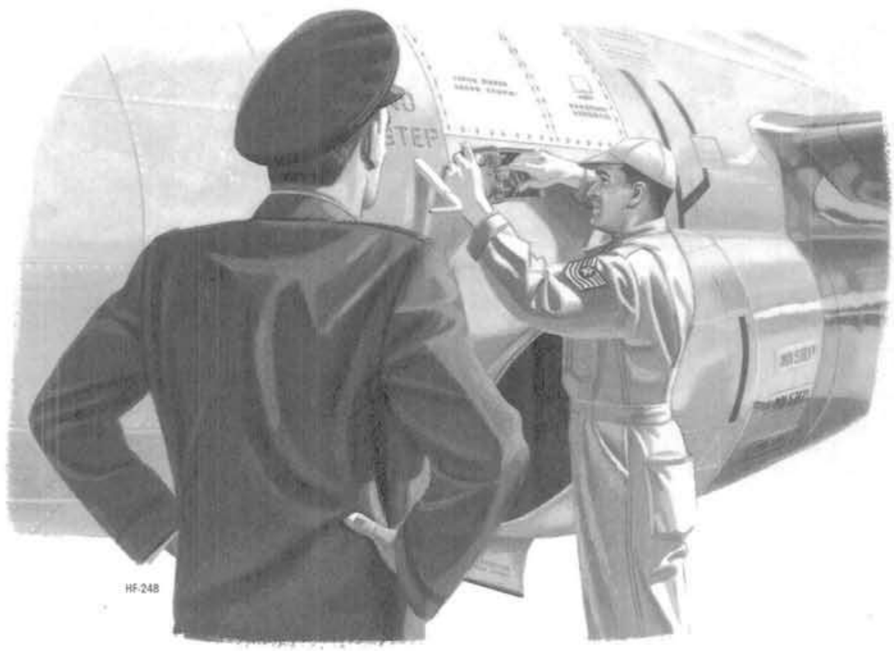
1. Safety belt and shoulder harness—Check for tightness; static cord lanyard—Connected above minimum safe ejection altitude.
2. Viewing scope—Place in stowed position.
3. Radar console assembly—Move to forward position.
4. Inertia reel—LOCKED.

## BEFORE LEAVING AIRPLANE.

1. All switches—OFF.
2. Ejection seat ground safety pins—IN.

**Note**

The following checklist is an abbreviated version of the procedures presented in the simplified checklists of Section VIII. This abbreviated checklist is arranged so you may remove it from your flight manual and insert it into a flip pad for convenient use. It is arranged so that each action is in sequence with the amplified procedure given in Section VIII.




HF-198

CUT ON DOTTED LINE

# NORMAL PROCEDURES

## F-89H ABBREVIATED CHECKLIST

(Radar Observer)

**Note**

The following checklist is an abbreviated version of the radar observer's duties and is accomplished by the radar observer.

## EXTERIOR INSPECTION

At the discretion of the pilot, the radar observer will assist in making the exterior inspection (figure 2-1).

### BEFORE ENTERING COCKPIT

1. Ejection seat—Check.
2. Flashlight—Check operation.
3. Circuit breakers—IN.

## INTERIOR CHECK

### REAR COCKPIT

1. Safety belt and shoulder harness—Fasten; inertia reel operation—Check; static cord lanyard—Connected; automatic-opening parachute lanyard—Connected.
2. E-9 fire control test panel—Check (see T.O. 1F-89H-1A).
3. Alternator breaker control switch momentarily at TRIP; external power switch—CLOSE (after external power is connected).
4. Interphone amplifier switch—ON.
5. Interior light switches—As necessary.
6. Canopy defog knob—IN.
7. Altimeter and clock—Set and cross-checked with pilot.
8. Canopy jettison pressure gage—Check pressure.
9. Interphone selector switch—COMM INTER; interphone toggle switch—INTER.
10. Communications equipment—Check operation.

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CONTINUED ON NEXT PAGE

# ABBREVIATED CHECKLIST

CUT ON DOTTED LINE

**2**

11. Emergency signal system—Check (with pilot).
12. Oxygen equipment—Check operation.
13. Hydraulic handpump system—Check.

### GROUND TESTS

1. 115-volt alternator system—Check.
2. Inverter buses—Check voltage.

### BEFORE TAKEOFF

1. Ejection seat ground safety pins—Remove.
2. Safety belt—Tighten; shoulder harness—Adjust; interia reel lock lever—LOCKED.
3. Anti "G" suit valve button—Press to check operation.

### AFTER TAKEOFF—CLIMB.

1. Static cord lanyard—Disconnected above minimum safe ejection altitude.

### DURING FLIGHT

1. Radar controls—Adjust for set operation (see T.O. 1F-89H-1A).

### BEFORE LANDING

1. Safety belt and shoulder harness—Check; static cord lanyard—Connected above minimum safe ejection altitude.
2. Viewing scope—Stow.
3. Radar console assembly—Move to forward position.
4. Inertia reel lock lever—LOCK.

### BEFORE LEAVING AIRPLANE

1. All switches—OFF.
2. Ejection seat ground safety pins—IN.

T.O. 1F-89H-1


The procedures in this section pertain only to all-weather operation and are in addition to the normal procedures in Sections II and IV. Normal procedures are repeated here only where necessary.

**TABLE OF CONTENTS**



Except for some repetition necessary for emphasis, clarity, or continuity of thought, this section contains only those procedures that differ from or are in addition to the normal operating instructions covered in Sections II and IV relative to instrument flight.

# INSTRUMENT FLIGHT PROCEDURES

## INTRODUCTION.

Flying the airplane in instrument weather conditions requires instrument proficiency and thorough preflight planning. In planning IFR flights, remember that fuel requirements for completion of instrument letdown approach procedures and possible diversion to alternate fields must be added to that normally required for VFR flights. Therefore, maximum range or endurance of the airplane, if required to land in IFR weather conditions, is reduced accordingly. The airplane has good stability characteristics and flight handling qualities for weather flying. For ease of handling, banks should be limited to 30 degrees unless maximum rate turns are ordered by GCI during interceptions. The flight computer installation greatly simplifies precision instrument flying. *Pilots should avoid any tendency, however, to concentrate exclusively on the flight computer indicator or to be hypnotized by it. Concentration on the indicator alone, particularly during rollout from turns, may cause a temporary sense of vertigo. When using the flight computer, monitor the action of the airplane with the basic standard flight instruments at all times to be sure that the airplane follows the flight path set up on the flight computer controls.*

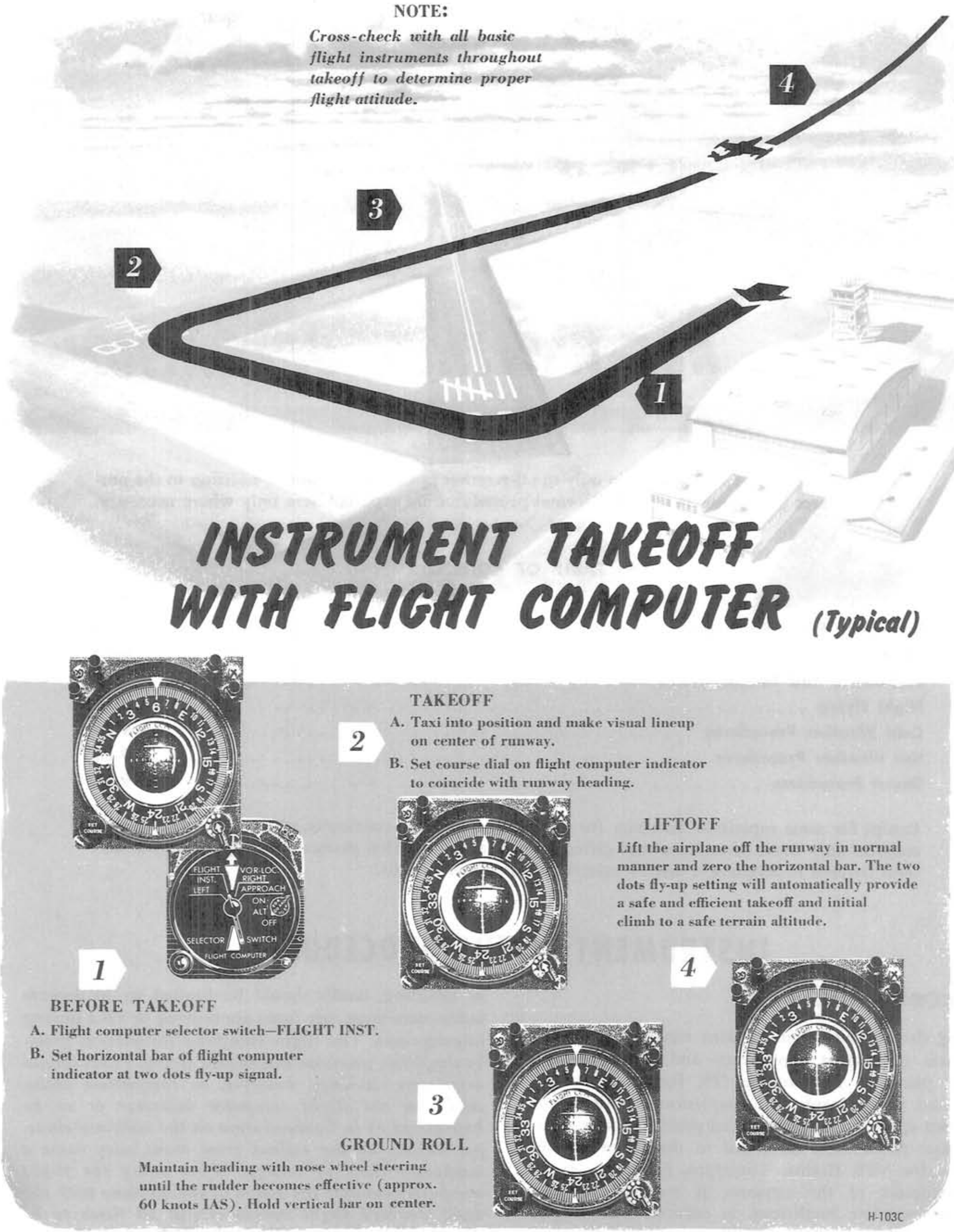

NOTE:
Cross-check with all basic flight instruments throughout takeoff to determine proper flight attitude.
INSTRUMENT TAKEOFF WITH FLIGHT COMPUTER (Typical)
1
BEFORE TAKEOFF
A. Flight computer selector switch—FLIGHT INST.
B. Set horizontal bar of flight computer indicator at two dots fly-up signal.
FLIGHT INST. LEFT
VOR-LOC RIGHT APPROACH
ON ALT OFF
SELECTOR SWITCH
FLIGHT COMPUTER
2
TAKEOFF
A. Taxi into position and make visual lineup on center of runway.
B. Set course dial on flight computer indicator to coincide with runway heading.
3
GROUND ROLL
Maintain heading with nose wheel steering until the rudder becomes effective (approx. 60 knots IAS). Hold vertical bar on center.
4
LIFTOFF
Lift the airplane off the runway in normal manner and zero the horizontal bar. The two dots fly-up setting will automatically provide a safe and efficient takeoff and initial climb to a safe terrain altitude.
H-103C

Figure 9-1.

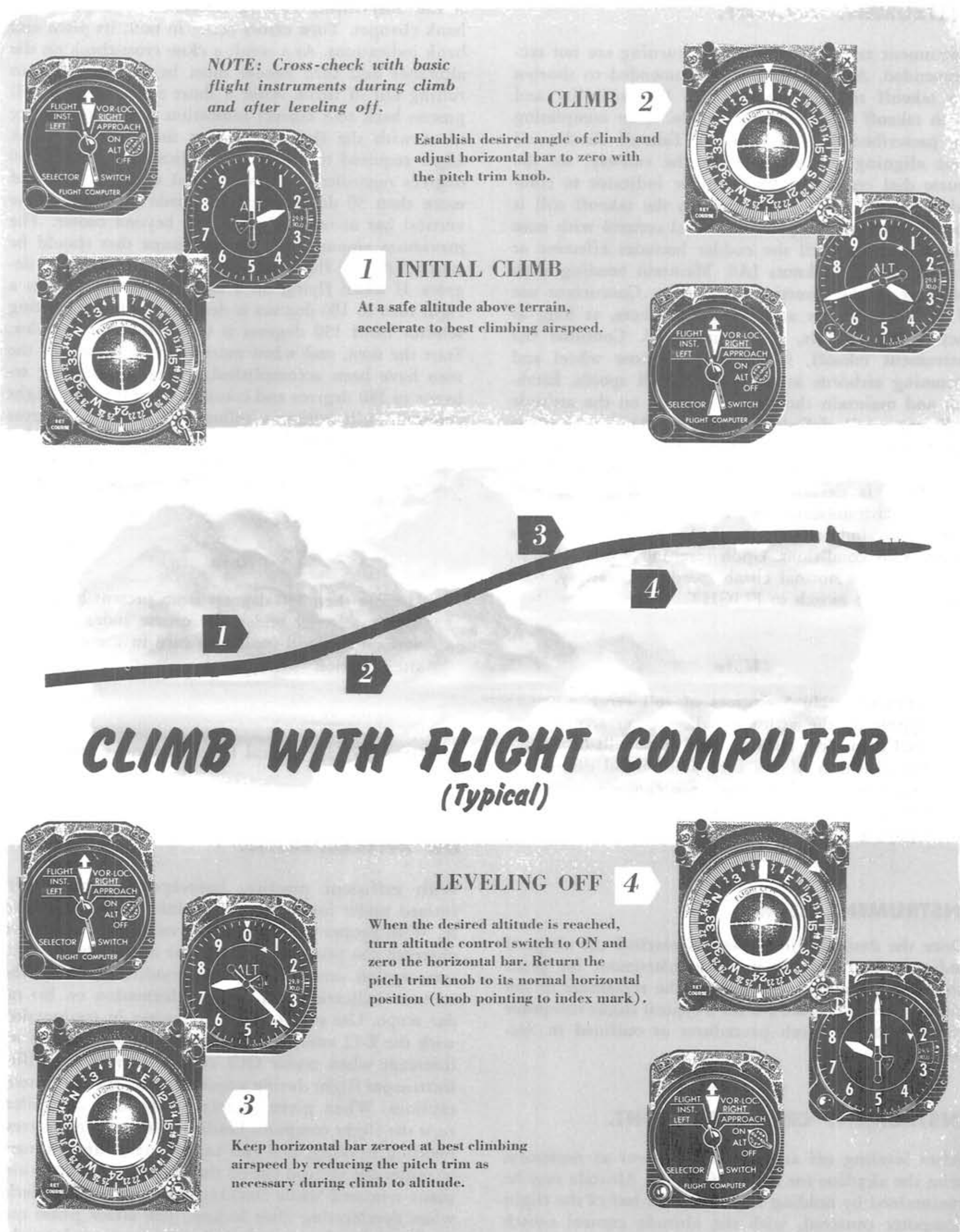

NOTE: Cross-check with basic flight instruments during climb and after leveling off.
CLIMB 2
Establish desired angle of climb and adjust horizontal bar to zero with the pitch trim knob.
1 INITIAL CLIMB
At a safe altitude above terrain, accelerate to best climbing airspeed.
1
2
3
4
CLIMB WITH FLIGHT COMPUTER
(Typical)
LEVELING OFF 4
When the desired altitude is reached, turn altitude control switch to ON and zero the horizontal bar. Return the pitch trim knob to its normal horizontal position (knob pointing to index mark).
3
Keep horizontal bar zeroed at best climbing airspeed by reducing the pitch trim as necessary during climb to altitude.
H-104C

*Figure 9-2.*

## INSTRUMENT TAKEOFF.

Instrument takeoffs without afterburning are not recommended. Afterburning is recommended to shorten the takeoff roll in conditions of low visibility and when takeoff in crosswind is made. After completing the prescribed Taxi and Before Takeoff checks and after aligning the airplane on the runway, set the course dial on the flight computer indicator to coincide with the runway heading. As the takeoff roll is started, maintain proper directional control with nose wheel steering until the rudder becomes effective at approximately 70 knots IAS. Maintain heading with reference to the directional indicator. Concurrent use of runway markers and visual references, as long as they remain visible, is recommended. Continue the instrument takeoff, lifting off the nose wheel and becoming airborne at the normal VFR speeds. Establish and maintain the proper attitude on the attitude indicator until definitely airborne. As the airplane leaves the ground the attitude indicator is primary for both bank and pitch and remains primary until the climb is definitely established. When the vertical velocity indicator and the altimeter show a definite climb indication, retract the gear and flaps as under VFR conditions. Upon reaching a safe altitude, accelerate to a normal climb speed. If necessary, turn the anti-icing switch to FLIGHT.

**Note**

> Approximately 5 degrees of roll error may appear on the attitude indicator on accelerated turn after takeoff. This error will be in the direction of the turn and should disappear within a short time. See figure 9-1 for typical instrument takeoffs with the flight computer.

## INSTRUMENT CLIMB.

Once the desired climb speed is reached the airspeed indicator becomes the primary instrument for pitch and remains as such throughout the remainder of the climb. Refer to figure 9-2 for a typical flight computer climb. Use the climb procedures as outlined in Section II.

## INSTRUMENT CRUISING FLIGHT.

After leveling off and adjusting power as necessary, trim the airplane for hands off flight. Altitude may be maintained by holding the horizontal bar of the flight computer centered, with the altitude control switch ON. However, the altimeter is still the primary instrument for pitch, since only it can provide the pilot with an indication of altitude. The attitude indicator is the only direct reading instrument for pitch and bank changes. Turn errors occur in both its pitch and bank indications. As a result a close cross-check on the altimeter and turn needle must be accomplished in rolling out of turns. After a short time the gyro will precess back to a correct indication. In accomplishing turns with the flight computer the maximum bank angle required to center the vertical bar is set at 30 degrees regardless of airspeed and altitude. Banks of more than 30 degrees may be made by holding the vertical bar at one or more dots beyond center. The maximum amount of heading change that should be selected on the flight computer at any time is 150 degrees. If when flying on a heading of 360 degrees a right turn to 180 degrees is desired, rotate the heading selector until 150 degrees is under the course index. Start the turn, and when more than 30 degrees of the turn have been accomplished, rotate the heading selector to 180 degrees and continue the turn. The flight computer will initiate a rollout indicating 22 degrees before the selected heading is reached. It is advantageous to roll out within reference to the vertical bar when a more rapid change of heading is desired.

**Note**

> If more than 150 degrees from present heading is selected under the course index, the vertical bar will indicate a turn in the opposite direction.

See figure 9-3 for typical flight computer turn procedure.

## IFR INTERCEPTIONS.

With sufficient practice, interceptions can be performed under instrument conditions without difficulty. With proper coordination between pilot and radar observer, the pilot can perform the attack phase of the interception under instrument conditions, using the attitude indication and target information on his radar scope. Use of the flight computer in conjunction with the E-11 autopilot during the initial phase of an intercept when under GCI control greatly simplifies instrument flight during ground control phase of interceptions. When given vectors by the GCI controller, turn the flight computer heading selector to the corresponding heading, and roll immediately into the turn to center the vertical bar on the indicator. Keep the airplane trimmed while tracking the target, particularly when decelerating after lockon. The attack phase can be flown by the attitude reference presented on the radar scope. Use the windshield wiper in precipitation to increase visual sighting range after lockon.

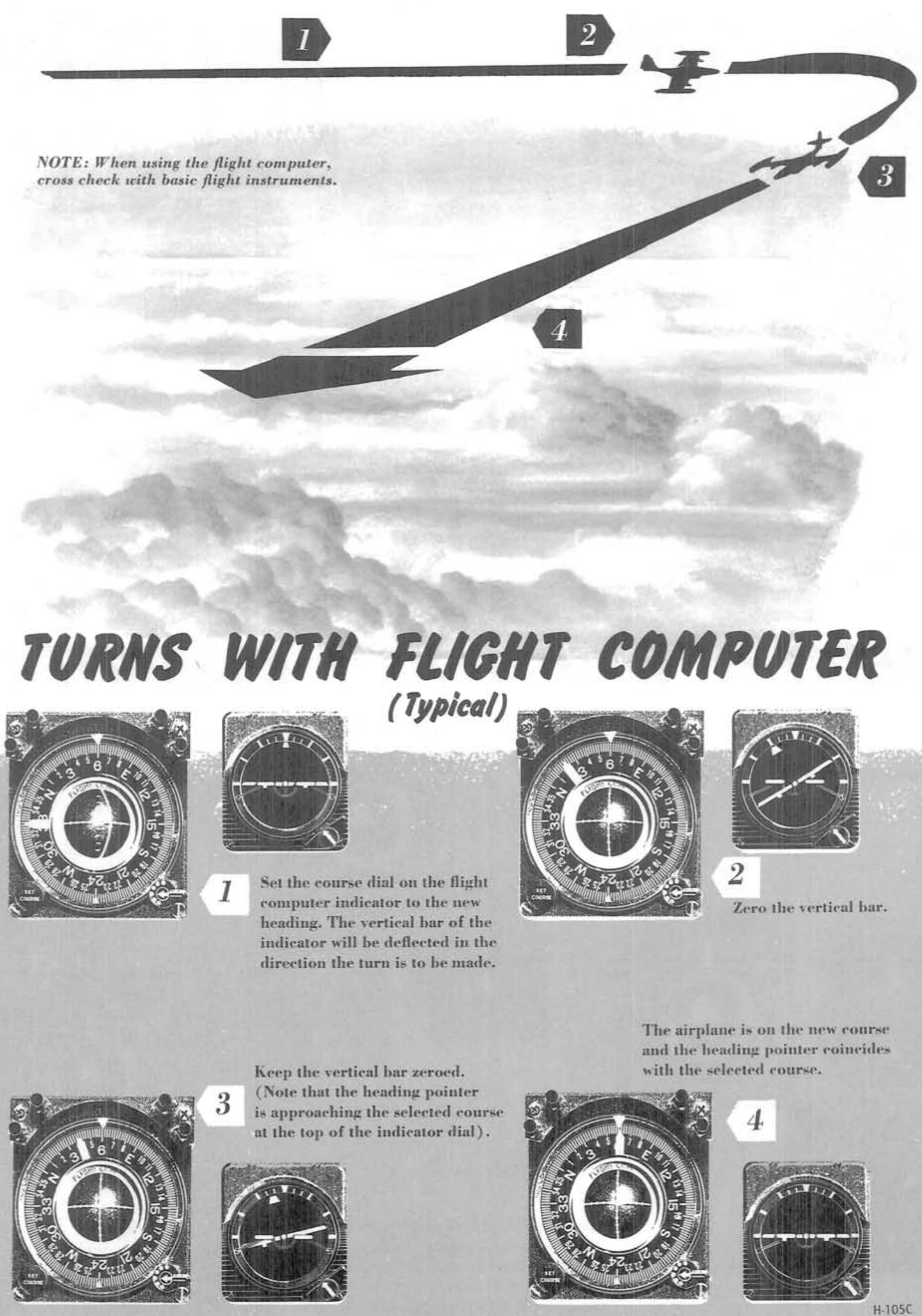

1
2
3
4
NOTE: When using the flight computer, cross check with basic flight instruments.
TURNS WITH FLIGHT COMPUTER
(Typical)
1 Set the course dial on the flight computer indicator to the new heading. The vertical bar of the indicator will be deflected in the direction the turn is to be made.
2 Zero the vertical bar.
3 Keep the vertical bar zeroed. (Note that the heading pointer is approaching the selected course at the top of the indicator dial).
4 The airplane is on the new course and the heading pointer coincides with the selected course.
H-105C

*Figure 9-3.*

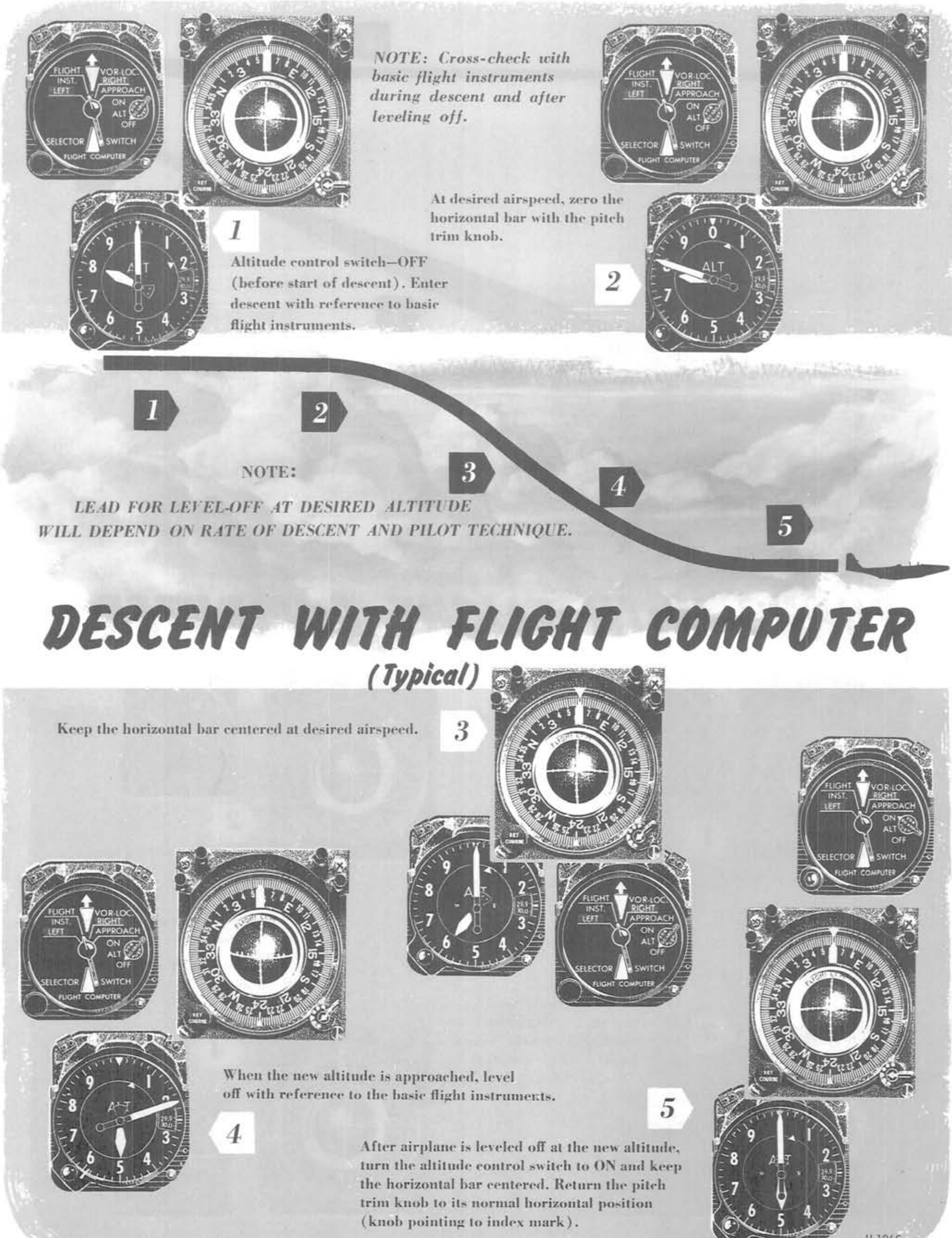

NOTE: Cross-check with basic flight instruments during descent and after leveling off.
1
Altitude control switch—OFF (before start of descent). Enter descent with reference to basic flight instruments.
2
At desired airspeed, zero the horizontal bar with the pitch trim knob.
NOTE:
LEAD FOR LEVEL-OFF AT DESIRED ALTITUDE WILL DEPEND ON RATE OF DESCENT AND PILOT TECHNIQUE.
DESCENT WITH FLIGHT COMPUTER
(Typical)
3
Keep the horizontal bar centered at desired airspeed.
4
When the new altitude is approached, level off with reference to the basic flight instruments.
5
After airplane is leveled off at the new altitude, turn the altitude control switch to ON and keep the horizontal bar centered. Return the pitch trim knob to its normal horizontal position (knob pointing to index mark).
FLIGHT INST. LEFT
VOR-LOC RIGHT
APPROACH
ON
ALT
OFF
SELECTOR
SWITCH
FLIGHT COMPUTER
ALT
H-106C

Figure 9-4.

## SPEED RANGE.

Airplane flight characteristics at high and low airspeeds are the same for VFR and IFR flying. For best cruise or loitering indicated airspeeds refer to applicable Appendix charts.

## RADIO AND NAVIGATION EQUIPMENT.

For proper background and use of radio and navigation equipment refer to Section IV. The operation of radio and navigation equipment is not affected by most weather conditions. The radio compass, however, is susceptible to precipitation static.

## DESCENT.

If icing conditions are probable, the descent should be made with sufficient power to provide adequate hot air for the anti-icing system. For maximum ease of handling, a constant-speed letdown is recommended. The optimum speed brake position depends on the IAS and rate of descent combination desired. The adjustable speed brakes make possible various rates of descent at the same IAS and throttle setting.

### RADIO PENETRATIONS.

Radio penetrations can be accomplished satisfactorily with various airplane configurations. Recommended, however, is an 85% rpm, 250-knot IAS and 4000 fpm descent, maintained with gears and flaps retracted and approximately one-half speed brakes. The exact procedures for jet penetrations *(Pilot's Handbook—Jet, East or West)* will vary with each field due to local terrain and radio variations.

**Note**

> The canopy defogging system should be actuated approximately 10 minutes prior to descent from altitude.

See figure 9-4 for a typical flight computer descent procedure.

## INSTRUMENT APPROACHES.

The airplane has excellent handling characteristics during instrument approaches. When power is at idle or low rpm the power response to throttle movement is very slow. Therefore, use relatively high power settings in the approach configuration, and control airspeed and rate of descent by using the speed brakes. Very little pitch change is required during transition from glide slope to touchdown, because the airplane is approximately in a landing attitude while on the glide slope. With flaps at takeoff, speed brakes open, and maximum practicable braking, the required runway length to stop, following instrument approaches, is short compared to other jet fighters. A 6500-foot GCA or ILS equipped runway is considered minimum for actual all-weather operations.

## RADIO APPROACHES.

Normally, radio range and omnirange approaches will be required only if the airplane is not VFR after descent to the low station and no GCA or ILS is available. Refer to the Pilot's Handbook—Jet for the local procedures of the standard instrument approach. The fuel required to complete an approach is largely determined by the time the airplane flies outbound before making the procedure turn and by the distance from the fix to the field. The time outbound from the radio fix, prior to initiating the procedure turn, need only be sufficient to permit completion of the cockpit check after the procedure turn and precision beam following to the station at the proper altitude. For radio approaches after a tear-drop type penetration the following procedures may be used.

**Note**

> If a procedure turn is to be made after a penetration, use 85% rpm and adjust speed brakes as required to maintain 195 knots IAS. Fly outbound for a minimum of 30 seconds and a maximum of 60 seconds (or as locally prescribed); then make procedure turn.

### INBOUND.

1. Landing gear lever—DOWN.
2. Wing flap lever—TAKEOFF.
3. Throttle—Minimum of 85% rpm.
4. Speed brake lever—As required to maintain 160 knots IAS.
5. Descent to proper altitude.

**Note**

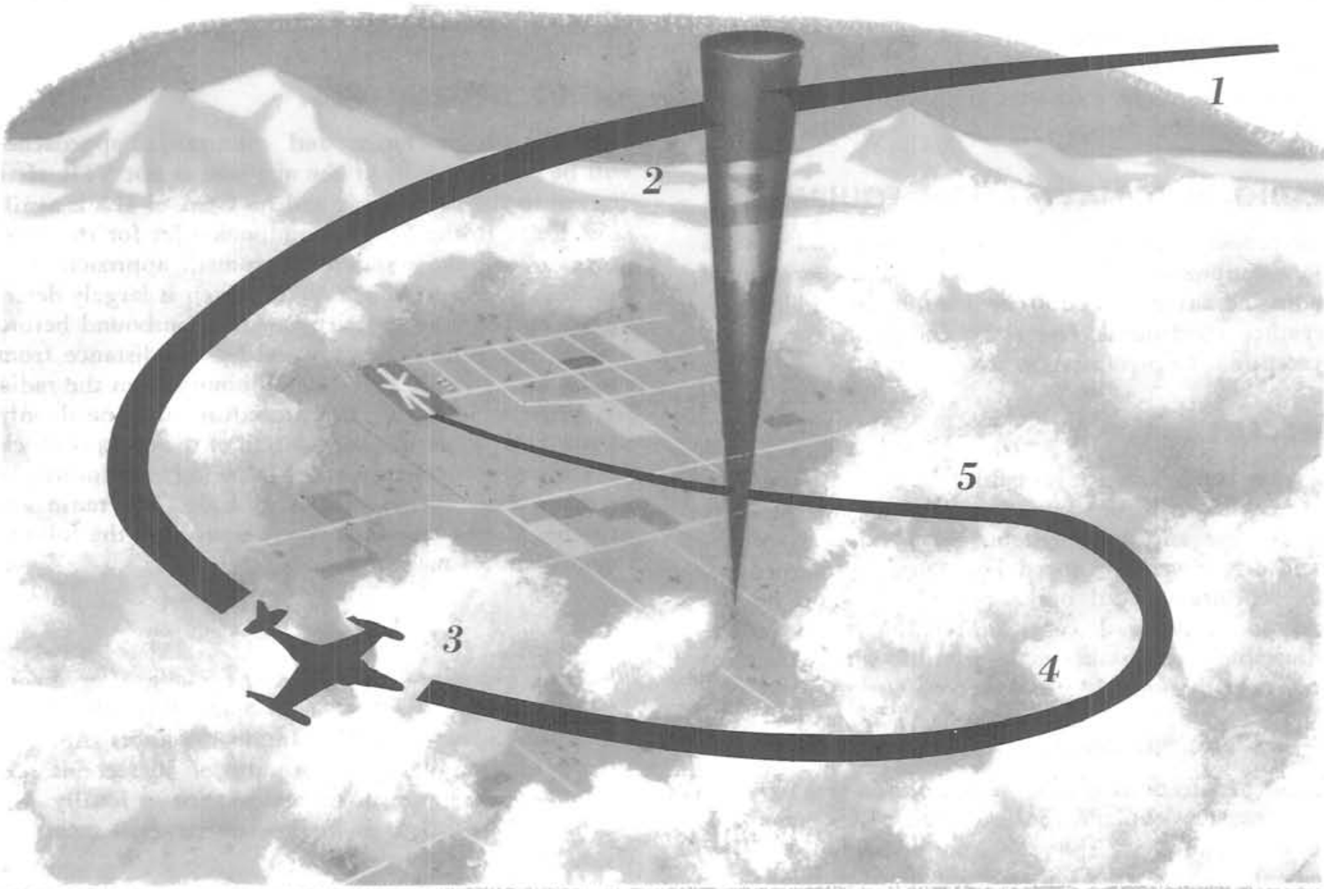
> If the time from the radio fix to the field exceeds 2 minutes, it is best to delay final configuration until over the station in order to expedite the approach and conserve fuel.

### LOW STATION.

Make the proper position report and descend to minimum altitude. Use the speed brakes to maintain airspeed in the descent. Descents during approaches are normally made at 500 fpm and should not exceed 1000 fpm. See figure 9-6 for typical radio approach.

## GROUND CONTROLLED APPROACH (GCA).

GCA approaches may consist of a rectangular pattern, a straight-in approach from the penetration, or modified versions of either dependent upon local facilities




# RADIO PENETRATION (Typical)

*1* APPROACH TO STATION

A. Canopy defogging—AS REQUIRED.
B. Windshield heat—AS REQUIRED.
C. Pitot heat—AS REQUIRED.
D. Interior cockpit lighting—AS REQUIRED.

*2* PENETRATION ENTRY

A. Throttle—85% RPM.
B. Establish 4000 feet per minute rate of descent.
C. Speed brakes—Adjust to maintain 250 KNOTS IAS.

*3* PENETRATION TURN

Maintain descent criteria and turn as prescribed by the appropriate "Pilot's Handbook—Jet."

*4* LEVEL OFF

A. Rate-of-descent—Decrease 1000 feet above level-off altitude.
B. Lead level-off altitude by approximately 10% of rate of descent.

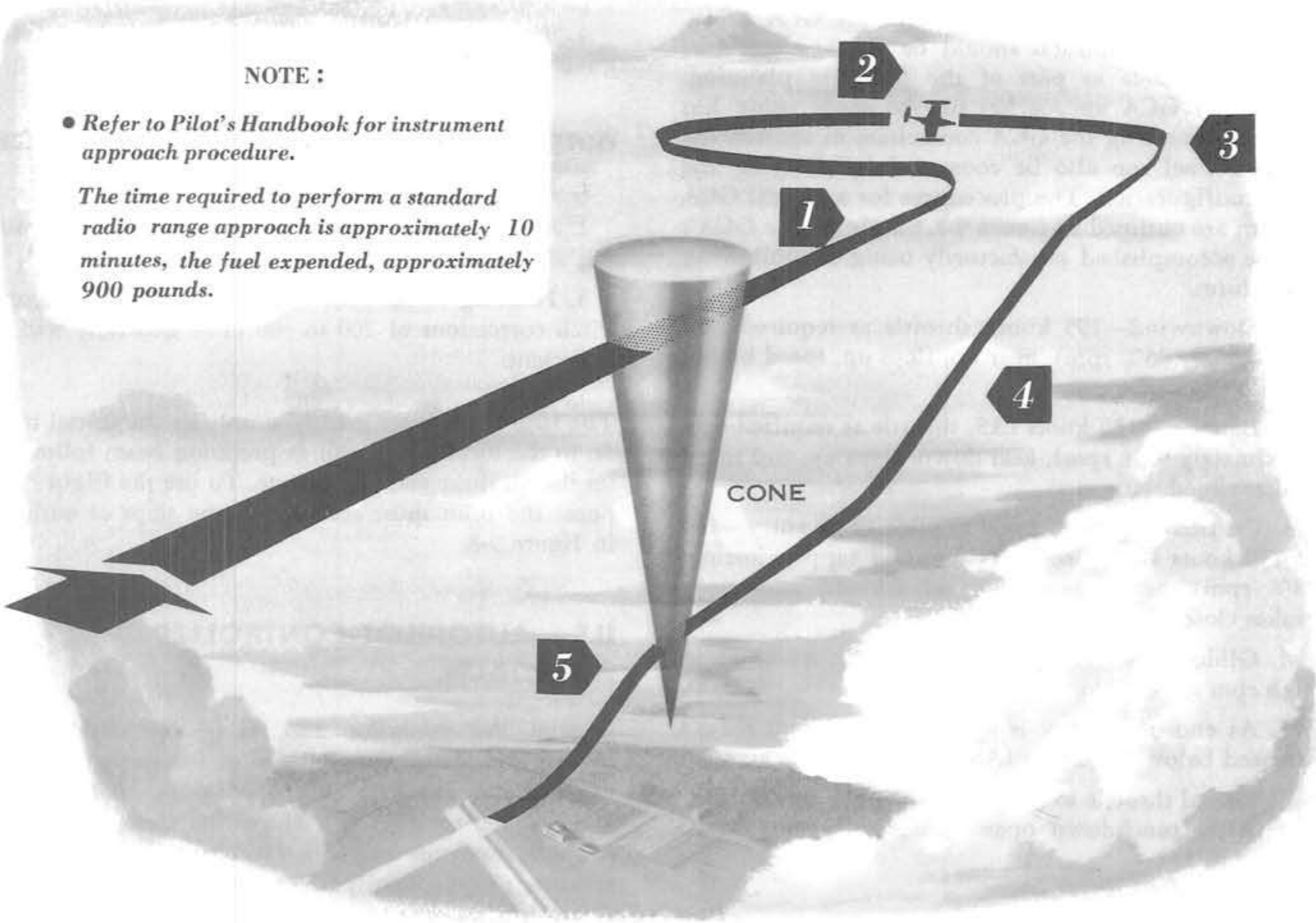
*5* INBOUND

A. Throttle—85% RPM.
B. Speed brakes—Adjust to maintain 200 KNOTS IAS.

*NOTE:*
*Refer to appropriate "Pilot's Handbook—Jet" for specific penetration instructions. Use the basic instruments and cross-check with the flight computer.*

H-107C

**Figure 9-5.**




# RADIO APPROACH (Typical)

**1 OUTBOUND**

A. Throttle—85% RPM minimum.

B. Speed brakes—As required to maintain 195 knots IAS.

C. Time— As locally required.

**2 PROCEDURE TURN**

**3 COCKPIT CHECK**

A. Landing gear—DOWN.

B. Wing flaps—TAKEOFF.

C. Throttle—85% RPM minimum.

D. Speed brakes—As required to maintain 160 knots IAS.

**4 INBOUND**

A. Descend to proper altitude.

B. Maintain final configuration.

**5 LOW STATION**

A. Make proper position report.

B. Descent to minimum altitude.

H-108C

Figure 9-6.

and terrain features. Therefore, the fuel and time required for a GCA will vary at different fields. The basic procedures remain the same for all patterns. That is, the cockpit checks and the final configuration are accomplished prior to being turned over to the final controller. On a cross-country flight, the GCA procedures at the destination should be checked and fuel allowances made as part of the preflight planning. Emergency GCA approaches can be made using less fuel by requesting the GCA controllers to shorten the pattern. Fuel can also be conserved by delaying the final configuration. The procedures for a typical GCA pattern are outlined in figure 9-7. Single-engine GCA's can be accomplished satisfactorily using the following procedures.

1. Downwind—195 knots, throttle as required (approximately 86% rpm), gear up, flaps up, speed brakes closed.

2. Base leg—180 knots IAS, throttle as required (approximately 95% rpm), gear down, flaps up, and speed brakes closed.

3. On final approach prior to glide slope entry—160 to 170 knots IAS, throttle as required (approximately 98% rpm), gear down, flaps at takeoff, and speed brakes closed.

4. Glide slope—160 to 170 knots IAS, maintain as high rpm as possible.

5. As end of runway is approached, do not reduce airspeed below 160 knots IAS until landing is assured.

6. Retard throttle to idle only when positive of landing. After touchdown open speed brakes to reduce ground roll.

## ILS APPROACHES.

ILS is very similar to GCA in that it is designed to give indications of both azimuth and elevation to the pilot throughout the complete approach. It does differ from a GCA since ILS gives a visual presentation of deviations from the approach, while in GCA the pilot is given verbal corrections throughout the approach. The procedures for the airplane are very similar for both GCA and ILS, and are as follows:

### OUTBOUND.

1. Landing gear—Up.
2. Wing flaps—Up.
3. Throttles—85% rpm minimum.
4. Speed brakes—As required to maintain 195 knots IAS.
5. Altitude as locally required.

### PROCEDURE TURN.

1. Begin procedure turn as locally prescribed.

### INBOUND TO OUTER MARKER.

1. Descend to proper altitude.
2. Landing gear—Down.
3. Wing flaps—Takeoff.
4. Throttles—85% rpm minimum, to maintain 160 knots IAS.

### OUTER MARKER AND INBOUND ON APPROACH.

1. Make the appropriate position report.
2. Intercept and bracket the glide slope, maintaining airspeed with use of the speed brakes.
3. Heading corrections should not exceed 5 degrees. Pitch corrections of 200 to 300 FPM generally will be sufficient.

The flight computer greatly simplifies the initial turn-on to the localizer as well as precision beam following on the localizer and glide slope. To use the flight computer the pilot must accomplish the steps as outlined in figure 9-8.

## ILS—AUTOPILOT-CONTROLLED APPROACH.

Engage the autopilot and, using any standard approach, maneuver the airplane to intercept the localizer beam at approximately 45 degrees, 10 miles out, and at 1200 to 1500 feet above the terrain. (The allowable intercept angle is 45 degrees at 8 miles, increasing proportionally to 90 degrees at 13 miles.) Use the following general procedure to obtain consistently good results.

1. Approach to localizer—Lower flaps and landing gear, adjust power for 160 knots IAS, and check that both flags on the course indicator are down. Trim the airplane for approximately level flight at 1200 to 1500 feet above the terrain, and place the altitude switch at ON if desired.

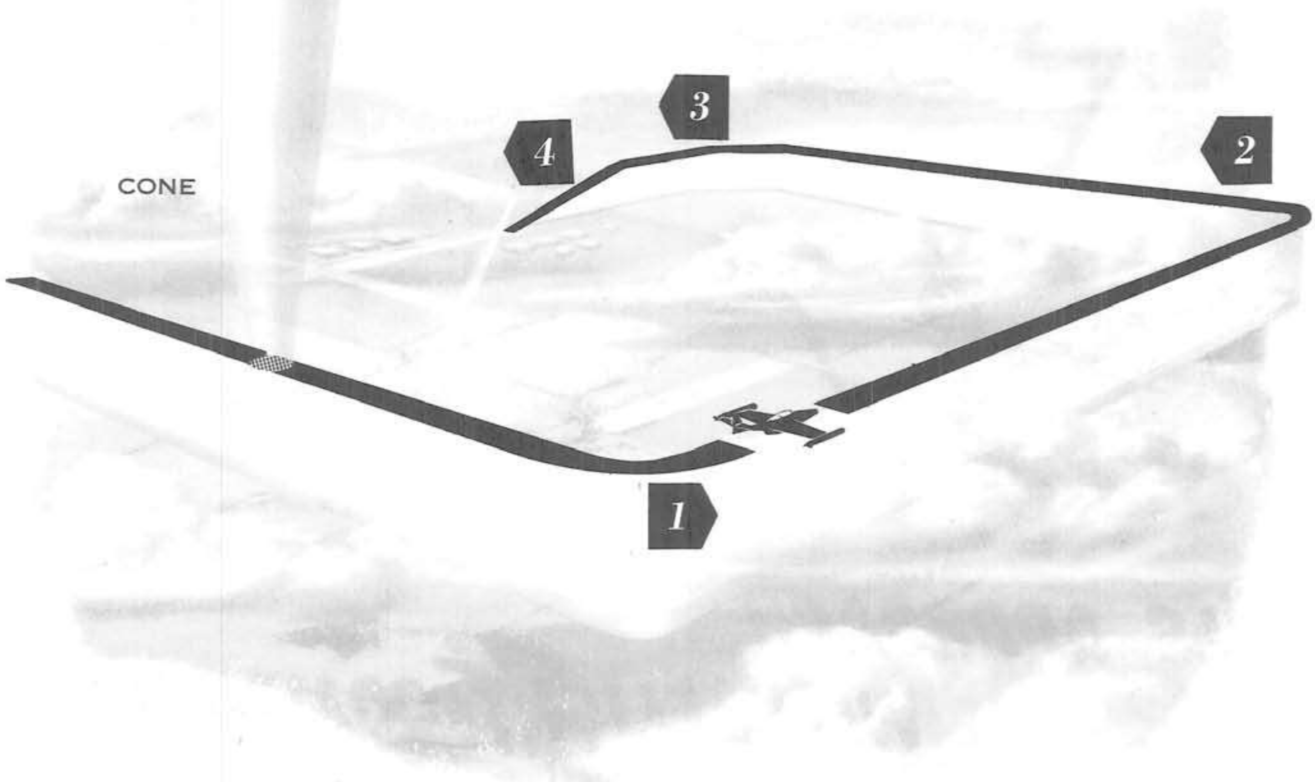
2. Intercepting localizer—When the airplane enters the localizer beam, the vertical bar on the course indicator will leave its stop. As soon as this occurs, place the localizer switch at ON. The airplane will bracket the beam automatically.

3. Intercepting the glide slope—When the airplane enters the glide slope, the horizontal needle of the course indicator will approach the center of the meter. When the needle enters the top half of the small circle, set the approach switch at ON. The airplane will start down the beam automatically.

4. On the glide slope—Adjust flaps and speed for flareout and landing.

5. Breakthrough or minimum altitude—Disengage the autopilot, complete flareout, and land manually.

NOTE:
*The time required to perform a standard GCA pattern is approximately 9.5 minutes, the fuel expended, approximately 740 pounds.*




# GCA APPROACH (Typical)

**1 DOWNWIND LEG**

A. Landing gear—UP.
B. Wing flaps—UP.
C. Throttle—85% RPM minimum.
D. Speed brakes—As required to maintain 195 knots IAS.

**2 BASE LEG**

A. Landing gear—DOWN.
B. Wing flaps—UP.
C. Throttle—85% RPM minimum.
D. IAS—180 KNOTS.

**3 FINAL APPROACH**

A. Wing flaps—TAKEOFF.
B. IAS—160 KNOTS.

**4 GLIDE SLOPE**

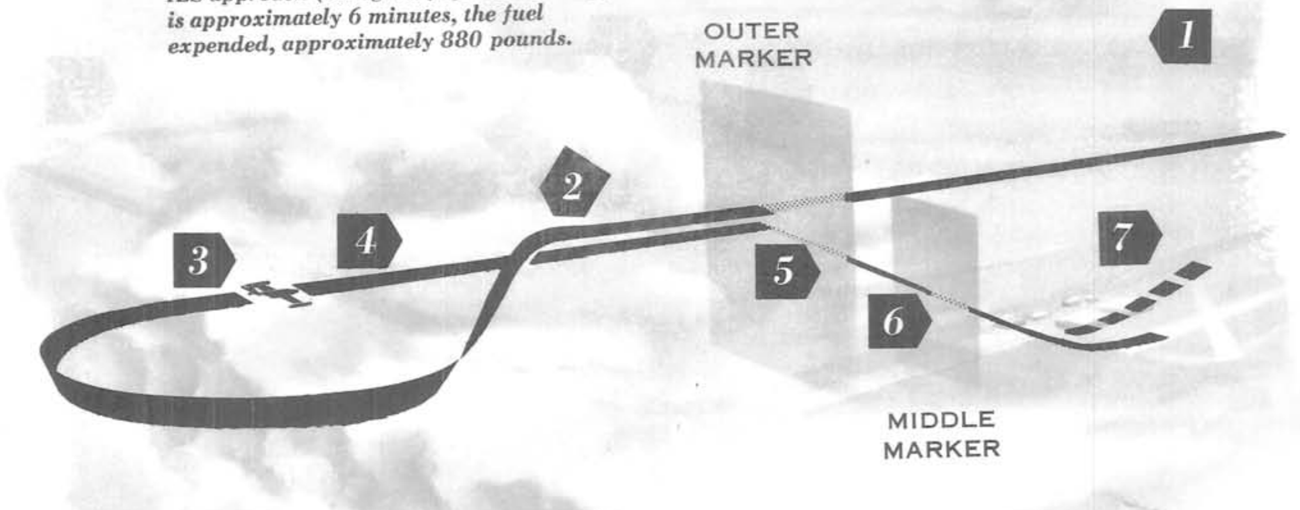
Use speed brakes to maintain 160 knots IAS.

H-109C

*Figure 9-7.*

NOTE:

- *When using the flight computer, cross-check with basic flight instruments.*
- *The time required to complete a standard ILS approach (using the flight computer), is approximately 6 minutes, the fuel expended, approximately 880 pounds.*




# ILS APPROACH WITH FLIGHT COMPUTER

*(Typical)*

**1** OUTBOUND

A. Flight computer selector switch—(VOR-LOC) LEFT.
B. Altitude—As locally prescribed.
C. Altitude control switch—ON.
D. Landing gear—UP.
E. Wing flaps—UP.
F. Throttle—85% RPM minimum.
G. Speed brakes—As required to maintain 195 knots IAS.

**2** PROCEDURE TURN

A. Begin procedure turn as locally prescribed.
B. Flight computer selector switch—FLIGHT INST.
C. Altitude control switch—OFF (prior to descent).

**3** INBCUND

A. Set heading pointer to localizer heading.
B. Turn flight computer selector switch to (VOR-LOC) RIGHT. This will cause flight computer vertical bar to deflect.
C. When the course indicator vertical bar begins to move off the peg, zero vertical bar. This will bring you to localizer beam.

**4** INTERCEPTING GLIDE SLOPE

When the course indicator horizontal bar reaches center (indicating you are on the glide slope), turn selector switch to APPROACH.

**5** COCKPIT CHECK

A. Descend to proper altitude.
B. Landing gear—DOWN.
C. Wing flaps—TAKEOFF.
D. Throttle—85% RPM minimum, to maintain 160 knots IAS.

**6** ON GLIDE SLOPE

Fly airplane to center horizontal and vertical bars to maintain position on localizer and glide slope.

**7** MISSED APPROACH

To go around in the event of a missed approach, press the go-around button and initiate afterburning. By centering the bars, you will assume a safe climbing attitude. Then follow local missed-approach procedure.

H-110A

*Figure 9-8.*

## MISSED-APPROACH GO-AROUND PROCEDURE.

If a missed approach or a go-around is required, accomplish the following:

1. Throttles—OPEN; use afterburners for acceleration if necessary, but consideration must be given to increased fuel consumption.
2. Speed brake lever—CLOSED.
3. Establish a takeoff or climb attitude.
4. When vertical velocity indicator and altimeter show definite climb indication, retract gear and flaps.
5. Execute established missed-approach procedure for the particular field.

## FLIGHT COMPUTER MISSED APPROACH WITH ILS.

**WARNING**

Do not use flight computer missed-approach procedure if a go-around with both afterburners and a clean configuration cannot be accomplished.

If an approach has been missed on ILS and a straight-ahead climbout can be made safely, the flight computer can be used to accomplish a go-around. Pressing the flight computer go-around button (altitude switch, figure 4-15) with the flight computer selector switch at APPROACH, will displace the horizontal bar to the optimum climbout angle. Flying the airplane to center the horizontal and vertical bars will then result in a safe climbout airspeed if maximum power is used on both engines. In the following go-around procedure, each step should be performed without hesitation.

1. Throttles—OPEN; use afterburners.
2. Speed brake lever—CLOSED.
3. Flight computer go-around button—Press.
4. Landing gear lever—UP.
5. Wing flap lever—UP.
6. Fly the airplane to center the horizontal and vertical bars until desired altitude is reached. Execute established missed-approach procedure for the particular field.

**Note**

When the desired altitude is reached, the go-around feature is cut out by turning the flight computer selector switch from the APPROACH position.

## INSTRUMENT LETDOWNS AND APPROACHES ON SINGLE ENGINE.

Letdowns and approaches on single engine, either by radar control or on the radio range, can be made satisfactorily. Use the following procedure when making a single-engine GCA or ILS approach:

1. GCA downwind leg and ILS outbound—Use 200 knots IAS, power at 88 ± 2% rpm, gear down, flaps up, and speed brakes closed.
2. GCA base leg and ILS inbound—Use 160 to 170 knots IAS, power at 96 ± 2% rpm, gear down, flaps up, and speed brakes closed.
3. Final approach—Use 160 to 170 knots IAS, gear down, flaps at takeoff, power as required to maintain desired flight path. Use 98% rpm and control rate of descent with speed brakes.


## INTRODUCTION.

The thin wings and high speeds of jet aircraft can result in critical ice accumulation in relatively light icing conditions in those airplanes with the anti-icing systems inoperative. Surface icing can reduce IAS and range of the airplane considerably. Icing occurs when the supercooled water in fog, clouds, or rain impinges and freezes on the airplane surfaces. Normally the heaviest icing takes place in clouds with strong vertical currents (cumulus clouds, projections above stratocumulus clouds, etc). Icing conditions as found in stratus clouds are generally light to moderate; however, severe icing conditions may occur in this type of cloud. Prolonged flights through moderate icing can build up as much ice as a short flight through severe icing conditions. The most severe type of ice formation will generally occur above −5°C (23°F).

## SURFACE ICING.

Surface icing normally occurs at temperatures near 0°C (32°F) on the outside air temperature gage. The anti-icing system will keep all heated surfaces clear of ice without noticeable loss of engine thrust. The system will also effectively de-ice the airplane if ice is allowed to accumulate on the wings and tail. The purpose of the system is to prevent formation of ice; therefore, use the system continuously whenever conditions indicate a possibility of ice. Refer to Section IV for operating instructions on the anti-icing systems.

**WARNING**

If the thermal anti-icing system is inoperative and any low level flying is to be performed under icing conditions, a higher than normal IAS should be used. Icing will cause the stalling speed to increase considerably; therefore extreme caution should be used, especially during takeoff, approaches, and landings.

## ENGINE ICING.

Axial flow jet engines are seriously affected by icing. The engine air intake anti-icing is controlled by the anti-icing switch and care must be taken to prevent ice buildup on these surfaces since ice ingestion by the engine can result in engine failure. Ice forms on the inlet screens when extended and compressor inlet guide vanes (stator) and restricts the flow of inlet air. This causes a loss of thrust and a rapid rise in exhaust gas temperatures. As the airflow decreases, the fuel-air ratio increases, which in turn raises the temperature of the gases going into the turbine. Complete turbine failure may occur in a matter of seconds after ice builds up in the engine air inlet. Critical ice build-up on inlet screens can occur in less than 1 minute under severe conditions. With the inlet screens retracted, blocking of the air passages between the inlet guide vanes can still occur in 4 minutes or less. The idea that heating due to ram pressure at high speed will prevent icing is dangerous. The heat generated at subsonic speed is insufficient to prevent ice formation. Engine screens should be extended after penetration or icing has been terminated. This procedure will minimize damage caused by large pieces of ice being ingested into the engine.

### In Below Freezing Air Temperature.

The rate of engine icing for a given atmospheric icing intensity with outside air below freezing temperature is relatively constant up to an airspeed of approximately 250 knots TAS. Assuming constant icing conditions, the rate of icing increases with increasing airspeed above 250 knots. Therefore, a reduction of airspeed to a safe minimum will reduce the rate of engine icing in ambient temperatures of 0°C (32°F) or below.

### In Above Freezing Air Temperature.

Unlike surface icing, engine inlet icing can occur at temperatures above freezing. Because serious inlet duct icing can occur without the formation of ice on the airplane external surfaces, it is necessary to understand what causes this type of icing in order to anticipate it, if possible, so that immediate corrective action will be taken when positive indications of engine icing appear. When jet airplanes fly at velocities below approximately 250 TAS at high power setting, the intake air is sucked, instead of rammed, into the engine compressor inlet. This suction causes a decrease in air temperature (adiabatic cooling). Under these conditions, air at a temperature above freezing may be reduced to subfreezing temperature as it enters the engine. Free moisture in the air may become supercooled and cause engine icing although no external surface icing is evident. The maximum temperature drop which can occur on most current engines is a drop of approximately 5°C (9°F). The greatest temperature drop occurs at high rpm on the ground and decreases with (1) decreasing engine rpm, and (2) increasing airspeed.

### Indication of Engine Icing.

The initial indication of engine icing is increased exhaust gas temperature. This is usually the only indication prior to complete engine failure. At the first sign of engine icing turn on the engine anti-icing system immediately. Refer to Section IV for the operation of this system.

## FLIGHT IN ICING CONDITIONS.

If a flight must be made in icing conditions, and if either the engine or surface anti-icing system is inoperative, observe the following precautions:

1. Avoid known areas of icing conditions. Many areas of probable icing conditions can be avoided by careful flight planning and study of weather conditions.

2. If the ambient temperature is in the range of 0°C (32°F) to 5°C (41°F) and water is present on the parking ramp or runways, the inlet screens should be retracted and the engine anti-icing system turned on immediately upon starting the engine.

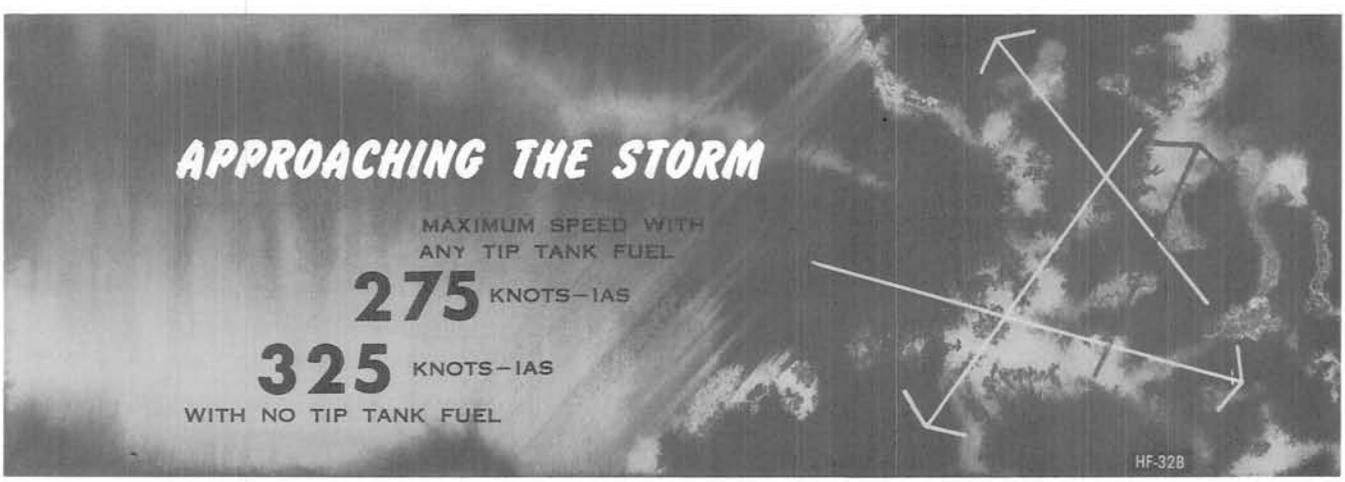
3. If possible, avoid takeoff when the temperature is between −10°C (14°F) and 5°C (41°F) if fog is present or if the dew point is within 4°C (7°F) of the ambient temperature. These are the conditions under which engine icing can occur without surface icing. When freezing rain or other icing conditions exist at takeoff, the anti-icing switch should be placed at TAKEOFF. The loss of thrust on takeoff is not noticeable to the pilot. Afterburners should be used to climb rapidly above the icing conditions.

4. If the ambient temperature is in the range of 0°C (32°F) to 5°C (41°F), the speed of the airplane should be maintained at 250 knots or above to lessen the possibility of inlet duct icing due to suction effect.

5. If icing conditions are encountered at freezing atmospheric temperatures, immediate action should be taken as follows: change altitude rapidly by climb or descent in layer clouds, or vary course as appropriate to avoid cloud formations; reduce airspeed (in freezing air) to minimize rate of ice buildup; maintain close watch of exhaust gas temperature and reduce engine rpm as necessary to prevent excessive exhaust gas temperature.


## INTRODUCTION.

Thunderstorms and their accompanying turbulence should be avoided if possible. The following information and procedures are to be used only when flying into a thunderstorm cannot be avoided. At altitudes above 35,000 feet, sufficient power is not available to regain airspeed in level flight once it has dropped to about 200 knots IAS. If it is noted that airspeed is dropping below 200 knots IAS, lower the nose slightly and maintain a descent of approximately 1000 feet per minute until airspeed is regained. Do not use afterburners in the storm as serious trouble could be encountered if the airplane inadvertently went into a steep spiral. At 30,000-foot altitude or lower, once the throttle adjustment is made, airspeed control is not a problem and the most serious trouble to be encountered is severe turbulence and possible hail damage. In the storm, the airplane should not be maneuvered intentionally. However, by observing the recommended turbulent air penetration airspeed, a maximum maneuverability margin will be sustained at all operating gross weights without developing prohibitive load factors. In less severe turbulence there are no airspeed restrictions, but maneuvering should be restricted in proportion to the degree of turbulence.



## APPROACHING THE STORM.

Prepare the airplane as follows before entering the storm.

1. Adjust power to obtain a safe and comfortable penetration speed of 225 to 275 knots IAS. If higher airspeeds are desired, do not exceed the following:

   With ANY tip tank fuel. . . . 275 knots IAS

   With NO tip tank fuel. . . . . . 325 knots IAS

2. Pitot heat switch—ON.
3. Anti-ice switch—FLIGHT; windshield de-ice and defog knob—NORMAL.
4. Flight computer altitude switch—OFF.
5. At night, turn cockpit lights and thunderstorm lights to full brightness.


## INTRODUCTION.

Night flying in this airplane is the same as day flight with the following exceptions.

## NIGHT TAKEOFF.

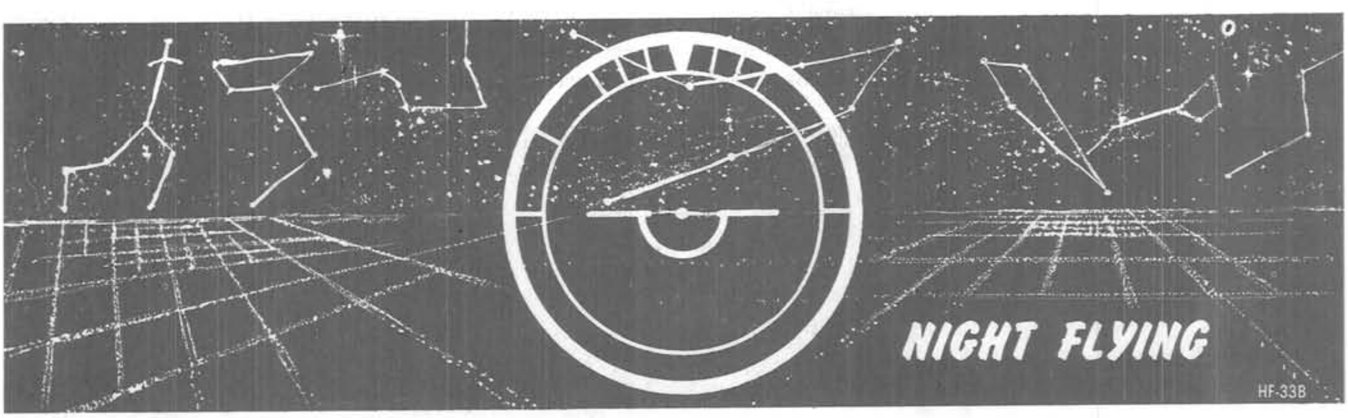
Follow instrument takeoff procedure (with normal reference) until a safe altitude is reached. Prior to landing, visually check main gear down by turning landing light on in the retracted position.

**CAUTION**

- Taxi light does not light area near the wing tips. Be on the alert for other airplanes, crew chief stands, and other hazards in the taxi and takeoff areas.
- After takeoff check altimeter, vertical velocity indicator, and airspeed indicator, to ensure positive climb and acceleration.

## NIGHT LANDING.

Use the normal landing procedure.




## BEFORE ENTERING THE COCKPIT.

Check to see that the following items have been accomplished:

1. Airplane covers removed.
2. Plugs removed from engine air intake ducts, exhaust nozzle, and engine nacelle doors.

3. Visual check of bottom section of front stator blades for evidence of ice. Engine heat on shutdown will melt ice accumulated on previous flight; melted ice will then refreeze in the lower section of the front stator and rotor blades. An attempted engine start will result in starter failure. If ice is suspected, check the engine for freedom of rotation. If engine is not free, external heat must be applied to forward engine section to melt the ice. Start engine as soon as possible after heat application to remove all moisture before refreezing can occur.

4. Wing flap servo followup screw and shaft cleaned of excessive oil and grease.

**Note**

Excessive oil or grease on this mechanism can cause shaft to bind in screw and move the servo valve spool to partially restrict hydraulic flow to flap motor, causing abnormally slow movement of flaps.

5. All ice removed from fuel tank vents, static air sources, and pitot tubes.

6. Ice and snow removed from nose wheels to prevent shimmy.

7. Fuel filters and draincocks checked for freedom from ice and heated, if necessary, to drain condensate.

8. Oil tanks preheated, if temperature is −45°C (−49°F) or lower, to reduce starter loads and assure proper lubrication. However, cold engine starts can be made if operations warrant.

9. Shock struts checked for proper inflation, and dirt and ice removed.

**CAUTION**

Ice should not be chipped away because the airplane may be damaged. Check that water resulting from ice removal does not refreeze on airplane surfaces, especially on control surface hinge lines.

10. All snow and ice accumulations removed from the wings, fuselage, and tail prior to flight.

**WARNING**

Snow and ice that accumulate on the airplane on the ground seriously affect the airplane's flight performance and alter handling characteristics. These accumulations result in longer takeoff distance requirements, increased stall speeds, poor climbout performance, and a vibration in flight that could result in an accident.

11. Canopy jettison system, seat air, and airbrakes serviced before each flight at temperatures below −35°C (−31°F).

## BEFORE STARTING ENGINES.

A ground power unit with two 28-volt d-c leads, each having a capacity of 500 amperes, is required for starting engines.

1. Pilot's seat—Adjust as desired. At temperatures below −35°C (−31°F), heat must be applied to the seat mechanism before the seat can be adjusted.

2. Hydraulic handpump handle—Install in pump. In flight, the radar observer may not be able to reach the handle in its stowed position because of his heavy arctic clothing.

3. Hydraulic supplemental pump—Check.

**Note**

Under some conditions of extreme subzero temperatures, difficulty in maintaining normal hydraulic pressure during supplemental pump check may occur. Operation of pump for from 3 to 5 minutes should provide normal pump operation.

4. In extremely low temperatures, below −40°C (−40°F), apply heat to the back side of the landing gear handle mechanism to clear any ice from the selector valve cable and prevent possible cable slippage.

## STARTING ENGINES.

Follow normal starting procedure outlined in Section II. When the engine reaches 10% rpm, open the throttle halfway and return to IDLE. This additional movement of the throttle loosens any connections that have become stiff, but does not alter the fuel flow. Oil pressure may be high after starting cold engines. This is not dangerous unless the pressure remains high. Delay takeoff until the pressure drops to normal.

**CAUTION**

When ambient temperature is 0°C (32°F) or below, have hot air from a portable heater blown into the engine air intake ducts and exhaust nozzles for 10 to 15 minutes. This procedure prevents the starter-generator unit from being damaged due to ice seizure of the compressor rotor.

## GROUND TESTS.

Because of increased air density at low ambient temperatures, thrust developed at all engine speeds is greater than normal. For ground tests at low temperatures use the following procedures:

1. Generator—Check output and make all checks requiring electrical power before having external power disconnected.
2. Cabin heat, windshield heat, and canopy defog—As required.

**CAUTION**

To prevent cracking of the windshield glass, keep windshield heat switch at NORMAL for at least 1 minute before turning to EMER. Never keep windshield heat switch at EMER longer than necessary.

3. Flight controls—Check operation. At temperatures below −35°C (−31°F), operate flight controls three or four times during engine runup until flight controls operate freely and easily.

**CAUTION**

At very low temperatures, hydraulic packing may fail and cause hydraulic leaks. Have ground personnel check flight control mechanism access doors for signs of excessive leakage.

4. Wing flaps—Check operation.
5. Speed brakes—Check operation and cycle several times to assure free movement.
6. Instruments—Check operation. Flight instruments require approximately 2 minutes for warmup.

**WARNING**

In cold weather, make sure that all instruments have warmed up sufficiently to ensure normal operation. Check for sluggish instruments during taxiing.

## TAXIING INSTRUCTIONS.

When taxiing in cold weather, observe the following precautions:

1. Avoid taxiing in deep snow because taxiing and steering are very difficult, and the brakes may freeze.
2. Taxi very slowly on icy or wet surfaces; the airplane is difficult to control during a skid.
3. Maintain directional control with nose wheel steering.

**CAUTION**

Under freezing conditions, use caution when actuating nose wheel steering on taxiing out of parking area or after landing. Nose wheel may be frozen in deflected position.

**Note**

The airplane has a strong tendency to weathervane when taxiing on ice; however, the steerable nose wheel will greatly facilitate directional control.

**CAUTION**

To preserve the battery, use only essential electrical equipment while taxiing at low engine speeds.

4. When taxiing behind another airplane on icy taxiways, allow enough distance between airplanes to stop safely and to prevent icing of the airplane surfaces by melted snow and ice in the jet blast of the preceding airplane.
5. When fine powder snow is on the taxiway, the preceding airplane's jet blast will cause a large blinding cloud of flying snow; the distance between airplanes must be increased for visibility.
6. Minimize taxi time to conserve fuel and to reduce amount of fog generated by jet engines.
7. At very low temperatures, operate flight controls frequently.

## BEFORE TAKEOFF.

When the taxiway is covered with ice, a full power check may not be possible before takeoff because the airplane may slip on the ice. In this case, the power check can be made at the start of the takeoff run by opening the throttles rapidly and turning on the afterburners. If afterburners do not ignite on both engines, discontinue takeoff. Very low temperatures do not appreciably affect rudder and elevator operation. However, at temperatures below −35°C (−31°F), the ailerons become stiff and should be cycled several times before takeoff to ensure easy movement.

1. Rocket heater switch—ON if mission requires use of rockets.
2. Anti-icing system—ON if necessary.

**WARNING**

During takeoff the anti-icing switch should not be used in the FLIGHT position unless the runway will allow a 20 to 25 percent longer run than required for a normal takeoff. This is due to the reduction of engine thrust caused by anti-icing hot air being bled (at a very high rate) from the 11th stage of the engine compressors whenever the anti-icing system is used with the switch placed in the FLIGHT position.

3. Fuel filter de-ice switch—Hold at each position for approximately 10 seconds to remove any accumulation of ice.

## TAKEOFF.

At the start of the takeoff run, advance the throttles rapidly and turn on afterburners to make power check. If afterburner on either engine does not ignite, do not take off. After a takeoff from a snow or slush covered field, operate the landing gear, wing flaps, and speed brakes several times to remove slush and snow that might cause these units to freeze in the streamlined positions.

**CAUTION**

Do not exceed landing gear and flap structural airspeed limitations.

Arctic flight tests have shown that light frost accumulations have no effect on takeoff and disappear at 250 knots IAS. At very low temperatures, do not apply brakes after takeoff to stop the wheels spinning because the brakes may freeze in the braked position.

**WARNING**

Depending on the weight of snow and ice accumulated, takeoff distances and climb-out performance can be seriously affected. The roughness and distribution of the ice and snow could vary stall speeds and characteristics to an extremely dangerous degree. Loss of an engine shortly after takeoff is a serious enough problem without the added, and avoidable, hazard of snow and ice on the wings. In view of the unpredictable and unsafe effects of such a practice, the ice and snow must be removed before flight is attempted.

## DURING FLIGHT.

Flight characteristics are unchanged by arctic conditions except for aileron stiffness at temperatures below −35°C (−31°F). The ailerons should be operated periodically throughout the flight if these temperatures are encountered. If only the left hydraulic system is operating, the rudder should also be operated periodically. Turn on de-icing and anti-icing systems as needed. Check all instruments since some instruments may be unreliable at low temperatures. Before penetration, fuel filter de-icing should be used for 10 seconds in each fuel system to de-ice the filters and engine fuel controls.

**Note**

Engine fuel control icing will cause the fuel flowmeter to fluctuate. This indicates that flameout of an engine may be imminent.

## APPROACH TO PATTERN.

At temperatures below −35°C (−31°F), operate the ailerons several times before entering the pattern to ensure smooth and easy operation. Follow normal pattern and approach procedures, but allow for longer approach than normal because high thrust at low temperature results in a flatter glide. Wing flap extension requires 2 seconds longer than normal, and retraction requires 7 seconds longer than normal at −65°F. Speed brake operation requires a maximum of 1.5 seconds additional time to open or close at −65°F. Normal landing gear extension and retraction requires 2 seconds longer at 65°F; however, emergency extension requires 25 seconds longer.

**Note**

- When making GCA approaches during arctic operations, decrease power settings about 3 percent because of increased thrust at low temperatures.
- The windshield and canopy defrost systems should be operated at the highest temperature possible (consistent with the pilot's comfort) during high-altitude flight in order to provide sufficient preheating of the transparent surfaces to preclude the formation of frost or fog during descent.
- On initial approach use alcohol on each engine for 10 seconds.

## LANDING.

**CAUTION**

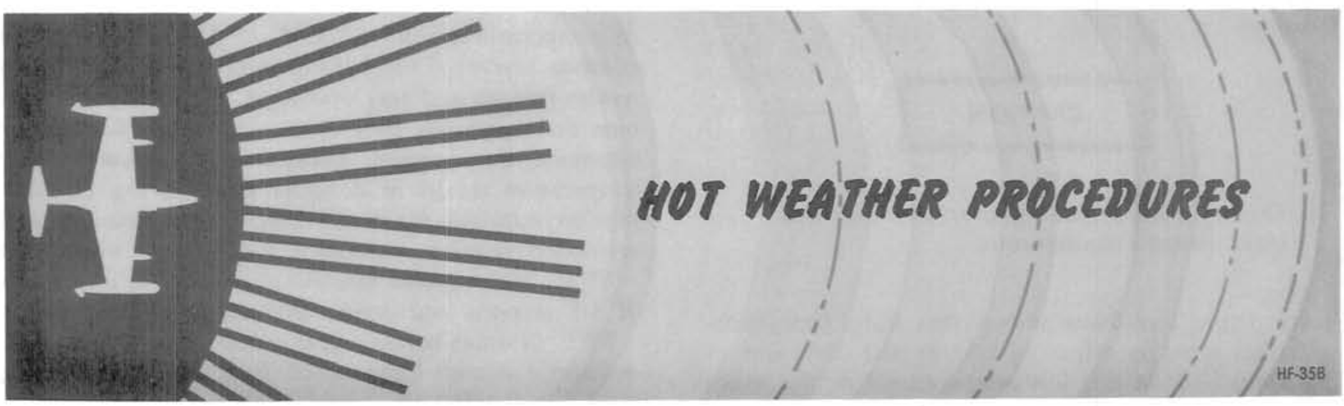
Operation of anti-icing system during landing affords protection against icing conditions but causes loss of thrust. If a go-around is necessary, the anti-icing switch may remain in the FLIGHT position only if two engines with maximum thrust and afterburning are available.

For minimum landing roll on wet or icy runways, both the wing flaps and speed brakes should be fully extended during landing roll, and the right engine should be shut down immediately after three wheel contact. Open the speed brakes after main gear touches down and leave extended until after turning off runway. The aerodynamic drag of the wing flaps and speed brakes partially offsets the decreased braking efficiency experienced when landing on wet and icy runways and the thrust eliminated by shutting down the idling right engine will aid in reducing the landing roll. Apply brakes carefully and intermittently after touchdown. If the airplane has snow-and-ice tires, apply brakes carefully and intermittently after touchdown to prevent tread from filling and glazing over. Glazing reduces braking effectiveness on icy runways, and landing ground roll distances may be increased as much as 100 percent more than the distances shown in the Landing Distance Chart (see Appendix).

## BEFORE LEAVING AIRPLANE.

Check that ground personnel perform the following:

1. Service airplane as soon as possible.
2. Remove dirt and ice from shock struts.
3. Clear snow and ice from nose wheels.
4. Service canopy jettison system and airbrake bottle if temperature is below −35°C (−31°F) and the airplane is to be used for another flight.
5. Check flight control access doors for signs of excessive hydraulic leakage.
6. Install plugs in engine air intake ducts, exhaust nozzles, and engine nacelle doors.
7. Cover pitot tubes and all static air sources.
8. Check fuel pumps, filters, and draincocks for ice and drain condensate within 30 minutes after stopping engines.
9. Bleed and recharge engine screen pneumatic system.
10. Install covers on wings, empennage, and canopy.
11. Remove battery and store in a heated room if layover of several days is anticipated, or if temperature is below −29°C (−20°F).




## INTRODUCTION.

Takeoff and landing rolls are longer in hot weather because of the lower air density which also lengthens takeoff rolls by decreasing engine performance. Added precaution should be taken to protect rubber and plastic parts of the airplane from damage by excessive heat.

## BEFORE ENTERING THE AIRPLANE.

Check tires for blisters, abrasions, proper inflation, and excessive wear. Be sure external ground cooler is disconnected.

## TAKEOFF.

Anticipate a longer takeoff distance than normal. Refer to Appendix I, figure A-6 for takeoff distances.

## AFTER TAKEOFF—CLIMB.

Be sure to maintain specified climbing airspeed, correcting maximum rates of climb as required by the effects of high temperatures on rates of climb encountered under hot weather flight conditions. Refer to Climb Chart in Appendix.

## LANDING.

Anticipate longer landing distances and use minimum wheel braking to prevent overheating of brakes. Refer to Appendix I, figure A-29 for applicable landing distance charts.

## BEFORE LEAVING AIRPLANE.

Be sure canopy is protected from direct rays of the sun.


## INTRODUCTION.

When operating under desert conditions, the normal hot weather procedure is followed. In addition, precautions must be taken to prevent external abrasion of the airplane surfaces and to keep sand and dust from entering the airplane systems.

## BEFORE ENTERING THE COCKPIT.

1. Check exposed shock struts and actuating cylinders for dust and sand. Have them cleaned if necessary.
2. Check all air intakes for sand and dust.
3. Check wheel brake disks for excessive abrasion.

## BEFORE TAKEOFF.

Do not run engines during a dust or sand storm unless absolutely necessary. Before engine runup, position the airplane so it will not receive dust from, or blow dust on, other airplanes.

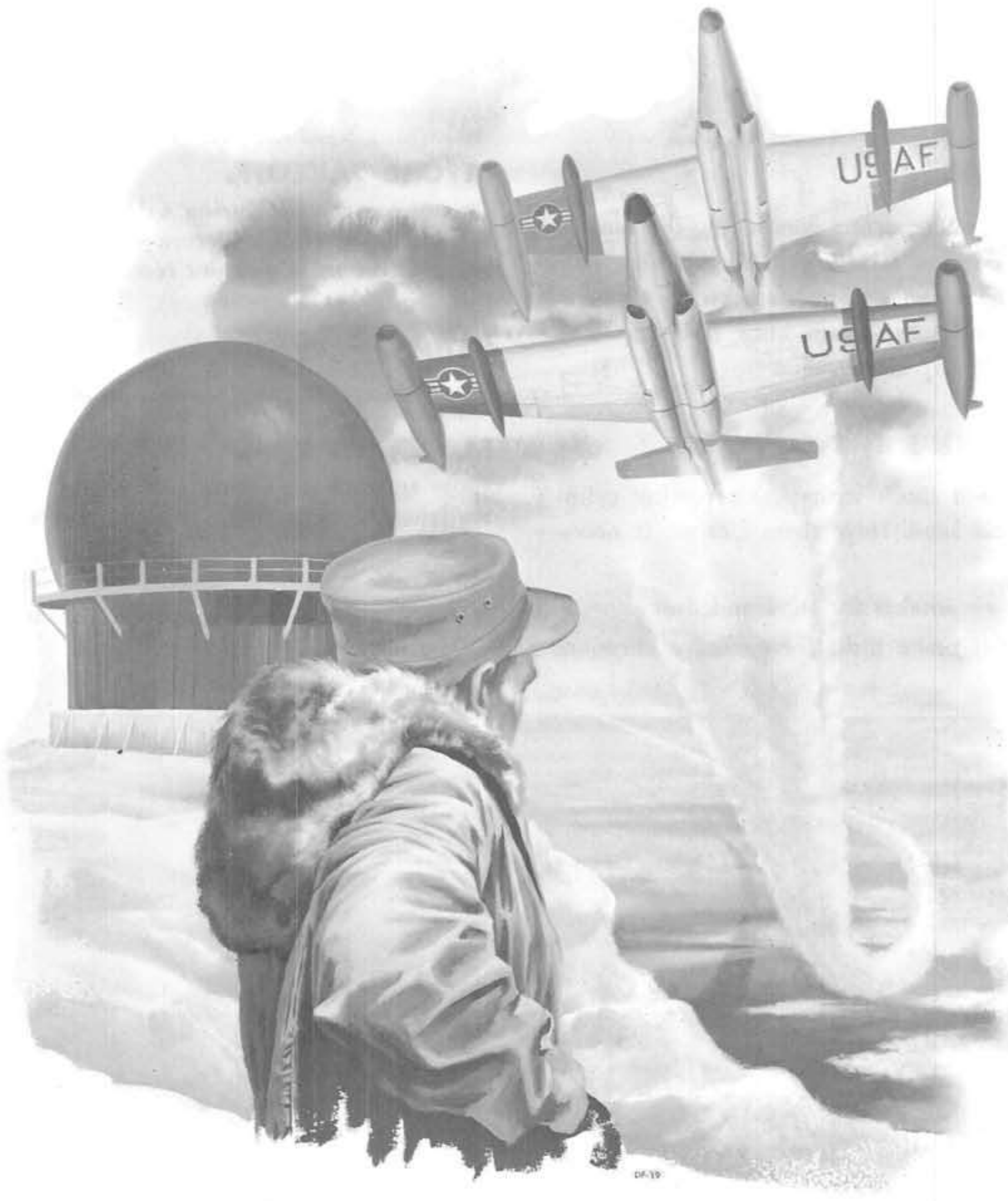
## TAKEOFF.

Avoid takeoff in blowing dust or sand.

## BEFORE LEAVING AIRPLANE.

Close and seal the canopy during dust or sand storms, and check that ground personnel perform the following:

1. Cover canopy to prevent sand abrasion.
2. Cover all air intakes and ducts as soon as possible after landing.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# PERFORMANCE DATA

APPENDIX I


## TABLE OF CONTENTS



## INTRODUCTION.

The flight performance charts in this section provide the pilot with flight planning data and airspeed and ambient temperature correction data. Two types of performance charts are included: profile-type charts for maximum range, endurance, and continuous power operation, and graphical charts for takeoff, climb, nautical miles per 1000 pounds of fuel, descents, and landings.

### PROFILE CHARTS.

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 configuration involved and give direct indication of the fuel and time required to cover a given distance if the recommended settings are adhered to. For flight planning based on settings other than those given on the profile charts, the graphical charts should be used. Decreased weight due to fuel consumption has been accounted for.

### GRAPHICAL CHARTS.

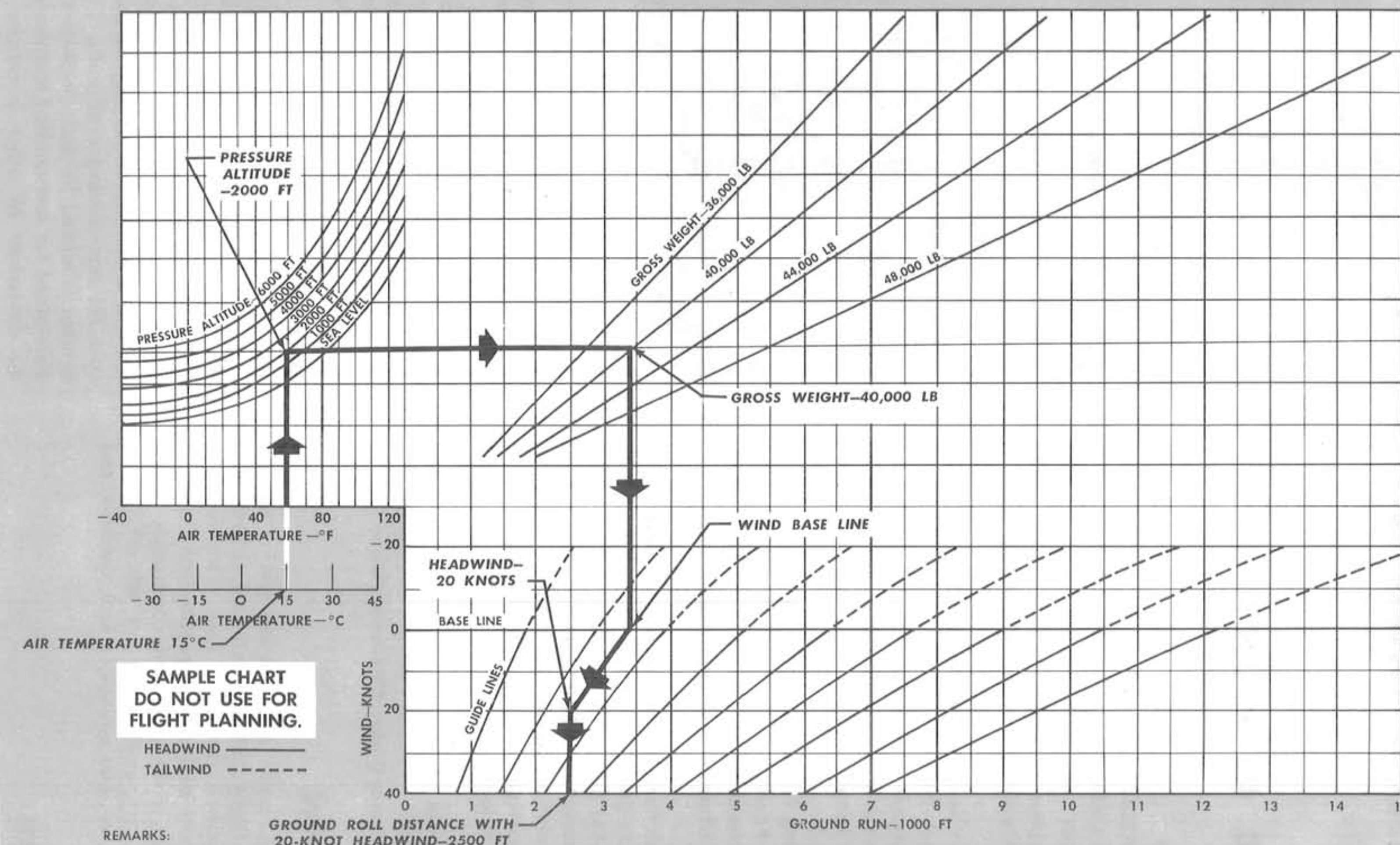
The graphical charts provide detailed performance data for one- and two-engine operation. These charts should be used for flight planning when performance data not covered in the profile charts is needed. Unless otherwise indicated, all data pertains exactly to NACA standard ambient temperatures but may be considered approximate for nonstandard conditions. The CAS or Mach number tabulated for each pressure altitude should be maintained for nonstandard temperatures regardless of the deviations of other quantities from the given values, except when it is necessary to use a lower CAS value or Mach number to avoid exceeding engine limits.

# TAKEOFF DISTANCE

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

MAXIMUM POWER
WITH OR WITHOUT PYLON TANKS

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL



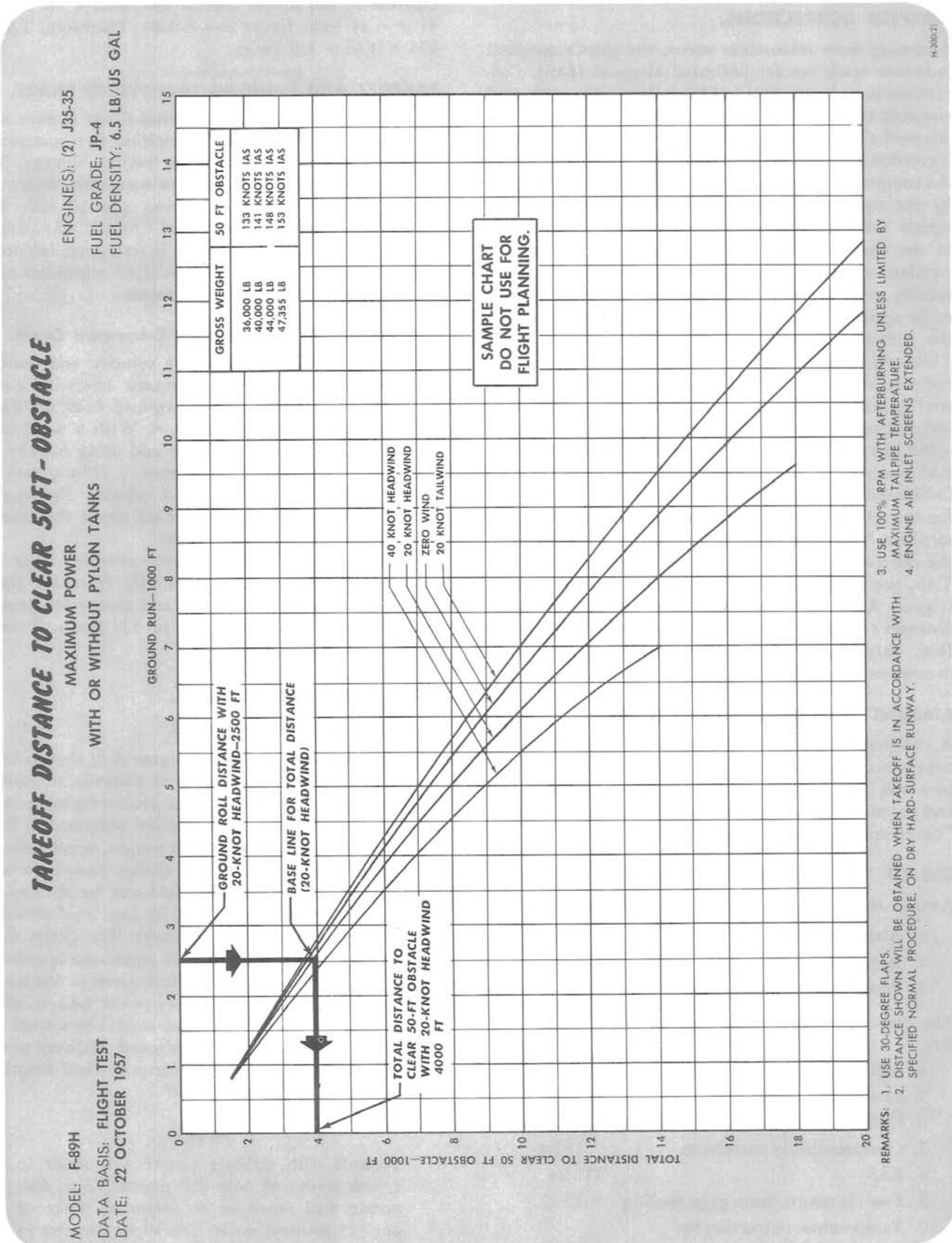

REMARKS:

1. USE 30 DEGREE FLAPS.
2. DISTANCE SHOWN WILL BE OBTAINED WHEN TAKEOFF IS IN ACCORDANCE WITH SPECIFIED NORMAL PROCEDURE, ON DRY, HARD SURFACE RUNWAY.
3. USE 100% RPM WITH AFTERBURNING UNLESS LIMITED BY MAXIMUM TAILPIPE TEMPERATURE.
4. ENGINE AIR INLET SCREENS EXTENDED.

| GROSS WEIGHT | NOSE WHEEL OFF | TAKEOFF |
|---|---|---|
| 36,000 LB | 120 KNOTS IAS | 124 KNOTS IAS |
| 40,000 LB | 127 KNOTS IAS | 131 KNOTS IAS |
| 44,000 LB | 133 KNOTS IAS | 138 KNOTS IAS |
| 47,355 LB | 138 KNOTS IAS | 143 KNOTS IAS |

H-300(1)

*Sample.*


TAKEOFF DISTANCE TO CLEAR 50FT-OBSTACLE
MAXIMUM POWER
WITH OR WITHOUT PYLON TANKS
MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957
ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL
GROSS WEIGHT | 50 FT OBSTACLE
36,000 LB | 133 KNOTS IAS
40,000 LB | 141 KNOTS IAS
44,000 LB | 148 KNOTS IAS
47,355 LB | 153 KNOTS IAS
GROUND RUN—1000 FT
TOTAL DISTANCE TO CLEAR 50 FT OBSTACLE—1000 FT
GROUND ROLL DISTANCE WITH 20-KNOT HEADWIND—2500 FT
BASE LINE FOR TOTAL DISTANCE (20-KNOT HEADWIND)
TOTAL DISTANCE TO CLEAR 50-FT OBSTACLE WITH 20-KNOT HEADWIND 4000 FT
40 KNOT HEADWIND
20 KNOT HEADWIND
ZERO WIND
20 KNOT TAILWIND
SAMPLE CHART DO NOT USE FOR FLIGHT PLANNING.
REMARKS: 1. USE 30-DEGREE FLAPS.
2. DISTANCE SHOWN WILL BE OBTAINED WHEN TAKEOFF IS IN ACCORDANCE WITH SPECIFIED NORMAL PROCEDURE, ON DRY HARD-SURFACE RUNWAY.
3. USE 100% RPM WITH AFTERBURNING UNLESS LIMITED BY MAXIMUM TAILPIPE TEMPERATURE.
4. ENGINE AIR INLET SCREENS EXTENDED.
H-300(2)

*Sample.*

# CORRECTION TABLES.

## AIRSPEED CORRECTIONS.

Assuming zero instrument error, the pilot's airspeed indicator reads correct indicated airspeed (IAS). Corrections must be applied to IAS to determine calibrated airspeed (CAS), equivalent airspeed (EAS), and true airspeed (TAS). The algebraic sum of the installation correction and IAS equals CAS. The CAS value minus the compressibility correction equals EAS. EAS divided by the square root of the relative air density ($\sqrt{\alpha}$) equals TAS. Relative air density is equal to the ratio of the free airstream ambient density at altitude to standard sea level density. Wind velocity added vectorially to TAS equals ground speed (GS). Corrections to be applied to convert IAS to CAS are tabulated in the Airspeed Position Correction Table (figure A-1). These corrections are given for values of IAS and pressure altitude for the operating range of the clean configuration; corrections for flap settings and gross weights are also shown. Landing gear position does not affect airspeed readings. Values for converting CAS to EAS are shown in the Compressibility Correction to Calibrated Airspeed Table (figure A-2) which covers the operating CAS and pressure altitude range of the airplane. Values of the reciprocal of the square root of the relative air density ($1 \div \sqrt{\alpha}$), used for determining TAS, are obtained from the Density Altitude Chart (figure A-4). The airspeed indicator in the radar observer's cockpit indicates approximate TAS; therefore, only the wind correction need be applied to determine ground speed.

## AMBIENT TEMPERATURE CORRECTIONS.

A compressibility correction must be applied to the temperature gage reading to obtain true ambient temperature. The correction is shown as a function of CAS and pressure altitude in the Temperature Correction for Compressibility Table (figure A-3).

## USE OF THE CORRECTION TABLES.

Assume the following instrument readings:

| | |
|---|---|
| 1. Altimeter | 35,000 ft |
| 2. Airspeed indicator | 284 kn |
| 3. Free air temperature gage | −19°C |

The correct airplane speed and ambient temperature are:

| | |
|---|---|
| 4. IAS (zero instrument error) | 284 kn |
| 5. Installation correction | +5 kn |
| 6. CAS | 289 kn |
| 7. Compressibility correction | −18 kn |
| 8. EAS | 271 kn |
| 9. Free air temperature gage reading | −19°C |
| 10. Temperature correction for compressibility error. | −25°C |
| 11. Correct ambient temperature | −44°C |

At 35,000-foot pressure altitude and −44°C, the reciprocal of the square root of the relative air density ($1 \div \sqrt{\alpha}$) from figure A-4 is 1.85. Therefore, TAS is $271 \times 1.85 = 501$ knots.

## TAKEOFF AND LANDING CROSSWIND CHART.

A Takeoff and Landing Crosswind Chart (figure A-5) enables the pilot to convert crosswind to a component headwind down the takeoff or landing runway. The component headwind is used to accurately determine takeoff ground run and landing ground roll. The Takeoff and Landing Crosswind Chart is also used to determine if takeoff or landing is recommended under crosswind conditions at the predicted minimum nosewheel liftoff and touchdown speeds.

### Use of Takeoff and Landing Crosswind Chart.

When the wind direction and velocity and runway heading are known, the component headwind down the takeoff runway can be determined from the Takeoff and Landing Crosswind Chart. With a wind from 330 degrees at 20 knots velocity and using runway 27, the chart is entered at (330 degrees − 270 degrees) 60-degree angle and 20-knot wind velocity. Reading to the left, the component headwind down the takeoff runway is found to be 10 knots.

To determine if takeoff is recommended under the above conditions, proceed vertically from the intersection of runway wind angle and crosswind lines to the predicted takeoff airspeed of 134 knots. Takeoff is found to be recommended.

# PERFORMANCE CHARTS.

## TAKEOFF DISTANCE CHARTS.

The Takeoff Distance Charts (figure A-6) show takeoff distances (ground roll and total distance to clear a 50-foot obstacle) as a function of gross weight, pressure altitude, wind velocity, and ambient temperature for a dry, hard-surface runway. Gross weight, wind velocity, and ambient temperature are always known factors; the pressure altitude of the field can be determined by setting the altimeter to 29.92 (sea level standard day pressure in inches of mercury). The charts show data for two-engine takeoffs with maximum or military power, using the normal procedure given in Section II. If an engine fails during military power takeoff, afterburning on the operating engine should be started immediately or the takeoff discontinued. Military power data may be used to estimate adequate field length if afterburners fail during takeoff.

**Note**

Takeoff with military power will result in a fuel saving of only 250 pounds. This fuel saving will result in an increased range of only 25 nautical miles. The slight increase in range must be weighed against the additional risks involved in military power takeoffs.

Single-engine maximum power takeoff data is also included to determine the required takeoff distance when power on one engine is lost during takeoff (see Section III). If the takeoff technique used is different from that specified in Section II, the distances will differ from those shown in the charts. A deviation of 5 percent from the airspeeds in Section II will result in a distance deviation of 10 percent or more.

#### Use of Takeoff Distance Charts.

The Takeoff Distance Sample Chart shows a maximum power takeoff at an ambient air temperature of 15°C, pressure altitude of 2000 feet, gross weight of 40,000 pounds and a 20-knot headwind. This results in a ground roll of 2500 feet and a total distance of 4000 feet to clear a 50-foot obstacle.

### CRITICAL FIELD LENGTH CHART.

The Critical Field Length Chart (figure A-7), in conjunction with the Refusal Speed Chart (figure A-8), can be used to determine a course of action if an engine fails at any point during the takeoff ground run for any combination of critical field and runway lengths. For example, comparison of the critical field length with the runway length available indicates the following takeoff limitations:

*Runway Length Greater Than Critical Field Length.*

1. At engine failure speeds below refusal speed: if the runway is longer than necessary for one-engine takeoff, the pilot has the option of either taking off or stopping. If the runway is shorter than necessary for one-engine takeoff, pilot must stop.

2. At engine failure speeds above refusal speed, pilot must take off, as stopping within the limits of the runway is impossible.

*Critical Field Length Greater Than Runway Length.*

1. At engine failure speeds below refusal speed, pilot must stop, as takeoff within the limits of the runway is impossible.

2. At engine failure speeds above refusal speed, the pilot must take off with remaining engine.

#### Use of Critical Field Length Chart.

The Critical Field Length Sample Chart shows a maximum power takeoff with ambient air temperature of 15°C, a pressure altitude of 2000 feet, a gross weight of 40,000 pounds, and a 20-knot headwind. These conditions indicate a critical field length of 4600 feet. According to the Takeoff Distance Chart (figure A-6) for one-engine takeoff, the runway length required for one-engine takeoff is 6800 feet. If the available runway length is 6000 feet, the refusal speed is found to be 109 knots IAS. Thus, the available runway length is greater than the critical field length but shorter than necessary for one-engine takeoff. Under these conditions, if the speed at the point of engine failure is less than 109 knots IAS, the pilot should stop the airplane rather than attempt a one-engine takeoff; if the speed at the point of engine failure is greater than 109 knots IAS, the pilot should take off, as stopping within the limits of the runway would not be possible.

### REFUSAL SPEED CHART.

The Refusal Speed Sample Chart shows a maximum mum speed at which engine failure permits stopping at the end of the runway. It is based on normal takeoff procedure and a dry, hard-surface runway.

#### Use of Refusal Speed Chart.

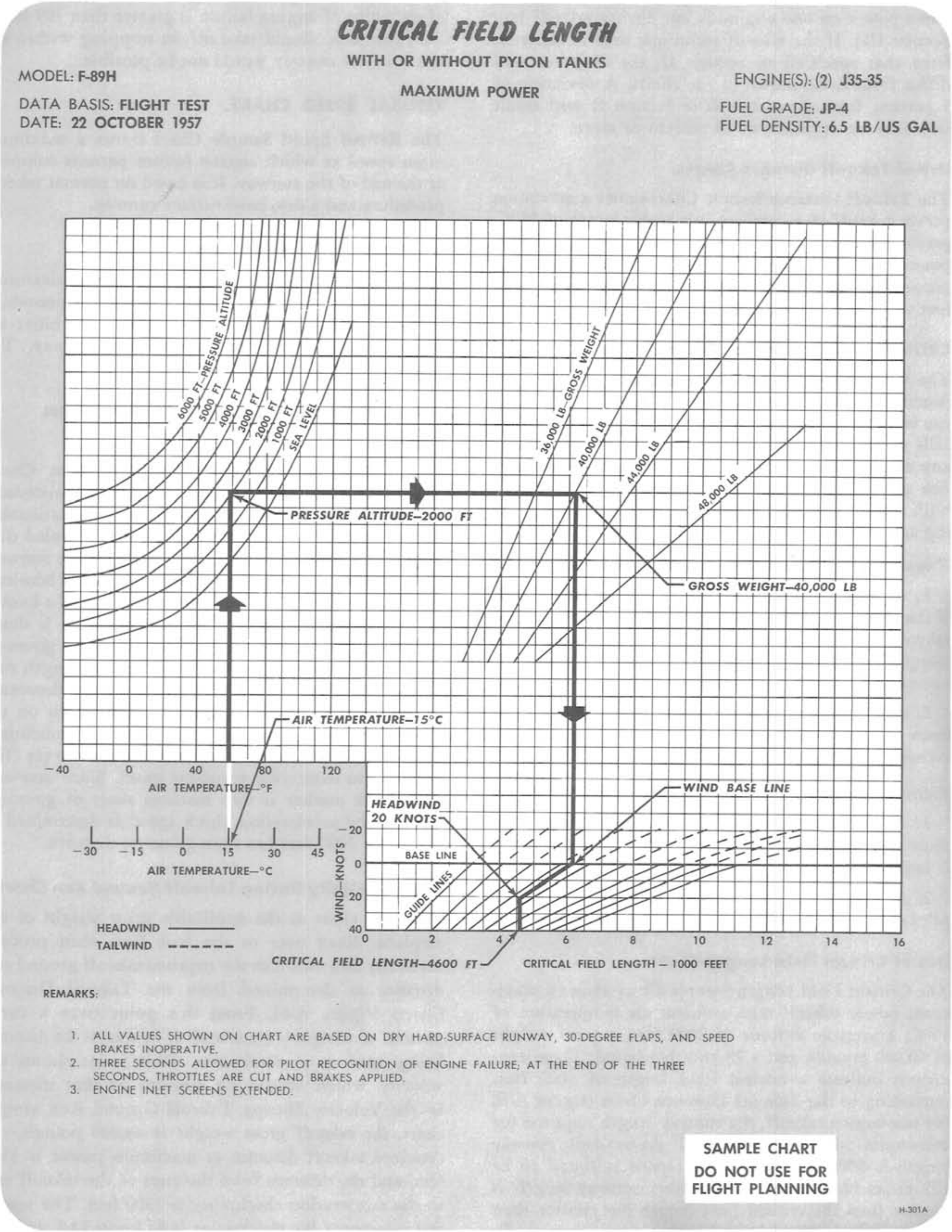
The Refusal Speed Sample Chart shows a maximum power takeoff at a gross weight of 46,000 pounds, a pressure altitude of 2000 feet with an ambient air temperature of 59°F, and a 7000-foot runway. The resulting refusal speed is 114 knots.

### VELOCITY DURING TAKEOFF GROUND RUN CHARTS.

The Velocity During Takeoff Ground Run Charts (figure A-9) are based on normal operating procedures as specified in Section II and show the relationship between indicated airspeed and distance traveled during takeoff ground run on a dry, hard-surface runway. These charts are useful for checking takeoff acceleration by reference to a go-no-go marker located a known distance from the end of the runway. This is determined by subtracting distance remaining at go-no-go marker from runway available. 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. This distance is used to enter acceleration curves (figure A-9) to determine go-no-go speed. Since acceleration check marker is two markers short of go-no-go marker, the acceleration check speed is determined at a distance 2000 feet less than go-no-go distance.

#### Use of Velocity During Takeoff Ground Run Charts.

Enter the chart at the applicable gross weight of the airplane. Read over to the base line, then proceed vertically downward to the required takeoff ground run distance as determined from the Takeoff Distance Charts (figure A-6). From this point trace a curve parallel to the guide lines until it intersects the distance being used as a checkpoint. This point shows the velocity which should be attained at that distance. In the Velocity During Takeoff Ground Run sample chart, the takeoff gross weight is 43,000 pounds, the required takeoff distance at maximum power is 3500 feet, and the distance from the start of the takeoff run to the acceleration checkpoint is 1500 feet. The resulting velocity at the checkpoint is 84 knots IAS, and the takeoff velocity is 136 knots IAS.


CRITICAL FIELD LENGTH
WITH OR WITHOUT PYLON TANKS
MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957
MAXIMUM POWER
ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL
6000 FT—PRESSURE ALTITUDE
5000 FT
4000 FT
3000 FT
2000 FT
1000 FT
SEA LEVEL
36,000 LB—GROSS WEIGHT
40,000 LB
44,000 LB
48,000 LB
PRESSURE ALTITUDE—2000 FT
GROSS WEIGHT—40,000 LB
AIR TEMPERATURE—15°C
−40
0
40
80
120
AIR TEMPERATURE—°F
−30
−15
0
15
30
45
AIR TEMPERATURE—°C
WIND BASE LINE
HEADWIND
20 KNOTS
BASE LINE
GUIDE LINES
WIND—KNOTS
HEADWIND
TAILWIND
CRITICAL FIELD LENGTH—4600 FT
CRITICAL FIELD LENGTH — 1000 FEET
0
2
4
6
8
10
12
14
16
REMARKS:
1. ALL VALUES SHOWN ON CHART ARE BASED ON DRY HARD-SURFACE RUNWAY, 30-DEGREE FLAPS, AND SPEED BRAKES INOPERATIVE.
2. THREE SECONDS ALLOWED FOR PILOT RECOGNITION OF ENGINE FAILURE; AT THE END OF THE THREE SECONDS, THROTTLES ARE CUT AND BRAKES APPLIED.
3. ENGINE INLET SCREENS EXTENDED.
SAMPLE CHART
DO NOT USE FOR
FLIGHT PLANNING
H-301A

*Sample.*

## REFUSAL SPEEDS

MAXIMUM POWER

WITH OR WITHOUT PYLON TANKS

MODEL: **F-89H**

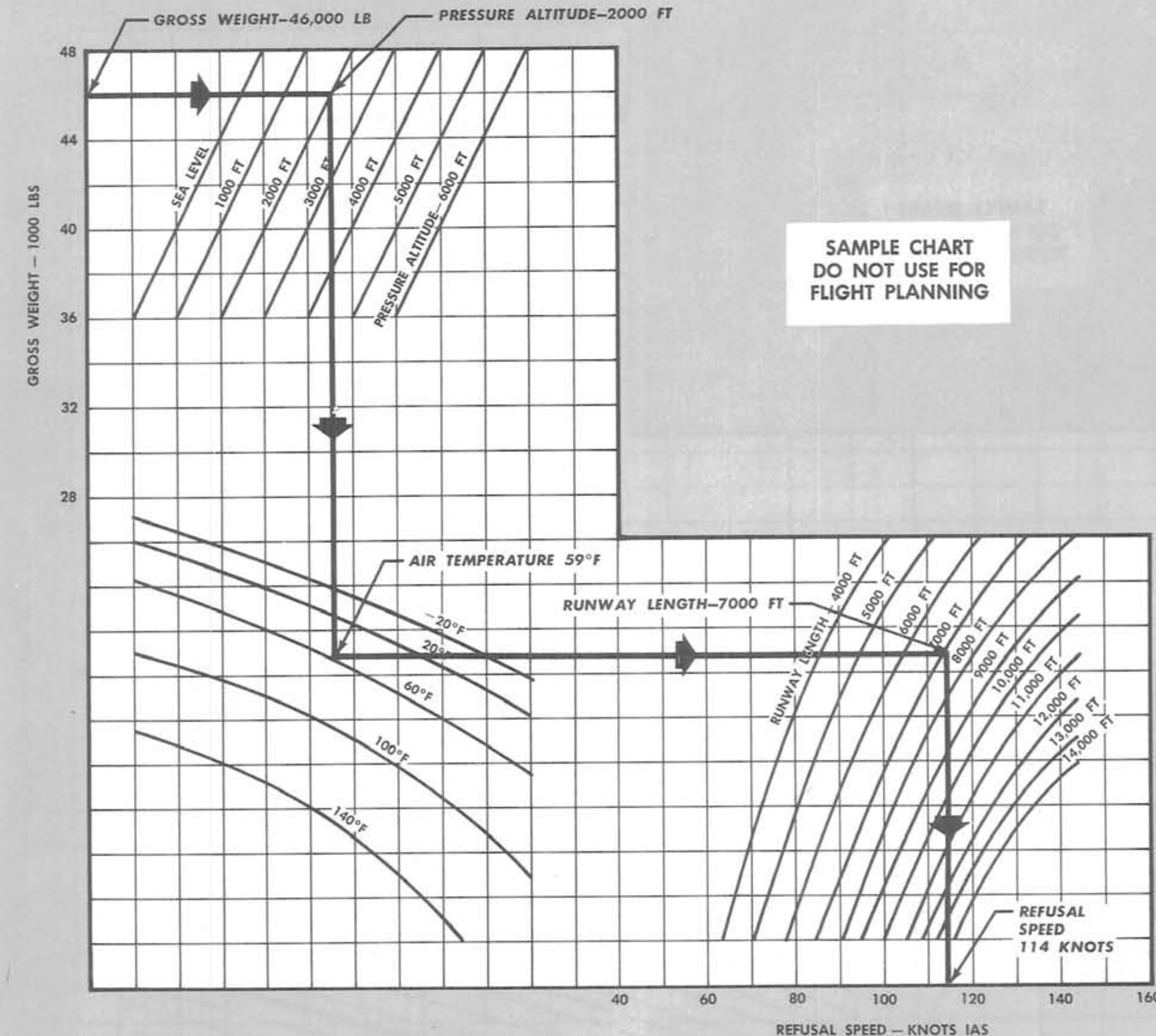
DATA BASIS: **FLIGHT TEST**

DATE: **22 OCTOBER 1957**

ENGINE(S): (2) J35-35

FUEL GRADE: **JP-4**

FUEL DENSITY: **6.5 LB/US GAL**




REMARKS:

1. ABOVE VALUES ARE BASED ON DRY HARD-SURFACE RUNWAY, USING SPECIFIED NORMAL TAKEOFF PROCEDURE UP TO POINT OF ENGINE FAILURE AND OPERATION IN ACCORDANCE WITH SECTION III AFTER ENGINE FAILURE.
2. ENGINE AIR INLET SCREENS EXTENDED.

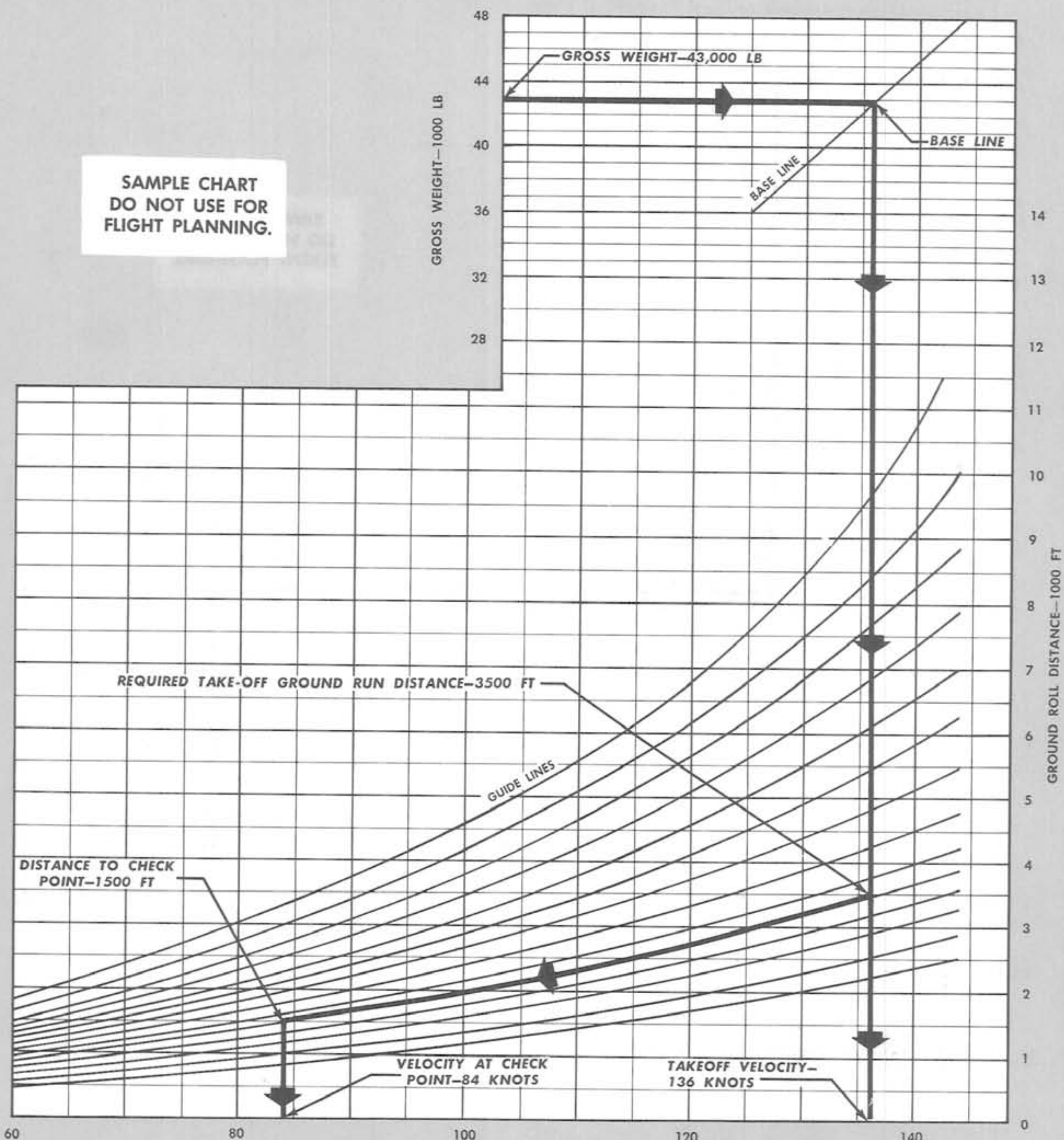
*Sample.*

# VELOCITY DURING TAKEOFF GROUND RUN

MAXIMUM POWER
WITH OR WITHOUT PYLON TANKS

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. VELOCITIES SHOWN WILL BE OBTAINED WHEN TAKEOFF IS IN ACCORDANCE WITH SPECIFIED NORMAL PROCEDURE.
2. ENGINE AIR INLET SCREENS EXTENDED.

H-303

*Sample.*

## MINIMUM DISTANCE CLIMB CHART.

Depending on gross weight and thrust, minimum distance climb (maximum angle of climb) at low altitudes may be obtained at the applicable airspeeds shown in figure A-10.

## USE OF MINIMUM DISTANCE CLIMB CHARTS.

Enter the applicable configuration chart at the intended gross weight and read up to the proper intersecting thrust line. From the point of intersection of gross weight and thrust lines, follow to the left and read minimum distance climb airspeed from the left side of the chart. For a climb following takeoff, initial climb weight is the takeoff gross weight minus the 906-pound takeoff fuel allowance.

## BEST CLIMB CHARTS.

The Best Climb Charts (figures A-11 through A-19) show climb performance in terms of fuel, time, air distance, rate of climb, and climb CAS necessary to attain this performance. Data is given for climbing with two engines at maximum, military, and normal power, and with one engine at maximum and military power. The fuel, time, and air distance values shown include the effects of kinetic energy change and weight reduction during climb, but do not include any allowance for start, takeoff, or acceleration. Time and distance are plotted against gross weight with guide lines to show the reduction in gross weight during climb due to fuel consumption. In most cases, three charts are provided for each configuration and power setting: these include two Best Climb Performance Charts (one plotted against distance, the other plotted against time): and one Best Climb Speed Chart (showing rate of climb and best climb CAS).

### Use of Best Climb Charts.

To obtain the desired data from the Best Climb Charts, enter the proper climb chart at the gross weight and altitude at start of climb and note the time (or distance) and fuel used at this point. From this initial point, trace a curve parallel to the guide lines until it intersects the desired altitude at end of climb. Note the time (or distance) and fuel used at this intersection. The difference between the initial and final time is the time required to climb. The difference between the initial and final values for distance and for fuel used gives, respectively, the distance traveled and fuel used in climb. Since time, distance, and fuel used in climb are zero at sea level, these values may be read directly for climbs starting at sea level. It must be kept in mind, however, that for a climb following takeoff, the initial climb weight is the takeoff gross weight minus the 906-pound takeoff fuel allowance. The appropriate sample shows the fuel used and time to climb from 10,000 feet to 35,000 feet using military power with pylon tanks and a gross weight of 41,000 pounds at start of climb. Rate of climb and best climb CAS may be obtained directly from the Best Climb Speed Charts.

## TAKEOFF DATA CARDS.

A Takeoff Data Card (see Abbreviated Checklist, Section II) is to be completed before each flight. The purpose of the takeoff data card is to familiarize the pilot with emergency procedures to be followed in the event of engine failure or other emergencies which may occur on takeoff. Critical field length, refusal speed, acceleration checkpoint speed, and the other information required on the takeoff data card may be found in the Appendix charts.

### Use of Takeoff Data Cards.

**Sample Problem.** Assuming that takeoff flaps are used and that the center of gravity is within limits, the following conditions are given preparatory to completing the Takeoff Data Card that follows:

**TAKEOFF DATA**

| | | | |
|---|---|---|---|
| Gross Weight | 40,000 Lb | Pressure Altitude | 2000 Ft |
| Runway Length | 8000 Ft | Headwind | 20 Kn |
| Temperature | 59°F | Surface (Dry, Wet, Icy) | |
| Takeoff Distance...Normal | 2700 Ft | 50-ft Obstacle | 3500 Ft |
| Takeoff Distance...1 Engine | 7500 Ft | 50-ft Obstacle | 12,300 Ft |
| Critical Field Length | 4600 Ft | Refusal Speed | 131 Kn |

**TAKEOFF (Maximum Power)**

| | | |
|---|---|---|
| Acceleration Check | 75 Knots IAS at | 1000 Ft |
| Nose Wheel Liftoff Speed | | 124 Kn |
| Takeoff Speed | | 129 Kn |
| Initial Climb Speed (To Clear 50-foot Obstacle) | | 141 Kn |

*Decision Factors:*

1. Critical field length is *less* (greater or less) than runway length.

2. If engine failure occurs at a speed *below* maximum refusal speed, you should *abort the takeoff*.

3. If engine failure should occur at a speed *in excess* of refusal speed, you should *proceed with maximum power on operating engine and use engine failure during takeoff procedure.*

## NAUTICAL MILES PER 1000 POUNDS FUEL CHART.

Cruise data throughout the normal speed range may be obtained from the Nautical Miles Per 1000 Pounds Fuel Charts (figures A-20, A-21, and A-22). Each chart includes specific range (nautical miles per 1000 pounds), fuel flow (pounds per hour), and power settings (% rpm), as well as curves of maximum endurance and recommended long-range cruise speeds for zero wind. Specific range is plotted against Mach number, with subscales of calibrated airspeed (CAS) and true airspeed (TAS).

### Use of Nautical Miles Per 1000 Pounds Fuel Charts.

To obtain the cruising range for a given amount of fuel, use the following steps:

1. Select the proper chart for the airplane configuration and altitude.

# BEST CLIMB PERFORMANCE (TIME)

MODEL: F-89H

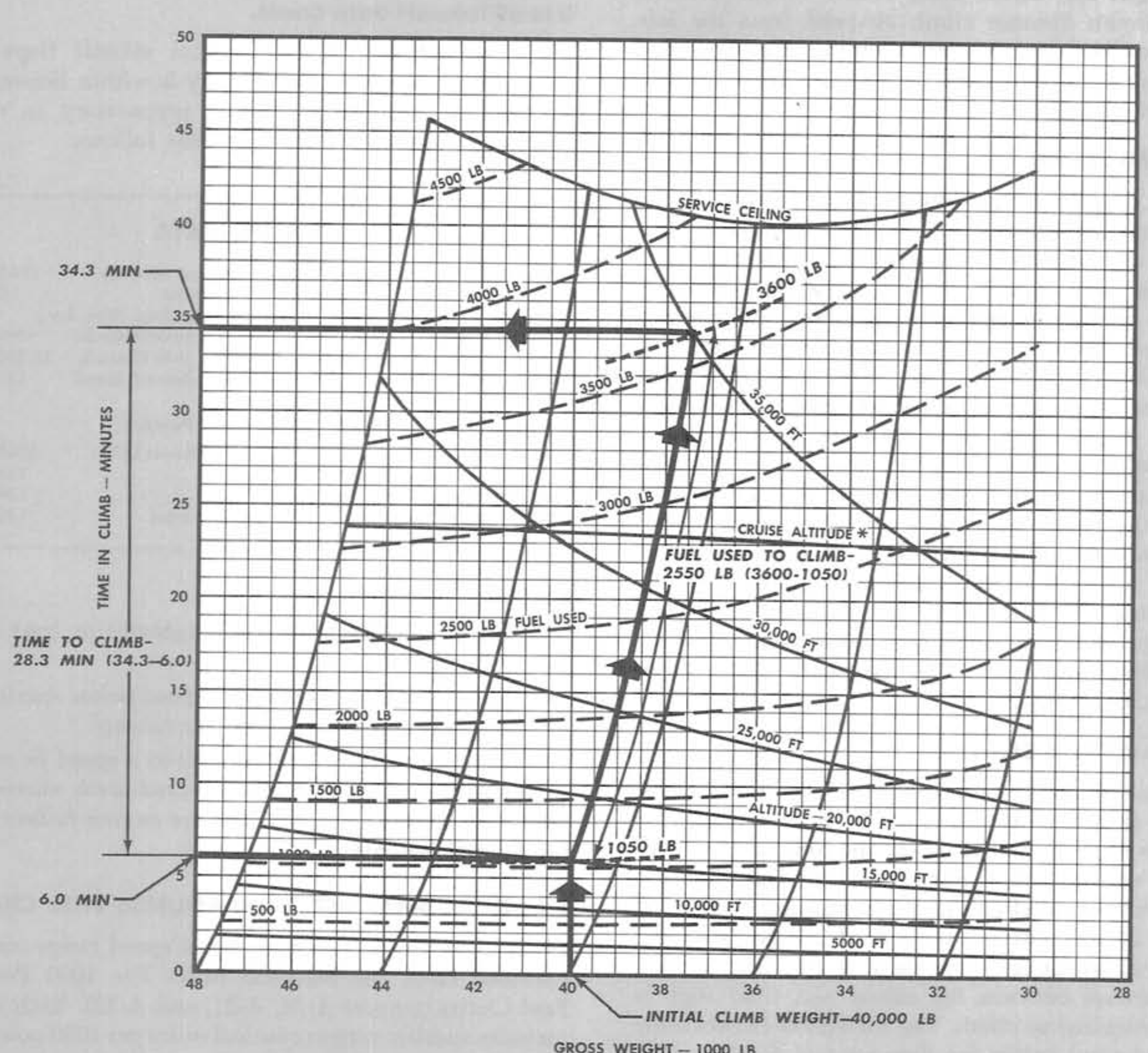
MILITARY POWER

PYLON TANK CONFIGURATION

ENGINE(S): (2) J35-35

DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT FOR SERVICE VARIATION.
2. SUBTRACT 906 POUNDS FROM AVAILABLE FUEL TO ALLOW FOR WARMUP, TAXI, AND TAKEOFF; ENTER CHART AT TAKEOFF GROSS WEIGHT LESS 906 POUNDS.
3. ENGINE AIR INLET SCREENS RETRACTED.

*OPTIMUM CRUISE ALTITUDE – NORMAL RATED POWER.

SAMPLE CHART
DO NOT USE FOR
FLIGHT PLANNING

H-304A

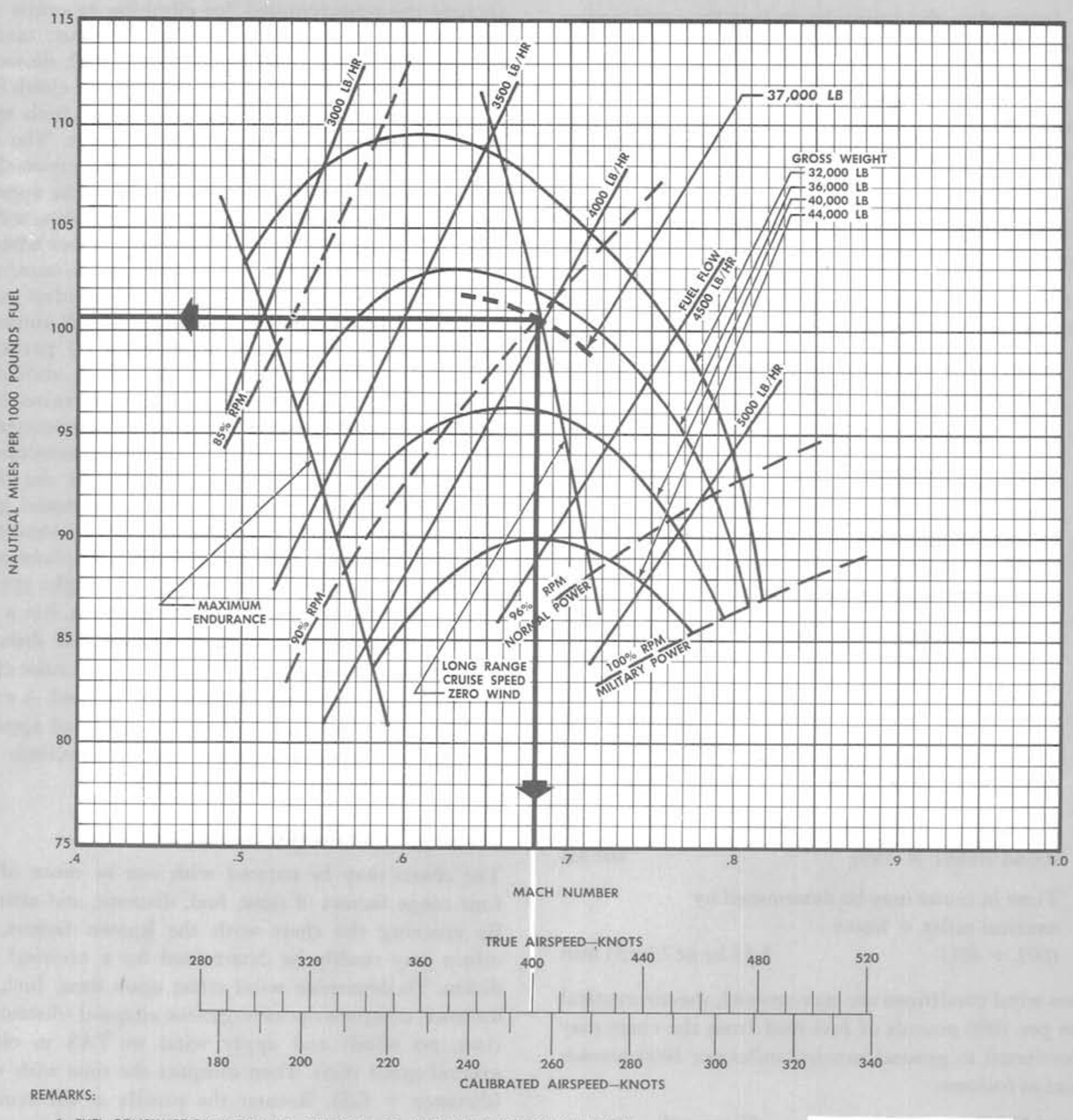
*Sample.*

## NAUTICAL MILES PER 1000 POUNDS FUEL

30,000 FEET
BASIC CONFIGURATION PLUS PYLONS

MODEL: **F-89H**
DATA BASIS: **FLIGHT TEST**
DATE: **22 OCTOBER 1957**

ENGINE(S): **(2) J35-35**
FUEL GRADE: **JP-4**
FUEL DENSITY: **6.5 LB/US GAL**




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

SAMPLE CHART
DO NOT USE FOR FLIGHT PLANNING

H-391A

*Sample.*

2. Determine the average weight of the airplane for the amount of fuel being considered.

3. Enter the graph at this average weight and the desired Mach number, or desired power setting (% rpm), to obtain specific range (nautical miles per 1000 pounds of fuel).

4. Multiply the specific range by the amount of fuel (pounds ÷ 1000) to obtain cruising range.

5. Interpolate the approximate fuel flow and power setting (% rpm) at the Mach number and average weight.

**Sample Problem.** Determine the range obtainable from 6000 pounds of fuel at an altitude of 30,000 feet and long-range cruise speed. The long-range cruise speed is the higher of two speeds for a given altitude and gross weight where 99% of the maximum range is obtainable.

With an initial airplane weight of 40,000 pounds and basic configuration plus pylons:

1. Select the proper chart for the airplane configuration and altitude.
2. Find the average weight $(40{,}000 - \frac{6000}{2})$ — 37,000 lb
3. Enter the chart at the intersection of the zero wind cruise line and 37,000 pounds gross weight and read:

| | |
|---|---|
| Specific range | 100.4 n mi per 1000 lb fuel |
| Mach number | 0.681 |
| RPM | 90% |
| Fuel flow | 4000 lb per hr |

4. The range is then found (100.4 ÷ 1000 × 6000) — 602 n mi
5. Average speed is Mach no. × speed of sound (0.681 × 589) — 401 kn
6. Time in cruise may be determined by nautical miles ÷ knots (602 ÷ 401) — 1.51 hr or 1 hr 31 min

When wind conditions are encountered, the air nautical miles per 1000 pounds of fuel read from the chart may be converted to ground nautical miles per 1000 pounds of fuel as follows:

$$\frac{\text{ground N MI}}{\text{1000 pounds}} = \frac{\text{air N MI}}{\text{1000 pounds}} \times \frac{\text{V ground}}{\text{V air}}$$

where

V air = airplane true airspeed

V ground = airplane true ground speed = V air ± V wind

## MISSION PROFILE CHARTS.

The Mission Profile Charts (figure A-23) show the relationship of time, fuel, distance, and altitude to maximum range for no-wind conditions. This relationship is based on a mission sequence of takeoff, military power climb, and long-range cruise. The fuel curves include a 906-pound allowance for start, taxi, and takeoff, the fuel used in climbing to each altitude, and the fuel required for long-range cruise. The time lines include the time required for climbing to cruise altitude, but do not include the time for start, taxi, or takeoff. The line labeled Initial Climb Path shows the distance traveled during the military power 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 power schedule until the rate of climb is 500 feet per minute, then leveling off and setting up the recommended power setting and Mach number. The airplane will automatically seek the cruise-climb altitude for its particular gross weight. The initial throttle setting should be maintained throughout the remainder of cruise-climb. For cruise at a constant altitude, the recommended Mach number should be set up at the intersection of the climb path and the cruise altitude. As the flight progresses, the power setting must be decreased gradually to maintain the recommended Mach number as fuel is consumed. As an aid to preflight planning, a line of best range for constant-altitude flight appears on the chart. This curve is not a flight path, but a plot for best cruise altitude against distance. For distances greater than those covered by the curve, cruise-climb procedure for maximum range should be used. A cruise table gives recommended Mach numbers and approximate operating conditions for both cruise-climb procedure and cruise at constant altitude.

### Use of Mission Profile Charts.

The charts may be entered with one or more of the four range factors of time, fuel, distance, and altitude. By entering the chart with the known factors, the others may readily be determined for a no-wind condition. To determine wind effect upon time, fuel, and distance, compute the average true airspeed (distance ÷ time, no wind) and apply wind to TAS to obtain ground speed (GS). Then compute the time with wind (distance ÷ GS). Reenter the profile at the cruising altitude and the computed time with wind to determine the fuel required with wind.

**Sample Problem 1.** Using the Mission Profile sample chart, find the fuel required, time, necessary speed, and power setting to cruise 250 nautical miles at 20,000 feet against a headwind of 40 knots with no external load.

| | |
|---|---|
| 1. Enter at 250 n mi and 20,000 ft to obtain fuel required (no wind) | 4800 lb |
| 2. Time (no wind) | 40 min (0.67 hr) |
| 3. Calculate average TAS (250 ÷ 0.67) | 375 kn |
| 4. Apply wind to obtain GS (375 − 40) | 335 kn |
| 5. Calculated time with 40-kn headwind (250 ÷ 335) | 45 min (0.75 hr) |
| 6. Reenter at cruise altitude at the time with wind. Fuel required with wind | 5200 lb |
| 7. Tabular cruise speed | 0.61 Mach no. |
| 8. Tabular cruise power setting | 87% rpm (approx) |

**Note**

If this flight had been made at 26,500 feet cruising altitude (reference, the line of best range at 250 nautical miles), the time and fuel required would have been less.

**Sample Problem 2.** Determine the maximum distance flyable with no external load, 10,000 pounds of fuel, and a 60-knot headwind.

| | |
|---|---|
| 1. Enter at 10,000 lb of fuel and obtain maximum air distance at cruise-climb (no wind) | 835 n mi |
| 2. Time (no wind) | 2 hr 4 min (2.07 hr) |
| 3. Calculated average TAS (835 ÷ 2.07) | 403 kn |
| 4. Apply wind to obtain GS (403 − 60) | 343 kn |
| 5. Calculate distance with wind (2.07 × 343) | 710 n mi |
| 6. Tabular cruise-climb speed | 0.70 Mach no. |

## INTERCEPT PROFILE CHARTS.

The Intercept Profile Charts (figure A-24) present the fuel required to fly a given distance in a minimum of time, consistent with reasonable range capabilities. These charts are based on maximum power climb and military power cruise; they are similar to the Mission Profile Charts and are used in the same manner. Notice, however, that use of the Intercept Profiles should be restricted to flights that require a minimum of time, whereas the Mission Profile Charts are used for maximum range flights.

**Sample Problem 1.** Using the Intercept Profile sample chart, find the fuel required, time, necessary speed and power setting to cruise 200 nautical miles at 25,000 feet against a head wind of 40 knots with no external load.

| | |
|---|---|
| 1. Enter at 200 n mi and 25,000 ft to obtain fuel required (no wind) | 5400 lb |
| 2. Time (no wind) | 25 min (0.42 hr) |
| 3. Calculate average TAS (200 ÷ 0.42) | 475 kn |
| 4. Apply wind to obtain GS (475 − 40) | 435 kn |
| 5. Calculated time with 40-kn wind (200 ÷ 435) | 28 min (0.46 hr) |
| 6. Reenter at cruise altitude at the time with wind, fuel required with wind | 6000 lb |
| 7. Tabular cruise speed | .81 Mach no. |
| 8. Tabular cruise power setting | 100% rpm |

**Sample Problem 2.** Determine the maximum distance flyable with no external load and 10,000 pounds of fuel and a 60-knot headwind.

| | |
|---|---|
| 1. Enter at 10,000 lb of fuel and obtain maximum air distance at cruise-climb (no wind) | 690 n mi |
| 2. Time (no wind) | 1 hr 32 min (1.53 hr) |
| 3. Calculated average TAS (690 ÷ 1.53) | 450 kn |
| 4. Apply wind to obtain GS (450 − 60) | 390 kn |
| 5. Calculate distance with wind (1.53 × 390) | 600 n mi |
| 6. Tabular cruise-climb speed | .77 Mach no. |

## OPTIMUM RETURN PROFILE CHARTS.

The Optimum Return Profile Charts (figure A-25) show the minimum fuel required for maximum distance (no wind) based on an optimum flight path from any 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 fuel curves are based on a military power climb to, and recommended cruise at, the optimum altitude. The military power climb speed schedule and recommended cruise settings are tabulated on each chart. No reserve for loiter, descent, or landing has been included. The time shown at the optimum altitude is cruise time only; it does not include the time required for climb to optimum altitude or any allowance for loiter, descent, or landing.

# MISSION PROFILE

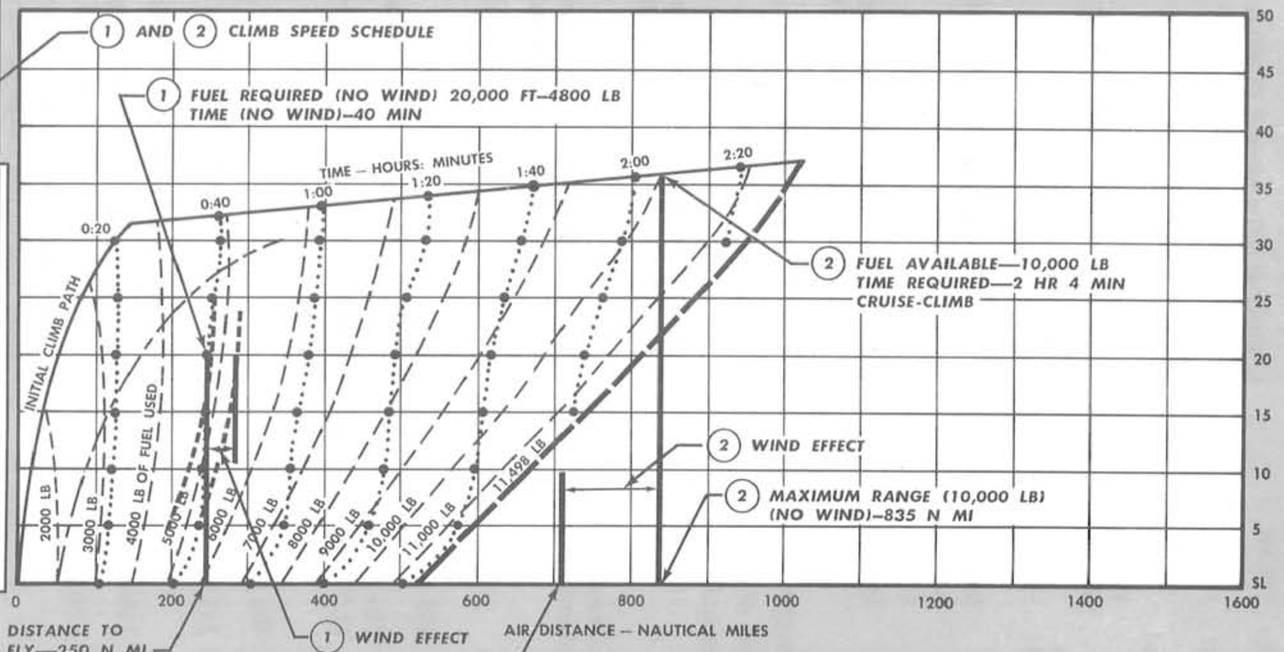
TAKEOFF GROSS WEIGHT
43,175 POUNDS
LONG RANGE CRUISE

CONFIGURATION: BASIC PLUS PYLONS

DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

MODEL: F-89H
ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

| MILITARY POWER CLIMB | | |
|---|---|---|
| MACH NO. | CAS | ALT. 1000 FT. |
| | | 45 |
| | | 40 |
| .67 | 225 | 35 |
| .68 | 250 | 30 |
| .66 | 275 | 25 |
| .63 | 290 | 20 |
| .60 | 300 | 15 |
| .56 | 310 | 10 |
| .52 | 315 | 5 |
| .48 | 315 | SL |




REMARKS:

1. FUEL ALLOWANCE FOR START, TAXI, AND TAKEOFF – 906 LB.
2. NO ALLOWANCE OR RESERVE MADE FOR LOITER, DESCENT, OR LANDING.
3. CLIMB AT MILITARY POWER.
4. CRUISE AT RECOMMENDED MACH NUMBER.
5. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
6. ENGINE AIR INLET SCREENS RETRACTED.

LEGEND

- ZERO FUEL REMAINING
- FUEL CONSUMED
- CRUISE-CLIMB PATH
- TIME (START, TAXI, AND TAKEOFF NOT INCLUDED)
- LINE OF BEST RANGE FOR CONSTANT-ALTITUDE FLIGHT

**SAMPLE CHART DO NOT USE FOR FLIGHT PLANNING**

(2) CRUISE SETTINGS

* CRUISE – CLIMB PROCEDURE

| ALTITUDE FEET | % RPM | MACH NO. |
|---|---|---|
| 32,000 | 92 | .70 |
| 33,000 | 92 | .70 |
| 34,000 | 92 | .70 |
| 35,000 | 92 | .70 |
| 36,000 | 91 | .70 |
| 37,000 | 91 | .70 |

(1) CRUISE SETTINGS

| CRUISE | | | | | |
|---|---|---|---|---|---|
| ALTITUDE FEET | MACH NO. | APPROXIMATE | | | |
| | | CAS | TAS | LB/HR | % RPM |
| CRUISE-CLIMB | .70 | | 410 | 4200-3200 | * |
| 30,000 | .68 | 260 | 405 | 4200 | 91 |
| 25,000 | .65 | 280 | 400 | 4300 | 89 |
| 20,000 | .61 | 285 | 380 | 4600 | 87 |
| 15,000 | .58 | 295 | 365 | 5000 | 85 |
| 10,000 | .56 | 315 | 360 | 5500 | 85 |
| 5,000 | .54 | 330 | 350 | 6100 | 84 |
| SEA LEVEL | .46 | 310 | 310 | 6200 | 80 |

H-305A

Sample.

# INTERCEPT PROFILE

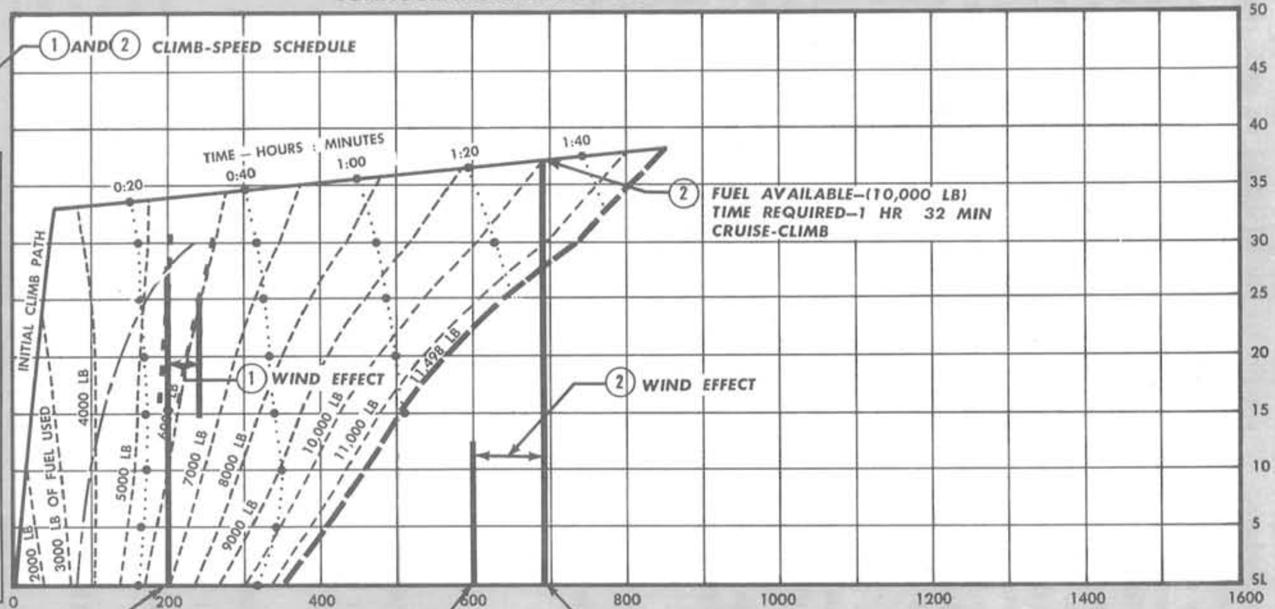
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

TAKEOFF GROSS WEIGHT
43,175 POUNDS
MILITARY POWER

MODEL: F-89H
ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

CONFIGURATION: BASIC PLUS PYLONS

| MAXIMUM POWER CLIMB | | |
|---|---|---|
| MACH NO. | CAS | ALT. 1000 FT. |
| | | 45 |
| | | 40 |
| .79 | 265 | 35 |
| .79 | 300 | 30 |
| .79 | 330 | 25 |
| .79 | 365 | 20 |
| .78 | 400 | 15 |
| .77 | 430 | 10 |
| .74 | 450 | 5 |
| .69 | 460 | SL |




DISTANCE TO FLY—200 N MI

MAXIMUM RANGE (10,000 LB)
CRUISE-CLIMB (60 KNOT)
HEADWIND—600 N MI (2)

(2) MAXIMUM RANGE (10,000 LB)
(NO WIND)—690 N MI

REMARKS:

1. FUEL ALLOWANCE FOR START, TAXI, AND TAKEOFF — 906 POUNDS.
2. NO ALLOWANCE OR RESERVE MADE FOR LOITER, DESCENT, OR LANDING.
3. CLIMB AT MAXIMUM POWER.
4. CRUISE AT RECOMMENDED MACH NUMBER.
5. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
6. ENGINE AIR INLET SCREENS RETRACTED.

LEGEND

- — — ZERO FUEL REMAINING
- - - - - FUEL CONSUMED
- ——— CRUISE-CLIMB PATH
- ●·····● TIME (START, TAXI, AND TAKEOFF NOT INCLUDED)
- — - — LINE OF BEST RANGE FOR CONSTANT-ALTITUDE FLIGHT

**SAMPLE CHART
DO NOT USE FOR
FLIGHT PLANNING**

(2) CRUISE SETTINGS

| CRUISE-CLIMB PROCEDURE | | |
|---|---|---|
| ALTITUDE FEET | % RPM | MACH NO. |
| 33,000 | 100 | .76 |
| 34,000 | 100 | .77 |
| 35,000 | 100 | .77 |
| 36,000 | 100 | .77 |
| 37,000 | 100 | .77 |
| 38,000 | 100 | .77 |

(1) CRUISE SETTINGS

| CRUISE | | | | | |
|---|---|---|---|---|---|
| ALTITUDE FEET | MACH NO. | APPROXIMATE | | | |
| | | CAS | TAS | LB/HR | % RPM |
| CRUISE-CLIMB | .77 | | 440 | 4,700-3,900 | 100 |
| 30,000 | .80 | 305 | 470 | 5,500 | 100 |
| 25,000 | .81 | 340 | 485 | 6,800 | 100 |
| 20,000 | .82 | 385 | 505 | 8,200 | 100 |
| 15,000 | .81 | 415 | 505 | 9,600 | 100 |
| 10,000 | .81 | 450 | 515 | 11,100 | 100 |
| 5,000 | .78 | 475 | 510 | 12,700 | 100 |
| SEA LEVEL | .72 | 475 | 475 | 14,300 | 100 |

H-306A

Sample.

### Use of Optimum Return Profile Charts.

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 necessary procedure, as stated in the note relative to the area, to obtain maximum range. The time required to fly the distance is the time at cruise altitude (obtained from the profile) plus the time required to climb, if necessary (obtained from the Military Power Climb Chart for the applicable configuration). 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 tailwind for the time it requires to complete the flight (neglecting the difference in wind at the lower altitudes since comparatively little time is spent during the climb phase).

**Sample Problem.** From the Optimum Return Profile sample chart, determine the fuel and time required to return to a base 800 nautical miles away. The airplane, carrying pylon tanks, is at 20,000 feet with 10,000 pounds of fuel on board (gross weight—41,957 pounds). A 60-knot headwind is assumed.

| | |
|---|---|
| 1. Enter profile at 800 n mi and 20,000 ft to establish starting point. Fuel required (no wind) | 8000 lb |
| 2. In this area, note that a climb is required and a cruise-climb procedure followed. | |
| 3. Following the climb path guide lines, the initial cruise altitude is | 31,000 ft |
| 4. Cruise time (no wind) | 1 hr 50 min |
| 5. From the military power chart for pylon tank configuration, time to climb | 13 min |
| 6. Total time (no wind; "4"+"5") | 2 hr 3 min |
| 7. Average TAS (distance ÷ total time) | 390 kn |
| 8. Average ground speed (TAS − headwind) | 330 kn |
| 9. Total time with headwind (distance ÷ average ground speed) | 2 hr 25 min |
| 10. Cruise time with wind ("9"−"5") | 2 hr 12 min |
| 11. Using the cruise time "10" on the profile, back track down the climb path from the line of best range to 20,000 ft to obtain fuel required with wind | 9650 lb |
| 12. Fuel remaining over base at altitude (10,000 − 9650) | 350 lb |
| 13. Use the flight path originally determined for no wind. | |

## MAXIMUM ENDURANCE CHARTS.

The Maximum Endurance Charts (figure A-26) show the maximum time available with the fuel on board when loitering at a constant altitude. The recommended calibrated airspeed and the approximate operating conditions are tabulated on each chart.

### Use of Maximum Endurance Charts.

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 and note the initial time. Reenter 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 and note the initial time. Reenter the chart at time of 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.

**Sample Problem.** From the Maximum Endurance sample chart, determine the fuel required to loiter at 30,000 feet with no external load for 45 minutes. The fuel on board at start of loiter is 6000 pounds (gross weight—37,677 pounds).

| | |
|---|---|
| 1. Initial time at 6000 lb and 30,000 ft | 1 hr 56 min |
| 2. Final time (1:56 − 0:45) | 1 hr 11 min |
| 3. Fuel on board at end of loiter (1:11 at 30,000 ft) | 3550 lb |
| 4. Fuel required to loiter (6000 lb − 3550 lb) | 2450 lb |
| 5. Recommended loiter CAS | 195 CAS |

## OPTIMUM MAXIMUM ENDURANCE PROFILE CHARTS.

The Optimum Maximum Endurance Profile Charts (figure A-27) give the maximum time in the air with 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 normal power climb (military power climb in the case of one-engine operation) to best endurance altitude, loiter at that altitude, and a maximum range 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 of Optimum Maximum Endurance Profile Charts.

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

# OPTIMUM RETURN PROFILE

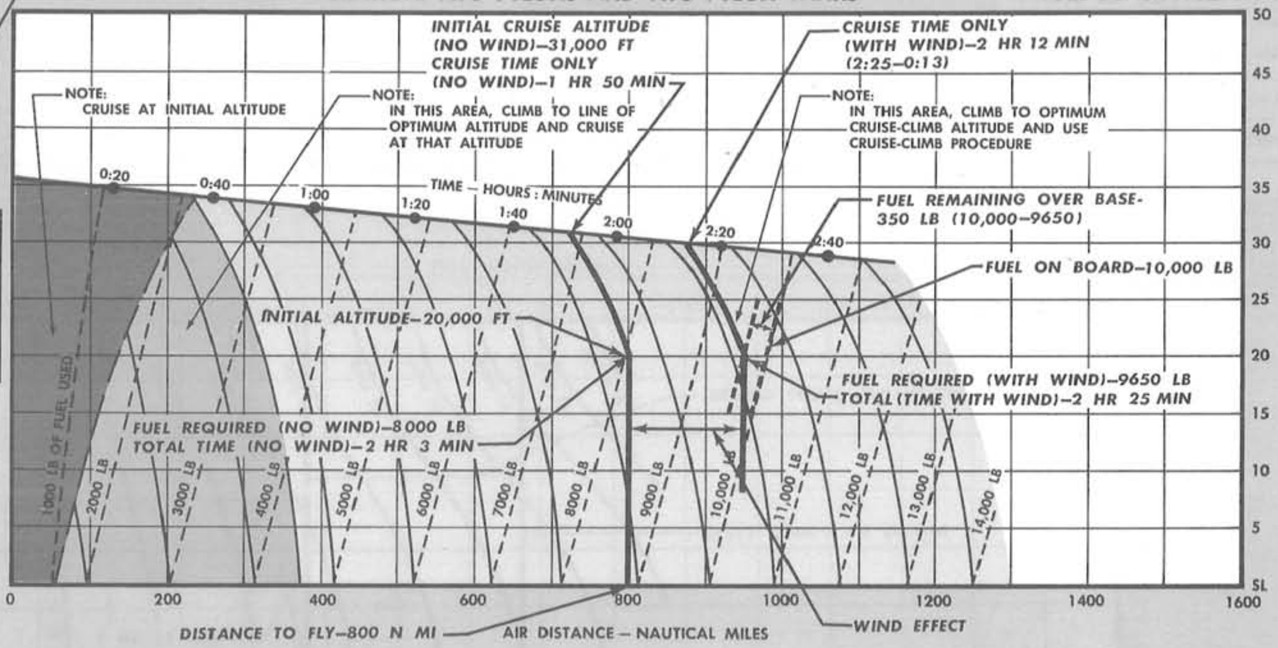
TAKEOFF GROSS WEIGHT
47,355 POUNDS

DATA BASIS: **FLIGHT TEST**
DATE: **22 OCTOBER 1957**

MODEL: **F-89H**
ENGINE(S): **(2) J35-35**
FUEL GRADE: **JP-4**
FUEL DENSITY: **6.5 LB/US GAL**

CONFIGURATION: TWO PYLONS AND TWO PYLON TANKS

| MILITARY POWER CLIMB | | |
|---|---|---|
| MACH NO. | CAS | ALT. 1000 FT. |
| | | 45 |
| | | 40 |
| | | 35 |
| .67 | 255 | 30 |
| .65 | 275 | 25 |
| .62 | 290 | 20 |
| .58 | 295 | 15 |
| .54 | 300 | 10 |
| .50 | 305 | 5 |
| .47 | 310 | SL |




REMARKS:

1. FUEL REQUIRED AT ANY POINT INCLUDES MILITARY POWER CLIMB TO FLIGHT ALTITUDE (IF BELOW THAT).
2. NO ALLOWANCE MADE 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. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
6. ENGINE AIR INLET SCREENS RETRACTED.

**SAMPLE CHART**
**DO NOT USE FOR**
**FLIGHT PLANNING**

LEGEND

- ● ● TIME AT CRUISE-CLIMB ALTITUDE
- - - - - - FUEL REQUIRED
- ——— CLIMB PATH GUIDE LINE
- — — LINE OF BEST RANGE FOR CONSTANT-ALTITUDE FLIGHT
- ▬▬ LINE OF BEST RANGE FOR CRUISE-CLIMB FLIGHT

*

| CRUISE-CLIMB PROCEDURE | | |
|---|---|---|
| ALTITUDE FEET | % RPM | MACH NO. |
| 28,000 | 94 | .68 |
| 29,000 | 94 | .68 |
| 30,000 | 94 | .68 |
| 31,000 | 93 | .68 |
| 32,000 | 93 | .68 |
| 33,000 | 93 | .68 |
| 34,000 | 93 | .69 |
| 35,000 | 92 | .69 |

CRUISE-CLIMB PROCEDURE

| CRUISE | | | | | |
|---|---|---|---|---|---|
| ALTITUDE FEET | MACH NO. | APPROXIMATE | | | |
| | | CAS | TAS | LB/HR | % RPM |
| CRUISE-CLIMB | .68 | | 395 | 4800-3500 | * |
| 25,000 | .64 | 265 | 385 | 4400 | 89 |
| 20,000 | .60 | 275 | 370 | 4700 | 88 |
| 15,000 | .57 | 285 | 355 | 5000 | 87 |
| 10,000 | .55 | 305 | 350 | 5700 | 86 |
| 5,000 | .53 | 320 | 345 | 6300 | 85 |
| SEA LEVEL | .46 | 305 | 305 | 6600 | 81 |

CRUISE-CLIMB PROCEDURE

H-307A

*Sample.*

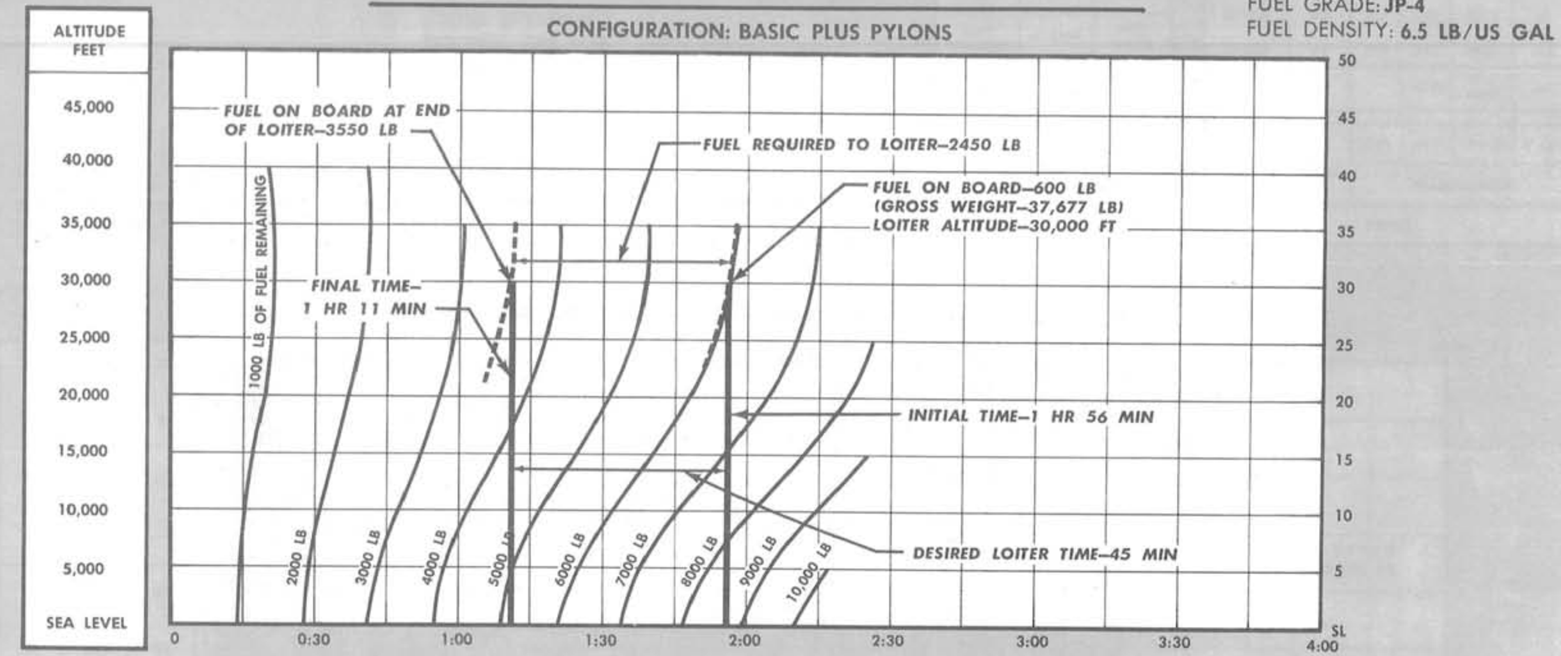
# MAXIMUM ENDURANCE

TAKEOFF GROSS WEIGHT
43,175 POUNDS

DATA BASIS: **FLIGHT TEST**
DATE: **22 OCTOBER 1957**

MODEL: **F-89H**
ENGINE(S): **(2) J35-35**
FUEL GRADE: **JP-4**
FUEL DENSITY: **6.5 LB/US GAL**

CONFIGURATION: BASIC PLUS PYLONS




REMARKS:

1. LOITER AT RECOMMENDED CAS.
2. MAINTAIN CONSTANT ALTITUDE.
3. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
4. ENGINE AIR INLET SCREENS RETRACTED.

RECOMMENDED LOITER CONDITIONS

| LOITER | | | | | |
|---|---|---|---|---|---|
| ALTITUDE FEET | CAS | APPROXIMATE | | | |
| | | TAS | MACH NO. | LB/HR | % RPM |
| 40,000 | 195 | 380 | .66 | 3200 | 99 |
| 35,000 | 195 | 340 | .59 | 3100 | 90 |
| 30,000 | 195 | 310 | .53 | 3300 | 87 |
| 25,000 | 200 | 290 | .48 | 3400 | 84 |
| 20,000 | 195 | 265 | .44 | 3500 | 81 |
| 15,000 | 195 | 240 | .39 | 3800 | 79 |
| 10,000 | 195 | 225 | .35 | 4000 | 75 |
| 5,000 | 195 | 210 | .32 | 4400 | 74 |
| SEA LEVEL | 195 | 195 | .30 | 4500 | 70 |

**SAMPLE CHART
DO NOT USE FOR
FLIGHT PLANNING**

H-308A

*Sample.*

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.

**Sample Problem.** Using the Optimum Maximum Endurance Profile Sample Chart, determine the time available and the necessary flight path for maximum endurance aloft in the pylon tank configuration with 6000 pounds of fuel remaining at 20,000 feet.

1. Enter profile at 20,000 ft and 6000 lb of fuel remaining to establish starting point. Total time available — 1 hr 55 min
2. In this area note that a climb is required.
3. Follow the climb path guide lines for the best endurance altitude — 27,600 ft
4. Descent time from 27,600 ft to sea level — 23 min
5. Elapsed time from start of climb to start of descent ("1" − "4") — 1 hr 32 min

If a reserve of 1000 lb of fuel is desired for landing, enter the profile at 6000 lb of fuel and follow the climb path guide line to the best endurance altitude — 27,600 ft

6. Subtract endurance time due to the 1000-lb fuel reserve (at altitude for best endurance) "5" − 18 min — 1 hr 14 min
7. Descent time from 27,600 ft to sea level — 23 min
8. Elapsed time from start of climb to sea level ("6" + "7") — 1 hr 37 min

## DESCENT CHARTS.

The Descent Charts (figure A-28) show descent performance for one and two engines operating in terms of fuel, time, air distance, and rate of descent for the gross weight range of the airplane denoted by the shaded areas. Charts are shown for no external load and maximum external stores configuration. Interpolation must be used for intermediate configurations and gross weights. The type of tip pod has negligible effect on descent. Three types of descents are shown: recommended descent with speed brakes closed (based on 0.70 Mach number), recommended descent with speed brakes open (based on 0.70 Mach number), and maximum range descent (based on approximately 200 knots IAS). All three types of descent are based on idle power. These charts may be used for descending from one altitude to another by taking the incremental values between the initial and final altitudes.

## LANDING DISTANCE CHARTS.

The Landing Distance Charts (figure A-29) show landing distances (ground roll and total distance to clear a 50-foot obstacle) for a dry, hard-surface runway as a function of gross weight, pressure altitude, wind velocity, and ambient temperature. The pressure altitude of the field can be determined by setting the altimeter to 29.92 (sea level standard day pressure in inches of mercury). The chart for two-engine operation shows data for landing using the normal procedure given in Section II. The chart for one-engine operation is based on inoperative speed brakes and flaps. If the landing technique used differs from that specified, the landing distances will vary from those shown on the charts. A 5-percent variation in speed causes approximately a 10-percent variation in distances; insufficient wheel braking may increase ground roll by 50 percent.

### Use of Landing Distance Charts.

The Landing Distance sample chart shows a landing with two engines operating at an ambient air temperature of 15°C and a pressure altitude of 2000 feet with a gross weight of 32,000 pounds and a 20-knot headwind. These conditions require a ground roll of 2250 feet and a total distance of 3250 feet from a 50-foot obstacle clearance to end of ground roll.

## LANDING IMMEDIATELY AFTER TAKEOFF DATA CARD.

A Landing Immediately after Takeoff Data Card is to be completed before each takeoff. The purpose of the landing immediately after takeoff data card is to familiarize the pilot with emergency procedures to be followed if loss of an engine or other emergencies necessitate landing immediately after takeoff. Information necessary to complete the normal landing and single-engine landing sections may be found in the Appendix charts.

### Use of Landing Immediately After Takeoff Data Card.

**Sample Problem.** The following conditions are given as a basis for completing the normal and single-engine landing sections of the sample Landing Immediately after Takeoff Data Card.

**LANDING IMMEDIATELY AFTER TAKEOFF DATA**

Maximum Emergency Landing Weight ................38,000 Lb
(Takeoff Weight Less Jettisonable Items)

| | *1 Engine* | *2 Engine* |
|---|---|---|
| Final Approach Speed | 177 Kn | 153 Kn |
| Touchdown Speed | 139 Kn | 122 Kn |
| Ground Roll Distance | 3900 Ft | 2900 Ft |
| Total Distance (To Clear 50-foot Obstacle) | 7000 Ft | 4000 Ft |

## LANDING DATA CARD.

A Landing Data Card (see Abbreviated Checklist, Section II) is to be completed before each flight. The purpose of the landing data card is to familiarize the pilot with emergency procedures to be followed if loss of an engine or other emergencies occur during landing. The information required by the normal landing and single-engine landing sections of the landing data card may be found in the Appendix charts.

# OPTIMUM MAXIMUM ENDURANCE PROFILE

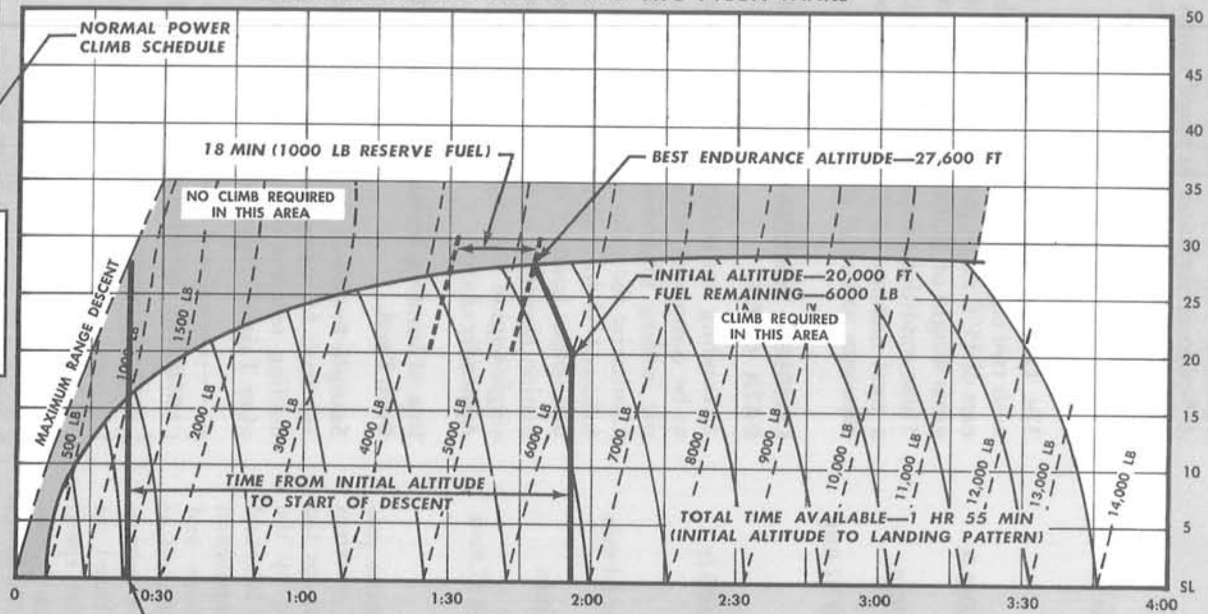
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

TAKEOFF GROSS WEIGHT
47,355 POUNDS

MODEL: F-89H
ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

CONFIGURATION: TWO PYLONS AND TWO PYLON TANKS

| NORMAL POWER CLIMB | | |
|---|---|---|
| MACH NO. | CAS | ALT. 1000 FT. |
| | | 45 |
| | | 40 |
| .63 | 210 | 35 |
| .63 | 235 | 30 |
| .61 | 255 | 25 |
| .57 | 260 | 20 |
| .52 | 260 | 15 |
| .48 | 265 | 10 |
| .44 | 265 | 5 |
| .41 | 270 | SL |




REMARKS:

1. USE NORMAL POWER FOR CLIMB.
2. LOITER AT RECOMMENDED CAS.
3. USE MAXIMUM RANGE DESCENT.
4. NO ALLOWANCE OR RESERVE MADE FOR LANDING.
5. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
6. ENGINE AIR INLET SCREENS RETRACTED.

RECOMMENDED LOITER

| LOITER — WITH PYLON TANKS | | | | | |
|---|---|---|---|---|---|
| ALTITUDE FEET | CAS | APPROXIMATE | | | |
| | | MACH NO. | TAS | LB/HR | % RPM |
| 35,000 | 200 | .60 | 345 | 3500 | 95 |
| 30,000 | 195 | .53 | 310 | 3500 | 88 |
| 25,000 | 185 | .45 | 270 | 3100 | 82 |
| 20,000 | 175 | .39 | 240 | 3000 | 78 |
| 15,000 | 185 | .37 | 230 | 3400 | 76 |
| 10,000 | 180 | .32 | 205 | 3800 | 74 |
| 5,000 | 180 | .29 | 190 | 4000 | 72 |
| SEA LEVEL | 185 | .28 | 185 | 4100 | 68 |

SAMPLE CHART
DO NOT USE FOR
FLIGHT PLANNING

LEGEND
- - - - - FUEL REMAINING
———— LINE OF OPTIMUM ALTITUDE FOR LOITER
——— NORMAL POWER CLIMB GUIDE LINES

H-309A

Sample.

### Use of Landing Data Cards.

**Sample Problem.** The following conditions are given as a basis for completing the normal landing and single-engine landing sections of the sample Landing Data Card.

**LANDING DATA**

| | | | | |
|---|---|---|---|---|
| Landing Gross Weight | | | | 38,000 Lb |
| Runway Length | 8000 Ft | Headwind | | 20 Kn |
| Temperature | 59°C | Pressure Altitude | | 2000 Ft |
| Surface: (Dry, Wet, Icy) | | | | |

**LANDING**

| | *1 Engine* | *2 Engine* |
|---|---|---|
| Final Approach Speed | 162 Kn | 140 Kn |
| Touchdown Speed | 128 Kn | 113 Kn |
| Landing Distance | 3200 Ft | 2450 Ft |
| Landing Distance (To Clear 50-foot Obstacle) | 6000 Ft | 3500 Ft |

## LANDING SPEEDS CHART.

The Landing Speeds Chart (figure A-30) presents the recommended indicated airspeeds for final approach, 50-foot obstacle clearance, touchdown, and nose wheel down. The chart may be read for applicable landing gross weights and for flap settings of 0 degrees, 30 degrees, and 50 degrees.

## COMBAT ALLOWANCE CHARTS.

The Combat Allowance Charts (figure A-31) show the relationship between time and fuel with changes in altitude for two-engine operation at maximum, military, and normal power. Combat time or fuel may be determined from this chart for a given power setting.

### Use of Combat Allowance Charts.

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.

# TYPICAL MISSION.

This sample problem combines the use of the charts in this section to plan a typical mission.

## FLIGHT PLAN DATA.

A combat mission is to be flown carrying pylon tanks on the inbound leg, the tanks to be dropped at the beginning of combat. Prepare a flight plan based on the following data:

| | |
|---|---|
| 1. Distance to combat area | 400 n mi |
| 2. Assigned altitude: | |
| Inbound to combat (cruise-climb) | 28,000 ft and above |
| Outbound from combat (cruise-climb) | 33,000 ft and above |
| 3. Combat at 40,000 ft (Maximum power) | 10 min |
| 4. Weather (assume standard day temperature throughout) | CAVU |
| Winds aloft inbound (28,000 ft and above) | 40-kn HW |
| Winds aloft outbound (33,000 ft and above) | 50-kn TW |
| Field elevation | 2000 ft |
| 5. Airplane gross weight: | |
| Operating minimum (includes crew of two, oil, trapped fuel, pylons, and miscellaneous equipment) | 30,155 lb |
| Forty-two 2.75″ FFAR rockets | 760 lb |
| Six GAR-1 missiles | 762 lb |
| Two 300-gallon pylon tanks | 280 lb |
| Maximum usable fuel—internal and external (2369 gallons) | 15,398 lb |
| Total gross weight | 47,355 lb |

## TAKEOFF.

Obtain takeoff distance from the maximum power takeoff distance chart, figure A-6. (Standard day temperature at 2000 feet is 11°C.) Assume 20-knot headwind.

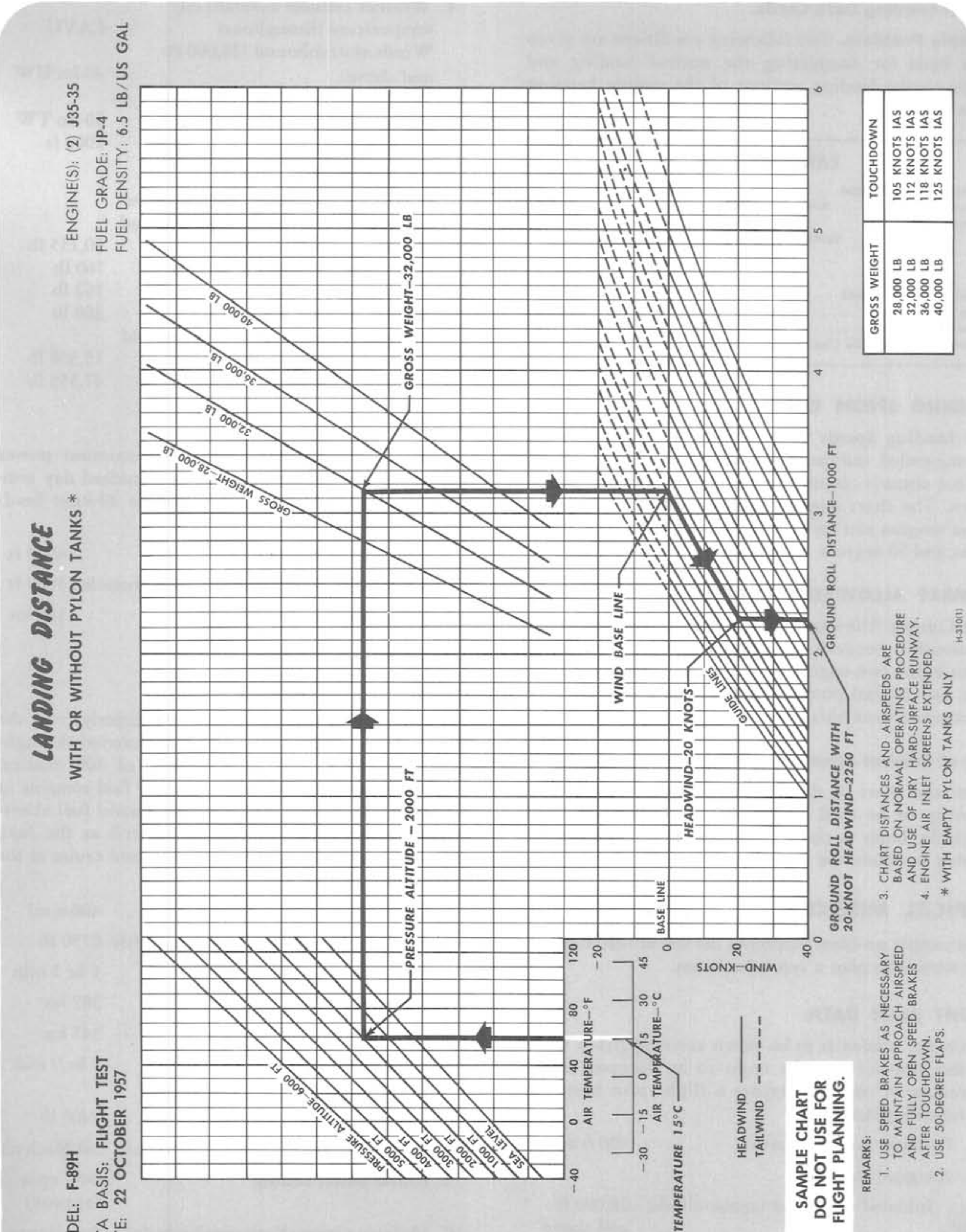
| | |
|---|---|
| 1. Ground roll distance (47,355 lb) | 4900 ft |
| 2. Total takeoff distance over 50-ft obstacle | 5800 ft |
| 3. Takeoff speed (IAS) | 144 kn |

## INBOUND LEG.

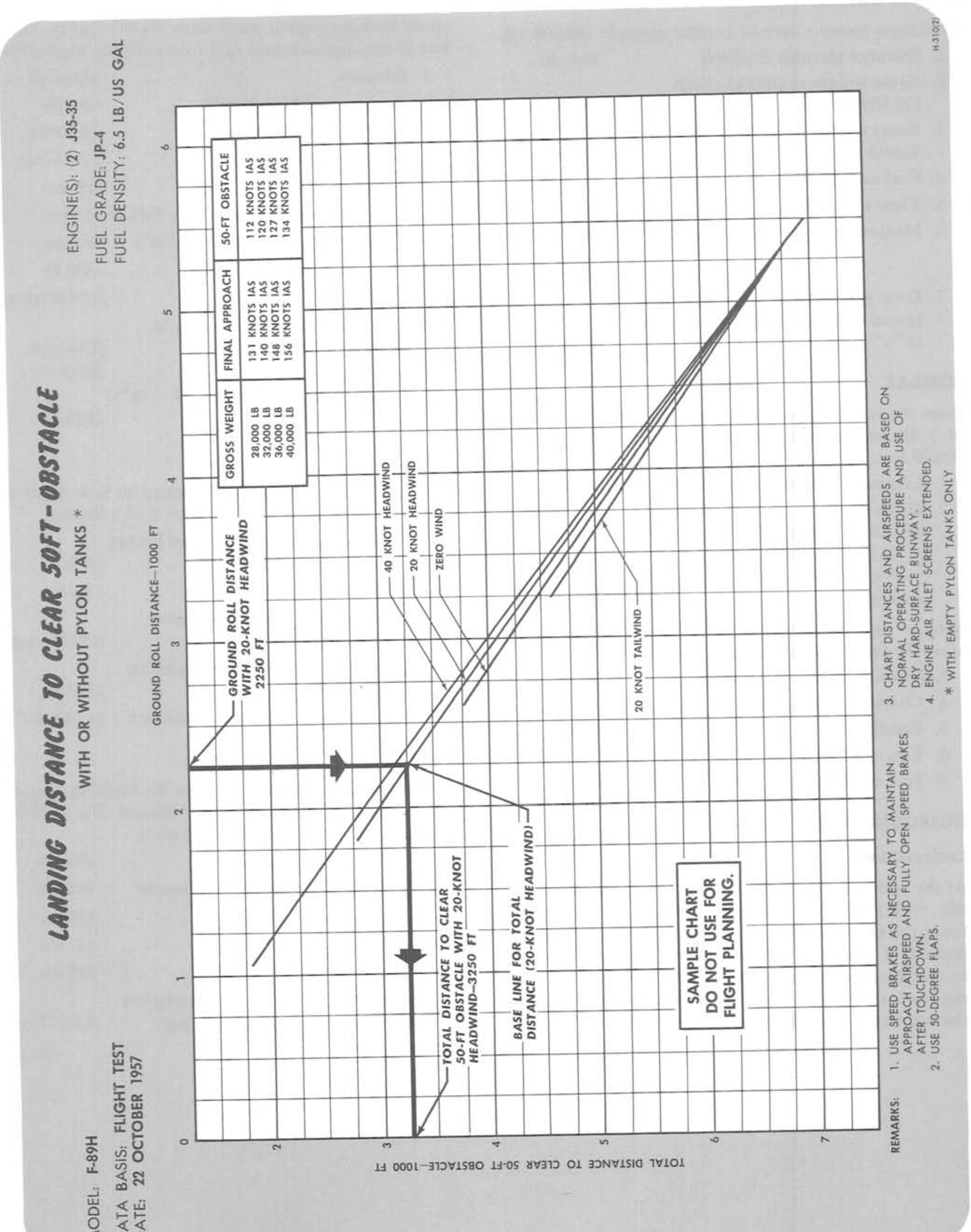
### Cruise.

The inbound leg may be determined directly from the Mission Profile Chart for pylon tanks carried throughout, figure A-23, since at a distance of 400 nautical miles at the cruise-climb altitude some fuel remains in the tanks. The profile includes a 906-pound fuel allowance for start, taxi, and takeoff, as well as the fuel, time, and range required for climb to and cruise at the cruise-climb altitude.

| | |
|---|---|
| 1. Distance | 400 n mi |
| 2. Fuel required (no wind) from profile | 6750 lb |
| 3. Time (no wind) from profile | 1 hr 2 min |
| 4. Average TAS ("1" ÷ "3") | 387 kn |
| 5. Ground speed ("4" − 40 kn) | 347 kn |
| 6. Time with wind ("1" ÷ "5") | 1 hr 9 min |
| 7. Fuel required (with wind) from profile | 7400 lb |
| 8. Cruise speed (cruise-climb altitude) | .68 Mach no. |
| 9. Cruise power setting | 94% rpm (approx) |
| 10. Military power climb speed schedule | (see figure A-16, Sheet 2 of 3 Sheets) |
| 11. Gross weight at end of cruise (47,355 lb − "7") | 39,955 lb |


LANDING DISTANCE
WITH OR WITHOUT PYLON TANKS *
MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957
ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL
GROSS WEIGHT—28,000 LB
32,000 LB
36,000 LB
40,000 LB
GROSS WEIGHT—32,000 LB
PRESSURE ALTITUDE—6000 FT
5000 FT
4000 FT
3000 FT
2000 FT
1000 FT
SEA LEVEL
PRESSURE ALTITUDE — 2000 FT
AIR TEMPERATURE—°F
-40 0 40 80 120
AIR TEMPERATURE—°C
-30 -15 0 15 30 45
AIR TEMPERATURE 15°C
WIND—KNOTS
-20 0 20 40
HEADWIND
TAILWIND
BASE LINE
WIND BASE LINE
HEADWIND—20 KNOTS
GUIDE LINES
GROUND ROLL DISTANCE—1000 FT
0 1 2 3 4 5 6
GROUND ROLL DISTANCE WITH 20-KNOT HEADWIND—2250 FT
GROSS WEIGHT
TOUCHDOWN
28,000 LB 105 KNOTS IAS
32,000 LB 112 KNOTS IAS
36,000 LB 118 KNOTS IAS
40,000 LB 125 KNOTS IAS
REMARKS:
1. USE SPEED BRAKES AS NECESSARY TO MAINTAIN APPROACH AIRSPEED AND FULLY OPEN SPEED BRAKES AFTER TOUCHDOWN.
2. USE 50-DEGREE FLAPS.
3. CHART DISTANCES AND AIRSPEEDS ARE BASED ON NORMAL OPERATING PROCEDURE AND USE OF DRY HARD-SURFACE RUNWAY.
4. ENGINE AIR INLET SCREENS EXTENDED.
* WITH EMPTY PYLON TANKS ONLY
SAMPLE CHART
DO NOT USE FOR
FLIGHT PLANNING.
H-310(1)

*Sample.*


LANDING DISTANCE TO CLEAR 50FT-OBSTACLE
WITH OR WITHOUT PYLON TANKS *
MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957
ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL
GROUND ROLL DISTANCE—1000 FT
TOTAL DISTANCE TO CLEAR 50-FT OBSTACLE—1000 FT
GROSS WEIGHT
28,000 LB
32,000 LB
36,000 LB
40,000 LB
FINAL APPROACH
131 KNOTS IAS
140 KNOTS IAS
148 KNOTS IAS
156 KNOTS IAS
50-FT OBSTACLE
112 KNOTS IAS
120 KNOTS IAS
127 KNOTS IAS
134 KNOTS IAS
GROUND ROLL DISTANCE WITH 20-KNOT HEADWIND 2250 FT
40 KNOT HEADWIND
20 KNOT HEADWIND
ZERO WIND
20 KNOT TAILWIND
TOTAL DISTANCE TO CLEAR 50-FT OBSTACLE WITH 20-KNOT HEADWIND—3250 FT
BASE LINE FOR TOTAL DISTANCE (20-KNOT HEADWIND)
SAMPLE CHART DO NOT USE FOR FLIGHT PLANNING.
REMARKS:
1. USE SPEED BRAKES AS NECESSARY TO MAINTAIN APPROACH AIRSPEED AND FULLY OPEN SPEED BRAKES AFTER TOUCHDOWN.
2. USE 50-DEGREE FLAPS.
3. CHART DISTANCES AND AIRSPEEDS ARE BASED ON NORMAL OPERATING PROCEDURE AND USE OF DRY HARD-SURFACE RUNWAY.
4. ENGINE AIR INLET SCREENS EXTENDED.
* WITH EMPTY PYLON TANKS ONLY
H-310(2)

*Sample.*

### Climb to Combat Altitude.

Maximum power climb to combat altitude (40,000 ft).

| | |
|---|---|
| 1. Distance traveled in climb | 35 n mi |
| 2. Gross weight at start of climb (29,500 ft) | 39,955 lb |
| 3. Gross weight at end of climb to 40,000 ft | 38,900 lb |
| 4. Fuel used to climb (39,955 − 38,900) | 1,055 lb |
| 5. Time to climb | 5 min |
| 6. Maximum power climb schedule | (See figure A-16, Sheet 1 of 3 Sheets) |
| 7. Drop pylon tanks at end of climb (gross weight at begining of combat is "3" − 280) | 38,620 lb |

### COMBAT.

From the combat allowance chart (figure A-31, Sheet 1 of 3 Sheets), obtain the fuel required for combat at 40,000 feet.

| | |
|---|---|
| 1. Combat—maximum power (10 min) | 1800 lb |
| 2. Gross weight at end of combat 38,620 − 1800 lb (combat fuel) − 762 lb (six GAR-1 missiles) − 760 lb (forty-two 2.75″ FFAR rockets) | 35,298 lb |

Assume zero distance traveled during combat. Determine the fuel remaining at end of combat.

| | |
|---|---|
| 3. Takeoff, climb, and cruise | 7400 lb |
| 4. Climb to combat altitude | 1055 lb |
| 5. Combat | 1800 lb |
| 6. Total fuel used | 10,255 lb |
| 7. Fuel remaining (15,398 − 10,255) | 5143 lb |

### OUTBOUND LEG.

### Cruise-Climb.

At the end of combat the airplane is 435 nautical miles 400 + 35) from the base at an altitude of 40,000 feet. Enter the Optimum Return Profile Chart (figure A-25, Sheet 1 of 3 Sheets) for basic configuration + pylons at the distance from the base and determine the fuel required and reserve with the existing tailwind. Note that optimum altitude for start of return at the distance is 34,400 feet; therefore, a recommended descent (with speed brakes open) is made from 40,000 feet to 33,300 feet (time, distance, and fuel consumed are negligible).

| | |
|---|---|
| 1. Distance | 435 n mi |
| 2. Fuel required (no wind) | 3600 lb |
| 3. Initial cruise altitude | 33,300 ft |
| 4. Total time (no wind) | 1 hr 4 min |
| 5. Average TAS ("1" ÷ "4") | 408 kn |
| 6. Average ground speed ("5" + 50 kn) | 458 kn |
| 7. Total time with wind ("1" ÷ "6") | 57 min |
| 8. Fuel required (with wind) | 3300 lb |
| 9. Cruise speed | 0.70 Mach no. |
| 10. Power setting (See figure A-20, Sheet 8 of 9 Sheets) | 92% rpm (approx) |
| 11. Reserve fuel over base (5143 − "8") at 35,600-ft altitude | 1843 lb |

### Descent.

Obtain the fuel required to descend to base from the Descent Chart (figure A-28, Sheet 1 of 2 Sheets).

| | |
|---|---|
| 1. Recommended descent, speed brakes open from 35,600 ft | 50 lb |
| 2. Time to descend | 1 min |
| 3. Descent speed, using idle power and speed brakes open | 0.70 Mach no. |
| 4. Fuel reserve for loiter and landing (1843 − 50) | 1793 lb |
| 5. Airplane gross weight for landing | 31,948 lb |

### Landing.

Obtain the landing distance from the Landing Distance Chart (figure A-29, Sheet 1 of 4 Sheets). Use 2000-foot altitude, 11°C and 20-knot headwind.

| | |
|---|---|
| 1. Ground roll distance | 2920 ft |
| 2. Total distance over 50-ft obstacle | 4080 ft |
| 3. Approach speed (IAS) | 150 kn |
| 4. 50-ft obstacle speed (IAS) | 127 kn |
| 5. Touchdown speed (IAS) | 119 kn |
| The sum of all the time required gives the time from takeoff to landing | 2 hr 22 min |

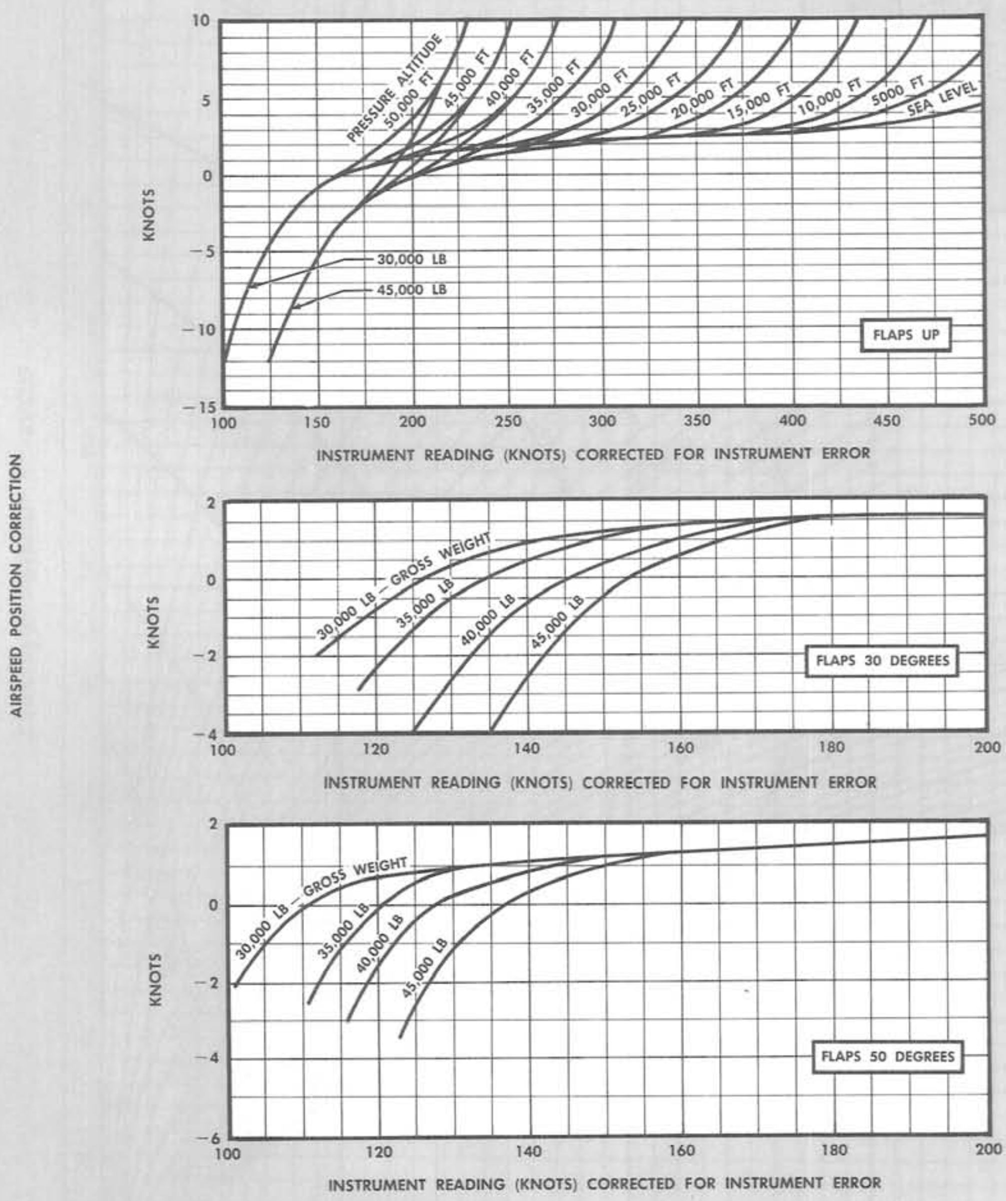
# AIRSPEED POSITION CORRECTION

MODEL: **F-89H**

DATA BASIS: **FLIGHT TEST**
DATE: **22 OCTOBER 1957**

ENGINE(S): **(2) J35-35**

FUEL GRADE: **JP-4**
FUEL DENSITY: **6.5 LB/US GAL**



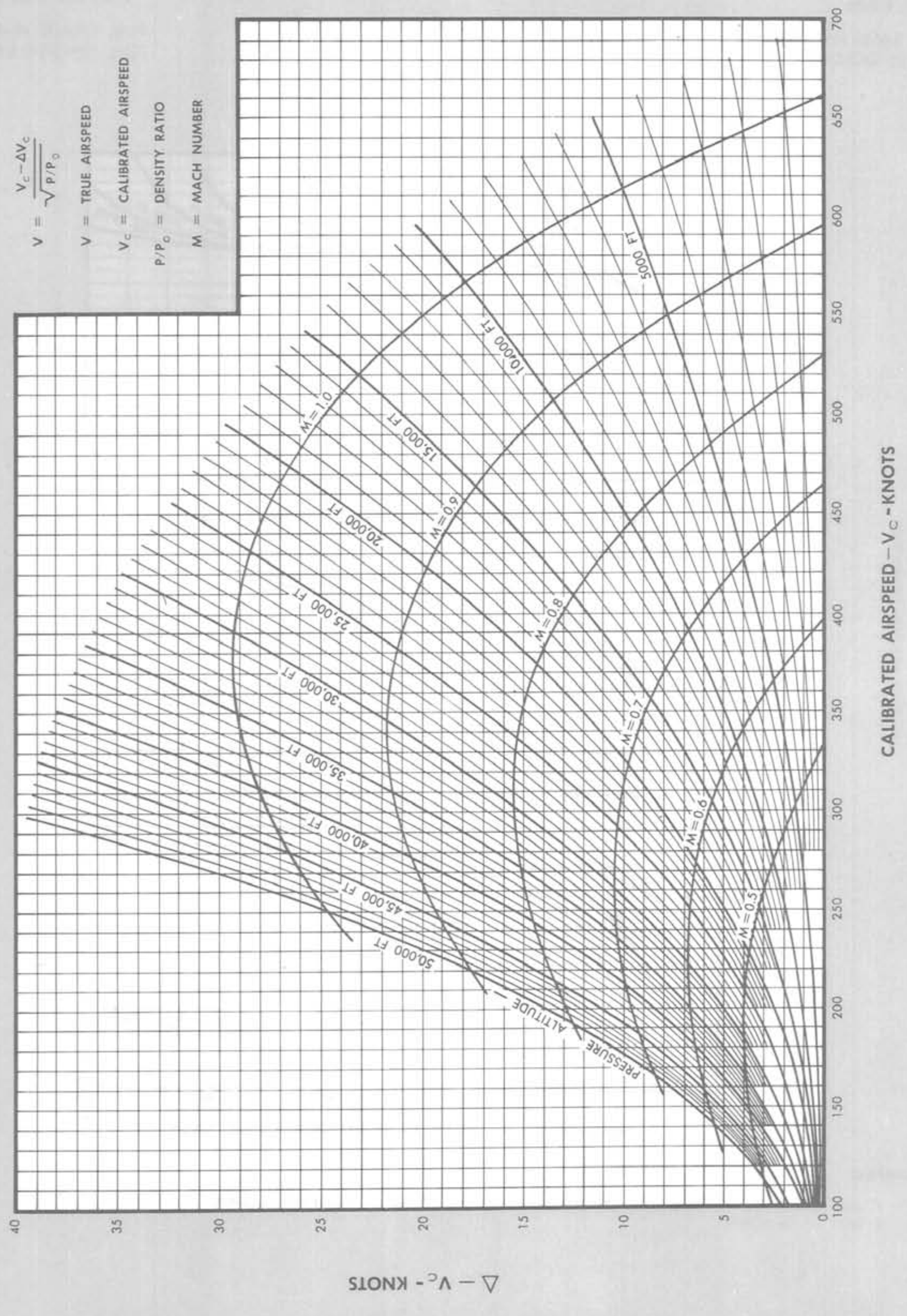

**REMARKS:**

1. ADD CORRECTION TO CORRECTED INSTRUMENT READING (IAS) TO OBTAIN CALIBRATED AIRSPEED.
2. GEAR UP OR DOWN.

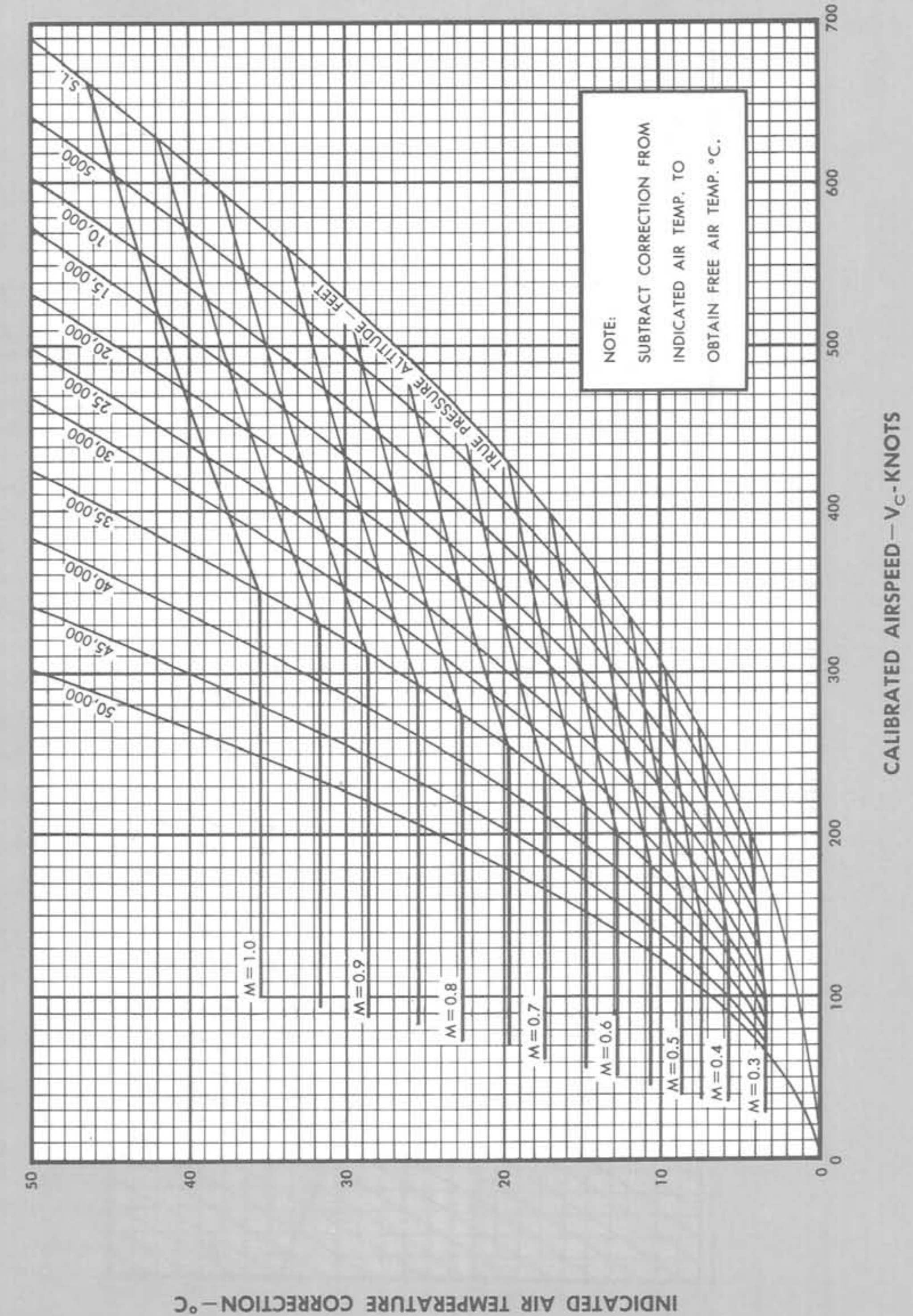
H311

*Figure A-1.*

## COMPRESSIBILITY CORRECTION TO CALIBRATED AIRSPEED



# TEMPERATURE CORRECTION FOR COMPRESSIBILITY



# DENSITY ALTITUDE CHART

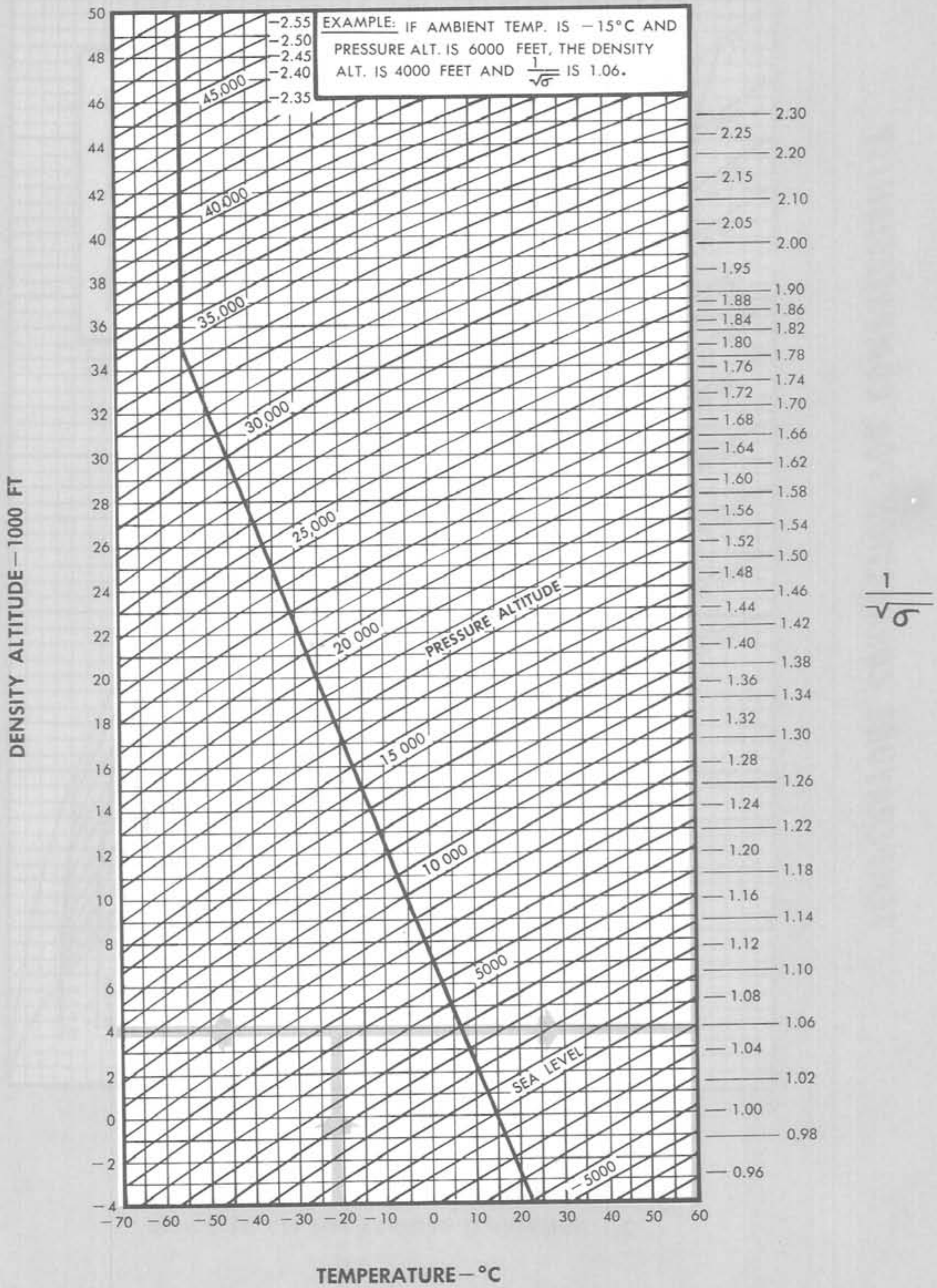
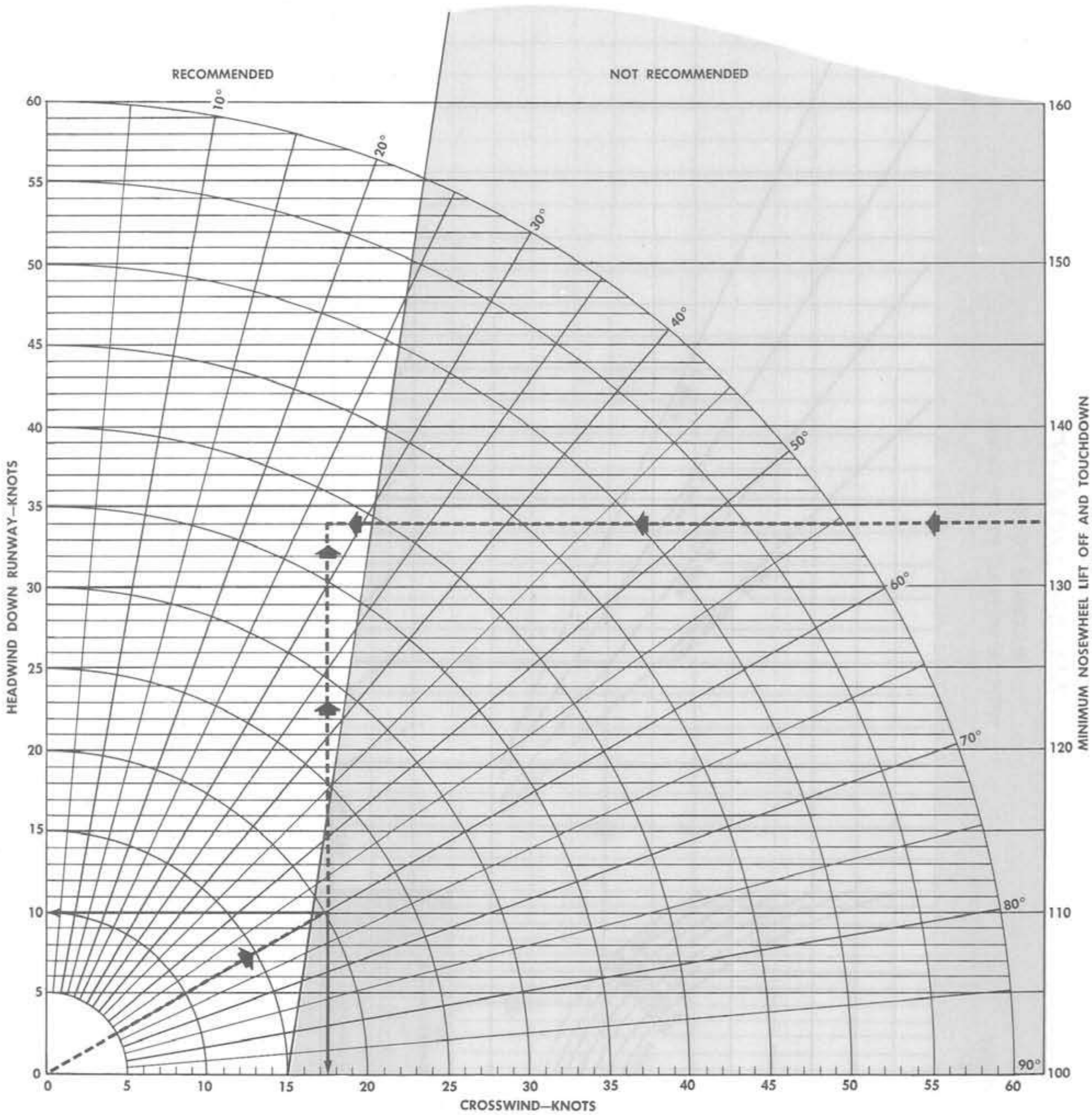



*Figure A-4.*

# TAKEOFF AND LANDING CROSSWIND CHART




GIVEN:
TAKEOFF RUNWAY = 27
WIND = 330°/20-KNOTS.

FIND:
IS TAKEOFF RECOMMENDED AT TAKEOFF SPEED OF 134-KNOTS IAS.

SOLUTION:
1. RUNWAY WIND ANGLE = 60°
2. AT WIND VELOCITY OF 20-KNOTS AND 60° RUNWAY ANGLE FIND CROSS WIND COMPONENTS OF 18-KNOTS, HEAD WIND = 10-KNOTS.
3. PROCEED VERTICALLY TO PREDICTED TAKEOFF AIRSPEED OF 134-KNOTS AND DETERMINE TAKEOFF AS RECOMMENDED.

H-210A

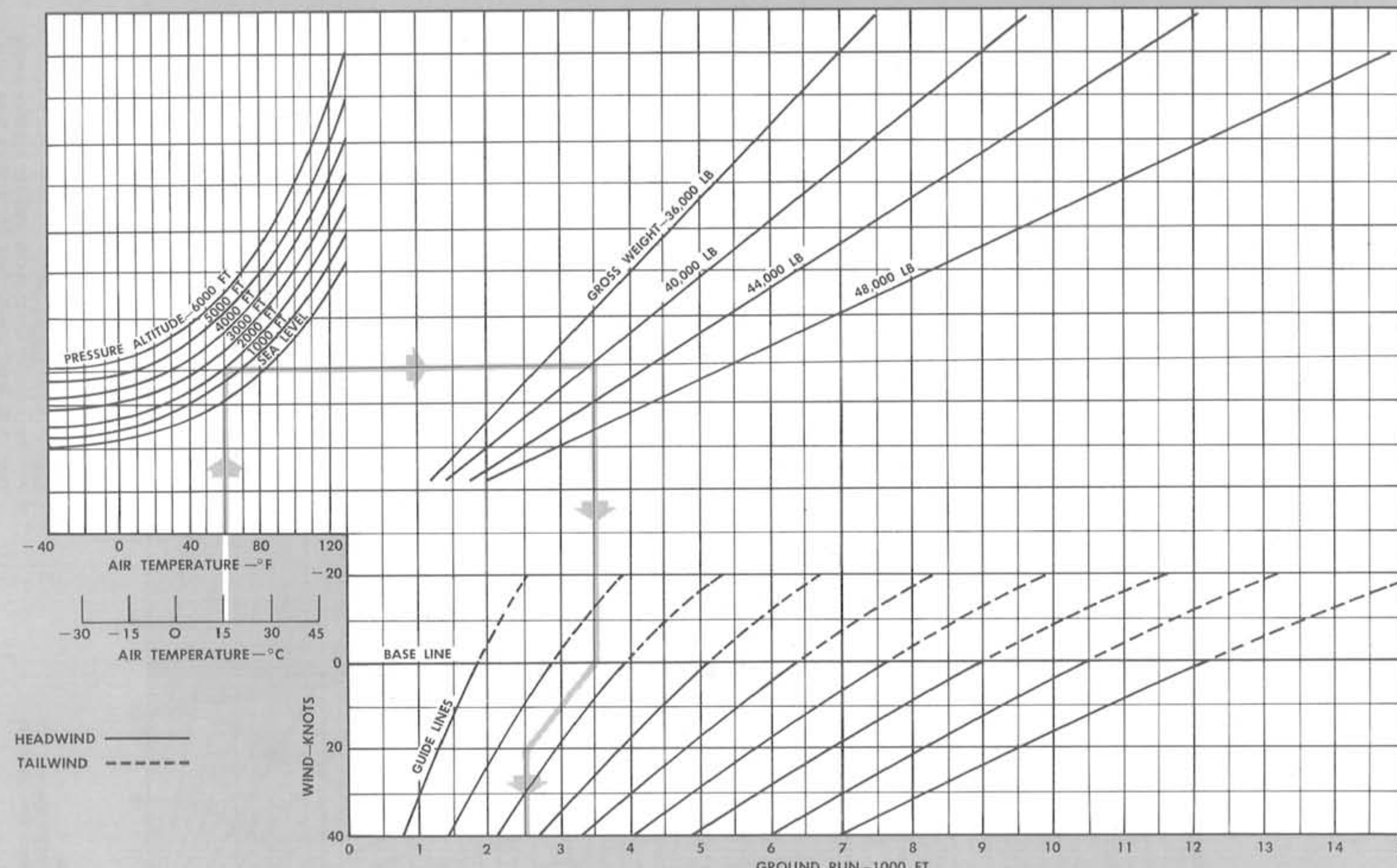
*Figure A-5.*

# TAKEOFF DISTANCE

MAXIMUM POWER
WITH OR WITHOUT PYLON TANKS

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. USE 30 DEGREE FLAPS.
2. DISTANCE SHOWN WILL BE OBTAINED WHEN TAKEOFF IS IN ACCORDANCE WITH SPECIFIED NORMAL PROCEDURE, ON DRY, HARD SURFACE RUNWAY.
3. USE 100% RPM WITH AFTERBURNING UNLESS LIMITED BY MAXIMUM TAILPIPE TEMPERATURE.
4. ENGINE AIR INLET SCREENS EXTENDED.

| GROSS WEIGHT | NOSE WHEEL OFF | TAKEOFF |
|---|---|---|
| 36,000 LB | 120 KNOTS IAS | 124 KNOTS IAS |
| 40,000 LB | 127 KNOTS IAS | 131 KNOTS IAS |
| 44,000 LB | 133 KNOTS IAS | 138 KNOTS IAS |
| 47,355 LB | 138 KNOTS IAS | 143 KNOTS IAS |

H-315(1)

Figure A-6 (Sheet 1 of 6).

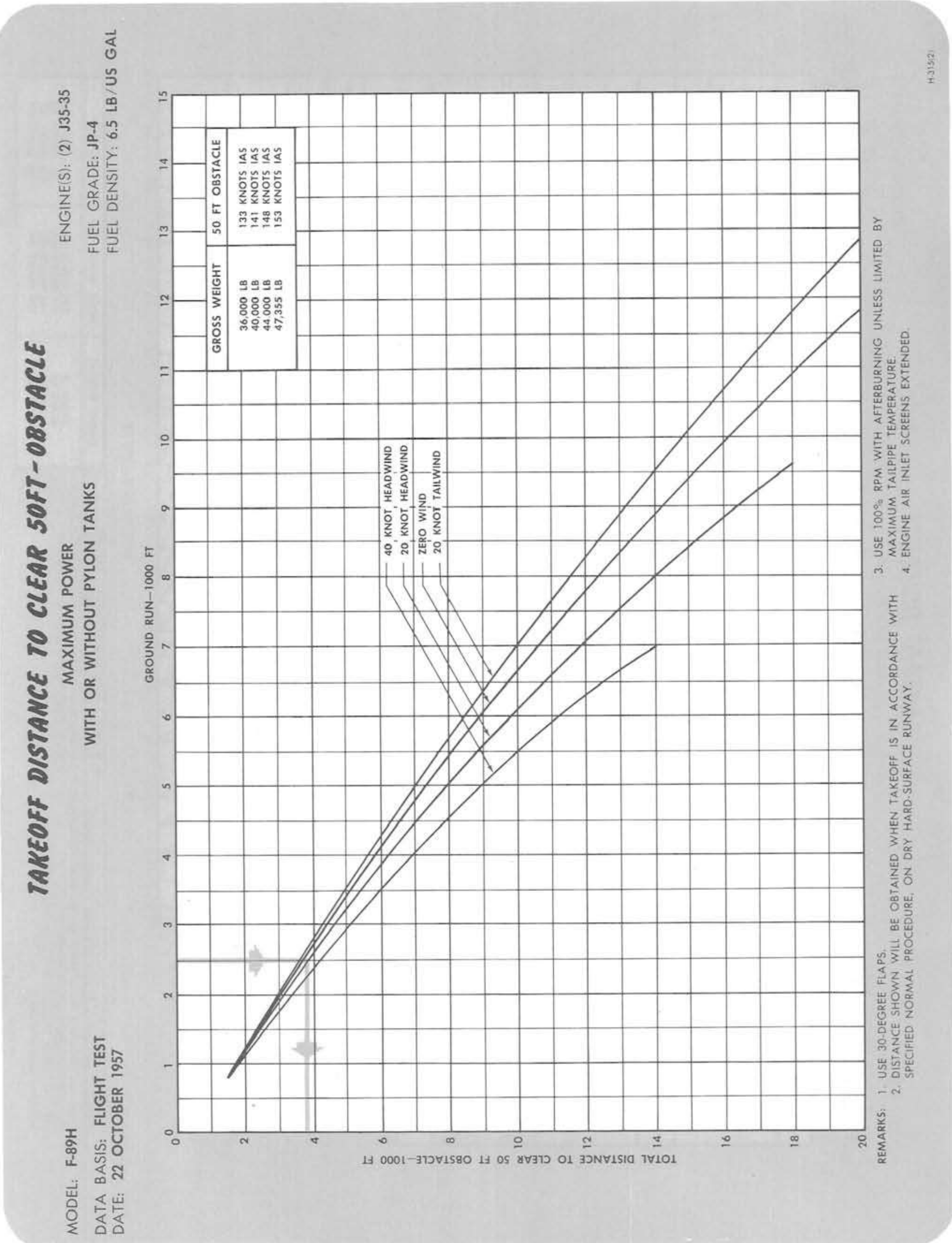



*Figure A-6 (Sheet 2 of 6).*

# TAKEOFF DISTANCE

MILITARY POWER

WITH OR WITHOUT PYLON TANKS

MODEL: F-89H

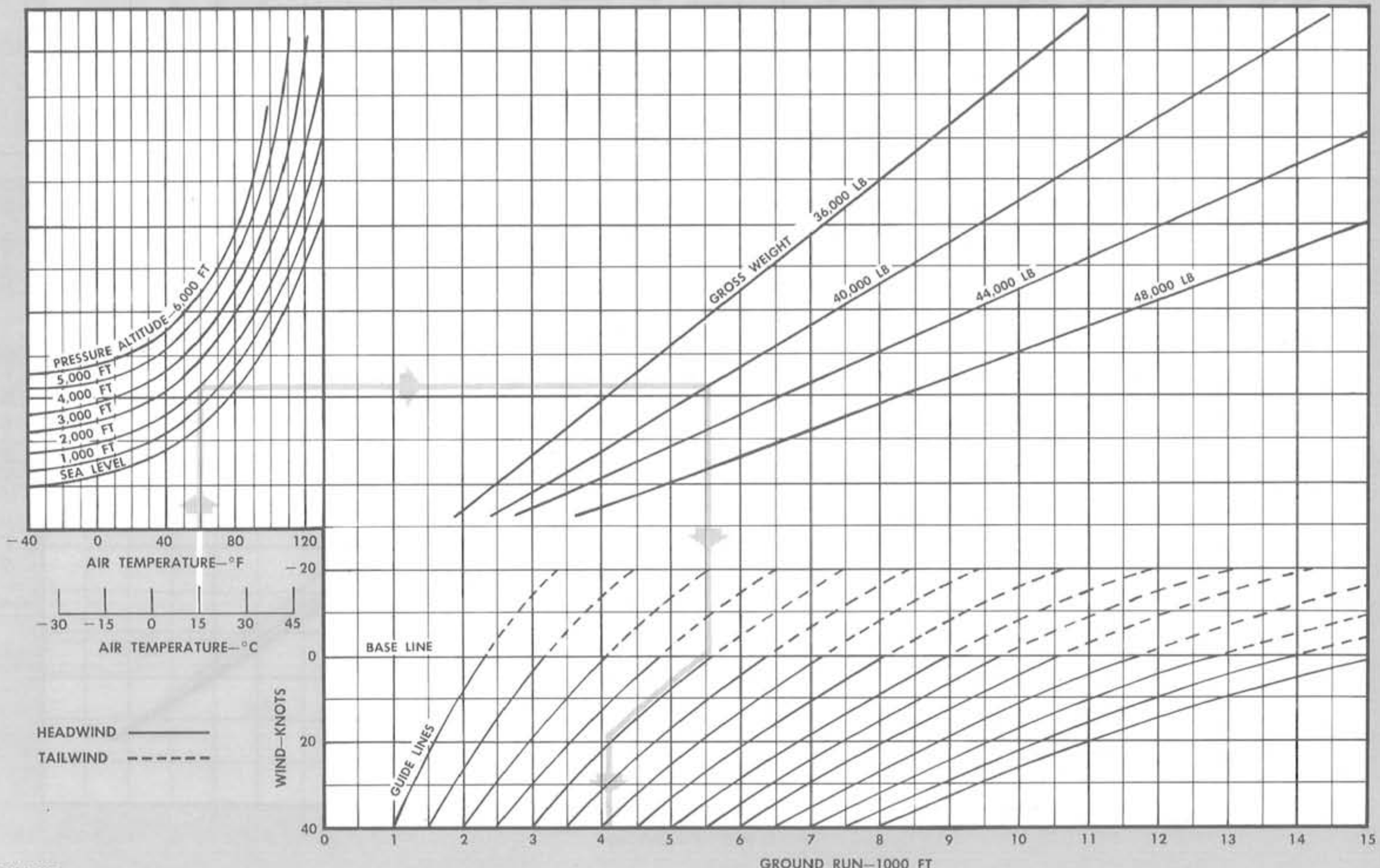
DATA BASIS: FLIGHT TEST

DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. USE 30-DEGREE FLAPS.
2. DISTANCE SHOWN WILL BE OBTAINED WHEN TAKEOFF IS IN ACCORDANCE WITH SPECIFIED NORMAL PROCEDURE, ON DRY HARD-SURFACE RUNWAY.
3. USE 100% RPM UNLESS LIMITED BY MAXIMUM TAILPIPE TEMPERATURE.
4. IF ONE ENGINE FAILS DURING TAKEOFF IMMEDIATELY START AFTERBURNING ON OPERATING ENGINE OR DISCONTINUE TAKEOFF.
5. ENGINE AIR INLET SCREENS EXTENDED.

JA-16(1)A

| GROSS WEIGHT | NOSE WHEEL OFF | TAKEOFF |
|---|---|---|
| 36,000 LB | 120 KNOTS IAS | 124 KNOTS IAS |
| 40,000 LB | 127 KNOTS IAS | 131 KNOTS IAS |
| 44,000 LB | 133 KNOTS IAS | 138 KNOTS IAS |
| 47,355 LB | 138 KNOTS IAS | 143 KNOTS IAS |

H-316(1)

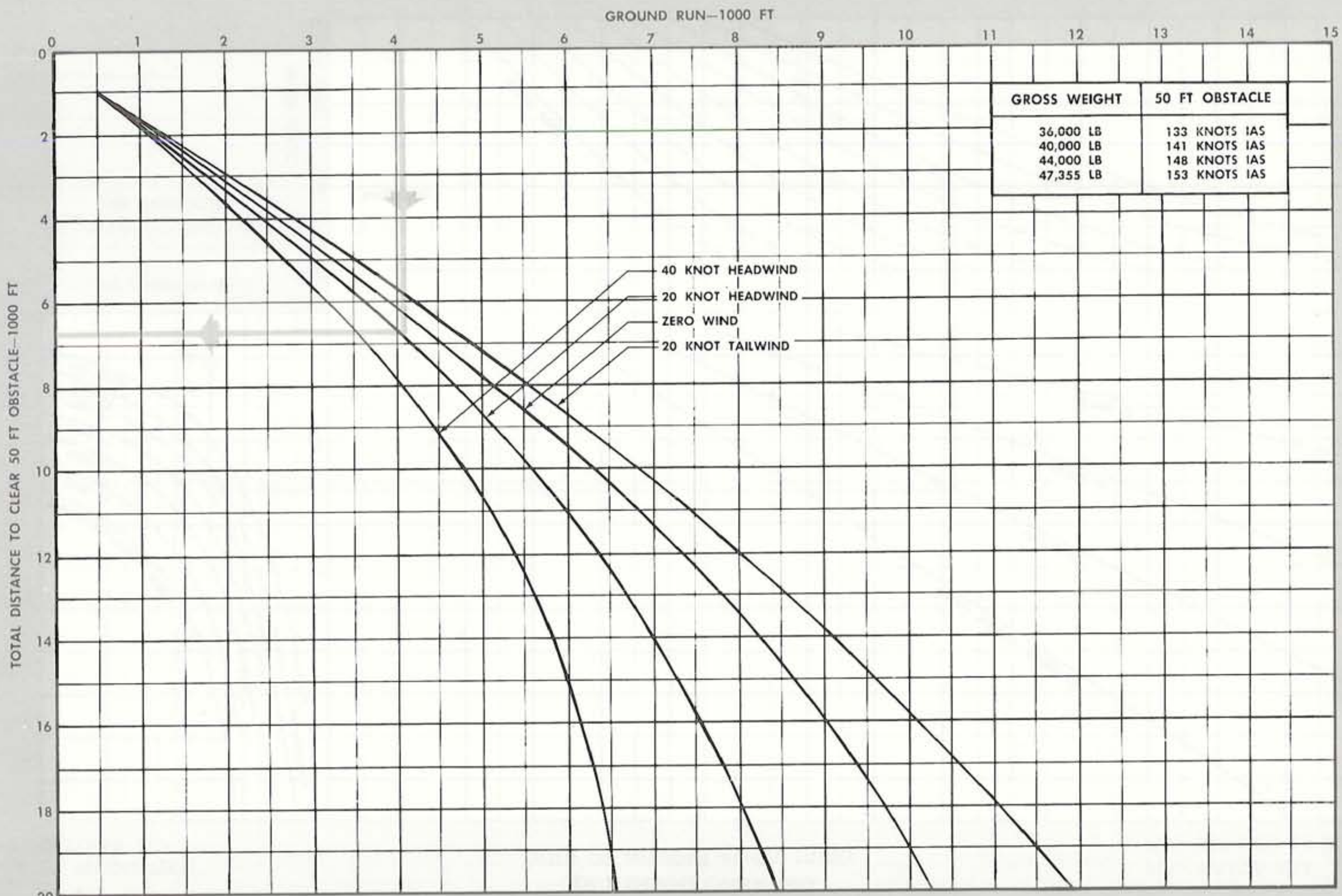
*Figure A-6 (Sheet 3 of 6).*

## TAKEOFF DISTANCE TO CLEAR 50FT-OBSTACLE

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

MILITARY POWER
WITH OR WITHOUT PYLON TANKS

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:
1. USE 30-DEGREE FLAPS.
2. DISTANCE SHOWN WILL BE OBTAINED WHEN TAKEOFF IS IN ACCORDANCE WITH SPECIFIED NORMAL PROCEDURE ON DRY HARD-SURFACE RUNWAY.
3. USE 100% RPM UNLESS LIMITED BY MAXIMUM TAILPIPE TEMPERATURE.
4. IF ONE ENGINE FAILS DURING TAKEOFF IMMEDIATELY START AFTERBURNER ON OPERATING ENGINE OR DISCONTINUE TAKEOFF.
5. ENGINE AIR INLET SCREENS EXTENDED.

H-316(2)

*Figure A-6 (Sheet 4 of 6).*

MODEL: **F-89H**

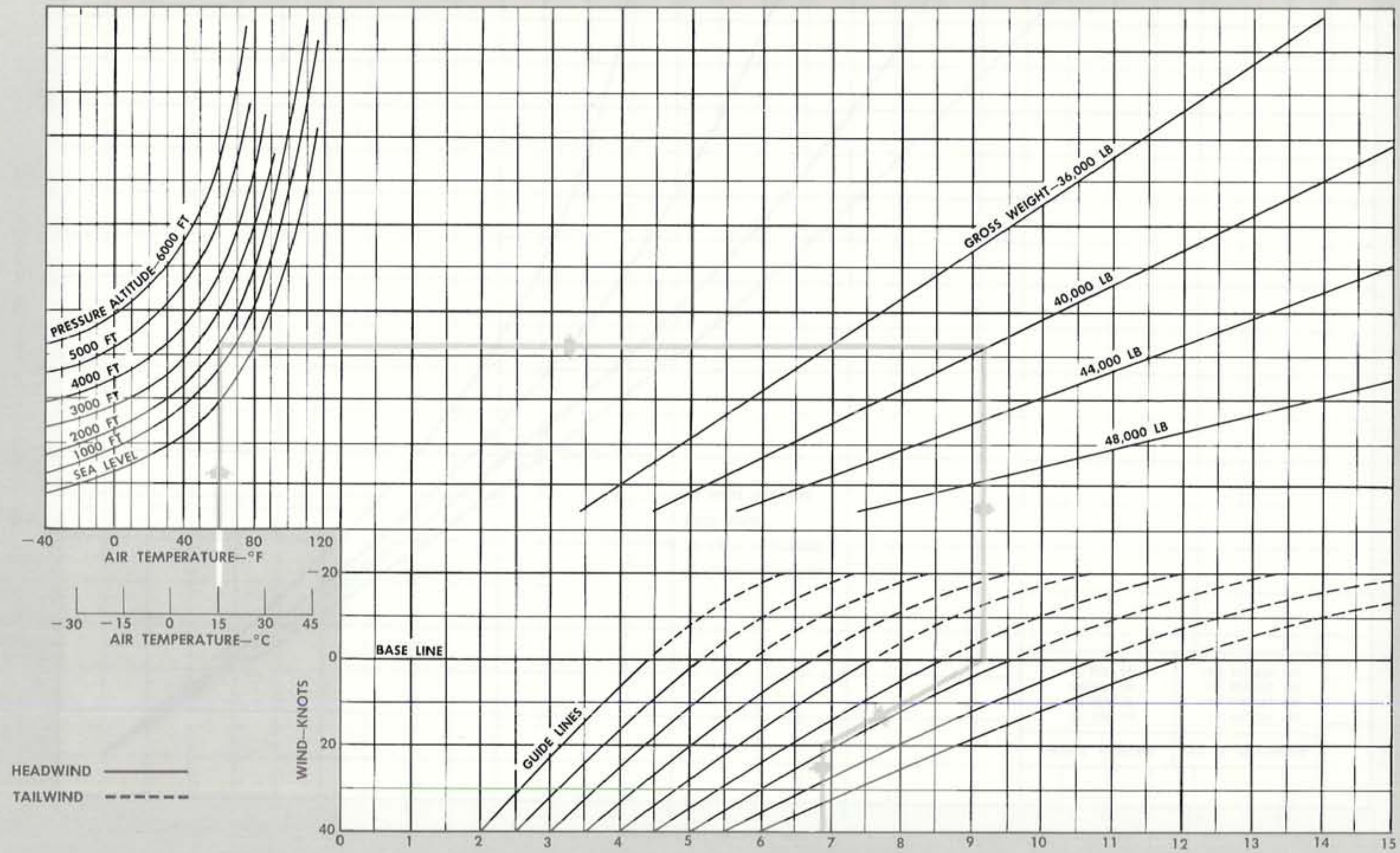
DATA BASIS: **FLIGHT TEST**
DATE: **22 OCTOBER 1957**

# TAKEOFF DISTANCE

MAXIMUM POWER
ONE ENGINE OPERATING
WITH OR WITHOUT PYLON TANKS

ENGINE(S): (2) J35-35

FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. USE 30-DEGREE FLAPS.
2. THE ABOVE VALUES (BASED ON DRY HARD-SURFACE RUNWAY) ARE TO BE USED ONLY FOR ESTIMATING TAKEOFF DISTANCE IN EVENT OF TOTAL LOSS OF POWER ON ONE ENGINE DURING TAKEOFF, RATHER THAN FOR SINGLE-ENGINE TAKEOFFS.
3. USE 100% RPM WITH AFTERBURNING UNLESS LIMITED BY MAXIMUM TAILPIPE TEMPERATURE.
4. ENGINE AIR INLET SCREENS EXTENDED.

| GROSS WEIGHT | NOSE WHEEL OFF | TAKEOFF |
|---|---|---|
| 36,000 LB | 124 KNOTS IAS | 120 KNOTS IAS |
| 40,000 LB | 131 KNOTS IAS | 127 KNOTS IAS |
| 44,000 LB | 138 KNOTS IAS | 133 KNOTS IAS |
| 47,355 LB | 143 KNOTS IAS | 138 KNOTS IAS |

H-317(1)

*Figure A-6 (Sheet 5 of 6).*

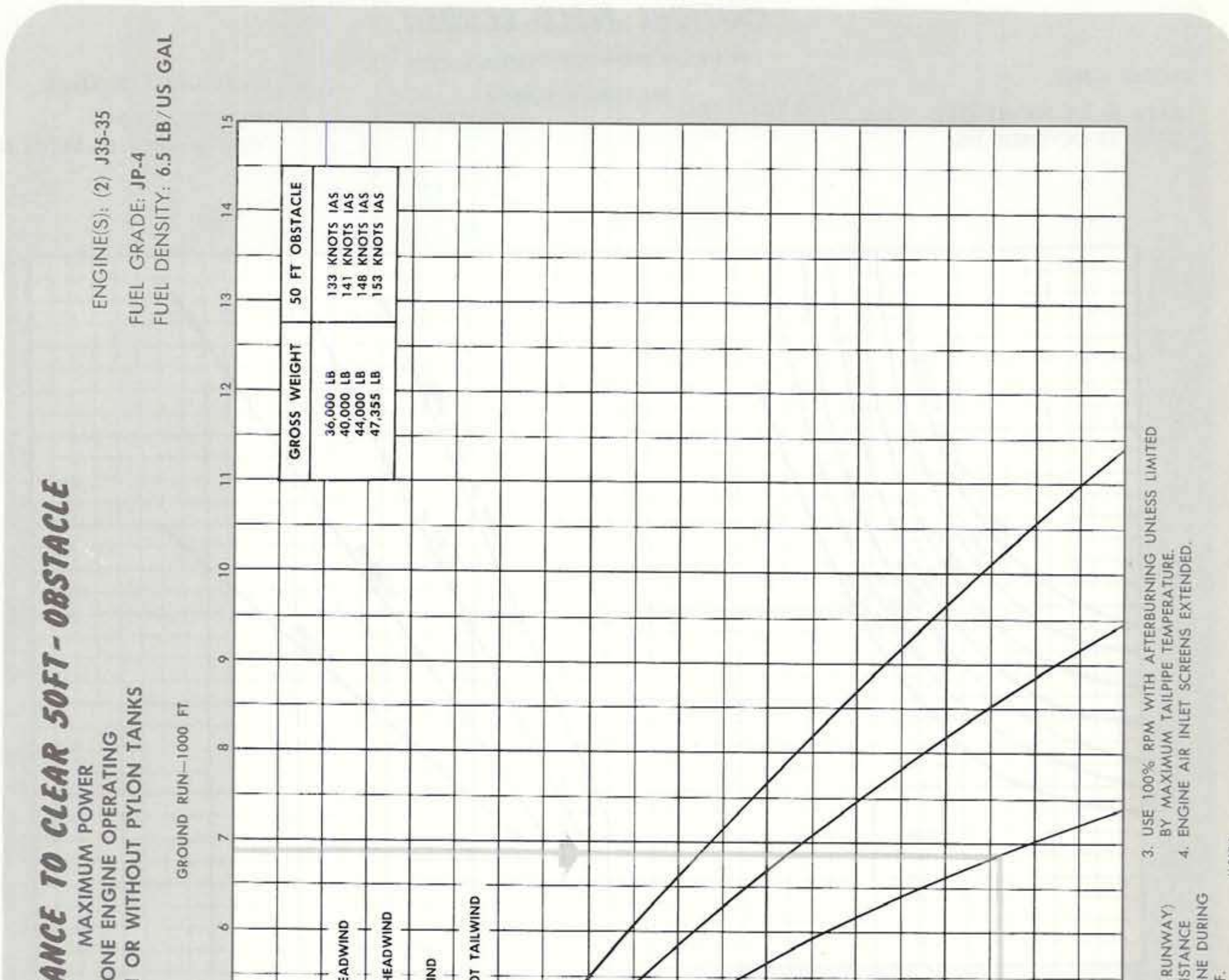



*Figure A-6 (Sheet 6 of 6).*

# CRITICAL FIELD LENGTH

WITH OR WITHOUT PYLON TANKS

MAXIMUM POWER

MODEL: F-89H

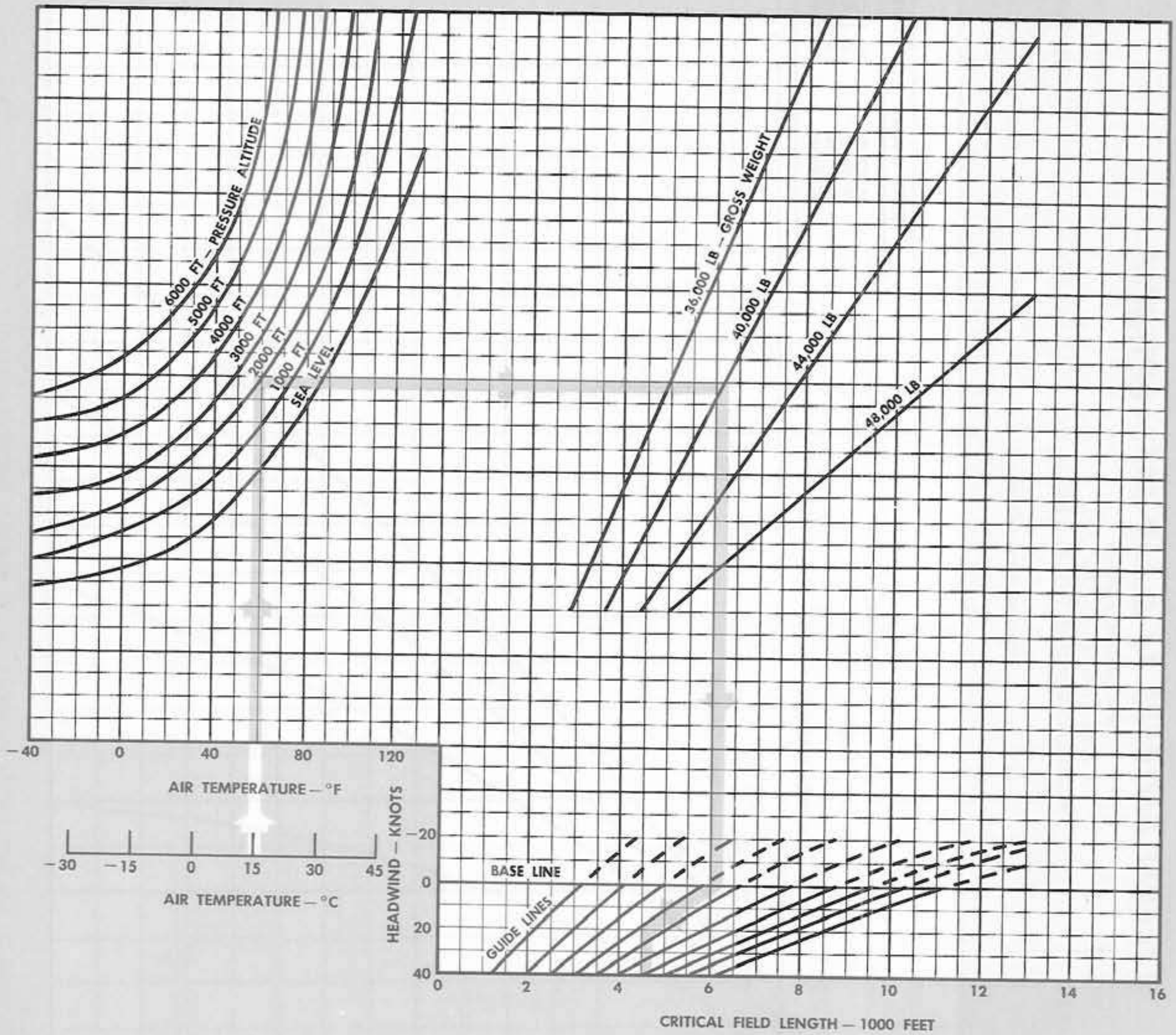
DATA BASIS: FLIGHT TEST

DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. ALL VALUES SHOWN ON CHART ARE BASED ON DRY HARD-SURFACE RUNWAY, 30-DEGREE FLAPS, AND SPEED BRAKES INOPERATIVE.
2. THREE SECONDS ALLOWED FOR PILOT RECOGNITION OF ENGINE FAILURE; AT THE END OF THE THREE SECONDS, THROTTLES ARE CUT AND BRAKES APPLIED.
3. ENGINE AIR INLET SCREENS EXTENDED.

H318

*Figure A-7.*

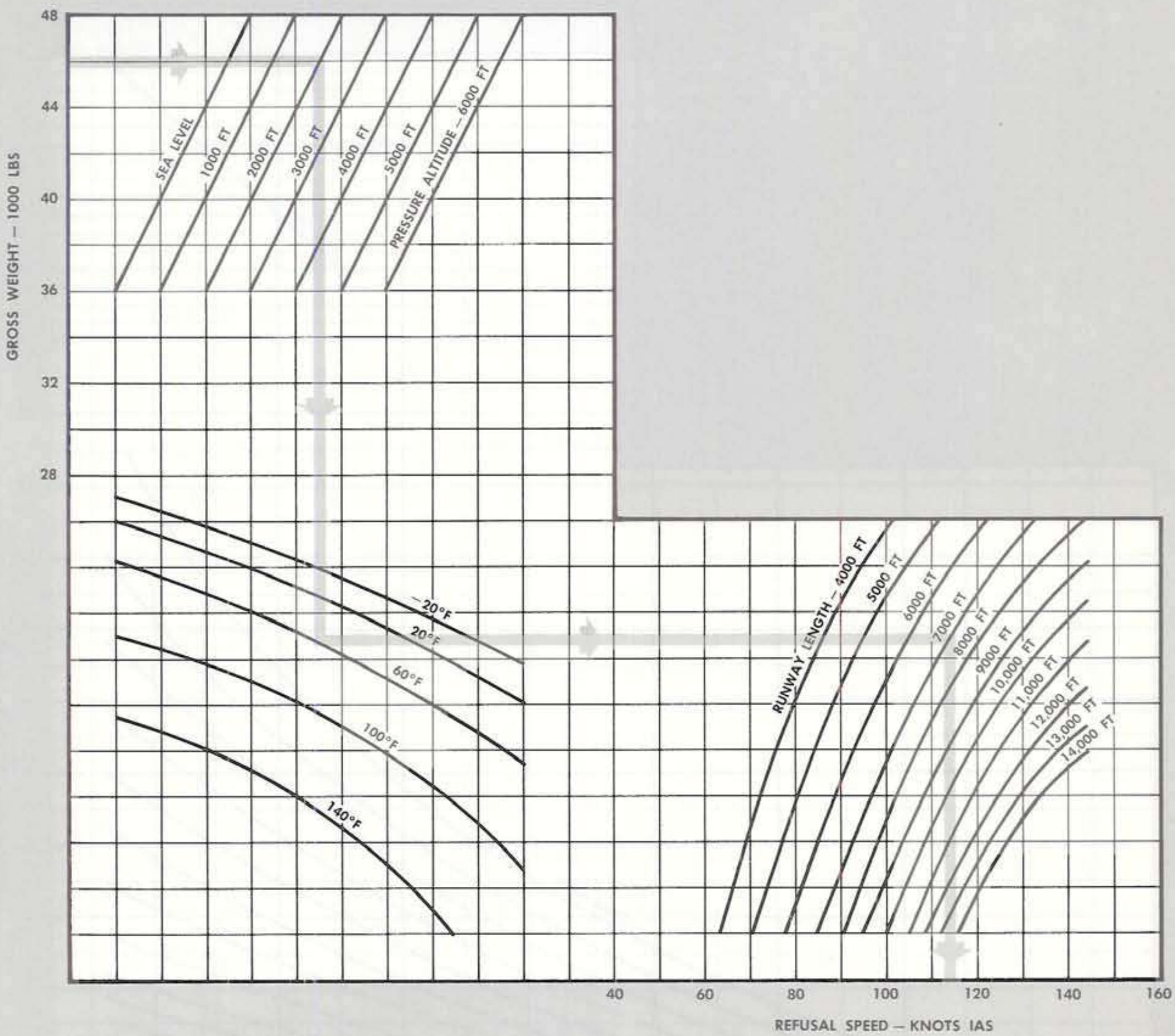
# REFUSAL SPEEDS

MAXIMUM POWER

WITH OR WITHOUT PYLON TANKS

MODEL: **F-89H**
DATA BASIS: **FLIGHT TEST**
DATE: **22 OCTOBER 1957**

ENGINE(S): **(2) J35-35**
FUEL GRADE: **JP-4**
FUEL DENSITY: **6.5 LB/US GAL**




REMARKS:

1. ABOVE VALUES ARE BASED ON DRY HARD-SURFACE RUNWAY, USING SPECIFIED NORMAL TAKEOFF PROCEDURE UP TO POINT OF ENGINE FAILURE AND OPERATION IN ACCORDANCE WITH SECTION III AFTER ENGINE FAILURE.
2. ENGINE AIR INLET SCREENS EXTENDED.

H319

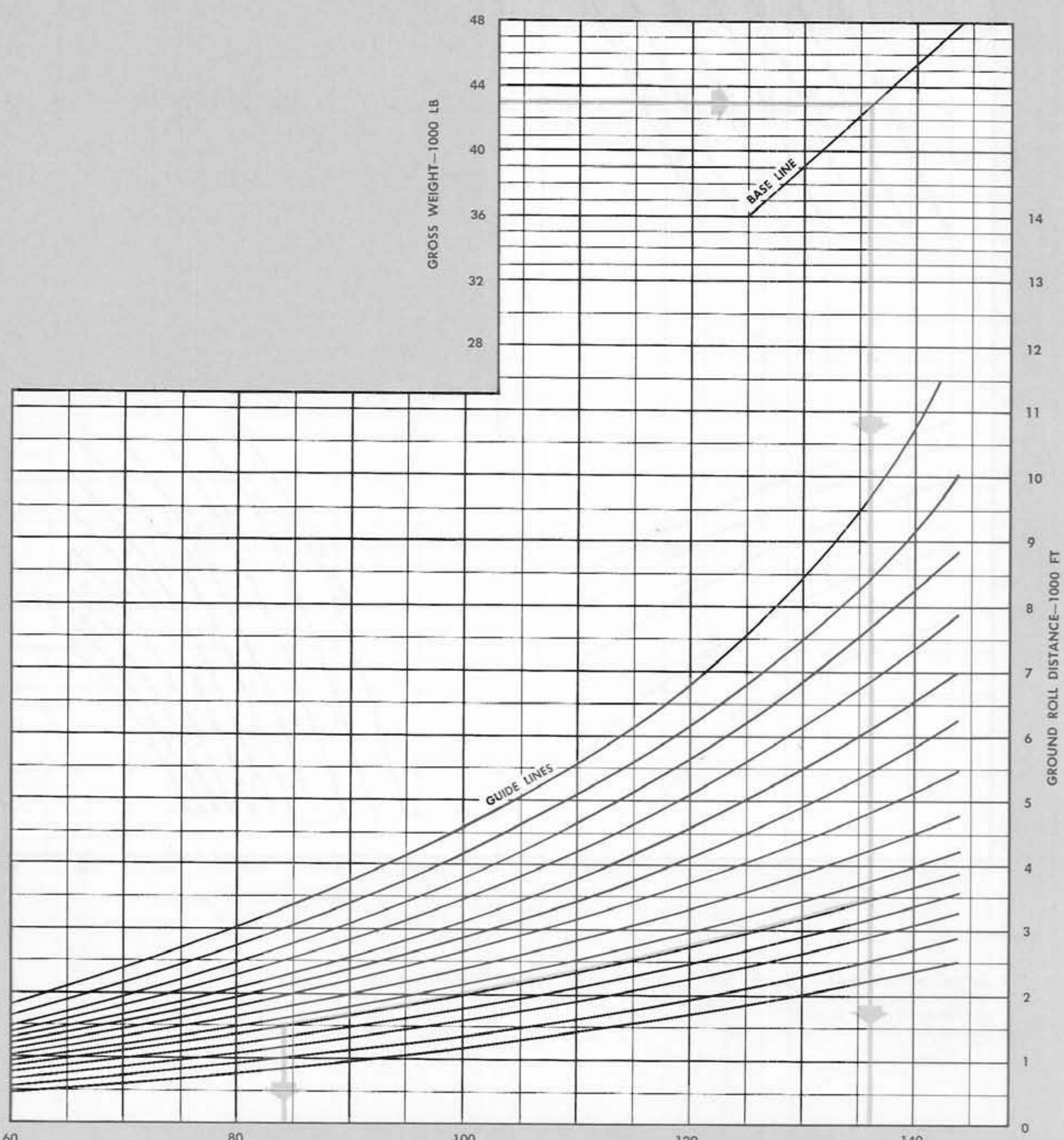
*Figure A-8.*

## VELOCITY DURING TAKEOFF GROUND RUN

MAXIMUM POWER
WITH OR WITHOUT PYLON TANKS

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. VELOCITIES SHOWN WILL BE OBTAINED WHEN TAKEOFF IS IN ACCORDANCE WITH SPECIFIED NORMAL PROCEDURE.
2. ENGINE AIR INLET SCREENS EXTENDED.

H-320A

*Figure A-9 (Sheet 1 of 2).*

# VELOCITY DURING TAKEOFF GROUND RUN

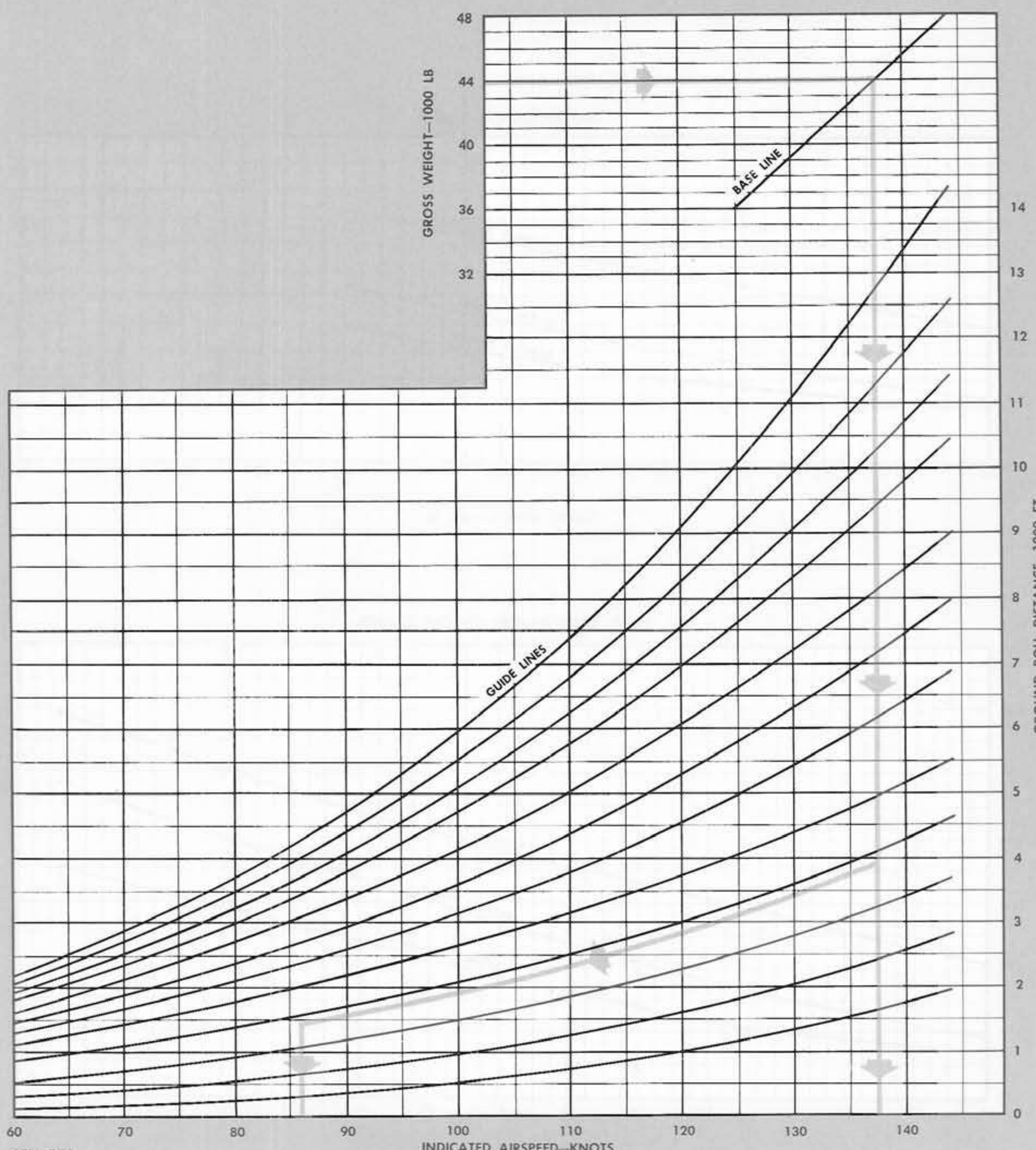
MODEL: F-89H

DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

MILITARY POWER
WITH OR WITHOUT PYLON TANKS

ENGINE(S): (2) J35-35

FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. VELOCITIES SHOWN WILL BE OBTAINED WHEN TAKEOFF IS IN ACCORDANCE WITH SPECIFIED NORMAL PROCEDURE.
2. ENGINE AIR INLET SCREENS EXTENDED.

H-321A

*Figure A-9 (Sheet 2 of 2).*

# MINIMUM DISTANCE CLIMB

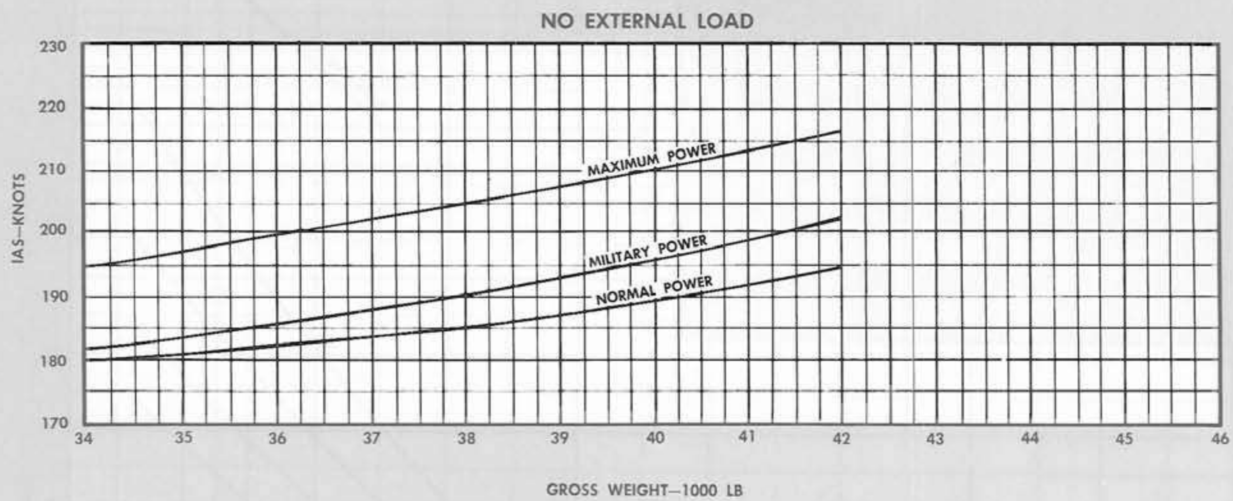
SEA LEVEL TO 10,000 FT

MODEL: F-89H

DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35

FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL



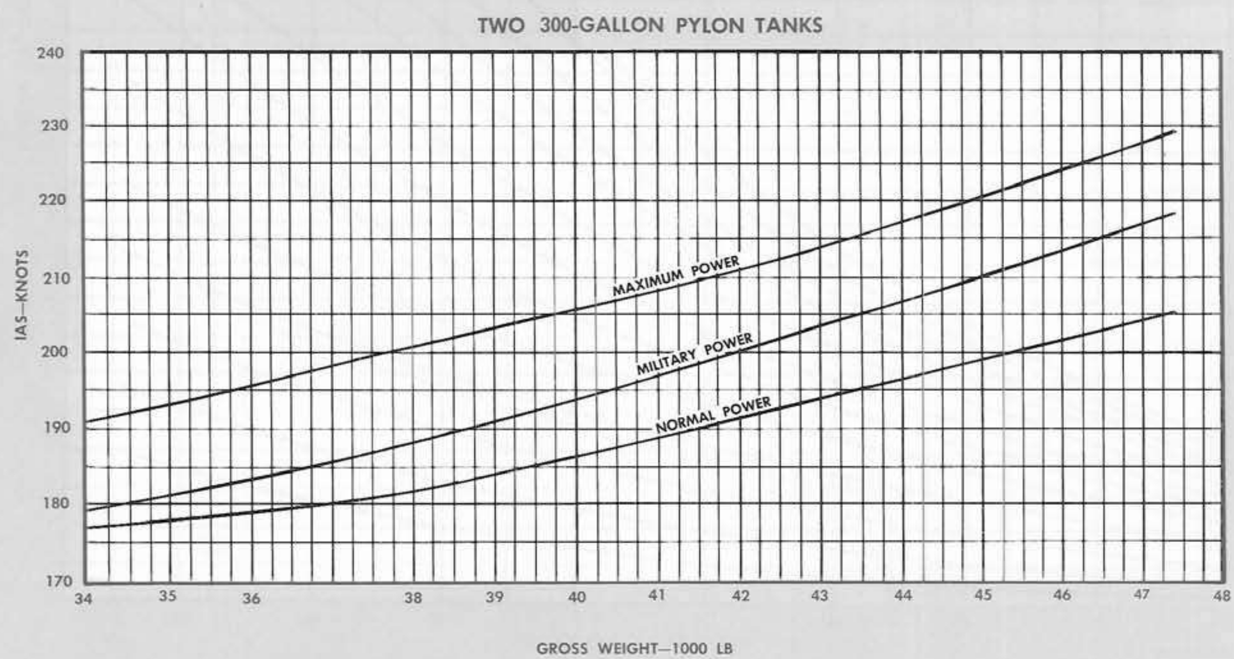



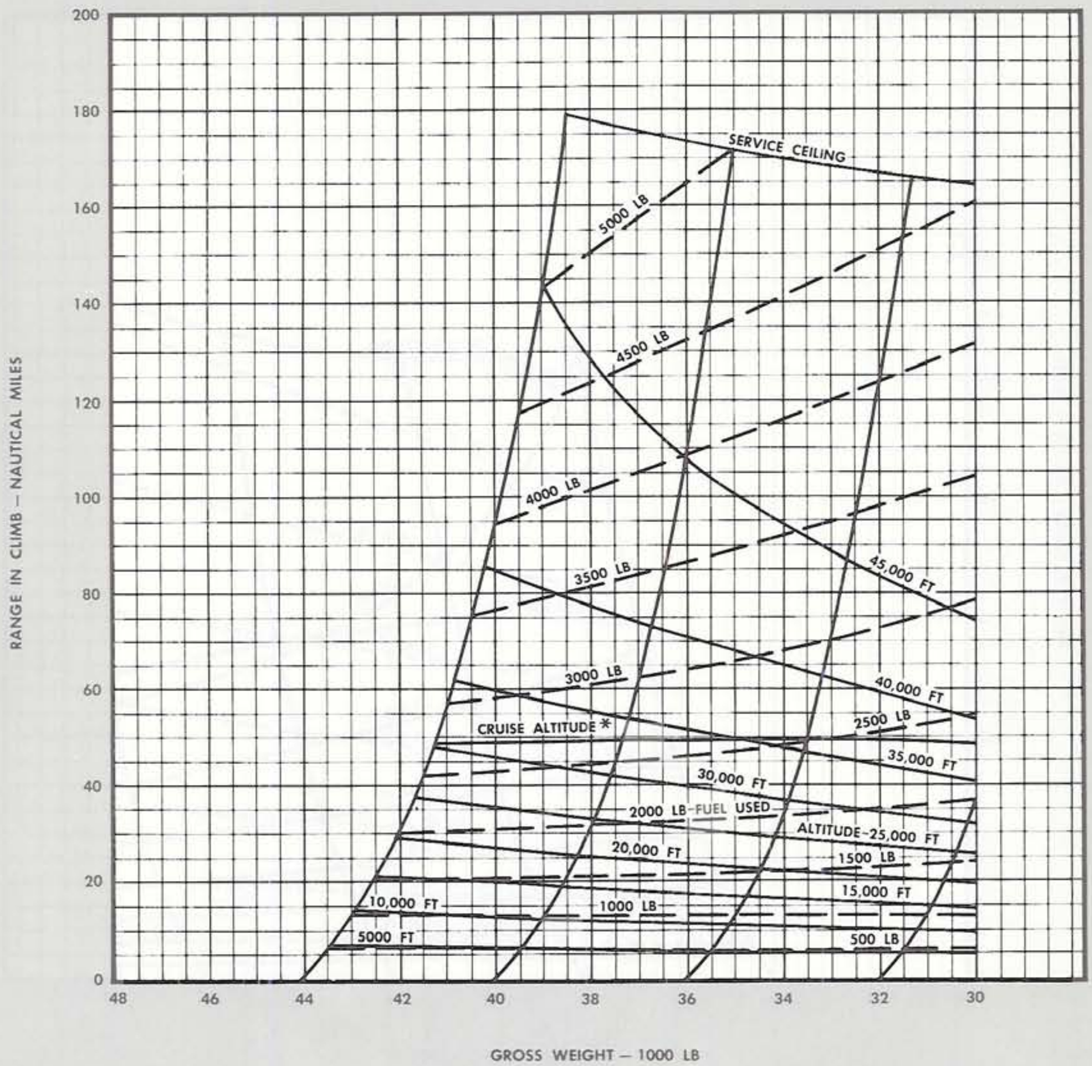

Figure A-10.

# BEST CLIMB PERFORMANCE (RANGE)

MAXIMUM POWER
BASIC CONFIGURATION PLUS PYLONS

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT FOR SERVICE VARIATION.
2. SUBTRACT 906 POUNDS FROM AVAILABLE FUEL TO ALLOW FOR WARMUP, TAXI, AND TAKEOFF; ENTER CHART AT TAKEOFF GROSS WEIGHT LESS 906 POUNDS.
3. ENGINE AIR INLET SCREENS RETRACTED.

*OPTIMUM CRUISE ALTITUDE – NORMAL RATED POWER.

H322

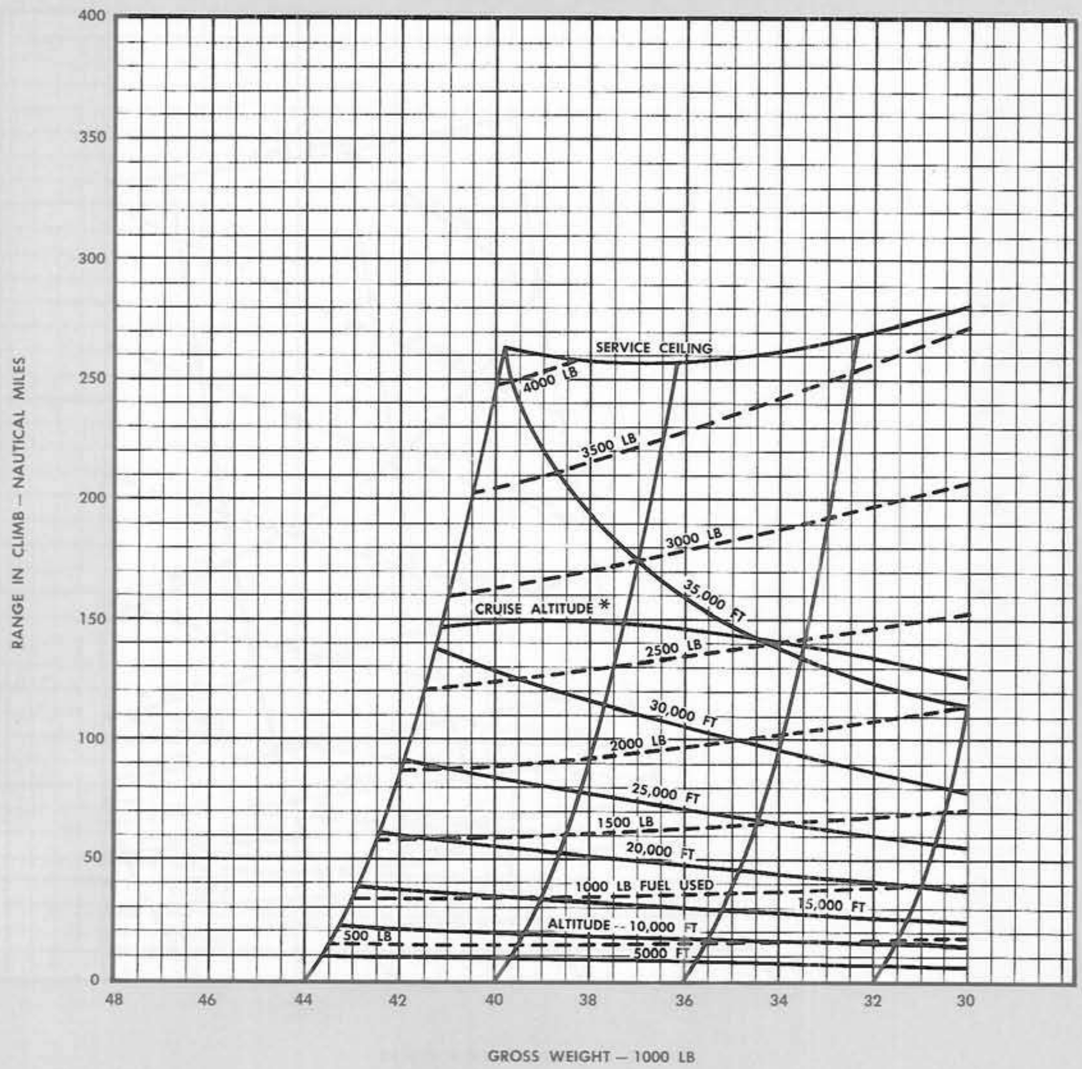
*Figure A-11 (Sheet 1 of 3).*

# BEST CLIMB PERFORMANCE (RANGE)

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

MILITARY POWER
BASIC CONFIGURATION PLUS PYLONS

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. SUBTRACT 906 POUNDS FROM AVAILABLE FUEL TO ALLOW FOR WARMUP, TAXI, AND TAKEOFF; ENTER CHART AT TAKEOFF GROSS WEIGHT LESS 906 POUNDS.
3. ENGINE AIR INLET SCREENS RETRACTED.

*OPTIMUM CRUISE ALTITUDE – NORMAL RATED POWER.

H323

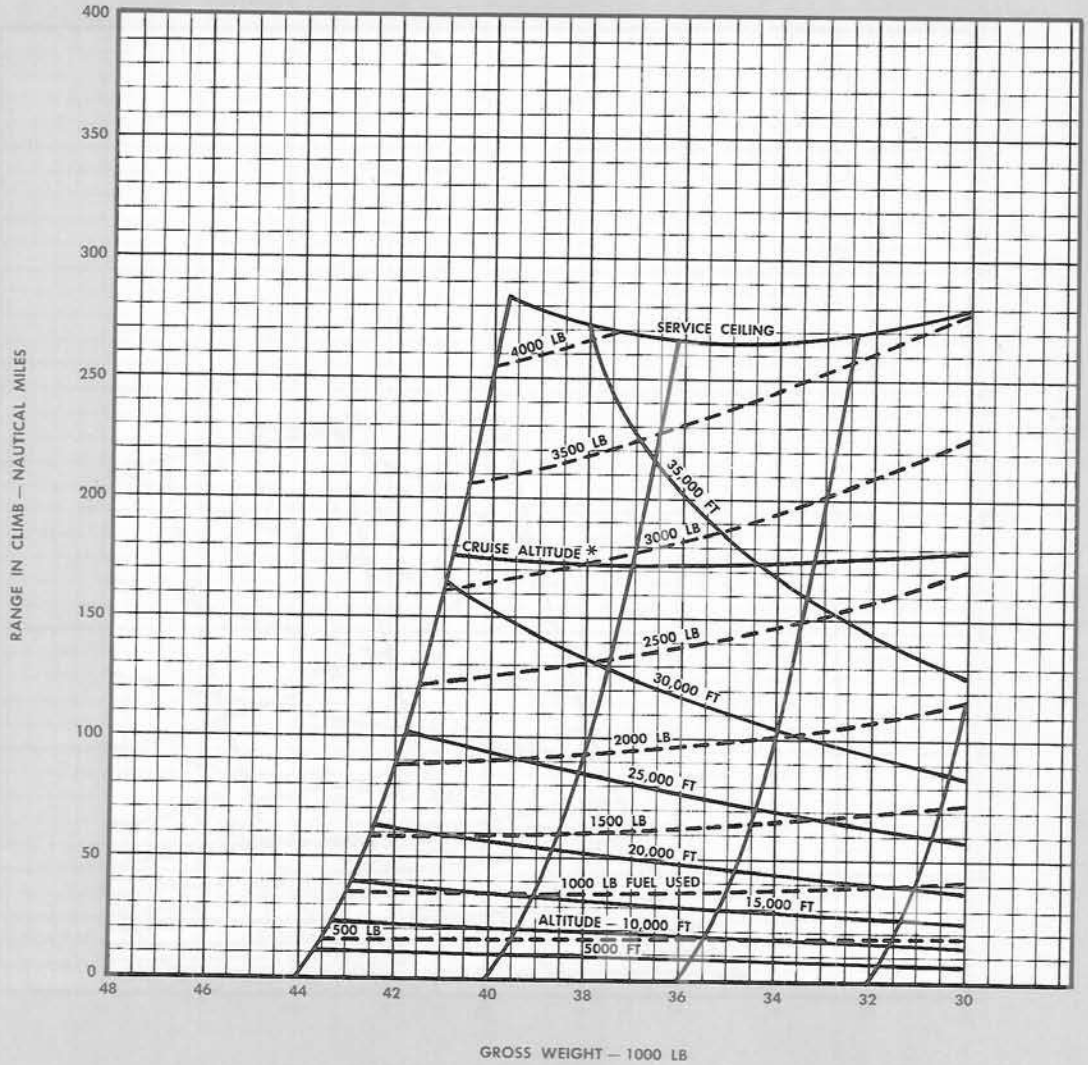
*Figure A-11 (Sheet 2 of 3).*

# BEST CLIMB PERFORMANCE (RANGE)

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

NORMAL POWER
BASIC CONFIGURATION PLUS PYLONS

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. SUBTRACT 906 POUNDS FROM AVAILABLE FUEL TO ALLOW FOR WARMUP, TAXI, AND TAKEOFF; ENTER CHART AT TAKEOFF GROSS WEIGHT LESS 906 POUNDS.
3. ENGINE AIR INLET SCREENS RETRACTED.

* OPTIMUM CRUISE ALTITUDE — NORMAL RATED POWER.

H324

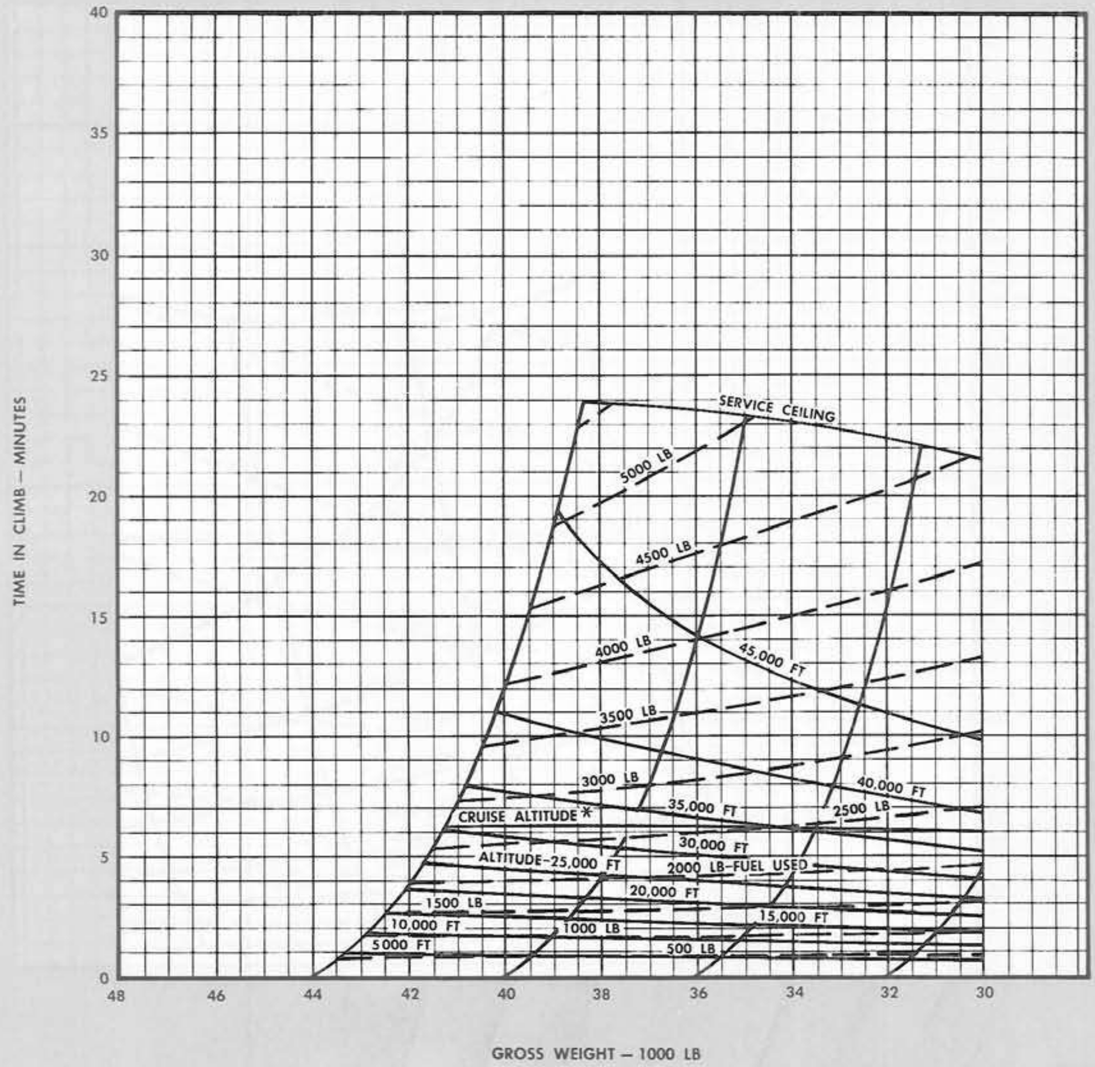
Figure A-11 (Sheet 3 of 3).

# BEST CLIMB PERFORMANCE (TIME)

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

MAXIMUM POWER
BASIC CONFIGURATION PLUS PYLONS

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT FOR SERVICE VARIATION.
2. SUBTRACT 906 POUNDS FROM AVAILABLE FUEL TO ALLOW FOR WARMUP, TAXI, AND TAKEOFF; ENTER CHART AT TAKEOFF GROSS WEIGHT LESS 906 POUNDS.
3. ENGINE AIR INLET SCREENS RETRACTED.

*OPTIMUM CRUISE ALTITUDE — NORMAL RATED POWER.

H325

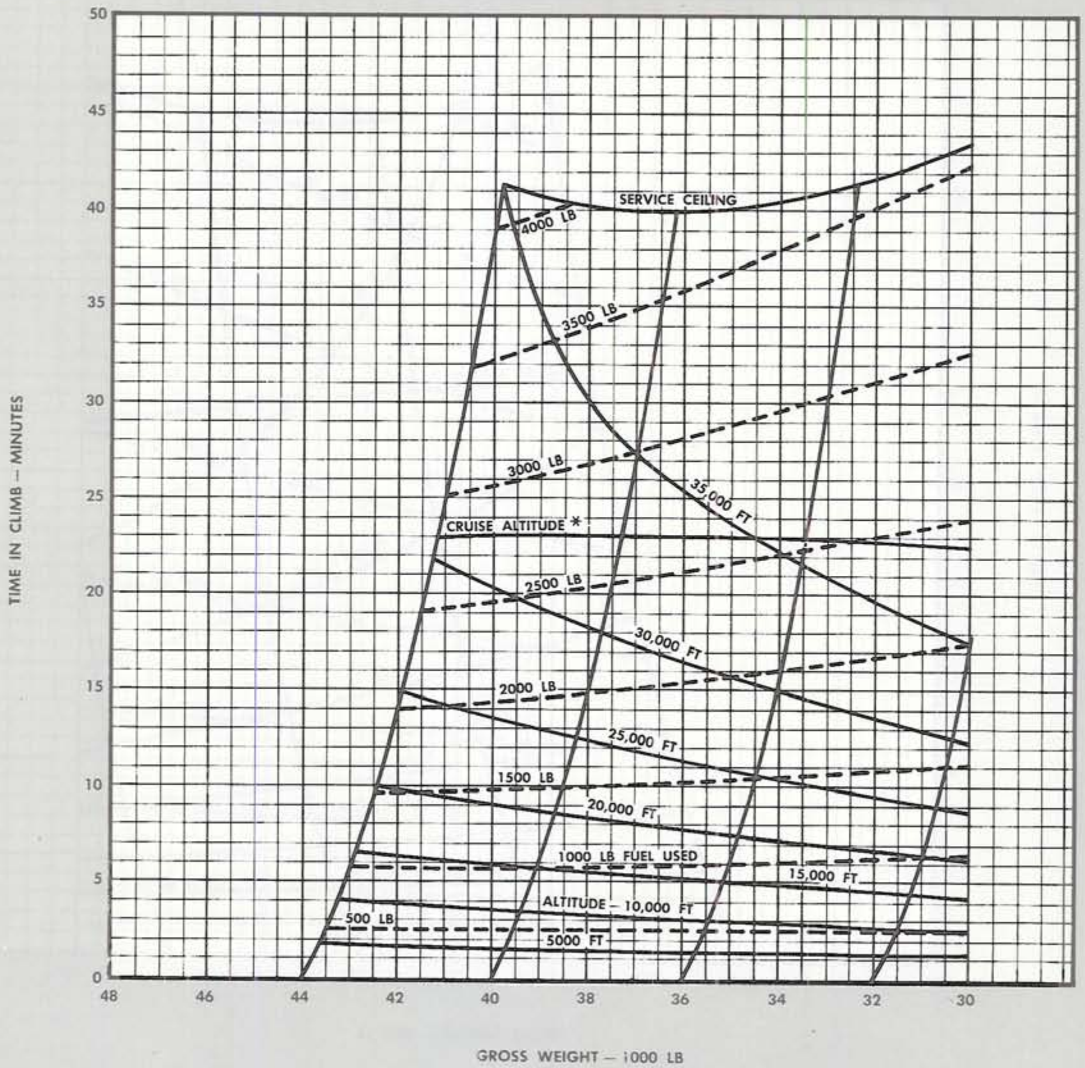
*Figure A-12 (Sheet 1 of 3).*

# BEST CLIMB PERFORMANCE (TIME)

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

MILITARY POWER
BASIC CONFIGURATION PLUS PYLONS

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. SUBTRACT 906 POUNDS FROM AVAILABLE FUEL TO ALLOW FOR WARMUP, TAXI, AND TAKEOFF; ENTER CHART AT TAKEOFF GROSS WEIGHT LESS 906 POUNDS.
3. ENGINE AIR INLET SCREENS RETRACTED.

*OPTIMUM CRUISE ALTITUDE – NORMAL RATED POWER.

H326

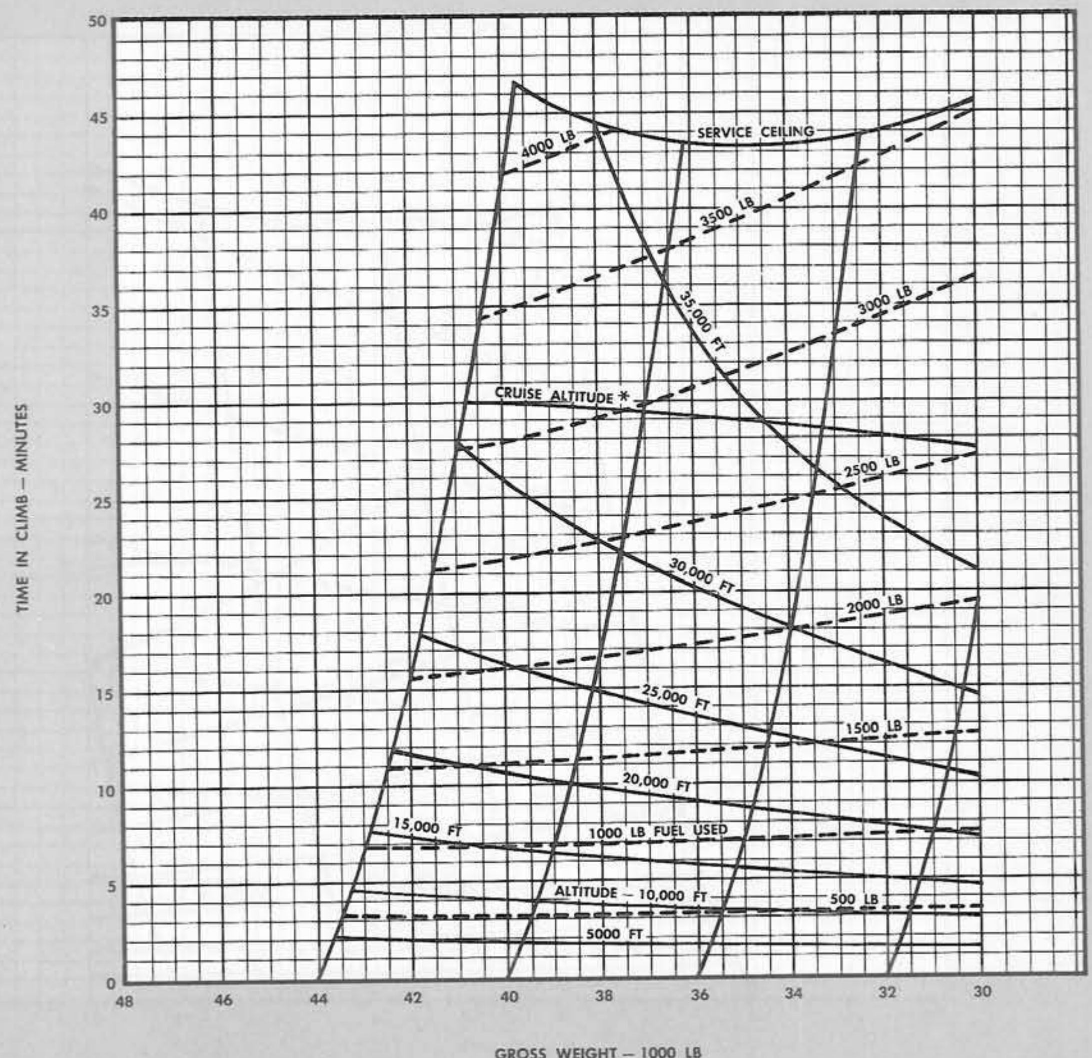
**Figure A-12 (Sheet 2 of 3).**

# BEST CLIMB PERFORMANCE (TIME)

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

NORMAL POWER
BASIC CONFIGURATION PLUS PYLONS

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. SUBTRACT 906 POUNDS FROM AVAILABLE FUEL TO ALLOW FOR WARMUP, TAXI, AND TAKEOFF; ENTER CHART AT TAKEOFF GROSS WEIGHT LESS 906 POUNDS.
3. ENGINE AIR INLET SCREENS RETRACTED.

* OPTIMUM CRUISE ALTITUDE – NORMAL RATED POWER.

H327

*Figure A-12 (Sheet 3 of 3).*

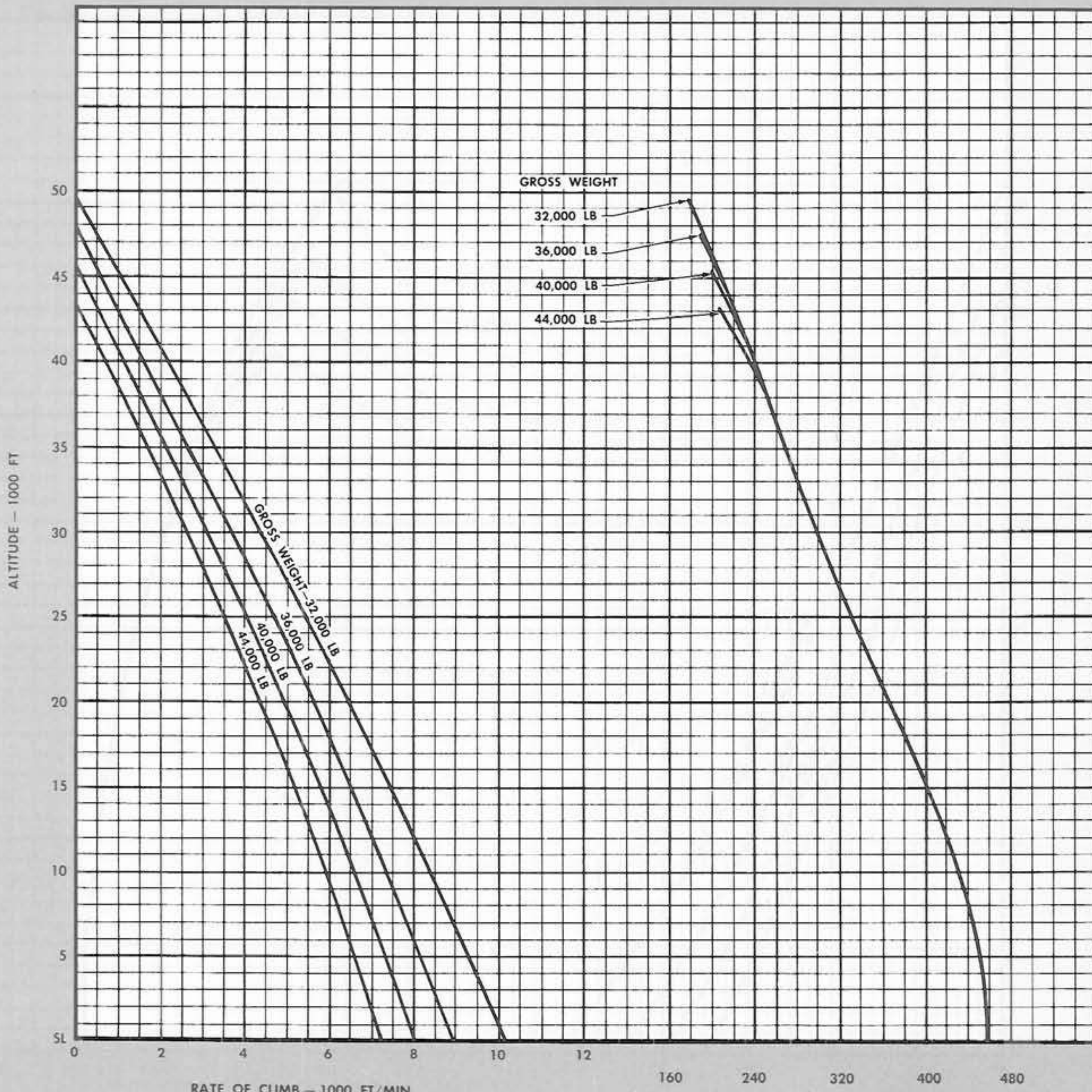
# BEST CLIMB SPEED

MAXIMUM POWER

BASIC CONFIGURATION PLUS PYLONS

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. CLIMB AT CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.
2. ENGINE AIR INLET SCREENS RETRACTED.

H328

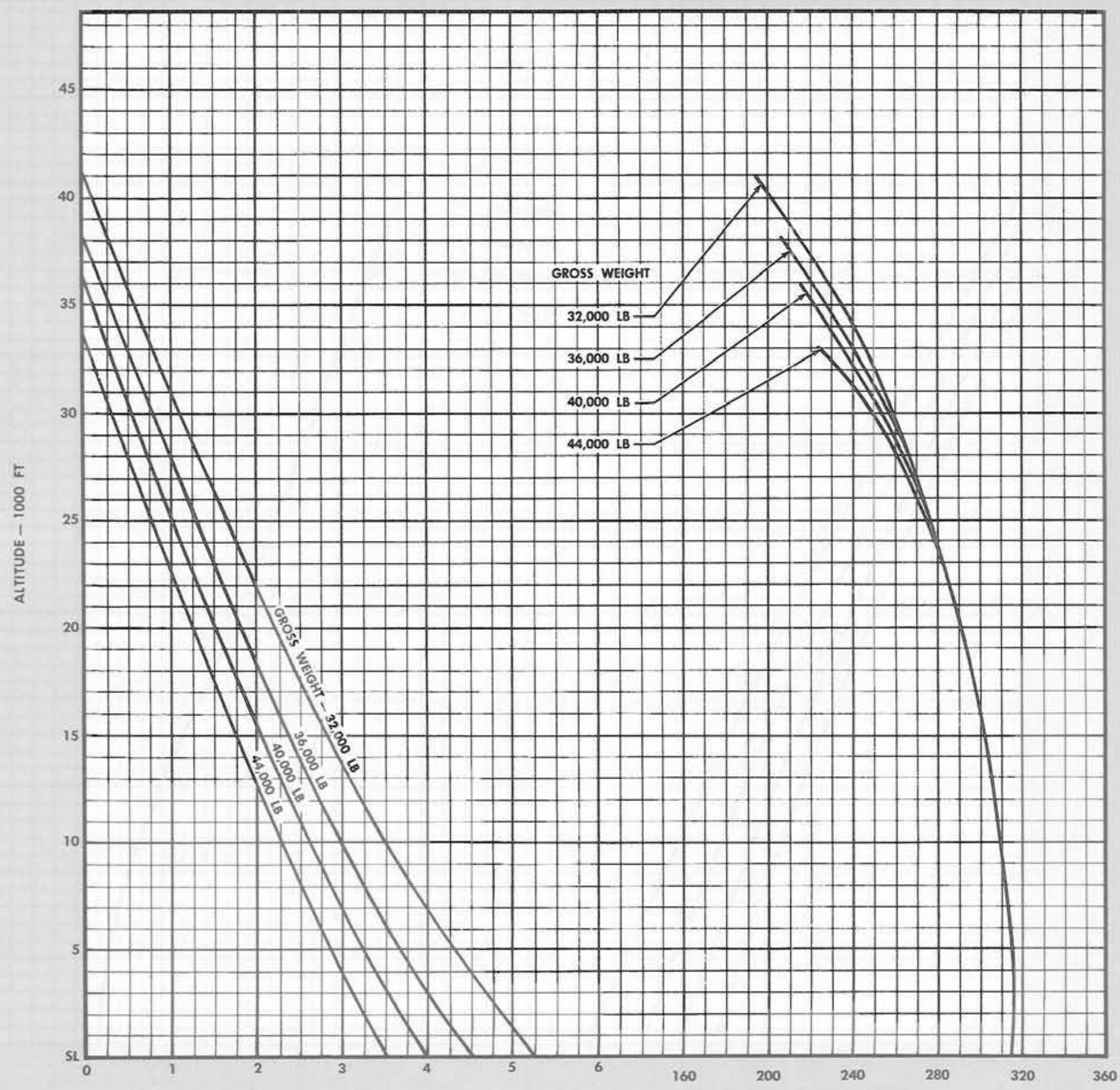
*Figure A-13 (Sheet 1 of 3).*

# BEST CLIMB SPEED

MILITARY POWER
BASIC CONFIGURATION PLUS PYLONS

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. CLIMB AT CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.
2. ENGINE AIR INLET SCREENS RETRACTED.

H329

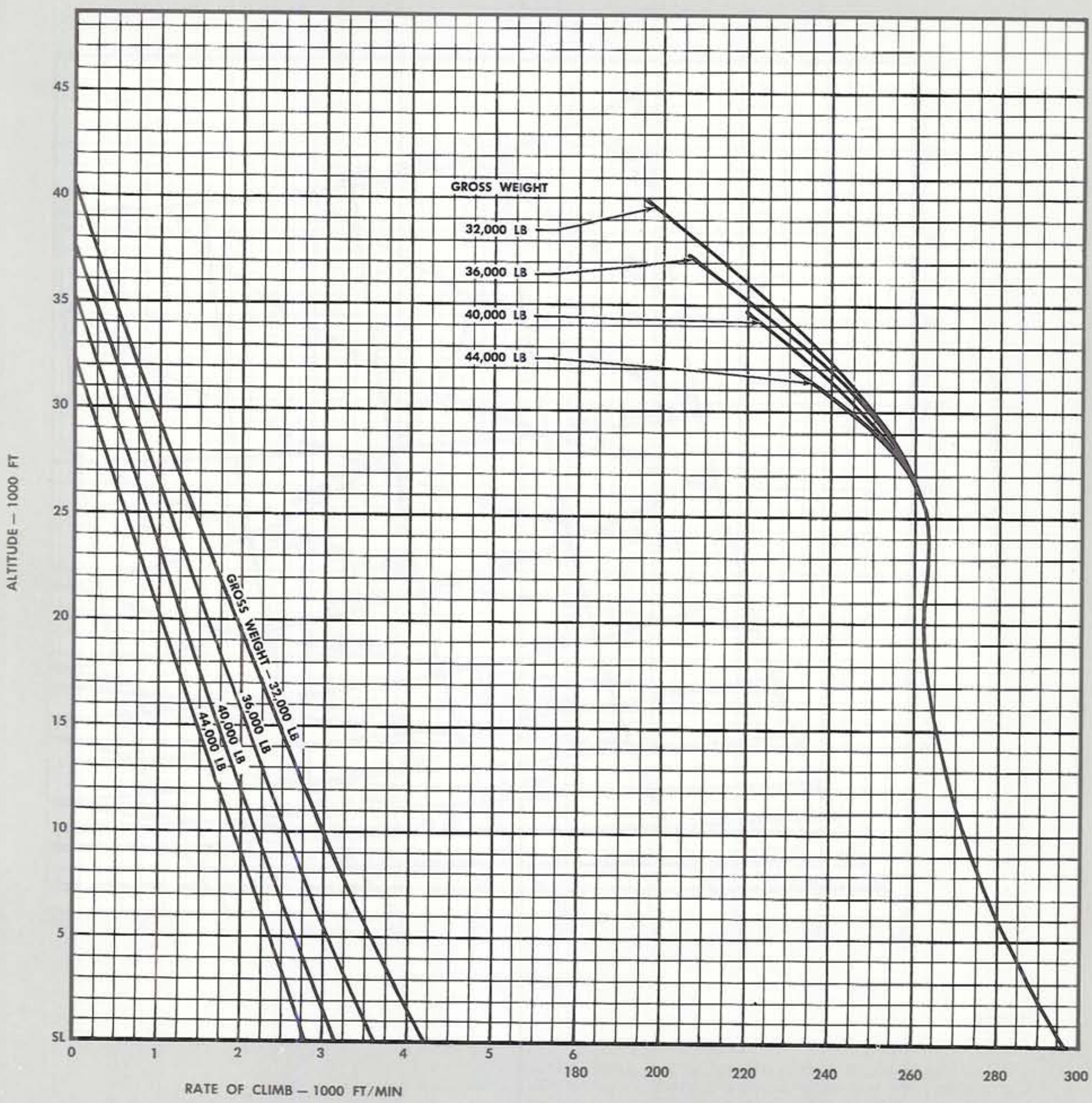
*Figure A-13 (Sheet 2 of 3).*

# BEST CLIMB SPEED

NORMAL POWER
BASIC CONFIGURATION PLUS PYLONS

MODEL: **F-89H**
DATA BASIS: **FLIGHT TEST**
DATE: **22 OCTOBER 1957**

ENGINE(S): **(2) J35-35**
FUEL GRADE: **JP-4**
FUEL DENSITY: **6.5 LB/US GAL**




REMARKS:

1. CLIMB AT CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.
2. ENGINE AIR INLET SCREENS RETRACTED.

H330

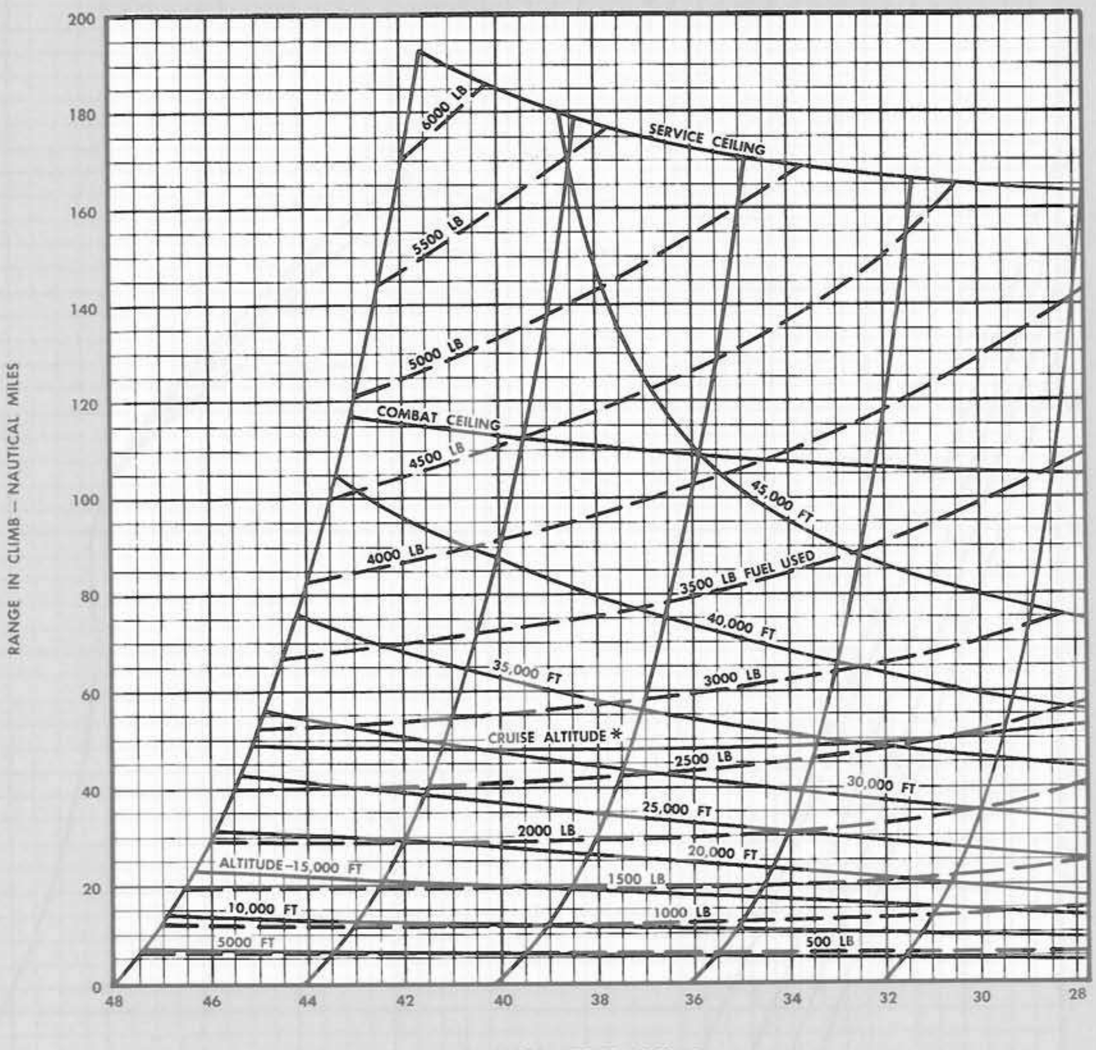
*Figure A-13 (Sheet 3 of 3).*

# BEST CLIMB PERFORMANCE (RANGE)

MAXIMUM POWER
PYLON TANK CONFIGURATION

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT FOR SERVICE VARIATION.
2. SUBTRACT 906 POUNDS FROM AVAILABLE FUEL TO ALLOW FOR WARMUP, TAXI, AND TAKEOFF; ENTER CHART AT TAKEOFF GROSS WEIGHT LESS 906 POUNDS.
3. ENGINE AIR INLET SCREENS RETRACTED.

*OPTIMUM CRUISE ALTITUDE – NORMAL RATED POWER.

H331

*Figure A-14 (Sheet 1 of 3).*

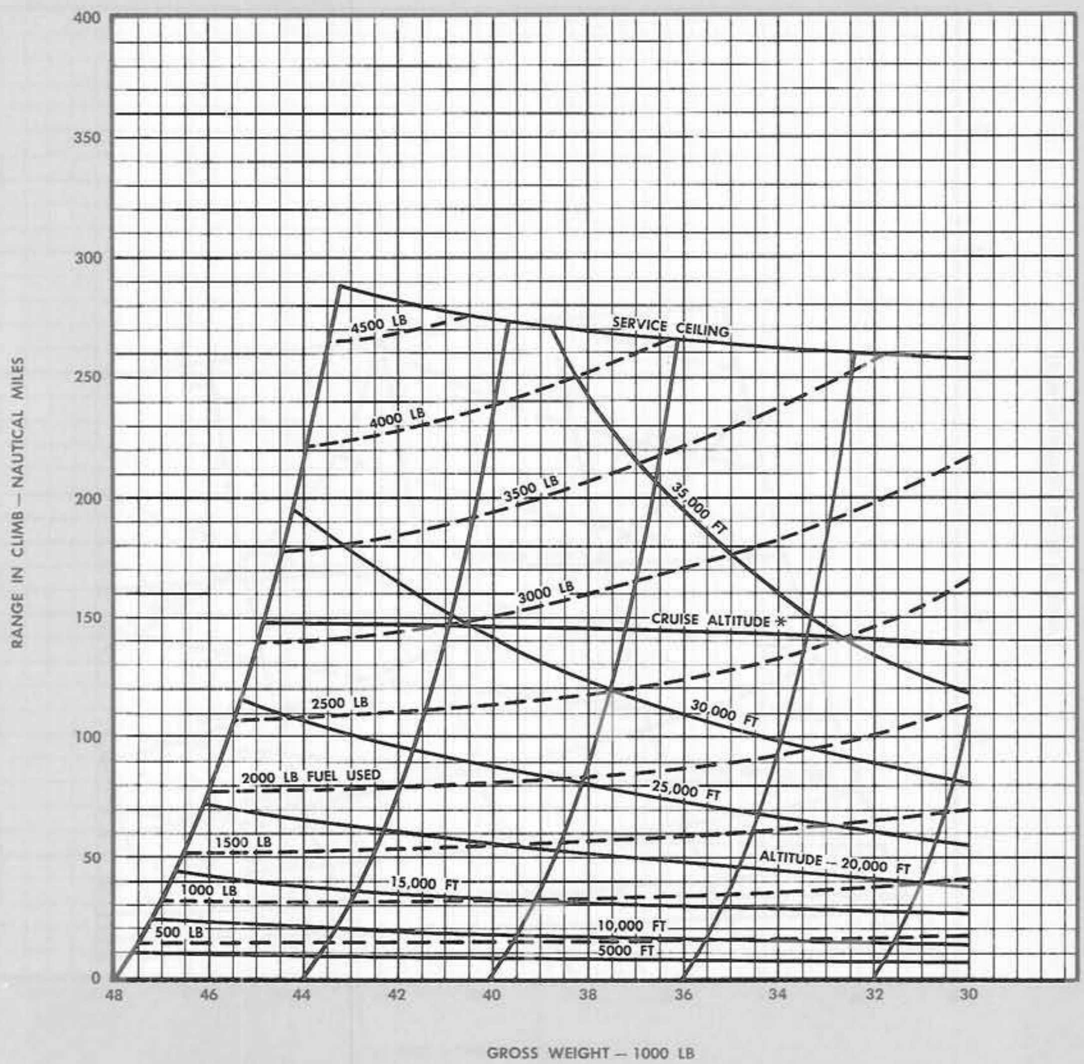
# BEST CLIMB PERFORMANCE (RANGE)

MILITARY POWER

PYLON TANK CONFIGURATION

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT FOR SERVICE VARIATION.
2. SUBTRACT 906 POUNDS FROM AVAILABLE FUEL TO ALLOW FOR WARMUP, TAXI, AND TAKEOFF; ENTER CHART AT TAKEOFF GROSS WEIGHT LESS 906 POUNDS.
3. ENGINE AIR INLET SCREENS RETRACTED.

*OPTIMUM CRUISE ALTITUDE — NORMAL RATED POWER.

H332

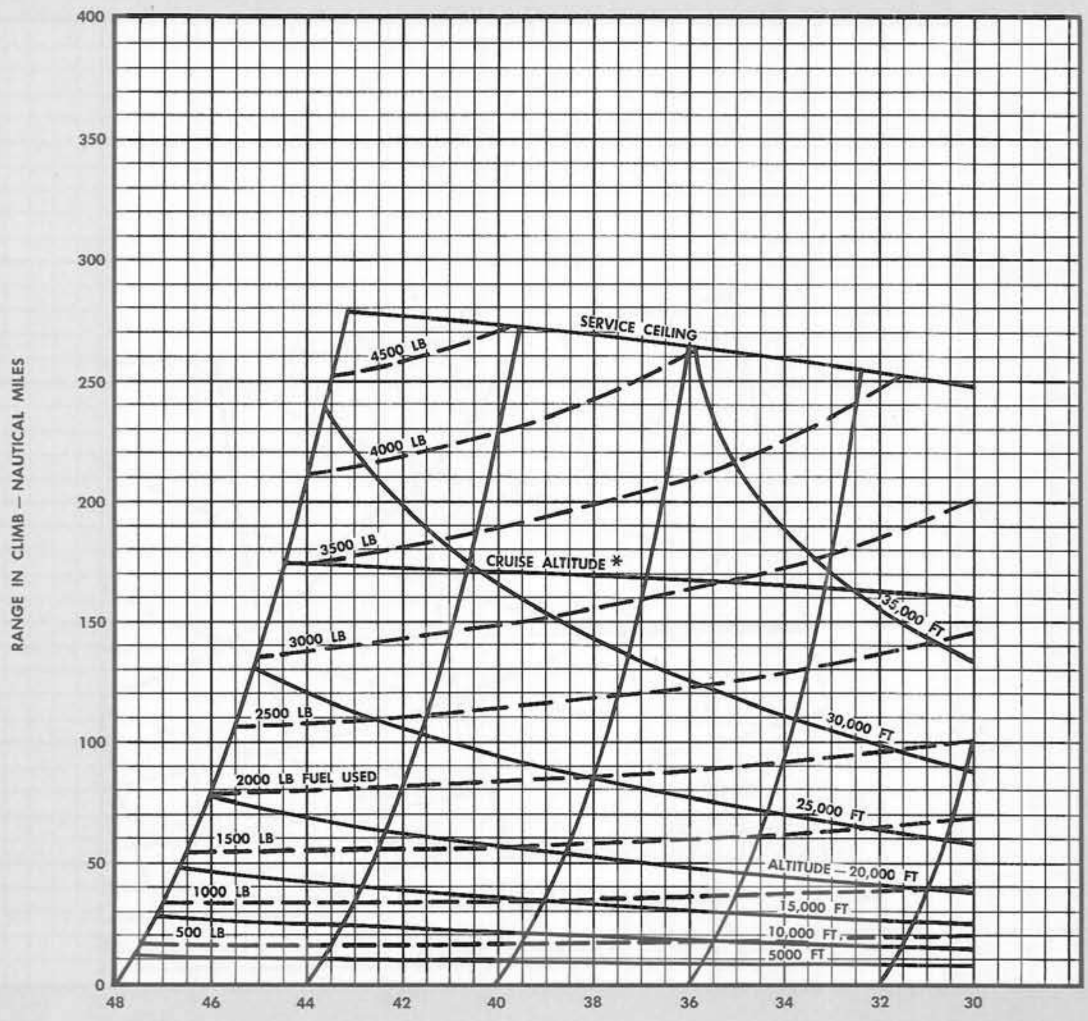
*Figure A-14 (Sheet 2 of 3).*

# BEST CLIMB PERFORMANCE (RANGE)

MODEL: **F-89H**
DATA BASIS: **FLIGHT TEST**
DATE: **22 OCTOBER 1957**

**NORMAL POWER**
**PYLON TANK CONFIGURATION**

ENGINE(S): **(2) J35-35**
FUEL GRADE: **JP-4**
FUEL DENSITY: **6.5 LB/US GAL**




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. SUBTRACT 906 POUNDS FROM AVAILABLE FUEL TO ALLOW FOR WARMUP, TAXI, AND TAKEOFF; ENTER CHART AT TAKEOFF GROSS WEIGHT LESS 906 POUNDS.
3. ENGINE AIR INLET SCREENS RETRACTED.

*OPTIMUM CRUISE ALTITUDE — NORMAL RATED POWER.

H333

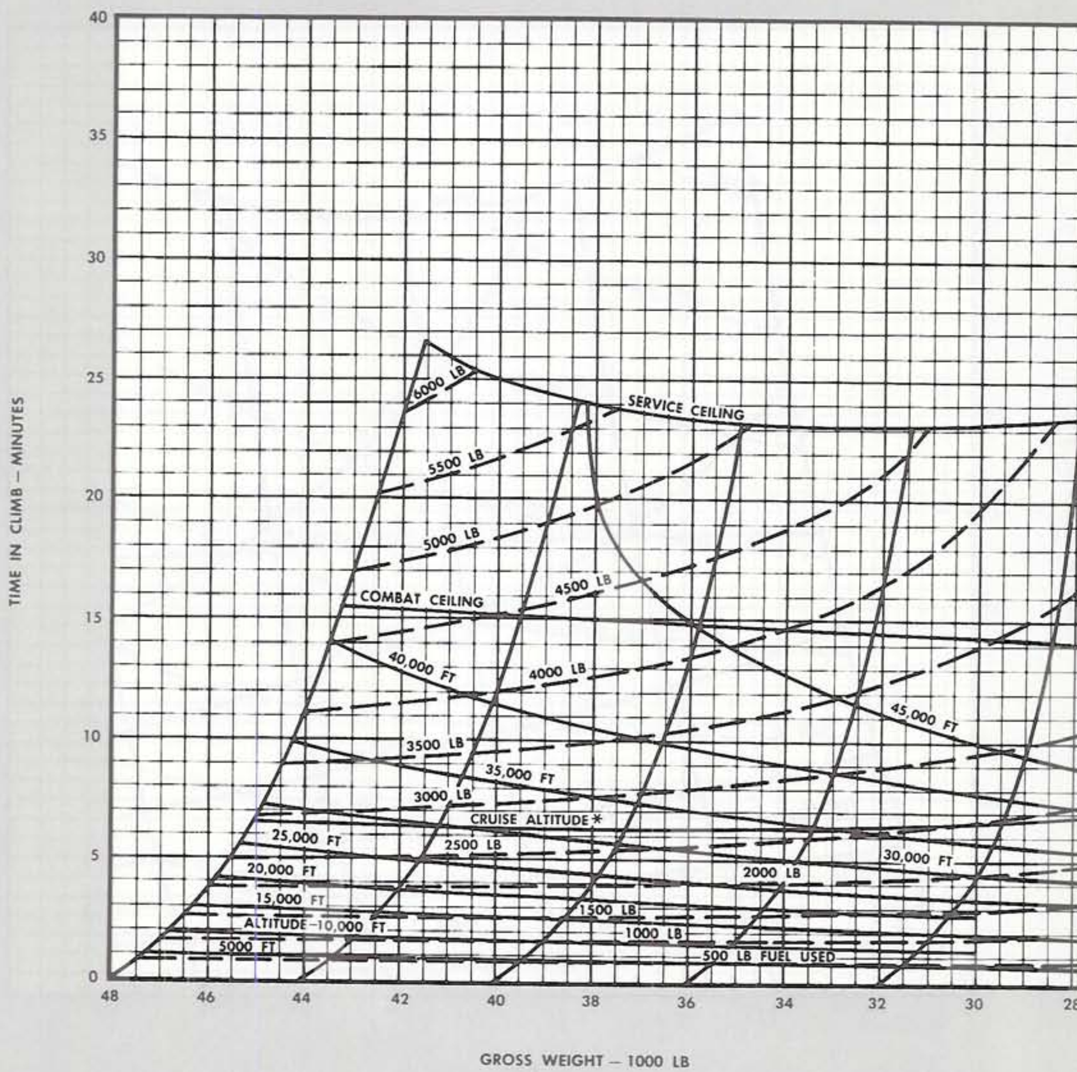
*Figure A-14 (Sheet 3 of 3).*

# BEST CLIMB PERFORMANCE (TIME)

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

MAXIMUM POWER
PYLON TANK CONFIGURATION

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT FOR SERVICE VARIATION.
2. SUBTRACT 906 POUNDS FROM AVAILABLE FUEL TO ALLOW FOR WARMUP, TAXI, AND TAKEOFF; ENTER CHART AT TAKEOFF GROSS WEIGHT LESS 906 POUNDS.
3. ENGINE AIR INLET SCREENS RETRACTED.

* OPTIMUM CRUISE ALTITUDE – NORMAL RATED POWER.

H334

*Figure A-15 (Sheet 1 of 3).*

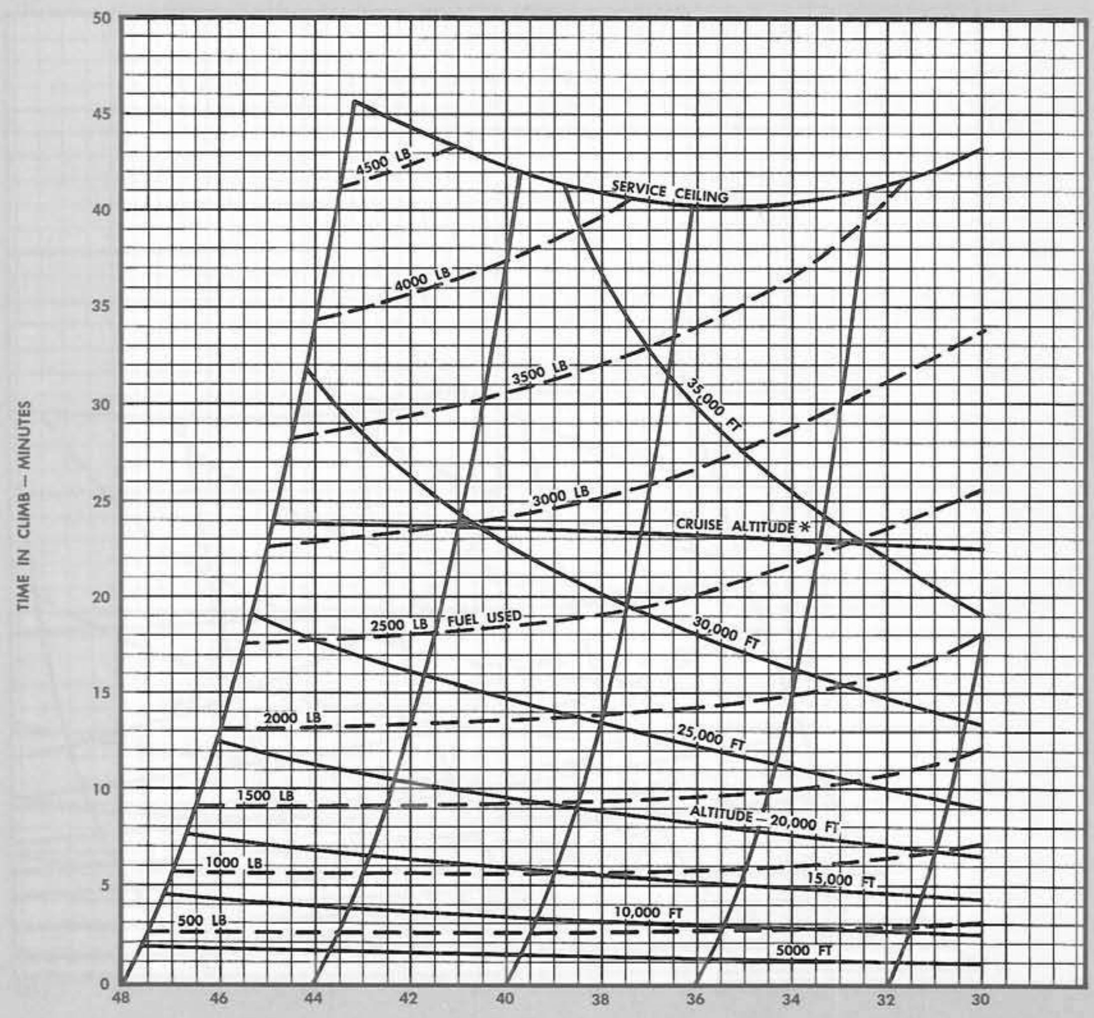
# BEST CLIMB PERFORMANCE (TIME)

MILITARY POWER

PYLON TANK CONFIGURATION

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT FOR SERVICE VARIATION.
2. SUBTRACT 906 POUNDS FROM AVAILABLE FUEL TO ALLOW FOR WARMUP, TAXI, AND TAKEOFF; ENTER CHART AT TAKEOFF GROSS WEIGHT LESS 906 POUNDS.
3. ENGINE AIR INLET SCREENS RETRACTED.

*OPTIMUM CRUISE ALTITUDE — NORMAL RATED POWER.

H335

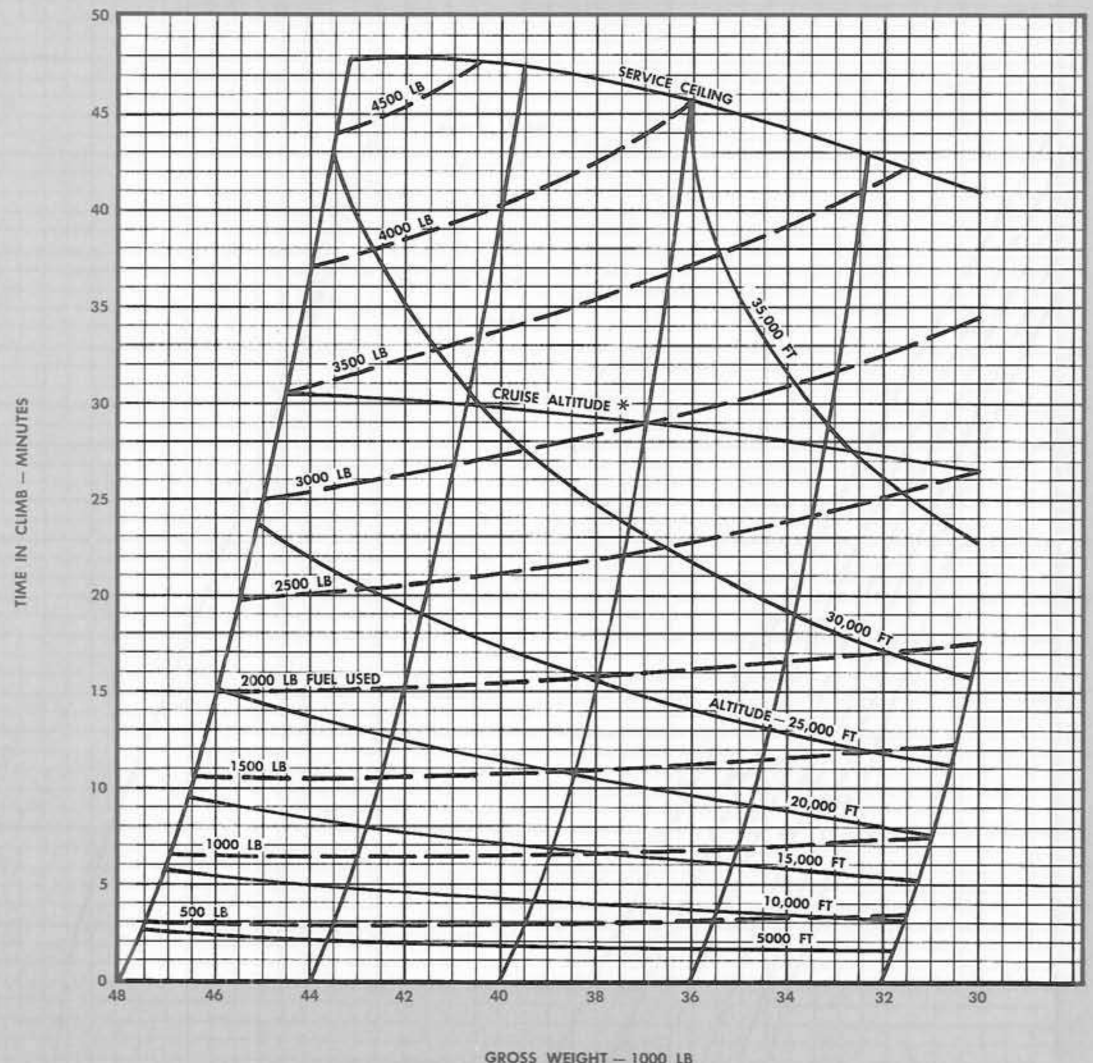
*Figure A-15 (Sheet 2 of 3).*

# BEST CLIMB PERFORMANCE (TIME)

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

NORMAL POWER
PYLON TANK CONFIGURATION

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. SUBTRACT 906 POUNDS FROM AVAILABLE FUEL TO ALLOW FOR WARMUP, TAXI, AND TAKEOFF; ENTER CHART AT TAKEOFF GROSS WEIGHT LESS 906 POUNDS.
3. ENGINE AIR INLET SCREENS RETRACTED.

*OPTIMUM CRUISE ALTITUDE — NORMAL RATED POWER.

H336

*Figure A-15 (Sheet 3 of 3).*

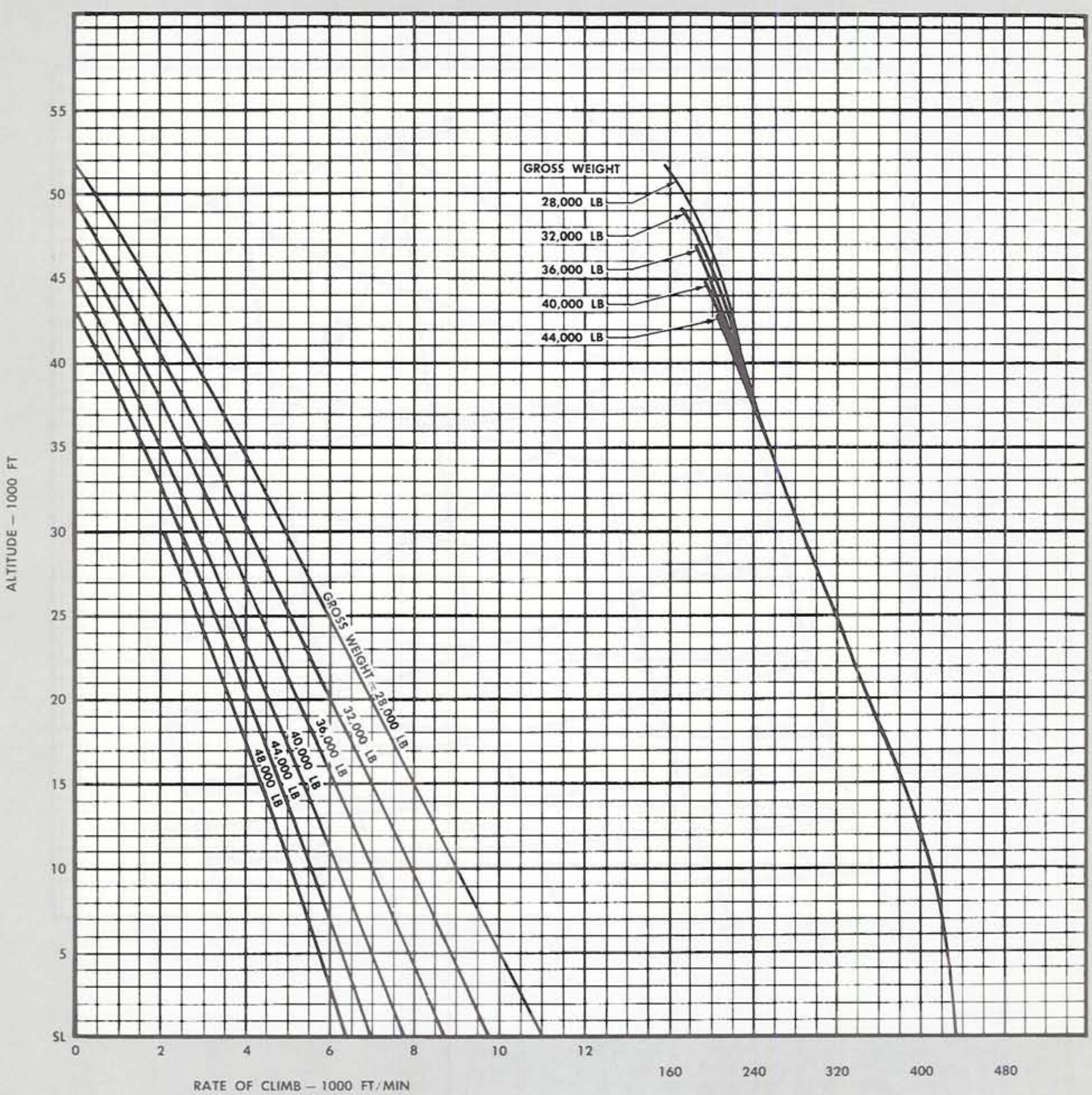
# BEST CLIMB SPEED

MAXIMUM POWER

PYLON TANK CONFIGURATION

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. CLIMB AT CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.
2. ENGINE AIR INLET SCREENS RETRACTED.

H337

*Figure A-16 (Sheet 1 of 3).*

# BEST CLIMB SPEED

MILITARY POWER

PYLON TANK CONFIGURATION

MODEL: F-89H

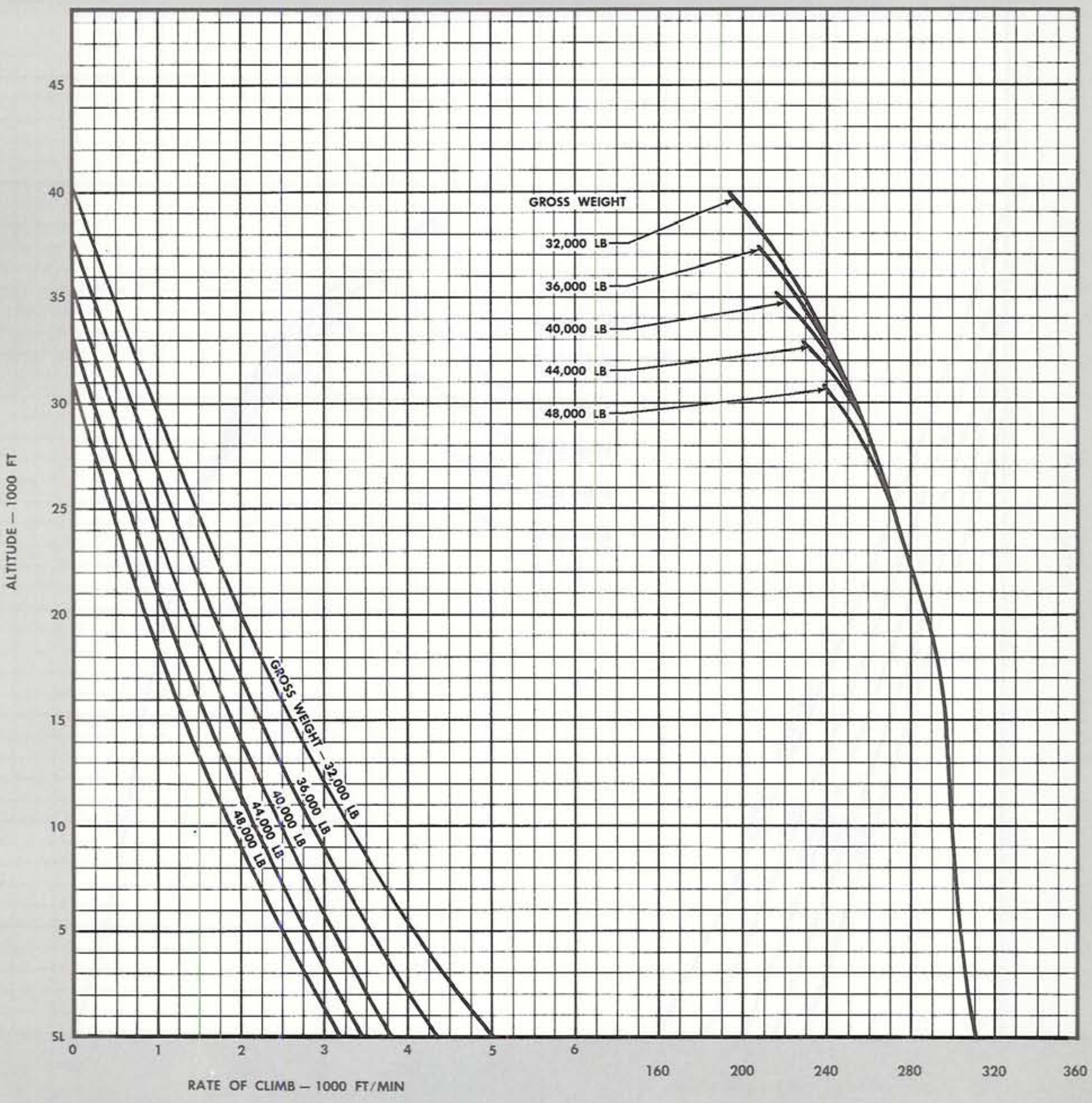
DATA BASIS: FLIGHT TEST

DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. CLIMB AT CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.
2. ENGINE AIR INLET SCREENS RETRACTED.

H338

*Figure A-16 (Sheet 2 of 3).*

# BEST CLIMB SPEED

NORMAL POWER

PYLON TANK CONFIGURATION

MODEL: F-89H

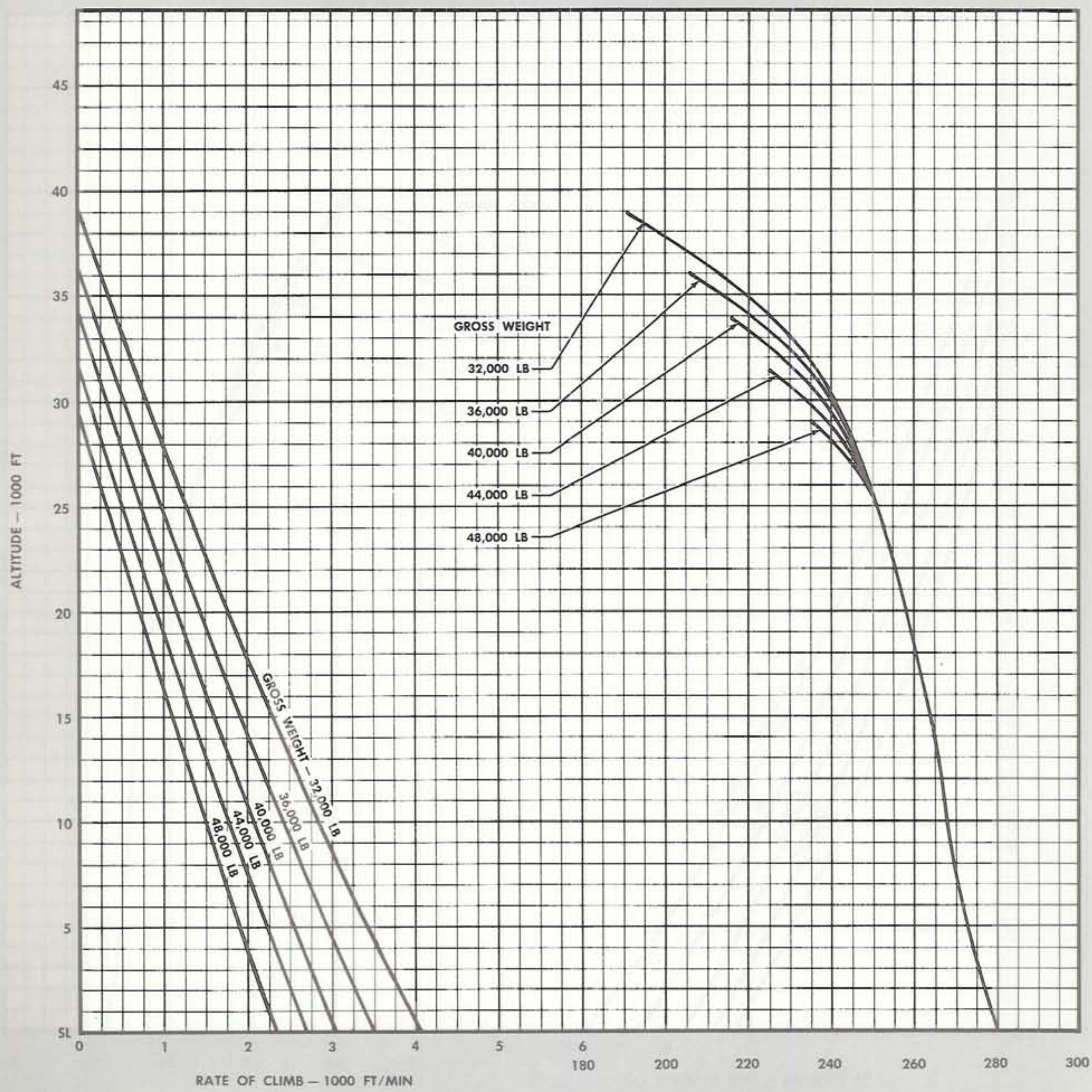
DATA BASIS: FLIGHT TEST

DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. CLIMB AT CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.
2. ENGINE AIR INLET SCREENS RETRACTED.

H339

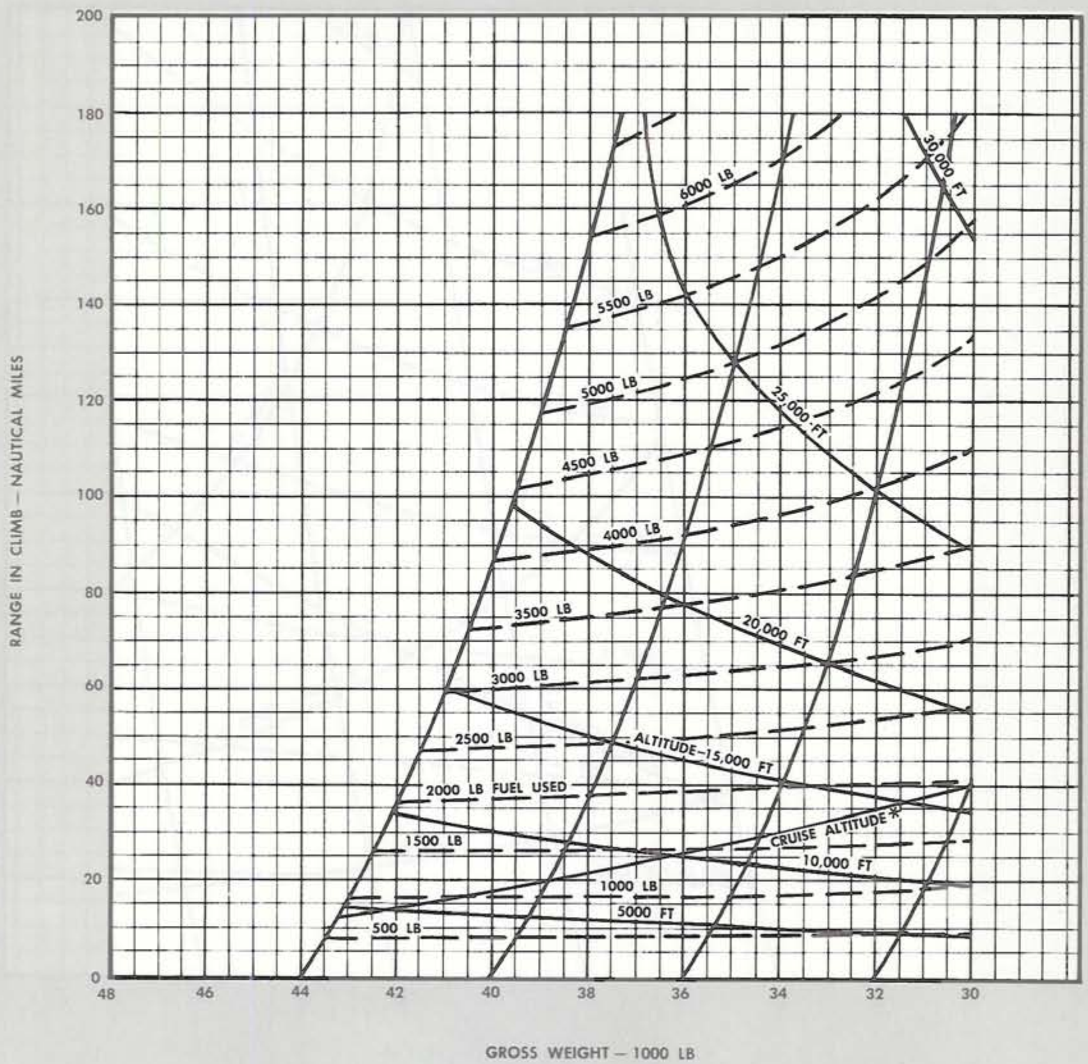
*Figure A-16 (Sheet 3 of 3).*

# BEST CLIMB PERFORMANCE (RANGE)

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

MAXIMUM POWER
BASIC CONFIGURATION PLUS PYLONS
ONE ENGINE OPERATING

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT FOR SERVICE VARIATION.
2. SUBTRACT 906 POUNDS FROM AVAILABLE FUEL TO ALLOW FOR WARMUP, TAXI, AND TAKEOFF; ENTER CHART AT TAKEOFF GROSS WEIGHT LESS 906 POUNDS.
3. ENGINE AIR INLET SCREENS RETRACTED.

* OPTIMUM CRUISE ALTITUDE — NORMAL RATED POWER.

H340

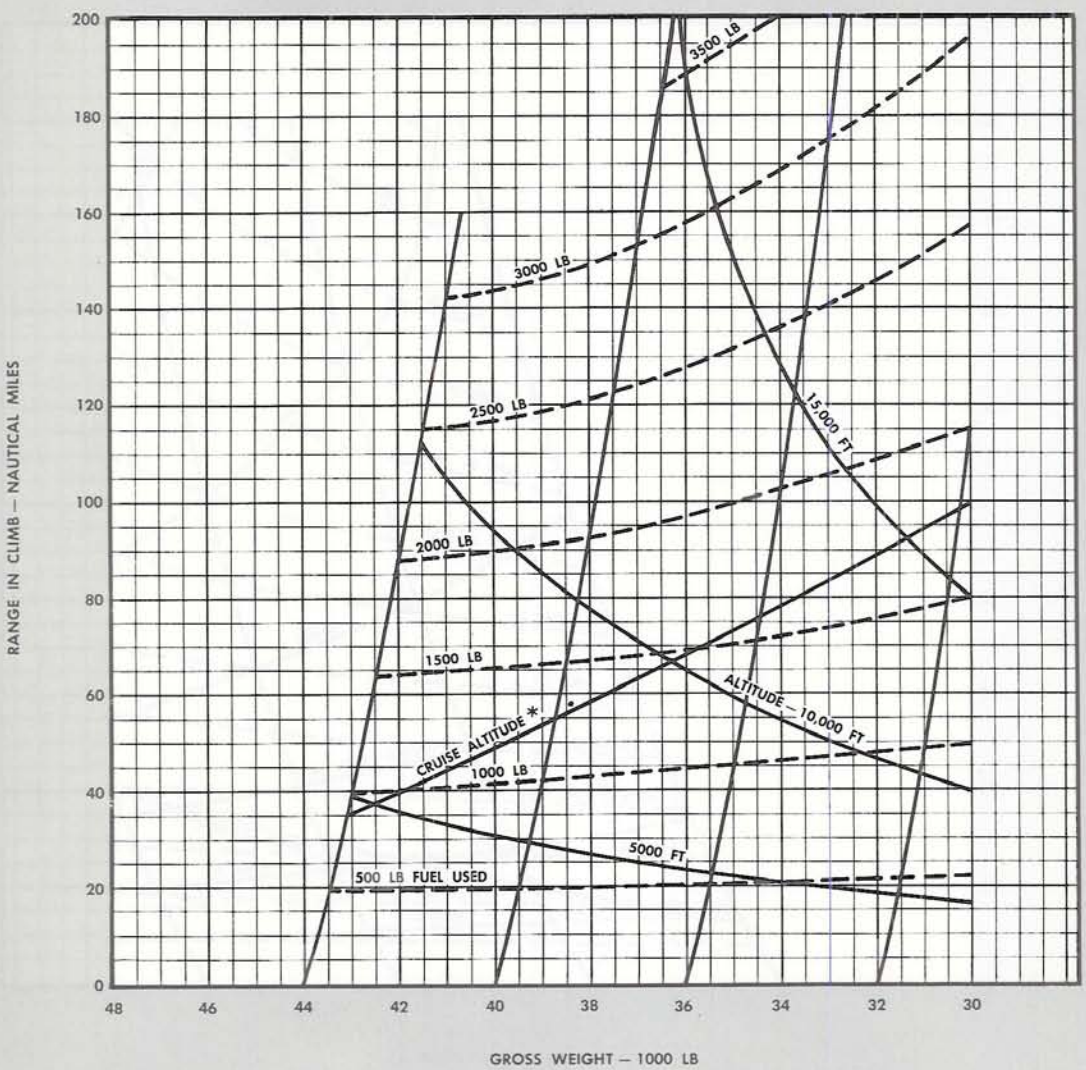
*Figure A-17 (Sheet 1 of 2).*

# BEST CLIMB PERFORMANCE (RANGE)

MILITARY POWER
BASIC CONFIGURATION PLUS PYLONS
ONE ENGINE OPERATING

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. SUBTRACT 906 POUNDS FROM AVAILABLE FUEL TO ALLOW FOR WARMUP, TAXI, AND TAKEOFF; ENTER CHART AT TAKEOFF GROSS WEIGHT LESS 906 POUNDS.
3. ENGINE AIR INLET SCREENS RETRACTED.

*OPTIMUM CRUISE ALTITUDE — NORMAL RATED POWER.

H341

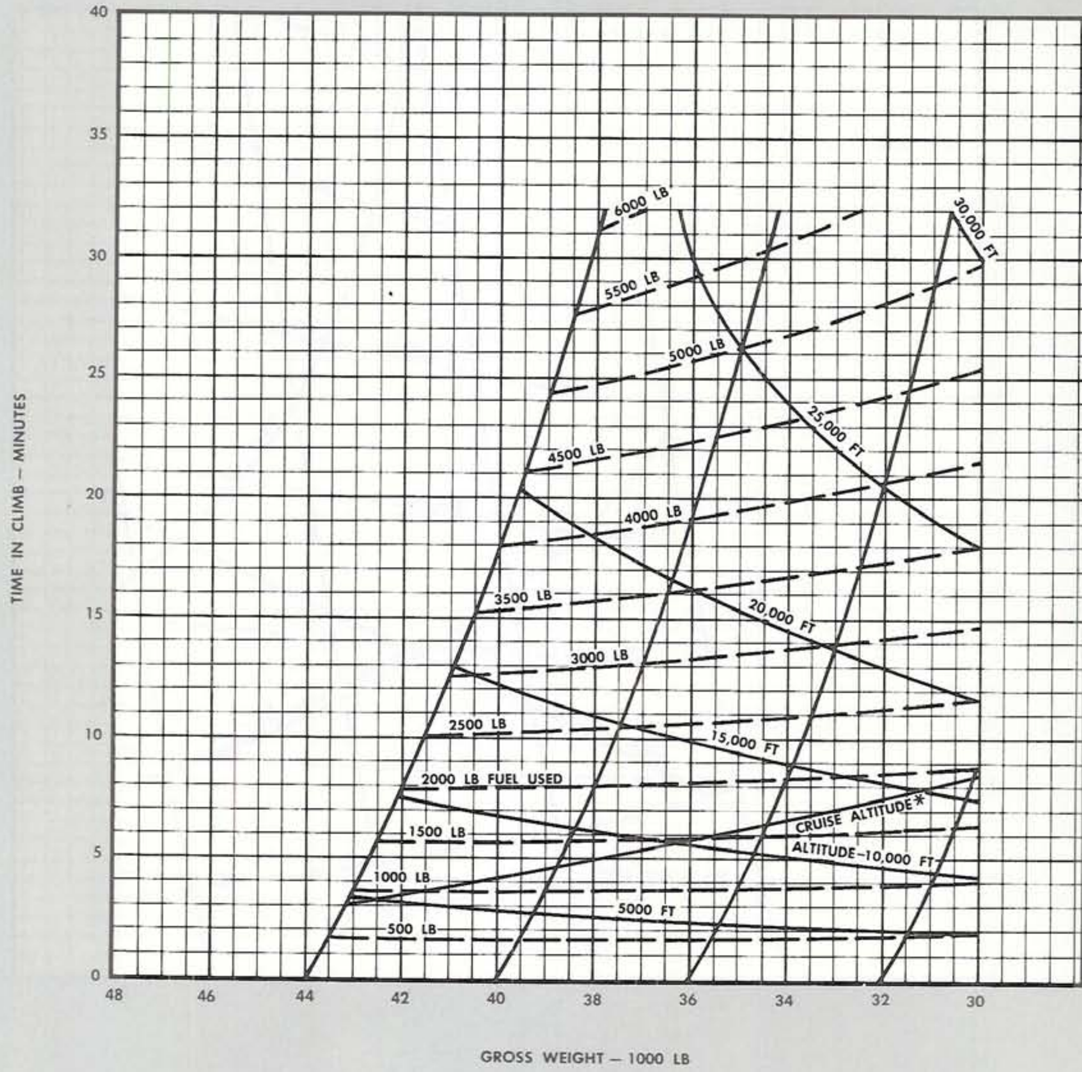
*Figure A-17 (Sheet 2 of 2).*

# BEST CLIMB PERFORMANCE (TIME)

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

MAXIMUM POWER
BASIC CONFIGURATION PLUS PYLONS
ONE ENGINE OPERATING

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT FOR SERVICE VARIATION.
2. SUBTRACT 906 POUNDS FROM AVAILABLE FUEL TO ALLOW FOR WARMUP, TAXI, AND TAKEOFF; ENTER CHART AT TAKEOFF GROSS WEIGHT LESS 906 POUNDS.
3. ENGINE AIR INLET SCREENS RETRACTED.

*OPTIMUM CRUISE ALTITUDE – NORMAL RATED POWER.

H342

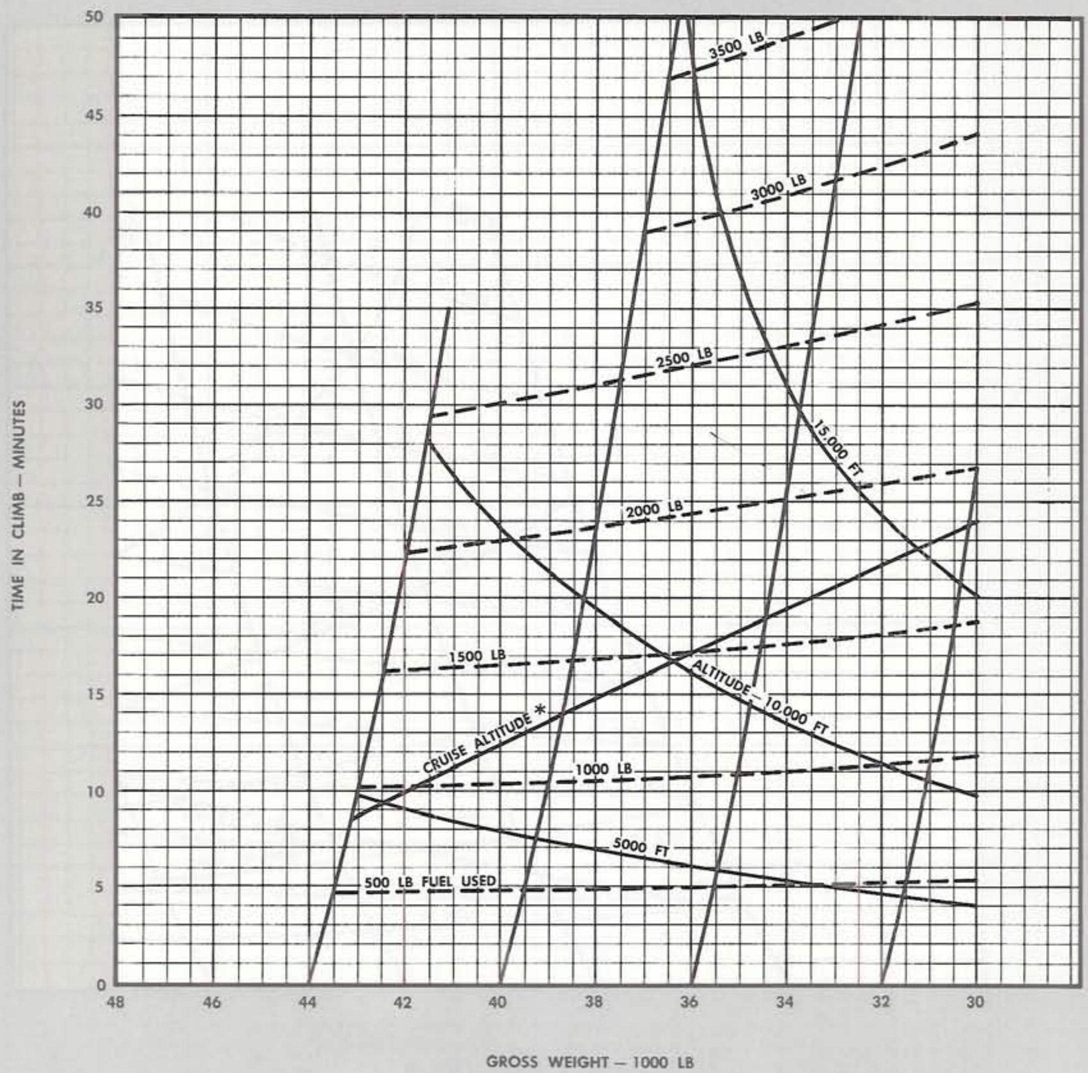
*Figure A-18 (Sheet 1 of 2).*

# BEST CLIMB PERFORMANCE (TIME)

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

MILITARY POWER
BASIC CONFIGURATION PLUS PYLONS
ONE ENGINE OPERATING

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT FOR SERVICE VARIATION.
2. SUBTRACT 906 POUNDS FROM AVAILABLE FUEL TO ALLOW FOR WARMUP, TAXI, AND TAKEOFF; ENTER CHART AT TAKEOFF GROSS WEIGHT LESS 906 POUNDS.
3. ENGINE AIR INLET SCREENS RETRACTED.

* OPTIMUM CRUISE ALTITUDE — NORMAL RATED POWER.

H343

*Figure A-18 (Sheet 2 of 2).*

# BEST CLIMB SPEED

MAXIMUM POWER

BASIC CONFIGURATION PLUS PYLONS

ONE ENGINE OPERATING

MODEL: **F-89H**

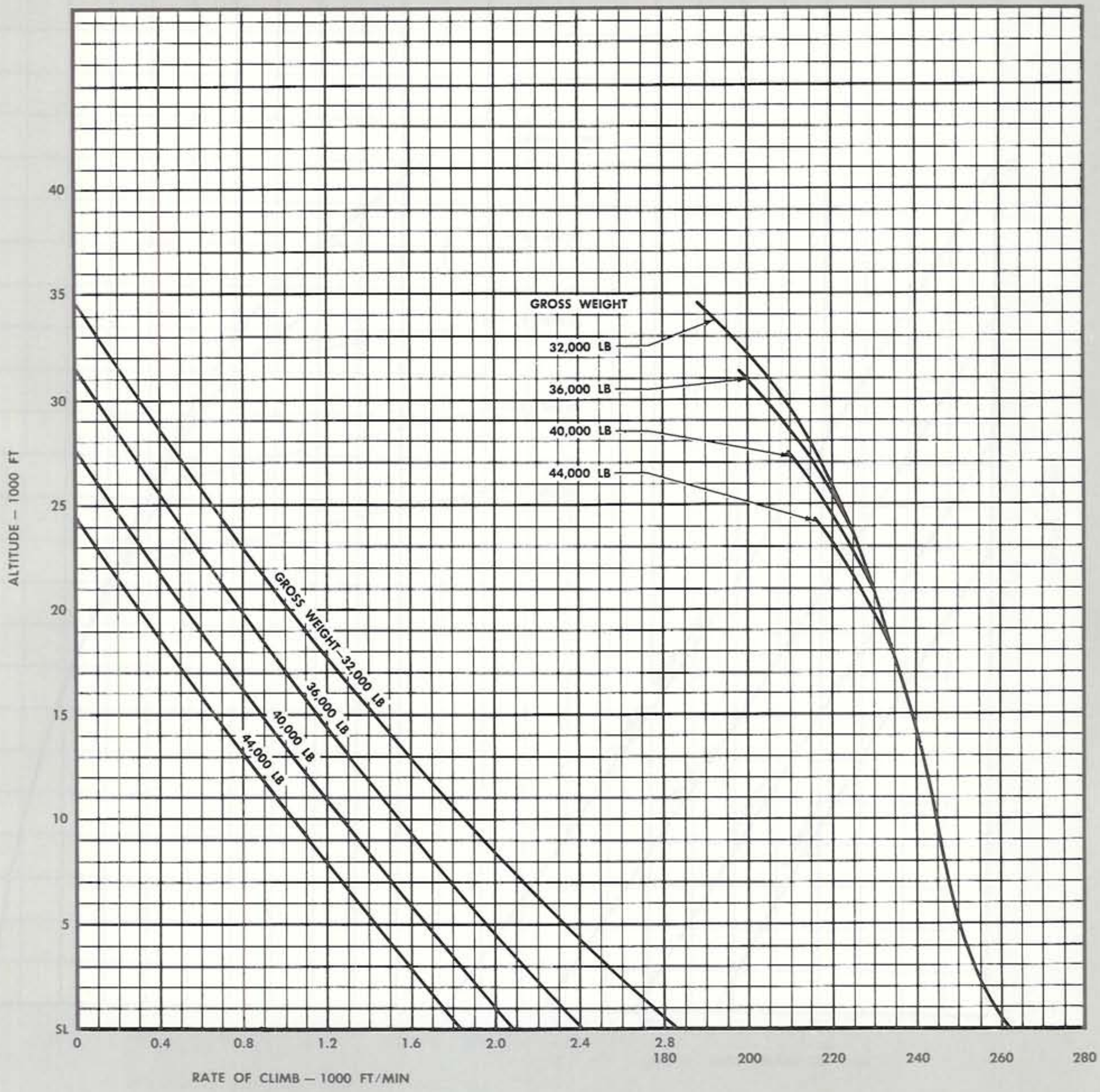
DATA BASIS: **FLIGHT TEST**

DATE: **22 OCTOBER 1957**

ENGINE(S): **(2) J35-35**

FUEL GRADE: **JP-4**

FUEL DENSITY: **6.5 LB/US GAL**




REMARKS:

1. CLIMB AT CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.
2. ENGINE AIR INLET SCREENS RETRACTED.

H344

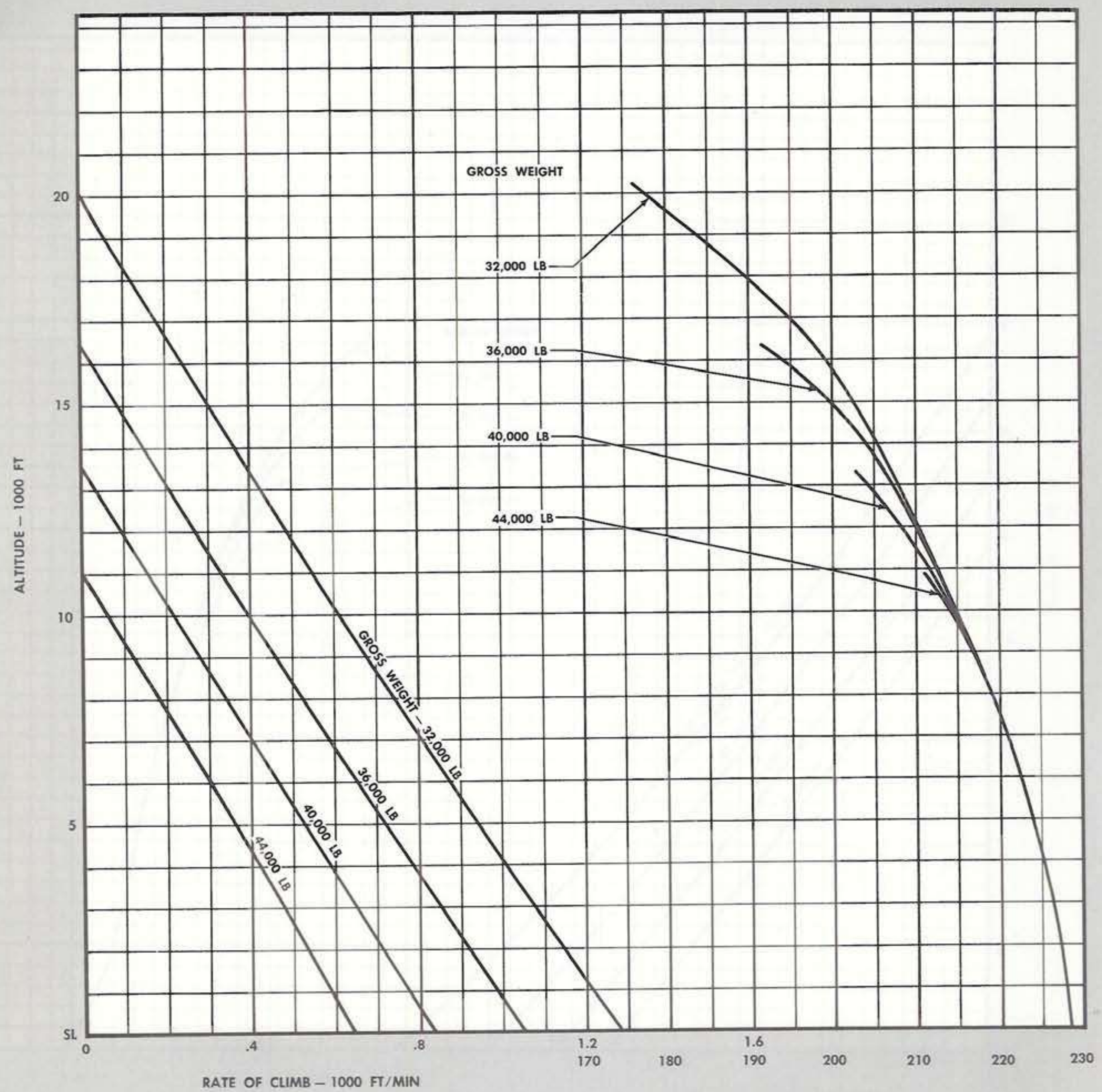
*Figure A-19 (Sheet 1 of 2).*

# BEST CLIMB SPEED

MILITARY POWER
BASIC CONFIGURATION PLUS PYLONS
ONE ENGINE OPERATING

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. CLIMB AT CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.
2. ENGINE AIR INLET SCREENS RETRACTED.

H345

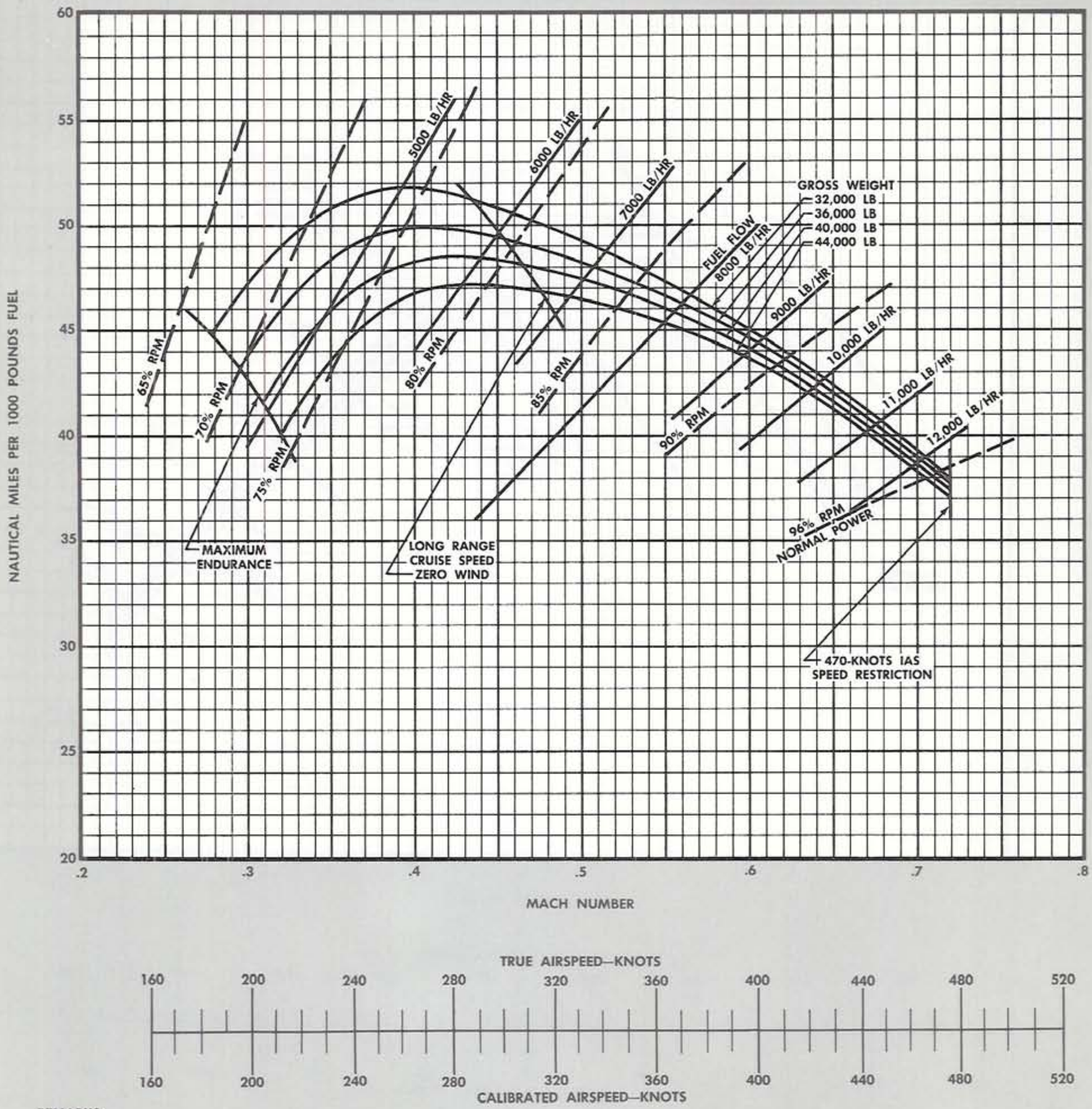
*Figure A-19 (Sheet 2 of 2).*

# NAUTICAL MILES PER 1000 POUNDS FUEL

SEA LEVEL
BASIC CONFIGURATION PLUS PYLONS

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

H346

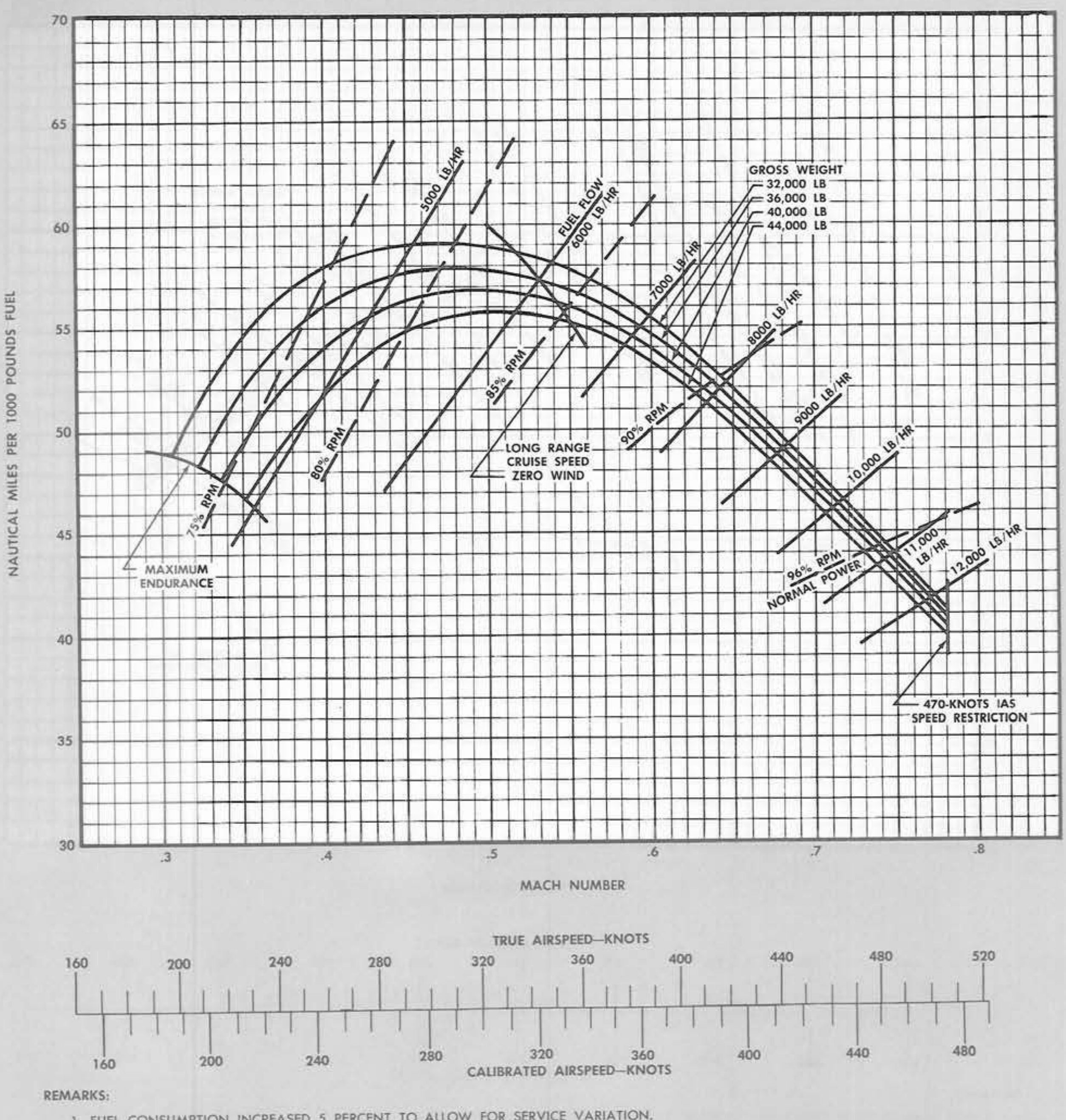
*Figure A-20 (Sheet 1 of 9).*

# NAUTICAL MILES PER 1000 POUNDS FUEL

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

5000 FEET
BASIC CONFIGURATION PLUS PYLONS

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

H347

*Figure A-20 (Sheet 2 of 9).*

# NAUTICAL MILES PER 1000 POUNDS FUEL

10,000 FEET

BASIC CONFIGURATION PLUS PYLONS

MODEL: F-89H

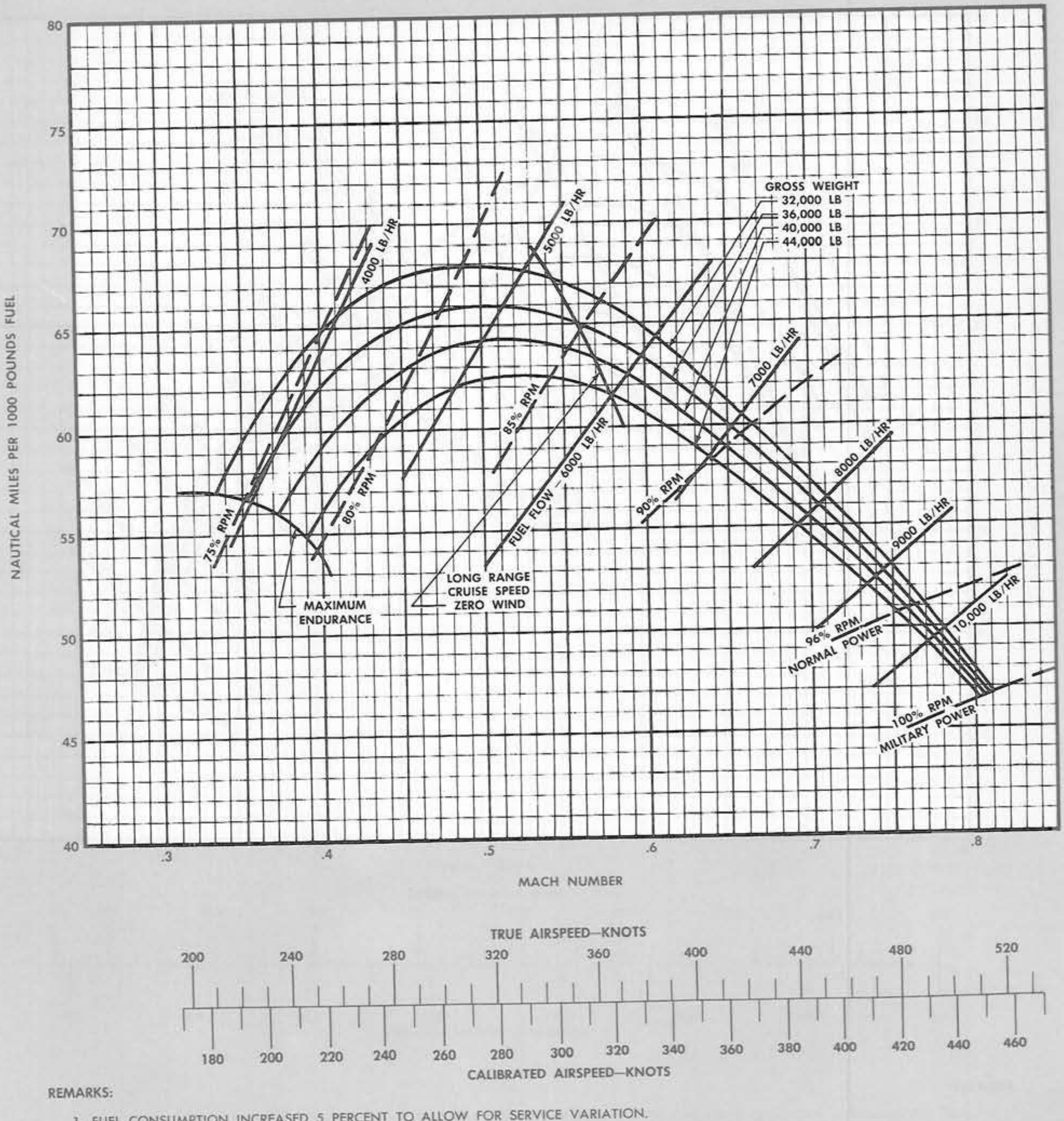
DATA BASIS: FLIGHT TEST

DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

H348

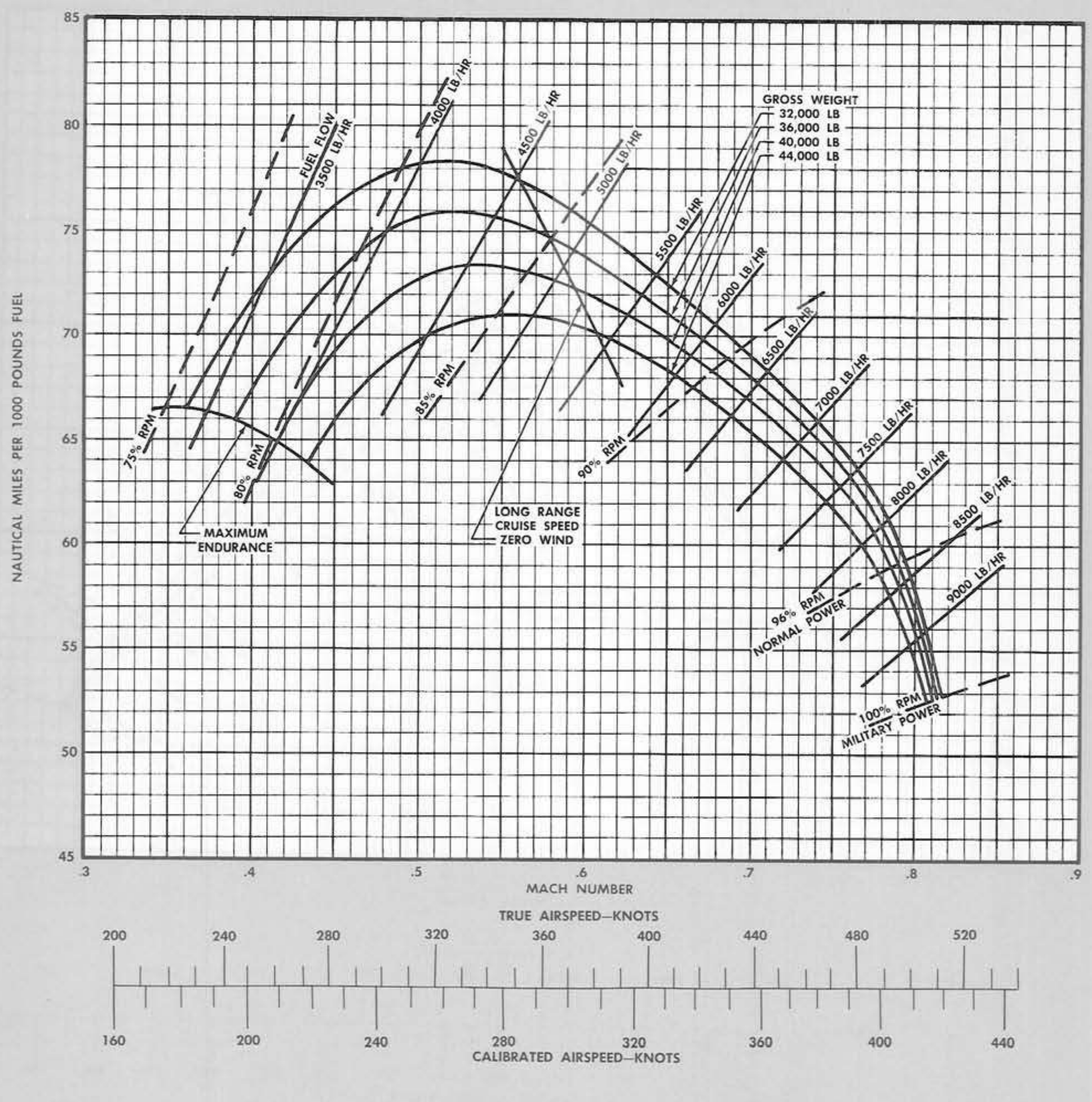
*Figure A-20 (Sheet 3 of 9).*

# NAUTICAL MILES PER 1000 POUNDS FUEL

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

15,000 FEET
BASIC CONFIGURATION PLUS PYLONS

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

H349

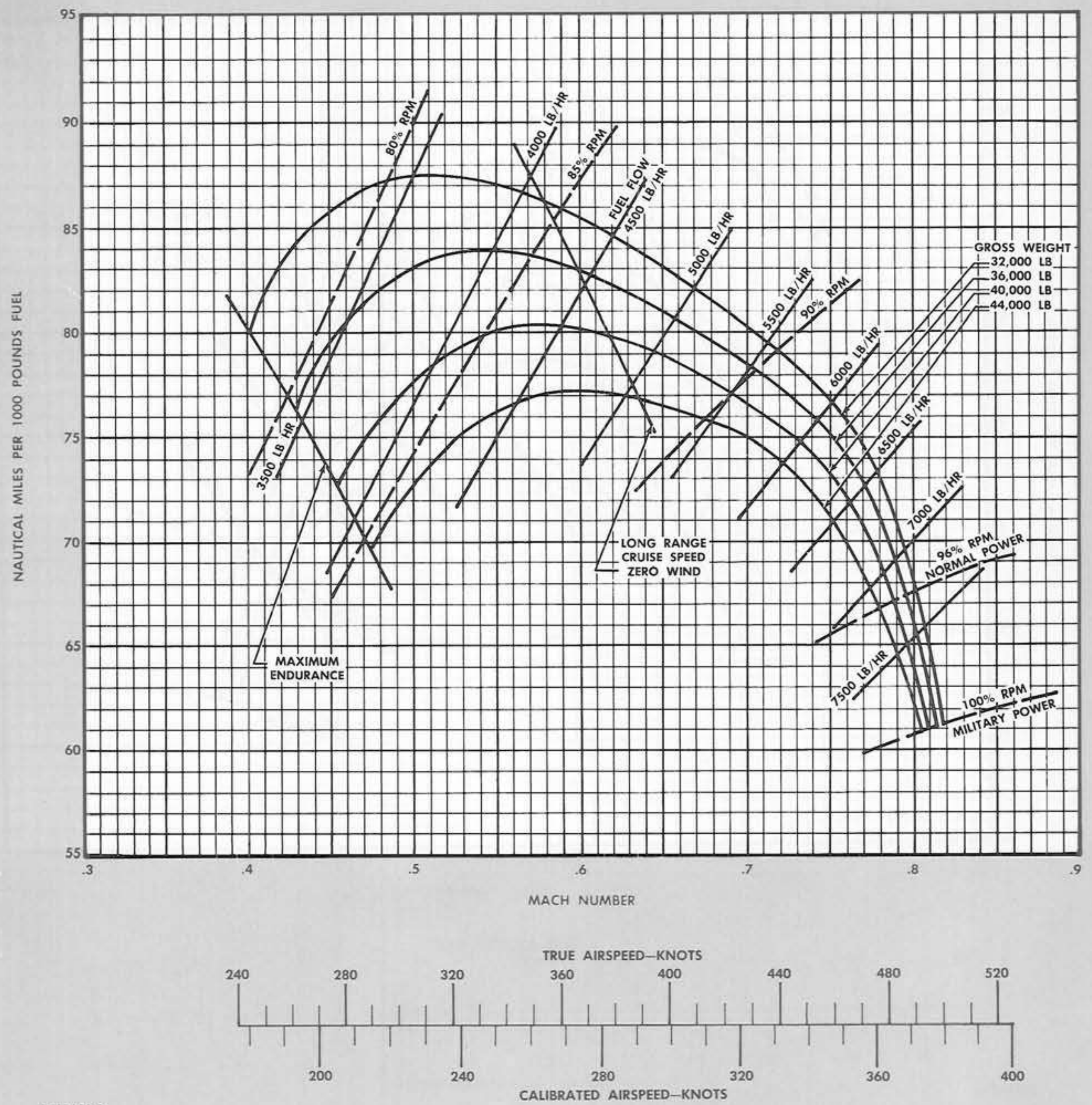
*Figure A-20 (Sheet 4 of 9).*

## NAUTICAL MILES PER 1000 POUNDS FUEL

20,000 FEET
BASIC CONFIGURATION PLUS PYLONS

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

H350

*Figure A-20 (Sheet 5 of 9).*

# NAUTICAL MILES PER 1000 POUNDS FUEL

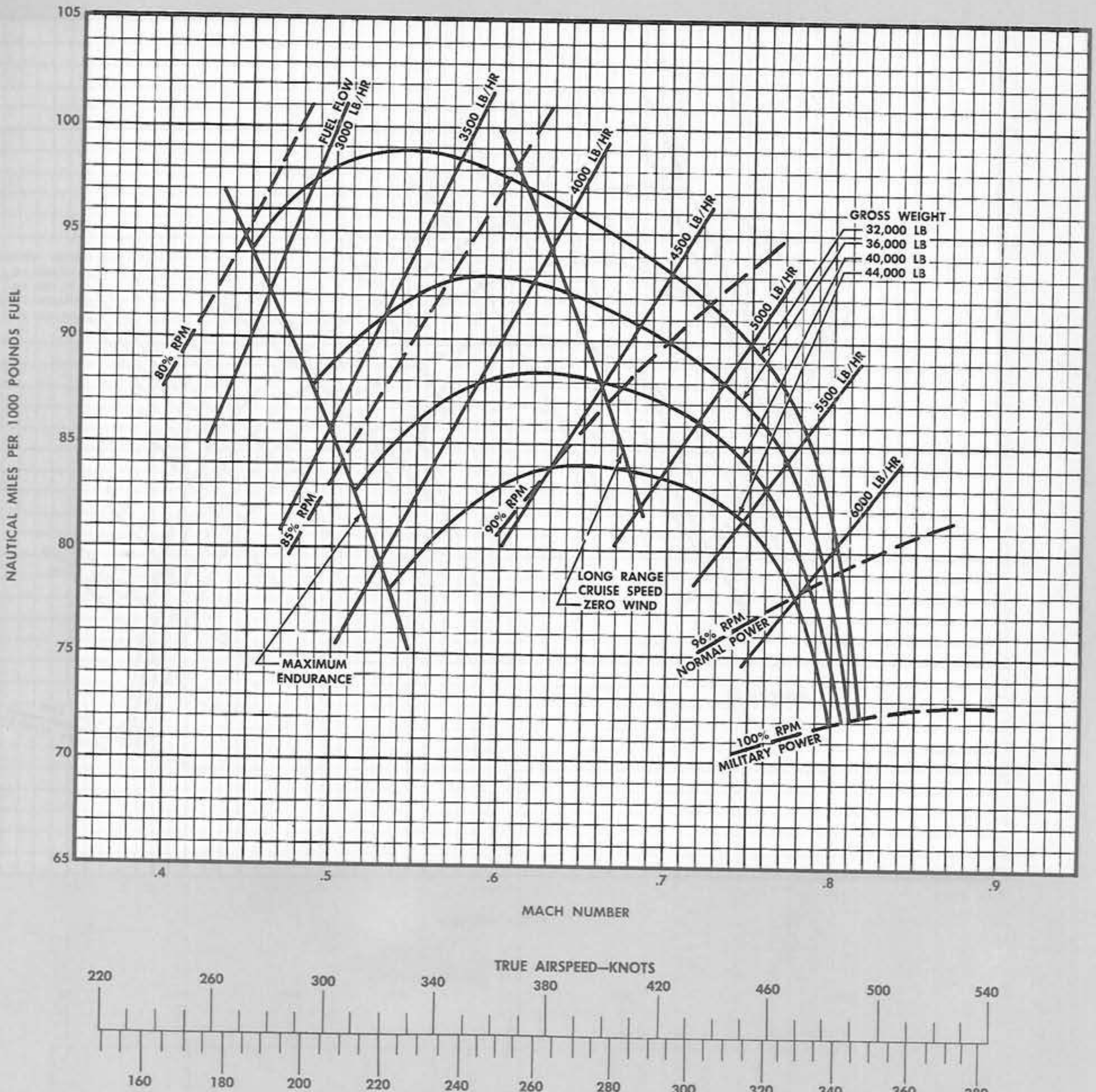
MODEL: F-89H

25,000 FEET
BASIC CONFIGURATION PLUS PYLONS

ENGINE(S): (2) J35-35

DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

H351

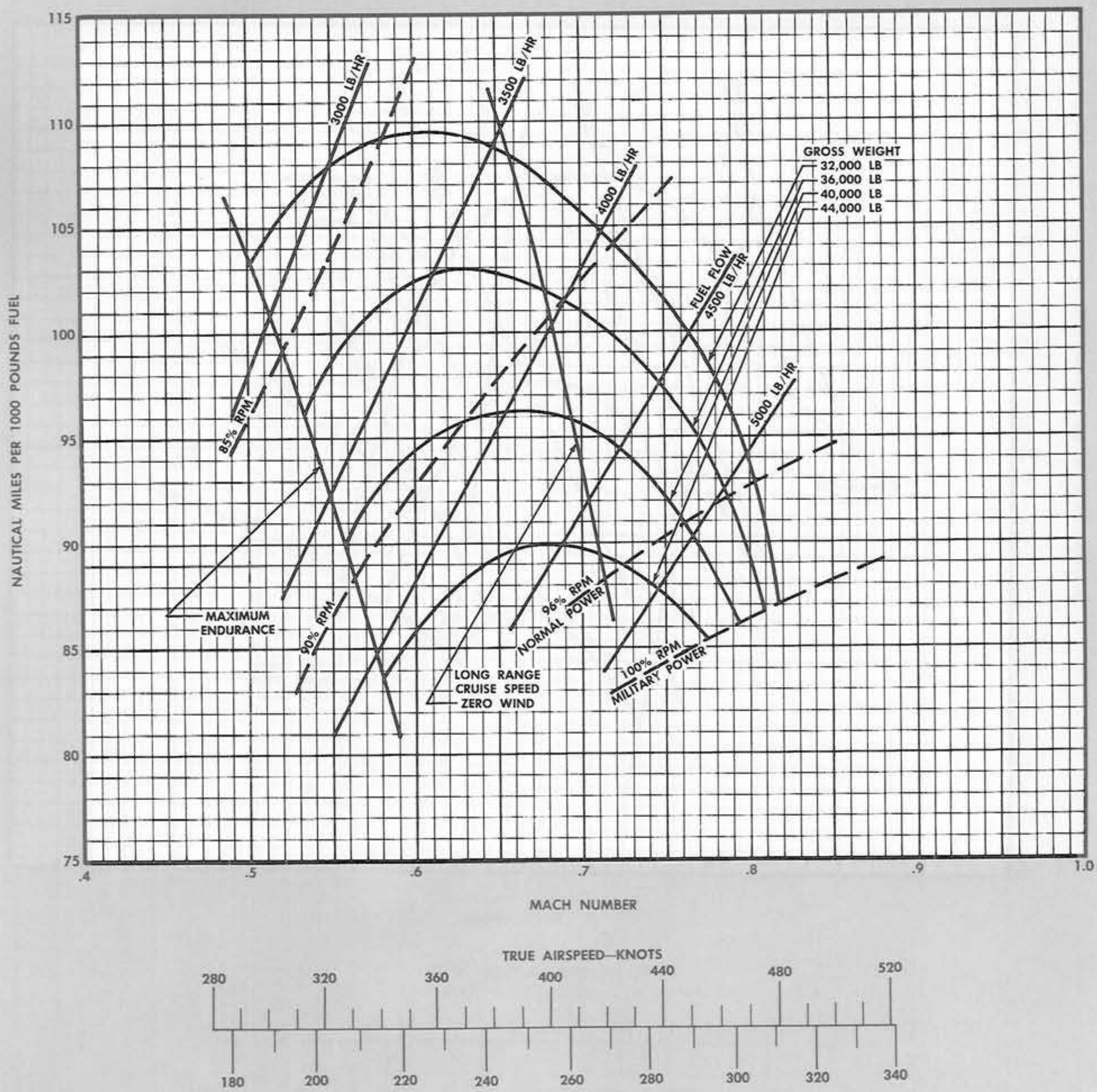
Figure A-20 (Sheet 6 of 9).

# NAUTICAL MILES PER 1000 POUNDS FUEL

30,000 FEET
BASIC CONFIGURATION PLUS PYLONS

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

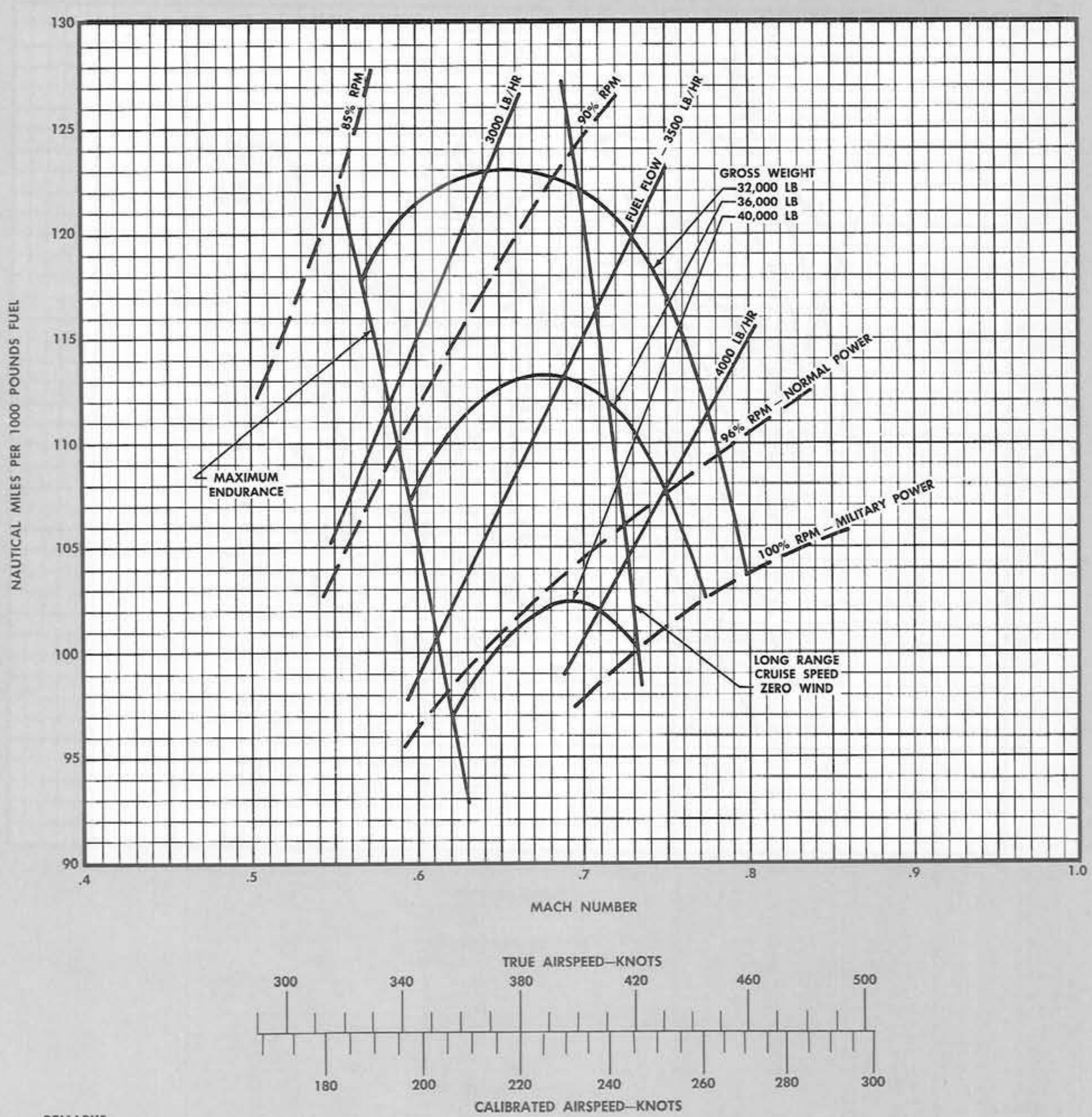
H352

*Figure A-20 (Sheet 7 of 9).*

## NAUTICAL MILES PER 1000 POUNDS FUEL

MODEL: F-89H
35,000 FEET
BASIC CONFIGURATION PLUS PYLONS
ENGINE(S): (2) J35-35

DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

H353

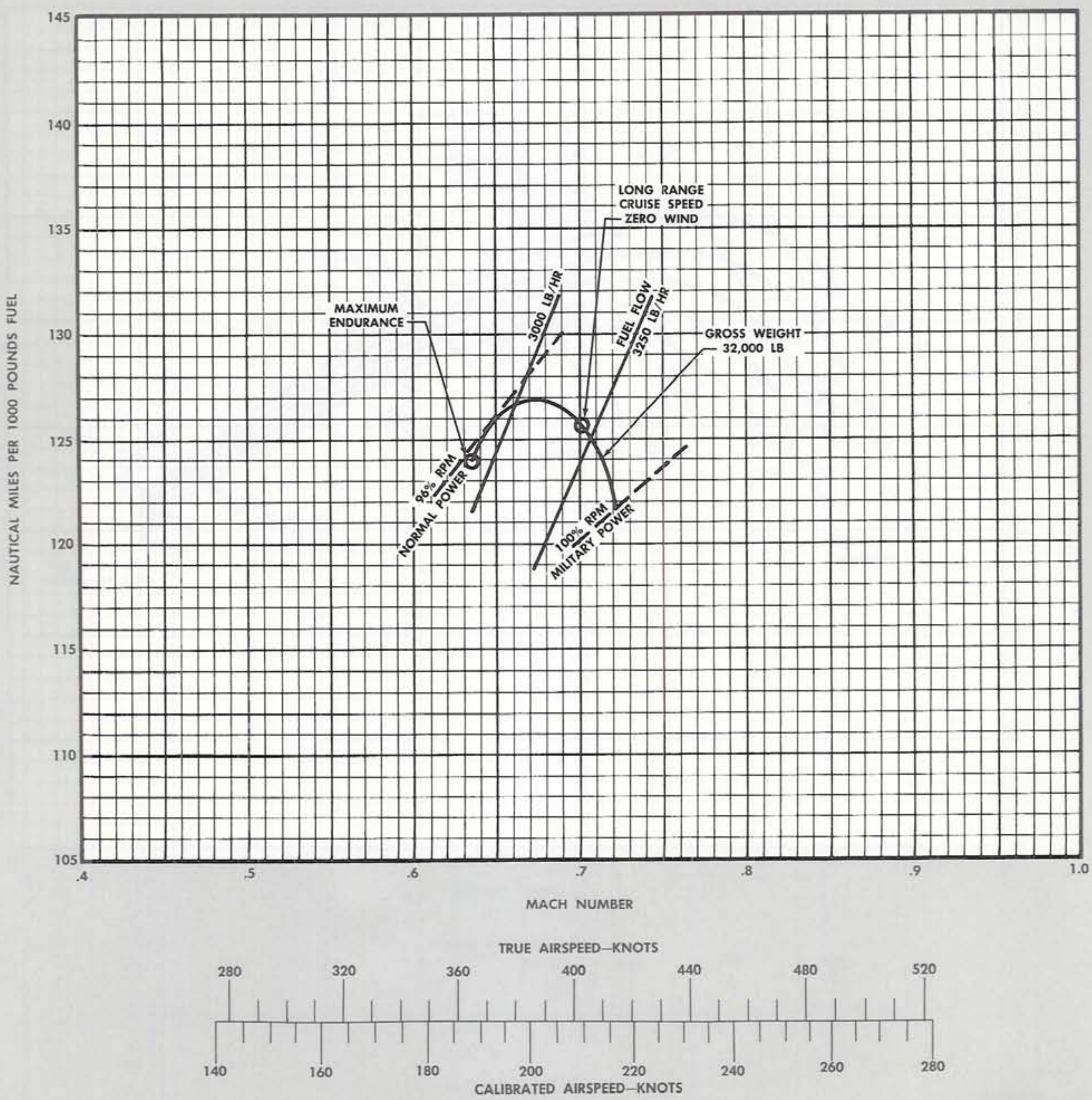
*Figure A-20 (Sheet 8 of 9).*

## NAUTICAL MILES PER 1000 POUNDS FUEL

40,000 FEET
BASIC CONFIGURATION PLUS PYLONS

MODEL: **F-89H**
DATA BASIS: **FLIGHT TEST**
DATE: **22 OCTOBER 1957**

ENGINE(S): **(2) J35-35**
FUEL GRADE: **JP-4**
FUEL DENSITY: **6.5 LB/US GAL**




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

H354

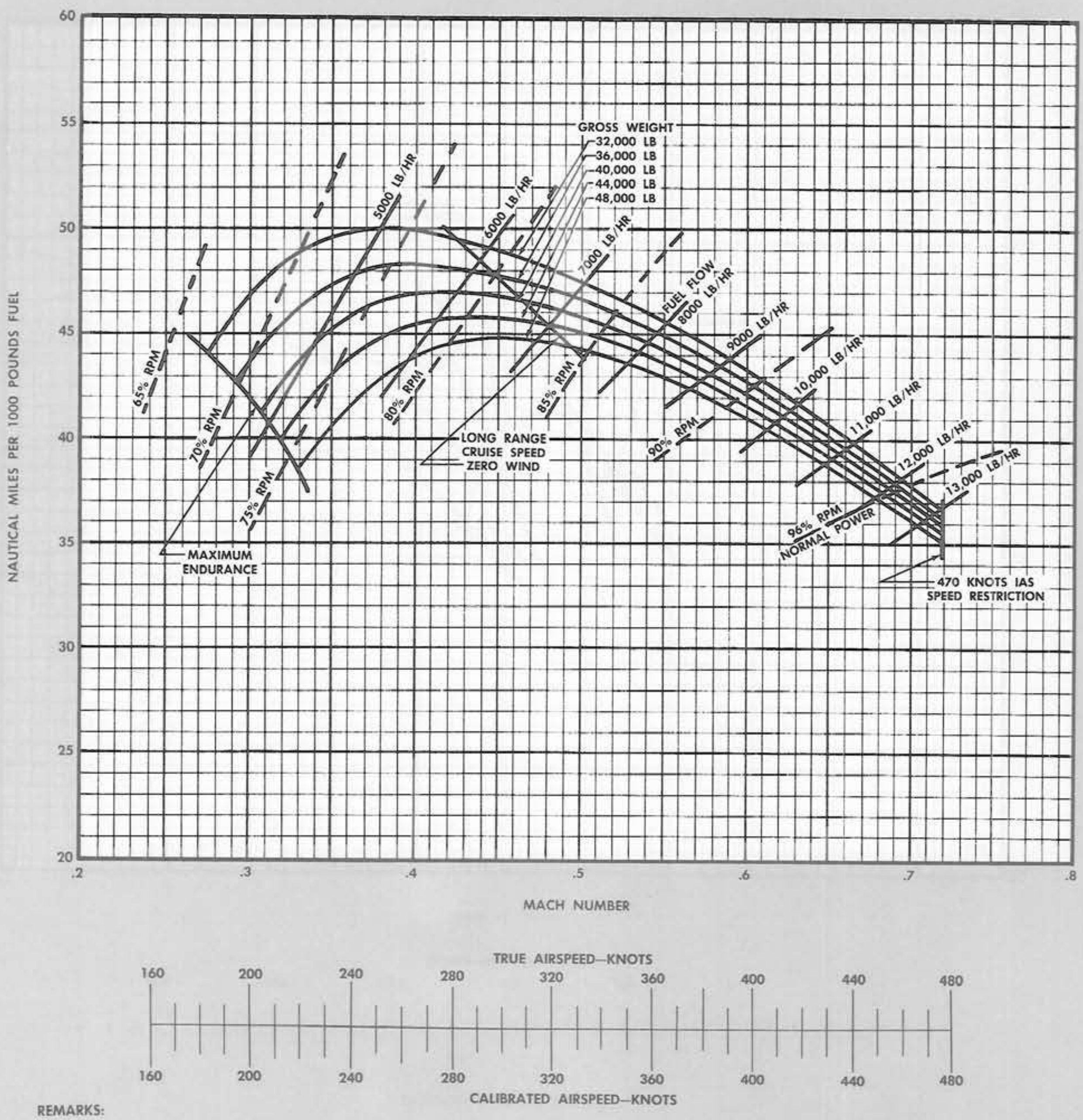
*Figure A-20 (Sheet 9 of 9).*

# NAUTICAL MILES PER 1000 POUNDS FUEL

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

SEA LEVEL
PYLON TANK CONFIGURATION

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

H355

*Figure A-21 (Sheet 1 of 8).*

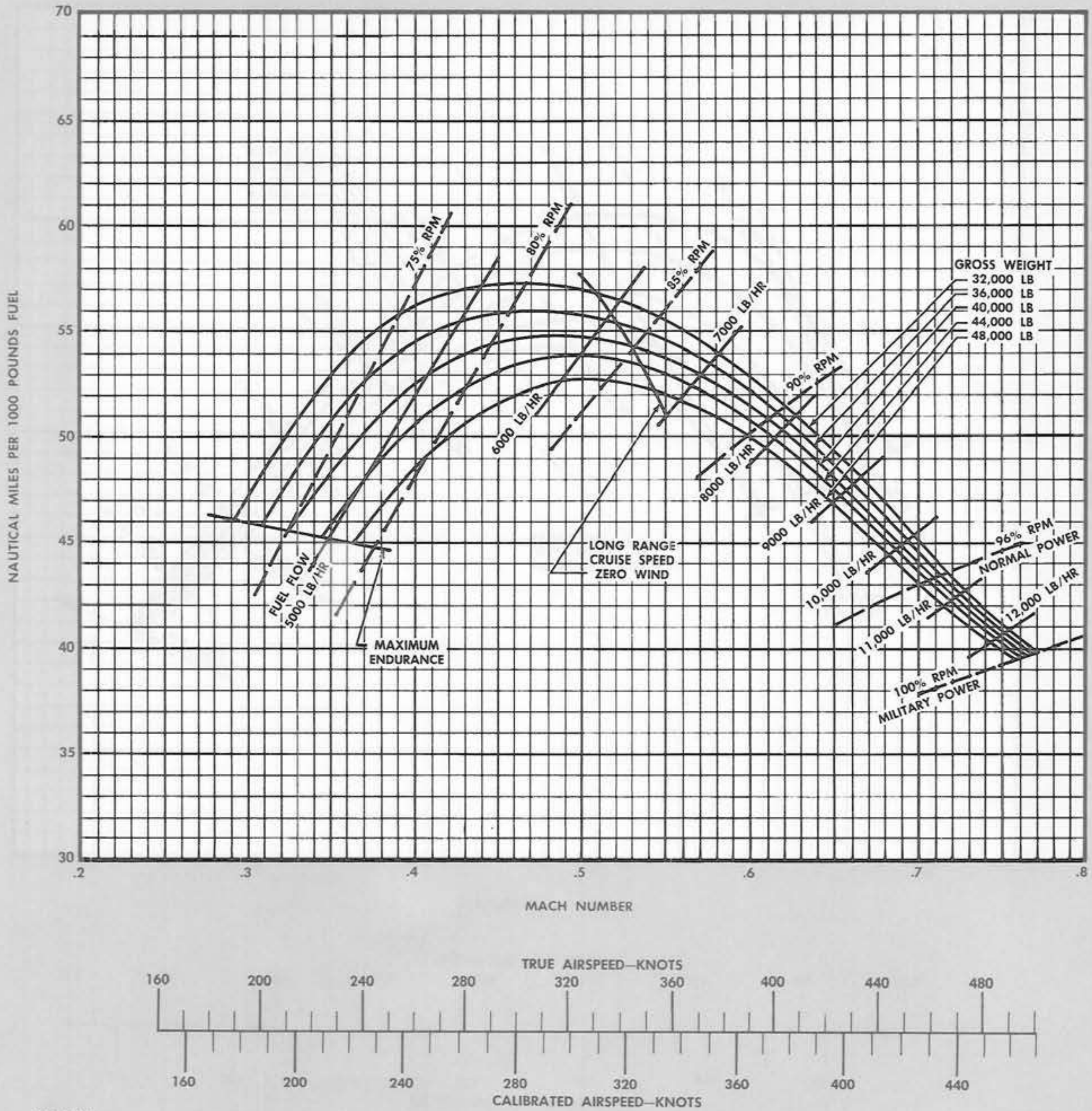
# NAUTICAL MILES PER 1000 POUNDS FUEL

5000 FEET

PYLON TANK CONFIGURATION

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

H356

*Figure A-21 (Sheet 2 of 8).*

# NAUTICAL MILES PER 1000 POUNDS FUEL

10,000 FEET

PYLON TANK CONFIGURATION

MODEL: **F-89H**

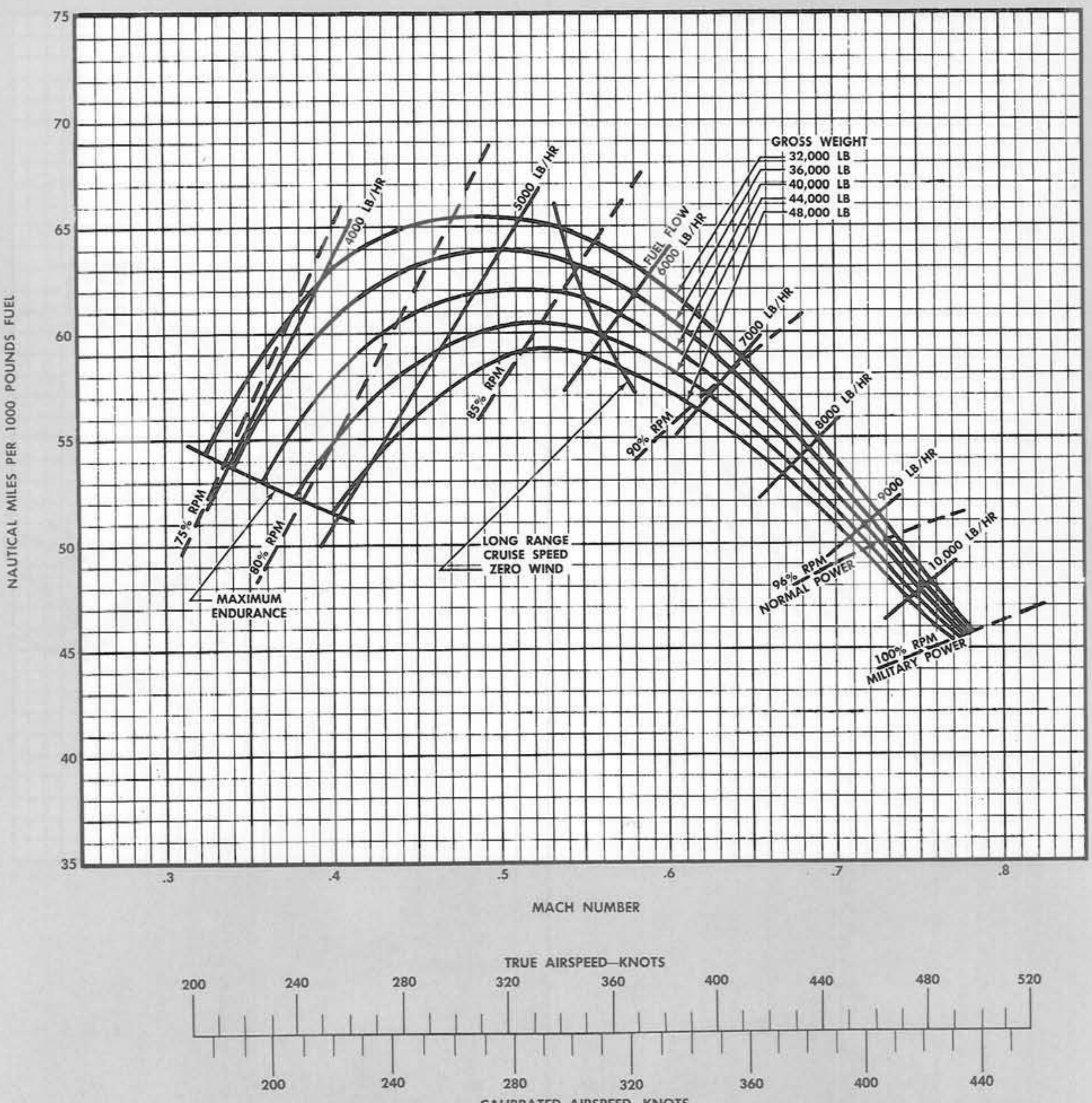
DATA BASIS: **FLIGHT TEST**

DATE: **22 OCTOBER 1957**

ENGINE(S): **(2) J35-35**

FUEL GRADE: **JP-4**

FUEL DENSITY: **6.5 LB/US GAL**




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

H357

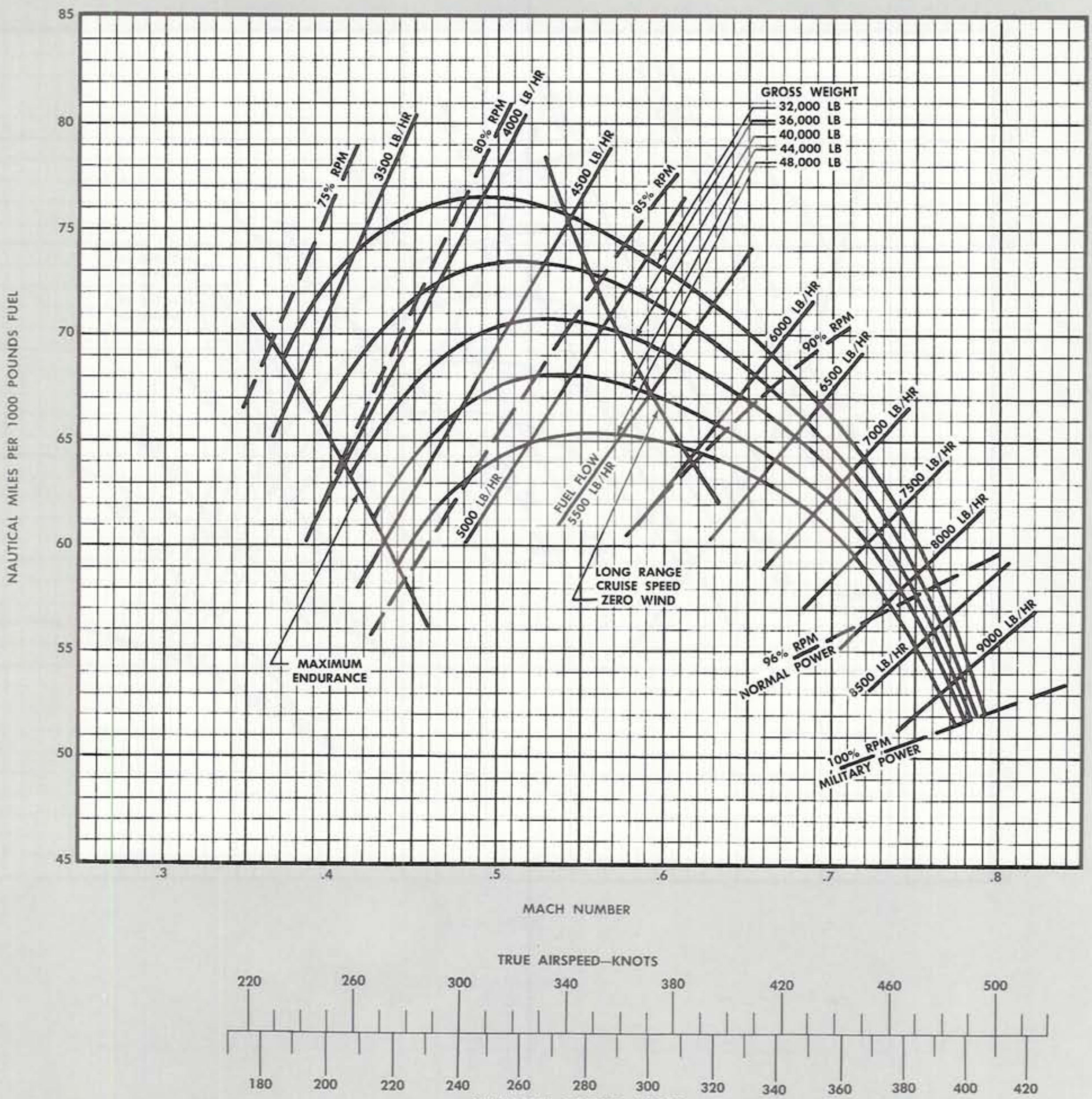
*Figure A-21 (Sheet 3 of 8).*

# NAUTICAL MILES PER 1000 POUNDS FUEL

15,000 FEET
PYLON TANK CONFIGURATION

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

H358

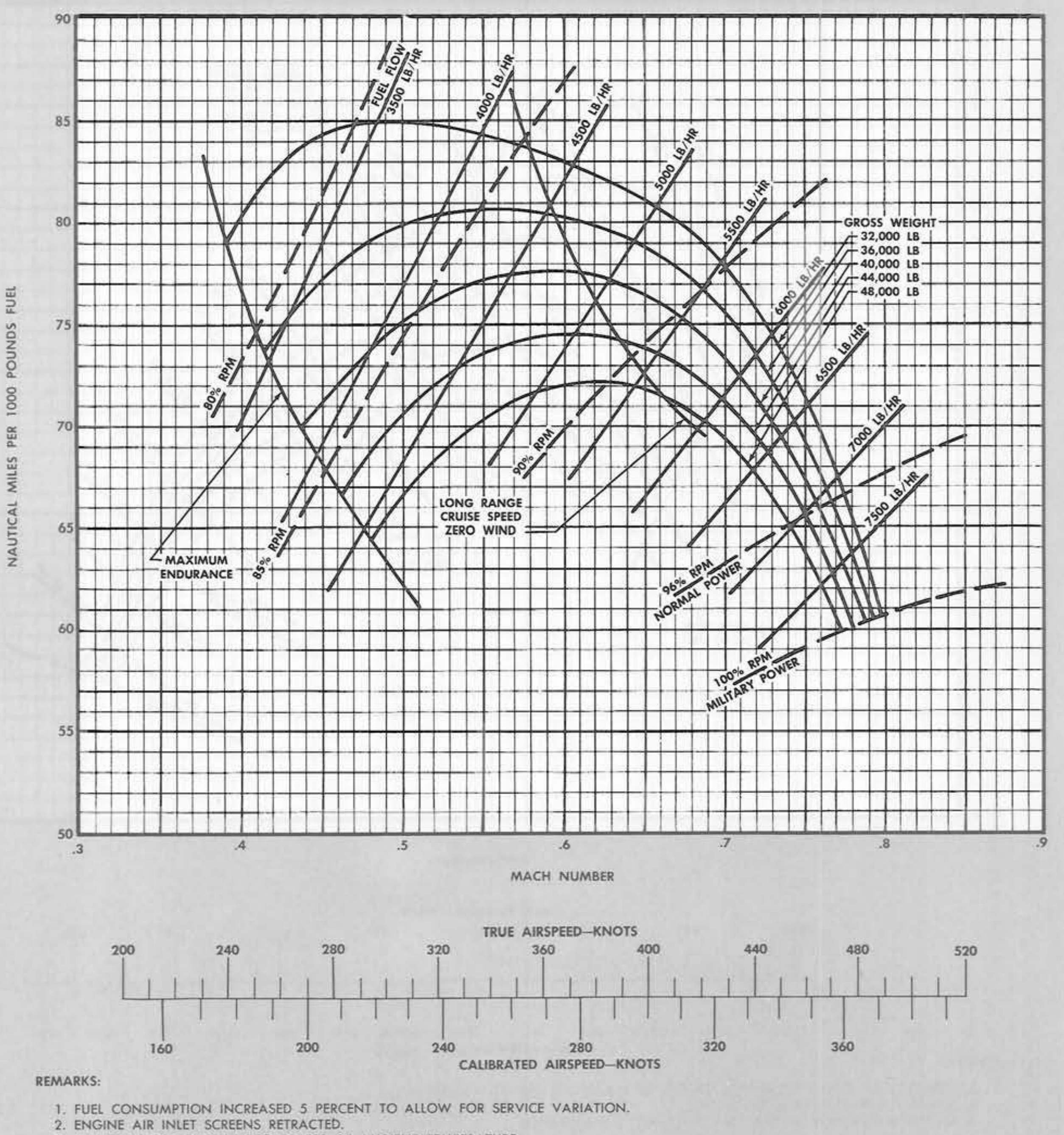
Figure A-21 (Sheet 4 of 8).

# NAUTICAL MILES PER 1000 POUNDS FUEL

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

20,000 FEET
PYLON TANK CONFIGURATION

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

H359

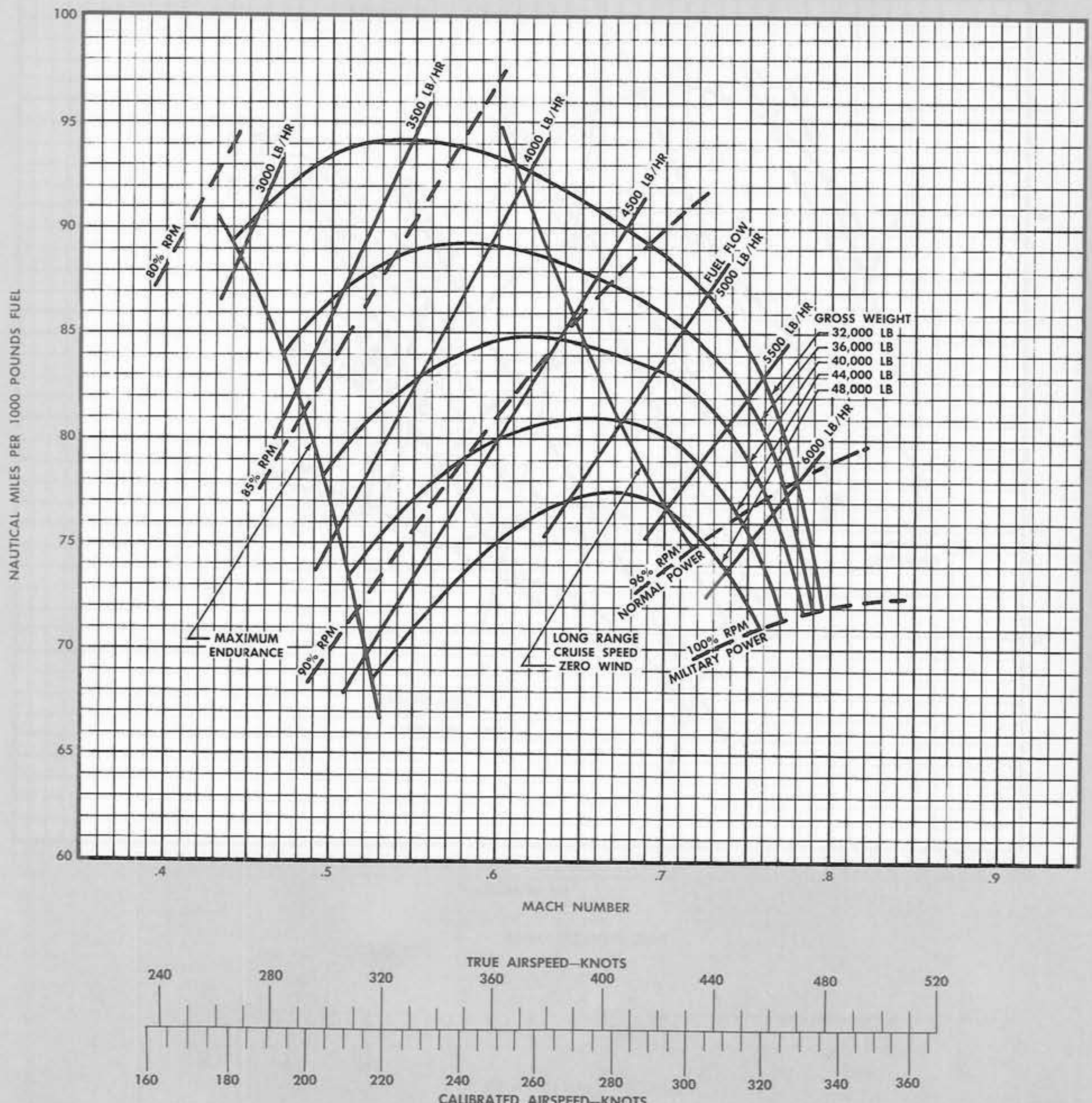
*Figure A-21 (Sheet 5 of 8).*

# NAUTICAL MILES PER 1000 POUNDS FUEL

25,000 FEET
PYLON TANK CONFIGURATION

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

H360

*Figure A-21 (Sheet 6 of 8).*

## NAUTICAL MILES PER 1000 POUNDS FUEL

30,000 FEET

PYLON TANK CONFIGURATION

MODEL: F-89H

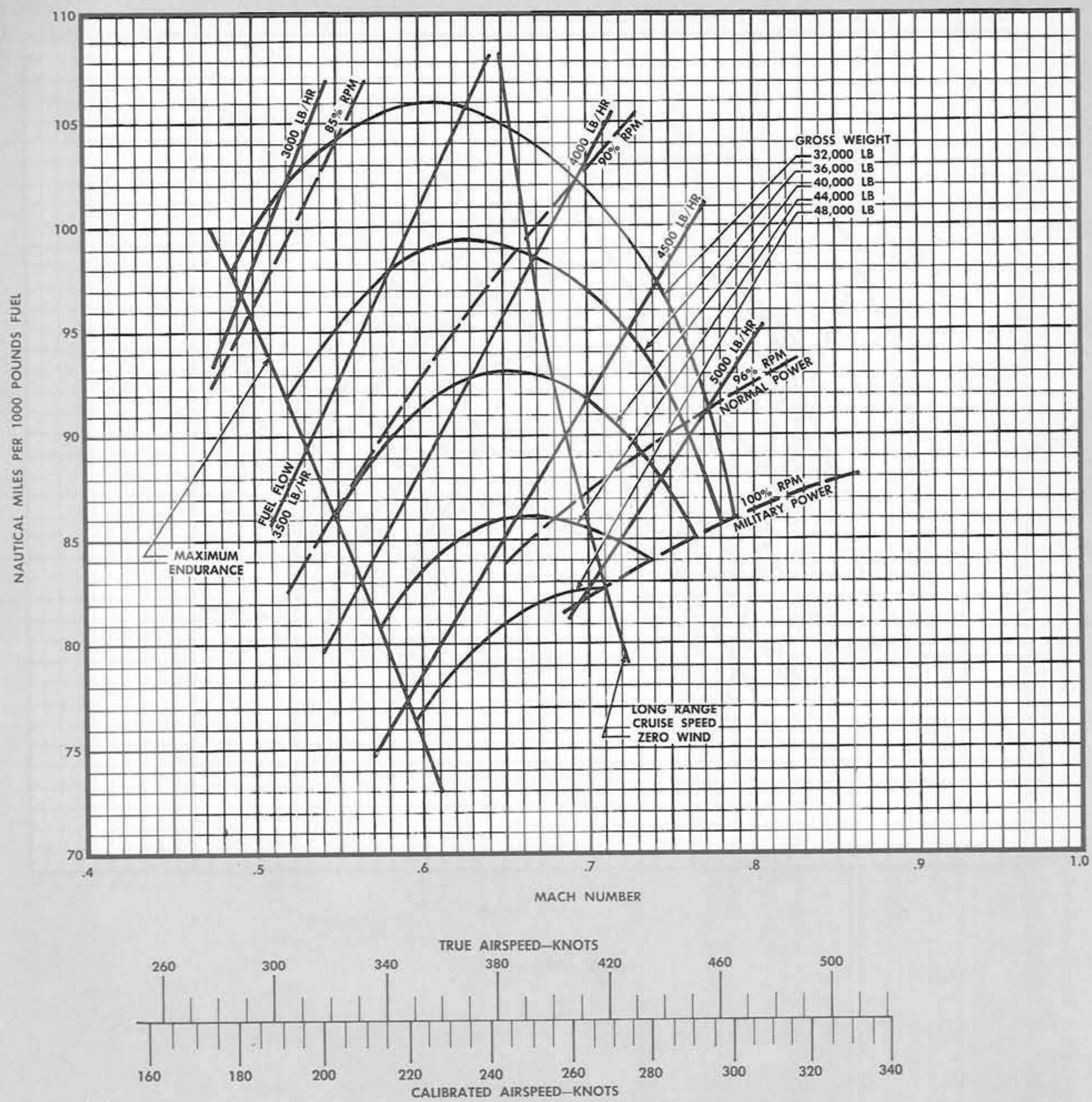
DATA BASIS: FLIGHT TEST

DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

H361

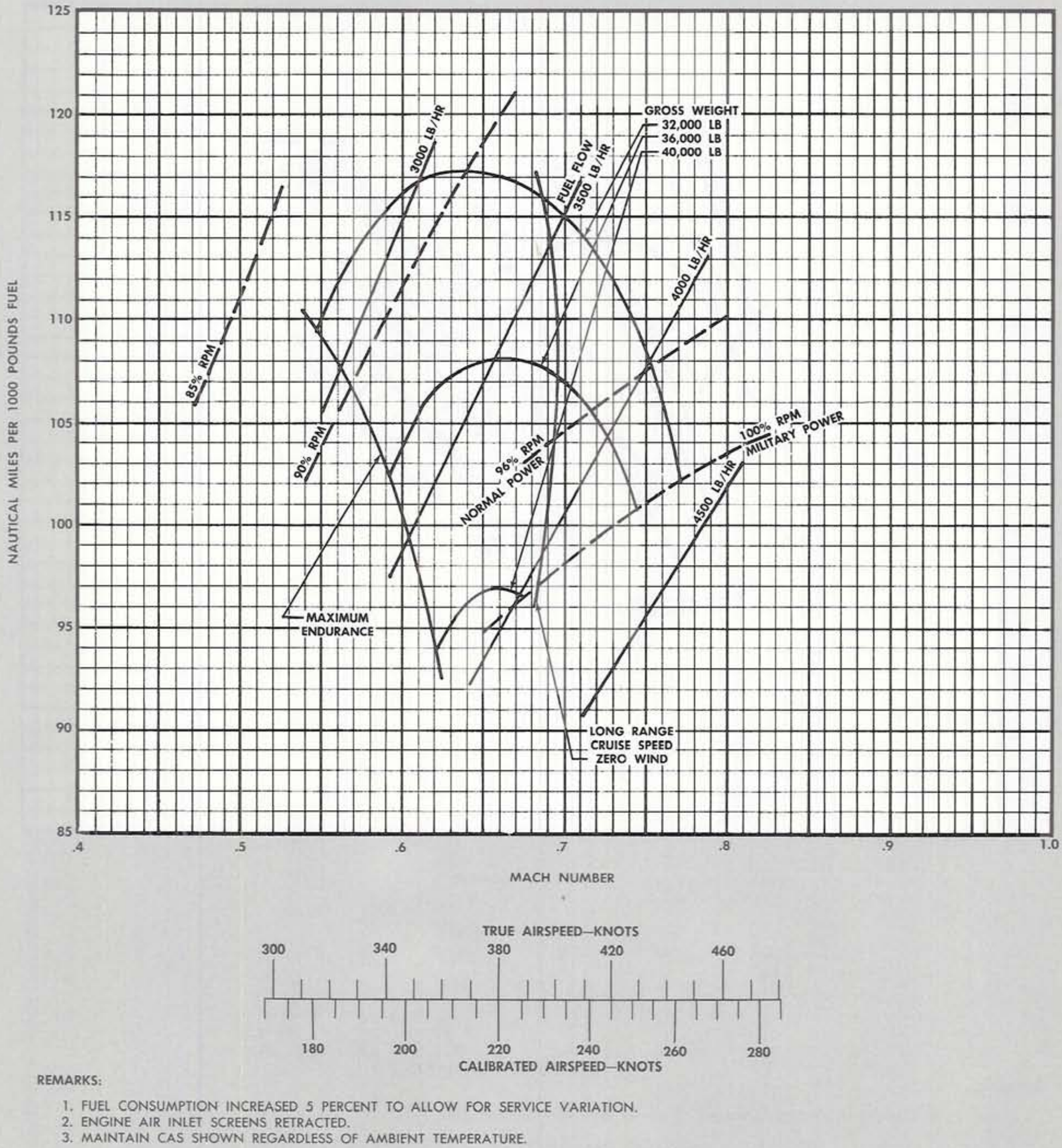
*Figure A-21 (Sheet 7 of 8).*

# NAUTICAL MILES PER 1000 POUNDS FUEL

35,000 FEET
PYLON TANK CONFIGURATION

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

H362

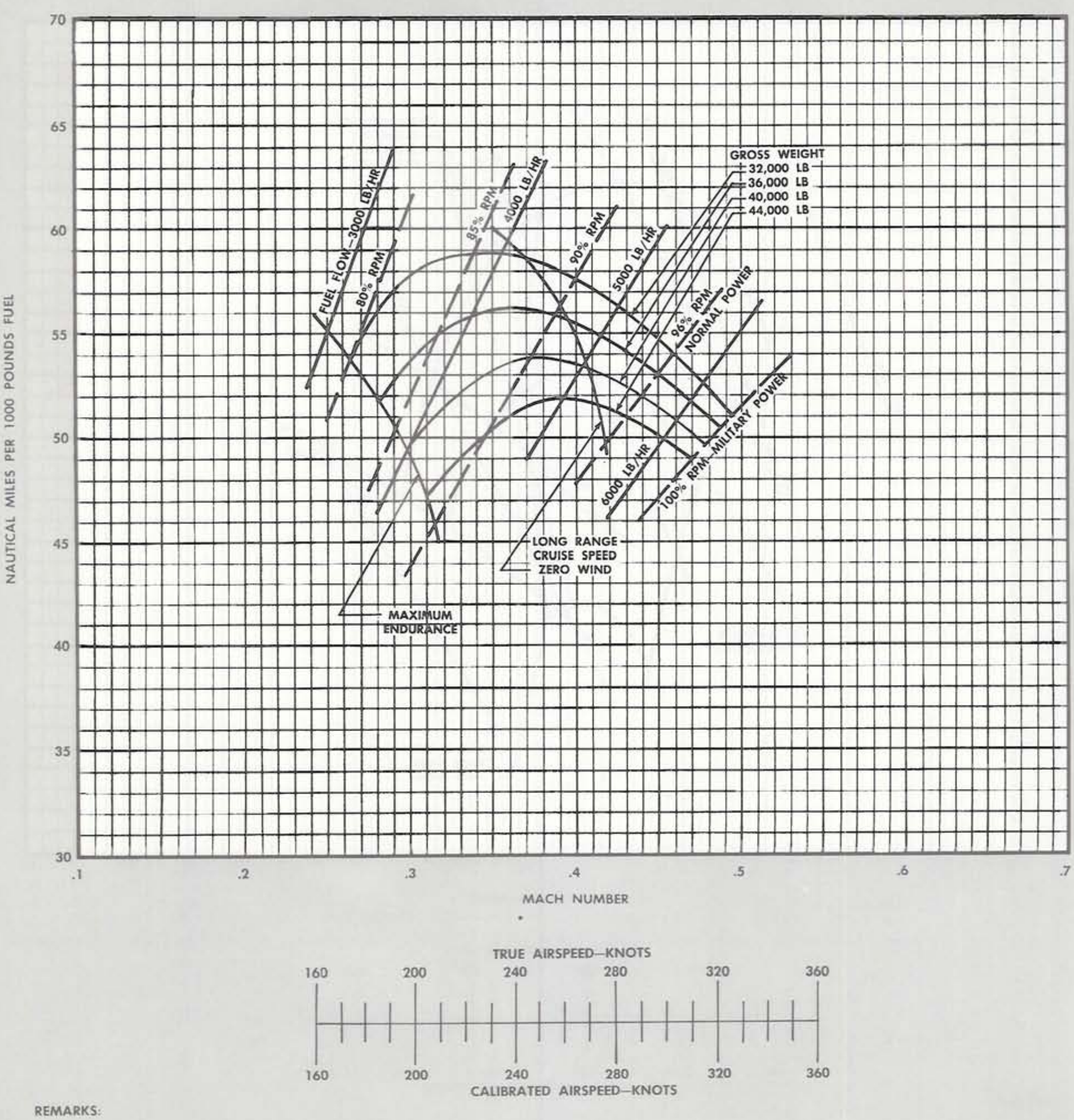
*Figure A-21 (Sheet 8 of 8).*

# NAUTICAL MILES PER 1000 POUNDS FUEL

SEA LEVEL
BASIC CONFIGURATION PLUS PYLONS
ONE ENGINE OPERATING

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

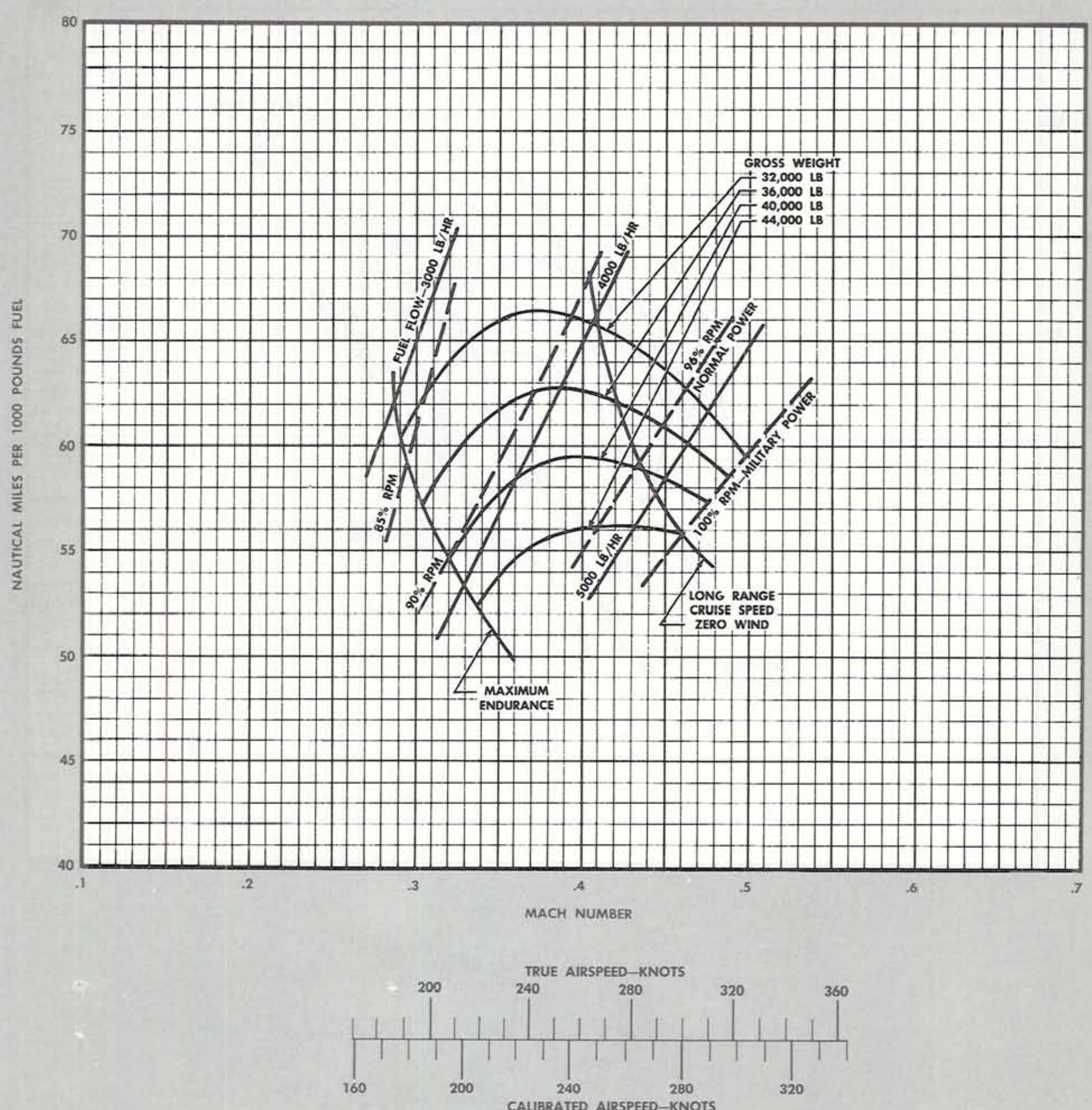
*Figure A-22 (Sheet 1 of 4).*

# NAUTICAL MILES PER 1000 POUNDS FUEL

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

5000 FEET
BASIC CONFIGURATION PLUS PYLONS
ONE ENGINE OPERATING

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

H364

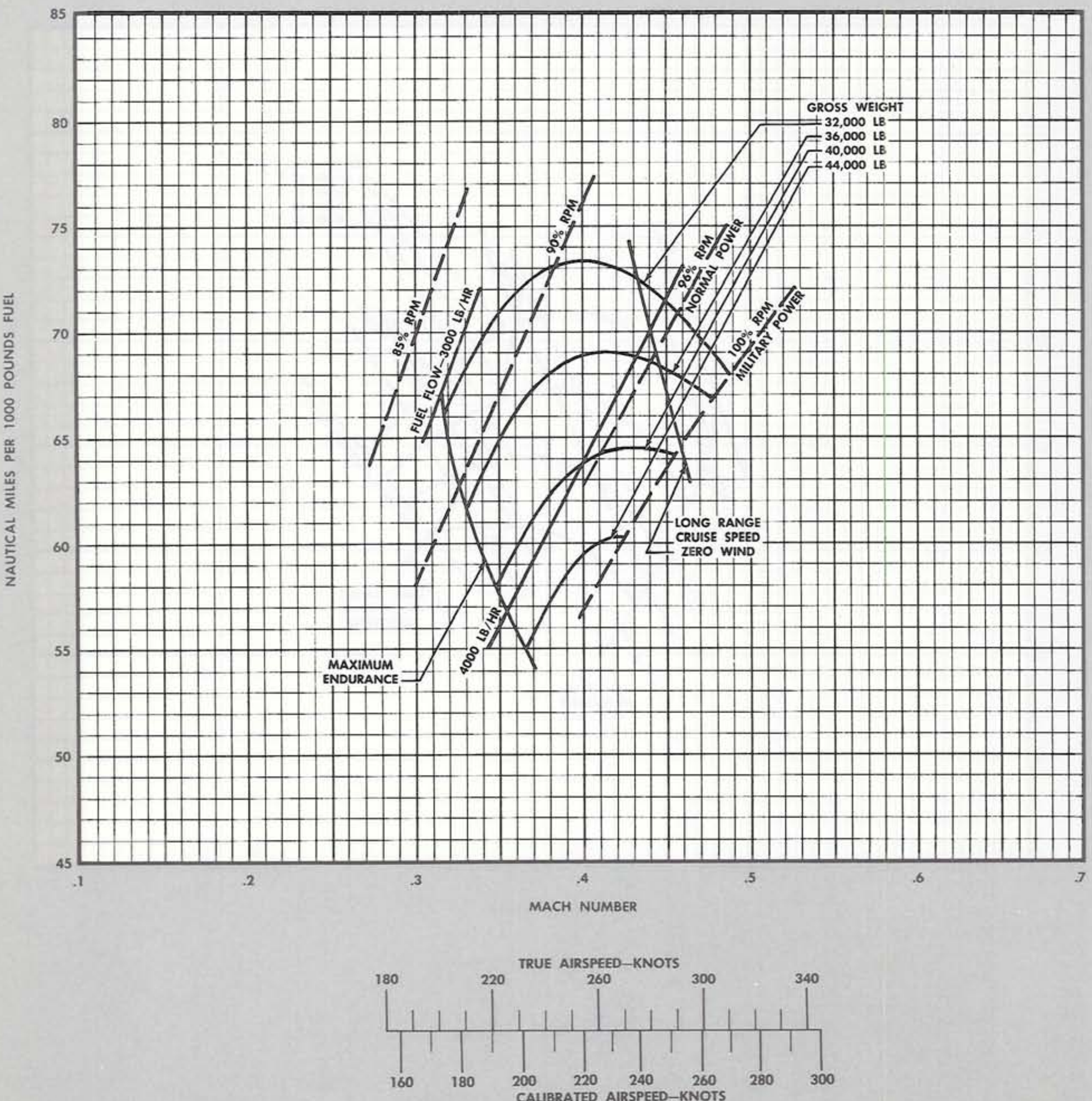
*Figure A-22 (Sheet 2 of 4).*

# NAUTICAL MILES PER 1000 POUNDS FUEL

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

10,000 FEET
BASIC CONFIGURATION PLUS PYLONS
ONE ENGINE OPERATING

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

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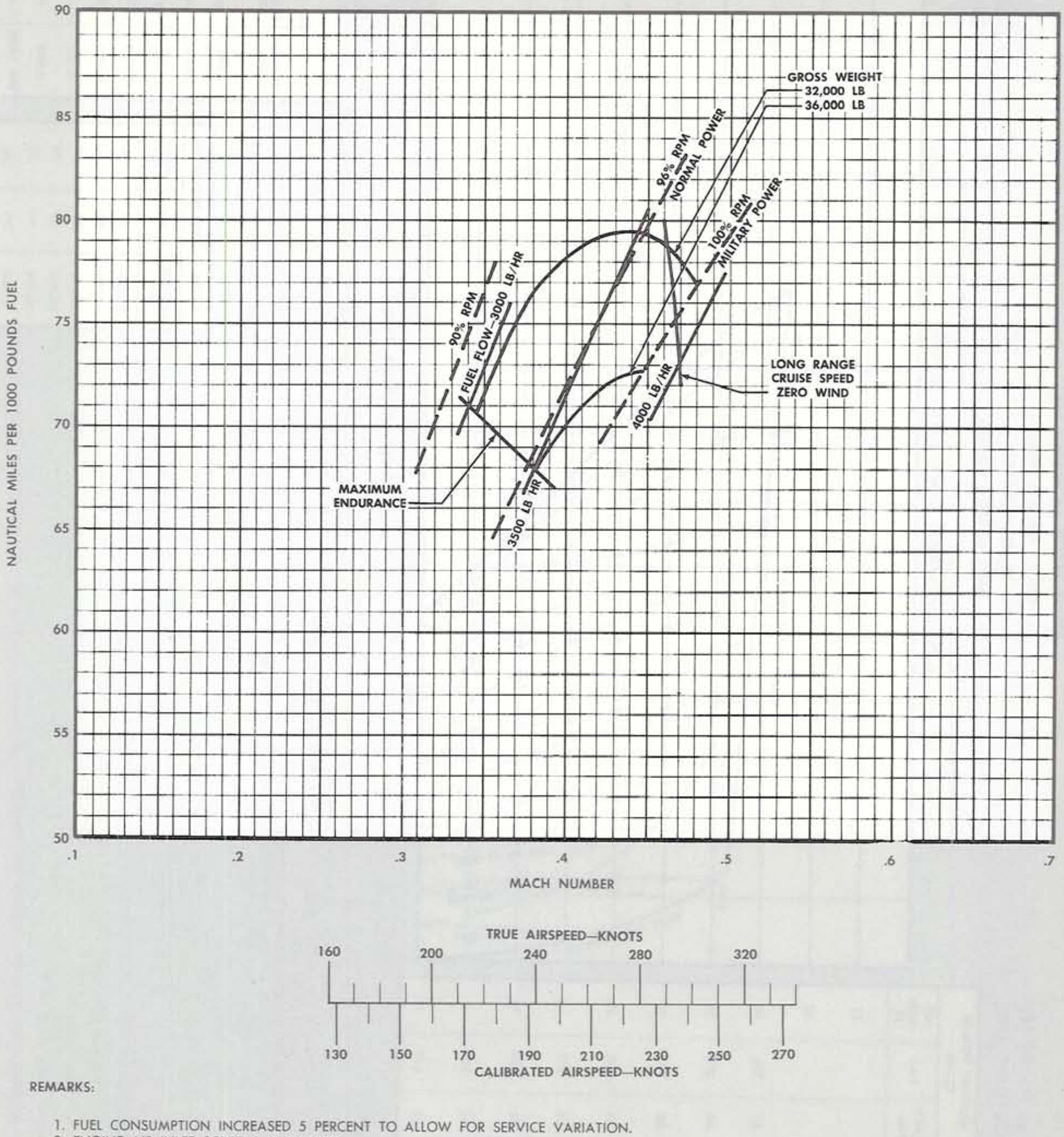
*Figure A-22 (Sheet 3 of 4).*

# NAUTICAL MILES PER 1000 POUNDS FUEL

15,000 FEET
BASIC CONFIGURATION PLUS PYLONS
ONE ENGINE OPERATING

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. MAINTAIN CAS SHOWN REGARDLESS OF AMBIENT TEMPERATURE.

H366

*Figure A-22 (Sheet 4 of 4).*

# MISSION PROFILE

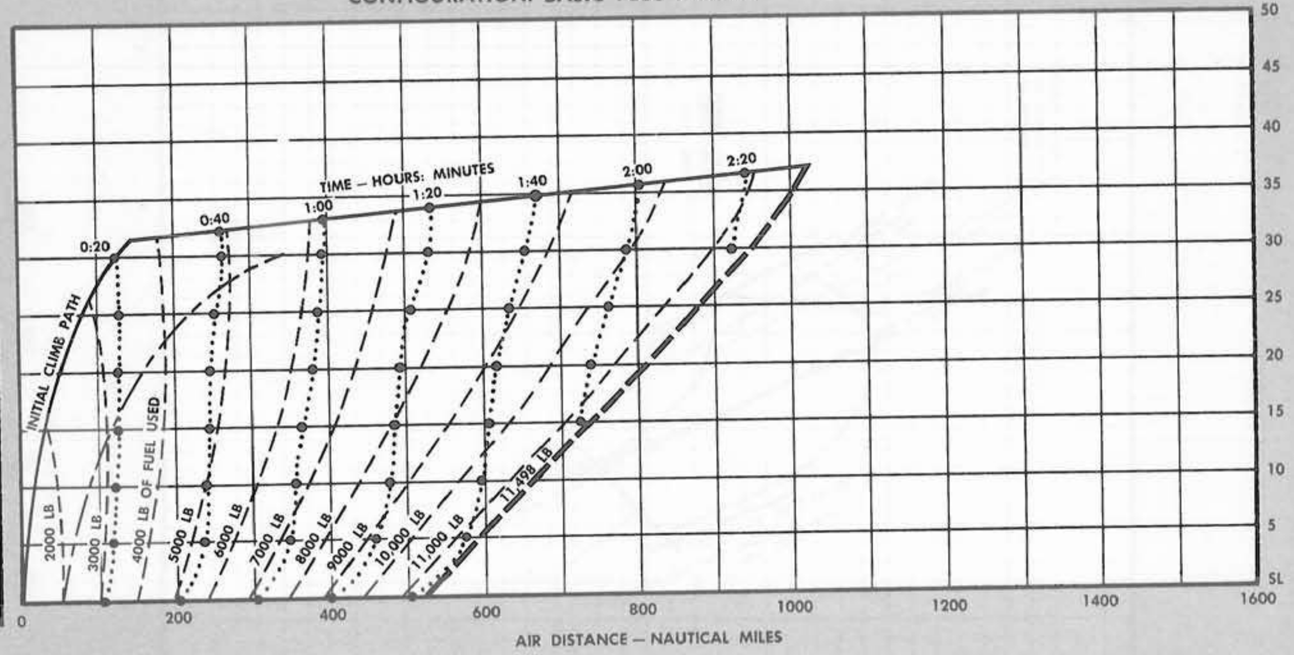
TAKEOFF GROSS WEIGHT
43,175 POUNDS
LONG RANGE CRUISE

CONFIGURATION: BASIC PLUS PYLONS

DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

MODEL: F-89H
ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

| MILITARY POWER CLIMB | | |
|---|---|---|
| MACH NO. | CAS | ALT. 1000 FT. |
| | | 45 |
| | | 40 |
| .67 | 225 | 35 |
| .68 | 250 | 30 |
| .66 | 275 | 25 |
| .63 | 290 | 20 |
| .60 | 300 | 15 |
| .56 | 310 | 10 |
| .52 | 315 | 5 |
| .48 | 315 | SL |




REMARKS:

1. FUEL ALLOWANCE FOR START, TAXI, AND TAKEOFF – 906 LB.
2. NO ALLOWANCE OR RESERVE MADE FOR LOITER, DESCENT, OR LANDING.
3. CLIMB AT MILITARY POWER.
4. CRUISE AT RECOMMENDED MACH NUMBER.
5. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
6. ENGINE AIR INLET SCREENS RETRACTED.

LEGEND

- ▬ ▬ ZERO FUEL REMAINING
- – – – – – FUEL CONSUMED
- ——— CRUISE-CLIMB PATH
- ●······● TIME (START, TAXI, AND TAKEOFF NOT INCLUDED)
- ——– – LINE OF BEST RANGE FOR CONSTANT-ALTITUDE FLIGHT

*

| CRUISE – CLIMB PROCEDURE | | |
|---|---|---|
| ALTITUDE FEET | % RPM | MACH NO. |
| 32.000 | 92 | .70 |
| 33,000 | 92 | .70 |
| 34,000 | 92 | .70 |
| 35,000 | 92 | .70 |
| 36,000 | 91 | .70 |
| 37,000 | 91 | .70 |

| CRUISE | | | | | |
|---|---|---|---|---|---|
| ALTITUDE FEET | MACH NO. | APPROXIMATE | | | |
| | | CAS | TAS | LB/HR | % RPM |
| CRUISE - CLIMB | .70 | | 410 | 4200-3200 | * |
| 30,000 | .68 | 260 | 405 | 4200 | 91 |
| 25,000 | .65 | 280 | 400 | 4300 | 89 |
| 20,000 | .61 | 285 | 380 | 4600 | 87 |
| 15,000 | .58 | 295 | 365 | 5000 | 85 |
| 10,000 | .56 | 315 | 360 | 5500 | 85 |
| 5,000 | .54 | 330 | 350 | 6100 | 84 |
| SEA LEVEL | .46 | 310 | 310 | 6200 | 80 |

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*Figure A-23 (Sheet 1 of 3).*

# MISSION PROFILE

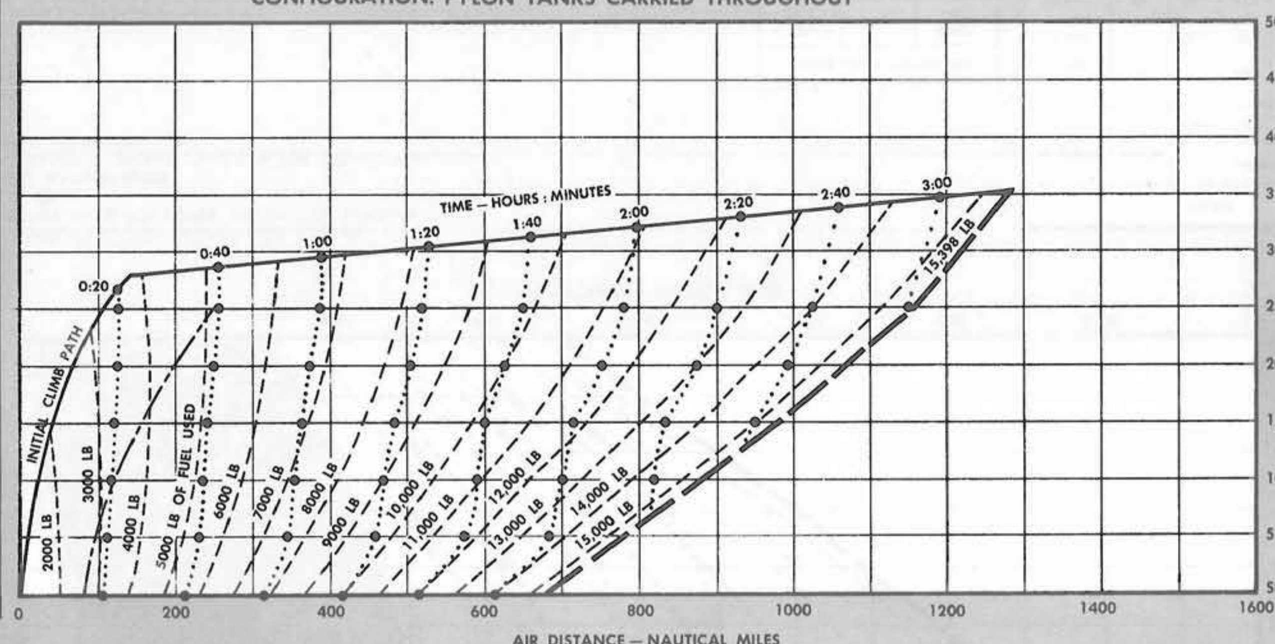
TAKEOFF GROSS WEIGHT
47,355 POUNDS
LONG RANGE CRUISE

CONFIGURATION: PYLON TANKS CARRIED THROUGHOUT

DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

MODEL: F-89H
ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

| MILITARY POWER CLIMB | | |
|---|---|---|
| MACH NO. | CAS | ALT. 1000 FT. |
| | | 45 |
| | | 40 |
| | | 35 |
| .67 | 255 | 30 |
| .65 | 275 | 25 |
| .62 | 290 | 20 |
| .58 | 295 | 15 |
| .54 | 300 | 10 |
| .50 | 305 | 5 |
| .47 | 310 | SL |




REMARKS:

1. FUEL ALLOWANCE FOR START, TAXI, AND TAKEOFF — 906 LB.
2. NO ALLOWANCE OR RESERVE MADE FOR LOITER, DESCENT, OR LANDING.
3. CLIMB AT MILITARY POWER.
4. CRUISE AT RECOMMENDED MACH NUMBER.
5. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
6. ENGINE AIR INLET SCREENS RETRACTED.

LEGEND

- ▬ ▬ ZERO FUEL REMAINING
- - - - - FUEL CONSUMED
- ——— CRUISE-CLIMB PATH
- ●·····● TIME (START, TAXI, AND TAKEOFF NOT INCLUDED)
- — - — LINE OF BEST RANGE FOR CONSTANT-ALTITUDE FLIGHT

*

| CRUISE-CLIMB PROCEDURE | | |
|---|---|---|
| ALTITUDE FEET | % RPM | MACH NO. |
| 28,000 | 94 | .68 |
| 29,000 | 94 | .68 |
| 30,000 | 94 | .68 |
| 31,000 | 93 | .68 |
| 32,000 | 93 | .68 |
| 33,000 | 93 | .68 |
| 34,000 | 93 | .69 |
| 35,000 | 92 | .69 |

| CRUISE | | | | | | |
|---|---|---|---|---|---|---|
| ALTITUDE FEET | MACH NO. | APPROXIMATE | | | | |
| | | CAS | TAS | LB/HR | % RPM | |
| CRUISE-CLIMB | * | | 395 | 4800-3500 | * | |
| 25,000 | .64 | 265 | 385 | 4400 | 89 | |
| 20,000 | .60 | 275 | 370 | 4700 | 88 | |
| 15,000 | .57 | 285 | 355 | 5000 | 87 | |
| 10,000 | .55 | 305 | 350 | 5700 | 86 | |
| 5,000 | .53 | 320 | 345 | 6300 | 85 | |
| SEA LEVEL | .46 | 305 | 305 | 6600 | 81 | |

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Figure A-23 (Sheet 2 of 3).

# MISSION PROFILE

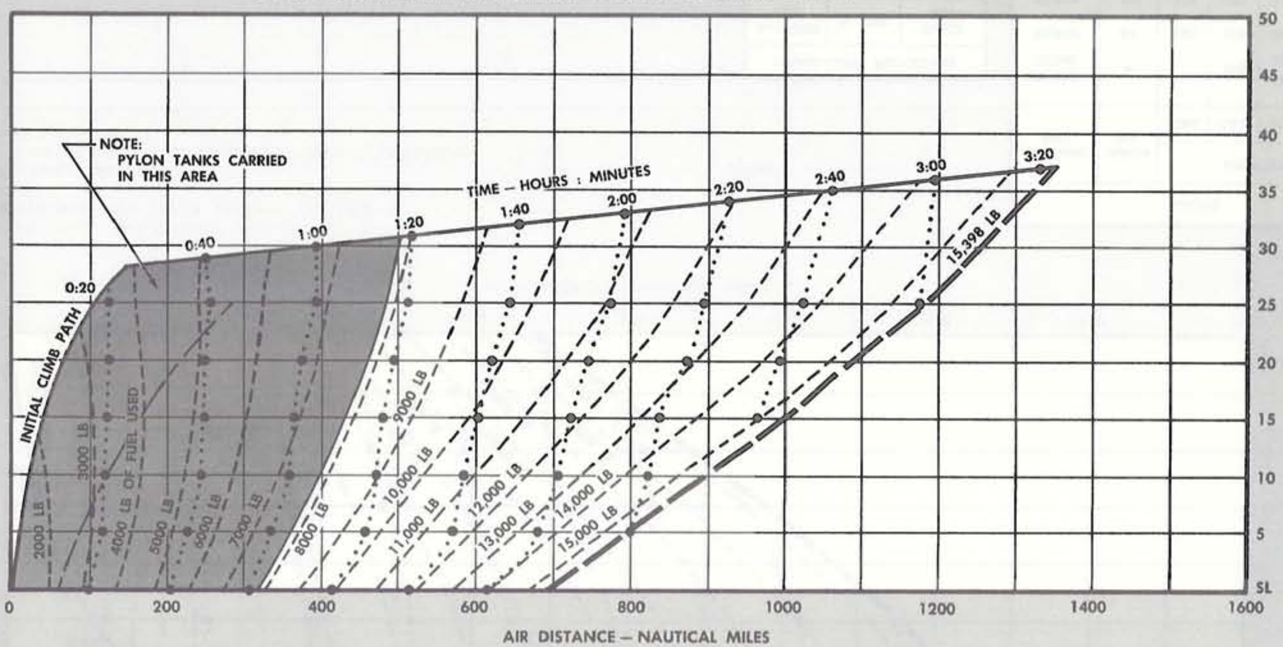
DATA BASIS: **FLIGHT TEST**
DATE: **22 OCTOBER 1957**

TAKEOFF GROSS WEIGHT
47,355 POUNDS
LONG RANGE CRUISE

MODEL: F-89H
ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

CONFIGURATION: PYLON TANKS DROPPED WHEN EMPTY

| MILITARY POWER CLIMB | | |
|---|---|---|
| MACH NO. | CAS | ALT. 1000 FT. |
| | | 45 |
| | | 40 |
| | | 35 |
| .67 | 255 | 30 |
| .65 | 275 | 25 |
| .62 | 290 | 20 |
| .58 | 295 | 15 |
| .54 | 300 | 10 |
| .50 | 305 | 5 |
| .47 | 310 | SL |




REMARKS:

1. FUEL ALLOWANCE FOR START, TAXI, AND TAKEOFF — 906 POUNDS.
2. NO ALLOWANCE OR RESERVE MADE FOR LOITER, DESCENT, OR LANDING.
3. CLIMB AT MAXIMUM POWER.
4. CRUISE AT RECOMMENDED MACH NUMBER.
5. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
6. ENGINE AIR INLET SCREENS RETRACTED.

LEGEND

- ZERO FUEL REMAINING
- FUEL CONSUMED
- CRUISE-CLIMB PATH
- TIME (START, TAXI, AND TAKEOFF NOT INCLUDED)
- LINE OF BEST RANGE FOR CONSTANT-ALTITUDE FLIGHT

* CRUISE-CLIMB PROCEDURE

| ALTITUDE FEET | % RPM | MACH NO. |
|---|---|---|
| 28,000 | 95 | .69 |
| 29,000 | 95 | .69 |
| 30,000 | 94 | .68 |
| 31,000 | 93 | .68 |
| 32,000 | 92 | .70 |
| 33,000 | 92 | .70 |
| 34,000 | 92 | .70 |
| 35,000 | 92 | .70 |
| 36,000 | 93 | .70 |
| 37,000 | 93 | .70 |

| CRUISE | | | | | |
|---|---|---|---|---|---|
| ALTITUDE FEET | MACH NO. | APPROXIMATE | | | |
| | | CAS | TAS | LB/HR | % RPM |
| CRUISE-CLIMB | * | | 400 | 4600-3200 | * |
| 25,000 | .65 | 270 | 390 | 4400 | 90 |
| 20,000 | .61 | 280 | 375 | 4700 | 88 |
| 15,000 | .58 | 295 | 365 | 5100 | 86 |
| 10,000 | .56 | 310 | 355 | 5600 | 85 |
| 5,000 | .53 | 320 | 345 | 6200 | 84 |
| SEA LEVEL | .46 | 305 | 305 | 6400 | 81 |

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*Figure A-23 (Sheet 3 of 3).*

# INTERCEPT PROFILE

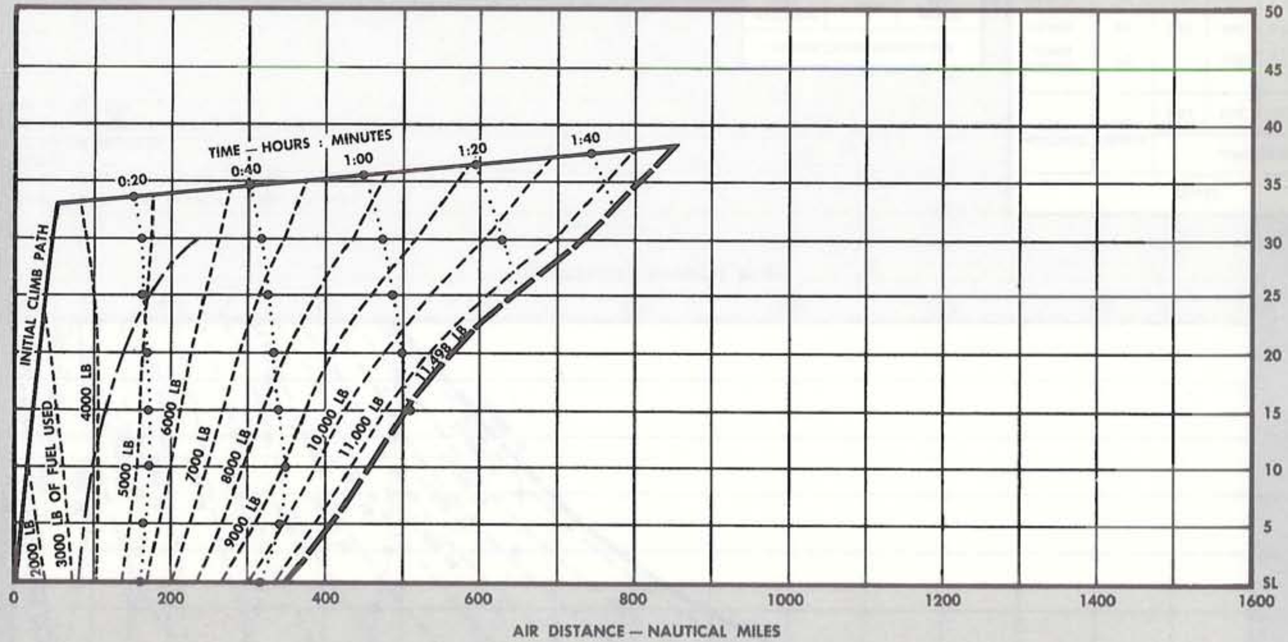
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

TAKEOFF GROSS WEIGHT
43,175 POUNDS
MILITARY POWER

MODEL: F-89H
ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

CONFIGURATION: BASIC PLUS PYLONS

| MAXIMUM POWER CLIMB | | |
|---|---|---|
| MACH NO. | CAS | ALT. 1000 FT. |
| | | 45 |
| | | 40 |
| .79 | 265 | 35 |
| .79 | 300 | 30 |
| .79 | 330 | 25 |
| .79 | 365 | 20 |
| .78 | 400 | 15 |
| .77 | 430 | 10 |
| .74 | 450 | 5 |
| .69 | 460 | SL |




REMARKS:

1. FUEL ALLOWANCE FOR START, TAXI, AND TAKEOFF — 906 POUNDS.
2. NO ALLOWANCE OR RESERVE MADE FOR LOITER, DESCENT, OR LANDING.
3. CLIMB AT MAXIMUM POWER.
4. CRUISE AT RECOMMENDED MACH NUMBER.
5. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
6. ENGINE AIR INLET SCREENS RETRACTED.

LEGEND

- — — ZERO FUEL REMAINING
- - - - - FUEL CONSUMED
- ——— CRUISE-CLIMB PATH
- ●·····● TIME (START, TAXI, AND TAKEOFF NOT INCLUDED)
- — - — LINE OF BEST RANGE FOR CONSTANT-ALTITUDE FLIGHT

| CRUISE-CLIMB PROCEDURE. | | |
|---|---|---|
| ALTITUDE FEET | % RPM | MACH NO. |
| 33,000 | 100 | .76 |
| 34,000 | 100 | .77 |
| 35,000 | 100 | .77 |
| 36,000 | 100 | .77 |
| 37,000 | 100 | .77 |
| 38,000 | 100 | .77 |

| CRUISE | | | | | |
|---|---|---|---|---|---|
| ALTITUDE FEET | MACH NO. | APPROXIMATE | | | |
| | | CAS | TAS | LB/HR | % RPM |
| CRUISE-CLIMB | .77 | | 440 | 4700-3,900 | 100 |
| 30,000 | .80 | 305 | 470 | 5,500 | 100 |
| 25,000 | .81 | 340 | 485 | 6,800 | 100 |
| 20,000 | .82 | 385 | 505 | 8,200 | 100 |
| 15,000 | .81 | 415 | 505 | 9,600 | 100 |
| 10,000 | .81 | 450 | 515 | 11,100 | 100 |
| 5,000 | .78 | 475 | 510 | 12,700 | 100 |
| SEA LEVEL | .72 | 475 | 475 | 14,300 | 100 |

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Figure A-24 (Sheet 1 of 3).

# INTERCEPT PROFILE

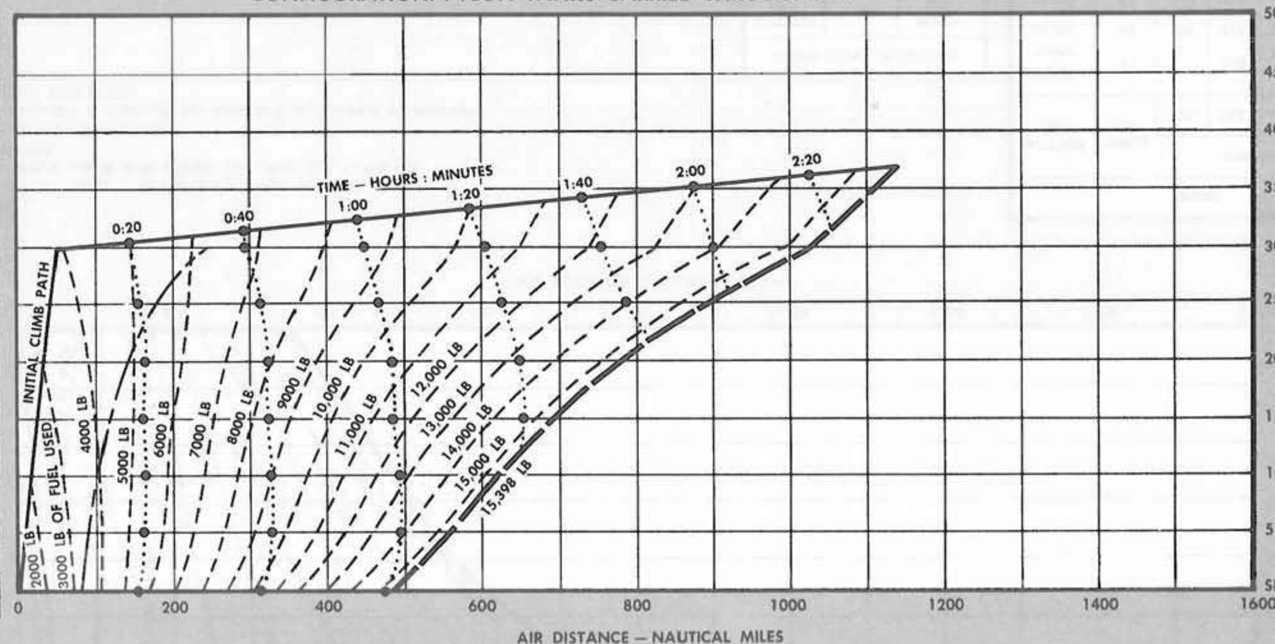
TAKEOFF GROSS WEIGHT
47,355 POUNDS
MILITARY POWER

DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

MODEL: F-89H
ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

CONFIGURATION: PYLON TANKS CARRIED THROUGHOUT

| MAXIMUM POWER CLIMB | | |
|---|---|---|
| MACH NO. | CAS | ALT. 1000 FT. |
| | | 45 |
| | | 40 |
| | | 35 |
| .76 | 290 | 30 |
| .76 | 320 | 25 |
| .76 | 355 | 20 |
| .75 | 385 | 15 |
| .73 | 410 | 10 |
| .70 | 425 | 5 |
| .65 | 430 | SL |




REMARKS:

1. FUEL ALLOWANCE FOR START, TAXI, AND TAKEOFF — 906 POUNDS.
2. NO ALLOWANCE OR RESERVE MADE FOR LOITER, DESCENT, OR LANDING.
3. CLIMB AT MAXIMUM POWER.
4. CRUISE AT RECOMMENDED MACH NUMBER.
5. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
6. ENGINE AIR INLET SCREENS RETRACTED.

LEGEND

— — ZERO FUEL REMAINING
- - - - - FUEL CONSUMED
——— CRUISE-CLIMB PATH
●·······● TIME (START, TAXI, AND TAKEOFF NOT INCLUDED)
—— - —— LINE OF BEST RANGE FOR CONSTANT-ALTITUDE FLIGHT

| CRUISE-CLIMB PROCEDURE | | |
|---|---|---|
| ALTITUDE FEET | % RPM | MACH NO. |
| 30,000 | 100 | .75 |
| 31,000 | 100 | .75 |
| 32,000 | 100 | .75 |
| 33,000 | 100 | .75 |
| 34,000 | 100 | .75 |
| 35,000 | 100 | .75 |
| 36,000 | 100 | .75 |
| 37,000 | 100 | .75 |

| CRUISE | | | | | |
|---|---|---|---|---|---|
| | | APPROXIMATE | | | |
| ALTITUDE FEET | MACH NO. | CAS | TAS | LB/HR | % RPM |
| CRUISE-CLIMB | .75 | | 435 | 5,200-4,000 | 100 |
| 30,000 | .78 | 295 | 460 | 5,400 | 100 |
| 25,000 | .79 | 335 | 475 | 6,600 | 100 |
| 20,000 | .79 | 365 | 485 | 8,000 | 100 |
| 15,000 | .79 | 405 | 495 | 9,500 | 100 |
| 10,000 | .78 | 440 | 500 | 10,900 | 100 |
| 5,000 | .77 | 470 | 500 | 12,600 | 100 |
| SEA LEVEL | .72 | 475 | 475 | 14,300 | 100 |

H372

*Figure A-24 (Sheet 2 of 3).*

# INTERCEPT PROFILE

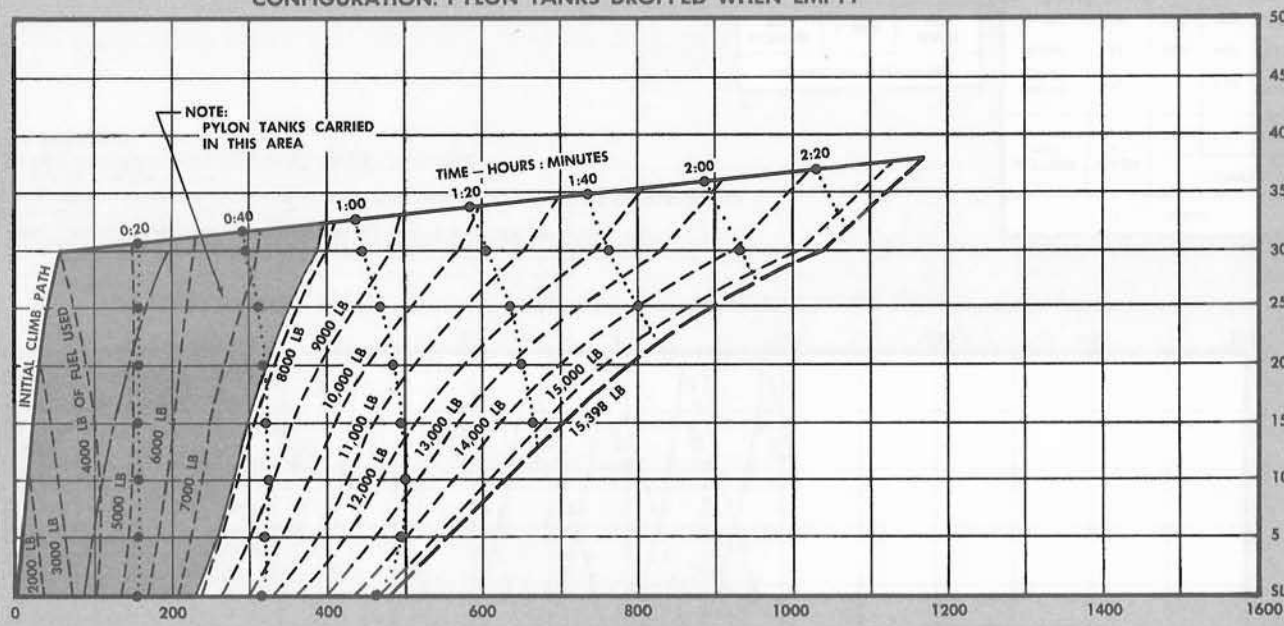
TAKEOFF GROSS WEIGHT
47,355 POUNDS
MILITARY POWER

DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

MODEL: F-89H
ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

CONFIGURATION: PYLON TANKS DROPPED WHEN EMPTY

| MAXIMUM POWER CLIMB | | |
|---|---|---|
| MACH NO. | CAS | ALT. 1000 FT. |
| | | 45 |
| | | 40 |
| | | 35 |
| .76 | 290 | 30 |
| .76 | 320 | 25 |
| .76 | 355 | 20 |
| .75 | 385 | 15 |
| .73 | 410 | 10 |
| .70 | 425 | 5 |
| .65 | 430 | SL |




REMARKS:

1. FUEL ALLOWANCE FOR START, TAXI, AND TAKEOFF — 906 POUNDS.
2. NO ALLOWANCE OR RESERVE MADE FOR LOITER, DESCENT, OR LANDING.
3. CLIMB AT MAXIMUM POWER.
4. CRUISE AT RECOMMENDED MACH NUMBER.
5. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
6. ENGINE AIR INLET SCREENS RETRACTED.

LEGEND

- ZERO FUEL REMAINING
- FUEL CONSUMED
- CRUISE-CLIMB PATH
- TIME (START, TAXI, AND TAKEOFF NOT INCLUDED)
- LINE OF BEST RANGE FOR CONSTANT-ALTITUDE FLIGHT

*

| CRUISE-CLIMB PROCEDURE | | |
|---|---|---|
| ALTITUDE FEET | % RPM | MACH NO. |
| 30,000 | 100 | .75 |
| 31,000 | 100 | .75 |
| 32,000 | 100 | .75 |
| 33,000 | 100 | .76 |
| 34,000 | 100 | .77 |
| 35,000 | 100 | .77 |
| 36,000 | 100 | .77 |
| 37,000 | 100 | .77 |
| 38,000 | 100 | .77 |

| CRUISE | | | | | |
|---|---|---|---|---|---|
| ALTITUDE FEET | MACH NO. | APPROXIMATE | | | |
| | | CAS | TAS | LB/HR | % RPM |
| CRUISE-CLIMB | * | | 435 | 5,300-3,900 | 100 |
| 30,000 | .78 | 295 | 460 | 5,400 | 100 |
| 25,000 | .80 | 335 | 480 | 6,700 | 100 |
| 20,000 | .80 | 370 | 490 | 8,100 | 100 |
| 15,000 | .80 | 410 | 500 | 9,600 | 100 |
| 10,000 | .79 | 445 | 505 | 11,000 | 100 |
| 5,000 | .77 | 470 | 500 | 12,600 | 100 |
| SEA LEVEL | .72 | 475 | 475 | 14,300 | 100 |

H373

Figure A-24 (Sheet 3 of 3).

# OPTIMUM RETURN PROFILE

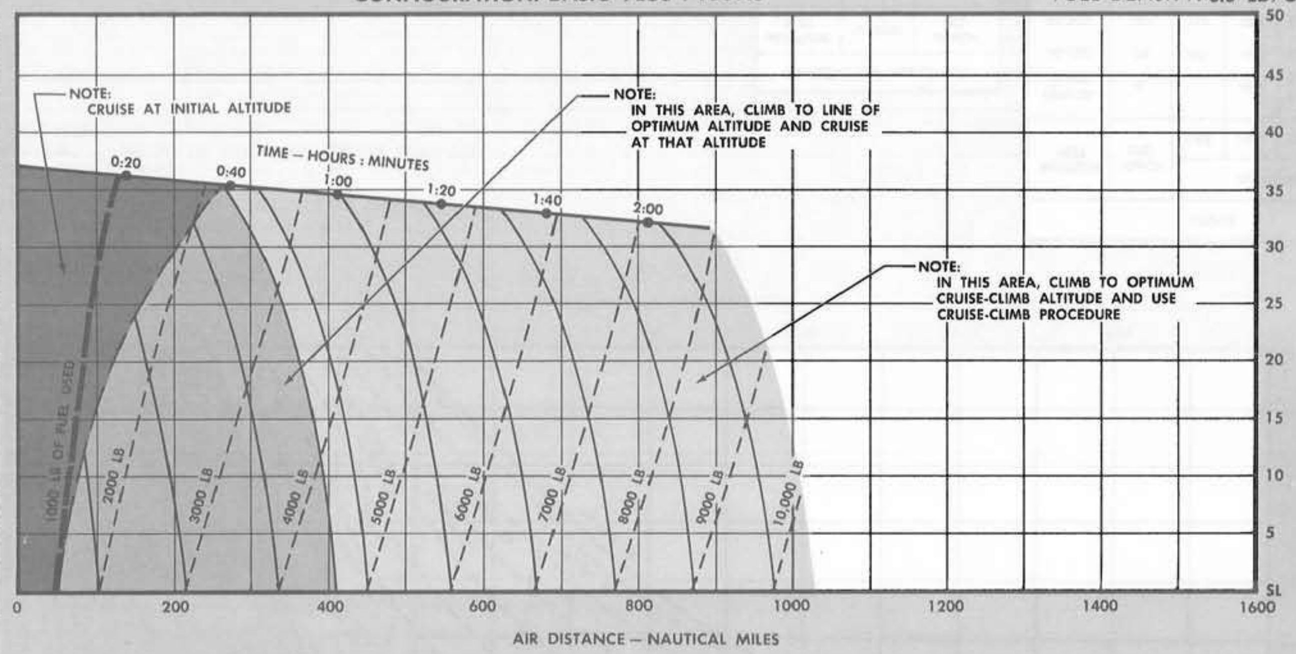
TAKEOFF GROSS WEIGHT
43,175 POUNDS

DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

MODEL: F-89H
ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

CONFIGURATION: BASIC PLUS PYLONS

| MILITARY POWER CLIMB | | |
|---|---|---|
| MACH NO. | CAS | ALT. 1000 FT. |
| | | 45 |
| | | 40 |
| .67 | 225 | 35 |
| .68 | 250 | 30 |
| .66 | 275 | 25 |
| .63 | 290 | 20 |
| .60 | 300 | 15 |
| .56 | 310 | 10 |
| .52 | 315 | 5 |
| .48 | 315 | SL |




REMARKS:

1. FUEL REQUIRED AT ANY POINT INCLUDES MILITARY POWER CLIMB TO FLIGHT ALTITUDE (IF BELOW THAT).
2. NO ALLOWANCE MADE FOR LOITER, DESCENT, OR LANDING.
3. BEST CRUISE CONDITION DETERMINED 3Y INTERSECTION OF CLIMB PATH GUIDE LINES AND LINES OF BEST RANGE.
4. CRUISE AT RECOMMENDED MACH NUMBER.
5. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
6. ENGINE AIR INLET SCREENS RETRACTED.

LEGEND

- ● ● TIME AT CRUISE-CLIMB ALTITUDE
- - - - - - FUEL REQUIRED
- ——— CLIMB PATH GUIDE LINE
- — — LINE OF BEST RANGE FOR CONSTANT-ALTITUDE FLIGHT
- ▬▬ LINE OF BEST RANGE FOR CRUISE-CLIMB FLIGHT

*

| CRUISE-CLIMB PROCEDURE | | |
|---|---|---|
| ALTITUDE FEET | % RPM | MACH NO. |
| 32,000 | 92 | .70 |
| 33,000 | 92 | .70 |
| 34,000 | 92 | .70 |
| 35,000 | 92 | .70 |
| 36,000 | 91 | .70 |
| 37,000 | 91 | .70 |

| CRUISE | | | | | |
|---|---|---|---|---|---|
| ALTITUDE FEET | MACH NO. | APPROXIMATE | | | |
| | | CAS | TAS | LB/HR | % RPM |
| CRUISE-CLIMB | .70 | | 410 | 4200-3200 | * |
| 30,000 | .68 | 260 | 405 | 4200 | 91 |
| 25,000 | .65 | 280 | 400 | 4300 | 89 |
| 20,000 | .61 | 285 | 380 | 4600 | 87 |
| 15,000 | .58 | 295 | 365 | 5000 | 85 |
| 10,000 | .56 | 315 | 360 | 5500 | 85 |
| 5,000 | .54 | 330 | 350 | 6100 | 84 |
| SEA LEVEL | .46 | 310 | 310 | 6200 | 80 |

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Figure A-25 (Sheet 1 of 3).

# OPTIMUM RETURN PROFILE

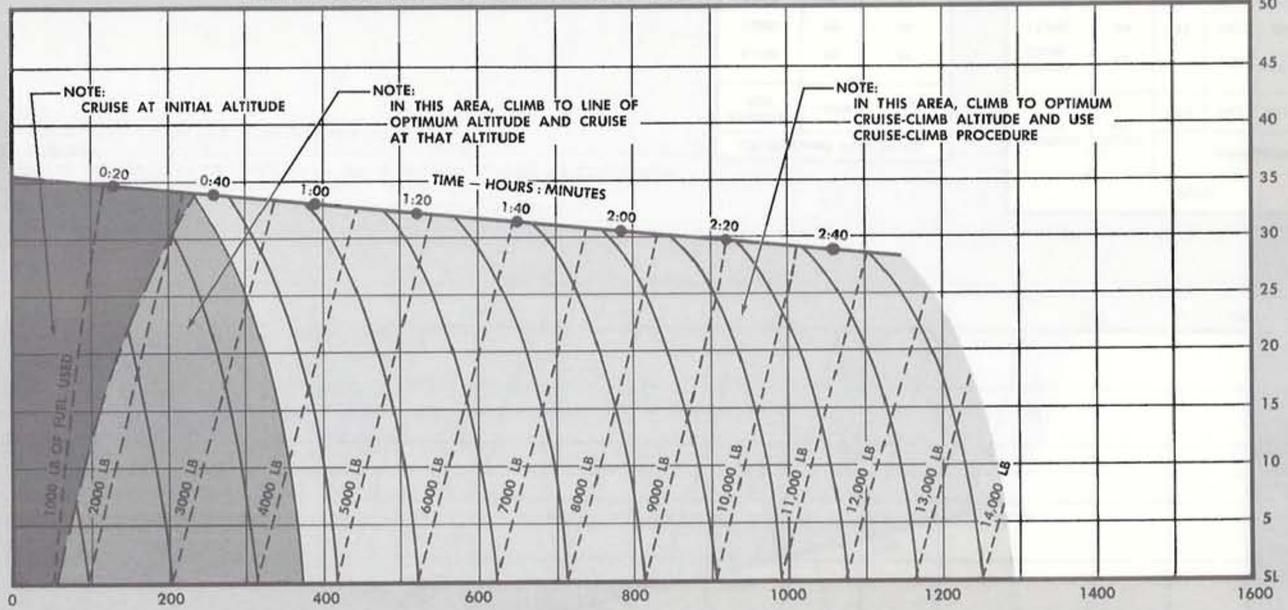
TAKEOFF GROSS WEIGHT
47,355 POUNDS

DATA BASIS: **FLIGHT TEST**
DATE: **22 OCTOBER 1957**

MODEL: **F-89H**
ENGINE(S): **(2) J35-35**
FUEL GRADE: **JP-4**
FUEL DENSITY: **6.5 LB/US GAL**

CONFIGURATION: TWO PYLONS AND TWO PYLON TANKS

| MILITARY POWER CLIMB | | |
|---|---|---|
| MACH NO. | CAS | ALT. 1000 FT. |
| | | 45 |
| | | 40 |
| | | 35 |
| .67 | 255 | 30 |
| .65 | 275 | 25 |
| .62 | 290 | 20 |
| .58 | 295 | 15 |
| .54 | 300 | 10 |
| .50 | 305 | 5 |
| .47 | 310 | SL |




REMARKS:

1. FUEL REQUIRED AT ANY POINT INCLUDES MILITARY POWER CLIMB TO FLIGHT ALTITUDE (IF BELOW THAT).
2. NO ALLOWANCE MADE 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. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
6. ENGINE AIR INLET SCREENS RETRACTED.

LEGEND

- ● ● TIME AT CRUISE-CLIMB ALTITUDE
- – – – – – FUEL REQUIRED
- ——— CLIMB PATH GUIDE LINE
- — — LINE OF BEST RANGE FOR CONSTANT-ALTITUDE FLIGHT
- ▬▬ LINE OF BEST RANGE FOR CRUISE-CLIMB FLIGHT

* CRUISE-CLIMB PROCEDURE

| ALTITUDE FEET | % RPM | MACH NO. |
|---|---|---|
| 28,000 | 94 | .68 |
| 29,000 | 94 | .68 |
| 30,000 | 94 | .68 |
| 31,000 | 93 | .68 |
| 32,000 | 93 | .68 |
| 33,000 | 93 | .68 |
| 34,000 | 93 | .69 |
| 35,000 | 92 | .69 |

| CRUISE | | | | | |
|---|---|---|---|---|---|
| ALTITUDE FEET | MACH NO. | APPROXIMATE | | | |
| | | CAS | TAS | LB/HR | % RPM |
| CRUISE-CLIMB | .68 | | 395 | 4800-3500 | * |
| 25,000 | .64 | 265 | 385 | 4400 | 89 |
| 20,000 | .60 | 275 | 370 | 4700 | 88 |
| 15,000 | .57 | 285 | 355 | 5000 | 87 |
| 10,000 | .55 | 305 | 350 | 5700 | 86 |
| 5,000 | .53 | 320 | 345 | 6300 | 85 |
| SEA LEVEL | .46 | 305 | 305 | 6600 | 81 |

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Figure A-25 (Sheet 2 of 3).

# OPTIMUM RETURN PROFILE

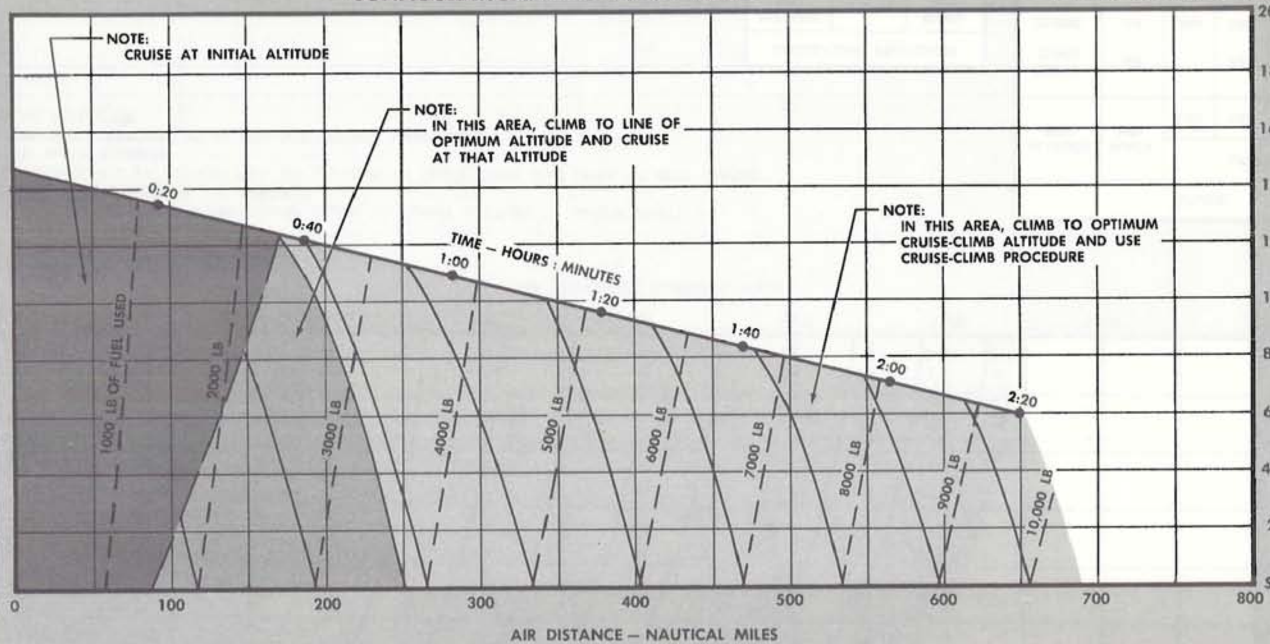
TAKEOFF GROSS WEIGHT
43,175 POUNDS
ONE ENGINE OPERATING

CONFIGURATION: BASIC PLUS PYLONS

DATA BASIS: **FLIGHT TEST**
DATE: **22 OCTOBER 1957**

MODEL: **F-89H**
ENGINE(S): **(2) J35-35**
FUEL GRADE: **JP-4**
FUEL DENSITY: **6.5 LB/US GAL**

| MILITARY POWER CLIMB | | |
|---|---|---|
| MACH NO. | CAS | ALT. 1000 FT. |
| | | 18 |
| | | 16 |
| .40 | 205 | 14 |
| .40 | 215 | 12 |
| .39 | 215 | 10 |
| .38 | 215 | 8 |
| .37 | 225 | 6 |
| .36 | 225 | 4 |
| .35 | 225 | 2 |
| .34 | 225 | SL |




REMARKS:

1. FUEL REQUIRED AT ANY POINT INCLUDES MILITARY POWER CLIMB TO FLIGHT ALTITUDE (IF BELOW THAT).
2. NO ALLOWANCE MADE FOR LOITER, DESCENT, OR LANDING.
3. BEST CRUISE CONDITION DETERMINED 3Y INTERSECTION OF CLIMB PATH GUIDE LINES AND LINES OF BEST RANGE.
4. CRUISE AT RECOMMENDED MACH NUMBER.
5. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
6. ENGINE AIR INLET SCREENS RETRACTED.

| CRUISE-CLIMB PROCEDURE | | |
|---|---|---|
| ALTITUDE FEET | %RPM | MACH NO. |
| 6,000 | 98 | .45 |
| 7,000 | 98 | .45 |
| 8,000 | 98 | .45 |
| 9,000 | 98 | .45 |
| 10,000 | 97 | .45 |
| 11,000 | 97 | .45 |
| 12,000 | 97 | .45 |
| 13,000 | 97 | .45 |
| 14,000 | 97 | .45 |

| CRUISE | | | | | | |
|---|---|---|---|---|---|---|
| ALTITUDE FEET | MACH NO. | APPROXIMATE | | | | |
| | | CAS | TAS | LB/HR | % RPM |
| CRUISE-CLIMB | .45 | | 290 | 4900-3700 | 97 |
| 12,000 | .44 | 235 | 280 | 3800 | 96 |
| 10,000 | .43 | 240 | 275 | 3900 | 94 |
| 8,000 | .42 | 240 | 270 | 4000 | 93 |
| 6,000 | .41 | 245 | 265 | 4100 | 92 |
| 4,000 | .40 | 250 | 260 | 4100 | 91 |
| 2,000 | .39 | 250 | 255 | 4200 | 89 |
| SEA LEVEL | .37 | 245 | 245 | 4200 | 88 |

LEGEND

- ● ● TIME AT CRUISE-CLIMB ALTITUDE
- - - - - - FUEL REQUIRED
- ——— CLIMB PATH GUIDE LINE
- — — LINE OF BEST RANGE FOR CONSTANT-ALTITUDE FLIGHT
- ▬▬ LINE OF BEST RANGE FOR CRUISE-CLIMB FLIGHT

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*Figure A-25 (Sheet 3 of 3).*

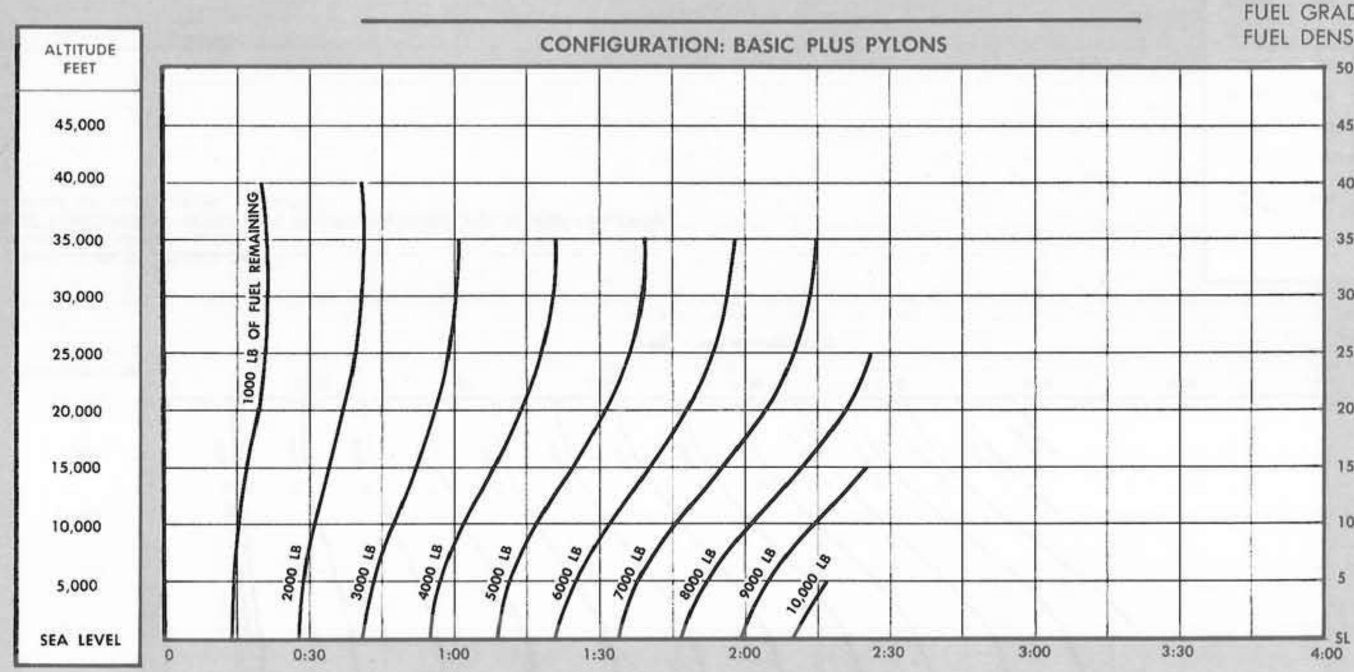
# MAXIMUM ENDURANCE

TAKEOFF GROSS WEIGHT
43,175 POUNDS

DATA BASIS: **FLIGHT TEST**
DATE: **22 OCTOBER 1957**

MODEL: **F-89H**
ENGINE(S): **(2) J35-35**
FUEL GRADE: **JP-4**
FUEL DENSITY: **6.5 LB/US GAL**

CONFIGURATION: BASIC PLUS PYLONS




REMARKS:

1. LOITER AT RECOMMENDED CAS.
2. MAINTAIN CONSTANT ALTITUDE.
3. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
4. ENGINE AIR INLET SCREENS RETRACTED.

| LOITER | | | | | |
|---|---|---|---|---|---|
| ALTITUDE FEET | CAS | APPROXIMATE | | | |
| | | TAS | MACH NO. | LB/HR | % RPM |
| 40,000 | 195 | 380 | .66 | 3200 | 99 |
| 35,000 | 195 | 340 | .59 | 3100 | 90 |
| 30,000 | 195 | 310 | .53 | 3300 | 87 |
| 25,000 | 200 | 290 | .48 | 3400 | 84 |
| 20,000 | 195 | 265 | .44 | 3500 | 81 |
| 15,000 | 195 | 240 | .39 | 3800 | 79 |
| 10,000 | 195 | 225 | .35 | 4000 | 75 |
| 5,000 | 195 | 210 | .32 | 4400 | 74 |
| SEA LEVEL | 195 | 195 | .30 | 4500 | 70 |

H377

*Figure A-26 (Sheet 1 of 3).*

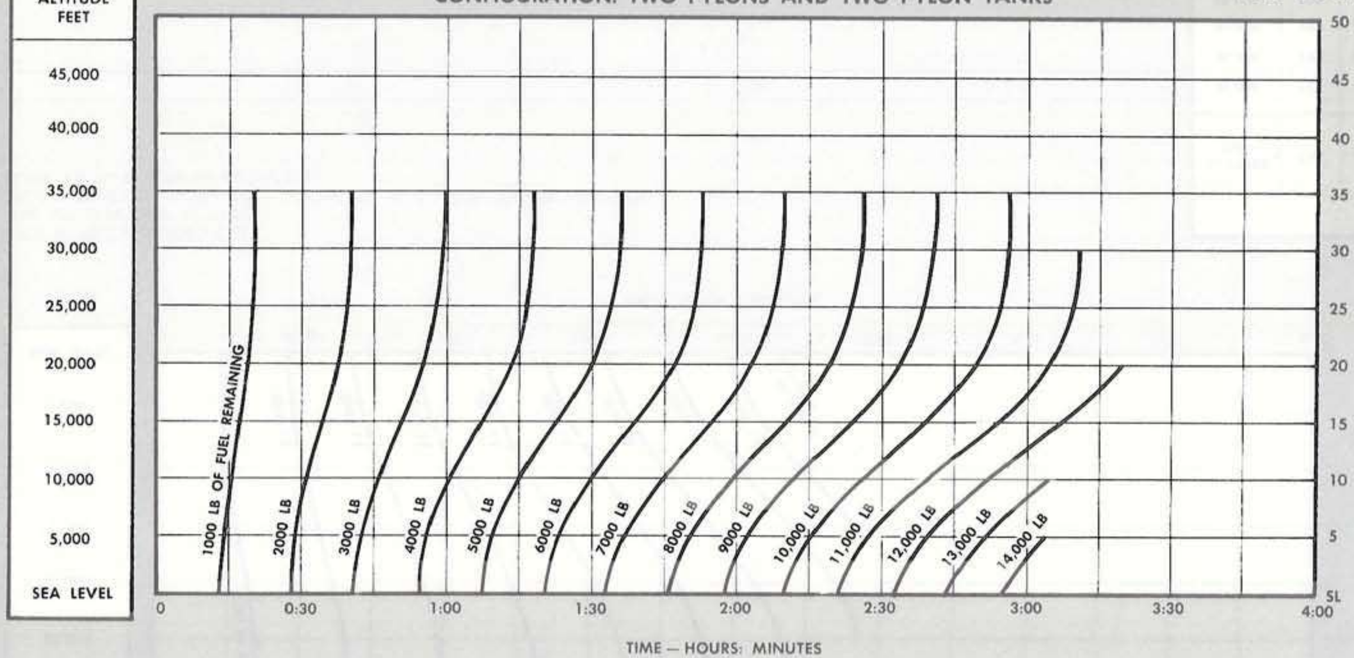
# MAXIMUM ENDURANCE

TAKEOFF GROSS WEIGHT
47,355 POUNDS

DATA BASIS: **FLIGHT TEST**
DATE: **22 OCTOBER 1957**

MODEL: **F-89H**
ENGINE(S): (2) J35-35
FUEL GRADE: **JP-4**
FUEL DENSITY: **6.5 LB/US GAL**

CONFIGURATION: TWO PYLONS AND TWO PYLON TANKS




REMARKS:

1. LOITER AT RECOMMENDED CAS.
2. MAINTAIN CONSTANT ALTITUDE.
3. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
4. ENGINE AIR INLET SCREENS RETRACTED.

| LOITER | | | | | |
|---|---|---|---|---|---|
| ALTITUDE FEET | CAS | APPROXIMATE | | | |
| | | TAS | MACH NO. | LB/HR | % RPM |
| 35,000 | 195 | 345 | .60 | 3400 | 94 |
| 30,000 | 195 | 310 | .53 | 3500 | 89 |
| 25,000 | 195 | 280 | .47 | 3600 | 85 |
| 20,000 | 200 | 265 | .43 | 3700 | 83 |
| 15,000 | 200 | 250 | .40 | 3900 | 79 |
| 10,000 | 195 | 225 | .35 | 4200 | 77 |
| 5,000 | 200 | 215 | .33 | 4700 | 75 |
| SEA LEVEL | 200 | 200 | .30 | 4800 | 71 |

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*Figure A-26 (Sheet 2 of 3).*

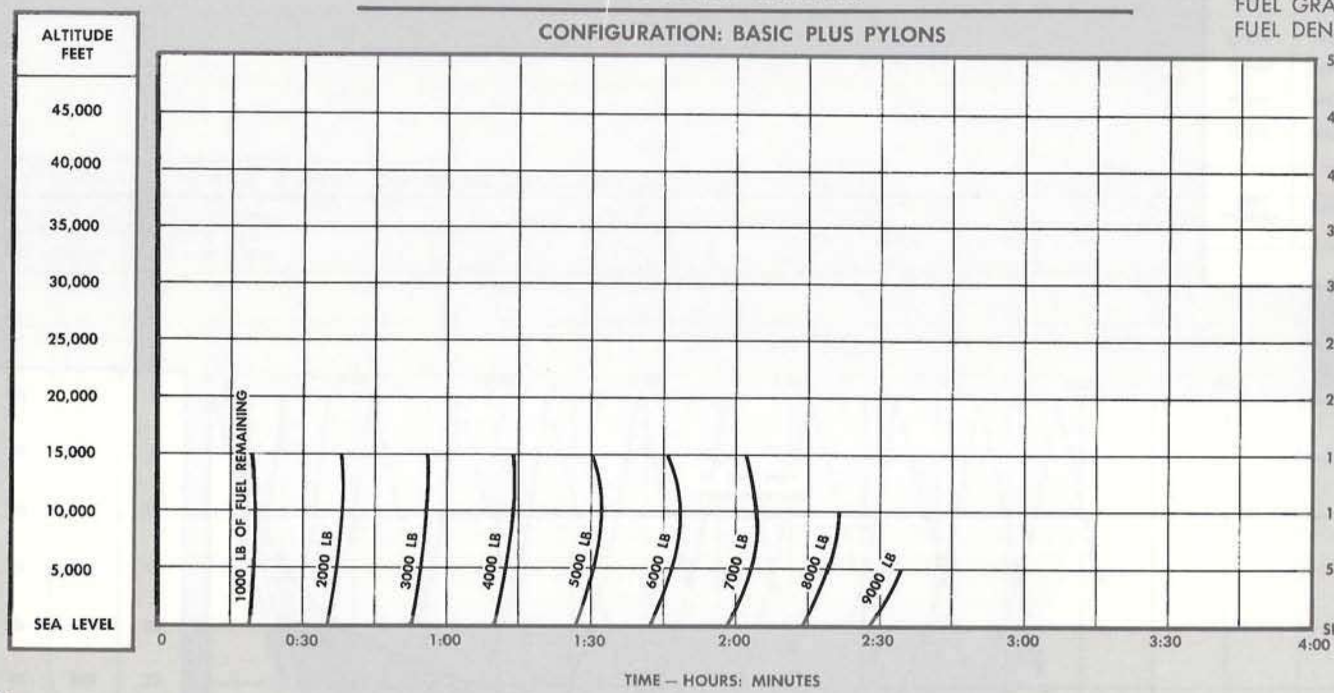
# MAXIMUM ENDURANCE

DATA BASIS: **FLIGHT TEST**
DATE: **22 OCTOBER 1957**

TAKEOFF GROSS WEIGHT
43,175 POUNDS
ONE ENGINE OPERATING

CONFIGURATION: BASIC PLUS PYLONS

MODEL: **F-89H**
ENGINE(S): **(2) J35-35**
FUEL GRADE: **JP-4**
FUEL DENSITY: **6.5 LB/US GAL**




REMARKS:

1. LOITER AT RECOMMENDED CAS.
2. MAINTAIN CONSTANT ALTITUDE.
3. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
4. ENGINE AIR INLET SCREENS RETRACTED.

| LOITER | | | | | |
|---|---|---|---|---|---|
| ALTITUDE FEET | CAS | APPROXIMATE | | | |
| | | TAS | MACH NO. | LB/HR | % RPM |
| 15,000 | 185 | 230 | .37 | 3400 | 96 |
| 10,000 | 180 | 210 | .33 | 3400 | 91 |
| 5,000 | 190 | 200 | .31 | 3500 | 87 |
| SEA LEVEL | 185 | 185 | .28 | 3600 | 85 |

H379

*Figure A-26 (Sheet 3 of 3).*

# OPTIMUM MAXIMUM ENDURANCE PROFILE

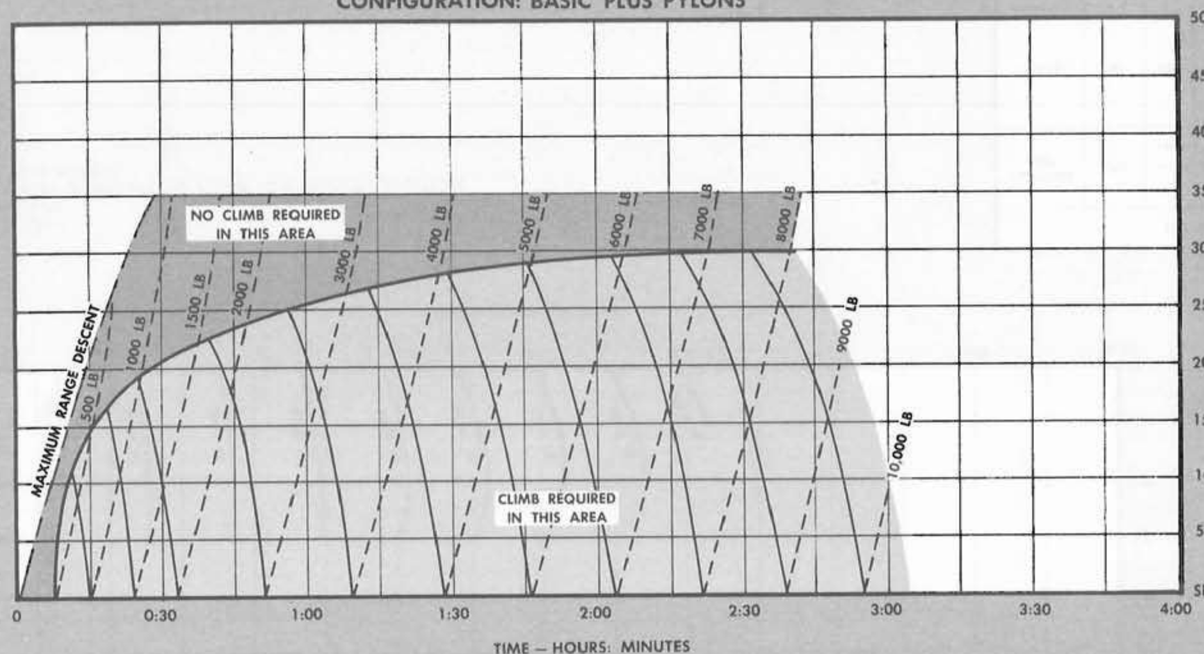
TAKEOFF GROSS WEIGHT
43,175 POUNDS

DATA BASIS: **FLIGHT TEST**
DATE: **22 OCTOBER 1957**

MODEL: **F-89H**
ENGINE(S): **(2) J35-35**
FUEL GRADE: **JP-4**
FUEL DENSITY: **6.5 LB/US GAL**

CONFIGURATION: BASIC PLUS PYLONS

| NORMAL POWER CLIMB | | |
|---|---|---|
| MACH NO. | CAS | ALT. 1000 FT. |
| | | 45 |
| | | 40 |
| | | 35 |
| .66 | 250 | 30 |
| .63 | 260 | 25 |
| .57 | 260 | 20 |
| .53 | 270 | 15 |
| .49 | 270 | 10 |
| .47 | 290 | 5 |
| .45 | 300 | SL |




REMARKS:

1. USE NORMAL POWER FOR CLIMB.
2. LOITER AT RECOMMENDED CAS.
3. USE MAXIMUM RANGE DESCENT.
4. NO ALLOWANCE OR RESERVE MADE FOR LANDING.
5. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
6. ENGINE AIR INLET SCREENS RETRACTED.

| LOITER | | | | | |
|---|---|---|---|---|---|
| ALTITUDE FEET | CAS | APPROXIMATE | | | |
| | | MACH NO. | TAS | LB/HR | % RPM |
| 35,000 | 200 | .60 | 345 | 3200 | 91 |
| 30,000 | 195 | .53 | 310 | 3200 | 86 |
| 25,000 | 185 | .45 | 270 | 2900 | 81 |
| 20,000 | 180 | .40 | 245 | 3100 | 78 |
| 15,000 | 180 | .36 | 225 | 3400 | 76 |
| 10,000 | 185 | .33 | 210 | 3700 | 73 |
| 5,000 | 190 | .31 | 200 | 4100 | 72 |
| SEA LEVEL | 185 | .28 | 185 | 4100 | 67 |

LEGEND

- - - - - FUEL REMAINING
——— LINE OF OPTIMUM ALTITUDE FOR LOITER
——— NORMAL POWER CLIMB GUIDE LINES

H380

Figure A-27 (Sheet 1 of 3).

# OPTIMUM MAXIMUM ENDURANCE PROFILE

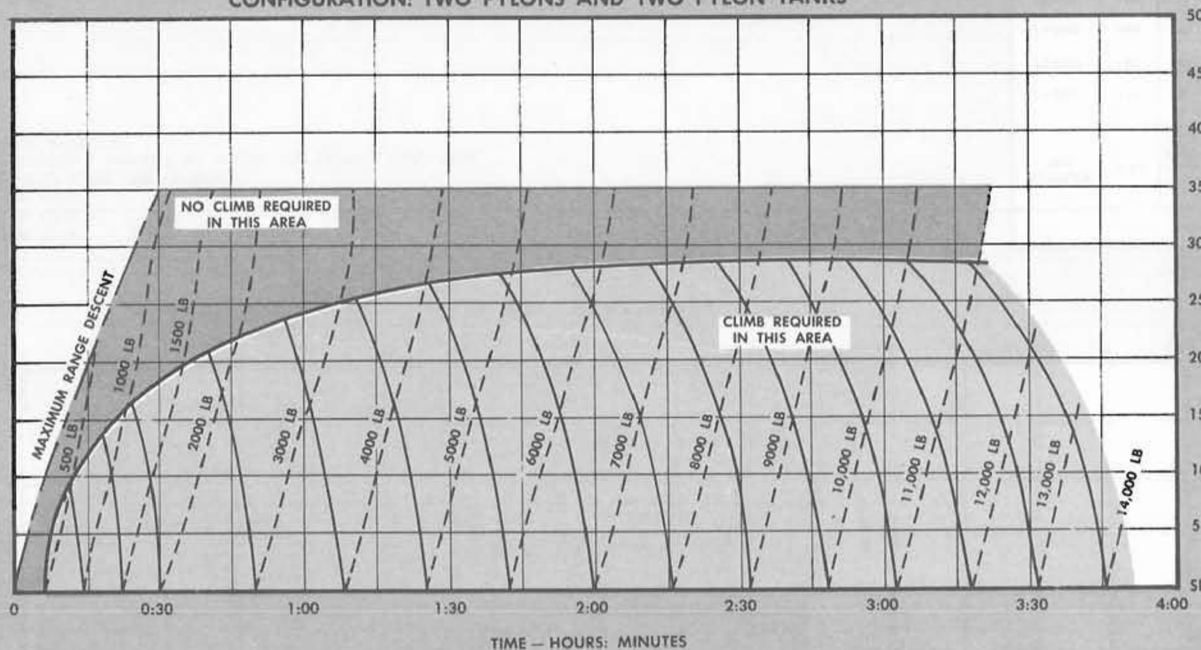
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

TAKEOFF GROSS WEIGHT
47,355 POUNDS

MODEL: F-89H
ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

| NORMAL POWER CLIMB | | |
|---|---|---|
| MACH NO. | CAS | ALT. 1000 FT. |
| | | 45 |
| | | 40 |
| .63 | 210 | 35 |
| 63 | 235 | 30 |
| .61 | 255 | 25 |
| .57 | 260 | 20 |
| .52 | 260 | 15 |
| .48 | 265 | 10 |
| .44 | 265 | 5 |
| .41 | 270 | SL |

CONFIGURATION: TWO PYLONS AND TWO PYLON TANKS




REMARKS:

1. USE NORMAL POWER FOR CLIMB.
2. LOITER AT RECOMMENDED CAS.
3. USE MAXIMUM RANGE DESCENT.
4. NO ALLOWANCE OR RESERVE MADE FOR LANDING.
5. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
6. ENGINE AIR INLET SCREENS RETRACTED.

| LOITER — WITH PYLON TANKS | | | | | |
|---|---|---|---|---|---|
| ALTITUDE FEET | CAS | APPROXIMATE | | | |
| | | MACH NO. | TAS | LB/HR | % RPM |
| 35,000 | 200 | .60 | 345 | 3500 | 95 |
| 30,000 | 195 | .53 | 310 | 3500 | 88 |
| 25,000 | 185 | .45 | 270 | 3100 | 82 |
| 20,000 | 175 | .39 | 240 | 3000 | 78 |
| 15,000 | 185 | .37 | 230 | 3400 | 76 |
| 10,000 | 180 | .32 | 205 | 3800 | 74 |
| 5,000 | 180 | .29 | 190 | 4000 | 72 |
| SEA LEVEL | 185 | .28 | 185 | 4100 | 68 |

LEGEND
- - - - - FUEL REMAINING
——— LINE OF OPTIMUM ALTITUDE FOR LOITER
——— NORMAL POWER CLIMB GUIDE LINES

H381

Figure A-27 (Sheet 2 of 3).

# OPTIMUM MAXIMUM ENDURANCE PROFILE

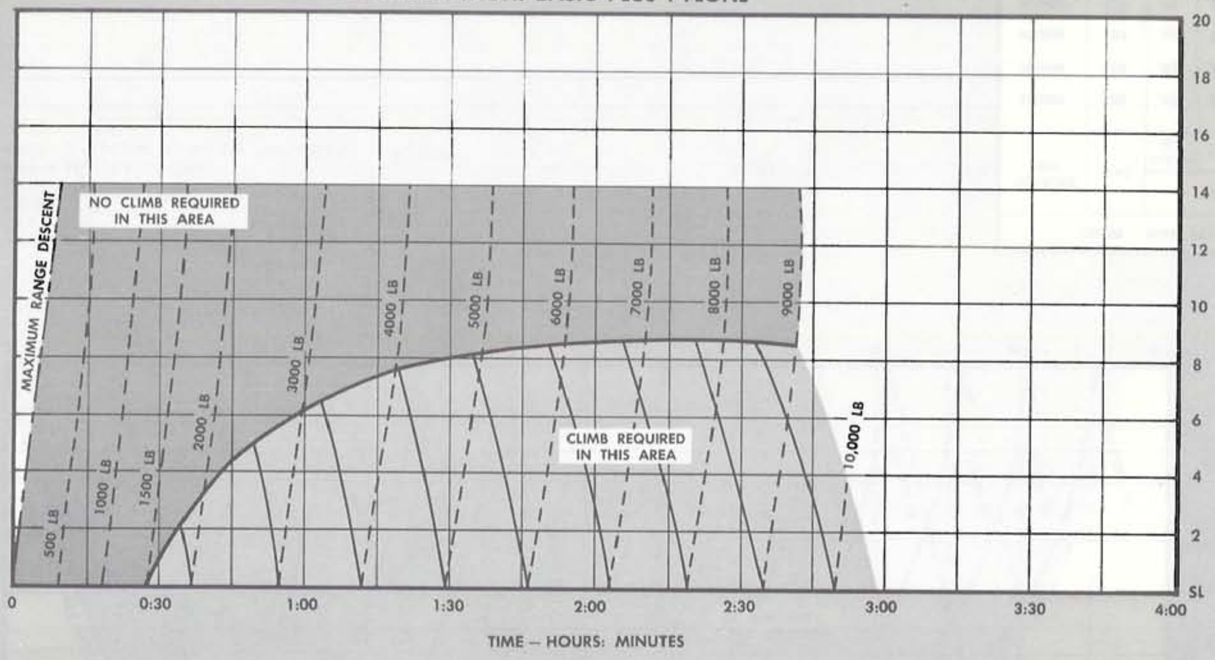
DATA BASIS: **FLIGHT TEST**
DATE: **22 OCTOBER 1957**

TAKEOFF GROSS WEIGHT
43,175 POUNDS
ONE ENGINE OPERATING

CONFIGURATION: BASIC PLUS PYLONS

MODEL: **F-89H**
ENGINE(S): **(2) J35-35**
FUEL GRADE: **JP-4**
FUEL DENSITY: **6.5 LB/US GAL**

| NORMAL POWER CLIMB | | |
|---|---|---|
| MACH NO. | CAS | ALT. 1000 FT. |
| | | 18 |
| | | 16 |
| .40 | 205 | 14 |
| .40 | 210 | 12 |
| .39 | 220 | 10 |
| .38 | 220 | 8 |
| .37 | 220 | 6 |
| .36 | 220 | 4 |
| .35 | 230 | 2 |
| .34 | 230 | SL |




REMARKS:

1. USE MILITARY POWER FOR CLIMB.
2. LOITER AT RECOMMENDED CAS.
3. USE MAXIMUM RANGE DESCENT.
4. NO ALLOWANCE OR RESERVE MADE FOR LANDING.
5. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
6. ENGINE AIR INLET SCREENS RETRACTED.

LEGEND

- - - - - FUEL REMAINING
▬▬ LINE OF OPTIMUM ALTITUDE FOR LOITER
—— NORMAL POWER CLIMB GUIDE LINES

| LOITER | | | | | |
|---|---|---|---|---|---|
| ALTITUDE FEET | CAS | APPROXIMATE | | | |
| | | MACH NO. | TAS | LB/HR | % RPM |
| 14,000 | 185 | .36 | 225 | 3400 | 95 |
| 12,000 | 180 | .34 | 215 | 3400 | 92 |
| 10,000 | 185 | .33 | 210 | 3500 | 91 |
| 8,000 | 180 | .31 | 200 | 3200 | 87 |
| 6,000 | 180 | .30 | 195 | 3200 | 86 |
| 4,000 | 180 | .29 | 190 | 3200 | 85 |
| 2,000 | 180 | .28 | 185 | 3300 | 83 |
| SEA LEVEL | 180 | .27 | 180 | 3300 | 81 |

H382

*Figure A-27 (Sheet 3 of 3).*

# DESCENTS

IDLE POWER

WITH OR WITHOUT PYLON TANKS

MODEL: **F-89H**

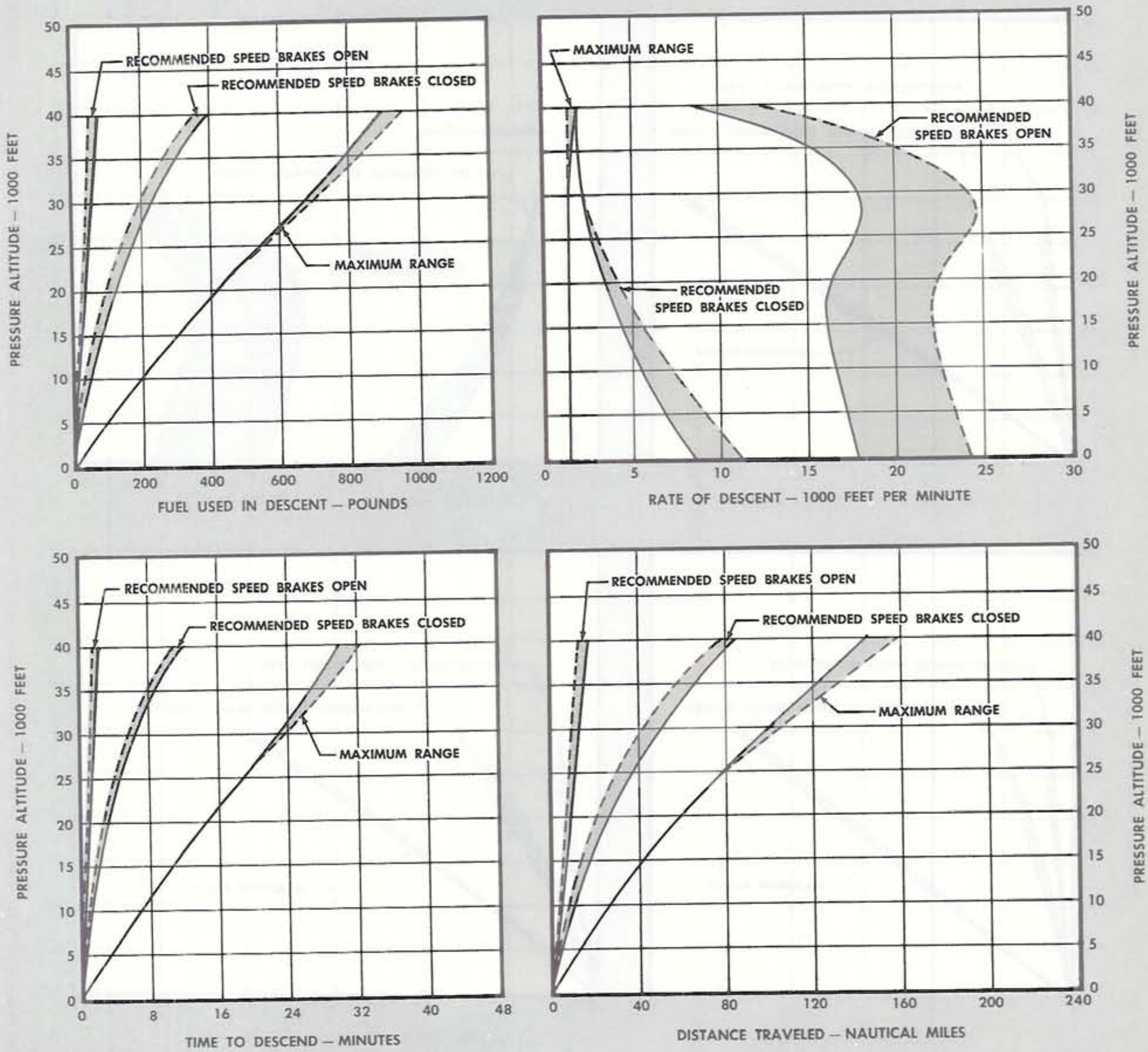
DATA BASIS: **FLIGHT TEST**

DATE: **22 OCTOBER 1957**

ENGINE(S): **(2) J35-35**

FUEL GRADE: **JP-4**

FUEL DENSITY: **6.5 LB/US GAL**




REMARKS:

1. FOR MAXIMUM RANGE DESCENT, MAINTAIN 208 KNOTS INDICATED AIRSPEED (IAS).
2. FOR RECOMMENDED DESCENT, MAINTAIN 0.7 MACH NUMBER (SPEED BRAKES OPEN OR CLOSED).
3. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
4. ENGINE AIR INLET SCREENS RETRACTED.

H383

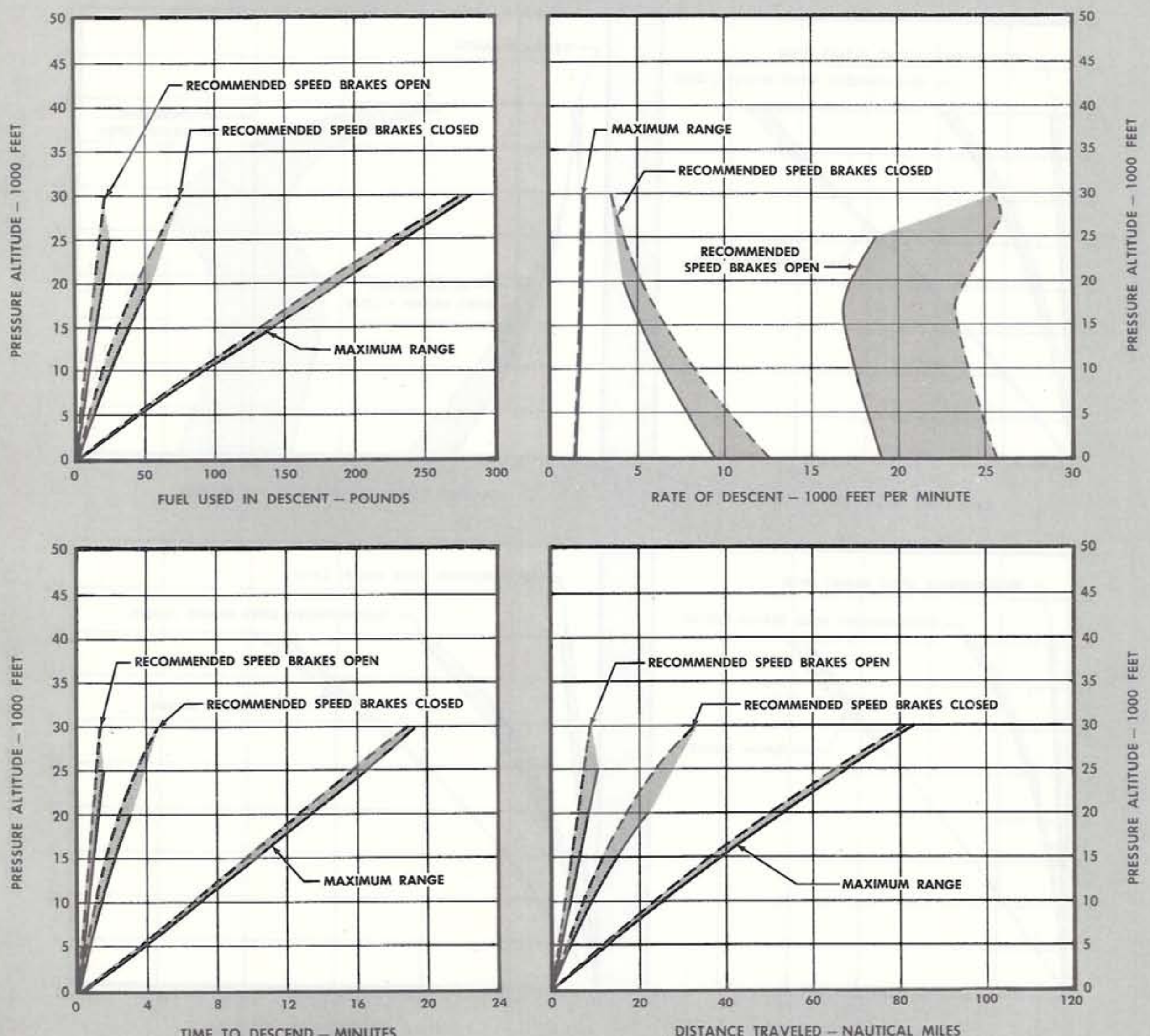
*Figure A-28 (Sheet 1 of 2).*

# DESCENTS

IDLE POWER
WITH OR WITHOUT PYLON TANKS
ONE ENGINE OPERATING

MODEL: **F-89H**
DATA BASIS: **FLIGHT TEST**
DATE: **22 OCTOBER 1957**

ENGINE(S): **(2) J35-35**
FUEL GRADE: **JP-4**
FUEL DENSITY: **6.5 LB/US GAL**




REMARKS:

1. FOR MAXIMUM RANGE DESCENT, MAINTAIN 208 KNOTS INDICATED AIRSPEED (IAS).
2. FOR RECOMMENDED DESCENT, MAINTAIN 0.7 MACH NUMBER (SPEED BRAKES OPEN OR CLOSED).
3. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
4. ENGINE AIR INLET SCREENS RETRACTED.
5. SINGLE-ENGINE DESCENTS NOT RECOMMENDED BECAUSE OF THE POSSIBILITY OF "DUCT RUMBLE" ON THE WINDMILLING ENGINE.

———— 44,000 LB
— — — — 32,000 LB

H384

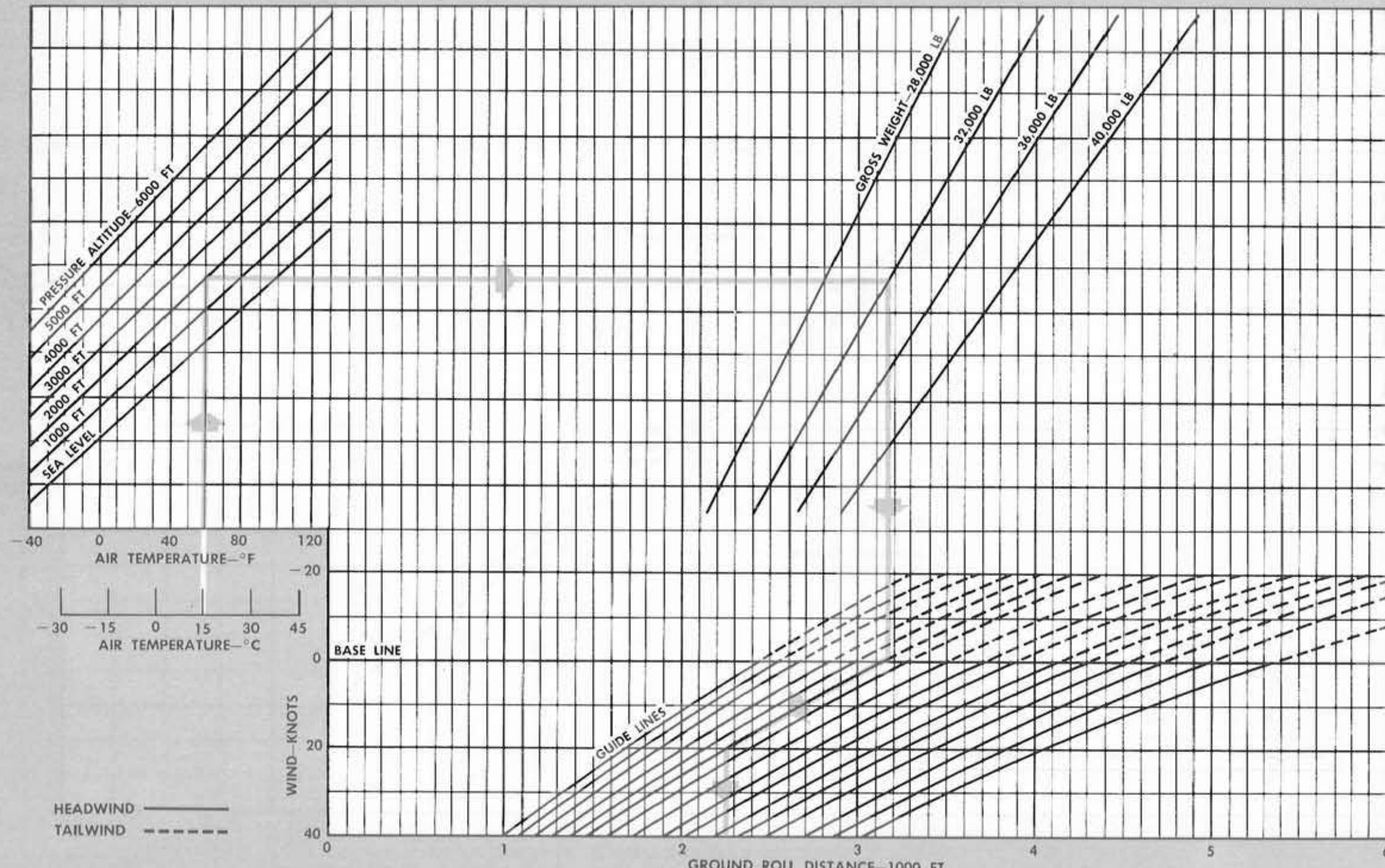
***Figure A-28 (Sheet 2 of 2).***

# LANDING DISTANCE

WITH OR WITHOUT PYLON TANKS *

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. USE SPEED BRAKES AS NECESSARY TO MAINTAIN APPROACH AIRSPEED AND FULLY OPEN SPEED BRAKES AFTER TOUCHDOWN.
2. USE 50-DEGREE FLAPS.
3. CHART DISTANCES AND AIRSPEEDS ARE BASED ON NORMAL OPERATING PROCEDURE AND USE OF DRY HARD-SURFACE RUNWAY.
4. ENGINE AIR INLET SCREENS EXTENDED.

* WITH EMPTY PYLON TANKS ONLY

| GROSS WEIGHT | TOUCHDOWN |
|---|---|
| 28,000 LB | 105 KNOTS IAS |
| 32,000 LB | 112 KNOTS IAS |
| 36,000 LB | 118 KNOTS IAS |
| 40,000 LB | 125 KNOTS IAS |

H-385(1)

Figure A-29 (Sheet 1 of 4).

# LANDING DISTANCE TO CLEAR 50FT-OBSTACLE

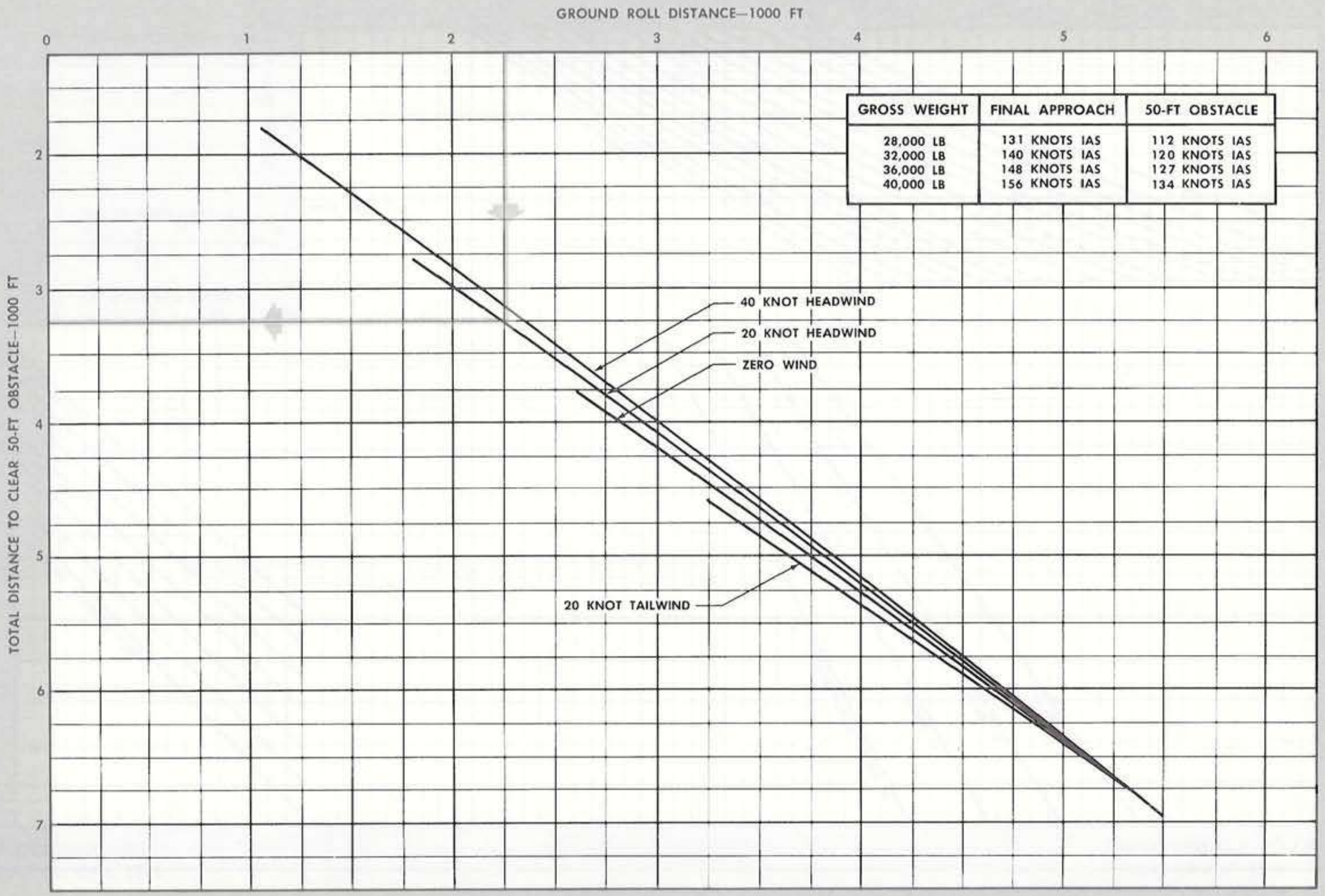
WITH OR WITHOUT PYLON TANKS *

MODEL: **F-89H**

DATA BASIS: **FLIGHT TEST**
DATE: **22 OCTOBER 1957**

ENGINE(S): **(2) J35-35**

FUEL GRADE: **JP-4**
FUEL DENSITY: **6.5 LB/US GAL**




| GROSS WEIGHT | FINAL APPROACH | 50-FT OBSTACLE |
|---|---|---|
| 28,000 LB | 131 KNOTS IAS | 112 KNOTS IAS |
| 32,000 LB | 140 KNOTS IAS | 120 KNOTS IAS |
| 36,000 LB | 148 KNOTS IAS | 127 KNOTS IAS |
| 40,000 LB | 156 KNOTS IAS | 134 KNOTS IAS |

REMARKS:
1. USE SPEED BRAKES AS NECESSARY TO MAINTAIN APPROACH AIRSPEED AND FULLY OPEN SPEED BRAKES AFTER TOUCHDOWN.
2. USE 50-DEGREE FLAPS.
3. CHART DISTANCES AND AIRSPEEDS ARE BASED ON NORMAL OPERATING PROCEDURE AND USE OF DRY HARD-SURFACE RUNWAY.
4. ENGINE AIR INLET SCREENS EXTENDED.

* WITH EMPTY PYLON TANKS ONLY

H-385(2)

*Figure A-29 (Sheet 2 of 4).*

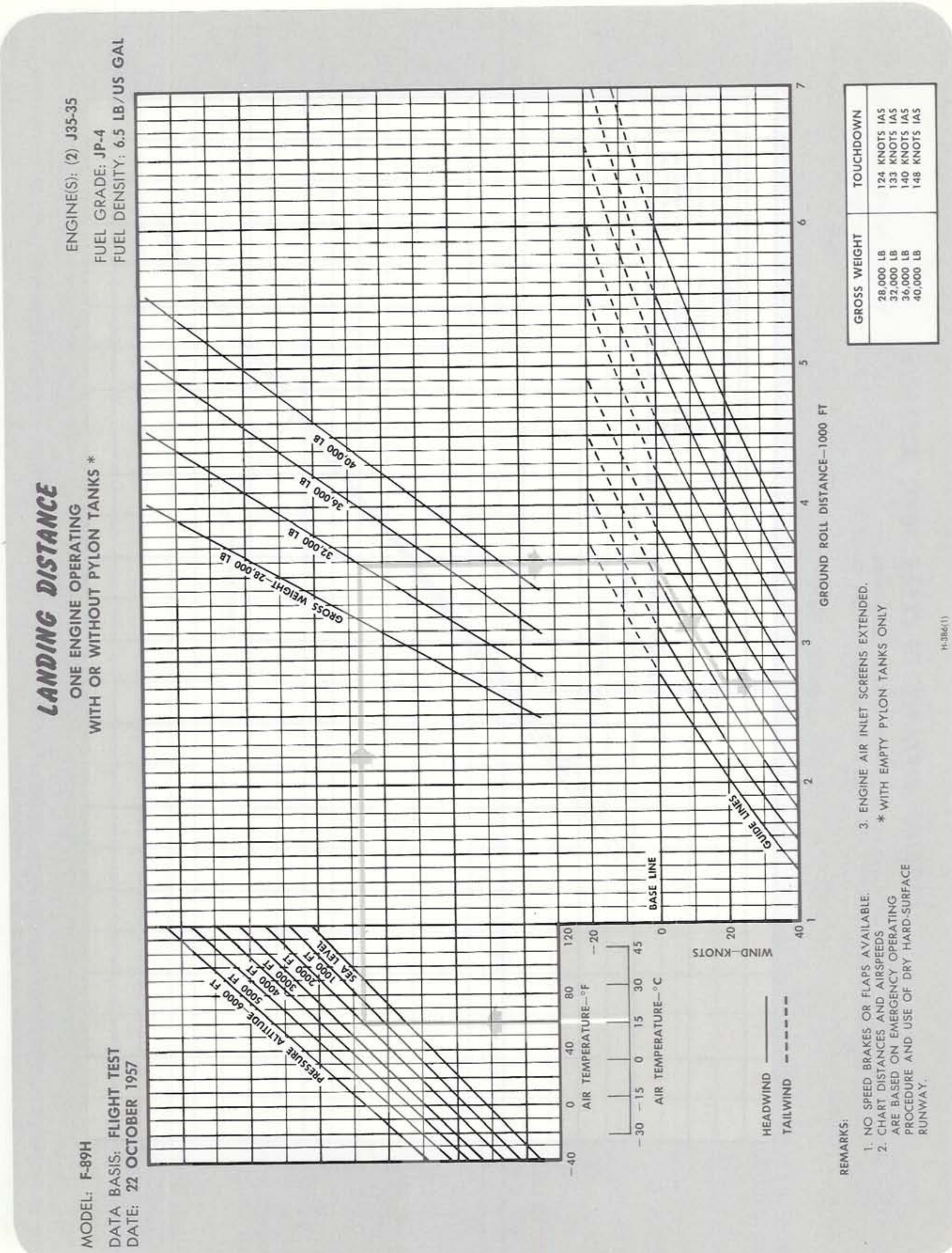
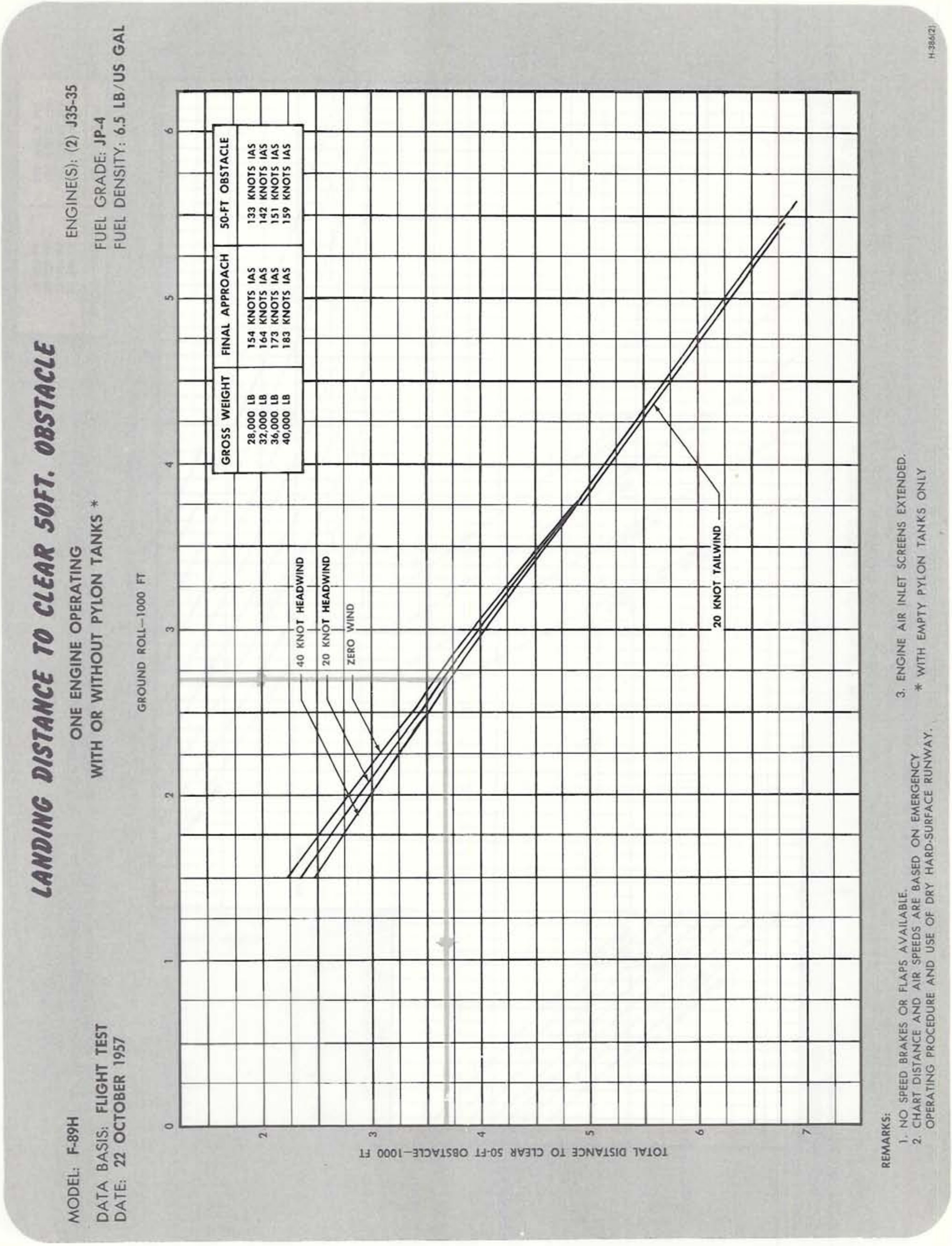



*Figure A-29 (Sheet 3 of 4).*




| GROSS WEIGHT | FINAL APPROACH | 50-FT OBSTACLE |
|---|---|---|
| 28,000 LB | 154 KNOTS IAS | 133 KNOTS IAS |
| 32,000 LB | 164 KNOTS IAS | 142 KNOTS IAS |
| 36,000 LB | 173 KNOTS IAS | 151 KNOTS IAS |
| 40,000 LB | 183 KNOTS IAS | 159 KNOTS IAS |

REMARKS:
1. NO SPEED BRAKES OR FLAPS AVAILABLE.
2. CHART DISTANCE AND AIR SPEEDS ARE BASED ON EMERGENCY OPERATING PROCEDURE AND USE OF DRY HARD-SURFACE RUNWAY.
3. ENGINE AIR INLET SCREENS EXTENDED.
* WITH EMPTY PYLON TANKS ONLY

*Figure A-29 (Sheet 4 of 4).*

# LANDING SPEEDS

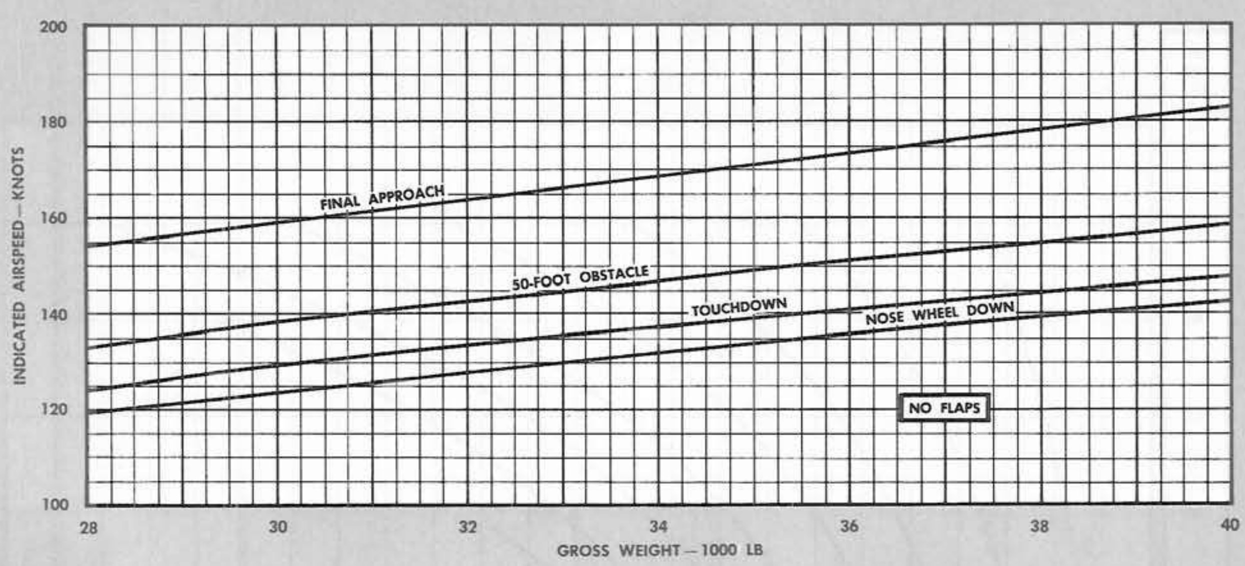
MODEL: F-89H

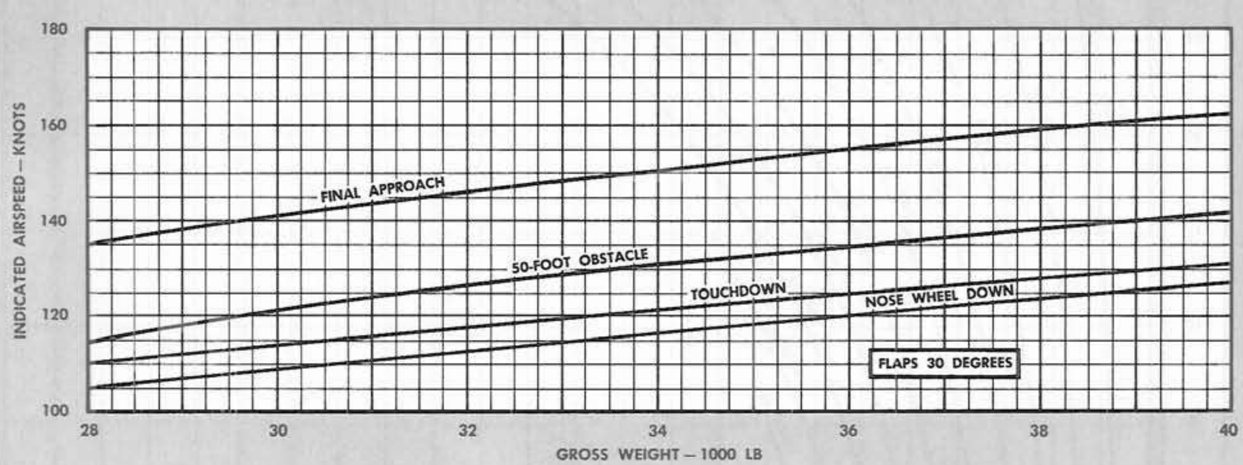
WITH OR WITHOUT PYLON TANKS

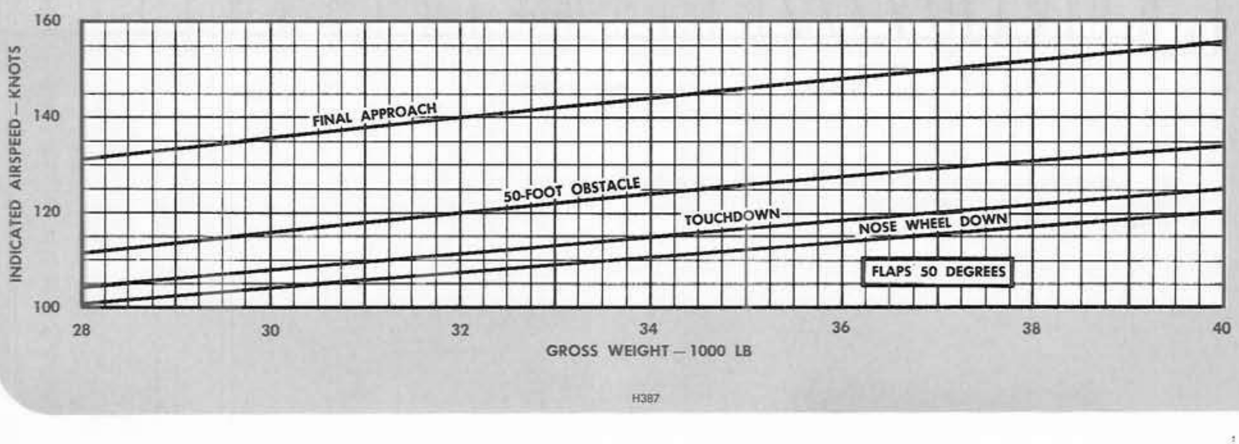
ENGINE(S): (2) J35-35

DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




H387

*Figure A-30.*

## COMBAT ALLOWANCE CHART

MAXIMUM POWER

BASIC CONFIGURATION PLUS PYLONS

MODEL: F-89H

DATA BASIS: FLIGHT TEST

DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35

FUEL GRADE: JP-4

FUEL DENSITY: 6.5 LB/US GAL


REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. EXHAUST TEMPERATURE LIMIT: 750°C.

H388

*Figure A-31 (Sheet 1 of 3).*

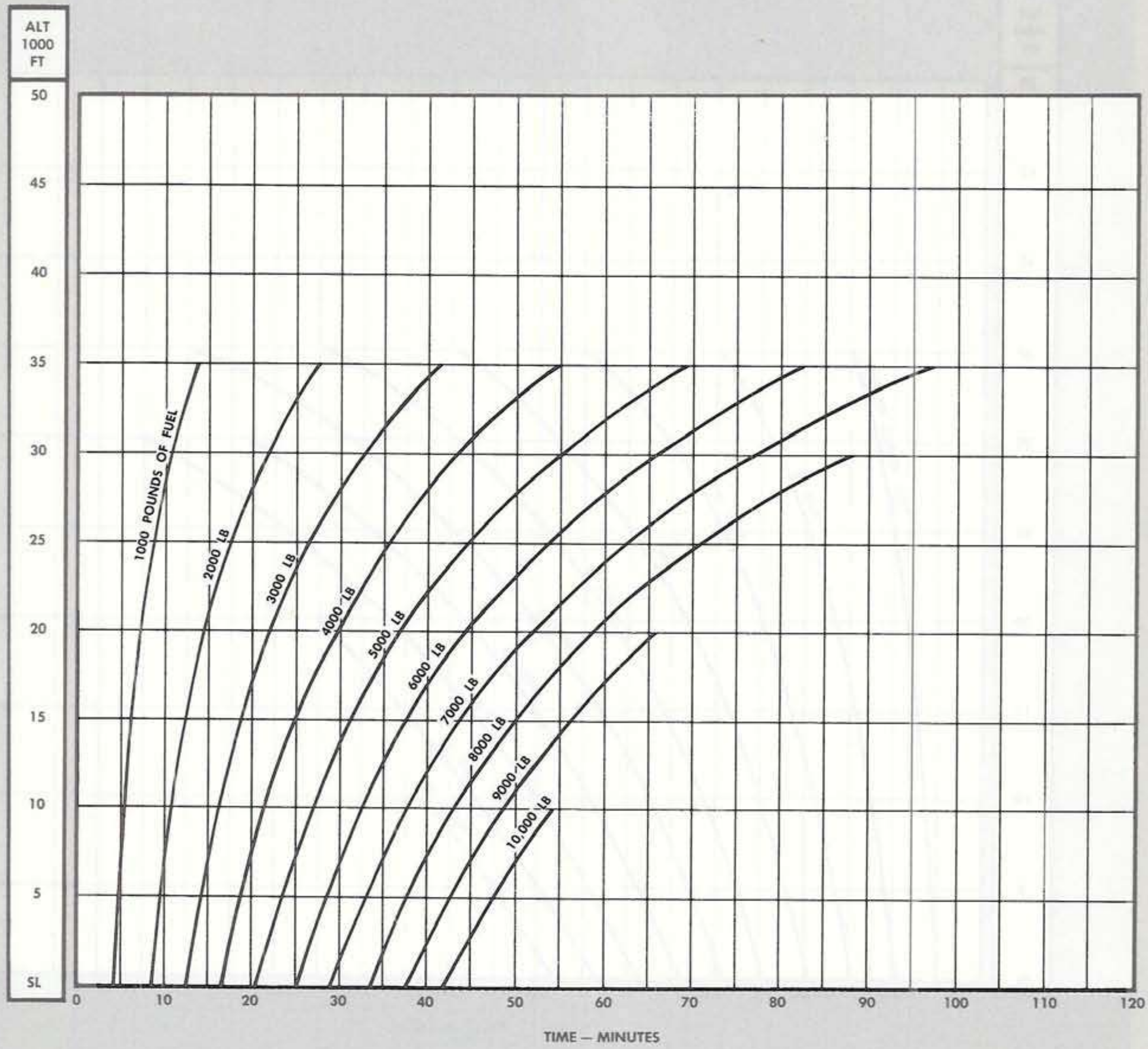
## COMBAT ALLOWANCE CHART

MILITARY POWER

BASIC CONFIGURATION PLUS PYLONS

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL




REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. EXHAUST TEMPERATURE LIMIT: 750°C.

H389

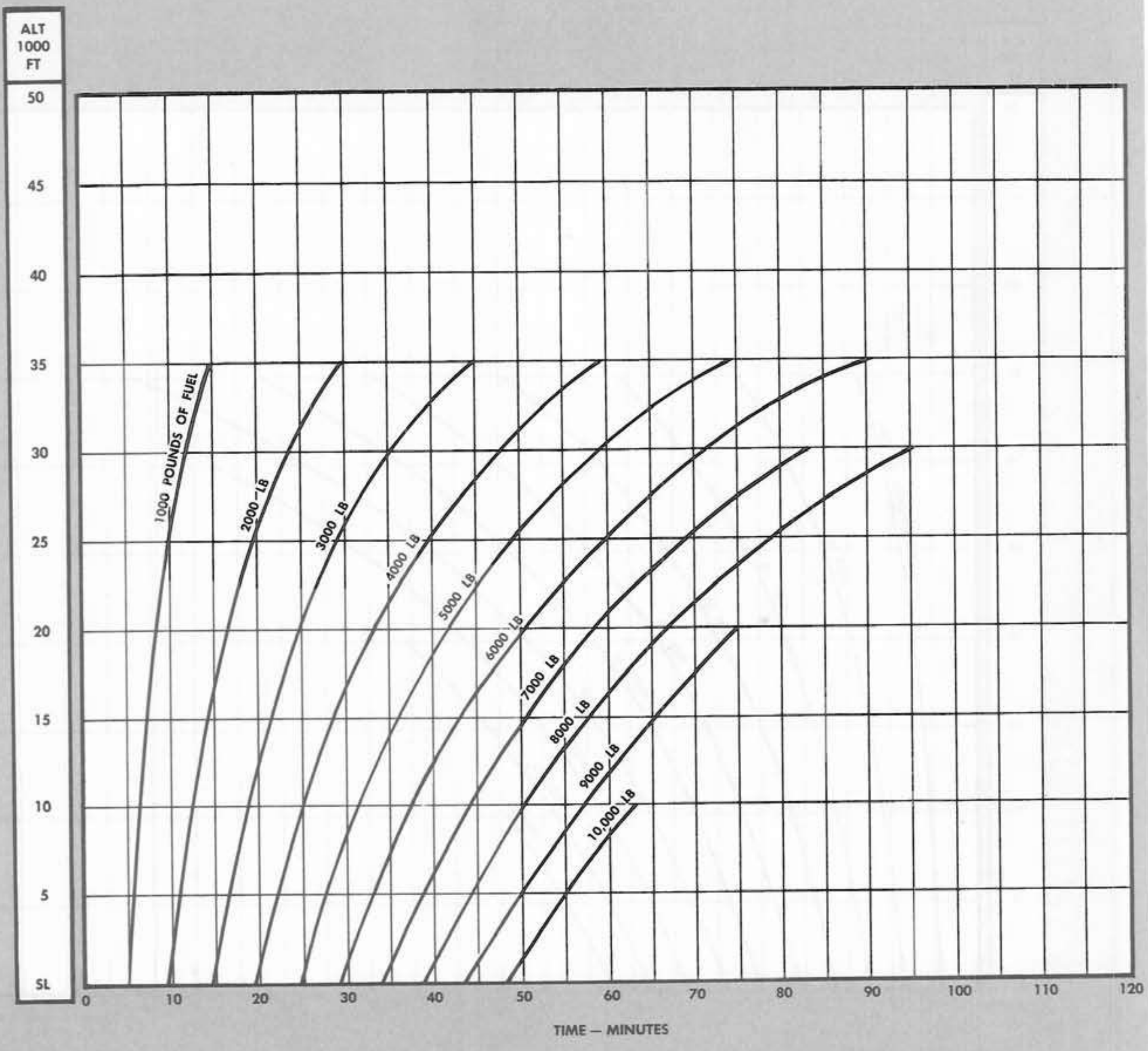
*Figure A-31 (Sheet 2 of 3).*

# COMBAT ALLOWANCE CHART

NORMAL POWER
BASIC CONFIGURATION PLUS PYLONS

MODEL: F-89H
DATA BASIS: FLIGHT TEST
DATE: 22 OCTOBER 1957

ENGINE(S): (2) J35-35
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

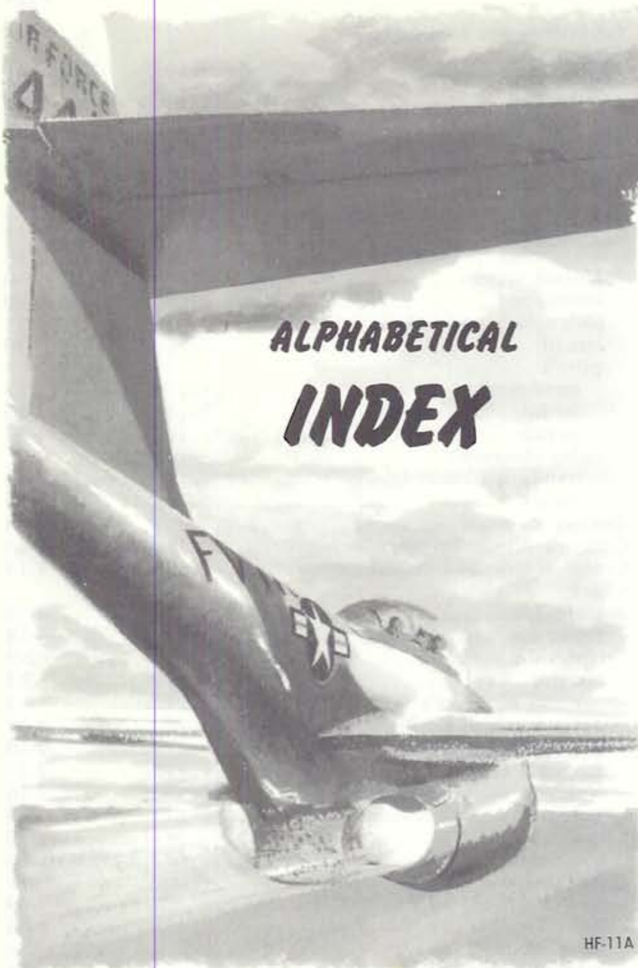



REMARKS:

1. FUEL CONSUMPTION INCREASED 5 PERCENT TO ALLOW FOR SERVICE VARIATION.
2. ENGINE AIR INLET SCREENS RETRACTED.
3. EXHAUST TEMPERATURE LIMIT: 680°C.

H390

*Figure A-31 (Sheet 3 of 3).*




## A



**(Boldface type denotes illustration)**

## B



## C



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# I



# J



# L



(Boldface type denotes illustration)

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# R



# S



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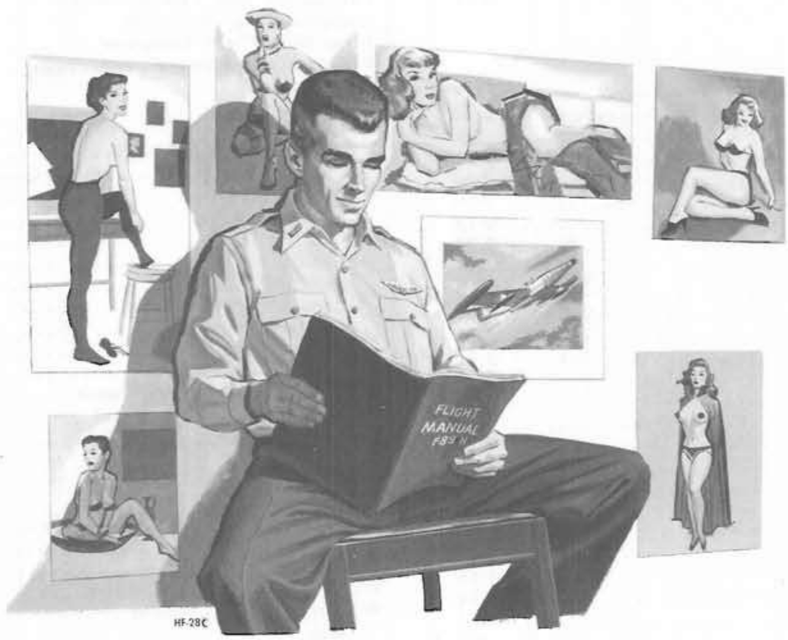
FLIGHT
MANUAL
F89 H
HF-28C