# F-94C FLIGHT HANDBOOK

**USAF SERIES** **T. O. 1F-94C-1**

SEE BASIC INDEX, T.O. 0-1-1 AND WEEKLY INDEX, T.O. 0-1-1A FOR STATUS OF SAFETY OF FLIGHT SUPPLEMENTS.

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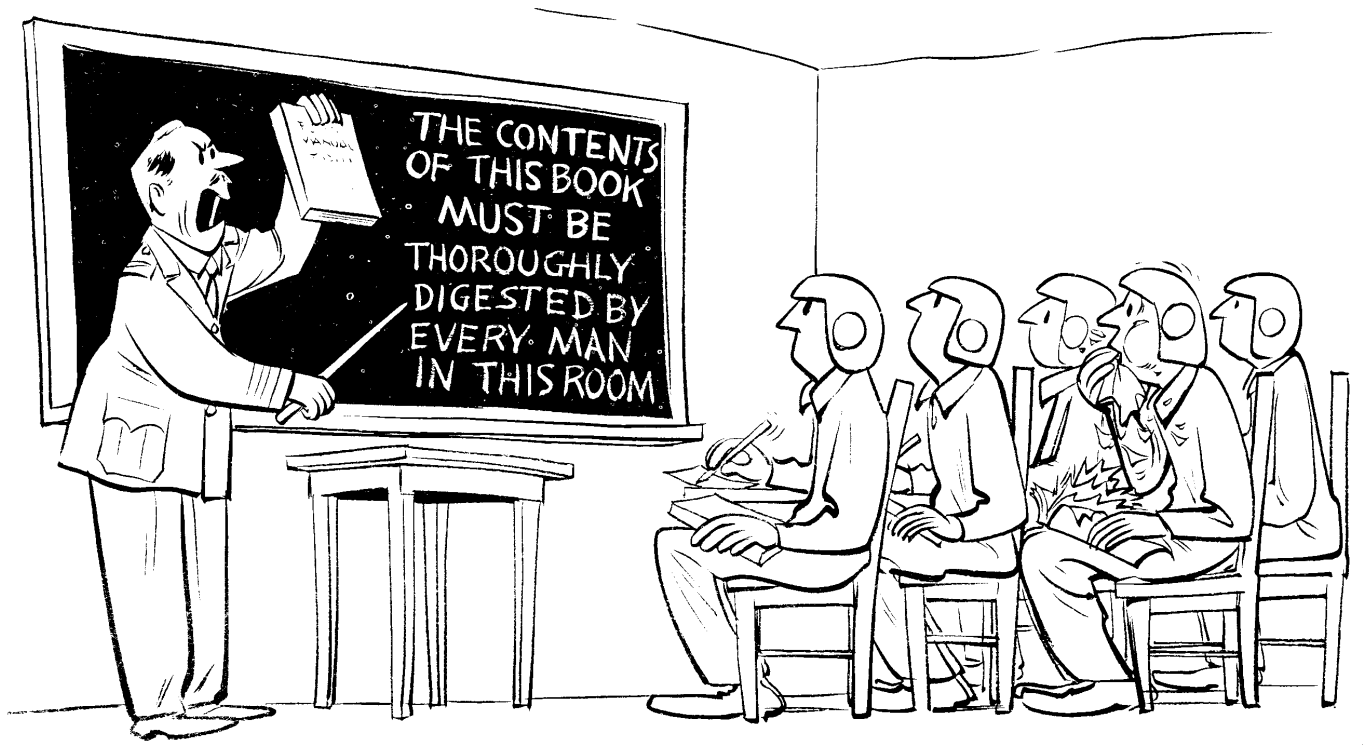
# IMPORTANT




SCOPE. This handbook contains all the information necessary for safe and efficient operation of the F-94C. 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 handbook are designed to provide for the needs of a crew inexperienced in the operation of this aircraft. This book provides the best possible operating instructions under most circumstances, but it is a poor substitute for sound judgment. Multiple emergencies, adverse weather, terrain, etc., may require modification of the procedures contained herein.

PERMISSIBLE OPERATIONS. The Flight Handbook 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 Handbook. Clearance must be obtained from ARDC before any questionable operation is attempted which is not specifically covered in the Flight Handbook.

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

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

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

PERSONAL COPIES, TABS AND BINDERS. Each flight crew member, except those attached to an administrative base, is entitled to have a personal copy of the Flight Handbook. Air Force Regulation 5-13 specifically makes that provision. Flexible, loose leaf tabs and binders have been provided to hold your personal copy of the Flight Handbook. These good-looking, simulated-leather binders will make it much easier for you to revise your handbook as well as to keep it in good shape. These tabs and binders are secured through your local staff materiel and contracting officers.

HOW TO GET COPIES. If you want to be sure of getting your handbooks 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 Handbooks 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 staff materiel 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 numbers as your Flight Handbook, 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 Handbook and title block of each Safety of Flight Supplement should also be checked to determine the effect that these publications may have on existing Safety of Flight Supplements. If you have ordered your Flight Handbook 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 "Warning," "Cautions," and "Notes" found throughout the handbook:

| | |
|---|---|
| **WARNING** | Operating procedures, practice, etc., which will result in personal injury or loss of life if not carefully followed. |
| **CAUTION** | Operating procedures, practices, etc., which if not strictly observed will result in damage to equipment. |
| **Note** | An operating procedure, condition, etc., which it is esential to emphasize. |

COMMENTS AND QUESTIONS. Comments and questions regarding any phase of the Flight Handbook program are invited and should be addressed to Commander, Detachment 1, Headquarters ARDC, Wright-Patterson AF Base, Ohio, Attention: RDZSPH.

# THE AIRPLANE

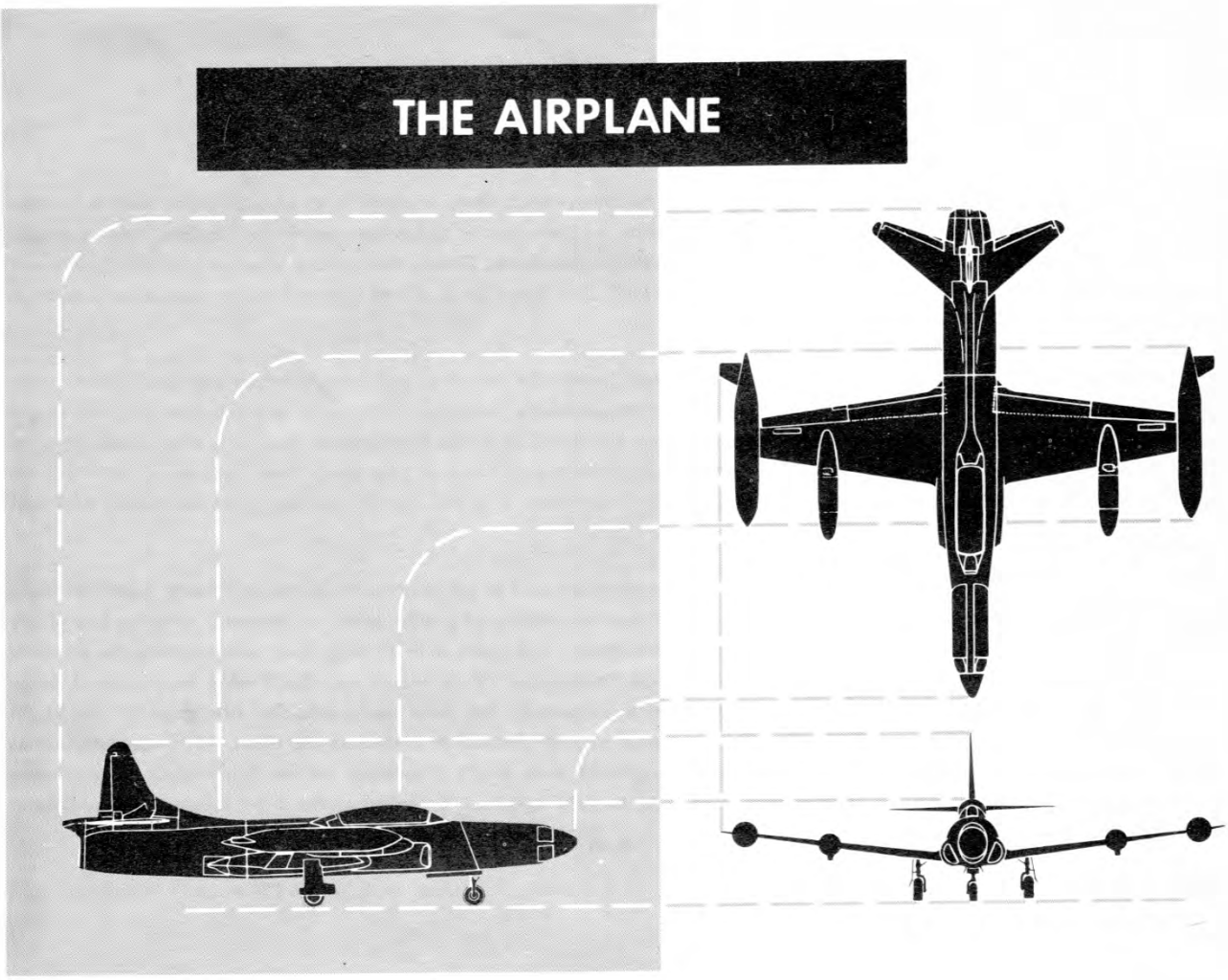


*Figure 1-1*

# description

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# GENERAL ARRANGEMENT

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3. WINDSHIELD WIPERS
4. RADIO COMPASS SENSE ANTENNA
5. RADAR SCOPE
6. RADIO COMPASS LOOP ANTENNA
7. ROCKET POD
8. WING DEICING BOOT
9. TIP FUEL TANK
10. SPOILER
11. WING FLAPS
12. EXTERNAL POWER RECEPTACLE
13. EMPENNAGE DEICING BOOT
14. ILAS GLIDE PATH ANTENNA
15. COMMAND RADIO ANTENNA
16. ILAS LOCALIZER ANTENNA
17. GYROSYN COMPASS TRANSMITTER
18. DRAG CHUTE COMPARTMENT
19. DRAG CHUTE DOORS
20. PRIMARY FUEL VENT
21. AFTERBURNER
22. AFT SPEED BRAKE
23. J-48 ENGINE
24. ENGINE FEED FUEL TANK
25. FUSELAGE FUEL TANK
26. WING FUEL CELLS
27. TIP TANK FILLER CAP
28. MID WING PYLON
29. PYLON TANK FILLER CAP
30. ROCKET TUBES
31. FORWARD SPEED BRAKE
32. RADAR OBSERVER'S SEAT
33. RADAR OBSERVER'S WINDSHIELD
34. PILOTS SEAT
35. OXYGEN BOTTLE
36. RADAR AND ELECTRICAL EQUIPMENT
37. ROCKET TUBES
38. ROCKET DOORS
39. GUN CAMERA

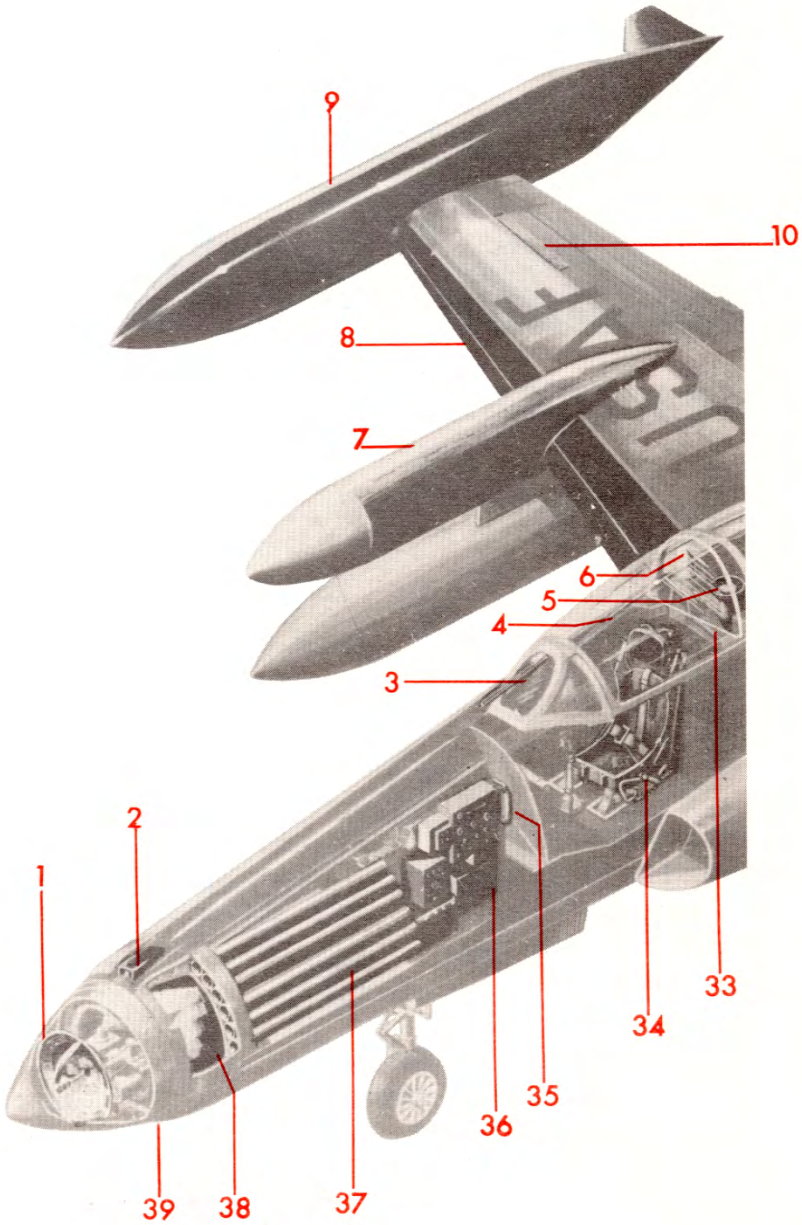


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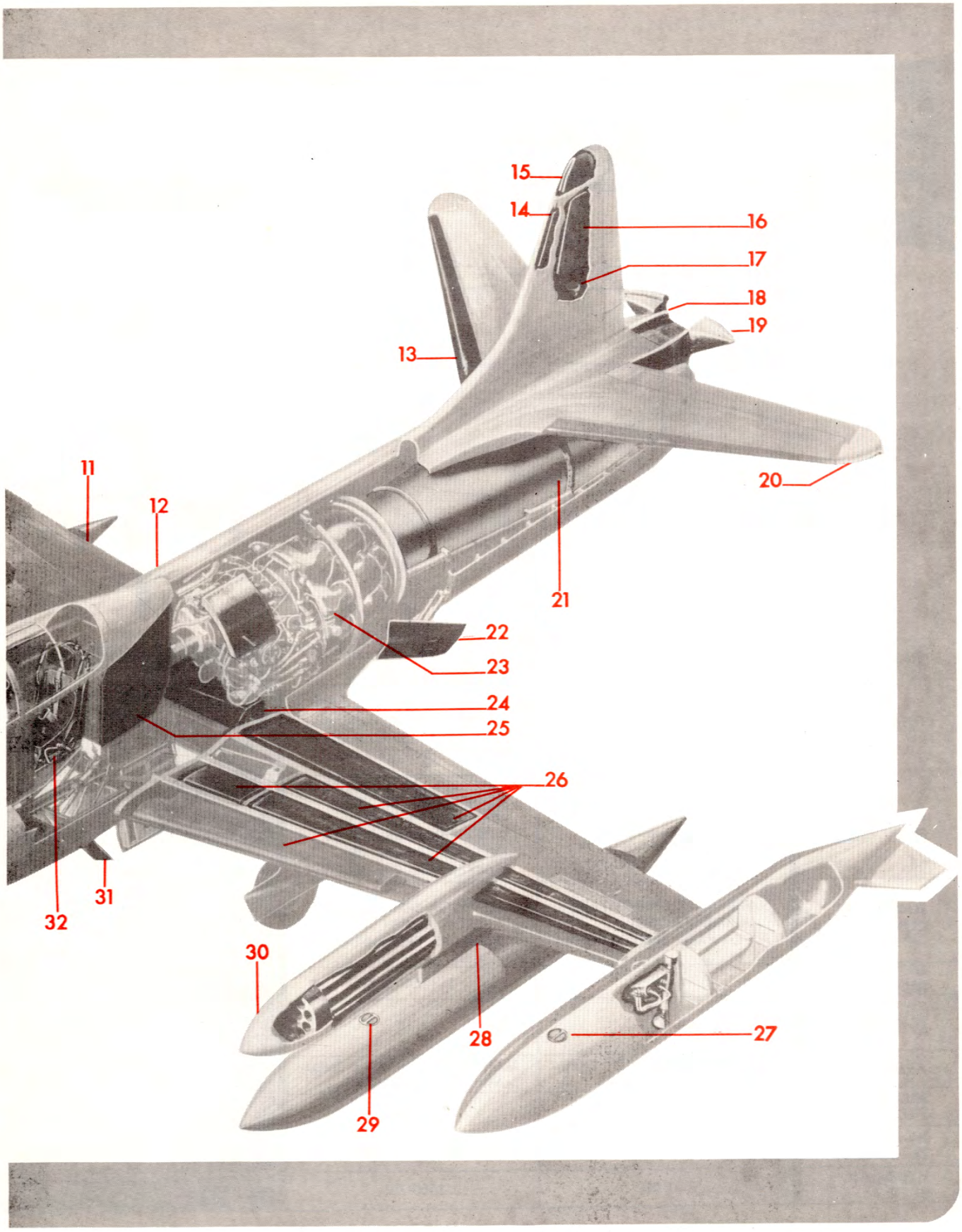
*Figure 1-2. (Sheet 1 of 2 Sheets)*

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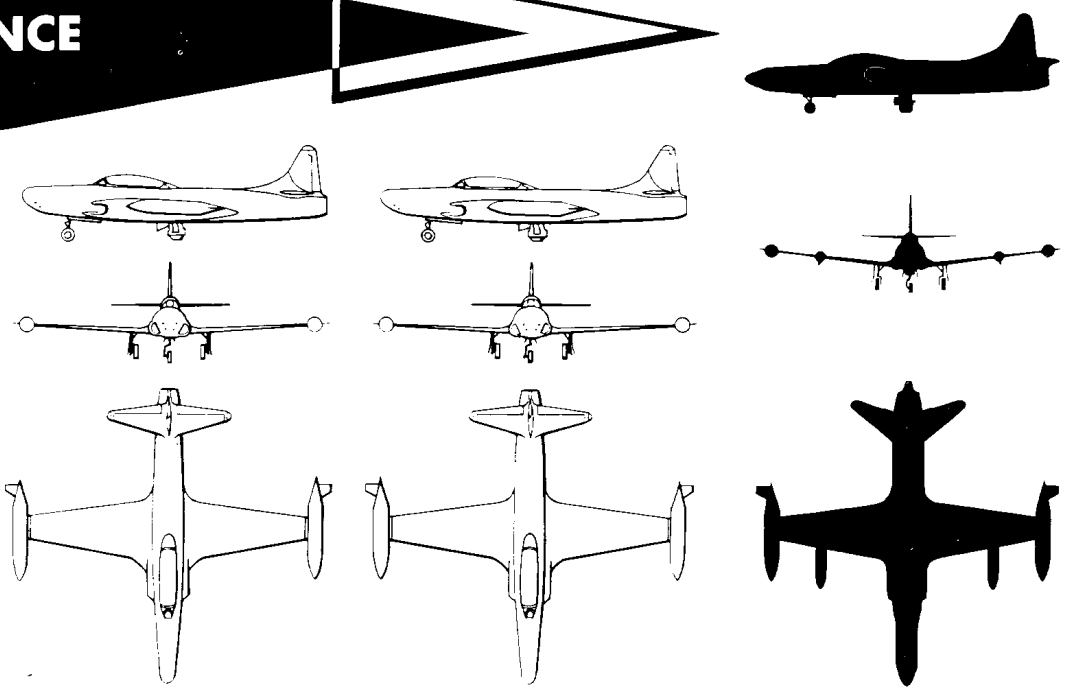
# MAIN DIFFERENCE TABLE



| ITEM | F-94A | F-94B | F-94C |
|---|---|---|---|
| ENGINE | J-33 ENGINE AND AFTERBURNER | J-33 ENGINE AND AFTERBURNER | J-48-P-7 ENGINE AND AFTERBURNER |
| FUEL SYSTEM | BOOSTER PUMPS IN MAIN TANKS, AIR PRESSURE IN TIP TANKS, 230 GALLON CENTERLINE TIP TANKS | BOOSTER PUMPS IN MAIN TANKS, AIR PRESSURE IN TIP TANKS, 230 GALLON CENTER- LINE TIP TANKS | GRAVITY FEED AND PRESSURIZED FUEL SYSTEM, SINGLE POINT REFUELING, 250 GALLON CENTER-LINE TIP TANKS |
| RADIO EQUIPMENT | INTERPHONE, UHF COMMAND, RADIO COMPASS, RADAR, IFF | ZERO READER, INTERPHONE, GLIDE SLOPE RECEIVER, LOCALIZER RECEIVER, UHF COMMAND, RADIO COMPASS, RADAR, IFF, MARKER BEACON RECEIVER | ZERO READER, INTERPHONE, UHF COMMAND, RADIO COMPASS, MARKER BEACON RECEIVER, GLIDE SLOPE RECEIVER, LOCAL-IZER RECEIVER, RADAR, IFF |
| FLIGHT CONTROL | ELEVATOR SPRING TABS, AILERON BOOST FORWARD SPEED BRAKES | ELEVATOR SPRING TABS, AILERON BOOST FORWARD SPEED BRAKES | SPOILERS, VARIABLE ELEVATOR BOOST RATIO, FORWARD AND AFT SPEED BRAKES VARIABLE EXTENSION, DRAG CHUTE, AILERON AND ELEVATOR BOOST. |
| OXYGEN REGULATOR | A-14 | D-1 OR D-2 | D-1 OR D-2 |
| GUNSIGHT | A-1C | A-1C | AN/APG-40 SEARCH TRACKING AND ROCKET FIRING N-3C STANDBY GUNSIGHT |
| ARMAMENT | MACHINE GUNS WITH PNEU-MATIC GUN CHARGERS | MACHINE GUNS WITH PNEU-MATIC GUN CHARGERS | ROCKETS IN NOSE AND WING PODS |
| AUTOMATIC PILOT | NO | NO | YES |
| WINGS AND EMPENNAGE | CONVENTIONAL | CONVENTIONAL | SWEPTBACK TAIL, THIN WING WITH INCREASED DIHEDRAL |
| HYDRAULIC SYSTEM | 1000 PSI | 1500 PSI | 1500 PSI |

*Figure 1-3*

## THE AIRPLANE.

The Lockheed F-94C is a two-place jet propelled interceptor with stations, enclosed by a single canopy, for a pilot in the front seat and a radar observer in the rear seat. Powered by a Pratt and Whitney J48 centrifugal turbo-jet engine equipped with an afterburner, the airplane is capable of high speeds at high altitudes. The tactical mission of the airplane is all-weather, around-the-clock interception utilizing radar for search and tracking and rocket firepower to destroy enemy targets.

### AIRPLANE DIMENSIONS.

The overall dimensions of the airplane are as follows:

| | |
|---|---|
| Wing span—without tip tanks | 37.3 feet |
| Wing span—with tip tanks | 42.6 feet |
| Fuselage length | 44.5 feet |
| Height (to top of fin) | 14.8 feet |

Refer to Section II for Turning Radius and Ground Clearance.

### AIRPLANE GROSS WEIGHT.

The normal take-off gross weight will vary from approximately 16,000 pounds clean (full useful load without tip tanks) to a maximum of approximately 24,000 pounds (full useful load, full tip and pylon tanks).

## ENGINE.

The Pratt and Whitney J-48-P-7 is a continuous flow, centrifugal type, turbo-jet engine designed for use with an afterburner for thrust augmentation. The rated sea-level static thrust of the J-48 engine without afterburner is 6350 pounds. Afterburning increases this thrust to a maximum of 8750 pounds. Components of the engine starting, ignition, and fuel systems are designed to function automatically after the controls are positioned by the pilot. The J-48-P-7 engine is different from earlier J-48-P-5 and 5A engines only in the method of controlling afterburner operation. The P-7 engines have a solenoid operated afterburner control valve rather than a mechanically operated valve.

### ENGINE FUEL CONTROL SYSTEM.

Fuel flow to the engine from the aircraft fuel tanks is shown schematically in Figure 1-4. After the fuel leaves the engine feed tank and passes through an emergency fuel shut-off valve, fuel pressure is boosted slightly by the engine driven secondary fuel pump which supplements the output of an electrically operated fuel boost pump located in the engine feed tank. In the event of failure of either pump, the other will maintain sufficient fuel flow to the engine driven dual fuel pump to permit satisfactory engine operation under all normal conditions. From the secondary fuel pump, the fuel is filtered by means of a two element, low pressure fuel filter. The filter is provided with an alcohol de-icing system designed to eliminate ice particles which tend to clog the filter elements under certain operating conditions. A bypass line is built into the filter housing. This permits an uninterrupted flow of fuel through the filter assembly if the filter elements become clogged to the extent that fuel cannot pass through them. Fuel is directed from the low pressure filter to the engine driven dual fuel pump which provides the fuel pressure necessary for engine operation. This pump has two stages which operate either in series or parallel, depending upon the needs of the engine as sensed by a pump regulating mechanism in the fuel control unit. The dual pumps are arranged so that if one stage should fail, the other will continue operating and supply the fuel necessary for engine operation. If both stages fail the engine will flame out. Fuel flow from the dual fuel pump is directed under high pressure to the engine fuel control unit incorporating both a normal and an emergency system to control the flow of fuel to the engine. Ordinarily, fuel flows through the normal section which includes various compensating units to regulate fuel flow. These include a governor which limits maximum engine speeds, and maintains approximately constant rpm for a given throttle setting regardless of airspeed or altitude. Another compensating unit is the acceleration valve which meters fuel to the engine only as rapidly as the engine is capable of handling it, no matter how rapidly the throttle is advanced.

# ENGINE FUEL SYSTEM DIAGRAM

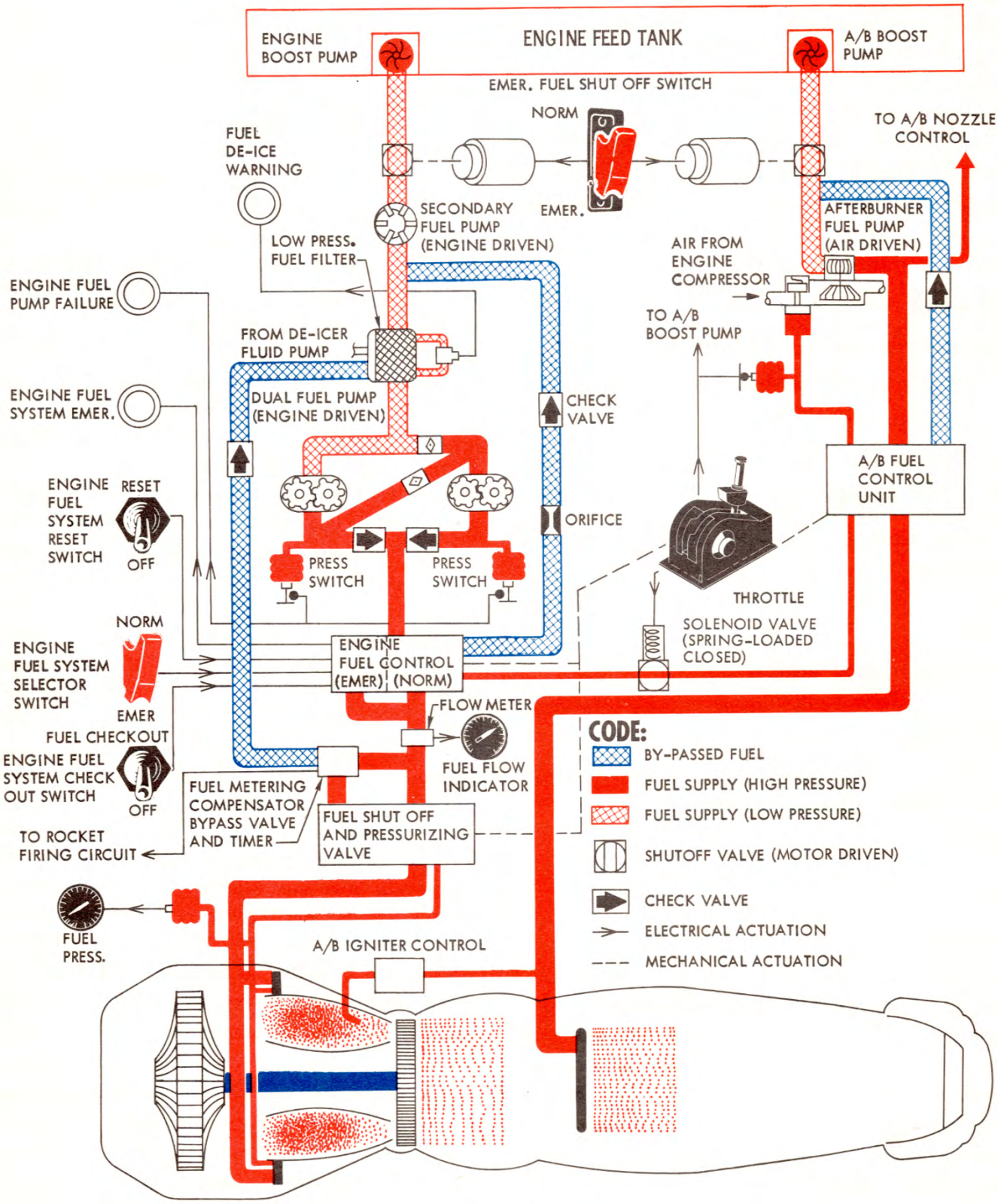



*Figure 1-4*

# THROTTLE QUADRANT

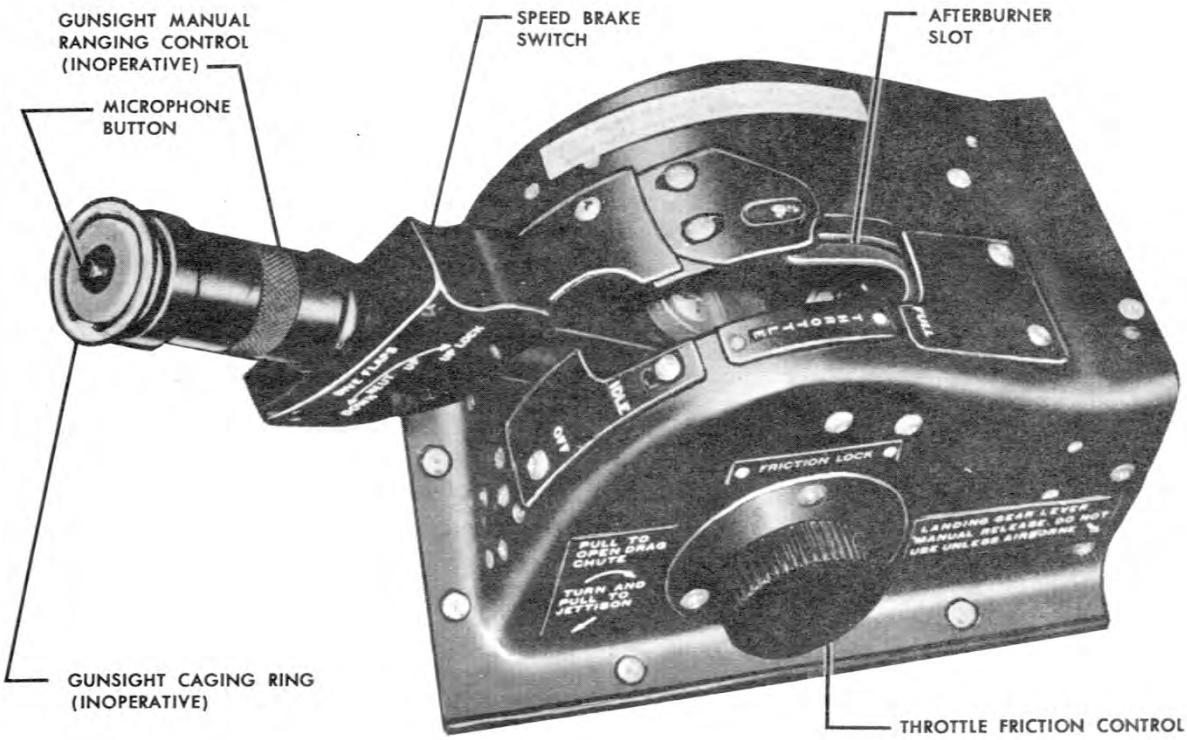
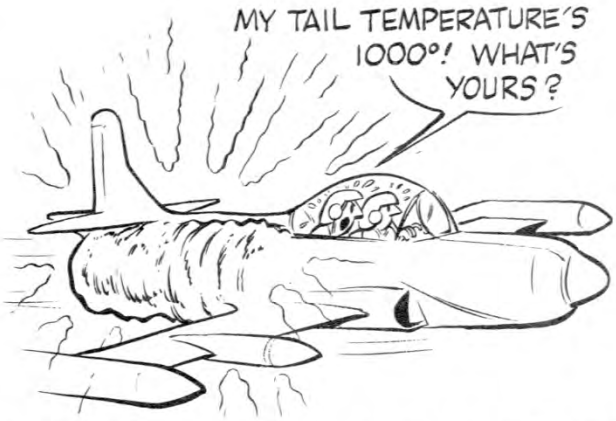



*Figure 1-5*

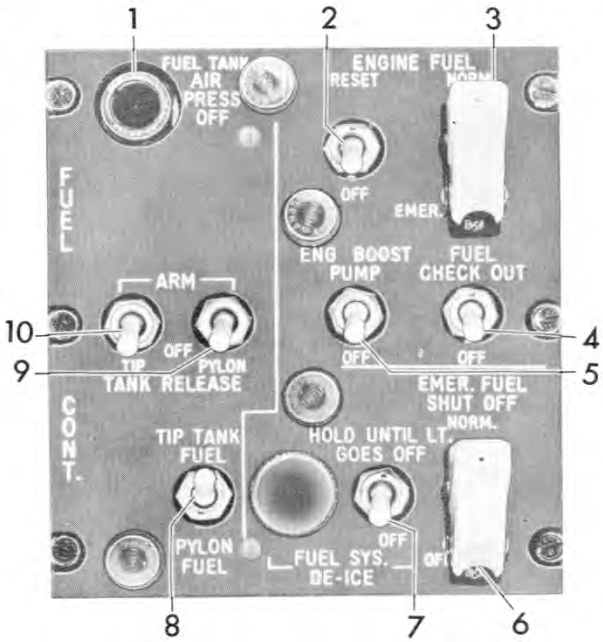
**CAUTION**




THE ACCELERATION CONTROL IS NOT ALWAYS EFFECTIVE AT HIGH ALTITUDES, AND THE THROTTLE MUST BE ADVANCED SLOWLY TO AVOID EXCESSIVE TAILPIPE TEMPERATURES, COMPRESSOR PULSATIONS OR POSSIBLE FLAME-OUT.

A deceleration mechanism, the variable minimum flow valve, is provided in the fuel control unit to insure sufficient fuel flow to maintain combustion when the throttle is retarded. There is also a fixed minimum flow valve, or high altitude idling jet, which permits sufficient fuel flow to maintain combustion when the throttle is in the IDLE position at altitudes above 15,000 feet. Any fuel in excess of that required for engine operation is bypassed from the engine fuel control back to the fuel flow line upstream of the low pressure filter. The emergency section of the fuel control unit provides a means for regulating fuel flow in the event of normal system failure. However, the emergency system does not incorporate those features of the normal system which govern engine speeds, acceleration, or deceleration, and caution must be exercised when manipulating the throttle on the emergency system to prevent engine overspeed, excessive tailpipe temperatures, compressor pulsation and flame-outs, particularly at high altitudes. Transfer from the normal to the emergency fuel control system is accomplished either automatically or manually. Automatic transfer occurs whenever fuel pressure at the outlet side of the normal fuel control drops to a predetermined point (20 psi) below the pressure of the

# FUEL CONTROL PANEL




1 FUEL TANK AIR PRESSURE OFF WARNING LIGHT

2 ENGINE FUEL SYSTEM RESET SWITCH

3 ENGINE FUEL SYSTEM SELECTOR SWITCH

4 ENGINE FUEL SYSTEM CHECK OUT SWITCH

5 ENGINE BOOST PUMP SWITCH

6 EMERGENCY FUEL SHUT-OFF SWITCH

7 FUEL SYSTEM DE-ICE SWITCH

8 TIP TANK FUEL SELECTOR SWITCH

9 PYLON TANK RELEASE ARMING SWITCH

10 TIP TANK RELEASE ARMING SWITCH

*Figure 1-6*

fuel entering the normal system. Manual transfer from normal to emergency is accomplished by means of a selector switch on the left hand side of the cockpit which controls the solenoid operated transfer valve in the fuel control unit. Metered fuel leaving the engine fuel control unit goes to the fuel shut-off and pressurizing valve before being directed to the pilot and main fuel manifolds. The fuel shut-off portion of this dual valve is actuated by throttle linkage. When the throttle is in the OFF position, the fuel shut-off valve is closed and no fuel can flow to the manifolds. When the throttle is moved forward from the OFF position during an engine start, the shut-off valve opens and fuel is directed to the primary fuel manifold only. When fuel pressure increases to approximately 200 psi, the pressurizing portion of the valve opens and fuel then goes to both the primary and main manifolds. The purpose for this arrangement is to provide a means of controlling fuel flow to the duplex fuel spray nozzles in the combustion chambers for optimum combustion during starting, as well as at higher power settings. A fuel metering compensator has been installed in the engine fuel system just upstream from the fuel shut-off and pressurizing valve. This unit is designed to compensate for the disturbance in fuel-air ratio which is caused by an increase in engine inlet air temperature and corresponding decrease in density when rockets are fired from the nose of the aircraft. At the moment of rocket firing, a percentage of the fuel flow from the fuel control unit to the burners is automatically bypassed from the fuel metering compensator back to the low pressure filter. A timing device automatically opens and closes the solenoid valve in this bypass line during rocket firing. The possibility of engine flame-out when firing rockets from the nose section still exists, even with the addition of this fuel metering compensator to the engine fuel system. Therefore, caution should be exercised when firing rockets from the nose, especially at high altitudes, and it is recommended that no more than 12 rockets be fired from the nose at one time.

### Engine Emergency Fuel System Warning Light.

The red warning light (14 figure 1-7) located on the instrument panel indicates when the fuel control unit is in emergency operation. This light is energized by a 28-volt d.c. circuit from the transfer mechanism in the fuel control unit.

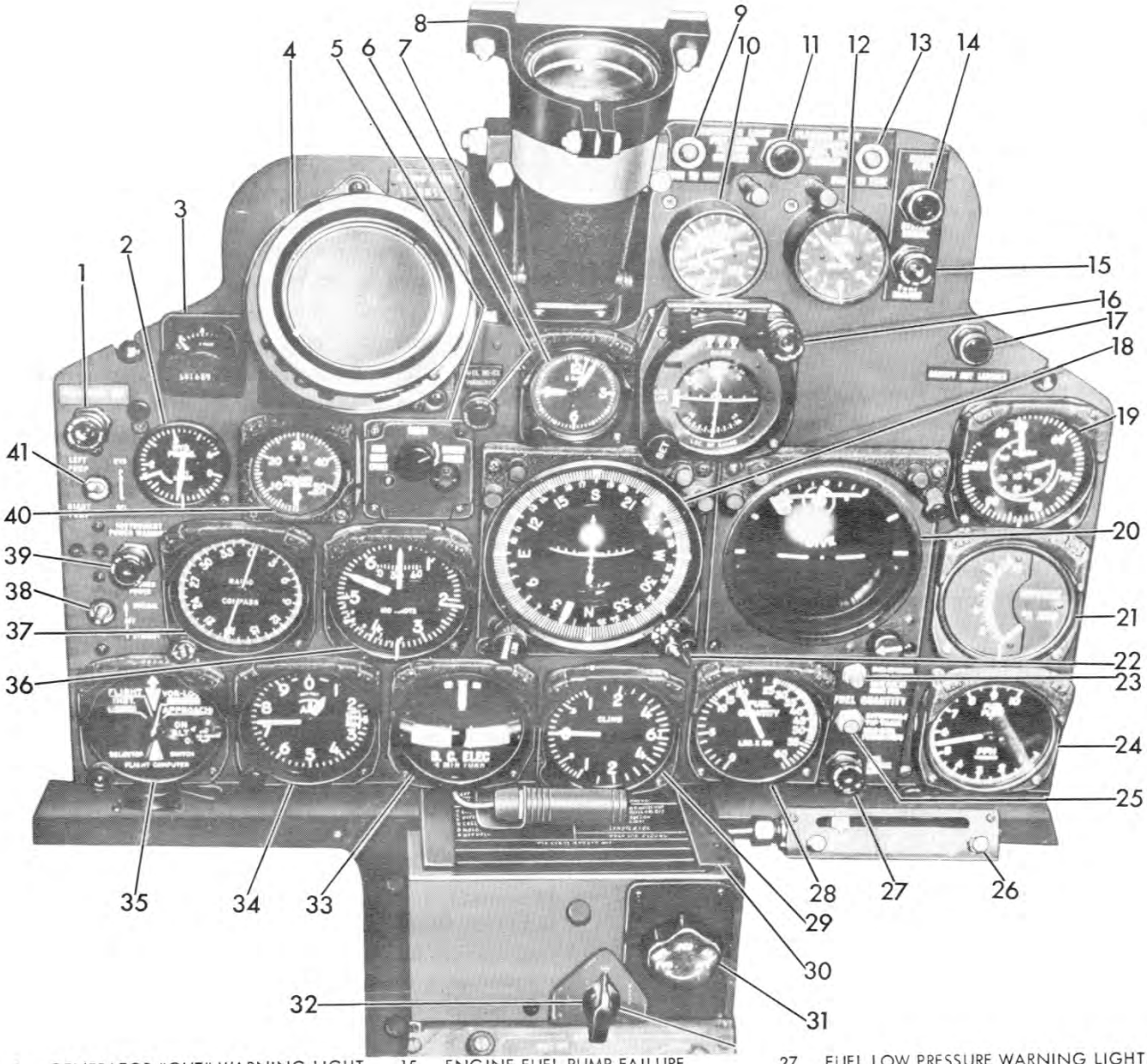
### Engine Fuel Pump Failure Warning Light.

This amber indicator light (15 figure 1-7) is located on the instrument panel and glows if either or both stages of the two-stage engine driven fuel pump should fail. A pressure switch for each stage will close the 28-volt d.c. circuit to the light whenever pump output from that particular stage falls below approximately 150 psi.

**Note**

When the engine is shut down both the engine emergency fuel system and the engine fuel pump failure warning lights will come on.

# INSTRUMENT PANEL




1 GENERATOR "OUT" WARNING LIGHT
2 HYDRAULIC PRESSURE INDICATOR
3 D.C. LOADMETER
4 RADARSCOPE
5 RADAR GYRO CONTROL
6 FUEL DE-ICE WARNING LIGHT
7 CLOCK
8 FIXED GUNSIGHT
9 PLENUM CHAMBER FIRE WARNING TEST SWITCH
10 ENGINE OIL PRESSURE INDICATOR
11 FIRE AND OVERHEAT WARNING LIGHT
12 FUEL PRESSURE INDICATOR
13 TAIL SECTION OVERHEAT WARNING TEST SWITCH
14 ENGINE EMERGENCY FUEL SYSTEM WARNING LIGHT
15 ENGINE FUEL PUMP FAILURE WARNING LIGHT
16 ILS DEVIATION INDICATOR AND MARKER BEACON RECEIVER
17 CANOPY UNLATCHED WARNING LIGHT
18 FLIGHT DIRECTOR INDICATOR
19 TACHOMETER
20 ATTITUDE INDICATOR
21 TAIL PIPE TEMPERATURE INDICATOR
22 PITCH ATTITUDE TRIM KNOB
23 FUEL QUANTITY INDICATOR TEST BUTTON
24 FUEL FLOW INDICATOR
25 FUEL QUANTITY TEST BUTTON
26 ELEVATOR BOOST RATIO INDICATOR
27 FUEL LOW PRESSURE WARNING LIGHT
28 FUEL QUANTITY INDICATOR
29 VERTICAL VELOCITY INDICATOR
30 PILOT'S CHECK LIST
31 RUDDER PEDAL ADJUSTING CONTROL
32 COCKPIT AIR CONTROL SELECTOR
33 TURN AND SLIP INDICATOR
34 ALTIMETER
35 FLIGHT DIRECTOR CONTROL
36 AIRSPEED INDICATOR
37 RADIO COMPASS INDICATOR
38 INSTRUMENT POWER SWITCH
39 INSTRUMENT POWER "OFF" WARNING LIGHT
40 CABIN PRESSURE ALTITUDE INDICATOR
41 HYDRAULIC PUMP PRESSURE SELECTOR SWITCH

*Figure 1-7*

## ENGINE CONTROLS.

### Engine Fuel System Selector Switch.

The engine fuel system selector switch (3 figure 1-6) is a cover guarded switch located on the fuel control panel. The switch has two positions labeled NORM and EMER and may be used to manually change the fuel flow through the engine fuel control unit. With the cover guard down, the switch will be in the NORM position. When the switch is placed in the EMER position, the solenoid operated transfer valve in the fuel control unit is energized by 28-volt d.c. and fuel will flow through the emergency section of the fuel control. If the normal fuel control fails, automatic transfer to the emergency system will take place as soon as there is 20 psi pressure drop across the normal portion of the fuel control unit. However, if this pressure drop is gradual, engine power may decrease excessively before automatic changeover to the emergency system takes place. Therefore, if power loss is experienced in a critical attitude, such as on take-off, it is important to changeover manually to the emergency fuel system rather than wait for automatic transfer to occur.

### Engine Fuel System Reset Switch.

The engine fuel system reset switch located on the fuel control panel (2 figure 1-6) has two positions, RESET and OFF, and is spring loaded to the OFF position. This switch must be used to reset the fuel control from emergency back to normal operation in all cases except during an engine start. Regardless of whether transfer from normal to emergency was automatic or manual, placing the engine fuel system selector switch in the NORM position is not sufficient, in itself, to change the fuel control back to normal operation. In addition to this, the reset switch must be placed in the momentary RESET position to complete the 28-volt d.c. circuit to the transfer valve and accomplish transfer to normal.

### Engine Fuel System Check-Out Switch.

The engine fuel system check-out switch located on the fuel control panel (4 fiigure 1-6) has two positions labeled FUEL CHECK-OUT and OFF. The purpose of this switch is to enable the pilot to check the automatic transfer feature in the fuel control unit. When the engine is shut down after flight, a pressure drop will occur across the normal side of the fuel control which should cause automatic transfer from normal to emergency. However, since the starter circuit also energizes the reset circuit, the fuel control will transfer back to normal as soon as the starter is engaged during an engine start, and the only means the pilot would have of determining whether or not the automatic transfer took place during the last engine shut-down would be an indication on the emergency fuel system warning light, which could be unreliable. This problem is overcome by use of the check-out switch which merely isolates the starter from the reset circuits so that the fuel control will not be reset back to normal when the starter is energized. The pilot can then determine if the automatic transfer feature worked properly by checking the stabilized engine rpm after the throttle is placed in the IDLE position. With the fuel control in emergency, the idle rpm will be stabilized at approximately 27-32%, and the engine fuel system warning light should remain on. If the automatic transfer did not occur, the engine rpm will stabilize at approximately 35% and the warning light should be off. Although the check-out switch will not affect engine operation after the engine is started, it should be placed in the OFF position prior to actuating the reset switch. The reason for this is to provide the pilot with a positive indication that the starter automatically disengaged. If not, the starter circuit will still be energized and as soon as the check-out switch is placed in the OFF position, the reset circuit will also be energized. This will cause the fuel control to transfer from emergency back to normal prior to actuation of the reset switch, and the stop-start circuit must then be energized to disengage the starter.

### Emergency Fuel Shut-Off Switch.

This switch (6 figure 1-6) has two positions: NORM and OFF. When placed in the NORM (guarded) position, 28-volt d.c. motor operated shut-off valves in the afterburner and engine fuel lines will be opened. The OFF position is provided so that fuel to both the engine and afterburner may be shut off in the event of an emergency.

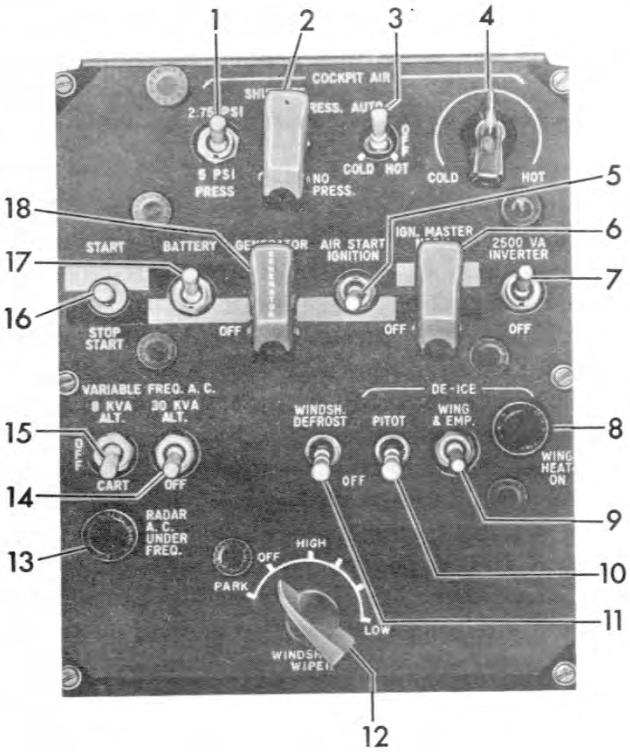
### Fuel System De-Ice Switch.

Provisions are included for de-icing the fuel system. For a description of this system, refer to Section IV of this handbook.

## START AND IGNITION SYSTEM.

In an emergency, the airplane battery is capable of supplying the engine starter with sufficient power for ground starts; however, to insure satisfactory starting, an external power source should be used. Air starts are accomplished without using the starter at 175-185 knots with windmilling engine rpm of 7½-9% rpm.

# CENTER CONTROL PANEL (GROUP A)



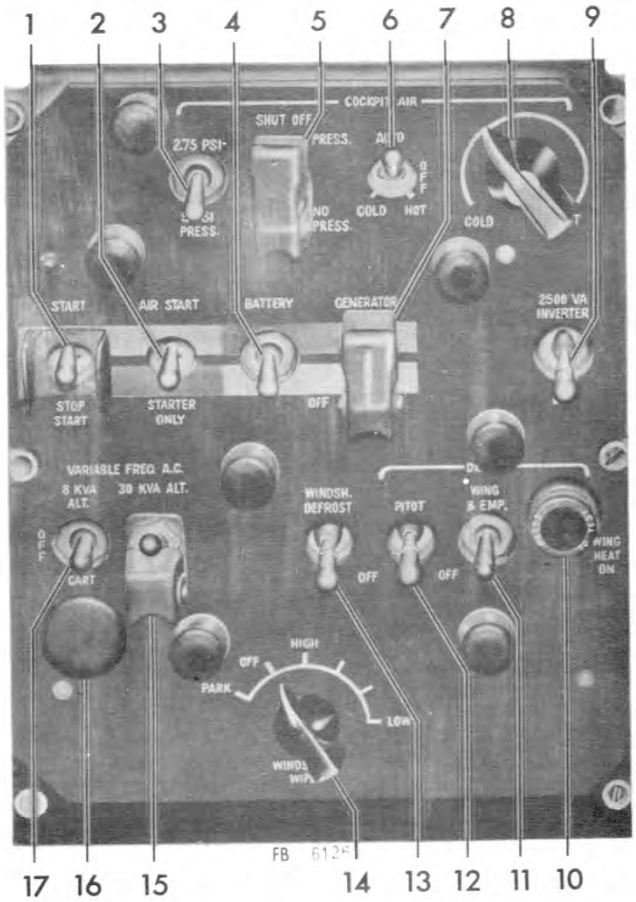

1 COCKPIT AIR PRESSURE SELECTOR SWITCH
2 COCKPIT AIR PRESSURE SHUT-OFF SWITCH
3 COCKPIT AIR TEMPERATURE SELECTOR SWITCH
4 COCKPIT AIR TEMPERATURE RHEOSTAT
5 AIR START IGNITION SWITCH
6 IGNITION MASTER SWITCH
7 2500 V.A. INVERTER SWITCH
8 WING HEAT ON INDICATOR LIGHT
9 WING AND EMPENNAGE DE-ICE SWITCH
10 PITOT DE-ICE SWITCH
11 AUXILIARY WINDSHIELD DEFROSTER SWITCH
12 WINDSHIELD WIPER CONTROL
13 RADAR A.C. UNDER FREQUENCY WARNING LIGHT
14 30 KV. A. ALTERNATOR SWITCH
15 8 KV. A. ALTERNATOR SWITCH
16 GROUND START SWITCH
17 BATTERY MASTER SWITCH
18 GENERATOR SWITCH

*Figure 1-8*

**CAUTION**

**Only under the most stringent of circumstances should the battery be used to start the engine. This procedure can result in damage to the engine starter and the engine itself.**

# CENTER CONTROL PANEL (GROUP B)

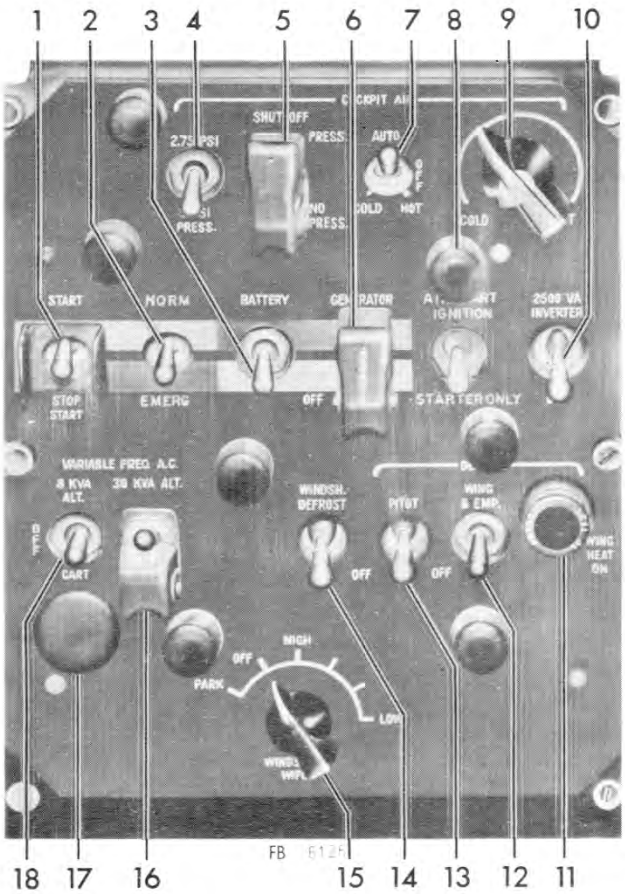



1 GROUND START SWITCH
2 AIR START IGNITION SWITCH
3 COCKPIT AIR PRESSURE SELECTOR SWITCH
4 BATTERY SWITCH
5 COCKPIT AIR PRESSURE SHUT OFF SWITCH
6 COCKPIT AIR TEMPERATURE SELECTOR SWITCH
7 GENERATOR SWITCH
8 COCKPIT TEMPERATURE RHEOSTAT
9 2500 V.A. INVERTER SWITCH
10 WING HEAT ON INDICATOR LIGHT
11 WING AND EMPENNAGE DE-ICE SWITCH
12 PITOT DE-ICE SWITCH
13 AUXILIARY WINDSHIELD DEFROSTER SWITCH
14 WINDSHIELD WIPER CONTROL
15 30 KV. A. ALTERNATOR SWITCH
16 RADAR A. C. UNDER FREQUENCY WARNING LIGHT
17 8 KV. A. ALTERNATOR SWITCH

*Figure 1-9*

**Ignition is used only for initial starting of the engine and not for sustaining combustion as in a reciprocating engine. It is automatically supplied by igniters during engine starting whenever the starter is energized; or will be supplied by the air start ignition switch when the air start procedure is being used. The ignition system and starting motor are placed in operation for the proper**

# CENTER CONTROL PANEL (GROUP C)




1 GROUND START SWITCH
2 START SELECTOR SWITCH
3 BATTERY SWITCH
4 COCKPIT AIR PRESSURE SELECTOR SWITCH
5 COCKPIT AIR PRESSURE SHUT OFF SWITCH
6 GENERATOR SWITCH
7 COCKPIT AIR MANUAL TEMPERATURE CONTROL SWITCH
8 AIR START IGNITION SWITCH
9 COCKPIT AIR TEMPERATURE SELECTOR
10 2500 V.A. INVERTER SWITCH
11 WING HEAT ON INDICATOR LIGHT
12 WING AND EMPENNAGE DE-ICE SWITCH
13 PITOT DE-ICE SWITCH
14 AUXILIARY WINDSHIELD DEFROSTER SWITCH
15 WINDSHIELD WIPER CONTROL
16 30 KV. A. ALTERNATOR SWITCH
17 RADAR A. C. UNDER FREQUENCY WARNING LIGHT
18 8 KV. A. ALTERNATOR SWITCH

*Figure 1-10*

duration by a relay which senses starter current drain. As the engine speed increases, the starter current decreases to a value which causes the relay to disconnect the starting motor and ignition system from the airplane electrical system.

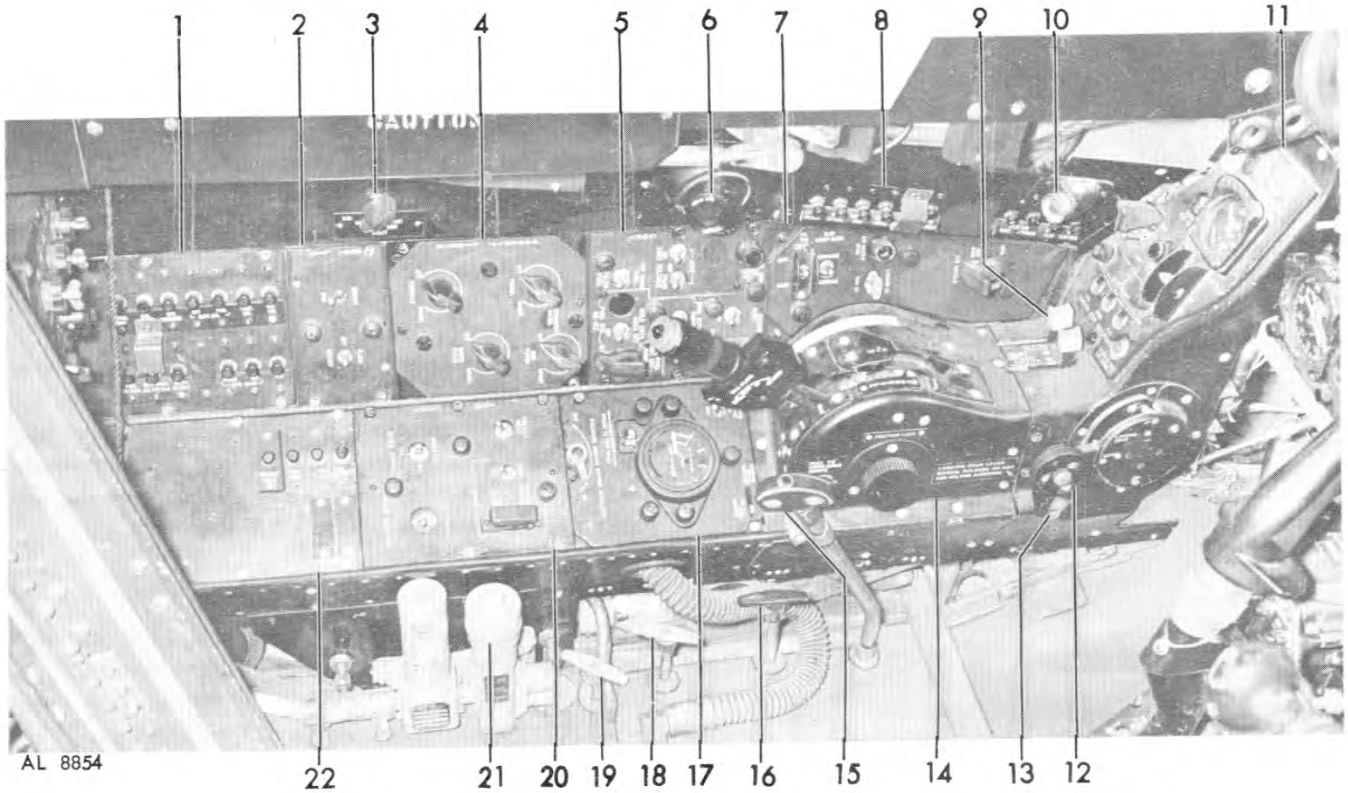
**Start and Ignition System Controls.**

**Ignition Master Switch (Group A Only).** Unmodified aircraft (Group A) have a two position ignition master switch on the center control panel (6 figure 1-8). With the switch in the NORM position (cover guard down), the spark igniters will be energized by 28-volt d.c. whenever the ignition circuit is closed by either the ground start or air start ignition switches. Placing the switch to OFF will open the ignition circuit and prevent flow of electrical power to the igniters.

**Air Start Ignition Switch.** This switch located on the center control panel (2 figure 1-9) has three positions. The UP position is labeled AIR START IGNITION and the down position STARTER ONLY. The switch is spring loaded OFF (neutral position). Momentarily moving the switch to the AIR START IGNITION position allows 28-volt d.c. to energize the spark igniters for a period of approximately 90 seconds. To discontinue ignition before this interval has elapsed, it is necessary to pull the circuit breaker on the center control pedestal or turn off the battery and generator switches. The STARTER ONLY position of this switch causes the starter circuit to be energized by 28-volt d.c. without energizing the ignition circuit. This position is used to provide engine rpm without ignition. Unmodified aircraft (Group A) have an air start ignition switch (5 figure 1-8) with no starter only provisions. This switch is spring loaded to OFF (center position) and must be momentarily placed in the AIR START IGNITION position to energize the spark igniters for approximately 90 seconds. Ignition may be discontinued on Group A aircraft by placing the ignition master switch to the OFF position.

**Start Selector Switch.** A start selector switch has been added to the center control panel of Group C aircraft (2 figure 1-10) to control external power during starting. This switch has two positions, NORMAL and EMERGENCY. The NORMAL position is used to direct current flow from a constant current external power supply to the engine starter circuit whenever the constant current power unit is available. This isolates the normal aircraft 28-volt d.c. system from the engine start system and permits uninterrupted use of inverters and other electrical equipment during the starting procedure without danger of damage to these units by voltage surges when the starter is energized. The EMERGENCY position of the switch is used during an engine start whenever there is no constant current starting unit available. When the position is used, the starter, as well as the aircraft electrical system, receives power from the same 28-volt d.c. external unit.

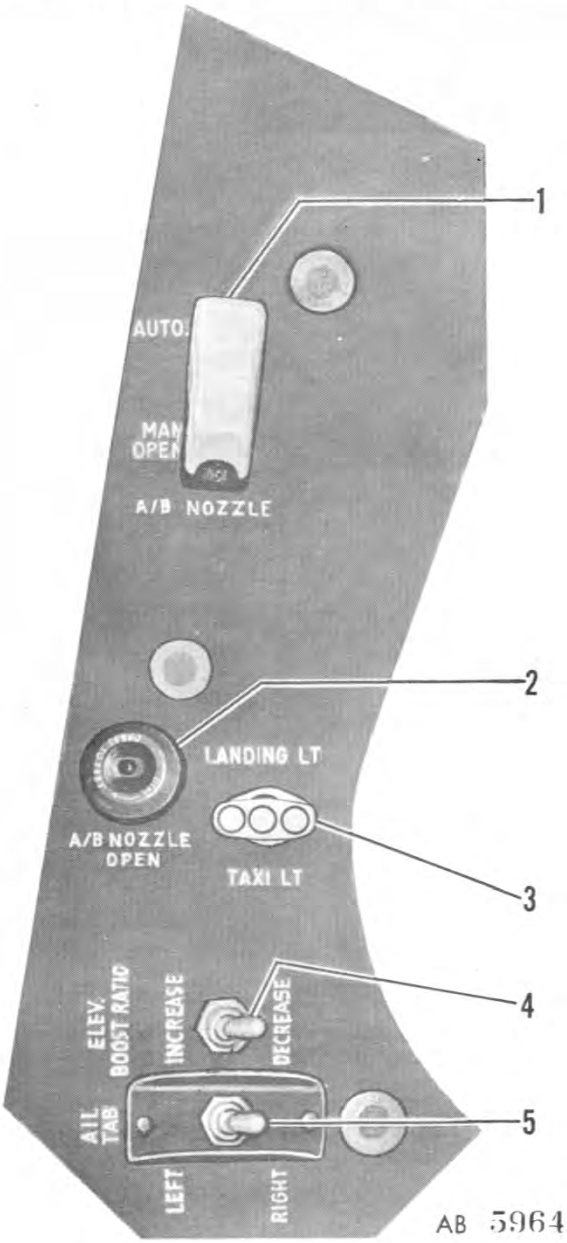
# PILOT'S COCKPIT, LEFT SIDE




1. LEFT AFT CIRCUIT BREAKER PANEL
2. EXTERIOR LIGHTS CONTROL PANEL
3. OPTICAL SIGHT RETICLE CONTROL
4. COCKPIT LIGHTS CONTROL PANEL
5. FUEL CONTROL PANEL
6. VENTILATING AIR INLET
7. LEFT FORWARD SIDE PANEL
8. LEFT FORWARD CIRCUIT BREAKER PANEL
9. AILERON AND ELEVATOR BOOST SHUT-OFF LEVERS
10. ATO FIRING SWITCH
11. LEFT FORWARD PANEL
12. LANDING GEAR CONTROL LEVER AND UNSAFE WARNING LIGHT
13. LANDING GEAR CONTROL LEVER SOLENOID LOCK RELEASE
14. THROTTLE QUADRANT
15. DRAG CHUTE RELEASE & JETTISON HANDLE
16. ATO JETTISON HANDLE
17. OXYGEN REGULATOR CONTROL PANEL
18. RIGHT TIP TANK MANUAL RELEASE
19. LEFT TIP TANK MANUAL RELEASE
20. ARMAMENT CONTROL PANEL
21. ANTI-G SUIT VALVE
22. LEFT LOWER CIRCUIT BREAKER PANEL

*Figure 1-11*

# LEFT FORWARD SIDE PANEL




1 AFTERBURNER NOZZLE OVERRIDE SWITCH
2 AFTERBURNER NOZZLE OPEN INDICATOR LIGHT
3 LANDING-TAXI LIGHT SWITCH
4 ELEVATOR BOOST RATIO SWITCH
5 AILERON TRIM TAB SWITCH

*Figure 1-12*

**Ground Start Switch.** The ground start switch (1 figure 1-9) is located on the center control panel. It has three positions and is spring loaded to the center (Off) position. The other two positions are labeled START and STOP START. When the switch is moved to the START position, the engine starter and the ignition system are automatically energized by 28-volt d.c. The starting system should automatically discontinue operation after the engine has started and attained approximately 21% rpm. If the attempted start is unsuccessful, the starting procedure must be discontinued by moving the starter switch to the STOP START position and moving the throttle to the OFF position.

## ENGINE INDICATORS.

### Exhaust Gas Temperature Gage (Tailpipe Temperature Gage).

The tailpipe temperature gage on the instrument panel (21 figure 1-7) is operated by four self generating thermocouples in the tailpipe of the aircraft. This gage provides the pilot with a visual indication of tailpipe temperature regardless of whether the aircraft electrical system is operating or not.

### Tachometer.

The tachometer (19 Figure 1-7) installed on the instrument panel is operated by an engine-driven tachometer generator mounted on the accessory section of the engine. This instrument indicates engine speed in percentage of maximum rated engine rpm (approximately 10,900) and does not require any power from the aircraft electrical system.

### Fuel Pressure Indicator.

A fuel pressure indicator (12 Figure 1-7) is installed in the upper right corner of the instrument panel to show the fuel pressure in the engine primary fuel manifold. This gage is calibrated from 0 to 1,000 psi.

### Fuel Flow Indicator.

The fuel flow indicator on the lower right side of the instrument panel (24 Figure 1-7) is operated by a flow meter installed in the engine fuel line, and indicates fuel flow to the engine in thousands of pounds per hour. The fuel flow and fuel pressure indicators require instrument inverter power stepped down to 26 volt a.c. through the instrument autotransformer.

### Oil Pressure Gage.

The oil pressure gage mounted on the upper right side of the instrument panel (10 figure 1-7) indicates oil pressure in the engine oil system from 0 to 100 psi. This gage is operated by 26-volt a.c. through the instrument autotransformer.

## AFTERBURNER.

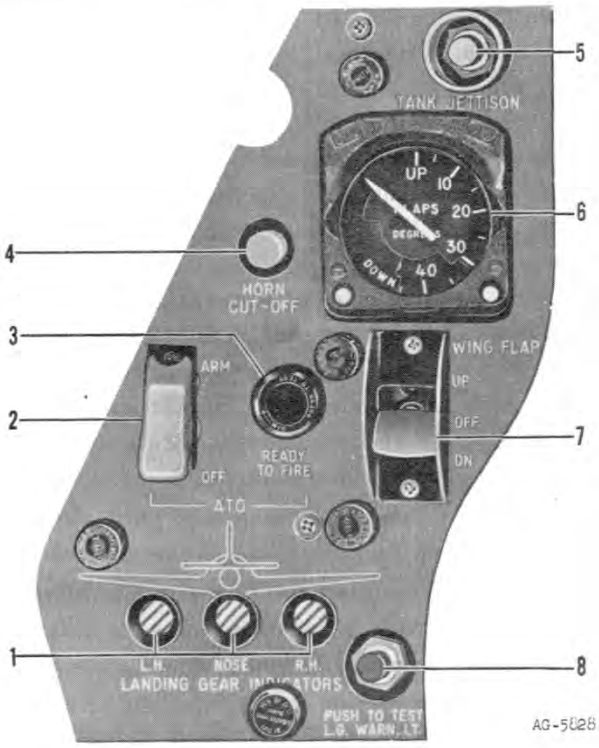
The afterburner utilizes the unburned oxygen in the engine exhaust to burn additional fuel that is injected into the tailpipe, thereby increasing the thrust normally available by approximately 33% at sea level for take-off

and 80% at flight speeds. When this additional thrust is needed, afterburning may be used for periods of up to 15 minutes in duration. The additional thrust of the airplane is controlled by the throttle and an afterburner nozzle which automatically increases the tailpipe exit area during operation with the afterburner and decreases the exit area during operation without the afterburner.

**AFTERBURNER FUEL SYSTEM.**

The afterburner has its own independent fuel system (figure 1-4) which goes into operation when the throttle is moved into the AUGMENT (afterburner) range. This throttle movement actuates a throttle switch controlling 28-volt d.c. circuits to the afterburner fuel boost pump in the engine fuel tank and the solenoid operated afterburner actuation valve. When the solenoid valve is energized, it opens and allows dual fuel pump pressure to flow through a pressure actuation line to the afterburner boost pump pressure switch and the afterburner fuel pump. This fuel pressure opens an air valve in the afterburner fuel pump so that air from the engine compressor is permitted to enter the assembly and operate the pneumatically driven afterburner fuel pump. The afterburner boost pump pressure switch acts as a safety device to protect the afterburner fuel pump. Any time the pressure switch senses pressure in the actuation line to the afterburner fuel pump, it closes the circuit to the afterburner boost pump. Consequently, the boost pump will be energized in the event of a leak or failure in the solenoid valve, regardless of throttle position. This will prevent the possibility of the afterburner fuel pump running dry. When the afterburner fuel pump starts operating, it furnishes fuel under high pressure to the afterburner fuel control unit. The afterburner fuel control has two regulating devices which control the flow of fuel to the afterburner. The primary metering valve senses engine compressor discharge pressure and acts as an altitude control, decreasing afterburner fuel flow as altitude increases. The other mechanism merely regulates fuel to the afterburner to keep afterburner temperature within limits despite variations in engine air flow and nozzle area on different installations. Fuel from the control unit is metered to the afterburner fuel manifold from which it is directed to eight spray nozzles inside the tailpipe. Small holes in the spray nozzles allow the fuel to spray into the tailpipe perpendicular to the flow of exhaust gasses. Afterburner ignition is accomplished automatically by the injection of fuel from the afterburner fuel line into the number 9 combustion chamber. The fuel ignites in the chamber, but because of the relatively large quantity of fuel and the force

## LEFT FORWARD PANEL




1 LANDING GEAR POSITION INDICATORS

2 ATO ARMING SWITCH

3 ATO READY INDICATOR LIGHT

4 LANDING GEAR WARNING HORN CUT-OUT SWITCH

5 TANK JETTISON SWITCH

6 WING FLAP POSITION INDICATOR

7 WING FLAP SWITCH

8 LANDING GEAR WARNING LIGHT TEST SWITCH

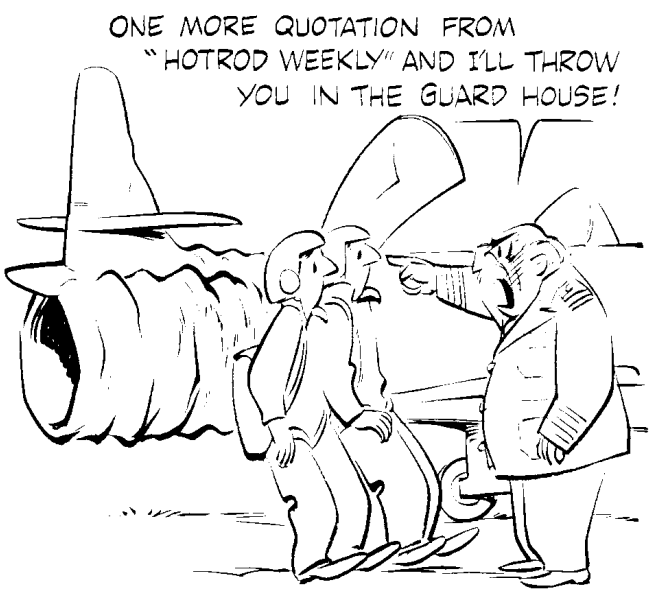
*Figure 1-13*

with which it is injected into the chamber, complete combustion does not occur. As a result, it passes through the chamber, the turbine wheel, and into the tailpipe as a "hot streak" of burning fuel. When this hot streak reaches the fuel being sprayed into the tailpipe from the spray nozzles, afterburner ignition takes place rather audibly. Three concentric rings called flameholders are installed in the tailpipe just aft of the spray nozzles. An area of low pressure is created behind these rings by the flow of exhaust gasses so that most of the afterburner combustion will occur inside the tailpipe, providing optimum thrust from afterburner operation.

## AFTERBURNER NOZZLE SYSTEM.

The afterburner nozzle opens during afterburner operation to prevent excessive tailpipe temperature and pressure from building up in the tail section. A bleed line from the afterburner fuel pump is directed to the afterburner nozzle control on top of the engine accessory section. Fuel pressure from the output side of the afterburner fuel pump opens a valve in this nozzle control which permits air from the engine compressor to flow through the nozzle control to two afterburner nozzle actuating cylinders, one on each side of the tailpipe. Each actuating cylinder is mechanically linked by a push-pull rod to one segment of the two-piece nozzle, and air pressure in the cylinder, working through the linkage, forces the nozzle open. The afterburner nozzle opens approximately three seconds before afterburner ignition occurs, and remains open until the afterburner is shut down. When afterburning is stopped, the afterburner fuel pump pressure to the nozzle control valve will be relieved, allowing spring pressure to close the valve. Compressor air is then directed to the other side of the nozzle actuating cylinders, forcing the nozzle closed. The nozzle may be opened manually by a switch in the cockpit which electrically positions the valve in the nozzle control to the open position.

**CAUTION**




THE THROTTLE MUST BE MANIPULATED VERY SLOWLY AT HIGH ALTITUDES. RAPID THROTTLE MOVEMENT MAY CAUSE COMPRESSOR STALLS, OVERSPEEDS, OVERTEMPERATURES OR FLAME-OUT.

## AFTERBURNER CONTROLS.

### Throttle.

The throttle (figure 1-5) is the primary afterburner control. Afterburning may be initiated by moving the throttle outboard into the afterburner slot between the 93% and 100% throttle positions. This movement closes the throttle switch which actuates the afterburner solenoid valve and afterburner boost pump, placing the afterburner into operation. The 93% to 100% rpm range in which the afterburner may be used permits wide latitude in engine thrust during afterburner operation. Above 93% rpm, the afterburner may be started or stopped without changing the rpm setting. To shut down the afterburner, merely move the throttle inboard out of the afterburner slot. In the event of electrical failure or solenoid malfunction, the afterburner will remain in the position it was in prior to the malfunction. If this should occur with the afterburner on, it is possible to stop the afterburner by retarding the throttle below the 93% rpm position.

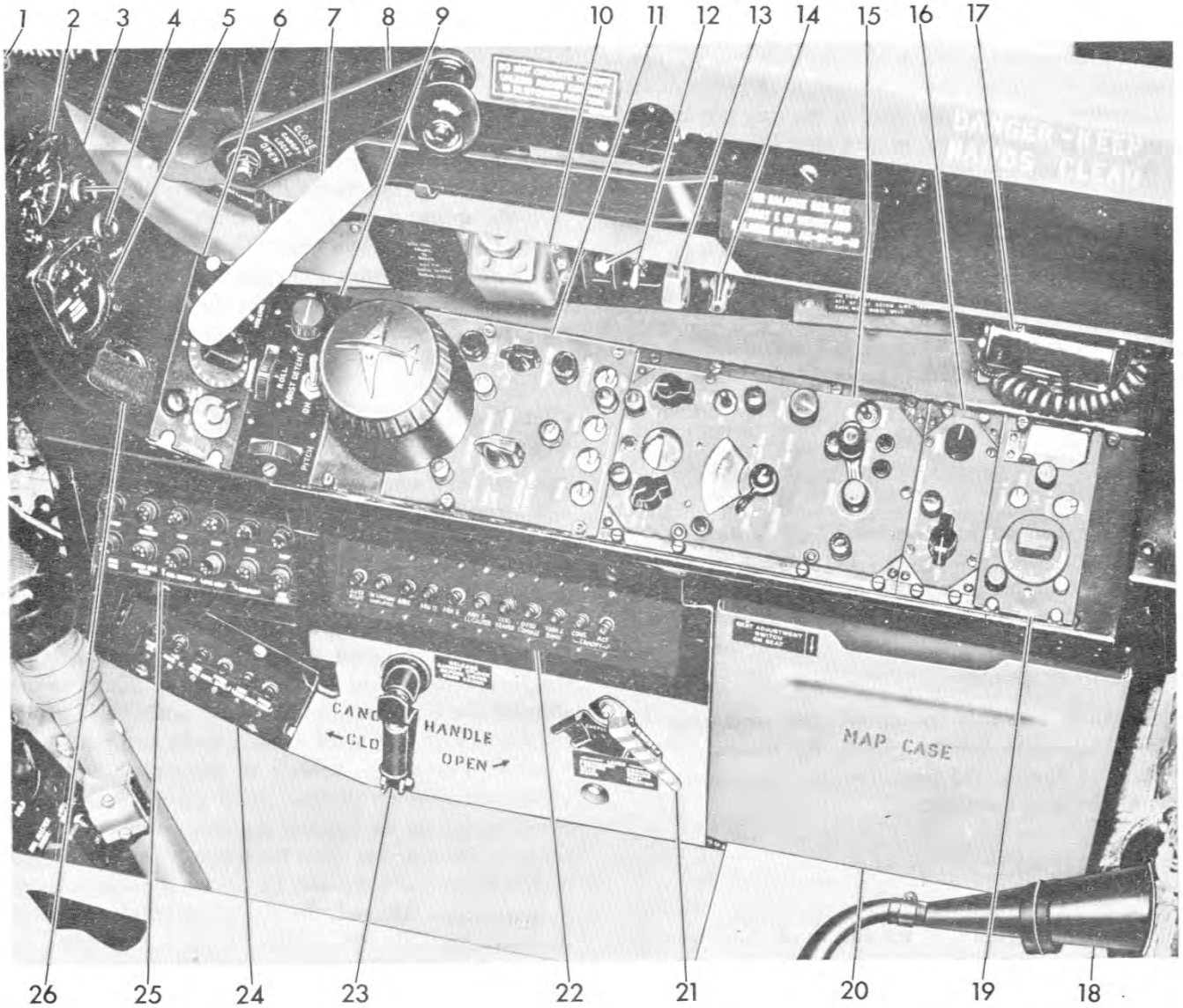
### Afterburner Nozzle Override Switch.

This switch on the left forward side panel (1 figure 1-12) has two positions, AUTO and MAN. OPEN. When placed in the AUTO position (cover guard down), the afterburner nozzle will be opened or closed automatically when the afterburner starts or stops. The MAN. OPEN position is provided to override the automatic control so that the nozzle may be opened when desired. With the switch in MAN. OPEN, a 28-volt d.c. circuit to the nozzle control valve is energized, opening the valve and allowing compressor air to flow through the control to open the nozzle. In order to close the nozzle after it has been manually opened, the override switch must be placed back to the AUTO position and the throttle must be moved out of the afterburner range. An amber afterburner nozzle open indicator light (2 figure 1-12) on the left forward side panel will glow whenever the afterburner nozzle is open. The 28-volt d.c. circuit to this light is controlled by a switch on the nozzle linkage.

**Note**

If the afterburner is not operating, and the afterburner nozzle is open, approximately 25% of normal engine thrust will be lost because of the increased area of the tailpipe opening.

# PILOT'S COCKPIT, RIGHT SIDE




1 ELEVATOR TAB NEUTRAL INDICATOR LIGHT
2 ACCELEROMETER
3 RIGHT FORWARD PANEL
4 OXYGEN WARNING LIGHTS
5 OXYGEN CYLINDER PRESSURE GAGE
6 COMMAND RADIO CONTROL PANEL
7 CANOPY JETTISON LEVER
8 CANOPY LOCKING HANDLE
9 AUTOMATIC PILOT TRIM HANDLE
10 AUTOPILOT CRUISE-TO-RADAR BUTTON
11 AUTOMATIC PILOT CONTROL PANEL
12 CANOPY SWITCHES
13 INTERPHONE (AUDIO BY-PASS) SWITCH
14 HEADSET VOLUME CONTROL
15 RADIO COMPASS CONTROL PANEL
16 ILAS RADIO CONTROL PANEL
17 TYPE C-4A SPOTLIGHT
18 PILOT'S RELIEF TUBE
19 IFF CONTROL PANEL
20 MAP CASE
21 EMERGENCY HYDRAULIC SYSTEM SELECTOR
22 RIGHT UPPER CIRCUIT BREAKER PANEL
23 CANOPY HANDCRANK
24 RIGHT LOWER CIRCUIT BREAKER PANEL
25 FUSE PANEL
26 PITCH ATTITUDE TRIM INDICATOR

*Figure 1-14*

## ASSIST TAKE-OFF SYSTEM.

Provisions are included for mounting two rocket (assisted take-off) units on the bottom of the fuselage. The rocket units add about one thousand pounds of thrust each, for approximately twelve seconds duration and will materially improve the airplane take-off performance when used. See Appendix I. If rocket units are installed, they must be used on the first take-off, or jettisoned, as they will not be safe after being subjected to the low temperatures of high altitudes.

### ATO CONTROLS.

#### ATO Arming Switch.

This switch (2 figure 1-13) arms the 28-volt d.c. ATO firing circuit when placed in the ARM position. A red ATO READY TO FIRE warning light is installed beside the switch to indicate that the ATO circuit is armed.

#### ATO Firing Switch.

The rocket units are fired electrically (28-V d.c.) by the push-button switch (10 figure 1-11) located on the left forward circuit breaker panel, after the ATO arming switch has been placed in the ARM position.

#### ATO Jettison Handle.

After ATO thrust is exhausted, the units may be mechanically jettisoned by pulling the manual release handle (16 figure 1-11) located on the floor on the left side of the pilot's cockpit.

## OIL SYSTEM.

The engine oil system operates automatically. The oil level may be determined by means of the dip stick attached to the oil tank filler cap. When full, the tank holds approximately 13 quarts of oil. For filler location and oil specification, refer to Figure 1-27.

## AIRPLANE FUEL SYSTEM.

Fuel may be carried internally in five interconnected tanks located in each wing, a fuselage tank behind the rear cockpit, and an engine feed tank mounted aft of and below the fuselage tank. These internal tanks are non-self-sealing nylon bladder type tanks. Additional fuel may be carried externally in droppable tip and pylon tanks. As shown on the schematic diagram of the airplane fuel system (figure 1-16) all fuel is transferred to the engine through the engine feed tank, where separate electrically operated submerged type boost pumps supply fuel to the engine and afterburner fuel systems. Fuel from the fuselage and wing tanks flows by gravity into the engine feed tank, whereas fuel from the tip and pylon tanks is forced into the fuselage tank by air pressure from the engine compressor. A dual float valve, mounted at the normal fuel level of the fuselage tank, controls flow from the external tanks. The fuel tanks may be refueled through the single point filler which will fill all except the pylon tanks; or the fuselage fuel tank filler may be used and all except the tip and pylon tanks will be filled. In either case, the empty external tanks may be filled separately. The quantity of fuel is indicated by a capacitance type gage system that indicates the quantity of fuel in pounds. Since the weight of the fuel is dependent upon the density, the quantities will vary slightly with any condition that changes the density of the fuel. The fuel grades and specifications are given on figure 1-27 and fuel quantity data is given on figure 1-17.

### FUEL TANK PRESSURIZATION AND VENT SYSTEM.

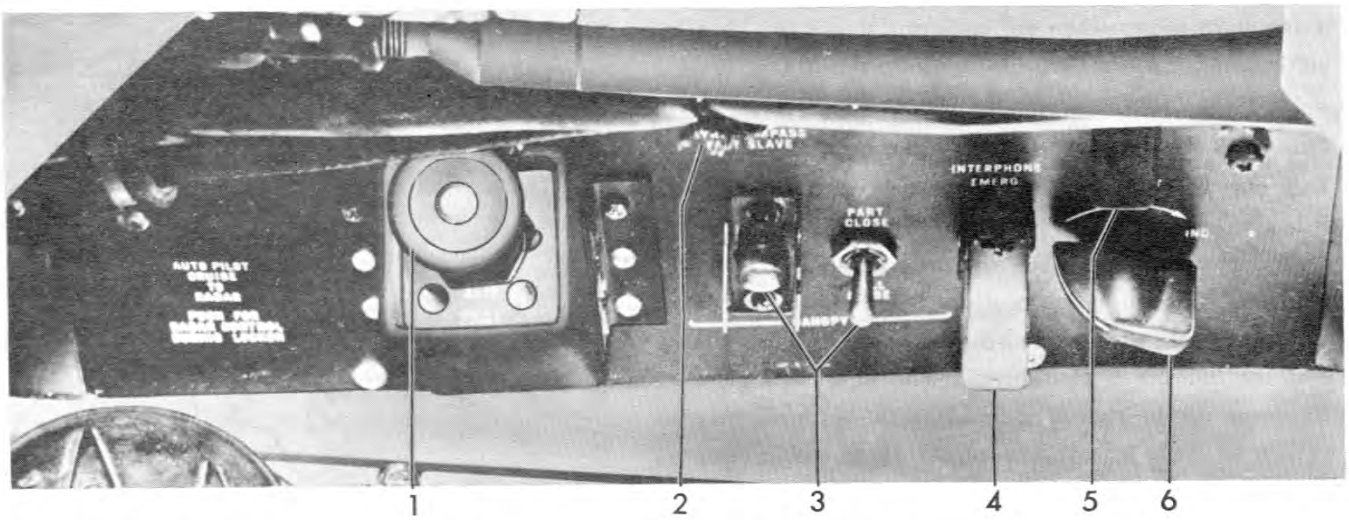
Air pressure from the engine compressor is reduced to and maintained at 12-14 psi in the external tanks by an air pressure regulator in the line. A sonic venturi is installed in the air line leading to each droppable tank to limit the flow and loss of air after the tank is emptied or jettisoned. The internal fuel tanks are pressurized at 5-6 psi to prevent fuel loss caused by vaporization of the fuel during rapid climbs to altitude. Protection is afforded the internal tanks by a dual sniffle valve which relieves excessive pressure in these tanks at 6 psi. In the event of loss of air pressure to the tanks, the sniffle valve will open on descent, or as otherwise required, allowing outside air to enter the tanks to prevent their collapse. The primary vents for this valve are at the tips of the horizontal stabilizer. In the event these primary outlets become blocked, the secondary relief valve will discharge through a flush port on the lower right side of the aft section. A sniffle valve in each external tank affords these tanks the same protection against abnormally high or low pressures.

### FUEL SYSTEM CONTROLS.

#### External Tank Fuel Selector Switch.

This switch (8 figure 1-6) has two positions: TIP TANK FUEL and PYLON FUEL. When placed in the TIP TANK FUEL position, solenoid operated valves in the tip tank fuel lines will be in the spring loaded open position. When placed in the PYLON FUEL position, the valves will be electrically closed by 28-volt d.c. This circuit is installed so that fuel from the pylon tanks may be used before the fuel in the tip tanks. A relay automatically closes the valves when tip tanks are not installed or when the tip tanks are jettisoned. In the event of electrical failure, the valves will open.

# RIGHT HAND AUXILIARY SWITCH PANEL




1 AUTOPILOT CRUISE-TO-RADAR BUTTON
2 FAST-SLAVE BUTTON
3 CANOPY SWITCHES
4 INTERPHONE (AUDIO BY-PASS) SWITCH
5 GROUND ROCKET DOOR OPENING SWITCH
6 HEADSET VOLUME CONTROL

*Figure 1-15*

**Engine Boost Pump Switch.**

When this switch is placed in the ENG. BOOST PUMP position, 28-volt d.c. operates the engine fuel boost pump located in the engine feed tank.

## FUEL SYSTEM INDICATORS.

**Fuel Quantity Indicator.**

The fuel quantity indicator (28, figure 1-7) located on the instrument panel, is operated by eight capacitance-type probes. Normally, the indicator shows the total internal fuel (in pounds). However, the amount of fuel in the tip tanks can be determined by pressing the internal plus tip tank fuel quantity test switch. It is possible under certain conditions to have an erroneous indication of the amount of internal fuel, since fuel characteristics and fuel temperature can cause an indication of more fuel in the internal system than is actually present. The erroneous indication will be only in the range of from 2300 to 2800 pounds, and above and below this range the dial indication error will be well within tolerances. If fuel system indications are above that normally expected, a check of the total airplane fuel, including tip tanks, will indicate whether or not the system is functioning properly.

**Note**

The quantity of fuel in the pylon tanks is not included in the reading of the fuel quantity indicator.

A fuel quantity indicator test button (23, figure 1-7) is provided near the indicator to check its operation. When the button is depressed the needle should move toward zero, and when the button is released the needle should return to the original fuel quantity reading. If the needle goes below the 800 pound mark, the fuel low level warning light should come on. When the internal plus tip tank fuel quantity switch (25, figure 1-7) is pressed, the fuel quantity indicator will show the amount of fuel in the internal tanks plus the fuel in the tip tanks. When the switch is released, the fuel quantity reading will be decreased by the amount of fuel in the tip tanks and the total internal fuel will be indicated.

**Fuel Low Level Warning Light.**

A red warning light (27, figure 1-7) is located on the instrument panel adjacent to the fuel quantity indicator. This light should glow whenever the fuel quantity

indicator shows less than 800 pounds (approximately 125 gallons). Operation of the light is a function of the indicator itself. The light may be checked by depressing the fuel quantity indicator test button, and noting if the light glows when the indicator shows less than 800 pounds.

**Fuel Tank Air Pressure Off Warning Lights.**

This red warning light (1, figure 1-6) is actuated by either a pressure switch located in the fuselage tank or a pressure switch located in the external tank air pressure line. If the air pressure drops below the setting of the appropriate pressure switch, the warning light will glow to indicate a malfunction. The light will glow whenever engine rpm is reduced below approximately 65% rpm, since at this low engine speed, compressor bleed air pressure is insufficient to open the pressure switches.

## EXTERNAL TANK RELEASE SYSTEM.

(See figure 1-18)

All external tanks may be jettisoned electrically by the TANK JETTISON button (5, figure 1-13) or the external tank (and bomb) release button (8, figure 1-21). The tip tanks may also be released manually by pulling the manual release handles (18 and 19, figure 1-11). To avoid damaging the aircraft when the tanks are jettisoned, the tip tanks are ejected laterally away from the wing tips by springs within each tank, and the pylon tanks are ejected downward by electrically fired cartridges. The pylons themselves are not jettisonable.

**External Tank Release Controls.**

**Tip Tank Safety Pins.** Red flagged ground safety pins are installed in the tip tank release lever assemblies to prevent inadvertent jettison of the tanks while on the ground. These pins are inserted through access holes located on top of each wing tip just inboard of the tip tanks. The pins should be removed before each flight and re-inserted after each flight.

**Tank Jettison Button.** This button (5, figure 1-13) located on the left forward panel, will release the tip and pylon tanks simultaneously when depressed. The circuit is connected directly to the battery and therefore is always "hot."

**CAUTION**

IF THE TANK JETTISON BUTTON HAS BEEN DEPRESSED WITH THE SAFETY PINS INSTALLED, THE TANKS WILL JETTISON WHEN THE PINS ARE REMOVED.

**Note**

This button may be protected against inadvertent actuation by a plastic cover which should be removed before flight.

**Tip Tank Release Arming Switch.** This switch (10, figure 1-6) has two positions: ARM and OFF. When in the ARM position, the circuit is armed so that both tip tanks may be released by depressing the tank release button on the control stick grip. On some aircraft (figure 1-18) the tip tank arming switch has three positions: ARM, OFF and AUTO. DROP. When the selector switch is placed in the ARM position, both tanks will release when the tank release button on the control stick is depressed. In the event one tip tank becomes disengaged, the remaining tank will automatically jettison if the selector switch is in the AUTO DROP position. The tank release button on the control stick is inoperative when the selector switch is in the AUTO DROP or OFF position.

# AIRPLANE FUEL SYSTEM DIAGRAM

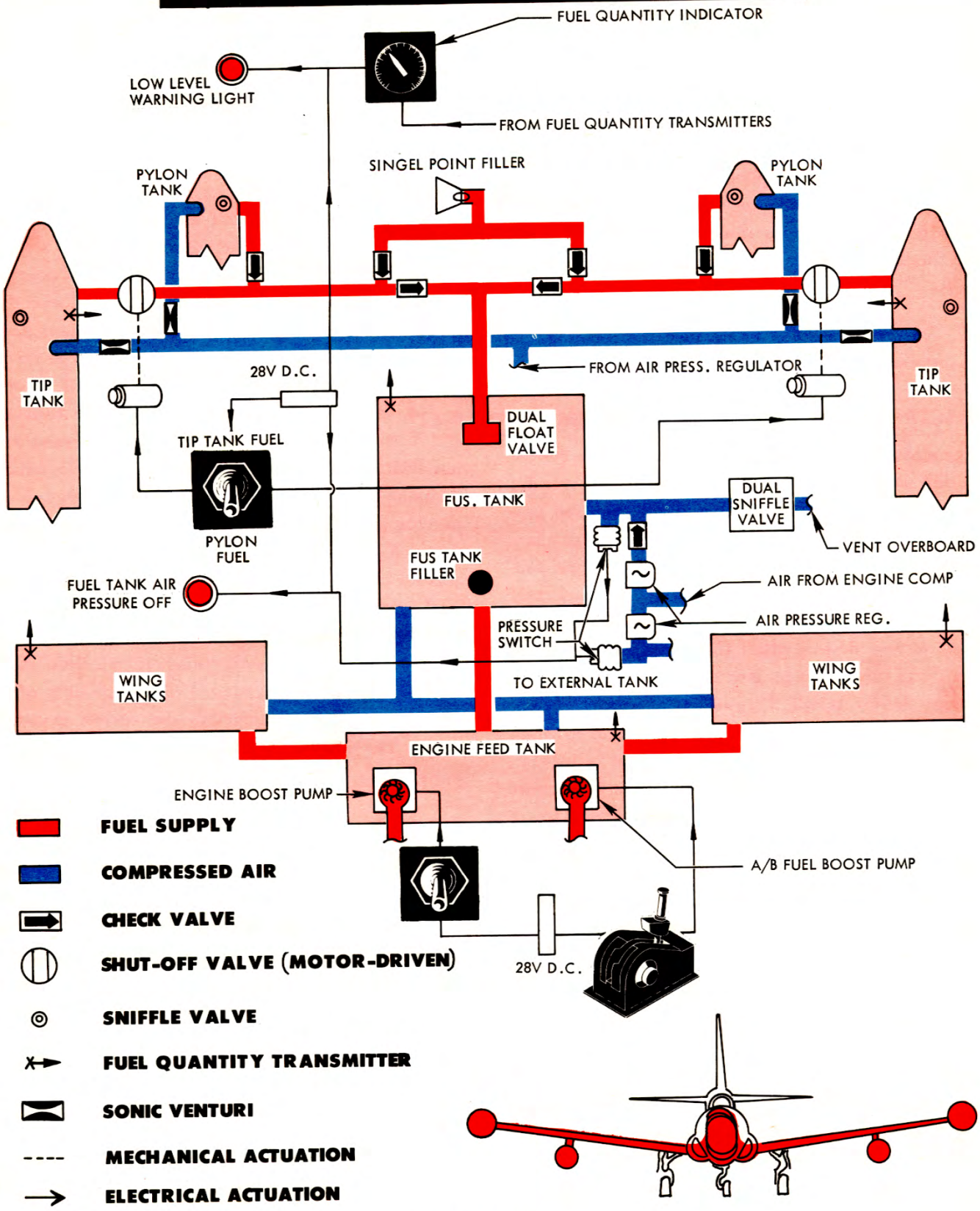



*Figure 1-16*

**Pylon Tank Release Arming Switch.** This switch (9 figure 1-6) has two positions: ARM and OFF. When in the ARM position, the circuit is armed so that both pylon tanks may be released by pressing the tank release button on the control stick.

**Tip Tank Manual Release Handles.** The tip tank manual release handles (18 and 19, figure 1-11) are provided to enable the pilot to jettison the tip tanks individually. The handles may also be used to mechanically jettison both tanks if they cannot be jettisoned electrically.

**Note**

No manual method is provided for releasing the pylon tanks.

## ELECTRICAL POWER SUPPLY SYSTEM.

The aircraft utilizes both direct and alternating current during normal operation (see figure 1-19). 28 volt d.c. electrical power is furnished by an engine-driven generator and a battery system which provides an auxiliary supply of direct current in the event of generator failure. The alternating current supply system consists of three inverters and two alternators. The inverters are motor-driven devices which change 28 volt d.c. from the direct current system into 115 volt a.c. The engine-driven alternators, which are merely alternating current generators, also require 28 volt d.c. to operate actuating relays and to energize the alternator field coils. Consequently, unless direct current is available from either the generator or the batteries, the entire electrical power supply system will be inoperative. External power receptacles are installed, which can be used to connect both d.c. and a.c. to the aircraft electrical system for ground operation of electrical equipment and starting.

### D.C. ELECTRICAL POWER DISTRIBUTION.

#### Generator System.

The generator, mounted on the engine accessory section, is rated at 400 amps at 30 volts. A voltage regulator maintains generator voltage at 28 volts. The voltage regulator is normally adjusted to the desired setting on the ground, but, if necessary can be adjusted in the air by a control in the radar observer's cockpit. Generator output to the aircraft electrical system is controlled through a reverse current relay by the generator control switch. The reverse current relay protects the generator by automatically disconnecting the generator from the d.c. electrical system any time generator voltage is less than battery voltage. This will occur at low engine speeds (below approximately 30% rpm), and will prevent the batteries from discharging into the generator.

#### Battery System.

Two 12 volt storage batteries connected in series are located in the nose section of the aircraft. Battery output to the d.c. electrical system is controlled by a battery relay through a switch in the pilot's cockpit. Whenever the relay is closed, the batteries are paralleled with the generator circuit, and during normal operation, their charge will be maintained by the generator. The external tank jettison, IFF detonator and external canopy control circuits are connected directly to the batteries and will be "hot" any time charged batteries are installed in the aircraft, regardless of battery switch position. The primary purpose for the batteries is to provide an auxiliary supply of direct current in the event of generator failure. The batteries are adversely affected by cold temperatures, and unless conditions are ideal, battery output may be even less than the rated figure of 200 amps for approximately 10 minutes. Do not turn the battery master switch to the BATTERY position or operate the external canopy switches when external power is connected to the aircraft electrical system. This will parallel the batteries with the external power source and cause damage to the batteries.

#### External Power Supply (Group A and B).

On unmodified aircraft, two identical direct current external power receptacles are located on the right side of the fuselage just behind the trailing edge of the wing (10 figure 1-27). These are connected in parallel for operation individually or together. Whenever external power is connected to these receptacles direct current is automatically furnished to the 28 volt d.c. system.

#### External Power Supply (Group C).

Some aircraft (designated Group C) have been modified to include a split bus starting system. In order to utilize this system, a constant current 28 volt d.c. external power source must be available. Instead of the two identical d.c. receptacles mentioned in the preceding para-

# FUEL QUANTITY DATA

| | | USABLE FUEL LEVEL FLIGHT ATTITUDE | | FULLY SERVICED TAXI ATTITUDE | |
|---|---|---|---|---|---|
| | NO. | GALLONS | POUNDS | GALLONS | POUNDS |
| **INTERNAL TANKS** | | | | | |
| WING | 2 | 231 | 1501.5 | 243.1 | 1580.2 |
| FUSELAGE | 1 | 94 | 611 | 95 | 617.5 |
| ENGINE FEED | 1 | 41 | 266.5 | 41 | 266.5 |
| TOTAL INTERNAL FUEL | 4 | 366 | 2379.0 | 379.1 | 2464.2 |
| **TIP TANKS** | 2 | 503.8 | 3274.7 | 516 | 3354.0 |
| **PYLON TANKS** | 2 | 460.0 | 2990.0 | 470 | 3055.0 |
| **TOTAL** COMBINED TANKS | 8 | 1329.8 | 8643.7 | 1365.1 | 8873.2 |

NOTE:

MANUFACTURING TOLERANCES CREATED SLIGHT VARIATION IN INDIVIDUAL TANK CAPACITIES. CONSEQUENTLY, THE QUOTED CAPACITIES ARE REPRESENTATIVE ONLY AND SHOULD NOT BE USED AS EXACT VALUES FOR ANY PARTICULAR AIRPLANE

REMARKS:

INTERNAL AND TIP TANKS SERVICED BY SINGLE POINT REFUELING AND PYLON TANKS SERVICED INDIVIDUALLY USING JP-4 FUEL. CONVERSION FACTOR FOR JP-4 FUEL - 6.5 LBS. PER GALLON UNDER STANDARD CONDITIONS.

*Figure 1-17*

graph, the modified aircraft have one such receptacle to accommodate a normal 28 volt d.c. power unit, and another, differently shaped receptacle, for the 28-volt d.c. constant current power unit. The modification is designed to separate the power source to the engine starter from the normal 28 volt d.c. system so that the instrument inverters and flight instruments may be warmed up and checked thoroughly prior to and during an engine start without danger of voltage surges causing damage to these units when the starter is energized.

## A.C. ELECTRICAL POWER DISTRIBUTION.

### Instrument Inverter System.

Two instrument inverters are located in the nose section of the aircraft. These are designated the normal and standby inverters, and are identical in operation and output. The inverters change 28 volt d.c. to 115 volt a.c. which is used to power various flight and engine instruments (see figure 1-19). A switch in the pilot's cockpit controls the flow of 28 volt d.c. to the inverters so that either inverter may be selected in the event of failure of the other. It is good practice to use the normal inverter continuously until it fails rather than divide the operating time between the two. Then if a failure occurs and the standby inverter has had very little operating time, it can be expected to function satisfactorily for the remainder of the flight. Transfer from one inverter to the other must be accomplished manually by movement of the switch. Part of the inverter power is directed to an instrument autotransformer which steps down inverter voltage from 115 volt a.c. to 26 volt a.c. for operation of the fuel pressure, oil pressure, hydraulic pressure and fuel flow indicators.

### 2500 VA Inverter System.

The 2500 VA inverter located in the nose section of the aircraft is driven by a 28 volt d.c. motor and supplies 115 volt a.c. power to the automatic cockpit temperature control, auto-pilot, and AN/APG 40 radar. It should be noted that VA is an abbreviation for volt-amperes, which is an indication of the real power the unit is capable of supplying. Direct current to the inverter is controlled by a switch in the pilot's cockpit. This inverter requires more direct current for its operation than any other unit on the aircraft. Consequently, under conditions where the 28 volt d.c. generator is not operating, the 2500 va inverter should be turned off in order to conserve battery power.

### 8 KVA Alternator System.

The 8 KVA (kilo volt-amperes) alternator is an engine-driven alternating current generator mounted on the engine accessory section. The alternator, although engine-driven, requires 28 volt d.c. to close the alternator relay and complete the alternator field circuit. The alternator relay will open automatically and disconnect the alternator from its load any time that engine rpm is not sufficient to maintain alternator frequency above 380 cycles a second. This will occur at or below approximately 55% engine rpm. When the alternator is operating properly, it supplies 115 volt a.c. to the rocket tube heaters, the radar system, and the AN/APX-6 IFF.

### 30 KVA Alternator System.

The 30 KVA alternator mounted in the center of the engine accessory section is an a.c. generator which supplies a.c. power to the wing and empennage de-icers. This alternator also requires 28 volt d.c. to close the alternator relay and complete the field circuit.

### External Power Supply System.

An alternating current external power receptacle is located adjacent to the 28 volt d.c. receptacles on the right side of the fuselage. External a.c. power for ground operation of the radar and rocket tube heaters may be made available by connecting an appropriate power unit to the receptacle. External a.c. power to the aircraft system is controlled by means of a switch in the pilot's cockpit.

## ELECTRICAL POWER SUPPLY SYSTEM CONTROLS.

### Generator Switch.

The generator switch located on the center control panel (7 figure 1-9) has two positions, GENERATOR (up) and OFF (down). The GENERATOR (guarded) position connects the generator to the 28 volt d.c. system. After completion of the engine start, the generator switch should be placed in the GENERATOR position and left there for the remainder of the flight, since the reverse current relay will automatically protect the generator at low output.

**CAUTION**

Moving the generator switch from OFF to GENERATOR during engine run-up or in flight could send a surge of current into the airplane batteries and damage them.

### Generator Voltage Adjusting Rheostat.

This rheostat (7 figure 4-18) located in the radar observer's cockpit, provides a means of adjusting generator voltage for peak loads while in flight. The adjustment varies the generator field exciting current controlled by the voltage regulator.

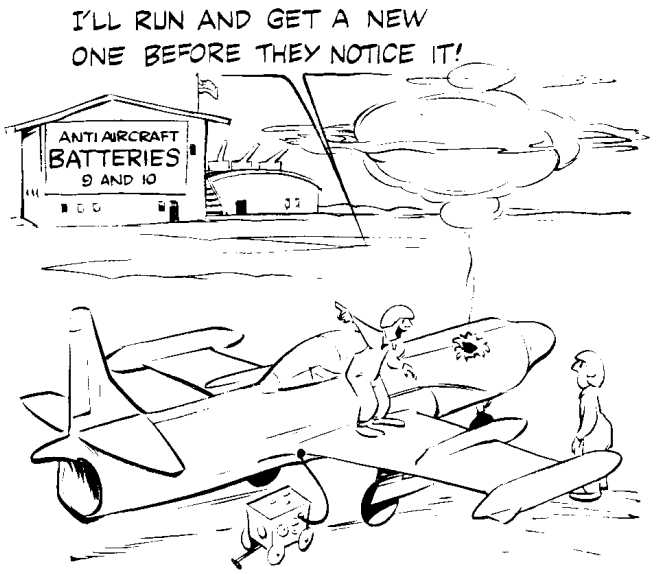
**CAUTION**

The system should never be adjusted for more than 28.5 volts. If adjustments are necessary before the system has warmed up (30 minutes operation), continue rechecking the adjustment until warm-up is complete.

### Battery Master Switch.

The battery master switch located on the center control panel (4 figure 1-9) has two positions, BATTERY (up) and OFF (down). When the switch is in the BATTERY position, it connects the battery to the 28 volt d.c. system through the battery relay. A minimum battery voltage of approximately 18 volts is required to close this relay (the battery relay must be closed before the generator can recharge the batteries).

**CAUTION**




DO NOT TURN THE BATTERY MASTER SWITCH TO THE **BATTERY** POSITION OR OPERATE THE EXTERNAL CANOPY CONTROLS WHEN EXTERNAL D.C. POWER IS CONNECTED TO THE AIRCRAFT ELECTRICAL SYSTEM. THIS WILL PARALLEL THE BATTERIES WITH THE EXTERNAL POWER SOURCE AND CAUSE DAMAGE TO THE BATTERIES.

**Instrument Power Switch.**

This switch, located on the instrument panel (38 figure 1-7) has three positions: NORMAL (up), OFF (center) and STANDBY (down), and controls the flow of 28 volt d.c. to the normal and standby instrument inverters. In the event of inverter failure, change-over from one inverter to the other must be made by means of this switch, since there are no automatic transfer provisions in the inverter system. With the switch in the OFF position, neither inverter will operate.

**2500 VA Inverter Switch.**

This switch on the center control panel (9 figure 1-9) controls the flow of 28 volt d.c. to the 2500 VA inverter. When the switch is in the 2500 VA INVERTER (up) position, the inverter will be energized whenever direct current is available. With the switch in the OFF (down) position, the inverter will not operate.

**8-KVA Alternator Switch.**

This switch (17 figure 1-9) located on the center control panel, has three positions: 8-KVA ALT (up), OFF (center), and CART (down). Placing the switch in the 8-KVA position, allows 28 volt d.c. to close the alternator relay and energize the alternator field. The CART position is provided so that auxiliary external a.c. power may be supplied to the radar equipment and rocket tube heaters for ground operation.

**8-KVA Alternator Voltage Adjusting Rheostat.**

The rheostat in the rear cockpit (6 figure 4-17) is accessible by raising the cover box and is provided to adjust the voltage of the 8-kva alternator if necessary.

**30-KVA Alternator Switch.**

This switch (15 figure 1-9), located on the center control panel controls 28 volt d.c. power to the alternator. When the switch is in the 30-KVA ALT position, a relay closes and completes the alternator field circuit. (On modified airplanes this switch is guarded to the 30-KVA ALT position.)

**CAUTION**

Make certain that the 30-kva and 8-kva alternator switches are On any time the engine is running. Leaving the switches Off will cause pitting and arcing, and eventually burn out the commutators.

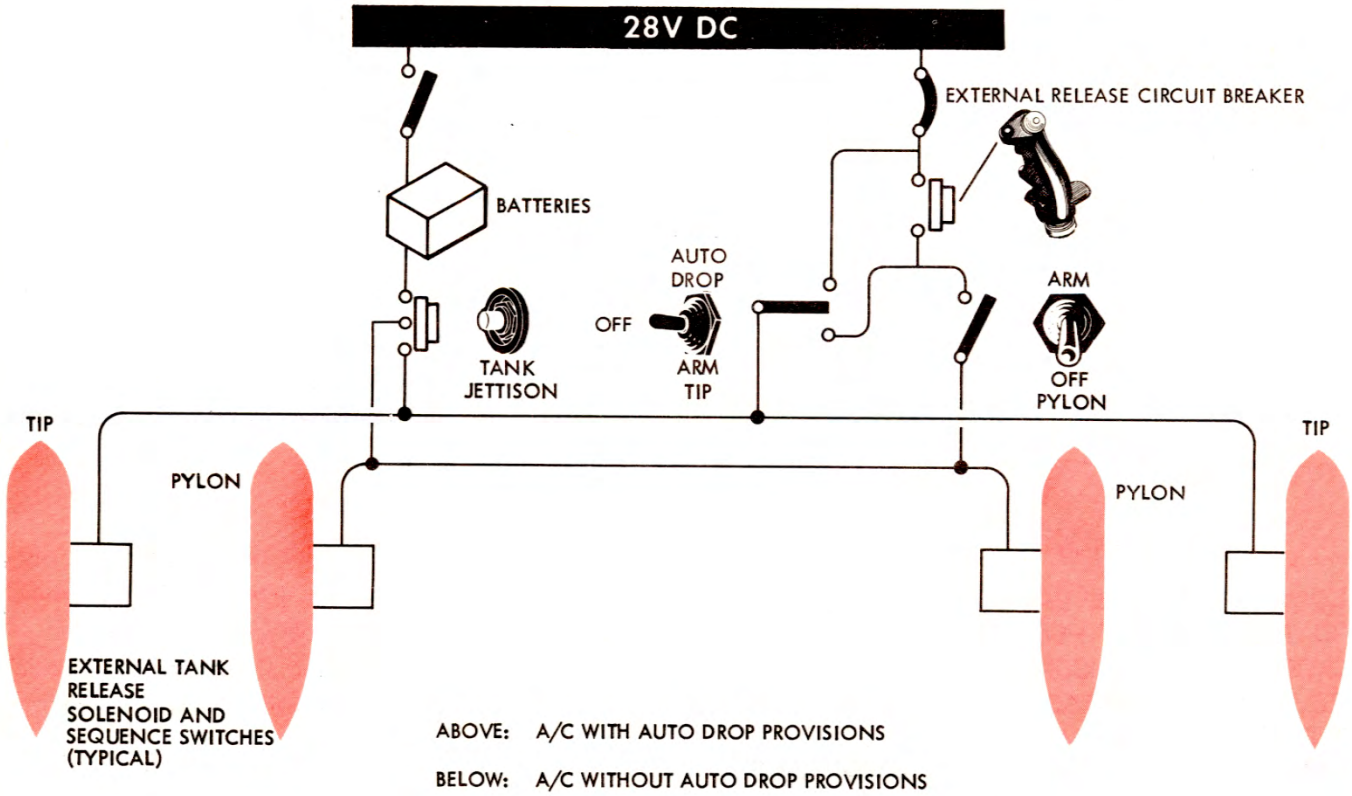
**30-KVA Alternator Voltage Adjusting Rheostat.**

This rheostat in the rear cockpit (7 figure 4-17) is accessible by raising the cover box and is provided to adjust the voltage of the 30-kva alternator, if necessary.

**CAUTION**

Never adjust the 30 kva or 8 kva alternators for less than 112.5 volts or more than 120.0 volts. If adjustment is necessary before the system has warmed up (30 minutes operation), continue rechecking the adjustment until warmup is complete.

# EXTERNAL TANK RELEASE CIRCUIT



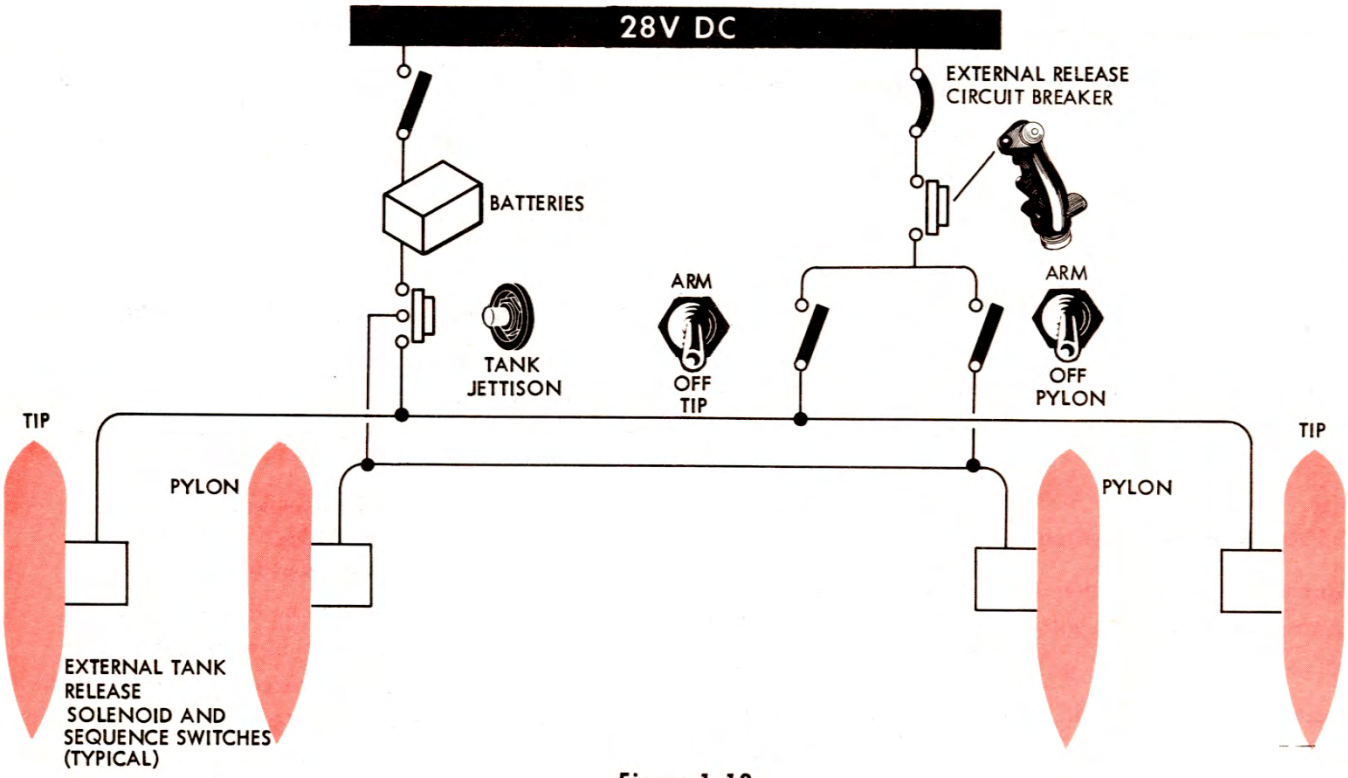




*Figure 1-18*

## ELECTRICAL POWER SUPPLY SYSTEM INDICATORS.

### Generator Out Warning Light.

An amber generator out warning light is installed on the left side of the instrument panel (1 figure 1-7). The light will glow whenever the generator is not connected to the d.c. electrical system, provided that an alternate source of direct current (batteries or external power) is available to energize the light. If the light comes on when the generator switch is in the GENERATOR position, the loadmeter should also be checked to determine whether the generator is actually off the line or if there is merely a short in the warning light circuit.

### Loadmeter.

The loadmeter on the left side of the instrument panel indicates the percentage of rated generator amperage output (400) being used by the system at any particular time. It is calibrated in tenths from 0 to +1.25. Thus, if the loadmeter is indicating .5, it means that the electrical load on the generator is 200 amps. (50% of rated generator output).

### D.C. Ammeter.

The d.c. ammeter is installed in the radar observer's cockpit and indicates generator current directly in amps.

### D.C. Voltmeter

A d.c. voltmeter is installed in the radar observer's cockpit to indicate the d.c. generator voltage output.

### Instrument Power Warning Light.

This red light (39 figure 1-7), located on the instrument panel is energized by 28 volt d.c. and is designed to glow when the inverter selected by the instrument power switch has failed. With direct current available, the inverters can be tested by means of the instrument power switch and the instrument power warning light. If the warning light glows, the inverter selected by the instrument power switch is not operating and, conversely, if the light does not glow the inverter is operating. The light will glow whenever the instrument power switch is OFF and the d.c. system energized.

### A.C. Voltmeter.

This voltmeter (11 figure 4-18), located in the radar observer's compartment, is used in conjunction with a selector switch (15 figure 4-17) that has three positions: RADAR INV. (2500 VA inverter), 30 KVA ALT, and 8 KVA ALT. The voltage output of any of these units may be determined by selecting the desired inverter or alternator and reading the indication on the a.c. voltmeter.

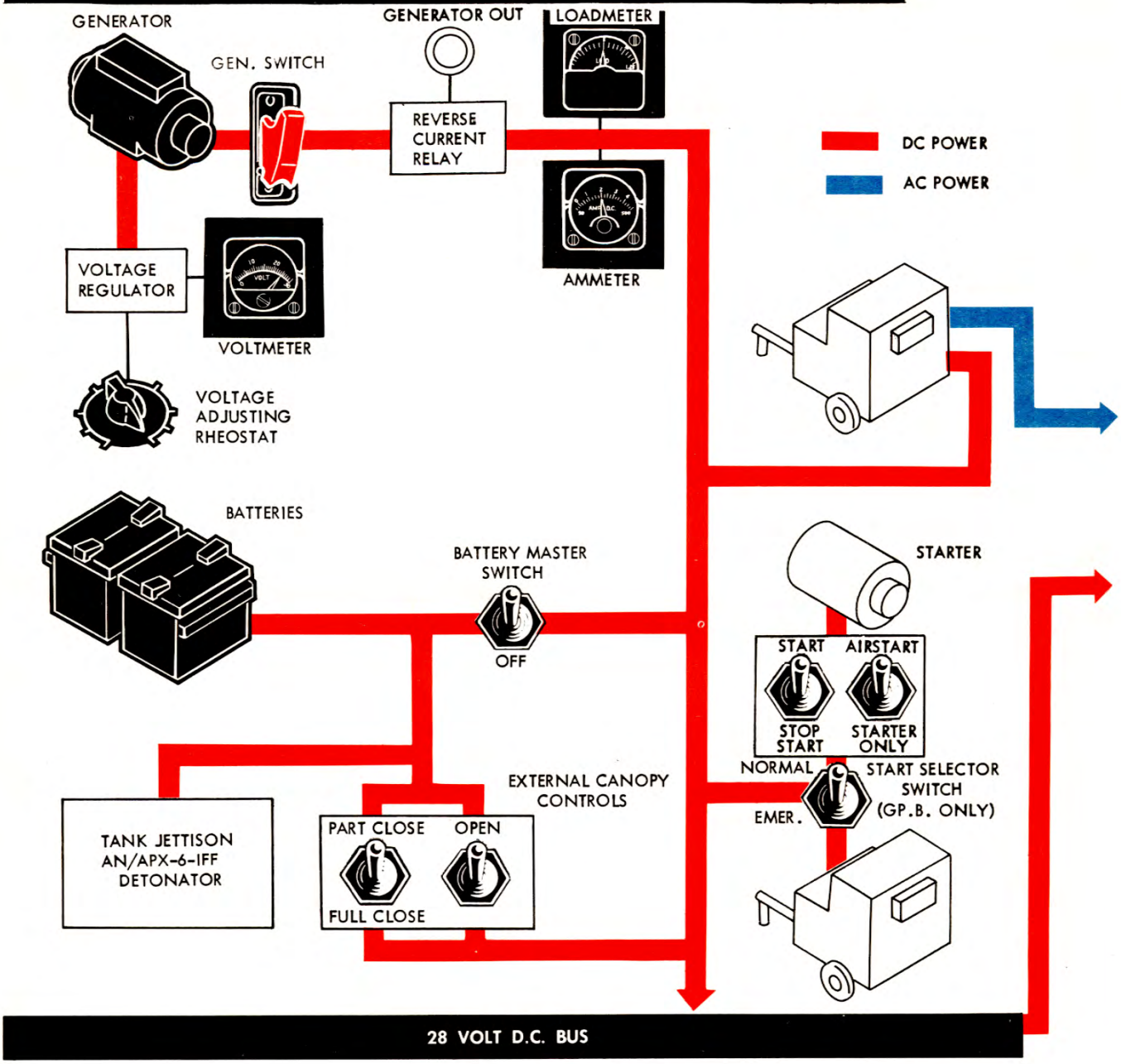
### Radar A.C. Under Frequency Warning Light.

This light (16 figure 1-9) is located on the center control panel. The amber light glows whenever the frequency of the 8 kv.a. alternator drops below approximately 380 cycles per second. This will occur at engine speeds below approximately 55% rpm. When the light is on, the radar will not operate properly and the scope presentations will not be accurate.

## HYDRAULIC POWER SUPPLY SYSTEMS.

The aircraft hydraulic power supply system (figure 1-20) consists of the normal hydraulic system which operates the aileron booster, elevator booster, speed brakes, landing gear, and rocket doors, and the emergency hydraulic system which may be used to lower the landing gear in the event of malfunction of the normal hydraulic system. The normal hydraulic system is powered by two engine-driven pumps which automatically regulate system pressure at 1500 (±50) psi above approximately 8-10% engine rpm. Protection against excessive system pressure is afforded by a system relief valve which relieves pressures in excess of 1725 (±25) psi. Two air-charged accumulators store system pressure to reduce fluctuations in pump loadings at peak demand and prevent surges in the system. When the automatic pilot is being used, the flow of hydraulic fluid to the boosters and rudder servo is controlled by the automatic pilot control valves and directed to the booster and servo cylinders to move the control surfaces and make the aircraft follow the selected course. To assure normal control stick forces, a "cheater" valve is installed in the system to isolate the aileron and elevator boost mechanism if the hydraulic pressure should drop to 800 psi or below. If the pressure drops, the "cheater" valve will shut off the flow of fluid to the landing gear, speed

# ELECTRICAL POWER DISTRIBUTION DIAGRAM




- AFTERBURNER NOZZLE OVER-RIDE
- AILERON TAB ACTUATOR AND CONTROL
- ANA-84 ROCKET BALLISTICS COMPUTER
- AN/APG-40 RADAR D.C.
- AN/APX-6 IFF RADAR D.C.
- AN/ARC-6 RADIO COMPASS
- AN/ARC-27 COMMAND RADIO
- ATO CONTROL CIRCUIT
- AUTOMATIC PILOT D.C.
- BOMB ARMING CONTROLS
- CAMERA HEATER
- CAMERA MOTOR AND CONTROLS
- CANOPY ACTUATOR AND CONTROLS
- COCKPIT AIR TEMPERATURE CONTROL
- CONTROL STICK TRIMMER
- DIRECTIONAL INDICATOR D.C.
- ELEVATOR BOOST RATIO CONTROLS
- ELEVATOR TAB ACTUATOR AND CONTROL
- EMERGENCY HYDRAULIC PUMP
- ENGINE IGNITION
- ENGINE STARTER
- EXTERIOR LIGHTS
- EXTERNAL TANKS RELEASE
- FUEL BOOST PUMPS
- FUEL QUANTITY INDICATOR
- FUEL SHUT-OFF VALVES
- FUEL SYSTEM DEICING PUMP AND CONTROL
- GLIDE PATH RECEIVER
- INTERIOR LIGHTS
- INTERPHONE AMPLIFIER
- LANDING GEAR INDICATORS
- LOCALIZER RECEIVER
- MARKER BEACON RECEIVER
- OVERHEAT AND FIRE WARNING LIGHTS
- PITOT HEATER
- RADAR PRESSURIZING PUMP AND CONTROLS
- ROCKET DOOR VALVE
- ROCKET FIRE CONTROL
- SPEED BRAKE CONTROL
- TURN AND SLIP
- WARNING AND INDICATOR LIGHTS
- WINDSHIELD DEFROSTING CONTROL
- WINDSHIELD DEICING CONTROL
- WING AND EMPENNAGE DEICING CYCLIC TIMER
- WING FLAP ACTUATOR AND CONTROL
- ZERO READER D.C.

*Figure 1-19. (Sheet 1 of 2 Sheets)*

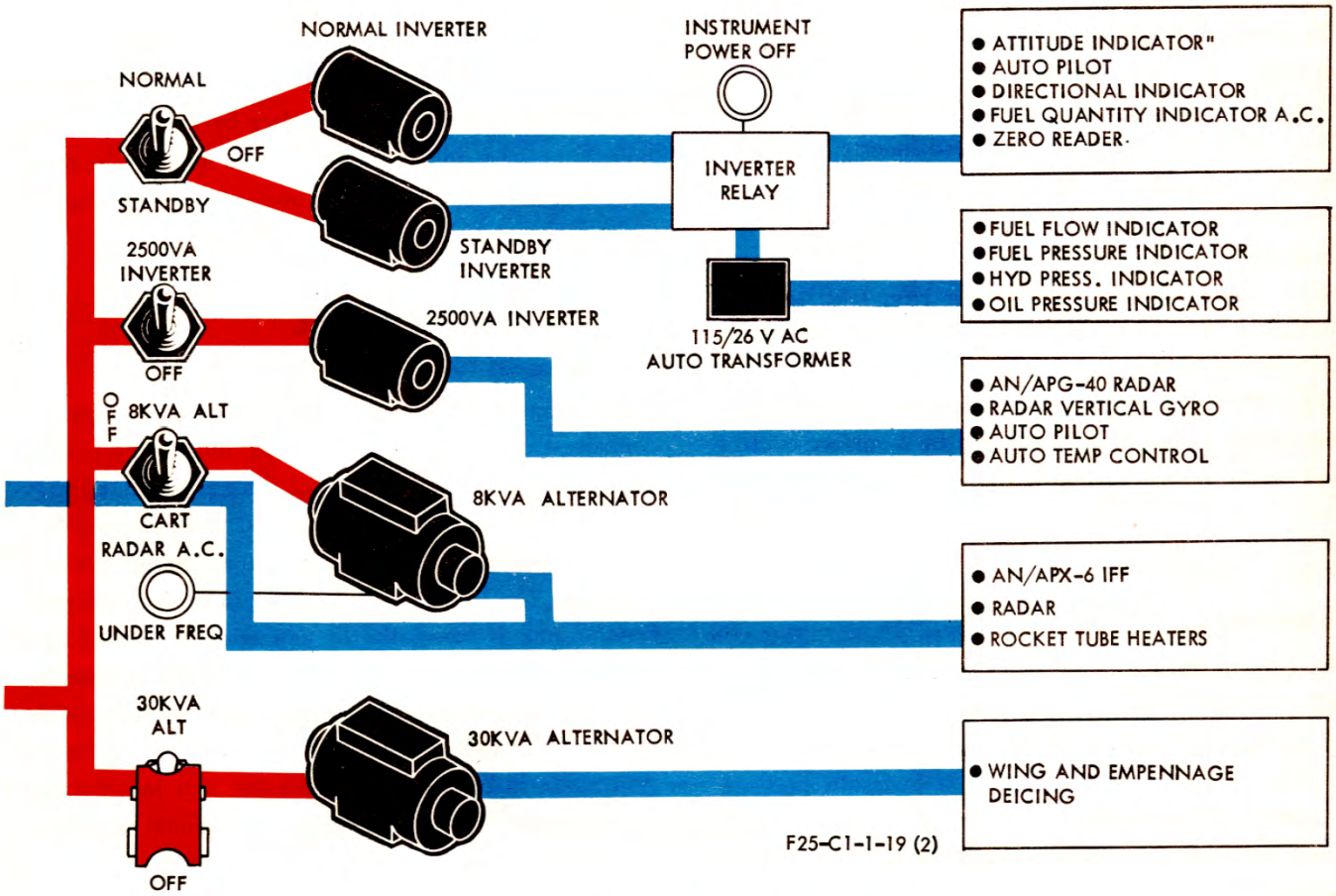



*Figure 1-19. (Sheet 2 of 2 Sheets)*

brakes and rocket doors, reserving available pressure for operation of the boosters. Operation of the normal hydraulic power system is automatic, and pressure is indicated by a gage (2, figure 1-7) located on the instrument panel. A two position switch (41 figure 1-7) is provided on the left side of the instrument panel to select the pressure output of either of the engine driven hydraulic pumps to be indicated on the hydraulic pressure gage. The emergency hydraulic system includes a separate one-gallon reservoir, an electric gear-type hydraulic pump operated by 28-volt d.c. power, and a selector lever which operates a valve to direct hydraulic fluid from the emergency system to the down side of the landing gear actuating cylinders. A two gallon fluid supply and an expansion space are provided by the main hydraulic reservoir that is located in the engine plenum chamber. The reservoir is pressurized by air from the engine compressor to reduce foaming and the possibility of pump cavitation. The hydraulic fluid grade and specification and replenishment locations are given on the aircraft servicing diagram, figure 1-27.

## FLIGHT CONTROL SYSTEM.

The primary flight controls are moved manually by conventional control stick and rudder pedals or remotely through the electrical and hydraulic systems of the automatic pilot. Hydraulically powered boosters for the ailerons and elevators are normally used to reduce control stick forces; however, the boosters may be turned off if desired. The airplane may be trimmed by electrically operated aileron and elevator trim tabs, ground-adjustable rudder and aileron bend tabs, and electrically repositioned springs to control lateral movement of the stick. When the airplane is parked, the control stick and rudder pedals may be secured by a surface control lock that is stowed during flight.

### FLIGHT CONTROLS.

#### Control Stick.

The control stick (figure 1-21) is connected by push-pull rods to the aileron and elevator assemblies. Elevator and aileron boost control valves are also positioned by movement of the control stick. If hydraulic pressure is available to the boost control valves, these valves will direct the pressure to boost cylinders which apply additional forces to the push-pull rods to augment the force applied by the pilot on the control stick. The control stick grip (2, figure 1-21) mounts the control stick trim and elevator trim tab switch, external tank (and bomb) release button, rocket firing trigger, automatic pilot disengage button, and interphone only button. The emergency hydraulic pump switch is mounted on the control stick below the grip.

#### Rudder Pedals.

The rudder pedals are mechanically connected by cables to the rudder bell crank. The rudder pedals are adjustable and may be extended or retracted by turning the rudder pedal adjusting crank (31, figure 1-7) located on the center control pedestal. Toe pressure on the rudder pedal foot rests actuates the airplane wheel brakes. (Refer to "Wheel Brake System" in this Section.)

**Note**

There is no hydraulic operation of the rudder except by the autopilot system.

#### Surface Control Lock.

The surface control lock consists of a tubular bracket (figure 1-22) that may be attached to the rudder pedals and control stick and held in place by a wing nut and bolt. It may be stowed in clips on the floor to the right of the pilot's seat, or in the radar observer's cockpit (9, figure 4-18).

### AILERON CONTROL SYSTEM.

#### Aileron Boost System.

The hydraulic aileron booster increases the applied control stick forces and the pilot must supply only about one forty-fifth of the total force required. Springs are installed to furnish the pilot an artificial feel that increases the stick forces as deflection of the ailerons increases. The booster unit is powered by the hydraulic system and is normally in operation whenever the engine is running. A hydraulic accumulator is installed in the booster section of the hydraulic system to provide smooth operation when other units of the hydraulic system are in operation. The booster unit incorporates an automatic bypass valve to permit manual operation of the ailerons in the event of failure of the hydraulic system.

**Aileron Booster Shut-Off Lever.** Hydraulic pressure to the aileron boost system is shut-off when the aileron booster shut-off lever is in the OFF position.

#### Control Stick Trim System.

When the control stick trim (and elevator trim tab) thumb switch (1, figure 1-21) is moved to the left or right, a 28-volt d.c. motor rotates a jackscrew to position the lateral feel springs so that the stick force can be reduced to zero to maintain the airplane in lateral trim. If the aileron booster is working normally, this system is primary for lateral trim. However, if the aileron booster is off or inoperative, the feel spring force will be negligible compared to the large stick force required, and the control stick lateral trim will be ineffective. In this condition the aileron trim tab switch should be utilized for lateral trim.

#### Spoilers.

Hinged spoilers (10, figure 1-2) located just forward of

**CAUTION**

ON SOME AIRCRAFT THE AILERON BOOSTER IS OFF WHEN THE SHUT-OFF LEVER IS IN THE FORWARD POSITION. THE **ON** AND **OFF** POSITIONS ARE PLACARDED AND SHOULD ALWAYS BE VISUALLY CHECKED PRIOR TO MOVING THE LEVER TO ASSURE THAT HYDRAULIC BOOST WILL BE AVAILABLE FOR TAKE-OFF.

each aileron on the upper wing surface, are mechanically connected to and operate in conjunction with the ailerons so that the spoiler raises any time the aileron is raised above the neutral position, and returns to a flush position on the wing surface when the ailerons are returned to neutral or lower. The spoilers increase lateral control at the trim change speed and at landing speed.

**Aileron Trim Tabs.**

The trim tab on the left aileron is operated by a 28-volt d.c. electric motor and is used to trim the airplane laterally. The bend tab on the right aileron is ground adjustable only.

**Aileron Trim Tab Switch.** This three-position switch (5, figure 1-12) located an the left forward side panel, controls the electric motor that operates the trim tab on the left aileron. The switch is spring-loaded to the center (off) position. Holding the switch down (RIGHT) moves the tab to lower the right wing, while holding the switch up (LEFT) lowers the left wing. This switch is used to trim the airplane laterally in place of the control stick trim switch when the aileron booster is shut off.

**ELEVATOR CONTROL SYSTEM.**

**Elevator Boost System.**

The elevator boost ratio is variable and the pilot may adjust this ratio between 2.64 to 1 and 11 to 1. The low boost ratios are generally used for flight at relatively low airspeeds and the higher boost ratios are used for high speed flight when the air loads on the elevators are greatly increased. The ratio is changed by an electric motor operated by the 28-volt d.c. system and override stops are incorporated to automatically shut off the motor when the limits are reached.

**Elevator Booster Shut-Off Lever.** Hydraulic pressure to the elevator boost system is shut off when the ELEVATOR BOOSTER shut-off lever (9, figure 1-11) is in the placarded OFF position. (This will correspond to the AILERON BOOSTER shut-off lever OFF position and should be visually checked prior to flight.)

**Elevator Boost Ratio Switch.** This switch (4, figure 1-12), located on the left forward side panel, is spring loaded to the center, off, position. The switch may be held in the INCREASE (up) or DECREASE (down) position to change the elevator boost ratio.

**Elevator Boost Ratio Indicator.** A sliding type indicator (26, figure 1-7) is provided at the right side of the instrument panel to show the elevator boost ratio being used.

**Elevator Trim System.**

The elevator trim tabs are located on the inboard trailing edges of the elevator and are operated by a 28-volt d.c. motor to trim the airplane longitudinally. The reversible motor is actuated by the control stick trim (and elevator trim tab) thumb switch on the control stick grip. When the thumb switch is pushed forward the aircraft is trimmed nose down, and when the switch is held aft the nose is trimmed up.

# HYDRAULIC SYSTEM DIAGRAM

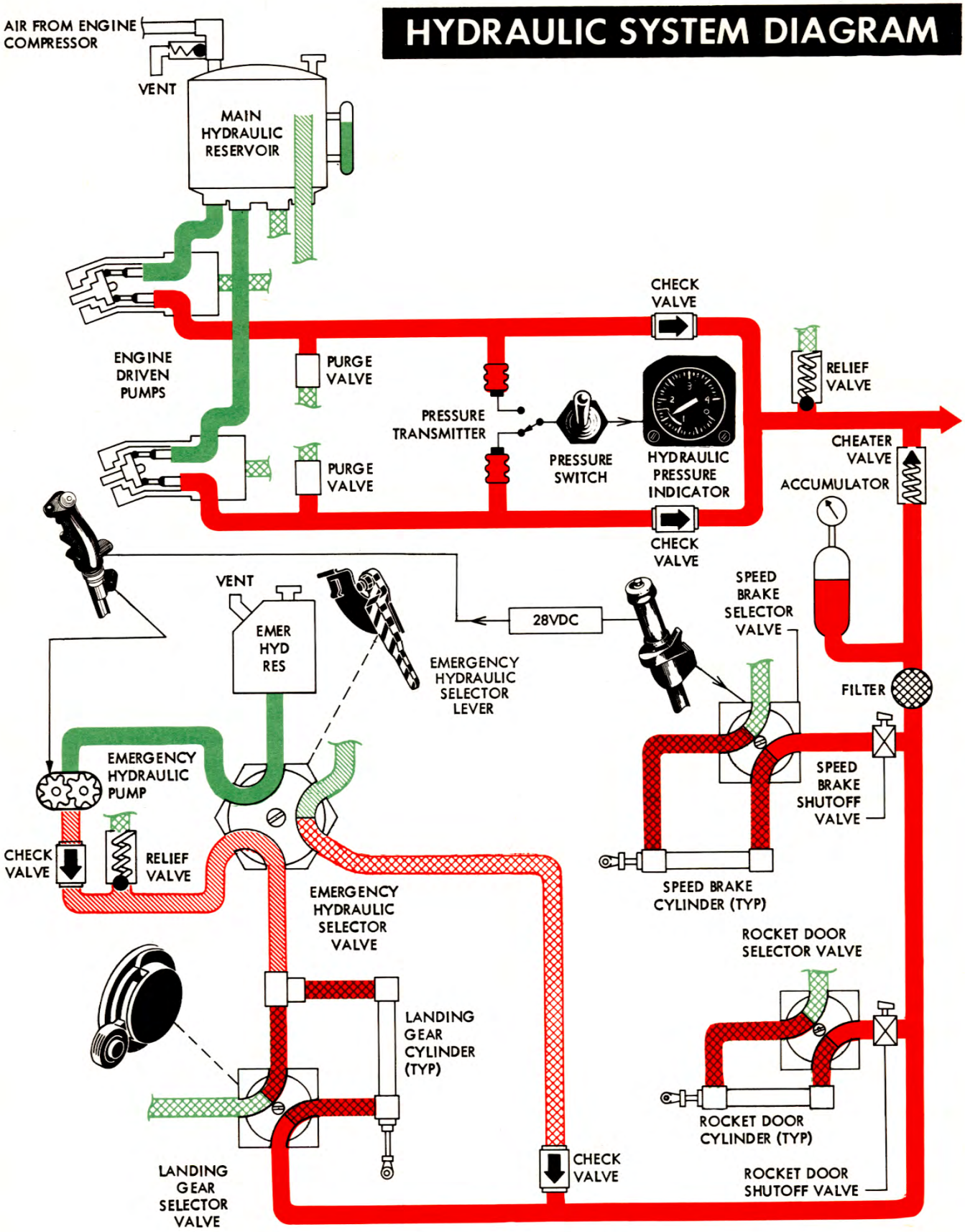



*Figure1-20. (Sheet 1 of 2 Sheets)*

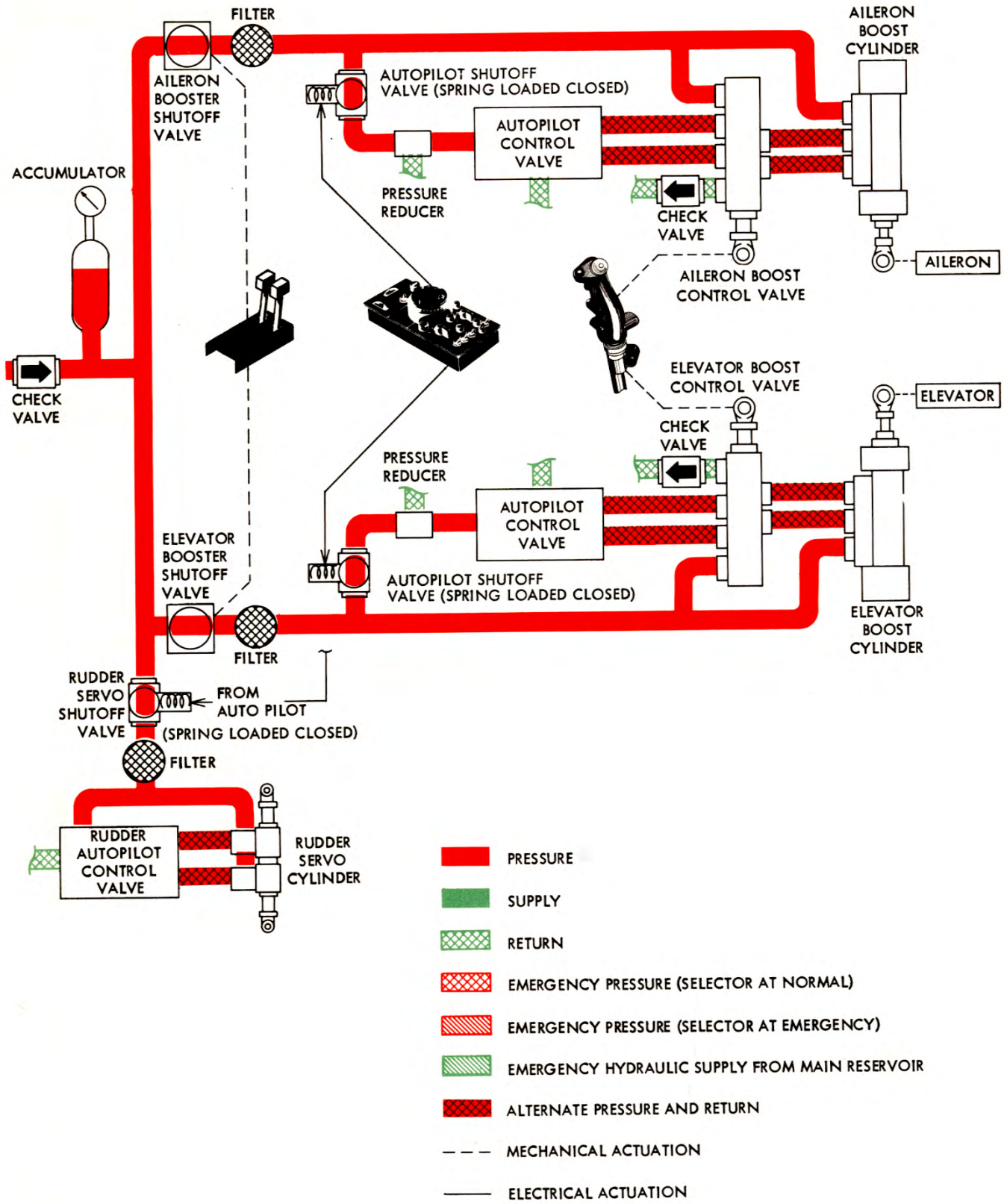



*Figure 1-20. (Sheet 2 of 2 Sheets)*

**CAUTION**

Make certain that the thumb switch returns to the neutral position after the airplane is trimmed.

**Elevator Tabs Neutral Indicator Light.** A green indicator light (1, figure 1-14) glows whenever the elevator tabs are in the neutral position. For night-time operations the light may be dimmed by rotating the cover of the light clockwise.

## WING FLAP SYSTEM.

Split-type wing flaps are mounted on hinges under the trailing edge surface of each wing, extending from the fuselage to the ailerons. The flaps are operated by two 28-volt d.c. motors mechanically interconnected by a flexible shaft so that if one motor fails, the remaining motor will operate both flaps. However, retraction and extension time will be slightly increased when only one motor is operating.

### WING FLAP SWITCH.

The wing flaps are controlled by a switch (7, figure 1-13) located on the pilot's left forward panel. The switch has three positions: UP, center (OFF), and DOWN. The flaps may be stopped in any intermediate position by moving the switch to the center position.

### WING FLAP POSITION INDICATOR.

The wing flap position indicator (6, figure 1-13) located on the left forward panel, shows the position of the flaps in degrees from 0° (up) to 45° (down).

## AERODYNAMIC DRAG DEVICES.

The aircraft is equipped with two pairs of hydraulically operated speed brakes which may be used to increase the drag of the airplane to control or reduce speed during any flight condition. The forward pair of speed brakes is located in the underside of the fuselage forward of the main landing gear wheel wells, and the aft pair is located in the fuselage behind the wing fillets. A drag chute is provided to reduce the landing roll distance. The chute is packed in a housing above the fuselage tail cone, and is designed to be used after touchdown when desired.

### SPEED BRAKE SYSTEM.

The hydraulically operated speed brakes are electrically controlled, and, although each brake has a separate hydraulic actuating cylinder, both pairs of brakes operate simultaneously. The speed brakes are controlled by a switch which allows partial extension or retraction of the brakes.

**Speed Brake Switch.**

Position selection of the speed brakes is made by a sliding switch (figure 1-5) mounted on the throttle. This switch controls the 28-volt d.c. motor that operates the speed brakes hydraulic selector valve. The switch has four positions: DOWN, NEUT, UP, and UP LOCK. When the switch is released from the UP or DOWN positions, it will spring to the NEUT position, allowing the pilot to stop the brakes at any desired angle within the full travel range. When the switch is placed in the UP LOCK position, the brakes will retract and will remain in the full UP position.

### DRAG CHUTE SYSTEM.

The 16 foot ribbon-type drag chute is released by a cable controlled mechanism, actuated by a handle in the pilot's cockpit. Use of the drag chute reduces the landing ground roll approximately 40%. Refer to Appendix I for landing distances.

**Note**

A safety link is installed in the drag chute cable. The link will shear and the chute will be jettisoned if the drag chute is released at speeds in excess of approximately 200 knots.

**Drag Chute Release and Jettison Handle.**

This handle (15, figure 1-11), located on the left side of the pilot's cockpit near the anti-G suit control valve releases and jettisons the drag chute. When the handle is in the down position the drag chute is not attached to the airplane. Pulling the handle up approximately

# CONTROL STICK AND SURFACE CONTROL LOCK

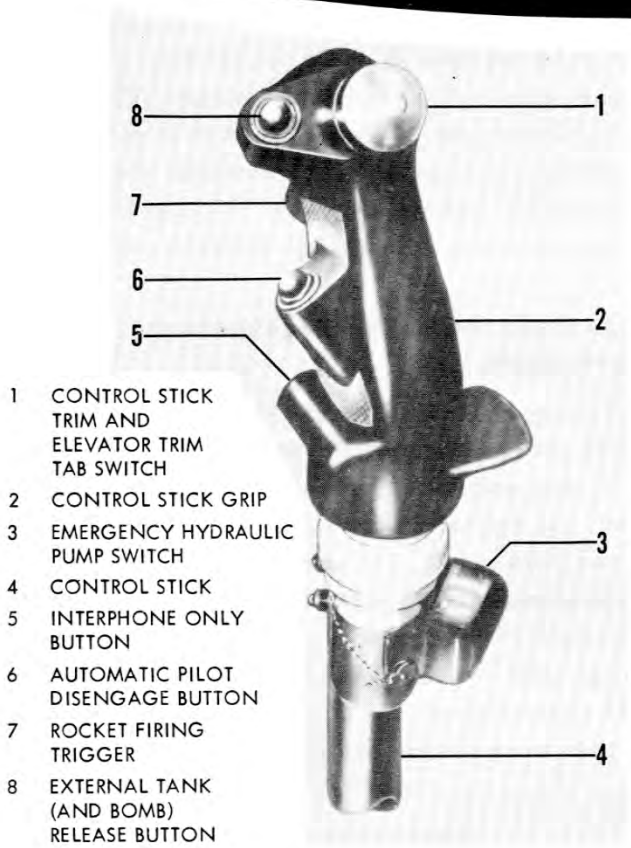



*Figure 1-21*

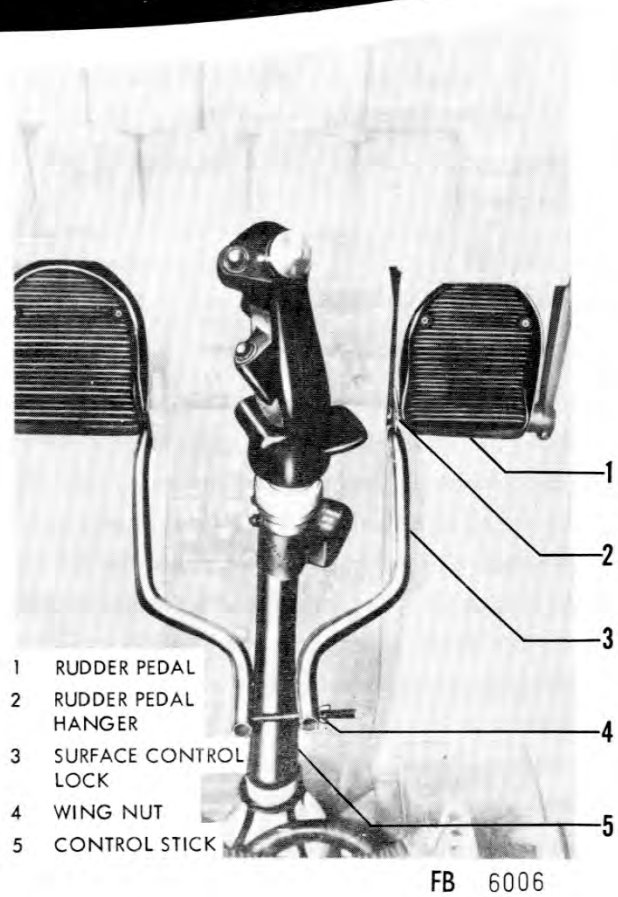



*Figure 1-22*

2½ inches engages the drag chute locking hook, opens the drag chute door, and releases the drag chute. Turning the handle one half turn (180°) in a clockwise direction and pulling the handle up approximately another two inches jettisons the drag chute.

## LANDING GEAR SYSTEM.

The hydraulically operated tricycle landing gear is controlled by the landing gear selector valve, which is mechanically positioned by the landing gear control lever (12, figure 1-11) on the left side of the pilot's cockpit. The nose gear doors are controlled mechanically by the nose gear strut, while the main landing gear wheel well doors are opened and closed hydraulically. Each gear is provided with a hydraulically operated uplock and downlock, and an electrically operated position indicator. A warning system is provided to indicate when all gears are up and locked or down and locked, and to give visual and audible warning when the throttle is retarded below approximately 65% and the gear is not down and locked. Air-oil landing gear shock struts on each gear absorb the landing impacts. Wheel brakes are mounted on each main landing gear, and the nose gear assembly includes a shimmy damper to dampen vibrations. Ground steering is accomplished by differential braking of the main gear. To prevent accidental folding of the landing gear drag struts while the airplane is parked with little or no hydraulic pressure, a safety clip and pins must be installed. The nose gear safety clip is installed on the spring loaded downlock cartridge, while each main gear safety pin is installed in a hole drilled through the landing gear actuating cylinder and actuating rod. The safety clip

and pins have long red streamers attached to attract attention during the preflight check.

**Note**

- Landing gear extension time is approximately 8 to 10 seconds on the normal system and 50 seconds on the emergency system.
- Landing gear retraction time is approximately 5 seconds.

## LANDING GEAR CONTROLS.

### Landing Gear Control Lever.

The landing gear control lever (12, figure 1-11) mechanically positions the landing gear selector valve which directs hydraulic pressure from the main hydraulic system to the up or down side of the landing gear actuating cylinders. The lever is held in either the UP or DOWN position by spring pressure and notches at each position. This lever must be in the DOWN position before the gear can be extended by the normal or emergency system. A warning light is incorporated in the center of the red plastic control handle and glows when the landing gear is in an unsafe position and 28-volt d.c. is available. A solenoid lock, actuated by a scissors switch on the left main gear strut, prevents movement of the landing gear control lever from the DOWN position while the weight of the airplane is on the gear.

### Landing Gear Control Lever Solenoid Lock Release.

If it becomes necessary to raise the gear while the aircraft is on the ground or if the gear control lever cannot be moved to the UP position when airborne, the landing gear control lever solenoid lock may be released by depressing the release lever (13, figure 1-11) and holding this lever down until the landing gear lever is started to the UP position.

**Note**

When airborne, it is not normally necessary to depress the solenoid release lever to raise the landing gear control lever.

## LANDING GEAR SYSTEM INDICATORS.

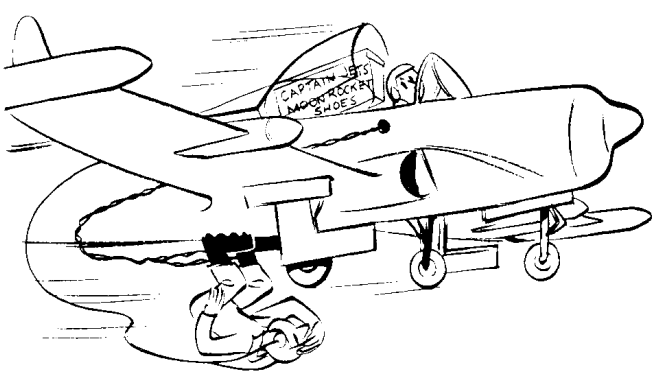
### Landing Gear Position Indicator.

The landing gear position indicators (1, figure 1-13) located on the left forward panel, shows the condition of each landing gear. If the 28 volt d.c. bus is not energized or if the gear is in an intermediate position, diagonal stripes will appear in each window. When the d.c. bus is energized, a wheel will appear in each window if the corresponding gear downlock switch has been actuated, and the word UP will appear if the corresponding gear uplock switch has been actuated.

### Landing Gear Unsafe Warning Light and Warning Horn.

The landing gear unsafe warning light is located in the landing gear control lever handle and glows whenever the landing gear is not up and locked or down and locked. The light also glows whenever the landing gear warning horn sounds. The landing gear warning horn sounds whenever power is reduced below approximately 65% and the landing gear is not down and locked. A landing gear warning horn cut-off button (4, figure 1-13) is provided on the left forward panel to silence the horn when desired. When this button is used, the

**CAUTION**




IF THE GEAR WARNING SYSTEM MICRO-SWITCHES BECOME FROZEN OR STUCK, THE CORRESPONDING POSITION INDICATORS MAY INDICATE DOWN OR UNSAFE AFTER THE GEAR IS RAISED. IF THIS HAPPENS, A VISUAL CHECK OF THE GEAR SHOULD BE MADE PRIOR TO LANDING SINCE THE DOWN AND LOCKED INDICATION MAY ALSO MALFUNCTION.

horn system will be automatically reset the next time the throttle is advanced beyond approximately 65%.

**CAUTION**

Due to the proximity of the horn cut-off button to the tank jettison button, the pilot should visually check the position of the button prior to using it to avoid inadvertently dropping the external tanks.

**Landing Gear Warning System Test Button.** This button (8, figure 1-13) is decalled PUSH TO TEST LG. WARN LT. and may be used to test both the landing gear warning light in the landing gear control lever handle and the landing gear warning horn. If 28 volt d.c. power is available and the button is depressed, the warning light should glow and the horn should sound.

## LANDING GEAR EMERGENCY EXTENSION SYSTEM.

The emergency landing gear system (figure 1-20) consists basically of an electrically-driven hydraulic pump, a separate reservoir, a selector valve, and a separate set of "down" lines to the gear actuating cylinders. The emergency hydraulic system is provided to extend the landing gear if the landing gear cannot be extended on the normal system. The system utilizes the hydraulic fluid from the emergency hydraulic reservoir and a separate group of hydraulic lines that lead to the landing gear actuating cylinders. The emergency landing gear extension procedure is illustrated on figure 3-6.

**CAUTION**

The emergency hydraulic pump must not be operated in flight on the normal hydraulic system, because if the hydraulic fluid in the normal system reservoir is below the top of the standpipe in the reservoir, the pump will run dry and probably fail. There is no way in flight of determining that the fluid is above the top of the standpipe. Therefore, use of the emergency pump is restricted to emergency extension of the landing gear with the emergency hydraulic system selector in the EMERGENCY position.

### Emergency Hydraulic System Controls.

**Emergency Hydraulic System Selector Lever.** The emergency hydraulic system selector lever (21, figure 1-14) operates a valve to allow emergency hydraulic system pressure to lower the landing gear. This lever has two positions, NORMAL and EMERGENCY. In the NORMAL position, normal hydraulic system fluid may be directed by the landing gear control line to retract or extend the gear. When the lever is in the EMERGENCY position, hydraulic fluid from the emergency hydraulic system reservoir is directed through a separate set of hydraulic lines to the down side of the landing gear actuating cylinders whenever the emergency hydraulic pump is energized.

**Note**

This lever must be in the NORMAL position to retract the gear.

**Emergency Hydraulic Pump Switch.** This switch (3, figure 1-21) is located on the control stick below the grip to allow the pilot to maintain control of the aircraft while operating the pump. The switch is spring loaded to the off position and, when pressed, energizes the emergency hydraulic pump that is operated by the 28-volt d.c. electrical system.

**CAUTION**

- Do not operate the pump for more than 3 minutes in any 23 minute period.
- Place emergency hydraulic system selector lever in EMER position before using the emergency hydraulic pump switch.
- The switch must be held ON to keep the pump operating.

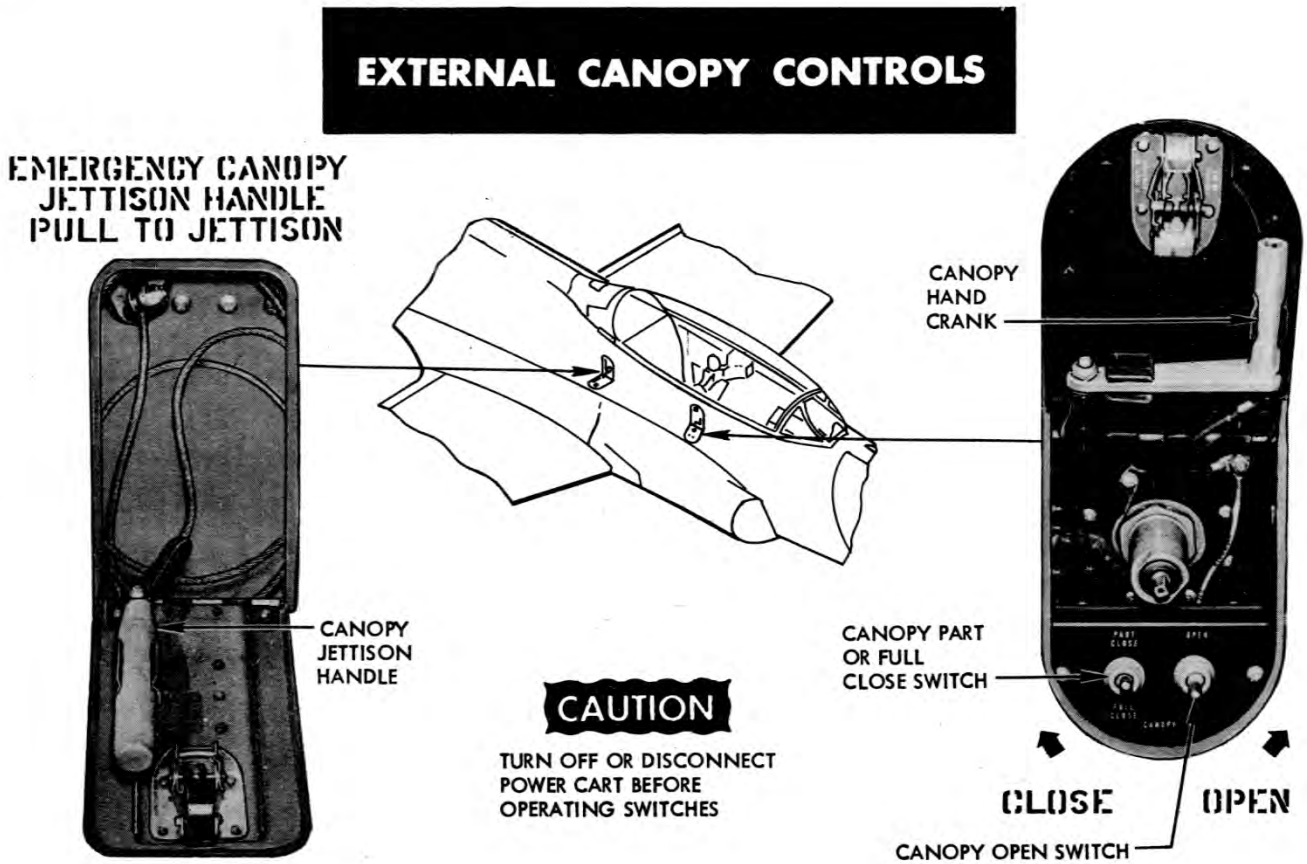



*Figure 1-23*

FB 6090

## WHEEL BRAKE SYSTEM.

The airplane is equipped with hydraulic brakes on the main gear, operated by toe pressure applied to the rudder pedal foot rests. The brake system is entirely separate from the main hydraulic system, and has its own reservoir in the top of the nose section (2, figure 1-27). The left and right wheel brakes operate independently except for utilizing the common fluid reservoir.

## INSTRUMENTS.

The pilot's instruments are mounted on three panels: the main (center) instrument panel, the left forward panel, and the right forward panel. All the flight and engine instruments are installed on the main instrument panel, and are grouped so that the flight instruments occupy the center portion of the panel. The radar observer's cockpit is equipped with instruments that are necessary to operate the radar equipment, check operation of the generator and alternators, and assist the pilot with navigation. These instruments include an ammeter, two voltmeters, an airspeed indicator, an altimeter, a directional indicator, and a radio compass indicator.

**Note**

Instruments that are an integral part of a system are discussed with that system.

### PITOT-STATIC SYSTEM.

Impact air pressure is transmitted to the airspeed indicators through a system of lines from the pitot tube mounted under the nose of the airplane. The pitot tube may be electrically heated to prevent or remove an accumulation of ice. When on the ground, the pitot tube should be covered to prevent entry of foreign matter into the pitot system.

**CAUTION**

This cover must be removed before flight since the airspeed indicators are inoperative with the pitot tube covered.

Outside static air pressure is transmitted to the airspeed indicators, altimeters, and vertical velocity indicator, from two flush-type vents near either side of the pitot tube.

### Airspeed Indicator.

Each cockpit is equipped with an airspeed indicator (36, figure 1-7, and 8, figure 4-17), operated by impact and static air pressures supplied by the pitot-static system. A pointer, mounted concentric with the white indicator needle, moves to indicate the best climb speed without afterburner (315 knots IAS at sea level). The indicated airspeed may be read accurately by using the small window at the upper center of the dial in conjunction with the white needle.

### Altimeter.

Altimeters (34, figure 1-7 and 9, figure 4-17), located in each cockpit, are operated by air pressure from the static air system. The instruments may be set for barometric pressure by twisting the knob on the lower left corner until the proper pressure shows in the window opposite the small arrow painted on the dial.

### Vertical Velocity Indicator.

The vertical velocity indicator (29, figure 1-7) is operated by the static air system, and indicates rate of climb or descent in feet per minute.

## ATTITUDE INDICATOR.

The B-1-A attitude indicator provides the pilot with a remote reference pictorial presentation of aircraft attitudes. The installation consists, basically, of a control assembly located in the sub-cockpit area, and an indicator on the instrument panel (20, figure 1-7). The control assembly includes a vertical gyro, rate of turn gyro, gyro erection system, and associated components. Any angular motion of the aircraft with respect to the reference established by the vertical gyro is detected by the control assembly and electrically transmitted to the universally mounted sphere on the indicator assembly. Indications of aircraft attitude are presented by movement of the sphere and horizon bar, which serve as a background for a miniature reference airplane. Bank angles are indicated by the position of the pointer at the top of the sphere in relation to the semicircular bank scale around the upper half of the instrument. The gyro is mounted so that aircraft attitudes are shown accurately through 360° of roll and plus or minus 82° of pitch. If the pitch limit of 82° is exceeded, the sphere will roll 180°, but still provide an accurate indication of aircraft attitude. As soon as the aircraft returns below the 82° limit the sphere will roll back to its normal position without introducing any errors into the system. The gyro erection system reduces turning errors to a minimum and prevents the accumulation of pitch errors during multiple acrobatic maneuvers. The sensitivity of the erection system is such that any turns made below a rate of 40° per minute will result in turn errors common to other instruments. Normally, all turns will be made above this rate and the instrument will be compensated for turn errors. In level flight, the maximum error in the indication of the airplane's attitude should be less than one-half degree.

**WARNING**

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 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 take-off run. At this time a climb indication error of approximately 1½ bar widths will normally be observed; however, the exact amount of error will depend upon the acceleration and elapsed time of each individual take-off. The erection system will automatically remove the error after the acceleration ceases.

Gyro caging is accomplished automatically by the erection system, thereby eliminating the necessity for manual caging provisions. An adjustment knob on the lower right side of the instrument permits alignment of the horizon bar and the miniature reference airplane to provide greater ease in maintaining a desired pitch attitude. An OFF flag in the upper left corner of the instru-

ment will be visible whenever d.c. or a.c. power to the instrument is disrupted. An instrument interlock mechanism insures the simultaneous application of 28v d.c. and 115v a.c. (instrument inverter power). This is a necessary requirement for proper operation of the B-1A. The system will start operating as soon as d.c. and a.c. are available, but the OFF flag will not retract until a warm-up period of approximately 2½ minutes has elapsed.

**WARNING**

There is a possibility of instrument malfunction caused by failure of certain components in the control assembly which will not cause the OFF flag to appear, and the other flight instruments should be cross-checked against the B-1A attitude indications to insure safe flight under instrument flying conditions.

### J-8 ATTITUDE INDICATOR.

Some aircraft are equipped with a J-8 attitude indicator which differs from the B-1A in several respects. The pitch limit of the J-8 is 27°. The instrmuent is subject to turn errors up to 5° of pitch and/or bank, and errors are induced by acrobatic maneuvers. Successive loops may cause the horizon bar to reach the limit of its movement (27°). The J-8 attitude indicator is manually caged by means of a PULL TO CAGE knob on the lower right side of the instrument. Allow 30 seconds after power is applied for the gyro to attain speed, then cage immediately to prevent torque stresses on the instrument mechanism.

**Note**

The J-8 attitude indicator should not be caged to correct in-flight errors unless the aircraft is in straight and level flight by visual reference to a true horizon. Otherwise, errors will be introduced into the system, since the gyro cages to the attitude of the aircraft and not the true vertical.

### TURN AND SLIP INDICATOR.

The conventional turn and slip indicator (33, figure 1-7) is operated by the 28 volt d.c. system. The turn needle markings are calibrated for four minute turns.

### STANDBY COMPASS.

A conventional magnetic compass is mounted on the upper right hand side of the windshield frame, and may be used for navigation in the event of instrument or electrical system failure. It may also be used to verify the operation of other direction indicating instruments.

### CLOCK.

The clock (7, figure 1-7) has a 12-hour dial and an 8-day hand-wound movement. Care should be exercised to avoid overwinding the clock.

## EMERGENCY EQUIPMENT.

### Fire and Overheat Warning System.

The fire and overheat warning system consists of two 28 volt d.c. circuits and one warning light on the instrument panel (11, figure 1-7). The fire warning circuit is actuated by thermoswitches in the engine compartment (plenum chamber) of the aircraft. Whenever one of these thermoswitches senses excessive temperatures, the switch closes, completing a 28 volt d.c. circuit to the warning light. The overheat warning circuit operates in an identical manner except that the thermoswitches are located in the aft or tail section of the aircraft. The red warning light will glow steadily whenever the fire warning circuit is energized, and will flash when the overheat circuit is energized. Two test buttons, one on each side of the light, have been provided to test the fire and overheat warning circuits. When the button to the left of the light is pushed, the fire warning circuit will be closed, while the right hand button when depressed, will close the overheat warning circuit.

**Note**

The fire and overheat warning circuits will be inoperative in the event of complete electrical failure.

## CANOPY.

A one-piece transparent clamshell-type canopy covers the pilot's and radar observer's stations. The canopy is hinged at the aft end, and is pivoted open or shut by an electrically-actuated chain-driven mechanism located between the seats. Upon closing, the canopy seal receptacle mates with a disconnect fitting allowing air from the engine compressor to inflate the rubber canopy seal tube which seals the canopy frame around the cockpit sill and windshield. A jettison catapult is provided for

# CANOPY UPLOCK MECHANISM

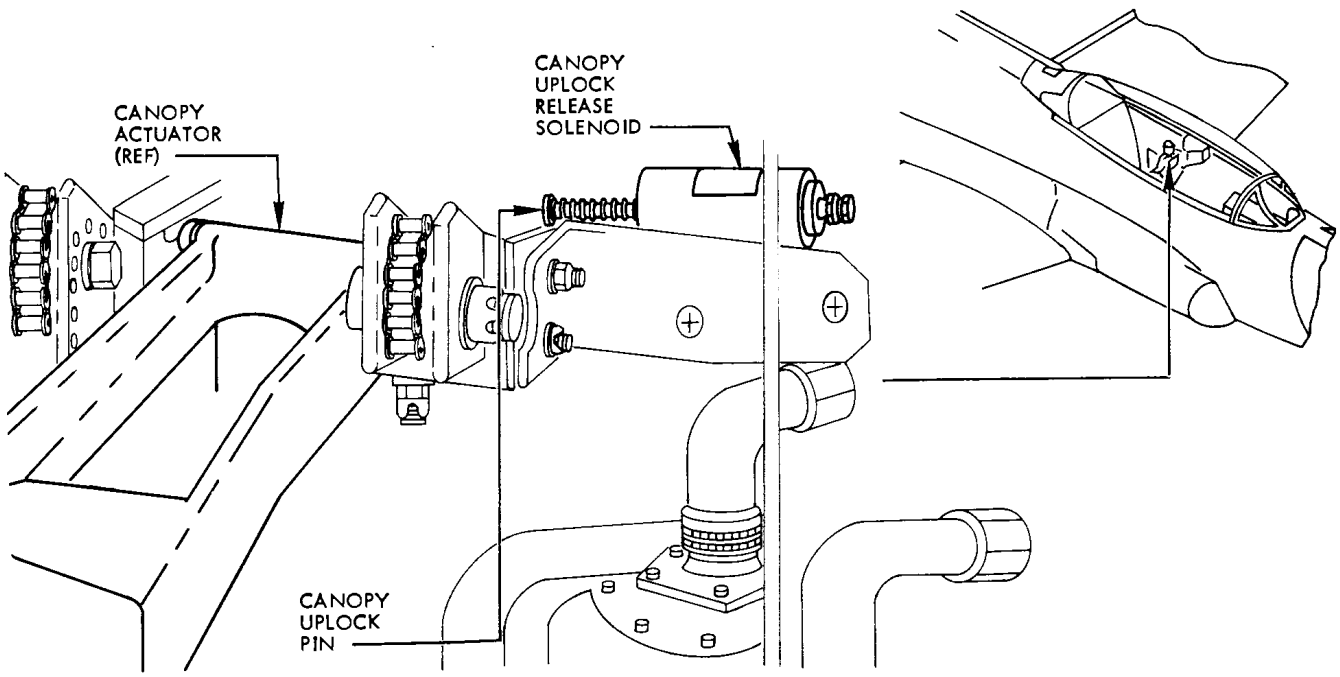



*Figure 1-24*

emergency removal of the canopy. A red flagged safety pin (figure 2-2) should be installed when the aircraft is on the ground to prevent inadvertent firing of the catapult. This ground safety pin must be removed before flight.

## CANOPY CONTROLS.

### Canopy Open Switches.

Canopy open switches are provided on the right side of both cockpits (12, figure 1-14) and in an external well on the right side of the fuselage (figure 1-23). The switches are all spring-loaded to the off position. When the canopy is raised to the full up position, a limit switch stops the canopy actuating motor and allows a spring-loaded uplock pin (figure 1-24) to engage to prevent the canopy from falling to the closed position if the canopy motor clutch fails. The external switches are wired to the battery system, and if an external power supply is connected and turned on, the batteries will be placed in parallel with the external power supply whenever the external canopy switches are actuated.

**CAUTION**

To avoid damaging the airplane batteries by placing them in parallel with the external power supply, do not actuate the external canopy switches when external power is connected to the aircraft.

### Canopy Part Close and Full Close Switches.

These canopy switches (12, figure 1-14 and figure 1-23) are spring loaded to the neutral (off) position and are located adjacent to the canopy open switches in each cockpit and in the external well. Each switch has three

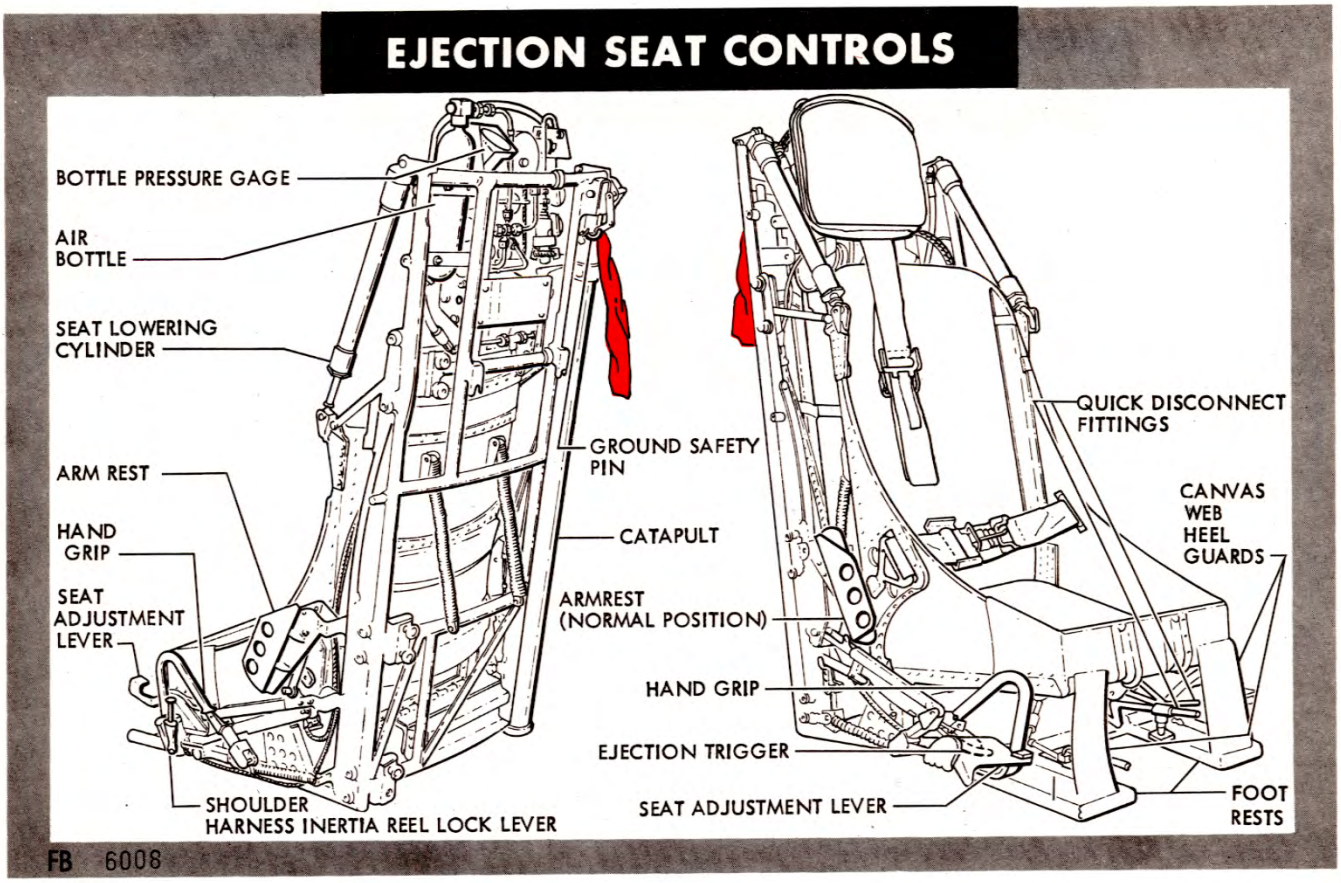



*Figure 1-25*

positions: PART CLOSE, OFF (center), and FULL CLOSE. When the switch is held in the PART CLOSE position, the canopy uplock release solenoid disengages the uplock pin and the actuating motor will lower the canopy to approximately the one-quarter open position. At this position a limit switch de-energizes the actuating motor and energizes the canopy full close circuit, allowing the canopy to close completely when the switch is held in the FULL CLOSE position.

**CAUTION**

Check that cockpit sills are clear before lowering the canopy to the part closed or full closed position, since the canopy closes forcibly and can cause damage or personal injury.

**Canopy Handcrank.**

If electrical power is not available, the canopy may be opened or closed manually by the handcrank (23, figure 1-14) on the right side of the pilot's cockpit or the handcrank (figure 1-23) in the external well.

**Note**

The canopy unlock pin (figure 1-24) must be held clear before the canopy can be manually lowered from or raised to the full open position.

**Canopy Lock Handle.**

Canopy locking handles (8, figure 1-14) are provided on the right side of each cockpit to lock the canopy in the closed position. The handle is pulled aft to lock and pushed forward to unlock. The canopy must be unlocked before opening on the ground but should not be unlocked before jettisoning. The lock handle in the rear compartment is normally stowed on the lower right canopy frame and must be removed and installed on the locking handle drive (1, figure 4-18) when it is to be used.

**Note**

The canopy locks actuate a limit switch to de-energize the canopy motor. Therefore, if the lock handle is not in the fully unlocked position, the canopy motor will not be operative.

**Canopy Unlatched Warning Light.** A red warning light (17, figure 1-7) located on the instrument panel, is energized by 28 volt d.c. when the canopy is unlocked and is off when the canopy is locked.

**Canopy Jettison Levers.**

Mechanically interconnected yellow canopy jettison levers (7, figure 1-14 and 2, figure 4-18) are located on the right side of each cockpit. As either of the levers is pulled downward and aft, the canopy is unlatched and the sear pin is pulled from an initiator mounted on the right canopy sill. This explodes a small cartridge within the initiator and the resulting gas pressure is directed to the canopy catapult where it forces the firing pin against an explosive cartridge in the catapult. Normally the canopy can only be jettisoned from the fully closed position. The canopy jettison mechanism may be actuated from outside the aircraft by pulling the external canopy jettison handle on the right side of the fuselage (figure 1-23).

**Note**

The map case (20, figure 1-14) on the right side of the pilot's cockpit, should be closed during flight to avoid interference with the canopy jettison lever.

**External Canopy Controls.**

On modified aircraft, an aft cockpit latch handle is installed which may be actuated either externally or internally. In addition an external crank handle is provided for the dual purpose of raising or lowering the canopy and canopy locking. An external gear box door assembly is provided on the right side of the aircraft opposite the aft cockpit for crank handle stowage. Clockwise rotation of the crank handle unlocks and opens the canopy. Counterclockwise rotation lowers and locks the canopy.

## EJECTION SEATS.

Ejection-type seats (32 and 34, figure 1-2) are provided in the pilot's and radar observer's cockpits. The seats are ejected by cartridge-type catapults which are actuated by gas initiators located on the upper right hand corner of the seats. Prior to being ejected, the seats are forced to the full down position by an aircharged seat bottoming mechanism. An air pressure storage cylinder is mounted behind each seat headrest, and a pressure gage adjacent to each cylinder is provided to indicate seat bottoming pressure available. Canvas webs are attached between the forward edge of the bucket seats and the seat frame heel rests to prevent the bucket from striking the heel of the occupant when the seat is bottomed. The seats may be adjusted manually by means of seat adjustment levers which release the seat position locks when depressed. Each seat is equipped with a (manual or automatic-opening) safety belt and a lockable inertia-reel type shoulder harness. A multiple unit quick-disconnect fitting is provided to automatically disconnect oxygen, radio, and anti-G suit lines during ejection. A red-flagged safety pin is installed in each gas initiator to prevent inadvertent ejection during ground operations. This pin must be removed prior to flight and re-inserted after flight.

**WARNING**

THE SEAT EJECTION SYSTEM IS INDEPENDENT OF THE CANOPY JETTISON SYSTEM AND THE SEAT AND OCCUPANT MAY BE FIRED THROUGH THE CANOPY. THEREFORE, EXTREME CAUTION SHOULD BE EXERCISED IF THE RIGHT ARM REST IS ACCIDENTALLY RAISED.

# AUTOMATIC SEAT BELT

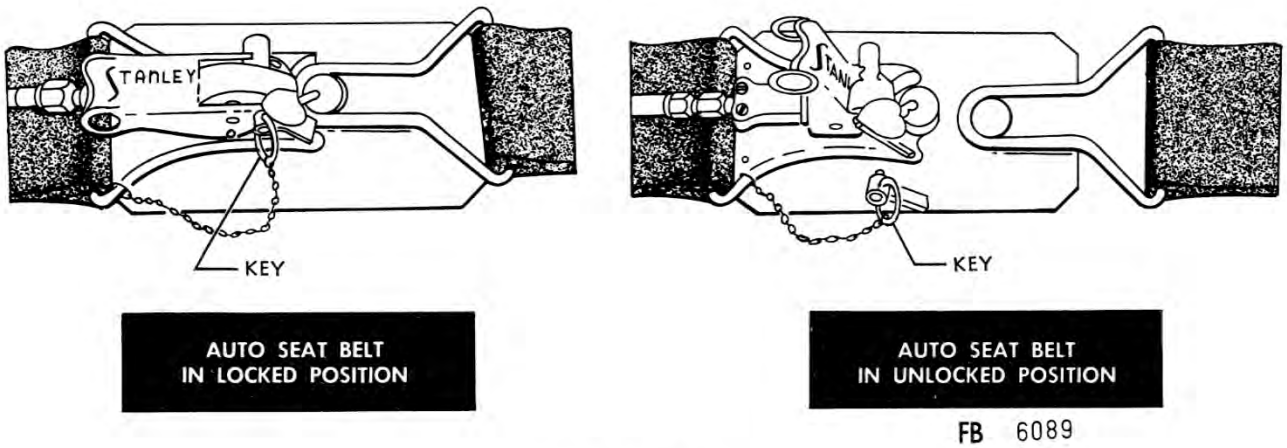



*Figure 1-26*

## EJECTION SEAT CONTROLS.

### Right Arm Rest.

The right arm rest is hinged at the aft end and is normally in the down position (figure 1-25). The arm rest is raised to the horizontal position by pulling up on the hand grip. This action also disengages the seat position locks and releases the air charge from the storage bottle into two cylinders which force the seat to its bottom position where it is automatically locked.

**WARNING**

- Do not raise the right arm rest unless preparing for ejection because the seat will be forced to and locked in its bottom position and cannot be repositioned during flight.

**Ejection Trigger.** The seat ejection trigger is located on the lower side of the right arm rest hand grip. When the arm rest is in the raised position, the seat may be ejected by squeezing the trigger. The trigger is not cocked unless the right arm rest is in the full up and locked position.

### Left Arm Rest.

This arm rest is normally stowed in the folded position. When raised to the horizontal position, it locks the shoulder harness.

**CAUTION**

Once raised, the arm rest cannot be lowered again during flight, nor can the shoulder harness be unlocked.

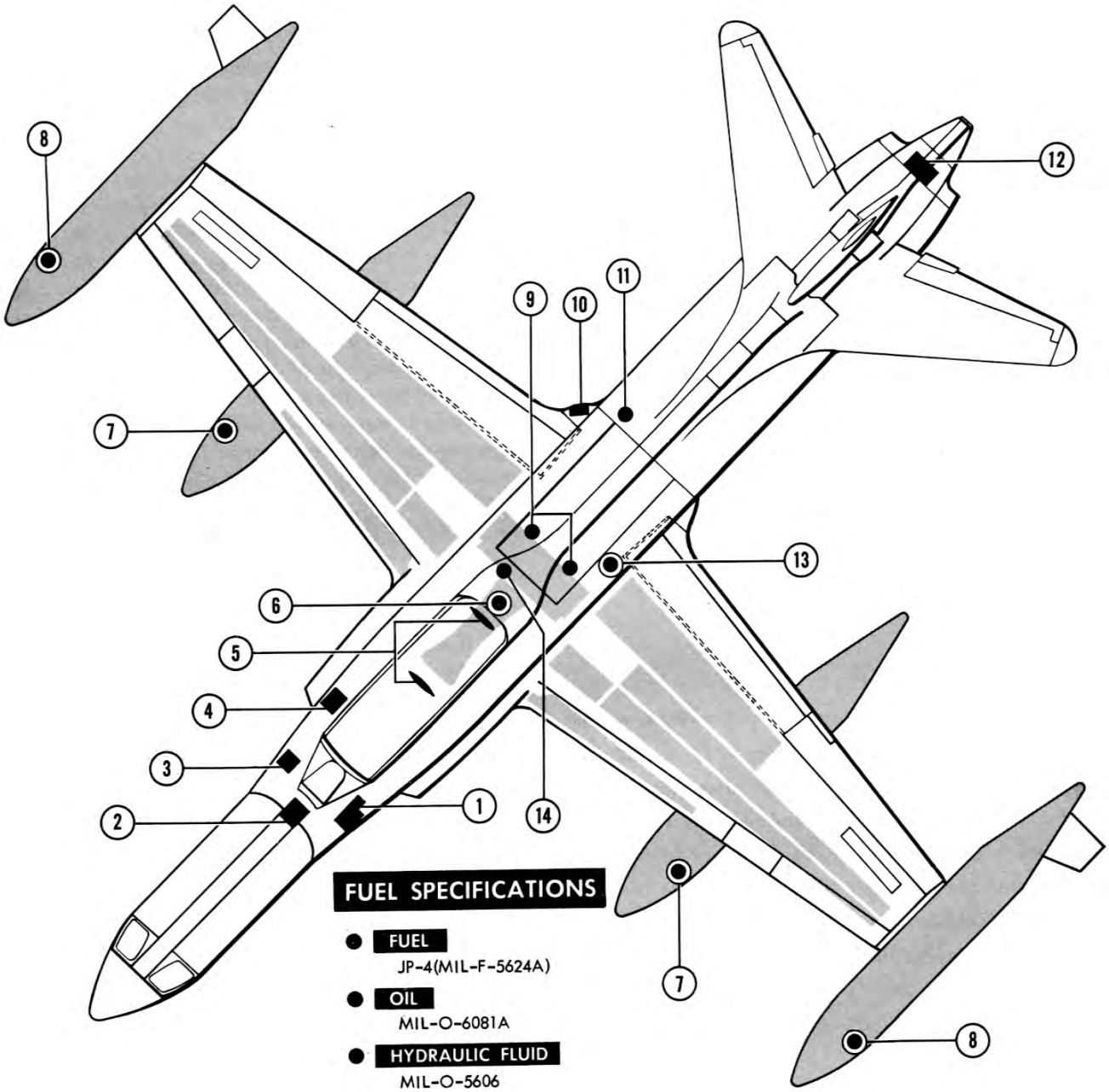
### Seat Adjustment Levers.

Each seat is equipped with two adjustment levers, located at the lower right and left seat corners. Pressing either lever will allow the seat to be moved to the desired position. Since the seat is spring-loaded to the up position, considerable weight may be required to force it down. A hand hold has been provided in the forward cockpit on the windshield frame to assist the pilot in making seat adjustments.

**Note**

Avoid stepping on the seat adjustment levers when entering the cockpit or the spring-load will permit the unweighted bucket seat to come up with considerable force.

# AIRPLANE SERVICING DIAGRAM




## FUEL SPECIFICATIONS

- **FUEL**
  JP-4(MIL-F-5624A)
- **OIL**
  MIL-O-6081A
- **HYDRAULIC FLUID**
  MIL-O-5606
- **OXYGEN**
  BB-O-925
- **FUEL FILTER DEICING FLUID**
  MIL-A-6091

1 SINGLE POINT FILLER VALVE
2 BRAKE RESERVOIR
3 OXYGEN SYSTEM FILLER
4 EMERGENCY HYDRAULIC SYSTEM RESERVOIR
5 EJECTION SEAT AIR BOTTLES
6 INTERNAL TANKS FILLER
7 PYLON TANK FILLER CAP
8 TIP TANK FILLER CAP
9 HYDRAULIC ACCUMULATORS
10 EXTERNAL POWER RECEPTACLE
11 ENGINE OIL FILLER
12 DRAG CHUTE
13 FUEL FILTER DE-ICING TANK
14 MAIN HYDRAULIC SYSTEM RESERVOIR

FB 6011

*Figure 1-27*

**Shoulder Harness Inertia Reel Locking Handle.**

A two-position handle is located on the left forward side of each seat to lock or unlock the shoulder harness inertia reel. The handle is retained in either position by a latch which may be released by pushing down on the top of the handle. When the handle is in the unlocked position, the reel harness cable will extend to allow the occupant to lean forward in the cockpit. However, the reel will automatically lock when the aircraft encounters a forward deceleration of 2 to 3 G's, and will remain locked until the handle is moved to the locked position and then returned to the unlocked position. When the handle is in the locked position, the reel harness cable is manually locked, preventing the occupant from bending forward.

**Note**

If a crash landing is anticipated, it is advisable to manually lock the shoulder harness as an added safety precaution.

## AUTOMATIC SEAT BELTS.

Most aircraft ejection seats are equipped with automatic opening seat belt assemblies (figure 1-26), to aid the occupant in separating from the seat after ejection. As the seat is ejected, a mechanical linkage fires a cartridge in the seat belt initiator located on the back of the seat. The initiator produces gas pressure which is directed to the belt buckle through a flexible hose, thus releasing the belt and shoulder harness. A time delay feature in the initiator insures that the belt will not release until the crew member is entirely clear of the airplane.

**CAUTION**

The initiator may be safetied for servicing by a maintenance safety pin. If the pin is installed, it must be removed before flight. (See figure 2-2.)

To lock the belt, it is necessary to insert a key into the buckle. If the crew member has an automatic-opening aneroid-type parachute with a key attached to a lanyard from the automatic ball-handle control, this key must be inserted into the belt buckle. As the crew member separates from the seat, the lanyard will arm the chute-opening device and the parachute will be deployed at the preset time interval or altitude. If the parachute is not equipped with a key, the key that is attached to the belt must be inserted into the belt buckle. The automatic opening seat belt may be manually unlocked in the same manner as a conventional seat belt.

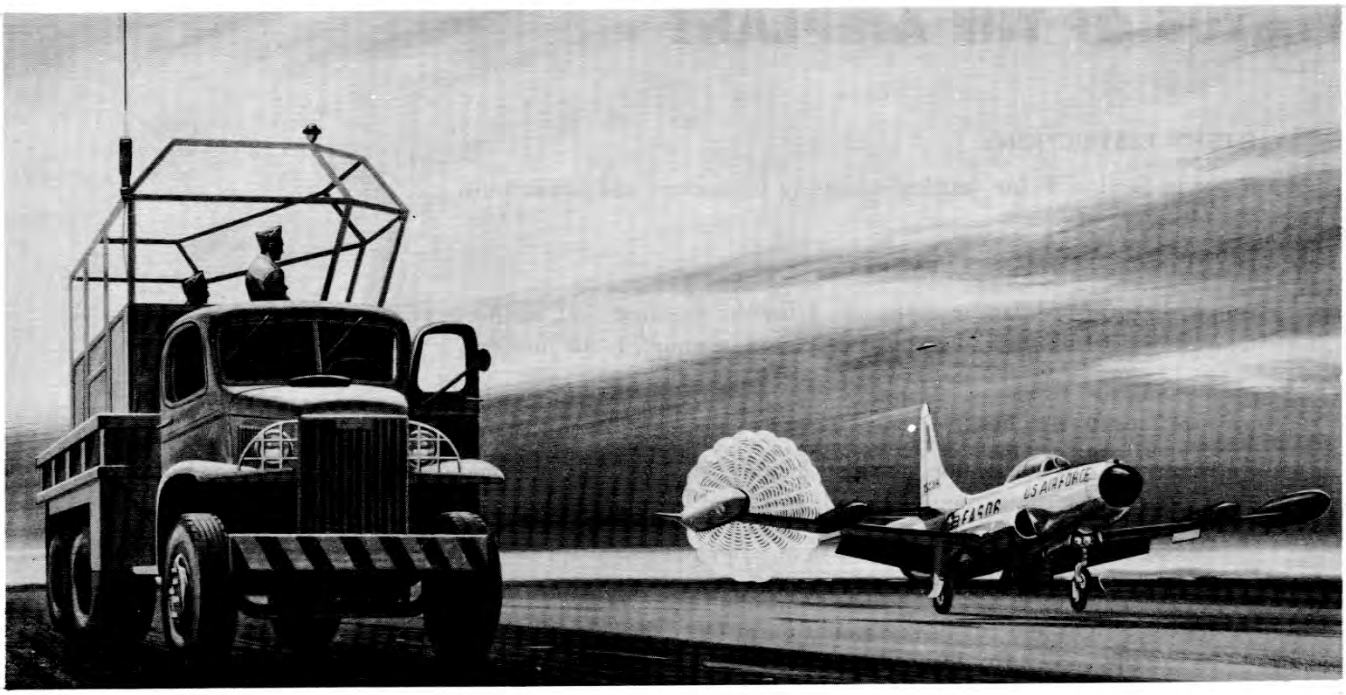
**WARNING**

If the belt is unlocked manually after ejection, the chute (manual or automatic-opening type) must be opened manually by pulling the "D" ring or automatic ball-handle control, because the lanyard is released when the buckle is opened manually.

## AUXILARY EQUIPMENT.

Information concerning the following auxiliary equipment is supplied in Section IV: Cockpit air conditioning and pressurization, anti-icing, windshield wiper, communication and associated electronic equipment, lighting, oxygen, navigation, armament, refueling and miscellaneous equipment.

Last page of Section I



# normal operating instructions

SECTION II

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# STATUS OF THE AIRPLANE

### FLIGHT RESTRICTIONS.

Refer to Section V for detailed operating limitations and restrictions.

### FLIGHT PLANNING.

Check performance data in Appendix I for the required fuel, airspeed, power settings, altitude and take-off and landing distances as necessary to accomplish the mission.

### WEIGHT AND BALANCE.

Refer to T. O. 1-1B-40 for detailed loading and balance information. For weight and balance limitations, refer to Section V. Before each flight complete the following checks:

1. Make sure that sufficient fuel, oxygen, armament, and special equipment are in the airplane as required to accomplish the mission.
2. Check weight and balance clearance Form DD 365 F is filled out and current. If no armament is installed check for proper ballast.
3. Check take-off and anticipated landing gross weight and balance.

### ENTRANCE.

Entrance to the cockpit is accomplished by opening the canopy, using either the Canopy Open Switch or the Handcrank located under the access door (figure 1-23) on the right side of the airplane. If a ladder is not available, climb over the leading edge onto either wing and then into the cockpit.

**CAUTION**

Do not operate the external canopy switches when auxiliary electrical power is connected. The batteries may be severely damaged.

### SEAT CUSHIONS.

It is very important that the correct seat cushion or kit be utilized to avoid the possibility of spinal injury during ejection or crash landing. Excessive cushioning may result in the following dangerous conditions:

a. Incorrect positioning of the pilot in the seat, making it difficult to reach all the controls necessary for efficient operation of the aircraft.

b. During ejection a definite injury hazard is created as the thick compressible mass allows several inches of upward seat travel before exerting a direct lifting force on its occupant. After this amount of travel, the seat has gathered such momentum that excessive impact is produced when the seat initially lifts the pilot, thereby increasing chances of vertebral injury.

c. Where a crash landing is made, the combined compressiveness of the two items will permit the pilot to sink down far enough to loosen the shoulder straps thus allowing the pilot to slump forward. In this position, the impact may severely injure his back.

CONTINUED ON NEXT PAGE

# STATUS OF THE AIRPLANE CONTINUED

d. The use of additional material under the pilot may raise him to such a height that his arms will not be held by the retainers on either arm rest and they will be subjected to damage due to possible flailing in the windblast.

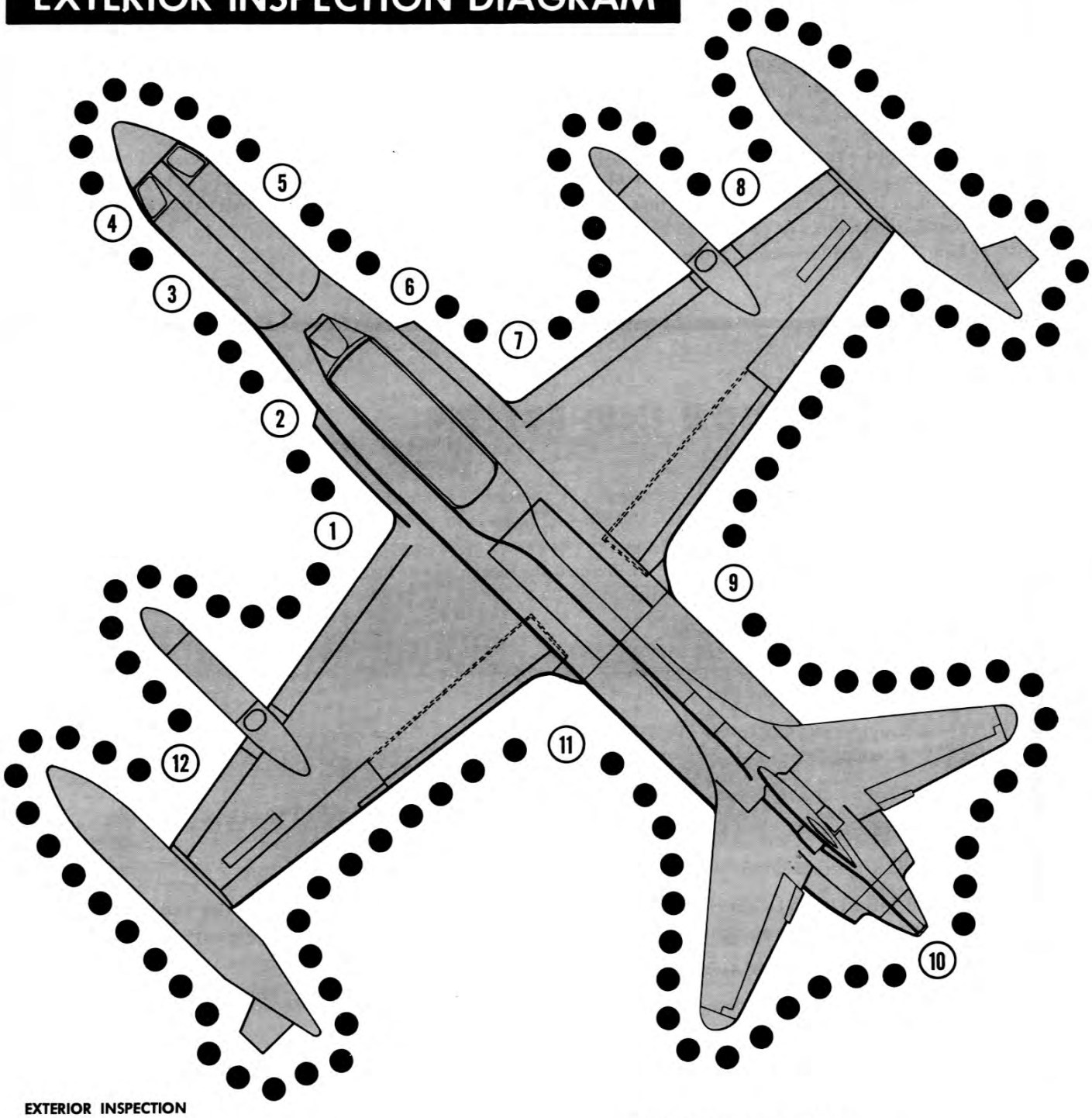
Use of the Type C-2A one-man life raft in conjunction with the contoured seat style survival kit container is not recommended because of the above reasons. This is also applicable to the Type C-2A one-man life raft used in conjunction with the aircraft seat cushion. The Type MD-1 survival kit container (commonly referred to as the modified Type A-1 container) is recommended for use on long range missions over land or water.

# BEFORE EXTERIOR INSPECTION

A complete visual inspection of the aircraft is a very important part of each mission. The pre-flight check starts before the pilot reaches the aircraft. Survey the proposed taxiing routes for any possible obstruction, such as a fuel truck or tug moving about, on or near the taxi ramp, and check for stray equipment or personnel that might be harmed by the jet blast. Prior to accomplishing the exterior inspection complete the following checks:

1. Tip tank safety pins—Installed.
2. Before entering the airplane, open canopy fully and check canopy jettison initiator ejection seat and all cockpit safety pins as follows:
   a. Canopy jettison levers—Full forward (check in up detent position) front cockpit lightly safetied.
   b. Canopy ground safety pins—Installed. (Refer to figure 2-2.)
   c. Arm rests (both cockpits)—Down.
   d. Seat ejection safety pin (both cockpits)—Installed.
3. AF form DD 781—Check for status, exceptional release, fuel, oxygen, oil, service and remarks pertaining to the condition of the aircraft and the technical order compliances in parts II and III.
4. Landing gear control lever—DOWN.
5. Oxygen pressure indicator—1800 psi.
6. 2500 VA inverter switch—OFF.
7. All armament switches—OFF.
8. Battery master switch—BATTERY.
9. Control stick trim and elevator trim tab switch—Operate in all four positions. Note that it automatically returns to neutral.
10. Elevator tab neutral indicator light—ON (green).
11. Battery master switch—OFF.
12. Surface control lock—Remove and stow.

# EXTERIOR INSPECTION DIAGRAM




**EXTERIOR INSPECTION**

1. **LEFT WHEEL WELL AREA.**
   a. OUTER FAIRING DOOR — SECURED
   b. TIRE — CONDITION AND SLIPPAGE
   c. WHEEL CHOCKS — IN PLACE
   d. BRAKE HYDRAULIC LINE — DAMAGE AND LEAKS
   e. LANDING GEAR SCISSORS MICROSWITCH — ENGAGED
   f. LANDING GEAR SHOCK STRUT EXTENSION — NORMAL
   g. LANDING GEAR DOWNLOCK SAFETY PIN — IN PLACE
   h. HYDRAULIC ACCUMULATOR PRESSURE GAGE — 600 ± 25 PSI
   i. FUEL AND HYDRAULIC LINES — LEAKS
   j. LANDING GEAR UPLOCK SWITCH — FREE
   k. LANDING GEAR AND SPEED BRAKE HYDRAULIC SHUT OFF VALVE — SAFETIED OPEN
   l. FUEL DRAIN VALVE — CLOSED

2. **LEFT FORWARD SPEED BRAKE AREA**
   a. AREA — LEAKS AND CONDITION
   b. SPEED BRAKE PIP PIN — INSTALLED
   c. SPEED BRAKE — SECURED
   d. FUEL DRAIN VALVE — CLOSED

3. **LEFT SIDE OF NOSE**
   a. LEFT DUCT COVER — REMOVED. NO FOREIGN OBJECTS
   b. SINGLE POINT FUEL FILLER CAP — SECURED
   c. STATIC SOURCE — CLEAR
   d. PITOT TUBE COVER — REMOVED
   e. NOSE COMPARTMENT DOORS — CLOSED AND LATCHED
   f. RADOME — SECURED AND CONDITION

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

4. **NOSE WHEEL WELL AREA**
   a. AREA — LEAKS AND SECURITY
   b. CIRCUIT BREAKERS — IN
   c. DUST COVER — IN PLACE
   d. FAIRING DOORS — SECURED
   e. NOSE LANDING GEAR MICROSWITCH — FREE
   f. DOWN-LOCK SAFETY CLIP — IN PLACE
   g. NOSE GEAR HYDRAULIC SHUTOFF VALVE — SAFETIED OPEN
   h. SHIMMY DAMPER — TIGHT
   i. SHIMMY DAMPER PINS — EXTENDED EQUALLY, LOCK NUTS TIGHT
   j. NOSE GEAR STRUT EXTENSION — NORMAL
   k. NOSE GEAR UPLOCK ROLLERS — FREE
   l. STATIC WIRE — GROUNDED
   m. TIRE — CONDITION AND SLIPPAGE
   n. LANDING AND TAXI LIGHTS — CONDITION
   o. NOSE GEAR SCISSORS — TIGHT

5. **RIGHT SIDE OF NOSE**
   a. RADOME — SECURED AND CONDITION
   b. NOSE COMPARTMENT DOORS — CLOSED AND LATCHED
   c. STATIC SOURCES — CLEAR
   d. YAW STRING — FREE (IF INSTALLED)
   e. OXYGEN FILLER CAP COVER — CLOSED AND SECURED
   f. EMERGENCY HYDRAULIC RESERVOIR FILLER CAP COVER—SECURED
   g. EXTERNAL CANOPY CONTROL ACCESS DOOR — SECURED
   h. EXTERNAL CANOPY JETTISON HANDLE ACCESS DOOR—SECURED
   i. RIGHT INTAKE DUCT OVER — REMOVED. NO FOREIGN OBJECTS

6. **RIGHT FORWARD SPEED BRAKE AREA**
   a. AREA — LEAKS AND CONDITION
   b. SPEED BRAKE PIP PIN — INSTALLED
   c. SPEED BRAKE — SECURED

7. **RIGHT WHEEL WELL AREA**
   a. FUEL AND HYDRAULIC LINES — LEAKS
   b. LANDING GEAR UPLOCK SWITCH — FREE
   c. LANDING GEAR HYDRAULIC SHUT-OFF VALVE — SAFETIED OPEN
   d. HYDRAULIC ACCUMULATOR PRESSURE GAGE — 600 ± 25 PSI
   e. LANDING GEAR DOWNLOCK SAFETY PIN — INSTALLED
   f. LANDING GEAR SHOCK STRUT EXTENSION — NORMAL
   g. LANDING GEAR SCISSORS MICROSWITCH — ENGAGED
   h. BRAKE HYDRAULIC LINE — DAMAGE AND LEAKS
   i. TIRE — CONDITION AND SLIPPAGE
   j. OUTER FAIRING DOOR — SECURED
   k. WHEEL CHOCKS — IN PLACE

8. **RIGHT WING AREA**
   a. UNDER SURFACE OF WING — FUEL LEAKS AND CONDITION OF SKIN
   b. PYLON TANK (IF INSTALLED) — CONDITION AND LEAKS
   c. DE-ICER BOOT — CONDITION
   d. ROCKET POD (IF INSTALLED) — CONDITION
   e. TIP TANK SAFETY PIN — INSTALLED
   f. TIP TANK FAIRING — SECURED
   g. TIP TANK FILLER CAP — SECURED
   h. TIP TANK AREA — FUEL LEAKS
   i. TIP TANK SPRING INDICATOR — FLUSH
   j. NAVIGATION LIGHTS — CONDITION
   k. TIP TANK FIN — SECURED
   l. AILERON — WARPAGE, EXCESSIVE PLAY, PROPER TRAVEL AND CLEARANCE
   m. SPOILER — CONDITION AND PROPER MOVEMENT
   n. WING FLAP — CONDITION AND CONNECTIONS
   o. UPPER WING SURFACE — CONDITION OF SKIN

9. **RIGHT FUSELAGE AREA**
   a. OIL FILLER WELL — QUANTITY AND CAP SECURED
   b. ACCESS DOORS — SECURED
   c. FUSELAGE LIGHTS — CONDITION
   d. RIGHT AFT SPEED BRAKE PIP PINS — INSTALLED
   e. AREA — HYDRAULIC LEAKS
   f. SKIN CONDITION AND AIR LOCK FASTENERS — CHECK

10. **EMPENNAGE AND AFT SECTION AREA**
   a. INSPECTION PLATES — SECURED
   b. DE-ICER BOOT — CONDITION
   c. FUEL VENT — CLEAR
   d. ELEVATOR — PROPER TRAVEL
   e. ELEVATOR TRIM TAB — NEUTRAL WHEN ELEVATOR IS NEUTRAL, EXCESSIVE PLAY
   f. RIGHT ELEVATOR AND RUDDER — SKIN CONDITION
   g. RUDDER BEND TAB — NOT BENT MORE THAN 1/4 IN.
   h. NOZZLE, TAILPIPE, AFTERBURNER AND TURBINE WHEEL — CONDITION
   i. DRAG CHUTE DOORS — CLOSED AND SECURED
   j. POSITION LIGHT — CONDITION
   k. LEFT ELEVATOR AND RUDDER — SKIN CONDITION
   l. ELEVATOR — PROPER TRAVEL
   m. ELEVATOR TRIM TAB — NEUTRAL WHEN ELEVATOR NEUTRAL, EXCESSIVE PLAY
   n. FUEL VENT — CLEAR
   o. DE-ICER BOOT — CONDITION
   p. INSPECTION PLATES — SECURED

11. **LEFT FUSELAGE AREA**
   a. LEFT AFT SPEED BRAKE PIP PINS — INSTALLED
   b. AREA — HYDRAULIC LEAKS
   c. SKIN CONDITION AND AIR LOCK FASTENERS — CHECK
   d. ACCESS DOORS — SECURED

12. **LEFT WING AREA**
   a. UPPER WING SURFACE — CONDITION OF SKIN
   b. WING FLAP — CONDITION AND CONNECTIONS
   c. SPOILER — CONDITION AND PROPER MOVEMENT
   d. AILERON — WARPAGE, EXCESSIVE PLAY, PROPER TRAVEL AND CLEARANCE
   e. TIP TANK FIN — SECURED
   f. NAVIGATION LIGHTS — CONDITION
   g. TIP TANK SPRING INDICATOR — FLUSH
   h. TIP TANK AREA — FUEL LEAKS
   i. TIP TANK FILLER CAP — SECURED
   j. TIP TANK FAIRING — SECURED
   k. TIP TANK SAFETY PIN — INSTALLED
   l. DE-ICER BOOT — CONDITION
   m. ROCKET POD (IF INSTALLED) — CONDITION
   n. PYLON TANK (IF INSTALLED) — CONDITION AND LEAKS
   o. UNDER SURFACE OF WING — FUEL LEAKS AND CONDITION OF SKIN

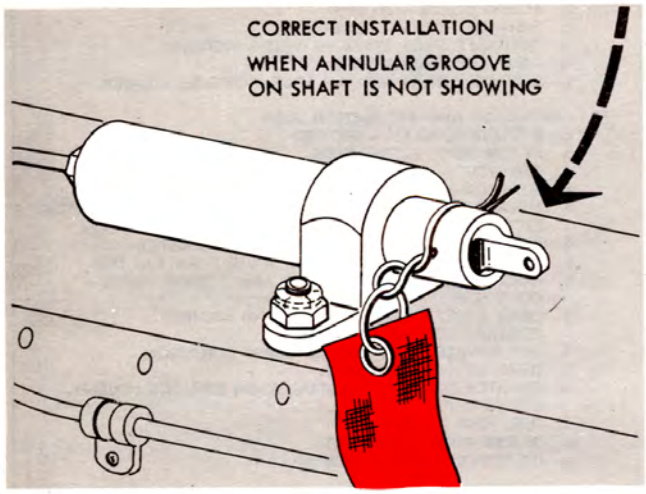
13. **TOP FUSELAGE AREA**
   a. FUSELAGE TANK FILLER CAP AND ACCESS DOOR — SECURED
   b. ALCOHOL RESERVOIR — FULL AND CAP SECURED
   c. MAIN HYDRAULIC RESERVOIR — FLUID LEVEL AND CAP SECURED
   d. ENGINE COMPARTMENT — CONDITION
   e. CIRCUIT BREAKERS — IN
   f. REAR COCKPIT EJECTION SEAT AIR BOTTLE PRESSURE GAGE — PROPER READING

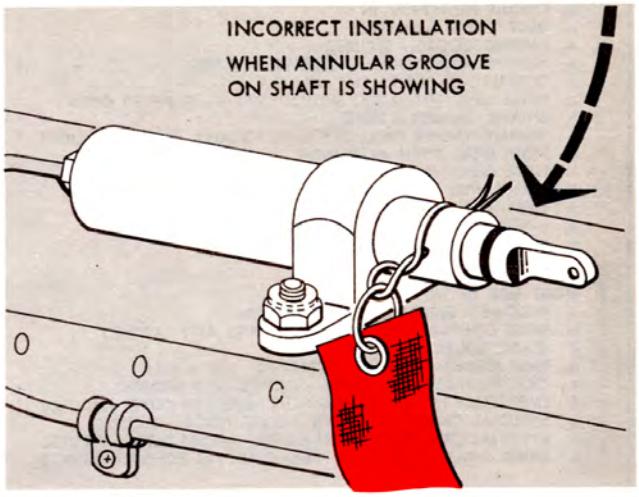
*Figure 2-1. (Sheet 2 of 2 Sheets)*

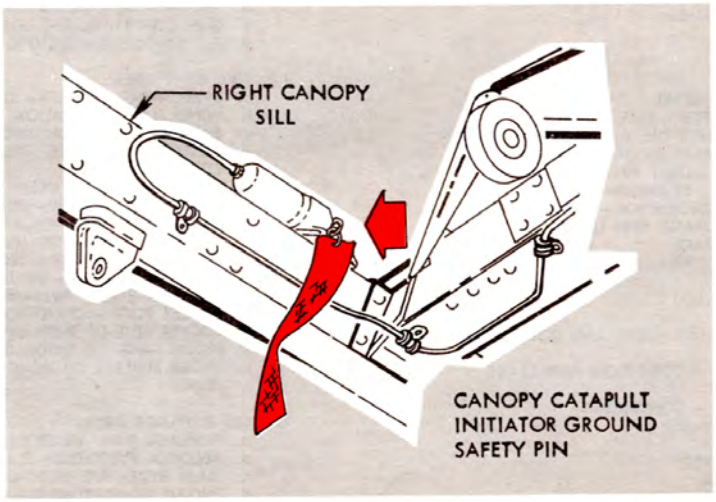
# EXTERIOR INSPECTION

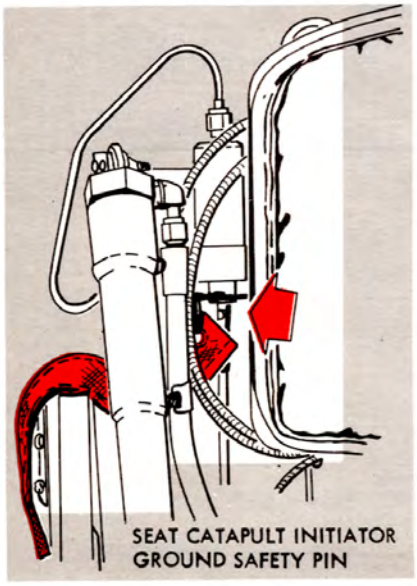
Perform the exterior inspection as shown in figure 2-1.

# COCKPIT SAFETY PINS



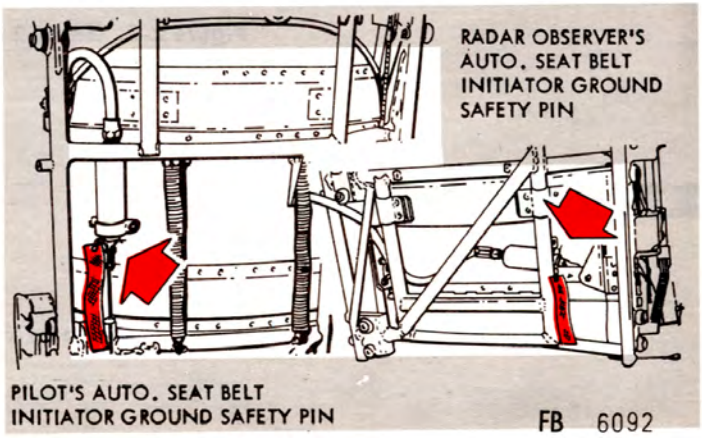




*Figure 2-2*

# INTERIOR INSPECTION

The pilot shall accomplish the interior checks as follows:
(Refer to Section VII for the Radar Observers interior check.

**AFT COCKPIT CHECK (SOLO FLIGHTS).**

1. Pressurization air inlet grills—SHUT.
2. Oxygen regulator supply valve lever—OFF.
3. Radar—OFF and scope stowed.
4. UHF local-remote switch—REMOTE (front cockpit on some aircraft).
5. Canopy jettison handle—In place and safetied.
6. Radio Compass—OFF.
7. Cockpit Lights—OFF.
8. Seat belt, shoulder harness, oxygen hose and radio cord—SECURED.
9. Loose equipment—SECURED.

**FRONT COCKPIT CHECK.**

1. Seat belt and shoulder harness—Fastened with shoulder harness inertia reel unlocked.
2. Seat—Adjusted.
3. Rudder pedals—Adjusted.
4. Pressurization air inlet grills—OPEN.
5. APU power—Applied.

**CAUTION**

Do not turn the battery master switch on when APU power is applied. The airplane batteries may be severely damaged.

6. Instrument power switch—NORMAL.
7. Head set and Oxygen mask—Connected.

**Note**

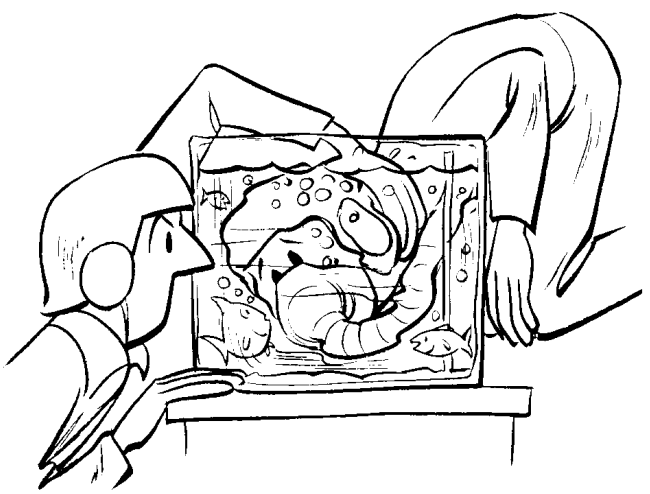
With the ejection seat adjusted fully forward and the control stick fully aft, the clearance between the seat and the stick is less than the diameter of the oxygen hose. If the oxygen hose is routed from the automatic disconnect fitting in the front center of the seat and up between the pilot's legs, it is possible that the hose will be wedged between the seat and the stick, restricting full rearward stick movement. Therefore, check the controls for freedom of movement to make sure the oxygen hose does not prevent full rearward movement of the control stick. If it does, route the oxygen hose under the left leg and up the left side of the body.

CONTINUED ON NEXT PAGE

# INTERIOR INSPECTION CONTINUED

8. Oxygen system—Check as follows:
   a. Oxygen pressure gage—1800 psi.
   b. Oxygen regulator supply lever—ON.
   c. Oxygen regulator—Check leakage by performing "blow-back" check with diluter lever in 100% OXYGEN and NORMAL OXYGEN positions.
   d. Oxygen regulator warning system switch—ON (check for bright light).
   e. Oxygen regulator emergency toggle lever—Deflect, then OFF (note proper warning light indication).
   f. Oxygen regulator diluter lever—100%.
   g. Oxygen regulator flow indicator—Proper operation (blinking).
   h. Oxygen regulator emergency toggle lever—Deflect.
   i. Mask—Test and note positive pressure. (Hold breath to check leakage around mask.)

**CAUTION**



IF YOU DISCONNECT YOUR MASK OR UN-BUCKLE ONE SIDE FROM YOUR HELMET, BE SURE TO RECHECK IT AGAIN FOR LEAKS BEFORE TAKE-OFF.

CONTINUED ON NEXT PAGE

# INTERIOR INSPECTION CONTINUED

j. Oxygen regulator emergency toggle lever—OFF (center).

k. Oxygen regulator diluter lever—As desired.

l. H-2 Oxygen cylinder—Tag and pin removed, hose connected.

**FRONT COCKPIT CHECK—LEFT SIDE.**

1. Aft panel circuit breakers—IN.
2. Exterior lights—As desired.
3. Cockpit lights—As desired.
4. Armament control panel—Check as follows:
   a. Bomb arming switch—OFF.
   b. Rocket heat switch—As required.
   c. Rocket firing selector switch—As required.
   d. Rocket arming switch—OFF.
5. Droppable tank manual release and ATO jettison handles—Safetied.
6. Drag chute release and jettison handle—In.
7. Fuel control panel—Check as follows:
   a. External tank fuel selector switch—As required.
   b. Tip tank release arming switch—AUTO DROP (if installed); otherwise OFF.
   c. Fuel tank air pressure off warning light—ON.
   d. Emergency fuel shut-off switch—NORM.
   e. Fuel system de-ice switch—OFF.
   f. Engine boost pump switch—ENG. BOOST PUMP.
   g. Engine fuel system check-out switch—OFF.
   h. Engine fuel system selector switch—NORM (guarded).
8. Aileron trim tab switch—Operate through a complete cycle, then OFF (center).
9. Elevator boost ratio switch—Operate through a complete cycle. Check proper movement of indicator.
10. Landing and taxi light switch—OFF.
11. Forward panel circuit breakers—In.
12. Afterburner nozzle override switch—AUTO.
13. Afterburner nozzle open indicator light—Test.
14. Throttle—OFF.

CONTINUED ON NEXT PAGE

# INTERIOR INSPECTION CONTINUED

15. Speed brake switch—NEUT.
16. Elevator and aileron booster control levers—ON.
17. Landing gear control lever—DOWN.
18. Landing gear position indicator, warning horn, and unsafe warning light—Check.
19. Wing flap switch—Check operation of flaps and set flaps at 32 degrees.

**FRONT COCKPIT CENTER CONTROL PEDESTAL.**

1. Cockpit air control selector—DEFROST.
2. Cockpit air pressure selector switch—5 PSI PRESS.
3. Cockpit air pressure shut-off switch—PRESS.
4. Cockpit air temperature control switch—AUTO.
5. Cockpit air temperature rheostat—As desired.
6. 2500 VA Inverter switch—OFF.
7. Generator switch—OFF.
8. Battery master switch—OFF.
9. 8 KVA alternator switch—8 KVA ALT.
10. 30 KVA alternator switch—30 KVA ALT.
11. Radar A.C. under frequency warning light—ON.
12. Auxiliary windshield defroster switch—OFF.
13. Pitot heat switch—OFF.
14. Wing and empennage de-ice switch—OFF.
15. Wing and empennage de-ice indicator light—OFF.
16. Center control pedestal circuit breakers—In.

**FRONT COCKPIT—RIGHT SIDE.**

1. Accelerometer—Checked and set.
2. Command radio function switch—OFF.
3. Auto pilot—OFF.
4. Ground rocket door opening switch—CLOSED.
5. Interphone (audio bypass) switch—NORMAL.
6. Headset volume—As desired.
7. Radio compass—ON (to allow warm-up).
8. Circuit breakers—In.

CONTINUED ON NEXT PAGE

# INTERIOR INSPECTION CONTINUED

9. Canopy handcrank—Stowed and safetied.
10. Emergency hydraulic system selector lever—NORMAL and safetied.
11. Relief tube hose—Stowed.

**FRONT COCKPIT—INSTRUMENT PANEL.**

1. Generator out warning light—ON.
2. Clock—Set and running.
3. Fire and overheat warning light—Test circuits and lights.
4. Engine fuel system emergency and engine fuel pump failure warning lights—ON.
5. Canopy unlatched warning light—ON.
6. Fuel quantity and fuel quantity indicating systems—Check.

**Note**

The quantity of fuel in the pylon tanks is not included in the reading of the fuel quantity indicator.

7. Vertical velocity indicator—Zero.
8. Altimeter—Set to field elevation and note error.
9. Zero reader—Check.
10. Airspeed indicator—30 to 35 knots.
11. Heading indicator—Set to take-off runway heading.
12. Attitude indicator—Checked and no flag.
13. Radio compass—Check operation in all positions, then—OFF.
14. Instrument inverter power switch (Group A and B airplanes)—STANDBY, then OFF.
15. Instrument inverter power switch (Group C airplanes) — STANDBY, then NORMAL, if additional constant current starting unit is available; if not, inverter power switch—STANDBY, then OFF.

# BEFORE STARTING ENGINES

Numerous instances of the presence of carbon monoxide in the flight compartment of jet aircraft have been suspected. Some of these instances have been brought to light through accident investigations. There are various possibilities by which carbon monoxide may enter these compartments during ground operation; however, as yet, neither the exact concentration nor the exact sources have been determined. If the aircraft is to be operated under possible conditions of carbon monoxide contamination, such as during run-up or taxiing directly behind another operating jet aircraft, or during run-up with its tail into the wind, the following procedure shall be used:

CONTINUED ON NEXT PAGE

# BEFORE STARTING ENGINES CONTINUED

1. Before starting engines, all crew members will don oxygen masks, connect hoses to oxygen regulator, and place diluter lever at the 100% OXYGEN position.
2. Whenever contamination is suspected, 100% oxygen will be used during ground operation and take-off.
3. After contamination is no longer suspected, place the diluter lever of the oxygen regulator at the NORMAL OXYGEN position.

**WARNING**

The oxygen diluter lever must be returned to the NORMAL OXYGEN position as soon as possible because the use of 100% oxygen throughout a long mission will so deplete the oxygen supply as to be hazardous to the flight crew.

# GROUND STARTING PROCEDURE

**(Group B and C Aircraft)**

Group A and B aircraft have no start selector switch and can be started with a single auxiliary power source capable of supplying 1200 amperes at 28.5 volts. Group C aircraft have been modif to include a start selector switch; however, an additional constant current power source (C-26 or C .6B units are suitable) must be available to utilize the split bus facilities included in the modification. If an additional power source is not available, Group C aircraft can be started in the same manner as Group B aircraft, by placing the start selector switch in the EMERGENCY position. Procedures preceded by an asterisk should be performed on the first flight each day the aircraft is flown.

| NORMAL PROCEDURE | IN THE EVENT OF MALFUNCTION |
|---|---|
| 1. Throttle—OFF. | |
| 2. Emergency fuel shut-off switch—NORMAL. | |
| 3. Engine boost pump switch—ENG. BOOST PUMP. | |
| *4. Engine fuel check-out switch—CHECK-OUT (to start on emergency system). | |
| 5. Engine fuel system selector switch—NORMAL. | |
| 6. Battery master switch—OFF. | |
| 7. Generator switch—OFF. | |
| 8. (Group C aircraft only.) Start selector switch—NORMAL, if additional constant current starting unit is available. If not place switch to EMERGENCY. | |

CONTINUED ON NEXT PAGE

# GROUND STARTING PROCEDURE CONTINUED

## (GROUP B AND C AIRCRAFT)

### NORMAL PROCEDURE

9. Air start ignition switch—STARTER ONLY and hold.

**CAUTION**

To avoid damaging or overheating the starter, do not attempt more than 3 successive ground starts. Allow at least a full minute interval between starts. If continuous use of starter exceeds 40 seconds, have power supply and/or starter checked. Allow 30 minutes cooling of the starter before attempting a 4th start.

10. Ground start switch — START. (After rpm has reached 7%.)
11. Air start ignition switch—OFF (center position).
12. Ground start switch—OFF, (center position) after 2 or 3 seconds.
13. Throttle—IDLE (at 9% rpm).

### IN THE EVENT OF MALFUNCTION

**STARTER FAILS TO PRODUCE 7% RPM.**

a. Release air start ignition switch to spring loaded OFF position and allow engine to windmill to a complete stop.

b. Secure adequate external power supply before attempting new start. If 7% rpm is still unavailable discontinue start and investigate.

**CAUTION**

The ground start switch must be placed in the START position before releasing the air start switch to prevent a momentary power interruption to the starter motor which could damage the starting system.

**RPM FAILS TO INCREASE.**

Starter holding coil has failed to maintain closed circuit to starter.

a. Ground start switch—STOP-START position; allow engine to windmill to a complete stop.

b. Repeat the starting procedure holding ground start switch in START position until approximately 21% rpm is attained.

**FALSE START.**

If ignition does not occur after the throttle has been moved to idle;

a. Throttle—OFF.

b. Ground start switch—STOP-START.

c. Check ignition system and accomplish engine clearing procedure before attempting another start.

CONTINUED ON NEXT PAGE

# GROUND STARTING PROCEDURE CONTINUED

## (GROUP B AND C AIRCRAFT)





| NORMAL PROCEDURE | IN THE EVENT OF MALFUNCTION |
|---|---|
| 14. Tailpipe temperature indicator—Check within limit as listed in Section V. | **HOT STARTS.**<br>Any start in which the tailpipe temperature exceeds the limit specified in Section V shall require entry in DD Form 781.<br>a. Throttle—OFF.<br>b. Ground start switch—STOP-START.<br>c. Do not attempt another start until engine has been inspected. |
| *15. Tachometer—26 to 36% stabilized idle rpm. | **HANGING START.**<br>If the engine fails to accelerate to idle rpm after ignition occurs:<br>a. Throttle—OFF.<br>b. Ground start switch—STOP-START.<br>c. Do not attempt new start until aircraft has been inspected. |
| *16. Engine fuel check-out switch—OFF (observe no change in engine operation). | **STARTER HAS NOT DISENGAGED.**<br>Normally starter disengages at 21% rpm. If rpm increases when engine fuel check-out switch is placed in the OFF position, the starter has not disengaged.<br>a. Ground start switch—STOP-START.<br>b. Continue mission and note discrepancy in DD Form 781. |
| *17. Engine fuel reset switch—RESET momentarily, then OFF.<br>18. Tachometer—35 ±1.5 rpm.<br>19. Engine fuel system emergency warning light—OUT. | **FUEL CONTROL TRANSFER FAILURE.**<br>If the engine fuel supply fails to transfer from the emergency system to the normal system:<br>a. Throttle—OFF.<br>b. Make entry in DD Form 781.<br>c. Do not fly the airplane until fuel system has been inspected and cleared. |

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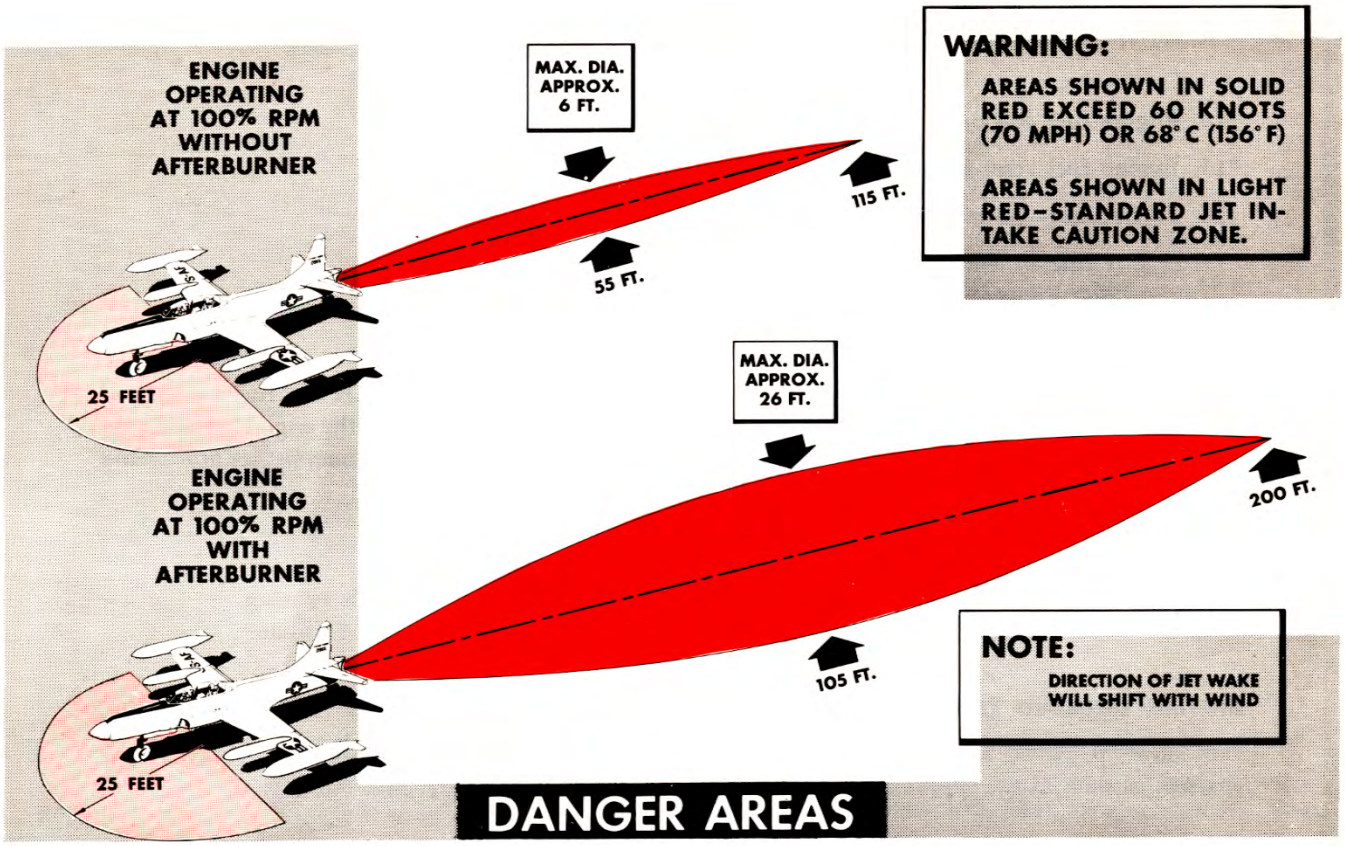


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*Figure 2-3*

# GROUND STARTING PROCEDURE CONTINUED

**(Group A Aircraft)**

1. Throttle—OFF.
2. Emergency fuel shut-off switch—NORMAL.
3. Engine boost pump switch—ENG. BOOST PUMP.

* 4. Engine fuel check-out switch—CHECK-OUT (to start on emergency system).

5. Engine fuel system selector switch—NORMAL.
6. Battery master switch—OFF.
7. Generator switch—OFF.
8. Ignition master switch—OFF.
9. Ground starter switch—START, 2 to 3 seconds, then release.
10. Ignition master switch—NORMAL when engine rpm reaches 7%.
11. Throttle—IDLE at 9% engine rpm.
12. Tailpipe temperature indicator—Within limits.

*13. Tachometer—26% to 36% stabilized rpm.

CONTINUED ON NEXT PAGE

# GROUND STARTING PROCEDURE CONTINUED

*14. Engine fuel check-out switch—OFF (no change in engine operation).

*15. Engine fuel reset switch—RESET momentarily, then OFF.

16. Tachometer—35 ±1.5% rpm.

17. Engine fuel system emergency warning light—OUT.

**ENGINE CLEARING PROCEDURE.**

If it is necessary to discontinue a start after the throttle has been moved to IDLE, and fuel has entered the engine; follow the ground starting procedure, steps 1 through 9, allowing the engine to turn over without ignition for 20 to 30 seconds to thoroughly dissipate excess fuel and fumes before attempting another start.

**Note**

The restart may be completed by accomplishing steps 10 through 19 after the engine has turned over from 20 to 30 seconds and is cleared of fuel.

**ENGINE GROUND OPERATION.**

No warm-up period is required. The engine can be operated at 100% rpm with afterburning, if desired, as soon as the engine instruments have been checked for proper indications.

# BEFORE TAXIING

The following checks shall be accomplished by the pilot before taxiing. (Refer to Section VII for the radar observers Before Taxi Check.)

1. Generator switch—GENERATOR (if an additional constant current APU is used. If not, disconnect APU prior to positioning the generator switch to GENERATOR) check loadmeter —indicating not over .65.
2. APU—Disconnected (if additional constant power APU used).
3. Battery master switch—BATTERY. Loadmeter indicating not over .65.
4. Instrument inverter power switch—NORMAL. Loadmeter indicating not over .65.
5. Oil pressure and other engine instruments—Proper indication.
6. Hydraulic pump pressure selector switch and indicator—Both pumps indicating within limits.
7. Elevator and aileron boost shut-off levers—OFF.
8. Flight controls—Free and proper movement.
9. Elevator and aileron boost shut-off levers—ON.

CONTINUED ON NEXT PAGE

## BEFORE TAXIING CONTINUED

10. Elevator boost ratio selector switch—INCREASE. Check indicator and control movement.
11. Elevator boost ratio selector switch—DECREASE. Check indicator at 2.64 to 1 ratio.
12. Control stick—Trimmed to center. Visually check ailerons.
13. 2500 VA inverter switch—2500 VA INVERTER.
14. UHF Command radio function switch—T/R + G REC.
15. Auto pilot—Check (if required). Return to STANDBY or OFF.
16. Radio compass—As required.
17. IFF—STANDBY.
18. Ground safety pins—Removed, except right arm rest safety pins (if installed).
19. Canopy—Check with Radar Observer, then position as desired (not more than 12 inches open).
20. Wheel chocks—Removed.
21. Oxygen regulator diluter lever—As required.

**Note**

Prolonged idling at low rpm may result in excessive tail pipe temperature. If this should occur, operate the engine at 55-65% rpm for a short period. This rpm gives the coolest ground operating temperature.

# TAXIING INSTRUCTIONS

The engine speed for taxiing is approximately 40 to 60% rpm depending upon the gross weight and ground conditions. Minimize the taxi time. The engine consumes 4 to 6 gallons of fuel per minute at 40 to 60% rpm, thus reducing the effiective range of the aircraft.

### TURNING RADIUS AND GROUND CLEARANCE.

Minimum turning radius on the ground is approximately 40 feet from the pivot point to the opposite wing tip. Approximate ground clearances are as follows:

a. Top of fin—14.8 feet.

b. Bottom of tail—3.5 feet.

c. Tip tanks—5 feet.

d. Front of nose—5.75 feet.

**CAUTION**

Every minute spent taxiing or waiting on the ground decreases the range approximately 8 miles.

CONTINUED ON NEXT PAGE

# TAXIING INSTRUCTIONS CONTINUED

Complete the following checks while taxiing:

1. Throttle friction—Set as desired.
2. Brakes—Use as necessary for steering. Check for proper operation.
3. Turn and slip indicator—Proper deflection of needle, ball free in race.
4. Standby compass—Swings freely, no bubbles. The airplane may be taxied with the canopy partly open.

**CAUTION**

Do not open canopy above 50 knots indicated airspeed or over 12 inches below 50 knots IAS.

# BEFORE TAKE-OFF

**BEFORE TAKING RUNWAY.**

1. Seat belt and shoulder harness—Secured.
2. Canopy—Cleared, closed and locked.

**CAUTION**

Get confirmation from radar observer that he is ready and that the cockpit sills are clear before closing the canopy.

3. Canopy unlatched warning light—Out.

**CAUTION**

Make certain the canopy is locked.

4. Speed brake selector switch—UPLOCK.
5. Afterburner nozzle—CLOSED.
6. Wing flap position indicator—32 degrees.
7. Elevator tab neutral indicator light—ON.
8. Elevator and aileron boost shut-off levers—ON.
9. Elevator boost ratio—Low boost. Check for free and proper movement of flight controls.
10. Oxygen regulator diluter lever—As desired.
11. Right arm rest safety pin—Removed (if installed).

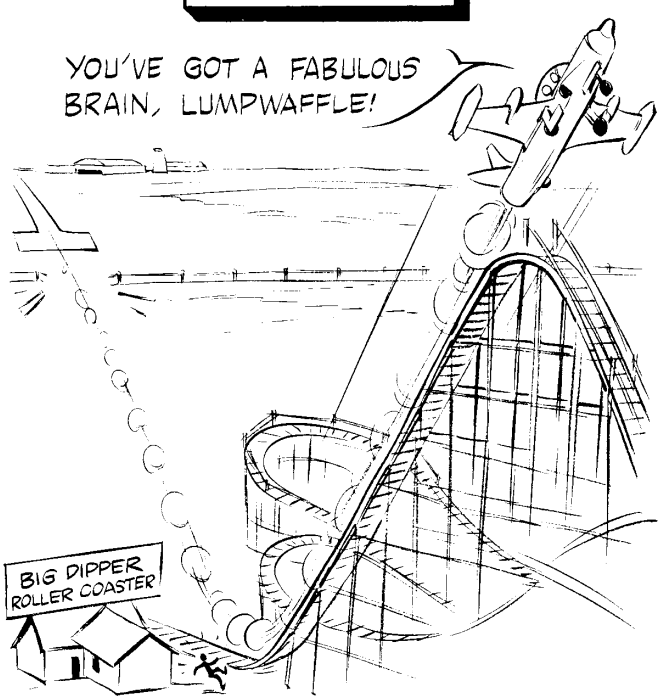
CONTINUED ON NEXT PAGE

# BEFORE TAKE-OFF CONTINUED

**TAKE-OFF POSITION CHECK.**

1. Line up on runway.
2. Brake pedals—Depress.
3. Engine fuel system selector switch—EMERG, momentarily, then return to NORMAL.
4. Fuel flow indicator—1100 lbs/hr maximum.
5. Throttle—Advance slowly to full. (100% rpm maximum.)
6. Throttle—Retard to Idle.
7. Engine fuel system reset switch—RESET momentarily, then release.
8. Throttle—Advance to full.
9. RPM and tailpipe temperature—Within limits.
10. Fuel, oil and hydraulic pressure—Within limits.
11. Loadmeter—.1 to .65.
12. Fuel flow indicator—6400 to 7200 lbs/hr.
13. Fuel tank air pressure of warning light—OFF.
14. Radar A.C. under frequency warning light—OFF.

**WARNING**




DO NOT TAKE OFF WITH THE WING FLAPS RETRACTED AS THE REQUIRED TAKE-OFF RUN AND AIRSPEED ARE GREATLY INCREASED.

# TAKE-OFF

Refer to Appendix I for take-off distances and to Section III for the procedure in event of engine and/or afterburner failure during take-off. Accomplish the following for take-off.

1. Brakes—Release.

**Note**

Use minimum braking when necessary at start of take-off roll to maintain directional control. The rudder will become effective at 40 to 60 knots.

2. Throttle—Move to afterburner position.

**Note**

Indications of proper afterburner actuation will be evidenced by a momentary thrust loss (interval between time of afterburner nozzle opening and ignition) and a definite increase in thrust as the afterburner ignites.

3. Tailpipe temperature indicator, tachometer, and afterburner nozzle open indicator light—Proper indications.
   a. Tailpipe temperature and engine rpm should fluctuate then stabilize at or near original indications.
   b. Afterburner nozzle open indicator light—ON.

**WARNING**

Watch the tailpipe temperature gage during afterburner starts. If the nozzle fails to open the temperature will go considerably higher than the allowable temperature. If this occurs, shut off the afterburner by retarding the throttle.

**Note**

If the nozzle is opened by the override switch, it will be necessary to return that switch to the auto position to close the nozzle after shutting off the afterburner. Check to see that the nozzle position indicator light goes out.

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# TAKE-OFF CONTINUED

## TAKE-OFF TECHNIQUE.

Raise the nose wheel and fly the aircraft off the runway in one continuous motion at the applicable speeds shown in the table below.

TAKE-OFF SPEED

| *Configuration* | *With Afterburner* | *Without Afterburner* |
|---|---|---|
| No External Tanks | 128 Knots | 128 Knots IAS |
| Full Tip Tanks | 145 Knots | 141 Knots IAS |
| Full Tip Tanks & Pods | 147 Knots | 143 Knots IAS |
| Full Tip & Pylon Tanks | 154 Knots | None |
| Full Tip & Pylon Tanks with Pods | 157 Knots | None |

**Note**

The exact speed at which the aircraft can be lifted is a function of airplane weight and C. G. In addition, the speed may vary between airplanes and between individual take-offs on the same airplane because of the possibility of brake dragging.

**CAUTION**

You probably will not notice the brake dragging effect as noted above. If you should encounter noticeable brake dragging (pulling to left or right, or retarded initial roll on take-off) return the airplane to the line for corrective action.

At the instant the main wheels leave the ground, the airplane tends to nose up slightly. Counteract this by relaxing some of the back pressure on the stick.

**CAUTION**

Although it is possible to take-off at slightly lower airspeeds, care must be taken to prevent the airplane from settling back on the runway especially when the afterburner is not used.

## SHORT FIELD TAKE-OFF.

For minimum ground roll use the afterburner and normal take-off technique, but pull the airplane off the ground at speeds about 10 knots lower than normal. Use extra care to prevent stalling the airplane or dragging the tail. To clear an obstacle, use the minimum ground roll technique to get off the ground and then hold the airplane in a climb attitude to limit the airspeed to approximately 15 knots above the take-off speed. Hold this speed until the obstacle is cleared, then push the nose down slightly to increase the speed gradually.

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# TAKE-OFF CONTINUED

### CROSSWIND TAKE-OFF.

Hold nose wheel firmly on the ground until take-off speed is reached, then pull the stick back. Use the downwind brake, if necessary, and the rudder, when it becomes effective, to hold the airplane on the runway heading.

**Note**

Increase the take-off speeds by 10 to 15 knots if the wind is gusty.

### ASSISTED TAKE-OFF.

Take-off distances can be considerably reduced by use of ATO. Performance will depend somewhat upon the firing point of the rocket units. Minimum ground roll will be obtained by firing the units shortly after the start of the take-off run, but the shortest distance to clear a 50-foot obstacle will be obtained by firing them later in the take-off run. See Appendix I for required distance and rocket firing point. Prior to take-off, move the ATO arming switch to ARM and fire the units at the proper time by pressing the ATO firing switch. If only one of the rocket units should fire, there will be no extreme yawing tendency. However, the rocket units should be jettisoned over a clear area as soon as possible to preclude the unexpected thrust that might develop from delayed ignition of the misfired unit. Lighter stick forces may be expected when using ATO, especially after the nose wheel leaves the ground.

**CAUTION**

Anticipate the lighter stick forces when the nose wheel leaves the ground. Be prepared to counteract a nose high attitude that could cause the tail to drag but do not over-control.

# AFTER TAKE-OFF

1. Landing gear control lever—UP, when definitely airborne. Retraction time is approximately 5 seconds.

**Note**

Air pressure on the landing gear fairing doors may prevent retraction above 170 knots IAS. If the gear does not retract; reduce speed below 170 knots and recycle the landing gear.

2. Wing flap switch—UP (160 to 175 knots IAS). Return switch to OFF after flaps are Up.

**Note**

Normal flap retraction time is approximately 4 seconds.

CONTINUED ON NEXT PAGE

## AFTER TAKE-OFF CONTINUED

3. Engine instruments—Proper indications.
4. Oxygen regulator diluter lever—NORMAL.
5. Tip tank release arming switch—OFF.

If ATO units were used on take-off, drop the cylinders in the prescribed area as specified by local regulations. Retard throttle out of afterburner detent position unless an afterburner climb is desired.

## CLIMB

Climb at 200-225 knots IAS to a safe altitude, then gradually accelerate to the best climb speed. Maintain some climb while accelerating especially when using the afterburner so that climb speed is reached between 5,000-8,000 feet altitude above the field. This technique does not result in maximum climb performance to high altitude but, for normal operation it does provide a greater margin of flight safety in the event of an emergency. Military thrust is recommended for climb for maximum range conditions when minimum climbing time to altitude is not important. For minimum time to altitude (maximum climb), maximum thrust (afterburner) should be used. Refer to the climb charts in Appendix I for the recommended indicated airspeeds, rate of climb, and fuel consumption appropriate for the type of climb performance desired.

## CRUISE CHECKS

After climb to altitude is completed, maintain the proper airspeed and power settings, as indicated in Appendix I commensurate with the altitude for the mission planned. Check the fuel quantity, engine instruments and hydraulic pressure for proper indications. Refer to Section VII for Systems Operation.

### FLIGHT CHARACTERISTICS.

Refer to Section VI for information concerning flight characteristics.

## DESCENT

Descents can be made with or without speed brakes extended. Extremely high rates can be obtained. Extension of the speed brakes slows the airplane and aids in pulling out of dives. The throttle can be retarded to IDLE without danger of engine flame-out, except that during descents in heavy rain, a possibility exists wherein excessive amounts of water entering the engine could cause a flame-out. Therefore, sufficient rpm should be maintained to keep the tailpipe temperature at 400°C minimum during all descents in heavy rain. Rapid descents generally cause the most severe fogging condition on the canopy and windshield since the airplane can descend to low altitudes where the air conditioning system will be bringing in humid air more rapidly than the system can raise the internal

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## DESCENT CONTINUED

temperature of the canopy. Because of this, it is necessary to have the canopy and windshield as warm as possible before descent to prevent excessive condensation. Since descents cannot always be anticipated, it is recommended that the cockpit air temperature at altitude be the maximum consistent with reasonable pilot comfort. To make a descent accomplish the following steps:

1. Cockpit air temperature selector—HOT.
2. Cockpit air control selector—DE-ICE.
3. Auxiliary windshield defroster switch—WINDSH. DEFROST.
4. Speed brake switch—DOWN.
5. Throttle—Retard to 65% rpm.
6. Airspeed—250 KIAS.

**Note**

To descend in minimum time (fuel or distance), extend the speed brakes, retard the throttle to IDLE, and maintain steepest dive angle possible to minimum safe recovery altitude. (Refer to figure 6-5 and 6-6 for altitude required for recovery.)

# BEFORE LANDING

Make radio transmission requesting landing instructions and accomplish the following checks while approaching the traffic pattern:

1. Alert the radar observer to prepare for landing.
2. Elevator boost ratio switch—DECREASE (2.65 to 1).
3. Hydraulic pressure indicator—Pressure output of both pumps within limits.
4. Fuel quantity—CHECK.
5. Radar—OFF, Scope stowed.

Refer to Section V for landing weight and balance limitations and Appendix I for runway lengths required for the landing roll.

# LANDING PATTERN

Refer to figure 2-4 for typical landing pattern.

### INITIAL APPROACH.

Enter the initial approach approximately 3 miles out from the approach end of the landing runway at 1000 feet minimum altitude above terrain and accomplish the following:

1. Airspeed—270 KIAS.
2. Speed brakes switch—DOWN.

CONTINUED ON NEXT PAGE

# LANDING PATTERN CONTINUED

3. Throttle—55 to 65% rpm.
4. Radio transmission—As required.

### DOWNWIND LEG.

Slow the aircraft down to below 215 KIAS maintaining 1000 feet above the terrain and complete the following:

1. Landing gear control lever—DOWN.

**Note**

The landing gear extension time is from 8 to 10 seconds.

2. Speed brake switch—UP (if pattern is to be extended).

### FINAL TURN.

Start final turn at a minimum of 500 feet above terrain not less than 3000 feet from approach end of the runway and accomplish the following steps:

1. Wing flap switch—DOWN.
2. Airspeed—150 KIAS minimum.

### FINAL APPROACH.

After rolling out on the final approach, check the following:

1. Airspeed—145 KIAS minimum.
2. Landing gear position indicators and warning system—Proper indications.
3. Speed brake switch—DOWN.
4. Throttle—Maintain 55 to 65% rpm until a safe landing is assured, then retard to—IDLE.

## GO-AROUND.

Make decision to go around as early as possible because of the slow acceleration characteristics of jet aircraft. Proceed as follows for a go-around:

**Note**

Be prepared for a nose high trim condition after advancing the throttle. As speed increases it will be necessary to add nose down trim.

1. Throttle—FULL (100% rpm)—The afterburner should not be used.

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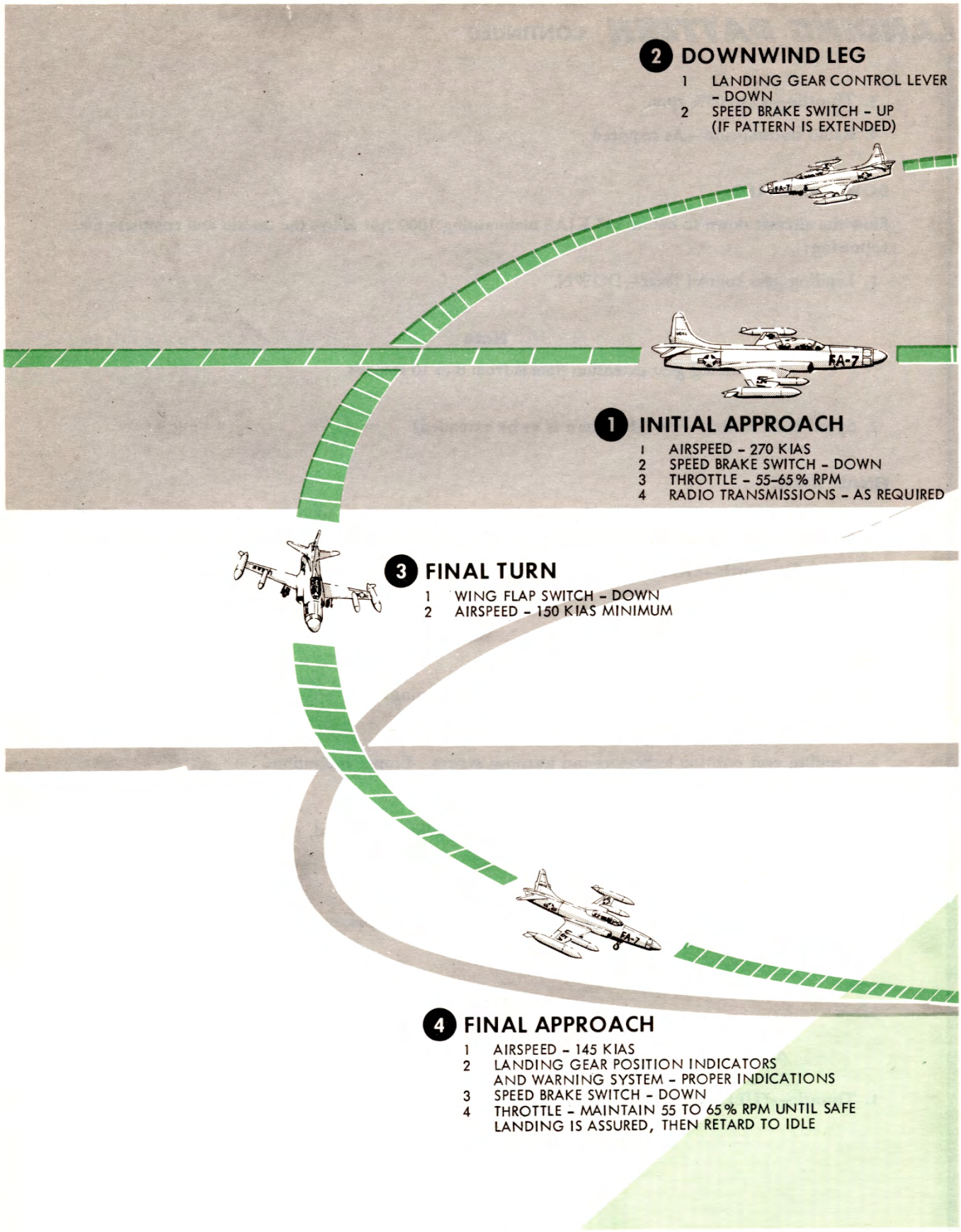
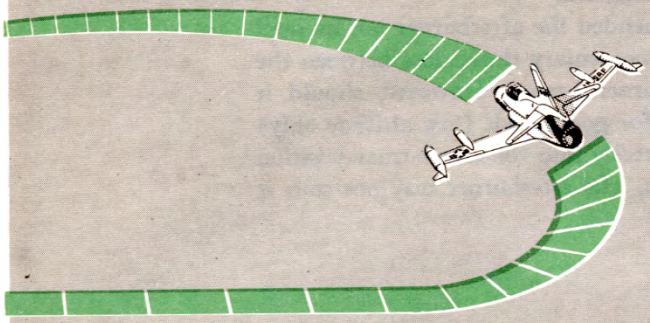
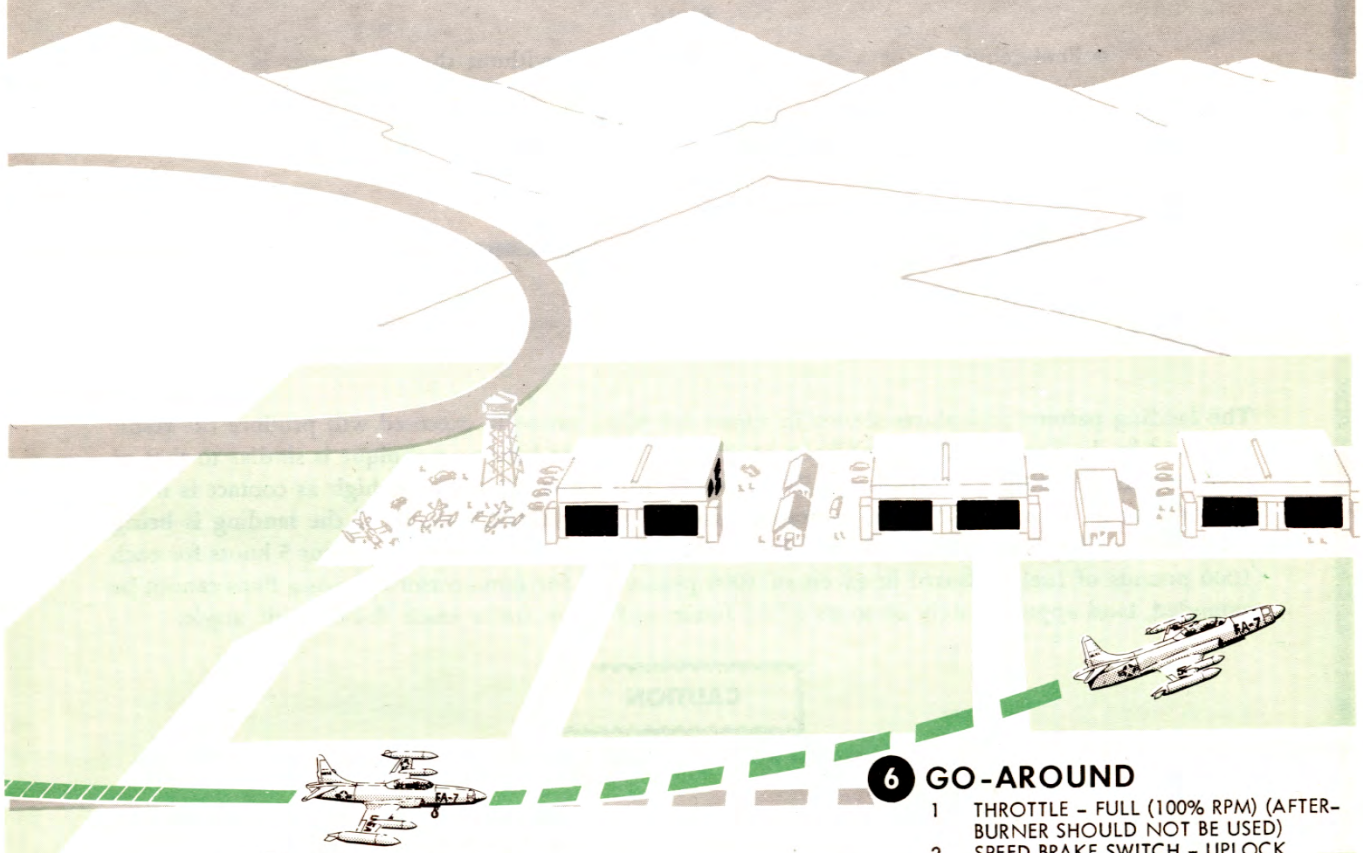



*Figure 2-4 (Sheet 1 of 2 Sheets)*

# LANDING AND GO-AROUND PATTERN (TYPICAL)

(REFER TO APPENDIX I FOR EXACT LANDING SPEEDS FOR VARIOUS GROSS WEIGHTS)






## 5 LANDING ROLL

1. DRAG CHUTE - RELEASE AFTER TOUCHDOWN
2. WING FLAP SWITCH - UP
3. WHEEL BRAKES - APPLY AS NECESSARY
4. DRAG CHUTE - JETTISON (ONLY IF BRAKES OPERATE SATISFACTORILY AND AIRCRAFT IS SUFFICIENTLY SLOWED)
5. CANOPY - POSITION AS DESIRED (NOT MORE THAN ONE FOOT OPEN)

## 6 GO-AROUND

1. THROTTLE - FULL (100% RPM) (AFTER-BURNER SHOULD NOT BE USED)
2. SPEED BRAKE SWITCH - UPLOCK
3. LANDING GEAR CONTROL LEVER - UP WHEN SAFELY AIRBORNE
4. WING FLAP SWITCH - UP AT 160 KIAS

## NOTE

IF DRAG CHUTE HAS BEEN RELEASED FOR LANDING, JETTISON CHUTE BEFORE ATTEMPTING A GO-AROUND

*Figure 2-4 (Sheet 2 of 2 Sheets)*

# LANDING PATTERN CONTINUED

**CAUTION**

Unless absolutely necessary, it is recommended the afterburner not be used for go-around, because there will be a momentary thrust loss between the time the nozzle opens and the afterburner ignites. However, should it become necessary to use the afterburner for go-arounds (low altitude only) it is permissible to move the throttle directly into the afterburner position when the engine speed is over 60% rpm. The afterburner may not start if this is done at lower rpm.

2. Speed brake switch—UPLOCK.
3. Landing gear control lever—UP, when safely airborne.
4. Wing flap switch—UP at 160 KIAS.

**Note**

- Fuel required for a short go-around pattern without the afterburner is approximately 250 pounds, and approximately 350 pounds with the afterburner.
- Accelerate to at least 180 KIAS before starting to climb.

# LANDING

The landing pattern procedures shown in figure 2-4 when properly executed will produce the result tabulated in the Landing Distance Charts of Appendix I. The landing technique is similar to that of other tricycle landing gear airplanes. The landing attitude is slightly nose high as contact is made with the main wheels first. Make contact at approximately 120-125 knots. If the landing is being made with an appreciable load of fuel, the landing speed should be increased about 5 knots for each 1000 pounds of fuel on board in excess of 1000 pounds. If for some reason the wing flaps cannot be extended, land approximately 20 to 25 KIAS faster and allow for a much flatter glide angle.

**CAUTION**

Extra care must be used to avoid dragging the tail on the runway when landing without flaps.

### LANDING ROLL.

As soon as solid contact is made, hold the stick back to prevent the nose wheel from slamming down hard on the runway and accomplish the following:

**Note**

If porpoising is encountered after touchdown, refer to Section VI for the corrective procedure.

CONTINUED ON NEXT PAGE

# LANDING CONTINUED

1. Drag chute—Release after touchdown.

**Note**

It is recommended that the drag chute be used for all landings, except in strong cross winds. However, it should be standard practice to land so that the airplane could be stopped on the runway without the chute. The drag chute is extremely effective in decelerating the airplane and also saves tire and brake wear. The chute can be used for approximately 75 landings before replacement is necessary. Repairs after 15 or 20 landings may be required and can be executed by any base parachute repair shop.

2. Wing flap switch—UP.

**Note**

Retracting the flaps immediately after touchdown distributes more weight on the main wheels, making the brakes more effective. The drag chute alone is very effective, especially at the higher rolling speeds and will reduce the landing ground roll approximately 40%.

3. Wheel brakes—Apply as necessary.
4. Drag chute—Jettison (only if brakes operate satisfactorily and the aircraft is sufficiently slowed.

**Note**

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

**CAUTION**

Do not make sharp turns during taxiing with the drag chute deployed to prevent the chute from collapsing and subsequently damaging the chute or chute compartment.

5. Canopy—Position as desired (not more than 12 inches open).

**CAUTION**

Do not open canopy on the landing roll until the airspeed has dropped below 50 KIAS.

CONTINUED ON NEXT PAGE

# LANDING CONTINUED

### CROSS WIND LANDING.

The procedure is the same as for a normal landing except that the wind drift must be compensated for by crabbing or dropping a wing or both.

**CAUTION**

- It is recommended that the drag chute not be used in a 90-degree cross wind exceeding 20 knots except in emergencies. In any cross wind landing it is recommended that the chuthe be deployed only after the nose wheel is on the ground, the flaps are retracted and the brakes have slowed the airplane down considerably.
- These conditions will minimize the effect of the weathervaning by the chute. Jettison the chute as soon as the airplane can be easily stopped on the runway without it. Make certain the chute will clear other aircraft when jettisoned.

The airplane can be taxiied satisfactorily with the drag chute deployed except in a strong cross wind.

**CAUTION**

Care should be used in drag chute operation during cross wind landing due to the resultant weathervaning effect on the airplane.

### MINIMUM RUN LANDING.

If the landing distance is marginal, exercise additional care and proceed as follows:

a. Use more power and keep the airspeed just above the stall warning buffeting range.

b. Reduce power gradually when close to the end of the runway. The airplane will lose altitude quickly as the power is reduced.

c. Contact the runway just as the airplane stalls.

d. Open the drag chute as soon as contact is made. Hold the stick back.

e. Retract the wing flaps immediately.

f. Brake the airplane as hard as possible but do not skid the tires.

### HEAVY WEIGHT LANDING.

The same technique for a normal landing applies for a heavy weight landing except for necessary increases in power settings. As the gross weight increases, approach and touchdown speeds should be increased accordingly. A full stall landing should be avoided if at all possible. Attempt to keep the G forces at a minimum during touchdown.

CONTINUED ON NEXT PAGE

# LANDING CONTINUED

**Note**

If a hard heavy-weight landing is made, make an entry in DD Form 781 so that the aircraft will be inspected for signs of overstress before the next flight.

### EMERGENCY LANDINGS.

Refer to Section III for Emergency Landing Procedures.

### AFTER LANDING.

Maintain directional control by use of brakes. Recheck speed brakes DOWN. Taxi to the parking area avoiding excessive use of brakes using idle rpm.

**Note**

The speed brakes should be left in the DOWN position for aft fuselage cooling, inspections and maintenance necessary after the engine is shut down.

# ENGINE SHUT-DOWN

1. Throttle—OFF.

**Note**

If the afterburner has been used, the engine should be run at idle rpm until the crew chief signals that the fuel has stopped draining from the afterburner fuel manifold. The fuel will drain out only when the throttle is in the IDLE position.

2. Right arm rest safety pin—Installed (if applicable).
3. Canopy open switch—OPEN, then OFF.
4. Wing flap switch—DOWN, then OFF; check flap indicator at 32 degrees.
5. Elevator tab neutral indicator light—ON.
6. Control stick—Centered. Visually check ailerons—Neutral.
7. Aileron trim tab—Neutral.
8. Alternator switches—ON.
9. Remaining cockpit switches—OFF or NORMAL.
10. Canopy and seat safety pins—Installed.

CONTINUED ON NEXT PAGE

# ENGINE SHUT-DOWN CONTINUED

11. Seat belt and shoulder harness—Unfasten.
12. DD Form 781—Fill out and list any discrepancies.

**Note**

Insure the security of the aircraft before leaving the area.

# CONDENSED CHECK LIST

Pages 2-33 through 2-49 contain a condensed checklist.

## F-94C CONDENSED CHECKLIST

**Note**

The following checklist is a condensed version of the airplane checklist. This checklist is accomplished by the pilot in command for all flights.

## BEFORE EXTERIOR INSPECTION

1. Tip tank safety pins—Installed.
2. Canopy and seat safety pins—Installed.
3. DD Form 781—Check and sign.
4. Landing gear control lever—DOWN.
5. Oxygen—1800 psi.
6. 2500 VA Inverter switch—OFF.
7. Armament switches—OFF.
8. Battery master switch—BATTERY.
9. Control stick trim and elevator trim tab switch—Operate in all four positions. Note that it automatically returns to Neutral.
10. Elevator tab neutral indicator light—ON.
11. Battery master switch—OFF.
12. Surface control lock—Removed and stowed.

## EXTERIOR INSPECTION

1. LEFT WHEEL WELL AREA.
   a. Outer fairing door—Secured.
   b. Tire—Condition and slippage.
   c. Wheel chocks—In place.

d. Brake hydraulic line—Damage and leaks.
e. Landing gear scissors microswitch—Engaged.
f. Landing gear shock strut extension—Normal.
g. Landing gear downlock safety pin—In place.
h. Hydraulic accumulator pressure gage—600 ± 25 psi.
i. Fuel and hydraulic lines—Leaks.
j. Landing gear uplock switch—Free.
k. Landing gear and speed brake hydraulic shut-off valve—Safetied open.
l. Fuel drain valve—Closed.

2. LEFT FORWARD SPEED BRAKE AREA.
   a. Area—Leaks and condition.
   b. Speed brake pip pin—Installed.
   c. Speed brake—Secured.
   d. Fuel drain valve—Closed.

3. LEFT SIDE OF NOSE.
   a. Left duct cover—Removed. No foreign objects.
   b. Single point fuel filler cap—Secured.
   c. Static source—Clear.
   d. Pitot tube cover—Removed.
   e. Nose compartment doors—Closed and latched.
   f. Radome—Secured and condition.

4. NOSE WHEEL WELL AREA.
   a. Area—Leaks and security.
   b. Circuit breakers—In.
   c. Dust cover—In place.
   d. Fairing doors—Secured.
   e. Nose landing gear microswitch—Free.

f. Down-lock safety clip—In place.
g. Nose gear hydraulic shut off valve—Safetied open.
h. Shimmy damper—Tight.
i. Shimmy damper pins—Extended equally, lock nuts tight.
j. Nose gear strut extension—Normal.
k. Nose gear uplock rollers—Free.
l. Static wire—Grounded.
m. Tire—Condition and slippage.
n. Landing and taxi lights—Condition.
o. Nose gear scissors—Tight.

5. RIGHT SIDE OF NOSE.
   a. Radome—Secured and condition.
   b. Nose compartment doors—Closed and latched.
   c. Static sources—Clear.
   d. Yaw string—Free (if installed).
   e. Oxygen filler cap cover—Closed and secured.
   f. Emergency hydraulic reservoir filler cap cover—Secured.
   g. External canopy control access door—Secured.
   h. External canopy jettison handle access door—Secured.
   i. Right intake duct cover—Removed. No foreign objects.

6. RIGHT FORWARD SPEED BRAKE AREA.
   a. Area—Leaks and condition.
   b. Speed brake pip pin—Installed.
   c. Speed brake—Secured.

7. RIGHT WHEEL WELL AREA.
   a. Fuel and hydraulic lines—Leaks.
   b. Landing gear uplock switch—Free.
   c. Landing gear hydraulic shut-off valve—Safetied open.
   d. Hydraulic accumulator pressure gage—600 ± 25 psi.
   e. Landing gear downlock safety pin—Installed.
   f. Landing gear shock strut extension—Normal.
   g. Landing gear scissors microswitch—Engaged.
   h. Brake hydraulic line—Damage and leaks.
   i. Tire—Condition and slippage.
   j. Outer fairing door—Secured.
   k. Wheel chocks—In place.

8. RIGHT WING AREA.
   a. Under surface of wing—Fuel leaks and condition of skin.
   b. Pylon tank (if installed)—Condition and leaks.
   c. De-icer boot—Condition.
   d. Rocket pod (if installed)—Condition.
   e. Tip tank safety pin—Installed.
   f. Tip tank fairing—Secured.
   g. Tip tank filler cap—Secured.
   h. Tip tank area—Fuel leaks.
   i. Tip tank spring indicator—Flush.
   j. Navigation lights—Condition.
   k. Tip tank fin—Secured.
   l. Aileron—Warpage, excessive play, proper travel and clearance.
   m. Spoiler—Condition and proper movement.
   n. Wing flap—Condition and connections.
   o. Upper wing surface—Condition of skin.

9. RIGHT FUSELAGE AREA.
   a. Oil filler well—Quantity and cap secured.
   b. Access doors—Secured.
   c. Fuselage lights—Condition.
   d. Right aft speed brake pip pin—Installed.
   e. Area—Hydraulic leaks.
   f. Skin condition and air lock fasteners—Check.

10. EMPENNAGE AND AFT SECTION AREA.
   a. Inspection plates—Secured.
   b. De-icer boot—Condition.
   c. Fuel vent—Clear.
   d. Elevator—Proper travel.
   e. Elevator trim tab—Neutral when elevator is neutral, excessive play.
   f. Right elevator and rudder—Skin condition.
   g. Rudder bend tab—Not bent more than ¼ in.
   h. Nozzle, tailpipe, afterburner and turbine wheel—Condition.
   i. Drag chute doors—Closed and secured.
   j. Position light—Condition.
   k. Left elevator and rudder—Skin condition.
   l. Elevator—Proper travel.
   m. Elevator trim tab—Neutral when elevator neutral, excessive play.
   n. Fuel vent—Clear.
   o. De-icer boot—Condition.
   p. Inspection plates—Secured.

11. LEFT FUSELAGE AREA.
   a. Left aft speed brake pip pins—Installed.
   b. Area—Hydraulic leaks.
   c. Skin condition and air lock fasteners—Check.
   d. Access doors—Secured.

12. LEFT WING AREA.
    a. Upper wing surface—Condition of skin.
    b. Wing flap—Condition and connections.
    c. Spoiler—Condition and proper movement.
    d. Aileron—Warpage, excessive play, proper travel and clearance.
    e. Tip tank fin—Secured.
    f. Navigation lights—Condition.
    g. Tip tank spring indicator—Flush.
    h. Tip tank area—Fuel leaks.
    i. Tip tank filler cap—Secured.
    j. Tip tank fairing—Secured.
    k. Tip tank safety pin—Installed.
    l. De-icer boot—Condition.
    m. Rocket pod (if installed)—Condition.
    n. Pylon tank (if installed)—Condition and leaks.
    o. Under surface of wing—Fuel leaks and condition of skin.

13. TOP FUSELAGE AREA.
    a. Fuselage tank filler cap and access door—Secured.
    b. Alcohol reservoir—Full and cap secured.
    c. Main hydraulic reservoir—Fluid level and cap secured.
    d. Engine compartment—Condition.
    e. Circuit breaker—In.
    f. Rear cockpit ejection seat air bottle pressure gage—proper reading.

## INTERIOR INSPECTION

### AFT COCKPIT CHECK (solo)

1. Pressurization air inlet grills—SHUT.
2. Oxygen regulator supply valve lever—OFF.

3. Radar—OFF and scope stowed.
4. UHF local-remote switch—REMOTE (front cockpit on some aircraft).
5. Canopy jettison handle—In place and safetied.
6. Radio compass—OFF.
7. Cockpit lights—OFF.
8. Seat belt, shoulder harness, oxygen hose and radio cord—Secured.
9. Loose equipment—Secured.

**FRONT COCKPIT CHECK**

1. Seat belt and shoulder harness—Adjusted and fastened.
2. Seat—Adjusted.
3. Rudder pedals—Adjusted.
4. Pressurization air inlet grills—OPEN.
5. APU power—Applied.
6. Instrument power switch—NORMAL.
7. Head set and oxygen—Connected.
8. Oxygen:
   a. Oxygen pressure gage—1800 psi.
   b. Oxygen regulator supply valve lever—ON.
   c. Oxygen regulator—Check leakage.
   d. Oxygen regulator warning system switch—ON (check for bright light).
   e. Oxygen regulator emergency toggle lever—Deflect, then OFF (note proper warning light indication).
   f. Oxygen regulator diluter lever—100%.
   g. Oxygen regulator flow indicator—Proper operation (blinking).
   h. Oxygen regulator emergency toggle lever—Deflect.
   i. Mask—Test.
   j. Oxygen regulator emergency toggle lever—OFF (center).
   k. Oxygen regulator diluter lever—As desired.
   l. H-2 Oxygen cylinder—Tag and pin removed, hose connected.

**Front cockpit check—Left side.**

1. Aft panel circuit breakers—In.
2. Exterior lights—As desired.
3. Cockpit lights—As desired.
4. Armament control panel
   a. Bomb arming switch—OFF.
   b. Rocket heat switch—As required.
   c. Rocket firing selector switch—As required.
   d. Rocket arming switch—OFF.
5. Droppable tank manual release and ATO jettison handles—Safetied.
6. Drag chute release and jettison handle—In.
7. Fuel control panel
   a. External tank fuel selector switch—As required.
   b. Tip tank release arming switch—AUTO DROP (if installed); otherwise OFF.
   c. Fuel tank air pressure off warning light—ON.
   d. Emergency fuel shut-off switch—NORM.
   e. Fuel system de-ice switch—OFF.
   f. Engine boost pump switch—ENG BOOST PUMP.
   g. Engine fuel system check-out switch—OFF.
   h. Engine fuel system selector switch—NORM. (Guarded)
8. Aileron trim tab switch—Operate through a complete cycle, then OFF (center).
9. Elevator boost ratio switch—Operate through a complete cycle. Check proper movement of indicator.
10. Landing and taxi light switch—OFF.
11. Forward panel circuit breakers—In.
12. Afterburner nozzle override switch—AUTO.
13. Afterburner nozzle open indicator light—Test.
14. Throttle—OFF.

15. Speed brake switch—NEUT.
16. Elevator and aileron booster control levers—ON.
17. Landing gear control lever—DOWN.
18. Landing gear position indicator, warning horn, and unsafe warning light—Check.
19. Wing flap switch—Check operation of flaps and set flaps at 32 degrees.

**Front cockpit—Center control pedestal.**

1. Cockpit air control selector—DEFROST.
2. Cockpit air pressure selector switch—5 PSI PRESS.
3. Cockpit air pressure shut-off switch—PRESS.
4. Cockpit air temperature control switch—AUTO.
5. Cockpit air temperature rheostat—As desired.
6. 2500 VA Inverter switch—OFF.
7. Generator switch—OFF.
8. Battery master switch—OFF.
9. 8 KVA Alternator switch—8 KVA ALT.
10. 30 KVA Alternator switch—30 KVA ALT.
11. Radar A.C. under frequency warning light—ON.
12. Auxiliary windshield defroster switch—OFF.
13. Pitot heat switch—OFF.
14. Wing and Empennage de-ice switch—OFF.
15. Wing and Empennage de-ice indicator light—OFF.
16. Center control pedestal circuit breakers—In.

**Front cockpit—Right side.**

1. Accelerometer—Checked and set.
2. Command radio function switch—OFF.
3. Auto pilot—OFF.

4. Ground rocket door opening switch—CLOSED.
5. Interphone (audio bypass) switch—NORMAL.
6. Headset volume—As desired.
7. Radio Compass—ON (to allow warm-up).
8. Circuit breakers—In.
9. Canopy handcrank—Stowed and safetied.
10. Emergency Hydraulic system selector lever—NORMAL and safetied.
11. Relief tube hose—Stowed.

**Front cockpit—Instrument panel.**

1. Generator out warning light—ON.
2. Clock—Set and running.
3. Fire and overheat warning light—Test circuits and lights.
4. Engine fuel system emergency and engine fuel pump failure warning lights—On.
5. Canopy unlatched warning light—On.
6. Fuel quantity and fuel quantity indicating system—Check.
7. Vertical velocity indicator—Zero.
8. Altimeter—Set to field elevation and note error.
9. Zero reader—Check.
10. Air speed indicator—30 to 35 knots.
11. Heading indicator—Set to take-off runway heading.
12. Attitude indicator—Checked and no flag.
13. Radio compass—Check operation in all positions, then OFF.
14. Instrument inverter power switch Group A and B airplanes—STANDBY then OFF.
15. Instrument inverter power switch Group C airplanes—STANDBY then NORMAL if additional constant current starting unit is available; if not, inverter power switch—STANDBY then OFF.

## GROUND STARTING PROCEDURE. (Group B and C aircraft)

Procedures preceded by an asterisk should be performed on the first flight each day the aircraft is flown.

1. Throttle—OFF.
2. Emergency fuel shut-off switch—NORMAL.
3. Engine boost pump switch—ENG BOOST PUMP.

*4. Engine fuel check-out switch—CHECK-OUT (to start on the emergency system).

5. Engine fuel system selector switch—NORMAL.
6. Battery master switch—OFF.
7. Generator switch—OFF.
8. Group B aircraft only, start selector switch—NORMAL, if additional constant current starting unit available. If not, place switch to EMERGENCY.
9. Air start ignition switch—STARTER ONLY and hold.
10. Ground start switch—START (at 7% RPM).
11. Air start ignition switch—OFF (center).
12. Ground start switch—OFF (center) after 2 or 3 seconds.
13. Throttle—IDLE (at 9% engine rpm).
14. Tailpipe temperature indicator—Within limits.

*15. Tachometer—26 to 36% stabilized rpm.

*16. Engine fuel check-out switch—OFF. No change in engine operation.

*17. Engine fuel reset switch—RESET momentarily, then OFF.

18. Tachometer—35 ± 1.5% rpm.
19. Engine fuel system emergency warning light—Out.

## GROUND STARTING PROCEDURE. (Group A aircraft)

1. Throttle—OFF.
2. Emergency fuel shut-off switch—NORMAL.
3. Engine boost pump switch—ENG. BOOST PUMP.
*4. Engine fuel check-out switch—CHECK-OUT (to start on emergency system).
5. Engine fuel system selector switch—NORMAL.
6. Battery master switch—OFF.
7. Generator switch—OFF.
8. Ignition master switch—OFF.
9. Ground starter switch—START, 2 to 3 seconds, then release.
10. Ignition master switch—NORMAL when engine rpm reaches 7%.
11. Throttle—IDLE at 9% engine rpm.
12. Tailpipe temperature indicator—Within limits.
*13. Tachometer—26% to 36% stabilized rpm.
*14. Engine fuel check-out switch—OFF (no change in engine operation).
*15. Engine fuel reset switch—RESET momentarily, then OFF.
16. Tachometer—35 ±1.5% rpm.
17. Engine fuel system emergency warning light—OUT.

## BEFORE TAXIING.

1. Generator switch—GENERATOR, if constant current APU used during start. If not, disconnect APU prior to turning on generator. Loadmeter .65 max.

2. APU—Disconnected (if additional constant power APU used).
3. Battery master switch—BATTERY, loadmeter .65 max.
4. Instrument power switch—NORMAL, loadmeter .65 max.
5. Oil pressure and other engine indicators—Proper indications.
6. Hydraulic pump pressure selector switch and indicator—Both pumps indicating within limits.
7. Elevator and aileron boost shut-off levers—OFF.
8. Flight controls—Free and proper movement.
9. Elevator and aileron boost shut-off levers—ON.
10. Elevator boost ratio selector switch—INCREASE. Check indicator and control movement.
11. Elevator boost ratio selector switch—DECREASE. Check indicator at 2.64 to 1 ratio.
12. Control stick—Trimmed to center. Visually check ailerons.
13. 2500 VA Inverter switch—2500 VA INVERTER.
14. UHF Command radio function switch—T/R + G REC.
15. Auto Pilot—Check (if required). Return to STANDBY or OFF.
16. Radio Compass—As required.
17. IFF—STANDBY.
18. Ground safety pins—Removed, except right arm rest safety pin (if installed).
19. Canopy—Check with R/O then position as desired. (Not more than 12 inches open).
20. Wheel chocks—Removed.
21. Oxygen regulator diluter lever—As required.

**TAXIING INSTRUCTIONS.**

1. Throttle friction control—As desired.
2. Brakes—Use as necessary for steering. Check for proper operation.
3. Turn and Slip Indicator—Proper deflection. Ball free in race.
4. Standby compass—Swings freely. No bubbles.

**BEFORE TAKING RUNWAY.**

1. Seat belt and shoulder harness—Secured.
2. Canopy—Cleared, closed, locked.
3. Canopy unlatched warning light—Out.
4. Speed brake selector switch—UPLOCK.
5. Afterburner nozzle—CLOSED.
6. Wing flap position indicator—32 Degrees.
7. Elevator tab neutral indicator light—ON.
8. Elevator and aileron boost shut-off levers—ON.
9. Elevator boost ratio—low boost. Check for free and proper movement of flight controls.
10. Oxygen regulator diluter lever—as desired.
11. Right arm rest safety pin—Removed (if installed).

**TAKE-OFF POSITION CHECK.**

1. Line up on runway.
2. Brake pedals—Depress.
3. Engine fuel system selector switch—EMERG. momentarily, then return to NORMAL.
4. Fuel flow indicator—1100 lbs/hr max.
5. Throttle—Advance slowly to FULL. (100% RPM maximum).
6. Throttle—Retard to IDLE.
7. Engine fuel system Reset switch—RESET momentarily, then release.
8. Throttle—Advance to FULL.
9. RPM and tailpipe temperature—Within limits.
10. Fuel, oil, and hydraulic pressure—Within limits.
11. Loadmeter—.1 to .65.
12. Fuel flow indicator—6400 to 7200 pounds per hour.
13. Fuel tank air pressure off warning light—OFF.
14. Radar A.C. under frequency warning light—OFF.

**TAKE-OFF CHECK.**

1. Brakes—Release.
2. Throttle—Move to afterburner position.
3. Tailpipe temperature indicator, tachometer, and afterburner nozzle open indicator light—Proper indications.

**AFTER TAKE-OFF.**

1. Landing gear control lever—UP, when definitely airborne.
2. Wing flap switch—UP (160 to 175 knots). Return to OFF after flaps are up.
3. Engine instruments—Proper indications.
4. Oxygen regulator diluter lever—NORMAL.
5. Tip tank release arming switch—OFF.

**DESCENT.**

1. Cockpit air temperature selector—HOT.
2. Cockpit air control selector—DE-ICE.
3. Auxiliary windshield defroster switch—WINDSH DEFROST.
4. Speed brake switch—DOWN.
5. Throttle—Retard to 65% RPM.
6. Airspeed—250 KIAS.

**BEFORE LANDING CHECK.**

1. Alert R/O to prepare for landing.
2. Elevator boost ratio switch—DECREASE (2.64 to 1).
3. Hydraulic pressure indicator—Pressure output of both pumps within limits.
4. Fuel quantity—Check.
5. Radar—OFF, scope stowed.

**LANDING PATTERN.**

**Initial Approach.**

1. Airspeed—270 KIAS.
2. Speed brake switch—DOWN.
3. Throttle—55-65% RPM.
4. Radio transmissions—As required.

**Downwind Leg.**

1. Landing gear control lever—DOWN.
2. Speed brake switch—UP (if pattern is extended).

**Final Turn.**

1. Wing flap switch—DOWN.
2. Airspeed—150 knots minimum.

**Final Approach.**

1. Airspeed—145 KIAS minimum.
2. Landing gear position indicators and warning system—Proper indications.
3. Speed brake switch—DOWN.
4. Throttle—Maintain 55 to 65% RPM until safe landing is assured, then retard to IDLE.

**GO-AROUND.**

1. Throttle—FULL (100% RPM) (Afterburner should not be used).
2. Speed Brake Switch—UPLOCK.
3. Landing gear control lever—UP, when safely airborne.
4. Wing flap switch—UP at 160 knots.

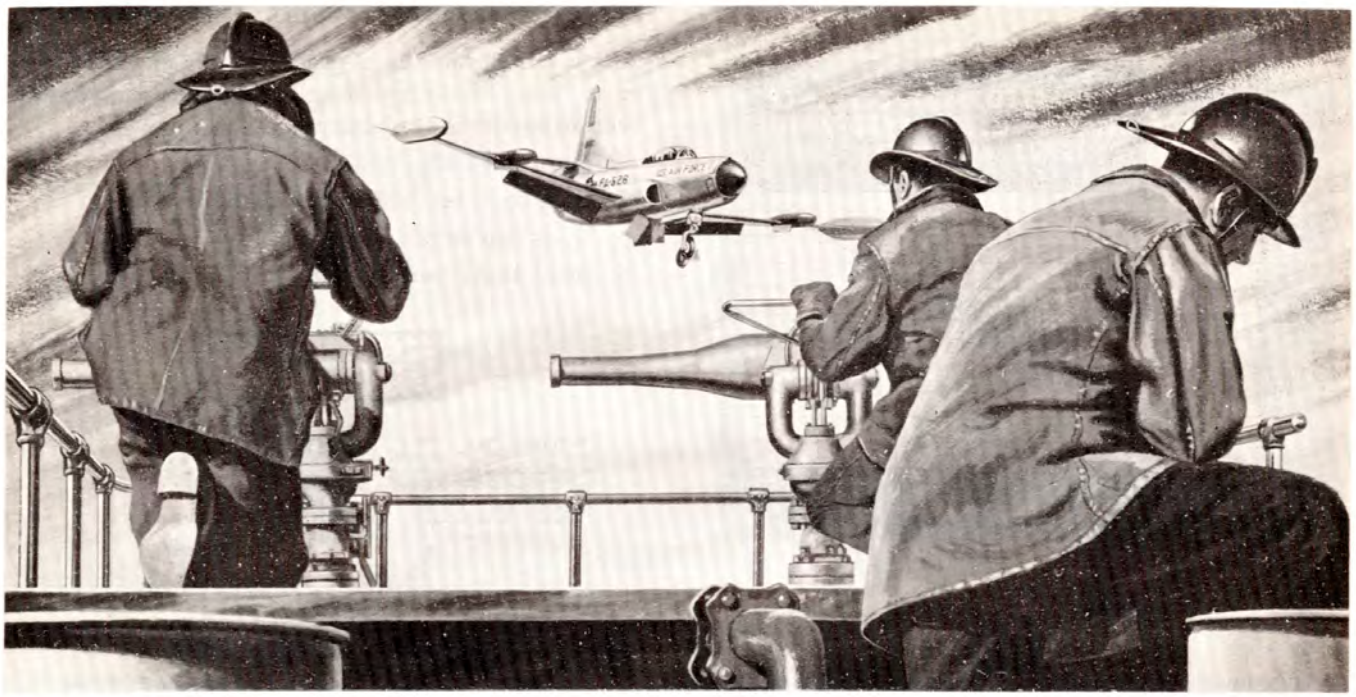
**LANDING ROLL.**

1. Drag Chute—Release after touchdown.
2. Wing flap switch—UP.
3. Wheel Brakes—Apply as necessary.
4. Drag chute—Jettison (only if brakes operate satisfactorily and aircraft is sufficiently slowed).
5. Canopy—Position as desired. (Not more than 12 inches open.)

**ENGINE SHUT DOWN.**

1. Throttle—OFF.
2. Right arm rest safety pin—Installed (if applicable).
3. Canopy open switch—OPEN, then OFF.
4. Wing flap switch—DOWN then OFF, flaps at 32°.
5. Elevator tab neutral indicator light—ON.
6. Control stick—centered. Visually check ailerons neutral.
7. Aileron trim tab—Neutral.
8. Alternator switches—ON.
9. Remaining cockpit switches—OFF or NORMAL.
10. Canopy and seat safety pins—Installed.
11. Seat belt and shoulder harness—Unfasten.
12. DD Form 781—Fill out and list any discrepancies.

Last Page of Condensed Check List



# emergency operating instructions

SECTION III

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## ENGINE FAILURE.

The majority of jet engine failures are the result of improper fuel flow caused by fuel system malfunction or incorrect technique in fuel system management. Specific information of this type of engine failure is described under FUEL SYSTEM FAILURE in this section. The engine and fuel system instruments will provide indications of fuel system failure prior to and during actual engine flame-out. If engine failure is due to malfunction or mismanagement of the fuel system, and if time permits, an air start can usually be accomplished. If the engine failure is caused by obvious mechanical or material failure within the engine, an air start should not be attempted.

### FLIGHT CHARACTERISTICS.

The flight characteristics of this airplane with a dead engine are conventional and rapid trim changes at the time of failure are not required. The best glide speed

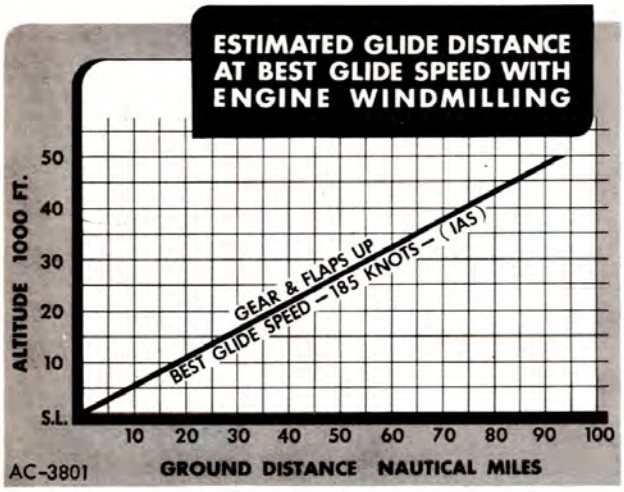



*Figure 3-1*

for maximum gliding distance is about 185 knots IAS (gear and flaps up). See Figure 3-1. The hydraulic pumps should supply pressure sufficient to operate all services while the engine is wind-milling; however, operating time will be lengthened.

**Note**

The pilot should alert the radar observer any time a situation is encountered which will require the use of emergency procedures.

## ENGINE FAILURE DURING TAKE-OFF ROLL.

If total power failure occurs before the airplane leaves the ground, proceed as follows:

1. Throttle—OFF.
2. Drag chute release handle—Pull.
3. Wing flap switch—UP.
4. Use the brakes as much as possible without skidding the tires.
5. Release external tanks if it is necessary to retract the gear.
6. Landing gear control lever—UP, if there is not sufficient runway for a normal stop, and no runway barrier is available.

**Note**

If the airplane is still on the ground, the landing gear lever solenoid lock must be released by depressing the lock release lever.

7. Jettison Canopy.
8. Emergency fuel shut-off switch—OFF.
9. Battery master and generator switches—OFF.

## RUNWAY OVERRUN BARRIER ENGAGEMENT.

If it is not possible to stop the aircraft on the runway or to attain flying speed and altitude, and a runway overrun barrier is available proceed as follows:

1. Throttle—OFF.
2. Drag chute release handle—Pull.
3. Wing flap switch—DOWN.
4. Speed brake switch—UP.

**CAUTION**

THE SPEED BRAKES MUST BE RETRACTED IN ORDER TO MAKE A SUCCESSFUL BARRIER ENGAGEMENT. IF THE SPEED BRAKES ARE EXTENDED, THEY WILL DEFLECT THE BARRIER ARRESTING CABLE DOWNWARD, CAUSING THE MAIN LANDING GEAR TO PASS OVER THE CABLE INSTEAD OF ENGAGING IT.

5. Use the brakes as much as possible without skidding the tires.

**CAUTION**

Excessive use of the brakes which might result in tire blow-out should be avoided, because a blow-out might result in loss of directional control and failure to stay on the runway for barrier engagement.

6. Pylon tanks—Jettison before engaging barrier.
7. Aim for the center of the barrier.

**Note**

Off center engagements have been successful and may be accomplished.

8. Try to hit the barrier at a speed of not less than 70 KIAS.

**Note**

More positive engagement can be assured if the barrier is contacted at a speed as close to the minimum as possible.

9. If the barrier fails to engage the aircraft proceed with steps 5 through 9 of the preceding paragraph.

**ENGINE FAILURE DURING TAKE-OFF** (Airborne).

If a total power failure occurs after leaving the ground, accomplish as much of the following as conditions permit:

1. Maintain flying speed.
2. Throttle—OFF.
3. External tank (and bomb) release button—Depress.
4. Prepare to land straight ahead.
5. Shoulder harness inertia reel lock control—Lock.
6. Landing gear control lever—DOWN, if gear has been retracted.
7. Wing flaps—32° (leave as for take-off).
8. Emergency fuel shut-off switch—OFF.
9. Battery and generator switches—OFF.
10. Canopy jettison handle—Pull if crash landing is imminent.
11. Drag chute handle—Pull to release chute (after contacting ground).

**PARTIAL POWER LOSS DURING TAKE-OFF** (Airborne).

Partial power loss may be caused by such things as a loose throttle friction knob, afterburner flame-out, restriction of fuel flow caused by dirt, water, or ice in the system, and failure of the engine fuel control unit. If partial power failure is experienced after becoming airborne, proceed as follows:

1. Throttle—Check position and friction.
2. Afterburner—Leave on if operating.
3. Engine fuel system selector switch—EMER.

**Note**

If engine speed is not less than 80% rpm, the engine fuel control can be transferred to the emergency system without retarding the throttle. If rpm is below 80%, retard the throttle about half way before moving the selector switch to EMER.

**CAUTION**

- If the fuel control unit has automatically transferred from normal to emergency operation, the engine fuel system selector switch must still be placed in the EMER. position. Then, if engine failure should occur, the possibility of attempting an airstart on the failed normal fuel control system will be eliminated.
- If a partial power loss is experienced, do not wait for automatic transfer of the fuel control from normal to emergency, because it may not occur until engine speed has dropped below the idle rpm.
- The emergency fuel control section does not have a governor or acceleration mechanism and caution must be exercised when moving the throttle to prevent engine overspeeds, overtemperature compressor pulsations, and possible flame-out.

4. Tank jettison button—Depress.
5. Landing gear control lever—UP, if it is evident that the aircraft will remain safely airborne.
6. Try to maintain flying speed. If necessary, lower the nose.
7. Wing flap switch—UP at 160 KIAS.
8. As circumstances warrant, use the following procedures to determine and remedy the cause of the power loss:
   a. Afterburner "blow-out"—Move throttle inboard out of the afterburner slot and continue flight on military power. Do not attempt to relight the afterburner unless necessary because of the loss of thrust which will be experienced if the nozzle opens and the afterburner does not light.
   b. Fuel system icing—If ice in the low pressure fuel filter is causing the power loss, the fuel system de-ice warning light should be on. If ice has formed in the engine fuel nozzle, the fuel pressure will be abnormally high. If the light is on, or if icing is suspected, hold the fuel system de-ice switch on until the power is regained, but not longer than 90 seconds, continuously.
   c. If dirt in the fuel nozzles is causing the power loss, the fuel pressure will be abnormally high and nothing can be done to remedy the situation; therefore land as soon as possible.
9. If full power cannot be regained, or if, for any other reason, it is deemed necessary, land immediately. If external fuel tanks have not been dropped,

use most of the fuel from these tanks before landing. If an immediate landing is necessary and fuel in the external tanks is excessive, drop the tanks over an uncongested area (preferably the prescribed tank drop area) before landing.

### ENGINE FAILURE DURING FLIGHT.

Engine flame-out in flight is usually caused by one of the following conditions:

1. Acceleration "blow-out" caused by rapid throttle movement.
2. Failure of fuel to feed because of prolonged negative acceleration.
3. Internal fuel tanks running out of fuel.
4. Fuel stoppage in the low pressure filter because of dirt or ice accumulation.
5. Deceleration flame-out when operating on the emergency fuel system.
6. Automatic changeover from normal to emergency fuel systems at high altitudes.

**WARNING**

AS SOON AS THE FLAME-OUT IS EXPERIENCED, MOVE THE THROTTLE TO **OFF** TO PREVENT FLOODING THE ENGINE WITH FUEL.

### ENGINE AIR STARTS.

Refer to figure 3-2 for the recommended engine air start procedures. If possible, remedy the cause of engine failure before attempting an air start. Do not attempt an air start if the flame-out was caused by an obvious mechanical failure within the engine itself. Air starts should be accomplished with the engine fuel system selector at EMER. because better starts will be obtained using this system. However, if it is known that the normal fuel system did not cause the flame-out, the fuel system should be reset to normal with the throttle in idle.

**Note**

Afterburner must not be turned on when operating on the emergency fuel system because the emergency fuel system does not have speed governing and the engine would overspeed when the nozzle opens before afterburner starts. However, with afterburner in operation, the emergency system may be used. At high altitude on the emergency system, the fuel scheduling may be so low that with full throttle, power will be insufficient to climb, or so high that the throttle will have to be pulled back out of the afterburning range in order to keep from exceeding the limit tailpipe temperature.

### MAXIMUM GLIDE.

For maximum gliding distance, establish a glide of 185 KIAS with gear, flaps and speed brakes up. Refer to figure 3-1 to determine maximum gliding distances at various altitudes.

### FORCED LANDINGS (Actual and Simulated).

Intentional dead engine landing tests have been conducted to determine the best procedures to follow if a landing with a flamed-out engine becomes necessary (see figure 3-3). Also, effective methods of simulating flame-out conditions to permit the practice of simulated flame-out landings have been established. The procedures given here assume that the pilot has altitude enough at the time of the flame-out to glide to some suitable landing area. Any average pilot who adheres to the principles given in the following procedures and who uses this data for serious practice, should have no difficulty in making a successful flame-out landing. Naturally, if there is insufficient altitude available for reaching the landing area the decision to bail out or crash land must be made.

### FLAME-OUT LANDING PATTERN.

(See figure 3-3.)

A basic pattern with three designated points (high key point, low key point, and 270° key point) should be used. The altitude of these points may vary considerably, but if possible, should be within the limits prescribed on figure 3-3. The pilot should become thoroughly familiar with the pattern and practical variations of the pattern by practicing simulated flame-out approaches at the altitudes given, from maximum to minimum, under various weight and wind conditions, and with boost on and boost off. Flame-out conditions may be simulated by operating the aircraft at 65% rpm with the speed brakes extended. It is apparent that there is insufficient altitude for a complete flame-out pattern, plan to enter the pattern at one of the lower key points with the gear

# AIR STARTS

1. **THROTTLE** AS SOON AS FLAMEOUT OCCURS, MOVE THROTTLE TO **OFF** TO PREVENT FLOODING ENGINE AND TAILPIPE WITH FUEL.

2. **ELECTRICAL LOAD** TURN OFF 2500 VA INVERTER AND ALL UNNECESSARY ELECTRICAL EQUIPMENT TO CONSERVE BATTERY POWER.

3. **FUEL CONTROL** ENGINE FUEL SYSTEM SELECTOR SWITCH - **EMERGENCY**

4. **ALTITUDE** DESCEND TO 25,000 FEET OR BELOW BEFORE ATTEMPTING AN AIRSTART. IF NECESSARY, AIRSTARTS MAY BE ATTEMPTED AS HIGH AS 29,000 FT. WHICH IS THE MAXIMUM ALTITUDE AIRSTARTS HAVE BEEN OBTAINED.

## NOTE

THE ENGINE WILL START QUICKER AND ACCELERATE BETTER FOLLOWING A FAST DESCENT WHERE THE ENGINE HAS BEEN DEAD FOR A SHORT PERIOD OF TIME.

5. **RPM** OPTIMUM RPM FOR AN AIRSTART IS 7 1/2 - 9%. OPTIMUM AIRSPEED IS 175 - 185 KNOTS. IT MAY BE NECESSARY TO SLOW THE AIRCRAFT BELOW 175 KNOTS TO OBTAIN THE OPTIMUM RPM FOR AN AIRSTART.

## WARNING

ABOVE THIS AIR SPEED AND RPM, THE ENGINE AIR FLOW MAY BE TOO HIGH TO OBTAIN STARTS.

6. **IGNITION** AIR START IGNITION SWITCH - **AIR START IGNITION** AND RELEASE.

7. **FUEL** THROTTLE - **IDLE** ENGINE SHOULD START WITHIN 10-15 SECONDS. WAIT AT LEAST 30 - 35 SECONDS BEFORE DISCONTINUING AIRSTART ATTEMPT.

8. **REPEAT** IF ENGINE FAILS TO START, MOVE THROTTLE TO **OFF** WAIT APPROXIMATELY 30 SECONDS AND REPEAT STEPS 5 THRU 7.

## CAUTION

AFTER STARTING, THE THROTTLE SHOULD BE MOVED SLOWLY BECAUSE THE ENGINE WILL BE OPERATING ON THE EMERGENCY FUEL SYSTEM.

THE THROTTLE MUST NOT BE LEFT IN **IDLE** FOR MORE THAN 35 SECONDS IF THE ENGINE FAILS TO START. ALLOW APPROXIMATELY 30 SECONDS BETWEEN STARTING ATTEMPTS TO ENABLE THE ENGINE TO CLEAR ITSELF OF FUEL.

*Figure 3-2*

# FORCED LANDING (DEAD ENGINE)

FINAL APPROACH AND TOUCHDOWN SPEEDS ARE BASED ON APPROXIMATELY 600 POUNDS OF FUEL AND NO WIND.

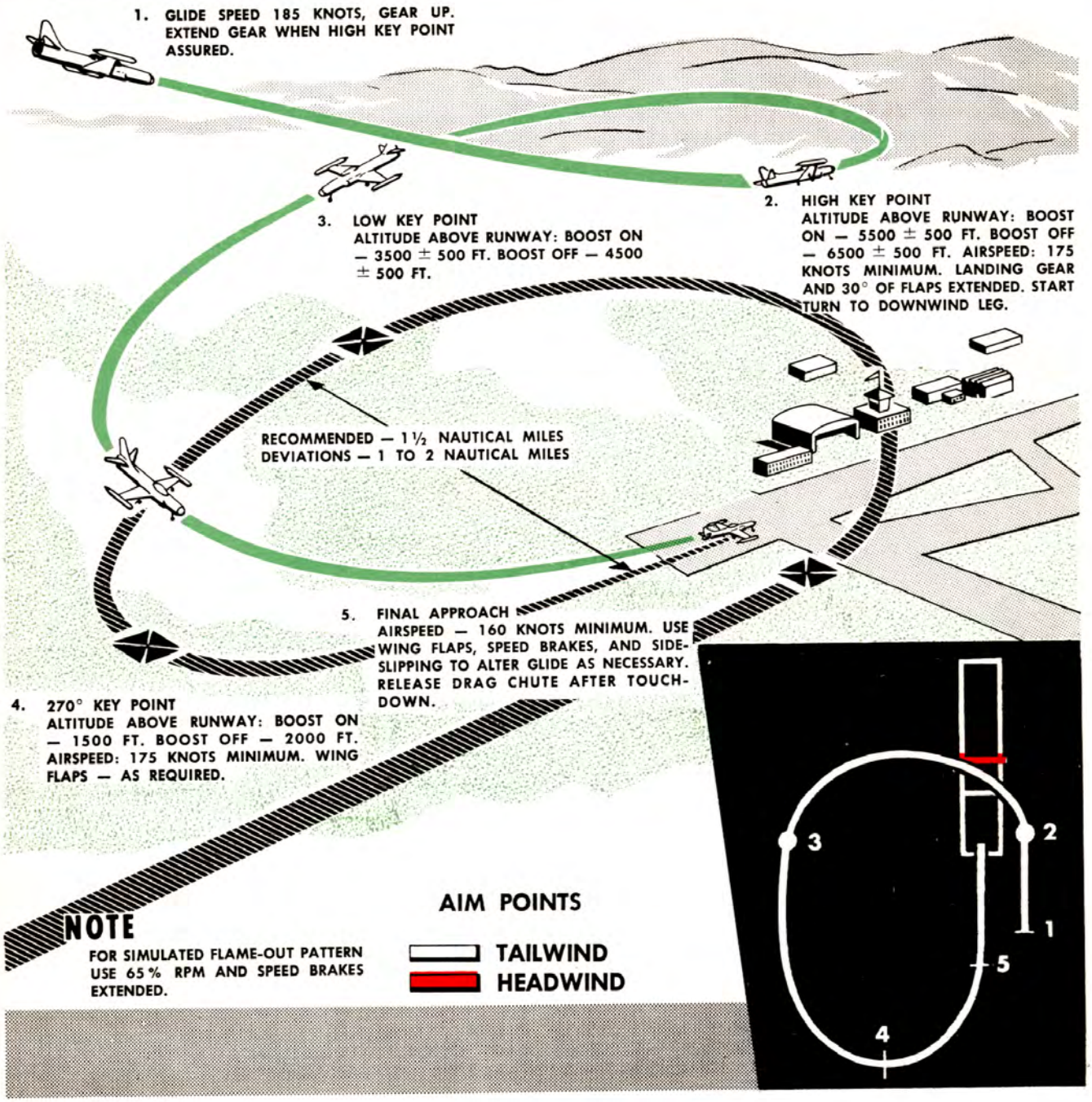



*Figure 3-3*

extended, if possible. If a straight-in approach is necessary, extreme care must be exercised to avoid undershooting. Gear extension time under these circumstances is critical if the engine windmilling speed is slow.

**Note**

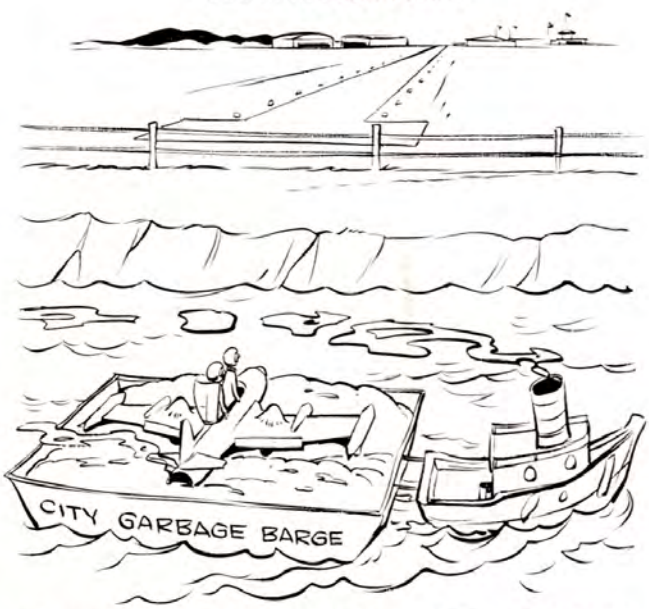
Either minimize aileron and elevator movement or turn off the boost controls so that a maximum amount of hydraulic pressure will be available for lowering the landing gear.

Landing gear can be extended by the normal hydraulic system with normal windmilling rpm in approximately 20 seconds. If the normal system is not operating the gear must be extended by the emergency system, and it may take as long as 90 seconds for the gear to extend and lock. If it is apparent that lowering the landing gear will prevent you from reaching the runway, leave the gear up and prepare for a crash landing as described in this section.

### HIGH KEY POINT.

1. Recommended altitudes—
   Boost ON 5500 ± 500 ft.
   Boost OFF 6500 ± 500 ft.
2. Airspeed—175 KIAS minimum.
3. Landing gear control lever—Down.

**CAUTION**




GLIDING DISTANCE IS DECREASED CONSIDERABLY WITH THE LANDING GEAR EXTENDED, AND GEAR EXTENSION SHOULD BE DELAYED IF ALTITUDE IS BELOW THE MINIMUM SPECIFIED IN FIGURE 3-3.

**Note**

- The landing gear may be extended before reaching the high key point provided there is no doubt about reaching this point at the desired altitude.
- Rates of turn should be increased (tighter pattern) if the altitude is lower than that recommended, and decreased if the altitude is higher than recommended.

4. Wing flaps—30°.

**Note**

The airspeed must be checked very closely to prevent a stall, especially on close-in approaches. To attain minimum turning radius with least loss of altitude, use 30° of wing flaps.

### LOW KEY POINT.

1. Recommended altitude above runway—
   Boost ON 3500 ± 500 feet.
   Boost OFF 4500 ± 500 feet.
2. Airspeed—175 KIAS minimum.
3. Landing gear—DOWN.
4. Wing flaps—30°.

**Note**

- The recommended speeds and altitudes are based upon no wind and approximately 600 pounds of fuel remaining.
- The pattern will have to be varied from the low key point in accordance with wind direction and velocity.

### 270° KEY POINT.

1. Recommended altitudes above runway—
   Boost ON 1500 feet.
   Boost OFF 2000 feet.
2. Airspeed—175 KIAS minimum.
3. Landing gear—DOWN.
4. Wing flaps—As required.
5. Speed brakes—DOWN if required.

**Note**

The wing flaps should not be extended more than 30° unless touchdown at the desired point is assured, or the runway is overshot.

### FINAL APPROACH.

1. Airspeed—160 KIAS minimum.
2. Landing gear—Re-check down and locked.

3. Shoulder harness—Locked.
4. Wing flaps—Extend full down if added drag is needed.
5. Speed brakes—DOWN, if required.
6. Use sideslipping as necessary if approach is high.
7. Drag chute—Release after touchdown.

**Note**

- If flare speed is excessive and touchdown will be some distance down the runway, the drag chute may be released after the airplane has been leveled off and is within 5 feet of the ground.
- Recommended maximum speed for release of the drag chute is 175 KIAS. However, if there is no alternative, it may be released safely at speeds up to 200 KIAS.

### SIMULATED FLAME-OUT PROCEDURES.

1. Extend speed brakes and regulate fuel flow to approximately 2100 lbs. per hour (maintain approximately 65% rpm at lower altitudes).
2. Recommended glide speed—185 KIAS (gear up).
3. Flame-out landing pattern—same as for actual dead engine landing.
4. The restricted engine rpm range of 68 to 76% rpm can be avoided without appreciable loss of effect of a simulated flame-out.

## FIRE.

### ENGINE FIRE DURING STARTING.

If the fire or overheat warning light comes on or if there is any other indication of fire during starting, proceed as follows:

1. Throttle—OFF.
2. Emergency fuel shut-off switch—OFF.
3. Let engine continue turning.
4. If the fire persists, evacuate the aircraft.

### ENGINE FIRE DURING TAKE-OFF ROLL.

If the fire or overheat warning light comes on during take-off, and sufficient runway remains to abort take-off, proceed as follows:

1. Throttle—OFF.
2. Emergency fuel shut-off switch—OFF.
3. Release drag chute and employ maximum braking action if necessary.
4. If unable to stop on the runway and a barrier is available, follow the procedure for barrier engagement outlined in this section.
5. If there is still evidence of fire after coming to a stop, abandon the aircraft immediately.

### ENGINE FIRE DURING TAKE-OFF (AIRBORNE).

#### Overheat Warning Light.

If the overheat warning light comes on after becoming airborne on take-off, or if insufficient runway remains to abort take-off, proceed as follows:

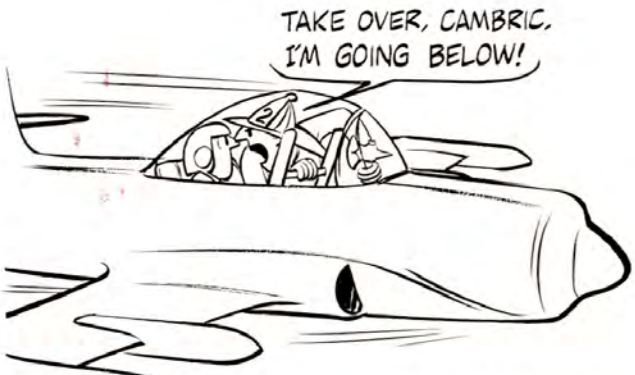
1. Remove throttle from the afterburner range.
2. Throttle back, but maintain sufficient power for flight.
3. Check tailpipe temperature for excessive reading.
4. Check tail for smoke.
5. If the light goes out, test the circuit.
6. If the light is inoperative when tested, the circuit may have been damaged by fire.
7. If the circuit is all right, proceed cautiously at reduced power settings and land as soon as possible.
8. If the light remains on, or there is any other indication of fire, an immediate decision will have to be made to either land straight ahead or continue around the field and land on the nearest runway.

**Note**

It is important to remember that crash equipment will be available immediately if a landing is made on the field, but that it will take much longer to reach an aircraft outside the field boundary.

#### Fire Warning Light.

**CAUTION**




SOME INSTANCES OF FALSE FIRE WARNINGS HAVE OCCURED. ALTHOUGH THE PERCENTAGE OF FALSE WARNINGS TO TRUE IS SMALL, IT IS PREFERABLE UNDER UNFAVORABLE FLIGHT CONDITIONS TO TAKE PRECAUTIONARY MEASURES BEFORE COMPLETELY SHUTTING DOWN THE ENGINE WHENEVER A FIRE WARNING LIGHT COMES ON.

If the fire warning light comes on after becoming airborne on take-off, or if insufficient runway remains to abort the take-off, proceed as follows:

1. Maintain maximum power and climb immediately to a safe ejection altitude.
2. Level off and throttle back as far as possible, maintaining sufficient power for flight.
3. Check tailpipe temperature for excessive reading.
4. Check tail for smoke.
5. If no evidence of fire exists, proceed cautiously and land as soon as possible.
6. If fire is evident, throttle—OFF, emergency fuel shut-off—OFF, and decide upon bailout or emergency landing.

## ENGINE FIRE DURING FLIGHT.

### Overheat Warning Light.

1. Shut down afterburner if it is being used.
2. If light remains on, reduce power and check for smoke.
3. Check tailpipe temperature for excessive reading.
4. If fire is evident, shut down the engine, emergency fuel shut-off—OFF, and decide upon emergency landing or bailout.

**Note**

Usually an aft fuselage fire will burn itself out without seriously damaging the aircraft.

6. If there is no further evidence of fire, fly at reduced rpm land immediately.

### Fire Warning Light.

If the fire warning light comes on in flight, and altitude or terrain permit, proceed as follows:

1. Throttle—OFF immediately.
2. Emergency fuel shut-off—OFF.
3. Engine boost pump switch—OFF.
4. Electrical equipment—OFF.
5. Check for any evidence of fire.
6. If fire is evident or even if it goes out, abandon the aircraft or prepare for an emergency landing.
7. If it is definitely determined that there is no fire, a restart may be attempted.

**CAUTION**

Do not attempt an air start if the engine has been shut down because of fire, even if the fire has gone out, since this will cause fuel to be introduced to the area where the fire was burning and may cause further combustion.

If altitude or terrain preclude shutting down the engine completely when the fire warning light comes on, proceed as follows:

1. Reduce power as much as possible in order to maintain flight.
2. Check for evidence of fire.
3. If it is definitely determined that there is no fire, proceed cautiously and land as soon as possible.
4. If evidence of fire exists, throttle—OFF, emergency fuel shut-off switch—OFF, and decide upon bailout or emergency landing.

## ENGINE FIRE AFTER SHUTDOWN.

If there is an indication of fire in the engine or tailpipe after shutdown, proceed as follows:

1. Emergency fuel shut-off switch—OFF.
2. Air start switch—Starter only and hold to allow the engine to windmill until fire goes out.
3. If the fire continues, abandon the aircraft.

## ELECTRICAL FIRES.

All of the circuits in the aircraft electrical system are protected by circuit breakers and fuses, minimizing the possibility of electrical fire. However, if an electrical fire should occur, proceed as follows:

1. Shut off all electrical equipment including battery master switch and generator.
2. Pull all circuit breakers.
3. Battery master switch—BATTERY.
4. Generator switch—GENERATOR.
5. Push circuit breakers in one at a time to find the unit causing the trouble.
6. When the malfunction is found, continue flight with that circuit off, if possible.

**Note**

Sometimes the auxiliary windshield defroster will cause an indication of an electrical fire when it is turned on. If this should occur, turn the defroster off and determine definitely if that has been the cause of the smoke. If so, leave the defroster off and continue the mission if possible.

# BAIL OUT PROCEDURE

## 1 JETTISON CANOPY

**1** THE CANOPY IS JETTISONED BY PULLING THE CANOPY JETTISON HANDLE IN EITHER COCKPIT DOWNWARD AND AFT.

**WARNING**

- THE CANOPY MAY NOT JETTISON IF IT IS UNLOCKED.
- IF THE CANOPY DOES NOT JETTISON, AN ATTEMPT SHOULD BE MADE TO OPEN THE CANOPY ELECTRICALLY AND/OR MANUALLY. AS A LAST RESORT, THE SEAT MAY BE EJECTED THROUGH THE CANOPY.

### IF TIME PERMITS

1. REDUCE AIRSPEED TO 200 KNOTS OR BELOW.
2. IFF-EMERGENCY.
3. AT ALTITUDE, PULL BAIL-OUT BOTTLE HANDLE.
4. STOW ALL LOOSE EQUIPMENT.
5. DISCONNECT OXYGEN AND RADIO CORDS.
6. LOWER VISOR.

## 2 RAISE ARMRESTS

**2** RAISING THE LEFT ARMREST LOCKS THE SHOULDER HARNESS. RAISING THE RIGHT ARMREST COCKS THE EJECTION TRIGGER AND BOTTOMS THE SEAT.

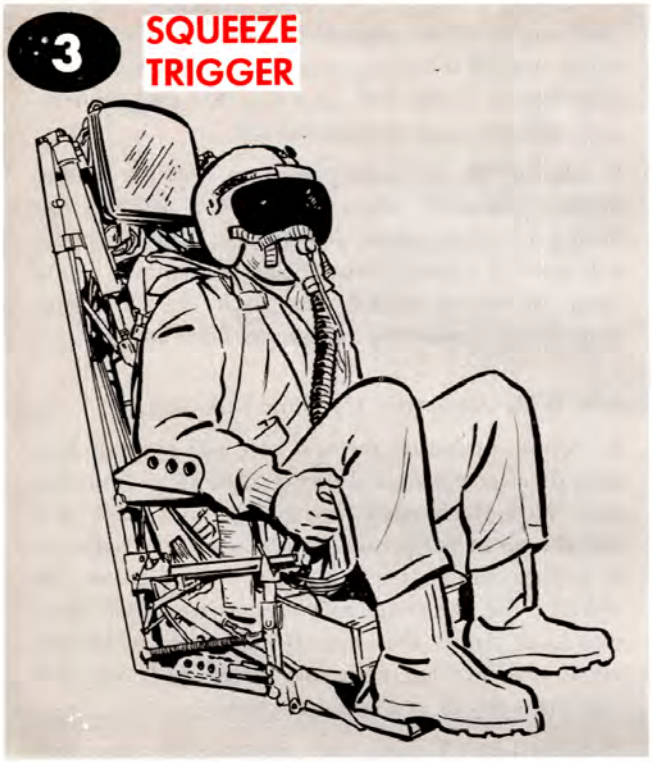
**NOTE:**

- THE SEAT BOTTOMS WITH CONSIDERABLE FORCE WHEN THE ARMREST IS RAISED.

**WARNING**

- IF THE TRIGGER IS SQUEEZED WHEN RAISING THE RIGHT ARMREST, THE SEAT MAY NOT FIRE. IF THIS OCCURS, RELEASE TRIGGER AND SQUEEZE AGAIN.
- BE EXTREMELY CAREFUL TO PLACE BOTH ARMS INSIDE THE ARMRESTS TO ASSURE CLEARANCE OF THE COCKPIT SILL DURING EJECTIONS.
- THE RADAR OBSERVER MUST STOW THE RADAR CONSOLE PRIOR TO EJECTION TO PREVENT ITS OBSTRUCTING HIS PATH OF DEPARTURE.

*Figure 3-4 (Sheet 1 of 2)*




3

PRIOR TO SQUEEZING THE TRIGGER FOR SEAT EJECTION, ASSUME THE PROPER POSITION FOR EJECTION:

A. HEELS IN FOOT RESTS.
B. SIT ERECT.
C. HEAD BACK.
D. BUTTOCKS BACK.
E. CHIN TUCKED IN.

## AFTER EJECTION

RELEASE SEAT BELT IF IT IS NOT RELEASED AUTOMATICALLY, AND KICK FREE OF SEAT. DELAY OPENING PARACHUTE AS LONG AS ALTITUDE PERMITS TO REDUCE OPENING SHOCK AND ALLOW SEAT TO FALL CLEAR.

*Figure 3-4 (Sheet 2 of 2)*

## ELIMINATION OF SMOKE OR FUMES.

Smoke or noxious fumes in the cockpit of this airplane can be caused by fluid leaks in the plenum chamber or electrical fires in the cockpit or plenum chamber. Smoke or fumes originating in the plenum chamber enter the cockpit through the cabin pressurization system. If smoke or fumes are noticed, determine the probable cause by lifting your oxygen mask and sniffing the air. Turn the oxygen regulator diluter to 100% OXYGEN to prevent breathing smoke or fumes. Shut off the cockpit pressurizing air by moving the switch to the NO PRESS position, and extend the speed brakes. Extending the speed brakes helps suck the cockpit air out through the dump valve by evacuating the sub-cockpit area. Shutting off the air also opens the cabin pressure dump valve and opens the ventilating air inlet. Pull the ventilating air nozzles out to get maximum flow of cold air.

**Note**

During certain atmospheric conditions, such as high temperature and high humidity, the cockpit refrigeration unit will put out a fog (or snow) which closely resembles smoke. However, it is cool and does not burn the eyes like smoke. This fog will only occur when the cockpit temperature is cold and can therefore be eliminated by turning the temperature control to the HOT position. This should clear the fog in about 30 seconds.

## BAIL OUT. (See figure 3-4.)

Escape from the airplane should be made with the ejection seat. If sufficient altitude is available, it is recommended that the crew members bail out in preference to ditching or an emergency landing even if over open country. With good visibility in the daytime over open country a crash landing may be preferable to bailing out if a suitable field is available. The bail-out procedure is the same for both cockpits. The radar observer should bail-out first immediately after the canopy is jettisoned; however, if the pilot should eject first, this will not hinder the radar observer's ejection.

**CAUTION**

- If bail-out is made at high altitude, remain connected to the airplane oxygen system while all other preparations for leaving the airplane are being made. Just before leaving the airplane, disconnect the oxygen hose at the mask and place the type H-2 emergency oxygen cylinder into operation, by pulling the rip cord cable of the oxygen cylinder (the caution tag and pin assembly having been removed prior to take-off).

1. Inform the other occupant as far in advance as possible that it will be necessary to bail out and check that he knows what to do.
2. If the airplane is still controllable, reduce speed to the lowest value at which straight and level flight can be maintained.
3. Turn IFF selector switch to EMERGENCY.

**Note**

If the canopy will not jettison or open electrically or manually, the seat can be jettisoned through the canopy.

**EJECTION ALTITUDE.**

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. The chances for successful escape are best when ejection is initiated from climb or level flight attitude at or above the following altitudes above the terrain:

A. Manual seat belt opened prior to ejection and any type parachute.....2000 FEET
B. Automatic seat belt and manually actuated parachute.....1000 FEET
C. Automatic seat belt and automatic parachute if parachute attached lanyard key is inserted into seat belt buckle..... 500 FEET

**After the Seat Ejects:**

Aircraft Without Automatic Opening Seat Belts.

1. Unfasten seat belt and kick free of seat.

**WARNING**

Before low altitude ejections (200 feet or below), without the automatic belt, unfasten the seat belt prior to ejection to aid in separating from the seat, provided position in the seat can be maintained during ejection.

2. If wearing a manually operated parachute, pull the "D" ring when the altitude (14,000 feet) is reached where normal breathing is possible. If ejection takes place below 14,000 feet, pull the "D" ring immediately after separating from the seat.
3. If wearing an automatic parachute, pull the arming lanyard manually when kicking free of the seat during ejections above 14,000 feet. The parachute will open at a preset altitude (approximately 14,000 feet). If below 14,000 feet, pull the "D" ring immediately following separation from the seat.

Aircraft With Automatic Opening Seat Belt.

1. In normal operation the seat belt will separate two seconds after ejection allowing separation from the seat. With the arming lanyard key inserted in the belt the automatic parachute will open automatically at a preset altitude (14,000 feet) or if below the altitude, the parachute will open two seconds after separation from the seat. If parachute automatic opening device has obviously failed, pull the "D" ring manually to open the parachute.
2. If the seat belt fails to open automatically after two seconds, manually unfasten the seat belt and kick free of the seat. Then pull the parachute arming lanyard if above 14,000 feet or the "D" ring if below 14,000.
3. If wearing a manually operated parachute, pull the "D" ring when altitude (14,000 feet) is reached where normal breathing is possible. Manually pull the "D" ring immediately following separation from seat for ejections below 14,000 feet.
4. Manually pull the "D" ring immediately following separations from the seat for all ejections below 14,000 feet. This applies to both manual or automatic parachutes.

**AIRSPEED.**

Recent study and analysis of escape techniques from aircraft by means of the ejection seat have revealed that ejection accomplished at airspeeds ranging from stall speed to 525 knots IAS result in relatively minor forces being exerted on the body thus reducing the injury hazard. The crew member will undergo appreciable forces on the body when ejection is performed at airspeeds of 525-600 knots IAS, and escape is more hazardous than at lower airspeeds. Above 600 knots IAS, ejection is extremely hazardous because of the excessive forces on the body.

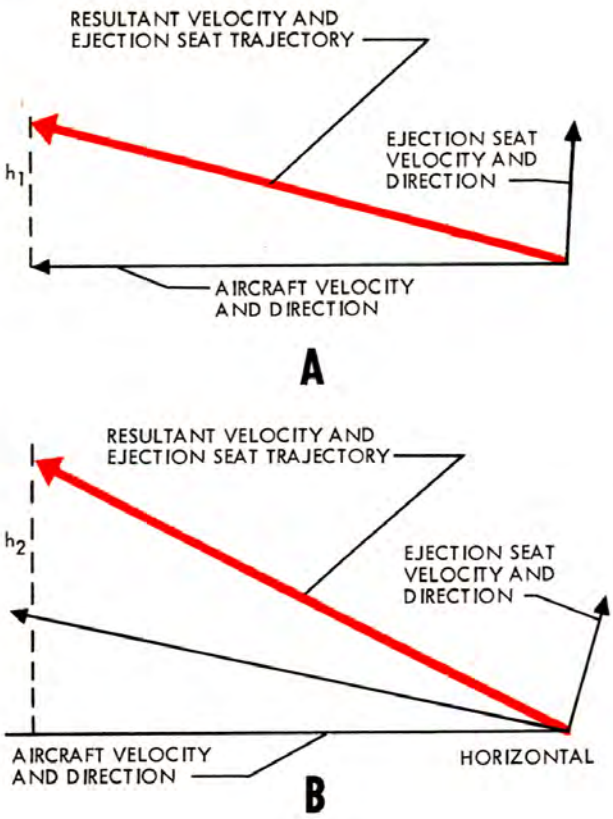



*Figure 3-5*

**SEAT TRAJECTORY.** (Refer to figure 3-5.)

Ejection at low altitudes is facilitated by pulling the nose of the aircraft up above the horizon ("zoom up" maneuver). Section A of figure 3-5, indicates the trajectory of the ejection seat from a level flight attitude. In comparison section B indicates the ejection seat trajectory from an aircraft in a nose up attitude. Sections A and B indicate that the trajectory of the ejection seat is not perpendicular to the flight path of the aircraft, but rather, is a resultant of the aircraft velocity and upward velocity of the ejection seat. Since the ejection seat velocity is very small compared to the aircraft velocity, the ejection seat tends to follow a nearly horizontal path as shown in section A. "Zoom up" maneuvers as indicated in section B, will result in the ejection seat trajectory coming closer to the vertical, thus effecting an increase in altitude (compare distances $h_1$ and $h_2$). This gain in altitude will increase the time available for separation from the seat and deployment of the parachute.

**CHUTE DEPLOYMENT.**

Flight tests accomplished thus far have indicated the following approximate difference between ejection altitude and the altitude at which full deployment of the parachute occurs. This data is based on use of an automatic safety belt and automatic parachute.

| Flight Conditions | Full Deployment Above Or Below Ejection Altitude |
|---|---|
| 1. Level flight—200 knots IAS | 100 to 150 feet below |
| 2. 6° nose up—200 knots IAS | 20 to 70 feet below |
| 3. 12° nose up—300 knots IAS | 10 feet below to 60 feet above |

With nose-up attitude ejections, high aircraft airspeeds will result in slight improvements in altitude of full parachute deployment relative to ejection altitude.

**Manual Safety Belt.**

For manual safety belt or manual parachute, full deployment will occur at a lower relative altitude.

**Instructions:**

1. Whenever circumstances permit, slow the aircraft down as much as possible prior to ejection.
2. When ejecting at low altitudes (below 2000 feet), pull the nose of the aircraft above the horizon if at all possible.

**Note**

Established minimum safe ejection altitudes for all combinations of automatic or manual seat belts and parachutes must be observed.

**EJECTION SEAT MALFUNCTION.**

If the ejection seat fails to operate, proceed as follows:

1. Release the seat belt, shoulder harness, radio, oxygen and G-suit connections.
2. Dive over the trailing edge of the wing from either side or roll the airplane on its back, trim full nose down and push clear. If you roll the airplane on its back, do not unfasten seat belt until ready to leave.

**CAUTION**

If the airplane is spinning, crawl out on side of spin.

**SEAT BELTS AND LOW ALTITUDE ESCAPE.**

Prior to the use of automatic seat belts in aircraft having ejection seats, instructions were issued that when bailout was necessary below 2000 feet that the seat belt be opened

manually prior to ejection. This procedure was necessary to minimize time required for separation of the crew member from the seat after ejection. This procedure was recommended until automatic seat belts could be obtained and installed. This procedure provided best capability to survive even though it was known that manual release of the seat belt may require the crew member to hold himself in the seat prior to ejection (due to negative "g" or uncontrollable maneuvers) and would place the crew member in a dangerous situation if he changed his mind and decided to crash land the aircraft (he would have no time to relock his seat belt).

**Seat Belt Release.**

With the standardization and installation of automatic seat belts in aircraft, the manual release of the seat belt becomes unnecessary and undesirable for the following reasons:

a. The automatic opening seat belt automatically opens two seconds after ejection.

b. The escape operation is faster. The automatic opening seat belt eliminates the step of manually opening the seat belt prior to ejection.

c. The manual opening of the automatic seat belt creates a hazard to survival during uncontrollable flight. The opening of the seat belt during uncontrollable flight will mean that the crew member cannot stay in his seat prior to ejection if negative "g" is incurred.

d. The manual opening of the automatic seat belt creates a hazard to survival if the crew member decides to crash land the aircraft. The crew member will probably not be able to fasten the seat belt and shoulder harness as he will probably be using both hands to control and crash land the aircraft.

e. The manual opening of the automatic seat belt will eliminate the automatic opening feature of the automatic opening parachute unless the crew member manually arms his automatic parachute by pulling the arming knobs.

f. Tail clearance is reduced by immediate separation of the crew member from the seat. In large aircraft and at extremely high speeds where tail clearance may be marginal, manually opening the automatic seat belt before ejection could possibly result in failure to clear the vertical stabilizer.

g. At the high speeds attainable in the present service aircraft, the peak deceleration due to air loads of the seat and crew member together is approaching the limits of human tolerance. Since the deceleration of a crew member alone is considerably greater than that of the crew member and the seat together, immediate separation at extremely high speeds could result in severe injury to the crew member.

h. Immediate separation of the crew member and seat at extremely high speeds could result in inadvertent opening of the parachute due to the pack being blown open. In this event, fatal injuries, will probably be incurred, because of the extremely high opening shock of the parachute at this speed, or because of serious damage to the parachute itself upon opening at high speeds.

In view of the above, the following procedures shall be employed:

**Manual Opening Seat Belt** (Non-automatic).

1. For ejection below 2000 feet, manually open seat belt prior to ejection to allow pulling of D-ring and rapid opening of parachute after ejection. In a dive, especially at high speeds, the belt should be manually opened at higher altitudes, even as high as 5000 feet under the worst conditions to permit rapid opening of the parachute.
2. For ejection at altitudes greater than those above, do not open the manual seat belt until after ejection, especially at extremely high airspeeds.

**Automatic Opening Seat Belt.**

Do not manually open the automatic opening seat belt prior to ejection at any altitude.

## LANDING EMERGENCIES.

### LANDING ON UNPREPARED SURFACES.

Emergency landings on unprepared surfaces shall be made with the landing gear extended.

**Note**

These instructions apply also in those cases in which the runway is overshot or undershot and touchdown cannot be avoided.

### CRASH LANDING.

If a crash landing becomes necessary notify the radar observer, then proceed as follows:

1. Pylon tanks—Release (if installed).
2. Tip tanks—Retain or release as desired.

**Note**

If a forced landing is anticipated, the pilot will make a decision concerning the retention or release of the tip tanks. Empty tip tanks should be retained because they act as skids and tend to preclude cart-wheeling caused by a wing tip digging in. Conversely if the tanks contain fuel, landing over rough terrain could rupture them, spraying fuel on the fuselage, thereby creating a fire hazard.

3. Speed brakes switch—UP.
4. Wing flap switch—DOWN (fully extended wing flaps may prevent a wing tip from digging in).
5. Throttle—OFF just before contact.
6. Emergency fuel shut-off switch—OFF.
7. Generator and master battery switch—OFF.
8. If time permits—Accomplish the following:
   a. Right arm rest safety pin—Install.
   b. Parachute harness—Unbuckled.
   c. Seat belt and shoulder harness—Locked.
   d. Shoulder harness inertia reel handle—Locked.

Make a normal approach and let the airplane touchdown slightly before the stall is reached. Refer to Flame-Out Landing procedure if the engine is dead. Jettison the canopy when the aircraft touches down or when the aircraft is not more than one foot from touchdown. Dirt may get in the pilot's eyes and the canopy does not always clear the vertical stabilizer at low airspeeds. Release the drag chute after contact is made with the ground.

**CAUTION**

Do not release the drag chute at speeds in excess of 200 knots or the drag chute shear link may fail and the drag chute will be lost when it is most needed.

### LANDING WHEN ALL GEAR WILL NOT EXTEND.

A study of landing gear configurations whenever all gear will not extend has revealed that less damage to the aircraft and less personal injury will result if the instructions contained herein are observed.

**Note**

The instructions below apply only to landings on prepared hard surfaces.

1. Whenever any of the gear cannot be extended with the normal hydraulic system, the emergency system will be used in an attempt to lower the remaining gear. (Refer to LANDING GEAR EMERGENCY EXTENSION, this section.)
2. A landing should be accomplished with gear down whenever both main gears can be extended and locked in the down position. However, in the event that both main gears cannot be fully extended, a gear up landing should be attempted.
3. Jettison canopy prior to crash landing.
4. External tanks containing fuel should be dropped prior to landing; however, empty tanks should be retained during either a gear retracted or partial gear extension landing.

### LANDING WITH FLAT TIRE.

When a landing in this condition is necessary, it should be made in the normal manner with the gear extended. If the nose gear tire is flat, hold the nose wheel off as long as possible. When landing with a flat main gear tire, set down on the side of the runway away from the flat. Lock shoulder harness prior to touchdown.

### LANDING WITH ENGINE INOPERATIVE.

(Refer to figure 3-3.)

1. When the emergency occurs, head for the nearest field.
2. Set up proper glide speed (185 knots), IAS.
3. Airstarts should be attempted (if engine is not damaged) down to approximately 10,000 feet above terrain. At this altitude a decision to bail out or crash land can be made more accurately.
4. If any airport landing is to be made on a runway known to be adequate in length, the landing gear should be down and locked at sufficient altitude, if practicable, to enable you to concentrate on pattern work. If intermittent aileron boost is encountered, turn it—OFF.

### WET OR ICY RUNWAY LANDINGS.

If a landing is made on a wet or icy runway which is marginal in length for a normal landing procedure, use the short field landing procedure except that braking action should be minimized to prevent skidding.

## EMERGENCY CANOPY OPERATION.

The canopy should be down and locked for all take-offs and landings, and should be left locked until after

landing roll is completed. This will permit the canopy to be jettisoned by use of the canopy jettison handle in case of emergency.

a. If the canopy is partly open and an emergency situation makes immediate evacuation necessary, an attempt should be made to open the canopy fully by means of the canopy open switches or the manual handcrank. Canopy jettison can be accomplished only after first closing the canopy fully.

**WARNING**

IN ANY GROUND SITUATION WHERE THERE IS A POSSIBILITY OF FUEL SPILLAGE IN THE VICINITY OF THE AIRCRAFT, THE CANOPY SHOULD NOT BE JETTISONED, EXCEPT AS A LAST RESORT, DUE TO THE ADDITIONAL FIRE HAZARD CREATED BY DETONATION OF THE CANOPY REMOVER CARTRIDGE.

b. In the event of a crash landing or an aborted take-off in which the landing gear must be retracted, the canpoy should be jettisoned before the aircraft comes to a complete stop. If this is not done, and time permits, the canopy should be opened mechanically or electrically to permit aircrew escape. If these systems fail, the canopy jettison mechanism may be used. If not already accomplished, the crew members should unfasten seat belt and should harness before jettisoning the canopy and unbuckle the parachute harness if time permits.

c. If the canopy is stuck partly open, an attempt to jettison the canopy can be made by either the occupants or rescue crew in the following manner:

1. On aircraft equipped with M-3 gas initiated canopy removers, apply a forward force (60 to 80 pounds) on the canopy remover link safety release. This is a small yellow lever arm which protrudes from the lower right surface of the canopy frame at about the same fore and aft position as the canopy remover. Sufficient force on this link will actuate the initiator which, in turn, fires the canopy remover. The link is exposed any time the canopy is opened more than 2 inches from the closed and locked position.

**WARNING**

Caution must be exercised to avoid being in the path of the canopy or canopy remover when this procedure is used.

2. On aircraft equipped with M2A1 cable operated canopy removers use the same procedure as above except that the canopy jettison handle (either internal or external) must be actuated after pressure is applied to the link.

**Note**

If the canopy can only be opened by use of the manual handcrank, the opening time can be reduced considerably if the radar observer will stand up and help lift on the canopy.

**EMERGENCY ENTRANCE ON THE GROUND.**

If the pilot and radar observer are unconscious, rescue crews may gain access to the cockpit by knocking out the right front windshield panel, unlocking the canopy from the inside, and raising the canopy manually by means of the external handcrank. On modified aircraft, the canopy can be unlocked externally.

**CAUTION**

To preclude the possibility of fire or an explosion, do not jettison the canopy on the ground or open it by use of the electrical system, except as a last resort.

## DITCHING.

This airplane should not be ditched if there is sufficient altitude for a safe bail-out. Ditching is not recommended because when contact is made the deceleration will be rapid and the chances of survival will be slight. If the fuel supply is nearing depletion, stay at high altitudes until it is exhausted because the remaining fuel plus the gliding distance with a dead engine will yield greater overall range. After the fuel is gone, glide down to 10,000 feet and bail out. If there is some reason that a safe bail-out cannot be accomplished, notify the radar observer, then ditch as follows:

1. IFF selector switch—EMERGENCY.
2. Jettison the external fuel tanks unless the sea is calm and the tanks are nearly empty.

**CAUTION**

If pylon tanks are carried, release them before making contact with the water, even if they are empty.

**Note**

The tip tanks, if empty, will add buoyance that will help to prevent a wing tip from "digging in."

3. Jettison the canopy.
4. Make certain the landing gear is up.

**WARNING**

Do not attempt a water landing with the landing gear extended.

5. Parachute harness—Unbuckle.
6. Shoulder harness and safety belt—Tighten and lock.
7. Speed brakes switch—DOWN, wing flaps—22° to 30°.

**Note**

The wing flaps and speed brakes will not cause the airplane to dive. Open speed brakes will aid in keeping the engine intake air ducts above water.

8. Throttle—OFF.
9. All switches—OFF.
10. Select a heading parallel to the wave crests if possible. Aim to touch down on the down side of a crest or on the falling side of a wave, never on the rising side.
11. As the airplane comes to rest, get out of the cockpit immediately and don't forget your life raft.

**Note**

If the crew is unable to get out of the aircraft before it submerges, respiration may be sustained by placing the oxygen regulator diluter lever to 100% OXYGEN and the emergency toggle lever to the emergency position.

## AIRCRAFT SYSTEMS.

### EXTERNAL TANK FUEL SYSTEM MALFUNCTION.

Failure of the external fuel tanks to feed will be quickly evidenced by reference to the fuel quantity indicator which will indicate that internal fuel is being used before the normal amount of time has elapsed for external fuel consumption. If one tip tank fails to feed or feeds more slowly than the other, eventually full stick trim may not hold the wings level at cruising airspeeds. Continued operation of the stick trimmer in one direction will indicate uneven tip tank feeding. If the wings can be held level at cruising airspeeds without undue effort, the heavy tank should be retained to see if it can be made to feed. Try the following, to get the tip tank to feed:

1. Climb as rapidly as possible to 25,000 to 30,000 feet. The ambient air pressure of low altitudes will remain inside the tank and may start the tank feeding.
2. Rock the wings rapidly from side to side without exceeding a maximum bank of 45° and maintain an indicated airspeed of about 250 knots.

**Note**

If it is determined that the heavy tank will not feed, it should be dropped in a safe area.

#### Release Mechanism Malfunction.

If a malfunction of the tip tank release mechanism precludes the dropping of the heavy tank, the aircraft should be checked to see if there will be enough aileron control to effect a safe landing. To perform this check, proceed as follows:

1. If possible, climb to 15,000 feet or more above the surrounding terrain. (Check aileron boost ON.)
2. Reduce the airspeed to 215 knots and make shallow turns noting the degree of aileron control.

3. Extend the landing gear and wing flaps at the proper speeds, lower the speed brakes and simulate a landing approach. Determine a landing speed consistent with good lateral control and runway length.
4. As the airspeed decreases, carefully note the amount of aileron pressure and degree of aileron control required to hold the wings level.

**Note**

If difficulty is experienced in holding the wings level, lower the nose, apply power and recover airspeed. Increased airspeed will restore aileron control.

**CAUTION**

Do not in any event allow the airspeed to decrease below 150 knots.

5. If the heavy tank cannot be dropped and the aircraft can be controlled satisfactorily at an airspeed of 170 to 195 knots, make a "straight in" approach and touchdown on the side of the runway opposite the side of the heavy tank (use the right side of the runway if the left tank has the extra fuel). Do not use the drag chute unless absolutely necessary. The airplane will veer sharply away from the heavy tank when the drag chute opens. Do not permit the airspeed to drop below 170 knots until the aircraft is flared out and is only a few feet above the runway. As soon as the touchdown is made, use rudder and brake as necessary to maintain directional control.

### Tip Tank Jettison Procedure.

In an emergency the tip tanks may be jettisoned either simultaneously or individually. They may be released by using the tank jettison button, the manual release handles, or the external tank release button on the control stick. The tank jettison button is used to jettison all tanks simultaneously in case an emergency arises when the lack of time requires immediate release of the tanks. This button is wired directly to the battery bus and will operate even if the battery switch is OFF. The manual release handles may be used in case of electrical failure to drop the tip tanks simultaneously or individually by pulling either or both handles. The pylon tanks cannot be jettisoned manually. The external tanks release button on the control stick is used to drop the tip or pylon tanks (when time permits) in a designated drop area when control of the exact time of release may be desired.

## ELECTRICAL FAILURE.

### High Loadmeter Reading.

If the loadmeter shows a continuous reading above .65 proceed as follows:

1. Check for a low charged or faulty battery by turning the battery master switch OFF and checking for a definite decrease or normal loadmeter reading. If the loadmeter reading returns to normal, leave the battery master switch OFF and land as soon as circumstances permit.
2. If the loadmeter does not show a decrease when the battery master switch is turned OFF, turn OFF the 2500 VA inverter and any operating radar equipment.
3. If loadmeter still reads above .65 systematically turn OFF all electrical equipment to find the trouble.
4. If one of these units is found to be the cause of the high loadmeter reading; turn it OFF and land as soon as possible, operating without it unless it is vital to the completion of the landing.

### Generator Failure.

Generator failure is indicated by a zero load meter reading accompanied by illumination of the generator out warning light. If generator failure occurs, proceed as follows:

**Note**

The loadmeter and generator out warning light should be crosschecked whenever either indicates generator failure. This will insure that the generator has actually failed and the indication was not caused by a faulty circuit.

1. 2500 VA inverter and all operating radar—OFF.
2. Turn OFF all non-essential electrical equipment including the engine boost pump.

**Note**

If generator failure should occur, a fully charged battery may last as long as 30 minutes if all non-essential electrical equipment is immediately de-energized. Consequently the conservation of battery energy is extremely important.

3. Land as soon as possible conserving battery energy for landing.

### Complete Electrical Failure.

Complete electrical failure is evidenced by a zero loadmeter reading and failure of all electrically operated

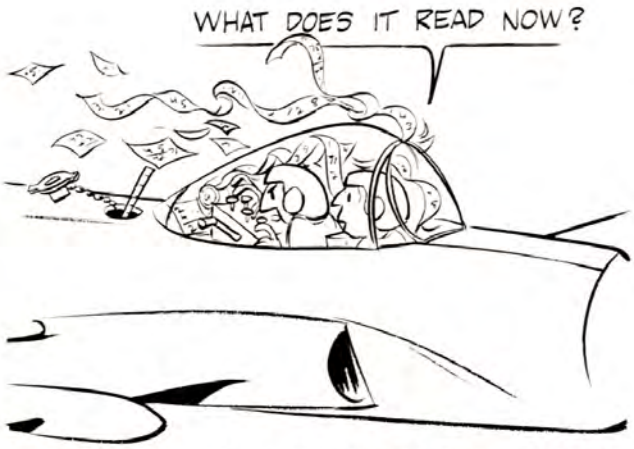
equipment. This condition occasionally arises because of generator failure. If the generator failure is not detected, the battery will not long support the heavy load resulting. A frequent check of loadmeter reading, especially during night flight, is good insurance. If the generator failure has not been detected, the pilot may receive some warning of impending complete electrical failure by noting faulty operation of the radio equipment or by noting that the cockpit lights are growing dim. If this evidence is recognized check for zero loadmeter, and take action required. Complete electrical failure will render all electrical equipment inoperable except the self energizing tailpipe temperature indicator and the tachometer. If complete electrical failure should occur, accomplish the following:

1. Battery master switch—OFF.
2. Generator switch—OFF.
3. Land as soon as possible.

**Note**

With complete electrical failure, the landing gear can be extended with the normal hydraulic system only. Landing gear indicator will indicate unsafe.

**CAUTION**




IF ELECTRICAL FAILURE OCCURS, FUEL REMAINING AND RATE OF CONSUMPTION WILL HAVE TO BE ESTIMATED BECAUSE THE FUEL QUANTITY AND FUEL FLOW INDICATORS WILL BE INOPERATIVE.

**HYDRAULIC POWER SYSTEM FAILURE.**

Two separate engine-driven pumps supply power to the hydraulic system and if either pump fails the other will supply power to the hydraulically operated units. The electrically operated emergency hydraulic pump supplies pressure for extension of the landing gear in case the gear cannot be extended successfully on the normal system. If the engine fails, windmilling rpm of 8-10% should be sufficient to furnish hydraulic pressure to operate the landing gear and assure operation of the aileron and elevator boosters if movement of the control surfaces is kept to a minimum when the gear is operating. Under this condition it is recommended that the control boosters be shut off until the gear is extended and locked.

**CAUTION**

The normal hydraulic system will be used for gear extension under all circumstances provided that hydraulic pressure from the normal system is available. Where it is imperative that the extension of the landing gear be expedited, e.g., during a flame-out landing, it is recommended that the aileron and elevator boosts be turned off during gear extension. If the gear does not lock down within one minute, place the hydraulic system selector lever in the EMERGENCY position and turn on the emergency hydraulic pump.

Hydraulic power system failure is evidenced by decreasing hydraulic pressure followed by loss of aileron and elevator boost. Extension of the speed brakes and the landing gear by the normal system will not be possible.

**FLIGHT CONTROL SYSTEM FAILURE.**

If the hydraulic system pressure falls below 250 psi the flight control booster units are automatically by-passed. If this should occur accomplish the following:

1. Reduce airspeed to below 215 KIAS.
2. Trim the aircraft with the electrically driven trim tabs.

**Note**

With hydraulic pressure loss the control stick trimmer will be ineffective.

3. Boost control shut-off levers—OFF.
4. Return to the base and land as soon as possible. Make a straight in approach for landing.

**CAUTION**

Do not exceed 15° of bank during turns because aileron stick forces are very high without the hydraulic booster assist. Turns are easily accomplished using a shallow bank with rudder pressure.

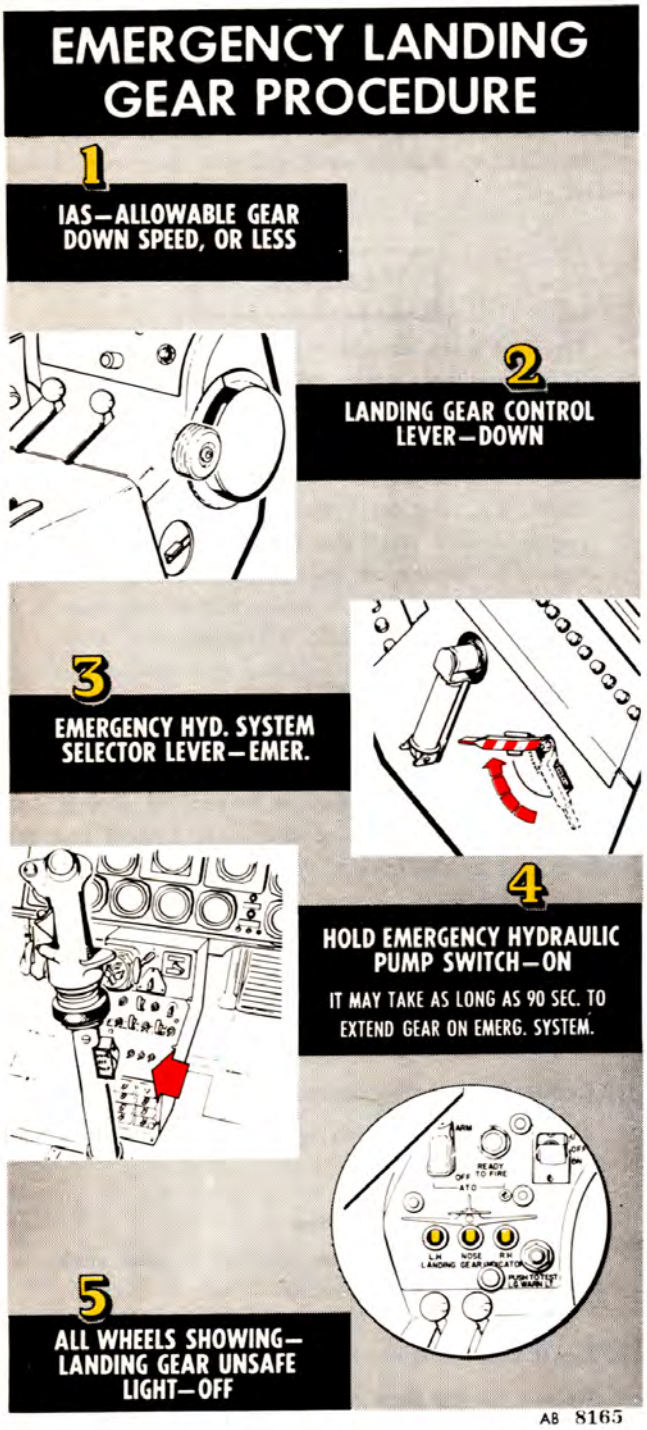



*Figure 3-6*

**LANDING GEAR SYSTEM FAILURE.**

If the landing gear cannot be extended by the normal hydraulic power system follow the procedure outlined in figure 3-6.

**CAUTION**

Operate the emergency hydraulic system only when the gear cannot be extended successfully on the normal system. Excessive use may damage the emergency hydraulic pump.

**Note**

The gear cannot be retracted on the emergency system. If it is necessary to retract the gear on the ground after extension has been made on the emergency system the emergency hydraulic selector lever must be placed in the NORMAL position. Cycle gear with the normal system if the above procedure is unsuccessful. This may lock gear down.

**BRAKE FAILURE.**

Weak or faulty brakes may be detected by tapping the brake pedals on the final approach. If it is anticipated that the brakes are faulty, stop-cock the throttle after touchdown and hold the nose wheel aft as long as possible, allowing the drag chute to completely decelerate the aircraft on the landing roll using rudder to maintain directional control. If brake failure occurs while taxiing, do not fly the aircraft.

**WING FLAP FAILURE.**

If both wing flap motors, or the electrical system fails, there is no emergency means of extending the wing flaps. If split flap operation occurs (one flap extended and the other in the up position) the aircraft cannot be controlled with aileron boost off. If difficulty is experienced after actuating the flap switch to the DOWN position, insure that aileron boost is ON and immediately place the flap switch in the UP position.

**CAUTION**

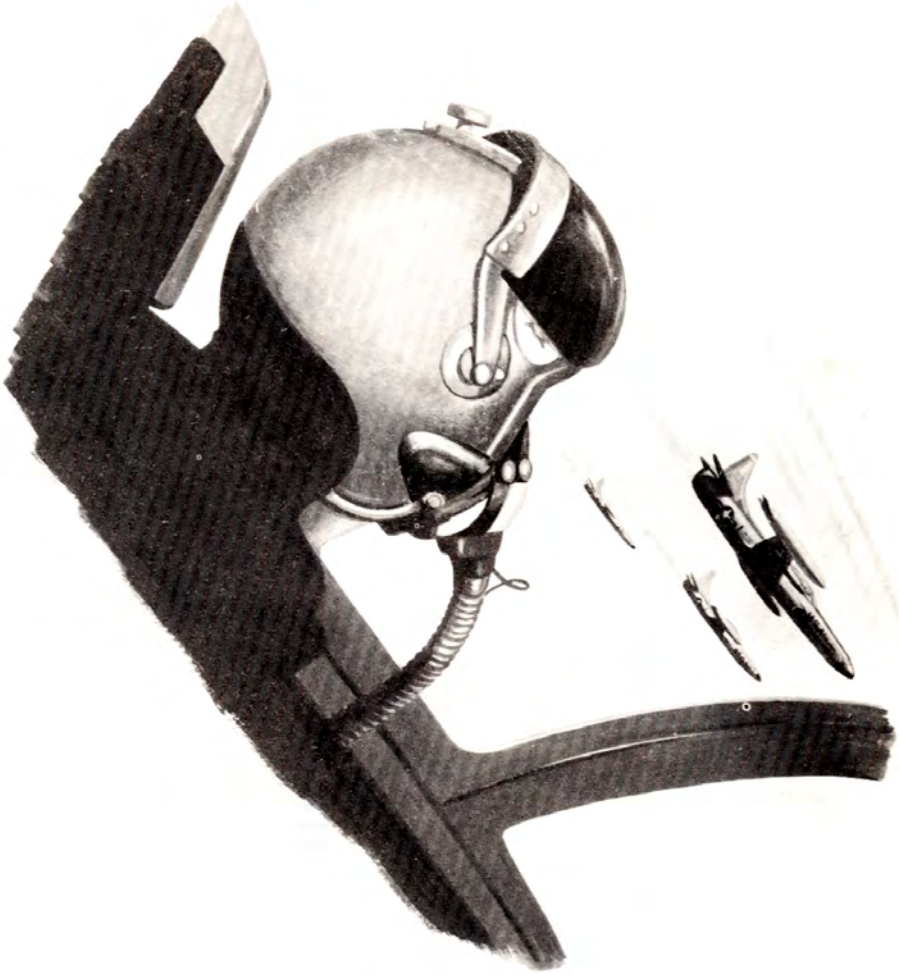
If for some reason the wing flaps cannot be lowered, land approximately 20-25 knots IAS faster, allowing for a much flatter glide angle and avoid dragging the tail on the runway.

**OIL SYSTEM MALFUNCTION.**

High oil pressure, or a continuing rise in oil pressure, indicates a restriction in the oil system or a false indication. If this condition exists, throttle back and return to the field and land as soon as possible. A zero oil

pressure reading indicates complete loss of engine oil or a malfunction of the gage itself. When this situation is encountered over friendly terrain, power should be reduced to the minimum necessary to maintain flight, and the aircraft should be lightened as much as possible by jettisoning as many external stores as feasible. A landing should be made at the nearest possible base. Over water or enemy territory, the minimum power setting necessary to execute a return to the nearest friendly base should be established, and the aircraft should be operated in as conservative a manner as possible so as to produce the least burden on the engine. High "G" forces should be avoided. In most cases, ultimate failure of the engine will not occur within ten minutes of oil pressure loss, and when it does occur, will be signaled by a steadily increasing vibration. At this time an engine shut down should be made to prevent such a destructive failure as would jeopardize a successful ejection or power-off control of the aircraft in a landing attempt.

Last Page of Section III



# auxiliary equipment

SECTION IV

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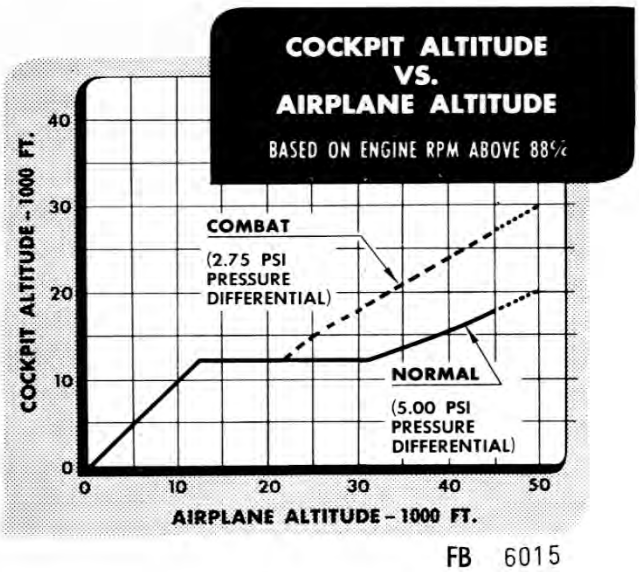



*Figure 4-1*

## AIR CONDITIONING AND PRESSURIZATION SYSTEM.

Hot compressed air for cockpit air conditioning and pressurization is obtained by bleeding air from the engine compressor (figure 4-2). Part of this bleed air is directed to the canopy seal, the anti-G suit valve, and the hydraulic reservoir, while the remainder passes through a shut-off valve to the air conditioning and pressurization system. The air conditioning process starts at the temperature control valve located in the bleed air line just downstream of the shut-off valve (figure 4-2). This is a butterfly valve whose position determines the proportion of compressor air which is directed through the refrigerator unit to that which by-passes the unit. The position of the butterfly valve is controlled either automatically, by a thermostat and cockpit control, or manually, by overriding the thermostat with a switch in the cockpit. For maximum cockpit cooling, the temperature control valve will direct all of the compressor bleed air through the refrigerator. If maximum heating is desired, the temperature control valve will respond to the selections made on the control switch and bypass all of the hot air around the refrigeration unit. In this manner, cockpit temperature can be varied from approximately 20° F to 200° F. The refrigeration unit consists of a heat exchanger and a cooling turbine. That portion of compressor bleed air directed to the refrigeration unit is initially cooled by the heat exchanger, and further cooled by passing through the cooling turbine. This cooled air meets and mixes with the hot by-pass air downstream of the refrigeration unit. From here the air, now at the desired temperature level, may flow into the front and rear cockpits through pressurization air inlet grilles (foot grilles) in each cockpit. The amount of air entering the foot grilles depends upon the degree to which the foot grilles are opened. Any air which does not enter the cockpit through these grills is directed to the cockpit air control valve. From here, it can flow through either the windshield defrost duct or the windshield de-ice duct depending upon the position of the cockpit air control valve. Cockpit pressurization is automatically regulated by a cockpit pressure regulator which releases air from the cockpit at a variable rate to maintain the proper pressure differential and rate of change of cockpit air. From sea level to 12,500 feet altitude, the cockpit is unpressurized; above 12,500 feet pressure is gradually increased until the differential above outside air pressure reaches either 2.75 or 5.00 psi, depending on the setting of the cockpit air pressure selector (see figure 4-1). The choice of pressures is provided so that the more comfortable pressure differential of 5.00 psi can be used for non-combat flight. However, during combat the pressure should be changed to 2.75 psi differential so that if the cockpit should be damaged, the effects of rapid decompression will not seriously affect the pilot and radar observer. The combination pressure relief, vacuum relief, and dump valve unit operates automatically to relieve excessive cockpit pressure, and can also be opened electrically by the cockpit air pressure shut-off switch to release air pressure. Outside ventilating air is available to each cockpit only if pressurization is shut off. All controls for the air conditioning and pressurization system are located on the center control panel.

### AIR CONDITIONING AND PRESSURIZATION SYSTEM CONTROLS AND INDICATORS.

#### Cockpit Pressure Shut-Off Switch.

This switch located on the center control panel (5 figure 1-9) controls the hot air shut-off valve, the relief and dump valve, and the solenoid operated valve in the ventilation air inlet duct. With the switch in the PRESS. position, the hot air shut-off valve will be open, allowing air from the engine compressor to enter the air conditioning and pressurization system. When the switch is placed to the NO PRESS. position, 28-volt d.c. actuates the motor-driven shut-off valve to the closed position, shutting off compressor air from the system. This position of the switch also opens the dump valve in the sub-cockpit area, allowing cockpit air to be dumped overboard, and opens the solenoid operated ventilation air inlet valve allowing cold, outside ram air to enter each cockpit through the ventilation air nozzle.

# AIR CONDITIONING AND PRESSURIZATION SYSTEM

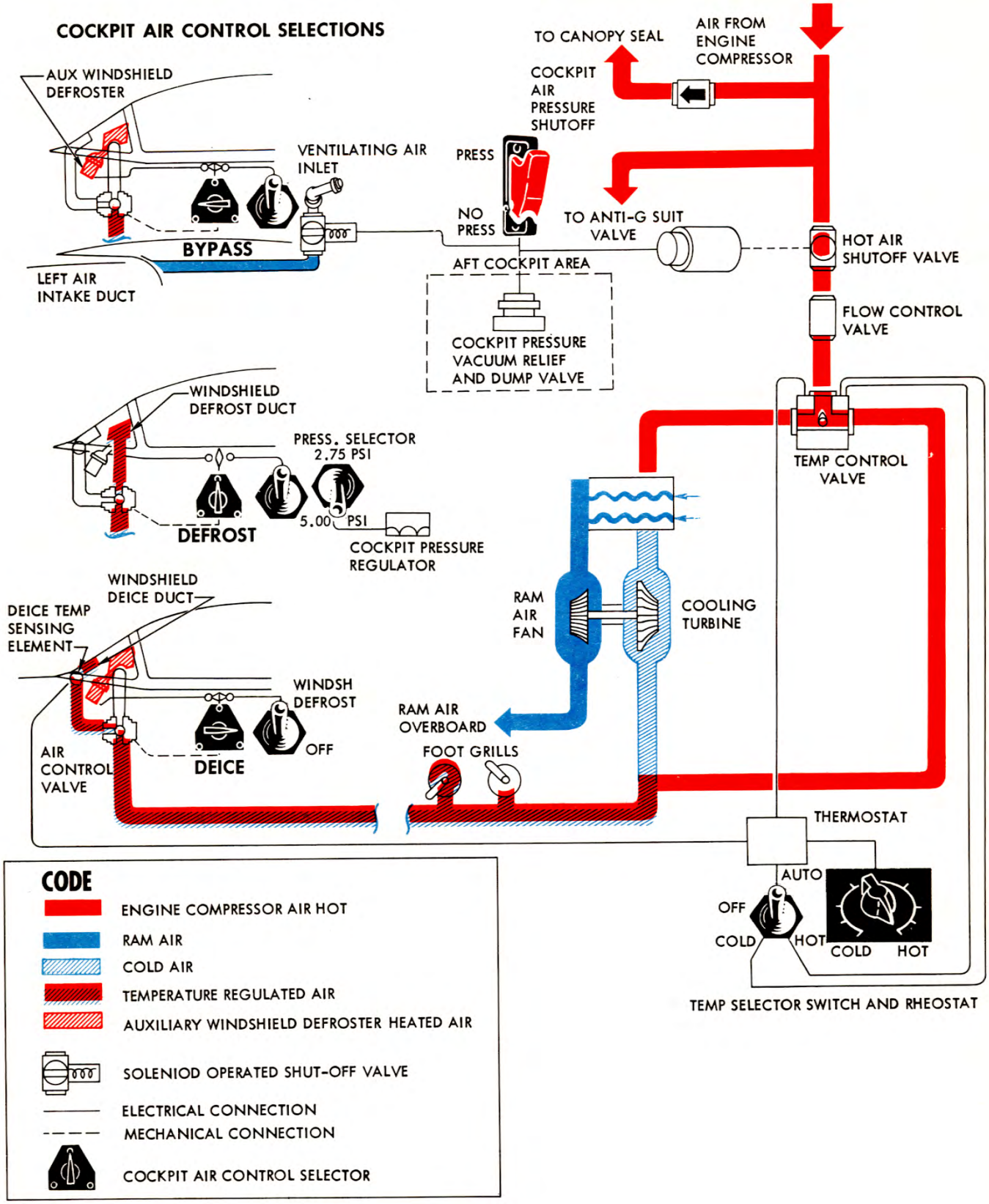



*Figure 4-2*

**Cockpit Air Pressure Selector Switch.**

The cockpit air pressure selector switch on the center control panel (3 figure 1-9) is provided to enable the pilot to vary the setting of the cockpit pressure regulator. The switch has two positions: 5.00 PSI PRESS. and 2.75 PSI. The 5.00 PSI selection is used for all normal flying and the 2.75 PSI selection for combat conditions. The cockpit air pressure selector circuit is energized by 28-volt d.c.

**Cockpit Air Temperature Selector Switch.**

The cockpit air temperature selector switch on the center control panel (6 figure 1-9) has four positions: AUTO, COLD, HOT, and OFF. In the AUTO position, the switch actuates the 2500 VA (115-volt a.c.) circuit to the thermostat control unit, and cockpit temperature will be controlled automatically in accordance with selections made on the cockpit temperature rheostat. Cockpit temperature is sensed by the thermostat through temperature sensing elements. The thermostat compares this temperature with rheostat selection and transmits electrical signals to the temperature control valve to position this valve as necessary to make cockpit temperature correspond with the rheostat selection. The pilot can also control the temperature manually by means of the COLD and HOT positions of the cockpit air temperature selector switch. Under these conditions, the thermostat is inoperative, and the temperature control valve is positioned directly any time the switch is held in the COLD or HOT positions, both of which are spring-loaded to OFF. Approximately six seconds is required for the temperature control valve to be cycled from one limit position to the other. When the switch is in the OFF position, the temperature control valve cannot be repositioned and will remain in whatever position it was at the time the switch was moved to OFF.

**Cockpit Temperature Rheostat.**

The cockpit temperature rheostat on the center control panel (8 figure 1-9) controls cockpit temperature through the thermostat control unit whenever the cockpit selector switch is in the AUTO position and 2500 VA inverter power is available. The rheostat has two extreme positions (COLD and HOT), and may be positioned as desired anywhere between them. In the COLD position (full counterclockwise) the temperature of the air entering the cockpit will be a minimum of approximately 20°F. Turning the rheostat clockwise causes less compressor bleed air to flow through the refrigeration unit and the temperature of the air entering the cockpit will increase accordingly to a maximum of 100°F when the rheostat is in the HOT (full clockwise) position.

**Cockpit Pressurization Air Inlets** (Foot Grilles).

Two pressurization air inlets (foot grilles) are located in each cockpit, and each grille has an adjustable damper that permits regulation of the inflowing air. If the dampers on all of the grilles are closed, all of the incoming, temperature regulated, cockpit air will be directed to either the windshield defrost or windshield de-ice ducts, depending upon the position of the cockpit air control valve. The open and shut positions of these foot grille dampers varies with different aircraft, but all of the dampers can be adjusted easily by foot movement. The grilles in the front cockpit are located on the inside of each foot rail and those in the rear are on the outside of each foot rail.

**Ventilating Air Inlet Control.**

Cold, outside, ram air for ventilation is available whenever the cockpit air pressure shut-off switch is in the NO PRESS. position. The amount and direction of this airflow may be controlled by the ventilating air inlet control (nozzle) located on the left side of each cockpit (6 figure 1-11 and 2 figure 4-17). Pulling the nozzle out increases air flow, and it may be shut off entirely by pushing the nozzle all the way in. The nozzle may be swiveled to direct the airflow as desired.

**Cockpit Altimeter.**

The cockpit altimeter located on the left side of the instrument panel (40 figure 1-7) gives an accurate indication of cockpit altitude, regardless of actual aircraft attitude. Some aircraft are equipped with a cockpit altimeter which shows actual aircraft altitude as well as cockpit altitude on the same instrument. A small window on the face of this instrument indicates differential pressure between the two altitudes in pounds per square inch.

## NORMAL OPERATION OF THE AIR CONDITIONING AND PRESSURIZATION SYSTEM.

1. Cockpit air pressure shut-off switch—PRESS.
2. Cockpit air pressure selector switch—5.00 PSI PRESS.
3. Cockpit air temperature selector switch—AUTO.
4. Cockpit temperature rheostat—As desired.

**Note**

The 2500 VA inverter must be available for proper operation of the automatic temperature control.

## EMERGENCY OPERATION OF THE AIR CONDITIONING AND PRESSURIZATION SYSTEM.

### Temperature Control Malfunction.

If cockpit temperature is not maintained at the desired level automatically, proceed as follows:

1. Cockpit air temperature selector switch—Hold in the manual HOT or COLD positions until cockpit temperature reaches desired level.

**Note**

If cockpit temperature is excessive and cannot be lowered automatically or manually, place the cockpit air pressure shut-off switch to NO PRESS. and open the ventilating air inlet nozzle.

### Cockpit Air Contamination.

If air in the cockpit becomes contaminated or if depressurization becomes necessary, proceed as follows:

1. Oxygen regulator diluter lever—100% OXYGEN. Emergency toggle lever to right or left lock position if oxygen pressure required.
2. Cockpit air pressure shut-off switch—NO PRESS.
3. Ventilating air inlet nozzle—Use as desired.
4. Descend below 25,000 feet if necessary.

## DEFROSTING AND DE-ICING SYSTEMS.

Various components of the aircraft require heating to prevent the accrual of ice, fog, or frost on critical surfaces whenever atmospheric conditions are suitable for such moisture formation. The windshield defrosting and de-icing systems require heated air from the engine compressor for effective operation. An auxiliary windshield defroster, in the form of an electric heater and blower unit, is installed to provide defrosting air when the normal supply is not available. Wing and empennage de-icing is accomplished electrically through de-icing boots which receive power from the 30 KVA alternator. The pitot tube is electrically heated by 28-volt d.c. when de-icing becomes necessary. The engine fuel system is subject to icing in the low pressure fuel filter, and this unit has been equipped with a de-icing system utilizing alcohol to dissolve any ice accumulation on the filter elements.

### WINDSHIELD DEFROSTING AND DE-ICING.

Hot air for defrosting and de-icing the windshield is taken from the cockpit air conditioning and pressurization system and distributed, by ducts, to the necessary locations. This air flow is directed by the air control valve which is positioned by the cockpit air control selector. As shown on figure 4-2, the valve will allow air to flow through either the windshield defrost duct at the inside base of the windshield or the windshield de-ice duct located between the two parts of the double windshield. When defrosting air is selected, the temperature of the air will normally be regulated by the automatic temperature control. However, when de-icing air is selected, the automatic control is by-passed and a temperature pick-up in the de-icing duct signals the thermostat to position the temperature control valve to the full hot position. This causes de-icing air to be maintained at the maximum temperature available, which will depend upon compressor discharge temperature and pressure as determined primarily by engine speed. The auxiliary windshield defroster consists of an electric heater unit and a fan which blows the heated air into the cockpit through the windshield defrost duct. The 28-volt d.c. circuit to the auxiliary defroster cannot be closed whenever normal defrosting air is selected. This switching arrangement is designed to prevent overheating and possible damage to the auxiliary defroster fan motor.

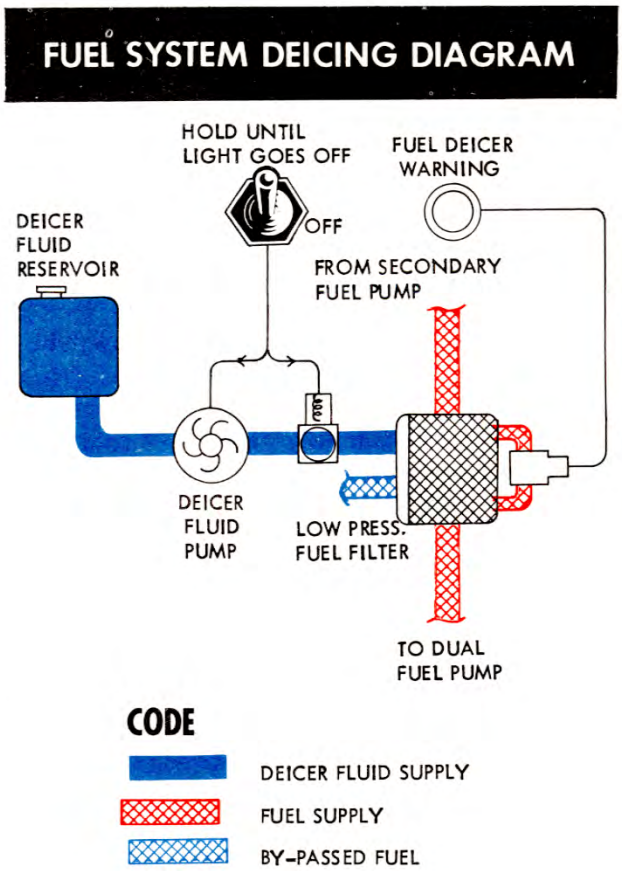


*Figure 4-3*

### Windshield Defrosting and De-Icing Controls.

**Cockpit Air Control Selector.** The cockpit air control selector (32 figure 1-7) has three positions: BYPASS, DEFROST, and DE-ICE. When the selector is in the

BYPASS position, the air control valve is mechanically positioned so that no air from the cockpit air conditioning and pressurization system will enter the windshield defrost or de-ice ducts. Consequently, all of the air flowing into the cockpit will have to enter through the foot grilles in the front and rear cockpits. When DEFROST is selected, all of the air in the air conditioning system which does not enter the cockpit through the foot grilles will be directed through the defrost duct at the inside base of the windshield. With the selector in the DE-ICE position, this airflow will be directed through the de-ice duct outlet located at the bottom of the air space between the two pieces of the double windshield. This de-icing air will be automatically maintained at a temperature of approximately 200°F at 100% engine rpm.

**Auxiliary Windshield Defroster Switch.** This switch, located on the center control panel (13 figure 1-9) has two positions: WINDSH. DEFROST and OFF. When the switch is in the WINDSH. DEFROST position, the electric fan and heater unit, operated by the 28-volt d.c. system, supplies hot air to the windshield defrost duct, provided that the air control selector is in either the BYPASS or DE-ICE position. The auxiliary defroster cannot be operated when the air control selector switch is in the DEFROST position because a cam on the air control selector shaft cuts out the 28-volt d.c. circuit to the defroster.

### Normal Operation of the Windshield Defrosting and De-Icing System.

To prevent or remove an accumulation of visible moisture on the transparent surfaces of the windshield and canopy, proceed as follows:

1. Cockpit air control selector—DE-ICE.

**Note**

The cockpit air control selector should be in the DEFROST position for all normal flight except prior to and during a descent from altitude, or whenever visible moisture (fog, frost, ice) is anticipated or encountered. When DE-ICE is selected, the automatic temperature control is inoperative and cockpit air temperature may be as high as 200°F, depending upon throttle setting and altitude.

2. Auxiliary windshield defroster switch—WINDSH. DEFROST.

**Note**

There is a possibility of smoke being emitted from the windshield defrost ducts shortly after turning on the auxiliary defroster, If this occurs turn the auxiliary windshield defroster switch OFF and, if the smoke stops, continue the mission. This white smoke is ordinarily caused by an accumulation of dirt or foreign matter on the defroster heating coils.

3. Windshield wiper control—As desired, if precipitation is obscuring forward visibility.

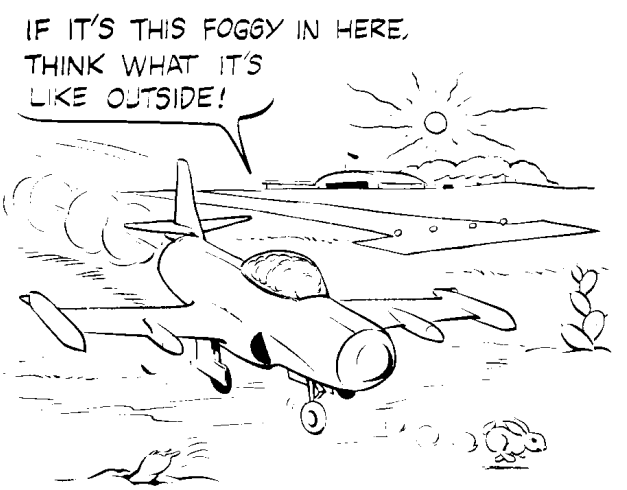
### Emergency Operation of the Windshield Defrosting and De-Icing System.

If the windshield cannot be cleared by normal procedures, and it is necessary to land without delay:

1. Check that the air control selector is in the DE-ICE position and the auxiliary windshield defroster is operating.
2. Cockpit pressurization air inlet grilles—CLOSED.
3. Engine rpm—Maximum, if fuel and time permit.

The above procedure will direct compressor air to the windshield outlets at its maximum available temperature and pressure.

**CAUTION**




IF EXCESSIVE FOG, VAPOR, OR VISIBLE MOISTURE OF ANY KIND ENTERS THE COCKPIT, RESTRICTING VISIBILITY ON TAKE-OFF, PLACE THE COCKPIT AIR PRESSURE SHUT-OFF SWITCH TO **NO PRESS**.

# TABLE OF COMMUNICATIONS AND ASSOCIATED ELECTRONIC EQUIPMENT

| | DESIGNATION | FUNCTION | OPERATOR | RANGE | LOCATION OF CONTROLS |
|---|---|---|---|---|---|
| ● INTERPHONE | AN/AIC-2A | CREW INTERCOMMUNICATION | PILOT OR R.O. | COCKPIT | PILOT'S AND R.O.'S COCKPITS |
| ● UHF COMMAND RADIO | AN/ARC 27 | AIR-TO-AIR AND AIR-TO-GROUND COMMUNICATION | PILOT OR R.O. | LINE-OF-SIGHT | PILOT'S AND R.O.'S COCKPITS |
| ● RADIO COMPASS | AN/ARN-6 | VOICE RECEPTION RADIO NAVIGATION | PILOT OR R.O. | DEPENDS UPON TRANSMITTER | PILOT'S AND R.O.'S COCKPITS |
| ● MARKER BEACON RECEIVER | AN/ARN-12 | MARKER BEACON RECEPTION | PILOT | | PILOT'S COCKPIT |
| ● GLIDE PATH RECEIVER | AN/ARN-5B OR AN/ARN-18 | ILAS APPROACH | PILOT | 15 MILES | PILOT'S COCKPIT |
| ● LOCALIZER RECEIVER | RC-103 D | ILAS APPROACH | PILOT | 15 MILES | PILOT'S COCKPIT |
| ● RADAR BEACON | AN/APG-40 | RADAR NAVIGATION | R.O. | 150 MILES | R.O.'S COCKPIT |
| ● IFF | AN/APX-6 | IDENTIFICATION | PILOT | LINE-OF-SIGHT | PILOT'S COCKPIT |

*Figu-- 4 4*

## WING AND EMPENNAGE DE-ICING.

The de-icing boots installed on the leading edges of the wing and horizontal stabilizer are electrically operated and powered by the 30 KVA engine-driven alternator. High resistance wires are imbedded in rubber de-icer boots to convert the electrical energy to heat energy. These integral wires are arranged so that when the system is operating, an area approximately 1½ inches wide along the leading edge of each boot is hot continuously and the remainder of the boots are alternately heated in narrow spanwise sections that progress aft from the leading edge. The spanwise sections are automatically selected by a cyclic timer operated by the 28-volt d.c. electrical system and each section is heated 10 out of every 100 seconds. A cut-out switch is installed in the left landing gear scissors to prevent inadvertent operation of the de-icers when the airplane is on the ground, but it is merely a safeguard, and the de-icer should be turned off any time the airplane is on the ground.

### Wing and Empennage De-Ice Switch.

The wing and empennage de-icing system is controlled by the two position wing and empennage de-ice switch on the center control panel (11 figure 1-9). Placing the switch up to the WING & EMP. position completes the 28-volt d.c. circuit to the cyclic timer and the de-icing system is placed into operation provided the 30 KVA alternator is operating and the aircraft is airborne. Moving the switch down (OFF) de-energizes the system.

### Wing and Empennage De-Icing Indicator.

A green indicator light on the center control panel adjacent to the wing and empennage de-ice switch (11 figure 1-9) will glow whenever the wing and empennage de-icing system is operating. The light is labelled WING HEAT ON.

### Wing and Empennage De-Icing System Ammeters.

Modified airplanes are equipped with three wing and empennage de-icing system ammeters in the rear cockpit to check operation of the de-icing system.

### Operation of the Wing and Empennage De-Icing System.

The de-icing system will be most effective if icing conditions are anticipated and the system is placed in operation several minutes before the ice actually begins to form. Use the following procedure:

**CAUTION**

Except when necessary, operate the wing and empennage de-icing system only when the rear cockpit is occupied. Otherwise, there will be no way of checking system voltage or amperage.

1. The pilot will check that the alternator switch is in the 30 KVA ALT position before take-off.
2. The radar observer will check the 30 KVA alternator voltage and adjust to 117 volts before system is turned on.
3. Prior to entering icing conditions the pilot will turn the de-icing switch to the WING & EMP. position and check that the indicator light comes on.
4. The radar observer will recheck the voltage and readjust if necessary after approximately 30 minutes.
5. The pilot and radar observer will visually check the boots for any sign of difficulty.
6. The radar observer will check the voltmeter needle. There should be a slight flicker every 10 seconds. On modified airplanes there are three ammeters. The ammeters should read between 75 and 90 amps.
7. The pilot will turn the de-icer switch OFF when icing conditions no longer exist.
8. The de-icer boots should be shut off immediately for any of the following conditions:
   a. Substantial voltage fluctuations.
   b. Voltage exceeding 120 volts.
   c. Ammeter readings outside limits, 75 to 90 amps.
   d. Failure of voltmeter or ammeter needles to flicker approximately every 10 seconds.
   e. Visible bubbles or arcing of boots.

**Note**

Due to the installation of rocket pods, the center wing de-icer boots have been disconnected. The severance of all power to these boots will cause a decrease in the load requirement during two consecutive power transfers. This will be noted by a dropping to no lower than 30 amperes of the Phase 1 and Phase 3 load meters located in the aft cockpit. This dropping will occur for a period of twenty seconds with a slight "kick" of the meter at ten seconds, once each one hundred second cycle.

## FUEL SYSTEM DE-ICING.

A fuel filter de-icing system (figure 4-3) is provided to remove ice from the low pressure fuel filter in the engine fuel system. It consists of a five gallon alcohol reservoir a spring-loaded closed solenoid valve, an electrically operated pump, a differential pressure switch, and a warning light. Whenever there is a pressure drop in excess of 5 psi across the low pressure filter, the differential pressure switch closes, causing 28-volt d.c. to energize the warning light. The alcohol supply, which is connected to the filter through the solenoid valve and pump, can be delivered to the filter at a rate of approximately one gallon per minute. If the filter is iced, the alcohol will dissolve the ice accumulation, reduce the pressure drop, and cause the light to go out.

### Fuel System De-Ice Switch.

The fuel system de-ice switch on the fuel control panel (7 figure 1-6) has two positions placarded HOLD UNTIL LIGHT GOES OFF (up) and spring-loaded to OFF (down). Placing the switch to the up position allows 28-volt d.c. to open the solenoid valve and energize the de-ice pump.

### Fuel System De-Ice Warning Light.

The red fuel system de-ice warning light on the instrument panel (6 figure 1-7) will glow whenever there is a 5 psi pressure drop across the low pressure filter, as determined by the differential pressure switch. The light will continue to glow until the differential pressure is reduced to approximately 3 psi.

### Operation of Fuel System De-Icing.

If the fuel system de-icing light comes on, proceed as follows:

1. Fuel system de-ice switch—Place in HOLD UNTIL LIGHT GOES OFF (up) position.
2. When light goes out release the switch.

**CAUTION**

- Do not hold the switch in the up position for more than 90 seconds at a time or the pump may burn out.
- If the light does not go out after 20 to 30 seconds, the filter may be clogged with dirt. If that is the case, the possibility of flame-out is increased, and the pilot should land as soon as possible.

**PITOT DE-ICING SYSTEM.**

An electrical heating element in the pitot head operates from the 28-volt d.c. system. It is controlled by a switch in the pilot's cockpit. The system is used to melt ice or evaporate moisture that accumulates in the pitot head, and should be used any time that instrument flying conditions are encountered.

**Pitot De-Ice Switch.**

This switch located on the center control panel (12 figure 1-9) has two positions labelled PITOT (up) and OFF (down). When the switch is placed in the PITOT position, 28-volt d.c. will energize the heating elements in the pitot head.

**CAUTION**

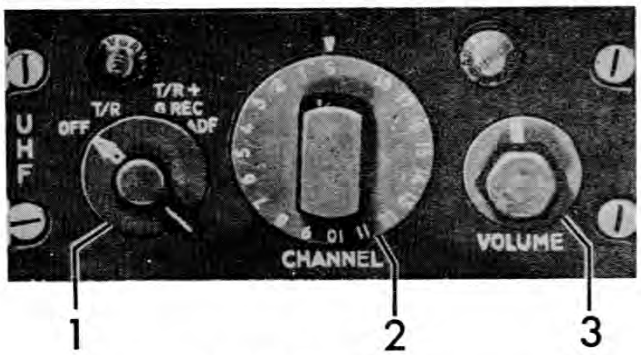
When the aircraft is on the ground, do not operate the pitot heater any longer than necessary or the heating element will be damaged.

## COMMUNICATIONS AND ASSOCIATED ELECTRONIC EQUIPMENT.

### AN/AIC-2A INTERPHONE

The interphone circuit is designed to provide continuous communication between the pilot and the radar observer. The microphones are operative any time the 28-volt d.c. system is energized. Volume controls (14 figure 1-14 and 14 figure 4-17) are provided for the pilot and radar observer so that the individual headset volume level may be adjusted. An additional interphone station with microphone and headset jacks is provided inside the right hand fillet adjacent to the cart plugs to permit communication between the pilot (or radar observer) and the ground crew. Switches are provided to remove all reception of the various radio sets from the interphone system to insure communication between the pilot and radar observer. The switch provided for the radar observer is located on the floor and is operated by his left foot. The switch for the pilot is located on the control stick grip (5 figure 1-21) and is operated by his little finger.

**AN ARC-27 COMMAND RADIO CONTROL PANEL**



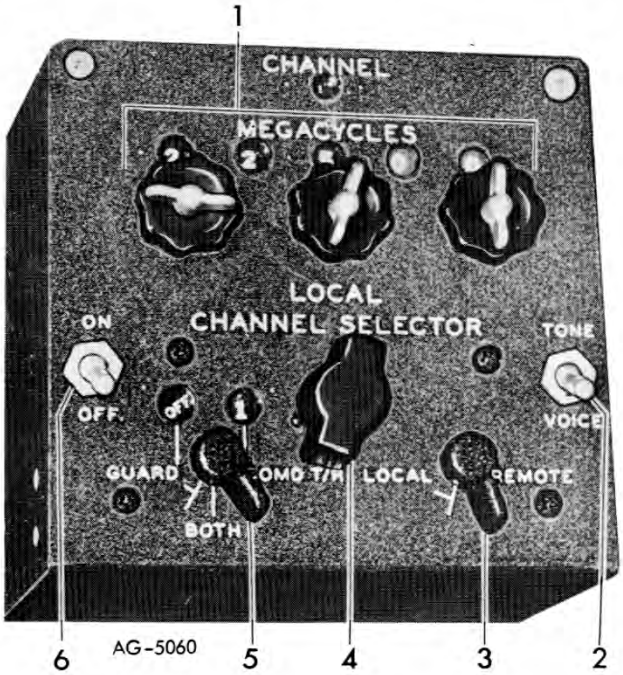

1. FUNCTION SWITCH
2. CHANNEL SWITCH
3. VOLUME CONTROL

*Figure 4-5*

### AN/ARC-27A UHF COMMAND RADIO

This equipment, powered by the 28-volt d.c. electrical system, allows the operator to transmit and receive on any one of 19 preset channels selected from the 1750 frequencies in the UHF band (225.0 to 399.9 megacycles). These frequencies can be pre-set in flight. Manual selection is provided to permit the operator to transmit and receive any frequency in the UHF band not already pre-set on the channel selector. A separate fixed tuned receiver in addition to the main transmitter receiver is incorporated to permit constant monitoring of a guard frequency. The AN/ARC-27 radio operates in the UHF frequency range. The propagation characteristics of these frequencies are very different from the VHF frequencies with which we are familiar. These frequencies are often subject to very rapid fading, resulting in broken up speech, and also very erratic antenna patterns. On the F-94C there is a cone of poor reception and transmission from about 20° to 75° nose down and 30° to each side. It may be found that there will be no reception or transmission to a ground station in this area. If this occurs it will help to have the ground station abeam or aft of the airplane or the airplane may be rolled or yawed. In addition the ARC-27

# AN/ARC-27 MASTER CONTROL PANEL




1 PRE-SET FREQUENCY SELECTOR CONTROLS

2 TONE-VOICE SWITCH

3 LOCAL-REMOTE SWITCH

4 CHANNEL SELECTOR SWITCH

5 MODE SELECTOR SWITCH

6 ON-OFF SWITCH

FB 6097

*Figure 4-6*

set itself may distort both the reeived and transmitted signal and the side tone level is excessively high. It should be noted that the difficulties described are not peculiar to F-94C aircraft but are common with other ARC-27 installations.

**C-628/ARC-27 Control Panel** (Figure 4-5).

The C-628/ARC-27 control panel (identified as UHF) is located on the right hand shelf in the front cockpit only. It is a remote control panel used in conjunction with the C-626/ARC-27 master control panel. Illumination is provided by two lamps on the face of the panel which has the following controls:

**Function Switch.** The function switch has four positions: OFF, T/R, T/R + G REC and ADF. When the function switch is rotated from the OFF position to the T/R position, transmission and reception is through the main transmitter-receiver only and on the frequency selected by the channel selector. In the T/R + G REC position conditions are the same as in the T/R position except that the guard channel is monitored simultaneously by the guard receiver. The ADF position is provided for use with the AN/ARA-25 UHF direction finder which is not installed on this aircraft.

**Channel Selector Knob.** The rotary channel selector knob (identified as CHANNEL) provides immediate selection of any one of 18 pre-set channels and a G position for the guard channel.

**Note**

The pre-set frequencies of the channel selector knob may be re-set during flight on the master radio control panel (C-626/ARC-27).

**Volume Control Knob.** The volume control knob (identified as VOLUME) provides selection of the desired audio frequency.

**C-626/ARC-27 Master Control Panel** (Figure 4-6).

The master radio control panel is installed on the left hand side panel (1 figure 4-17) in the rear cockpit (or on the left hand shelf in the front cockpit on modified aircraft) so that it will be accessible to the crew members to facilitate changing the pre-set channel selector frequencies in flight. It has the following switches and controls:

**Frequency Selector Knobs.** The three frequency selector knobs placarded MEGACYCLES are used to select the pre-set channel frequencies. Windows above these knobs indicate the digits of the frequencis so that any of the 1750 UHF frequencies may be selected.

**Tone-Voice Switch.** This switch has two positions TONE and VOICE for audio emission selection. The TONE position modulates the transmitter at 1020 cps. The VOICE position selects vocal audio emissions.

**Local-Remote Switch.** This switch selects operation from the local or remote panels. The LOCAL position selects operation from the C-626/ARC-27 master control panel and the REMOTE position selects operation from the 628/ARC-27 remote control panel.

**Channel Selector Switch.** This rotary type switch selects one of 19 pre-set channels or manual operation which is indicated in a small window located next to the switch.

**Mode Selector Switch.** This rotary type switch has three positions GUARD, BOTH and COMD. T/R. It selects operation on the guard frequency, indicated channel frequency, or both.

**On-Off Switch.** This two position switch serves as the primary power control. The switch must be ON before the pre-set channel frequencies may be selected or the C-626/ARC-27 remote panel will be operable.

### AN/ARC-27 Operation.

To transmit and receive using the C-628/ARC-27 remote control panel proceed as follows:

**Note**

Allow at least one minute for the set to warm up before operating to preclude damage to the equipment.

1. Check master radio control panel, ON-OFF switch —ON; local remote switch—REMOTE; and Tone-voice switch—As desired.
2. Rotate function switch to—T/R position.
3. Rotate channel selector knob to the desired pre-set frequency.
4. Rotate function switch to T/R + G REC position if simultaneous reception of the guard frequency channel and one of the other 18 channels is desired.
5. Adjust volume control to the desired intensity.
6. To transmit—The pilot must depress the microphone button on top of the throttle. The radar observer must depress the microphone button located on the forward left hand console.

To pre-set or change frequencies use the C-626/ARC-27 master radio control panel as follows:

1. Local-remote switch—LOCAL.
2. ON-OFF switch—ON.
3. Mode selector switch—COMD. T/R.
4. Channel selector switch—Desired channel.
5. Loosen the three wing nuts on the frequency selector knobs by counterclockwise rotation.
6. Rotate the three knobs until the numerals in the windows represent the desired frequency.
7. Tighten the three wing nuts by clockwise rotation.
8. Turn the channel selector switch to any other channel, then back to the channel that has just been set up, and check frequency.
9. Repeat steps 3, 4, 5, 6, and 7 above for each of the channels to be pre-set.
10. Mode selector switch—GUARD.
11. Local-remote switch—REMOTE.

## AN/ARN-6 RADIO COMPASS.

The AN/ARN-6 radio compass is primarily an automatic direction finder receiver operating on any frequency between 200 and 1750 KCS. It can also be used manually as a direction finder as well as receive audio signals up to 500 miles. The radio compass indicators are located on the pilot's instrument panel and on the canopy frame in the radar observer's compartment.

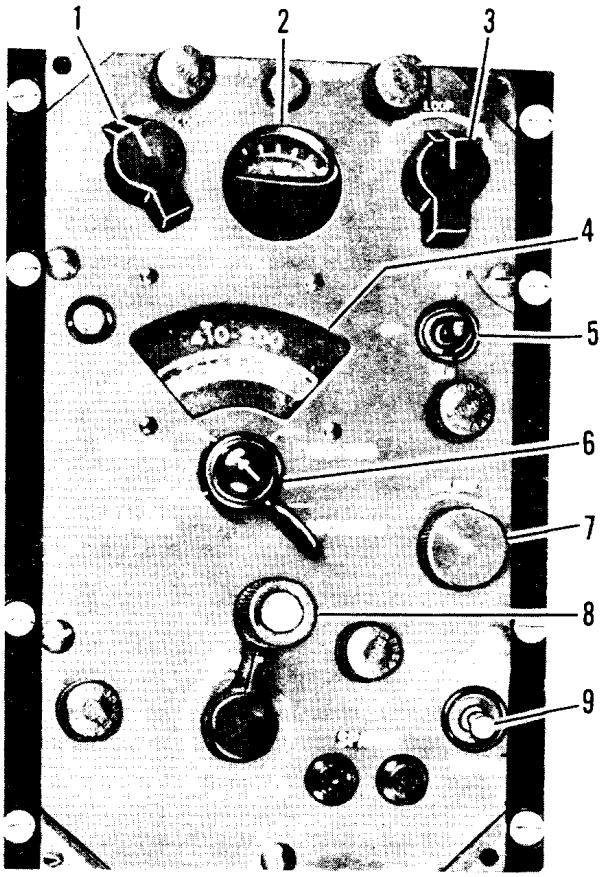
### C-403A/ARN-6 Control Panel.

The ARN-6 control panel is located on the right hand side of the pilot's cockpit (15 figure 1-14) and in some aircraft on the left hand shelf of the radar observer's cockpit. It contains the following switches and controls:

### Function Switch.

The function switch is used to (1) turn the set on, (2) obtain control and (3) select the type of operation. In the COMP. position, the set functions as an automatic direction finder. Relative bearing of the station selected is indicated on azimuth scale opposite the pointer of the radio compass indicator. In the ANT. position, the antenna is switched from the loop to the sense antenna. In the LOOP position, the loop can be manually rotated by the use of the loop left-right switch. The momentary CONT. position obtains tuning control in the cockpit desired.

# AN/ARN-6 RADIO COMPASS CONTROL PANEL




1. FUNCTION SWITCH
2. TUNING METER
3. LOOP L/R SWITCH
4. TUNING DIAL
5. LIGHT SWITCH
6. BAND SWITCH
7. VOLUME CONTROL
8. TUNING CRANK
9. VOICE-CW SWITCH

AL9233

*Figure 4-7*

**Tuning Meter.**

The tuning meter indicates relative signal strength and tuning accuracy.

**Loop L-R Switch.**

This switch is provided to permit manual control of the loop when the function switch is in the LOOP position.

**Light Switch.**

This switch provides three positions; OFF, HIGH and LOW to adjust the intensity of the control panel lighting.

**Frequency Range Selector Knob.**

The frequency range selector knob is used to select any one of four low frequency bands (100 to 200 kc) (200 to 410 kc, 410 to 850 kc and 850 to 1750 kc) for tuning. The frequency selected is indicated at the lubber line of the tuning dial located just above the frequency range selector knob.

**Volume Control.**

This knob provides selection of the desired intensity of audio reception.

**Voice-CW Switch.**

This switch provides selection of continuous wave or voice reception.

**Tuning Crank.**

The tuning crank is used to tune the desired station for maximum signal strength.

## OPERATION OF THE RADIO COMPASS.

1. Obtain control by rotating the function switch to the momentary CONT. position with the light switch in the HIGH position and noting illumination of the lamp in intensity meter light.
2. Rotate function switch back to the ANT. position.
3. Select the desired frequency range with the frequency selector knob.
4. Rotate the tuning crank to the desired station frequency and tune for maximum audio signal strength.
5. Rotate the function switch to the COMP. position.
6. Note relative bearing of the station on the azimuth scale opposite the pointer on the radio compass indicator.
7. Rotate function switch to the LOOP position and use the loop left-right switch if manual operation is desired.
8. Rotate function switch to OFF to de-energize the set.

**CAUTION**

Erratic operation of the compass can be expected when the airplane is in a bank of 45 degrees or more as manifested by any one of the following:

a. The pointer of the radio magnetic compass indicator may slow down so that

there is considerable lag between the relative bearing and the airplane heading.

b. The pointer may stop altogether or move in jerks.

c. The pointer may start moving in the opposite direction of the turn, later change direction, but still lag behind the aircraft heading.

d. The pointer may oscillate violently. Because the erratic operation occurs only during a turn, it will not affect the use of the radio compass in normal flight.

### AN/ARN-12 MARKER BEACON RECEIVER.

The AN/ARN-12 marker beacon receiver is an airborne navigational aid, powered by the 28-volt d.c. electrical system. The receiver will deliver a visual signal to the pilot whenever the aircraft is directly over an ILAS marker, fan marker or "Z" marker.

### AN/ARN-12 Marker Beacon Receiver Operation.

The receiver is fully automatic receiving any 75 megacycle transmissions whenever the 28-volt d.c. bus is energized and the aircraft is over a 75 megacycle ground radio facility. The visual signal is indicated by the amber light (16 figure 1-7) on the ID-249 cross pointer indicator in the pilot's cockpit.

### AN/ARN-18 GLIDE SLOPE RECEIVER.

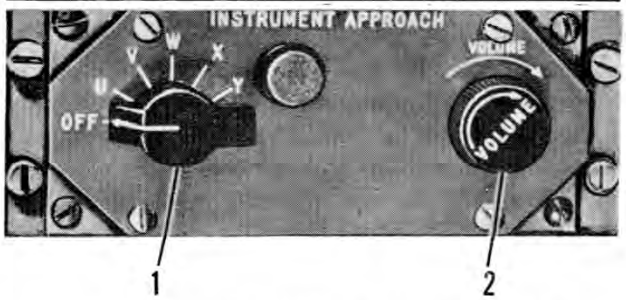
The glide slope receiver supplies signals to the horizontal needles of the (ID-249) course indicator for vertical guidance during ILAS operation. It operates by the 28-volt d.c. power supply of the aircraft. The glide slope receiver is automatically tuned to the correct glide path when a localizer channel is selected on the glide slope receiver control panel.

### AN/ARN-18 Control Panel.

The control panel is located in the front cockpit on the right hand console. It automatically controls the localizer receiver RC-103D as well as the glide path receiver for ILAS operations and is equipped with the following switches and controls:

**On-Off Switch.** This two position switch serves as the power control for the AN/ARN-18 glide slope and RC-103 localizer receivers. The ON position energizes the receivers and indicators. The OFF position discontinues ILAS operations.

**AN ARN-5B ILAS RECEIVER CONTROL PANEL**




1. CHANNEL SELECTOR AND OFF SWITCH
2. VOLUME CONTROL

AL 9234

*Figure 4-8*

**Channel Selector Switch.** This rotary type switch has six positions placarded around the dial. The positions represent localizer frequencies in megacycles. Two of the positions are not used (inoperative) the remaining four are 108.3, 109.5, 109.9 and 110.3. These positions when selected automatically tune the glide slope receivers for ILAS operation.

**Volume Control Knob.** This knob provides selection of the desired intensity level of audio reception. Rotating the knob clockwise increase volume.

### AN/ARN-18 Operation.

To operate the AN/ARN-18 Glide slope receiver proceed as follows:

1. ON-OFF switch—ON.
2. Channel selector switch—Desired localizer frequency.
3. Check for deviation of the vertical and horizontal needles of the ID-249 course indicator.

### AN/ARN-5B GLIDE SLOPE RECEIVER.

On some aircraft the AN/ARN-18 is replaced with the AN/ARN-5B glide slope receiver. The two sets are functionally the same except that on the AN/ARN-5B the ON-OFF switch and channel selector knob have been incorporated into one control consisting of a rotary type switch with an OFF position and the letters U, V, W, X, Y, and Z substituted for the placarded localizer frequencies.

## ID-249 COURSE INDICATOR.

The ID-249 course indicator (16 figure 1-7) is mounted on the instrument panel in the front cockpit only. Signals are directed into this indicator from the RC-103D receiver to operate the vertical needle for course guidance. A course SET knob in the lower left corner of the instrument is used to select the desired course for inbound or outbound tracking, the magnetic value of which appears in a window at the top of the instrument. The horizontal needle is operated by the AN/ARN-18 glide slope receiver for glide path guidance during ILAS operations. TO and FROM indications are shown in a window in the upper left hand corner of the instrument. Two flag arms (one for course and one for glide slope) are provided to operate any time a signal is unreliable, weak, or nonexistant.

## FLIGHT COMPUTER (ZERO READER) SYSTEM.

The Zero Reader is an automatic flight instrument that combines all of the information required to fly the airplane on a predetermined flight plan in a safe manner and presents it to the pilot visually on the zero reader indicator. Displacement of the bars on the indicator shows the pilot the corrective action he must take to return the airplane to the desired flight path. When the bars are zeroed (centered), the airplane is either on course or in an attitude that will bring it to the desired flight path. The zero reader may be used for instrument flying or for making instrument approaches. When it is being used, the other flight instruments should be checked for reference. Briefly stated, the zero reader can be compared to an automatic pilot in which the human pilot replaces the servos, since all that is required of him is the proper response to its indications without the necessity of making any mental computations. Power for the zero reader is supplied by the direct current bus and the 115-volt a.c. instrument inverter. Hence, it is energized whenever 28-volt d.c. is available and the instrument power switch is on. The system is operated by means of a flight computer selector switch, a heading selector and an indicator, all located on the pilot's instrument panel. Other components of the system are located in the nose section of the aircraft and include an altitude control, vertical gyro, quick erector for the gyro, and an amplifier. The zero reader has several modes of operation which may be selected by the pilot. These include localizer and approach functions which furnish ILAS signals to the system so that the zero reader may be used as an aid on an ILAS approach. The computer also receives heading signals from the directional indicator system during all normal operation.

### Flight Computer Control.

The flight computer control (35 figure 1-7) on the instrument panel (located on the center control panel of earlier aircraft) incorporates a selector switch, an altitude control switch combined with a go-around button (not included on earlier aircraft) and an altitude control indicator light. The selector switch has four positions; LEFT, FLIGHT INSTR., VOR. LOC. RIGHT, and APPROACH. When the selector switch is in the (Blue) LEFT position, localizer signals are fed to the zero reader indicator. This position is used whenever the reciprocal of the localizer final approach heading is being flown, regardless of whether proceeding inbound on the back beam or outbound on the approach beam. The FLIGHT INST. position is used for all flying when radio navigation is not required. No radio signals (directional indicator signals only) are fed to the zero reader indicator when the selector switch is in this position. When in the VOR. LOC. (blue) RIGHT position, localizer signals are supplied to the zero reader indicator. This position is used whenever the localizer final approach heading is being flown, regardless of whether proceeding outbound on the back beam or inbound on the approach beam. The radio signals fed to the zero reader indicator when the switch is in this position, are the same as those fed to it when the switch is in the (Blue) LEFT position, except that the vertical bar is displaced in the opposite direction so that it will always be necessary to fly toward the bar to zero the needle. Moving the selector switch to APPROACH provides the zero reader indicator with glide slope signals in addition to the localizer signals. The installation in this airplane is adjusted so that when the zero reader indicator bars are zeroed, the aircraft will actually be in the upper half of the glide slope beam and thus be automatically provided with a safe margin of obstruction clearance.

The altitude control switch, when in the ON position, energizes the altitude control which sends barometric signals to the computer. These signals position the horizontal bar so that the pilot will be informed how to fly to maintain a constant altitude. The altitude control switch is mechanically interconnected with the selector switch so that when the selector switch is turned to the APPROACH position, the altitude control is turned OFF. When the altitude control switch is OFF, the green altitude control indicator light will be energized.

**Flight Computer Indicator and Heading Selector.**

The flight computer indicator (cross-pointer) is incorporated with the heading selector and the directional indicator to form a single unit (18 figure 1-7) on the instrument panel (on earlier aircraft the zero reader cross-pointers and heading selector are separate).

**Flight Computer Operation.**

The zero reader should be placed into operation and checked before flight as follows:

1. Selector switch—FLIGHT INST.
2. Altitude control—OFF (green light on).
3. Rotate heading selector to aircraft heading and check vertical bar centered.
4. Rotate heading selector 10° to either side of aircraft heading and check vertical bar for correct response (it should move opposite to heading selector movement).
5. Set heading selector to take-off runway heading.
6. Rotate pitch trim knob right and left and check response of horizontal bar.
7. Set horizontal bar for take-off.
   a. 2½ dots above center with afterburner.
   b. 1¼ dots above center without afterburner.
8. To check ILAS function of zero reader move selector switch to VOR. LOC. after ILAS receivers are operating and check that vertical bar moves toward localizer transmitter and corresponds with movement of ILAS deviation indicator vertical bar.

**AN/APX-6 IFF RADAR.**

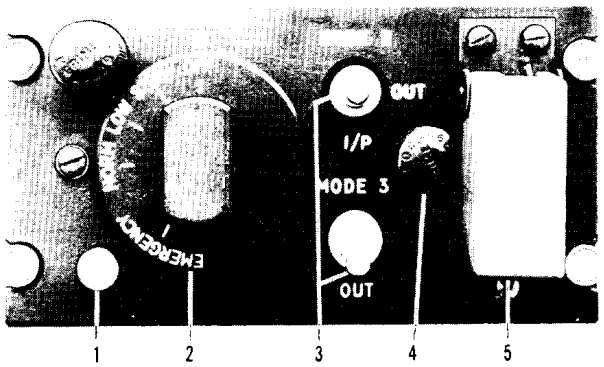
The Radar Identification Set AN/APX-6 is an airborne transpondor and is one of several equipments which may be operated together to provide a system of electronic identification and recognition. The purposes of the AN/APX-6 are:

a. To identify the airplane in which it is installed as friendly when correctly challenged by an interrogator-respondor associated with friendly shore, shipboard and airborne radars, and,

b. To permit surface tracking and control of aircraft in which it is installed.

Functionally, the AN/APX-6 receives challenges, which are initiated by an interrogator-respondor, and transmits replies back to the interrogator-respondor where the replies are displayed, along with the associated radar targets, on the radar indicators. When a radar target is accompanied by a proper IFF reply, as transmitted by the AN/APX-6, that target is considered friendly.

**AN APX-6 CONTROL PANEL**




1. EMERGENCY DIAL STOP
2. MASTER SELECTOR
3. MODE 2 AND 3 SWITCHES
4. PANEL LIGHT
5. DESTRUCT SWITCH

*Figure 4-9*

**AN/APX-6 Controls.**

The AN/APX-6 controls are installed on a panel located on the right hand shelf in the front cockpit (16 figure 1-14), and include the following:

**Master Switch.** The master switch is a five-position rotary switch permitting selection of the following operating conditions:

a. The OFF position de-senitizes the transpondor units and secures the equipment except for the panel lighting and the destructor firing circuit.

b. The STDBY. position allows primary power to energize and warm up the tube; however, the transpondor receiver is not sensitized and no replies can be transmitted.

c. The LOW position selects mode 1 transpondor operation with the transpondor receiver operating at reduced sensitivity. Replies will be transmitted only upon receipt of strongly interrogated signals, ordinarily from nearby interrogator-responsors.

d. The NORM. position selects mode 1 transpondor operation and allows the receiver to operate with full sensitivity and maximum performance.

e. The EMERGENCY position permits the transpondor to transmit a distinctive emergency or distress reply upon receipt of any mode of interrogation. The EMERGENCY DIAL STOP must be pressed so that the master switch can be rotated clockwise to the EMERGENCY position.

**Mode 2 Switch.** The mode 2 switch has 3 positions: MODE 2, OUT, and I/P. This switch functions only when the master switch is in LOW or NORM. It provides separate control of Mode 2 transpondor operation when placed in the MODE 2 position, and is independent of the other modes of interrogation. The I/P position permits the transpondor to reply to Mode 2 interrogations only when the aircraft radio transmitter is operating. In the OUT position no Mode 2 interrogations are accepted, hence no Mode 2 replies are transmitted.

**Mode 3 Switch.** The Mode 3 switch has 2 positions; MODE 2 and OUT. The MODE 3 position permits the transpondor to reply to Mode 3 interrogations the OUT position cuts off all reception of Mode 3 interrogation.

**Note**

The transpondor receiver will receive Mode 1 interrogation whenever the master switch is in LOW or NORM as well as Mode 2 and Mode 3 interrogations if the respective switches are on.

**Destruct Switch.** The destruct switch is protected by a safetied cover to prevent inadvertent firing. It has two positions: ON and OFF. The ON position completes the circuit to the destructor units destroying the set in case the aircraft falls into enemy hands. The explosion is not severe enough to injure personnel or damage the aircraft. The OFF position cuts off voltage to the destructor units unless a special IMPACT SWITCH (if installed) is tripped as might result from a sharp blow or jolt resulting from a crash landing.

## LIGHTING EQUIPMENT.

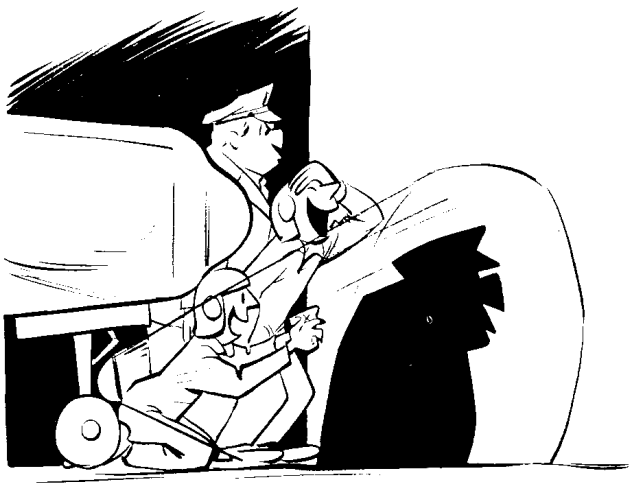
The aircraft lighting equipment consists of exterior lighting, including landing and taxi lights, navigation lights and fuselage lights, and interior lighting in both front and rear cockpits. All the aircraft lighting equipment is operated by the 28-volt d.c. electrical system.

### EXTERIOR LIGHTING.

#### Landing and Taxi Lights and Control Switch.

Two non-adjustable lights are mounted on and turn with the nose gear to provide illumination for night operation. The lights are controlled by a three position switch located on the left forward side panel (3 figure 1-12). The switch has three positions: LANDING LT., off (center), and TAXI LT. When the switch is in the LANDING LT. position, both lights are turned on. In the TAXI LT. position only the left light is turned on. Both lights are off when the switch is in the center position.

**CAUTION**



LANDING LIGHTS MUST NOT BE LEFT ON LONGER THAN FIVE MINUTES AT ANY TIME WHEN THE AIRPLANE IS ON THE GROUND, OR THE LIGHTS MAY BURN OUT.

#### Navigation Lights and Control Switches.

Conventional navigation lights are installed on the top and bottom of each wing tip and on the aft end of the fuselage. The lights are turned on, off, or connected through a flasher unit by the navigation light steady-flash switch located on the pilot's exterior light control panel (2 figure 1-11). When in the FLASH position the navigation lights will flash alternately with the yellow tail light. Brilliance is controlled by the brilliance control switch (1 figure 4-10). Navigation lights are installed on each wing tip fuel tank to automatically operate in place of the normal lights when tip tanks are carried.

#### Fuselage Lights.

6-watt fuselage lights are installed on the top and on the bottom of the fuselage. The lights burn continuously whenever the navigation light steady-flash switch is in either the STEADY or FLASH position, and the brilliance also is controlled by the brilliance control switch.

### INTERIOR LIGHTING.

Each instrument in the pilot's and radar observer's compartment is lighted by an individual lighting shield, and the control panels are indirectly lighted by recessed lamps. Red flood lamps and Type C-4A spot lights are also provided in each compartment to supplement the instrument and control panel lighting. The instruments, control panel lights and flood lights are controlled by rheostats located in each cockpit. These rheostats labeled CONSOLE, PANEL, and FLOOD may be rotated clockwise from OFF to BRIGHT as desired to vary the intensity of the associated lights. The rheostats which control the C-4A spotlights are incorporated in the light assemblies. On some airplanes, white flood lights are provided to illuminate the cockpit during thunderstorm flying. An additional rheostat labeled WHITE FLOOD is provided in the cockpit lights control panel (3 figure 4-11) to control the intensity of this light.

## OXYGEN SYSTEM.

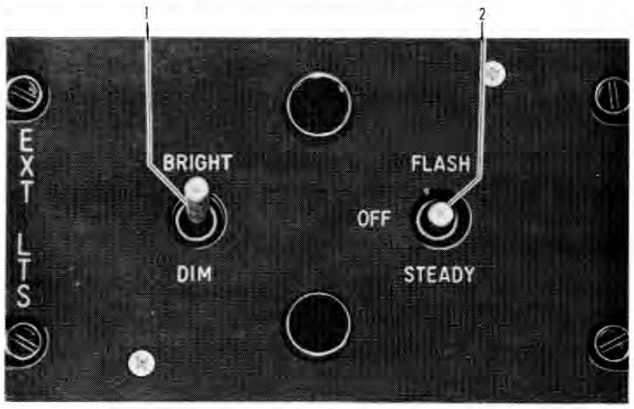
Gaseous oxygen is stored under high pressure in two cylinders located in the nose section of the aircraft. Oxygen is introduced to the cylinders through a filler valve which can be reached by means of an access door on the right side of the nose section (3 figure 1-27). When fully serviced, oxygen pressure in these cylinders should be approximately 1800 psi.

**Note**

Under conditions of extreme cold, such as would be encountered at high altitudes, the oxygen cylinders will become chilled and the oxygen pressure gage indication will drop, sometimes rather rapidly. This should not cause undue alarm, since the normal supply of breathing oxygen will still be available, and the pressure will tend to rise again when the aircraft descends to warmer altitudes. If oxygen pressure decreases rapidly at low altitudes or during a descent, it is indicative of a leak in the system and a thorough check should be made of the system to determine the cause.

Flow of oxygen is directed from the storage cylinders through a pressure reducer and check valve to oxygen regulators in each cockpit. The regulators include all the necessary controls for operation of the oxygen system, as well as a pressure gage and a flow indicator. See figure 4-12 for oxygen duration.

**EXTERIOR LIGHTS CONTROL PANEL**




1. BRILLIANCE CONTROL SWITCH
2. NAVIGATION LIGHT STEADY-FLASH SWITCH

*Figure 4-10*

### OXYGEN REGULATOR.

A diluter demand oxygen regulator (type D-1 or D-2) is located on the right console in the pilot's cockpit (17 figure 1-11) and on the left console in the radar observer's cockpit (10 figure 4-17). The regulators automatically supply the crew member's oxygen requirements. Three levers on the regulator panel control the flow of oxygen through the regulator and into the oxygen mask. The supply lever, when turned ON, opens a supply valve allowing oxygen from the cylinders to enter the regulator. The correct mixture of cockpit air and oxygen is maintained automatically at all altitudes by an air inlet valve which is controlled by the diluter lever. Oxygen under pressure can be obtained at any time by means of an emergency toggle lever. The flow of oxygen should be monitored closely by frequent checks of the flow indicator (blinker) and the pressure gages.

### OXYGEN SYSTEM CONTROLS.

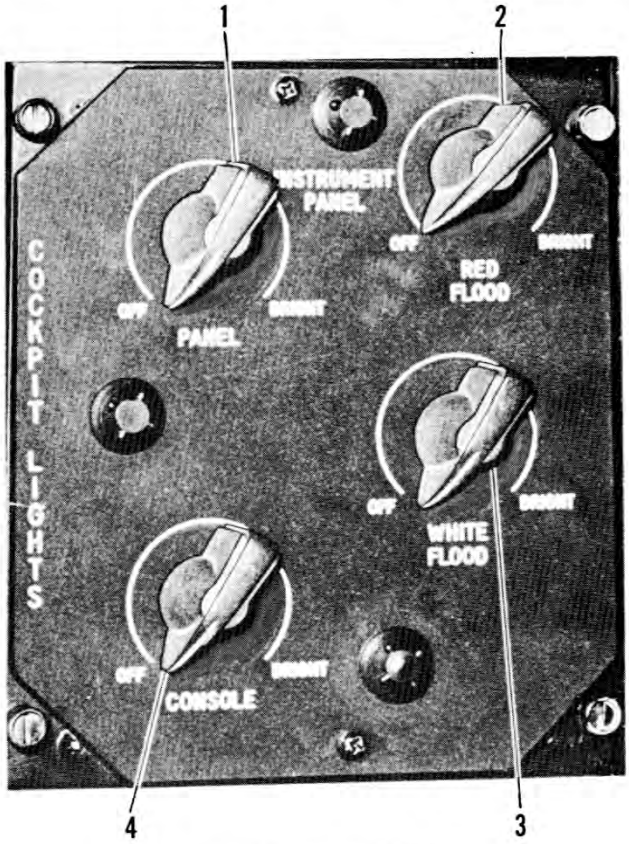
#### Oxygen Regulator Supply Valve Lever.

The oxygen regulator supply valve lever is located at the aft end of the regulator control panel (6 figure 4-13). Turning the lever to the ON (clockwise) position opens the supply valve and allows oxygen to enter the regulator. The OFF (counterclockwise) position closes the supply valve and shuts off oxygen flow to the regulator.

#### Oxygen Regulator Diluter Lever.

The oxygen regulator diluter lever located on the forward end of the regulator control panel (2 figure 4-13)

# COCKPIT LIGHTS CONTROL PANEL




1. PANEL LIGHTS RHEOSTAT
2. RED FLOOD LIGHTS RHEOSTAT
3. WHITE FLOOD LIGHTS RHEOSTAT
4. CONSOLE LIGHTS RHEOSTAT

*Figure 4-11*

has two positions, 100% OXYGEN and NORMAL OXYGEN. Moving the lever outboard to the 100% OXYGEN position closes the air inlet valve in the regulator so that 100% oxygen will be supplied to the crew member's mask. In the NORMAL OXYGEN position, the air inlet valve is opened and automatically furnished a proper mixture of air and oxygen at all altitudes.

### Oxygen Regulator Emergency Toggle Lever.

The emergency toggle lever (5 figure 4-13) on the oxygen regulator control panel provides a means of manually supplying positive pressure to the mask for emergency use. Pushing the lever down gives a positive pressure to the mask which is automatically stopped when the lever is released. Pushing the lever to either side (right or left) locks the lever to give a continuous positive pressure to the mask.

**Note**

The oxygen mask fit may be tested at any altitude by pushing the emergency toggle lever. Be sure that the toggle lever is not left in the lock position after testing or the oxygen supply will be rapidly depleted.

### Oxygen Regulator Warning System Switch.

A toggle switch (1 figure 4-13) for operating the warning light circuit is provided on each regulator panel. The toggle switch at the ON position allows 28-volt d.c. to energize the oxygen warning light circuit. The toggle switch at the OFF position turns off the oxygen warning light circuit. The toggle switch should be ON whenever oxygen is being used.

## OXYGEN SYSTEM INDICATORS.

The pilot's oxygen cylinder pressure gage (5 figure 1-14) is located on the right forward panel. The radar observer's oxygen cylinder pressure gage (4 figure 4-18) is located on the right shelf. These gages indicate the pressure in the oxygen cylinders and are used to determine oxygen duration.

**CAUTION**

The low pressure gage on the regulator indicates the pressure delivered to the regulator and not the pressure in the oxygen cylinders. The high pressure oxygen cylinder pressure gages must be used to determine duration.

### Oxygen Regulator Low Pressure Gage.

A low pressure gage (3 figure 4-13) is located on each oxygen regulator control panel to indicate the pressure of the oxygen supplied to the oxygen regulator. The high pressure of the oxygen cylinders is reduced by a pressure reducer to approximately 400-450 psi, which is the pressure that the low pressure gages should indicate whenever the oxygen regulator supply valve lever is turned on.

### Oxygen Regulator Flow Indicator.

A flow indicator (blinker) is incorporated in each regulator low pressure gage. When oxygen flows through the regulator, the indicator slots will appear white. Otherwise, they are a dull black.

**Oxygen Warning Light.**

Oxygen warning lights (4 figure 1-14 and 3 figure 4-18) are provided on the right forward panel in the pilot's compartment and on the right shelf in the radar observer's compartment. The pilot is provided with two warning lights, one for his oxygen supply and one for the radar observer's oxygen supply. The warning circuit for each station is turned on by the oxygen regulator warning system switch on the respective oxygen regulator control panel. There are basically three different light indications:

a. A dim continuous glow—This indicates that the crew member has connected his mask to the oxygen regulator and is breathing oxygen normally through the mask.

b. Bright (continuous or blinking) light—This indicates either that there is no flow of oxygen through the regulator or that there is a continuous flow of oxygen through an unused regulator. The former indication can be caused by breathing through the mask while the oxygen regulator supply lever is OFF. The latter indication can result if the oxygen regulator supply lever is ON and the regulator is unused at high altitudes.

**Note**

A bright (blinking or continuous) illumination of the light will also occur when the oxygen warning light circuit is first turned ON until a few breaths have been taken through the oxygen mask.

c. No light—This indication can be caused by either a burned out bulb, lack of electrical power or a broken electrical circuit.

**PRESSURE DEMAND OXYGEN MASKS.**

Only the type A-13, A-13A, or MS22001 pressure demand oxygen mask will be used. These masks can be identified by the presence of a gray anodized aluminum exhalation valve (pressure-compensating) Specification No. MIL-V-7053 or AN-V-32, which is located in the mask directly below the chin position.

Pressure demand masks, when used at altitude, will occasionally produce a distinct vibration in the mask that can be identified by a "wheezing" sound. This condition may be overlooked in that operational qualities are not disturbed in any manner. If a blocking condition

**WARNING**

OXYGEN MASKS OTHER THAN SPECIFIED IN THE ABOVE PARAGRAPH WILL NOT BE USED WITH THIS OXYGEN SYSTEM. USE OF UNAUTHORIZED OXYGEN MASKS RESULTS IN RAPID DEPLETION OF THE AIRPLANE OXYGEN SUPPLY, AND PRESSURE BREATHING REQUIRED AT ALTITUDE WILL BE LOST.

(cannot inhale) occurs during flight, a "sharp" exhalation will usually correct the difficulty; however, if this does not correct the blocking condition the mask may be lifted off the face momentarily at the chin section.

**WARNING**

Extreme care must be exercised when using this procedure, since the danger of hypoxia increases rapidly above 30,000 feet cabin altitude.

**OXYGEN SYSTEM PREFLIGHT CHECK.**

1. Fasten the oxygen mask tie-down connector strap to the parachute chest strap as follows (see figure 4-14):

   a. Attach the connector tie-down strap on the mask male connector to the parachute chest strap by routing the tie-down strap under the parachute chest strap as close to the chest strap snap as possible, up behind the chest strap then down in front of the chest strap, around again, and finally snapped to the connector.

## CREW MEMBER OXYGEN DURATION—HOURS

| CABIN ALTITUDE FEET | GAGE PRESSURE—P.S.I. 1800 | 1600 | 1400 | 1200 | 1000 | 800 | 600 | 400 | BELOW 400 |
|---|---|---|---|---|---|---|---|---|---|
| 40,000 | 5.3<br>5.3 | 4.7<br>4.7 | 4.1<br>4.1 | 3.5<br>3.5 | 2.9<br>2.9 | 2.3<br>2.3 | 1.8<br>1.8 | 1.2<br>1.2 | EMERGENCY<br>DESCEND TO ALTITUDE NOT REQUIRING OXYGEN |
| 35,000 | 5.3<br>5.3 | 4.7<br>4.7 | 4.1<br>4.1 | 3.5<br>3.5 | 2.9<br>2.9 | 2.3<br>2.3 | 1.8<br>1.8 | 1.2<br>1.2 | |
| 30,000 | 3.8<br>3.9 | 3.4<br>3.5 | 3.0<br>3.0 | 2.5<br>2.6 | 2.1<br>2.2 | 1.7<br>1.7 | 1.3<br>1.3 | 0.8<br>0.9 | |
| 25,000 | 2.9<br>3.7 | 2.6<br>3.3 | 2.3<br>2.9 | 2.0<br>2.5 | 1.6<br>2.0 | 1.3<br>1.6 | 1.1<br>1.2 | 0.7<br>0.8 | |
| 20,000 | 2.2<br>4.2 | 2.0<br>3.7 | 1.7<br>3.2 | 1.5<br>2.8 | 1.2<br>2.3 | 1.0<br>1.9 | 0.7<br>1.4 | 0.5<br>0.9 | |
| 15,000 | 1.8<br>5.0 | 1.6<br>4.5 | 1.4<br>3.9 | 1.2<br>3.4 | 1.0<br>2.8 | 0.8<br>2.2 | 0.6<br>1.7 | 0.4<br>1.1 | |
| 10,000 | 1.4<br>6.7 | 1.3<br>6.0 | 1.1<br>5.2 | 1.0<br>4.5 | 0.8<br>3.7 | 0.6<br>3.0 | 0.5<br>2.2 | 0.3<br>1.5 | |

BLACK FIGURES INDICATE DILUTER LEVER "NORMAL OXYGEN"

RED FIGURES INDICATE DILUTER LEVER "100% OXYGEN"

2 CREW MEMBERS

2 TYPE AN6025 AX386 CYLINDERS

*Figure 4-12*

b. Connect the mask-to-regulator tubing female disconnect to the mask male connector, listen for the click and check that the sealing gasket is only half exposed.

c. Attach the aligator clip to the end of the mask male connector strap.

**WARNING**

It is imperative that the connector tie-down strap on the mask male connector not be single looped around the parachute chest strap or attached to the chest strap snap. Failure to double loop the connector tie-down strap around the parachute chest strap will result in the tie-down strap slipping into the chest strap snap and inadvertently opening the snap during bailout.

2. Oxygen pressure gage—1800 psi.
3. Oxygen regulator supply valve lever—ON.
4. Oxygen regulator—Check for leakage by performing "blow-back" check with diluter lever in 100% OXYGEN and NORMAL OXYGEN positions.
5. Oxygen regulator warning system switch—ON (check for bright light).
6. Oxygen regulator emergency toggle level—Deflect, then OFF (note proper warning light indication).
7. Oxygen regulator diluter lever—100% OXYGEN.
8. Oxygen regulator flow indicator—Proper indication (blinking).
9. Oxygen regulator emergency toggle lever—Deflect.
10. Oxygen mask—Test, and note positive pressure (hold breath to check leakage around mask).
11. Oxygen regulator emergency toggle lever—OFF (center).
12. Oxygen regulator diluter lever—As desired.
13. H-2 Oxygen cylinder—Tag and pin removed, hose connected.

### NORMAL OPERATION OF OXYGEN SYSTEM.

1. Oxygen regulator supply valve lever—ON.
2. Oxygen regulator diluter lever—As required.

**Note**

If the aircraft is to be operated under possible conditions of carbon monoxide contamination during ground operations, place the oxygen regulator diluter lever to the 100% OXYGEN position.

**WARNING**

The diluter lever must be returned to the NORMAL OXYGEN position as soon as possible because the use of 100% oxygen through-

out a long mission will so deplete the oxygen supply as to be hazardous to the flight crew.

3. Oxygen regulator warning switch—ON.
4. Emergency toggle lever—Centered.

### EMERGENCY OPERATION OF OXYGEN SYSTEM.

Any time that symptoms of hypoxia are noted, or smoke or fumes detected in the cockpit, proceed as follows:

1. Regulator diluter lever—100% OXYGEN.
2. Emergency toggle lever—Deflect to right or left lock position.

**CAUTION**

Use of the emergency toggle lever will rapidly deplete the oxygen supply. Therefore, return the toggle lever to center as soon as the emergency is over. The radar observer should inform the pilot immediately if he finds it necessary to use 100% oxygen or the emergency toggle lever.

3. If regulator is not functioning properly and cockpit altitude is above 14,000 feet, pull the ball handle on the H-2 emergency oxygen cylinder.

## W-3A AUTOMATIC PILOT.

The W-3A automatic pilot is an electrohydraulic flight control system, designed to relieve the pilot of the responsibility of continually cross-checking his instruments and making manual corrections to maintain a desired flight attitude. The automatic pilot will detect errors and make corrections, without tiring, in a much more rapid and precise manner than the human pilot is capable of doing, regardless of his experience level and proficiency. The automatic pilot operates in response to signals received from three electrically driven non-tumbling rate gyros that offer 360° of operation about the pitch, roll and yaw axes, affording unlimited aircraft maneuverability. It receives its electrical power from the 2500 VA inverter and the instrument inverter. When the auto pilot is engaged, the gyros send electrical impulses to shut-off valves which open, directing normal hydraulic system pressure through the elevator and aileron boost control valves to the boost cylinders for actual movement of the control surfaces. Hydraulic fluid for rudder actuation is sent directly to the rudder servo cylinder. The name, electrohydraulic flight control system, is derived from the fact that electrical energy is utilized to control hydraulic valves, metering fluid pressure into the flight control system in direct proportion to the responses received from the rate gyros of the automatic pilot.

### W-3A AUTOMATIC PILOT CONTROL PANEL.

The automatic pilot control panel (figure 4-15) provides the necessary means of engaging the automatic pilot and selecting the desired mode of operation. It is located on the pilot's right hand console and is equipped with the following switches and controls:

#### Automatic Pilot Power Switch.

The automatic pilot power switch is a two position switch placarded AUTOPILOT and OFF. The AUTOPILOT position introduces 400-cycle a.c. and 28-volt d.c. current into the system, energizing the gyros and electronic amplifiers for automatic pilot actuation. The OFF position de-energizes the automatic pilot, discontinuing its function.

#### Channel Selector Switches.

Three channel selector switches are provided so that automatic pilot control of pitch, roll and/or yaw may be discontinued if desired. For example, during landing or go-around, automatic pilot control of roll and yaw may be retained with the pilot manually controlling pitch. These switches have two positions, OFF and the individually placarded positions PITCH, ROLL and YAW.

#### Automatic Pilot Indicator Light.

The green automatic pilot indicator light will illuminate to indicate that the automatic pilot is in operation. The light will not illuminate at all when the mode selector switch is in the STANDBY position, nor will it illuminate when any other mode of operation is selected prior to completion of a 25 second warm-up period.

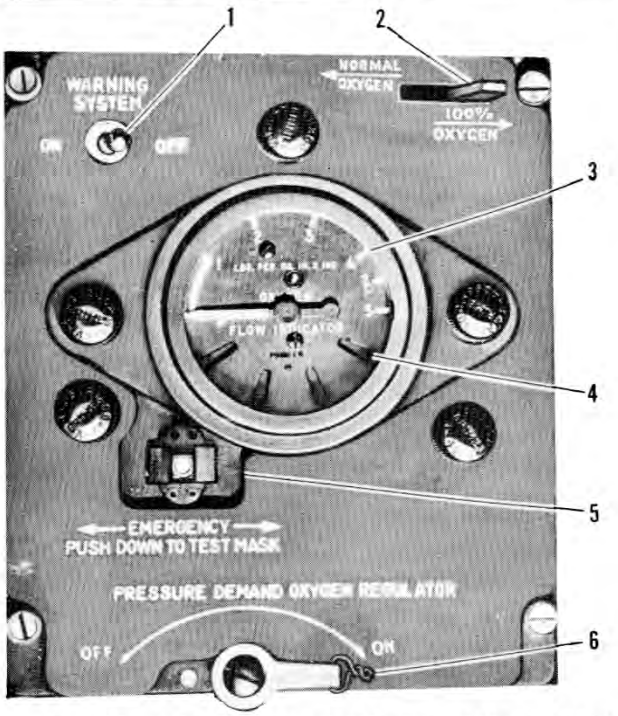
#### Course Trim Selector Switch.

The course trim selector switch is provided to alter the heading of the aircraft up to a maximum of ten degrees at a time in either direction. It is a rotary type switch spring loaded to the center (O) position, with a depress to rotate feature incorporated to prevent inadvertent actuation.

#### Mode Selector Switch.

The automatic pilot mode selector switch is provided to select the type of operation desired. It is a rotary type switch with six positions placarded around the dial. The switch must be depressed before it can be rotated from or passed through the center STANDBY position. The six positions and their functions, reading clockwise around the dial, are as follows:

# OXYGEN REGULATOR CONTROL PANEL




1. OXYGEN REGULATOR WARNING SYS. SWITCH
2. OXYGEN REGULATOR DILUTER LEVER
3. OXYGEN REGULATOR LOW PRESSURE GAGE
4. OXYGEN REGULATOR FLOW INDICATOR
5. OXYGEN REGULATOR EMER. TOGGLE LEVER
6. OXYGEN REGULATOR SUPPLY VALVE LEVER

*Figure 4-13*

**Localizer and Glide Path.** This position is utilized during an ILAS approach to provide automatic control of pitch and yaw along the course prescribed by the glide path and localizer beams. Course, altitude and rate of change of altitude are automatically controlled. The controller grip is neutralized in yaw and pitch, and provides no manual control in either axis. Directional information is furnished to the automatic pilot by the localizer transmitter. Pitch information is furnished by the glide path transmitter. The roll channel remains engaged with neutralization provided by the controller grip spring centering on its axis.

**Localizer.** This position is used to intercept the localizer beam within 25 to 30 miles of the station. The controller hand grip is neutralized in the pitch and yaw axes, however the aircraft may be controlled in pitch by moving the controller grip out of neutral to the desired position. It will return to neutral when released. There is no manual control about the yaw axes, however controller grip action in roll is still usable in this mode of operation.

**Cruise.** When the switch is moved to the CRUISE position, the airplane will maneuver as called for by the position of the automatic pilot controller grip. If the airplane is maneuvering at the time the automatic pilot is engaged, it will continue in that attitude. Turning the grip in the yaw axis will give a coordinated turn that will be maintained until the grip is returned to the zero detent. The angle of bank is limited by the automatic pilot to approximately 70 degrees. A controlled rate of climb or dive up to 7,500 feet per minute may be made by moving the grip about the pitch axis. If it is desired to deviate from a set course by predetermined amounts up to 10 degrees, the course trim selector switch may be turned the required amount in the desired direction. The automatic altitude control may be engaged by moving the controller grip to the zero detent in the pitch axis and the airplane will then continue to fly at the existing altitude.

**Standby.** The STANDBY (center) position is provided to permit the synchronization of the autopilot with the airplane controls in the pitch and yaw axis and to keep the autopilot in readiness until needed. When the automatic pilot disengage switch (6 figure 1-21) located on the control stick grip is pressed, the automatic pilot will also be placed in standby operation. The automatic pilot must always be turned on with the mode selector switch in the STANDBY position in order to permit the rate gyros to reach speed and the electronic amplifiers to warm up. This warm up period requires at least 25 seconds after which the automatic pilot may be used in any position desired.

**Boost.** No automatic coordination nor outside control is furnished to the automatic pilot when the mode selector switch is in the BOOST position. The motion of the automatic pilot controller grip in this particular mode duplicates the action of the control stick and rudder pedals in one control to produce angular rates of change in the airplane attitude. Yaw, pitch, and roll will be entirely controlled by moving the controller grip. The BOOST mode is very effective for ground and flight check-out of the automatic pilot. It may also be used for rate damping in any one or more of the airplane axes, pitch, roll, or yaw, during straight and level flight in rough air.

**Radar.** This position may be used to couple the automatic pilot to the E-5 fire control system. Steering information from the fire control system is directed to the pitch and yaw rate gyros which in turn vector the aircraft automatically to its target. However the autopilot cruise to radar button is normally used to engage the automatic pilot with the E-5 fire control system with the mode selector switch in the CRUISE position.

### ILAS Indicator Light.

The ILAS indicator light will illuminate when the ILAS localizer and/or glide path receivers are turned on and are receiving signals and the automatic pilot is operating with the mode selector switch in the LOCALIZER or LOCALIZER AND GLIDE PATH positions.

### Automatic Pilot Controller Grip.

The automatic pilot controller grip is provided to control the aircraft manually, through the automatic pilot. The grip may be moved in the same manner as a ball in a socket, either fore and aft, clockwise or counterclockwise or tilted to the right and left. Movement of the controller grip operates the control surfaces through the automatic pilot allowing the pilot to fly the aircraft in a manner similar to the method used with conventional controls. Combinations of movements will result in maneuvers such as climbing rolling turns when the mode selector switch is in the BOOST position. Maneuvers are limited when the switch is in any other position. Detents are provided to identify the neutral position for pitch and yaw in the CRUISE mode only. The controller is spring loaded to the center position for roll.

### Automatic Trim Panel.

The automatic trim panel has three knurled knobs for trimming the autopilot circuits in roll, pitch and yaw and a boost-detent ON-OFF toggle switch. The trim knobs should be used only for making small, in-flight, corrections to the ground adjustments of the auto pilot, and not to maneuver the aircraft. The boost detent switch provides the pilot with an option of having neutral detents for the controller hand grip in the BOOST mode of operation. All other modes of operation have automatic provisions for neutralizing the controller hand grip.

### Autopilot Cruise-to-Radar Button.

This switch located forward of the canopy control switches (1 figure 1-15) is used to engage the autopilot to the radar steering error signals when the mode selector is in CRUISE position. This switch will only stay engaged as long as the mode selector is in CRUISE and the "on target" signal is present on the pilot's radar scope. An amber light in the knob of the switch will remain on as long as the switch is engaged. While this switch is engaged, yaw and pitch signals to control the autopilot are supplied by the E-5 fire control system through the radar coupler. During phases I and II of a radar attack, both pitch and yaw steering signals are supplied from the E-5 system. During phase III of radar attack, pitch signals only are furnished from the E-5 system and yaw signals are furnished from the radar coupler to return the plane to level flight prior to firing.

### Pitch Trim Indicator.

This indicator (26 figure 1-14), is located on the right forward panel below the oxygen cylinder pressure gage and indicates the relative automatic pilot force on the elevator. For completely smooth disconnects and optimum operation of the pitch channel of the autopilot, the airplane shall be trimmed in pitch manually (by the elevator trim tab thumb switch) to bring the needle of the pitch trim indicator as close as possible to zero.

### Automatic Pilot Disengage Switch.

The automatic pilot may be disengaged by pressing the button on the control stick grip (6 figure 1-21). This action simulates moving the selector switch to the STANDBY position. The indicator light will go out and the automatic pilot will remain in the standby condition, regardless of the position of the selector switch. The automatic pilot can be re-engaged, provided that the release button is not being held down, by returning the selector switch, momentarily, to STANDBY position, and then returning it to the desired position.

## W-3A AUTOMATIC PILOT OPERATION.

**Note**

- Hydraulic boost must be on for autopilot operation.
- Do not engage autopilot below 5,000 ft. or above 350 KIAS.
- If autopilot is used with afterburner, elevator boost must be in high ratio.

### Starting.

1. 2500 VA Inverter—2500 VA INVERTER.

(Allow 2 minutes for warm-up of 2500 VA Inverter):

2. Autopilot power switch—AUTOPILOT.
3. Trim aircraft manually for "hands off" straight flight.
4. Allow 30 secs. for warm-up after power switch is turned on.

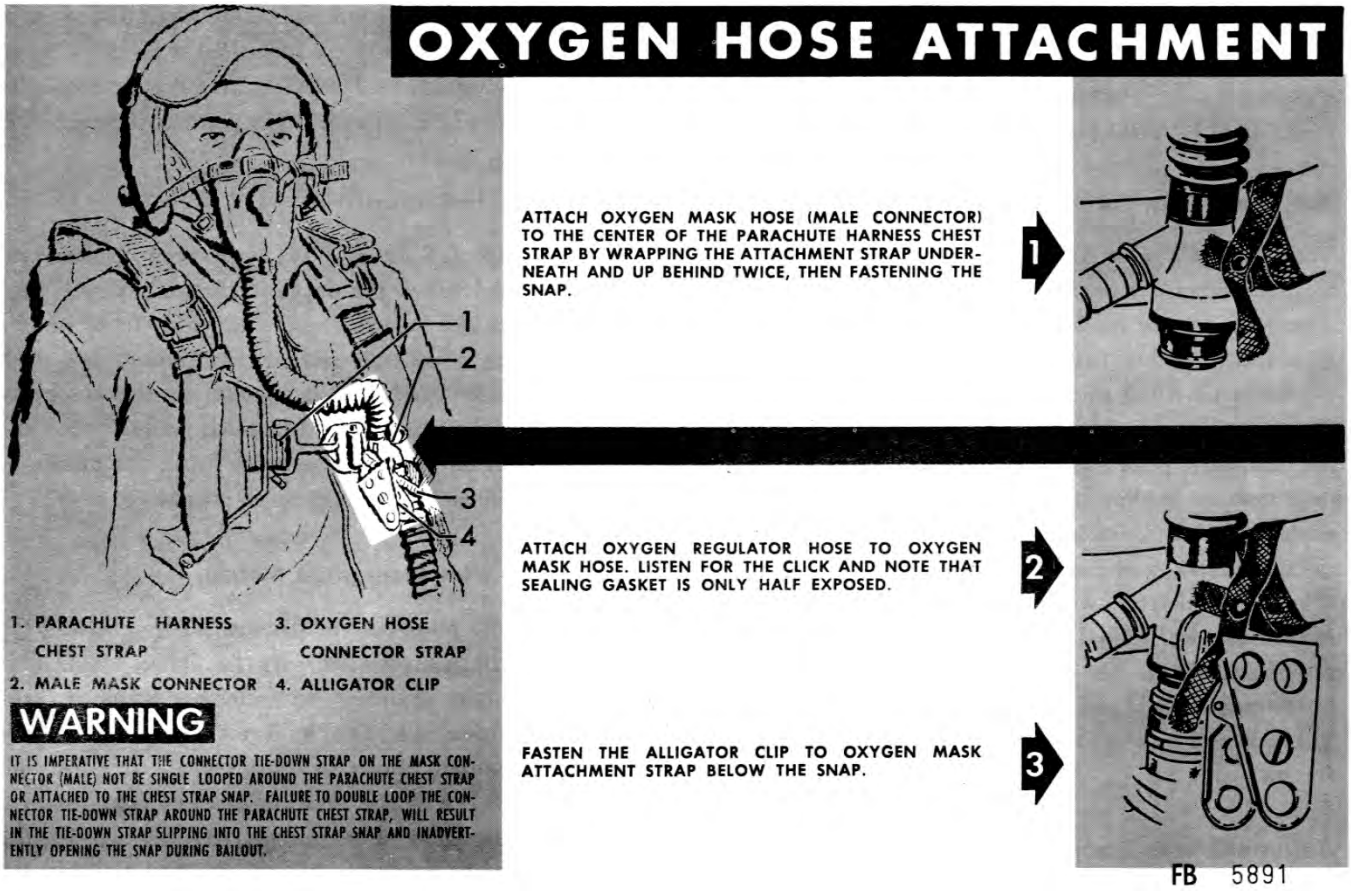



*Figure 4-14*

5. Check trim controls—NEUTRAL.
6. Channel selector switches — PITCH, ROLL, and YAW positions.
7. Mode selector switch—BOOST.
8. Check autopilot light—ON.

**Boost Mode Operation.**

1. Check mode selector switch—BOOST.
2. Flight controls should respond in direction and magnitude of controller grip movements. No automatic coordination of flight controls is provided.

**Trimming.**

1. Adjust roll trim control for wings level flight.
2. Adjust yaw trim control for course selection.
3. Adjust pitch trim control for minimum altitude engaging error. (Re-check trim by turning pitch switch off and on.)
4. Use normal elevator trim to maintain pitch trim indicator at ZERO $\pm 1/8$ inch.

**Cruise Mode Operation** (Normal operation).

1. Check controller grip—NEUTRAL.
2. Mode selector switch—CRUISE.
3. Re-trim autopilot as required for wings level flight.

**Note**

Do not adjust pitch and yaw trim in cruise mode.

4. Level flight—Autopilot should maintain heading and altitude when controller grip is in pitch, bank, and yaw detents (NEUTRAL).
5. Turns—Autopilot should produce coordinated turns when controller grip is rotated about yaw axis.

6. Climbs and descents—Autopilot should produce rate climbs or descents when controller grip is rotated about pitch axis.
7. Trim—Use normal elevator trim to maintain pitch trim indicator at ZERO $+\frac{1}{8}$ inch.

**Note**

Autopilot trim controls should not be used to maneuver aircraft.

8. Course trim operation—Move course trim knob right or left for small course changes.

**Disengaging.**

**CAUTION**

Trim for pitch trim indicator reading of zero $\pm\frac{1}{8}$ inch prior to disengaging autopilot.

1. Controller grip—NEUTRAL.
2. Depress disengage button on stick.
3. Mode selector switch—STANDBY.
4. Channel selector switches (pitch, roll, and yaw) PITCH, ROLL, and YAW positions.
5. Trim controls (pitch, roll, and yaw)—NEUTRAL.
6. Autopilot power switch—OFF.

**RADAR COUPLER OPERATION.**

By using autopilot radar coupler, automatic tracking provides greater steering accuracy during Phase I and Phase II of the attack.

1. Autopilot must be turned on, trimmed and in CRUISE mode as described previously.
2. After the attack display has appeared on the pilot's scope, push the AUTOPILOT CRUISE-TO-RADAR button.

**Note**

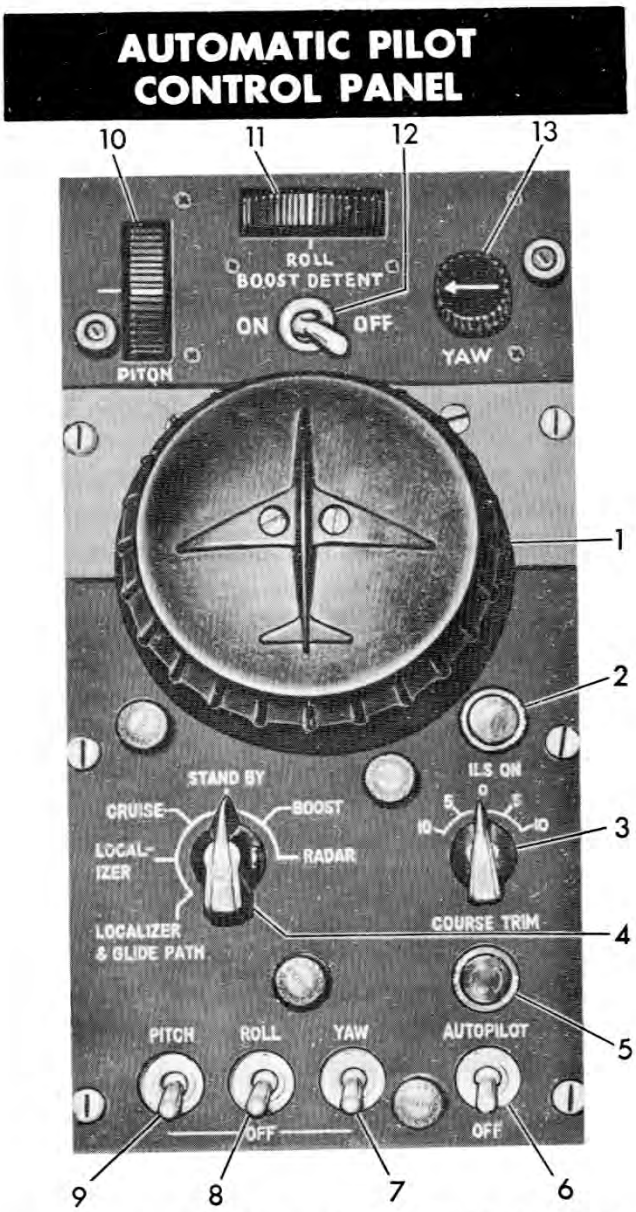
- The automatic tracking system can be engaged at large azimuth and elevation errors without danger of producing excessive accelerations. However, a large error signal applied to the autopilot at high altitude may result in a partial stall. Therefore, in this case, automatic tracking should not be engaged until after the error signal has been considerably reduced by manual steering. Initial E-5 error signal after target lock-on may be erratic and will cause uncomfortable airplane reaction therefore, the intercept should be allowed to progress to Phase II before engaging coupler. During all autopilot radar coupled operation, bank is limited to approximately 70°.
- If the radar lock-on should be broken either accidentally or to unlock from altitude line or chaff, the CRUISE-TO-RADAR button will automatically be released and the autopilot will control the airplane in cruise mode at the existing altitude and heading. Automatic tracking must be re-engaged after target lock-on has been re-established. Where the radar has locked on the altitude line, the airplane may nose up or down before the R.O. breaks the lock. In this case the pilot should disengage radar control immediately by pulling the CRUISE-TO-RADAR button, or by using the autopilot emergency disconnect button. Once the system has been disengaged by the latter method, the mode selector switch should be returned to STANDBY and then to CRUISE mode of operation before returning to automatic tracking.

3. To permit the radar to fire the rockets automatically, the AUTOMATIC RADAR ROCKET FIRING switch should be used in lieu of the trigger switch on the control stick, to avoid interference with autopilot operation.
4. When rockets have fired, the CRUISE-TO-RADAR button is automatically released and the autopilot will control the airplane in cruise mode at the existing altitude and heading.

**CAUTION**

Pilot must be prepared to accomplish "break" maneuvers by using autopilot controller knob.

5. If for some reason autopilot CRUISE mode of operation is inoperative but BOOST mode is functioning properly, automatic tracking can be engaged by placing the autopilot mode selector switch from BOOST to RADAR position. Under this condition, if radar lock-on is lost or attack is completed, the aircraft returns to straight level flight until lock-on is re-established or mode selector is returned to BOOST or STANDBY.




1. AUTOMATIC PILOT CONTROLLER GRIP
2. ILS INDICATOR LIGHT
3. COURSE TRIM SELECTOR
4. MODE SELECTOR SWITCH
5. AUTOMATIC PILOT INDICATOR LIGHT
6. AUTOMATIC PILOT POWER SWITCH
7. YAW CHANNEL SELECTOR SWITCH
8. ROLL CHANNEL SELECTOR
9. PITCH CHANNEL SELECTOR SWITCH
10. PITCH TRIM CONTROL
11. ROLL TRIM CONTROL
12. BOOST DETENT SWITCH
13. YAW TRIM CONTROL

*Figure 4-15*

## AUTOMATIC APPROACH EQUIPMENT.

The autopilot may be used in conjunction with the localizer and glide-path receivers to automatically control the heading, altitude and descent of the aircraft during ILAS approaches. Refer to the W-3A Automatic pilot discussion in this section and Section IX for description of the automatic approach provisions and procedures.

## NAVIGATION EQUIPMENT.

### DIRECTIONAL INDICATOR.

The J-2 directional indicator system consists fundamentally of a directional indicator on the instrument panel (18 figure 1-7), a gyro control, an amplifier and a transmitter. Compass heading is indicated by a single pointer on the directional indicator. 28-volt d.c. as well as 115-volt a.c. (instrument inverter power) is necessary for proper operation of the directional indicator system. An instrument interlock mechanism insures simultaneous application of a.c. and d.c. power, which is a primary requirement of the system. If d.c. is interrupted, the gyro will be sent into a fast slaving cycle and the indicator will be unreliable for approximately 2½ minutes. Therefore, the a.c. and d.c. circuits have been made independent of each other after power is initially applied through the interlock mechanism so that there will be no interruption of d.c. and subsequent fast slaving in the event of a.c. interruption. This permits changeover from one inverter to the other without sending the gyro into a fast slave cycle. After power is applied, the system requires a warm-up period of approximately 2½ minutes before it is ready for use. When the gyro has reached operating speed, the reading of the directional indicator should be checked against the standby compass to make sure that the needle does not show a 180° ambiguity. If the ambiguity is present, the system is not functioning properly.

#### Fast Slave Button.

A fast slave button has been provided on the right hand auxiliary switch panel (2 figure 1-15) of some aircraft. The purpose of this switch is to quickly bring the indicator to the correct heading if the gyro tumbles because of acrobatics or other airplane maneuvers. Pushing the fast slave button momentarily disrupts d.c. power to the amplifier and starts a fast slaving cycle as in initial starting. In the event the fast slave button does not accomplish its desired function, pull out the gyro compass circuit breaker on the right upper circuit breaker panel (22 figure 1-14) then reset it. This will interrupt d.c. power and send the gyro into a fast slave cycle.

**CAUTION**

- The fast slave button is placarded against using more than once in ten minutes, as more frequent use will cause damage to the erection mechanism.
- It is imperative that heading and airspeed remain constant and a level attitude be maintained as long as the indicator system is in fast slave. If take-off is started or turns made while the gyro is in the fast slave cycle, a 20°-40° error will be introduced immediately.

## ARMAMENT.

The primary armament of the aircraft consists of forty-eight 2.75 inch FFAR rockets. Twenty-four rockets may be carried in closed breach launching tubes in the nose of the aircraft, and twelve each in rocket pods on each wing (7 figure 1-2). Rocket firing is normally controlled automatically by the E-5 rocket-firing control system employing radar tracking and computing combined with a rocket firing computer. A standby fixed optical gun sight is provided for rocket firing in the event of radar system malfunction. A camera is installed in the nose compartment of the aircraft to record the accuracy of a rocket-firing strike.

### BOMBING EQUIPMENT.

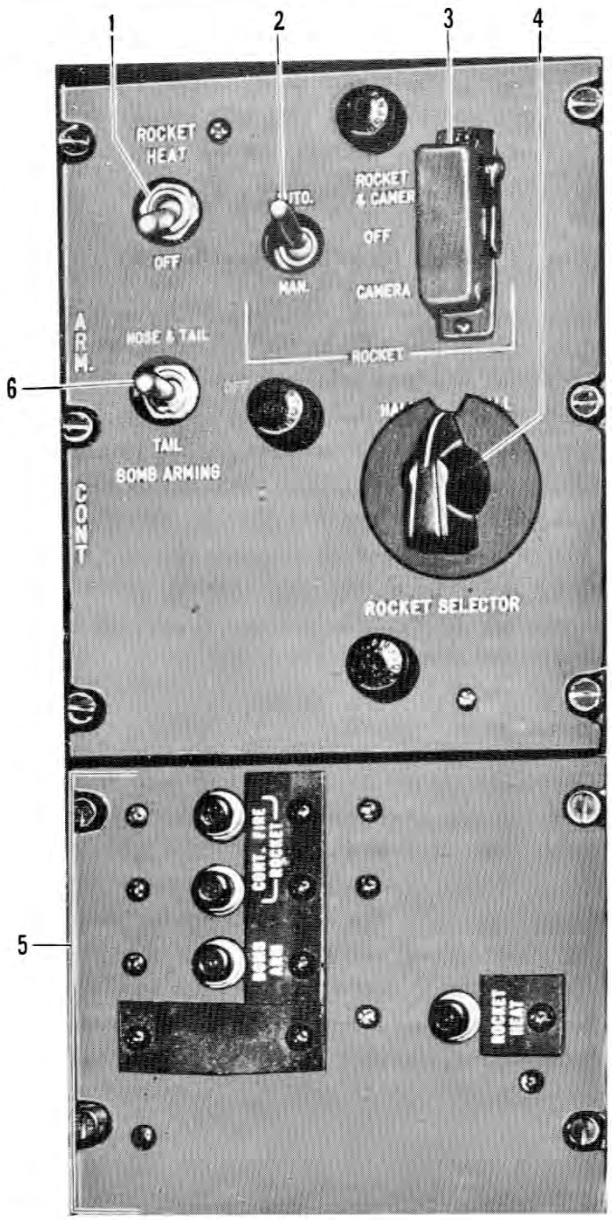
Provisions are included in the wing pylons to mount, arm, and drop two bombs weighing up to 1000 pounds each. The bomb arming switch (6 figure 4-16) located on the armament control panel may be used to arm the TAIL or NOSE and TAIL of the bombs. No bomb sight is provided. The bombs may be released by moving the pylon tank release arming switch (9 figure 1-6) to the ARM (forward) position and then pressing the external tank release button (8 figure 1-21) located on the control stick grip. The bombs may also be released electrically with the tip tanks by pressing the tank jettison switch (5 figure 1-13).

### ROCKET EQUIPMENT.

#### Rocket Doors.

The nose section rocket launching tubes are exposed prior to rocket firing by the opening of four circumferential doors hinged at the forward end and operated by the aircraft hydraulic system. The doors are opened or closed simultaneously by hydraulic pressure directed to an individual actuating cylinder for each door. The

## ARMAMENT CONTROL PANEL




1. ROCKET HEAT SWITCH
2. ROCKET FIRING SELECTOR SWITCH
3. ROCKET ARMING SWITCH
4. ROCKET SALVO SELECTOR SWITCH
5. CIRCUIT BREAKER PANEL
6. BOMB ARMING SWITCH

*Figure 4-16*

flow of hydraulic fluid is controlled by a spring-loaded closed solenoid valve which is opened when the trigger is squeezed with the rocket firing circuit armed. An automatic time delay prolongs closing of the doors for three seconds after the trigger is released. A contact switch on each door is installed to prevent rockets being fired from any tubes aligned with a rocket door which is not fully opened.

**Note**

Opening the rocket doors causes a rumbling noise and vibration, especially evident at high speeds, which should not be confused with engine noise or vibration.

### Ground Rocket Door Opening Switch.

Because of the remote possibility of a dud rocket firing after a rocket firing flight, the ground rocket door opening switch has been relocated from the nose section to the forward cockpit on modified airplanes. This allows operation of the doors without ground personnel being adjacent to the nose section. The switch may be actuated by the pilot when it is necessary that ground maintenance crews inspect for evidence of a dud rocket. The switch is located on the right auxiliary panel below the canopy sill (5 figure 1-15), and is guarded to prevent inadvertent actuation.

### Rocket Pods.

Two rocket pods, one attached to each wing leading edge, are equipped with twelve rocket tubes each. The rocket pod nose is constructed of a plastic material which is shattered by the rocket exhaust gasses when rockets are fired. The controls used for the nose compartment rockets are also used for the pod rockets. Salvos of six or twelve rockets from each pod may be fired manually or automatically, in conjunction with a corresponding number of twelve or twenty-four nose compartment rockets.

### Rocket Heating.

Some rockets are extremely heat sensitive and must be maintained at the proper temperature in order to attain maximum accuracy. For this reason, the rocket tubes are covered with insulated electric heating elements energized by 115-volt a.c. from the 8 KVA alternator. Power to the heating elements is controlled by the switch on the armament control panel, and should be applied to the rocket tube heaters prior to take-off whenever heat sensitive rockets are carried.

### Rocket Controls.

**Rocket Heat Switch.** The rocket heat switch (1 figure 4-16) is located on the armament control panel, and has two positions, ROCKET HEAT (forward) and OFF. When the 8 KVA alternator power is available and the rocket heat switch is in the ROCKET HEAT position, power is supplied to the rocket tube heaters.

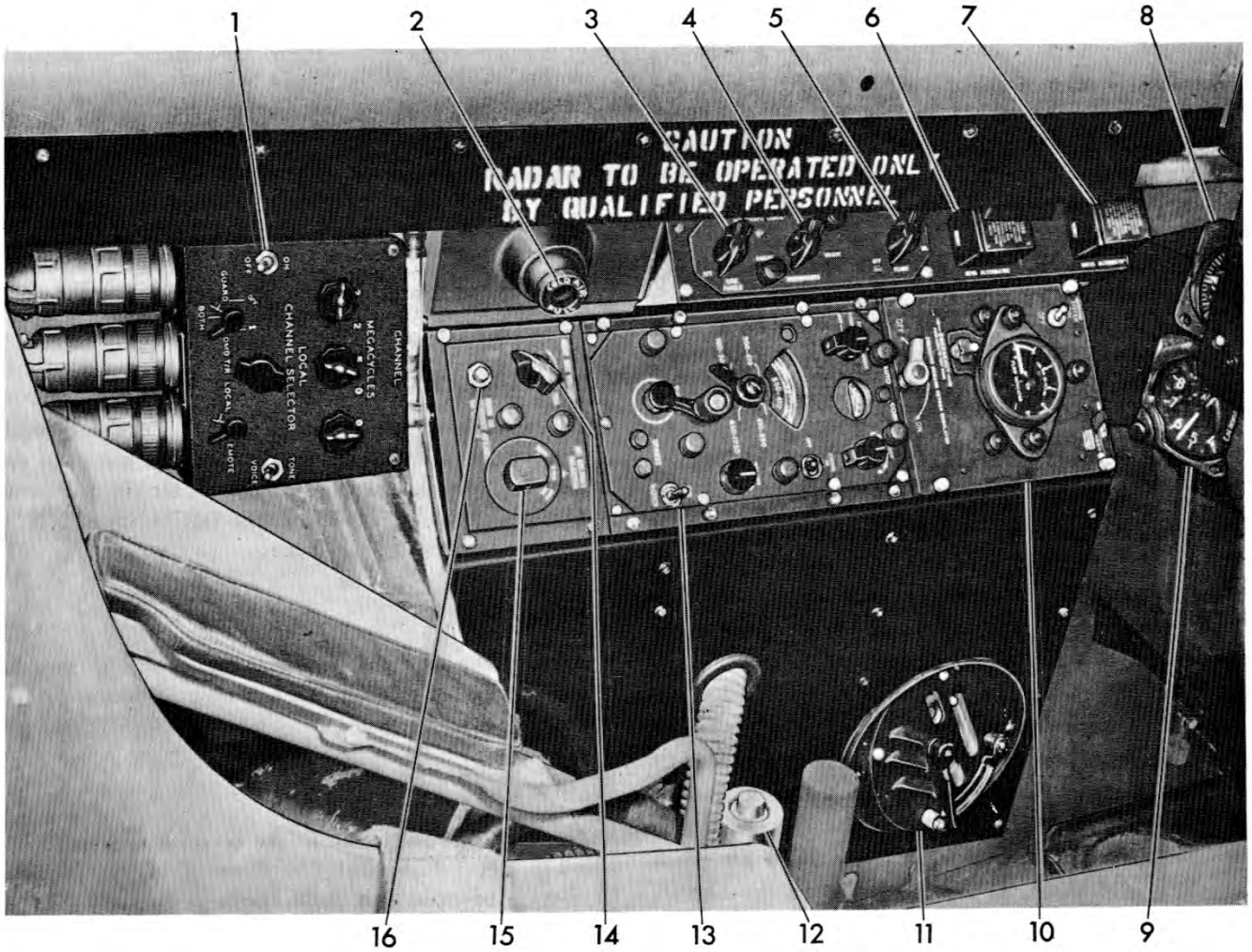
**Rocket Firing Selector Switch.** This switch (2 figure 4-16) has two positions: AUTO and MAN. When the switch is in the AUTO position, the rockets will be automatically fired by the radar equipment when the airplane is on the correct course for a successful attack and the trigger has been been squeezed. When the switch is in the MAN. position the rockets will be fired when the control stick trigger is squeezed to the second position. Also, when the switch is moved to the MAN. position, the reticle of the fixed gunsight will be illuminated and the radar will not lock on.

**Rocket Arming Switch.** The rocket arming switch (3 figure 4-16) has ROCKET and CAMERA, OFF, and CAMERA positions and is guarded to the OFF position. This switch arms the circuits to the rocket and camera or camera only so that the circuits to the respective equipment are energized when the trigger is squeezed.

**Rocket Salvo Selector Switch.** The rotary type rocket salvo selector switch on the armament panel (4 figure 4-16) has two positions labeled HALF and ALL. When the switch is placed in the HALF position and the trigger is squeezed, half the rocket load will be fired provided the firing circuit has been armed. If it is desired to fire the remaining rockets while the salvo selector is in the HALF position, the trigger must be released and squeezed again. When the selector switch is in the ALL position all the rockets will be fired when the trigger is squeezed. On earlier airplanes this switch is a two position toggle switch labeled 2 and 4 instead of HALF and ALL.

**Trigger.** The trigger (7 figure 1-21) is located on the control stickgrip and operates two switches in sequence as the trigger is squeezed (or released). The first switch operates the camera and when the rockets are being fired manually it also opens the solenoid valve that releases hydraulic pressure to operate the rocket doors. The second switch fires the rockets when the rocket firing selector switch is in the MAN. position or arms the circuits so that the doors will open and the rockets

# RADAR OBSERVER'S COCKPIT, LEFT SIDE




1 AN/ARC-27 COMMAND RADIO MASTER CONTROL UNIT (ON SOME AIRPLANES--RELOCATED TO PILOT'S COCKPIT AFT LEFT SIDE)

2 VENTILATING AIR INLET

3 SIDE PANEL LIGHTS RHEOSTAT

4 INSTRUMENT LIGHTS RHEOSTAT

5 FLOOD LIGHTS RHEOSTAT

6 8 KV.A. ALTERNATOR VOLTAGE ADJUSTING RHEOSTAT

7 30 KV.A. ALTERNATOR VOLTAGE ADJUSTING RHEOSTAT

8 AIRSPEED INDICATOR

9 ALTIMETER

10 OXYGEN REGULATOR CONTROL PANEL

11 COCKPIT PRESSURIZATION AIR INLET

12 ANTI-G SUIT VALVE

13 RADIO COMPASS CONTROL PANEL

14 HEADSET VOLUME CONTROL

15 A.C. VOLTMETER SELECTOR

16 COMMAND RADIO MICROPHONE BUTTON

*Figure 4-17*

will be fired by the radar equipment at the proper time when the rocket firing selector switch is in the AUTO position. In both cases (AUTO and MAN. firing), the trigger must be fully depressed for the rockets to fire and the rocket arming switch must be in the proper position for the trigger to be operative.

**Automatic Radar Rocket Firing Switch** (Modified Airplanes). This switch is located on the armament control panel and is used in lieu of the trigger switch to permit the radar equipment to fire the rockets during an autopilot controlled attack when the rocket firing selector switch is in the AUTO position. The AUTOMATIC RADAR ROCKET FIRING SWITCH will not fire the rockets when the rocket firing selector switch is in the MAN. position. This switch must be held in the momentary ON position until the rockets are automatically fired.

## SINGLE POINT REFUELING EQUIPMENT.

All the aircraft fuel tanks with the exception of pylon tanks, may be refueled through a single-point filler well located on the left side of the nose section (1 figure 1-27). During the refueling process fuel under high pressure (up to 50 psi) enters the single point filler well and is directed to the internal tanks and the tip tanks through the normal fuel transfer lines (see figure 1-16). If the external tank fuel selector switch is in the PYLON FUEL position, the valve in the tip tank fuel transfer line will be closed and the tip tanks cannot be refueled from the single point filler. There are no other controls in the cockpit to regulate single point refueling, and there are no provisions on the aircraft for aerial refueling. The internal tanks and tip tanks may be de-fueled through the single point filler well.

## MISCELLANEOUS EQUIPMENT.

### ANTI-G SUIT EQUIPMENT.

Air pressure for inflation of the pilot's and radar observer's anti-G suits is provided by the engine compressor. Individually controlled pressure regulating valves operate at a predetermined number of G's, depending upon the setting of the pressure regulator valve.

#### Anti-G Suit Pressure Regulator Valves.

The anti-G suit pressure regulating valves (21, figure 1-11 and 12, figure 4-17) are located on the left sides of the pilot's seat and the radar observer's seat. The regulator valves are marked HI and LO. When a valve is turned to the HI position, suit pressurization begins at 1.5 G and increases at the rate of 1.4 psi per G. At the LO setting, suit pressurization begins at 1.7 G and increases at the rate of one psi per G. A button on top of the valve can be manually depressed to inflate the suit momentarily when desired. This feature may be used to massage the body and thus lessen fatigue on a long flight. Air pressure outlet connections are provided on the left sides of the pilot's and radar observer's seats for attachment of the anti-G suit tube.

### WINDSHIELD WIPER.

On some aircraft a windshield wiper is installed to remove excessive moisture during low speed operations or while taxiing out to perform a mission during rainy weather.

#### Windshield Wiper Switch.

The windshield wiper switch is a four position rotary type switch powered by the 28-volt d.c. electrical system, mounted at the base of the center control panel. The positions are PARK, OFF, HIGH and LOW to provide selective wiper speeds.

### DATA CASE.

An airplane data case is located in the nose compartment accessible through the left nose section armament door.

### MAP CASE.

The map case is located in the forward cockpit on the lower right side panel (20 figure 1-14) to facilitate stowage of maps and publications.

### CHECK LIST.

A pilot's check list is mounted on the front cockpit instrument panel (30 figure 1-7).

### RELIEF TUBE.

A relief tube is supplied in each cockpit located on the floor.

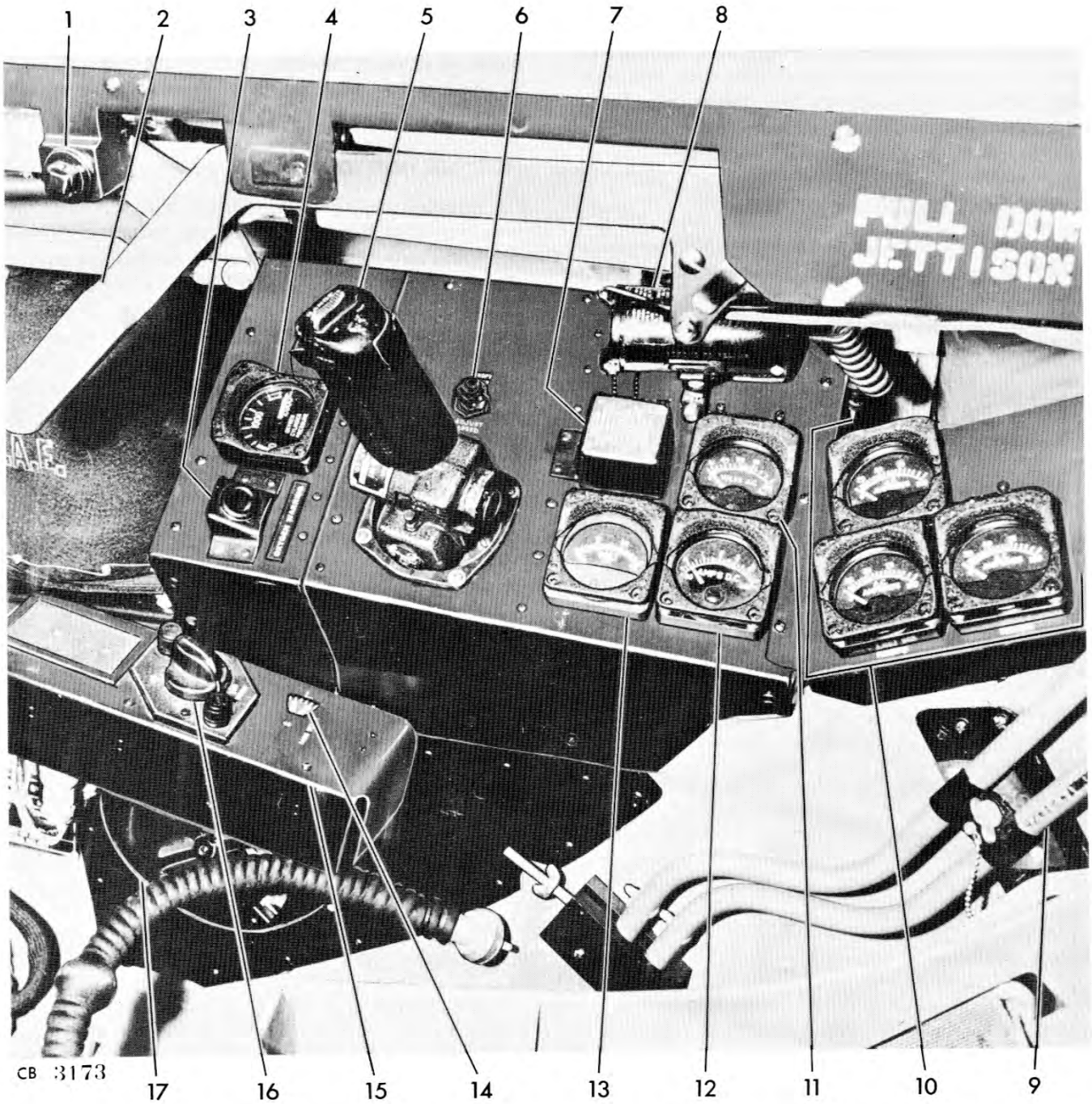
### SURFACE CONTROL LOCK.

The surface control lock is stowed in clips on the floor to the right of the pilot's seat. On some airplanes it is stowed on the right hand side panel in the aft cockpit.

### REAR VIEW MIRROR.

A rear view mirror is installed in the front cockpit on the left windshield sill.

# RADAR OBSERVER'S COCKPIT, RIGHT SIDE




1. CANOPY LOCKING HANDLE CONNECTION
2. CANOPY JETTISON LEVER
3. OXYGEN WARNING LIGHT
4. OXYGEN CYLINDER PRESSURE GAGE
5. RADAR ANTENNA CONTROL
6. CANOPY MOTOR SPEED ADJUSTMENT
7. GENERATOR VOLTAGE ADJUSTING RHEOSTAT
8. TYPE C-4A SPOTLIGHT
9. SURFACE CONTROL LOCK (STOWED)
10. WING AND EMPENNAGE DE-ICER SYSTEM AMMETERS
11. A.C. VOLTMETER
12. D.C. AMMETER
13. D.C. VOLTMETER
14. AIRPLANE BASIC WEIGHT POTENTIOMETER
15. AIRPLANE LOAD ADJUSTER
16. FUEL WEIGHT POTENTIOMETER
17. COCKPIT PRESSURIZATION AIR INLET

*Figure 4-18*

## AIRPLANE LOAD ADJUSTER (RADAR).

This control box (15, figure 4-18) is located on the right side of the radar observer's cockpit and contains two potentiometers that are used in conjunction with the radar equipment. One potentiometer must be set to the airplane basic weight by means of a screwdriver. The other potentiometer is hand adjustable and must be set to the existing airplane fuel weight immediately before an attack is made using radar. This feeds weight information to the angle of attack computer.

## RADAR PRESSURIZATION SYSTEM.

Components of the radar power supply are pressurized to reduce electrical arcing. Air is taken from the pilot's cockpit, passed through a silica gel dehydrator then to an electric motor-driven dry air pump. The pressurized air is then distributed to the radar equipment.

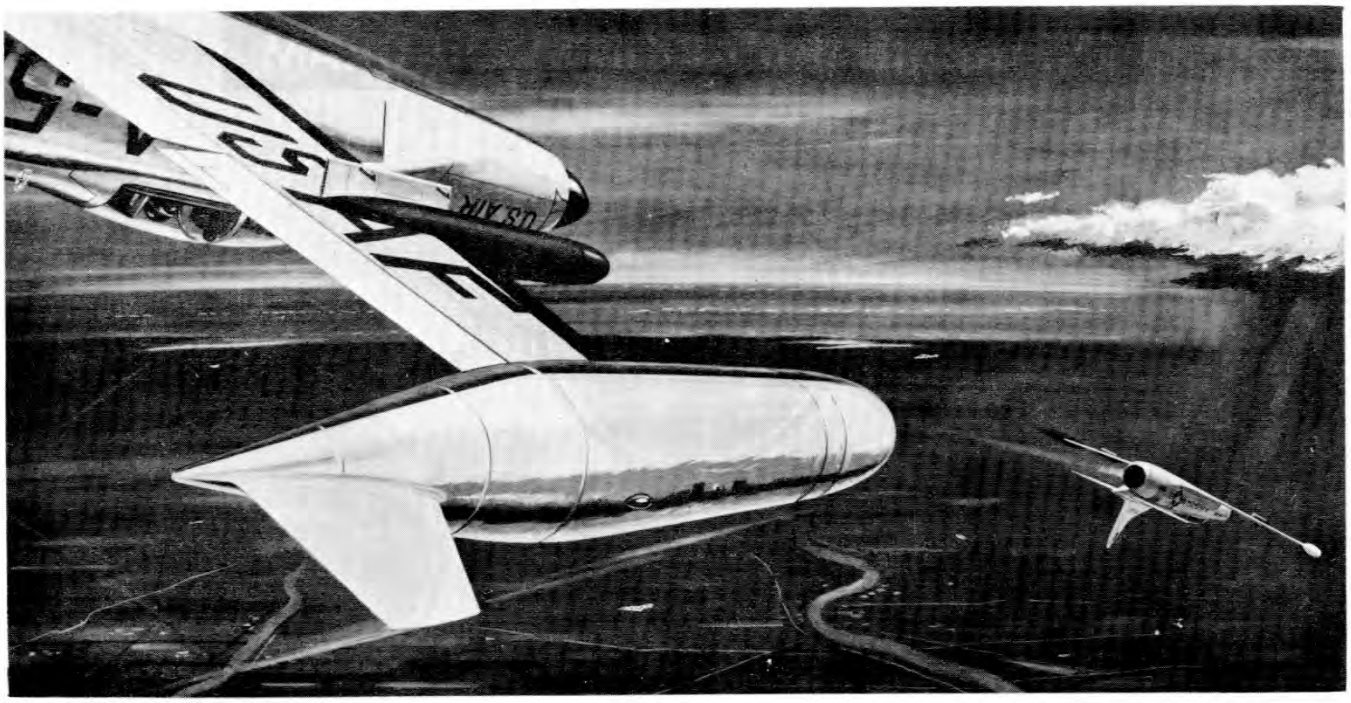
### Radar Pressurization Switch.

The radar pressurization is controlled by the switch located on the radar console that has three positions: MANUAL, OFF, and AUTOMATIC. When the radar equipment is being used, the switch should be in the AUTOMATIC position. While in that position an altitude-compensated pressure-actuated switch senses the line pressure and maintains it at 14.7 psi. When the switch is in the MANUAL position the pressure must be controlled by reference to the pressure gage located on the radar console.

## NOSE SECTION COOLING BLOWER.

On modified airplanes a blower has been added in the nose section to circulate air over the radar low voltage power supply unit. The blower obtains its power through the 2500 VA inverter bus and the circuit is interconnected with the right landing gear down-lock switch. When the 2500 VA inverter and battery master switch are on the landing gear is down and locked the blower will automatically operate. Upon take-off the blower will be automatically shut off when the landing gear begins to retract.

Last Page of Section IV



# operating limitations

SECTION V

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## INTRODUCTION.

Operating limitations are derived from design limits, extensive flight testing, and operational experience to insure your safety and still obtain maximum utility from the airplane and its equipment. The instrument dials are marked as shown on figure *5-1* as a constant reminder of limitations that are not necessarily covered in the text. Additional limitations are given in the following illustrations and paragraphs.

## MINIMUM CREW REQUIREMENTS.

The minimum crew requirement for this airplane is one pilot in the front cockpit. An additional crew member as required will be added at the discretion of the Commander.

## ENGINE LIMITATIONS.

All normal engine limitations are shown in figure *5-1*.

### ENGINE SPEED.

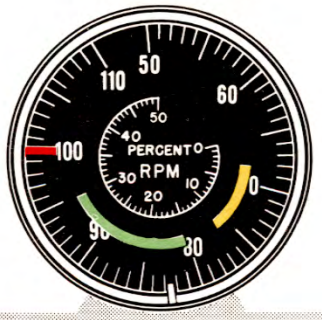
a. Engine rpm tolerance is 98½% to 101½%.

b. Overspeeding between 101.5% to 103.5% for any length of time will require turbine wheel inspection to determine engine serviceability.

c. If engine rpm exceeds 103.5% rpm, the engine is to be rejected and sent to overhaul. Proper notation must be entered in DD form 781.

# INSTRUMENT MARKINGS DIAGRAM

## TACHOMETER

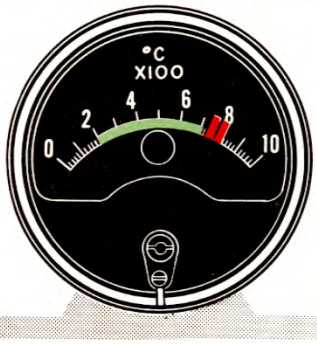



- 68-76% rpm—AVOID STEADY OPERATION IN THIS RANGE EXCEPT WHEN NECESSARY ON ILS APPROACHES
- 81-95% rpm—NORMAL CRUISE
- 100% rpm—MAX. ALLOWABLE

## AIR SPEED

- 205 KNOTS IAS — FULL FLAPS. 215 KNOTS IAS — LANDING GEAR EXTENDED.
- 550 KNOTS IAS — MAXIMUM, OR SPEED WHERE ROLL-OFF BECOMES EXCESSIVE.
- THE INSTRUMENT SETTING IS SUCH THAT THE WHITE POINTER WILL MOVE TO INDICATE THE BEST CLIMB SPEED WITHOUT AFTERBURNER (315 KNOTS AT SEA LEVEL).

## TAIL PIPE TEMPERATURE




| | | |
|---|---|---|
| | 200°-705°C | CONTINUOUS OPERATION |
| | 705°-760° | LIMITED OPERATION (SEE PARAGRAPH 7-10) |
| | 780°C | MAX. FOR 5 MINUTES |
| | 800°C | MAX. ALLOWABLE DURING ACCELERATION FOR 5 SECONDS |
| | 780°C | MAX. DURING STARTING |

## HYDRAULIC PRESSURE

- 1250 — 1750 psi — NORMAL
- 1750 psi — MAXIMUM

**BASED ON MIL-F-5624A FUEL (GRADE JP-4)**

## OIL PRESSURE

- 10 psi — MINIMUM
- 10 — 45 psi — CONTINUOUS OPERATION
- 45 psi — MAXIMUM

## ACCELEROMETER

- 8.67 G—MAXIMUM WITH OR WITHOUT TIP TANKS
- —3.00 G—MAXIMUM WITH OR WITHOUT TIP TANKS

*Figure 5-1*

### ENGINE EXHAUST TEMPERATURE.

The following engine exhaust temperature limits must not be exceeded:

a. 780°C during a start.

b. 800° (or in excess of 800°C for 5 seconds) during acceleration.

c. 750° during run-up on the ground (with or without afterburner).

d. Operation in flight with a tailpipe temperature of 780°C is limited to five minutes with or without afterburner.

e. Operation at 100% rpm in flight with a tailpipe temperature of 760°C is limited to fifteen minutes with afterburner.

f. Operation at 100% rpm in flight with a tailpipe temperature of 760°C is limited to 30 minutes operation without afterburner.

g. Avoid steady operation between 68% and 76% except when absolutely necessary. A high frequency vibration is set up in the engine in this rpm range, and continued operation between 68% and 76% rpm can cause engine damage.

## AFTERBURNER LIMITATIONS.

Do not turn the afterburner on until the engine has reached 95-100% rpm except on a go-around or take-off where the afterburner may be turned on after reaching 60% rpm.

## AIRSPEED LIMITATIONS.

### WITH OR WITHOUT TIP TANKS INSTALLED.

No Mach number limitation is imposed on the airplane with or without tip tanks. However, the airspeed limitation at any altitude is 550 knots IAS, or airspeed where roll-off becomes excessive.

### PYLON TANKS INSTALLED.

Do not exceed 0.82 Mach number or 440 knots IAS, whichever is encountered first, with pylon tanks installed.

### LANDING GEAR EXTENSION SPEED.

Limit airspeed for landing gear extension is 215 knots IAS. If the landing gear is extended in excess of 215 knots IAS, the air loads may damage the fairing doors, or operating mechanism.

### WING FLAP LOWERING SPEED.

If the following limitations are exceeded, the aircraft structure may be damaged:

45° (full down) — 205 knots IAS

23° (half down) — 215 knots IAS

11° (fourth down)—245 knots IAS

### SPEED BRAKE EXTENSION SPEED.

The speed brakes may be extended at any speed.

### TANK JETTISON SPEEDS.

Centerline mounted wing tip tanks (250 gallons) equipped with a spring ejection cartridge may be jettisoned at any speed up to 391 knots IAS. Above 391 knots IAS, tip tanks should only be jettisoned in cases of extreme emergency. At speeds above 391 knots IAS there is a possibility of minor damage to the wing tip and aileron during tip tank jettisoning. The pylon tanks can be safely jettisoned when full or empty in the climb or cruise speed range of the aircraft. However, pylon tanks with a partial fuel load should not be jettisoned except in an emergency. If it becomes necessary to jettison partially filled pylon tanks, the aircraft should be placed in a slight climb (nose-up) attitude at airspeeds not in excess of 325 knots IAS.

### CANOPY OPENING SPEED.

Never unlock the canopy in flight.

## PROHIBITED MANEUVERS.

### INVERTED FLIGHT.

Inverted flying or any maneuver resulting in prolonged negative acceleration will result in engine flame-out as a result of fuel starvation.

### VERTICAL STALLS.

Vertical stalls are prohibited. See Section VI for flight characteristics.

### INVERTED SPINS.

Inverted spins are prohibited. See Section VI for flight characteristics.

### AEROBATICS WITH PYLON TANKS.

All aerobatic maneuvers are prohibited when pylon tanks are installed. Pylon tanks should be jettisoned before entering combat.

## ACCELERATION LIMITATIONS.

### MAXIMUM ACCELERATION.

Maximum allowable acceleration for symmetrical maneuvers are plus 8.67 G's and minus 3.0 G's for all airplane configurations except with pylon tanks on. The maximum allowable positive acceleration with full pylon tanks installed is plus 3.85 G's. Maximum allowable accelerations for rolling pullouts are plus 5.78 G's and minus 1.0 G for all airplane configurations except with pylon tanks on. Rolling pullouts are not allowed with pylon tanks installed. The maximum positive load factor in a roll with full pylon tanks installed is plus 1.0 G at 118 degrees per second roll rate.

**Note**

Limitations and restrictions with pylon tanks installed are subject to change and latest service directives and orders must be consulted.

The Operating Flight Limits diagram (figure 5-2) shows the acceleration and airspeed limitations graphically for the airplane with or without tip tanks. The black line shows accelerated stall speeds and the green lines the maximum speed for a given G and altitude. It can be seen that there is no possibility of exceeding the limit positive acceleration of plus 8.67 G except at altitudes below approximately 10,000 feet. This is because inherent characteristics of the airplane prevent load factors greater than shown. In addition, airplane speed capabilities preclude the possibility of exceeding the speed limitation of 550 knots IAS above this altitude. This means maximum effort pull-ups may be made under any condition of airspeed and altitude above 10,000 feet without danger of exceeding any structural limit. Below 10,000 feet, limit load factor may be attained only in the 400 to 500 knot IAS speed range. The irregular shape of the curves at high altitude is due to Mach number effects on the airspeed system.

**Note**

These limitations and restrictions are subject to change and latest service directives and orders must be consulted.

## CENTER OF GRAVITY LIMITATIONS.

The curves in figure 5-3 show the CG travel weight change as fuel and/or armament are added or consumed. Starting with the empty weight condition, the CG moves forward with the addition of pilot, radar observer, engine oil, etc. The most forward CG is obtained with all rockets and no fuel, while the most rearward is obtained with full internal fuel, empty tip tanks and 1,000 pound bombs mounted on the pylons. Firing or the omission of a full load of nose rockets moves the CG position aft 8% with no fuel load and about 5% with full fuel load. Firing the pod rockets causes a rearward shift in CG position but not as great as that caused by firing the nose rockets. Dropping two 1000 pound bombs from the pylons shifts the CG forward about 0.5%. The addition or consumption of tip tank and pylon tank fuel and dropping the tip tanks and/or pylon tanks causes a negligible change in CG position, as does extension of the landing gear. Use of internal fuel moves the center-of-gravity forward 1½% to 3%, depending on the initial center-of-gravity position. The airplane's basic stability is affected by movements of the CG within the limits shown. An extreme forward CG is a stable condition that requires a greater stick force or higher elevator boost ratio per G. An extreme rearward CG is a less stable condition that is manifested by lighter control stick forces per G and the airplane should be flown at a lower elevator boost ratio. Since there is no in-flight control of CG position other than the normal expenditure of rockets and release of external loads, it is necessary to refer to the Handbook of Weight and Balance Data AN 01-1B-40 for weight and balance information prior to flight.

## WEIGHT LIMITATIONS.

### LANDING.

If possible, the maximum landing gross weight should be limited to that with full tip tanks. The reason is that an aircraft is designed structurally to accommodate a hard landing only at normal landing gross weight. At gross weights greater than normal landing weight, the rate of sink at touchdown must be controlled proportionally to avoid a hard landing in which gear strength might be exceeded. When landing with fuel in the underwing pylon tanks, there is the added fire hazard in the event the gear collapses due to an excessively hard landing in this gross weight condition. Therefore, this condition should be avoided, if possible, by jettisoning the pylon tanks prior to a heavy weight landing.

**CAUTION**

- If a landing must be made with fuel in the pylon tanks, adhere closely to the proper airspeed and maintain as low a rate of sink as possible at touchdown.
- Do not attempt to land with one tip tank full and the other empty, except in an emergency such as being unable to jettison the tanks, as the wing with the full tip tank will be very heavy and extremely difficult to hold up at low airspeeds. Refer to instructions in Section III for procedure to be followed when it is necessary to land with an asymmetrical tip tank loading.

## ROCKET FIRING LIMITATIONS.

For purposes of operational training, the maximum number of rockets that may be fired from the nose compartment at one time is limited to 12 at altitudes above 25,000 feet. The rocket exhaust gases can cause an increase in engine inlet air temperature and a corresponding decrease in air density which may adversely affect engine operation. A fuel metering compensator is provided to prevent this, however, the possibility of compressor stall, over temperature and flameout still exists especially at engine speeds above 96% rpm. If any of these conditions occur in conjunction with rocket firing, full details of the incident, including percent engine rpm, number of rockets fired, altitude and duration of the condition, should be noted in the DD form 781. There is also a possibility of cockpit contamination as a result of rocket exhaust gases being sucked into the

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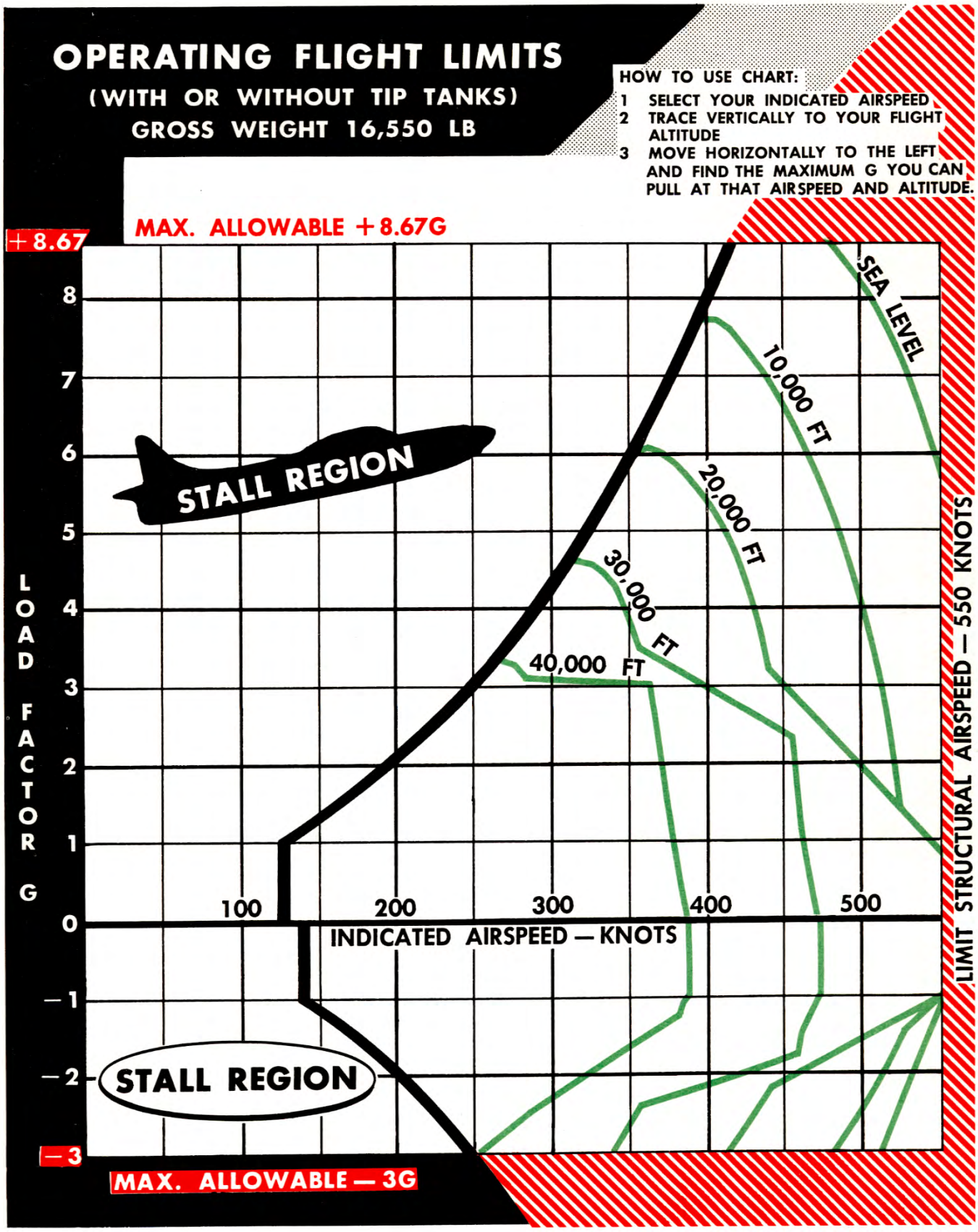
OPERATING FLIGHT LIMITS
(WITH OR WITHOUT TIP TANKS)
GROSS WEIGHT 16,550 LB
HOW TO USE CHART:
1 SELECT YOUR INDICATED AIRSPEED
2 TRACE VERTICALLY TO YOUR FLIGHT ALTITUDE
3 MOVE HORIZONTALLY TO THE LEFT AND FIND THE MAXIMUM G YOU CAN PULL AT THAT AIRSPEED AND ALTITUDE.
MAX. ALLOWABLE +8.67G
+8.67
8
7
6
5
4
3
2
1
0
−1
−2
−3
LOAD FACTOR G
STALL REGION
SEA LEVEL
10,000 FT
20,000 FT
30,000 FT
40,000 FT
100
200
300
400
500
INDICATED AIRSPEED — KNOTS
LIMIT STRUCTURAL AIRSPEED — 550 KNOTS
STALL REGION
MAX. ALLOWABLE — 3G

*Figure 5-2*

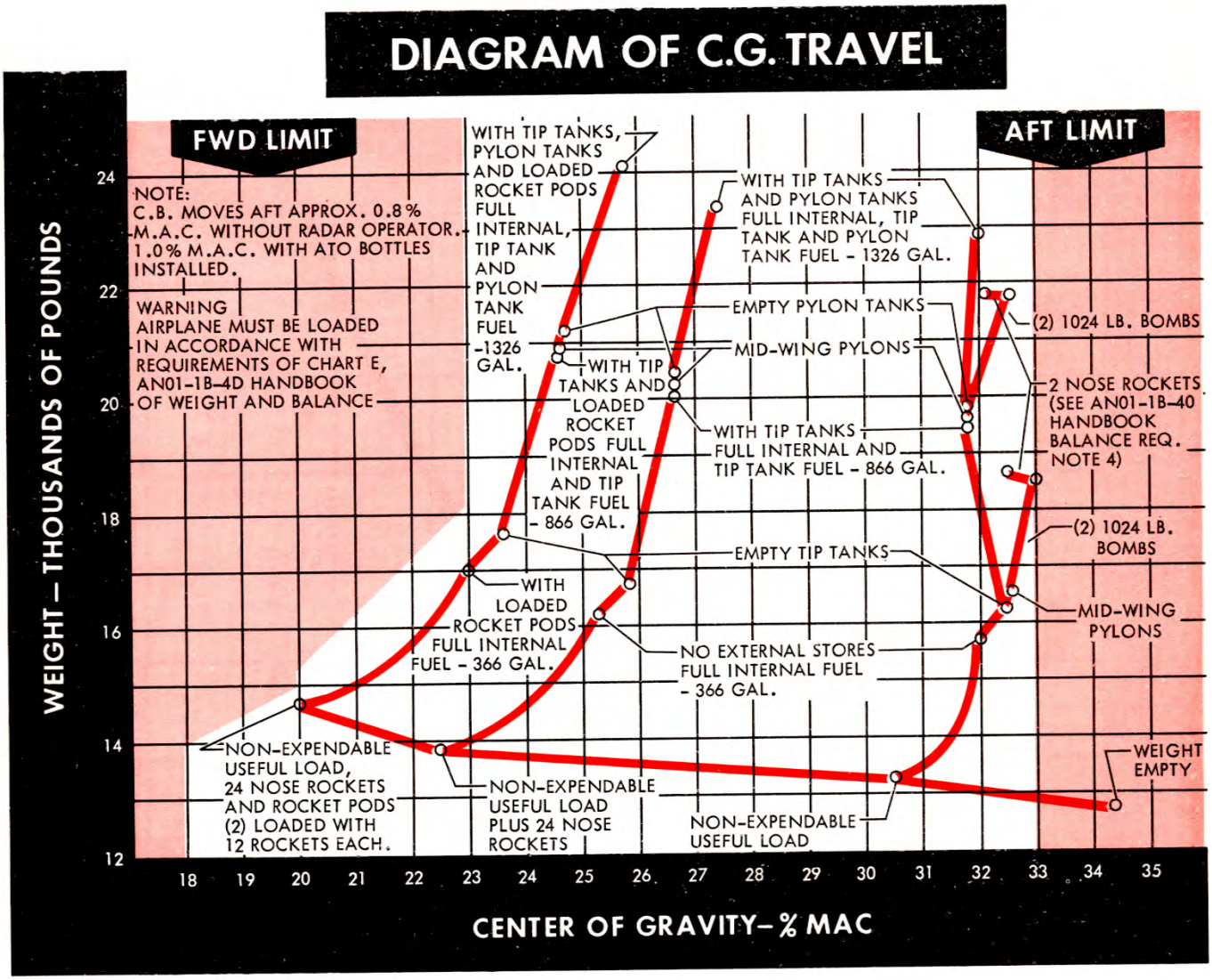


*Figure 5-3*

engine intake and forced into the cockpit air conditioning and pressurization system. If this occurs, place the oxygen diluter lever at the 100% OXYGEN position during rocket firing.

## LIMITATIONS WITH BOMB RACKS INSTALLED.

In order to help prevent the possibility of failure of type S-2, S-2A, S-3, MA-4, or MA-4A, bomb racks, a notation should be made in the DD form 781 any time a suspended fuel tank collapses in flight in order to insure that adequate inspections are accomplished.

With more than 1000 pounds suspended from type S-2, S-2A, MA-4, or MA-4A bomb racks, or more than 2,000 pounds suspended from type S-3 bomb racks, a notation should be made in the DD form 781 whenever any of the following conditions are encountered:

a. If the aircraft exceeds 90 degrees per second rate of roll.

b. If the aircraft exceeds 4.5 G's.

c. If any unusual incident occurs in flight or during ground operations which could cause damage to any part of the racks, such as rough taxiing or hard landing.

Last Page of Section V

# flight characteristics

SECTION VI

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## INTRODUCTION.

The flight characteristics of the aircraft are typified by high climb, level flight, and dive speeds. The airplane is stable directionally, laterally, and longitudinally at all approved center of gravity positions. The lateral stability is very positive at all altitudes with and without external tanks. The increased dihedral makes the rudder very effective in producing roll in turns without the use of ailerons. Despite the advantage of simplified engine controls, the maximum overall performance and tactical value are not obtained automatically. In order to secure safely the best results, the pilot must be willing to learn the technique required to utilize fully the capabilities of the airplane. He must have training in basic theory and must think further ahead than he was required to in lower speed aircraft. A knowledge of compressibility effects on jet aircraft flight characteristics is a requisite.

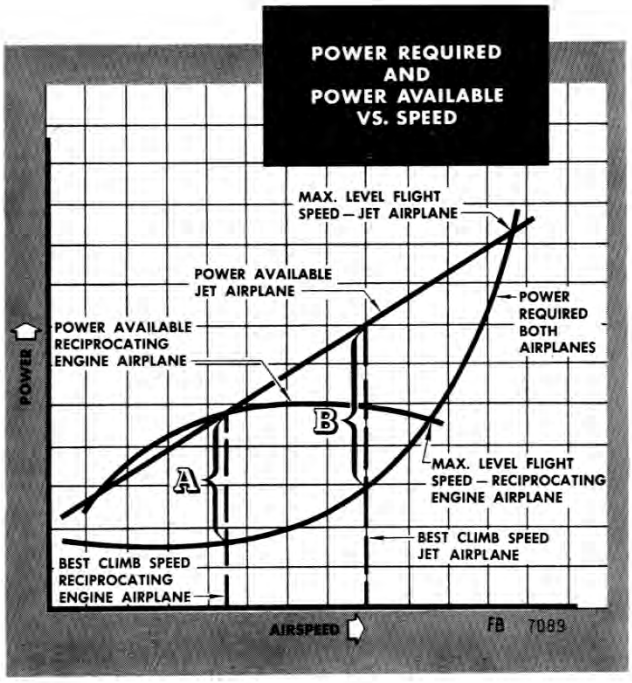



*Figure 6-1*

## JET AIRCRAFT FLIGHT CHARACTERISTICS.

The performance characteristics peculiar to jet aircraft, i.e., high level flight speeds and high climb speeds, result from the thrust characteristics of the jet engine. At this point it is necessary to distinguish between thrust and power. Thrust is a force, and it is this force or thrust that is delivered by the engine. Power, however, is the time rate of doing work. It is equal to force (or thrust) times distance divided by time. Since the distance divided by time is equivalent to speed, you can see that power is a combination of thrust and speed. The jet engine characteristics which determine the unique flight characteristics of the jet airplane is this: At a fixed throttle setting the thrust remains approximately constant regardless of the airplane speed. Therefore, since power is the product of thrust and speed, you can see that the power available is proportional to speed, being low at low speed and attaining its greatest value at maximum speed. Another jet aircraft flight characteristic explained by the speed-power relationship is the high climb speed. Maximum rate of climb occurs at the speed for maximum excess power, excess power being the difference between power available and power required. Figure 6-1 shows representative power available curves for a jet airplane and for a propeller driven airplane. Also shown is a representative power required curve. Maximum excess power for the propeller-driven airplane is shown at "A." The corresponding speed is the best climb speed for the propeller-driven airplane. The situation in the jet airplane is totally different. You can see at "B" on figure 6-1 that the speed for maximum excess power is quite high. The best climb speed for a jet airplane is correspondingly high—much higher than it is for the propeller-driven airplane. You should maintain the recommended speed when climbing even though you have a strong tendency to reduce air speed because, at low speed, you suffer a great loss of power and thereby sacrifice climb performance. During combat climbs it is particularly important to keep the speed up because climb performance and power must be kept at top levels if tactical advantage is to be maintained. A jet airplane will not reach a stable airspeed following a power adjustment as rapidly as a propeller-driven airplane. This can be clarified by reference to figure 6-1. Assume the airplane to be flying initially in stable, level flight at airspeed "A." This means that the engine is operating at part throttle so that the power available just equals the power required value at "A" on the red line. Now assume that full throttle is applied resulting in maximum power available from the power plant represented by point "A" on the two black lines. The difference between the black and red lines is the excess power available for increasing the speed of the airplane. If the altitude is maintained constant by proper use of elevator control, airspeed will increase and the power available and power required will change as illustrated. The final stable speed will be at the intersection of the power available and power required curves. Now note the difference between the propeller-driven and jet airplanes. The total gain in airspeed from "A" to maximum level flight speed is greater for the jet than the propeller airplane, although the excess power at "A" is the same, because the power available curve for the jet more nearly parallels the power required curve. The nearly parallel condition of the power available and power required curves also results in the excess power during the last few knots before the stable speed is reached being less for the jet. Thus the jet airplane will take longer to accelerate to a stable speed for a given change in power setting because the total speed increment is greater and the time to stabilize the last few knots will also be greater. There is another flight characteristic which should be discussed here even though it is not peculiar to jet aircraft alone. This phenomenon, which affects all airplanes, is known as flying on the "wrong" side of the speed-power curve. It is best explained by showing how total drag and power are inter-related throughout the speed range of the airplane.

Total drag—the resistance to motion which must be overcome by the engine—consists of two parts; parasite drag and induced drag. Parasite (or form) drag is the resistance offered by a fluid (such as air) in the form of external viscous forces. Parasite drag varies with the airspeed, being low at low speed and becoming very high at high speed. Induced drag is a component of the backward leaning lift line. It may therefore be considered to be the drag induced by the production of lift. It is low at high speed and high at low speed. Now refer to figure 6-1 and imagine an airplane flying at maximum level flight speed. At this point the power required and the power available are equal. The angle of attack of the wing is low, the induced drag is low, and the parasite drag is high. If the throttle is now retarded, to say, maximum cruise setting, the air plane will slow down until the power required is equivalent to the power available at the new throttle setting. Notice that the power required is less than it was at high speed. The parasite drag will be less and the induced drag will be greater, but the sum of the two will be such that the power required will be less than it was at high speed. The nose of the airplane will be up a little bit because the angle of attack has to be greater in order to provide the same lift at lower speed. This situation, i.e., less power required with lower speed, prevails until the airplane has slowed to the speed corresponding to the lowest point on the power required curve. If the speed is reduced below that for minimum power required, the situation changes. No longer is the power required decreased because of the lower speed. On the contrary, the power must be increased if level flight is to be maintained. The reason for this is that the induced drag has now increased so much that it overbalances the effect of lower speed. The airplane is now flying on the "wrong" side of the power curve and any further reduction in speed will be accompanied by an increase in the power required to maintain level flight. Flying on the "wrong" side of the speed-power curve is not a stable condition. The angle of attack is high and the airplane is near the stalled condition; level flight at fixed throttle is difficult, if not impossible. The best solution is to put the nose down and sacrifice altitude to regain speed. In this airplane it is very easy to get on the "wrong" side at airspeeds below 200 knots.

## MACH NUMBER.

Airplane trim and handling characteristics change at speeds approaching the speed of sound. These high speed phenomena are known as compressibility effects. Any one of these effects occurs at a speed that is a fixed percentage of the speed of sound at all altitudes rather than at a constant indicated airspeed. A speed expressed as a percentage of sonic speed is called Mach number. For example, if you are flying at 0.50 Mach number, your speed is 50% of the speed of sound. The speed of sound, being a function of air temperature only, decreases with increase in altitude. For example, the speed of sound is approximately 660 knots at sea level, 614 knots at 20,000 feet, and 575 knots at 40,000 feet. So if you are flying at 0.50 Mach number, your true speed will be 330 knots at sea level, 307 knots at 20,000 feet, and 287.5 knots at 40,000 feet. The Mach number for any altitude and indicated airspeed condition may be found on figure 6-2.

## STALLS.

### Unaccelerated Stalls.

The airplane stalls normally with plenty of warning; it mushes noticeably and begins to shake and buffet about 10 knots above the stall speed. Although no difficulty in controlling the airplane will be experienced, prompt corrective action with aileron and/or rudder should be taken as required to maintain wings level, unyawed flight. During a complete stall, a wing may drop. Both rudder and aileron may be used effectively to raise the dropping wing. Recovery is quick and easy from stalls entered gradually; the ailerons and rudders are effective throughout. When stalling with an aft center-of-gravity, the normal tendency for the elevator stick force, which is already light at this center-of-gravity position, to lighten further right at the stall may give the impression that the airplane is rooting slightly. However, the nose of the airplane drops promptly as the stick is moved forward. Tip and pylon tanks have no effect on normal 1 G stalls. Both rudder and aileron are effective in raising a dropping wing with tip and pylon tanks installed. The stalling speeds are shown in figure 6-3.

### Practice Stalls.

Practice stalls should be made above 15,000 feet. Stalls should be entered by slowly raising the nose and gradually easing into the stall. Particularly when doing power on stalls, the entry should be gradual, bleeding the airspeed off without attaining an excessively nose-high attitude. Abrupt entry into the stall with excessive speed and power will result in stalling in a near vertical attitude. Recovery from this condition will be obtained only by losing an enormous amount of altitude. In addition, such stalls conducted with rearward center-of-gravity may cause excessive roll-off because of the longer time required to recover from the very nose-high attitude and low airspeed.

### Accelerated Stalls.

Accelerated stalls are preceded by buffeting. The airplane will normally shake and mush straight ahead or in the direction of the maneuver. The stall characteristics are similar with or without tip tanks. Recovery from accelerated stalls is made by relaxing stick pressure.

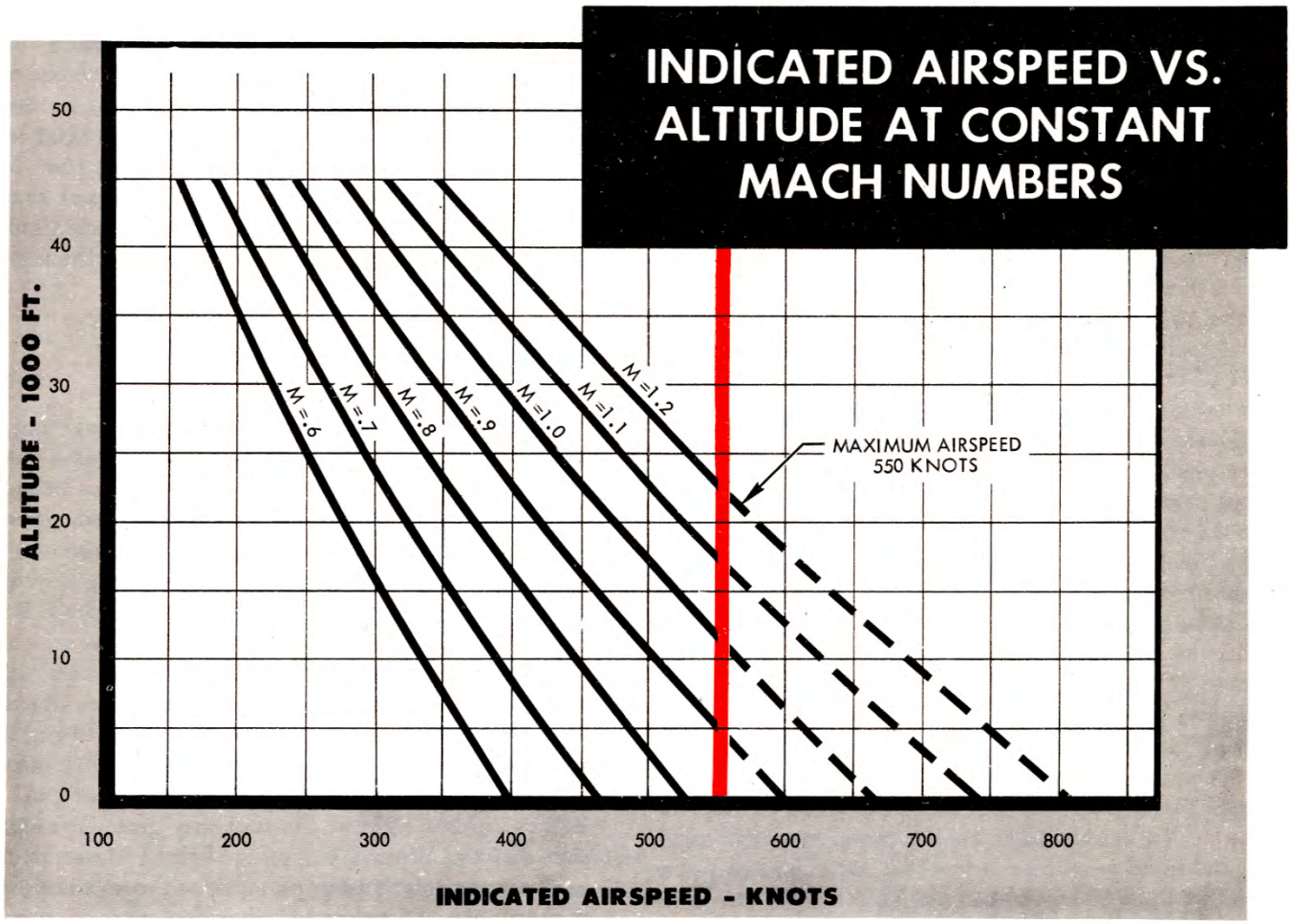



*Figure 6-2*

**SPINS.**

In general the airplane has excellent spin characteristics. Normally the airplane spins in a nose down attitude at a fairly steady rate. The buffeting during erect spins is severe.

**Erect Spins.**

Erect spins are excellent with gear and flaps up or down, and with tip tanks on or off; full or empty. Oscillations, whipping and variable rudder forces may occur to some degree when spinning with gear and flaps down. The use of power will increase the rotational speed and produce additional buffeting. With crossed controls it is difficult to start a spin but with an aft center of gravity, once the spin is started, it tends to flatten out if the aileron is held against the spin. Each turn of a spin may consume as much as 2500 feet of altitude with 3000 feet more required to re-establish level flight.

**Note**

Rudder feel and general recovery are better with speed brakes retracted than extended.

**Recovery From Erect Spins.**

Recovery from erect spins is best accomplished in the following conventional manner:

a. Throttle to IDLE.
b. Hold ailerons neutral.
c. Hold stick FULL AFT.
d. Apply forceful opposite rudder.
e. Relax back pressure on the stick as rotation stops.

With tip tanks ON, full or empty, the airplane will also recover if the pilot removes his hands and feet from the controls. As soon as the airplane stops rotation, retract the wing flaps, and landing gear, if down, to prevent excessive loads which may result in the recovery by exceeding their placard speeds. Avoid sharp pull-ups to prevent a secondary or accelerated stall.

**Note**

If quick dive recovery at low altitude is imperative after rotation has stopped, lower the wing flaps immediately to decrease the pull-out flight path radius.

# STALL SPEED CHART

| WING FLAP POSITION | LANDING GEAR POSITION | ANGLE OF BANK | PRESSURE ALT FEET | STALLING SPEED IAS KNOTS GROSS WEIGHT - POUNDS | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 13,000 | 17,000 | 20,000 | 24,000 | |
| 0 | UP | 0 | 0 | 115 | 130 | 145 | 160 | |
| | | | 5,000 | 115 | 135 | 150 | 165 | |
| | | | 10,000 | 115 | 135 | 150 | 165 | |
| | | | 20,000 | 120 | 140 | 155 | 175 | |
| | | | 30,000 | 125 | 150 | 160 | 180 | |
| | | | 40,000 | 135 | 155 | 165 | 180 | |
| | | | 45,000 | 135 | 155 | 165 | 185 | |
| | | 30 | 0 | 125 | 140 | 155 | 175 | POWER ON |
| | | | 1,000 | | 140 | 155 | 175 | |
| | | | 2,000 | | 145 | 155 | 175 | |
| | | | 3,000 | | 145 | 155 | 175 | |
| | | | 4,000 | | 145 | 160 | 175 | |
| | | | 5,000 | | 145 | 160 | 175 | |
| | | 45 | 0 | 135 | 155 | 175 | 190 | |
| | | | 1,000 | | 160 | 175 | 195 | |
| | | | 2,000 | | 160 | 175 | 195 | |
| | | | 3,000 | | 160 | 175 | 195 | |
| | | | 4,000 | | 160 | 175 | 195 | |
| | | | 5,000 | | 160 | 175 | 195 | |
| | | 60 | 0 | 165 | 185 | 205 | 230 | |
| | | | 1,000 | | 185 | 205 | 230 | |
| | | | 2,000 | | 190 | 205 | 230 | |
| | | | 3,000 | | 190 | 205 | 230 | |
| | | | 4,000 | | 190 | 210 | 230 | |
| | | | 5,000 | | 190 | 210 | 235 | |
| 32 | DOWN | 0 | 0 TO 5,000 | 105 | 120 | 130 | 145 | MILITARY OR MAX POWER |
| | | 30 | | 115 | 130 | 140 | 155 | |
| | | 45 | | 125 | 145 | 160 | 170 | |
| | | 60 | | 150 | 175 | 190 | 205 | |
| 45 | DOWN | 0 | 0 TO 5,000 | 105 | 120 | 130 | 140 | IDLE POWER |
| | | 30 | | 115 | 130 | 140 | 150 | |
| | | 45 | | 125 | 145 | 160 | 170 | |
| | | 60 | | 150 | 175 | 190 | 205 | |

*Figure 6-3*

# MANEUVERING STICK FORCE DIAGRAM

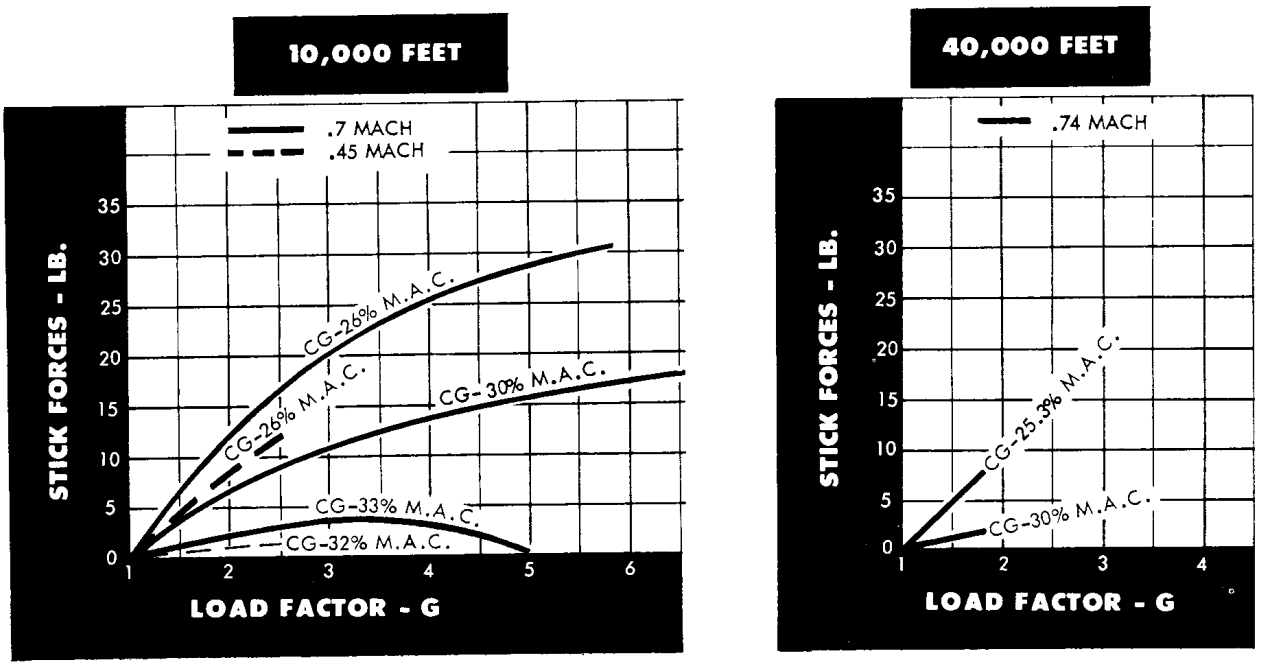



*Figure 6-4*

**Inverted Spins.**

Inverted spins are not recommended due to reversal stick forces and a tendency to "flatten out" with aft center of gravity loading. The recovery procedure for inverted spins is as follows:

a. Throttle to IDLE.
b. Ailerons neutral.
c. Simultaneous application of rudder against spin and aft stick until rotation stops.

There should be no confusion as to which rudder to use during an inverted spin recovery. All the pilot should remember is to push on the rudder pedal that is opposite from the direction of rotation as he observes it. Any prolongation of inverted spins may bring about a difficult recovery. If such has occurred and recovery appears difficult, it is believed that the use of the drag chute will bring about a recovery. If recovery is affected by this method, the drag chute should then be jettisoned. If the ground clearance goes below 10,000 feet it is recommended the canopy be jettisoned since this will serve as a first step toward possible bailout and further, it may assist recovery. Consequently if you stay with the airplane for a few seconds after the canopy has been jettisoned, recovery may be affected.

**WARNING**

If a definite recovery from the spin has not been accomplished and a pull-up initiated prior to the aircraft reaching a ground clearance of 5,000 feet—BAIL OUT.

## FLIGHT CONTROLS.

**Elevator Control.**

Longitudinal control of the airplane is obtained with a conventional stabilizer—elevator configuration. The elevator is equipped with trim tabs to trim the airplane for nose heavy or tail heavy conditions. The elevator control system incorporates a boost system to reduce the stick forces required of the pilot. Appreciable elevator deflection is required to make the airplane pitch moderately when the center-of-gravity is located well forward (see Figure 6-4). Consequently the airplane is not overly sensitive to control stick movement and the airplane pitching attitude can be held or changed exactly as desired. The stick forces can be maintained at any desired level by proper selection of boost ratio. At the

aft center of gravity (33% MAC), the airplane has neutral stability and is, therefore, very sensitive to small changes of elevator angle. This results in a tendency to over control that will make it difficult to maintain desired airspeeds or accelerations. As the airplane accelerates through the sonic speed region in dives, stability increases, requiring relatively large elevator movement to change pitch attitudes. Conversely, as the airplane decelerates through the sonic region, as when pulling out of a dive, stability decreases to neutral. The higher than normal stick forces required at high Mach numbers decrease rapidly as speed is reduced. This can result in overshooting desired accelerations and possible elevator stick reversal at high G's. However, there is no danger of structural damage except when very near sea level, because the maximum accelerations that can be attained are limited by wing stall or heavy buffeting as shown in Figure 5-2. When flying with the center of gravity near the aft limit, such as after having expended the rockets, more attention will be required to keep from over controlling, especially during instrument flight conditions. If a flight is to be made without rockets, the center of gravity should be maintained well forward by installing compensating ballast.

### Aileron Control.

The aileron control system incorporates a hydraulic aileron booster which increases the applied control stick forces and the pilot must supply one forty-fifth of the total force required. Spoilers are incorporated just forward of each aileron on the upper wing surface to increase lateral control at the trim change speed and at landing speed. A trim tab is incorporated on the left aileron for trimming the airplane laterally in flight. Characteristics are completely normal in the normal flight speed range. At speeds just above maximum afterburning level flight speed, a lateral out-of-trim condition evidenced by a roll to the right or left may be experienced. Since this occurs in a speed range obtainable only in a dive, complete information on effects and proper pilot techniques is given in the discussion on diving.

### Aileron and Elevator Boost.

If the hydraulic pressure drops below 250 psi, or if the aileron and/or elevator boost systems are turned off, the pilot still has complete control over the elevator and aileron control surfaces (except at very high speeds). However, stick movement will not be assisted by the boost system, and corresponding control stick displacements will require greater forces by the pilot. The aileron control will be particularly stiff with boost off since aileron boost ratio is approximately 45 to 1. While there is usually no reason for turning the aileron and elevator boost off in flight, either one can be safely turned off or on at any time at low to moderate indicated airspeeds. If the airplane is not trimmed and/or the stick is off center when the boost is turned on, an abrupt maneuver may occur because the boost will react more quickly than the pilot. The airplane should be trimmed in low elevator boost ratio before turning the boost off because in high ratio the stick forces for a considerable out-of-trim condition can be quite light, misleading the pilot into thinking that the airplane is practically trimmed. The aileron tab should be faired before turning the aileron boost off. With the boost off, the aileron tab will be more effective in lateral trimming than the stick trimmer. Consequently, the tab will become the more effective lateral trimming device, which is just the reverse of boost-on operation. For practice purposes, it is recommended that each boost be turned off in low speed flight to obtain first-hand information concerning the control forces required. At high speed without boost, stick forces for more than mild maneuvering will be beyond the capabilities of the pilot. In the event of boost failure while in high speed level flight, no action will be required until more than mild maneuvering is desired. Then it will probably be necessary to reduce airspeed by reducing rpm and/or climbing or turning. If the boost fails with the airplane in a high speed climbing attitude, speed should be reduced by reducing rpm. Fully extending the speed brakes will greatly increase the nose-high attitude of the airplane because only partial counter-balance of the resulting 2½ to 3½ G load will be possible without the boost. If the boost fails in a dive, rpm should be reduced and the speed brakes should be extended which will both reduce airspeed and effect dive recovery.

### Rudder Control.

Directional control of the airplane is obtained with a conventional cable operated rudder. Rudder control is satisfactory and very effective in executing most maneuvers.

## SPEED BRAKES.

The speed brakes are more effective on this airplane than on previous models because an additional pair is provided on the aft fuselage. They are useful in dive recovery to increase G's and as a drag producing device to slow the airplane down. The amount of drag added depends upon the degree of brake extension which can be controlled by the length of time the actuating switch is held down. The speed brakes operate together and can be extended or retracted at any speed or in any flight

attitude, as long as normal system hydraulic pressure is available. A moderate to strong buffet is present depending on the amount of speed brake extension. The pitch change when the speed brakes are fully extended will produce a positive acceleration load of from 2½ to 3½ G's but is easily counteracted with the aid of the boosted elevator control. The G loading resulting from the extension of the speed brakes will vary with the amount of extension. Extension will be accompanied by a nose-up tendency whereas retraction of the speed brakes will give the opposite effect. The force required to counteract this pitch change varies with amount of extension and speed; being very light at low indicated speeds but heavier at high indicated speeds and large extension angles. The pilot should be familiar with the magnitude of the required stick force so that trouble may be avoided when the elevator boost is inoperative. The speed brakes may be used effectively in formation flying. Since they slow the airplane down, they also produce a noticeable reduction in the turning radius. They will permit a more rapid descent from altitude without building up excessive speed. Some noise and roughness can be anticipated when flying at high speeds with speed brakes extended. Use of the speed brakes below 12,000 feet will sometimes affect the pilot's ears because of the change in cabin pressure. Below 12,000 feet, the cabin is not pressurized and the cabin air outflow valve is open. This valve is in the forward speed brake area, and since opening the speed brakes lowers the pressure behind them, the cabin pressure is also lowered. Above 12,000 feet, however, the cabin is pressurized and the pressure regulator reacts with sufficient speed to eliminate this effect.

## LEVEL FLIGHT CHARACTERISTICS.

### Low Speeds.

**Slow Flying.** Slow flying is of very little value with this airplane since operating at speeds below the normal cruising range results in a waste of fuel and actually decreases the range. However, maximum endurance is attained at speeds below the normal cruising range. Whenever possible, slow flying should be done in the clean configuration because fuel consumption will be increased with gear and flaps extended and also because the engine can be accelerated faster than the airplane can be cleaned up. However, to lose altitude and still maintain a low airspeed, it will be necessary to increase airplane drag by extending speed brakes, landing gear, and wing flaps. The low speed flight characteristics of this airplane are normal. All controls are effective down to the stall. Slow flight should be practiced at a safe altitude. Reduce the airspeed by retarding the throttle to IDLE and maintain altitude by holding the nose up. When the desired airspeed has been attained, it can be maintained by applying power. When descending at low airspeeds, retard throttle to IDLE, extend speed brakes, and decelerate to a speed at which the landing gear and wing flaps may be extended. After the gear and wing flaps have been extended, set up the desired rate of descent by varying the speed brake extension or by adjusting the power.

**Approach and Landing.** Particular attention is required during the approach leg with this airplane. If the nose is raised at a slow airspeed, the drag increases very rapidly and, as a result, the airspeed will drop off unless power is applied immediately. It is desirable from the standpoint of safety, to keep 55 to 65% rpm until you are quite close to the runway; then, if power is needed for any reason, the response will be almost immediate. If the runway length is short enough to be marginal, the approach speed must be closely controlled —5 knots too fast can mean a touchdown too far down the runway to stop or go around; 5 knots too slow can mean a hard landing, possibly short of the runway. If the runway is of adequate length for high performance jet-type aircraft, it will not be necessary to approach as slow as for a marginal field. With a gliding approach, using 55 to 65% rpm and the proper airspeed, the airplane can be flared normally to touchdown. The installation of the spoilers improves lateral control during low speed flight. If a level power-on drag approach is made it is necessary that more power be kept on until a few feet away from the runway. The airplane may drop suddenly if the power is pulled off too abruptly. If the speed during final approach is excessive, it should be reduced by speed brake extension, or, if necessary, reduction of power. Slipping is permissible in the landing pattern to lose altitude. Touchdown should be made in a slightly nose-high attitude on the main wheels. Do not get the nose so high that the tail will drag. Also avoid landing on the nose wheel. As soon as the wheels touch, you can retract the wing flaps and thus get better traction for braking. When landing in a crosswind, make a crabbing approach or hold a wing down to compensate for wind drift. Straighten out just before touchdown. Approaches for dead-stick landings should be made 25 knots IAS higher because of the reduced ability to flare with power off. The airspeed should not be allowed to drop below 150 knots during a dead-stick approach at light weight. At heavier weights, increase the minimum speed 5 knots for each additional 1000 pounds. If the dead-stick landing must be made before the tip tanks are empty, drop them. However, empty tip tanks will improve the flaring ability somewhat; so if empty they should not be dropped. Using the drag chute will reduce the ground

roll to such an extent that landing on the average field will be relatively easy. It provides an extra margin of safety and reduces wear on tires and brakes; it should be used accordingly. Use the same approach speeds and technique whether or not the drag chute is installed. Although quite safe and easy landings have been readily completed after chute openings with the wheels slightly above the runway, the drag chute should be opened just as the main wheels touch the runway. When landing with a crosswind, the chute will cause strong weathercocking, consequently, use of brakes to maintain direction along the runway may be required.

**Porpoising.** If during a landing the pilot allows the nose wheel to contact the runway first, a porpoising oscillation may result. Porpoising is a condition wherein the aircraft bounces back and forth between nosewheel and main gear during the initial phase of ground contact in landing. If, through improper corrective technique, the porpoise is allowed to progress, a violent unstable oscillation about the lateral axis of the aircraft develops within three or four bounces, causing repeated heavy impacts of the aircraft on the ground and ultimate structural damage or failure of the landing gear and airframe. Therefore, if the nosewheel contacts the runway before the main gear and bounces during landing, such a porpoising oscillation is quite likely to develop unless the following corrective action is taken immediately:

1. Position the control stick in neutral or slightly aft of neutral and hold it there, while simultaneously advancing the throttle to 100% rpm. (Do not attempt to counteract the bounce with opposite stick movement, since the combined reaction time of pilot and aircraft is such that control movement aggravates the porpoising.) The object of this first step is to damp out the oscillation as soon as it begins by restricting control movement and by getting the aircraft completely airborne again, where further bouncing on the landing gear is impossible.
2. After thus eliminating the porpoise, the pilot should immediately decide whether to make a normal landing on the remaining runway or retain 100% power and execute a go-around. This decision will depend on such factors as fuel quantity, weather, length and condition of runway, availability of drag chute, and/or runway crash barrier, etc.
3. If an emergency condition makes it necessary to land at an excessive speed which might cause the nosewheel to contact the runway before the main gear (in normal landing configuration), the landing should be made with the wing flaps retracted. It should be noted that in this configuration the approach and touchdown speeds should be increased by about 20-25 knots above normal approach and landing speeds. If the pilot becomes airborne after the aircraft is damaged and determines that the minimum controllable speed is not within the safe maximum touchdown speed (approximately 180 knots), the aircraft should be abandoned. If abandonment is impossible because of ejection system malfunction or low altitude, the landing should be made with landing gear retracted.

### Cruise Speed.

Stability and control characteristics in the cruise speed region are excellent. At any speed in this range the longitudinal stick forces can be trimmed out by normal application of trim tab. The response to rudder and aileron is also completely normal. The rudder bend tab is effective in maintaining straight unyawed flight, and the aileron stick trimmer will maintain a wings level attitude.

### High Speed.

The airplane is capable of level flight speeds up to 0.82 Mach number at military power and 0.85 Mach number with maximum power. From zero airspeed to 0.82 Mach number (speeds up to maximum level flight without afterburning) normal longitudinal control exists. The stick must be pushed forward to increase airspeed. At any speed in this range the stick forces can be trimmed out by normal application of trim tab. The response to rudder and aileron is also completely normal. The rudder bend tab is effective in maintaining straight unyawed flight, and the aileron stick trimmer will maintain a wings level attitude.

## MANEUVERING FLIGHT.

All acrobatics, except inverted spins, vertical stalls, and acrobatics requiring extended negative accelerations are permissible. During negative accelerations a flame-out will occur if the inverted condition is maintained for more than approximately 10 seconds, since fuel will not be fed to the engine. Snap maneuvers should be avoided to prevent overstressing the airplane.

**Note**

At least 10 quarts of oil are required in the engine reservoir to provide sufficient lubrication during acrobatics.

You must use extreme care in executing maneuvers which require a downward recovery as the loss of altitude in such a recovery is very rapid. Refer to figure 6-5. In general, acrobatics should not be attempted below 10,000 feet until you become familiar with the speed at which the airplane can gain and lose altitude. Consideration also should be given to the possible influence of the Mach number effects on proper execution of high speed low altitude maneuvers. Maneuvering loads are incurred when an airplane is turned, rolled, yawed, pulled out of a dive, or accelerated in some manner. It is the pilot's responsibility to prevent these loads from becoming excessive by restricting the maneuvers to the specified acceleration limits. For this purpose he must rely on the accelerometer, an instrument designed to detect the acceleration loads placed upon the airplane. Although the accelerometer is generally reliable, it has limitations which can, under some circumstances, mislead the pilot into believing that he is executing a safe maneuver, whereas, in reality he may be dangerously overstressing the airplane. The limitations of the accelerometer are (1) it reads only the accelerations in a vertical plane, and (2) it is located on the pilot's instrument panel and cannot accurately detect accelerations of the airplane tail assembly. As an example, during maneuvers such as yaws and skids, the accelerometer will read approximately 1G. At the same time fairly large loads are being imposed on the vertical tail assembly of the airplane. Actually, the steady loads that are applied during these maneuvers are usually not excessive and are almost directly proportional to the rudder pedal forces being applied. Of more importance is the rate of application or particularly, the rate of release of these forces. During rapid application and/or rapid release of large control forces, very high loads can be imposed on the airplane structure. This is not meant to imply that the pilot should apply control forces gradually in order to avoid excessive loads, it is merely a caution that very rapid application or release of forces can, at moderate to high airspeeds, result in structural damage to the airplane. During maneuvers, the lateral out-of-trim condition, evidenced by a roll to the right or left at speeds just above maximum afterburning level flight speed, may be induced by high G's at speeds lower than indicated above. Consequently, particular care should be exercised in high speed maneuvers close to the ground. Typical values of stick forces during maneuvering flight are shown in figure 6-4.

## DIVING.

The pilot should be completely familiar with the compressibility of Mach number effects before attempting high speed dives. With a knowledge of the effects as given below, the pilot will be able to apply proper techniques that will assure good control and satisfactory diving characteristics at all times. All of the Mach number effects are described in the following paragraphs, whether or not corrective action by the pilot is required. However, not all of these effects may be noticed in any one dive because their magnitudes are reduced by rapid transition through the speed range where they occur. The effects and proper pilot techniques as presented below apply both to the clean airplane and to the airplane equipped with 250 gallon tip tanks. There is no difference in limiting restrictions between the two configurations. The pilot techniques suggested are the results of extensive high Mach number flying in the aircraft.

### Nose Tuck.

In the 0.82 to 0.88 Mach number range a slight nose-down pitching tendency is noticeable. However, the elevator trim tab should not be used because it becomes ineffective in this speed range. For all flying at speeds above the maximum non-afterburning level flight speed, the trim tab should be returned to neutral and boost ratio should be at least 7:1. Operation at high Mach numbers with large tab angles may result in considerable buffeting of the tab, and during pull-out an additional nose-up or down pitching will result depending on which side of the trim setting the tab was set when the tab abruptly regains its effectiveness as speed reduces.

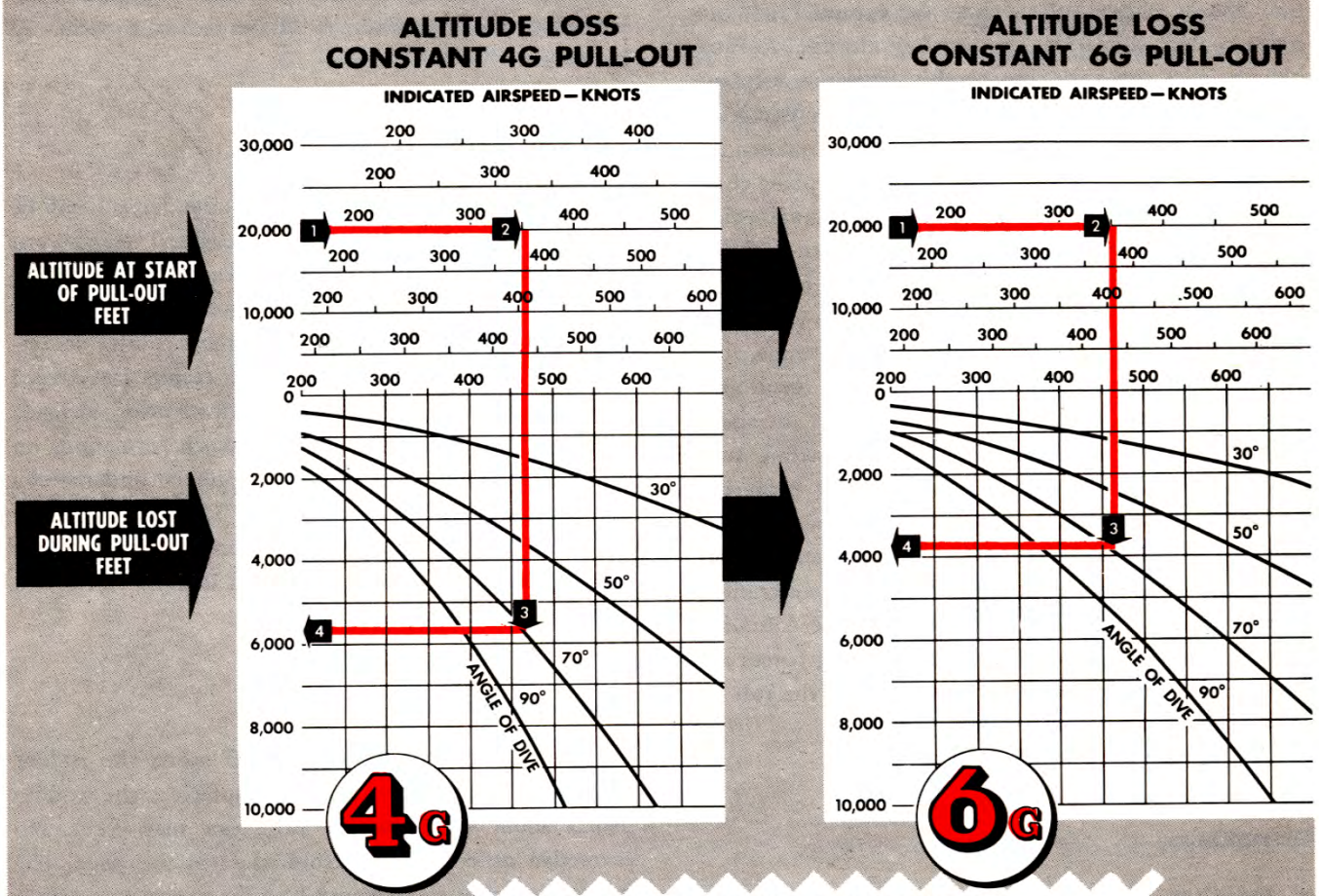
### Roughness.

Between 0.82 and 0.88 Mach numbers depending upon altitude, a slight airplane roughness may be noticed. This will not increase materially at higher speeds.

### Roll-Off.

At speeds just above maximum afterburning level flight speed, a lateral out-of-trim condition evidenced by a roll to the right or left may be experienced. This unbalance of the lift forces on the wing due to compressibility effects exists between 0.87 and 0.90 Mach numbers. Above this speed range symmetrical lateral trim is restored. Corrective control will be required to maintain wings level in this speed range. Partial stick deflection will be required at high altitude increasing to full stick deflection at low altitude. By the same token the stick force required will be light at high altitude but will be heavier at low altitude where the indicated airspeed is high. If this speed range (0.87 Mach to 0.90 Mach) is traversed very rapidly, as in a steep dive, the lateral trim change may feel more like a rough air bump and will occur so rapidly that the stick will be returned to neutral almost as soon as it is displaced.

# ALTITUDE LOSS IN DIVE RECOVERY




REFER TO V-G DIAGRAMS, TO DETERMINE WHETHER THE NUMBER OF "G'S" REQUIRED FOR PULLOUT ARE AVAILABLE.

## HOW TO USE CHARTS:

SELECT APPROPRIATE CHART, DEPENDING UPON ACCELERATION (4G OR 6G) TO BE HELD IN PULL OUT; THEN—

1. ENTER CHART AT ALTITUDE LINE NEAREST ACTUAL ALTITUDE AT START OF PULL-OUT. (FOR EXAMPLE, 20,000 FT.)
2. ON SCALE ALONG ALTITUDE LINE, SELECT POINT NEAREST THE IAS AT WHICH PULL-OUT IS STARTED (350 KNOTS IAS).
3. SIGHT VERTICALLY DOWN TO POINT ON CURVE OF DIVE ANGLE (70°) DIRECTLY BELOW AIRSPEED.
4. SIGHT BACK HORIZONTALLY TO SCALE AT LEFT TO READ ALTITUDE LOST DURING PULL-OUT. (CONSTANT 4G PULL-OUT—5700 FT; CONSTANT 6G PULL-OUT—3800 FT.)

AB 8213

*Figure 6-5*

Above 20,000 feet roll-off is easily controllable and presents no particularly objectionable characteristic. At low altitude, however, considerable aileron and stick deflection will be required due to reduced aileron effectiveness. However, if the stick were to be released, the resulting rate of roll would be lower than would normally be expected from a roll maneuver at lower airspeeds with this amount of aileron. Deceleration through the roll-off speed range is so rapid during a dive recovery that the effects are minimized. Pull-outs from speeds above roll-off may be executed without lateral control difficulties even at low altitude. Roll-off characteristics can vary considerably from one airplane to another due to small differences in wing construction allowed by manufacturing tolerances. It is recommended that each individual investigate particular airplane characteristics and his own limitations before exceeding roll-off speed at low altitude. After experience in flying in this range is gained, the full capabilities of the airplane may be utilized. As this out-of-trim condition exists over a relatively small Mach number range, it is not necessary to trim to zero stick force. As mentioned before, it feels more like a rough air bump if the speed range is crossed rapidly. In prolonged operation, such as a long descent at roll-off speed, if the balancing forces were trimmed out, a resulting roll, when decelerating out of this condition, would be experienced. This would be abrupt at low altitude where deceleration, normally accomplished by extending the speed brakes, is rapid. Due to aileron boost, the balancing forces are not excessive. Therefore, lateral trimming in the roll-off speed range, is not recommended at any time.

**Aileron Buzz.**

At about the same speed that roll-off occurs the airplane is subject to aileron buzz which can be recognized by motion of the trailing edge of the ailerons. Dampers have been installed in the airplanes to limit this condition to acceptable limits. It is necessary to have approximately 1 inch motion at the trailing edge of the aileron in order for the dampers to function. This condition is experienced only over a very narrow Mach number range (at approximately 0.87 Mach number) and is generally most noticeable when pulling approximately 2 to 3 G's. No buzz will be encountered at lower or higher Mach numbers. The forces causing buzz are highest at low altitude where the indicated speed is high. If buzz amplitudes greater than 2 inches are experienced, have the buzz dampers checked.

**Spoiler Buzz.**

Below 25,000 feet a spoiler buzz may be noticed, visually, by a small amplitude high frequency motion of the trailing edge of the up spoiler. This condition, which is harmless, occurs only at small amounts of spoiler deflection and at about the same speed as aileron buzz. Therefore, it is most commonly encountered at the threshold of roll-off when one spoiler is raised a little to maintain lateral trim. Spoiler buzz may be noticed individually or may accompany aileron buzz. However, the frequency is higher when experienced by itself.

**Spoiler Jump.**

At approximately roll-off speed "spoiler jump" may be experienced especially during accelerated maneuvers. This is a rapid lateral trim change causing the airplane to roll caused by spoiler motion independent of stick control. High airloads cause considerable spoiler depression at a fixed aileron angle which results in reduced effectiveness. Under conditions of fluctuating airloads such as experienced with unstable shock formations on the wing, the up spoiler tends to "jump" and thereby results in a lateral trim fluctuation. The spoiler motion is instantaneous and therefore corrective control is not always necessary. The spoiler action is more noticeable to the lower altitudes.

**Rudder Shift.**

At just slightly faster than roll-off speed the rudder will shift either left or right displacing the rudder pedals about 1½ inches. A little yaw may occur. No corrective action will be required from the pilot. The rudder will return to neutral as the speed approaches 1.0 Mach number. Again no pilot effort is required when this happens. The airplane will maintain a directional trimmed condition with negligible yaw at all higher Mach numbers.

**Rudder Buzz.**

A rudder buzz which is felt through the rudder pedals may be experienced about .91 to .92 Mach number or just above rudder shift speed. Although uncomfortable, it is not structurally dangerous. During a steep dive it is encountered very rapidly but diminishes rapidly as its Mach range is very narrow. At low altitudes where the airspeed is high, rudder buzz will be more uncomfortable.

**Reduced Elevator Effectiveness.**

Between Mach numbers of 0.89 and 0.90 positive longitudinal stability will be restored and increasingly strong push forces will be required to increase airspeed further. Starting at about 0.90 Mach number a deterioration of elevator effectiveness through neutral will be evident. Little stick force or airplane response will occur for about 4 inches stick travel on either side of neutral. However, this is no cause for alarm because beyond this dead band the elevators will be effective in decreasing or increasing airspeed. The elevator boost should be at least as high as 7:1 because at lower ratios the elevator may jiggle the stick erratically in this dead band and also because the stick force, to move the elevator outside the dead band, will be too high. If a pushover dive entry has been used, full forward stick travel may be necessary to gain speed rapidly at speeds above onset of elevator dead band. Considerable stick travel will be required for pull-outs at speeds above that for elevator dead band. However, dive recovery from maximum attainable airplane speeds may be effected by use of the elevator alone. In all cases where maximum speed dives are anticipated use 11:1 boost ratio. Maximum effort may be exerted on the control stick without exceeding structural limitations on the airplane except between 400 and 500 knots IAS below 10,000 feet. This is because airplane capabilities limit maximum attainable G's to less than limit structural load factor under all other speed and altitude conditions. Speed brakes may be used any time during dives or pull-outs at all airspeeds, and the positive G's produced are mild and readily controllable. For maximum attainable load factor at any airspeed and altitude see figure 5-2.

**WARNING**

Fuel in tip tanks and forward CG locations will reduce the available G's and will require more altitude for pull-outs.

**Dive Recovery.**

During the dive pull-out from supersonic speeds, air flow conditions over the airplane limit the available G's until the speed decreases to subsonic. This may be noticed by an abrupt increase in aft stick travel and corresponding increase in airplane load factor when the Mach number becomes subsonic. A typical supersonic pull-out may be described as follows: Upon the initial pull, the stick feels "bottomed out" when maximum elevator boost output is reached. At this point the recovery may appear slow as the maximum load factor is approximately 2.0 to 3.0 G's. As the Mach number decreases to subsonic, marked changes in airflow characteristics vary the pressure patterns over the tail, permitting greater elevator deflection. This results in an abrupt increased aft stick movement without an increase in stick force or even with relaxing stick pressure. Accompanying the stick movement, the load factor will build up substantially to execute a comfortable recovery. If the pull-out is from sonic speed or less, the control feel is positive at all times. A tendency for the stick to jump fore and aft may be experienced during the supersonic dive recovery described above. This may occur at the point in the recovery when the aft stick travel may be increased. This is similar to the low boost jiggle phenomenon and occurs at the stick force for maximum boost output. If this condition is encountered increase the aft stick pressure. This will stop the tendency immediately. This phenomenon is encountered only in a relatively small Mach number band just below sonic speed. Therefore, if only mildly resisted, the oscillation will stop when the Mach number decreases below this band. However, as the increase in load factor available at this point is desirable for recovery, firm aft stick pressure resisting the tendency is recommended. As flight at speed greater than approximately .92 Mach number is buffet free, pull-outs from high Mach number dives are smooth, decelerating into moderate to heavy buffet as speed and altitude are decreased. During recovery from a high Mach number dive such as described above, all the Mach number effects will be experienced but in the reverse order. However, the Mach number will generally be reduced so rapidly that these effects will be minimized, some of them to the extent that the pilot will be completely unaware of their occurrence. Following dive recovery, the boost ratio should be reduced to lower elevator sensitivity for normal level flying.

**Maximum Attainable Mach Number.**

As high Mach numbers are readily obtained at high altitude with relatively low indicated airspeed, all phenomena previously described should be investigated in this region. This airplane is capable of supersonic speeds in dives at the higher altitudes. Maximum airplane Mach number is attained above 35,000 feet. Below this altitude the maximum attainable Mach number decreases with altitude. Therefore, if only maximum Mach number is desired, dives should be conducted at high altitude and may be terminated at 30,000 feet as maximum Mach number attainable will only decrease below this altitude. Pulling G's while diving, such as in a split S entry reduce the chances of attaining maximum airplane speeds.

**WARNING**

Altitude required to complete a dive entered by a "split S" at high speed and high power is great, due primarily to the large angle change necessary for recovery and, therefore, should not be attempted.

### Airspeed Jump.

In the preceding paragraphs various high speed characteristics have been discussed which are caused by compressibility effects on the airplane. Similarly the airspeed system is subjected to inaccurate readings as the pressure it senses changes rapidly under shifting shock patterns. In steep dives the airspeed indicator hand will jump suddenly to a higher airspeed and the altimeter will actually indicate rapidly increasing altitude when rapid changes in pressure distribution are experienced. This is called the "airspeed jump" which occurs as sonic speed is approached. Above the jump, readings follow normal variation but are inaccurate. These airspeed gyrations do not damage the instruments. When speed decreases the reverse pressure change is sensed and readings again become normal and accurate.

### Altitude Losses During Dive Recoveries.

Altitude losses during 4 and 6 G dive recoveries are shown in figures 6-5 and 6-6.

## FLIGHT CHARACTERISTICS WITH ROCKET PODS.

Flight characteristics with the rocket pods installed are basically unchanged. The pod installation results in a more forward C.G. location which improves the longitudinal stability resulting in slightly heavier and more positive elevator stick forces.

## FLIGHT CHARACTERISTICS WITH EXTERNAL LOADS.

Under normal conditions, the tip tanks have very little effect on flying characteristics. However, uneven transfer of fuel from the tip tanks does cause wing heaviness, but this can usually be trimmed out with the stick trimmer. If an unbalanced load exists, the pilot should avoid high rolling velocities, especially in the direction which moves the heavy tank down. Also, excessive G's should be avoided, such as in steeply banked turns or in pull-ups, because G's increase the effect of the unbalanced load. These precautions, while not necessarily confined to low-altitude low-speed maneuvers, are especially applicable to a landing approach because aileron capacity for inducing or controlling roll is reduced at low airspeeds. If during the landing pattern the airplane is rolled into a steep turn with the heavy tank moving down, the reduced aileron effectiveness at low speed combining with the G magnification of the unbalanced load may make it very difficult to stop the roll at the desired bank angle. Prior to landing with an unbalanced load, sufficient aileron control should be determined by making a simulated landing down to touchdown speed at an altitude of about 15,000 feet. It will be found that the rudder is quite effective in raising the wing. If in doubt, jettison the heavy tank and repeat the simulated landing. If control is still doubtful, jettison the remaining tank. Control will be more critical for the aileron boost out condition.

## FLIGHT CHARACTERISTICS WITH AUTOPILOT.

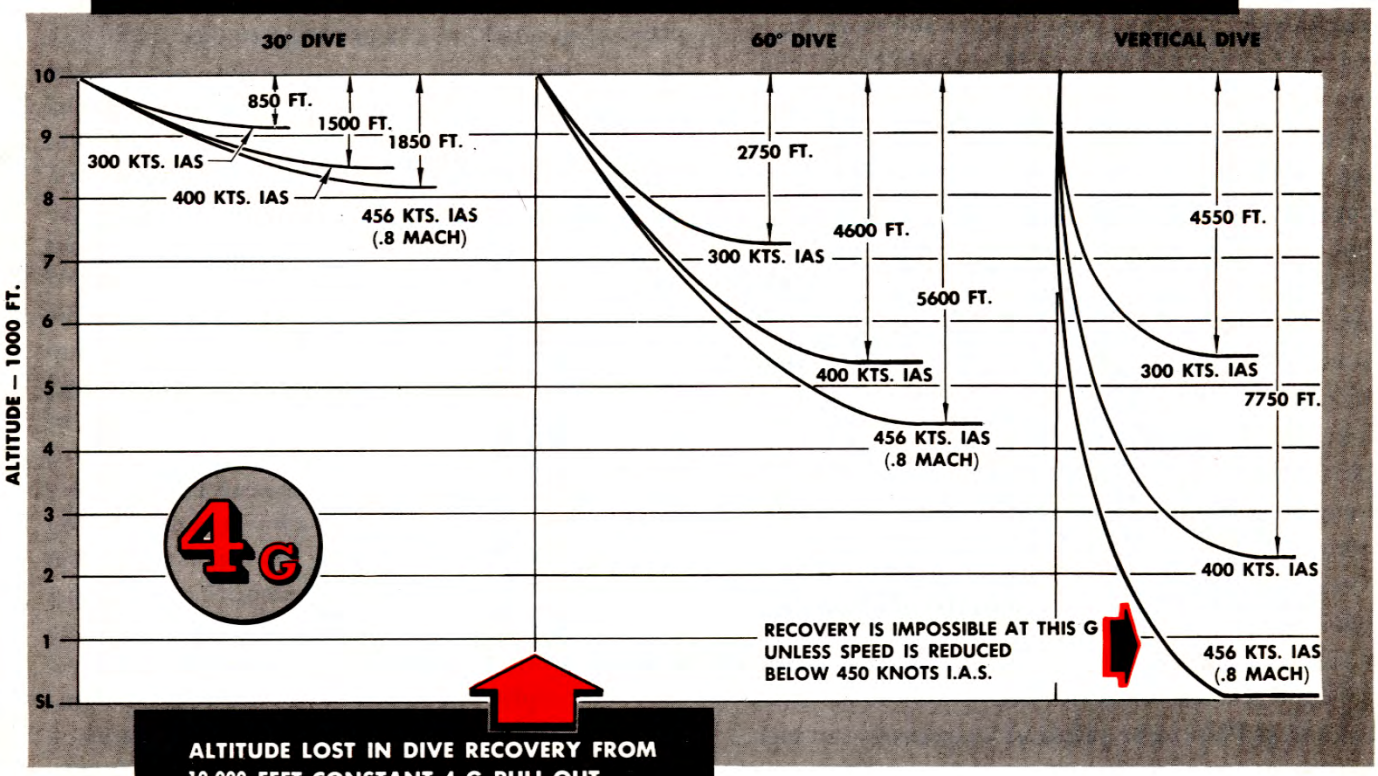
### CRUISE MODE.

**CAUTION**

When using autopilot above 450 knots IAS, autopilot behavior shall be watched because of effect of airplane trim change. The pilot shall keep his feet on the pedals and his hand on the controls when using the autopilot at high speed or when close to the ground.

This mode is to be used for normal cruising automatic pilot operation. It provides compass heading retention, altitude retention, automatically coordinated flight, both straight and in turns, and closely controlled vertical rates of climb and descent. In the pitch detent position of the controller grip, the automatic pilot will maintain the airplane at the pressure altitude at which the controller grip was last placed in the pitch detent, within about 0.3% over short intervals. A slow creeping rate of climb or dive of about 25 ft./min. may be noticed at altitudes up to 40,000 feet. A slight tendency to hunt about reference altitude may occur wherein the altitude may deviate from plus or minus 5 to plus or minus 20 feet at a frequency of approximately 20 to 30 seconds per cycle. A slight adjustment of the elevator trim tab will reduce this hunting. This creates a slight out-of-trim condition which will be indicated by the pitch trim indicator. Pitch axis stability with respect to rapid changes in pitch attitude of the airplane on automatic

# TYPICAL DIVE RECOVERIES FROM 10,000 FEET




ALTITUDE LOST IN DIVE RECOVERY FROM 10,000 FEET CONSTANT 4 G PULL-OUT

ALTITUDE LOST IN DIVE RECOVERY FROM 10,000 FEET CONSTANT 6 G PULL-OUT

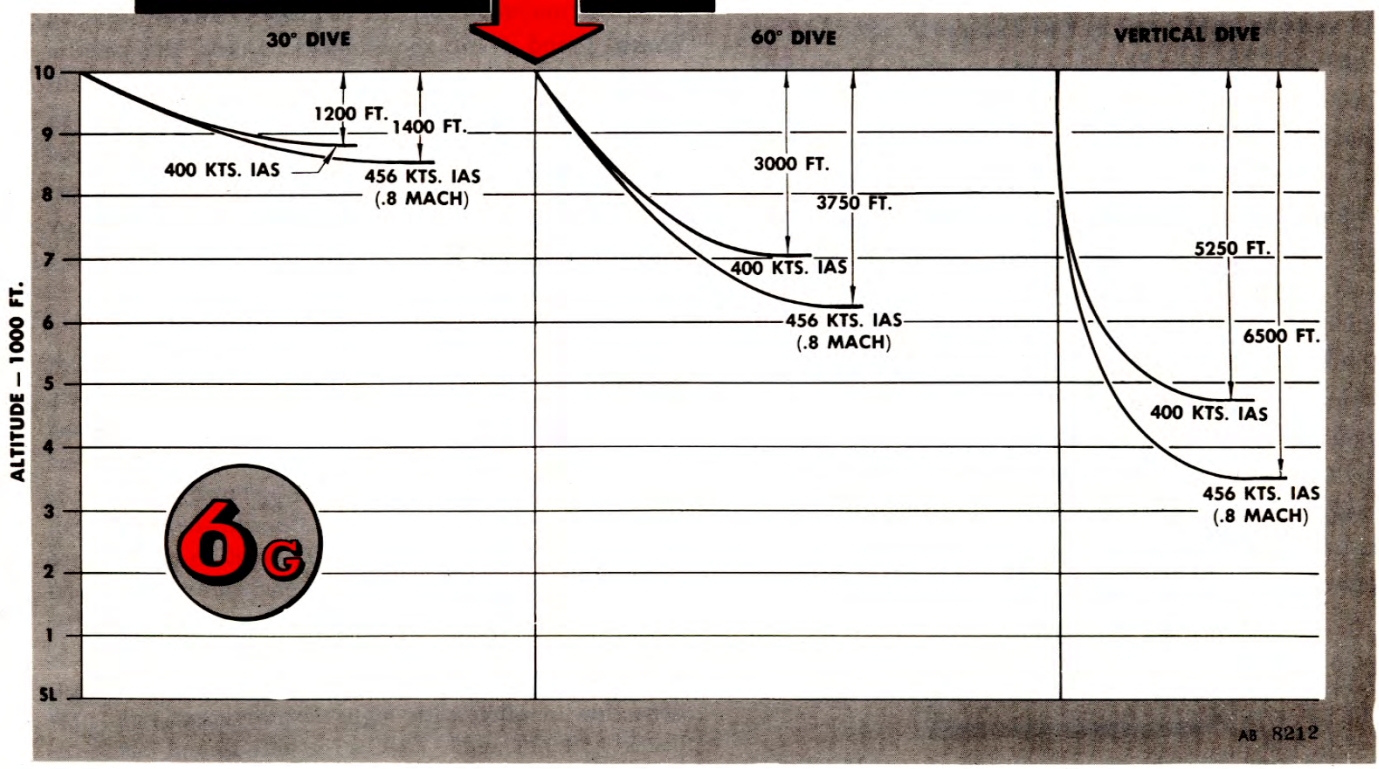



*Figure 6-6*

pilot is excellent and is especially useful above 40,000 feet and at high speed. Under this condition, the automatic pilot will maintain much closer and more stable pitch attitude control than can be obtained by the pilot manually. With automatic pilot operation within effective trim tab speed range, change the airplane trim to keep the pitch trim indicator at ZERO within plus or minus ⅛ inch at all times. With automatic pilot operation within the ineffective trim tab speed range use the same procedure as in manual flight. Although the automatic pilot will fly somewhat better on high elevator boost ratio, it can be flown in any boost ratio used for manual flying except in medium to high speed dives (350 knots IAS or over) or when using the afterburner. It is safe to turn the automatic pilot on or off at any boost ratio and make changes in the boost ratio with the automatic pilot on. At medium to high speeds (350 knots IAS or over), the automatic pilot requires high elevator boost ratio in order to maintain altitude or climb. It is possible to produce pitch maneuvers up to +3.8 G's at 420 knots IAS and −1.0 G at 300 knots IAS for pull-up and push-over respectively at high boost ratio. It is easy to hold a stable speed or vary it at will, using the controller grip. The automatic pilot will enable the pilot to fly the standard climb schedule from 10,000 feet up very well. Stall characteristics with the automatic pilot on in CRUISE mode are excellent with gear, flaps, or dive flaps up or down. In the yaw detent position of the controller grip, the automatic pilot will maintain a compass course heading well within the accuracy of the gyrosyn compass from which the heading information is derived. Moving the controller grip out of the yaw detent will produce coordinated turns. Maximum bank angle in coordinated turns for full controller deflection should not exceed 70 degrees. Climbing or diving coordinated turns may be made by simultaneous operation of the controller grip in both pitch and yaw directions. The coordination produced by the automatic pilot in turns and in straight flight is good and should not be more than ¼ ball width off on the ball indicator. Entry and recovery from turns are well coordinated.

**WARNING**

Do not attempt to use autopilot on ILAS take-off.

**RADAR MODE.**

This mode is to be used for automatic steering of the airplane in an attack on a target being tracked by E-5 fire control system. In this mode of autopilot operation, the azimuth and elevation steering error signals from the E-5 fire control system are fed into the radar-to-auto-pilot coupler as well as being presented as horizontal and vertical deflections of the steering dot on the pilot's scope. These error signals are modified by the coupler as necessary and supplied to the pitch and directional control circuits of the autopilot. The autopilot acts upon the control surfaces to cause each of these steering errors to be reduced toward zero. Whenever the combined errors exceed one degree the coupler causes rapid response of the airplane at a sensitivity to achieve fast reduction of errors, particularly in following evasive target maneuvers. Whenever the combined azimuth and elevation errors have been reduced and are being held to less than one degree, the radar coupler automatically increases the proportional strength of signals to the autopilot to reduce the errors to a very small value. At the same time the coupler responds much slower to error signal changes than it does when the error signal is large, in order to prevent instability and to ignore small extraneous variations in the error signals. As the coupler switches between operating conditions noted above a slight control stick movement may be noticed which should be too rapid for the airplane to follow. During phases I and II of an automatic attack, the coupler controls the autopilot from both azimuth and elevation error signals. During phase III the coupler controls in elevation only and azimuth control is maintained by the radar coupler, which returns the airplane to approximately level flight. Directional stability is maintained by lateral rate damping and by lateral acceleration.

**BOOST MODE.**

Motion of the autopilot controller grip in the BOOST mode produces angular rates independently in pitch, roll, and yaw, proportioned to the controller grip displacement in each of these directions. No attitude reference, altitude reference, or compass course reference is provided in the BOOST mode. Coordinated turns can be made by the pilot's manual coordination of the three motions of the controller grip. The autopilot is relatively weak in the BOOST mode and cannot be used for acrobatics. However, it is completely maneuverable through 360° in all directions. Maximum controller grip deflection in pitch with high elevator boost ratio produces +3.2 G's and −1.3 G's for pull-up and push-over at maximum speed and aft CG. Maximum roll rate is 40°/sec. to 60°/sec. Full 360° rolls may be made.

## AFTERBURNER.

When the afterburner is lit, the increase in thrust will be obvious. However, there will be no noticeable change of airplane trim at the time of lighting. The maximum level flight speed with afterburning is in the transonic range. Consequently some of the Mach number effects described previously will be encountered.

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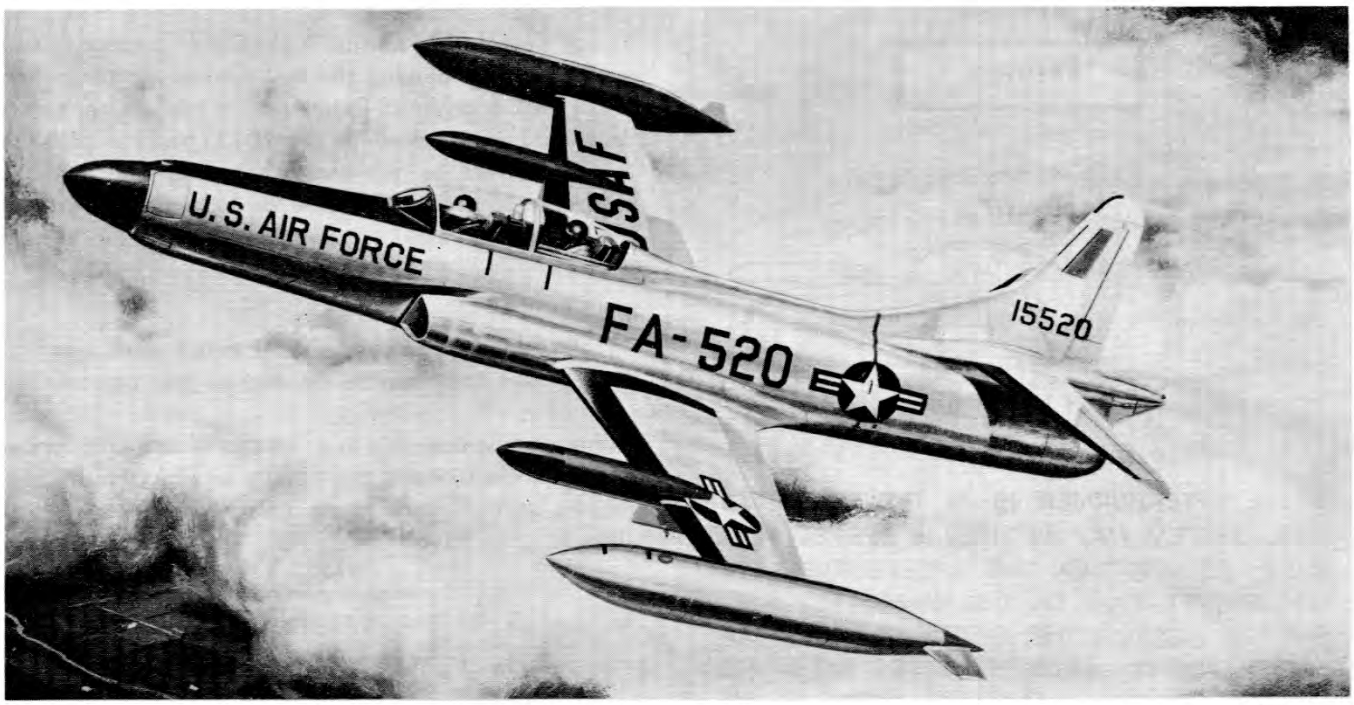


# systems operation

SECTION VII

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## ENGINE OPERATION IN FLIGHT.

### GENERAL OPERATION.

a. Climb, cruise, and military power operation must be within the limits shown in Section V of this Handbook.

**Note**

Tailpipe temperature control is of the utmost importance to the life of the engine and, therefore, it is essential that the limiting temperature for any given condition be strictly observed.

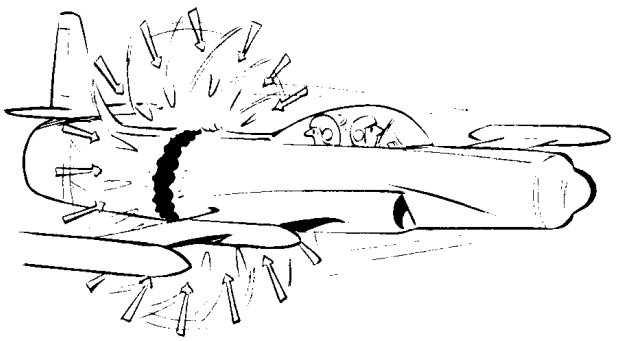
b. Refer to the charts in Appendix I for cruise power settings and performance data.

c. An inherent operating characteristic of the engine is the effect of speed and altitude upon the tailpipe temperature. During high rpm operation at low airspeeds, such as during climbs, the tailpipe temperature increases over the take-off value (at high airspeeds the tailpipe temperature generally decreases). In addition the tailpipe temperature increases with increasing altitude.

### THROTTLE OPERATION.

When operating on the normal fuel system, the rate at which the throttle may be moved without engine roughness and possible flameout decreases as altitude increases and varies considerably among engines. From sea level to 25,000 feet very little caution is necessary; from 25,000 to 35,000 feet some caution is necessary and above 35,000 feet all throttle movements should be made slowly and carefully.

**CAUTION**



IF THE AFTERBURNER IS ON, THE EMERGENCY FUEL SYSTEM MAY BE USED IF DESIRED. HOWEVER, DO NOT TURN THE AFTERBURNER ON WHILE OPERATING ON THE EMERGENCY FUEL SYSTEM, BECAUSE THE AFTERBURNER NOZZLE OPENS SEVERAL SECONDS BEFORE THE AFTERBURNER IGNITES AND SINCE THERE IS NO OVERSPEED GOVERNOR IN THE EMERGENCY SYSTEM THE ENGINE WILL OVERSPEED WHEN THE AFTERBURNER IGNITES.

**Roughness.**

Combustion roughness can be expected for any operation of the afterburner at approximately 30,000 feet, or above, or may be encountered when operating at maximum rpm without afterburner at these altitudes. Although combustion roughness causes no damage and may vary in intensity from engine to engine, forward throttle movements must be made with extreme care at high altitudes, since roughness is more severe when the engine is accelerated and the possibility of acceleration flameout is increased. When operating at maximum or near maximum power, such as in a climb, an increase in speed will tend to reduce roughness by decreasing jet temperatures.

**WARNING**

Tailpipe temperature must be maintained during accelerations and must not exceed the maximum limit at any time, or engine damage may result.

**Operating on Emergency Fuel System.**

When the engine is operating on the emergency fuel system, the throttle movements must be made slowly to prevent blow-out, flameout, over-speeding, or overtemperature operation. The emergency control does not regulate the fuel flow during accelerations and decelerations.

At any time during normal flight the emergency system can be used by moving the fuel system selector switch to the EMER. position. Except during take-off, the throttle should be retarded to the IDLE position prior to the switchover to prevent overfueling and possible blow-out. It is also desirable to have the throttle in IDLE position when transferring back to the normal system.

**Note**

The engine fuel system reset switch must also be used to return to the normal fuel control.

Although it is desirable to make fuel system transfers at idle rpm, changeovers can usually be satisfactorily performed at high rpm in an emergency if at medium altitude.

**CAUTION**

Changeover to the emergency system at high rpm at *high altitude* may result in acceleration "blow-out."

**Idle Operation.**

The normal engine fuel control will not allow the fuel flow to fall below that required for engine operation. With the throttle in IDLE position, normal idle engine speed will be obtained at low altitude, but at high altitude, the idle rpm will increase: at 40,000 feet the idle rpm will be approximately 75%-80%. The IDLE setting may be used at any altitude without danger of deceleration flameout or roughness.

## MANUAL AFTERBURNER NOZZLE OPERATION WITHOUT AFTERBURNER.

The afterburner nozzle override switch can be moved to MAN OPEN at any time during engine operation without the afterburner operating to induce greater cooling air flow through the aft fuselage and reduce tailpipe temperatures.

**Note**

Return the switch to AUTO to close the nozzle.

## AFTERBURNER OPERATION IN FLIGHT.

Afterburning should be used only when airplane performance at maximum power is desired, such as for maximum take-off and climb performance to increase airspeed rapidly in dives or during combat maneuvers, to minimize airspeed loss while pulling G's. Afterburning should not be used for cruising flight due to the high rate of fuel consumption.

The afterburner is started in flight, using the same procedure as on the ground, by moving the throttle outboard into the slot anywhere between the 93% and 100% rpm position. Afterburner operation can then be controlled between 93% and 100% rpm as desired. The afterburner may be stopped anywhere in this rpm range by inboard movement of the throttle. In all afterburner starts, the throttle should be advanced smoothly, especially at high altitudes, to prevent acceleration rumble and possible engine blowouts.

**Afterburner Starts.**

Positive afterburner starts on the first attempt at high altitude are not assured. If the afterburner has not started within 10 seconds, retard the throttle out of afterburner position and try again. If the afterburner still does not light, a successful start may be accomplished by reducing altitude several thousand feet.

**CAUTION**

If the afterburner should go out, and fuel pressure continue, the nozzle will stay open until the throttle is pulled out of afterburner position to cut off the afterburner fuel. When the throttle is moved out of the afterburner slot, afterburner fuel flow will be stopped, and the afterburner nozzle will close. The throttle may then be advanced to the mechanical stop at the FULL position for operation without the afterburner.

**Afterburner Nozzle.**

Whenever the afterburner is operating, be alert for sudden tailpipe temperature or power increases that may be caused by closing of the afterburner nozzle. If this should occur, as indicated by afterburner nozzle indicator light going out, either open the nozzle with the afterburner nozzle override switch or shut the afterburner off.

**CAUTION**

When shutting off the afterburner, check that the afterburner nozzle position indicator light goes out.

## SEVERE ENGINE VIBRATION.

Severe vibration is encountered when turbine bucket failures are experienced in J48-P-7 engines during flight. Continued operation of the engine, when vibration is encountered, will result in failure of the turbine oil seals and subsequent loss of oil. Should severe vibration be experienced in flight use the following procedure:

a. Fuel control selection should remain on normal operation when vibration is encountered, unless some previous trouble has required change to the emergency system.

b. Adjust engine speed, slowly, to a setting which will give minimum vibration. Broken buckets in test engines have produced maximum amplitude of vibration in the ranges of 69 to 71 percent and 80 to 82 percent rpm. Therefore, an engine speed setting above or below these ranges may be selected; however, it is recommended that the engine speed be reduced to the lowest rpm possible to maintain adequate flying speed.

c. The adjusted engine speed will not eliminate engine vibration but will reduce its severity to a minimum and will allow continued use of the engine until a landing can be made.

d. A normal landing should be made as soon as possible, if severe vibration is encountered in flight.

e. Closely watch tailpipe temperature gage; if the temperature rises above 800°C, shut down the engine and shut off the cockpit air with the pressure shut off switch. Check for presence of fire in aft section, and land as soon as possible.

**Note**

Test engines have operated approximately 1½ hours at the maximum amplitude of vibration before running out of oil.

## FUEL SYSTEM OPERATION IN FLIGHT.

The fuel system is automatic, requiring no control by the pilot unless pylon tanks are carried. In this case the fuel from the pylon tanks is used before the fuel from the tip tanks by placing the external tank fuel selector switch in the PYLON FUEL position.

**Note**

When using pylon tank fuel, watch for a drop in the fuel quantity indicator reading then switch to tip tank fuel.

**CAUTION**

If the afterburner is on, the emergency fuel system may be used if desired. However, do not turn the afterburner on while operating on the emergency fuel system, because the afterburner nozzle opens several seconds before the afterburner ignites and since there is no overspeed governor in the emergency system the engine will overspeed when the afterburner ignites.

## CONTROL TRIM OPERATION.

### AILERON TRIM OPERATION IN FLIGHT.

The control stick trimer and the aileron trim tab operate separately. Normally the airplane is flown with the aileron booster on, and loads on the control stick are neutralized by using the control stick trimmer. The aileron trim tab should be kept in neutral and used only when the aileron booster is turned off.

### ELEVATOR TRIM AND ELEVATOR BOOST RATIO OPERATION IN FLIGHT.

The airplane may be trimmed for changing loads by the elevator trim tab up to the maximum level flight speeds of the airplane. Above those speeds, or in dives, the tab becomes ineffective and it should be left in neutral.

#### Elevator Boost Ratio.

The elevator boost ratio may be adjusted to suit the feel of the individual pilot any time the boost is on. However, the following recommendations are made for its use:

a. Low boost ratio is recommended for take-off, climb, cruising, and landing.

b. Medium boost ratio is recommended for high Mach number dives and flight above approximately 450 knots.

c. Maximum boost ratio is recommended for recovery from maximum speed dives at low altitude.

d. Due to the reduced effectiveness of the elevator servo at low boost ratio, turning on the afterburner with the autopilot operating may cause the airplane to gradually lose altitude. Therefore, autopilot operation at medium to high speeds, (350 knots IAS or over), or with afterburner on, requires maximum elevator boost ratio to maintain altitude control operation. At lower speeds any boost ratio may be used; however, except as noted above, it is recommended that boost ratio normally used for manual flying be used during autopilot operation, so that if the autopilot is disconnected, normal elevator "feel" will be present for manual operation.

## ELECTRICAL SYSTEM.

### USE OF THE FIELD FLASHING CIRCUIT FOR THE 30 KVA ALTERNATOR.

Erratic operation of the 30 KVA alternator may be caused by polarity reversal of the alternator exciter. The most common reason for polarity reversal is the presence of hydraulic oil on the commutator and the slip rings and their respective brushes and brush riggings. The characteristic indication of exciter polarity reversal is violent fluctuation of the voltmeter when the voltmeter selector switch is turned to 30 KVA ALT. position for reading alternator voltage. The fluctuations can be comparatively slow depending on the rotating speed of the alternator. In most cases the polarity reversal can be corrected by using the field flashing circuit. The circuit automatically applies direct current of the proper polarity from the ship's direct current system through a resistor to the exciter field of the alternator when the alternator field switch is turned to the 30 KVA ALT. position. If the voltmeter fluctuates when reading alternator voltage, apply the following procedure:

1. Check to see that the wing and empennage de-icing switch is OFF, and if not, turn it OFF.
2. Turn the 30 KVA alternator field switch, located on the center control panel, to the OFF position and immediately back to the 30 KVA ALT. position.

**Note**

This separate excitation remains on for approximately two seconds and then a time delay relay opens the circuit and locks it out until such time as the 30 KVA alternator field switch is turned OFF or until the ship's direct current system is de-energized.

3. Check voltmeter to insure that voltage is normal.
4. Turn de-icing switch to WING & EMP. if desired.

**Note**

Under certain circumstances it may be necessary to repeat steps 2 and 3. If this is the case, wait one full minute before turning the 30 KVA alternator field switch to the 30 KVA ALT. position the second time in order that the thermally operated time delay may return to normal.

### 8 KVA ALTERNATOR.

Have radar observer check that voltage is between 112.5 and 130.0 volts.

**CAUTION**

If adjustments of the generator or alternators is necessary before the systems have warmed up (30 minutes operation), continued rechecking the adjustments until warm-up is complete.

## WHEEL BRAKE OPERATION.

In order to prevent accidents and reduce maintenance difficulties caused by wheel brake failure, it is important that the brakes be operated properly. Procedures such as stopping the aircraft as quickly as possible, regardless of runway length, consistently using the brakes for speeding up turns, and dragging the brakes while taxiing, all tend to cause excessive brake wear, reducing brake life considerably.

### OPTIMUM BRAKING OPERATION.

Brakes, themselves, can merely stop the wheel from turning, but stopping the airplane is dependent on the friction of the tires on the runway. For this purpose it is easiest to think in terms of coefficient of friction which is equal to the frictional force divided by the load on the wheel. It has been found the optimum braking occurs with aproximately a 15 to 20 percent rolling skid; i.e. the wheel continues to rotate but has approximately 15 to 20 percent slippage on the surface so that the rotational speed is 80 to 85 percent of the speed which the wheel would have were it in free roll. As the amount of skid increases beyond this amount, the coefficient of friction decreases rapidly so that with a 75 percent skid the friction is approximately 60 percent of the optimum and, with a full skid, becomes even lower. There are two reasons for this loss in braking effectiveness with skidding. First, the immediate action is to scuff the rubber, tearing off little pieces which act almost like rollers under the tire. Second, the heat generated starts to melt the rubber and the molten rubber acts as a lubricant. Figures have shown that for an incipient skid with an approximate load of 10,000 lbs. per wheel, the coefficient of friction on dry concrete is as high as .8, whereas the coefficient is of the order of .5 or less with a 75 percent skid. Therefore, if one wheel is locked during application of brakes there is a very definite tendency for the airplane to turn away from that wheel and further application of brake pressure will offer no corrective action. Since the coefficient of friction goes down when the wheel begins to skid, it is apparent that a wheel, once locked, will never free itself until brake pressure is reduced so that the braking effect on the wheel is less than the turning moment remaining with the reduced frictional force.

### BRAKE OPERATION AT HIGH SPEED.

Use extreme care when applying brakes immediately after touchdown or at any time when there is considerable lift on the wings to prevent skidding the tires and causing flat spots. A heavy brake pressure can result in locking the wheel more easily if brakes are applied immediately after touchdown than if the same pressure is applied after the full weight of the aircraft is on the wheels. A wheel once locked in this manner immediately after touchdown will not become unlocked as the load is increased as long as brake pressure is maintained. Proper braking action cannot be expected until the tires are carrying heavy loads. If maximum braking is required immediately after touchdown, lift should first be decreased as much as possible by raising the flaps and dropping the nose before applying brakes. This procedure will improve braking action by increasing the frictional force between the tires and the runway. For short landing rolls, a single, smooth application of the brakes with constantly increasing pedal pressure is most desirable. The full landing roll should be utilized to take advantage of aerodynamic braking and to use the brakes as little and as lightly as possible.

### BRAKE COOLING.

Whenever a landing requires braking action, a time interval should be allowed for brake cooling before another such landing is attempted. It is recommended that this interval between landings be a minimum of fifteen minutes if the landing gear remains extended in the slipstream, and thirty minutes if the landing gear is retracted. Additional time should be allowed for cooling if brakes are used for steering or cross-wind taxiing. After the brakes have been used excessively for an emer-

gency stop and are in a heated condition, the aircraft should not be taxied into a crowded parking area. Peak temperatures occur in the wheel and brake assembly from five to fifteen minutes after a maximum braking operation. The brakes should not be dragged when taxiing and should be used as little as possible for turning the aircraft on the ground.

**CAUTION**

To prevent brake fire, and possible wheel assembly explosion, it is important that the recommended procedure for brake cooling be followed.

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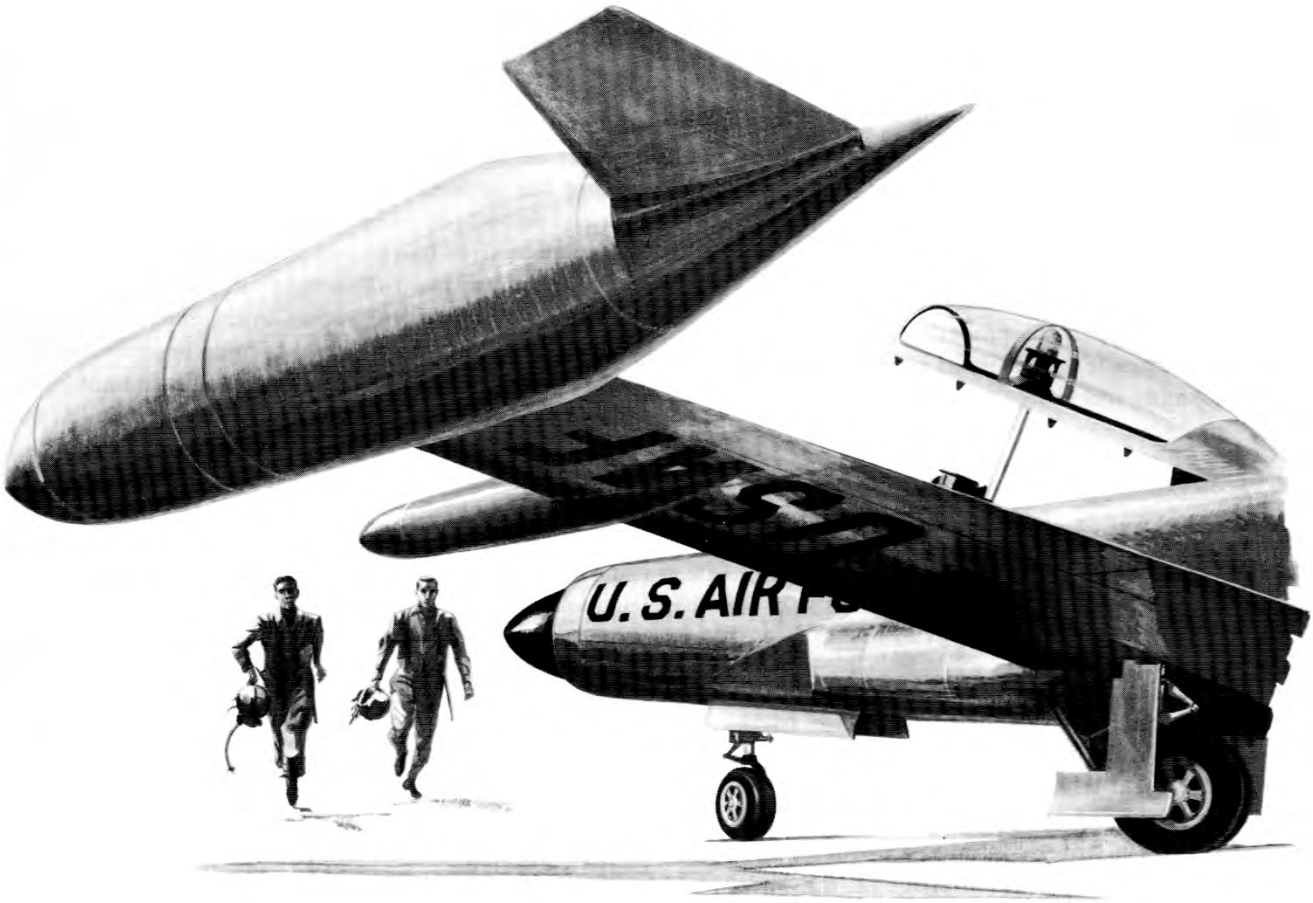

# crew duties

SECTION VIII

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## PILOT DUTIES.

Flying the airplane is the primary duty of the pilot and the procedures are given in Sections II and III of this Handbook. The pilot also has the secondary duties of controlling and operating the auxiliary equipment discussed in Section IV.

## RADAR OBSERVER DUTIES.

The primary duty of the radar observer is controlling the radar equipment so that the pilot is given the optimum chance of shooting down enemy aircraft or of identifying aircraft when considered necessary. Secondary duties of the radar observer consist of:

a. Assisting the pilot with navigation by use of D.R., radio compass operation, ground map and beacon features of the radar equipment.

b. Simple in-flight maintenance of the radar equipment.

c. Checking generator and alternator output by means of the ammeter and voltmeters installed in his cockpit.

d. Assisting the pilot in preflight inspections of the aircraft, and initiating check lists before and during flight.

## RADAR OBSERVER CHECK LIST.

### Pre-Start Check:

1. Seat belt and shoulder harness—Check.
2. UHF master control panel. (Front cockpit on some aircraft.)
   a. ON-OFF switch—OFF.
   b. Mode selector switch—BOTH.
   c. Local-remote switch—REMOTE.
   d. Tone—voice switch—VOICE.
3. Head set volume—FULL INCREASE.
4. Radio compass—OFF.
5. Cockpit lights—As desired.
6. Oxygen system—Check.
   a. Oxygen pressure—1800 psi.
   b. Oxygen regulator supply lever—ON.
   c. Oxygen regulator warning system switch—ON.
   d. Oxygen regulator diluter lever—100%.
   e. Oxygen regulator and blinker—Check. Test masks for leaks.
   f. Oxygen regulator diluter lever—As required.
   g. Oxygen regulator emergency toggle lever—Checked and centered.
   h. H-2 oxygen cylinder—Tag and pin removed, hose connected.
7. Altimeter—Set to field elevation. Note error.
8. Airspeed indicator—30-35 knots.
9. Radar power switch—OFF.
10. All radar controls—COUNTERCLOCKWISE.
11. Fuel potentiometer—SET ON 2380 to 2400.
12. Map light—Stowed.
13. Canopy locking handle—Stowed.
14. Canopy jettison handle—In place and safetied.
15. Air grilles—As desired.
16. Seat belt and shoulder harness—Adjusted and fastened.
17. Headset and oxygen—Connected.
18. Foot operated radio cut-out switch—Clear.
19. All loose objects—Stowed.

### Radar Pre-Operation Check:

1. Master power switch—OFF.
2. Controls—COUNTERCLOCKWISE.
3. Short range search.
4. Pressure—13-20 psi.
5. Pressure switch—AUTO.
6. Test selector switch—DISCONNECT.
7. El scan—HORIZONTAL.
8. Operation switch—SHORT PULSE.
9. Az scan—BROAD.
10. Clutter eliminator—OUT.
11. Circuit breakers—IN.

**Pre-Taxi Check:** (Check with pilot).

1. Battery switch—BATTERY.
2. Check for removal of ground safety pins. (Except right arm rest pin.)
3. Interphone—Check operation.
4. 2500 VA inverter—ON.
5. Alternators—ON.
6. Control stick—Trimmed to center.
7. Elevator and aileron controls—Free and correct movement.
8. Loadmeter—Check .65 maximum.
9. Fuel pump failure warning light—OFF.
10. UHF command radio—T/R + G REC.
11. IFF—STANDBY.
12. Flaps—Set at 32°.
13. Canopy—Clear, ladder removed, then PART CLOSED.
14. Radio compass—Check operation in ANTENNA, COMPASS, and LOOP positions, check L-R switch.

**Before Take-Off Check:** (Check with pilot).

1. Air pressure warning light—OFF.
2. Seat belt and shoulder harness—Secured.
3. Canopy—Cleared, closed, locked and unlatched. Warning light out.
4. Speed brakes—UP. A/B nozzle closed.
5. Emergency fuel system warning light—OFF.
6. Flaps—Set at 32°.
7. Elevator tab neutral indicator—ON.
8. Elevator and aileron boost shut-off lever—ON. Elevator boost ratio—LOW. Check free and correct movement of flight controls.
9. Gyro driven instruments—Operating properly.
10. Pitot heat—As required.
11. Radio call—As required.

**Radar Turn-On:** (When airborne unless on a Tactical Scramble).

NOTE: Turning on radar during a night take-off may seriously impair the pilot's vision.

1. 8 KVA and 2500 VA—Check voltage indications.
2. Radar pressure—Within limits.

3. Master power switch—STANDBY.
4. Check voltages A, B, K, L, M, N, P, R, and S.
5. Check press to test lights.
6. Intensity control—½ turn clockwise.
7. Master power switch—OPERATE when range trace is visible.
8. Reduced power light—OFF.
9. Check voltages C, D, E, F, G, H, and J.
10. Computer light—ON.

**After Take-Off Check:**

1. Oxygen regulator diluter lever—NORMAL.
2. Airspeed indicator—Check IAS against pilot's IAS.
3. Altimeter—Check against pilot's indication after level-off.
4. Heading indicator—Check against pilot's indication.

**In-Flight Check:** (Check with pilot).

1. Oxygen—Check for proper feeding at 20,000 feet on a climb.
2. Fuel quantity—Check periodically.
3. Altitude—Check every 10,000 feet on a descent.

**Before Landing Check:** (Check with pilot).

1. Elevator boost—Low ratio.
2. Seat belt and shoulder harness—Tight.
3. Oxygen—As required.
4. Ailerons—Check visually for excessive trim.
5. Hydraulic pressure and fuel quantity—Check.
6. RADAR—OFF and scope stowed (turn radar off at least 5 minutes before landing or after touchdown).

**Landing Pattern Check:** (Check with pilot).

1. Landing gear—Check down and locked.
2. Wheel brakes—Check for pressure.
3. Flaps—Check for full down position on final approach.

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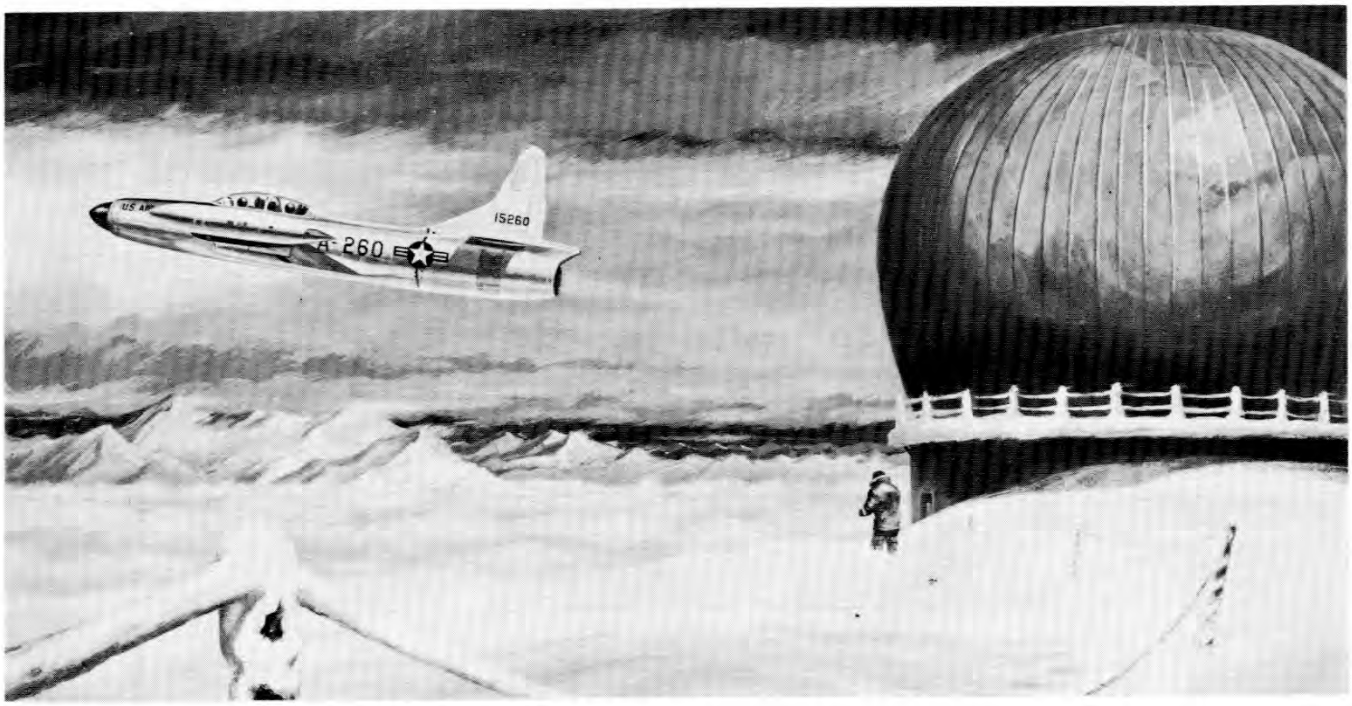


# all weather

SECTION IX

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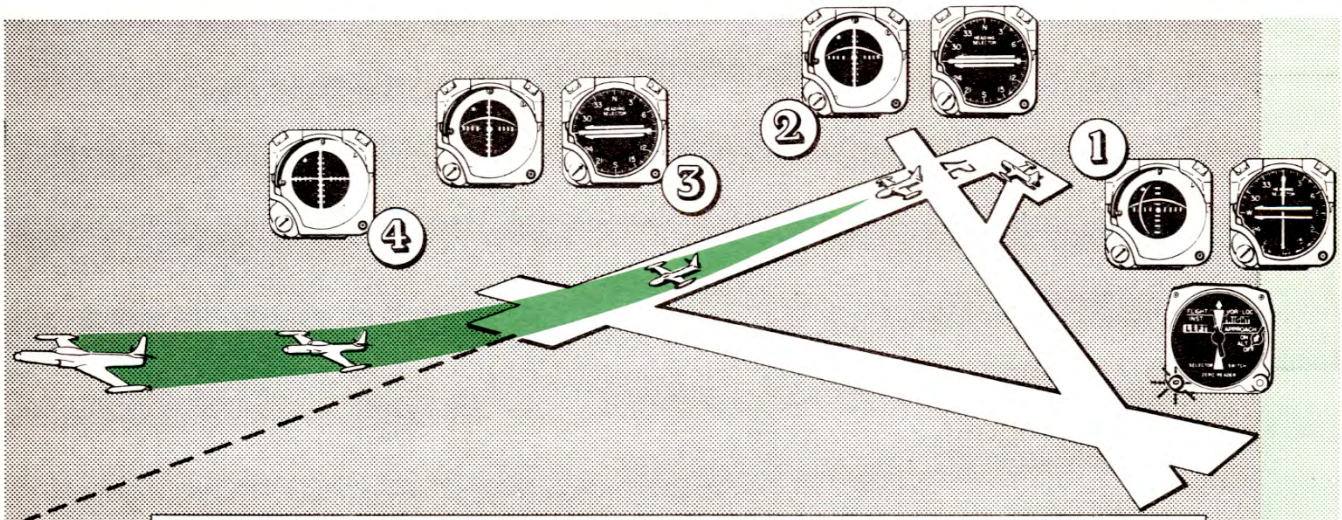
## INTRODUCTION.

Except where repetition is 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 outlined in Section II.

## INSTRUMENT FLIGHT PROCEDURES

Instrument flying in this aircraft, as in all jet fighters, requires constant attention to all flight instruments. However, use of the automatic pilot, zero reader and ILAS systems reduce the strain of flying under instrument conditions. 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 and/or endurance of the airplane if required to land in IFR conditions, is reduced accordingly. Furthermore, consideration must be given to loss of range on jet aircraft resulting from decreased rate of descent that may be imposed during instrument flight: i.e. holding in a stack and the different types of penetration procedures of radio aids. The aircraft has good stability characteristics and flight handling qualities for weather flying. The zero reader indicator provides all the attitude information you need to safely fly a predetermined flight path. Reference to the normal flight instrument readings should be made as a cross-check on the performance of the zero reader. The automatic pilot will hold the course and altitude you select, will make climbs and descents and will make coordinated turns when changing heading. With experience, the zero reader and auto pilot can be used from take-off to landing in all kinds of weather. The ILAS system was designed to permit the execution of a safe approach to a landing

# USE OF THE ZERO READER ON INSTRUMENT TAKE-OFF




1 ACCOMPLISH BEFORE-TAKE-OFF CHECK LIST AND:
   a. SET ZERO READER SELECTOR SWITCH TO "FLIGHT INST."
   b. SET HEADING SELECTOR DOUBLE POINTER TO COINCIDE WITH RUNWAY HEADING.
   c. SET HORIZONTAL BAR OF ZERO READER INDICATOR FOR 2 1/2 INCREMENT FLY-UP SIGNAL.
2 TAXI INTO POSITION AND START TAKE-OFF USING NORMAL PROCEDURE.
3 MAINTAIN DIRECTION BY HOLDING VERTICAL BAR ON "ZERO".
4 LIFT THE AIRPLANE OFF THE RUNWAY IN THE NORMAL MANNER AND "ZERO" THE HORIZONTAL BAR. THE TWO AND ONE HALF INCREMENT FLY-UP SETTING WILL AUTOMATICALLY PROVIDE A SAFE AND EFFICIENT CLIMB.

**CAUTION**

THE OTHER FLIGHT INSTRUMENTS SHOULD BE CROSS-CHECKED TO INSURE SAFE FLIGHT IN THE EVENT OF ZERO READER MALFUNCTION.

*Figure 9-1*

runway during minimum IFR conditions. It can be utilized as an individual flight instrument or, when properly engaged with the automatic pilot, will provide glide path and heading information for the auto pilot to follow. The same information is provided for the zero reader when the ILAS is properly engaged to that instrument.

**Note**

If the automatic pilot and zero reader are inoperative, your attentions will be constantly required to observe changes in the flight instrument readings, particularly the attitude indicator. The airplane is sensitive to the touch so use light control pressures at all times. Make slow entries into and out of turns and keep the airplane trimmed at all times.

## ON ENTERING AIRPLANE.

Check the map case to make sure that all the necessary charts and publications are available. After determining that a suitable external power source has been connected, the AN/APG-40 and AN/APX-6 radar equipment should be placed in standby operation, and the pitot de-icer, lighting equipment, and zero reader should be checked thoroughly (see Section IV for zero reader checks). After the engine is running, check the automatic pilot for proper operation (see Section IV for auto pilot checks).

## TAXIING.

Check for proper operation of the turn and slip indicator, heading indicator, and the radio compass pointer during turns.

## BEFORE TAKE-OFF.

1. Line up visually with runway centerline.
2. Heading indicator—Set to take-off runway heading and pointer at the top of the dial.
3. Attitude indicator—Set.
4. Zero reader heading selector—Set to runway heading.
5. Zero reader pitch attitude trim knob—Set horizontal bar 2½ dots up (for climb angle with afterburner).
6. Throttle—Advance to obtain 100% rpm.

**INSTRUMENT TAKE-OFF AND INITIAL CLIMB.**

1. Release brakes and advance throttle to the afterburner position.
2. Maintain heading with brakes until rudder becomes effective at approximately 60 knots.
3. Take-off at normal airspeed.
4. Establish initial climb by reference to the zero reader, cross-checking with attitude indicator, vertical velocity indicator and altimeter.
5. Landing gear control lever—UP when definitely airborne.
6. Wing flap switch—UP (160 to 175 knots IAS).

**Note**

Only a slight additional nose-up trim will be required when the flaps are retracted.

**CLIMB.**

After desired climb airspeed and attitude is obtained, reset the zero reader horizontal bar to zero position by use of the pitch attitude trim knob. Limit bank angles to 30°. The maximum bank angle required to center the zero reader is 30°.

**Note**

Required nose-up pitch attitude to maintain continuous climbing airspeeds without afterburner is approximately one-half that required with the afterburner operating. As aircraft attitude changes with changes in airspeed, it will be necessary to continually re-adjust the zero reader horizontal bar in the climb.

**CLIMB WITH AUTOMATIC PILOT.**

The auto pilot flies the climb schedule very well from 10,000 feet up and may be placed into operation during a climb as follows:

1. Automatic pilot power switch—ON.
2. Channel selector switches—YAW, ROLL, and PITCH.
3. Pitch, roll, and trim knobs—NEUTRAL.
4. Mode selector switch—CRUISE.
5. Roll trim knob—adjust for wings level flight.

**DURING INSTRUMENT CRUISING FLIGHT.**

The zero reader and automatic pilot are highly advantageous to the pilot during instrument flight. They relieve the strain of manually flying the airplane and permit more time for in-flight navigation and position reports. The zero reader may be used as a flight instrument (without radio navigation signals). Although practically self-sufficient when used in this manner a continuous cross-check of other flight instruments is considered necessary. The procedure for making climbs using the zero reader is shown on Figure 9-2. The procedure for making turns is shown on Figure 9-3. Those procedures can also be combined to produce climbing turns. When cruising speed is attained, the attitude indicator should be adjusted to indicate level flight. The heading indicator pointer should be rotated to the top of the dial for maximum accuracy in maintaining the desired headings.

**Note**

Before starting turns, rotate the heading indicator until the new heading is under the index mark at the top of the dial.

**UNUSUAL MANEUVERS.**

The fastest recovery from unusual maneuvers and/or positions is made by reference to the airspeed, altimeter, turn and slip indicator and attitude gyro. (Listed in order of importance.)

**RADIO AND NAVIGATION EQUIPMENT.**

The automatic pilot may be used in conjunction with the zero reader. The only difference is that you maneuver the airplane with the automatic pilot controller grip instead of with the control stick. Upon reaching cruise altitude, turn zero reader altitude control switch ON and accelerate to cruising speed. At cruising speed, put the autopilot mode selector switch in STANDBY and trim the airplane and auto pilot as described in Section IV. Return the autopilot mode selector switch to CRUISE and turn all three channel switches ON. Use of the zero reader in turns is described in Figure 9-3. After roll out from turns, the attitude indicator may still show a wing down position because of precession. The zero reader and/or the horizon indication on the radar scope should be used for accurate heading and attitude presentation during this period.

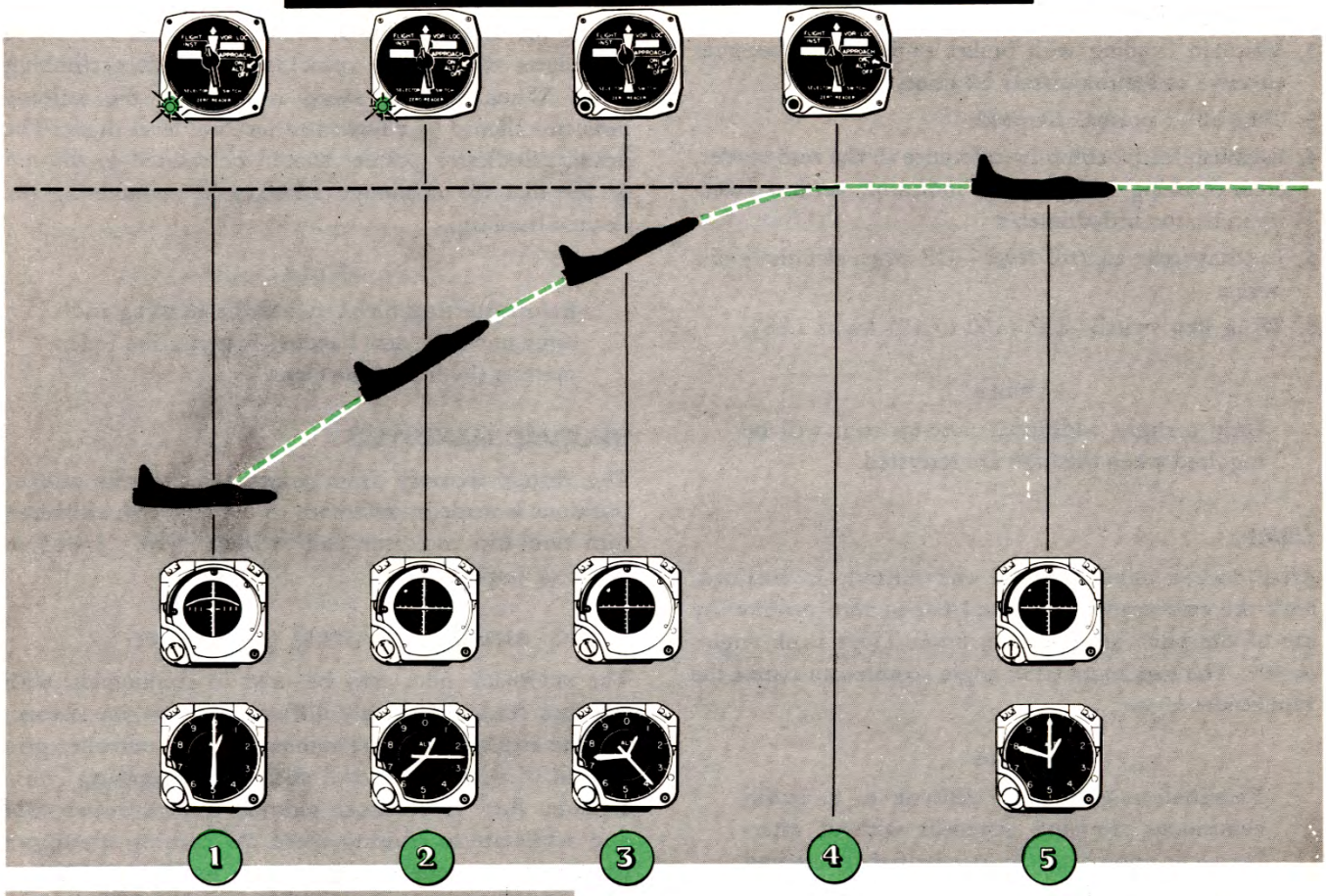
**Note**

The J-8 type attitude indicator will normally remain in a right wing down indication (up to 10°) for roll out from turns to right or left. As much as two (2) minutes may be required to precess back to a straight and level indication. The gyro can be manually erected to cut precession time by pulling out the cage knob.

**DESCENTS.**

Steep straight ahead descents without turns can be made in weather without difficulty. Instrument descents can be made with or without speed brakes. However, to limit airspeed and distance covered at high rates of

# CLIMBS WITH ZERO READER




1 A TURN ZERO READER SELECTOR SWITCH TO "FLIGHT INST."
B TURN "ALTITUDE" CONTROL SWITCH "OFF" (GREEN LIGHT WILL GLOW).
C SET ZERO READER INDICATOR HORIZONTAL BAR TO GIVE A FLY-UP SIGNAL (TWO INCREMENT GIVES THE SAFEST AND MOST EFFICIENT CLIMB) OR TO GIVE A FLY-DOWN SIGNAL IF A DESCENT IS DESIRED.

2 ZERO THE HORIZONTAL BAR.

3 KEEP THE HORIZONTAL BAR ZEROED.

4 WHEN THE NEW ALTITUDE IS REACHED TURN THE "ALTITUDE" CONTROL SWITCH "ON."

5 A RE-ZERO THE HORIZONTAL BAR.
B RETURN PITCH ATTITUDE TRIM KNOB TO ITS NORMAL VERTICAL POSITION (THE ARROW PROVIDES A MEANS OF REFERENCE).

*Note*

CLIMBS AND DESCENTS ARE MADE IN A SIMILAR MANNER.

*Figure 9-2*

descent, use of speed brakes is recommended. With speed brakes extended and throttle at IDLE, descents at high airspeeds, particularly at the lower altitudes, become very steep and recovery from such descents requires several thousand feet. Descents at steep angles are not recommended below 10,000 feet. The following procedures are recommended for descents in weather:

1. Auxiliary windshield defroster switch WINDSH. DEFROST.
2. Cockpit air control selector—DE-ICE.

**Note**

It is recommended that the defroster system be turned on 10 to 15 minutes before descents are started, especially if a rapid descent is contemplated.

3. Speed brake switch—DOWN.
4. Throttle—IDLE.

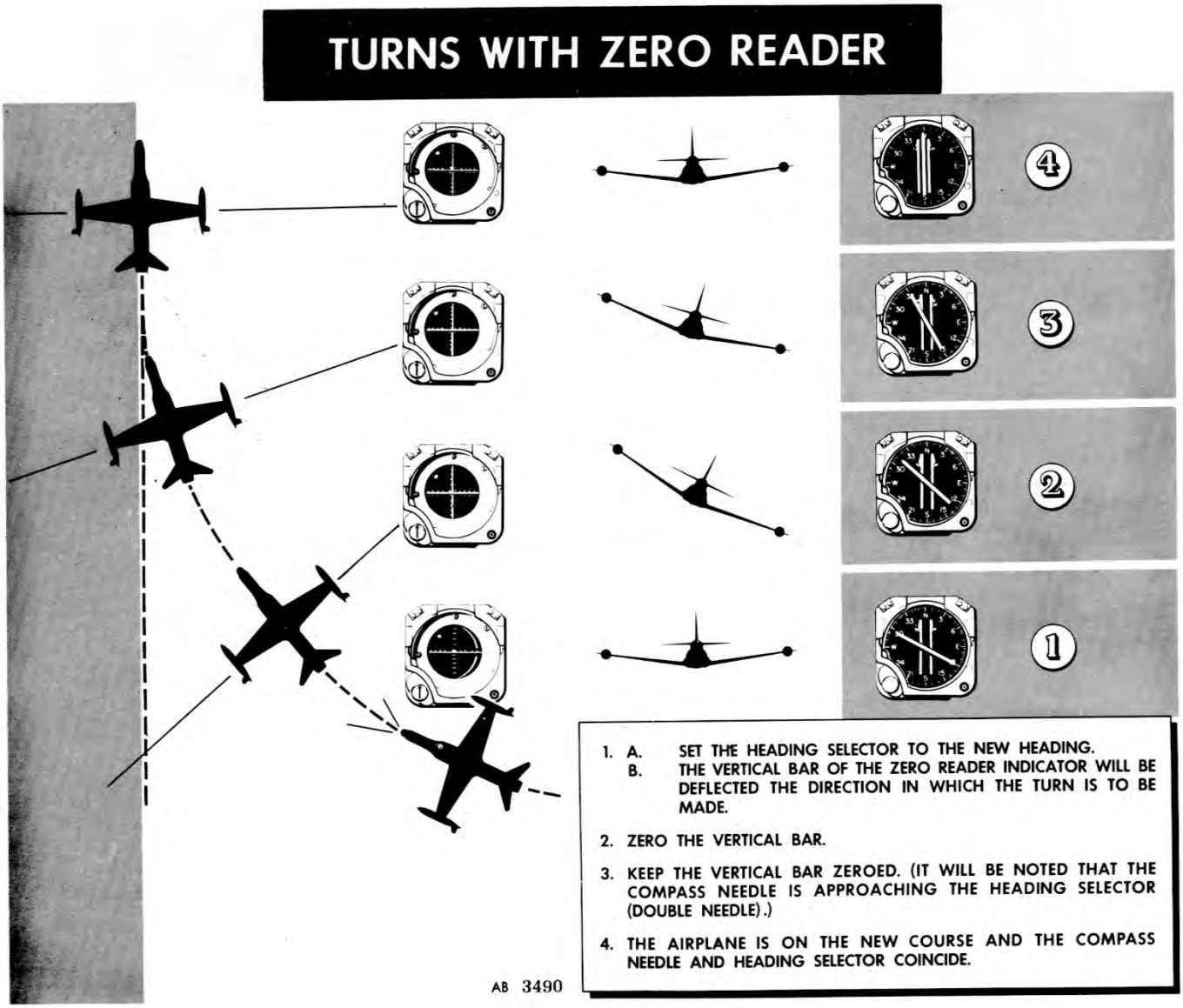



*Figure 9-3*

**CAUTION**

During descents in heavy rain there is a possibility of flame-out caused by excessive amounts of water entering the engine. Therefore sufficient engine rpm should be maintained to keep the jet temperature at least 400 degrees C.

**Note**

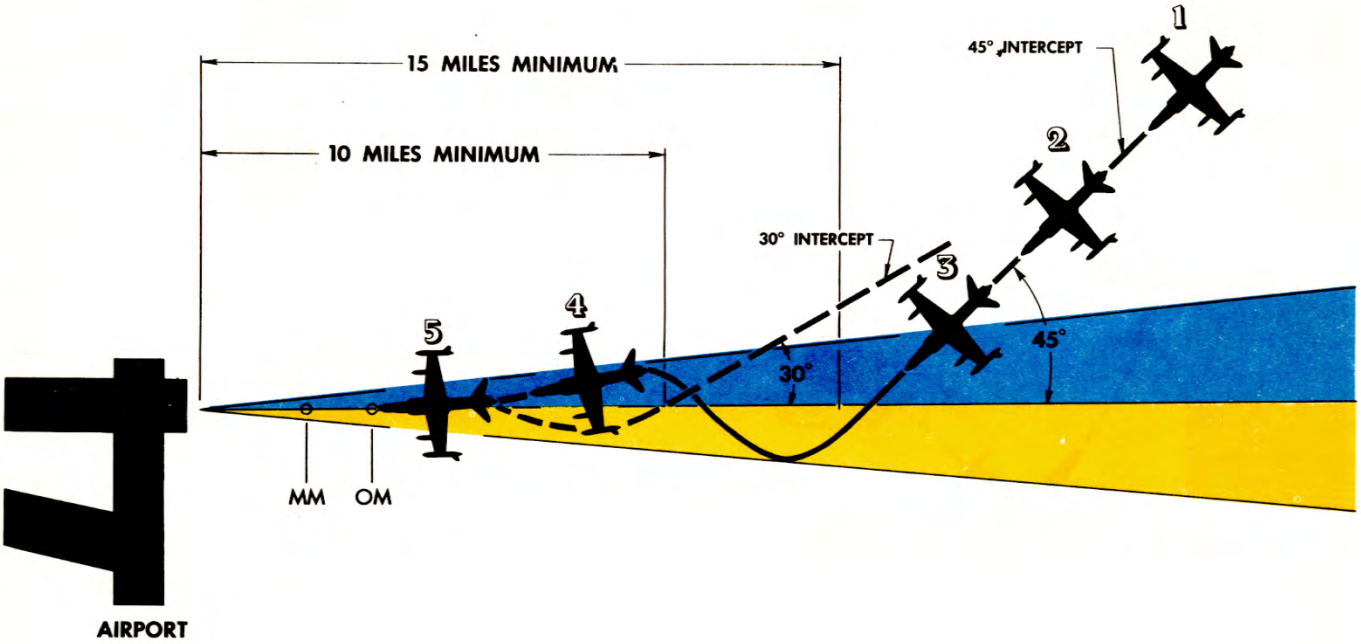
At steep pitch angles during high rates of descent at idle power with speed brakes down, the horizon bar of the attitude indicator rises to a position very high on the instrument face, making accurate determination of pitch difficult. The niniature plane should be left at the level setting; however, during descents, cross reference should be made with the airspeed indicator to monitor pitch attitude.

5. Turns—Limit bank to 30°.

**CAUTION**

Descending turns at high rates of descent become progressively more difficult to control as bank angles increase. At steep bank angles with the nose down in a high rate of descent, there is danger, unless extreme caution is exercised, of falling into a steep spiral. Therefore, turns during high rates of descent should be limited to 30 degrees of bank.

# AUTOMATIC APPROACH PROCEDURE




1. Fly autopilot in CRUISE MODE.

2. Fly straight and level with controller grip in neutral detents at normal approach altitude for the specific airport with gear and wing flaps up. Use dive flaps as necessary to minimize operation in the 68-76% engine rpm restricted range.

Note

Intercepts to the localizer beam should normally not be made more severe than 45 degrees intercept angle from 15 miles out or 30 degrees intercept angle from 10 miles out. Any interceptions at greater angles than these or at distances nearer the field, may result in reaching the runway before the ILAS beam is bracketed properly.

3. When vertical bar of ILAS crosspointer comes off peg, switch autopilot to LOCALIZER mode.

4. When airplane is almost stable on localizer beam, slow to gear placard speed or less, drop gear, set wing flaps at 32 degrees, retract dive flaps if used, and reset power.

5. When horizontal bar of ILAS crosspointer approaches within one dot of center, switch autopilot to LOCALIZER and GLIDE PATH mode, set power to 80-85% rpm to hold 160 knots IAS. On breakthrough, disconnect autopilot and make manual landing.

**WARNING**

Do not attempt to use autopilot on ILAS take-off. Monitor autopilot on approach to preclude possibility of malfunction at low altitude and airspeed.

CB 3421

*Figure 9-4*

### HOLDING.

Due to fuel consumption, jet aircraft normally have priority for letdowns and approaches in weather conditions. However, when holding is necessary, the following altitudes, airspeeds, and configuration is recommended:

1. Altitude—20 thousand and above.
2. Configuration—Clean.
3. Airspeed—With tip and/or pylon fuel 215 knots. With internal fuel only—200 knots.

### INSTRUMENT APPROACHES.

#### Radio Range Letdown.

Jet penetrations vary at different bases; owing to location and traffic control zones. Therefore, when planning a flight, careful consideration of fuel allowances should be made as part of pre-flight planning. Various type techniques can be used for radio range letdowns in this airplane. Letdowns with or without gear extended can be made, depending on the existing weather conditions. If icing conditions exist, letdowns with gear UP are recommended because of the lesser possibility of heavy accumulations of ice creating hazardous drag conditions upon leveling out.

#### Ground Controlled Approach. (See Figure 9-6.)

#### ILAS. (See Figure 9-5.)

#### Zero Reader Instrument Approach. (See Figure 9-5.)

When making an actual instrument approach with zero reader on later airplanes (equipped with the go-around feature), prior to pushing the GO-AROUND button, reduce airplane weight by dropping external tanks if you have a full complement of rockets, (nose and rocket pods) and more than 3000 pounds of fuel aboard; if no rockets or ballast are carried, the zero reader go-around feature may be safely used with a maximum of 4000 pounds of fuel aboard. The zero reader is adjusted to intercept the localizer beam at a 60° angle when the flight selector is set in the BLUE RIGHT position and the localizer needle is fully deflected. This will cause overshoot of the beam. Therefore, a manual intercept of the localizer beam is recommended, using normal instrument procedures, to obtain approximately a 45° angle of intercept. Refer to Figure 9-5.

#### Go-Around With Zero Reader.

1. 100% rpm without afterburner.
2. Push GO-AROUND button.
3. Fly zero reader on ZERO.
4. Speed brake switch—UP.
5. Landing gear control lever—UP.
6. Leave wing flaps DOWN.
7. Continue flying zero reader on zero until safe and positive rate of climb is assured. (Duration approximately 30 seconds.)
8. Switch zero reader to FLIGHT INSTRUMENT position. Raise wing flaps. Set zero reader for climb.

**Note**

If using the zero reader go-around feature for practice and the airplane weight is heavy and/or the temperature is high, resume manual flight if the airspeed drops below 150 knots IAS.

### MISSED APPROACH GO-AROUND PROCEDURE.

1. Throttle—FULL. AFTERBURNER position, if necessary.

**CAUTION**

Unless absolutely necessary, it is recommended the afterburner not be used for go-around, because if the afterburner does not light and the exhaust nozzle opens, approximately 25% thrust will be lost.

2. Speed brake switch—UP.
3. Landing gear control lever—UP.
4. Wing flap switch—UP.

### RADAR OPERATION.

Sufficient information is presented on the radar scope attitude indicator for satisfactory instrument flight during tracking of target aircraft in the overcast, day or night, without reference to other instruments on the panel. However, continued reference to other flight instruments is considered necessary.

## ICE AND RAIN

Avoid atmospheric icing conditions whenever feasible. It is recognized that the most proficient weather service cannot always predict accurately just when or where icing may be encountered. However, many areas of probable icing conditions can be avoided by careful flight planning that utilizes available weather information.

### RECOGNITION OF ICING CONDITIONS.

Icing occurs because of supercooled water in fog, clouds, or rain. Normally, the heaviest icing takes place in

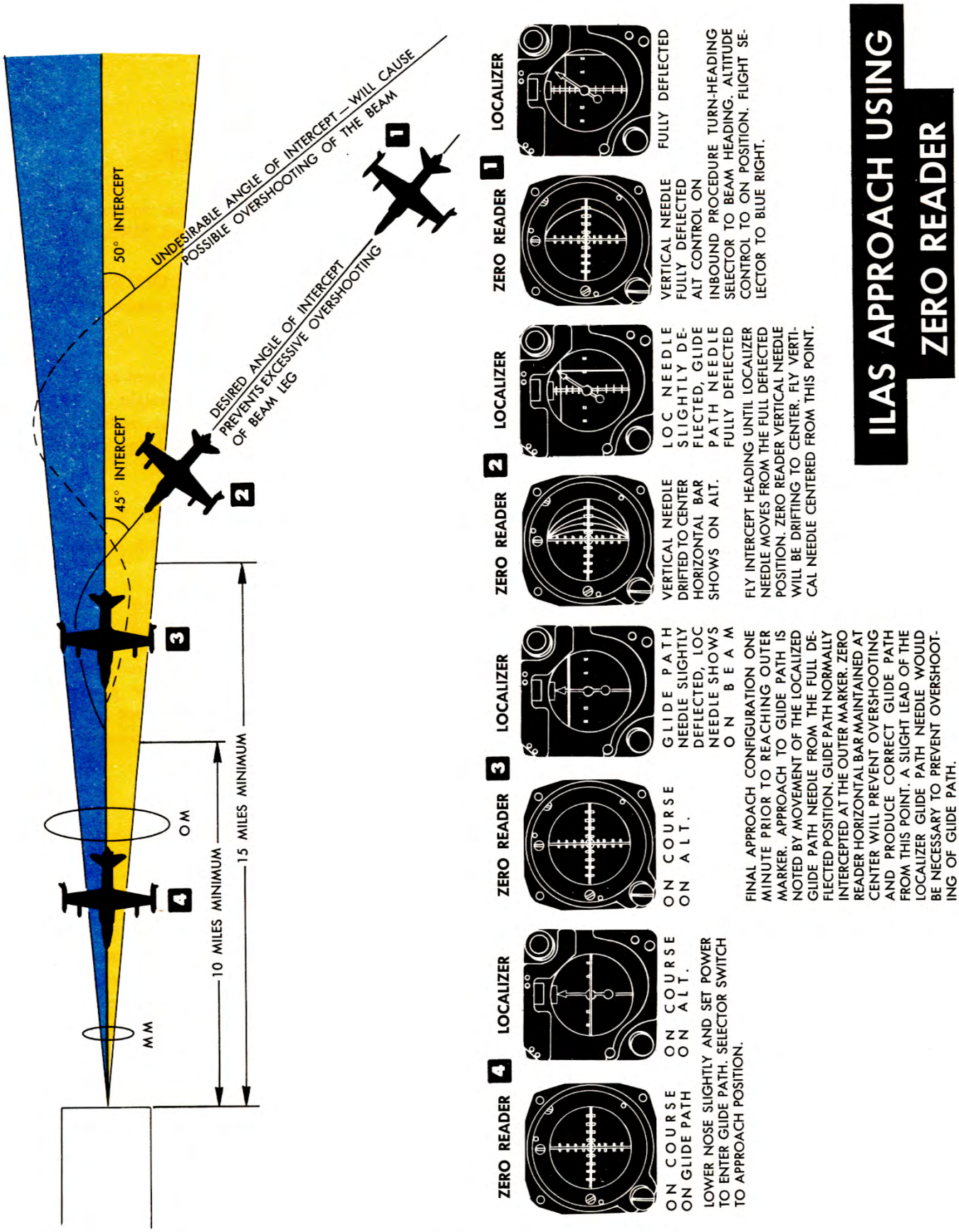

ILAS APPROACH USING ZERO READER
50° INTERCEPT
45° INTERCEPT
UNDESIRABLE ANGLE OF INTERCEPT — WILL CAUSE POSSIBLE OVERSHOOTING OF THE BEAM
DESIRED ANGLE OF INTERCEPT PREVENTS EXCESSIVE OVERSHOOTING OF BEAM LEG
MM
OM
10 MILES MINIMUM
15 MILES MINIMUM
1
2
3
4
ZERO READER
LOCALIZER
ON COURSE ON GLIDE PATH
LOWER NOSE SLIGHTLY AND SET POWER TO ENTER GLIDE PATH. SELECTOR SWITCH TO APPROACH POSITION.
ON COURSE ON ALT.
ON COURSE ON ALT.
GLIDE PATH NEEDLE SLIGHTLY DEFLECTED, LOC NEEDLE SHOWS ON BEAM
FINAL APPROACH CONFIGURATION ONE MINUTE PRIOR TO REACHING OUTER MARKER. APPROACH TO GLIDE PATH IS NOTED BY MOVEMENT OF THE LOCALIZED GLIDE PATH NEEDLE FROM THE FULL DEFLECTED POSITION. GLIDE PATH NORMALLY INTERCEPTED AT THE OUTER MARKER. ZERO READER HORIZONTAL BAR MAINTAINED AT CENTER WILL PREVENT OVERSHOOTING AND PRODUCE CORRECT GLIDE PATH FROM THIS POINT. A SLIGHT LEAD OF THE LOCALIZER GLIDE PATH NEEDLE WOULD BE NECESSARY TO PREVENT OVERSHOOTING OF GLIDE PATH.
VERTICAL NEEDLE DRIFTED TO CENTER HORIZONTAL BAR SHOWS ON ALT.
LOC NEEDLE SLIGHTLY DEFLECTED, GLIDE PATH NEEDLE FULLY DEFLECTED
FLY INTERCEPT HEADING UNTIL LOCALIZER NEEDLE MOVES FROM THE FULL DEFLECTED POSITION. ZERO READER VERTICAL NEEDLE WILL BE DRIFTING TO CENTER. FLY VERTICAL NEEDLE CENTERED FROM THIS POINT.
VERTICAL NEEDLE FULLY DEFLECTED ALT CONTROL ON
FULLY DEFLECTED
INBOUND PROCEDURE TURN-HEADING SELECTOR TO BEAM HEADING. ALTITUDE CONTROL TO ON POSITION. FLIGHT SELECTOR TO BLUE RIGHT.

*Figure 9-5*

# STANDARD GROUND CONTROLLED APPROACH

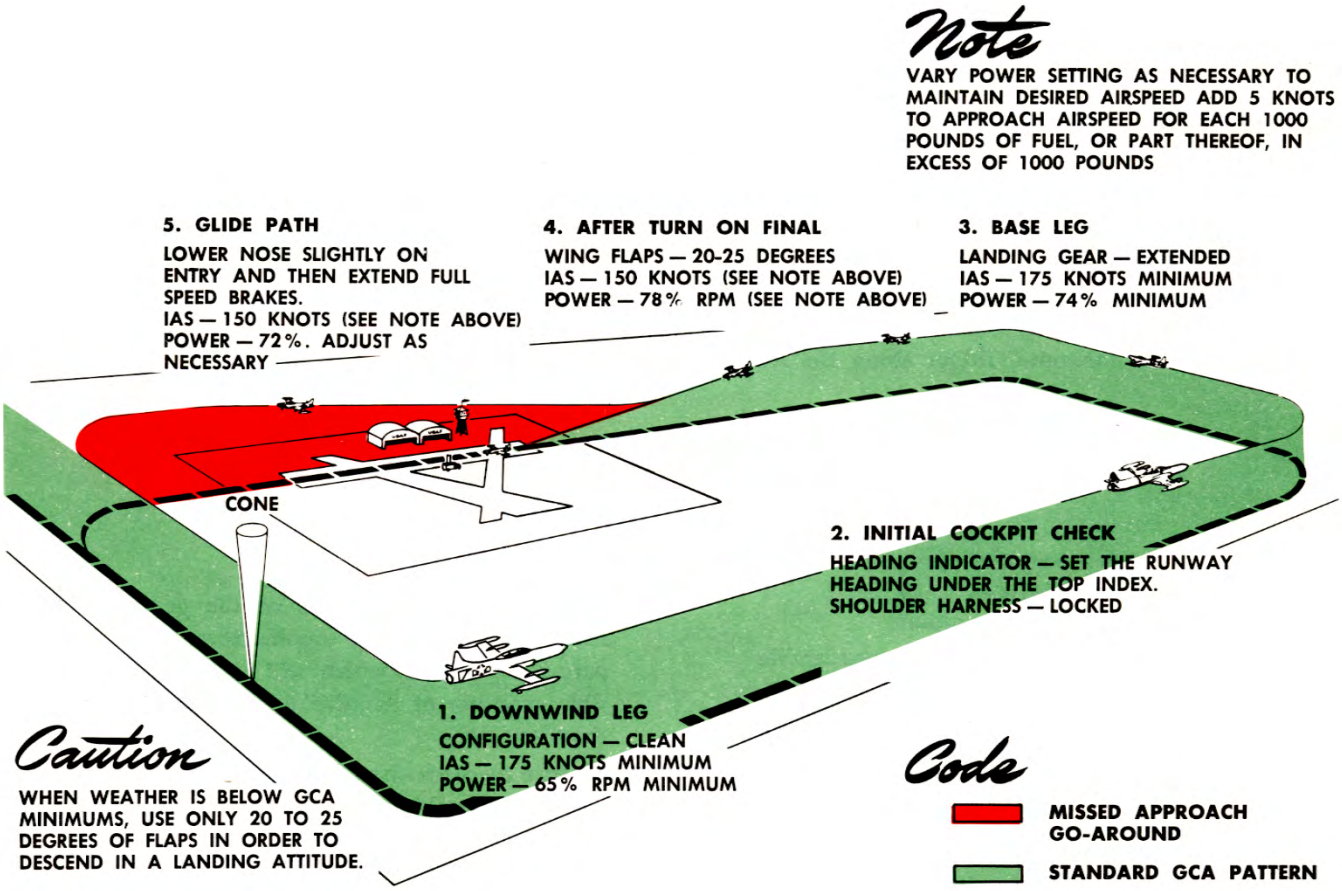



*Figure 9-6*

clouds with strong vertical currents (cumulus clouds, projections above strato-cumulus 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 about 5°C (23°F).

**ENGINE ICING.**

The centrifugal compressor type of engine is relatively free of icing difficulties and while it may be possible to ice, the engine icing conditions must be extremely severe. In flight, the rotation of the air as it enters the engine effectively separates the water droplets from the air and deposits them on the engine surfaces where icing is not considered serious.

**SURFACE ICING.**

Rime and clear icing can be expected at any and all altitudes. Ice will normally adhere to the windshield, leading edge of wings, radome, empennage, and nose of the tip tanks. Build-ups on the leading edge of the wing may extend out to approximately three (3) inches in moderate to heavy icing conditions. Rime ice will normally form in horizontal ridges along the leading edge of the wing. Clear ice assumes no definite pattern. Instrument control becomes very sluggish when heavy icing accumulates on the aircraft. Up to 80 knots IAS may be lost at cruising speeds. Normally, airspeed cannot be regained with power as long as the heavy ice formations remain on the aircraft. Therefore, it is necessary to lose altitude to regain lost airspeed. Clear ice formations will normally be associated with turbulent air conditions.

**WARNING**

Heavy icing may increase the stall speed in the clean configuration up to approximately 170 knots IAS.

**DE-ICING.**

The best de-icing procedure is to place the wing and empennage de-icer and pitot de-ice systems in operation before the actual ice has begun to form. If the de-icers fail, decrease airspeed and change altitude immediately, if possible. If heavy icing still clings to the aircraft, diving and/or violent maneuvers, if altitude permits, will often remove it.

## TURBULENCE AND THUNDERSTORMS

**CAUTION**

Thunderstorm flying demands considerable instrument experience and should be intentionally undertaken only by pilots able to qualify for an official instrument card. However, many routine flight operations require a certain amount of thunderstorm flying since it is often impossible to detect individual storms and find the in-between clear areas. A pilot, using modern equipment and possessing a combination of proper experience, common sense, and instrument flying proficiency, can safely fly through thunderstorms.

Power setting and pitch attitude required for desired penetration air speed should be established before entering the storm. This power setting and pitch attitude, if maintained throughout the storm, will result in approximately a constant average air speed, regardless of any false readings of the airspeed indicator. The zero reader will greatly assist you in maintaining the pitch attitude.

**BEFORE TAKE-OFF.**

1. Make a thorough analysis of the general weather situation to determine thunderstorm areas and prepare a flight plan which will require the least possible exposure of the airplane to regions of possible thunderstorms.
2. Be sure to check the following for proper operation before undertaking any instrument flight and also before attempting flight into thunderstorm areas: All flight instruments, navigation equipment, pitot de-icer, and instrument panel lights.

**APPROACHING THE STORM.**

It is imperative that you prepare the airplane prior to entering a zone of turbulent air. If the storm cannot be seen, its proximity can be detected by radio crash static. Prepare the airplane as follows:

1. Adjust throttle as necessary to obtain recommended safe penetration speed of 250 knots IAS.
2. Pitot de-ice switch—PITOT.
3. 30 KV.A. alternator switch—Check in 30 KVA ALT position.

4. Wing and empennage de-icer switch—WING AND EMP. position.
5. Zero Reader selector switch—FLT. INST. (Altitude control OFF).
6. Zero Reader indicator—Zero horizontal bar with pitch trim knob.
7. Check gyro instruments for proper settings.
8. Seat belt and shoulder harness fastened.
9. Turn off any radio equipment rendered useless by static.
10. At night, turn cockpit lights full bright to minimize blinding effect of lighting.
11. Notify radar observer to raise the blackout curtain over his compartment.

**CAUTION**

Do not lower gear and flaps as they merely decrease the aerodynamic efficiency of the airplane.

**IN THE STORM.**

1. Maintain power setting and pitch attitude (established before entering the storm) throughout the storm. Hold these constant and your air speed will remain approximately constant regardless of the airspeed indicator.
2. Devote your full attention to flying the airplane.
3. Expect turbulence, precipitation, and lightning. Don't allow these conditions to cause undue concern.
4. Maintain attitude. Concentrate principally on holding a level attitude by reference to the attitude indicator. The zero reader may be used if desired as a flight instrument.
5. Maintain original heading. Do not make any turns unless absolutely necessary.
6. Don't chase the airspeed indicator, since doing so will result in extreme airplane attitudes. If a sudden gust should be encountered while the airplane is in a nose high attitude, a stall might easily result. A heavy rain, by partial blocking of the pitot tube pressure head, may decrease the indicated airspeed reading considerably.
7. The altimeter may be unreliable in thunderstorms because of differential barometric pressure within the storm. A gain or loss of several thousand feet may be expected. Make allowance for this error in determining minimum safe altitude.

**Note**

Altitudes between 10,000 and 20,000 feet are usually the most turbulent areas in a thunderstorm. The least turbulent areas will be above 30,000 feet. Therefore, altitudes in excess of 30,000 feet are recommended for thunderstorm penetration.

# COLD WEATHER PROCEDURES

The success of low temperature operation depends primarily upon the preparations made during the post-flight inspection, in anticipation of the requirement for operation on the following day. The post-flight procedures outlined in this section (BEFORE LEAVING THE AIRPLANE) must be followed to expedite the pre-flight inspection and to insure satisfactory operation of the airplane and its systems during the next flight.

**BEFORE ENTERING THE AIRPLANE.**

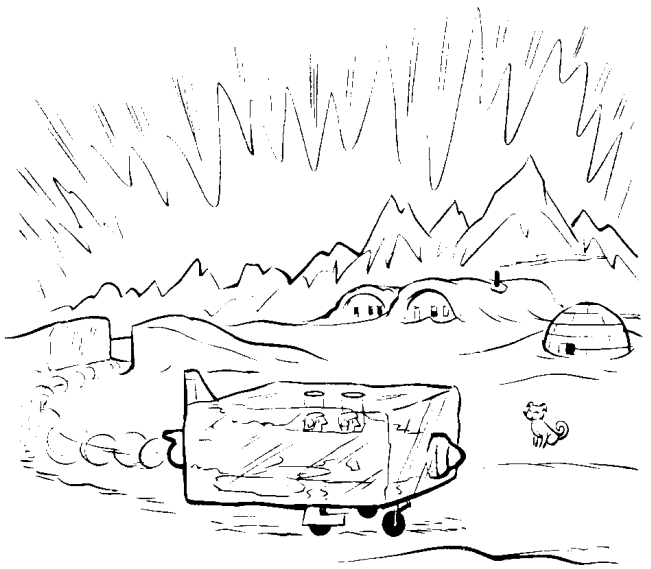
**Snow and Ice Removal.**

Remove all protection covers and dust plugs, and check the entire aircraft for freedom from frost, snow, and ice. All frost, snow, and ice must be removed before take-off. Take-off distances and climb-out performances can be adversely affected depending on the weight and distribution of any accumulated snow and ice. This roughness, pattern and location of the snow and ice can affect stall speeds and handling characteristics to a dangerous degree. Structural damage has also resulted due to vibrations induced in flight by unbalanced loads of unremoved accumulations. These hazards can be eliminated by removing the snow and ice from the wings, fuselage and tail before flight is attempted.

**CAUTION**

- Care should be exercised to insure that any water from melted ice is sponged so that it will not drain to some critical area and refreeze. Make sure that ice is not chipped or scraped from the aircraft surfaces as this action may cause damage to the airplane.

**WARNING**



FAILURE TO REMOVE SNOW AND ICE ACCUMULATED ON AIRCRAFT WHILE ON THE GROUND CAN RESULT IN SERIOUS AERODYNAMIC AND STRUCTURAL EFFECTS WHEN FLIGHT IS ATTEMPTED.

**PRE-HEATING.**

At temperatures below −26°C (−15°F), preheat is necessary for satisfactory closure of the cockpit canopy. Besides heating the canopy, heat should also be applied to the canopy seal, the cockpit, and the instrument panel. The following procedure is recommended for preheating the cockpit:

1. Heater duct should be placed in cockpit.
2. Canopy should be lowered to heater duct; insure that heater airflow is not choked by the canopy.
3. Canopy cover should be placed over the partially closed canopy.

**PREFLIGHT CHECKS.**

1. Check that the fuel tank vents, fuel filter, and drain cocks are free from ice. Open drain plugs to drain condensate.
2. Check shock struts and actuating cylinders for dirt and ice. Check shock struts for proper inflation.
3. No preheat or oil dilution is required to insure crankability or proper lubrication down to −54°C (−65°F) when using grade 1005 oil; however, if a start is necessary with an inadequate power unit, the accessory section and the oil sump should be preheated to facilitate the start by decreasing starter loads.
4. Check that the fuel filter de-icing system has been serviced.
5. When ATO rocket units are to be used they should be installed just prior to engine start to minimize cooling period before use.
6. Check that airplane batteries are installed.

**ON ENTERING THE AIRPLANE.**

1. Check flight controls for proper operation.
2. Insure that canopy can be closed and locked.
3. Use an external power source to operate and check electrical and radio equipment.

**BEFORE STARTING ENGINE.**

An external power cart is required for starting. If minimum starting rpm (8%) cannot be obtained, shut down the engine and connect another adequate power unit. Preheat the engine through the air intake ducts if a start is necessary with an inadequate power source. After a suitable power source is connected, move the 8 KV.A. alternator switch to CART and rocket heat switch ON after rockets are installed.

**STARTING ENGINE.**

Start the engine using the normal starting procedure outlined in Section II. If there is no indication of oil pressure immediately after an engine start is evident, or if the pressure drops to zero after a few minutes of ground running, stop the engine and investigate.

**Note**

At temperatures below −40°C (−40°F) it may be necessary to advance the throttle a little beyond the IDLE setting to get a satisfactory start. If this proves unsuccessful, and as a last resort, the engine may be started on the emergency fuel system by advancing the throttle to obtain 1000 to 1200 pounds per hour fuel flow at −40°C (−40°F) and up to 1200 to 1400 pounds per hour at −54°C (−65°F). Caution must be observed when operating on the emergency system, since there is no acceleration or deceleration control provided.

**WARM-UP AND GROUND CHECK.**

1. Turn on cockpit heat and windshield defrosting system, as required, immediately after engine start.
2. Check surface controls, speed brakes, and aileron and elevator trim tabs for proper operation.
3. Check wing flap and flap indicator operation. If questionable readings result, cycle flaps three to four times to correct indicator action.

4. Check the fuel de-icing system operation by energizing the system and checking the loadmeter for an increased load reading.
5. Check instruments for proper operation. Electric gyro instruments will require approximately two minutes to warm up after electrical power is applied.

**WARNING**

Make sure all instruments have warmed-up sufficiently to insure normal operation. Check for sluggish instruments during taxiing.

**Note**

Because of low ambient temperatures, the thrust developed at all engine speeds is noticeably greater than normal even though 100% rpm may not be reached.

**WARNING**

Use firmly anchored wheel chocks for all engine run-ups. The airplane should be tied down securely before attempting a full power run-up.

6. After external power cart is disconnected, move 8 KV.A. alternator switch to 8 KV.A. ALT. (up) position.

**TAXIING INSTRUCTIONS.**

1. Avoid taxiing in deep snow as taxiing and steering are extremely difficult and frozen brakes may result.
2. Use only essential electrical equipment, to preserve battery life, when taxiing at low engine speeds.
3. Increase the taxi interval at subfreezing temperatures to insure safe stopping distance and to prevent icing of airplane surfaces by melted snow and ice blown by the jet blast of a preceding airplane.
4. Minimize taxi time to conserve fuel and to reduce the amount of ice fog generated by the engine.

**BEFORE TAKE-OFF.**

1. Energize the fuel system de-icer switch for 15 seconds to preclude the possibility of engine failure during take-off.
2. Check that canopy is locked.
3. Turn pitot de-ice switch to PITOT position.
4. Make final instrument check during the first part of the take-off roll as the brakes will not hold the airplane on snow-covered or icy runways at full throttle.

**TAKE-OFF.**

Throttle—FULL. Maximum engine speed of 100% may not be available at low ambient temperatures because of increased air density. However, the governor control should not be reset to 100% rpm as the rated output and design strength of the engine may be exceeded. Although take-off thrust can be obtained at less than maximum engine speed, do not take off unless at least 95% rpm is available at full throttle.

**CAUTION**

Avoid engine pulsation by limiting basic engine fuel flow to 8500 pounds per hour during take-offs made in ambient temperatures of 0°F and below.

**Note**

If afterburner is not to be used, check take-off distance chart in Appendix I.

**AFTER TAKE-OFF.**

After taking off from a wet snow or slush-covered runway, operate the landing gear and wing flaps through several complete cycles to prevent their freezing.

**CLIMB.**

Climb performance will be improved during cold weather operation at lower altitudes. Follow recommended climb speeds as given in Appendix I.

**OPERATION IN FLIGHT.**

Engine operation during flight in cold weather should be governed by normal procedures (with the exception of operation of the fuel de-icing system as directed in the following paragraph.

**OPERATION OF THE AIRCRAFT SYSTEMS DURING FLIGHT.**

If icing conditions are anticipated, place the wing and empennage de-icing system in operation as follows:

1. 30 KV.A. alternator switch—check—30 KV.A. ALT. position.
2. Wing and empennage de-ice switch—WING & EMP.

**Note**

The wing heat indicator light should glow, indicating that the boots are operative. If light remains off, check wing heat circuit breakers on center circuit breaker panel.

3. Radar observer should note voltage and current readings—voltage 117 volts and ammeters in range of 75-90 amps.

**Note**

Due to the installation of rocket pods, the center wing de-icer boots have been disconnected. The severance of all power to these boots will cause a decrease in the load requirement during two consecutive power transfers. This will be noted by a dropping, to no lower than 30 amps, of the Phase 1 and Phase 3 loadmeters located in the aft cockpit. This dropping will occur for a period of twenty seconds with a slight "kick" of the meter at ten seconds, once each one hundred second cycle.

**CAUTION**

If either the voltage reading should fluctuate violently, or ammeter readings are outside the above limits, the wing and empennage de-ice switch should be turned OFF.

**CAUTION**

Ground operation of the wing and empennage de-icer system for 8½ seconds will destroy the boots.

4. Use cockpit heat, windshield de-icer, or windshield defroster as required. Adjust cockpit temperature to the maximum consistent with reasonable pilot comfort.

**Note**

It is recommended that the defroster system be turned on 10 to 15 minutes before descents are started, especially if a rapid descent is contemplated.

5. Operate the fuel de-icing system when required. After clearing the first ice accumulation from the filter, energize the de-icing system for 15 seconds every 30 minutes for the duration of the flight to keep the filter clear of ice.

**DESCENT.**

1. Operate auxiliary defroster, if necessary, to clear windshield of frost usually formed during a rapid descent from altitude.
2. Check engine operating temperatures during descents and in the landing pattern as lower temperatures are common at low altitudes because of frequent temperature inversions.

**APPROACH.**

1. Operate fuel de-icing system for 15 seconds before entering pattern.
2. Turn off all non-essential electrical equipment at least one minute before final approach to reduce battery load when generator cuts out.
3. Make normal patterns and landings but allow for a flatter glide because of increased thrust.

**LANDING.**

Landing speeds and technique are normal with the usual care being exercised in the use of the brakes on snow-covered or slippery runways.

**AFTER TOUCH-DOWN.**

If wing and empennage de-icing system and pitot de-ice system are operating, turn them off as follows:

1. Wing and empennage de-ice switch—OFF.
2. Pitot de-ice switch—OFF.

**STOPPING THE ENGINE.**

Stop the engine in the normal manner.

**BEFORE LEAVING THE AIRPLANE.**

1. Release brakes after wheels are chocked.
2. Leave canopy partly open to allow circulation within the cockpit to prevent canopy cracking from contraction and to reduce windshield and canopy frosting.
3. The shock struts and actuating cylinders should be inspected, and wiped with a rag soaked in hydraulic fluid. It is advisable that shock struts be kept exceptionally clean, as any scarring of the seals will result in excessive leakage.
4. The fuel pumps should be drained within 30 minutes after stopping engine.
5. Whenever possible, leave the airplane parked with full fuel tanks. Every effort should be made, during servicing, to prevent moisture from entering the fuel system.
6. Protection covers and dust plugs should be installed. The batteries should be removed when the airplane is to be parked at temperatures below −29°C (−20°F) for more than four hours.

# HOT WEATHER PROCEDURES

### BEFORE ENTERING THE AIRPLANE.

1. All metal surfaces exposed to the sun are burning hot to the touch. Gloves should be worn to prevent burns. (Tape, cord, or cloth muffs around the control stick, etc., are advisable.)
2. Check tires for proper inflation and for evidence of blisters or other deterioration.
3. Check particularly for hydraulic system leaks as heat and moisture may cause valves and packings to swell.
4. Note particularly electrical wiring and equipment for evidence of corrosion.

### ON ENTERING THE AIRPLANE.

Care should be exercised in allowing foreign objects to come in contact with the canopy, since it is possible to damage the Plexiglas in extremely hot weather.

### STARTING THE ENGINE.

Normal starting procedures are used in hot weather. Temperatures will probably be on the high side of operating ranges.

### WARM-UP AND GROUND TEST.

Ground testing should be complete but accomplished as rapidly as possible.

### TAXIING INSTRUCTIONS.

1. Brakes should be used as little as possible to prevent their overheating.
2. The airplane may be taxied with the canopy partially open.

### BEFORE TAKE-OFF.

Be sure that take-off distances have been checked in Appendix I.

### TAKE-OFF.

During take-off, the airplane will accelerate slowly and ground run will be longer because the air is less dense in hot weather. Therefore it is very important that runway temperature and corresponding take-off distance for the airplane gross weight be determined prior to take-off (Refer to Appendix I for take-off distance charts) to insure that adequate runway length will be available for take-off under the prevailing conditions. Ground speed, compared with indicated airspeed, will be greater than normal.

### ENGINE OPERATION IN FLIGHT.

Engine operation in flight should not be affected at normal altitudes. At low altitudes, temperatures may be on the high sides of the operating ranges.

### LANDING.

1. Hot weather operation requires the pilot to be more cautious of premature stalling.
2. Landing ground rolls are longer than those in moderate temperature.

### BEFORE LEAVING THE AIRPLANE.

1. The canopy may be left partially open if the location is not subject to blowing sand or dust.
2. In locations with high humidity and excessive temperature changes from day to night, it is probably preferable to leave the canopy slightly open and the cockpit ventilation ducts open.

# DESERT PROCEDURES

Most hot weather procedures are also applicable to desert operation. Blowing dust and sand is the main enemy when operating in the desert.

### BEFORE ENTERING THE AIRPLANE.

1. Check that fuel and hydraulic system filters have been serviced and cleaned.
2. Check that airplane is clear of other airplanes prior to starting the engine.

### TAXIING INSTRUCTIONS.

1. Taxi carefully with minimum power to minimize the blowing of dust and sand onto other airplanes.
2. Keep adequate distance from any airplanes taxiing ahead of you.

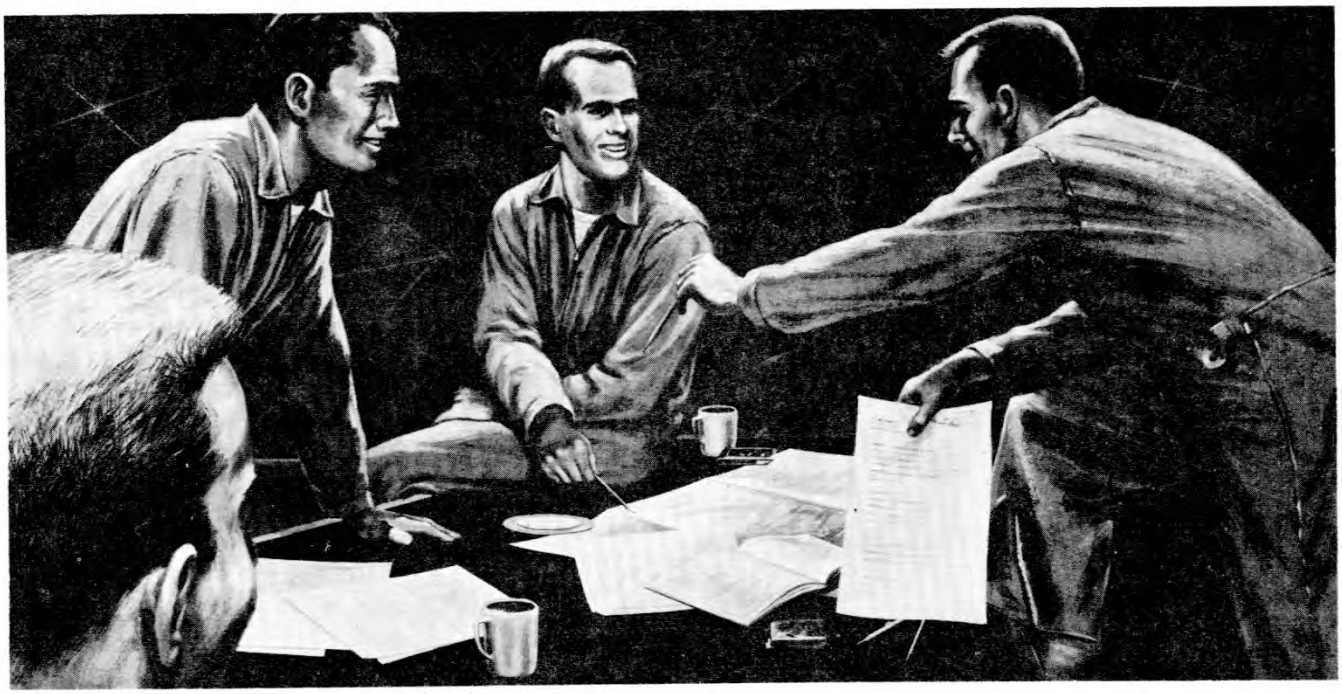
### TAKE-OFF.

Be prepared for sudden gusts of wind during take-off run.

### BEFORE LEAVING THE AIRPLANE.

Cover all ducts and air intakes as soon as possible to prevent the entrance of blowing sand.

Last Page of Section IX



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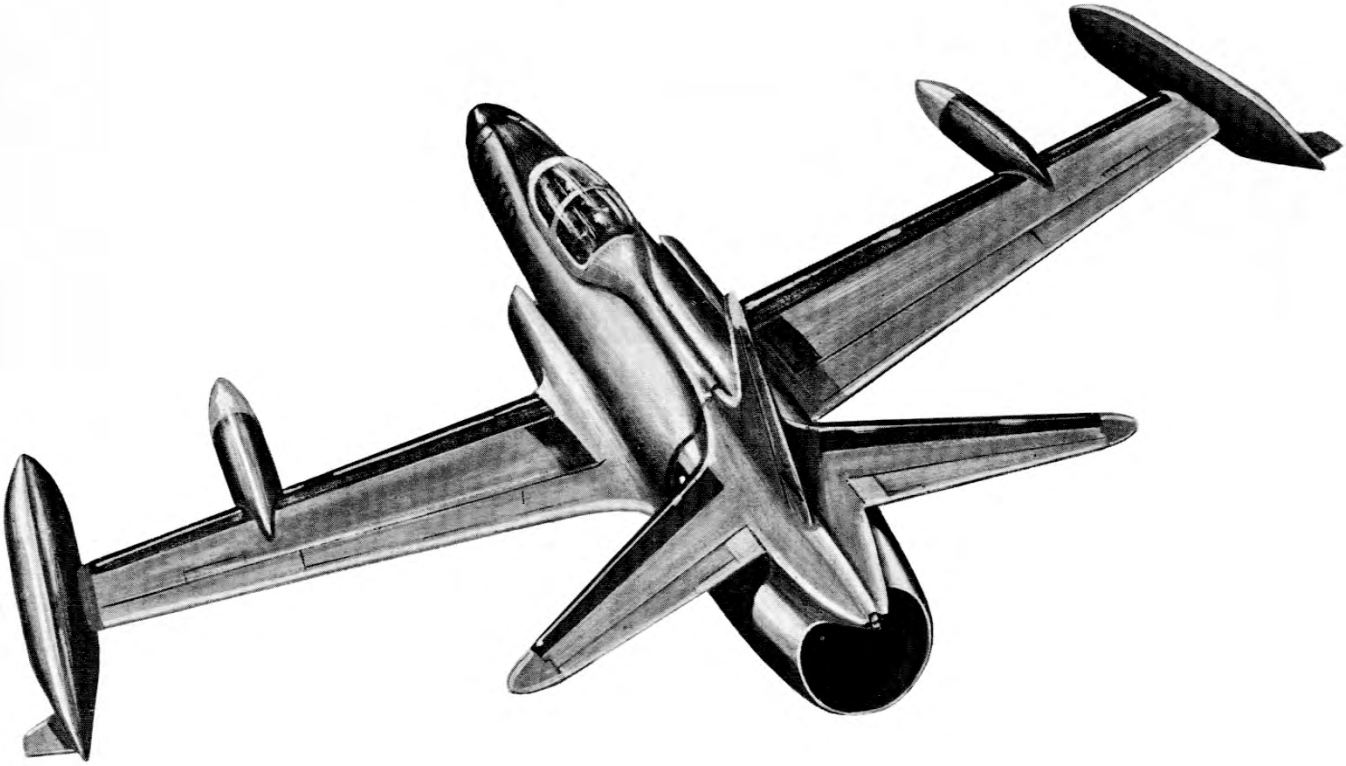

# Part 1—Introduction

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## INTRODUCTION

### SCOPE AND ARRANGEMENT.

This appendix contains all the performance data which are necessary for accurate and complete flight planning, and is applicable to airplanes operating with or without tip tanks and external stores. The appendix is divided into "Parts" which contain material for planning general phases of each flight. Descriptive text in each Part discusses and explains the use of the charts provided. Profile-type charts that present range and endurance performance information are included to supplement the graphical performance data.

### PERFORMANCE DATA BASIS.

Flight planning information shown in this appendix is based on the results of flight tests and, unless specifically stated otherwise, is consistent with the recommended operating procedures and techniques set forth elsewhere in this handbook. The charts are based on performance under standard atmospheric conditions; however, corrections for non-standard temperature conditions have been included on the charts when possible.

### FUEL AND FUEL DENSITY.

All performance and operating weight ranges included in this appendix are based on operation with JP-4 fuel at a nominal fuel density of 6.5 pounds per U.S. gallon. If fuel density is known to be different from the nominal value, enter the performance charts with an airplane weight which has been corrected to reflect the difference in weight of fuel on board.

### STANDARD CORRECTION CHARTS.

Readings obtained directly from flight airspeed and altimeter instruments should be subjected to certain standard corrections prior to use. Standard correction charts showing the necessary corrections are presented in Figures A1-2 through A1-8. These include a temperature conversion chart, airspeed and altimeter position error correction charts, a compressibility correction to calibrated airspeed chart, and a standard atmosphere table. The position error correction data are of considerable

## SYMBOLS AND DEFINITIONS

| SYMBOLS | DEFINITIONS |
|---|---|
| IAS | Indicated airspeed, airspeed indicator reading uncorrected. Mechanical error in the instrument is assumed to be zero where this symbol (I.A.S.) is used on the performance charts. |
| $\Delta V_i$ | Airspeed position error correction |
| CAS | Calibrated airspeed, indicated airspeed corrected for position error: $CAS = IAS + \Delta V_i$ |
| $\Delta V_c$ | Airspeed compressibility correction |
| EAS | Equivalent airspeed, calibrated airspeed corrected for compressibility: $EAS = CAS + \Delta V_c$ |
| TAS | True airspeed, equivalent airspeed corrected for atmospheric density: $TAS = EAS \times 1/\sqrt{\sigma}$ |
| OAT | Outside air temperature |
| $\Delta H$ | Altimeter position error correction |
| ICAO | International Civil Aviation Organization |
| M | Mach number |
| N.MI. | Nautical miles |

*Figure A1-1*

importance for predictions of altimeter and airspeed indicator readings, and for comparisons of actual performance with standard values shown on the performance charts. The standard altitude table provides reference air temperature, pressure, and density, and sonic speed information which may be of assistance in overall flight planning.

### USE OF POSITION ERROR CORRECTION CHARTS.

Position error corrections, which are shown on Figures A1-3, A1-4, A1-5, and A1-6, can be determined directly for the airspeed indicator and altimeter by entering the appropriate charts with indicated airspeed (corrected for individual mechanical instrument error). Algebraically add the position error correction values read from the curves to the corrected instrument readings to obtain calibrated airspeed or altitude.

### USE OF AIRSPEED COMPRESSIBILITY CORRECTION CHART.

The airspeed compressibility correction chart, Figure A1-7, supplies data to correct calibrated airspeed to equivalent airspeed. The method is the same as given for airspeed position error correction. Failure to use position error and airspeed compressibility correction data properly can result in the apparent inability to obtain predicted airplane performance.

### EXAMPLE USE OF STANDARD CORRECTION CHARTS.

The example given below illustrates the procedure to be followed when using the standard correction charts.

Configuration .....Tip Tanks
Flight altitude .....40,000 ft.
Airspeed indicator reading—corrected for instrument error (IAS) .....247 kts.

Position error correction ($\triangle V_i$),
Figure A1-3 ..... −2 kts.
Calibrated airspeed (CAS), (247 kts. −2 kts.)....245 kts.
Position error correction ($\triangle h$),
Figure A1-5 .....175 ft.
Pressure altitude ($H_p$), (40,000 ft. −175 ft.)....39,825 ft.
Correction for compressibility ($\triangle V_c$),
Figure A1-7 ..... −15 kts.
Equivalent airspeed (EAS), (245 kts. −15 kts.)
.....230 kts.

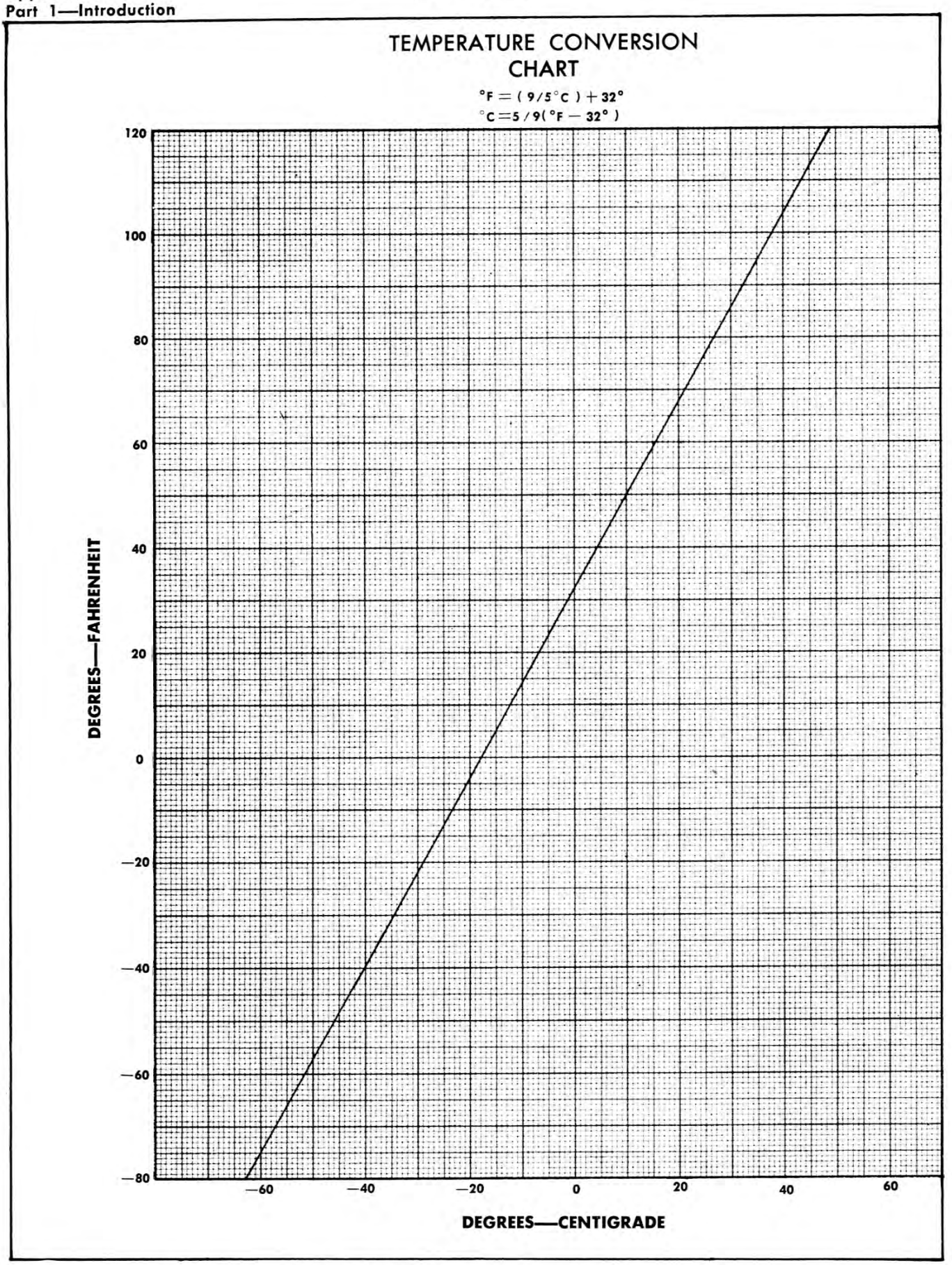



*Figure A1-2. Temperature Conversion Chart*

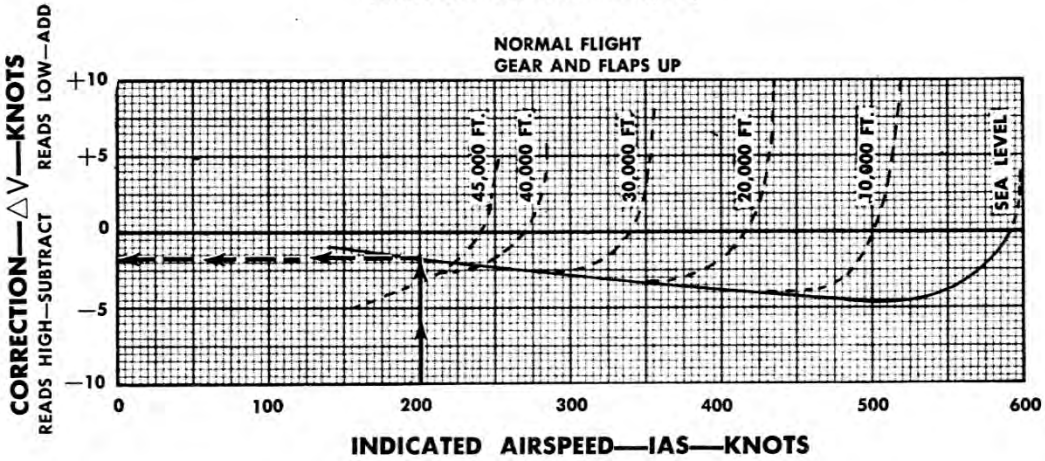
# AIRSPEED POSITION ERROR CORRECTION

CLEAN — WITH TIP TANKS

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.

REMARKS: ADD POSITION CORRECTION TO INDICATOR AIRSPEED TO OBTAIN CALIBRATED AIRSPEED (CAS)




CAS=IAS+ΔV; (EXAMPLE: 200-2=198 KNOTS).
CAS=AIRSPEED CORRECTED FOR INSTRUMENT AND POSITION ERROR.
IAS=AIRSPEED CORRECTED FOR INSTRUMENT ERROR.

NOTE: FLUSH STATIC LOCATION @WL 81.4 STATION 50.

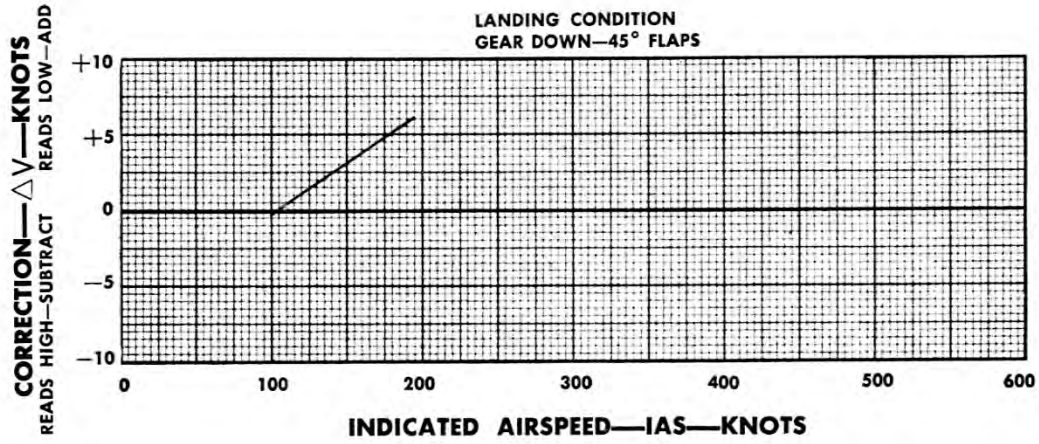


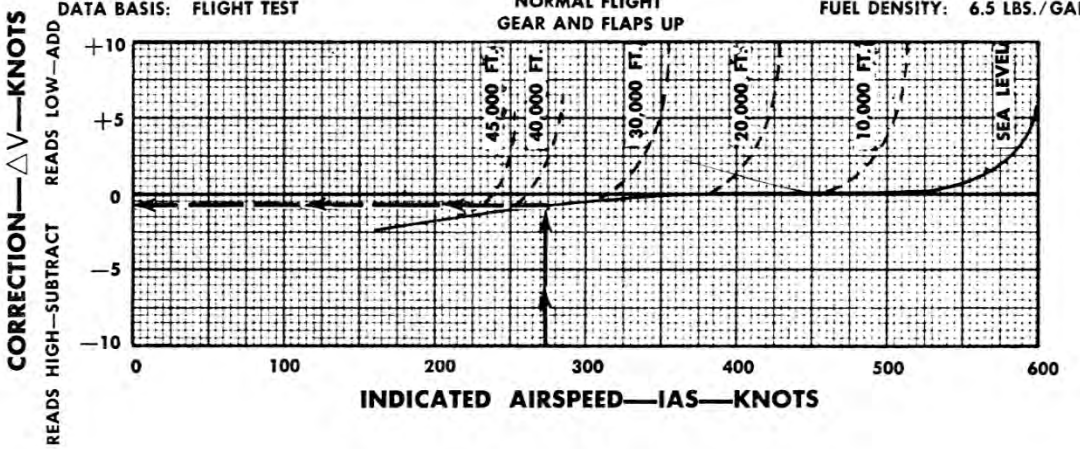

*Figure A1-3. Airspeed Position Error Correction—Clean—With Tip Tanks*

# AIRSPEED POSITION ERROR CORRECTION

TIP TANKS & ROCKET PODS — TIP TANKS, PYLON TANKS AND ROCKET PODS — TIP TANKS & PYLON TANKS

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.




REMARKS:
ADD POSITION CORRECTION TO INDICATED AIRSPEED TO OBTAIN CALIBRATED AIRSPEED (C.A.S.)

CAS=IAS+△V; (EXAMPLE: 275-1=274 KNOTS).
CAS=AIRSPEED CORRECTED FOR INSTRUMENT AND POSITION ERROR.
IAS=AIRSPEED CORRECTED FOR INSTRUMENT ERROR.

NOTE: FLUSH STATIC LOCATION @ WL 81.4 STATION 50

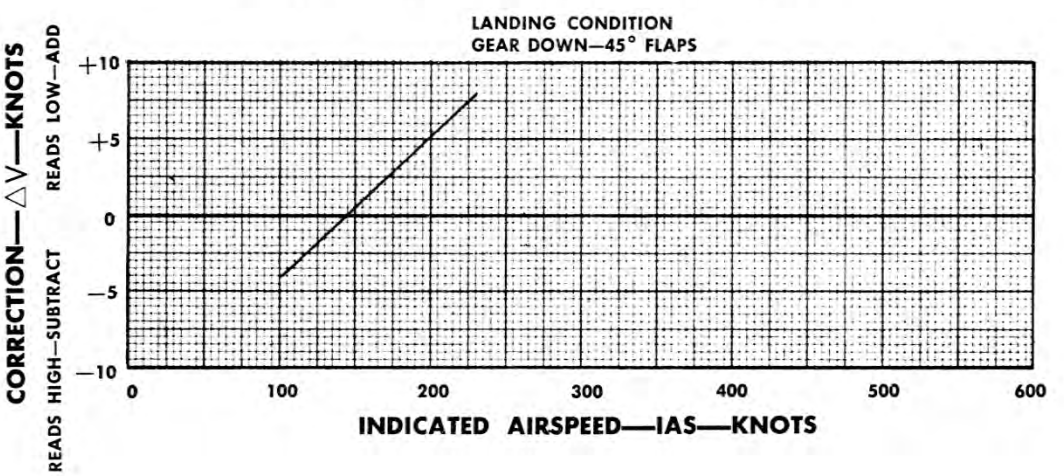


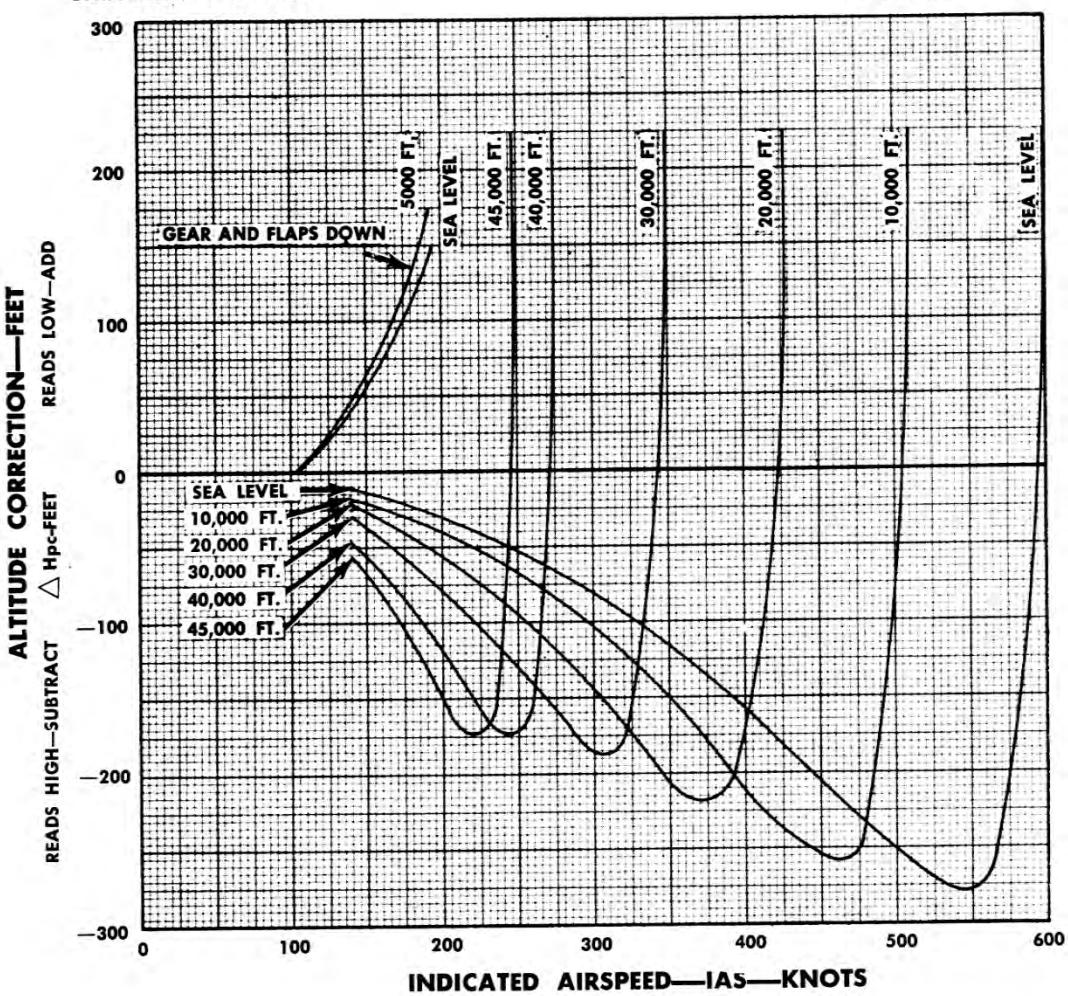

*Figure A1-4. Airspeed Position Error Correction—Tip Tanks and Rocket Pods, Tip Tanks, Pylon Tanks and Rocket Pods, Tip Tanks and Pylon Tanks*

# ALTIMETER POSITION ERROR CORRECTION

CLEAN — WITH TIP TANKS

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.




NOTE: FLUSH STATIC LOCATION @ WL 81.4 STATION 50

IAS = AIR SPEED CORRECTED FOR INSTRUMENT ERROR

*Figure A1-5. Altimeter Position Error Correction—Clean—With Tip Tanks*

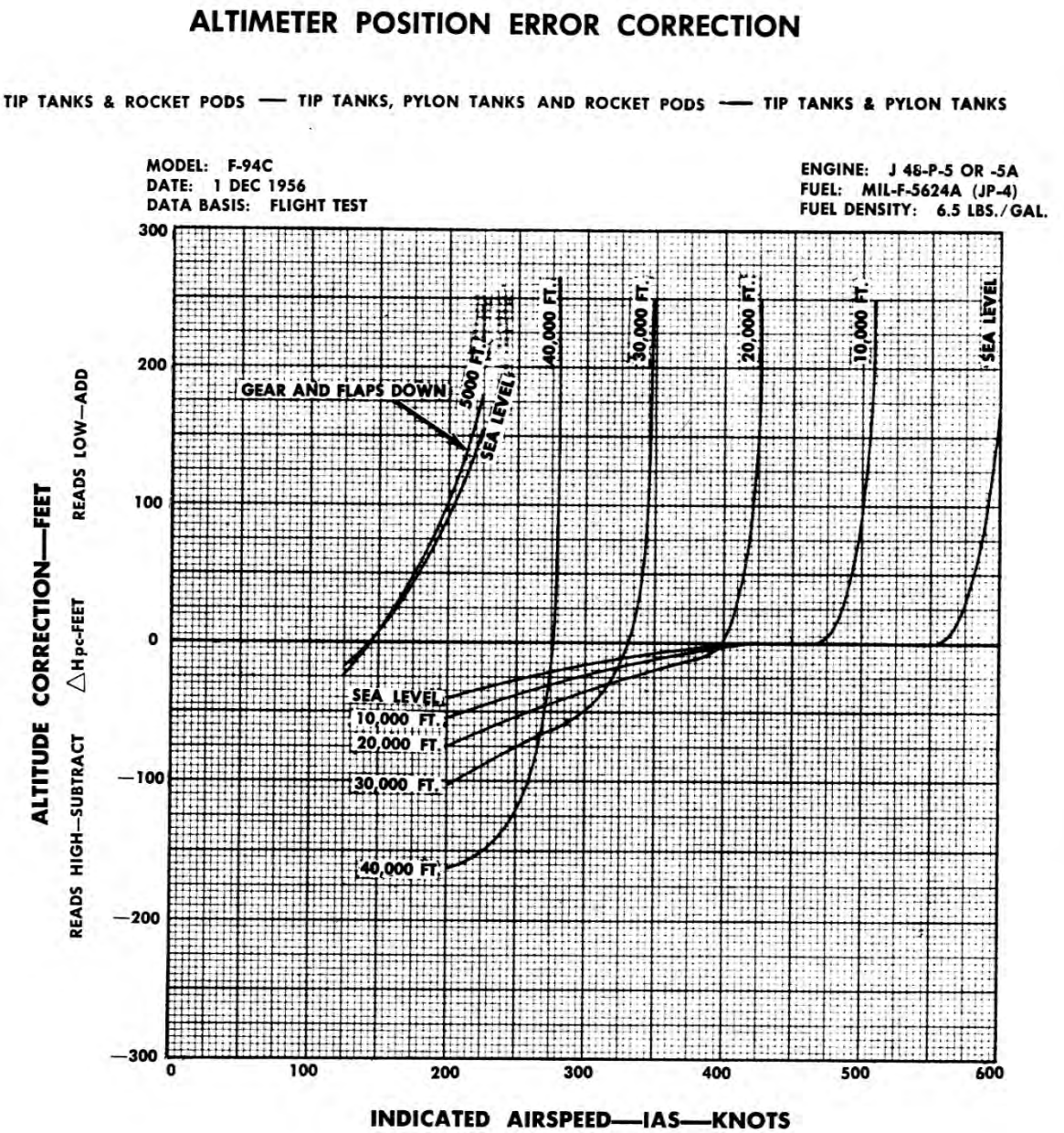
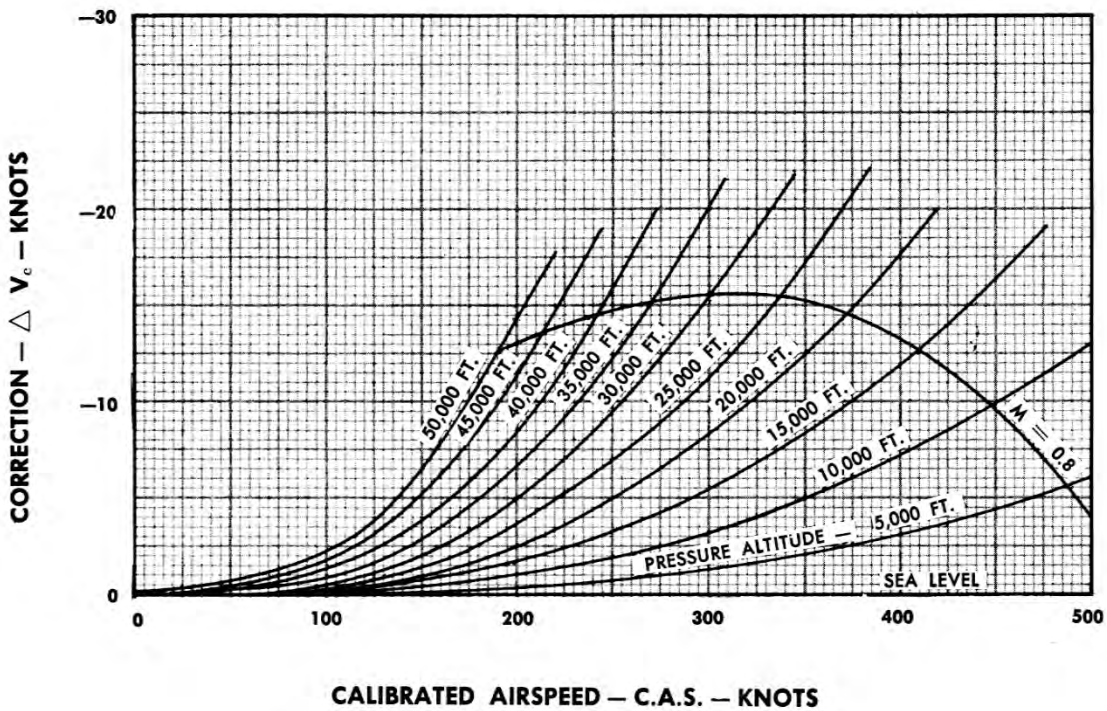



*Figure A1-6. Altimeter Position Error Correction—Tip Tanks and Rocket Pods, Tip Tanks, Pylon Tanks and Rocket Pods, Tip Tanks and Pylon Tanks*

## COMPRESSIBILITY CORRECTION TO CALIBRATED AIRSPEED




REMARKS: ADD COMPRESSIBILITY CORRECTION TO CALIBRATED AIRSPEED TO OBTAIN EQUIVALENT AIRSPEED (E.A.S.).

E.A.S. = C.A.S. + $\Delta V_c$
E.A.S. = EQUIVALENT AIRSPEED
C.A.S. = AIRSPEED CORRECTED FOR INSTRUMENT AND POSITION ERRORS
M = MACH NUMBER

*Figure A1-7. Compressibility Correction to Calibrated Airspeed*

# STANDARD ALTITUDE TABLE

Standard Sea Level Air:
T = 59° F
P = 29.921 in. of Hg.

W = .076475 lb/cu.ft. $\rho_0$ = .0023769 slugs/cu.ft.
1" of Hg. = 70.732 lb/sq.ft. = 0.4912 lb/sq.in.
$a_0$ = 1116.89 ft./sec. $\sigma = \rho/\rho_0$

Based on International Civil Aviation Organization (ICAO) Standard Atmosphere
(NACA Technical Report No. 1235)

| ALTITUDE FEET | DENSITY RATIO $\rho/\rho_0$ | $1/\sqrt{\sigma}$ | TEMPERATURE DEG. F | TEMPERATURE DEG. C | SPEED OF SOUND RATIO $a/a_0$ | PRESSURE IN. OF Hg. | PRESSURE RATIO $P/P_0$ |
|---|---|---|---|---|---|---|---|
| 0 | 1.0000 | 1.0000 | 59.000 | 15.000 | 1.0000 | 29.92 | 1.0000 |
| 1000 | .9711 | 1.0148 | 55.434 | 13.019 | .9966 | 28.86 | .9644 |
| 2000 | .9428 | 1.0299 | 51.868 | 11.038 | .9931 | 27.82 | .9298 |
| 3000 | .9151 | 1.0454 | 48.302 | 9.057 | .9896 | 26.82 | .8962 |
| 4000 | .8881 | 1.0611 | 44.735 | 7.075 | .9862 | 25.84 | .8637 |
| 5000 | .8617 | 1.0773 | 41.169 | 5.094 | .9827 | 24.90 | .8320 |
| 6000 | .8359 | 1.0938 | 37.603 | 3.113 | .9792 | 23.98 | .8014 |
| 7000 | .8106 | 1.1107 | 34.037 | 1.132 | .9756 | 23.09 | .7716 |
| 8000 | .7860 | 1.1279 | 30.471 | −0.849 | .9721 | 22.22 | .7428 |
| 9000 | .7620 | 1.1456 | 26.905 | −2.831 | .9686 | 21.39 | .7148 |
| 10000 | .7385 | 1.1637 | 23.338 | −4.812 | .9650 | 20.58 | .6877 |
| 11000 | .7156 | 1.1822 | 19.772 | −6.793 | .9614 | 19.79 | .6614 |
| 12000 | .6932 | 1.2011 | 16.206 | −8.774 | .9579 | 19.03 | .6360 |
| 13000 | .6713 | 1.2205 | 12.640 | −10.756 | .9543 | 18.29 | .6113 |
| 14000 | .6500 | 1.2403 | 9.074 | −12.737 | .9507 | 17.58 | .5875 |
| 15000 | .6292 | 1.2606 | 5.508 | −14.718 | .9470 | 16.89 | .5643 |
| 16000 | .6090 | 1.2815 | 1.941 | −16.699 | .9434 | 16.22 | .5420 |
| 17000 | .5892 | 1.3028 | −1.625 | −18.681 | .9397 | 15.57 | .5203 |
| 18000 | .5699 | 1.3246 | −5.191 | −20.662 | .9361 | 14.94 | .4994 |
| 19000 | .5511 | 1.3470 | −8.757 | −22.643 | .9324 | 14.34 | .4791 |
| 20000 | .5328 | 1.3700 | −12.323 | −24.624 | .9287 | 13.75 | .4595 |
| 21000 | .5150 | 1.3935 | −15.889 | −26.605 | .9250 | 13.18 | .4406 |
| 22000 | .4976 | 1.4176 | −19.456 | −28.587 | .9213 | 12.64 | .4223 |
| 23000 | .4807 | 1.4424 | −23.022 | −30.568 | .9175 | 12.11 | .4046 |
| 24000 | .4642 | 1.4678 | −26.588 | −32.549 | .9138 | 11.60 | .3876 |
| 25000 | .4481 | 1.4938 | −30.154 | −34.530 | .9100 | 11.10 | .3711 |
| 26000 | .4325 | 1.5206 | −33.720 | −36.511 | .9062 | 10.63 | .3552 |
| 27000 | .4173 | 1.5480 | −37.286 | −38.492 | .9024 | 10.17 | .3398 |
| 28000 | .4025 | 1.5762 | −40.852 | −40.473 | .8986 | 9.725 | .3250 |
| 29000 | .3881 | 1.6052 | −44.419 | −42.455 | .8948 | 9.297 | .3107 |
| 30000 | .3741 | 1.6349 | −47.985 | −44.436 | .8909 | 8.885 | .2970 |
| 31000 | .3605 | 1.6654 | −51.551 | −46.417 | .8871 | 8.488 | .2837 |
| 32000 | .3473 | 1.6968 | −55.117 | −48.398 | .8832 | 8.106 | .2709 |
| 33000 | .3345 | 1.7291 | −58.683 | −50.379 | .8793 | 7.737 | .2586 |
| 34000 | .3220 | 1.7623 | −62.294 | −52.361 | .8754 | 7.382 | .2467 |

*Figure A1-8 (Sheet 1 of 2)*

## STANDARD ALTITUDE TABLE (Cont)

| ALTITUDE FEET | DENSITY RATIO $\rho/\rho_0$ | $1/\sqrt{\sigma}$ | TEMPERATURE DEG. F | TEMPERATURE DEG. C | SPEED OF SOUND RATIO $a/a_0$ | PRESSURE IN. OF Hg. | PRESSURE RATIO $P/P_0$ |
|---|---|---|---|---|---|---|---|
| 35000 | .3099 | 1.7964 | −65.816 | −54.342 | .8714 | 7.041 | .2353 |
| 36000 | .2981 | 1.8315 | −69.382 | −56.323 | .8675 | 6.712 | .2243 |
| 37000 | .2844 | 1.8753 | −69.700 | −56.500 | .8671 | 6.397 | .2138 |
| 38000 | .2710 | 1.9209 | −69.700 | −56.500 | .8671 | 6.097 | .2038 |
| 39000 | .2583 | 1.9677 | −69.700 | −56.500 | .8671 | 5.811 | .1942 |
| 40000 | .2462 | 2.0155 | −69.700 | −56.500 | .8671 | 5.538 | .1851 |
| 41000 | .2346 | 2.0645 | −69.700 | −56.500 | .8671 | 5.278 | .1764 |
| 42000 | .2236 | 2.1148 | −69.700 | −56.500 | .8671 | 5.030 | .1681 |
| 43000 | .2131 | 2.1662 | −69.700 | −56.500 | .8671 | 4.794 | .1602 |
| 44000 | .2031 | 2.2189 | −69.700 | −56.500 | .8671 | 4.569 | .1527 |
| 45000 | .1936 | 2.2728 | −69.700 | −56.500 | .8671 | 4.355 | .1455 |
| 46000 | .1845 | 2.3281 | −69.700 | −56.500 | .8671 | 4.151 | .1387 |
| 47000 | .1758 | 2.3848 | −69.700 | −56.500 | .8671 | 3.956 | .1322 |
| 48000 | .1676 | 2.4428 | −69.700 | −56.500 | .8671 | 3.770 | .1260 |
| 49000 | .1597 | 2.5022 | −69.700 | −56.500 | .8671 | 3.593 | .1201 |
| 50000 | .1522 | 2.5630 | −69.700 | −56.500 | .8671 | 3.425 | .1145 |
| 51000 | .1451 | 2.6254 | −69.700 | −56.500 | .8671 | 3.264 | .1091 |
| 52000 | .1383 | 2.6892 | −69.700 | −56.500 | .8671 | 3.111 | .1040 |
| 53000 | .1318 | 2.7546 | −69.700 | −56.500 | .8671 | 2.965 | .09909 |
| 54000 | .1256 | 2.8216 | −69.700 | −56.500 | .8671 | 2.826 | .09444 |
| 55000 | .1197 | 2.8903 | −69.700 | −56.500 | .8671 | 2.693 | .09001 |
| 56000 | .1141 | 2.9606 | −69.700 | −56.500 | .8671 | 2.567 | .08578 |
| 57000 | .1087 | 3.0326 | −69.700 | −56.500 | .8671 | 2.446 | .08176 |
| 58000 | .1036 | 3.1063 | −69.700 | −56.500 | .8671 | 2.331 | .07792 |
| 59000 | .09877 | 3.1819 | −69.700 | −56.500 | .8671 | 2.222 | .07426 |
| 60000 | .09414 | 3.2593 | −69.700 | −56.500 | .8671 | 2.118 | .07078 |
| 61000 | .08972 | 3.3386 | −69.700 | −56.500 | .8671 | 2.018 | .06746 |
| 62000 | .08551 | 3.4198 | −69.700 | −56.500 | .8671 | 1.924 | .06429 |
| 63000 | .08150 | 3.5029 | −69.700 | −56.500 | .8671 | 1.833 | .06127 |
| 64000 | .07767 | 3.5881 | −69.700 | −56.500 | .8671 | 1.747 | .05840 |
| 65000 | .07403 | 3.6754 | −69.700 | −56.500 | .8671 | 1.665 | .05566 |

*Figure A1-8 (Sheet 2 of 2)*

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# Part 2—Take-off

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# TAKE-OFF

## TAKE-OFF CHARTS.

This part presents and discusses the charts to be used in obtaining military and maximum power and military and maximum power plus ATO take-off distances. The non-ATO distances are based on normal acceleration using the normal take-off technique described in Section II. The military and maximum power plus ATO take-off performance is based on ATO firing speed schedules that result in minimum ground roll or minimum 50-foot obstacle clearance distances.

## TAKE-OFF PLANNING.

A planning procedure and charts for normal operation with military and maximum power are included in this part for the purpose of checking acceleration as late in the ground run as safely possible. Acceleration is related to total runway length available so that, in the event of subnormal acceleration, a decision to continue or abort the take-off may be made. Definitions of the terms used in the planning procedure, plus the purpose of each chart in the planning concept, are given in the following paragraphs.

## GROUND RUN DISTANCE AND TAKE-OFF SPEED.

### MILITARY AND MAXIMUM POWER.

Take-off ground run distance is the actual length of runway used from the start of the ground run until the airplane becomes airborne. Distances that represent normal procedure performance are shown in chart form in this Part. These charts may be used to predict take-off distances for operation from dry, hard surface runways for most normal variations in operating altitude, temperature, wind, and runway slope conditions. Applicable take-off speeds are also provided.

### MILITARY AND MAXIMUM POWER PLUS ATO.

Minimum take-off ground run distances that are obtained through the use of military or maximum power plus two 1000-pound thrust ATO units are shown on the following pages for a wide variation of operating altitude, temperature, wind, and runway slope conditions. These minimum values may be obtained by firing the ATO units in accordance with the firing speed schedules provided. ATO duration varies with temperature from 18 seconds at 0°F to 12 seconds at 120°F. If the units are fired in accordance with the firing speed schedules they will be expended about the time the airplane leaves the ground. The corresponding charts of total distance to clear a 50-foot obstacle, based on minimum ground run only, are also contained in this section. Separate charts provide minimum obstacle distance data and appropriate ATO firing speed schedules.

## ACCELERATION AND STOPPING PERFORMANCE.

### PREDICTED ACCELERATION.

Take-off acceleration performance for operation with military and maximum power is shown in this Part, together with stopping distance charts. These charts provide a means of comparing actual acceleration during take-off with that predicted, so that the run can be aborted if a safe take-off is not assured, and a stop be made within the available field length remaining. Comparison of actual acceleration with predicted acceleration is accomplished by comparing actual and predicted speeds (line speeds) at some check distance (line distance) during the take-off run.

### LINE SPEEDS.

Two line speeds should be determined from the acceleration charts: normal line speed and minimum allowable line speed. Normal line speed is the speed that will be attained at a chosen line distance during normal acceleration. Minimum allowable line speed is the speed at the chosen line distance that will allow the aircraft to leave the ground at the end of the runway or stop in the remaining runway length. If this speed is more than 10 knots below the normal predicted line speed, a minimum allowable line speed that is 10 knots less than the normal line speed should be used instead.

### STOPPING DISTANCE CHECK.

Obviously, the point at which the acceleration is to be checked should be chosen so that the airplane may be stopped on the remaining runway from the minimum allowable line speed at that point. The Stopping Distance Chart, therefore, should be entered at the minimum allowable line speed obtained from the acceleration chart to determine if the aircraft can be stopped in the remaining runway distance.

### CONDITIONS.

The acceleration curves were determined for no wind, level runway conditions. The take-off ground roll distance that is used in the Take-Off Acceleration Chart to determine normal line speed should, therefore, be based on zero wind, zero runway slope conditions. An example showing its use is included on each chart.

## TOTAL DISTANCE TO TAKE-OFF AND CLEAR 50 FEET.

### MILITARY AND MAXIMUM POWER.

The total distance to clear a 50-foot obstacle is the sum of the ground run distance and the air distance traveled while attaining a height of 50 feet above the runway. Total distance charts are provided in this Part for military and maximum power operation. Distances are shown for a range of altitude, temperature, wind, and runway slope conditions. Obstacle clearance speeds also are included on the charts.

### MILITARY AND MAXIMUM POWER PLUS ATO.

Minimum total distance data to take-off and clear a 50-foot obstacle using military or maximum power plus ATO are presented on the following pages for all required altitude, temperature, wind and runway slope conditions. These distances are based upon firing the ATO units according to the firing speed schedules shown. Use of these schedules will result in burn-out of the units near the 50-foot elevation point.

## EFFECT OF ALTITUDE AND OUTSIDE AIR TEMPERATURE ON TAKE-OFF PERFORMANCE.

Engine thrust decreases as altitude or outside air temperature increases. Consequently, greater take-off distances are required at higher altitudes and on warm days. Representative performance showing the effects of altitude and air temperature on take-off distances are shown on the accompanying sketch. Note the rates at which both ground roll distance and distance to attain a certain elevation above ground increase at higher outside air temperatures and altitudes.

## TAKE-OFF PLANNING PROBLEM.

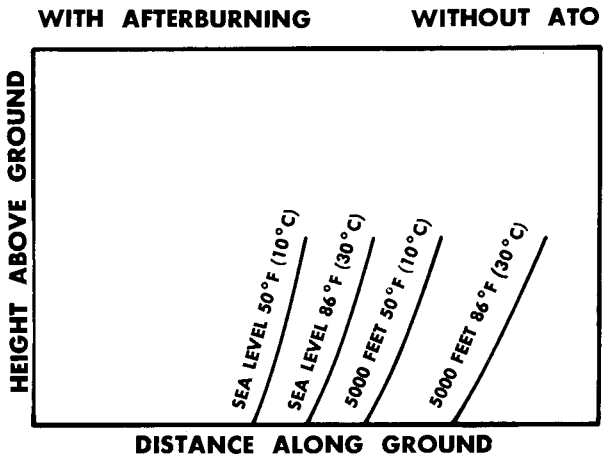
The procedures to follow for accurate take-off planning are presented below by a sample problem. The methods used for solution of the example apply to the actual performance charts discussed.

### SAMPLE PROBLEM.

Determine the take-off performance for the following conditions:

Tip tank and rocket pod configuration
Maximum power, without ATO
Gross weight—21,000 pounds

EFFECT OF ALTITUDE AND TEMPERATURE ON TAKE-OFF PERFORMANCE




Field outside air temperature—100°F
Field pressure altitude—5000 feet
Wind—0 knots
Runway—7000 feet long, level, dry and hard surface

1. From Figure A2-7 (Take-Off Distance—Maximum Power) read ground run distance....6350 ft.
   Take-off airspeed from same chart.....148 kts IAS
2. From Figure A2-8 (Take-off Distance to Clear 50 Feet—Maximum Power) read the total distance .....8250 ft.
   Speed at the 50-foot obstacle point.....163 kts.

The take-off acceleration performance may be obtained from Figure A2-34. For this example, assume that the take-off acceleration speed check point is 3500 feet from brake release point. Available runway length is 7000 feet.

1. Zero wind, zero runway slope, ground run distance (Figure A2-7) .....6350 ft.
2. Normal line speed at runway check point.....110 kts.
3. Line speed at runway check point that will allow aircraft to leave ground at end of runway .....104 kts.

If the speed of the aircraft at the check point location is less than 104 knots IAS, the take-off should be aborted. Stopping distance requirements may be determined from Figure A2-36. A hard-braked stop with drag chute deployed is used.

1. Stopping distance, including pilot reaction time, at minimum allowable line speed of 104 knots at 5000 ft, and 100°F .....2500 ft.
2. Total distance traveled from brake release to stopping point (3500 ft. + 2500 ft.).....6000 ft.

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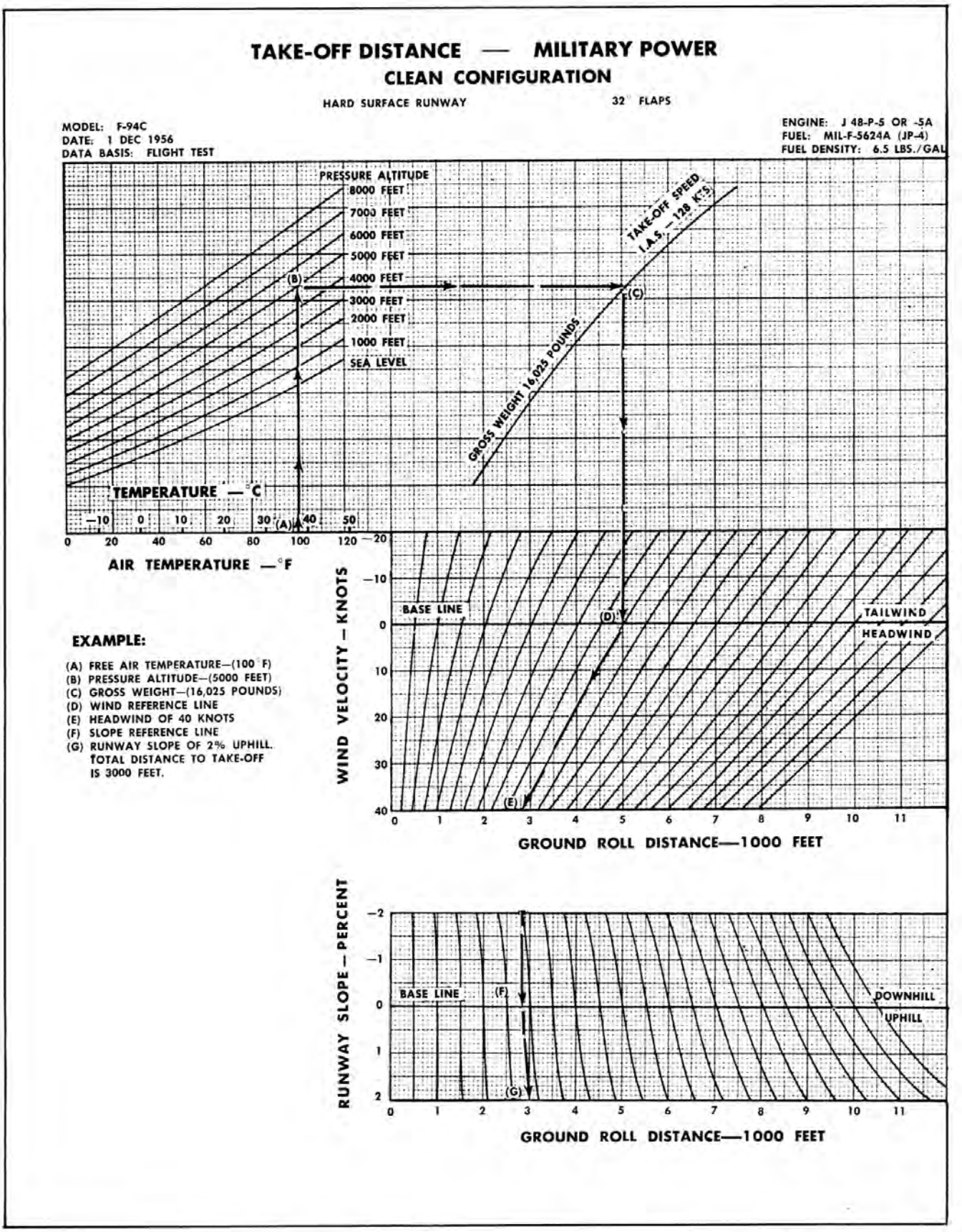



*Figure A2-1. Take-Off Distance—Military Power—Clean Configuration*

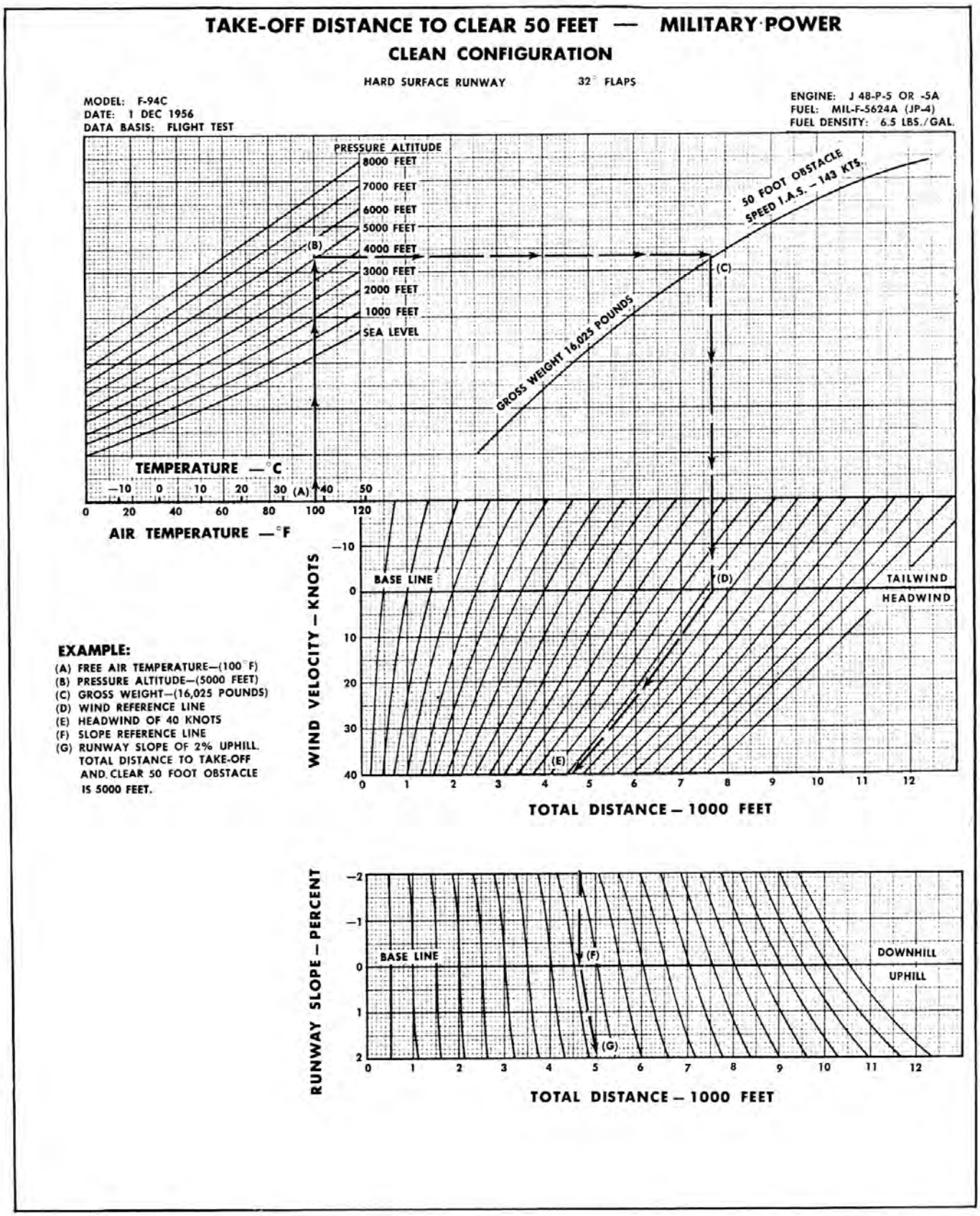



*Figure A2-2. Take-Off Distance to Clear 50 Ft.—Military Power—Clean Configuration*

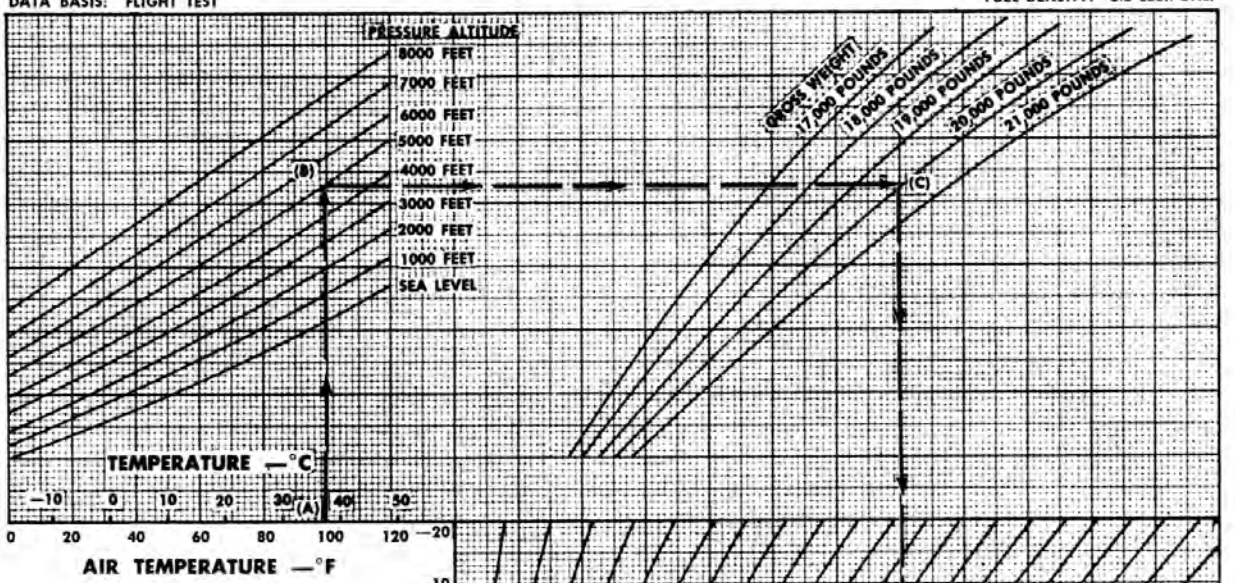
## TAKE-OFF DISTANCE — MILITARY POWER

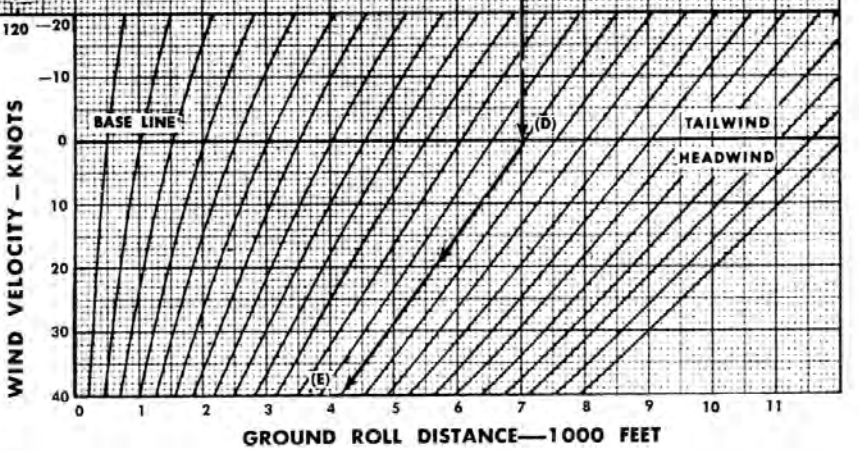
### TIP TANKS — TIP TANKS AND ROCKET PODS

HARD SURFACE RUNWAY 32° FLAPS

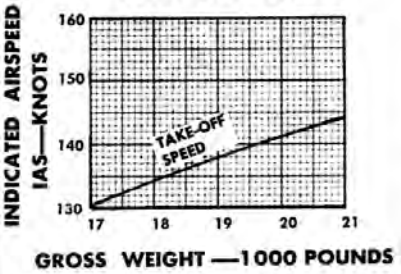
MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

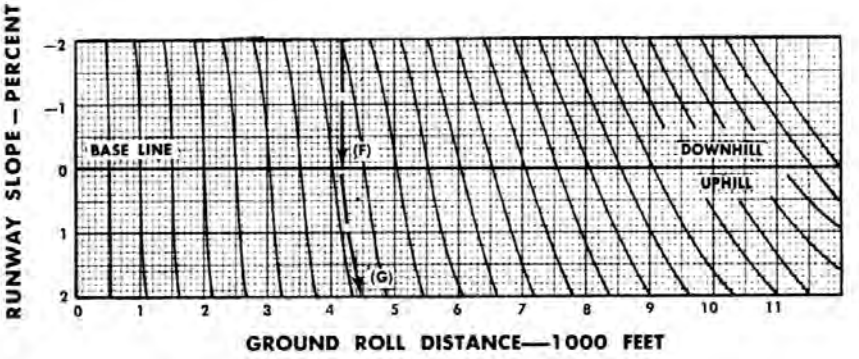
ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.




SPEED SCHEDULE




**EXAMPLE:**

(A) FREE AIR TEMPERATURE—(100°F)
(B) PRESSURE ALTITUDE—(5000 FEET)
(C) GROSS WEIGHT—(20,000 POUNDS)
(D) WIND REFERENCE LINE
(E) HEADWIND OF 40 KNOTS
(F) SLOPE REFERENCE LINE
(G) RUNWAY SLOPE OF 2% UPHILL. TOTAL DISTANCE TO TAKE-OFF IS 4450 FEET.

*Figure A2-3. Take-Off Distance—Military Power—Tip Tanks—Tip Tanks and Rocket Pods*

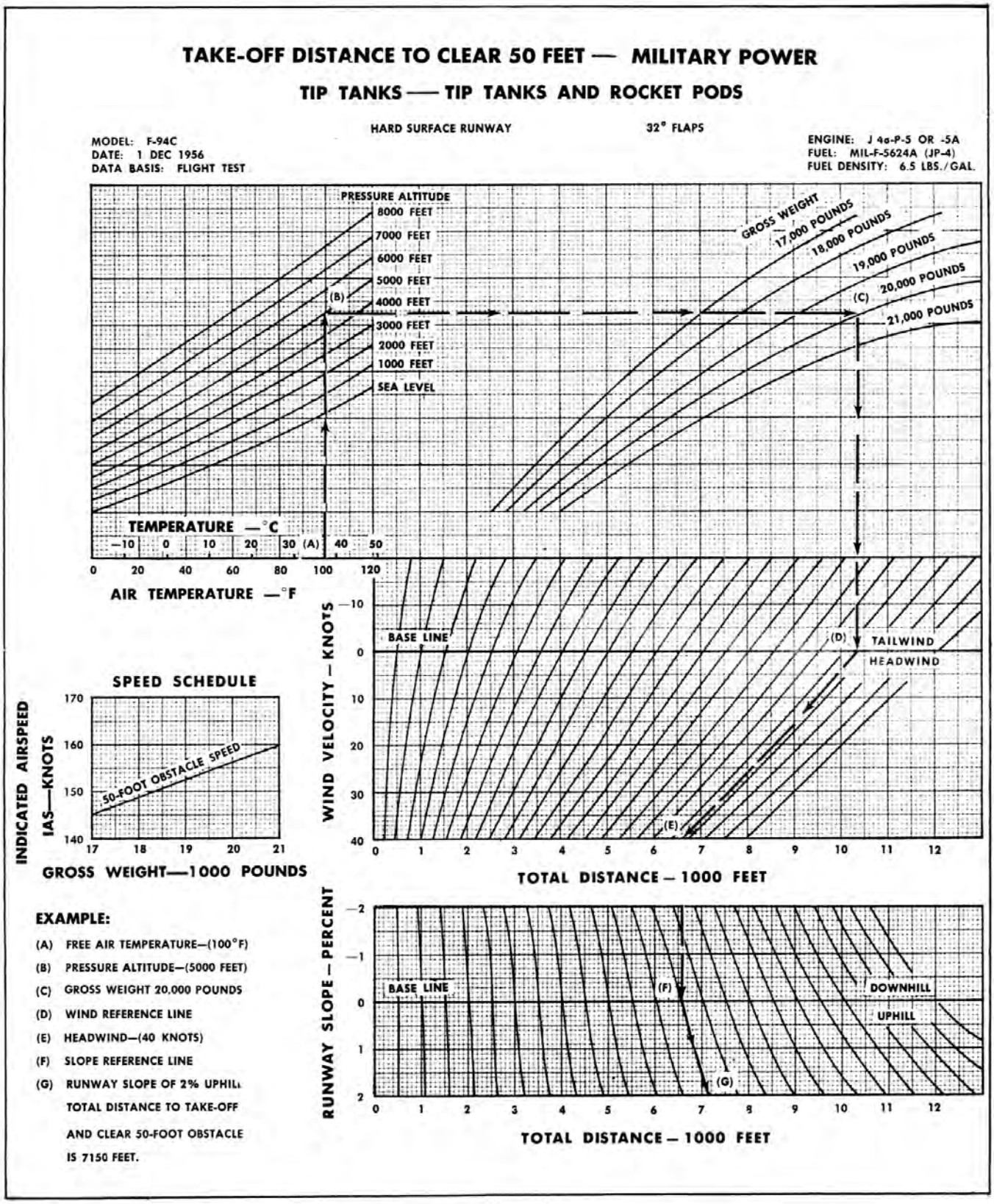



*Figure A2-4. Take-Off Distance to Clear 50 Ft.—Military Power—Tip Tanks—Tip Tanks and Rocket Pods*

# TAKE-OFF DISTANCE — MAXIMUM POWER

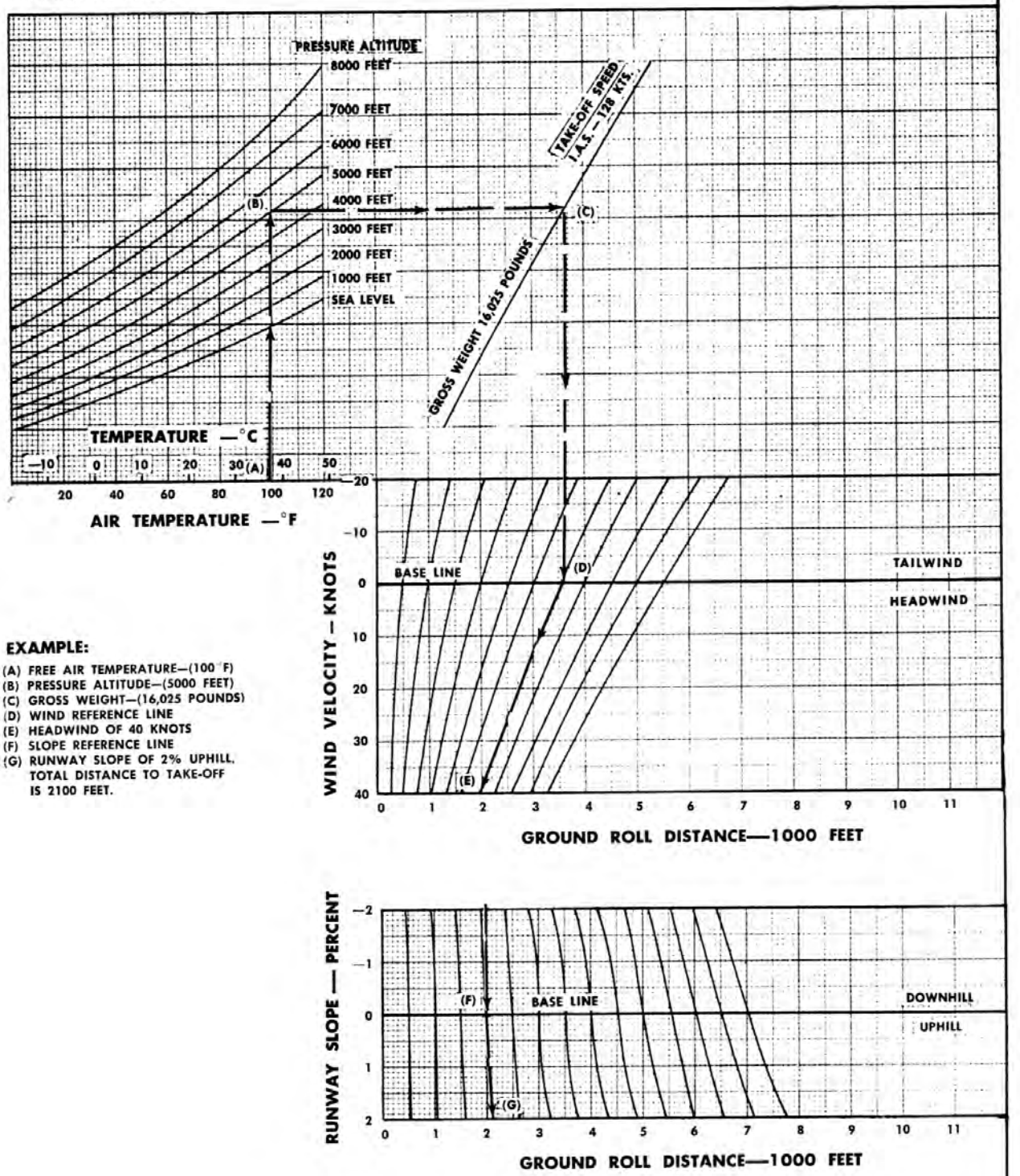
## CLEAN CONFIGURATION

HARD SURFACE RUNWAY

32° FLAPS

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.




**EXAMPLE:**

(A) FREE AIR TEMPERATURE—(100°F)
(B) PRESSURE ALTITUDE—(5000 FEET)
(C) GROSS WEIGHT—(16,025 POUNDS)
(D) WIND REFERENCE LINE
(E) HEADWIND OF 40 KNOTS
(F) SLOPE REFERENCE LINE
(G) RUNWAY SLOPE OF 2% UPHILL. TOTAL DISTANCE TO TAKE-OFF IS 2100 FEET.

*Figure A2-5. Take-Off Distance—Maximum Power—Clean Configuration*

## TAKE-OFF DISTANCE TO CLEAR 50 FEET — MAXIMUM POWER

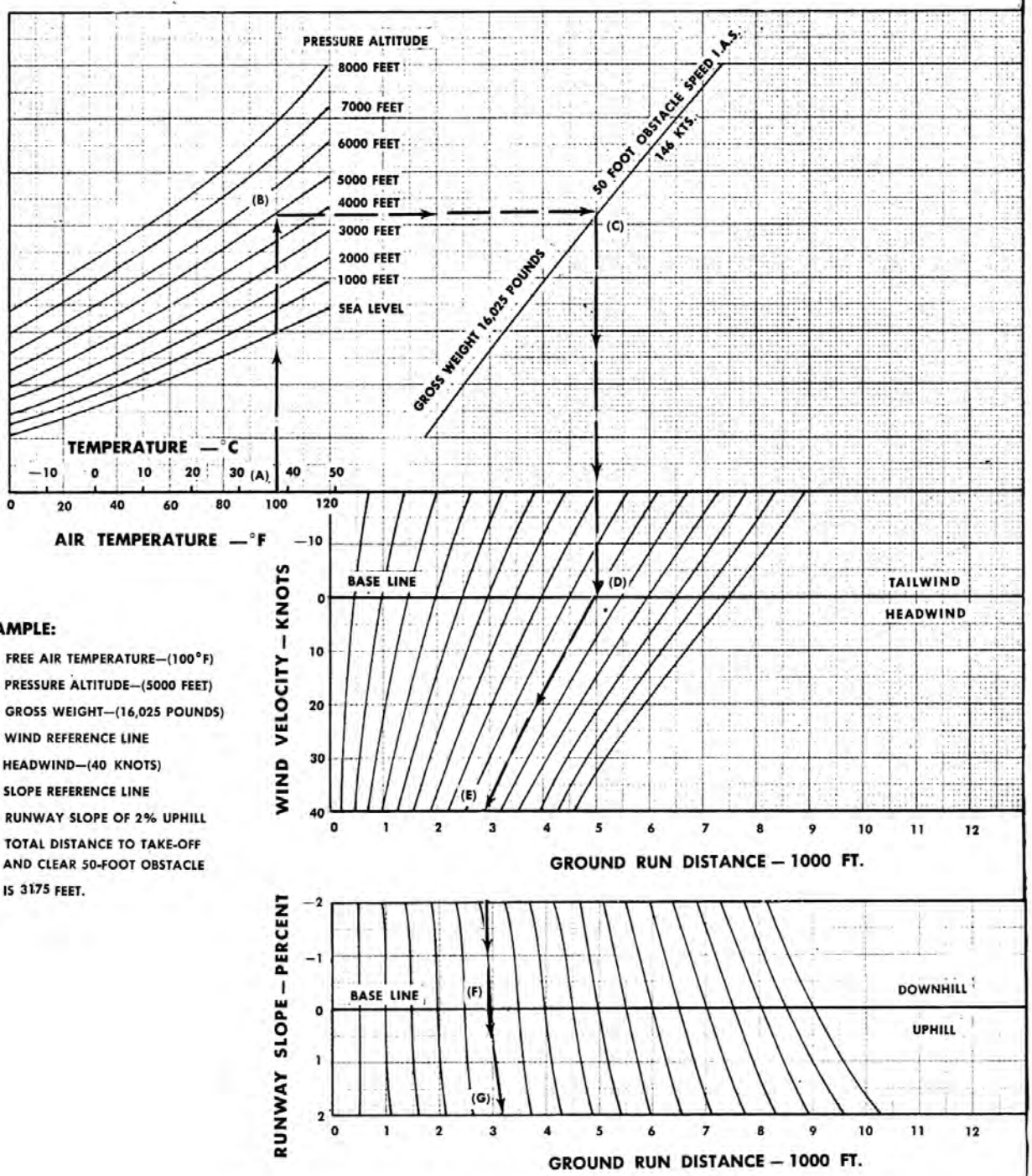
### CLEAN CONFIGURATION

HARD SURFACE RUNWAY

32° FLAPS

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.




**EXAMPLE:**

(A) FREE AIR TEMPERATURE—(100°F)
(B) PRESSURE ALTITUDE—(5000 FEET)
(C) GROSS WEIGHT—(16,025 POUNDS)
(D) WIND REFERENCE LINE
(E) HEADWIND—(40 KNOTS)
(F) SLOPE REFERENCE LINE
(G) RUNWAY SLOPE OF 2% UPHILL

TOTAL DISTANCE TO TAKE-OFF AND CLEAR 50-FOOT OBSTACLE IS 3175 FEET.

*Figure A2-6. Take-Off Distance to Clear 50 Ft.—Maximum Power—Clean Configuration*

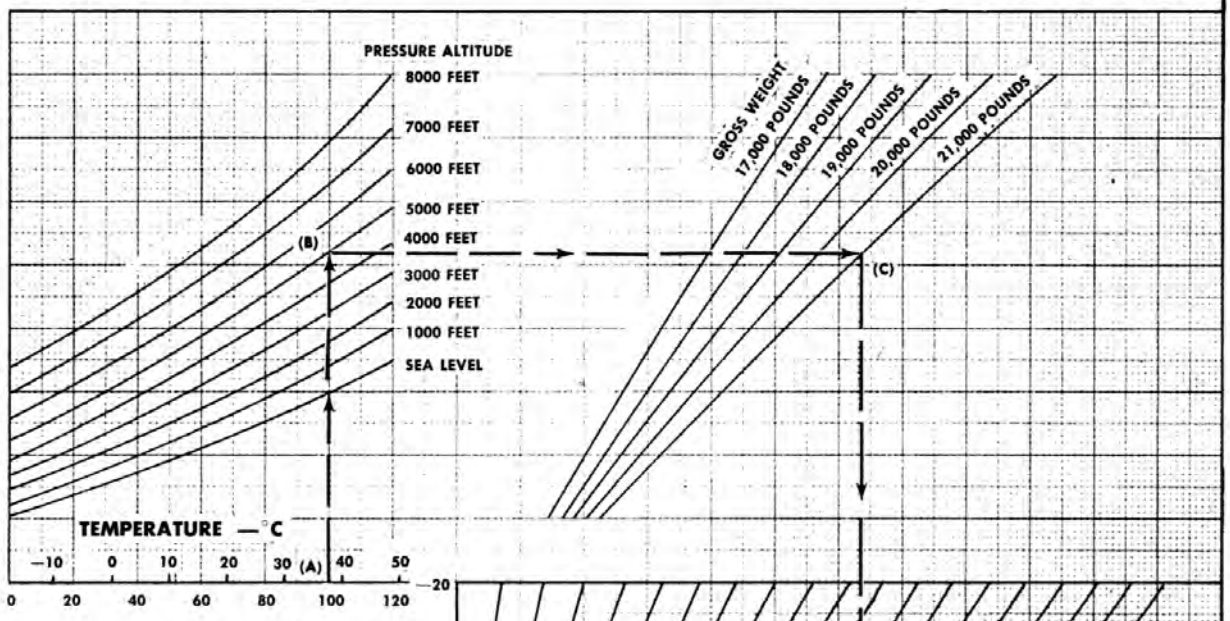
## TAKE-OFF DISTANCE — MAXIMUM POWER

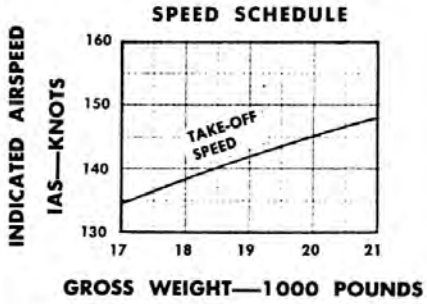
### TIP TANKS — TIP TANKS AND ROCKET PODS

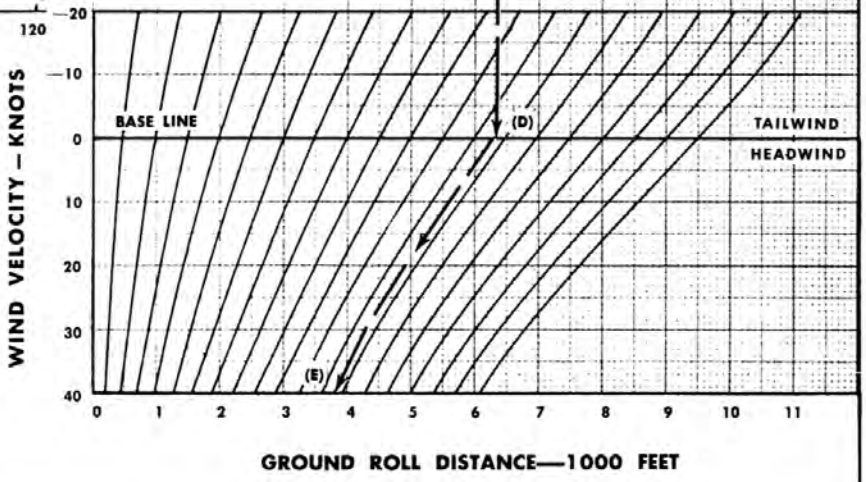
HARD SURFACE RUNWAY 32° FLAPS

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL




**EXAMPLE:**

(A) FREE AIR TEMPERATURE—(100°F)
(B) PRESSURE ALTITUDE—(5000 FEET)
(C) GROSS WEIGHT—(21,000 POUNDS)
(D) WIND REFERENCE LINE
(E) HEADWIND—(40 KNOTS)
(F) SLOPE REFERENCE LINE
(G) RUNWAY SLOPE OF 2% UPHILL
TOTAL DISTANCE TO TAKE-OFF IS 4150 FEET.

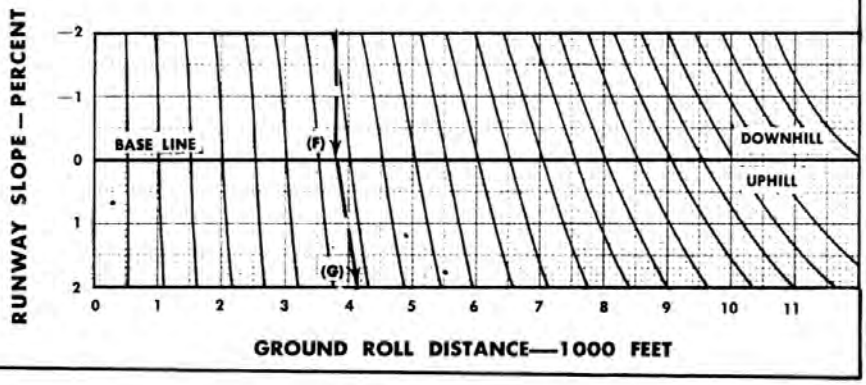



*Figure A2-7. Take-Off Distance—Maximum Power—Tip Tanks—Tip Tanks and Rocket Pods*

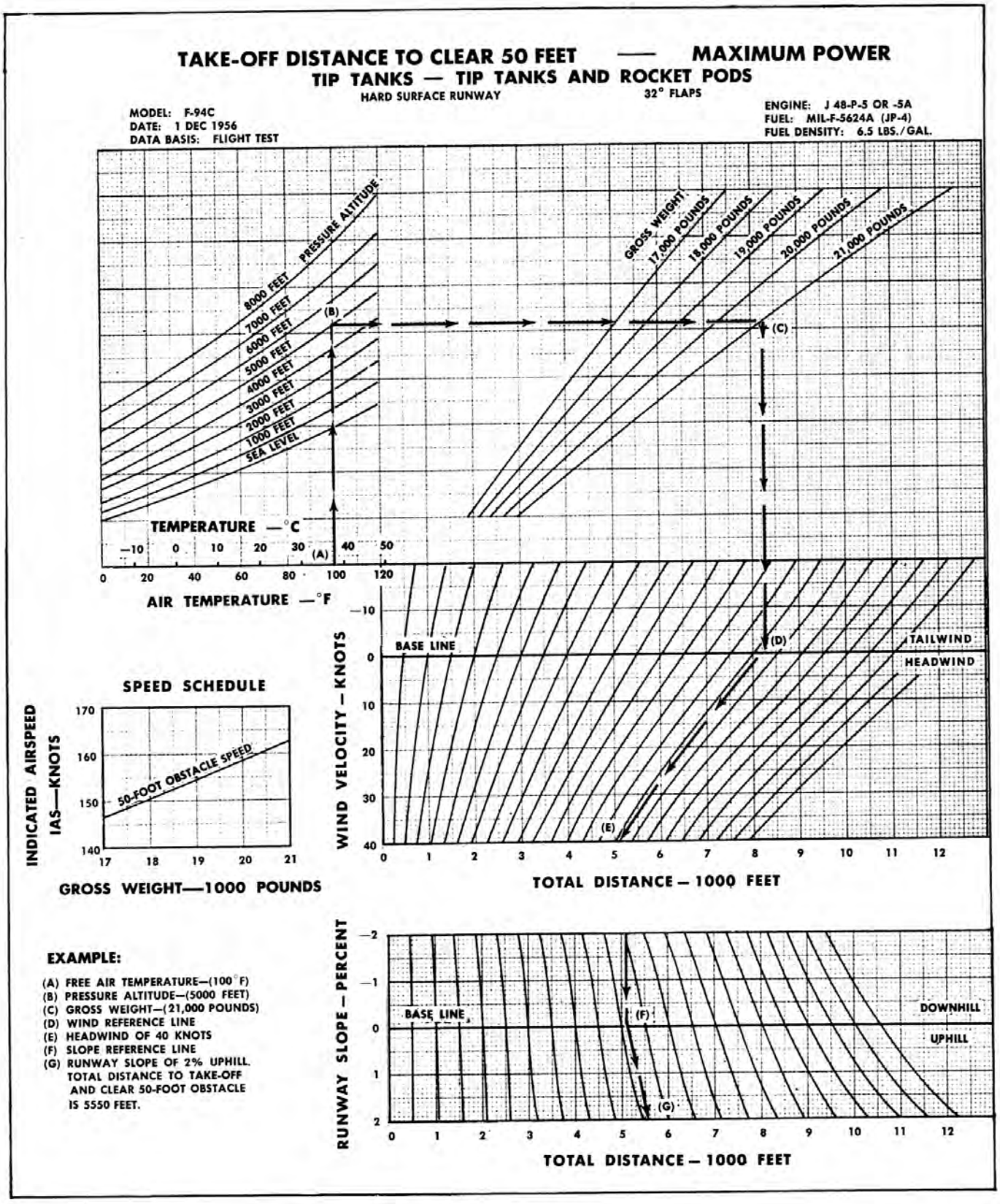



*Figure A2-8. Take-Off Distance to Clear 50 Ft.—Maximum Power—Tip Tanks—Tip Tanks and Rocket Pods*

## TAKE-OFF DISTANCE — MAXIMUM POWER

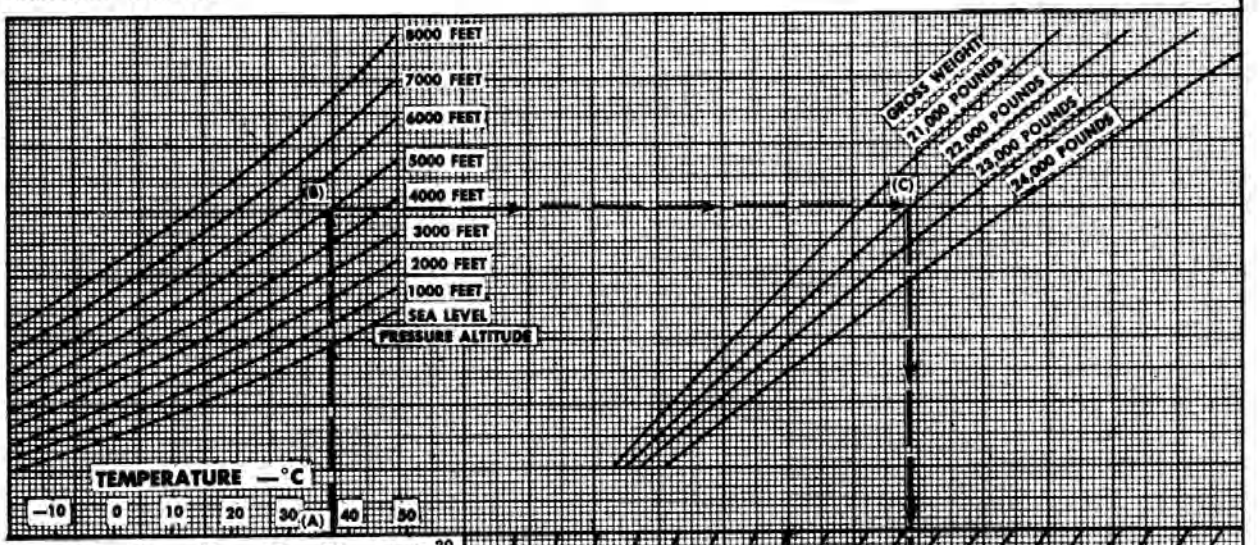
### TIP TANKS AND PYLON TANKS — TIP TANKS, PYLON TANKS AND ROCKET PODS

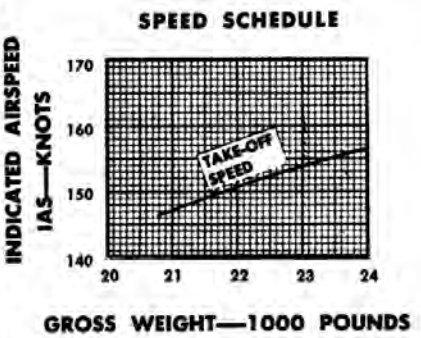
HARD SURFACE RUNWAY

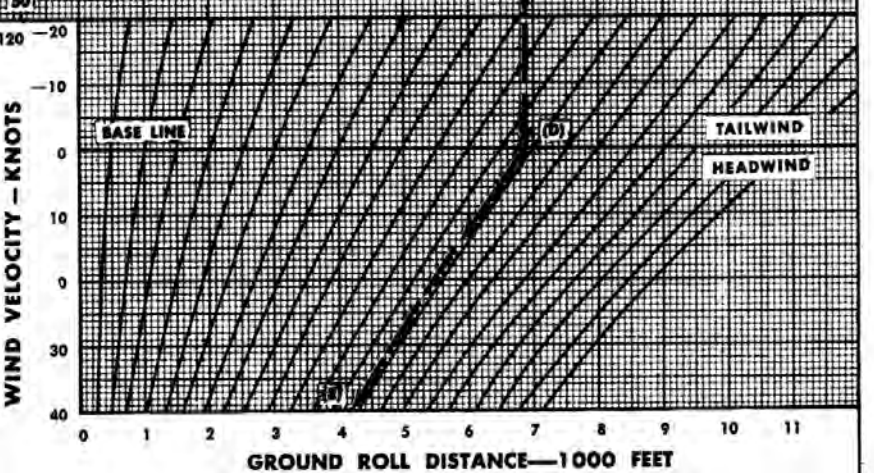
32° FLAPS

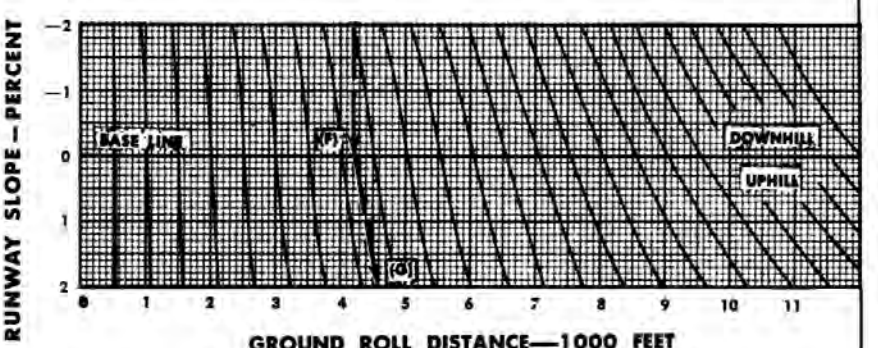
MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.




**EXAMPLE:**

(A) FREE AIR TEMPERATURE—(100°F)
(B) PRESSURE ALTITUDE—(5000 FEET)
(C) GROSS WEIGHT—(22,000 POUNDS)
(D) WIND REFERENCE LINE
(E) HEADWIND OF 40 KNOTS
(F) SLOPE REFERENCE LINE
(G) RUNWAY SLOPE OF 2% UPHILL. TOTAL DISTANCE TO TAKE-OFF IS 4575 FEET.

*Figure A2-9. Take-Off Distance—Maximum Power—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods*

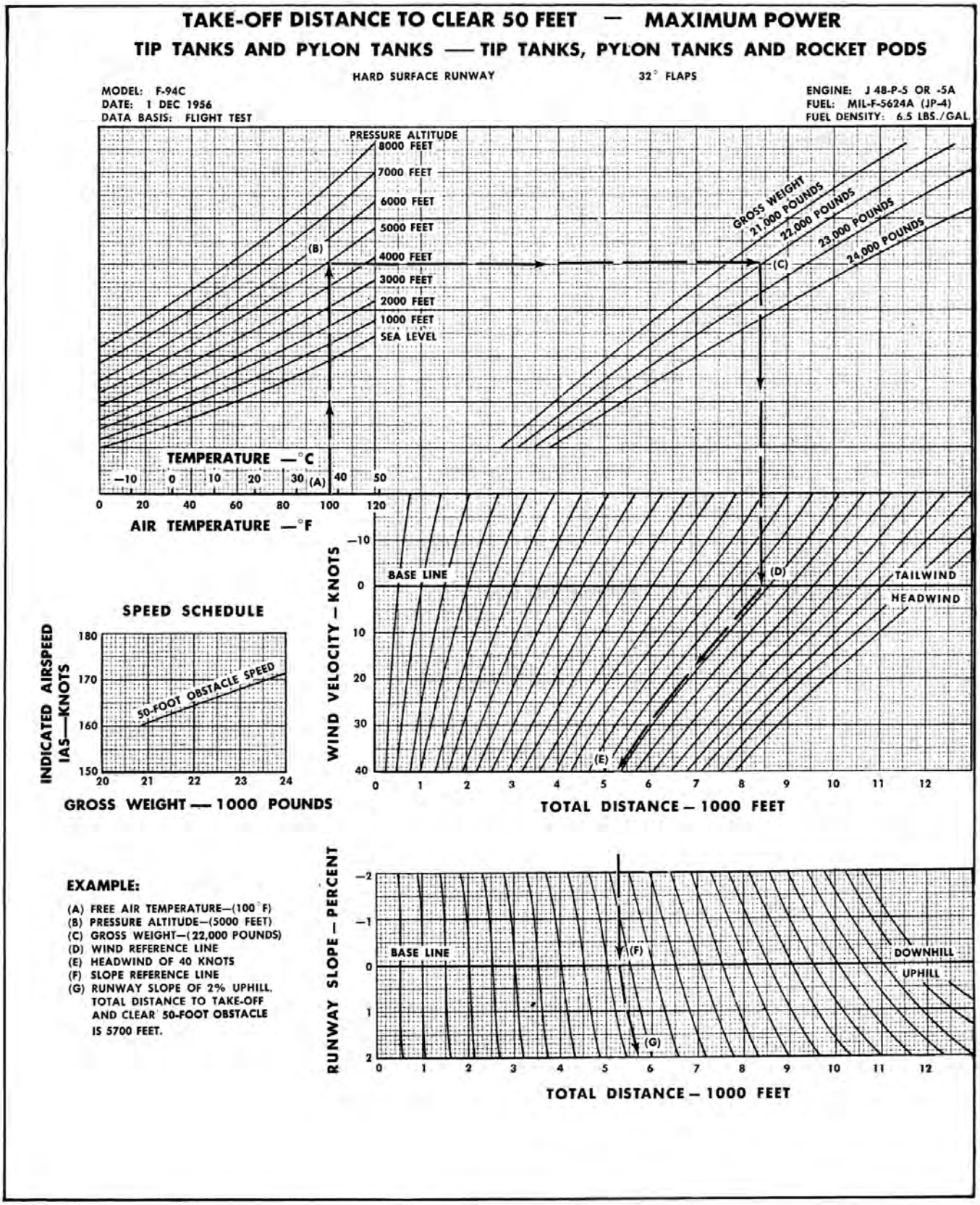



*Figure A2-10. Take-Off Distance to Clear 50 Ft.—Maximum Power—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods*

# TAKE-OFF DISTANCE — MILITARY POWER + ATO

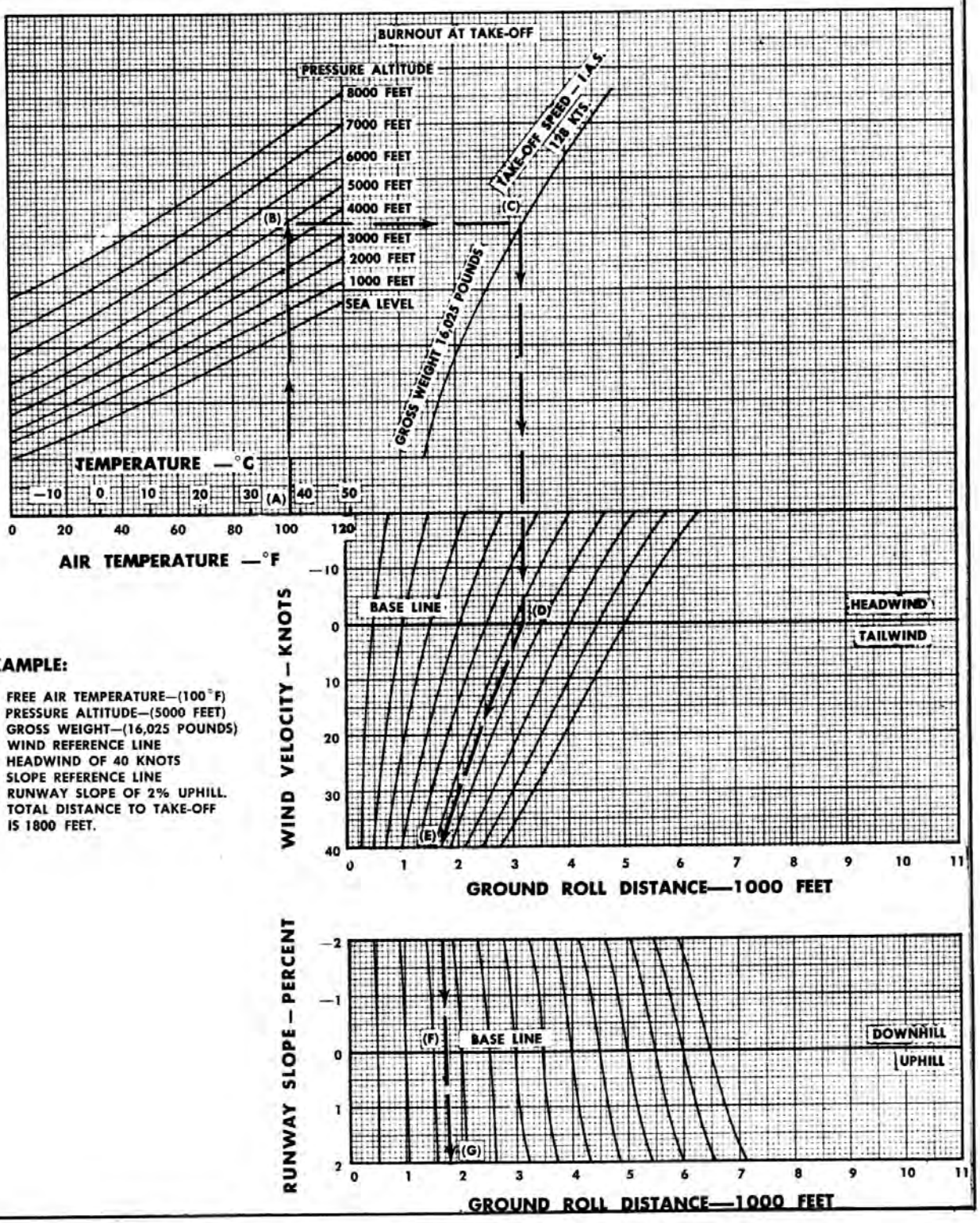
## CLEAN CONFIGURATION

HARD SURFACE RUNWAY

32° FLAPS

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.




**EXAMPLE:**

(A) FREE AIR TEMPERATURE—(100°F)
(B) PRESSURE ALTITUDE—(5000 FEET)
(C) GROSS WEIGHT—(16,025 POUNDS)
(D) WIND REFERENCE LINE
(E) HEADWIND OF 40 KNOTS
(F) SLOPE REFERENCE LINE
(G) RUNWAY SLOPE OF 2% UPHILL. TOTAL DISTANCE TO TAKE-OFF IS 1800 FEET.

*Figure A2-11. Take-Off Distance—Military Power + ATO—Clean Configuration*

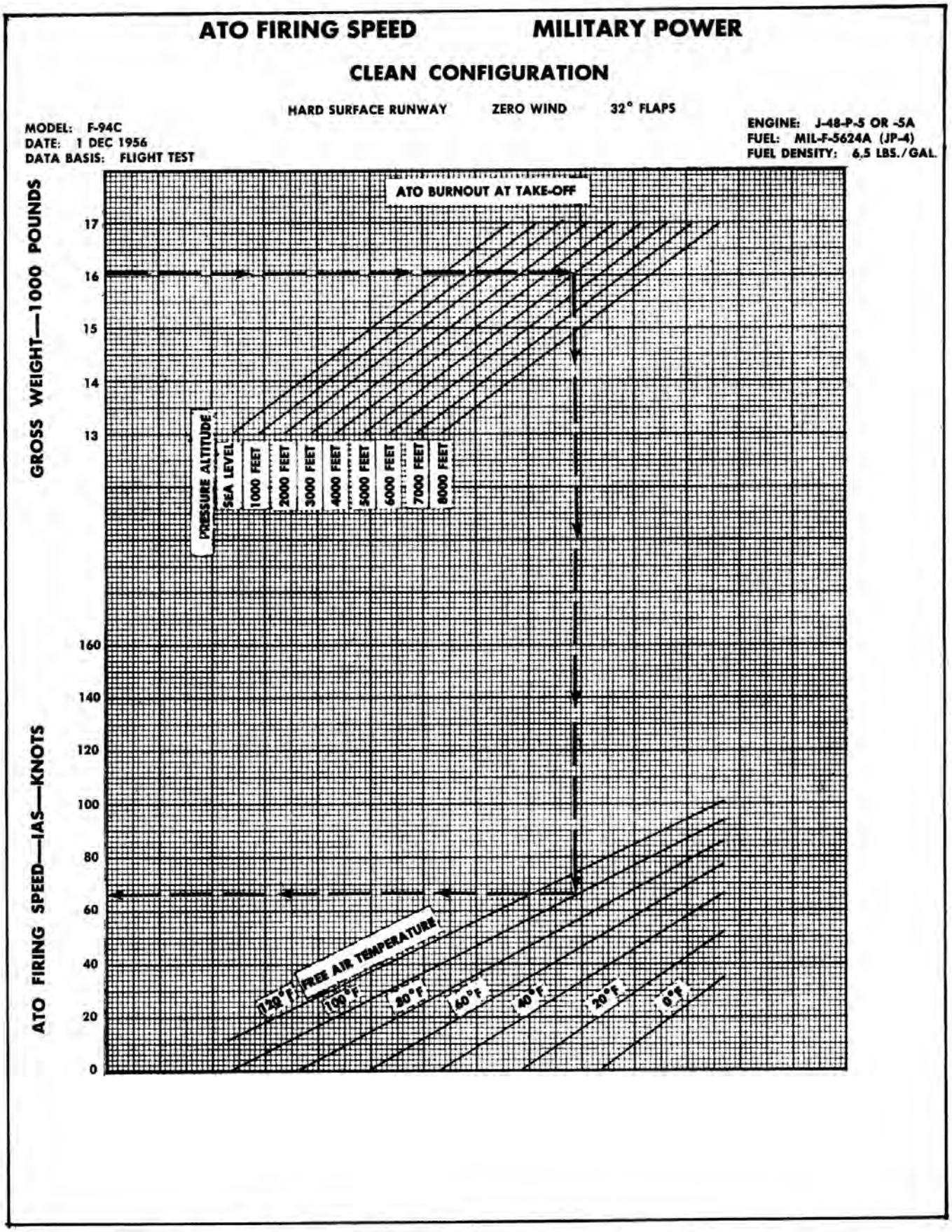



*Figure A2-12. ATO Firing Speed—Military Power—Clean Configuration*

# TAKE-OFF DISTANCE TO CLEAR 50 FEET — MILITARY POWER + ATO

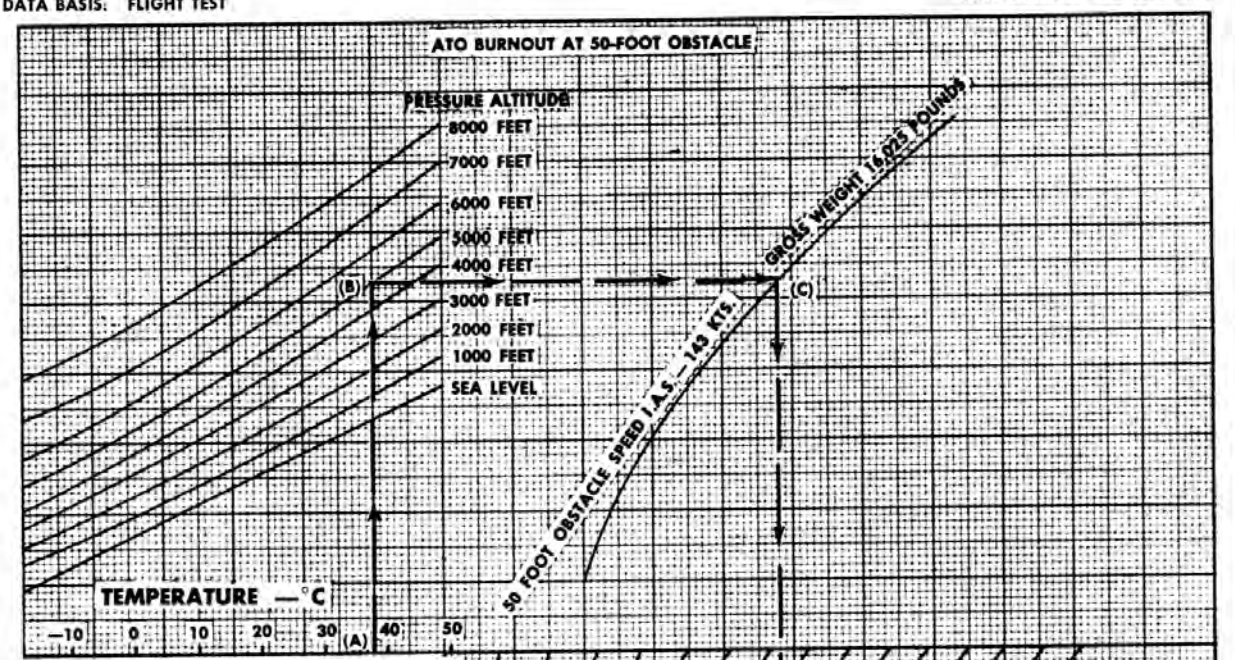
## CLEAN CONFIGURATION

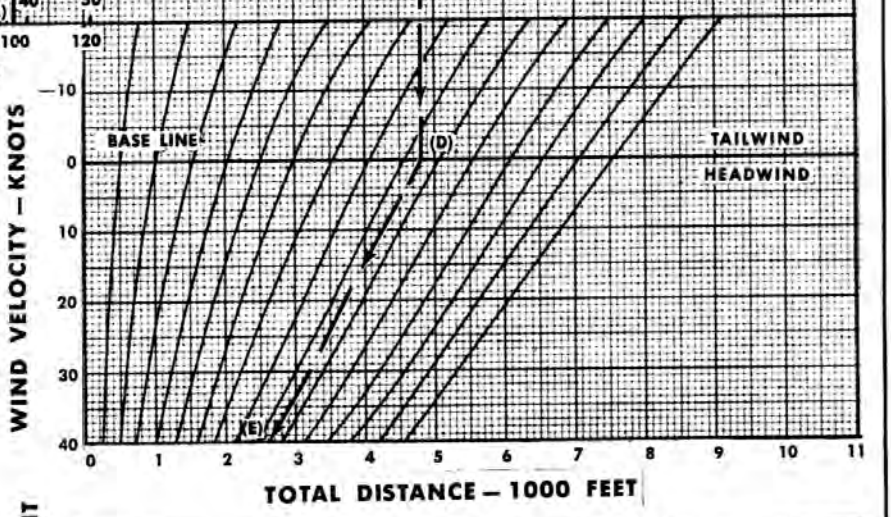
HARD SURFACE RUNWAY

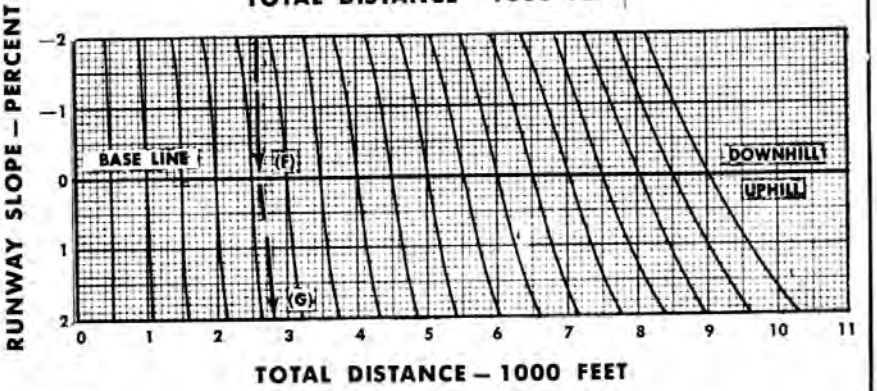
32° FLAPS

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.




**EXAMPLE:**

(A) FREE AIR TEMPERATURE—(100°F)
(B) PRESSURE ALTITUDE—(5000 FEET)
(C) GROSS WEIGHT—(16,025 POUNDS)
(D) WIND REFERENCE LINE
(E) HEADWIND OF 40 KNOTS
(F) SLOPE REFERENCE LINE
(G) RUNWAY SLOPE OF 2% UPHILL. TOTAL DISTANCE TO TAKE-OFF AND CLEAR 50-FOOT OBSTACLE IS 2800 FT.

*Figure A2-13. Take-Off Distance to Clear 50 Ft.—Military Power + ATO—Clean Configuration*

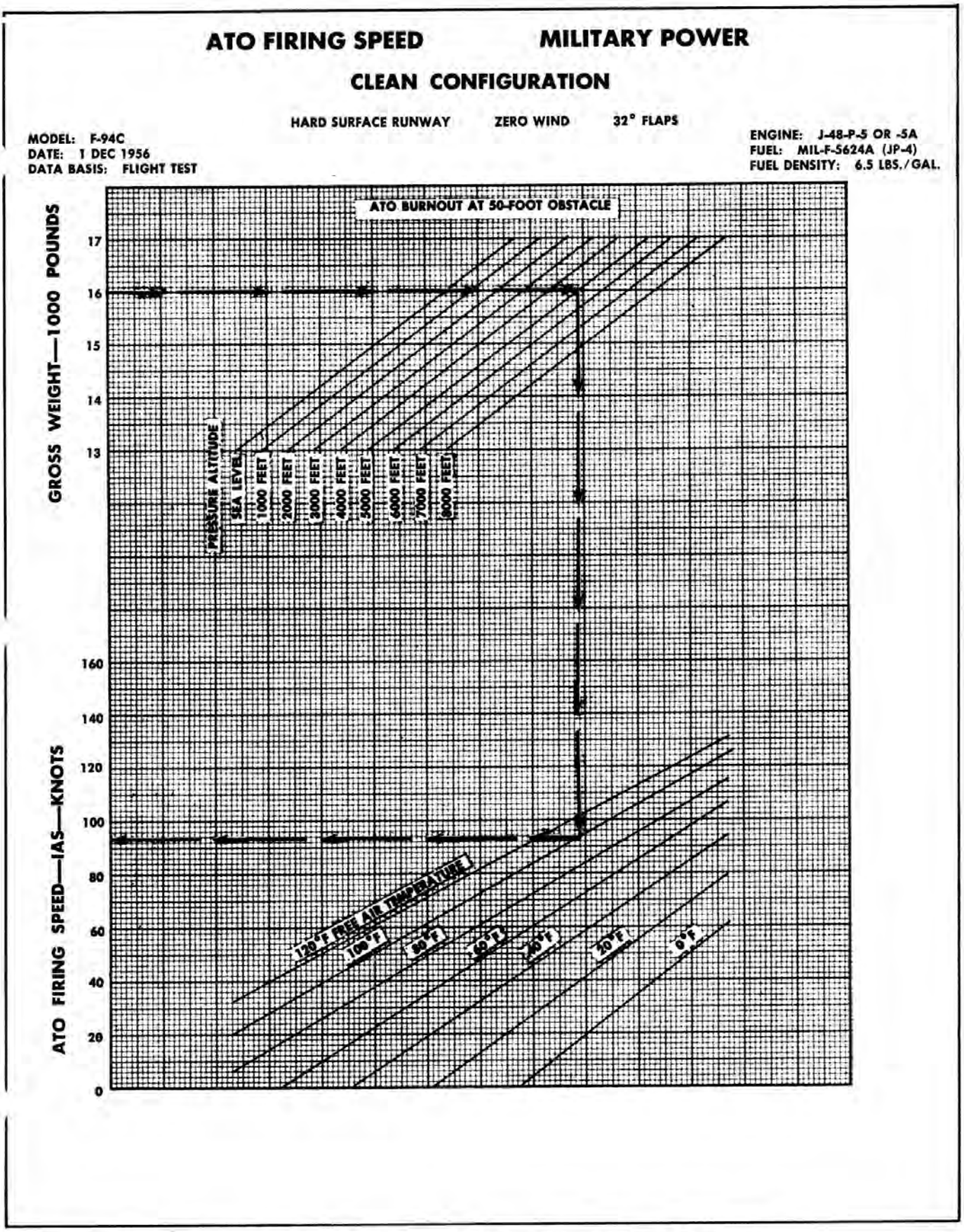



*Figure A2-14. ATO Firing Speed—Military Power—Clean Configuration*

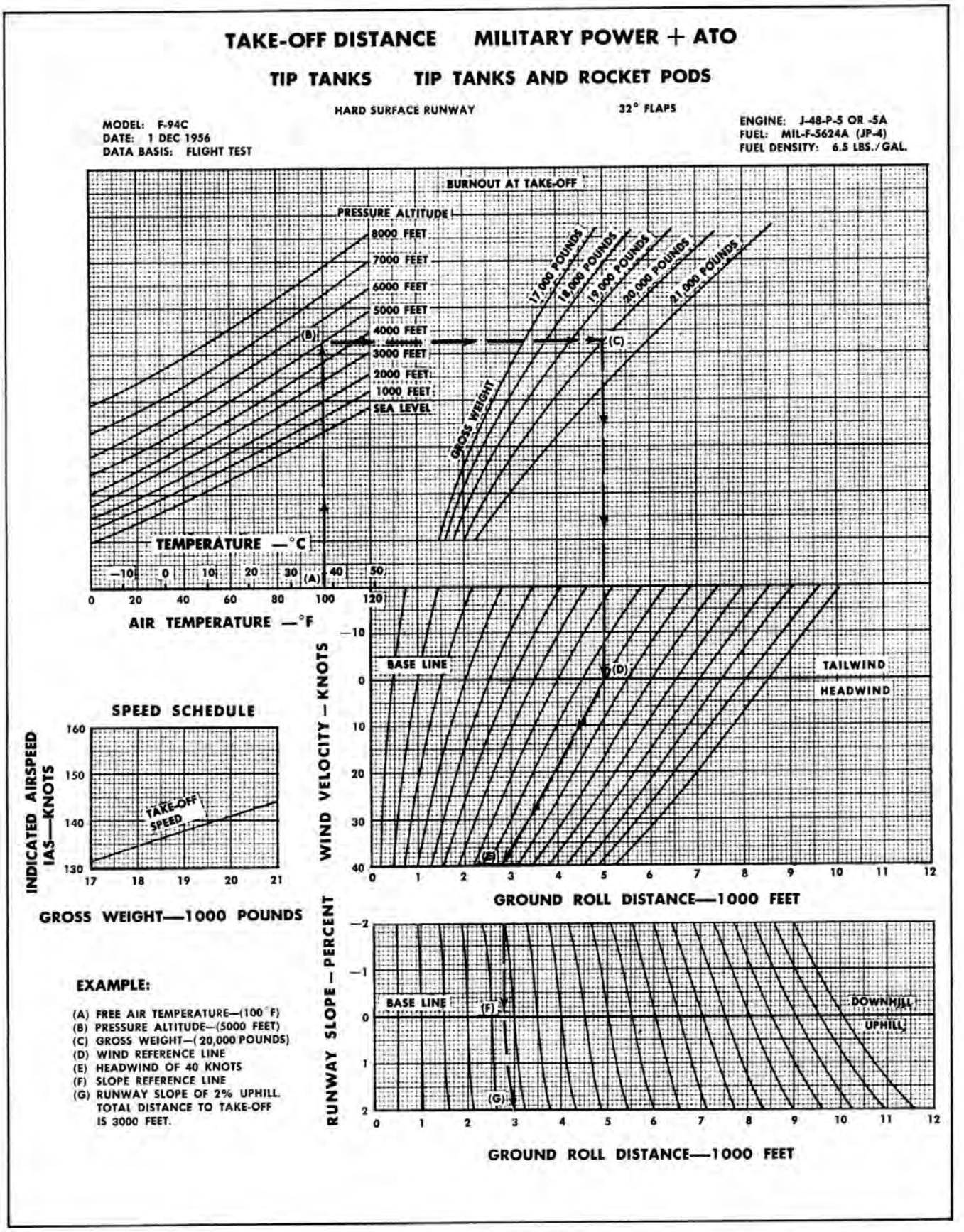



*Figure A2-15. Take-Off Distance—Military Power + ATO—Tip Tanks—Tip Tanks and Rocket Pods*

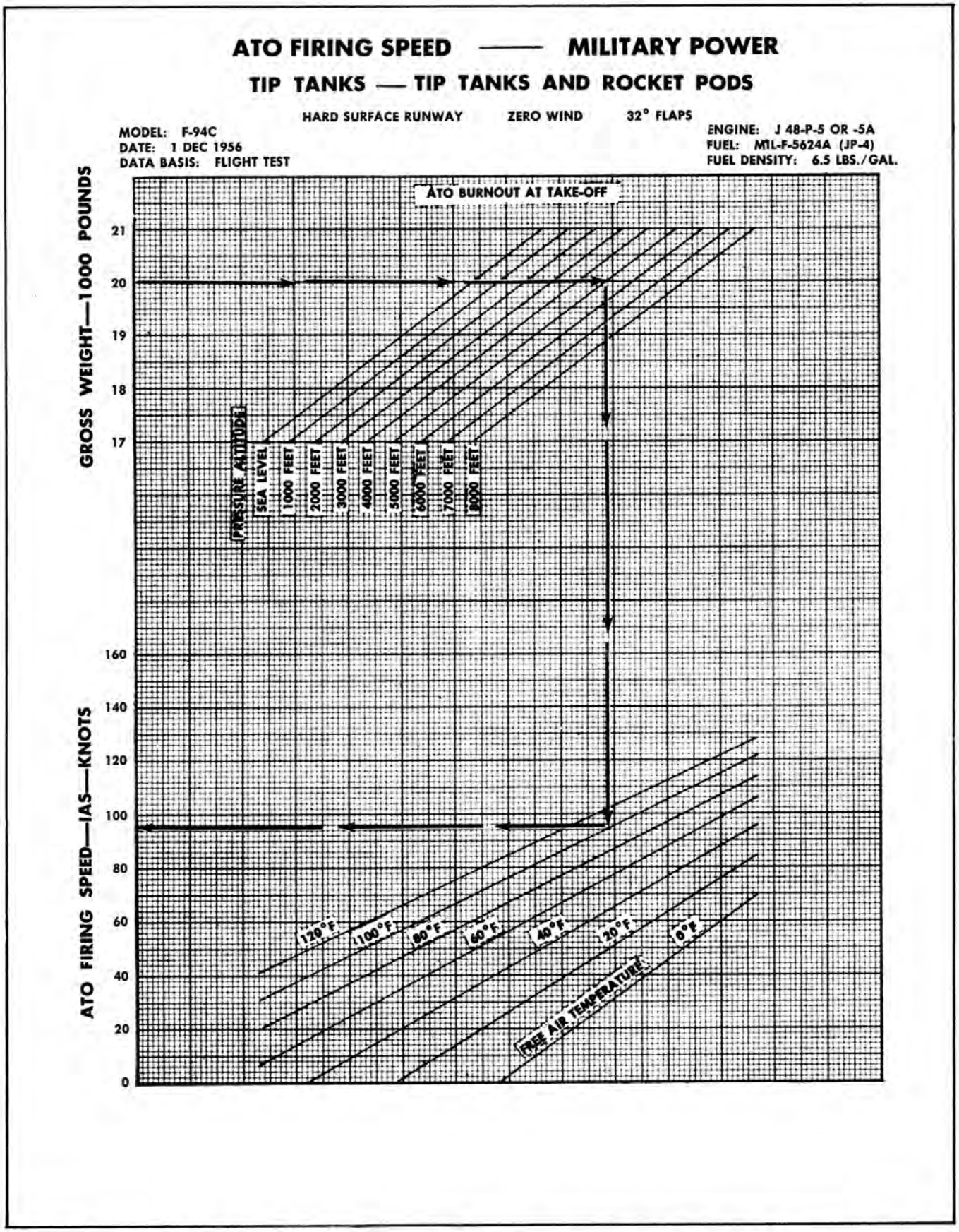



*Figure A2-16. ATO Firing Speed—Military Power—Tip Tanks—Tip Tanks and Rocket Pods*

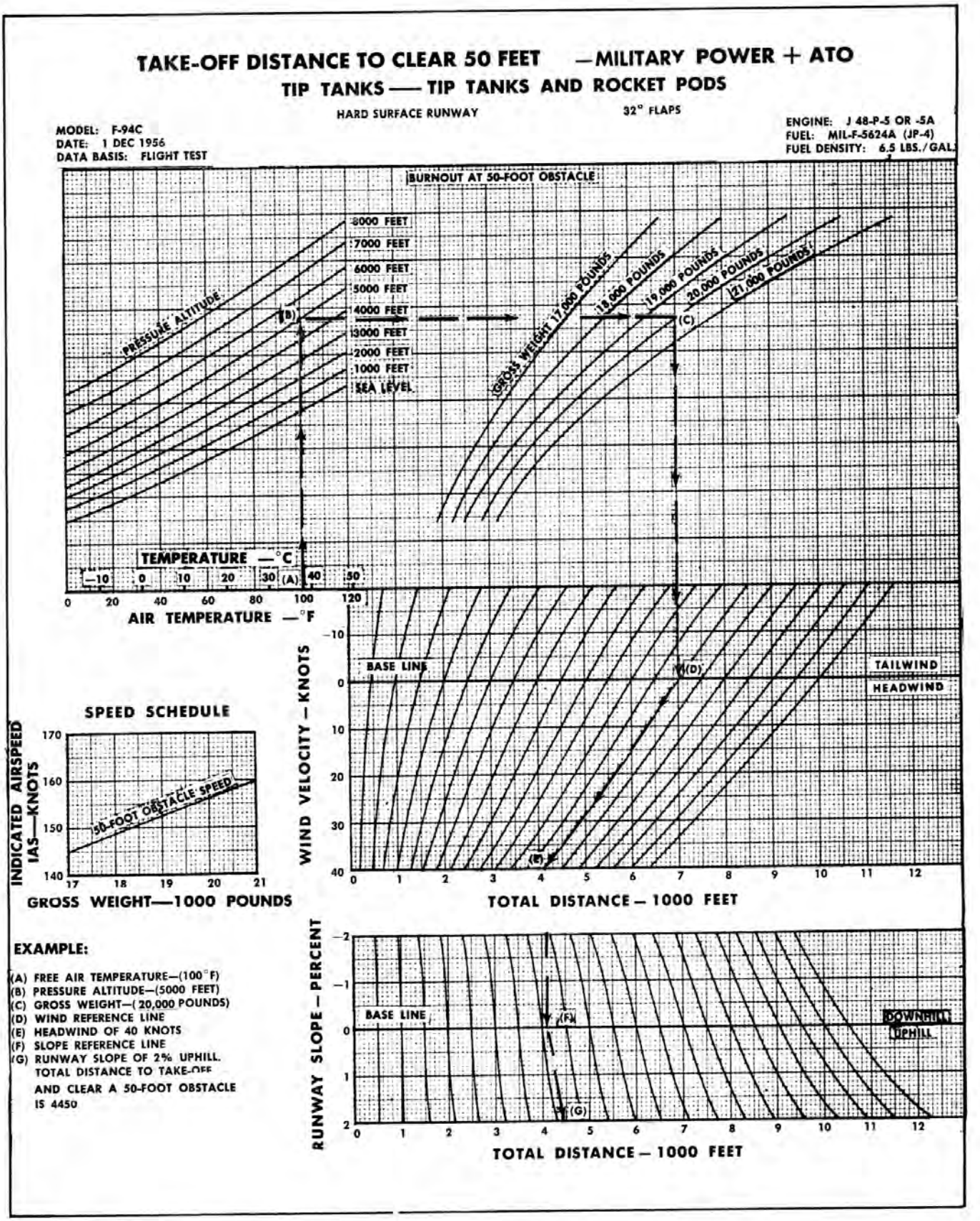



*Figure A2-17. Take-Off Distance to Clear 50 Ft.—Military Power + ATO Tip Tanks—Tip Tanks and Rocket Pods*

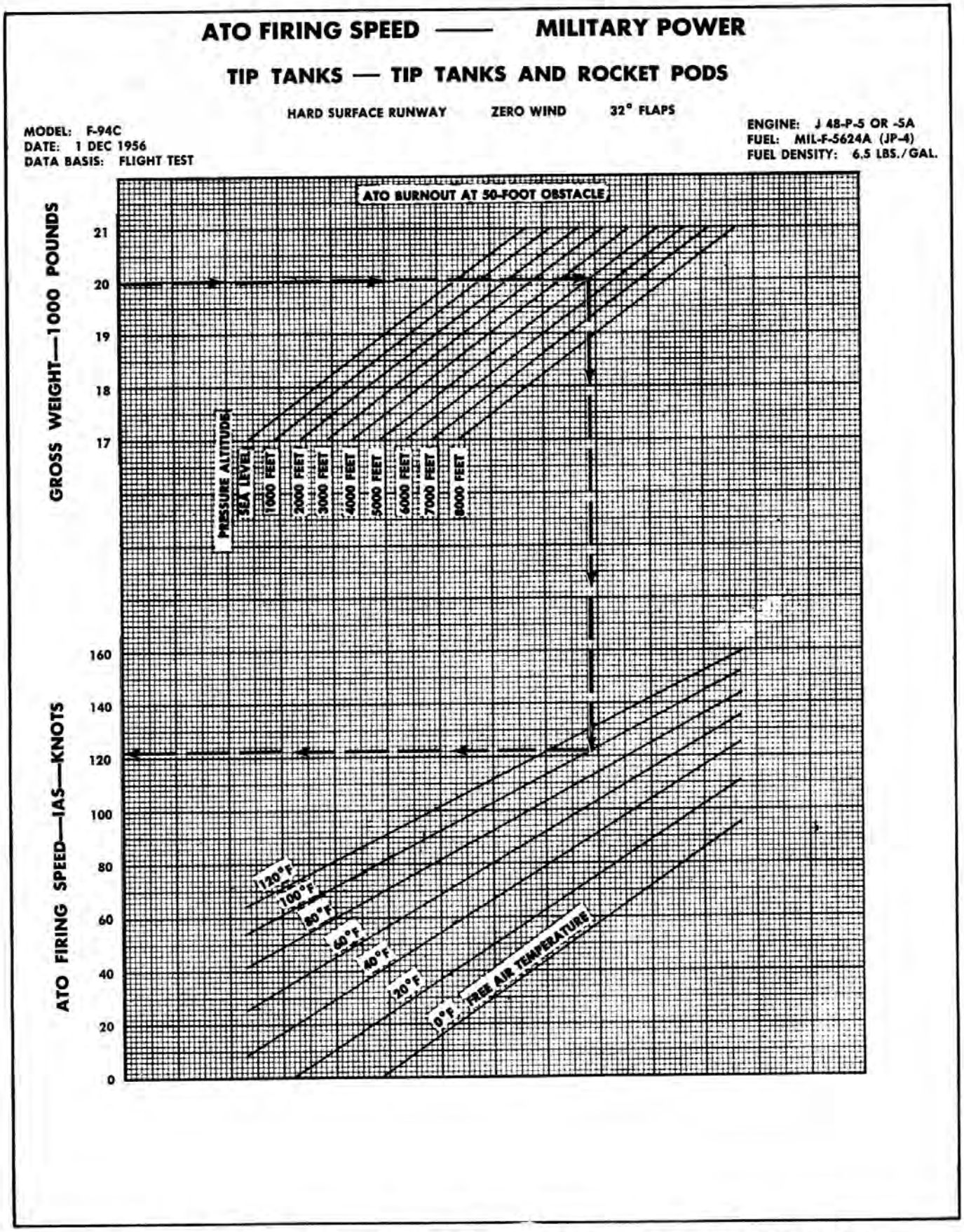



*Figure A2-18. ATO Firing Speed—Military Power—Tip Tanks—Tip Tanks and Rocket Pods*

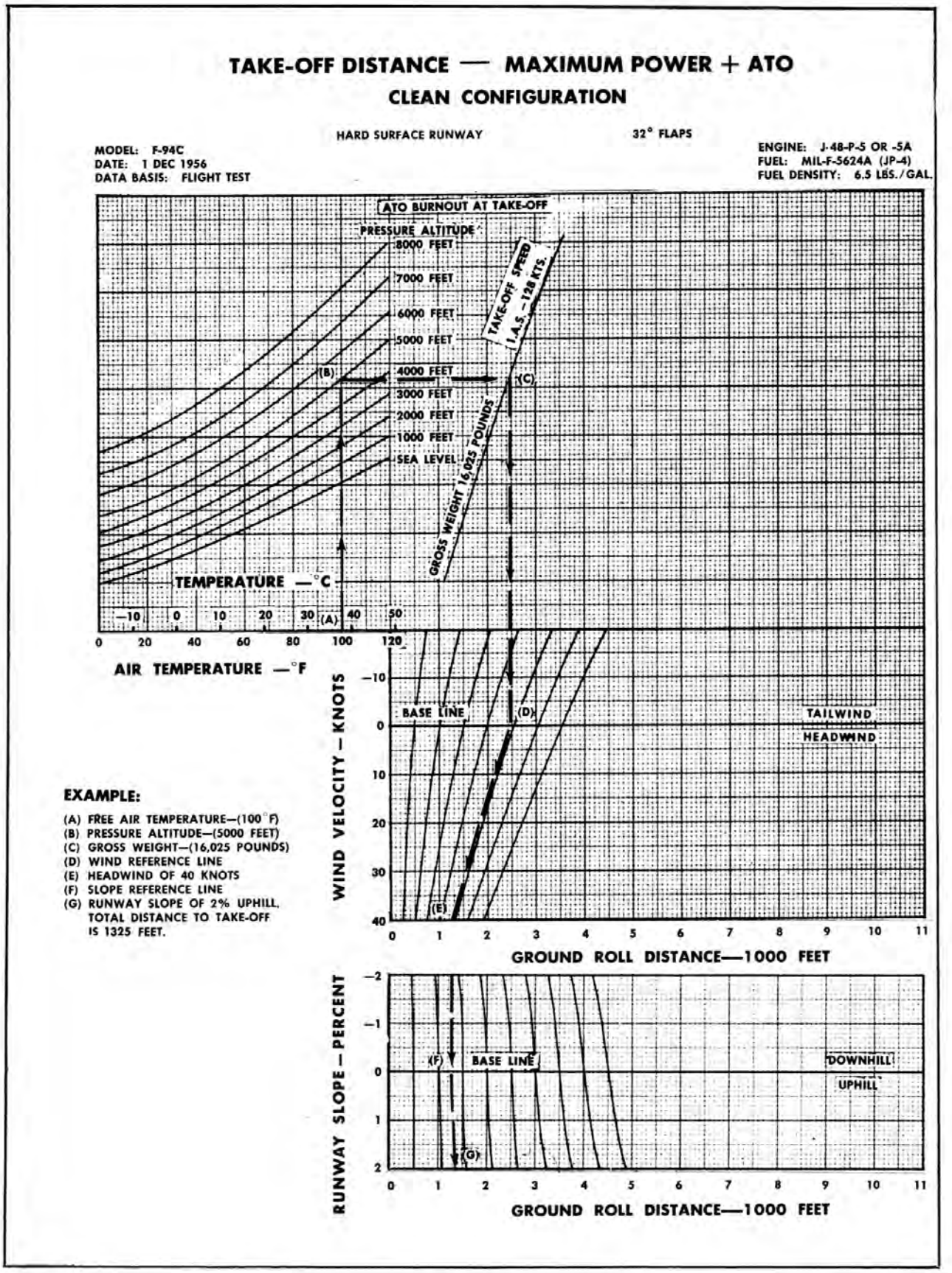



*Figure A2-19. Take-Off Distance—Maximum Power + ATO—Clean Configuration*

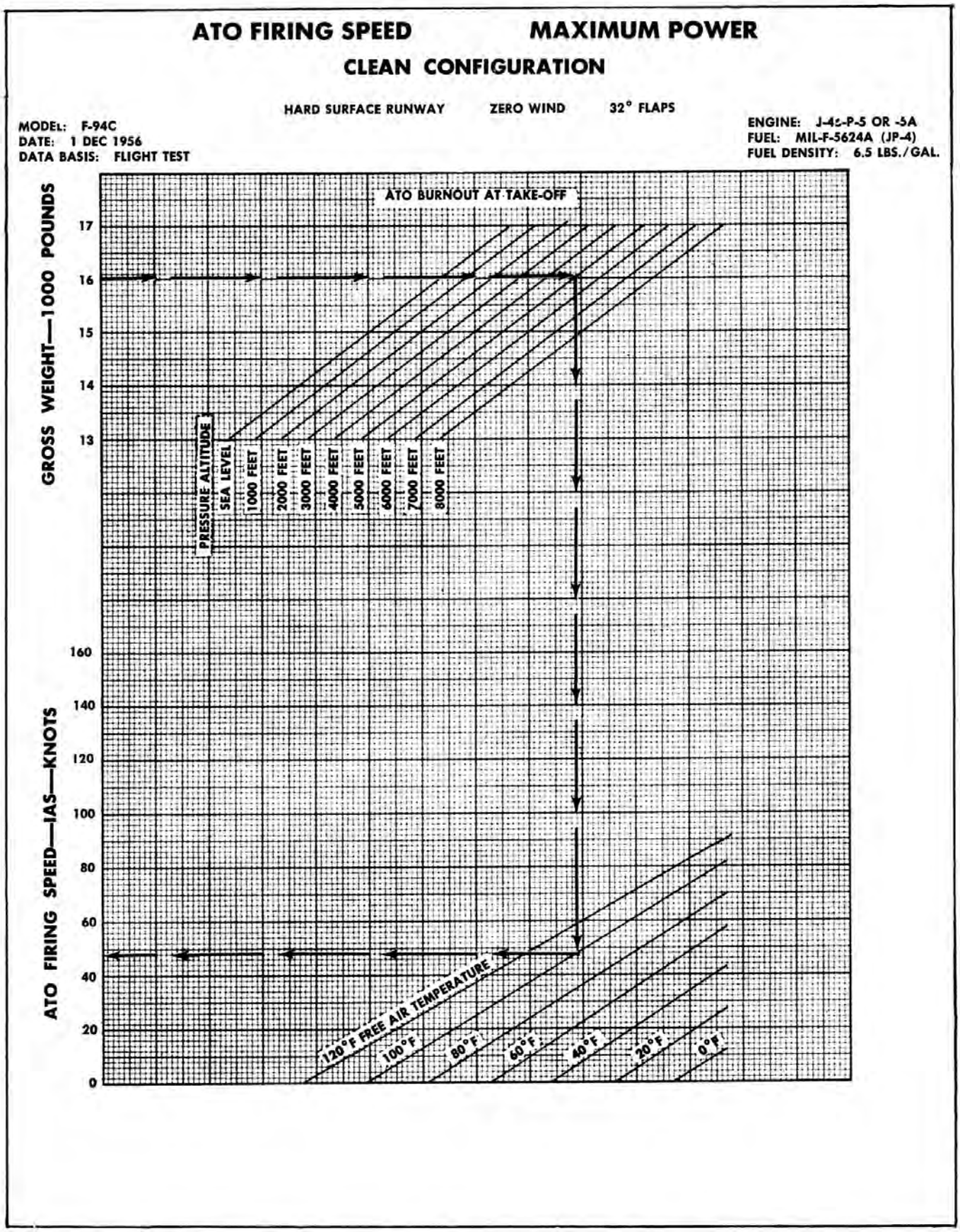



*Figure A2-20. ATO—Firing Speed—Maximum Power—Clean Configuration*

# TAKE-OFF DISTANCE TO CLEAR 50 FEET — MAXIMUM POWER + ATO

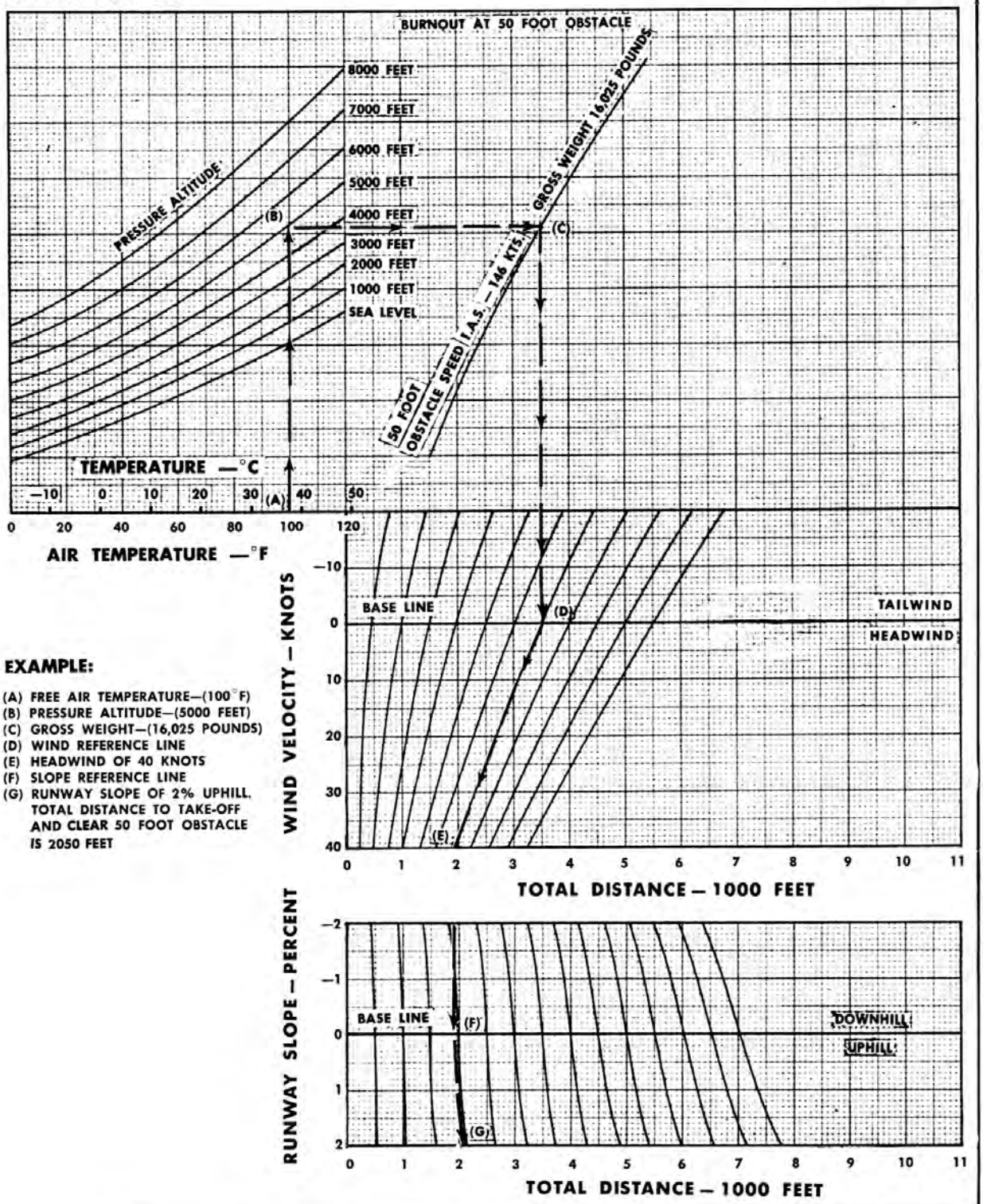
## CLEAN CONFIGURATION

HARD SURFACE RUNWAY

32° FLAPS

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ENGINE: J-48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.




**EXAMPLE:**

(A) FREE AIR TEMPERATURE—(100°F)
(B) PRESSURE ALTITUDE—(5000 FEET)
(C) GROSS WEIGHT—(16,025 POUNDS)
(D) WIND REFERENCE LINE
(E) HEADWIND OF 40 KNOTS
(F) SLOPE REFERENCE LINE
(G) RUNWAY SLOPE OF 2% UPHILL. TOTAL DISTANCE TO TAKE-OFF AND CLEAR 50 FOOT OBSTACLE IS 2050 FEET

*Figure A2-21. Take-Off Distance to Clear 50 Ft.—Maximum Power + ATO—Clean Configuration*

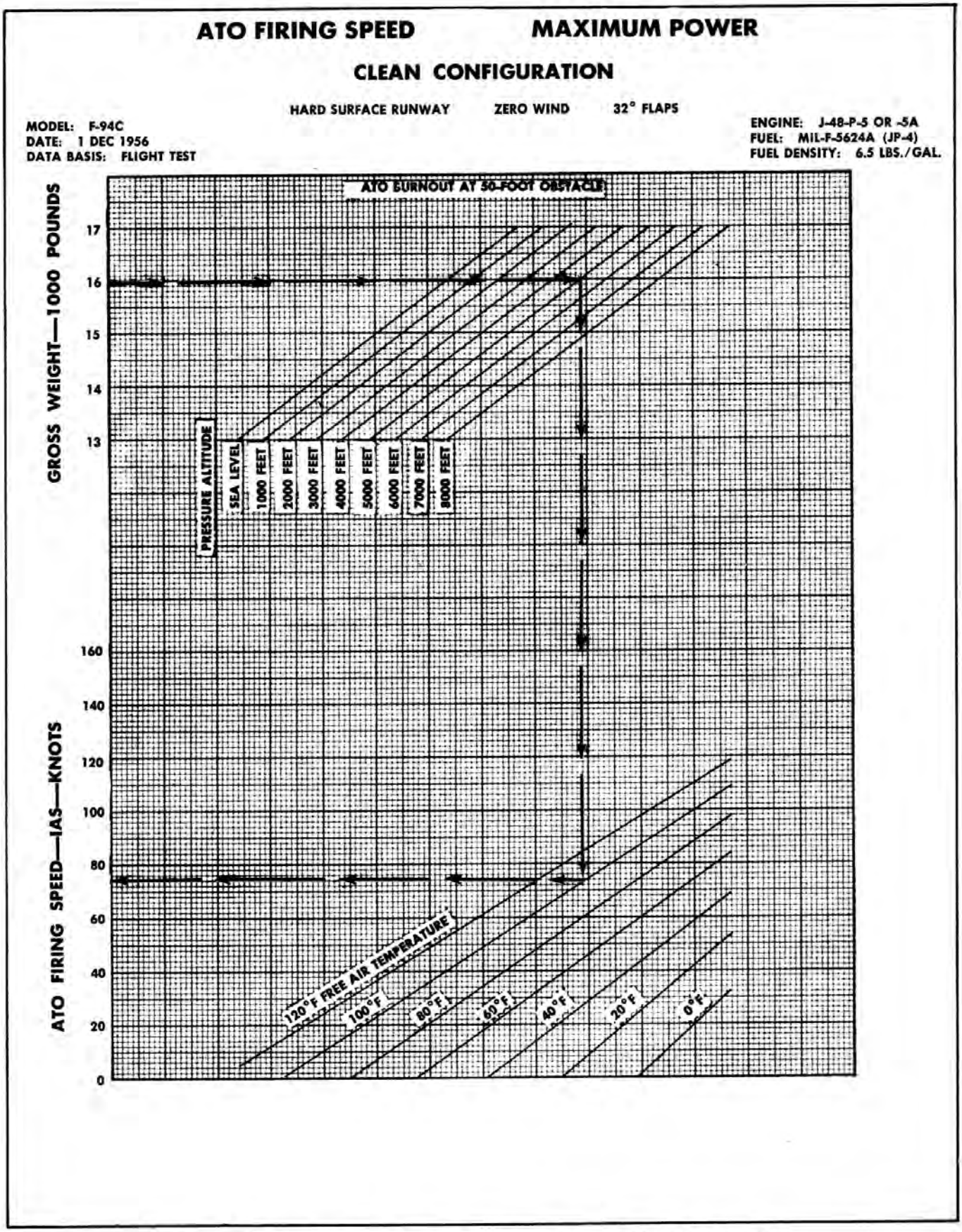



*Figure A2-22. ATO Firing Speed—Maximum Power—Clean Configuration*

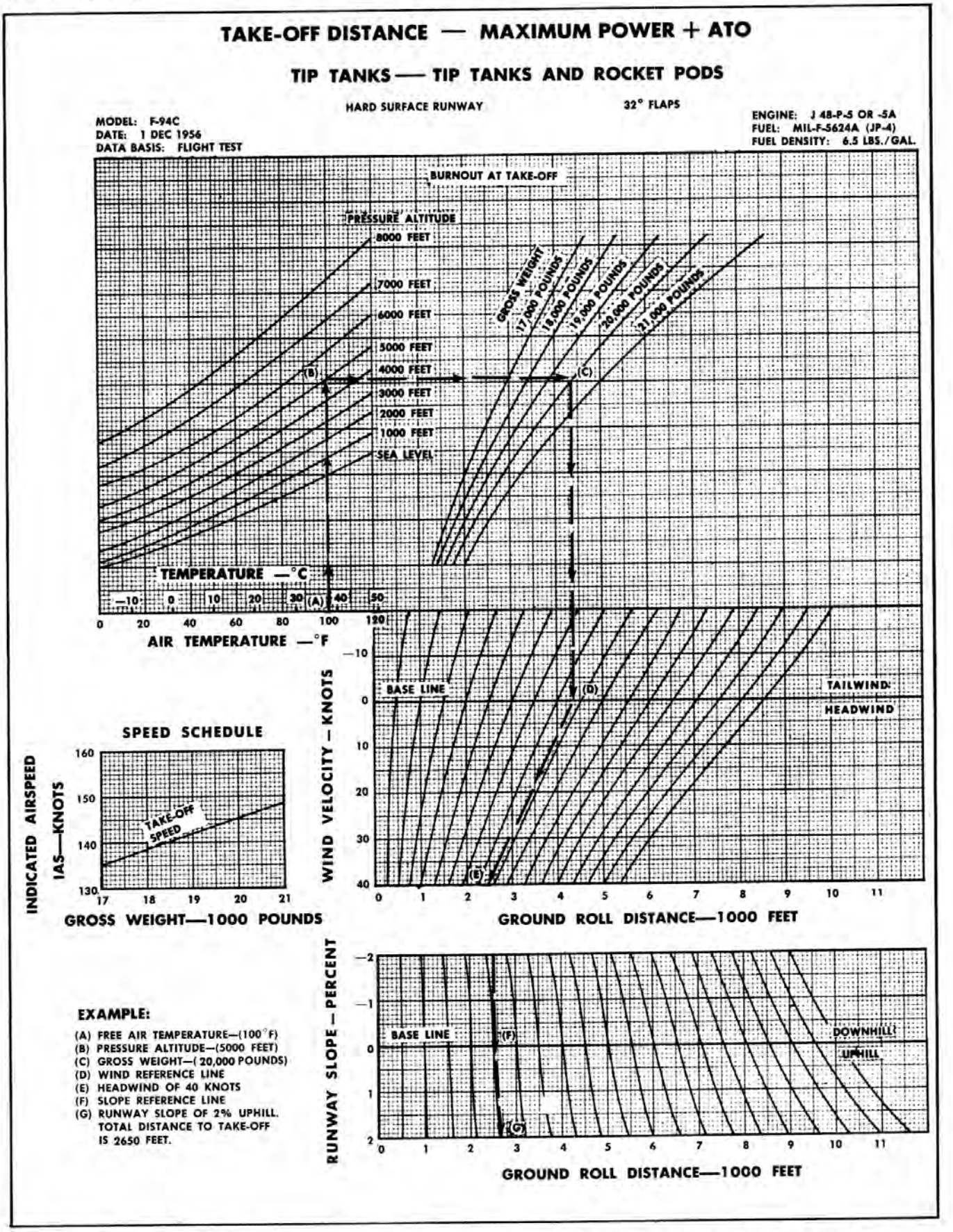



*Figure A2-23. Take-Off Distance—Maximum Power + ATO—Tip Tanks—Tip Tanks and Rocket Pods*

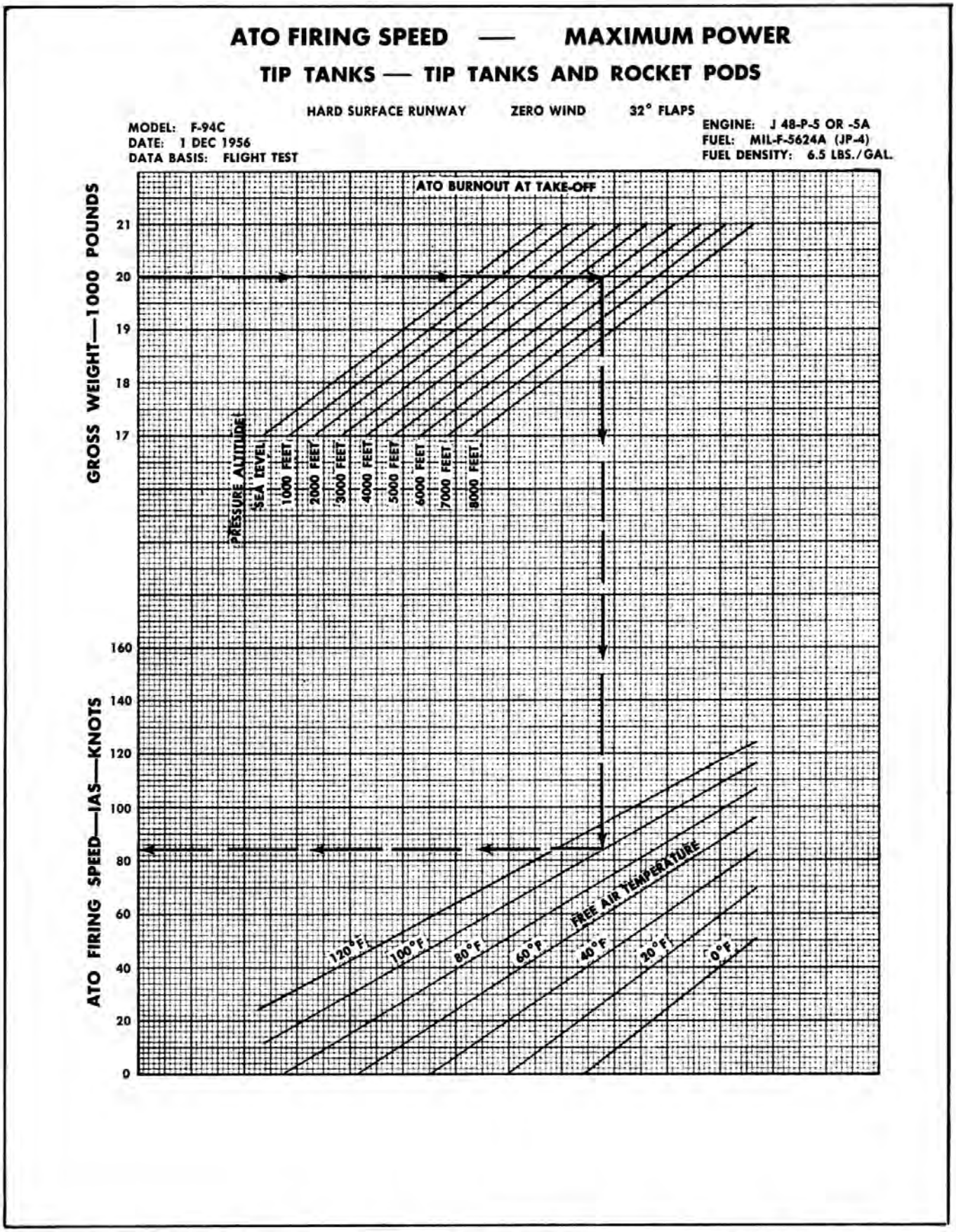



*Figure A2-24. ATO Firing Speed—Maximum Power—Tip Tanks—Tip Tanks and Rocket Pods*

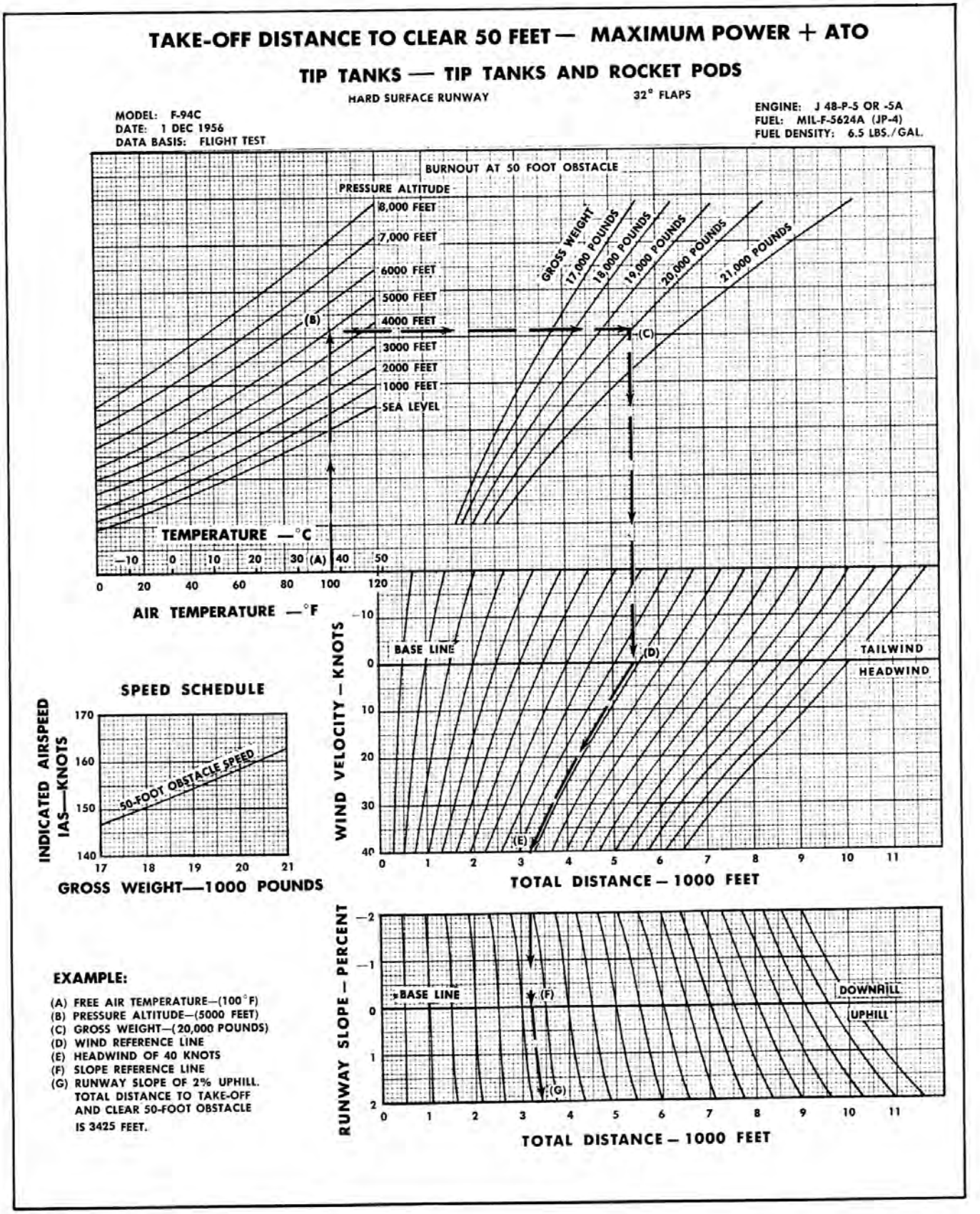



*Figure A2-25. Take-Off Distance to Clear 50 Ft.—Maximum Power—Tip Tanks—Tip Tanks and Rocket Pods*

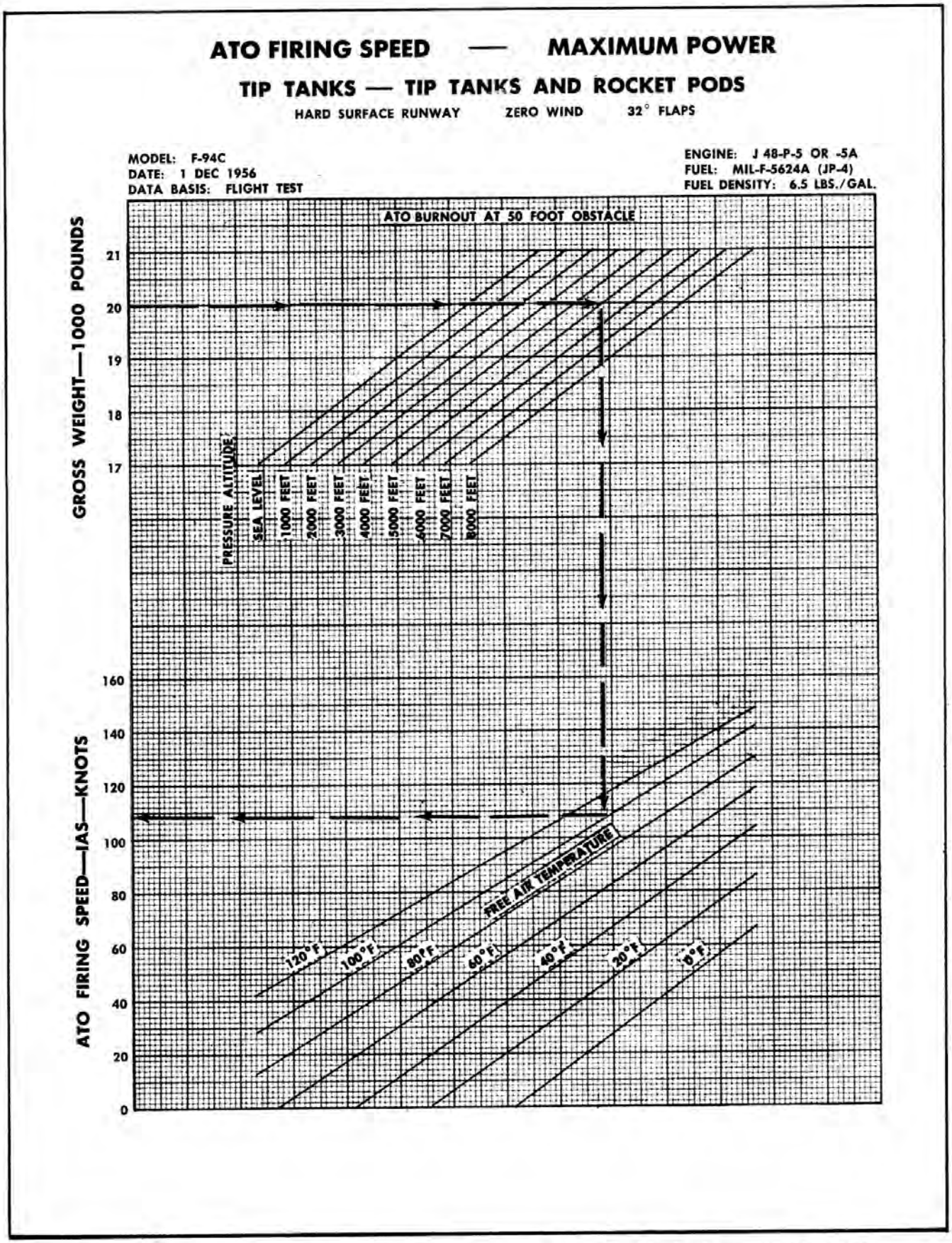



*Figure A2-26. ATO Firing Speed—Maximum Power—Tip Tanks—Tip Tanks and Rocket Pods*

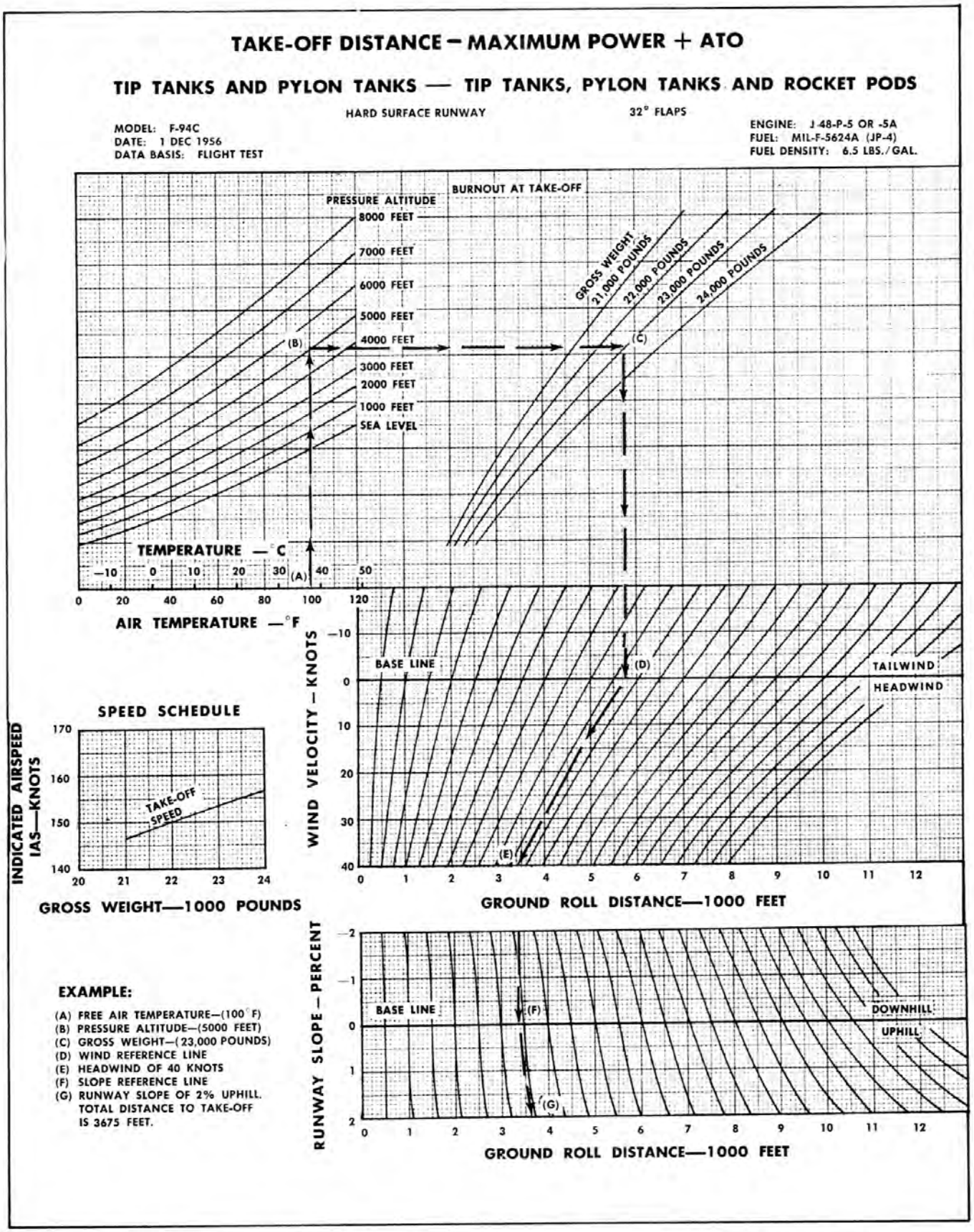



*Figure A2-27. Take-Off Distance—Maximum Power + ATO—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods*

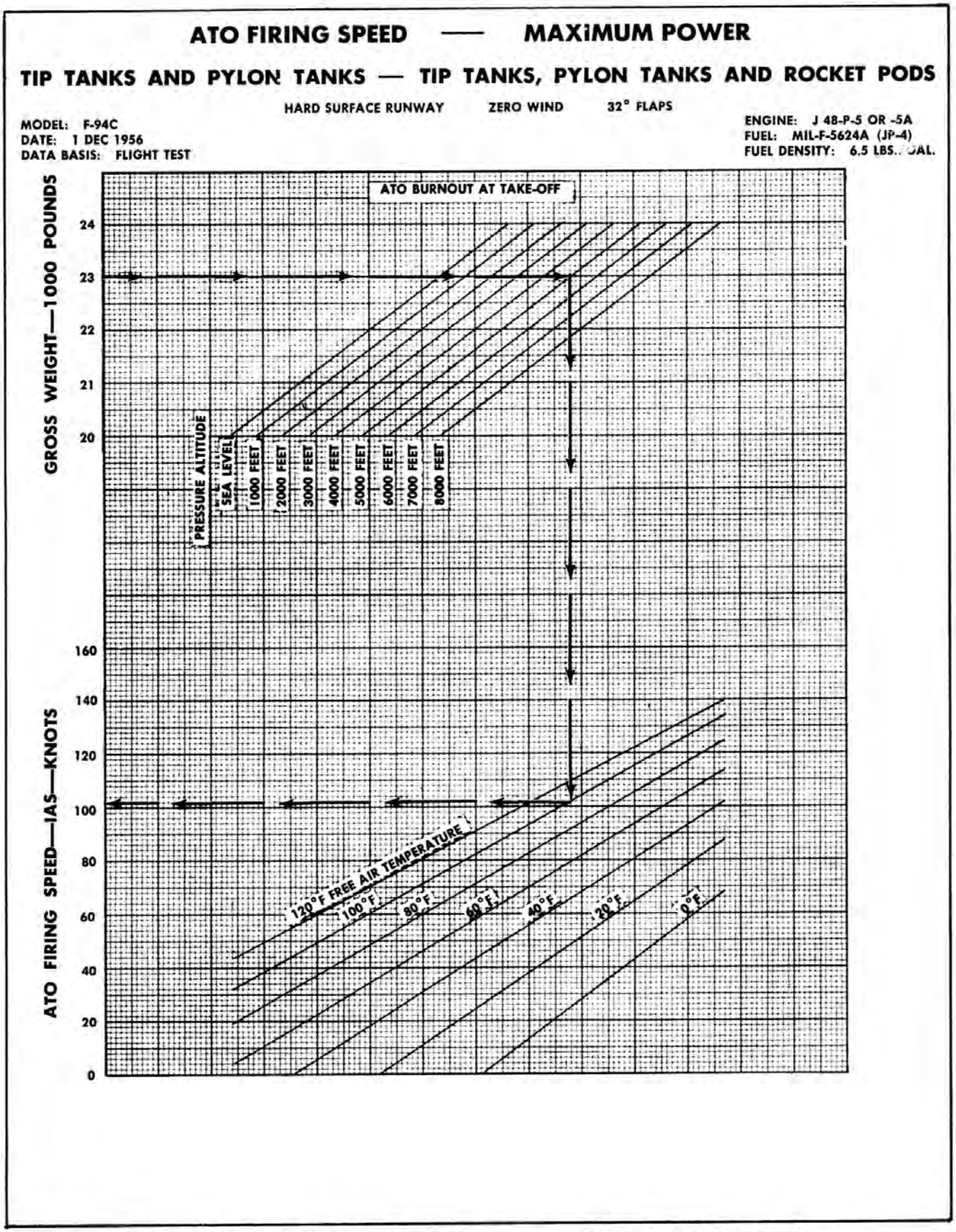



*Figure A2-28. ATO Firing Speed—Maximum Power—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods*

## TAKE-OFF DISTANCE TO CLEAR 50 FEET — MAXIMUM POWER + ATO

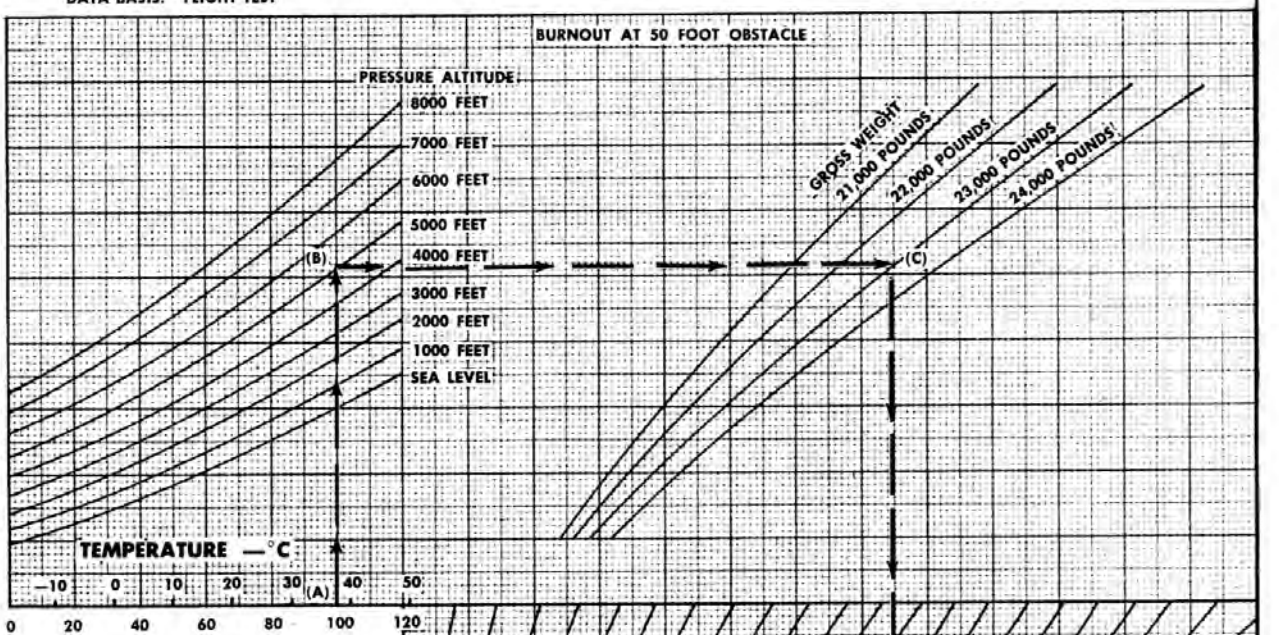
### TIP TANKS AND PYLON TANKS — TIP TANKS, PYLON TANKS AND ROCKET PODS

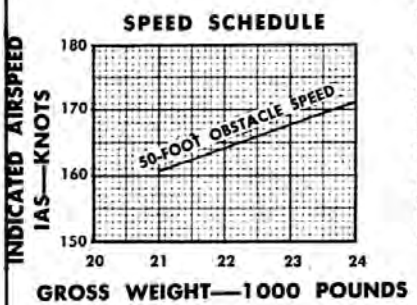
HARD SURFACE RUNWAY

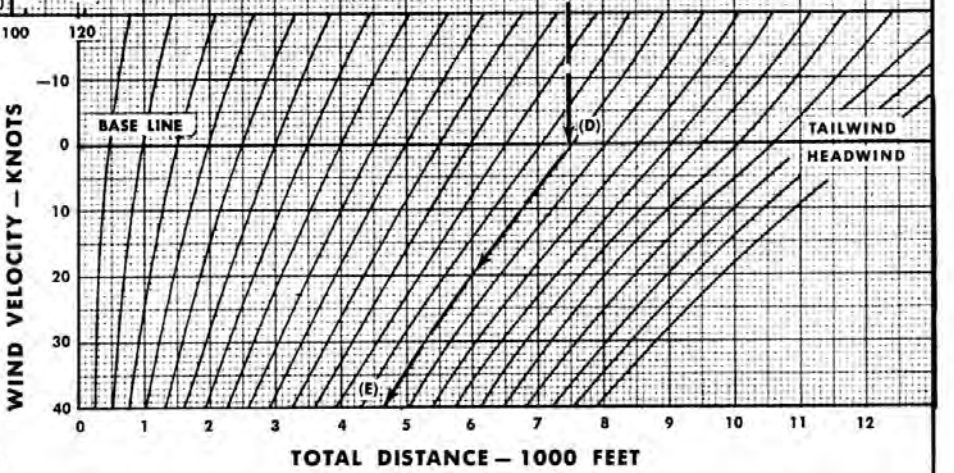
32° FLAPS

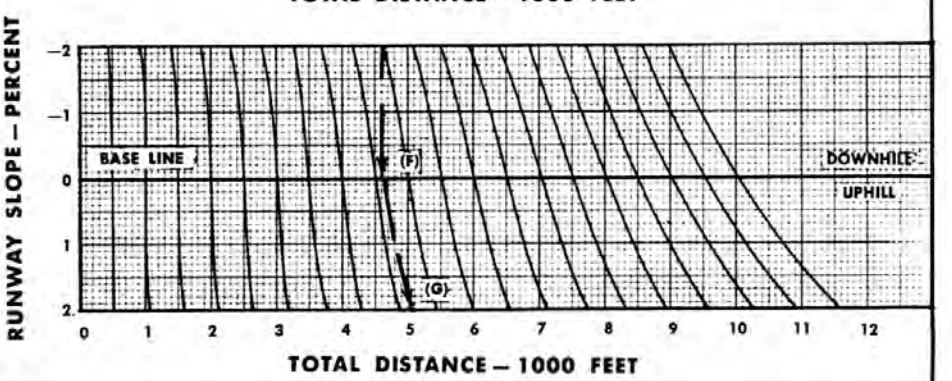
MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.




**EXAMPLE:**

(A) FREE AIR TEMPERATURE—(100°F)
(B) PRESSURE ALTITUDE—(5000 FEET)
(C) GROSS WEIGHT—(23,000 POUNDS)
(D) WIND REFERENCE LINE
(E) HEADWIND OF 40 KNOTS
(F) SLOPE REFERENCE LINE
(G) RUNWAY SLOPE OF 2% UPHILL.
TOTAL DISTANCE TO TAKE-OFF AND CLEAR 50-FOOT OBSTACLE IS 5025 FEET.

*Figure A2-29. Take-Off Distance to Clear 50 Ft.—Maximum Power + ATO—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods*

## ATO FIRING SPEED — MAXIMUM POWER

### TIP TANKS AND PYLON TANKS — TIP TANKS, PYLON TANKS AND ROCKET PODS

HARD SURFACE RUNWAY ZERO WIND 32° FLAPS

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.

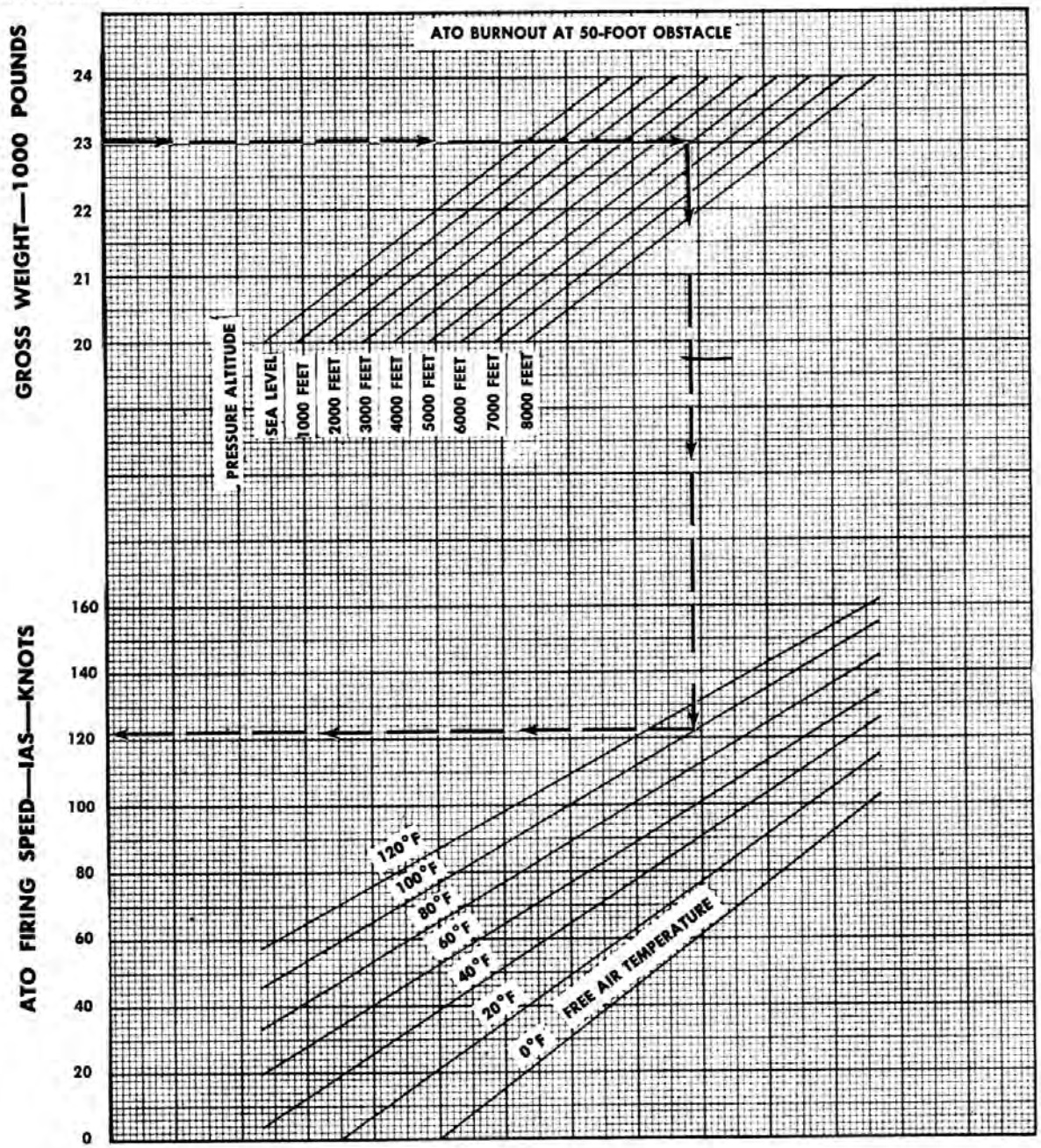


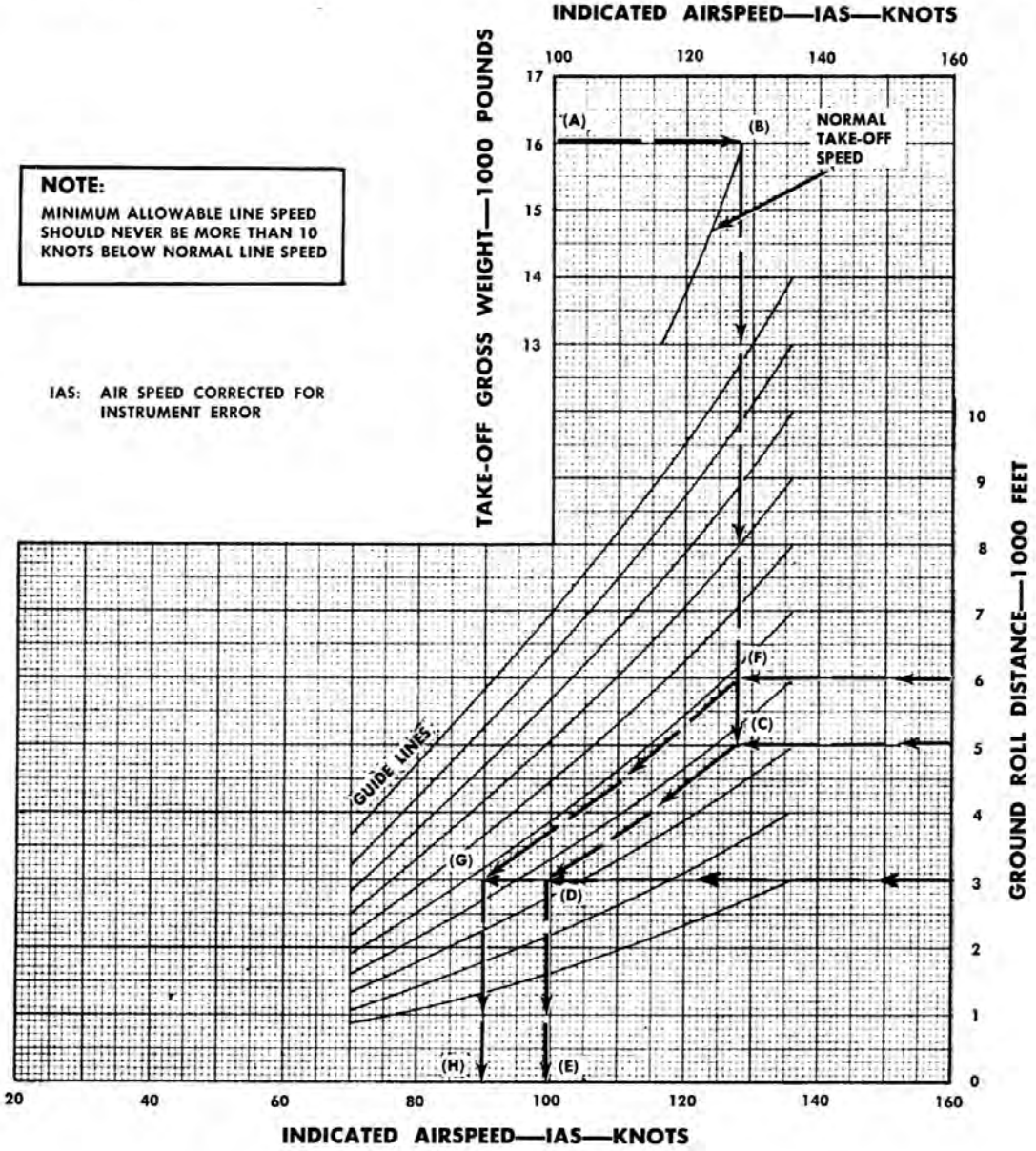

*Figure A2-30. ATO Firing Speed—Maximum Power—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods*

## VELOCITY DURING TAKE-OFF GROUND RUN — MILITARY POWER
## CLEAN CONFIGURATION

HARD SURFACE RUNWAY ZERO WIND 32° FLAPS

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.




**NOTE:**
MINIMUM ALLOWABLE LINE SPEED SHOULD NEVER BE MORE THAN 10 KNOTS BELOW NORMAL LINE SPEED

IAS: AIR SPEED CORRECTED FOR INSTRUMENT ERROR

**EXAMPLE:**

DETERMINE NORMAL LINE SPEED
(A) TAKE-OFF GROSS WEIGHT 16,025 LBS.
(B) NORMAL TAKE-OFF AIRSPEED 128. KNOTS
(C) GROUND ROLL DISTANCE WITH ZERO WIND FROM FIGURE A 2— 31 IS 5000 FEET
(D) RUNWAY CHECK POINT LOCATION AT 3000 FEET
(E) NORMAL LINE SPEED AT RUNWAY CHECK POINT IS 100 KNOTS

**EXAMPLE:**

DETERMINE MINIMUM ALLOWABLE LINE SPEED
(A) TAKE-OFF GROSS WEIGHT 16,025 LBS.
(B) NORMAL TAKE-OFF AIRSPEED 128. KNOTS
(F) AVAILABLE RUNWAY LENGTH OF 6000 FEET
(G) RUNWAY CHECK POINT LOCATION AT 3000 FEET
(H) LINE SPEED AT RUNWAY CHECK POINT THAT WILL ALLOW AIRCRAFT TO LEAVE GROUND AT END OF RUNWAY—90 KNOTS

*Figure A2-31. Take-Off Acceleration Curve—Military Power—Clean Configuration*

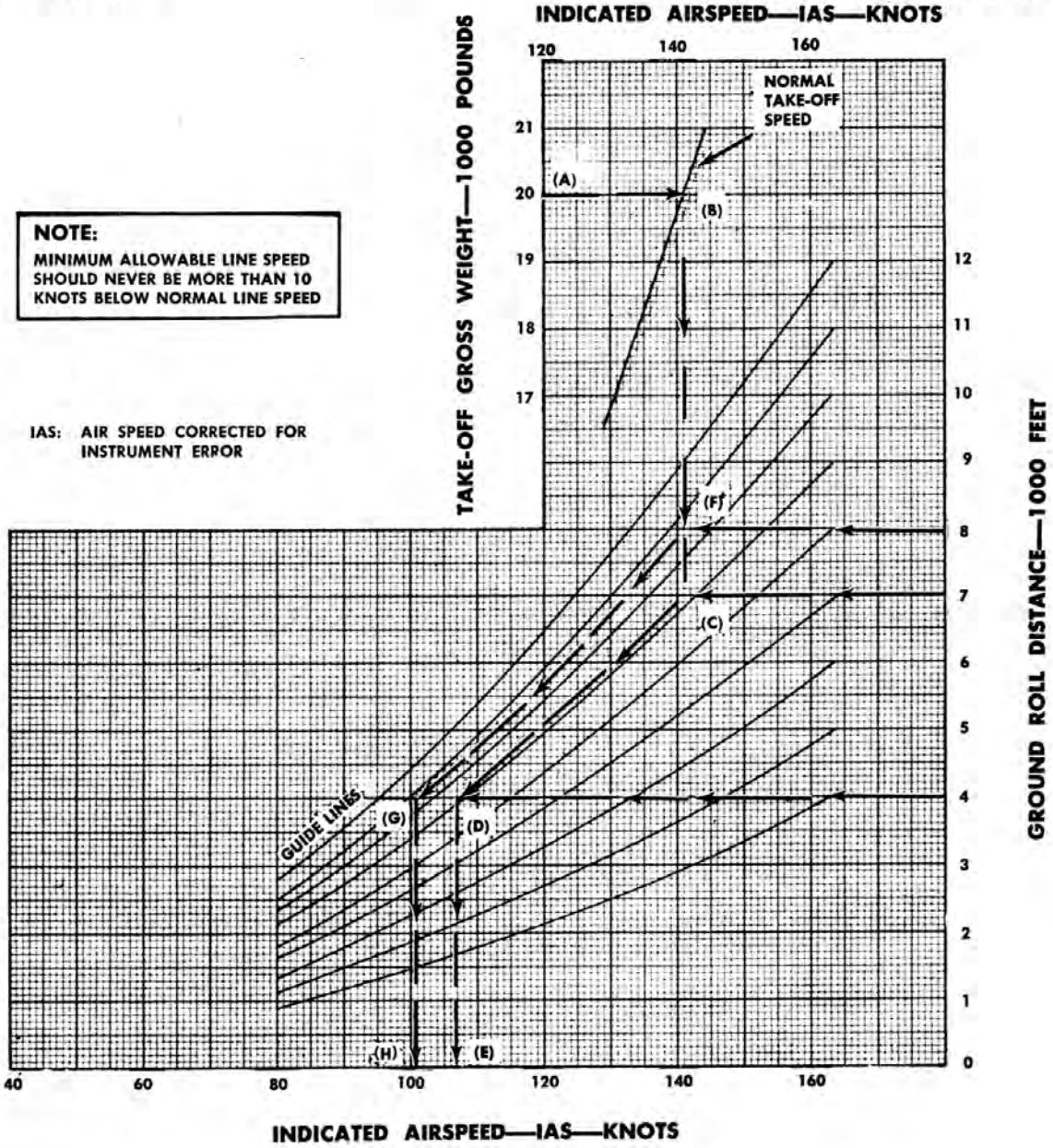
# VELOCITY DURING TAKE-OFF GROUND RUN — MILITARY POWER

## TIP TANKS — TIP TANKS AND ROCKET PODS

HARD SURFACE RUNWAY ZERO WIND 32° FLAPS

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.




**NOTE:**
MINIMUM ALLOWABLE LINE SPEED SHOULD NEVER BE MORE THAN 10 KNOTS BELOW NORMAL LINE SPEED

IAS: AIR SPEED CORRECTED FOR INSTRUMENT ERROR

**EXAMPLE:**

DETERMINE NORMAL LINE SPEED
(A) TAKE-OFF GROSS WEIGHT 20,000 LBS.
(B) NORMAL TAKE-OFF AIRSPEED 141 KNOTS
(C) GROUND ROLL DISTANCE WITH ZERO WIND FROM FIGURE A 2— 32 IS 7000 FEET
(D) RUNWAY CHECK POINT LOCATION AT 4000 FEET
(E) NORMAL LINE SPEED AT RUNWAY CHECK POINT IS 107 KNOTS

**EXAMPLE:**

DETERMINE MINIMUM ALLOWABLE LINE SPEED
(A) TAKE-OFF GROSS WEIGHT 20,000 LBS.
(B) NORMAL TAKE-OFF AIRSPEED 141 KNOTS
(F) AVAILABLE RUNWAY LENGTH OF 8000 FEET
(G) RUNWAY CHECK POINT LOCATION AT 4000 FEET
(H) LINE SPEED AT RUNWAY CHECK POINT THAT WILL ALLOW AIRCRAFT TO LEAVE GROUND AT END OF RUNWAY—101 KNOTS

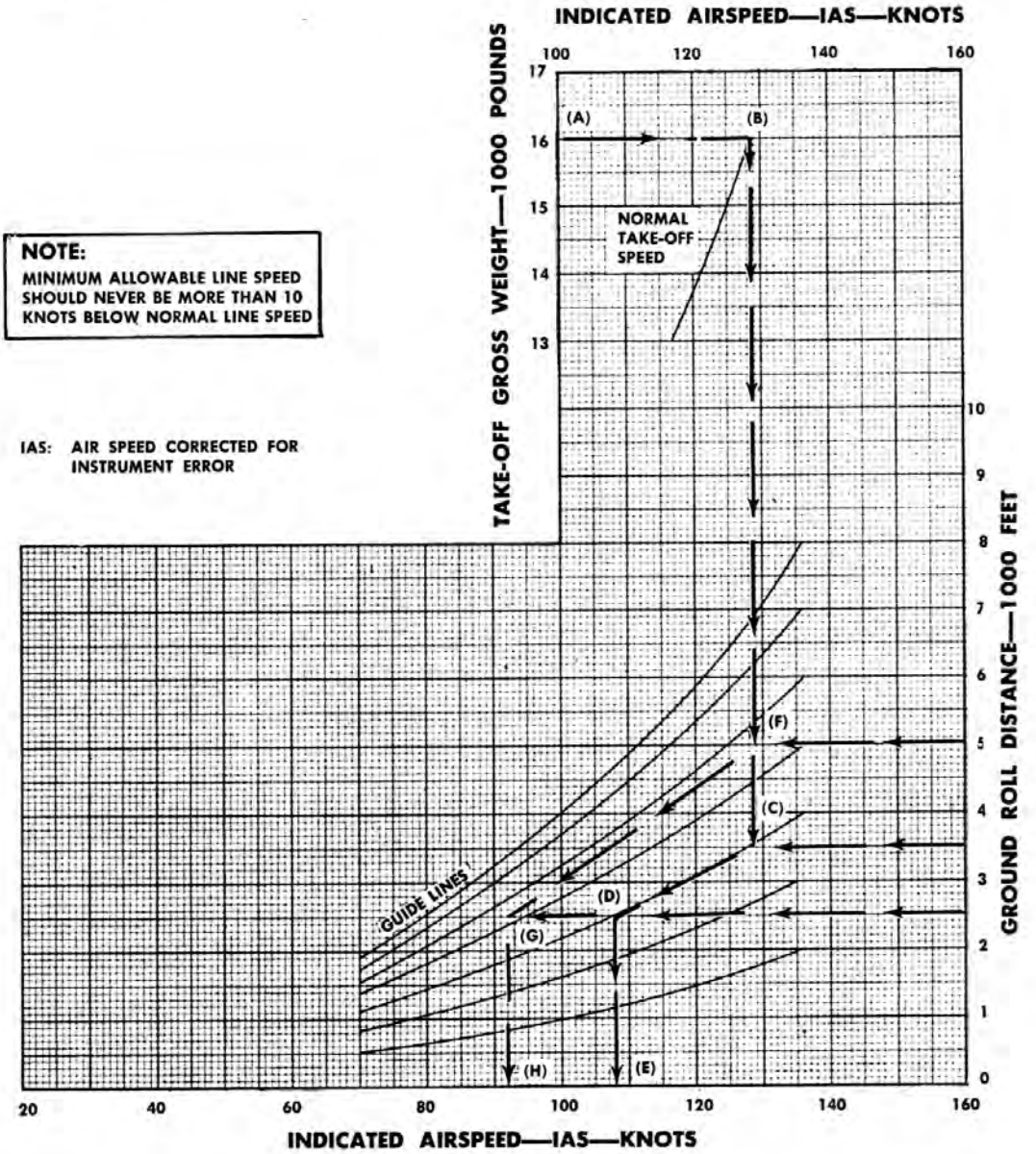
*Figure A2-32. Take-Off Acceleration Curve—Military Power—Tip Tanks—Tip Tanks and Rocket Pods*

## VELOCITY DURING TAKE-OFF GROUND RUN — MAXIMUM POWER
### CLEAN CONFIGURATION

HARD SURFACE RUNWAY ZERO WIND 32° FLAPS

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.




**NOTE:**
MINIMUM ALLOWABLE LINE SPEED SHOULD NEVER BE MORE THAN 10 KNOTS BELOW NORMAL LINE SPEED

IAS: AIR SPEED CORRECTED FOR INSTRUMENT ERROR

**EXAMPLE:**

DETERMINE NORMAL LINE SPEED
(A) TAKE-OFF GROSS WEIGHT 16,025 LBS.
(B) NORMAL TAKE-OFF AIRSPEED 128.0 KNOTS
(C) GROUND ROLL DISTANCE WITH ZERO WIND FROM FIGURE A 2 — 33 IS 3530 FEET
(D) RUNWAY CHECK POINT LOCATION AT 2500 FEET
(E) NORMAL LINE SPEED AT RUNWAY CHECK POINT IS 108 KNOTS

**EXAMPLE:**

DETERMINE MINIMUM ALLOWABLE LINE SPEED
(A) TAKE-OFF GROSS WEIGHT 16,025 LBS.
(B) NORMAL TAKE-OFF AIRSPEED 128.0 KNOTS
(F) AVAILABLE RUNWAY LENGTH OF 5000 FEET
(G) RUNWAY CHECK POINT LOCATION AT 2500 FEET
(H) LINE SPEED AT RUNWAY CHECK POINT THAT WILL ALLOW AIRCRAFT TO LEAVE GROUND AT END OF RUNWAY—92 KNOTS
(I) MINIMUM ALLOWABLE LINE SPEED — 98 KNOTS (SEE NOTE)

*Figure A2-33. Take-Off Acceleration Curve—Maximum Power—Clean Configuration*

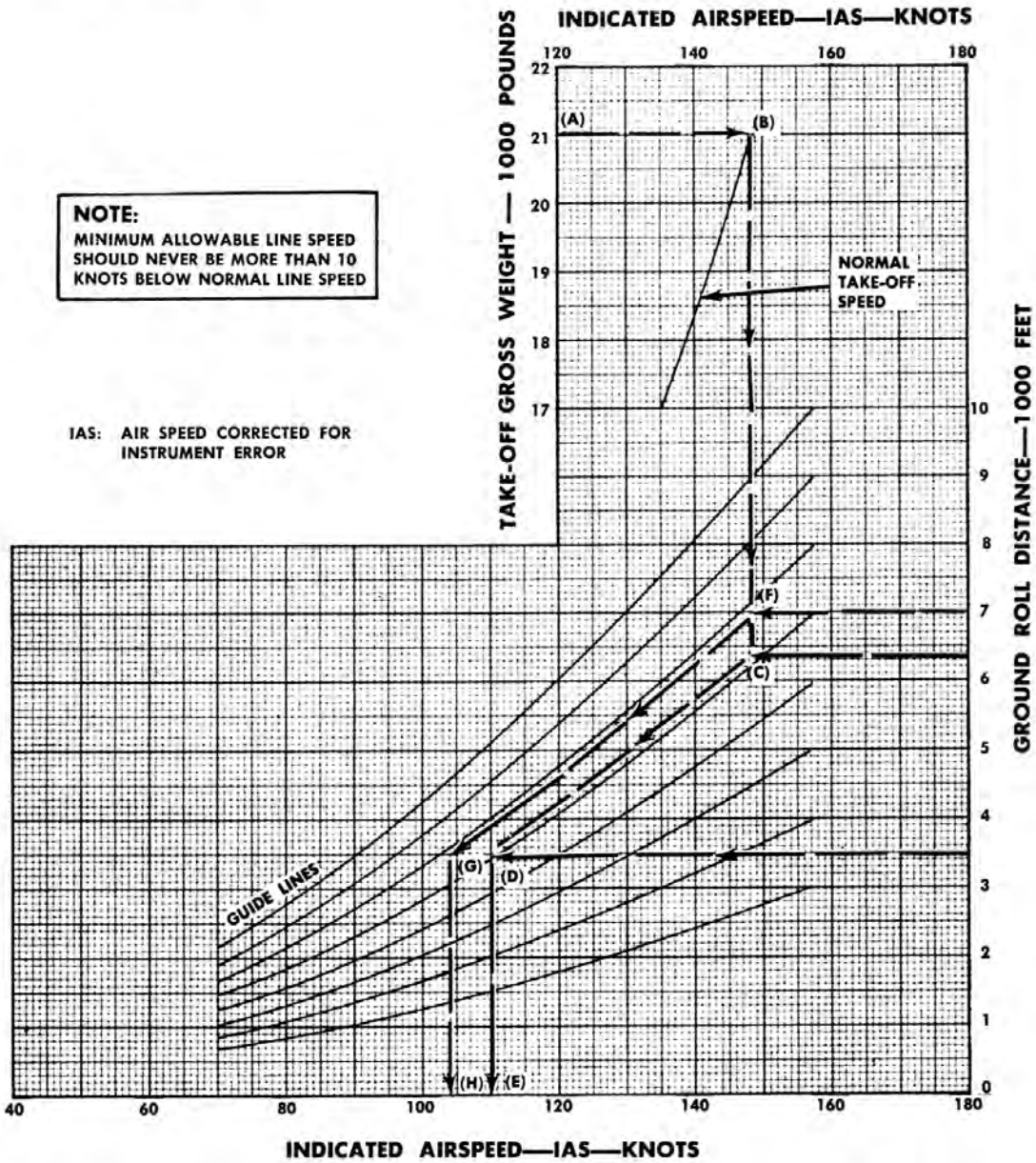
## VELOCITY DURING TAKE-OFF GROUND RUN — MAXIMUM POWER

### TIP TANKS — TIP TANKS AND ROCKET PODS

HARD SURFACE RUNWAY ZERO WIND 32° FLAPS

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ENGINE: J-48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.




**NOTE:**
MINIMUM ALLOWABLE LINE SPEED SHOULD NEVER BE MORE THAN 10 KNOTS BELOW NORMAL LINE SPEED

IAS: AIR SPEED CORRECTED FOR INSTRUMENT ERROR

**EXAMPLE:**

DETERMINE NORMAL LINE SPEED
(A) TAKE-OFF GROSS WEIGHT 21,000 LBS.
(B) NORMAL TAKE-OFF AIRSPEED 148 KNOTS
(C) GROUND ROLL DISTANCE WITH ZERO WIND FROM FIGURE A 2— 34 IS 6330 FEET
(D) RUNWAY CHECK POINT LOCATION AT 3500 FEET
(E) NORMAL LINE SPEED AT RUNWAY CHECK POINT IS 110 KNOTS

**EXAMPLE:**

DETERMINE MINIMUM ALLOWABLE LINE SPEED
(A) TAKE-OFF GROSS WEIGHT 21,000 LBS.
(B) NORMAL TAKE-OFF AIRSPEED 148 KNOTS
(F) AVAILABLE RUNWAY LENGTH OF 7000 FEET
(G) RUNWAY CHECK POINT LOCATION AT 3500 FEET
(H) LINE SPEED AT RUNWAY CHECK POINT THAT WILL ALLOW AIRCRAFT TO LEAVE GROUND AT END OF RUNWAY— 104 KNOTS

*Figure A2-34. Take-Off Acceleration Curve—Maximum Power—Tip Tanks—Tip Tanks and Rocket Pods*

## VELOCITY DURING TAKE-OFF GROUND RUN — MAXIMUM POWER

### TIP TANKS AND PYLON TANKS — TIP TANKS, PYLON TANKS AND ROCKET PODS

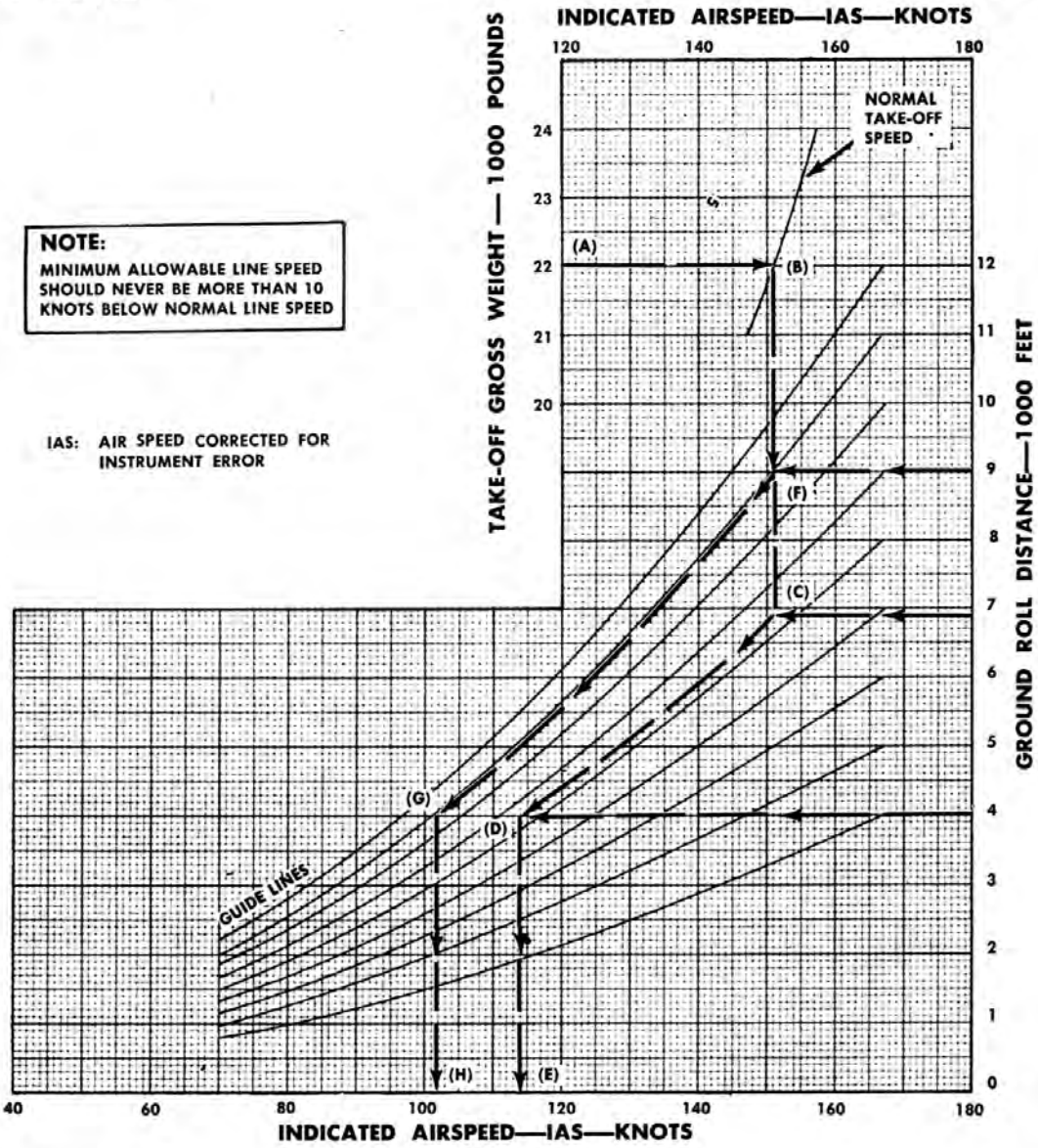
HARD SURFACE RUNWAY ZERO WIND 32° FLAPS

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.

**NOTE:**
MINIMUM ALLOWABLE LINE SPEED SHOULD NEVER BE MORE THAN 10 KNOTS BELOW NORMAL LINE SPEED

IAS: AIR SPEED CORRECTED FOR INSTRUMENT ERROR




**EXAMPLE:**

DETERMINE NORMAL LINE SPEED
(A) TAKE-OFF GROSS WEIGHT 22,000 LBS.
(B) NORMAL TAKE-OFF AIRSPEED 151 KNOTS
(C) GROUND ROLL DISTANCE WITH ZERO WIND FROM FIGURE A 2— 35 IS 6900 FEET
(D) RUNWAY CHECK POINT LOCATION AT 4000 FEET
(E) NORMAL LINE SPEED AT RUNWAY CHECK POINT IS 114 KNOTS

**EXAMPLE:**

DETERMINE MINIMUM ALLOWABLE LINE SPEED
(A) TAKE-OFF GROSS WEIGHT 22,000 LBS.
(B) NORMAL TAKE-OFF AIRSPEED 151 KNOTS
(F) AVAILABLE RUNWAY LENGTH OF 9000 FEET
(G) RUNWAY CHECK POINT LOCATION AT 4000 FEET
(H) LINE SPEED AT RUNWAY CHECK POINT THAT WILL ALLOW AIRCRAFT TO LEAVE GROUND AT END OF RUNWAY—102 KNOTS
(I) MINIMUM ALLOWABLE LINE SPEED — 104 KNOTS (SEE NOTE)

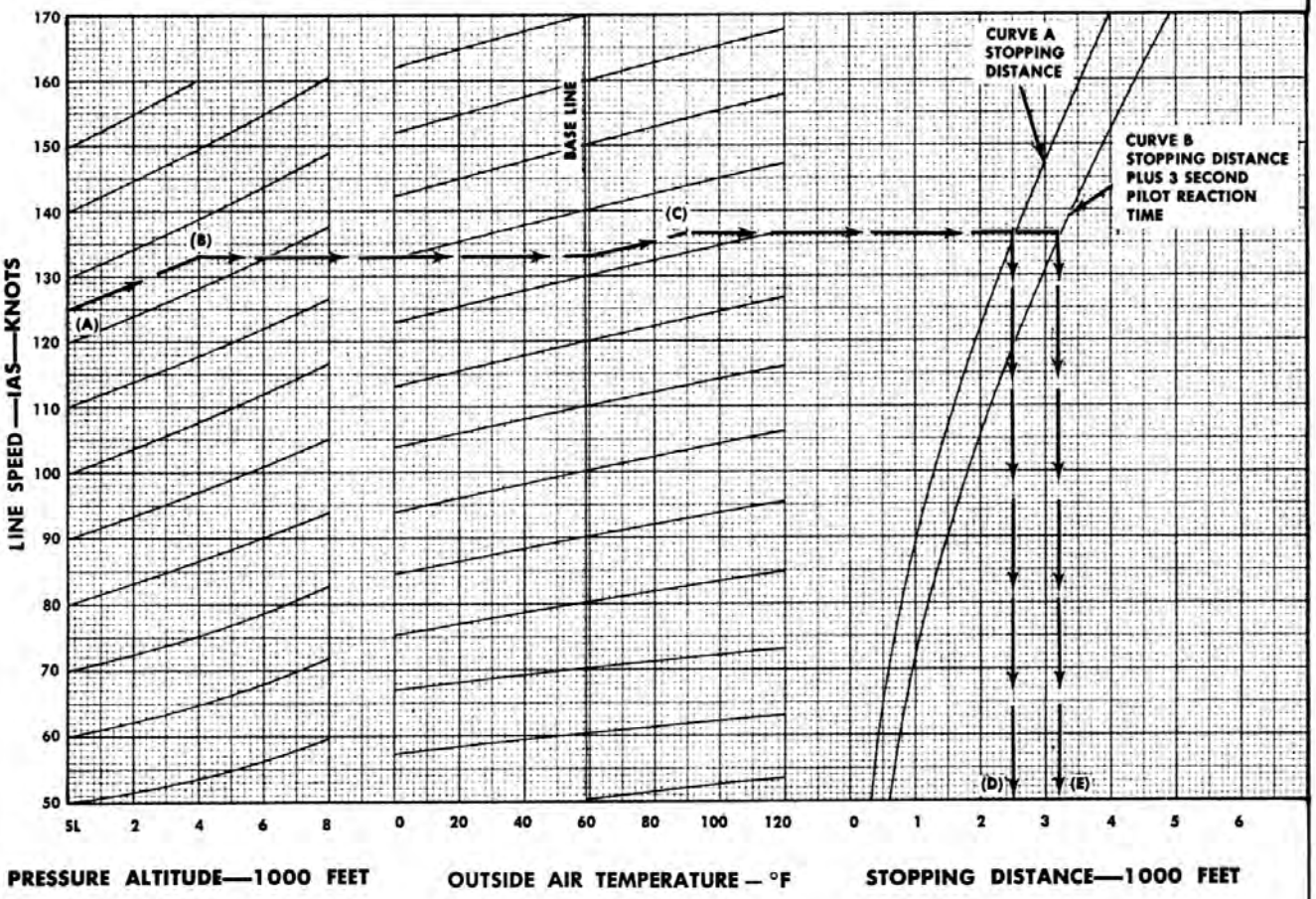
*Figure A2-35. Take-Off Acceleration Curve—Maximum Power—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods*

## STOPPING DISTANCE — WITH 16-FOOT DRAG CHUTE

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

HARD SURFACE RUNWAY ZERO WIND 32° FLAPS

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.




**EXAMPLE:**

(A) IS NORMAL LINE SPEED (125 KNOTS)
(B) IS PRESSURE ALTITUDE (4000 FEET)
(C) IS FREE AIR TEMPERATURE (90°F)
(D) IS STOPPING DISTANCE (FROM CURVE A—2500 FEET)
(E) IS STOPPING DISTANCE ALLOWING FOR PILOT REACTION TIME (FROM CURVE B—3200 FEET)

NOTE:
1. THROTTLE IDLE
2. HARD BRAKED STOP

IAS: AIRSPEED CORRECTED FOR INSTRUMENT ERROR

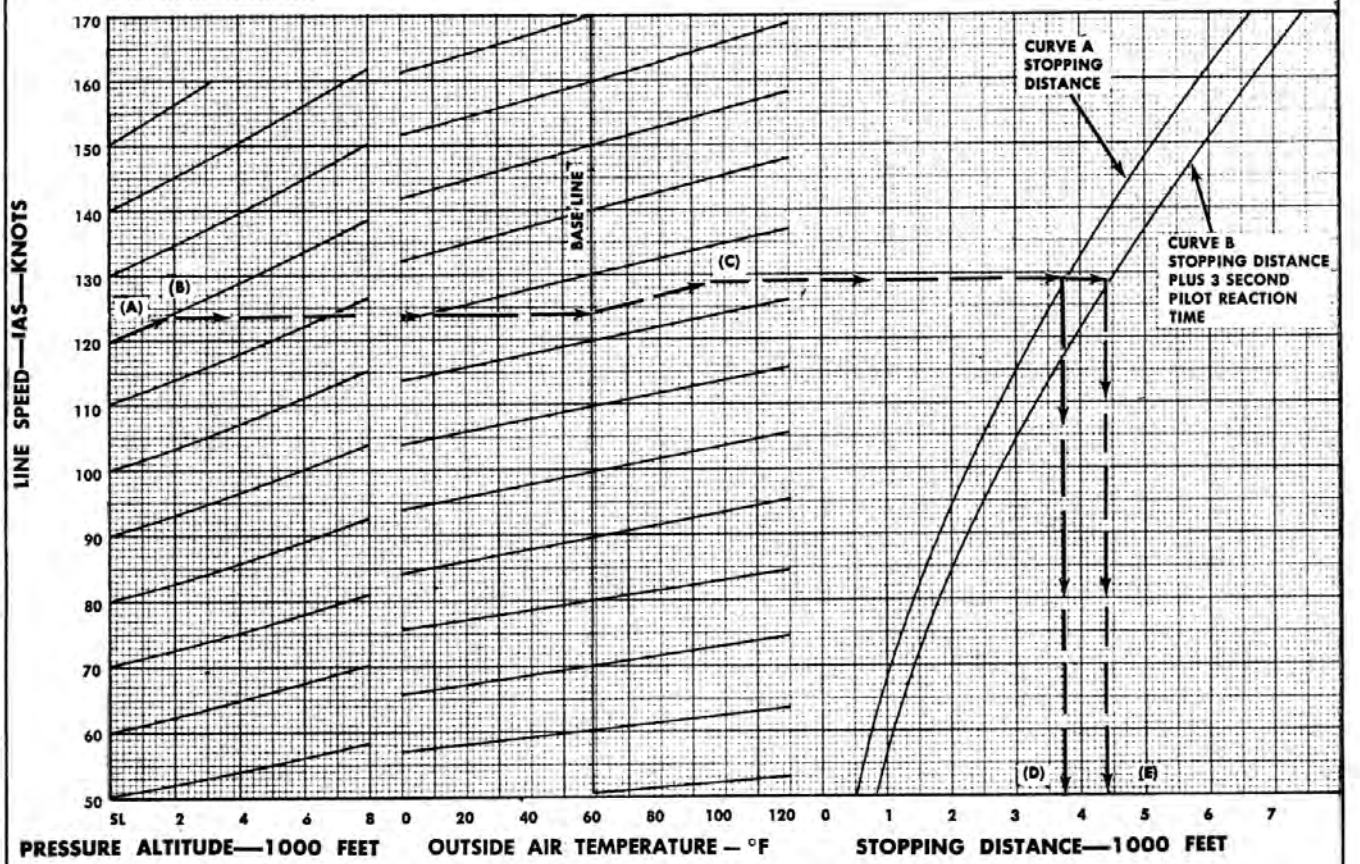
*Figure A2-36. Stopping Distance—With Drag Chute*

## STOPPING DISTANCE NO DRAG CHUTE

HARD SURFACE RUNWAY ZERO WIND ZERO RUNWAY SLOPE

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.




**EXAMPLE:**

(A) IS NORMAL LINE SPEED (120 KNOTS)
(B) IS PRESSURE ALTITUDE (2000 FEET)
(C) IS FREE AIR TEMPERATURE (95°F)
(D) IS STOPPING DISTANCE (FROM CURVE A—3775 FEET)
(E) IS STOPPING DISTANCE ALLOWING FOR PILOT REACTION TIME (FROM CURVE B—4400 FEET)

NOTE:
1. THROTTLE IDLE
2. HARD BRAKED STOP

IAS: AIRSPEED CORRECTED FOR INSTRUMENT ERROR

*Figure A2-37. Stopping Distance—No Drag Chute*

# Part 3—Climb

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| Climb Speed Schedule | A3-2 |
| Climb Speed Determination | A3-2 |
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# CLIMB

## CLIMB PERFORMANCE INFORMATION PRESENTED.

Variable weight, standard day climb performance, with or without external stores is shown for normal power, military power, and maximum power operation. Performance is presented in terms of distance and time to climb versus gross weight for altitudes ranging from sea level to the service ceiling (rate-of-climb of 100 feet per minute). Guide lines are shown to provide a close measure of weight reduction during climb due to fuel consumption. Rate of climb and climb speed can be obtained for any point during the climb to altitude by using the constant weight curves which are also shown.

## FUEL ALLOWANCES.

No allowances have been included in the construction of the climb performance curves that compensate for the time required to accelerate to the climb speed from take-off, or cruising speeds. However, a note is included on the climb performance curves which indicates the allowances that should be added to the fuel consumed to allow for ground maneuvers, take-off, and acceleration to climb speed.

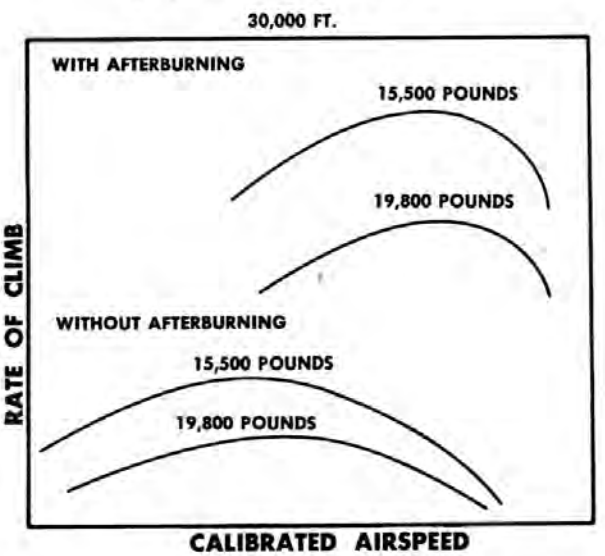
## CLIMB SPEED SCHEDULE.

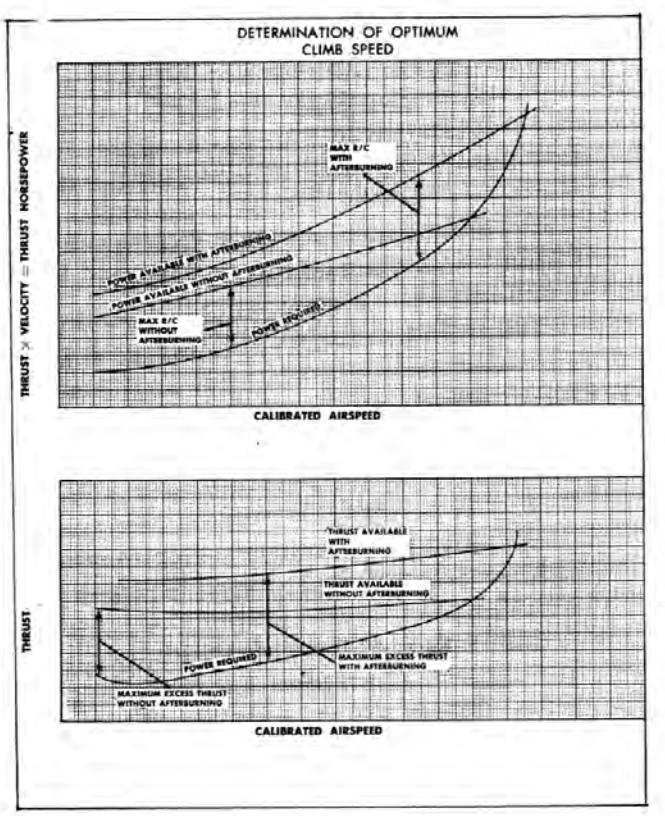
The data used to construct the charts are based on the climb speed schedules shown. Strict adherence to the recommended climb speed schedules is required to obtain optimum performance. Use of climb speed schedules other than shown on the climb charts will result in reduced rates of climb at all altitudes. Consequently, fuel used and time required to reach altitude will be increased.

## CLIMB SPEED DETERMINATION.

Rate of climb is proportional to excess thrust horsepower; therefore, the maximum rate of climb will be attained at the airspeed for which excess thrust horsepower is at a maximum. The difference between power required to maintain airspeed and power available from engine output is excess thrust horsepower. The speed at which the difference is at a maximum is the speed for maximum rate of climb.

EFFECT OF AIRSPEED AND WEIGHT ON RATE OF CLIMB

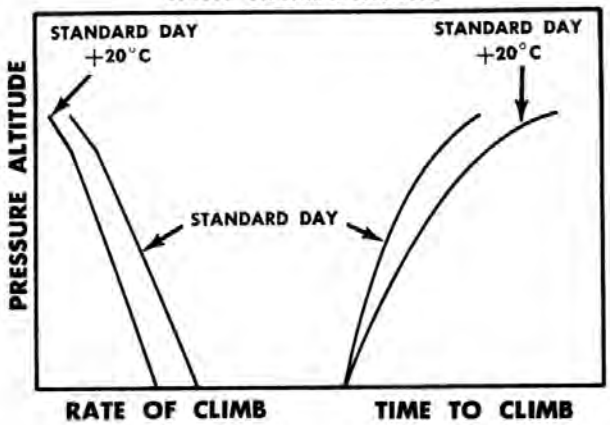


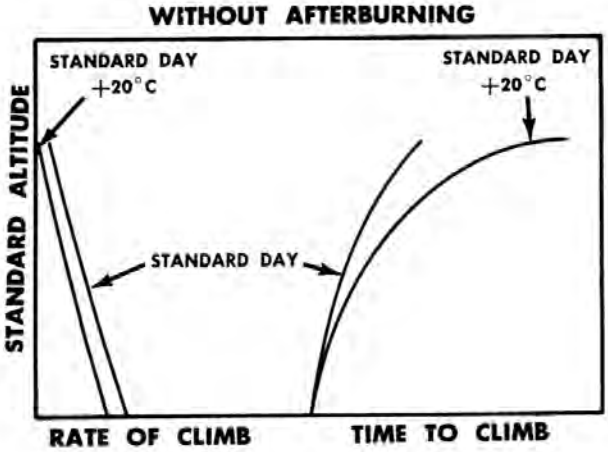
## RATE OF CLIMB FOR NON-STANDARD TEMPERATURES.

The climb charts present performance data for standard day conditions. However, an equivalent weight correction method has been devised which permits determination of non-standard day climb performance through the use of the standard day climb charts. This method replaces the actual airplane gross weight value at start of climb by an equivalent weight number which is used for entering the climb charts. Equivalent weight for a hot day is obtained by adding 150 pounds to the actual airplane weight for each 1 degree hotter than standard. Equivalent weight for a cold day is obtained by subtracting 150 pounds from the actual airplane weight for each 1 degree colder than standard.

EFFECT OF FREE AIR TEMPERATURE ON CLIMB PERFORMANCE
WITH AFTERBURNING




EFFECT OF FREE AIR TEMPERATURE ON CLIMB PERFORMANCE
WITHOUT AFTERBURNING




## USE OF THE CHARTS.

A sample problem is provided to show the use of the climb performance charts.

### SAMPLE PROBLEM.

Determine the non-standard day climb performance for a maximum power climb from sea level to 40,000 feet at an initial actual airplane gross weight of 18,900 pounds in the tip tank and rocket pod configuration. The average outside air temperature is −2°F and is assumed to occur at the average pressure altitude of 20,000 feet.

1. Enter Figure A1-8 (Standard Atmosphere Table) and by interpolation read the standard air temperature for the average pressure altitude of 20,000 feet ..... −12°F

2. For an outside air temperature of −2°F and a standard air temperature of −12°F the temperature deviation is 10°F above standard (hot day).

3. The weight correction to compensate non-standard air temperature is 150 pounds for each 1 degree hotter than standard added to the actual weight of the airplane (150 lb. × 10) ..... 1500 lb.

4. Equivalent gross weight (18,900 lb. + 1500 lb.) ..... 20,400 lb.

5. Enter Figure A3-11 (Maximum Power Climb Chart) at this equivalent weight and initial pressure altitude. Read:
   Initial distance ..... 0 n. mi.

6. Trace a curve parallel to the nearest guide line until it intersects the final altitude (40,000 feet). Read:
   Final distance .....54 n. mi.
   Final time .....8 min.
   Final equivalent weight .....18,800 lb.

7. Distance to climb is then (54 n. mi. − 0 n. mi.) .....54 n. mi.

8. Time to climb is (8 min. −0 min.).....8 min.

9. Fuel to climb is (20,400 lb. −18,800 lb).....1600 lb.

10. Actual gross weight at end of climb equals (18,900 lb. − 1600 lb.) .....17,300 lb.

To find rate of climb for the climb conditions:

1. Use Figure A3-12. At sea level and equivalent weight of 20,400 pounds, read:
   Rate of climb .....8700 ft./min.

2. At 40,000 feet and final equivalent weight of 18,800 pounds, read:
   Rate of climb .....2200 ft./min.

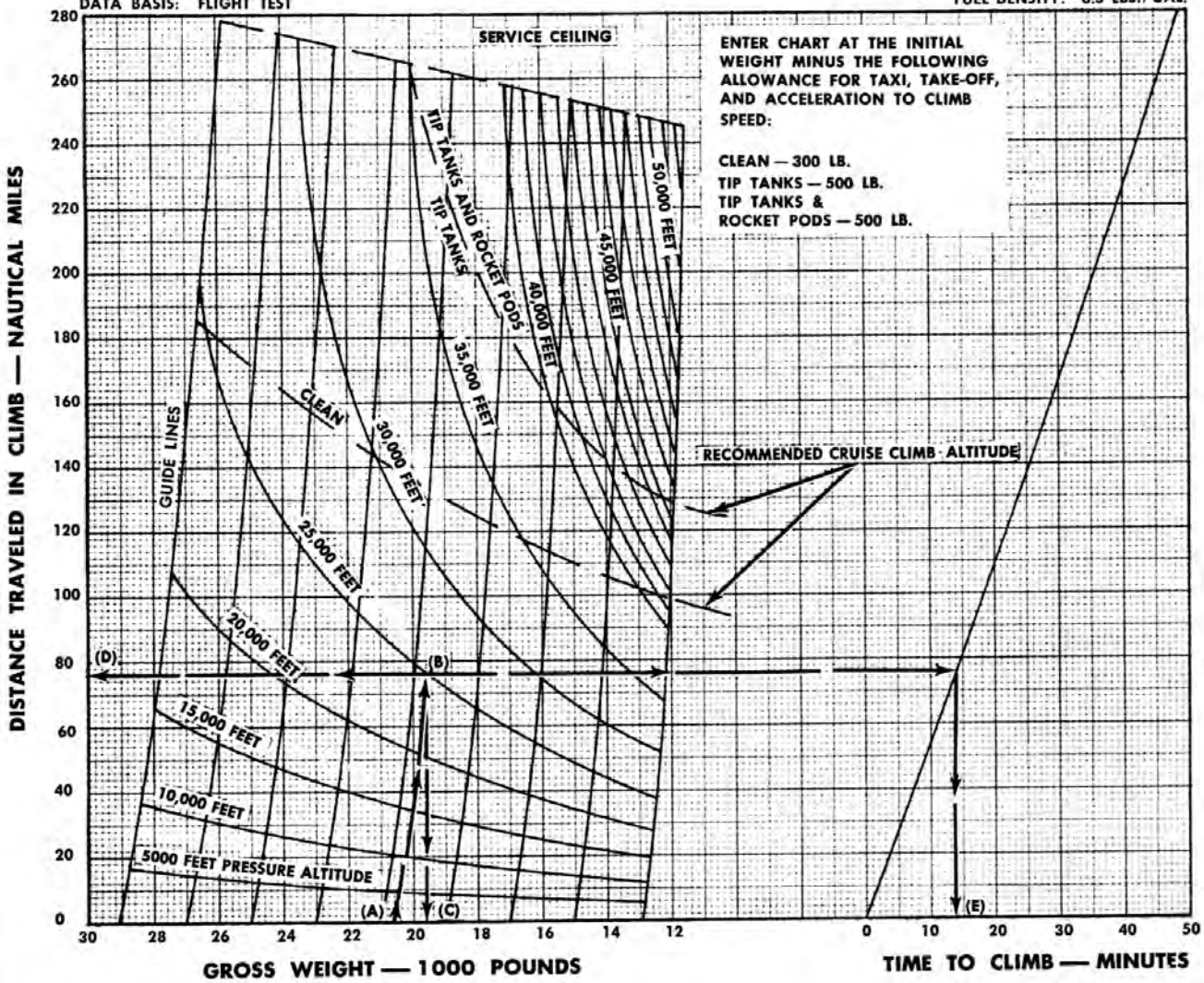
# NORMAL POWER CLIMB PERFORMANCE

## CLEAN — TIP TANKS — TIP TANKS AND ROCKET PODS

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ICAO STANDARD DAY

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.




**EXAMPLE:**

(A) IS INITIAL GROSS WEIGHT (20,575 LBS.)
(B) IS PRESSURE ALTITUDE (25,000 FT.)
(C) IS FINAL GROSS WEIGHT (19,600 LBS.)
(A)-(C) IS FUEL USED TO CLIMB (975 LBS.)
(D) IS DISTANCE TRAVELED IN CLIMB (76 NAUTICAL MILES)
(E) IS TIME TO CLIMB (13.8 MINUTES)

REMARKS:

1. FOR EACH 1°F HOTTER THAN STANDARD O.A.T. ADD 150 LBS. TO ACTUAL GROSS WEIGHT TO OBTAIN AN EQUIVALENT WEIGHT FOR CLIMB DETERMINATION.
2. FOR EACH 1°F COOLER THAN STANDARD O.A.T. SUBTRACT 150 LBS. FROM ACTUAL GROSS WEIGHT TO OBTAIN AN EQUIVALENT WEIGHT FOR CLIMB DETERMINATION.

| CLIMB SPEEDS | |
|---|---|
| ALTITUDE FEET | CAS KNOTS |
| 50,000 | 153 |
| 45,000 | 171 |
| 40,000 | 190 |
| 35,000 | 207 |
| 30,000 | 225 |
| 25,000 | 240 |
| 20,000 | 256 |
| 15,000 | 270 |
| 10,000 | 285 |
| 5,000 | 300 |
| S.L. | 315 |

*Figure A3-1. Normal Power Climb Performance—Clean—Tip Tanks—Tip Tanks and Rocket Pods*

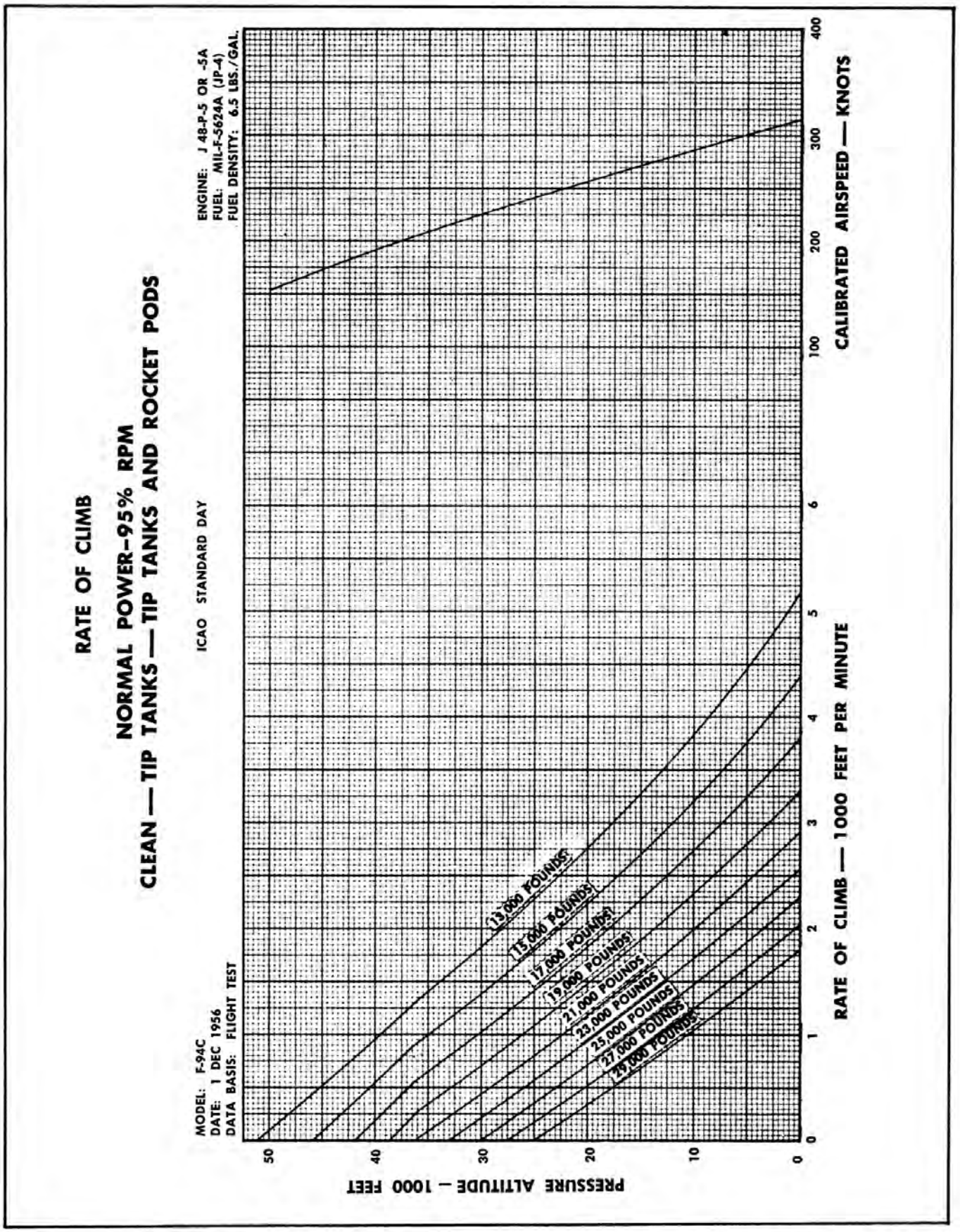


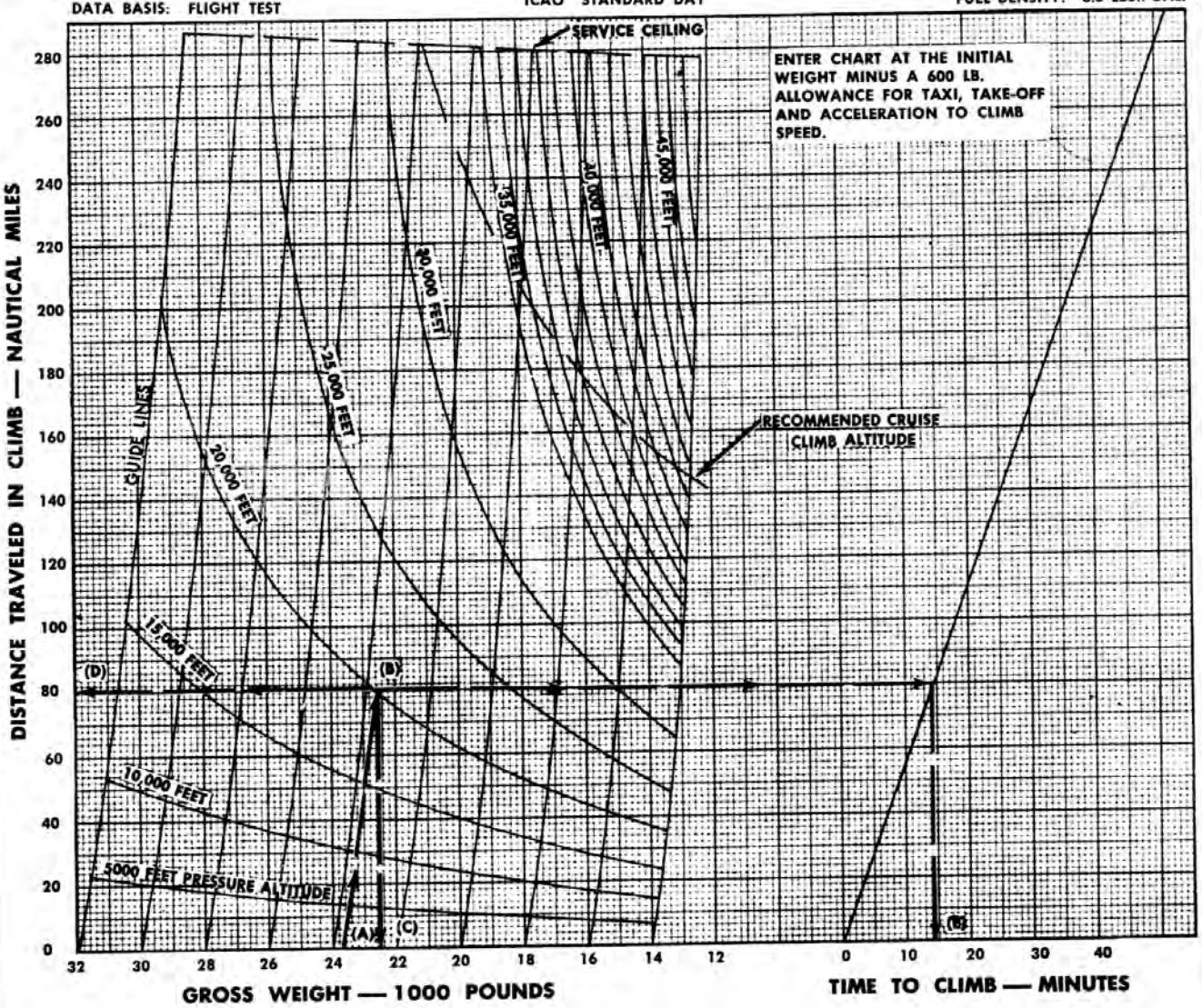

*Figure A3-2. Rate of Climb—Normal Power—95% RPM—Clean—Tip Tanks—Tip Tanks and Rocket Pods*

# NORMAL POWER CLIMB PERFORMANCE
## TIP TANKS, PYLON TANKS AND ROCKET PODS
## TIP TANKS AND PYLON TANKS

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ICAO STANDARD DAY

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.




**EXAMPLE:**

(A) IS INITIAL GROSS WEIGHT (23,700 LBS.)
(B) IS PRESSURE ALTITUDE (20,000 FEET)
(C) IS FINAL GROSS WEIGHT (22,500 LBS.)
(A)-(C) IS FUEL USED TO CLIMB (1200 LBS.)
(D) IS DISTANCE TRAVELED IN CLIMB (80 NAUTICAL MILES)
(E) IS TIME TO CLIMB (14.3 MINUTES)

REMARKS:

1. FOR EACH 1°F HOTTER THAN STANDARD O.A.T. ADD 150 LBS. TO ACTUAL GROSS WEIGHT TO OBTAIN AN EQUIVALENT WEIGHT FOR CLIMB DETERMINATION.
2. FOR EACH 1°F COOLER THAN STANDARD O.A.T. SUBTRACT 150 LBS. FROM ACTUAL GROSS WEIGHT TO OBTAIN AN EQUIVALENT WEIGHT FOR CLIMB DETERMINATION.

| CLIMB SPEEDS | |
|---|---|
| ALTITUDE FEET | CAS KNOTS |
| 50,000 | 153 |
| 45,000 | 171 |
| 40,000 | 190 |
| 35,000 | 207 |
| 30,000 | 225 |
| 25,000 | 240 |
| 20,000 | 256 |
| 15,000 | 270 |
| 10,000 | 285 |
| 5,000 | 300 |
| S.L. | 315 |

*Figure A3-3. Normal Power Climb Performance—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods*

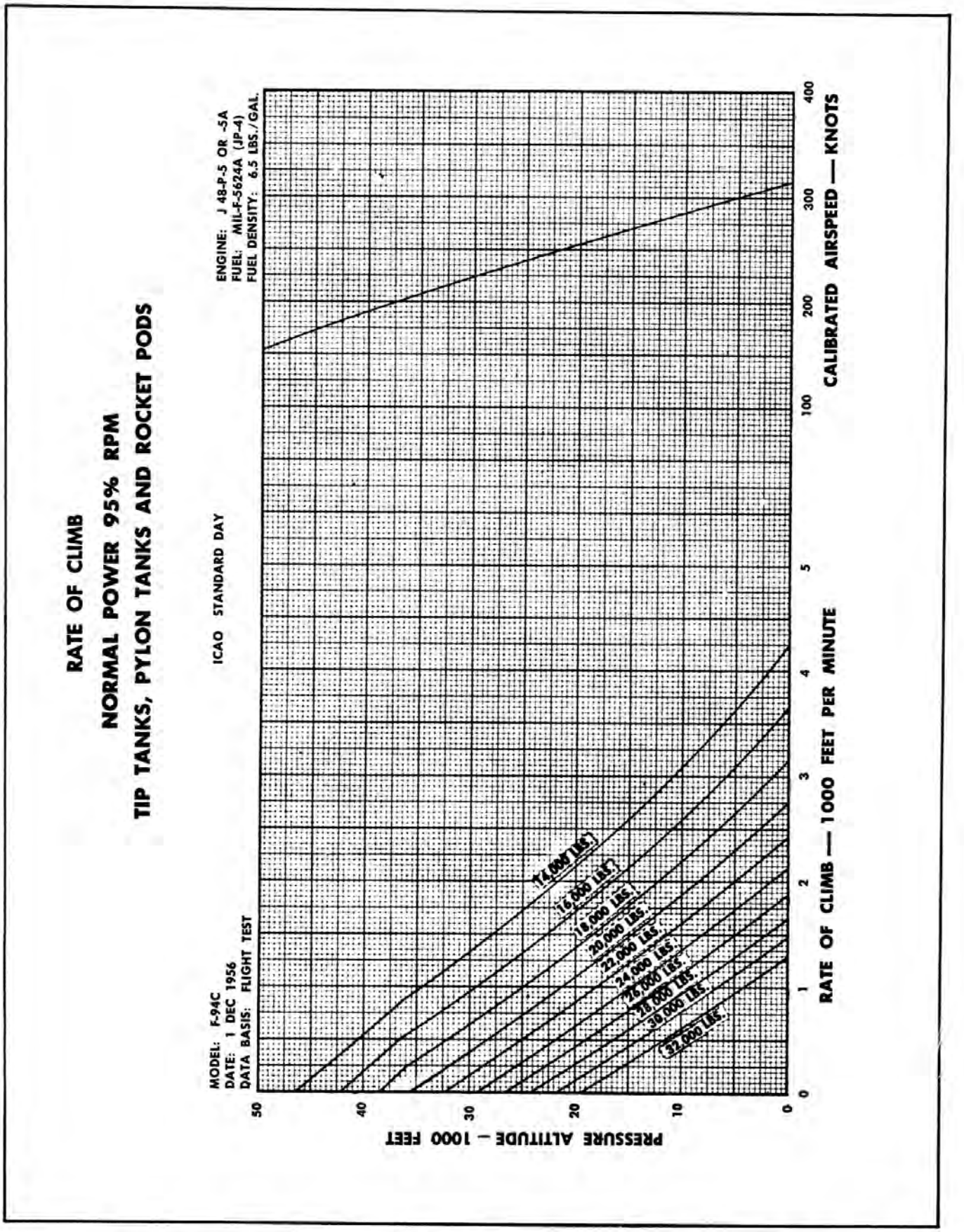



*Figure A3-4. Rate of Climb—Normal Power—95% RPM—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods*

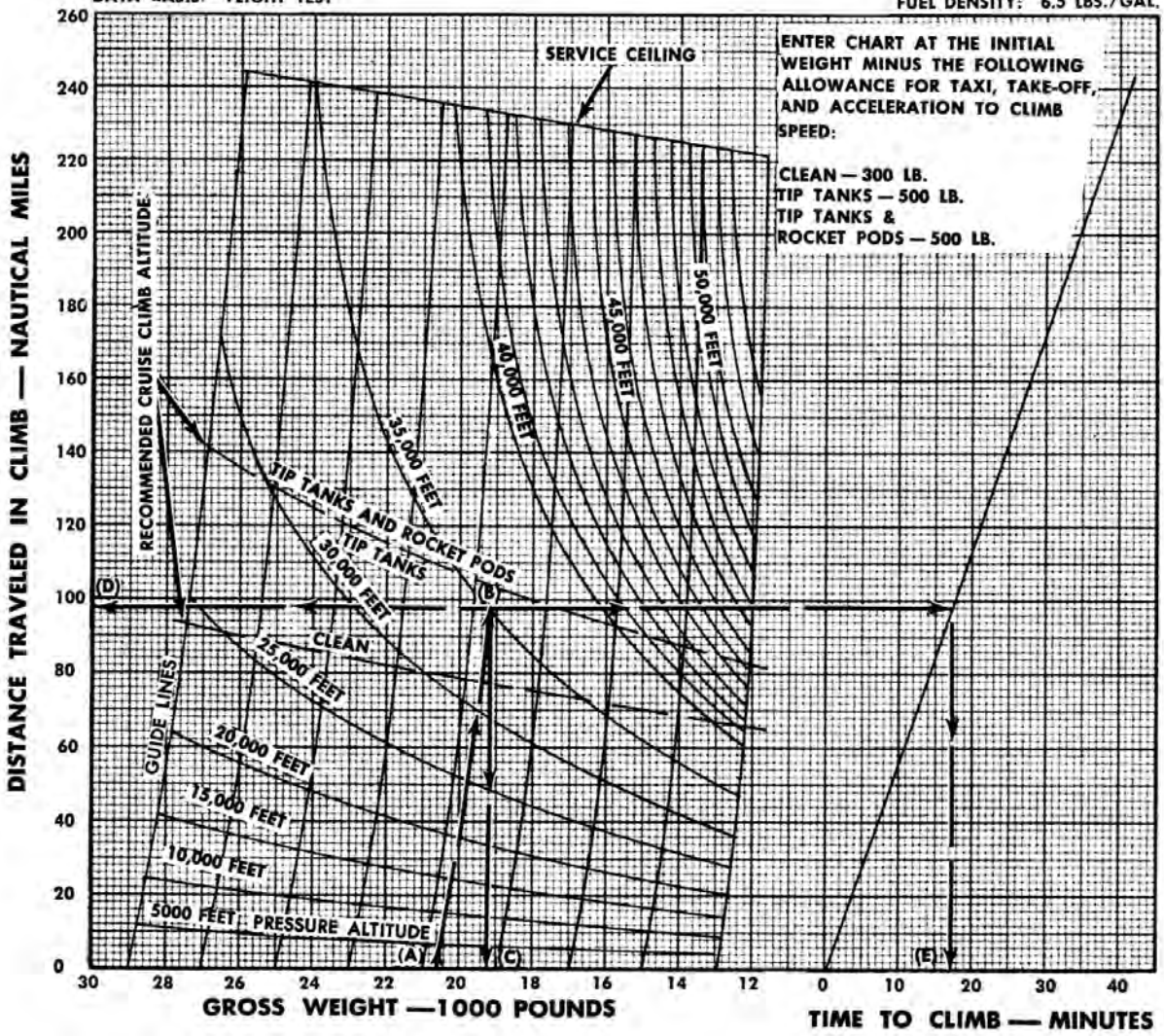
# MILITARY POWER CLIMB PERFORMANCE

## CLEAN — TIP TANKS — TIP TANKS AND ROCKET PODS

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ICAO STANDARD DAY

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.




**EXAMPLE:**

(A) IS INITIAL GROSS WEIGHT (20,575 LBS.)
(B) IS PRESSURE ALTITUDE (35,000 FEET)
(C) IS FINAL GROSS WEIGHT (19,250 LBS.)
(A)-(C) IS FUEL USED TO CLIMB (1325 LBS.)
(D) IS DISTANCE TRAVELED IN CLIMB (98 NAUTICAL MILES)
(E) IS TIME TO CLIMB (17.2 MINUTES)

REMARKS:

1. FOR EACH 1°F HOTTER THAN STANDARD O.A.T. ADD 150 LBS. TO ACTUAL GROSS WEIGHT TO OBTAIN AN EQUIVALENT WEIGHT FOR CLIMB DETERMINATION.
2. FOR EACH 1°F COOLER THAN STANDARD O.A.T. SUBTRACT 150 LBS. FROM ACTUAL GROSS WEIGHT TO OBTAIN AN EQUIVALENT WEIGHT FOR CLIMB DETERMINATION.

| CLIMB SPEEDS | |
|---|---|
| ALTITUDE FEET | CAS KNOTS |
| 50,000 | 153 |
| 45,000 | 171 |
| 40,000 | 190 |
| 35,000 | 207 |
| 30,000 | 225 |
| 25,000 | 240 |
| 20,000 | 256 |
| 15,000 | 270 |
| 10,000 | 285 |
| 5,000 | 300 |
| S.L. | 315 |

*Figure A3-5. Military Power Climb Performance—Clean—Tip Tanks—Tip Tanks and Rocket Pods*

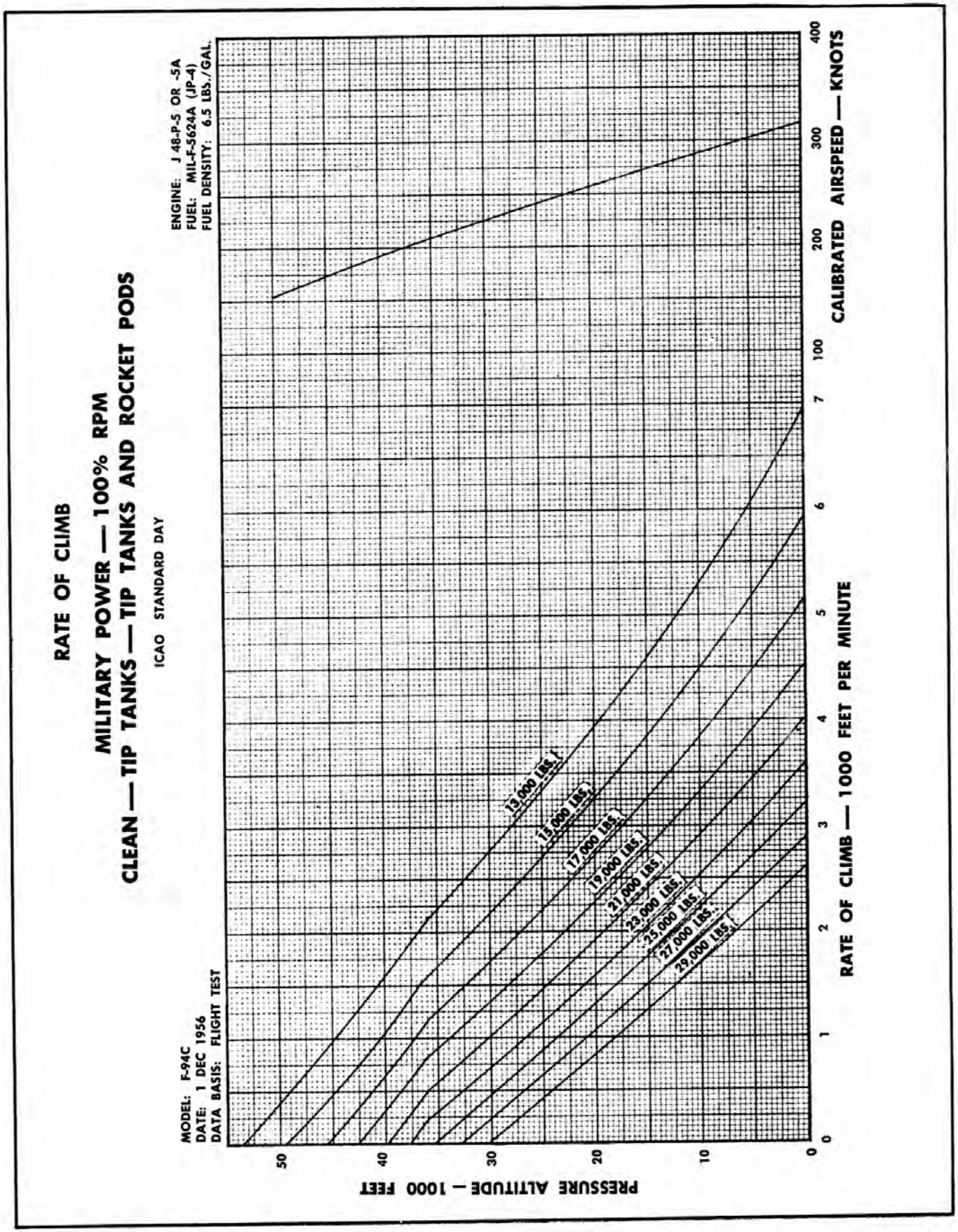



*Figure A3-6. Rate of Climb—Military Power—100% RPM—Clean—Tip Tanks—Tip Tanks and Rocket Pods*

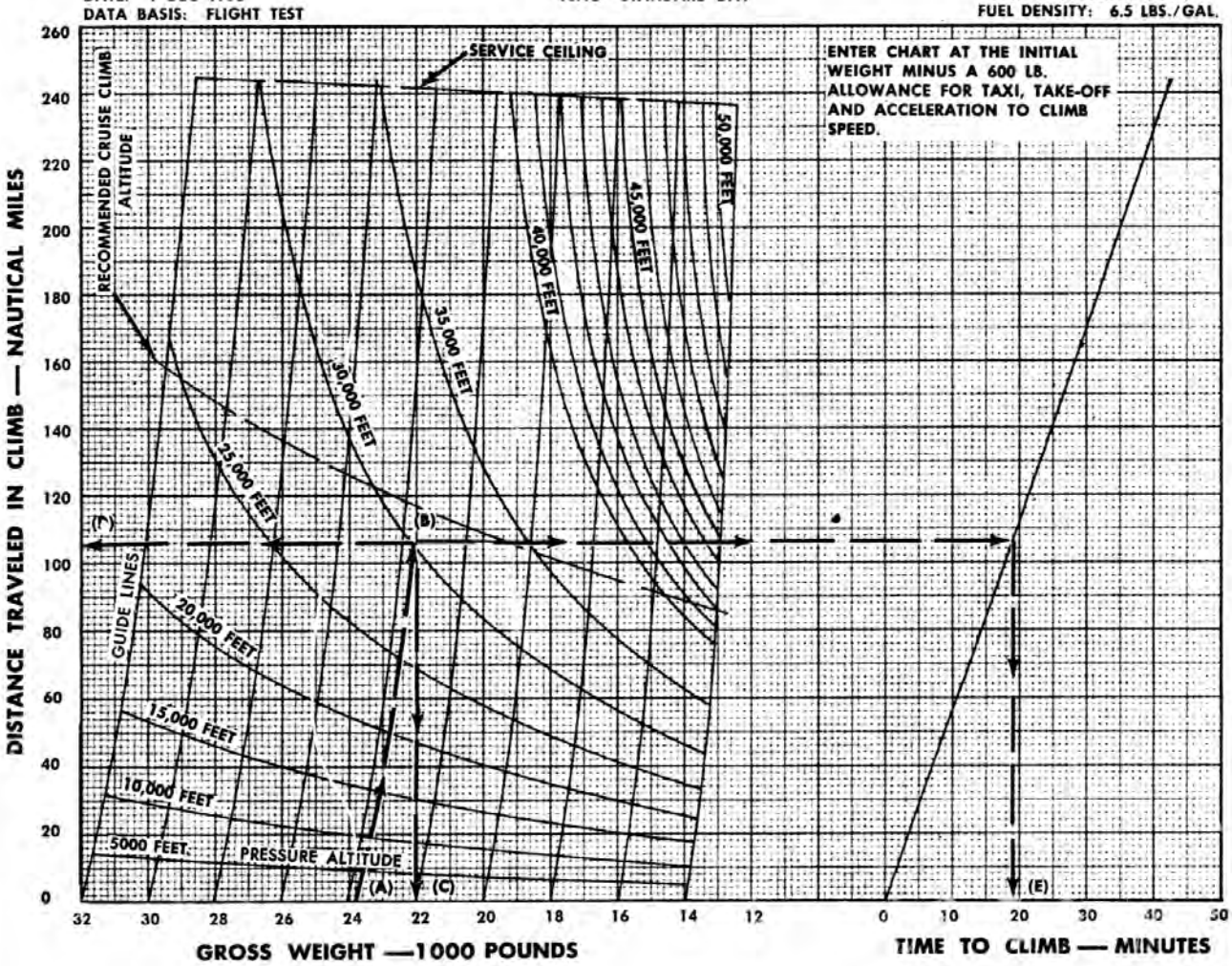
# MILITARY POWER CLIMB PERFORMANCE

## TIP TANKS, PYLON TANKS AND ROCKET PODS
## TIP TANKS AND PYLON TANKS

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ICAO STANDARD DAY

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.




**EXAMPLE:**

(A) IS INITIAL GROSS WEIGHT (23,700 LBS.)
(B) IS PRESSURE ALTITUDE (30,000 FEET)
(C) IS FINAL GROSS WEIGHT 22,000 LBS.)
(A)-(C) IS FUEL USED TO CLIMB (1700 LBS.)
(D) IS DISTANCE TRAVELED IN CLIMB (106 NAUTICAL MILES)
(E) IS TIME TO CLIMB (19.0 MINUTES)

REMARKS:

1. FOR EACH 1°F HOTTER THAN STANDARD O.A.T. ADD 150 LBS. TO ACTUAL GROSS WEIGHT TO OBTAIN AN EQUIVALENT WEIGHT FOR CLIMB DETERMINATION.
2. FOR EACH 1°F COOLER THAN STANDARD O.A.T. SUBTRACT 150 LBS. FROM ACTUAL GROSS WEIGHT TO OBTAIN AN EQUIVALENT WEIGHT FOR CLIMB DETERMINATION.

| CLIMB SPEEDS | |
|---|---|
| ALTITUDE FEET | CAS KNOTS |
| 50,000 | 153 |
| 45,000 | 171 |
| 40,000 | 190 |
| 35,000 | 207 |
| 30,000 | 225 |
| 25,000 | 240 |
| 20,000 | 256 |
| 15,000 | 270 |
| 10,000 | 285 |
| 5,000 | 300 |
| S.L. | 315 |

*Figure A3-7. Military Power Climb Performance—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods*

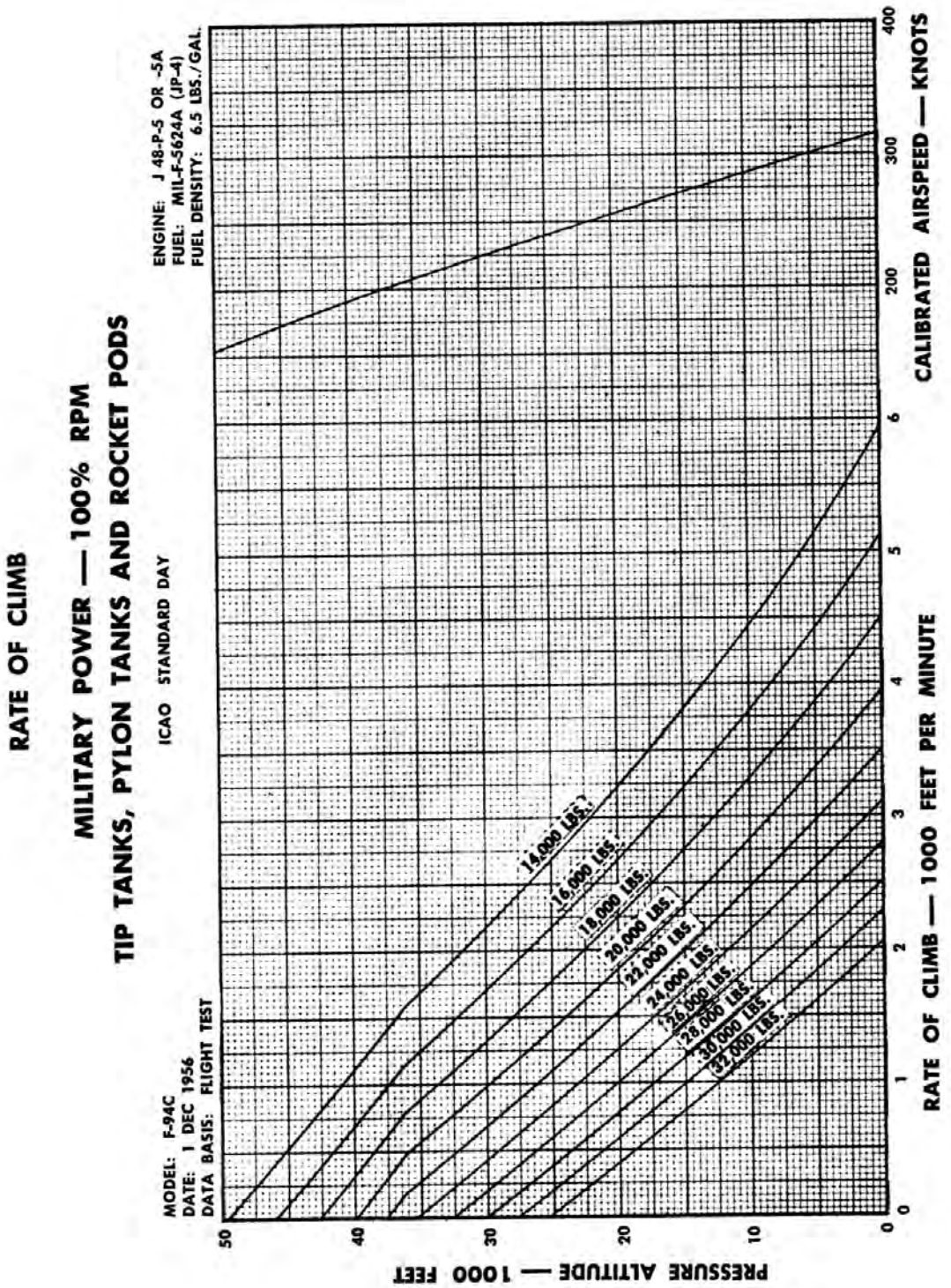



*Figure A3-8. Rate of Climb—Military Power—100% RPM—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods*

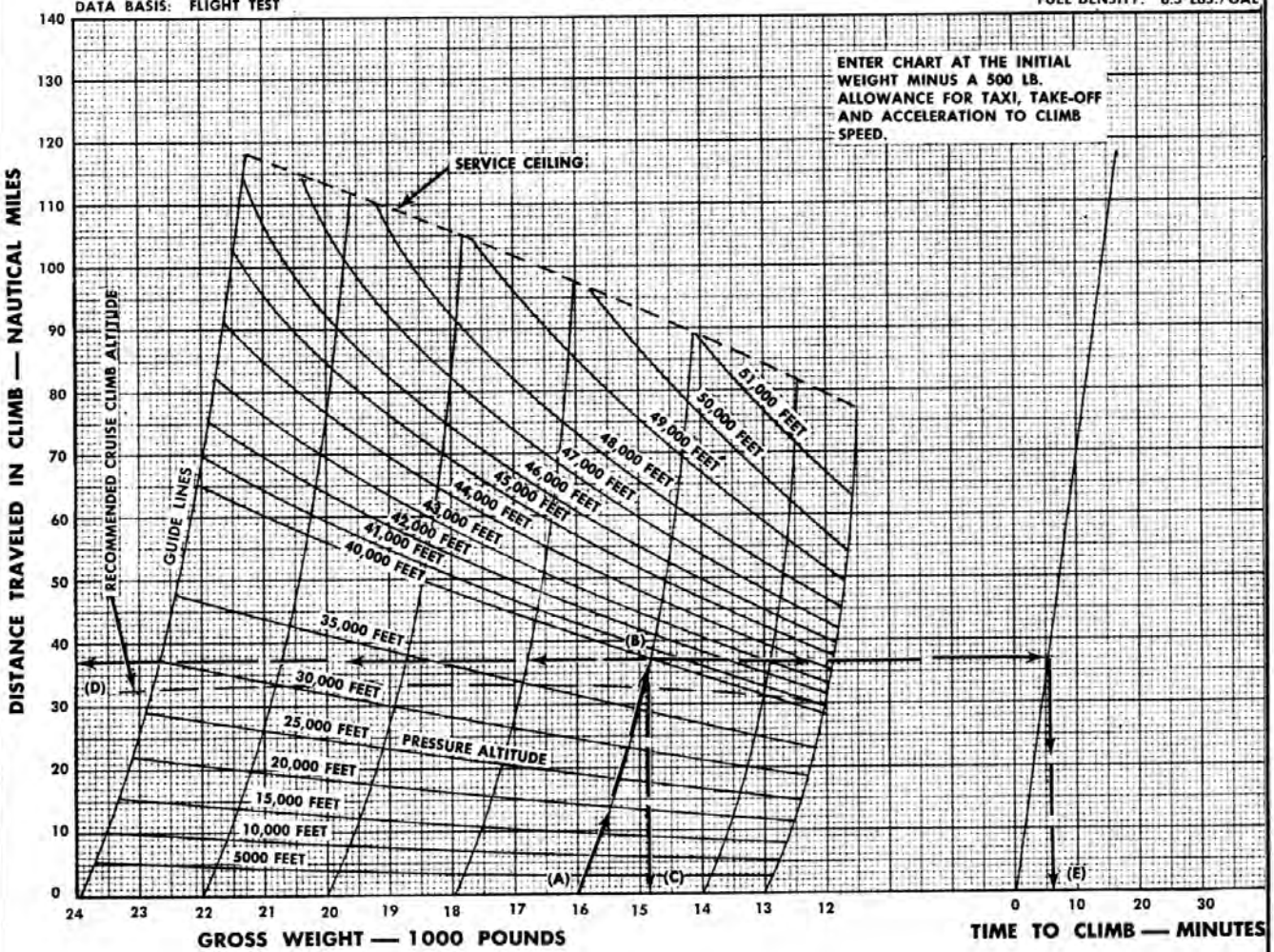
# MAXIMUM POWER CLIMB PERFORMANCE

## CLEAN CONFIGURATION

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ICAO STANDARD DAY

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL




**EXAMPLE:**

(A) IS INITIAL GROSS WEIGHT (16,025 LBS.)
(B) IS PRESSURE ALTITUDE (40,000 FT.)
(C) IS FINAL GROSS WEIGHT (14,840 LBS.)
(A)-(C) IS FUEL USED TO CLIMB (1185 LBS.)
(D) IS DISTANCE TRAVELED IN CLIMB (37 NAUTICAL MILES)
(E) IS TIME TO CLIMB (6 MINUTES)

REMARKS:

1. FOR EACH 1°F HOTTER THAN STANDARD O.A.T. ADD 150 LBS. TO ACTUAL GROSS WEIGHT TO OBTAIN AN EQUIVALENT WEIGHT FOR CLIMB DETERMINATION.
2. FOR EACH 1°F COOLER THAN STANDARD O.A.T. SUBTRACT 150 LBS. FROM ACTUAL GROSS WEIGHT TO OBTAIN AN EQUIVALENT WEIGHT FOR CLIMB DETERMINATION.

| CLIMB SPEEDS | |
|---|---|
| ALTITUDE FEET | CAS KNOTS |
| 50,000 | 175 |
| 45,000 | 195 |
| 40,000 | 225 |
| 35,000 | 250 |
| 30,000 | 280 |
| 25,000 | 310 |
| 20,000 | 340 |
| 15,000 | 370 |
| 10,000 | 400 |
| 5,000 | 430 |
| S.L. | 460 |

*Figure A3-9. Maximum Power Climb Performance—Clean Configuration*

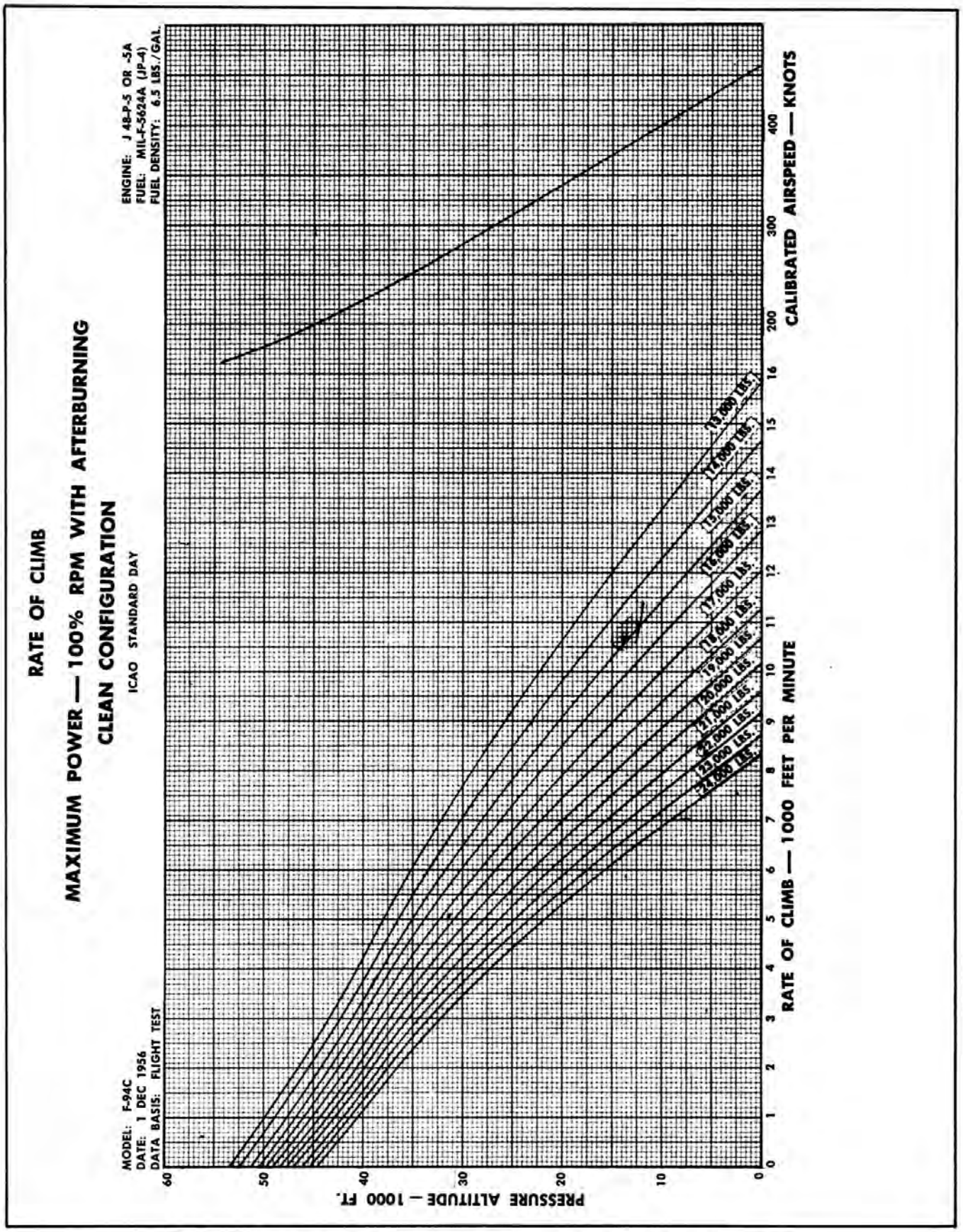



*Figure A3-10. Rate of Climb—Maximum Power—100% RPM with Afterburning—Clean Configuration*

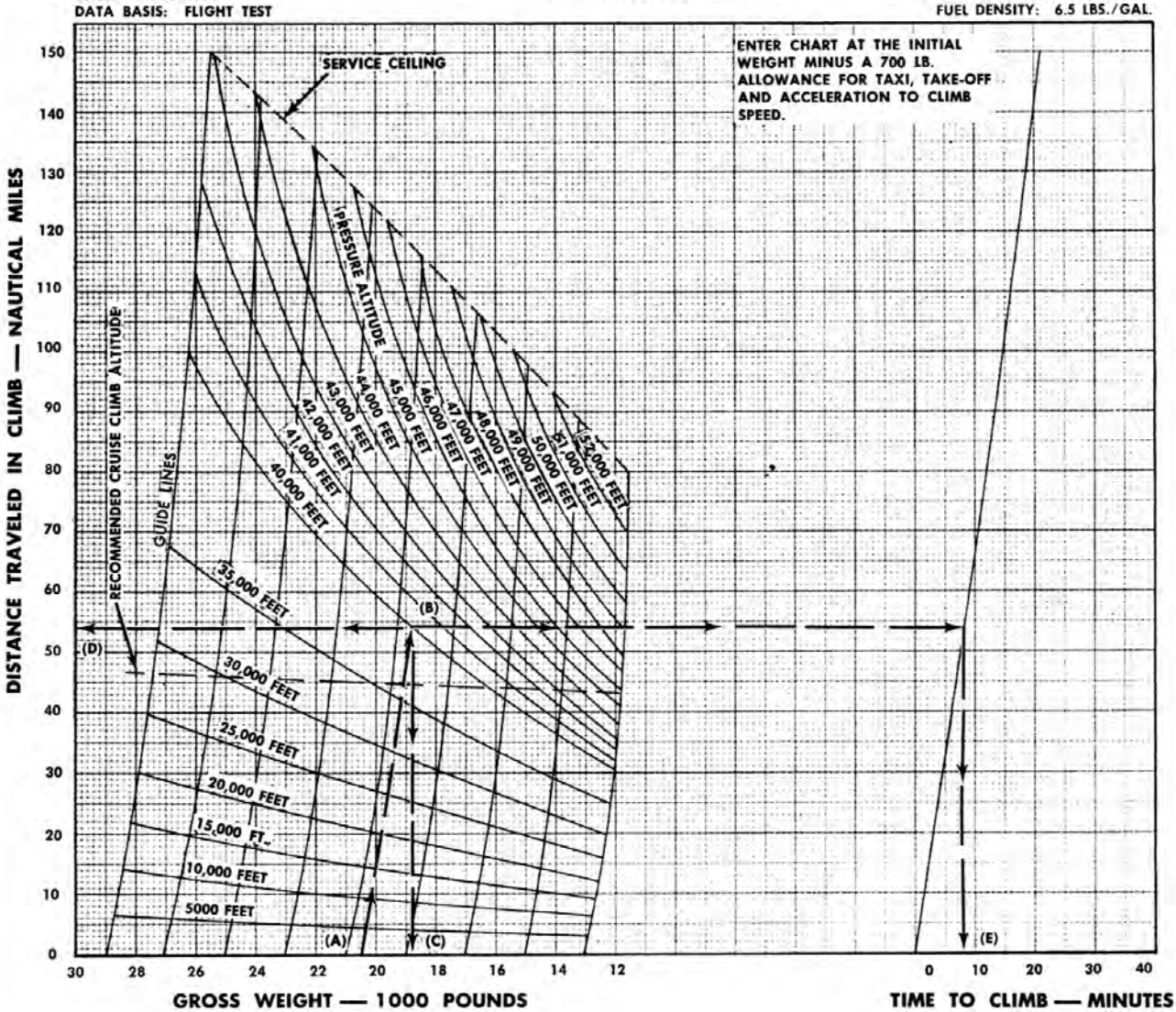
# MAXIMUM POWER CLIMB PERFORMANCE

## TIP TANKS AND ROCKET PODS TIP TANKS

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ICAO STANDARD DAY

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.




**EXAMPLE:**

(A) IS INITIAL GROSS WEIGHT (20,575 LBS.)
(B) IS PRESSURE ALTITUDE (40,000 FT.)
(C) IS FINAL GROSS WEIGHT (18,800 LBS.)
(A)-(C) IS FUEL USED TO CLIMB (1775 LBS.)
(D) IS DISTANCE TRAVELED IN CLIMB (54 NAUTICAL MILES)
(E) IS TIME TO CLIMB (8.0 MINUTES)

REMARKS:

1. FOR EACH 1°F HOTTER THAN STANDARD O.A.T. ADD 150 LBS. TO ACTUAL GROSS WEIGHT TO OBTAIN AN EQUIVALENT WEIGHT FOR CLIMB DETERMINATION.
2. FOR EACH 1°F COOLER THAN STANDARD O.A.T. SUBTRACT 150 LBS. FROM ACTUAL GROSS WEIGHT TO OBTAIN AN EQUIVALENT WEIGHT FOR CLIMB DETERMINATION.

| CLIMB SPEEDS | |
|---|---|
| ALTITUDE FEET | CAS KNOTS |
| 50,000 | 175 |
| 45,000 | 195 |
| 40,000 | 225 |
| 35,000 | 250 |
| 30,000 | 280 |
| 25,000 | 310 |
| 20,000 | 340 |
| 15,000 | 370 |
| 10,000 | 400 |
| 5,000 | 430 |
| S.L. | 460 |

*Figure A3-11. Maximum Power Climb Performance—Tip Tanks—Tip Tanks and Rocket Pods*

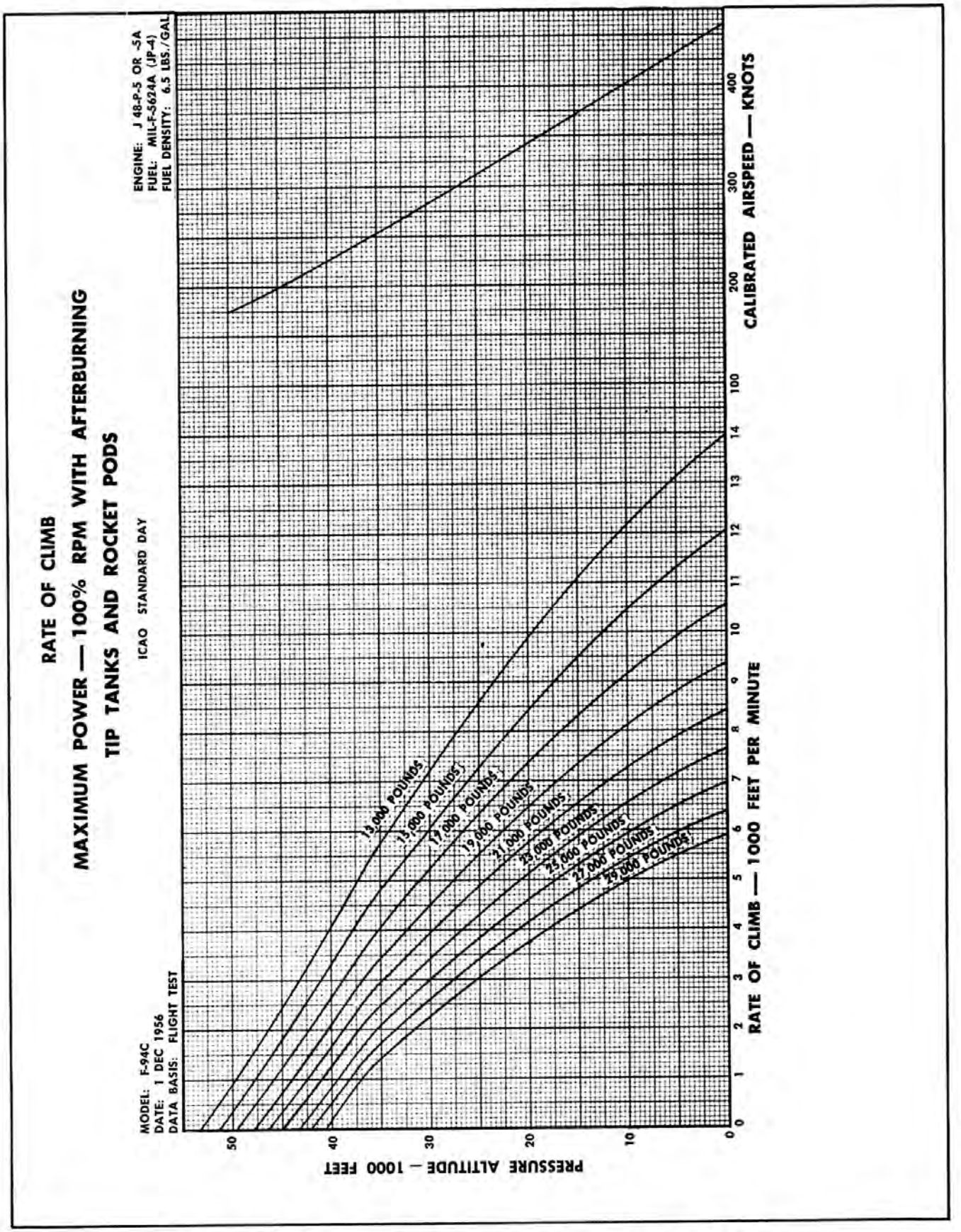
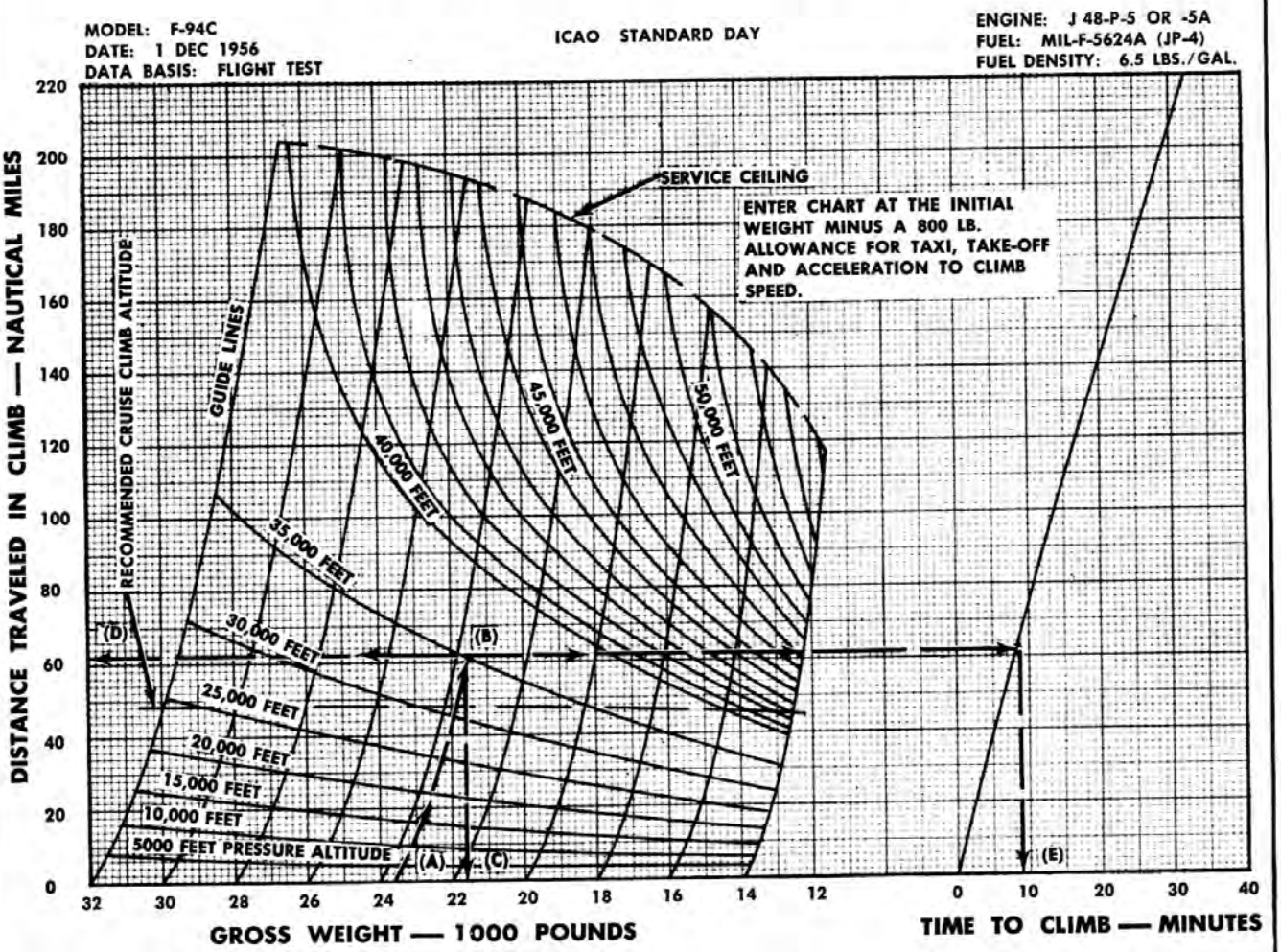



*Figure A3-12. Rate of Climb—Maximum Power—100% RPM with Afterburning—Tip Tanks—Tip Tanks and Rocket Pods*

# MAXIMUM POWER CLIMB PERFORMANCE

## TIP TANKS, PYLON TANKS AND ROCKET PODS

## TIP TANKS AND PYLON TANKS




**EXAMPLE:**

(A) IS INITIAL GROSS WEIGHT (23,700 LBS.)
(B) IS PRESSURE ALTITUDE (35,000 FEET)
(C) IS FINAL GROSS WEIGHT (21,600 LBS.)
(A)-(C) IS FUEL USED TO CLIMB (2100 LBS.)
(D) IS DISTANCE TRAVELED IN CLIMB (60.8 NAUTICAL MILES)
(E) IS TIME TO CLIMB (8.9 MINUTES)

REMARKS:

1. FOR EACH 1°F HOTTER THAN STANDARD O.A.T. ADD 150 LBS. TO ACTUAL GROSS WEIGHT TO OBTAIN AN EQUIVALENT WEIGHT FOR CLIMB DETERMINATION.
2. FOR EACH 1°F COOLER THAN STANDARD O.A.T. SUBTRACT 150 LBS. FROM ACTUAL GROSS WEIGHT TO OBTAIN AN EQUIVALENT WEIGHT FOR CLIMB DETERMINATION.

| CLIMB SPEEDS | |
|---|---|
| ALTITUDE FEET | CAS KNOTS |
| 50,000 | 156 |
| 45,000 | 186 |
| 40,000 | 216 |
| 35,000 | 245 |
| 30,000 | 266 |
| 25,000 | 286 |
| 20,000 | 304 |
| 15,000 | 324 |
| 10,000 | 342 |
| 5,000 | 361 |
| S.L. | 380 |

*Figure A3-13. Maximum Power Climb Performance—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods*

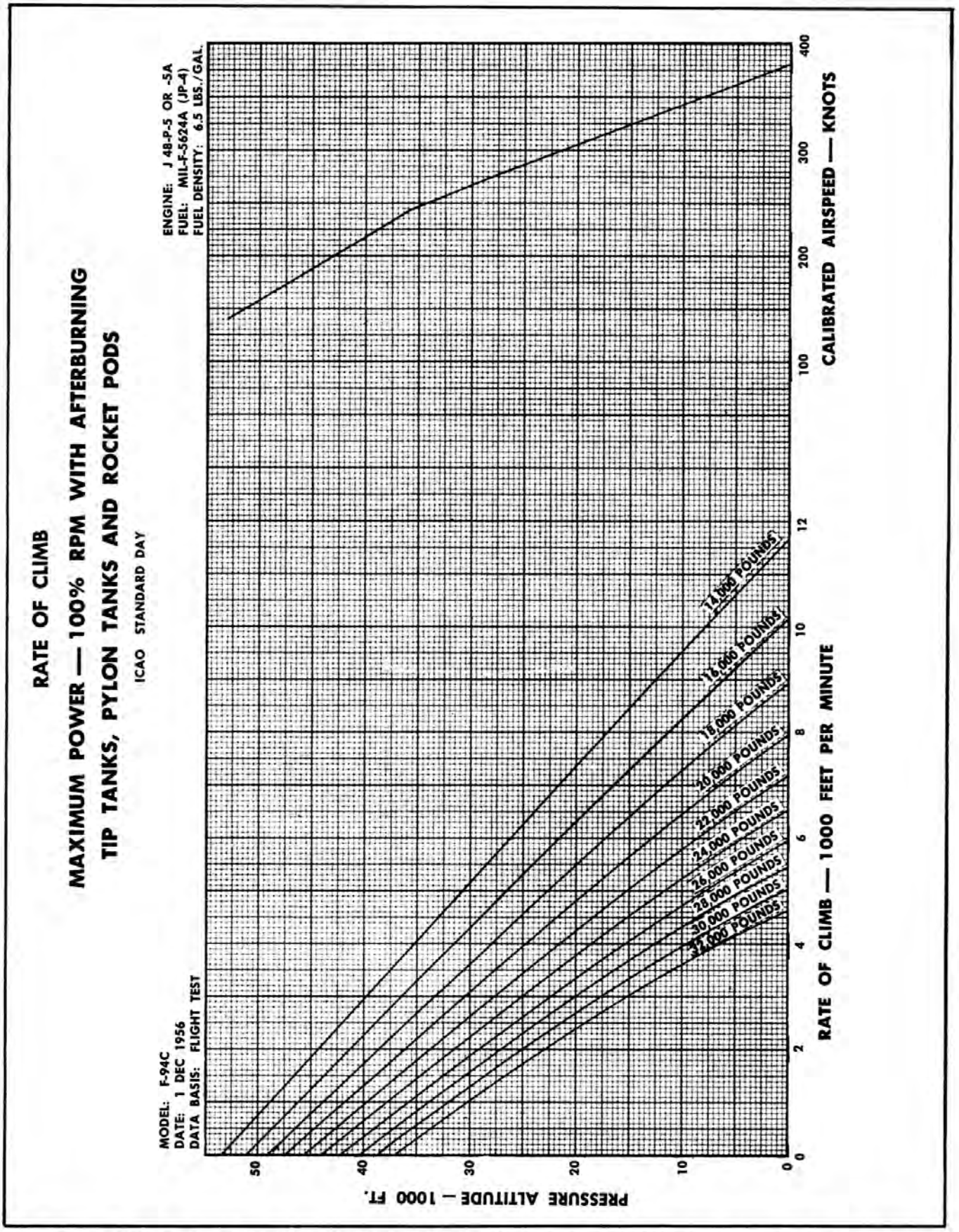



*Figure A3-14. Rate of Climb—Maximum Power—100% RPM with Afterburning—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods*

# Part 4—Range

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## RANGE

### RANGE PROFILE CHARTS.

The range profile charts present the range characteristics of the airplane in a convenient pictorial form, and provide for accurate flight planning for the majority of missions where cruise control must be considered. These charts eliminate much of the computation required in adapting data from the graphical nautical mile per gallon and climb charts to obtain correct estimates of the fuel and time to fly a particular mission. This is done by pictorially presenting the relationship of time, fuel, and distance obtainable at optimum cruise settings for all altitudes at which the airplane is capable of flying. The range data presented consist of three types of profile charts: Mission Profiles, Intercept Profiles, and Optimum Return Profiles.

### MISSION PROFILE CHARTS.

#### CHART SCOPE.

The Mission Profile charts present both the level flight cruise and the variable altitude (cruise-climb) maximum range characteristics of the airplane. The charts give the time and fuel required to fly a given distance under a no-wind condition at any cruising altitude from sea level to the optimum cruise-climb altitude.

#### CHART BASIS.

A mission sequence of take-off, military power climb, and maximum range cruise is assumed. However, the charts may also be used on an incremental basis as

described in a later section. Each chart is based on the take-off gross weight with full fuel load for the particular airplane configuration. A fuel allowance has been included for ground maneuver, take-off, and acceleration to climb speed. This allowance is listed on the appropriate charts. The charts do not include any reserve for loiter, descent, or landing at the end of the cruise.

### CHART ARRANGEMENT.

In general, the Mission Profile Chart is read from left to right in a flight sequence of initial climb followed by cruising flight. The initial climb path in indicated by a solid line which shows the distance traveled in the climb from the point at which initial climb speed is reached to any desired cruising altitude. The total range attainable (not including distance to accelerate to climb speed or to descend) for any desired value of fuel consumed and altitude is indicated by the dashed "pounds of fuel used" lines. For example, at a desired cruise altitude of 25,000 feet and a range of 590 nautical air miles in the tip tank configuration (see Figure A4-2) a total of 5000 pounds of fuel will be used from the time the engine is started until the aircraft is 590 nautical air miles away at 25,000 ft. The time required to climb to any altitude and cruise-out is indicated by the dotted lines which does not include take-off, acceleration, or descent time. The optimum level flight cruise altitude line indicates the best cruise altitude for any desired range. This line is not a flight path line. The cruise-climb (variable altitude) cruise performance is indicated by the intersection of the "pounds of fuel used" and time lines with the "cruise-climb flight path" line. Using the charts on an incremental basis, level flight cruise-out and return performance can be determined for any fuel loading or fuel quantity used. Enter the chart at the cruise altitude and fuel consumed value to obtain initial distance and time readings. Add the desired cruise altitude distance to the initial distance reading to obtain a final distance reading. Enter the chart at the final distance value and cruise altitude to obtain final fuel and time consumed readings. The difference between the initial and final fuel and time values is the fuel and time to cruise the required distance.

## STANDARD DAY CRUISE TECHNIQUE.

### LEVEL FLIGHT CRUISE.

The climb to cruising altitude is made at military power, 100% RPM, using the speed schedule shown on the charts. The climb path shown on the profile is applicable to whatever cruising altitude is selected. The recommended cruise speeds (CAS) for best level flight cruise range are tabulated at the bottom of the profile chart along with the approximate initial cruise RPM. Approximate values of fuel flow and true airspeed are also given. At the end of the initial climb, the recommended level flight cruise speed at a given altitude should be exceeded slightly before climb power is reduced in order to maintain adequate speed until stable cruise conditions are established. Then, the recommended calibrated airspeed should be maintained throughout cruising flight. Constant altitude should be maintained by adjusting engine speed as required. The required rpm will reduce as fuel is consumed.

### CRUISE-CLIMB.

To achieve absolute maximum range, the pilot must fly continuously at the optimum cruise altitude for each momentary gross weight. The optimum altitude for cruising flight increases as fuel is consumed and gross weight is reduced. This results in a continuous, but gentle, climbing flight path for maximum range. This cruise-climb technique should be flown at a constant Mach number and power setting. However, since this aircraft is not equipped with a Mach number indicator, it is possible to cruise-climb by following the fuel remaining versus airspeed schedule presented on the charts.

### ALTITUDE TO INITIATE CRUISE CLIMB.

The flight path at altitude for cruise-climb flight will vary from day to day as the air temperature varies. However, climb performance also will vary with temperature. If the cruise is to be initiated after making a climb to altitude, this change in climb performance can be used as a guide in determining the altitude at which to initiate the cruise-climb. The proper altitude at which to initiate the cruise-climb procedure depends upon the airplane configuration and can be obtained by climbing at the recommended military power climb speed schedule until the rate of climb reduces to 1500 feet per minute for the clean configuration without external stores; 900 feet per minute with tip tanks or tip tanks and rocket pods; or 700 feet per minute with tip tanks and pylon tanks or tip tanks, pylon tanks and rocket pods. The pilot should level off and trim the airplane to a higher speed before reducing power. Then, as long as the recommended rpm and CAS as given on the chart are maintianed, the airplane will seek the proper altitude for cruise-climb, maximum range flight.

## HOT DAY CRUISE TECHNIQUE.

### HOT DAY LEVEL FLIGHT CRUISE.

For level flight cruise at altitudes near 40,000 feet and on very hot days, it is possible that more than 95% rpm (maximum continuous power) will be required to maintain constant altitude at the recommended CAS. The best technique, however, is to maintain the recommended CAS and 95% rpm and allow the airplane to seek its own altitude. You will lose altitude at first, and then gradually return again to the desired cruise altitude; from this point on, rpm may be reduced as fuel is consumed.

### HOT DAY CRUISE-CLIMB.

The reduction in climb performance on a hot day obviously will have the greatest effect when the cruise-climb technique is used. This is because the altitude level for the entire flight will be reduced. As mentioned previously, the cruise-climb should be initiated when the rate of climb at military power drops to 1500 feet per minute, 900 feet per minute, or 700 feet per minute, depending on the configuration, regardless of free air temperature.

## WIND EFFECT ON CRUISE PERFORMANCE.

The effect of wind should be applied to the flight plan to obtain the true fuel and time required to fly a given ground distance. Since the wind may be from any direction with respect to the airplane course, some question may arise as to the method of handling winds other than direct headwinds or tailwinds. For purposes of cruise control, all winds may be expressed as effective winds by considering the head or tail wind component for the time required to complete the mission. To determine the effect of wind upon time, fuel, and distance, compute the average true airspeed (TAS) [distance ÷ time (no wind)], and apply wind to the average TAS to obtain average ground speed (GS) [average TAS − headwind, or + tailwind]. Multiply actual distance by the airspeed: groundspeed ratio (TAS ÷ G.S.). This is the "air" distance to be flown. Re-enter the profile at the air distance with wind and cruising altitude to obtain the fuel required with wind.

## EFFECT OF OUTSIDE AIR TEMPERATURE ON RANGE.

The effect of non-standard free air temperature on level flight cruise range is small if the recommended CAS schedule is maintained. Engine speed may have to be adjusted to operate at a desired altitude. However, the resultant change in fuel flow is compensated for by a change in TAS so that fuel economy is substantially unchanged. Flight time, of course, is different by the percentage change in ground speed.

## USE OF CHARTS.

The following sample problems are submitted as an aid to the proper understanding of the use of the mission profile range charts.

### SAMPLE PROBLEM NO. 1.

Determine the time, fuel required, cruise speed, and approximate cruise power setting to cruise 650 nautical miles at 30,000 feet on a standard day with a 30-knot headwind in the tip tank and rocket pod configuration (Figure A4-2).

1. Enter profile at 650 nautical miles and 30,000 feet to obtain fuel required (no wind).....5000 lb.
2. Time (no wind).....1 hr. 47 min. (1.78 hr.)
3. Average TAS [distance ÷ time (no wind) = 650 n. mi. ÷ 1.78 hr.].....365 kts.
4. Average G.S. [average TAS − headwind = 365 kts. − 30 kts.].....335 kts.
5. Air distance with wind [(average TAS ÷ average G.S.) × actual distance = (365 ÷ 335) × 650].....708 n. mi.
6. Re-enter profile at cruise altitude at the air distance with wind to obtain fuel required with wind .....5350 lb.
7. Determine cruise speed from table.....226 kts., CAS
8. Determine approximate initial cruise power setting from table.....91.5% (approx.)

**SAMPLE PROBLEM NO. 2.**

Determine the maximum distance attainable for the tip tank configuration, with 5000 pounds of fuel, and a 50-knot headwind. Allow a fuel reserve of 500 pounds for descent and landing.

1. Fuel available for climb and cruise climb (fuel loading—reserve = 5000 lb. − 500 lb.).....4500 lb.
2. Enter profile at 4500 pounds of fuel and obtain maximum distance at cruise climb (no wind) .....625 n. mi.
3. Time (no wind).....1 hr. 38 min. (1.63 hr.)
4. Average TAS [distance ÷ time (no wind) = 625 n. mi. ÷ 1.63 hr.].....384 kts.
5. Average G.S. [average TAS − headwind = 384 kts. − 50 kts.].....334 kts.
6. Maximum distance attainable (with wind) [no wind distance × G.S./TAS = 625 × 334/384] = .....544 n. mi.
7. Determine cruise-climb speed from chart .....approx. Mach 0.69
8. Determine cruise-climb power setting from chart .....95% RPM

## INTERCEPT PROFILE CHART.

This type of profile chart shows the time and fuel required to fly a given air distance using maximum power climb to altitude and 95% RPM or normal power cruise at a constant altitude. The chart should be used for flights which require a minimum time to fly a given distance. The Intercept Profile is similar to the Mission Profile and is used in the same manner. The values of CAS and true airspeed shown in the chart are based on an average gross weight at each altitude.

## OPTIMUM RETURN PROFILE CHART.

The Optimum Return Profile Chart shows the maximum range which can be obtained with any amount of fuel remaining at a given altitude by making a military power climb to cruise-climb altitude and then cruise-climbing until all fuel is expended. The chart does not show level flight cruise range except for the case where the fuel remaining is so small that there is no advantage in climbing to cruise-climb altitude. This type of profile is useful for planning the return from a mission and for maximum radius flights.

**CRUISE-CLIMB TECHNIQUE.**

The cruise-climb technique involved in the Optimum Return Chart is exactly the same as that described for the Mission Profile Chart. The climb to cruise-climb altitude, if required, is made at military power, 100% RPM, using the climb speed schedule shown. The climb path guide lines (solid lines) indicate the distance traveled and, in conjunction with the fuel remaining lines (dashed lines), the fuel used in climb. No fuel allowance has been made for loiter, descent, or landing. Wind and outside air temperature effects, as discussed on the Mission Profile Chart, also apply to the Optimum Return Profile.

## OPTIMUM RETURN LEVEL FLIGHT RANGE.

There is no advantage in climbing to cruise-climb altitude with small amounts of fuel on board because an equal, or greater range can be obtained at lower altitudes. This is shown by the two shaded areas on the profiles. In one area, you climb to the altitude given by the line of best range for constant altitude flight and cruise in level flight at this altitude at the recommended CAS shown. In the other area, you maintain present altitude and cruise out in level flight at the recommended CAS. In situations where large amounts of fuel are on board and a level flight cruise return is desired instead of the cruise-climb technique, the return performance may be determined by using the Mission Profile chart on an incremental basis.

## USE OF CHART.

By entering the proper Optimum Return Profile Chart at the fuel remaining and actual altitude of the airplane, you can obtain the maximum possible range. The area on the chart in which the initial conditions fall determines the cruising procedure to use, as stated in the note for each area. To allow for a fuel reserve, find the range

available at the intersection of the desired reserve fuel line and the cruise altitude line and subtract this value from the maximum range for all the available fuel to determine the distance available. To obtain the fuel required to fly a given distance, subtract the distance from the maximum range for all the available fuel, and enter the chart at the distance and cruise altitude. Read the fuel remaining directly and subtract from total available fuel to obtain the fuel required. Time of flight is the sum of time to climb (if climb is necessary) plus the time at cruise altitude. The effect of wind must be applied to obtain the true fuel and time required to fly a given ground distance. Since the wind may be from any direction with respect to the airplane course, a close approximation can be obtained by considering the head or tail wind component for the time required to complete the mission (neglect the variation of wind with altitude since comparatively little time is spent in climb). A sample problem is provided to show the use of the optimum return charts.

**SAMPLE PROBLEM.**

Determine the fuel and time required to fly to a base 400 nautical miles away in a 40-knot headwind. The airplane is equipped with tip tanks and rocket pods and is at 15,000 feet with 4500 pounds of fuel on board (Figure A4-8).

1. Initial gross weight = 19,800 lb. − 4500 lb. .....15,300 lb.
2. Enter profile at 15,000 feet and 4500 pounds of fuel on board to establish initial point. In this area a military power climb followed by cruise-climb is required. Read directly the maximum range attainable by expending all fuel (zero wind) .....808 n. mi.
3. Follow the climb path guide lines to line of best range for cruise-climb flight and read altitude at which to initiate cruise-climb procedure .....37,000 ft.

   Also read the time in cruise-climb to expend all fuel (zero wind) .....1 hr. 50 min.
4. Time to climb from 15,000 feet to 37,000 feet .....9.5 min.
5. Total time to climb and cruise-climb until all fuel is expended (zero wind) (1 hr. 50 min. + 9.5 min.) .....1 hr. 59.5 min.
6. Enter profile at 408 nautical miles (808 n. mi. − 400 n. mi.) and intersect climb flight path. Read time in cruise-climb (zero wind) .....1 hr. 02 min.
7. Time required to fly 400 nautical miles in zero wind.....(1 hr. 59.5 min. − 1 hr. 02 min.) or 57.5 min. (.95 hr.)
8. Average TAS [distance ÷ time (no wind) = 400 n. mi. ÷ .95 hr.].....421 kts.
9. Average G.S. [average TAS − headwind = 421 kts. − 40 kts.].....381 kts.
10. Total time with wind [distance ÷ average G.S. = 400 ÷ 381).....1.05 hrs. (1 hr. 03 min.)
11. Cruise-climb time with wind [total time (with wind) − climb time = 1:03 − :09.5] .....53.5 min.
12. Subtract cruise-climb time with wind from from time in cruise-climb to expend all fuel in zero wind (1.50 − :53.5).....56.5 min.
13. Locate 56.5 min. on line of best range for cruise-climb flight and read fuel remaining .....1700 lb.
14. Fuel required to fly to base with wind (4500 lb. − 1700 lb.).....2800 lb.

# MISSION PROFILE
## CLEAN

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

TAKE-OFF GROSS WEIGHT 16,025 POUNDS

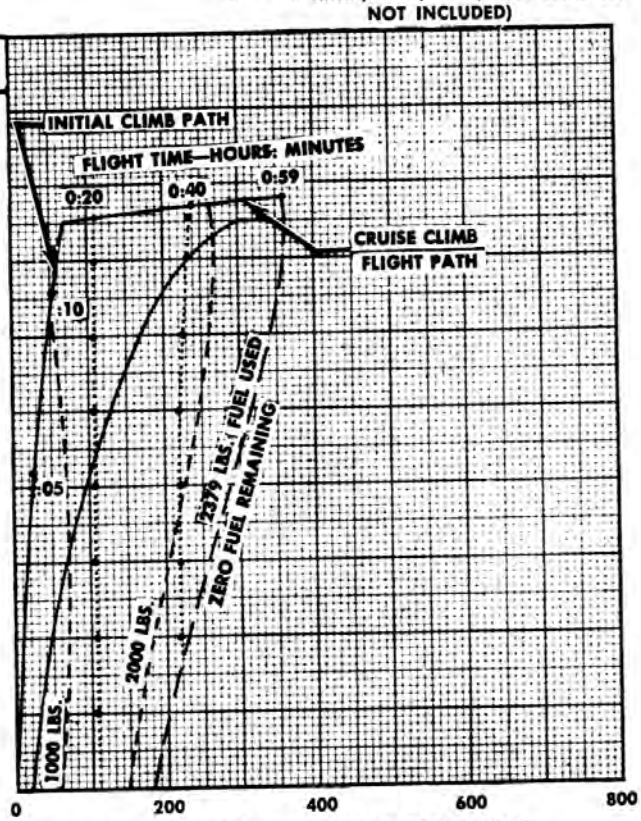
ICAO STANDARD DAY

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.

**LEGEND:**
- OPTIMUM LEVEL FLIGHT CRUISE ALTITUDE
- ZERO FUEL REMAINING
- FUEL CONSUMED—POUNDS
- TIME (START, TAXI, AND TAKE-OFF NOT INCLUDED)

MILITARY POWER CLIMB

| C.A.S. KNOTS | ALTITUDE 1000 FT. |
|---|---|
| 170 | 45 |
| 190 | 40 |
| 205 | 35 |
| 225 | 30 |
| 240 | 25 |
| 255 | 20 |
| 270 | 15 |
| 285 | 10 |
| 300 | 5 |
| 315 | S.L. |




**NOTES:**
1. FUEL ALLOWANCE FOR GROUND MANEUVER, AFTERBURNING TAKE-OFF AND MILITARY POWER ACCELERATION TO CLIMB SPEED—300 LBS. IS INCLUDED.
2. NO ALLOWANCE OR RESERVE MADE FOR LOITER, DESCENT, OR LANDING.
3. USE MILITARY POWER FOR CLIMB.
4. ADJUST RPM TO CRUISE AT RECOMMENDED C.A.S. FOR LEVEL FLIGHT OPERATION.
5. TO CRUISE CLIMB: SET 89%RPM. ADJUST ALTITUDE TO MAINTAIN FOLLOWING SPEED — FUEL LOADING SCHEDULE.

| LEVEL FLIGHT CRUISE | | | | |
|---|---|---|---|---|
| ALTITUDE FEET | CAS | TAS | INITIAL APPROXIMATE | |
| | | | LB./HR. | %RPM |
| 35000 | 212 | 367 | 1565 | 86 |
| 30000 | 225 | 356 | 1735 | 84 |
| 25000 | 238 | 347 | 1945 | 83 |
| 20000 | 251 | 337 | 2200 | 81 |
| 15000 | 265 | 329 | 2505 | 80 |
| 10000 | 283 | 326 | 2870 | 79 |
| 5000 | 304 | 326 | 3325 | 78 |
| S.L. | 329 | 329 | 3930 | 78 |

| FUEL LOADING—LBS. | CAS KNOTS |
|---|---|
| 1200 | 207 |
| 900 | 205 |
| 600 | 204 |
| 300 | 202 |
| 0 | 200 |

CAS = CALIBRATED AIRSPEED—KNOTS
TAS = TRUE AIRSPEED—KNOTS
LB./HR. = FUEL FLOW—POUNDS PER HOUR

*Figure A4-1. Mission Profile—Clean*

# MISSION PROFILE

## TIP TANKS AND ROCKET PODS

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

TAKE-OFF GROSS WEIGHT 20,650 POUNDS
ICAO STANDARD DAY

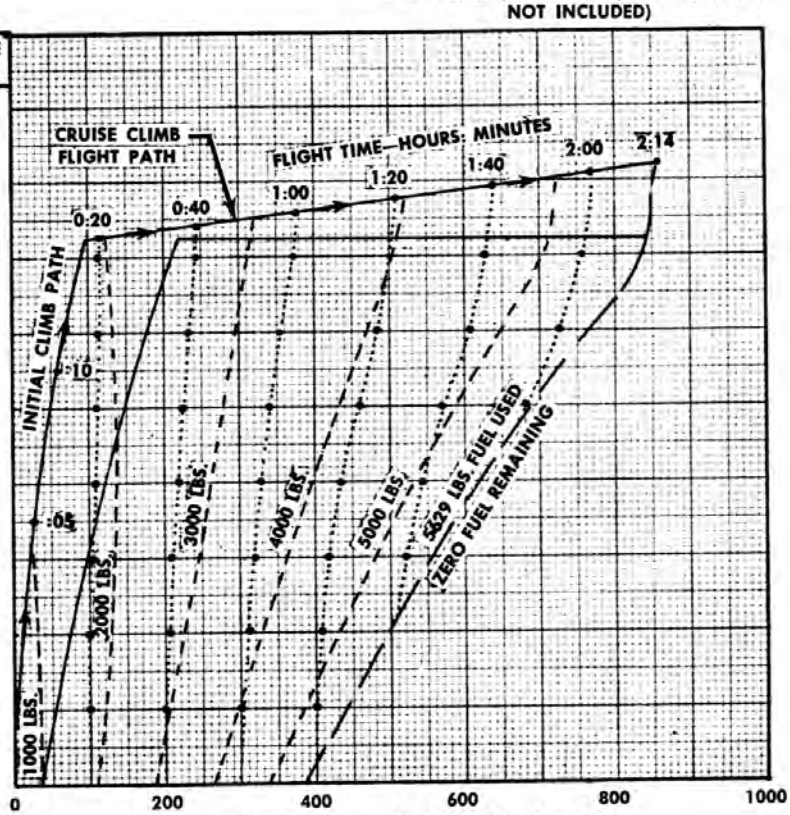
ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.

DATA SHOWN ARE APPLICABLE TO TIP TANK CONFIGURATION

**LEGEND:**
——— OPTIMUM LEVEL FLIGHT CRUISE ALTITUDE
— — ZERO FUEL REMAINING
– – – – FUEL CONSUMED—POUNDS
·····• TIME (START, TAXI, AND TAKE-OFF NOT INCLUDED)

MILITARY POWER CLIMB

| C.A.S. KNOTS | ALTITUDE 1000 FT. |
|---|---|
| 170 | 45 |
| 190 | 40 |
| 205 | 35 |
| 225 | 30 |
| 240 | 25 |
| 255 | 20 |
| 270 | 15 |
| 285 | 10 |
| 300 | 5 |
| 315 | S.L. |




**NOTES:**

1. FUEL ALLOWANCE FOR GROUND MANEUVER, AFTERBURNING TAKE-OFF AND MILITARY POWER ACCELERATION TO CLIMB SPEED—500 LBS. IS INCLUDED.
2. NO ALLOWANCE OR RESERVE MADE FOR LOITER, DESCENT, OR LANDING.
3. USE MILITARY POWER FOR CLIMB.
4. ADJUST RPM TO CRUISE AT RECOMMENDED C.A.S. FOR LEVEL FLIGHT OPERATION.
5. CRUISE DATA BASED ON CARRYING EXTERNAL STORES FOR ENTIRE FLIGHT.
6. TO CRUISE CLIMB: SET 95% RPM. ADJUST ALTITUDE TO MAINTAIN FOLLOWING SPEED — FUEL LOADING SCHEDULE.

| LEVEL FLIGHT CRUISE | | | | |
|---|---|---|---|---|
| ALTITUDE FEET | CAS | TAS | INITIAL APPROXIMATE | |
| | | | LB./HR. | %RPM |
| 35000 | 222 | 382 | 2150 | 94.0 |
| 30000 | 226 | 358 | 2390 | 91.5 |
| 25000 | 232 | 339 | 2500 | 89.0 |
| 20000 | 241 | 324 | 2525 | 87.0 |
| 15000 | 253 | 314 | 2590 | 86.0 |
| 10000 | 267 | 308 | 2900 | 84.5 |
| 5000 | 283 | 304 | 3640 | 82.5 |
| S. L. | 300 | 300 | 4050 | 81.0 |

| FUEL LOADING—LBS. | CAS KNOTS |
|---|---|
| 3800 | 224 |
| 3600 | 224 |
| 2600 | 218 |
| 1600 | 212 |
| 600 | 203 |
| 0 | 202 |

CAS = CALIBRATED AIRSPEED—KNOTS
TAS = TRUE AIRSPEED—KNOTS
LB./HR. = FUEL FLOW—POUNDS PER HOUR

*Figure A4-2. Mission Profile—Tip Tanks—Tip Tanks and Rocket Pods*

# MISSION PROFILE

## TIP TANKS, PYLON TANKS AND ROCKET PODS

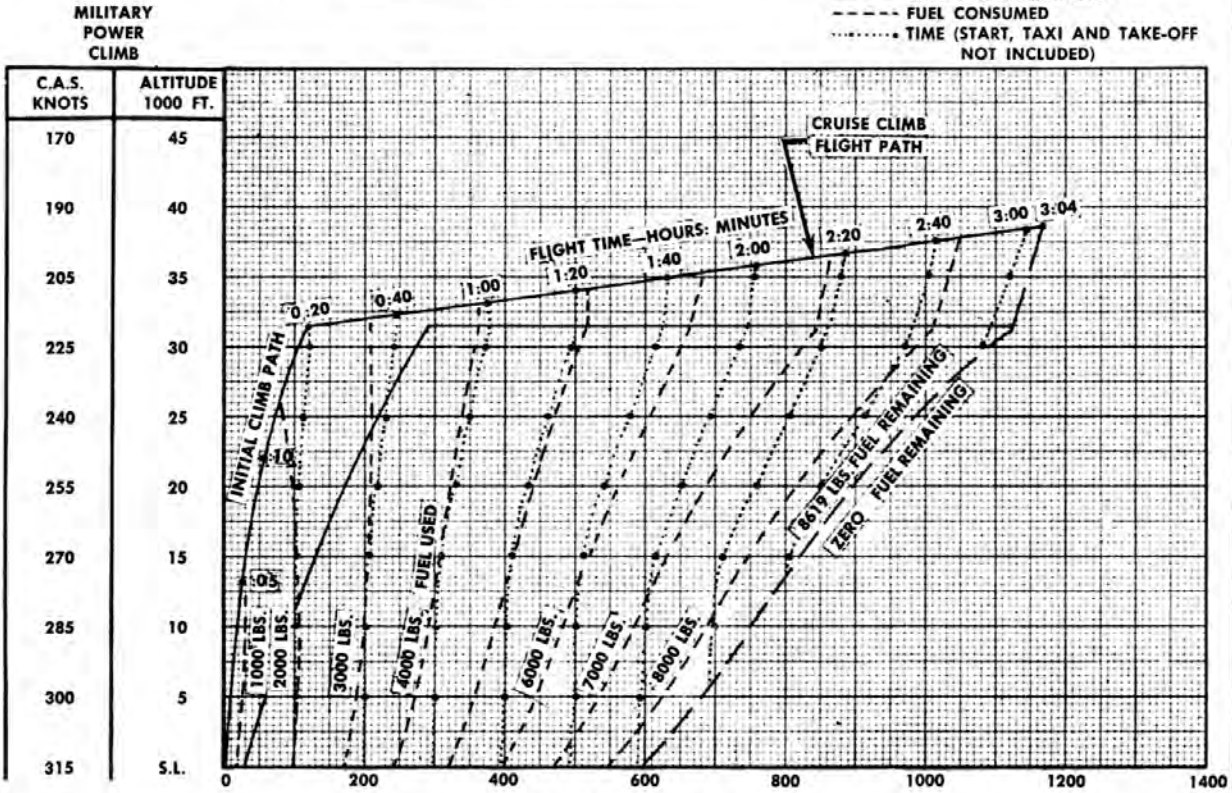
TAKE-OFF GROSS WEIGHT 24,000 POUNDS
ICAO STANDARD DAY

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.

DATA SHOWN ARE APPLICABLE TO TIP TANK AND PYLON TANK CONFIGURATION

**LEGEND:**
- ——— OPTIMUM LEVEL FLIGHT CRUISE ALTITUDE
- — — ZERO FUEL REMAINING
- - - - - FUEL CONSUMED
- ·····• TIME (START, TAXI AND TAKE-OFF NOT INCLUDED)




**NOTES:**
1. FUEL ALLOWANCE FOR GROUND MANEUVER, AFTERBURNING TAKE-OFF AND MILITARY POWER ACCELERATION TO CLIMB SPEED—600 LBS. IS INCLUDED.
2. NO ALLOWANCE OR RESERVE MADE FOR LOITER, DESCENT, OR LANDING.
3. USE MILITARY POWER FOR CLIMB.
4. ADJUST RPM TO CRUISE AT RECOMMENDED C.A.S. FOR LEVEL FLIGHT OPERATION.
5. CRUISE DATA BASED ON CARRYING EXTERNAL STORES FOR ENTIRE FLIGHT.
6. TO CRUISE CLIMB: SET 95% RPM. ADJUST ALTITUDE TO MAINTAIN FOLLOWING SPEED— FUEL LOADING SCHEDULE.

| FUEL LOADING—LBS. | CAS KNOTS | FUEL LOADING—LBS. | CAS KNOTS |
|---|---|---|---|
| 6300 | 246 | 2600 | 225 |
| 5600 | 243 | 1600 | 220 |
| 4600 | 236 | 600 | 212 |
| 3600 | 232 | 0 | 209 |

| LEVEL FLIGHT CRUISE | | | | |
|---|---|---|---|---|
| ALTITUDE FEET | CAS | TAS | INITIAL APPROXIMATE | |
| | | | LB./HR. | %RPM |
| | | | | |
| | | | | |
| 30000 | 228 | 360 | 2750 | 94 |
| 25000 | 233 | 340 | 2950 | 92 |
| 20000 | 238 | 320 | 3110 | 90 |
| 15000 | 245 | 305 | 3280 | 88 |
| 10000 | 256 | 295 | 3505 | 86 |
| 5000 | 272 | 290 | 3825 | 83 |
| S. L. | 294 | 294 | 4190 | 82 |

CAS = CALIBRATED AIRSPEED—KNOTS
TAS = TRUE AIRSPEED—KNOTS
LB./HR. = FUEL FLOW—POUNDS PER HOUR

*Figure A4-3. Mission Profile—Tip Tanks and Pylon Tanks, Tip Tanks, Pylon Tanks and Rocket Pods*

# INTERCEPT PROFILE

## CLEAN

TAKE-OFF GROSS WEIGHT 16,025 LBS

ICAO STANDARD DAY

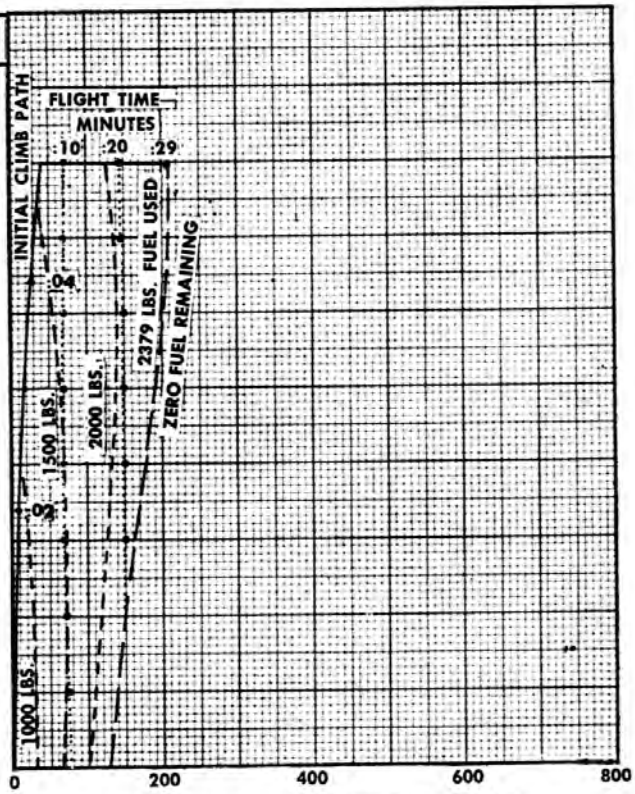
MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.

LEGEND
— — ZERO FUEL REMAINING
- - - - FUEL CONSUMED—POUNDS
·····• TIME (START, TAXI, AND TAKE-OFF NOT INCLUDED)

MAXIMUM POWER CLIMB

| C.A.S. KNOTS | ALTITUDE 1000 FT. |
|---|---|
| 170 | 45 |
| 190 | 40 |
| 205 | 35 |
| 225 | 30 |
| 240 | 25 |
| 255 | 20 |
| 270 | 15 |
| 285 | 10 |
| 300 | 5 |
| 315 | S.L. |




DISTANCE — NAUTICAL MILES

**NOTES:**

1. FUEL ALLOWANCE FOR START, TAXI, AND TAKE-OFF 500 LBS. IS INCLUDED.
2. NO ALLOWANCE OR RESERVE MADE FOR LOITER, DESCENT, OR LANDING.
3. USE MAXIMUM POWER FOR CLIMB.
4. CRUISE AT NORMAL POWER—95%.

CAS = CALIBRATED AIRSPEED—KNOTS
TAS = TRUE AIRSPEED—KNOTS
LB./HR. = FUEL FLOW -POUNDS PER HOUR

| LEVEL FLIGHT CRUISE | | | | |
|---|---|---|---|---|
| ALTITUDE FEET | CAS | TAS | INITIAL APPROXIMATE | |
| | | | LB./HR. | %RPM |
| 40000 | 226 | 433 | 1950 | 95 |
| 35000 | 266 | 452 | 2360 | 95 |
| 30000 | 296 | 459 | 2840 | 95 |
| 25000 | 326 | 466 | 3360 | 95 |
| 20000 | 355 | 470 | 3950 | 95 |
| 15000 | 384 | 471 | 4570 | 95 |
| 10000 | 412 | 470 | 5250 | 95 |
| 5000 | 439 | 469 | 6000 | 95 |
| S. L. | 467 | 467 | 6830 | 95 |

*Figure A4-4. Intercept Profile—Clean*

# INTERCEPT PROFILE

## TIP TANKS AND ROCKET PODS

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

TAKE-OFF GROSS WEIGHT 20,650 POUNDS
ICAO STANDARD DAY

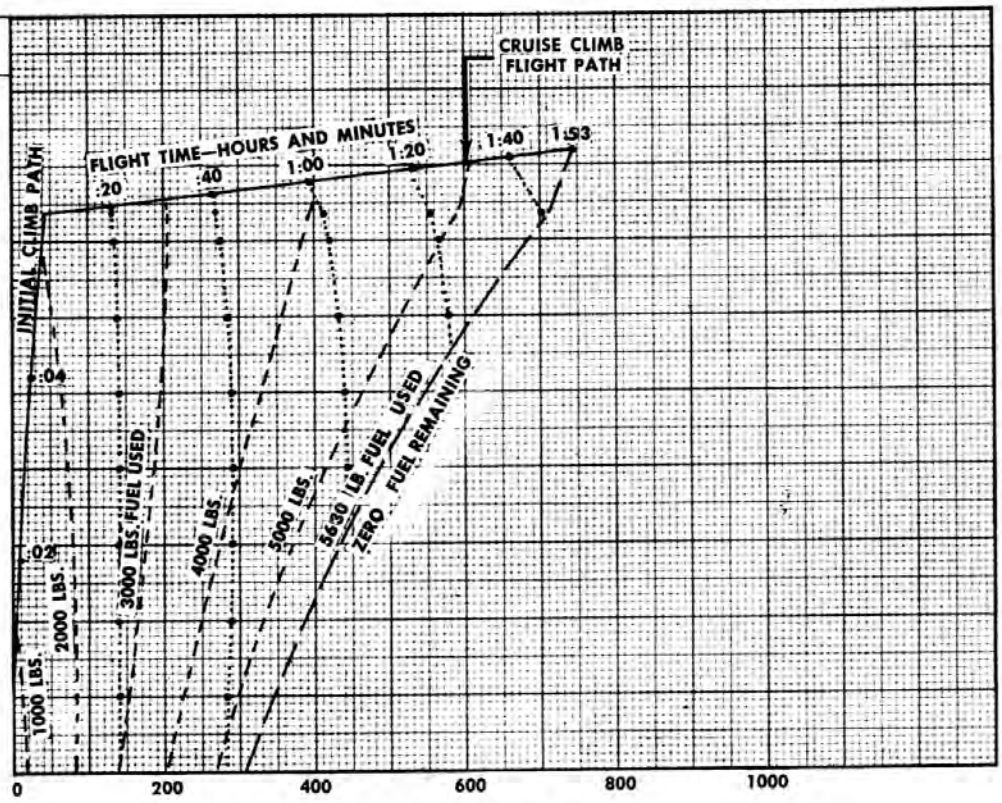
ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.

DATA SHOWN ARE APPLICABLE TO TIP TANK CONFIGURATION

LEGEND
— — ZERO FUEL REMAINING
– – – – FUEL CONSUMED—POUNDS
·-·-·-·-· TIME (START, TAXI, AND TAKE-OFF NOT INCLUDED)

MAXIMUM POWER CLIMB

| CAS KNOTS | ALTITUDE 1000 FT. |
|---|---|
| 170 | 45 |
| 190 | 40 |
| 205 | 35 |
| 225 | 30 |
| 240 | 25 |
| 255 | 20 |
| 270 | 15 |
| 285 | 10 |
| 300 | 5 |
| 315 | S.L. |




**NOTES:**

1. FUEL ALLOWANCE FOR START, TAXI, AND TAKE-OFF-700 LBS. IS INCLUDED.
2. NO ALLOWANCE OR RESERVE MADE FOR LOITER, DESCENT, OR LANDING.
3. USE MAXIMUM POWER FOR CLIMB.
4. CRUISE AT NORMAL POWER—95% RPM.
5. TO CRUISE CLIMB: SET 95% RPM. ADJUST ALTITUDE TO MAINTAIN THE FOLLOWING SPEED—FUEL LOADING SCHEDULE.

| FUEL LOADING-LBS. | CAS KNOTS |
|---|---|
| 3500 | 221 |
| 2600 | 217 |
| 1600 | 211 |
| 600 | 204 |
| 0 | 202 |

| LEVEL FLIGHT CRUISE | | | | |
|---|---|---|---|---|
| ALTITUDE FEET | CAS | TAS | INITIAL APPROXIMATE | |
| | | | LB./HR. | %RPM |
| 35000 | 252 | 430 | 2360 | 95 |
| 30000 | 282 | 440 | 2840 | 95 |
| 25000 | 307 | 441 | 3360 | 95 |
| 20000 | 333 | 442 | 3950 | 95 |
| 15000 | 357 | 439 | 4570 | 95 |
| 10000 | 383 | 438 | 5250 | 95 |
| 5000 | 402 | 430 | 6000 | 95 |
| S. L. | 427 | 427 | 6830 | 95 |

CAS = CALIBRATED AIRSPEED—KNOTS
LB./HR. = FUEL FLOW—POUNDS PER HOUR
TAS = TRUE AIRSPEED

*Figure A4-5. Intercept Profile—Tip Tanks—Tip Tanks and Rocket Pods*

# INTERCEPT PROFILE

## TIP TANKS, PYLON TANKS AND ROCKET PODS

TAKE-OFF GROSS WEIGHT 24,000 POUNDS

ICAO STANDARD DAY

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

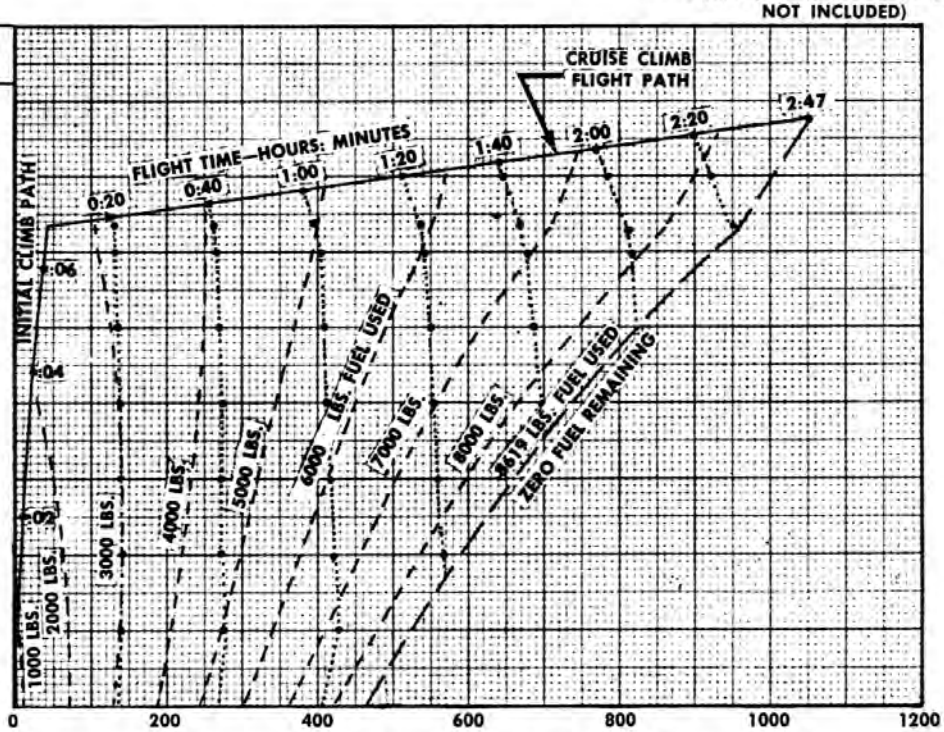
ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.

DATA SHOWN ARE APPLICABLE TO TIP TANK AND PYLON TANK CONFIGURATION

LEGEND
— — ZERO FUEL REMAINING
- - - - FUEL CONSUMED
·•·····• TIME (START, TAXI AND TAKE-OFF NOT INCLUDED)

MAXIMUM POWER CLIMB

| CAS KNOTS | ALTITUDE 1000 FT. |
|---|---|
| 190 | 40 |
| 205 | 35 |
| 225 | 30 |
| 240 | 25 |
| 255 | 20 |
| 270 | 15 |
| 285 | 10 |
| 300 | 5 |
| 315 | S.L. |




DISTANCE—NAUTICAL MILES

**NOTES:**

1. FUEL ALLOWANCE FOR START, TAXI, AND TAKE-OFF 800 LBS. IS INCLUDED.
2. NO ALLOWANCE OR RESERVE MADE FOR LOITER, DESCENT, OR LANDING.
3. USE MAXIMUM POWER FOR CLIMB.
4. CRUISE AT NORMAL POWER—95% RPM
5. TO CRUISE CLIMB : SET 95%RPM , ADJUST ALTITUDE TO MAINTAIN FOLLOWING SPEED — FUEL LOADING SCHEDULE.

| FUEL LOADING-LBS. | CAS KNOTS |
|---|---|
| 6000 | 244 |
| 5600 | 242 |
| 4600 | 231 |
| 3600 | 231 |
| 2600 | 225 |
| 1600 | 218 |
| 600 | 212 |
| 0 | 208 |

| LEVEL FLIGHT CRUISE | | | | |
|---|---|---|---|---|
| ALTITUDE FEET | CAS | TAS | INITIAL APPROXIMATE | |
| | | | LB./HR. | %RPM |
| | | | | |
| | | | | |
| 30000 | 260 | 408 | 2840 | 95 |
| 25000 | 286 | 413 | 3360 | 95 |
| 20000 | 311 | 414 | 3950 | 95 |
| 15000 | 337 | 415 | 4570 | 95 |
| 10000 | 357 | 406 | 5250 | 95 |
| 5000 | 382 | 408 | 6000 | 95 |
| S. L. | 403 | 403 | 6830 | 95 |

CAS = CALIBRATED AIRSPEED—KNOTS
TAS = TRUE AIRSPEED—KNOTS
LB./HR. = FUEL FLOW—POUNDS PER HOUR

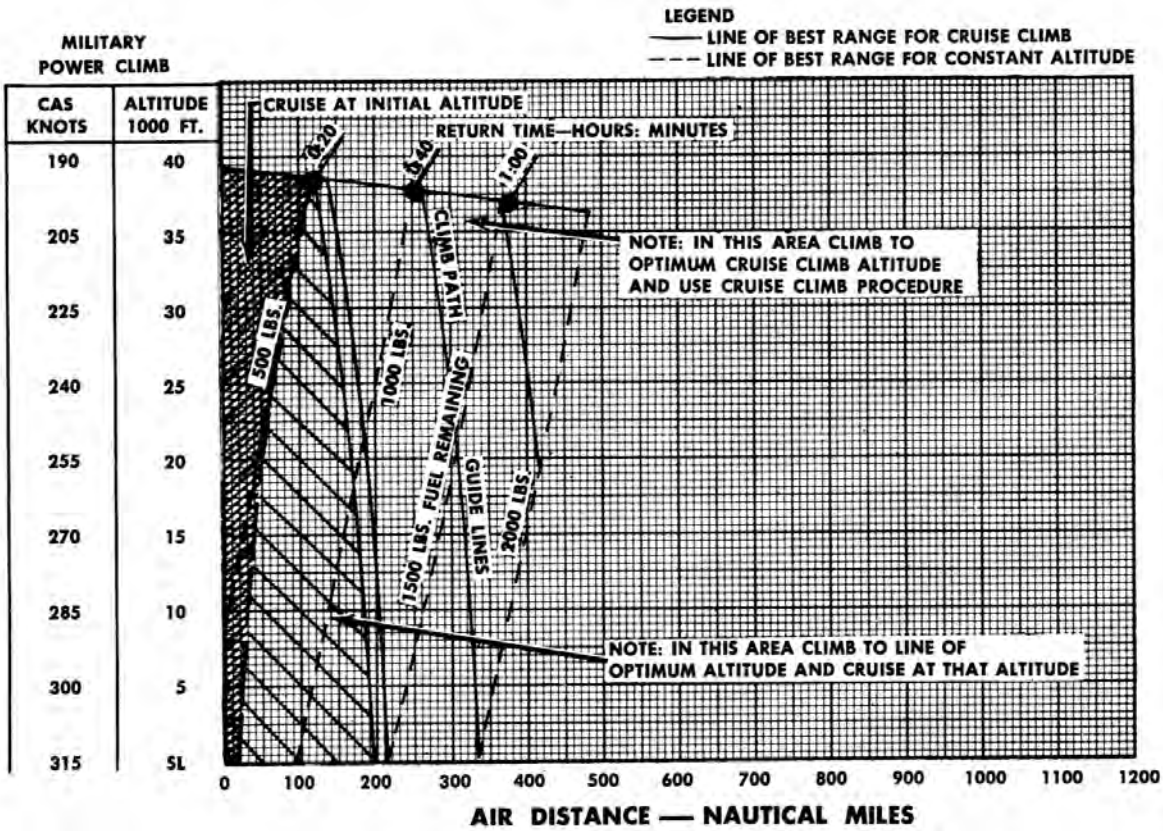
*Figure A4-6. Intercept Profile—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods*

# OPTIMUM RETURN PROFILE
## CLEAN

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

GROSS WEIGHT 13,646 LBS. TO 16,025 LBS.
ICAO STANDARD DAY

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.




**NOTES:**

1. FUEL REQUIRED AT ANY POINT INCLUDES MILITARY POWER CLIMB TO CRUISE CLIMB ALTITUDE (IF CLIMB IS NECESSARY).
2. NO ALLOWANCE MADE FOR LOITER, DESCENT OR LANDING.
3. BEST CRUISE CONDITION IS DETERMINED BY INTERSECTION OF THE CLIMB PATH GUIDE LINE AND THE LINES OF BEST RANGE.
4. ADJUST RPM TO CRUISE AT RECOMMENDED C.A.S. FOR LEVEL FLIGHT OPERATION.
5. TO CRUISE CLIMB SET 89%RPM. ADJUST ALTITUDE TO MAINTAIN FOLLOWING SPEED-FUEL LOADING SCHEDULE.

| FUEL LOADING POUNDS | CAS KNOTS |
|---|---|
| 2000 | 214 |
| 1500 | 211 |
| 1000 | 207 |
| 500 | 203 |
| 0 | 200 |

| ALTITUDE FEET | LEVEL FLIGHT CRUISE | | | |
|---|---|---|---|---|
| | CAS | TAS | INITIAL APPROXIMATE | |
| | | | LB/HR | % RPM |
| 35,000 | 209 | 362 | 1470 | 86 |
| 30,000 | 221 | 351 | 1660 | 84 |
| 25,000 | 234 | 342 | 1860 | 83 |
| 20,000 | 248 | 333 | 2130 | 82 |
| 15,000 | 262 | 326 | 2405 | 80 |
| 10,000 | 281 | 323 | 2855 | 80 |
| 5,000 | 303 | 322 | 3250 | 79 |
| S.L. | 326 | 326 | 3835 | 78 |

CAS = CALIBRATED AIRSPEED—KNOTS
LB./HR. = FUEL FLOW—POUNDS PER HOUR
TAS = TRUE AIRSPEED

*Figure A4-7. Optimum Return Profile—Clean*

# OPTIMUM RETURN PROFILE
## TIP TANKS AND ROCKET PODS

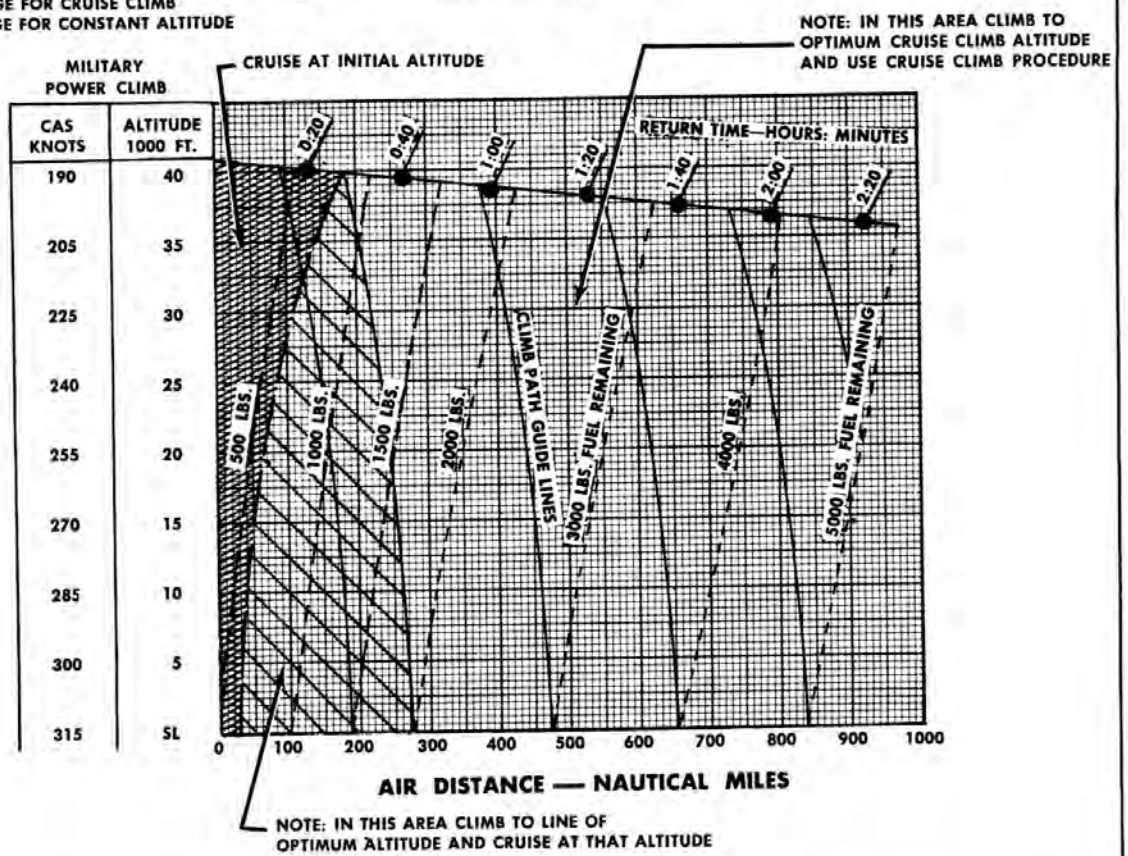
MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

GROSS WEIGHT: 15,023 TO 20,652 LB.
ICAO STANDARD DAY

DATA SHOWN ARE APPLICABLE TO TIP TANK CONFIGURATION

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.

LEGEND
—— LINE OF BEST RANGE FOR CRUISE CLIMB
— — LINE OF BEST RANGE FOR CONSTANT ALTITUDE




**NOTES:**

1. FUEL REQUIRED AT ANY POINT INCLUDES MILITARY POWER CLIMB TO CRUISE CLIMB ALTITUDE (IF CLIMB IS NECESSARY).
2. NO ALLOWANCE MADE FOR LOITER, DESCENT OR LANDING.
3. BEST CRUISE CONDITION IS DETERMINED BY INTERSECTION OF THE CLIMB PATH GUIDE LINE AND THE LINES OF BEST RANGE.
4. ADJUST RPM TO CRUISE AT RECOMMENDED C.A.S. FOR LEVEL FLIGHT OPERATION.
5. TO CRUISE CLIMB SET 95%RPM. ADJUST ALTITUDE TO MAINTAIN FOLLOWING SPEED-FUEL LOADING SCHEDULE.

| FUEL LOADING POUNDS | CAS KNOTS | FUEL LOADING POUNDS | CAS KNOTS |
|---|---|---|---|
| 3500 | 221 | 1500 | 210 |
| 3000 | 218 | 1000 | 208 |
| 2500 | 215 | 500 | 204 |
| 2000 | 213 | 0 | 202 |

| ALTITUDE FEET | LEVEL FLIGHT CRUISE | | | |
|---|---|---|---|---|
| | CAS | TAS | INITIAL APPROXIMATE | |
| | | | LB./HR. | % RPM |
| 40,000 | 216 | 415 | 1980 | 96 |
| 35,000 | 217 | 376 | 1800 | 90 |
| 30,000 | 221 | 351 | 1905 | 87 |
| 25,000 | 225 | 329 | 2075 | 85 |
| 20,000 | 236 | 318 | 2300 | 84 |
| 15,000 | 244 | 304 | 2560 | 82 |
| 10,000 | 260 | 300 | 2910 | 81 |
| 5,000 | 279 | 299 | 3325 | 80 |
| S.L. | 299 | 299 | 3920 | 79 |

CAS = CALIBRATED AIRSPEED—KNOTS
LB./HR. = FUEL FLOW—POUNDS PER HOUR
TAS = TRUE AIRSPEED

*Figure A4-8. Optimum Return Profile—Tip Tanks—Tip Tanks and Rocket Pods*

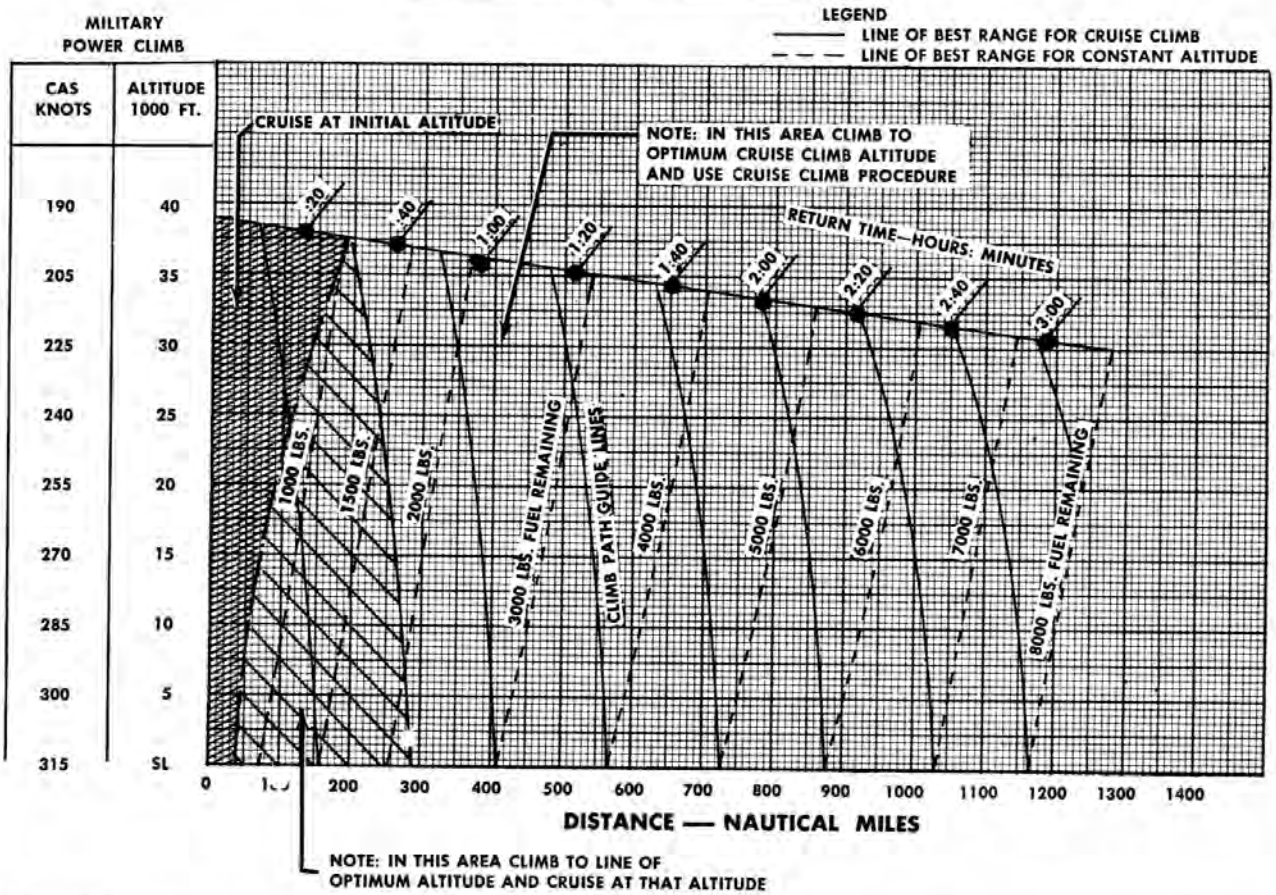
# OPTIMUM RETURN PROFILE
## TIP TANKS, PYLON TANKS AND ROCKET PODS

MODEL: F-94C
DATE. 1 DEC 1956
DATA BASIS: FLIGHT TEST

GROSS WEIGHT 15,393 LBS. TO 24,012 LBS.
ICAO STANDARD DAY

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.

DATA SHOWN ARE APPLICABLE TO TIP TANK AND PYLON TANK CONFIGURATION




**NOTES:**

1. FUEL REQUIRED AT ANY POINT INCLUDES MILITARY POWER CLIMB TO CRUISE CLIMB ALTITUDE (IF CLIMB IS NECESSARY).
2. NO ALLOWANCE MADE FOR LOITER, DESCENT OR LANDING.
3. BEST CRUISE CONDITION IS DETERMINED BY INTERSECTION OF THE CLIMB PATH GUIDE LINE AND THE LINES OF BEST RANGE.
4. ADJUST RPM TO CRUISE AT RECOMMENDED C.A.S. FOR LEVEL FLIGHT OPERATION.
5. TO CRUISE CLIMB SET 95%RPM. ADJUST ALTITUDE TO MAINTAIN FOLLOWING SPEED-FUEL LOADING SCHEDULE.

| ALTITUDE FEET | LEVEL FLIGHT CRUISE | | | |
|---|---|---|---|---|
| | CAS | TAS | INITIAL APPROXIMATE | |
| | | | LB/HR | % RPM |
| 40,000 | | | | |
| 35,000 | 218 | 376 | 2030 | 92 |
| 30,000 | 220 | 349 | 2130 | 89 |
| 25,000 | 223 | 325 | 2230 | 87 |
| 20,000 | 227 | 306 | 2365 | 84 |
| 15,000 | 235 | 293 | 2535 | 82 |
| 10,000 | 248 | 286 | 2790 | 79 |
| 5,000 | 267 | 287 | 3208 | 78 |
| S.L. | 294 | 294 | 3800 | 77 |

| FUEL LOADING POUNDS | CAS KNOTS | FUEL LOADING POUNDS | CAS KNOTS |
|---|---|---|---|
| 7000 | 260 | 3000 | 228 |
| 6000 | 244 | 2000 | 219 |
| 5000 | 238 | 1000 | 213 |
| 4000 | 234 | 0 | 207 |

CAS = CALIBRATED AIRSPEED—KNOTS
LB./HR. = FUEL FLOW-POUNDS PER HOUR
TAS = TRUE AIRSPEED

*Figure A4-9. Optimum Return Profile—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods*

# Part 5—Endurance

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| Maximum Endurance Profile—Clean Configuration | **A5-3** |
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## ENDURANCE

### MAXIMUM ENDURANCE CHARTS.

Maximum endurance is obtained at a given altitude by flying at the condition which will give the lowest rate of fuel consumption in conjunction with speed stability at that altitude. This condition will be obtained by flying at the airspeeds recommended on the maximum endurance charts except at low altitudes where the RPM required to maintain the endurance airspeeds will fall within the restricted engine operation region of 68-76% RPM. When this occurs, loiter at 76% RPM. Maximum endurance obtainable with any fuel loading when loitering at constant altitude is shown for all configurations. The approximate engine speed and fuel flow values shown in the tables are based on an average gross weight at each altitude.

### USE OF MAXIMUM ENDURANCE CHARTS.

#### LOITER TIME.

To find maximum loiter time for a given amount of fuel consumed: Enter the Maximum Endurance Chart for the proper airplane configuration at the fuel load and flight altitude at start of loiter. Note the initial time. Subtract fuel to be used in loiter from the fuel load at start of loiter to obtain the fuel remaining at the end of the endurance period. Enter the chart at this fuel remaining value and read the final time. The difference between the initial and final time is the time available to loiter at constant altitude for the given amount of fuel consumed.

#### LOITER FUEL.

To find fuel required to loiter a given time: Enter the appropriate Maximum Endurance Chart at the altitude and fuel load condition for the start of loiter. Read the initial time. Subtract the time to loiter from the initial time to obtain the time at the end of the endurance flight. Enter the chart with this time and read the final fuel remaining. The difference between the initial and final fuel load is the fuel required to loiter at constant altitude for the given time.

#### SAMPLE PROBLEM.

Determine the fuel required to loiter 40 minutes at 30,000 feet with tip tanks and rocket pods installed. The fuel on board at start of loiter is 4000 pounds. Use Figure A5-2.

1. Initial time at 4000 pounds and 30,000 ft. ..... 1 hr. 56 min.
2. Final time (1 hr. 56 min. − 0:40 min.) ..... 1 hr. 16 min.
3. Fuel on board at end of loiter ..... 2550 lb.
4. Fuel required to loiter (initial fuel load − final fuel load) (4000 lb. − 2550 lb.) ..... 1450 lb.
5. Loiter at recommended CAS or RPM as indicated on chart.

## OPTIMUM MAXIMUM ENDURANCE CHARTS.

The optimum maximum endurance profiles (presented for all configurations) show the maximum loiter time for any fuel remaining value based on loitering at optimum altitude. The area above the optimum loitering altitude line indicates the altitudes and fuel loadings where the airplane should remain at its present altitude for maximum endurance. The area under this line indicates the altitudes and fuel loadings at which a 95% RPM, normal power climb should be made to the optimum loitering altitude to increase the maximum endurance. Constant lines of fuel-on-board are indicated by dashed lines. The fuel lines are based on normal power climb to optimum altitude (if climb is necessary), loiter at altitude and maximum range descent to sea level. No allowance is made for a landing reserve. Climb path guide lines are shown in the area below the optimum loitering altitude line by solid lines. Approximate fuel consumption and rpm values (based on an average airplane gross weight) are included for each altitude.

### CLIMB TO OPTIMUM ALTITUDE.

It must be emphasized that for altitudes and fuel loadings where a climb is designated, it is necessary to climb to optimum altitude in order to obtain the endurance shown on the charts. Climbs should not be made above the optimum altitude as this will result in less endurance. The climb speed schedule is tabulated on the chart.

## USE OF OPTIMUM MAXIMUM ENDURANCE PROFILE CHART.

The chart is utilized by entering at the initial altitude with either the maximum airborne time desired (to determine the fuel requirement) or the fuel remaining (to determine the maximum airborne time available). If the initial point falls in the area above the optimum loitering altitude line, maintain present altitude and read directly the maximum total endurance which includes time for descent. If the initial point falls in the area below the optimum loitering altitude line, read the maximum total endurance directly. To obtain this endurance you will have to climb immediately at 95% RPM to optimum loitering altitude.

### SAMPLE PROBLEM.

Determine the maximum time available and the necessary flight path to remain airborne with 3000 pounds of fuel remaining at an initial altitude of 20,000 feet in the tip tank and rocket pod configuration, allowing for a 500 pound fuel reserve for landings. Use Figure A5-5.

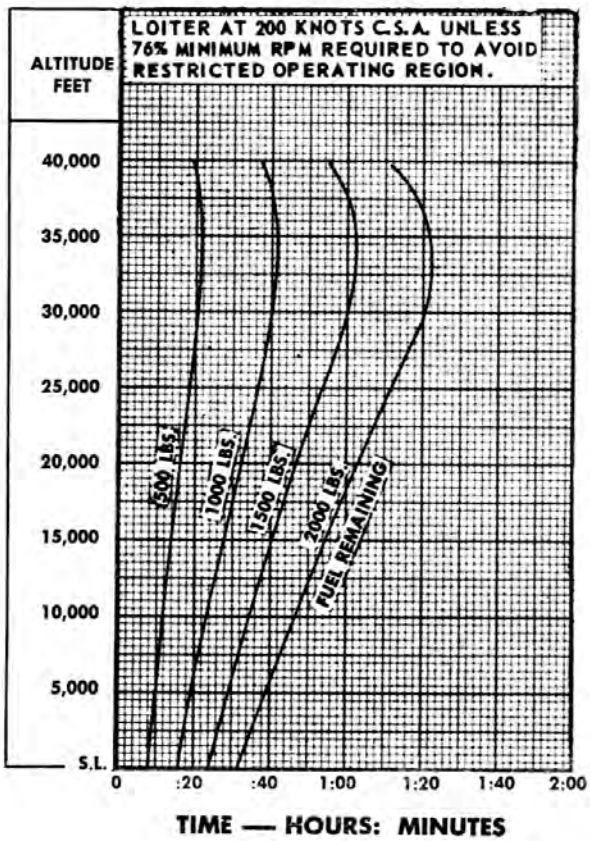
1. Enter profile at 20,000 feet and 3000 pounds of fuel remaining to establish initial point. Total time available if all fuel expended ..... 1 hr. 26 min.
2. A 95% RPM climb is required to optimum loitering altitude. Follow climb path guide lines to optimum loitering altitude and read altitude to loiter ..... 32,000 ft.
3. From the descent chart (figure A7-2) find fuel used in maximum rate descent from 32,000 feet ..... 10 lb.
4. Fuel required for descent and landing reserve (500 lb. + 10 lb.) ..... 510 lb.
5. Time at end of loiter (from profile at 510 pounds at 32,000 feet ..... 16 min.
6. Time for start of climb to start of descent (1 hr. 26 min. − 16 min.) ..... 1 hr. 10 min.
7. Time to descend from 32,000 feet to sea level (Maximum rate data only) ..... 0.7 min.
8. Maximum time available to remain airborne (1 hr. 10 min. + 0.7 min.) ..... 1 hr. 11 min.

# MAXIMUM ENDURANCE PROFILE
## CLEAN

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ICAO STANDARD DAY

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.




| ALTITUDE FEET | LEVEL FLIGHT LOITER APPROXIMATE | |
|---|---|---|
| | LBS./HR. | %RPM |
| 40,000 | 1700 | 92 |
| 35,000 | 1500 | 86 |
| 30,000 | 1620 | 84 |
| 25,000 | 1780 | 82 |
| 20,000 | 1950 | 79 |
| 15,000 | 2160 | 76 |
| 10,000 | 2600 | 76 |
| 5,000 | 3070 | 76 |
| S.L. | 3660 | 76 |

LBS./HR. = FUEL FLOW-POUNDS PER HOUR

*Figure A5-1. Maximum Endurance Profile—Clean Configuration*

# MAXIMUM ENDURANCE PROFILE

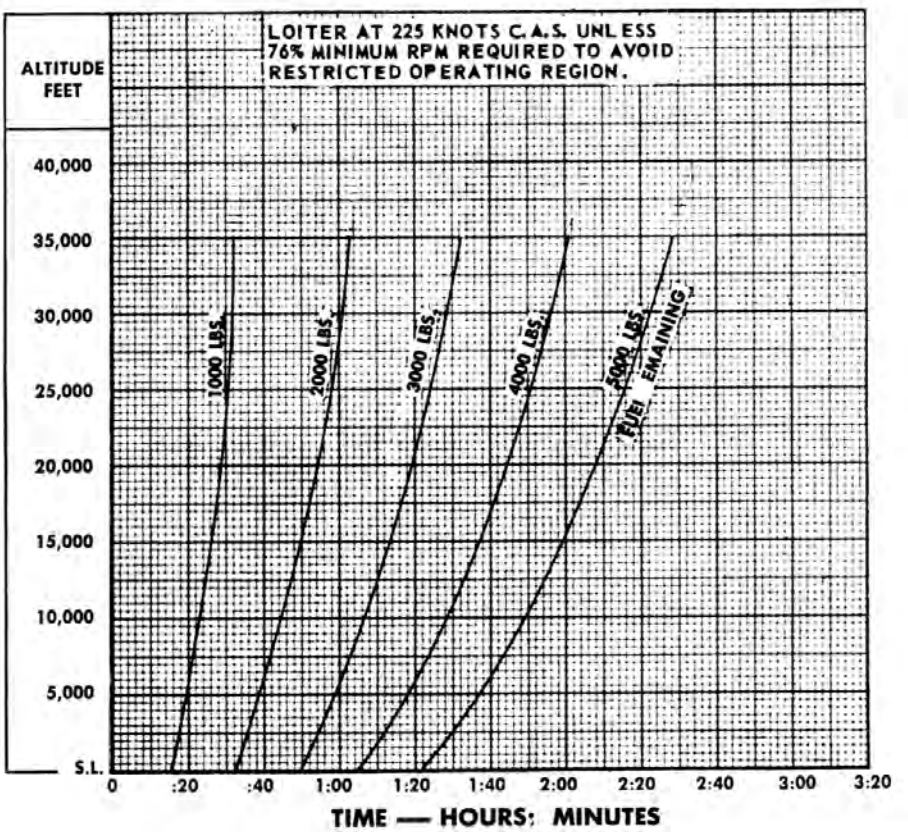
## TIP TANKS AND ROCKET PODS

ICAO STANDARD DAY

DATA SHOWN ARE APPLICABLE TO TIP TANK CONFIGURATION

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.




| ALTITUDE FEET | LEVEL FLIGHT LOITER APPROXIMATE | |
|---|---|---|
| | LBS./HR. | %RPM |
| 35,000 | 2300 | 95 |
| 30,000 | 2200 | 90 |
| 25,000 | 2100 | 87 |
| 20,000 | 2340 | 84 |
| 15,000 | 2500 | 81 |
| 10,000 | 2770 | 79 |
| 5,000 | 3070 | 76 |
| S.L. | 3660 | 76 |

LBS./HR. = FUEL FLOW -POUNDS PER HOUR

*Figure A5-2. Maximum Endurance Profile—Tip Tanks—Tip Tanks and Rocket Pods*

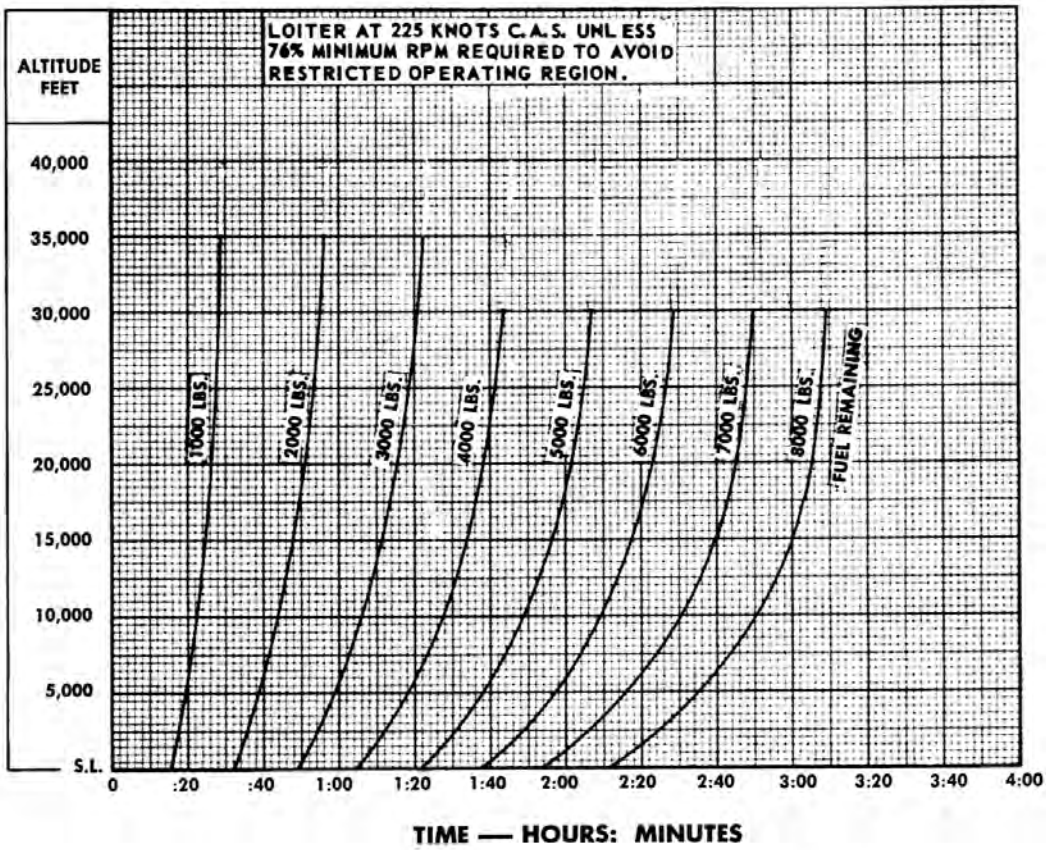
# MAXIMUM ENDURANCE PROFILE
## TIP TANKS, PYLON TANKS AND ROCKET PODS

MODEL: F-94C
DATE. 1 DEC 1956
DATA BASIS: FLIGHT TEST

ICAO STANDARD DAY

DATA SHOWN ARE APPLICABLE TO TIP TANK AND PYLON TANK CONFIGURATION

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.




| ALTITUDE FEET | LEVEL FLIGHT LOITER APPROXIMATE | |
|---|---|---|
| | LBS./HR. | %RPM |
| 35,000 | 2300 | 94 |
| 30,000 | 2560 | 93 |
| 25,000 | 2750 | 91 |
| 20,000 | 2950 | 89 |
| 15,000 | 3000 | 86 |
| 10,000 | 2940 | 81 |
| 5,000 | 3070 | 76 |
| S.L. | 3660 | 76 |

LBS./HR. = FUEL FLOW -POUNDS PER HOUR

*Figure A5-3. Maximum Endurance Profile—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods*

# OPTIMUM MAXIMUM ENDURANCE PROFILE

## CLEAN

MODEL: F-94C
DATE. 1 DEC 1956
DATA BASIS: FLIGHT TEST

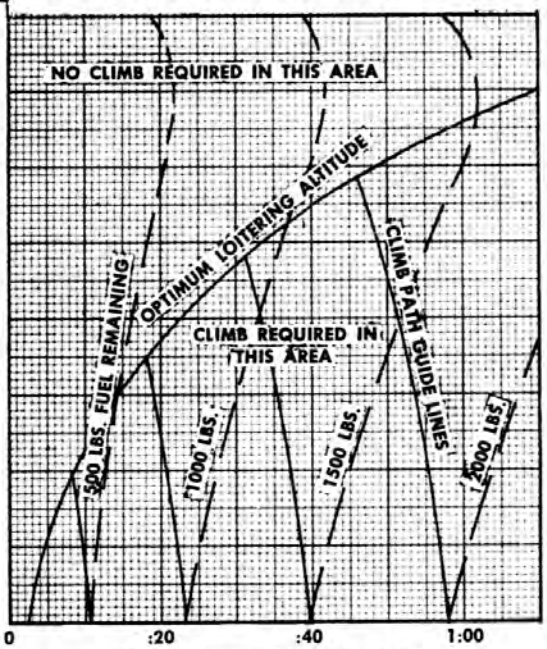
ICAO STANDARD DAY

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.

NORMAL POWER CLIMB

| CAS KNOTS | ALTITUDE 1000 FT. |
|---|---|
| 190 | 40 |
| 205 | 35 |
| 225 | 30 |
| 240 | 25 |
| 255 | 20 |
| 270 | 15 |
| 285 | 10 |
| 300 | 5 |
| 315 | S.L. |

LOITER AT 200 KNOTS C.A.S. UNLESS 76% MINIMUM RPM REQUIRED TO AVOID RESTRICTED OPERATING REGION.




TIME — HOURS: MINUTES

**NOTES:**

1. FUEL REQUIRED AT ANY POINT INCLUDES NORMAL POWER CLIMB, IF REQUIRED, TO ALTITUDE, LOITER AND IDLE POWER DESCENT TO SEA LEVEL.
2. NO ALLOWANCE OR RESERVE MADE FOR LANDING.
3. AREA UNDER OPTIMUM LOITERING ALTITUDE LINE INDICATES CLIMB TO ALTITUDE, LOITER AND DESCEND.
4. AREA ABOVE OPTIMUM LOITERING LINE INDICATES LOITER AT ALTITUDE AND DESCEND.

LBS./HR. = FUEL FLOW —POUNDS PER HOUR

| ALTITUDE FEET | LEVEL FLIGHT LOITER APPROXIMATE | |
|---|---|---|
| | LBS./HR. | %RPM |
| 40,000 | 1700 | 92 |
| 35,000 | 1500 | 86 |
| 30,000 | 1620 | 84 |
| 25,000 | 1780 | 82 |
| 20,000 | 1950 | 79 |
| 15,000 | 2160 | 76 |
| 10,000 | 2600 | 76 |
| 5,000 | 3070 | 76 |
| S.L. | 3660 | 76 |

*Figure A5-4. Optimum Maximum Endurance Profile—Clean Configuration*

# OPTIMUM MAXIMUM ENDURANCE PROFILE
## TIP TANKS AND ROCKET PODS

MODEL: F-94C
DATE. 1 DEC 1956
DATA BASIS: FLIGHT TEST

ICAO STANDARD DAY

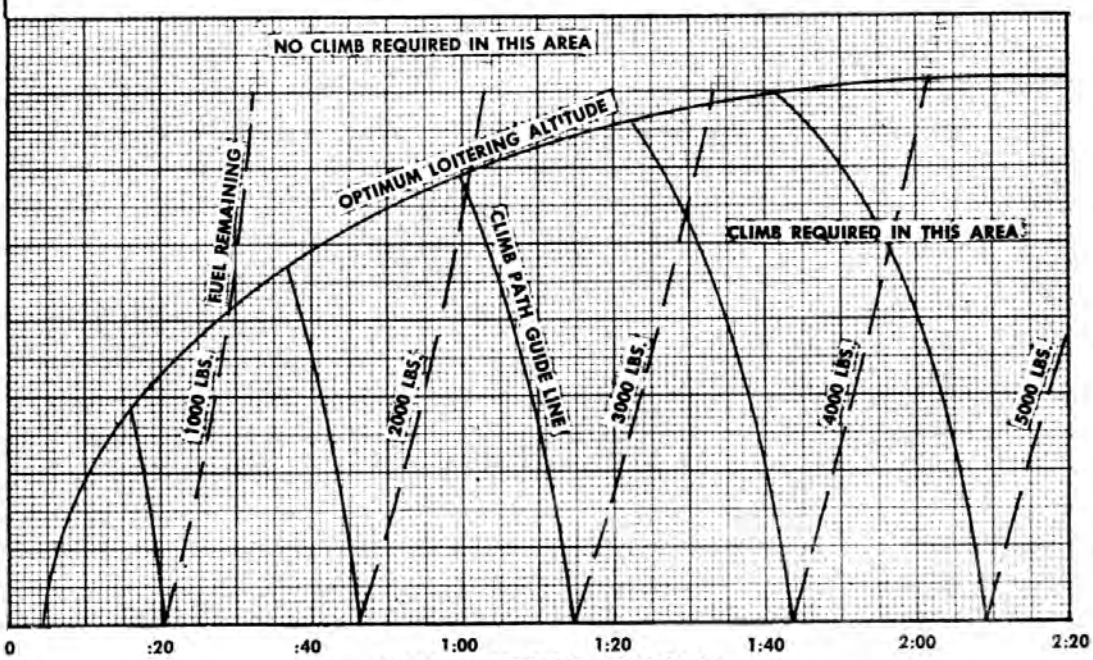
DATA SHOWN ARE APPLICABLE TO TIP TANK CONFIGURATION

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.

LOITER AT 225 KNOTS C.A.S. UNLESS 76% MINIMUM RPM REQUIRED TO AVOID RESTRICTED OPERATING REGION.

NORMAL POWER CLIMB

| CAS KNOTS | ALTITUDE 1000 FT. |
|---|---|
| 190 | 40 |
| 205 | 35 |
| 225 | 30 |
| 240 | 25 |
| 255 | 20 |
| 270 | 15 |
| 285 | 10 |
| 300 | 5 |
| 315 | S.L. |




TIME — HOURS: MINUTES

**NOTES:**

1. FUEL REQUIRED AT ANY POINT INCLUDES NORMAL POWER CLIMB, IF REQUIRED, TO ALTITUDE, LOITER AND IDLE POWER DESCENT TO SEA LEVEL.
2. NO ALLOWANCE OR RESERVE MADE FOR LANDING.
3. AREA UNDER OPTIMUM LOITERING ALTITUDE LINE INDICATES CLIMB TO ALTITUDE, LOITER AND DESCEND.
4. AREA ABOVE OPTIMUM LOITERING LINE INDICATES LOITER AT ALTITUDE AND DESCEND.

LBS./HR. = FUEL FLOW -POUNDS PER HOUR

| ALTITUDE FEET | LEVEL FLIGHT LOITER APPROXIMATE | |
|---|---|---|
| | LBS./HR. | %RPM |
| 35,000 | 2300 | 95 |
| 30,000 | 2200 | 90 |
| 25,000 | 2100 | 87 |
| 20,000 | 2340 | 84 |
| 15,000 | 2500 | 81 |
| 10,000 | 2770 | 79 |
| 5,000 | 3070 | 76 |
| S.L. | 3660 | 76 |

*Figure A5-5. Optimum Maximum Endurance Profile—Tip Tanks and Rocket Pods*

# OPTIMUM MAXIMUM ENDURANCE PROFILE
## TIP TANKS, PYLON TANKS AND ROCKET PODS

ICAO STANDARD DAY

DATA SHOWN ARE APPLICABLE TO TIP TANK AND PYLON TANK CONFIGURATION

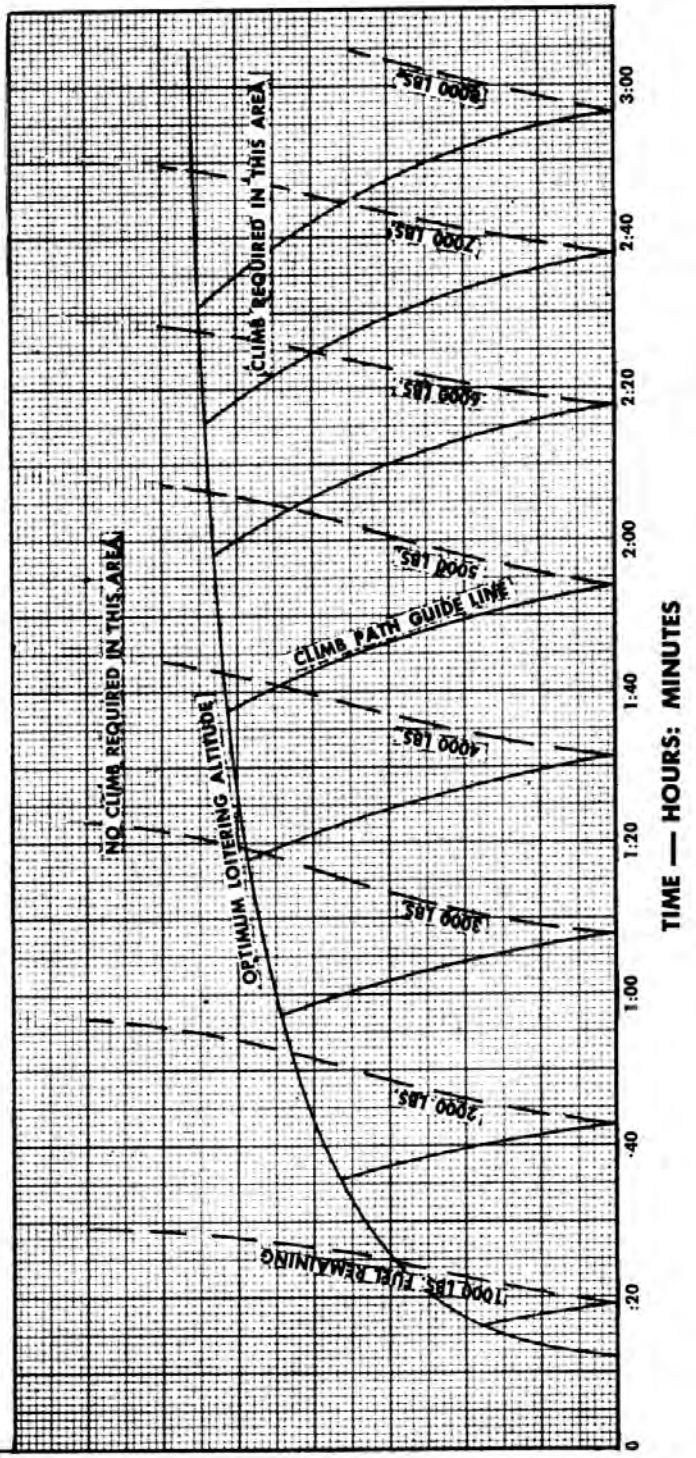
ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.

MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

NORMAL POWER CLIMB

| CAS KNOTS | ALTITUDE 1000 FT. |
|---|---|
| 190 | 40 |
| 205 | 35 |
| 225 | 30 |
| 240 | 25 |
| 255 | 20 |
| 270 | 15 |
| 285 | 10 |
| 300 | 5 |
| 315 | S.L. |

LOITER AT 225 KNOTS C.A.S. UNLESS 76% MINIMUM RPM REQUIRED TO AVOID RESTRICTED OPERATING REGION.




| ALTITUDE FEET | LEVEL FLIGHT LOITER APPROXIMATE | |
|---|---|---|
| | LBS./HR. | %RPM |
| 35,000 | 2300 | 94 |
| 30,000 | 2560 | 93 |
| 25,000 | 2750 | 91 |
| 20,000 | 2950 | 89 |
| 15,000 | 3000 | 86 |
| 10,000 | 2940 | 81 |
| 5,000 | 3070 | 76 |
| S.L. | 3660 | 76 |

**NOTES:**
1. FUEL REQUIRED AT ANY POINT INCLUDES NORMAL POWER CLIMB, IF REQUIRED, TO ALTITUDE, LOITER AND IDLE POWER DESCENT TO SEA LEVEL.
2. NO ALLOWANCE OR RESERVE MADE FOR LANDING.
3. AREA UNDER OPTIMUM LOITERING ALTITUDE LINE INDICATES CLIMB TO ALTITUDE, LOITER AND DESCEND.
4. AREA ABOVE OPTIMUM LOITERING LINE INDICATES LOITER AT ALTITUDE AND DESCEND.

LBS./HR. = FUEL FLOW—POUNDS PER HOUR

*Figure A5-6. Optimum Maximum Endurance Profile—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods*

# Part 6—Combat Allowance

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**Page numbers in bold face type denote charts.**

| Title | Page |
|---|---|
| Combat Allowance Charts | A6-1 |
| Use of Combat Allowance Charts | A6-1 |
| Combat Allowance Chart—Normal Power | **A6-2** |
| Combat Allowance Chart—Military Power | **A6-3** |
| Combat Allowance Chart—Maximum Power | **A6-4** |

## COMBAT ALLOWANCE

### COMBAT ALLOWANCE CHARTS.

The Combat Allowance Charts show the quantity of fuel required for operation at normal, military, and maximum power for any desired length of time at a given altitude. Note that the time limitation for maximum power is 15 minutes and for military power it is 30 minutes. There is no time limitation placed on normal power operation.

### USE OF COMBAT ALLOWANCE CHARTS.

The following examples illustrate the use of the charts:

#### SAMPLE PROBLEM NO. 1.

Determine the fuel required for 55 minutes of normal power operation at 25,000 feet.

1. Enter normal power curve on Figure A6-1 (Combat Allowance Chart) at 25,000 feet and 55 minutes time. Read the fuel required....3100 lb.

#### SAMPLE PROBLEM NO. 2.

Determine the time available while using maximum power at 35,000 feet if 2000 pounds of fuel are to be used.

1. Enter maximum power curve on Figure A6-3 (Combat Allowance Chart) at 35,000 feet and 2000 pounds of fuel. Read the time available .....13.2 min.

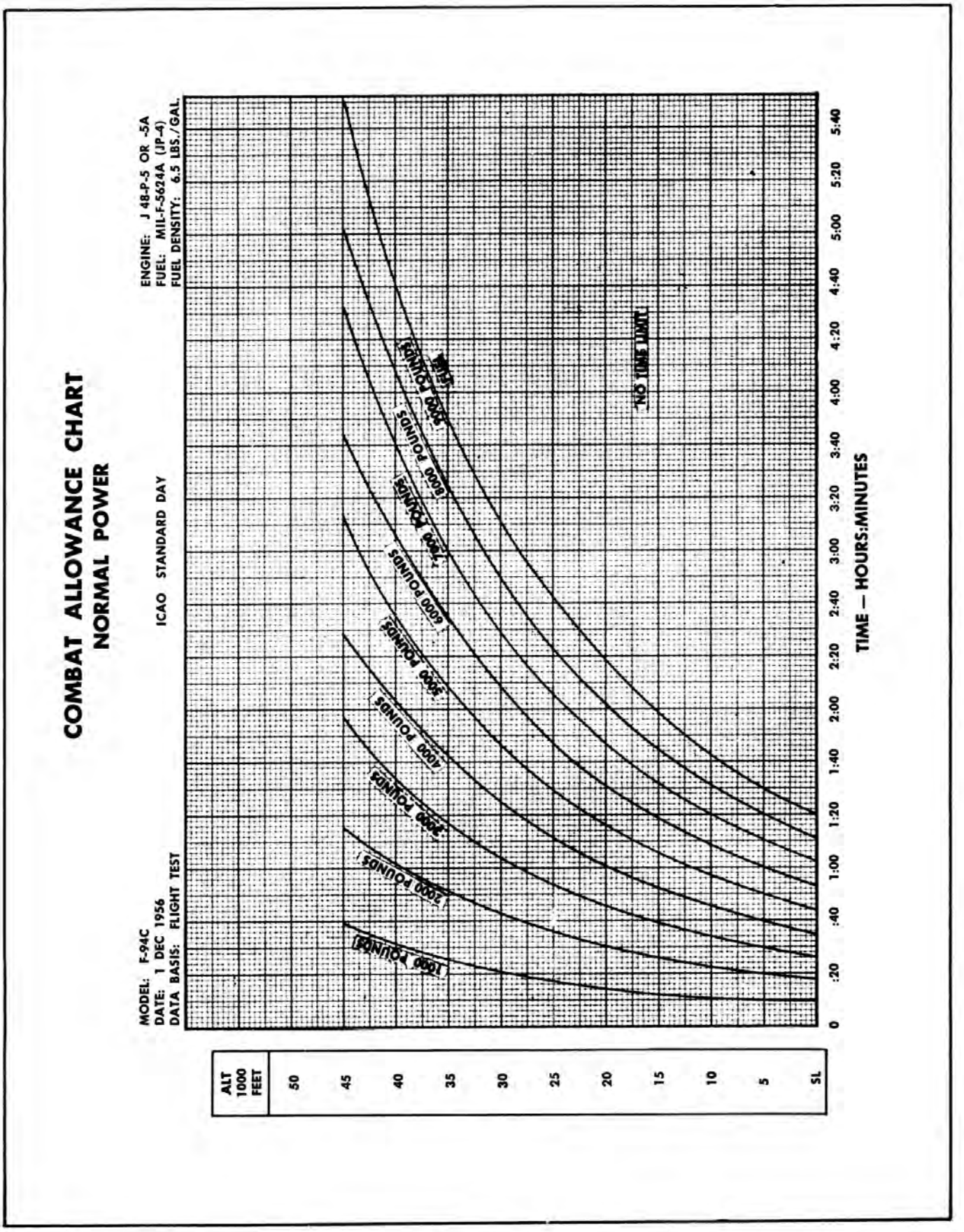
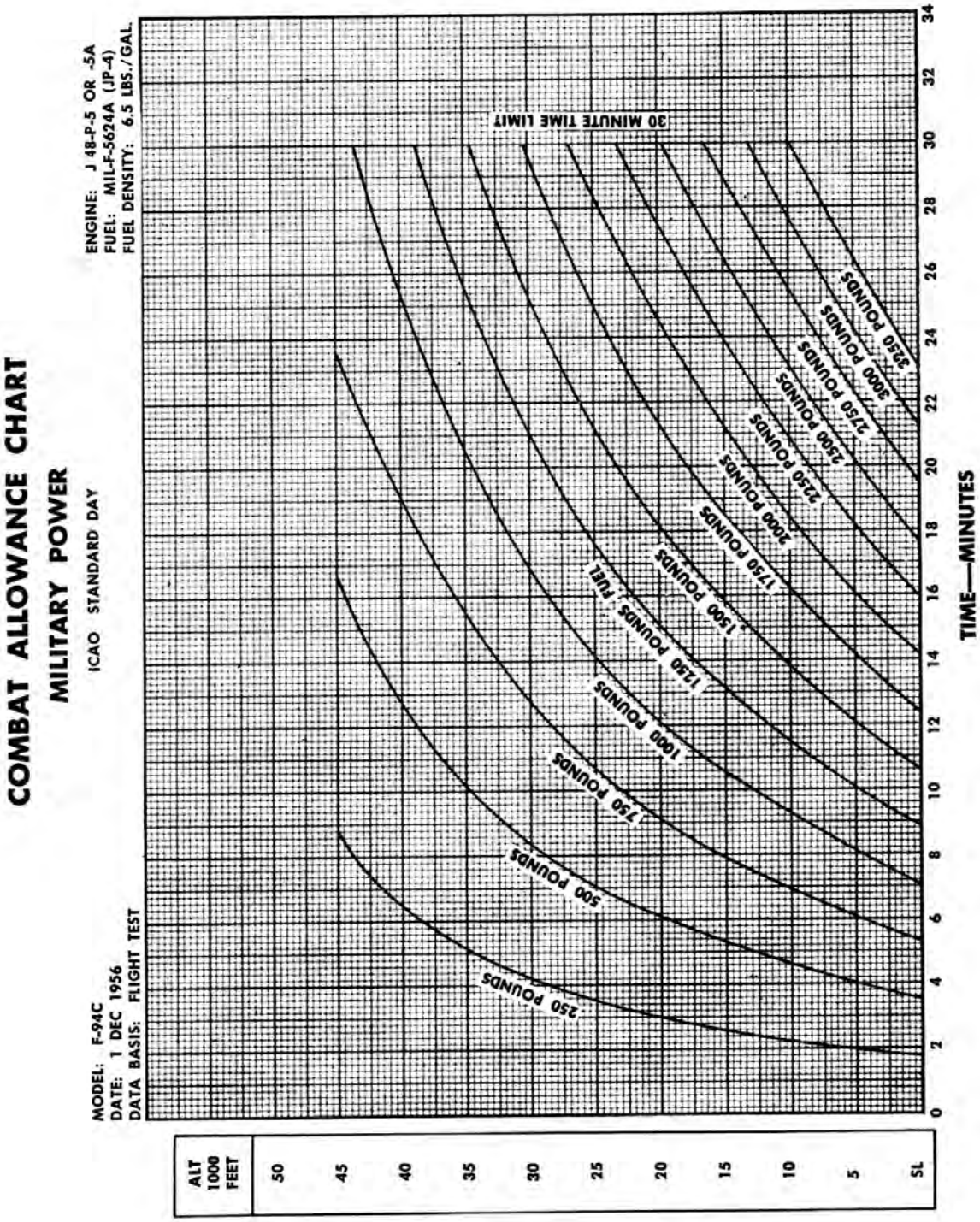



*Figure A6-1. Combat Allowance Chart—Normal Power*




*gure A6-2. Combat Allowance Chart—Military Power*

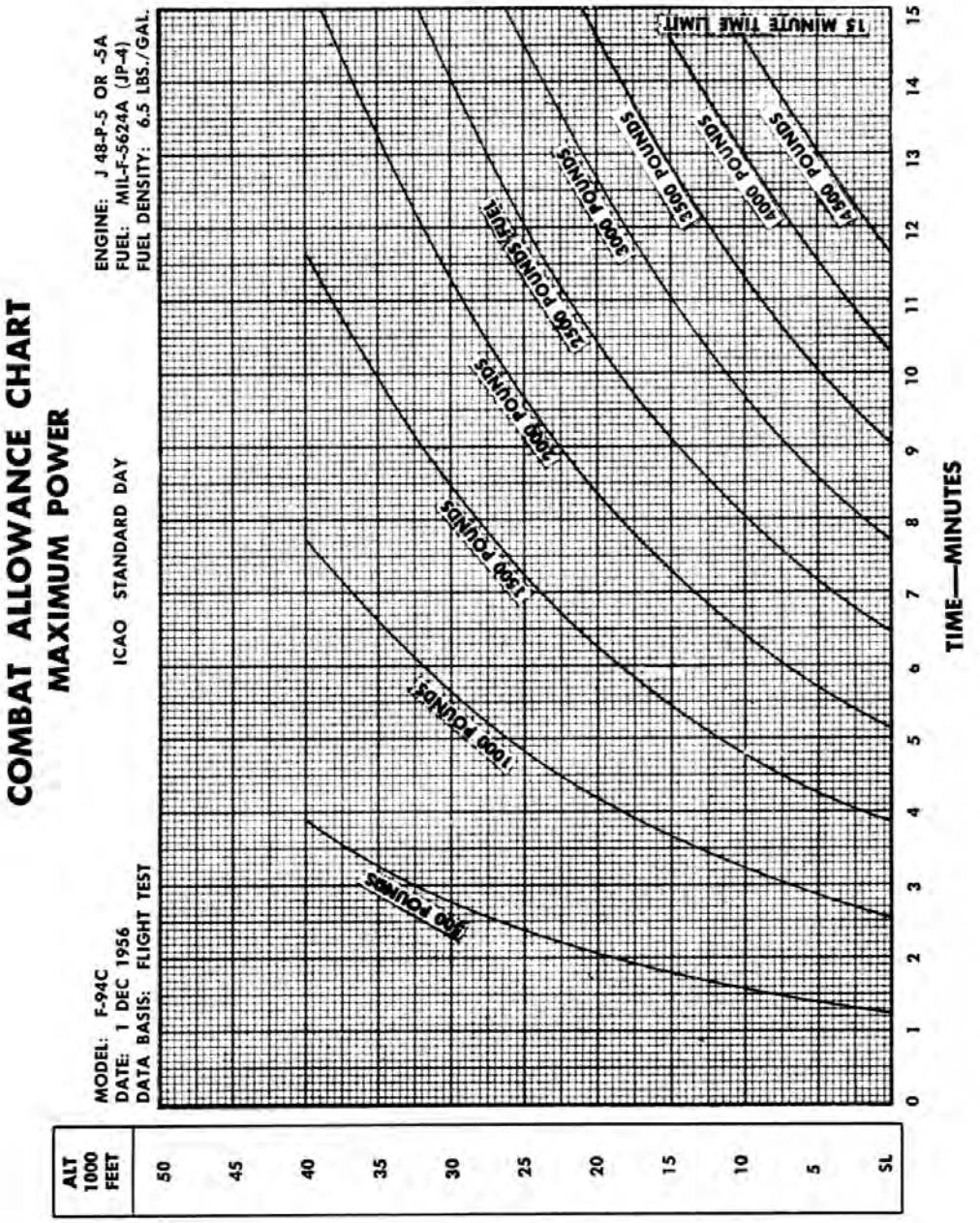



*Figure A6-3. Combat Allowance Chart—Maximum Power*

# Part 7—Descent

## TABLE OF CONTENTS

**Page numbers in bold face type denote charts.**

| Title | Page |
|---|---|
| Descent Performance Presented | A7-1 |
| Use of the Descent Charts | A7-1 |
| Descent—Clean | **A7-2** |
| Descent—External Tanks | **A7-3** |

## DESCENT

### DESCENT PERFORMANCE PRESENTED.

Distance, time, and fuel required to descend from altitude with idle rpm are presented for configurations with and without external tanks (Figures A7-1 and A7-2 respectively). These data, including the proper speed schedule, are shown for maximum rate descent on each chart. Gear and landing flaps should be in the retracted position, and dive flaps should be extended for descent.

### USE OF THE DESCENT CHARTS.

A sample problem is provided to show the use of the descent charts.

#### SAMPLE PROBLEM.

For an airplane equipped with tip tanks find fuel used, time and distance traveled in a maximum rate descent from 35,000 feet to sea level.

Enter figure A7-2 at 35,000 feet and read 11 pounds of fuel, 0.86 minutes, and 4.4 nautical miles to descend to sea level.

**NOTE**

Refer to Section VI for dive recovery altitude requirements.

# DESCENT

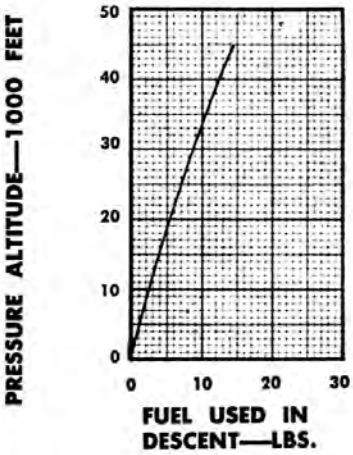
## CLEAN

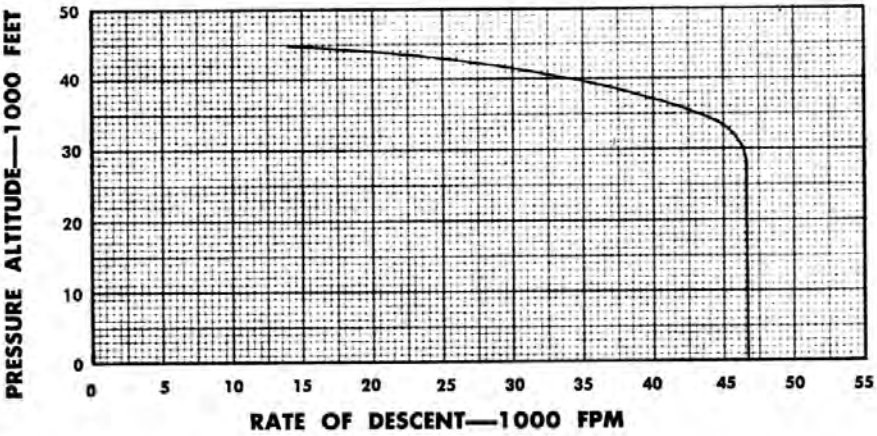
### ICAO STANDARD DAY

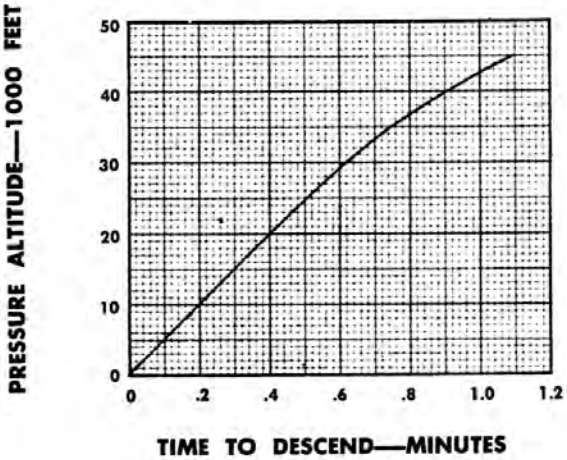
GROSS WEIGHT — 13,700 LBS.

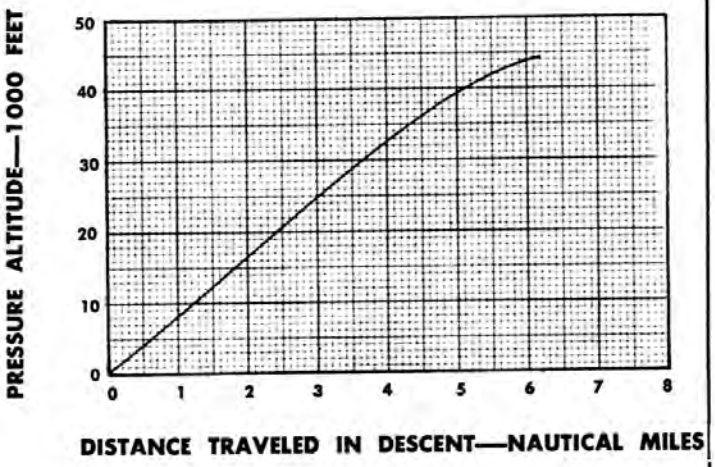
MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ENGINE: J 48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.




| DESCENT SPEEDS | |
|---|---|
| ALTITUDE FEET | CAS KNOTS |
| 45,000 | 205 |
| 40,000 | 245 |
| 35,000 | 290 |
| 30,000 | 320 |
| 25,000 | 360 |
| 20,000 | 400 |
| 15,000 | 435 |
| 10,000 | 475 |
| 5,000 | 520 |
| SL | 550 |

USE DIVE FLAPS ALL THE WAY DOWN
USE IDLE RPM—NOZZLE CLOSED
DO NOT EXCEED A CAS OF 550 KNOTS

*Figure A7-1. Descent—Clean*

# DESCENT

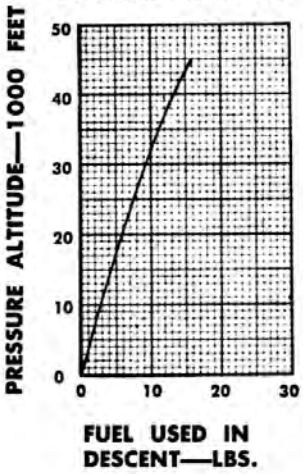
## EXTERNAL TANKS

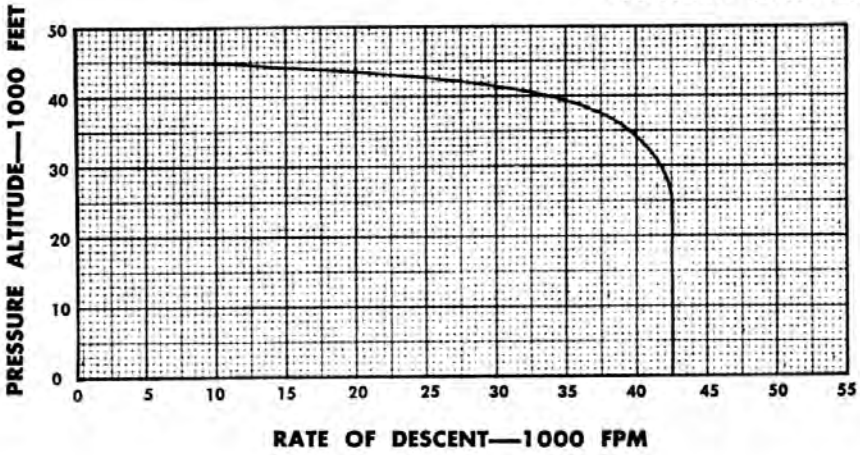
### ICAO STANDARD DAY

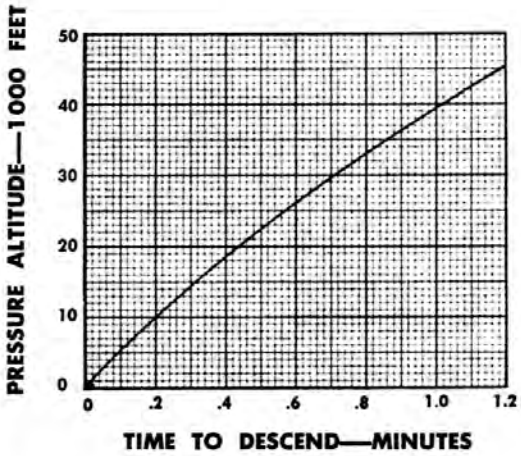
GROSS WEIGHT — 14,570 LBS.

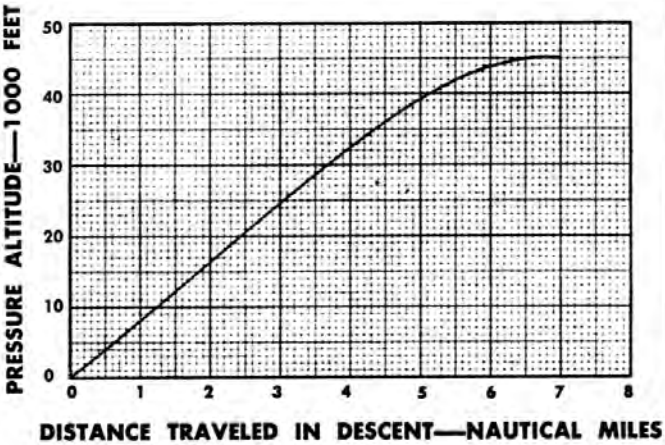
MODEL: F-94C
DATE: 1 DEC 1956
DATA BASIS: FLIGHT TEST

ENGINE: J-48-P-5 OR -5A
FUEL: MIL-F-5624A (JP-4)
FUEL DENSITY: 6.5 LBS./GAL.




| DESCENT SPEEDS | |
|---|---|
| ALTITUDE FEET | CAS KNOTS |
| 45,000 | 215 |
| 40,000 | 255 |
| 35,000 | 290 |
| 30,000 | 325 |
| 25,000 | 360 |
| 20,000 | 400 |
| 15,000 | 435 |
| 10,000 | 475 |
| 5,000 | 520 |
| SL | 550 |

USE DIVE FLAPS ALL THE WAY DOWN
USE IDLE RPM—NOZZLE CLOSED
DO NOT EXCEED A CAS OF 550 KNOTS

*Figure A7-2. Descent—External Tanks*

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# Part 8—Landing

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**Page numbers in bold face type denote charts.**

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| Performance Basis | A8-1 |
| Use of Charts | A8-1 |
| Landing Distance—No Chute | **A8-2** |
| Landing Distance—With Chute | **A8-3** |

## LANDING

### PERFORMANCE INFORMATION PRESENTED.

Minimum total distances to clear a 50-foot obstacle and stop, plus normal ground roll distances with and without drag chute, are presented on the landing distance charts Figures A8-1 and A8-2, for various conditions of outside air temperature, pressure altitude, gross weight, and effective headwind. Included on the charts are landing speed schedules for 50-foot obstacle clearance and touchdown, plotted in terms of indicated airspeed versus airplane gross weight.

### PERFORMANCE BASIS.

The landing performance shown is based on a short field-obstacle clearance technique and does not represent the performance that would be obtained using the normal landing technique described in Section II. The performance data can be duplicated by adhering to the recommended speed schedules and employing maximum braking during ground roll. A dry, hard-surface runway is assumed. Refer to Section V for maximum and overload weight landing instructions.

### USE OF CHARTS.

A sample problem is provided to show the use of the landing charts.

#### SAMPLE PROBLEM.

Determine the landing ground roll distance without the drag chute, and the minimum total landing distance to clear a 50-foot obstacle and stop for the following conditions:

Gross Weight—16,000 pounds.

Field Pressure Altitude—2000 feet.

Field Outside air temperature (at airplane level)—95°F.

Runway wind—20 knot headwind.

1. From Figure A8-1 (Landing Distance—No Chute) the ground roll distance for touchdown to stop is found to be 3450 feet.
2. The touchdown speed (IAS) is 133 kts.
3. The minimum total distance to clear a 50-foot obstacle and stop is 4450 feet.
4. The speed (IAS) at the 50-foot obstacle is 142 kts.

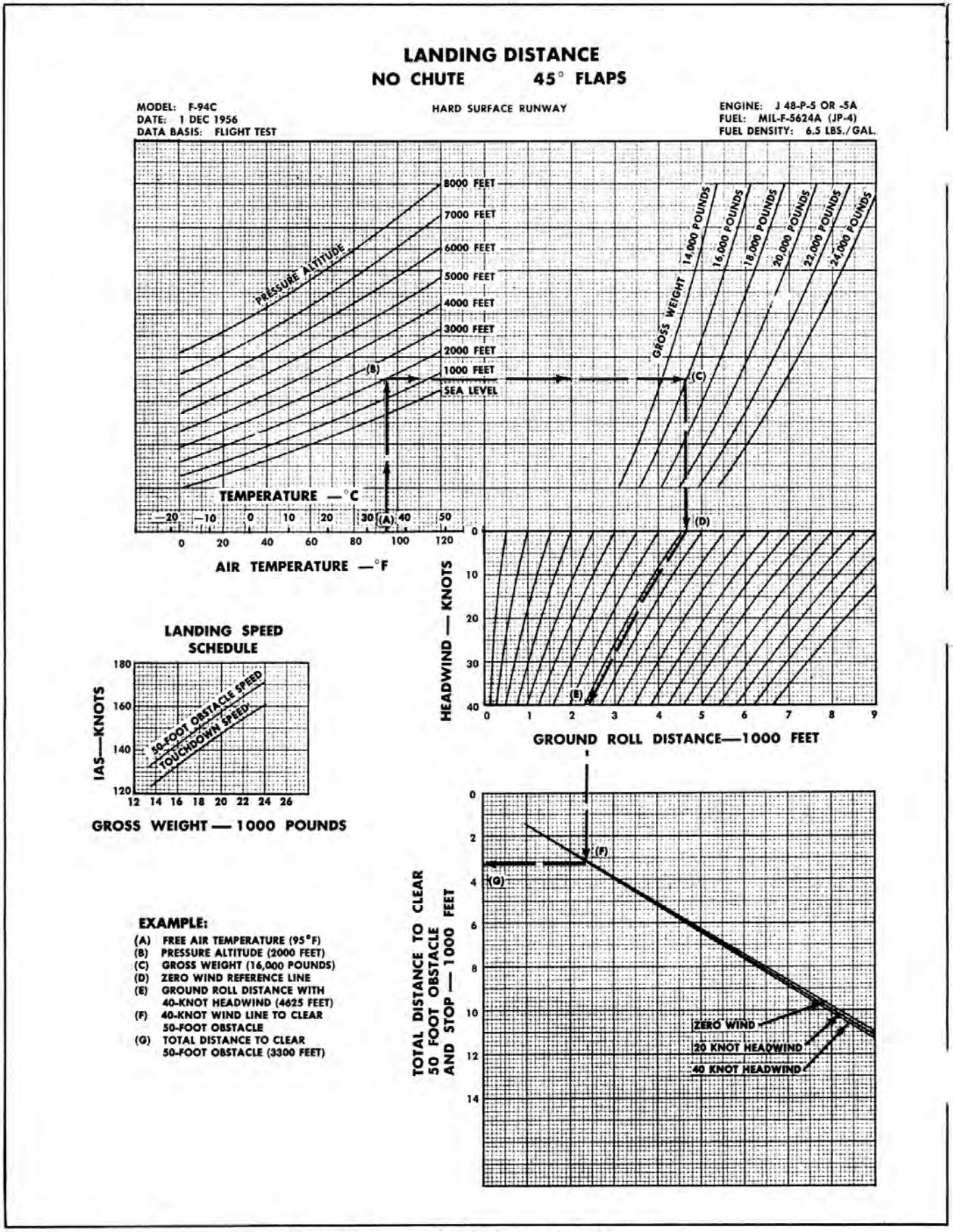


*Figure A8-1. Landing Distance—No Chute*

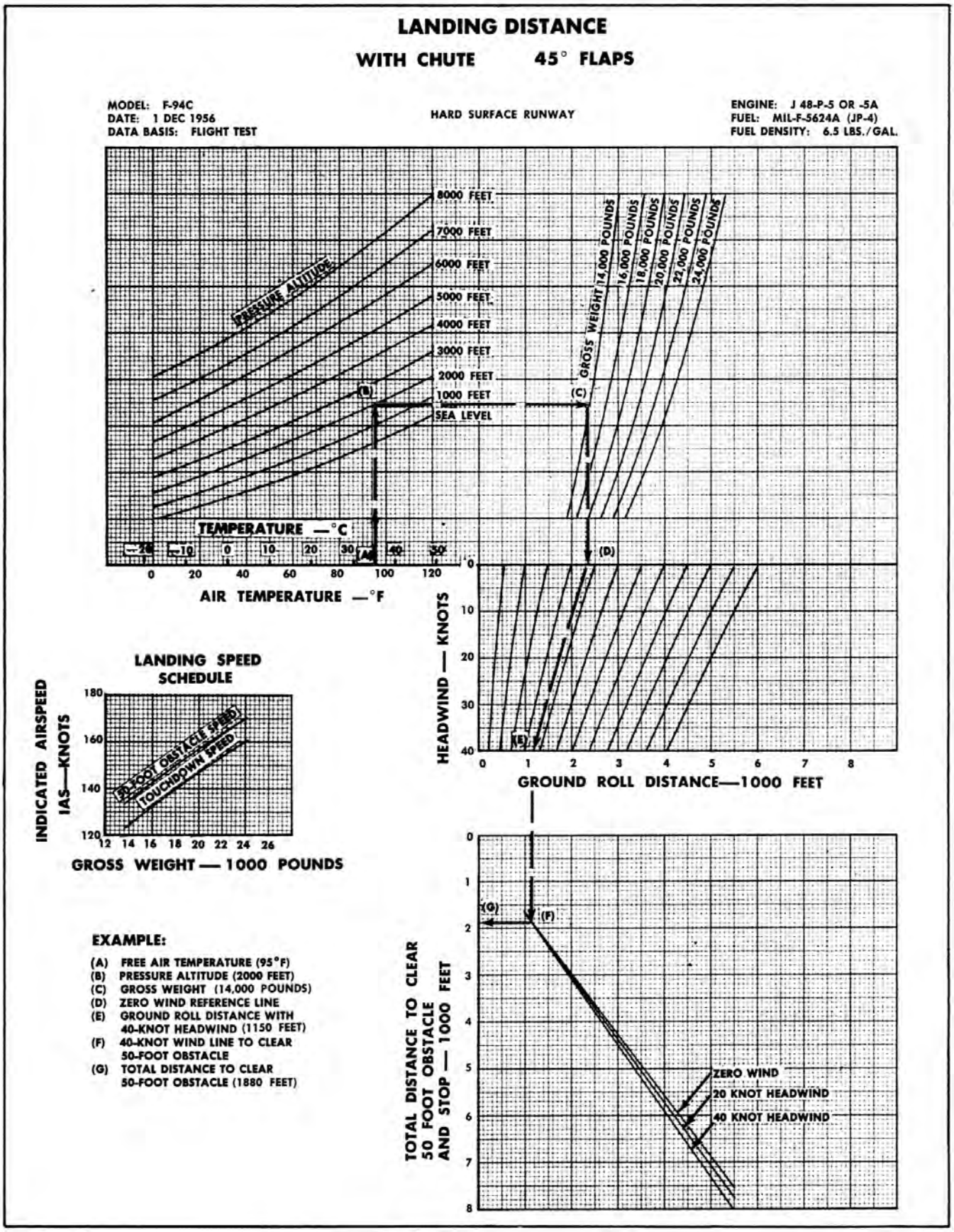


*Figure A8-2. Landing Distance—With Chute*

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# Part 9—Nautical Miles Per 1000 Pounds of Fuel

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**Page numbers in bold face type denote charts.**

| Title | Page |
|---|---|
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| Calibrated Airspeed for Level Flight Cruise | A9-2 |
| Nautical Miles Per 1000 Pounds of Fuel—Sea Level—Clean Configuration | **A9-3** |
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| Nautical Miles Per 1000 Pounds of Fuel—25,000 Feet—Clean Configuration | **A9-6** |
| Nautical Miles Per 1000 Pounds of Fuel—35,000 Feet—Clean Configuration | **A9-7** |
| Nautical Miles Per 1000 Pounds of Fuel—40,000 Feet—Clean Configuration | **A9-8** |
| Nautical Miles Per 100 Pounds of Fuel—Sea Level—Tip Tanks—Tip Tanks and Rocket Pods | **A9-9** |
| Nautical Miles Per 1000 Pounds of Fuel—5000 Feet—Tip Tanks—Tip Tanks and Rocket Pods | **A9-10** |
| Nautical Miles Per 1000 Pounds of Fuel—15,000 Feet—Tip Tanks—Tip Tanks and Rocket Pods | **A9-11** |
| Nautical Miles Per 1000 Pounds of Fuel—25,000 Feet—Tip Tanks—Tip Tanks and Rocket Pods | **A9-12** |
| Nautical Miles Per 1000 Pounds of Fuel—35,000 Feet—Tip Tanks—Tip Tanks and Rocket Pods | **A9-13** |
| Nautical Miles Per 1000 Pounds of Fuel—40,000 Feet—Tip Tanks—Tip Tanks and Rocket Pods | **A9-14** |
| Nautical Miles Per 1000 Pounds of Fuel—Sea Level—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods | **A9-15** |
| Nautical Miles Per 1000 Pounds of Fuel—5000 Feet—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods | **A9-16** |
| Nautical Miles Per 1000 Pounds of Fuel—15,000 Feet—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods | **A9-17** |
| Nautical Miles Per 1000 Pounds of Fuel—25,000 Feet—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods | **A9-18** |
| Nautical Miles Per 1000 Pounds of Fuel—35,000 Feet—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods | **A9-19** |
| Nautical Miles Per 1000 Pounds of Fuel—40,000 Feet—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods | **A9-20** |

# NAUTICAL MILES PER 1000 POUNDS OF FUEL

## PERFORMANCE INFORMATION PRESENTED.

The Nautical Miles Per 1000 Pounds of Fuel charts furnish standard day airplane performance in terms of nautical miles per 1000 pounds of fuel, fuel flow and power settings for level flight operation in zero wind under any condition from maximum speed to the speed for minimum power flight. Charts are given for the following altitudes: sea level, 5000 feet, 15,000 feet, 25,000 feet, 35,000 feet, and 40,000 feet which cover the operating weight range for the various airplane configurations. Recommended cruise speed lines for maximum range operation are presented on the charts for zero wind and 100 knot headwind conditions. A small plot of the variation of fuel economy (miles per 1000 pounds of fuel) versus airspeed for altitudes from sea level to 40,000 feet is provided on each chart to show the relation of the fuel economy at a given altitude to the fuel economy available at other cruising altitudes.

## USE OF CHARTS.

Normally, in flight planning, it is necessary to determine the fuel and time needed to cruise a given distance in level flight. These values may be obtained from the Nautical Miles per 1000 Pounds of Fuel charts by using the following procedure for a zero wind or for a wind condition.

1. Divide the distance to travel into convenient increments.
2. Determine the airplane gross weight at the start of level flight cruise.
3. Enter the Nautical Miles Per 1000 Pounds of Fuel chart for the airplane configuration and altitude at which the flight is to be made. Use the initial gross weight from Step 1 and the desired calibrated airspeed. Read the nautical miles per 1000 pounds of fuel and true airspeed (zero wind). To determine the effect of wind upon fuel and time, the nautical miles per 1000 pounds of fuel value should be corrected to ground conditions by the following equation: Ground n.mi./lb. = air n.mi./lb. × G.S./T.A.S.
4. The cruising fuel needed for the first distnace increment is obtained by dividing the distance increment by the applicable nautical miles per 1000 pounds of fuel value from Step 3.
5. The time required to fly the initial distance increment is obtained by dividing the increment by the true airspeed (zero wind), or ground speed (with wind) from Step 3.
6. The cruising fuel and time required for each succeeding increment is obtained in the same manner, except that the initial airplane gross weight should be corrected for the amount of fuel consumed in obtaining the previous distance increment. The corrected weight is then used to determine a new nautical miles per 1000 pounds of fuel value as in Step 3.

The accuracy of the fuel and time predictions depend on the size of the increment of distance chosen. The smaller the increment, the more accurate the resultant range data.

## CALIBRATED AIR SPEED FOR LEVEL FLIGHT CRUISE.

It should be emphasized that calibrated airspeed is the most important control item for level flight cruise in order to obtain predicted range data. Differences in the performance of individual airplanes and variations due to non-standard day air temperature should be handled by proper adjustment of rpm when operating at less than normal rated power. If your speed requirement is limited by the normal power rating, then altitude must be sacrificed. In either of the above cases, the speed should be maintained. As mentioned previously, the nautical miles per 1000 pounds of fuel will not change due to changes in air temperature. The required rpm and rate of fuel consumption will vary from standard day values, but a compensating change will occur in true airspeed. Thus, your time between check points will change also.

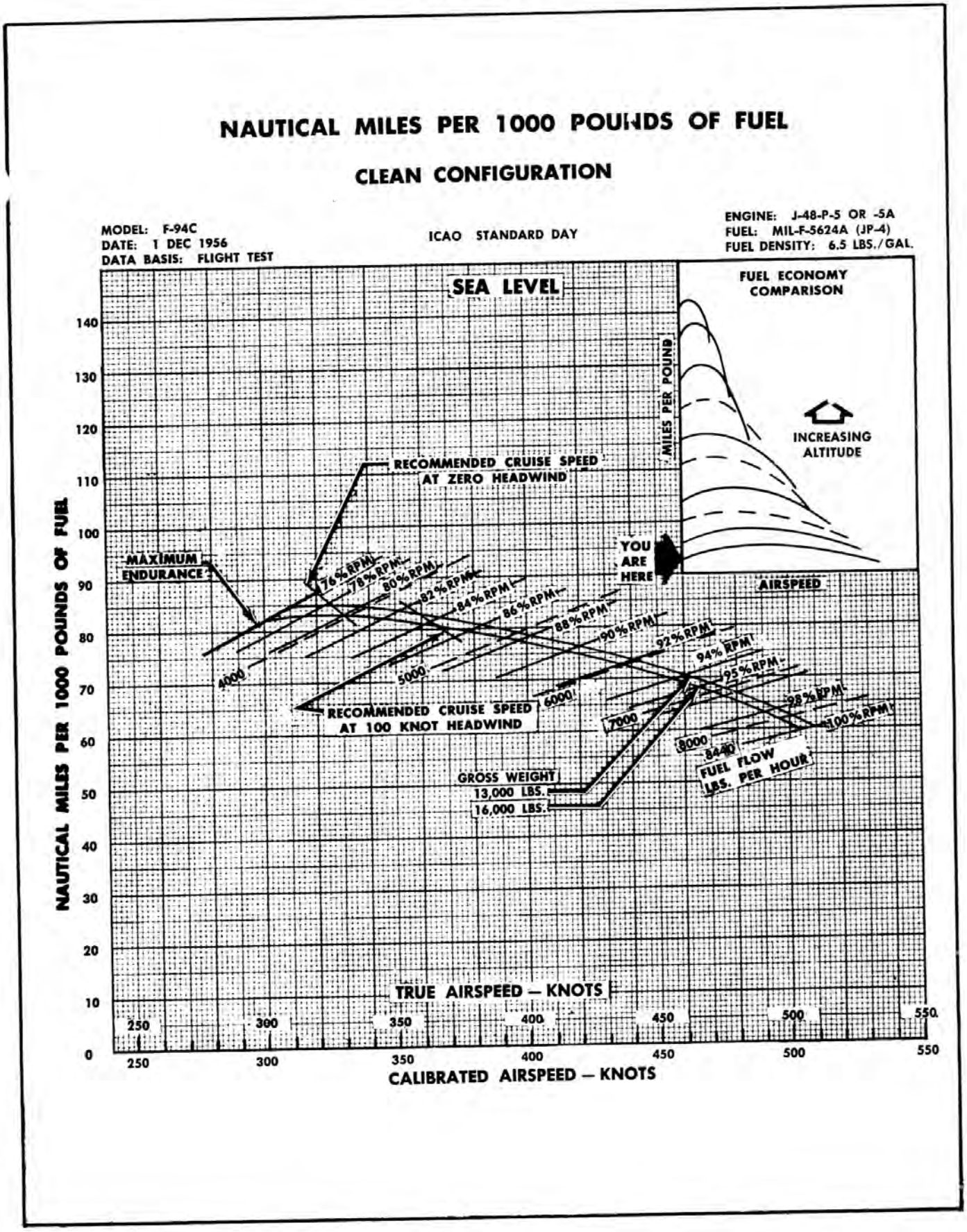


*Figure A9-1. Nautical Miles Per 1000 Pounds of Fuel—Sea Level—Clean Configuration*

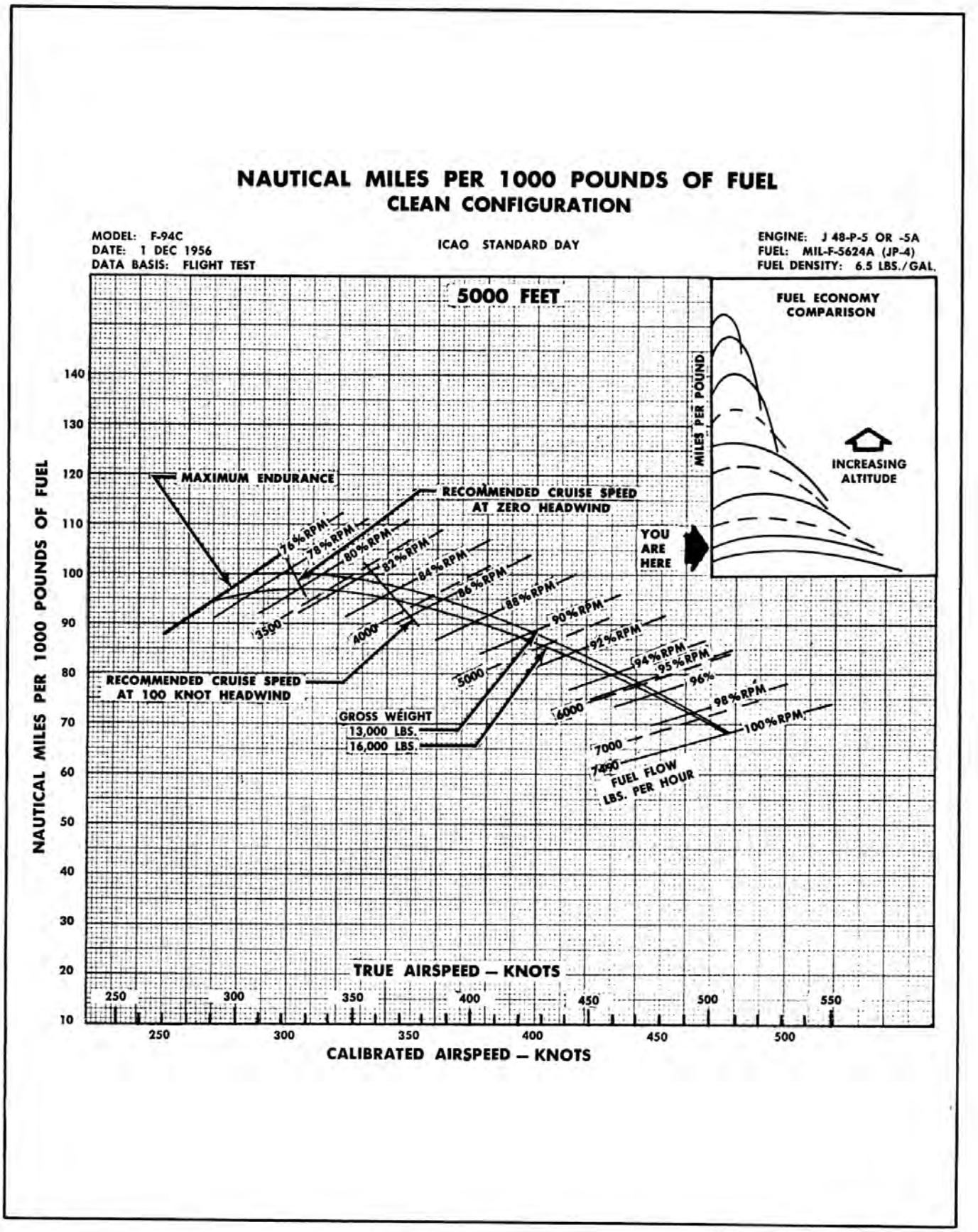


*Figure A9-2. Nautical Miles Per 1000 Pounds of Fuel—5000 Feet—Clean Configuration*

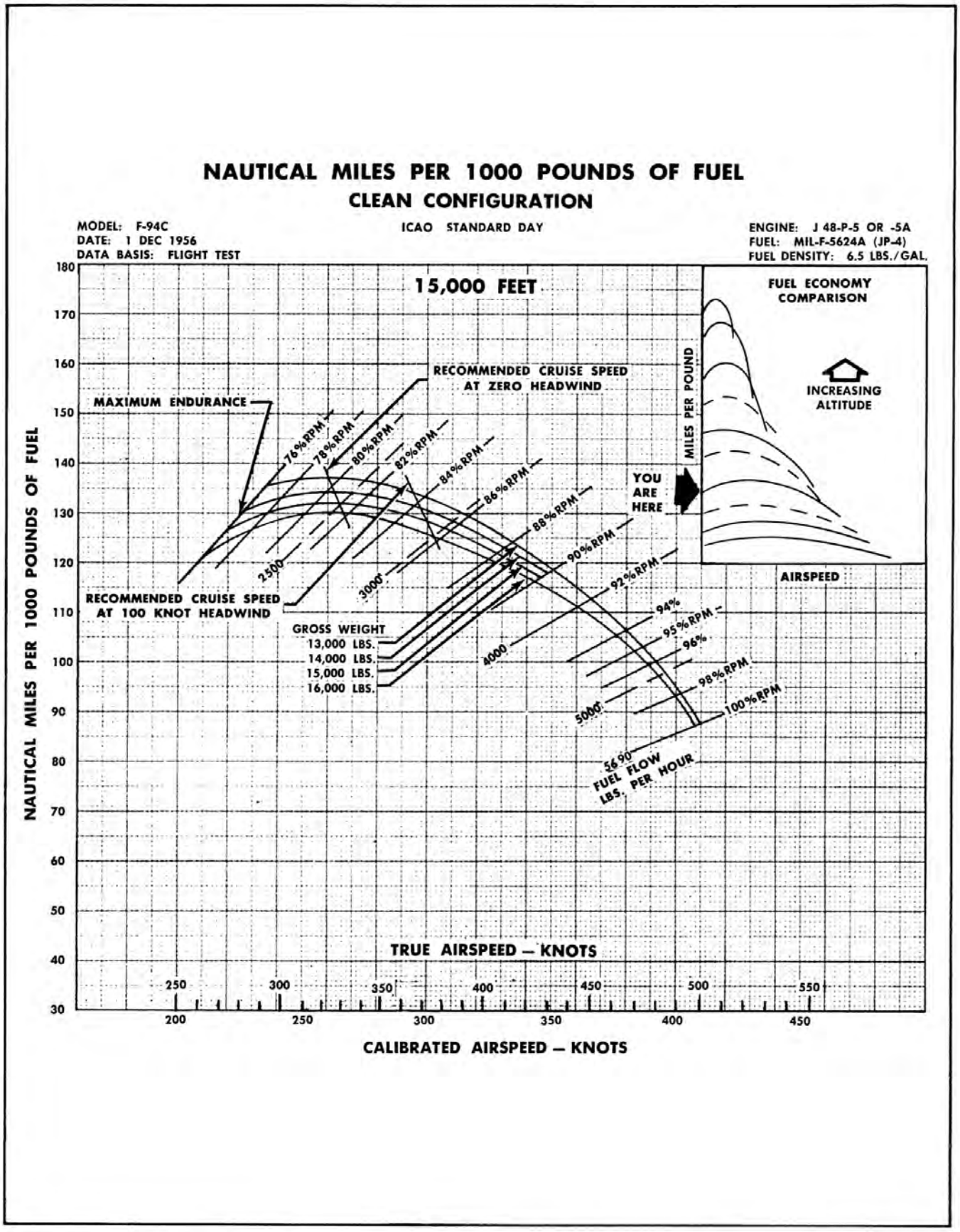


*Figure A9-3. Nautical Miles Per 1000 Pounds of Fuel—15,000 Feet—Clean Configuration*

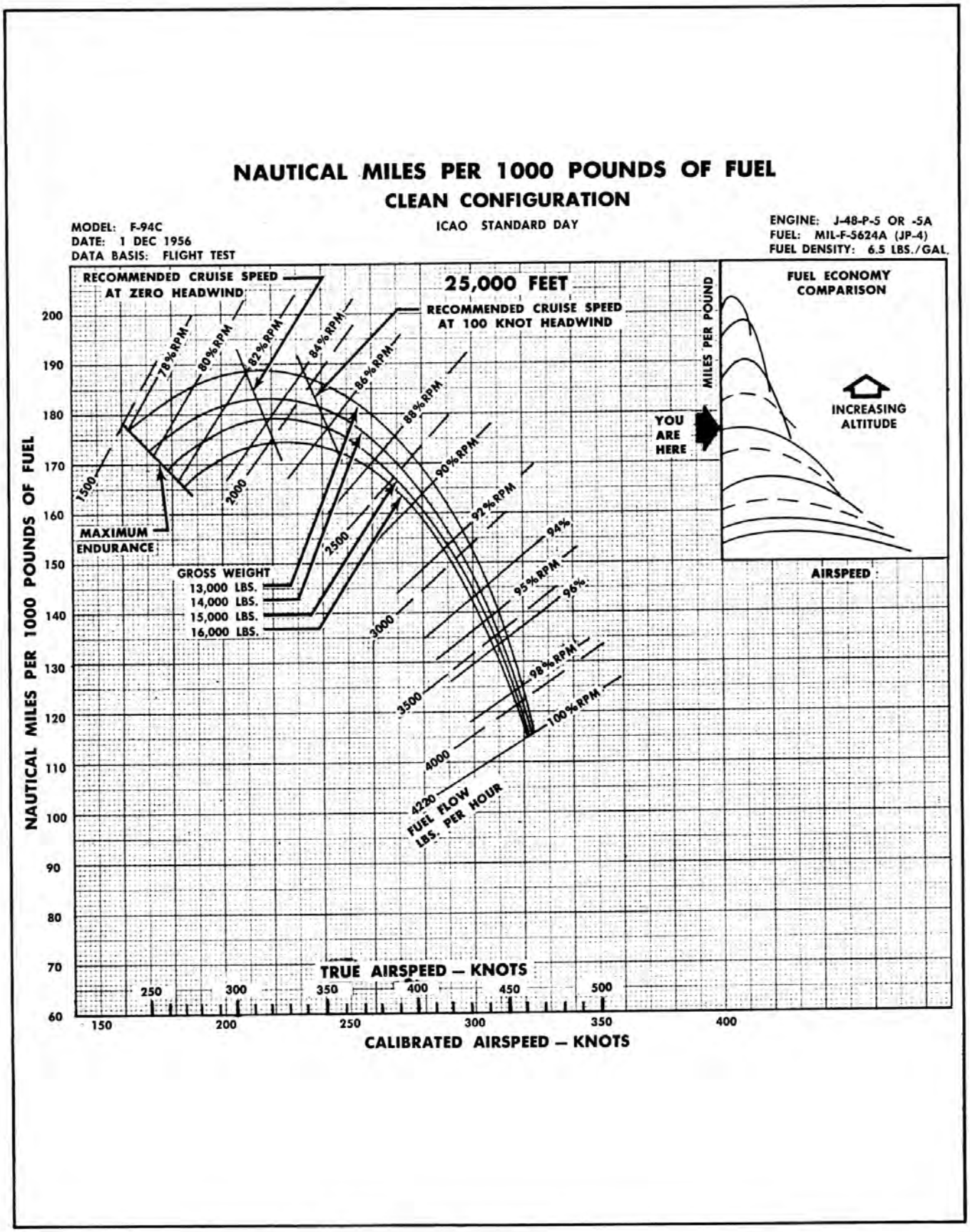


*Figure A9-4. Nautical Miles Per 1000 Pounds of Fuel—25,000 Feet—Clean Configuration*

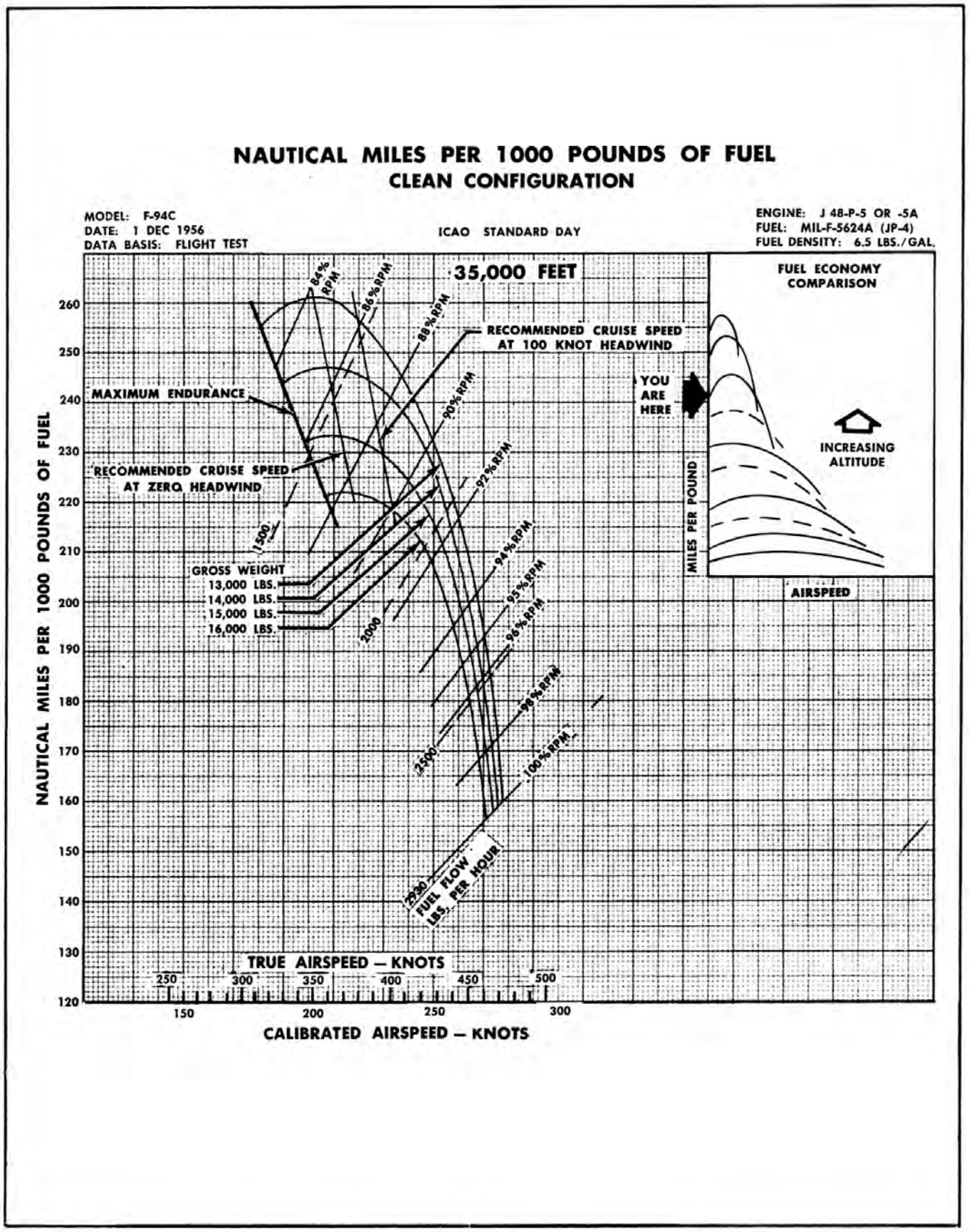


*Figure A9-5. Nautical Miles Per 1000 Pounds of Fuel—35,000 Feet—Clean Configuration*

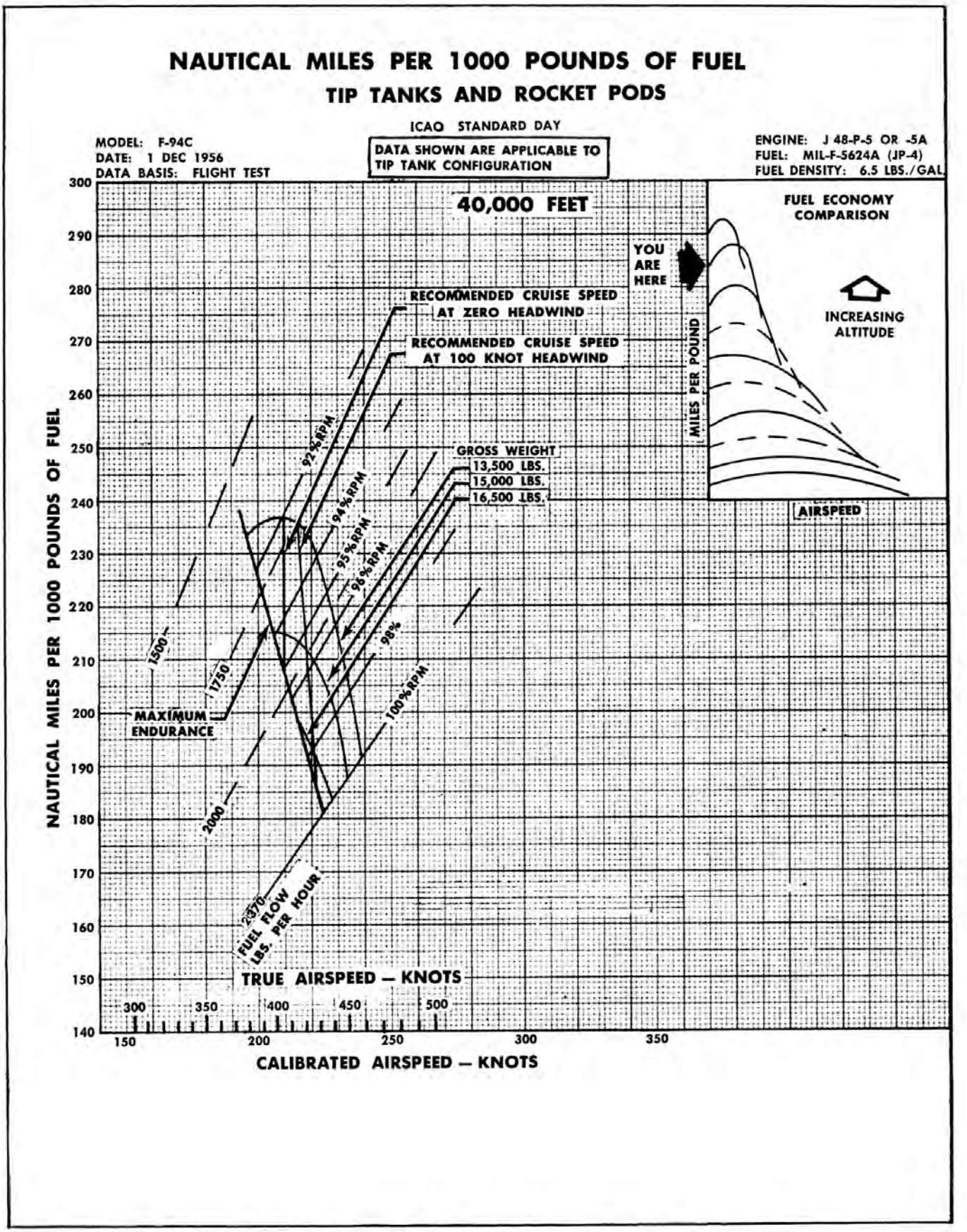


*Figure A9-6. Nautical Miles Per 1000 Pounds of Fuel—40,000 Feet—Clean Configuration*

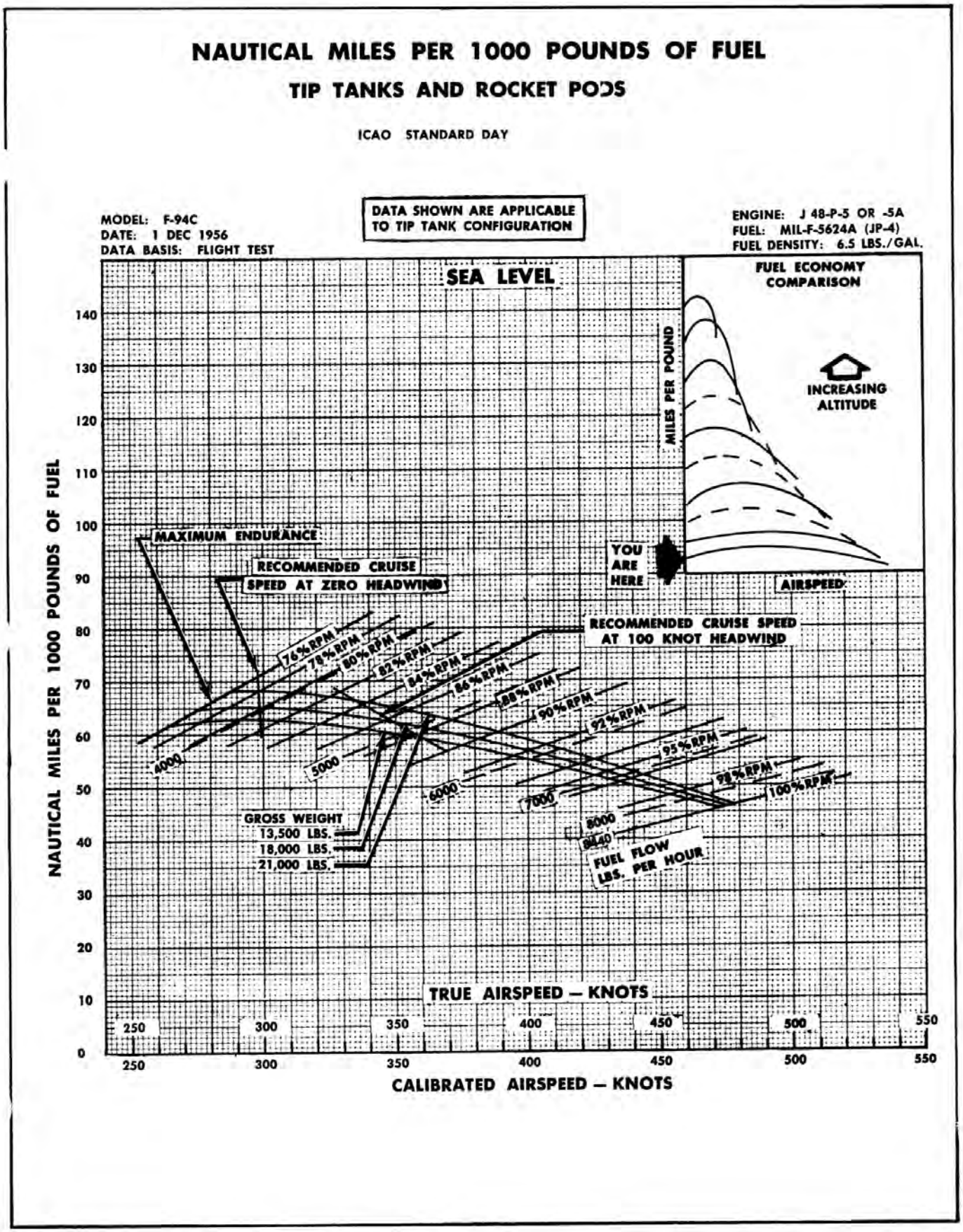


*Figure A9-7. Nautical Miles Per 1000 Pounds of Fuel—Sea Level—Tip Tanks—Tip Tanks and Rocket Pods*

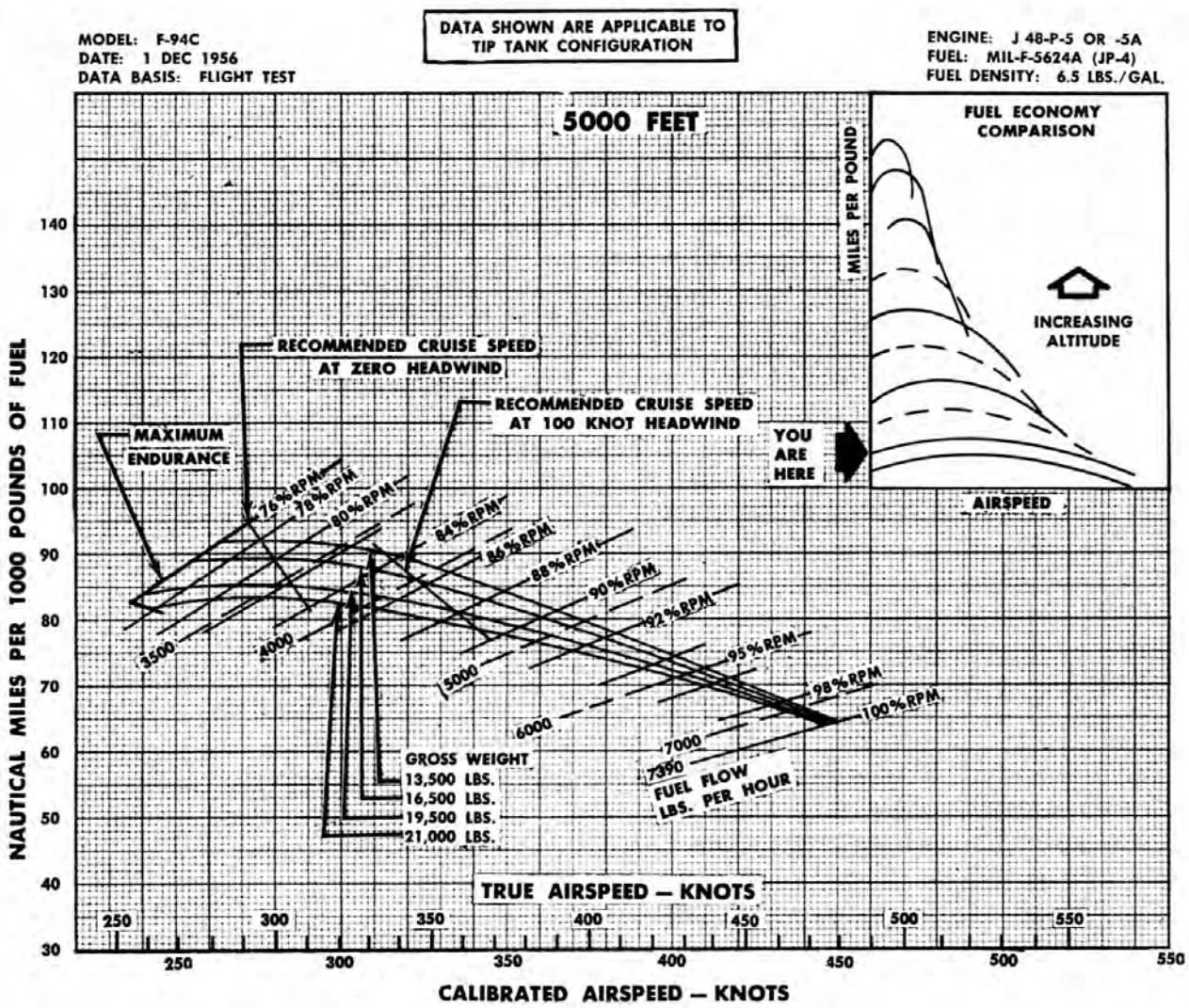


*Figure A9-8. Nautical Miles Per 1000 Pounds of Fuel—5000 Feet—Tip Tanks—Tip Tanks and Rocket Pods*

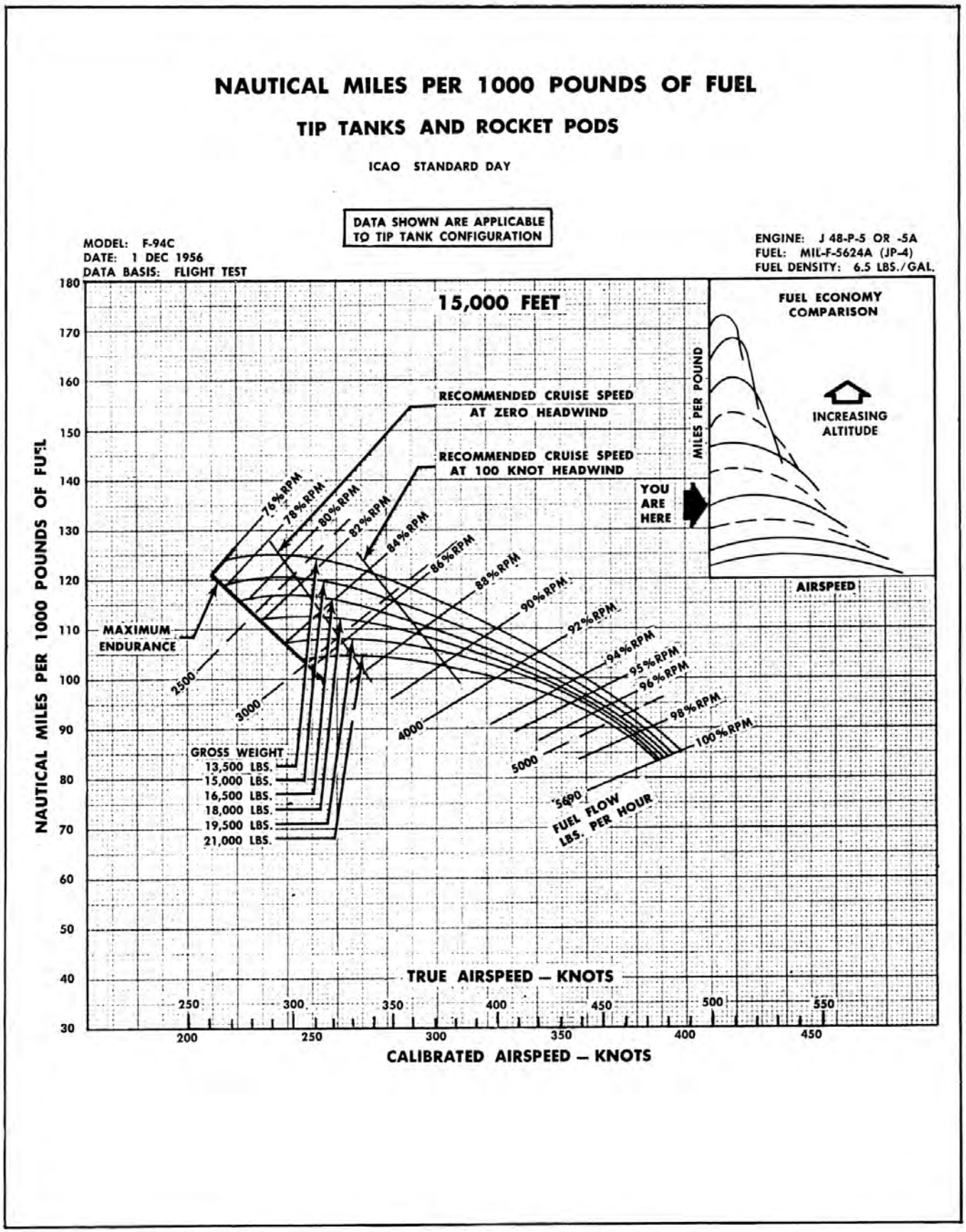


*Figure A9-9. Nautical Miles Per 1000 Pounds of Fuel—15,000 Feet—Tip Tanks—Tip Tanks and Rocket Pods*

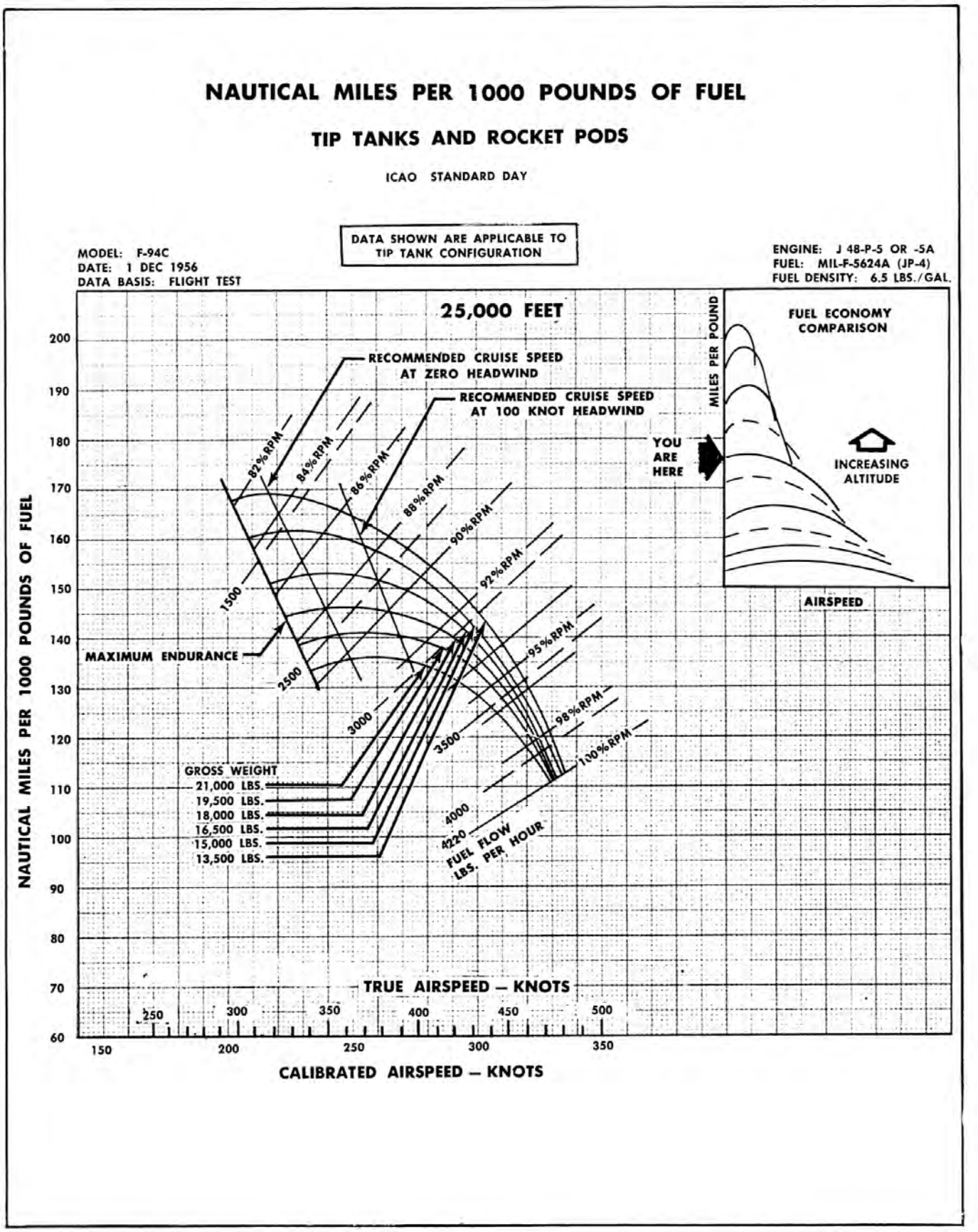


*Figure A9-10. Nautical Miles Per 1000 Pounds of Fuel—25,000 Feet—Tip Tanks—Tip Tanks and Rocket Pods*

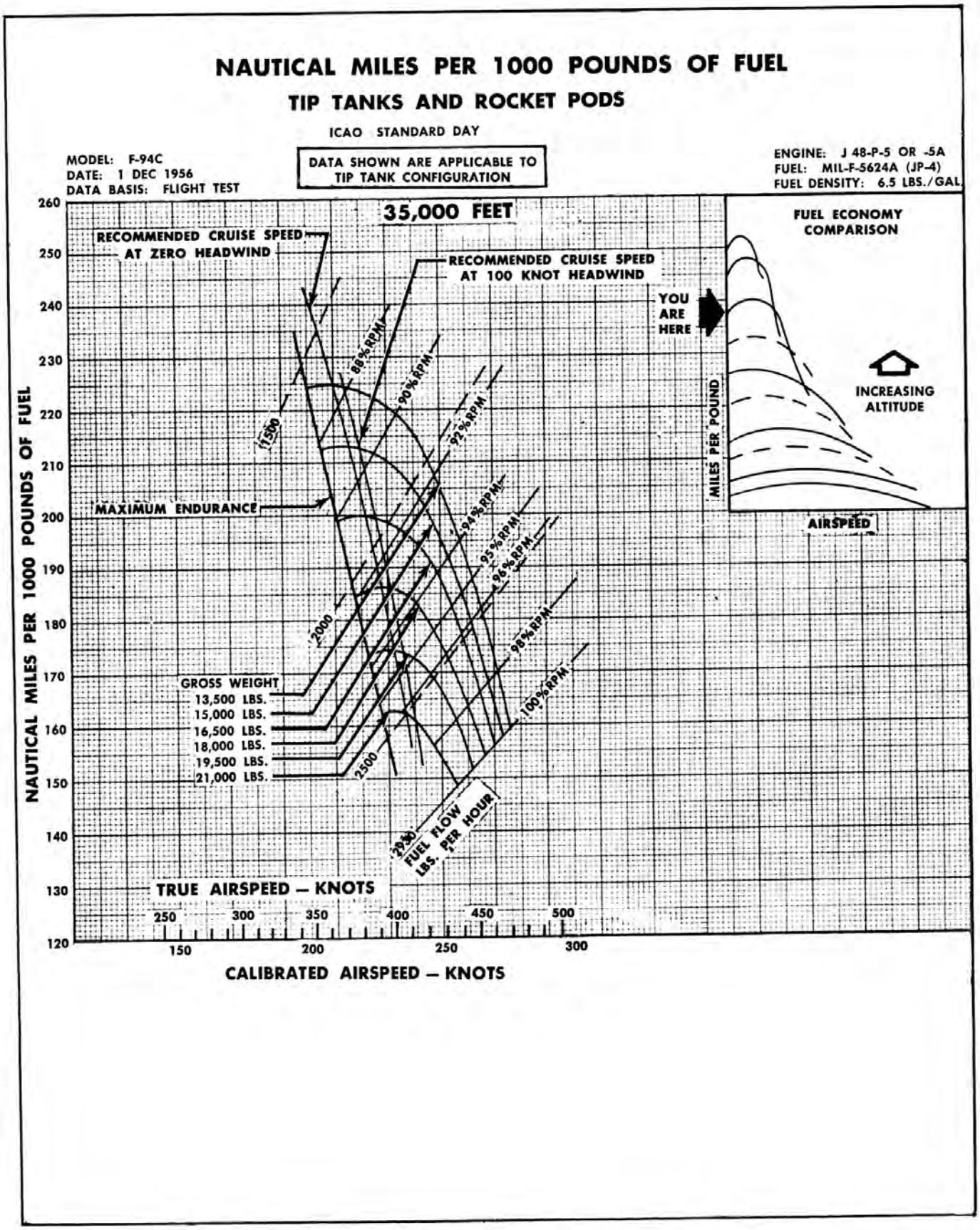


*Figure A9-11. Nautical Miles Per 1000 Pounds of Fuel—35,000 Feet—Tip Tanks—Tip Tanks and Rocket Pods*

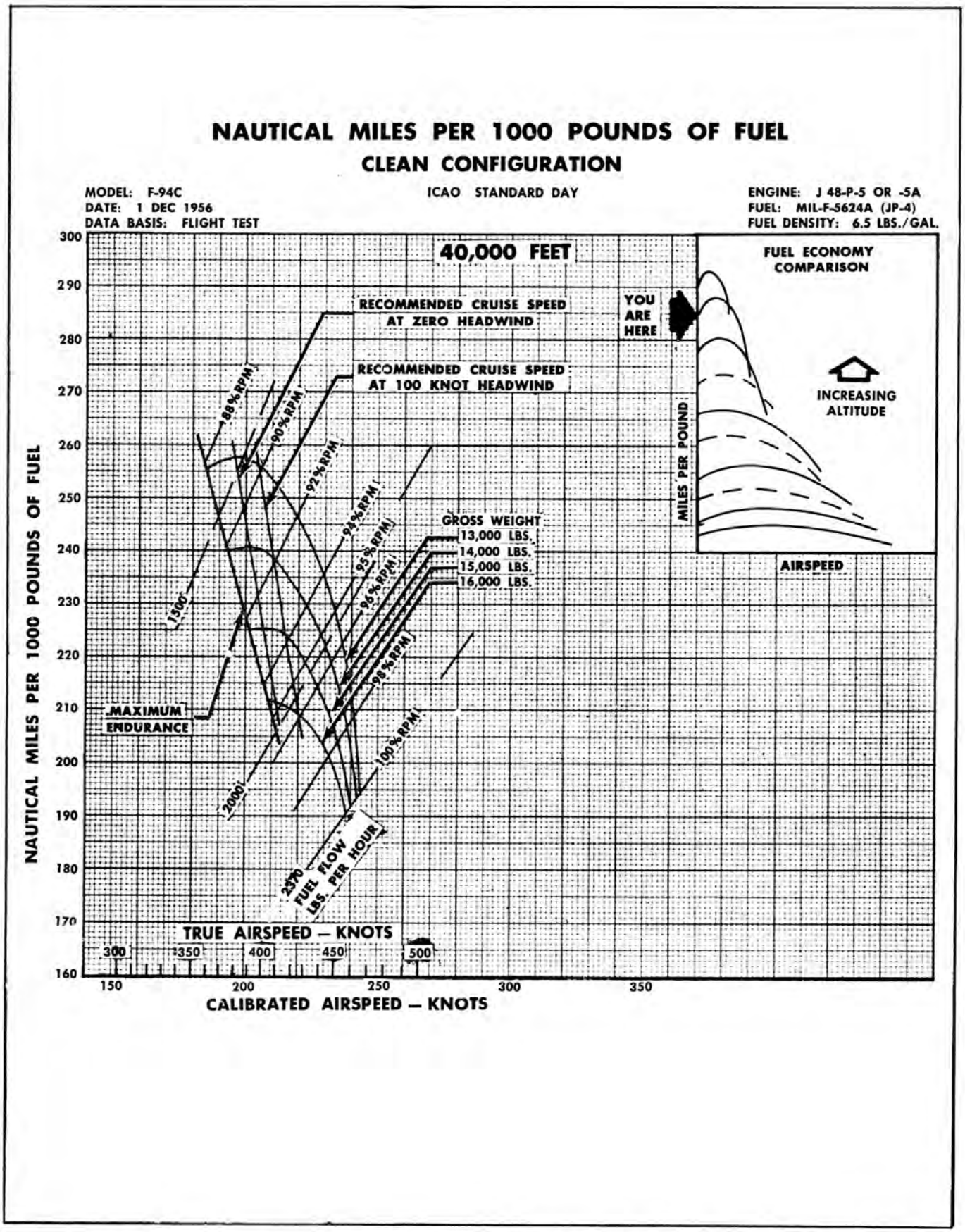


*Figure A9-12. Nautical Miles Per 1000 Pounds of Fuel—40,000 Feet—Tip Tanks—Tip Tanks and Rocket Pods*

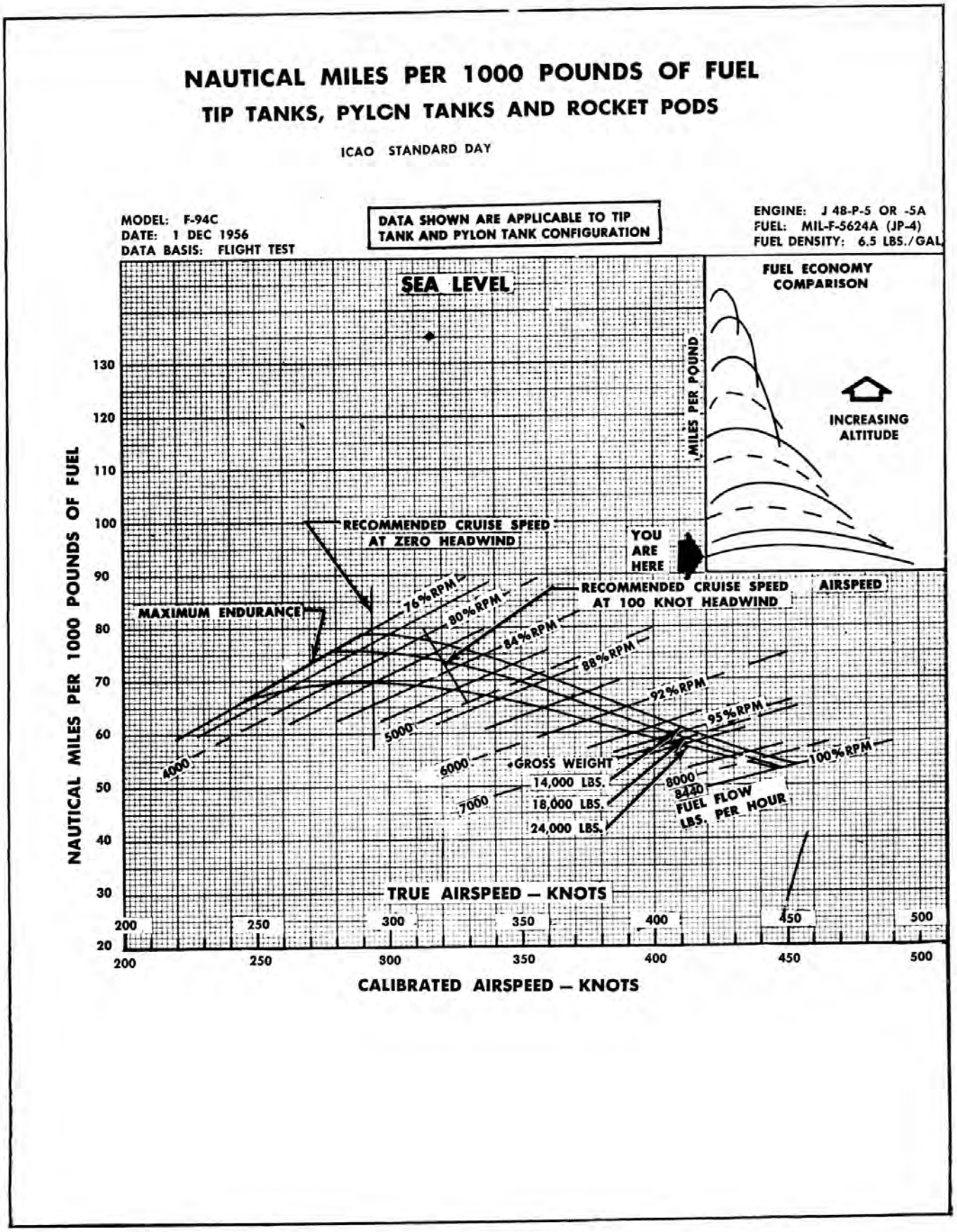


*Figure A9-13. Nautical Miles Per 1000 Pounds of Fuel—Sea Level—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods*

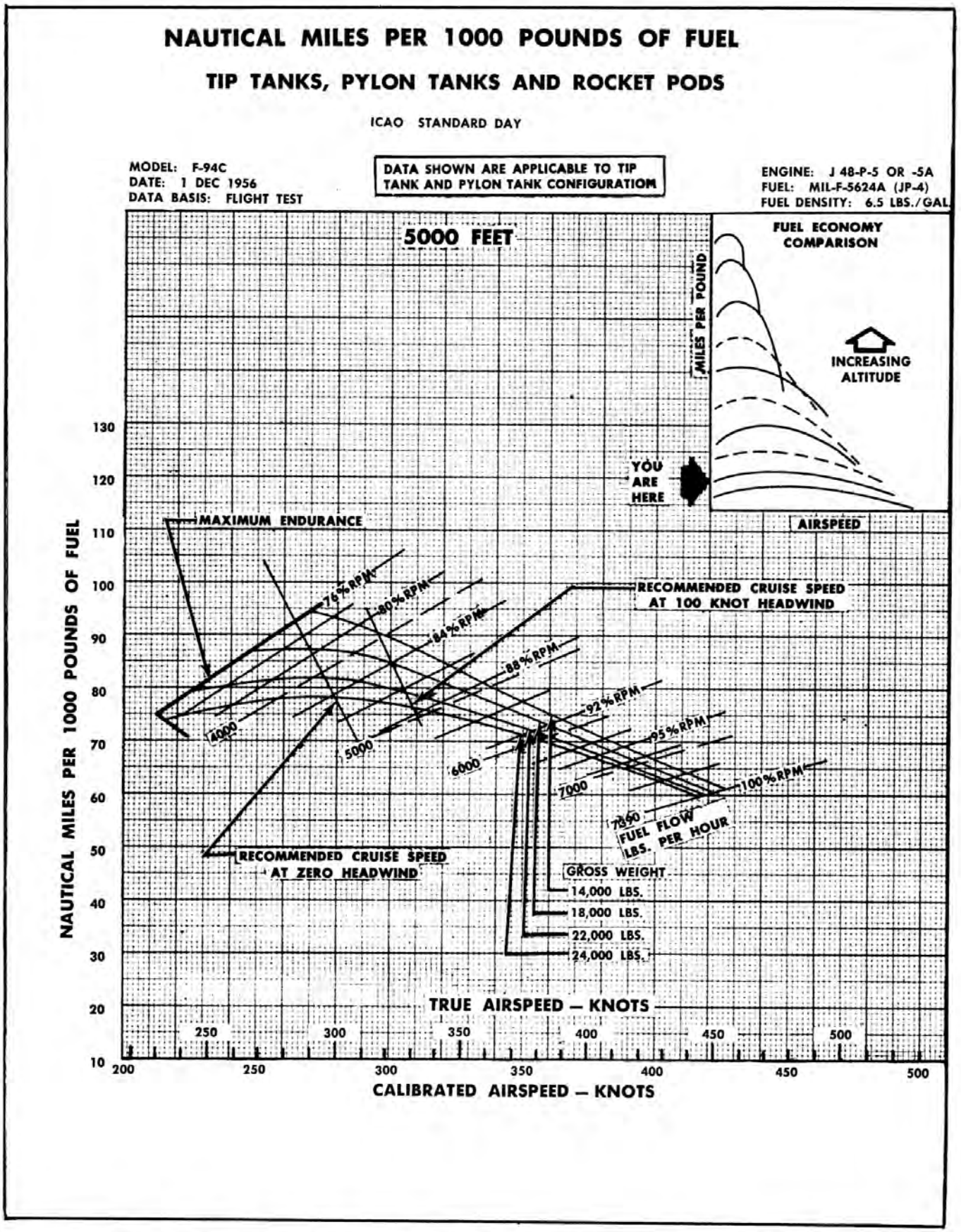


*Figure A9-14. Nautical Miles Per 1000 Pounds of Fuel—5000 Feet—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods*

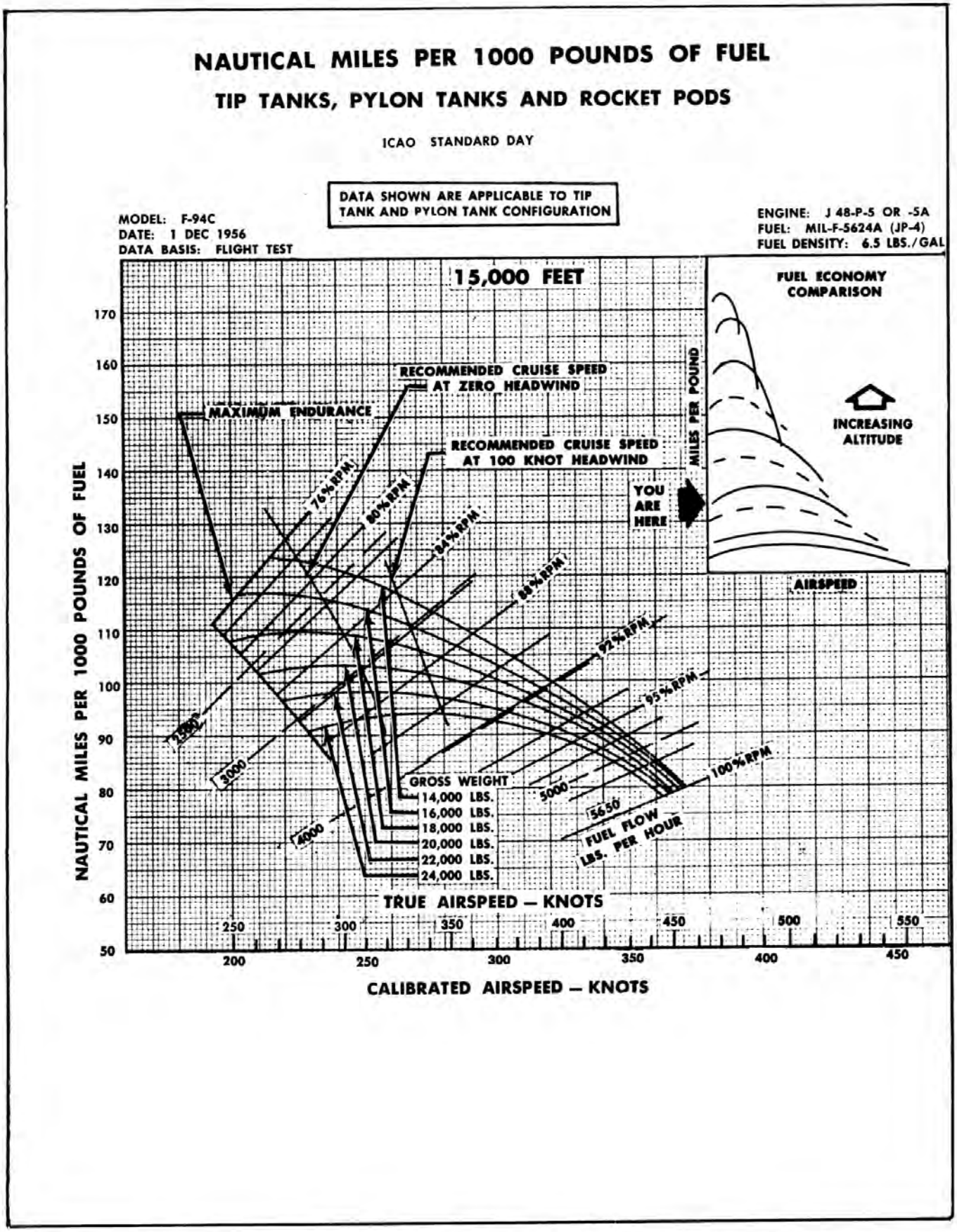


*Figure A9-15. Nautical Miles Per 1000 Pounds of Fuel—15,000 Feet—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods*

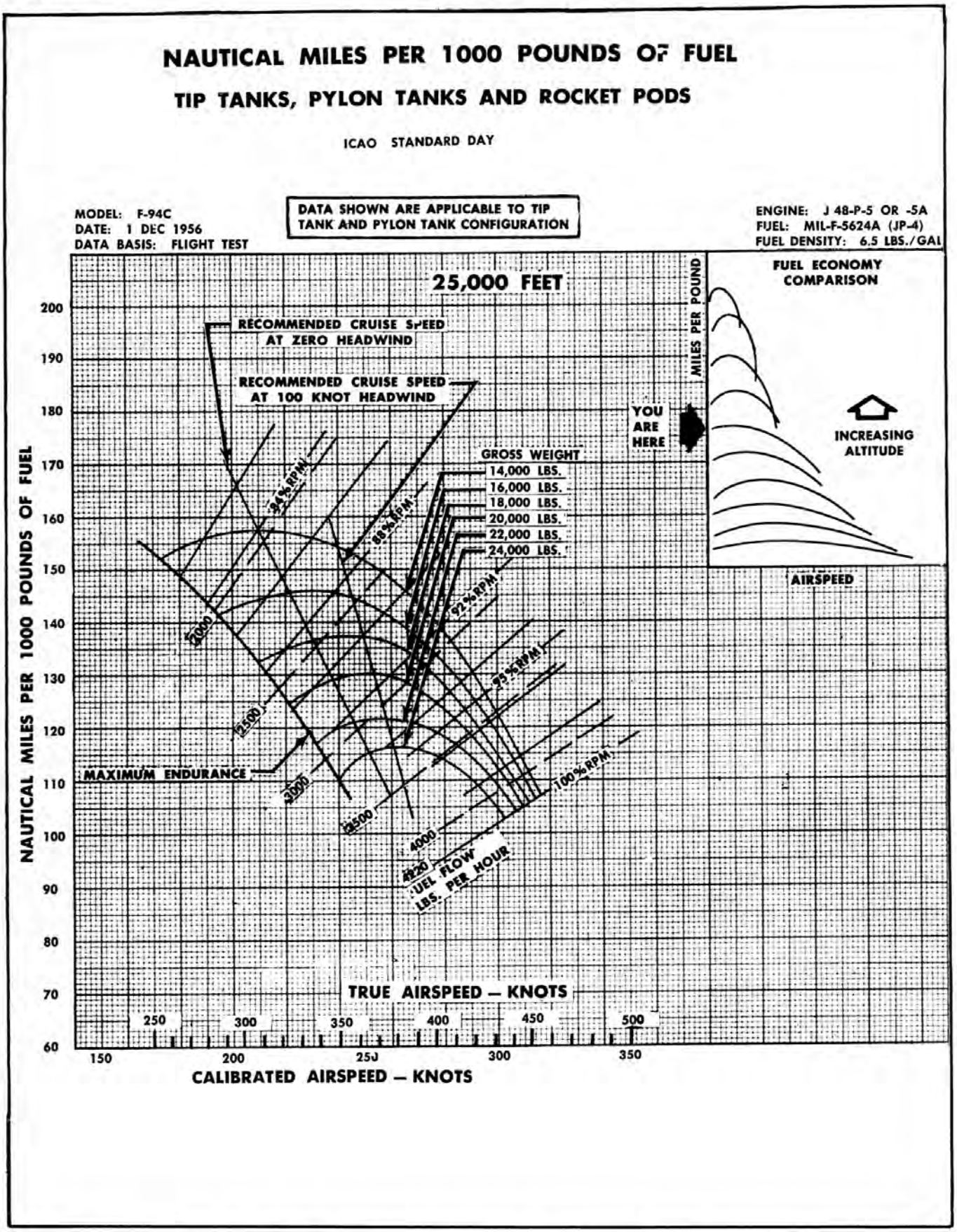


*Figure A9-16. Nautical Miles Per 1000 Pounds of Fuel—25,000 Feet—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods*

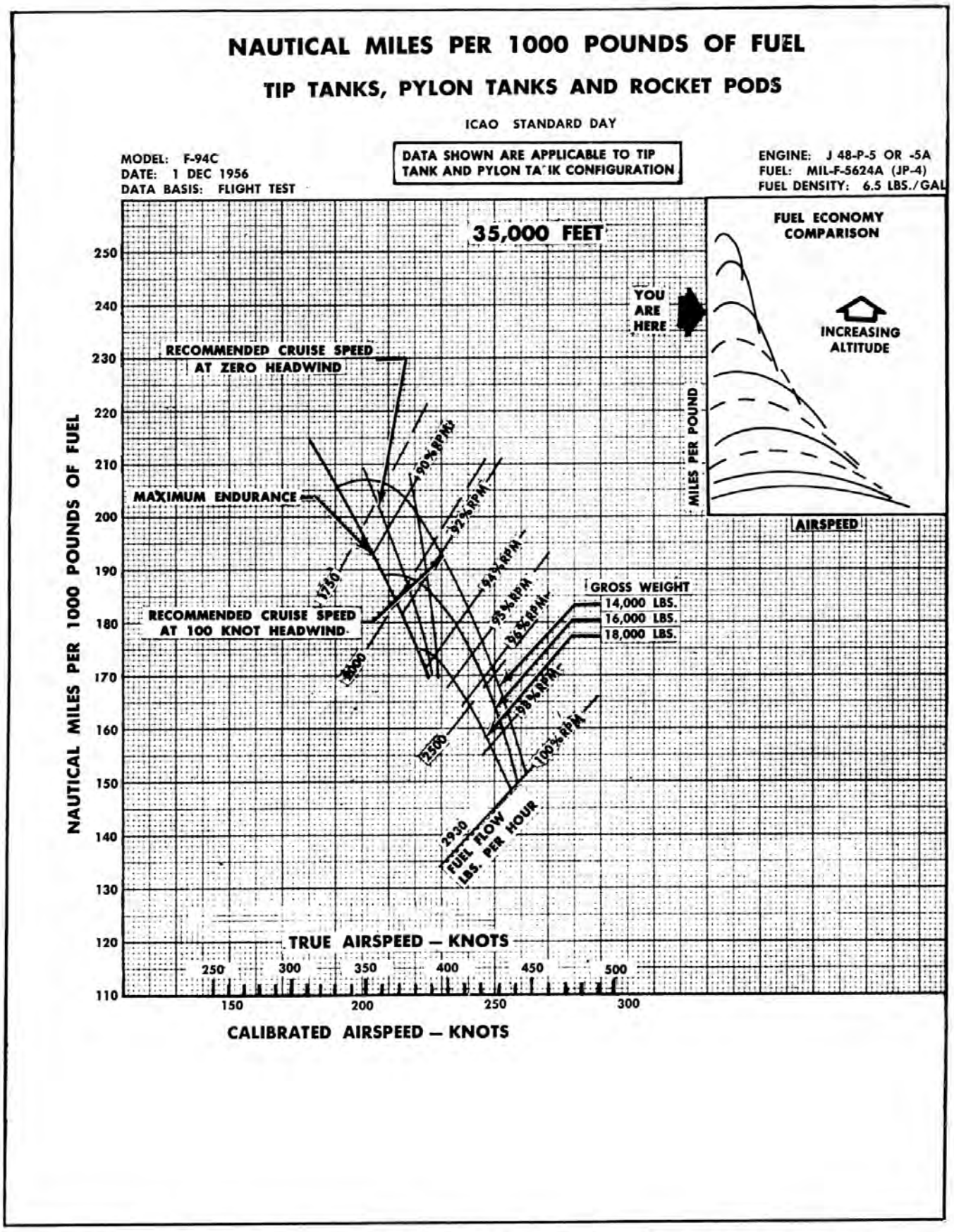


*Figure A9-17. Nautical Miles Per 1000 Pounds of Fuel—35,000 Feet—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods*

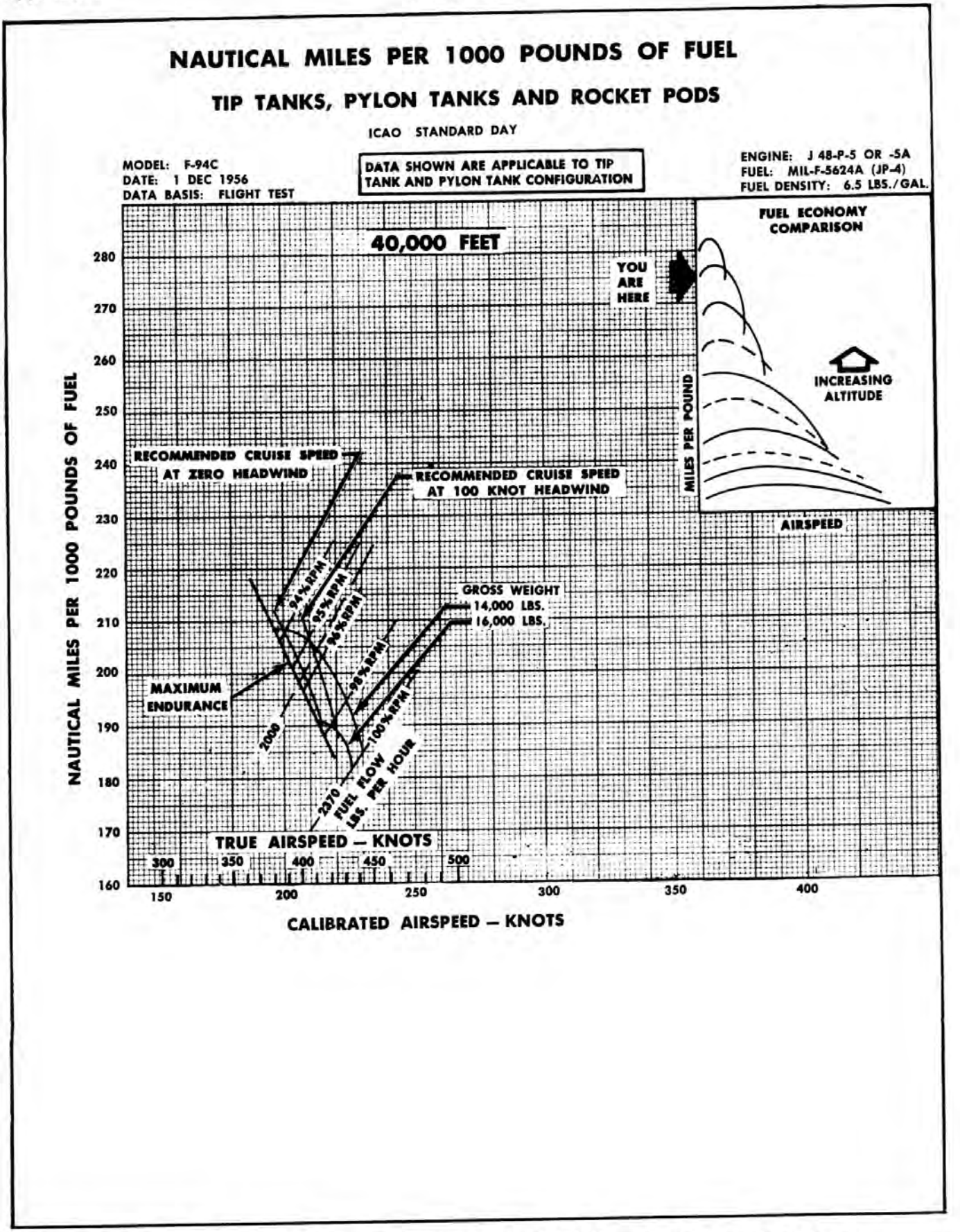


*Figure A9-18. Nautical Miles Per 1000 Pounds of Fuel—40,000 Feet—Tip Tanks and Pylon Tanks—Tip Tanks, Pylon Tanks and Rocket Pods*

# Part 10—Mission Planning

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## MISSION PLANNING

### NEED FOR MISSION PLANNING.

The high fuel consumption and wide range of operational speeds and altitudes of jet aircraft require that special emphasis be placed on mission planning. Accurate mission planning and constant checking of progress against the flight plan are necessary to obtain optimum use of the aircraft. During the flight the pilot should consider the difference from the planned fuel at various check points and apply the deviation to the reserve expected at destination. The most important factors to consider if results differ appreciably from the flight plan are:

Fuel used for ground maneuver, take-off, and acceleration to climb speed.

Deviation from recommended speed schedules.

Deviations in predicted winds and temperatures.

Faulty aircraft or instruments.

### MISSION PLANNING PROCEDURE.

The charts presented in parts 1 through 9 provide the performance information necessary to plan many different types of missions. The procedure for integrating the available performance information into a workable flight plan depends upon the type of mission involved. Two basic procedures are available. On many flights it may be necessary to report in at various check points and to make frequent changes in heading which result in changing wind components. Under these conditions the estimated distance, time, and fuel requirements of the aircraft will be needed for each leg of the flight. This requires a leg-by-leg cruise tabulation. This procedure is illustrated in Sample Mission No. 1. If the temperature and wind effects are small enough to be disregarded, the distance, time, and fuel requirements for each leg may be read directly from the Mission Profile Chart. The profile type charts eliminate many of the calculations required in the leg-by-leg procedure. The profile charts are especially applicable to long flights with constant wind components, or to flights that require maximum utilization of the aircraft through the use of proper climb, cruise, and loiter procedures. Sample Mission No. 2 illustrates how the profile charts may be combined for a mission of this type.

### SAMPLE MISSION NO. 1.

This sample mission illustrates how the performance charts are used in planning each leg of a flight. The sample flight plan involves a climb to 35,000 ft., cruise at 35,000 ft. until 400 nautical miles from take-off point, and return to base to make a total flight of 800 nautical miles. Estimated time and fuel requirements are needed at check points 200 nautical miles apart. The tip tank and rocket pod configuration is used. A military power climb is assumed.

Meteorological data:

Mean temperature in climb and descent (10° F above standard day) ..... $\Delta T = +10°$ F
Temperature at 35,000 ft. ..... −66° F (−54° C) (Standard Day)
Wind component for first 400 n. mi. ..... 60 kt. H.W.
Wind component for return legs ..... 60 kt. T.W.
Mean wind for descent ..... 30 kt. T.W.

**TAKE-OFF.**

The take-off performance is determined from Part 2 for a maximum power take-off. Data which would be needed if a heavy weight landing were to be made immediately after take-off are obtained from Part 8. The data are recorded as follows:

Conditions:

| | |
|---|---|
| Gross weight | 19,800 lbs. |
| Runway length | 6,500 ft. |
| OAT | 91°F. |
| Pressure altitude | 3,000 ft. |
| Wind | 20 kts. |

Take-off:

| | |
|---|---|
| Take-off distance | 3,500 ft. |
| Take-off speed | 145 kts. IAS |
| Take-off distance to clear 50 feet | 4,600 ft. |
| 50-foot obstacle speed | 158 kts. IAS |

**CLIMB.**

Climb performance is determined from Figure A3-5 for a 10°F hot day. Initial altitude is 3,000 ft. (field pressure altitude) and final altitude is 35,000 ft.

1. Initial climb weight: initial weight − take-off and acceleration allowance (19,800 lbs. − 500 lbs.) ..... 19,300 lbs.
2. Equivalent initial climb weight: weight + $\Delta W$ (19,300 lbs. + 1500 lbs.) ..... 20,800 lbs.
3. Final equivalent climb weight (at 35,000 ft.) ..... 19,400 lbs.
4. Fuel used to climb (20,800 lbs. − 19,400 lbs.) ..... 1400 lbs.
5. Distance to climb: final distance reading − initial distance reading (99 n. mi. − 4 n. mi.) ..... 95 n. mi.
6. Time to climb: final time reading − initial time reading (18 min. − 1 min.) ..... 17 min.

**CRUISE—FIRST LEG.**

Since 95 n. mi. are traveled in climb only 105 n. mi. remain before reaching the first 200 mile check point. The level flight cruise performance for 35,000 ft. is determined from Figure AD-11.

1. Initial cruise weight-fuel weight − take-off and climb fuel (19,800 lbs. − 500 lbs. − 1400 lbs.) ..... 17,900 lbs.
2. Recommended CAS ..... 228 kts.
3. True airspeed ..... 393 kts.
4. True ground speed (393 kts. − 60 kts. H.W.) ..... 333 kts.
5. Air n. mi./1000 lbs. (at 17,900 lbs. and recommended CAS) ..... 186 n. mi./1000 lbs.
6. Ground n. mi./1000 lbs. (air n. mi./1000 lbs. × VG/TAS) (186 × 333/393) ..... 157.5 n. mi./1000 lbs.
7. Fuel required for leg (ground distance ÷ ground n. mi./1000 lbs.) (103 ÷ 157.5) × 1000 ..... 0.654 × 1000 = 654 lbs.
8. Time for leg (ground distance ÷ ground speed) (103 n. mi. ÷ 333 kts.) ..... 0.309 Hr. (18 min.)
9. Total time for first 200 n. mi. (17 min. + 18 min.) ..... 35 min.

**CRUISE—SECOND LEG (200 n. mi.).**

The fuel and time requirements for this portion of the flight may be determined by using the above procedure. The cruise performance should be based on the initial gross weight for this 200 mile leg. If the leg were much longer than 200 miles it would be broken into several segments (of approximately 200 miles each) and the performance for each segment based on the initial weight for the segment.

1. Initial weight for leg (17,900 lbs. − 654 lbs.) ..... 17,246 lbs.
2. Air n. mi./1000 lb. (Figure A9-11 at 17,246 lbs. and 226 kts. CAS) ..... 191 n. mi./1000 lbs.
3. Ground n. mi./gal. (191 × 333/393) ..... 162 n. mi./1000 lbs.
4. Fuel required for leg (200 n. mi. ÷ 162 n. mi./1000 lbs.) ..... 1.230 × 1000 or 1230 lbs.
5. Time for leg (200 n. mi. ÷ 333 kts.) ..... 0.6 hrs. (36 min.)

**CRUISE—THIRD LEG.**

The data for this 200 n. mi. return leg is determined as before except that a 60 knot tailwind is present.

1. Initial weight for leg (17,246 lbs. − 1230 lbs.) ..... 16,016 lbs.
2. Air n. mi./1000 lbs. at 16,016 lbs. and 221 knots CAS ..... 203 n. mi./1000 lbs.
3. Ground speed (393 kts + 60 kt. T.W.) ..... 453 kts.
4. Ground n. mi./1000 lbs. (203 × 453/393) ..... 234 n. mi./1000 lbs.
5. Fuel required for leg (200 n. mi. ÷ 234 n. mi./1000 lbs.) ..... 0.855 × 1000 or 855 lbs.
6. Time for leg (200 n. mi. ÷ 453 kts.) ..... 0.442 hr. (26 min.)

**CRUISE—FINAL LEG.**

The aircraft is now 200 n. mi. from the base. The time, distance and fuel required for the descent from 35,000 ft. to 3000 ft. must be found before the cruise portion of the final leg can be determined. Maximum rate descent data may be found from Figure A7-2.

1. Time to descent (0.86 min.) ..... approx. 1 min.
2. Fuel to descend ..... 11 lbs.
3. Distance to descend (without wind) ..... 4.3 n. mi.
4. The final 200 n. mi. leg is composed of a 196 n. mi. cruise at 35,000 ft. and maximum rate descent. The level flight cruise data are determined as before and only the results are given here.
5. Fuel required for 196 n. mi. ..... (820 lbs.)
6. Time for 196 n. mi. ..... 0.433 hr. (26 min.)
7. Total fuel for leg (11 lbs. + 820 lbs.) ..... 831 lbs.
8. Total time for leg (26 min. + 1 min.) ..... 27 min.

**LANDING.**

The landing performance (with drag chute) is determined from Part 8.

Conditions:

Gross weight ..... 14,330 lbs.

Runway length ..... 6,500 ft.

OAT ..... 91°F

Pressure altitude ..... 3,000 ft.

Wind ..... 20 kts.

Landing:

Total distance to clear 50 foot obstacle ..... 2,900 ft.

50 foot obstacle speed ..... 138 kts. IAS

Landing ground roll ..... 1,900 ft.

Touchdown speed ..... 128 kts. IAS

**SUMMARY.**

The estimated performance for each leg may be summarized and tabulated on a flight plan for convenient in-flight use.

## SAMPLE PROBLEM NO. 2.

This sample problem illustrates how the profile charts may be integrated to form a complete flight plan. A rather complicated combat type mission is to be flown involving the flight sequence presented below. Temperature and wind effects have been adequately discussed previously and are not included in this example. Initial fuel loading is 5629 pounds (tip tanks and rocket pods installed).

Flight Sequence:

1. Cruise at 30,000 ft. until 200 n. mi. from take-off point.
2. Maximum rate descent to 10,000 ft.
3. Simulated combat at 10,000 ft. for 5 minutes.
4. Loiter at optimum loitering altitude for 5 minutes.
5. Return to take-off point using cruise-climb procedure.

Solution:

1. From the Mission Profile (Figure A4-2) at 30,000 ft. and 200 nautical miles determine—

   Fuel required ..... 2400 lbs.

   Time for leg ..... 33.5 min.

2. From the Descent Chart (Figure A7-2) determine the descent performance from 30,000 feet to 10,000 feet—

   Fuel required .....7 lbs.

   Time to descend .....0.5 min.

   Distance traveled .....2.5 n. mi.

3. Fuel remaining is 5629 lbs. − 2400 lbs. − 7 lbs. .....3222 lbs.

4. From Combat Allowance Chart (Figure A6-2) determine fuel required for 5 minutes of combat at 10,000 ft. and military power .....540 lbs.

5. From Optimum Maximum Endurance Chart (Figure A5-2) at an initial fuel load of (3222 − 540 lbs.) 2682 lbs., determine—

   Optimum loitering altitude .....30,500 ft.

   Total time to climb and loiter for 5 min. (1 hr. 17 min. − 1 hr.) .....17 min.

   Fuel remaining at end of loiter .....1950 lbs.

6. From Optimum Return Chart (Figure A4-8) determine return cruise performance. Initial altitude is 30,500 ft. with 1950 lbs. of fuel remaining.

   Distance to travel (200 n. mi. + 2.5 n. mi.) .....202.5 n. mi.

   Initial distance reading .....375 n. mi.

   Time to climb to optimum cruise-climb altitude .....7 min.

   Initial time reading at cruise-climb altitude....52 min.

   Final distance reading (375 n. mi. − 202.5 n. mi.) .....172.5 n. mi.

   Final fuel remaining over take-off point.....800 lbs.

   Final time reading over take-off point.....0:6 min.

   Time for leg (52 min. − 0:6 min. + 0:2.5 min.) .....48.5 min.

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