Extra

FLIGHT MANUAL
RT-33A
USAF SERIES RT-33A AIRCRAFT

COMMANDERS ARE RESPONSIBLE FOR BRINGING THIS TECHNICAL PUBLICATION TO THE ATTENTION OF ALL PERSONNEL CLEARED FOR OPERATION OF T-33A AIRCRAFT.

PUBLISHED UNDER THE AUTHORITY OF THE SECRETARY OF THE AIR FORCE

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CURRENT FLIGHT CREW CHECKLISTS

1T-33(R)A-CL-1-1 1 APRIL 1962

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EXPOSURE TIME 240 SECONDS

SCOPE. This manual contains the information necessary for safe and efficient operation of the RT-33A. These instructions provide you with a general knowledge of the airplane, its characteristics, and specific normal and emergency operating procedures. Your flying experience is recognized, and therefore, basic flight principles are not discussed.

SOUND JUDGMENT. Instructions in this manual are for a pilot inexperienced in the operation of the airplane. This manual provides the best possible operating instructions under most circumstances, but it is not a substitute for sound judgment. Multiple emergencies, adverse weather, terrain, etc. may require modification of the procedures presented herein.

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

STANDARDIZATION AND ARRANGEMENT. Standardization procedures ensure that the scope and arrangement of all flight manuals are identical. The manual is divided into ten fairly independent sections to simplify using it as a reference manual. The first three sections must be read thoroughly and be understood fully before attempting to fly the airplane. The remaining sections provide important information for safe and efficient mission accomplishment.

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

CHECKLISTS. The Flight Manual contains only amplified checklists. Condensed (abbreviated) checklists have been issued as separate technical orders. See the back of the title page for T. O. number and date of your latest checklist. Line items in the Flight Manual and checklists are identical with respect to arrangement and item number. Whenever a Safety of Flight Supplement affects the condensed (abbreviated) checklist, write in the applicable change on the affected checklist page. As soon as possible a new checklist page, incorporating the supplement, will be issued. This will keep hand-written entries of Safety of Flight Supplement information in your checklist to a minimum.

HOW TO GET PERSONAL COPIES. Each flight crew member is entitled to personal copies of the Flight Manual, Safety of Flight Supplements, and Checklists. The required quantities should be ordered before you need them to ensure their prompt receipt. Check with your supply personnel. It is their job to fulfill your Technical Order requests. Basically, you must order the required quantities on the Publication Requirements Table (T. O. 0-3-1). Technical Orders 00-5-1 and 00-5-2 give detailed information for properly ordering these publi-

cations. Make sure a system is established at your base to deliver these publications to the flight crews immediately upon receipt.

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

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

WARNING

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

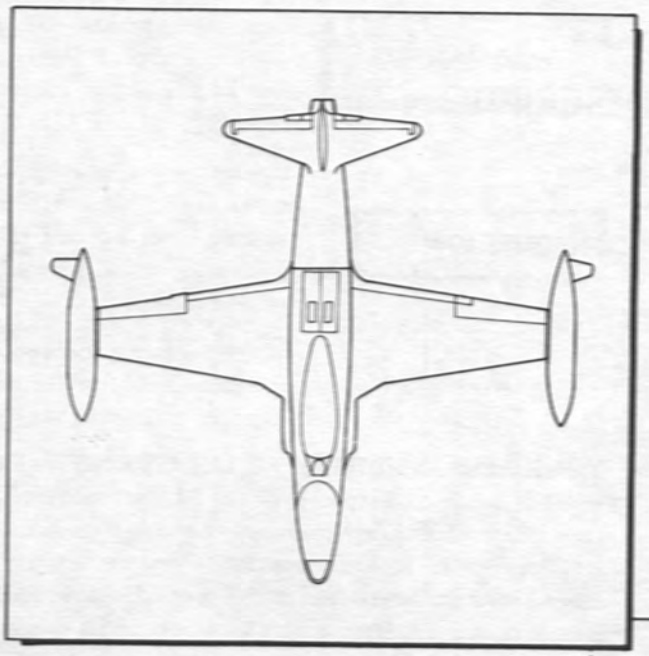
CAUTION

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

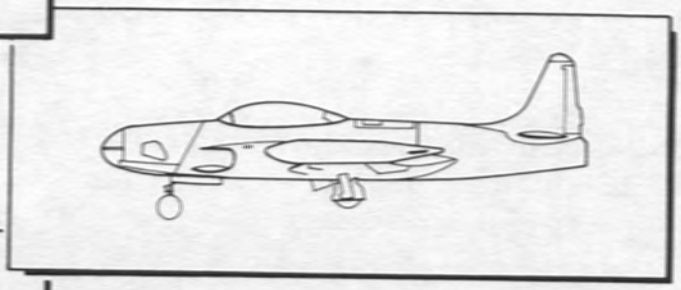
Note

An operating procedure, condition, etc., which it is essential to highlight.

YOUR RESPONSIBILITY TO LET US KNOW. Every effort is made to keep the Flight Manual current. Review conferences with operating personnel and a constant review of accident and flight test reports ensure inclusion of the latest data in the manual. However, we cannot correct an error unless we know of its existence. In this regard, it is essential that you do your part. Comments, corrections, and questions regarding this manual or any phase of the Flight Manual program are welcomed. These should be forwarded through command headquarters to SMAMA, McClellan AFB, California, attn: SMNEO.



RT-33A the airplane



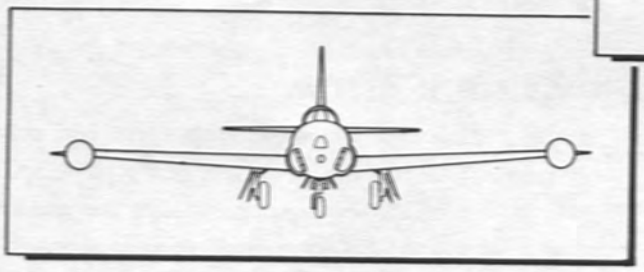


Figure 1-1

Section I – DESCRIPTION

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THE AIRCRAFT.

The RT-33A is a jet-propelled, single place version of the T-33A aircraft with an enlarged nose section to accommodate photographic equipment. The aft cockpit area contains an additional bladder-type fuel cell with a usable capacity of 165 gallons. (See figure 1-2.)

DIMENSIONS.

The overall dimensions of the aircraft are as follows:

Wing Span (with tip tanks)	38.9 feet
Fuselage Length	37.5 feet
Height (to top of fin)	11.7 feet

GROSS WEIGHT.

The design gross weight (full useful load with empty tip tanks and normal camera equipment) is approximately 12,735 pounds. The alternate takeoff weight (full useful load with full 230-gallon tip tanks and normal camera equipment) is approximately 15,725 pounds. Add 150 pounds for heaviest camera equipment.

ENGINE.

The aircraft is powered by a J33-A-35 centrifugal compressor turbojet propulsion engine rated at 4600 pounds minimum static thrust before installation in the aircraft.

ENGINE FUEL SYSTEM.

The engine incorporates two independent fuel control systems fed by a dual engine-driven, gear-type pump. The main section of the dual pump supplies the main fuel control unit and the emergency section supplies the emergency fuel control unit. The pump is so designed that in the event of failure of the main pump section, the emergency section can provide adequate fuel through the emergency fuel control unit. Changeover from main to emergency fuel control units is accomplished manually by operating a switch. Fuel from the emergency section of the pump is normally bypassed to the pump inlet, but is available in case of loss of main pump pressure. (See figure 1-3.)

STARTING FUEL CONTROL.

A starting fuel control is included for automatic fuel metering during start. This provides simplified engine starting and controlled acceleration to idling speed.

MAIN FUEL CONTROL UNIT.

The main fuel control unit is a wide-range governor operated by the throttle. The unit is compensated to

general arrangement diagram

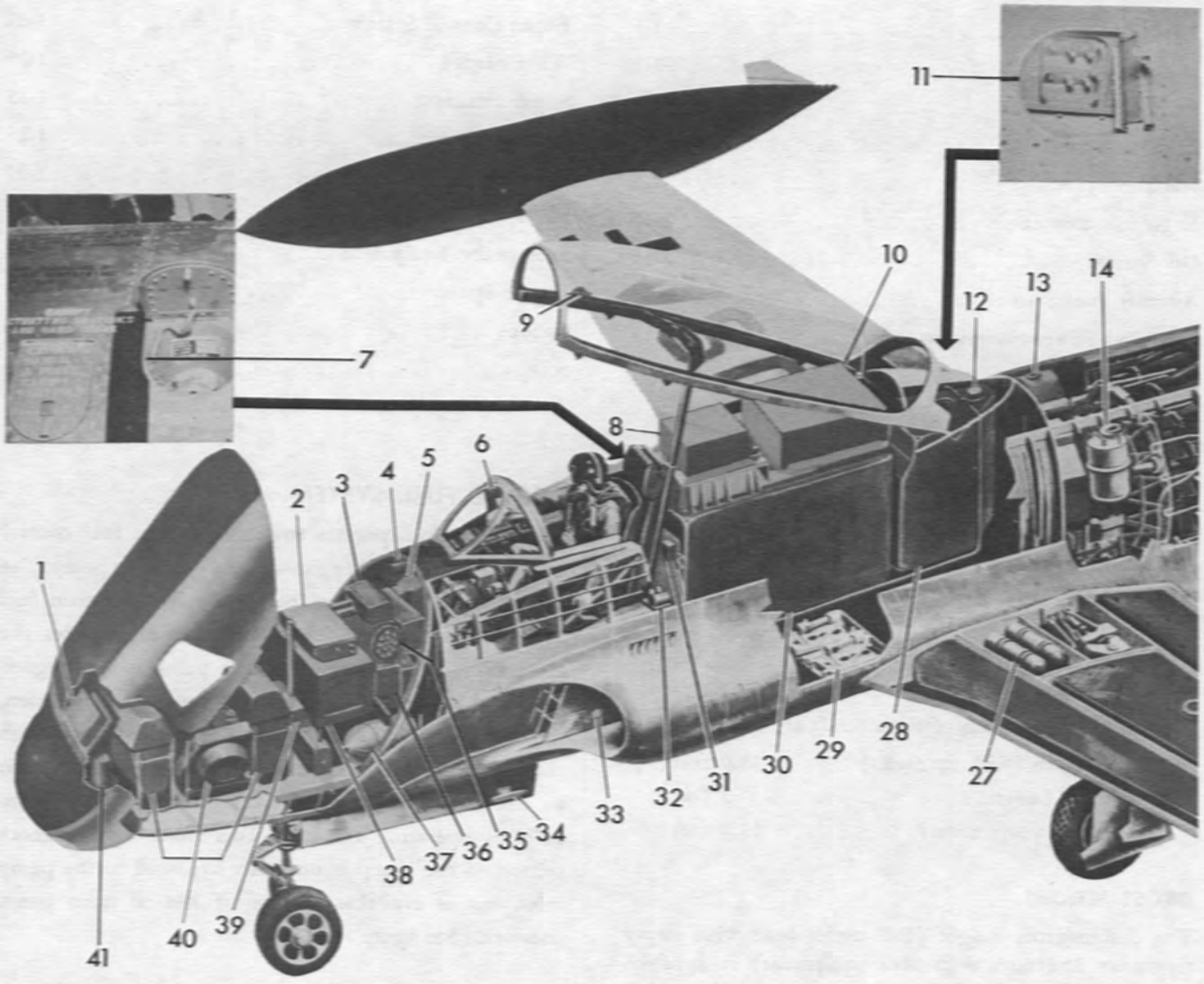

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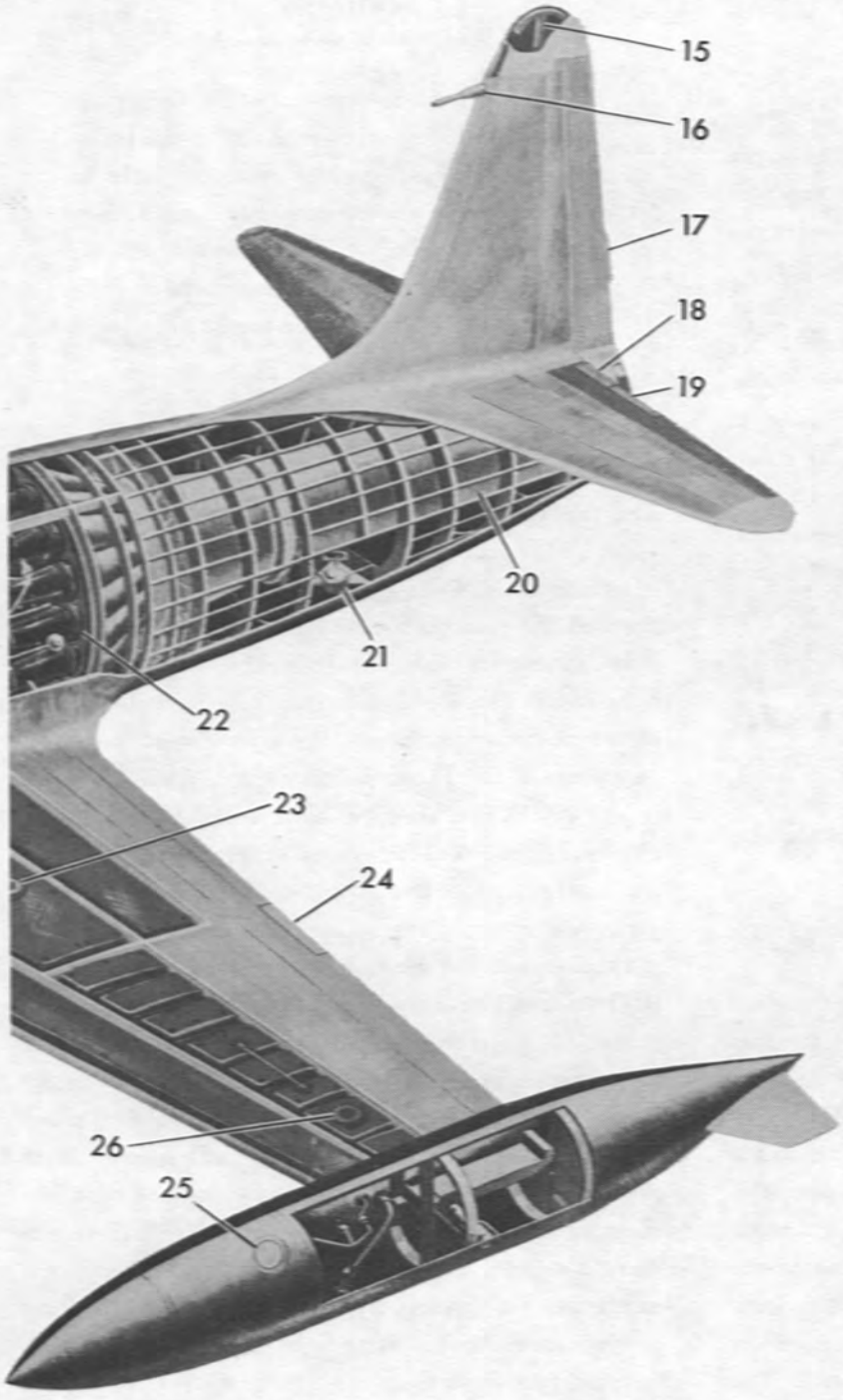
Figure 1-2 Sheet 1



1. AN/ANH-2 WIRE RECORDER
2. CAMERA JUNCTION BOX
3. AN/ARN-12 MARKER BEACON RECEIVER
4. PRESSURE INSTRUMENT INVERTER
5. BRAKE FLUID RESERVOIR
6. STANDBY COMPASS
7. EMERGENCY HYDRAULIC SYSTEM FLUID, FILLER CAP
8. AN/ARC-27 TRANSCEIVER
9. COCKPIT LIGHT
10. AN/ARN-6 ADF RECEIVER
11. EXTERNAL POWER RECEPTACLE
12. FUSELAGE FUEL TANKS FILLER CAP
13. DE-ICER FLUID TANK AND FILLER CAP
14. MAIN HYDRAULIC SYSTEM FLUID RESERVOIR
15. AN/ARC-27 ANTENNA
16. PITOT HEAD
17. RUDDER BEND TAB
18. ELEVATOR SPRING TAB
19. ELEVATOR TRIM TAB
20. TAIL PIPE
21. REMOTE COMPASS
22. J-33 ENGINE
23. WING FUEL TANKS FILLER CAP
24. AILERON TRIM TAB
25. TIP FUEL TANK FILLER CAP
26. LEADING EDGE FUEL TANK FILLER CAP
27. D-2 TYPE OXYGEN CYLINDERS (2 PLACES)
28. AFT FUSELAGE TANK
29. SPEED BRAKES
30. FWD FUSELAGE FUEL TANK
31. C-823/AIC-10 CONTROL BOX
32. AN/AIC-10 DYNAMOTOR
33. OXYGEN FILLER
34. OUTSIDE AIR TEMPERATURE SENSING HEAD
35. STANDBY 250 VA INVERTER
36. AN/APX-25 IFF EQUIPMENT
37. F-1 TYPE OXYGEN CYLINDERS (2 PLACES)
38. BATTERY RACK
39. A-18 MAGAZINE AMPLIFIER
40. CAMERA BAYS
41. AN/ARN-6 ADF LOOP ANTENNA

Figure 1-2 Sheet 2

limit maximum engine speed, to maintain approximately constant rpm regardless of airspeed or altitude, to limit acceleration temperature, and to limit engine deceleration to that required to maintain combustion. To do this it controls the amount of fuel delivered to the combustion chambers, bypassing any fuel in excess of that required for the throttle setting, engine speed, altitude, and airspeed.

EMERGENCY FUEL CONTROL UNIT.

The emergency fuel control is mechanically linked to the throttle and the main fuel control. This unit provides manual alternate control of engine power for use in the event of failure of the main side of the engine-driven pump or of the main fuel control system. It consists of a throttle valve, an altitude-compensated (or barometric) relief valve, and a solenoid-operated bypass valve (spring-loaded open). The relief valve is adjusted to provide 100% engine rpm on the ground on a 100°F day. Available full throttle rpm will vary with free-air temperature and altitude. When the free-air temperature is above 86°F care must be exercised to prevent engine rpm from exceeding 100%. The altitude compensator attempts to maintain constant engine rpm for a given throttle setting regardless of airspeed and altitude. In the event of a complete electrical failure the engine can be operated only on the main fuel control. The emergency fuel control is not available because the solenoid-operated bypass valve is spring-loaded open, and requires electrical power to hold it closed.

THROTTLE.

The throttle lever (24, figure 1-7) regulates the main and emergency fuel control units which meter the fuel pressure to the engine combustion chambers and the resulting fuel flow determines engine speed. When the throttle is in the OFF (full aft) position, all fuel to the engine is shut off unless the starting fuel control is energized. During an automatic start when the throttle is moved to the IDLE position, a cutoff switch in the throttle linkage at the main fuel control unit will open, interrupting the circuit to the solenoid-operated inlet valve and drip valve of the starting fuel control. The throttle slot is staggered to provide straight fore and aft motion in the operating range between IDLE and FULL, while an outboard and aft motion is required when moving from IDLE to the OFF position. The speed brakes switch and the microphone button are installed on the throttle lever. Throttle friction may be adjusted by turning the throttle friction control knob (23, figure 1-7) on the left console.

CAUTION

Do not move the throttle out of the OFF position except during starts with the engine rotating at a minimum of 26% rpm and flame or ignition in the combustion chambers. Otherwise fuel will drain or be pumped through the engine and may collect in the tailpipe in sufficient quantity to create a fire hazard at the next start attempt.

Emergency Fuel Switch.

The emergency fuel switch, located on the instrument panel (51, figure 1-6), is a two-position toggle switch placarded NORMAL and EMERGENCY. It controls the solenoid-operated bypass valve (spring-loaded open) in the emergency fuel control unit, the solenoid-operated bypass valve (spring-loaded closed) in the main element of the dual fuel pump, and the operation of the emergency fuel system amber indicator light. With the switch in the NORMAL position both main and emergency elements of the dual fuel pump supply fuel to the main and emergency fuel control units, respectively; the emergency fuel control bypasses fuel back to the inlet side of the fuel pump, and the main fuel control meters fuel to the burners. The emergency fuel system indicator light is out. The starting fuel switch must be OFF or the throttle must be in the IDLE to FULL range before the bypass valve in the main element of the dual fuel pump can be energized by the emergency fuel switch. With the switch in the EMERGENCY position the main element of the dual fuel pump bypasses fuel; therefore, there is no fuel flow to the main fuel control unit, the emergency fuel control bypass valve is closed, and the fuel system amber indicator light is illuminated. Consequently, fuel flows from the emergency fuel control to the burners. The manual changeover function and the operation of the emergency fuel control can be ground-checked by placing the emergency fuel switch in the EMERGENCY position while the engine is operating.

WARNING

If the emergency fuel system is selected while the starting fuel switch is in AUTO, excessive fuel flow will result, causing overtemperature and overspeeding of the engine.

Emergency Fuel Checkout Switch.

(This switch is disconnected.)

Emergency Fuel System Indicator Light.

An emergency fuel system amber indicator light (51, figure 1-6), located on the instrument panel, will illuminate whenever the emergency fuel switch is in the EMERGENCY position and during all starts.

IGNITION SYSTEM.

The system consists of an ignition control unit, ignition coils, and spark plugs. The spark plugs are used for initiating combustion in engine combustion chambers 7 (bottom) and 14 (top). The ignition system and starting motor are energized for the proper 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. Ignition for air starting, independent of the starter system, is supplied through the air start ignition switch.

Ignition Switch.

A dc-powered ignition switch (1, figure 1-8) is located on the right shelf in the cockpit; it has two positions, NORMAL and OFF. When in the NORMAL position, ignition is supplied through a relay in the starter circuit. When the switch is in the OFF position, the starter motor can be operated without ignition. During a start the ignition switch should be left in the OFF position until engine rpm has reached 9%. By waiting until the engine is thus turning fairly rapidly, with a good airflow, the possibility of igniting residual fuel collected in the tailpipe is eliminated.

Air Start Ignition Switch.

The air start ignition switch (12, figure 1-7), located on the left side panel of the cockpit, has two positions, START and OFF (spring-loaded). When the switch is operated to START and released, ignition will be provided for approximately 45 seconds regardless of whether or not the starter is used, provided only that the ignition switch is in the NORMAL position.

STARTING SYSTEM.

An external electric power source, capable of enough power to turn the engine at a speed of at least 9% rpm is necessary for starting. The starting unit output must be 28 volts and be set between 800 and 1200 amperes. A setting of 1200 amperes is recommended, resulting in a cooler start. Any amperage output between 800 and 1200 may be used if the unit will not deliver 1200. The aircraft batteries may be capable of starting the engine, depending on condition and state of charge. However, battery starts are not recommended and should be resorted to only under emergency situations.

Starter Switches.

The dc-powered starter switch (2, figure 1-8), located on the right shelf of the cockpit, has a START and STOP–START position and is spring-loaded to the center NEUTRAL position. When the switch is operated to START and held for 3 seconds, the starting motor and ignition system (provided the ignition switch is in the NORMAL position) are energized until engine speed increases to 17% to 19% rpm; at this point a relay opens, disconnecting both the starter and ignition system. The STOP–START position provides a means of stopping the starting cycle immediately by overriding the automatic relay. It is only necessary to hold the switch in this position momentarily.

STARTING FUEL SYSTEM.

Two starting fuel control systems (automatic and manual) are provided (figure 1-3). The automatic system provides controlled acceleration during the initial starting phase and should be used in preference to the manual system for ground starts.

Starting Fuel Switch.

The dc-powered starting fuel switch (11, figure 1-7), located on the left shelf, has three positions, OFF, AUTO, and MAN. The switch is guarded to the OFF position and must be left there at all times except during the

engine fuel system

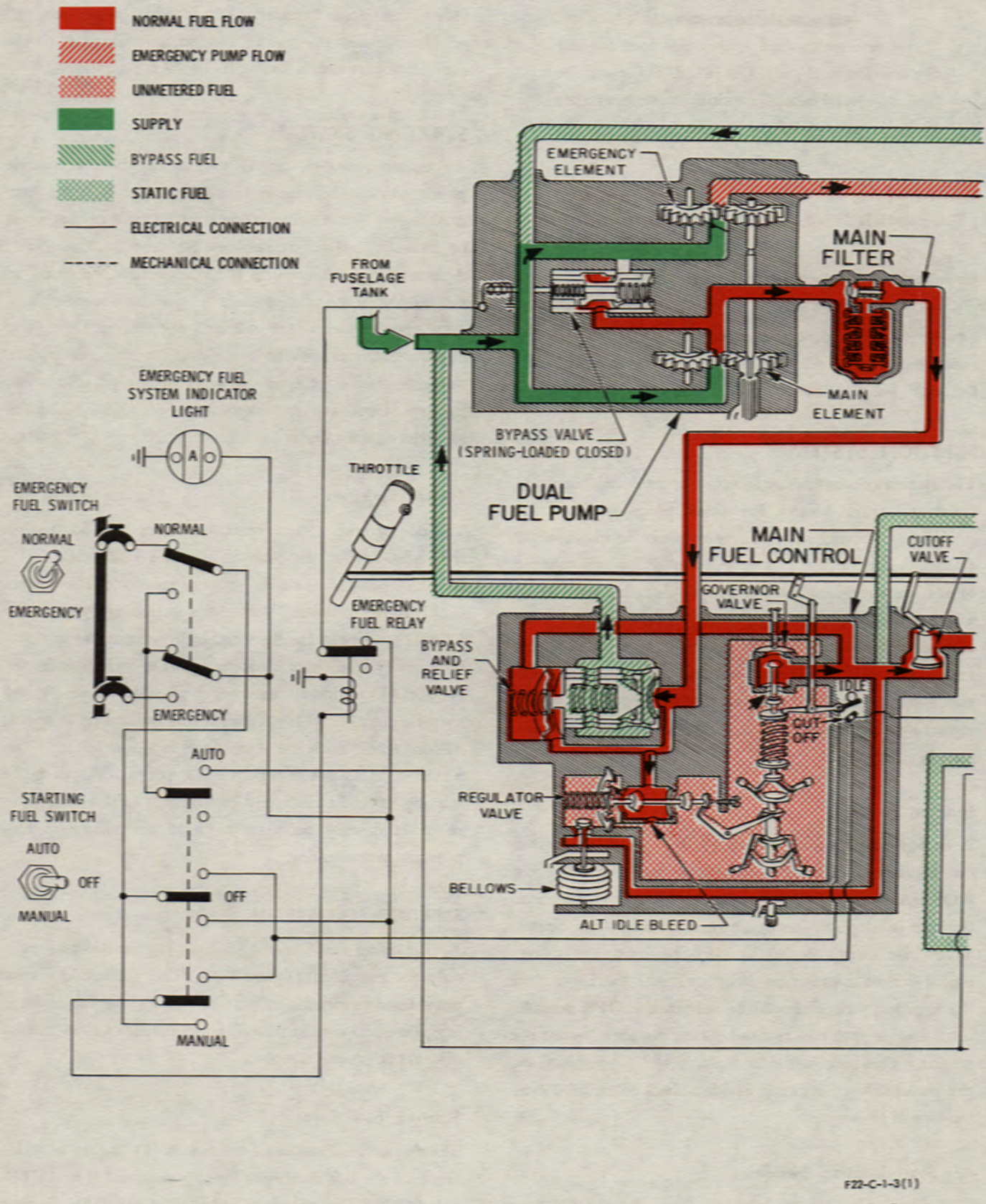


Figure 1-3 Sheet 1

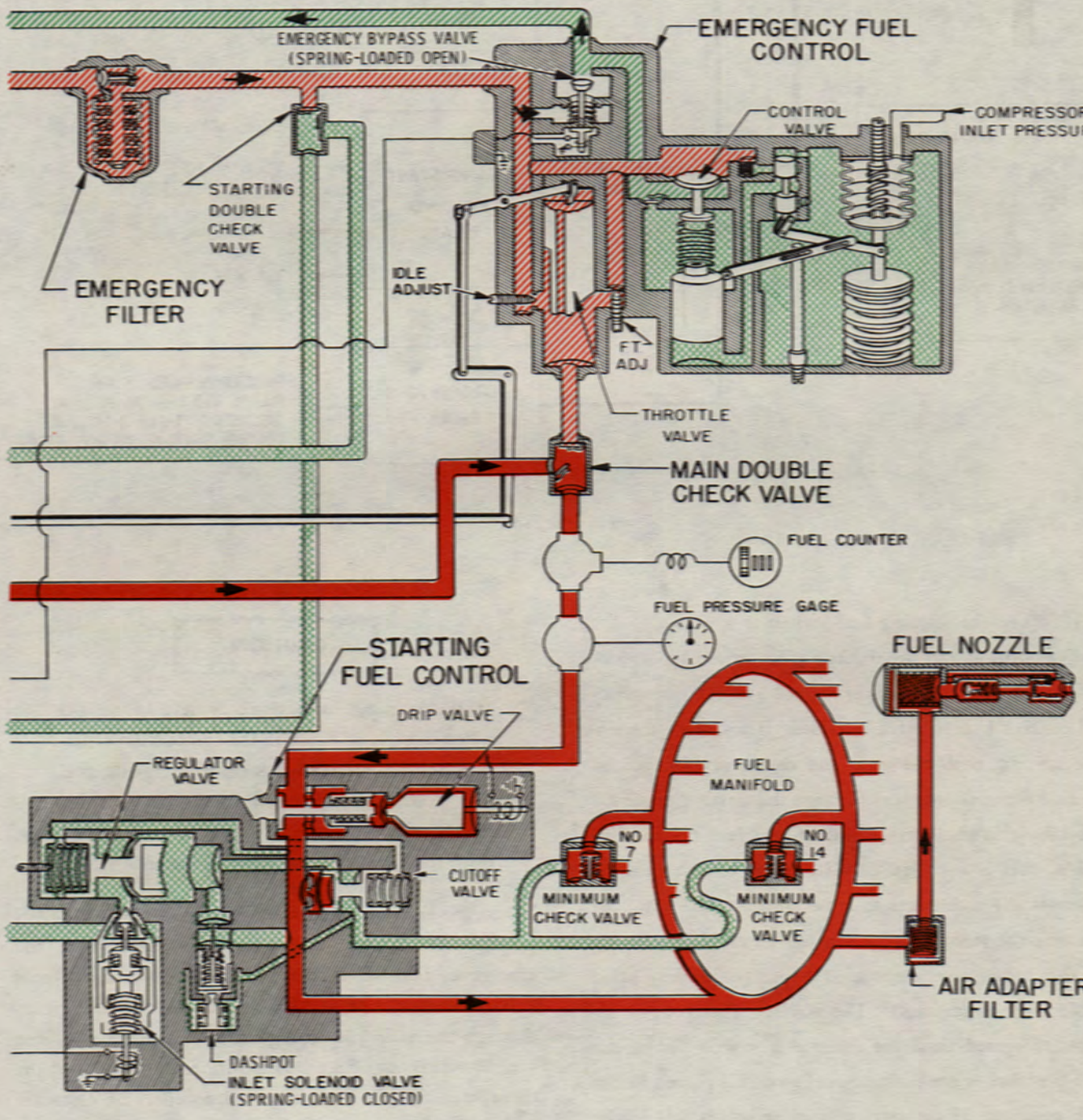


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Figure 1-3 Sheet 2

gang start system

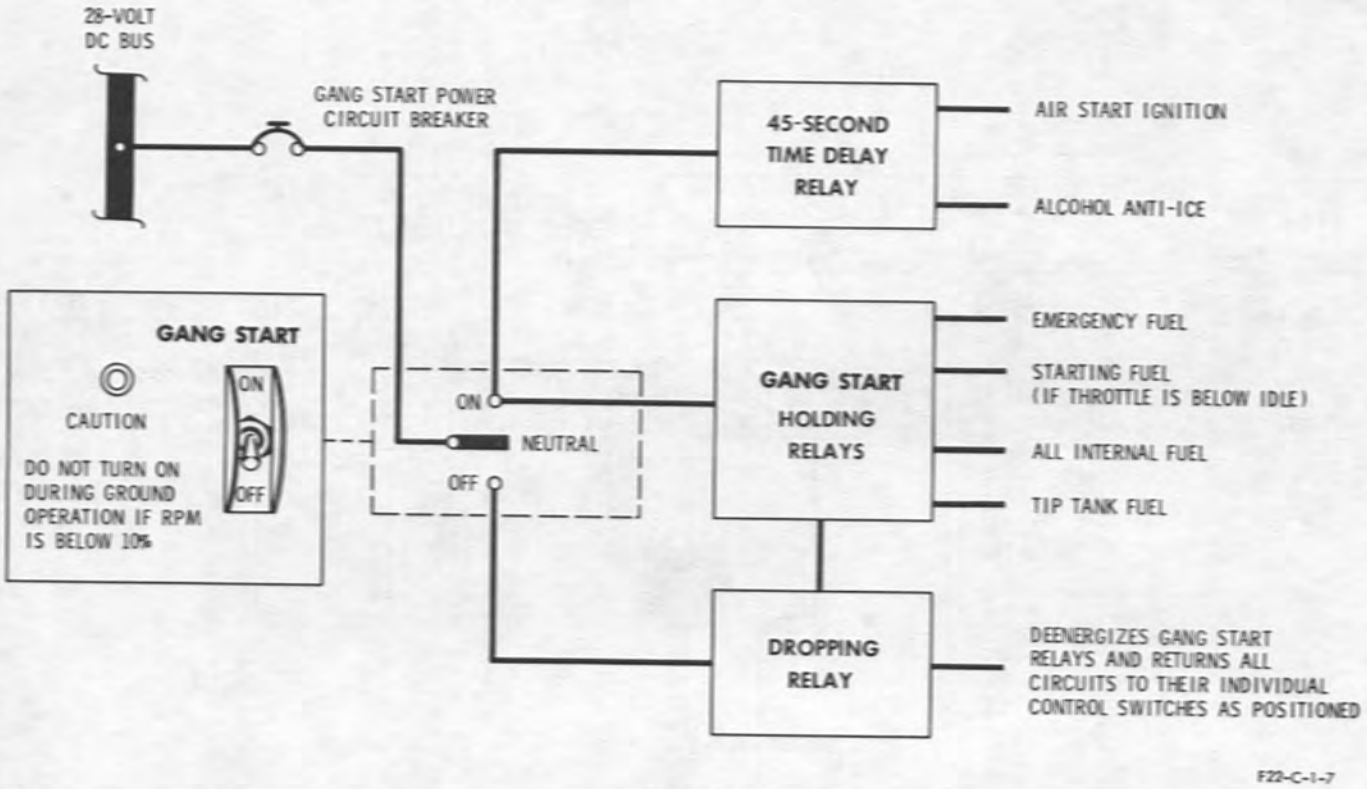


Figure 1-4

start. When the starting fuel switch is operated to the AUTO position and the throttle is in the OFF position, the starting fuel control is energized and the emergency fuel control bypass valve is closed. Thus, with the engine turning, both the main and emergency sections of the dual pump supply fuel through the starting manifold to combustion chambers 7 and 14. As fuel pressure increases, fuel is supplied to all burners and the engine automatically accelerates to approximately 26% rpm. At this time the throttle should be moved to IDLE causing the rpm to increase to about 35% rpm (depending upon ambient air conditions). The starting fuel control remains energized until the throttle is moved out of the OFF position or the starting fuel switch is placed in the OFF position. If the starting fuel switch is left in the AUTO position, the automatic starting system will operate whenever the throttle is retarded to OFF.

CAUTION

If the starting fuel switch is left in AUTO when there is no flame in the combustion chambers and the electrical system is energized, fuel will drain or be pumped through the engine into the tailpipe or out of the manifold drain onto the ground, creating a fire hazard.

When the starting fuel switch is operated to the MAN position, the starting fuel control is deenergized, the emergency fuel bypass valve is closed, the main bypass valve remains closed, and fuel is fed to all of the burners through the main and emergency fuel controls provided the throttle is out of the OFF position. Movement of the throttle to the IDLE position has no effect on electrical sequencing because the starting fuel control is not used in manual starts. If the switch is left in the MAN position after starting, both the main and emergency fuel

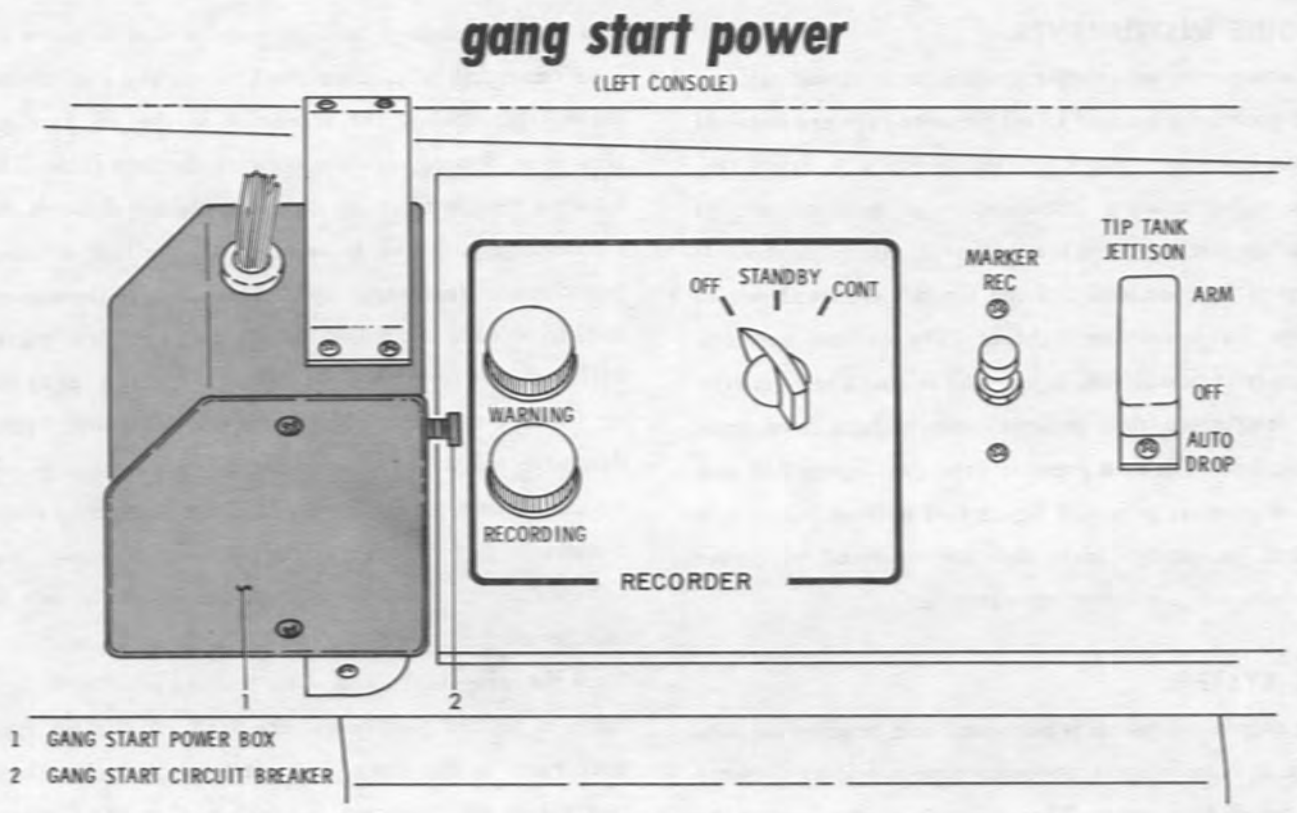


Figure 1-5

FZ2-C-1-8

systems will continue to supply fuel. Under this condition, overspeeding is very likely to occur because there is no governor protection; the idling speed also will be excessively high.

GANG START SYSTEM.

The gang start system consists of a single pilot-operated switch which is connected in parallel, through various relays and associated circuits, to all of the systems necessary for effecting an air start. This system makes it possible to make an air start using only the gang start switch and the throttle provided the dc bus is energized and the ignition switch is in the NORMAL position. Refer to Section VII for gang start system operation.

Gang Start Switch.

The gang start switch (49, figure 1-6) is located on the instrument panel. It receives its electrical power from the dc bus. The switch has three positions, ON (momentary up), NEUTRAL (spring-loaded center position), and OFF (momentary down). Refer to figure 1-4 for the functions of the switch positions.

Note

- Regardless of the position of the normal aircraft switches except ignition, the ON position of the gang start switch provides 45–60 seconds of alcohol, turns on the emergency fuel system, turns on starting fuel (if throttle is OFF), and turns on main wing boost pumps, leading edge boost pumps, and the tip tanks. Except for ignition and anti-ice, all these items will remain on until the gang start switch is turned off.
- When the dc bus is deenergized, the gang start holding relays return to neutral, disengaging the gang start system.

Gang Start Indicator Light.

The gang start indicator light is located adjacent to the gang start switch. The light illuminates, and remains on (indicating that the gang start system is energized), whenever the gang start switch is momentarily held in the ON position.

Gang Start Power Box.

The gang start power box (figure 1-5) contains the relays for the gang start system. The box is located on the left side aft of the AN/ANH-2 wire recorder. The forward side of the box contains the gang start circuit breaker.

ENGINE INSTRUMENTS.

A tachometer, an exhuast gas temperature indicator, a fuel pressure gage, and an oil pressure gage are installed on the instrument panel. The tachometer (23, figure 1-6) is a self-generating instrument that indicates engine speed in percentage of the maximum allowable rpm. It operates independently of the aircraft electrical system except for instrument lighting. The exhaust gas temperature indicator (24, figure 1-6) is also a self-generating instrument that indicates temperature in degrees centigrade. The fuel pressure gage (25, figure 1-6) and the oil pressure gage (28, figure 1-6) indicate pressure in pounds per square inch; they are operated by power from the pressure instruments inverter.

OIL SYSTEM.

The engine oil system is automatic and requires no controls. It is an integral, wet-sump type providing pressure and splash lubrication. The oil supply is contained in the accessory drive gear housing. A pressure gage (28, figure 1-6) is located on the instrument panel. Oil level in the reservoir may be determined by a graduated dipstick located on the right side of the accessory drive gear housing. The reservoir holds 12 quarts of oil. (Refer to the Servicing Diagram, figure 2-5, for oil specifications.)

AIRCRAFT FUEL SYSTEM.

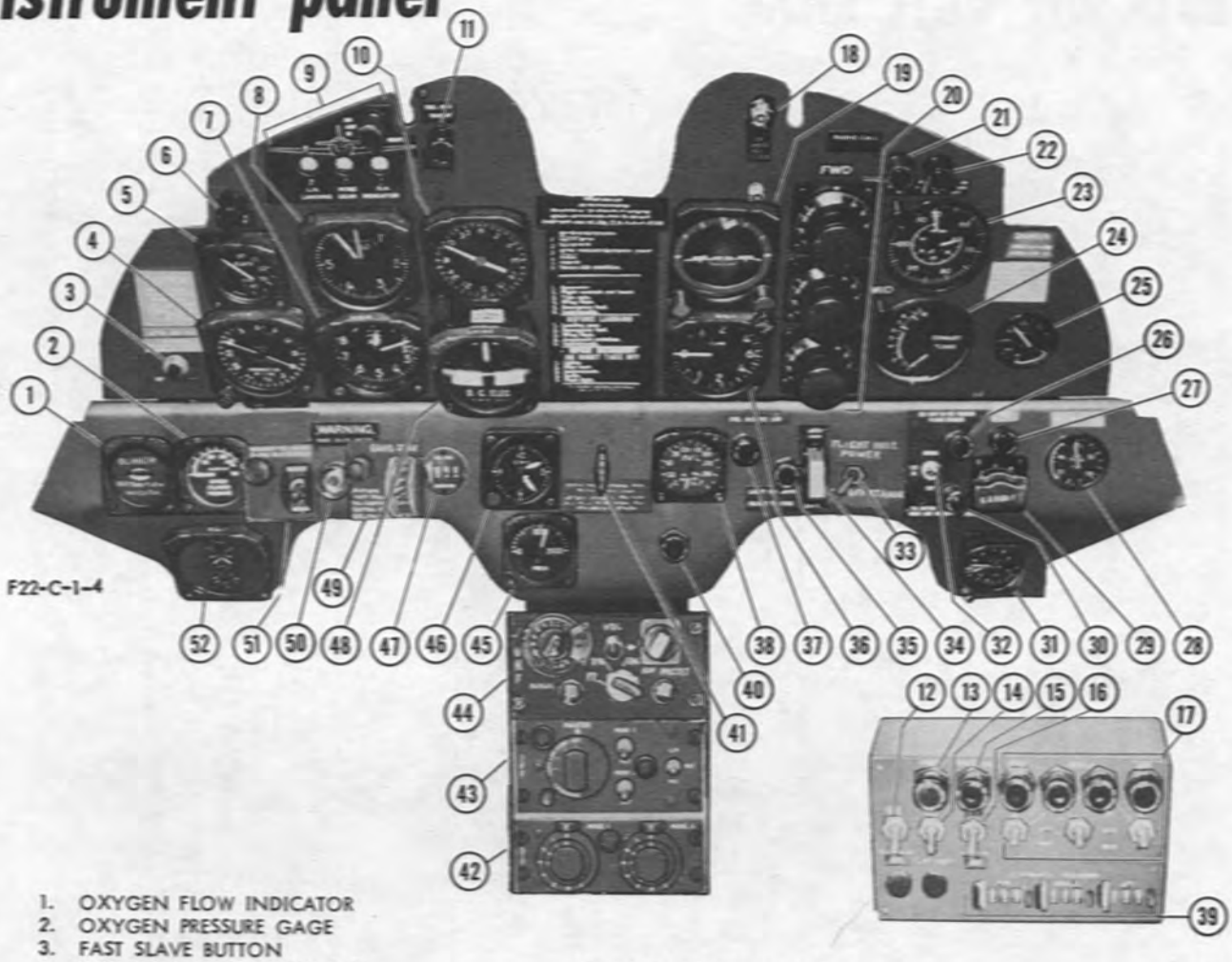
Fuel is carried in four groups of tanks as shown in figure 1-10. Jettisonable 230-gallon centerline tip tanks are normally carried. There are two groups of fuel cells located within the wings. The fuel cells forward of the front wing spar are designated as the leading edge group and have a capacity of 52 gallons for each wing. The fuel cells located in the inboard wing section between the main spars are designated as the wing tank group; each wing tank group has a capacity of 77 gallons. The fuselage group comprises two fuel cells, a 165-gallon tank located in the cockpit area immediately aft of the pilot's seat, and a 95-gallon fuselage tank installed just aft of the cockpit area. The forward fuselage tank feeds into the aft fuselage tank by gravity flow through an interconnecting tube. Two check valves and a standpipe prevent fuel below the standpipe in the aft fuselage tank from flowing into the forward fuselage tank. The forward tank is filled by a reverse process through the aft fuselage tank and standpipe. All the fuel is transferred to the aft fuselage tank before going to the engine. Fuel transfer is controlled automatically by float valves within the aft fuselage tank. When the fuel level in the aft fuselage tank drops below the level of a float valve, the valve opens and admits fuel from the tank group associated with the valve, provided the tank-group selector switch is turned on. The locations of these float valves determine that fuel from the tip tanks will be transferred first, from the leading edge tanks next, and from the wing tanks last. The leading edge tank float valve is located just below the level of the tip tank float valve in the top of the aft fuselage tank. These two valves will maintain the fuel level in the fuselage tank when their respective tank selector switches are turned on. The wing tank float valve opens at the 109-gallon level so that the CG will not exceed its forward limit during fuel transfer. The fuselage tank level is maintained at each float valve level until that tank group is empty.

A pressure switch is incorporated in the supply line from each tank group. When a tank group empties, the pressure drop causes a red indicator light, located above the tank selector switch, to glow, indicating that the switch may be turned off. Turning a tank selector switch to OFF extinguishes the indicator light and turns off the corresponding booster pump. However, the tip tank selector switch should be left on so that air pressure from the engine compressor will prevent the tanks from collapsing during a rapid descent. (Refer to Section VII for fuel system operation.)

FUEL SPECIFICATIONS AND GRADES.

Refer to the servicing diagram (figure 2-5) for fuel specifications and grades.

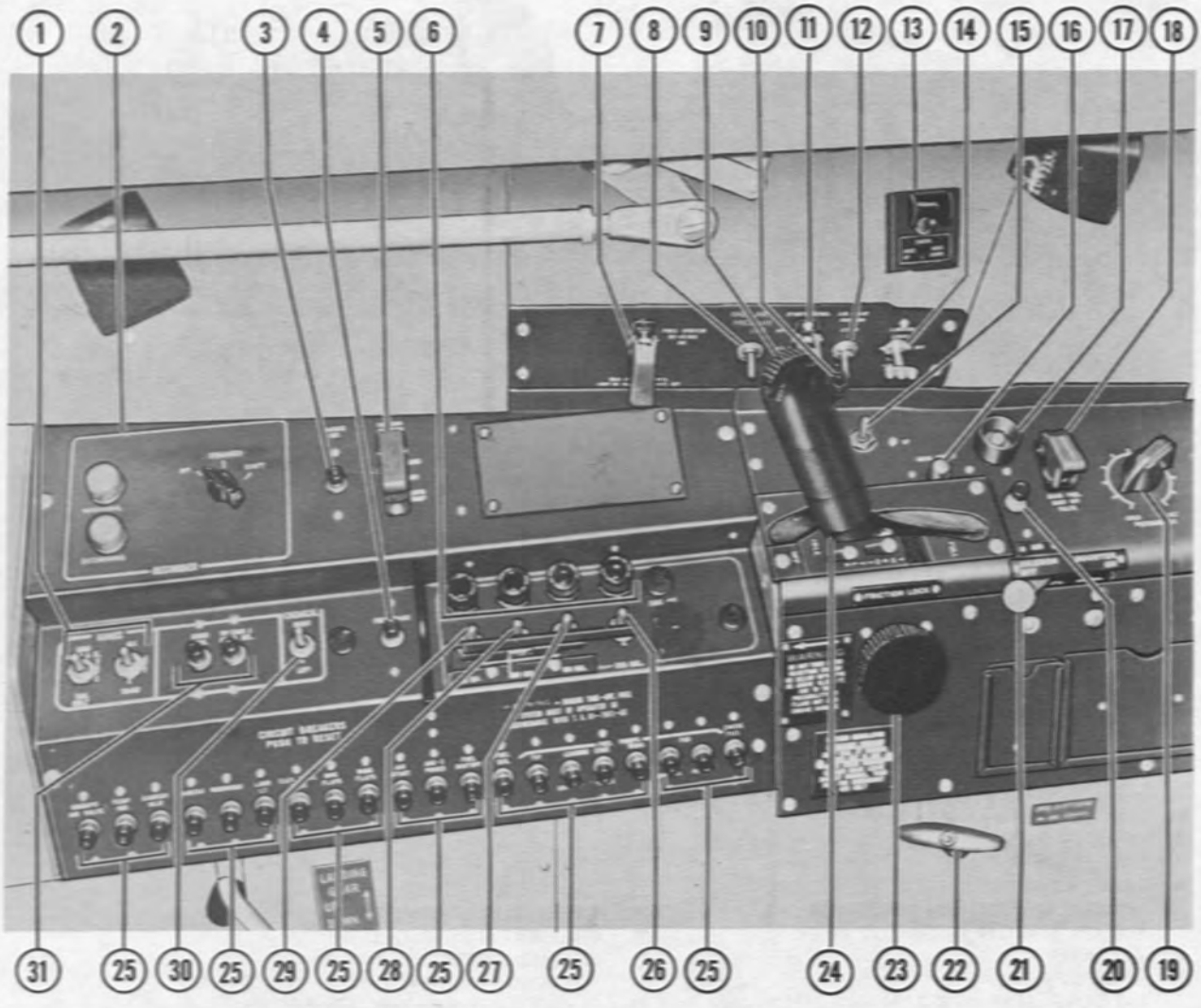
instrument panel



1. OXYGEN FLOW INDICATOR
2. OXYGEN PRESSURE GAGE
3. FAST SLAVE BUTTON
4. RADIO COMPASS INDICATOR
5. WING FLAP POSITION INDICATOR
6. MARKER BEACON INDICATOR LIGHT
7. ALTIMETER
8. AIRSPEED INDICATOR
9. LANDING GEAR POSITION INDICATOR AND UNSAFE WARNING LIGHT
10. DIRECTIONAL INDICATOR
11. FUEL DE-ICER WARNING LIGHT
12. CAMERA RUNAWAY SWITCH
13. CAMERA BAY OVERHEAT WARNING LIGHT
14. CAMERA TEMPERATURE CONTROL SWITCH
15. CAMERA POWER INDICATOR LIGHT
16. CAMERA POWER SWITCH
17. CAMERA CONTROL SWITCHES AND INDICATOR LIGHTS
18. CANOPY UNLATCHED WARNING LIGHT
19. ATTITUDE INDICATOR
20. INTERVALOMETERS
21. GYRO INSTRUMENT WARNING LIGHT
22. TURN-AND-SLIP INSTRUMENT WARNING LIGHT
23. ENGINE TACHOMETER
24. EXHAUST GAS TEMPERATURE GAGE
25. ENGINE FUEL PRESSURE GAGE
26. FIRE WARNING LIGHT
27. GENERATOR-OUT WARNING LIGHT
28. OIL PRESSURE GAGE
29. GENERATOR LOADMETER
30. OVERHEAT WARNING LIGHT
31. ACCELEROMETER
32. FIRE AND OVERHEAT CIRCUIT TEST SWITCH
33. FLIGHT INSTRUMENT POWER SWITCH
34. JATO ARMING SWITCH
35. JATO READY INDICATOR LIGHT
36. VERTICAL VELOCITY INDICATOR
37. FUSELAGE FUEL TANK, FUEL RESERVE LOW, WARNING LIGHT
38. FUSELAGE FUEL TANKS QUANTITY GAGE
39. FILM EXPOSURE COUNTERS
40. ELEVATOR TABS NEUTRAL INDICATOR LIGHT
41. PACKING BRAKE HANDLE
42. C1128/APX-25 CONTROL PANEL
43. C-1158/APX-25 CONTROL PANEL
44. C-1904/ARC-24 CONTROL PANEL
45. HYDRAULIC PRESSURE GAGE
46. CLOCK
47. FUEL QUANTITY COUNTER
48. TURN-AND-SLIP INDICATOR
49. GANG START SWITCH AND INDICATOR LIGHT
50. BOMBS (OR TANKS) SALVO BUTTON
51. EMERGENCY FUEL SYSTEM SWITCH AND INDICATOR LIGHT
52. CAMERA AIR TEMPERATURE AND OUTSIDE AIR TEMPERATURE GAGE

Figure 1-6

cockpit—left side

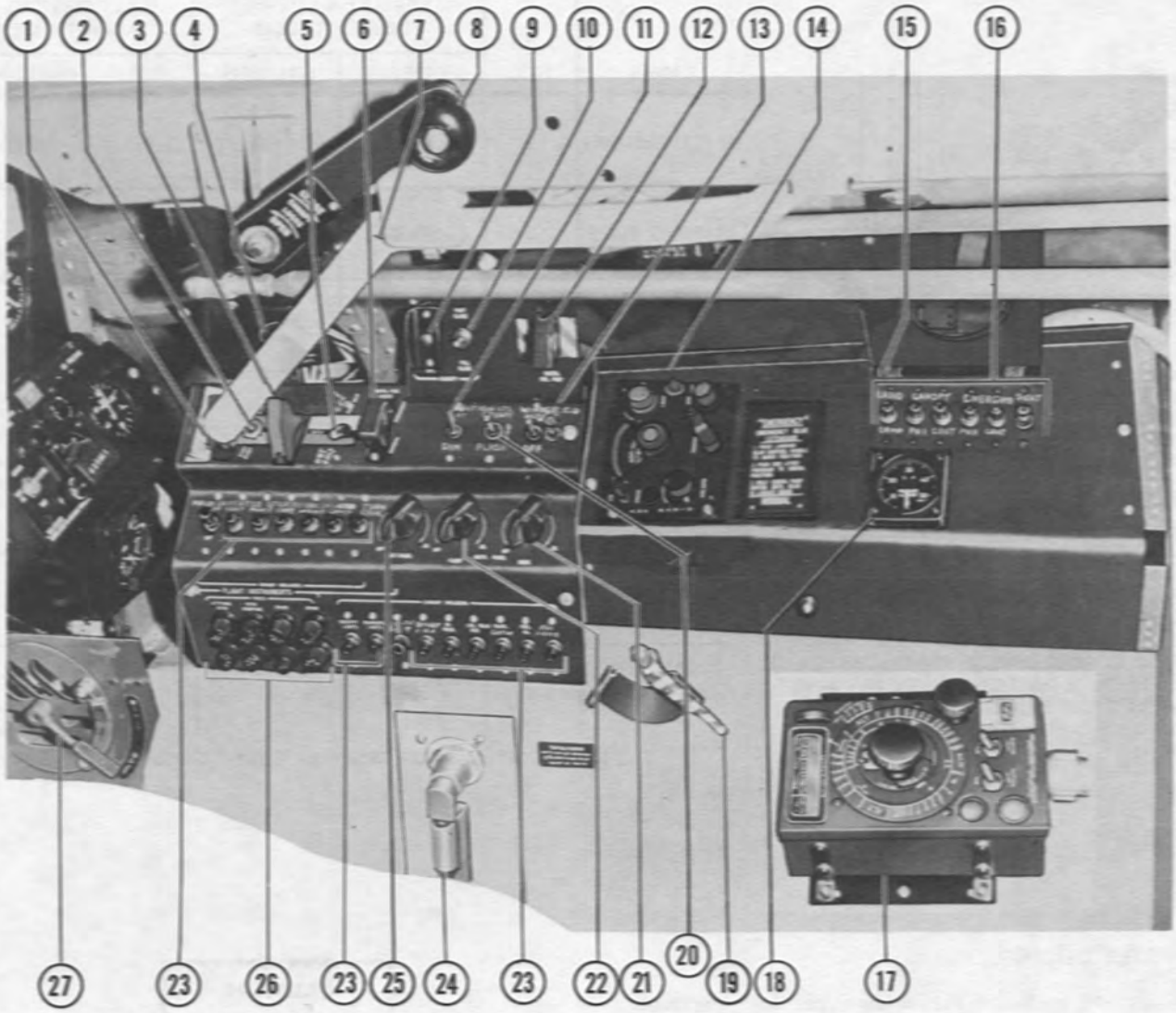


1. BOMB ARMING AND SELECTOR SWITCHES
2. AN/ANH-2 WIRE RECORDER
3. MARKER BEACON CIRCUIT BREAKER
4. FUEL SYSTEM DE-ICER CIRCUIT BREAKER
5. TIP TANK JETTISON SWITCH
6. FUEL TANK INDICATOR LIGHTS
7. FUEL SYSTEM DE-ICING SWITCH
8. CABIN PRESSURE DUMP SWITCH (LATER AIRCRAFT)
9. SPEED BRAKE SWITCH
10. MICROPHONE BUTTON
11. STARTING FUEL SWITCH
12. AIR START IGNITION SWITCH
13. ELEVATOR TRIM OVERRIDE SWITCH (LATER AIRCRAFT)
14. LANDING-TAXI LIGHT SWITCH
15. WING FLAP SWITCH
16. LANDING GEAR WARNING HORN CUTOUT BUTTON
17. JATO FIRING BUTTON
18. MAIN FUEL SHUTOFF SWITCH
19. CABIN TEMPERATURE RHEOSTAT
20. JATO CIRCUIT BREAKER
21. AILERON BOOST SHUTOFF LEVER
22. JATO JETTISON CONTROL HANDLE
23. THROTTLE FRICTION CONTROL KNOB
24. THROTTLE
25. LEFT SIDE CIRCUIT BREAKERS
26. FUSELAGE FUEL TANK SELECTOR SWITCH
27. WING TANK FUEL SELECTOR SWITCH
28. LEADING EDGE TANK FUEL SELECTOR SWITCH
29. TIP TANK FUEL SELECTOR SWITCH
30. CHEMICAL TANK SELECTOR SWITCH
31. BOMB ARMING AND TIP TANK RELEASE CIRCUIT BREAKERS

F22-C-1-5

Figure 1-7

cockpit—right side

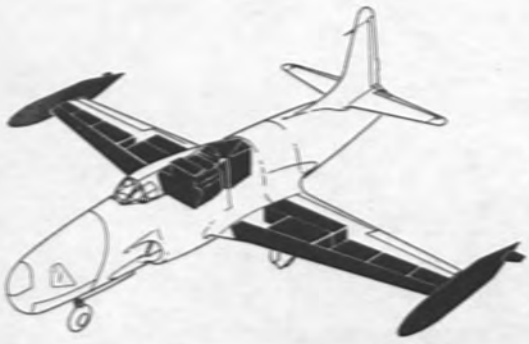


1. IGNITION SWITCH
2. STARTER SWITCH
3. BATTERY GENERATOR SWITCH
4. PANEL LIGHT RHEOSTAT
5. PITOT HEAT SWITCH
6. EMERGENCY FUEL CHECKOUT SWITCH (INOPERATIVE)
7. CANOPY JETTISON LEVER
8. CANOPY LOCKING HANDLE
9. CANOPY OPEN SWITCH
10. CANOPY PART CLOSE AND FULL CLOSE SWITCH
11. FUSELAGE LIGHTS DIM-BRIGHT SWITCH
12. EMERGENCY HYDRAULIC PUMP SWITCH
13. AUXILIARY WINDSHIELD DEFROSTER SWITCH
14. C-1514/ARN-6 CONTROL PANEL
15. C-4 CONTROL BOX MOUNT
16. RIGHT CIRCUIT BREAKERS
17. C-4 CONTROL BOX (INSTALLED OVER CIRCUIT BREAKERS)
18. CABIN ALTIMETER
19. EMERGENCY HYDRAULIC SYSTEM SELECTOR LEVER
20. NAVIGATION LIGHTS STEADY FLASH SWITCH
21. INDIVIDUAL INSTRUMENT PANEL LIGHT RHEOSTAT
22. INSTRUMENT PANEL FLOODLIGHT RHEOSTAT
23. RIGHT CIRCUIT BREAKERS
24. CANOPY HANDCRANK
25. SIDE PANEL LIGHTS RHEOSTAT
26. FLIGHT INSTRUMENT FUSES AND SPARES
27. CABIN PRESSIZATION GRILL SHUTOFF LEVER

F22-C-1-6

Figure 1-8

fuel quantity data—u. s. gallons



REMARKS:
LEVEL FLIGHT ATTITUDE TOP OF FUSELAGE 1°30' NOSE UP
TAXI ATTITUDE TOP OF FUSELAGE 4°30' NOSE UP

DATA BASIS:
GROUND TESTS

NOTE:
DUE TO MANUFACTURING TOLERANCES OF FUEL TANKS, A VARIATION OF ± 1.5% MAY EXIST IN INDIVIDUAL TANK CAPACITIES. CONSEQUENTLY, THE QUOTED CAPACITIES ARE REPRESENTATIVE ONLY AND SHOULD NOT BE USED AS EXACT VALUES FOR ANY PARTICULAR AIRPLANE.

F-22-B-1-9

TANKS	NO.	USABLE FUEL (LEVEL FLIGHT ATTITUDE)		FULLY SERVICED TAXI ATTITUDE	
		LBS.	GALLONS	LBS.	GALLONS
TIP (CENTERLINE)	2	2,990.0	460	2,996.5	461
LEADING EDGE	2	676.0	104	(1)	(1)
WING	2	1,001.0	154	(1)	(1)
FORWARD FUSELAGE TANK	1	1,072.5	165	(1)	(1)
AFT FUSELAGE TANK	1	617.5	95	(1)	(1)
TOTAL (WITHOUT TIPS)	6	3,367.0	518	(1)	(1)
TOTAL (WITH CENTERLINE TIPS)	8	6,357.0	978	(1)	(1)

(1) NOT DETERMINED FOR SEPARATE TANK GROUPS.

Figure 1-9

FUEL FILTER DEICING.

Provisions are included for deicing the low pressure fuel filter. For a description of this system, refer to Section IV.

Tip Tank Fuel Selector Switch.

The dc-powered tip tank fuel selector switch (29, figure 1-7) has two positions, ON and OFF. When in the ON position, the solenoid valve is deenergized, causing it to move by spring pressure to the open position and admit air pressure from the engine compressor into the tip tanks. The air pressure forces fuel from the tip tanks into the fuselage tank when the tip tank float valve is open. In case of electrical failure, the solenoid valve will open automatically and fuel will be fed from the tip tanks to the fuselage tank. In the OFF position this solenoid valve is closed.

CAUTION

Tip tanks usually retain pressure for quite some time after the engine is shut down. Therefore, it is necessary to relieve tank pressure by partially loosening the filler caps before removing them.

Leading Edge Tank Fuel Switch.

The dc-powered leading edge tank fuel switch (28, figure 1-7), has two positions, ON and OFF. In the ON position, it turns on a booster pump in each leading edge tank. These pumps transfer fuel into the fuselage tank when the leading edge tank float valve is open. When in the OFF position, the booster pumps are turned off.

Wing Tank Fuel Switch.

The dc-powered wing tank fuel switch (27, figure 1-7), is a two-position switch, placarded ON and OFF.

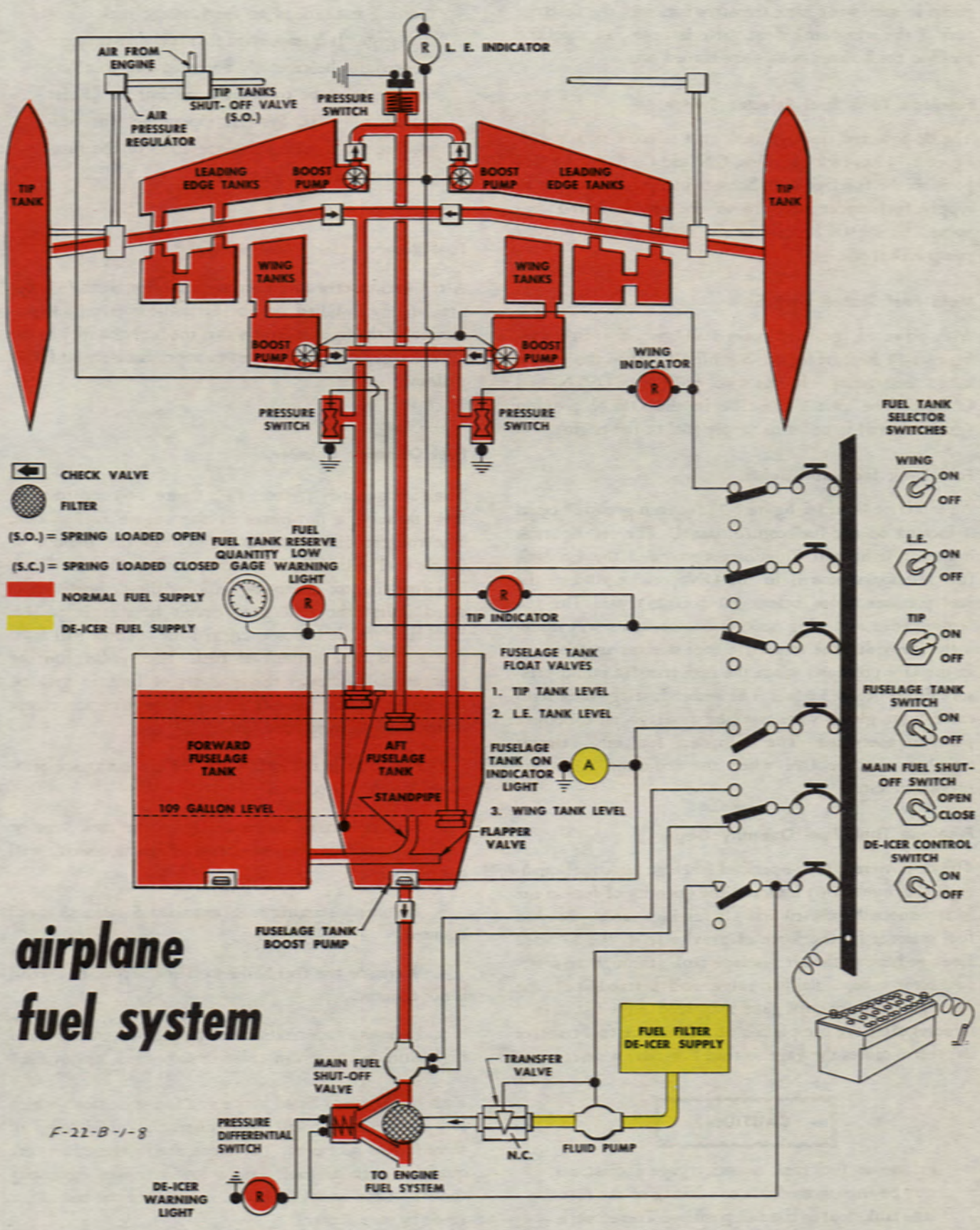

airplane
fuel system
AIR FROM ENGINE
AIR PRESSURE REGULATOR
TIP TANKS SHUT- OFF VALVE (S.O.)
PRESSURE SWITCH
L. E. INDICATOR
TIP TANK
LEADING EDGE TANKS
BOOST PUMP
WING TANKS
WING INDICATOR
CHECK VALVE
FILTER
(S.O.) = SPRING LOADED OPEN
(S.C.) = SPRING LOADED CLOSED
NORMAL FUEL SUPPLY
DE-ICER FUEL SUPPLY
FUEL TANK QUANTITY GAGE
FUEL RESERVE LOW WARNING LIGHT
TIP INDICATOR
FUSELAGE TANK FLOAT VALVES
1. TIP TANK LEVEL
2. L.E. TANK LEVEL
3. WING TANK LEVEL
FORWARD FUSELAGE TANK
AFT FUSELAGE TANK
109 GALLON LEVEL
STANDPIPE
FLAPPER VALVE
FUSELAGE TANK ON INDICATOR LIGHT
FUSELAGE TANK BOOST PUMP
FUEL TANK SELECTOR SWITCHES
WING
L.E.
TIP
FUSELAGE TANK SWITCH
MAIN FUEL SHUT-OFF SWITCH
OPEN
CLOSE
DE-ICER CONTROL SWITCH
ON
OFF
FUEL FILTER DE-ICER SUPPLY
MAIN FUEL SHUT-OFF VALVE
TRANSFER VALVE
PRESSURE DIFFERENTIAL SWITCH
N.C.
FLUID PUMP
TO ENGINE FUEL SYSTEM
DE-ICER WARNING LIGHT
F-22-B-1-8

Figure 1-10

When the switch is in the ON position, a booster pump in each wing tank transfers fuel into the fuselage tank if the wing tank float valve is open. In the OFF position the booster pumps are turned off.

Fuselage Tank Fuel Selector Switch.

The dc-powered fuselage tank fuel selector switch (26, figure 1-7) has two positions, ON and OFF. In the ON position the fuselage tank booster pump is turned on to supply fuel under pressure to the engine-driven fuel pump. In the OFF position the fuselage tank booster pump is shut off.

Main Fuel Shutoff Switch.

A dc-powered, guarded main fuel shutoff switch (18, figure 1-7) is provided to shut off all fuel to the engine in an emergency. It has two positions, OPEN and CLOSE. The switch must be in the OPEN position (guard down) in order to supply fuel to the engine.

Fuel Tank Indicator Lights.

An indicator light (6, figure 1-7) for each group of tanks is located on the fuel control panel. The red tip tank indicator light will illuminate (provided the tip tank fuel selector switch is in the ON position) when the fuel pressure drops below 3.0 ($\pm$0.25) psi. The red leading edge and wing tanks indicator lights will illuminate (provided the respective fuel selector switches are in the ON position) when the fuel transfer pump pressure drops below 3.0 psi. The amber fuselage tank indicator light glows whenever the fuselage tank booster pump is energized. The individual fuel tank selector switches must be ON when the indicator lights are pressed to test.

Fuselage Tank Fuel Quantity Gage.

The dc-powered, float-operated fuselage tank fuel quangage (38, figure 1-6) indicates the quantity of fuel in the interconnected forward and aft fuselage tanks. Because fuel transfer by the force of gravity from the forward fuselage tank to the aft fuselage tank (through an interconnector tube, a flapper valve, and a standpipe), the fuselage tank quantity gage may read high for 2 to 5 minutes after the completion of a climb. A fuel transfer in reverse causes the gage to read low after a descent.

CAUTION

Erroneous fuel tank quantity gage indications may be encountered due to sticking of the fuselage tank float in the full position. Therefore, it is essential that caution be exercised when interpreting indications on the fuselage tank quantity gage. It is important that fuel management procedures be carefully observed and that fuel consumption be constantly monitored. (Refer to Section VII, Systems Operation, for procedure for checking the operation of the fuselage tank fuel quantity gage.)

Fuel Reserve Low Warning Light.

A red fuel reserve low warning indicator light (37, figure 1-6) is installed on the instrument panel. Illumination of the light indicates that the fuel quantity in the aft fuselage tank has dropped to approximately 80 ($\pm$5) gallons.

Fuel Quantity Counter.

The fuel quantity counter (47, figure 1-6) records fuel flow through a flowmeter in the engine fuel system. The counter dial must be set to read the amount of usable fuel in the airplane each time the tanks are filled. The fuel counter cannot be set after the dc bus is energized unless the fuel gage circuit breaker is pulled. Each time the dc bus is energized the counter will indicate a loss of 2 gallons of fuel. The reading on the counter dial indicates the quantity of fuel, in gallons, remaining in the aircraft and will be accurate except under the following conditions:

1. Fuel that is released when the tip tanks are jettisoned will not be counted.

2. Fuel siphoning overboard from the tank vent or leaking from fuel lines upstream of the flowmeter will not be counted.

3. Automatic starting fuel (normally 5 gallons) is not counted.

4. Warm or hot fuel boiling off at the time of takeoff is not counted.

5. Excessive vaporization during high-speed climb and high-altitude cruise can cause unaccounted loss of fuel.

Each of the items listed above is a factor through which loss of fuel may result. Any one or a combination of these factors may exist. Therefore, the fuselage fuel tank quantity gage or fuel reserve low warning light may show that the actual fuel load is less than the indication given by the counter.

tip tank release circuit

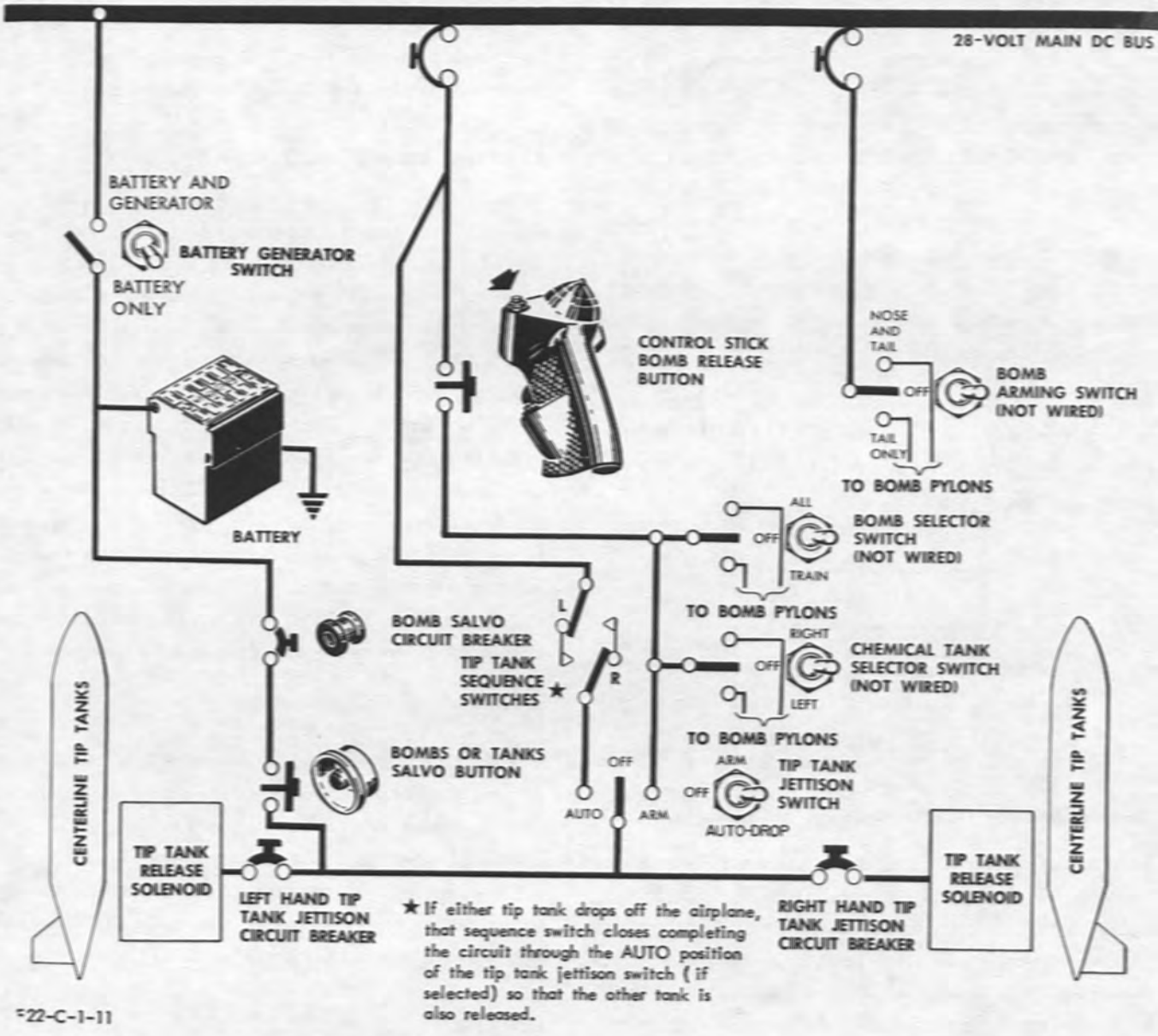


Figure 1-11

TIP TANK RELEASE SYSTEM.

The tip tanks may be released either manually or electrically. The tanks are released manually by pulling the manual release handles located on the cockpit floor at the left side of the pilot's seat; the forward handle releases the right tip tank and the aft handle releases the left tip tank. The tanks are released electrically by depressing the bomb (or tanks) salvo button. Some aircraft have not been modified to disable the control stick bomb release button and it is possible to drop the tip tanks with this button if the tip-tank jettison switch is in ARM position. However, this method of release is not recommended. This button is deactivated on many aircraft due to the number of inadvertent jettisons resulting from its use.

Bomb or Tanks Salvo Button.

A dc-powered, bomb or tanks salvo button (50, figure 1-6) is located on the instrument panel. When the switch is depressed, tip stores are released simultaneously. The switch is directly connected to the battery through a circuit breaker located in the nosewheel well and is always "hot," provided the circuit breaker is in.

Tip Tank Jettison Switch.

The tip tank jettison switch (figure 1-11) has three positions, AUTO-DROP, ARM, and OFF. When the jettison switch is placed in the AUTO-DROP position, the automatic drop circuit is energized so that if one tip tank becomes disengaged the other tank will be jettisoned automatically. This provides protection against sudden loss of lateral control which could result from the accidental loss of one tank during takeoff. When the switch is placed in the ARM position, the release button on the control stick is energized so that the tip tanks may be jettisoned simultaneously by pressing the release button (the release button on the control stick has been disabled on some aircraft.)

It is always possible to jettison the tip tanks quickly, with the jettison switch in the AUTO-DROP or OFF position, by pushing the bomb (or tanks) salvo button on the instrument panel.

CAUTION

The release button on the control stick will not release the tip tanks when the jettison switch is in the AUTO-DROP position.

Manual Release Handles – Tanks or Bombs.

Left and right manual release handles are located on the floor of the cockpit to the left of the pilot's seat (figure 3-8). The handles are safetied with light copper wire to prevent inadvertent release of the tanks. The tanks may be released separately or together by pulling hard on either or both handles. When midwing pylon tanks or bombs are installed, the pylon manual release is tied into its respective tip tank release cable. Thus, when the tip tank release handle is pulled, the pylon load also will be released. This control provides an alternate method of releasing the external load in the event it cannot be done electrically.

Tip Tank Ground Safety Pins.

Red-flagged ground safety pins are installed in each tip release lever to prevent accidental jettisoning while on the ground. The pins should be removed before flight and reinstalled after flight.

ELECTRICAL SYSTEM.

The dc electrical system is a 28-volt, single-wire circuit that is grounded through the aircraft structure. Alternating current is supplied by three rotary inverters that are energized from the 28-volt dc system. The electrical power distribution system is shown on figure 1-12.

EXTERNAL POWER RECEPTACLE.

A polarized external power receptacle (containing two sets of identical male connectors) located near the trailing edge of the right-hand wing fillet (figure 1-2) is provided to connect an external power source to the dc bus. For ground operation a 28-volt, auxiliary power unit (APU), set between 800 and 1200 amperes, is required. No manual switching is provided to control the APU when it is connected to the aircraft. A relay in the external power receptacle circuit will automatically close and connect the APU to the dc bus whenever the APU is plugged into the receptacle and is operating. Either set of male connectors can be used when connecting the APU. In case an APU that will provide over 800 amperes is unavailable, two can be used to start the engine by connecting one to each set of connectors.

DC SYSTEM.

The dc system power supply consists of one 28-volt 400-ampere dc generator, two batteries, a voltage regulator, reverse-current relay, external power receptacle, and associated warning lights, relays, circuit breakers, and control switches. Power is supplied to the dc bus by the engine-driven generator as shown on the Electrical Power Distribution Diagram (figure 1-12, sheet 1).

Batteries.

The batteries are connected in series for 24-volt operation and located in the nose compartment. They are connected to the primary dc bus through the battery relay and are maintained in a charged condition by the generator. In the event of a generator failure fully charged lead–acid batteries will last from 7 to 10 minutes and nickel–cadmium batteries will last for a minimum of 20–25 minutes with the essential electrical equipment on and the standby inverter operating.

Battery Generator Switch.

Control of dc power is accomplished by means of a three-

position switch placarded BATTERY AND GENERATOR, OFF, and BATTERY ONLY (3, figure 1-8). When the switch is in the OFF position the batteries are disconnected from the dc bus. When the switch is in the BATTERY AND GENERATOR position, both the battery and generator are connected to the dc bus. When the switch is in the BATTERY ONLY position, the batteries are connected to the dc bus and the generator is disconnected from the dc bus.

Note

The BATTERY ONLY position must be used when the generator or one of its components has failed and IFF operation is necessary.

Generator Loadmeter.

A generator loadmeter (29, figure 1-6) is provided, consisting of an ammeter, the scale of which has been calibrated to read from 0 to 1.25 (times the generator rated output) in 0.1 increments to show generator load. (See figure 5-1 for loadmeter limitations.)

Generator-Out Warning Light.

The generator-out amber warning light, installed on the instrument subpanel (27, figure 1-6), illuminates whenever the generator is off line, provided the inverter relay and warning lights circuit breaker is IN and the dc bus is energized either by the aircraft batteries or by external power.

AC SYSTEM.

Three independent and functionally separate dc power inverters supply alternating current to the directional and attitude gyro-operated indicators, pressure instruments, IFF equipment, and ADF equipment. The ac system consists of the inverters, an inverter switch, inverter relays, an ac bus tie relay, a warning light, and primary and secondary ac buses. Power for the inverters is supplied from the dc bus, as shown in figure 1-12.

Pressure Instruments Inverter.

The engine oil pressure and fuel pressure indicators are powered by a 26-volt, single-phase, 6-va alternating current inverter. No control switch is provided; inverter power is supplied to these instruments whenever the primary dc bus is energized.

Main Inverter.

The main (750-va) inverter supplies 115-volt, 3-phase, 400-cycle ac current to both the primary and secondary ac buses as long as the inverter is operating. When the main inverter or one of its components has failed power will be available only to the primary ac bus from the standby inverter.

Standby Inverter.

A standby (250-va) inverter is provided to supply 115-volt, 3-phase, 400-cycle ac power to the primary ac bus.

Flight Instrument Power Switch.

The flight instrument power switch (33, figure 1-6) is located on the cockpit instrument panel. The switch has three positions, MAIN, OFF, and STANDBY. In the MAIN position, the 750-va inverter supplies power to both the primary and secondary ac buses. In the OFF position, neither bus is energized. In the STANDBY position, the 250-va inverter supplies power to the primary ac bus (the secondary ac bus is not energized; thus the IFF equipment is not available).

Gyro Instruments Warning Light.

The gyro instruments warning light (33, figure 1-6) is located on the instrument panel in the front cockpit. The light will illuminate if the selected inverter fails or if the flight instrument power switch is OFF, thus indicating that the primary ac bus is not energized. (See figure 1-12, sheet 2.)

CIRCUIT BREAKERS.

The aircraft dc electrical circuits are protected by individual circuit breakers as indicated on the electrical power distribution diagram (figure 1-12). Those that are accessible in flight are located on the right and left consoles (figures 1-7 and 1-8)). If a circuit is overloaded its circuit breaker automatically pops out, disconnecting it from the electrical system.

If it becomes necessary to conserve battery energy because of generator failure, the pilot can manually disconnect those electrical circuits not essential to flight by pulling their individual circuit breakers. They can be reset by pushing them back in.

CAUTION

If a circuit breaker automatically pops out during flight, the pilot should check for electrical fire before resetting. After the circuit breaker has been reset, the loadmeter should be carefully monitored. If it reads high, the circuit breaker should be manually pulled out.

electrical power distribution

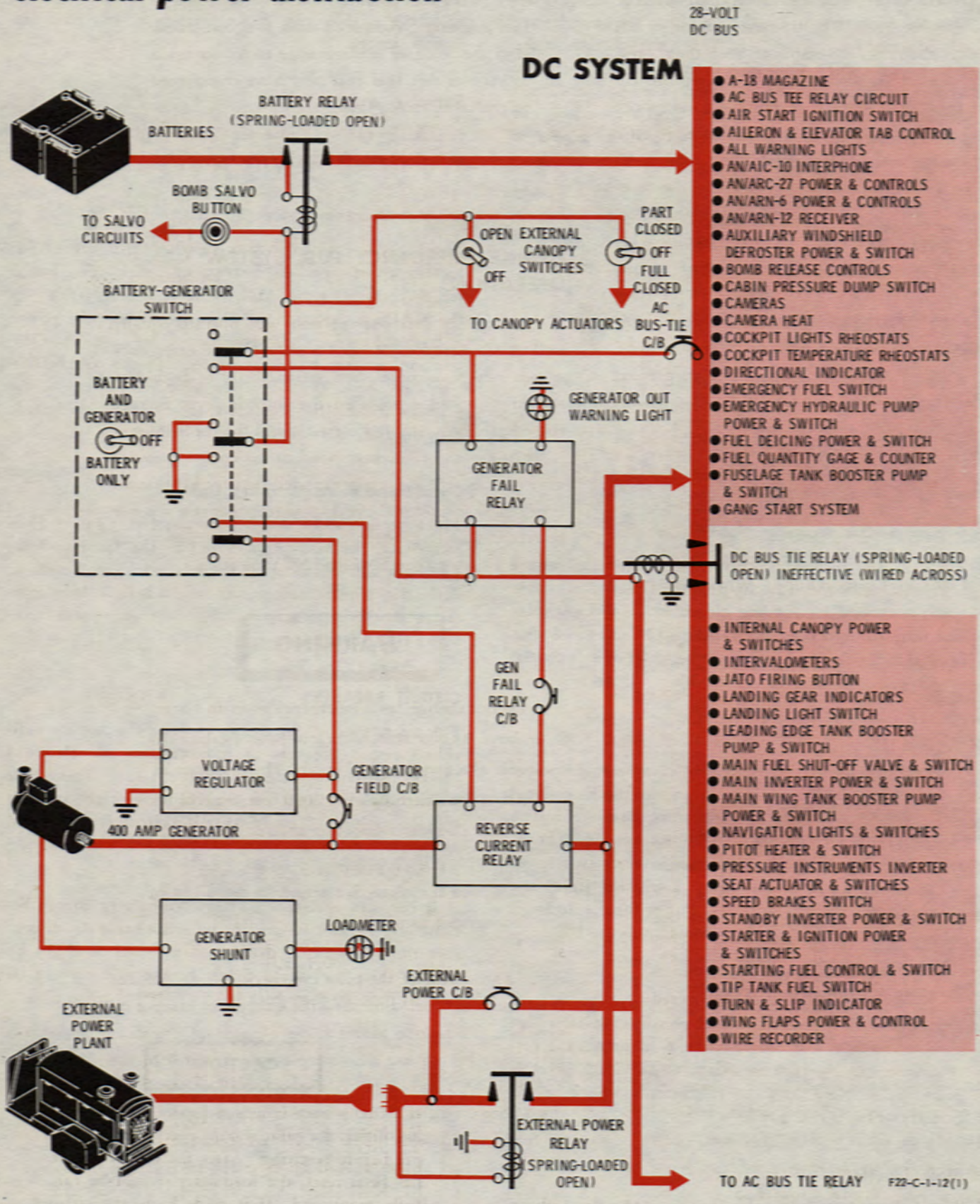


Figure 1-12 Sheet 1

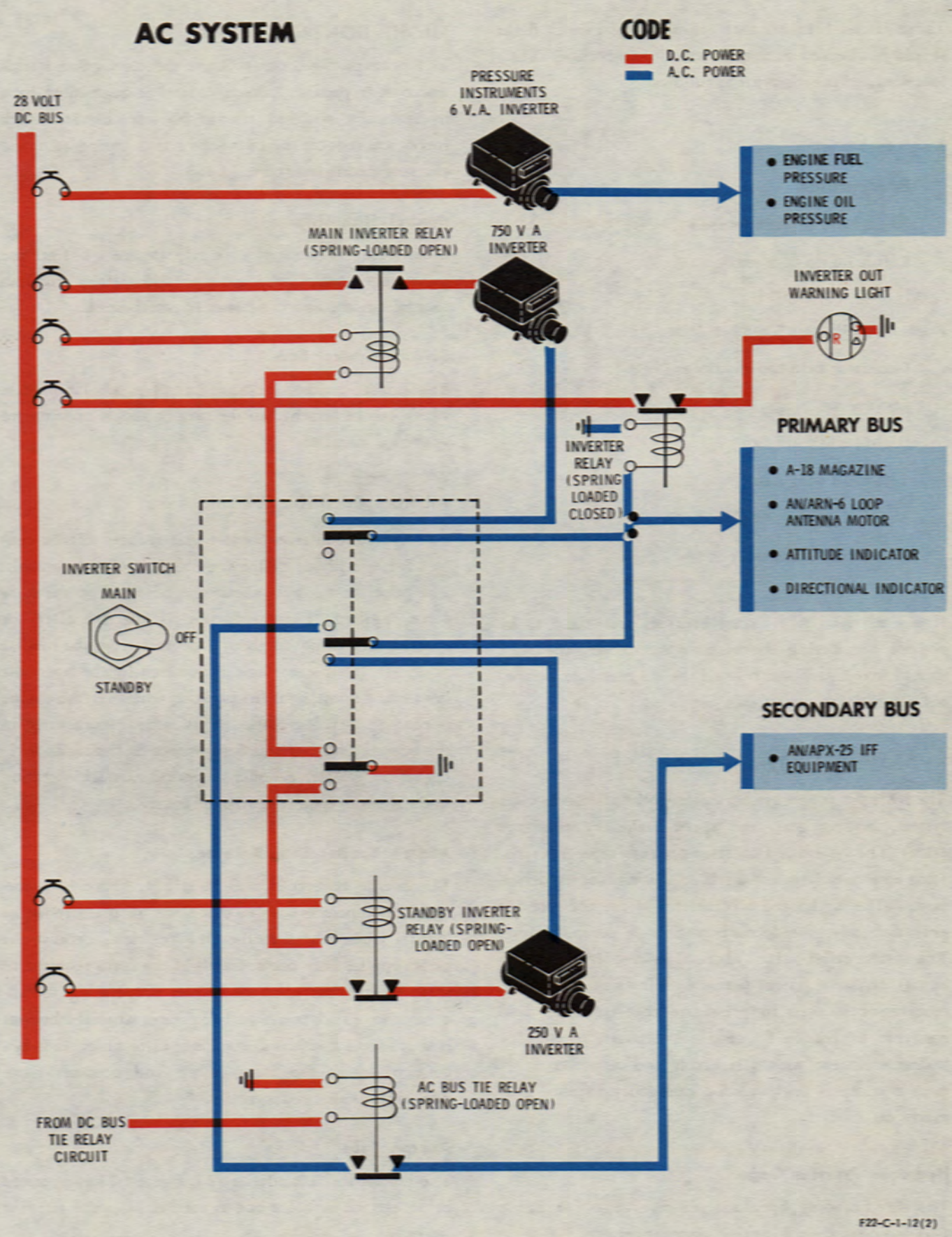


Figure 1-12 Sheet 2

Those circuit breakers that are not accessible in flight should be checked during the exterior inspection. Their locations and functions are as follows:

Nosewheel Well

- Bomb jettison
- Right-hand tip tank jettison
- Left-hand tip tank jettison

Right-Hand Plenum Chamber Area

- Generator field and switches
- Dynamotor
- Right-hand wing flap
- Left-hand wing flap
- External power
- Generator failure relay

If any of the above circuit breakers are found to be popped out during the exterior inspection, the pilot should investigate and consult the maintenance personnel before flying the aircraft.

HYDRAULIC SYSTEM.

The hydaulic power system operates the aileron booster system, landing gear, and speed brakes. (See figure 1-13.) The system is a constant-pressure type, incorporating an accumulator and a self-regulating, engine-driven pump. The aircharged accumulator stores pressure for peak demands to reduce fluctuation in pump loading. The system relief valve functions as a safety device to bypass excessive system pressure. Air from the engine compressor is used to pressurize the hydraulic fluid reservoir to reduce foaming. A separate emergency hydraulic system with a reservoir and dc-powered hydraulic pump is provided for emergency landing gear extension.

Hydraulic Pressure Gage.

The direct-reading hydraulic pressure gage (45 figure 1-6) indicates main hydraulic system pressure.

FLIGHT CONTROL SYSTEM.

The primary flight controls are the conventional stick and rudder pedals. Aileron control is augmented by a hydraulically powered aileron booster. Elevator stick forces are reduced by two servoacting spring tabs and two servoacting trim tabs.

Control Stick Grip.

Mounted on the control stick grip (figure 1-14) are the gun trigger switch, the elevator and aileron trim tab control switch, and the bomb release button.

Surface Control Lock.

The surface control lock consists of a tubular bracket which can be attached to the rudder pedals and control stick by a wing nut.

AILERON CONTROL SYSTEM.

The hydraulic aileron booster unit reduces aileron control forces without destroying the feel of the controls. The pilot must supply about one fifteenth of the total force required. Force reduction is effective after the control stick is moved about 2 degrees from the neutral position. The booster unit is powered by the hydraulic system and normally is in operation whenever the engine is running. An automatic bypass valve, incorporated in the booster unit, automatically prevents hydraulic locking of the booster cylinder to permit manual operation in the event of hydraulic system failure.

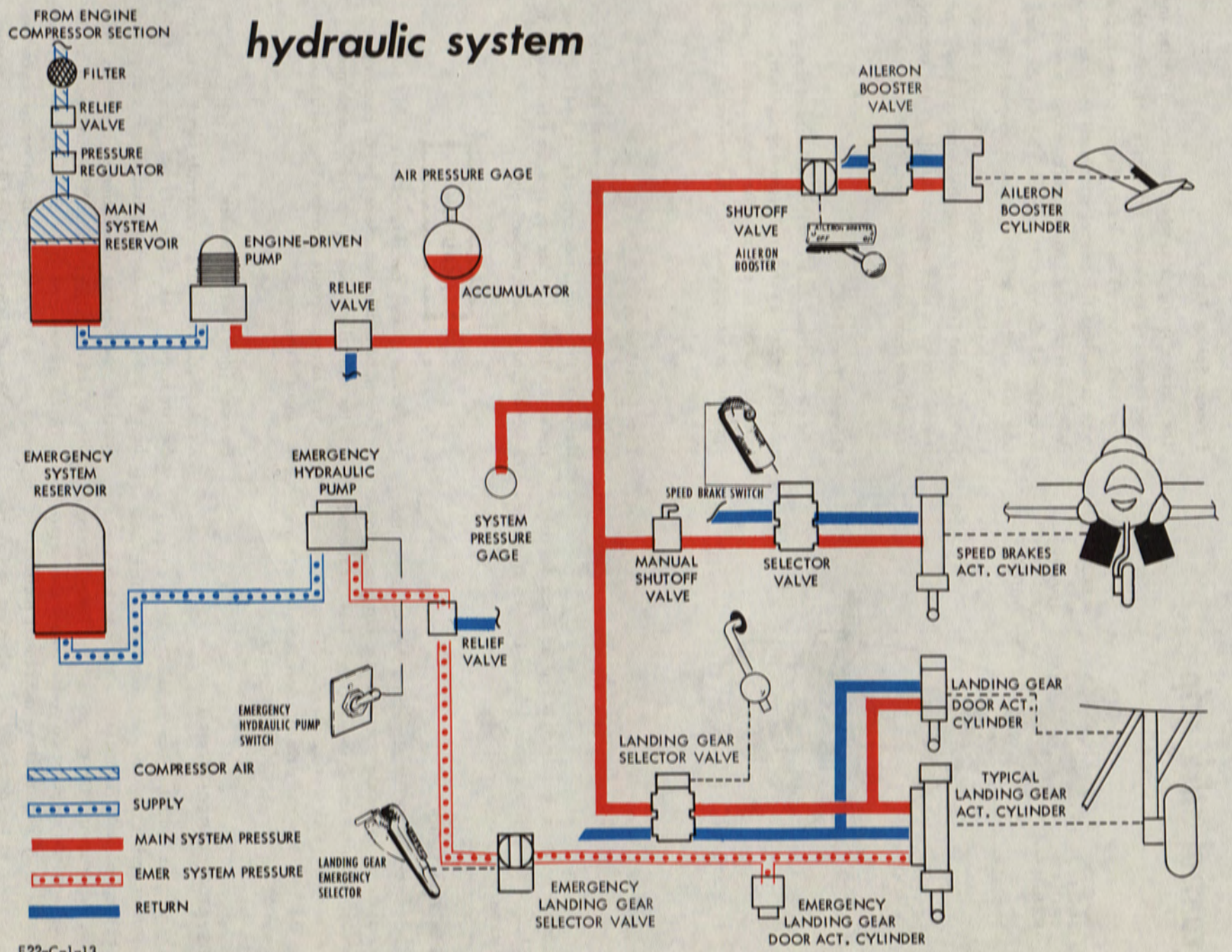
Aileron Booster Shutoff Lever.

The aileron booster shutoff lever (21, figure 1-7), mechanically operates a valve that shuts off pressure to the booster when moved to the OFF position. Because the pilot supplies only one fifteenth of the force required to move the ailerons when the booster is operating, the aileron control stick forces will be greater when the booster is shut off. A considerable amount of lost motion is evident whenever the boost is off and becomes more noticeable as airspeed increases.

Aileron Tabs.

The tab on the left aileron (24, figure 1-2) is operated by an electric actuator and is used to trim the airplane laterally.

hydraulic system



F22-C-1-13

Figure 1-13

control stick grip

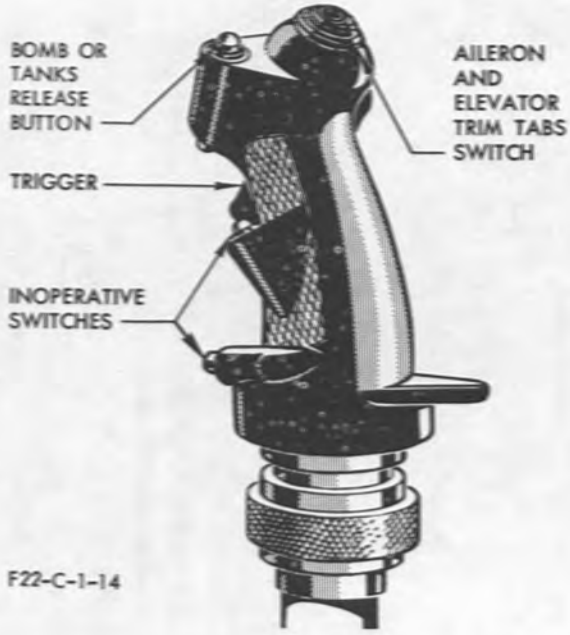


Figure 1-14

The tab on the right aileron is ground-adjustable only. The position of the aileron tab can be seen from the cockpit.

Trim Tabs Switch.

The trim tab on the left aileron and the trim tabs on the elevators are electrically operated. Operating a spring-loaded-to-neutral thumb switch (figure 1-14) at the top of the control stick controls the tabs. Moving the switch to the left or to the right operates the aileron tab to lower the left or right wing, respectively.

ELEVATOR CONTROL SYSTEM.

The elevator control system includes a bungee spring, a pair of spring tabs, and two conventional trim tabs. The bungee spring is installed to tailor stick forces to pilot requirements. On the ground the bungee spring holds the elevators in the up position when the surface is raised to 26 degrees above the neutral position and holds them in the down position when the surface is moved below neutral. This action gives a peculiar feel to the control on the ground but is unnoticeable in flight.

Elevator Spring Tabs.

The elevator spring tabs, which are located on the inboard corners of the elevator (18, figure 1-2), reduce elevator stick forces. They deflect in proportion to the force exerted on the control stick until the maximum deflection is obtained. At low stick forces, there is no force applied directly to the elevators because the spring tabs, due to their deflected position, displace the elevators. At higher stick forces, the spring tabs remain fully deflected (thus reducing the forces required) and the stick force is then applied directly to the elevator through the horn assembly and torque tube.

Elevator Trim Tabs.

The elevator trim tabs are located outboard of the spring tabs (19, figure 1-2) and are operated by an electric actuator. In addition to electric operation, automatic servo operation is incorporated to aid in reducing elevator stick forces.

Trim Tabs Switch.

The aileron and elevator trim tabs switch is located on the top of the control stick grip (figure 1-14). Pushing the switch forward or aft operates the elevator tabs to lower or raise the nose, respectively.

CAUTION

Because sticking tab switches have caused accidents, be certain that the tab switch returns to the neutral position by applying thumb pressure in the opposite direction after each movement of the switch.

Elevator Trim Override Switch.

A four-position elevator trim override switch, located on the left console, (13, figure 1-7) just outboard of the throttle, provides an alternate trim circuit that permits overriding the elevator trim button on the control stick grip. When the switch is in the NORMAL position, the dc circuit is completed to the aileron and elevator trim button on the control stick grip for normal operation. When the switch is moved to the OFF (center) position, dc power to the trim button is disconnected, thus aileron trim is not available in the cockpit. The switch is spring-

loaded to the OFF position from two momentary positions, NOSE UP and NOSE DOWN. Holding the switch in either momentary position overrides any malfunction of the normal trim switch and trims the airplane accordingly.

Elevator Tabs Neutral Indicator Light.

A green indicator light (40, figure 1-6), located on the instrument panel, glows when the elevator trim tabs are in the neutral position.

RUDDER CONTROL SYSTEM.

Rudder.

The rudder and its control is entirely conventional.

Rudder Pedals.

The rudder pedals may be adjusted fore and aft by releasing the adjustment lock lever on the outboard side of each pedal. When the adjustment lock levers are moved outboard, spring action moves the rudder pedals toward the pilot. Holding the levers in the unlocked positions and applying slight foot pressure will adjust the rudder pedals for the desired leg length.

Rudder Tab.

A bend tab (17, figure 1-2) is installed on the rudder and is ground-adjustable only.

WING FLAPS.

The wing flaps are actuated by two electric motors mechanically interconnected by a flexible shaft so that if one motor fails the remaining motor will actuate both flaps. Retraction and extension time will be slightly increased when only one motor is operative. There is no emergency method of operating the flaps.

Wing Flaps Switch.

The wing flaps are controlled by a switch (15 figure 1-7) on the left shelf. It has three positions, UP, OFF (center), and DOWN. The flaps may be stopped in any intermediate position by moving the switch to the OFF position.

Wing Flap Position Indicator.

The wing flap position indicator (5, figure 1-6) is located on the instrument panel and shows flap position in degrees from zero to 45 degrees. The instrument will indicate 45 degrees when flaps are fully extended. The flaps are positioned at 30 degrees for normal takeoff.

SPEED BRAKES.

Speed brakes are a drag-increasing device used for reducing speed in a dive or in any other flight attitude where speed reduction is desired. The speed brakes may be used at any airspeed and the direction of flap travel may be reversed at any time. The flaps extension is 60 degrees. On early aircraft no partial or intermediate extension of the flaps is possible; they must be full up or full down. On later aircraft the flaps have incremental control and may be partially extended to any desired increment of full travel. The speed brakes are hydraulically actuated by individual cylinders. The pin connecting each actuating piston to the flap is quickly removable to permit safe access to lower fuselage for ground maintenance. No position indicator is installed.

Speed Brakes Switch.

Speed brakes are controlled by a slide-type switch mounted on the throttle. The switch has two positions, UP and DOWN. Later aircraft that incorporate incremental speed brake control have a three-position thumb switch located on top of the throttle (9, figure 1-7). The switch positions are UP, OFF (center), and DOWN. Due to normal leakage of the speed brakes selector valve the brakes will gradually extend when the control switch is OFF. Inadvertent extension may be prevented by leaving the speed brakes switch in the UP position whenever the speed brakes are not being used.

LANDING GEAR.

The tricycle landing gear and wheel well doors are hydraulically actuated. The main gear retracts inboard and the nose gear retracts aft. All three struts are provided with uplocks and downlocks. The nosewheel is equipped with a shimmy damper and is turned by differential main wheel braking. An emergency hydraulic system is provided to extend the gear in case of failure of the main hydraulic system. During normal operation the gear should retract and doors close and lock in approximately 6 seconds.

LANDING GEAR SAFETY CLIPS.

Clips are provided to be fastened on the downlock cartridge of each gear when the aircraft is parked. When they are installed the gear cannot be retracted by any means. Always verify that the landing gear lever in the cockpit is in the DOWN position before removing the clips since it is possible to remove them when the gear is not locked in the down position. If the landing gear lever should be in the UP position, and the hydraulic

landing gear lever lock release

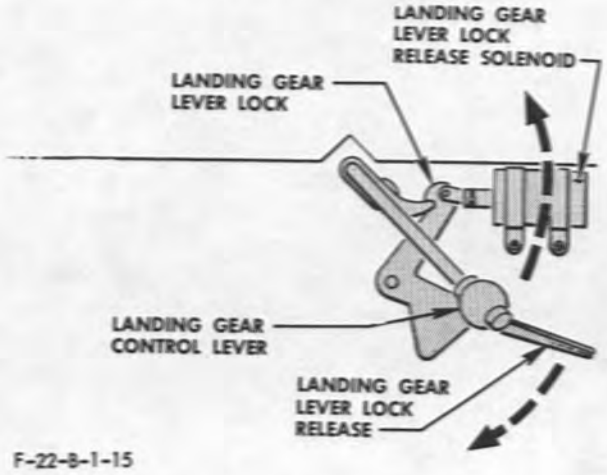


Figure 1-15

system were pressurized, the gear could collapse when the clips were removed. Long red streamers are attached to the clips to attract the pilot's attention during his walkaround inspection.

Landing Gear Lever.

The landing gear is operated by a lever (figure 1-15) located on the left side panel in the cockpit. The lever is held in either the UP or DOWN position by a spring-loaded lock which must be released by pressing the button on the end of the lever before it can be moved and the gear repositioned. If the button cannot be depressed it may be necessary to move the lever in the opposite direction in order to relieve side loads on the latch. A solenoid lock, operated by the scissors switch on the left main gear strut, prevents movement of the landing gear control lever to the UP position while the main strut is compressed.

Landing Gear Lever Solenoid Lock Release.

The landing gear lever solenoid lock may be released by actuating the lever lock release (figure 1-15) and raising the landing gear lever simultaneously.

EMERGENCY EXTENSION SYSTEM.

The emergency extension system consists of an electrically driven pump, a separate reservoir, a selector valve, a set of "down" lines to the landing gear actuating cylinders and emergency landing gear door release cylinders. Emergency gear extension time with a complete loss of normal system pressure is between 20 and 40 seconds, depending on where the failure occurs. The landing gear cannot be retracted by the emergency system. Because of the limited fluid supply only one complete extension of the gear is possible.

Emergency Hydraulic System Selector Lever.

The emergency hydraulic system selector lever (19, figure 1-8) is located on the right side of the cockpit. The lever operates the emergency hydraulic system for landing gear extension. It has two placarded positions, NORMAL and EMERGENCY; it is mechanically connected to a selector valve that directs emergency system pressure through a differential area shuttle valve to the down side of the landing gear cylinders. In the NORMAL position the emergency pump pressure line to the landing gear is shut off. When the lever is in the EMERGENCY position and the emergency hydraulic pump is operating, one-way pressure is directed to the down side of the landing gear actuating cylinders. When the lever is in the NORMAL position and the emergency hydraulic pump is operating, fluid is returned to the emergency system reservoir through a relief valve which is set to open at 1250 (±25) psi.

Emergency Hydraulic Pump Switch.

The emergency hydraulic pump switch (12, figure 1-8) is a guarded, two-position switch located on the right side panel in the cockpit. When in the ON position, the emergency hydraulic pump electric motor is energized.

Landing Gear Position Indicator.

The landing gear position indicator (9, figure 1-6) on the instrument panel shows the position of each individual landing gear. When the dc bus is not energized, diagonal stripes appear in each window. When the bus is energized, a wheel appears in each window for each gear that is down and locked, and the word UP appears for each gear that is up and locked. If the gear is in any intermediate position, the diagonal stripes appear.

Landing Gear Unsafe Warning Light and Warning Horn.

The landing gear unsafe red warning light (9, figure 1-6), located on the instrument panel in each cockpit, illuminates whenever the landing gear is not down and locked or not up and locked. The warning horn sounds and the light illuminates whenever the throttle is retarded below the position for 65% (+0, —5%) rpm, and the landing gear is not down and locked.

altimeter preflight setting

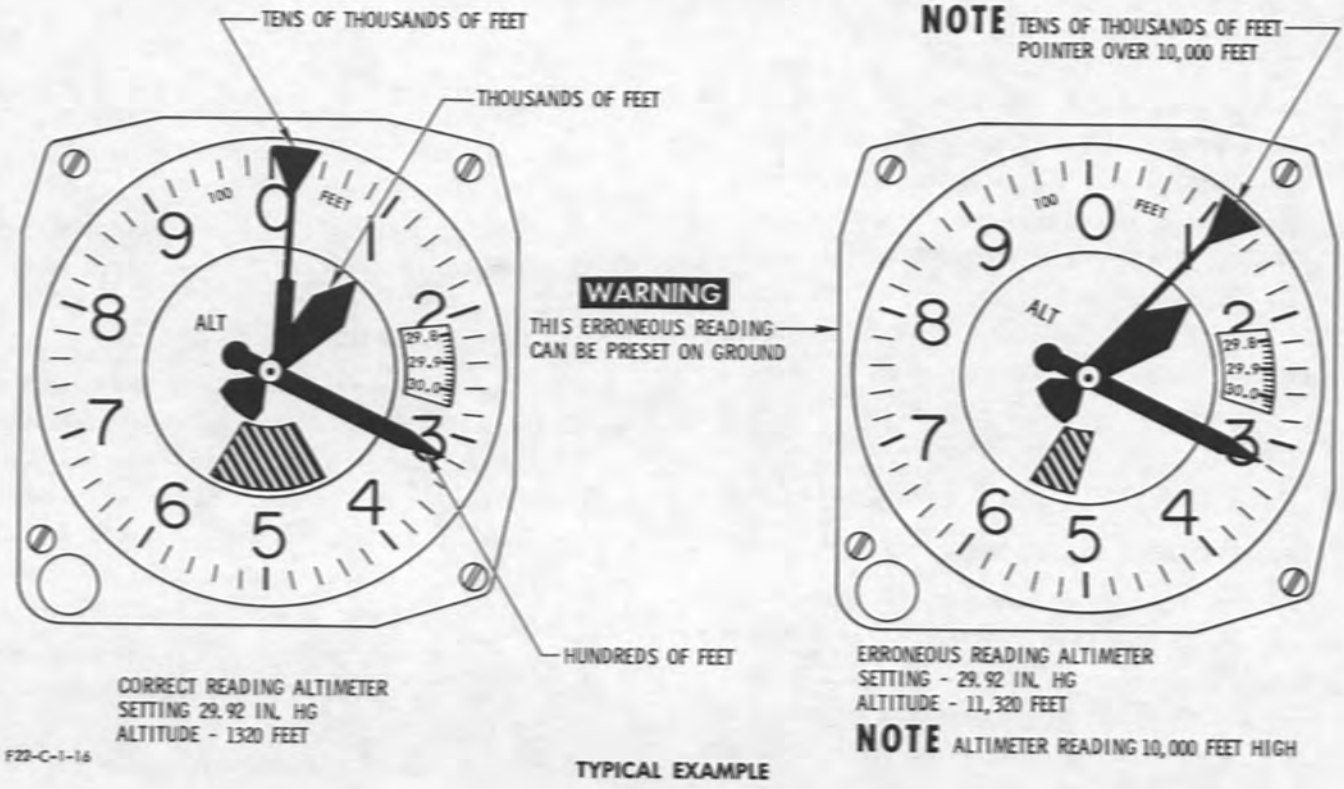


Figure 1-16

Landing Gear Warning Horn Cutout Button.

A landing gear warning horn cutout button (16, figure 1-7) is located on the left console of the cockpit adjacent to the wing flaps switch. The button provides a means of silencing the warning horn. The throttle-actuated horn switch will be reset each time the throttle is advanced beyond the 65% (+0, —5%) rpm position.

BRAKES.

The brakes are actuated by an independent hydraulic system and are operated by the conventional toe pedals. No emergency braking provisions are provided. (Refer to Section VII for proper braking technique.)

Parking Brake Handle.

The parking brake handle (41, figure 1-6) consists of a T-handle below the instrument panel in the cockpit. It provides a means of setting the brakes for extended periods. When applying the parking brakes it is necessary to apply toe pressure first and then pull out the handle. Brakes are released by applying toe pressure momentarily to both pedals, and releasing.

CAUTION

If the handle is pulled out before toe pressure is applied, damage to the brake piston seal will result.

FLIGHT INSTRUMENTS.

VERTICAL VELOCITY INDICATOR.

The vertical velocity indicator (37, figure 1-6), located on the instrument panel, is a direct-reading pressure instrument requiring no electrical power for its operation.

ALTIMETER.

An altimeter (8, figure 1-6) is installed on the instrument panel to indicate aircraft altitude. This instrument is a direct-reading pressure indicator requiring no electrical power for operation. On some aircraft the altimeter includes a 10,000-foot pointer incorporating a notched disc with a pointer extension and a warning indicator consisting of a striped section which appears

through the notched disc at altitudes below 16,000 feet. This altimeter provides a constant reminder to the pilot when aircraft altitude is less than 16,000 feet.

Note

It is possible to set a majority of the standard altimeters in USAF use in error by 10,000 feet. This happens when the barometric set knob is continuously rotated after the baro scale is out of view. The knob can be rotated until eventually the numbers will reappear in the Kollsman window from the opposite side. If the correct altimeter setting is then established, the altimeter will read approximately 10,000 feet in error. (See figure 1-16 for examples of correctly and incorrectly set altimeters.)

CABIN PRESSURE-ALTITUDE INDICATOR.

A cabin pressure-altitude indicator (18, figure 1-8) is located on the right-hand console. This instrument indicates cabin pressure in terms of altitude. It provides a method of checking cockpit pressurization by comparing the aircraft's actual altitude indicated on the aircraft altimeter with the cockpit altitude indicated on the cabin pressure altitude indicator. It is a direct reading pressure instrument requiring no electrical power for operation and has no provisions for adjustment of the barometric pressure.

TURN-AND-SLIP INDICATOR.

The turn-and-slip indicator (48, figure 1-6) is located on the instrument panel. It operates on 24-volt dc power. This instrument is protected by a circuit breaker and when it is pulled out, power to the turn and bank indicator will be interrupted.

Turn-and-Slip Indicator Warning Light.

A turn-and-slip indicator red warning light (22, figure 1-6) is installed on the instrument panel in the cockpit. Illumination of the light indicates a failure of power to the indicator.

STANDBY MAGNETIC DIRECTIONAL INDICATOR.

The standby magnetic compass, located on the windshield, is a standard-type magnetic compass to be used as a check on the operation of the gyrosyn compass system or in the event of an emergency. Readings should be taken only during steady flight, since errors may be introduced by turns or acceleration. A compass correction card indicating deviation is located on the left side panel.

Note

Disturbing magnetic fields in the vicinity of the compass, created by the proximity of operating electrical equipment such as the heater blower, may create as much as 10 degrees deviation.

J-8 ATTITUDE INDICATOR.

The J-8 attitude indicator (19, figure 1-6), located on the instrument panel, is an electrically driven, vertical-seeking, nontumbling gyro. An expanded-motion horizon bar provides sensitive pitch indications near the level-flight position. An index marker, coupled to the roll gimbal, furnishes bank attitude information. Immediate warning of a power failure in the gyro motor and incorrect phase rotation in the power supply to the instrument is given by a flag alarm at the upper right-hand corner of the dial face. The gyro erects itself automatically at the rate of about 3 to 4 degrees per minute. A self-retracting caging knob on the lower right side of the bezel permits quick erection of the gyro to the vertical position. The knob on the lower left side of the bezel is used to adjust the trim indicator to correspond to different loading conditions of the airplane. The instrument is ready for use 15 seconds after applying power and manually erecting the gyro to vertical. The operating temperature range is from —55°C to +70°C.

Presentation. (See figure 1-17.)

The instrument permits 360-degree rotation about the aircraft pitch and bank axes without tumbling the gyro. The expanded-motion horizon bar provides sensitive pitch indications near the level-flight position. The bar moves up with respect to the case to indicate a diving maneuver and down with respect to the case to indicate a climbing maneuver. Maximum pitch attitude is indicated within a range of 25 (±2) degrees, or approximately ¾-inch of bar displacement. When the aircraft exceeds 25 (±2) degrees in pitch, the horizon bar is held in the extreme position and the sphere becomes the new reference. A continued increase of climb or dive angle (approaching the vertical attitude) is indicated by graduations on the sphere. When the aircraft nears vertical,

J-8 attitude gyro indications

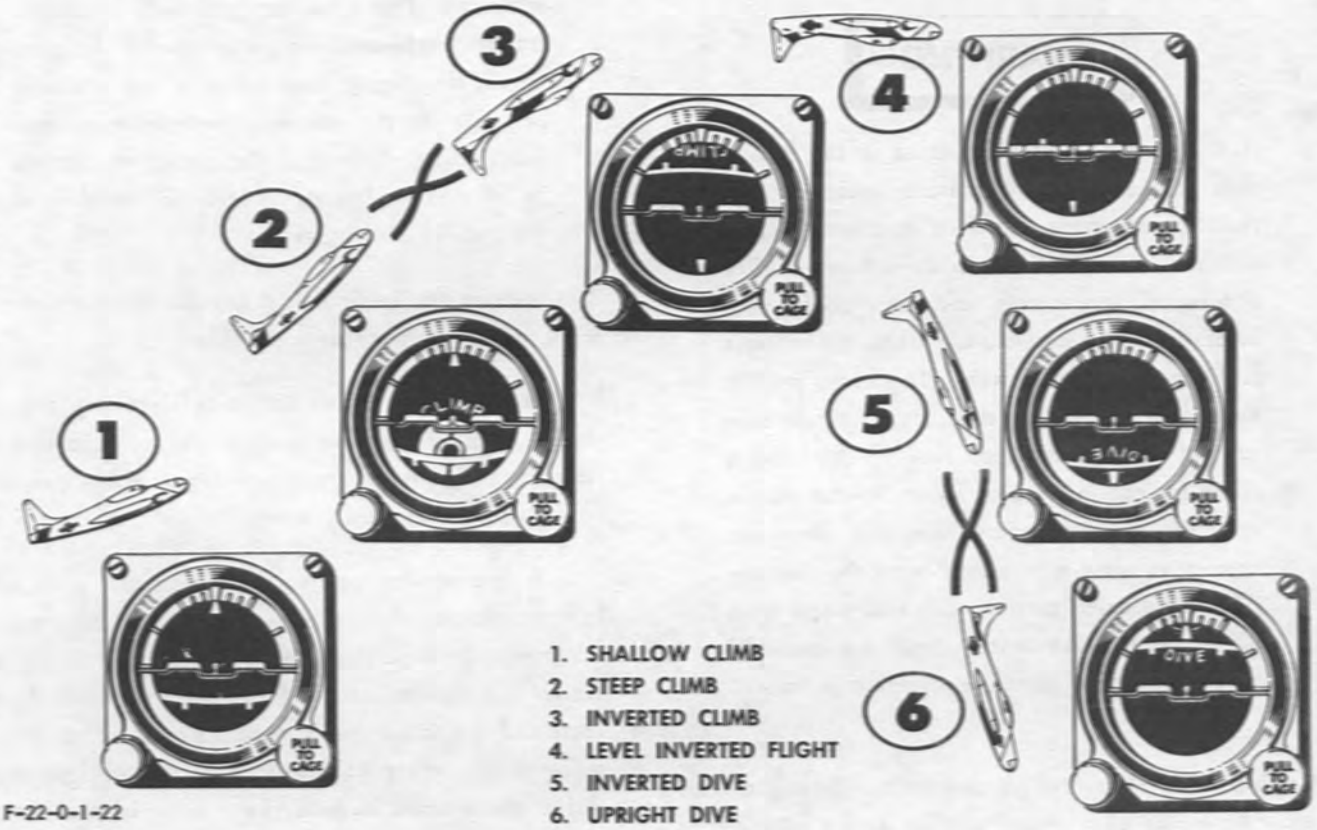


Figure 1-17

as in a loop, the indication begins to rotate 180 degrees (counterclockwise when in a climb and clockwise when in a dive). As soon as the aircraft departs from vertical the instrument again indicates the attitude of the aircraft. This momentary rotation of indication is known as controlled precession and should not be confused with gyro tumbling. The attitude of the aircraft about the roll axis is shown by the angle between the miniature airplane and the horizon bar and also by the bank index relative to the degree markings on the bezel mask.

Characteristic Errors.

After a loop, displacement of the horizon bar in excess of 5 degrees in pitch or bank may result. The J-8 indicator will immediately begin to correct these errors once true gravitational forces are sensed. This characteristic error is commonly called "sluggishness" or "lag" by pilots.

Note

In successive loops, the above-described error may become increasingly greater and may cause the horizon bar to reach the limit of its movement. This is normal in successive loops and is not indicative of a defective instrument.

Because of acceleration forces acting on the erection mechanism of the attitude indicator during a normal aircraft turn, errors in pitch or bank up to 5 degrees may be noted upon return to straight and level flight. This error is "turn error" and is also commonly referred to as "sluggishness" or "lag." The J-8 indicator will immediately begin to correct these errors once true gravi-

tational forces as sensed. If errors in excess of the aforementioned tolerance are encountered, the instrument should be replaced.

WARNING

A slight amount of pitch error in the indication of the Type J-8 attitude indicator will result from accelerations or decelerations. It will appear as a slight climb indication after a forward acceleration and as a slight dive indication after deceleration when the aircraft is flying straight and level. This error will be most noticeable at the time the aircraft breaks ground during the takeoff run. At this time, a climb indication error of about 1½ bar widths normally will be noticed; however, the exact amount of error will depend upon the acceleration and elapsed time of each individual takeoff. The erection system will automatically remove the error after the acceleration ceases.

Caging. The J-8 attitude indicator may be caged manually by means of a gyro-centering device operated by pulling the cage knob. To cage the gyro, the PULL TO CAGE knob should be drawn smoothly away from the face of the instrument. (A violent or hard pull will damage the instrument.) The force of the pull required to operate the caging knob varies sharply during travel. If caging is not done smoothly and gently the instrument may be damaged. As soon as the knob reaches the limit of its travel, it should be released quickly. For ground operation the gyro should be caged before power is applied and held in the cage position for 15 seconds after power is applied in order to prevent unnecessary torque stresses on the instrument.

WARNING

If the gyro is not manually caged by the pilot, it may possibly erect in the inverted position. A visual check should be made to ensure it has caged in the proper position.

Note

A check to determine whether the caging mechanism has completely released can be made by pushing the caging knob against the instrument case after it has been released. If further travel is evidenced or precession of the gyro noted, the caging mechanism is not releasing properly or the erection mechanism is malfunctioning. Failure of the caging mechanism to release completely may result in tumbling of the gyro in maneuvers.

The manual caging device on the J-8 attitude indicator serves a twofold purpose, as follows:

1. It provides a means for quickly erecting the gyro on the ground prior to takeoff, thus eleminating the necessity of applying ground power to aircraft on alert to keep the instrument erected.

2. It provides a means of erecting the gyro when inflight characteristic errors are induced by turns or acrobatics. In these instances, it is essential that the pilot realize that the indicator cages to the attitude of the aircraft and not to the true vertical. Therefore, the instrument should never be caged to correct inflight errors unless the aircraft is determined to be in straight and level flight by visual reference to a true horizon.

CAUTION

- Early production J-8 indicators incorporate ball bearings for engagement of the roll and pitch cams in the caging process. These bearings may break or fall off after excessively severe caging. Care is therefore required in caging the gyro.
- If there is any evidence of loose or broken bearings in the instrument, the indicator should be replaced immediately. Failure of these bearings will be evidenced by failure of the instrument to zero-out when caged. Other deficiencies which render the instrument unserviceable will be reflected by excessive vibration of the horizon bar, by failure of the instrument to erect or level-out, or by excessive errors resulting from turns or loops as outlined in the preceding paragraph.

escape systems

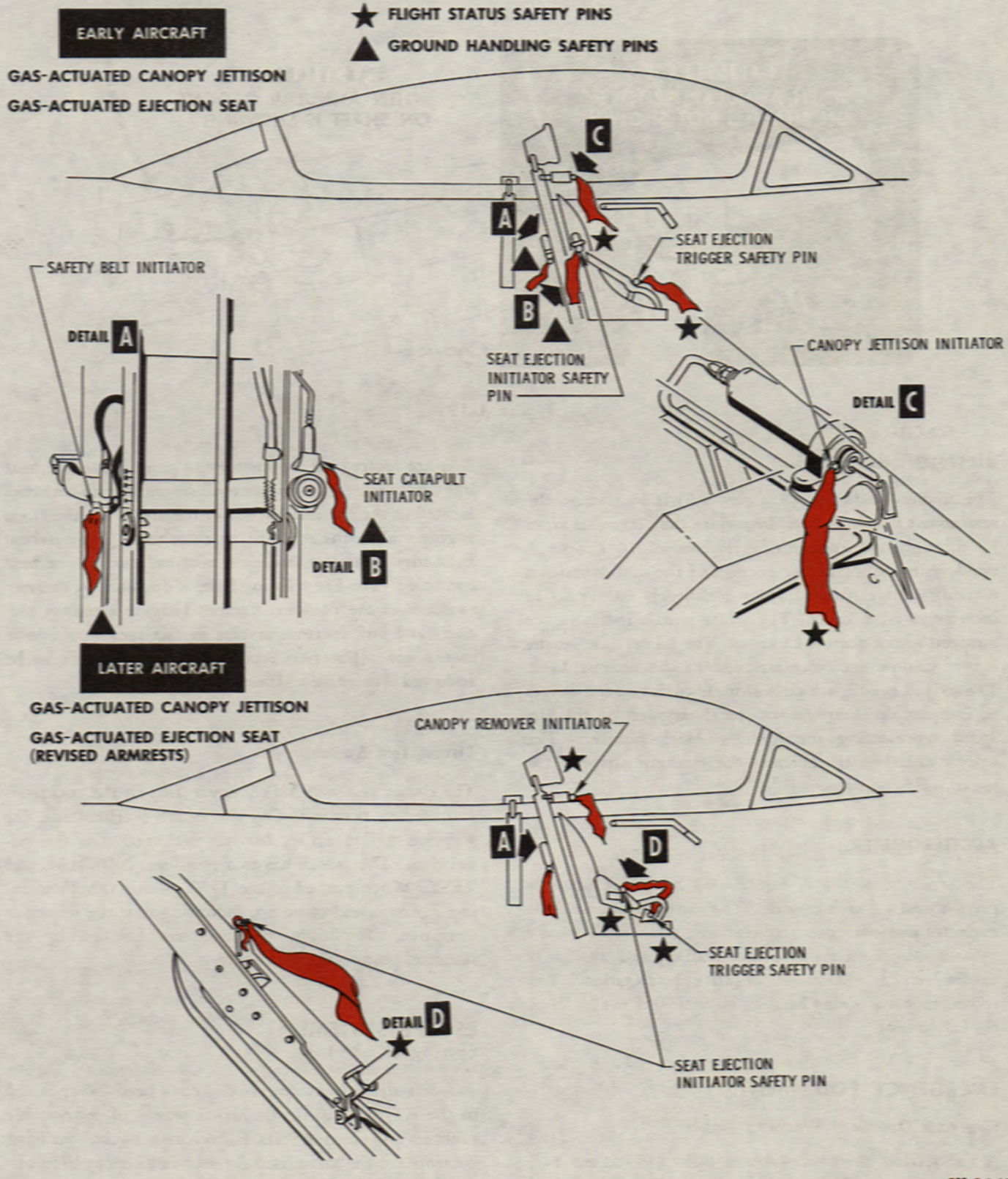


Figure 1-18

safety pin installation

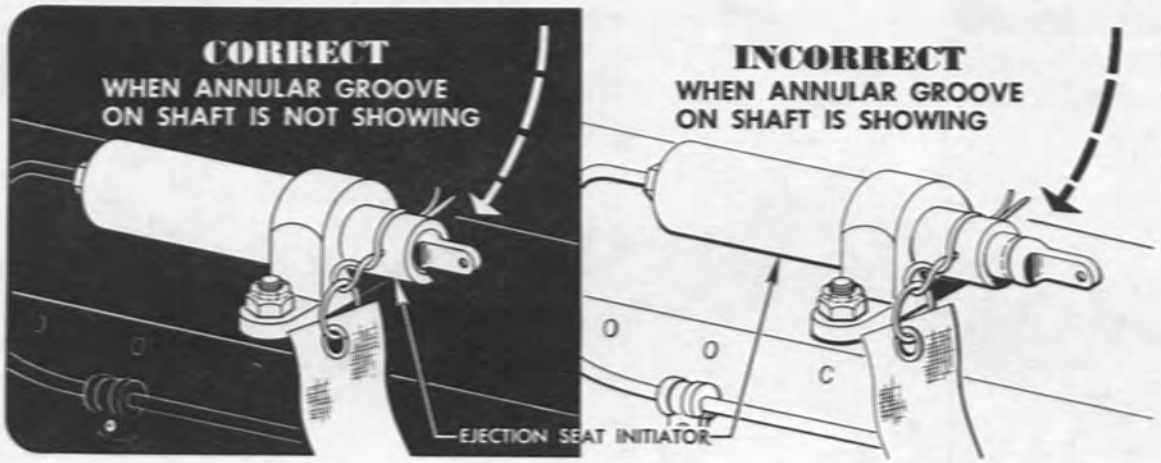


Figure 1-19

F22-C-1-18

AIRSPEED INDICATOR.

The airspeed indicator (8, figure 1-6) is located on the instrument panel. It is calibrated on the outer dial from 50 through 650 knots in increments of 10 knots. A window in the top center portion of the dial contains a rotating card calibrated from 0 through 100 knots in increments of 2 knots. The white needle indicates the airspeed to the nearest 10 knots. The lubber line on the inner window indicates airspeed to the nearest knot. The striped needle, which is altitude-compensated, moves to indicate the limiting structural airspeed or the airspeed representing the limiting Mach number. The yellow radial mark indicates the limiting airspeed for use of full wing flaps.

ACCELEROMETER.

The accelerometer (31, figure 1-6) has three separate needles and a common scale. The outer or main needle indicates instantaneous accelerations; the middle needle records maximum positive acceleration; and the inner needle records maximum negative acceleration. The recording needles may be reset by means of the knob on the instrument.

EMERGENCY EQUIPMENT.

Fire and Overheat Warning Lights.

A tail section overheat warning light (30, figure 1-6) and plenum chamber red fire warning light (26, figure 1-6) are located on the instrument panel. The overheat light is operated by any one of several thermoswitches located in the tail section and in the area from the front engine seal to the combustion chambers. The overheat light may indicate a fire, or it may indicate an overheat condition. The fire warning light is operated by thermoswitches in the plenum chamber (engine accessory section) and any overtemperature in this area would indicate a fire. (Refer to Section III for procedure to be followed if these lights illuminate.)

Circuit Test Switch.

The circuit test switch (32, figure 1-6) in the cockpit is provided to permit testing the entire overheat and fire warning wiring up to, but not including, the thermoswitches. The switch has two positions, NORMAL and TEST. When pushed to the TEST position, both warning lights should come on, indicating that the wiring is operative. The light filaments are checked by the standard push-to-test procedure.

ESCAPE SYSTEMS.

(See figure 1-18.)

Two variations in escape systems have been incorporated in the RT-33A during the development of jettisonable canopies and ejection seats. In both systems the operating controls are the same, and the seat and canopy are both gas fired. There is no interlock between the canopy and

the seat; consequently, the seat may be fired through the canopy as a last resort method. The second system is essentially the same as the first except that the armrests are slightly modified in appearance and gas-actuated automatic lap belt initiators are installed.

SAFETY PIN REMOVAL.

All escape system safety pins should be removed prior to flight. The following paragraphs indicate those that are installed when the aircraft is on flight status and those that are installed during maintenance or ground handling. Figure 1-19 indicates the correct method of installing the safety pins.

Earlier Systems.

The right-hand armrest safety pins and the canopy initiator safety pin are installed when the aircraft is on flight status. The seat catapult initiator safety pins have to be installed prior to maintenance or ground handling only and removed prior to returning the aircraft to flight status. (See figure 1-18.) All safety pins must be removed prior to flight.

Later Systems.

The canopy initiator safety pin and the seat safety pins in the right-hand armrests (2, figure 1-18) should be installed when the aircraft is on flight status. The safety pin in the hand grip should be installed prior to maintenance or ground handling only and removed prior to returning the aircraft to flight status. All safety pins must be removed before flight.

CANOPY.

The clamshell canopy is hinged at the aft end and is raised or lowered electrically or by a manually operated chain and sprocket actuator at the base of the remover which is attached to the canopy cross member. An explosive remover provides a means of jettisoning the canopy in an emergency. When closed, the canopy seal is inflated by engine air pressure to seal the canopy frame against the cockpit sill and windshield. The canopy must be manually locked closed by an internal locking handle. A red-flagged safety pin is installed in the initiator to prevent inadvertent firing of the catapult when on the ground.

CANOPY CONTROLS.

Interior and exterior canopy controls are provided to open and close the canopy electrically or mechanically and to jettison it in an emergency. An interior locking lever is provided to keep the canopy closed and locked in flight. The controls consist of an OPEN switch, a PART CLOSE and FULL CLOSE switch, a manual handcrank, a jettison lever, and an exterior locking handle. The jettison controls unlock the canopy when operated. On some aircraft there is no way to unlock the canopy from the outside except by pulling the jettison cable which will unlock, as well as jettison the canopy provided the canopy is in the closed and locked position.

Canopy Open Switch.

The dc-powered CANOPY OPEN switches (9, figure 1-8) are located on the right side panel and in the external well (figure 1-20) on the right side of the fuselage. The switches are wired in parallel so that either switch operates the canopy. The switches are spring-loaded to the OFF position. The external switch is wired directly to the battery so that it will operate when the battery switch is OFF. Hence, when it is in the OPEN position, the 28-volt dc bus is energized.

Canopy Part Close and Full Close Switch.

The dc-powered canopy closing switches are located next to the CANOPY OPEN switches (10, figure 1-8) in the cockpit and in the external well (figure 1-20). Each switch has three positions, PART CLOSE, center OFF, and FULL CLOSE; the switches are spring loaded to OFF. Canopy closing requires partial closing before fully closing. After the canopy reaches the part closed position the switch is moved to the FULL CLOSE position; however, neither switch should be actuated until after checking that the cockpit sills are clear.

CAUTION

Do not use external canopy switches while an external power supply is connected and energized because it will parallel the airplane batteries with the external power source and probably damage them.

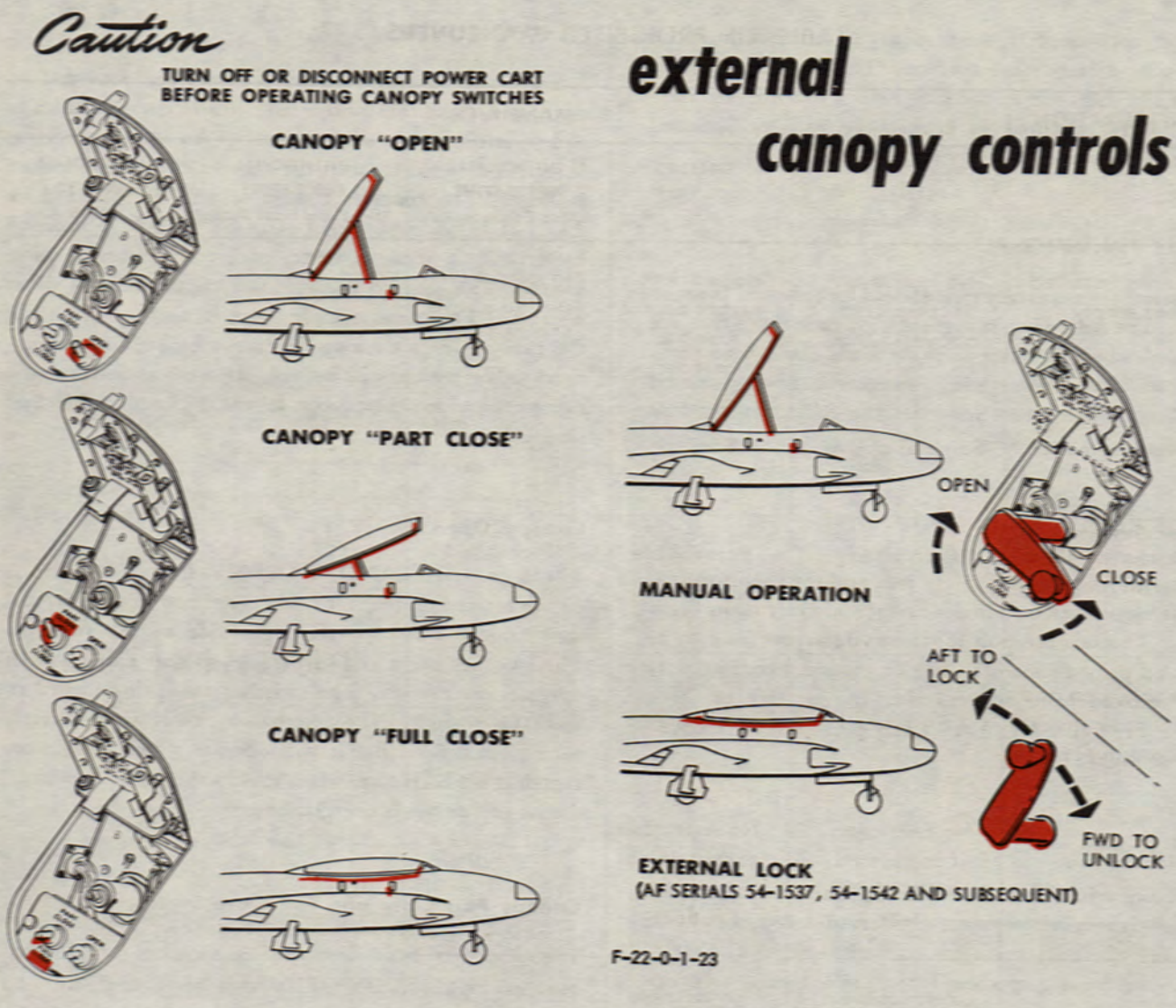


Figure 1-20

Canopy Handcrank.

A handcrank (24, figure 1-8) for manual operation of the canopy is located on the right side of the cockpit and in the external well (figure 1-20). The internal crank is turned counterclockwise and the external crank turned clockwise to open the canopy.

Note

If the canopy handcrank is used to lower the canopy from the full open position, the canopy uplock (figure 1-21) located on the crossmember behind the cockpit must be released manually.

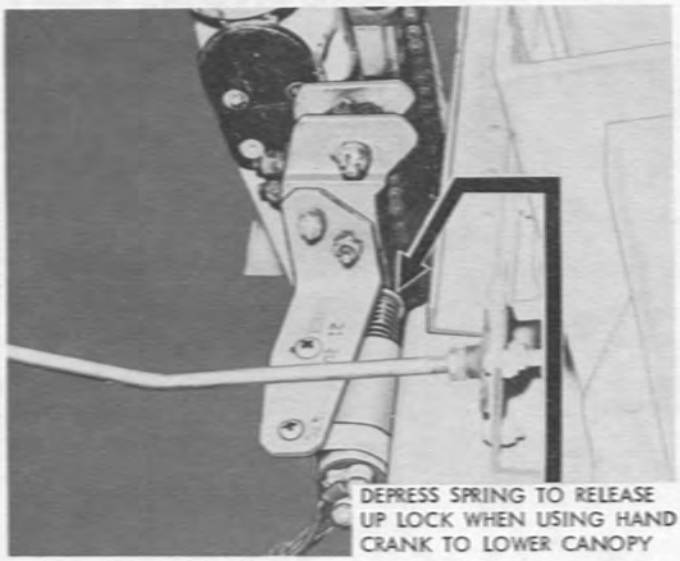
Internal Canopy Lock.

A canopy locking handle (8, figure 1-8), used to lock the canopy closed during flight, is located on the right side of the cockpit. The handle is permanently mounted and can be rotated aft to lock and forward to unlock the canopy. When the handle is in the locked position it contacts an internal switch which opens the canopy actuator circuit, thus preventing electrical operation of the canopy. The canopy must be unlocked for normal opening, but should not be unlocked prior to jettisoning. If the canopy is unlocked prior to jettisoning it may raise slightly and render the jettison system inoperative. The jettison lever linkage unlocks the canopy prior to firing the remover.

CAUTION

If the canopy lock handle is not in the fully unlocked position the entire canopy electrical system may be rendered inoperative.

canopy uplock release



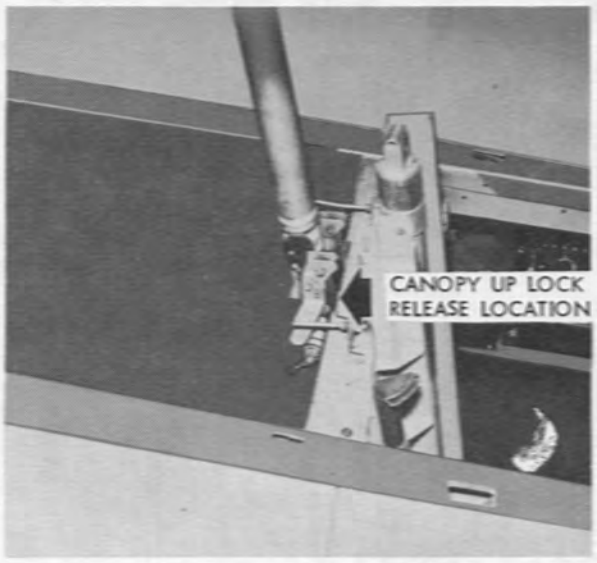


Figure 1-21

F22-C-1-21

External Canopy Lock.

On some aircraft a hexagonal drive (figure 1-20), located in the external skin on the right side of the airplane, can be used to lock or unlock the canopy from the outside. The lock is operated by engaging the external canopy handcrank with the hexagonal drive and turning forward to unlock and aft to lock.

Canopy Unlatched Warning Light.

A red light (18, figure 1-6) on the instrument panel glows when the canopy in unlocked, and is off when the canopy is locked.

Canopy Jettison Lever.

The canopy jettison lever (7, figure 1-8) is located on the right side of the cockpit. Pulling the lever aft unlatches the canopy and fires the canopy initiator. Normally, the canopy can only be jettisoned from the fully closed position. If no remover is installed, pulling the lever unlocks the canopy.

CAUTION

Make sure the canopy jettison lever is FULL UP before unlocking the canopy. If the handle is out of detent, it may inadvertently jettison when unlocked.

External Jettison Handle.

A handle attached to a coiled cable (figure 3-7) is stowed in the exterior well on the right side of the airplane to permit jettisoning of the canopy from the outside when the airplane is on the ground. The cable permits jettisoning from a safe distance.

SEAT.

An ejection seat is provided which, when actuated, will catapult the occupant clear of the tail surfaces at any speed or altitude. A catapult aft of the seat contains an explosive cartridge that supplies the propelling force for seat ejection. The seat is equipped with a lap belt and an inertia reel shoulder harness. A multiple unit quick-disconnect fitting is provided on the left side of

ejection seat

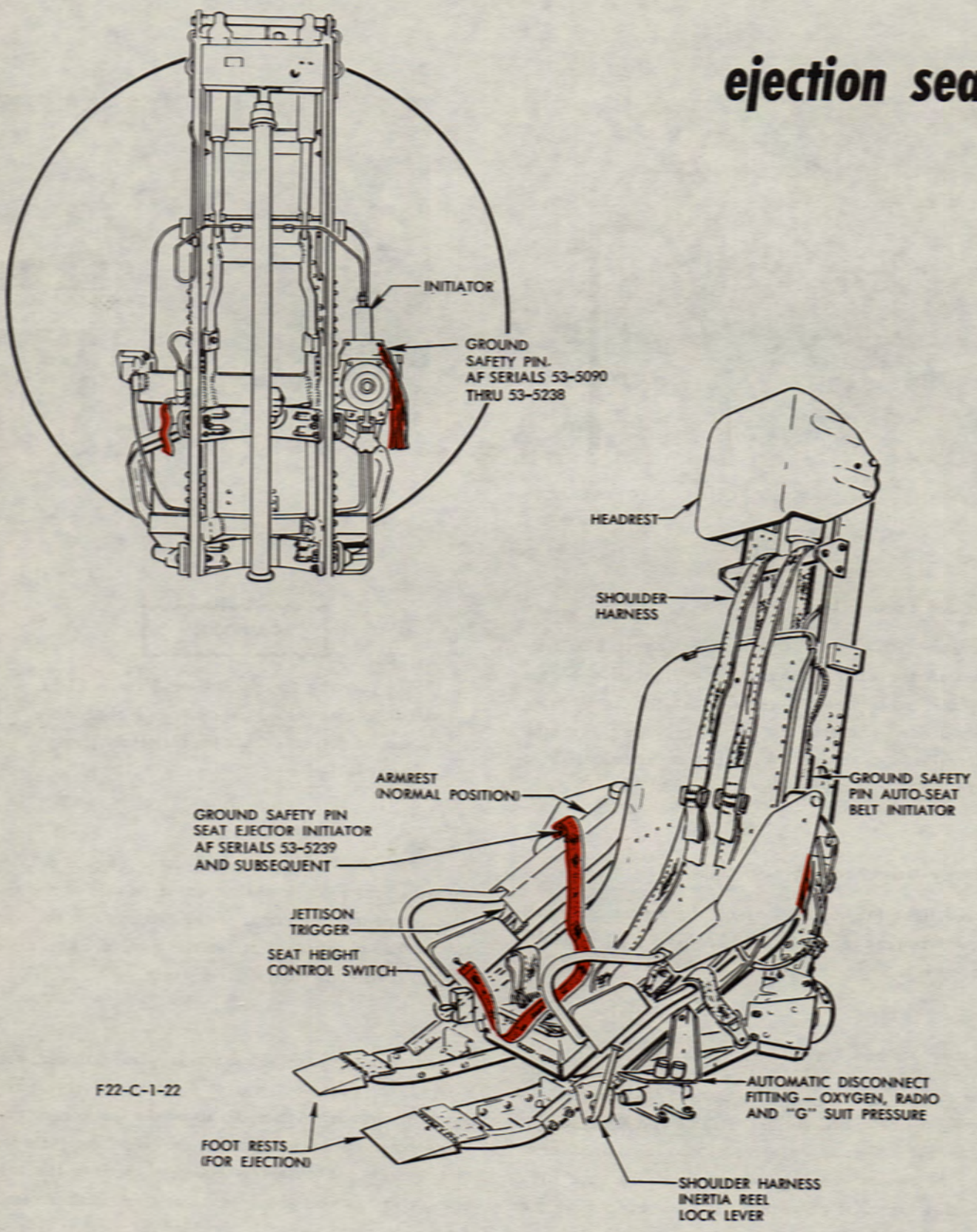


Figure 1-22

the seat to automatically disconnect oxygen, radio, and G-suit lines when the seat is ejected.

Seat Armrests.

The seat is ejected by raising both armrests and squeezing the trigger located on the front end of the right armrest. Raising the right armrest cocks the seat ejection trigger. Raising the left armrest locks the shoulder harness. (See figure 1-19 for safety pin installation; this pin must be removed prior to flight.) The seat catapult can be fired by an initiator on the right side of the seat (figure 1-18) independent of canopy operation. There is no linkage between the canopy and seat remover. Therefore, once the seat safety pin is removed for flight there is no protection against inadvertently firing the seat while the canopy is in place. While on the ground the safety pin is installed in the initiator.

WARNING

- The ejection seat must be given the same care in handling as a loaded gun. Always check that the safety pins are installed and be extra careful that clothing or gear does not catch on controls when entering or leaving the seat.

- If the right armrest is raised, only a qualified maintenance specialist is authorized to return it to its normal position. The system must then be inspected before the seat is considered safe.

- To avoid inadvertent ejection do not raise armrest except to eject.

- It has been found possible to install the ground safety pin in the initiator in such a manner that no protection is provided (figure 1-19). The seat safety pin is the only protection against inadvertent ejection. The safety pin engages an annular groove in the shaft when properly installed and practically no motion of the shaft is possible. However, if the shaft is pulled about ¼ inch out of the initiator, the safety pin still can be installed with no protection gained and the initiator can be fired with the safety pin installed in this manner.

- The pilot will be settled in the seat before removing the safety pin and will install the pin before unfastening the lap belt and other equipment prior to leaving the seat.

The armrests (figure 1-22) are depressed out of the way of the pilot's arm actions. The right-hand assembly is the arming lever and trigger mechanism and is locked down by a hook which engages the bolt at the lower end of the telescoping support strut. The left armrest, when raised, locks the shoulder harness reel and serves as a support for the pilot during ejection. The right-hand armrest is painted orange–yellow and is placarded in red, CAUTION: RAISE FOR EJECTION ONLY. A flagged safety pin is installed while on the ground to prevent raising the right armrest. Raising the right armrest arms the ejection mechanism. The right arm rest can be unlocked and raised only by first grasping the handgrip and pulling upward with a force of 30 pounds. When the armrest is locked down, upward forces on any part of the lever other than the handgrip cannot raise the arming lever. In the down position the trigger housed in the right handgrip is completely shielded by guards on both sides so that the trigger cannot be grasped until the armrest is elevated. The safety pin flap has a pin attached at both ends. One pin is inserted in the initiator through a guide hole in the top of the arming lever (figure 1-18) and the other pin is inserted through the trigger guard.

Jettison Trigger.

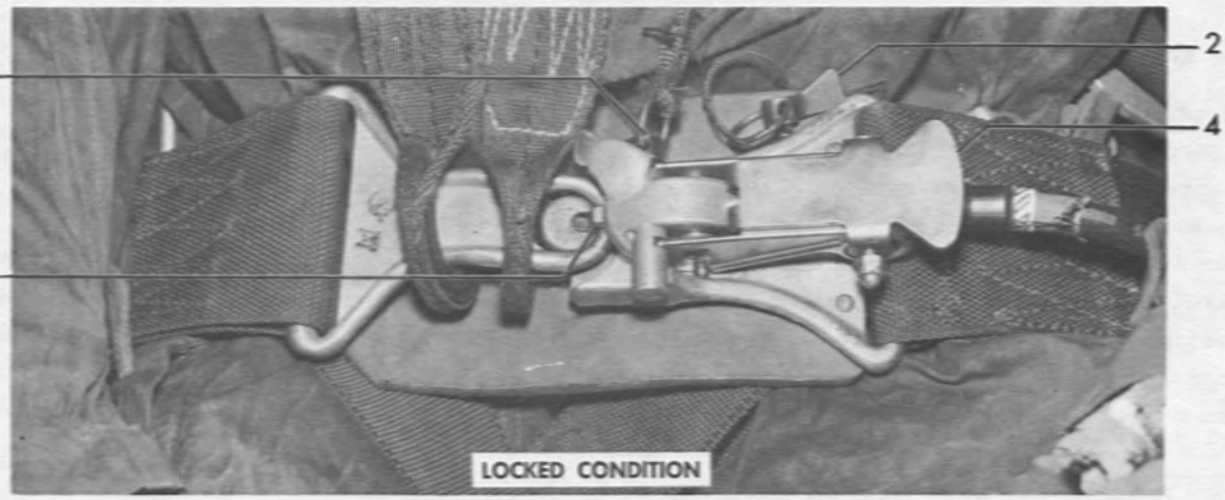
The ejection seat trigger is located on the forward end of the right armrest. After the armrest is raised to the horizontal position, squeezing the trigger ejects the seat, provided that the seat catapult safety pin has been removed.

Shoulder Harness Inertia Reel Lock Lever.

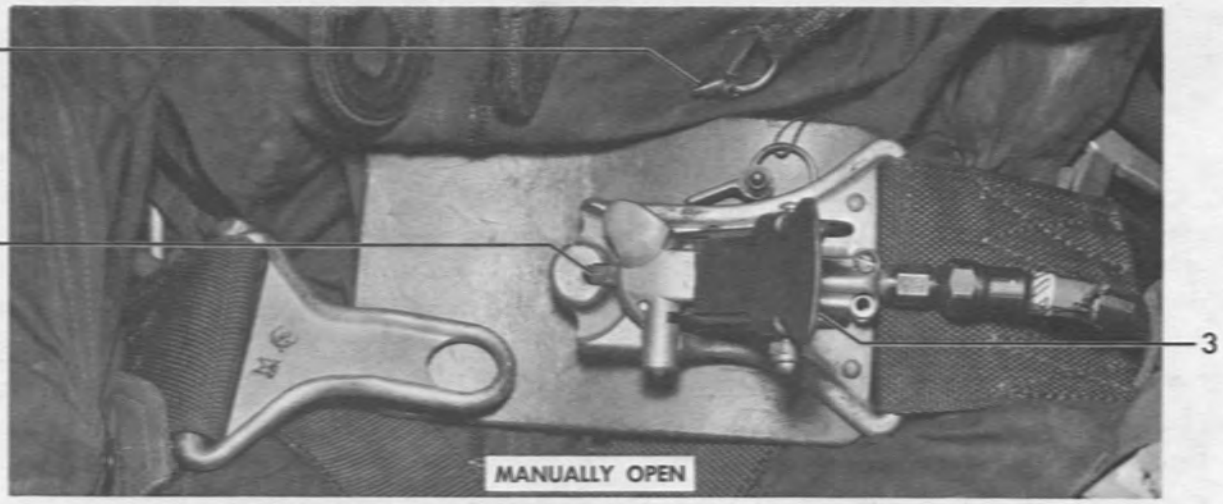
The shoulder harness inertia reel lock lever (figure 1-22), located on the left side of each seat, has two positions, LOCKED and UNLOCKED. A latch is provided for positively retaining the control handle at either position of the quadrant. By pressing down on the top

automatic safety belt

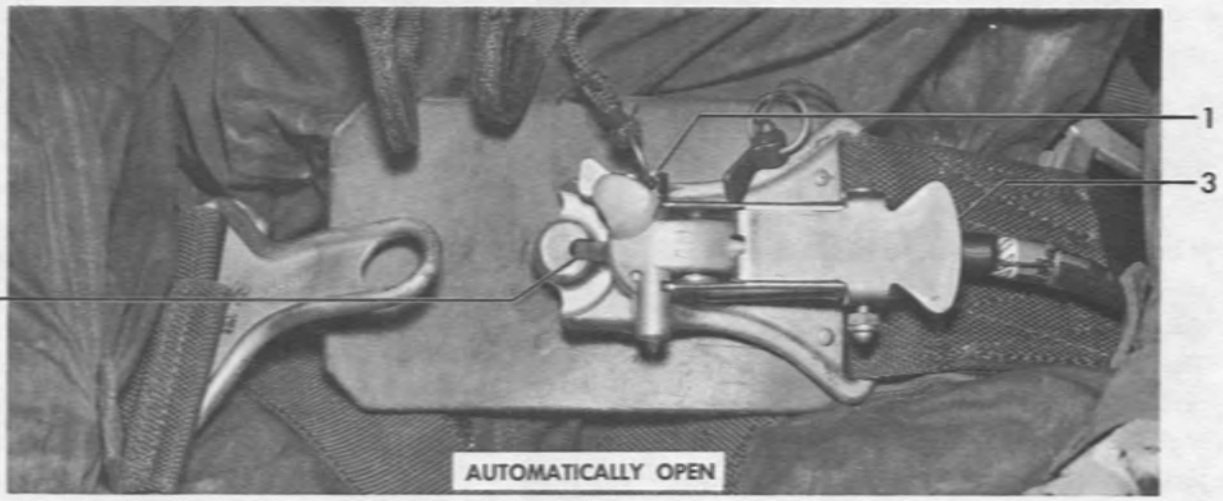
TYPE MA-1 AUTOMATIC LAP BELT



1. PARACHUTE LANYARD KEY 2. SPARE KEY 3. LATCH EXTENDED 4. LOCKHEED TYPE HANDLE EXTENTION



1. KEY EJECTED 2. LATCH RETRACTED 3. RELEASE LEVER RAISED

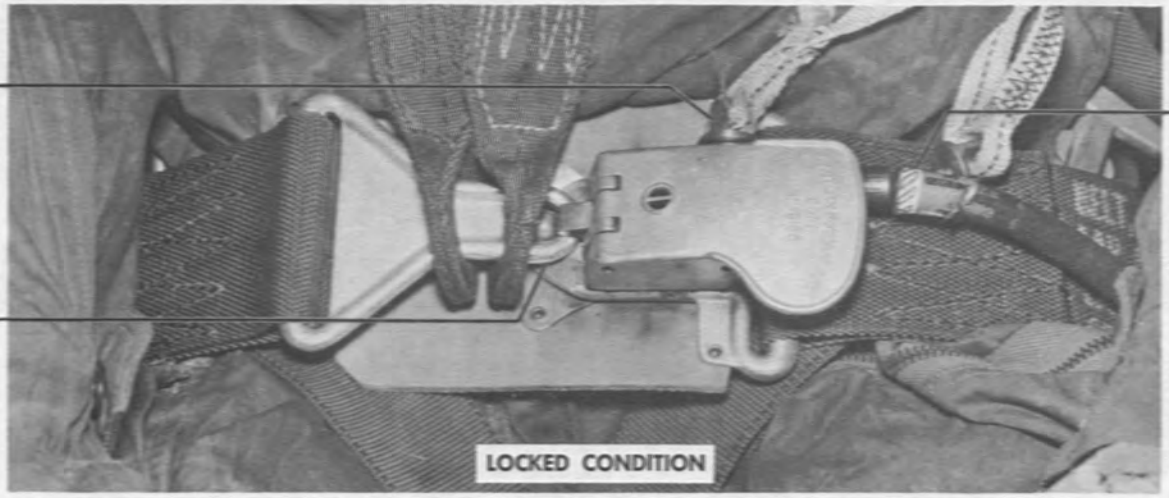


F-20-F-1-32(1) 1. KEY RETAINED 2. LATCH RETRACTED 3. RELEASE LEVER (LOCKED)

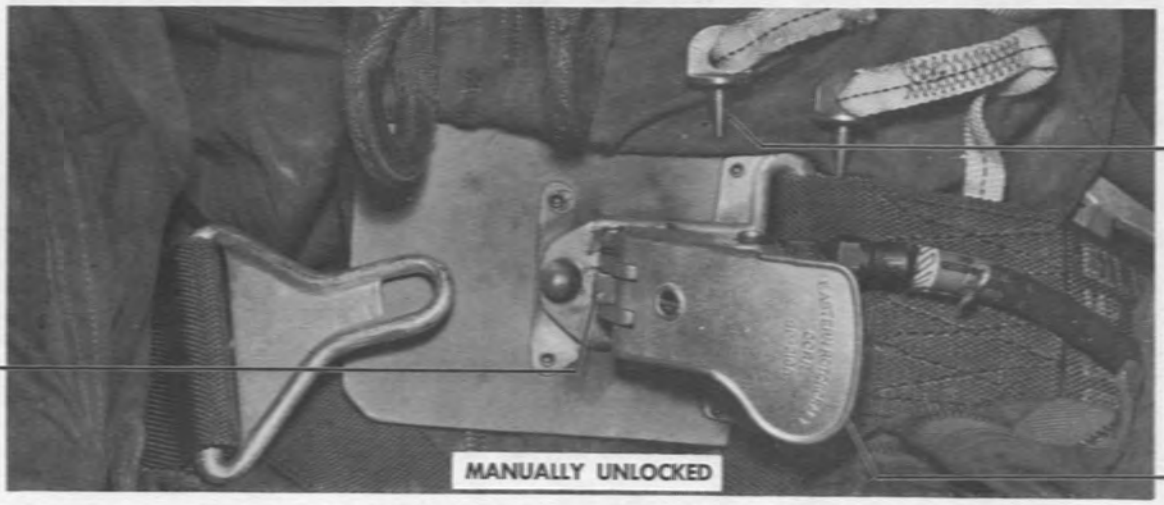
Figure 1-23 Sheet 1

automatic safety belt

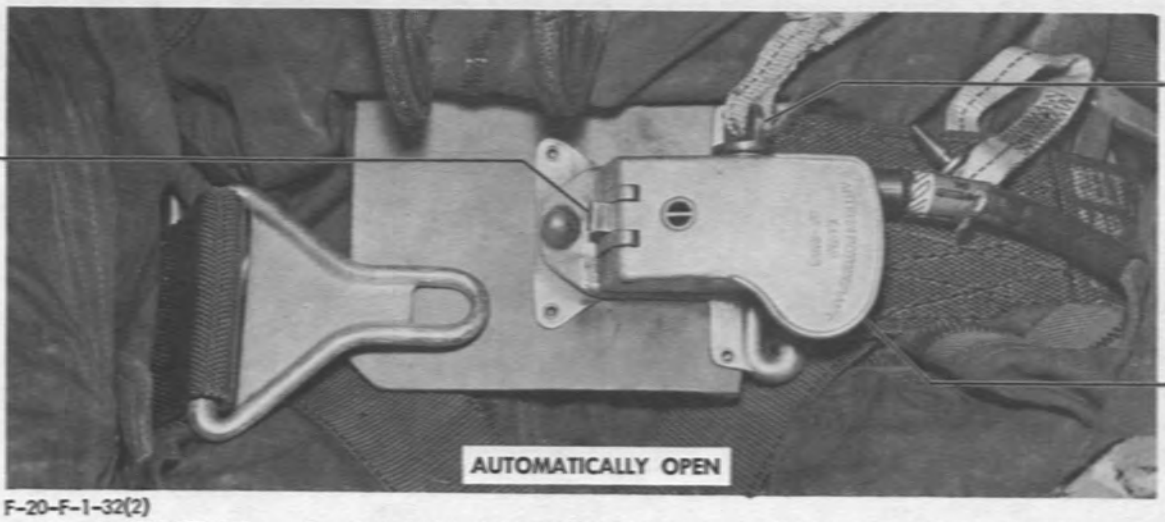
TYPE MA-3 OR MA-4 AUTOMATIC LAP BELT



1. PARACHUTE LANYARD KEY 2. SPARE KEY 3. LATCH EXTENDED



1. KEY EJECTED 2. LATCH RETRACTED 3. RELEASE LEVER RAISED



F-20-F-1-32(2)

1. KEY RETAINED 2. LATCH PIVOTED UP (FREE TO PIVOT) 3. RELEASE LEVER DOWN (LOCKED)

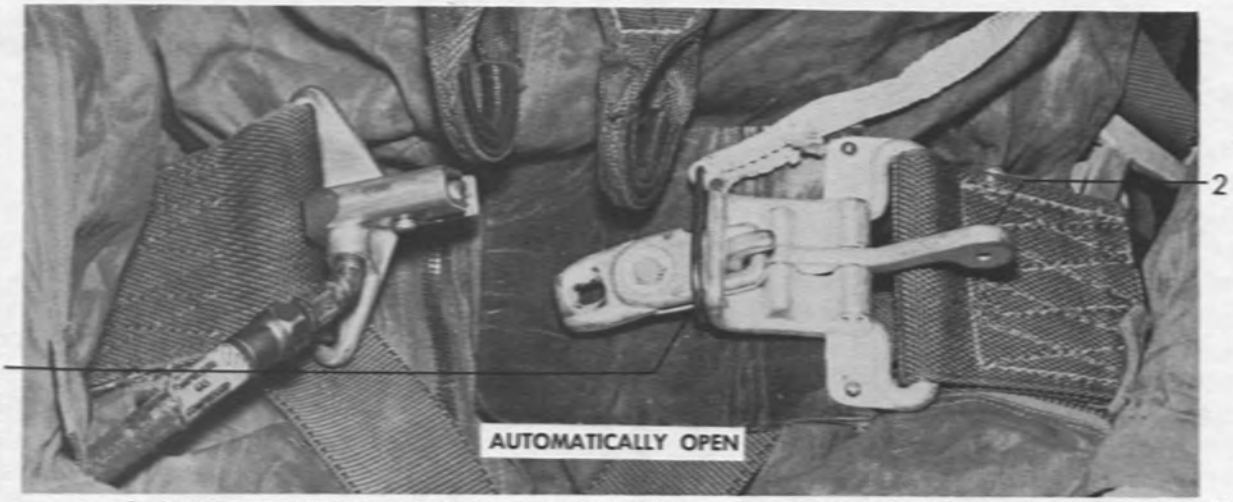
Figure 1-23 Sheet 2

automatic safety belt

TYPE MA-5 OR MA-6 AUTOMATIC LAP BELT

1. AUTOMATIC RELEASE 2. PARACHUTE LANYARD ANCHOR 3. SWIVEL LINK 4. MANUAL RELEASE

1. PARACHUTE LANYARD ANCHOR FREE



1. PARACHUTE LANYARD ANCHOR RETAINED BY SHOULDER ON SWIVEL LINK 2. MANUAL RELEASE LEVER LOCKED F22-C-1-23

Figure 1-23 Sheet 3

of the control handle the latch is released and the control handle may then be moved freely from one position to the other. When the control is in the UNLOCKED position the reel harness cable will extend to allow the pilot to lean forward in the cockpit. However, the reel will automatically lock when the aircraft encounters a deceleration force of 2 to 3 G. When the reel is locked in this manner it will remain locked until the control handle is moved to the LOCKED position and then returned to the UNLOCKED position. When the control is in the LOCKED position the reel harness cable is manually locked and prevents the pilot from bending forward.

Seat Adjustment Switch.

A seat adjustment control switch (figure 1-22) is located at the right side of the seat. The switch is pushed down to lower the seat and lifted to raise the seat. When the switch is released it will return to the OFF (center) position. The position of the seat does not affect ejecting.

CAUTION

- To avoid jamming the seat in the up position do not operate the switch unless the seat is occupied.
- If the seat has been raised to the full up position, check the oxygen hose and radio headset connections to see that they are still intact. To avoid damage to oxygen hose and headset connections the pilot should check to see that they are clear before the seat is lowered to the full down position.

AUTOMATIC LAP BELT.

The ejection seat is equipped with an automatic-opening lap belt which facilitates pilot separation from the seat following ejection. Belt opening is accomplished as part of the ejection sequence requiring no effort on the part of the pilot. As the seat leaves the aircraft during ejection the lap belt initiator is fired. This is a 1-second delay initiator which, upon firing, forces gas pressure through a flexible hose to the belt buckle. Gas pressure opens the belt buckle, releasing the lap belt and shoulder harness. The automatic lap belt may be one of three basic types as follows: MA-1, MA-3 or 4, and MA-5 or 6. Refer to figure 1-23, sheets 1 through 3, for their operation. The automatic-opening lap belt is unlocked in the same manner as a conventional lap belt and can be opened manually if automatic opening fails.

WARNING

Manual release of the lap belt renders the automatic parachute system inoperative.

AUTOMATIC PARACHUTE CONNECTIONS.

If the pilot is wearing an automatic-opening, aneroid-type parachute, the parachute lanyard anchor from the parachute opening device must be attached to the swivel link. As the pilot separates from the seat the lanyard, which is anchored to the belt, serves as a static line to arm the parachute opening device. The parachute will then open at the preset time lapse or altitude. The low-altitude lanyard may be routed either over or under the ejection seat shoulder restraint harness contingent upon individual preference. (Refer to Section II.)

WARNING

- A hazardous condition exists when wearing a backpack-type parachute. During ejection it is possible for the knees to strike the windshield frame, causing serious injury. Pilots with seated thigh lengths of 23 inches or less may wear either a seat pack or backpack parachute. Pilots with seated thigh lengths over 23 inches up to and including 28 inches must use the seat pack parachute.
- Do not use a seat cushion when wearing a life raft. Sitting on both of these items does not provide any added comfort but actually creates a definite injury hazard as well as possibly positioning the pilot where it may be difficult to reach all controls. Chance of vertebral injury is increased considerably when sitting on a thick, compressible mass. When utilizing the ejection seat in this circumstance, it will not exert a direct force on its occupant until the seat has moved 2 or 3 inches upward. After this amount of travel the seat has gathered such momentum that excessive impact is produced when the seat initially lifts the pilot. If 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 and allow him to slump forward. In this position the impact may severely injure his back. If additional height in the seat is needed, a solid filler block may be used in conjunction with the life raft. The combined thickness should not, however, exceed 5 inches.

zero-delay lanyard

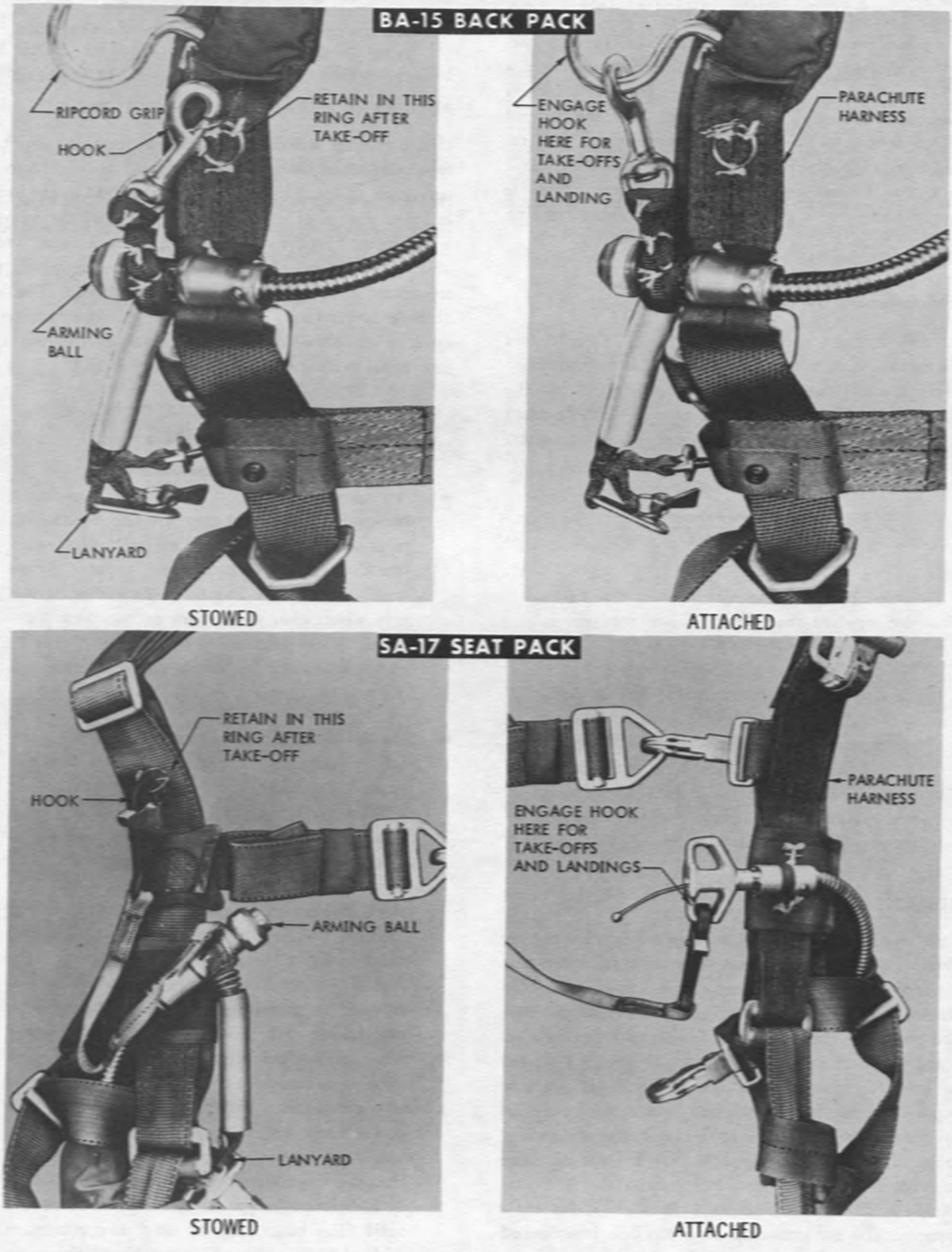


Figure 1-24

Zero-Delay Lanyard.

In order to provide an improved low altitude escape capability, a 1-second safety belt delay and a zero-second parachute delay ("one and zero" system) is provided for ejection seat escape systems. This system makes use of a detachable lanyard (figure 1-24) that connects the parachute timer knob to the parachute "D" ring. At very low altitudes and airspeeds this zero-delay lanyard must be connected to provide parachute actuation immediately after separation of the aircrew member from the ejection seat. At other altitudes and airspeeds the zero-delay lanyard MUST BE DISCONNECTED from the "D" ring to allow the timer to actuate the parachute below the critical opening speed and below the timer altitude setting. A ring attached to the parachute harness is provided for stowage of the lanyard hook when it is not connected to the "D" ring. This "HOOK UP" and "UNHOOK" OF THE ZERO DELAY LANYARD MUST BE DONE MANUALLY BY THE CREW MEMBER.

AUXILIARY EQUIPMENT.

Auxiliary equipment, including cockpit heating and pressurization, oxygen, armament, lighting, and electronics is described in Section IV.

Section II – NORMAL PROCEDURES

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PREPARATION FOR FLIGHT.

FLIGHT RESTRICTIONS.

Refer to Section V for all operating limitations.

FLIGHT PLANNING.

Preflight planning data, such as takeoff, performance, required fuel, cruise data, and other performance information to complete the proposed mission will be determined using the performance data contained in the Appendix. Communications requirements will be determined from the appropriate flight-planning and flight-information publications.

TAKEOFF AND LANDING DATA CARD.

Takeoff and landing data cards are contained in the Pilot's Abbreviated Flight Crew Checklist, T. O. 1T-33(R)A-CL)1-1. Compute the takeoff and landing data and complete the takeoff and landing data card as illustrated in Part 10 of the Appendix.

WEIGHT AND BALANCE.

Refer to the Handbook of Weight and Balance, T. O. 1-1B-40, and T. O. 1T-33(R)A-5 for weight and balance data. (See typical center-of-gravity diagram, figure 5-3, Section V.)

CHECKLISTS.

Section II contains the amplified checklists. The abbreviated checklist is published separately as T. O. 1T-33(R)A-(CL)1-1. Refer to AFR 60-9 for the mandatory and nonmandatory phases of the checklists.

ENTRANCE.

CAUTION

- Check that external power unit (if connected) is turned OFF while the canopy-open switch is being operated to raise the canopy.
- When stepping on or off the wing, do not step on the false leading edges of the inboard wing sections. Any shift or change in contour to these modifying attachments may create undesirable stall and spin characteristics.

PREFLIGHT CHECK.

It will be the pilot's responsibility to ensure that the preflight and postflight inspections, as required

by the Technical Manual Inspection Requirements, T.O. 1-T-33 (R)A-6, have been performed. The aircrew inspection procedures are based upon the assumption that maintenance personnel have completed all of the requirements of the Technical Manual Inspection Requirements, T.O. 1-T-33(R)A-6. Therefore, duplicate inspections and operational checks of systems by aircrew personnel have been eliminated except for certain checks required in the interest of safety.

EXTERIOR INSPECTION.

1. Form 781 — Check.

CAUTION

- Stowage of clothing or loose equipment in the nose section which interferes with circulation of air over the inverters is prohibited. Also, such loose equipment could fall through the canvas flap in the nosewheel compartment and interfere with nose gear retraction.
- If the nose compartment hood is closed with the yaw string inside it can wrap around the inverter shaft and result in inverter failure.

2. General condition — Check.

a. Visible fluid leaks.

b. All panels and visible lines secure.

c. Popped rivets and wrinkled skin.

A. RIGHT FORWARD FUSELAGE.

1. Camera equipment — Check.
2. Nose compartment hood — Securely closed.
3. Yaw string — Free.
4. Pitot head cover — Removed.
5. Static sources — Clear.

B. NOSEWHEEL WELL.

1. Wheel and tire — Check.
2. Circuit breakers — In.

C. RIGHT AIR INTAKE (Check).

D. RIGHT SPEED BRAKE AREA.

1. Pressurization air shutoff lever (if installed) — Positioned parallel to fuselage.

E. RIGHT WHEEL WELL.

1. Low-pressure fuel filter — General condition, leaks, and security of fuel lines.

2. Wheel and tire — Check.

F. FUSELAGE TANK AND RIGHT PLENUM CHAMBER.

1. Fuselage tank — Check.

Fuel quantity, cap condition and security, access cover closed, and airlock fastener secure.

WARNING

Make sure that the fuselage tank cap is secured. A loose cap will result in fuel siphoning into the plenum chamber.

2. Engine access doors — Closed and fasteners secured.

3. Alcohol tank — Quantity and cap secure.

4. Engine oil filler cap (dipstick) — Secured.

CAUTION

Instances have occurred where maintenance personnel have not properly secured the oil filler cap after servicing, resulting in noxious oil fumes entering the cockpit, obscured vision, and oil starvation. In order to prevent this happening, the oil filler cap must be physically checked prior to each flight to ensure that the cap is secure.

G. RIGHT WING AND TIP TANK.

1. Fuel tanks — Quantity and caps secure.
2. Aileron — Condition and freedom of movement.

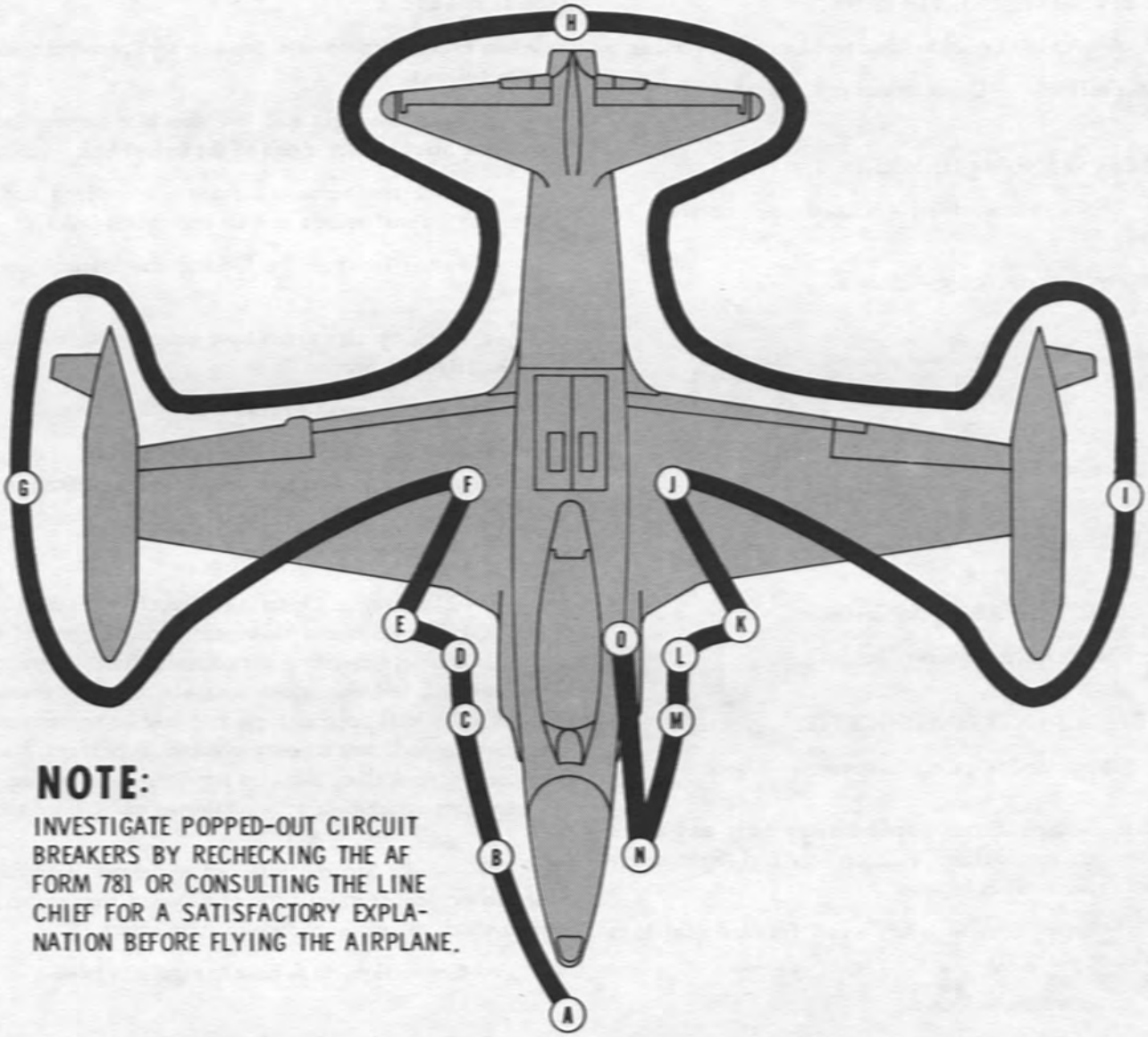
H. AFT SECTION.

1. JATO stores — Check.

Check JATO bottles, travel pod, radar reflectors; and tow target attachments as applicable for security of mounting. Check travel pod door closed and locked.

2. Elevator — Freedom of movement and alinement of tabs.

exterior inspection



NOTE:

INVESTIGATE POPPED-OUT CIRCUIT BREAKERS BY RECHECKING THE AF FORM 781 OR CONSULTING THE LINE CHIEF FOR A SATISFACTORY EXPLANATION BEFORE FLYING THE AIRPLANE.

A	RIGHT FORWARD FUSELAGE	I	LEFT WING AND TIP TANK
B	NOSE WHEEL WELL	J	LEFT PLENUM CHANBER
C	RIGHT AIR INTAKE	K	LEFT WHEEL WELL
D	RIGHT SPEED BRAKE AREA	L	LEFT SPEED BRAKE AREA
E	RIGHT WHEEL WELL	M	LEFT AIR INTAKE
F	FUSELAGE TANK AND RIGHT PLENUM CHAMBER	N	LEFT FORWARD FUSELAGE
G	RIGHT WING AND TIP TANK	O	BEFORE ENTERING COCKPIT
H	AFT SECTION		

F22-C-2-1

Figure 2-1

3. Rudder — Freedom of movement and center spring loading.

4. Tailpipe — Cover removed.

I. LEFT WING AND TIP TANK.

1. Ailerons — Condition and freedom of movement.

2. Fuel tanks — Quantity and cap secured.

J. LEFT PLENUM CHAMBER.

1. Engine access doors — Closed and fasteners secured.

2. Hydraulic tank cap — Secure.

K. LEFT WHEEL WELL.

1. Wheel and tire — Check.

L. LEFT SPEED BRAKE AREA (Check).

M. LEFT AIR INTAKE (Check).

N. LEFT FORWARD FUSELAGE.

1. Static sources — Clear.

O. BEFORE ENTERING COCKPIT.

1. Canopy and seat ejection systems — Check.

Before entering aircraft, open canopy fully and check canopy jettison initiator, ejection seat and flight safety pins (figure 1-18) as follows:

a. Canopy jettison lever — Full forward (check in up detent position).

b. Arm rests — Down.

c. Flight status safety pins — Installed.

d. Ground status safety pins — Removed.

WARNING

- If any discrepancy is noted during inspection of this system, do not enter the aircraft.
- If the ground status safety pins are installed, consult maintenance personnel regarding the status of the ejection system before occupying the seat.

INTERIOR INSPECTION.

1. Cockpit — Check for loose items, equipment, tools, etc.

2. Shoulder harness, lap belt and oxygen equipment — Strap and adjust.

When using the automatic lap belt and parachute, strap on as follows:

a. Place the right and left shoulder harness loops over the manual release end of the swivel link.

b. Place the automatic parachute lanyard anchor over the manual release end of the swivel link.

c. Fasten lap belt by locking the manual-release lever.

d. Hook up all oxygen hose attachments, including mask. (Refer to Section IV.)

3. Oxygen system — Check.

(Figures 4-9 and 4-10 show the correct method of oxygen hose attachment.) Preflight the following items:

P—Pressure, 400 to 450 psi.

D—Diaphragm. Operate automix lever to the 100% OXYGEN position and blow gently into the end of the regulator hose, simulating normal exhalation. If there is no blowback leak the system is satisfactory (the demand check valve will open at 1 psi.). Little or no resistance to blowing indicates a faulty demand diaphragm, faulty diluter valve, leaking mask to regulator hose tubing, or faulty hose attachment at regulator or quick disconnect.

M—Mask. Securely attached to helmet. Condition of rubber, proper installation of valves, arrows down on inlet check valve covers and lip strap intact.

c—Connection, mask hose to regulator hose.

C—Connection, regulator hose to regulator. Knurled collar of regulator outlet tight, OXYGEN hose securely clamped; check hose for visible deterioration and flat spots.

R—Regulator, OXYGEN. Open EMERGENCY DIAL briefly to ensure the regulator will deliver OXYGEN; move automix lever back and forth to be sure it moves freely and inspect automix screen on side of regulator for cleanliness.

I—Indicator. Check blinking (only slight movement of blinker will be noted below 5,000 feet when regulator automix is in the NORMAL position).

P—Pressure Test.

a. Connect mask and check for ease of breathing.

b. Turn regulator pressure control knob to 43M and hold breath; continued flow of OXYGEN indicates a loose mask, faulty exhalation valve, or loose fittings.

c. Regulator pressure back to NORMAL, exhale to check valves for sticking.

E—Emergency Cylinder. RED FLAG PIN REMOVED, 1800 psi minimum, connect to mask at GROUND LEVEL.

4. ZERO-DELAY LANYARD — HOOK UP. The lanyard may be routed either over or under the shoulder restraint harness.

a. When routing lanyard OVER the shoulder restraint harness, hook lanyard snap to ripcord grip (D-ring) after completing lap belt and shoulder harness connection and adjustment.

b. When routing lanyard UNDER the shoulder restraint harness, hook lanyard strap to ripcord grip (D-ring) after donning parachute, then connect and adjust shoulder restraint harness and lap belt.

5. Anti-G suit valve — Connect if required.

a. Make sure check valve has been removed from G suit prior to flight.

b. Check that anti-G suit hose is not routed under lap belt or in any other manner which would interfere with disconnecting.

6. Shoulder harness inertia reel — Unlocked.

7. Manual release handles (tanks or bombs) — In and safetied.

8. Landing gear lever — DOWN.

9. Interphone panel — Properly set.

10. Left console circuit breakers — In.

11. Bomb arming and selector switches — OFF and SAFE.

12. Wire recorder — OFF.

13. Fuel tank switches — OFF.

14. Tip tank jettison switch — OFF or SAFE.

15. Cabin pressure dump switch (if installed) — OFF.

16. Starting fuel switch — OFF.

Note

Check that switch returns to OFF from the MANUAL position when the cover is closed.

17. Landing-taxi light switch — OFF.

18. Elevator trim override switch — NORMAL (and safetied).

19. Wing flap switch — OFF.

20. Throttle — OFF and friction lock adjusted.

21. Speed brake switch — DOWN.

22. Main fuel valve shutoff switch — OPEN (guard down and safetied).

23. Cabin temperature selector rheostat — Position at "11 o'clock."

24. Aileron booster lever — ON (forward).

25. All other left console switches OFF and circuit breakers IN.

26. Windshield defroster knob — Out and unlocked.

27. Altimeter, clock, fuel counter, and cabin altimeter — Check for proper settings.

WARNING

Special attention should be given to the altimeter to ensure that the 10,000-foot pointer reads correctly. (See figure 1-16.)

28. Bomb salvo button — Safety cover removed (if installed).

29. Emergency fuel switch — OFF or NORMAL.

30. UHF radio — OFF.

31. IFF equipment — OFF.

32. Camera control panel — Set as required.

33. Intervalometers — Set as required.

34. JATO arming switch — SAFE.

35. Flight instrument power switch — OFF.

36. Accelerometer — Zeroed.

37. Cockpit pressurization dump valve lever (if installed) — CLOSED.

38. Cockpit pressure air inlet ducts (3) — Open.

39. Ignition switch — OFF.

40. Battery generator switch — ON.

41. Pitot heater — Check.

a. Pitot heat switch — ON for 20–25 seconds, then OFF.

b. Request ground crew to hand-check pitot head.

42. Battery-generator switch — OFF.

43. Navigation lights switches — OFF.

44. Auxiliary windshield defroster switch — OFF.

45. Circuit breakers (right side) — IN.

46. AC fuses and spares — Screwed in clockwise finger tight.

47. Emergency hydraulic pump switch — OFF (guard down).

48. Emergency hydraulic system selector lever — NORMAL (safetied).

49. Manual canopy handcrank handle — Stowed and safetied.

50. Map case — Secure.

51. Signal ground crew to connect external power.

52. Internal cockpit lighting rheostats (4) — as required.

53. Seat height switch — Readjust and reset rudder pedal length (if required).

54. All warning and indicator lights — TEST.

Push to test the circuits and set for desired brilliance.

55. Fire and overheat warning lights circuit test switch — TEST.

56. Navigation light switches — As required.

For IFR or night mission — Check operation with ground crew.

57. Landing light and taxi light switch — As required.

58. Camera power switch — ON; check indicator light then turn switch — OFF.

59. Film exposure counters — Set for correct reading.

60. Aileron trim tab — Check.

61. Elevator trim tab — Check.

Check operation of the elevator trim tabs and neutral indicator light with the control stick trim switch. Check that the override switch is safetied in the NORMAL position. Check stick grip for security.

STARTING ENGINES — GROUND STARTS.

For all starts head the aircraft into the wind whenever practicable, especially when using gasoline type fuels. Be sure that the danger areas shown in figure 2-2 are clear before starting.

Note

Avoid starting the engine when a strong tail wind component exists.

AUTOMATIC GROUND START.

(See figure 2-3.)

ALTERNATE GROUND STARTS.

(Refer to Section VII.)

CARBON MONOXIDE ELIMINATION.

a. Whenever carbon monoxide is suspected, use 100 percent oxygen during ground operation and takeoff.

b. After contamination is estimated to no longer exist, move the oxygen regulator diluter lever to NORMAL OXYGEN.

danger areas

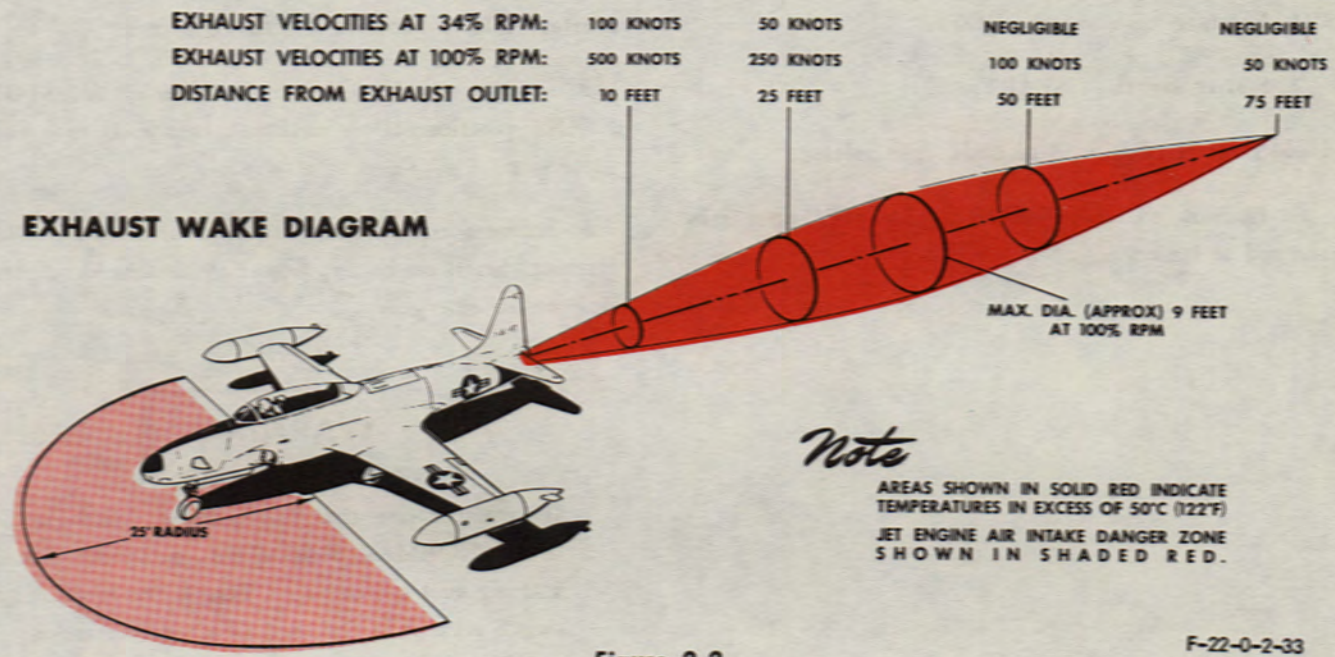


Figure 2-2

WARNING

The oxygen-diluter regulator lever must be returned to the NORMAL OXYGEN position as soon as possible because the use of 100% oxygen throughout a long mission may deplete the oxygen supply before the mission is completed.

BEFORE TAXIING.

1. Radios — ON; allow 2 minutes warmup before transmitting.
2. J-8 attitude indicator — CAGE.
3. Anti-G suit operation — Check if required.
4. Inverters — ON and check.

Turn flight instrument power switch to STANDBY, then OFF, then MAIN; check gyro-instrument-out warning light illuminated in the OFF position and out in the MAIN and STANDBY positions.

5. Loadmeter — Check.

Plus indication but not to exceed the limitations set forth in Section V.

Note

Nickel-cadmium batteries not fully charged may cause temporarily high loadmeter readings. Loadmeter should indicate within limits before taking off.

6. Speed brakes switch — UP.

As speed brakes retract, note hydraulic pressure to momentarily drop to a minimum of 475 psi and then build up to normal.

Note

- Before raising speed brakes, ensure that the speed brake area is clear.
- The speed brake switch should be left in the UP position after retraction.

7. Wing flap lever — DOWN approximately 30° (70%), then neutral.

Verify flap extension with ground crew.

Note

During cold weather, questionable readings may be observed on the flap position indicator. If this occurs, cycle the flaps three or four times.

AUTOMATIC GROUND START

NORMAL PROCEDURE

1. Fuselage tank switch — OFF.

2. Starter switch — START.

Hold in start position 3 seconds, then release.

3. Ignition switch — NORMAL after rpm has reached at least 9%.

4. Starting fuel switch — AUTO when rpm is stabilized above 10%.

Note

The engine should start immediately and accelerate to at least 26% rpm.

5. Exhaust gas temperature — Check.

Closely monitor exhaust gas temperature gage for excessive temperatures. (Refer to Section V.)

IN THE EVENT OF MALFUNCTION

Starter Fails to Produce 9% to 10% rpm.

a. Starter switch — Hold momentarily in STOP–START position; allow engine to windmill to a complete stop.

b. Secure adequate external power prior to new start attempt. Starts on battery power alone should be made only in an emergency.

WARNING

It is imperative that the ignition switch be in the NORMAL position before turning the starting fuel switch to AUTO. If the ignition switch is turned to NORMAL after the starting switch is moved to AUTO, an explosion, followed by fire, will very likely occur.

False Start – Combustion does not occur within 5 seconds after moving starting fuel switch to AUTO.

a. Starting fuel switch — OFF.

b. After 30 seconds of windmilling, starter switch — STOP–START momentarily and wait until engine comes to a complete stop.

c. Have ignition system checked before attempting a new start.

d. Check the plenum chamber area and the area between the tailpipe and fuselage skin for the presence of fuel or fuel fumes which might cause a fire or explosion. Drain the tailpipe if necessary.

Hot or Hanging Start Procedure.

If the engine speed stabilizes at any rpm between 12% and 18% (hanging start) or the exhaust gas temperature exceeds the limits specified in Section V (hot start), proceed as follows:

Figure 2-3. (Sheet 1)

NORMAL PROCEDURE	IN THE EVENT OF MALFUNCTION
	a. Starting fuel switch — OFF. b. Ignition switch — OFF. c. Starter switch — STOP–START after all traces of combustion have vanished. d. Make entry in Form 781 as applicable. e. Do not attempt a new start until the aircraft has been inspected and cleared by engineering personnel.
6. Throttle — IDLE (above 26% rpm).	If external power is disconnected before the throttle is moved to IDLE the engine fuel supply will be cut off. In this case, proceed as follows: a. Starting fuel switch — OFF. b. Ignition switch — OFF. c. Allow engine to windmill to a complete stop before attempting a new start.
7. Starting fuel switch — OFF. Turn the starting fuel switch OFF by pushing the guard down to avoid the possibility of inadvertently placing the switch in the MANUAL position.	If the fuel filter ice warning light comes on and stays on, shut down the engine and have the filter checked for ice and contamination.
8. Engine instruments — Check. (Refer to Section V.)	
9. External power source —Disconnect.	
10. Battery generator switch — BATTERY AND GENERATOR.	If there is no indication of oil pressure after 30 seconds of engine operation, or if the pressure drops to zero after a few minutes of ground operations, shut down the engine and investigate.
CAUTION If a start is attempted immediately after a normal engine shutdown, a visual inspection should be made to ascertain that there are no fuel and or fuel fumes in the plenum chamber. Fuel should also have stopped draining from the fuel system drains before a new start is attempted.	**Note** During cold weather operation no warmup is required if the oil pressure remains below 100 psi at full throttle. A temporarily high oil pressure (above 100 psi) is not dangerous but takeoff should be delayed until the pressure drops below 100 psi. If the oil pressure remains above 100 psi, an oil system malfunction is indicated and the aircraft should not be flown.

Figure 2-3. (Sheet 2)

8. Communications and navigation equipment — Check.

a. Radio compass — Check for cockpit control, frequency alinement, antenna reception, manual loop rotation, and ADF operation. Tune to a low-frequency range or homer that serves field of departure, identify it, and set function switch as desired.

b. UHF or vhf communications radio — Check.

c. IFF — STDBY.

9. Altimeter — Set current barometric pressure.

Note

Note difference between altimeter indication and actual field altitude. If the altimeter indicates an error over ±75 feet do not fly the aircraft under IFR conditions. Reset altimeter to field elevation and check difference between Kollsman dial indication and current altimeter setting. Apply this difference to subsequent altimeter settings.

10. Canopy Operation — Check.

a. Verify canopy operation by slightly lowering canopy with the canopy part-close switch.

WARNING

Check that cockpit sills are clear before closing canopy.

b. Reposition canopy full open or closed and locked.

11. Surface controls — Check.

a. Freedom of movement and direction of operation.

b. Monitor hydraulic pressure rise after ailerons are actuated.

12. Emergency fuel system — Check.

The emergency fuel system check can be made either before or during taxiing, depending on the congestion of the parking ramp or taxi ways. To make the check, proceed as follows:

a. Fuselage tank switch — OFF.

b. Emergency fuel switch — NORMAL.

c. Starting fuel switch — OFF.

d. Throttle — Advance to obtain an rpm of 55% and allow engine speed to stabilize.

e. Emergency fuel switch — EMERGENCY.

Observe that a slight rpm drop (not to exceed 12%) usually occurs; however, in some cases a slight rpm rise may occur.

CAUTION

If flameout occurs, move throttle to OFF. Do not return the emergency fuel switch to NORMAL.

f. Throttle — Advance to approximately 70% rpm and allow engine to stabilize.

g. Emergency fuel switch—NORMAL while rapidly retarding the throttle to IDLE. The emergency fuel amber indicator light will go out.

13. Fuselage tank switch — ON.

14. Emergency Fuel Switch — NORMAL. Check amber light out.

15. Safety pins and clips — Removed.

a. All flight status safety pins — Removed. If carried in the aircraft, the pins shall be stowed so as not to interfere with the flight controls or seat mechanism.

b. Signal ground crew to remove landing gear safety clip and tip tank safety pins. Visually display seat and canopy safety pins to ground crew personnel. (Stow as required.)

16. Wheel chocks — Removed.

Test brakes by pumping, then hold brakes and signal ground crew to remove wheel chocks.

TAXI.

During normal operations, advance throttle smoothly to approximately 70% rpm before releasing brakes. Allow aircraft to gain momentum straight ahead before

making any turns. Throttle may be retarded as turn is entered to avoid blasting adjacent aircraft or equipment. Forward momentum should be maintained if on soft ground, or any time turns of short radius are made, since it is difficult to start moving if once stopped under these conditions. Brakes must be used for steering. Taxi time should be cut to an absolute minimum. A good rule to remember is: Every minute on the ground requires between 3 and 4 gallons of fuel or subtracts about 7 miles from the cruising range of the aircraft.

WARNING

Do not rest arms on canopy sills while taxiing with canopy in the open position. If the canopy should fall, serious injury to the arms will occur.

1. Leading edge and main wing fuel booster pumps — Check.

Check leading edge fuel tank boost pump operation by turning the leading edge tank fuel switch ON and observing the indicator light and noting a positive increase on the fuselage tanks fuel quantity gage (liquidometer). As the switch is turned ON or OFF monitor the loadmeter for indication that current is reaching pump motors. Check main wing fuel tank booster pump operation by turning the main wing fuel tank switch ON, then OFF, and observing the indicator light and loadmeter.

2. Flight instruments — Check.

a. Airspeed indicator — 30–35 knots (wind calm).

b. Directional indicator — Check.

Slave gyro — Set takeoff heading under top index; check pointer for proper indication and operation while taxiing.

c. Attitude Indicator — Set the miniature aircraft level with the 90-degree indices on the sides of the case. This should give approximately level flight indication.

d. Turn-and-slip indicator — Operating (check needle deflecting in the direction of the turn while taxiing, ball free in the race).

e. Vertical velocity indicator — Check for zero setting.

f. Standby magnetic directional indicator — Check heading indication, card swings freely, and bowl is full of fluid.

3. Navigation equipment — As required.

BEFORE TAKEOFF.

1. Pitot heat — Climatic.

2. Tip tank jettison switch — AUTO-DROP. (The bomb salvo button will be used if jettisoning is required.)

3. Fuselage tank — Refill from the leading edge tanks (if necessary) to 245 gallons (on aircraft not equipped with the PN FV400-SANTA ANITA fuselage fuel cap).

Note

On aircraft not equipped with the PN FV400 SANTA ANITA fuselage caps, do not fill the fuel tank with more than 245 gallons for takeoff. A stuck float valve in the fuselage fuel tank may result in fuel being forced into the fuselage tank filler or the fuel quantity transmitter wells and being drawn from there through open plenum chamber doors into the plenum chamber. After takeoff, the plenum chamber doors are closed and this will not occur.

4. Oxygen regulator diluter lever — As required.

5. Flaps — Check 30° down.

6. Elevator trim — Recheck.

7. Fuel filter deice switch — ON for 30 seconds, if required.

8. IFF — As directed.

9. Canopy — Close and lock. Check canopy warning light — Out.

10. Takeoff and landing data — Confirm (check wind, etc.).

11. Tip tank fuel switch — ON (as required).

Note

If the tips are full or nearly full, delay turning tip tank switch ON until runup is initiated.

12. Zero–delay and anchor lanyard — Check.

LINEUP CHECK.

Aline the aircraft with the runway so that the nosewheel will be centered when the brakes are released for takeoff.

1. Directional indicator — Check against runway heading.

2. Attitude indicator — Check for excessive precession.

3. Throttle — Advance to 80% rpm.

4. Exhaust gas temperature, fuel, oil, and hydraulic pressure — Check within limits.

5. Loadmeter — Check.

6. Tip tanks — Feeding and indicator light out.

7. Fuel selector switches — Gangload on (on aircraft equipped with the PN FV400 — SANTA ANITA fuselage fuel caps).

WARNING

It is not recommended that takeoffs be made with the flaps retracted because takeoff runs will be greatly increased.

TAKEOFF.

a. Release brakes simultaneously.

b. Throttle — Full open. (Refer to Section V for engine temperature and rpm limits.) (Refer to Section IX for All-Weather Operating Information.)

c. RPM, EGT, and fuel pressure — Recheck.

d. Maintain directional control by differential braking until the rudder becomes effective (at approximately 50 knots).

e. At approximately 85 knots apply back pressure on the stick so that sufficient weight is removed from the nosewheel to extend the strut, but not enough to lift the nosewheel off the ground. Maintain this attitude throughout the takeoff run. In this attitude total drag is minimum and aircraft acceleration is maximum. At approximately 100 knots during an instrument takeoff, increase the pitch attitude approximately 2 bar widths on the attitude indicator.

Note

Check acceleration speed at the second 1000-foot marker from the point of brake release. (Refer to the Appendix).

f. Acceleration speed — Check. (Refer to the Appendix.)

g. At computed takeoff speeds, fly the aircraft off the ground by slightly increasing the nose up pitch attitude.

WARNING

- If too much back pressure is applied, a nose high attitude will result which will materially extend takeoff roll. Takeoff speed is reduced and the ability to remain airborne and accelerate to climb speed is doubtful.
- When taking off from a runway covered with large puddles of water, do not lift nosewheel until 10 knots below takeoff speed.

CROSSWIND TAKEOFF.

In addition to the procedures given for a normal takeoff the following steps are included for crosswind takeoffs.

a. Increase lift-off speed about 10 knots by leaving the nose down a little longer during the takeoff run.

b. Counteract drift when the aircraft becomes airborne by lowering the upwind wing or crabbing into the wind.

MINIMUM RUN — OBSTACLE CLEARANCE.

When it becomes necessary to make a takeoff using a minimum run, reduce the gross weight of the aircraft as much as possible by reducing the fuel or ballast load to the absolute minimum necessary for the flight. The initial takeoff run is the same as for a normal takeoff. Use a maximum performance climb until all obstacles are cleared.

JATO TAKEOFF.

JATO thrust tends to raise the nose; this should be anticipated and corrected during the comparatively short (12 seconds) duration. Takeoff performance will depend somewhat upon the JATO firing point. Minimum ground run is obtained when the units are fired shortly after the start of the takeoff run. The best performance to clear a 50-foot obstacle is obtained by firing the units later

on in the takeoff run so that the units are expended at about the same time the aircraft clears the obstacle. (Refer to the Appendix for JATO performance data.)

Note

Before using JATO, check the weight and balance to make sure that the static load limits are not exceeded. Installation of JATO bottles moves the CG 2.3% aft and the low thrust line of the JATO power vector shifts the "effective" CG further aft. Refer to T.O. 1-1B-40 for installation of ballast to get the CG as far forward as practical.

If JATO is to be used, proceed as follows:

a. JATO ready switch — ARM.

b. JATO READY indicator light — Check.

c. JATO firing button — Press to fire JATO units.

d. JATO arming switch — SAFE, after the JATO units are expended.

WARNING

If JATO units are not used or misfire during the takeoff run, they should be jettisoned before climbing to altitude. The units may explode if subjected to low temperatures at high altitudes.

AFTER TAKEOFF.

1. Landing gear lever — UP and locked.

Check position indicator and warning light for proper indications.

a. VFR — when definitely airborne and with safe airspeed (minimum 125 knots IAS).

b. IFR — the landing gear should be raised completely after reaching 500-fpm rate of climb and 125 knots IAS and before reaching the structural limit speeds listed in Section V.

CAUTION

- After takeoff from a wet snow or slush-covered runway operate the landing gear and flaps, if practicable, through several complete cycles to prevent their freezing.
- After taking off from a runway covered with large puddles of water, wait at least 15 seconds after breaking ground to retract the gear so that the centering cam can position the nose gear for retraction.

2. Wing flap lever — UP, between 140–165 knots.

Flaps should be completely up before reaching structural limit speed listed in Section V. Return the flap lever to the OFF position after flaps are up.

Note

If IFR, it is necessary to increase the pitch attitude approximately one bar width during flap retraction.

CLIMB

1. Climb — Establish as required.

Note

- After an instrument takeoff maintain a vertical speed of 1000 to 1500 fpm until the desired climb airspeed is reached.
- Recommended climb speeds are given in the Appendix. The best rate of climb can be obtained at 100% rpm, although under some conditions it may be necessary to climb at 96% rpm.

2. Fuel tanks — Check that no fuel is escaping through the filler caps.

Note

If fuel is siphoning overboard from the fuselage filler cap or the fuselage fuel vent (sabre drain) the pilot cannot see it. It is recommended that a frequent check of the fuel quantity gage, fuel counter, and fuel tank indicator lights be made during climb and initial cruise at altitude.

5000 FOOT ABOVE TERRAIN CHECK.

1. Fuel switches — Discontinue gang-loading after checking the fuselage fuel tank quantity gage approximately full.

2. Fuselage fuel tank quantity gage — Check for tip tank fuel transfer.

3. Tip tank jettison switch — OFF (if applicable).

4. Oxygen system — Check.

a. Oxygen regulator diluter level — NORMAL.

b. Oxygen pressure dial — NORMAL.

c. Oxygen pressure gage — Check pressure.

d. Oxygen flow indicator — Blinking.

e. Oxygen hose hookup — Recheck.

5. Zero-delay lanyard — Unhook and stow.

6. IFF — Checked.

Note

If positive operation of the normal mode of IFF has not been established with an Air Traffic Control facility during departure, a check should be made with such a facility as soon after takeoff as flight conditions permit. This check must be made prior to entering a radar advisory area. If IFF is inoperative, consult the appropriate navigation publications.

23,500-FOOT CHECK.

1. Altimeter — Set to 29.92 in. Hg. when climbing through 23,500 feet.

CRUISE.

(Refer to Section IV for Oxygen System Operation and the Appendix for Cruise Operating Data.)

Engine operation during flight in cold weather should be governed by normal procedures except that the fuel filter deicing system be operated as follows:

1. Fuel filter deice switch — As required. (Refer to Section IV.)

During periods of high altitude flight or when above the freezing level alcohol should be used for:

a. 15 seconds every 30 minutes of flight.

b. 15 seconds when beginning penetration prior to reducing power.

c. 30 seconds prior to pattern entry.

During ground operation when sub-freezing temperatures are encountered, alcohol should be used for 30 seconds before takeoff.

2. Windshield defroster — As required.

Note

Several minutes prior to anticipated descent engage defroster control valve and turn on auxiliary windshield defroster, if necessary. It may be necessary to adjust the cabin heat to the hot position to warm the canopy and windshield and prevent the formation of fog or frost on these surfaces during rapid descents from higher altitudes.

SYSTEMS OPERATION.

(Refer to Section VII for information regarding systems operations.)

FLIGHT CHARACTERISTICS.

(Refer to Section VI for information regarding flight characteristics.)

DESCENT.

1. Fuel filter deice switch — As required. (Refer to Section IV.)

2. Altimeter — Set to station pressure when passing through flight level 240.

3. IFF — Checked.

Note

This check should be performed within one hour prior to estimated time of landing.

5000 FOOT ABOVE TERRAIN CHECK.

At or prior to reaching 5000 feet above the terrain, make the following checks:

1. Fuselage tank fuel gage — Check quantity.

2. All Fuel Switches — GANGLOAD ON for all tanks containing fuel.

3. Zero–Delay Lanyard — Hook up (in accordance with engagement requirements, figure 3-7, Section III).

BEFORE LANDING.

The entry leg and airspeed will be determined by local field conditions. Accomplish the following before landing:

1. ZERO-DELAY LANYARD—CHECK HOOKED-UP.

2. Fuel quantity — Check.

3. Hydraulic pressure — Check.

4. Speed brakes switch — As desired.

5. Landing gear lever — DOWN (release button and jiggle).

Check position indicator and warning light.

Note

Jiggle the landing gear lever without depressing the lever button to ensure that the lever is locked in position.

6. Brakes — Check pedal pressure.

7. Wing flaps — Down.

A typical landing pattern, using the overhead approach (figure 2-4) should be accomplished as follows:

INITIAL APPROACH.

Unless otherwise specified, fly the initial approach at 1500 to 1700 feet above the terrain at approximately 240 knots IAS.

a. Zero-delay lanyard — Check hooked-up.

b. Fuel quantity — Check.

c. Hydraulic pressure — Check.

180° TURN TO DOWNWIND LEG (PITCHOUT).

At a point near the end of the runway, the exact location of which will be determined by traffic density and headwind conditions, begin a 180° level turn to the downwind leg by rolling slowly and smoothly into a bank of approximately 60°. Fly the aircraft around the turn to the downwind leg. This turn to the downwind leg is a smooth, steep turn.

a. Speed brake switch — DOWN (if not already extended).

CAUTION

Do not extend the landing gear and speed brakes simultaneously while the aircraft is in a bank. The drop in hydraulic pressure may cause a momentary loss of aileron booster control.

b. Throttle — Retard to 50–60% rpm.

DOWNWIND LEG.

Roll out on the downwind leg, fly straight-and-level maintaining altitude while reducing airspeed to a minimum of 160 knots IAS.

a. Landing gear lever — DOWN (release button and jiggle) at 195 knots IAS or below. Check landing gear indicator and hydraulic pressure.

b. Brakes — Check pedal pressure.

c. Wing flap switch — DOWN at 175 knots IAS or below.

180° TURN TO FINAL APPROACH.

Roll into the 180° turn to final approach at a minimum of 160 knots, using a medium bank descending turn. Do not allow airspeed to drop below 140 knots IAS while in the turn.

a. Throttle — As required.

b. Landing gear lever — Recheck down and locked.

FINAL APPROACH.

The rollout onto final approach shall be completed at not less than 140 knots IAS, 500 feet above the terrain, and approximately ¾ nautical miles from the end of the runway.

a. Throttle — As required.

b. Airspeed — Maintain a minimum of 120 knots IAS.

Add 5 knots airspeed for each 100 gallons (or increments thereof) of fuel on board above 200 gallons.

Note

With the exception of gust correction factors or flight control difficulties, the final approach speed should not exceed 140 knots IAS.

STRAIGHT-IN APPROACH.

A straight-in approach is not recommended except in an emergency because it is difficult to accurately establish the final approach. There is a strong tendency to set up the approach too far back from the end of the runway which frequently results in undershooting. If a straight-in approach is necessary proceed as follows:

a. Reduce airspeed to below the maximum gear down speed (195 knots IAS). Extend the landing gear and plan to arrive at a point 3 miles from the end of the runway at an altitude of 1500 to 1700 feet above the terrain at approximately 160 knots IAS.

b. Extend wing flaps, reduce airspeed to 120 knots IAS minimum plus fuel, and maintain a descent as required to reach a point ¾ nautical mile from the end of the runway at 500 feet above the terrain.

c. Final approach from this point is the same as for the normal pattern.

Note

If radar facilities are available it may be desirable to use them (after contact with approach control and clearance obtained).

LANDING.

Note

The final approach, flare, and touchdown speeds that are discussed in the following paragraphs are based on an aircraft gross weight of 11,100 pounds, which includes 200 gallons of fuel. Because these speeds will vary at different gross weights, they should be carefully determined before entering the traffic pattern.

The landing pattern and airspeeds are shown in figure 2-4. The landing distances are given in the Appendix. The flareout for landing should be gradual, with speed reduced to a minimum of 105 knots IAS as you pass the end of the runway just before landing. The use of nose-up trim during flareout and touchdown will aid in effecting a nose-high attitude so that your aircraft contacts the ground on the two main wheels. The aircraft should touch down on the runway at approximately 90–100 knots IAS, or slightly above stalling speed.

CAUTION

Care should be exercised to avoid extreme tail-low landing attitudes, to prevent the tail section from hitting the runway.

Hold the nose gear off, easing it down as speed decreases. When the nose gear touches after landing do not attempt to raise it again. If the nosewheel drops on landing or you touch down three points, trying to pull the nosewheel back off the runway can result in a scraped tailpipe.

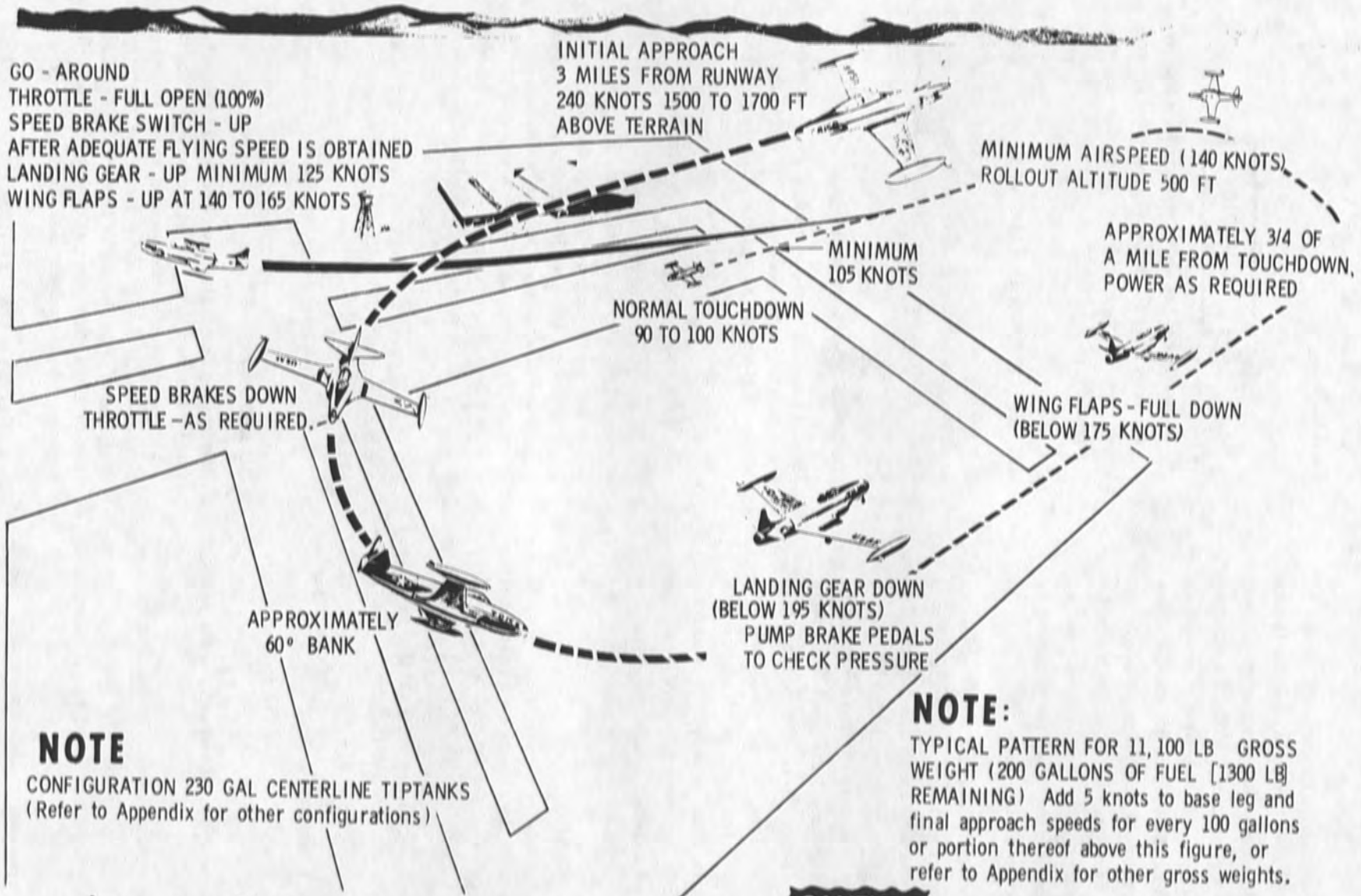
CAUTION

Avoid landing on the nosewheel first or porpoising may result.

If porpoising should develop, position the control stick slightly aft of neutral and hold it there, while simultaneously advancing the throttle to 100% rpm. (Do not attempt to counteract bounces 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.

GUST CORRECTION.

Adding 30 knots to the stalling speed is considered the best final approach speed because it provides a safe margin of pitch control for the aircraft under normal approach and landing conditions without resulting in excessive floating. However, this margin may not be adequate for surface wind conditions which produce sudden accelerations on the aircraft. Accelerations of this kind may result from "thermals" or "jet wash" close to the ground as well as from gusty wind conditions regardless of direction. When gusty wind conditions exist, a correction factor should be added to the final approach speed to prevent an inadvertent stall. Stall may be induced by the pilot when correcting for gusts if the airspeed is too close to the stall speed. This gust correction factor is determined by increasing the final approach speed by ½ of the reported gust velocity which is ½ the amount the wind is gusting over the constant wind velocity. For example: if the aircraft has 250 gallons of fuel on board (Gross weight 11,500 pounds), adding 5 knots for each 100 gallons (or increment thereof) of fuel on board above 200 gallons, results in a best final approach speed of 125 knots. If the wind velocity is reported at 20 knots with gusts up to 30 knots; the gust velocity would be 10 knots; ½ of 10 is 5 knots, which is the gust correction that should be added to the final approach speed (125 + 5, or 130 knots). The gust correction factor should only be introduced on the final approach and not throughout the traffic pattern.



NOTE

CONFIGURATION 230 GAL CENTERLINE TIPTANKS
(Refer to Appendix for other configurations)

NOTE:

TYPICAL PATTERN FOR 11,100 LB GROSS WEIGHT (200 GALLONS OF FUEL [1300 LB] REMAINING) Add 5 knots to base leg and final approach speeds for every 100 gallons or portion thereof above this figure, or refer to Appendix for other gross weights.

CAUTION

DO NOT RETARD THROTTLE TO IDLE UNTIL LANDING IS DEFINITELY ASSURED (It takes 6 or 7 seconds to accelerate from 50% to 100% RPM).

F22-C-2-3

(typical) landing and go-around pattern

Figure 2-4

Note

- Use of a correction factor for gusts should be undertaken with consideration of all the factors involved. If a correction is required to compensate for a given gust velocity, the value of the correction must be the same regardless of wind direction. This is true because the objective is to provide a safety margin above the stall while flying the aircraft through a series of accelerations. The accelerations can be equally severe whether they are produced by headwind, crosswind, or tailwind.

- Since a pilot cannot estimate the frequency or timing of gusts with practical accuracy, it is possible for the airplane to arrive at the flare point with gust correction added during an interval when gusts have stopped momentarily. Under such conditions, the touchdown point may occur further down the runway than planned. Therefore, whenever a correction factor is added for gusts or other accelerations, the pilot must be prepared to accept a corresponding higher flare speed with the possibility of increased landing distance.

CROSSWIND LANDING.

The crosswind landing procedure is the same as for normal landings with the exception of drift correction. It is recommended that the upwind wing low (slip) method of drift correction be used. In very strong crosswinds a combination of wing low and crab methods may be used for counteracting drift. Under these conditions land in the center of the runway.

MINIMUM RUN LANDING.

For a minimum run landing, use the following procedure:

a. Plan power-on approach and aim for the near end of the runway.

b. On final approach maintain airspeed 10 knots below the recommended final approach speed.

c. Retract wing flaps and speed brakes immediately upon touchdown.

d. After the nosewheel touches the runway, ease the control stick full back against the stop and apply brakes smoothly and steadily to a point just short of locking the wheels. Refer to Section VII for use of landing wheel brakes.

CAUTION

In addition to the above procedures, it may be necessary after touchdown to move the throttle to OFF and open the canopy to decrease the landing roll.

WET OR ICY RUNWAY LANDINGS.

If a landing is made on a wet or icy runway use the minimum run landing procedure. Refer to the landing distance chart in the Appendix for landing distances on a wet runway.

TOUCH-AND-GO LANDING.

To make a touch-and-go landing adjust the final approach so that the touchdown occurs within the first one third of the runway, then accomplish the following:

a. Throttle — Open to 100% rpm.

b. Speed brakes switch — UP as throttle is advanced.

Note

It will be unnecessary to trim the aircraft. If the elevator was properly trimmed on the final approach, an attitude will be established where total drag produced is at a minimum. The aircraft will accelerate more rapidly and tend to fly off the ground as flying speed is reached.

c. Landing gear lever — UP after aircraft is airborne and a definite rate of climb is established (minimum of 125 knots IAS).

d. Wing flap lever — UP between 140–165 knots IAS.

GO-AROUND.

Acceleration time will be increased considerably if engine speed is less than 50% rpm. In the event that the landing cannot be completed, the decision to go around should be made as soon as possible during the final approach. A minimum of 20 gallons of fuel will be required for a close-in go-around pattern. Complete the following steps for the go-around procedure:

1. Throttle — Open to 100%.

2. Speed brake switch — UP as throttle is advanced.

3. Landing gear lever — UP after aircraft is airborne and a definite rate of climb is established (minimum of 125 knots IAS).

Note

A touchdown may be necessary during go-around.

4. Wing flap lever — UP between 140–165 knots IAS.

Retract flaps and start climbout as prescribed for normal takeoff.

Note

If the wheel brakes are not used no time limit is imposed for subsequent landings.

AFTER LANDING.

After Touchdown.

1. Speed brake switch — UP.
2. Wing flap lever — As desired.

Note

Braking action is more effective if the wing flaps are immediately retracted after touchdown. The lift of the wings is reduced, putting more weight on the wheels and thus improving the traction of the tires.

After Clearing Runway.

1. IFF — OFF or STANDBY.
2. Oxygen diluter lever — As required.
3. Canopy — FULL OPEN or FULL CLOSED.
4. Radio equipment — As required.
5. Pitot heat switch — OFF.

Prior to Engine Shutdown.

1. Fuel selector switches — OFF.
2. Windshield defroster — OFF.
3. Navigation equipment — OFF.
4. Auxiliary defroster switch — OFF.
5. Trim tabs — NEUTRAL (check elev tab indicator light and aileron tab).
6. Speed brakes switch — DOWN (just prior to parking).

ENGINE SHUTDOWN.

After the aircraft is parked, operate engine at idle rpm for 30 seconds before shutting down to allow engine temperatures to stabilize.

1. Brakes — Hold until chocks are installed.
2. Wing flaps — As desired.
3. Communications equipment — OFF.
4. Inverters — OFF.
5. Ignition switch — OFF.
6. Canopy — OPEN.
7. Throttle — OFF; lock friction brake.
8. Battery generator switch — OFF.
9. All other switches — OFF.
10. All flight status safety pins and clips (seat, canopy, tip tanks, and landing gear) — Installed.

WARNING

To prevent accidentally firing the seat while leaving the aircraft, the pilot should check that the flight status safety pins are installed in the armrest on all modified aircraft before rising out of the seat. The pilot should rise from the seat by placing his hands on the armrests and pushing himself up and not by pulling down on the canopy sill.

BEFORE LEAVING THE AIRCRAFT.

1. Oxygen diluter lever — NORMAL OXYGEN.
2. Zero-delay lanyard — Disconnect and stow.
3. Make entries in all the aircraft forms.

CAUTION

In addition to the established requirements for reporting any system defects or unusual and excessive operations, the flight crew will also make entries in Form 781 to indicate when any limits listed in the Flight Manual have been exceeded.

4. Ensure the security of the aircraft before leaving the area.

STRANGE FIELD PROCEDURES.

When the requirements of T.O. 1T-33(R)A-6 become the responsibility of the pilot, the appropriate work cards 1T-33(R)A-6PRPO will be used in accomplishing the inspection. Servicing specifications indicated by figure 2-5 will be followed.

Note

The use of the barrier will be requested for all takeoffs and landings at strange fields.

servicing

FLUID SPECIFICATIONS

FUEL – SPECIFICATION MIL-J-5624 GRADE JP-4 FOR ALL NORMAL OPERATION INCLUDING STARTING

SPECIFICATION MIL-J-5624 JP-5 FOR ALTERNATE USE (REFER TO T.O. 42B1-1-14)

SPECIFICATION MIL-G-5572 (GASOLINE) LOWEST GRADE AVAILABLE FOR EMERGENCY USE

ENGINE OIL – MIL-O-6081 GRADE 1010 (BELOW 20°F USE GRADE 1005) BETWEEN +20°F AND -20°F EITHER GRADE IS ACCEPTABLE

HYDRAULIC OIL – MIL-O-5606

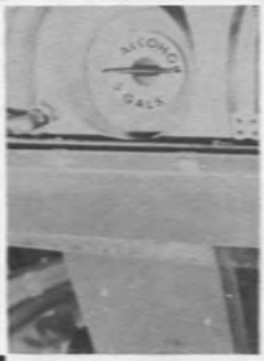
DE-ICER FLUID – MIL-A-6091 OR MIL-F-5566

NOTE: MIXTURES OF THE ABOVE MAY BE USED

OXYGEN – SPECIFICATION 88-0-925

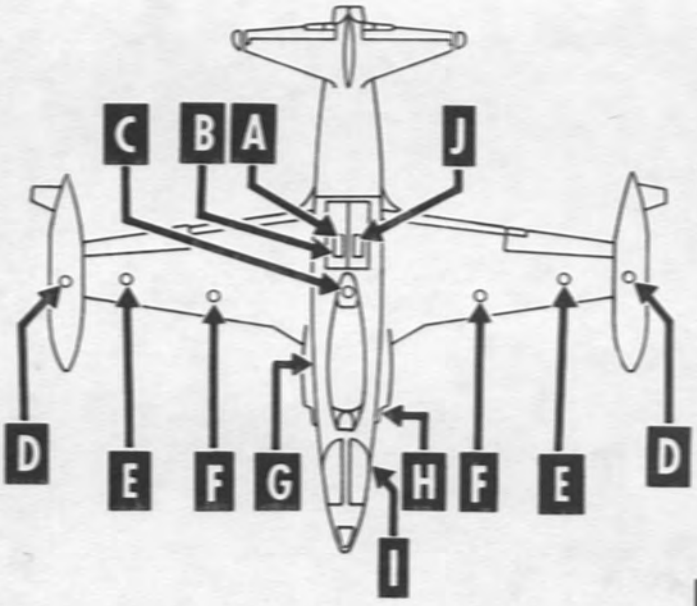
APU – 28 VOLT, 800 AMP (28 VOLT, 1200 AMP, IF MODIFIED BY T.O. 8D3-5-2-501)

A OIL TANK FILLER DIP STICK



B ALCOHOL TANK

C FUSELAGE TANK FILLER CAP



J MAIN HYDRAULIC SYSTEM RESERVOIR

I HYDRAULIC BRAKE SYSTEM RESERVOIR FILLER CAP

H OXYGEN FILLER VALVE

D TIP TANK FILLER CAP - BOTH SIDES

E LEADING EDGE TANK FILLER CAP - BOTH SIDES

F MAIN WING TANK FILLER CAP - BOTH SIDES

G EMERGENCY HYDRAULIC SYSTEM FLUID RESERVOIR

F22-C-2-4

Figure 2-5

Section III – EMERGENCY PROCEDURES

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INTRODUCTION.

Most emergency procedures can be divided into two categories, *critical* and *noncritical*, as follows:

CRITICAL. Those steps of procedure which must be performed immediately and instinctively without reference to written checklists. These critical steps are displayed in CAPITAL LETTERS and should be committed to memory.

NONCRITICAL. All steps of procedure, other than critical, wherein there is time available to consult a checklist before correcting or alleviating the emergency.

For those emergencies arising from materiel failure or system component malfunction, land at the closest suitable facility as soon as practicable. If the emergency involves a malfunction wherein engine failure is likely it is recommended that a simulated flameout landing pattern be used with modifications as necessary.

ENGINE FAILURE.

The majority of jet engine flameouts are the result of improper fuel flow caused by a fuel system malfunction or incorrect fuel system management. Specific information pertaining to engine flameout is described under Fuel System Failure, this section. The instruments will provide indications of fuel system failure prior to, and during, actual engine flameout. If the engine failure is due to a malfunction or mismanagement of the fuel system, and if time permits, an air start can usually be accomplished. If it is caused by an obvious materiel failure in the engine, an air start should not be attempted. During partial power failures the engine should not be shut down unless the pilot finds he cannot maintain the exhaust gas temperature within limits. With partial power failure, it is more difficult to restart the engine than to keep it running.

FLIGHT CHARACTERISTICS – DEAD ENGINE.

The flight characteristics of this aircraft with a dead engine are normal and rapid trim changes are not necessary. The recommended glide speed with a seized or windmilling engine is 180 knots IAS. (See figure 3-1.) This speed should provide a windmill rpm of at least 6%, which is sufficient for air starting, and will eliminate the use of the starter (300 to 1200 amp drain) thereby conserving battery energy for fuel transfer, air-start ignition, and wing flap extension. A speed of 180 knots IAS is the optimum glide speed with a full fuel load. It is not necessary to vary the glide speed according to fuel load since difference in glide distances from 40,000 feet

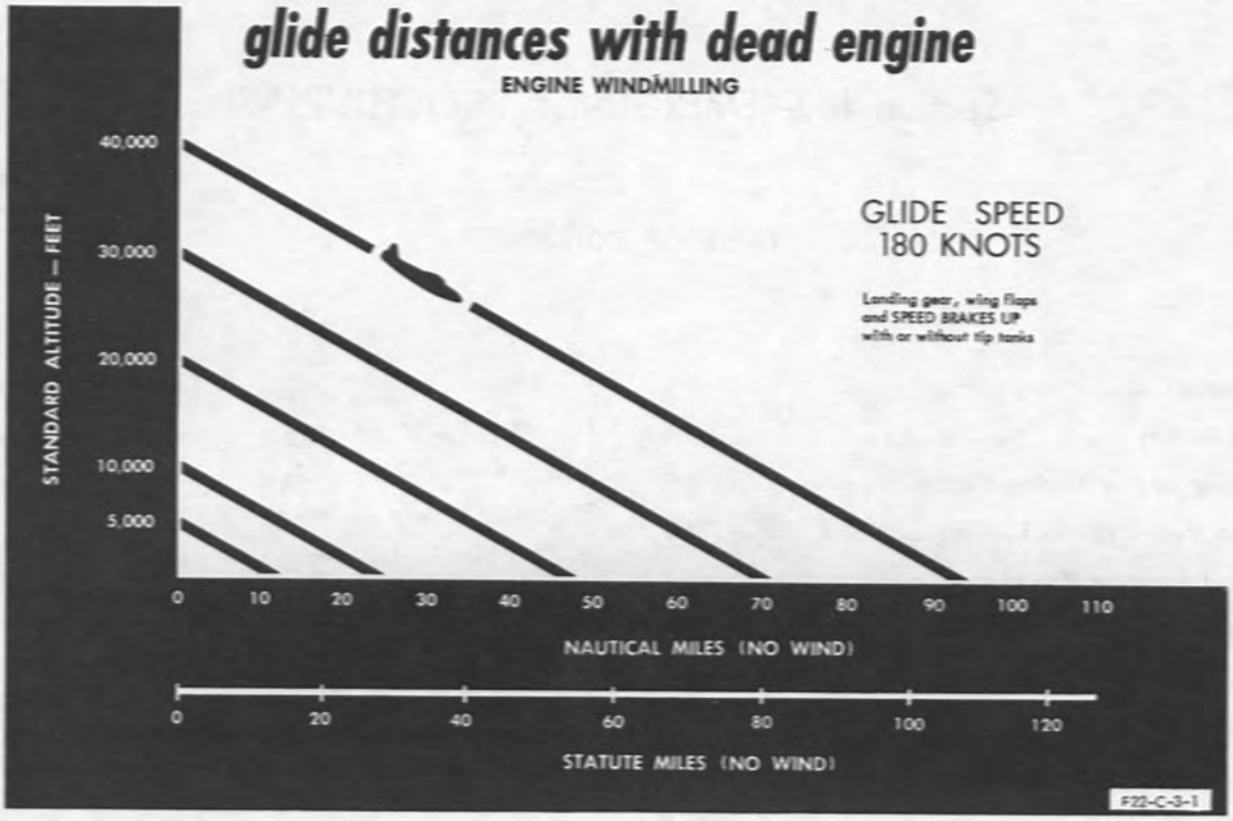


Figure 3-1

at 150 knots IAS (the optimum glide speed—no fuel remaining) and 180 knots IAS is only 2½ nautical miles. At this speed the glide ratio is approximately 12:1.

ENGINE FAILURE DURING TAKEOFF.

If an engine failure should occur during takeoff, the pilot will have to use his own discretion in any critical situations that arise.

Note

In the event the landing gear is retracted during an aborted takeoff, the canopy should be jettisoned before the aircraft comes to a complete stop because if there is leaking fuel from ruptured cells and the canopy is jettisoned after the aircraft comes to a stop, the fuel may be ignited by the explosion of the canopy charge. If the canopy is not jettisoned, and time permits, the electrical or mechanical methods of opening the canopy should be used.

COMPLETE POWER FAILURE DURING TAKEOFF.

Refer to the Abort paragraph under Takeoff and Landing Emergencies, this section.

COMPLETE POWER FAILURE AFTER LEAVING THE GROUND.

Refer to the Abort paragraph under Takeoff and Landing Emergencies, this section.

PARTIAL POWER LOSS DURING TAKEOFF.

If power loss is evident the pilot must immediately decide to continue or abort the takeoff. If the decision is to abort, proceed as described for Complete Power Failure After Leaving the Ground; if flight can be sustained, proceed as follows:

1. THROTTLE — CHECK FULL OPEN.
2. GANG START — ON.
3. TIP TANKS — JETTISON IF NECESSARY.

4. THROTTLE — AS REQUIRED.

5. LANDING GEAR — UP.

6. AIRSPEED — MAINTAIN AT LEAST 130 KNOTS IAS.

7. WING FLAPS — UP AT 130 KNOTS IAS.

8. LAND — AS SOON AS POSSIBLE using a flameout pattern.

FLUCTUATING FUEL PRESSURE OR ENGINE VIBRATION.

Unstable engine operation and flameouts have been caused by icing downstream from the low-pressure fuel filter. Engine vibration may occur separately or in combination with fuel pressure fluctuation, which could indicate fuel starvation, or bearing or turbine failures. Vibration might also occur at airspeeds above 250 knots, caused by manufacturing tolerance buildup. When fuel pressure fluctuations or engine vibrations occur the pilot should analyze and attempt to determine whether an engine malfunction is actually occurring. When it is suspected that a malfunction is occurring, proceed as follows:

1. GANG START SWITCH — ON.

2. THROTTLE — RETARD TO 80%–96%.

3. CHECK FOR FIRE.

4. LAND AS SOON AS POSSIBLE (use a flameout pattern).

WARNING

When it is desirable to switch from the emergency system back to the main system, the switch should be made below 23,000 feet and at 80% (stabilized) rpm.

FLAMEOUT CHARACTERISTICS.

There is no single positive indication that can be used to distinguish between a partial power loss and a complete flameout. However, the first few steps of any of the air start procedures will correct many of the causes of either condition. The initial symptoms of flameout vary from an immediate and continuous drop in all engine gage indications, to a period of engine roughness, oscillating engine gage indications, and apparent flameouts and relights (during a flameout from fuselage tank fuel exhaustion). Sound, feel, rpm, EGT, and fuel pressure are the significant indications. Fuel pressure is the most positive indication and although a surging engine occasionally recovers, fuel pressure below 20 psi and falling generally means a flameout has occurred. EGT falls to about 200° C and then decreases slowly to less than 100° C. RPM decreases rapidly to about 30%; the rate of drop slows from that point to windmill rpm.

RESTARTING ENGINE DURING FLIGHT.

If a flameout occurs that is not accompanied by a fire, explosion, overheat condition, strong fuel fumes in the cockpit, heavy vibration, or other conditions indicating mechanical or materiel failure, an air start should be successful.

Engine flameout in flight is usually caused by one of the following conditions:

a. Fuselage tank running out of fuel.

b. Failure of one of the fuel system units.

c. Inability of the filter to pass fuel because of stoppage by ice or dust accumulation.

d. Failure of fuel to feed because of negative acceleration.

e. Induction icing.

f. Ice accumulation downstream of the low pressure fuel filter.

Although a minimum of 9% rpm is required for ground starts, 6% windmill rpm is sufficient for air-starting due to increased airflow. A 180-knot glide speed will ensure a minimum of 6% windmill rpm. Consequently, it should not be necessary to use the aircraft starter, thereby conserving battery energy.

Note

It is extremely important to conserve battery energy so that enough power will be available for ignition (and starter, if necessary). If time permits, unnecessary electrical equipment should be turned OFF as soon as the flameout occurs.

AIR START USING GANG START SYSTEM.

It is recommended that air starts be made using the gang start system whenever possible. This system provides a single switch air start capability which corrects

practically all causes of engine flameout except those resulting from mechanical or materiel failure. Many air-starts made utilizing this system will be the "low altitude" type where the throttle is never moved to the OFF position. Whenever a rough engine is encountered, the pilot should immediately activate the gang start system because the early stages of a flameout resulting from fuel starvation produces definite rough engine symptoms. Consequently, if a gang start is attempted when the first signs of a flameout occur, a flameout may be prevented. To make an air start using the gang start system, proceed as follows:

ABOVE 25,000 FEET.

1. Throttle — OFF.
2. Airspeed — 180 knots IAS.
3. Altitude — 25,000 feet or below.
4. Gang start switch — ON, momentarily up, then release.
5. Throttle — IDLE after start occurs, then position as desired.

25,000 FEET OR BELOW.

1. GANG START SWITCH — ON, MOMENTARILY UP, THEN RELEASE. CHECK AMBER LIGHT ILLUMINATED.
2. THROTTLE — RETARD IF TIME AND ALTITUDE PERMIT.
3. AIRSPEED — 180 KNOTS IAS.
4. THROTTLE — OFF IF START DOES NOT OCCUR AND RPM DROPS BELOW 15%.
5. GANG START SWITCH — ON, TO PROVIDE A NEW IGNITION CYCLE.
6. THROTTLE — IDLE WHEN ENGINE STARTS, THEN POSITION AS DESIRED.

Note

After making an air start on this system the pilot would normally leave the gang start switch ON and land as soon as practicable. However, if it is necessary to go back to the main fuel system, do so at 80% (stabilized) rpm below 23,000 feet. The optimum altitude for switchback is 15,000 feet. Switchback at this altitude is smoother than at higher altitudes, yet is high enough to allow a reasonable time for corrective action in the event of inadvertent flameout. If a landing is made with the gang start system energized, the gang start switch should be turned off after throttle is moved to OFF.

AIR STARTS WITHOUT GANG START SYSTEM.

On aircraft that do not incorporate the gang start system it is recommended that air starts be made on the emergency fuel system. This procedure will eliminate icing or other difficulties encountered with the main fuel control unit. After several unsuccessful air start attempts using the emergency fuel system an air start on the main fuel system should be attempted. (Refer to Section VII.) It takes almost as much time to make an air start as it does a ground start. It is absolutely essential that the engine be given sufficient time to start before deciding that a start will be unsuccessful.

1. Throttle — OFF.
2. Airspeed — 180 knots IAS.
3. Trouble Check — Circuit breakers IN; Ignition switch NORMAL. Battery generator switch — ON.
4. Altitude — Below 25,000 ft.
5. Fuel Switches — GANG LOAD.
6. Emergency Fuel Switch — Emergency.
7. Starter Switch — START for 3 seconds (only if rpm is below 6%).

CAUTION

To prevent unnecessary battery drain, operate starter switch to STOP–START if air start is unsuccessful.

8. Air start ignition switch — START (and release after 1 second).
9. Starting fuel switch — AUTO. Monitor fuel pressure and EGT for air start indications.
10. Fuel filter deice switch — ON (for 15 seconds).
11. Throttle — Move rapidly to IDLE after rpm has stabilized.
12. Starting fuel switch — OFF.

LOW ALTITUDE AIR STARTS (Without Gang Start System).

Low altitude air starts depend mainly upon the rapidity with which the procedure is accomplished, even to the extent of overspeeding or overheating the engine. Elimination of the starting fuel control, which is not a requirement for successful air starts, from the low altitude air start procedure will aline and simplify air starting procedures with other jet aircraft.

Note

Low altitude procedure starts can be made at any altitude up to 15,000 feet. However, this type of start is limited by rpm requirements and is most effective if begun during or immediately after flameout, while rpm is still high (15% or above). Any loss of power on takeoff or climbout can best be corrected by executing the low altitude airstart procedure, even though a complete flameout has not yet occurred. The low altitude procedure should be the "first try" (15,000 feet and below) because it has no disadvantage and has the following advantages:

(a) It is the fastest way to regain full power.

(b) Requires the least time and attention from the pilot.

(c) Lights cool or not at all.

(d) Leads directly into any subsequent air start procedure.

Air Start 15,000 Feet MSL (Or Less).

The following procedure should be accomplished as rapidly as possible and in the sequence directed to prevent high temperatures at restart and to accomplish a successful air start below the minimum bailout altitude. The pilot should commit the procedure to memory and review it prior to flight.

1. THROTTLE — IDLE IF TIME AND ALTITUDE PERMIT.
2. AIR START IGNITION SWITCH — START.
3. FUEL SWITCHES — GANG LOAD ON.
4. EMERGENCY FUEL SWITCH — EMERGENCY.
5. THROTTLE — ADVANCE UNTIL BURNERS LIGHT, THEN RESET to maintain exhaust gas temperatures within limits (if possible).

AIR START INDICATIONS.

Shortly after operating the automatic starting fuel switch the EGT should rise to approximately 200° C and the fuel pressure oscillate near 10 psi. RPM should not change. Then, in rapid succession, fuel pressure should rise to 35 or 40 psi, mild combustion rumble occur, EGT increase in steps to a final peak and then settle near 500° C, and rpm build up slowly to above ground idle rpm (similar to an automatic ground start). A mild vibration often occurs near 30% rpm. The engine idle rpm at 25,000 feet, while running on the automatic starting fuel control only, is approximately 75%, as compared with approximately 30% rpm during a typical ground start.

UNSUCCESSFUL AIR START.

If an air start attempt results in an explosion, heavy vibration, or strong fuel fumes in the cockpit, or if the overheat or fire warning light comes on and stays on, accomplish the following:

1. Throttle — OFF.
2. Gang start switch — OFF (if applicable).
3. Starting fuel switch — OFF.
4. Main fuel shutoff switch — OFF.
5. All fuel switches — OFF.

WARNING

Do not attempt another air start. Decide to eject or make a forced landing, as conditions warrant.

MAXIMUM GLIDE DISTANCES.

(Refer to Flight Characteristics — Dead Engine, this section.)

EJECTION VERSUS FORCED LANDING.

Because of the many variables encountered the decision to attempt a flameout landing, or to eject, must remain with the pilot. It is impossible to establish a predetermined set of rules and instructions which would provide a ready-made decision applicable to all emergencies. The basic conditions listed below, combined with the pilot's analysis of the condition of the aircraft, type of emer-

gency, and his proficiency are of prime importance in determining whether to attempt a flameout landing, or to eject. These variables make a quick and correct decision difficult. If the decision is made to eject, the pilot must attempt to steer the aircraft toward an area where injury or damage to persons or property will be minimized. Before a decision is made to attempt a flameout landing, the following basic requirements should be considered:

a. The pilot should have satisfactorily completed simulated flameout approaches in this aircraft.

b. Flameout landings should only be attempted on a prepared or designated suitable surface.

c. Approaches to the runway should be clear.

Note

No attempt should be made to land a flamed-out aircraft at any field whose approaches are over heavily populated areas if a suitable area is available to abandon the aircraft.

d. Weather and terrain conditions must be favorable and must not hamper the establishment of a proper flameout landing pattern.

Note

Flameout landings at night or under poor lighting conditions should not be contemplated regardless of weather or field lighting.

e. Flameout landings should only be attempted when either a satisfactory "high key" or "low key" position can be achieved.

f. If conditions do not appear ideal for successful completion of the landing, eject. EJECT no later than the "low key" altitude, if possible.

FLAMEOUT LANDING PROCEDURE.

If the decision is made to attempt a flameout landing, it is extremely important that the pilot devote sufficient concentration to establishing a satisfactory flameout pattern. Regaining power must be afforded a high priority, yet not allow dangerous distractions in accomplishing a successful flameout pattern and landing. Attempt to complete all air-start efforts before high key is reached so that full attention may be devoted to accomplishing a successful landing. If circumstances of the flameout have prevented conclusive air-start attempts prior to high key, or a flameout has occurred after high key, further air starts may be attempted but primary attention must be devoted to proper execution of the flameout patterns. Subsequent air start attempts after low key is reached are not recommended. However, if initial flameout occurs below low-key point, an air start may be attempted.

Flameout landings can be made with the high-key point as low as 3000 feet above the terrain, provided a tighter pattern is used. It is also possible to enter the pattern at one of the lower key points, if sufficient altitude is not available for a complete 360-degree pattern. The following procedure should be used from any entry point.

1. Aileron boost lever — OFF.
2. Landing gear lever — DOWN.
3. Wing flap lever — As desired.
4. Speed brake switch — As desired.
5. Airspeed — 140 knots IAS minimum until flare is initiated.

FLAMEOUT LANDING PATTERN.

The recommended traffic pattern for a flameout landing is a 360-degree overhead approach. The point over the touchdown end of the runway is the HIGH-KEY POINT. The point opposite the end of the runway on the downwind leg is the LOW-KEY POINT. The entry to the base leg is the 270-degree POINT. (See figure 3-2.)

High-Key Point.

a. Plan arrival at the high-key point at 150 knots IAS and 5500 feet above the terrain.

b. Aileron boost — OFF.

c. Landing gear — DOWN.

d. Wing flaps — DOWN 20°.

e. Speed brakes — UP.

Low-Key Point.

a. Altitude — 3500 feet above terrain.

b. Airspeed — 150 knots IAS.

c. Landing gear — DOWN.

d. Wing flaps — As desired.

e. Speed brakes — UP.

270-Degree Point.

a. Altitude — 1500 feet above terrain.

b. Airspeed — 150 knots IAS.

c. Landing gear — DOWN.

typical flame-out landing pattern

LOW KEY POINT ❷
(a) 3,500 feet above ground
(b) Wing flaps – **AS DESIRED**
(c) Speed brakes – **UP**
(d) IAS – 150 Knots

Note
When making a precautionary landing using this pattern, the speed brakes should be extended. If a flame-out occurs, immediately retract speed brakes.

HIGH KEY POINT ❶
(a) 5,500 feet above ground
(b) Boost – **OFF**
(c) Landing gear – **DOWN**
(d) Wing flaps – **DOWN 20°**
(e) Speed brakes – **UP**
(f) IAS – 150 Knots

270° POINT ❸
(a) 1,500 feet above ground
(b) Wing flaps – **AS REQUIRED**
(c) Speed brakes – **UP**
(d) IAS – 150 Knots

RECOMMENDED 1½ STATUTE MILES
DEVIATIONS 1 TO 2 STATUTE MILES

Aim for the first 1/3 point of the runway until the pattern characteristics and wind effect are established.

FINAL APPROACH ❹
(a) Wing flaps – **AS REQUIRED**
(b) Speed brakes – **AS REQUIRED**
(c) IAS – 140 Knots until flare is initiated

FZD-C-3-3

Figure 3-2

d. Wing flaps — As required.

e. Speed brakes — UP.

Final Approach.

a. Airspeed — 150 knots IAS minimum until flareout is initiated. Attempt to touch down on the first one third of the runway.

b. Speed brakes — As required.

c. Wing flaps — As required if the added drag is needed to steepen the final approach.

d. Airspeed — 140 knots IAS to flareout.

SIMULATED FLAMEOUT PROCEDURE.

A flameout condition is simulated as follows:

a. Above 10,000 feet with speed brakes extended, position throttle to maintain IDLE or 60% rpm, whichever is higher.

Note

At high altitudes, IDLE rpm will be in excess of 60%. As the aircraft descends, IDLE rpm decreases proportionately. Consequently, when the rpm begins to drop below 60% during the descent, the throttle should be advanced to maintain 60% rpm.

b. Below 10,000 feet with speed brakes extended position throttle to maintain 45% rpm.

WING FLAP RETRACTION.

Intentional.

If properly executed, wing flap retraction can increase glide distance during a flame-out pattern, provided the following restrictions are observed:

a. Airspeed must be 140 knots IAS or above.

b. Aircraft gross weight must not exceed 12,100 pounds (full internal fuel) or less.

c. The aircraft must be in unaccelerated flight, i.e., wings level, 1-G flight.

Note

This procedure can be used with shallow bank angles if airspeed is above 140 knots IAS.

WARNING

A marked increase in pitch attitude will be required to prevent the sink rate from increasing as the flaps retract. The required upward rotation of the aircraft nose will exceed that experienced when the flaps are retracted after takeoff.

Unintentional.

Unintentional wing flap retraction at low airspeed and low altitude can result in such an increased sink rate that recovery becomes marginal. Recovery from a stall or high sink rate resulting from wing flap retraction should be made in the order shown as follows:

1. WING FLAPS SWITCH — DOWN IMMEDIATELY.

2. THROTTLE — OPEN TO 100% RPM (IF POWER IS AVAILABLE).

3. SPEED BRAKES SWITCH — UP.

TAKEOFF AND LANDING EMERGENCIES.

RUNWAY OVERRUN BARRIER ENGAGEMENT.

The aircraft will engage the MA-1 runway overrun barrier successfully during either the takeoff run or landing roll at 40 to 110 knots ground speed. The presence of pylons and chaff dispensers does not compromise the barrier engagement capability. Engagement results in minor sheet metal damage to the pylons, chaff dispensers, outer and inner wheel doors, and wheel well doors. A tendency to yaw is likely when the barrier webbing engages the nose gear; however, differential braking will usually be adequate to offset the yaw. Steer the aircraft toward the center of the barrier and attempt to engage it squarely. This precaution will minimize the danger of a one gear engagement, which would cause the aircraft to veer off the overrun. If brakes are available, use them to maintain directional control.

WARNING

Speed brakes must be retracted in order to make a successful engagement. If speed brakes are extended the cable may be deflected, resulting in an unsuccessful engagement.

ABORT (Before Leaving the Ground).

If an emergency occurs before the airplane is airborne and a decision is made to abort the takeoff, accomplish as many of the following steps as necessary:

1. THROTTLE — OFF.
2. SPEED BRAKES — UP.
3. WING FLAPS — UP.
4. BRAKES — OPTIMUM.
5. CANOPY — FULL OPEN.

6. BARRIER — ENGAGE SQUARELY.

Note

If no barrier is available the landing gear may be retracted in order to decrease the stopping distance. Depress the landing gear lever lock release while raising the lever in order to retract the landing gear. Jettison tip tanks if they contain fuel.

7. MAIN FUEL SHUTOFF SWITCH — CLOSED.

8. BATTERY GENERATOR SWITCH — OFF.

ABORT (After Leaving the Ground).

If complete power failure occurs after leaving the ground, the procedure for making a safe landing will depend upon the position of the aircraft relative to the runway. The airspeed, altitude, and length of remaining runway will directly affect the pilot's decision. If the engine failure occurs a few feet off the ground and there is sufficient runway remaining, the aircraft should be landed on the runway and brought to a stop. If the engine failure occurs when the aircraft is several feet in the air and there is not sufficient runway remaining, the aircraft should be landed straight ahead. In the event of an aborted takeoff, in which there is a danger of rupturing fuel tanks, the canopy should be jettisoned to prevent the canopy ejection blast from igniting the fuel.

If there is sufficient altitude and airspeed to maintain directional control, it may be possible to land the aircraft on another runway or in an adjacent field. Emergency landings on unprepared surfaces should be made with the landing gear extended or at least partially extended. When landing on prepared surfaces, a gear down landing should be attempted when any two gear can be extended and locked in the down position. If two gear cannot be extended, the landing should be made with the landing gear retracted. Landing on unprepared surfaces should be made with any gear extended, or partially extended, as a last resort. If a power failure occurs after leaving the ground, accomplish as much of the following as possible:

1. AIRSPEED — MAINTAIN FLYING SPEED AND CONTROL UNTIL TOUCHDOWN IS MADE.

2. THROTTLE — OFF.

3. LANDING GEAR — DOWN.

4. TIP TANKS — JETTISON (if they contain fuel).

5. APPROACH — STRAIGHT AHEAD IF POSSIBLE.

6. SPEED BRAKES — UP.

7. WING FLAPS — DOWN.

8. MAIN FUEL SHUTOFF SWITCH — CLOSED (guard up).

9. CANOPY — JETTISON.

WARNING

When canopy is jettisoned, dirt in the cockpit may get into the pilot's eyes.

10. SHOULDER HARNESS — LOCK.

11. BATTERY GENERATOR SWITCH — OFF (before touchdown).

LANDING WITH STRUCTURAL DAMAGE.

If structural damage to the aircraft occurs in flight, the pilot must decide whether to abandon the aircraft or attempt a landing. If the aircraft is flyable, simulate a landing pattern at a safe altitude in order to determine whether the aircraft is controllable at approach and landing speeds.

1. Climb — 15,000 feet above terrain and simulate a landing approach.

2. Airspeed — Note the IAS at which the aircraft becomes difficult to control.

WARNING

Do not permit the aircraft to stall. When control becomes difficult, recover as in partial stall recoveries. If control cannot be maintained below 150 knots IAS abandon the aircraft at the position, heading, and altitude prescribed by local policy.

3. Speed brakes, gear and flaps — DOWN for descent to field.

4. Airspeed — 20 knots IAS above minimum controllable speed during descent and in traffic pattern.

5. Traffic pattern — Fly a wide pattern using power on final approach.

LANDING WITHOUT CANOPY.

If the canopy has been lost or jettisoned in flight, make a landing in the following manner:

1. Airspeed — 160 knots IAS approaching the pattern.

2. Traffic pattern — Fly a wide pattern with final turn and approach speeds 10 knots faster than normal.

3. Approach and landing — Make a flat approach and shallow flareout.

LANDING WITH FLAT TIRE OR COCKED NOSE WHEEL.

If the nose gear tire is flat, hold the nosewheel off as long as possible. If the nose gear is cocked, touch down on the side of the runway opposite the direction in which the nose gear is cocked. With a flat main gear tire, land on the side of the runway away from the flat. Lock the shoulder harness prior to touchdown.

DITCHING.

Ditching this aircraft is not recommended. Deceleration forces will be extremely high and the aircraft will sink rapidly as forward motion is lost. All the emergency equipment is carried by the crew member and there is no particular advantage in riding the aircraft down when ejection is possible.

DITCHING PROCEDURE.

If ejection is impractical, ditch as follows:

1. IFF equipment — EMERGENCY.

2. Oxygen-diluter lever — 100%; Pressure dial — SAFETY.

WARNING

Do not use bailout bottle for underwater breathing.

3. Right armrest trigger safety pin — Install.

4. Tip tanks — Retain.

Note

Tip tanks will hold the engine air intake ducts out of the water until the initial speed is lost; they will also provide additional buoyancy.

5. Canopy — Jettison.

6. Gear — Up.

WARNING

Do not ditch with the landing gear extended.

7. Parachute harness — Unbuckle, unless the dinghy is attached.

8. Shoulder harness and lap belt — Locked.

CAUTION

You are restricted from bending forward when the shoulder harness is locked. Therefore, all switches not readily accessible should be turned off before locking shoulder harness.

9. Throttle — OFF.

10. Wing flaps and speed brakes — DOWN.

Note

Extending the wing flaps and speed brakes will not cause nosing over, but will allow the aircraft to be slowed to a safe touchdown speed and will aid in keeping the engine ducts above the surface.

Select a heading parallel to the wave crests if possible. Attempt to touch down on the falling side of a wave instead of the rising side. After the aircraft comes to rest, get out of the cockpit immediately; do not forget the life raft. Over calm water is may be very difficult to visually judge altitude. Therefore, the pilot should monitor the vertical velocity indicator and maintain a constant safe rate of descent until contact is made.

HYDRAULIC SYSTEM FAILURE.

HYDRAULIC PRESSURE LOSS.

If the hydraulic pressure gage indicates no pressure, operate the ailerons to determine if the gage is faulty. If the pressure is lost, follow the procedure for aileron boost failure and use the emergency procedure for extending the gear.

LANDING GEAR MALFUNCTION.

The emergency hydraulic system should be used to extend the gear if the normal system fails. It may be used if any gear fails to lock down after using the normal system, even though full normal system pressure is available. If

emergency landing gear extension

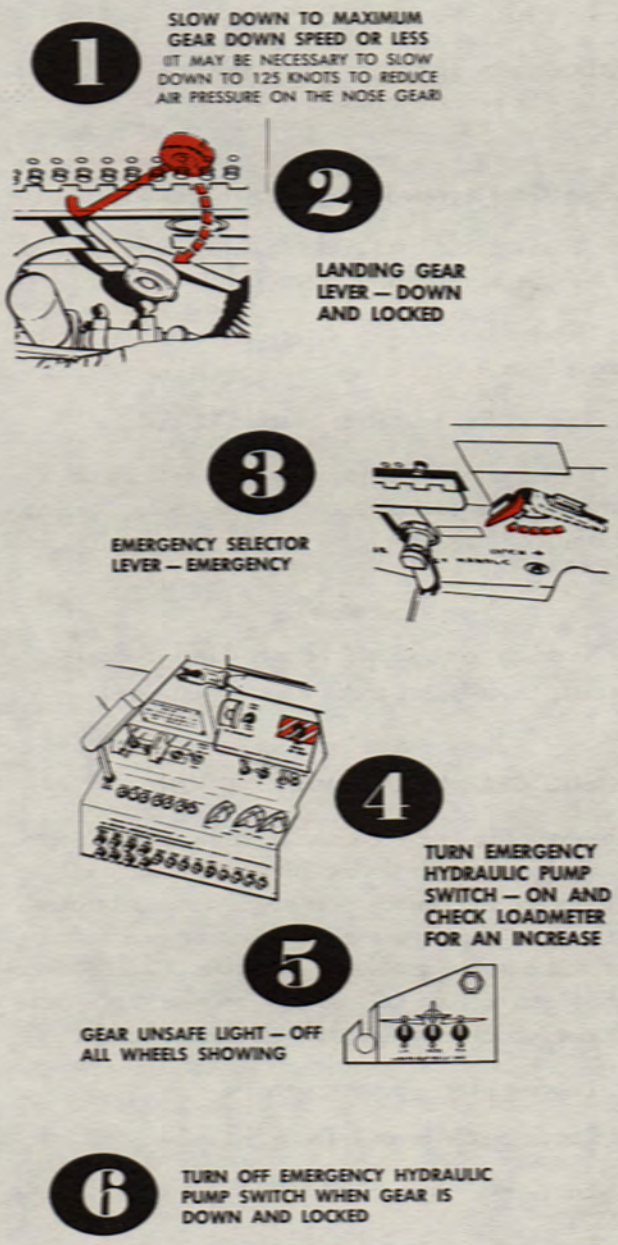


Figure 3-3

the gear is retracted by the normal system, after having used the emergency system, fluid from the emergency lines will be returned to the main reservoir. Thus, the emergency system will not be available again until the emergency reservoir has been reserviced. If both main and emergency hydraulic system pressure is lost it is unlikely that the landing gear can be locked down by any other means.

EMERGENCY LANDING GEAR EXTENSION.

Emergency extension of the landing gear is accomplished as shown in figure 3-3.

WARNING

The emergency hydraulic system is for emergency extension of the gear only.

The landing gear cannot be retracted by use of the emergency system. If the normal system is undamaged it may be used if necessary to retract the gear after the emergency selector lever is returned to the NORMAL position. Otherwise, leave the emergency hydraulic system selector lever in the EMERGENCY position.

Whenever any of the gears will not extend using the normal hydraulic system, the emergency system should be used in an attempt to lower the remaining gear.

Note

Landing gear extension time using the emergency system is approximately twice that using the normal system. Extension time may consume as much as 40 seconds, or 1300 feet of altitude, in a glide with frozen or windmilling engine. A minimum extension time of 20 seconds may be expected only in high ambient air temperatures. Landing gear extension must be initiated while sufficient altitude remains.

LANDING GEAR LEVER MALFUNCTION.

Excessive forces on the landing gear handle may shear the mechanism. This can cause the handle either to swing freely, or jam in one position.

Landing Gear Lever Fails To Remain In The Down Position.

If for some reason the landing gear lever will not remain in the DOWN position use the following procedure:

1. Landing gear lever — DOWN and hold.

2. Hydraulic pressure and landing gear indicators — Check.

3. Landing gear warning indicator and warning light circuit breaker — Pull out.

Note

Pulling the circuit breaker will deenergize the landing gear lever lock release solenoid. After the landing gear lever has been moved to the DOWN position, the gear lever cannot be raised. If pulling the circuit breaker is unsuccessful, the landing should be made holding the landing gear lever in the DOWN position.

4. Landing pattern — Fly a rectangular pattern keeping airspeed below 195 knots IAS.

5. After touchdown — Roll straight ahead and stop.

CAUTION

Do not taxi after completing landing roll until maintenance personnel have inserted the down-lock clips.

Landing Gear Lever Stuck In Up Position.

It is possible to extend the landing gear even though the lever is not in the DOWN position. This is accomplished by reducing the normal hydraulic pressure and overriding it with the emergency system pressure. In the event the landing gear lever becomes stuck in the UP position or broken off in the UP position, proceed as follows:

1. Landing Pattern — Fly a rectangular or flameout pattern, keeping airspeed below 195 knots IAS.

2. Throttle — Reduce to lowest engine rpm consistent with maintaining safe flight conditions in the landing pattern.

3. Speed Brakes — Cycle continuously to reduce normal hydraulic pressure.

4. Aileron Boost — OFF, if normal system pressure indicates less than 500 psi during speed brake cycling.

5. Emergency Selector Lever — EMERGENCY.

6. Emergency Hydraulic Pump Switch — ON.

7. Throttle — OFF, after touchdown.

8. Speed Brakes — Cycle continuously until engine rotation stops.

9. Emergency Hydraulic Pump Switch — OFF, after landing gear pins are installed.

Landing Gear Lever Stuck In Down Position.

If the landing gear lever sticks in the DOWN position, and flight must be continued proceed as follows:

1. Depress landing gear lever detent button and try to move lever UP.

2. Trip landing gear lever solenoid lock release.

3. If gear does not retract — Return to the field, expend the excess fuel at speeds below 195 knots IAS, and land.

Note

Normally gear should be left down, the aircraft landed, and malfunction investigated.

LANDING GEAR UPLOCK MALFUNCTION.

In the event that one or both of the uplocks is uncocked, the only indication in the cockpit is an instantaneous up indication on the landing gear position indicator immediately upon gear retracton. The landing gear warning light will not give an unsafe condition. Generally the landing gear uplock fails to lock because the uplocks were not cocked prior to retraction. Proceed as follows:

1. Landing gear — Recycle once.

2. Landing gear lever — DOWN.

3. Emergency hydraulic selector lever — EMERGENCY.

4. Emergency hydraulic pump switch — ON for 10 seconds, then OFF (to re-cock the uplocks).

5. Emergency hydraulic selector lever — NORMAL.

6. Landing gear lever — UP.

If this procedure fails to have effect remain airborne at less than maximum gear-down airspeed until the fuel supply is low enough to make a safe landing.

LANDING WITH DEFECTIVE BRAKES.

In the event of brake failure of one or both main landing gear wheels, make a minimum run landing on the longest runway most nearly headed into the wind. Retract the speed brakes and retard the throttle to OFF at touchdown. Use aerodynamic braking by holding the nose gear off the runway as long as possible. After the nosewheel contacts the runway, keep the stick full aft until the indicated airspeed is 50 knots; raise the canopy to full open for additional drag. Use the rudder as long as it is effective to steer the aircraft toward the barrier. If the aircraft is veering off the runway, or does not make a barrier engagement, the landing gear may be retracted to prevent overrun into rough terrain. If brake failure is discovered after landing, use as much of this procedure as possible.

AILERON BOOST FAILURE.

In the event of aileron boost failure, proceed as follows:

1. Aileron boost shutoff lever — OFF immediately.
2. Hydraulic pressure — Check.

CAUTION

If hydraulic pressure reads low, or below normal, do not turn the aileron boost back ON.

WARNING

- Do not diagnose a roll tendency as aileron boost trouble when the wing flaps or gear are extended. (Refer to Asymmetrical Flap Condition, this section.) Retract the flaps, then the gear, to determine whether that will correct the difficuty. If this procedure is not successful, try to correct the condition by turning off the aileron boost (at an altitude of at least 10,000 feet). Keep your hand on the aileron boost control so it can be turned on immediately. This condition can exist also with one empty and one full tip tank.
- Without aileron boost gusty or crosswind landings should be avoided. (Refer to crosswind landings and gust correction factors in Section II.)

FIRE.

If the fire or overheat warning lights illuminate, check the following items to determine the presence of an actual fire:

a. Smoke trail behind the aircraft.

b. Smoke in the cockpit.

c. Loss of engine rpm.

d. Fluctuating fuel pressure and rpm.

Illumination of the overheat warning light generally results from one of the following:

a. Fire (generally located aft of the plenum chamber).

b. A leaky tailpipe, tail cone, or connections.

c. Climbing at low airspeeds and high rpm.

d. Idling the engine for long periods when parked in a strong tailwind.

e. Improper installation of or a shorted warning light circuit.

Illumination of the red fire warning light generally results from one of the following:

a. Fire (generally located in the plenum chamber area).

b. Hot spots on the flame tube or a broken flame tube (on early unmodified aircraft).

c. Improper installation of or a shorted warning light circuit.

If either the fire or overheat warning light illuminates and then goes out, proceed as follows:

a. Push to test each bulb individually to see if the bulbs are burned out.

b. If the bulbs are not defective, operate the fire and overheat warning test switch to the TEST position to check for defective circuit.

Note

If the circuit is defective, remember that the wiring could have burned out from an existing fire.

c. Check for other indications of fire as indicated above and land as soon as possible. If such a condition occurs before takeoff, do not fly the aircraft.

ILLUMINATED FIRE OR OVERHEAT WARNING LIGHTS (DURING TAKEOFF).

(Refer to the Abort Before Leaving The Ground Procedure, this Section.)

ILLUMINATED FIRE OR OVERHEAT WARNING LIGHTS (AFTER TAKEOFF OR FLIGHT).

If the fire or overheat warning lights illuminate when airborne or too late to abort the takeoff, proceed as follows:

1. THROTTLE—MINIMUM PRACTICAL POWER (MAINTAIN HIGHEST POWER POSSIBLE UNTIL A SAFE EJECTION ALTITUDE IS REACHED).

2. CHECK — FIRE, SMOKE, LOSS OF CONTROL, EXPLOSIONS, AND ENGINE INSTRUMENTS.

3. IF FIRE IS CONFIRMED—EJECT NOT LOWER THAN MINIMUM EJECTION ALTITUDE.

4. IF FIRE CANNOT BE CONFIRMED — USE MINIMUM POWER AND LAND AS SOON AS POSSIBLE, PREFERABLY FROM A SIMULATED FLAMEOUT PATTERN.

COCKPIT FOG REMOVAL.

During certain atmospheric conditions, the air cooler will create a vapor condition in the cockpit which resembles smoke. This can usually be eliminated by temporarily setting the cabin temperature control at the full HOT position.

COCKPIT SMOKE REMOVAL.

Smoke in the cockpit may be caused by oil that was spilled during the postflight servicing or during maintenance; or, it may result from the oil filler cap coming off. This type of smoke is generally light grey or white and is no cause for immediate alarm. If there is smoke in the cockpit, proceed as follows:

1. CHECK — FOR PRESENCE OF FIRE.

2. OXYGEN REGULATOR DILUTER LEVER — 100%.

3. BATTERY/GENERATOR SWITCH — OFF (until it is determined that the smoke is not caused by a short circuit in the electrical wiring).

WARNING

If smoke in the cockpit is caused by a short circuit in the electrical wiring, turn OFF all electrical equipment. Turn ON the battery and generator switches. Turn ON the electrically operated units one at a time and monitor the loadmeter until the malfunctioning unit or system is located. Isolate the unit from the electrical system and land as soon as possible.

4. Pressurization grills and standpipe inlet ducts — CLOSED.

5. Cabin pressure — DUMP if necessary.

Note

On aircraft equipped with the electrically operated air shutoff valve, remember that once the cabin pressure dump switch has been operated to the DUMP position, cabin pressurization will no longer be available until the air shutoff valve in the speed brake area is manually reset to the open position. Thus, rapid accumulation of frost can be expected.

6. Cabin temperature selector — COLD.

7. Defroster — OFF.

8. Speed brakes — DOWN.

Extension of the speed brakes will facilitate cockpit smoke removal because the cockpit pressure dump valve empties into the speed brake area.

9. Cockpit ram air ventilator — OPEN.

10. Canopy — Jettison, if smoke becomes severe.

11. Land as soon as possible.

EJECTION.

Escape from the aircraft has been successfully accomplished with and without the use of the ejection seat. If sufficient altitude is available the crew member should eject in preference to ditching or crash-landing. A forced landing may be preferable to ejection if a suitable field is available.

WARNING

If bailout is made at high altitude, remain connected to the aircraft oxygen system while making all other preparations for leaving the aircraft. Just before leaving the aircraft, put the type H-2 emergency oxygen cylinder into operation by pulling the ripcord cable of the oxygen cylinder (the caution tag and pin assembly having been removed prior to takeoff), then disconnect the oxygen hose. If practicable descend to about 14,000 feet before ejecting.

EJECTION PROCEDURE.
(See figure 3-4.)

Bailout Procedure If Ejection Seat Inoperable.

If an emergency occurs necessitating a bailout without the use of the ejection seat, proceed as follows:

1. LAP BELT, SHOULDER HARNESS, OXYGEN AND RADIO CONNECTIONS — RELEASE.

2. CANOPY — JETTISON.

3. BAIL OUT.

Note

If the aircraft is controllable, trim full nose down and pull stick back to slow the aircraft. Roll into an inverted position. Keep a positive G-load until inverted; then abruptly release stick and push free.

4. PARACHUTE ARMING LANYARD — PULL (IF APPLICABLE).

Note

Without the automatic parachute, pull the D-ring when the estimated altitude is 14,000 feet, or immediately after clearing the aircraft if below 14,000 feet.

EJECTION ALTITUDES.

Figure 3-5 shows the minimum altitude for successful ejection with different combinations of automatic parachute timing sequence using the M-5 seat catapult. The figures are applicable for LEVEL FLIGHT attitudes. The data is conservative for climbing attitudes and optimistic for diving attitudes. Since the "one and zero" system will be used only during the takeoff and landing phases of a flight, the data for these systems is applicable only for velocities of 140 to 300 knots IAS. The following combinations are applicable to the RT-33A:

a. M12 (1 second) automatic safety belt delay initiator.

b. M5 seat catapult.

c. Seat or backpack-type automatic parachute equipped in accordance with T.O. 14D1-1-1 with the 1 second F-1B timer or the zero-delay lanyard incorporating either the backpack or seat pack.

Once the equipment combination is determined, the minimum altitude for safe ejection can be found on figure 3-5. In low-altitude ejection, the possibility of success can be materially improved by zooming and ejecting while the nose of the aircraft is above the horizon and the airspeed above 120 knots IAS. The zoom will exchange airspeed for altitude, thus providing maximum terrain clearance at time of ejection as well as reducing airspeed to a safe value for ejection. Ejecting while the nose of the aircraft is above the horizon will result in a more nearly vertical trajectory for the seat, thus providing more altitude and time for seat separation and parachute deployment. At low altitudes, a minimum airspeed of 120 knots IAS is recommended to ensure rapid deployment of the chute.

WARNING

A determined effort should be made to separate from the seat as soon as the belt releases if maximum terrain clearance is to be attained when the parachute deploys. THIS IS PARTICULARLY IMPORTANT ON LOW ALTITUDE EJECTIONS.

When ejecting under level-flight conditions, eject at least 2000 feet above terrain if possible; under spin or dive conditions, eject at least 10,000 feet above terrain if possible.

WARNING

Emergency minimum ejection altitudes listed in figure 3-5 were determined through extensive flight tests and are based on distance above

before ejection

IF AN EJECTION BECOMES NECESSARY AND THE AIRCRAFT IS STILL UNDER CONTROL WITH SUFFICIENT ALTITUDE REMAINING, THE FOLLOWING PRECAUTIONS CAN BE TAKEN (AS APPLICABLE) TO MINIMIZE THE DANGER OF PHYSICAL INJURY AND THEREFORE INCREASE THE CHANCES OF A SUCCESSFUL ESCAPE.

1. **IFF SELECTOR SWITCH-EMERGENCY**
   Transmit **MAYDAY** and give position report.
2. **STOW LOOSE EQUIPMENT.**
3. **CHECK LAP BELT, SHOULDER HARNESS, AND OXYGEN HOSE ATTACHMENT.**
4. **LOWER HELMET VISOR.**
5. **REDUCE AIRSPEED AS MUCH AS POSSIBLE.**
   If ejection is to be attempted below 2000 feet manually hook up zero-delay lanyard and pull the nose of the aircraft slightly above the horizon if possible.
6. **ACTUATE BAILOUT BOTTLE IF ABOVE 14,000 FEET.**

T.O. 1T-33(R)A-1
Red Plate
Figure 3-4 (Sheet 1)
Page 3-16

F22-C-3-5 (1)

Figure 3-4 Sheet 1

ejection procedure

1 JETTISON CANOPY

WARNING

- CANOPY MAY NOT JETTISON IF IT IS UNLOCKED.
- RIGHT-HAND ARM REST MUST NOT BE RAISED BEFORE CANOPY IS JETTISONED. CANOPY JETTISON HANDLE IS EXTREMELY DIFFICULT TO OPERATE WHEN THE ARM REST IS IN THE RAISED POSITION.
- IF THE CANOPY DOES NOT JETTISON ATTEMPT TO RELEASE IT EITHER MANUALLY OF ELECTRICALLY. IF ALL ATTEMPTS TO RELEASE THE CANOPY FAIL AND THE AIRCRAFT HAS BEEN MODIFIED TO INCORPORATE AN EJECTION SEAT WITH A CANOPY BREAKING HEADREST, IT IS POSSIBLE TO EJECT THROUGH THE CANOPY. ADJUST THE SEAT TO THE FULL BOTTOM POSITION BEFORE EJECTING THROUGH THE CANOPY.

PULL THE CANOPY JETTISON LEVER FULL AFT USING BACKHAND GRIP.

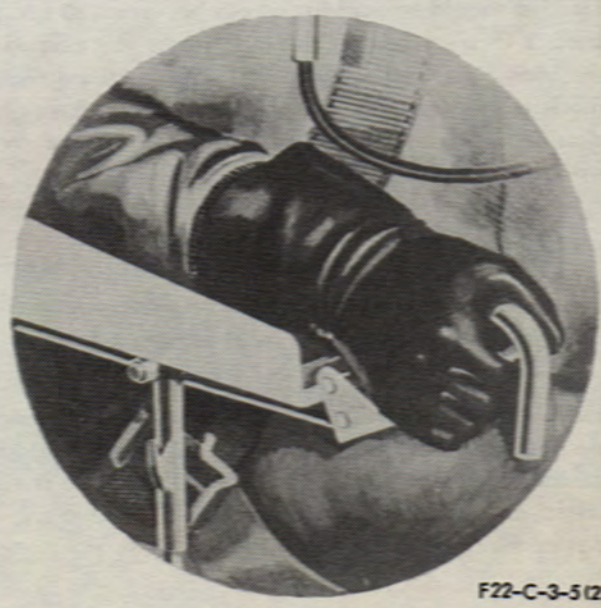
PREPARE FOR EJECTION

HOOK HEELS IN FOOTRESTS - SIT ERECT WITH HEAD BACK, CHIN TUCKED IN AND BOTH ELBOWS INSIDE ARM RESTS.

2 RAISE BOTH ARMRESTS AND SQUEEZE TRIGGER

NOTE

- RAISING THE LEFT ARM REST LOCKS THE SHOULDER HARNESS
- IF TRIGGER IS SQUEEZED WHILE RAISING ARM REST THE SEAT MAY NOT FIRE. IF THIS OCCURS RELEASE TRIGGER AND SQUEEZE AGAIN.



F22-C-3-5(2)

Figure 3-4 Sheet 2

emergency ejection altitudes

	1-SECOND PARACHUTE (F-18 TIMER)		0-SECOND PARACHUTE (LANYARD TO "D" RING)	
	BA-15 OR 18 BACKPACK / C-9 CANOPY	SA-19 OR 20 SEATPACK / C-11 OR C-9 CANOPY	BA-15 OR 18 BACKPACK / C-9 CANOPY	SA-19 OR 20 SEATPACK / C-11 OR C-9 CANOPY
1-SECOND AUTOMATIC SAFETY BELT (M12 INITIATOR)	200 FT	250 FT	100 FT	150 FT
	NOTE THESE FIGURES DO NOT PROVIDE ANY SAFETY FACTORS FOR SUCH MATTERS AS EQUIPMENT MALFUNCTION, DELAYS IN SEPARATING FROM THE SEAT, ETC; THEY ONLY SHOW THE MINIMUM ALTITUDE THAT MUST BE REACHED IN THE EVENT OF LOW-ALTITUDE EMERGENCIES SUCH AS FIRE ON TAKEOFF.			

F-20-1-3-68

Figure 3-5

terrain on initiation of seat ejection (i.e., time seat is fired). *They shall not be used as a basis for delaying ejection when above 2000 feet since accident statistics emphatically show a progressive decrease in successful ejections as ejection altitude is decreased below 2000 feet. Therefore whenever possible, eject above 2000 feet.*

EJECTION SPEEDS.

Ejection should be made at speeds between 120 and 525 knots IAS since relatively minor forces are exerted on the body. Between 525 and 600 knots IAS appreciable forces will be exerted on the body; above 600 knots IAS, ejection is extremely hazardous since excessive forces will be encountered.

Note

With the zero-delay lanyard connected, maximum speed for ejection must be reduced, as indicated in figure 3-6, to avoid parachute failure.

The automatic lap belt should not be opened prior to ejection regardless of altitude. If this should be done, the automatic opening feature of the parachute is eliminated, and separation of the crew member from the seat may be too rapid at high speeds.

(See figure 3-6 for zero-delay lanyard engagement requirements.)

If Canopy Fails to Jettison.

If the canopy does not jettison, an attempt should be made to release the canopy by unlocking it and operating the canopy open switch to the OPEN position, or by using the manual handcrank. If the seat is equipped with a canopy-breaking headrest, it can be ejected through the canopy. However, this should be attempted only as a last resort after all other attempts at opening the canopy have failed. When ejecting through the canopy it is recommended that the seat be adjusted to the lowest position to allow the greatest clearance between the top of the head and the top of the headrest.

If the seat fails to eject when the trigger is squeezed, it is possible that the trigger may have been accidentally squeezed while raising the right armrest. If this was the case, release it and squeeze again. If this action fails to succeed, refer to Bailout Procedure If Ejection Seat Inoperable paragraph.

If Automatic Safety Belt Fails to Open.

If the automatic safety belt fails to open after the proper time interval (1 to 2 seconds), manually unfasten the 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 feet. Immediately after ejection, attempt

zero-delay lanyard engagement requirements

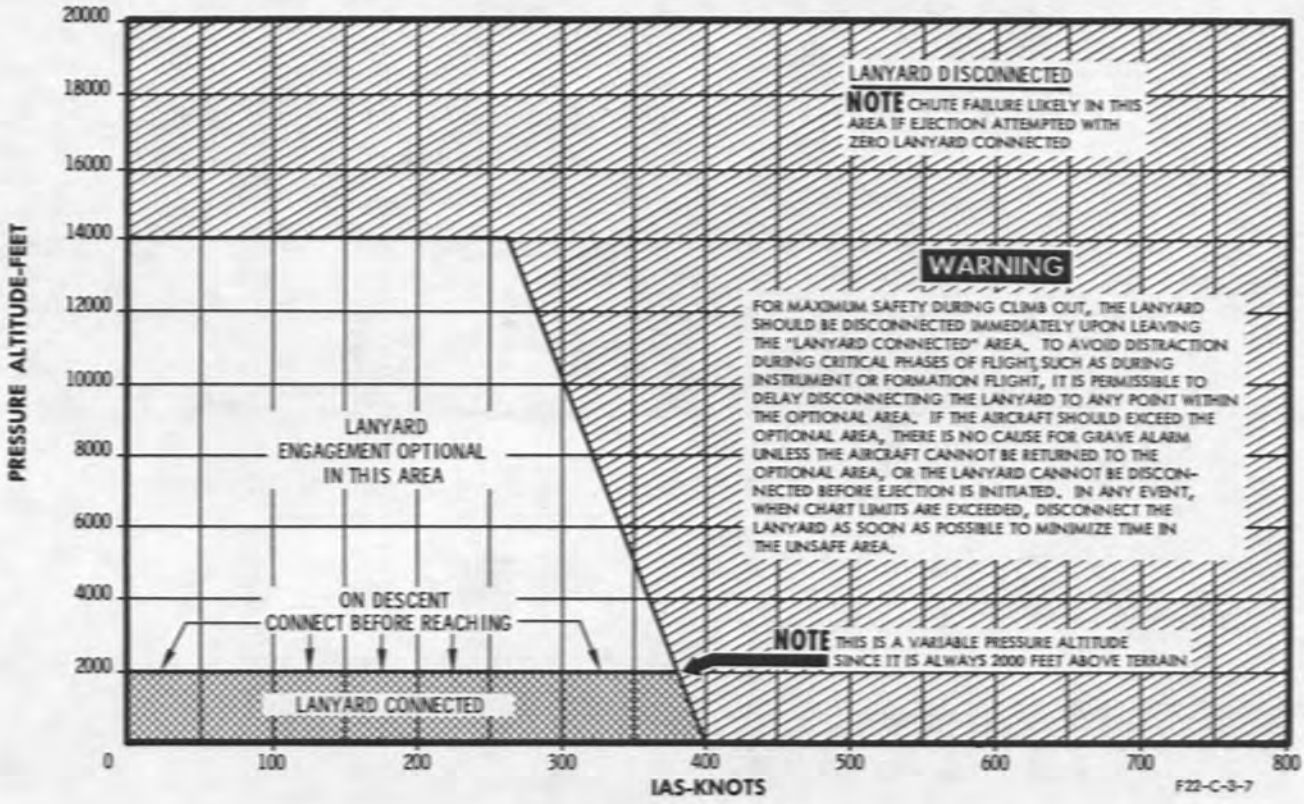


Figure 3-6

to manually open the lap belt. This is strictly a precautionary measure in case the belt fails to open automatically. If the belt is operating normally it will be impossible to surpass the automatic opening action.

CANOPY REMOVAL.

On aircraft equipped with the latest ejection seat the canopy can be jettisoned from any intermediate position from closed-and-locked to full open by pulling the yellow canopy jettison lever or pulling the external cable from outside the aircraft.

On earlier aircraft the canopy can be jettisoned only from a closed-and-locked position. During conditions of extreme emergency an attempt to jettison the canopy while partly open can be made by applying a force of 60 to 80 pounds on the canopy remover link safety release 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, will fire the canopy remover. This link is exposed at any time the canopy is more than 2 inches open from the closed-and-locked position.

WARNING

The canopy remover will fire when the link is actuated and personnel should not be in the path of the canopy when jettisoned.

emergency entrance

F-20-D3-3-8

Figure 3-7

CANOPY REMOVAL BY GROUND CREW.

The external canopy jettison control should be used unless explosive fuel fumes are noted in the cockpit area. In the event that the aircraft is already burning, the external canopy jettison control should be used for immediate removal of the canopy. (See figure 3-7.) On some aircraft the canopy can be unlocked from the outside by the external handcrank; on others it is necessary to take the risk of jettisoning the canopy or breaking the right-hand windscreen with an axe. Actuation of the external canopy-open switch could ignite fuel fumes. It is recommended that the canopy be opened by electrical power only when fuel vapors are not present and quick removal of the canopy by jettison control is not considered necesary.

CANOPY REMOVAL WITHOUT EXPLOSIVE REMOVER.

In Flight.

If the explosive remover is not installed, or fails to fire, the canopy may blow off if the canopy is unlocked. If it fails to go, raise it into the airstream, using the canopy OPEN switch or the manual handcrank.

On the Ground.

If the explosive remover is not installed, there are two alternate methods of opening the canopy as described in the paragraphs following.

Electrical Operation. If there are no explosive fumes present, turn the battery switch ON, unlock the canopy and raise it by pressing the canopy-open switch. By pushing upward against the canopy, opening time can be reduced from the normal 6 seconds to about 4 seconds.

Handcrank Operation.

a. Unlock the canopy.

b. Push in handcrank to engage and rotate counterclockwise to raise canopy.

Canopy Malfunction.

To preclude the possibility of jettisoning the canopy if the jettison lever should be moved out of the stowed position proceed as follows:

a. Insert the safety pin in the canopy initiator after landing.

b. Place the jettison handle back in the stowed position.

c. Hold the canopy jettison handle in the stowed position when the canopy normal locking handle is moved forward for normal unlocking of the canopy on the ground.

d. Hold the canopy jettison handle in the stowed position until maintenance personnel arrive to ensure deactivation of the system prior to getting out of the aircraft.

FUEL SYSTEM FAILURE.

If fuel system failure occurs, proceed as indicated in the paragraphs following.

THROTTLE LINKAGE FAILURE.

If throttle linkage failure occurs above 70% rpm, the power setting will probably return to about 70%. If the failure occurs below 70% rpm, power will return to IDLE rpm. IF the failure occurs in the throttle quadrant the power setting may remain where it was; if this occurs at an engine rpm sufficient to sustain flight and power cannot be retarded, proceed as follows:

1. Tip tanks — Jettison or burn out tip-tank fuel.

2. Speed brakes switch — DOWN.

3. Landing gear lever — DOWN (Below limit gear down speed).

4. Traffic pattern — Fly as required, commensurate with available engine rpm.

5. Wing flaps — As desired.

6. Main fuel shutoff switch — CLOSED when landing is assured.

If the failure occurs at an rpm below that sufficient to sustain flight, accomplish the following:

1. Starting fuel switch — MANUAL below 25,000 feet and 70% rpm.

Note

With the starting fuel control in the MANUAL position, fuel is supplied to the engine from both the main and emergency fuel control units. Enough additional power to sustain flight should result.

2. RPM and EGT — Check indicators.

If throttle linkage failure should occur at near maximum fuel loads with low rpm, it may be necessary to jettison the tip tanks to sustain flight. No difficulty should be encountered in turning the starting fuel switch back to the OFF position in the event a decreased power setting is desired for descending, landing, or taxiing. After landing, the engine can be shut down using the main fuel shutoff switch. The net result of this procedure is that two power settings, other than OFF, are available, (1) the rpm at which the throttle is stuck, and (2) the additional rpm resulting from selecting the MANUAL position of the starting fuel switch.

Symptoms of throttle linkage failure are as follows:

a. A frozen throttle control grip.

b. Inability to vary rpm with throttle movement.

c. Inability to increase power from IDLE rpm.

d. Loose or sloppy throttle control action with no effect upon rpm.

Note

A stagnated rpm is not necessarily an indication of throttle linkage failure. It could result from engine fuel system icing, fuel depletion, main fuel control unit failure, emergency fuel transfer malfunction, or engine fuel pump failure.

ENGINE FUEL PUMP FAILURE.

The engine will flame out if the main element of the dual fuel pump fails and the emergency fuel switch is in the NORMAL position. The aircraft should be landed as soon as possible to prevent further failure in the engine fuel system.

FLUCTUATING FUEL PRESSURE.

(Refer to the Fluctuating Fuel Pressure Or Engine Vibration paragraph, this section.)

BOOSTER PUMP FAILURE.

If a wing or leading edge tank booster pump fails, fuel cannot be withdrawn from that tank by the engine-driven pump. Fuel will, however, be fed normally from the corresponding tank on the opposite side of the aircraft if its booster pump is operating. Fuel may be drawn out of the fuselage tank by the engine-driven pump, without the aid of the booster pump, at a rate in excess of that necessary to provide 100% rpm up to an altitude of at least 17,000 feet. Cold fuel flows to the engine at a higher rate. The aircraft has been flown at altitudes above 36,000 feet with the fuselage tank booster pump inoperative with relatively cold fuel. If the situation requires, it is possible to remain at altitudes up to 36,000 feet if the pilot is reasonably certain the fuel is cold.

FLOAT VALVE STUCK OPEN.

A float valve stuck open is indicated by fuel fumes present in the cockpit and by noting an excessively rapid rate of fuel transfer. Also fuel will be pumped overboard through the sabre drain. If the above symptoms occur, indicating a float valve stuck open, proceed as follows:

1. Fuel selector switches — OFF, except the fuselage tank selector switch.

2. Tips and leading edge tanks — transfer fuel (when fuselage fuel tank has dropped to the 90-gallon level) until the fuselage tank is again full.

3. Repeat step 2 until the tip and leading edge tanks are empty.

If it can be determined which set of tanks are malfunctioning because of a float valve stuck open, the above procedure may be applied only to that set of tanks.

FLOAT VALVE STUCK CLOSED.

A float valve in the fuselage tank stuck in the up (closed) position may be indicated by a decrease in fuselage tank quantity before sufficient fuel has been transferred to empty the tank group feeding the fuselage tank. It should be noted, however, that the above indication may also be indicative of other malfunctions and is not a positive check. If a float valve should stick (or be suspected stuck) in the up (closed) position, proceed as follows:

1. Descend below the freezing level (if practicable).

2. Fuselage tank — Fill from one of the other tank groups.

3. At 240 knots IAS — Fishtail and porpoise the aircraft.

4. Fuel tank selector switches — OFF, except for the tank with the malfunctioning valve. Observe the fuselage tank fuel level. If fuel does not feed into the fuselage tank, repeat the above procedures.

LEAKING OR SIPHONING FUEL TANKS.

If a fuel leak should be encountered in flight, the pilot must plan to land the aircraft as soon as it seems safe to do so. It may be possible to isolate the tank group in which the leak occurs, or it may be advisable to turn off all the other tanks and consume the fuel from the leaking or siphoning tank as rapidly as possible. It is recommended that the aircraft be landed as soon as possible or that the pilot eject if the leak is serious enough to create a fire before a landing can be made.

CAUTION

Severe siphoning from the wing or leading edge tank caps has resulted in loss of all fuel through the float valve in the aft fuselage tank. A decreasing pressure in the fuselage tank allows it to collapse, keeping the fuel level high enough to cause an erroneous indication on the fuselage tank fuel quantity gage until the fuel supply is depleted. Since the external tanks feed into the fuselage tank, fuel from them may also be lost overboard.

ENGINE FUEL SYSTEM ICING.

Ice formation within the aircraft and engine fuel system can result in engine fuel starvation and subsequent flameout. Water mixes readily with JP-4 fuel and its presence cannot be ascertained visually unless some of the water has settled to the bottom of the fuel tank. Do not fly the aircraft until all visible water has been drained from the fuel system (tanks and low-pressure fuel filter). In areas of low temperatures it is possible that the water accumulation in the area of the tank drains may be frozen, making it impossible to drain the fuel sumps. While it is presently impossible to remove all water from fuel, pilots must always be on the alert to recognize ice formation in the fuel system. Ice can form downstream of the low-pressure fuel filter, in which case, the fuel filter ice warning light will not illuminate. At low power settings, the possibility of ice formation is greater due to the decreased rate of fuel flow. Ice formation may be indicated by one or more of the following:

a. Gradual increase or decrease in rpm.

b. Fluctuating rpm.

c. Inability to obtain higher rpm.

d. Apparent loss of throttle control.

e. Fuel filter ice warning light on.

By closely monitoring engine instruments for easily noticeable fluctuations, ice formation may be removed before reaching a hazardous state. When system icing is evident or suspected, use the following procedure:

1. FUEL FILTER DEICE SWITCH — ON FOR 15 SECONDS.

Note

During flight at high altitudes or during the winter seasons when sub-freezing temperatures are prolonged, alcohol should be used for 15 seconds for every 30 minutes of flight to prevent fuel system icing. The use of alcohol for more than 30 seconds at a time is not recommended.

2. ENGINE INSTRUMENTS AND FUEL FILTER ICE WARNING LIGHT — CHECK.

Note

It may take up to 30 seconds after releasing the fuel filter deice switch before deicing is effective.

If engine operation does not return to normal proceed as follows:

3. GANG START SWITCH — ON.

Note

The pilot would normally leave the gang start switch ON; however, if it is necessary to return to the normal fuel system, do so at 80% rpm below 23,000 feet.

4. Land — As soon as possible.

Note

If landing is made with the gang start system energized, the gang start switch should be turned off after throttle is moved to OFF.

TIP TANK FUEL SYSTEM MALFUNCTION.

For normal operations, the tip tanks should not contain more than 75 gallons of fuel each during landing. In an emergency a safe landing with full tip tanks is possible provided that:

a. The gross weight of the aircraft does not exceed 15,000 pounds.

b. Tip tank jettison switch (if installed) — AUTO—DROP.

c. Full engine power is available to control the rate of descent.

d. Adequate runway length is available.

e. Pilot's proficiency is sufficient to safely handle the situation.

f. A long, flat approach is used with a sink rate not exceeding 6 feet per second (360 feet per minute).

Failure of both tip tanks to feed will be quickly evidenced by reference to the fuselage fuel tank fuel quantity gage or exhaustion of the other fuel tank groups if they are turned on. The tip tank indicator light may be illuminated or it may be out when the tip tanks are not feeding. If both tip tanks cannot be made to feed, it is recommended that they be dropped in a safe area before a landing is attempted. If the tip tanks cannot be dropped either electrically or manually, fuel from the main wing and leading edge tanks should be used up before a landing is made. If one tip tank fails to feed or feeds more slowly than the other eventually full aileron trim may not hold the wings level at approach and landing airspeeds. Continued operation of the aileron trim tab 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 — To between 25,000 and 30,000 feet as rapidly as possible (the ambient air pressure of low altitudes will remain inside the tank and may start the tank feeding).

2. Airspeed — 240 knots IAS.

3. Wings — Rock rapidly from side to side. Do not exceed 45 degrees of bank.

4. Tip tank circuit breaker — PULL.

5. Speed brakes — Cycle.

Note

If the fuel load is unequally distributed and it is determined that the heavy tank will not feed, drop it in a safe area.

RELEASE MECHANISM MALFUNCTION.

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

1. Climb — To 15,000 feet or more above the surrounding terrain.

2. Aileron boost — ON.

3. Airspeed — 195 knots IAS and make shallow turns noting the degree of the aileron control.

4. Gear flaps and speed brakes — DOWN and simulate a landing approach.

5. Check — Aileron pressure and degree of aileron control required to hold the wings level as airspeed decreases.

WARNING

- If difficulty is experienced in holding the wings level, lower the nose, apply power, and recover airspeed. Increased airspeed will restore aileron control.
- Do not in any event allow the airspeed to drop below 130 knots IAS.
- If satisfactory lateral control cannot be regained, abandon the aircraft.

6. Traffic pattern — Make a straight-in approach if the aircraft can be controlled satisfactorily at an airspeed of 150 knots IAS or below.

7. Final approach — 20 knots IAS above that speed where control difficulty occurred. In no case should a touchdown be attempted at more than 150 knots IAS.

8. Landing — Touch down on the side of the runway opposite the heavy tank. Use the right side of the runway if the left tank has the extra fuel and vice versa.

CAUTION

With an asymmetric fuel load, a yawing motion is created when the gear and flaps are lowered. This will require a reversal in rudder position and higher than normal control forces and engine power. Consequently, it is recommended that the gear and flaps be lowered at a speed between 170–195 knots IAS in order that longitudinal control may be maintained.

TIP TANK JETTISON PROCEDURE.

Tip tanks may be jettisoned either simultaneously or individually. (See figure 3-8.) They may be released by using the bomb salvo button, the manual release handles, or with the bomb release buttons on the control stick. The bomb salvo button is used to jettison both tanks simultaneously 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. Manual release handles may be used (in case of electrical failure) to drop the tanks simultaneously or individually by pulling either or both handles. A bomb release button (when wiring is connected) on the control stick may be used to drop the tip tanks whenever the bomb release switches are properly positioned.

Note

The bomb release button is not wired on some aircraft.

The recommended airspeed for tip-tank jettison is approximately 240 knots IAS whether empty or full. Tip tanks have been successfully dropped at airspeeds from 130 to 435 knots. Drop the tip tanks at the location, heading and altitude prescribed by local policy.

CAUTION

Do not jettison tip tanks in turbulent air or in close proximity to other aircraft where slipstream or jetwash may be encountered. The tip tanks may strike the fuselage or tail, causing structural damage.

tip tank jettison

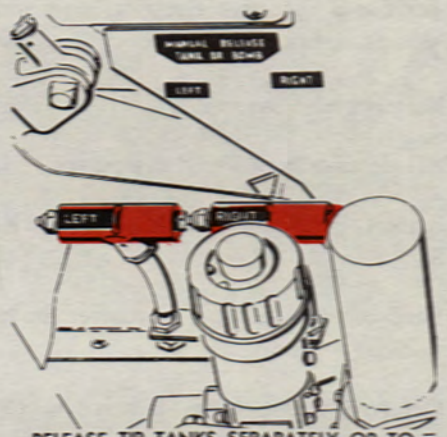


Figure 3-8

WING FLAPS MALFUNCTION.

There is no emergency method of extending the wing flaps. If the flaps cannot be lowered, approach the runway approximately 10 knots faster than normal and allow for a flatter gliding angle and longer landing roll. (Refer to Stall Speed Chart, figure 6-2).

ASYMMETRICAL FLAP CONDITION.

In the event of a 45-degree split-flap condition there is sufficient aileron control to completely overcome the effects of the rolling moment introduced, provided the aileron boost is on. However, a split-flap landing should not be attempted initially because of an approximate 3 degree yaw that is introduced in the direction of the split-flap, and the resulting buffet that is subsequently introduced as a result of applied opposite rudder. When split-flap symptoms occur in the landing pattern, proceed as follows:

1. FLAPS — ATTEMPT TO RETRACT.
2. AIRSPEED — 160 KNOTS IAS MAXIMUM AND INITIATE A GO-AROUND.
3. AILERON BOOST — RECHECK ON.
4. LAND — 20 KNOTS ABOVE NORMAL.

If the flaps can be retracted, a landing should then be accomplished in the no-flap configuration. In the event the pilot cannot raise the flaps, the landing may be accomplished by maintaining an approach speed 20 knots above normal. However, buffet and yaw will still be present. The aircraft cannot be controlled for an asymmetrical 45-degree split-flap configuration with aileron boost inoperable; therefore, ejection is recommended if this condition should occur.

ELECTRICAL FAILURE.

Electrical failure is evidenced by either illumination of the generator-out or the gyro instruments-out warning light, zero or high loadmeter indications, fail-

ure of any or all of the electrical system components, overloaded circuits that have popped out their circuit breakers, or an electrical fire.

HIGH LOADMETER READING.

High loadmeter readings indicate an overloaded or shorted circuit which, if uncorrected, will eventually cause battery failure, battery burning, battery explosion, or complete electrical failure. If the loadmeter indicates a continuous reading above the limits specified in Section V, check for a defective electrical unit such as radios, boost pumps, lights, etc. as follows:

1. Battery generator switch — OFF.

2. All electrically powered equipment — OFF.

3. Battery generator switch — BATTERY GENERATOR.

4. Loadmeter — Monitor loadmeter for high readings while turning units on.

5. Defective unit — OFF. If it is vital to the completion of the mission, use when necessary and land as soon as possible.

ZERO LOADMETER READING.

A zero loadmeter reading generally indicates generator failure and is usually accompanied by illumination of the generator-out warning light. The loadmeter should be checked immediately before and immediately after takeoff and at least once every 15 minutes of flight. If during one of these checks, a zero loadmeter reading is detected, check for a faulty gage as follows:

1. Auxiliary windshield defroster — ON momentarily, then OFF.

2. Loadmeter — Check for an increase. If the reading increases it indicates an erroneously low reading or a faulty gage. Continue the flight and frequently recheck loadmeter.

3. Generator-out warning light — Check for illumination.

If the light illuminates, the generator has failed. If the loadmeter indication does not increase and the generator-out warning light does not illuminate, generator failure must be assumed. Proceed as under Generator Failure, this section.

COMPLETE ELECTRICAL FAILURE.

Complete electrical failure is evidenced by a zero loadmeter reading and failure of all electrically operated equipment. If a generator failure is not detected, the battery power will eventually become depleted. A frequent check of loadmeter reading, especially during IFR or 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 an OFF flag on the J8 attitude indicator, faulty operation of gyro instruments, weak radio reception, or dimming of the cockpit lights. If this evidence is recognized, check for a zero loadmeter reading, and take whatever action is required. Complete electrical failure will render all electrical equipment inoperable. The important items to remember are:

a. All electrical instruments will fail with their pointers in the operating range, except the fuselage tank fuel quantity gage and wing flap position indicator (if installed), which will fall below zero, and the landing gear indicators, which will display the barber-pole pattern.

b. Neither the aircraft lights nor any of the radios will operate.

c. Fuel will be available only from the fuselage fuel tanks and tip tanks. No leading edge or main wing fuel can be fed into the fuselage tank. If tip tanks have been emptied, note that no more than 260 gallons of fuel will be available.

d. The fuel counter and the fuselage fuel tank indicator (liquidometer) will be inoperative. There will be no indication when tip tanks are empty of fuel.

e. Tip tanks can be dropped only by using the manual release handles.

f. The emergency fuel system cannot be used. Control of fuel from the emergency system is effected through a solenoid-operated valve, and this cannot be closed without electrical energy. If main fuel system failure occurs, or has already occurred and the aircraft is operating on the emergency fuel system, a flameout will occur.

g. Gear position indicators (Selsyn windows, lights, and horn) will be inoperable.

h. The wing flaps and the speed brakes cannot be operated.

i. Attitude indicator, heading indicator, and turn needle will be inoperable.

j. The air start switch will be inoperable.

k. The emergency hydraulic pump will be inoperable and the landing gear can be lowered only by the normal system.

l. Trim tabs will remain as set prior to electrical failure.

m. The canopy must be opened manually.

GENERATOR FAILURE.

Generator failure is indicated by illumination of the generator-out warning light and a zero loadmeter reading. When the generator is inoperable, battery life will be dependent upon the type of batteries installed. Nickel–cadmium batteries will last a minimum of 20 minutes for normal inflight operations and up to 60 minutes if electrical loads are reduced to a minimum. Fully charged lead–acid batteries may only last as long as 7 to 10 minutes. With either type the main factors that affect battery life are state of charge and electrical loads. Because the pilot has no way of knowing how long battery power will be available, it should be conserved by closely controlling the demand placed upon it. The type of mission, altitude, terrain, weather, geographical position, and other flight conditions will determine which electrical equipment is necessary. It is imperative that the pilot closely monitor the generator-out warning light, especially during night or IFR missions, so that a generator failure will be recognized immediately.

CAUTION

During night or IFR flight conditions do not confuse illumination of the gyro instrument warning light or the turn-and-slip indicator warning light with the generator-out warning light. Always carry a flashlight and make sure which light has illuminated by identifying its individual placard so that the proper emergency procedures can be initiated.

GENERATOR FAILURE PROCEDURE.

When a generator failure occurs, the pilot should analyze the situation to determine what electrical equipment is necessary to sustain flight until a landing can be made. All nonessential electrical loads should be removed from the dc bus either by turning off the equipment or by pulling the circuit breaker. The following procedure is recommended if the generator fails:

1. All electrical equipment not needed to sustain flight — OFF, except the command radio.

2. Command radio — Make emergency and position report.

3. Fuselage tank fuel selector switch — OFF.

CAUTION

Do not turn off the command radio because there may not be enough battery power available to reenergize the set once it has been turned off. Do not make unnecessary transmissions.

4. Standby inverter — ON (if necessary).

5. Lower flaps on downwind leg and do not extend speed brakes.

6. Land as soon as possible.

The pilot should plan to land the aircraft as soon as possible after a generator failure. Battery power should be conserved so that flight can be sustained until a landing can be made. It may be advisable to descend immediately when the flight is being conducted under IFR or night flight conditions. The standby inverter requires 10 amperes for operation and there is no way of knowing how long the flight instruments will remain operative. If it is necessary to transfer fuel, in order to sustain flight to the landing destination, allow the fuselage tank to empty to 90 gallons, then transfer fuel from the main wing and leading edge tanks until the fuselage tank contains 109 gallons. Repeat this procedure after the fuselage tank has again emptied to the 90-gallon level. The use of equipment requiring high amperage should be avoided, except when it is absolutely necessary. The following list shows the amperage required for various electrical equipment requiring 10 or more amperes.

a. Starter motor ..... 300 to 1200 amp

b. Fuel deice pumps (early aircraft) .. 200 to 250 amp
(later aircraft) ..... 115 amp

c. 750-VA inverter ..... 50 amp

d. Windshield defroster ..... 43 amp

e. Fuselage tank fuel booster pump ..... 28 amp

f. Wing flaps ..... 25 amp

g. Seat adjustment actuator ..... 22 amp

h. Leading edge tanks fuel booster pumps (each) .....17 amp

i. Command radio .....16 amp

j. Main wing tanks fuel booster pumps (each) .....11 amp

k. 250-VA inverter .....10 amp

INVERTER FAILURE.

Whenever the gyro instrument warning light or the inverter-out warning light illuminates, switch to the standby inverter.

RUNAWAY TRIM.

On aircraft equipped with the elevator trim override switch, the stick-grip trim switch can be disconnected and the trim controlled by the override switch.

"Runaway" trim occurs more frequently with the elevator trim, although it may also occur with the aileron trim. A faulty switch may cause the trim tab motor to move the tab to the maximum limit of travel, despite efforts to halt the travel by use of the stick-grip switch. At high airspeeds, the amount of control force necessary to resist the trim effect may become great.

One common occurrence that resembles "runaway" trim results from failure to return the trim switch to neutral with thumb pressure after trim is used. Check the trim switch for neutral position if trim movement does not stop after using the switch. If a runaway trim condition occurs, use procedure as given in the paragraphs following:

Runaway Nose-Down Trim.

1. MAINTAIN AIRCRAFT CONTROL.

2. THROTTLE — RETARD AS NECESSARY TO REDUCE SPEED.

3. SPEED BRAKES SWITCH — DOWN.

4. ELEVATOR TRIM OVERRIDE SWITCH — NOSE UP.

Runaway Nose-Up Trim.

1. MAINTAIN AIRCRAFT CONTROL.

2. ROLL INTO A BANK.

3. THROTTLE — RETARD AS NECESSARY TO REDUCE SPEED.

4. ELEVATOR TRIM OVERRIDE SWITCH — NOSE DOWN.

5. LOWER THE FLAPS AS NECESSARY.

Runaway Aileron Trim.

1. Control stick — Apply back pressure to decrease speed and side pressure to hold wings level.

2. Throttle — Retard as necessary to reduce speed.

3. Aileron boost shutoff lever — Check ON.

4. Aileron tab — Visually check for amount of deflection.

OIL SYSTEM MALFUNCTION.

High, low, or zero oil pressure indicates oil starvation of one or more bearings due to a restriction in an oil line, ruptured lines, or complete loss of oil. If this condition exists proceed as follows:

1. Avoid high G forces.

2. Throttle — Adjust to between 68% and 85% rpm. Do not reduce thrust until landing is assured.

3. Land as soon as possible, using a precautionary landing pattern.

WARNING

Bearing failure will be accompanied by a relatively gradual buildup of vibration as it progresses. Normally, engine failure will not occur within 10 minutes. If vibration becomes severe it may be necessary to shut down the engine to prevent such destructive failure as would jeopardize aircraft control or successful ejection.

PITOT-STATIC SYSTEM MALFUNCTION.

Dirt or ice accumulation over the static ports will cause the altimeter, airspeed indicator, and vertical velocity indicator to give inaccurate indications. Malfunction of the pitot head or failure to remove the dust cover will render the airspeed indicator inoperative. The recommended solution in the event of failure of either the static ports or pitot head is the use of a chase plane to monitor approach and landing airspeeds. If a chase plane is unavailable make a radar approach using power and a controlled rate of descent to get the aircraft on the ground.

Note

If the pitot cover has been inadvertently left on during the exterior inspection, use of the pitot heat will not burn the cover off.

PITOT-STATIC ICE ACCUMULATION.

If rime ice accumulates on the leading edge of the wings, it is safe to assume that ice has formed ahead of the static ports. Stalls tests conducted with ice immediately ahead of the static ports produced indicated stalling speeds considerably above normal. If rime ice is present use power as a reference, rather than airspeed, while flying the landing pattern.

Note

Rime ice accumulation ahead of the static ports produces a low pressure area over the vent holes resulting in excessively high indicated airspeeds.

If ice is present the pilot should remember that the aircraft will stall at higher indicated airspeeds and he should be especially alert for false or high indications of the pitot–static instruments.

AIR-CONDITIONING AND PRESSURIZATION SYSTEM MALFUNCTION.

If the air-conditioning and pressurization system should malfunction during flight, it may be difficult to defrost the windshield after descent from high altitudes. An immediate, rapid descent should be considered in order to prevent cold-soaking of the windshield and to allow warmer temperatures at lower altitudes to remove the frost or fog that may have already formed. Do not land until it melts sufficiently to allow adequate visibility. If the frost does not melt, and fuel level is low, the canopy should be jettisoned by pulling the canopy jettison lever prior to landing. If the temperature control valve or the turbo refrigerator air cooler should malfunction it may be possible to vary the cockpit temperature by use of the auxiliary defroster or the cockpit ventilation system, as necessary. A landing should be made as soon as possible. In case of a malfunctioning anti-G suit valve (where the anti-G suit fails to deflate after a maneuver), the pilot should immediately disconnect the anti-G suit hose from the pressurization system by pulling on the hose.

Section IV – AUXILIARY EQUIPMENT

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AIR-CONDITIONING AND PRESSURIZATION SYSTEM.

The cockpit is heated, ventilated, and pressurized by air from the engine compressor as shown in figure 4-1. When closed, the canopy is sealed by a pneumatic rubber gasket, automatically inflated by the pressure air system. Pressurization air enters the cockpit through two pressurization inlet grilles and the canopy defrost duct (standpipe) behind the seat. Cockpit temperature is regulated by a mixing valve in the temperature control which diverts a portion of the hot compressor air through the turbo-refrigerator for cooling before it enters the cockpit. The mixing valve is controlled by the cockpit temperature rheostat in the cockpit. Cockpit pressure differential is automatically maintained by the cockpit pressure regulator. A cockpit altimeter, which indicates equivalent cockpit altitude, and a cockpit temperature gage are located on the right shelf.

CABIN TEMPERATURE SELECTOR.

The cabin temperature selector consists of a rheostat-type switch, located on the left shelf in the cockpit (19, figure 1-7), that controls the position of the mixing valve. The mixing valve diverts compressor air through the turbo-refrigerator to control cabin temperature. The cabin temperature selector control knob may be set at any intermediate position between HOT and COLD to obtain the desired cabin temperature.

COCKPIT VENTILATION SYSTEM.

Outside air is available through a scoop in the left engine air intake duct. The air enters the cockpit through a tube containing a shutoff valve and swivel fitting, located above the left shelf, that provides directional adjustment. A check valve in the tube prevents loss of cockpit pressure regardless of the position of the shutoff lever.

COCKPIT PRESSURE AND DUMP VALVE.

The combination cockpit pressure and dump valve operates automatically to relieve excessive cabin pressure in case of failure of the cockpit pressure regulator, and may be operated manually to dump cabin pressure. On some aircraft a toe-operated cockpit pressure dump valve lever is located on the floor of the front cockpit. The lever is pushed down to release cabin pressure.

CABIN PRESSURE DUMP SWITCH.

On some aircraft the dump valve lever is replaced by a cabin pressure dump toggle switch located on the left console in the front cockpit (8, figure 1-7). The switch is dc-powered; its two positions are DUMP and OFF. When the switch is in the DUMP position the pressurization air shutoff valve is closed and the dump valve opened, thus reducing cabin pressure to atmospheric. Five seconds is required for the air shutoff valve to move to the closed position, after which the switch should

air system

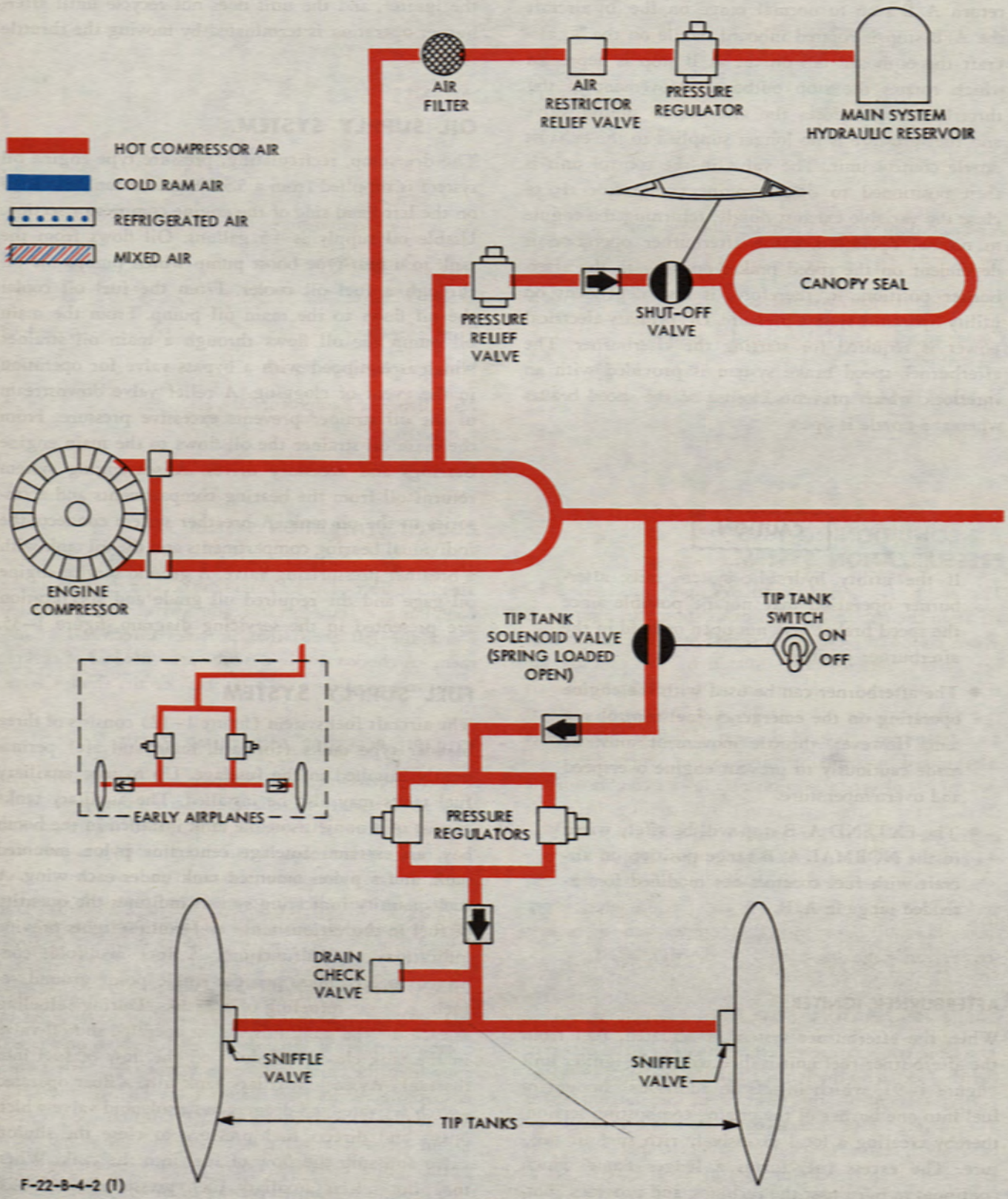

Figure 4-1 (Sheet 1 of 2)

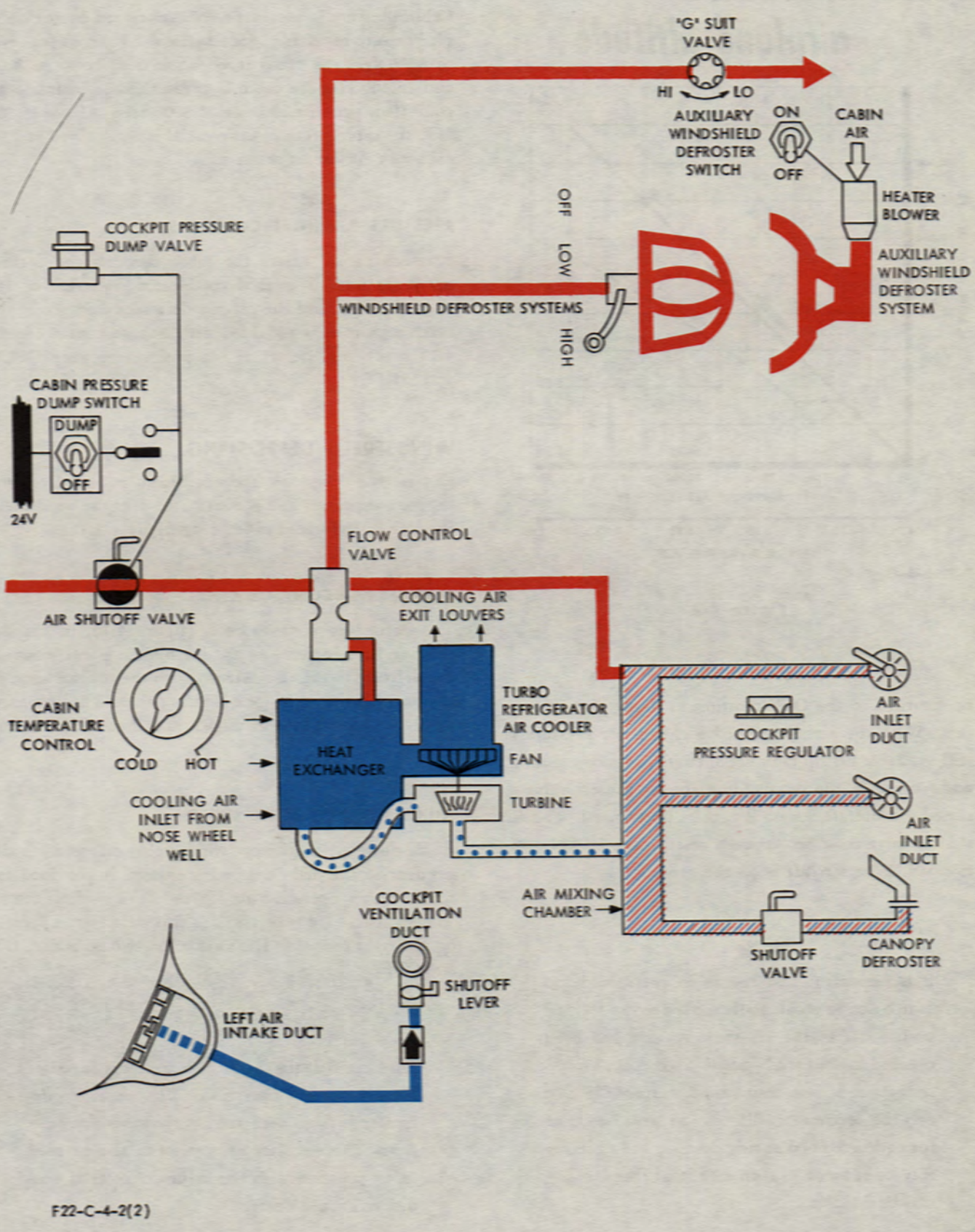

Figure 4-1 Sheet 2

cabin altitude vs airplane altitude

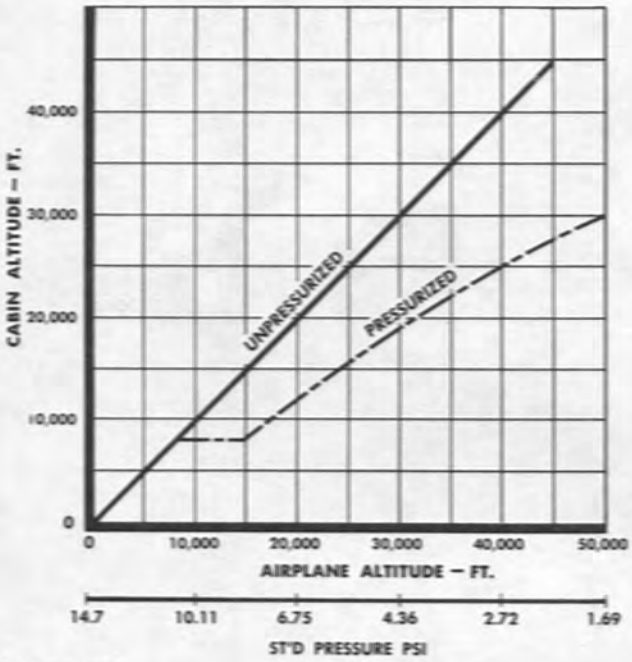

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Figure 4-2

be returned to the OFF position to deenergize the circuit. With the air shutoff valve closed, air pressure is still available for tip tank pressurization, canopy sealing, and for the G-suit valve. Once the air shutoff valve is closed the aircraft can no longer be pressurized. The air shutoff valve must be manually reset to the OPEN position while the aircraft is on the ground.

Note

It is important that the cabin pressure dump switch not be accidentally moved to the DUMP position after the air shutoff valve has been checked in the OPEN position. If cockpit pressurization is not maintained during flight it may be extremely difficult to remove frost formation formed during descent, and visibility may be reduced to such an extent that landing may be difficult.

CABIN PRESSURE REGULATOR.

Cabin pressure is automatically maintained by the cockpit pressure regulator. (See figure 4-2.) From sea level to 8000 feet the cabin is unpressurized; between 8000 and 15,300 feet the cabin is pressurized to maintain an equivalent pressure altitude of 8000 feet. Above 15,300 feet, the cabin pressure differential is maintained at 2.75 psi above outside air pressure.

PRESSURE AIR INLET CONTROLS.

Pressurizing air enters the cabin through the cockpit pressurization air inlet ducts located outboard of the rudder pedals, and the canopy defroster duct aft of the seat. Each inlet is provided with a shutoff lever (figure 4-1) which may be set at any position between OPEN and SHUT.

WINDSHIELD DEFROSTING.

Hot air for defrosting the windshield is bled from the engine compressor and is distributed over the windshield through a perforated tube. (See figure 4-1.)

DEFROSTING CONTROL KNOB.

The defrosting control knob (figure 4-1), in the defrosting tube forward of the instrument panel, controls the defrost system. To defrost, push the control knob in and turn clockwise to lock it in position. Turn counterclockwise and release to unlock and shut off defrosting air.

AUXILIARY DEFROSTER SWITCH.

A dc-powered auxiliary windshield defroster, independent of the main defrosting system, is provided for cold weather operation or for use during idle descent. The switch (13, figure 1-8) for this defroster is located on the right console. The switch has two positions, ON and OFF.

Note

On most aircraft, the main defroster is adequate for all normal operation. *The auxiliary defroster is to be used in case the main defroster fails.* The auxiliary defroster can also be used in conjunction with the main defroster if conditions should warrant.

WINDSHIELD AND CANOPY DEFROSTING SYSTEM OPERATION.

The windshield and canopy defrosting system should be operated at the highest temperature possible (consistent with the pilot's comfort) during high altitude flight in order to provide sufficient preheating of the transparent surfaces to prevent the formation of frost or fog during descent. When anticipating a rapid descent or a series of maneuvers resulting in constantly changing altitude, switch the cockpit temperature control to HOT, turn on the auxiliary windshield defroster, if necessary, and partially close the cockpit pressurization air inlet ducts to increase the airflow to the manifold.

Note

- Closing these inlet ducts may reduce pressurization and should not be construed as failure of the pressurization system.
- There is no time limit imposed upon the operation of the auxiliary windshield defroster system.

FUEL FILTER DEICER SYSTEM.

The fuel filter deicer system consists of a 5-gallon alcohol tank, an electrically driven pump, a solenoid-operated shutoff valve, a check valve, a differential pressure switch, and a warning light. The pump motor requires 7.5 amperes for normal operation. The pump is set to maintain a flow of 60 gallons per hour (approximately a 5-minute supply).

CAUTION

Damage to the system will occur if an improper type of deicer fluid is used. (Refer to the servicing diagram, figure 2-5, for the proper fluid specifications.)

FUEL FILTER DEICER SWITCH.

The fuel filter deicer toggle switch (7, figure 1-7), located on the left console in the cockpit, has two positions, ON and spring-loaded OFF. Holding the switch in the ON position turns on the pump and opens the solenoid valve so that alcohol is pumped into the filter.

FUEL FILTER ICE WARNING LIGHT.

A fuel filter ice warning light (11, figure 1-6), located on the instrument panel, is connected to the differential pressure switch which senses fuel pressure drop across the low pressure filter. If the pressure drop reaches approximately 2 psi the warning light glows, indicating filter restriction caused by ice or foreign matter. If the filter is iced, the alcohol will dissolve the ice accumulation, which reduces the pressure drop and extinguishes the warning light. (Refer to Engine Fuel System Icing, Section III.)

FUEL FILTER DEICER SYSTEM OPERATION.

When engine fuel system icing is suspected, or when it is evidenced by illumination of the fuel filter ice warning light, proceed as follows:

a. Fuel filter deicer switch — ON for 30 seconds and monitor loadmeter increase.

b. Fuel filter ice warning light and engine instruments — Check.

c. Emergency fuel switch — EMERGENCY, if icing symptoms continue.

d. Land as soon as possible (after selecting emergency fuel switch).

CAUTION

Closely monitor warning light and engine instruments and use the deicer system as necessary during descent and landing.

COMMUNICATIONS AND ASSOCIATED ELECTRONIC EQUIPMENT.

The communications and associated electronic equipment installed in the aircraft are listed in the six categories of type, designation, function, primary operator, range, and location of the controls. (See figure 4-3.)

MICROPHONE AND HEADSET CONNECTIONS.

The microphone and headset connections are attached to the aircraft oxygen supply hose.

communication and associated electronic equipment

TYPE	DESIGNATION	FUNCTION	RANGE	LOCATION OF CONTROLS
VHF RADIO SET	AN/ARC-27	SHORT RANGE TWO-WAY VOICE COMMUNICATION	LINE OF SIGHT	CENTER STAND
LF RADIO COMPASS SET	AN/ARN-6	RECEPTION OF VOICE AND CODED SIGNALS FOR DIRECTION FINDING AND BEARING	500 MILES	RIGHT SHELF
AN/ARN-12 MARKER BEACON RECEIVER	AN/ARN-12	AURAL AND VISUAL CODED RECEPTION OF MARKER BEACON SIGNALS	ANY VERTICAL DISTANCE OVER A MARKED BEACON	INSTRUMENT PANEL
WIRE RECORDER	AN/ANH-2	RECORD AUDIO SIGNALS TRANSMITTED OR RECEIVED BY THE PILOT DURING PHOTOGRAPHIC OPERATIONS	NOT APPLICABLE	LEFT SHELF
INTERPHONE EQUIPMENT	AN/AIC-10	ASSIST IN WIRE RECORDING OPERATIONS	NOT APPLICABLE	LEFT OF PILOT'S SEAT
IDENTIFICATION SET	AN/APX-25	RECEPTION AND TRANSMISSION OF IDENTIFICATION SIGNALS	LINE OF SIGHT	CENTER STAND

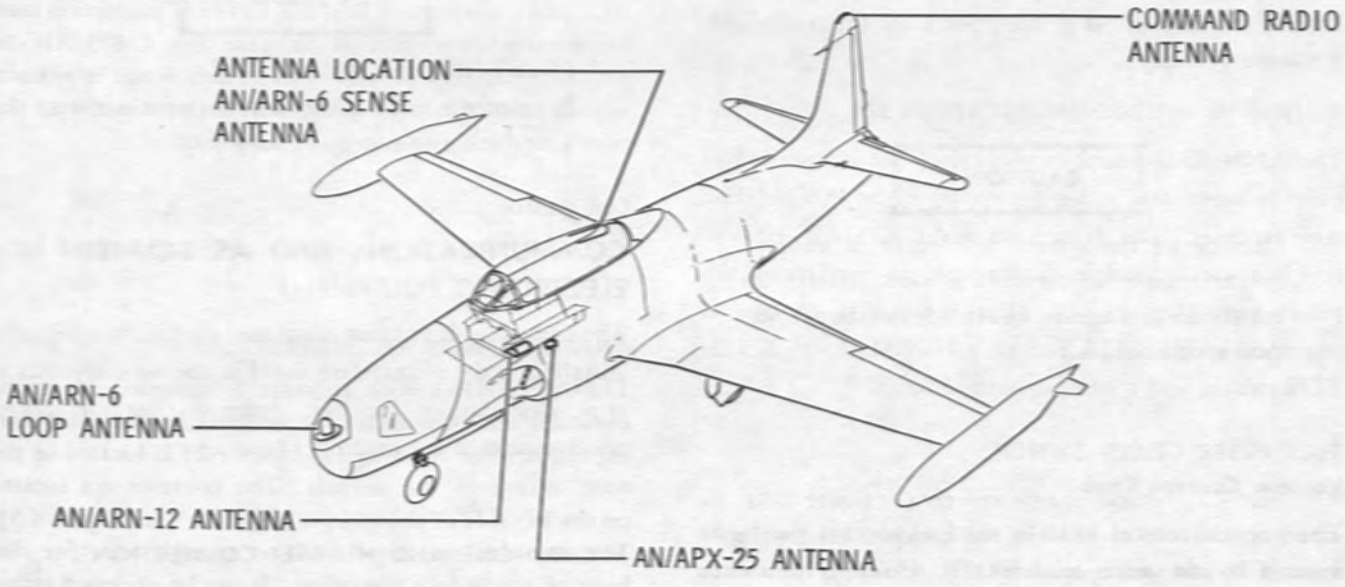


Figure 4-3

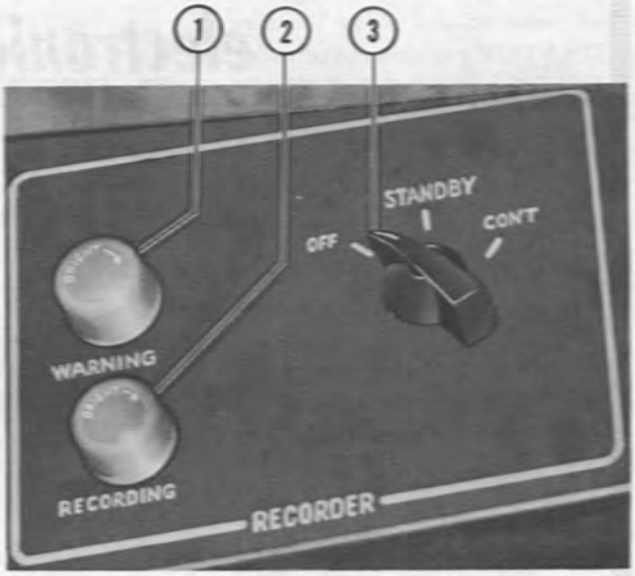
an/aic-10 control box

1. CALL BUTTON
2. NORMAL – AUX LISTEN SWITCH
3. VOLUME CONTROL KNOB

Figure 4-4

F22-C-4-4

an/anh-2 wire recorder



1. WARNING INDICATOR LIGHT
2. RECORDING INDICATOR LIGHT
3. SELECTOR SWITCH

F22-C-4-5

Figure 4-5

MICROPHONE BUTTON.

The microphone button (10, figure 1-7) is located on the throttle grip in the cockpit. It is used to open the voice channel to transmit with the UHF command radio receiver–transmitter.

AN/AIC-10 INTERCOMMUNICATION SET.

The AN/AIC-10 intercommunication set is installed to provide input and volume control to the AN/ANH-2 wire recorder. The dynamotor and C-823/AIC-10 control box are located in the cockpit, to the left of the pilot's seat (figure 1-2). The C-823/AIC-10 box is equipped with a CALL button, a NORMAL–AUX LISTEN switch, and a volume control knob.

Volume Control Knob.

The volume control knob is used to control the input volume to the wire recorder. It serves as a master volume control for the ADF, VHF, and marker beacon receivers. The volume is preset on the ground before takeoff and needs no further adjustment during flight.

Normal-Aux Listen Switch.

The normal–auxiliary listen switch has two positions, NORMAL and AUX LISTEN. It is safetied in the NORMAL position. The AUX LISTEN position is used for emergency operation in case the C-823/AIC-10 amplifier becomes inoperative. In this usage it permits signals from the radio equipment to go directly to the pilot's headset, bypassing the amplifier.

Call Button.

The call button is inoperative and is protected by a safety cover.

AN/ANH-2 WIRE RECORDER.

The AN/ANH-2 wire recorder is designed to record audio signals transmitted or received by the pilot during flight. The recorder (1, figure 1-2) is located in the nose section of the aircraft. The controls are located on the left side of the cockpit (figure 1-7 and figure 4-5). The recorder magazine contains enough wire for one hour of continuous operation. It can be operated either continuously or intermittently. No playback or erasing facilities are provided. The recording can only be reproduced on ground-operated equipment.

Selector Switch.

The selector switch has three positions, OFF, STANDBY, and CONTINUOUS. The switch is used to turn on the recorder and select the type of operation. In the STANDBY position the recorder will operate only when the microphone button is depressed. The CONTINUOUS position allows the set to record all communications received by the aircraft radios and all transmissions made by the pilot. In this position the recorder runs continuously as indicated by illumination of the green recording indicator light.

Recording Indicator Light.

The green recording indicator light glows when the magazine reel motor is operating, indicating to the pilot that the recorder is functioning.

Warning Indicator Light.

The red warning indicator light will glow when approximately 5 minutes of recording time remains.

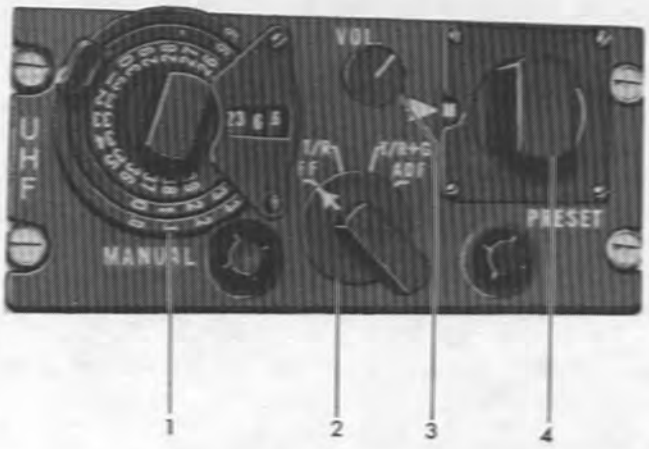
AN/ANH-2 OPERATION.

Turn the recorder on by rotating the selector switch to the STANDBY position; allow approximately 1 minute for the tubes to warm up. The recorder may be operated in the STANDBY position by depressing the microphone button. In this position the pilot can either transmit and record or record only, depending upon whether or not the UHF transceiver is on. The recorder may be operated in the CONTINUOUS position by turning on the ADF receiver, the UHF receiver, or by depressing the microphone button. In this position the recorder will record all signals received in the pilot's headset.

AN/ARC-27 UHF COMMAND RADIO.

This equipment is operated in the same manner as the AN/ARC-3 equipment which it replaces. The equipment includes a separate guard channel receiver in addition to the main transmitter–receiver and operates in the ultra-high frequency range of 225 to 400 megacycles. The guard receiver is tuned to the guard channel only and the main transmitter–receiver can be switched to any one of the preset channels plus the guard channel. The main control panel is not accessible in flight; therefore, the local–remote switch on this panel must be in the REMOTE position for cockpit control.

c-1904/arc-27 control panel



1. FREQUENCY SELECTOR DIAL
2. FUNCTION SWITCH
3. VOLUME CONTROL
4. CHANNEL SELECTOR

F22-C-4-6

Figure 4-6

C-1904/ARC-27 CONTROL PANEL.

The C-1904/ARC-27 control panel (figure 4-6) is installed in the center of the instrument panel in the cockpit (44, figure 1-6) for convenient pilot operation. The illuminated face of the panel contains a preset channel selector, a function switch, a volume control, and a manual selector.

Preset-Channel Selector.

The preset-channel selector provides immediate selection of any one of the 20 preset channels, or the letter M for operation of the manual selector. The number of the channel selector is indicated at the 9-o'clock position of the selector.

Function Switch.

The function switch (2 figure 4-6) has four positions, OFF, T/R, T/R + G, and ADF. When the switch is in the OFF position the equipment is deenergized. In the T/R position, transmission and reception is through the main transmitter–receiver only and on the channel selected by the channel selector. In the T/R + G position conditions are the same as in the T/R position except that the guard channel is monitored simultaneously by the guard receiver.

Volume Control.

The rheostat-type volume control provides selection of the desired audio level.

Manual Selector.

Any one of the 1750 UHF channels can be selected by setting the desired frequency in the window with the rotating concentric knobs provided. From the center knob out, the numbers represent hundreds, tens, units, and tenths of megacycles.

AN/ARC-27 Operation.

a. Rotate the function switch on the control panel from OFF to T/R and allow at least 2 minutes for warmup.

b. Rotate channel selector switch to desired frequency channel. Set is now ready to transmit and receive.

c. Rotate function switch to T/R + G, if simultaneous reception on guard frequency channel and another channel is desired.

d. Adjust volume controls as desired.

e. To transmit, press microphone button on the throttle.

f. If it is desired to transmit and receive on a frequency not previously set on the channel selector, rotate the channel selector until the letter M appears at the 9 o'clock position and select the desired frequency on the frequency selector dial.

g. Rotate function switch to OFF to deenergize set.

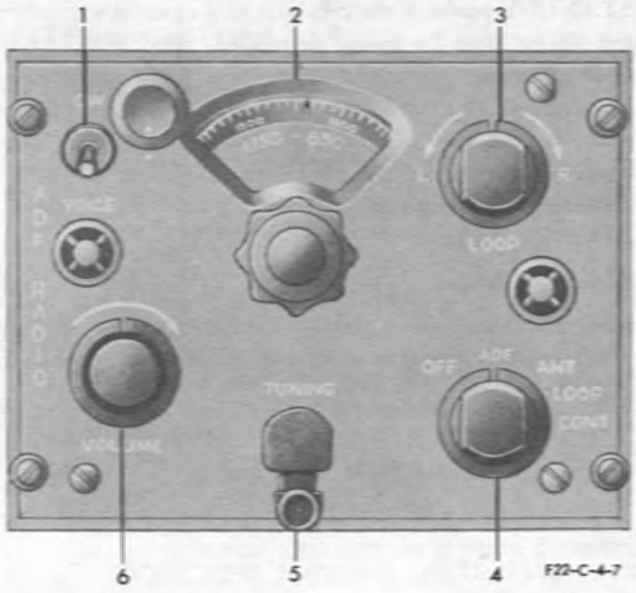
AN/ARN-6 RADIO COMPASS.

The AN/ARN-6 radio compass provides navigational aid as well as aural reception. The receiver is located on top of the aft cockpit fuel cell (10, figure 1-2), and receives power from the dc bus.

C-1514/ARN-6 CONTROL PANEL.

The C-1514/ARN-6 control panel (figure 4-7) is located on the right-hand console (14, figure 1-8). Illumination is provided by two lamps on the face of the panel which contains the operating controls.

C-1514/A-ARN-6 CONTROL PANEL



1. VOICE - CW SWITCH
2. TUNING DIAL
3. LOOP L/R SWITCH
4. FUNCTION SWITCH
5. TUNING CRANK
6. VOLUME CONTROL

Figure 4-7

Function Switch.

The function switch is used to turn the set on and to select the type of operation. The CONT position is not used in this aircraft. In the ADF position, the set functions as an automatic direction finder. 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. In the OFF position the set is deenergized.

Loop L-R Switch.

The loop left-right (L-R) switch is provided to permit manual control of the loop when the function switch is in the LOOP position.

Volume Control.

The volume control knob provides control of the level of audio reception.

Voice-CW Switch.

The voice–CW switch provides selection of continuous wave or voice reception.

Band Selector.

The band selector provides selection of any one of four frequency bands; the band selected will be indicated on the tuning dial (2, figure 4-7).

Tuning Crank.

By using the tuning crank the desired station is tuned for maximum signal strength as indicated on the tuning meter.

ID-91/ARN-6 RADIO COMPASS INDICATOR.

The ID-91/ARN-6 radio compass indicator (4, figure 1-6) is located in the cockpit on the instrument panel. The needle indicates relative bearing to the station as selected by the AN/ARN-6 radio compass.

AN/ARN-6 OPERATION.

The set is energized by turning the function switch to ADF, ANT, or LOOP. Turn the function switch to OFF to deenergize 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 ID-91/ARN-6 radio compass indicator may slow down so there is considerable lag between the beaming indication and the airplane heading.

b. The ID-91/ARN-6 radio compass indicator may stop altogether or move jerkily.

c. The ID-91/ARN-6 radio compass indicator may start moving in a direction opposite to the turn, later changing direction but still lagging the airplane heading considerably.

d. The ID-91/ARN-6 radio magnetic indicator may oscillate violently. Since 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 navigation aid, powered by the 28-volt dc electrical system. The receiver will deliver an audio and visual signal to the pilot whenever the aircraft is directly over an ILS marker, fan marker, or "Z" marker. The receiver is fully automatic, receiving any 75-megacycle transmissions whenever the aircraft is over a 75-megacycle ground radio facility. The visual signal is indicated by an amber light (6, figure 1-6) on the instrument panel. The audio signal is received in the pilot's headset by way of the interphone panel.

IFF EQUIPMENT.

To ensure safety of flight, all aircraft operating within a radar advisory area on a VFR, DVFR, or VFR on top clearance, are required by Air Route Traffic Control to have a functional IFF. In the event the IFF is inoperative, an aircraft may proceed through a radar advisory area only if ARTC has granted approval. When a radar facility is available, the IFF should be checked for normal operation twice during each flight. The first check must be performed after takeoff and prior to entering radar advisory areas and the second should be within 1 hour of landing.

AN/APX-25 IFF AND SIF.

The AN/APX-25 is an airborne, pulse-type transponder which enables the aircraft to identify itself whenever it is challenged by interrogating systems equipped for either Mark X or SIF (selective identification feature) replies. The system utilizes dc power from the dc bus and ac power from the No. 2 ac bus. The set cannot operate simultaneously in Mark X and SIF systems. A preset

an/apx-25 control panel

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Figure 4-8

adjustment switch within the receiver–transmitter enables operation of either one or the other system. This switch cannot be reset during flight; therefore, the pilot must know which system was preselected on the ground. The SIF reply permits the aircraft to reveal itself as friendly when interrogated. Also, it can identify itself with regard to serial number, flight number, mission, or in any other code previously arranged. The IFF system is usually operated in conjunction with search radar. IFF interrogation signals automatically actuate the transmission of a coded reply which is received and displayed on a plan position indicator or letter symbol indicator enabling specific identification and location of the aircraft. Two control panels are provided. The C-1158-IFF panel is used to energize, set, and select the conditions and modes of operation; the C-1128-SIF panel permits the pilot to select the SIF coded replies in modes 1 and 3.

C-1158 Control Panel.

The C-1158 control panel is located on the right console (figure 4-8). The panel is equipped with two illuminating lamps and the controls listed in the following paragraphs.

Emergency Dial Stop. The emergency dial stop must be pressed in order to rotate the master switch to the EMERGENCY position.

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

OFF. In the OFF position the set is deenergized.

STDBY. In the STDBY position, all primary power is turned on and tubes are warm and ready for immediate operation. However, the transponder receiver is not energized, and no replies can be transmitted.

NORM. In the NORM position, the transponder receiver is operated in any of the 32 mode-1 codes as selected by the mode-1 control dial on the C-1128 panel. The set is energized and operates at maximum capability.

LOW. In the LOW position, the transponder receiver operates the same as in the NORM position but at reduced sensitivity; replies will be transmitted upon receipt of strong interrogation signals, ordinarily from nearby interrogator responders. Transmitted power from the transponder is the same for the LOW and the NORM positions.

EMERGENCY. In the EMERGENCY position a distinctive emergency reply is transmitted in response to either mode 1 or mode 3 interrogations. Mode 3 permits quicker positive identification of an aircraft in distress. The reply is four successive groups of selected pulse trains.

Mode 2 Switch. The mode 2 switch has two positions, OUT and MODE 2 (up). In the MODE 2 position (provided the master switch is in LOW or NORM) there are 400 possible reply codes available. The number and interval of these codes must be preset on the code selector, located on the transponder, prior to flight.

Mode 3 Switch. The mode 3 switch has two positions, OUT and MODE 3 (up). In the MODE 3 position (provided the master switch is in LOW or NORM) 64 possible reply codes, as selected by the Mode 3 dial on the SIF panel, are available to the pilot.

I/P-OUT-MIC Switch. The I/P-OUT-MIC switch operates in SIF as follows:

I/P. Holding the switch in the I/P (spring-loaded up) position causes a double mode-1 or mode-3 code train to be transmitted in response to each mode-1 or mode-3 interrogation. This response will continue for 30 seconds after the switch is released to OUT from the I/P position.

MIC. Moving the switch to the MIC position (down) produces the same results as holding the switch in the I/P position, except that the response occurs only when the microphone button on the throttle is depressed. Thus, it is not necessary for the pilot to remove his hand from the throttle in order to reply to mode-1 or mode-3 interrogations.

C-1128 Control Panel.

The C-1128 control panel is located on the right console adjacent to the C-1158 panel (figure 4-8). The panel provides selection of the various reply modes in both mode-1 and mode-3 transponder operation. The panel contains two illuminating lamps and two coaxial dials labeled MODE 1 and MODE 3. Their description and operation is covered in the following paragraphs.

Mode 1 Dial. The mode 1 dial consists of two coaxial knobs; the outer knob bears the numbers 0 through 7 and the inner knob the numbers 0 through 3. This makes possible 32 different selected responses for mode-1 operation. The set will respond to mode-1 interrogations (according to the code selected by the mode 1 dial) whenever the master switch on the C-1158 panel is in the LOW or NORM position. Mode 1 will operate independently of, or concurrently with, mode 2 and 3 operation.

Note

The pilot has no control over selection of mode 2 code replies. The number and interval of these replies must be preset on the code selector of the transponder prior to flight.

Mode 3 Dial. The mode 3 dial also consists of two coaxial knobs. Both the outer and inner knobs are placarded from 0 through 7, making possible 64 different selected responses for mode-3 operation. The set will respond to mode-3 interrogations according to the code selected on the mode 3 dial provided the C-1158 panel master switch is in the LOW, NORM, or EMERGENCY position and the mode 3 switch is in MODE 3 position and/or the I/P-OUT-MIC switch is in I/P or MIC position. Mode 3 will operate independently of, or concurrently with, modes 1 and 2 operation.

LIGHTING EQUIPMENT.

LANDING AND TAXI LIGHTS.

Two identical, nonadjustable landing and taxi lights are mounted on the nose gear and turn with the gear. Landing and taxi lights are controlled by a switch (14, figure 1-7), located on the left shelf, which has three positions, LANDING LIGHTS, OFF, and TAXI LIGHT. When the switch is in the LANDING LIGHTS position, both lights are on. In the TAXI LIGHT position, only one light is on.

COCKPIT LIGHTING.

Cockpit lighting is provided by individual red instrument lights and shields; a portable penlite (21, figure 1-8) is mounted on the right-hand side of the cockpit.

NAVIGATION LIGHTS.

Conventional navigation lights are installed on each wing tip and on the empennage. When 230-gallon (centerline) tip tanks are installed, navigation lights on each tip tank replace the normal wing tip light. If the navigation lights are on, an automatic switching arrangement is provided to turn on the normal lights if the tanks are dropped. The navigation light switch (20, figure 1-8) is located on the right shelf. The lights are turned on or off, or connected through the flasher by the switch. The lights are flashed by a C-2 flasher and cannot be coded. Brilliance is controlled by the BRIGHT-DIM switch.

FUSELAGE LIGHTS.

A 6-watt fuselage light is installed on the top of the fuselage. The fuselage lights may be dimmed, but not flashed. The fuselage light switch (11, figure 1-8), located on the right shelf, has three positions, DIM, OFF (center), and BRIGHT.

OXYGEN SYSTEM.

A pressure oxygen system consisting of four type D-2 and two type F-1 oxygen cylinders is installed in the aircraft. Two type D-2 cylinders are installed in each wing and the two type F-1 cylinders are installed in

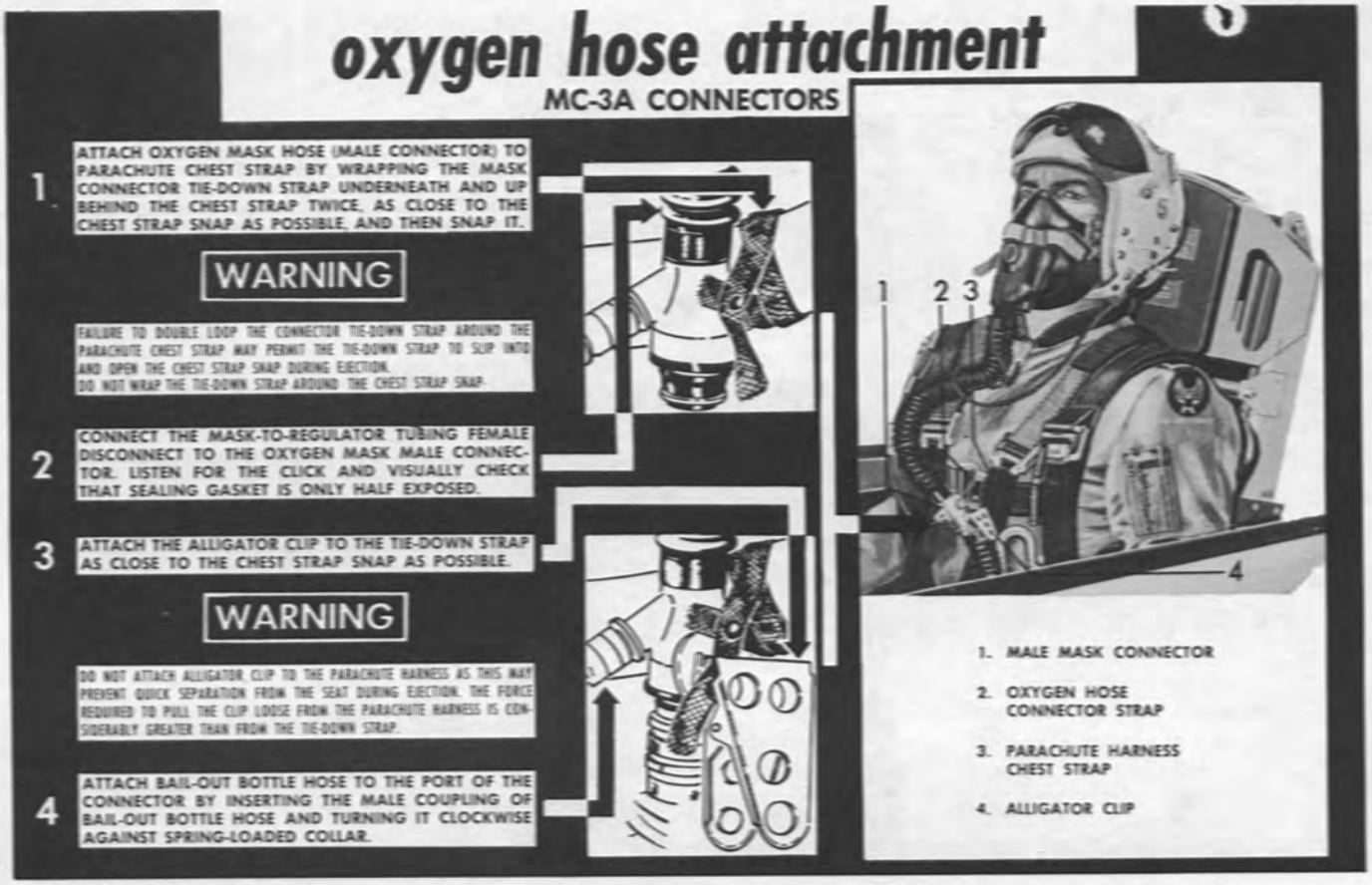

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Figure 4-9

the fuselage nose. The system may be refilled through a single filler valve (33, figure 1-2) located in the engine air intake duct on the left side of the fuselage. The oxygen pressure gage (2, figure 1-6) and flow indicator (1, figure 1-6) are located on the lower left side of the instrument panel in the cockpit. The type A-14 pressure-breathing, diluter-demand oxygen regulator is located on the inboard side of the left shelf of the cockpit floor. Only a pressure breathing demand oxygen mask should be used.

Note

As an aircraft ascends to high altitudes, where the temperature is normally quite low, the oxygen cylinders become chilled. As the cylinders grow colder, the oxygen gage pressure is reduced, sometimes rather rapidly. With a 100° F decrease in temperature in the cylinders the gage pressure can be expected to drop 20%. This rapid fall in pressure is occasionally a cause for unnecessary alarm. All the oxygen is still there and as the aircraft descends to warmer altitudes, the pressure will increase. A rapid fall in oxygen pressure while the aircraft is in level flight, or while it is descending, is not ordinarily due to falling temperature, of course. When this happens, leakage or loss of oxygen must be suspected.

OXYGEN HOSE HOOKUP.

Proper attachment of the oxygen mask connecter is extremely important to ensure that:

a. The oxygen hose does not become accidentally disconnected during flight, resulting in loss of oxygen supply.

b. The oxygen hose does not prevent quick separation from the seat during an ejection.

F22-C-4-10

Figure 4-10

c. The oxygen hose does not flail during an ejection, causing injury.

d. When using the MC-3A connector, the tiedown strap does not accidentally open the parachute chest strap snap during ejection.

MC-3A Connector.

(See figure 4-9.)

The following procedures shall be followed in hooking up the oxygen supply system through the MC-3A connector and for the proper attachment of the tiedown strap:

1. Attach oxygen mask (male connector) to parachute chest strap by wrapping the mask connector tiedown strap underneath and up behind the chest strap twice, as close to the chest-strap snap as possible, and then snap it.

WARNING

- Failure to double-loop the connector tiedown strap around the parachute chest strap may permit the tiedown strap to slip into and open the chest-strap snap during ejection.
- Do not wrap the tiedown strap around the chest-strap snap.

2. Connect the mask-to-regulator tubing female disconnect to the oxygen mask male connector. Listen for the click and visually check that sealing gasket is only half exposed.

3. Attach the alligator clip to the tiedown strap as close to the chest strap as possible.

WARNING

Do not attach alligator clip to the parachute harness as this may prevent quick separation from the seat during ejection. The force required to pull the clip loose from the parachute harness is considerably greater than from the tiedown strap.

oxygen duration—hours

CABIN ALTITUDE FEET	GAGE PRESSURE—P.S.I. 400	350	300	250	200	150	100	BELOW 100
40,000	11.2 11.2	9.6 9.6	8.0 8.0	6.4 6.4	4.8 4.8	3.2 3.2	1.6 1.6	DESCEND TO BELOW 10,000 FEET
35,000	11.2 11.2	9.6 9.6	8.0 8.0	6.4 6.4	4.8 4.8	3.2 3.2	1.6 1.6	
30,000	8.5 8.5	7.2 7.2	5.9 5.9	4.8 4.8	3.7 3.7	2.4 2.4	1.3 1.3	
25,000	6.7 8.0	5.9 6.9	4.8 5.6	3.7 4.5	2.9 3.5	1.9 2.4	1.1 1.1	
20,000	5.3 9.1	4.5 7.7	4.0 6.4	3.2 5.1	2.4 3.7	1.6 2.7	0.8 1.3	
15,000	4.3 10.9	3.7 9.3	2.9 7.7	2.4 6.1	1.9 4.8	1.3 3.2	0.5 1.6	
10,000	3.7 14.1	3.2 12.5	2.7 10.4	2.1 8.3	1.6 6.1	1.1 4.3	0.5 2.1	

UPPER FIGURES INDICATE 100%

LOWER FIGURES INDICATE NORMAL

4 TYPE D-2 CYLINDERS

2 TYPE F-1 CYLINDERS

F-22-8-4-10

Figure 4-11

4. Attach bailout bottle hose to the port of the connector by inserting the male coupling of bailout bottle hose and turning it clockwise against the spring-loaded collar.

CRU-8/P Connector.
(See figure 4-10.)

The following procedures shall be followed in hooking up the oxygen supply system through the CRU-8/P connector:

1. Insert connector into the mounting plate attached to the parachute harness. Check that the connector is firmly attached and that the lockpin is locked.

2. Insert male bayonet connector, on the end of the oxygen mask hose, into the female receiving port of the CRU-8/P connector. Turn bayonet connector to lock prongs into the recess in the lip of receiving port.

3. Couple the seat oxygen hose to the lower port of the connector.

4. Snap the strap attached to the seat oxygen hose onto the CRU-8/P connector.

WARNING

The CRU-8/P system should not have an alligator clip on the seat hose. If clip is installed, the clip shall not be used.

5. Attach the bailout bottle hose to the swiveling port of the connector by inserting the male coupling of the bailout bottle hose and turning it clockwise against the spring-loaded collar.

OXYGEN DURATION.

Refer to figure 4-11 for oxygen duration during flight. Note that at altitudes above 30,000 feet oxygen duration is the same regardless of the position of the diluter lever.

OXYGEN SYSTEM PREFLIGHT CHECK.

Refer to Section II for the oxygen system preflight check; in addition, check before takeoff that there is NOT LESS

THAN 400 PSI PRESSURE IN THE SYSTEM. If the pressure is less than 400 psi, the oxygen system will be charged to capacity prior to flight. The oxygen system pressure should be checked upon the completion of each mission and an entry made in Form 781 if the pressure is below 50 psi.

WARNING

Do not allow the oxygen supply to be completely exhausted. An empty oxygen system will allow moisture to enter the system which may cause freezing of the equipment or obstruction of the system during low-temperature operations. On aircraft that have returned from missions with the oxygen system pressure below 50 psi, the system must be refilled within a period of 2 hours after the airplane lands. If the oxygen system is not filled within 2 hours after the aircraft lands, it will be necessary to purge the system. If the oxygen cylinder pressure drops below 50 psi the system must be purged.

NORMAL OPERATION.

The diluter lever of the oxygen regulator should always be set at the NORMAL OXYGEN position except under emergency conditions. The pressure dial of the oxygen regulator should be set as follows:

1. For cabin altitudes below 30,000 feet, leave dial at NORMAL OXYGEN position.

2. For cabin altitudes between 30,000 and 40,000 feet, set the pressure dial at SAFETY position.

3. For cabin altitudes above 40,000 feet, set the pressure dial to the cabin altitude.

EMERGENCY OPERATION.

With symptoms of the onset of hypoxia, set the diluter lever to 100% OXYGEN and SAFETY dial setting. If the oxygen regulator becomes inoperative, pull the cord of the H-2 emergency oxygen cylinder and descend immediately to an altitude at which oxygen is not required. If smoke or fuel fumes should enter the cabin, proceed as follows:

1. Set oxygen regulator diluter lever to 100% OXYGEN position.

2. If pressure oxygen is desired, set pressure dial of oxygen regulator as required by cabin altitude.

NAVIGATION EQUIPMENT.

J-2 COMPASS SYSTEM.

The J-2 compass system consists of a directional indicator (10, figure 1-6) electrically slaved to a magnetic fluxvalve located in the tail section. The compass system receives ac power from the inverters and dc power through the inverter relay; it operates whenever the aircraft electrical system is energized. Approximately 3 minutes are required for the leveling and torque units to slave the gyro to the fluxvalve after the system is energized.

Note

The slave gyro system of the J-2 compass may occasionally become 90 or 180 degrees out of phase. Periodic cross-checking with the standby magnetic directional indicator is considered good technique.

J-2 GYRO COMPASS LIMITATIONS.

Gyro.

The gyro in the directional gyro control unit is free to operate within 85 degrees (when using either the Type S-1 or S-3 directional gyro control) and 80 degrees (when using the Type S-3A directional gyro control) of level flight in normal dive and climb, and in normal right and left bank. At the limits, it strikes mechanical stops which render the indications on the directional gyro control and the settable dial indicator inaccurate. After return to level flight, errors up to 5 degrees in heading may be introduced, but the gyro will recover its erect and slaved positions automatically in a period of 5 minutes or less, and thereafter will again resume

correct indication until the limits are once again exceeded. Abnormal acrobatic maneuvers, especially those of a complex and sustained nature, may result in heading errors of more than 5 degrees. The gyro will nevertheless automatically recover its erect and slaved positions at a rate of 1 to 3 degrees per minute.

Transmitter.

The fluxvalve unit of the remote compass transmitter remains pendulous through 30 degrees on both sides of the vertical in pitch and roll. When these limits are exceeded a "spider" picks up the vertical component of earth's field which distorts its sensing and thus gives false signals. Restoration of the aircraft to an attitude within these limits renders the fluxvalve unit pendulous again, and it automatically resumes correct sensing.

Directional Indicator Fast-Slaving Pushbutton.

On later aircraft a momentary-type, fast-slaving pushbutton (3, figure 1-6) is installed on the cockpit instrument panel. It provides a method of rapidly slaving the gyro if it should tumble or get out of phase with the flux gate valve because of acrobatic maneuvers. The gyro will automatically slave at a rate of 3 to 5 degrees per minute; however, with the use of the fast-slaving pushbutton the slaving rate is as high as 80 degrees per minute. Momentarily pushing the fast-slaving pushbutton interrupts dc power to the gyro mechanism and starts the fast-slaving cycle as in initial starting. The fast-slaving cycle continues for approximately 3 minutes regardless of the amount of error to be corrected. Therefore, since it is imperative that both airspeed and heading remain constant while the gyro mechanism is in fast slave, it is recommended that the fast-slaving pushbutton not be used for directional indicator errors less than 10 degrees. This is so because the automatic slaving feature of the gyro mechanism will correct them within the 3-minute period without the necessity of maintaining constant heading and airspeed.

CAUTION

Because the fast-slaving mechanism employs a thermal switch the fast-slave pushbutton is placarded against use more than once in 10 minutes. More frequent use will cause damage to the erection mechanism.

STANDBY MAGNETIC DIRECTIONAL INDICATOR.

The standby magnetic directional indicator (compass), located above the instrument panel on the windshield in the cockpit, is a standard-type magnetic compass to be used as a check on the operation of the electrically operated compass system or in the event of an emergency.

Note

Whenever the heater blower is operating, the compass may be as much as 10° in error in addition to the error shown on the correction card. This error is caused by the magnetic field being disturbed by the electrical impulses generated by the heater blower.

ASSISTED TAKEOFF SYSTEM.

Provisions are included for mounting two ATO (assisted takeoff) units on the bottom of the fuselage. They add about 1000 pounds of thrust each for approximately 12 seconds, and materially improve the takeoff performance. If ATO units are installed they must be used on the first takeoff or jettisoned, because they will not be safe after being subjected to the low temperatures encountered at altitude.

JATO Arming Switch.

A two-position, dc-powered JATO arming switch, labeled ARM and SAFE, is located on the cockpit instrument panel (34, figure 1-6). In the ARM position it energizes the JATO firing button and the red JATO READY indicator light on the instrument panel. When in the SAFE position, the JATO firing circuit is inoperative and the indicator light is out.

JATO Firing Button.

A JATO firing button (17, figure 1-7) is located on the left console of the cockpit. Depressing the button will fire the ATO units provided the JATO arming switch is in the ARM position.

JATO Jettison Handle.

The ATO units may be jettisoned mechanically by pulling the manual release handle (22, figure 1-7) located on the left side in the cockpit.

JATO Ready Indicator Light.

A JATO ready indicator light (35, figure 1-6) is located on the instrument panel. It glows when the ATO firing circuit is armed and ready for firing.

EXTERNAL STORES.

Midwing pylons can be installed from which chemical tanks, bomb clusters, or bombs of various sizes may be installed. The following controls are provided for normal or emergency bomb and chemical tank release.

Bomb Arming Switch.

The bomb arming switch (1, figure 1-7) located on the left console has two positions, NOSE AND TAIL and TAIL ONLY. It is used to arm the fuse in the bomb prior to release. The position used depends upon how the bomb is fused. The chemical tank circuit is wired through this switch so that when in the NOSE and TAIL position the chemical tanks can be operated simultaneously.

Bomb Selector Switch.

The bomb selector switch, located on the left console (1, figure 1-7), has three positions, ALL, OFF, and TRAIN. In the ALL position the bombs are dropped simultaneously. The TRAIN position is used to drop the bombs individually.

Chemical Tank Selector Switch.

The chemical tank selector switch (30, figure 1-7) is located on the left console. It has three positions, LEFT RIGHT, and OFF; it is used to select individual chemical tank operation.

Bomb or Tank Salvo Switch.

A bomb or tank salvo button (50, figure 1-6), located on the instrument panel, is provided to permit simultaneous release of external load in an emergency. The button is directly connected to the battery and is always energized.

OPERATION OF EXTERNAL STORES CONTROLS.

To arm the bombs, operate the bomb arming switch to the TAIL ONLY or NOSE AND TAIL position. To drop the bombs individually, place the bomb selector switch in the TRAIN position and press the bomb release button on the control stick grip. The left bomb will drop first; the right bomb will drop the next time the bomb release button is pressed. To drop both bombs simultaneously, place the bomb selector switch in the ALL position and press the bomb release button.

CAUTION

Operate arming switches to OFF as soon as possible following the release of bombs to preclude the possibility of the arming wire being retained in the rack, where the resultant whipping action of the wire may damage the skin of the aircraft.

To operate the chemical tanks individually, place the chemical tank selector switch in the LEFT or RIGHT position and press the bomb release button on the control stick. To operate the chemical tanks simultaneously, place the bomb arming switch in the NOSE AND TAIL position and press the bomb release button on the control stick. To jettison the chemical tanks follow the same procedure given for bombs.

TOWING TARGETS.

Either the fuselage-type, bomb pylon, or the JATO latch-type installation may be used. With these installations a banner-type A-6B or A25B target is used. Use the following procedure:

Note

Increase takeoff distances approximately 20 percent above those given in the Appendix.

1. Lay the tow cable out on the ground in a straight line behind the aircraft.

Note

If the tow cable is laid out in a 180-degree "U" position the target may be damaged by the violent snatch as the aircraft reaches the end of the tow cable.

CAUTION

- If takeoff is other than in the center of the runway, be sure the weighted end of the target bar is toward the center of the runway to prevent target drifting off the near side of the runway and snagging or causing damage to runway lights.
- On two-target installations that are not attached to the centerline of the aircraft, yaw must be anticipated toward the side on which the target is attached.

2. Use 100-percent power and 30 degrees (70 percent) flaps, roll straight down the runway.

3. At 95 knots IAS apply back pressure to lighten the weight on the nose gear.

4. The aircraft will break ground at 120 knots IAS with no external tanks and 125 knots IAS with 165 gallons of fuel in tip tanks.

WARNING

Allow the aircraft to fly off the ground in a normal takeoff attitude. Do not pull the aircraft off the runway.

5. When 40–50 feet above the ground, operate the landing gear lever to UP and smoothly establish a climb speed of 130 knots IAS.

WARNING

During any emergency, jettison the target immediately.

6. When 1000 feet above the ground, milk up the flaps.

CAUTION

Anticipate nose-up pitch change.

7. Allow the airspeed to build up smoothly to 165 knots until reaching 15,000 feet; above 15,000 feet, the airspeed must be decreased slightly (145–165 knots IAS) to maintain rate of climb.

Note

- Use 100-percent power during entire climb.
- Since the aircraft with a target in tow will not climb well during turns above 15,000 feet, it is important to plan the climb to altitude and firing area using a minimum number of turns.

8. Do not exceed 165 knots IAS during firing period or descent.

9. At the end of the mission, release the target where directed at approximately 160 to 165 knots IAS.

10. If the target fails to release, use a slightly steeper final approach and maintain 130 knots IAS throughout final approach.

CAUTION

If a landing must be made with the target in tow, touch down at a slightly higher than normal airspeed because the aircraft will decelerate very rapidly as the target contacts the ground. Touchdown should be far enough down the runway to prevent having the target hit the approach lights or barrier.

FRANGIBLE TOW TARGET SYSTEMS.

For the MA-3 or RMU/1 frangible tow target systems refer to the applicable 43E14 series technical orders.

PHOTOGRAPHIC EQUIPMENT.

The photographic equipment is installed in the nose section which is divided into three camera bays, forward, middle, and aft. A camera junction box containing an intervalometer selector switch, circuit breakers, and fuses is mounted on top of the battery rack. A thermostatic control is installed on the lower right side of the battery rack which closes when the temperature in the camera

compartment rises to 90°F (32.2°C), completing the circuit which lights the camera bay warning light on the instrument panel. A camera control box, mounted on the top center section of the instrument panel, incorporates all the controls for operation of the cameras and the intervalometers, except the A-18 film magazine. Three intervalometers are mounted on the instrument panel to control the time interval between film exposures during automatic camera operation. A control box for the A-18 film magazine is located on the right console. The following standard camera equipment installation provides photographic coverage:

Forward Bay (forward oblique position)—one K-22A camera with a 12-inch lens cone and A-5A magazine.

Middle Bay (capable of accommodating right and left oblique positions simultaneously)—two K-17C cameras, each with a 6-inch lens cone and A-5A magazine.

Aft Bay (vertical position)—one K-38 camera with 24-inch lens cone and A-8B magazine.

The following camera equipment substitutions for the above configuration are possible without modification of the camera racks.

Camera Section	No.	Cameras	Lens Cone	Magazine	Position
Forward Bay	1	K-17C	6 in.	A-5A	Vertical
	1	K-17C	6 in.	A-18	Vertical
	1	K-22A	24 in.	A-5A	Oblique
Middle Bay	1	K-22A	12 in.	A-5A	Vertical
	1	K-22A	24 in.	A-5A	Vertical
Aft Bay	1	K-22A	24 in.	A-5A or A-9B	Vertical
	1	K-38	36 in.	A-8B	Vertical

Camera Power Switch.

The camera power switch (16, figure 1-6), located on the camera control box, has two positions, ON and OFF. The ON position energizes the entire camera electrical system.

Camera Temperature Control Switch.

The camera temperature control switch (14, figure 1-6), located on the camera control box, has two positions, HOT and COLD. This switch is used in conjunction with a thermostat to control the temperature of the camera bays.

Camera Heat Shutoff Valve.

The camera heat shutoff valve is electrically controlled by the camera temperature control switch on the pilot's instrument panel. When the switch is in the HOT position the valve opens and allows hot air from the engine compressor to enter the camera bays. When the switch is in the COLD position the valve is closed, shutting off the hot air flow.

Runaway Switch.

The runway switch (12, figure 1-6) has two positions, ON and OFF. OFF is the normal position. In the ON position the cameras operate continuously provided the respective camera control switches are in the MAN position.

Camera Control Switches.

The three camera control switches (17, figure 1-6), located on the camera control box, have three positions, INT, OFF, and MAN and are placarded FWD, MIDDLE, and AFT to designate the cameras they control. When the switches are in the INT position the cameras operate automatically according to the time interval at which the intervalometers are set. The MAN position allows the pilot to operate the cameras with the runaway switch or with the trigger switch on the stick grip.

Camera Vacuum Ejection System.

The camera vacuum ejection system incorporates engine compressor air passing through a venturi to create the vacuum necessary to hold the film on the plate during camera operation. Relief valves are incorporated in the system to prevent excessive vacuum at the cameras. The system is completely automatic and requires no controls.

Intervalometers.

The three intervalometers (20, figure 1-6), located on the right side of the instrument panel are placarded FWD, MID, and AFT and designate the respective cameras. They are calibrated in increments of ½ second from 0 to 60 with an OFF position at the extreme end

intervalometer selector switch

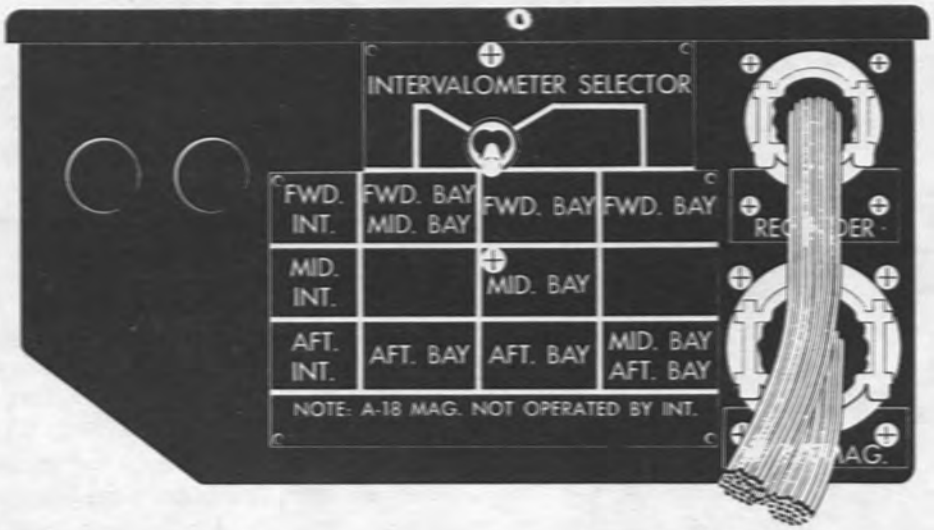

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Figure 4-12

of counterclockwise rotation. The OFF position is used to stop the intervalometers during automatic camera operation if it is desired to change or reset the time interval.

Intervalometer Selector Switch.

The camera intervalometer selector switch, located in the nose section on the left side of the camera junction box (figure 4-12), has positions at 2-, 6-, and 10-o'clock. The 2-o'clock position allows the forward intervalometer to operate the forward bay camera and the aft intervalometer to operate both middle and aft bay cameras. The 6-o'clock (normal) position permits the forward intervalometer to operate the forward bay camera, the middle intervalometer to operate the middle bay cameras, and the aft intervalometer to operate the aft bay camera. The 10-o'clock position allows the forward intervalometer to operate both forward and middle bay cameras and the aft intervalometer to operate the aft bay camera. The intervalometer selector switch must be set to the desired position prior to takeoff since the pilot does not have access to it during flight.

Outside Air Temperature and Camera Compartment Air Temperature Indicator.

An outside air temperature and a camera compartment air temperature indicator are combined in one instrument. This instrument (52, figure 1-6) is located on the left side of the lower instrument panel. The left-hand needle indicates the temperature of the air in the camera bays, while the right-hand needle indicates the outside air temperature. The outside air temperature sensing head (34, figure 1-2) is located on the left nosewheel door panel.

Camera Bay Overheat Warning Light.

The camera bay overheat warning light (13, figure 1-6), located above the camera temperature control switch, lights white whenever the camera bays become too hot. The pilot may then exercise control of the camera compartment heat by turning the camera temperature control switch to the COLD position.

Camera Power Indicator Light.

The camera power amber indicator light (15, figure 1-6), located above the camera power switch, lights when the camera power switch is ON.

C-4 control box

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1. KNURLED KNOB
2. LUBBER LINE
3. ALTITUDE AND GROUND SPEED ADJUSTMENT KNOB
4. CAMERA SWITCH
5. POWER SWITCH
6. SYNCHRONIZING ANGLE ADJUSTMENT SCREW
7. FOCAL LENGTH ADJUSTMENT KNOB
8. MOVABLE POINTER

Figure 4-13

Film Winding Indicator Lights.

The film winding indicator lights (17, figure 1-6), located on the camera control box, are green blinker lights. They flash intermittently when the film is being wound.

Film Exposure Counters.

The film exposure counters (39, figure 1-6) indicate the number of exposures remaining each time an exposure is made. The counter dial must be set to read the correct number of exposures each time the film magazines are loaded. (The counters are not used with the A-18 magazine.)

A-18 MAGAZINE.

The A-18 rollfilm image motion compensating aircraft camera magazine and the C-4 remote control box are installed in this aircraft to be used with the K-17C aerial camera mounted in the forward camera bay. The magazine uses a 400-foot film spool with 485 exposures and is independently controlled by the C-4 control box (17, figure 1-8 and figure 4-13) located on the right console.

C-4 CONTROL BOX.

The C-4 control box (figure 4-13) incorporates a computer consisting of an altitude dial, a groundspeed dial, a filmspeed dial, a focal-length dial, and three synchronizing angle adjustment screws. When the computer is correctly adjusted for these factors, the proper film speed is automatically attained since it is a function of groundspeed, altitude, focal length, and the synchronizing angle.

Operating Range.

A knurled knob (1, figure 4-13) turns an altitude range cylinder assembly to determine operating ranges for various focal-length lenses in terms of altitude and groundspeed.

Synchronizing Angle Adjustment Screws.

Three synchronizing angle adjustment screws (6, figure 4-13) hold the altitude dial in place. By loosening them, the altitude dial can be rotated to set the lubber line (2, figure 1-13) to the correct degrees from vertical at which the camera is mounted. This adjustment must be made before flight.

Altitude and Groundspeed Adjustment Knob.

The altitude and groundspeed adjustment knob (3, figure 4-13) is used to rotate the groundspeed dial to aline the correct groundspeed with the actual altitude on the fixed altitude dial.

Focal-Length Adjustment Knob.

The focal-length adjustment knob (7, figure 4-13) rotates the lubber line of the center focal-length dial to aline it with the proposed groundspeed on the groundspeed dial.

Power Switch.

The power switch (5, figure 4-13) applies power to the magazine amplifier and motor, and must be turned on at least 3 minutes before turning the camera switch ON.

Camera Switch.

The camera switch (4, figure 4-13) energizes the magnetic clutch which starts the film in motion. The switch is turned ON when ready to start exposures, allowing the magazine to cycle at the correct frequency for the settings on the computer.

Film Transport Light.

The green film transport light illuminates when the camera switch is turned ON to indicate that the film is in motion.

Synchronization Light.

The amber synchronization light flickers or blinks during camera operation to indicate that the filmspeed is in synchronization with groundspeed, altitude, focal length, and angle of obliquity.

Exposure Counter.

The exposure counter indicates the approximate number of exposures remaining in the magazine after each picture is taken. The exposure counter must be set before each flight.

OPERATION OF THE CAMERA CONTROLS.

The camera equipment may be operated either manually or automatically. It is possible to operate individual units manually while other units are operating automatically, or vice versa, depending upon the position of the individual camera selector switches.

Manual Operation.

To operate the cameras manually, proceed as follows:

1. Turn the camera power switch ON; check illumination of the amber camera power indicator light.

2. Move the camera temperature control switch to the HOT position.

3. Set the individual camera selector switches in the MAN position.

4. Operate the cameras manually by pressing the gun trigger switch on the control-stick grip or by placing the runaway switch in the ON position.

Automatic Operation.

To operate the cameras automatically, proceed as follows:

1. Turn the camera power switch ON; check illumination of the amber camera power indicator light.

2. Move the camera temperature control switch to the HOT position.

3. Set the desired time interval between exposures on the respective intervalometers.

4. Operate the individual camera selector switches to the INT position.

MISCELLANEOUS EQUIPMENT.

PITOT HEAT.

Pitot Heat Switch. The pitot heater is controlled by the pitot heat switch (5, figure 1-8), located on the right side forward panel.

ANTI-G SUIT VALVE.

An anti-G suit valve is installed on the left side of the cockpit at floor level. The valve receives air under pressure from the engine compressor and automatically meters it to the pneumatic suit during positive-G accelerations. At the high setting, suit pressurization begins at approximately 1.75 G and increases at the rate of 1.4 psi per G. At the low setting, suit pressurization begins at approximately 1.75 G and increases at the rate of one psi per G. A button on top of the valve can be manually depressed to inflate or check the suit momentarily, when desired. This feature may be used to massage the body and thus lessen fatigue on a long flight. The suit is connected to the valve through a quick-disconnect fitting attached to the seat.

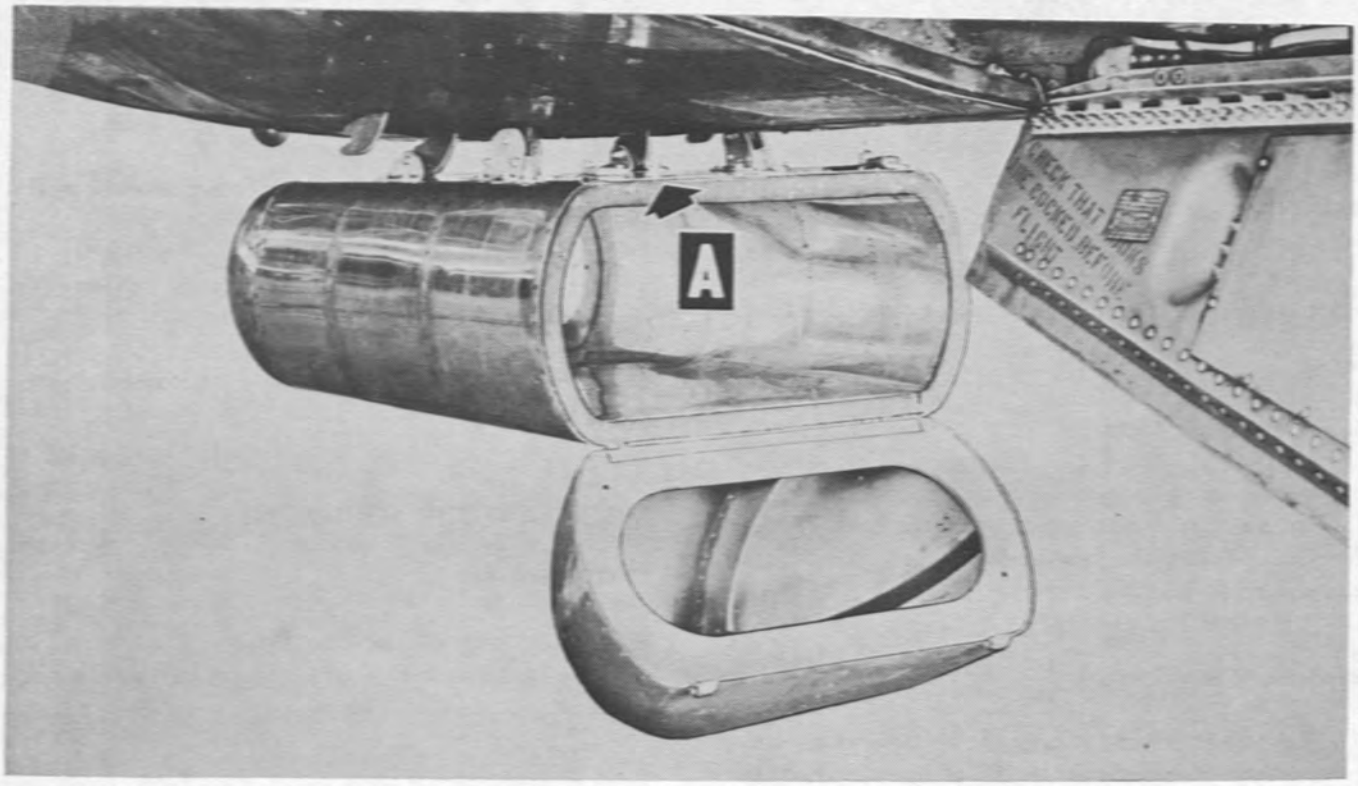
MAP CASE.

The map case is installed in the right side panel of the cockpit. It is hinged at the bottom and is pulled out from the top. Be sure it is out of the way of the canopy jettison handle.

DATA CASE.

The standard size data case is installed under the camera compartment hood in the nose section.

Travel Pod



F22-C-4-14

DETAIL A

Figure 4-14

TRAVEL POD.

The travel pod is a nonjettisonable, streamlined, watertight metal case provided to carry clothing or personal equipment on long cross-country or administrative missions. It is designed to carry 100 pounds maximum, 10 pounds of which may be stored in the forward section of the travel pod. The travel pod is mounted on the JATO hooks underneath the aircraft. (See figure 4-14.)

The top of the travel pod is stenciled to show the support bracket adjustment. (Refer to the Appendix for aircraft performance with travel pod attached.)

CAUTION

Do not store high-density material in the forward section or the pod may be damaged.

Section V – OPERATING LIMITATIONS

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OPERATING LIMITATIONS.

Operating limitations are derived from extensive flight testing and operational experience to ensure your safety and to help obtain maximum utility from the equipment. The instrument dials are marked as shown on figure 5-1 as a constant reminder of airspeed and engine limitations; however, additional limitations on operational procedures, acrobatics, and aircraft loading are given in the following paragraphs.

INSTRUMENT MARKINGS.

Cognizance must be taken of the instrument markings as shown on figure 5-1, since they represent limitations that are not necessarily repeated elsewhere.

GENERAL FLIGHT RESTRICTIONS.

a. Never unlock the canopy in flight.

b. Do not attempt to land with one heavy tip tank if lateral control cannot be maintained at 150 knots IAS or less.

230-GALLON TIP TANKS.

Do not jettison 230-gallon tip tanks at a speed higher than 390 knots IAS except in an extreme emergency.

MIDWING PYLON STORES.

The midwing pylon stores table indicates the maximum recommended speeds for the stores listed when carried on the underwing bomb pylon.

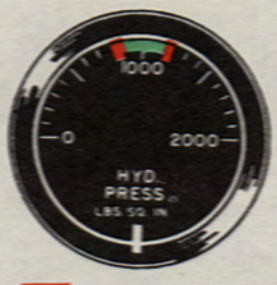
MIDWING PYLON STORES

STORE	MAX SUSTAINED SPEED (KNOTS IAS)	MAX SUSTAINED MACH NO.	MAX DROP SPEED (KNOTS IAS)
BOWSER 100 GAL NAPALM BOMB	390	0.70	435*
1000 LB GP BOMB	460	0.79	UNDETERMINED
500 LB GP BOMB	460	0.79	UNDETERMINED
750 LB EXTERNAL FIRE BOMB	460	0.79	460
E-51 FIRE BOMB	460	0.79	460

* When aircraft is accelerated to maximum drop speed, buffeting is very severe above 390 knots IAS.

instrument markings

HYDRAULIC PRESSURE



- 850 MINIMUM
- 850 TO 1200 NORMAL (steady-state operation approximately 1075 psi)
- 1200 MAXIMUM

FUEL PRESSURE

- 38 psi – MINIMUM
- 38 – 180 psi – NORMAL
- 180 psi – MAXIMUM

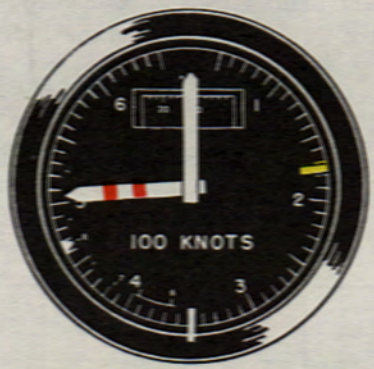
Note

If nickel-cadmium batteries are installed, the load meter may indicate +1.25 momentarily during initial runup.

LOADMETER

+0.6 Maximum Continuous
(Equals 240-amp Load)

AIRSPEED-KNOTS



- 175 KNOTS – MAXIMUM WING FLAPS EXTENDED
  (195 KNOTS – MAXIMUM LANDING GEAR EXTENDED)
  190 KNOTS – MAXIMUM FOR UP TO 50% WING FLAP EXTENSION

THE RED AND WHITE POINTER WILL MOVE TO INDICATE THE LIMITING STRUCTURAL AIR SPEED OF 505 KNOTS, OR THE AIRSPEED REPRESENTING THE LIMITING MACH NUMBER OF .8, WHICHEVER IS LESS

F22-C-5-1 (1)

Figure 5-1 Sheet 1

instrument markings

OIL PRESSURE

- 7 psi – MINIMUM DURING FLIGHT (MINIMUM OF 2 psi MAY BE EXPECTED WHEN ENGINE IS IDLING)
- 7–50 psi – CONTINUOUS OPERATION
- 50 psi – MAXIMUM (AT SEA LEVEL)
- 100 psi – MAXIMUM ALLOWANCE DURING WARM-UP
- ± 3 psi – FLUCTUATION TOLERANCE

ACCELEROMETER

- +7.33 G MAXIMUM WITH CENTERLINE TIP TANKS CONTAINING ANY AMOUNT OF FUEL
- −3 G MAXIMUM WITH CENTERLINE TIP TANKS CONTAINING ANY AMOUNT OF FUEL

BASED ON
MIL-F-5624 (JP-4) FUEL
ALTERNATE MIL-F-5572
(GASOLINE) LOWEST GRADE
AVAILABLE

EXHAUST GAS TEMPERATURE

- 275° – 715°C – CONTINUOUS OPERATION
- 715°C – MAXIMUM FOR FLIGHT
- 900°C – MAXIMUM FOR STARTING
- 625°C – MINIMUM FOR TAKE-OFF AT 100% RPM

TACHOMETER

- 85–96% rpm – BEST CRUISING
- 100% rpm – MAXIMUM

F22-C-5-1 (2)

Figure 5-1 Sheet 2

TIP-TANK SHACKLE LOADS.

Only the following items may be carried on the wing tip shackles:

1. Practice bombs, 100 pound M38A2.

2. General purpose bombs, 500-pound type AN-M64A1, modified.

3. General purpose bombs, 1000-pound type AN-M64A1, modified.

4. MK47 practice bomb racks only when aircraft and bomb racks are modified.

5. Tip tanks (165 gallon) with the following restrictions:

a. 5.33 G will not be exceeded in pullups nor will –2 G be exceeded in nose-down or inverted flight maneuvers.

b. Extreme caution will be exercised in a rolling maneuver. The roll should be slow and not exceed a full roll in 8 seconds. Rolling maneuvers induce high loads in the tank and these are multiplied five times to the bomb shackle. It is possible to overstress the bomb shackles by loads developed during rapid maneuvers.

BOMB RACKS.

Whenever any of the following conditions are encountered with more than 1000 pounds suspended from type S-2, S-2A, M9-4, or MA-4A bomb racks, or more than 2000 pounds suspended from type S-3 bomb racks, make appropriate entry in Form 781.

1. The aircraft exceeds 90 degrees per second rate of roll.

2. The aircraft exceeds 4.5 G.

3. Any unusual incident occurs in flight or during ground operations (such as rough taxiing or a hard landing) which could cause damage to any part of the racks.

ENGINE LIMITATIONS.

MAXIMUM ENGINE SPEEDS.

The maximum permissible continuous inflight engine speed is 100% rpm. Engine ground operation above 85% rpm shall be limited to 1 minute. The Engine Speed Limits table indicates engine overspeed limitations and remedial action.

ENGINE SPEED LIMITS

Normal ground setting .....100%-101% (11,750-11,870 rpm)
Ground idle setting .....34%-35% (4000-4125 rpm)

Speed	Action
Over 105% (12,340 rpm)	Remove engine for overhaul
Over 101.5% (11,925 rpm) for more than 15 seconds	Inspect the turbine wheel (refer to T.O. 2J-J33-12)
Over 101.5% (11,925 rpm) for less than 15 seconds	Make a preflight inspection
Between 101.5% and 105% (11,925 and 12,340 rpm)	Inspect turbine wheel Correct the cause of overspeeding before further flight

Note

During takeoff, any value between 100% and 101% rpm is acceptable. Refer to Section IX for cold or hot weather takeoffs.

ENGINE TEMPERATURE LIMITS.

The exhaust gas temperature range for continuous operation is 275° to 715° C. It is, however, acceptable for the exhaust temperature of the engine to exceed 715°C during inflight accelerations and ground start accelerations, under the conditions indicated in the Starting and Acceleration Overtemperature Limits table below. During a ground start if the exhaust gas temperature (EGT) exceeds 900°C (1652°F), the engine should be shut down and appropriate entry made in Form 781. The minimum EGT for takeoff is 625°C.

STARTING AND ACCELERATION OVERTEMPERATURE LIMITS

Exhaust Gas Temperature	Time	Action Required
900°-999°C (1625°-1830°F)	5 seconds	*Inspect turbine wheel (Refer to T.O. 2J-J33-12)
Reaches 1000°C(1832°F)		*Inspect turbine wheel (Refer to T.O. 2J-J33-12)

*Record each overtemperature, its duration, and its possible cause in Form 781. Take remedial action if two successive overtemperatures occur.

TABLE OF PROHIBITED MANEUVERS

CONFIGURATION	MANEUVER				
	INTENTIONAL STALLS (Any Configuration)	SIDESLIPS OR YAW	INTENTIONAL ERECT SPINS (Clean Configuration)	INTENTIONAL ERECT SPINS (Gear and Flaps Down)	INTENTIONAL INVERTED SPINS
Tip tanks installed but empty	No restriction if completed above 15,000 feet	No restriction except do not use full rudder	No restriction if started above 20,000 feet	PROHIBITED	
Tip tanks removed	Same as above	Same as above	Prohibited		
Tip tanks installed with fuel	Prohibited	Permissible only in emergency	Prohibited		
External pylon and JATO hook stores except travel pod	Prohibited	Prohibited	Prohibited		
Travel pod	No restriction if completed above 15,000 feet	No restriction except do not use full rudder	Prohibited		
Wing pylons only	Permissible only for flight test purposes	Permissible only in emergency	Prohibited		

Note

The minimum EGT varies considerably in various engine and aircraft combinations; therefore, the acceleration check prior to becoming airborne must be used to make certain that full power is available for takeoff.

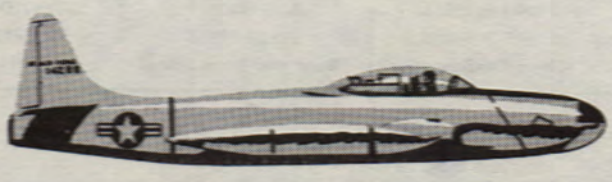
PROHIBITED MANEUVERS.

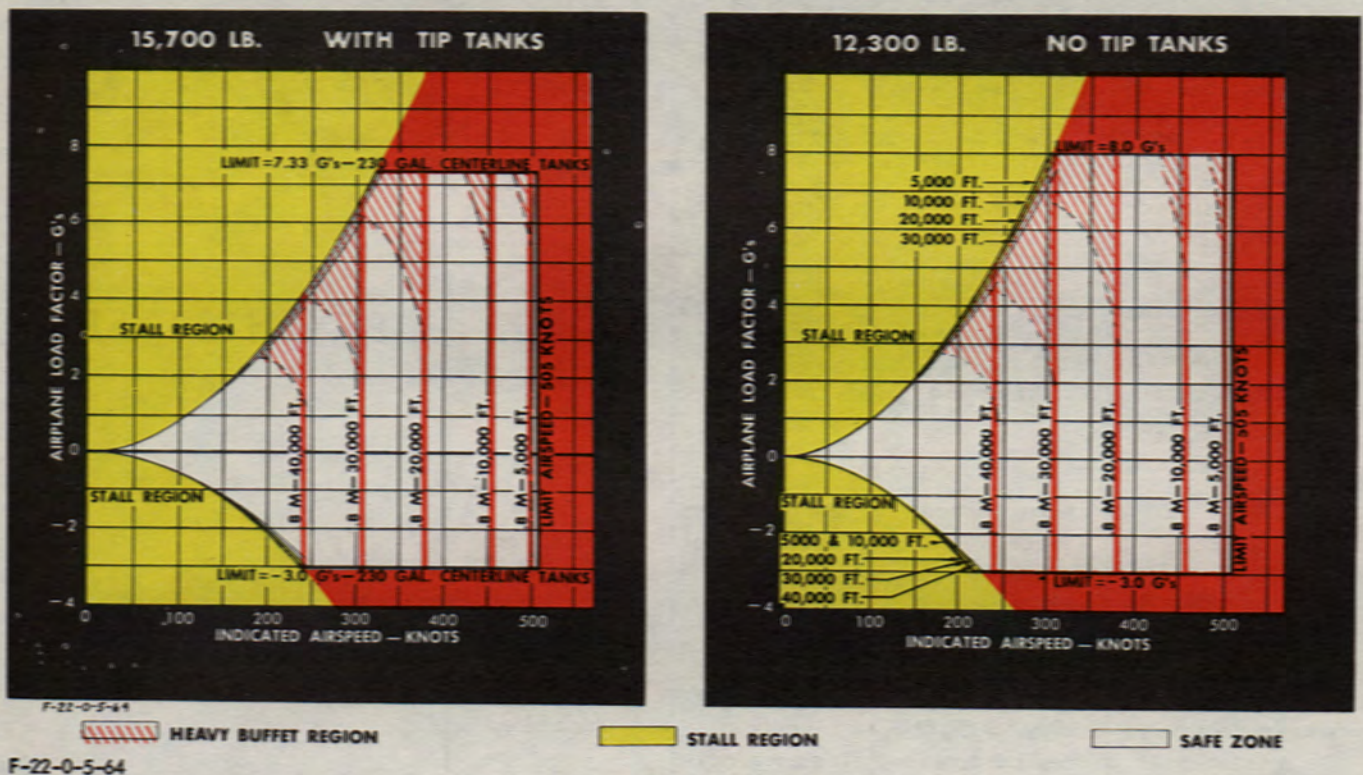
Inverted flying or any maneuver resulting in prolonged negative acceleration will result in engine flameout. There is no means of ensuring a continuous flow of fuel or of maintaining oil pressure for more than 10 seconds in this attitude. The Table of Prohibited Maneuvers indicates conditions under which various maneuvers are prohibited. With gear and flaps extended, sideslips are further limited to the use of one-half of full rudder deflection. All other acrobatics are permitted, providing tip tanks, if installed, are empty. Acrobatics are prohibited with external stores. All vertical stalls are prohibited.

AIRSPEED LIMITATIONS.

Airspeed is limited to 505 knots IAS, 0.8 IMN (indicated Mach number) or aileron buzz, whichever is encountered first. (See figure 5-1.) The approximate airspeed limit will be shown by the red limit hand on the airspeed indicator. Below 4000 feet the red needle will stop at 505 knots; above 4000 feet, it will show the airspeed equivalent of 0.8 IMN. At Mach number

flight strength diagram





F-22-0-5-64

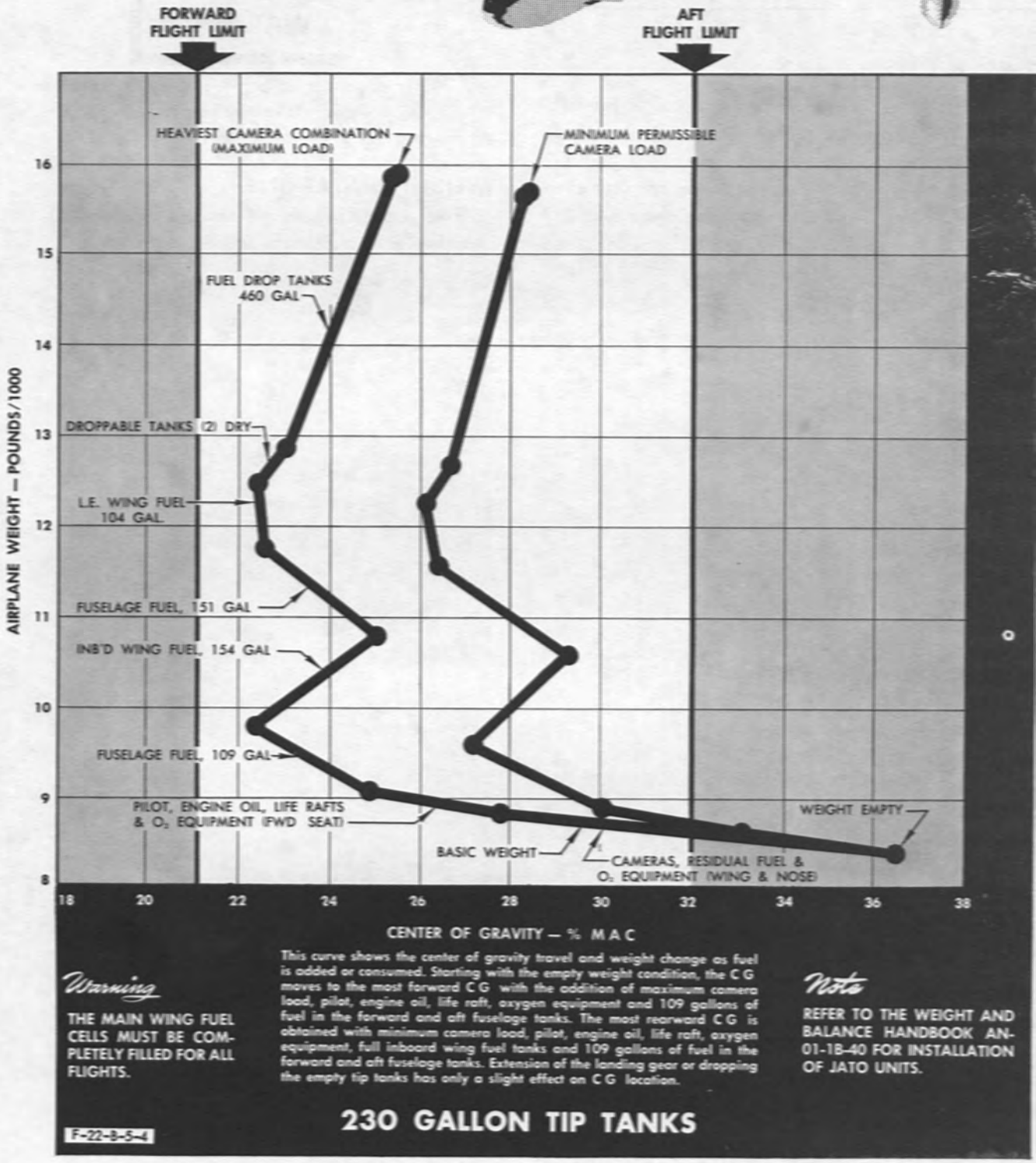
Figure 5-2

greater than 0.8, compressibility effects cause aileron buzz, trim changes, and aircraft buffeting. Aileron buzz can be recognized by a high-frequency vibration that is transmitted throughout the aircraft structure. It may be recognized visually by observing a fuzzy outline at the trailing edge of the ailerons.

ACCELERATION LIMITATIONS.

The Flight Strength diagrams (figure 5-2) show the acceptable limits to which the airplane can be flown during both accelerated and unaccelerated flight. Curves are shown in the Flight Strength diagrams which indicate the number of G's that can be obtained before the airplane stalls. At the higher indicated airspeeds, the number of G's that can be obtained without stalling exceeds the limit load factors shown in the diagrams. Indicated airspeed for 0.8 IMN at various altitudes and the limit structural airspeed of 505 knots are also shown in the diagrams. The shaded areas represent the conditions under which heavy buffet can be expected. Flight tests have shown buffeting to be tolerable, and structural loads within limits, up to the shaded areas in the diagrams. No flight tests have been made in the heavy buffet region, and operation in this region must be avoided. The following chart indicates the maximum limit load factors with or without the installation of the travel pod.

c g travel chart



Warning

THE MAIN WING FUEL CELLS MUST BE COMPLETELY FILLED FOR ALL FLIGHTS.

This curve shows the center of gravity travel and weight change as fuel is added or consumed. Starting with the empty weight condition, the C G moves to the most forward C G with the addition of maximum camera load, pilot, engine oil, life raft, oxygen equipment and 109 gallons of fuel in the forward and aft fuselage tanks. The most rearward C G is obtained with minimum camera load, pilot, engine oil, life raft, oxygen equipment, full inboard wing fuel tanks and 109 gallons of fuel in the forward and aft fuselage tanks. Extension of the landing gear or dropping the empty tip tanks has only a slight effect on C G location.

Note

REFER TO THE WEIGHT AND BALANCE HANDBOOK AN-01-1B-40 FOR INSTALLATION OF JATO UNITS.

F-22-8-5-4

230 GALLON TIP TANKS

Figure 5-3

CONFIGURATION	SYMMETRICAL PULLOUT	ROLLING PULLOUT
Without Tip Tanks	+8.0 G −3.0 G	+5.33 G
230 Gallon Centerline Tip Tanks	+7.33 G −3.0 G	+4.9 G

DIVES.

Steep angle dives should not be attempted at low altitude at speeds near the red needle because compressibility buffet may prevent successful pullout if high G's are attempted or required. Speed brakes are very effective for reducing speed and increasing the amount of available G's.

CENTER OF GRAVITY.

The weights shown in figure 5-3 are for general information only and should not be interpreted as imposing any weight limitations on the airplane. These limitations and restrictions are subject to change. Consult latest directives and orders.

WARNING

Without proper ballast, it is possible to obtain a CG position aft of the rearward limit. (See figure 5-3.)

WEIGHT LIMITATIONS.

For weight and balance information refer to T.O. 1-1B-40, Handbook of Weight and Balance Data.

Section VI—FLIGHT CHARACTERISTICS

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INTRODUCTION.

The operational capabilities of this aircraft include flight speeds to 0.8 IMN and altitudes to 45,000 feet. The aircraft is directionally and longitudinally stable at all approved center-of-gravity positions. Laterally, the aircraft is neutrally stable, a characteristic that does not require any special technique other than frequent reference to the lateral attitude.

MACH NUMBER.

Mach number represents a percentage of the speed of sound. For example, if you are flying at 0.50 IMN, your speed is 50 percent of the speed of sound. The speed of sound, being a function of air temperature only, decreases as you climb since the air temperature decreases with altitude. The IMN for any altitude and indicated airspeed condition may be found on figure 6-1.

STALLS.

ONE-G STALLS.

The aircraft stalls normally with adequate warning with gear and flaps up; it mushes noticeably and begins to shake and buffet about 10 knots above the stall speed. With gear and flaps down the warning is less; moderate warning will occur 4 to 8 knots above the stall speed. During a complete stall, a wing may drop. The aircraft should not be held in the stall attitude because it may enter a spin. Stalls should be entered by slowly raising the nose and gradually easing into the stall. Abrupt nose-high stalls with power off and gear and flaps up should be avoided, especially at rearward center-of-gravity positions, because the aircraft may flip over on its back. Practice stalls should be completed 15,000 feet above terrain. If tip tanks are installed, they should be empty. If there is any amount of fuel in the tip tanks, a stall approach is prohibited unless all of the following conditions exist:

a. It has been ascertained that an asymmetrical tip-tank fuel load does *not* exist (by visually checking the aileron trim tab position, etc.).

indicated airspeed vs altitude at constant mach number

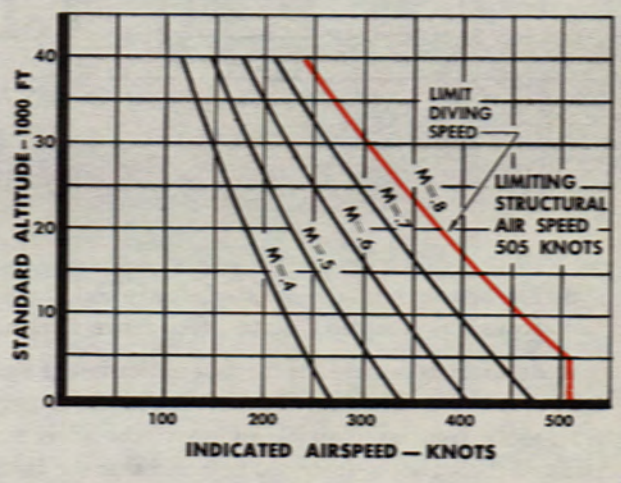


Figure 6-1

stall speed chart

WITH OR WITHOUT TIP TANKS

STALLING SPEED IAS KNOTS

WING FLAP POSITION	LANDING GEAR POSITION	ANGLE OF BANK	PRESSURE ALTITUDE FEET	GROSS WEIGHT — POUNDS 10,000	12,000	14,000	15,000	16,000	
0°	UP	0°	0 TO 45,000	95	105	110	115	120	POWER ON
		30°	0 TO 5,000	100	110	120	125	130	
		45°		115	125	135	140	145	
		60°		135	150	160	165	175	
70% (30°)	DOWN	0°	0 TO 5,000	85	95	100	105	110	POWER ON
		30°		90	100	105	110	115	
		45°		100	110	120	125	130	
		60°		120	130	140	145	150	
100% (45°)	DOWN	0°	0 TO 5,000	85	95	100	105	105	IDLE POWER
		30°		90	100	105	110	115	
		45°		100	110	120	125	125	
		60°		120	130	140	145	150	

F20-G-6-111 LANDING GEAR POSITION HAS A NEGLIGIBLE EFFECT ON THE STALLING SPEED F22-C-6-2

Figure 6-2

b. The approach is accomplished slowly and gradually and recovery is completed 10,000 feet above terrain.

c. Recovery is initiated at the first indication of buffet. Stall speeds are shown on the Stall Speed Chart (figure 6-2). Stall recovery is quick and easy; the ailerons are effective throughout. It should be noted that the landing gear position has a negligible effect on the stall speed.

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. The acceleration and flight strength limitations of the aircraft are shown in figure 5-2.

SPINS.

Intentional erect spins are permissible in aircraft modified with the revised wing leading edge and stall strips, provided the spin is started at 20,000 feet or more above the terrain. Intentional spins in aircraft that do not incorporate the above modifications are prohibited because the aircraft may go out of control and considerable altitude may be lost before a recovery can be made. Large quantities of fuel in the tip tanks produce an adverse effect on spins and spin recovery. Therefore, if a spin has developed and there is no response indicating recovery, the tanks should be jettisoned if they are more than half full. This applies to both erect and inverted spins and the out-of-control condition. Empty tip tanks retained on the aircraft will afford better recovery characteristics than if they are jettisoned. With the correct

configuration the aircraft spins consistently well and recovers easily. The optimum configuration for favorable spin characteristics and good recovery is as follows:

a. Tip tanks installed but empty.

b. Equivalent ballast installed, if cameras are removed.

c. Throttle — IDLE.

d. Ailerons — NEUTRAL.

e. Landing gear and wing flaps — RETRACTED.

Any configuration other than those listed above will be detrimental to spin recovery.

SPIN RECOVERY PROCEDURE.

It should be remembered that the recovery technique and order of steps is the same for both erect and inverted spins.

To recover from an erect or inverted spin use the following procedure:

1. Throttle — IDLE.
2. Ailerons — NEUTRAL.
3. Control stick — FULL AFT.
4. Landing gear and wing flaps — RETRACT (if extended).
5. Rudder — AGAINST THE SPIN (until rotation has stopped) THEN NEUTRAL.
6. Release back pressure on the control stick — *after rotation has stopped and the nose is well down.*

CAUTION

The rudder should be neutralized immediately when rotation stops to prevent entry into another spin.

After the recovery is underway, the airspeed should be permitted to build up so that another spin will not develop before leveling off.

Note

Jettisoning the canopy may assist in recovery. It will also serve as the first step toward possible ejection.

WARNING

If a definite recovery from the spin has not been established and a pullup initiated prior to the aircraft reaching a ground clearance of 10,000 feet — EJECT.

ERECT SPINS.

Note

An erect spin is easily recognized because positive-G forces exerted on the pilot will force him against the seat.

Each turn of an erect spin normally is accompanied by an oscillation in which the nose swings low, then high near the horizon. The rudder should be applied against the spin when the nose it at the lowest point of oscillation because here the controls are more effective. Recovery initiated when the nose is low will take one-half to three-quarters of a turn.

INVERTED SPINS.

Note

An inverted spin is easily recognized because negative-G forces exerted on the pilot will force him against the lap belt.

Inverted spins are usually caused by too much forward stick during slow speed inverted flight or by pushing the stick forward too quickly when rotation stops during recovery from an erect spin. In the latter case the spin will start from a right-side-up attitude. The aircraft may progress into an inverted spin from an out-of-control condition. If this occurs, it may be difficult to determine the direction of rotation. If the pilot looks along the nose of the aircraft he may get one impression of spin rotation. Conversely, if he looks high up on the canopy, which is directly toward the ground he may get the opposite impression of spin rotation. The needle of the turn-and-slip indicator should be used to determine the direction of spin rotation. Recovery from an inverted spin may be initiated at any time. The recovery will be prompt if the aircraft configuration is correct as previously noted. Inverted spins are fast, uncomfortable, and confusing. They should never be entered intentionally.

OUT-OF-CONTROL CONDITION.

In an out-of-control condition the aircraft gyrations are frequently violent and erratic and do not follow any particular pattern. At the start of the gyrations the pilot may have considerable difficulty keeping abreast of the changes of aircraft attitude. He may become disoriented and lose approximately 2000 to 3000 feet of altitude before the gyrations cease and he becomes oriented. The out-of-control condition can develop from the following circumstances.

a. Exceeding the limit of critical sideslip angle.

b. Abrupt nose-high stalls.

c. Prolonged aggravated stalls or rudder exercise stalls with stick full aft.

d. Popping the stick forward at too low an airspeed when recovering from a spin.

e. Any abrupt cross-control maneuver at low airspeeds.

After the aircraft has lost 2000 feet or more, the erratic nature of the gyration will develop into a spin, usually an inverted spin from which a normal spin recovery can be executed.

WARNING

The out-of-control condition should never be practiced intentionally.

RECOVERY FROM OUT-OF-CONTROL CONDITION.

To recover from an out-of-control condition use the following technique:

1. Attain the correct aircraft configuration for an erect or inverted spin.

2. Throttle — IDLE.

3. Ailerons and rudder — NEUTRAL.

4. Control stick — FULL AFT.

Note

Because of the rapid changes in aircraft attitude and the acceleration forces on the pilot it may become difficult to hold the rudder and ailerons neutral, and the stick full aft. The recommended procedure is to occasionally look in the cockpit and concentrate on holding the controls in the proper position. If the controls are thus held the aircraft will recover sooner.

5. When the spin has developed and the direction of rotation is apparent, use rudder to stop rotation and proceed as in any spin recovery.

RECOVERY FROM VERTICAL CLIMB POSITION.

Vertical stalls are prohibited. However, it is possible for pilots to inadvertently maneuver the aircraft into an attitude approaching a vertical stall. Before the aircraft stalls in a vertical attitude, the following recovery should be initiated:

1. Throttle — 100% rpm.

2. Gear, flaps, and speed brakes — RETRACT (if applicable).

3. Roll the aircraft toward the nearest horizon.

4. Apply smooth back stick pressure.

5. Allow nose to drop through the horizon to a nose-low inverted attitude, permit airspeed to build up.

6. At 130 knots IAS or more, smoothly roll the aircraft to an erect attitude.

CAUTION

- Maintain smooth back stick forces throughout the maneuver to avoid stalling and do not "split S" from the nose-low attitude.
- If an out-of-control condition or spin develops before the recovery is accomplished, reduce power to IDLE and follow the out-of-control or spin recovery procedure.

RECOVERY FROM INVERTED, NOSE-HIGH, LOW-AIRSPEED POSITION.

The inverted, nose-high, low-airspeed condition usually develops from an improper over-the-top maneuver. If sufficient back pressure is not maintained throughout the over-the-top maneuver, the aircraft will normally hang inverted after the nose passes through the vertical. Adding full back stick pressure at this point will cause a spin or out-of-control condition. With smooth back pressure and power at 100% rpm, the nose will slowly fall below the horizon. Power at 100% will help maintain the airspeed as the pilot initiates smooth back pressure to nurse the nose below the horizon. When an inverted, nose-high, low-airspeed condition is encountered, recover using the following procedure:

1. Throttle — 100% rpm.

2. Ailerons and rudder — NEUTRAL.

3. Gear, flaps, and speed brakes — RETRACT (if applicable).

4. Apply SMOOTH BACK STICK PRESSURE.

5. Allow nose to drop through the horizon to a nose-low inverted attitude, permit airspeed to build up.

6. At 130 knots IAS or more, smoothly roll the aircraft to an erect position.

CAUTION

If an out-of-control condition or spin develops before the recovery is accomplished, reduce power to IDLE and follow the out-of-control or spin recovery procedure.

SIDESLIPS.

Aircraft equipped with the wing leading edge and stall strip modifications can be slipped to the full limit of rudder travel at airspeeds just above the stall and still afford excellent control and recovery characteristics. Aileron control is excellent throughout the maneuver. Sideslip characteristics are good in the clean configuration, with gear or flaps extended, and with or without tip tanks installed. However, with this aircraft a critical limit of yaw angle exists during sideslip maneuvers. Tests indicate that this aircraft may go out of control for several seconds if the sideslip angle exceeds approximately 20 degrees. The out-of-control condition is discussed in a preceding paragraph. Sideslips with bombs carried on midwing bomb pylons are prohibited because of the poor directional stability at low airspeeds. The installation of the travel pod does not materially affect sideslips. Sideslips in aircraft that are not modified with the revised wing leading edge and stall strips are prohibited.

Note

The yaw string in front of the windshield will afford an indication of sideslip to the pilot. However, the yaw string will not indicate the magnitude of sideslip accurately much above 5 degrees because of the asymmetrical airflow over the nose.

If applied smoothly, normal application of aileron and full opposite rudder does not produce enough sideslip to reach the critical limit.

The following circumstances may cause the sideslip angle to exceed the critical limit:

a. Roughly jerking the aircraft into a sideslip by too rapid application of rudder.

b. Rapidly changing the direction of sideslip from right to left or left to right.

c. Abruptly crossing the controls at low airspeeds with gear and flaps down.

d. Encountering a sudden crosswind component of gust or jet wash during full rudder sideslip.

Sideslip maneuvers are usually employed on final approach, at low airspeeds, and with gear and flaps extended. Consequently, if the critical limit of sideslip angle is exceeded and the aircraft goes out of control, it is probable that sufficient altitude will not be available for recovery. Therefore, the application of full rudder in a sideslip is not recommended unless essential in the completion of an emergency landing.

FLIGHT CONTROLS.

SPEED BRAKES.

The speed brakes are effective in many ways, principally as a drag-producing device to slow the aircraft down. They can be extended or retracted at any speed or in any flight attitude as long as hydraulic pressure is available. The extension of the speed brakes will be accompanied by a nose-up tendency, whereas retraction will give the opposite effect. The force required to counteract this pitch change varies with speed, being very light at the lower airspeeds but quite high at maximum airspeed. In view of this characteristic, the pilot must be alerted to the change, particularly when retracting the speed brakes at high speeds near the ground. The pitching moment that accompanies operation of the speed brakes, however, is never strong enough to cause damage to any part of the aircraft at any permissible speed at normal G loads, nor is it strong enough to prevent the pilot from overcoming the pitching moment without use of the elevator trim tab.

Speed brakes are used effectively in formation flying, since they have a noticeable effect upon the turning radius. This is primarily a result of slowing the aircraft down. They will permit a more rapid descent without exceeding the Mach number limit and also, because of the nose-up pitching moment, they tend to counteract the "tucking under" tendency of the aircraft if it is permitted to exceed this limit. Considerable noise and roughness can be anticipated when flying at high speeds with the 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 pressure differential is small and the cabin air outflow valve is open. This valve is in the 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 pressure differential is greater and the pressure regulator reacts with sufficient speed to eliminate this effect.

AILERON BOOST.

While there is usually no reason for turning aileron boost off in flight, it can be turned on or off at any time. If the aircraft is not trimmed or the stick is off center when the boost is turned on, an abrupt maneuver may occur because the aircraft will react more quickly than the pilot. For practice purposes, it is recommended that the aileron boost be turned off in low-speed flight to obtain first-hand information on the control forces required. In the event of boost system failure, it is best to reduce speed to obtain lighter aileron control forces,

since these forces increase with airspeed. Manual aileron control may be supplemented by the use of aileron tab to obtain a fairly high rate of roll at high speed, but it is not considered good technique to depend on the tab for the fine control required, such as in formation or other precision flying.

LEVEL FLIGHT CHARACTERISTICS.

CRUISE.

When setting up the cruise conditions given in the Mission Profile charts, approach the speed condition from the high side. At high altitudes the speed must be kept up to the values given in the charts in order to attain the ranges listed. Although the fuel economy is practically constant for a wide range of speeds at altitudes below 30,000 feet, the speed range for best fuel economy becomes quite narrow at altitudes above 30,000 feet because of compressibility and induced drag effects. At altitudes above 30,000 feet, small deviations from the recommended speeds will result in a serious reduction in range. Best cruising performance is realized when the air is smooth. Rough air and turbulence will require more thrust to hold the desired airspeed. This results in increased fuel consumption and less range.

TRIM.

Since there is no torque effect from the engine in this aircraft, the rudder trim does not change with variations in speed and thrust if the rudder tab has been correctly adjusted on the ground. The elevator tab becomes fairly sensitive at high speeds. If the tab mechanism should fail, causing the tab to travel to the fully deflected position, the sudden stick force could be excessive. However, this condition can easily be overpowered if speed is reduced. The pitch change for the extremes of flight speed is considerable in any jet aircraft because of the extremely wide speed range. At low airspeeds, such as on a radar final approach, trim may be insufficient to completely eliminate nose heaviness.

VIBRATION OR "SHAKING."

A small percentage of RT-33A aircraft sometimes exhibit a mild vibration or shaking, characteristic above approximately 250 knots IAS. The motion felt by the pilot may be fore-aft, left-right, or vertical; or a combination of the directions. The magnitude of motion is small and usually not annoying. Cause of the shaking is attributed primarily to buildup of manufacturing tolerances in the engine air ducts, and differences in engine accessory configurations. In some cases the motion is caused entirely by improper rigging of wing flaps and landing gear doors in their retracted position. If the tip tanks appear secure, the tachometer and exhaust gas temperature are not fluctuating and the motion disappears when airspeed is reduced below about 200 or 250 knots, it is likely a characteristic of the particular aircraft and not anything serious.

SLOW FLYING.

Slow flying is of very little value with this aircraft since operation at speeds below the normal cruising range results in a waste of fuel and actually decreases the range and endurance. However, if slow flying is necessary, it should be done whenever possible in the clean configuration (gear, wing flaps, and speed brakes retracted), because the engine can be accelerated faster than the aircraft can be cleaned up and also because the fuel consumption will be increased with gear and flaps extended.

Slow Flying Technique.

The slow flight characteristics of this aircraft are normal. All controls are effective down to the stalling speed. 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 is reached, it can be maintained by varying the thrust. When descending at low airspeeds, retard the throttle to IDLE and decelerate to speeds 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 adjusting power as necessary.

APPROACH AND LANDING.

Because of the time required for the engine to accelerate from low engine speed, it is desirable from the standpoint of safety to maintain at least 50% rpm on landing approach until you are quite close to the runway, then, if additional thrust is needed for any reason the response will be quicker. If the runway is short enough

to be marginal, the approach speed must be closely controlled; 5 knots too slow may mean a hard landing, possibly short of the runway. If the runway is of adequate length for high-performance aircraft, it will not be necessary to approach at as slow an airspeed as for a marginal field. With a gliding approach and the proper airspeed, using 50% rpm, the aircraft can be flared normally to touchdown. If a flat approach is made, it is necessary that more thrust be maintained until a few feet from the runway. The aircraft may drop suddenly if the power is decreased abruptly. Touchdown should be made in slightly nose-high attitude. Avoid landing on the nosewheel.

When landing in a crosswind, it is advisable to hold a wing down rather than crab the aircraft. The crabbed approach method is considered desirable only in extreme crosswind conditions and should be used in combination with the wing-down method.

Dead-stick landings should be made at 10 knots higher IAS because of the reduced ability to flare without thrust.

GO-AROUNDS.

The importance of holding at least 50% rpm becomes apparent if the landing approach is short or if it is necessary to go around. The throttle should immediately be advanced to full open and the landing gear raised at 125 knots IAS minimum when a definite rate of climb is established. Flaps should be retracted at 140 knots IAS minimum. The gear and flaps should be retracted to eliminate their drag and thus enable the aircraft to accelerate more rapidly. If the engine speed is approximately 50% rpm, it will require only about 7 seconds to accelerate to 100% rpm. However, if the engine is operating at idling speed, it will require approximately 12 seconds to accelerate and the thrust available will be small during the first 6 seconds of the engine acceleration.

PORPOISING.

Porpoising is a condition in which the aircraft bounces back and forth from nosewheel to main gear during the initial phase of ground contact in landing. It occurs when the nosewheel contacts the ground before the main gear, usually because the pilot attempts to force the aircraft onto the runway at an excessive speed. If, through improper corrective technique, porpoising is allowed to progress, a violently 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. (See Section II for corrective procedures.)

After eliminating porpoising, the pilot should decide immediately 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 runway crash barrier, etc.

CLIMB.

Optimum climb performance will be attained by following the climb speeds shown on the Climb Chart in the Appendix. Small deviations from these recommended speeds will not seriously affect the climb performance at low altitudes; however, when above 30,000 feet, it is necessary to adhere closely to the proper climb speed in order to avoid a large reduction in rate of climb. Also, if turns are required, it is best to make these at an altitude below 25,000 feet.

MANEUVERING FLIGHT.

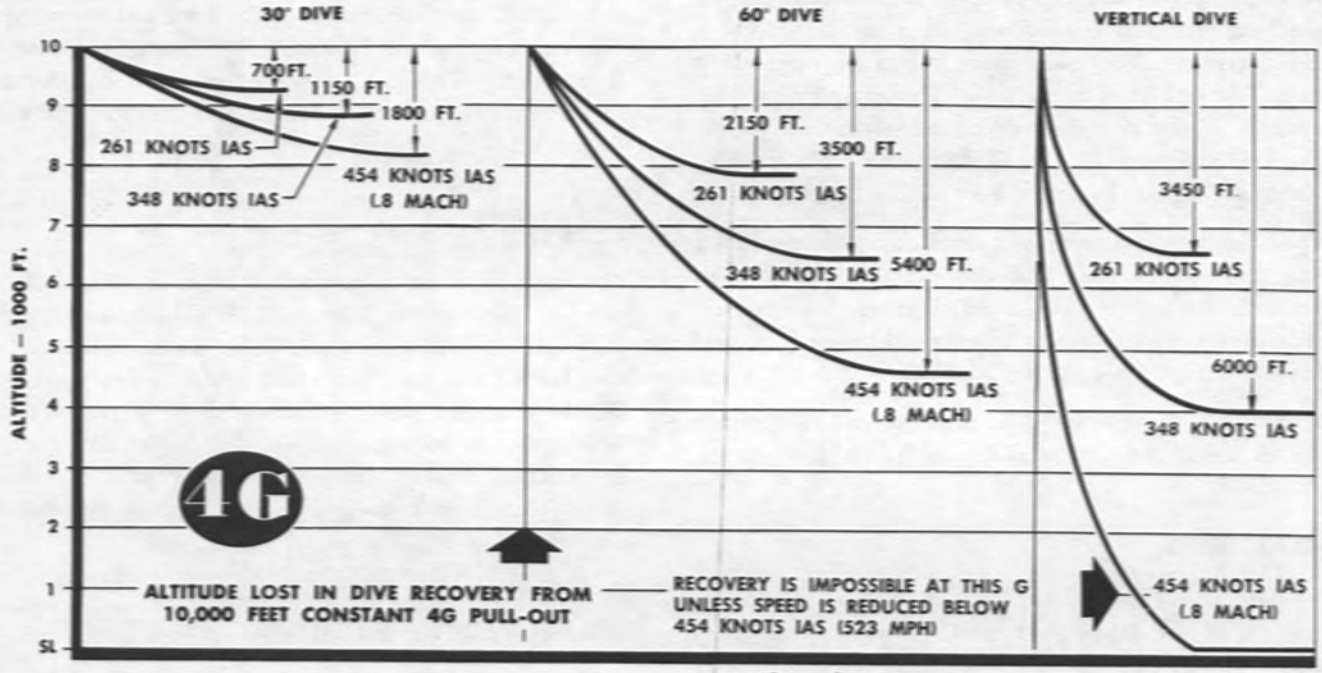
Maneuvering loads are incurred when an aircraft is turned, rolled, yawed, pulled out of a dive, or accelerated in some manner. It is the pilot's responsibility to prevent these loads from becoming excessive by restricting the maneuvers to the specified acceleration limits. For this purpose he relies on the accelerometer, an instrument designed to detect the acceleration loads placed upon the aircraft. 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 aircraft. The limitations of the accelerometer are:

1. It reads only the accelerations in a vertical plane.

2. It is located on the pilot's instrument panel and cannot accurately detect accelerations of the aircraft 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 aircraft. Actually, the steady loads that are applied during these maneuvers are usually not excessive and are almost directly proportional to the rudder pedal force being applied. Of more importance is the rate of application, or more particularly, the

altitude loss in dive recovery from 10,000 feet



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Note

AT .8 MACH NUMBER 4.5 G's ARE THE MAXIMUM OBTAINABLE AT 10,000 FEET WITHOUT HEAVY BUFFET.

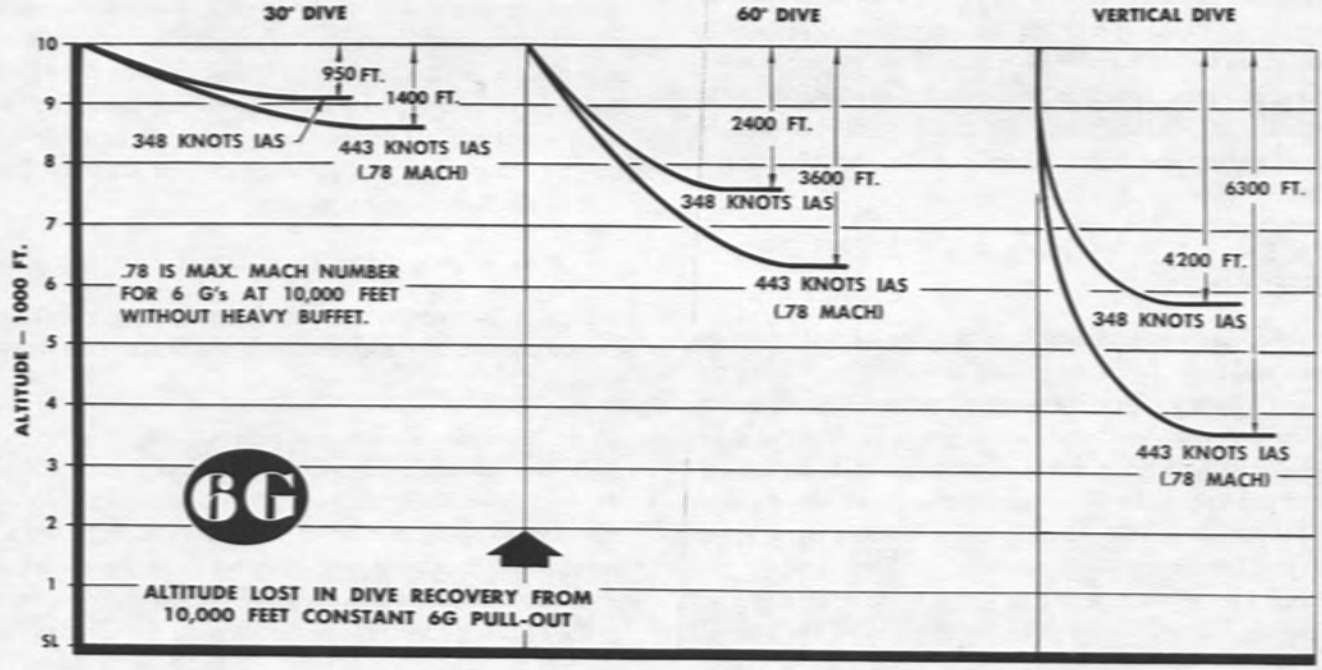
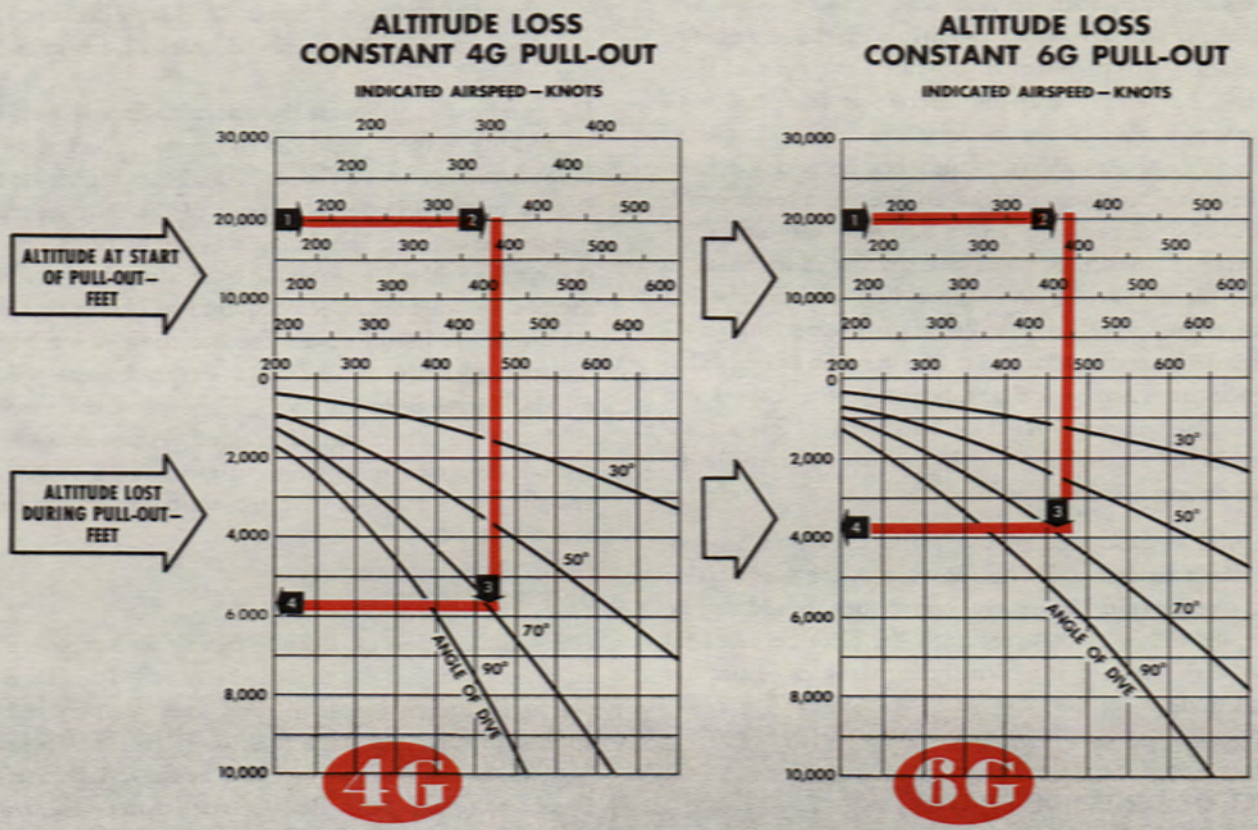


Figure 6-3

altitude losses in dive recovery—knots



REFER TO V-G DIAGRAM (FIG. 5-2) TO DETERMINE WHETHER NUMBER OF "G's" REQUIRED FOR PULL-OUT ARE AVAILABLE WITHOUT ENCOUNTERING HEAVY BUFFET.

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.)

F-22-0-6-69

Figure 6-4

rate of release of these forces. During rapid application or release of large control forces, very high loads can be imposed on the aircraft structure.

PERMISSIBLE ACROBATICS.

All acrobatics, except vertical stalls, intentional spins (unless modified with revised wing leading edge, and stall strips, and acrobatics requiring extended negative acceleration, are permissible, provided the tip tanks are installed but empty and the aircraft is equipped with equivalent ballast if the cameras are removed. (Refer to the Table of Prohibited Maneuvers, Section V.) During negative accelerations the engine oil pressure will drop almost immediately and a flameout may occur. If the inverted condition is maintained for more than 10 seconds flameout will occur since fuel will not be fed to the engine. Negative acceleration greater than 1 G may cause immediate flameout. If a mission is scheduled which requires acrobatic flight, be sure to check the Form 781 for oil quantity. At least 10 quarts of oil are required in the engine reservoir to provide sufficient lubrication during acrobatics.

The pilot is cautioned to use extreme care in maneuvers which require a diving recovery as the loss of altitude is very rapid. In general, acrobatics should not be attempted below 10,000 feet until the pilot becomes familiar with the rate at which the airplane can gain and lose altitude.

EFFECT OF CENTER OF GRAVITY.

The external and internal loading of the aircraft affects the CG (center of gravity). Variations in nose compartment camera loading can affect the CG position as much as 3.7%. Tip tank fuel loading moves the CG aft approximately 2%. In the aft CG range stick forces are lighter. The aircraft is quite sensitive to elevator trim at CG's aft of 29% but stick forces and stability remain positive. (Refer to the CG Travel Chart, figure 5-3.)

DIVES.

This aircraft has a limit of 0.80 IMN, 505 knots IAS, or aileron buzz, whichever occurs first. Up to this limit it is readily and safely controllable. Above Mach 0.80 the aircraft's lateral stability decreases rapidly because of the airflow separation over the wing. This will also cause the ailerons to buzz with a resulting stick vibration, particularly if tip tanks are installed. During accelerated flight, such as pullouts, turns, etc., aileron buzz can be anticipated at speeds less than 0.80 IMN.

CAUTION

- Speeds within the buzz range should be avoided as lateral control becomes difficult and prolonged operation within this range will eventually cause structural fatigue.
- Do not attempt high-speed flight without the use of the aileron booster. A rolling tendency may occur with varying degrees of intensity.

Longitudinally, although the aircraft will still be stable, a "tucking under" tendency becomes apparent as the Mach number is exceeded. At these higher speeds, the aircraft will buffet as a result of the flow separation mentioned before. This buffet will not be pronounced at the limiting Mach number at high altitudes because of the low indicated airspeed required to obtain this limit. At low altitudes, however, the buffeting is much more pronounced since the indicated airspeed corresponding to Mach 0.80 is considerably higher and the resulting air loads are accordingly increased. Altitude losses for typical dive recoveries from an altitude of 10,000 feet and during 4- and 6-G dive recoveries are shown in figures 6-3 and 6-4.

DIVE RECOVERY.

For minimum loss of altitude during dive recovery it is recommended that the throttle be retarded to IDLE and the speed brakes extended. All stick forces should be applied in such a manner that the G forces imposed do not exceed the limitations listed in the Flight Strength Diagram, figure 5-2. Elevator stick forces are reasonable and well within pilot capabilities. Elevator trim should not be used during high-speed dive recovery.

FLIGHT WITH EXTERNAL LOAD.

FUEL TANKS, CHEMICAL TANKS, AND BOMBS.

The fuel and chemical tanks are carried on the wing tips and have very little effect upon the aircraft stability. Uneven transfer of fuel from the wing-tip fuel tanks or uneven depletion of the chemical tanks will create wing heaviness, which can usually be trimmed out with the aileron tab. However, if the fuel or chemical tank differential is significant, refer to Section III for Tip Tank Fuel System Malfunction. Midwing pylon bombs have a negligible effect on flight characteristics.

JATO HOOK STORES.

JATO bottles or a travel pod can be carried on the JATO hooks with no appreciable effect upon flight characteristics. Refer to the applicable technical order for flight characteristics of aircraft equipped to carry tow targets or radar reflectors on the JATO hooks.

Section VII – SYSTEMS OPERATION

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AIRCRAFT FUEL SYSTEM OPERATION.

The normal sequence of fuel transfer is tip tanks first, leading edge tanks second, and main wing tanks last. Manual control of the sequence, e.g., selection of main wing tank transfer ahead of the leading edge tanks, should not be practiced because the center of gravity will move past the forward flight limits and create a nose heavy condition with very heavy stick forces.

CAUTION

The main wing tanks must be completely full prior to takeoff for all flights to preclude the possibility of a nose heavy condition created by the center of gravity exceeding its forward flight limits.

After fuel transfer has been completed and the fuel quantity in the interconnected fuselage tanks is less than 110 gallons, any prolonged nose-low attitude (such as a prolonged letdown or a steep dive) may cause the fuel to flow from the aft fuselage tank to the forward tank. (A flapper valve located at the forward end of the aft fuselage tank restricts the fuel flow, however.) The aft tank contains the float valve for the fuselage tank fuel quantity gage; therefore, any prolonged nose-low attitude with less than 110 gallons in the fuselage tank will result in a fuel quantity gage indication lower than the actual amount present in the tanks. A nose-low attitude should not be maintained when the fuselage tank gage indicates 40 gallons remaining because as little as 15 gallons may actually be available, although there would still be fuel in the forward tank available for straight-and-level flight. After the airplane is returned to straight-and-level flight, there will be a time lag of 2 to 5 minutes before the fuselage tank fuel quantity gage will indicate the accurate total amount of available fuel remaining. With a low quantity of fuel remaining, the rate of fuel flow from the forward fuselage tank to aft fuselage tank through the flapper valve is less than the flow requirements of the engine when it is operating at high rpm. Such a condition is indicated with a liquidometer reading of less than that of the fuel quantity counter because the liquidometer indicates fuel immediately available to the engine, it is imperative that when the liquidometer approaches a 25-gallon reading, power be reduced in order to allow the forward fuselage tank to refill the aft fuselage tank.

NORMAL SEQUENCE OF FUEL TANK USE.

(See figure 7-1.)

1. All fuel selector switches shall be OFF during engine starting.

2. Prior to takeoff, booster pump operation for the leading edge and the wing tanks shall be checked by referring to the warning lights and the fuselage tank fuel gage for an indication that the tank is being replenished. As the switches are turned ON or OFF separately, monitor the loadmeter for an indication that current is reaching the booster pump.

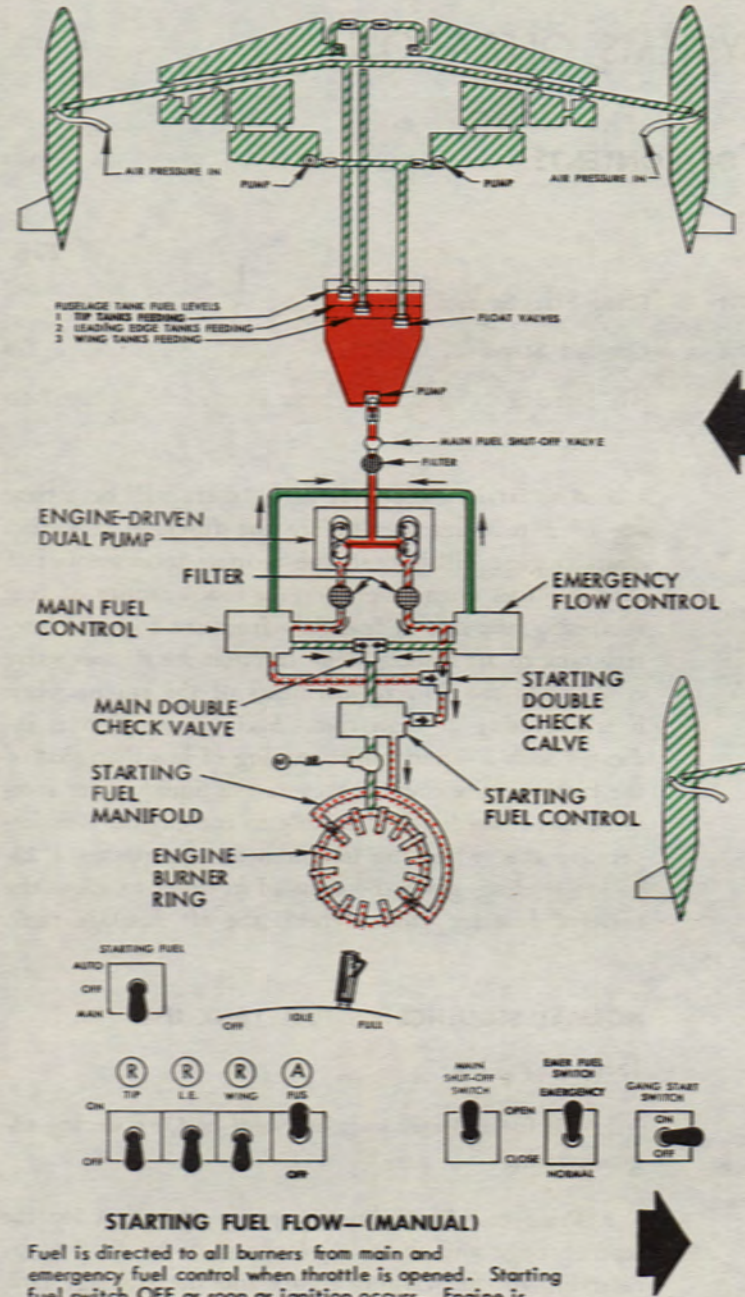
3. The tip-tank selector switch shall be ON prior to runup and a check made of tip tank feeding after runup to 100% rpm.

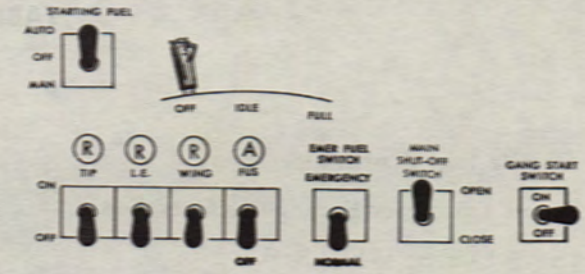
4. For takeoff, all fuel selector switches shall be gang-loaded ON for aircraft modified with the PN FV 400 Santa Anita fuselage fuel cap. On other aircraft the fuselage and tip tanks switches shall be ON.

courses of fuel flow

NOTE:

The courses of fuel flow during ground starting utilizing the gang start switch are the same as for an automatic start except all switches are in the OFF or NORMAL position.



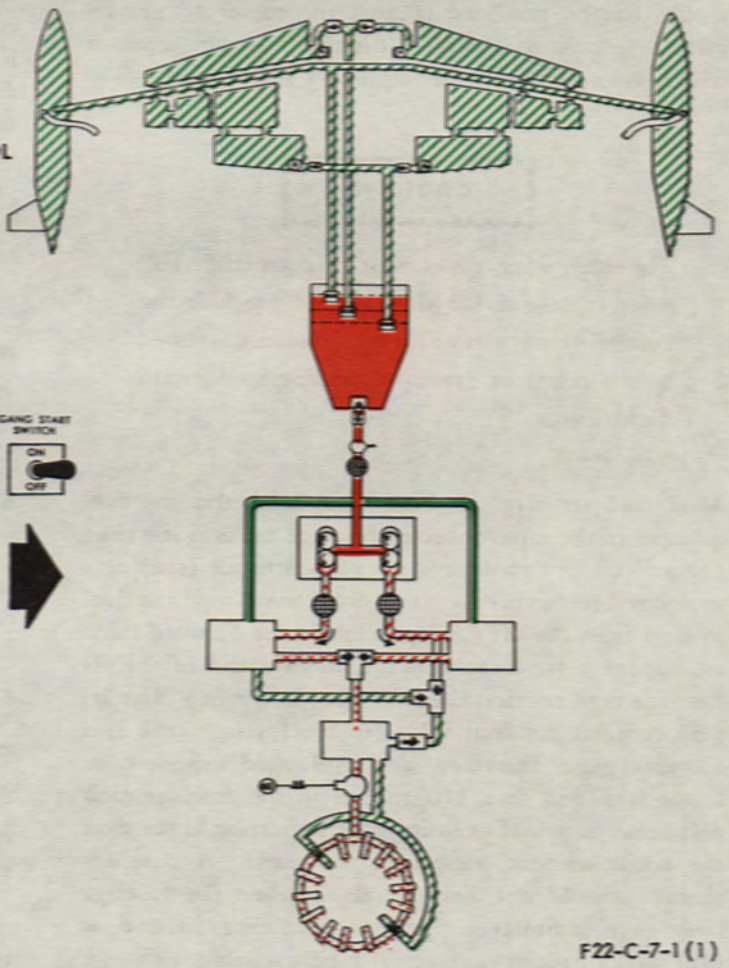


STARTING FUEL FLOW—(AUTOMATIC)

Fuel is supplied from the fuselage tank by gravity flow to both elements of the dual fuel pump and from there to the main and emergency fuel control units. Both of these units discharge fuel through the starting double check valve to the inlet valve of the starting fuel control to insure sufficient volume for starting. Initially fuel is directed to burners No. 7 and 14 and as pressure builds up, fuel is then directed to all the burners.

STARTING FUEL FLOW—(MANUAL)

Fuel is directed to all burners from main and emergency fuel control when throttle is opened. Starting fuel switch OFF as soon as ignition occurs. Engine is accelerated on emergency fuel control.

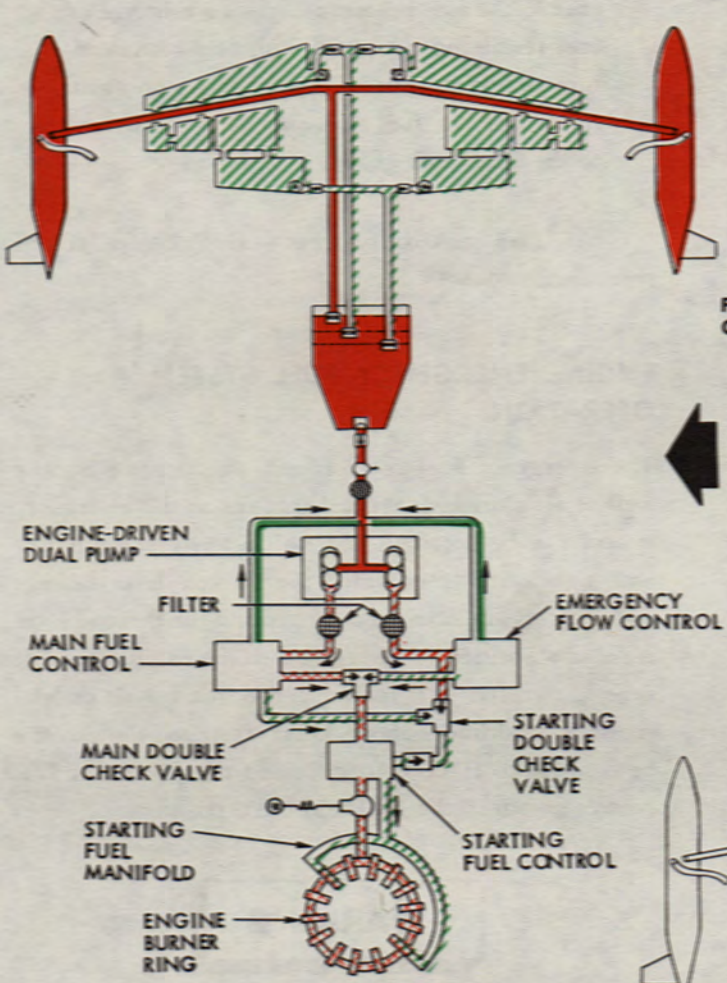


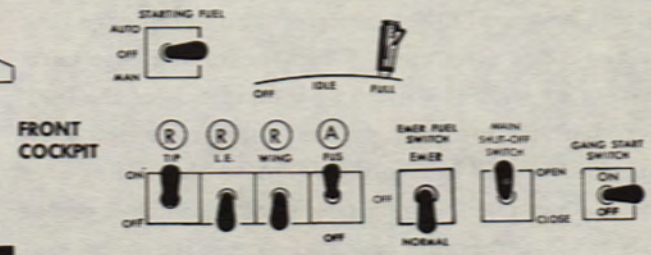
FUEL FLOW
NORMAL FUEL SUPPLY
BYPASS FUEL
MAIN PUMP FUEL FLOW
EMERGENCY PUMP FUEL FLOW
STARTING FUEL FLOW
STATIC FUEL

F22-C-7-1(1)

Figure 7-1 Sheet 1

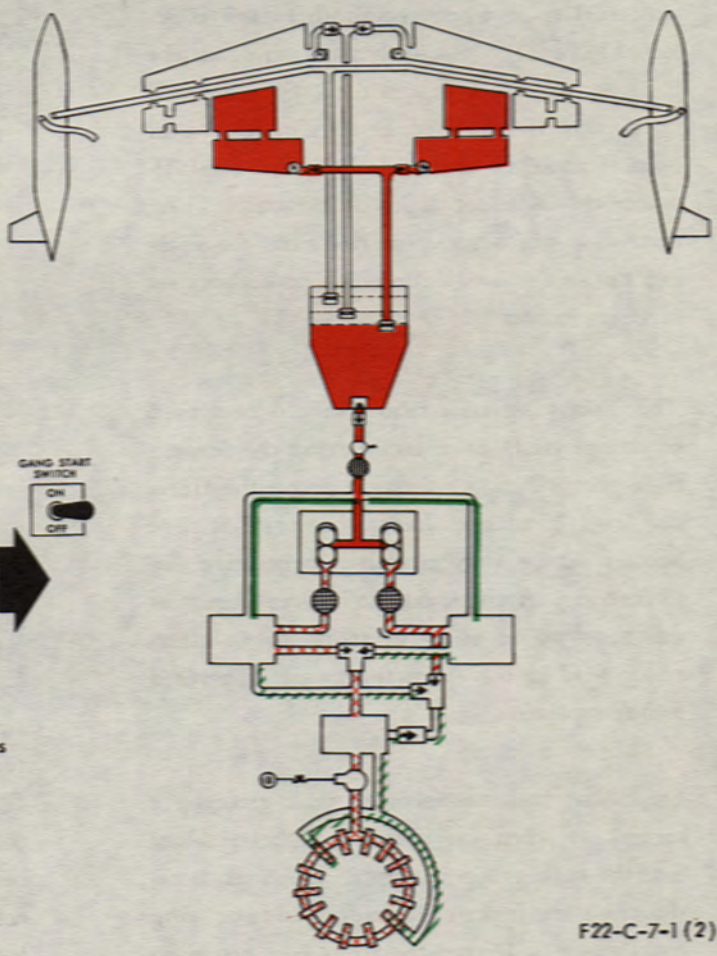
courses of fuel flow

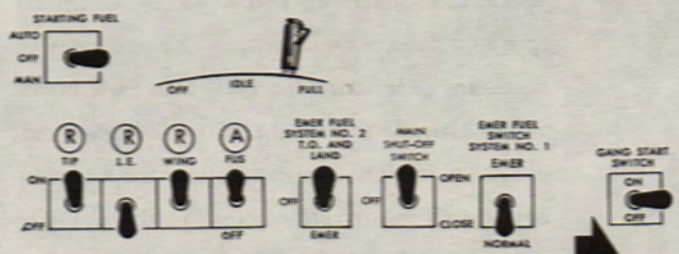




TAKEOFF FUEL FLOW

Fuel transfers from the tip tanks to the fuselage tank and then flows through the main element of the dual fuel pump thru the main fuel control unit to the burner ring. The emergency fuel switch is placed in the take-off and land position energizing the emergency fuel pressure switch as a safeguard against failure of the main pump. On aircraft equipped with the PN FV400 Santa Anita Fuselage Fuel Cap, gang-load all fuel switches ON.





CRUISE AND LANDING FUEL FLOW

As fuselage tank level drops the upper float valve opens until each succeeding tank group is empty. Turn each tank group switch OFF (except tip tank and fuselage tank switches which remain on throughout flight) as indicator light above comes on. In this case the tip tanks and leading edge tanks are empty. Fuel is transferred from the wing tanks to the fuselage tank and then thru the main fuel control unit to the burner ring.

F22-C-7-1 (2)

Figure 7-1 Sheet 2

5. After takeoff, fuel is transferred from the tip tanks until they are empty as indicated by illumination of the tip-tank warning light. The tip-tank selector switch is left ON after the tanks are empty to keep them pressurized, thus preventing their collapse. After the tip tanks are empty, the leading edge tank selector switch should be turned ON to transfer the leading edge tank fuel to the fuselage tank. When the leading edge tanks become empty, as indicated by illumination of the leading edge tank warning light, the leading edge tank selector switch should be turned OFF. After the leading edge tanks are empty, the wing tank selector switch is turned ON to allow the wing tank fuel to transfer to the fuselage tank. When the wing tanks become empty, as indicated by illumination of the wing tank warning light, the wing tank switch should be turned OFF to prevent unnecessary operation of the booster pump.

Note

- A visual check should be made of the fuselage tank fuel gage whenever another tank is selected in order to positively determine that the fuselage tank is being refilled. Whenever a float valve is suspected of sticking closed or open at any time during flight, check the fuel-overboard indicator light if installed. Then, determine which group of tanks has the sticking float valve and follow the procedures set forth in Section III.

- The main wing tank switch should be turned on momentarily prior to selecting the leading edge group during operation above the freezing level. Instances have occurred where booster pumps were rendered inoperative due to freezing. A check on the booster pumps at this time would allow diversion to an emergency field in the event they were discovered to be inoperative.

- In normal fuel management, tank groups are turned on when the indicator lights indicate that the tank group is empty. However, occasionally some fuel in the leading edge or wing tank group will transfer from one group to the other through the vent lines. Thus, if reference to the fuel counter indicates a shortage of fuel remaining compared with fuel consumed, turn the wing or leading edge tanks on again to recover any fuel that may have transferred to the other tank group.

6. All fuel selector switches — OFF before engine shutdown.

ENGINE EMERGENCY FUEL SYSTEM OPERATION.

The emergency fuel control unit will operate equally well at all altitudes. Manual transfer to the emergency system can be accomplished satisfactorily at both low and high altitudes provided the throttle lever linkage and controls are adjusted correctly and the throttle lever is set at a position to correspond to the engine speed at time of transfer. It is recommended that for all manual transfers at altitudes above 15,000 feet that the throttle be retarded to IDLE before moving the emergency fuel control switch to the EMERGENCY position.

WARNING

Do not change from emergency to main system above 23,000 feet or below 80% (stabilized) rpm as a flameout will occur. The optimum altitude for switchback is 15,000 feet. Switchback at this altitude is smoother than at higher altitudes, yet is high enough to allow for a reasonable time for corrective action in the event of inadvertent flameout.

After a ground start, the pilot can check manual transfer from the main fuel control to the emergency control by simulating a failure of the main element of the dual fuel pump by moving the emergency fuel switch to the EMERGENCY position. A check for illumination of the amber emergency fuel system indicator light should be made at this time. The NORMAL position of the emergency fuel switch should be used for takeoff and landing.

STARTING FUEL SEQUENCING

AIRCRAFT WITH EMERGENCY FUEL PRESSURE SWITCH REMOVED

SWITCH POSITIONS		THROTTLE	DUAL FUEL PUMP BYPASS VALVE		STARTING FUEL CONTROL			EMERGENCY FUEL CONTROL BYPASS VALVE		AMBER LIGHT
EMER. FUEL	ST. FUEL					INLET	DRIP VALVE			
NORMAL	AUTO	CUTOFF	DE-ENERGIZED	CLOSED	ENERGIZED	OPEN	CLOSED	ENERGIZED	CLOSED	ON
NORMAL	AUTO	IDLE	DE-ENERGIZED	CLOSED	DE-ENERGIZED	CLOSED	PRESSURE CLOSED	DE-ENERGIZED	OPEN	OUT
NORMAL	OFF	IDLE	DE-ENERGIZED	CLOSED	DE-ENERGIZED	CLOSED	PRESSURE CLOSED	DE-ENERGIZED	OPEN	OUT
EMER	AUTO	CUTOFF	DE-ENERGIZED	CLOSED	ENERGIZED	OPEN	CLOSED	ENERGIZED	CLOSED	ON
EMER	AUTO	IDLE	ENERGIZED	OPEN	DE-ENERGIZED	CLOSED	PRESSURE CLOSED	ENERGIZED	CLOSED	ON
EMER	OFF	IDLE	ENERGIZED	OPEN	DE-ENERGIZED	CLOSED	PRESSURE CLOSED	ENERGIZED	CLOSED	ON
NORMAL	MAN	CUTOFF	DE-ENERGIZED	CLOSED	DE-ENERGIZED	CLOSED	PRESSURE CLOSED	ENERGIZED	CLOSED	ON
NORMAL	MAN	IDLE	DE-ENERGIZED	CLOSED	DE-ENERGIZED	CLOSED	PRESSURE CLOSED	ENERGIZED	CLOSED	ON
NORMAL	OFF	IDLE	DE-ENERGIZED	CLOSED	DE-ENERGIZED	CLOSED	PRESSURE CLOSED	DE-ENERGIZED	OPEN	OUT
EMER	MAN	CUTOFF	DE-ENERGIZED	CLOSED	DE-ENERGIZED	CLOSED	PRESSURE CLOSED	ENERGIZED	CLOSED	ON
EMER	MAN	IDLE	DE-ENERGIZED	CLOSED	DE-ENERGIZED	CLOSED	PRESSURE CLOSED	ENERGIZED	CLOSED	ON
EMER	OFF	IDLE	ENERGIZED	OPEN	DE-ENERGIZED	CLOSED	PRESSURE CLOSED	ENERGIZED	CLOSED	ON

Figure 7-2

engine rpm limits on emergency fuel system

F-20-F-2-4

COMPRESSOR INLET TEMPERATURE °C	°F	MINIMUM RPM (PER CENT)	MAXIMUM RPM (PER CENT)
−20	−4.0	89.3	93.3
−15	5.0	90.0	94.0
−10	14.0	90.6	94.6
− 5	23.0	91.3	95.3
0	32.0	92.0	96.0
5	41.0	92.7	96.7
10	50.0	93.3	97.3
15	59.0	94.0	98.0
20	68.0	94.7	98.7
25	77.0	95.3	99.3
30	86.0	96.0	100.0
35	95.0	96.6	100.6
40	104.0	97.3	101.2
45	113.0	98.0	101.8

FB 6714

Figure 7-3

FULL THROTTLE EMERGENCY FUEL SYSTEM CHECK.

If a full throttle emergency fuel system check is required proceed as follows:

1. Throttle — Advance to obtain 55% rpm and allow engine speed to stabilize.

2. Emergency fuel switch — EMERGENCY.

3. Throttle — Retard to IDLE when the amber emergency fuel indicator light comes on and note engine rpm. Then advance the throttle slowly to determine the maximum engine rpm available consistent with compressor inlet air temperature (approximately the same as outside air), as shown in the table, figure 7-3.

Note

The exhaust gas temperature must be maintained within limits by means of throttle movement since the emergency fuel control unit does not provide acceleration control.

4. Emergency fuel switch — Move to NORMAL while rapidly retarding the throttle to return to the main fuel system (the amber light will go out).

USE OF LANDING WHEEL BRAKES.

In order that brakes can be used as little and as lightly as possible, take full advantage of the length of the runway utilizing aerodynamic braking to stop the airplane. The following paragraphs discuss precautions to be observed to minimize brake wear, insofar as is practicable.

BRAKE OPERATION AT HIGH SPEED.

Use extreme care when applying brakes immediately after touchdown, or any time there is considerable lift on the wings, to prevent skidding the tires. Heavy brake pressure will lock the wheels more easily immediately after touchdown than when the same pres-

sure is applied after the full weight of the airplane is on the tires. As long as brake pressure is maintained a wheel once locked will not unlock as load increases. Braking can stop the wheels from turning, but stopping the airplane is dependent upon the frictional force between the tires and runway. As the load on the tires increases, the frictional force increases, giving better braking action. During a skid, the frictional force is reduced, thus requiring increased stopping distance.

MIMIMUM ROLL LANDINGS.

If maximum wheel braking is required, decrease lift as much as possible by lowering the nose gear and raising the flaps before applying brakes. This procedure will improve braking action since the load on the tires will be increased, thus increasing the frictional force between the tires and the runway. Opening the canopy after the nosewheel has contacted the runway will materially decrease the landing roll.

OPTIMUM BRAKING ACTION.

On final approach, the brake pedals should be pumped several times until the sponginess disappears. After touchdown when the nosewheel has contacted the runway, a single smooth application of the brakes with constantly increasing pedal pressure will result in optimum braking and the shortest stopping distance possible.

BRAKE COOLING.

During a series of successive landings, a minimum of 15 minutes should elapse between landings where the landing gear remains in the slip stream, and a minimum of 30 minutes between landings if the landing gear is retracted, to allow adequate cooling time between brake applications. This time restriction is not applicable to touch-and-go type landings when no brake application is involved. The brakes should not be dragged while taxiing, and should be used as little as possible for turning the aircraft on the ground.

CAUTION

At the first indication of brake malfunction, or if brakes are suspected to be overheated after excessive use, maneuver the aircraft off the active runway and stop. Do not taxi the aircraft into a crowded parking area and do not set the parking brakes. Overheated wheels and brakes must be cooled before the aircraft is subsequently towed or taxied. Peak temperatures in the wheel and brake assembly are not reached until some time after a maximum braking operation (the time required may vary from 5 to 60 minutes). The time required to reach peak temperatures is dependent upon various factors, such as the severity of the maximum braking operation, wheel and brake assembly installation in different aircraft, etc. In extreme cases heat buildup can cause the wheel and tire to fail with explosive force or be destroyed by fire if proper cooling is not provided. To prevent brake fire and possible wheel assembly explosion, contact the ground maintenance crew immediately for the specified procedure for cooling brakes.

Note

Taxiing at low speeds to obtain air cooling of over-heated brakes will not reduce temperatures adequately and can actually cause additional heat buildup.

GANG START SYSTEM OPERATION.

The gang start system provides accessibility and instant operation, making it possible for a pilot to get a start at almost the instant a flameout occurs. Consequently, the majority of starts made with this system will be the "low altitude" type where the throttle is never retarded to OFF. The exception to this is the case where the flameout occurs at high altitude. Even when using the gang start system, air starts usually cannot be made much above 25,000 feet. In such a case, a 180-knot glide to 25,000 feet will provide approximately 8% rpm. It naturally follows that the throttle should be OFF during the descent and the start made on starting fuel by actuating the gang start switch with the throttle in the OFF position. Air starts on this system are very smooth. First signs of combustion are a rise in fuel pressure (35–40 psi), then a rise in EGT. The starts are cool, with the EGT seldom exceeding 700°.

Actually, the gang start system parallels the various circuits and does not change the function of any of the switches presently installed. For example, if a flameout occurred as the result of main fuel control ailure, an air start could be made by holding the gang start switch to the momentary-ON position. After the

start when the engine began operating normally, the pilot would select the emergency fuel system by turning the emergency fuel switch to EMERGENCY. Then, the gang start switch could be turned OFF since there would be no need to continue operation of the boost pumps and the starting fuel control unit.

Normally, a pilot having experienced a flameout would leave the gang start switch ON and land as soon as practical. IF this is done, the gang start switch must be turned OFF after the throttle is moved to the OFF position. During operation of the gang start on the ground it must be treated the same as the emergency fuel switch and starting fuel, that is, if the engine is running on the emergency fuel system (which will be the case with gang start switch ON) the engine must be run up to approximately 70% rpm and the throttle retarded prior to switching back to the normal fuel system.

Turning gang start ON at any time during flight produces no adverse effect on engine operation. A pilot should not hesitate to use gang start if a rough engine is encountered, since the early stages of a flameout from fuel starvation produce rough engine indications. Selecting gang start when first signs of flameout occur may prevent flameout. At high altitude the throttle should be retarded to 80% rpm prior to selecting gang start to prevent possible engine overspeed or overtemperature.

GROUND STARTS.

In addition to the recommended automatic ground start procedure in Section II the engine may be started using the following alternate ground start procedures:

GROUND START USING GANG START SWITCH.

1. Throttle — OFF.
2. Fuselage fuel tank switch — OFF.
3. APU — Connected and ON.
4. Starter switch — START.

Hold to start position for 3 seconds, then release.

5. Ignition switch — NORMAL after rpm has reached at least 9%.
6. Gang start switch — ON momentarily, then release.
7. Tachometer and EGT — Monitor.

CAUTION

If EGT and rpm do not rise normally (as in any other automatic start) turn the gang start switch OFF and the starter switch to STOP–START.

8. Throttle — IDLE when rpm stabilizes at 26% rpm, then advance to 70% rpm.
9. Gang start switch — OFF momentarily, then release while rapidly retarding the throttle to IDLE.

CAUTION

- It is most important to remember that the gang start switch parallels the function of the *emergency fuel switch*. Consequently, switching from gang start ON to gang start OFF must be done in the same manner as switching from emergency fuel to normal fuel (that is, throttle must be advanced to 70% rpm, and retarded while turning gang start switch OFF.) Disconnecting the APU during gang start system operation causes a switchback from the emergency to the normal fuel system. If this is done at IDLE rpm an overtemperature condition will probably occur.
- Another important thing to bear in mind is that gang start provides fuel and ignition. These ingredients are hazardous without air flow. It subsequently follows that gang start should not be turned on unless the engine is rotating. For most normal ground operation treat it with the same regard as the tip-tank salvo button.

MANUAL GROUND STARTS.

It is not recommended that a manual ground start be used if the automatic starting system is available. If a manual ground start is necessary, follow procedure in table following:

MANUAL GROUND START

NORMAL PROCEDURE	IN THE EVENT OF MALFUNCTION
1. Emergency fuel switch — EMERGENCY.	
2. Fuselage fuel tank switch — ON (up).	
3. Starter switch — START (Hold to start position for 3 seconds, then release).	**Starter Fails to Produce 9% to 10% RPM.** a. Starter switch — Hold momentarily in STOP–START position. Allow engine to windmill to a complete stop. b. Fuselage tank switch — OFF. c. Secure adequate external power prior to attempting new start. Starts on battery power alone should be made only in an emergency.
Note Do not attempt to start the engine below 9% rpm as it may cause serious damage.	
4. Ignition switch — NORMAL after rpm has reached at least 9%.	
5. Starting fuel switch — MAN at 10% or higher stabilized rpm.	
6. At maximum obtainable rpm (not less than 9%) — move the throttle rapidly to the full-open position.	**False Start.** (Combustion does not occur within 3 seconds after throttle is opened.) a. Throttle — OFF (stopcocked). b. After 30 seconds windmilling, starter switch — STOP–START, momentarily and release. c. Starting fuel switch — OFF. d. Emergency fuel switch — NORMAL. e. Fuselage tank switch — OFF. f. Allow engine to windmill to a stop. g. Before attempting a new start have ignition system checked and inspect plenum chamber area and the area between the tailpipe and fuselage skin for evidence of fuel fumes which might cause a fire or an explosion and drain tailpipe if necessary.
7. When fuel pressure starts to build up — rapidly retard the throttle to IDLE, or slightly below.	
8. As soon as combustion rumble is heard and EGT starts to rise, starting fuel switch — OFF.	
9. Closely monitor EGT gage for excessive temperatures. (Refer to Engine Limitations, Section V.)	**Hot Starts.** Any start in which the exhaust temperature exceeds the limits specified in section V constitutes a hot start. If exhaust gas temperature reaches 900°C for 5 seconds or any temperature above 900°C for any length of time, do the following: a. Throttle — OFF (stopcocked). b. Starting fuel switch — OFF. c. Emergency fuel switch — NORMAL. d. Ignition switch — OFF. e. Fuselage tank switch — OFF. f. Disconnect external power after all traces of combustion disappear. g. Make entry in Form 781. h. Investigate cause before attempting a new start.
10. After engine starts — Adjust throttle as required to keep EGT below 900°C. Attempt to maintain the temperature between 800° and 900°C until engine reaches IDLE rpm.	
11. Advance throttle to approximately 70% rpm.	
12. Retard throttle rapidly and at the same time turn emergency fuel switch to NORMAL in order to return engine to main fuel system.	
Note Manual starts can be made on either the main or emergency fuel system. Return engine to main system by moving emergency fuel switch in NORMAL.	

NORMAL PROCEDURE

13. At idling speed check all engine instruments within the desired range. (Refer to Section V.) If the fuel filter ice warning light comes on and stays on, shut down the engine and have the filter checked for ice and contamination.

14. External power supply — Disconnect.

15. Battery generator switch — Battery and generator.

16. Inverters — ON.

CAUTION

If a start is attempted immediately after a normal engine shutdown, a visual inspection should be made to ascertain that there is no fuel or fuel fumes in the plenum chamber. Fuel should have also stopped draining from the fuel system drains before a new start is attempted.

IN THE EVENT OF MALFUNCTION

Note

Do not disconnect external power supply until the emergency fuel switch is in the OFF position or until the generator cuts in. A sudden transfer from the emergency system to the normal system may result in an exhaust gas temperature surge.

If there is no indication of oil pressure after 30 seconds of engine operation, or if the pressure drops to zero after a few minutes of ground operation, stop the engine and investigate.

Note

During cold weather operation no warmup is required if the oil pressure remains below 100 psi at full throttle. A temporarily high oil pressure (above 100 psi) is not dangerous but takeoff should be delayed until the pressure drops below 100 psi. If the oil pressure remains above 100 psi, an oil system malfunction is indicated and the aircraft should not be flown.

AIR STARTING.

In addition to the recommended air starting procedures listed in Section III, an air start may be accomplished using the following alternate procedure:

Note

After a flameout occurs, the engine should be started on the emergency fuel system as indicated in Section III. However, after several unsuccessful attempts, the start should be tried on the main system.

MANUAL AIR START.

A manual air start is accomplished using the main fuel system as follows:

1. Throttle — OFF.

2. Airspeed — 180 knots IAS.

3. Trouble Check — Circuit Breakers — IN, ignition switch — NORMAL, battery generator switch — BATTERY-GENERATOR.

4. Altitude — Below 25,000 ft.

5. Fuel switches — GANG LOAD.

6. Emergency fuel switch — NORMAL.

7. Starter switch — START for 3 seconds (only if rpm is below 6%).

CAUTION

Place started switch in STOP-START if an air start is unsuccessful, to prevent unnecessary battery drain.

8. Air start ignition switch — START (and release after 1 second).

9. Starting fuel switch — MANUAL.

10. Throttle — FULL OPEN while monitoring fuel pressure.

11. Throttle — IDLE when fuel pressure begins to rise.

12. Starting fuel switch — OFF IMMEDIATELY after combustion occurs (as indicated by EGT rise and engine rumble).

13. Fuel filter deice switch — ON (for 15 seconds).

WARNING

If a flameout occurs when turning the starting fuel switch OFF, make another manual air start but leave the starting fuel switch in the MANUAL position. Such a situation could develop as a result of malfunction of the electrical components of the emergency fuel switch.

AIR START INDICATIONS.

Shortly after the automatic starting fuel sequence switch is actuated during an automatic start or after the throttle is moved to full open during a manual start, the EGT rises to and holds near 200°C, while the fuel pressure oscillates near 10 psi. There is no immediate change in rpm. Then, in rapid succession, fuel pressure rises to and holds at 35 to 40 psi, mild combustion rumble occurs, EGT rises in steps to a final peak and then settles near 500°C and rpm slowly builds up to above ground idle rpm (similar to an automatic ground start). A mild vibration often occurs near 30% rpm.

Note

The engine idle rpm while running only on the automatic starting fuel control at 25,000 feet is approximately 75%, as compared with approximately 30% rpm during a typical ground start.

Section IX – ALL-WEATHER OPERATION

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INSTRUMENT FLIGHT PROCEDURES.

The aircraft has the same stability and flight-handling characteristics during instrument flight conditions as when flown under VFR conditions. However, like most jet fighters, it is sensitive to changes of control pressures and requires constant attention to the indications of the flight instruments. For best results, make all changes in pitch, bank, and power smoothly and keep the aircraft properly trimmed. The range and endurance factors are critical so special attention should be given to cruise control during preflight planning of IFR flights. Allow for delays and additional fuel required for departure, letdown, and recovery. The following techniques are recommended from takeoff to touchdown under instrument and night flying conditions. These techniques are applicable when using any type of radio or radar aids to navigation and when making letdowns or landing approaches under instrument flying conditions.

INSTRUMENT TAKEOFF AND INITIAL CLIMB.

Complete the normal taxi and before takeoff checks as prescribed in Section II and set the directional indicator pointer under the top index. After the takeoff run is started, correct directional deviations by differential braking until the rudder becomes effective at approximately 50 knots IAS. During the takeoff run, the directional indicator is used for directional control; however, as long as runway markings remain visible they should be used as an aid to maintain the proper heading. At approximately 85 knots IAS apply back pressure to the stick to start establishing a takeoff attitude. Takeoff attitude is established by increasing the pitch attitude two horizon bar widths on the attitude indicator. Takeoff attitude should be fully established at approximately 100 knots IAS. By maintaining this attitude the aircraft normally will become airborne at the takeoff speeds given in the Appendix. As the aircraft leaves the ground the attitude indicator is used to maintain pitch and bank control and continues as such until the climb is established.

Note

Establish the initial climb by maintaining a wing-level, 2-bar-width, nose-high attitude on the attitude indicator.

When the vertical velocity reaches at least 500 fpm climb and airspeed is a minimum of 125 knots IAS, retract the landing gear and increase the vertical velocity to 1000 fpm. At 140 knots IAS, raise the wing flaps and increase the pitch attitude approximately one horizon bar width. Maintain a 1000-fpm climb until approaching recommended climb airspeed.

Instrument Climb.

Instrument climbs normally are made at 100% rpm and at airspeeds given in the Appendix. As the climb speed is approached, increase pitch attitude to maintain the desired indicated airspeed. A slow airspeed or low rate climb may be required occasionally in high density traffic areas. This type of climb presents no particular

problem except that the control of power becomes important and constant attention to flight instruments must be maintained.

DURING INSTRUMENT CRUISING FLIGHT.

After leveling off from a climb, it may be necessary to maintain high power until cruising airspeed is established. Although seldom is it necessary to exceed a 30-degree bank in routine instrument flight, the aircraft can be controlled in steep turns up to 60 degrees of bank. The attitude indicator may precess in pitch or bank during turns so a constant cross-check of other flight instruments is necessary to maintain the desired attitude. When flying precise headings, or a constant heading for a prolonged period, it is recommended that the selected heading be placed directly under the top index of the directional indicator.

Speed Range.

The aircraft handles well at all altitudes and at all airspeeds from 10–20 knots above stalling up to within 10 knots of Mach 0.8.

Radio and Navigation Equipment.

The ARN-6 radio compass is very susceptible to static, especially precipitation and ice crystal static, when flying at high airspeeds and altitudes. Reception can usually be improved by switching to the loop position and rotating the bearing indicator 90 degrees to the station or to the area of maximum reception. Occasionally, it will be necessary to use the loop position for navigation by aural-null procedures when automatic direction finding becomes erratic and unreliable. The use of the COMP position to receive radio range aural signals should be avoided because the automatic volume control will cause distortion of the signal pattern.

DESCENT.

When cruising at altitudes above 20,000 feet, a descent to initial penetration altitude prior to reaching the destination fix may be made at the airspeeds and power settings given in the descent charts in the Appendix. If a faster descent to 20,000 feet is desired, speed brakes may be used. When cruising or continuing a letdown below 20,000 feet, descent should be made at the airspeed, power setting, and configuration specified for normal penetration.

CAUTION

Descents at idle rpm and airspeeds of Mach 0.6 or higher produce extremely steep pitch attitudes and very high airspeeds at lower altitudes. Furthermore, idle rpm may result in insufficient defrosting; therefore, descents of this type are not recommended below 20,000 feet under instrument conditions.

For a normal penetration starting at initial penetration altitude reduce power to 65% rpm and lower the pitch attitude to place the horizon bar on the 60-degree bank index (if airspeed increase required is large) or halfway to the 60-degree bank index (if airspeed increase required is small). As the airspeed approaches 250 knots IAS, lower the speed brakes and maintain 250 knots IAS.

Note

An engine speed of 70% rpm is recommended for formation penetrations.

Figure 9-1 shows a typical penetration descent. However, the published procedures for jet penetration may vary at different installations. At certain installations radar-controlled penetrations may be available for IFR recovery. This system allows for maximum economy of fuel and time by providing guidance to an entry gate for a radar final approach. No special apparatus is required and the pilot merely follows the verbal instructions of the operator. (See figure 9-2.)

WARNING

Due to the high rate of descent inherent in jet penetrations, the altimeter should be closely monitored throughout the penetration. AVOID MISREADING ALTIMETER.

Start level-off from a penetration when approximately 1000 feet above the desired altitude. Decrease the pitch attitude on the attitude indicator by one half to establish about 2000 feet per minute rate of descent. When approximately 200 feet above the desired altitude, slowly

raise the nose of the aircraft to level off at the desired altitude. Allow the airspeed to decrease to 195 knots and retract speed brakes. Maintain a minimum of 65% rpm and 175 knots IAS inbound to the fix (low station).

Note

With the increase in traffic density, it is often necessary to maintain initial penetration altitude for a specified distance while proceeding outbound on the penetration track. In such cases, level-off from penetration should be modified by raising the speed brakes 1000 feet above minimum penetration altitude and decreasing the pitch attitude by one half. Level off at minimum penetration altitude and allow the excess airspeed to dissipate to 175 knots IAS while proceeding inbound.

As aircraft configurations and the published procedures for jet penetrations at different installations vary, fuel for penetration at destination and alternate must be carefully checked and allowances made for the fuel required.

Note

Prior to beginning penetration, ascertain the weather conditions and the availability of radar. Make the decision to begin penetration or proceed to alternate while still at altitude.

Minimum Fuel Penetration.

When fuel shortage or other emergency conditions require fuel economy during penetration, the following procedure will aid in reducing the amount of fuel used during descent:

1. When departing the initial penetration altitude and fix, retard the throttle to IDLE, lower the nose to place the horizon bar to approximately the 60-degree bank index on the attitude indicator and establish 250 knots IAS. As the airspeed approaches 250 knots IAS extend the speed brakes.

Note

If the spread between the outbound penetration and the reciprocal of the inbound course is less than 30 degrees, adjust the outbound course to a 30-degree angular difference.

2. Penetrate outbound one third of the altitude to be lost and start penetration turn (if required). Use 30 degrees of bank during turns.

3. When 2000 feet above the desired altitude for level-off, raise the speed brakes and maintain the descent, allowing the airspeed to build up.

4. Approximately 500 feet above the desired altitude start raising the nose of the aircraft and level off at the desired altitude.

5. Use the excess airspeed to expedite arrival at the approach fix, and maintain idle rpm until airspeed dissipates to approximately 175 knots IAS. Normally the aircraft will arrive over the fix with an airspeed in excess of 175 knots IAS (throttle still at IDLE rpm).

Note

The above penetration procedure should be used only under emergency conditions or, with caution, when a clearance for an unrestricted penetration has been obtained.

Holding.

To enter a holding pattern, simultaneously begin a turn to the desired heading, reduce power to the desired setting and extend the speed brakes if the indicated airspeed to be lost exceeds 25 knots. Slow the aircraft to 200 knots IAS and retract the speed brakes, then use power as required to maintain 200 knots IAS. To descend, after holding at high altitude, reduce power to 65% rpm and maintain the holding pattern airspeed. Lead the desired level-off altitude about 100 feet by adjusting power as necessary. To descend after holding at low altitude (below 14,000 feet) extend the speed brakes and maintain the holding pattern airspeed. Lead the desired level-off altitude about 100 feet by retracting speed brakes.

INSTRUMENT APPROACHES.

If instrument flight conditions exist at minimum penetration altitude it will be necessary to execute an instrument approach. Figure 9-2 shows a standard radar approach. As the aircraft handles well down to 10–20 knots above stall, approaches present no particular flight control problem. However, with heavy loads or turbu-

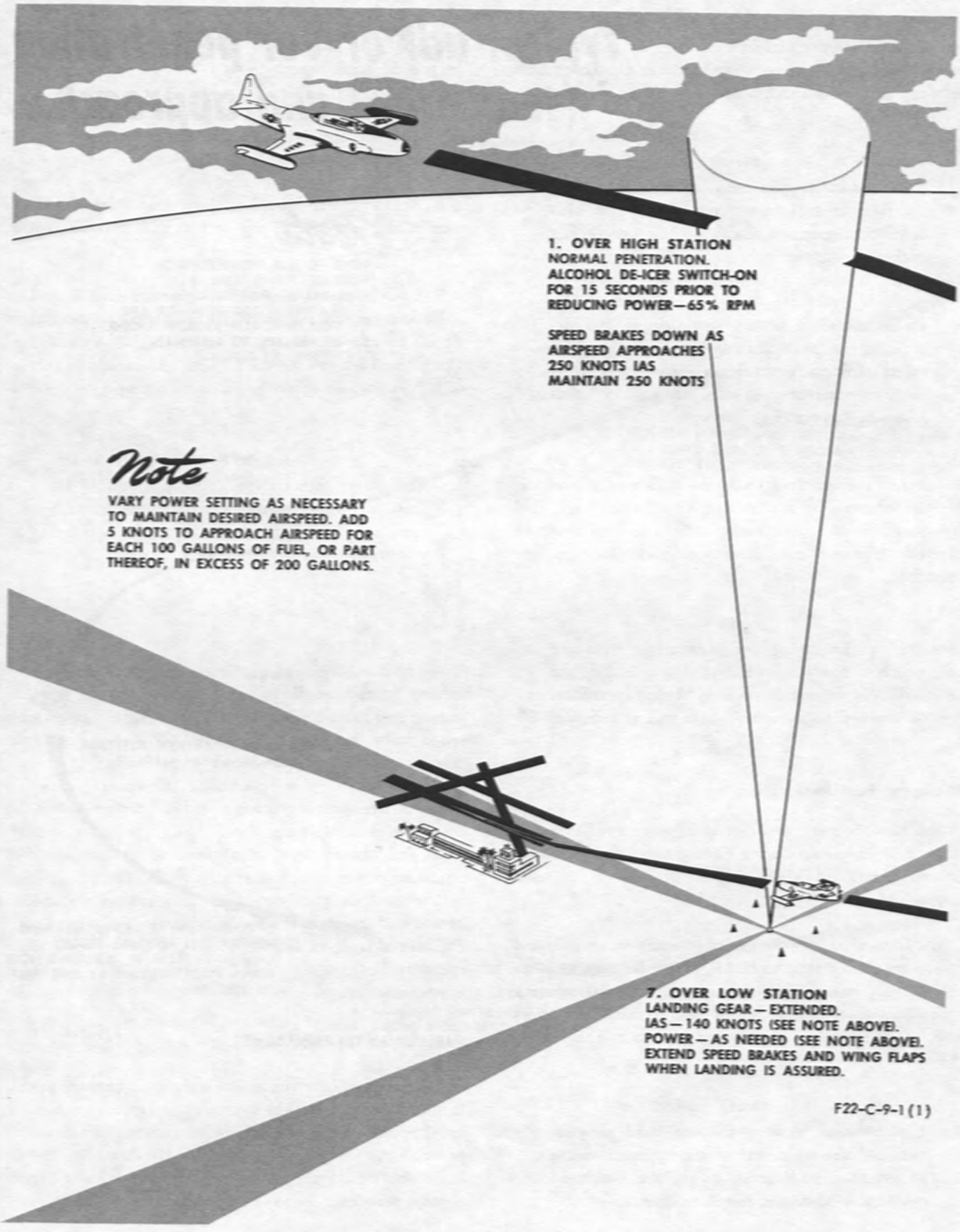

Figure 9-1 Sheet 1

typical adf or vor penetration (tear drop) and approach

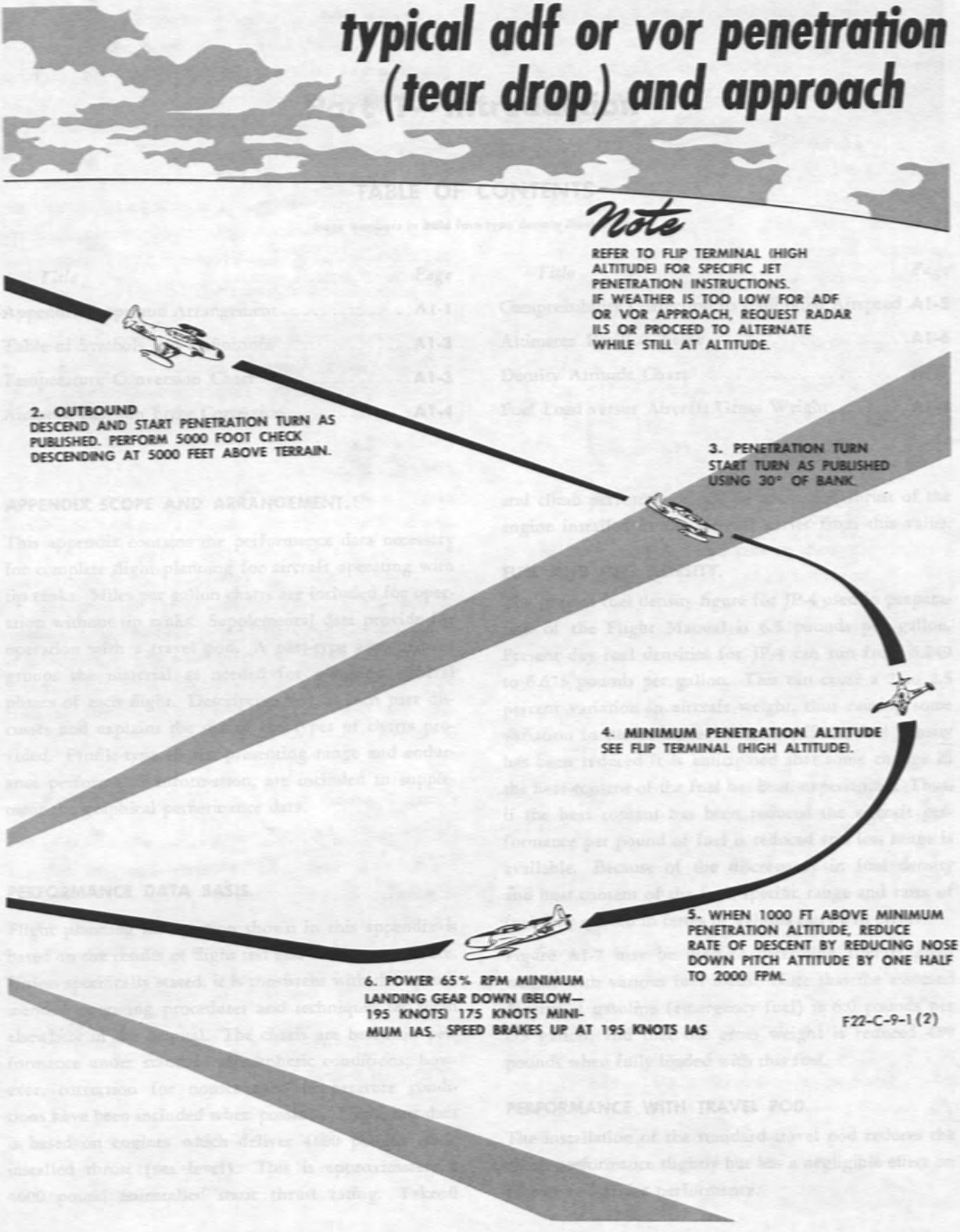

Figure 9-1 Sheet 2

lent conditions, it may be necessary to use higher than normal power to maintain the desired indicated airspeeds. A pilot should have an understanding of the characteristics of flight on the "wrong" side of the speed–power curve. It is possible to inadvertently get in this condition during approaches. Normally, 175 knots IAS is used for all approach maneuvering prior to extending the landing gear. After the landing gear is extended, indicated airspeed may be decreased to 140 knots and after wing flaps are extended on final approach, airspeed may be reduced to 120 knots.

Note

Approach speeds may be reduced to 115 knots IAS with 200 gallons or less fuel remaining, if stopping distance appears to be marginal.

To descend with clean aircraft configuration, it is recommended that power be maintained at a minimum of 65% rpm, and the speed brakes extended during descent to keep the indicated airspeed from increasing. During small descents when the indicated airspeed will not increase appreciably, the use of speed brakes is not required. To descend with gear (and wing flaps) extended, vary the power setting as necessary to maintain the desired airspeed. Turns required during an approach should not exceed 30 degrees angle of bank. It is recommended that rudder be used for coordination during all turns at approach airspeeds. In executing an approach, follow the published procedures or verbal instructions. Occasionally, conditions may require the execution of a missed approach. The recommended procedure for missed approach is to apply power to 100% rpm, retracting speed brakes as power is applied, and establish an instrument takeoff attitude. The landing gear and wing flaps are retracted in the same manner (and with the same restrictions) as they are during an instrument takeoff. When the climb airspeed reaches 175 knots IAS, reduce power to approximately 80%-85% rpm to maintain a climb at 175 knots IAS, until reaching missed approach altitude. When the desired altitude is reached, reduce power to maintain a minimum of 175 knots IAS or a minimum power setting of 65% rpm.

As the published instrument approach procedures vary at different installations, it is recommended that letdown procedures be reviewed as a part of preflight planning. Some approach procedures allow only a small area for maneuvering; consequently, close attention and prior planning is necessary to prevent exceeding published limitations when flying at 175 knots IAS or more. The published procedure may (or may not) require the execution of a procedure turn prior to starting final approach to the field. If a procedure turn is required, a teardrop type procedure turn will be used. After reaching the station, turn to the published outbound teardrop procedure turn course or, if no teardrop is published, turn 30 degrees from the published course from the station to procedure turn. Start the time over the station and fly outbound for 1 minute and 30 seconds while descending to procedure-turn altitude. After time has elapsed, turn back inbound to the station. Complete the approach as published, maintaining appropriate airspeeds. Landing gear is normally extended after completion of the procedure turn. When executing approaches not requiring a procedure turn, the gear is extended after reaching the station at minimum penetration altitude. For a straight-in approach and landing, extend speed brakes and wing flaps when the landing is assured. When a circling approach is required, extend speed brakes and wing flaps on base leg or final approach as desired.

Radar Approach.

The procedures for radar approach are outlined in figure 9-2. The fuel and time required may be different at different bases depending on local procedures and the type of pattern in use. Emergency radar approaches may be made with less fuel by requesting the radar controller to shorten the pattern.

ICE AND RAIN.

VISION IN RAIN.

If mist or light rain is reported, vision will be significantly affected during landing. If moderate rain is reported, vision will be greatly reduced. If heavy rain is reported, forward vision will be virtually impossible.

typical radar approach

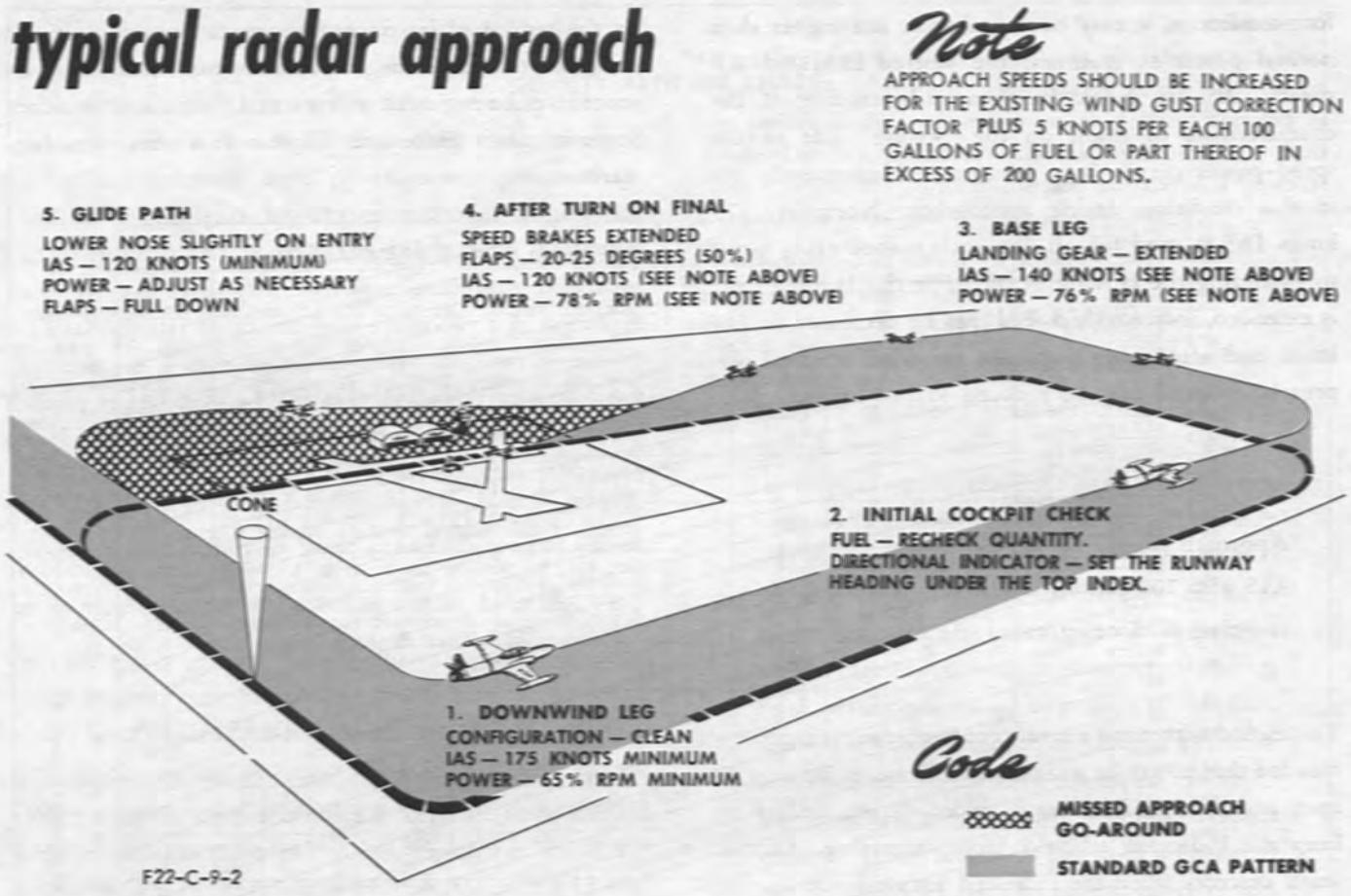

Figure 9-2

Under these conditions, better visibility is obtained by looking through the curved triangular portions of the windshield.

STRUCTURAL ICING.

When flying in weather, the possibility of engine or airframe icing is often present. The thinner wing sections and higher speeds of jet aircraft can result in critical ice accumulations in relatively light icing conditions. However, this aircraft will normally operate above icing levels, and its performance characteristics generally make it possible to fly out of dangerous icing altitudes. If the aircraft does ice up, remember the two most serious aspects. First, engine ice can result in major engine damage. Second, any accumulation of airfoil ice destroys lift and increases drag, resulting in abnormally high stall speeds.

Ice will normally adhere to the windshield and leading edge of the wing and may extend out to approximately 3 inches in moderate to heavy icing conditions. Rime ice, normally associated with stratus-type clouds, will usually form in horizontal ridges along the leading edge of the wing. Clear ice, normally associated with turbulent air conditions, assumes no definite pattern. Aircraft control becomes very sluggish when heavy icing accumulates on the aircraft; up to 80 knots IAS may be lost at cruising speeds. Normally, airspeeds 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. When structural icing

is encountered critical accretion may be prevented by climbing to clear air above the clouds or by climbing to an altitude where ambient temperature is low enough to prevent further ice accretion. If a climb is impractical, a descent to an altitude where temperature is above freezing is often the best solution.

WARNING

Icing can cause the stall speeds to increase considerably. Heavy ice may raise the stall speeds in the clean configuration up to approximately 170 knots IAS; therefore, extreme caution must be exercised when making instrument approaches and landings in icing conditions. During heavy icing conditions ice may close the static pressure inlet port. Such a condition is evidenced by an abnormally high indicated airspeed in proportion to the amount of power applied. This erroneous indicated airspeed, coupled with a higher stalling speed (created by wing and structural icing), requires that extreme caution be used, especially at low altitudes and during landing operations.

INDUCTION ICING.

The centrifugal-compressor-type engine is relatively free from icing difficulties. In flight, the rotation of the air as it enters the engine effectively separates the water droplets from the air and deposits them on surfaces where icing is not considered serious. While it may be possible to ice the engine, icing conditions must be extremely severe to do so. The initial indication of induction icing is an increase of exhaust gas temperature and a loss of thrust. This usually is the only indication prior to complete engine failure. When induction icing occurs, power should be reduced immediately until the exhaust gas temperature is within normal operating limits. In severe cases of induction icing, it may be necessary to retard the throttle to OFF and descend to a lower altitude where outside air temperature is high enough to melt the ice and allow an air start to be made. Atmospheric icing conditions should be avoided whenever possible. It is recognized that the most proficient weather service cannot always accurately predict just when or where icing may be encountered. Many areas of probable icing conditions can be avoided by careful planning and utilization of available weather information. (Refer to Engine Fuel System Icing, Section III.)

ICE AND SNOW REMOVAL.

Depending on the weight of snow and ice accumulated, takeoff distances and climbout performance can be seriously affected. The roughness and distribution of the ice and snow could vary stall speeds and characteristics to an extremely dangerous degree. Loss of an engine shortly after takeoff is a serious enough problem without the added and avoidable hazard of snow and ice on the wings. In view of the unpredictable and unsafe effects of such a practice, the ice and snow must be removed before flight is attempted.

TURBULENCE AND THUNDERSTORMS.

Routine instrument flights may require the penetration of turbulent air areas or thunderstorms. If this becomes necessary the power setting and pitch attitude required for penetration should be established prior to entry. If this power setting and pitch attitude is maintained in the turbulent area, the airspeed and attitude will remain fairly constant regardless of false airspeed and attitude indications.

A safe and comfortable penetration speed for this aircraft at or below 30,000 feet is 250 knots IAS. Above 30,000 feet it is necessary to reduce airspeed somewhat in order to provide a comfortable and safe margin (approximately 30 knots) between penetration airspeed and the limiting Mach number of the aircraft. Example: At 40,000 feet, 210 knots IAS would be a safe and comfortable airspeed. 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 aircraft to regions of possible thunderstorms.

Be sure to check proper operation of all flight instruments, navigation equipment, pitot heater, and instrument panel lights before attempting flight into thunderstorm areas.

It is imperative that the pilot prepare the aircraft prior to entering a zone of turbulent air. If the storm cannot be seen, its proximity may often be detected by crash static. Prepare the aircraft by adjusting power as necessary to obtain a safe penetration speed of 210–250 knots IAS. Then turn the pitot heater ON. Check the gyro instruments for proper settings and tighten safety belt tight and shoulder harness. Adjust the seat to secure adequate head clearance. Secure all loose equipment. Turn off any radio equipment rendered useless by lightning static and turn cockpit lights full bright to minimize blinding effect of lightning. Do not lower landing gear or wing flaps since they do not increase aerodynamic efficiency. While in the storm maintain power setting and pitch attitude. Hold these constant and the airspeed will remain approximately constant regardless of the indicated airspeed. Expect turbulence, precipitation and lightning. Concentrate principally on holding a level attitude by reference to the attitude indicator. Do not chase the airspeed indicator; doing so could result in extreme aircraft attitudes. Partial blocking of the pitot tube pressure head, caused by heavy rain, may decrease the indicated airspeed considerably. Use as little elevator and aileron control as possible to maintain aircraft attitude in order to minimize the stresses imposed on the aircraft.

NIGHT FLYING.

For night flying check the lighting equipment thoroughly and be familiar with the location of all switches in the cockpit. Switch locations and lighting equipment differ in various aircraft serial groups, so be familiar with the particular airplane you are going to fly and be sure to carry a functioning flashlight. For taxiing at night, move the landing light and taxi light switch to the TAXI LIGHT position. For takeoff and landing use the landing lights as desired. For prolonged flight in night weather it is recommended that the navigation lights switch be in the STEADY position to reduce eye distraction created by reflection from clouds. All instrument, console, and warning lights should be dimmed as necessary. Remember, red lighting is easiest on night vision.

COLD WEATHER OPERATION.

The success of low-temperature operation depends primarily upon the preparations made during the postflight inspection in anticipation of the requirements for operation of the following day. The procedures outlined must be followed to expedite the preflight inspection and to ensure satisfactory operation of the airplane and its systems during the next flight.

BEFORE EXTERIOR INSPECTION.

Remove all protective covers and dust plugs and check the entire airplane for freedom from frost, snow, and ice. Brush off all light snow and frost. Remove all ice by a direct flow of air from a portable ground heater.

WARNING

Care should be exercised to ensure that water from melted ice is sponged so that it will not drain to some critical area and refreeze. Dangerous loss of lift may result if the aircraft is not adequately cleaned of all frost, snow, and ice.

CAUTION

Do not attempt to chip or scrape ice from the aircraft surfaces as this action may cause damage to the airplane.

At temperatures below –26°C (–15°F), preheating is necessary for satisfactory closure of the cockpit canopy and should be applied to ensure proper heating of the canopy seals, the cockpit, and the instrument panel. Place heater duct in cockpit and lower canopy to heater duct. Ensure that heater airflow is not "choked" by the canopy. Then, place the canopy cover over the partially closed canopy. Be sure that the fuel tank vents, fuel filter, and drain cocks are free of ice and drain condensate. Check shock struts and actuating cylinders for dirt and ice; clean with a rag soaked in hydraulic fluid

and check struts for proper inflation. No preheating or oil dilution is required to ensure ability to start or proper lubrication down to –54°C (–65°F). However, if a start is necessary with an inadequate power unit, preheating the accessory section and the oil sump will facilitate the start by decreasing starter loads. Verify that the fuel filter deicing system has been serviced. If JATO units are to be used, install units just prior to starting engine to minimize cooling period before use.

INTERIOR INSPECTION.

Check flight controls for proper operation and ensure that canopy can be closed and locked. To conserve the battery use external power source to operate and check electrical and radio equipment.

Starting Engine.

Check that the power unit output is set for 28 volts and between 800 and 1200 amperes. A setting of 1200 amperes is recommended, resulting in a cooler start. Any amperage output between 800 and 1200 may be used if the unit cannot deliver 1200 amperes. If minimum starting rpm (9%) cannot be obtained, shut down the engine and connect an adequate power unit. Preheat through the intake ducts if a start is necessary with an inadequate power source.

Start the engine using the normal starting procedure outlined in Section II. If there is no indication of oil pressure after 30 seconds of engine operation, or if the pressure drops to zero after a few minutes of ground running, stop the engine and investigate.

Note

No warmup is required if the oil pressure remains below 100 psi at full throttle. A temporary high oil pressure (above 100 psi) is not dangerous but takeoff should be delayed until the pressure drops below 100 psi. If the oil pressure remains above 100 psi, an oil system malfunction is indicated and the airplane should not be flown.

BEFORE TAXIING.

Turn on cabin heat and windshield defrosting system, as required, immediately after engine start. Check wing flap and flap indicator operation. If questionable readings result, cycle flaps three to four times to correct indicator action. Check the fuel filter deicing system operation by energizing the system and checking the generator loadmeter for an increased reading.

WARNING

Make sure all instruments have warmed up sufficiently to ensure normal operation. Check for sluggish instruments during taxi.

Note

Because of low ambient temperatures, the thrust developed at all engine speeds is noticeably greater than normal.

CAUTION

Use firmly anchored wheel chocks for all engine runups.

TAXI.

Avoid taxiing in deep snow; such taxiing makes steering extremely difficult and frozen brakes may result. Use only essential electrical equipment to preserve battery life when taxiing at low engine speeds. Decrease taxiing speed and increase the taxi interval at subfreezing temperatures to ensure safe stopping distance and to prevent icing of airplane surfaces by melted snow and ice in the jetblast of a preceding airplane.

Energize the fuel filter deicing system for 30 seconds to preclude the possibility of fuel icing during takeoff. Recheck the pitot heat switch ON and turn the gun heat switch ON, if necessary. Make final instrument check during the first part of the takeoff roll as the brakes will not hold the airplane on snow-covered or icy runways at full throttle.

WARNING

- Adjust cabin temperature to a comfortably warm setting to help prevent cockpit fog forming on takeoff.
- Recheck windshield defrosting system while taxiing and readjust as necessary to prevent the windshield from becoming obscured by frost during takeoff.

TAKEOFF.

During cold weather operation the maximum engine speed of 100% rpm will not be available at low ambient air temperature because of increased air density. However, the governor control should not be reset to 100% rpm because the rated output and design strength of the engine will be exceeded. For cold weather takeoffs the following chart will indicate the maximum engine speeds attainable.

MAXIMUM ENGINE SPEED NORMALLY ATTAINABLE DURING LOW-TEMPERATURE OPERATION

Compressor Inlet Temperature		J33-A-35 Engine Speed	
°C	°F	Percent	RPM
–18	0	99.6	11,703
–23	–10	98.8	11,609
–29	–20	98.0	11,515
–34	–30	97.2	11,421
–40	–40	96.5	11,339
–46	–50	95.7	11,245
–51	–60	95.0	11,162

AFTER TAKEOFF CLIMB.

After taking off from a runway covered with large puddles of water, do not retract the gear for at least 15 seconds after breaking ground so that the centering cam can position the nose gear for retraction.

Increased thrust during cold weather operation at low altitudes will result in better climb performance. Follow recommended climb speeds as given in the Climb Chart in the Appendix.

CRUISE.

Aircraft operation during flight in cold weather should be governed by normal procedure.

DESCENT.

Several minutes prior to starting a descent, adjust the cabin heat control to the HOT position, engage defroster control valve and turn on the auxiliary windshield defroster, if required. This will warm the canopy and windshield and prevent the formation of fog or frost on these surfaces during rapid descent from higher altitudes.

Check engine operating temperatures during descents and in the landing patterns as lower temperatures are common at low altitudes because of temperature inversions.

BEFORE LANDING.

Operate fuel filter deicing system for 30 seconds before entering the pattern and turn off all nonessential electrical equipment to reduce battery load when generator cuts out. Make normal patterns and landings but allow for a flatter glide because of increased thrust. Pump brakes to check operation. Landing speeds and technique are normal with the usual care being exercised in the use of the brakes on snow-covered or slippery runways.

ENGINE SHUTDOWN.

Shut down the engine in the normal manner.

BEFORE LEAVING THE AIRCRAFT.

Release brakes after wheels are chocked and leave canopy partly open to allow circulation within the cockpit to prevent canopy cracking from contraction and to reduce windshield and canopy defrosting. Then inspect shock struts and actuating cylinders and wipe with a rag soaked in hydraulic fluid. It is advisable to keep shock struts exceptionally clean as any scarring of the seals will result in excessive leakage. Whenever possible, leave the aircraft parked with full fuel tanks. Every effort should be made during servicing to prevent moisture from entering the fuel system. Install protective covers and dust plugs and remove batteries when the aircraft is to be parked at temperatures below –29°C (–20°F) for more than four hours.

HOT WEATHER OPERATION.

Hot weather and desert operation is virtually identical with normal operation with a few exceptions which are discussed below.

BEFORE EXTERIOR INSPECTION.

Inspect intake ducts and plenum chamber for the presence of sand. If excessive sand is found, do not start the engine.

CAUTION

- Always inspect air intake ducts.
- Be careful when removing fuel caps. Thermally expanded fuel vapor may blow the cap in your face.

Inspect tires for blisters, other deteriorations, and improper inflation. Check particularly for hydraulic system leaks as heat and moisture may cause valves and packings to swell. Check electrical wiring and equipment for evidence of corrosion.

INTERIOR INSPECTION.

Care should be exercised not to allow foreign objects to come in contact with the canopy because it is possible to damage the plexiglass in extremely hot weather.

STARTING THE ENGINE.

Normal starting procedures are used in hot weather.

BEFORE TAXIING.

Ground testing should be complete but accomplished as rapidly as possible.

TAXI.

Taxi carefully with minimum power to minimize the blowing of dust and sand onto other aircraft. Maintain adequate distance from any aircraft taxiing ahead. Brakes should be used as little as possible to prevent overheating. Be sure that takeoff distances have been checked in the Appendix.

TAKEOFF.

At ambient air temperatures above 15°C (59°F), full thrust will not be obtainable because of decreased air density even though 100% rpm is possible. For operation with ambient air temperatures above 50°C (128°F) it usually will be necessary for the pilot to reduce engine speed below 100% rpm to prevent the exhaust gas temperature from exceeding 715°C.

Note

Takeoff planning is very important when ambient air temperatures exceed 15°C (59°F) especially on runways of marginal length. The aircraft will accelerate slowly and takeoff distance will be longer because the air is less dense. Groundspeed will be increased for the same indicated airspeed. The refusal speed and distance and the speed and distance checks should be carefully calculated. On extremely hot days it may be necessary to use JATO for takeoff on runways of marginal length. Takeoff planning is not possible above 50°C (128°F) because the takeoff charts in the Appendix do not include temperatures above 50°C. Consequently, takeoffs under these temperature conditions are not recommended.

AFTER TAKEOFF CLIMB.

Follow normal procedures. Rates of climb should be held as low as practicable because fuel in the tanks is warm and more susceptible to vaporization losses with rapid climbs to altitude.

CRUISE.

Engine operation in flight should not be affected at normal altitudes. At low altitudes temperatures may be in the high ranges.

DESCENT.

Turn on auxiliary defroster and engine defroster control valve prior to descent since warm humid air is likely to cause canopy frosting in hot weather descents.

BEFORE LANDING.

Follow normal procedures.

AFTER LANDING.

Hot weather operation requires the pilot to be cautious of gusts and windshifts near the ground. Landing ground rolls are slightly longer than those in normal temperature.

ENGINE SHUTDOWN.

Shut down the engine in the normal manner.

BEFORE LEAVING THE AIRCRAFT.

The canopy may be left partially open if the location is not subject to blowing sand or dust. In locations with high humidity and excessive temperature changes from day to night, it may be preferable to leave the canopy slightly open and cockpit ventilation duct shutoff levers open. In desert localities cover all ducts and air intakes as soon as possible to prevent blowing sand from entering.

Appendix 1—Performance Data

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Part 1—Introduction

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APPENDIX SCOPE AND ARRANGEMENT.

This appendix contains the performance data necessary for complete flight planning for aircraft operating with tip tanks. Miles per gallon charts are included for operation without tip tanks. Supplemental data provide for operation with a travel pod. A part-type arrangement groups the material as needed for planning general phases of each flight. Descriptive text in each part discusses and explains the use of the types of charts provided. Profile-type charts, presenting 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 test and service experience. Unless specifically stated, it is consistent with the recommended operating procedures and techniques set forth elsewhere in the manual. The charts are based on performance under standard atmospheric conditions; however, correction for nonstandard temperature conditions have been included when possible. Flight test data is based on engines which deliver 4100 pounds static installed thrust (sea level). This is approximately a 4600 pound uninstalled static thrust rating. Takeoff and climb performance will be affected if thrust of the engine installed in the aircraft varies from this value.

FUEL AND FUEL DENSITY.

The normal fuel density figure for JP-4 used in preparation of the Flight Manual is 6.5 pounds per gallon. Present day fuel densities for JP-4 can run from 6.249 to 6.675 pounds per gallon. This can cause a 2 to 2.5 percent variation in aircraft weight, thus causing some variation in performance. Likewise, if the fuel density has been reduced it is anticipated that some change in the heat content of the fuel has been experienced. Thus, if the heat content has been reduced the aircraft performance per pound of fuel is reduced and less range is available. Because of the discrepancy in fuel density and heat content of the fuel, specific range and rates of fuel flow quoted in terms of gallons can be in error.

Figure A1-7 may be used to determine aircraft gross weight with various fuel loads. Note that the assumed density of gasoline (emergency fuel) is 6.0 pounds per US gallon, and that the gross weight is reduced 489 pounds when fully loaded with this fuel.

PERFORMANCE WITH TRAVEL POD.

The installation of the standard travel pod reduces the climb performance slightly but has a negligible effect on takeoff and cruise performance.

STANDARD CORRECTION CHARTS.

Readings obtained directly from flight airspeed and altimeter instruments must be subjected to certain standard corrections prior to use. Standard correction charts showing the necessary corrections are presented in figures A1-2 through A1-6. These include a temperature conversion chart, airspeed and altimeter position error corrections, a compressibility correction to calibrated airspeed chart, and a density altitude chart. The position error correction data are of considerable importance for predictions of altimeter and airspeed indicator readings, and for comparisons of actual performance with standard values shown on the performance charts. A density altitude chart is given to facilitate the calculation of true airspeed and density altitude under different temperature conditions.

AIRSPEED POSITION ERROR AND COMPRESSIBILITY CORRECTION CHARTS.

Airspeed position error correction can be determined directly from figure A1-3. Algebraically add the position correction to indicated airspeed (corrected for individual mechanical instrument error) to obtain calibrated airspeed. For example: With the landing gear down at 140 knots IAS, the CAS is 134 knots. Compressibility correction to calibrated airspeed can be determined from figure A1-4. The method of use is the same as for the airspeed position error correction chart. It is important that the instrument be calibrated if suspected error exists. (Flush statics should be maintained in good condition.) Failure to use position error and airspeed compressibility correction data properly can result in apparent inability to realize predicted aircraft performance.

ALTIMETER POSITION ERROR CHART.

The altimeter position error chart, figure A1-5, supplies the position error correction for the altimeter. The system reads high; therefore, subtract the error from the assigned flight level to obtain proper altitude indicator reading. (Refer to example on chart.)

EXAMPLE OF USE OF STANDARD CORRECTION CHARTS.

The example given below illustrates the correct procedure to follow in using the standard correction charts.

Conditions:

- Altimeter indicator reading ..... 35,000 feet
- Airspeed indicator reading corrected for instrument error (IAS) ..... 220 knots
- Outside air temp (OAT) ..... —40°F.
- Headwind ..... 20 knots

a. Density altitude (H_d), figure A1-6 .... 36,000 feet

b. Altimeter position error correction (ΔH) (from figure A1-5) ..... 380 feet (high)

c. Flight level (H_P) (35,000 ft —380 ft) ... 34,620 ft

d. Position error correction (ΔV_i) (from figure A1-3) ..... —5.7 knots

e. Calibrated airspeed (CAS) (220 kn —5.7 kn) ..... 214.3 knots

f. Correction for compressibility (ΔV_c), from figure A1-4 ..... —8 knots

g. Equivalent airspeed (EAS), (214.3 kn —8 kn) ..... 206.3 knots

h. $1\sqrt{\sigma}$, (from figure A1-6) 1.84

i. True airspeed (TAS), (206.3 kn × 1.84) ..... 380 knots

j. Groundspeed (GS), (380 kn —20 kn) ..... 360 knots

SYMBOLS AND DEFINITIONS

SYMBOL	DEFINITION
IAS	Indicated airspeed; airspeed indication uncorrected for instrument error. Where this symbol is used on the performance charts, mechanical error is assumed to be zero.
ΔV_i	Airspeed position error correction.
CAS	Calibrated airspeed. Indicated airspeed corrected for position error: CAS = IAS + ΔV_i.
ΔV_c	Airspeed compressibility correction.
EAS	Equivalent airspeed. Calibrated airspeed corrected for compressibility: EAS = CAS + ΔV_c.
TAS	True airspeed, equivalent airspeed corrected for atmospheric density: TAS = EAS × $1/\sqrt{\sigma}$. ($1/\sqrt{\sigma}$) from figure A1-6.
M	Mach number.
OAT	Outside air temperature.
GS	Groundspeed. True speed relative to the ground; true airspeed corrected for the wind component velocity: GS = TAS + V_w.
H_D	Density altitude. That value obtained from the Density Altitude Chart, figure A1-6, at which air density at the observed pressure altitude equals air density as defined by the NASA for standard atmospheric conditions.
H_P	Pressure altitude
ΔH	Altimeter position error
NASA	National Aeronautics and Space Administration, Washington.
ρ	Air density at altitude
ρ_o	Standard air density at sea level
σ	Relative air density (ρ/ρ_o)
% RPM	Engine speed expressed as (actual RPM/11,750) × 100%.
Lb	Pounds
Ft	Feet
Min	Minutes
nmi	Nautical miles
Mi/Gal	Nautical miles per gallon of fuel
lb-nmi/lb	Range factor expressed as pound—nautical miles per pound of fuel
GPH	Fuel flow, gallons of fuel per hour
Kn	Knots
V_w	Wind component velocity

Figure A1-1

TEMPERATURE CONVERSON CHART

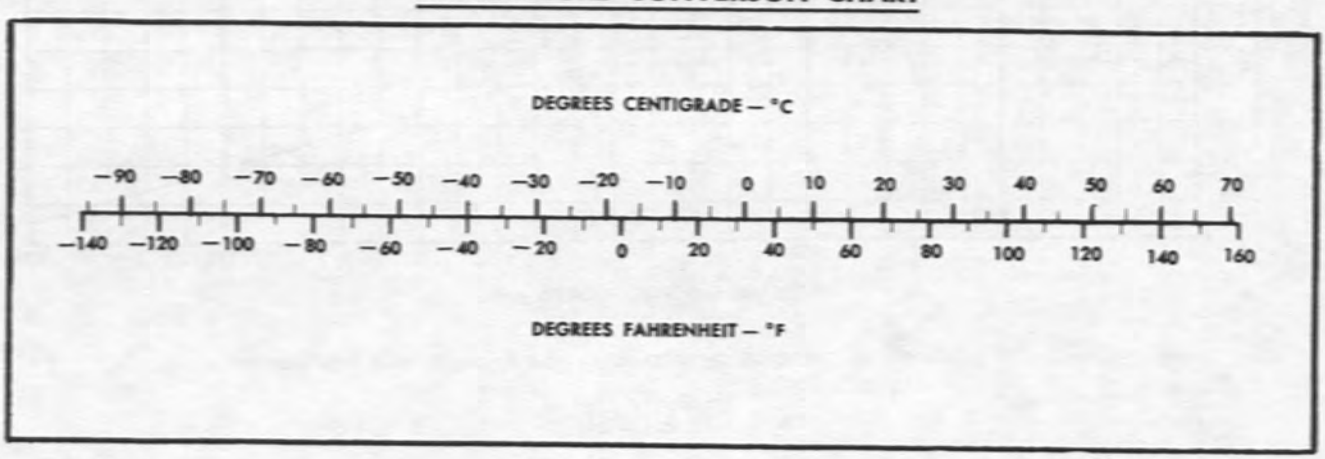


Figure A1-2

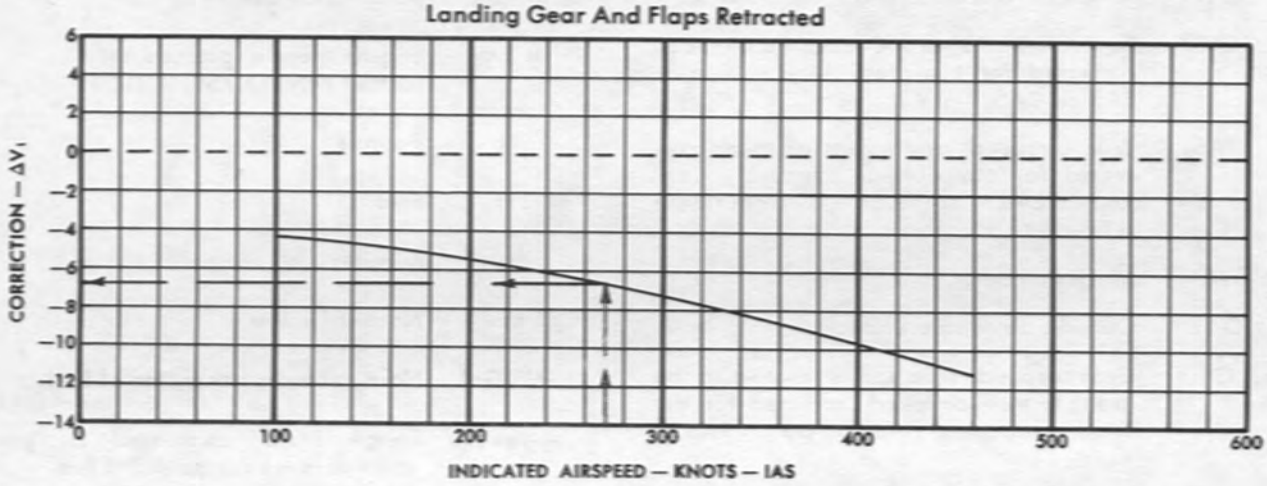
AIRSPEED POSITION ERROR CORRECTION

MODEL: RT-33A
DATA AS OF: 15 FEBRUARY 1962
DATA BASED ON: FLIGHT TEST

TAKE-OFF
POSITION ERROR CORRECTION IS 0 KNOTS DURING TAKE-OFF GROUND RUN.

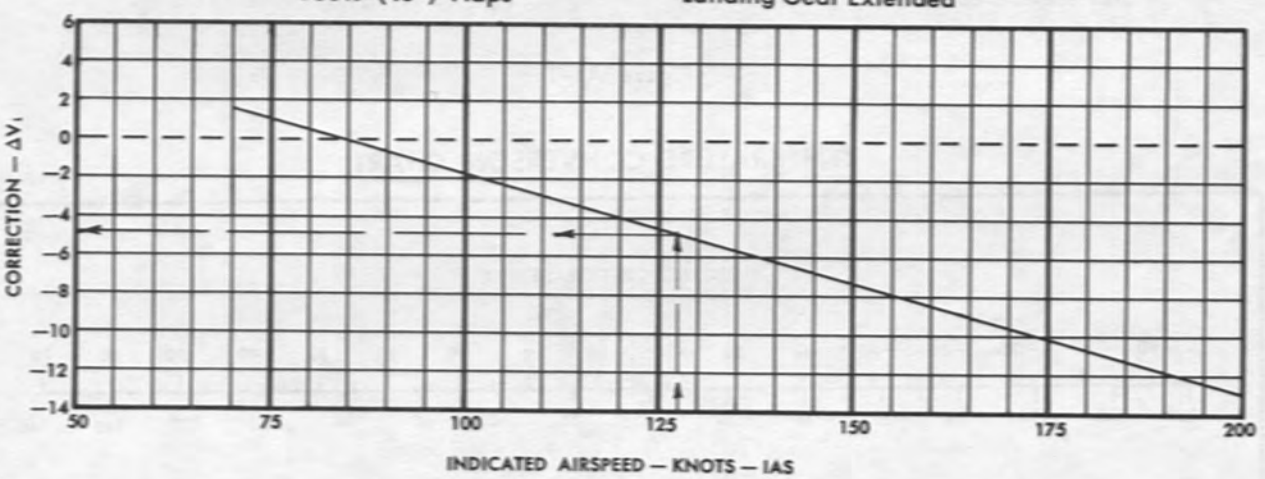
NORMAL FLIGHT

Landing Gear And Flaps Retracted



LANDING CONDITION

100% (45°) Flaps Landing Gear Extended



REMARKS: CORRECTION TO INDICATED AIRSPEED TO OBTAIN CALIBRATED AIRSPEED.

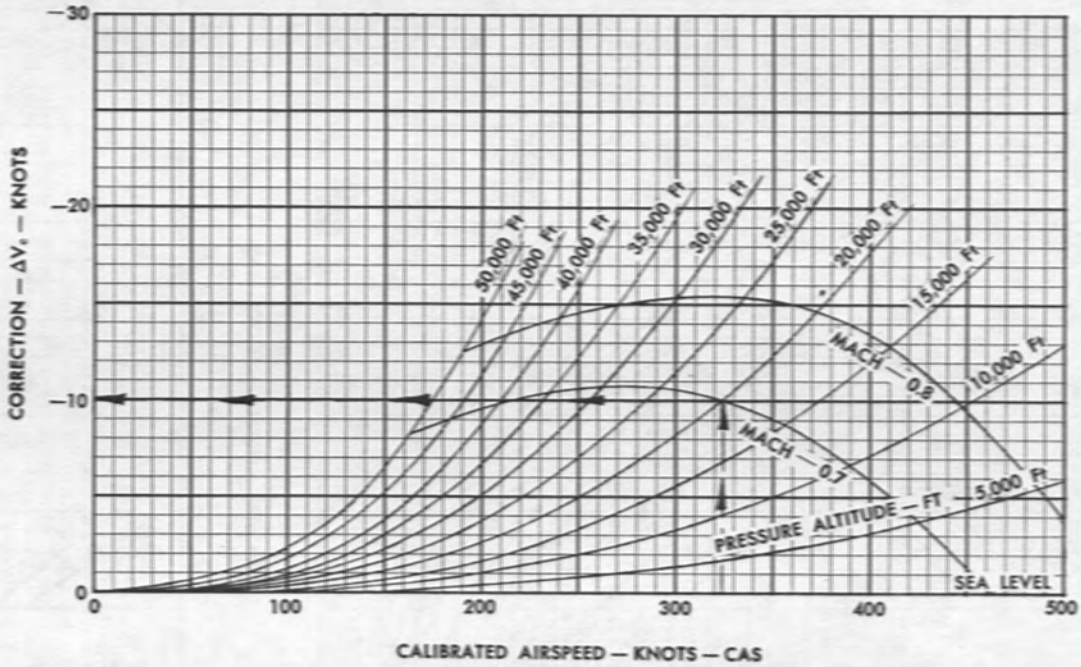
$CAS = IAS + \Delta V_i$

$IAS = CAS - \Delta V_i$

Figure A1-3

COMPRESSIBILITY CORRECTION TO CALIBRATED AIRSPEED

MODEL: RT-33A
DATA AS OF: 1 OCTOBER 1958
DATA BASED ON: CALCULATION



REMARKS: ADD COMPRESSIBILITY CORRECTION TO CALIBRATED AIRSPEED TO OBTAIN EQUIVALENT AIRSPEED ($V_{T\sigma^{1/2}}$)

$EAS = CAS + \Delta V_c$ $\quad CAS = EAS - \Delta V_c$

EAS = EQUIVALENT AIRSPEED ($V_T / 1/\sqrt{\sigma}$)

CAS = AIRSPEED CORRECTED FOR INSTRUMENT AND POSITION ERRORS

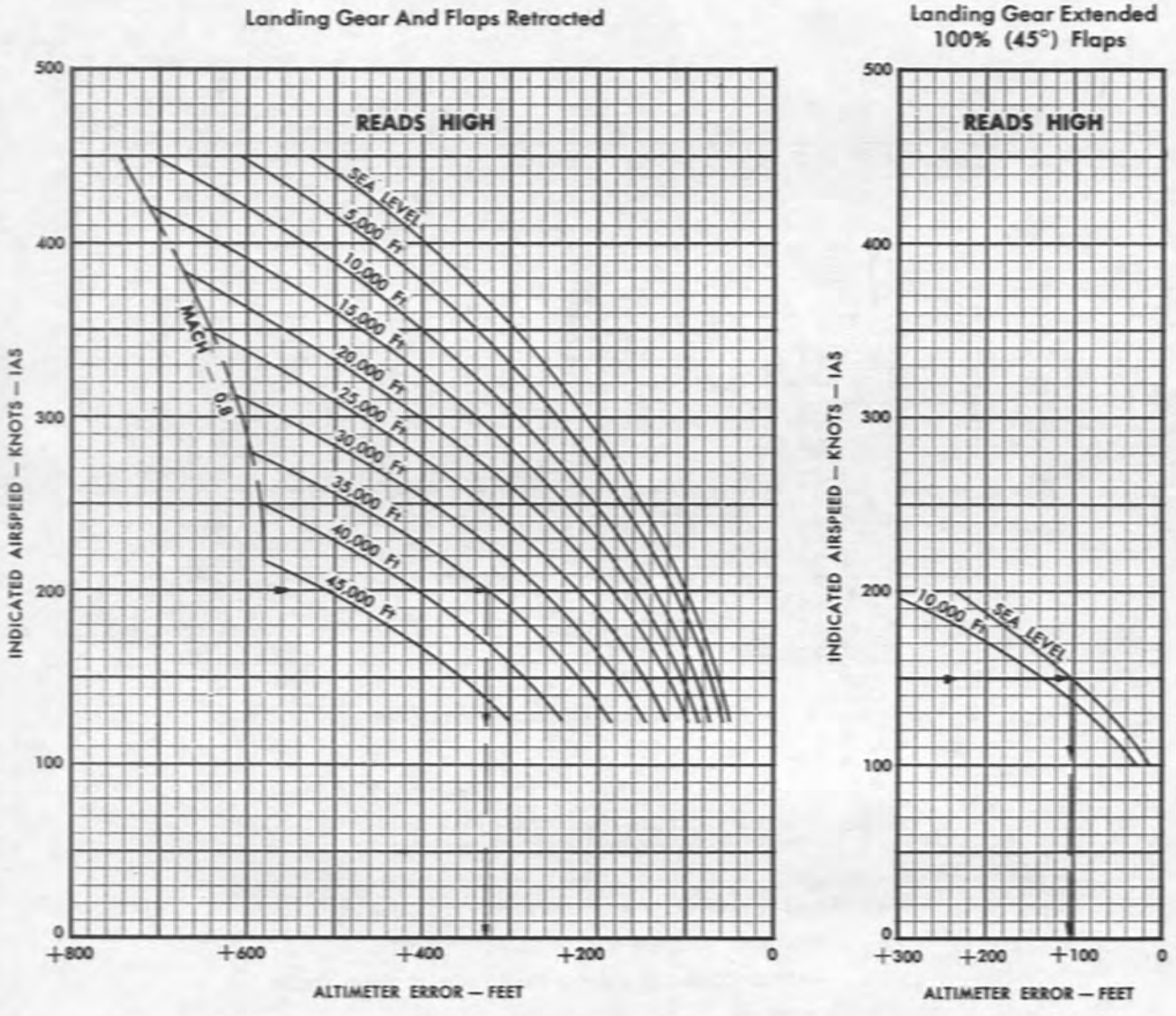
M = MACH NUMBER

Figure A1-4

ALTIMETER POSITION ERROR

MODEL: RT-33A
DATA AS OF: 15 FEBRUARY 1962
DATA BASED ON: FLIGHT TEST

ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB /GAL
FUEL GRADE: JP-4



ADD CORRECTION TO ASSIGNED FLIGHT LEVEL TO OBTAIN PROPER ALTITUDE INDICATOR READING.

EXAMPLE:

TO FLY AT ASSIGNED FLIGHT LEVEL OF 35,000 FEET PRESSURE ALTITUDE, 200 KNOTS IAS, INDICATE 35,330 FEET ON ALTIMETER TO ACCOUNT FOR POSITION ERROR.

35,000 Ft Pressure altitude flight level (Aircraft indicating 35,330 feet.)

Aircraft indicating 35,000 feet (330 feet low)

Figure A1-5

DENSITY ALTITUDE CHART

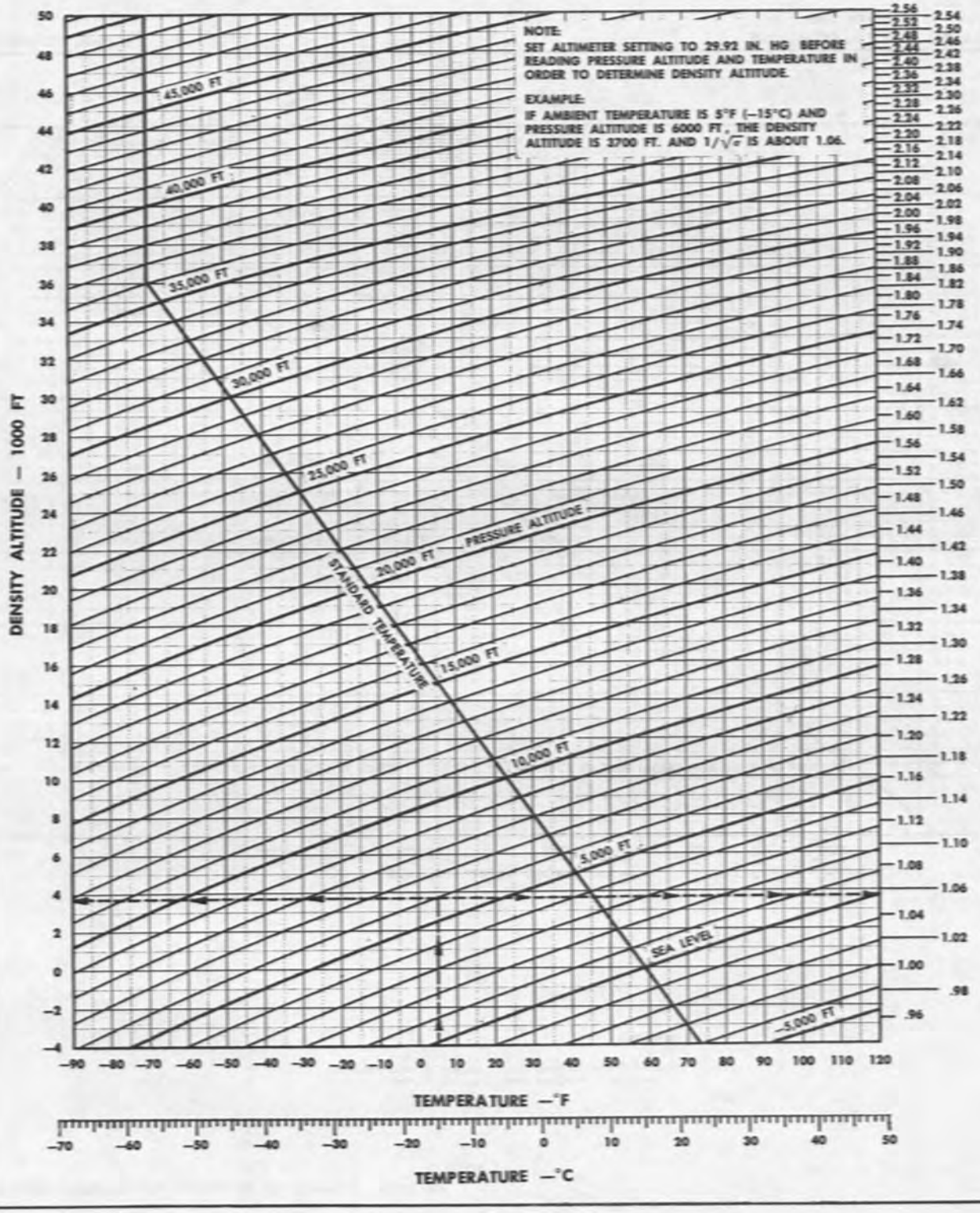


Figure A1-6

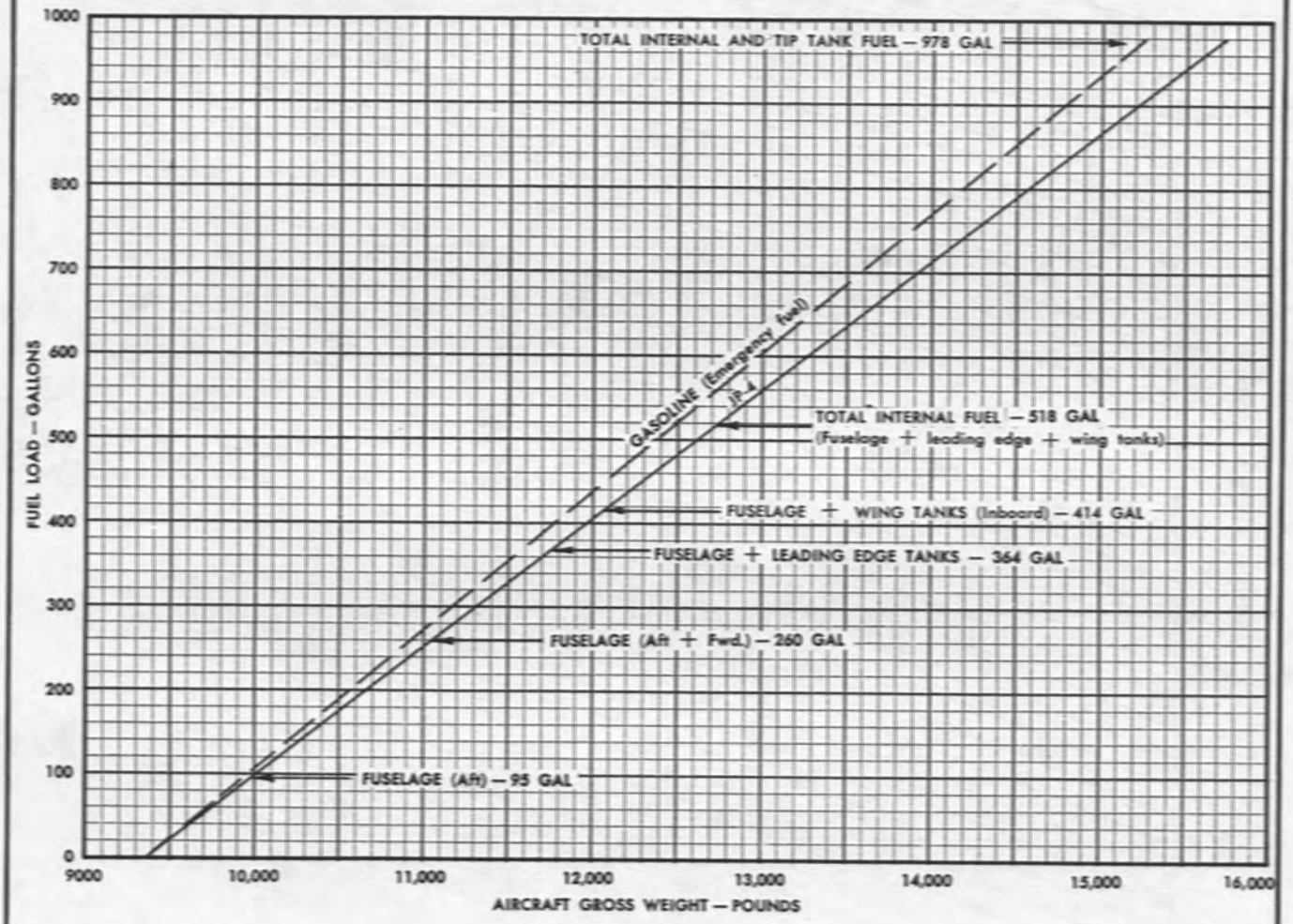
CONFIGURATION

Two 230-Gallon Tip Tanks

FUEL LOAD VS. AIRCRAFT GROSS WEIGHT

MODEL: RT-33A
DATA AS OF: 15 FEBRUARY 1962
DATA BASED ON: CALCULATION

ENGINE: J33-A-35



FUEL DENSITY:

JP-4	6.5 Lb /Gal	
JP-5 (Alternate fuel)	6.5 Lb /Gal	Approx.
Gasoline (Emergency fuel)	6.0 Lb /Gal	

NOTE:
ADD WEIGHT OF TRAVEL POD (30 POUNDS) PLUS BAGGAGE IF CARRIED.

Figure A1-7

Part 2—Takeoff

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Page numbers in **bold face** type denote illustration.

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Obstacle Clearance	A2-2
Wind Component Chart	**A2-5**
Military Thrust Takeoff Performance Charts	**A2-6**
Takeoff Performance Charts With JATO	**A2-10**

TAKEOFF CHARTS.

This part presents and discusses the charts to be used in obtaining maximum thrust and maximum thrust plus JATO takeoff distances. The maximum thrust distances are based on normal acceleration using the normal takeoff technique described in Section II. The maximum thrust plus JATO takeoff performance is based on two JATO firing speed schedules that result either in minimum ground run or minimum 50-foot obstacle clearance distances.

TAKEOFF PLANNING.

Charts for normal operation with maximum thrust and a planning procedure are included in this part for the purpose of monitoring takeoff progress. The acceleration check portion of the go, no-go, concept is introduced as a part of this procedure whereby speed is checked 2000 feet beyond the start of the takeoff run. Allowable check speed tolerance is related to total runway length available so that, in the event of subnormal acceleration, a decision to continue or abort the takeoff may be made before the refusal distance is reached. 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 TAKEOFF SPEED.

Military Thrust.

Takeoff ground run distance is the actual length of runway used from the start of the ground run until the aircraft becomes airborne. Distances representing normal procedure performance are shown in figure A2-2. This chart may be used to predict takeoff distances for operation from dry, hard-surfaced runways for most normal variations of operating altitude, temperature, wind, and slope conditions. The applicable takeoff speeds are also provided on the chart and should be adhered to. Taking off at less than recommended speed often results in the aircraft settling back on the runway. Higher than normal speed results in excessive ground run. The recommended speeds are 124 knots IAS for normal takeoff and 119 knots for minimum ground run with a full load of fuel.

Military Thrust Plus JATO.

Minimum takeoff ground run distances obtained through use of two 1000-pound-thrust JATO units are shown in figure A2-6 for a wide variety of operating altitude, temperature, wind, and slope conditions. These minimum values may be attained by firing the JATO units in accordance with the firing speed schedule shown in figure A2-8. JATO duration varies with temperature ranging from 18 seconds at 0°F, to 12 seconds at 120°F. By firing the units in accordance with the firing speed schedule the units will be expended at about the time the aircraft leaves the ground. The corresponding chart of total distance to clear a 50-foot obstacle, based on minimum ground run, is presented in figure A2-7. Similar charts provide minimum distance performance for 50-foot obstacle clearance.

REFUSAL SPEED.

Refusal speed is the highest speed to which the aircraft can be accelerated, assuming normal acceleration, and still be stopped on the runway remaining. The refusal speed chart (figure A2-3) includes data which account for various gross weights, pressure altitudes, temperatures, and actual runway lengths. Refusal speeds are presented for level, hard-surfaced runways with either dry or wet surface conditions.

Refusal speed should always be checked when operating from short or wet runways. Refusal speed may be less than acceleration check speed.

REFUSAL DISTANCE.

Refusal distance is the distance at which the aircraft will reach the refusal speed, assuming normal acceleration. Refusal distance is obtained from the Velocity During Takeoff Ground Run chart (figure A2-4). This chart is a plot of ground run distance versus indicated airspeed and shows normal acceleration guide lines that indicate the speed–distance relationship for all required takeoff conditions of gross weight, field pressure altitude, and air temperature.

ACCELERATION CHECK SPEED AND DISTANCE.

The acceleration check distance for this aircraft is a point 2000 feet beyond the start of the takeoff run. Abort the takeoff if airspeed is less than the minimum acceleration check speed at the check-distance point.

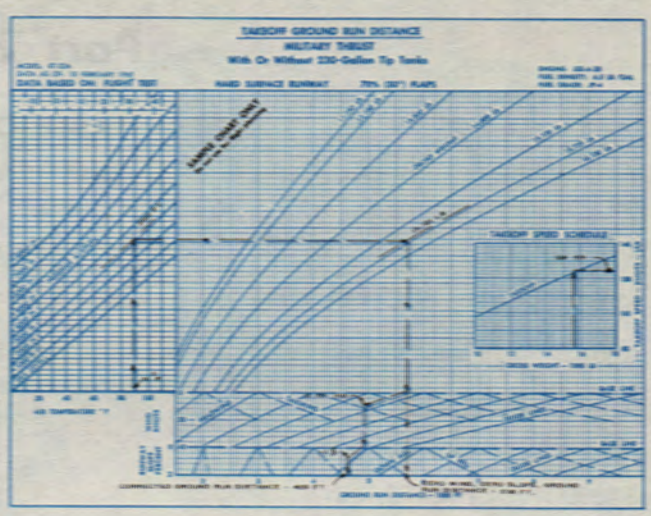
Minimum acceleration check speed is defined as the normal speed predicted for existing takeoff conditions minus a speed tolerance which allows completion of the takeoff within 90% of the runway length available. In no case is a tolerance greater than 10 knots IAS allowed.

Normal and minimum allowable airspeeds are determined from figure A2-4 as demonstrated by the sample problem following. Note that acceleration check speeds must be corrected for actual wind component at the runway in the manner illustrated.

TOTAL DISTANCE TO TAKE OFF AND CLEAR 50 FEET.

NORMAL OPERATION.

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. A total distance chart is provided for military thrust operation in figure A2-5. Distances are shown for a range of altitude, temperature, wind, and slope conditions. Normal takeoff speeds and speeds at which the 50-foot-height point should be reached are included in the charts.



SAMPLE PROBLEM.

Determine takeoff performance for the following conditions:

- Military Thrust, without JATO
- Gross Weight — 15,725 lb
- OAT, air temperature at runway — 91°F
- Field pressure altitude — 3000 ft
- Wind, from 70° — 13 kn
- Runway 030° heading, —1% slope — 6500 ft

(Allow 50 feet to turn and lineup on runway.)

a. The acceleration check will be made after a takeoff run of 2000 ft.

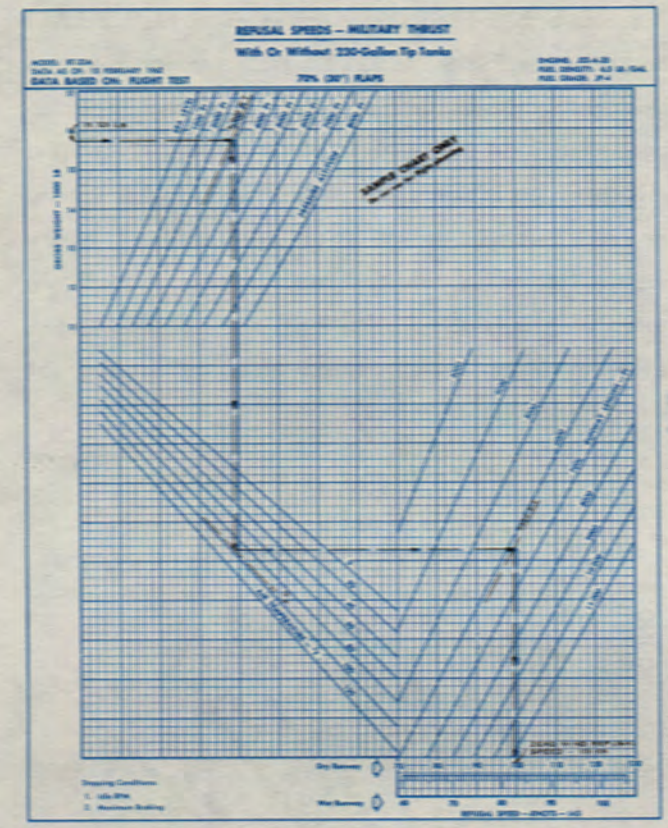
b. Determine the runway wind component, using figure A2-1. At a reported wind velocity of 13 knots and an angle of 70° — 30°, or 40°, the headwind component is 10 knots.

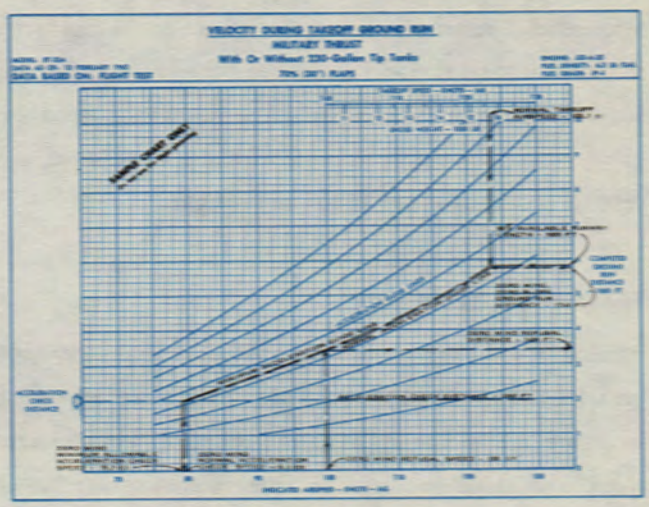
c. From figure A2-2 obtain the takeoff speed and zero-wind, zero-slope ground run distance by the sequence shown for use in determining the acceleration check speed requirements.

Takeoff speed . . . . . 123.7 (124) knots IAS

Zero-wind distance . . . . . 5740 ft

d. From the same figure, find the ground run distance corrected for wind and slope to be 4650 ft.





e. Determine the zero-wind refusal speed directly from figure A2-3 as shown by the sample plot, correcting the runway length for lineup allowance (100 knots). Add the headwind component (10 knots) to obtain corrected refusal speed of 110 knots IAS.

f. Enter figure A2-4 at the takeoff weight and zero-wind takeoff ground run distance and establish the normal acceleration guide line for the takeoff conditions. Read the corrected refusal distance at the intersection of the acceleration guide line and the zero-wind refusal speed as 3420 ft.

g. Continue along the normal acceleration guide line to intersect the 2000-foot ground run distance line. The speed at this point is the normal acceleration check speed for zero-wind conditions, or 79.6 knots IAS.

h. To correct for effect of wind, add the 10-knot headwind component to 79.6 kn and check speed becomes 90 knots IAS.

i. Still using figure A2-4, find the minimum allowable acceleration check speed. Establish a normal acceleration guide line for 90% of the usable runway length (.90 × 6450 = 5805 ft) and read the speed at the 2000-foot ground run distance line to be 79.3 knots IAS.

j. Add the 10-knot wind component to find the minimum allowable acceleration check speed of 89 knots IAS (79.3 kn + 10 kn).

k. A difference of up to but not more than 10 knots is allowable. Minimum acceleration check speed remains 89 knots IAS.

However, if the minimum check speed had been 78 knots IAS, 10 knots would have been subtracted from the normal check speed; (90 kn — 10 kn) = 80 knots, and 80 knots would have been the minimum allowable check speed.

l. Find the normal distance to take off and climb 50 feet and the corresponding speed at 50 feet from figure A2-5. For 10-knot headwind and —1% slope the distance is 8140 ft and the speed is 142.7 (143) knots IAS.

Ground roll distances and total distance to 50 feet with the external travel pod installed are the same as for the standard configuration. No extra allowance need be given when planning a takeoff with the travel pod, except to account for the additional weight.

TAKEOFF WITH JATO.

Minimum total distances to take off and clear a 50-foot obstacle using military thrust plus JATO are presented in figure A2-10 for all required altitude, temperature, wind, and slope conditions. These distances are based on firing the JATO units according to the firing speed schedule shown in figure A2-11. The corresponding ground run distances (figure A2-9) are not minimum distances, since the distances are based on total distances where JATO is expended as the 50-foot obstacle point is reached.

RUNWAY WIND COMPONENT.

Normal acceleration speeds at the acceleration check point must be corrected for wind. The correction is made by adding runway wind component directly to the no-wind speeds. Figure A2-1 presents a chart for computing runway wind component for takeoff and landing. This chart may also be used to obtain crosswind component speeds. Normal takeoff planning procedure may ignore the effect of headwind on takeoff ground run distance, thus considering the benefits of a headwind as an added safety margin. Although headwinds may be ignored in computing takeoff distance, as a safety factor the runway component must be included when determining acceleration check and refusal speeds.

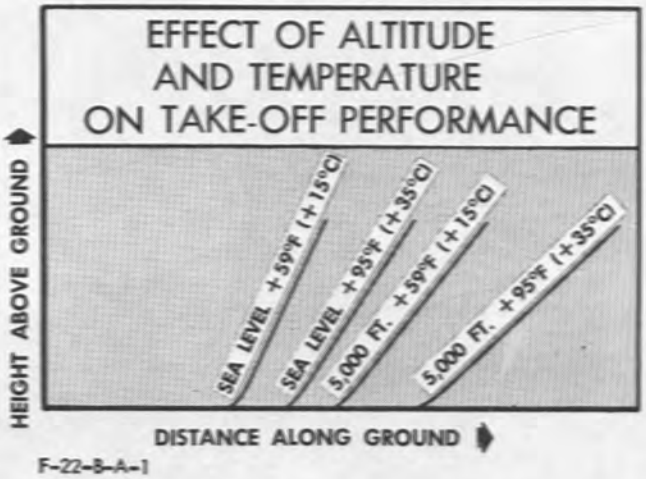
Example.

Conditions:

- Takeoff gross weight .....15,725 lb.
- Wind 60 degrees relative to runway heading at 30 knots, with gusts to 38 knots.

Find: Is takeoff recommended?

Solution: No. From the takeoff schedule (figure A2-6) find the takeoff speed of 124 knots. Enter the crosswind chart using maximum gust velocity and the angle between the wind and runway of 60 degrees. Note that this condition is in the shaded area portion of the chart. Proceed vertically upwards to the maximum recommended crosswind line and read minimum lift-off airspeed of 126 knots. The takeoff is not recommended. (The minimum takeoff speed must not exceed the scheduled takeoff airspeed.)



F-22-8-A-1

EFFECT OF ALTITUDE AND OUTSIDE AIR TEMPERATURE ON TAKEOFF PERFORMANCE.

Engine thrust decreases as altitude or outside air temperature increases. Consequently, greater takeoff distances are required at higher altitudes and on warm days. Representative performance showing the effects of altitude and air temperature on takeoff distances are shown on the accompanying sketch. Note the rates at which both ground run distance and distance to attain a certain elevation above ground increase at higher outside air temperatures and altitudes.

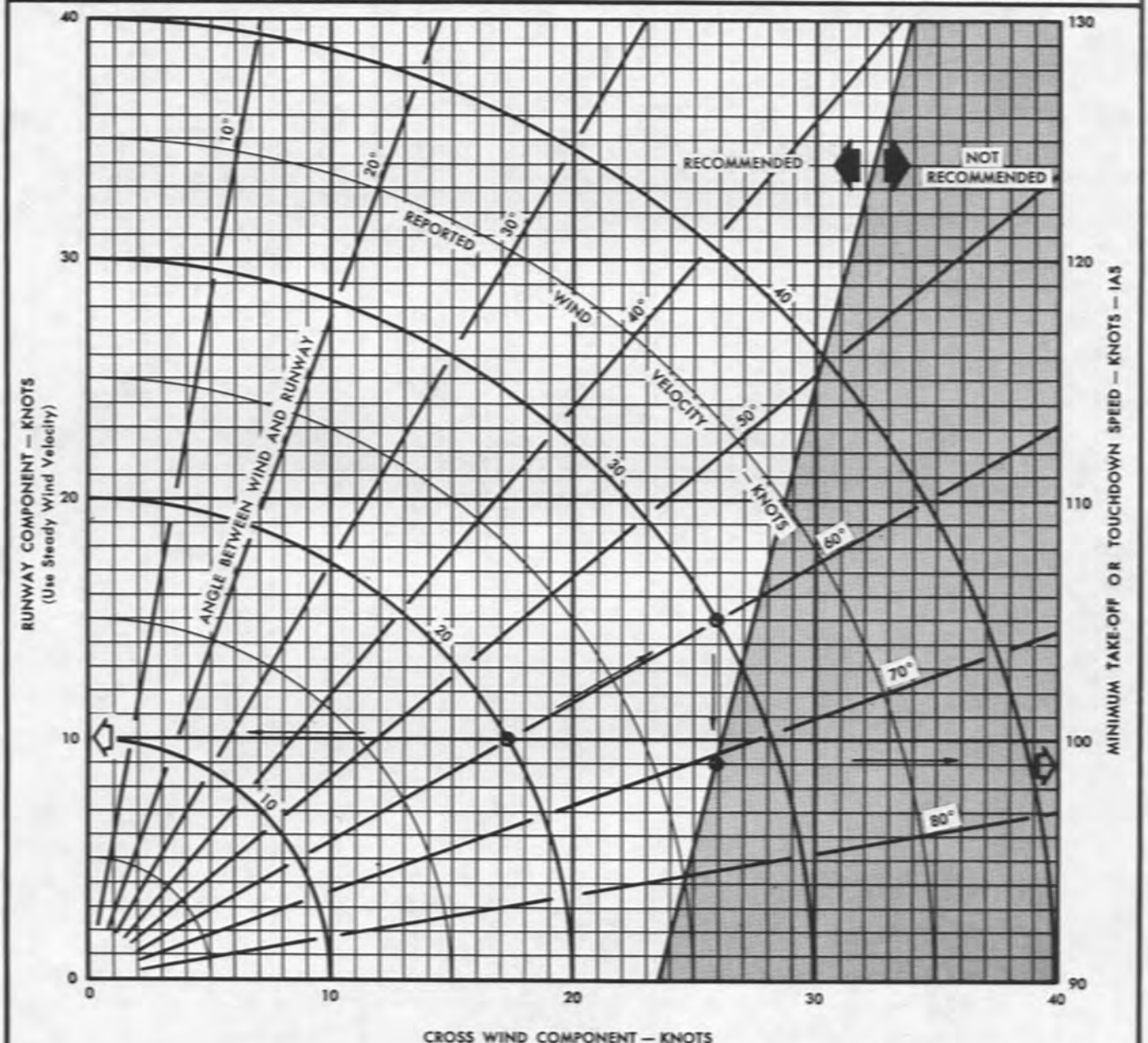
TAKEOFF PLANNING PROBLEM.

The procedures to follow for accurate takeoff planning are presented in the sample problem. The methods used for solution of the example apply to the actual performance charts discussed. Reference sample charts (mentioned in parenthesis) are provided for illustration purposes only and are not to be used for actual performance calculations.

TAKE-OFF AND LANDING WIND COMPONENT CHART

MODEL: RT-33A
DATA AS OF: 15 FEBRUARY 1962
DATA BASED ON: FLIGHT TEST

ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB /GAL
FUEL GRADE: JP-4



NOTES:

1. REFER TO SECTION II FOR TAKE-OFF PROCEDURE.
2. CHECK MINIMUM TAKE-OFF (or touchdown) AIRSPEED, IF GUSTS EXCEED TWENTY-FIVE KNOTS.
3. ALLOWANCE FOR AIRSPEED POSITION ERROR INCLUDED.
4. MAXIMUM RECOMMENDED CROSSWIND BASED ON FIFTEEN DEGREES SIDESLIP.

EXAMPLE:

FOR TWENTY-KNOT WIND, SIXTY DEGREES FROM RUNWAY HEADING, WITH GUSTS UP TO THIRTY KNOTS:

1. USE 10-KNOT HEADWIND FOR TAKE-OFF (or landing) PLANNING.
2. A 26-KNOT MAXIMUM CROSSWIND COMPONENT REQUIRES 99 KNOTS — IAS MINIMUM TAKE-OFF (or touchdown) SPEED.

LANDING CONDITION: DRIFT MAY BECOME SEVERE DURING LANDING GROUND ROLL, IF AIRSPEED TRANSITION THROUGH SHADED (NOT RECOMMENDED) AREA OF CHART IS NECESSARY. DRIFT WILL CONTINUE UNTIL A SUBSTANTIAL PORTION OF THE AIRCRAFT'S WEIGHT IS ON THE RUNWAY.

Figure A2-1

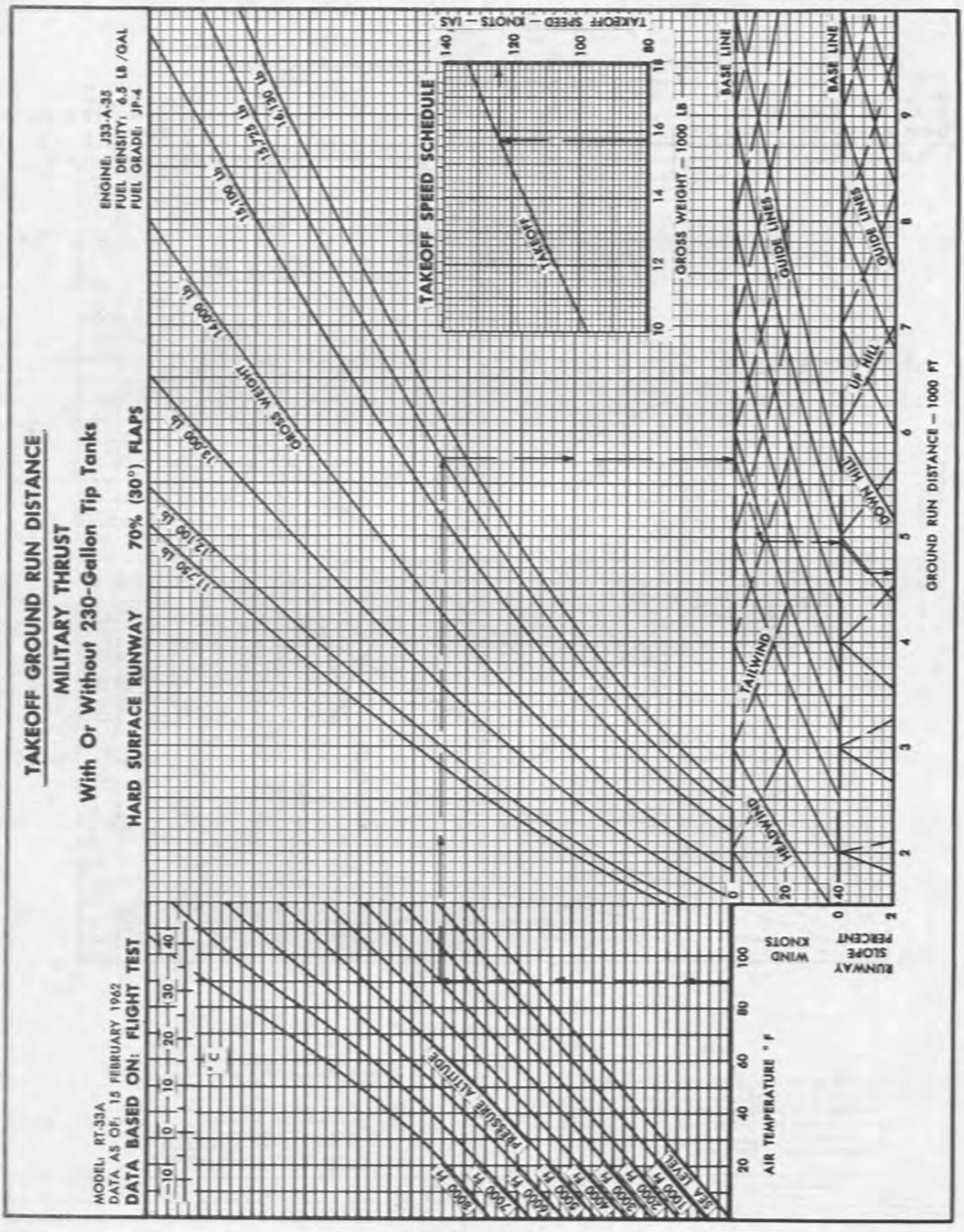

TAKEOFF GROUND RUN DISTANCE
MILITARY THRUST
With Or Without 230-Gallon Tip Tanks
HARD SURFACE RUNWAY 70% (30°) FLAPS
DATA BASED ON: FLIGHT TEST
MODEL: RT-33A
DATA AS OF: 15 FEBRUARY 1962
ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB /GAL
FUEL GRADE: JP-4
TAKEOFF SPEED SCHEDULE
TAKEOFF SPEED — KNOTS — IAS
GROSS WEIGHT — 1000 LB
11,750 LB
12,500 LB
13,000 LB
14,000 LB
15,100 LB
15,723 LB
16,190 LB
PRESSURE ALTITUDE
SEA LEVEL
1000 FT
2000 FT
3000 FT
4000 FT
5000 FT
6000 FT
7000 FT
8000 FT
AIR TEMPERATURE °C
AIR TEMPERATURE °F
WIND KNOTS
RUNWAY SLOPE PERCENT
HEADWIND
TAILWIND
BASE LINE
GUIDE LINES
UP HILL
DOWN HILL
GROUND RUN DISTANCE — 1000 FT

Figure A2-2

REFUSAL SPEEDS — MILITARY THRUST

With Or Without 230-Gallon Tip Tanks

MODEL: RT-33A
DATA AS OF: 15 FEBRUARY 1962
DATA BASED ON: FLIGHT TEST

70% (30°) FLAPS

ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4

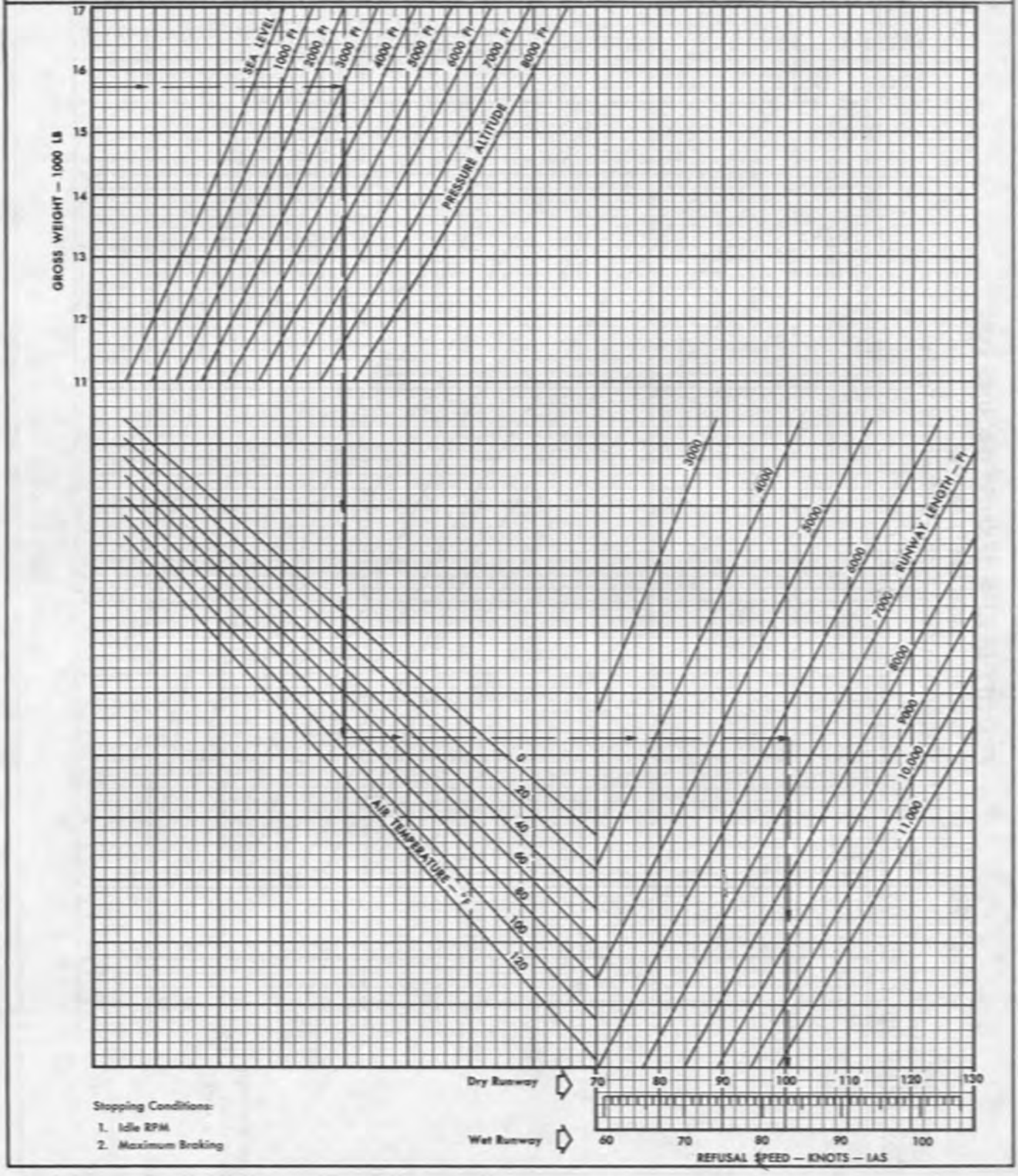


Figure A2-3

VELOCITY DURING TAKEOFF GROUND RUN

MILITARY THRUST

With Or Without 230-Gallon Tip Tanks

MODEL: RT-33A
DATA AS OF: 15 FEBRUARY 1962
DATA BASED ON: FLIGHT TEST

70% (30°) FLAPS

ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB /GAL
FUEL GRADE: JP-4

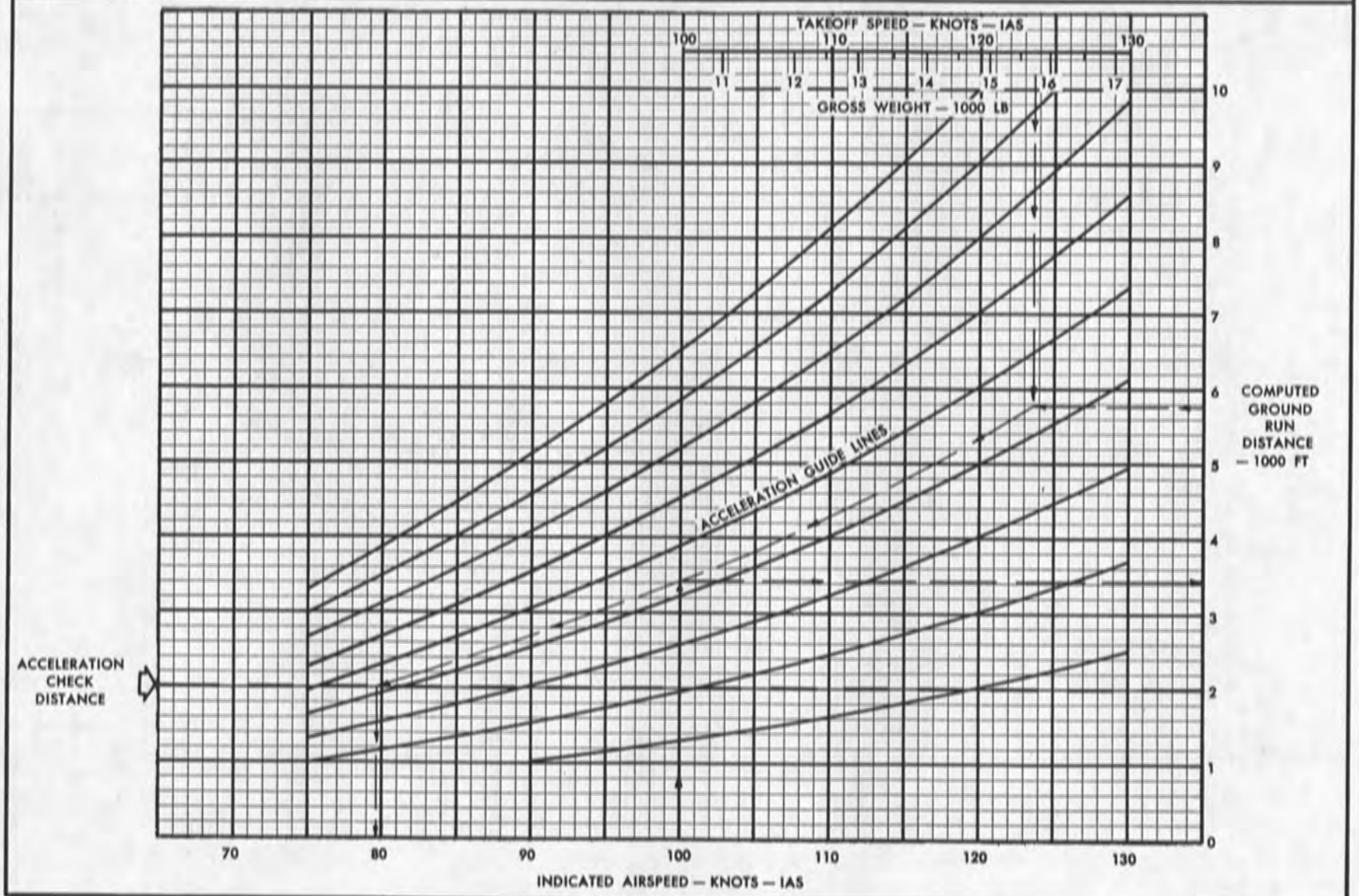


Figure A2-4

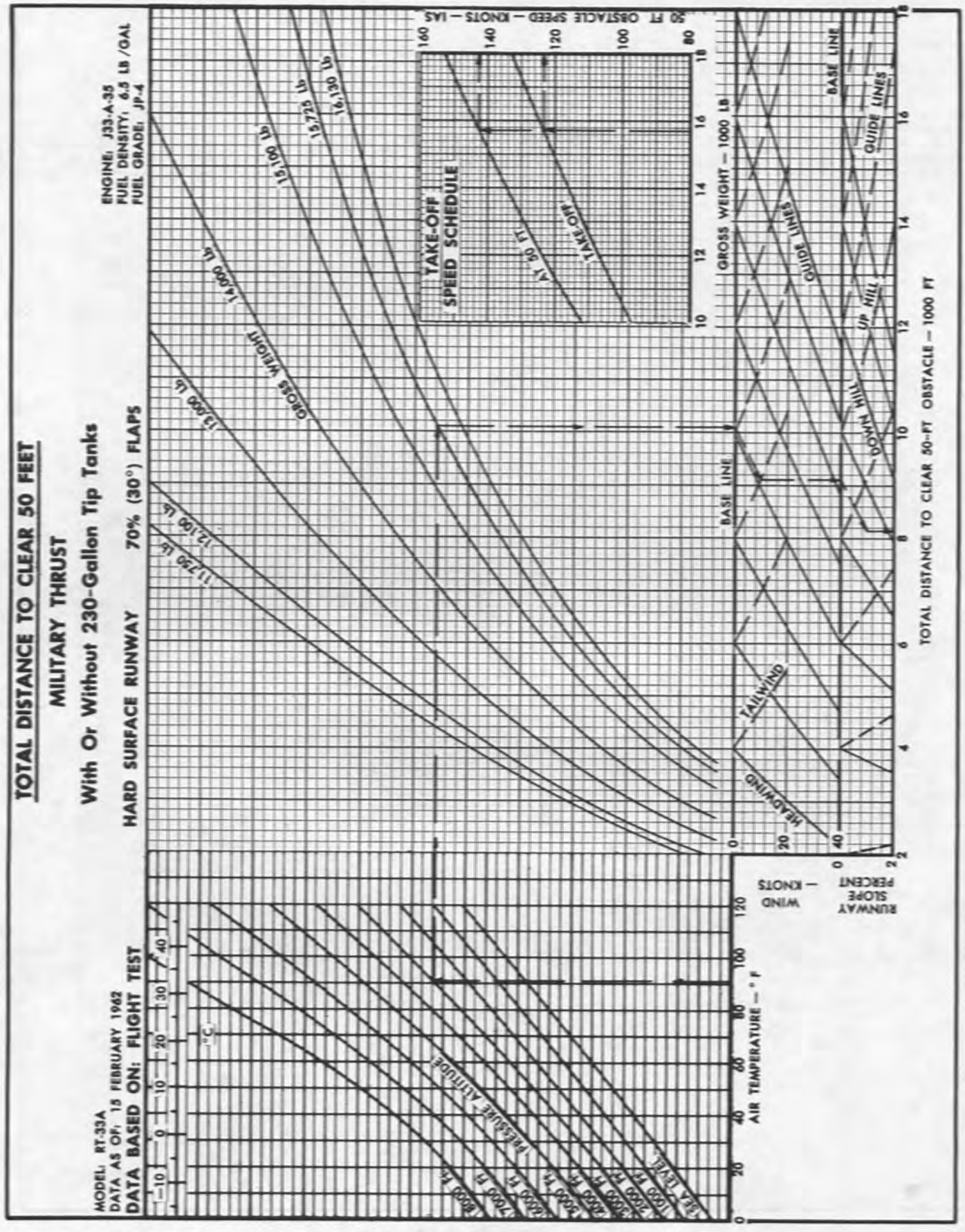

TOTAL DISTANCE TO CLEAR 50 FEET
MILITARY THRUST
With Or Without 230-Gallon Tip Tanks
HARD SURFACE RUNWAY 70% (30°) FLAPS
DATA BASED ON: FLIGHT TEST
DATA AS OF: 15 FEBRUARY 1962
MODEL: RT-33A
ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB /GAL
FUEL GRADE: JP-4
GROSS WEIGHT
17,000 Lb
15,100 Lb
15,725 Lb
16,130 Lb
13,000 Lb
12,100 Lb
11,750 Lb
SEA LEVEL
1000 FT
2000 FT
3000 FT
4000 FT
5000 FT
6000 FT
PRESSURE ALTITUDE
AIR TEMPERATURE — °F
°C
WIND — KNOTS
RUNWAY SLOPE PERCENT
HEADWIND
TAILWIND
BASE LINE
GUIDE LINES
DOWN HILL
UP HILL
GROSS WEIGHT — 1000 LB
TOTAL DISTANCE TO CLEAR 50-FT OBSTACLE — 1000 FT
TAKE-OFF SPEED SCHEDULE
AT 50 FT
TAKE-OFF
50 FT OBSTACLE SPEED — KNOTS — IAS

Figure A2-5

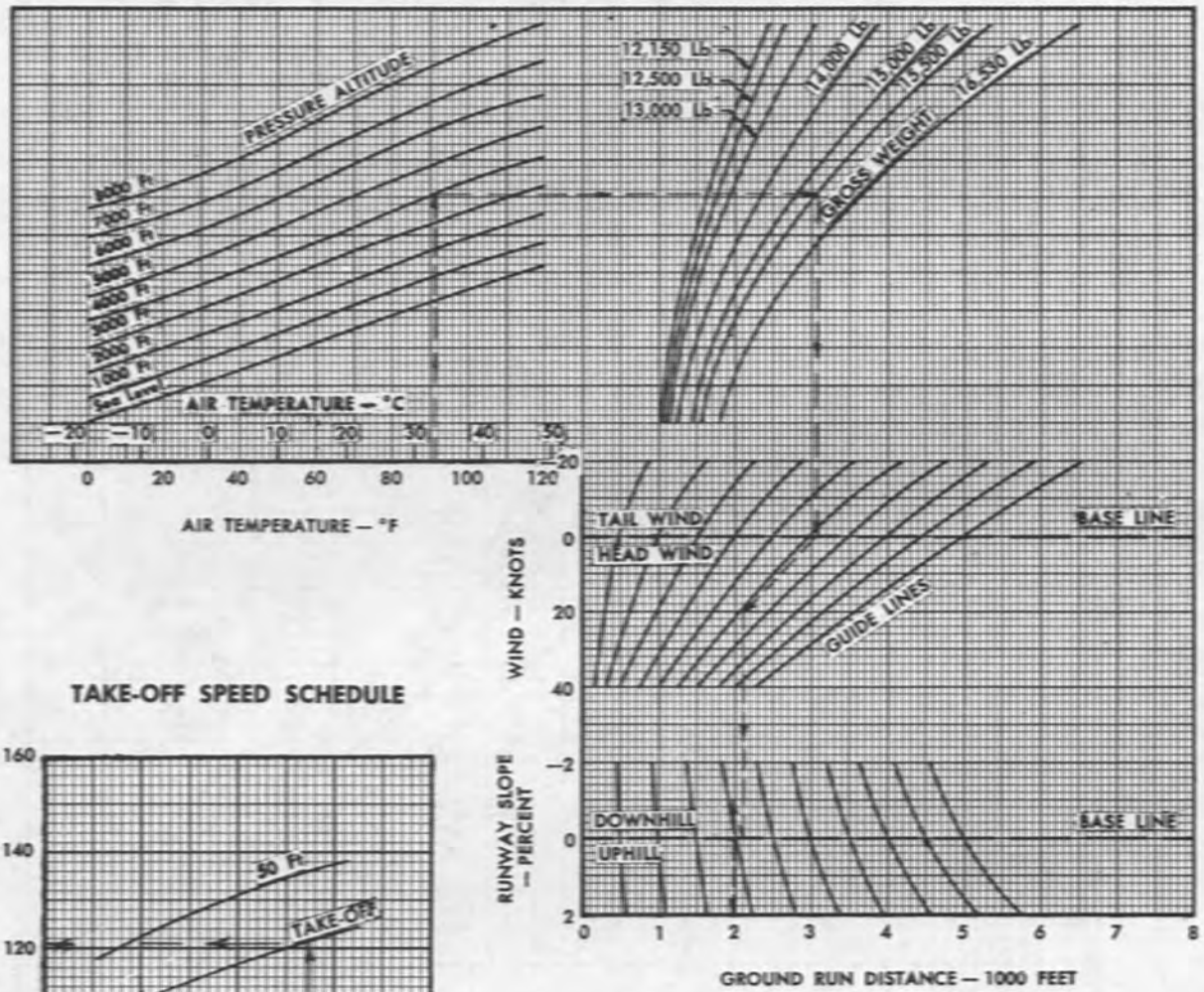
MINIMUM TAKE-OFF GROUND RUN DISTANCE

MILITARY THRUST + JATO

MODEL: RT-33A
DATA AS OF: 1 OCTOBER 1958
DATA BASED ON: FLIGHT TEST

HARD SURFACE RUNWAY
70% (30°) FLAPS

ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4



TAKE-OFF SPEED SCHEDULE

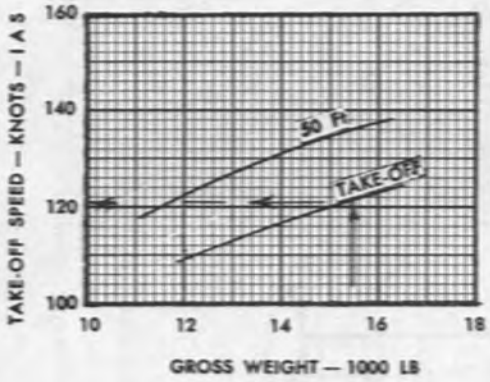


Figure A2-6

MINIMUM DISTANCE TO TAKE OFF AND CLEAR 50 FEET

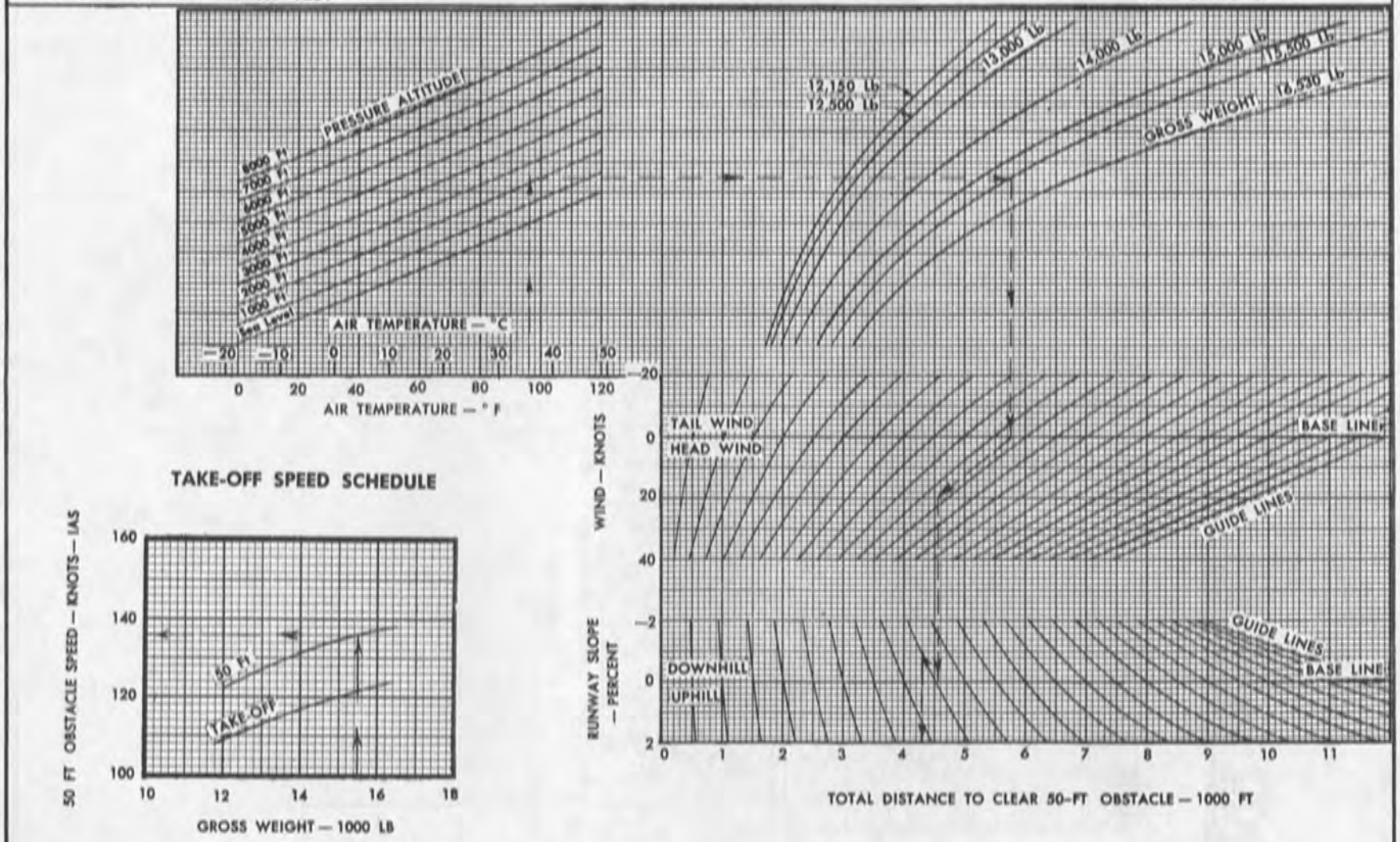
MILITARY THRUST + JATO

BASED ON MINIMUM TAKE-OFF GROUND RUN DISTANCE

MODEL: RT-33A
DATA AS OF: 1 OCTOBER 1958
DATA BASED ON: FLIGHT TEST

HARD SURFACE RUNWAY
70% (30°) FLAPS

ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4



TAKE-OFF SPEED SCHEDULE

Figure A2-7

JATO FIRING SPEEDS FOR MINIMUM TAKE-OFF GROUND RUN

MODEL: RT-33A
DATA AS OF: 1 OCTOBER 1958
DATA BASED ON: FLIGHT TEST

HARD SURFACE RUNWAY

70% (30°) FLAPS

ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4

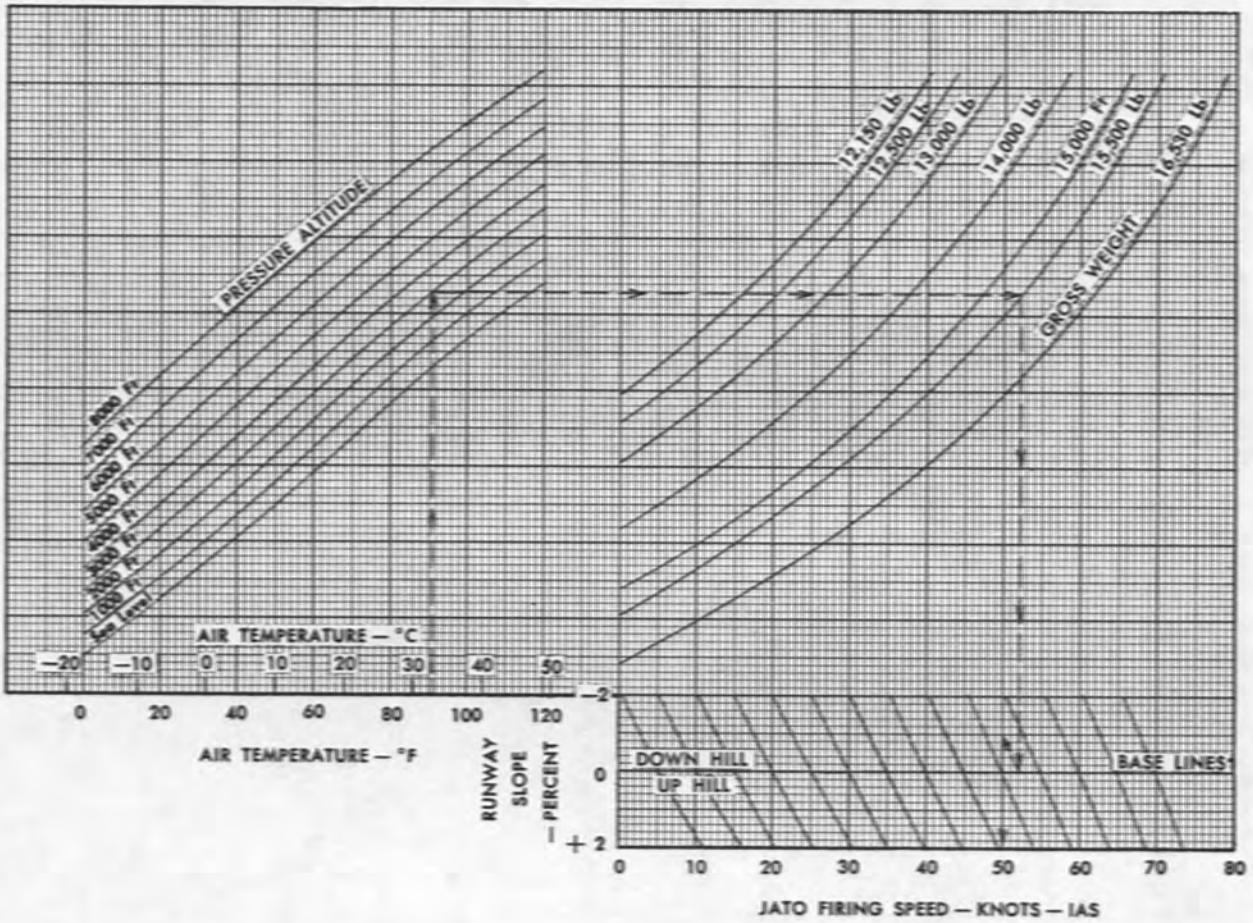


Figure A2-8

TAKE-OFF GROUND RUN DISTANCE

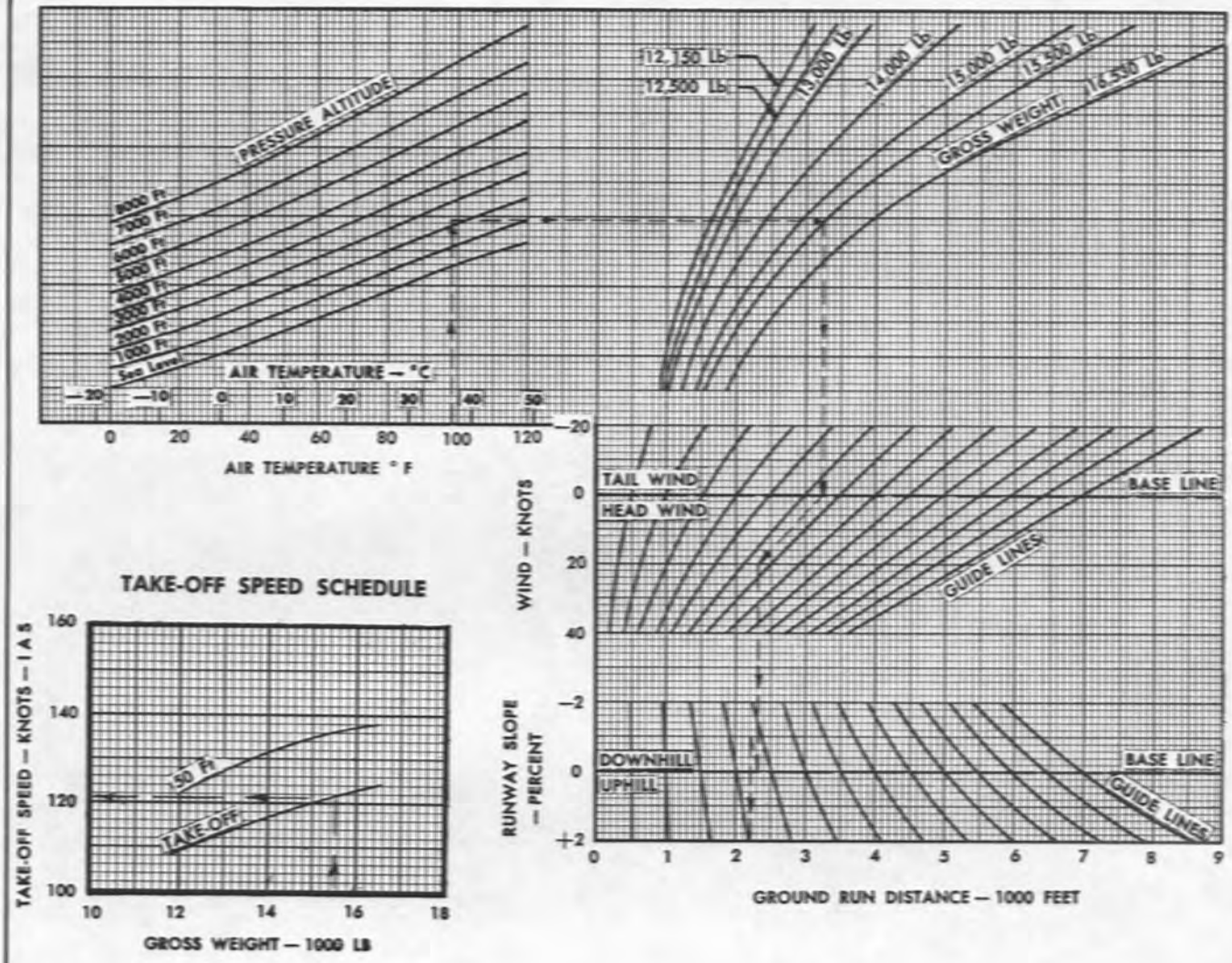
MILITARY THRUST + JATO

BASED ON JATO FIRING SPEED FOR MINIMUM DISTANCE TO CLEAR 50 FEET

MODEL: RT-33A
DATA AS OF: 1 OCTOBER 1958
DATA BASED ON: FLIGHT TEST

HARD SURFACE RUNWAY
70% (30°) FLAPS

ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4



TAKE-OFF SPEED SCHEDULE

Figure A2-9

DISTANCE TO TAKE OFF AND CLEAR 50 FEET

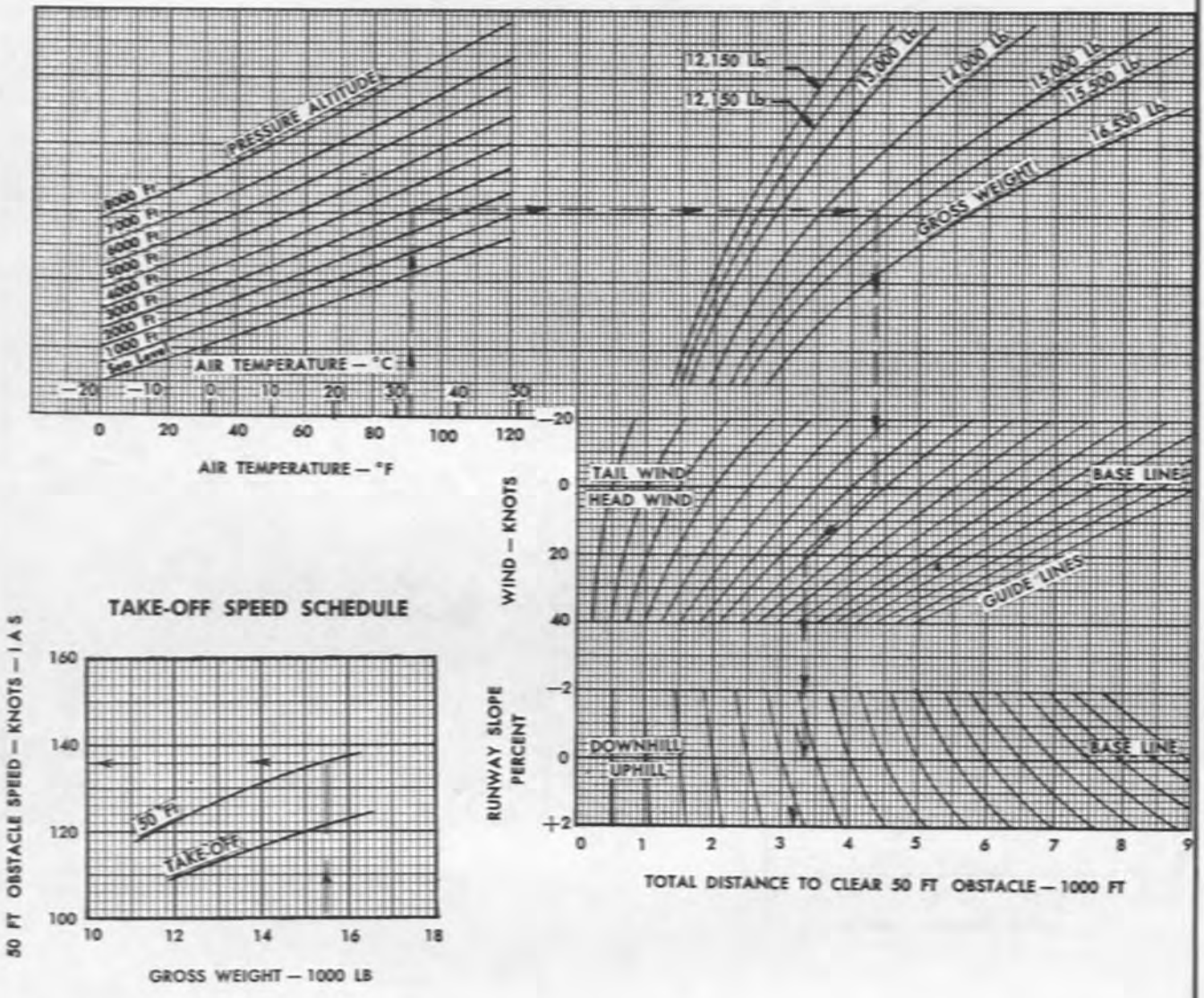
MILITARY THRUST + JATO

BASED ON JATO FIRING SPEEDS FOR MINIMUM TAKE-OFF GROUND RUN

MODEL: RT-33A
DATA AS OF: 1 OCTOBER 1958
DATA BASED ON: FLIGHT TEST

HARD SURFACE RUNWAY
70% (30°) FLAPS

ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4



TAKE-OFF SPEED SCHEDULE

Figure A2-10

JATO FIRING SPEEDS FOR MINIMUM DISTANCE TO CLEAR 50 FEET

MODEL: RT-33A
DATA AS OF: 1 OCTOBER 1958
DATA BASED ON: FLIGHT TEST

HARD SURFACE RUNWAY

70% (30°) FLAPS

ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4

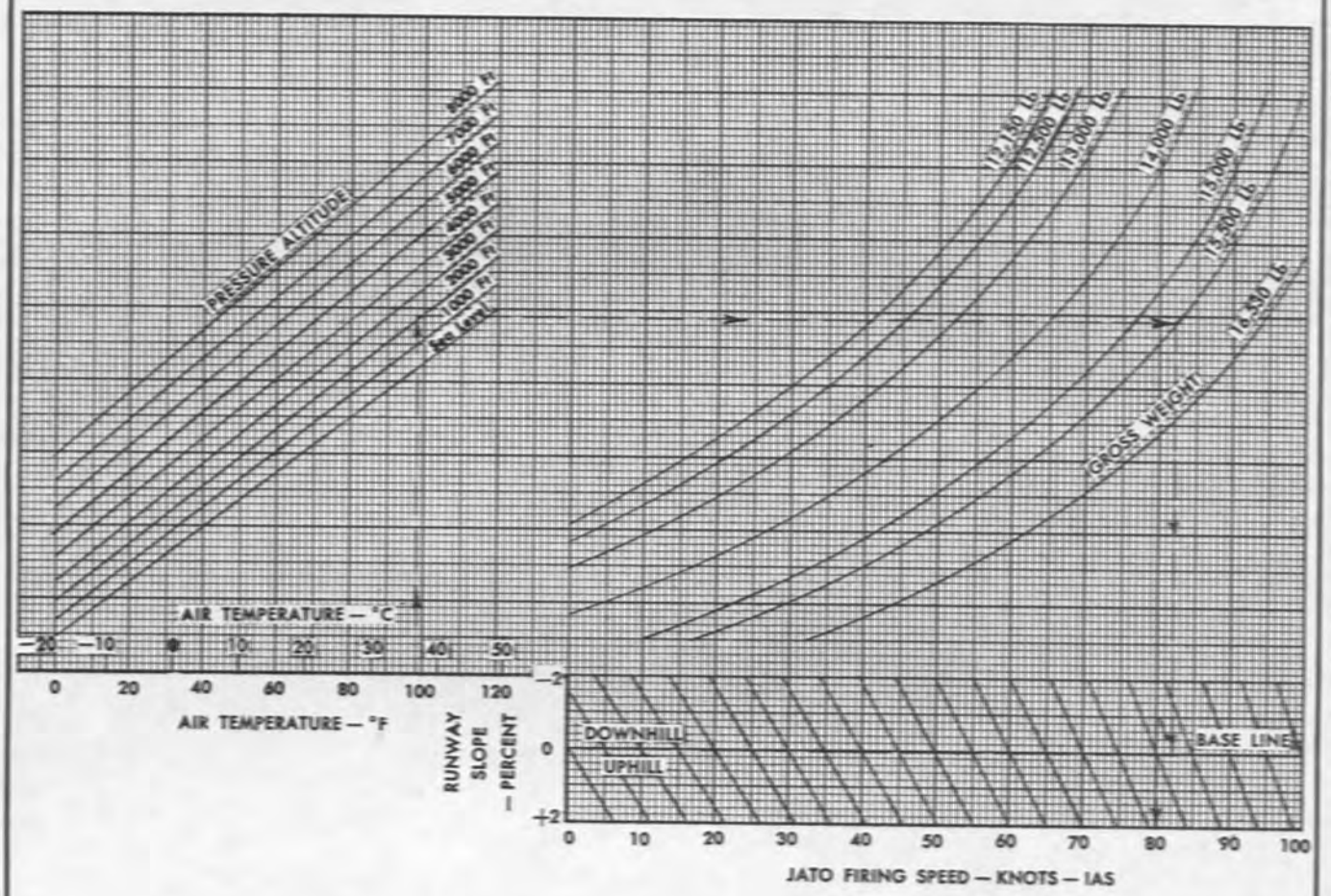


Figure A2-11

Part 3—Climb

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Page numbers in **bold face** type denote illustration.

Title	*Page*
Climb Performance Information	A3-1
Climb Speed Determination	A3-2
Military Thrust — Climb Performance	**A3-5**
Military Thrust — Rate of Climb	**A3-6**
Normal Thrust — Climb Performance	**A3-7**
Normal Thrust — Rate of Climb	**A3-8**

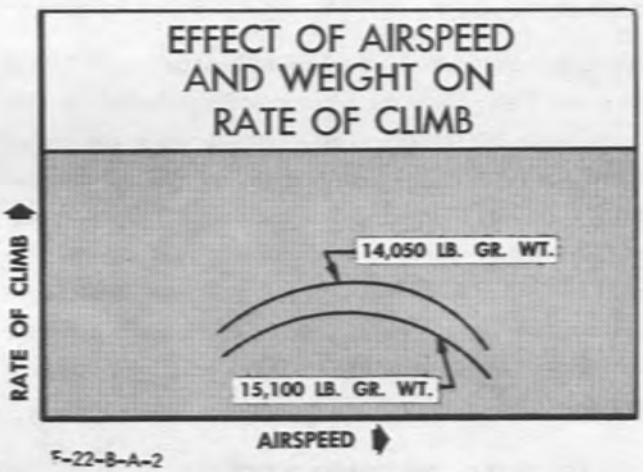
CLIMB PERFORMANCE INFORMATION PRESENTED.

Variable weight standard day climb performance with tip tanks is shown in figures A3-1 and A3-3 for Military thrust and normal thrust 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 the weight reduction in climb due to the fuel used. Rate of climb and climb speed can be obtained for any point during climb to altitude by use of the constant-weight curves in figures A3-2 and A3-4.

Low installed thrust does not significantly reduce the climb performance if the low and high thrust engines can be operated at the same (100%) engine speed. However, engine speed deviations of ±2% can cause 300 to 500 feet per minute deviations from standard rates of climb.

FUEL ALLOWANCES.

No allowances have been included in the construction of the climb performance curves which compensate for time to accelerate to climb speed from takeoff or previous cruising speeds. However, a note is included in the climb performance curves which indicates the allowances that should be added to the fuel consumed to allow for ground maneuvers, takeoff, and acceleration to climb speed.



CLIMB SPEED SCHEDULES.

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. A typical variation of rate of climb with airspeed and gross weight is shown on the accompanying sketch.

The climb is entered after an acceleration from takeoff to the initial climb schedule. The aircraft's nose is rotated upward at approximately 10 knots below the desired climb speed and the schedule maintained by initially reducing the indicated airspeed 2 knots per 1000 feet.

The addition of the standard travel pod does not change climb performance significantly if the recommended climb speed schedule is used. Climbing the aircraft at higher than recommended speeds with the travel pod installed results in a rate of climb reduction of approximately 150 feet per minute at all altitudes.

ALTERNATE CLIMB SPEED SCHEDULE.

Altitude Feet	Climb Speed Knots—CAS
Sea Level	290
10,000	270
20,000	250
25,000	240
30,000	225
35,000	210
40,000	195

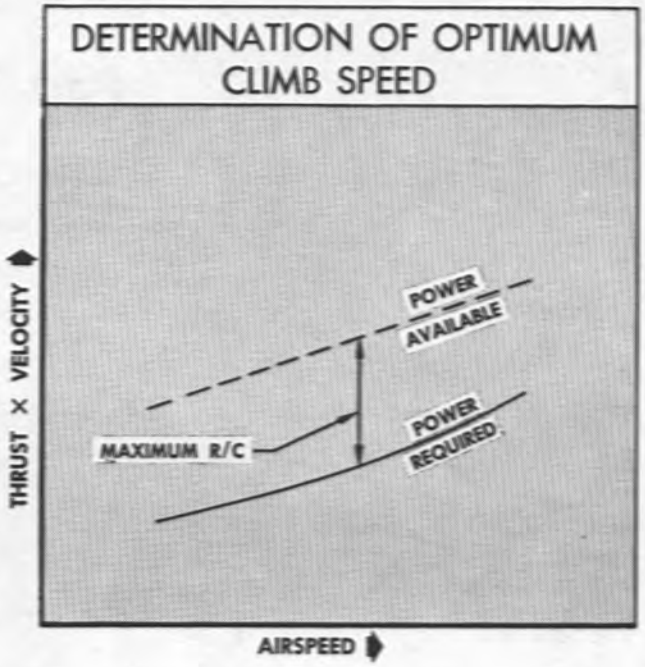
An alternate climb speed schedule may be used which is 20 knots faster than the recommended schedule at altitudes up to 25,000 feet. Test climbs flown at the higher speed schedule indicate that greater range is obtained for the aircraft with tip tanks installed. There is no significant change in the time to climb or fuel used but the increased speed gives a 10 nautical mile increase in range when climbing to 40,000 feet. This climb schedule should be used as an alternate if the maximum range is desired.

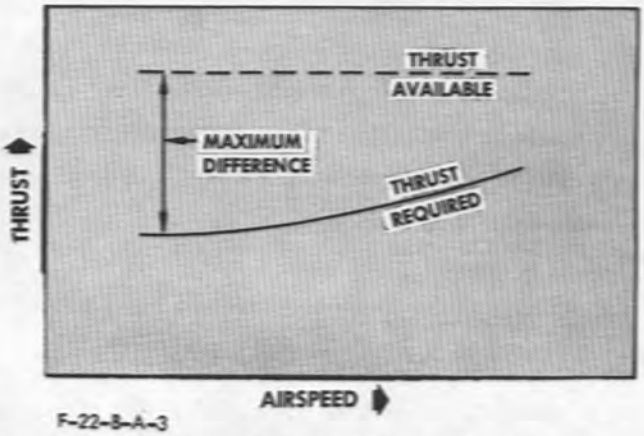
CLIMB SPEED DETERMINATION.

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. Sample curves of airspeed versus power required to maintain airspeed and power available from engine output are shown in the upper part of the accompanying illustration. The difference between these two quantities is excess thrust horsepower. The speed at which the difference is a maximum is the speed for maximum rate of climb. The relationship of thrust required and thrust available is shown in the lower part of the illustration for comparison.

RATE OF CLIMB FOR NONSTANDARD TEMPERATURES.

The climb charts present performance data for standard day conditions. However, an equivalent weight correction method has been devised which prevents determination of nonstandard day climb performance through use of the standard day climb charts. This method replaces the actual aircraft gross weight value at start of climb by an equivalent weight number which is used for entering the climb charts. Equivalent weight is obtained by applying a weight increment (Δ Weight) to actual aircraft gross weight. This Δ Weight compensates for outside air temperature variation from standard temperature (Δ Temperature). A Δ Weight versus Δ Temperature curve is provided on each climb performance chart, and gives the Δ Weight for any Δ Temperature up to 40°F deviation from standard. The following equations, which are also included on the climb charts, should be used when applying the Δ Weight correction to determine equivalent weight.





F-22-8-A-3

1. Hot day: Equivalent weight = actual aircraft gross weight + Δ Weight.

2. Cold day: Equivalent weight = actual aircraft gross weight — Δ Weight.

Equation (1) should be used when the OAT is greater than standard-day temperature. Equation (2) should be used when the OAT is less than standard-day temperature.

DETERMINATION OF EQUIVALENT WEIGHT.

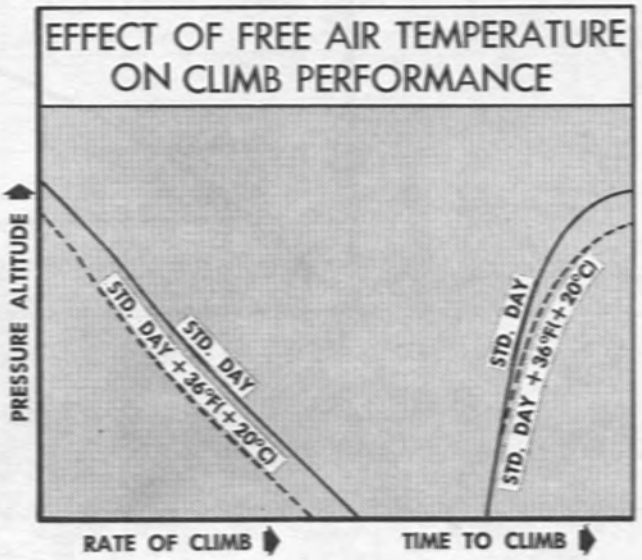
The procedure to use in determining equivalent weight is as follows:

1. Determine from meterological forecasts the average OAT during climb to altitude.

2. Enter the Density Altitude Chart, figure A1-6, at the average pressure altitude during climb and obtain the standard-day temperature.

3. Determine Δ Temperature. The difference between the standard-day temperature, step 2 and the OAT, step 1, is the Δ Temperature.

4. Enter the Δ Weight versus Δ Temperature curve on the applicable climb performance chart at the Δ Temperature from step 3 and read the Δ Weight.

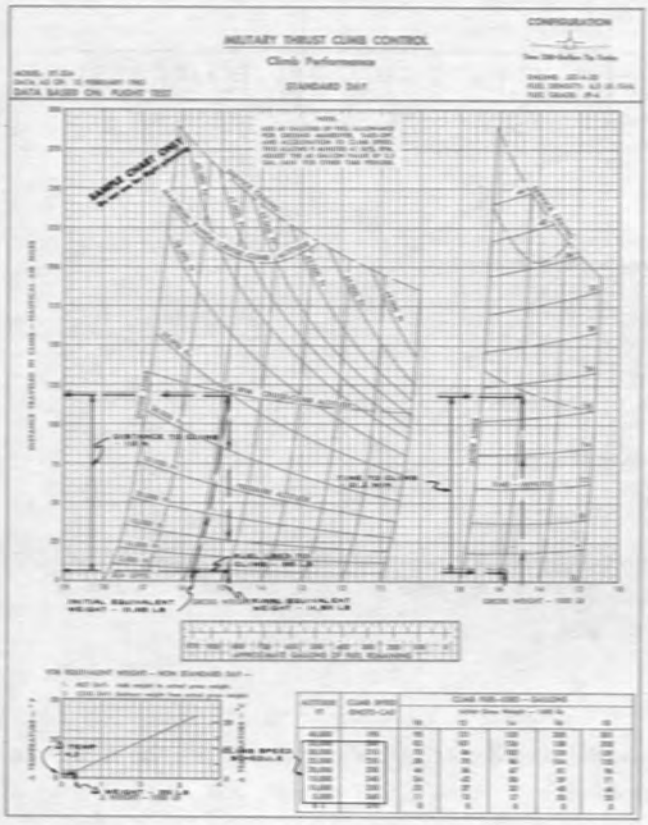


F-22-B-A-4

5. Using the suitable nonstandard temperature equation on the climb chart, algebraically add the Δ Weight from step 4 to the actual aircraft gross weight at start of climb to obtain the equivalent weight.

USE OF THE CLIMB CHARTS.

A sample problem is provided to show the use of the climb performance charts. A time-and-distance prediction climb chart is shown in sample chart form to further illustrate the method for their use.



SAMPLE PROBLEM.

Determine the nonstandard day climb performance for a Military thrust climb from 5000 to 35,000 feet, at an initial actual aircraft gross weight of 15,335 pounds. The average outside air temperature is −8°F and is assumed to occur at the average pressure altitude of 20,000 feet.

a. Enter figure A1-6 at the average pressure altitude (20,000 ft) and the standard air temperature −12.3°F.

b. For an outside air temperature of −8°F and a standard air temperature of −12.3°F the temperature deviation (ΔT) is 4.3°F above standard (a hot day)

c. The Δ Weight correction to compensate for nonstandard atmosphere is obtained from the curve in the lower portion of figure A3-1. For a Δ Temperature of +4.3°F the Δ Weight is 350 lb.

d. Using the hot day temperature correction equation in figure A3-1 add the Δ Weight to actual weight of 15,335 lb to obtain an equivalent weight of 15,685 lb.

e. Enter figure A3-1 at this equivalent weight and initial pressure altitude. Read:

Initial distance .....8 nmi

Initial time .....1.8 min

f. Trace a curve parallel to the nearest guide line until it intersects the final altitude (35,000 feet). Read:

Final distance .....120 nmi

Final time .....23.0 min

Final equivalent weight .....14,800 lb

g. Distance to climb is then 112 nmi (120 nmi − 8 nmi).

h. Time to climb is 23.0 min. − 1.8 min, or 21.2 min.

i. Fuel to climb is 15,685 lb − 14,800 lb, or 885 lb.

j. Actual gross weight at end of climb equals 14,450 lb (15,335 lb − 885 lb).

To find rate of climb for the climb conditions:

a. Use figure A3-2. At 5000 feet and equivalent weight of 15,865 pounds, read:

Rate of climb .....2670 fpm

b. At 35,000 feet and final equivalent weight of 14,800 pounds, read:

Rate of climb .....690 fpm

MILITARY THRUST CLIMB CONTROL

Climb Performance

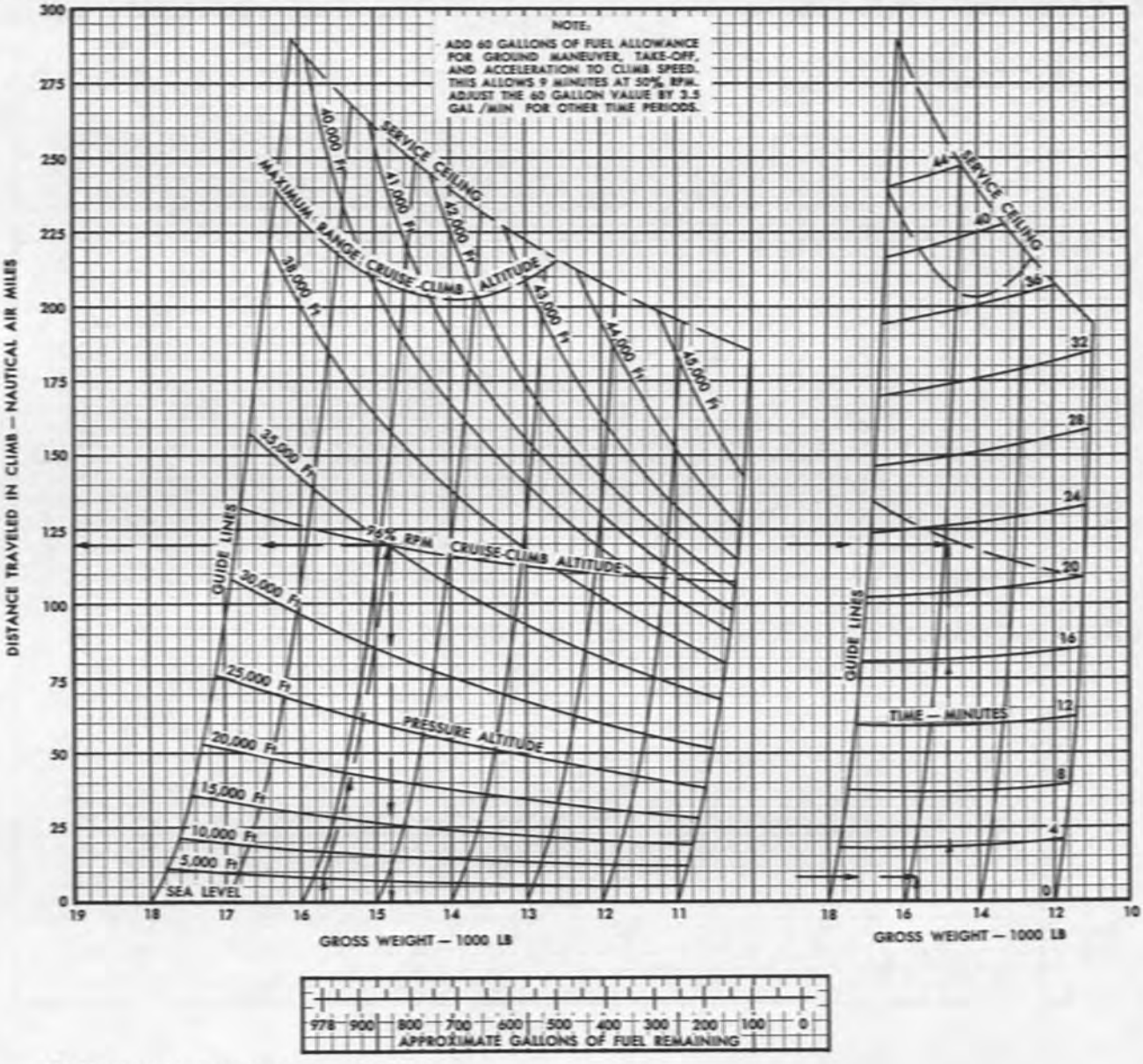
MODEL: RT-33A
DATA AS OF: 15 FEBRUARY 1962
DATA BASED ON: FLIGHT TEST

STANDARD DAY

CONFIGURATION

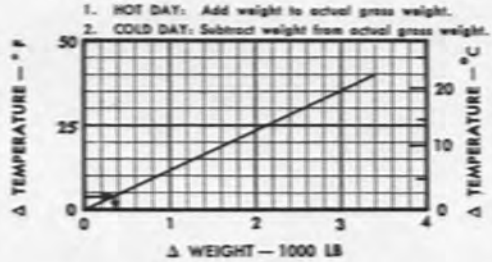
Two 230-Gallon Tip Tanks

ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB /GAL
FUEL GRADE: JP-4



FOR EQUIVALENT WEIGHT — NON STANDARD DAY —

1. HOT DAY: Add weight to actual gross weight.
2. COLD DAY: Subtract weight from actual gross weight.



ALTITUDE FT	CLIMB SPEED KNOTS-CAS	CLIMB FUEL-USED — GALLONS				
		Initial Gross Weight — 1000 Lb				
		10	12	14	16	18
40,000	190	95	121	155	205	301
35,000	200	82	101	126	158	205
30,000	210	70	86	105	128	159
25,000	220	58	70	86	104	125
20,000	230	46	56	67	81	96
15,000	240	34	42	50	59	71
10,000	250	23	27	33	40	46
5,000	260	11	13	17	20	23
S L	270	0	0	0	0	0

Figure A3-1

MILITARY THRUST CLIMB CONTROL

Rate Of Climb

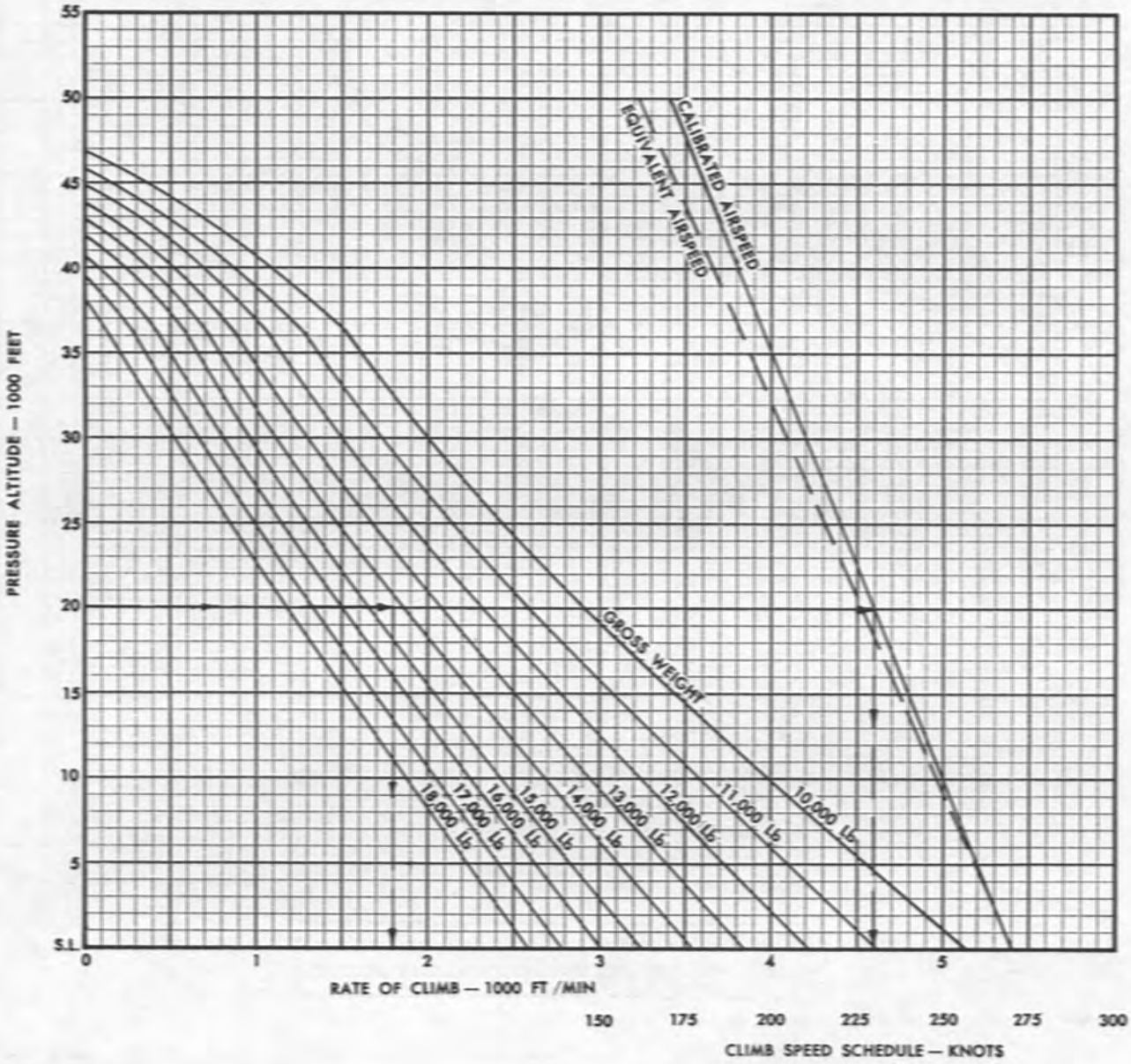
CONFIGURATION

Two 230-Gallon Tip Tanks

STANDARD DAY

MODEL: RT-33A
DATA AS OF: 15 JULY 1961
DATA BASED ON: FLIGHT TEST

ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4



NOTE: ADD 60 GALLONS OF FUEL ALLOWANCE FOR GROUND MANEUVER, TAKE-OFF, AND ACCELERATION TO CLIMB SPEED. THIS ALLOWS 9 MINUTES AT 50% RPM. ADJUST THE 60 GALLON VALUE BY 3.5 GAL /MIN FOR OTHER TIME PERIODS.

Figure A3-2

CONFIGURATION

Two 230-Gallon Tip Tanks

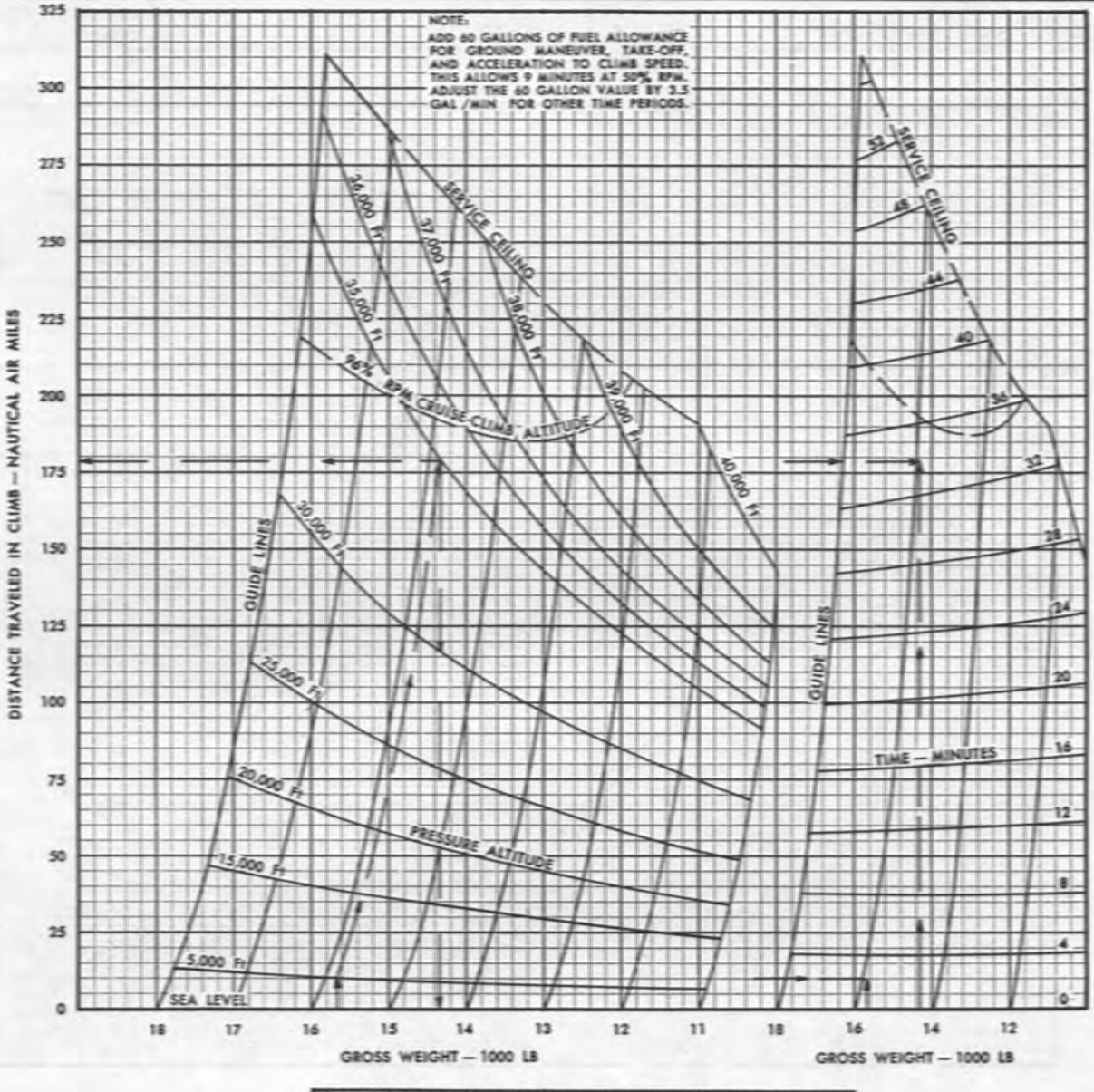
ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4

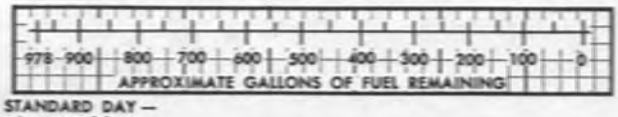
NORMAL THRUST CLIMB CONTROL

Climb Performance

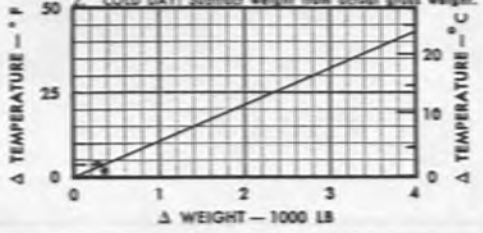
STANDARD DAY

MODEL: RT-33A
DATA AS OF: 15 FEBRUARY 1962
DATA BASED ON: FLIGHT TEST





FOR EQUIVALENT WEIGHT — NON STANDARD DAY —
1. HOT DAY: Add weight to actual gross weight.
2. COLD DAY: Subtract weight from actual gross weight.



ALTITUDE FT	CLIMB SPEED KNOTS CAS	CLIMB FUEL-USED — GALLONS Initial Gross Weight — 1000 Lb 10	12	14	16	18
35,000	200	112	140	180	238	314
30,000	210	93	116	148	188	240
25,000	220	76	94	118	147	181
20,000	230	60	73	91	112	135
15,000	240	44	53	66	80	96
10,000	250	28	34	43	51	62
5,000	260	14	17	21	25	29
S. L.	270	0	0	0	0	0

Figure A3-3

NORMAL THRUST CLIMB CONTROL

Rate Of Climb

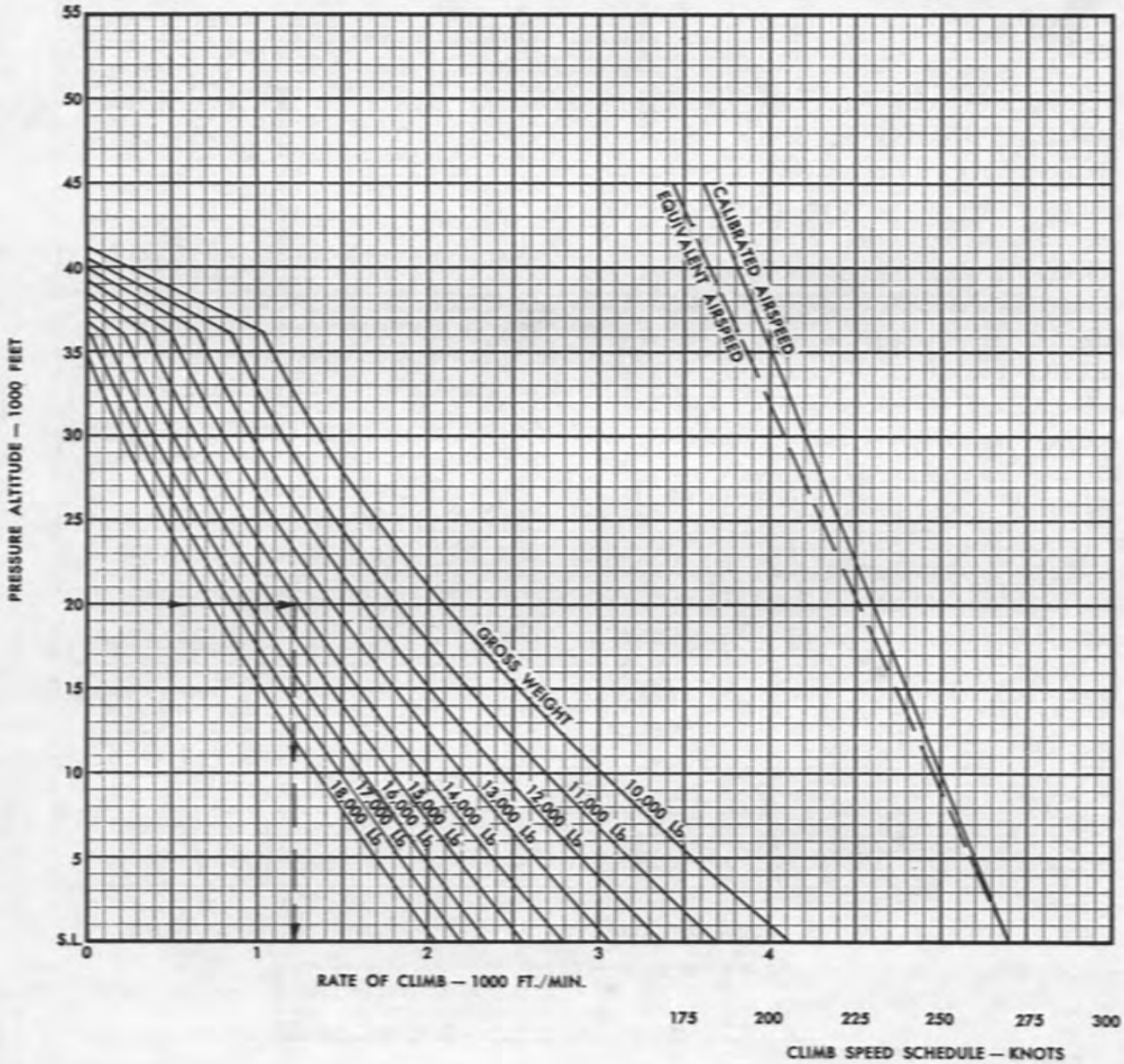
CONFIGURATION

Two 230-Gallon Tip Tanks

MODEL: RT-33A
DATA AS OF: 15 JULY 1961
DATA BASED ON: FLIGHT TEST

STANDARD DAY

ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4



NOTE: ADD 60 GALLONS OF FUEL ALLOWANCE FOR GROUND MANEUVER, TAKE-OFF, AND ACCELERATION TO CLIMB SPEED. THIS ALLOWS 9 MINUTES AT 50% RPM. ADJUST THE 60 GALLON VALUE BY 3.5 GAL /MIN FOR OTHER TIME PERIODS.

Figure A3-4

Part 4—Range

TABLE OF CONTENTS

Page numbers in **bold face** type denote illustration.

Title	*Page*
Mission Profile Charts	A4-1, **A4-6**
Diversion Range Tables	A4-3, **A4-8**

RANGE DATA PRESENTED.

The Mission Profile chart presents the range characteristics of the aircraft in a convenient pictorial form and allows accurate flight planning for the majority of missions where cruise control must be considered. This chart eliminates much of the computation required in adapting data from the graphical nautical-miles-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 aircraft is capable of flying. The range data presented includes a diversion range table and a mission profile which are directly applicable to operation with tip tanks. Miles-per-gallon charts, which can be used for planning operations without tip tanks, are included in Part 8.

MISSION PROFILE CHARTS.

Chart Scope.

The Mission Profile chart presents both the level flight cruise and the variable altitude (cruise–climb) maximum range characteristics of the aircraft. This chart gives 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 takeoff, Military thrust climb, and maximum range cruise is assumed. However, the chart may also be used on an incremental basis as described in a later paragraph. The chart is based on a takeoff gross weight of 15,725 pounds with a full fuel load of 978 gallons. A fuel allowance of 60 gallons has been included for ground maneuver, takeoff, and acceleration to climb speed. The chart does 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 is indicated by a solid line and shows the distance traveled in climb from the point where the 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 "gallons consumed" lines. For example, at a desired cruise altitude of 25,000 feet and range of 400 nautical air miles in the tip tank configuration (figure A4-1) a total of 400 gallons of fuel will be used from the time the engine is started until the aircraft is 400 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 and does not include engine starting, taxiing, or descending time. The cruise–climb (variable altitude) cruise performance is indicated by the intersection of the gallons used and time lines with cruise–climb flight path line.

Use of Charts on an Incremental Basis.

Level flight cruise out and return performance can be determined for any fuel loading. Enter the chart at the cruise altitude and fuel loading to obtain initial distance and time readings. Adding the desired cruise altitude distance to the initial distance readings gives the final distance reading and fuel and time consumed values. The difference between the initial and final fuel and times 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 thrust, 100% rpm, using the speed schedule shown on the charts. The climb path shown on the profile is applicable for 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 average approximate cruise rpm. Approximate average 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 thrust is reduced to ensure maintaining adequate speed until stable cruise conditions are established. Then throughout cruising flight, the recommended calibrated airspeed should be maintained. Constant altitude should be maintained by use of whatever engine speed is necessary. The required rpm will become less as fuel is consumed.

Cruise–Climb.

To achieve absolute maximum range the pilot must fly continuously at the optimum cruise altitude for each momentary change in gross weight. The optimum altitude for cruising flight increases as fuel is consumed and gross weight reduced, necessitating a continuous but gentle climb flight path for maximum range. This cruise–climb technique requires that the flight be made at as high a thrust setting as possible and an indicated airspeed schedule related to the altitude being flown. This airspeed schedule is maintained by increasing the altitude as fuel is consumed. The speed schedule for the tip-tank configuration is based on an indicated airspeed of 185 knots at 45,000 feet altitude with a decrease of 4 knots for each additional 1000-foot increase in altitude.

Altitude to Initiate Cruise–Climb.

The altitude for cruise–climb flight will vary from day to day as the air temperature varies. However, the climb performance will also change 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 to initiate the cruise–climb. The proper altitude to initiate the cruise–climb procedure can be obtained by climbing at the recommended Military thrust climb speed schedule until the rate of climb reduces to 200 feet per minute. The pilot should level off and trim the aircraft. Then as long as 100% rpm and correct cruise–climb speed schedule are maintained, the aircraft 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 greater than 96% rpm (up to maximum continuous thrust) will be required to maintain constant altitude at the recommended CAS. In this condition the best technique is to maintain the recommended CAS and 100% rpm and allow the aircraft 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 to maintain the proper CAS.

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 thrust drops to 200 feet per minute, 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 aircraft 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 headwind or tailwind component for the time required to complete the mission. To determine the effect of wind upon time, fuel, and dis-

tance, compute the average TAS (distance ÷ time, no wind), and apply wind to the average TAS to obtain average GS (average TAS — headwind, or + tailwind). Compute the time with wind (distance ÷ average GS) and the air distance with wind (average TAS × time, with wind). 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 nonstandard 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 resulting 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 groundspeed.

Note

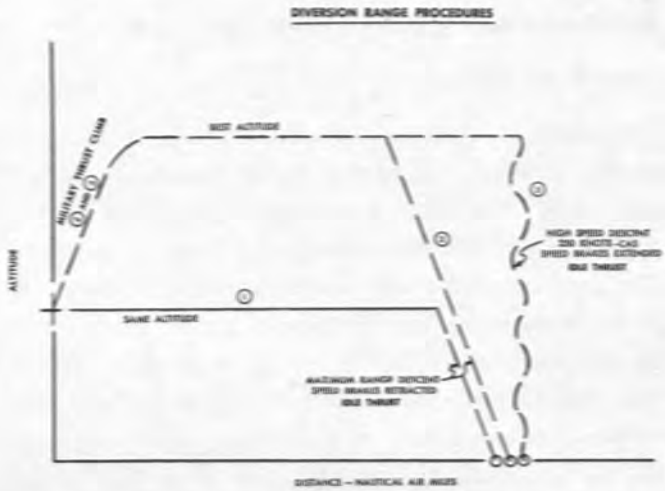
The Mission Profile chart shows the range obtainable when using Grade JP-4 fuel. If gasoline is used as an emergency fuel, multiply the gallons of fuel required to fly a given distance by a factor of 1.08.

EFFECT OF TRAVEL POD INSTALLATION.

The installation of the standard travel pod has a negligible effect on the cruise performance of the RT-33A aircraft. However, if the standard travel pod is to be carried, comparable fuel economy will be achieved by reducing maximum range cruise speeds. This reduction in airspeed compensates for the added drag of the travel pod. The normal maximum range cruise speeds must be reduced by approximately 10 knots indicated airspeed at 25,000 feet and above, and 15 knots indicated airspeed below 25,000 feet to achieve comparable performance.

DIVERSION RANGE SUMMARY TABLE.

The Range Summary table presented is in a form readily usable when rapid determination of the range available with low fuel-remaining values is desired. Information is presented for the tip-tank configuration. Range available using three different flight procedures is presented for fuel-remaining values of 60, 80, 100, 150, and 200 gallons. The procedures as indicated on each of the tables are the following:



1. Cruise at same altitude, descending on course to base with Idle thrust (Maximum range descent with speed brakes retracted—175 knots CAS, figure A6-1.)

2. Climb to best altitude and cruise at that altitude, descending on course to base (speed brakes retracted). Climb with Military thrust at the speed schedules indicated in notes (refer to part 3 for detailed climb performance). Cruise at the recommended airspeeds. Maximum range descent with Idle thrust is 175 knots CAS, figure A6-1.

3. Climb to best altitude, cruise at that altitude until over base, and Idle thrust descent (High-speed descent with speed brakes extended—250 knots CAS, figure A6-2.)

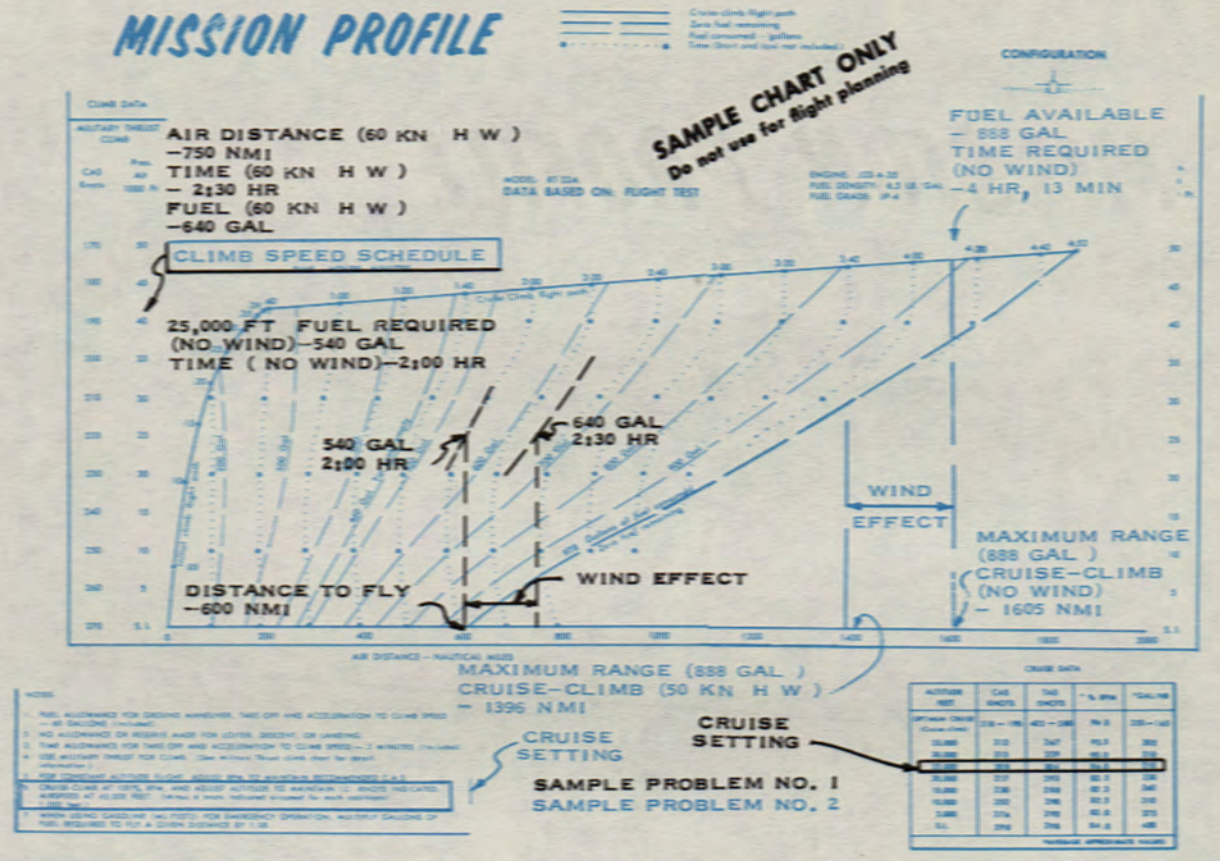
A 20-gallon allowance is included for approach and landing after a Military thrust climb, level cruise, and either a maximum range (175 knots CAS) or a high-speed (250 knots CAS) descent to sea level. Cruise at same altitude includes an allowance for a maximum range (175 knots CAS) descent and 20 gallons approach and landing fuel.

Use of the tables is indicated by the following example. Conditions:

- Tip tank configuration
- Fuel remaining — 150 gal
- Initial altitude — 20,000 ft
- Distance to base — 215 nmi

Determine the proper procedure to obtain the required distance to base. Inspection of the tip-tank configuration table shows that by using procedure 2, the following performance is available with 150 gallons remaining:

a. Total distance	234 nmi
b. Total time	50.4 min
c. Best altitude	40,000 ft
d. Climb at	236 IAS
e. Cruise at	215 IAS
f. Start Maximum Range descent at	85 gal remaining



SAMPLE PROBLEM 1.

Using the sample chart shown, determine the time, fuel required, cruise speed, and approximate cruise power setting to cruise 600 nautical miles at 25,000 feet on a standard day with a 60-knot headwind in the tip-tank configuration.

a. Enter profile at 600 nautical miles and 25,000 feet to obtain fuel required (no wind) — 540 gal.

b. Time (no wind) 2 hr, 0 min.

c. Average TAS is 300 kn (distance ÷ time, no wind = 600 nmi ÷ 2:00 hr).

d. Average GS is 240 kn (average TAS — headwind = 300 kn — 60 kn).

e. Time (with wind) is 2 hr, 30 min (distance ÷ average GS = 600 nmi ÷ 240 kn).

f. Air distance with wind is 750 nmi (average TAS × time, with wind = 300 kn × 2.5 hr).

g. Reenter profile at cruise altitude at the air distance with wind to obtain fuel required with wind, 640 gal.

h. Determine cruise speed from table to be 208 knots, CAS.

i. Determine approximate average cruise power setting from table to be 86% (approx).

SAMPLE PROBLEM 2.

Determine the maximum distance attainable for the tip-tank configuration with 978 gallons of fuel and a 50-knot headwind. Allow a fuel reserve of 90 gallons for descent and landing.

a. Fuel available for climb and cruise climb is 888 gal (fuel loading-reserve = 978 gal — 90 gal).

b. Enter profile at 888 gallons of fuel and obtain maximum distance at cruise climb (no wind) — 1605 nmi.

c. Time (no wind) is 4 hr, 13 min (4.23 hr).

d. Average TAS is 380 knots (distance ÷ time, no wind = 1605 nmi ÷ 4.23 hr).

e. Average GS is 330 knots (average TAS — headwind = 380 kn — 50 kn).

f. Maximum distance attainable (with wind) 1396 nmi (average GS × time, no wind = 330 kn × 4.23 hr).

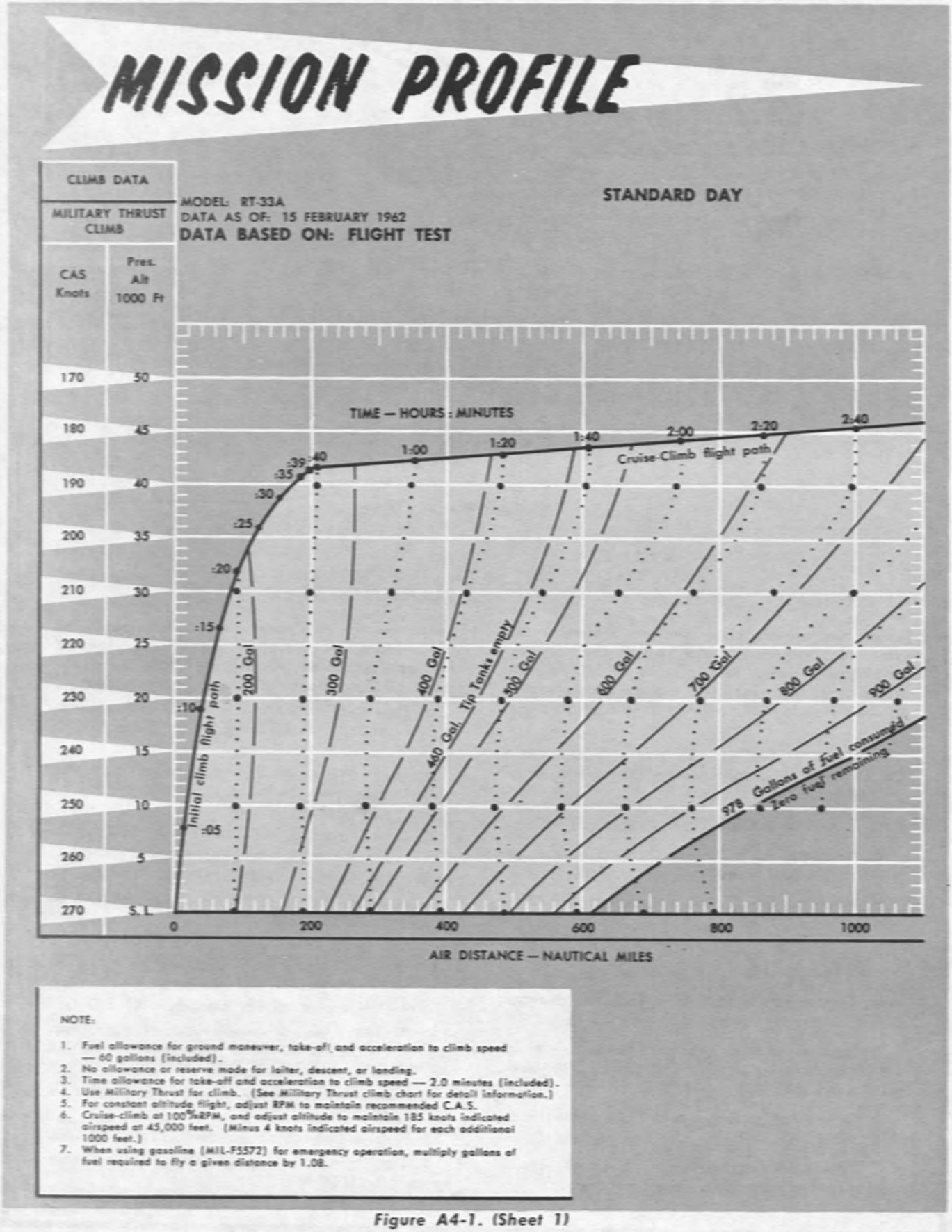
g. Initial cruise—climb altitude — 41,500 ft.

h. Final cruise—climb altitude at maximum distance attainable, 1396 nmi (with wind) is 47,500 ft.

i. Initial cruise—climb speed from notes is 199 knots IAS.

j. Final cruise—climb speed is 175 knots IAS.

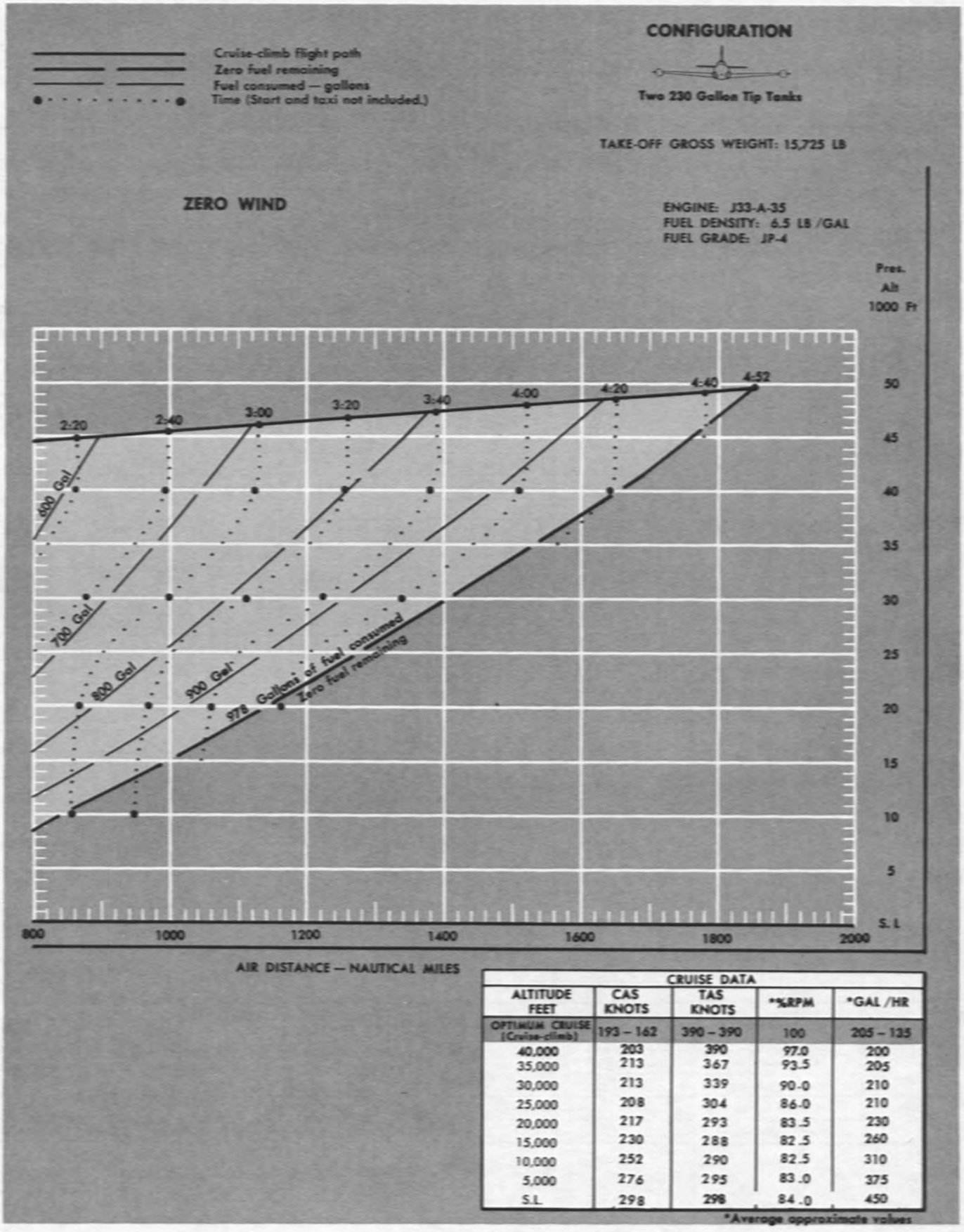
k. Determine cruise—climb thrust setting from table to be 100% rpm.



NOTE:

1. Fuel allowance for ground maneuver, take-off and acceleration to climb speed — 60 gallons (included).
2. No allowance or reserve made for loiter, descent, or landing.
3. Time allowance for take-off and acceleration to climb speed — 2.0 minutes (included).
4. Use Military Thrust for climb. (See Military Thrust climb chart for detail information.)
5. For constant altitude flight, adjust RPM to maintain recommended C.A.S.
6. Cruise-climb at 100% RPM, and adjust altitude to maintain 185 knots indicated airspeed at 45,000 feet. (Minus 4 knots indicated airspeed for each additional 1000 feet.)
7. When using gasoline (MIL-F5572) for emergency operation, multiply gallons of fuel required to fly a given distance by 1.08.

Figure A4-1. (Sheet 1)



CRUISE DATA				
ALTITUDE FEET	CAS KNOTS	TAS KNOTS	**%RPM	*GAL /HR
OPTIMUM CRUISE (Cruise-climb)	193 – 162	390 – 390	100	205 – 135
40,000	203	390	97.0	200
35,000	213	367	93.5	205
30,000	213	339	90.0	210
25,000	208	304	86.0	210
20,000	217	293	83.5	230
15,000	230	288	82.5	260
10,000	252	290	82.5	310
5,000	276	295	83.0	375
S.L.	298	298	84.0	450

*Average approximate values

Figure A4-1. (Sheet 2)

RT-33A DIVERSION RANGE SUMMARY TABLE

With 230-Gallon Tip Tanks

CONFIGURATION

Two 230-Gallon Tip Tanks

DATA AS OF: 15 FEBRUARY 1962
DATA BASIS: FLIGHT TEST

STANDARD DAY ZERO WIND

REFERENCE: T.O. 1T-33 (R) A-1
DATED: 15 APRIL 1962

FUEL	RANGE TIME	INITIAL ALTITUDE — 1000 FT S.L.	5	10	15	20	25	30	35	40	
60 GAL	Cruising At Same Altitude	26.6	33.8	44.7	54.0	63.5					N.Mi
		5.4	8.8	12.4	15.4	18.0					Min
	Best Altitude	SL/SL	5/5	10/10	15/15	20/20	/25	/30	/35	/40	1000 Ft
	Using Best Alt Max. Range Descent	26.6	33.8	44.7	54.0	63.5					N.Mi
		5.4	8.8	12.4	5.4	18.0					Min
	Using Best Alt High Speed Descent (250 Knots)	26.6	29.7	33.9	38.5	43.8	48.8	53.1	56.8	60.5	N.Mi
		5.4	7.1	9.1	10.9	12.8	14.5	16.2	16.6	17.0	Min
80 GAL	Cruising At Same Altitude	39.9	49.9	64.3	77.4	91.3	104.5	115.1	124.0		N.Mi
		8.0	12.1	16.5	20.4	23.9	27.0	29.4	31.3		Min
	Best Altitude	10/10	10/10	15/15	20/20	25/25	25/25	30/30	35/35	/40	1000 Ft
	Using Best Alt Max. Range Descent	52.8	57.7	70.0	82.0	94.7	104.5	115.1	124.0		N.Mi
		13.9	15.1	19.0	22 1	24.8	27.0	29.4	31.3		Min
	Using Best Alt High Speed Descent (250 Knots)	42.0	46.6	54.5	62.2	71.5	81.4	90.3	98.8	107.4	N.Mi
		10.4	11.5	14.4	16.8	19.0	22.9	25.3	26.0	26.4	Min
100 GAL	Cruising At Same Altitude	53.2	66.1	83.9	100.8	118.9	136.9	152.0	165.7	178.2	N.Mi
		10.7	15.5	20.5	25.4	29.8	33.7	36.9	38.9	40.6	Min
	Best Altitude	15/15	20/15	25/20	25/25	30/25	30/30	35/40	40/40	40/40	1000 Ft
	Using Best Alt Max. Range Descent	77.3	88.1	102.5	114.5	127.6	140.3	155.3	170.6	178.2	N.Mi
		20.2	23.3	26.8	29.1	31.6	34.3	36.8	39.2	40.6	Min
	Using Best Alt High Speed Descent (250 Knots)	61.8	69.0	80.1	91.4	103.7	115.5	133.0	146.4	153.9	N.Mi
		15.6	17.3	20.7	23.4	25.7	28.5	29.0	31.0	32.4	Min
150 GAL	Cruising At Same Altitude	86.6	106.3	132.7	159.0	187.6	217.4	243.5	268.7	293.1	N.Mi
		17.5	23.7	30.5	37.6	44.3	50.2	54.9	57.4	58.4	Min
	Best Altitude	30/25	35/35	35/40	40/40	40/40	40/40	40/40	40/40	40/40	1000 Ft
	Using Best Alt Max. Range Descent	156.5	174.3	191.4	213.4	234.2	253.6	272.4	285.6	293.1	N.Mi
		37.6	41.0	44.2	47.4	50.4	53.2	56.1	58.0	59.4	Min
	Using Best Alt High Speed Descent (250 Knots)	132.2	147.4	169.0	189.1	209.9	229.3	248.1	261.3	268.8	N.Mi
		31.5	33.6	36.3	39.1	42.2	45.0	47.8	49.8	51.1	Min
200 GAL	Cruising At Same Altitude	120.0	158.5	181.5	217.0	255.6	297.1	333.7	369.7	405.6	N.Mi
		24.2	34.4	40.8	49.9	58.6	66.6	72.6	75.1	78.7	Min
	Best Altitude	40/40	40/40	40/40	40/40	40/40	40/40	40/40	40/40	40/40	1000 Ft
	Using Best Alt Max. Range Descent	261.5	289.4	304.6	324.8	346.2	366.2	385.3	398.5	405.6	N.Mi
		54.0	59.4	62.9	65.7	68.7	71.4	74.2	76.2	77.6	Min
	Using Best Alt High Speed Descent (250 Knots)	237.2	260.0	280.4	300.6	321.9	341.9	361.0	374.4	381.7	N.Mi
		47.8	50.3	54.6	57.7	60.5	63.3	66.1	67.8	69.0	Min
KNOTS — IAS	Military Climb	277	267	257	246	236	226	216	206	195	
	Level Cruise	306	278	257	233	215	205	192	194	193	
START DESCENT WITH	N. Miles To Go	0	13	27	42	57	74	93	115	143	Max Range Descent
	Fuel Remaining	20	35	43	50	56	61	68	75	85	
	N. Miles To Go	0	4	9	13	18	22	27	31	36	High Speed Descent
	Fuel Remaining	20	23	25	27	29	30	32	33	34	

EXAMPLE:

BEST ALTITUDE 15/20

Maximum Range Descent — High Speed Descent

REMARKS

Twenty gallon allowance included for approach and landing after Military Thrust climb, level cruise, and either a Maximum Range descent or a High Speed descent (250 Knots) to sea level. Cruise at initial altitude includes allowance for Maximum Range descent and twenty gallon approach and landing fuel.

Figure A4-2

Part 5 — Endurance

MAXIMUM ENDURANCE CHART.

Maximum endurance is obtained at a given altitude by flying at the condition which will give the lowest rate of fuel consumption at that altitude. The recommended schedule is given on the Maximum Endurance chart. Maximum endurance obtainable with any fuel loading when loitering at constant altitude is shown in figure A5-1 for the tip-tank configuration. The approximate rpm and fuel flow values shown in the table are based on an average gross weight at each altitude.

USE OF MAXIMUM ENDURANCE CHART.

Loiter Time.

To find maximum loiter time for a given amount of fuel consumed do the following:

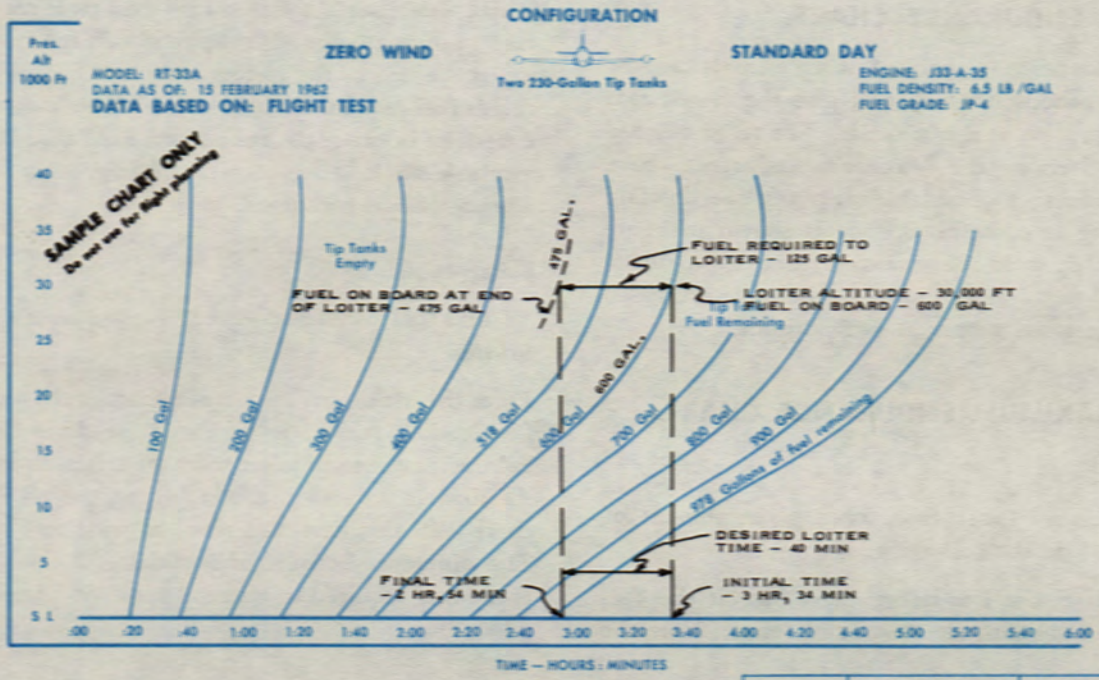
Enter the Maximum Endurance chart first at the fuel loading and flight altitude at start of loiter. Note the initial time. Subtract fuel to be used in loiter from the fuel loading at start of loiter to obtain the fuel remaining at the end of the endurance period. Enter the chart at this fuel-remaining 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 do the following:

Enter the Maximum Endurance chart at the altitude and fuel loading at 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 period. 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.

MAXIMUM ENDURANCE PROFILE



RECOMMENDED LOITER CONDITIONS

ALTITUDE FT	WITH TIP TANK FUEL — Loiter Speed 200 KN — CAS		WITHOUT TIP TANK FUEL — Loiter Speed 175 KN — CAS	
	*GAL / HR	* % RPM	*GAL / HR	* % RPM
40,000	210	98.0	165	92.0
35,000	205	93.5	160	88.0
30,000	210	90.0	165	84.0
25,000	215	86.5	170	80.5
20,000	220	83.0	185	78.5
15,000	240	80.0	215	74.5
10,000	270	77.0	250	73.0
5,000	310	75.0	285	71.0
S L	355	74.0	335	70.0

*Average approximate values

SAMPLE PROBLEM.

From the sample chart shown, determine the fuel required to loiter 40 minutes at 30,000 feet with tip tanks installed. The fuel on board at start of loiter is 600 gallons.

a. Initial time at 600 gal and 30,000 ft is 3 hr, 34 min.

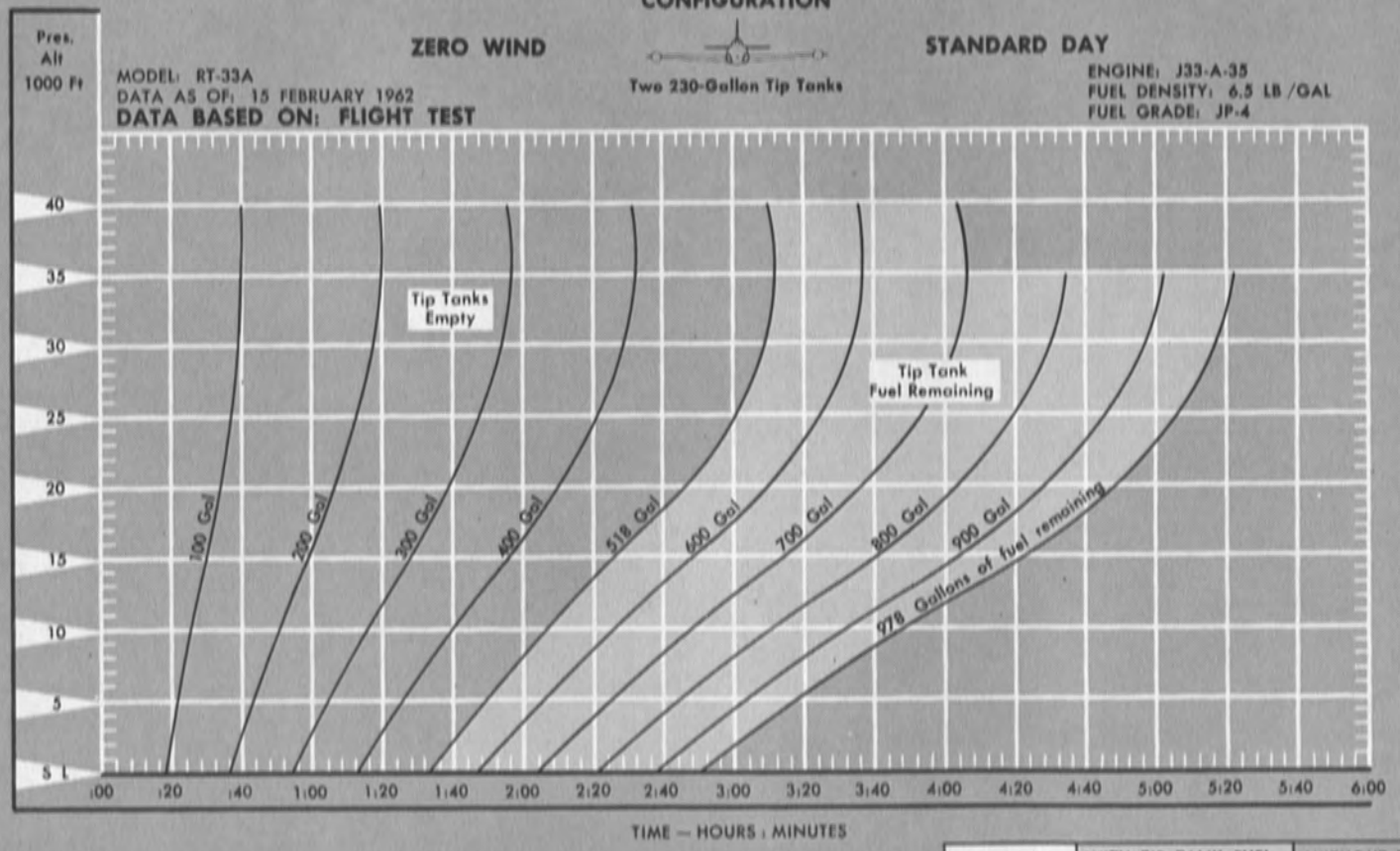
b. Final time is 2 hr, 54 min (3:34 — 0:40).

c. Fuel on board at end of loiter is 475 gal.

d. Fuel required to loiter, initial fuel load — final fuel load, is 125 gal (600 gal — 475 gal).

e. Recommended loiter CAS is 200 kn (with tip tank fuel), and 175 kn (without tip tank fuel).

MAXIMUM ENDURANCE PROFILE



ALTITUDE FT	WITH TIP TANK FUEL Loiter Speed 200 KN — CAS		WITHOUT TIP TANK FUEL Loiter Speed 175 KN — CAS	
	*GAL/HR	* % RPM	*GAL/HR	* % RPM
40,000	210	98.0	165	93.0
35,000	205	93.5	160	88.0
30,000	210	90.0	165	84.0
25,000	215	86.5	170	80.5
20,000	220	83.0	185	78.5
15,000	240	80.0	215	74.5
10,000	270	77.0	250	73.0
5,000	310	75.0	285	71.0
5 L	355	74.0	335	70.0

*Average approximate values

Figure A5-1

Part 6—Descent

DESCENT PERFORMANCE PRESENTED.

Distance, time, fuel required, and rate of descent for descent from altitude are presented for the tip-tank configuration. (See figure A6-1, A6-2, and A6-3.)

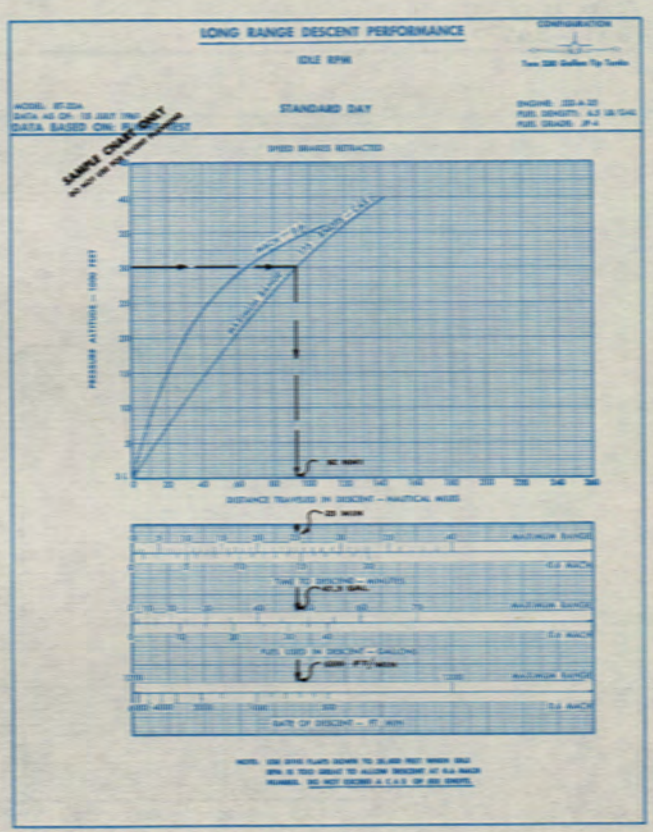
Data are shown for long-range descent performance, high-speed descent performance at Idle rpm, and high-speed descent performance at 85% rpm. Long-range descent performance data is presented for constant Mach 0.6 and 175 knots, CAS, descents. High-speed descent performance (Idle rpm) data is shown for constant 250 knots CAS descent with speed brakes extended, and constant 255 knots CAS descent with speed brakes retracted. High-speed descent performance (85% rpm) data is shown for 250 knots CAS with speed brakes extended. Speed brakes should be retracted for long-range descent. On some aircraft Idle rpm at altitudes above 35,000 feet may result in a level-flight speed in excess of the desired long-range descent speed. When this occurs establish the desired rate of descent and use speed brakes to keep airspeed below limit values.

USE OF THE DESCENT CHARTS.

A sample problem is provided to show the use of the descent charts.

SAMPLE PROBLEM.

For an aircraft equipped with two 230-gallon tip tanks determine the fuel used, time, distance traveled, and rate of descent for maximum range (175 knots CAS) descent from 30,000 feet to sea level.



Enter figure A6-1 at 30,000 feet and read on the maximum range line:

Distance traveled in descent	92 nmi.
Time to descend	25 min.
Fuel used in descent	47.5 gal.
Rate of descent	1200 fpm.

LONG RANGE DESCENT PERFORMANCE

IDLE RPM

CONFIGURATION

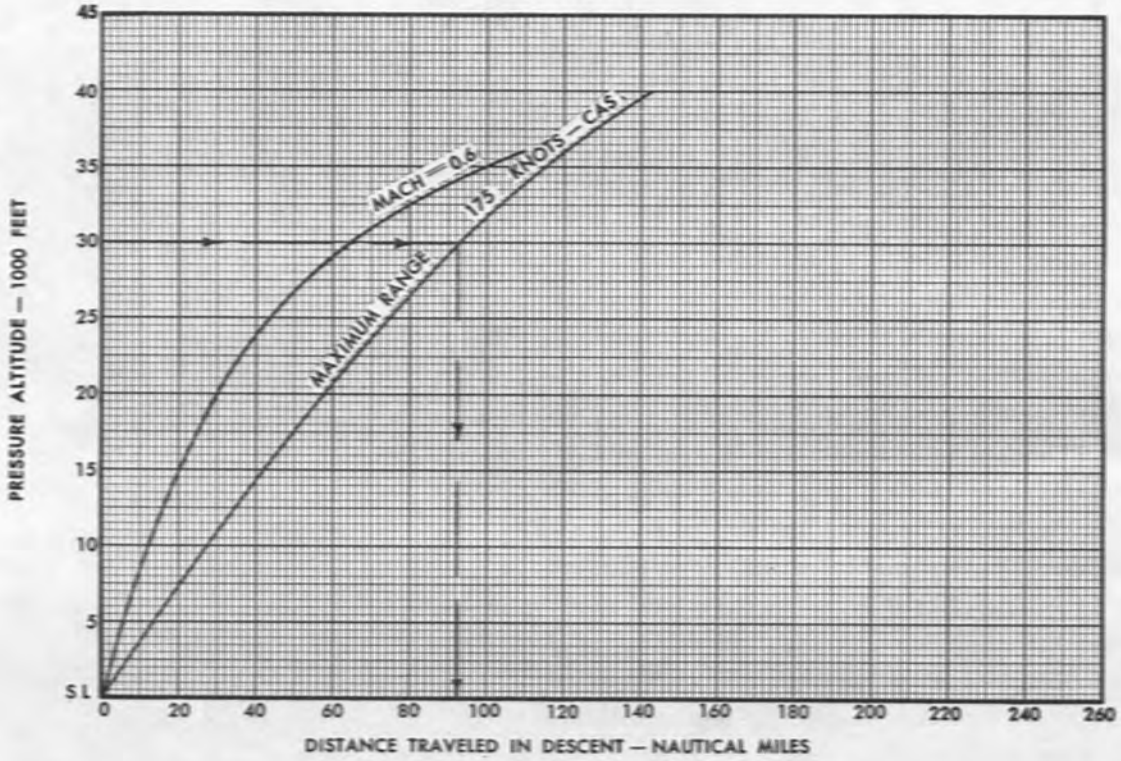
Two 230 Gallon Tip Tanks

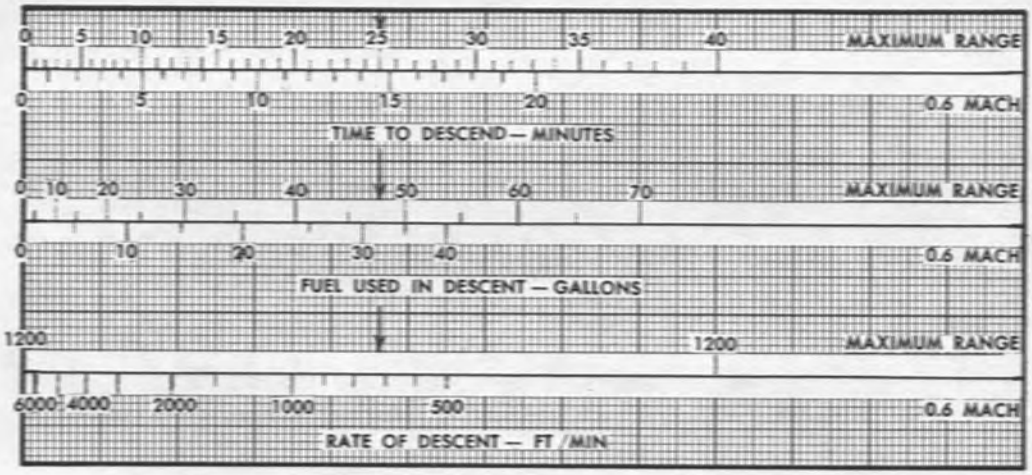
MODEL: RT-33A
DATA AS OF: 15 JULY 1961
DATA BASED ON: FLIGHT TEST

STANDARD DAY

ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4

SPEED BRAKES RETRACTED





NOTE: USE DIVE FLAPS DOWN TO 35,000 FEET WHEN IDLE RPM IS TOO GREAT TO ALLOW DESCENT AT 0.6 MACH NUMBER. DO NOT EXCEED A C A S OF 505 KNOTS.

Figure A6-1

HIGH SPEED DESCENT PERFORMANCE

IDLE RPM

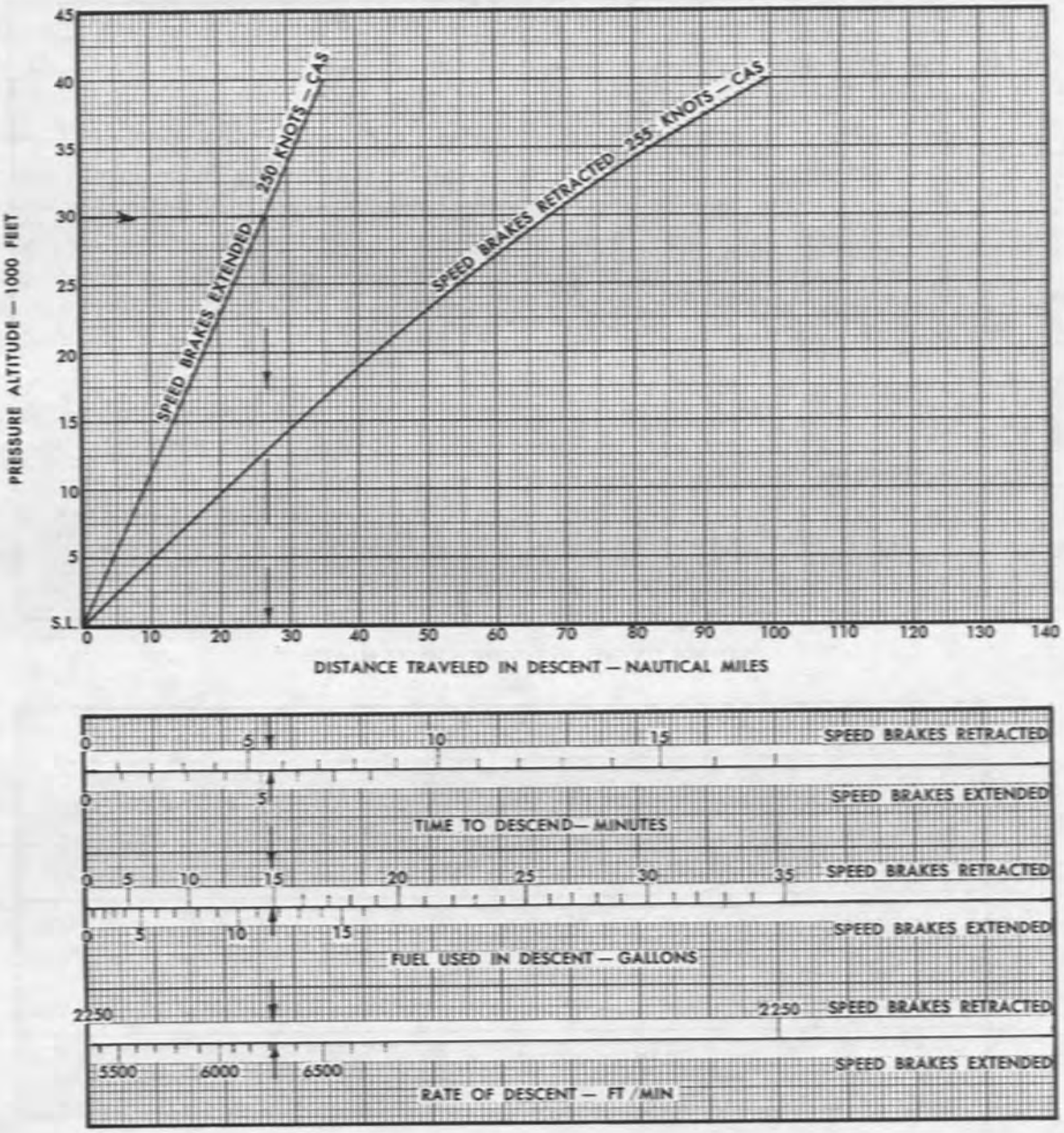
CONFIGURATION

Two 230-Gallon Tip Tanks

STANDARD DAY

MODEL: RT-33A
DATA AS OF: 15 JULY 1961
DATA BASED ON: FLIGHT TEST

ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4



DO NOT EXCEED A C A S OF 505 KNOTS

Figure A6-2

HIGH SPEED DESCENT PERFORMANCE

85% RPM

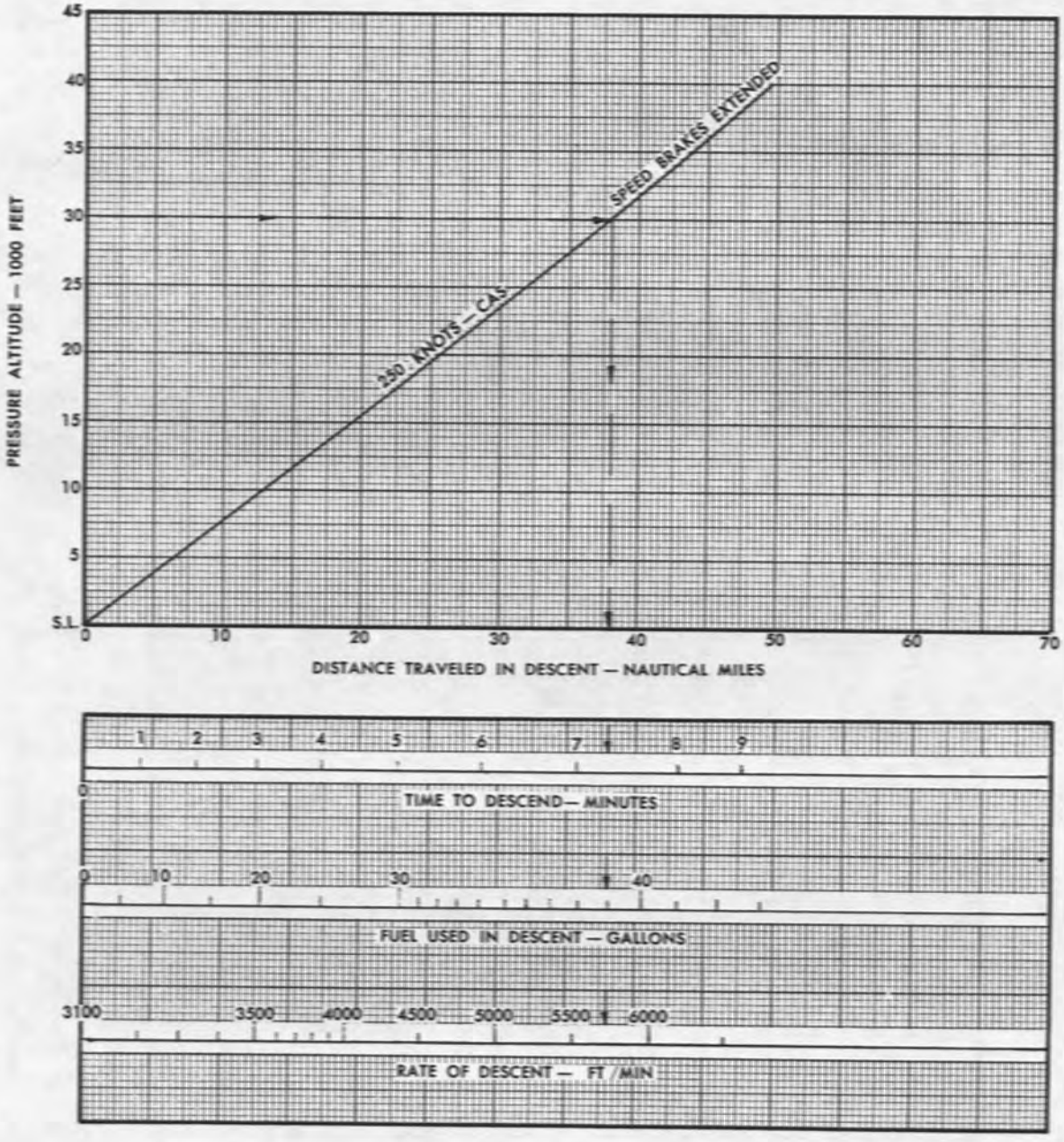
CONFIGURATION

Two 230 Gallon Tip Tanks

STANDARD DAY

MODEL: RT-33A
DATA AS OF: 15 JULY 1961
DATA BASED ON: FLIGHT TEST

ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4



DO NOT EXCEED A C A S OF 505 KNOTS

Figure A6-3

Part 7—Landing

PERFORMANCE INFORMATION PRESENTED.

Minimum total distances to clear a 50-foot obstacle, land, and stop, plus ground roll distances, are presented on the Landing Distance Chart, figure A7-1, for various conditions of outside air temperature, pressure altitude, gross weight, wind along the runway, and runway slope. Landing speed schedules are included in terms of indicated airspeed versus aircraft gross weight. A dry, hard-surfaced runway is assumed. A method for determining zero wind ground roll distance on a wet runway is also shown.

RUNWAY WIND COMPONENT.

A Runway Wind Component chart (figure A2-1) applicable for takeoff and landing is presented on page A2-6 for computing runway wind component for takeoff and landing. This chart may also be used to obtain crosswind component speeds.

Example.

Conditions:

- Landing gross weight — 13700 lb.
- Wind 90 degrees relative to runway heading, with gusts to 30 knots.

Find: Is the landing recommended?

Solution: Yes. From the landing speed schedule (figure A7-1) find the touchdown landing speed of 124 knots. Enter crosswind chart using maximum landing speed of 124 knots. The landing is recommended. (The minimum landing speed must not exceed the scheduled touchdown airspeed.)

CAUTION

Drift may become severe during landing ground roll, if airspeed transition through shaded (not recommended) area of chart is necessary. Drift will continue until a substantial portion of the aircraft's weight is on the runway.

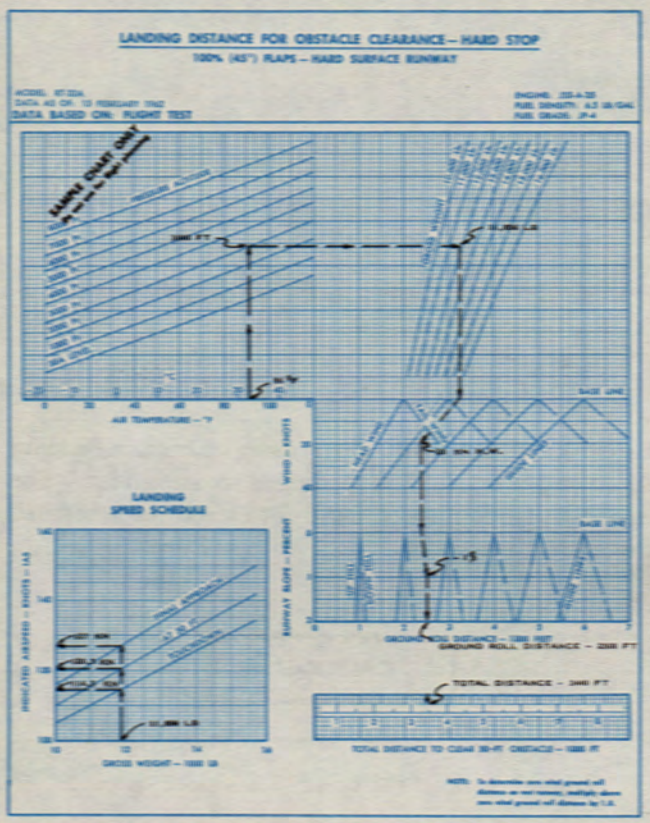
PERFORMANCE BASIS.

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.

USE OF CHART.

A sample problem is provided to show the use of the landing charts. A sample chart is presented with the problem as a further aid in understanding the function of the charts.

SAMPLE PROBLEM.



Determine the landing ground roll distance and the minimum total landing distance to clear a 50-foot obstacle and stop for the following conditions:

- Gross weight — 11,856 pounds.
- Field pressure altitude — 3000 feet.
- Field outside air temperature (at aircraft level — 91°F.
- Runway wind component — 20-knot headwind.
- Runway slope — 1% downhill.

a. From figure A7-1 the ground roll distance for touchdown to stop is found to be 2500 feet.

b. The touchdown speed (IAS) is 114.5 knots.

c. The minimum total distance to clear a 50-foot obstacle and stop is 3440 feet.

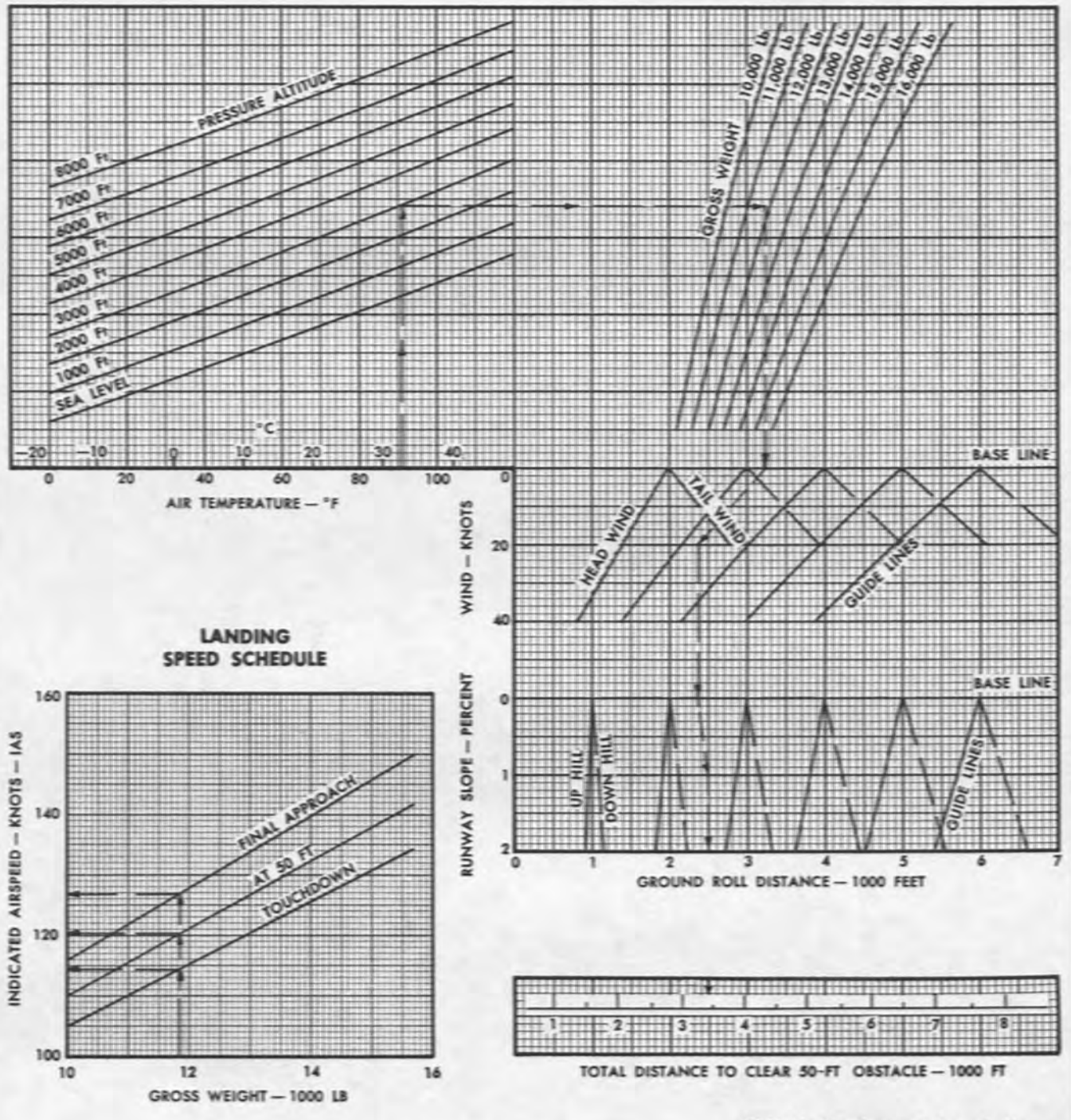
d. The speed (IAS) at the 50-foot obstacle is 120.5 knots.

LANDING DISTANCE FOR OBSTACLE CLEARANCE — HARD STOP

100% (45°) FLAPS — HARD SURFACE RUNWAY

MODEL: RT-33A
DATA AS OF: 15 FEBRUARY 1962
DATA BASED ON: FLIGHT TEST

ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4



NOTE: To determine zero wind ground roll distance on wet runway, multiply above zero wind ground roll distance by 1.8.

Figure A7-1

Part 8—Nautical Miles Per Gallon of Fuel

TABLE OF CONTENTS

Page numbers in **bold face** type denote illustration.

Title	*Page*
Nautical Miles Per Gallon of Fuel	A8-1
Tip Tanks	**A8-3**
No External Stores	**A8-12**

PERFORMANCE INFORMATION PRESENTED.

The Nautical Miles Per Gallon of Fuel charts furnish standard-day aircraft performance in terms of nautical miles per gallon of fuel and fuel flow for level flight operation in zero wind under any condition from maximum to loiter speed. Charts are given for altitudes from sea level to 40,000 feet in 5000-foot increments which cover the operating weight range for the aircraft configurations, with and without tip tanks. Recommended cruise speed lines for maximum range operation are presented on the charts for zero wind and 100-knot headwind conditions.

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 Gallon of Fuel charts by using the following procedure:

1. Divide the distance to travel into convenient increments.

2. Determine the aircraft gross weight at the start of level flight cruise.

3. Enter the Nautical Miles Per Gallon of Fuel chart for the aircraft 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 gallon and true airspeed (zero wind). To determine the effect of wind upon fuel and time, the nautical-miles-per-gallon value should be corrected to ground conditions by the following equation: Ground nmi/gal = air nmi/gal × GS/TAS.

4. The cruising fuel needed for the first distance increment is obtained by dividing the distance increment by the applicable nautical-miles-per-gallon value from step 3.

5. The time required to fly the initial distance increment is obtained by dividing the distance increment by the true airspeed (zero wind), or groundspeed (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 aircraft gross weight should be corrected for the amount of fuel consumed in obtaining the previous distance increments. The corrected weight is then used to determine a new nautical-miles-per-gallon value as in step 3.

The accuracy of the fuel and time predictions depends upon the size of the distance increment chosen. The smaller the increment, the more accurate the resulting range data.

CALIBRATED AIRSPEED 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.* If your speed requirement is limited by the normal thrust rating, then altitude must be sacrificed. *In either of the above cases, the speed should be maintained.* As mentioned previously, the nautical-miles-per-gallon of fuel will not change due to changes in air temperature. The required rpm and rate of fuel consumption will change, but a compensating change will occur in true airspeed also. Thus, your time between check points will change but not range available. These effects are illustrated in the table, following.

With Tip Tanks — 13,000 lb Gross Weight

	Standard Day —48°F	*Standard + 18°F Hot Day (—30°F)*
Pressure altitude, feet	30,000	30,000
Recommended CAS, knots	215	215
Fuel flow, gal/hr	213	218
True airspeed, knots	342	349
Fuel economy, nmi/gal	1.60	1.60

TABULATED DATA.

Cruise performance data of IAS, TAS, RPM, and fuel flow, based on an average gross weight, is presented in tabulated form on the Nautical Miles Per Gallon of Fuel charts for normal, high speed (100% RPM), and endurance cruise conditions.

FUEL ECONOMY COMPARISON.

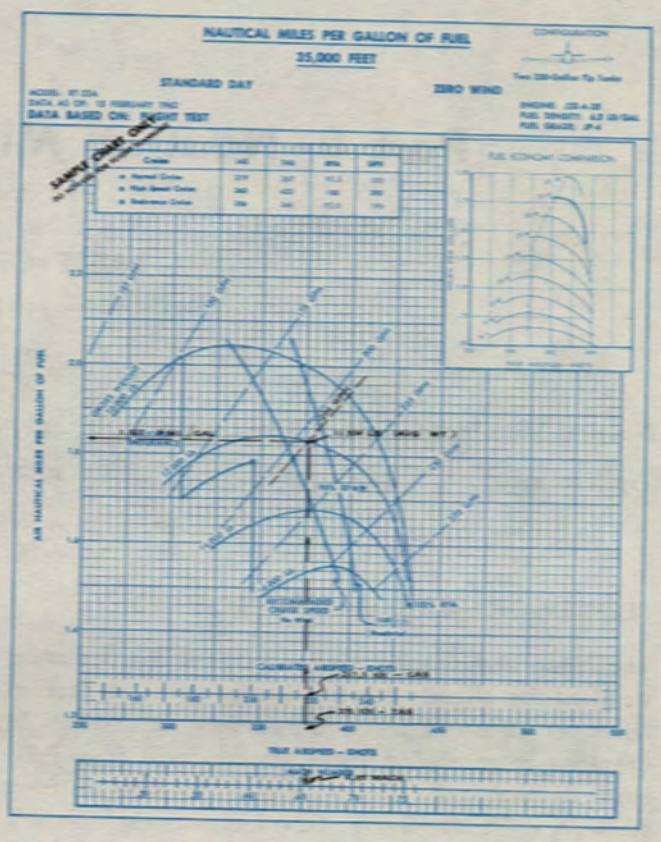
A small chart presenting the variation of fuel economy (nautical miles per gallon of fuel) versus airspeed for altitudes from sea level to 40,000 feet is provided on each Nautical Miles Per Gallon of Fuel chart to show the relation of the fuel economy at a given altitude to the fuel economy available at other cruising altitudes. These charts are based on average gross weights typical for each altitude.

EFFECT OF TRAVEL POD INSTALLATION.

Installation of the travel pod does not significantly affect the range available if a small change in cruise speed schedules is made. When operating with the travel pod, cruise approximately 10 knots IAS slower than normal for long range if flight levels are 25,000 feet or higher. Below 25,000 feet, use indicated airspeeds 15 knots slower than recommended for normal long-range cruise. Use of the lower speeds effects a suitable compromise between the drag of the travel pod and the basic miles per gallon of fuel characteristics of the aircraft, so as to minimize range loss with this external load.

NAUTICAL MILES PER GALLON SAMPLE PROBLEM.

Determine the range available at 35,000 feet, time required, and fuel flow to cruise at a constant airspeed of 375 knots TAS. The initial cruise weight is 13,500 lb and a 1000-lb reserve is desired. Assume that it is a standard day with a 60-knot headwind component and the aircraft is in the tip-tank configuration. The zero fuel weight is assumed to be 9368 lb.



a. True airspeed .....375 kn.

b. Calibrated airspeed (from chart) .....217.5 kn.

c. From figure A1-3 determine indicated airspeed to be 223.0 kn.

d. Groundspeed is 315 kn (375 kn — 60 kn).

e. Empty gross weight .....9368 lb.

f. Gross weight with 1000-lb reserve is 10,368 lb. (9368 lb + 1000 lb).

g. Average cruise gross weight is 11,934 lb. $\frac{(13{,}500 \text{ lb} + 10{,}368 \text{ lb})}{2}$.

h. Enter the chart at 375 kn TAS and 11,934 lb. Read average air nmi/gal of fuel to be 1.837 nmi/gal.

i. Determine average ground nmi/gal of fuel to be 1.54 nmi/gal by using the formula: Ground nmi/gal = air nmi/gal × GS/TAS (1.837 × 315 kn/375 kn).

j. Fuel to be used in cruise is 3132 lb (482 gal) (13,500 lb — 10,368 lb).

k. Range available is 742 nmi (1.54 × 482 gal).

l. Time required is 2.35 hr (742 nmi/315 kn).

m. From chart, read average fuel flow of 204 gal/hr; at 13,500 pounds, approximately 220 gal/hr.

NAUTICAL MILES PER GALLON OF FUEL

SEA LEVEL

CONFIGURATION

Two 230 Gallon Tip Tanks

STANDARD DAY **ZERO WIND**

MODEL: RT-33A
DATA AS OF: 15 FEBRUARY 1962
DATA BASED ON: FLIGHT TEST

ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4

Cruise	IAS	TAS	RPM	GPH
• Normal Cruise	305	298	84.0	450
• High Speed Cruise	473	462	100	925
• Endurance Cruise	206	200	73.0	355

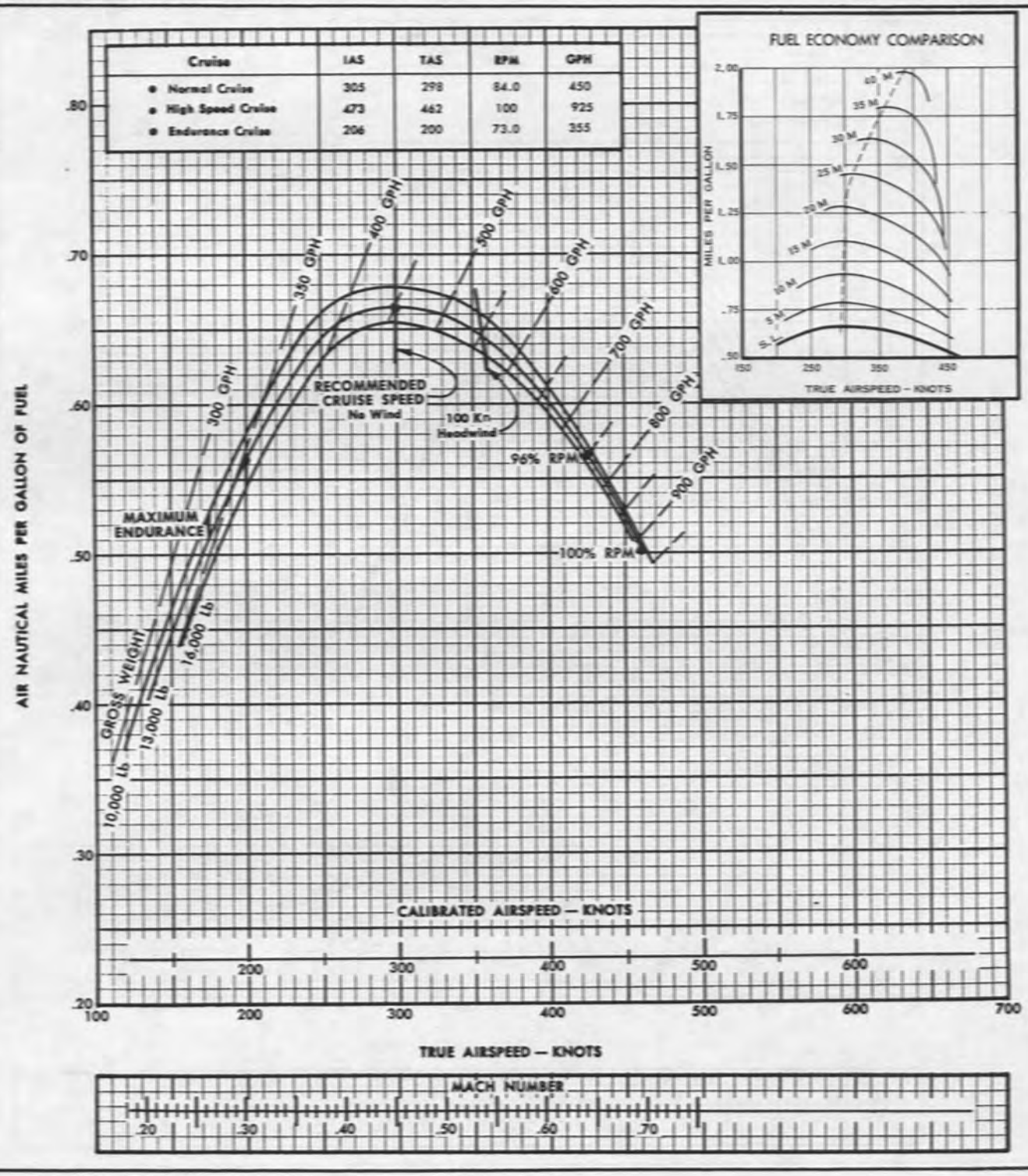


Figure A8-1

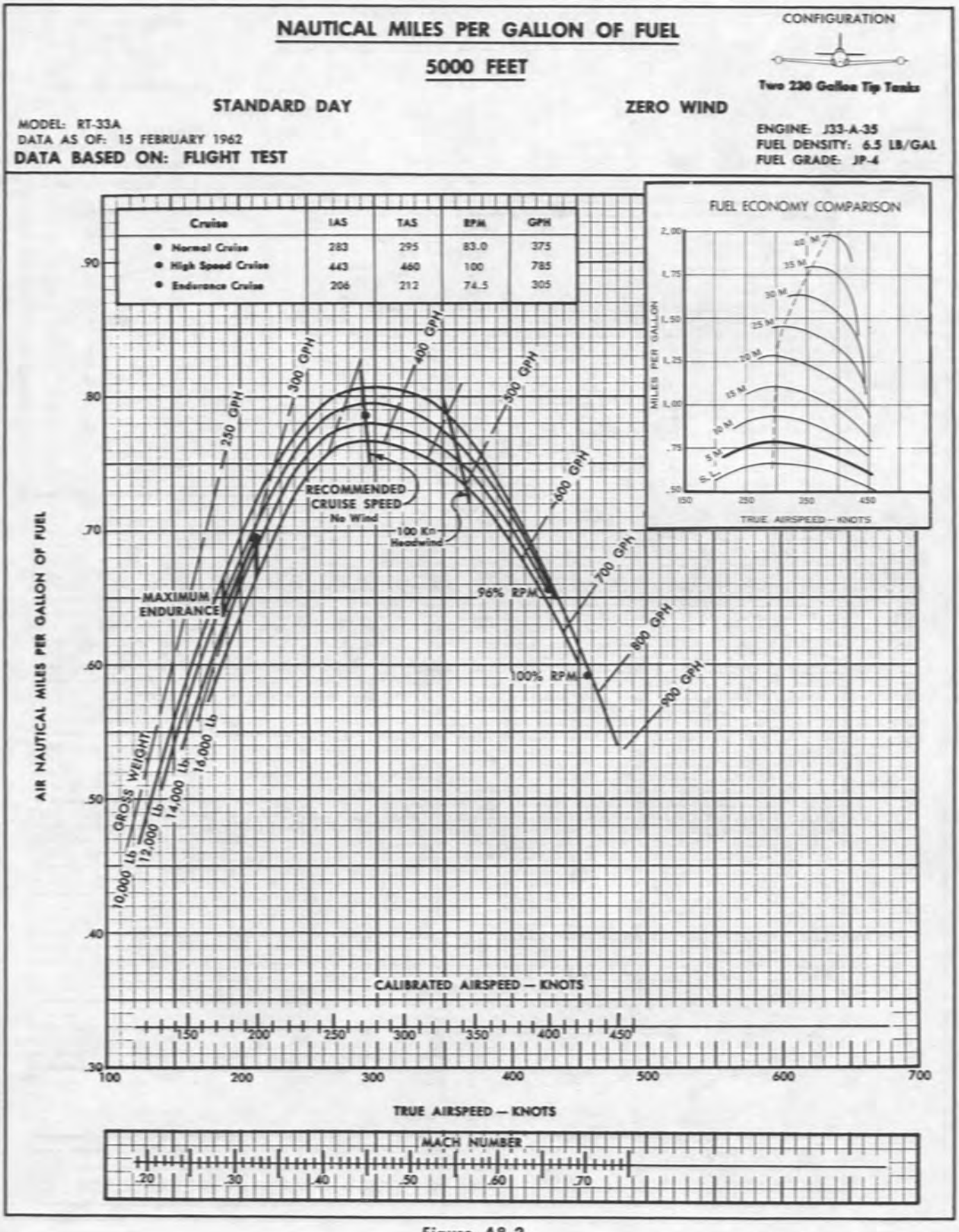

NAUTICAL MILES PER GALLON OF FUEL
5000 FEET
STANDARD DAY
ZERO WIND
CONFIGURATION
Two 230 Gallon Tip Tanks
MODEL: RT-33A
DATA AS OF: 15 FEBRUARY 1962
DATA BASED ON: FLIGHT TEST
ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4
Cruise | IAS | TAS | RPM | GPH
Normal Cruise | 283 | 295 | 83.0 | 375
High Speed Cruise | 443 | 460 | 100 | 785
Endurance Cruise | 206 | 212 | 74.5 | 305
FUEL ECONOMY COMPARISON
MILES PER GALLON
TRUE AIRSPEED — KNOTS
AIR NAUTICAL MILES PER GALLON OF FUEL
230 GPH
300 GPH
400 GPH
500 GPH
600 GPH
700 GPH
800 GPH
900 GPH
RECOMMENDED CRUISE SPEED
No Wind
100 Kn Headwind
MAXIMUM ENDURANCE
96% RPM
100% RPM
GROSS WEIGHT
10,000 Lb
12,000 Lb
14,000 Lb
16,000 Lb
CALIBRATED AIRSPEED — KNOTS
TRUE AIRSPEED — KNOTS
MACH NUMBER

Figure A8-2

NAUTICAL MILES PER GALLON OF FUEL

10,000 FEET

CONFIGURATION

Two 230-Gallon Tip Tanks

STANDARD DAY

ZERO WIND

MODEL: RT-33A
DATA AS OF: 15 FEBRUARY 1962
DATA BASED ON: FLIGHT TEST

ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4

Cruise	IAS	TAS	RPM	GPH
● Normal Cruise	258	290	82.5	310
● High Speed Cruise	412	459	100	680
● Endurance Cruise	206	230	76.5	265

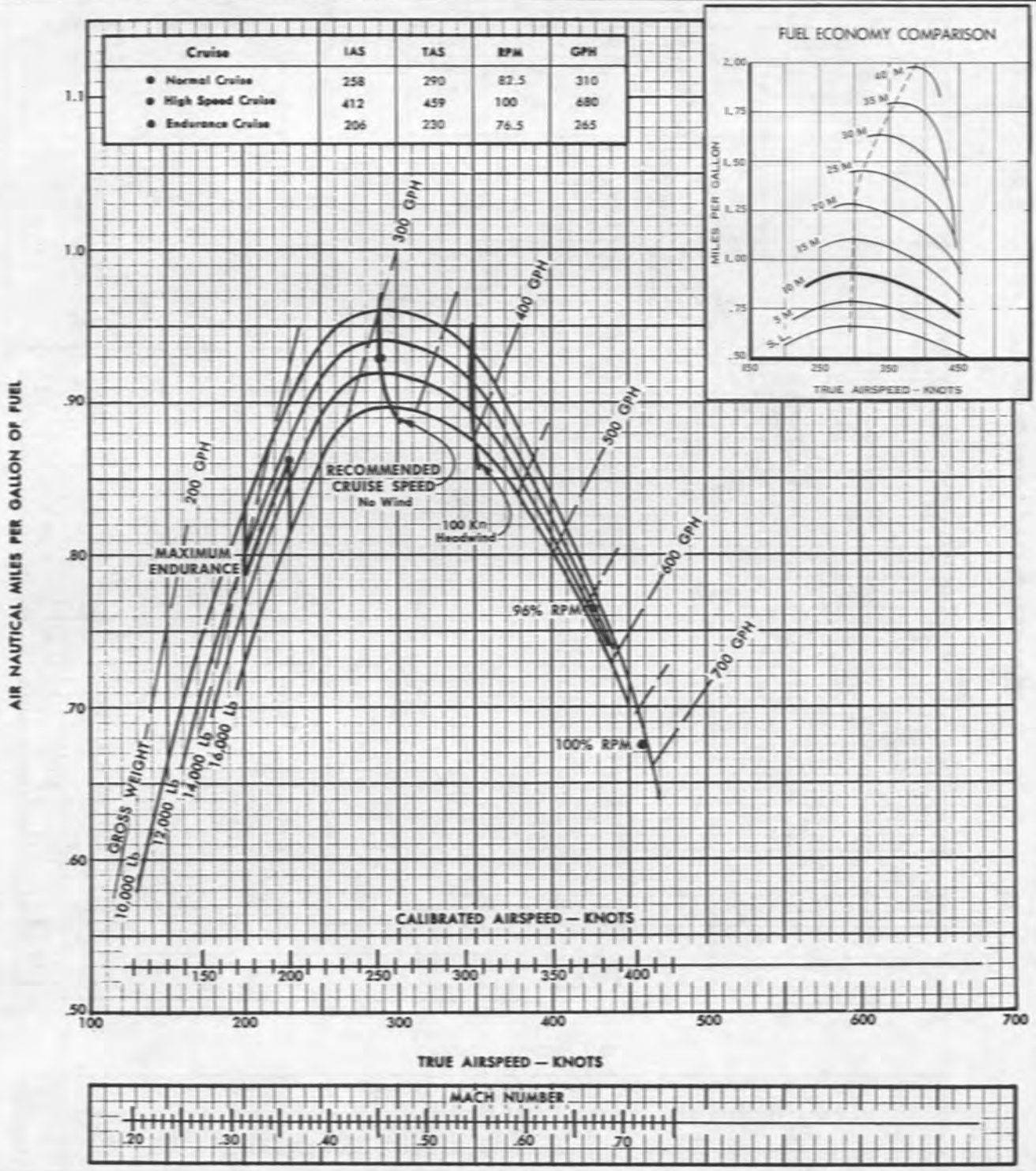


Figure A8-3

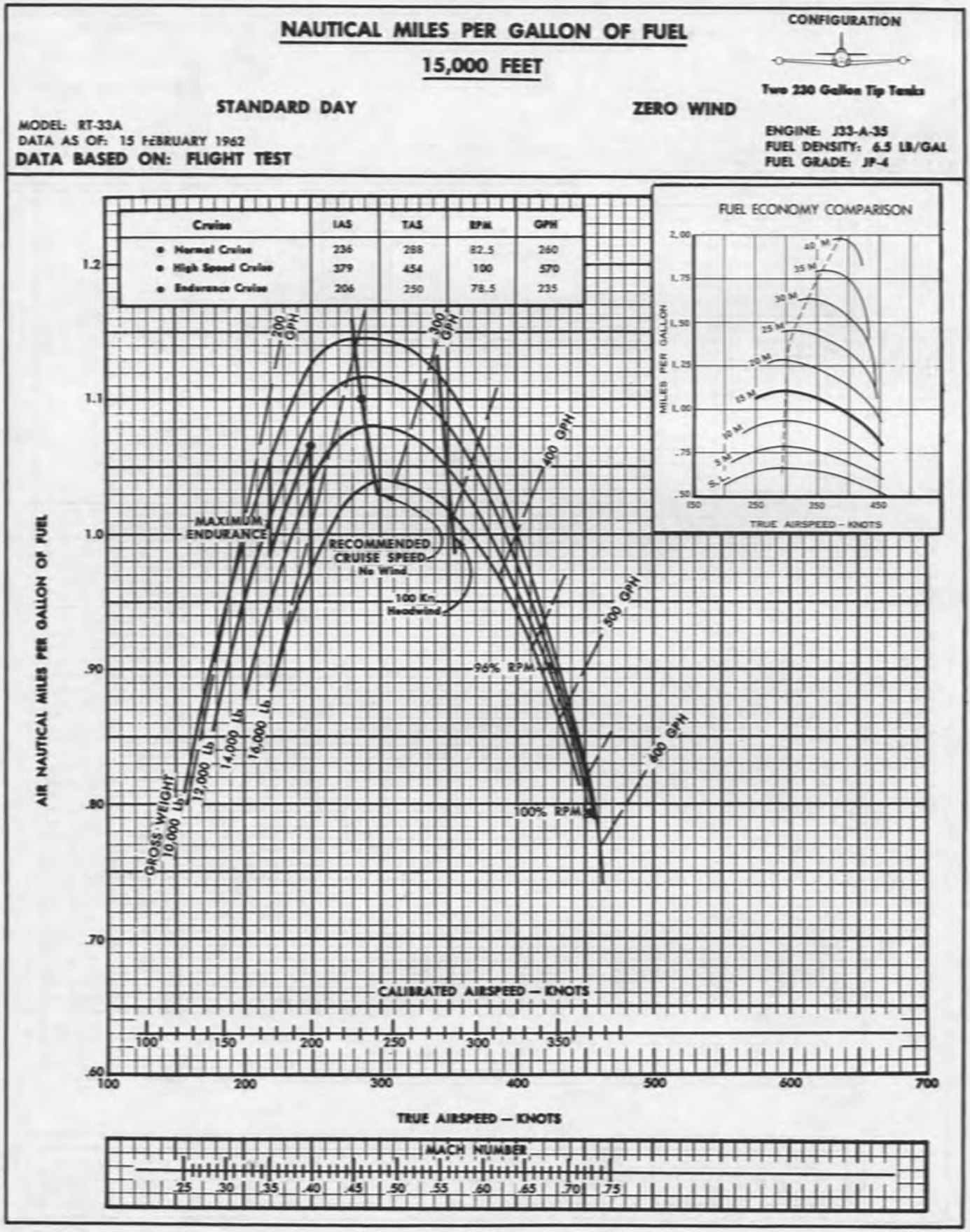

NAUTICAL MILES PER GALLON OF FUEL
15,000 FEET
STANDARD DAY
ZERO WIND
CONFIGURATION
Two 230 Gallon Tip Tanks
MODEL: RT-33A
DATA AS OF: 15 FEBRUARY 1962
DATA BASED ON: FLIGHT TEST
ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4
Cruise | IAS | TAS | RPM | GPH
Normal Cruise | 236 | 288 | 82.5 | 260
High Speed Cruise | 379 | 454 | 100 | 570
Endurance Cruise | 206 | 250 | 78.5 | 235
FUEL ECONOMY COMPARISON
MILES PER GALLON
TRUE AIRSPEED – KNOTS
AIR NAUTICAL MILES PER GALLON OF FUEL
MAXIMUM ENDURANCE
RECOMMENDED CRUISE SPEED
No Wind
100 Kn Headwind
96% RPM
100% RPM
GROSS WEIGHT
10,000 Lb
12,000 Lb
14,000 Lb
16,000 Lb
200 GPH
300 GPH
400 GPH
500 GPH
600 GPH
CALIBRATED AIRSPEED – KNOTS
TRUE AIRSPEED – KNOTS
MACH NUMBER

Figure A8-4

NAUTICAL MILES PER GALLON OF FUEL

20,000 FEET

CONFIGURATION

Two 230 Gallon Tip Tanks

STANDARD DAY **ZERO WIND**

MODEL: RT-33A
DATA AS OF: 15 FEBRUARY 1962
DATA BASED ON: FLIGHT TEST

ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4

Cruise	IAS	TAS	RPM	GPH
● Normal Cruise	223	293	83.5	230
● High Speed Cruise	351	454	100	495
● Endurance Cruise	206	270	82.0	215

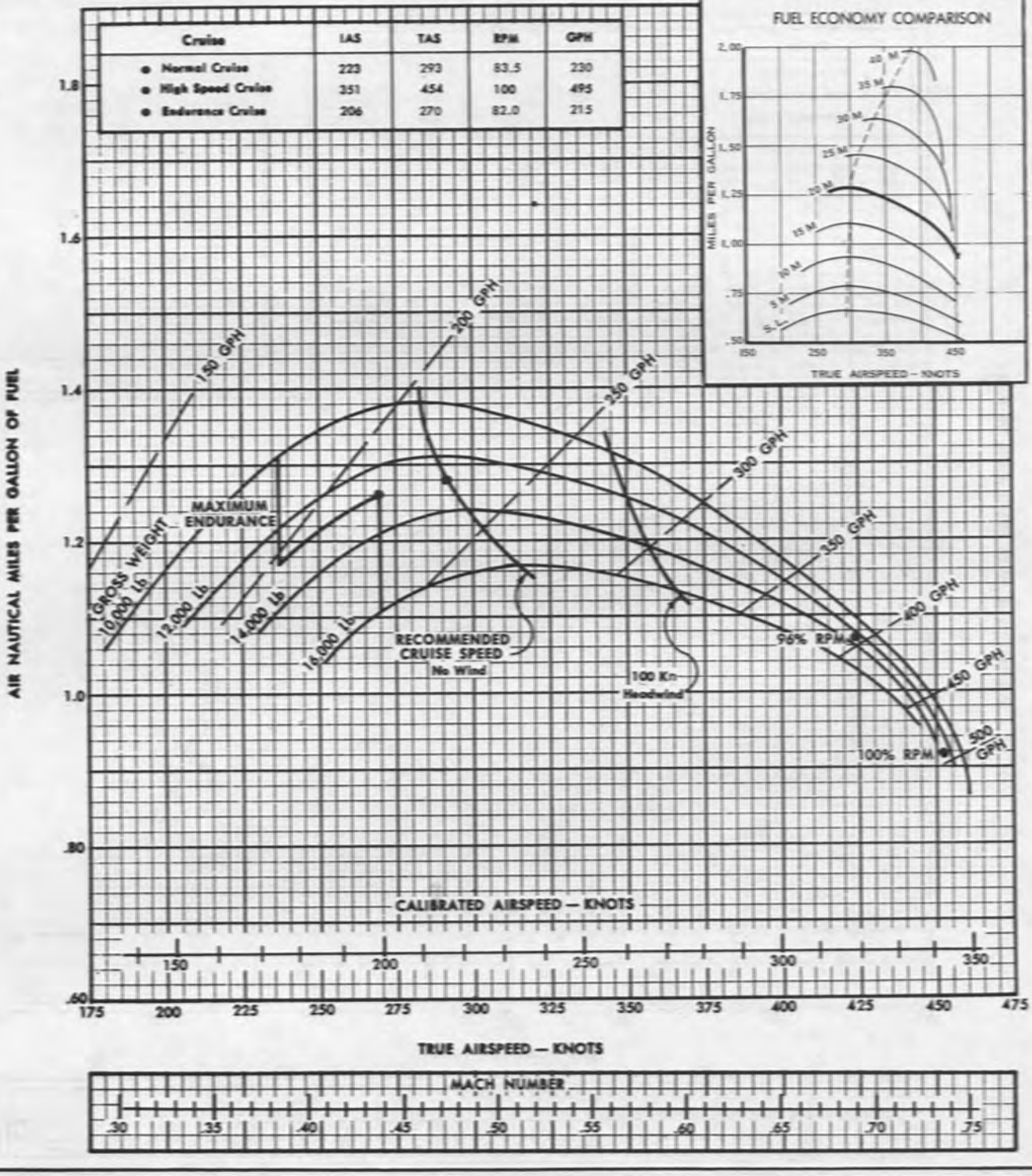


Figure A8-5

NAUTICAL MILES PER GALLON OF FUEL

25,000 FEET

CONFIGURATION

Two 230 Gallon Tip Tanks

STANDARD DAY

ZERO WIND

MODEL: RT-33A
DATA AS OF: 15 FEBRUARY 1962
DATA BASED ON: FLIGHT TEST

ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4

Cruise	IAS	TAS	RPM	GPH
● Normal Cruise	213	304	86.0	210
● High Speed Cruise	320	447	100	420
● Endurance Cruise	206	293	85.0	205

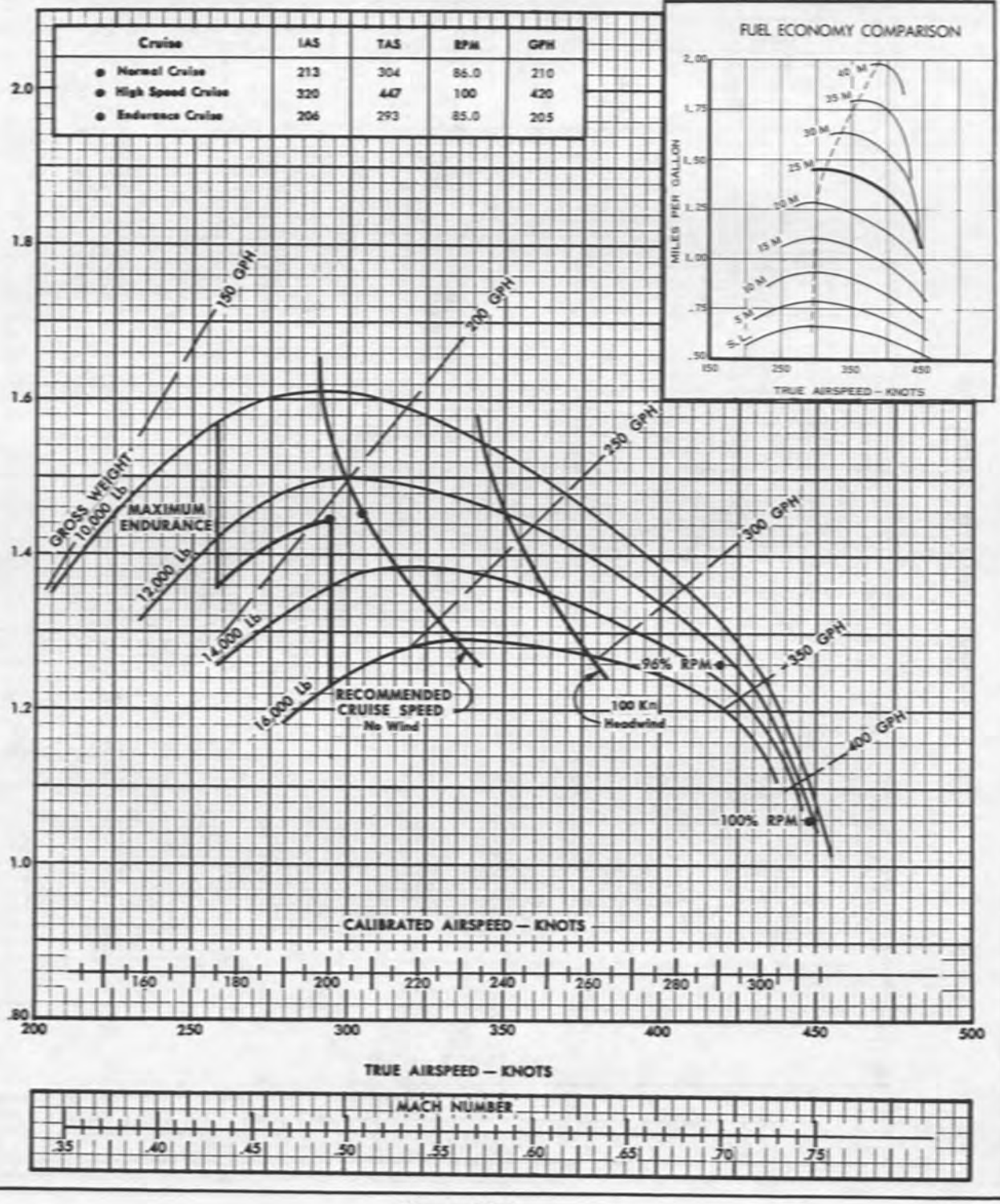


Figure A8-6

NAUTICAL MILES PER GALLON OF FUEL

30,000 FEET

CONFIGURATION

Two 230 Gallon Tip Tanks

STANDARD DAY

ZERO WIND

MODEL: RT-33A
DATA AS OF: 15 FEBRUARY 1962
DATA BASED ON: FLIGHT TEST

ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4

Cruise	IAS	TAS	RPM	GPH
● Normal Cruise	219	339	90.0	210
● High Speed Cruise	292	442	100	350
● Endurance Cruise	206	319	89.0	200

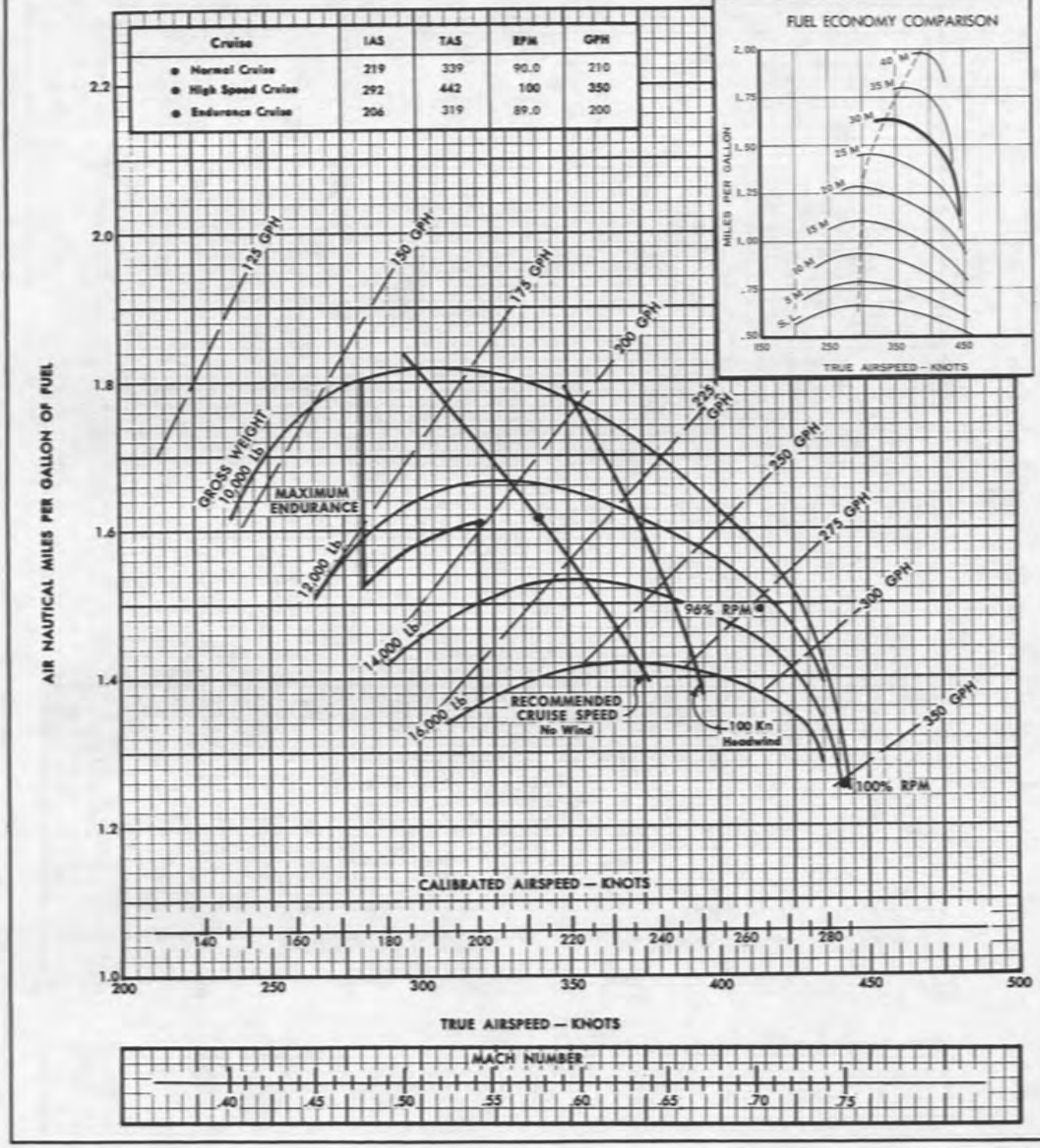


Figure A8-7

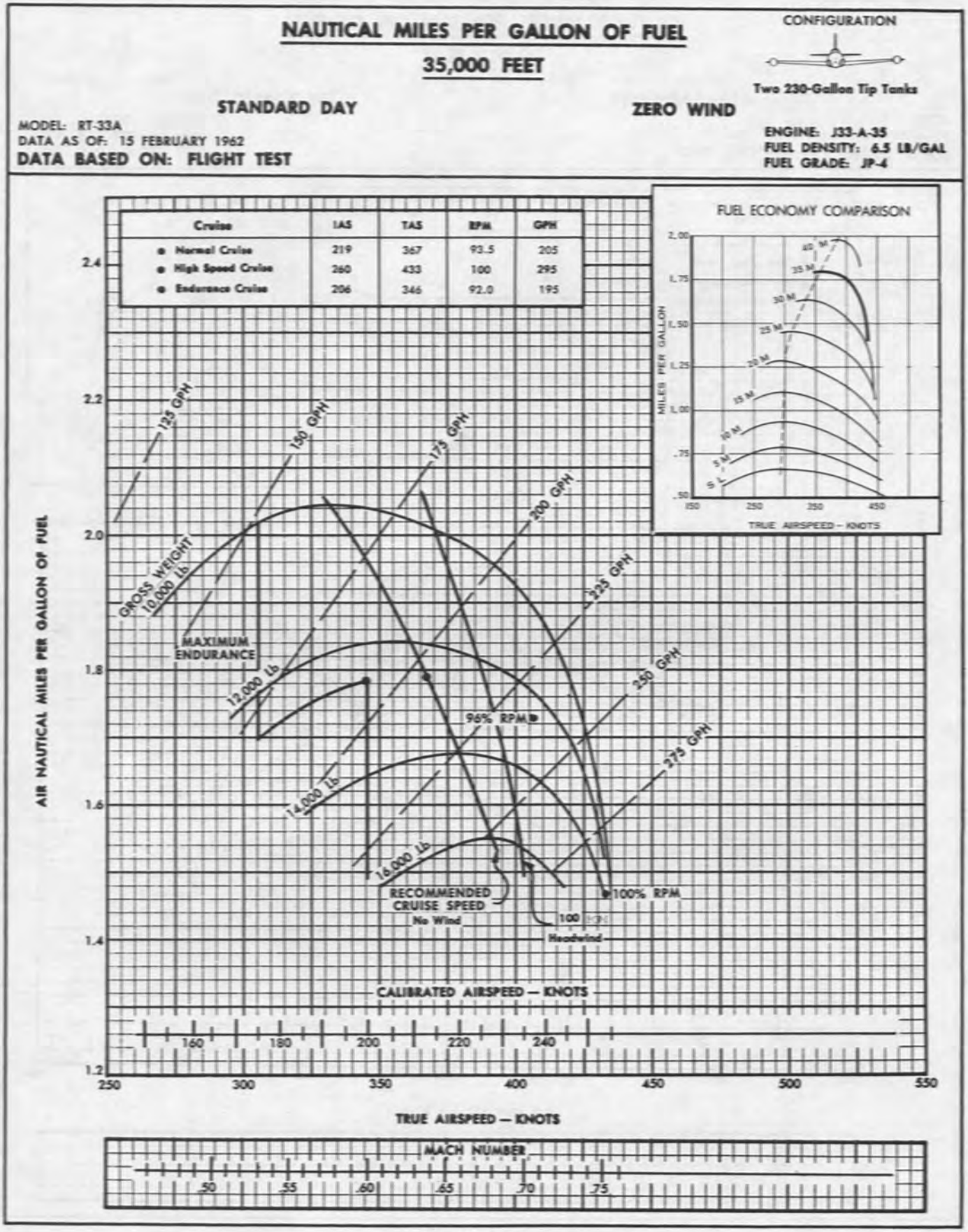

NAUTICAL MILES PER GALLON OF FUEL
35,000 FEET
CONFIGURATION
Two 230-Gallon Tip Tanks
STANDARD DAY
ZERO WIND
MODEL: RT-33A
DATA AS OF: 15 FEBRUARY 1962
DATA BASED ON: FLIGHT TEST
ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4
Cruise | IAS | TAS | RPM | GPH
Normal Cruise | 219 | 367 | 93.5 | 205
High Speed Cruise | 260 | 433 | 100 | 295
Endurance Cruise | 206 | 346 | 92.0 | 195
FUEL ECONOMY COMPARISON
MILES PER GALLON
TRUE AIRSPEED – KNOTS
AIR NAUTICAL MILES PER GALLON OF FUEL
125 GPH
150 GPH
175 GPH
200 GPH
225 GPH
250 GPH
275 GPH
GROSS WEIGHT 10,000 Lb
12,000 Lb
14,000 Lb
16,000 Lb
MAXIMUM ENDURANCE
96% RPM
100% RPM
RECOMMENDED CRUISE SPEED
No Wind
100 Kt Headwind
CALIBRATED AIRSPEED – KNOTS
TRUE AIRSPEED – KNOTS
MACH NUMBER

Figure A8-8

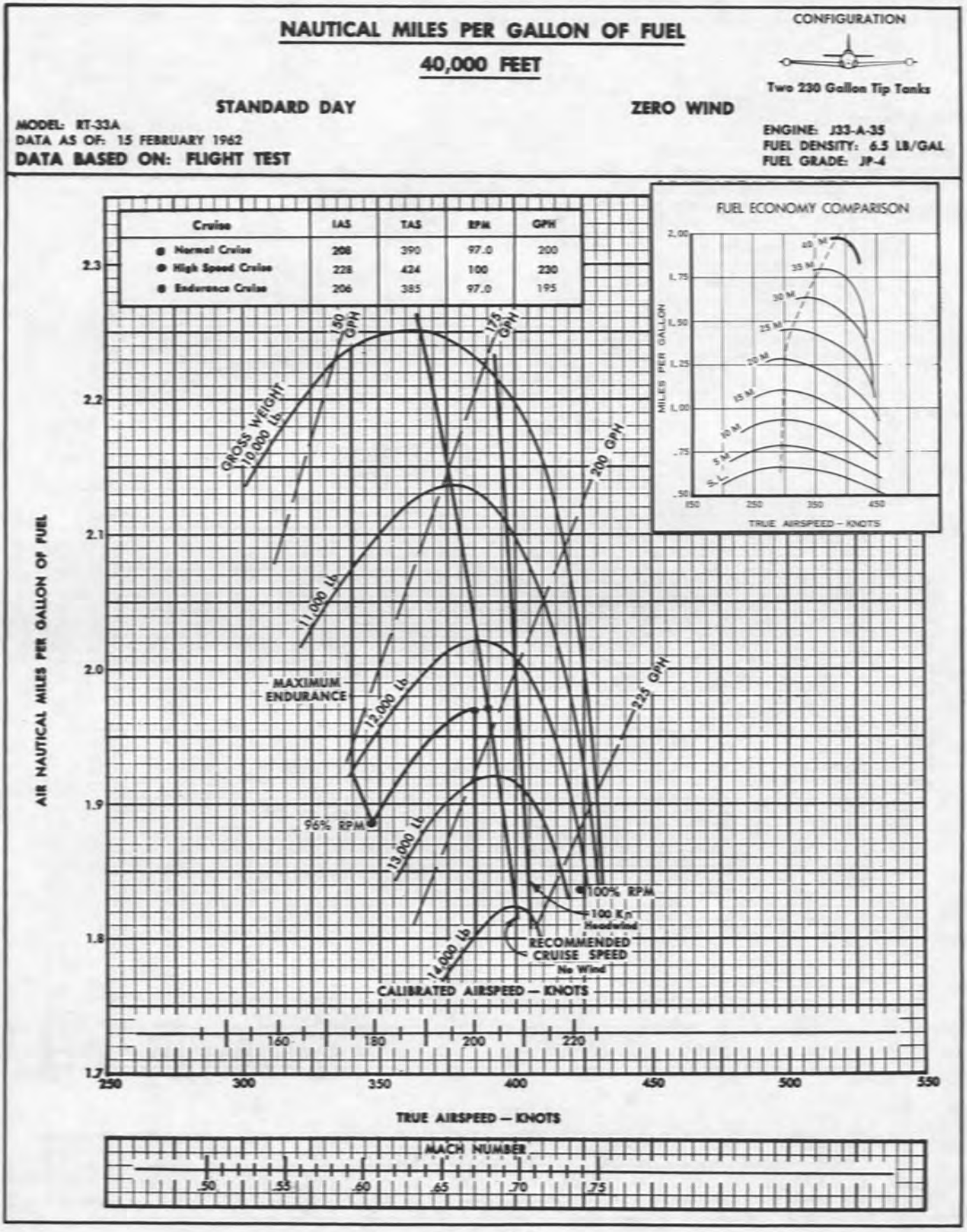

NAUTICAL MILES PER GALLON OF FUEL
40,000 FEET
CONFIGURATION
Two 230 Gallon Tip Tanks
STANDARD DAY
ZERO WIND
MODEL: RT-33A
DATA AS OF: 15 FEBRUARY 1962
DATA BASED ON: FLIGHT TEST
ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4
Cruise | IAS | TAS | RPM | GPH
Normal Cruise | 208 | 390 | 97.0 | 200
High Speed Cruise | 228 | 424 | 100 | 230
Endurance Cruise | 206 | 385 | 97.0 | 195
FUEL ECONOMY COMPARISON
MILES PER GALLON
TRUE AIRSPEED – KNOTS
AIR NAUTICAL MILES PER GALLON OF FUEL
GROSS WEIGHT 10,000 Lb.
11,000 Lb.
12,000 Lb.
13,000 Lb.
14,000 Lb.
150 GPH
175 GPH
200 GPH
225 GPH
MAXIMUM ENDURANCE
96% RPM
100% RPM
100 Kn Headwind
RECOMMENDED CRUISE SPEED
No Wind
CALIBRATED AIRSPEED — KNOTS
TRUE AIRSPEED — KNOTS
MACH NUMBER

Figure A8-9

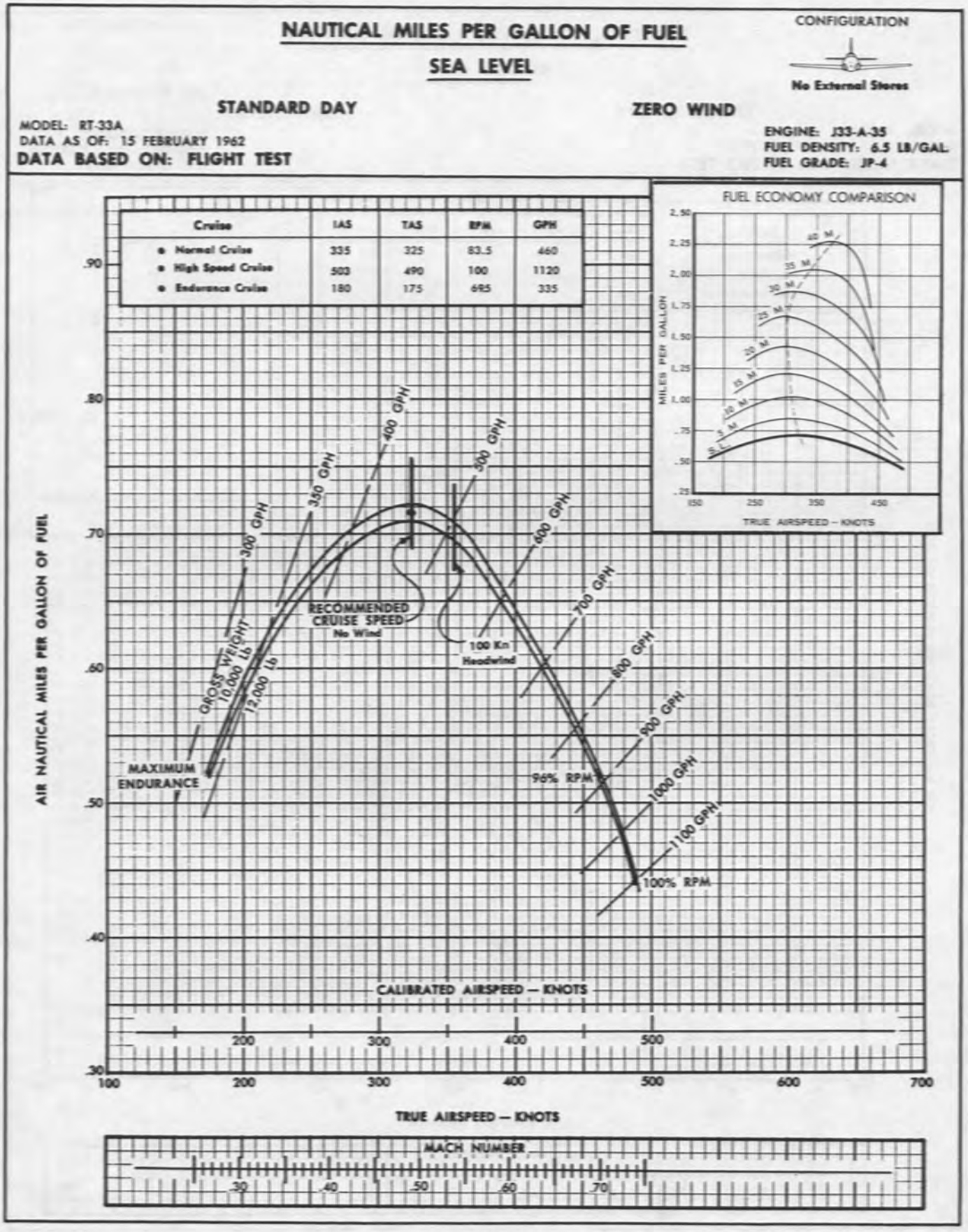

NAUTICAL MILES PER GALLON OF FUEL
SEA LEVEL
STANDARD DAY
ZERO WIND
CONFIGURATION
No External Stores
MODEL: RT-33A
DATA AS OF: 15 FEBRUARY 1962
DATA BASED ON: FLIGHT TEST
ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL.
FUEL GRADE: JP-4
Cruise | IAS | TAS | RPM | GPH
Normal Cruise | 335 | 325 | 83.5 | 460
High Speed Cruise | 503 | 490 | 100 | 1120
Endurance Cruise | 180 | 175 | 695 | 335
FUEL ECONOMY COMPARISON
MILES PER GALLON
TRUE AIRSPEED — KNOTS
AIR NAUTICAL MILES PER GALLON OF FUEL
300 GPH
350 GPH
400 GPH
500 GPH
600 GPH
700 GPH
800 GPH
900 GPH
1000 GPH
1100 GPH
GROSS WEIGHT
10,000 Lb
12,000 Lb
RECOMMENDED CRUISE SPEED
No Wind
100 Kn Headwind
MAXIMUM ENDURANCE
96% RPM
100% RPM
CALIBRATED AIRSPEED — KNOTS
TRUE AIRSPEED — KNOTS
MACH NUMBER

Figure A8-10

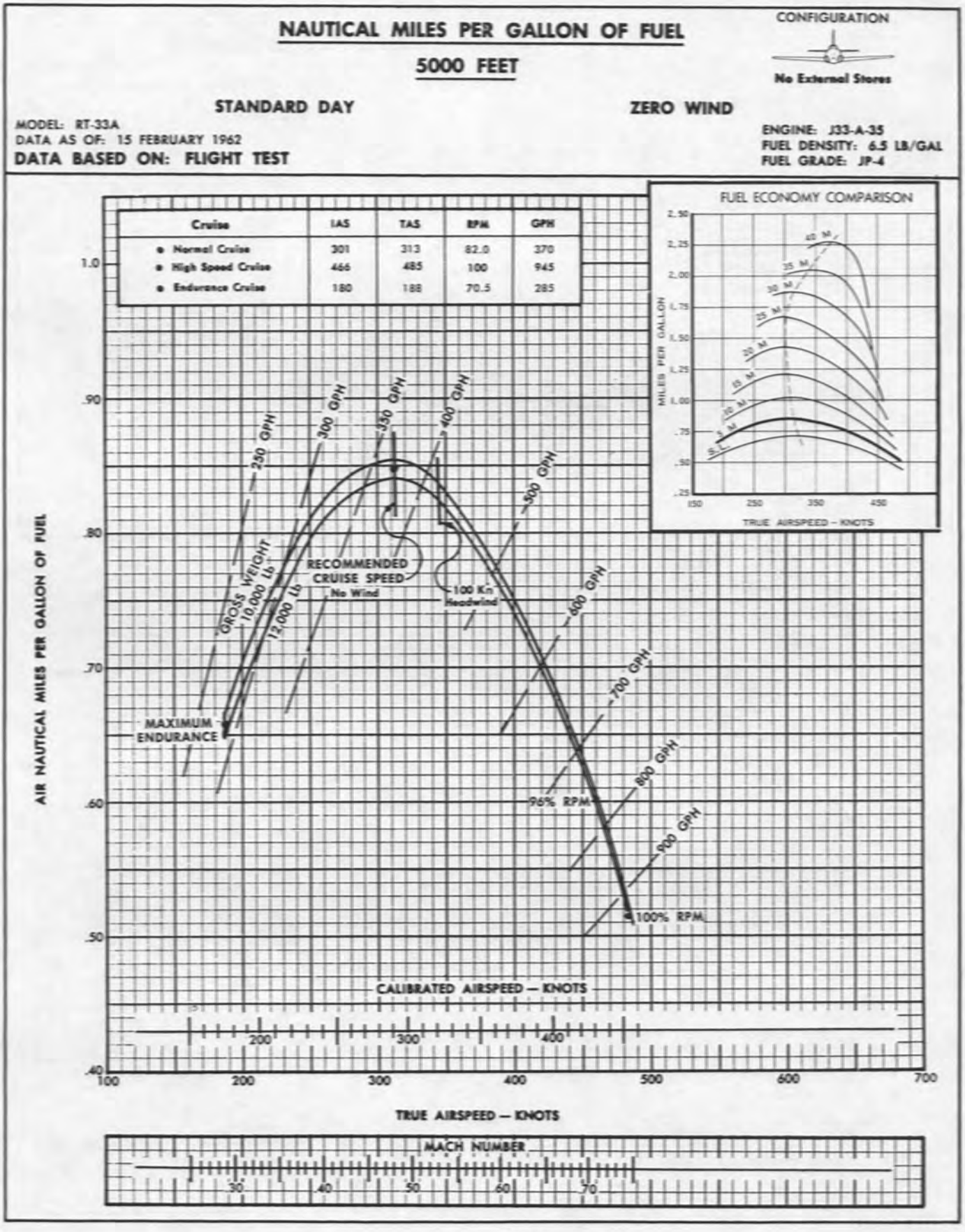

NAUTICAL MILES PER GALLON OF FUEL
5000 FEET
CONFIGURATION
No External Stores
STANDARD DAY
ZERO WIND
MODEL: RT-33A
DATA AS OF: 15 FEBRUARY 1962
DATA BASED ON: FLIGHT TEST
ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4
Cruise | IAS | TAS | RPM | GPH
Normal Cruise | 301 | 313 | 82.0 | 370
High Speed Cruise | 466 | 485 | 100 | 945
Endurance Cruise | 180 | 188 | 70.5 | 285
FUEL ECONOMY COMPARISON
MILES PER GALLON
TRUE AIRSPEED – KNOTS
AIR NAUTICAL MILES PER GALLON OF FUEL
250 GPH
300 GPH
350 GPH
400 GPH
500 GPH
600 GPH
700 GPH
800 GPH
900 GPH
GROSS WEIGHT
10,000 Lb
12,000 Lb
RECOMMENDED
CRUISE SPEED
No Wind
100 Kn
Headwind
MAXIMUM
ENDURANCE
96% RPM
100% RPM
CALIBRATED AIRSPEED – KNOTS
TRUE AIRSPEED – KNOTS
MACH NUMBER

Figure A8-11

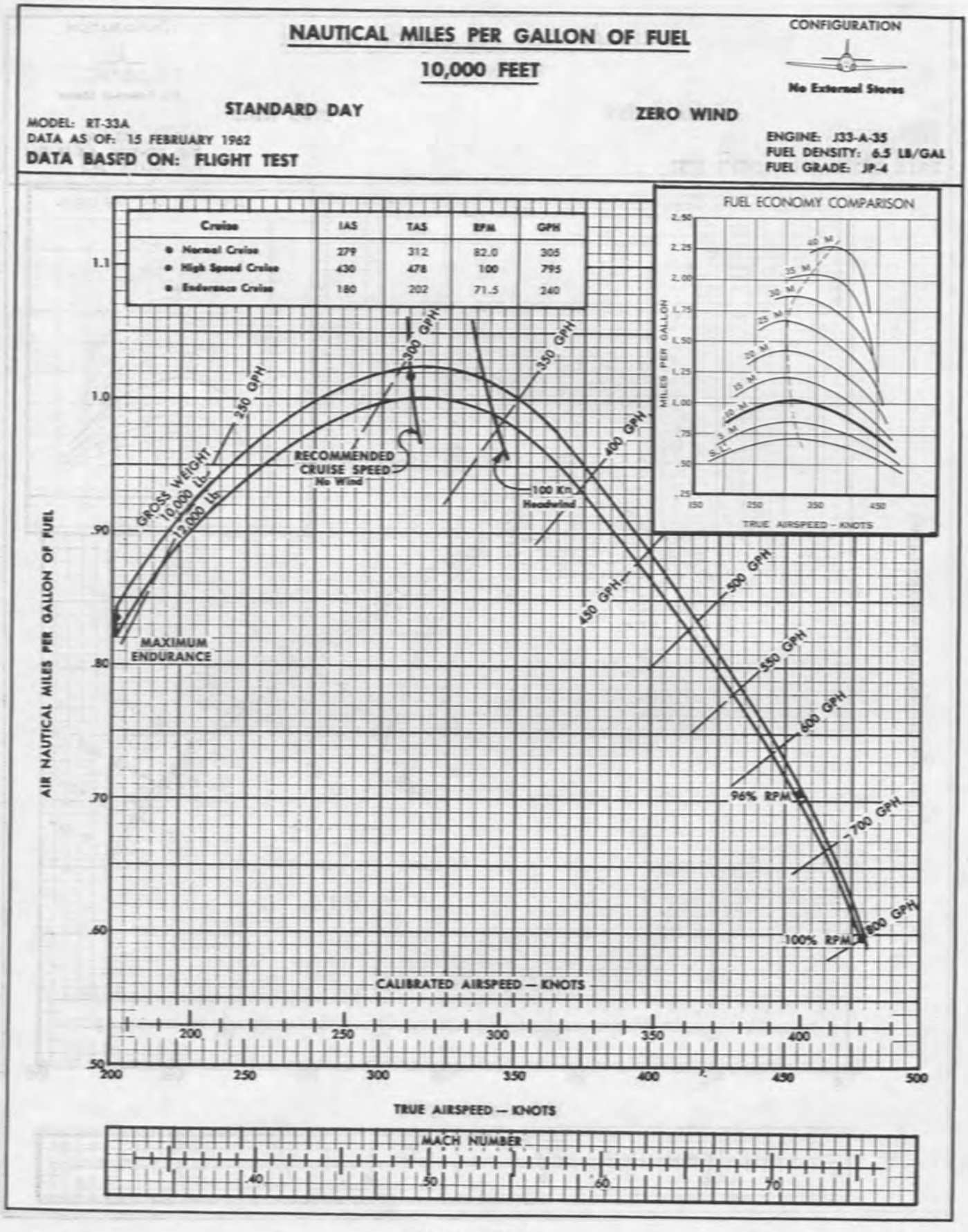

NAUTICAL MILES PER GALLON OF FUEL
10,000 FEET
CONFIGURATION
No External Stores
STANDARD DAY
ZERO WIND
MODEL: RT-33A
DATA AS OF: 15 FEBRUARY 1962
DATA BASED ON: FLIGHT TEST
ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4
Cruise | IAS | TAS | RPM | GPH
Normal Cruise | 279 | 312 | 82.0 | 305
High Speed Cruise | 430 | 478 | 100 | 795
Endurance Cruise | 180 | 202 | 71.5 | 240
FUEL ECONOMY COMPARISON
MILES PER GALLON
TRUE AIRSPEED – KNOTS
AIR NAUTICAL MILES PER GALLON OF FUEL
GROSS WEIGHT
10,000 Lbs
12,000 Lbs
250 GPH
300 GPH
350 GPH
400 GPH
450 GPH
500 GPH
550 GPH
600 GPH
700 GPH
800 GPH
RECOMMENDED CRUISE SPEED
No Wind
100 Kn Headwind
MAXIMUM ENDURANCE
96% RPM
100% RPM
CALIBRATED AIRSPEED – KNOTS
TRUE AIRSPEED – KNOTS
MACH NUMBER

Figure A8-12

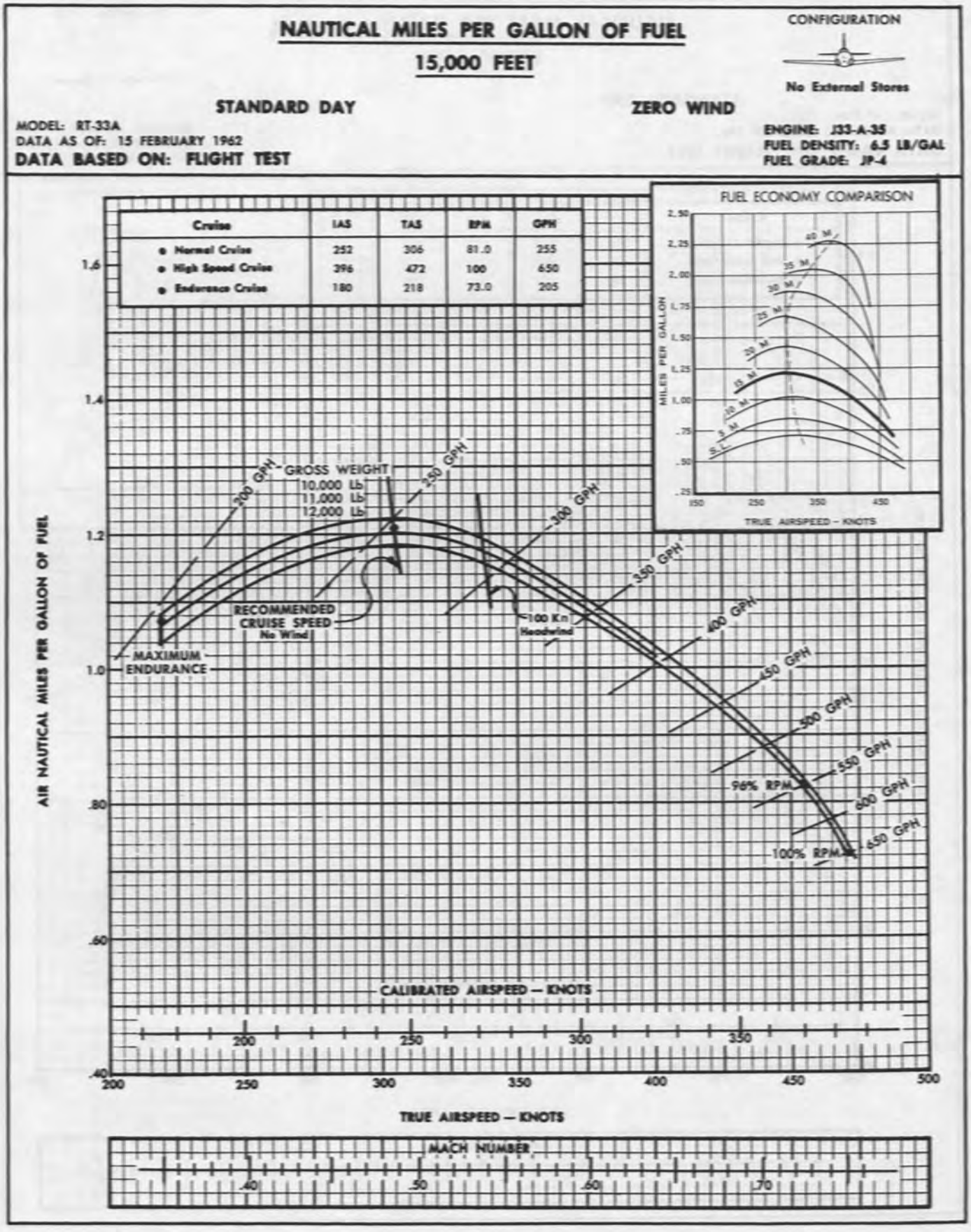

NAUTICAL MILES PER GALLON OF FUEL
15,000 FEET
CONFIGURATION
No External Stores
STANDARD DAY
ZERO WIND
MODEL: RT-33A
DATA AS OF: 15 FEBRUARY 1962
DATA BASED ON: FLIGHT TEST
ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4
Cruise | IAS | TAS | RPM | GPH
Normal Cruise | 252 | 306 | 81.0 | 255
High Speed Cruise | 396 | 472 | 100 | 650
Endurance Cruise | 180 | 218 | 73.0 | 205
FUEL ECONOMY COMPARISON
MILES PER GALLON
TRUE AIRSPEED - KNOTS
GROSS WEIGHT
10,000 Lb
11,000 Lb
12,000 Lb
200 GPH
250 GPH
300 GPH
350 GPH
400 GPH
450 GPH
500 GPH
550 GPH
600 GPH
650 GPH
96% RPM
100% RPM
RECOMMENDED CRUISE SPEED No Wind
100 Kn Headwind
MAXIMUM ENDURANCE
AIR NAUTICAL MILES PER GALLON OF FUEL
CALIBRATED AIRSPEED — KNOTS
TRUE AIRSPEED — KNOTS
MACH NUMBER

Figure A8-13

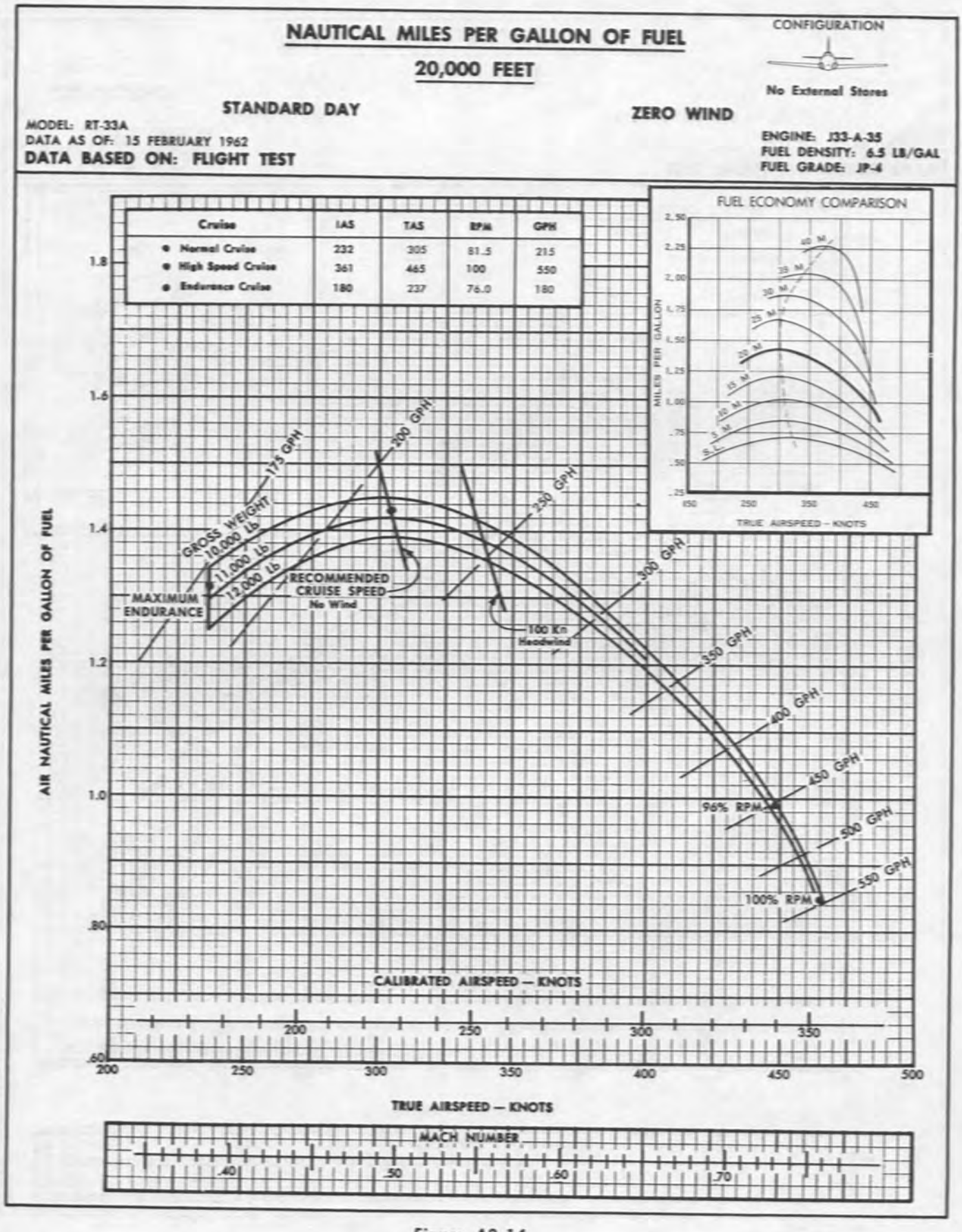

NAUTICAL MILES PER GALLON OF FUEL
20,000 FEET
CONFIGURATION
No External Stores
STANDARD DAY
ZERO WIND
MODEL: RT-33A
DATA AS OF: 15 FEBRUARY 1962
DATA BASED ON: FLIGHT TEST
ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4
Cruise | IAS | TAS | RPM | GPH
Normal Cruise | 232 | 305 | 81.5 | 215
High Speed Cruise | 361 | 465 | 100 | 550
Endurance Cruise | 180 | 237 | 76.0 | 180
FUEL ECONOMY COMPARISON
MILES PER GALLON
TRUE AIRSPEED — KNOTS
AIR NAUTICAL MILES PER GALLON OF FUEL
GROSS WEIGHT
10,000 Lb
11,000 Lb
12,000 Lb
175 GPH
200 GPH
250 GPH
300 GPH
350 GPH
400 GPH
450 GPH
500 GPH
550 GPH
MAXIMUM ENDURANCE
RECOMMENDED CRUISE SPEED
No Wind
100 Kn Headwind
96% RPM
100% RPM
CALIBRATED AIRSPEED — KNOTS
TRUE AIRSPEED — KNOTS
MACH NUMBER

Figure A8-14

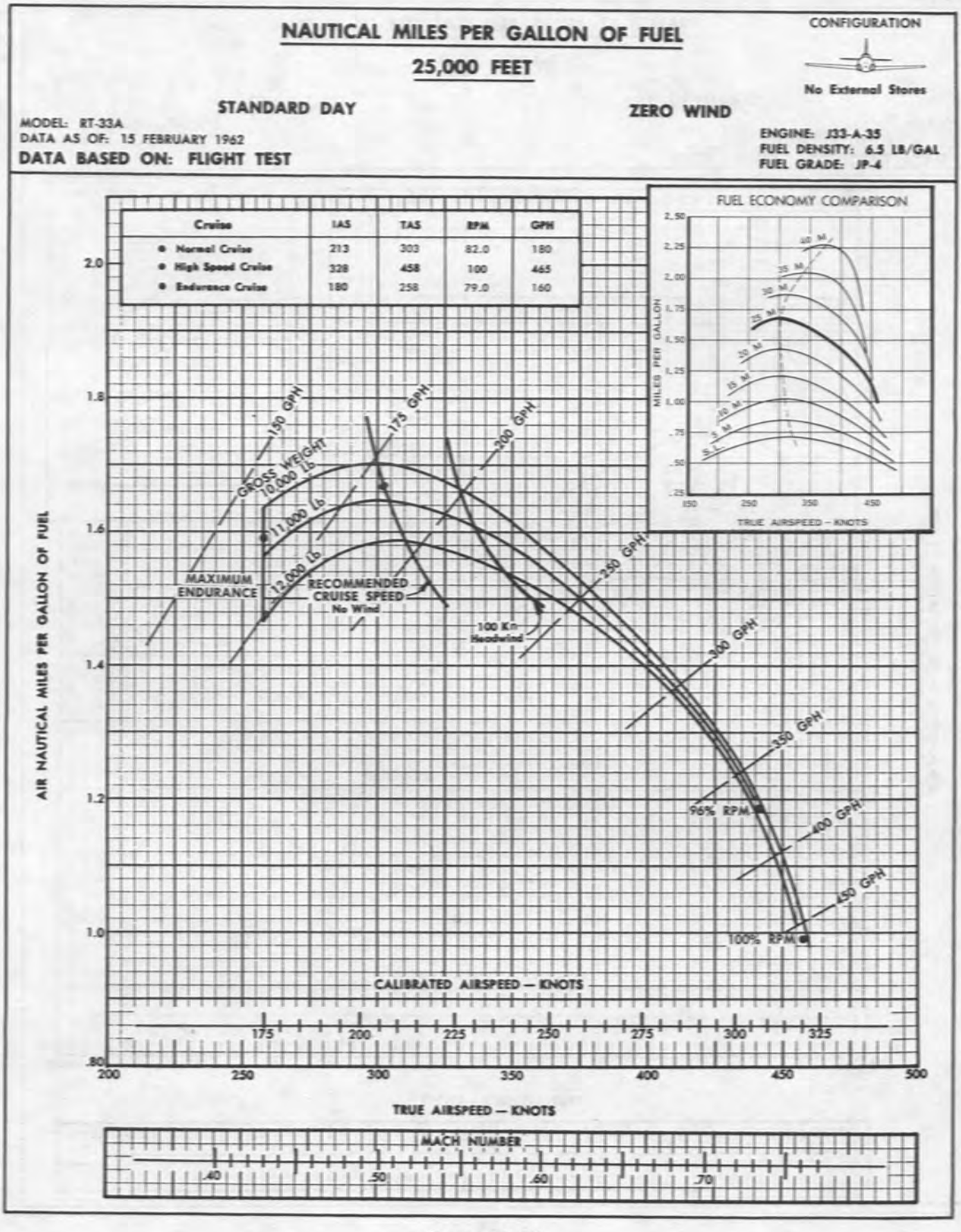

NAUTICAL MILES PER GALLON OF FUEL
25,000 FEET
CONFIGURATION
No External Stores
STANDARD DAY
ZERO WIND
MODEL: RT-33A
DATA AS OF: 15 FEBRUARY 1962
DATA BASED ON: FLIGHT TEST
ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4
Cruise | IAS | TAS | RPM | GPH
Normal Cruise | 213 | 303 | 82.0 | 180
High Speed Cruise | 328 | 458 | 100 | 465
Endurance Cruise | 180 | 258 | 79.0 | 160
FUEL ECONOMY COMPARISON
MILES PER GALLON
TRUE AIRSPEED – KNOTS
AIR NAUTICAL MILES PER GALLON OF FUEL
150 GPH
175 GPH
200 GPH
250 GPH
300 GPH
350 GPH
400 GPH
450 GPH
GROSS WEIGHT
10,000 Lb
11,000 Lb
12,000 Lb
MAXIMUM ENDURANCE
RECOMMENDED CRUISE SPEED
No Wind
100 Kn Headwind
96% RPM
100% RPM
CALIBRATED AIRSPEED – KNOTS
TRUE AIRSPEED – KNOTS
MACH NUMBER

Figure A8-15

NAUTICAL MILES PER GALLON OF FUEL

30,000 FEET

CONFIGURATION

No External Stores

STANDARD DAY

ZERO WIND

MODEL: RT-33A
DATA AS OF: 15 FEBRUARY 1962
DATA BASED ON: FLIGHT TEST

ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4

Cruise	IAS	TAS	RPM	GPH
• Normal Cruise	202	314	84.5	165
• High Speed Cruise	296	450	100	485
• Endurance Cruise	180	282	82.5	155

FUEL ECONOMY COMPARISON

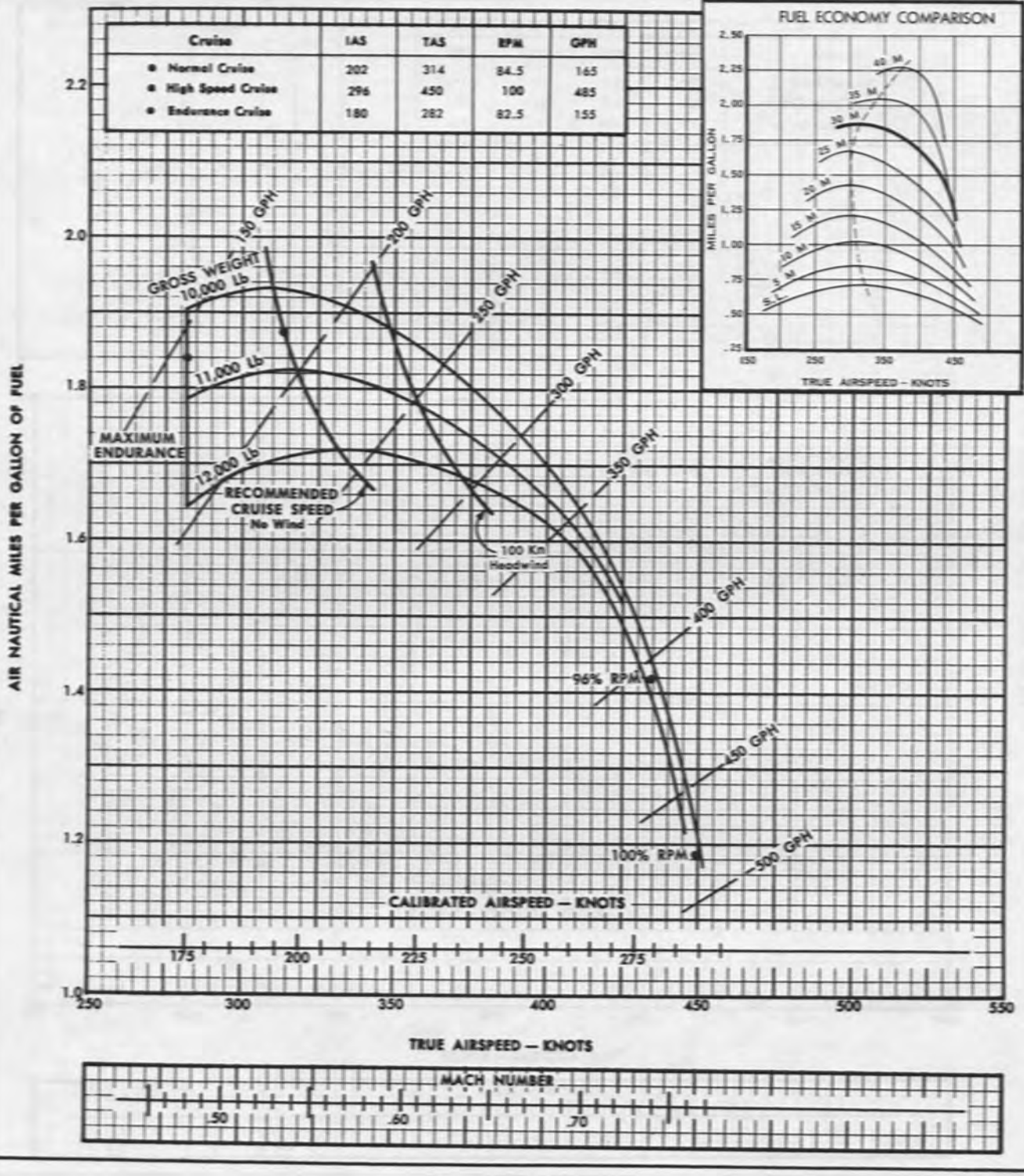


Figure A8-16

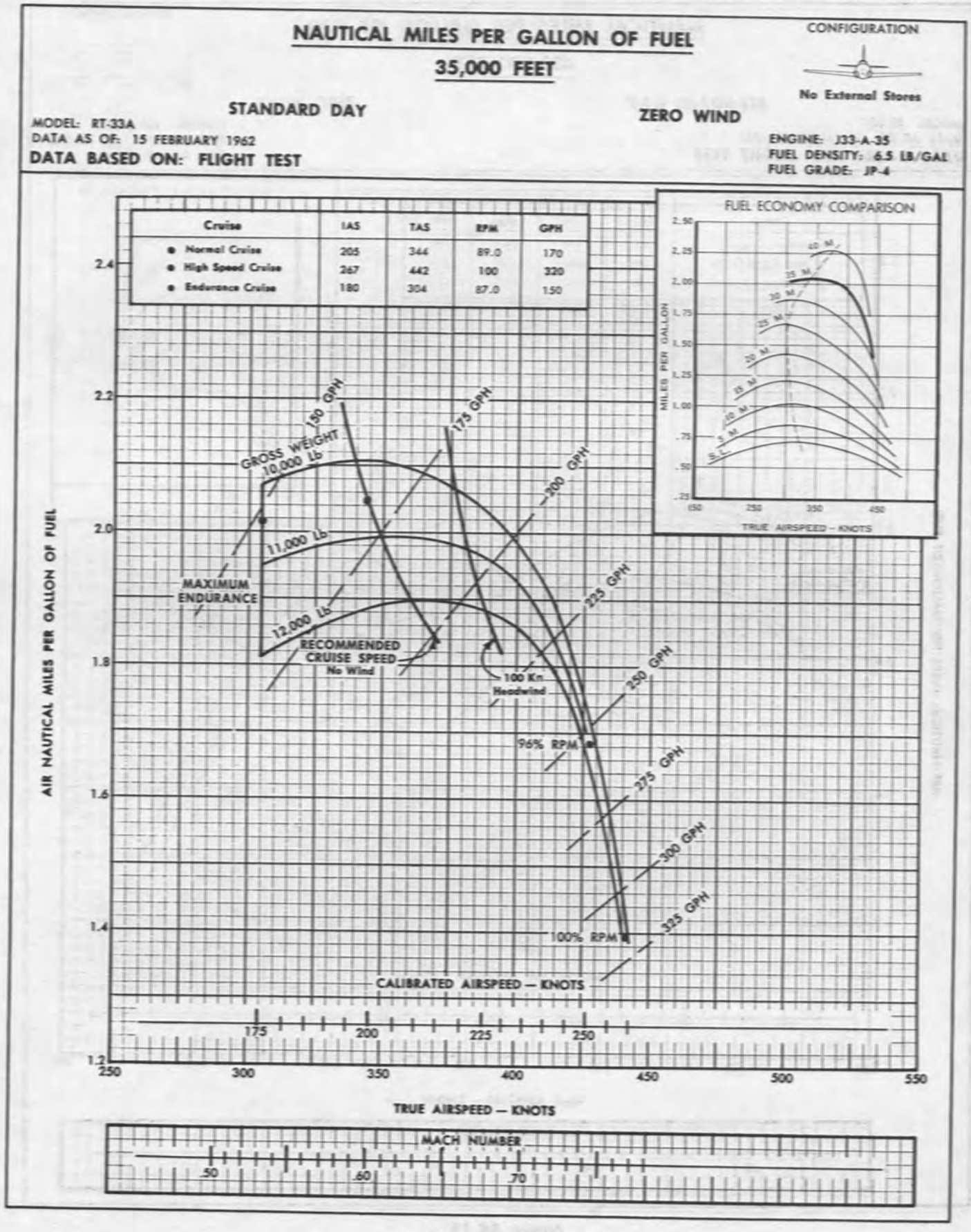

NAUTICAL MILES PER GALLON OF FUEL
35,000 FEET
CONFIGURATION
No External Stores
STANDARD DAY
ZERO WIND
MODEL: RT-33A
DATA AS OF: 15 FEBRUARY 1962
DATA BASED ON: FLIGHT TEST
ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4
Cruise | IAS | TAS | RPM | GPH
Normal Cruise | 205 | 344 | 89.0 | 170
High Speed Cruise | 267 | 442 | 100 | 320
Endurance Cruise | 180 | 304 | 87.0 | 150
FUEL ECONOMY COMPARISON
MILES PER GALLON
TRUE AIRSPEED – KNOTS
AIR NAUTICAL MILES PER GALLON OF FUEL
GROSS WEIGHT 10,000 Lb
11,000 Lb
12,000 Lb
MAXIMUM ENDURANCE
RECOMMENDED CRUISE SPEED No Wind
100 Kn Headwind
96% RPM
100% RPM
150 GPH
175 GPH
200 GPH
225 GPH
250 GPH
275 GPH
300 GPH
325 GPH
CALIBRATED AIRSPEED – KNOTS
TRUE AIRSPEED – KNOTS
MACH NUMBER

Figure A8-17

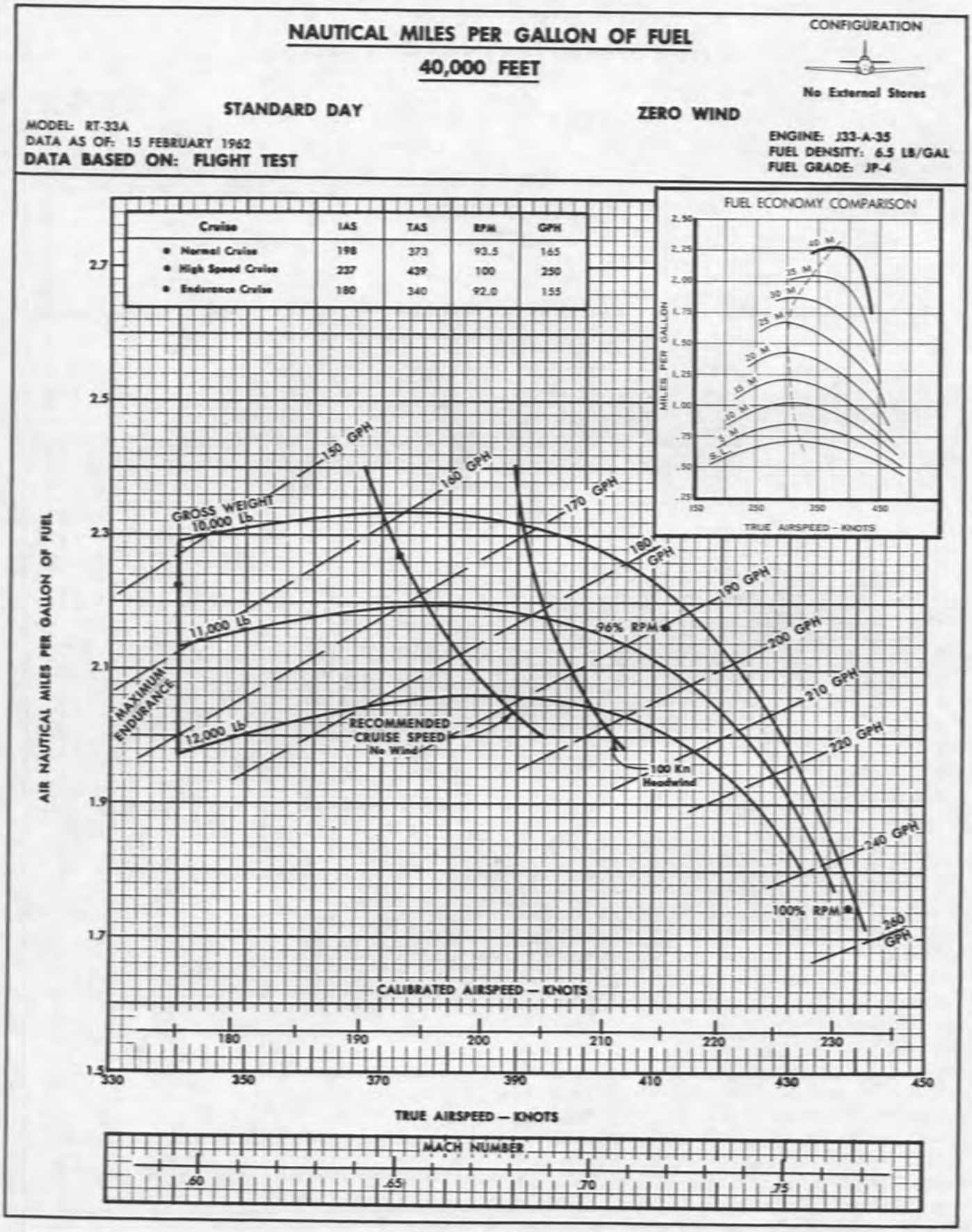

NAUTICAL MILES PER GALLON OF FUEL
40,000 FEET
CONFIGURATION
No External Stores
STANDARD DAY
ZERO WIND
MODEL: RT-33A
DATA AS OF: 15 FEBRUARY 1962
DATA BASED ON: FLIGHT TEST
ENGINE: J33-A-35
FUEL DENSITY: 6.5 LB/GAL
FUEL GRADE: JP-4
Cruise | IAS | TAS | RPM | GPH
Normal Cruise | 198 | 373 | 93.5 | 165
High Speed Cruise | 237 | 439 | 100 | 250
Endurance Cruise | 180 | 340 | 92.0 | 155
FUEL ECONOMY COMPARISON
MILES PER GALLON
TRUE AIRSPEED – KNOTS
40 M
35 M
30 M
25 M
20 M
15 M
10 M
5 M
S.L.
AIR NAUTICAL MILES PER GALLON OF FUEL
GROSS WEIGHT
10,000 Lb
11,000 Lb
12,000 Lb
MAXIMUM ENDURANCE
RECOMMENDED CRUISE SPEED
No Wind
100 Kn Headwind
96% RPM
100% RPM
150 GPH
160 GPH
170 GPH
180 GPH
190 GPH
200 GPH
210 GPH
220 GPH
240 GPH
260 GPH
CALIBRATED AIRSPEED – KNOTS
TRUE AIRSPEED – KNOTS
MACH NUMBER

Figure A8-18

Part 9—Mission Planning

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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 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 (1) fuel used for ground maneuver, takeoff, and acceleration to climb speed (mission profiles allow 60 gal), (2) deviation from recommended speed schedules, (3) deviations in predicted winds and temperatures, (4) faulty aircraft or instruments, and (5) altimeter position error neglected.

MISSION PLANNING PROCEDURE.

The charts presented in Parts 1 through 8 of this appendix provide all 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 neglected, 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 for long flights under constant wind components, or flights requiring maximum utilization of the aircraft through use of proper climb, cruise, and loiter procedures. The sample problem in the range part illustrates how the profile charts may be used for a mission of this type.

SAMPLE PROBLEM.

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 takeoff 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 configuration is used.

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 40 nmi—60 kn headwind
- Wind component for return legs—60 kn tailwind
- Mean wind for descent ..... 30 kn tailwind

TAKEOFF DATA CARD

CONDITIONS:

Gross Weight	15,725 lb
Runway Length	7000 ft
OAT	58°F
Pressure Altitude	3000 ft
Runway Gradient	—1%
Effective Wind Component	10 kn headwind

TAKEOFF:

Takeoff Distance	3700 ft
Takeoff Speed	123.7 IAS
2000-ft Acceleration Check Speed	98 IAS

LANDING IMMEDIATELY AFTER TAKEOFF:

Approach Speed	150 IAS
Landing Ground Roll	3900 ft

TAKEOFF.

The takeoff performance is determined from Part 2 for a Military thrust takeoff. Data which would be needed if a heavyweight landing were to be made immediately after takeoff are obtained from Part 7. The data are recorded on the Takeoff Data Card.

CLIMB.

Climb performance is determined from figure A3-1 for a 10°F hot day. Initial altitude is 3000 ft (field pressure altitude) and final altitude is 35,000 ft.

1. Initial climb weight: initial weight — takeoff and acceleration allowance is 15,335 lb [15,725 lb —390 lb (60 gal)].

2. Equivalent initial climb weight: weight + ΔW is 16,165 lb (15,335 lb + 830 lb).

3. Final equivalent climb weight (at 35,000 ft) is 15,200 lb.

4. Total fuel used to end of climb (16,165 lb — 15,200 lb) + 390 lb (Takeoff allowance) is 965 + 390, or 1355 lb (208 gal).

5. Distance to climb: final distance reading — initial distance reading, or 123 nmi (128 nmi — 5 nmi).

6. Total time to end of climb: final time reading — initial time reading, or 25 min (24 min — 1 min) + (2 minutes to accelerate to climb speed).

CRUISE — FIRST LEG.

Since 123 nmi are traveled in climb, only 77 nmi remain before reaching the first 200-mile check point.

The level flight cruise performance for 35,000 ft is determined from figure A8-8.

1. Initial cruise weight: Initial gross weight — takeoff and climb fuel, or 14,370 lb (15,725 lb — 390 lb — 965 lb).

2. Recommended CAS .....221 kn.

3. True airspeed .....380 kn.

4. True groundspeed is 320 kn (380 kn — 60 kn headwind).

5. Air nmi/gal is 1.65.4 nmi/gal (at 14,370 lb and recommended CAS).

6. Ground nmi/gal is 1.394 (air nmi/gal × GS ÷ TAS) = (1.65.4 ×320/380).

7. Fuel required for leg is 55.2 gal or 359 lb (ground distance ÷ ground nmi/gal) = (77 ÷ 1.394).

8. Time for leg is 0.241 hr or 14.4 min (ground distance ÷ ground speed) = (77 nmi ÷ 320 kn).

9. Total time for first 200 nmi is 39.4 min (25 min + 14.4 min).

CRUISE — SECOND LEG (200 nmi).

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 (approximately 200 miles each) and the performance for each segment based on the initial weight for the segment.

1. Initial weight for leg is 14,011 lb (14,370 lb — 359 lb).

2. Air nmi/gal is 167 (figure A8-8 at 14,011 lb and 213 kn CAS).

3. Ground nmi/gal is 1.405 (1.67 × 319/379).

4. Fuel required for leg is 142 gal or 925 lb (200 nmi ÷ 1.405 nmi/gal).

5. Time for leg is 0.628 hr or 37.6 min (200 nmi ÷ 319 kn).

CRUISE — THIRD LEG (200 nmi).

The data for this 200-nmi return leg is determined as before except that a 60-knot tailwind is present.

1. Initial weight for leg is 13,086 lb (14,011 lb — 925 lb).

2. Air nmi/gal is 1.75 (at 13,086 lb and 216 knots CAS).

3. Groundspeed is 433 kn (373 kn + 60 kn tailwind).

4. Ground nmi/gal is 2.03 (1.75 × 433/373).

5. Fuel required for leg is 98.5 gal or 640 lb (200 nmi ÷ 2.03 nmi/gal).

6. Time for leg is 0.463 hr or 27.8 min (200 nmi ÷ 433 kn).

CRUISE — FINAL LEG.

The aircraft is now 200 nmi from 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 range (175 kn, CAS) descent data may be found from figure A6-1.

1. Time to descend is approx 26.7 min (29.6 min — 2.9 min).

2. Fuel to descend is 45.5 gal, or 296 lb (55.5 gal — 10 gal).

3. Distance to descend, without wind, is 106.5 nmi (114.5 nmi – 8 nmi).

4. Without wind, 106.5 nautical miles are covered in 26.7 minutes. A 30-knot tailwind adds (30/60) or ½ mile per minute (0.5 mi/min × 26.7 min = 13.5 mi). Distance to descend, with 30 kn mean tailwind, is 120 nmi (106.5 nmi + 13.5 nmi).

The final 200 nmi leg is composed of a 120 nmi maximum range descent and 80 nmi cruise at 35,000 ft. The level-flight cruise data are determined as before and only the results are given here.

5. Fuel required for 80 nmi is 38.7 gal or 252 lb.

6. Time for 80 nmi is 0.187 hr or 11.25 min.

7. Total fuel for leg is 548 lb, or 84.4 gal (296 lb + 252 lb).

8. Total time for leg is 37.95 min (11.25 min + 26.7 min).

LANDING.

The landing performance is determined from Part 7 and recorded on the Landing Data Card.

LANDING DATA CARD

Conditions

Gross Weight	12,247 lb.
Runway Length	7000 ft
OAT	48°F
Pressure Altitude	3000 ft
Runway Gradient	+1%
Effective Wind Component	10 kn tailwind
Forecast Altimeter Setting	29.75 in. Hg.

Landing

Approach Speed	129 knots IAS
Landing Ground Roll	3400 ft

See condensed Checklist in Section II for Landing Data Card form.

SUMMARY.

The estimated performance for each leg may be summarized and tabulated on a flight plan card similar to the form AF 21A shown in figure A9-1.

AIRCRAFT TYPE AND NO.				PILOT				FROM			TO				
RT-33A															
ALTERNATE						TOTAL DISTANCE		TAKE-OFF TIME					TOTAL AMT FUEL		
						800		1400 Hours					978 Gallons		
ROUTE (Check points)	NAV	IDENT / FREQ	RPT	IDENT / FREQ	MAG HEAD	LEG / REMAIN	ETE / EST TOTAL	ETA / ATA	GROUND SPEED				EST LEG REMAIN	ACTUAL FUEL REMAIN	
CLIMB						123	:23	1425					208		
						677	:25						770		
1st LEG						77	:14.4	1439	320				55.2		
						600	:39.4						714.8		
2nd LEG						200	:37.6	1517	319				142		
						400	1:17						572.8		
3rd LEG						200	:27.8	1545	433				98.5		
						200	1:44.8						474.3		
4th LEG						80	:11.3	1556	428				38.7		
						120	1:56.1						435.6		
DESCENT						120	:26.7	1623					45.5		
						0	2:22.8						390.1		
POSITION REPORT															
IDENT	POSITION		TIME		ALT	IFR (VFR)		EST NEXT FIX		NAME OF SUCCEEDING REPTG PT					

AF FORM 21a JUN 58 PREVIOUS EDITIONS OF THIS FORM MAY BE USED

PILOT'S FLIGHT PLAN AND FLIGHT LOG

Figure A9-1

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