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By: A. M. Johnson Maj

Utility

FLIGHT HANDBOOK

USAF SERIES

YDB-47E

AIRCRAFT

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

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IMPORTANT

In order that you will gain the maximum benefits from this handbook it is imperative that you read these pages carefully.

This Handbook has been prepared by the Boeing Airplane Company and contains all the information necessary for safe and efficient operation of the YDB-47E series airplanes in the bomber configuration. These instructions do not teach basic flight principles, but are designed to provide you with a general knowledge of the airplane, its flight characteristics, and specific normal and emergency operating procedures. Your flying experience is recognized, and elementary instructions have been avoided.

The only source of technically accurate and constantly current operating instructions is your Flight Handbook. These instructions are based on the technical knowledge of the aircraft manufacturer and the Air Force as well as the experience of the using commands. You would never recognize these new books as your old familiar, undesirable -1 technical order. These new books have considered your specific problems and have therefore been made attractive, accurate, current, and very easy to use. Not all of the books have been prepared to the new requirements, but you can tell the old from the new very easily. The new type handbook has a full page cover illustration whereas the old book has a small "spot" illustration.

Each flight crew member EXCEPT THOSE ATTACHED TO AN ADMINISTRATIVE BASE is entitled to have a personal copy of the Flight Handbook while he is stationed at a given base. Don't let anyone tell you different! AIR FORCE REGULATION 5-13, dated 11 August 1953, specifically makes that provision.

You would be surprised at how well the technical order distribution system will work if you just do your part. Order your required quantity of handbooks before they are needed instead of waiting until the need arises. If you order them early, the Air Force will print enough to cover your requirements. If you delay, you will probably be kept waiting a long time when you do order because sufficient copies may not have been originally printed to cover your request - sometimes it takes a discouragingly long time to get new printing!

The Technical Order system is very easy to cope with. TECHNICAL ORDER 00-5-2 explains, in just a few pages, the easy means by which you can set the automatic machinery into motion. Actually all you have to do is reflect your required quantities on the PUBLICATIONS REQUIREMENTS TABLE (T.O. 00-3-1) and all the revisions, reissues, and supplements will be automatically forwarded to you in the same quantities. Talk to your base supply officer - he should know all about the system since it is his job to fulfill your technical order requests. Of course, each base must develop a system of feeding these books and related data to their flight crew members so that no one will be using an obsolete book.

One more thing - we admit it takes a long time to revise the Flight Handbook. Since the time lag is excessive for safety of flight information, a new program has been put into effect to get such information to you in a hurry. This is done by means of Safety of Flight Supplements which use the same number as your Flight Handbook except for the addition of a suffix letter. Supplements covering loss of life will get to you in 48 hours; those concerning serious damage to equipment will make it in 6 days. And what do you have to do to get these Supplements? Absolutely nothing! If you have ordered your Flight Handbook on the publications requirements table, you will automatically receive all Supplements pertaining to your aircraft. Technical Order 00-5-1 covers some additional information regarding these Supplements.

Your comments and questions regarding any phase of the Flight Handbook program are invited and should be directed to the Wright Air Development Center, Attn: WCSOH. This handbook is divided into nine sections, an appendix, and an alphabetical index, as follows:

SECTION I - DESCRIPTION

The Function of this section is to describe the airplane and all its systems and controls which contribute to the physical act of flying the airplane. Included also in this section is all the emergency equipment that is not part of an auxiliary system.

SECTION II - NORMAL PROCEDURES

This section contains the steps of procedure to be accomplished from the time the airplane is approached by the flight crew until it is left parked on the ramp after accomplishing one complete non-tactical mission under normal conditions.

SECTION III - EMERGENCY PROCEDURES

The purpose of this section is to clearly and concisely describe the procedure to be followed in meeting any emergency (except those in connection with the auxiliary equipment) that could reasonably be expected to be encountered.

SECTION IV - DESCRIPTION AND OPERATION OF AUXILIARY EQUIPMENT

This section includes the description, normal operation and emergency operation of all equipment not directly contributing to flight but which enables the airplane to perform certain specialized functions.

SECTION V - OPERATING LIMITATIONS

The various ground and flight limitations which must be observed if the airplane is to be operated with safety and efficiency are set forth in this section.

SECTION VI - FLIGHT CHARACTERISTICS

This section is designed to familiarize the pilot with the sort of control response and general maneuverability he may reasonably expect in flying this airplane. It treats the more important flight characteristics with respect to their advantage or disadvantage to the pilot.

SECTION VII - SYSTEMS OPERATION

The function of this section is to explain the operation of the various systems contributing to the efficient functioning of the airplane. Such explanations will be found to cover the various conditions of altitude, speed, weather, etc, encountered while flying the airplane.

SECTION VIII - CREW DUTIES

Omitted

SECTION IX - ALL WEATHER OPERATION

Omitted

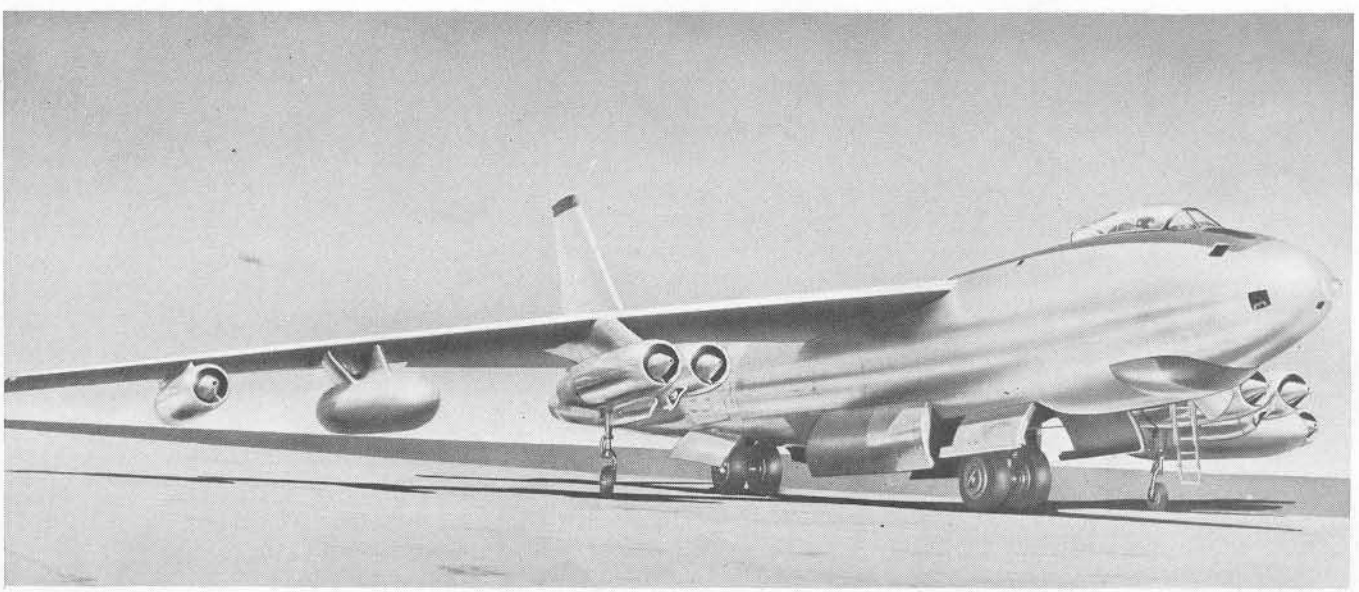
APPENDIX I - OPERATING DATA

All performance data necessary for preflight and in-flight mission planning with explanatory text on the use of the data is presented in this section.

ALPHABETICAL INDEX - This index is provided for the purpose of locating subject material and illustrations contained within the sections of this handbook.

NOTE

Supplemental Utility Flight Handbook T.O. No. 1B-47(D)(Y)E-1A covers the YDB-47E airplane in the director configuration. However, to avoid duplication, those portions of this Handbook that are applicable to the director configuration are not repeated in the Supplemental Handbook but reference is made therein to this Handbook. Therefore, to obtain complete coverage on the director configuration, both this Handbook and the Supplemental Handbook are required.



The Airplane

SECTION I

DESCRIPTION

NOTE

The YDB-47E airplane is a B-47E bomber that has been modified to incorporate either one of two kits. Use of these kits, a bomber kit and a director kit, permits rapid conversion between two tactical configurations. These configurations and the method of providing Flight Handbook coverage are as follows:

1. BOMBER CONFIGURATION. With the bomber kit installed, the YDB-47E airplane is equipped as a gravity bomber and can perform the type of missions usually assigned to medium bomber aircraft.

This Handbook covers the YDB-47E airplane in the bomber configuration.

2. DIRECTOR CONFIGURATION. With the director kit installed, the YDB-47E airplane is equipped for carrying a pilotless parasite bomber (PPB). No provisions are made for gravity bombing.

AIRPLANE.

The Boeing YDB-47E "Stratojet" airplane in the bomber configuration is a land-based, six-engine, jet-propelled medium bomber capable of long range flight at high speeds and high altitudes. It has a single tail, high swept-back wings, and under-slung engines. Provisions are incorporated that permit rapid conversion of the airplane to a director configuration for carrying a pilotless parasite bomber (PPB). For information on the director configuration, see Supplemental Handbook T.O. No. 1B-47(D)(Y)E-1A.

ITEM	B-47A	B-47B	B-47E	YDB-47E*
EXTERNAL WING TANKS	No	Yes	Yes	Yes
EJECTION SEATS	Yes	No	Yes	Yes
AERIAL REFUELING	No	Yes	Yes	Yes
SINGLE POINT GROUND REFUELING	No	Yes	Yes	Yes
TRANSPARENT NOSE	Yes	No	No	No
SOLID NOSE WITH BOMB SIGHT PROTUBERANCE	No	Yes	Yes	Yes
BOMB BAY TANK	No	Yes	Yes	Yes
LONG BOMB BAY DOORS	Yes	No	No	No
SHORT BOMB BAY DOORS	No	Yes	Yes	Yes
TAIL TURRET	No	Yes	Yes	Yes
PROVISIONS FOR CONVERSION TO DIRECTOR CONFIGURATION	No	No	No	Yes

*Bomber Configuration

Figure 1-1. Main Difference Table

AIRPLANE DIMENSIONS.

Wing Span	116 feet
Over-all Length	107 feet, 1.5 inches
Height (to top of fin in taxi attitude)	28 feet
Tread (between outriggers)	44 feet, 4 inches

GROSS WEIGHTS.

Design Gross Weight	125,000 pounds
Maximum Gross Take-Off Weight	
17% to 30% cg Limits	185,000 pounds
17% to 32% cg Limits	182,600 pounds
Maximum Flight Gross Weight (with aerial refueling)	202,000 pounds
Design Landing Gross Weight	125,000 pounds

FUNCTION.

The airplane is designed as a bomber for short and medium range assignments as well as for long range strategic destruction of land and naval material objectives.

CREW.

The normal flight crew consists of a pilot, copilot, and observer. The observer's duties are navigation, bombing and operation of radar equipment. All regular crew duties are executed in a pressurized compartment which extends from a pressure bulkhead aft of the copilot's station forward to the nose section. The pilot and copilot are seated in tandem in the cockpit, while the observer's compartment is situated in the nose section. Although movement of the crew will not generally be required for normal flight operations, a walkway is provided on the left side of the fuselage from the observer's station aft to the pressure bulkhead. In addition, it is also possible during flight to gain access to a platform in the bomb bay by means of a door located in the airplane entrance passage and leading into a crawlway just to the left of the forward main wheel well. Since this necessitates depressurization of the crew compartment however, such passage will be avoided, particularly at high altitudes. (See figure 1-3.)

CHARACTERISTICS AND FEATURES.

The outstanding characteristics of this airplane are a bubble-type canopy located on top of the fuselage well forward of the wing leading edge, and a bicycle-type main landing gear with a lateral support outrigger landing gear located in each inboard engine

WITH ENGINE THROTTLE IN CUT OFF

FUEL SELECTOR SWITCH ON –	FUEL TANK VALVES AND BOOST PUMPS WILL BE –	FUEL FIRE SHUTOFF VALVE WILL BE –	IGNITION WILL BE –	OIL AND HYDRAULIC FIRE SHUTOFF VALVE WILL BE –
TE or ME	Closed and Off	Open unless fire shut-off switch is pulled	Not available	Open unless fire shutoff switch is pulled
TME	Open and Operating	Open unless fire shut-off switch is pulled	Not available	Open unless fire shutoff switch is pulled
WITH ENGINE THROTTLE ADVANCED APPROXIMATELY 2°				
TE or TME	Open and Operating	Open unless fire shut-off switch is pulled	Available	Closed if fire shutoff switch is pulled
ME	Closed and Off	Open unless fire shut-off switch is pulled	Available	Closed if fire shutoff switch is pulled

When throttle is advanced approximately 3°, fuel stopcock commences to open.
When throttle is advanced approximately 12°, fuel stopcock is fully open.
When throttle is in start detent; engine idles 13% to 15% rpm.

When throttle is advanced to 35% rpm, surface controls must be unlocked for further throttle movement.
When throttle is advanced to 50% rpm landing gear and wing flap warning horn switches will be actuated.
When throttle is advanced to 100% rpm, water injection system may be utilized if desired.

Figure 1-2. Throttle Position Chart

nacelle. In addition, it features a specifically designed receptacle for refueling while in flight, and internally mounted assist take-off units. Although the bomb bay is designed for a basic bomb load of 10,000 pounds, alternate and special arrangements are possible which will carry various bomb and bomb bay fuel loads up to and including a single, 22,000-pound bomb.

ENGINES.

A single engine is mounted in each outboard nacelle and two parallel engines in each inboard nacelle. When viewed in the direction of flight, the engines are numbered from left to right with the left outboard engine being No. 1. The conventional jet controls and accessories are provided.

The J47-GE-25 axial flow turbo-jet engine has a guaranteed sea level static performance of 5970 pounds of thrust at 100% (7950) rpm. The engine has electrically operated retractable screens in the air-guide section of the engine and a water injection system as an integral part of the engine. All frontal areas of the engine have an anti-icing system.

ENGINE FUEL CONTROL SYSTEM.

The throttles are the major controls for the engine fuel system. The supply of fuel in the necessary quantities to the combustion chambers of the engine is controlled by the pilot's or copilot's throttle. Initial movement of a throttle out of CUT OFF starts to open a stopcock (primarily an open and close valve) which remains fully open for any position past the idle position. Continued movement of the throttle mechanically actuates the fuel regulator which governs the engine speed by establishing the main fuel pressure through the fuel control valve. Fuel is supplied from the airplane fuel system through a filter to an engine-driven constant displacement fuel pump and then through an engine fuel filter and oil cooler in which the fuel serves as a coolant for absorbing heat from engine oil. The fuel continues through the flow divider to the engine fuel nozzles, which atomize the fuel into the combustion chambers in a quantity established by the fuel regulator. This fuel regulator is the governing mechanism of the fuel control system and determines the fuel pressure in accordance with three factors: throttle setting; conditions of altitude, airspeed, and temperature; and allowable operating limits of the engine.

ENGINE CONTROLS.

THROTTLES. The pilot and copilot are each provided with six throttles (4, figure 1-13 and 2, figure 1-29) on their control stands. All throttle quadrants are marked CUT OFF at the aft end of travel, and 100% RPM at the forward end of travel. Throttle stops prevent the throttles from being inadvertently advanced out of the CUT OFF position or from being retarded below the idle position. Each throttle can be moved past the stops when the throttle is lifted. The throttles cannot be advanced beyond 35% rpm when the surface lock lever (6, figure 1-13) is in the LOCK position. The throttles mechanically actuate the fuel regulators which control fuel pressure to maintain the desired engine rpm.

CAUTION

When retarding throttles, the pulling motion should follow an arc to match the contour of the control stand as it has been found possible to inadvertently retard the throttles past the idle position into CUT OFF by pulling the throttles in a horizontal plane.

The throttle quadrant is also designed with a starting position. This position is marked START and the throttle must be lifted up before it can be advanced beyond this point. The position is used during the starting procedure to make possible "fixed throttle starts," thus eliminating throttle jockeying during starts and permitting automatic tailpipe temperature stabilization. The rpm will be 13% to 15% while the throttles are in the START position; when the throttles are in the idle position, the engines will idle at approximately 40%.

Throttle movement actuates micro switches to provide partial automatic electrical control of engine operation and warning horn circuits as shown on chart in figure 1-2.

THROTTLE LOCK LEVER. The throttles are prevented from creeping by an ON--OFF throttle lock lever (5, figure 1-13) on the pilot's control stand. When this lever is in the aft or OFF position, the throttles are free to move. Advancing the lever applies an increasing amount of friction to hold the throttles in the desired position.

FIRE SHUTOFF SWITCHES. Six two-position pull-push LIGHT ON--PULL FOR EMERGENCY STOP fire shutoff switches (17, figure 1-9) on the pilot's instrument panel controls engine fire shutoff. Each switch has a red push-to-test fire warning light in the end of the knob, which indicates an engine overheat condition by illumination. Pulling the fire shutoff switch closes the fuel, oil, and hydraulic (engines No. 3 and 4) shutoff valves, trips the generator field relays, and deenergizes the alternator (engines No. 1 and 6 only). Shut-down condition of the engine will exist until the fire shutoff switch is again pushed in, restoring the above systems to normal with the exception of the generator field relay and the alternators. The generator field relay may be restored to normal by placing the generator switch momentarily in RESET and then to ON position. Restoring the alternators to normal operation is accomplished by placing the alternator power switches to RH ALT RESET and LH ALT RESET and then to NORMAL position. Throttle position has no effect on fire shut-down operation; however, it is advisable to move the throttle in or near CUT OFF position before pulling the fire shutoff switch.

ENGINE SCREEN SWITCH. Engine screens are provided in eight sections in the air inlet section of each engine. The screens are electrically opened and closed by a three-position CLOSE--open--AUTOMATIC switch (15, figure 1-14) on the pilot's switch panel. The CLOSE position of the switch will extend the screens and the open position retract the screens. When the switch is in the AUTOMATIC position, the landing gear safety switch will automatically open the screens on take-off and close the screens on landing. When the anti-icing exterior surface switch is turned on and the screens are in closed position, the screens will automatically open. It is estimated that the gross thrust of the engine will be decreased by 4% with the screens closed.

ENGINE STALL PREVENTION SWITCH. An engine stall prevention switch (43, figure 1-9) is located on the pilot's instrument panel. This switch has ON--OFF positions and should be in the OFF position except when flying below 10,000 feet with an OAT of 59°F (15°C) or below. The switch should be ON for aerial refueling and formation flying and unusual maneuvers such as practice stalls, regardless of altitude. Placing the switch in ON position deenergizes a solenoid which opens a valve to allow bleeding of air pressure from the pressure sensing line between the engine compressor section and the fuel regulator of each engine. This bleeding of air pressure affects the engine acceleration time, as governed by the fuel regulator, by lowering the actual pressure to be sensed by the fuel regulator. This causes a slower engine acceleration and aids in preventing engine compressor stalls which may be caused by throttle manipulation. If the switch is left in ON position at higher altitudes, a loss of rpm may be encountered (maximum obtainable rpm may be as low as 93%). If the switch is left in the ON position at an OAT of 60°F (16°C) or above, engine acceleration time of up to approximately 30 seconds from idle to 100% rpm may be encountered on a 100°F day. The same conditions may exist in the event of DC failure to the air bleed valve solenoid since the valve is held closed by electrical power when the switch is in OFF position. Circuit breakers for the system are on the lower DC power panel.

ENGINE INDICATORS.

ENGINE FUEL PRESSURE GAGES. Fuel pressure gages (27, figure 1-9), one for each engine, indicate engine fuel pressure and are located on the pilot's instrument panel.

TACHOMETERS. Engine speed in percent of rpm is

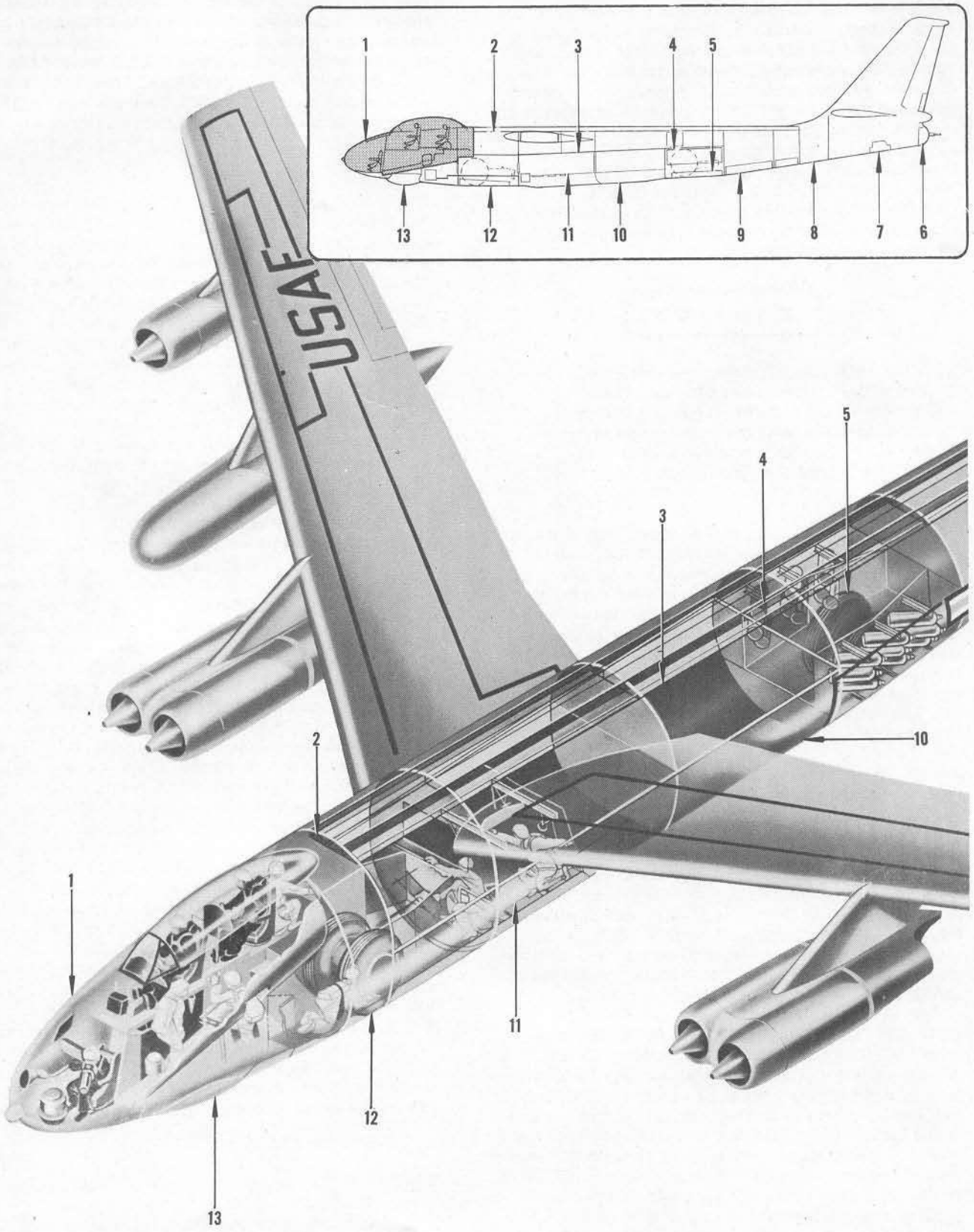
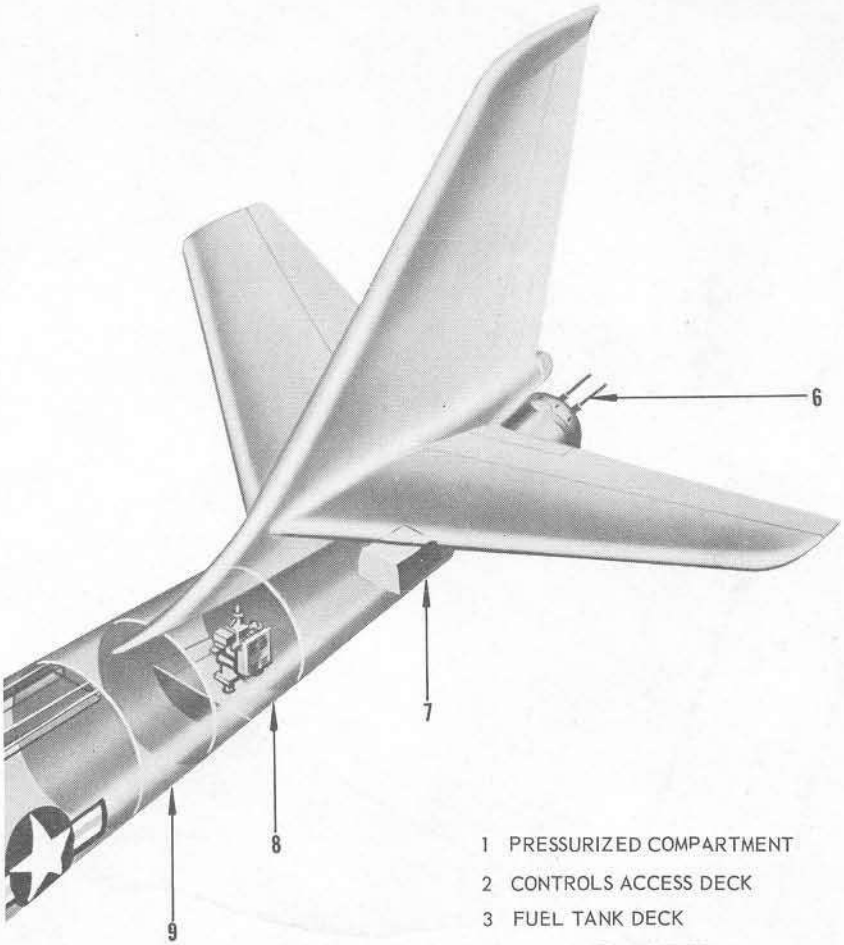


Figure 1-3. Crew Movement and Compartments (Sheet 1 of 2)



1 PRESSURIZED COMPARTMENT
2 CONTROLS ACCESS DECK
3 FUEL TANK DECK
4 ATO COMPARTMENT
5 REAR WHEEL WELL
6 TAIL TURRET
7 BRAKE CHUTE COMPARTMENT
8 CAMERA COMPARTMENT
9 AFT FUEL TANK COMPARTMENT
10 BOMB BAY FUEL TANK COMPARTMENT
11 BOMB BAY
12 FORWARD WHEEL WELL
13 RADOME

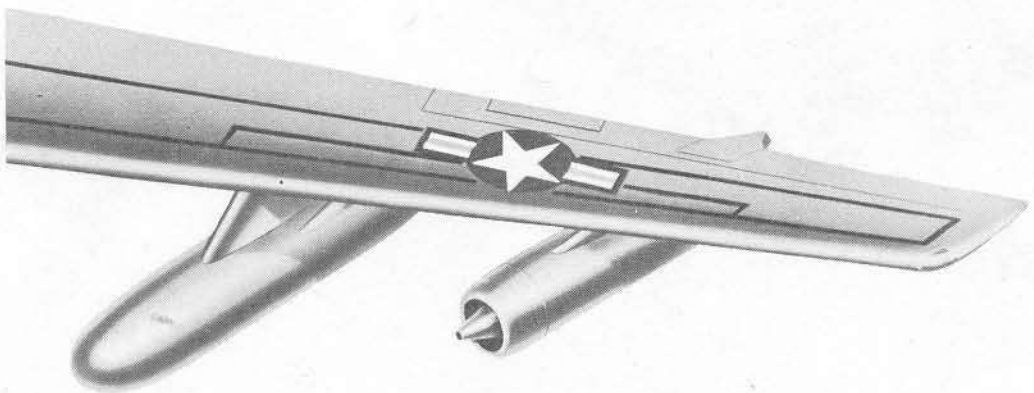


Figure 1-3. Crew Movement and Compartments (Sheet 2 of 2)

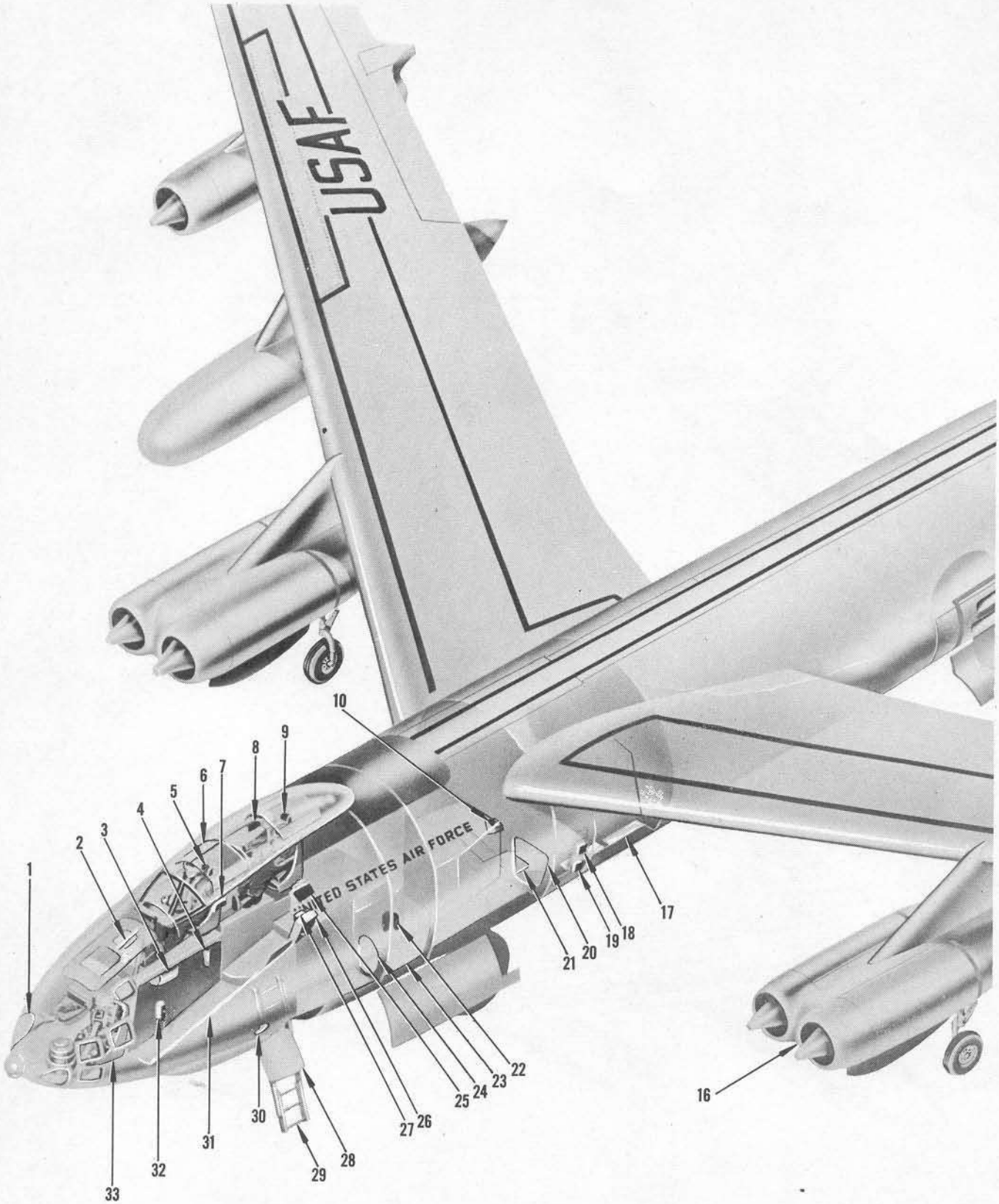
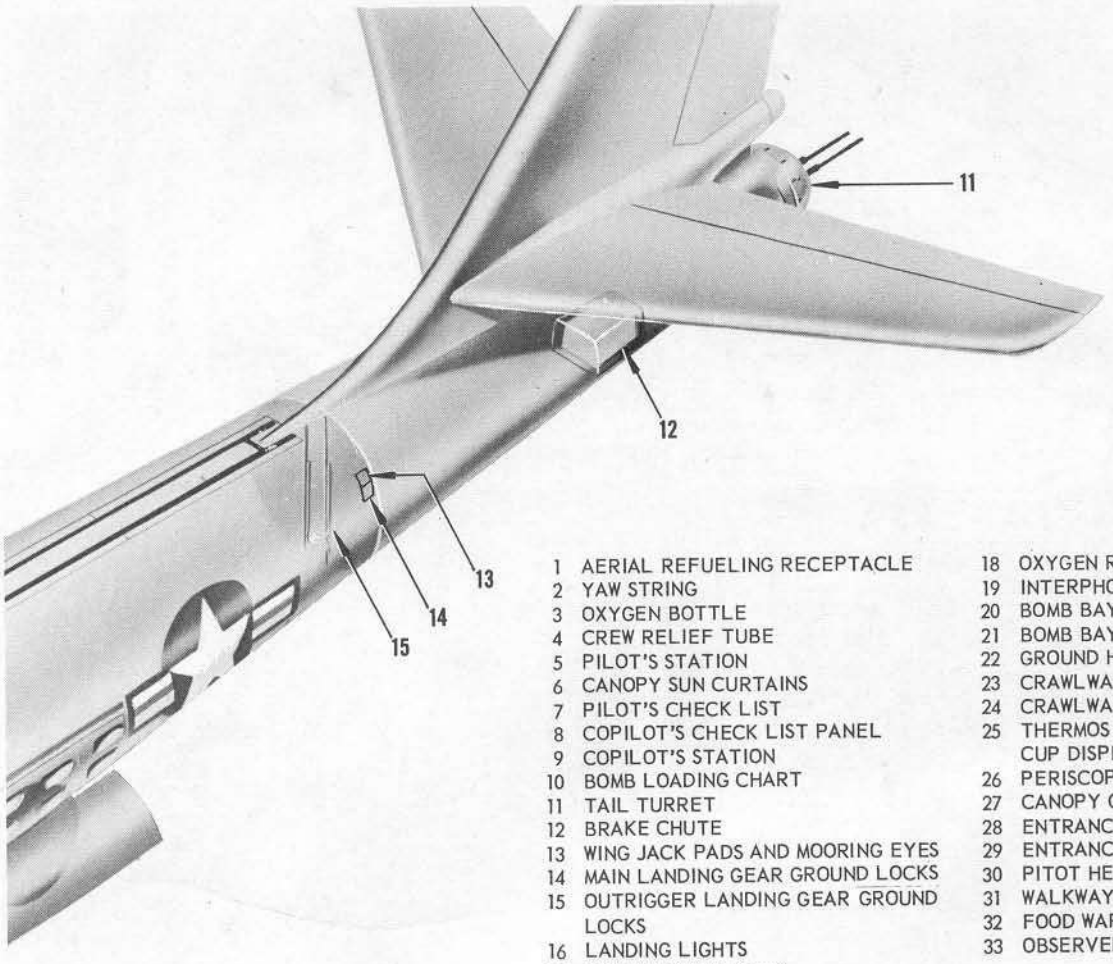
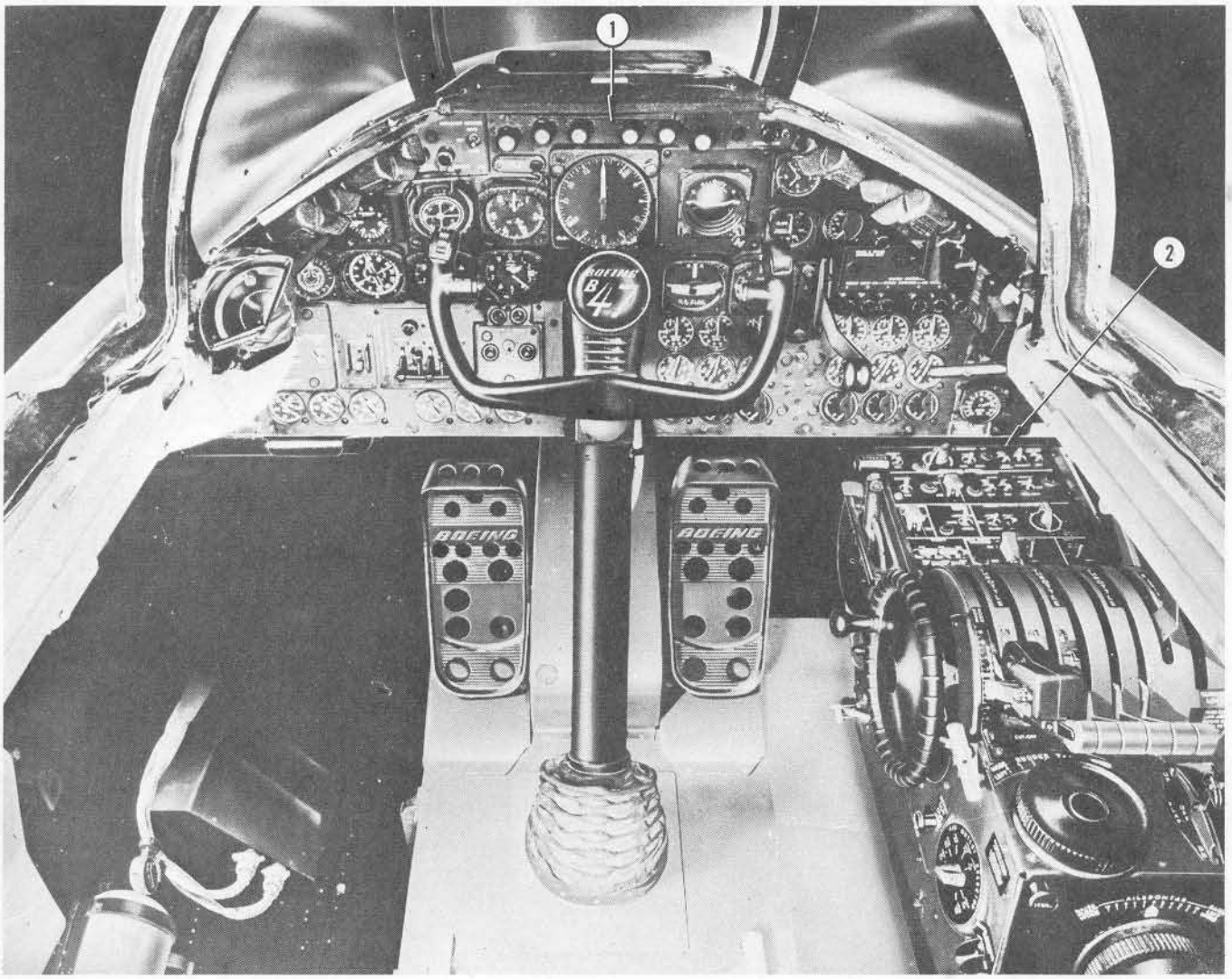


Figure 1-4. General Arrangement (Sheet 1 of 2)



1 AERIAL REFUELING RECEPTACLE
2 YAW STRING
3 OXYGEN BOTTLE
4 CREW RELIEF TUBE
5 PILOT'S STATION
6 CANOPY SUN CURTAINS
7 PILOT'S CHECK LIST
8 COPILOT'S CHECK LIST PANEL
9 COPILOT'S STATION
10 BOMB LOADING CHART
11 TAIL TURRET
12 BRAKE CHUTE
13 WING JACK PADS AND MOORING EYES
14 MAIN LANDING GEAR GROUND LOCKS
15 OUTRIGGER LANDING GEAR GROUND LOCKS
16 LANDING LIGHTS
17 BOMB BAY WALKWAY
18 OXYGEN REGULATOR PANEL
19 INTERPHONE
20 BOMB BAY ACCESS OPENING
21 BOMB BAY PLATFORM
22 GROUND HEAT ACCESS PANEL
23 CRAWLWAY
24 CRAWLWAY ACCESS DOOR
25 THERMOS BOTTLES AND DRINKING CUP DISPENSER
26 PERISCOPIC SEXTANT (STOWED)
27 CANOPY GROUND LOCK
28 ENTRANCE DOOR
29 ENTRANCE LADDER
30 PITOT HEAD
31 WALKWAY
32 FOOD WARMING CUP
33 OBSERVER'S STATION

Figure 1-4. General Arrangement (Sheet 2 of 2)



1 PILOT'S INSTRUMENT PANEL
2 PILOT'S SWITCH PANEL

Figure 1-5. Pilot's Station

pilot's instrument panel (25, figure 1-9) and six on the copilot's instrument panel (17, figure 1-27).

EXHAUST TEMPERATURE GAGES. The temperature of the exhaust gases in degrees centigrade is indicated by six exhaust temperature gages on the pilot's instrument panel (29, figure 1-9).

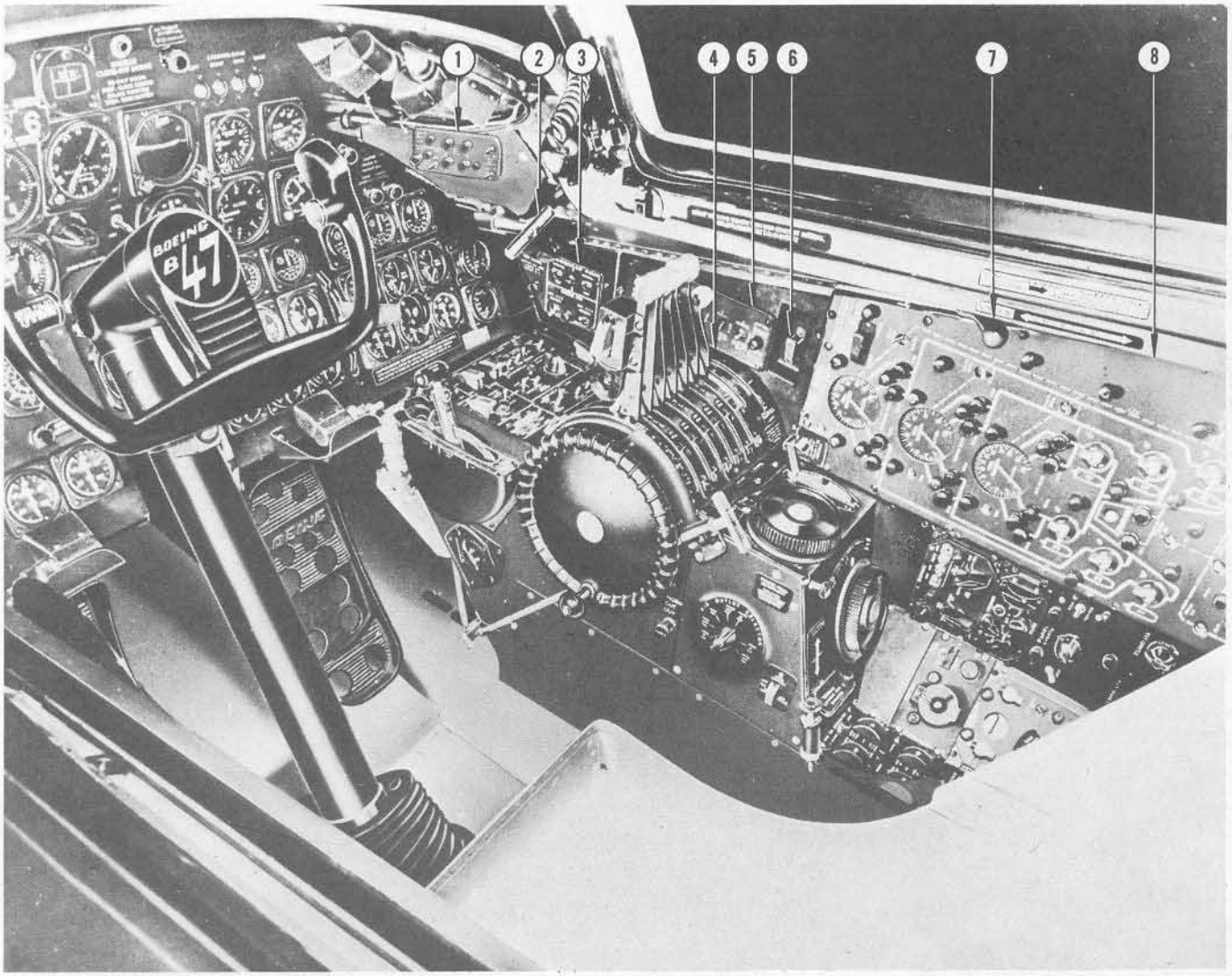
OIL PRESSURE GAGES. Six electrically operated oil pressure gages (40, figure 1-9) located on the pilot's instrument panel indicate engine oil pressure.

WATER INJECTION SYSTEM.

NOTE

The water injection system is inoperative at present.

A water injection system is incorporated to provide additional thrust at 100% RPM throttle setting. This additional thrust results from the pump-injection of a water-alcohol mixture into the engine combustion chambers, thereby increasing the mass rate flow from the exhaust nozzle. This brings about a resultant increase in thrust. Since the injection of this mixture tends to cause a slight decrease in exhaust gas temperature, a tab is inserted automatically into the exhaust stream during the injection process to reduce that area, thus maintaining the desired temperature. A 300 US gallon tank comprised of three cells is located in each inboard wing. Each tank supplies the three engines on that respective side with a water-alcohol mixture which is pumped into the engine combustion chamber by an individual air-driven pump for each engine. Operation of the system is quite simple, the pilot being concerned with only one



1 SURFACE POWER CONTROL PANEL
2 BRAKE CHUTE DEPLOYMENT HANDLE
3 FIRE WARNING TEST PANEL
4 PILOT'S CONTROL STAND
5 IGNITION SWITCH PANEL
6 BOMB SALVO SWITCH
7 CANOPY LOCK LEVER
8 FUEL CONTROL PANEL

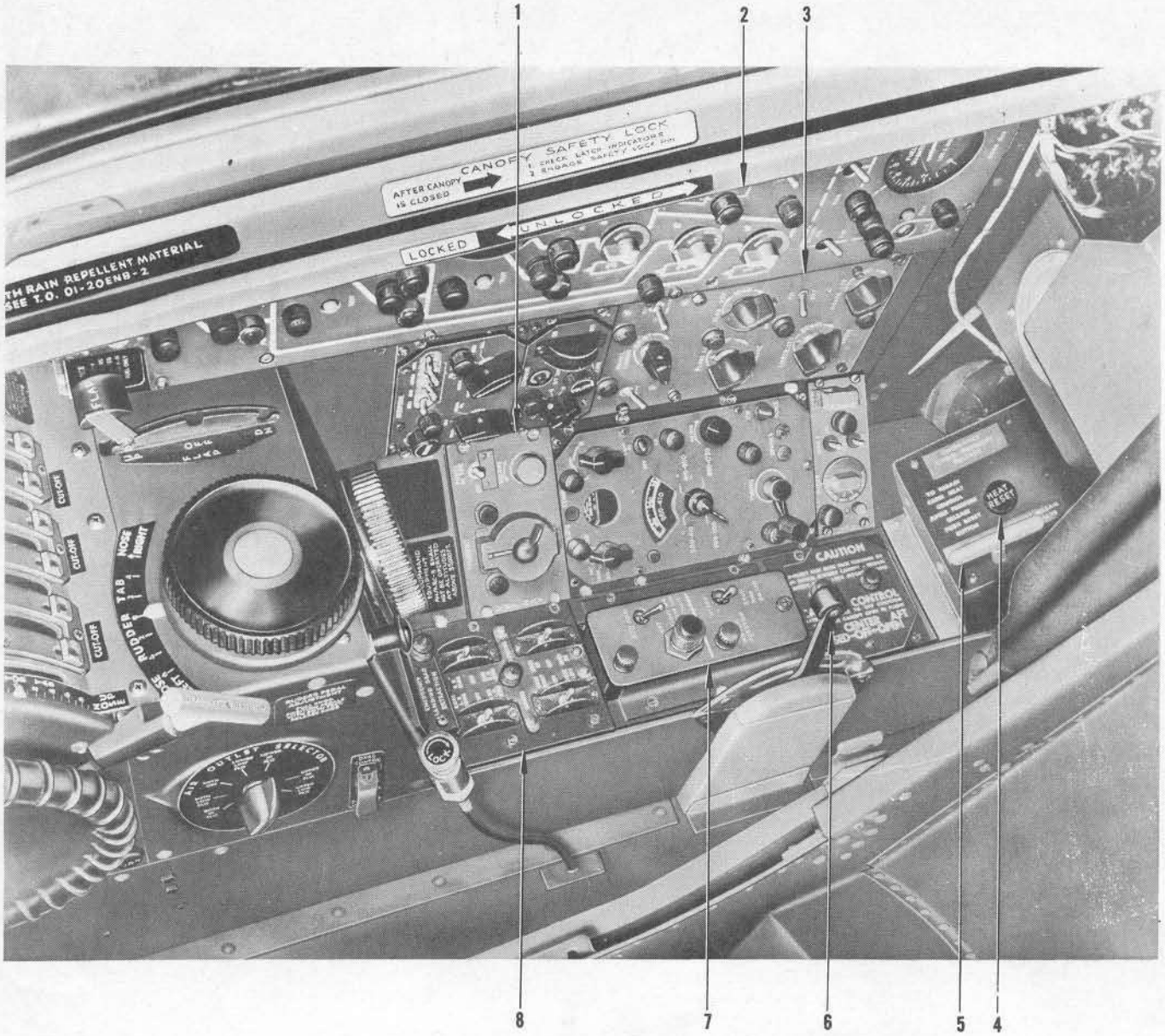
Figure 1-6. Pilot's Station - Right Side

switch; the remainder of the operation takes place automatically with throttle movement. In the event of failure of the water injection system on one engine the water-alcohol supply will be directed to the operative systems. Consequently, this enables the engines receiving water injection to continue at a higher thrust for a longer period of time, compensating in part for the loss of thrust from the engine or engines not receiving water. A control circuit fault of one system on one side will render the control circuit inoperative for the corresponding system on the opposite side, thus preventing the existence of an unbalanced thrust condition. For example, if a control circuit failure occurs on the No. 1 engine water injection system, the control circuit for the No. 6 engine water injection system will be rendered inoperative. See figure 1-45 for water-alcohol specification.

WATER INJECTION SYSTEM CONTROLS.

WATER INJECTION SYSTEM SWITCH. A three-position START--OFF--STOP AND DRAIN switch (2, figure 1-10), spring-loaded from the START position, is located on the ATO control panel. This switch and a throttle microswitch, which energizes the system when throttles are advanced to 100% RPM, constitute electrical control of the water injection system. Throttles placed in the 100% RPM position actuate the water injection system only if the water injection switch has been placed momentarily in START position. When water-alcohol pressure diminishes, the pumps are automatically turned off by pressure switches in the manifold lines.

Placing the switch in STOP AND DRAIN position stops



1 PILOT'S RADIO PANELS
2 FUEL CONTROL PANEL
3 PILOT'S LIGHTING PANEL
4 CABIN HEAT RESET BUTTON
5 EMERGENCY CABIN PRESSURE RELEASE HANDLE
6 CANOPY CONTROL LEVER
7 ATO CONTROL PANEL
8 TRIM TAB COORDINATION SWITCH PANEL

Figure 1-7. Pilot's Station - Aft Right Side

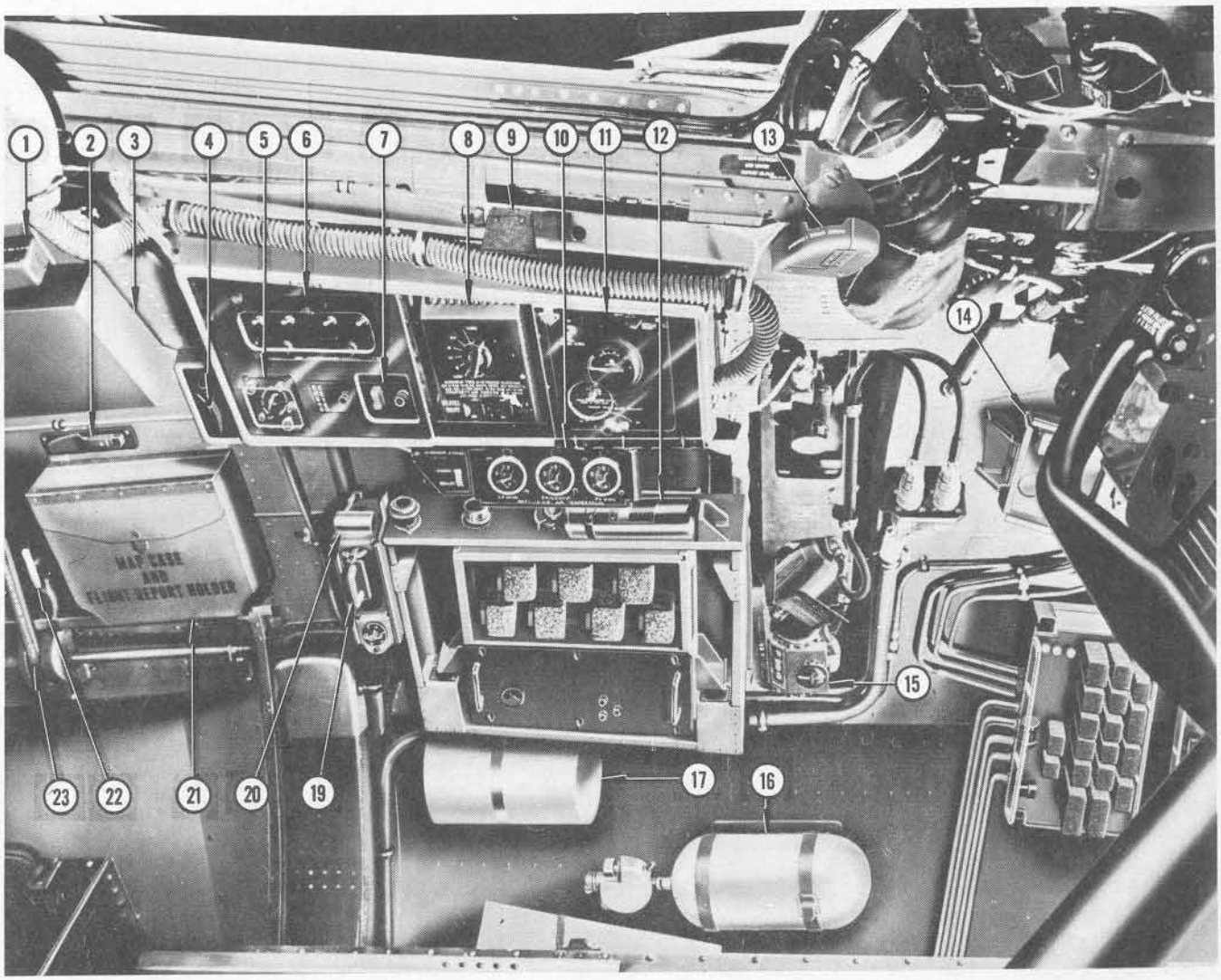
pump operation and opens both the engine drain and manifold drain valves. This operation completely drains overboard all water-alcohol from the tanks and manifold line. Retarding the throttles from 100% RPM will stop the pumps but will not drain the tanks or open the engine drain valves.

WATER INJECTION SYSTEM INDICATORS.

WATER INJECTION INDICATOR LIGHTS. Six red lights (24, figure 1-9), one for each engine, are located on the pilot's instrument panel. When the water injection system is pressurized and the pump is delivering water, the lights will not be illuminated. If for any reason the pump for a particular engine should fail, the indicator light for that respective engine and the corresponding engine on the other side of the airplane will illuminate.

IGNITION SYSTEM.

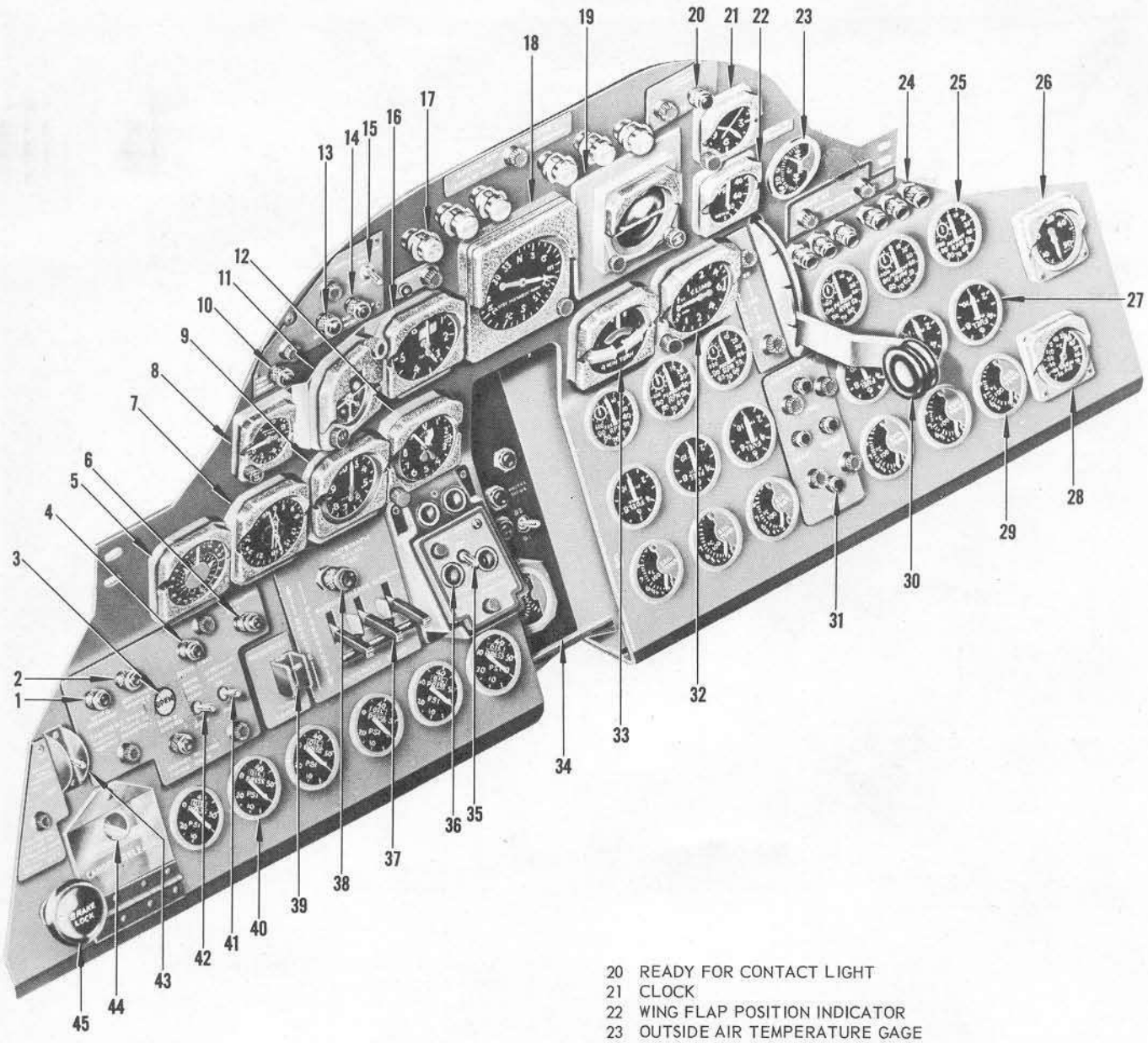
A separate DC ignition system is installed for each engine to start engine combustion. Each system con-



1 FIRST AID KIT
2 EMERGENCY KNIFE
3 BLOOD PLASMA KIT
4 INTERCOMMUNICATION SYSTEM FILTER SWITCH
5 MAP LIGHT PANEL
6 POSITION LIGHT PANEL
7 EMERGENCY KEYER PANEL
8 HEATED SUIT RHEOSTAT AND RECEPTACLES
9 AIRPLANE CHECK LIST
10 ANTI-ICING AIR TEMPERATURE PANEL
11 OXYGEN REGULATOR PANEL
12 FIRE EXTINGUISHER
13 CANOPY EMERGENCY JETTISON HANDLE
14 SPARE AMPLIFIERS RACK
15 AUTOMATIC PILOT CONTROLLER AND SUPPORT
16 PORTABLE OXYGEN BOTTLE
17 OBSERVER'S ANTI-EXPOSURE SUIT
18 DELETED
19 FOOD WARMING CUP
20 REAR VIEW MIRROR
21 MAP CASE AND FLIGHT REPORT HOLDER
22 BAIL-OUT CONTROL HANDLE
23 PRESSURE DOOR RELEASE HANDLE

Figure 1-8. Pilot's Station - Left Side

sists of an ignition switch, ignition control relay, throttle operated microswitch, and two ignition units. Normal ignition is not available until a starter switch is closed which energizes the ignition circuit, provided the throttle is moved out of CUT OFF, and the ignition switch is placed in NORMAL position. During normal starting, ignition continues until the starter system is deenergized. Ignition may be stopped at anytime during the automatic starting cycle by placing the ignition switch in the OFF position, placing the throttle in CUT OFF position, or placing the starter switch in CUT OFF position. During air starts, the ignition system may be operated continuously by placing the ignition switch in ALTITUDE START OR TEST, regardless of throttle or starter switch positions.



1 WING OVERHEAT WARNING LIGHT
2 EMPENNAGE OVERHEAT WARNING LIGHT
3 BOMB DOOR POSITION INDICATOR
4 BOMBS AWAY INDICATOR LIGHT
5 DATA INDICATOR
6 N-1 COMPASS INOPERATIVE LIGHT
7 MAGNETIC COURSE INDICATOR
8 ACCELEROMETER
9 MACHMETER
10 ANTI-SKID INOPERATIVE LIGHT
11 ID-249 COURSE INDICATOR
12 ALTIMETER
13 INSTRUMENT INVERTER INDICATOR LIGHT - BUS POWER OFF
14 INSTRUMENT INVERTER INDICATOR LIGHT - SPARE INVERTER ON BUS
15 INSTRUMENT INVERTER SWITCH
16 MAXIMUM ALLOWABLE AIRSPEED INDICATOR
17 FIRE SHUTOFF SWITCHES
18 REMOTE COMPASS REPEATER INDICATOR
19 VERTICAL GYRO INDICATOR
20 READY FOR CONTACT LIGHT
21 CLOCK
22 WING FLAP POSITION INDICATOR
23 OUTSIDE AIR TEMPERATURE GAGE
24 WATER INJECTION INDICATOR LIGHTS
25 TACHOMETERS
26 CABIN PRESSURE GAGE
27 FUEL PRESSURE GAGES
28 CABIN AIR TEMPERATURE GAGE
29 EXHAUST TEMPERATURE GAGES
30 LANDING GEAR LEVER
31 LANDING GEAR POSITION INDICATORS
32 RATE-OF-CLIMB INDICATOR
33 TURN-AND-BANK INDICATOR
34 IFM CONTROL BOX
35 MASTER OXYGEN WARNING CONTROL SWITCH
36 OXYGEN WARNING LIGHTS
37 AUTOMATIC PILOT ENGAGING SWITCHES
38 AUTOMATIC PILOT OFF LIGHT
39 TURN CONTROL SWITCH
40 OIL PRESSURE GAGES
41 DIRECTIONAL DAMPER SWITCH
42 ALTERNATE BOMB DOOR SWITCH
43 ENGINE STALL PREVENTION SWITCH
44 CANOPY EMERGENCY RELEASE HANDLE
45 BRAKE LOCK KNOB

Figure 1-9. Pilot's Instrument Panel

Ignition is provided by four single electrode-type plugs located two each in the No. 3 and 7 combustion chambers.

IGNITION SWITCHES.

An ignition switch (1, figure 1-12) for each engine is located on the ignition switch panel and has three positions, NORMAL--OFF--ALTITUDE START OR TEST. When the switches are in the OFF position, the ignition system cannot be energized. When a switch is placed in NORMAL position, the ignition system is armed so that ignition will occur when a starter switch has been placed in START and the throttle is advanced out of CUT OFF. Normal ignition terminates automatically when either automatic or manual cut-off of the starter occurs. When an ignition switch is actuated to the ALTITUDE START OR TEST position, the ignition system is energized continuously, and the switch must be placed in OFF position to stop ignition.

CAUTION

- Do not place ignition switch for any engine in the ALTITUDE START OR TEST position when air intake and tailpipe closures are installed, because explosive combustion may occur. Possible fuel leakage within the engine under these conditions can result in a combustible mixture. This mixture can be expelled by removing closures and motoring the engine for approximately 30 seconds before making ignition test.

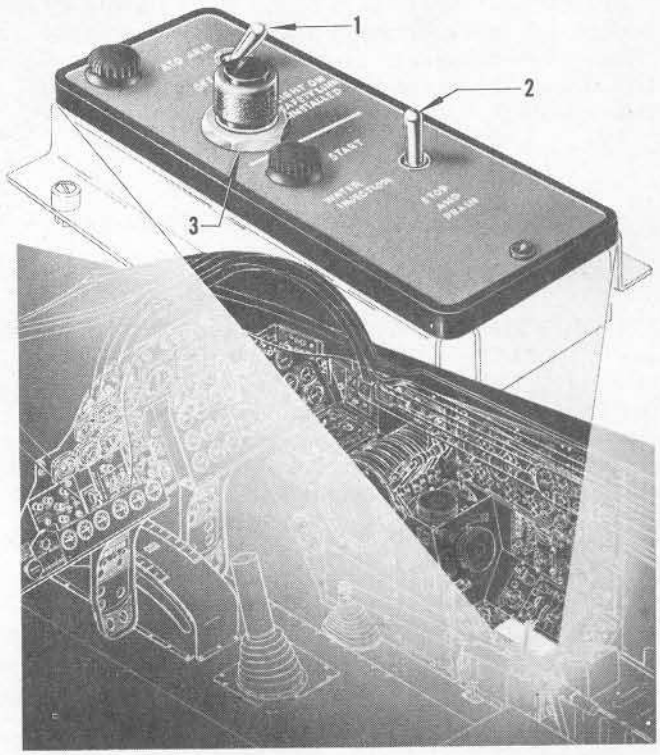
- Do not energize any ignition circuit longer than 15 minutes continuously at any one time or damage to the ignition units may result.

STARTER SYSTEM.

Engine starting torque for each engine is provided by a 28-volt DC combination starter-generator unit geared to the engine main rotor. Power is supplied to the starter either by an external power cart or by the airplane batteries. The starter-generator unit is used as a starter motor during engine start, and is then normally used, after engine is started, as a generator for the airplane DC system. Starting current is automatically terminated, when the engine reaches approximately 20% RPM, by a current relay, which senses decreasing load to the starter motor when engine acceleration is being supported by normal combustion. On engines No. 3 and 4, a hydraulic pump pressure release valve opens to relieve load on the engine during starting. After the engine starter drops out, the hydraulic pressure release valve closes and permits hydraulic pressure to build up within the system.

NOTE

During air starting, hydraulic pressure loads remain on the engine because the normal starting circuit is not utilized.



1 ATO ARMING SWITCH
2 WATER INJECTION SYSTEM SWITCH
3 ATO SAFETY LINK INSTALLED INDICATOR LIGHT

Figure 1-10. ATO Control Panel

STARTER SYSTEM CONTROLS.

STARTER SELECTOR SWITCH. A starter selector switch (9, figure 1-14) marked OFF--1--2--3--4--5--6 is located on the pilot's switch panel. When the selector switch is in the OFF position, the starter switch cannot be energized. Placing the selector switch to the number of the engine to be started automatically energizes the starter circuits for the respective engine when the starter switch is placed in START position.

STARTER SWITCH. A single three-position START--OFF--CUTOFF starter switch (14, figure 1-14) located on the pilot's switch panel is spring-loaded to the OFF position. When the starter selector switch is positioned to the engine to be started and the starter switch moved to START, the starter-generator is motorized for starting, the ignition circuit is armed, and (on engines No. 3 and 4 only) the hydraulic pump pressure release valve is opened. When the starter switch returns to OFF position, the starter-generator remains motorized for starting until the current relay opens and the circuit changes to connect the generator as a generator. The CUTOFF position provides a manual means of accomplishing cutoff of a starter in

the event this relay fails to open. When starter cutoff occurs, the hydraulic pump pressure release valve closes. Control circuit breakers for the starter control circuit are on the lower DC power panel (12, figure 1-19).

NOTE

During air starting, hydraulic pressure loads remain on the engine because the normal starter circuit is not utilized.

STARTER EMERGENCY OVERRIDE SWITCH. A two-position START--OFF starter emergency override switch (10, figure 1-14) spring-loaded to the OFF position, is located on the pilot's switch panel. When placed in the START position, the starter bus is connected to the airplane battery bus. Actuating the starter switch simultaneously with the override switch permits engine starting from the airplane batteries while on the ground. When the switch is in the OFF position, the starter-generators may be motorized only by means of an external power source.

NOTE

This switch must be used for emergency starting when external power is not available and for ground starting when external power is connected to only the normal airplane bus portion of the external power receptacle.

ASSIST TAKE-OFF (ATO) SYSTEM.

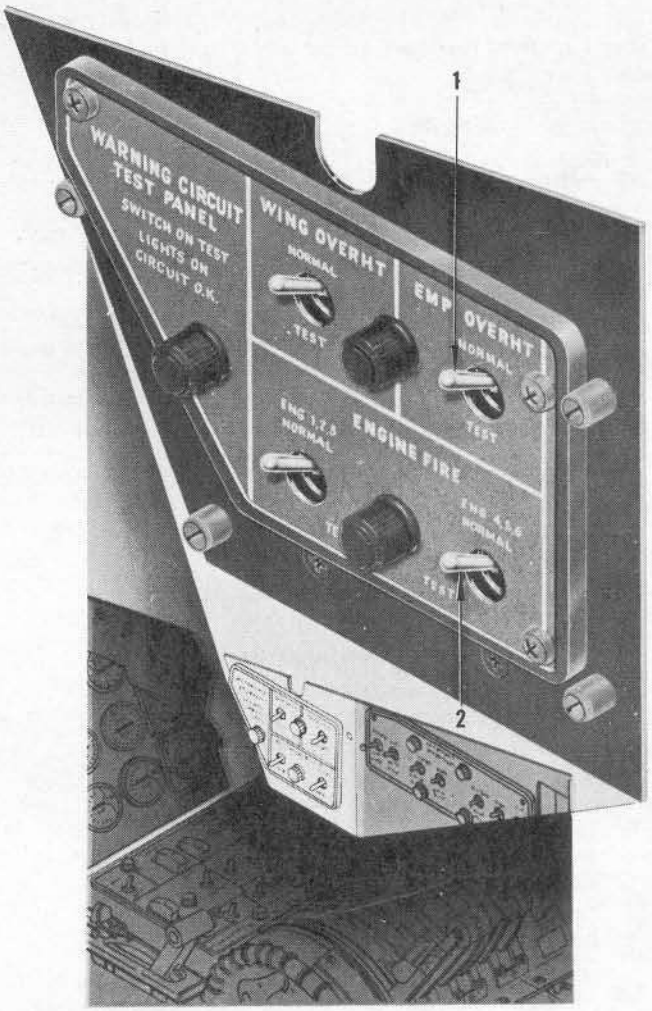
Provisions are made for installing 18 solid fuel ATO units, 9 recessed in a shroud on each side of the fuselage at the rear main wheel well. These units supply additional thrust when it is desired for high gross weight take-off or to shorten take-off distance. The system is electrically controlled from the ATO control panel (figure 1-10). The units are fired simultaneously until fuel is exhausted. A removable ground safety link located in the aft wheel well is used to complete the circuit to the ATO unit ignitors. The safety link is manually removed to prevent firing of the units while servicing the airplane. The safety link must be installed if ATO is to be used for take-off.

WARNING

Only the 14AS-1000 MK2 Mod 3 and 14DS-1000 MK4 Mod 1 rockets are approved for usage in the ATO rack.

ASSIST TAKE-OFF SYSTEM CONTROLS.

ATO ARMING SWITCH. The ATO control circuit is armed through an ATO-ARM--OFF switch (1, figure 1-10) on the ATO control panel. When the switch is in the ATO-ARM position, electrical power is supplied to the ATO firing switch. When the switch is in the OFF position, the ATO control circuit is disarmed.



1 WING AND EMPENNAGE OVERHEAT WARNING CIRCUIT TEST SWITCHES

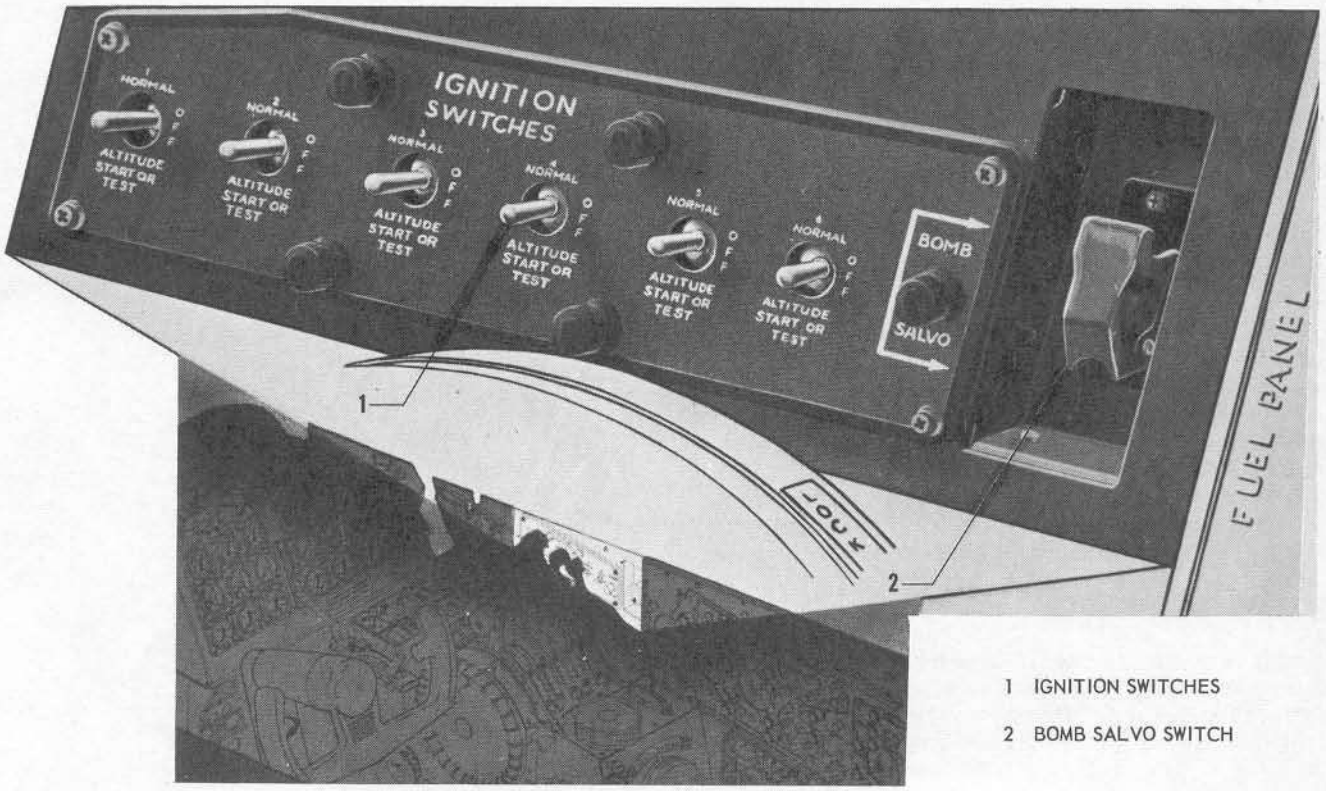
2 ENGINE FIRE WARNING CIRCUIT TEST SWITCHES

Figure 1-11. Fire Warning Test Panel

ATO FIRING SWITCH. An ATO two-position FIRE--OFF switch (3, figure 1-13), guarded in the OFF position, is mounted on the pilot's No. 1 engine throttle. With the switch in the FIRE position, the safety link in place, and the ATO arming switch in the ATO-ARM position, the circuit is energized to fire the ATO units. With the ATO firing switch in the OFF position, the firing circuit is deenergized.

ASSIST TAKE-OFF SYSTEM INDICATORS.

ATO SAFETY LINK INSTALLED WARNING LIGHT. A green indicator light (3, figure 1-10) on the ATO control panel, when illuminated, indicates that the safety link is installed. The light will go out when the airplane landing gear leaves the ground.



1 IGNITION SWITCHES

2 BOMB SALVO SWITCH

Figure 1-12. Ignition Switch Panel

OIL SYSTEM.

Each engine is provided with an independent oil system, including an oil tank and two engine-driven oil pumps. Each tank, located in the wing panel adjacent to each engine, has a capacity of 9.4 US gallons and has an additional expansion space of 4.6 US gallons. A combination pressure and scavenge pump geared to the accessory section supplies clean oil at the proper lubricating temperature through jet nozzles to all bearings and to the accessory section gears. An additional scavenge pump located in the midframe section is provided to return the oil from the aft bearing sumps to the oil tank. The oil pressure pump also supplies oil to the fuel regulator from which variable control oil is supplied to operate the fuel control valve. For system operating pressures, see figure 5-1. In order to prevent foaming, the oil tanks are automatically pressurized by the air entrained in the oil returned to the tank. The return oil from the aft sump scavenge pump is cooled by passage through a heat exchanger where heat from the oil is transferred to the fuel passing to the fuel flow divider. For oil specification and grade, see figure 1-46.

OIL SYSTEM CONTROLS.

FIRE SHUTOFF SWITCH. An oil system fire shutoff valve is energized to its closed position when the fire shutoff switch (17, figure 1-9) on the pilot's instrument panel is pulled for the desired engine to be shut down. The valve is energized to its open position when the fire shutoff switch is reset regardless of throttle position.

FUEL SYSTEM.

The main fuel system consists of three tanks housed within the fuselage structure. (See figure 1-16.) Each main tank supplies fuel for one engine on each side of the airplane. The forward main tank provides fuel for engines No. 1 and 6, the center main tank for engines No. 2 and 5, and the aft main tank for engines No. 3 and 4. All main tanks can be manifolded to supply fuel from any tank to any engine. However, check valves prevent transfer of fuel between main tanks. Additional fuel may be carried in the following auxiliary tanks: forward auxiliary tank, ATO tank, bomb bay tank, and two external wing tanks, if installed. Each wing has provisions for installing an external wing tank. Installation of wing tanks may be used as an alternate configuration when additional auxiliary fuel is required for a particular mission. All auxiliary fuel, except the forward auxiliary fuel, is used directly from the auxiliary tanks. The forward auxiliary fuel is transferred to the forward and center main tanks. A dry ice fuel tank purging system is provided for all tanks except the external wing tanks.

Facilities for aerial refueling are provided. The aerial refueling is accomplished with a tanker airplane through a refueling boom to the aerial refueling

receptacle. From the receptacle, the fuel is transferred through a 4-inch manifold into the airplane fuel system. The aerial refueling manifold is an extension of the single point refueling system.

A single point ground refueling system may be used for filling both main and auxiliary tanks from a single receptacle (29, figure 1-46) on the right side of the airplane. A single point refueling (SPR) control panel must be used during SPR operations.

The single point refueling system is designed to permit defueling of the airplane either by means of an external pumping source or by use of the airplane boost pumps. When defueling is required in a minimum amount of time, both means may be used simultaneously. Refer to section IV for additional information on aerial refueling and single point refueling systems. For fuel specification and grade to be used on this airplane, see figure 1-46.

FUEL SYSTEM PURGING.

The fuel system purging arrangement consists of 10 electrically heated gas-tight sublimation containers for crushed dry ice. Nine of these containers are located in the aft wheel well and one in the forward wheel well. The containers automatically discharge CO_2 gas to any fuel tanks from which fuel is being pumped for engine operation and to the aerial refueling and SPR systems when these systems are being scavenged. The external wing tanks are not purged. Control of the purging arrangement is entirely automatic. The containers should be serviced with crushed dry ice within 3 hours prior to flight.

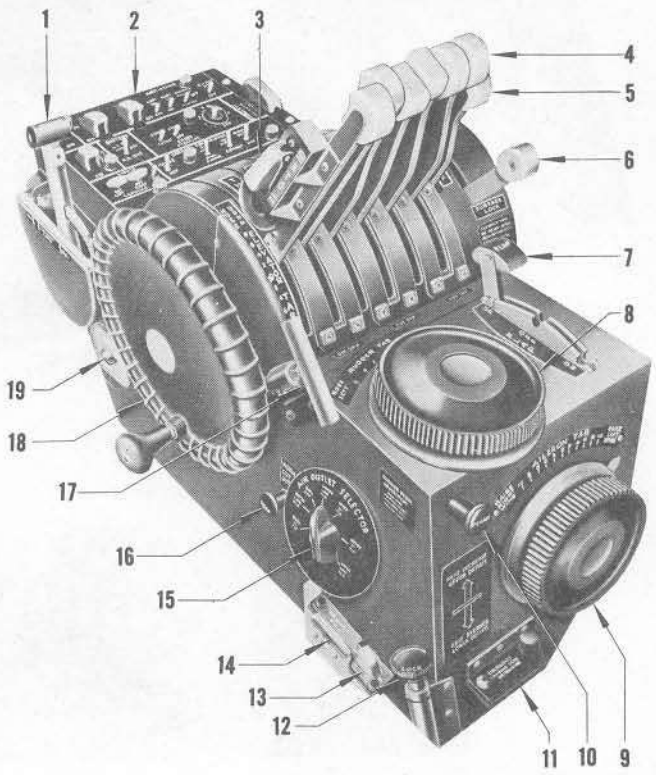
FUEL SYSTEM CONTROLS.

FUEL SELECTOR SWITCHES. Six rotary-type fuel selector switches (4, figure 1-15) on the fuel control panel provide a means of electrically operating the main fuel tank boost pump and shut-off valves. Each switch has three positions, TE (tank to engine), TME (tank to manifold and engine), and ME (manifold to engine). When the switches are in the TE position, the DC operated fuel tank valves will be opened and the DC operated boost pumps energized as soon as the throttles are advanced out of CUT OFF. When the switches are in the TME position, the fuel tank valves are opened, the boost pumps energized, and the manifold valves opened regardless of throttle position. When the switches are in the ME position, only the manifold valves are opened regardless of throttle position.

NOTE

Selection of TME and ME positions from the TE position is accomplished by clockwise rotation of the fuel selector switches.

AUXILIARY TANK VALVE AND BOOST PUMP SWITCHES. Five ON--OFF auxiliary tank valve and boost pump switches (10, figure 1-15) on the fuel control panel are used to electrically open the auxiliary

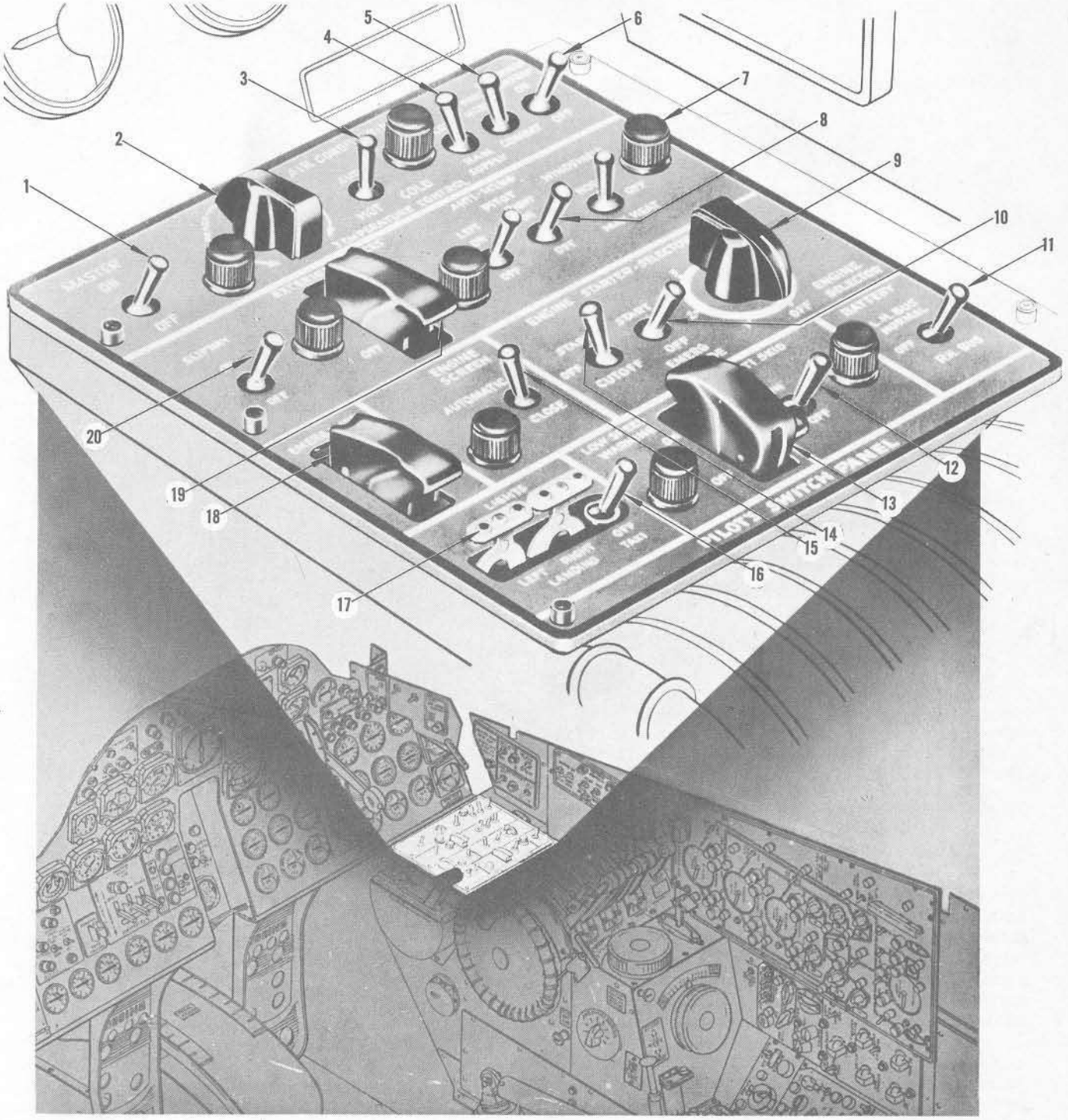


1 STEERING RATIO SELECTOR LEVER
2 PILOT'S SWITCH PANEL
3 ATO FIRING SWITCH
4 THROTTLES
5 THROTTLE LOCK LEVER
6 SURFACE LOCK LEVER
7 WING FLAP LEVER
8 RUDDER TRIM CONTROL KNOB AND INDICATOR
9 AILERON TRIM CONTROL KNOB AND INDICATOR
10 RUDDER PEDAL ADJUSTMENT KNOB
11 LANDING GEAR EMERGENCY RETRACTION SWITCH
12 CABIN HEAT DISTRIBUTION KNOB
13 DRAG CONTROL SWITCH
14 CONTROL COLUMN DISCONNECT HANDLE
15 AIR OUTLET SELECTOR KNOB
16 LANDING GEAR WARNING HORN RELEASE KNOB
17 BRAKE CHUTE JETTISON HANDLE
18 ELEVATOR TRIM CONTROL WHEEL AND INDICATOR
19 WINDSHIELD WIPER SWITCH

Figure 1-13. Pilot's Control Stand

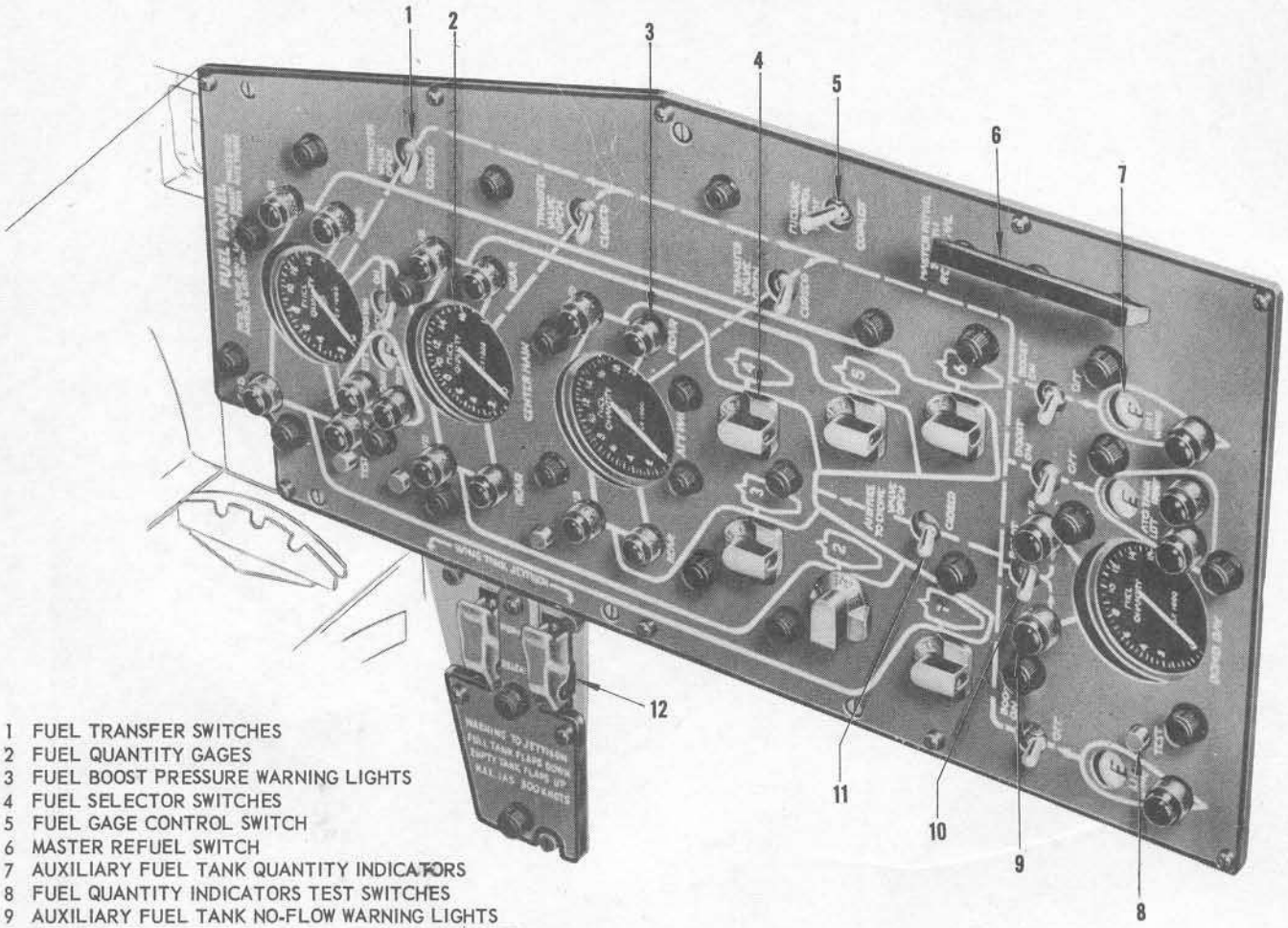
fuel tank valves and energize the auxiliary fuel tank boost pumps. Circuit breakers for the auxiliary tank valves and boost pumps are located on the upper DC power panel (9, figure 1-19).

FUEL TRANSFER SWITCHES. Fuel transfer into the main fuel tanks from the refueling manifold is DC controlled by three OPEN--CLOSED fuel transfer switches (1, figure 1-15) on the fuel control panel. When the switches are placed in the OPEN position, the transfer-refueling valve between each main tank and the refueling manifold is electrically actuated to the open position. High-level float switches in each main tank override the fuel transfer switches to pre-



1 MASTER AIR CONDITIONING SWITCH
2 CABIN TEMPERATURE SELECTOR RHEOSTAT
3 HEAT SELECTOR SWITCH
4 CABIN AIR SELECTOR SWITCH
5 CABIN PRESSURE REGULATION SELECTOR SWITCH
6 WINDSHIELD DEFROST SWITCH
7 WINDSHIELD ANTI-ICING SWITCH
8 PITOT ANTI-ICING SWITCHES
9 STARTER SELECTOR SWITCH
10 STARTER EMERGENCY OVERRIDE SWITCH
11 BATTERY SWITCH
12 ANTI-SKID SWITCH
13 LOW SPEED WARNING SWITCH
14 STARTER SWITCH
15 ENGINE SCREEN SWITCH
16 TAXI LIGHT SWITCH
17 LANDING LIGHT SWITCHES
18 EMERGENCY ALARM SWITCH
19 EXTERIOR SURFACES ANTI-ICING SWITCH
20 AERIAL REFUELING SLIPWAY ANTI-ICING SWITCH

Figure 1-14. Pilot's Switch Panel



1 FUEL TRANSFER SWITCHES
2 FUEL QUANTITY GAGES
3 FUEL BOOST PRESSURE WARNING LIGHTS
4 FUEL SELECTOR SWITCHES
5 FUEL GAGE CONTROL SWITCH
6 MASTER REFUEL SWITCH
7 AUXILIARY FUEL TANK QUANTITY INDICATORS
8 FUEL QUANTITY INDICATORS TEST SWITCHES
9 AUXILIARY FUEL TANK NO-FLOW WARNING LIGHTS
10 AUXILIARY TANK VALVE AND BOOST PUMP SWITCHES
11 AUXILIARY FUEL TO ENGINES SWITCH
12 WING TANK JETTISON SWITCHES

Figure 1-15. Fuel Control Panel

vent overfilling of the tanks. When the fuel transfer switches are in the CLOSED position, the motor-driven valves are closed. The transfer-refueling valves are also controlled by the refueling valve switches (3, figure 4-22) and the fuel transfer switches are deenergized when the master refuel switch is placed in REFUEL position.

AUXILIARY FUEL TO ENGINES SWITCH. A two-position OPEN--CLOSED auxiliary fuel to engines switch, (11, figure 1-15) located on the fuel control panel, controls auxiliary fuel flow to the engine manifold. Placing the switch in the OPEN position opens a shutoff valve allowing fuel to be transferred directly from the bomb bay, external wing, or ATO tanks into the engine manifold. With the switch in OPEN position and the master refuel switch in REFUEL position, the auxiliary fuel to engine switch is deenergized and the shutoff valve is closed thus preventing high fuel pressures from entering the engine manifold during aerial refueling. Should the shutoff valve be already closed at the time the master refuel switch is placed in REFUEL position, the shutoff valve is deenergized and cannot be opened until the switch is placed in NORMAL position. The shutoff valve is then controlled by the auxiliary fuel to engines switch. With the switch in CLOSED position, the shutoff valve is closed preventing auxiliary fuel from being directed into the engine manifold.

MASTER REFUEL SWITCH. A two-position REFUEL--NORMAL switch (6, figure 1-15) is located on the fuel control panel. For aerial refueling operations, this switch is placed in REFUEL position to energize the refueling valve switches (3, figure 4-22) on the aerial refueling panel at the copilot's station. When placed in NORMAL position, the refueling valve switches on the aerial refueling panel are deenergized.

The REFUEL position of the switch deenergizes the auxiliary fuel to engines switch and closes the auxiliary fuel to engines valve thus preventing high fuel pressures from entering the engine manifold during aerial refueling. The master refuel switch must be placed in NORMAL when fuel from auxiliary and

bomb bay tanks is being used. Placing the master refuel switch to NORMAL reenergizes the auxiliary fuel to engine circuit.

FUEL GAGE CONTROL SWITCH. A two-position PILOT--COPILOT switch (5, figure 1-15) is located on the fuel control panel at the pilot's station. This switch controls the fuel quantity gages for the main and bomb bay tanks. With the switch in PILOT position, the fuel quantity gages on the fuel control panel are energized, permitting them to be read only from the pilot's station. When the switch is in COPILOT position, the fuel quantity gages on the aerial refueling panel are energized, enabling only the copilot to read the fuel quantities.

WING TANK JETTISON SWITCHES. Two guarded wing tank jettison switches (12, figure 1-15), one for each external wing tank, are located below the fuel control panel. Each switch has two positions NORMAL and RELEASE and is used to electrically release its respective tank. When either switch is placed in RELEASE position that tank will be jettisoned, provided the master refuel switch is in NORMAL. No provisions are made for releasing both external wing tanks simultaneously.

FUEL SYSTEM INDICATORS.

FUEL QUANTITY GAGES. Four electronic quantity gages (2, figure 1-15) on the fuel control panel and the aerial refueling panel (2, figure 4-22) show the quantity of fuel in pounds for the three main tanks and the bomb bay tank. The fuel quantity readings are obtained from only one set of instruments at a time.

NOTE

The fuel quantity gages are calibrated for a level flight attitude, except that the full mark is calibrated for a taxi attitude. When the airplane is on the ground, the gages will read low for all quantities less than full (figure 1-17).

FUEL BOOST PRESSURE WARNING LIGHTS. Twelve red fuel boost pressure warning lights (3, figure 1-15), one for each main fuel tank boost pump, are on the fuel control panel. The lights will illuminate whenever a low fuel pressure exists in the line. The fuel boost warning lights are energized as soon as DC power is on the airplane.

AUXILIARY FUEL TANK QUANTITY INDICATORS. Four DC operated tab-window type indicators (7, figure 1-15), on the fuel control panel show by interchangeable tabs the condition of fuel quantity in the forward auxiliary, ATO, and external wing tanks. A full tank is indicated by an "F" tab, an empty tank by an "E" tab, and all intermediate quantities by a divided black and white circle tab. The indicating circuits are energized when DC power is on the airplane.

AUXILIARY FUEL TANK NO-FLOW WARNING LIGHTS. Eight amber auxiliary fuel tank no-flow warning lights (9, figure 1-15), one for each auxiliary fuel tank boost pump, are on the fuel control panel. The lights will illuminate when the corresponding boost pump is energized and no fuel is flowing in the line.

ELECTRICAL POWER SUPPLY SYSTEMS.

The airplane is provided with a direct current (battery and generators), a regulated alternating current (inverters), and an unregulated alternating current (alternators) system to supply power to the various electrically operated equipment. These systems utilize circuit breakers and/or fuses for individual circuit protection, and current limiters for protection of some bus circuits. Each system may be connected to an external power source through external receptacles for ground operation.

DIRECT CURRENT SYSTEM.

Direct current power is provided by six 28-volt, 400-ampere engine-driven generators. The generators are combination starter and generator units, acting as starters to turn the engine rotors until combustion in the engine is self-sustaining (approximately 20% rpm), after which they function as generators. Two 12-volt batteries connected in series are provided for emergency battery starts when external power is not available and for partial voltage stabilization during normal operation. Some systems are connected directly to the batteries, independent of battery switch position, using the batteries for emergency power in case of failure of battery busses and/or generator failures. Systems that are or may be operated directly by the battery are: the emergency alarm bell, AN/APX-6 destructor circuit, and the bomb salvo circuit operated by the bomb salvo switch (10, figure 4-19) on the bomb control panel.

Emergency power may be used for operation of the pilot and copilot turn-and-bank indicators.

Direct current power distribution buses are interconnected by three parallel wires. Each wire is fused at both ends. If a short to the airplane structure occurs on a bus or distribution wire, current limiters and/or fuses will blow and clear the fault. This is known as a fail-safe system. A single ground return system supplies power from the distribution buses to the electrical units. Circuit breakers are provided for individual circuit protection. See figure 1-23 for systems using DC power and power distribution.

DC SYSTEM CONTROLS.

BATTERY SWITCH. A battery switch (11, figure 1-14) located on the pilot's switch panel has L.H. BUS NORMAL--OFF--R.H. BUS positions. The L.H. BUS NORMAL position of the switch connects the battery to the DC distribution system through a left-

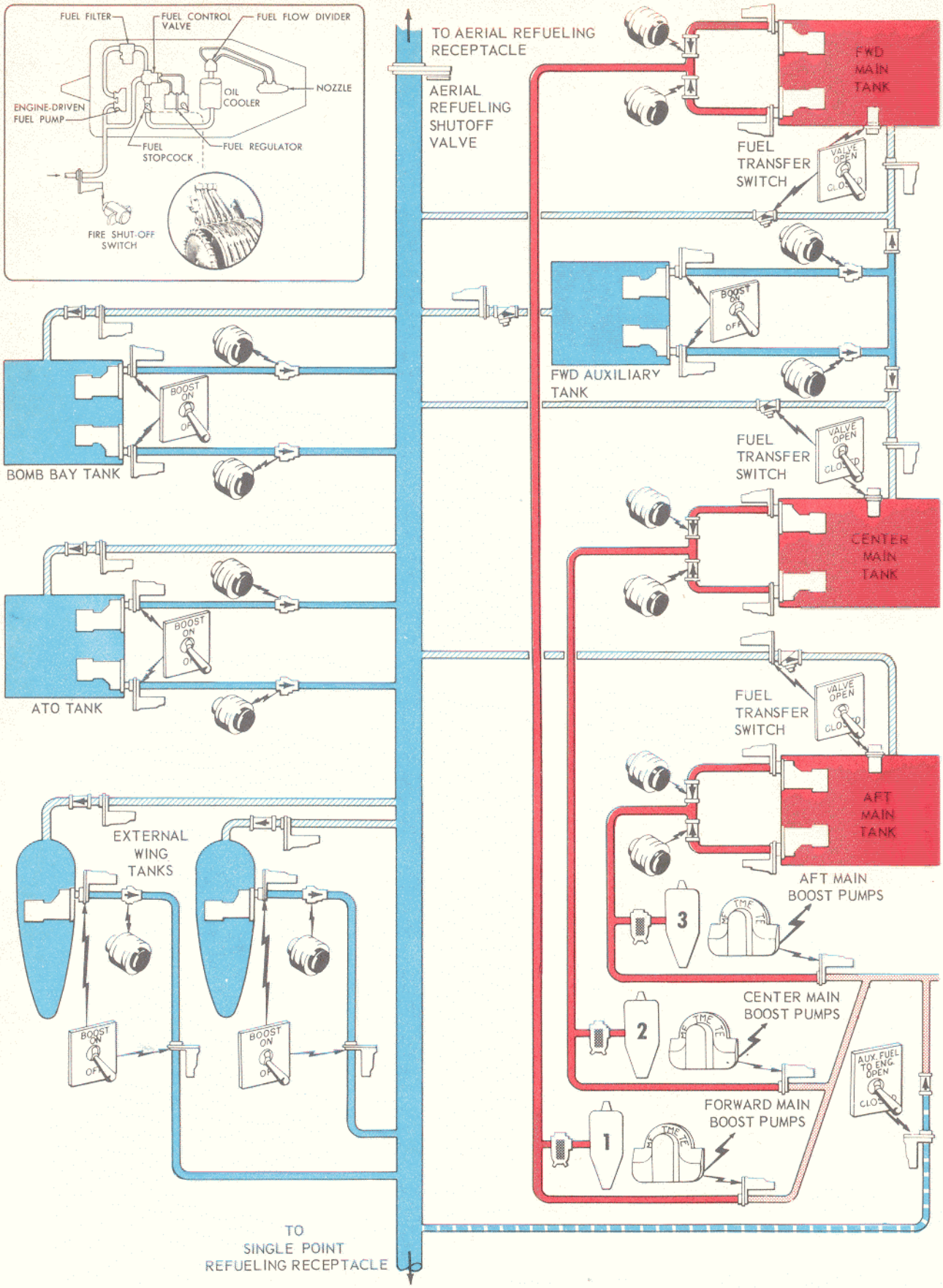
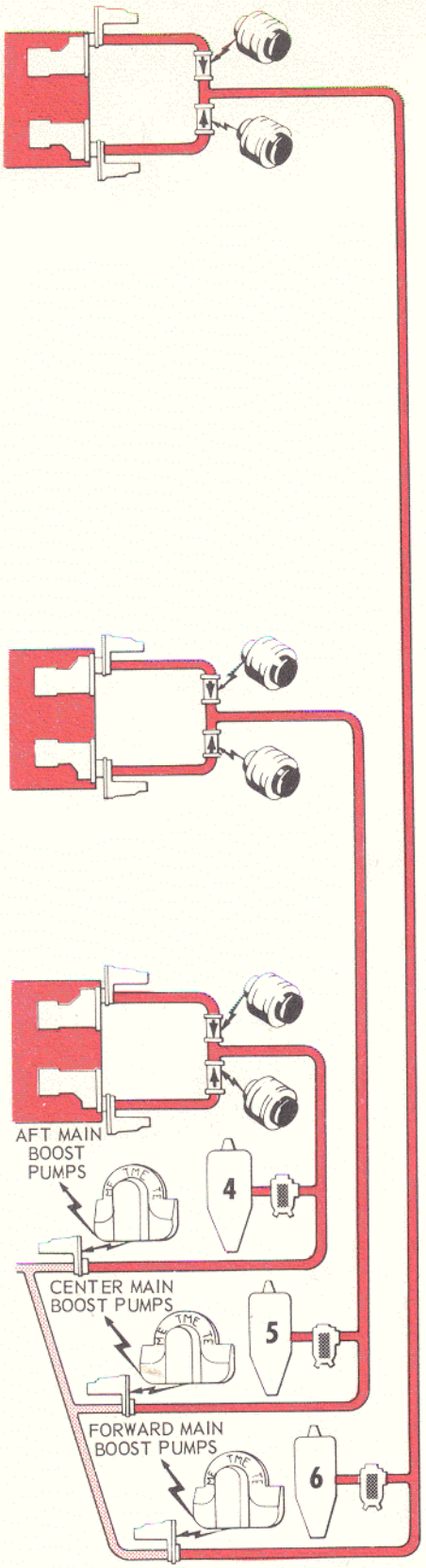


Figure 1-16. Fuel Supply and Transfer System (Sheet 1 of 2)



FUNCTIONAL CHART
TYPICAL FUEL FLOW FOR ANY ENGINE

WHEN THE FUEL SELECTOR SWITCH IS IN THE POSITION	AND THE THROTTLE POSITION IS	THE MAIN TANK VALVE AND BOOST PUMP IS	AND THE MANIFOLD VALVE IS	FUEL FLOW WILL BE
TE	Open	On	Closed	Main Tank to Engine
	Closed	Off	Closed	None
TME	Open	On	Open	Main Tank to Manifold & Engine
	Closed	On	Open	Main Tank to Manifold & Engine
ME	Open	Off	Open	None ▶
	Closed	Off	Open	None ▶

▶ Manifold to Engine - Providing One of the Fuel Selector Switches is in TME Position

FUNCTIONAL CHART
AUXILIARY FUEL FLOW DIRECT TO ENGINES
TYPICAL FOR EXTERNAL WING, ATO, AND BOMB BAY TANK

WHEN THE MASTER REFUEL SWITCH IS	AND THE AUXILIARY FUEL TO ENGINES SWITCH IS	AND THE AUXILIARY TANK	AND THE AUX. TANK BOOST PUMP IS	AUX. TANK NO FLOW WARNING LIGHT WILL BE	FUEL FLOW WILL BE FROM THE
Normal	Open	Contains Fuel	On	Off	Auxiliary Tank
			Off	Off	Main Tank
		Is Empty	On	On	
			Off	Off	

SYMBOLS

- FUEL BOOST PRESSURE WARNING LIGHTS
- AUXILIARY FUEL TANK NO-FLOW WARNING SWITCH AND LIGHT
- CHECK VALVE
- BOOST PUMP AND SHUTOFF VALVE
- TRANSFER FUEL VALVES
- FLOAT SWITCH
- FUEL FILTER
- SHUTOFF VALVE

- MAIN FUEL SYSTEM
- ENGINE MANIFOLD
- AUXILIARY FUEL SYSTEM
- INTER-MANIFOLD
- REFUELING LINE
- MECHANICAL LINKAGE
- ELECTRICAL CIRCUIT

Figure 1-16. Fuel Supply and Transfer System (Sheet 2 of 2)

TANKS	NO.	USABLE FUEL (LEVEL FLIGHT ATTITUDE)	FULLY SERVICED (TAXI ATTITUDE)	EXPANSION SPACE	TOTAL VOLUME
Forward Main	1	2930	2954	76*	3030*
Forward Auxiliary	1	990	990	70*	1060*
Center Main	1	2810	2874	126*	3000*
ATO	1	510	558	17*	575*
Bomb Bay	1	3156*	3184*	132*	3316*
Aft Main	1	3430	3445	105*	3550*
External Wing	2	3010	3040	460*	3500*

USABLE FUEL TOTALS (LEVEL FLIGHT ATTITUDE)	
Main Tanks	9170
Main Tanks and Forward Auxiliary Tank	10,160
Main Tanks, Forward Auxiliary Tank and ATO Tank	10,670
Main Tanks, Forward Auxiliary Tank, ATO Tank and Bomb Bay Tank	13,826*
Main Tank and all Auxiliary Tanks	16,836*

NOTE

*These quantities are calculated values. Additional data will be furnished when available

DATE: 15 August 1952

DATA BASIS: Ground Test

REMARKS:

Level flight attitude - Top of fuselage 2° 30' nose up

Taxi attitude - Top of fuselage 5° 15' nose up

Tanks serviced individually

Figure 1-17. Fuel Quantity Data (U.S. Gal)

hand bus and is the normal position of the switch. Placing the switch in the OFF position disconnects the battery from the left or right-hand bus. The R.H. BUS position of the switch connects the battery to the DC distribution system through a right-hand bus as an alternate transfer.

DC BUS SELECTOR SWITCH. A bus selector switch (10, figure 1-19) on the copilot's upper DC power panel has SECONDARY--NORMAL--PRIMARY TEST positions, providing a manual means for controlling DC power to the upper and lower DC power panels. With the switch in the NORMAL position, normal operation of the automatic transfer relay in the DC system is permitted. Should a fault occur on the forward main bus, the automatic transfer relay will transfer the DC power panels to the right main bus. The SECONDARY position of the switch connects both DC power panels to the right main bus as an operational test of the changeover from the forward main bus, and serves as a manual transfer to the right main bus in the event of automatic transfer relay failure. The momentary PRIMARY TEST position connects the DC power panels to the forward main bus as a test of the automatic power transfer relay. Automatic transfer or manual transfer may be observed by a flicker of the generator field trip warning lights on the pilot's and copilot's instrument panels.

CAUTION

During flight, the bus selector switch should always be in the NORMAL position to allow for normal operation of the DC system.

GENERATOR SWITCHES. Six generator switches (20, figure 1-27) are located on the copilot's instrument panel. Each switch has ON--OFF--RESET positions and is guarded to the OFF position. The momentary RESET position of the switch resets the generator field relay to allow turning on or restoring generator operation. When the generator switch is moved to the RESET position, releasing the switch will allow it to return to OFF. Placing the switch in the ON position turns on the generator if the generator field relay is reset. Six indicator lights are provided and will illuminate if the generator field relays are tripped. Resetting will cause the lights to go out. The generator switch guards are stenciled with the number of the respective engine and generator.

GENERATOR VOLTAGE RHEOSTATS. Six generator voltage rheostats (21, figure 1-27), one for each generator, are located behind a hinged cover guard

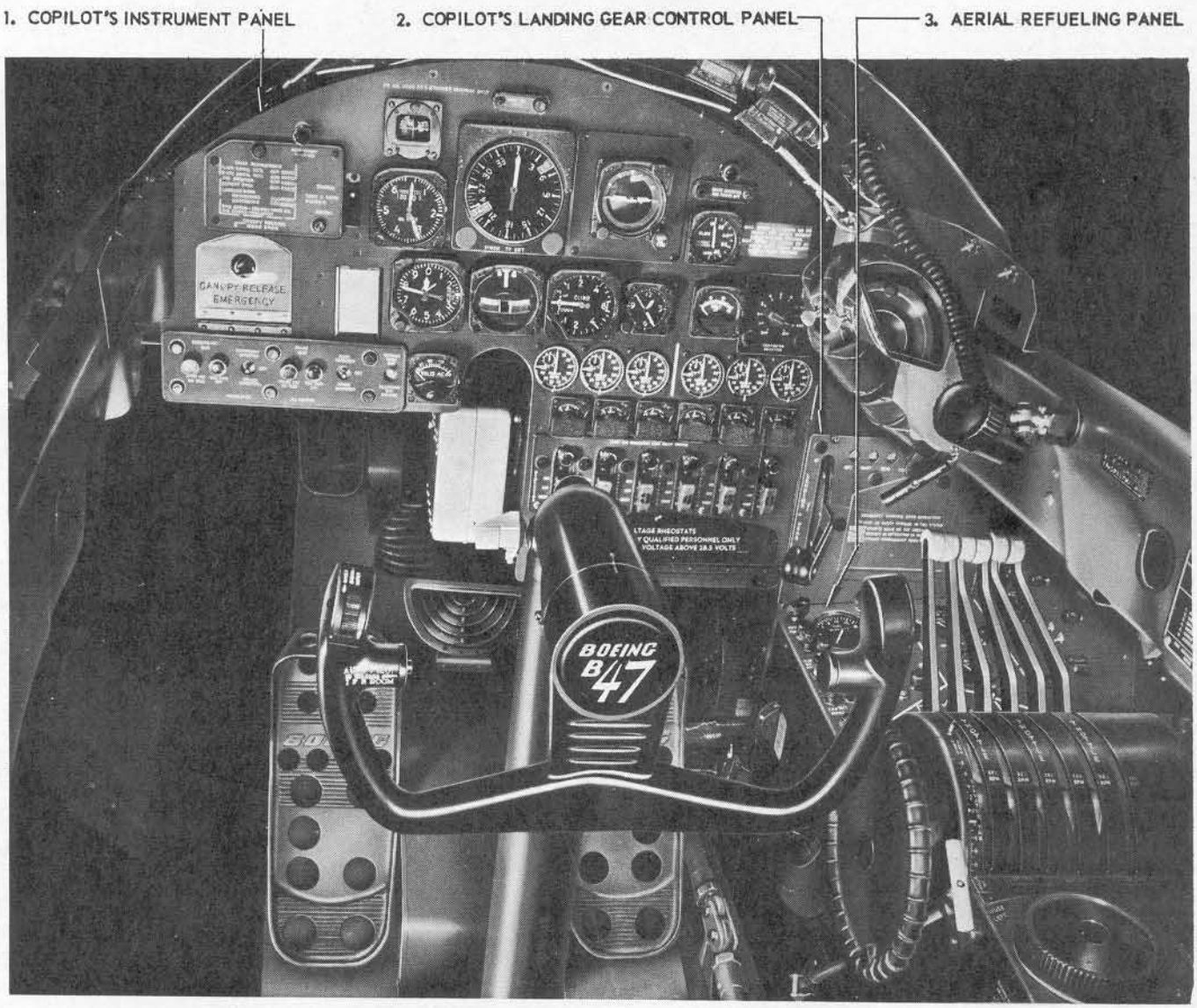


Figure 1-18. Copilot's Station

on the copilot's instrument panel. The rheostats enable the copilot to adjust all generator output voltages, as indicated by the voltmeter, to equalize small differences in output voltage. The voltage differences are caused by variation in generator load distribution.

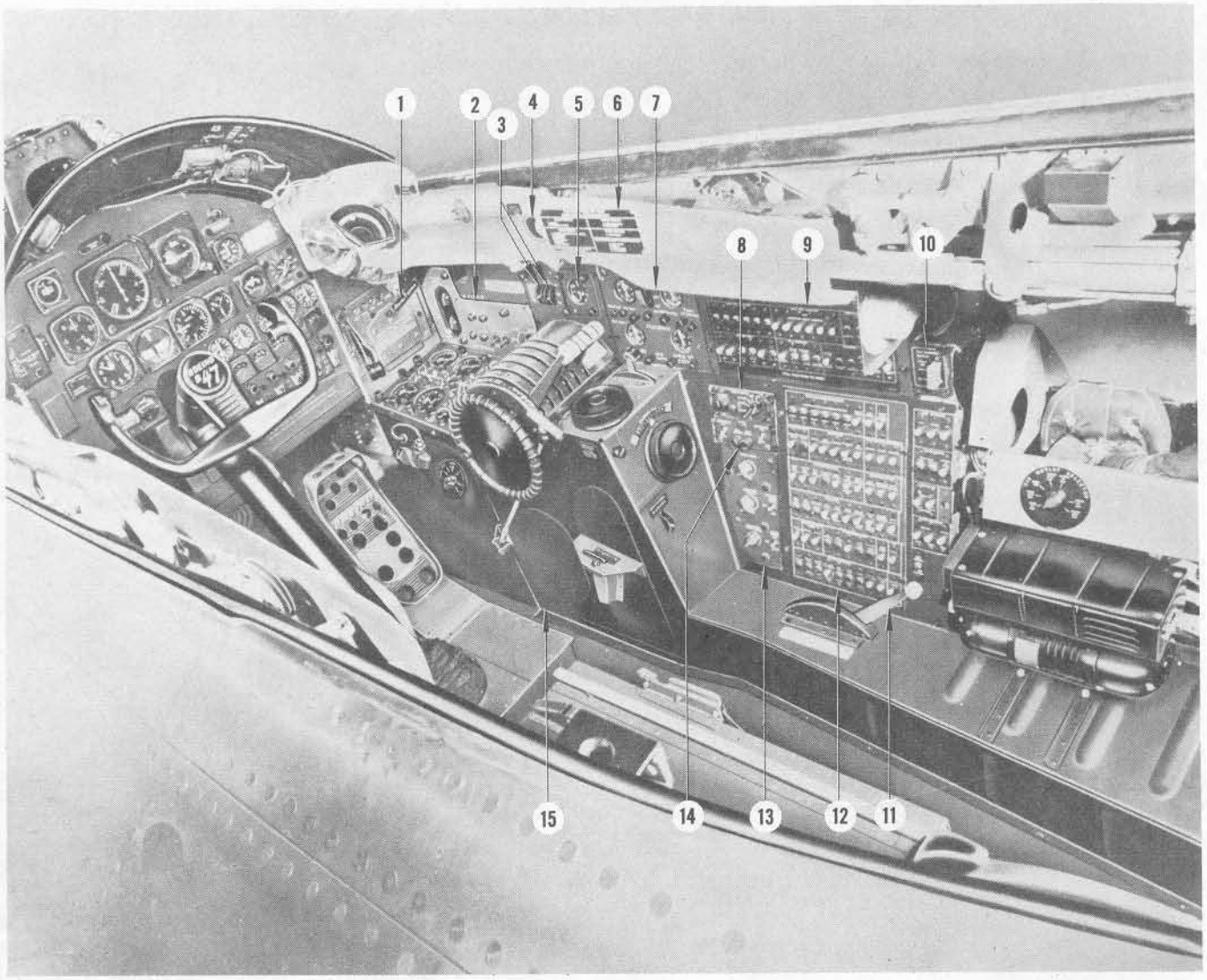
NOTE

For ease in equalizing small differences in generator output voltage, decrease the higher voltage before increasing the lower voltage. Do not adjust rheostats unless, after a 10-minute warm-up, two or more generators are incorrectly adjusted or have tripped off the bus. Unless proper adjustment procedures are observed, adjustment should not be attempted since it is possible for other generators to trip off the bus during incorrect adjustment.

DC VOLTMETER SELECTOR SWITCH. A rotary-type switch (16, figure 1-27) on the copilot's instrument panel provides a means of obtaining DC bus voltage and generator output voltage readings on a single voltmeter. The switch has OFF--1--2--3--4--5--6--R BUS--FWD BUS--L BUS--OFF positions. The OFF positions of the switch disconnect the voltmeter from any source of voltage. Positions 1 through 6 connect the voltmeter to the respective DC generator outputs to give individual voltage readings. When the switch is placed in R BUS position, the DC voltmeter is connected to measure voltage on the right-hand bus. The FWD BUS position connects the DC voltmeter to measure voltage on the forward bus. The L BUS position connects the DC voltmeter to measure voltage on the left-hand bus.

DC SYSTEM INDICATORS.

GENERATOR FIELD TRIP WARNING LIGHTS. Six



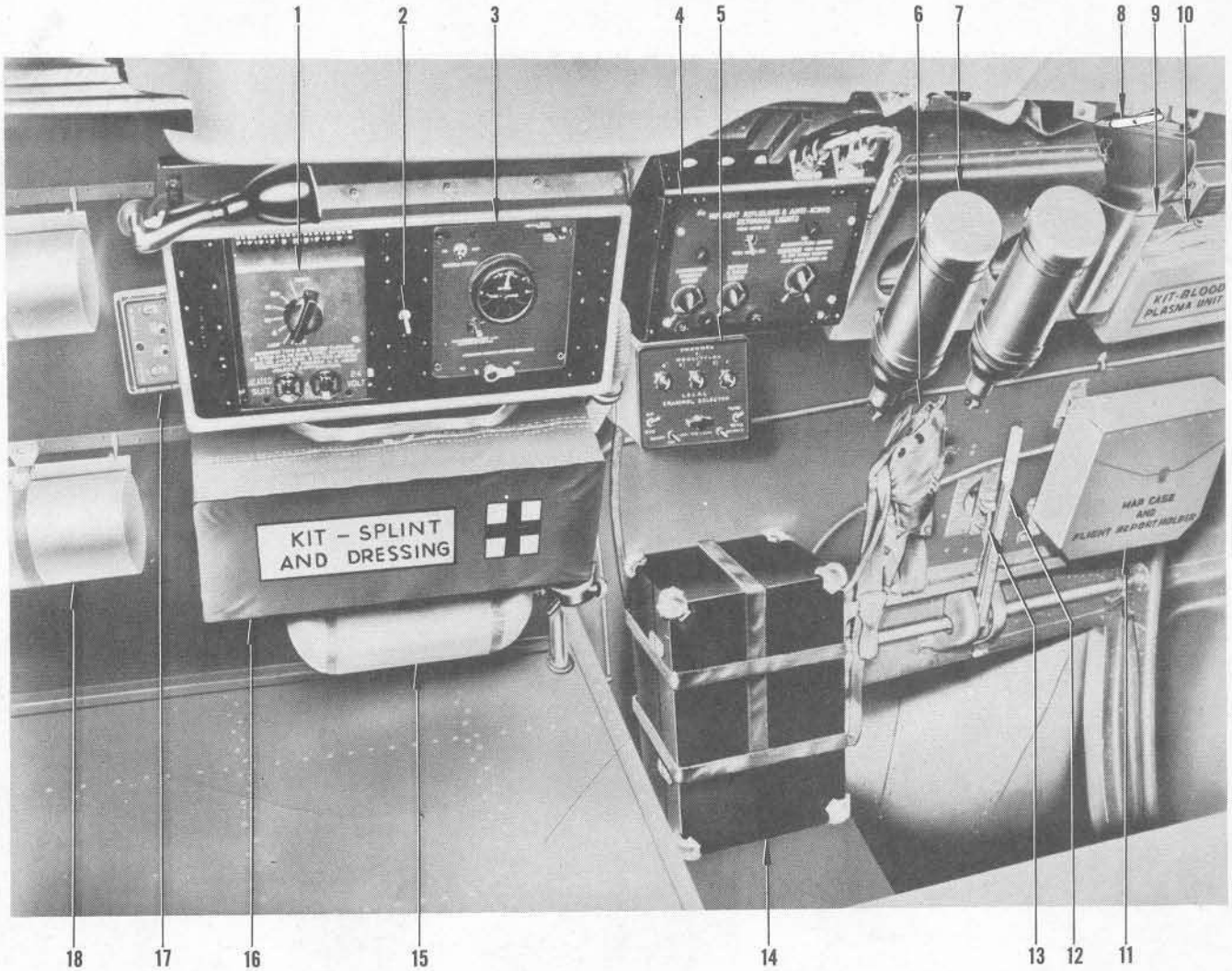
1 BRAKE CHUTE DEPLOYMENT HANDLE
2 UNREGULATED AC POWER PANEL
3 WING FLAP EMERGENCY SWITCHES
4 CANOPY LOCK PIN INSPECTION HOLE
5 HYDRAULIC FLUID QUANTITY GAGE
6 COPILOT'S CHECK LIST
7 HYDRAULIC CONTROL PANEL
8 COPILOT'S INTERPHONE PANEL
9 UPPER DC POWER PANEL
10 DC BUS SELECTOR SWITCH
11 AERIAL REFUELING VALVE LEVER
12 LOWER DC POWER PANEL
13 COPILOT'S LIGHTING PANEL
14 ECM CONTROL PANEL
15 COPILOT'S CONTROL STAND

Figure 1-19. Copilot's Station - Right Side

generator field trip warning lights (19, figure 1-27) are provided on the copilot's instrument panel. A light will illuminate when the respective generator field relay is tripped to indicate that the generator is no longer furnishing power to the DC system. The field relays will trip when a malfunction occurs in the system or when an engine fire shutdown is accomplished. The warning lights are protected by 10-ampere throttle and engine control circuit breakers in the lower DC power panel.

DC VOLTMETER. A direct current voltmeter (15, figure 1-27) on the copilot's instrument panel is used to indicate individual generator or bus voltages. A rotary-type selector switch adjacent to the voltmeter may be positioned to give the desired generator or bus reading on the voltmeter.

DC LOADMETERS. Six direct current loadmeters (18, figure 1-27) are located on the copilot's instrument panel to provide indication of DC current load of the individual generators. The loadmeter scale is calibrated in percent of the rated generator load.



1 HEATED SUIT RHEOSTAT AND RECEPTACLES
2 DOME LIGHT SWITCH
3 OXYGEN REGULATOR PANEL
4 AERIAL REFUELING AND ANTI-ICING EXTERNAL LIGHTS PANEL
5 UHF COMMAND RADIO PANEL
6 PARACHUTE STATIC LINE
7 THERMOS BOTTLES
8 CANOPY EMERGENCY JETTISON HANDLE
9 CUP DISPENSER
10 BLOOD PLASMA KIT
11 MAP CASE AND FLIGHT REPORT HOLDER
12 PRESSURE DOOR RELEASE HANDLE
13 BAIL-OUT CONTROL HANDLE
14 PERISCOPIC SEXTANT AND BASE
15 PORTABLE OXYGEN BOTTLE
16 BATTLE SPLINT AND DRESSING KIT
17 ECM CONTROL PANEL
18 ANTI-EXPOSURE SUITS

Figure 1-20. Copilot's Station - Left Side

REGULATED ALTERNATING CURRENT SYSTEM.

MAIN INVERTER SYSTEM.

Regulated 115-volt 400-cycle alternating current (figure 1-24) is supplied to a main, secondary and an A-5 bus by three single-phase inverters. In normal operation, the main inverter supplies power to the main bus, the secondary inverter supplies power to the secondary bus, and an A-5 inverter supplies power to the A-5 bus. The secondary inverter will automatically operate, or can be manually selected, to supply power to either the main or the A-5 bus in the event of failure of the main or A-5 inverter. If both main and A-5 inverters are inoperative at the same time, the secondary inverter output will automatically transfer to the main bus only. An inverter transfer control is provided for manual selection, connecting the secondary inverter to any desired bus. For equipment requiring regulated alternating current, see figure 1-24.

1 CANOPY AIR BOTTLE PRESSURE GAGE
2 ASH TRAY
3 GUNNER'S LIGHT RHEOSTAT
4 GUNNER'S WORK LIGHT RHEOSTAT
5 HEATED SUIT RHEOSTAT AND RECEPTACLES
6 BATTLE SPLINT AND DRESSING KIT
7 LANDING GEAR INDICATOR LIGHTS
8 RELIEF CONTAINERS
9 LANDING GEAR EMERGENCY EXTENSION LEVERS
10 ANTI-EXPOSURE SUITS

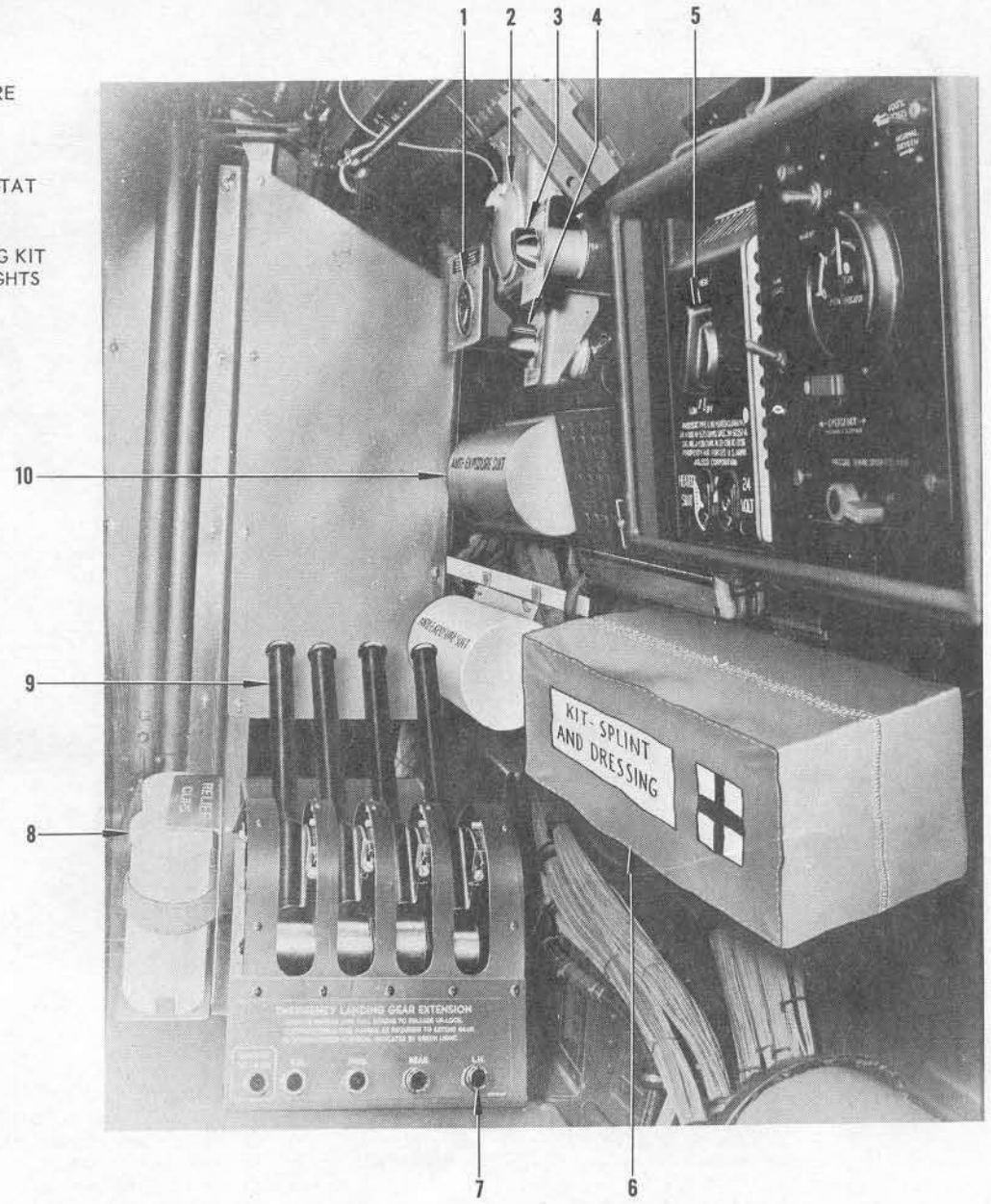
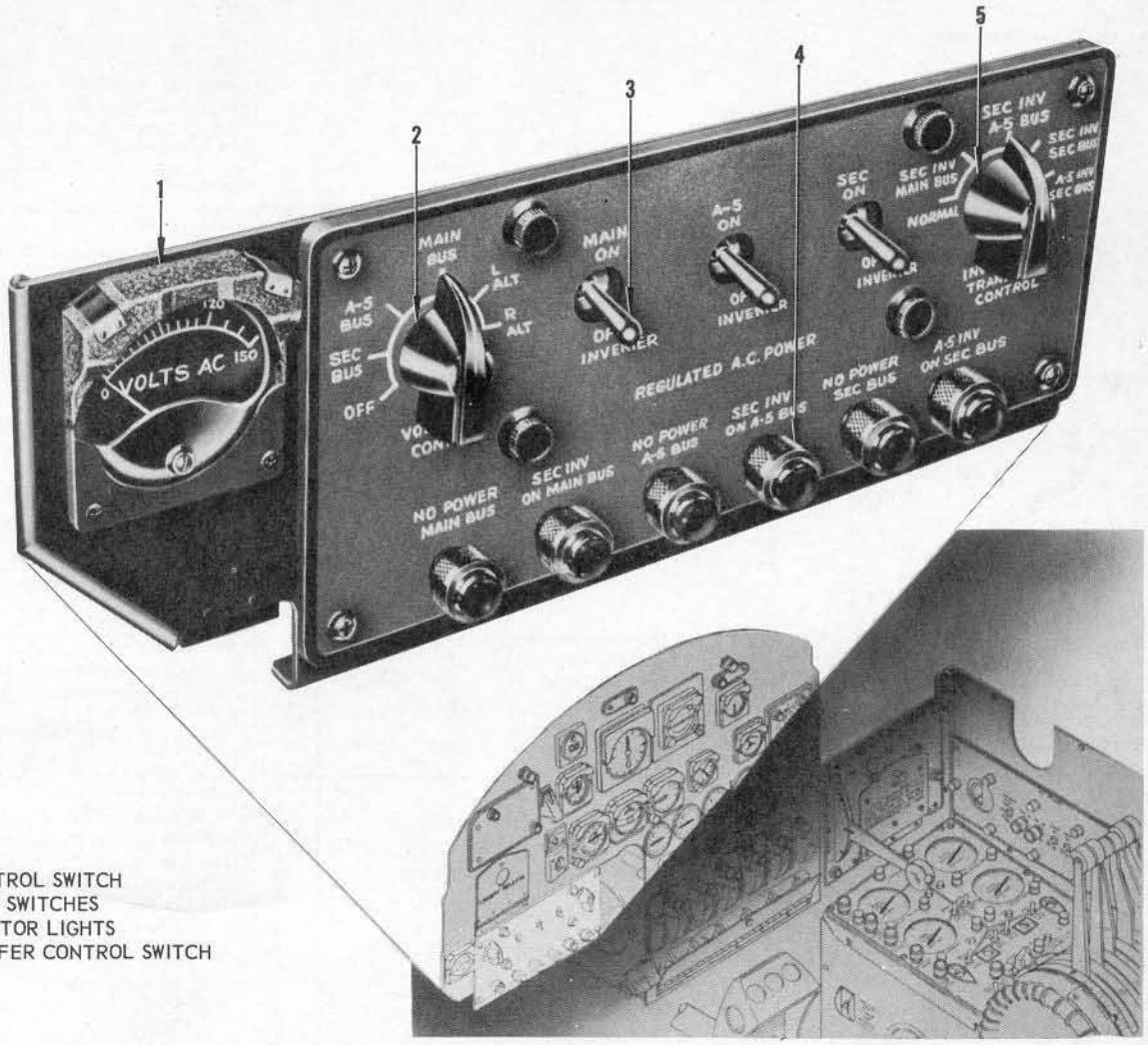


Figure 1-21. Copilot's Station - Aft Left Side

MAIN INVERTER SYSTEM CONTROLS.

INVERTER POWER SWITCHES. Three ON--OFF switches (3, figure 1-22) on the regulated AC power panel control the main, secondary, and A-5 inverters. Placing any inverter switch in ON position will energize the respective inverter starting relays and the inverter output is connected to the respective bus, provided the transfer control switch is in NORMAL position. Placing any inverter switch in the OFF position will deenergize that inverter.

INVERTER TRANSFER CONTROL SWITCH. A five-position selector switch (5, figure 1-22) on the regulated AC power panel is provided to manually transfer power from the secondary inverter to any inverter bus or the A-5 inverter to the secondary bus in case of failure of the automatic change-over relays. The switch has NORMAL--SEC INV MAIN BUS--SEC INV A-5 BUS--SEC INV SEC BUS--A-5 INV SEC BUS positions. With the switch in NORMAL position, each inverter is connected to its respective bus; however, should the main or A-5 inverter fail, the automatic change-over relay will transfer secondary inverter output to the main or A-5 bus. If both main and A-5 inverters fail,,the secondary inverter output transfers automatically to the main bus only. The SEC INV MAIN BUS position may be used to manually



1 AC VOLTMETER
2 VOLTMETER CONTROL SWITCH
3 INVERTER POWER SWITCHES
4 INVERTER INDICATOR LIGHTS
5 INVERTER TRANSFER CONTROL SWITCH

Figure 1-22. Regulated AC Power Panel

transfer secondary inverter output to main bus in the event the automatic transfer relay fails. The SEC INV A-5 BUS position may be used to manually transfer secondary inverter output to the A-5 bus in the event of failure of the automatic transfer or if both main and A-5 inverters have failed and secondary in inverter output has been automatically transferred to the main bus. In the event the secondary inverter has been transferred automatically to the main or A-5 bus by the changeover relay and it is desired to return the secondary inverter output to the secondary bus, place the transfer control switch to SEC INV SEC BUS. In the event the secondary inverter has failed or has been automatically transferred to the main bus, the A-5 inverter may be manually transferred to the secondary bus by placing the transfer control switch to the A-5 INV SEC BUS position.

MAIN INVERTER SYSTEM INDICATORS.

AC VOLTMETER AND CONTROL SWITCH. An AC voltmeter (1, figure 1-22) located on the regulated AC power panel provides voltage readings on the main, secondary, and A-5 inverter buses and the left and right alternator buses. A six-position voltmeter control switch (2, figure 1-22) located on the regulated AC power panel has OFF--SEC BUS--A-5 BUS--MAIN BUS--L ALT--R ALT positions. The switch is used in reading bus voltages on the AC voltmeter.

INVERTER INDICATOR LIGHTS. Six amber warning lights (4, figure 1-22) on the regulated AC power panel are provided for indications of the main, secondary, and A-5 inverter power conditions. Three lights marked "No Power Main Bus," "No Power A-5 Bus" and "No Power Sec Bus" when illuminated indicate no voltage on the respective buses. The "Sec Inv On Main Bus" indicates that secondary inverter output has been transferred, automatically or manually, to the main bus. The "Sec Inv On A-5 Bus" indicates that secondary inverter output has been diverted, automatically or manually, to the A-5 bus. The "A-5 Inv On Sec Bus" indicates that the A-5 inverter output has been diverted manually to the

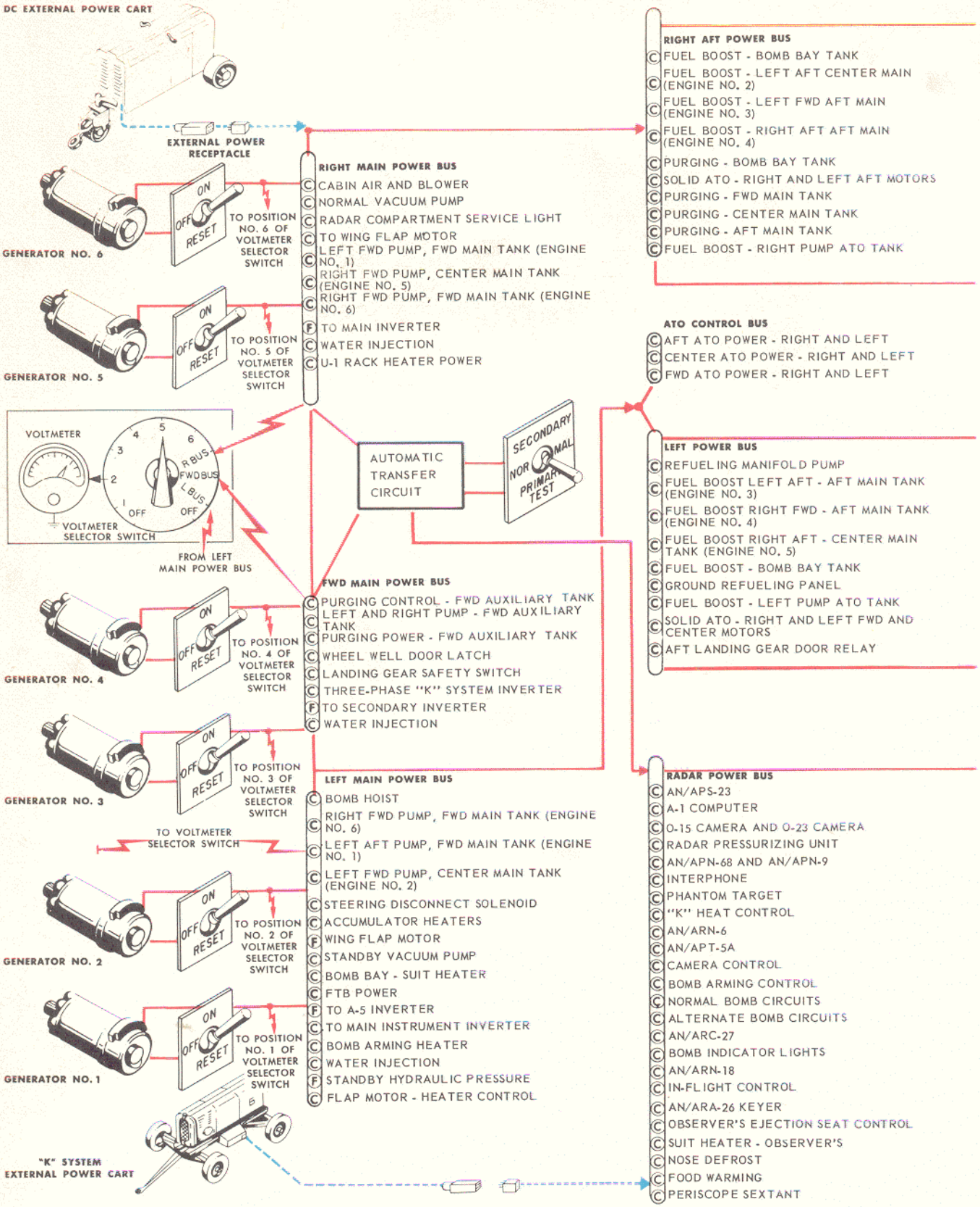


Figure 1-23. DC Power Control, Generation, and Distribution (Sheet 1 of 2)

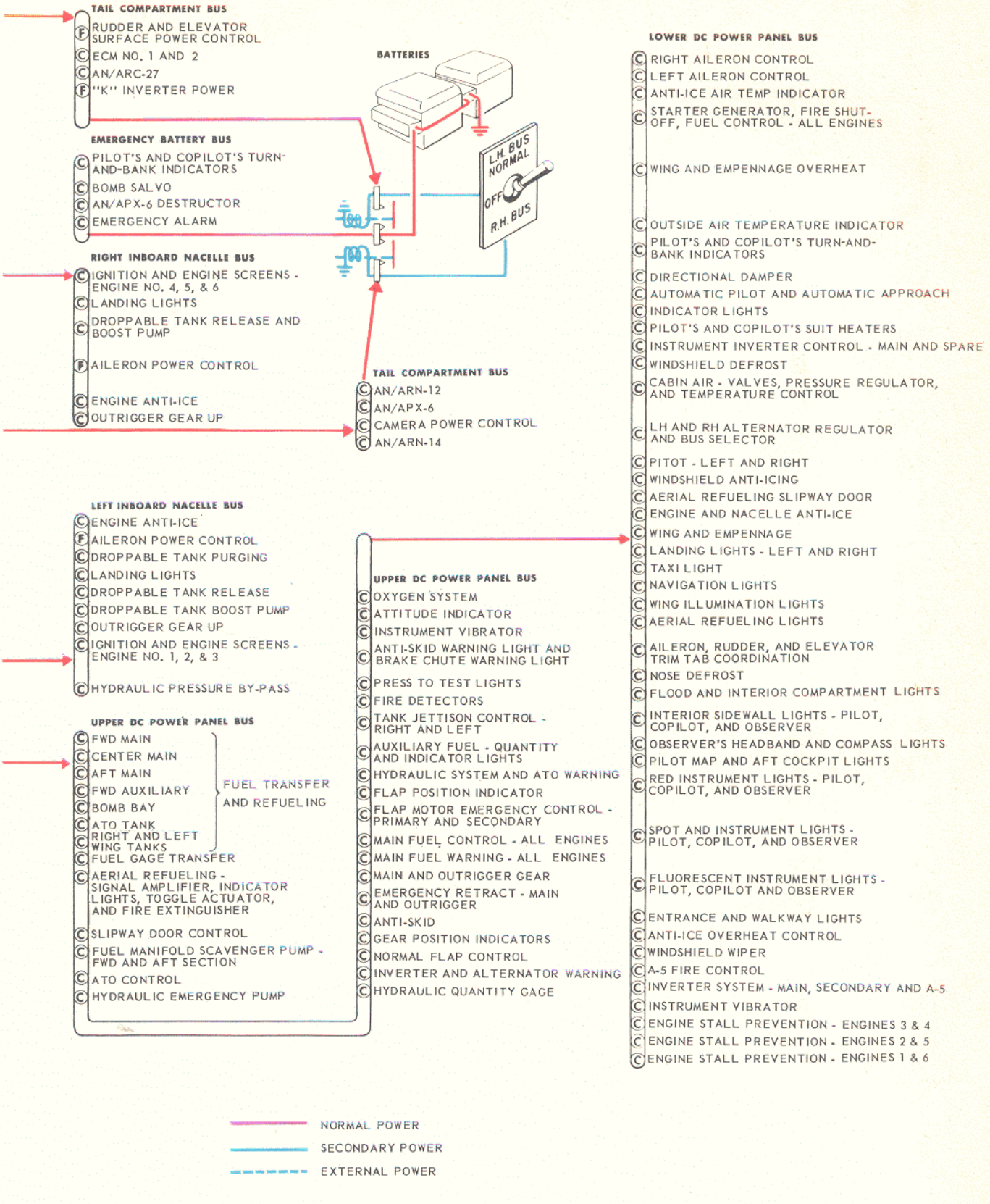


Figure 1-23. DC Power Control, Generation and Distribution (Sheet 2 of 2)

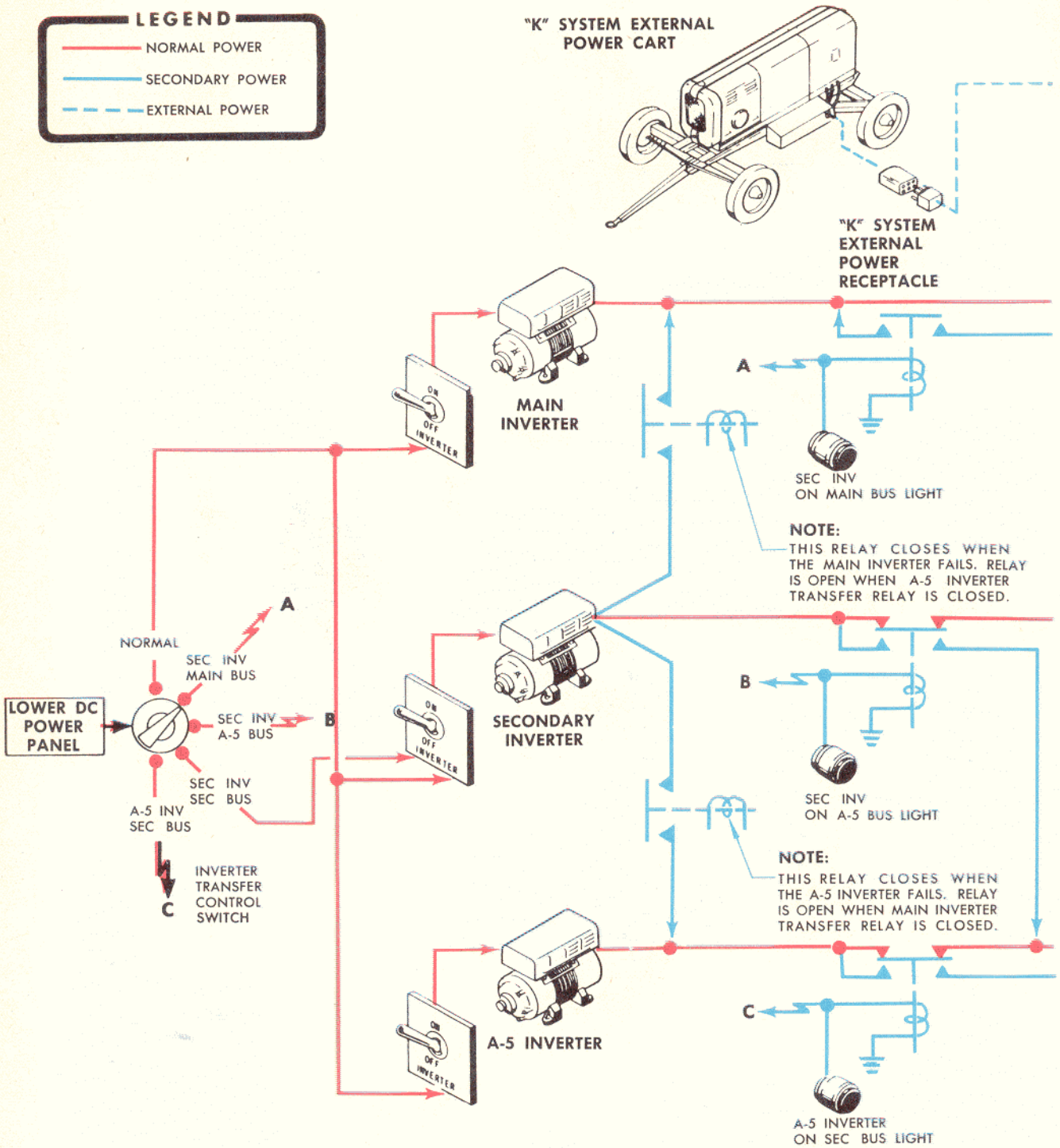


Figure 1-24. Regulated AC Power Generation and Distribution (Sheet 1 of 2)

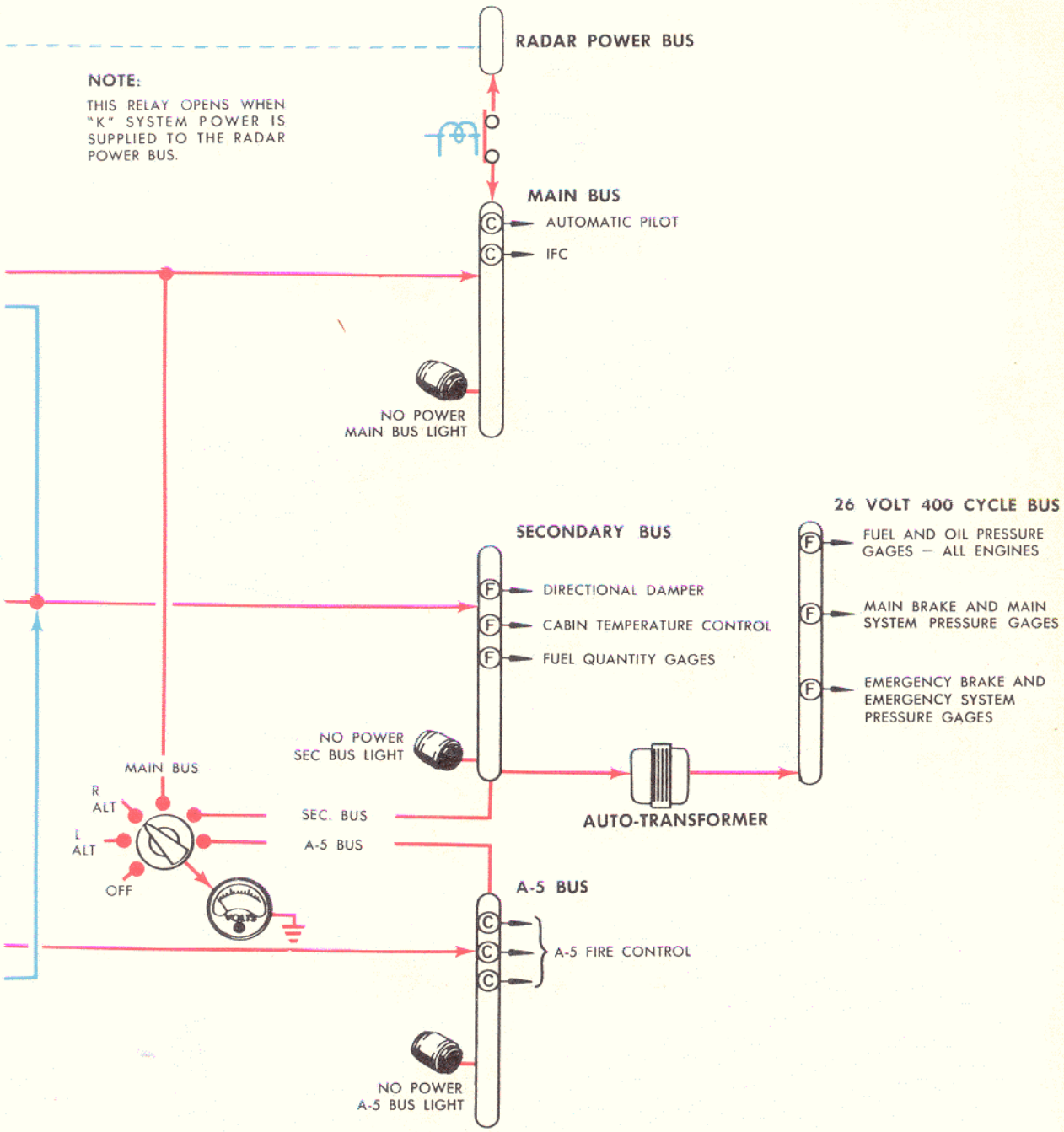


Figure 1-24. Regulated AC Power Generation and Distribution (Sheet 2 of 2)

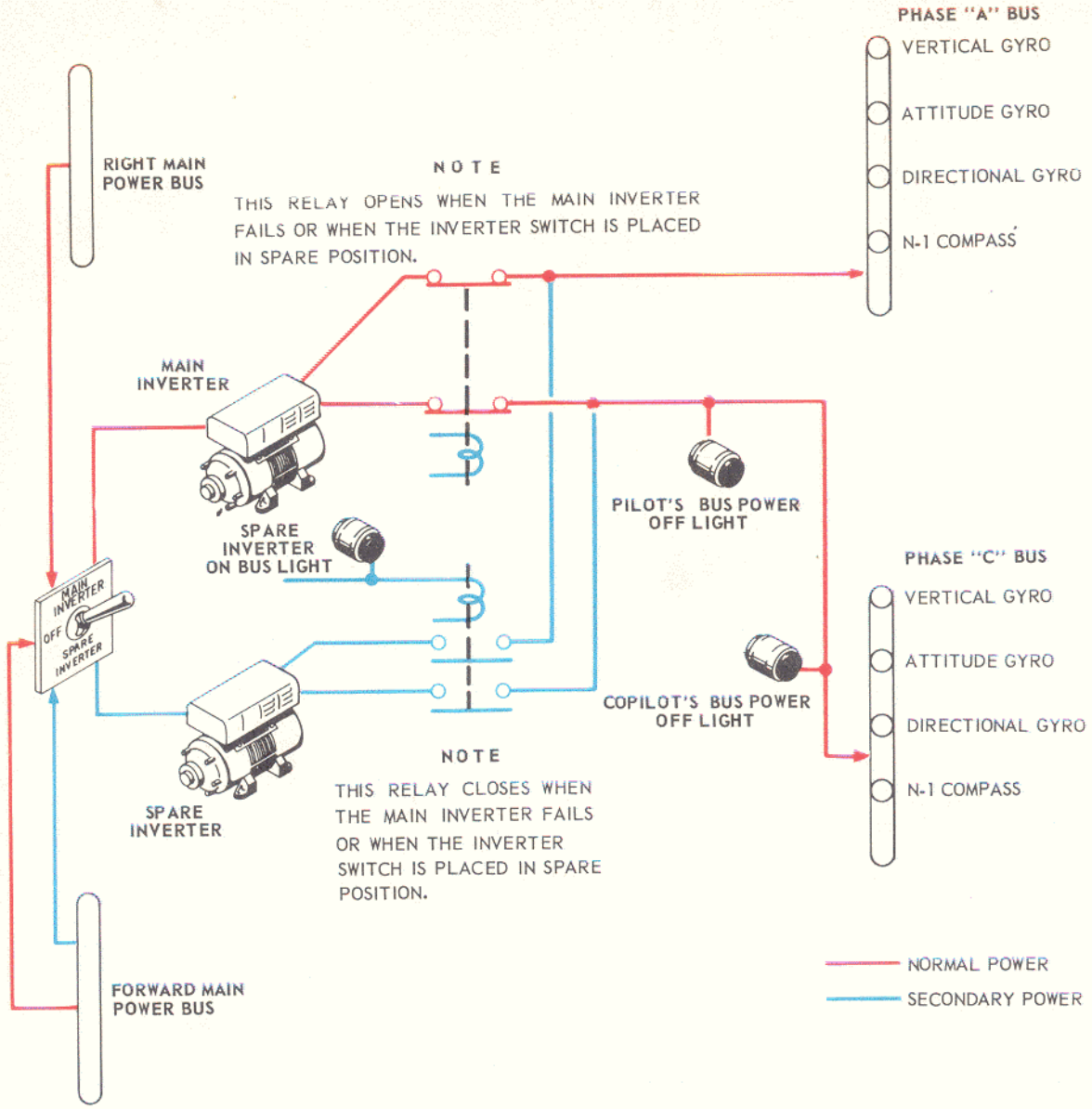


Figure 1-25. Instrument Inverter Power Generation and Distribution

secondary bus. All indicator lights are DC energized and will not illuminate unless the airplane DC system is energized.

INSTRUMENT INVERTER SYSTEM.

Regulated 115-volt 400-cycle alternating current (figure 1-25) is supplied to the instrument buses by two three-phase instrument inverters. One inverter serves as a standby or spare inverter which will automatically operate, or can be manually selected, to supply power to the instrument bus in the event of failure of the main instrument inverter. The attitude and vertical gyro indicators receive power from the instrument bus.

INSTRUMENT INVERTER SYSTEM CONTROLS.

INSTRUMENT INVERTER SWITCH. An instrument inverter MAIN--OFF--SPARE switch (15, figure 1-9) is on the pilot's instrument panel. The switch controls the main and spare inverter. When the switch is in the MAIN position, the main inverter is energized and supplies regulated AC power to the instrument bus. An automatic change-over relay automatically energizes the spare inverter in case the main inverter fails. The SPARE position for this switch provides a manual means of disconnecting the main inverter and connecting (and energizing) the spare inverter to the instrument bus. When the switch is in the OFF position, both inverters are de-energized.

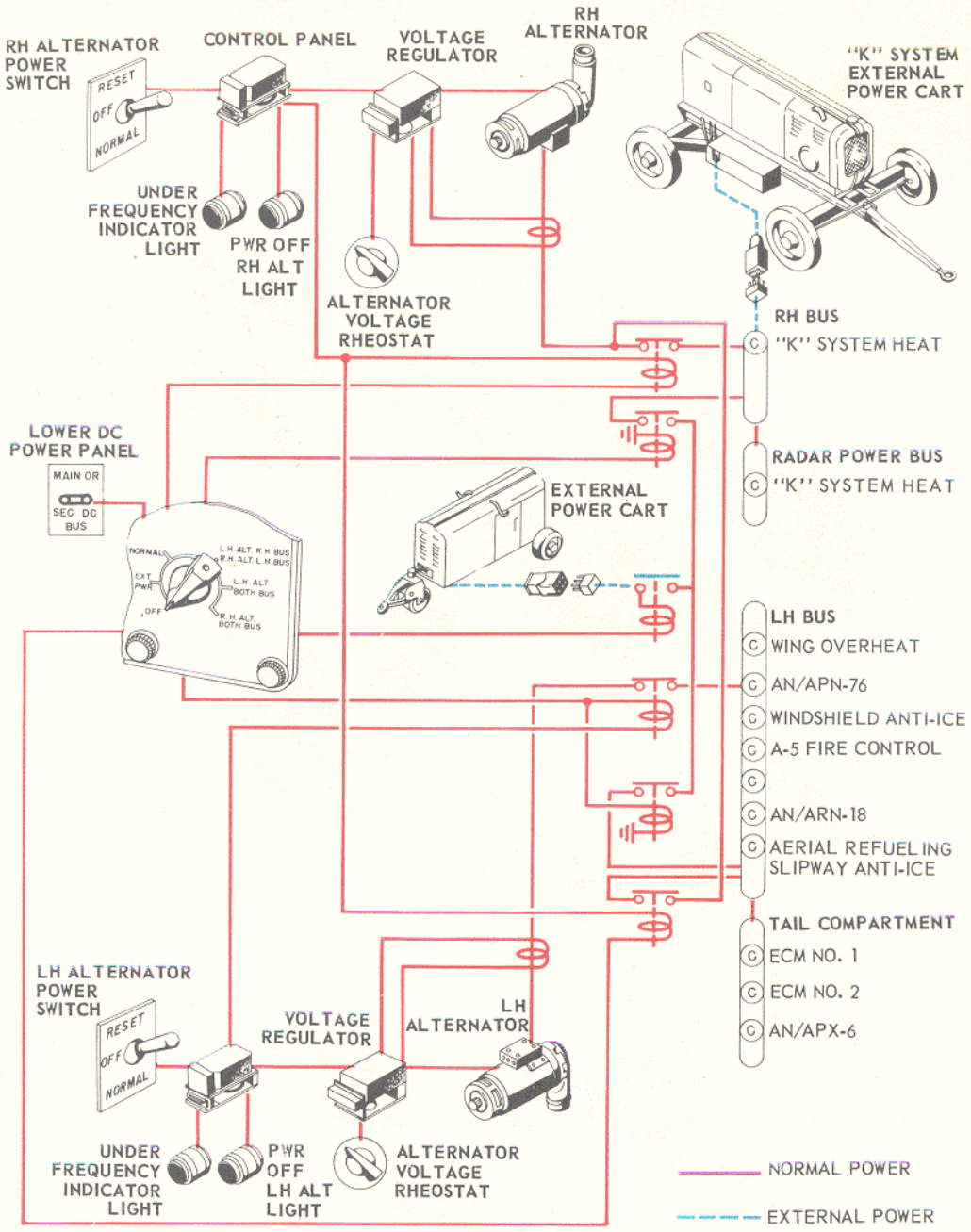


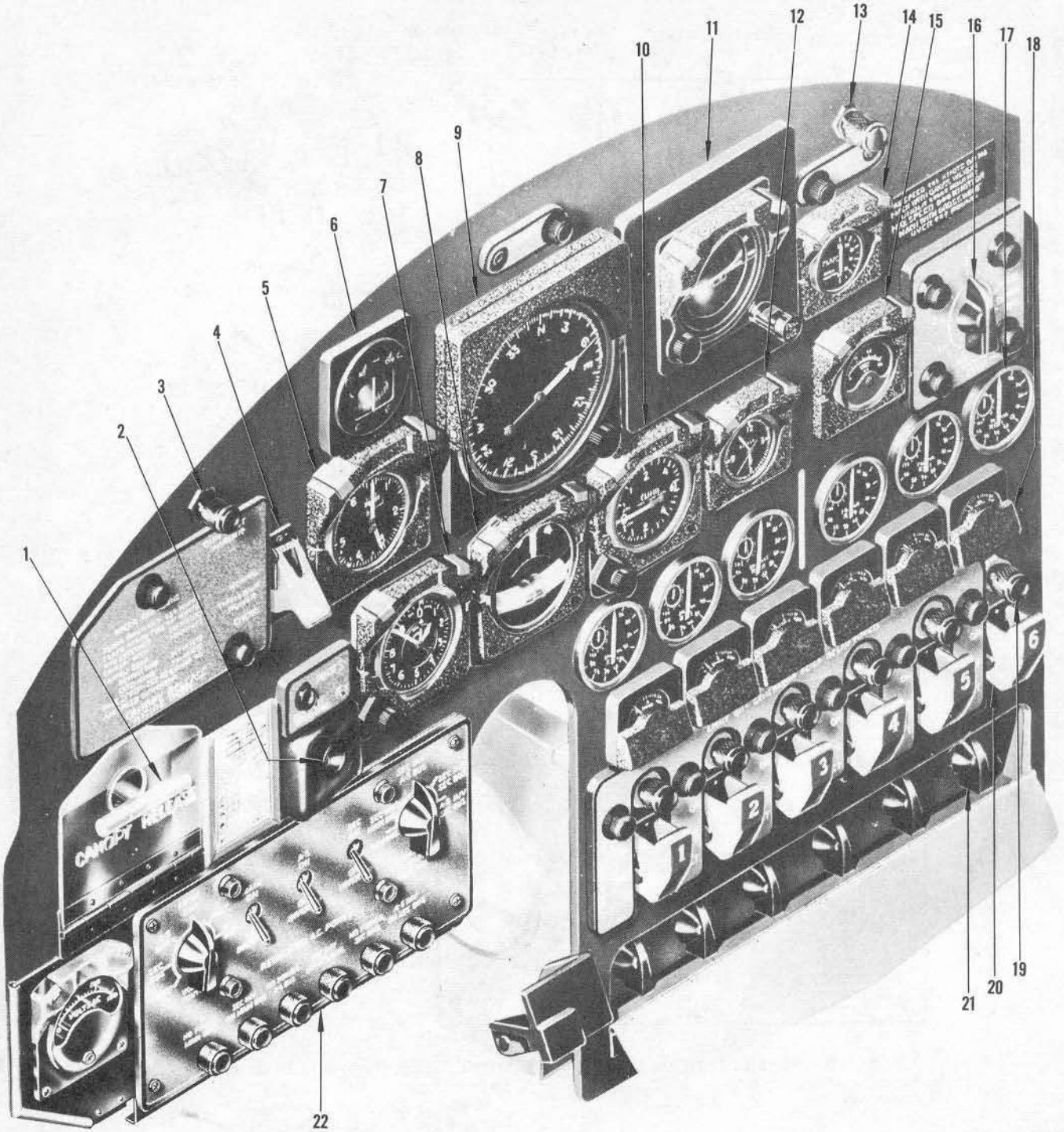
Figure 1-26. Unregulated AC Power Control, Generation, and Distribution

INSTRUMENT INVERTER SYSTEM INDICATORS.

INSTRUMENT INVERTER INDICATOR LIGHTS. Two lights (13 and 14, figure 1-9) on the pilot's instrument panel are provided for indications of main or spare instrument inverter power conditions. An amber light marked "Spare Inverter On Bus" will illuminate when the instrument bus is receiving power from the spare inverter. In case of under voltage failure of the main inverter, the red light will illuminate until change-over has been accomplished and then the amber light will illuminate. In case of overvoltage failure, only the amber light will illuminate. A red light (13, figure 1-27) on the copilot's instrument panel marked "Bus Power Off" will illuminate when no power is being supplied to the instrument bus.

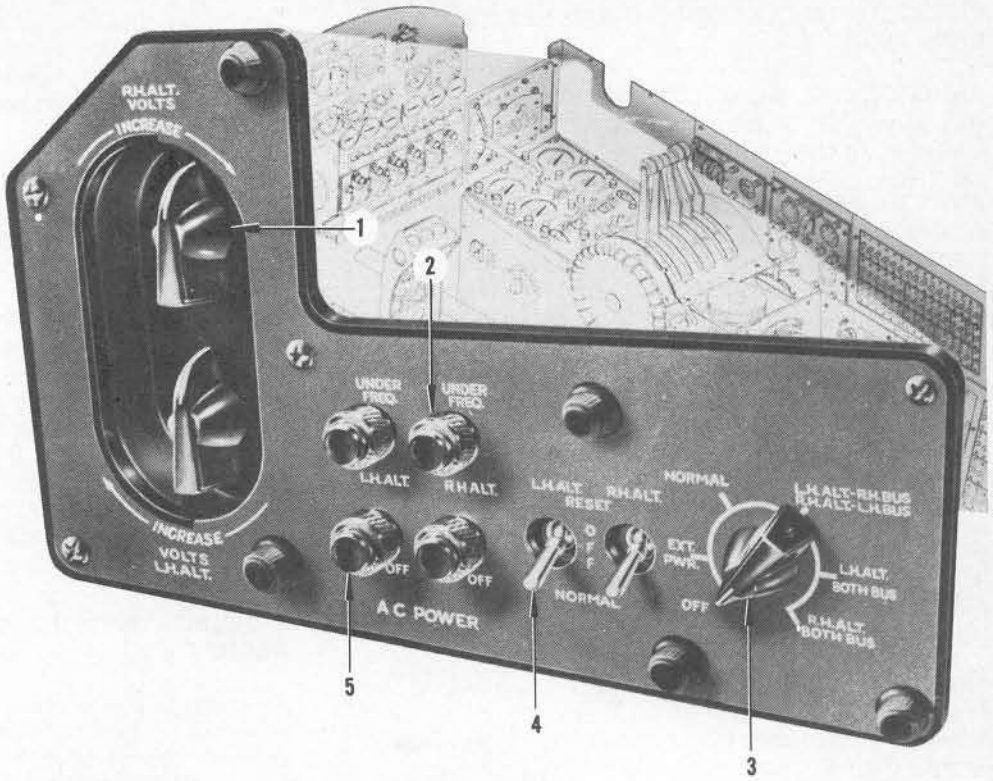
"K" SYSTEM INVERTER.

A three-phase inverter is provided for the "K" system stabilization unit. It is turned on or off by the "K" system function switch.



1 CANOPY EMERGENCY RELEASE HANDLE
2 OXYGEN WARNING LIGHT (PILOT'S)
3 GUN TARGET WARNING LIGHT
4 TURN-AND-BANK POWER SWITCH
5 MAXIMUM ALLOWABLE AIRSPEED INDICATOR
6 STANDBY COMPASS
7 ALTIMETER
8 TURN-AND-BANK INDICATOR
9 DIRECTIONAL GYRO
10 RATE-OF-CLIMB INDICATOR
11 ATTITUDE INDICATOR
12 CLOCK
13 INSTRUMENT INVERTER INDICATOR LIGHT
14 WING FLAP POSITION INDICATOR
15 DC VOLTMETER
16 DC VOLTMETER SELECTOR SWITCH
17 TACHOMETERS
18 DC LOADMETERS
19 GENERATOR FIELD TRIP WARNING LIGHTS
20 GENERATOR SWITCHES
21 GENERATOR VOLTAGE RHEOSTATS
22 REGULATED AC POWER PANEL

Figure 1-27. Copilot's Instrument Panel



1 ALTERNATOR VOLTAGE RHEOSTATS
2 UNDER FREQUENCY INDICATOR LIGHTS
3 BUS SELECTOR SWITCH
4 ALTERNATOR POWER SWITCHES
5 POWER OFF INDICATOR LIGHTS

Figure 1-28. Unregulated AC Power Panel

"K" SYSTEM INDICATOR LIGHT. A red indicator light on the observer's lighting panel (figure 4-12) marked "K-4 Inverter Power Off" will come on if the "A" and "C" phases of the three-phase "K" system inverter fail. If only the "A" or "C" phase fails, the light will not come on.

UNREGULATED ALTERNATING CURRENT SYSTEM.

Unregulated frequency 115-volt alternating current is supplied by two engine-driven alternators. The alternator driven by No. 1 engine normally supplies a left unregulated AC bus and the one driven by No. 6 engine normally supplies a right unregulated AC bus. The unregulated alternating current system (figure 1-26) supplies power for the aerial refueling deicing, windshield anti-icing, AN/APT-5A ECM equipment, AN/APX-6 IFF, AN/APN-76 rendezvous radar, AN/ARN-18 glide path approach control, A-5 fire control and "K" system components.

UNREGULATED ALTERNATING CURRENT SYSTEM CONTROLS.

BUS SELECTOR SWITCH. A rotary-type selector switch (3, figure 1-28) on the unregulated AC power panel has OFF--EXT PWR--NORMAL--LH ALT-RH BUS, RH ALT-LH BUS--LH ALT, BOTH BUS--RH ALT, BOTH BUS positions. This switch controls relays connecting alternator output to either bus or both buses. In OFF position, all power is disconnected from the buses. EXT PWR position connects the left- and right-hand buses to the AC external power receptacle. In NORMAL position, relays operate to connect No. 1 engine alternator output power to the left bus, No. 6 engine alternator output to the right bus and, if external power is connected to the airplane, No. 1 and 6 engine alternators are disconnected from the buses. LH ALT-RH BUS, RH ALT-LH BUS position operates relays to switch alternators to opposite buses. LH ALT, BOTH BUS position operates relays to disconnect the right-hand alternator and connect the left-hand alternator to both buses. RH ALT, BOTH BUS position operates relays to disconnect the left-hand alternator and connect the right-hand alternator to both buses.

ALTERNATOR POWER SWITCHES. Two alternator switches (4, figure 1-28) are provided on the unregulated AC power panel and are labeled RH ALT RESET--OFF--NORMAL and LH ALT RESET--OFF --NORMAL. The RESET positions reset the alternator control circuits if the alternator circuits have been tripped. The OFF positions disconnect the alternators from the buses. The NORMAL positions connect the alternators to supply unregulated AC power to their respective buses.

ALTERNATOR VOLTAGE RHEOSTATS. An "R.H. Alt. Volts" and an "L.H. Alt. Volts" rheostat (1, figure 1-28) are located on the unregulated AC power panel. Rotating either rheostat in a clockwise direction will increase the output voltage for the respective alternator. Conversely, rotating a rheostat in a counterclockwise direction will decrease the alternator voltage output.

UNREGULATED ALTERNATING CURRENT SYSTEM INDICATORS.

UNREGULATED AC VOLTMETER. The voltmeter (1, figure 1-22) on the regulated AC power panel is also used to check alternator voltage.

POWER OFF INDICATOR LIGHTS. Two amber indicator lights (5, figure 1-28) on the unregulated AC power panel illuminate whenever unregulated power fails to be delivered to the right or left unregulated AC buses. This power failure may be from the engine-driven alternators, an external power source during ground operation, or due to the operation of the alternator bus selector switch. The lights are marked "Pwr Off L.H. Alt." and "Pwr Off R.H. Alt."

UNDER FREQUENCY INDICATOR LIGHTS. An amber "Under Freq" indicator light (2, figure 1-28) is provided for each alternator marked "LH Alt" and "RH Alt." These lights will illuminate during alternator operation when engine rpm drops to below approximately 50.5%.

CIRCUIT BREAKERS AND FUSES.

Individual DC control circuit protection is provided by pull-push-to-reset circuit breakers on the co-pilot's upper and lower DC power panels (9 and 12, figure 1-19). If a circuit breaker trips, this thermal type of circuit breaker prevents the possibility of holding the circuit closed. To reset a circuit breaker, arm by pulling out on the stem and then push in to reset position. Most DC operated systems are controlled by two circuit breakers. A circuit breaker on the upper or lower DC power panel provides protection of a switch actuated circuit to a relay which, when energized, completes power circuits to the DC operated units. These power circuits are protected by circuit breakers in DC power shields. Current limiters for the DC power distribution system are in main power shields in the front wheel well and in other power shields throughout the airplane. AC circuits are protected by fuses in the main AC power shield (3, figure 1-30).

EXTERNAL AC AND DC POWER RECEPTACLES.

External AC and DC power receptacles (13, figure 1-46) are located on the lower left side of the fuselage aft of the front wheel well. The AC receptacle connects external AC power to the alternator power shield. A hinged access door is provided as a cover on each receptacle.

The DC power receptacle has two rows of contact pins. The top row provides a means for connecting an externally controlled current power cart to a start bus which is isolated from the normal airplane DC bus. The bottom row provides for connection of a regulated voltage from the same power cart to the normal airplane bus for internal airplane equipment which eliminates voltage surges within the airplane DC bus during engine starts. If a controlled current power cart is not available, a regulated voltage power cart will start the engines if connected to the start bus. The external bomb hoist attachment on these airplanes is provided power through the normal pins in the receptacle.

"K" SYSTEM EXTERNAL POWER RECEPTACLE.

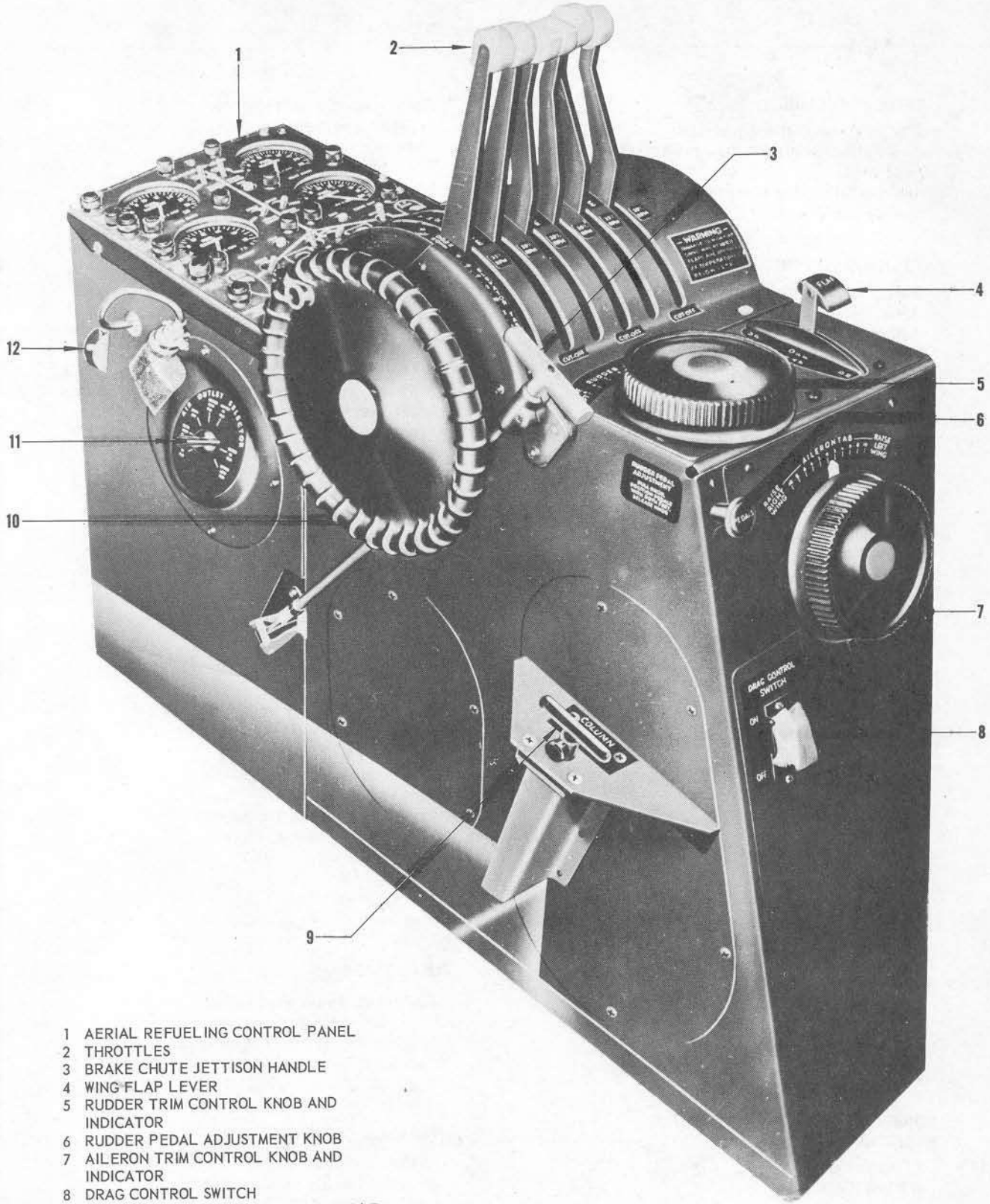
An external power receptacle and shield (21, figure 1-46) is provided for ground operation of the "K" bombing and navigation system. The receptacle is located just aft of the lower radar access door on the right side of the airplane. This receptacle is protected by an access door and mates with the "K" external power adapter cart plug to furnish single- and three-phase regulated and unregulated 115-volt AC power and 28-volt DC power to the shield. A ground blower is automatically energized, and relays in the shield prevent airplane bus power from being applied to the "K" system circuits when external power is connected.

A-5 FIRE CONTROL SYSTEM EXTERNAL POWER RECEPTACLE

An external power receptacle (32, figure 1-46) is provided for ground operation of the A-5 fire control system. The receptacle is located on the inner right side of the fuselage in the battery compartment. When the receptacle is mated with the plugs of the A-5 external power cart, unregulated AC, single- and three-phase regulated 115-volt AC power, and 28-volt DC power are furnished to the A-5 fire control system. Relays in the A-5 external power shield prevent airplane bus power being applied to the A-5 fire control system circuits when external power is connected.

HYDRAULIC POWER SUPPLY SYSTEM.

Power is supplied to various actuating units throughout the airplane by either a main or an emergency hydraulic system, (figure 1-32) except for certain surface power control systems, which utilize independent hydraulic systems. The main and emergency systems are normally operated at 3000 psi and are interconnected by a series of shuttle valves in such a manner that the affected actuating units will automatically be supplied by the emergency system in the event the main system pressure should fall below emergency system pressure. Manually operated service valves located in the crawlway are accessible in flight as well as for ground servicing. The valves have two labeled positions ON and OFF and are lockwired in the OFF position for all normal operation of the system. In some sections of hydraulic lines requiring intermittent flow (close and open pressure for canopy system, main and emergency pressure for aerial refueling system), hydraulic fuses are installed as a safety feature to seal off the line in the event a rupture should occur. These fuses will automatically close when a break in the downstream line allows more than the calibrated rate of flow (40 cu in./min), thus preventing the loss of an excessive quantity of hydraulic fluid.



1 AERIAL REFUELING CONTROL PANEL
2 THROTTLES
3 BRAKE CHUTE JETTISON HANDLE
4 WING FLAP LEVER
5 RUDDER TRIM CONTROL KNOB AND INDICATOR
6 RUDDER PEDAL ADJUSTMENT KNOB
7 AILERON TRIM CONTROL KNOB AND INDICATOR
8 DRAG CONTROL SWITCH
9 CONTROL COLUMN DISCONNECT HANDLE
10 ELEVATOR TRIM CONTROL WHEEL AND INDICATOR
11 AIR OUTLET SELECTOR KNOB
12 AERIAL REFUELING SYSTEM SELECTOR SWITCH

Figure 1-29. Copilot's Control Stand

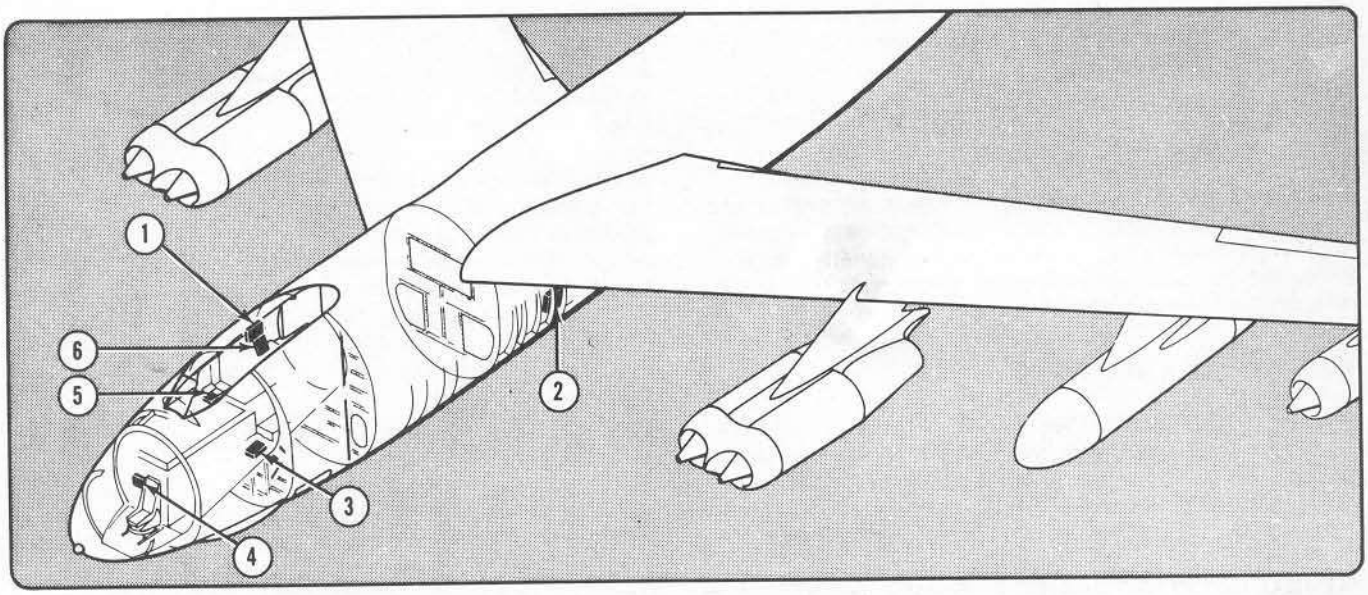
CIRCUIT	PANEL
AERIAL REFUELING	
Disconnect - normal and emergency	1
Fuel manifold scavenge - forward and aft	1
Signal amplifier, fire extinguisher	1
Slipway door control	1
ANTI-ICING SYSTEMS	
Engine and nacelle	6
Aerial refueling	6 and 2
Left and right ATO	6
Left and right pitot	6
Windshield	6 and 2
Wing, nacelle, empennage	6
Overheat - wing, empennage	6
Air temperature indicator	6
Overheat control	6 and 3
ATO SYSTEM	
ATO control and warning	1
Left and right ATO motors - aft, center and forward	6
AUTOMATIC PILOT	
Autopilot	6 and 3
BOMB SYSTEM	
Normal, indicator lights, and arming	4
BOMB DOOR	
Alternate system	4
Hydraulic stand-by	1
BRAKE SYSTEM	
Anti-skid and warning	1
CABIN HEATING, VENTILATING, AND PRESSURIZING SYSTEMS	
Cabin air temperature	6 and 3
Cabin air valves	6
Nose defrost	4
Windshield defrost	6
COMMUNICATIONS AND ASSOCIATED ELECTRONIC EQUIPMENT	
AF combat interphone	4
IFM and IFC	6, 4 and 3
Radar bombing, navigational and computing systems	4 and 3
Radar power panel	2
Radar pressurizing	4
Radio compass	4
Command radio	4
Radar warning	3
Emergency keyer	4
ELECTRICAL SYSTEM	
Alternator distribution	4 and 2
Alternator regulator, RH & LH	6
AC warning lights	1, 2 and 3
Alternator warning lights	2
Changeover relay - main bus and secondary bus	3
Instrument inverters	6 and 3
Inverter control - main, secondary, A-5, spare and warning	6
Inverter distribution - main, secondary	3
Three-phase inverter	3
Observer's ejection seat vertical control	4
FIRE CONTROL SYSTEM	
Turret control	3 and 6
FLIGHT CONTROL SYSTEM	
Directional damper	3 and 6
Flap control - emergency (primary and secondary motors)	1
Flap control - normal and warning	1
Surface control - rudder, elevator, ailerons	6
Surface power	5
Trim tab coordination	6
Wing flap motor heater control	6
FUEL SYSTEM	
Fuel control - main (engines No. 1, 2, 3, 4, 5 and 6), and warning	1
Fuel transfer and refuel - main and auxiliary	1
Wing tank jettison	1
HYDRAULIC SYSTEM	
Hydraulic oil quantity	1
Hydraulic stand-by control (emergency pump), and warning	1

NOTE—THIS CHART SHOWS ONLY THOSE CIRCUIT BREAKERS AND FUSES ACCESSIBLE IN FLIGHT.

Figure 1-30. Circuit Breaker and Fuse Locations (Sheet 1 of 2)

CIRCUIT	PANEL
INSTRUMENTS	
Auxiliary fuel indicators and indicator light	1
Flap position indicator	1
Fuel and oil pressure gages	3
Fuel gage transfer	1
Fuel quantity - main and bomb bay	3
Gyro - attitude, and directional	1 and 3
Hydraulic oil quantity	1
Hydraulic pressure gage	3
Landing gear position	1
Outside air temperature	6
Radio compass	4
Turn-and-bank - pilot's, copilot's	6
Voltmeter - regulated AC	3
Voltmeter - unregulated AC	2
LANDING GEAR SYSTEM	
Landing gear - main, outrigger	1
Landing gear - retraction, emergency	1
LIGHTING EXTERIOR	
Flash and steady position	6
Aerial refueling and wing illumination	6
Left and right landing	6
Navigation lights	6
Taxi	6

CIRCUIT	PANEL
LIGHTING INTERIOR	
Bomb bay and tunnel dome	6
Entrance and walkway	6
Instrument - fluorescent, red and spot	6
Panel - pilot's, copilot's, and observer's	6
Periscopic sextant	6
Press-to-test power	1
Table, headband, flood and compass	6
MISCELLANEOUS EQUIPMENT	
Camera	4
Fire detection	1
Food warming cup	6
Oxygen system	1
Vibrators - instrument panel	6
Suit heater - pilot's, copilot's, and observer's	6
Windshield wiper	6
POWER PLANT	
Engine screen control	6
Throttle and engine control	6
Water injection control	6
Oil and hydraulic fire shutoff	6
Engine stall prevention	6



1 UPPER DC POWER PANEL
2 UNREGULATED AC POWER SHIELD
3 MAIN AC POWER SHIELD
4 RADAR POWER PANEL
5 SURFACE POWER CONTROL PANEL
6 LOWER DC POWER PANEL

Figure 1-30. Circuit Breaker and Fuse Locations (Sheet 2 of 2)

MAIN HYDRAULIC SYSTEM.

A pressurized main system reservoir, installed in the forward wheel well, supplies hydraulic fluid to two engine-driven hydraulic pumps, one each at engines No. 3 and 4. Each pump delivers a fluid flow of 3 to 4 gallons per minute at 2600 psi, the flow decreasing to zero when the normal operating pressure of 3000 psi is attained. This pressure is maintained generally by means of a pressure regulator contained within the pump; however, a pressure relief valve, which allows the fluid to return to the reservoir at 3450 psi, is incorporated to guard against surge pressures. The return port of this valve closes when the pressure falls back to 3100 psi. Although the pump runs continuously, sufficient fluid is by-passed through the pump for necessary lubrication and cooling. Check valves in the pressure line from each pump prevent the output of one pump from entering the other pump in the event either should fail. A pressure release valve is located in each wing aft of engines No. 3 and 4. When the starter is energized, the pressure release valve will open to direct the pump output back into the pump supply line, thereby reducing the torque load on the engine starter. When the starter switch is released, the valve will close, allowing the pump to build up normal hydraulic pressure. A hydraulic fire shut-off valve is located in the wing adjacent to the pressure release valve. This fire shut-off valve will close when the corresponding fire shutoff switch on the pilot's instrument panel is pulled out, and will open when that switch is pushed back to its normal position.

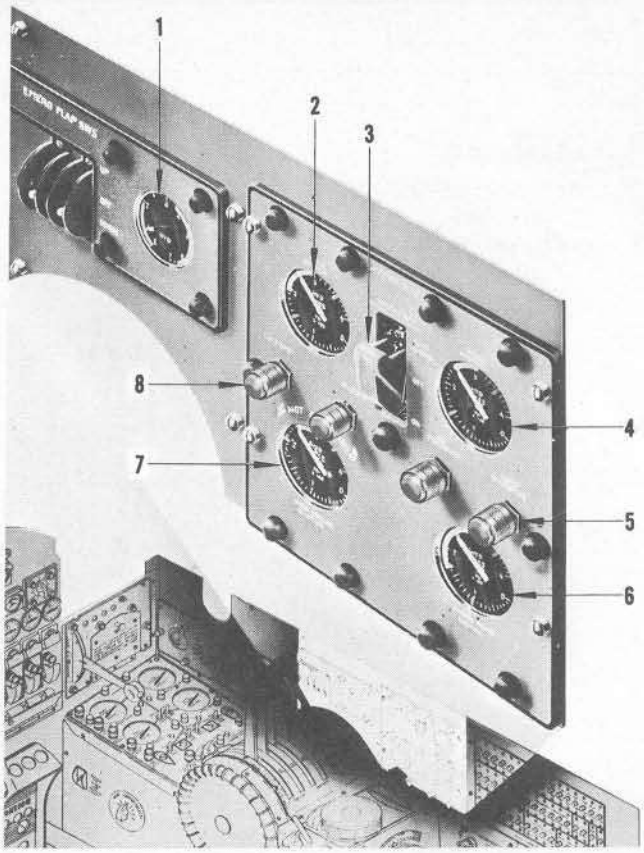
MAIN HYDRAULIC SYSTEM CONTROLS.

HYDRAULIC SERVICE VALVES. Manually operated service valves located in the crawlway are accessible in flight as well as for ground servicing. The valves have two labeled positions ON and OFF and are lockwired in the OFF position for all normal operation of the system. Opening the forward service valve opens the emergency lines to the main system lines. This allows the main hydraulic system to be energized with the emergency system pump for ground servicing or, in case of main system pump failure, eliminates the necessity of operating engines when functional tests and other ground operations are being performed on the main or emergency hydraulic systems. Opening the aft service valve opens the emergency lines to the return lines to bleed down emergency pressure thus depressurizing the emergency system.

MAIN SYSTEM INDICATORS.

MAIN SYSTEM PRESSURE GAGE. A pressure transmitter connected directly to the main system pressure line transmits electrically an indication of main system pressure to a main system pressure gage (2, figure 1-31) located on the hydraulic control panel.

HYDRAULIC FLUID QUANTITY GAGE. A fluid quantity gage (1, figure 1-31) located on the hydraulic control panel indicates the fluid level in the main system reservoir. The transmitter for this gage is located at the top of the reservoir and circuit protection is provided by a circuit breaker on the upper DC power panel. A fluid level sight gage is also provided on the main system reservoir in the forward wheel well. See figure 1-46.



1 HYDRAULIC FLUID QUANTITY GAGE
2 MAIN SYSTEM PRESSURE GAGE
3 EMERGENCY HYDRAULIC PUMP SWITCH
4 EMERGENCY SYSTEM PRESSURE GAGE
5 EMERGENCY HYDRAULIC PUMP INDICATOR LIGHTS
6 EMERGENCY BRAKE SYSTEM PRESSURE GAGE
7 MAIN BRAKE SYSTEM PRESSURE GAGE
8 MAIN HYDRAULIC PUMP WARNING LIGHTS

Figure 1-31. Hydraulic Control Panel

MAIN HYDRAULIC PUMP WARNING LIGHTS. A low-pressure warning switch is located in the pressure line from each engine-driven hydraulic pump. When either pressure falls below 950 (± 50) psi, the low-pressure warning switch for that pump will close, causing a warning light marked either "L.H. Pump Not Operating" or "R.H. Pump Not Operating" (8, figure 1-31) on the hydraulic control panel to illuminate.

EMERGENCY HYDRAULIC SYSTEM.

The emergency hydraulic system, through independent lines and an electrically driven pump, provides emergency pressure for most of those actuators served by the main system. The emergency pump is operated by a DC motor capable of 20 minutes continuous duty with a 35-minute cooling period. The pump motor is energized by a switch on the hydraulic control panel and a pressure switch installed adjacent to the pump in the front wheel well. The pressure switch contacts are normally open and will

close to start pump operation when the pressure drops to 2700 psi. When the pressure increases to 3000 psi, the switch opens the circuit to deenergize the control relay to stop pump operation. Fluid is supplied to the pump from an emergency hydraulic reservoir located in the forward wheel well. This reservoir is not filled directly, but receives overflow from the main reservoir when the main reservoir is more than approximately one-third full. Fluid flow is also automatically diverted to the emergency reservoir by the return selector valve at any time the main system pressure falls to 100 psi. The emergency reservoir is pressurized to approximately 13 psi by main reservoir pressurization and a connecting line. A check valve located at the inlet side of the emergency filter prevents reverse flow into the pump when the pump is inoperative. Another check valve at the inlet side of the emergency relief valve isolates the emergency brake accumulator in order that emergency brake accumulator pressure may be utilized only for emergency brake application. The emergency relief valve opens into the return line at 3450 psi and closes at 3100 psi.

EMERGENCY SYSTEM CONTROLS.

EMERGENCY HYDRAULIC PUMP SWITCH. A guarded AUTO NORMAL--OFF--ON switch (3, figure 1-31) spring-loaded to OFF, on the copilot's hydraulic control panel electrically controls the emergency hydraulic pump. When in AUTO NORMAL, the emergency pump maintains the emergency system pressure between 2700 and 3000 psi, as controlled by the pressure switch. Holding the switch in the ON position by-passes the pressure switch and allows the pump to build up the pressure to the maximum of 3450 psi before the relief valve opens. With the switch in the OFF position, the pump motor is deenergized. The emergency pump circuit breaker is located on the upper DC power panel (9, figure 1-19).

EMERGENCY SYSTEM INDICATORS.

EMERGENCY SYSTEM PRESSURE GAGE. A pressure gage (4, figure 1-31) is located on the copilot's hydraulic control panel to indicate the pressure available in the emergency system. The gage is electrically connected to a pressure transmitter located on the air-side of the emergency accumulator and will read accumulator pressure.

NOTE

Pressure readings below 1500 psi are accumulator air pre-load pressures. Below 1500 psi, the hydraulic system pressure will be zero.

EMERGENCY HYDRAULIC PUMP INDICATOR LIGHTS. Two emergency pump indicator lights marked "No Pressure" and "Pump Operating" (5, figure 1-31) are located on the hydraulic control panel to indicate pump operation and emergency system pressure condition. The circuit of the light marked "Pump Operating" is closed by a pressure switch at the time pressure builds up, thereby indicating that the pump is operating. The other light, marked "No Pressure," operates by a pressure switch in the emergency pump pressure line and causes the light to illuminate when emergency system pressure drops to 2200 psi.

FLIGHT CONTROL SYSTEMS.

Hydraulic pressure is employed as the primary means of actuating the control surfaces. Hydraulic actuation of the surfaces relieves the pilot of all control pressures, and artificial control pressure, or feel, is inducted in the power control system to simulate normal control feel. With power control on, hydraulic actuating units at the control surfaces are operated through a conventional cable control system. With power control off, this same cable control system operates the control surfaces directly, and the pilot is then aided by a balance action of the trim tabs, as well as an internal balance system on all control surfaces. (See "Control Surfaces Balance System," section VI.) In addition to the stabilizing action of the trim tabs and balance systems, directional stability at low to medium airspeeds is provided by a directional damper unit in the rudder control system. All control surfaces, are of course, operated automatically when the automatic pilot is engaged.

SURFACE POWER CONTROL SYSTEMS.

RUDDER-ELEVATOR SURFACE POWER CONTROL SYSTEM.

A surface power control system in the empennage supplies hydraulic pressure to operate the rudder and elevators. The system is entirely independent of the main and emergency hydraulic power supply systems and has a fluid reservoir, electrically driven pump, surface actuators, and controls. The system is operated by the pilot's and copilot's flight controls and by circuit breaker switches on a surface power control panel (1, figure 1-6) at the pilot's station. When the control surfaces are locked, the system is automatically deenergized.

AILERON SURFACE POWER CONTROL SYSTEMS.

A separate surface power control system (figure 1-34) in each wing supplies hydraulic pressure to operate the aileron on its side of the airplane. These aileron power control systems also operate the flaperons. Hydraulic pressure to operate each aileron is supplied by a dual hydraulic surface power control system which provides main and emergency pressure. For normal operation of the aileron surface power control systems, the airplane main hydraulic system pressure is utilized. A pressure reducer in each aileron system reduces main hydraulic pressure from 3000 to 1500 psi. Each aileron system incorporates a fluid reservoir and an electrically driven hydraulic pump as a means of supplying emergency hydraulic pressure. If, during normal operation, the aileron system hydraulic pressure drops to below 950 (± 50) psi, a pressure switch will automatically energize the emergency

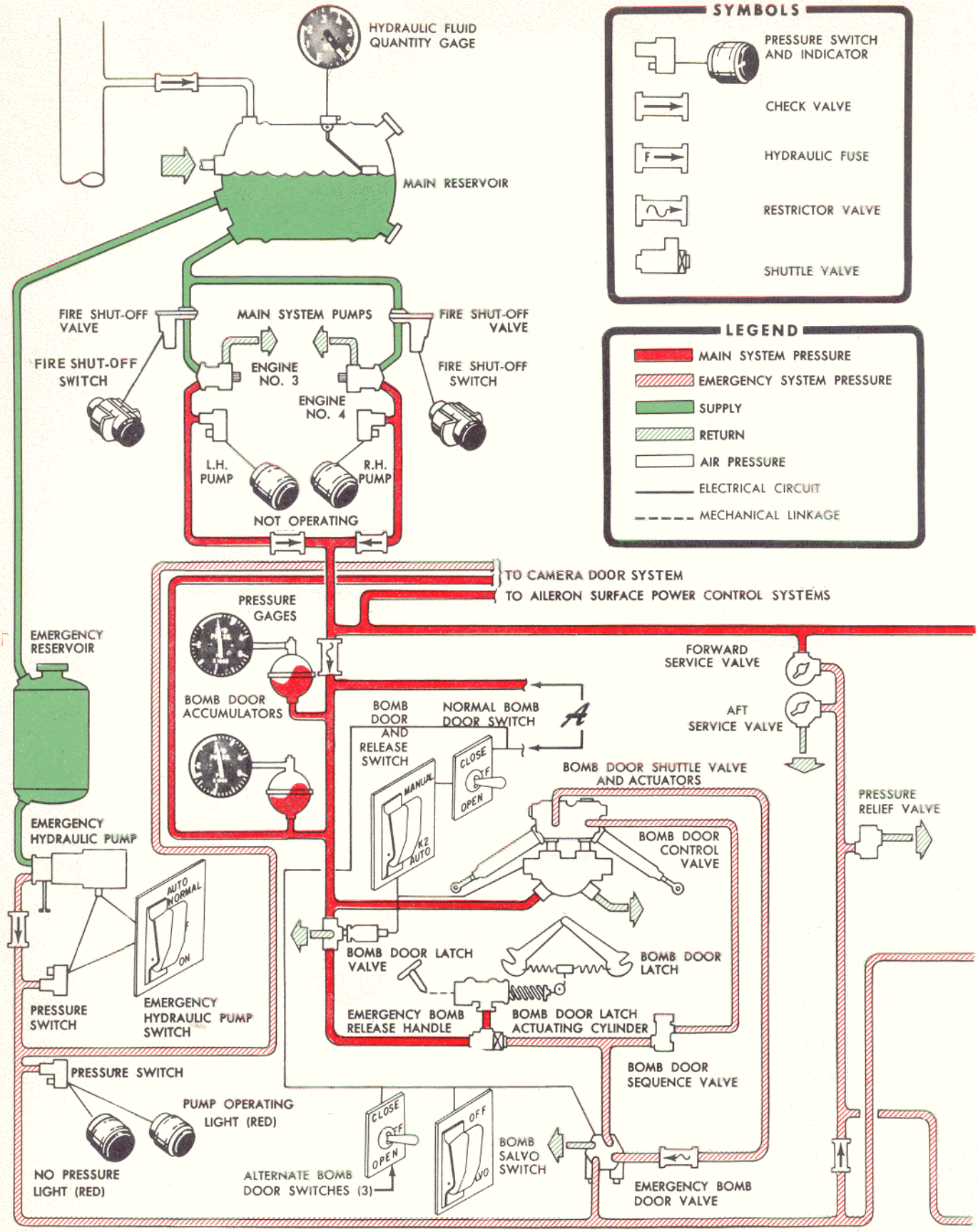


Figure 1-32. Hydraulic System (Sheet 1 of 2)

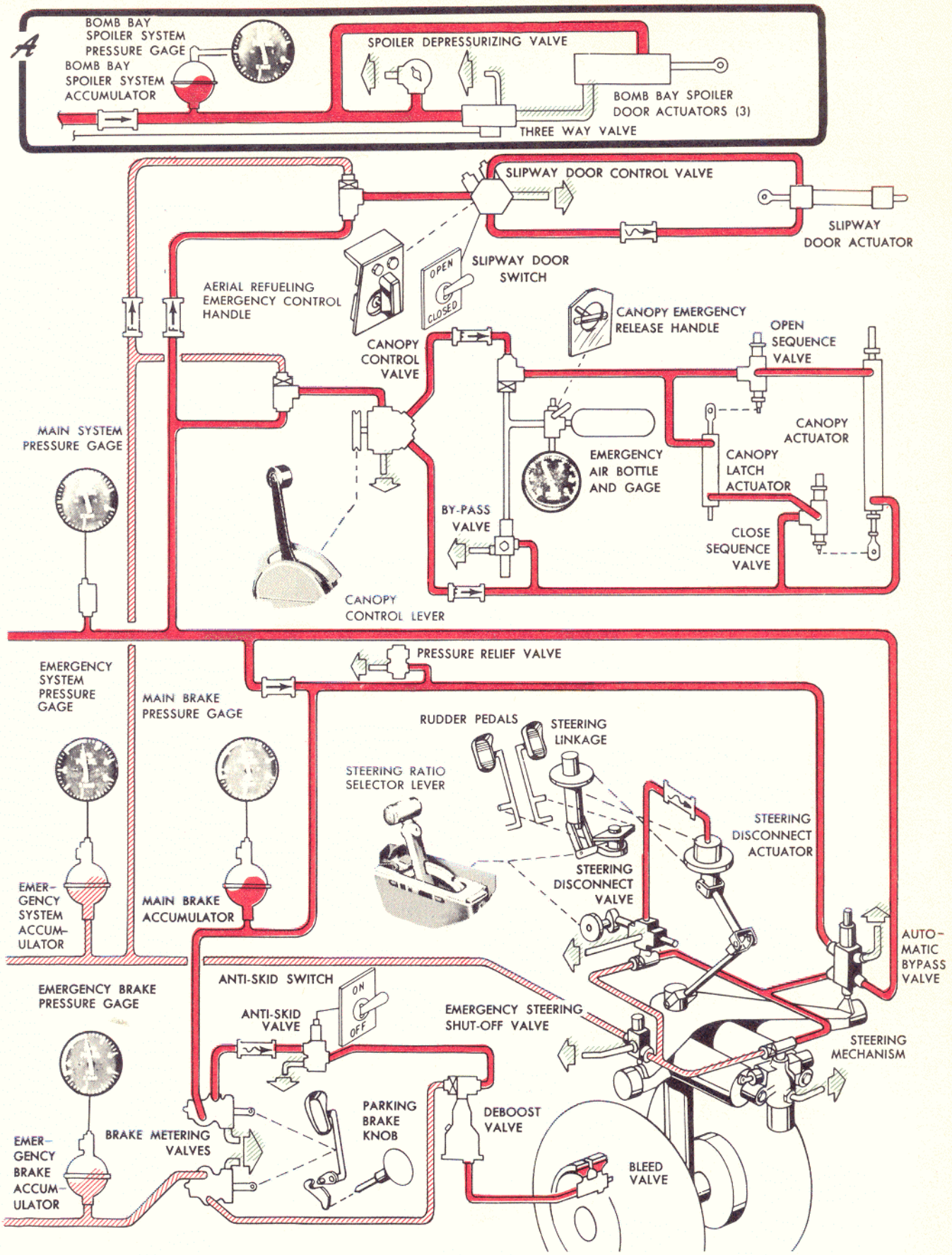


Figure 1-32. Hydraulic System (Sheet 2 of 2)

electric pump. When the emergency pressure exceeds the main pressure, a shuttle valve opens allowing emergency pressure to charge the system and simultaneously diverts return hydraulic fluid to the emergency system reservoir. The aileron surface power control systems are operated by the pilot's and copilot's flight controls and by two-position NORMAL--OFF switches on the surface power control panel. When the control surfaces are locked, the systems are automatically deenergized. An aileron surface power control emergency pump heater is provided on both left and right pumps to facilitate rapid starting and operation at low ambient temperatures. An automatic thermal switch on each of the emergency pumps will energize the heaters if the ambient temperature is below -6° (±5°) C (20° (± 8°)F) and power is on the DC bus. The pump heaters operate on 28-volt DC power. Circuit breakers protecting the heater circuits are on the nacelle compartment and are not available to the crew during flight.

SURFACE POWER CONTROL SYSTEM CONTROLS.

RUDDER-ELEVATOR SURFACE POWER CONTROL SWITCH. A NORM --OFF switch (2, figure 1-33) located on the surface power control panel electrically controls hydraulic pressure to operate the rudder and elevator. Positioning the switch to NORM energizes the rudder and elevator surface power control system. When the switch is placed in OFF, the system is de-energized and the control surfaces are operated manually. A circuit breaker for the surface power control circuits is located on the lower DC power panel.

AILERON SURFACE POWER CONTROL SWITCHES. Two NORM --OFF switches (5, figure 1-33), located on the surface power control panel, electrically control hydraulic pressure to operate the left aileron (and flaperon) and the right aileron (and flaperon). Positioning any one switch to NORM deenergizes a normally open control valve to supply main system hydraulic pressure (reduced to 1500 psi) to the selected surface power control system and energizes the control circuit to the system emergency pump. Positioning the switch to OFF electrically closes a control valve supplying hydraulic pressure to the selected surface power control system causing main system hydraulic pressure to be by-passed into the return line. The control surfaces must then be operated manually. Circuit breakers for the power control systems are located on the lower DC power panel.

SURFACE POWER CONTROL SYSTEM INDICATORS.

RUDDER-ELEVATOR SURFACE POWER CONTROL WARNING LIGHT. When hydraulic pressure in the rudder and elevator surface power control system falls below 350 (± 55) psi, the system is automatically ineffective, a low pressure DC warning light (1, figure 1-33) on the surface power control panel is illuminated, and the rudder and elevator must then be manually operated by the conventional cable system.

1 RUDDER-ELEVATOR SURFACE POWER CONTROL WARNING LIGHT
2 RUDDER-ELEVATOR SURFACE POWER CONTROL SWITCH
3 AILERON POWER OFF INDICATOR LIGHTS
4 AILERON EMERGENCY ON INDICATOR LIGHTS
5 AILERON SURFACE POWER CONTROL SWITCHES

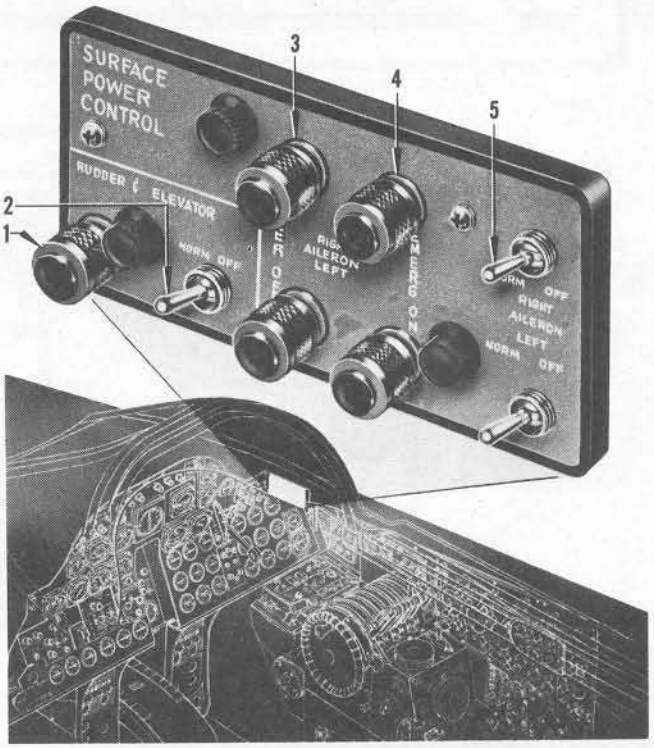


Figure 1-33. Surface Power Control Panel

AILERON EMERGENCY ON INDICATOR LIGHTS. Two amber indicator lights (4, figure 1-33), one for each aileron surface power control system, are on the surface power control panel. Each light is connected to the control circuit terminal of the respective electrically driven emergency hydraulic pump and, when illuminated, indicates that the emergency hydraulic pump is operating.

AILERON POWER OFF INDICATOR LIGHTS. Two red indicator lights (3, figure 1-33), one for each aileron surface power control system, are on the surface power control panel. Each light is connected to a hydraulic pressure switch located on the actuator side of the system control valve. When system hydraulic pressure falls below 350 (± 55) psi, the pressure switch causes the power-off light to illuminate and indicates lack of sufficient hydraulic pressure to operate the system. This light also remains illuminated when the respective aileron surface power control switch is placed in OFF.

AILERON SURFACE POWER CONTROL SYSTEM

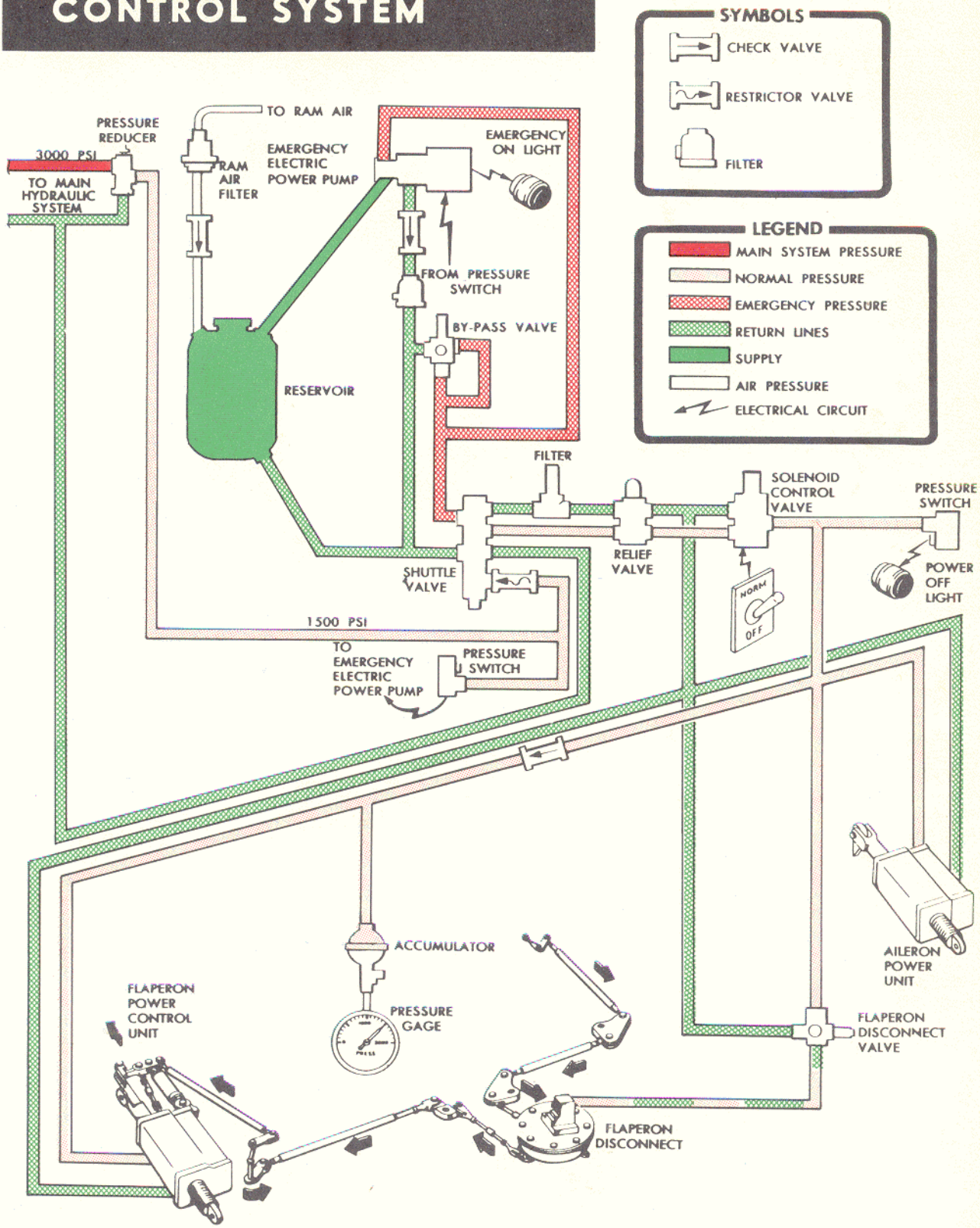


Figure 1-34. Aileron Surface Power Control System

CAUTION

- If both the red and amber lights for one aileron power control system are illuminated simultaneously, a leak in the aileron hydraulic system is indicated. The corresponding control switch should be placed in the OFF position to prevent loss of main system hydraulic fluid.
- Out-of-trim forces will be encountered when surface power control system fails.

TRIM CONTROL SYSTEM.

Trim tabs are provided on the control surfaces to facilitate trimming the airplane during flight with the surface power control system off. In addition, all trim tabs are linked to their respective control surface in such a manner as to move opposite to the direction of rotation of the control surface. This materially aids in the movement of the control surface by reducing the surface hinge moment.

Lateral trim is obtained through operation of a conventional trim tab in each aileron, while minor directional control for yaw conditions is accomplished by a rudder trim tab. The elevator contains two trim tabs. The right trim tab is operated by the pilot or copilot for normal elevator trim and by the automatic pilot during automatic pilot operation. The left tab operates automatically and mechanically with the extension or retraction of the wing flaps to partially compensate for the pitching tendencies during flap operation.

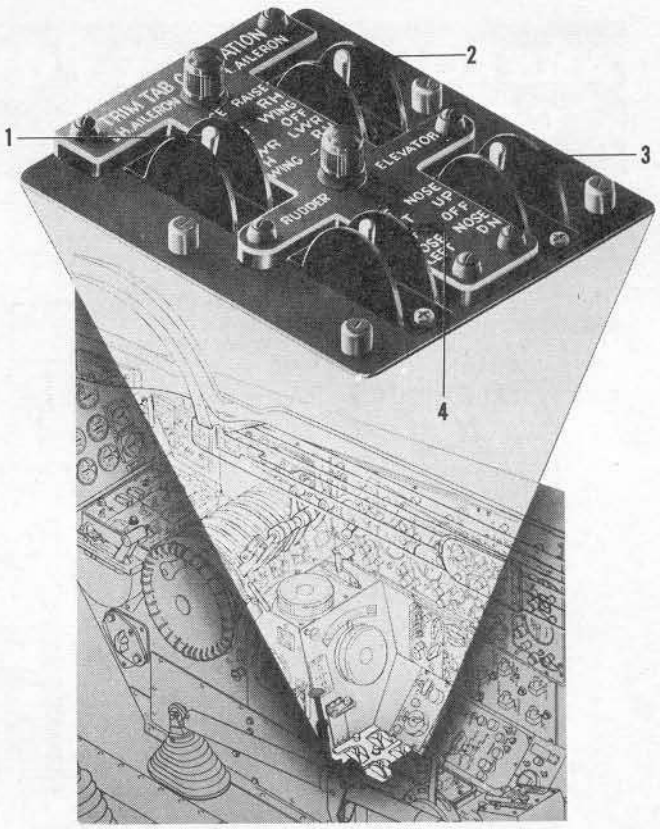
With surface power control on, trim tab surfaces have no effect on control surfaces due to surface power control system hydraulic pressure. Trim is accomplished by positioning the trim controls which reposition centering springs and Q-springs, moving the entire control surface to accomplish the trim. Trim tab surfaces are also moved to corresponding positions so if loss of power control occurs, no violent trim change will result.

TRIM CONTROL KNOBS AND INDICATORS.

Conventional trim control knobs and indicators are on the pilot's and copilot's control stands (8, 9, 18, figure 1-13 and 5, 7, 10, figure 1-29).

TRIM TAB COORDINATION SYSTEM.

In order to avoid excessive forces on the airplane structure in the event of surface power control failure, a trim tab coordination system is incorporated in the flight control system. The trim tab at each flight control surface can be positioned by means of an actuator driven by a DC motor operated by one of four momentary switches on the trim tab coordination switch panel (8, figure 1-7). On the first flight after repairs or adjustments have been made to the flight control system, a trim coordination procedure must be accomplished to establish a coordination between the position of the trim tab and the neutral position of the corresponding centering springs (for ailerons) and Q-springs (for rudder and elevator). Once trim coordination has been satisfactorily established, the actuator motor plugs should be disconnected from their power source receptacle and plugged into dummy receptacles adjacent to the actuators. In this manner, inadvertent trim changes are avoided.



1 LEFT AILERON TAB SWITCH
2 RIGHT AILERON TAB SWITCH
3 ELEVATOR TAB SWITCH
4 RUDDER TAB SWITCH

Figure 1-35. Trim Tab Coordination Switch Panel

TRIM TAB COORDINATION CONTROLS.

TRIM TAB COORDINATION SWITCHES. Four guarded momentary switches (1, 2, 3, and 4, figure 1-35) located on the trim tab coordination switch panel are provided for operation of trim tab coordination actuators. The left aileron tab switch has RAISE LH WING--OFF--LWR LH WING positions and the wing is lowered or raised by placing the switch in the appropriate position; a similar switch with RAISE RH WING--OFF--LWR RH WING positions is provided for the right aileron tab. The elevator

tab switch is marked NOSE UP--OFF--NOSE DN and the airplane nose is trimmed up or down by placing the switch in the appropriate position, or trimmed right or left by the rudder tab switch marked NOSE RIGHT--OFF--NOSE LEFT. When a switch is in OFF, the actuator controlled by that switch is de-energized. Circuit breakers for the trim tab coordination control system are located on the lower DC power panel.

NOTE

These switches are normally inoperative. In the event the trim tabs become out of coordination with the trim tab indicators, adjustment must be accomplished during a maintenance trim tab coordination control flight.

DIRECTIONAL DAMPER.

A directional damper system is provided to correct automatically any directional oscillating tendencies that might be encountered during flight operations. The system is controlled by a directional rate gyro installed in the right side of the bomb bay. When yaw conditions are encountered, a signal is supplied from the rate gyro to operate an electric motor connected to the rudder control rod. The telescoping rod is lengthened and shortened to move the rudder and correct the yaw tendency. This action does not affect and is not affected by the cockpit controls and takes place without the knowledge of the pilot and copilot. When the system is turned off, either by a switch or automatically at airspeeds above 350 knots IAS, the rudder control rod is locked in a fixed length and normal condition is restored.

NOTE

When the automatic pilot is operating with the rudder engage switch in ENGAGE, the directional damper is automatically disengaged.

DIRECTIONAL DAMPER CONTROLS.

DIRECTIONAL DAMPER SWITCH. A directional damper ON--OFF switch (41, figure 1-9) is on the pilot's instrument panel. Placing the switch in ON energizes the damper system; when the switch is OFF, the directional damper is inoperative. A circuit breaker for the directional damper is located on the lower DC power panel.

FLAPERONS.

The outboard flap on each wing operates as a conventional flap with the additional feature of rotating upward to supplement aileron action. The flaps must be fully extended and aileron surface power control operating to obtain flaperon action. Rotating an aileron upward from approximately 5° up to full up will result in the corresponding flaperon moving upward from 35° down to 10° down. Each flaperon is hydraulically actuated by the surface power control system that operates the corresponding aileron. Failure of an aileron power control system results in full extension of the corresponding flaperon to permit that flaperon to operate only as a conventional flap.

RUDDER PEDALS.

Both rudder pedals as a unit can be adjusted by pull knobs on the pilot's and copilot's control stands (10, figure 1-13 and 6, figure 1-29). When the knob is pulled out, the pedals spring to the aft position. When the pedals are moved to the desired position and the knob is released, the pedals are latched in place. Toe pressure on any of the four pedals will actuate all brakes during either normal or emergency braking. Fore and aft movement of the rudder pedals will actuate the rudder in flight or the front gear steering system on the ground, provided the steering ratio selector lever is in TAXI or TAKE-OFF, LAND The pedals are used to operate the rudder hydraulically with surface control power on the manually with power off.

CONTROL COLUMN AND WHEEL.

A conventional control column and wheel at the pilot's and copilot's stations are used to operate the ailerons and elevator through hydraulic pressure with surface power on and manually with power off. Either column can be mechanically disengaged and stowed in a forward position to facilitate movement into and out of the seat. A disconnect handle (14, figure 1-13 and 9, figure 1-29) disengages the control column when pulled approximately 1 1/2 inches to the full extended position and latched. The control column may be reengaged by unlatching it from the instrument panel, depressing the thumb button on the disconnect handle, and pulling the control column as far aft as possible. Engagement is automatic and the disconnect handle will return to the engage position.

CAUTION

Do not push the disconnect handle down when reengaging the control column as improper management will result in damage to the elevator disconnect rod assembly, which may result in dangerous flight conditions.

SURFACE LOCK LEVER.

A surface lock lever (6, figure 1-13) with LOCK and UNLOCK positions is located on the pilot's control stand. The control surfaces are locked by placing the lever in the LOCK position and operating the ailerons, elevator, and rudder until lock plungers seat and the surface controls cannot be moved.

Rudder and ailerons are locked in neutral and the elevator is locked full down. The surface lock lever mechanically prevents the throttles from being advanced beyond 35% rpm when the surfaces are locked. Neither can the surfaces be locked if any throttle is beyond 35% rpm. When the lock lever is in the LOCK position, the surface power control systems are electrically disconnected and are inoperable; with the lever in the UNLOCK position, all flight controls and the throttles are free to move and the surface power control systems can be energized.

CAUTION

To prevent damage to the throttle lock mechanism, throttles must be in CUTOFF before placing the surface lock lever in the LOCK position.

YAW STRING.

The strong interaction between aileron and rudder trim makes it important for the pilot to be able to detect small amounts of yaw. For this purpose, a yaw string (2, figure 1-4) is provided. The forward end of the string is attached to the forward end of the observer's escape hatch on the airplane centerline. The string is wrapped approximately 1 1/2 inches from the aft end to allow a tassel to form in order to stabilize the string during flight. A white line has been painted along the fuselage centerline directly forward of the pilot's windshield to provide a reference from which the amount of yaw may be determined. In normal flight, the yaw string lays along the white reference line, but any yaw will cause the string to move to the corresponding side of the reference line.

WING FLAP SYSTEM.

The wing flaps are designed to provide high lift and low drag, and to operate with a minimum of pilot attention. Primary and secondary motors, powered independently of the battery switch from the DC bus, drive the flaps by connection with a series of torque tubes. The flap motors provide fast flap extension (approximately 20 seconds) with both motors in operation, and a comparatively slow flap retraction (approximately 40 seconds) due to primary motor operation only. The slow retraction allows the airplane to accelerate before the flaps reach the full up position. Limit switches are provided to prevent over-running of mechanical stops. If the flaps are retracted to the 22.5% position before 195 (+ 3/-2) knots IAS is reached, a ram air pressure switch in the pitot system will open the flap retraction circuit and prevent further flap retraction until 195 (+ 3/-2) knots IAS is obtained; this prevents the airplane from settling due to insufficient lift. Landing gear squat switches deenergize the low speed warning and 22.5% stop retraction circuits to allow extension and full retraction of the wing flaps when the airplane is on the ground. To prevent an attempted take-off with flaps retracted, the warning horn will sound when all throttles are advanced to 50% rpm and the flaps are not fully extended. This circuit is energized by the squat switch and throttle-actuated microswitches. There is no provision for silencing the horn when all throttles are advanced above 50% rpm, flaps not full down, and the airplane is on the ground. The wing flaps also operate the left elevator trim tab mechanically. This coordinated flap-tab action provides automatic trim of the airplane under flight conditions to reduce the trim change resulting from flap extension.

CAUTION

The wing flap lever should be in OFF position before actuation of flap emergency switches. This will safeguard against sudden reversal and possible damage to flap drive motor.

WING FLAP CONTROLS.

WING FLAP LEVERS. The wing flaps are normally controlled by levers (7, figure 1-13 and 4, figure 1-29) on the pilot's and copilot's control stands. The handle on each lever is in the shape of a miniature airfoil to facilitate recognition. The pilot's wing flap lever has notched UP--OFF--DN positions. The copilot's lever has similar positions but is not notched. Both wing flap levers are interconnected and controllable from either station. When the lever is in UP, the flaps retract in approximately 40 seconds; when in DN, the flaps extend in approximately 20 seconds. The flaps are held in any intermediate position by placing the lever in OFF.

WING FLAP EMERGENCY SWITCHES. Two guarded DOWN--OFF--UP switches (3, figure 1-19) in front of the hydraulic control panel control the wing flap primary and secondary motors for emergency operation. These switches by-pass all limit, safety, and control lever switches. When either switch is placed in DOWN, both motors operate and extend the flaps in approximately 20 seconds. When emergency retraction is desired, either the primary or secondary motor is selected by moving the corresponding switch to UP. Placing one switch to UP retracts the flaps in approximately 40 seconds; placing both switches to UP retracts the flaps in approximately 20 seconds. When the flaps approach wither full-up or full-down position through actuation of the emergency switches, caution should be exercised so as not to overrun the mechanical stops. It is suggested that the emergency switches be released before either the full-up or full-down position is reached and then flap actuation be continued by intermittent actuation of the switches to either extreme position.

LOW SPEED WARNING SWITCH. A low speed warning switch (13, figure 1-14) on the pilot's switch panel has ON and OFF positions and is guarded to the ON

position. With the warning switch in the ON position, a ram air pressure switch in the pitot system will stop flap retraction at 22.5% down if the airspeed is below 195 (+ 3/-2) knots IAS. With the warning switch in the OFF position and the wing flap lever in the UP position, the flaps will retract completely regardless of airspeed. With the warning switch in the ON position, a warning horn will sound if the airplane airspeed drops to approximately 192 (± 3) knots IAS and the flaps are less than 20% down. Lowering the flaps beyond the 20% flaps down position, placing the warning switch in OFF position, or increasing airspeed above approximately 195 (+ 3/-2) knots IAS will silence the warning horn.

NOTE

The low speed warning switch should normally be left in ON position, as the OFF position not only silences the warning horn but also permits full flap retraction at dangerously low airspeeds.

WING FLAP INDICATORS.

WING FLAP POSITION INDICATORS. DC operated remote indicating wing flap position indicators (22, figure 1-9 and 14, figure 1-27) on the pilot's and copilot's instrument panels indicate flap position in percent of travel. A circuit breaker for the flap position indicators is located on the upper DC power panel (9, figure 1-19).

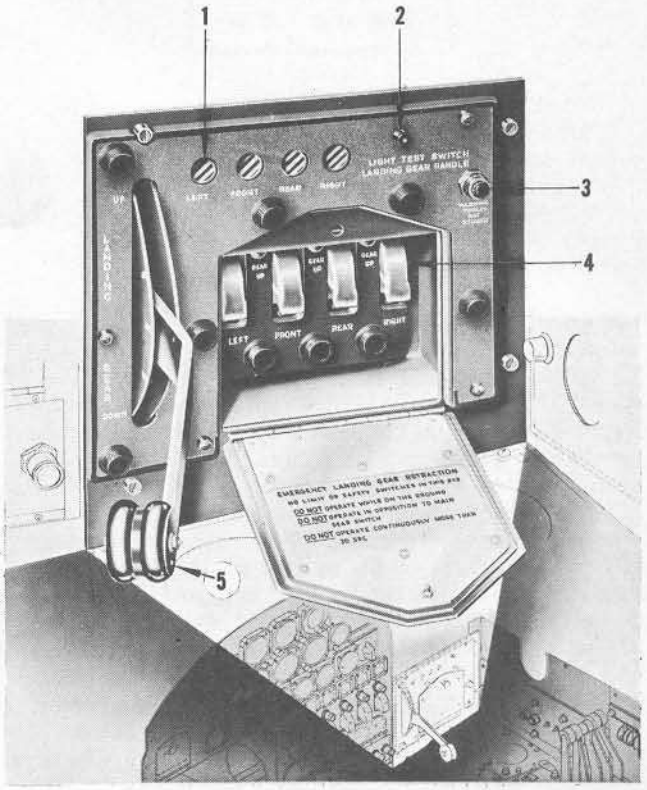
LANDING GEAR SYSTEM.

A DC motor-operated landing gear is provided which, in temperatures of -20° F to 120° F, will retract in approximately 11 seconds and extend in approximately 4 seconds.

NOTE

In the temperature range of -20° F and below, the extension time will be progressively greater. However, the maximum allowable time for these temperatures is 45 seconds.

Bicycle-type front and rear main landing gears are mounted on the fuselage centerline and retract forward and upward into the fuselage. Lateral supporting outrigger gears are mounted under and retract forward into the inboard nacelles. Steering control of the front main landing gear is hydraulically accomplished by movement of the rudder pedals. The outrigger gears are free-castering up to 28° inboard and 93° outboard. Full swiveling of the outrigger gears for ground handling is accomplished by manually removing the torsion link quick-disconnect pins on each outrigger gear. Two DC motors are provided for each main gear and one for each outrigger gear. Both main gear motors are energized during normal retraction and one during normal extension. The same motors are energized for emergency retraction through a hot wire electrical system which by-passes all safety and limit switches. Emergency extension of the landing gear is accomplished by a manually operated cable system which unlocks the gear and allows it to free fall. After free fall, complete extension and locking is accomplished by further actuation of the manually operated cable system.



1 LANDING GEAR POSITION INDICATORS
2 LANDING GEAR HANDLE LIGHT TEST SWITCH
3 TURRET NOT STOWED LIGHT
4 EMERGENCY RETRACTION SWITCHES
5 COPILOT'S LANDING GEAR LEVER

Figure 1-36. Copilot's Landing Gear Control Panel

The main landing gear wheel well doors are automatically opened and closed by the landing gear and have an electrically operated door latch which locks the doors in the closed position. These latches are released by solenoids when the landing gear lever is placed in the DOWN position. The door actuators, aided by a serrated brake, hold the wheel well doors in the open position. The brake consists of two pair of matching serrated plates. As the door approaches the full open position, the serrations are meshed together and held by a leaf spring attached to the fuselage structure, thus serving as an anti-buffeting device. The main gear wheel well doors hang open in a nearly vertical position when the landing gear is extended. When the forward main gear is retracted, the doors will open wider during the initial portion of their closing cycle. This is because of the geometric locations of the attaching points of the door actuating arms. The same is true during the later portion of the opening cycle of the forward landing gear wheel well doors. The outrigger doors hang open in a nearly vertical position when that gear is extended. These doors are actuated by a mechanical linkage driven by contact of the shock strut cylinder. To prevent buffeting the doors are locked open by an overcenter position of the actuators.

CAUTION

Prior to flight, the wheel well door-up latches should be inspected to make certain the door latch is in the unlatched position. If the latch is not in the unlatched position, the doors cannot be fully closed when the gears are retracted. Damage may result to the doors due to airloads at high speeds.

LANDING GEAR CONTROLS.

LANDING GEAR LEVERS. Interconnected UP--OFF --DOWN landing gear levers (30, figure 1-9 and 5, figure 1-36) are on the pilot's instrument panel and the copilot's landing gear control panel. Each position of the pilot's lever is fixed by detents. The copilot's lever is mechanically connected to the pilot's lever. When the levers are in the UP position, the landing gear will retract and the brakes will be applied automatically, provided the front wheels are centered and all wheels are off the ground. When the levers are in the DOWN position, the landing gear will extend and, when in OFF position the landing gear normal actuating circuits are deenergized. A landing gear solenoid lock (electrically actuated by the squat switch) prevents the normal landing gear levers from being moved to the UP position while the airplane is on the ground. Landing gear control circuit breakers are located on the upper DC power panel.

WARNING

The landing gear levers will be left in the DOWN position during take-off, landing, and ground operation in order to prevent inadvertent retraction of the gear on the ground.

LANDING GEAR EMERGENCY RETRACTION SWITCHES. The pilot can accomplish emergency retraction of all landing gears simultaneously by lifting a single guarded switch (11, figure 1-13) on the pilot's control stand. Individual emergency retraction of any main or outrigger gear can be accomplished by actuation of one of four guarded GEAR UP switches (4, figure 1-36) on the copilot's instrument panel. All landing gear emergency retraction switches will override the ground safety switches (squat switches) to cause retraction of the landing gear either on the ground or in flight.

CAUTION

The landing gear lever must be in the OFF position before emergency retraction switches are placed in the GEAR UP position. Retraction motors would be damaged or burned out if emergency switches were actuated to the GEAR UP position while the landing gear lever remained in the DOWN position.

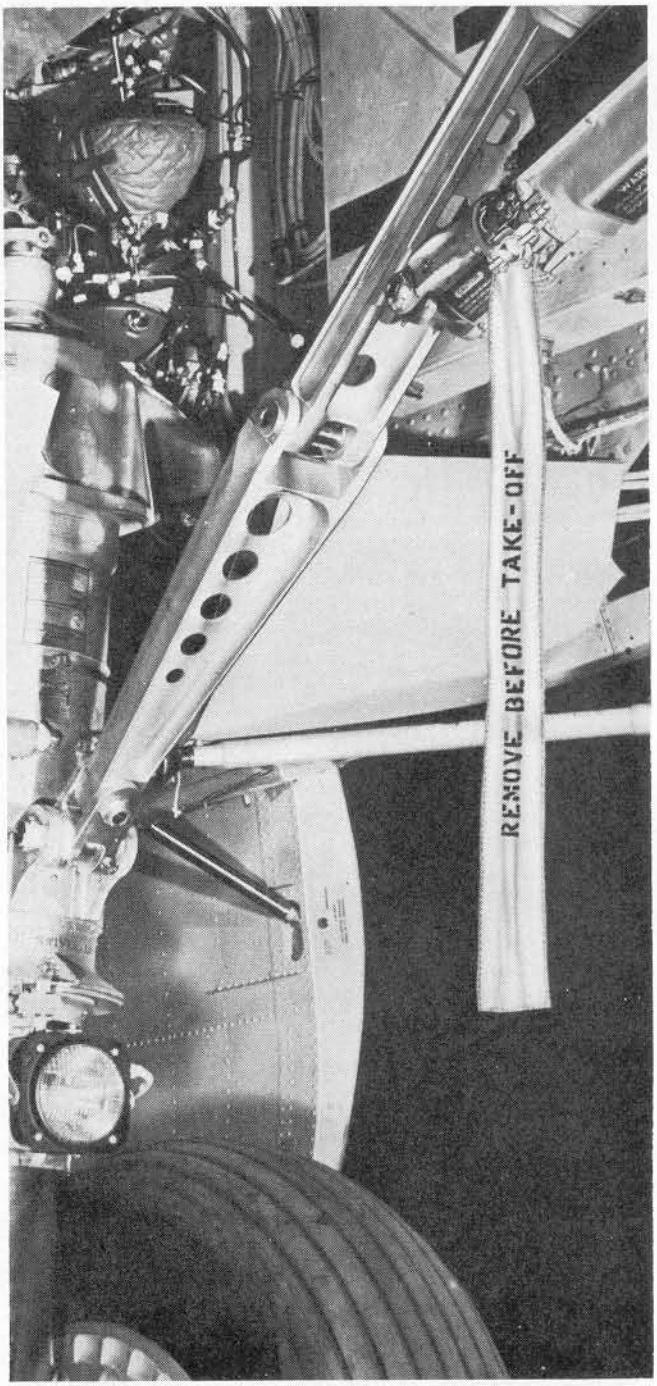


Figure 1-37. Forward Main Landing Gear Ground Lock

LANDING GEAR EMERGENCY EXTENSION LEVERS. Emergency mechanical extension of all landing gears is largely accomplished by means of gravity forces and is aided by air drag.

An emergency landing gear extension stand with a ratcheting lever (5, figure 1-36) for each landing gear is located at the aft side of the copilot's station. When these levers are ratcheted individually, the corresponding landing gear will be unlocked ant the gear will drop to or near the fully extended position. Further actuation of the ratcheting lever is required to fully extend and lock the gear. Actuation of the levers should be continued until there is a noticeable increase in the force required to pull the lever. When the landing gear is down and fully locked, an indicator light on the forward lower side of the extension stand will glow.

NOTE

When operating ratchet lever to unlock and release landing gear, use full strokes. As many as five full strokes may be necessary to release the up lock.

CAUTION

Allowing a ratchet lever to snap back is likely to result in severe damage to the emergency extension system.

DRAG CONTROL SWITCH. A two-position ON--OFF drag control switch (13, figure 1-13 and 8, figure 1-29) is located on the pilot's and copilot's control stands. Both switches are guarded and spring-loaded to the OFF position. When either switch is placed in the momentary ON position, both outrigger gears and the aft main gear will extend, causing additional drag. For the gear to be completely extended and locked in the full-down position, the switch must be held in the ON position until a down indication appears in the windows of the gear position indicators. The landing gear lever must be in the OFF position before the drag control switch will lower the gear

LANDING GEAR HANDLE LIGHT TEST SWITCH. A push-to-test switch (2, figure 1-36) located on the co-pilot's landing gear control panel is provided to test the light which is located in the pilot's and copilot's landing gear levers.

LANDING GEAR GROUND LOCKS. Inadvertent collapse of the forward and rear main landing gears is prevented by manual insertion of a shear pin type ground lock (figures 1-37 and 1-38) in a hole located in the lower end of each main landing gear retracting screw mechanism. Accidental collapse of the out-rigger gears is prevented by installing a strut type ground lock (figure 1-39) between a lug on the forward side of each outrigger gear strut assembly and a boss on each outrigger gear trunnion support. These locks are stowed just inside and forward of the camera access door located in the underside of the fuselage below the dorsal fin. See 14 and 15, figure 1-4.

LANDING GEAR INDICATORS

LANDING GEAR POSITION INDICATORS. Four DC operated tab window-type indicators (31, figure 1-9)

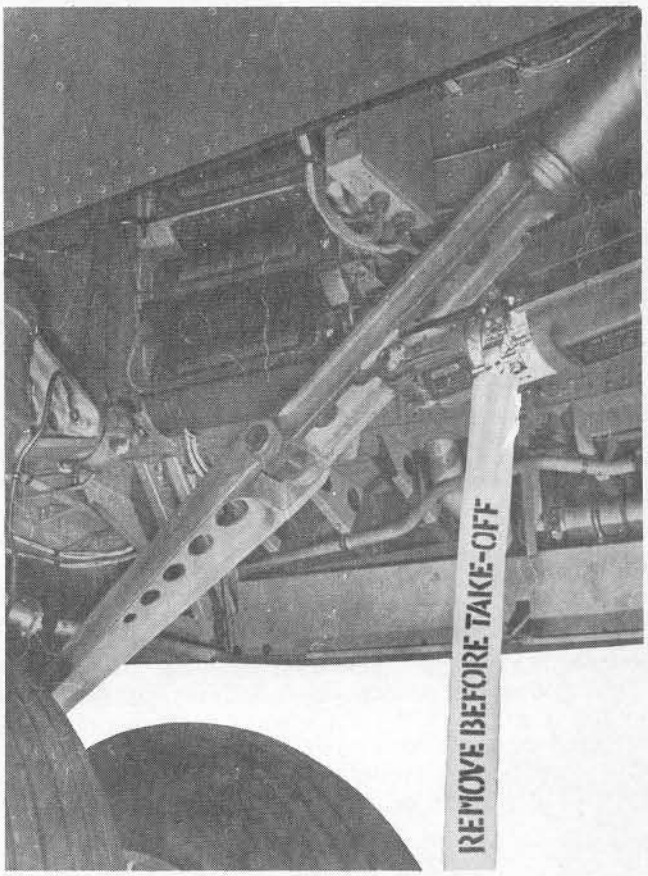


Figure 1-38. Rear Main Landing Gear Ground Lock

on the pilot's instrument panel and four identical indicators (1, figure 1-36) on the copilot's landing gear control panel show, by interchangeable tabs, the positions of the main and outrigger gears. When the outrigger gears are up and locked and the main gears are up and locked and the door latches in latched position, an UP tab will appear in the window. A gear in an intermediate position or a main gear door latch in an unlatched position will be indicated by a tab with slanting alternate red and white stripes; and a down and locked gear will be indicated by a tab showing a figure of a wheel.

LANDING GEAR INDICATOR LIGHTS. One set of lights including one red "unsafe to land" light and four green "gear down and locked" lights (7, figure 1-21) are on the emergency landing gear extension stand at the copilot's station. The red "unsafe to land" light is on at all times when any of the gears are not in "up and locked" or "down and locked" position. A red "unsafe to land" light is located in the tip of the pilot's and copilot's landing gear levers. Circuit breakers for the landing gear warning system are on the upper DC power panel (9, figure 1-19).

WARNING HORN. If any one of the landing gears is not down and locked when any throttle is retarded below 50% rpm, a landing gear warning horn will sound. A mechanical horn release knob on the pilot's control stand (16, figure 1-13) will silence the horn.

FRONT GEAR STEERING SYSTEM.

The front landing gear is steerable through a hydraulic control system operated by the rudder pedals. Hydraulic pressure is supplied by the main or emergency hydraulic system. When the landing gear is retracted, the front gear is automatically centered and the steering system is disconnected from the rudder pedals. Extension of the landing gear automatically aligns the front gear to correspond with the position of the rudder pedals after it has cleared the wheel well. Shimmy dampening is also provided by the hydraulic steering system.

FRONT GEAR STEERING SYSTEM CONTROLS.

STEERING RATIO SELECTOR LEVER. The front gear steering ratio selector lever (1, figure 1-13) on the pilot's control stand, when placed in the TOW position, actuates a hydraulic disconnect valve. The valve mechanically disconnects the rudder pedals from the front gear steering system. When the selector is in the TAXI or TAKE-OFF, LAND position, the rudder pedals are connected to the steering system in ratios best suited for these operations. TAXI allows a maximum wheel deflection of 60° right or left (a total of 120°) which will permit turning the airplane within an area 160 feet in diameter. TAKE-OFF, LAND position allows a maximum wheel deflection of 6° right or left (a total of 12°).

CAUTION

Do not place the steering ratio selector lever in TOW position at any time during flight since the plunger in the steering disconnect valve may stick and cause a malfunction in the steering system during landing.

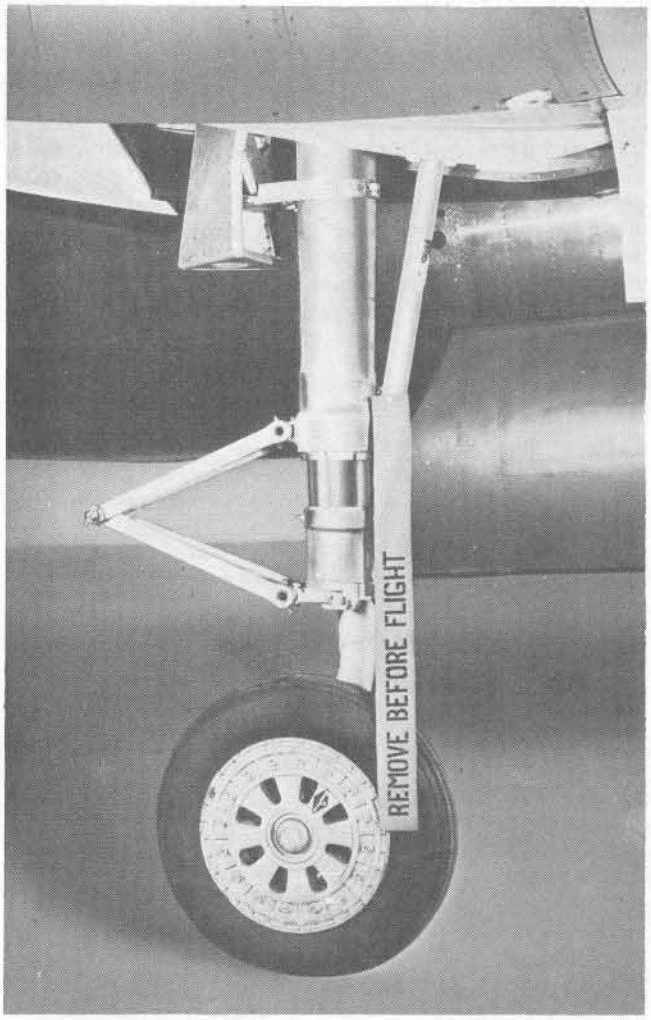


Figure 1-39. Outrigger Landing Gear Ground Lock

BRAKE SYSTEM.

Hydraulic pressure to operate the brakes is provided by the main or emergency hydraulic systems. Toe pressure on any one of the four rudder pedals will actuate brakes simultaneously on the front and rear main landing gears. Should the main hydraulic system fail, emergency brakes are applied by depressing the rudder pedals further than is normally necessary for normal braking. Retraction of the main gear automatically operates the brakes to prevent wheel rotation. The pilot's indication of automatic brake valve operation is a pitching movement of the airplane as the brakes are automatically applied. In the event of failure of the automatic brake actuation system and the gear is partially retracted, brakes should be applied gradually. Rapid application of brakes with gear in a partially retracted position can impose forces which would overload the retraction screw. An anti-skid system on each main gear wheel is available to relieve brake pressure when a skid is detected. The only difference between conventional braking and use of anti-skid is that, with anti-skid operative, the brakes can be applied earlier in the landing roll and maximum braking can be maintained without excessive tire wear due to skids.

BRAKE SYSTEM CONTROLS.

BRAKE LOCK KNOB. Parking brakes are set by depressing the pilot's left rudder pedal and pulling out a brake lock knob (45, figure 1-9) on the pilot's instrument panel.

ANTI-SKID SWITCH. An anti-skid ON--OFF switch (12, figure 1-14) on the pilot's switch panel controls the anti-skid system on both main landing gear wheels. Anti-skid is effective only in the main brake system. Emergency brake pressure by-passes the anti-skid valves.

BRAKE SYSTEM INDICATORS.

MAIN BRAKE SYSTEM PRESSURE GAGE. A remote indicating pressure gage (7, figure 1-31) on the hy-

draulic control panel is connected electrically to the air side of the main system brake accumulator. Normal main system brake pressure is 2000 to 3000 psi, see figure 5-1.

ANTI-SKID INOPERATIVE LIGHT. An amber light (10, figure 1-9) on the pilot's instrument panel will illuminate when the anti-skid switch is placed in the ON position; shortly thereafter it will go out and remain out. The light will show a steady signal when the anti-skid system on any one of the main wheels is inoperative. The design of the anti-skid system allows a certain amount of flashing of the light immediately after touchdown. This flashing actually indicates normal operation and is caused by the operation of the fail-safe relay within the system.

NOTE

A separate circuit breaker for the anti-skid indicator light circuit permits the light to illuminate to indicate an inoperative condition where a fault in the anti-skid system has tripped out the anti-skid circuit breaker.

EMERGENCY BRAKE SYSTEM PRESSURE GAGE. A remote indicating pressure gage (6, figure 1-31) on the hydraulic control panel is connected electrically to the air side of the brake accumulator. Emergency brake pressure is not available to the emergency brake metering valve until the pressure in the system has reached normal operating values as indicated on figure 5-1.

BRAKE CHUTE SYSTEM.

A 32-foot ribbon-type brake chute is installed in the aft section of the fuselage and can be deployed by either the pilot or copilot. The brake chute is provided as a means of applying large decelerating forces over the first part of the landing roll. It should not be deployed at speeds above 115 knots for normal operation or 125 knots in an emergency. Deployment at higher speeds may cause the brake chute to fail and result in material damage to the aircraft.

BRAKE CHUTE SYSTEM CONTROLS.

BRAKE CHUTE DEPLOYMENT HANDLES. Deployment handles (2, figure 1-6 and 1, figure 1-19) to open the brake chute are above the control stands at the pilot and copilot stations. The handles are connected by cables to the brake chute compartment, and a pull on either handle mechanically opens the chute compartment doors and deploys the chute.

CAUTION

To insure proper deployment of brake chute, pull deployment handle with an even steady pull to the full extent of its travel (approximately 4 1/2 inches). Hold momentarily at end of travel.

WARNING

Remain clear of brake chute compartment doors as doors are spring-loaded and open with considerable force.

BRAKE CHUTE JETTISON HANDLES. Brake chute jettison handles (17, figure 1-13 and 3, figure 1-29) are on the pilot's and copilot's control stands. Pulling either one of these handles through its full travel of approximately 5 1/2 inches after the brake chute has been deployed with mechanically jettison the brake chute. If the brake chute has not been deployed, actuation of either jettison handle will not jettison the brake chute.

CAUTION

To insure proper action of the jettison mechanism, pull jettison handle slowly through its full travel.

INSTRUMENTS.

Flight instruments are grouped in regulated alternating current, direct current, pitot-static, and miscellaneous classes.

REGULATED ALTERNATING CURRENT INSTRUMENTS.

Regulated alternating current instruments include gyro compasses and altitude indicators. Fuses for these instruments are in the main AC power shield (3, figure 1-30).

VERTICAL GYRO INDICATOR. A Type B-1 vertical gyro indicator (19, figure 1-9) is installed on the pilot's instrument panel and is operated by a Type K-4 remote vertical gyro control unit installed below the pilot's floor. The vertical gyro is fully aerobatic in that it is not limited by pitch or roll. The vertical gyro indicator system is supplied power by the instrument inverters through two fuses located in the main AC power shield and a circuit breaker on the upper DC power panel. Failure of either AC or DC power will deenergize the gyro system. When a power failure occurs or the system becomes deenergized, a flag within the indicator will appear. The flag will disappear in approximately 2 minutes after power is again restored to the system. The lower sensitivity limit of the turn error compensating mechanism in the K-4 remote vertical gyro is 40° per minute. Performance of turn maneuvers below this rate will result in turn errors seen on other conventional instruments. These errors can reach a maximum value equal to the angle of bank of the airplane. After the airplane has leveled out and is flying straight and level at constant speed, the error will be erected out at an erection rate between the limits of 3° or 6° per minute. Performance of turn maneuvers above 40° per minute will provide turn errors compensation.

The system is not compensated for fore and aft accelerations and errors at the rate of 3° to 6° per minute will be induced as a result of accelerations or decelerations.

WARNING

A slight amount of pitch error in the indication of the Type B-1A attitude indicator will result from accelerations or decelerations. It will appear as a slight climb indication after a forward acceleration and as a slight dive indication after deceleration when the airplane is flying straight and level. This error will be most noticeable at the time the airplane breaks ground during the takeoff run when using water injection and/or ATO. At this time, a climb indication error of approximately one and one-half bar widths will normally be observed; however, the exact amount of error will depend upon the acceleration and elapsed time of each individual takeoff. The erection system will automatically remove the error after the acceleration ceases.

ATTITUDE INDICATOR. A Type J-8 attitude indicator (11, figure 1-27) is installed on the copilot's instrument panel to provide that crew member with a constant visual indication of the flight attitude of the airplane in pitch and roll. The instrument has complete freedom through 360° of rotation about the roll axis and effective freedom of 360° about the pitch axis. The indicator may be caged manually by means of a gyro centering device operated by pulling the cage knob.

NOTE

The caging knob should not be pulled violently as damage to gyro may result. Repetitious caging and uncaging should be kept at a minimum and accomplished in flight only when flying straight and level.

The pitch attitude of the airplane is indicated with a range of 27° in climb or dive by displacement of the horizon bar with respect to the adjustable miniature airplane. When the airplane exceeds 27° 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.

The attitude of the airplane 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.

Because of acceleration forces acting on the erection mechanism of the attitude indicator during a normal airplane turn, errors in pitch and/or bank up to 5° may be noted upon return to straight and level flight. This "turn error" or "lag" will immediately begin to correct once true gravitational forces are sensed. If errors in excess of the aforementioned tolerance are encountered, the instrument should be replaced.

DIRECT CURRENT INSTRUMENTS.

Direct current instruments include turn-and-bank and outside air temperature indicators. Circuit breakers for these indicators are on the lower DC power panel (12, figure 1-19).

DIRECT CURRENT INSTRUMENT CONTROLS. A turn-and-bank power switch (4, figure 1-27) with NORMAL--EMERGENCY positions is located on the copilot's instrument panel. This switch when placed in the NORMAL position energizes the pilot's and copilot's turn-and-bank indicators from the airplane DC power bus when the battery switch is on. When the switch is placed in the EMERGENCY position, the indicators receive power directly from the airplane batteries regardless of battery switch position. The switch is guarded in the NORMAL position. Separate circuit breakers for the pilot's and copilot's turn-and-bank indicators are located on the lower DC power panel (12, figure 1-19).

PITOT-STATIC INSTRUMENTS.

The airspeed indicators, Machmeter, altimeters, and rate-of-climb indicators are connected to pitot-static sources.

NOTE

During bomb bay door operation, the airspeed, Machmeter, altimeter, and rate-of-climb instruments show erroneous readings. The airspeed indicator will read 5 knots low, altimeter will indicate 150 to 200 feet low, rate-of-climb indicator will read 1500 feet per minute descent and the Machmeter will read .02 low. All of the instrument errors noted above are approximate values and may vary under certain flight conditions.

MISCELLANEOUS INSTRUMENTS.

Accelerometer and magnetic compass indicators are self-operated and are thus independent of the airplane electrical or pitot-static systems.

NOTE

- The magnetic compass as installed may not have an accuracy of ± 5° as required.
- The present accelerometer installation is likely to give unreliable readings during coordinated banks and turns and should not be depended upon during these flight conditions.

INSTRUMENT PANEL VIBRATORS.

Due to the low vibration level of the airplane, instrument panels are not shock-mounted and vibrators are installed to induce sufficient vibration to prevent indicator points from sticking. A circuit breaker for the vibrators is on the upper DC power panel (9, figure 1-19).

EMERGENCY EQUIPMENT.

HAND-OPERATED FIRE EXTINGUISHERS.

A stored pressure chlorobromomethane-type fire extinguisher (12, figure 3-1) is installed on the walkway sidewall. A trigger-type handle located on top of the extinguisher permits the extinguisher to be operated by one hand.

WARNING

Fire extinguishing fluids are poisonous and fumes are extremely toxic. Go on 100% oxygen immediately as exposure to smoke and fumes must be avoided. When using extinguisher, apply only the minimum quantity of fluid necessary to control fire. The area should be ventilated as soon as possible after fire is extinguished.

EMERGENCY ALARM BELLS.

Emergency alarm bells are located on the pilot's floor beam immediately aft of the observer's seat and on the left side in the forward portion of the bomb bay. A guarded ON--OFF switch (18, figure 1-14) on the pilot's switch panel controls the bells. In the ON position, power is supplied directly from the battery to ring the bells. In the OFF position, the circuit is deenergized.

FIRST AID KITS.

An aeronautic first aid kit is installed on the left sidewall opposite and forward of the pilot's instrument panel; a blood plasma kit (5, figure 3-1) is installed on the left sidewall above the pressure door; and a battle splint and dressing kit (6, figure 3-1) is installed on the left sidewall opposite the copilot's seat.

EMERGENCY KNIFE.

An emergency knife (3, figure 3-1) is installed on the forward walkway sidewall.

HAND AXE.

A hand axe (2, figure 3-1) is installed on the forward walkway sidewall.

ANTI-EXPOSURE SUITS.

Anti-exposure suits (9, figure 3-1) are stowed on the left sidewall opposite the pilot's station and on the left sidewall aft of the copilot's station.

SURVIVAL KIT.

Space is provided in the bottom of each crew member's seat for a seat-type survival kit (4, figure 3-1). The survival kit may include a sleeping bag, life raft, tent, rifle-shotgun, rain coat, and many small items depending on the type of survival kit used for a particular mission.

The survival kit may be made an integral part of the parachute by stringing the leg straps of the parachute harness through the slots in the top of the survival kit. Some survival kits have snaps for attaching the kit to the accessory rings of the parachute harness.

OBSERVER'S EMERGENCY ESCAPE HATCH.

An emergency escape hatch is installed above the observer's seat ahead of the pilot's windshield. An emergency hatch release lever (2, figure 4-6) is located on the sidewall at the forward left corner of the hatch. Moving this lever inboard releases the latching dogs holding the hatch, enabling the observer to push the hatch clear of the airplane. The hatch can be released from outside the airplane by means of a pull-handle which is accessible through a small hinged door in the left side of the fuselage outboard of the hatch. Pulling this handle releases the hatch in the same manner as does the oberver's hatch release lever. A spring-loaded actuator raises the forward left side of the hatch, thereby exposing the edge of the hatch which provides a handhold for lifting the hatch from the airplane.

WARNING

The observer's emergency escape hatch is for emergency exit and entrance on the ground only and should not be used in flight. The release lever for the hatch is safety-wired in the locked position to prevent inadvertent release of the hatch.

OBSERVER'S DOWNWARD EJECTION HATCH.

A downward ejection hatch is installed in the floor of the observer's station beneath the observer's ejection seat. The hatch is provided to allow the observer's ejection seat to be catapulted downward out of the airplane. Jettisoning of the hatch is controlled by a D-ring handle on the ejection seat. A static line from the hatch to the seat catapult arms the catapult as the hatch is jettisoned, thereby preventing premature catapulting of the ejection seat before the hatch is jettisoned. An inspection window is provided in the observer's downward ejection hatch for visually checking the engagement of the hatch lock pin prior to flight.

CABIN PRESSURE RELEASE DOOR.

A cabin pressure release door, located in the right side of the fuselage at the pilot's station, is installed to permit emergency cabin depressurization. The door can be released from the pilot's, copilot's, and observer's stations by actuation of the left handgrip control on the pilot's and copilot's seats and the leg braces on the observer's seat. An electric switch installed on the door locking mechanism sounds the alarm bell as the door is jettisoned. An initiator attached to each of the three seats contains an ex-

plosive cartridge which supplies the required pressure to unlock the locking mechanism on the door, and cabin pressure then blows out the door.

BAIL-OUT SPOILER AIR BOTTLE.

An emergency air bottle (16, figure 1-46) located in the main entranceway furnishes pneumatic pressure for extending the bail-out spoiler when the bail-out control handle is pulled. A pressure gage located in the cabin entranceway indicates air pressure available for bail-out spoiler actuation.

CANOPY AIR BOTTLE.

An emergency air bottle (14, figure 1-46) located in the crawlway supplies pneumatic pressure for in-flight canopy jettisoning or ground canopy release. A pressure gage located on the left sidewall aft of the gunner's ash tray indicates air pressure available for canopy actuation.

ENTRANCE DOOR EMERGENCY ESCAPE PROVISIONS.

Emergency escape through the entrance door is facilitated by provision for mechanically jettisoning of the door and ladder and extension of a bail-out spoiler to deflect the airstream around the doorway. An entrance door bail-out control handle (22, figure 1-8) is located in the walkway just above the pressure door. Pulling this handle out approximately 14 inches accomplishes the following in the order named: releases entrance door safety strap, jettisons entrance door, jettisons ladder, unlatches bail-out spoiler, and opens a valve on a spoiler actuation air bottle to extend the spoiler. Once the entrance door is jettisoned and the spoiler extended, the differential pressure created makes it impossible to open the pressure door.

CAUTION

Pull the bail-out control handle with an even steady pull to insure proper sequence of operation.

When the pressure door is closed and locked, a pressure door locking pin extends into the entrance door bail-out control handle and prevents its use until the pressure door is manually unlocked and open.

NOTE

This arrangement does not eliminate the possibility of pulling the bail-out control handle prematurely, since the bail-out control handle can be pulled as soon as the pressure door is unlocked and starts to open. However, this arrangement does serve as a reminder that the pressure door must be unlocked and fully opened before pulling the bail-out control handle.

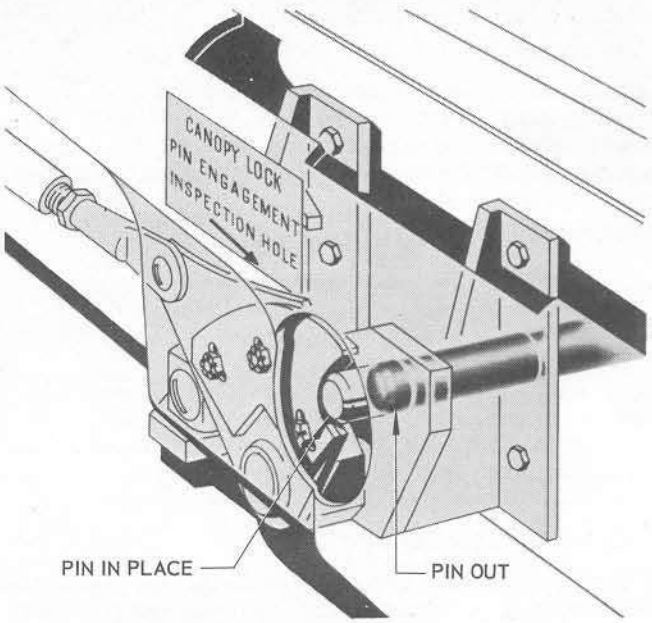


Figure 1-40. Canopy Lock Pin

WARNING

As the bail-out spoiler extends with considerable force, stand clear of area during any operational check of system.

PARACHUTE.

Provisions are made for the installation of an emergency chest pack parachute in the aft end of the crawlway (8, figure 3-1).

PARACHUTE STATIC LINES.

Parachute static lines for emergency bail-out of injured personnel are mounted on the wall above the pressure door (11, figure 3-1) and in the aft end of the crawlway (7, figure 3-1).

FIRE WARNING SYSTEM.

ENGINE FIRE WARNING. Thermally actuated fire detector units are mounted in the accessory section, airguide section, compressor section, and tailcone section of each engine nacelle and the nacelle strut of each inboard nacelle. Six red fire warning lights, one for each engine, are an integral part of the fire shut-off switches (17, figure 1-9) on the pilot's instrument panel.

When any one fire detector unit is thermally actuated, the warning light for the affected engine is illuminated. Two engine fire warning circuit TEST--NORMAL switches (2, figure 1-11), the left switch for engines No. 1, 2, and 3 and the right for engines No. 4, 5, and 6, are on the fire warning test panel.

When a switch is in TEST position, illumination of the warning lights indicates that the warning light circuits have continuity. When a switch is in NORMAL position, the circuits are armed for fire warning and, as a safety factor in the event of an open circuit or wire breakage, an alternate circuit for each engine is connected to the fire detector units through the switches. A circuit breaker for the fire warning lights is on the upper DC power panel (9, figure 1-19).

WING AND EMPENNAGE OVERHEAT WARNING LIGHTS. Two red lights (1, 2, figure 1-9) are installed on the pilot's instrument panel. One light is labeled "Wing Overheat" and the other "Empennage Overheat." When an overheat condition (200° F) is detected by either a left or right wing thermal switch or an empennage thermal switch, the affected warning light will be illuminated. Wing and empennage NORMAL--TEST overheat warning circuit test switches (1, figure 1-11) are located on the fire warning circuit test panel. These switches are spring-loaded to the NORMAL position. When either switch is placed in the TEST position, illumination of the affected warning light indicates that the warning light circuit continuity is satisfactory. When the switches are in the NORMAL position, the circuits are armed for overheat warning.

CANOPY CONTROL SYSTEM.

The canopy can be opened or closed while on the ground by hydraulic pressure supplied from the main or emergency hydraulic system.

NOTE

If the canopy fails to open or close after actuation of the canopy control lever while the airplane is parked, operation of any part of the hydraulic system will allow the canopy to resume normal operation. Usually application of the brakes is sufficient.

A canopy air bottle is provided which pneumatically opens and releases the canopy, allowing removal from the airplane by ground personnel. A lock assembly used to hold the canopy positively in the open position during ground operation is stowed on the walkway step near the copilot's station.

The canopy can be opened during flight at airspeeds below 215 knots IAS.

The canopy may be jettisoned in flight to accommodate emergency seat ejection bail-out of pilot and copilot. Canopy jettisoning is automatically initiated by seat ejection controls prior to ejection of pilot's or co-pilot's seat. The canopy may also be jettisoned by separate manual control, independent of seat ejection.

CANOPY CONTROL SYSTEM CONTROLS.

CANOPY CONTROL LEVER. A canopy control lever (6, figure 1-7) on the right side of the pilot's station has CLOSE--OFF--OPEN positions. When the lever is placed in CLOSE, the canopy is closed and latched hydraulically. When the lever is in OPEN, the canopy is unlatched and opened hydraulically. The lever is left in CLOSE at all times.

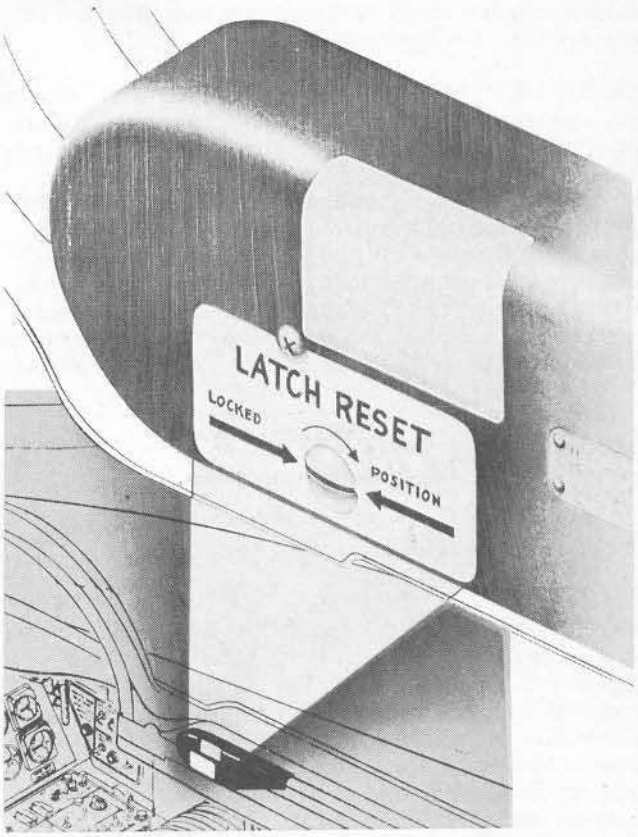


Figure 1-41. Canopy Roller Lock Indicator

WARNING

Do not unlock or open canopy while cabin is pressurized because canopy may release and travel an unpredictable path causing damage to equipment and injury to personnel.

CANOPY LOCK LEVER. A canopy lock lever (7, figure 1-6) on the right side of the pilot's station has LOCKED--UNLOCKED positions. Placing the lever in the LOCKED position extends the locking pins "in place" (figure 1-40), locking the canopy latches. Placing the lever in the UNLOCKED POSITION retracts the locking pins, permitting the canopy to be opened. The lever prevents the canopy latches from unlatching and must be unlocked before canopy control lever is moved to OPEN or to CLOSE position.

A canopy lock pin inspection hole (4, figure 1-19) is located in the canopy guard rail on each side of the copilot's station. By visually checking this hole, the

copilot can determine if the canopy lock pins are out or in place. See figure 1-40.

CANOPY EMERGENCY RELEASE HANDLES. Canopy emergency release handles are on the pilot's and copilot's instrument panels (44, figure 1-9 and 1, figure 1-27) and on the outside of the airplane on the left side of the fuselage just ahead of the pilot's windshield. Pulling out a handle approximately 12 inches mechanically disconnects the canopy actuating mechanism, removes the lock pin from the latches, and opens an air bottle. Pneumatic pressure unlatches and opens the canopy and the canopy is then free to be lifted manually from the airplane.

WARNING

The canopy emergency release is for emergency release on the ground only. Do not use in flight.

CANOPY EMERGENCY JETTISON HANDLE. Canopy emergency jettison handles (13, figure 1-8 and 8, figure 1-20) are located on the left canopy sidewall opposite the pilot's and copilot's stations. Pulling the handle out mechanically retracts the canopy lock pins, disconnects the canopy actuating mechanism, and opens an air bottle. Pneumatic pressure inserts a hinge pin at the aft end of the canopy, unlatches the canopy, and actuates air jacks which push the front of the canopy up into the airstream. As the canopy is lifted up into the airstream, the hinge pin releases allowing the canopy to jettison. Static lines attached to the canopy pull out safety pins in the pilot's and copilot's seat ejection catapult, readying seat ejection triggers for firing. This sequence of operation prevents seats from being ejected before canopy is jettisoned.

WARNING

Do not jettison canopy while in the open position since the canopy hinge will not engage the hinge pin and the canopy will travel an unpredicted path. This will endanger the pilot and copilot since there is a possibility of being incapacitated by the unguided jettisoned canopy.

NOTE

Depressurize cabin before attempting to jettison canopy with canopy emergency jettison handle. There is a possibility that the canopy latches may fail to release when the cabin is pressurized. A maximum of 12 seconds may be required for depressurization to take place.

CANOPY GROUND LOCK. A lock is provided for securing the canopy in the open position while the airplane is on the ground. The lock (27, figure 1-4) is stowed at the aft end of the walkway to the left of the copilot's seat.

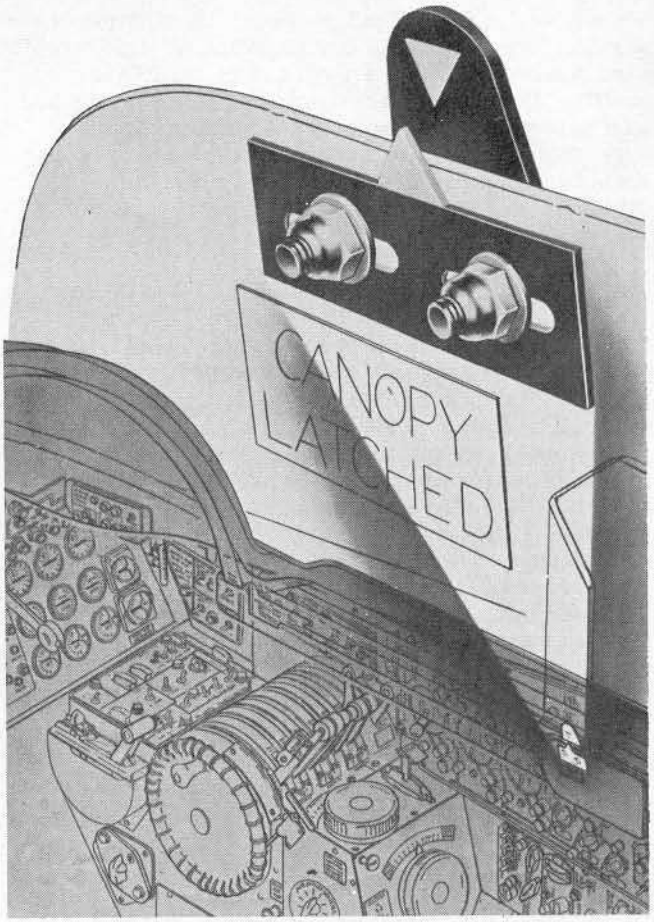


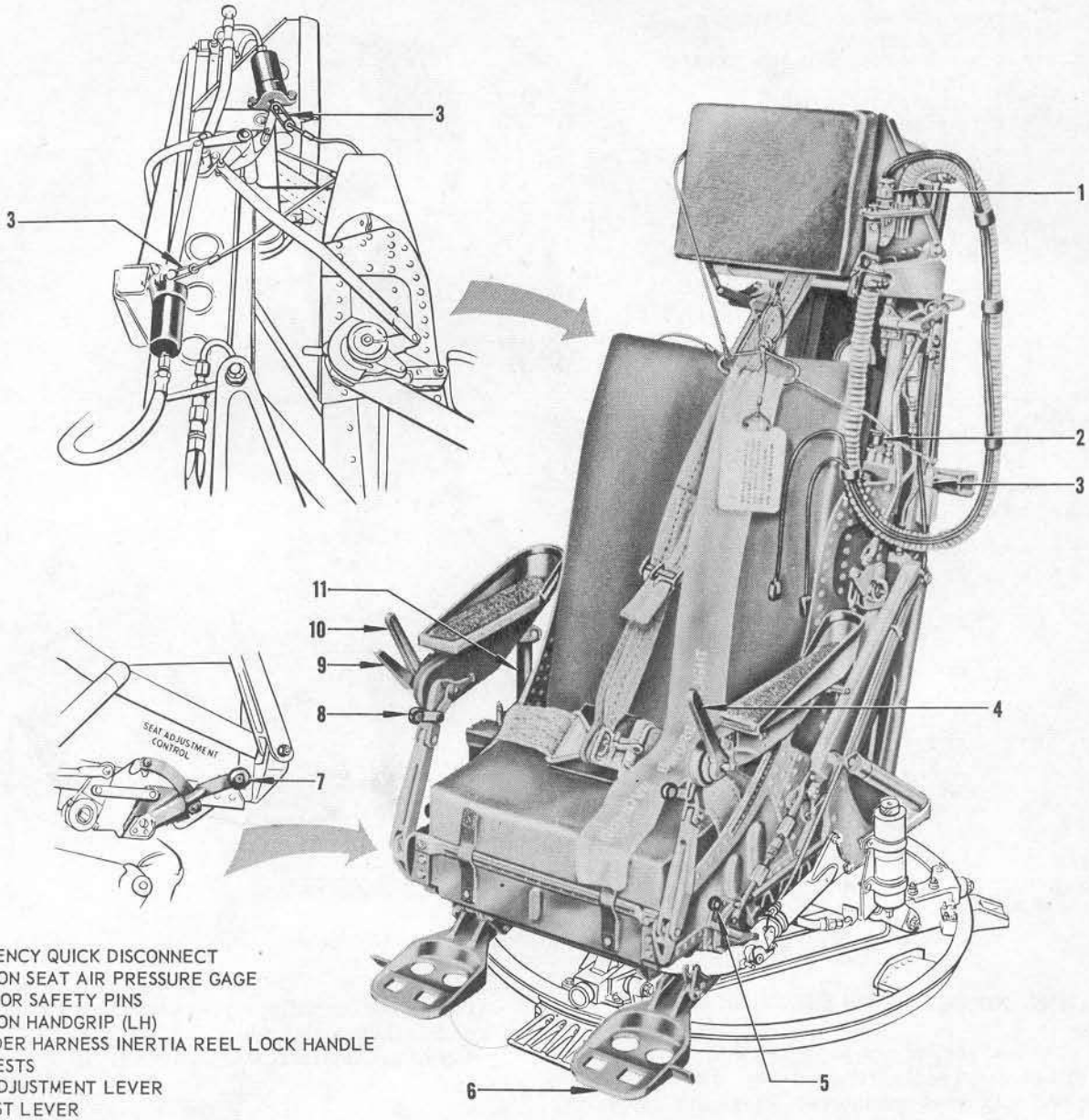
Figure 1-42. Canopy Latch Indicator

CANOPY CONTROL SYSTEM INDICATORS.

CANOPY ROLLER LOCK INDICATOR. A roller lock indicator (figure 1-41) is provided to permit a visual check of the position of the forward roller lock. This lock is installed to permit the canopy to be detached from the airplane for replacement or maintenance purposes only and should be in the LOCKED POSITION at all other times.

WARNING

Check that the canopy roller lock indicator is in the LOCKED POSITION (horizontal) prior to each flight. If a flight were made with the roller unlocked (vertical), the canopy could release in flight if opened, travel an unpredictable path, and strike the pilot and copilot, thus incapacitating them.



1 EMERGENCY QUICK DISCONNECT
2 EJECTION SEAT AIR PRESSURE GAGE
3 INITIATOR SAFETY PINS
4 EJECTION HANDGRIP (LH)
5 SHOULDER HARNESS INERTIA REEL LOCK HANDLE
6 FOOTRESTS
7 SEAT ADJUSTMENT LEVER
8 ARMREST LEVER
9 CATAPULT FIRING TRIGGER
10 EJECTION HANDGRIP (RH)
11 SEAT TILT AND ROTATION HANDLE (COPILOT'S SEAT ONLY)

Figure 1-43. Pilot's and Copilot's Ejection Seat

CANOPY LATCH INDICATOR. A canopy latch indicator (figure 1-42), located on each side of the canopy guard rail at the pilot's station, provides the pilot with an additional means of visually checking the canopy for being closed and latched. A decal marked "Canopy Latched" is located beneath the indicator. For the canopy to be in the latched position, the pointer on the canopy latch arm must align with the canopy latch indicator.

CANOPY AIR BOTTLE PRESSURE GAGE. A pressure gage on the left sidewall aft of the gunner's ash tray indicates air pressure available for emergency canopy jettison or canopy ground emergency release actuation.

EJECTION SEATS.

Catapult-type ejection seats are installed at all crew stations. The seats are normally used as standard seats. However, in emergencies, they provide an effective and expedient means for bail-out at all speeds. Each seat accommodates a back-type parachute and survival kit or seat cushion and is equipped with a conventional safety belt and shoulder harness. Footrests and headrests are provided with each seat to aid the crew member in maintaining proper posture during ejection. Each seat has an emergency quick-disconnect plug containing electrical and oxygen connections which automatically release at the time of ejection.

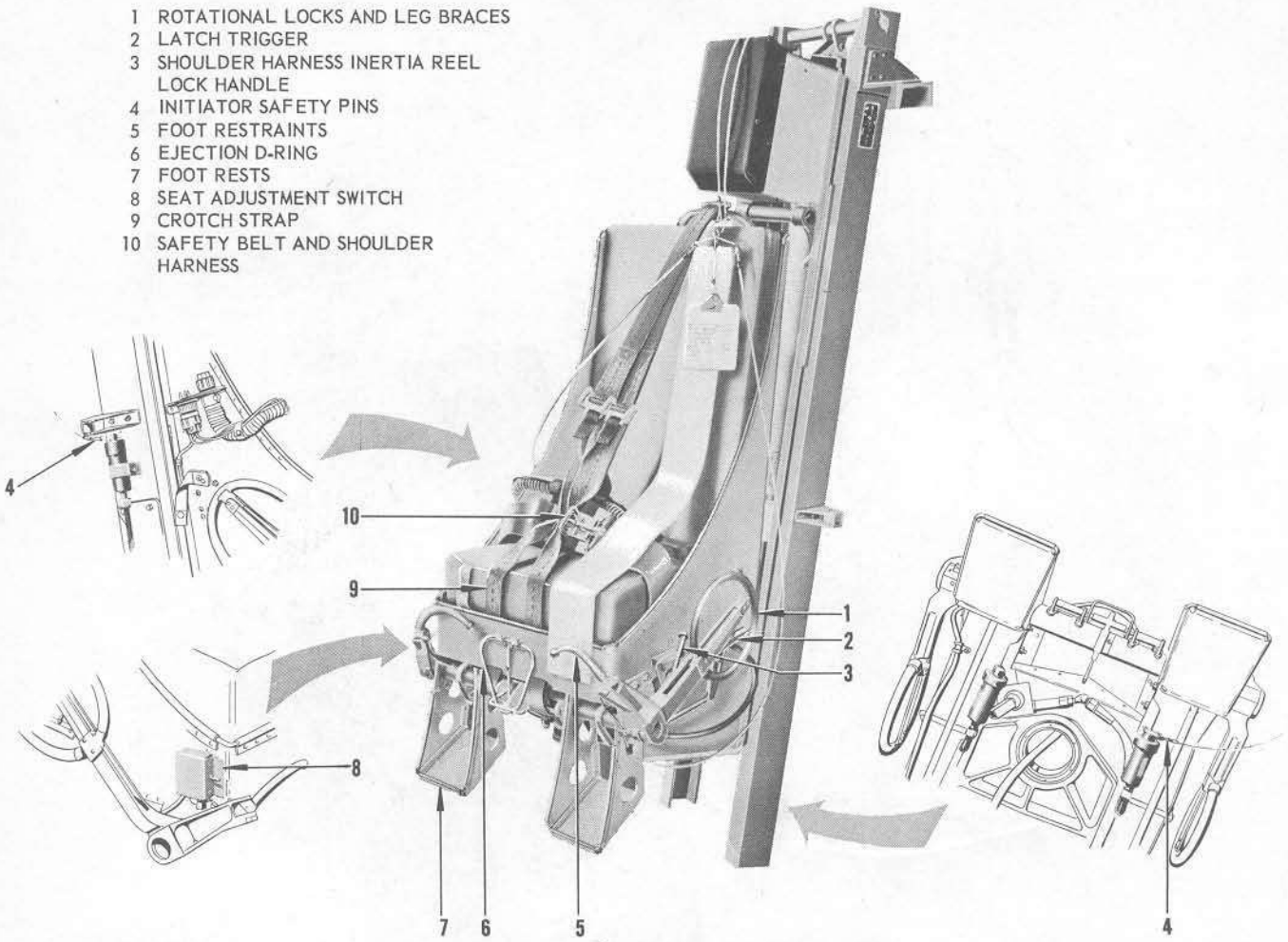


Figure 1-44. Observer's Ejection Seat

PILOT'S AND COPILOT'S EJECTION SEATS

The pilot and copilot are provided with catapult-type upward ejection seats (figure 1-43). Each seat is equipped with three initiators. These are explosive cartridges which provide high pressure forces to unlock the cabin pressure release door, disconnect and stow the control column, and fire the seat ejection catapult. Ejection is controlled by two ejection handgrips and a catapult firing trigger. Actuation of the handgrips automatically prepares the seat for ejection, while closing the firing trigger fires the catapult, ejecting the seat and occupant from the airplane.

Footrests on the pilot's seat are fixed to the bottom of the seat assembly, while the copilot's footrests are stowed beneath the seat assembly and are extended automatically when the left handgrip is raised. Also, each seat has armrests that may be stowed to give the pilot and copilot more freedom while getting in or out of the seat.

The vertical and horizontal adjustment is accomplished simultaneously by a combination of the occupant's physical effort and a spring-loaded cartridge. Maximum adjustment is 4 inches vertically and 3 inches horizontally, giving a total diagonal seat travel of 5 inches during which the seat may be locked in any of six intermediate positions.

NOTE

Care should be exercised when unlocking the seat adjustment lever while the seat is in the upper forward positions since the seat may suddenly bottom and restrict the visibility of the occupant.

In addition, the copilot's seat rotates to facilitate use of additional equipment not readily accessible from the normal seat position. Due to restricted clearance between the copilot's seat and the canopy, the seat assembly must be tilted forward before rotation can be accomplished. A hydraulically operated tilting mechanism is provided to tilt the seat assembly, allowing it to be rotated 180° left of forward.

CAUTION

- To prevent damage to the canopy, the copilot's seat should not be untilted when in

any position other than facing forward or aft.

- The copilot should ascertain that the seat is in the normal untilted position prior to ejection since ejection while in the tilted position may result in serious injury to the copilot and possible seat failure.

OBSERVER'S EJECTION SEAT.

The observer is provided with a catapult-type ejection seat (figure 1-44) that ejects downward through an ejection escape hatch at the observer's station. The seat is equipped with three initiators. These explosive cartridges provide high pressure forces to unlock the cabin pressure release door, unlatch the downward ejection hatch, and fire the seat ejection catapult. The seat is equipped with leg braces which serve to hold the observer's legs in place, a crotch strap which restrains the upward motion of the safety belt, and foot restraints which keep the feet down on the footrests during the ejection thrust. Vertical adjustment of the seat is controlled by an electrically operated jack screw which is supplied power through a circuit breaker located on the radar power panel. Rotational adjustment is accomplished manually. The seat rotates 20° to the left and 90° to the right of forward and automatically locks in either of the two extreme positions or at an intermediate position of 45° right of forward.

EJECTION SEAT CONTROLS

SHOULDER HARNESS INERTIA REEL LOCK HANDLE. A handle (5, figure 1-43 and 3, figure 1-44) with LOCKED and RELEASED positions is located on the left side of each crew member's seat. A latch is provided for positively retaining the handle at either position of the quadrant. By pressing down on the top of the handle, the latch is released and the handle may then be moved freely from one position to the other. When the handle is in the RELEASED position, the reel harness cable will extend to allow the crew member to lean forward; however, the reel harness cable will automatically lock when an impact force of 2 to 3 "g's" is encountered. When the reel is locked in this manner, it will remain locked until the handle is moved to the LOCKED position and then returned to the RELEASED position. When the handle is in the LOCKED position, the reel harness cable is manually locked so the crew member is prevented from bending forward. The LOCKED position is used for seat ejection bail-out or when a crash landing is anticipated. This position provides an added safety precaution over and above that of the automatic safety lock. Rotating the left ejection handgrip on the pilot's or copilot's seat forward to the final position will automatically lock the shoulder harness if the seat is in the full down position. Raising the leg braces on the observer's seat to the full upright position will lock the shoulder harness regardless of vertical position of the seat.

PILOT'S AND COPILOT'S SEAT EJECTION HANDGRIPS. Two ejection handgrips (4 and 10, figure 1-43) installed on each seat are used to prepare the seat for ejection. Each handgrip is stowed beneath the armrest and rotates forward through 205° to a mechanical stop. For a detailed description of ejection handgrip operation, refer to figure 1-45.

PILOT'S AND COPILOT'S CATAPULT FIRING TRIGGER. A catapult firing trigger (9, figure 1-43) is attached to the right ejection handgrip on the pilot's and copilot's seat. The trigger is interlocked with the right handgrip and maintains a 25° lag as the handgrip is moved to the mechanical stop. The trigger is locked and cannot be actuated until the canopy is jettisoned. Pulling the trigger through the 25° will fire the catapult and jettison the seat.

NOTE

In the event that any of the operations listed below malfunction during the ejection procedure, the pilot or copilot can use the normal control for that operation as an emergency override.

1. Release cabin pressure and actuate emergency alarm.
2. Bottom seat.
3. Disengage and stow control column and center the control wheel.
4. Lock shoulder harness inertia reel.
5. Jettison canopy.

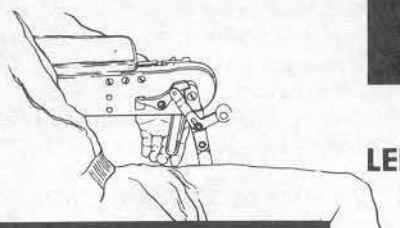
WARNING

The canopy must be jettisoned before the seat catapult can be fired.

COPILOT'S SEAT TILT AND ROTATION HANDLE. A seat tilt and rotational handle (11, figure 1-43) located on the right side of the copilot's seat is a manual control which hydraulically tilts the seat forward or aft. A knob located on top of the handle may be rotated clockwise or counterclockwise. Rotating the knob clockwise allows the seat to be tilted forward through actuation of the handle and permits the seat to be rotated. Turning the knob counterclockwise permits the seat to be untilted following seat rotation.

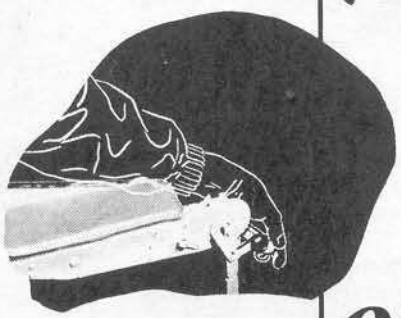
PILOT'S AND COPILOT'S SEAT ADJUSTMENT LEVER. A two-position seat adjustment lever (7, figure 1-43) located on the right side of the pilot's and copilot's seat, locks and unlocks the seat adjustment mechanism allowing the seat to be adjusted from a lower-aft to an upper-forward position through a total travel of 5 inches. Placing the lever in the aft position unlocks the adjustment mechanism while placing the lever in the forward detent locks the adjustment mechanism.

Pilot's & Copilot's



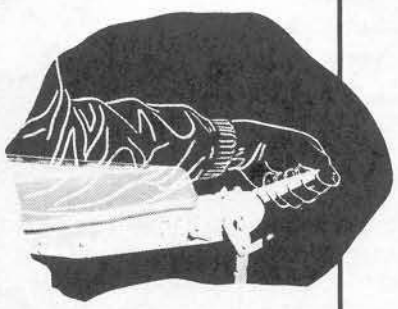
LEFT HANDGRIP

1st ADVANCE



Movement from stowed position through an arc of 65° to the first advance position is free travel and removes slack from the linkage.

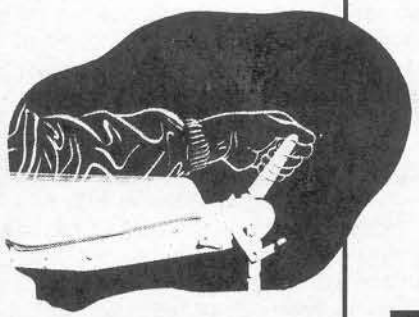
2nd ADVANCE



Movement through an arc of 35° to the second advance position causes the following to happen:

1. Copilot's foot rests extend.
2. Free travel of the pilot's handgrip.

FINAL



Movement through an additional arc of 35° to the final position causes the following to happen:

1. Pressure relief door unlocks releasing cabin pressure.
2. Emergency alarm bell sounds.
3. Shoulder harness inertia reel is prepared for locking.
4. Right handgrip becomes unlocked.
5. Handgrip locked in final position.

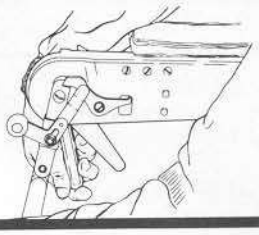
NOTE

The first advance, second advance, and final positions are not determined by notches or detents but are given only to show what occurs during each phase of movement of the handgrips.

Figure 1-45. (Sheet 1 of 2)

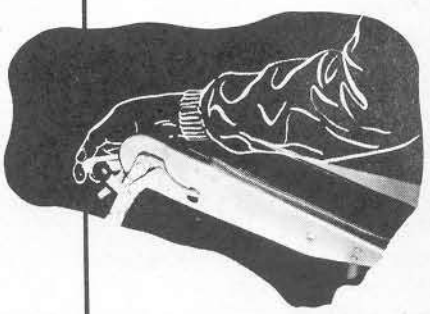
EJECTION SEAT CONTROLS

RIGHT HANDGRIP



POSITION

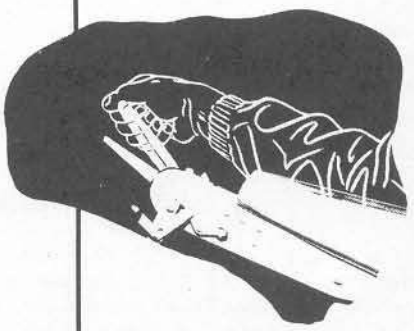
Movement from stowed position through an arc of 65° to the first advance position is free travel and removes slack from the linkage. The trigger (being interlocked with the right handgrip) maintains 25° lag until the handgrip reaches final position.



POSITION

Movement through an arc of 45° to the second advance position causes the following to occur:

1. Seat locking mechanism unlocks.
2. Seat is power driven to bottom position.
3. Shoulder harness inertia reel locks (when seat is in bottom position).
4. Unlocks linkage which allows 25° additional handgrip rotation.



POSITION

Movement through an arc of 25° to the final position causes the following to occur:

1. Control column spring cartridge disconnects and stows control column and centers wheel.
2. Canopy spring cartridge actuates air bottle valve which unlocks and unlatches the canopy, engages the hinge pin and extends the air jacks to jettison the canopy.
3. Jettisoning canopy removes safety pin from ejection delay stop, which allows the trigger to be rotated.
4. Unlocks the catapult trigger interlock.
5. Locks handgrip in final position.
6. Rotating the trigger through an arc of 25° to final position fires the catapult.

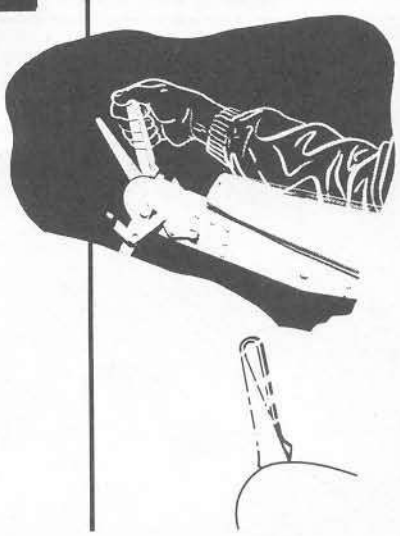
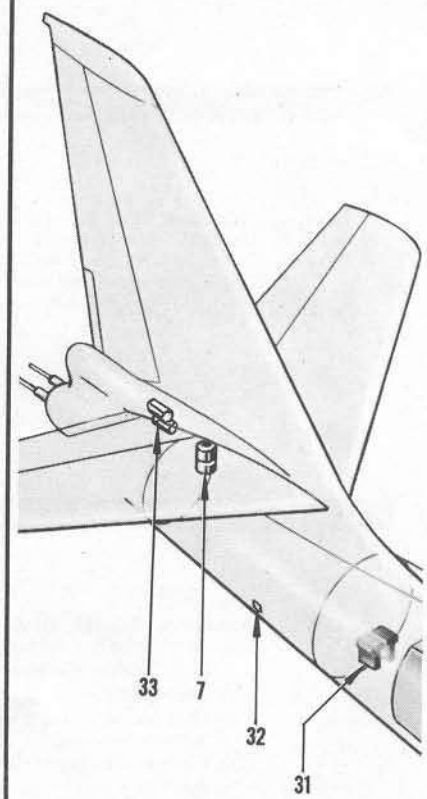


Figure 1-45. (Sheet 2 of 2)

SERVICING MATERIALS

TO SERVICE	USE	SPECIFICATION	GRADE
All Fuel Tanks	Fuel	MIL-F-5624A MIL-F-5572	JP-4 (Recommended) Any (Alternate)
All Engine Oil Tanks	Oil	MIL-O-6081A MIL-O-6081A	1010 (Recommended) 1005 (Alternate) See Note I
Pneumatic Bomb Release Storage and A-5 Fire Control System Air Tanks	Clean dry air at approximately 70° F		
Surface Power Control Fluid Reservoirs	Hydraulic fluid	MIL-O-5606	
Flaperon Accumulator	Clean dry air		
Fuel Tank Purging Dry Ice Containers	Crumbled dry ice		
ATO Racks	ATO Units	14AS-1000 MK2 14DS-1000 MK4	Mod 3 Mod 1
Hydraulic Accumulators	Clean dry air		
Hydraulic System Fluid Reservoirs	Hydraulic fluid	MIL-O-5606	
Spoiler and Canopy Air Bottle	Clean dry air at approximately 70° F		
Oxygen Filler Valve	Oxygen	AN-O-1c, Type 1	A
Aerial Refueling CO2 Fire Extinguisher System (must be removed to service)	Replace any bottle used or deficient by weight		
Water Injection System	MIXTURE: Alcohol (26% initial volume) Water (74% initial volume) Soluble Oil (10 qts. per 500 gal.) Triton X100 (1 pt. per 500 gal.)	O-M-232 MIL-C-4339 MIL-W-16791A	A Minimum solids content available
Batteries	Add distilled water to cover battery plates		

NOTE I - For temperatures below -29° C (-20° F), only specification MIL-O-6081A grade 1005 oil will be used.



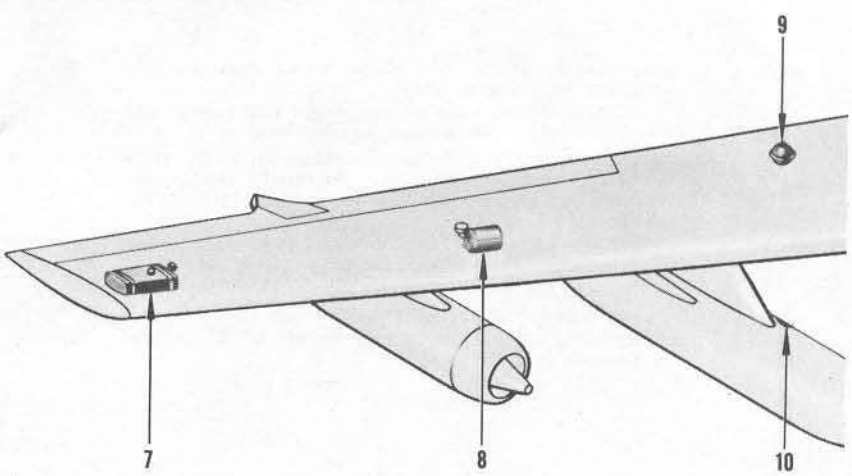


Figure 1-46. Servicing (Sheet 1 of 2)

1 AFT MAIN FUEL TANK
2 ATO FUEL TANK
3 FUEL TANK PURGING DRY ICE CONTAINERS
4 BOMB BAY FUEL TANK
5 CENTER MAIN FUEL TANK
6 NO. 3 ENGINE OIL TANK
7 SURFACE POWER CONTROL FLUID RESERVOIR
8 OIL TANK
9 FLAPERON ACCUMULATOR
10 EXTERNAL WING FUEL TANK
11 NO. 2 ENGINE OIL TANK
12 WATER INJECTION SYSTEM TANK
13 EXTERNAL POWER RECEPTACLES
14 CANOPY AIR BOTTLE
15 SEAT BOTTOMING AIR BOTTLE
16 BAIL-OUT SPOILER AIR BOTTLE
17 DOWNWARD EJECTION HATCH AIR BOTTLE
18 AERIAL REFUELING RECEPTACLE
19 AERIAL REFUELING CO_2 FIRE EXTINGUISHER BOTTLES - REMOVE TO SERVICE
20 OXYGEN FILLER VALVE
21 "K" SYSTEM EXTERNAL POWER RECEPTACLE
22 FORWARD AUXILIARY FUEL TANK
23 FORWARD MAIN FUEL TANK
24 HYDRAULIC ACCUMULATORS (6 IN FORWARD WHEEL WELL)
25 HYDRAULIC SYSTEM FLUID RESERVOIRS (2 IN FORWARD WHEEL WELL)
26 PNEUMATIC BOMB RELEASE STORAGE TANKS
27 NO. 5 ENGINE OIL TANK
28 NO. 4 ENGINE OIL TANK
29 SINGLE POINT GROUND REFUELING RECEPTACLE
30 ATO UNITS
31 BATTERIES
32 A-5 EXTERNAL POWER RECEPTACLE
33 A-5 FIRE CONTROL SYSTEM AIR TANKS

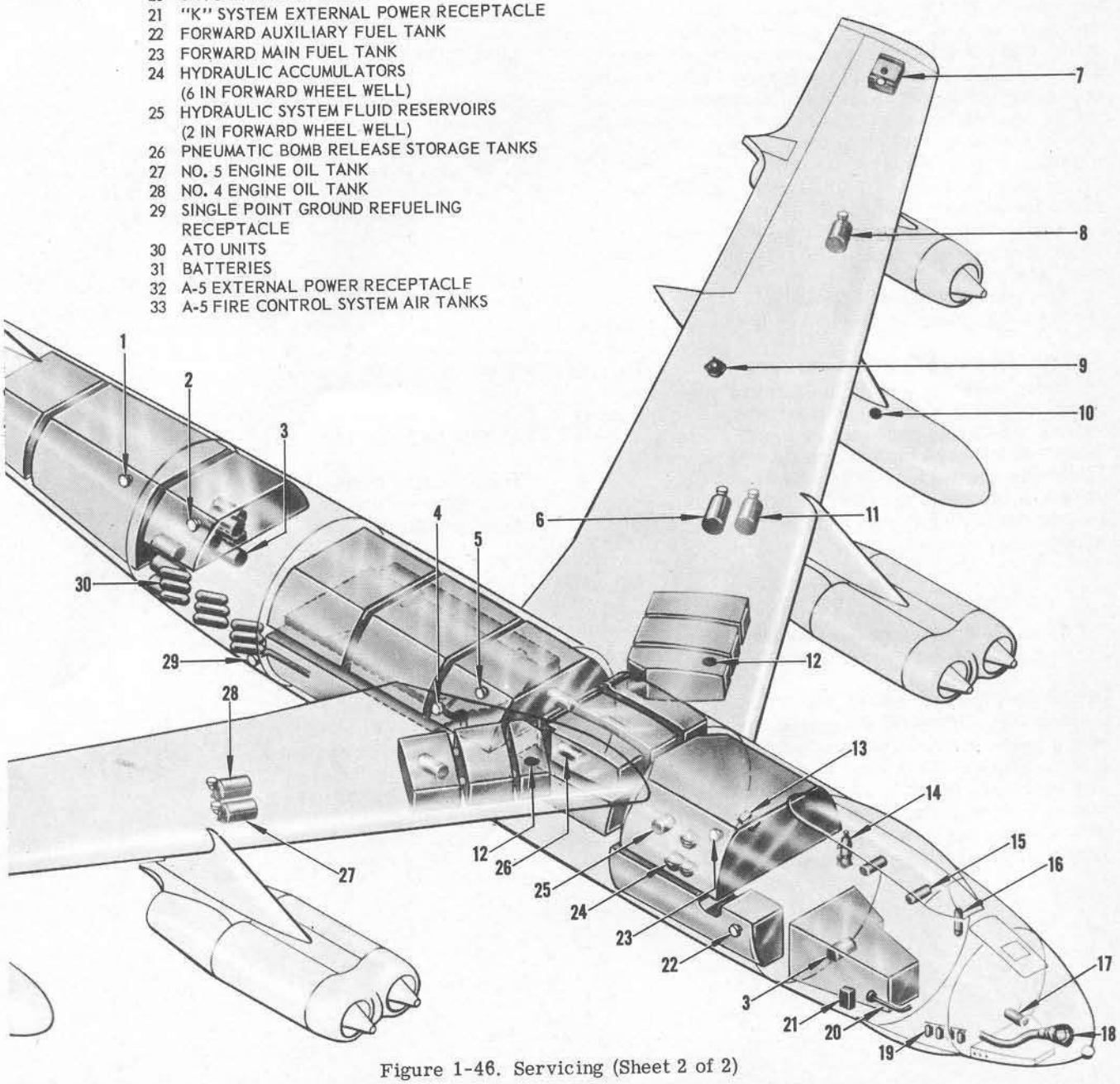


Figure 1-46. Servicing (Sheet 2 of 2)

PILOT'S AND COPILOT'S ARMREST LEVER. An armrest lever (8, figure 1-43) located below each armrest on the pilot's and copilot's seat serves to unlock the armrest allowing it to be stowed. The armrests are stowed in the down position for freedom of movement in or out of the seat. When the armrests are raised to an extended position they lock automatically and serve as leg braces for seat ejection.

OBSERVER'S SEAT ROTATIONAL LOCKS AND LEG BRACES.

Two leg braces (1, figure 1-44) are located on the observer's seat and serve as normal and emergency controls. A latch trigger (2, figure '-44) located within each leg brace prevents the leg brace from being raised until the trigger is squeezed. For normal operation, the braces are used for rotating the seat. The seat can be rotated 20° left or 90° right of forward position by pushing down on either leg brace. The seat can also be locked in an intermediate position of 45° right of forward. For emergency operation when the leg braces are in the upright locked position, the leg braces serve as an aid in maintaining proper posture during ejection. As the leg braces are raised from the stowed position to the locked position, the following occurs simultaneously:

1. Initiator on right rail will fire and unlock the cabin pressure release door.
2. Cabin air pressure will blow out the door.
3. Emergency alarm bell will ring when the pressure door is jettisoned.
4. Shoulder harness will lock.
5. Foot restraints will be moved to the open position.

OBSERVER'S EJECTION D-RING. An ejection D-ring (6, figure 1-44) located on the forward edge of the observer's seat operates with a "two-pull" sequence. Pulling the D-ring once (approximately 3 inches) unlocks and jettisons the observer's downward ejection hatch. As the hatch is jettisoned, the catapult is armed by means of a static line attached to the hatch. Pulling the D-ring the second time (approximately 1 1/2 inches) fires the catapult.

NOTE

No vertical adjustment of the observer's seat is necessary prior to seat ejection.

OBSERVER'S SEAT ADJUSTMENT SWITCH. A three-position UP--OFF--DOWN spring-loaded switch (8, figure 1-44), located at the lower right side of the seat, is provided to control vertical seat adjustment. The switch is spring-loaded to the OFF position. To raise or lower the seat, move the switch to UP or DOWN. Three inches of vertical adjustment is provided with limit switches controlling the seat travel. The seat can be adjusted vertically in any rotated position.

INITIATOR SAFETY PINS AND STREAMERS. Initiator safety pins accompanied by a red streamer are provided with each crew seat. The safety pins are inserted through the top of the initiators to prevent inadvertent firing while the airplane is on the ground. The pilot's and copilot's seats each require three initiator safety pins (3, figure 1-43) while the observer's seat requires two initiator safety pins (4, figure 1-44). The safety pins for the pilot's and copilot's seats attach to the cabin pressure release door, control column disconnect, and seat catapult initiators. The safety pins for the observer's seat attach to the pressure release door and the downward ejection hatch initiators. The pins must be removed and stowed in containers at each crew station before every flight and replaced immediately after parking the airplane.

EJECTION SEAT INDICATORS.

EJECTION SEAT AIR PRESSURE GAGE. The pilot's and copilot's seats are each equipped with an air pressure gage, (2 figure 1-43) located on the left side of the seat below the headrest. The gage indicates air pressure in the seat bottoming air bottle. Normal pressure is 950 psi and minimum pressure is 850 psi.

OBSERVER'S DOWNWARD EJECTION HATCH AIR PRESSURE GAGE. An air gage (26, figure 4-6) is installed in the forward portion of the observer's downward ejection hatch to show the pressure charge of the hatch air cylinder. The normal pressure is 2000 psi.

AUXILIARY EQUIPMENT.

The following equipment and its operation is described in section IV, "Description and Operation of Auxiliary Equipment":

Cabin Heating, Ventilating, and Pressurizing System
Anti-Icing and Defrosting Systems
Communication and Associated Electronic Equipment
Lighting Equipment
Oxygen System
Automatic Pilot
Navigation Equipment
Bombing System
Gunnery System
Photographic Equipment
Aerial Refueling System
Miscellaneous Equipment

SECTION II
NORMAL PROCEDURES

NOTE

The high fuel consumption during ground operation makes it necessary to hold engine time and speed to an absolute minimum. The check lists in this section were planned to complete the maximum number of check items prior to starting engines.

STATUS OF THE AIRPLANE.

FLIGHT RESTRICTIONS.

Refer to section V for information concerning the restrictions imposed on the aircraft in flight.

FLIGHT PLANNING.

Jet aircraft require special emphasis on mission planning and cruise control because of the inherently high fuel consumption of jet engines and the wide range of speeds and altitudes attainable. To successfully complete any mission, it will be necessary for the pilot to become familiar with the operating data charts in the Appendix to determine the required fuel quantity, take-off distance, ATO requirements, and power settings for climb and cruise control

TAKE-OFF AND CLIMB TABLE.

The take-off and climb table should be completed for all missions.

For instructions in completing the above charts, refer to the Appendix.

WEIGHT AND BALANCE.

Refer to "Weight and Balance Data" handbook, AN 01-1B-40, for detailed loading information.

a. Check that required amounts of fuel, oil, water, ATO bottles (if required), and bombs have been loaded.

b. Obtain the take-off and anticipated landing gross weights and estimated cg locations.

c. Check weight and balance clearance (Form F) for completion of entries and for proper clearance.

NOTE

- Maximum gross take-off weight at 17% to 30% cg limits is 185,000 pounds; at 17% to 32% cg limits it is 182,600 pounds.
- Design landing gross weight is 125,000 pounds.
- Refer to section V for further information concerning the weight and cg limitations of this airplane.

ENTRANCE.

Entrance into the airplane is gained through a door on the lower left side of the fuselage immediately aft of the radome. A small ladder will be required to reach the entrance door handle and to release the entrance way ladder (figure 2-1).

BEFORE EXTERIOR INSPECTION.

After gaining entrance to the airplane, complete the following:

a. Form 1 - checked
   Check and complete all entries on Form 1.

b. Controls - LOCKED
   Check all controls LOCKED.

c. Trim Tabs - ZERO
   Check trim tabs on ZERO.

d. Hydraulic Pressure - BLED
   Pump brake pedals to bleed off all system pressure.

e. Parking Brakes - OFF
   Leave parking brakes OFF.

f. Battery Switch - OFF
   Check battery switch OFF.

g. Emergency Turn-and-Bank - ON EMERGENCY - CHECKED - ON NORMAL
   Place turn and bank power switch on copilot's instrument panel to EMERGENCY and listen for pilot's and copilot's turn and bank to operate. Place switch back to NORMAL.

EXTERIOR INSPECTION.

Upon completion of the Before Exterior Inspection, the pilot will return to the ground and perform the visual Exterior Inspection as shown on figure 2-2.

If the engine stall prevention switch is inoperative, capping or uncapping of the compressor discharge pressure bleed line on each engine must be accomplished on the ground prior to flight. If OAT is 15 °C (59 °F) or below under 10,000 feet, or if aerial refueling or formation flying or unusual maneuvers such as practice stalls are to be accomplished at any altitude, the pilot will check with the crew chief to insure the bleed line is uncapped; otherwise, the line should be capped.

CAUTION

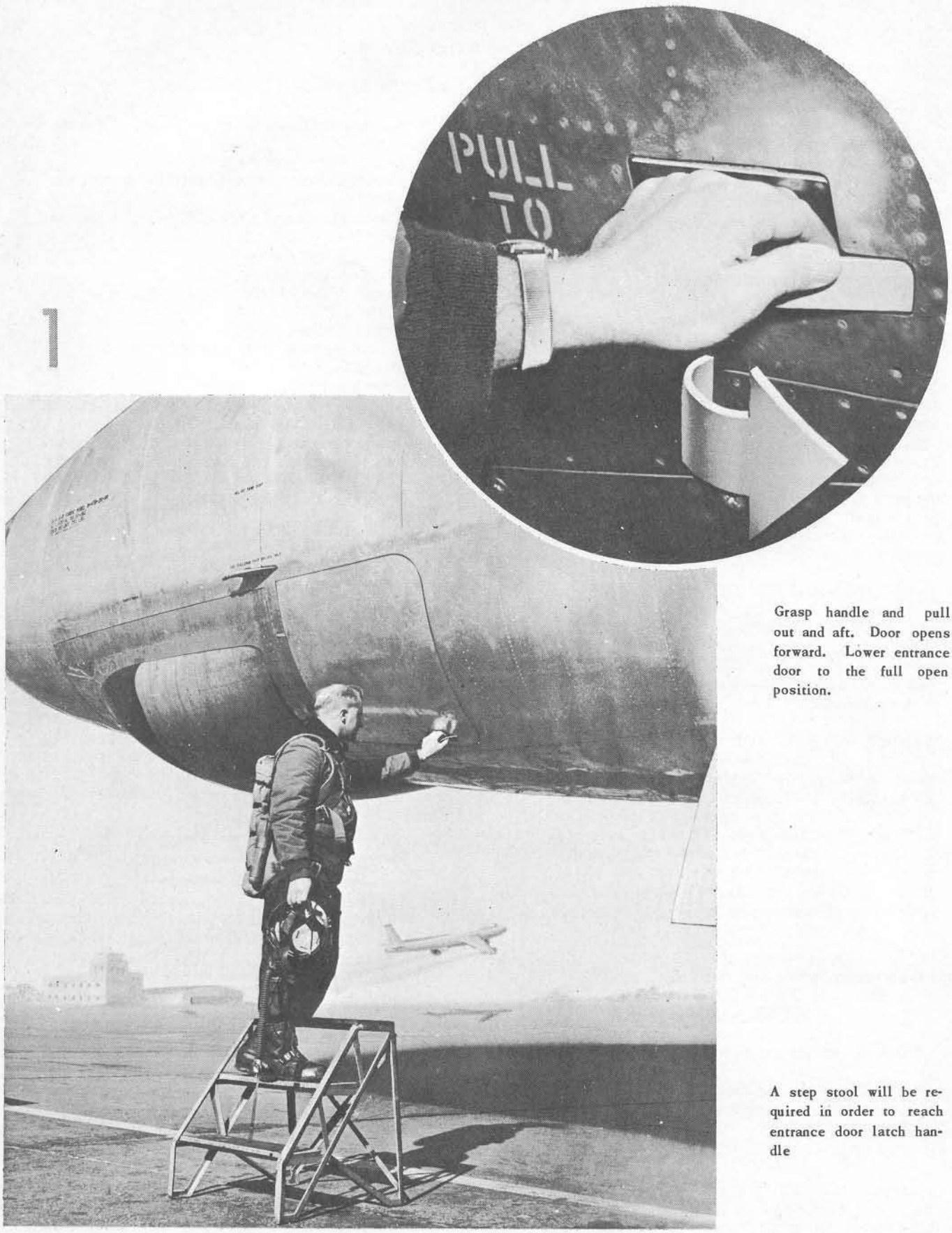
Any operation uncapped above 15 °C (59 °F) will result in excessive acceleration times and should be considered by the pilot before ordering uncapped operation. In addition, uncapped operation will result in large amounts of rpm dropoff at altitude.

ON ENTERING THE AIRPLANE.

INTERIOR CHECK (ALL FLIGHTS).

The following check is to be accomplished after completion of the exterior inspection.

1. Bail-Out Spoiler Air Bottle - 2000 psi
   Check spoiler air bottle pressure gage; should read 2000 psi.
2. Crawlway Clear and Door Locked
   Inspect crawlway area for fuel leaks around fuel tank sump. Aft crawlway closure curtain installed and crawlway clear. Close and latch crawlway door.

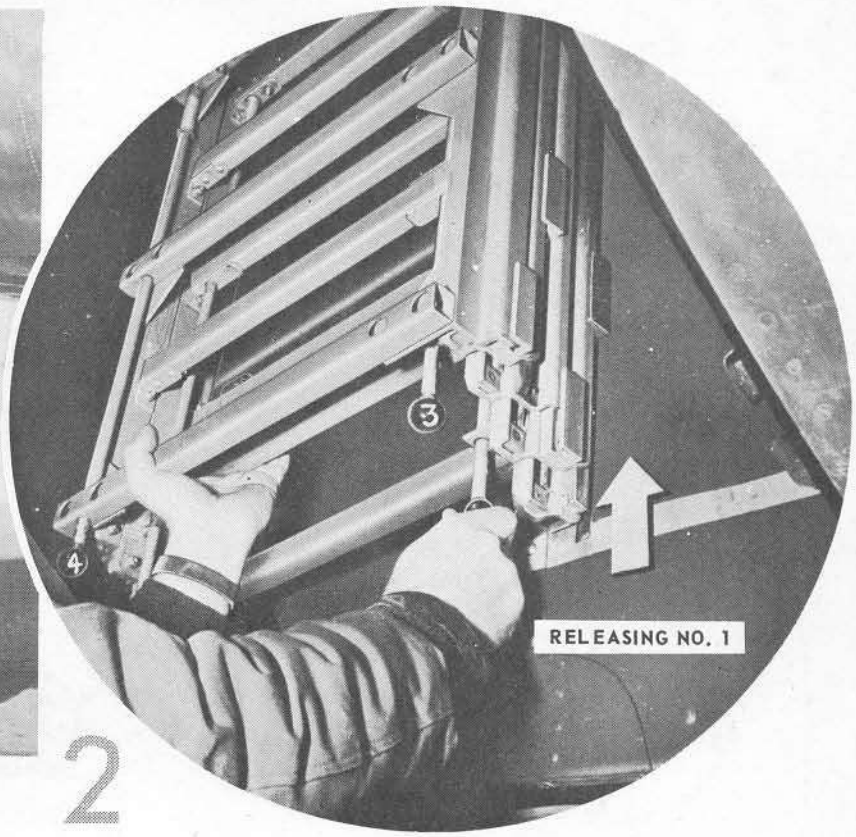


1

Grasp handle and pull out and aft. Door opens forward. Lower entrance door to the full open position.

A step stool will be required in order to reach entrance door latch handle

Figure 2-1. Entrance to the Airplane (Sheet 1 of 2)



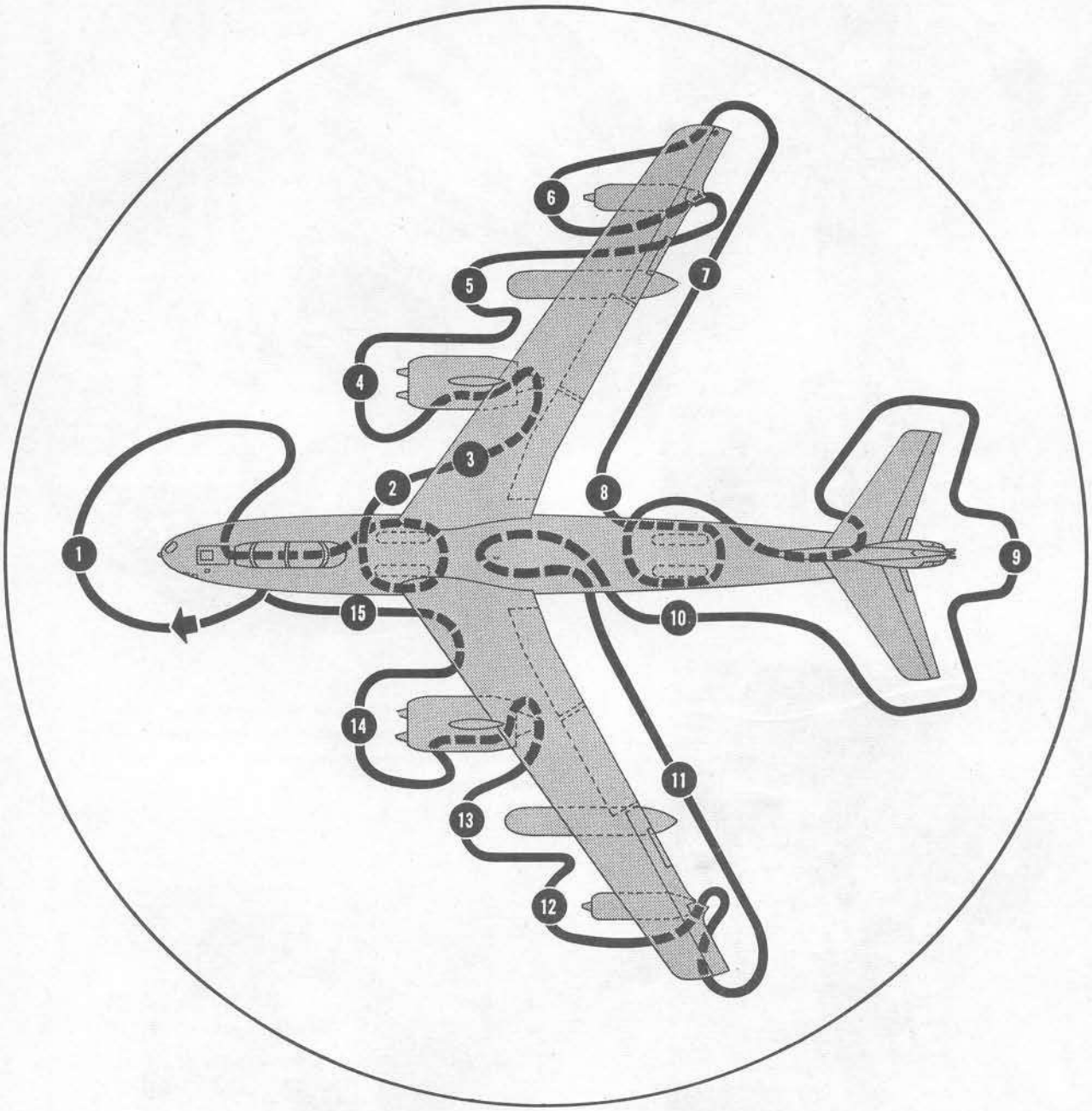
2

Support ladder with left hand while pushing up on ladder release knob with right hand. Lower one section at a time in sequence. Release knobs are numbered in the recommended sequence.

3

4

Figure 2-1. Entrance to the Airplane (Sheet 2 of 2)



NOTE

THE EXTERIOR INSPECTION IS A VISUAL INSPECTION AND WILL BE ACCOMPLISHED BY THE PILOT AIDED BY THE AIRCRAFT CREW CHIEF.

Figure 2-2. Exterior Inspection (Sheet 1 of 3)

1 NOSE SECTION

a. Left pitot cover - REMOVED
b. Observer's downward ejection hatch - FLUSH - HANDLE FLUSH WITH SKIN
c. Aircraft - GENERAL APPEARANCE SATISFACTORY
d. Bomb sight protuberance - CLEAR AND UNBROKEN
e. Camera pressure release door - SECURE
f. Cabin pressure release door - SECURE
g. CO_2 thermal discharge indicators - INTACT
h. Right pitot tube cover - OFF
i. Upper and lower radar compartment doors - SECURE
j. Fuel tank caps - ALIGNED AND SECURE
k. Static ports - CLEAR
l. Radome - FLUSH AND LATCHED
m. AN/APN-76 antenna - CRACKS OR DENTS
n. Forward auxiliary fuel pumps - NO LEAKS

2 FORWARD WHEEL WELL

a. Wheel chocks and down locks - IN PLACE
b. Right door roller and actuator - CHECKED
c. Wheels, tires, brakes and anti-skid - CHECKED
d. Forward gear squat switches and brake lines - CHECKED
e. Oleo strut - PROPER EXTENSION - NO LEAKS
f. Taxi light and centering switch - SECURE
g. Forward gear steering mechanism - CHECKED
h. Left and right power shield covers - SECURE
i. Fuel lines - NO LEAKS
j. Hydraulic reservoir cap and fluid levels - SECURE AND CHECKED (use stand to check)
k. Spoiler door accumulator - 3000 psi (1 gage)
l. Hydraulic system - NO LEAKS
m. Left door, actuator, and roller - CHECKED
n. Dry ice container - CHECKED
o. Forward shield covers (3) - SECURE
p. Motors and cannon plugs - CHECKED AND SECURE
q. Gear door up-latch - UNLATCHED
r. Actuating screw - CHECKED
s. Torsion link cotter pin - CHECKED

3 RIGHT BOMB BAY DOOR

a. Bomb door skin - CHECKED
b. Wing and strut access panels - SECURE
c. Bomb door latch pin - REMOVED AND STOWED

4 INBOARD NACELLE

a. Aft nacelle fairing - NO CRACKS OR WRINKLES
b. Turbine, cone and tailpipe - CHECKED - TABS SECURE
c. Strut fairing and torsion links - CHECKED
d. Oleo strut - NO LEAKS
e. Wheel and tire - CHECKED
f. Ground safety lock - IN PLACE
g. Outrigger doors and actuators - SECURE
h. Nacelle panel latches - SECURE
i. Left nacelle panels - SECURE
j. Airscoops - NO FLUID OR FOREIGN OBJECTS
k. Accessory cones - SECURE
l. Right nacelle and strut panels - SECURE
m. Wing access panels - SECURE

5 WING DROP TANK

a. Fairing, filler cap, access panels, nose and tailcones - CHECKED AND SECURE
b. Vent line - NO OBSTRUCTIONS
c. Red indicator flag - CHECKED
d. Side strut latch pin - CHECKED

6 OUTBOARD NACELLE

a. Aft nacelle fairing - NO CRACKS OR WRINKLES
b. Turbine, cone and tailpipe - CHECKED - TAB SECURE
c. Left nacelle panels - SECURE
d. Airscoop - NO FLUID OR FOREIGN OBJECTS
e. Accessory cone - SECURE
f. Right nacelle panels - SECURE

7 RIGHT WING

a. Aileron power control reservoir - CAP SECURE - FLUID CHECKED
b. Aileron power control unit - NO LEAKS - CIRCUIT BREAKERS IN
c. Wing access panels - SECURE
d. Top of wing - NO FOREIGN OBJECTS - VORTEX GENERATORS CHECKED, COVERS REMOVED
e. Fuel caps (3) - ALIGNED AND SECURE
f. Aileron and trim tab - CHECKED AND PROPER POSITION
g. Fuel lines and shutoff valves - NO LEAKS
h. Flaperon accumulator pressure gage - 1500 psi

NOTE

Due to the allowable internal leakage of the flaperon power control unit, the pressure may be lower than 1500 psi; however, it should not be lower than the accumulator preload pressure of 500 psi.

i. Tracks, rollers and actuating screws - CHECKED
j. Flaperons and flaps - NO BULGING OR WARPING

8 RIGHT SIDE FUSELAGE AND REAR WHEEL WELL

a. Right fuselage - NO DENTS, WRINKLES OR LOOSE PANELS
b. Single point refueling cap - SECURE
c. Wheel chocks and down lock - IN PLACE
d. Right door, roller and actuator - CHECKED
e. Wheels, tires, brakes, and anti-skid - CHECKED
f. Static ground wire - SECURE AND TOUCHING
g. Oleo strut - PROPER EXTENSION - NO LEAKS
h. Hydraulic fuel lines and shutoff valves - NO LEAKS
i. Dry ice containers - CHECKED
j. ATO rack pin indicators (6) are in LOCK position
k. ATO safety link - REMOVED (if ATO installed)
ATO control shield circuit breakers - IN

Figure 2-2. Exterior Inspection (Sheet 2 of 3)

l. Left door, actuator and roller - CHECKED
m. Aft power shield covers - SECURE - CIRCUIT BREAKERS IN
n. Motors and cannon plugs - SECURE
o. Gear door up latch - UNLATCHED
p. Actuating screw - CHECKED
q. Aft main fuel pumps - NO LEAKS
r. Camera compartment equipment and doors - CHECKED AND CLOSED - NO LEAKS
s. Antennas - SECURE
t. Battery compartment battery covers, and aft power panel - CHECKED AND SECURE
u. Tail compartment - BRAKE CHUTE MECHANISM CHECKED
v. Rudder elevator power control reservoir - CAP SECURE - FLUID CHECKED
w. Rudder elevator power control system - NO LEAKS
x. Brake chute - INSTALLED - DOORS FLUSH
y. Torsion link cotter pin - CHECKED
z. Ammunition cans - SAFETIED

9 EMPENNAGE

a. Empennage - GENERAL APPEARANCE SATISFACTORY
b. Right horizontal stabilizer - CHECKED
c. Elevator trim tabs - PROPER POSITION
d. Vertical fin and rudder tabs - PANELS CLOSED - TAB CHECKED
e. Tail turret - CHECKED - CONE SECURE
f. Left horizontal stabilizer - CHECKED
g. Vertical fin - CHECKED - AIR DUCT OPEN

10 LEFT FUSELAGE AND BOMB BAY

a. Left fuselage - NO DENTS, WRINKLES, OR LOOSE PANELS
b. Bomb bay tank and fuel pumps - NO LEAKS
c. Bomb door down locks - IN PLACE
d. Left bomb bay fuel lines, valves, and sumps - NO LEAKS
e. Junction box covers - SECURE
f. Oxygen regulator and heated suit - OFF
g. Service and interconnect valves - SAFETIED OFF
h. Bomb bay light and vacuum pump switches - OFF
i. Bomb release and bottles - CHECKED 1500 psi (2 bottles)
j. Bomb door accumulator - 1750 psi (2 bottles)
k. Spoiler and spoiler pressure valve - CHECKED AND OFF
l. Bomb door up latch and microswitch - UNLATCHED AND CHECKED
m. Right bomb bay fuel lines, valves, and sumps - NO LEAKS
n. Defueling valve - SAFETIED OFF
o. Interphone cord - STOWED

11 LEFT WING

a. Flaperons and flaps - NO BULGING OR WARPING
b. Flap motors, solenoids and wiring - SECURE
c. Tracks, rollers and actuating screws - CHECKED
d. Flaperon accumulator pressure gage - 1500 psi

NOTE

Due to the allowable internal leakage of the flaperon power control unit, the pressure may be lower than 1500 psi; however, it should not be lower than the accumulator preload pressure of 500 psi.

e. Fuel lines and shutoff valves - NO LEAKS
f. Aileron and trim tab - CHECKED AND PROPER POSITION
g. Top of wing - NO FOREIGN OBJECTS -VORTEX GENERATORS CHECKED, COVERS REMOVED
h. Aileron power control reservoir - CAP SECURE - FLUID CHECKED
i. Aileron power control unit - NO LEAKS - CIRCUIT BREAKERS IN
j. Wing access panels - SECURE

12 OUTBOARD NACELLE

a. Aft nacelle fairing - NO CRACKS OR WRINKLES
b. Turbine, cone and tailpipe - CHECKED - TAB SECURE
c. Left nacelle panels - SECURE
d. Airscoop - NO FLUID OR FOREIGN OBJECTS
e. Accessory cone - SECURE
f. Right nacelle panels - SECURE
g. Wing and strut access panels - SECURE

13 WING DROP TANK

a. Fairing, filler caps, panels, nose and tailcones - CHECKED AND SECURE
b. Vent line - FREE OF OBSTRUCTION
c. Red indicator flag - CHECKED
d. Side strut latch pin - CHECKED

14 INBOARD NACELLE

a. Aft nacelle fairing - NO CRACKS OR WRINKLES
b. Turbine cones and tailpipes - CHECKED - TABS SECURE
c. Strut fairing and torsion links - CHECKED
d. Oleo strut - NO LEAKS
e. Wheel and tire - CHECKED
f. Ground safety lock - IN PLACE
g. Outrigger doors and actuators - SECURE
h. Nacelle panel latches - SECURE
i. Left nacelle panels - SECURE
j. Airscoops - NO FLUID OR FOREIGN OBJECTS
k. Accessory cone - SECURE
l. Right nacelle and strut panels - SECURE
m. Wing access panels - SECURE

15 LEFT SIDE OF FUSELAGE

a. Left bomb door skin - CHECKED
b. External power and interphone - CONNECTED
c. Static ports - CLEAR
d. Air intake and exhaust plugs - REMOVED
e. Bomb bay door switch - OFF
f. Fuel drains - NO LEAKS
g. Bomb bay actuating cylinder pin - LOCKED

Figure 2-2. Exterior Inspection (Sheet 3 of 3)

3. Fire Extinguisher - CHECKED AND IN PLACE
   Check that hand fire extinguisher is full, stowed and secure.
4. Hand Axe - STOWED
   Check that hand axe is stowed and secure.
5. First Aid Kit - CHECKED AND IN PLACE
   Complete first aid kit stowed in place and secure.
6. Portable Oxygen Bottle - CHECKED AND IN PLACE
   Portable bottle stowed in proper rack and secured. Test spring clothing clip. Bottle charged to minimum of 400 psi.
7. Observer's Escape Hatch - IN PLACE; Emergency Release Lever - LOCKED
   Inspect observer's escape hatch in place and properly secured. Emergency handle release locked and flush and safety wired.
8. If observer is not flying:
   a. "K" System Computer Function Switch - OFF.
   b. "K" System Radar Power Control Switches - OFF.
   c. Observer's Oxygen Panel - PRESSURE CHECKED AND OFF.
      Check oxygen pressure reading at least 400 psi, warning light switch and supply lever OFF.

CAUTION

Due to the automatic pressure breathing feature of the regulator, a continuous flow of oxygen at altitude will result if the regulator is not being used and the supply shut-off lever is left on. This condition will cause a rapid loss of oxygen.

   d. Master Bomb Control Power and Indicator Light Switches - OFF.
   e. Camera Master Switch - OFF.
      Check camera master switch OFF and camera breaker pushed in.
   f. Salvo Control Switches - NORMAL & OFF
      Check salvo selector switch in NORMAL and salvo control in OFF. Switch guards closed.
   g. "K" System Heating Control Switches - OFF
      Check cockpit area and radar compartment heating switches in OFF.
   h. Observer's Light Switches - OFF
      Seven light switches on observer's lighting panel and window defrost switch in OFF.
   i. Observer's Air Outlet - BOTH OFF
      Position observer's air outlet selector to BOTH OFF.
   j. Equipment in Nose - SECURE
      Check all equipment in nose for security, loose equipment removed, observer's safety belt and shoulder harness buckled, safety pins and streamer installed on observer's ejection seat.
9. Aerial Refueling Accumulator Pressure Gage - 2000 psi
   Check aerial refueling accumulator pressure gage; should read 2000 psi.
10. Data Case - NAVIGATION TECH ORDERS IN PLACE
    Check data case for the following technical orders: Radio Data Charts and Flight Information (2--LF/MF edition and VOR edition), Supplementary Flight Information, Pilot's Handbook of Let Down Charts (PHACUS), and Weights and Balance Data (AN 01-1B-40).
11. Canopy Ground Lock - REMOVED AND STOWED
    If canopy has been left open, remove canopy ground lock from left and right canopy rail and stow in place.
12. Aft Portable Oxygen Bottle - CHECKED AND IN PLACE
    Portable bottle stowed in proper rack and secured. Test spring clothing clip. Bottle charged to a minimum of 400 psi.
13. ELGE System - ADJUST LIGHTS
    Check ELGE stand extension levers stowed full aft on the stand. Set all warning indicator lights to full bright (dim for night flights). Open ELGE stand inspection door and inspect for pawls disengaged.
14. G-File - CHECKED
    Check G-File for the following technical orders of the latest issue: Flight Handbook (T.O. No. 1B-47(D)(Y)E-1.) and T.O. No. 1B-47(D)(Y)E-1A.), Handbook Erection and Maintenance Instructions (T.O. No. 1B-47B-2 and T.O. No. 1B-47B-2B), Parts Catalog (T.O. No. 1B-47B-4 and T.O. No. 1B-47B-4A) and Inspection Requirements (T.O. No. 1B-47A-6 and T.O. No. 1B-47A-6A).
15. Gunner's Air Outlet - BOTH OFF
    Position gunner's air outlet selector to BOTH OFF position.
16. Circuit Breakers - IN
    Check that all circuit breakers on main AC power shield and upper, lower, and aft DC power panels are pushed in.
17. Canopy - NO LEAKS
    Inspect canopy for cracks, defects or damage.
18. Loose Equipment - STOWED
    Remove all unnecessary loose objects in the pressure compartment.
    Stow and secure.
19. Canopy Air Bottle Pressure Gage; should read 2000 psi.
    Check canopy air bottle pressure gage, should read 2000 psi.
20. Pilot's and Copilot's Ejection Seats - CHECKED - STREAMERS & PINS REMOVED
    Pilot and copilot perform the following check:
    a. Check ejection seat air pressure gage; should read 850 to 950 psi.
    b. Check static cable secured to canopy; connected to safety pin, and safety pin properly installed.
    c. Remove safety pins (three at each seat) and stow with attached streamer in bags provided.
    d. Manually check shoulder harnesses and inertia reels for proper operation.
21. Observer's Ejection Seat - CHECKED - STREAMER & PINS REMOVED
    Observer makes the following check:
    a. Check that safety pin is properly installed in catapult initiator.
    b. Check that static cable is attached to observer's downward ejection hatch.
    c. Check that hatch lockpin is engaged by looking through lockpin inspection window.

d. Manually check shoulder harness and inertia reel for proper operation.
e. Remove safety pins (two) and attached streamer and stow in bag provided.
f. Check downward ejection hatch air bottle pressure gage; should read 2000 psi.

22. Observer's Escape Hatch - FLUSH; Yaw String - INSTALLED
Inspect by looking through pilot's windshield that observer's escape hatch is flush and yaw string is installed. Inspect windshield and canopy for cracks, defects, or damage.

NOTE

The following check list is an amplified version of the aircraft check list. This check list is accomplished by the copilot calling off the items to the pilot. For identification purposes, all responses made by the pilot are noted in capital letters and those made by the copilot are lower case.

23. Seats & Pedals - ADJUSTED - adjusted
Pilot and copilot adjust seats and rudder pedals as required for comfort, visibility, and utility.
24. Safety Belt & Shoulder Harness - FASTENED - fastened
Pilot and copilot adjust and fasten safety belt and shoulder harness. Check inertia reel lock lever in RELEASED position.

WARNING

If safety belt is removed in flight or on the ground while changing pilots, be careful that the belt is not thrown over the right side of the seat as the belt end may inadvertently turn some switches off.

25. Inverter - OFF - off
a. Pilot checks main and spare instrument inverter switch OFF.
b. Copilot checks main, secondary, and A-5 inverter power switches OFF.
26. Bomb Door Switch - OFF
Pilot checks that bomb door switch if OFF.
27. ATO Switches - BOTH OFF
Pilot checks that ATO arming switch is OFF, ATO firing switch is OFF, and switch guard closed.
28. Steering Ratio & Gear Lever - TOW & DOWN
Pilot places steering ratio selector lever to TOW and landing gear lever to DOWN
29. Windshield Wiper - PARK
Pilot checks windshield wiper rheostat switch in PARK.

NOTE

Do not check windshield wiper operation on dry glass.

30. Alarm Bell - ok
Pilot places switch ON; copilot and observer report "ok" if they are able to hear alarm bell.
31. Ignition - OFF
Pilot checks all (six) ignition switches OFF.
32. Bomb Salvo - OFF
Pilot checks bomb salvo switch OFF and switch guard closed.
33. Tank Jettison - NORMAL
Pilot checks tank jettison switches (two) NORMAL and switch guards closed.
34. Flap Lever - OFF - off
Pilot checks that wing flap lever is OFF. Copilot checks that wing flap lever is OFF and wing flap emergency switches (two) are OFF.
35. Throttle - CUT OFF - cut off
Pilot checks throttle lock lever is off and all throttles (six) in CUT OFF. Copilot checks all throttles (six) in cut off.
36. Emergency Gear Retraction - OFF - off
Pilot checks landing gear emergency retraction switch OFF (spring-loaded to lower switch position) and switch cover closed. Copilot checks landing gear retraction switches (four) OFF and switch guards closed.
37. Surface Power Controls - OFF
Pilot checks all surface power control switches (three) OFF.
38. Canopy Control Lever - OFF
Pilot checks canopy control lever OFF.
39. Battery - CHECK
Pilot positions battery switch to LH BUS NORMAL. Copilot positions DC voltmeter selector switch to L BUS FWD BUS and R BUS and reads voltage at each position to pilot. Pilot changes battery switch to RH BUS; copilot positions DC voltmeter selector switch to L BUS FWD BUS and R BUS and reads voltage at each position to pilot (minimum allowable voltage, 18 volts).
40. Bus Selector - checked, normal
Copilot moves bus selector switch from NORMAL to PRIMARY TEST; power should remain on the system and no flickering of lights or instruments should be observed. Moves bus selector switch to SECONDARY; this will momentarily interrupt power to the bus causing warning lights in the cockpit to flicker. Positions bus selector to NORMAL and closes switch guard. Informs pilot "Bus selector switch checked and switch normal."

NOTE

Failure of either bus to take the DC load will be grounds for a mandatory abortion of the mission.

41. Cockpit Lights - OFF - off
Pilot and copilot check cabin and instrument lighting panels to insure that all unnecessary switches are off.
42. External Power
Copilot calls "Copilot to ground crew, connect external DC power."

43. Mike Cord, Mask, Bail-Out Bottle - CONNECTED - connected
    Pilot and copilot connect mike cord, mask, and bail-out bottle.
44. Battery - OFF
    Ground crew informs pilot "External DC power on airplane"; then pilot positions battery switch OFF.
45. Position Lights - OFF
    Pilot checks navigation lights, emergency keyer, and dome lights switches OFF.
46. Aerial Refueling & Anti-Icing Lights - off
    Copilot checks slipway door, navigator's window, and wing illumination light switches OFF.
47. Oxygen Check - Crew Reports
    Pilot turns master oxygen warning control switch ON. All crew members will accomplish the following oxygen check:
    a. Check oxygen supply shutoff lever in OFF and bleed pressure from regulator by depressing emergency toggle lever; pressure should drop to zero and remain at zero when emergency toggle lever is returned to neutral.
    b. Position oxygen supply shutoff lever ON and check system pressure (400 to 450 psi).
    c. Place warning system switch ON; oxygen warning light at that station will come on bright. Check quick disconnect fitting (fitting should separate with a 10- to 15-pound pull).
    d. Set regulator diluter lever to 100% OXYGEN and depress emergency toggle lever to flush the regulator hose; oxygen flow blinker should indicate continuous flow and warning light at that station should dim and then come on bright.
    e. With emergency toggle lever still depressed, block regulator hose tightly with the hand; the blinker will indicate no flow, the warning light at that station should dim, blink, and then come on bright. A hissing of the regulator or a flow indication will indicate a ruptured regulator diaphragm or other pressure leak. Check the hose and hose fitting.
    f. Release emergency toggle lever. Plug in oxygen mask.
    g. Adjust mask on face and check blinker operation during normal breathing; warning light should go dim and remain dim.
    h. Depress the emergency toggle lever to TEST MASK. Hold breath; the blinker should indicate no flow. After approximately 10 seconds or less, the warning light should come on bright (12 seconds after a 5-minute warm-up period during regulator use). A pressure leak will be indicated by a flow indication or a hissing of the regulator.
    i. Return emergency toggle lever to neutral and set regulator diluter lever to NORMAL OXYGEN.
    j. Report over interphone "Oxygen check complete, 400 psi (or system pressure) warning switch ON."
48. Canopy Emergency Release & Jettison Handle - IN PLACE - in place
    Pilot and copilot check canopy emergency release handles in place and transparent doors closed.

    Pilot and copilot check that canopy emergency jettison handles are in place.
49. Directional Damper - OFF
    Pilot checks that directional damper switch is in OFF position.
50. Inverters - CHECKED & ON - checked & on
    Pilot:
    Checks instrument inverters: With main and spare instrument inverter OFF, red warning light labeled "Bus Power Off" will be on. Place instrument inverter switch on SPARE; red light will go out and the amber light labeled "Spare Inverter On Bus" will come on. Place inverter switch on MAIN; both indicator lights should be out. Leave switch on MAIN.
    Copilot:
    Checks inverters in the following manner:
    a. Check inverter transfer control switch in NORMAL and main, secondary, and A-5 inverter power switches in OFF. The three inverter transfer indicator lights will go out and the three "No Power" indicator lights will come on.
    b. Place main, A-5, and secondary inverter power switches in ON, one at a time, and note that the appropriate "No Power" indicator light goes out each time. Check appropriate bus voltage between 110 to 120 volts as each inverter is turned on. Leave secondary inverter power switch ON.
    c. Place inverter transfer control switch in SEC INV MAIN BUS. "No Power Sec Bus" and "Sec Inv on Main Bus" lights will come on and "No Power Main Bus" light will go out. Check main bus voltage between 110 and 120 volts.
    d. Place inverter transfer control switch in SEC INV A-5 BUS. "No Power Main Bus" and "Sec Inv on A-5 Bus" lights will come on and "No Power A-5 Bus" light will go out. Check A-5 bus voltage between 110 120 volts.
    e. Place inverter transfer control switch in SEC INV SEC BUS. "No Power Sec Bus" and "Sec Inv on A-5 Bus" lights will go out and the "No Power A-5 Bus" light will come on. Check secondary bus voltage between 110 and 120 volts. Place secondary inverter power switch in OFF. "No Power Sec Bus" light will come on.
    f. Place A-5 inverter power switch in On and inverter transfer control switch in A-5 INV SEC BUS. "No Power A-5 Bus" and "A-5 Inv on Sec Bus" lights will come on and the "No Power Sec Bus" light will go out. Check secondary bus voltage between 110 and 120 volts.

g. Return inverter transfer control switch to NORMAL and place main and secondary inverter power switches in ON. All indicator lights will go out.

51. Heat Selector - AUTO
Pilot places heat selector switch in AUTO and temperature rheostat positioned at 12:00 o'clock.

52. Brake Chute - COCKED - cocked
Pilot and copilot check deployment and jettison handles to insure they are cocked.

53. Instruments & Push-to-Test Lights - CHECKED - checked
Pilot and copilot make the following checks where applicable to their station:
a. Clock running and set for time
b. Vertical gyros erecting
c. Stand-by compass on proper heading
d. Slaved gyro and RMI indicating same heading and approximately same as stand-by compass
e. Check fuel pressure, oil pressure, EGT, and tachometers all reading zero.
f. Rate-of-climb, airspeed, Machmeter and turn-and-bank indicate proper static conditions
g. Altimeters, free air temp and cabin temp gage readings correspond approximately with pressure and weather conditions
h. Test all push-to-test lights and adjust lights for bright or dim as desired.
Pilot resets all fire shutoff switches while testing engine fire warning lights. This may be done by using a little more pressure than required for testing the lights.

Copilot depresses landing gear handle test switch; pilot and copilot check that landing gear handle tip light comes on.

54. Fire Warning & Overheat Lights - TESTED
Pilot places engine fire warning test switch for engines No. 1, 2, and 3 in TEST; fire warning lights for engines No. 1, 2, and 3 will glow if circuits are ok. Places test switch for engines No. 4, 5, and 6 in TEST, warning lights for engines No. 4, 5, and 6 will glow if circuits are ok. Places wing and empennage over-heat test switches in TEST; wing and empennage over-heat warning lights on instrument panel will glow if circuits are ok. Checks that all switches have returned to NORMAL and lights are out.

NOTE

If instrument panel lights are on, engine fire warning lights will glow dim.

55. Engine Screen - AUTO
Pilot places engine screen switch in AUTOMATIC.

NOTE

If take-off conditions are marginal, the engine screen switch will be placed in OPEN position to get maximum available thrust.

56. Slipway, Exterior and Pitot Heat - OFF
Pilot checks slipway anti-icing, exterior surfaces anti-icing and pitot heat switches (two) OFF

56a. Overheat Control - NORMAL
Pilot places the anti-icing overheat control switch in NORMAL; switch guard closed.

57. Anti-Skid - ON - LIGHT OUT
Pilot places anti-skid switch ON. (If anti-skid switch has been ON, place switch in OFF to test light. The light will not glow until switch has been off for 2 or 3 seconds. Return switch to ON). Checks light out.

58. Master Air - ON
Pilot places master air conditioning switch ON.

59. Cabin Air - COMPRESSOR (RAM)
Pilot places cabin air selector switch in AIR COMP and his response will be "Compressor."

NOTE

If "K" equipment is not being used or not installed, additional cabin ventilation may be obtained during hot weather by placing this switch in RAM SUPPLY.

60. Cabin Pressure - NORMAL
Pilot checks that cabin pressure regulation selector switch is in PRESS NORMAL.

61. Windshield Heat & Defrost - NORMAL & ON
Pilot places windshield anti-ice switch in NORMAL and windshield defrost switch ON. Checks for blower output around windshield.

NOTE

If weather conditions are conducive to fogging in the cabin or on the windshield, the windshield defrost switch may be left ON.

62. Low-Speed Warning - ON
Pilot checks low-speed warning switch ON and switch guard closed.

63. Control Lock - FORWARD, IN DETENT
Pilot moves surface lock lever to full forward position and checks that it is in the detent.

NOTE

Surface power controls cannot be energized until surface control lock is in the full forward detent.

64. Radios - ON
Pilot places IFF and all radios on for warm-up (omni-range, radio compass, and UHF Command).

65. Hydraulic System - checked
Copilot makes the following system check:
Turns emergency hydraulic pump switch OFF and assures that brake system is fully bled.
Checks air preload pressures and fluid quantity:
a. Main brake system, 1500 psi
b. Emergency system, 1500 psi
c. Emergency brake system, 1000 psi
d. Main system, 0 psi
e. "No Pressure" warning lights (two) are on
f. Fluid Quantity, 6.5 US gallons
Places emergency pump switch ON to build up emergency pressure to 2200 psi at which time the "No Pressure" light goes out. (While emergency pump is operating, pump operating light is on.) Places emergency pump switch in AUTO and checks that pressure builds up to

3000 psi and pump cuts out as indicated by "Pump Operating" light going out.

NOTE

Main system pressure will be zero until one of the engine-driven pumps is operating.

66. Dump Valve - RESET
Pilot checks that dump valve (emergency cabin pressure release handle) is down.

67. Controls - ENGAGED - engaged
Pilot and copilot will engage the control columns in the following manner:
a. Unlatch the control column from the instrument panel with the left hand and unlock the disconnect handle with the right hand by pressing in on the thumb button.

CAUTION

Do not push the disconnect handle down because damage to the disconnect rod assembly may result. With a damaged disconnect rod assembly, improper engagement of the control column may result in no down elevator being available, creating a dangerous in-flight condition.

b. Pull the control column as far aft as possible with the left hand. The control column will engage and the disconnect handle will enter the engaged position automatically.

68. Power Controls and Trim Tabs - ON CHECKED - zero
Pilot places all surface power control switches (three) in normal position; warning lights on panel will go out.

NOTE

If power control warning lights do not go out, recheck surface lock lever for full FORWARD DETENT.

Pilot calls "Ground from pilot, standby to check trim tabs." Ground observer notifies pilot of tab movement and direction of movement. Pilot actuates tabs as follows:
a. Aileron trim tabs to full left, to full right, and then zero.
b. Rudder trim tab to full left, to full right, and then zero.
c. Elevator trim tab to full down, to full up, and then zero.
d. Copilot checks trim indicators on zero.

NOTE

Only right elevator tab will move during this check.

69. Automatic Pilot - CHECKED - release ok - OFF
Pilot makes the following check:
a. Extend the automatic pilot support, check automatic approach switch in AUTOMATIC PILOT, turn knob in detent, altitude control switch to OFF, and turn control switch to PILOT position.
b. Center trim tabs and flight controls place the automatic pilot master switch in ON, then place all three engaging switches in ENGAGE.
c. Rotate turn knob to the left; control wheel should follow until the limit switch is contacted and automatic pilot disengages. Reengage automatic pilot and repeat check with right turn.
d. Reengage automatic pilot and have copilot push his release switch. Reengage automatic pilot and check the release switch on the pilot's wheel.
e. Check all switches in off and stow automatic pilot support.

70. Flight Controls - CHECKED - POWER ON & OFF
Pilot checks all surface power control switches (three) in NORMAL; warning lights on panel should be out.
a. Move surface lock lever toward LOCK approximately 5°; surface power control warning lights will come on. Position surface lock lever in UNLOCK detent; lights will go out.
b. Call on interphone "Ground from pilot, stand by to check flight controls." Pilot moves control wheel full left, and ground observer reports positions of ailerons, trim tabs, and flaperons.
c. Pilot moves control wheel full right, and ground observer reports positions of ailerons, trim tabs, and flaperons.
d. Complete check of elevators and rudder to each extreme with ground observer reporting their positions.
e. Move aileron to full left and start wing flaps up; as flaps retract to approximately 95% to 97%, left flaperon will drop flush with flap.

CAUTION

If flaperon fails to drop flush with the flap at approximately 97% to 95%, do not retract flaps beyond 93% as a system malfunction may result.

f. Move aileron to full right and start flaps down; as flaps extend to approximately 95% to 97%, the right flaperon will spill up. Check flaps 100% down and center ailerons.
g. Place surface power controls OFF and move control surfaces through their full range and have ground observer report movements.

NOTE

Check that flaperons do not move.

71. Parking Brakes - SET
Pilot depresses left pedal and locks parking brakes ON.

NOTE

- Parking brakes may not be effective until engine No. 3 or 4 has been started and main hydraulic pressure is available.
- If left pedal remains down, this indicates parking brakes are set. If pedal returns up, push in parking brake pedal and repeat procedure.

72. Flaps - checked & up
    Copilot calls "Ground from copilot, check wing flaps." Ground observer notifies copilot when flaps move or stop and the action of the left elevator trim tab during flap operation.
    a. Copilot retracts flaps to approximately 80% with normal flap lever.
    b. Retracts flaps approximately 10% with each emergency switch.
    c. Retracts flaps to full up with normal flap lever.

    The wing flaps retract in approximately 40 seconds and extend in approximately 20 seconds using the normal flap lever.

CAUTION

Use care during flap operation with the emergency switches, as there are no limit switches incorporated in the emergency system.

73. Engine Stall Prevention Switch - AS REQUIRED
    Pilot places engine stall prevention switch ON if temperature is below 15°C (59°F) or if formation flying or aerial refueling mission is to be performed.
74. Remove Bomb Door and Gear Locks
    Copilot calls to ground crew "Remove bomb door and gear locks." Ground crew will acknowledge and proceed with removal.
75. Fuel Panel - SET
    Pilot places all fuel selector switches in ME and checks that fuel boost pressure warning lights (12) are illuminated.

NOTE

If any lights are not illuminated, release pressure on the manifold by momentarily lifting one throttle (preferably No. 1) out of CUT OFF position.

Pilot places all engine fuel selector switches on TME; all fuel boost pressure warning lights should go out. Checks all auxiliary tank valve and boost pump switches (five) OFF, all fuel transfer switches (three) in CLOSED, and auxiliary fuel to engine switch OPEN. Selects first auxiliary tanks to be used by placing respective tank valve and boost pump switches ON. Pilot then tests each of the four fuel quantity gages by depressing test button adjacent to each fuel quantity gage.

76. Master Refuel Switch - REFUEL - checked - NORMAL
    Pilot places master refuel switch in REFUEL. Copilot checks that green master refuel indicator light comes on. Pilot returns master refuel switch to NORMAL.
77. Fuel Gage Control - COPILOT - checked - ON PILOT
    Pilot places fuel gage control switch on COPILOT. Copilot reads off fuel quantities and tests each of four fuel quantity gages by depressing the test button adjacent to each fuel quantity gage; indicator should start moving toward zero if indicator circuits are ok. Pilot returns fuel gage switch to PILOT.
78. Refuel Panel - valves closed, disc intact
    Copilot checks all refueling valve switches (eight) on VALVE CLOSED, slipway door switch CLOSED, fire extinguisher selector switch OFF, and all four CO_2 discs intact. Places emergency fire extinguisher switch to EMERGENCY ON; "Power-On Fire Extinguisher" light will come on. Returns to NORMAL; light will go out. Checks aerial refueling system selector switch OFF.
79. Generators - reset & off
    Copilot sets all generator switches (six) to RESET, then to OFF.

NOTE

Placing the generator switch to RESET prior to OFF resets the field trip relay to regain generator (and starter) control which was lost at the time of engine shut-down when the fire shutoff switch was actuated.

80. Alternators - reset & off
    Copilot sets both alternator power switches to RESET, then to OFF.

CAUTION

If alternator power is required, the alternator power switches must be placed in RESET prior to starting engines No. 1 and 6. If this procedure is not followed, a long delay will be observed before alternator output will be connected to the bus system, or flashing of the alternator field may be necessary to obtain alternator operation.

Copilot checks left and right alternator switches OFF. If external AC power is connected for "K" system preflight, bus selector switch will be positioned on EXT. PWR. If external AC power is not required, bus selector switch will be OFF.

81. ELGE Lights & Gear Indicators - CHECKED - checked
    Copilot checks emergency landing gear extension stand green "Gear Down-and-Locked" indicator lights (four) are on, and the red "Unsafe to Land" light is off. Pilot and copilot check that four position indicators on the instrument panels show gears down and locked. Check that landing gear lever light is out.
82. Synchronize N-1 Compass Master Indicator - synchronized
    If the observer is not flying, the copilot synchronizes the N-1 compass master indicator in the following manner:
    a. Rotate the latitude correction knob counterclockwise until the latitude correction pointer indicates OFF.

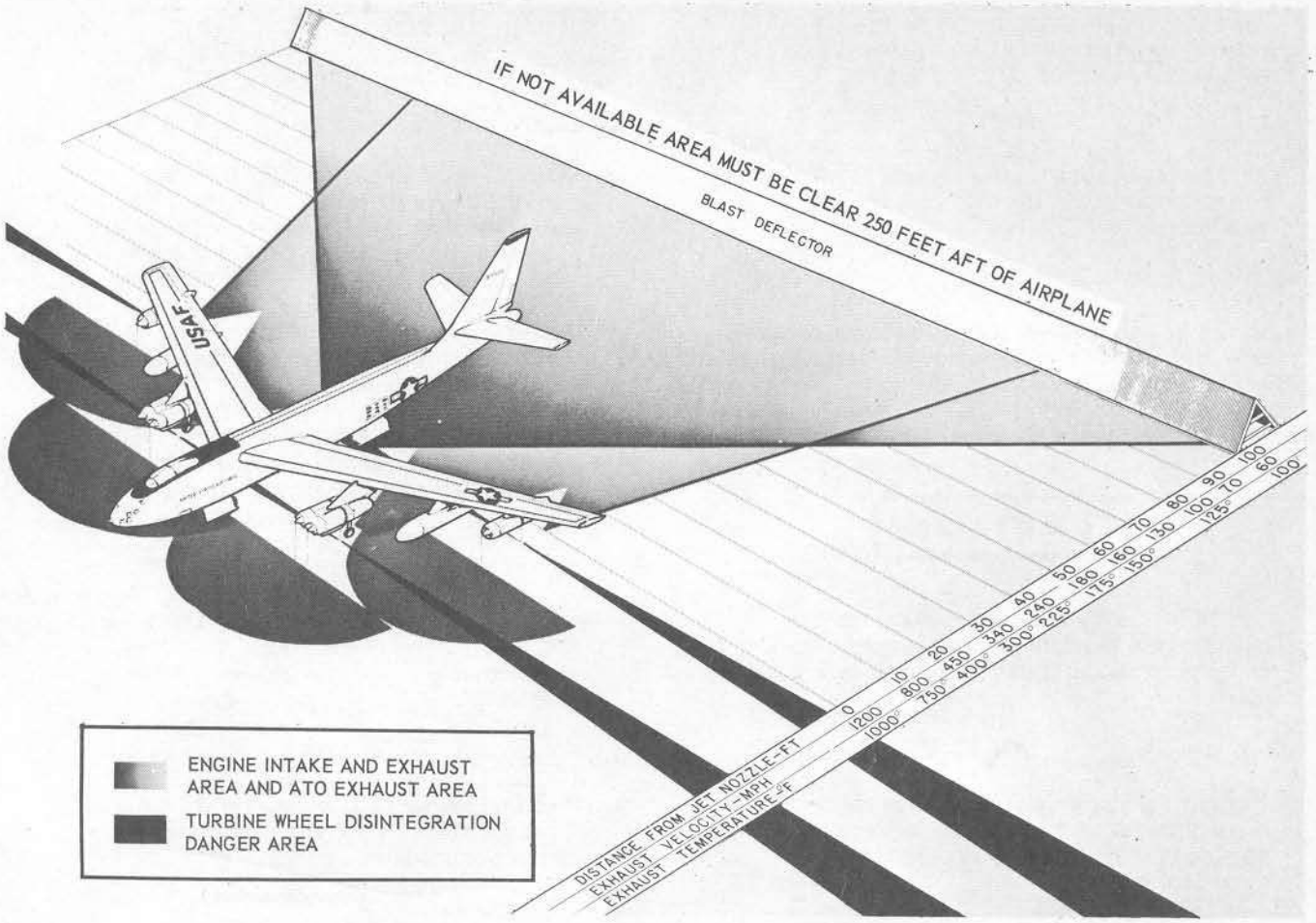


Figure 2-3. Engine Danger Areas

b. Engage and rotate the synchronizer knob in the direction indicated by the annunciator pointer; clockwise if the annunciator pointer indicates "R" and counterclockwise if it indicates "L," until the annunciator pointer is on its center index.

CAUTION

Do not synchronize on the unstable null; ie, 180° from the correct magnetic heading.

83. Radios - CHECKED
    Pilot checks all radios for proper operation. Turns all radios OFF except UHF Command.
84. Bomb Door & Gear Locks - IN SIGHT
    Pilot visually checks that four gear ground locks and two bomb door locks are displayed on ramp and to the left of airplane.
85. ATO Safety Link - INSTALLED
    Pilot requests crew chief to install ATO safety link. Indicator light on ATO control panel will come on when safety link has been installed.

WARNING

ATO firing area must be clear of all ground personnel when ATO safety link is installed.

FUEL SPECIFICATION AND GRADE.

The fuel used in this airplane shall conform to Specification MIL-F-5624A, Grade JP-4 (recommended); or Specification MIL-F-5572, any grade aviation gasoline (alternate).

WARNING

Prior to starting engines and during engine operation, be sure the engine danger areas around air intake ducts and exhaust jet nozzles, shown on figure 2-3, are clear of personnel, aircraft and vehicles; air intake suction is sufficient to kill or seriously injure personnel if drawn into or suddenly

against the air intake; danger in rear of exhaust jet is created by high exhaust temperature and velocity.

NOTE

The operating limits are identical for the recommended and alternate fuel grades. (See section V.)

BEFORE STARTING ENGINES.

Prior to starting engines, the pilot should become familiar with the Engine Fire During Starting procedure in section III in case of an engine fire while or after starting an engine. The following additional precautions should also be observed.

CAUTION

Position the airplane so that consideration can be given to other aircraft, personnel, and ground installations when engines are started.

NOTE

Engines should be run up with the airplane headed into or at right angles to the wind since a tail wind may increase exhaust gas temperatures.

CAUTION

When practicable, start and run up engines with airplane on clean concrete or other paved surface to minimize possibility of dirt or other objects being drawn into engine compressor and damaging engines.

INTERIOR CHECK (NIGHT FLIGHTS).

In addition to the preceding checks perform the following for night operations. These additional checks will be performed after external power has been connected.

a. Floodlights - Test cabin floodlights at pilot's and copilot's station; RED and WHITE.
b. Side Panel Lights - Test and inspect for bulbs not lighting at pilot's and copilot's station.
c. Compass Light - Test compass light on BRIGHT and DIM at pilot's and copilot's station.
d. Landing and Taxi Lights - Test individually (5 seconds, maximum for test).
e. Position Lights - Test and verify lighting with ground observer. Test operation of position light code selector as determined by local SOP.
f. Reposition light switches as desired for night flights at pilot's and copilot's station.
g. Check that flashlight is available with fresh batteries at each crew station. Flashlight stowed.

STARTING ENGINES.

NOTE

Engine starting sequence - 4, 5, 6, 3, 2, and 1.

1. Ready to Start Engines - READY - ready
   Pilot notifies crew and crew chief "Stand by to start engines." Crew chief confirms with "Clear to start, fire guard on No. 4." Copilot positions DC voltmeter selector switch to engine being started and informs pilot.
2. Ignition Switches - NORMAL
   Pilot checks all ignition switches (six) in NORMAL position.
3. Start Engines
   The procedure for starting engine is as follows:
   a. Pilot places starter selector switch to engine to be started. Engage starter switch and hold for approximately 2 seconds and release.
   b. Copilot informs pilot when engine rpm reaches approximately 6%. At 6% rpm, pilot advances throttle to START position and watches tailpipe temperature for indications of combustion. Fuel pressure fluctuation shall not exceed ± 35 psi at stabilized rpm.

NOTE

If no fuel pressure is noted, retard the throttles to CUT OFF and repeat the starting procedure.

CAUTION

Engine must not be operated with the throttle in the START position for longer than 30 seconds.

NOTE

If combustion does not occur within 7 seconds after advancing throttle or when the engine speed reaches 9%, or if the engine speed has not reached 9% within 40 seconds after the starter switch is engaged, momentarily position the starter switch to CUTOFF and close the throttle to discontinue the start. Allow combustion chambers to drain and starter to cool for at least 3 minutes before attempting another start. The starter should not be used to turn the engine longer than 1 minute without the assistance of combustion; starter is limited to three runs of 1-minute duration during any 30-minute period. Allow starter to cool 30 minutes before using again.

CAUTION

After opening the throttle with the starter energized, do not change the position of the

MINIMUM TURNING RADIUS

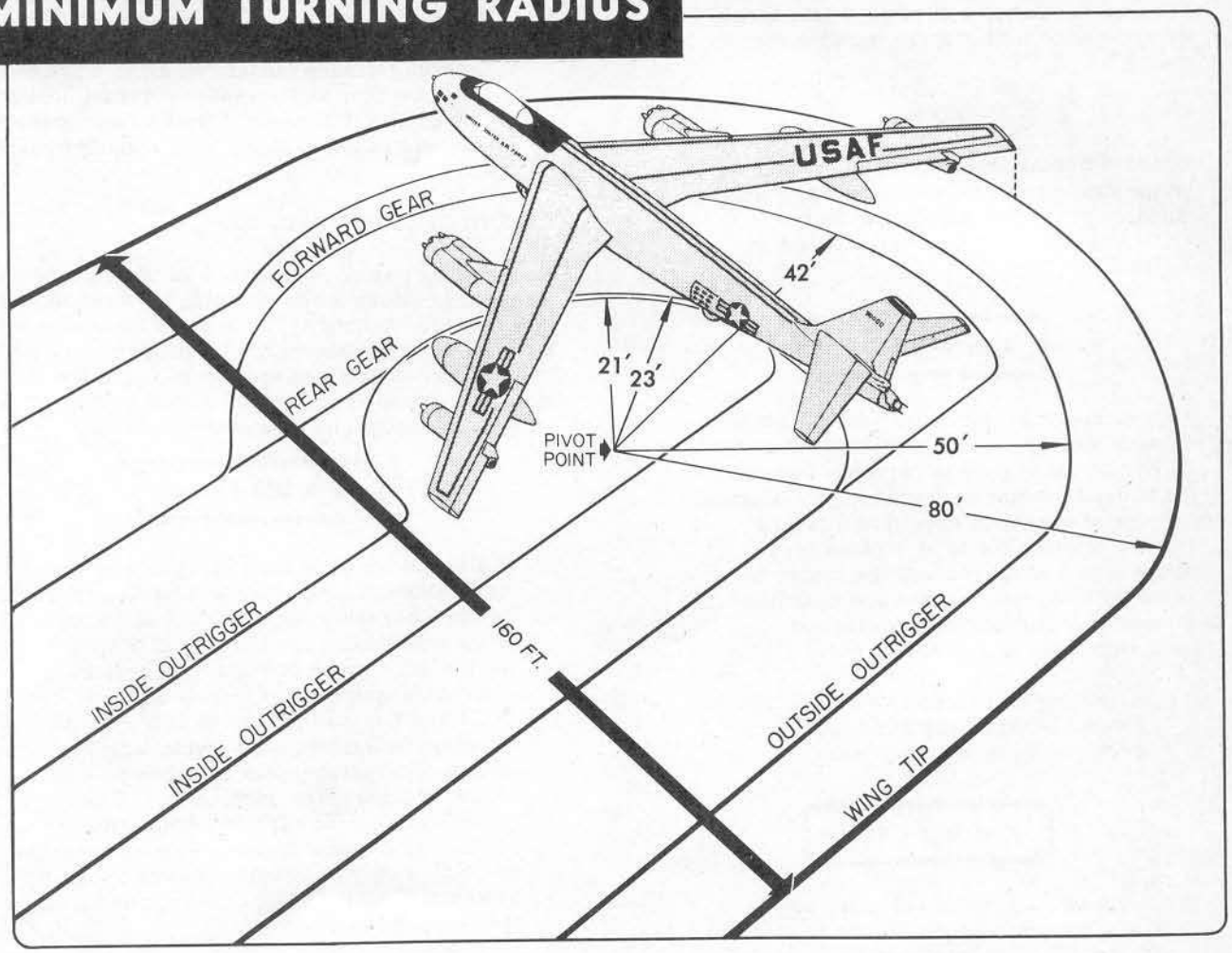


Figure 2-4.

fuel selector switches or turn on the ignition switch. If improper settings are noted during the start, shut off engine as described above and allow engine to drain. Repeat starting procedure after making sure that ignition switch is in NORMAL position and fuel selector switches are properly positioned.

c. When the engine has fired, the rpm will stabilize at approximately 13% to 15% with the throttle in START position. Allow tailpipe temperature to stabilize and, as temperature begins to drop, lift throttles out of starting detent and advance at a rate to maintain the tailpipe temperature between 650° and 690° C. Advance throttle to 40% rpm (idling position). Observe that tailpipe temperature does not exceed 690° C. Copilot will check for starter cut-off at approximately 15% to 25% rpm by observing a momentary voltage flicker on the DC voltmeter. If starter cut-off does not occur by 30% rpm, notify pilot.

d. Pilot will place starter switch in CUTOFF if notified by copilot. Copilot will note when engine No. 4 is started that main hydraulic pump warning light goes out and that main hydraulic system pressure builds up to normal. When engine No. 3 is being started, check that the remaining main hydraulic pump warning light goes out.

NOTE

The time required for the engine to accelerate from 0% to idle rpm varies from about 1 minute on cool days to about 2 minutes on hot days.

CAUTION

Any one start or acceleration during which exhaust temperature exceeds 1000° C or any ten starts or accelerations during which exhaust temperature exceeds 870° C shall constitute overtemperature operation

and require that the engine be removed from the airplane and returned to overhaul. (The ten hot starts will require this action regardless of time elapsed between the starts.)

NOTE

In order to maintain necessary over-temperature records, the occurrence and duration of exhaust gas temperature exceeding 870° C should be recorded on Form 1.

CAUTION

Five starts or accelerations during which exhaust temperature exceeds 870° C require that the engine be carefully inspected for possible damage prior to flight. Engine overspeed operation exceeding 104% of rated rpm, either with or without over-temperature, requires that the engine be removed from the airplane and returned to overhaul. All cases of overspeed operation shall be entered in Form 1.

e. Allow engine to stabilize at 35% rpm and check all engine instruments before accelerating to a higher rpm.

CAUTION

If no rise in oil pressure is noted by the time idle rpm is reached, increase rpm until a definite rise in oil pressure becomes apparent. If no pressure increase is noted before 80% rpm is reached, shut down and investigate the cause for lack of pressure.

NOTE

During cold weather starts, oil pressure may exceed maximum limits until the oil temperature reaches normal.

f. Check for positive oil pressure rise during acceleration.

g. As aoon as starter cut-out occurs, the pilot will start the remaining engines as above.

4. Engines 1 and 6 - 52% - alternators on
   If alternator power is required, pilot will adjust throttles for engines No. 1 and 6 to obtain a minimum of 52% rpm. Copilot will place alternator switches to RESET, then to NORMAL; the "Under Freq" lights should remain out.
5. Hydraulic Pressure - lights out, pressure up
   Copilot will check that main hydraulic system and main brake system pressures are up within operating range and both main pump warning lights are off.
6. Ignition Switches - OFF
   The pilot will place all (six) ignition switches in the OFF position.
7. Entrance Door - closed & locked
   Retract entrance ladder and close and lock entrance door and pressure compartment door. The copilot will check this and then return to seat and refasten safety belt, shoulder harness, etc.

ENGINE GROUND OPERATION.

No warm-up period is required for jet engines other than a time allowance to stabilize the exhaust gas temperature. Normally, as soon as the engines stabilize at idling speed, the throttles may be advanced to full open. Rapid forward movement of the throttles must be avoided at all times. Refer to figure 2-5 for allowable exhaust gas temperatures.

CAUTION

If alternators were not reset prior to starting engines, a long delay will be observed before alternator output will be connected to the bus system, or flashing of the alternator field may be necessary to restore alternator operation. Operate engines No. 1 and 6 at a minimum of 52% rpm (to maintain under frequency lights out), actuate alternator power switches to NORMAL, and place unregulated AC bus selector switch to NORMAL before disconnecting external power. Failure to maintain 52% rpm will interrupt power to the "K" system and may result in damage to the electronic equipment.

BEFORE TAXIING.

1. Generators - on, loads & voltages checked
   The copilot will position all generator switches (six) to ON. Check that all generators are charging; place DC voltmeter selector switch on each generator position and check voltage. Check that generator loads are approximately equal by comparing loadmeter indications.
2. Battery Switch - ON
   The pilot will place the battery switch in the LH BUS NORMAL position.
3. Bomb Doors - CLEAR, CLOSED & LOCKED
   Pilot will check with ground observers that bomb doors are clear to close. Position bomb door switch to CLOSE. An alternate black and white striped tab will appear in the bomb door position indicator tab window while the doors are closing and a LOCK tab will appear when the doors are closed and locked.
4. Alternator Bus Switch - on normal
   Copilot places unregulated AC bus selector switch to NORMAL after engines are operating at a minimum of 52% rpm; "Power Off" indicator lights should go out.

5. External Power, Chocks & Interphone - REMOVED & IN SIGHT
   Pilot requests ground crew to remove external AC and DC power and wheel chocks, disconnects ground interphone, and place equipment forward, to the left, and clear of airplane where visible to the pilot.
6. Radio Call - COMPLETE, ALTIMETER SETTING - _____ - altimeter set
   Pilot calls tower for taxi and take-off instructions and altimeter setting. Notifies copilot and observer to set altimeters.
7. Hydraulic Pressures & Quantity - checked
   Copilot checks that hydraulic system pressures are within operating range, fluid quantity is within limits, and all lights are out.
8. Rudder Elevator Surface Control - ON
   Pilot places rudder-elevator surface power control switch NORM.

NOTE

Without surface power control, rudder motion, caused by a cross-wind, is transmitted into the steering system.

9. Steering Ratio Selector - TAXI
   Pilot places steering ratio selector lever in TAXI position and insures that it is in the locked (in detent) position.

NOTE

Prior to moving lever, neutralize rudder pedals.

10. Clear to Taxi - READY TO TAXI ON CREW CHIEF'S SIGNAL
    Pilot signals crew chief when ready to taxi and obtains clearance to roll. Releases parking brakes.

TAXIING INSTRUCTIONS.

CAUTION

Do not actuate unnecessary hydraulic equipment while taxiing with No. 3 or 4 engines at idle rpm because the added load on the hydraulic system may reduce the effectiveness of brakes and steering.

All steering during taxiing is accomplished by use of the front gear steering system. Differential braking is not possible with the bicycle type landing gear, and differential thrusts with the engines should not be used because this method is ineffective. The airplane must be in motion before executing turns; use the largest turning radius possible to minimize tire wear and landing gear stress. For minimum turning radius, see figure 2-4. Taxi the airplane with engines operating at 35% rpm or more as needed. Use the brakes as little as possible.

NOTE

If the steering system is inoperative when the aircraft is taxied from the parked position, move the steering ratio selector lever rapidly from TAXI to TOW and back to TAXI position. If the malfunction is caused by a sticking disconnect valve plunger, this procedure may free the plunger and return the steering system to normal operation.

CONDITION	TIME	MAXIMUM TEMPERATURE
Take-off	5 Minutes	691° C
Military Rated	30 Minutes	658° C
Normal Rated and Below	Continuous	635° C
Start and Accelerations	20 Seconds	716° C

NOTE
All temperatures shown are maximum.
All temperatures over 870° are considered overtemperature operation and will be noted in Form 1.

Figure 2-5. Allowable Exhaust Gas Temperatures

NOTE

- During taxi, test normal brake system with anti-skid switch at OFF. Return switch to ON and check action of anti-skid system.
- The high fuel consumption of approximately 100 to 150 pounds per minute during taxiing makes it necessary to hold engine speed and taxi time to an absolute minimum. Avoid excessive jockeying of throttles during taxiing.

CAUTION

If the airplane is stopped while executing a turn, do not change directional position of the forward main gear prior to putting the airplane in motion again. Any radical change in the steering direction while stopped could cause damage to an outrigger gear when taxiing is resumed.

WHILE TAXIING.

1. Hydraulic Pressures - checked
   Copilot checks main hydraulic system and main brake system pressures periodically while taxiing (at 30-second intervals in congested areas).
2. Circuit Breakers - checked in
   Copilot checks to insure all circuit breakers on the upper and lower DC power panels are in and none have tripped.
3. Automatic Pilot - OFF
   Pilot checks that automatic pilot master switch is in OFF position.
4. Canopy - CLOSED, LATCHED, LOCKED - pins in place
   Before closing canopy, pilot checks canopy lock lever in UNLOCKED position. Copilot checks that lock pins are out and notifies pilot, "Clear to close." Pilot calls, "Closing canopy." After canopy closes, pilot checks canopy latch indicators on "Canopy Latched," leaves control

lever in CLOSED position, and moves lock lever to LOCKED position. Copilot checks that locking pins are in place. If canopy has been closed, check "Canopy Latched," canopy lock lever LOCKED, and control lever in CLOSED position. Copilot checks that the canopy locking pins are in place.

5. Canopy Roller Lock Indicator - LOCKED POSITION
   Check that canopy roller lock indicator is in LOCKED position.

WARNING

Check that the canopy roller lock indicator is in the LOCKED (horizontal) position prior to each flight. If a flight were made with the roller in the UNLOCKED (vertical) position, the canopy (if opened in flight) could release, travel an unpredictable path and strike the pilot and copilot.

6. Trim Tabs - SET FOR TAKE-OFF
   Pilot checks his trim tabs set for take-off (figure 2-6).
7. Elevators Engaged - CHECKED - checked
   Copilot holds control column in neutral. Pilot attempts to move control column to insure that control columns are engaged.
8. Fuel Control Panel - SET, LIGHTS OUT
   Pilot checks all engine fuel selectors (6) on TME and all warning lights out; auxiliary fuel to engines switch OPEN; auxiliary tank, first to be used, boost pump switch ON. (See section VII for fuel system management.)
9. Flaps - checked and full down
   a. Copilot extends flaps to approximately 20% with normal flap lever.
   b. Extend flaps approximately 10% with each emergency switch.
   c. Extend flaps full down with normal flap lever. Pilot checks flap position indicator for 100% flaps. Check flap lever in OFF.
10. Surface Power Controls - ON, LIGHTS OUT
    Pilot checks all surface power control switches on NORMAL. Surface power control warning lights should be out.
11. Flaperons - CHECKED
    Pilot moves aileron to full left and full right and visually checks flaperons for normal operation.
12. Cabin Air Selector Switch - AIR COMPRESSOR
    Pilot checks that cabin air selector switch is in AIR COMP position.
13. Flight Instruments - CHECKED - checked
    Pilot and copilot check the attitude gyro; if gyro has not erected properly at this time, cage it momentarily. Check that stand-by compass, RMI, and slave gyro indicate approximate runway heading; rate-of-climb, turn-and-bank, airspeed, and Machmeter read zero or the normal static reading.

BEFORE TAKE-OFF.

1. Brakes - HOLD
   Pilot aligns airplane with runway and holds brakes.
2. Compass Repeater Indicator - CHECKED
   Pilot checks that the remote compass repeater indicates approximately the same heading as the runway heading.

2a. Engine Screens - OPEN
   Pilot check engine screen switch OPEN

3. Steering Ratio - TAKE-OFF & LAND
   Pilot places steering ratio selector lever in TAKE-OFF AND LAND.
4. ATO Arming Switch - ARMED
   If an ATO take-off is to be made, pilot places ATO arming switch in ARMED.
5. Throttles Open - OIL, FUEL, EGT OK, 100% - alternators & generators checked
   Pilot slowly moves all throttles to 100% RPM. Checks all tachometers for engines at 100% rpm. Checks oil and fuel pressure within operating limits. Copilot checks generator loads and alternator output.

CAUTION

Watch carefully for engine overspeed or excessive tailpipe temperature.

TAKE-OFF.

NOTE

The techniques as outlined herein are those required to produce the results illustrated in the take-off charts in the Appendix.

Close attention should be given to the correct take-off procedure on this airplane, since differences from reciprocating engine bombers appreciably affect ground roll. The principal new factors are:

Jet engine thrust which is nearly constant throughout take-off.

Bicycle-type landing gear assures that the pilot will attain a correct attitude for take-off.

ATO units (assisted take-off by solid rockets) which shorten take-off distances.

TAKE-OFF THRUST.

On this airplane, the minimum take-off distance is attained by maintaining military rated power; therefore all take-offs are to be made at 100% rpm. Thrust at this setting varies with exhaust gas temperature, outside air temperature, and field pressure altitude as shown on figure 2-5. The stabilized exhaust gas temperature that will result from a 100% rpm take-off is established by varying the nozzle area through the installation of area reducing tabs. Although the installation of these tabs is a ground crew function, the pilot should be familiar with the calculations necessary to arrive at the proper tab area.

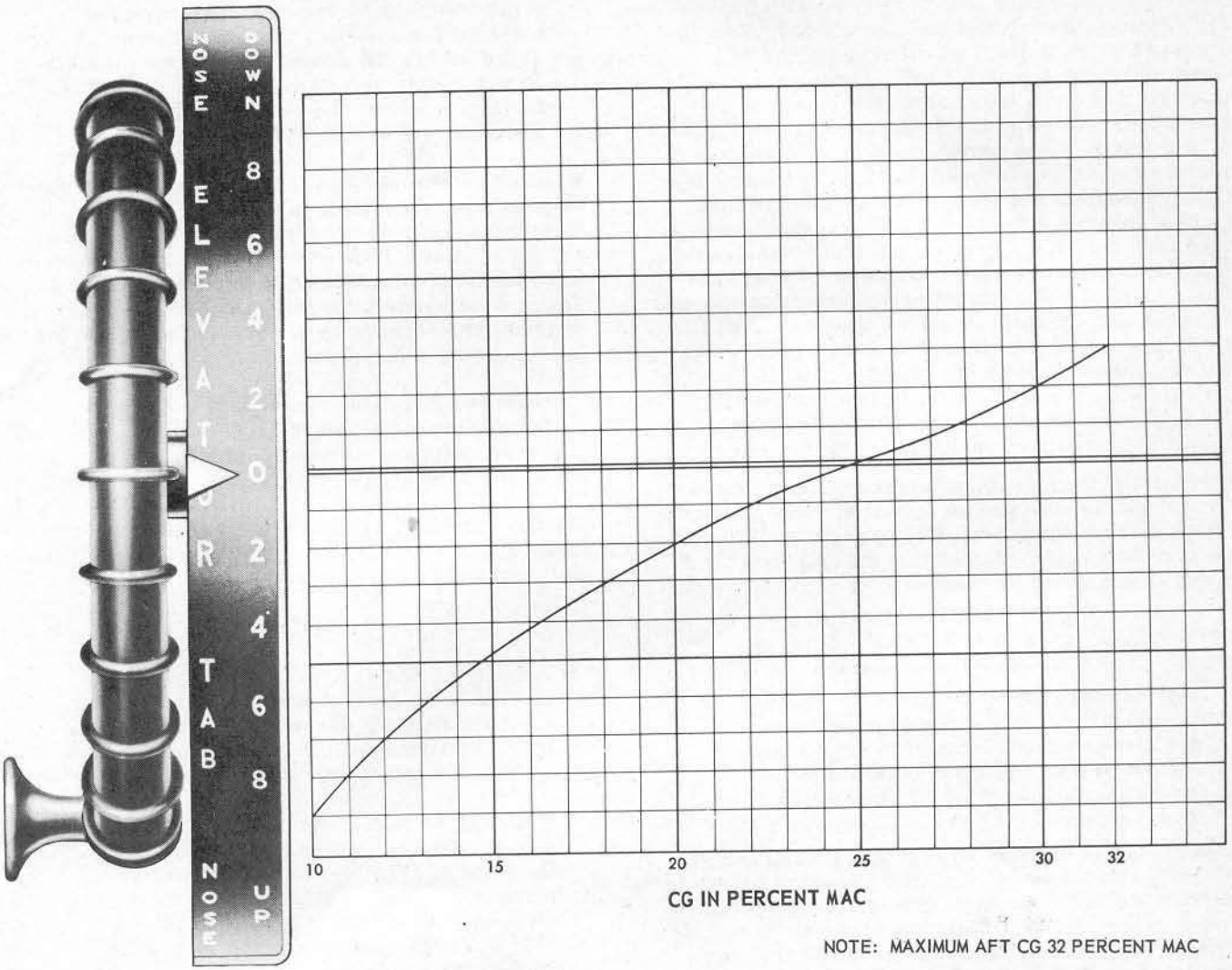


Figure 2-6. Trim Required for Take-off

CAUTION

- Engine temperatures will not stabilize until the engine has been operating at least 8 to 10 minutes. If stabilization is not attained at this time, it is evident that the engine is malfunctioning internally. A temperature of 691° C with an overshoot of 25° C or a maximum of 716° C for 20 seconds is permissible as indicated in figure 2-5.

- Rapid throttle advance (throttle burst) should be avoided except as required during engine acceleration checks, touch-and-go landings, or emergencies. When rapid throttle advance is required, 870° C EGT must not be exceeded.

NOTE

Take-off will require about 2 1/2% more runway for each 10° C that the engine tailpipe temperatures for all six engines are below the correct temperature for properly "tabbed" engines. Therefore, it is important that the temperature indicating instrument be accurate.

WING FLAP OPERATION.

CAUTION

- When operating the wing flaps at low temperatures, the flap position indicator should be closely observed for positive movement. If the flaps should stall, immediately place the flap lever in OFF position to prevent damage to the motor.

- Wing flaps may not retract at speeds above 175 knots IAS during prolonged exposures at temperature between -40° C (-40° F) and -54° C (-65° F).

Minimum take-off distance is attained with flaps fully extended throughout the take-off run. This increases the lift and will shorten the ground roll. (Also, the flaperon control will operate only when flaps are full down and aileron power control operating.) Lowering the flaps during the roll instead of at the start, as is sometimes done to achieve better acceleration, is of no benefit because of the low drag flaps. Flaps are more important on this airplane than on previous airplanes. Full extension is always used and no partial flap positions are recommended. The flap controls require a minimum of attention from the pilot. The retraction and extension times coincide with the airplane speed changes during flap operation so that the airplane is always well above the stall and well below the structural limit. Also, the elevator trim mechanism is coordinated with the flaps to automatically compensate for trim changes during flap transition.

On take-off, the flap retraction time (approximately 40 seconds) is slow enough so that airplane acceleration will keep the speed well above the stall, yet the flaps retract fast enough so that the flap structural speed should never be reached.

CAUTION

During operation at low gross weights and particularly at low ambient temperatures, the airplane accelerates very rapidly and care should be taken not to exceed the speed limitations of the flap retraction. (See figure 2-8.)

Conditions are more critical at high than at low weights, since the minimum flight speed is nearer to the flap structural placard. Speed changes during flap operation in level flight are shown on figure 2-8. The flap retraction curves are for take-off power with gear up. Loss of one engine or failure of the gear to retract will reduce acceleration but not sufficiently to cause a stall.

NORMAL TAKE-OFF.

To preclude any possibility of stalling and to obtain optimum control and climb after take-off, hold elevator in neutral during ground roll and allow the airplane to fly off the ground with both gears leaving simultaneously. The elevator can be used to pull the front gear off when the airplane appears to rock between the front and rear gears.

NOTE

Maximum directional control can be obtained by maintaining slight forward pressure on the control column.

The amount of elevator trim required for take-off is dependent upon cg location. In order to obtain the most desirable trim conditions under various cg conditions, refer to figure 2-6.

NOTE

The take-off run can be shortened approximately 7% by pulling the airplane off the ground with the elevators at a lower speed than that for a normal take-off with both gears leaving the ground at the same time. However, this is not advisable since, at the slower speed, the performance reserve after take-off will be reduced.

It should be realized that take-off performance can be accurately estimated, particularly since the bicycle landing gear practically fixes the airplane attitude at take-off, therefore eliminating the usually large factor of pilot technique on elevator control. To accurately determine take-off distance and optimum procedures, the pilot should ascertain the following data and apply it.

Gross weight
Outside air temperature (OAT) at time of take-off
Field length and pressure altitude
Wind direction and velocity

Relative humidity, which appreciably affects reciprocating engine power, has a negligible effect on turbojet thrust and take-off distances.

NOTE

- If the anti-icing system is operating during take-off, take-off distance will be increased approximately 5% due to the hot air removed from the engine compressor section to operate the anti-icing system.

- If the engine stall prevention switch is inadvertently placed in the ON position, or in the event of DC power failure to the compressor discharge pressure bleed valve; the engine acceleration time from idle (40%) to 100% rpm will be approximately 30 seconds.

EFFECT OF HEADWIND ON TAKE-OFF.

The effect of headwind is to reduce the minimum required length of runway. To determine headwind corrections for the take-off distance and critical engine failure speeds see the Appendix.

OBSTACLE CLEARANCE TAKE-OFF.

When a maximum obstacle clearance take-off is necessary, set the elevator trim tab for four units more "nose up" trim than is indicated on figure 2-6 for the airplane center of gravity. Apply a slight pull force on the control column so that both front and rear gear leave the ground simultaneously. Retract the gear as soon as possible, but leave flaps fully extended. The optimum climb speed for maximum obstacle clearance will be the same as the take-off speed. However, as the airplane leaves the ground, allow the air-speed to increase approximately 6 knots greater than take-off speed to allow for the ground effect error in the indicated airspeed. When the obstacle is cleared, increase the airspeed approximately 15 knots and begin flap retraction.

CROSS-WIND TAKE-OFF

During a crosswind take-off, full flaps are necessary in order to obtain full flaperon action. Use full aileron deflection at the beginning of the ground roll to lower the upwind wing and maintain as nearly a wing-level attitude as possible.

NOTE

If crosswind is of a large enough magnitude, it may cause the airplane to "heel" over on the downwind outrigger, but this differential loading is not detrimental as the outrigger gear is designed with a long stroke shock strut and is amply stressed for such loads.

The amount of aileron wheel deflection required to keep a wing-level attitude will diminish as the airspeed increases to the take-off speed. Hold some push force on the control column to assist front gear steering during the take-off roll and allow the rear gear to break ground first. With the rear gear off the ground, pull front gear clear of runway to approximately the same attitude as the rear gear. As the airplane becomes airborne, obtain the proper crab angle to maintain a ground track down the center of the runway. When airplane is definitely airborne and the climb established, retract the landing gear. Allow airplane to accelerate approximately 15 knots and start flap retraction.

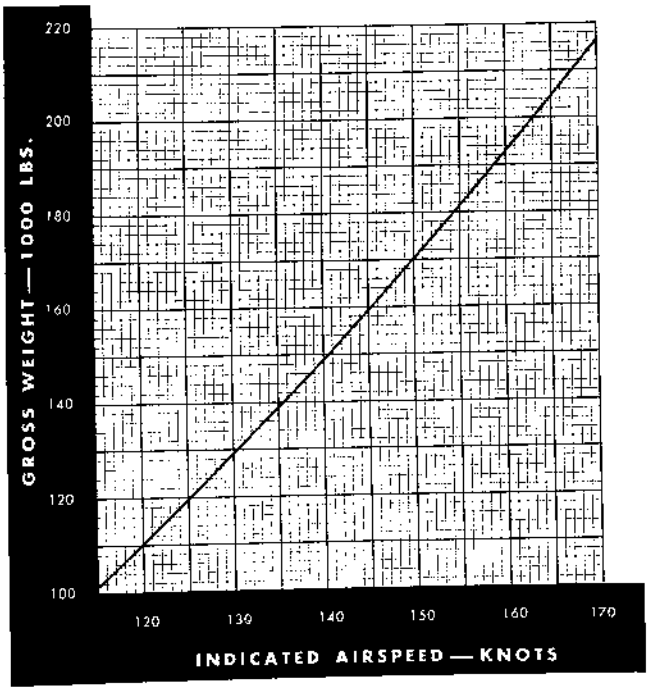
NIGHT TAKE-OFF.

When making a night take-off, use the same procedure as for a day take-off with the following exceptions:

In order to maintain proper ground clearance and as an aid in judging the climb angle, both landing lights should be on throughout the ground roll and take-off until airplane is airborne, the climb established, and obstacles cleared.

TAKE-OFF SPEED.

The gross weight of the airplane is the important factor in determining the take-off speed. To estimate the take-off indicated airspeed, see figure 2-7.



REMARKS:
TAKE-OFF SPEEDS CORRECTED FOR GROUND EFFECT

DATE:
DECEMBER 1952

DATA BASIS:
FLIGHT TEST

Figure 2-7. Take-off Speed

TAKE-OFF PERFORMANCE -- NO ATO.

Although solid rockets are provided on the B-47 airplane for augmenting take-off thrust, many take-offs will not require their use. The possibility of an engine failure during the take-off run influences take-off procedure and should in all cases be considered. With an engine failure, the pilot must be able either to stop or take off safely. The speed to which an engine failure permits acceleration to lift off in the same distance that the airplane may be decelerated to a stop is called its critical engine failure speed for the particular weight, altitude, and temperature.

During the take-off roll, if an engine fails before this critical engine failure speed has been attained, stopping is obviously the correct procedure. The runway length required to permit either stopping or continued takeoff during the take-off roll is known as critical field length.

Normal take-off distance with no engine failure will always be less than the critical field length. Refer to the Appendix for critical field length and take-off distance charts.

TAKE-OFF PROCEDURE.

1. Release Brakes
   When "Before Take-Off" check list has been completed, pilot releases parking brakes and starts ground roll. Maximum directional control can be obtained by maintaining slight forward pressure on control column.
2. Copilot Calls Critical Engine Failure Speed & ATO Firing Speed
   Copilot notifies pilot when critical engine failure speed and ATO firing speed have been reached.
3. Pilot Fires ATO
   As ATO firing speed is approached, pilot lifts

ATO firing switch guard. Pilot fires ATO when firing speed is reached.

4. Gear Up - gear up, lever off
   As soon as airplane is definitely airborne, pilot notifies copilot to retract gear. Copilot places landing gear lever to UP on pilot's command. Copilot checks gear position indicators showing all four gears up and locked; returns landing gear lever to OFF.

NOTE

If landing gear doors remain open in flight for extended periods of time, such as during training flights, the buffeting encounted will cause cracking of the bulkhead skin at the rear of the aft landing gear compartment.

CAUTION

If the landing gear position indicators show any of the gear in an intermediate position the airplane should be flown at speeds below 215 knots IAS until a complete gear-up indication is obtained. If recycling of the gear fails to obtain a gear-up indication, the flight should be discontinued since the landing gear doors may be unlatched and a hazardous flight condition may result at higher airspeeds.

5. Flaps - flaps up, lever off
   At approximately 15 knots IAS above take-off speed, pilot notifies copilot to retract flaps. On pilot's command, copilot places flap lever in UP position; waits approximately 5 seconds after flap position indicator shows flaps full up, then places flap lever OFF.

NOTE

Be sure the flaps are fully retracted prior to establishing climb speed to avoid damage to the flaps and flap mechanism.

6. Climb Speed - REDUCE POWER 96%
   As best climb speed is reached, pilot reduces power on all engines to 96% rpm.

ASSISTED TAKE-OFF.

TAKE-OFF PERFORMANCE -- ATO.

NOTE

The techniques as outlined herein are those required to produce the results illustrated in the operating data charts of the Appendix.

MINIMUM GROUND RUN TAKE-OFF — ATO.

For minimum ground run, the rockets should be fired 15 seconds before take-off so they expire just as the airplane takes off. The recommended procedure is to fire the ATO approximately 10 seconds before take-off since ATO thrust for a short time after take-off is very desirable. This given somewhat higher ground run distances but permits partial retraction of the gear to decrease drag in the event an engine fails during take-off. In tactical operation, it may be desirable to use only the number of ATO bottles required for safe take-off operation. The Appendix contains charts for this purpose. The consideration of engine failure during take-off is equally important when using ATO. As in the NO ATO case, the pilot should be able to stop or take off in the event of engine failure during the take-off run. If an engine fails before the critical engine failure speed is reached, the airplane can be stopped in the remaining runway distance. If failure occurs above the critical engine failure speed, take-off must be continued with one engine out and the rockets fired at the recommended firing speed.

The recommended firing speed is the same whether or not an engine fails. Recommended firing speeds are given in the Appendix. If more than the minimum required number of ATO rockets are used, the firing speed should remain the same.

CAUTION

In making ATO take-offs, particular care must be taken to maintain sufficient airspeed at all times. Airplane climb angle should be decreased slightly before termination of ATO thrust to prevent excessive loss of airspeed.

Refer to the Appendix for charts illustrating take-off distances with ATO, NO ATO, minimum number of bottles required, firing speeds, and critical engine failure speeds.

AFTER TAKE-OFF.

Flight procedure immediately after take-off will depend primarily on local terrain and operating conditions. The difference in the amounts of fuel and time involved in reaching a 1000-foot altitude is so small that it is not a determining factor in the choice of flight paths.

NORMAL FLIGHT PROCEDURE.

Assuming no high obstacles, this path is the one that will most generally be used by pilots, as it provides a reasonable altitude for turns and maneuvers, as well as a fairly rapid acceleration. The gear should be retracted immediately after take-off and flap retraction should begin as soon as possible. With no initial climb, the flap retraction time is such that the airspeed will remain well above the stall and below

the structural placard. With an initial climb, a slight delay in retracting the flaps will maintain this margin above the stall, the amount of delay being determined by the steepness of the climb. A good procedure is to allow the airplane to accelerate 15 knots in a slight climb before starting flap retraction. Any prolonged delay without an accompanying steepening of the climb angle may result in exceeding flap placard limits.

MINIMUM ACCELERATING DISTANCE.

NOTE

This is not a normal or recommended procedure and is to be used only under special conditions.

When the pilot desires to maintain a minimum altitude above the ground in order to accelerate to climb speed as quickly as possible, both the gear and flaps should be retracted immediately after take-off. Care must be exercised not to exceed the structural limits of the flaps. The limiting speeds with flaps extended are shown on figure 2-8.

MAXIMUM OBSTACLE CLEARANCE.

When it is necessary to clear an obstacle in a short distance, the gear should be retracted immediately after take-off and the climb made at not less than take-off speed to prevent stalling and to provide a reasonable margin of lift for maneuverability. For the same reason, flap retraction should not begin until the obstacle clearance altitude is reached.

CLIMB.

Either military rated or normal rated rpm may be used for climb. Full climb data is presented in the Appendix. Varying speeds ± 10 knots from the optimum will not materially affect performance.

The fuel consumption and time are only slightly less for a climb at military rated than at normal rated rpm. The differences for a climb to the optimum cruising altitude are approximately 500 pounds of fuel and 1 minute. For most climbs, it is recommended that normal rated rpm be used, since the loss in performance is slight and engine life is influenced by turbine operating speeds and temperature. Full anti-icing during a climb at military rated rpm may overheat the airplane structure. Climbs at less than normal rated rpm will result in a loss of range because of the excessive time spent in climbing.

FLIGHT CHARACTERISTICS.

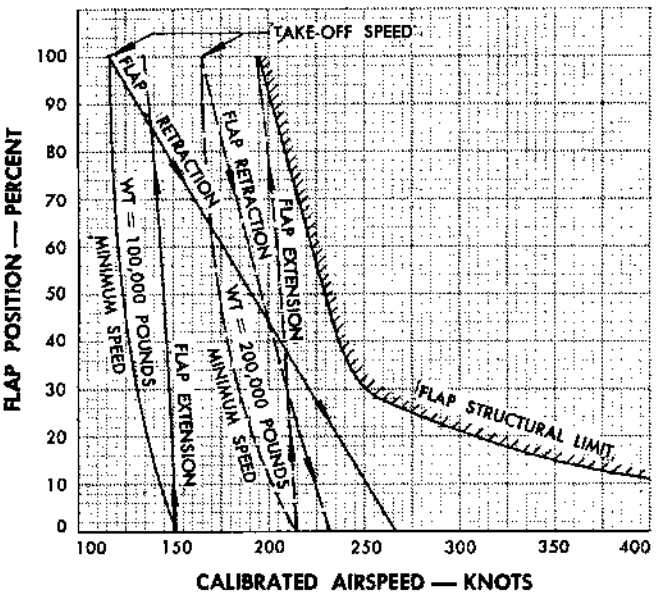
Refer to section VI for information regarding flight characteristics.

SYSTEMS OPERATION.

Refer to section VII for information regarding systems operation.

BEFORE DESCENT.

1. Check cg - CHECKED



CONDITIONS:
LEVEL FLIGHT
60°F AT SEA LEVEL

Figure 2-8. Speed Changes During Flap Operation

Pilot will calculate the airplane gross weight and check the cg from elevator trim tab setting.

2. Oxygen (Night) - 100% - 100%
   Pilot and copilot will go on 100% oxygen for night descent and landing.
3. Temperature Rheostat - ADJUSTED
   Pilot will adjust cabin temperature selector rheostat as required to minimize interior fogging.
4. Windshield Anti-Ice - MAX HEAT
   Pilot will place windshield anti-icing switch in MAX HEAT position in sufficient time prior to descent to prevent fogging or frosting of the windshield during descent.
5. Gear - DOWN
   Pilot reduces airspeed to 305 knots IAS and extends landing gear by placing gear lever in DOWN; checks that landing gear position indicators show all gears "Down and Locked." Leave landing gear lever in DOWN position.

CAUTION

If alternators are required for anti-icing or "K" equipment, maintain engines No. 1 and 6 at 52% rpm or more until alternator power is no longer required.

DESCENT.

The high cruising altitude near the end of the mission can be converted into a small range extension by correct descent procedure. The general rule to follow is to AVOID EARLY DESCENT. Since jet engine fuel consumption is excessive at low altitude, even at idling rpm, a premature descent will result in a loss in range.

Descent performance is presented in the Appendix.

NORMAL DESCENT - ALL GEAR DOWN.

This is the recommended procedure for all let-downs where there is no range emergency.

a. Maintain cruising altitude until about 50 miles from the landing base.
b. Reduce speed to 305 knots IAS and actuate landing gear lever to lower landing gear.
c. Retard all engines to the idle stop. The regulators will govern minimum rpm to prevent burner blow-out. Sufficient generator output will be available for normal electrical loads during descent.

CAUTION

- When retarding throttles, the pulling motion should follow an arc to match the contour of the control stand as it has been found possible to inadvertently retard the throttles past the idle position into CUTOFF by pulling the throttles in a horizontal plane.

- Before reducing power on engines No. 1 and 6 below 52% rpm, turn off all equipment using alternator power and turn off both alternators.

- If alternator power is required for Nesa windshield or "K" system operation, maintain engines No. 1 and 6 at 52% rpm or more.

d. Above 31,000 feet, the descent is made at Mach .81, the practical limit to avoid buffeting with the gear down. Below 31,000 feet, the descent is made at 305 knots IAS, which is the gear down structural limit.

Using the above procedure results in the following:
Maximum rate of descent
Shortest distance during descent
Minimum fuel consumption during descent

ALTERNATE DESCENT PROCEDURE - GEAR UP.

a. Maintain cruising altitude until about 350 nautical miles from the landing base.
b. Cut engines No. 2 and 5 and retard the other throttles to the minimum idle stop.

CAUTION

When retarding throttles, the pulling motion should follow an arc to match the contour of the control stand as it has been found possible to inadvertently retard the throttles past the idle position into CUTOFF by pulling the throttles in a horizontal plane.

c. Descent at 185 knots IAS to about 10,000-foot altitude.
d. Restart the two engines at about 10,000 feet, lower the gear and continue the descent at 305 knots IAS with all six engines idling.

The alternate descent gives:
Minimum rate of descent
Maximum time of descent
High fuel consumption and descent distance because of the long time involved
Approximately the same fuel reserve if two engines are cut as the normal descent

BEFORE LANDING.

1. Automatic Pilot - OFF
   Pilot checks automatic pilot master switch OFF, automatic approach switch in AUTOMATIC PILOT, and stows automatic pilot control panel by placing controller support actuator switch in stow position.

1a. Engine Screens - OPEN
   Pilot checks engine screen switches OPEN

2. Engine Stall Prevention Switch - AS DESIRED
   Pilot places engine stall prevention switch ON when passing through 10,000-foot altitude if OAT is below 15°C (59°F)

3. Safety Belt & Shoulder Harness - FASTENED - fastened
   Pilot and copilot adjust and fasten safety belt and shoulder harness. Check inertia reel lever in UNLOCK position. Copilot checks his seat swivel lock in LOCKED position.

4. "K" Equipment - off
   Copilot checks with observer that "K" system equipment has been turned off before turning alternators off.

5. Alternators - off (1 & 6 engines below 52%)
   Copilot turns alternators OFF and notifies pilot "Alternators Off" before pilot reduces power below 52% rpm on engines No. 1 and 6.

6. Radio Call - COMPLETED - ALTIMETER SETTING _____, altimeter set
   Pilot calls control tower for landing information, instructions, and altimeter setting. Pilot notifies copilot of altimeter setting. Copilot confirms.

7. Fuel Panel - SET, LIGHTS OUT - FUEL READINGS
   Pilot sets engine No. 2 fuel selector switch on TME and all other fuel selector switches on TE.

CAUTION

- To prevent possible simultaneous failure of all engines when operating at traffic pattern altitude due to all fuel selectors in the same relative position of ME, the following procedure is to be used: In the event of minimum fuel quantities of 12,000 pounds or less, position the fuel selector switches for No. 2 and 4 engines to TE and all other selector switches to TME. Should fuel gages be inaccurate

or inoperative, flame-out will occur on No. 2 and 4 engines if the corresponding tank has run dry.

● Checks that all fuel pump warning lights are out and transfers fuel quantity gage readings to copilot.

8. Gross Weight - best approach speed _____ knots
   Copilot takes fuel quantity readings, computes airplane gross weight, and determines best approach speed. Calls pilot and gives "Gross weight _____ and best approach speed ____ knots." Pilot returns fuel quantity gage control to pilot.
9. Surface Power Control Switches - NORMAL, LIGHTS OUT
   Pilot checks surface power control switches (three) in NORMAL position and all warning lights out.
10. Low Speed Warning Switch - ON
    The pilot will check the low speed warning switch ON and switch guard closed.
11. Steering Ratio - TAKE-OFF & LAND
    The pilot will check that the steering ratio selector lever is locked in the TAKE-OFF AND LAND position.
12. Anti-Skid - ON, LIGHT CHECKED
    Pilot will check that the anti-skid switch is in the ON position and check push-to-test indicator light to be sure light will glow.
13. Flaps - FULL DOWN
    Pilot reduces speed to 230 knots IAS and requests copilot to extend flaps 50%. When speed is reduced to 195 knots IAS, pilot requests copilot to extend flaps 100%. Return flap lever to OFF.
14. Gear - DOWN & LOCKED - 4 green lights
    The pilot and copilot make the following checks where applicable to their station:
    a. Landing gear lever in DOWN and landing gear lever red light off.
    b. Landing gear position indicators show gear down and locked.
    c. The four green gear-down-and-locked lights on emergency extension stand are illuminated.
    d. The red unsafe-to-land light on emergency extension stand is off.

    Should there be no indication that the forward main gear is in the full-down position, make a visual check by looking through the access panel aft of crawlway forward entrance door. Parallel black and yellow stripes on the forward landing gear drag link and drag strut will indicate the gear is in full-down position.
15. Generators - loads & voltages checked
    Copilot checks generator output for each generator by placing the DC voltmeter selector switch on numbers 1 through 6 and reports voltmeter and loadmeter readings to pilot.
16. Hydraulic Pressures & Quantity - checked
    Copilot will check that hydraulic system pressures are within operating range, fluid quantity is up, and all lights are out. Check emergency hydraulic pump switch in AUTO NORMAL.
17. Circuit Breakers - checked in
    Copilot checks all circuit breakers on upper and lower DC power panels to insure that all the circuit breakers are in.

APPROACH AND LANDING.

Although the airplane is not a difficult airplane to land, it does have some characteristics that differ from previous piston engine aircraft and it is essential that the pilot of the airplane have a thorough knowledge of these characteristics in order to be able to accomplish landings with the greatest degree of precision and safety under all runway and weather conditions. Flight experience to date has yielded the following recommended general procedures. These procedures produce the results as stated in the landing charts in the Appendix.

PATTERN.

A normal landing pattern can be used, provided the high speed, slow deceleration, and relatively flat gliding angles of the airplane are taken into account. A desirable approach pattern for normal conditions is shown on figure 2-9. Modification may be required to meet individual requirements.

The normal approach (figure 2-9) avoids large or sudden changes of power and should be flown by gradually decreasing rpm, airspeed, and altitude from the downwind leg to the runway. Maintain approximately 30 knots above best flare speed on the downwind leg (minimum of 155 knots IAS). The airspeed should be gradually decreased in a continuous 20° to 25° banked turn by reducing power so that, as the airplane rolls out on the final approach, the airspeed will be 15 knots above the best flare speed. The gradual decrease of airspeed is continued so that the airplane arrives over the end of the runway at the best flare speed.

APPROACH SPEEDS.

In time past, approach speeds for heavy transport and bomber-type aircraft have been in the order of 30% above stall speed. Example: Stall speed, 100 knots; approach speed would be 130 knots, giving a 30-knot margin to take care of maneuver loads, error in instrument readings, etc. Because of the high drag, rapid change of airspeed with change of attitude, and the steep approach angles, such a margin was desirable and was quickly dissipated during the flare.

This airplane has very low drag, does not change airspeed rapidly with slight changes of attitude, and has a flat glide path calling for only slight flare at the end of approach. Consequently, such a wide spread between stall speed and flare speed is not only undesirable because of the long float required to dissipate excess speed, but under normal conditions is not necessary. An ideal approach for the airplane to a short runway in smooth air would place the speed approximately 6 knots above a stall. This is touchdown. Example: Gross weight, 100,000 pounds; first stall warning, 114 knots; touchdown speed, 120 knots; and margin above first stall warning, 6 knots. This touchdown speed will place the airplane in simultaneous touchdown attitude if sufficient power is retained to give zero rate of descent.

LANDING PATTERN DIAGRAM

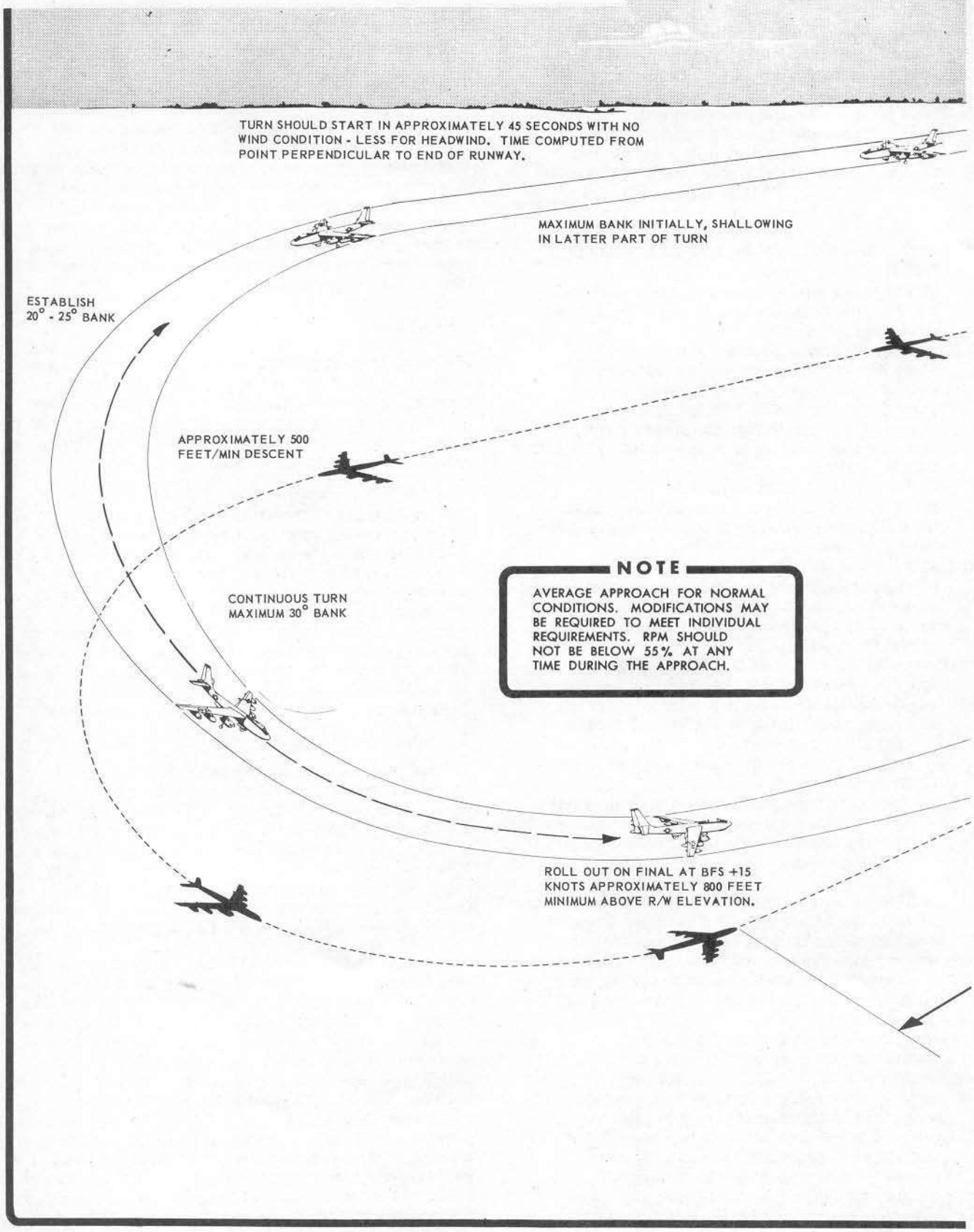
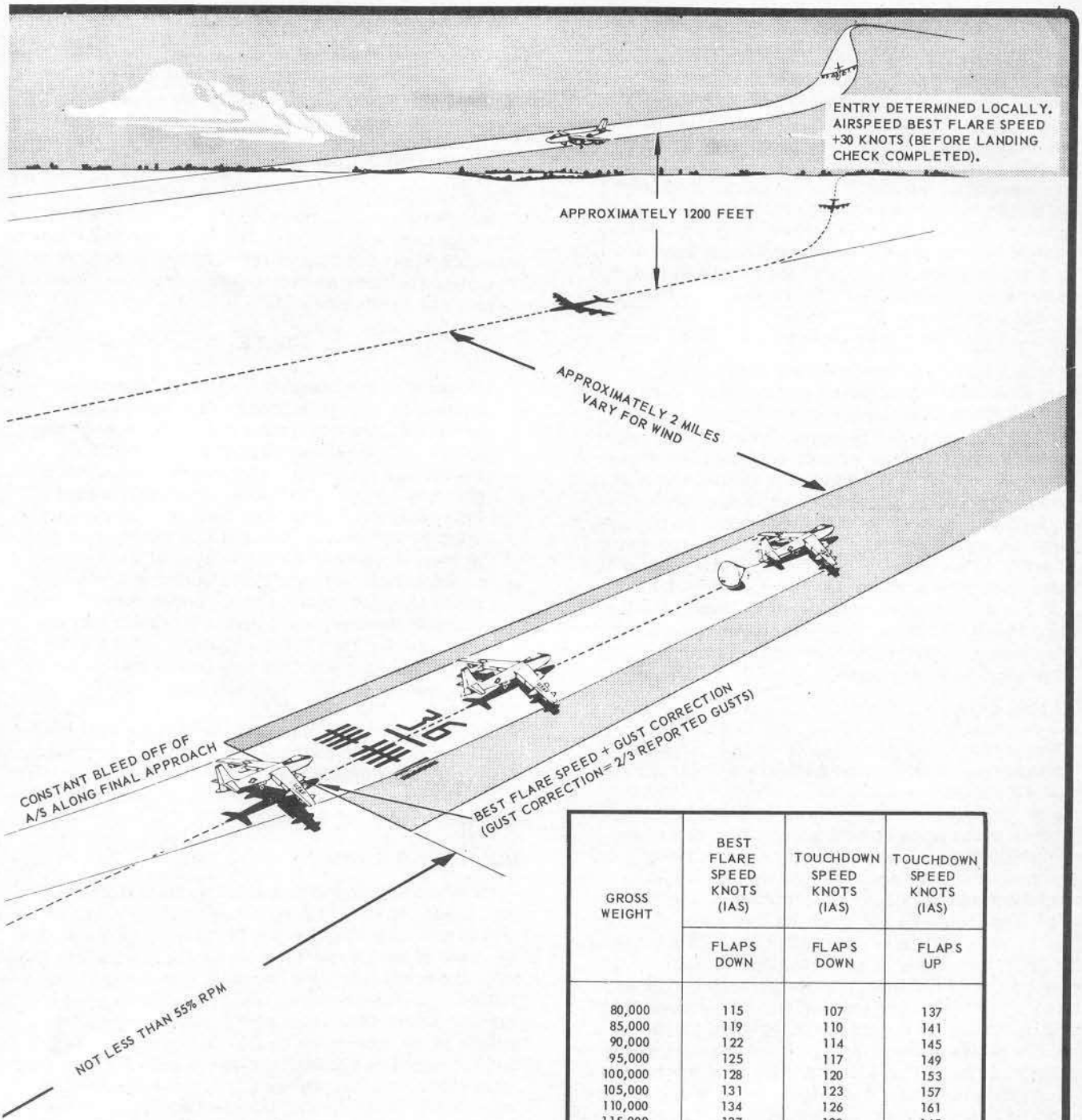


Figure 2-9. (Sheet 1 of 2)



GROSS WEIGHT	BEST FLARE SPEED KNOTS (IAS) FLAPS DOWN	TOUCHDOWN SPEED KNOTS (IAS) FLAPS DOWN	TOUCHDOWN SPEED KNOTS (IAS) FLAPS UP
80,000	115	107	137
85,000	119	110	141
90,000	122	114	145
95,000	125	117	149
100,000	128	120	153
105,000	131	123	157
110,000	134	126	161
115,000	137	128	165
120,000	140	131	168
125,000	143	134	172
130,000	146	137	175
135,000	149	139	178
140,000	151	142	182
145,000	154	144	185
150,000	156	147	188

* FIGURES ARE FOR EMERGENCY LANDING ONLY AS EXPLAINED IN SECTION III

Figure 2-9. (Sheet 2 of 2)

Although the airplane flies nicely and with adequate control response at speeds 6 knots above first stall warning, such flare speeds leave little margin to compensate for permissible instrument and fuel gage tolerances, unreported small gusts, and maneuver loads. (An acceleration of 1/10 "g" would increase the stall speed of a 100,000-pound airplane by 6 knots.) Consequently, use of this touchdown speed is not considered desirable except in an extreme condition requiring touchdown on the first few feet of runway. When this is necessary, the airplane may first be stalled at 15,000 feet, gear and flaps down, as a check of the accuracy of airspeed and fuel quantity gage indications. Speed should not be reduced to touchdown until reaching the runway threshold at an altitude not to exceed 5 or 6 feet.

Adding 8 knots to the touchdown speed will give a spread of 13 to 15 knots above first stall warning and is considered best flare speed because it provides a safe margin for the airplane under normal approach and landing conditions without resulting in excessive float for runways from which the airplane is normally operated. However, this margin is not adequate for surface wind conditions in which there are gusts of large values. Therefore, if the wind is reported as 10 knots or more, one-half of the velocity above 10 knots should be added to the flare speed. This will still result in less runway required than if the landing were accomplished in a zero wind condition at best flare speed. Twelve knots should be the maximum increment added for gusts.

ENGINE POWER SETTINGS.

When approaching with a piston engine airplane with the throttles at idle, almost instant acceleration is available when needed in an emergency. Probably all pilots have had the experience of "flying" an airplane through unexpected down drafts, gusts, or an approaching stall by an immediate application of power. However, the J-47 engines used on this airplane have very slow acceleration characteristics when at idle, requiring from 12 to 20 seconds to accelerate from idle to 100%. This is obviously too much time to effect recovery from an approaching stall at low altitude. Most of the time required for acceleration is from idle to 60%, but from idle to 55%, there is little gain in thrust. However, from 55% on, there is a very considerable increase in thrust for each slight increase in rpm. Therefore, during final approach after descending below 200 feet, power should not be reduced below 55% until after reaching the runway at an altitude not in excess of 5 or 6 feet. Necessary power reductions to correct for a high or fast condition should be accomplished during the first part of final while still above 200 feet.

CAUTION

If an instrument approach is being executed using the glide path receiver, power must not be reduced below 52% rpm on engines No. 1 and 6 until flight of the airplane is taken over visually. When power from engines No. 1 and 6 is reduced below 52% rpm, alternator power is inadequate to operate glide path receiver and may cause damage to equipment..

WARNING

During a normal approach with 55% power, the landing gear warning horn may not sound if any one of the landing gears is not down and locked since warning horn is set to sound when any throttle is retarded below 50% rpm with gear up.

Gliding with a minimum of 55% power will result in a flat approach which is also favorable inasmuch as considerably less rotation of the airplane is required to complete the flare since the flat approach attitude is nearer the landing attitude.

NOTE

Because of the comparatively light elevator control forces, it is possible to impose sizeable accelerations on the airplane with minimum effort. An acceleration of 0.2 "g" would increase the stall speed of a 100,000-pound airplane by 12 knots. Therefore, when trimmed for low speed flight, care must be taken not to attempt abrupt flares or pullups in order to prevent accelerated stalls. Special care must be exercised during night landings to avoid rapid elevator motions since under some circumstances the ground suddenly appears to be much closer than it did a moment before and can result in a startled reaction of pulling up elevator.

If the airspeed is too high and the landing appears to be too long, decide on a go-around before decreasing the engine rpm below 55%. A speed of 10 knots IAS too high will increase the required runway length by approximately 1700 feet.

ROLL DUE TO YAW.

Although most aircraft exhibit a certain degree of roll as a result of yaw, this tendency is much more pronounced in this airplane due to its swept wing design. Because of the geometry of this wing design, air flow over the advancing wing during a yawed condition becomes more chord-wise, resulting in increased lift for that wing, while flow over the retreating wing becomes more span-wise thus resulting in loss of lift and, at very low speeds, perhaps a stall for that wing. This characteristic will result in considerable unwanted roll if the rudder is overcontrolled. However, it also makes the rudder a very effective control for raising a low wing and, at speeds approaching the stall, it may be impossible to recover a dropping wing rapidly unless ample rudder is applied with aileron. Since rudder is a very effective lateral control at low speeds, good coordinated use of all controls is essential.

TOUCH DOWN.

With the bicycle landing gear, the landing attitude of the airplane is fixed so that the speed for simultaneous touchdown of both gears is a safe margin above stall. The attitude is always the same at the touchdown speed corresponding to the actual landing gross weight.

NOTE

The front gear is well forward of the cg and if it is allowed to touch first, a bounce is almost certain to occur. This usually is the result of too much speed.

The recommended touchdown is with the rear gear first about 3 knots below the touchdown speed. This allows an adequate flare and prevents a bounce. However, the airplane should not be held off too long, since drag is low next to the ground and the floating distance will be long. Also, if the front gear is too high when the rear gear touches, it will strike the ground hard and give an uncomfortably rough landing.

CROSS-WIND LANDING.

A combination of crabbing into the wind and lowering the up-wind wing is recommended for landing in a cross-wind. Touching an outrigger gear first is not serious because the outrigger shock struts are designed with unusually long stroked and are free castering to facilitate the most severe cross-wind landing conditions. Caution must be exercised that the up-wind wing is not lowered to the point where the outboard nacelle will drag. If possible, straighten the airplane before touchdown.

NOTE

- Landings can be made safely in cross winds of approximately 20 knots.
- Deployment of brake chute should be delayed until satisfactory steering is obtained with the forward main gear.

NORMAL LANDING RUN.

All landings should be planned and conducted as though the brake chute is not installed. The use of the chute should be considered only as an aid to braking. However, if the brake chute is required it should be remembered that the decelerating force of the chute drops off very rapidly at low speeds since its drag is proportional to the square of the velocity. Therefore, for most effective use, the chute should be fully inflated as soon in the landing run as possible.

CAUTION

The brake chute should not be deployed before the airplane has decelerated to 115 knots, since speeds in excess of this may cause failure of the chute.

With the engine idling, thrust remains relatively constant throughout the landing run; consequently, if the application of brakes is delayed too long, the ground roll will be excessive. Since it is desirable to avoid excessive use of the brakes, a good compromise considering stopping distances and brake deterioration is to apply the brakes at 40 knots. However, flight tests of this airplane have indicated that brakes may be applied consistently at speeds as high as 80 knots without serious brake wear.

Maximum braking effectiveness with anti-skid operative is obtained by depressing the rudder pedals to obtain very slow (2 or 3 seconds) cycling of the anti-skid system. This occasional "release" of the brakes can be recognized by a slight lurching of the airplane. Applying pressure in excess of this will lengthen the landing roll, cause undue strain on the front gear, and make directional stability difficult to maintain. In addition, excessive use of the anti-skid valve will set up oscillations which, coupled with possible failure of steering and dampener systems, may lead to destructive shimmy. In other words, as with conventional braking, too much pressure can be applied when using anti-skid. The only difference between conventional braking and use of anti-skid is that with anti-skid operative, the brakes can be applied earlier in the landing roll and maximum braking can be maintained without excessive tire wear due to skids.

CAUTION

Under no circumstances should the copilot aid the pilot on the brakes when adequate main system braking is available with normal effect; nor should the brakes be applied by either the pilot or copilot placing their feet in the high side or top of the brake pedals as the additional pedal force can result in overriding the main system, activating the emergency system and locking the wheels.

MINIMUM LANDING RUN.

Minimum landing run is realized with the anti-skid operative by deploying the brake chute as soon as the airplane has decelerated to 115 knots IAS, applying the brakes when the load on the rear gear is sufficient and continuing brake application throughout the landing roll. The brake chute provides considerable deceleration forces over the first portion of the landing roll; however, the brakes are quite ineffective until the airplane has decelerated to approximately 80 knots, at which time sufficient weight is on the wheels to allow effective braking.

NOTE

- Under emergency conditions the brake chute may be deployed at speeds up to 125 knots IAS.
- Deployment of the brake chute or application of brakes prior to touchdown is not recommended.

The time required for the brake chute to open is about 3 seconds after the deployment handle is pulled. If the chute is deployed during the flare while the airplane is floating, there is a tendency for the airplane to drop-in due to the rapid deceleration caused by the chute. Therefore, the chute is to be deployed only on touchdown for all normal landings. It is recommended that the chute be removed as soon as possible after landing to prevent possible chute damage. Request a ground crew to stand by to receive the chute after the landing has been completed and the airplane stopped. Before taxiing, the chute will be jettisoned and retrieved by the ground crew. Jettisoning is accomplished by pulling the brake chute jettison handle to the limit.

TOUCH-AND-GO LANDINGS.

Touch-and-go landings will be the same as for normal take-off and landing except that the brake chute will not be deployed after touch-down and after take-off the landing gear lever must be placed in OFF and then returned to DOWN. This will return the anti-skid system to the armed condition to facilitate the operation of this system during the next subsequent landing.

WARNING

The anti-skid system must be returned to the armed condition to prevent hydraulic pressure from being fed to the brakes prior to touch-down during the next landing.

HEAVY WEIGHT LANDINGS.

If landings with gross weights in excess of the Design Landing Weight of 125,000 pounds are necessary, precautions should be taken to reduce the rate of sink at touchdown as much as possible. However, even at a landing weight of 180,000 pounds, the airplane is structurally adequate for a sinking speed in excess of 6 feet per second. This is sufficiently above the average sinking speed of 4 feet per second in a normal landing to make high gross weight landings feasible. Power reduction should be carefully accomplished because of the increased inertia at the higher weights. Make every effort to make as smooth a landing as possible to reduce "g" loads on the gear. The landing pattern and approach and the airplane attitudes will be the same as for all normal landings. With the increased weight, the flare and touchdown will be higher and the landing distance will be longer.

For Best Flare Speeds and touchdown speeds not shown on figure 2-9, refer to figure 6-1. To estimate runway stopping distances, refer to the Appendix.

EMERGENCY LANDINGS.

For emergency landing instructions, refer to section III.

NIGHT LANDINGS.

Night landings will be the same as for all normal day landings.

GO-AROUND.

To make a go-around, open the throttles and retract the landing gear as soon as possible after it is certain that the airplane will not touch the ground. Wing flaps should be raised as soon as possible at the pilot's discretion. Go-around decisions should be made as early as possible since jet engine acceleration time is high and approach speeds are relatively close to touchdown speeds; hence, initial settling is more pronounced than on propeller-driven airplanes.

NOTE

Allow approximately 7 minutes and 2700 pounds of fuel for go-around.

AFTER LANDING.

1. Hydraulic Pressures - checked
   Copilot checks main hydraulic system and main brake system pressures periodically while taxiing (at 30-second intervals in congested areas).

NOTE

Maximum directional control can be obtained by using slight forward pressure on the control column.

2. Steering Ratio - TAXI
   Before taxiing, pilot places steering ratio selector lever in TAXI.
3. Flaps - full up
   Copilot retracts flaps full up and then returns flap lever to OFF.
4. Brake Chute - jettisoned
   During landing roll, pilot uses sufficient throttle on engines No. 3 and 4 to prevent brake chute from contacting the runway. After landing, turn off runway and stand by for ground crew to retrieve chute before jettisoning. Copilot notifies pilot "Clear to Taxi" after chute is jettisoned and retrieved.
5. Engine Stall Prevention Switch - OFF
   Pilot places engine stall prevention switch in OFF.
6. Surface Power Controls - OFF
   The pilot will place surface power control switches in the OFF position.

NOTE

If a strong cross-wind exists, rudder-elevator surface power control must be left ON.

7. Canopy - UNLOCKED - pins out - OPEN
   If the pilot desired to open canopy, he will place the canopy lock lever in the UNLOCKED position and inform copilot "Canopy Unlocked." Copilot will check that the canopy locking pins are out and confirm on the interphone by "Pins Out." Pilot will then place canopy control lever in the OPEN position.
8. Bomb Doors - OPEN, SWITCH OFF
   Pilot will place the bomb door switch in the OPEN position; bomb doors open indicator light should come on after doors are fully open. When light comes on, return bomb door switch to OFF.
9. Cut Engines 1, 2, 5, & 6 Prior to Entering Parking Area
   Just prior to entering airplane parking area, pilot will retard throttles for engines No. 1, 2, 5, and 6 to the CUT OFF position.

AFTER PARKING

1. Brakes - SET
   Pilot depresses left pedal and sets parking brakes.
2. Engine Screens - CLOSED
3. Flaps - DOWN
   Pilot extends flaps 100% and returns flap lever to OFF.
4. Inverters - OFF - off
   Pilot positions instrument inverter switch to OFF; "Bus Power Off" light illuminates. Co-pilot places main, secondary, and A-5 inverter power switches OFF; main, secondary, and A-5 "Bus Pwr Off" indicator lights should illuminate.
5. Radios and IFF - OFF - off
   Pilot turns off all radios and IFF. Copilot turns off command radio.
6. Steering Ratio Selector - TOW
   Pilot places steering ratio selector lever in TOW.
7. Engines 3 and 4 - CUTOFF
   Pilot retards throttles for engines No. 3 and 4 to the idle stop and holds for 1 to 2 minutes; then closes throttles rapidly to CUTOFF.
8. Controls - LOCKED
   Pilot places surface lock lever in LOCK and operates ailerons, rudders, and elevators until lock plungers seat and controls cannot be moved. Pilot disengages control column and latches it to the instrument panel. Requests copilot to "Disengage" and latch control column.
9. Surface Power Controls - OFF
   Pilot places all surface power control switches OFF.
10. Fuel Selectors - MANIFOLD TO ENGINE
    After engines are cut, pilot sets engine fuel selector switches for all engines on ME.
11. Anti-Skid - OFF
    Pilot places anti-skid switch OFF.
12. Windshield Defrost and Anti-Ice - OFF
    Pilot places windshield defrost and anti-ice switches OFF.
13. Emergency Hydraulic Pump Switch - OFF
    Copilot places emergency hydraulic pump switch OFF.
14. Lights - OFF - off
    Pilot and copilot turn off any interior or exterior lights.
15. Chocks in place - BRAKES OFF
    After ground crew indicates chocks in place, pilot releases parking brakes.
16. Fire Shutoff Switches - PULLED
    When engine rpm drops to zero, pilot pulls fire shutoff switches.
17. Battery - OFF
    Pilot places battery switch in OFF.
18. Ejection Seats - CHECKED, SAFETY PINS AND STREAMERS INSTALLED (All Crew Members)
    Pilot, copilot, and observer install safety pins and streamers in ejection seats. Copilot and observer will notify pilot when pins and streamers are installed.

POST FLIGHT.

1. ATO Link - REMOVED
   Pilot checks that the ATO link has been removed.
2. Chocks - IN PLACE
   Pilot insures that wheel chocks are in place.
3. Down Locks - IN PLACE
   Pilot insures that down locks have been installed on the forward main, rear main, and both outrigger gears.
4. Visual Inspection - COMPLETE
   Pilot and copilot complete a visual inspection of the aircraft exterior.
5. Form 1 - COMPLETE & SIGNED
   The pilot completes Form 1 and notes any discrepancies about the airplane. Signs form when completed.

SECTION III

EMERGENCY PROCEDURES

ENGINE FAILURE.

FLIGHT CHARACTERISTICS UNDER PARTIAL POWER CONDITIONS.

Engine failure, even of an outboard engine just at the point of breaking ground on take-off introduces much less yaw and out-of-trim effect than on propeller-driven airplanes. Hence, with surface power control operating, engine failure on this airplane affects directional control less than on propeller-driven airplanes. The most critical condition would be failure after the critical engine failure speed is reached on take-off with very high gross weights and high outside air temperature. Under these conditions, acceleration to climb speed would be slow and ability to maintain altitude during acceleration would be marginal.

The possibility of an engine failure during the take-off run influences take-off procedure and should in all cases be considered. With an engine failure, the pilot must be able either to stop on the runway or continue take-off safely. The maximum speed to which an airplane can be accelerated and then stopped on a given length runway is called its refusal speed. The speed at which engine failure permits acceleration to lift off in the same distance that the airplane may be decelerated to a stop, considering weight, altitude, and temperature, is called its critical engine failure speed. To determine the critical engine failure speed for the particular weight, altitude, and temperature, see the Appendix. If an engine fails before the critical engine failure speed has been attained, stopping is obviously the correct procedure. If the engine fails at a higher speed however, the airplane cannot stop in the remaining runway distance and should therefore continue the take-off. The critical field length, allowing for an engine failure on take-off, is determined by the condition where an engine fails at the critical engine failure speed and the pilot either just stops on the runway or continues take-off with one engine out. Refer to the Appendix for curves on critical field length for single engine failure at the refusal speed. The consideration of engine failure during take-off is equally important when using ATO. As in the NO ATO case, the pilot should be able to stop or take off in the event of an engine failure during the take-off run. If an engine fails before the critical engine failure speed is reached, the airplane can be stopped in the remaining runway distance. If failure occurs above the critical engine failure speed, take-off must be continued with one engine out and the rockets fired at the recommended firing speed.

NOTE

All charts in the Appendix showing the number of bottles required for ATO take-off distances allow for a single engine failure at the critical engine failure speed.

The recommended firing speed is the same whether or not an engine fails.

Failure of an engine during cruise will not appreciably affect directional control but will cause a decrease in IAS and, depending on the gross weight, make it necessary to select a lower cruise altitude. If the automatic pilot is in operation with altitude control on and an engine fails, the altitude will be maintained but with a resultant loss in IAS. If the altitude control is off, the IAS will be maintained with a resultant decrease in altitude. Minimum control speeds with various combinations of inoperative engines at low altitudes are shown in figure 3-2. Service ceilings possible with various combinations of gross weights and inoperative engines are shown in figure 3-3.

NOTE

Operation with three engines on one side inoperative and the remaining engines operating at 100% should be avoided because of possible control difficulties. If such operation is necessary in an emergency, the recommended minimum control speed for failure of aileron or rudder boost is 160 knots IAS at sea level.

The first and most positive indication of engine failure will be a drop in the EGT reading, whether during take-off, climb, cruise, or descent. The failure of one or more engines during take-off or climb however, will show a marked reduction in the normal rate of acceleration. The tachometer will immediately show a decrease in percent rpm.

NOTE

In the event of an oil pressure drop, fuel boost failure, etc., there will be a drop in EGT. This condition will require an engine shutdown to prevent engine damage.

If an engine fails during or immediately after the take-off operation, climb performance at high weights is marginal for high temperatures and altitudes until the gear is raised. This is the reason for saving some ATO duration for the initial climb while the gear is starting up.

Gear drag lowers the rate of climb approximately 300 feet per minute at take-off speeds with flaps down. An engine failure decreases the rate of climb by approximately 500 feet per minute under the same con-

ditions. Climb performance at take-off speeds with one engine out and gear and flaps down is shown in the Appendix.

PROCEDURE ON ENCOUNTERING ENGINE FAILURE.

Due to the simplicity of power controls for jet engines, emergency stopping of an engine after failure in flight is comparatively simple. (See "Engine Failure Under Specific Conditions.")

ENGINE COMPRESSOR STALL.

During some phases of engine operation, the engine compressor may develop a partial stall. This condition is primarily caused by forward movement of the throttle and results in upsetting the balance between fuel flow and engine air flow. Compressor stall is characterized by a mild vibration, the rpm stopping at approximately 70% rpm, and the EGT continuing to rise as the throttle is advanced. When this condition is observed, the throttle should be retarded immediately. After the EGT has returned to a normal level, another attempt may be made with the throttle being advanced more slowly.

ENGINE RESTART IN FLIGHT.

Engine restarts become progressively hotter with higher altitudes. Make engine accelerations and decelerations as slowly as practicable at altitude to avoid flame-out or compressor stalls. All restarts should be made at engine windmill rpm. Successful restarts may be made at altitudes up to 40,000 feet.

CAUTION

- All restarts should be made at minimum safe airspeeds after it has been determined that a restart will be reasonably safe.

- It is inadvisable to practice stopping and restarting the engines excessively. The effect of cooling will cause the shroud ring to contract more rapidly than the turbine wheel. This allows the turbine buckets to strike the inner circumference of the shroud ring, with the likelihood of both parts being damaged extensively. However, in cases of actual emergency, and particularly for fire, the engine must be shut down immediately.

Since the airflow will cause the engine to windmill, it is not necessary to use the starter above 150 knots IAS. Restarting procedure is as follows:

a. On loss of power, immediately retard throttles to CUT OFF. Allow approximately 2 or 3 minutes for airflow to purge engine of accumulated fuel before proceeding.

b. Adjust airspeed to appropriate rpm on inoperative engine, as related to altitude in following table.

ALTITUDE (FT)	RPM (MAX)
30,000 to 40,000	19% (approximately 1500 rpm)
25,000 to 30,000	21% (approximately 1700 rpm)
0 to 25,000	25% (approximately 2000 rpm)

c. Position ignition switch to ALTITUDE START OR TEST approximately 1 minute prior to opening throttle to allow purging the spark plugs and combustion chambers of any residual fuel which might remain.

If either engine No. 1 or 6 is to be restarted, make sure the corresponding alternator power switch (LH for engine No. 1 and RH for engine No. 6) is placed in RESET prior to starting engines. If this procedure is not followed, a long delay will be observed before alternator output will be connected to the bus system, or flashing of the alternator field may be necessary to restore alternator operation. After 52% engine rpm has been reached, place the alternator power switch to NORMAL. Alternator operation below 52% engine rpm may result in damage to equipment receiving power from the alternator.

d. Move throttle to starting detent and watch for evidence of combustion on exhaust temperature gage.

NOTE

If there is no indication of combustion after 30 seconds, close throttle to CUT OFF, allow 1 or 2 minutes for fuel line drainage, and then repeat restarting procedure.

e. Advance throttle to increase fuel pressure and flow as required to maintain an exhaust temperature between 450° and 500°C until normal idle rpm for that altitude is obtained.

f. Return ignition switch to OFF and adjust engine to desired rpm.

NOTE

Some ignition system units are likely to become overheated if energized for extended periods. The ignition switch should therefore be allowed to remain in the ALTITUDE START OR TEST position for no longer than 15 minutes at any one time.

ENGINE FAILURE UNDER SPECIFIC CONDITIONS.

ENGINE FAILURE DURING TAKE-OFF, TAKE-OFF REFUSED. If the critical engine failure speed is not attained before failure, proceed as follows:

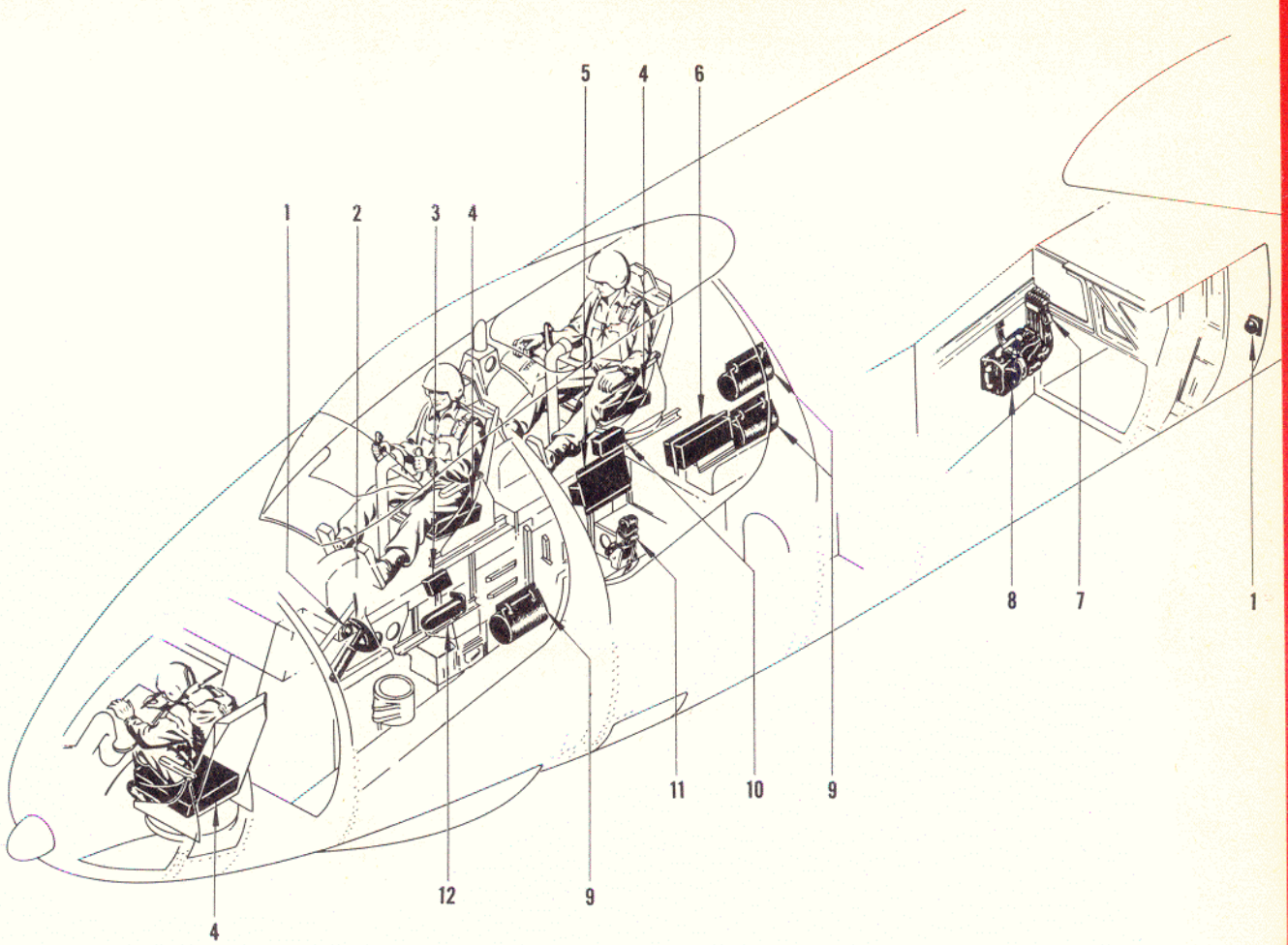
a. Immediately retard all throttles to the idle stop, deploy the brake chute, and apply the brakes. If stop appears to be marginal, retard all throttles to CUT OFF and pull the fire shutoff switch.

b. If a stop cannot be made before an obstruction will be reached and IAS is not appreciably greater than 60 knots, position the steering ratio selector lever to TAXI and ground-loop the airplane.

c. If it becomes apparent that it will be impossible to stop or ground-loop the airplane before an obstacle is reached, as a last resort retract all landing gears by actuating the landing gear emergency retraction switch on the pilot's control stand.

CAUTION

The landing gear lever must be in the OFF position before emergency retraction switches are placed in the GEAR UP position. Retraction motors would be damaged or burned out if emergency switches were actuated to the GEAR UP position while the landing gear lever remained in the DOWN position.



1 EMERGENCY ALARM BELL
2 HAND AXE
3 EMERGENCY KNIFE
4 SURVIVAL KIT
5 BLOOD PLASMA KIT
6 BATTLE SPLINT AND DRESSING KIT
7 PARACHUTE STATIC LINE
8 CHEST PACK PARACHUTE
9 ANTI-EXPOSURE SUITS
10 AERONAUTIC FIRST AID KIT
11 PARACHUTE STATIC LINE
12 FIRE EXTINGUISHER

Figure 3-1. Emergency Equipment

d. Cut the battery switch after the landing gears retract.

e. Remove canopy and leave the airplane as soon as possible. To prevent possible injury caused by leaping from the airplane, use the wing as a ramp.

ENGINE FAILURE DURING TAKE-OFF, TAKE-OFF CONTINUED. (See figure 3-2.)

a. Take-off is committed at the critical engine failure speed. If engine failure occurs after critical engine failure speed or after ATO is fired, take-off is continued.

b. Retract the landing gear as soon as airborne.

c. If engine failure is accompanied by vibration or fire, immediately retard throttle to CUT OFF and pull fire shutoff switch.

NOTE

Lesser symptoms of malfunction may permit continued operation of the engine throughout the take-off, thus allowing utilization of what thrust is being developed until cause of the malfunction can be determined.

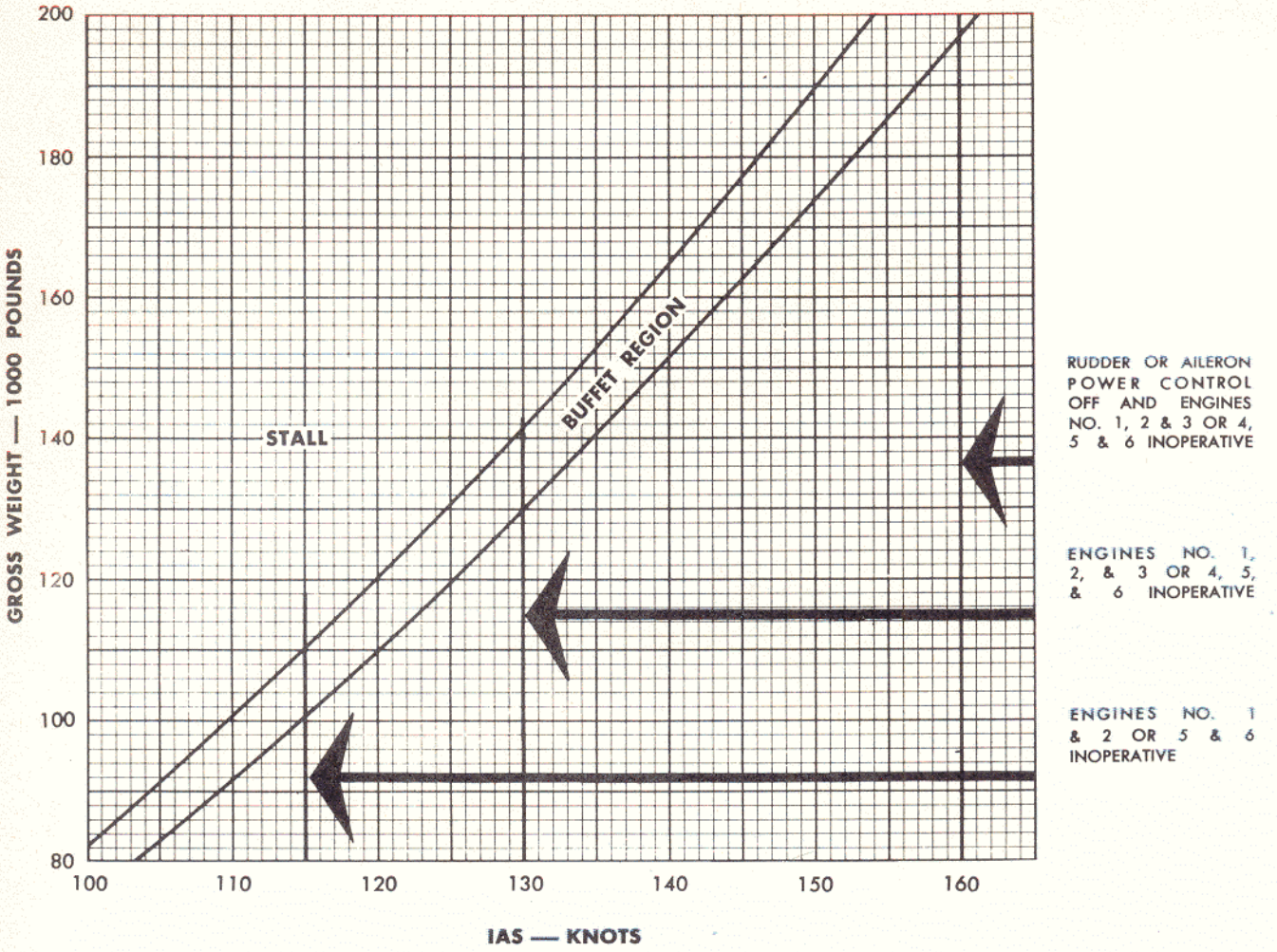
d. Start retracting flaps at approximately 20 knots above take-off speed. Settling of the airplane is noticeable when the flaps retract beyond the 50% position if the IAS is less than approximately 170 knots. Therefore, care should be exercised in raising the flaps beyond 50% if acceleration is extremely slow.

e. Gain a minimum of 175 knots before attempting climb.

ENGINE FAILURE DURING TAKE-OFF, FORCED LANDING. If it is impossible to maintain altitude after continued take-off with engine failure, accomplish the following:

a. Jettison external wing tanks and bombs, close bomb bay doors.

b. If wing flaps have been raised, extend them to full down.



NOTES

1. ALL ENGINES OPERATING AT 100% RPM
2. FLAPS DOWN
3. J47-25 ENGINES (DRY)
4. MINIMUM CONTROL SPEEDS DECREASE AS ALTITUDE INCREASES

DATE: MARCH 1953

DATA BASIS: FLIGHT TEST

CONDITIONS: SEA LEVEL
NACA STANDARD DAY

Figure 3-2. Minimum Control Speeds With Inoperative Engines

c. Open canopy and leave control lever in OPEN position. This procedure maintains hydraulic pressure in the actuating cylinder and will prevent the canopy from creeping or slamming closed during crash landing.
d. Check safety belt and shoulder harness.
e. Retard all throttles to CUT OFF.
f. Turn battery switch OFF.
g. Open brake chute just prior to touchdown to prevent airplane from floating.
h. Land straight ahead, changing direction only enough to miss obstacles.
i. After airplane has stopped, actuate observer's emergency hatch release lever and canopy emergency release handle.
j. Leave airplane as soon as possible, using wing as ramp.

ENGINE FAILURE DURING FLIGHT.

a. Retard throttle of failed engine to CUT OFF and pull fire shutoff switch.

NOTE

For service ceilings that can be attained with one or more inoperative engines, see figure 3-3.

CAUTION

As there is no means for reducing engine rpm due to windmilling after a fire shut-down, there is a possibility of additional engine damage due to lack of lubrication of the moving parts within the engine caused by severance of the oil supply to the engine when the fire shut-off switch was pulled. When an engine failure has been encountered, the pilot may at his own discretion reset the fire shut-off switch to permit lubrication to the windmilling engine.

b. If engine was not on fire and malfunction can be corrected, reset fire shut-down and restart engine. (See "Engine Restart in Flight.")

For information concerning "Range With Partial Engine Operation," see Appendix.

MAXIMUM GLIDE.

The possibility of a total loss of thrust for any reason other than fuel exhaustion is extremely remote. In the event such a situation should arise, a considerable distance may be obtained from high altitudes if close attention is given to the proper procedure for maximum range gliding. The maximum glide distances will be found in the chart on figure 3-4. As shown on the chart, a glide ratio of approximately 18 to 1 is available with a no-wind condition and with fuel exhausted. When a total loss of thrust is experienced, proceed as follows:

a. Check to see that landing gear and flaps are both up.
b. Trim airplane to glide at 185 knots IAS.
c. Jettison external wing tanks.
d. Glide straight ahead; any necessary turn should be made with the angle of bank as shallow as possible.

LANDING WITH ONE OR MORE ENGINES INOPERATIVE.

Landings with engine failure can be accomplished by following the normal landing procedure.

CAUTION

Care should be exercised in the event of multi-engine failure to avoid excessive reduction of speed or altitude until certain that the landing field is within range of the reduced-power glide. Under these conditions, landing gear should not be extended until it is certain the landing area can be reached. However, enough time should be allowed to lower gear on emergency system.

NOTE

Under any approach conditions involving reduced power, the necessity of early anticipation of additional power requirements cannot be overemphasized.

GO-AROUND WITH ONE OR MORE ENGINES INOPERATIVE.

When attempting a landing with one or more engines inoperative and a go-around becomes necessary, it can be accomplished without undue difficulty if proper flare speed and altitude have been maintained and gross weight is limited. Proper directional control will depend on balanced power. If two engines are inoperative on one side, especially if one of them is

an outboard engine, it will require considerable pilot technique to maintain directional control with full power on the remaining four engines. Assuming that a go-around is to be attempted with one or more engines inoperative on opposite sides, and leaving the remaining power equally balanced, the following procedure is recommended.

a. Advance throttles on all operative engines to 100% RPM and maintain airspeed.

b. When certain that airspeed is sufficient to prevent "mushing" back onto runway, place landing gear lever in UP position.

CAUTION

If thrust is unbalanced due to engine malfunction or failure on one side, it may be necessary to seek a more balanced condition. Any appreciable amount of yaw at low speeds will result in a potentially critical rolling tendency which should be corrected immediately. With a reduction in thrust, or even complete failure, of only one engine on one side, it is entirely possible to compensate for yaw by use of the rudder with surface power control on and at normal landing gross weights. With a reduction in the thrust of more than one engine on one side however, care should be exercised that this yaw does not become uncontrollable. When the possibility of such a condition becomes noticeable as throttles are advanced, retard the throttle for the outboard engine on the side with predominant thrust until it is apparent that the yaw can be controlled with rudder.

During an attempted go-around with unbalanced thrust, the airplane may turn toward the side of deficient thrust. If this turn can be controlled by use of the rudder rather than retarding a throttle on the side of predominant thrust, it will be an advantage to do so. This will allow a more rapid increase in the IAS to a point where more effective directional control can be maintained. If the angle of bank tends to increase the turn beyond the effect of the rudder, a throttle on the high side must be retarded until the wings can be leveled and more complete control regained. Moreover, it may be found advisable to fly with the thrust-deficient wing slightly high in order to maintain adequate directional control.

TAKE-OFF WITH ONE OR MORE ENGINES INOPERATIVE.

Take-off with one or more engines inoperative is not recommended. However, if emergency conditions require evacuation of the airplane to another location, it will be necessary to consider carefully the field altitude, ambient runway temperature, available runway length, wind velocity, and gross weight at take-off. With a low take-off gross weight plus the added thrust to be obtained by use of ATO, a successful take-off will be possible by use of normal take-off procedure. Use of the charts in the Appendix will aid in determining the critical engine failure speed for take-off with ATO and no ATO.

GROSS WEIGHT IN LBS	SERVICE CEILING IN FEET			
	ONE ENGINE INOPERATIVE	TWO ENGINES INOPERATIVE	THREE ENGINES INOPERATIVE	FOUR ENGINES INOPERATIVE
80,000	49,200	45,000	38,000	26,700
100,000	44,500	40,000	32,400	20,200
120,000	40,700	35,600	27,100	14,000
140,000	37,500	32,000	22,000	8,300
160,000	34,800	27,600	17,200	3,300
185,000	30,300	22,800	12,000	Flight Cannot be Maintained
200,000	28,000	20,000	9,000	

BASED ON: NACA standard day
Wing flaps and gear up; 100% RPM on operating engines

DATE: October 1952

DATA BASIS: Flight Test

Figure 3-3. Service Ceilings with Inoperative Engines

CAUTION

Do not attempt to take-off with more than one engine inoperative on either side. Minimum safe take-off is with four engines at normal operation.

TWO-ENGINE ENDURANCE.

Maximum endurance at altitudes below approximately 10,000 feet is attained with only two engines operative.

Minimum airplane drag and related endurance speeds are the prime factors for maximum endurance. To reduce load on the two remaining generators, all electrical equipment such as landing gear and flaps should be actuated before engine shut-down. With two engines operating, thrust available to sustain flight is marginal with either gear or flaps extended and inadequate if both are extended. When it is necessary to remain in the air at low altitudes for holding over destination, or other reasons, and fuel supply remaining is critical, proceed as follows:

a. Check airplane in "clean" condition (landing gear and wing flaps fully retracted).

b. Turn off all unnecessary electrical equipment. (See "Electrical System Emergency Operation.")

c. Retard throttles to the idle stop on engines No. 1, 2, 5, and 6; wait at least 30 seconds (60 seconds desired) to allow contraction of shroud ring and turbine wheel to become equalized, then move throttles to CUT OFF.

d. Do not pull fire shutoff switch.

NOTE

● If "K" system operation, windshield anti-icing and/or aerial refueling slipway anti-icing is

required, engines No. 1 and 6 must be kept operating at the minimum of 52% rpm to provide alternator power and to maintain symmetrical thrust.

● Allowing the engines to windmill will permit rapid restarts without the use of starters.

e. Accomplish fuel system management to utilize all fuel and maintain airplane cg within limits by positioning the fuel selector switches for the highest level tank to TME and all other fuel selector switches to ME. Because of electrical load requirements, position fuel selector switches so as to have only four boost pumps operating at any one time.

CAUTION

Maintain the airplane in clean condition and do not attempt anything but endurance flight while operating on two engines.

f. After endurance flight period is completed and/or before making landing approach, restart remaining four engines.
g. Turn on additional electrical equipment as desired and proceed as in normal flight.

PRACTICE MANEUVERS WITH ONE OR MORE ENGINES INOPERATIVE.

For practice maneuvers with an inoperative engine or engines, an altitude of 10,000 feet or above and a gross weight within the normal landing weight range (90,000 to 110,000 pounds) is recommended. Under these conditions, such maneuvers as approach and landing and go-around with reduced thrust may be safely practiced. For such operations, it is inadvisable that the engine or engines be shut down completely, but the throttle merely retarded to the idle stop. This reduction in thrust will provide control and maneuverability problems essentially the same as with a complete loss of thrust on an engine. Practice maneuvers may be performed with both power on and power off for the individual control surfaces, but considerable care should be exercised during these maneuvers. The ability of the pilot to hold the airplane in level flight with any surface power control system off will vary with the IAS, the number of engines out on one side, and the amount of thrust maintained on the other side. It is recommended that practice maneuvers with surface power control off be made with only one throttle retarded and at several indicated airspeeds before attempting any further reductions in thrust.

NOTE

In the event that three engines on one side are rendered inoperative during flight and the remaining three engines are operating at 100% rpm, the recommended minimum control for failure of aileron or rudder surface power control is 160 knots IAS at sea level.

FIRE.

ENGINE FIRE DURING STARTING.

NOTE

No engine fire extinguishing system is installed in this airplane.

In case of engine fire during starting, proceed as follows:
a. Immediately retard the throttles for all engines to CUT OFF and call for a fire truck if the pilot deems it necessary.

NOTE

To avoid motoring the engine with oil supply shut off, do not pull fire shutoff switch.

b. Let starter windmill to remove excessive fuel and eliminate fire and/or smoke.
c. If smoke or fire is eliminated, actuate fire shutdown, shut off all switches and have crew chief locate cause of fire.
d. If smoke or fire continues for an abnormal period (assuming an oil fire, or hydraulic fire if on No. 3 or 4 engines) pull fire shutoff switch. Shut off all switches. Direct ground crew to use external fire extinguisher if necessary. A knock-out panel in the cowl panel of each nacelle is the only effective point for discharging agent into the engine.

ENGINE FIRE WITH AUXILIARY POWER DISCONNECTED.

In case of visible engine fire after auxiliary power has been disconnected from the airplane, proceed as follows:
a. Pilot closes throttle to engine affected. If fire is located in the inboard nacelles, close the throttles to both inboard engines on that side.
b. If taxiing, stop immediately and set parking brakes.
c. Copilot calls the tower, giving position of the airplane and the existing emergency conditions.
d. Pilot pulls fire shutoff switch on engine or engines affected.

NOTE

In the event burning fuel or raw fuel is running from the engine on fire, the airplane should be swung around or moved to prevent the fuel from accumulating under the wing.

e. Pilot closes throttles on all other engines and pulls fire shutoff switch.
f. Pilot gives the order to abandon the airplane over interphone followed by one long ring on the alarm bell.
g. Pilot places battery switch to OFF position.
h. Crew members abandon the airplane by the safest means.

ENGINE FIRE DURING FLIGHT.

In case of an engine fire during flight, accomplish the following:

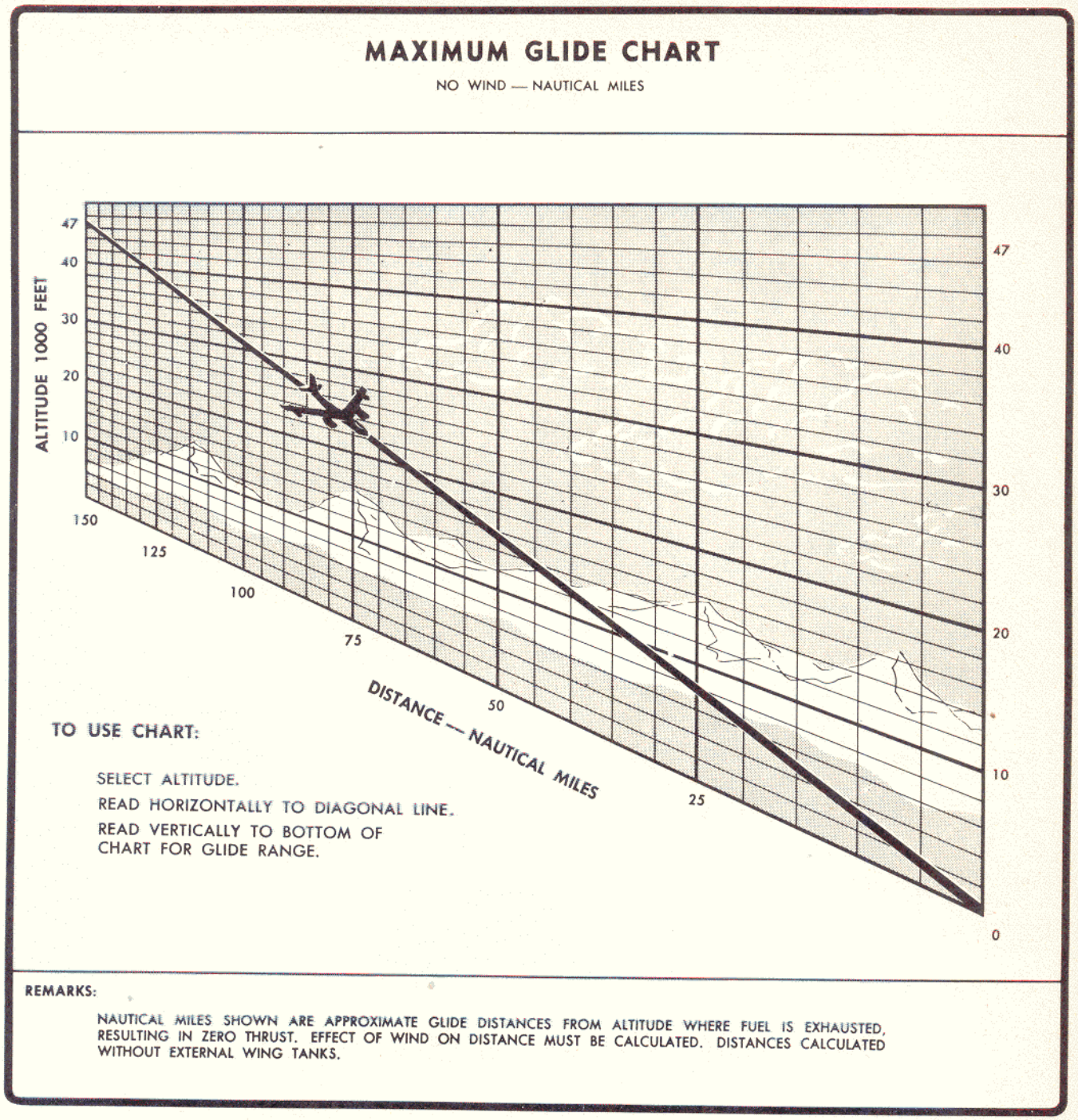


Figure 3-4.

a. Immediately retard throttle for engine on fire to CUT OFF, pull fire shutoff switch and place fuel selector switch to TE. This procedure will shut down fuel, hydraulic, and oil supply to the engine and de-energize any electrical power to the engine. Airflow through the engine caused by ram air will expel any oil or fuel and eliminate fire and/or smoke. After fire has been expelled and it becomes necessary, the fuel selector switch may be repositioned for efficient fuel management.

NOTE

During engine fire shutdown, copilot checks that main fuel control circuit breakers are in to insure operation of fire shutdown.

b. Do not attempt to restart engine.

CAUTION

As there is no means for reducing engine rpm due to windmilling after a fire shutdown, there is a possibility of additional engine damage due to lack of lubrication to the moving parts within the engine caused by severence of the oil supply to the engine when the fire shutoff switch was pulled. When an engine fire has

been encountered and extinguished, the pilot may at his own discretion reset the fire shut-off switch to permit lubrication of the windmilling engine.

c. If smoke or fumes are detected in the pressurized compartment, immediately notify crew to put on oxygen masks and to position all oxygen regulator diluter levers to 100% OXYGEN and place oxygen emergency toggle levers in the EMERGENCY position.

WARNING

It is necessary to use both the diluter lever and the emergency toggle lever because the diluter lever will supply 100% oxygen only on suction of the crew member, while the emergency lever provides a fixed pressure increase over that being supplied automatically, thereby assuring that the crew member will not get any smoke or fumes.

d. As soon as all crew members are on oxygen, pull emergency cabin pressure release handle; with master air conditioning switch at ON, this action will shut off engine compressor air to the crew compartment and automatically open the ram air valve to provide fresh air ventilation. If cockpit does not clear, reduce speed and open canopy.

e. When fire is out and smoke dissipated, repressurize and operate airplane according to instructions under "Engine Failures" in section III.

f. If fire is uncontrollable, abandon airplane by giving spoken warning on interphone, bell warning by three short rings on alarm bell, bail-out order on interphone, and bail-out signal by one long ring on alarm bell. (See "Bail-Out.")

ENGINE FIRE DURING SHUT-DOWN.

In case of engine fire during normal shut-down, accomplish the following:

a. Maintain 35% rpm on engines still operating and not affected by the fire, thereby furnishing sufficient DC power to motor the affected engine. If no engines are operating, power from the battery will sustain starter operation for a limited period of time.

b. If fire shut-down of the engine has not been accomplished, place starter selector switch in appropriate engine position and place starter switch and starter emergency override switch simultaneously in START positions to motor engine. Motoring engine will increase airflow through the engine and eliminate fire and/or smoke.

CAUTION

Motoring of engine by the starter should not exceed more than 1-minute duration without the aid of combustion because damage to or failure of the starter may occur.

c. If fire shut-down of the engine has been accomplished:

1. Push appropriate fire shutoff switch in to discontinue engine fire shutdown.
2. Place the generator switch momentarily in RESET position and then to OFF position to reset the generator.
3. Place the starter selector switch to the appropriate engine position and place the starter switch and emergency override switch simultaneously in START positions to motor engine. Motoring engine will increase airflow through the engine and eliminate fire and/or smoke.

CREW COMPARTMENT FIRE.

A hand fire extinguisher is provided to fight crew compartment fires. The following procedure is recommended:

a. All crew members put on oxygen masks, position oxygen regulator diluter levers to 100% OXYGEN, and place oxygen emergency toggle levers in the EMERGENCY position.

WARNING

It is necessary to use both the diluter lever and the emergency toggle lever because the diluter lever will supply 100% oxygen only on suction of the crew member, while the emergency lever provides a fixed pressure increase over that being supplied automatically, thereby assuring that the crew member will not get any smoke or fumes.

b. Turn radar equipment off and place LH and RH alternator power switches in OFF and all inverter power switches in OFF. Turn off any unnecessary DC electrical equipment.

c. Apply minimum extinguishing agent necessary at base of flame.

WARNING

Fire extinguishing fluids, their products of decomposition, and the products of combustion of various combustible materials are toxic. In addition, the fire extinguishing fluids are serious eye and skin irritants. Exposure to the fire extinguishing fluids or vapors should be avoided to the greatest extent possible and the aircraft should be ventilated as soon as possible after use or spillage of the fluid.

d. As soon as fire is out, clear cockpit of smoke and fumes by pulling emergency cabin pressure release handle. If cockpit does not clear, reduce speed and open canopy.

e. When fire is out and smoke dissipated, repressurize cabin.

f. If fire is uncontrollable, abandon airplane by giving spoken warning on interphone, bell warning by three short rings on alarm bell, bail-out order on interphone, and bail-out signal by one long ring on alarm bell. (See "Bail-Out.")

WING FIRE.

Since no fire extinguishing system is provided to fight a wing or empennage fire, the following procedure is recommended:

a. Turn off all electrical equipment in the affected area.

b. Set the engine fuel selector switches for the engines on the side that is on fire to TE.

NOTE

For a wing fire outboard of either engine No. 1 or 6, only the engine nearest the fire need be shut down.

c. Set the fuel selector switches for the engines on the opposite side as necessary to keep all three engines running.

d. Place the throttles for the engines on the side of the fire to CUT OFF and pull the fire shutoff switch.

CAUTION

To assure fuel being cut off to the fire area, do not move throttles out of CUT OFF or attempt restarting engines.

NOTE

By setting the fuel selectors for the engines on the side of the fire to TE, the manifold valves will be closed on the side of the fire, preventing any fuel from getting into the wing and allowing unrestricted selection of fuel management on the opposite side of the fire.

CAUTION

If the airplane is operating greatly above or below the crossover point of aileron trim forces, considerable aileron control force may be required to maintain level flight until the airplane can be trimmed to lessen the control wheel forces.

NOTE

If bail-out is necessary, the aileron surface power control switch for the wing on fire should be placed ON because the automatic pilot cannot maintain level flight with one aileron surface power control system inoperative. However, if the surface power control system is rendered inoperative by fire, both aileron power control systems should be turned off and the ailerons trimmed to load the automatic pilot servo slightly. This will improve control by removing the effect of the control surface "lost motion."

e. If fire is uncontrollable, abandon airplane by giving spoken warning on interphone, bell warning by three short rings on alarm bell, bail-out order on interphone, and bail-out signal by one long ring on alarm bell. (See "Bail-Out.")

NACELLE FIRE.

If an overheated condition or a fire occurs in any of the engines, a fire detector unit is thermally actuated and the warning light for the affected engine is illuminated. The throttle on the affected engine should be retarded to CUTOFF (or near CUTOFF) position and the emergency fire shutdown switch pulled. This action will cut off all fuel, oil, and hydraulic fluid to the engine. Shutdown of the engine will exist until the fire shutoff switch is again pushed in. Restart should not be attempted in flight. If the fire is uncontrollable and is spreading to the strut and wing, abandon the airplane.

FUSELAGE AND/OR EMPENNAGE FIRES.

Since no fire extinguishing system is installed to combat an empennage fire, the following procedure is recommended:

a. Turn off all electrical equipment in the affected area.

b. Place rudder and elevator surface power control switch in OFF to determine if fire is caused by this system and/or to prevent any hydraulic leaks, which may have been caused by the fire, from feeding the fire.

CAUTION

If the airplane is operating greatly above or below the cross-over point of elevator trim forces, considerable elevator control force may be required to maintain level flight until the airplane can be trimmed to lessen the control column force.

c. If the fire is uncontrollable and continued flight is hazardous, abandon airplane by giving spoken warning on interphone, bell warning by three short rings on alarm bell, bail-out order on interphone, and bail-out signal by one long ring on alarm bell.

NOTE

If bail-out is necessary, the rudder and elevator surface power control switch should be placed in NORM prior to engaging the automatic pilot.

SMOKE ELIMINATION.

If smoke or fumes are detected in the pressurized crew compartment, the following procedure should be followed:

a. Immediately notify all crew members to put on oxygen masks, position all oxygen regulator diluter levers to 100% OXYGEN and place oxygen emergency toggle levers in the EMERGENCY position.

WARNING

It is necessary to use both the diluter lever and the emergency toggle lever because the diluter

lever will supply 100% oxygen only on suction of the crew member, while the emergency lever provides a fixed pressure increase over that being supplied automatically, thereby assuring that the crew member will not get any smoke or fumes.

b. As soon as all crew members are on oxygen, pull emergency cabin pressure release handle.

c. Fumes may be caused by a fuel line break in the engine accessory dome. Determine engine causing trouble, pull fire shutoff switch and retard throttle to CUT OFF.

NOTE

- If the smoke and/or fumes are not in the air conditioning system and smoke and/or fumes remain in the crew compartment, press the heat reset button; this will direct a greater flow of air through the crew compartment.

- For more rapid dissipation of smoke and/or fumes, reduce speed and open canopy.

d. When smoke and/or fumes have dissipated, repressurize crew compartment.

CANOPY EMERGENCY OPERATION DURING FLIGHT.

OPENING THE CANOPY IN FLIGHT.

Do not open canopy in flight unless it is required to improve the safety of operating the airplane. Such cases would include those where opening is required for removal of smoke in the cockpit or for use as a clear vision panel under adverse landing conditions.

WARNING

Do not unlock or open canopy while cabin is pressurized as canopy may release, travel an unpredictable path, causing serious injury to the pilot and copilot and extensive damage to exposed equipment.

If it is deemed necessary to open the canopy in flight, the following precautions should be observed prior to opening the canopy:

a. Extreme caution should be exercised to make certain that the cabin is fully depressurized.

NOTE

Under the most adverse conditions, a maximum of 12 seconds time may be required after actuating the cabin pressure release handle for the cabin to become fully depressurized.

b. Indicated airspeed must not exceed 215 knots IAS and, when feasible, a lower airspeed is desirable.

c. The airplane should be flown in an unyawed condition.

d. Pilot's and copilot's seats should be lowered to the bottom position and the pilot and copilot should lean forward as far as practical to get their head and shoulders as low in the cockpit as feasible.

MANUAL JETTISONING OF THE CANOPY.

If for some reason it is necessary to jettison the canopy (in flight) independent of the seat ejection sequence, the same precautions listed for opening the canopy should be observed. The canopy may then be jettisoned manually by pulling the canopy emergency jettison handle at either the pilot's or copilot's station.

LANDING EMERGENCIES.

LANDING WITH UNEQUAL QUANTITIES IN EXTERNAL WING TANKS.

Unequal fuel usage from the external wing tanks that cannot be corrected may result in sufficient unbalance to make landing hazardous. If, at any time during flight, such an asymmetrical loading condition is suspected, proceed as follows:

a. Make a check at best flare speed with gear and flaps extended to determine the amount of aileron trim and control wheel deflection required to maintain level flight. If full trim is required and the control wheel position indicates a requirement in excess of one half of the total aileron throw, the external fuel tanks should be dropped prior to landing.

b. If trim and control wheel position requirements are below those outlined in "a" above, the normal pattern and approach may be followed with the exception that the roll-out on final approach should be completed at least three miles from the touchdown point. This will alleviate any necessity for large control corrections during the latter part of the final approach when lateral control will be marginal because of the lower speeds.

c. Control of the aircraft after touchdown is marginal due to the asymmetrical weight condition and with full opposite aileron it may be impossible to hold the heavy wing up. It may be necessary to hold as much as approximately 1/4 rudder deflection during the ground roll to maintain a straight path.

LANDING WITH FRONT GEAR STEERING FAILURE.

If it appears that the front gear steering system will be inoperable on landing, position the steering ratio selector lever to TOW and maintain directional control by use of the rudder; some bicycling effect can be obtained by use of the ailerons. The brake chute will help keep the airplane straight during the first part of the landing roll. Jettison the brake chute if it tends to swing the airplane off the landing path as speed is reduced.

LANDING WITH LANDING GEAR FAILURE.

If electrical extension of the landing gear with the normal systems fails, emergency extension will normally be accomplished by the copilot, utilizing the emergency extension levers.

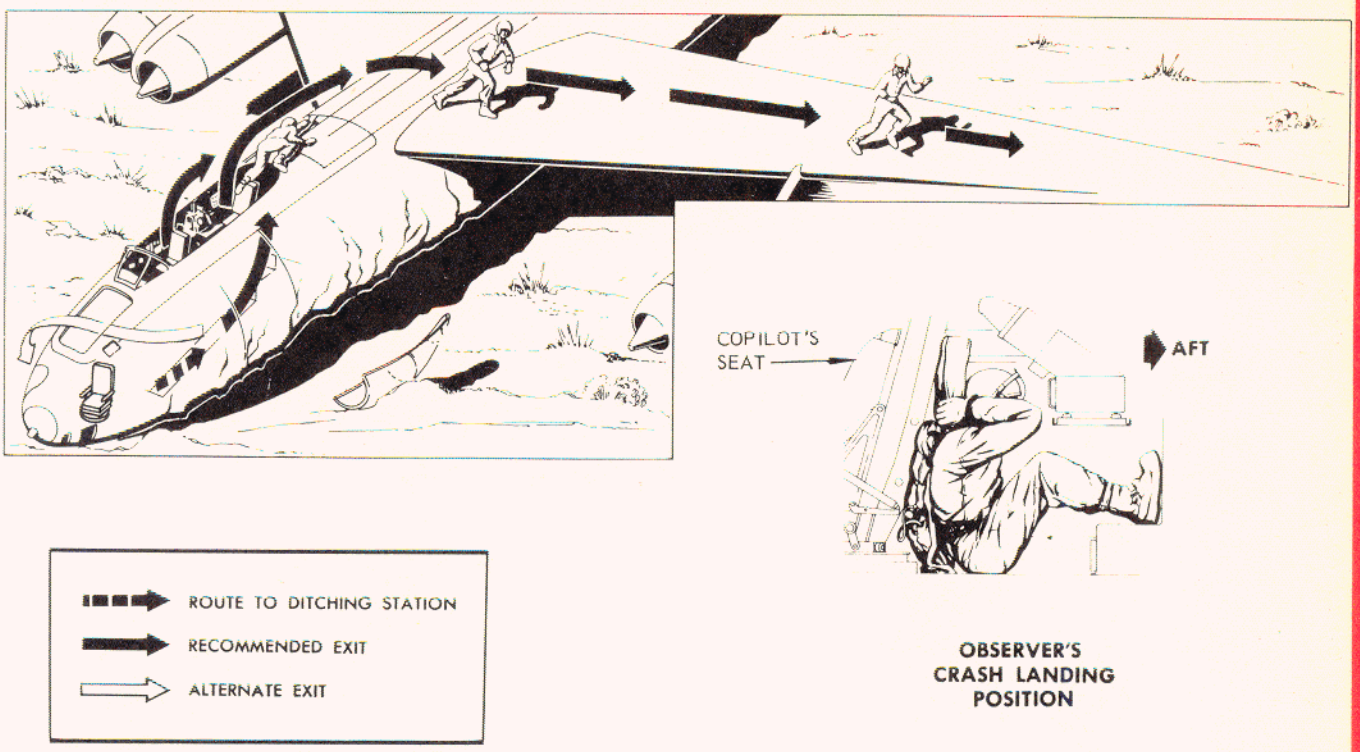


Figure 3-5. Crash Landing Positions and Exits

If emergency extension of the landing gear is impossible, the following procedure is recommended:

a. If either or both outrigger gears fail to extend, make normal landing on main gear; wings should be held level with ailerons as long as possible. If no cross-wind exists, airplane will probably remain upright on dual wheel main gear.

b. If only the front main landing gear will extend and lock, a normal landing should be made. (If the outrigger gears will also extend and lock, a slightly improved balance condition will result.) Hold the wings level and tail up as long as possible. As speed decreases, allow tail to contact runway as easily as possible.

c. If the front gear will not extend and lock, it is recommended that all gears be retracted and, at the discretion of the pilot, a crash landing or controlled bailout be executed.

LANDING WITH VORTEX GENERATOR ICING.

WARNING

Until the effects of vortex generator icing have been definitely determined, when operating under icing conditions, caution must be exercised with respect to the possible effect on flare and landing speeds. If ice has accumulated on the vortex generators, a stall check should be made in order that the stalling speed may be compared with those speeds shown in figure 2-9. The difference found between the two stalling speeds should be added to the best flare speed to assure adequate speed margin during approach and landing.

CRASH LANDING.

Provided the terrain and other conditions are favorable to a successful crash landing, the following technique will be employed:

WARNING

If ATO units with ignitors installed are exposed to an intense fire as a result of a crash landing, they normally ignite after approximately 2 minutes, provude thrust, and expend themselves completely. Therefore, it is recommended that ATO units be expended prior to a forced landing.

a. Use up all fuel in forward auxiliary, rear main, bomb bay, and external wing tanks and all unnecessary fuel in remaining tanks.

b. Copilot sets up command radio and pilot starts emergency keyer operation.

c. Give prepare-to-crash-land warning over interphone and by six short rings on alarm bell. Copilot starts emergency radio procedure.

d. Fully extend wing flaps.

e. Jettison external wing tanks, actuate bomb salvo switch, and close bomb bay doors.

f. Pull emergency cabin pressure release handle approximately 1 3/4 inches.

g. Pilot and copilot remain in seat, unbuckle parachute, retain safety belt and shoulder harness. Observer moves to ditching station aft of the copilot's seat carrying his seat cushion and parachute with him. The copilot will move his seat full forward and the observer place his parachute against the rear of the

PREPARATION FOR DITCHING

	DUTY	PROVIDE	POSITION	EXIT
PILOT	Give prepare-to-ditch warning by interphone and by six short rings on alarm bell. Start emergency keyer operation.	Parachute, anti-exposure suit, survival kit and life vest	Pilot's seat	Over side after canopy has been jettisoned
COPILOT	Acknowledge prepare-to-ditch warning and start emergency radio procedure	Parachute, anti-exposure suit, survival kit and life vest	Copilot's seat	Over side after canopy has been jettisoned
OBSERVER	Move to ditching station behind copilot's seat, and assume ditching position	Parachute, anti-exposure suit, survival kit and life vest	Behind copilot's seat	Over side at pilot's or co-pilot's station

NOTE

Chances for survival and rescue will be greatly enhanced if anti-exposure flying suits are worn by the crew member. Approximately 3 minutes are required to don a suit; therefore if flight over water is known, anti-exposure suits should be donned prior to reaching the water area. If for any reason it is impossible for a crew member to don his anti-exposure suit before the airplane is actually ditched, he should do so after reaching the water, if at all possible.

Figure 3-6. Ditching Chart

seat, placing the seat cushion above. Observer takes a position facing aft, leaning against cushion and parachute and with feet against the bulkhead.

h. Pilot gives "Stand by for canopy jettison" order. Jettisons canopy (190 knots minimum IAS). If pilot elects not to jettison canopy, the canopy should be opened and control lever left in OPEN position.

i. Start normal approach.

j. At approximately 500 feet altitude place all generator switches (6) in OFF.

k. At point in approach where throttles are normally retarded to the idle stop, retard them to CUT OFF; give brace-for-crash-landing warning over interphone and place battery switch in OFF.

l. Assume a normal landing attitude at lowest possible airspeed and rate of descent consistent with safe control of the airplane. Do not stall in.

m. Give brace-for-crash-landing-impact warning by one long sustained ring on alarm bell.

n. LOCK shoulder harness and brace for crash landing.

CAUTION

The crew member is prevented from bending forward when the shoulder harness inertia reel lock handle is LOCKED; therefore, all switches not readily accessible should be properly positioned prior to locking shoulder harness.

o. Deploy brake chute at point where normal contact would occur; without brake chute, airplane will float for a considerable distance.

p. Remain in position until the airplane comes to a stop. As soon as the airplane stops, cut battery switch. If canopy has not been jettisoned, the pilot or copilot pulls the canopy emergency release handle and, working together, manually push the canopy up approximately 1/2 inch and then aft sufficiently to allow all crew members to exit. In case it is impossible to release the canopy, the observer's escape hatch may be used as an alternate exit. To prevent possible injury caused by leaping from the airplane, use the nose or wing as a ramp to the ground.

WARNING

If the emergency jettison handle is used to release the canopy, the canopy must be open since pulling the emergency jettison handle with the canopy closed will engage the lock-pin and prevent the aft end of the canopy from being lifted from the airplane.

In case it is impossible to release the canopy, the observer's escape hatch may be used as an alternate exit by pulling the emergency escape hatch release handle.

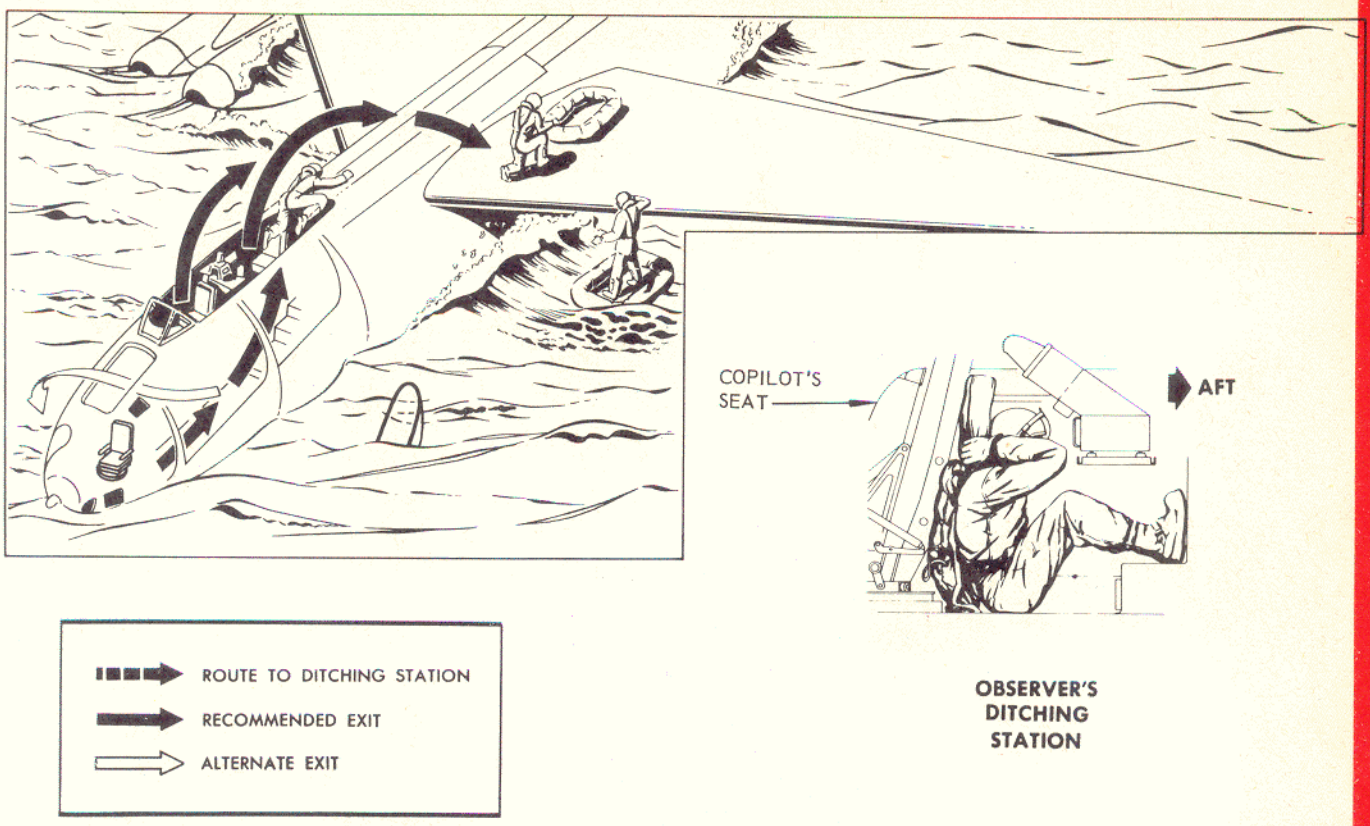


Figure 3-7. Ditching Positions and Exits

DITCHING

In a properly executed ditching, the airplane pressurized compartment and fuselage fuel tanks should permit the fuselage to remain afloat long enough to allow crew members to abandon the airplane. However, the high wing position, underslung engine pods, external wing tanks, lack of internal wing tanks for buoyancy, and the bomb bay opening all combine to make careful handling extremely important during the ditching operation.

DITCHING TECHNIQUE

Choose direction of ditching run carefully. If uniform wave or swell pattern exists, best results will be achieved by ditching parallel to waves or swells. Try to touch down on crest or just after crest passes. Recommended procedure: if wind is more than 25 knots or surface is irregular, approach into the wind and touch down on the falling side of the wave.

a. Give prepare-to-ditch warning over interphone and by six short rings on alarm bell.

b. Copilot sets up command radio and pilot starts emergency keyer operation.

c. Jettison wing tanks.

d. Salvo bombs, making sure bomb bay doors are closed after salvo.

e. Pull emergency cabin pressure release handle approximately 1 3/4 inches.

f. Landing gear fully retracted.

g. Fully extend flaps.

h. Pilot and copilot remain in seat, unbuckle parachute, retain safety belt and shoulder harness. Observer moves to ditching station aft of the copilot's seat carrying his seat cushion and parachute with him. The copilot will move his seat full forward and the observer place his parachute against the rear of the seat placing the seat cushion above. Observer takes a position facing aft, leaning against the cushion and parachute and with feet against bulkhead.

i. Check life vest.

j. Pilot gives "Stand-by for canopy jettison" order. Jettisons canopy (190 knots minimum IAS). If pilot elects not to jettison canopy, the canopy should be opened and control lever left in OPEN position.

k. Establish normal approach.

l. At point in approach where throttles are normally retarded to idle stop, retard them to CUT OFF, give brace-for-ditching warning on interphone and place battery switch in OFF.

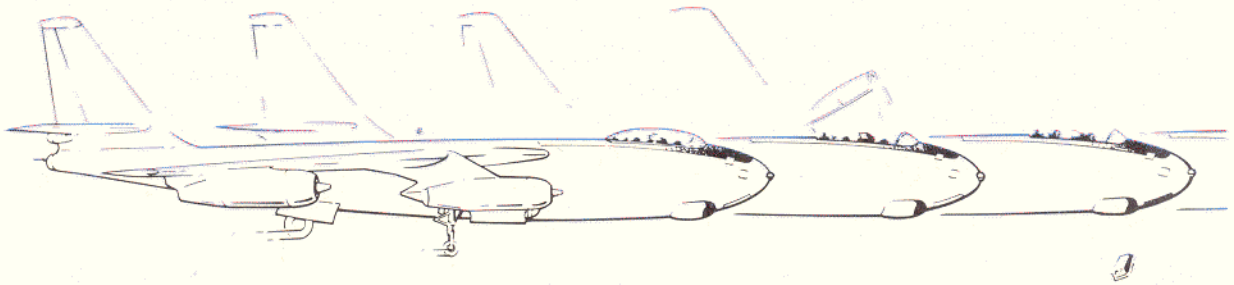
m. Approximately 5 seconds before contacting water, give brace-for-ditching warning by one long sustained ring on alarm bell; shoulder harness inertia reel lock handle in LOCKED position.

CAUTION

The crew member is prevented from bending forward when his shoulder harness inertia reel is LOCKED; therefore, all switches not readily accessible should be properly positioned before locking shoulder harness.

n. Flare out just over water and touch down in a medium nose-high attitude, near 10°. Avoid contact

pilot	copilot	observer
1 Gives bail-out order over interphone and by one long ring on alarm bell	1 Positions seat facing forward and returns seat from forward tilted position back to normal ejection position	1 Positions seat facing forward
2 Rotates left handgrip forward from stowed position until reaching mechanical stop	2 Rotates left handgrip forward from stowed position until reaching mechanical stop	2 Raises leg braces from stowed position to locked position by pulling either or both triggers and rotating leg braces forward
3 Rotates right handgrip forward from stowed position until reaching mechanical stop	3 Rotates right handgrip forward from stowed position until reaching mechanical stop	3 Grasps D-ring with both hands and pulls once, approximately 3 inches
WARNING Crew member should keep head back against head rest, elbows in place, and feet on foot rests		
4 Fires seat catapult by squeezing catapult trigger (right handgrip)	4 Fires seat catapult by squeezing catapult trigger (right handgrip)	4 Fires seat catapult by pulling D-ring a second time approximately 1½ inches (maintains grip on D-ring during ejection)



bail-out ejection seats

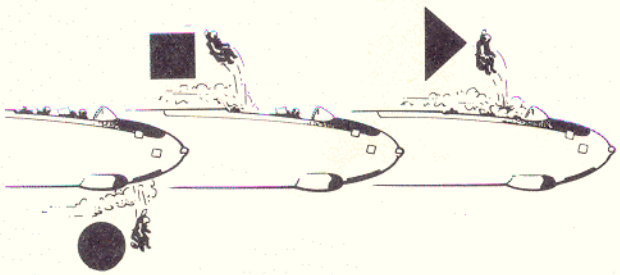
Figure 3-8. (Sheet 1 of 2)

IF TIME AND CONDITIONS PERMIT OBSERVE THE FOLLOWING PRECAUTIONS:

1. If at an altitude of 2,000 feet or below, pilot and copilot will unfasten their safety belts to aid in separation from seats after ejection
2. Check to make sure oxygen hose is clipped to chest strap of parachute harness prior to ejection, to prevent subsequent difficulty in leaving seat
3. If above 10,000 feet altitude, each crew member check bail-out oxygen bottle for proper connection and pull release
4. Pilot drops drag gear to reduce airspeed (190 knots minimum IAS) trims airplane for level flight and engages automatic pilot
5. Observer, copilot, and pilot is the desired order of ejection

WARNING

In the event that an extra crew member is aboard, it is necessary that he evacuate the airplane after the observer has fired his ejection seat and before the canopy is jettisoned to prevent subsequent difficulty in leaving airplane. This evacuation may be made either through the observer's downward ejection hatch or the entrance door bail-out chute.



NOTE

Unfasten safety belt and kick free of seat as soon as possible. Delay opening parachute as long as possible.

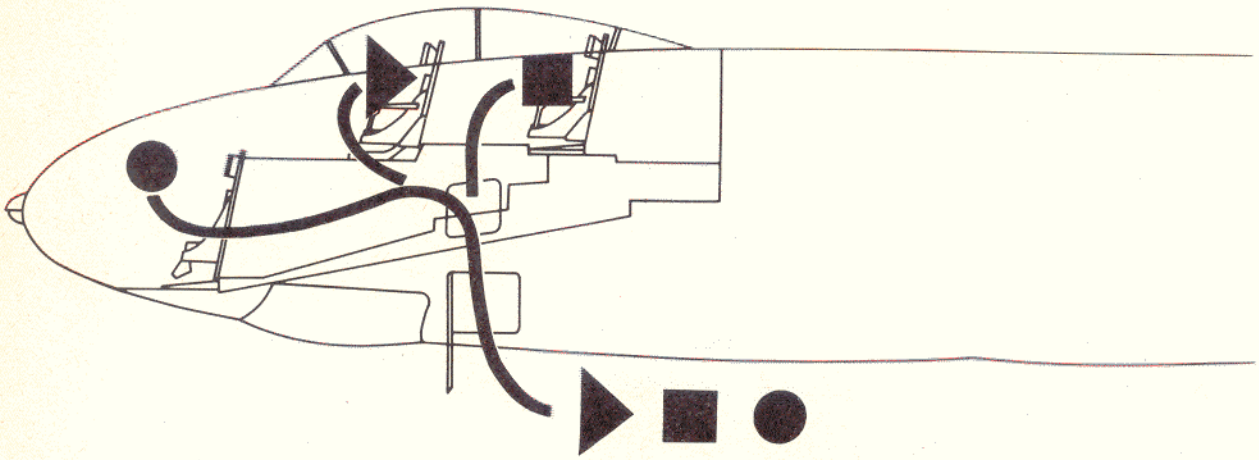
WARNING

Crew member should be absolutely sure he is completely free of the seat before deploying the parachute

Figure 3-8. (Sheet 2 of 2)

bailout

escape chute



pilot	copilot	observer
1 Gives bailout warning over interphone and by three short rings on the alarm bell. Pulls emergency cabin release handle.	1 Unfastens safety belt and shoulder harness.	1 Unfastens safety belt and shoulder harness.
2 Reduces airspeed as much as possible (maximum IAS 195 knots without spoiler, with spoiler extended maximum IAS 280 knots) trims airplane for level flight and engages automatic pilot, stows control column.	2 Stows control column.	2 Unlocks and opens pressure compartment door. Pulls entrance door bailout control handle to full travel.
3 Check landing gear retracted and bomb doors closed. Gives abandon-airplane signal by one long ring on alarm bell. Unfasten safety belt and shoulder harness.	3 Proceeds to bail out escape chute. Bail out, feet first, facing aft.	3 Bail out, feet first, facing aft.
4 Bail out, feet first facing aft.		

Figure 3-8A. (Sheet 1 of 2)

OBSERVE THE FOLLOWING PRECAUTIONS:

NOTE

The observer, copilot, and pilot will proceed in the order named, through the pressure compartment and utilize either of the following procedures for abandoning the airplane:

Stand just forward of the entrance door facing aft and jump feet first straight through the escape chute, using hand-holds to stabilize body position back as close to the bailout spoiler as possible while passing through escape chute in order to insure maximum protection by the spoiler. Lower head slightly during fall to reduce the chance of the head hitting the spoiler.

Should any crew member be injured so as to prevent his bailout normally, assist crew member to pressure compartment door opening, connect parachute static line to ripcord, lower crew member head first facing aft through pressure compartment opening and drop him through escape chute.

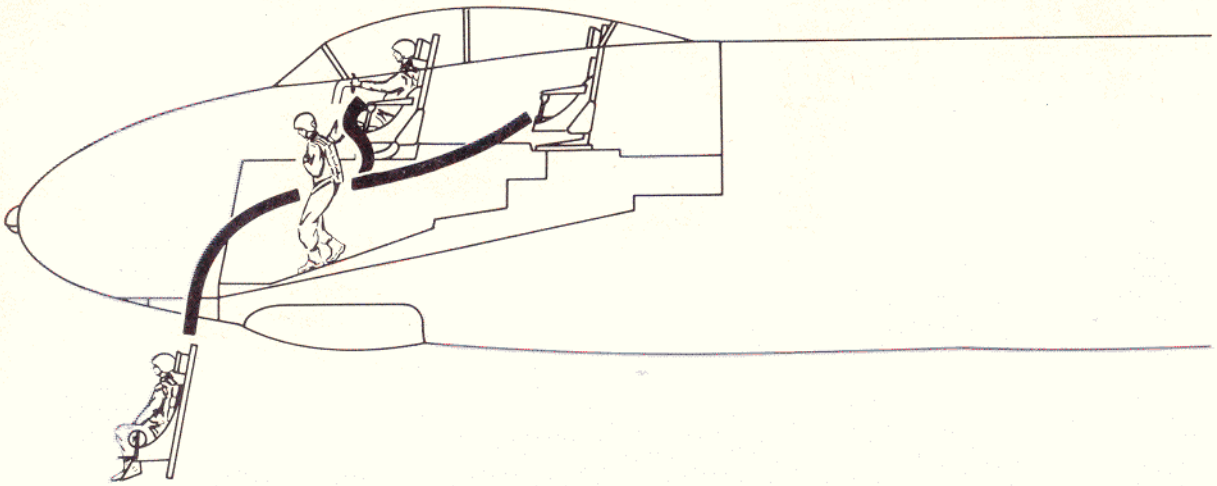
IF TIME AND CONDITIONS PERMIT

1. Pilot starts emergency keyer operation.
2. Copilot sets command radio master switch ON and transfer switch in REMOTE.
3. If above 10,000 feet altitude, all crew members check bailout oxygen bottle for proper connection and pull release.

Figure 3-8A. (Sheet 2 of 2)

bailout

observer's downward ejection hatch opening



pilot

1. Gives bailout warning over interphone and by three short rings on the alarm bell.
2. Reduces airspeed as much as possible (maximum 195 knots IAS). Trims airplane for level flight and engages automatic pilot. Stows control column.
3. Gives abandon-airplane signal by one long ring on alarm bell. Unfastens safety belt and shoulder harness.
4. Follows copilot in bailout thru observer's downward ejection hatch opening.

copilot

1. Unfastens safety belt and shoulder harness.
2. Stows control column and stands by for observer's ejection.
3. After observer's ejection, proceeds forward. Bailout is made through observer's downward ejection hatch opening.

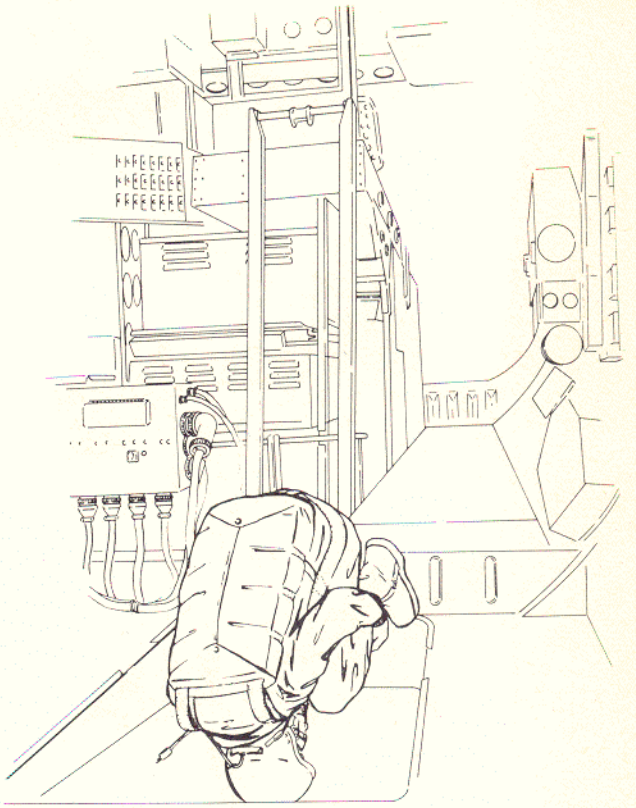
observer

1. Positions seat facing forward, checks safety belt and shoulder harness to insure properly fastened.
2. Raises leg braces from stowed to locked position by pulling either or both triggers and rotating leg braces forward. Grasps D-ring with both hands and pulls once approximately 3 inches.
3. On bailout order fires seat catapult by pulling D-ring a second time, approximately 1½ inches (maintains grip on D-ring during ejection).

Figure 3-8B. (Sheet 1 of 2)

OBSERVE THE FOLLOWING PRECAUTIONS:

1. Pilot should reduce airspeed as much as possible (minimum 145 knots IAS).
2. If gear is used to reduce speed, all gear must be raised prior to bailout.
3. Copilot should crouch at left side of observer's downward ejection hatch opening and roll, head first, out the opening.
4. Pilot follows in same manner.



WARNING

Observer should keep head back against headrest, elbows in place, and feet on footrests.

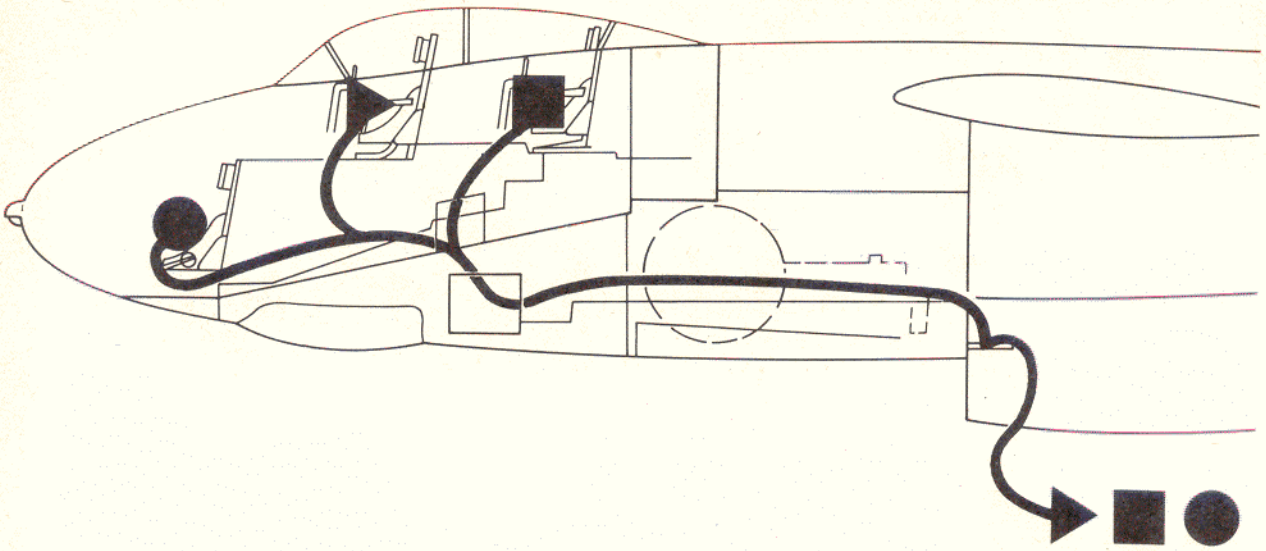
Observer should be absolutely sure he is completely free of the seat before deploying the parachute.

IF TIME AND CONDITIONS PERMIT

1. Pilot starts emergency keyer.
2. Copilot sets command radio master switch ON and transfer switch in REMOTE.

Figure 3-8B. (Sheet 2 of 2)

alternate

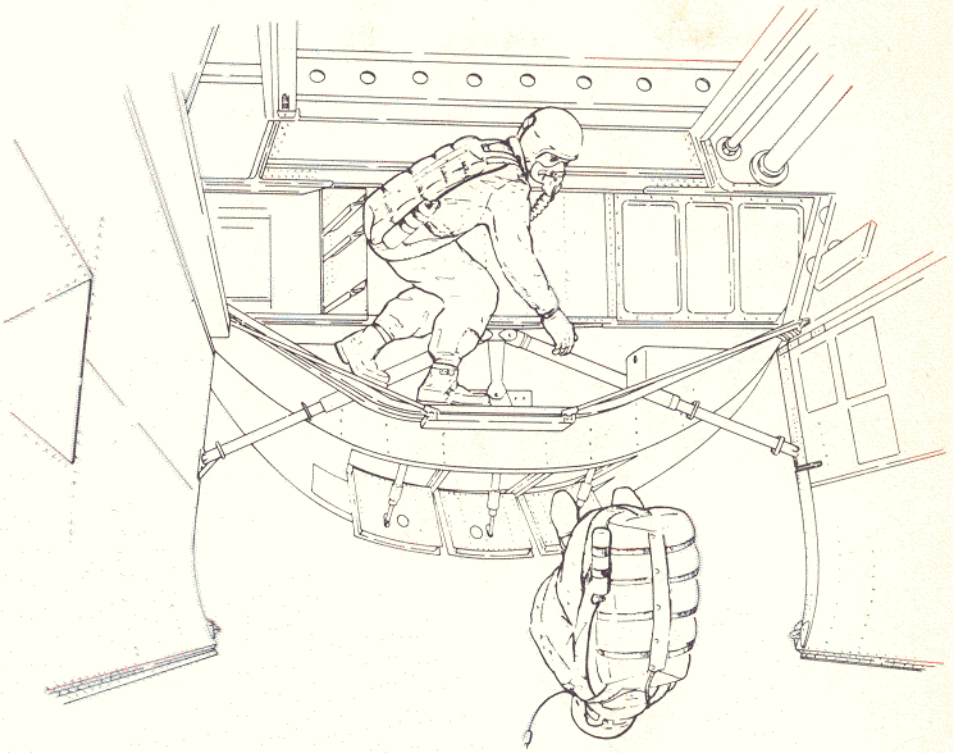


pilot	copilot	observer
1 Gives bailout warning over interphone and by three short rings on the alarm bell. Pulls emergency cabin release handle.	1 Sets command radio master switch ON and transfer switch in REMOTE.	1 Actuates bomb salvo switch. Unfastens safety belt and shoulder harness.
2 Reduces speed as much as possible (maximum IAS 195 knots). Trims airplane for level flight and engages automatic pilot. Stows control column.	2 Stows control column and unfastens safety belt and shoulder harness.	2 Opens pressure entrance door.
3 Check rear landing gear retracted and bomb doors open. Gives abandon-airplane signal by one long ring on alarm bell. Unfasten safety belt and shoulder harness.	3 Follows observer aft to bomb bay platform.	3 Proceeds aft to bomb bay platform.
4 Proceeds aft to bomb bay platform and follows copilot in bailout through bomb bay.	4 Follow observer in bailout through bomb bay.	4 Bailout through bomb bay.

Figure 3-8C. (Sheet 1 of 2)

bailout

bomb bay controllable flight



OBSERVE THE FOLLOWING PROCEDURES AND PRECAUTIONS

NOTE

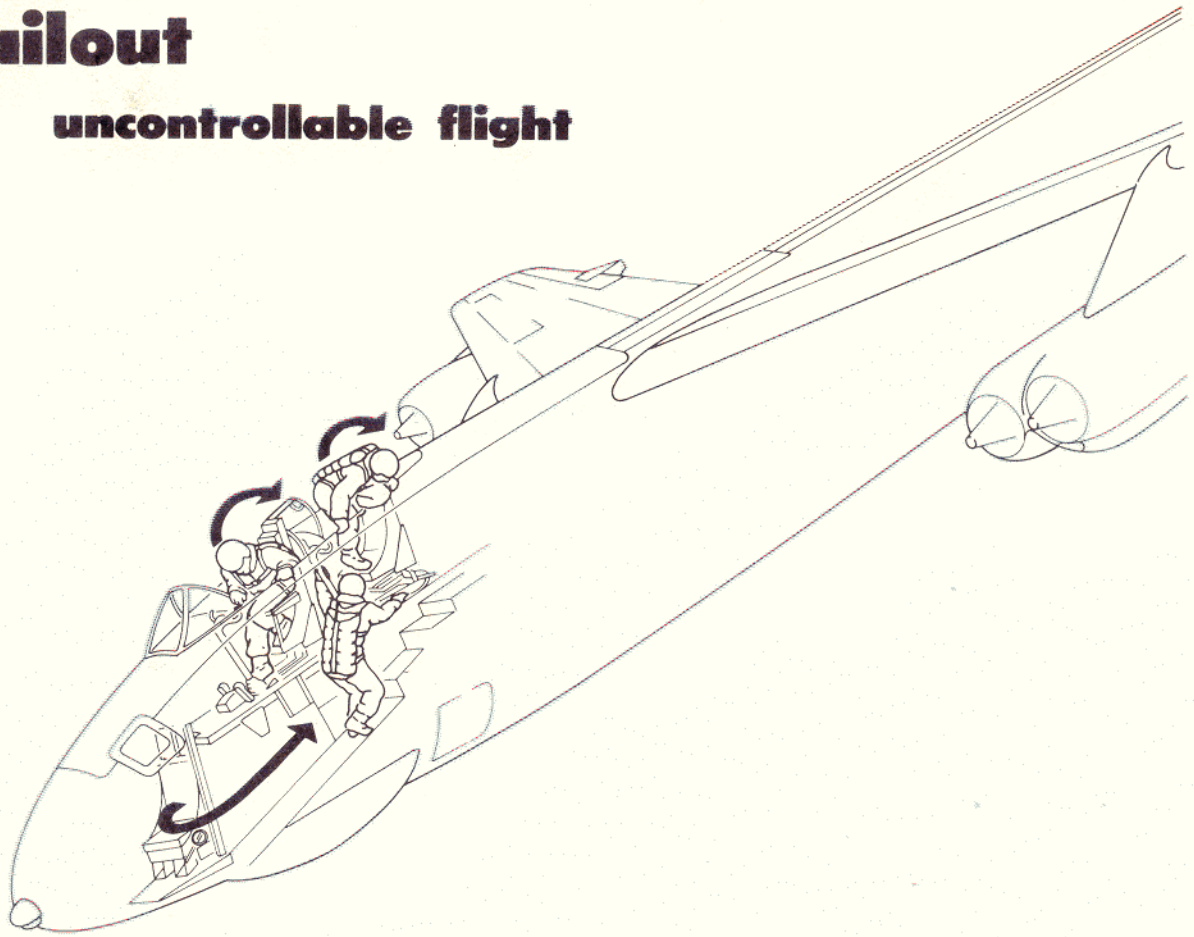
- If above 10,000 feet altitude, all crew members check bailout oxygen bottle for proper connection and pull release.

- The observer leaves first followed by the copilot and pilot, in that order. To bail out, squat on bomb bay platform facing aft with feet at edge of platform, wrap arms around legs, tuck head between knees and roll forward out the bomb bay.

Figure 3-8C. (Sheet 2 of 2)

* alternate bailout

uncontrollable flight



pilot

1. Gives bail out warning over interphone and gives "jettison canopy" order.
2. Unfastens safety belt and shoulder harness. Bail out through cockpit opening, over the side of airplane.

copilot

1. Pulls canopy emergency jettison handle.
2. Unfastens safety belt and shoulder harness. Bail out through cockpit opening, over the side of airplane.

observer

1. Unfastens safety belt and shoulder harness. Proceeds aft in walkway to position near copilot.
2. Follows copilot in bail out through cockpit opening, over the side of airplane.

*** THIS METHOD OF BAILOUT TO BE USED ONLY IF NO OTHER EXIT CAN BE UTILIZED.**

Figure 3-8D.

in nose-low attitude and keep wings level.

o. Make contact at lowest possible airspeed and keep rate of descent consistent with safe control of airplane. Do not stall airplane.

p. Remain in position until the airplane comes to a stop. As soon as the airplane stops, if the canopy has not been jettisoned, the pilot or copilot pulls the canopy emergency release handle and, working together, manually push the canopy up approximately 1/2 inch and then aft sufficiently to allow crew members to exit. In case it is impossible to release the canopy, the observer's escape hatch may be used as an alternate exit. If the airplane is floating, gather all emergency gear and prepare to inflate life rafts but remain with the airplane as long as it floats. If the airplane is under water or sinking rapidly, get clear of the airplane. Retain parachute for survival purposes in life raft.

WARNING

If the emergency jettison handle is used to release the canopy, the canopy must be open, since pulling the emergency jettison handle with the canopy closed will engage the lock pin and prevent the aft end of the canopy from being lifted from the airplane.

In case it is impossible to release the canopy, the observer's escape hatch may be used as an alternate exit by pulling the emergency escape hatch release handle.

BAILOUT

CONTROLLABLE FLIGHT

The methods of bailout are listed below in order of preference:

1. Ejection Seats (except as noted below)
2. Escape Chute - Spoiler extended
3. Observer's Downward Ejection Hatch Opening (Pilot and Copilot Only)
4. Escape Chute - Spoiler not extended
5. Bomb Bay

EJECTION SEATS. Whenever possible, bailout should be made by using the ejection seats (figure 3-8).

The airspeed should not be reduced below 190 knots for ejection to insure jettisoning of the canopy. If time and conditions permit and if an altitude of 2000 feet or below, pilot and copilot will unfasten safety belts to aid in rapid separation from seat after ejection.

WARNING

Do not use observer's downward ejection seat with safety belt unlatched.

ESCAPE CHUTE - SPOILER EXTENDED. If for any reason the ejection seats are inoperable or not installed, the escape chute with spoiler extended is the most desirable means of egress. The airplane should be trimmed for level flight and the drag gear extended to reduce as much speed as possible (definitely below 280 knots IAS) to insure proper spoiler extension and to eliminate possible parachute malfunction. All gear must be raised prior to bailout. Refer to figure 3-8A.

OBSERVER'S DOWNWARD EJECTION HATCH OPENING (PILOT & COPILOT ONLY). The observer's downward ejection hatch opening may also be used for egress by the pilot and copilot after the observer has ejected. Maximum speed for safe egress is 195 knots IAS. Refer to figure 3-8B.

ESCAPE CHUTE - SPOILER NOT EXTENDED. The escape chute (without spoiler extended) can be used; however, airspeed should be reduced as much as possible (maximum 195 knots IAS for safe egress) and all gear raised prior to bailout (figure 3-8A).

BOMB BAY. It is possible, when considerable time is available, to egress through the bomb bay. This method is considered least desirable due to the distance from the crew members' stations and the difficulties encountered crawling through the small passageway to the bomb bay (figure 3-8C).

ALTERNATE BAILOUT

UNCONTROLLABLE FLIGHT

The methods of bailout are listed below in order of preference:

1. Ejection Seats
2. Jettison Canopy - over the side.

EJECTION SEATS. If the ejection seats are operative, regardless of structural condition, they should be used to abandon the airplane. Ejection should be performed in the same manner as in a controllable airplane (figure 3-8).

CANOPY OPENING. If the ejection seats are inoperative and there are no other means of abandoning the airplane, the canopy can be jettisoned and the crew egress through the opening and over the side as a last resort (figure 3-8D).

EMERGENCY ENTRANCE.

Entrance into the airplane may be gained through three openings. These openings are the observer's escape hatch, the canopy, and the regular door entrance. For method of gaining entrance using the regular door, refer to figure 2-1. As a wheel-up or crash landing will probably make the regular entrance door inaccessible, the emergency release facilities must be used. See figure 3-9.

EMERGENCY GROUND STARTING ON BATTERY.

If external power is not available for starting, proceed as follows:

a. Turn off all equipment requiring DC power.
b. Position battery switch to L.H. BUS NORMAL.

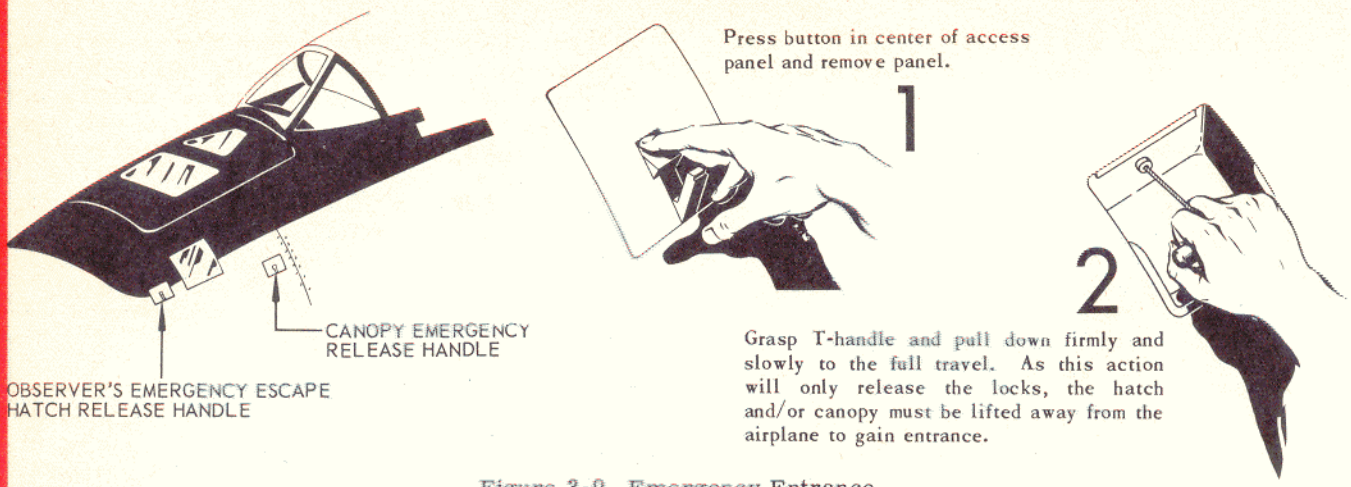


Figure 3-9. Emergency Entrance

c. Position all generator switches to RESET, then to OFF.
d. Place fuel selector switch for No. 2 engine on TME; all other fuel selector switches on ME.
e. Position starter selector switch for engine to be started. Simultaneously actuate starter emergency override switch and starter switch to START.
f. Engine starting sequence 4, 5, 6, 3, 2, and 1. Use normal starting procedure.
g. After starting engines No. 4, 5, and 6, place all generator switches to ON position and battery switch to OFF. Start remaining engines on generator DC power from three operating engines.

CAUTION

Generator loads should be evenly distributed before using generator power for starting to avoid blowing current limiters.

EMERGENCY GROUND STARTING WITH EXTERNAL POWER.

If rectifier power cart (500 amps capacity) or a motor generator cart (800 to 1000 amps capacity) is available, proceed as follows:
a. Turn battery switch OFF.
b. All electrical equipment turned off.

NOTE

No fuel, oil, or hydraulic indications will be shown during engine starts.

c. Connect external power.
d. Place all generator switches to RESET, then to OFF.
e. Place fuel selector switches for No. 2 engine on TME; for all other engines on ME.
f. Position starter selector switch for engine to be started. Simultaneously actuate starter emergency override switch and starter switch to START.
g. Engine starting sequence No. 4, 5, 6, 3, 2, and 1. Use normal starting procedure.
h. After starting engines No. 4, 5, and 6, place all generator switches in ON position and start remaining engines. After all engines are started, place remaining five fuel selector switches on TME.

CAUTION

Generator loads should be evenly distributed before using generator power for electrical equipment to avoid blowing current limiters.

i. Turn on electrical equipment as desired.

EMERGENCY TAXIING.

In case of front gear steering failure, directional control of the airplane cannot be maintained during taxiing. Discontinue taxiing and request to be towed.

In the event an outrigger gear should become mired in mud or other soft surfaces, shut down the engines and await the assistance of a tow vehicle.

SURFACE POWER CONTROL INOPERATIVE.

With the surface power control systems inoperative, the controls are manually actuated through a cable control system. The design of the cable control system is such that each control may be moved a short distance in either direction from the neutral position before actually effecting a movement of the control surface. This "dead motion" however, is of negligible magnitude since the lost motion forces are extremely light in comparison to the forces required to move the surface. The control forces to fly the airplane will be heavy and vary with the airspeed.

WARNING

Very high mach number flight and very high indicated airspeed flight should not be attempted with surface power control inoperative because irregular control characteristics and high control forces will be encountered.

If one or more of the surface power control systems fail, retrim the airplane and position the switch for the malfunctioning system to OFF. The recommended

minimum control speed for failure of aileron or rudder-elevator surface power control, with three engines inoperative on one side and the remaining engines operating at 100% rpm, is 160 knots IAS at sea level.

NOTE

- If the surface power control system is inoperative, the automatic pilot may be used to alleviate pilot fatigue during sustained flight. Oscillatory motion of the airplane during flight can be minimized by manually trimming the surfaces involved to load the automatic pilot servo slightly. This will improve control by removing the effect of the control surface "lost motion."

- After sustained flight using the automatic pilot with surface power control inoperative, the pilot should record in Form 1 the length of time of this operation and the axes involved. The entry made in Form 1 will serve as a notice to the ground crew to check the servo motors and the servo control for any damage caused by the heat generated while applying the continuous loads to the servo motors.

- The trim of the control surfaces should be checked frequently to prevent the loads as indicated by the trim indicators from becoming excessive, because if the automatic pilot would disengage or fail, the control loads would be imposed on the pilot.

LANDING TECHNIQUE WITH RUDDER-ELEVATOR SURFACE POWER CONTROL INOPERATIVE.

When landing with the rudder-elevator power control inoperative, adjust elevator trim so that a pull force of approximately 20 pounds is required to maintain the desired angle of approach. In this manner, corrections in airspeed may be accomplished by simply relaxing or increasing the amount of back pressure on the control column, thereby avoiding movement of the control column within the dead-motion zone and the resultant tendency to overcontrol. A back pressure of this force will require approximately a 30-pound pull to execute the flare on a normal approach.

NOTE

For forward cg landings, full nose-up trim will be required in the initial approach and additional pull force will be required for the last part of the final approach and landing. Maximum pilot effort will be required for a 10% cg landing.

CROSS-WIND LANDING TECHNIQUE WITH RUDDER-ELEVATOR SURFACE POWER CONTROL INOPERATIVE.

Because of heavy rudder pedal forces, a landing with rudder-elevator power control off should be made into the wind. If this is not possible, the following additional comments are applicable: Deployment of the brake chute should not be made until the weight of the airplane has settled onto the rear main gear. This action will allow utilization of the front gear steering system to correct for the "weather-cocking" tendency of the brake chute.

NOTE

Do not deploy brake chute at speeds greater than 125 knots IAS since the brake chute may fail.

If the length of the runway requires that a minimum landing roll be obtained where cross-wind conditions prevail, the steering ratio selector lever may be moved to the TAXI position immediately after touchdown. Then, when the brake chute is deployed at the early part of the landing roll, a greater range of steering will be available to aid in maintaining directional control.

AILERON OPERATION WITH SURFACE POWER CONTROL INOPERATIVE.

CAUTION

If aileron trim is necessary during operation with one aileron surface power control inoperative, trim the airplane to level flight by moving the control wheel, then operate the trim tab control to reduce control wheel forces to zero.

At or near the speed where no trim is necessary, when an aileron power control unit fails, the aileron floats in the midposition of the "lost motion." Control wheel movements in either direction will result in operation of the operative boost and the light forces of power control on operation will be present. Movement of the control wheel beyond the lost motion will result in much higher forces as the aileron with the inoperative power control unit is moved. With both aileron power control units inoperative and at this same speed, the lost motion will be present but as speed is decreased to the speeds at or near those used for approach and landing, the lost motion is not present because of the tendency for both ailerons to float up. The control forces initially felt will be those of one aileron until the control wheel motion is great enough to operate the opposite aileron at which time the control forces will be quite heavy.

NOTE

With both aileron power controls inoperative, it may not be possible with maximum pilot effort to obtain full control wheel deflection.

When airflow separation occurs on the wing in the vicinity of the aileron balance cavity, the normal aerodynamic balance of the aileron is destroyed. This loss of aerodynamic balance results in aileron

"overbalance." The airflow separation which occurs on the wing in the high speed buffeting and at the low speed stall region causes this overbalance.

CAUTION

Because of aileron overbalance, practice stalls should not be attempted with one or both aileron power control units inoperative. Flight at or near first stall warning with one or both power control units inoperative should be avoided.

Sufficient lateral control is available in the event of an aileron power control failure while flying in the high-speed buffeting region. Aileron buffeting will be experienced if flight is continued on into the high-speed buffeting region with aileron power control unit off.

NOTE

Abrupt pitch down will occur when flying at high indicated airspeeds in the event of simultaneous failure of both aileron power control units.

In the event of one aileron power control failure while in the approach for landing or immediately after take-off, position both aileron surface power control switches to OFF. This will result in zero trim being required and the maneuvers can then be completed with no large out-of-trim conditions occurring.

LANDING TECHNIQUE WITH AILERON SURFACE POWER CONTROL INOPERATIVE.

In the event only one of the aileron power controls has failed, there are both advantages and disadvantages to accomplishing the landing with the operative system either on or off. In either case, every possible effort should be made to land the airplane as directly into the wind as possible. If no cross-wind prevails, position both aileron power control switches OFF and maintain an airspeed approximately 5 knots IAS above the best flare speed for a normal approach pattern. This additional speed should be sufficient to prevent aileron overbalance as a result of approach too near the stall region.

With both aileron power control systems inoperative, the lateral control forces will be quite heavy, and the flaperons will be inoperative with a resultant lower rate of roll. The airplane will, however, be trimmed at zero for lateral forces, thus eliminating the possibility of any sudden change in trim at approach speeds.

Nose-high attitudes should be avoided and touchdown should be made with both wheels simultaneously. The brake chute may be deployed only at speeds below 125 knots IAS.

CROSS-WIND LANDING TECHNIQUE WITH AILERON SURFACE POWER CONTROL INOPERATIVE.

In the event it becomes necessary to land in a prevailing cross-wind, it may be advantageous to utilize the one operative aileron power control unit.

Place the switch for the inoperative aileron surface power control unit to OFF.

It will be necessary to turn the aileron trim control knob fully toward the operative side in order to keep the wings level at approach speeds. For this reason, it is imperative that both the pilot and copilot guard the controls and the aileron trim knob closely throughout the approach and landing. If the operative aileron power control unit were to fail suddenly, immediate corrective action would be required to prevent a roll in the direction of trim.

NOTE

With one aileron power system operative, the lateral control forces will be lighter, full aileron control wheel deflection can be obtained, and one flaperon will be operative to provide a greater rate of roll.

As in the case with both aileron power control units off, an addition of 5 knots IAS should be maintained in the approach.

ARTIFICIAL FEEL SYSTEM INOPERATIVE.

If ram air pressure to the rudder-elevator Q-spring is lost because of icing of the ram air intake on the fin leading edge or if a mechanical failure were to occur within the system, a loss of "feel" on the rudder elevator axis and an apparent control "sloppiness" will be experienced. The impression of loss of elevator effectiveness results from the extreme ease with which the rudder and elevator can be moved. With these light forces the control surface can be deflected at a rate which is considerably above the normal rate and faster than the airplane can respond. This condition will be particularly apparent at low airspeeds and will make the airplane control feel sluggish. At high airspeeds the reverse condition will exist, that is, the airplane response will increase and be extremely sensitive to control motions. There is no actual change in control effectiveness under this condition. Automatic pilot operation remains satisfactory. Care should be taken not to make abrupt or exaggerated control motions on rudder and elevator when the control forces become extremely light in order to prevent overstressing the airplane at high speeds.

CAUTION

Because of lack of control forces when the Q-spring is inoperative, there is a tendency to neglect using the elevator trim tab. This fact coupled with the possible pitching tendencies of the airplane if surface control fails when the airplane is out of trim could result in a hazardous condition. Therefore, the airplane should be kept in trim at all times. To accomplish trim, the surface power control must be turned OFF. The airplane must be re-trimmed for each new flight condition caused by raising or lowering gear and flaps, and changes in airspeed or flight attitude. Periodic trim checks should be accomplished during normal flight to compensate for changes in CG caused by fuel consumption.

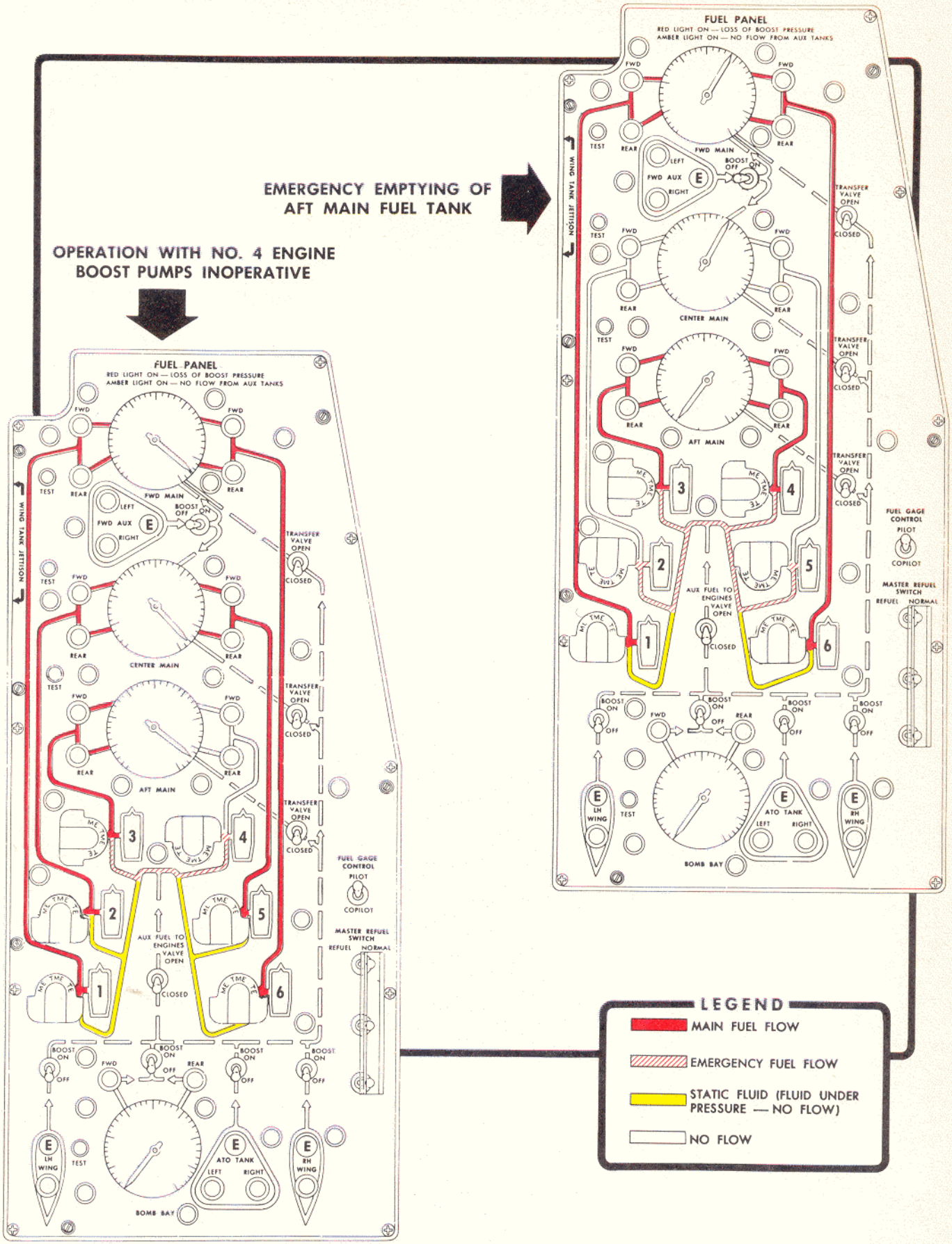


Figure 3-10. Fuel System Emergency Operation

FUEL SYSTEM EMERGENCY OPERATION.

OPERATION WITH BOOST PUMP FAILURE - TAKE-OFF.

Boost pump failure during take-off presents no serious emergency as all engines are fed through the manifold.

NOTE

During any fuel system emergency operation procedure, care must be exercised that cg limits are not exceeded.

OPERATION WITH BOOST PUMP FAILURE - IN-FLIGHT.

The consideration of a boost pump failure in flight does not propose a serious problem, particularly so during auxiliary fuel transfer as the auxiliary boost pump capacity is sufficient to sustain flight when no main boost pumps are operating and auxiliary fuel is being routed to the engine manifold. However, in the event one or both boost pumps for an engine fail after transfer of all auxiliary fuel, the following emergency counter-measures should be established:

a. Fuel selector switch for malfunctioning engine to ME.

b. Fuel selector switch for engine opposite the malfunctioning engine to TME.

c. Reposition No. 2 engine fuel selector switch to TE. This will maintain equal fuel consumption from main tanks during flight.

d. If the boost pumps for No. 2 engine fail, position the fuel selector switch for No. 5 engine to TME and position the fuel selector switch for No. 2 engine to ME.

OPERATION WITH FUEL LINE FAILURE.

If loss of boost pressure occurs under conditions that indicate a broken fuel line, accomplish the following fuel system management:

a. Position fuel selector switch for the engine affected to ME (No. 2 engine fuel selector will be on TME). If loss of boost pressure occurs for the boost pumps supplying the manifold, a broken fuel line is evident. In this case, reposition fuel selector switch for the affected engine to TE, retard the throttle to CUT OFF, and pull fire shutoff switch.

b. If No. 2 engine is the affected engine, place the No. 5 fuel selector switch to TME and No. 2 fuel selector switch to ME. If loss of pressure occurs for boost pumps supplying the manifold, a broken fuel line is evident. In this case, reposition No. 2 engine fuel selector switch to TE, retard throttle to CUT OFF, and pull fire shutoff switch.

c. After positioning the fuel selector switch for an affected engine to ME, if a loss of boost pressure is not indicated for the boost pumps supplying the manifold, this indicates faulty boost pumps supplying the affected engine and the procedure for "Operation With Boost Pump Failure" should be followed.

NOTE

When one engine is shut down in flight, a change in fuel management will be required in order that the cg limits of the airplane are not exceeded.

EMERGENCY TANK EMPTYING.

In case it becomes necessary to empty one main tank rapidly, position the fuel selector switches for the engines receiving fuel from the defective tank to TME. Then position two other fuel selector switches to ME. When the defective tank is nearly empty, reposition the latter two fuel selector switches to TE, position any fuel selector switch for an engine being supplied by another main tank to TME, and the fuel selector switches for both engines being supplied by the defective tank to TME. When all four boost pressure warning lights for the defective tank remain on, reposition fuel selector switches for each engine being supplied by that tank to ME.

WARNING

When emergency emptying of any main fuel tank is being performed, care must be exercised that the cg limits are not exceeded.

OPERATION WITH ASYMMETRICAL FUEL LOADING IN EXTERNAL WING TANKS.

If, at any time during flight, unequal fuel usage from the external wing tanks is experienced, a close check of the aileron trim and control wheel position should be made by flight at the best approach speed (figure 2-9) with gear and flaps extended to determine the amount of aileron trim and control wheel rotation required to maintain level flight. It is recommended that this check be accomplished at altitudes not greatly in excess of 15,000 feet and no lower than is deemed safe by the pilot. If, under these conditions, full trim is required and the control wheel position indicates a requirement in excess of one-half of the total aileron throw, the external wing tanks should be dropped prior to landing.

However, if the trim is within the above limits, a safe landing can be accomplished using a normal landing pattern and approach with the exception that the roll-out on final approach should be completed at least 3 miles from the touchdown point. This will alleviate any necessity for large control corrections during the latter part of the final approach because of marginal lateral control at lower speeds. When landing during any unfavorable wind conditions, such as crosswind or gusty wind, lateral control will be marginal at any adverse loading condition.

Control of the airplane after touchdown is marginal due to the asymmetric weight condition and, with full opposite aileron, it will be impossible to hold the heavy wing up. Therefore, it will be necessary to hold approximately one-quarter rudder deflection during the ground roll to maintain a straight landing run.

EXTERNAL WING TANK JETTISONING.

Before jettisoning the external wing tanks, the tank capacity, flap position, and airspeed should be considered:

Full Tanks - Flaps down
Empty Tanks - Flaps up
Minimum IAS - 155 knots
Maximum IAS - 300 knots

Observe flap structural speed (flap placard). When it is necessary to jettison external wing tanks, lift switch guards and position wing tank jettison switches to RELEASE.

NOTE

Excessive time delay may occur for the external wing tanks to jettison after the wing tank jettison switches have been placed in the RELEASE position. This is caused by the parachute failing to deploy immediately upon actuation of the wing tank jettison switch. Maximum time delay has been as high as 10 minutes.

FAILURE OF ONE EXTERNAL WING TANK TO JETTISON.

Failure of one external wing tank to jettison in flight should not present a serious problem on landing, provided proper trim has been applied to compensate for the extra weight and drag.

NOTE

Airplane should be slowed down to touchdown speed at a safe altitude before landing in order to check directional and lateral control. If unable to control at touchdown speed, add 10 knots to speed at which control is lost for the desirable touchdown speed. Approximately 8 or 9 knots is then added for a desirable flare speed.

ELECTRICAL SYSTEM EMERGENCY OPERATION.

GENERATOR FAILURE.

If the generator field trip relay lights indicate that a generator has tripped off the line, the generator may be reset, if it is absolutely needed, by positioning the respective generator switch to RESET. If two or more generators become inoperative, a careful check of the load on the remaining generators should be made. Many electrical loads are not absolutely essential and may be momentarily or permanently removed from the line during emergency conditions. The table in figure 3-11 shows the approximate power requirements for the main electrical loads. Each generator is rated at 400 amperes with an overload rating of 600 amperes for a 5-minute period. Total the loads for any operation and check against the power available to determine if any loads must be removed from the line. The most critical partial generator operation likely to be encountered is for two-engine endurance; the detailed procedure is given as follows:

NOTE

Any tabulation of electrical loads must be an approximation or an average because loads vary with existing conditions and with the age of the equipment.

OPERATION WITH TWO GENERATORS.

Operation with only two generators, as encountered during two-engine endurance flight (see "Two-Engine Endurance" in this section), requires careful consideration of the limited electrical power available. However, if all non-essential electrical equipment is turned off, sufficient electrical power is available from the remaining two generators to operate essential equipment. In addition, should one of these generators fail, the overload capacity (600 amperes for 5 minutes) of the remaining generator is sufficient to operate the essential equipment until another engine can be restarted.

The following tabulation is taken from the chart in figure 3-11 and lists the essential electrical loads and the stand-by loads for two-engine endurance and their average amperage requirements. This equipment must be operating, or electrical power must be available for operation, at all times:

ITEM	AMPERES
Instrument inverters	10
Surface power control system	61
Hydraulic accumulator heat	14
Instruments and instrument panel vibrators	5
Automatic pilot	25
Pitot heat	9
Flying suits	12 (average)
Lighting	26
Main inverter	105 (max)
Battery charging	15 (approx)
Fuel boost pumps (4)	104
Radio equipment	16 (approx)
Generator field and control	23
Fuel tank purging heaters	8
Total essential and stand-by load	555
Two-engine generator capacity	800
Single engine generator overload capacity (50% overload for 5 minutes)	600

A study of the complete listing of major electrical equipment items (figure 3-11) will show that the operation of starters, unnecessary fuel boost pumps, "K" system radar, wing flaps, landing gear, and hydraulic equipment must be avoided during two-engine flight. However, certain other equipment, such as the window defroster, may be operated if the need is urgent and the total amperage load is kept to a minimum. It is recommended that the total amperage of equipment operated should not be allowed to exceed the 600-ampere overload capacity of a single generator.

EQUIPMENT	NO. UNITS	AMPS. PER UNIT	TAKE-OFF CLIMB	CRUISE	CRUISE COMBAT	DESCENT LANDING
ARMAMENT						
"K" system	1	29.5	24	30	30	
Pump, vacuum (normal)	1	20	20			
Pump, vacuum (standby)	1	20				
Gun turret	1			17	214	
CONTROL SURFACES						
Flaps (extend)	2	90.5				181
Flaps (retract)	1	127	127			
Surface power control	1	100	100	100	100	100
Autopilot	1	20.6		21	21	
ELECTRICAL POWER						
Battery Charging	2		121	91	61	30
Inverter, main	1		64	164	164	64
Inverter, A5	1		76	111	168	
Inverter, secondary	1		71	67	67	71
Inverter, 3 phase	1		20	20	20	15
Inverter, A-5 3 phase	1			44	43	
Inverter, main or spare instrument	1		25	25	25	25
FUEL						
Main tank boost	12	22.5	274	274	274	274
Fwd. aux. boost	2	52		104	104	
Drop tank boost	2	52		104		
Bomb bay tank boost	2			105	105	
ATO tank boost	2			105		
Tank purging heaters	10		21	88	65	21
HEAT, VENT, & ANTI-ICE						
Cabin air, ground	1	23	23			23
Nose defrost	1	23	23	18	18	23
Clothing heater	3	10				
Accumulator heater blanket	5	2.5	13	13	13	13
Flap Motor heater	2	10.7	22	22	22	22
Hot cup	1	20		20		
Pitot heater	2	4.2	8			8
INSTRUMENTS						
Instruments & vibrators			5	5	5	5
LANDING GEAR						
Fwd main gear (retract)	2	173	346			
Fwd main gear (extend)	1	neg.				
Aft main gear (retract)	2	133	266			
Aft main gear (extend)	1	neg.				
Outriggers (retract)	2	126	252			
Outriggers (extend)	2	neg.				
LIGHTS						
Navigation lights			8	8		8
Landing lights	2	21.4	43			43
Taxi light	1	5.4	5			5
Interior lighting			23	23	19	23
Aerial refueling lighting				19		
PHOTOGRAPHIC EQUIPMENT						
Camera, radar recording	2				8	
RADAR						
Miscellaneous				6	5	
RADIO						
Intercommunication	1	10.7	11	11	11	11
Navigation	1	7.7		8	8	8
VHF command (receive)	1	17	17	17	17	17
VHF command (transmit)	1	20	20	20	20	20

GENERATOR CAPACITY - NORMAL: SIX GENERATORS AT 400 AMPS EACH, 2400 AMPS.
OVERLOAD (5 MIN.): SIX GENERATORS AT 600 AMPS EACH, 3600 AMPS.

Figure 3-11. Major DC Electrical Loads

FAILURE OF FORWARD MAIN BUS.

Should a fault occur on the forward main bus which will deenergize all equipment served from the upper, lower, and aft DC power panels, and the radar power panels, an automatic changeover relay will transfer the power panels to the right main bus. If the change-over relay does not immediately restore power to the upper, lower, and aft DC power panels and the radar power panel, place the bus selector switch in SECONDARY position. This procedure will manually transfer power to the right main bus.

INVERTER FAILURE.

In case of failure of either the main or A-5 inverter, automatic changeover relays will transfer the secondary inverter output to the failed bus. In case of failure of both the main and A-5 inverters, automatic change-over relays will transfer the secondary inverter to the main bus only.

In case both main and A-5 inverters have failed and secondary bus voltage is momentarily required, place inverter transfer control switch in SEC INV SEC BUS position.
In case the secondary inverter has failed or has been automatically transferred to the main bus, and secondary bus power is required, place the inverter transfer control switch in the A-5 INV SEC BUS position.

If the main and/or A-5 inverter fails and the automatic changeover relays fail to operate, the secondary inverter output may be manually transferred by placing the inverter transfer control switch in the SEC INV MAIN BUS or SEC INV A-5 BUS position.

INSTRUMENT INVERTER FAILURE.

In the event the main instrument inverter fails, an automatic change-over relay will energize the spare inverter to supply the instrument bus. In case the main instrument inverter fails and the automatic change-over relay fails to function, place the instrument inverter switch in the SPARE position.

ALTERNATOR FAILURE.

In the event of complete failure of both alternators, place both alternator power switches in OFF, place bus selector switch in OFF, and turn off all equipment receiving power from the alternators.

INSTRUMENT FAILURE.

If electrical power is lost to any or all of the following instruments, these instruments may deceptively continue to give indications of the conditions that existed prior to the power failure.

1. Engine fuel pressure gages
2. Engine oil pressure gages
3. Fuel quantity gages
4. Hydraulic quantity gage
5. Hydraulic pressure gages
6. Flap position indicators
7. N-1 compass master indicator
8. Vertical gyro indicator
9. Remote compass repeater

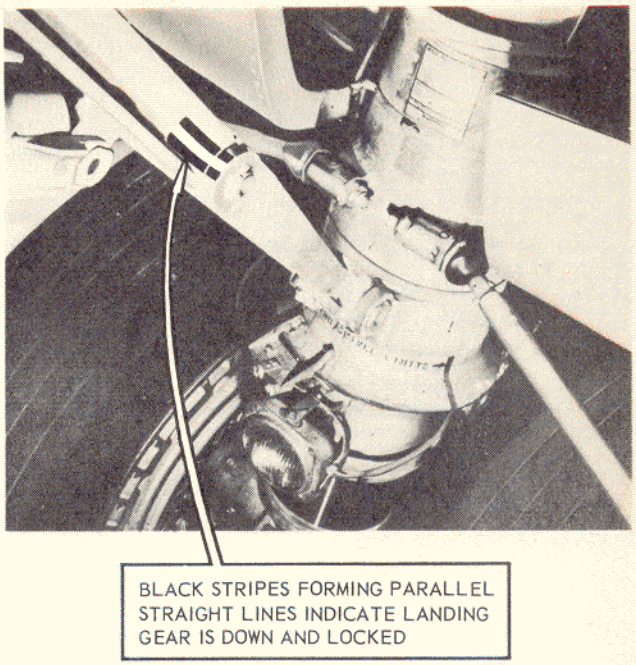


Figure 3-12. Visual Landing Gear Check

HYDRAULIC SYSTEM EMERGENCY OPERATION.

Whenever main system pressure falls below emergency system pressure, shuttle valves are automatically actuated causing the emergency system to supply the actuating units. If emergency system pressures are below 2700 psi when the emergency hydraulic pump switch is in AUTO NORMAL and the circuit breaker is depressed, hold the switch ON. In the ON position, a pressure switch is by-passed and pressure should build up to the maximum of 3450 psi.

LANDING GEAR EMERGENCY OPERATION.

EMERGENCY RETRACTION OF LANDING GEAR.

The landing gear can be retracted by a landing gear emergency retraction switch at the pilot's station or by individual landing gear emergency retraction switches at the copilot's station. Except in an extreme emergency where it is necessary to retract the gear immediately, use the individual retraction switches at the copilot's station. Place individual retraction switches OFF as soon as gear retraction is completed.

CAUTION

- Landing gear emergency retraction switches by-pass all limit switches. Release the switches from the GEAR UP position immediately when the UP tab appears in the window of the gear position indicators.

- Do not use emergency landing gear retraction switches unless landing gear lever is in OFF position.

EMERGENCY EXTENSION OF LANDING GEAR.

In case the landing gear fails to extend, accomplish the following:

CAUTION

Before operating landing gear emergency extension lever, the normal landing gear levers must be in OFF position and airspeed reduced to the lowest practical figure. In no case shall this speed be in excess of 200 knot IAS.

a. Select extension lever for gear to be extended (one for each gear) and operate with full strokes fore and aft until gear is unlocked.

b. As soon as the gear starts to free fall, place the emergency extension lever in the aft position and leave it there during the free fall period.

CAUTION

Do not hold the lever in the forward position during the free fall period.

c. Operate lever with full strokes fore and aft until gear is down and locked. When gear is fully down and locked, an indicator light (green) on the forward side of the extension stand will glow and gear down tabs will appear at pilot and copilot stations.

NOTE

The number of strokes to unlock the gear and the number of strokes required after free fall very considerably with the conditions under which the system is operated. The length of stroke will vary with each operator, thus the total number of strokes required will vary with each operator. The amount of free fall will vary with airplane attitude, airspeed and temperature, thus the number of strokes required to extend the gear from the free fall position to the "Down and Locked" position will vary with these conditions. The "Down and Locked" position as indicated by the green light, is usually reached with maximum effort of approximately 75 pounds when the lock is engaged. There is a perceptible change in the load required to pull the handle when the "Down and Locked" position is reached since the operating loads immediately prior to this point are in the range of 10 to 25 pounds. In all cases requiring the use of the emergency extension levers, continue the stroking action until position indicators show a "Down and Locked" position and a definite change in handle operating loads is encountered.

d. When one gear is down and locked, continue to extend remaining gears.

NOTE

If the landing gear fails to free fall when using the emergency system, longitudinal rocking of the airplane may assist in breaking it loose.

e. In case it is impossible to lower all landing gears, follow required emergency landing procedure.

CAUTION

Do not allow ratchet handle to snap back as this may result in damage to the emergency extension system.

VISUAL INSPECTION OF FORWARD MAIN LANDING GEAR.

A ground heat access panel (22, figure 1-4) is provided on the right side of the crawlway. If landing gear lights and position indicators are inoperative and any doubt exists as to whether the forward main landing gear is in the down-and-locked position, a visual inspection can be made by opening this access panel and observing the relationship of parallel black and yellow stripes painted on the drag link and drag strut at the connecting point. When these stripes form parallel straight lines, the gear is in the full-down position (figure 3-12). To insure a full interior locking of the gear, use emergency extension handles until force required to operate handle indicates a locked condition. If the lines appear to be broken at an angle, further efforts should be made to assure full extension and locking of the forward main landing gear.

WING FLAP EMERGENCY OPERATION.

The wing flaps, when extended, provide a minimum of drag and their only limiting effect on the airplane is the flap limit speed. The flaps are retracted or extended in an emergency by actuating the wing flap emergency switches. Slow retraction is accomplished by placing either switch, primary or secondary motor, to UP. Rapid retraction is accomplished by simultaneously placing both switches to UP. Rapid extension is always provided regardless of which switch is placed in DOWN. The wing flap emergency switches by-pass all limit switches, and must be released to OFF when the flaps reach their full travel.

WARNING

Normally retract the wing flaps with only one emergency switch at a time. The use of both emergency switches simultaneously results in considerable loss of lift and the airplane will settle rapidly.

LANDING TECHNIQUE WITH FLAPS UP.

Landings should never be performed with the flaps retracted unless it becomes necessary due to malfunction of the system. The pattern should be comparable to that shown on figure 2-9, allowing for the increased airspeeds required. The recommended airspeeds in the pattern are as follows:

a. Downwind, 35 knots above touchdown speed flaps up;

b. Base leg, 25 knots above touchdown speed flaps up;

c. And at beginning of final approach, 15 knots above touchdown speed flaps up. Despite the absence of flaperon action, the available rate of roll will be approximately the same as that for flaps down because of the higher approach speeds. The approach angle will be approximately the same as for a flaps down landing. The touchdown should be made approximately 10 knots above the first stall warning flaps up as shown on figure 6-1. This will result in a nose-high attitude with the front main landing gear approximately 2 feet off the runway when touchdown of the rear main landing gear occurs. The elevator control at touchdown will be sufficient to prevent the front landing gear from striking the runway with a severe impact. The landing roll will be longer, of course, and the touchdown should be as close to the end of the runway as possible in order to allow for the increased landing speed and the brake chute should be deployed as soon as the airplane has decelerated to 125 knots.

BRAKE SYSTEM EMERGENCY OPERATION.

LANDING WITH BRAKE FAILURE.

If it appears that the main hydraulic system has failed and if no emergency braking can be obtained by further depression of the rudder pedals, proceed as follows:

a. Upon touching down, immediately retard all throttles to CUT OFF, pull fire shutoff switch, and deploy brake chute.

b. If a stop cannot be made before an obstruction will be reached, and IAS is not appreciably greater than 60 knots, position steering ratio selector lever to TAXI and ground-loop airplane.

c. If it becomes apparent that it will be impossible to stop or ground-loop airplane before an obstacle is reached, as a last resort retract all landing gears by actuating landing gear emergency retraction switch on pilot's control stand.

d. Cut battery switch after landing gears retract.

e. Leave airplane as soon as possible. To prevent possible injury caused by leaping from airplane, use wing as ramp.

CONDITION	LANDING ROLL EQUALS
No brake failure	6770 ft
One brake failure	7460 ft
Two brake failure	8400 ft
Three brake failure	9850 ft
Four brake failure	12,360 ft

CONDITIONS:

Gross Weight 135,000 lbs
60° F at 1000 altitude
Dry concrete runway
Brake failure at touchdown
No brake chute
2 engines at idle stop, all others cut-off

DATE: March 1952

DATA BASIS: Calculated

Figure 3-13. Stopping Distances - Brake Failure

LOSS OF MAIN BRAKE SYSTEM PRESSURE.

Hydraulic pressure for emergency operation of the brakes is automatically supplied by the emergency hydraulic system. Emergency brakes are applied by depressing the rudder pedals farther than is normally necessary. Emergency brake action is conventional with no anti-skid protection.

INSUFFICIENT BRAKING WITH MAIN BRAKE SYSTEM.

There is the remote possibility of a condition existing where main system pressure has not failed but, due to some other malfunction, it is impossible to maintain adequate braking with the main brake system. It is then necessary for the copilot to aid the pilot in depressing the rudder pedals past the normal brake range. This action will override the main brake system, including anti-skid, and apply the emergency brakes.

PARTIAL BRAKE FAILURE.

The effect of brake failure on stopping distance is tabulated on figure 3-13.

SECTION IV

DESCRIPTION AND OPERATION OF AUXILIARY EQUIPMENT

CABIN HEATING, VENTILATING, AND PRESSURIZING SYSTEM.

Hot compressed air for the cabin heating, ventilating, and pressurizing system (figure 4-2) is supplied from any or all of the No. 1, 2, and 3 engine compressors. This air is cooled by a refrigerator unit as required to maintain a desired cabin temperature and discharged into the cabin through an upper and lower outlet at each crew station. The cabin may also be ventilated by ram air during unpressurized flight and ground operation. Whenever the airplane is on the ground and the DC power distribution system is energized, a supplemental ram air blower operates to provide ram air ventilation. To prevent damage to the ram air blower when changing from the pressurized condition to ram air ventilation, a cabin pressure differential switch operates automatically to delay opening of a ram air shut-off valve until cabin pressure has been substantially dissipated. Circuit protection for the cabin air conditioning system is provided on the copilot's lower DC power panel (6, figure 1-30) and the main AC power shield (3, figure 1-30).

Cabin pressurization is maintained by cabin pressure regulators, on the left aft and lower forward sides of the pressure section, which control the escape of cabin air to the atmosphere. A cabin pressure relief valve relieves cabin pressure at 7.12 psi pressure differential in the event the cabin pressure regulators fail. This valve also serves as a vacuum relief valve whenever cabin pressure is less than atmospheric and as an emergency cabin pressure dump valve when rapid depressurization is desired. The following cabin pressure conditions are provided by the cabin pressure regulators:

a. Atmospheric range (sea level to 5,000 feet), cabin unpressurized.

b. Isobaric range (5,000 to 24,100 feet), constant 5,000-foot cabin pressure altitude.

c. High differential pressure range (above 24,100 feet), constant 6.55 psi cabin pressure differential.

d. Combat range (above 27,600 feet), cabin pressure differential varying from 6.55 psi at 27,600 feet to 2.05 psi at 45,000 feet.

Cabin altitude at any flight altitude should be in accordance with the aforementioned data and/or figure 4-1.

NOTE

Combat pressure differential values are designed to insure that maximum safe decompression rates for personnel will not be exceeded should explosive decompression of the cabin occur.

CABIN HEATING, VENTILATING, AND PRESSURIZING SYSTEM CONTROLS.

MASTER AIR CONDITIONING SWITCH. An ON--OFF master air conditioning switch (1, figure 1-14) is on the pilot's switch panel. When the switch is in the ON position, DC power is supplied to operate the heating, ventilating, and pressurizing system. When the switch is in the OFF position, the system is rendered inoperative and power is supplied directly to close a hot air shut-off valve and a refrigerator by-pass valve.

HEAT SELECTOR SWITCH. An AUTO--OFF--HOT --COLD switch (3, figure 1-14) is used to select automatic or manual temperature regulation. The switch must be held in the HOT or COLD positions because the switch is spring-loaded to the OFF position. When the switch is in the AUTO position, the cabin temperature is electrically controlled by a cabin temperature regulator. When the switch is in the OFF position, no temperature regulation is provided and cabin air temperature will be determined by the outside air temperature and the last position of the refrigerator unit DC operated by-pass valve. When the switch is in the HOT position, the refrigerator unit by-pass valve is moved toward the open position, permitting more air to by-pass the refrigerator unit and raise the temperature of the air entering the cabin. When the switch is in the COLD position, the refrigerator unit by-pass valve is moved toward the closed position, increasing the flow of air through the refrigerator unit and lowering the temperature of the air entering the cabin.

CABIN TEMPERATURE SELECTOR RHEOSTAT. A rheostat (2, figure 1-14) marked DECREASE--INCREASE is used to select the temperature desired between 40° and 100° F for automatic operation. With the heat selector switch in the AUTO position, turning the knob in the DECREASE or INCREASE direction electrically resets the cabin temperature regulator to provide a corresponding decrease or increase in the automatically maintained cabin air temperature.

NOTE

The first two-thirds of travel of the cabin temperature selector rheostat increases the cabin temperature from 40° to 60° F. The last one-third of travel increases the temperature from 60° to 100° F. Allow sufficient time for temperature stabilization between settings of this rheostat.

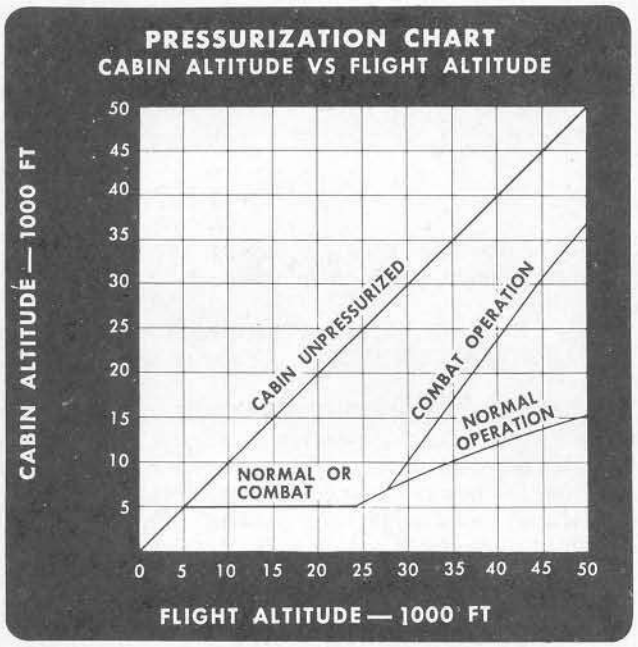


Figure 4-1. Pressurization Chart

CABIN HEAT DISTRIBUTION KNOB. A push-pull knob (12, figure 1-13) marked HEAT DECREASE UPPER OUTLETS--HEAT DECREASE LOWER OUTLETS on the pilot's control stand is used to control the relative temperature of air being supplied to the upper and lower crew outlets. Pulling the knob in the HEAT DECREASE UPPER OUTLETS direction mechanically actuates a cabin heat distribution valve to decrease the upper outlet duct temperature and increase the lower outlet duct temperature. Pushing the knob in the HEAT DECREASE LOWER OUTLETS direction mechanically actuates the cabin heat distribution valve to decrease the lower outlet duct temperature and increase the upper outlet duct temperature. The knob can be locked in any desired position by turning the knob in a clockwise direction and released by turning in a counterclockwise direction.

AIR OUTLET SELECTOR KNOBS. An air outlet selector knob (15, figure 1-13 and 11, figure 1-28) is located at each crew station to provide the crew member with a means of controlling the air flow at his station. Each knob is marked BOTH HI FLO--BOTH LO FLO--BOTH OFF--LOWER LO FLO--LOWER HI FLO--UPPER HI FLO--UPPER LO FLO and, when positioned accordingly, mechanically actuates a flow valve to provide high flow, low flow, or shut-off conditions at either the upper or lower outlet or both as desired. When positioning of the selector knobs limits the total air flow, a spill valve will discharge the excess air into the cabin to maintain the proper air flow for pressurization.

NOTE

During take-off, climb, or after reaching altitude, it may be impossible to position the air outlet selector valve as desired for proper operation. This condition is caused by condensation or moisture freezing around the valve. Rather than force the valve and cause possible damage, this condition can be remedied by moving the cabin temperature selector rheostat to INC position which increases the temperature of the air going through the valve. If rapid thawing is desired, position the heat selector switch to HOT which permits a greater flow of air through the valve.

CABIN AIR SELECTOR SWITCH. A cabin air selector switch (4, figure 1-14) on the pilot's switch panel marked AIR COMP--RAM SUPPLY is used to select engine compressor air for cabin heating and pressurizing or ram air for cabin ventilating. When the switch is in the AIR COMP position, DC power is supplied to the heat selector switch for cabin heating control. When the cabin air selector switch is in the RAM SUPPLY position, the cabin heating control system is deenergized, and power is supplied to close the hot air shut-off valve and, as soon as cabin pressure is substantially dissipated, open the ram air shut-off valve.

CABIN PRESSURE REGULATION SELECTOR SWITCH. A PRESS NORMAL--COMBAT switch (5, figure 1-14) on the pilot's switch panel is used to select the type of cabin pressure regulation desired. When the switch is in the PRESS NORMAL position, the cabin pressure regulators function to provide atmospheric, isobaric, or high (6.55 psi) pressure differential regulation of cabin pressure, depending on the altitude. When the switch is in the COMBAT position, the cabin pressure regulators function to provide normal pressure regulation up to 27,600 feet, but above 27,600 feet pressure differential is gradually reduced, becoming 2.05 psi at 45,000 feet.

EMERGENCY CABIN PRESSURE RELEASE HANDLE. A push-pull handle (5, figure 1-7) located just aft of the pilot's control stand provides a means for rapid cabin pressure release. When the handle is pulled up, mechanical and pneumatic action opens the cabin pressure relief valve, dumping air into the crawlway. Pulling up the handle also actuates a pressure dump valve switch. When the pressure dump valve switch is actuated, the cabin heating control system is deenergized and DC power is supplied to close the hot air shut-off valve, and as soon as cabin pressure is substantially dissipated, open the ram air shut-off valve. Cabin pressurizing and heating can be restored by pushing the handle down.

CABIN HEAT RESET BUTTON. A button (4, figure 1-7) located just outboard of the emergency cabin pressure release handle at the pilot's station is used to restore heating after the cabin has been depressurized by pulling up the emergency cabin pressure release handle. The button is spring-loaded to the up position and, when depressed, will reset the pressure dump valve switch to supply DC power to close the ram air shut-off valve, open the hot air shut-off valve, and reenergize the cabin heating control system. Once depressed, the button has no

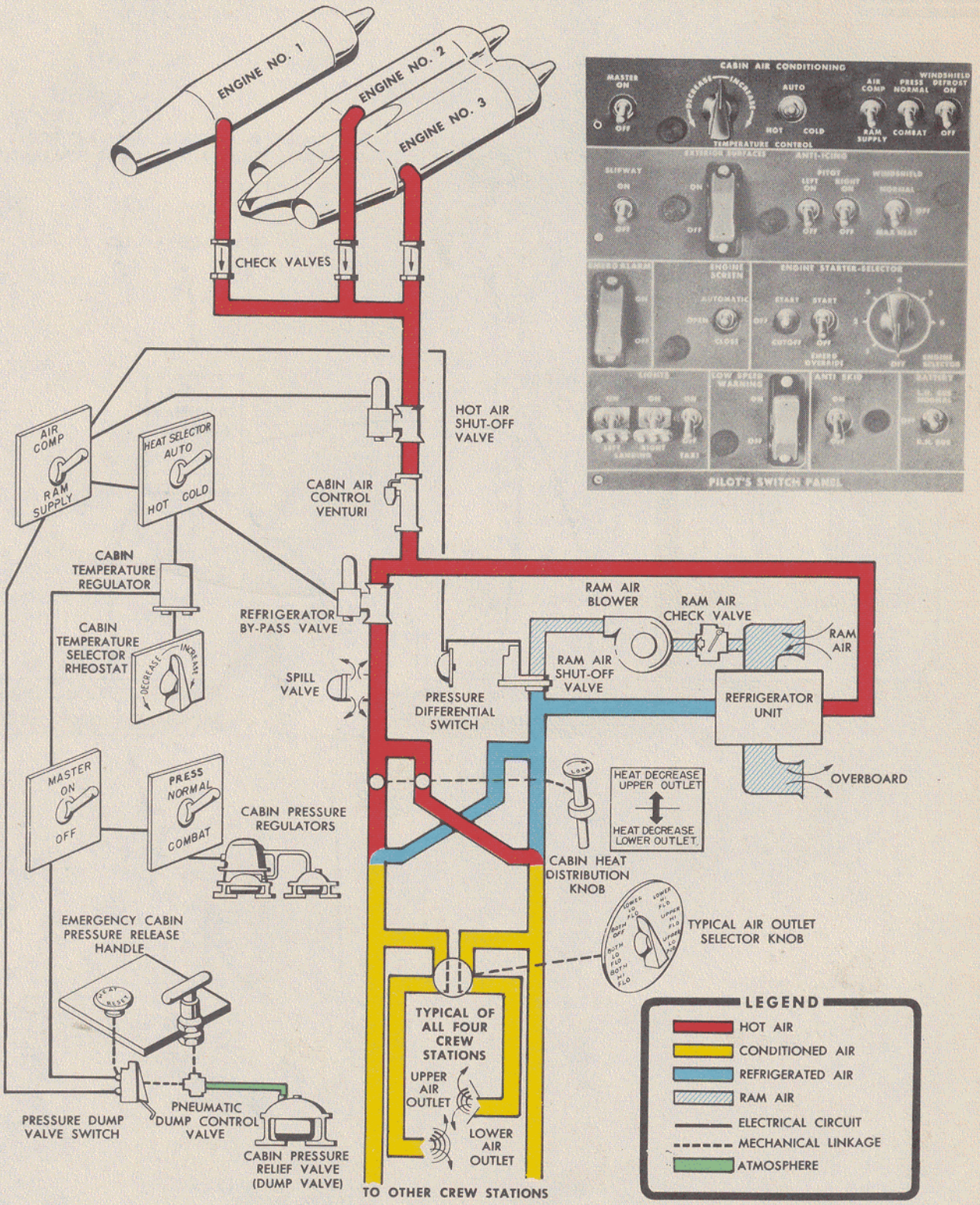


Figure 4-2. Cabin Heating, Ventilating, and Pressurizing System

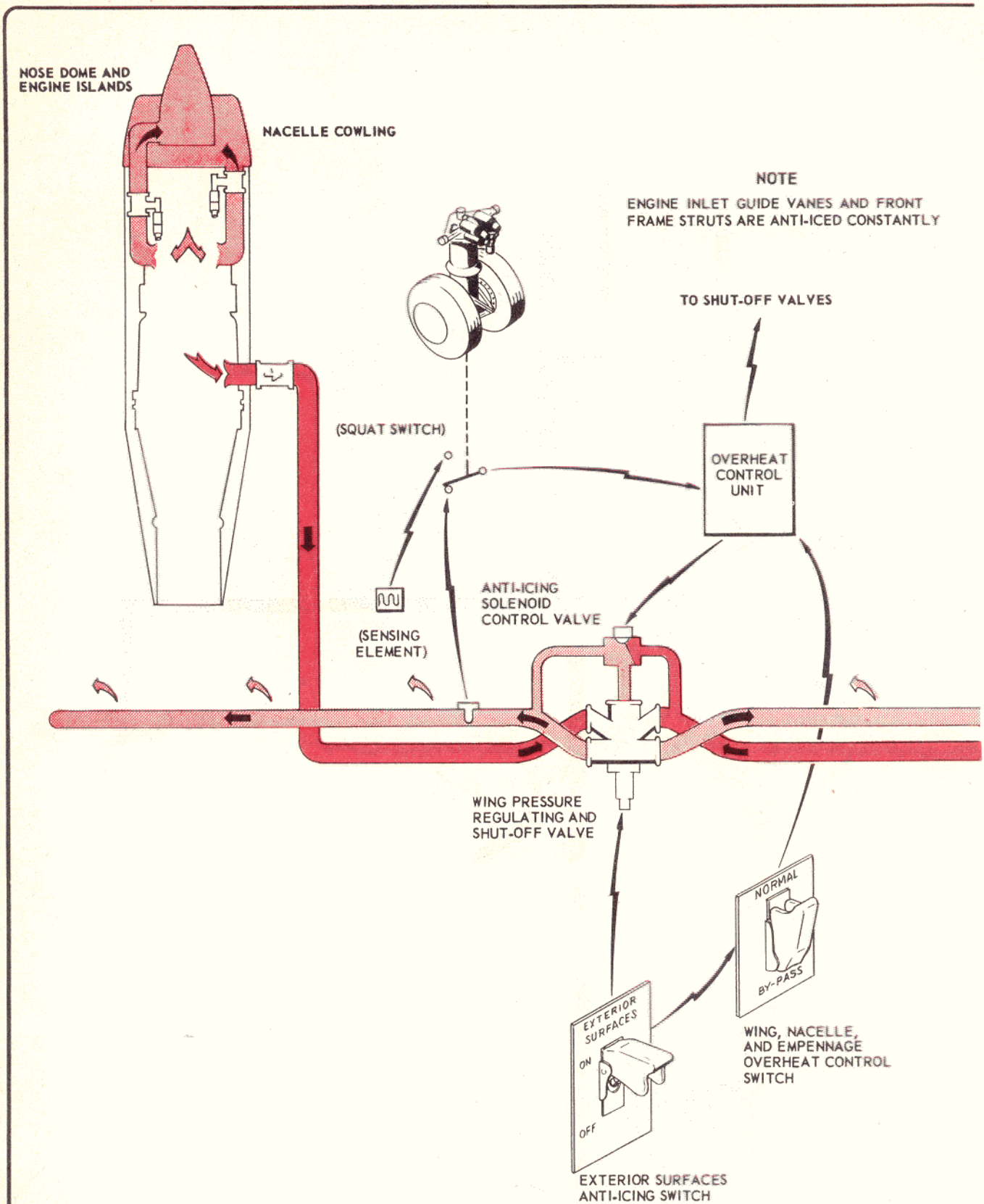


Figure 4-3. Anti-Icing System (Sheet 1 of 2)

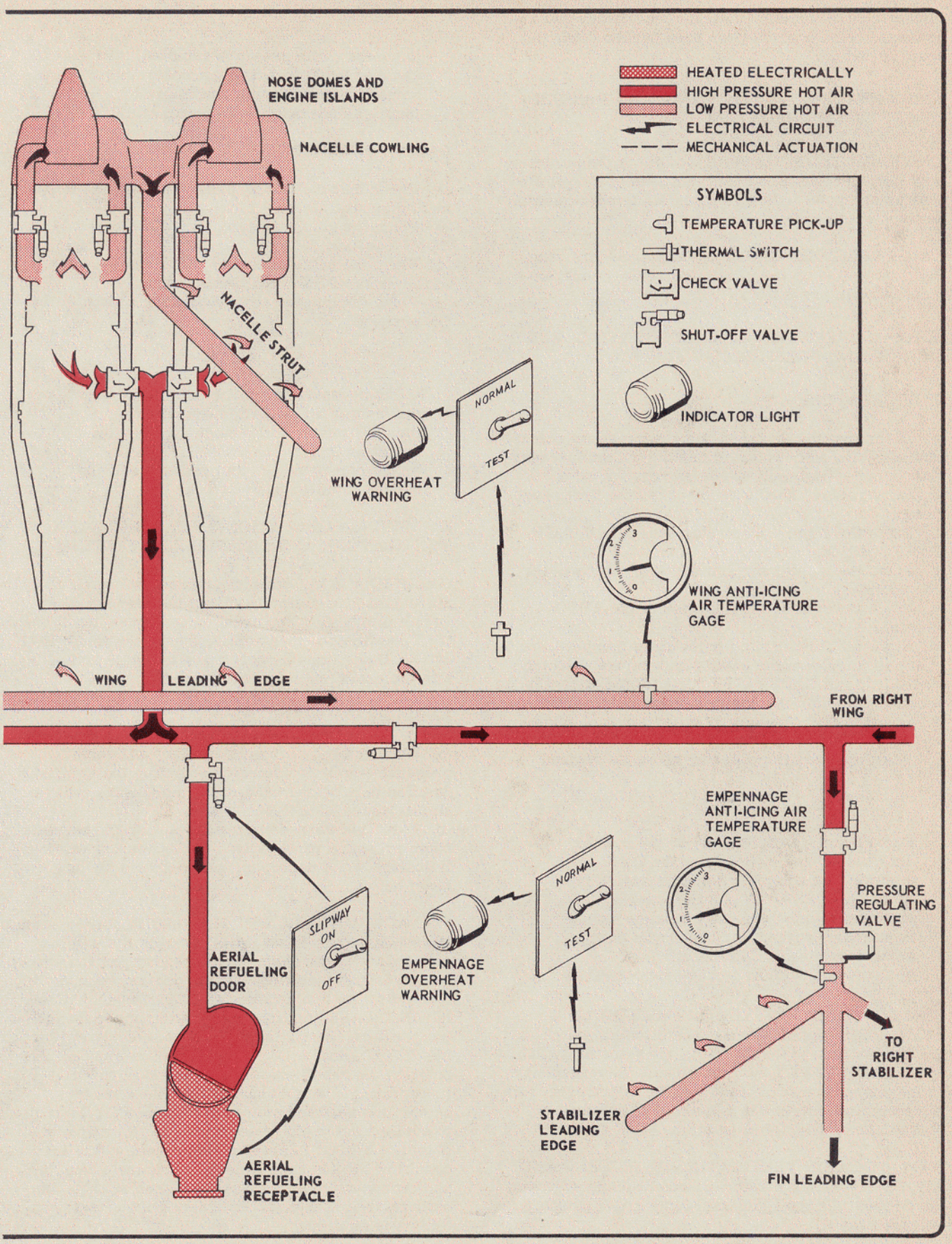


Figure 4-3. Anti-Icing System (Sheet 2 of 2)

further control function until the emergency cabin pressure release handle has been pushed down and again pulled up.

CABIN HEATING, VENTILATING, AND PRESSURIZING SYSTEM INDICATORS.

CABIN AIR TEMPERATURE GAGE. A temperature gage (28, figure 1-9) on the right side of the pilot's instrument panel indicates cabin air temperature in degrees centigrade.

CABIN PRESSURE GAGE. A cabin pressure gage (26, figure 1-9) on the pilot's instrument panel indicates cabin pressure altitude in feet.

NORMAL OPERATION OF CABIN HEATING, VENTILATING, AND PRESSURIZING SYSTEM.

CABIN HEATING.

a. Check that the emergency cabin pressure release handle is pushed down or, if heating without pressurization is desired, pull up the emergency cabin pressure release handle and depress the heat reset button.
b. Place the cabin air selector switch in the AIR COMP position.
c. Place the master air conditioning switch in the ON position.
d. Place the heat selector switch in the AUTO position.
e. Allow sufficient time for the cabin temperature to stabilize, then turn the cabin temperature selector rheostat in the DECREASE or INCREASE direction as required to obtain the desired cabin temperature.
f. Position the cabin heat distribution knob as desired.
g. Position air outlet selector knobs as desired.

NOTE

Cabin heating is off whenever the master air conditioning switch is in the OFF position, the cabin air selector switch is in the RAM SUPPLY position, or the emergency cabin pressure release handle is pulled up without the heat reset button being depressed. Cabin heating cannot be turned off without losing pressurization.

RAM AIR CABIN VENTILATING (BELOW 5,000 FEET). With the master air conditioning switch in the ON position, place the cabin air selector switch in the RAM SUPPLY position or pull the emergency cabin pressure release handle. The latter procedure is recommended when it is planned to continue on ram air ventilation after reaching 5,000 feet.

RAM AIR CABIN VENTILATING (5,000 FEET AND ABOVE). With the master air conditioning switch in the ON position, pull the emergency cabin pressure release handle.

NOTE

Since the cabin pressure regulator will close at 5,000 feet, this procedure must be used at that altitude and above to insure an adequate flow of ram air.

CABIN PRESSURIZING.

a. Check that the canopy and the pressure compartment door are closed.
b. Place the cabin air selector switch in the AIR COMP position.
c. Place the cabin pressure regulation selector switch in the PRESS NORMAL position.
d. Place the master air conditioning switch in the ON position.

NOTE

Cabin pressurizing will be off whenever the master air conditioning switch is in the OFF position, the cabin air selector switch is in the RAM SUPPLY position, or the emergency cabin pressure release handle is pulled up.

EMERGENCY OPERATION OF CABIN HEATING, VENTILATING, AND PRESSURIZING SYSTEM.

CABIN HEATING. When the desired cabin air temperature cannot be maintained with the heat selector switch in the AUTO position, place the switch in the OFF position and then actuate the switch to the HOT or COLD positions as necessary to obtain and maintain the cabin temperature desired.

CABIN PRESSURIZING.

a. When combat is imminent, place the cabin pressure regulation selector switch in the COMBAT position to provide reduced cabin pressure differentials above 27,600 feet.
b. For rapid depressurization, pull up the emergency cabin pressure release handle. To restore heating, if desired while depressurized, depress the heat reset button.

FOG ACCUMULATION IN THE CABIN. Under certain atmospheric conditions, it is possible for fog to accumulate in the cabin while pressurized and seriously restrict visibility. If this occurs, immediately turn the cabin temperature selector rheostat to the full INCREASE position (if operating under manual temperature control, hold the heat selector switch in the HOT position). After the cabin has cleared, reposition the cabin temperature selector rheostat (if operating under manual temperature control, actuate the heat selector switch to the COLD position) to obtain a cabin air temperature sufficiently higher than the original to prevent recurrence of the fog condition. If a comfortable temperature cannot be maintained without fogging, depressurize the cabin until an area with more favorable atmospheric conditions is entered.

DEFROSTING SYSTEMS.

WINDSHIELD DEFROSTING.

The main and side windshields are defrosted by forced airflow of cabin air across the inner surface from a motor-driven blower. The defroster blower is controlled by an ON--OFF switch (6, figure 1-14) located on the pilot's switch panel. The defroster motor is DC operated and supplied power through a circuit breaker on the lower DC power panel. Since the defroster is more effective when used to prevent frost and fogging than to remove it, the defrost switch should be in ON position at all times.

The anti-icing Nesa glass should be used in conjunction with the defroster to prevent frost or fog on the inside of the main windshield panel. Since the main windshield panel is very thick and therefore has a high resistance to temperature change, the windshield anti-icing system switch should be in NORMAL position at all times. During Nesa glass operation approximately 95% of the heat flow is to the outer surface with the remainder flowing through the thick glass panel to the inner surface. This requires that a period of operation at maximum heat be allowed prior to descent in order to prevent formation of frost and fog under the extreme conditions encountered in a descent to warm humid air. The preheat times (windshield anti-icing switch on MAX HEAT prior to maximum rate descent) are given in the following chart:

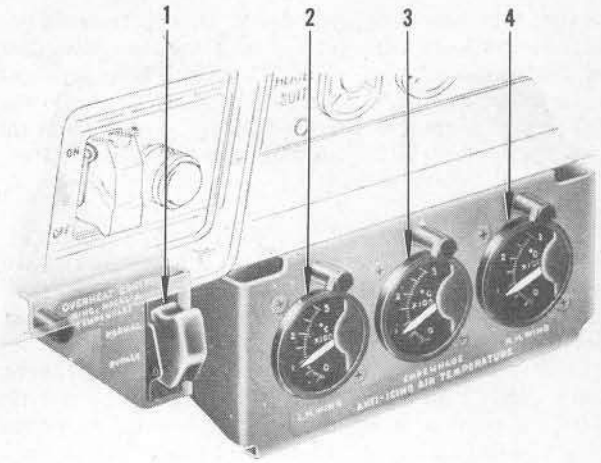
DESCENT		PREHEAT TIME
ABOVE 25,000 FT.	BELOW 5000 FT.	40 MINUTES
	ABOVE 5000 FT.	15 MINUTES
BELOW 25,000 FT.	BELOW 5000 FT.	15 MINUTES
	ABOVE 5000 FT.	0 MINUTES

NOSE WINDOWS DEFROSTING.

The observer's station windows are defrosted by a forced airflow of cabin air across the inner surface from a motor-driven blower. The defroster blower is controlled by an ON--OFF switch located on the observer's lighting panel (figure 4-12). The defroster motor is DC operated. See figure 1-30 for circuit breaker location. When possible, the need for defrosting the observer's windows should be anticipated and the defroster operated to prevent frost formation. This procedure will be more effective than waiting until the windows become frosted.

CANOPY DEFROSTING.

No canopy defrosting provisions, as such, are provided. However, the pilot's, copilot's, and gunner's upper air outlets are located so that when properly controlled by means of the air outlet selectors and the heat distribution control, these outlets are effective in defrosting the canopy.



1 WING, EMPENNAGE, AND NACELLE OVERHEAT SWITCH
2 LEFT WING ANTI-ICING AIR TEMPERATURE GAGE
3 EMPENNAGE ANTI-ICING AIR TEMPERATURE GAGE
4 RIGHT WING ANTI-ICING AIR TEMPERATURE GAGE

Figure 4-4. Anti-icing Air Temperature Panel

ANTI-ICING AND DEICING SYSTEMS.

Anti-icing systems prevent ice formation while deicing systems remove ice after it has formed. Hot compressed air bled from the engine compressors is used mainly in the anti-icing systems covering large areas while electrical heating elements are used on small units to be anti-iced. Wing, empennage, engines, aerial refueling slipway, and nacelles are all anti-iced by means of engine compressor air. Pitot heads, aerial refueling slipway, and windshield are anti-iced electrically.

NOTE

The present anti-icing system is deficient when the engines are operating in the lower rpm ranges. The J47 engine provides only marginal anti-icing protection for the nacelle lips and accessory cover at or below 80 - 85% rpm. At rpm's below 60 - 65% the inlet guide vanes, struts and island fairings do not receive adequate heat. Therefore, an attempt should be made to maintain an engine rpm higher than 80 - 85% when flying in atmospheric conditions conducive to icing.

WINDSHIELD ANTI-ICING SYSTEM.

The center panel of the windshield is made of laminated bullet-resistant Nesa glass. This glass may be

heated for anti-icing by passing AC electric current across the Nesa film within the glass as controlled by the windshield anti-icing switch. The equipment uses DC power from a circuit breaker on the lower DC power panel and unregulated AC power from the left alternator bus through circuit breakers in the alternator power shield.

WINDSHIELD ANTI-ICING SWITCH. A windshield anti-icing switch (7, figure 1-14) located on the pilot's switch panel has NORMAL--OFF--MAX HEAT positions. In NORMAL position, AC voltage is applied across the Nesa panel to automatically maintain a windshield temperature sufficiently high to prevent icing under most conditions. In MAX HEAT position, a higher voltage is applied to the panel to automatically maintain a higher windshield temperature to prevent icing under the most severe conditions. OFF position turns off windshield anti-icing.

NORMAL OPERATION OF WINDSHIELD ANTI-ICING SYSTEM.

Windshield anti-icing should be on normal at all times during flight. This will insure an ice-free windshield under most conditions and permit maximum windshield anti-icing to be turned on immediately when severe conditions are encountered. Operating procedure is as follows:

a. Check that left alternator bus voltage is 110 to 120 volts.

CAUTION

Operate engines No. 1 and 6 above a minimum of 52% rpm since alternator power is required for windshield anti-icing operation.

b. Place windshield anti-icing switch in NORMAL position.

c. If windshield panel will not remain free of ice, place switch in MAX HEAT position.

CAUTION

Do not place the windshield anti-icing switch in MAX HEAT position without allowing the windshield to warm up to operating temperature with the switch in NORMAL; otherwise the windshield Nesa panel may be damaged.

d. Turn off windshield anti-icing by placing switch in OFF position.

EMERGENCY OPERATION OF WINDSHIELD ANTI-ICING SYSTEM.

There is no emergency operating procedure for the windshield anti-icing system.

PITOT ANTI-ICING.

The left and right airspeed pitot tubes are heated for anti-icing by electric heating elements in the pitot heads. Each pitot tube heater is controlled by an ON--OFF switch (8, figure 1-14) on the pilot's switch panel. Pitot anti-icing switches should be ON whenever icing conditions are anticipated in flight. An automatic temperature control within the head will control current flow to prevent damage by overheating or to overcome extremely cold temperatures. The pitot heaters use DC power protected by two circuit breakers on the lower DC power panel.

EXTERIOR SURFACES ANTI-ICING SYSTEM.

Hot compressed air for wing, empennage, and nacelle anti-icing is bled from all engine compressors (figure 4-3). A check valve downstream from each engine prevents reverse airflow when the engine is shut down. Air for wing and empennage anti-icing passes through DC operated shut-off and pressure regulating valves which reduce the air pressure to operating values. The low pressure is ducted through the leading edge ducts and double skin areas of the wing, nacelles, inboard nacelle strut, and empennage and then exhausted overboard. Shut-off valves in the nacelles, controlled through the throttle switches for the inboard nacelles, supply low pressure air for anti-icing the nacelle cowl rings and inboard nacelle struts. In the inboard nacelles, when an engine is inoperative and throttle is in cut-off, the shut-off valve will be closed to prevent reverse flow. Structural overheat warning circuits are provided for each wing and for the empennage. Overheat controls are provided for wings, nacelles, and empennage. Separate overheat control circuits are used for ground and flight operation and are selected by position of the landing gear squat switch.

Hot air taken from the engine is used directly to anti-ice the engine island fairings and nose domes and is controlled by a solenoid-operated shut-off valve. The engine inlet guide vanes and front frame struts are anti-iced constantly during engine operation.

Control circuits for the exterior surfaces anti-icing system are protected by circuit breakers on the lower DC power panel. Unregulated AC power from the left alternator bus supplied through a circuit breaker in the alternator power shield is utilized by the flight overheat control system.

EXTERIOR SURFACES ANTI-ICING SYSTEM CONTROLS.

EXTERIOR SURFACES ANTI-ICING SWITCH. An ON--OFF exterior surfaces anti-icing switch (19, figure 1-14), guarded in the OFF position, is on the pilot's switch panel. ON position supplies power to electrically open the wing, empennage, nacelle, and engine shut-off valves. This allows compressor hot air to enter the leading edge areas of the wing,

empennage, nacelles, inboard nacelle struts, engine nose domes, and island fairings.

NOTE

If the exterior surfaces anti-icing switch is placed ON and overheating occurs, the wing, nacelle, and empennage overheat control will close the wing hot air shut-off valve until the anti-icing surfaces cool to lower temperatures, provided the wing, nacelle, and empennage overheat control switch is in NORMAL position.

When the switch is in the OFF position, the wing, empennage, nacelle, and engine shut-off valves are electrically closed, stopping the flow of hot air through the anti-icing ducts.

WING, NACELLE, AND EMPENNAGE OVERHEAT SWITCH. A wing, nacelle, and empennage overheat switch (1, figure 4-4) is located below the pilot's oxygen and rheostat panel on the left sidewall. The switch has NORMAL--BYPASS positions and is guarded to NORMAL position. In NORMAL position, an overheat control system will control temperatures of the low pressure hot air to prevent overheating and consequent damage to the structure. When on the ground, an overheat system is used which is controlled by thermal switches in the wing low pressure hot air ducts. When in flight, a different overheat control system utilizing AC power is used which is controlled by sensing elements in the wing leading edge. When an overheat condition is detected in either over-heat system, the nacelle and empennage shut-off valves are closed electrically and the wing pressure regulating valve is closed pneumatically.

When temperatures cool, the valves are opened and anti-icing system operation resumes. In BYPASS position, the automatic overheat control systems are cut out, and this position should be used only in an emergency. Control of the system then must be accomplished by use of the exterior surfaces switch and the anti-icing air temperature gages.

EXTERIOR SURFACES ANTI-ICING SYSTEM INDICATORS.

WING AND EMPENNAGE OVERHEAT WARNING LIGHTS. Wing and empennage red overheat warning lights (1 & 2, figure 1-9) are located on the pilot's instrument panel and will illuminate when a structural overheat condition is detected in either the left or right side of the wing or in the empennage.

NOTE

During some flight conditions, it is possible to have a high temperature in the anti-icing air ducts which would damage the leading edge skins but would not create a structural overheat condition nor illuminate the overheat warning lights.

Continuity of the warning light circuits may be tested by actuating the wing and empennage overheat test switches (1, figure 1-11) on the fire warning test panel to TEST position. Illumination of the warning lights then indicates circuits are satisfactory. The overheat warning lights are DC powered through a circuit breaker on the lower DC power panel and will indicate overheat conditions at all times when DC power is available in the airplane.

ANTI-ICING AIR TEMPERATURE GAGES. Temperature gages (2, 3 and 4, figure 4-4) showing air temperatures in the low pressure anti-icing ducts for each wing and the empennage are installed below the pilot's oxygen and rheostat panel. The gages read in degrees Centigrade and are marked as given in figure 5-1. The gages are DC powered through a circuit breaker on the lower DC power panel and will indicate duct temperatures whenever DC power is available in the airplane.

NOTE

During flight, temperatures on the gages are not positive indication of structural overheat; therefore, the overheat warning lights must be relied on for such indications.

NORMAL OPERATION OF EXTERIOR SURFACES ANTI-ICING SYSTEM.

GROUND OPERATION. The exterior surfaces anti-icing system may be used for ground defrosting of the wing, empennage, and nacelle surfaces and continued anti-icing of the surfaces by accomplishing the following procedure during engine operation:

a. Check wing and empennage overheat circuits by using wing and empennage overheat test switches to check that overheat warning lights will illuminate.

b. Lift the exterior surfaces anti-icing switch guard and place switch in ON position. Check that the wing, nacelle, and empennage overheat control switch is in the guarded NORMAL position.

c. For maximum ground defrosting effect, adjust throttles so that anti-icing air temperature gages read on the green arc.

The empennage will not defrost satisfactorily if the anti-icing system is permitted to cycle in the overheat range (where anti-icing air temperature gages read on the red arc). Engine speeds will be approximately 60% rpm for best operation with six engines.

NOTE

Operation may be satisfactorily accomplished with one engine operating on each wing; however, care must be taken to maintain air temperatures within the green arc on the anti-icing air temperature gages by means of throttle adjustment.

CAUTION

- Overheat temperatures during two-engine operation may occur at high rpm and the low duct pressures available may not per-

mit the overheat control system to pneumatically close the wing shut-off valve.

- Do not attempt operation of the anti-icing system by use of only one engine.

d. Turn off exterior surfaces anti-icing system by placing exterior surfaces anti-icing switch in OFF position.

FLIGHT OPERATION. Wing, nacelle, and empennage anti-icing should be operated only as required for icing condition. If possible, the exterior surfaces anti-icing system should be turned on before entering the icing area as there is a delay for anti-icing surfaces to warm up. Use the following procedure:

a. Check wing and empennage overheat circuits by actuating wing and empennage overheat test switches to check that overheat warning lights will illuminate.

b. Lift exterior surfaces anti-icing switch guard and place switch in ON position. Check that wing, nacelle, and empennage overheat switch is in NORMAL position.

CAUTION

Operate engines No. 1 and 6 above a minimum of 52% rpm since alternator power from left alternator bus is required for proper operation of anti-icing system overheat control. Failure of power from the left alternator bus will result in failure of the overheat control and consequent damage to the wing.

c. Check that the overheat control system is working by noting that anti-icing air temperature gages show a cycling reading in the green arc. Temperatures over the red radial are permissible provided they are cycling and the overheat lights are not illuminated.

CAUTION

- Do not operate anti-icing system unless icing conditions are known to exist as the leading edges of the wing may be damaged. There is a possibility during anti-icing system operation in non-icing conditions at low engine rpm that temperatures in the wing leading edge will exceed allowable temperatures and pressures in the ducts will not be sufficient to close the wing shut-off valve. This condition may occur during descent into warmer air.

- Continuous flight in severe icing conditions should not be attempted. Normally all the water which impinges on the leading edges would be evaporated by the anti-icing system. However, if the icing conditions are so severe that all the water is not evaporated, the water which runs back from the leading edge will freeze on the wing, resulting in a loss of aerodynamic efficiency and a corresponding loss in performance and range. Run-back ice can probably be first detected near the tips of the wings.

NOTE

If increased anti-icing is required, engine power should be increased or altitude reduced so as to increase duct temperatures.

d. If the overheat control fails and a warning light comes on or if the overheat control fails, overheat warning lights fail, and excessively high air temperatures are shown on the anti-icing air temperature gages, place the exterior surfaces anti-icing switch in OFF position and see "Emergency Operation of Exterior Surfaces Anti-Icing System."

e. Turn off exterior surfaces anti-icing system by placing exterior surfaces switch in OFF position.

EMERGENCY OPERATION OF EXTERIOR SURFACES ANTI-ICING SYSTEM.

OVERHEAT CONTROL FAILURE. During operation of exterior surfaces anti-icing system, if the overheat control were to fail, the structure would become overheated and an overheat warning light would illuminate. The following procedure should be used if continued anti-icing desired:

a. Place exterior surfaces anti-icing switch in OFF position.

NOTE

Check that alternator power is available on the left alternator bus since failure of that power will result in overheat control failure and damage to the wing. If power has failed on that bus, secure power on that bus from the right alternator as given in "Electrical System Emergency Operation" in section III and resume normal operation. If power is available and the overheat control has failed for other reasons, proceed as follows:

b. Lift wing, nacelle, and empennage overheat switch guard and place switch in BYPASS position; this cuts out the automatic overheat control system. Control then must be accomplished by use of the exterior surface anti-icing switch and the anti-icing air temperature gages.

c. When the overheat warning light goes out, place exterior surfaces anti-icing switch in ON position until the temperature reaches the upper part of the green arc on the temperature gages, then place switch in OFF position.

d. Continue operation by maintaining the temperatures within the green arc on the gages.

CAUTION

Place exterior surfaces anti-icing switch in OFF position whenever an overheat warning light illuminates since the temperature gages are not positive indications of structural overheat.

OVERHEAT WARNING LIGHT FAILURE. During operation of exterior surfaces anti-icing system, if overheat warning lights were to fail and overheat control were operating, no overheat would occur. However, if a high steady temperature reading, above the yellow radial (216° C), was observed on the anti-icing air temperature gages, the following procedure should be accomplished:

a. Check warning light for failure by actuating overheat circuit test switches and pushing press-to-test lens.

b. If warning light has failed, accomplish steps "a" through "d" under "Overheat Control Failure" above.

SHUT-OFF VALVE FAILURE. After the exterior surfaces anti-icing switch has been placed in OFF position, if continued high temperatures above the yellow radial (216° C) are noted, or an overheat warning light is illuminated, a shut-off valve has failed to close. Reducing engine power may allow the overheat warning lights to go out and reduce overheat damage.

CAUTION

Structural overheat damage will not cause loss of the airplane but may reduce the strength of the affected area.

AERIAL REFUELING SLIPWAY ANTI-ICING.

The aerial refueling slipway door is anti-iced by hot compressed air, obtained from the engines, which after passing through a DC operated shut-off valve, is ducted directly to the door hinge and, after passing through the hinge and circulating within the door, is discharged overboard

Electrically heated electric blankets, receiving power from the left alternator bus, are installed for anti-icing the aerial refueling slipway receptacle, door frame, and pressure pan areas.

An ON--OFF slipway anti-icing switch (20, figure 1-14) located on the pilot's switch panel controls the hot air shut-off valve and controls the power supplied to the heater blankets. Aerial refueling slipway anti-icing should be used as given in section VII under "Aerial Refueling."

COMMUNICATIONS AND ASSOCIATED ELECTRONIC EQUIPMENT.

Primary power for communications, radar, and electronic equipment is supplied by the airplane DC system, regulated 115-volt 400-cycle inverters, unregulated 115-volt 380- to 800-cycle alternators, and a 115-volt 400-cycle three-phase inverter.

UHF COMMAND. (AN/ARC-27)

A UHF command radio provides voice or modulated code communication from plane to plane or plane to ground. A guard receiver is used to facilitate constant monitoring of a frequency channel other than the channel being used by the main receiver and transmitter. The copilot's command radio control panel is located on his left sidewall, and the pilot's command radio panel is a part of the pilot's radio panel. The equipment operates from 28-volt DC power, protected by a 25-ampere circuit breaker in the tail compartment shield and a 10-ampere circuit breaker in the radar power panel. For antenna location, see 10, figure 4-9.

NORMAL OPERATION OF UHF COMMAND RADIO. The UHF command radio may be operated at either the pilot's or copilot's position, depending upon the position of the copilot's transfer switch. In the LOCAL position the UHF command radio is operated from the copilot's UHF command panel. In the REMOTE position the radio is operated from the pilot's UHF command panel.

Copilot operation (LOCAL) is as follows:

a. Place the master power switch in the ON position.

b. Select mode of operation at the copilot's command switch.

c. Select channel desired at local channel selector switch. Preset frequency will appear on frequency tab indicators. Channel number selected will also appear in window above frequency tab indicators.

d. If some frequency other than those preset is desired, select M on the local channel selector switch. Turn frequency selector knobs until desired frequency appear on frequency tab indicators.

e. In normal operation the tone voice switch is in VOICE position. In TONE position the radio set will transmit a continuous tone modulated signal.

Pilot operation (REMOTE) is as follows:

a. Select mode of operation desired at pilot's command operation switch.

b. Select any one of 18 preset channels at remote channel selector switch. This switch also has a G position which sets transmitter and main receiver to guard frequency.

c. Adjust volume control to desired level.

NOTE

Tone modulation is not available from pilot's panel.

TYPE	DESIGNATION	FUNCTION	PRIMARY OPERATOR	RANGE	LOCATION OF CONTROLS
Intercommunication equipment	AN/AIC-10	To provide a means for distributing audio to crew from UHF, marker beacon, ILAS. Provides intercommunication between crew and audio to modulate the UHF transmitter	Pilot and Copilot	Crew stations within the airplane	Control panel at each crew member station and in bomb bay, aft wheel well, and external power shield
UHF command set	AN/ARC-27	Short range, two-way voice Communication. Tone modulated transmission by copilot only	Pilot and Copilot	Line of sight	Pilot and copilot stations, and interphone panel at observer's station
Radio compass	AN/ARN-6	For homing and bearing; also receives voice and code signals	Pilot	Up to 200 miles depending on operating frequency and time of day	Instrument on pilot's panel, controls on pilot's radio panel, and audio received at all crew stations from interphone panel
Localizer and omni-directional range	AN/ARN-14	Receives localizer signal for approach and omni-directional signal for direction	Pilot	Localizer approximately 45 miles and omni-directional 100 miles, depending on altitude of airplane	Two instruments on pilot's panel, controls on pilot's radio panel, and audio received at all crew stations from interphone panel. One indicator in battery, rudder and radar compartment
Marker beacon set	AN/ARN-12	Receives location marker signal on navigational beam	Pilot	Low altitude	Indicator light on pilot's course indicator ID-249/ ARN-14
Glide path approach control	AN/ARN-18	Indicates glide angle for automatic approach	Pilot	15 miles	Receiver automatically operated by operation of AN/ARN-14 control panel; horizontal needle indication on ID-249/ ARN-14 indicator
IFF set	AN/APX-6	Identifies airplane as friend or foe	Pilot	Line of sight	Pilot's station
N-1 Compass system	N-1	Provides magnetic heading of the airplane at all latitudes	Observer	All latitudes	Observer's station
Rendezvous radar	AN/APN-76	Serves as transponder for other airplanes carrying radar set AN/APN-2B	Observer	Line of sight	Observer's station
ECM	AN/APT-5A	Jams enemy radar equipment	Copilot	Line of sight	Copilot's station
Radar system	"K" system includes AN/APS-23 search radar and bombing computer	Bombing-navigation	Observer	Line of sight	Observer's station
Emergency keyer	AN/ARA-26	Automatically keys radio equipment	Pilot		Pilot's station
Gun laying radar	AN/APG-32	Provides information and control for tail turret	Copilot	Line of sight	Gunner's station

Figure 4-5. Table of Communications and Associated Electronic Equipment

If the command radio is to be turned off, turn pilot's command switch to OFF if copilot's transfer switch is in REMOTE position. Turn master power switch to OFF if copilot's transfer switch is in LOCAL position.

EMERGENCY OPERATION OF UHF COMMAND RADIO. If an obstruction has caused the defective operation of a desired channel, place the remote channel selector switch to a different frequency and return immediately to the desired channel. This will often correct the difficulty.

A crystal failure on one frequency will not affect all frequencies. Try operation at a different frequency.

In case pilot's remote channel selector switch becomes inoperative, the equipment may be operated using the local channel selector switch at the copilot's station. If neither channel selector switch functions properly, the copilot should turn the local channel selector switch to M position, loosen the three wing nuts on the frequency selector knobs by rotating them counterclockwise, and adjust the knobs to the desired frequency. Tighten the three wing nuts again by clockwise rotation, holding the frequency selector knobs during the process.

LOCALIZER AND OMNI-DIRECTIONAL RANGE RECEIVER.

An omni-range and localizer receiver provides navigation information and comprises a portion of the instrument low-approach system (ILAS). An ID-249 indicator on the pilot's panel provides visual airplane azimuth position with respect to the localizer beam and selected omni-bearing. If a localizer or omni-signal is being received, a small warning flag in the top of the indicator will disappear from view to provide positive indication of station reception. A radio magnetic indicator ID-250 on the pilot's panel provides indication of the closest inbound magnetic bearing to the station. The receiver utilizes the interphone system to distribute received audio to the crew. The localizer and omni-range panel is located on the pilot's radio panel. DC voltage to the receiver is protected by a 10-ampere circuit breaker in the tail compartment relay shield.

NORMAL OPERATION OF LOCALIZER AND OMNI-DIRECTIONAL RANGE RECEIVER. The localizer or omni-range receiver is made operative and inoperative by the following procedure:
a. Place the power switch in TONE position.
b. To turn off the receiver, place the power switch in OFF position.

EMERGENCY OPERATION OF LOCALIZER AND OMNI-RANGE RECEIVER. When emergency operation of this receiver is desired, the equipment may be operated from the battery supply for short durations only. Emergency operation does not differ from normal operating procedure. In case of emergency, the receiver could be used on channel D for VHF reception.

GLIDE PATH RECEIVER. (AN/ARN-18)

A glide path receiver utilizes ground station signals to comprise a portion of the ILAS. Glide path signals are also used by the automatic pilot during an automatic approach. Frequency selection and on-off control of the receiver are automatically accomplished by the operation of the omni-range and localizer controls. The equipment is DC operated through the localizer and omni-range receiver.

The glide path receiver also receives power from the unregulated AC power system and is protected by circuit breakers on the radar power panel (figure 1-30).

NORMAL OPERATION OF GLIDE PATH RECEIVER. The glide path receiver is turned on and off by operation of the pilot's localizer and omni-range power switch. The glide path receiver will then operate continuously as long as the battery switch is in the LH BUS NORMAL or RH BUS position and AC power is available on the LH alternator bus.

EMERGENCY OPERATION OF GLIDE PATH RECEIVER. When emergency operation of the glide path receiver is desired, the equipment may be operated from the battery supply for short durations only. Emergency operation does not differ from normal operating procedure.

MARKER BEACON RADIO. (AN/ARN-12)

A marker beacon receiver is used as a navigational and landing aid. When flying over a beacon, a signal is heard in the interphone system and is visually shown in the form of light illumination.

NORMAL OPERATION OF MARKER BEACON. The system is turned on and off by the battery switch, and operates continuously as long as the battery switch is placed in LH BUS NORMAL position.

EMERGENCY OPERATION OF MARKER BEACON. When emergency operation of beacon receiver is desired, the radio may be operated from the battery supply for short durations only. Emergency operation does not differ from normal operating procedure.

RADIO COMPASS RECEIVER. (AN/ARN-6)

A radio compass receiver receives compass station signals which are heard through the interphone system. Two antennas are provided, one being a loop for aural-null direction finding the receiver operation, the other for receiver operation only. The radio is operated by DC power, protected by a circuit breaker on the radar power panel.

NORMAL OPERATION OF RADIO COMPASS. The radio compass is made operative and inoperative by the following procedure:
a. Place the function switch on the pilot's radio panel in the desired (type of operation) position.
b. With the pilot's light switch in HI or LO position,

the tuning meter of the pilot's radio control panel will illuminate.
c. To turn off the equipment, place the function switch in OFF position.

EMERGENCY OPERATION OF RADIO COMPASS. When emergency operation of the compass receiver is desired, the equipment may be operated from the battery supply for short durations only. Emergency operation does not differ from normal operating procedure.

RENDEZVOUS RADAR (AN/APN-76).

The AN/APN-76 radar equipment is used as a navigational aid to aerial refueling. The equipment consists of an SB-215/APN-76A control panel, a transponder, and two antennas. The control panel (35, figure 4-6) is located on the observer's left sidewall. The transponder is located in the upper radar compartment. The receiving antenna (3, figure 4-9) is mounted on the fuselage bottom centerline forward of the aft landing gear. The transmitting antenna (11, figure 4-9) is installed on the fuselage bottom centerline forward of the forward landing gear. AC voltage is provided for the radar equipment from the left-hand alternator bus protected by a 5-ampere circuit breaker in the radar power panel. DC voltage is provided to the radar equipment protected by a 5-ampere circuit breaker in the radar power panel.

NORMAL OPERATION OF AN/APN-76 RENDEZVOUS RADAR. The radar equipment is made operative and inoperative by the following procedure:
a. Place the master power switch in ON position.
b. Allow approximately 3 minutes for warmup and place the receiver standby switch in ON position.
c. To make the radar set inoperative, place the master power switch in OFF position and the receiver standby switch in STANDBY.

EMERGENCY OPERATION OF AN/APN-76 RENDEZVOUS RADAR. No special emergency operating procedures are provided other than manual keying of the transmitter.

ECM. (AN/APT-5A)

AN/APT-5A noise modulated transmitting equipment is utilized to jam enemy radar signals. The equipment is used only in flight for tactical purposes. An ECM control panel (14, figure 1-19), located on the copilot's right sidewall panel, allows the copilot to operate two different jamming transmitters. A 5-ampere circuit breaker on the radar power panel (4, figure 1-30) provides circuit protection for the DC operated radar transmitters.

NORMAL OPERATION OF ECM TRANSMITTERS. The ECM transmitters are made operative and inoperative by the following procedure:
a. Place the ECM transmitter power switches in ON position. After a delay of 2 minutes, the transmitters will be operative. The amber indicator light or lights will illuminate.
b. To turn off the equipment, place the power switches in OFF position. The amber indicator light or lights will go out.

EMERGENCY OPERATION OF ECM TRANSMITTERS. The equipment operating frequency is preset prior to flight for operation at a desired frequency. The power switch must be place in ON position a few minutes before operation of the equipment is desired.

IFF. (AN/APX-6)

A radar transponder provides electronic identification and recognition between plane and plane (or planes) and plane and ground. One 10-ampere and two 5-ampere circuit breakers in the tail compartment relay shield provide circuit protection for the equipment. All controls are located on the pilot's radio panel.

NORMAL OPERATION OF IFF. The IFF equipment is made operative and inoperative by the following procedure:
a. Place the IFF master switch in STDY position.
b. Further settings of the IFF master switch and mode switches will depend on the tactical situation and/or instructions from the communications officer.
c. To turn off the equipment, place IFF master switch in OFF position.

EMERGENCY OPERATION OF IFF. The destruct switch should be operated only when the IFF equipment is in danger of falling into enemy hands. The following manual procedure should be used to fire destructors:
a. Lift destructor switch guard by breaking the safety wire.
b. Place toggle switch in up (or on) position.

INTERCOMMUNICATION SYSTEM.

An intercommunication (intercom) system is provided with controls at all crew stations. The intercom system receives audio from individual radio equipment and affords distribution to all crew members, provides communication between crew members, and provides microphone connection to UHF command transmitting equipment. The pilot's and copilot's intercom panels are identical and are provided with the main controls. Limited operation facilities are on the observer's intercom panel. Intercom panels and outlets are also provided in the bomb bay, external AC power receptacle, and the aft wheel well.

Loudspeakers are provided behind the pilot's and observer's seats to provide by an alternate means the same audio to the crew members as that heard by headphone. The copilot is not provided with a loudspeaker and can hear the pilot only through his headphone. The copilot can, however, hear the observer through the pilot's loudspeaker.

NOTE

When a crew member speaks into his mike, his voice is not transmitted over his respective loudspeaker.

Controls other than on the panels are located on the pilot's and copilot's control wheels, pilot's left sidewall, observer's and gunner's floors, and on the loudspeakers. The system is operative when the DC power distribution system is energized. The intercom system circuit breakers are located on the radar power panel (4, figure 1-30).

NORMAL OPERATION OF THE INTERCOMMUNICATION SYSTEM. Communication between crew members may be accomplished as follows:

a. Place the normal-auxiliary listen switch in NORMAL and move the selector switch to INTER position. On the pilot's and copilot's panels move all of the mixer toggle switches to the off position. The system is not set up for normal intercommunication between crew members.

b. Pilot or copilot may communicate with the other intercom stations by actuating his control wheel mike switch to the MIC position. The observer or gunner may use his foot switch to permit use of his throat mike. Volume of signals received may be regulated by the volume knob.

c. Loudspeaker operation may be used in lieu of headphones by placing the loudspeaker switch on the loudspeaker in ON position. When the crew member speaks in his mike, his voice is not transmitted over his loudspeaker. Loudspeaker volume may be regulated by the volume knob on the intercom panel.

d. Call to all crew members by the pilot or copilot may be made by moving his control wheel mike switch to MIXED SIGNALS INTER position or placing his selector switch on CALL and simultaneously moving his mike switch to MIC position. Call by the observer or gunner may be made by positioning the selector on CALL and using the foot mike switch. Call from the auxiliary stations in the bomb bay, aft wheel well, or the external power shield may be made by pressing the call button on that panel. While the system is on CALL, all of the auxiliary equipment facilities are disconnected from the intercom system.

Operation of the radio facilities in conjunction with the intercommunication system may be accomplished as follows:

a. UHF command radio may be heard by the pilot or copilot along with the intercommunication between crew members by placing the mixer toggle switch marked "Comm" in on position, while the selector switch is in INTER position. Each crew member may transmit or receive through the UHF command radio by positioning his selector switch to COMM position and using his mike and mike switch. When transmitting over the command radio the crew member will hear a side tone in his headphones or loudspeaker. The crew member may also listen to the other facilities while on command radio selection by positioning the desired mixer toggle switch in on position.

b. Radio compass signals may be heard along with other communication facilities by placing the mixer toggle switch marked "Adf" in on position. The radio compass may be used separately by positioning the selector switch in ADF position. The pilot may select the type of signal to be received by positioning the filter switch. For reception of both range and voice signals, position the switch in BOTH position. By using the ADF VOICE or ADF RANGE positions reception of that respective signal at full volume with the other at a lower level will be obtained. The crew member may also listen to the other facilities while on radio compass selection by placing the desired mixer toggle switch in on position.

c. Marker beacon or localizer reception may be heard in conjunction with other communication facilities by positioning the mixer toggle switch marked "Marker" or "Local" to on position.

d. Separate reception of an auxiliary equipment facility, while that facility is being used in connection with other equipment, may be obtained by using the normal-auxiliary listen switch. Place the switch in AUX LISTEN position and the facility heard will be that given by the farthest left mixer toggle switch in on position. If no mixer toggles are in on positions the facility heard will be that given by the selector switch. Volume control is ineffective while the switch is in AUX LISTEN position.

EMERGENCY OPERATION OF THE INTERCOMMUNICATION SYSTEM. In case all stations are to be contacted in an emergency, place a call as follows:

a. Pilot or copilot moves his control wheel mike switch to MIXED SIGNALS INTER position. The pilot or copilot may also position his selector switch in CALL and simultaneously move his mike switch to MIC.

b. Observer or gunner moves his selector switch to CALL and presses his foot switch.

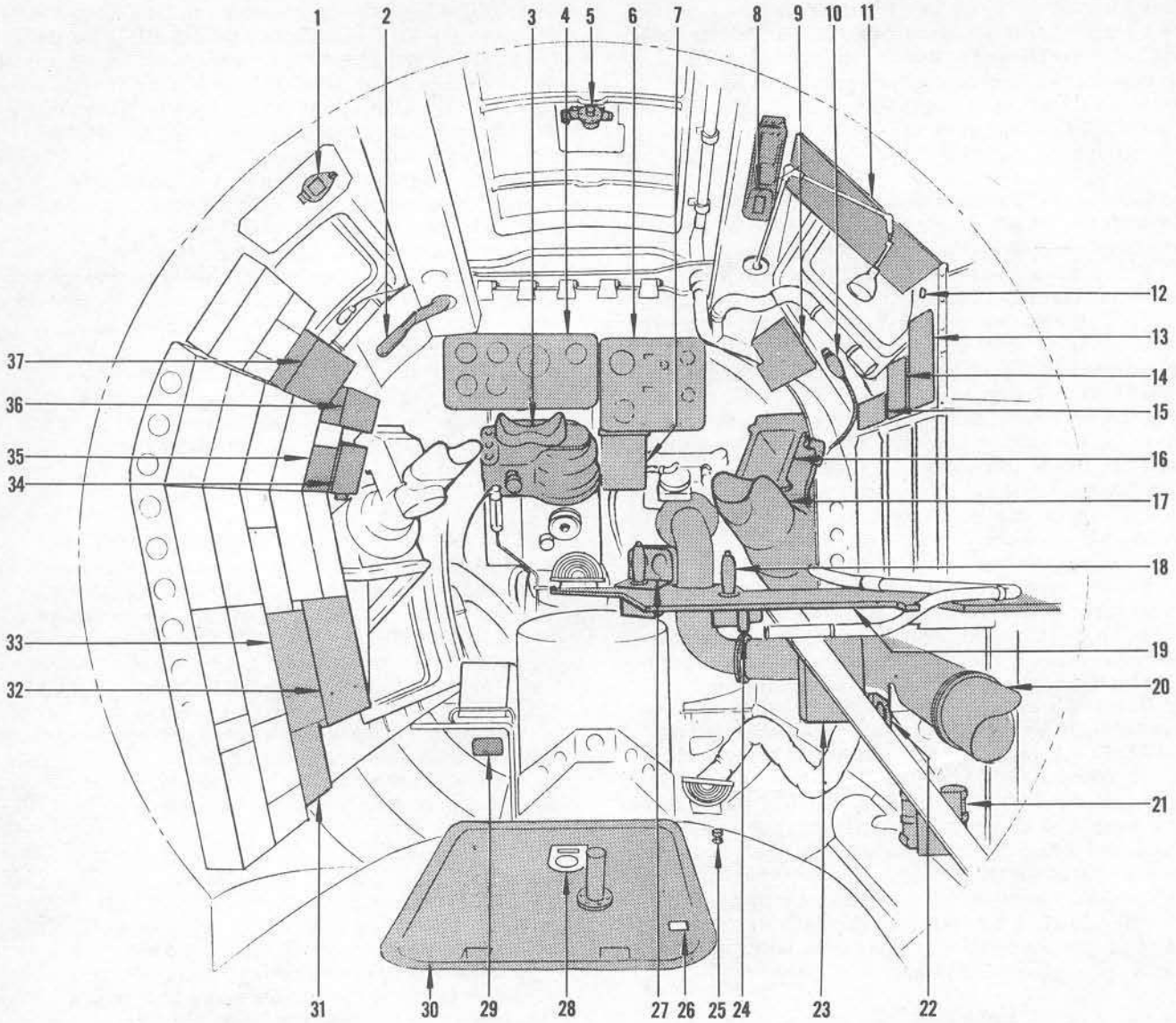
c. A crew member at the auxiliary station in the bomb bay need only press his call button.

NOTE

If the intercom panel at a crew member's station becomes inoperative, the panel at another station may be used since the pilot's panel receives power from one dynamotor and the copilot's and observer's panels receive power from another dynamotor.

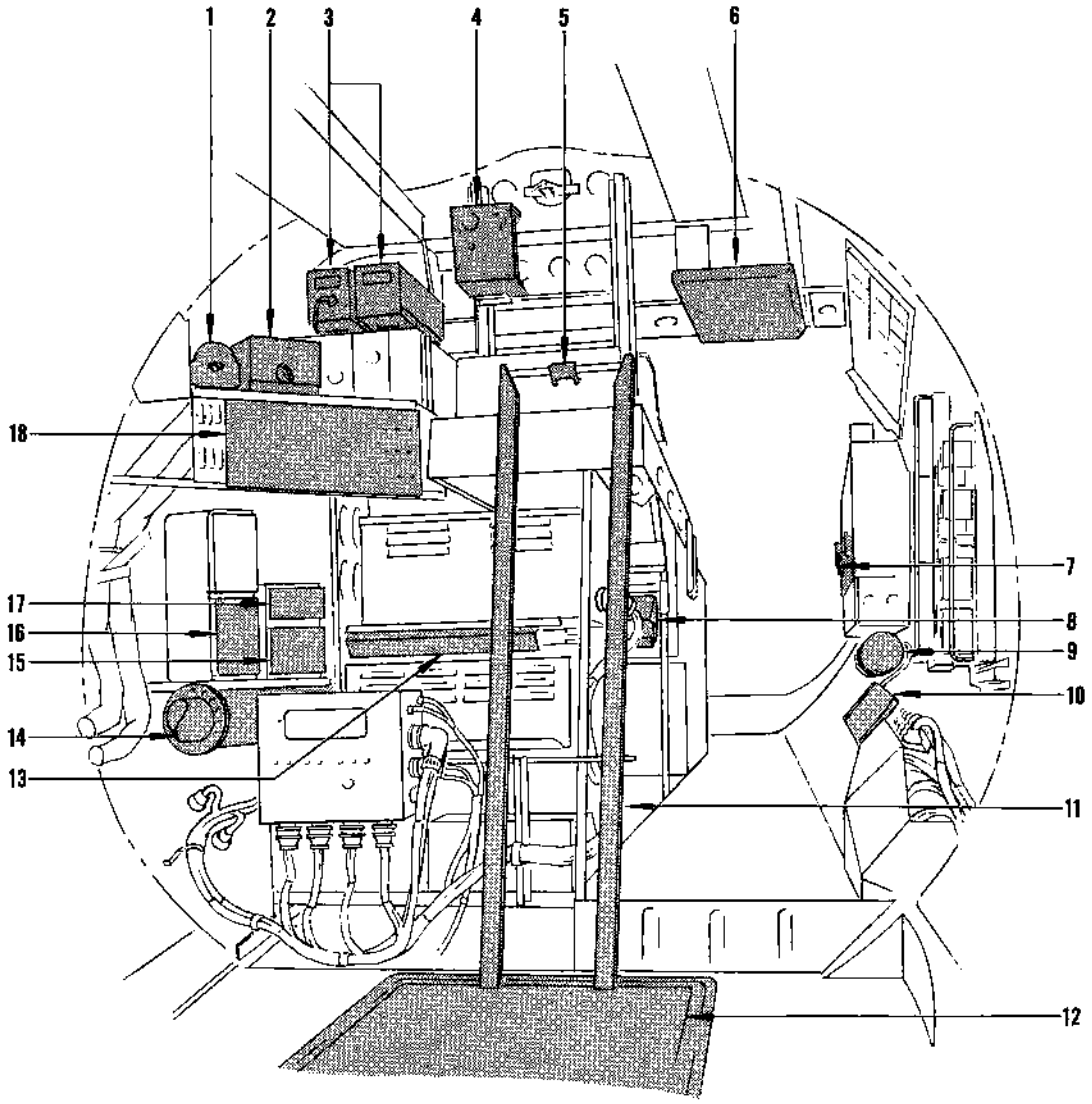
N-1 COMPASS SYSTEM.

The N-1 compass system is a remote-indicating compass system having a directional gyro which provides the directive force to position and stabilize the heading indication at all times. The system has "magnetic slaved" or "directional gyro" operational modes which provide an accurate directional reference for all latitudes. Operation as a magnetic slaved compass may be used in any locality except near the magnetic poles or areas where severe magnetic distortion occurs. When in magnetic slaved operation, the system is slaved to a remote compass transmitter. Operation as a directional gyro may be used in any latitude but is especially useful where the magnetic field is weak or distorted or when used for grid navigation in the polar regions. When in directional gyro operation, the system operates free of magnetic influence as a directional gyro having an arbitrary gyro heading reference as selected by the observer.



1 EMERGENCY BOMB ARMING SAFE HANDLE
2 EMERGENCY ESCAPE HATCH RELEASE LEVER
3 BOMBSIGHT
4 OBSERVER'S INSTRUMENT PANEL
5 PERISCOPIC SEXTANT MOUNT
6 NAVIGATION COMPUTER CONTROL PANEL
7 OXYGEN REGULATOR PANEL
8 BOMB EMERGENCY RELEASE HANDLE
9 BOMB CONTROL PANEL
10 BOMB RELEASE SWITCH
11 OBSERVER'S LIGHTING PANEL
12 OXYGEN WARNING LIGHT
13 CAMERA INTERVALOMETER
14 CAMERA CONTROL PANEL
15 BOMB INDICATOR LIGHTS
16 RADAR CAMERA
17 RADAR SCOPE
18 TRACKING CONTROL HANDLE
19 OBSERVER'S WORK TABLE
20 AERIAL REFUELING MANIFOLD
21 RELIEF CONTAINERS
22 AERIAL REFUELING ACCUMULATOR PRESSURE GAGE
23 HEATED SUIT RHEOSTAT
24 AERIAL REFUELING EMERGENCY DOOR HANDLE
25 MICROPHONE FOOT SWITCH
26 DOWNWARD EJECTION HATCH PRESSURE GAGE
27 AZIMUTH AND SIGHTING INDICATOR
28 LOCK PIN INSPECTION WINDOW
29 OBSERVER'S EJECTION SEAT SAFETY PIN STOWAGE
30 DOWNWARD EJECTION HATCH
31 RADAR AUTO TRANSFORMER
32 APS-23 CONTROL UNIT
33 BOMBING NAVIGATIONAL COMPUTER
34 OBSERVER'S TURN CONTROLLER
35 RENDEZVOUS RADAR CONTROL PANEL
36 BOMB RELEASE INTERVAL CONTROL PANEL
37 LINE OF SIGHT CONTROL

Figure 4-6. Observer's Station - Forward



1 CABIN AIR OUTLET SELECTOR
2 OBSERVER'S INTERCOM PANEL
3 MAIN AND SPARE AERIAL REFUELING SIGNAL AMPLIFIER
4 RADAR PRESSURIZING CONTROL PANEL
5 SPARE LIGHT BULB STOWAGE BOX
6 PILOT'S DATA DRAWER
7 FOOD WARMING CUP
8 RELIEF CONTAINERS
9 OBSERVER'S ANTI-EXPOSURE SUIT
10 OBSERVER'S DITCHING VEST
11 EJECTION SEAT RAILS
12 DOWNWARD EJECTION HATCH
13 OBSERVER'S PENCIL BOX
14 AERIAL REFUELING MANIFOLD
15 T-35 IFC UNIT
16 RADAR CAMERA CONTROL PANELS
17 T-19 IFC UNIT
18 RADAR POWER PANEL

Figure 4-7. Observer's Station - Aft

The heading indication is latitude corrected for apparent gyro drift due to the earth's rotation. The N-1 compass system supplies directional reference control to the automatic pilot system and directional reference information to the radio compass and localizer and omni-range indicators. A master indicator having the operational controls is installed on the observer's instrument panel and a repeater indicator is installed on the pilot's instrument panel. The N-1 compass system receives power from the main instrument inverter bus, main inverter bus, and the DC system, and is operating at all times when power is available on those buses. Equipment is protected by fuses and circuit breakers in the main AC power shield and on the lower DC power panel.

NORMAL OPERATION OF N-1 COMPASS SYSTEM. The N-1 compass system is operating when the power is available from the instrument inverter bus, main inverter bus, and the DC system; however, the system should be allowed approximately 10 minutes warmup before use.

Operation of the N-1 compass system is controlled by the observer as given by the following procedures:

a. If magnetic slaved operation is desired, rotate the latitude correction knob until the latitude correction pointer reads OFF.

NOTE

The system should be synchronized before use as a magnetic slaved compass since airplane movement on the ground without power may cause the system to be out of synchronization. The system will automatically synchronize itself, but only at a slow rate which may consume a large amount of time if far out of synchronization. Manual synchronization eliminates the time required.

b. Synchronize the master indicator by engaging and rotating the synchronizer knob until the annunciator pointer is on the center index. The synchronizer knob must be rotated counterclockwise when the annunciator pointer is in the L area of the scale and clockwise when the annunciator pointer is in the R area of the scale.

c. Check the heading pointer reading with the co-pilot's standby compass to assure that the system synchronization was not attempted on the 180° from correct heading. Once the system is correctly synchronized, the heading pointer will indicate the magnetic heading of the airplane continuously. During automatic pilot operation, the system will hold the airplane on a constant magnetic heading.

NOTE

- During turns, the annunciator pointer may swing to the L or R area of its scale indicating a normal condition requiring no correction. Do not attempt to reposition the master indicator heading pointer during or immediately after turns since the system will remain in synchronization during and after the turn.
- When on automatic pilot operation, rotation of the synchronizer knob from the synchronized position will cause the airplane to alter course at approximately 3° per minute and assume the new heading set on the master indicator heading pointer.

a. If directional gyro operation is desired, rotate the latitude correction knob clockwise until the latitude correction pointer indicates the latitude of the airplane position. The system is then independent of the magnetic compass equipment and latitude correction for apparent gyro drift is given to the heading pointer.

NOTE

As the airplane changes latitude in flight, the latitude correction pointer should be reset (at approximately 2° intervals) to the new latitude.

b. Set the master indicator heading pointer to the desired gyro heading datum by means of the synchronizer knob. The gyro reference datum is not referenced to a geographical coordinate system and if a constant heading is flown, the path of the airplane will be a great circle course under a no-wind condition.

NOTE

- Repositioning the heading pointer by means of the synchronizer knob will cause only a change in the heading datum and will not cause the airplane to change heading whether on automatic pilot operation or not.
- The synchronizer knob should not be rotated without checking or recording the old and new headings on the master indicator; otherwise, the basic heading datum may be lost.

EMERGENCY OPERATION OF THE N-1 COMPASS SYSTEM. There are no provisions for emergency operation of the N-1 compass system. In case of failure of the system, the standby compass or the "K" system may be used.

"K" RADAR SYSTEM.

A "K" system provides automatic computation for bombing and navigation. Operating controls are located at the observer's station. Circuit breakers for the system are located on the radar power panel (4, figure 1-30) and the unregulated AC power shield (2, figure 1-30).

DATA INDICATORS. A data indicator (5, figure 1-9) is located on the pilot's instrument panel and three data indicators (1, 5, and 9, figure 4-15) are located on the observer's instrument panel.

RADAR PRESSURIZING SYSTEM.

To insure proper operation of "K" radar equipment at all altitudes, the modulator and transceiver units are pressurized. The radar pressurizing system is controlled from a radar pressurizing control panel (4, figure 4-7) located above the observer's seat. The system is energized by DC power and protected by two circuit breakers on the radar power panel.

NORMAL OPERATION OF RADAR PRESSURIZING SYSTEM. The radar pressurizing system must be turned on whenever "K" radar equipment is to be operated and left on throughout the operation of this equipment. At all other times, radar pressurizing should be off.

a. Place the radar pressurizing control switch in the ON position. The pump pressure indicator light should come on and remain on until pressure builds up to within the green operating range on the radar pressure gage. When pressure stabilizes within the green operating range, "K" radar equipment may be turned on.

b. After "K" radar equipment has been turned off, place the radar pressurizing control switch in the OFF position.

EMERGENCY OPERATION OF RADAR PRESSURIZING SYSTEM. In the event the pressure regulator switch malfunctions or fails and continued operation of "K" radar equipment is essential, radar pressurizing may be maintained by manual control.

a. Place the radar pressurizing control switch in the OFF position.

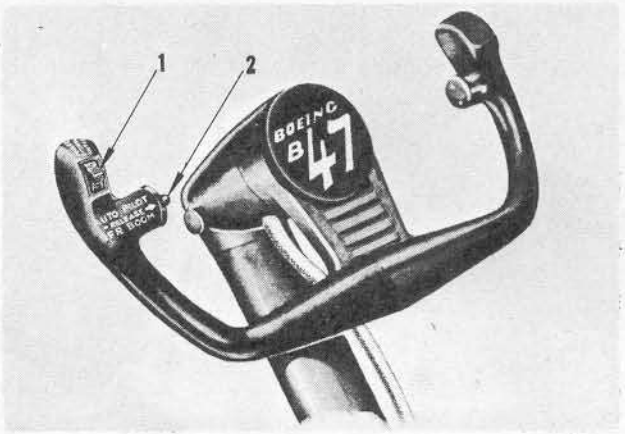
b. Bring pressure within green operating range on the radar pressure indicator either by holding the pressurizing control switch in the MOM-ON position or by pushing and holding in the pressure bleed valve knob.

c. Whenever the pressure drops to the low limit of the green operating range, hold the radar pressurizing control switch in the MOM-ON position until the pressure builds up to the high limit. Repeat this procedure as necessary to maintain the pressure within the limits of the green operating range.

NOTE

In an extreme emergency only, when pressure cannot be maintained in the green operating range but can be kept within the upper and lower limits of the red (marginal) range on the radar pressure indicator, "K" radar equipment may be kept in operation by manual tuning of the units.

If failure of the compressor, broken lines, or similar difficulty makes it impossible to maintain proper pressure either by automatic or manual means, proceed as follows:



1 INTERCOM MIKE SWITCH
2 AUTOMATIC PILOT-AERIAL REFUELING BOOM RELEASE SWITCH

Figure 4-8. Control Wheel Switches

a. Place the radar pressurizing control switch in the OFF position.

b. Turn off "K" radar equipment

CAUTION

Continued operation of "K" radar equipment after failure of the radar pressurizing system is likely to result in damage to the "K" radar system modulator and transceiver units.

EMERGENCY KEYER.

An emergency keyer provides automatic keying of modulation of the command radio equipment. The international morse code message consists of an SOS sent three times, followed by the last four digits of the airplane serial number three times, followed by a sequence of six continuous four second tone signals. The keyer equipment is provided with 28-volt DC power protected by a circuit breaker in the radar power panel. The controls are located on an emergency keyer panel (7, figure 1-8) on the pilot's oxygen and rheostat panel.

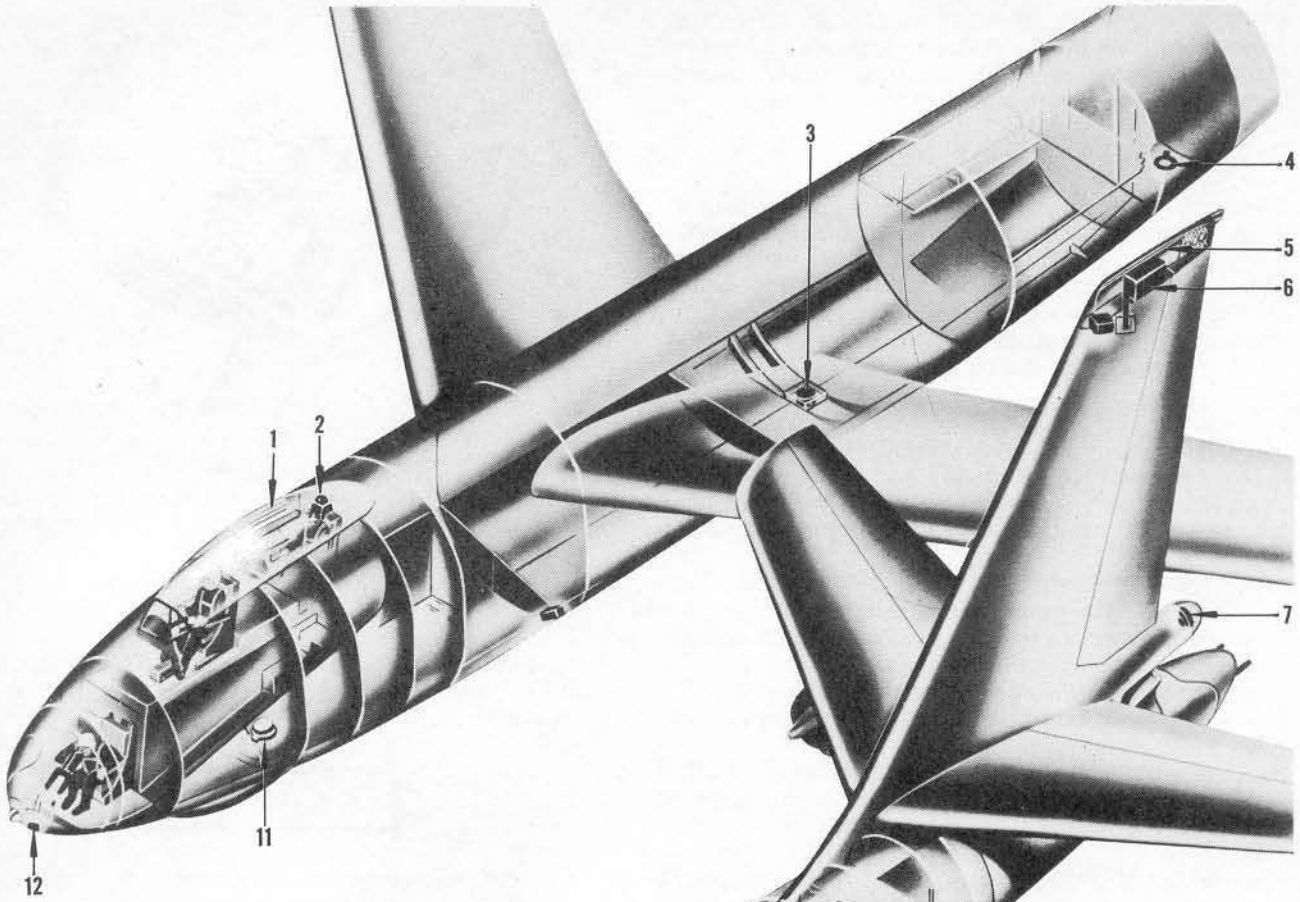
NORMAL OPERATION OF EMERGENCY KEYER.

a. Place the keyer power switch in ON position. The amber keyer indicator light will illuminate approximately 10 seconds after the switch is activated.

b. Place the keyer power switch in OFF position to stop keyer operation.

GUN-LAYING RADAR.

Gun-laying radar is used to control the operation of the A-5 tail turret. Controls and indicators are located at the gunner's station aft of the copilot.



1. RADIO COMPASS SENSE ANTENNA
2. RADIO COMPASS LOOP ANTENNA
3. RENDEZVOUS RADAR RECEIVING ANTENNA
4. IFF ANTENNA
5. LORAN ANTENNA
6. LOCALIZER AND OMNI-RANGE ANTENNA
7. GUN-LAYING RADAR ANTENNA
8. MARKER BEACON ANTENNA
9. ECM ANTENNA
10. UHF COMMAND ANTENNA
11. RENDEZVOUS RADAR TRANSMITTING ANTENNA
12. GLIDE PATH APPROACH CONTROL ANTENNA

Figure 4-9. Antenna Locations

LIGHTING EQUIPMENT.

EXTERIOR LIGHTING EQUIPMENT.

See figure 4-10.

INTERIOR LIGHTING EQUIPMENT.

See figure 4-11.

OXYGEN SYSTEM.

A low pressure oxygen system, supplied by four Type G-1 and six Type F-1 oxygen cylinders, is installed in the airplane. Four cylinders are located beneath the cockpit floor inside and on the lower right side of the pressurized compartment, two cylinders are installed in the upper part of the radome compartment, and four cylinders are installed in pairs on each side of the bomb bay. For combat safety, each oxygen station is supplied from two distribution lines through automatic check valves. The complete oxygen system may be serviced through a single filler valve located in a service hatch on the right side of the fuselage ahead of the forward wheel well. Three portable oxygen units are installed, one each on the pilot's and copilot's left sidewalls and one on the aft inboard side of the crawlway. Recharging facilities for the portable units are provided at the pilot's, copilot's and bomb bay station. Type D-1 oxygen regulator units combining the function of an oxygen flow indicator,

LIGHTS	LOCATION AND NUMBER OF LIGHTS	SWITCH LOCATION
LANDING LIGHTS		
Right-hand (clear)	Forward edge right-hand inboard nacelle (1)	Pilot's switch panel
Left-hand (clear)	Forward edge left-hand inboard nacelle (1)	Pilot's switch panel
	Power circuit breakers are located on the right and left inboard junctions, and control circuit breakers are located on the lower DC power panel.	
NAVIGATION AND FUSELAGE LIGHTS		
Right-hand wing tip (green)	Right-hand wing tip (1)	Pilot's position light panel
Left-hand wing tip (red)	Left-hand wing tip (1)	Pilot's position light panel
Top fuselage (white)	Top fuselage (2)	Pilot's position light panel
Bottom fuselage (white)	Bottom fuselage (2)	Pilot's position light panel
Tail (yellow)	Tail (1)	Pilot's position light panel
Tail (clear)	Tail (1)	Pilot's position light panel
	Circuit breakers for above lights are located on lower DC power panel.	
TAXI LIGHTS		
Forward landing gear (clear)	Forward landing gear (1)	Pilot's switch panel
	Circuit breakers for above lights are located on lower DC power panel.	
AERIAL REFUELING, DOOR, AND RECEPTACLE LIGHTS		
Door (clear)	In receptacle (3)	Aerial refueling receptacle and door light rheostat on co-pilot's aerial refueling and anti-icing external lights panel
Observer's window (clear)	Right and left side of observer's windows (2)	Observer's window lights rheostat, copilot's aerial refueling and anti-icing external lights panel
Right- and left-hand side wing illumination (clear)	Below aft end of canopy (2)	Wing illumination light, co-pilot's aerial refueling and anti-icing external lights panel
	Circuit breakers for above lights are located on lower DC power panel.	

Figure 4-10. Exterior Lighting

pressure gage, and pressure demand regulator are installed at each crew station and in the bomb bay. Pressure demand type oxygen masks must be used with these regulator units. The oxygen warning system DC circuit breaker is mounted on the upper DC power panel. The approximate duration of the system is shown in figure 4-15.

OXYGEN SYSTEM CONTROLS.

REGULATOR DILUTER LEVER. A NORMAL OXYGEN--100% OXYGEN diluter lever (3, figure 4-13) is provided on each regulator unit. When the lever is in the NORMAL position, the regulator unit will function to provide automatic mixing of air and oxygen is sea-level oxygen concentration at all altitudes. When the lever is in the 100% OXYGEN position, the automatic air-oxygen mixing feature is by-passed and 100% oxygen is supplied for emergencies regardless of altitude.

OXYGEN SUPPLY SHUTOFF LEVER. An ON--OFF oxygen supply shutoff lever (4, figure 4-13) is provided on each regulator unit. When the lever is in the ON position, system oxygen is supplied to the regulator unit. When the lever is in the OFF position, the oxygen supply to the regulator is shut off to prevent any flow of oxygen from that unit when not in use.

LIGHTS	LOCATION AND NUMBER OF LIGHTS	SWITCH LOCATION
INSTRUMENT LIGHTS		
Copilot's instrument panel right side (red)	Copilot's instrument panel (1)	Copilot's lighting panel
Anti-icing air temperature panel (red)	Anti-icing air temperature panel (4)	Pilot's lighting panel
Pilot's instrument panel (red)	Pilot's instrument panel (33)	Pilot's lighting panel
Copilot's instrument panel (red)	Copilot's instrument panel (32)	Copilot's lighting panel
Observer's instrument panel (red)	Observer's instrument panel flood lights (3)	Observer's lighting panel
Pilot's instrument panel left side (red)	Pilot's instrument panel flood lights (2)	Pilot's lighting panel
Pilot's instrument panel right side (red)	Pilot's instrument panel flood lights (2)	Pilot's lighting panel
PILOT'S PANEL LIGHTS		
ATO control panel	ATO control panel (2)	Rheostat, pilot's lighting panel
Pilot's switch panel	Pilot's switch panel (8)	Rheostat, pilot's lighting panel
Fire warning test panel	Fire warning test panel (3)	Rheostat, pilot's lighting panel
Ignition switch panel	Ignition switch panel (5)	Rheostat, pilot's lighting panel
Pilot's fuel control panel	Pilot's fuel control panel (27)	Rheostat, pilot's lighting panel
Pilot's oxygen regulator and suit heater rheostat panel	Pilot's oxygen regulator and suit heater rheostat panel (3)	Rheostat, pilot's lighting panel
Pilot's lighting panel	Pilot's lighting panel (6)	Rheostat, pilot's lighting panel
Trim tab coordination switch panel	Trim tab coordination switch panel (2)	Rheostat, pilot's lighting panel
Pilot's control stand	Pilot's control stand (1)	Rheostat, pilot's lighting panel
Surface power control panel	Surface power control panel (3)	Rheostat, pilot's lighting panel
Canopy control panel	Canopy control panel (2)	Rheostat, pilot's lighting panel
Pilot's oxygen regulator	Pilot's oxygen regulator panel (1)	Rheostat, pilot's lighting panel
Automatic pilot control	Automatic pilot control panel (1)	Rheostat, pilot's lighting panel
Windshield wiper	Windshield wiper panel (2)	Rheostat, pilot's lighting panel
Emergency keyer panel	Emergency keyer panel (1)	Rheostat, pilot's lighting panel
Pilot's instrument panel	Pilot's instrument panel (16)	Rheostat, pilot's lighting panel
Speed restriction panel	Speed restriction panel (2)	Rheostat, pilot's lighting panel
Control column disconnect panel	Control column disconnect panel (3)	Rheostat, pilot's lighting panel
Drop tank jettison switch panel	Drop tank jettison switch panel (2)	Rheostat, pilot's lighting panel
Map light panel	Map light panel (2)	Rheostat, pilot's lighting panel
COPILOT'S PANEL LIGHTS		
Emergency landing gear panel	Emergency landing gear panel (9)	Rheostat, copilot's lighting panel
Copilot's refueling panel	Copilot's refueling panel (17)	Refueling switch, pilot's fuel control panel
AC power panel	AC power panel (6)	Rheostat, copilot's lighting panel

Figure 4-11. Interior Lighting (Sheet 1 of 3)

LIGHTS	LOCATION AND NUMBER OF LIGHTS	SWITCH LOCATION
COPILOT'S PANEL LIGHTS - Continued		
Aerial refueling and anti-icing external lights	Aerial refueling and anti-icing external lights panel (4)	Rheostat, copilot's lighting panel
Copilot's instrument Panel	Copilot's instrument panel (21)	Rheostat, copilot's lighting panel
Hydraulic fluid quantity panel	Hydraulic fluid quantity panel (5)	Rheostat, copilot's lighting panel
Copilot's lighting panel	Copilot's lighting panel (4)	Rheostat, copilot's lighting panel
Hydraulic control panel	Hydraulic control panel (11)	Rheostat, copilot's lighting panel
Oxygen regulator (red)	Over oxygen regulator (1)	Rheostat, copilot's lighting panel
SPOTLIGHTS		
Observer's spot	Left side of observer (1)	On lamp assembly rheostat
Pilot's spot	Left side of pilot (1)	On lamp assembly rheostat
Copilot's spot (red)	Left side of copilot (1)	On lamp assembly rheostat
Bomb bay oxygen panel spot	Front bomb bay (1)	On front bomb bay light assembly, left-hand side
Gunner's spot	Gunner's left side (1)	On lamp assembly rheostat
TABLE, HEADBAND AND COMPASS LIGHTS		
Observer's work light (clear)	Observer's table (1)	Rheostat, observer's light control panel
Gunner's work light (red)	Gunner's station (1)	Rheostat, right-hand side of gunner's ash tray
Gunner's control panel	Gunner's station (1)	Rheostat, right-hand side of gunner's ash tray
OBSERVER'S PANEL LIGHTS		
Observer's lighting panel	Observer's lighting panel (8)	Rheostat, observer's lighting panel
Camera control panel	Camera control panel (3)	Rheostat, observer's lighting panel
Bomb control panel	Bomb control panel (11)	Rheostat, observer's lighting panel
Bomb door and release control panel	Bomb door and release control panel (1)	Rheostat, observer's lighting panel
BOMB BAY AND TUNNEL DOME LIGHTS		
Tunnel dome (clear)	Tunnel (2)	Above entrance door
Crawlway (clear)	Crawlway (1)	Above entrance door
Center bomb bay (clear)	Center bomb bay (1)	On front bomb bay light assembly, left-hand side
Left rear bomb bay (clear)	Left rear bomb bay (1)	On front bomb bay light assembly, left-hand side
Right rear bomb bay (clear)	Right rear bomb bay (1)	On front bomb bay light assembly, left-hand side
Left bomb bay (white)	Left bomb bay (1)	On front bomb bay light assembly, left-hand side
Right bomb bay (white)	Right bomb bay (1)	On front bomb bay light assembly, left-hand side

Figure 4-11. Interior Lighting (Sheet 2 of 3)

LIGHTS	LOCATION AND NUMBER OF LIGHTS	SWITCH LOCATION
BOMB BAY AND TUNNEL DOME LIGHTS - Continued		
Front bomb bay (clear)	Front bomb bay (1)	On front bomb bay light assembly, left-hand side
Bomb bay worktable	Front bomb bay (1)	On front bomb bay light assembly, left-hand side
Bomb bay oxygen panel (red filter)	Front bomb bay (1)	On front bomb bay light assembly, left-hand side
FLOODLIGHTS		
Copilot's compartment (clear)	Copilot's compartment (1)	Copilot's lighting panel
Copilot's compartment (red)	Copilot's compartment (1)	Copilot's lighting panel
Observer's table (red)	Observer's table (1)	Observer's lighting panel
Observer's table (red)	Observer's table (1)	Observer's lighting panel
Observer's instrument panel	Observer's instrument panel (5)	Observer's lighting panel
Observer's compartment (clear)	Observer's compartment (1)	Observer's lighting panel
Observer's compartment (red)	Observer's light control panel (1)	Observer's lighting panel
Pilot's compartment and instrument panel (clear)	Pilot's instrument panel (2) Pilot's compartment (1)	Pilot's lighting panel
Pilot's compartment (red)	Pilot's compartment (2)	Pilot's lighting panel
Map light (clear)	Pilot's compartment (1)	Pilot's map light panel
Map light (red)	Pilot's compartment (1)	Pilot's map light panel
ENTRANCE AND WALKWAY LIGHTS		
Walkway (red)	Walkway (4)	Switches controlling all entrances and walkway lights are located as follows; entrance way, copilot's oxygen panel, observer's lighting panel, and pilot's oxygen regulator and suit heater rheostat panel. A dome light color selector switch is on the pilot's oxygen and rheostat panel.
Walkway (white)	Walkway (4)	
Entrance (white)	Entrance (1)	
RADAR COMPARTMENT SERVICE LIGHTS		
Radar compartment dome (clear)	Radar compartment (1)	Lower radar compartment
STANDBY COMPASS LIGHTS		
Standby compass (red)	Copilot's instrument panel (1)	Copilot's rheostat panel

NOTE

Circuit breakers for all of the above lights except the radar compartment dome light are located on the lower DC power panel. The circuit breaker for the radar compartment dome light is located on the right main power shield.

Figure 4-11. Interior Lighting (Sheet 3 of 3)

CAUTION

Due to the automatic pressure breathing feature of the regulator, a continuous flow of oxygen at altitude will result if the regulator is not being used and the supply shutoff lever is left ON. This condition will cause a rapid loss of oxygen.

OXYGEN EMERGENCY TOGGLE LEVER. An emergency toggle lever (5, figure 4-13) is provided on each regulator for manually supplying a positive oxygen pressure to the mask for emergency use. The depressing of the lever gives a positive oxygen pressure to the mask which may be used for testing the oxygen mask fit at any altitude. The positive pressure of oxygen to the mask is automatically shut off when the lever is released. Pushing the lever to either side (right or left of normal position) locks the lever to give a continuous positive pressure to the oxygen mask for emergency use.

MASTER OXYGEN WARNING CONTROL SWITCH. An ON--OFF oxygen warning switch (35, figure 1-9) is on the pilot's instrument panel. When the switch is in the ON position, oxygen warning light circuits are completed to each regulator unit. When the switch is in the OFF position, all the oxygen warning light circuits are inoperative.

OXYGEN WARNING SYSTEM SWITCHES. An ON--OFF oxygen warning system switch (1, figure 4-13) is provided on each regulator unit. When the switch is in the ON position, power is supplied to the warning light circuits for that crew station. When the switch is in the OFF position, the warning light circuits for that crew station are deenergized.

OXYGEN SYSTEM INDICATORS.

OXYGEN PRESSURE GAGES. An oxygen pressure gage (2, figure 4-13) provided on each regulator unit indicates oxygen system pressure in psi.

NOTE

If the oxygen cylinders are chilled, such as at high altitude, the oxygen pressure gage will show lower pressures. Depending on the temperature decrease, this pressure drop may be quite rapid, however, all oxygen is still there, and as descent to warmer altitudes is made, the pressure will tend to rise again. A rapid fall in oxygen pressure while the airplane is in level flight or descending will indicate a leak or loss of oxygen.

OXYGEN FLOW INDICATORS. A blinker-type oxygen flow indicator (2, figure 4-13) is provided on each oxygen regulator unit. Black and luminescent segments alternately appear through four slots in the indicator face with each breath taken by the crew member.

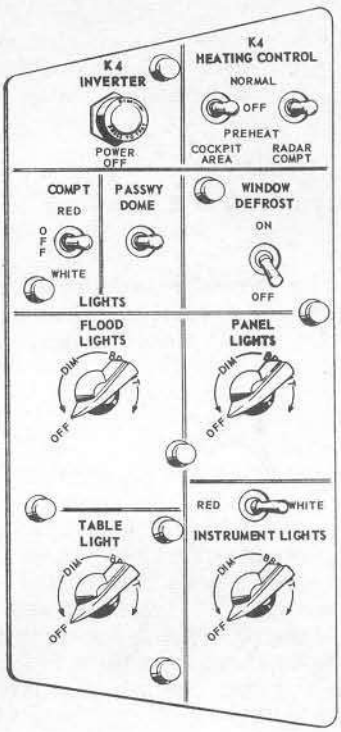


Figure 4-12. Observer's Lighting Panel

OXYGEN WARNING LIGHTS. An oxygen warning light for each crew station is on the pilot's instrument panel and, in addition, an individual oxygen warning light is located at each of the other crew stations. The lights for any one crew station will illuminate only when the master oxygen warning control switch and the oxygen warning switch on the applicable crew station regulator are in ON positions. The lights will be bright, dim or blinking bright indicating the condition of operation of oxygen at each crew station. See figure 4-14.

A pilot's monitor oxygen warning light (2, figure 1-27) is installed on the copilot's instrument panel. This light functions in the same manner as the other oxygen warning lights, and enables the copilot to observe that the pilot is using oxygen.

NOTE

At cabin altitudes below 10,000 feet with the oxygen regulator operating and the mask being used, the lights may blink brightly. Since this condition is peculiar mostly to low altitudes, it should not cause undue concern. At flight altitudes below 10,000 feet the oxygen system may be turned off since the possibility of hypoxia is only critical at high altitudes.

NORMAL OPERATION OF OXYGEN SYSTEM.

BEFORE TAKE-OFF. Check oxygen system and mask as follows:

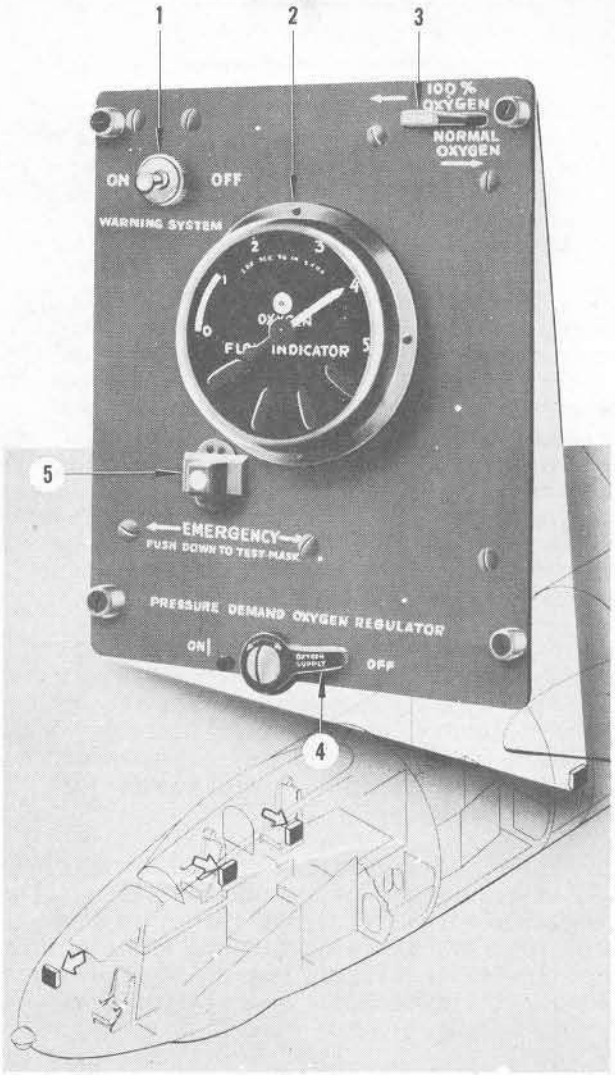
a. Check to see that the oxygen shut-off valves are off by bleeding pressure from the regulator with the emergency toggle lever. The pressure should drop to zero and remain at zero when the lever is returned to neutral.

NOTE

Insure that all D-1 regulators not in use are shut off.

b. At the station to be checked, place the oxygen supply shutoff lever in ON position. Check the indicated system pressure, which should be 400 to 450 psi.
c. Place master oxygen warning control switch and crew station oxygen warning system switch in the ON position. A bright continuous illumination of the warning lights should result.
d. Place the regulator diluter lever in 100% OXYGEN position and depress the emergency toggle lever to flush the regulator hose; the oxygen flow blinker will indicate continuous flow and the warning light should go dim momentarily, then bright continuously.
e. With the emergency toggle lever depressed, block the regulator hose tightly with the hand; the blinker should indicate no flow and, after a few seconds of dim light followed by bright blinking, the warning light should come on continuous bright. A hissing of the regulator or a flow indication will indicate a ruptured regulator diaphragm or other pressure leaks. Check the hose and hose fittings.
f. Release the emergency toggle lever, plug in the oxygen mask, and check the quick-disconnect fitting. (The fitting should separate with a 10- to 15-pound pull.)
g. Plug in and adjust the mask on the face and check blinker operation during normal breathing; the warning light should go dim and remain dim.
h. Depress the emergency toggle lever to the TEST MASK position and hold breath; the blinker should indicate no flow. After approximately 10 seconds or less, the warning light will blink brightly, then remain bright. A pressure leak will be indicated by a flow indication or a hissing sound from the regulator.
i. Release the emergency toggle lever (allowing return to neutral) and set the diluter lever in NORMAL OXYGEN position. The system is now ready for use.

IN-FLIGHT. The pressure regulator diluter lever should always be in the NORMAL OXYGEN position except when operating under emergency conditions. When going on oxygen, proceed as follows:
a. Place oxygen supply shutoff lever in the ON position.
b. Check regulator diluter lever in the NORMAL OXYGEN position.
c. Place master oxygen warning control switch and crew station oxygen warning system switch in the ON position. The warning lights should illuminate brightly.
d. Put on mask and connect mask tube to regulator unit. As breathing through the mask is commenced, the warning lights should change to a dim continuous glow, and the oxygen flow indicator should start functioning. The proper flow of oxygen will be automatically maintained by the regulator unit.



1 OXYGEN WARNING SYSTEM SWITCH
2 OXYGEN FLOW INDICATOR AND PRESSURE GAGE
3 REGULATOR DILUTER LEVER
4 OXYGEN SUPPLY SHUTOFF LEVER
5 OXYGEN EMERGENCY TOGGLE LEVER

Figure 4-13. Oxygen Regulator Panel

NOTE

Pressure demand masks, when used at altitudes exceeding 30,000 feet, will occasionally produce a distinct vibration in the mask that can be identified by a "wheezing" sound. This condition may be overlooked in that operational qualities are not disturbed in any manner.

EMERGENCY OPERATION OF OXYGEN SYSTEM.

With symptoms of hypoxia or if smoke or fumes should enter the cabin, immediately put on oxygen mask and place the regulator diluter lever in the 100%

DIM LIGHT (intermittent oxygen flow)	BRIGHT BLINKING LIGHT	BRIGHT LIGHT (no oxygen flow)	BRIGHT LIGHT (continuous oxygen flow)
Crew member breathing normally with mask connected to regulator.	Transition from normal breathing to no oxygen flow.	*Mask on and crew member not breathing or *Oxygen supply depleted or Mask off at low altitude	*Oxygen mask off at high cabin altitude (28,000 ft. and up) or *Large leak in regulator or between regulator and crew member at high cabin altitude or Emergency toggle lever in emergency position
NOTES Operation with master oxygen warning control switch and crew member's oxygen warning switch in the ON position *Indicates emergency condition.			

Figure 4-14. Oxygen Warning Light Indications

OXYGEN position and place emergency toggle lever in the EMERGENCY position.

NOTE

It is necessary to use both the diluter lever and the emergency toggle lever because the diluter lever will supply 100% oxygen only on suction of the crew member, while the emergency toggle lever supplies oxygen under pressure. The use of both levers, therefore, assures that the crew member will not get any smoke or fumes.

CAUTION

When the regulator diluter lever is placed in the 100% OXYGEN position or the emergency toggle lever placed in the EMERGENCY position, inform the pilot immediately as these actions will reduce the oxygen duration of the airplane.

In the event of accidental loss of cabin pressure, immediately go on oxygen in the same manner as for in-flight normal operation. If oxygen is being used prior to the accidental loss of cabin pressure, no action is required as the regulator unit will automatically compensate for the increased cabin altitude.

If a regulator unit becomes inoperative or the oxygen system is suspected of being contaminated, disconnect mask and connect it to a portable oxygen cylinder. If an adequately filled cylinder is not available, pull the cord on the H-2 emergency oxygen cylinder.

WARNING

When use of H-2 emergency oxygen cylinder becomes necessary, inform the pilot immediately so that he can descent to an altitude at which oxygen is not required.

AUTOMATIC PILOT.

Automatic flight control consists of an E-4 automatic pilot, an automatic approach system, an N-1 compass system, and provisions in coordination with the "K" bombing and navigation system.

NOTE

If the N-1 compass fails, as indicated by the N-1 compass inoperative light on the pilot's instrument panel, the automatic pilot will no longer control the heading of the airplane.

An altitude control is also provided to maintain constant barometric pressure altitude. Servo motors to operate the rudder, ailerons, elevators, and elevator trim are connected to the flight control system cables. The automatic pilot can operate the control surfaces only with surface power control on and therefore it should be turned off if surface power control fails. The airplane is designed to be flown normally with surface power control on and the automatic pilot will operate most satisfactorily with the airplane in this normal condition. The automatic pilot can be used to fly the airplane with surface power control off; however, this is not normal procedure and should not be attempted except in an emergency. For operation with surface power control off, see "Surface Power Control Inoperative" in section III. The automatic pilot automatically and continuously synchronizes itself to the changing attitudes of the airplane while the automatic pilot is disengaged. This allows the automatic pilot to be engaged throughout the present range of allowable cg's, at any speeds below the present limiting airspeeds and Mach numbers, and in any normal flight attitude except a turn. During operation the automatic pilot provides automatic elevator trim to assume a portion of the load and cg shift compensation. Automatic pilot controls are on a stowable control panel (15, figure 1-8) at the left side of the pilot's station, on the lower left corner of the pilot's instrument panel (37, figure 1-9), at the observer's station (34, figure 4-6), and on the pilot's and copilot's control wheels (2, figure

CREW MEMBER OXYGEN DURATION IN HOURS

CABIN ALTITUDE FEET	GAGE PRESSURE - P.S.I. 400	350	300	250	200	150	100	BELOW 100
40,000	13.7 13.7	11.8 11.8	9.8 9.8	7.8 7.8	5.9 5.9	3.9 3.9	1.9 1.9	EMERGENCY DESCEND TO ALTITUDE NOT REQUIRING OXYGEN
35,000	13.7 13.7	11.8 11.8	9.8 9.8	7.8 7.8	5.9 5.9	3.9 3.9	1.9 1.9	
30,000	10.2 10.2	8.7 8.7	7.3 7.3	5.9 5.9	4.3 4.3	2.9 2.9	1.4 1.4	
25,000	8.1 9.7	7.0 8.3	5.9 6.9	4.6 5.5	3.5 4.2	2.4 2.8	1.1 1.4	
20,000	6.6 10.9	5.6 9.4	4.8 7.8	3.8 6.1	2.8 4.6	1.8 3.1	.9 1.5	
15,000	5.2 13.2	4.5 11.3	3.6 9.4	2.9 7.6	2.2 5.6	1.5 3.8	.7 1.8	
10,000	4.5 17.6	3.8 15.1	3.2 12.6	2.5 10.1	1.9 7.6	1.3 5.0	.7 2.5	

NOTE:
Black figures indicate diluter lever "NORMAL OXYGEN"
Red figures indicate diluter lever "100% OXYGEN"
Cylinders: 4 type G-1, 6 type F-1
Crew: 3

Figure 4-15. Oxygen Duration

4-8). Automatic pilot and automatic approach circuits are protected by five circuit breakers on the lower DC power panel and a circuit breaker in the main AC power panel. The automatic pilot electrical units are energized and gyros erected when power is available on the DC system and the main inverter bus. Failure of AC or DC power will cause the automatic pilot to disengage, turn off, and remain locked off until power is available. When power is again restored, a delay of approximately 3 minutes may be expected before the master switch will become unlocked and can be placed in ON position.

AUTOMATIC PILOT CONTROLS.

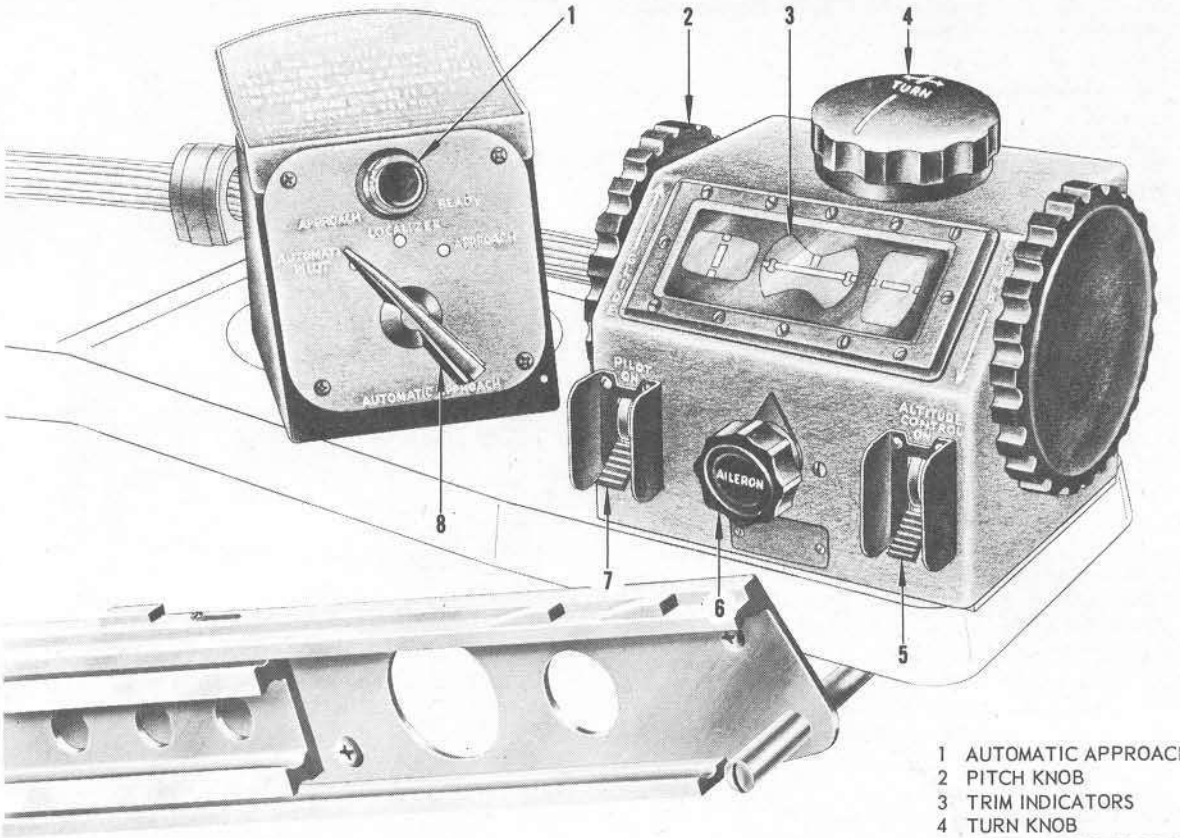
AUTOMATIC PILOT ENGAGING SWITCHES. Three switches (37, figure 1-9) on the pilot's instrument panel have ENGAGE and DISENGAGE positions. ENGAGE position of the switch provides individual engaging of the rudder, aileron, elevator, and elevator trim tab servos. If the directional damper is operating and the rudder engage switch is placed in ENGAGE position, the directional damper is rendered inoperative. DISENGAGE position of the switches disengages the servos from control of surface cables.

AUTOMATIC PILOT RELEASE SWITCHES. Release switches are provided on both the pilot's and copilot's wheels (2, figure 4-8). Pressing one of these push-button switches disengages all automatic pilot servo motors, thereby eliminating automatic pilot control.

CONTROLLER SUPPORT ACTUATOR SWITCH. The automatic pilot controller support may be extended into the walkway in reach of the pilot by actuating a two-position switch located below the canopy rail and above the pilot's oxygen regulator panel. When the switch is placed in extend position, a DC operated actuator motor drives the support and controller from the stowed position to a position within reach of the pilot's left hand. Two limit switches within the actuator stop the motor when support is extended or retracted. When the switch is placed in retract position the actuator moves the support to its stowed position in a recess in the cockpit sidewall.

WARNING

Under emergency conditions the automatic pilot controller should be stowed as soon as possible for two reasons: 1) the support cannot be stowed after electrical power has failed and 2) the extended support will definitely limit the pilot and observer in bail-out or



1 AUTOMATIC APPROACH READY LIGHT
2 PITCH KNOB
3 TRIM INDICATORS
4 TURN KNOB
5 ALTITUDE CONTROL SWITCH
6 AILERON TRIM KNOB
7 AUTOMATIC PILOT MASTER SWITCH
8 AUTOMATIC APPROACH SWITCH

Figure 4-16. Automatic Pilot Controller and Automatic Approach Switch

under ditching conditions. The automatic pilot can be used to control the flight of the airplane even though the controller is in the stowed position.

When the actuator switch is placed in the extend position, the automatic pilot off light becomes operative. When the actuator switch is placed in the retract position, the automatic pilot off light becomes inoperative.

AUTOMATIC PILOT CONTROLLER. The pilot's automatic pilot controller (figure 4-16) on the pilot's controller support provides a means for maneuvering the airplane from the pilot's position when the automatic pilot system is engaged.

MASTER SWITCH. An automatic pilot master switch (7, figure 4-16) on the front of the controller has ON and OFF positions. ON position of the switch permits the signal system to be synchronized to changing attitudes of the airplane and permits ready engagement of the servos.

NOTE

The master switch is prevented from being placed in ON position if any of the following conditions exist:
Engaging switches not in DISENGAGE position.
Turn knob not centered (in detent)
Turn control switch not in PILOT position.
Automatic approach switch not in AUTOMATIC PILOT position.

OFF position of the switch allows the electrical units to be warm and the gyros to be erected when power is on in the airplane; however, the signal system is not synchronized and the servo cannot be engaged.

If, while servos are engaged, a surface reaches its full allowed travel, a limit switch will be actuated and the servos and servo switches for that surface will become disengaged. The master switch will not be tripped to OFF position, nor will the automatic pilot off light blink.

ALTITUDE CONTROL SWITCH. An altitude control switch on front of the controller (5, figure 4-16) has ON and OFF positions. When the switch is placed in ON position, the pitch knobs are disengaged and the elevator servos are controlled by a barometric pressure control unit, providing constant pressure altitude flight. When the switch is placed in OFF position, the constant altitude control is made inoperative.

CAUTION

Pitching action may be encountered unless the altitude control switch is placed in OFF position before large changes in airspeed are made or landing gear or flaps are raised or lowered.

PITCH KNOBS. Two large pitch knobs (2, figure 4-16) on either side of the controller are interconnected by a common shaft. The pitch knobs control the elevators for climb or glide. Forward rotation of the knobs results in descent; aft rotation results in climb. The degree of rotation is proportional to the airplane degree of dive or climb. The pitch knob always returns to zero when the automatic pilot is turned off or when the altitude control is operating, and is inoperative during ILAS approaches.

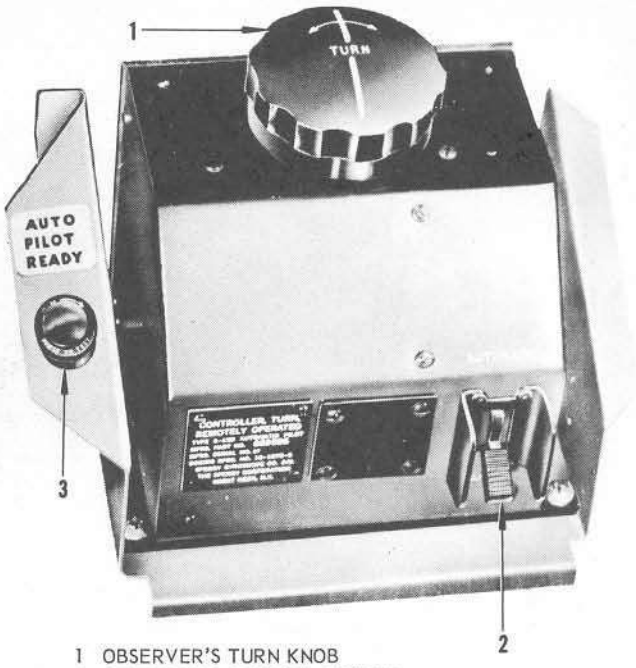
TURN KNOB. A pilot's turn knob (4, figure 4-16) on top of the controller provides coordinated turns for all airspeeds. When the knob is not being used, it should be placed in detent or the center position of total knob rotation. Turning the knob approximately 140° in either direction gives a maximum bank of approximately 40°. Rate of turn is dependent on airspeed.

AILERON TRIM KNOB. An aileron trim knob (6, figure 4-16) on front of the controller provides aileron trim correction if the automatic pilot is energized and the airplane is not level about the roll axis. Out of trim forces, as indicated by trim indicator being displaced from center reference while automatic pilot is engaged, should be trimmed by disengaging the automatic pilot on that axis and trimming the airplane by means of the airplane manual trim knobs.

TURN CONTROL SWITCH. A turn control switch (39, figure 1-9) on the pilot's instrument panel has BOMBARDIER and PILOT positions. BOMBARDIER position of the switch transfers directional control of the airplane to the observer's station. PILOT position of the switch allows control of the automatic pilot from the pilot's controller only.

OBSERVER'S TURN CONTROLLER. The observer's controller (34, figure 4-6 and figure 4-17) enables the observer to fly the airplane through coordinated turns if the turn control switch is placed in BOMBARDIER position.

OBSERVER'S CONTROL SWITCH. A control switch (2, figure 4-17) on the observer's controller has AUTOMATIC and MANUAL positions. AUTOMATIC position of the switch transfers control of the automatic pilot to the "K" bombing and navigation system. If the turn knob (1, figure 4-17) on the controller is moved from detent, the switch will automatically move to MANUAL position. MANUAL position of the switch provides turn control operation from the turn knob.



1 OBSERVER'S TURN KNOB
2 OBSERVER'S CONTROL SWITCH
3 AUTOMATIC PILOT READY LIGHT

Figure 4-17. Observer's Turn Controller

AUTOMATIC APPROACH SWITCH. An automatic approach switch (8, figure 4-16) on the pilot's automatic pilot controller support has AUTOMATIC PILOT--LOCALIZER--APPROACH positions. The normal position of the switch is AUTOMATIC PILOT. LOCALIZER position of the switch controls the lateral position of the airplane after the localizer beam has been intersected. The APPROACH position controls both the lateral and vertical positions of the airplane after the glide path beam has been intercepted.

AUTOMATIC PILOT INDICATORS.

AUTOMATIC APPROACH READY LIGHT. A green automatic approach ready light (1, figure 4-16) illuminates when the ARN-14 receiver is turned on and tuned to any frequency between 108.0 and 111.9 megacycles.

PILOT'S TRIM INDICATORS. Three trim indicators (3, figure 4-16) on the front panel of the automatic pilot controller provide a visual indication that rudder, aileron, and elevator are out of or in trim or that the servos are exerting force against out of trim forces when automatic pilot is engaged.

AUTOMATIC PILOT OFF LIGHT. A red automatic pilot off light (38, figure 1-9) above the engaging switches will blink whenever the automatic pilot is disengaged on all three axes. The automatic pilot off light will go out when the controller support actuator switch is placed in stow position.

AUTOMATIC PILOT READY LIGHT. An observer's automatic pilot ready light (3, figure 4-17) will illuminate when the pilot's turn control switch is placed in BOMBARDIER position, to indicate that control transfer has been accomplished.

NORMAL OPERATION OF THE AUTOMATIC PILOT.

Normal operation of the automatic pilot may be accomplished by the following procedure:

a. Place the controller support actuator switch in extend position to extend the automatic pilot support and controller within reach.

b. Trim the airplane with the manual trim controls for hands-off flight. An airplane that is not trimmed properly will impose an unnecessary load on the automatic pilot and produce undesirable flight characteristics.

NOTE

Out of trim condition is evidenced by one or more of the trim indicator needles, on the pilot's controller, being steadily displaced from center reference.

c. Check that all servo engaging switches are in DISENGAGE.

d. Check turn control switch in PILOT.

e. Check automatic pilot controller for:
1. Turn knob in detent.
2. Aileron trim knob centered.
3. Automatic pilot master switch OFF.

f. Check automatic approach switch on AUTOMATIC PILOT.

WARNING

The automatic approach switch must be in AUTOMATIC PILOT position during all normal automatic flights. If the switch were inadvertently left in one of the other positions during normal automatic flight, there is a possibility of violent control action if the airplane were to pass over an omni-range station.

g. Check that N-1 compass inoperative light is not illuminated.

h. Place automatic pilot master switch ON.

i. Check that trim indicators are in center reference position.

WARNING

If any trim indicator needle is not in center reference position before engaging servos, malfunction of the automatic pilot is indicated and the servo for this axis should not be engaged. To do so may result in a violent maneuver when that servo is engaged.

j. Place automatic pilot engaging switches in ENGAGE.

NOTE

Servos may be engaged when in a normal climb or descent and the airplane will continue to fly in that attitude until the pilot moves his pitch knob.

CAUTION

Do not engage automatic pilot when in a turn.

k. The airplane is now under automatic control on all three axes.

NOTE

- Any airplane axis may be flown manually by placing the engaging switch for that axis in DISENGAGE.
- The automatic pilot should be disengaged on the rudder axis when the N-1 compass inoperative light is illuminated which indicates the automatic pilot will be unable to hold a heading.
- The automatic pilot rudder axis should also be disengaged whenever the heading pointer in the N-1 compass master indicator oscillates or moves erratically since a malfunction is indicated in the N-1 system. The rudder axis will be disengaged automatically if the N-1 compass system were to give the automatic pilot a hard-over signal.

l. Standard maneuvers may be executed with the pitch and turn knobs. Climb and descent are accomplished with the pitch knob; turns are made with the turn knob. A climbing or descending turn is made with a combination of the two knobs.

NOTE

While executing any of the above maneuvers the trim indicators will deflect momentarily and center again.

m. During flight, check that trim indicators are in center position. The elevator trim tab servo will automatically trim the airplane about the pitch axis. If the aileron or rudder trim indicator is steadily displaced from center, that axis must be trimmed manually. Disengage and trim airplane about the axis. If a low wing condition is encountered and the aileron trim needle is aligned, the condition may be corrected by use of the automatic pilot aileron trim knob.

n. When it is desirable to maintain a specific pressure altitude, place the altitude control switch ON. The airplane will fly at a constant pressure altitude

and pitch control is inoperative. Place the altitude control switch in OFF and the airplane will return to the pitch attitude flown before the switch was turned on.

CAUTION

Pitching action may be encountered unless the altitude control switch is placed in OFF position before large changes in airspeed are made or landing gear or flaps are raised or lowered.

o. Automatic pilot control may be disconnected at any time by pressing the pilot's or copilot's disconnect switches on the respective control wheels, by placing the engaging switches in DISENGAGE position, or by placing the automatic pilot master switch in OFF.

NOTE

While master switch is ON and servos are disengaged the signal system is synchronized to changing attitudes of the airplane and the automatic pilot is ready for engagement. When the master switch is OFF the signal system is not synchronized, but the electrical units are still warm and the gyros are erected.

p. Place master switch OFF before stowing controller and controller support.
q. Stow controller and controller support by placing actuator switch in the retract position.

EMERGENCY OPERATION OF THE AUTOMATIC PILOT.

There are no special operating procedures to be used during an emergency. However, if the automatic pilot is engaged and manual flight control is desired, press the pilot's or copilot's disconnect switches for immediate automatic pilot disconnect.

NAVIGATION EQUIPMENT.

An observer's station is installed in the nose (figures 4-6 and 4-7). The observer's seat is centrally located and may be swiveled to the left and right to facilitate use of the adjacent navigation, bombing, and radar equipment. A periscopic sextant may be installed beneath the emergency escape hatch above the observer's seat. An additional celestial navigation window is provided in each sidewall below the emergency escape hatch. Further vision is provided by two windows located below the bombsight and four auxiliary side windows, three on the left and one on the right. No driftmeter is provided as the bombsight may be used to take drift readings.

Navigation equipment arranged within reach of observer when seated includes turn controller, instrument panel, work table with pencil box, navigation-computer control panel, radar control panel, radar scope, horizontal bombsight, "K" system control panels, and polar navigation units.

The periscopic sextant is stowed in a box (14, figure 1-20) on the step just aft of the pressure door.

BOMBING SYSTEM.

The structure of the airplane provides a bomb bay section approximately 26 feet long extending from the forward to the aft wheel well. The design provides for three different bomb bay configurations; two short bomb bay configurations and one long bomb bay configurations. The short bomb bay configurations include a bomb load in only the front half of the bomb bay, the rear half being taken up by a built-in bomb bay fuel tank. The tank is not droppable and no bomb doors are provided in the tank area.

SHORT BOMB BAY CONFIGURATIONS.

a. The basic configuration consists of a 10,000-pound special purpose bomb and provisions in the bomb bay to include a Type U-2 bomb rack and built-in bomb hoist. In addition, a crew station, platform, walkway, auxiliary equipment container, lights, bomb tools, manual arming knob, and vacuum system are among items included to facilitate in-flight servicing of the bomb. Electrically controlled pneumatic pressure supplied from air bottles is used for normal release of the bomb and a manual cable system is provided for emergency release.
b. Two master kits are supplied to provide the necessary racks and accessories in the basic bomb bay area to accommodate alternate bomb load configurations.

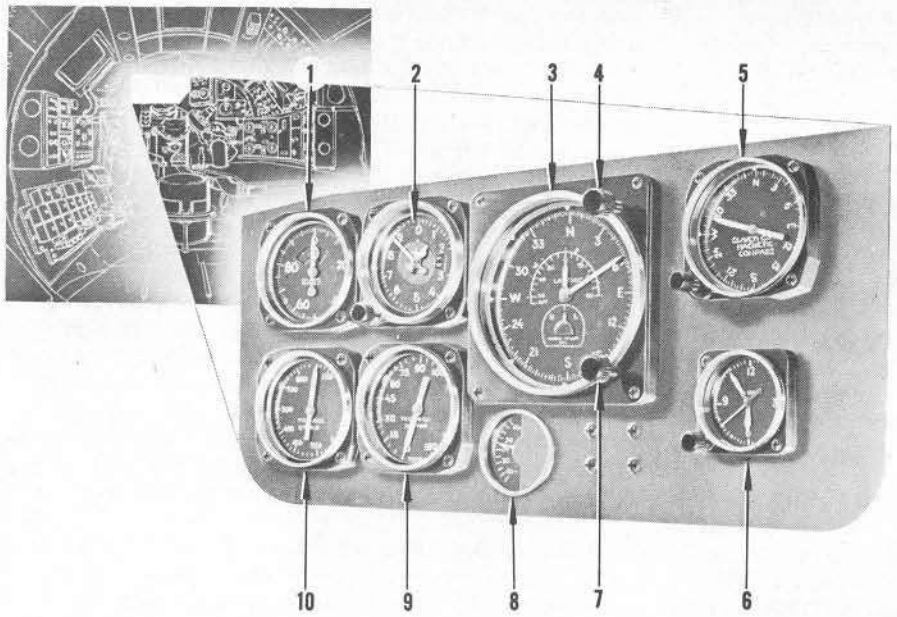
Incorporation of the alternate configuration master kits requires removal of the 10,000-pound bomb rack, bomb hoist, platform, and accessories as noted on loading charts located on the inside of the bomb bay. Normal release of the bombs is accomplished electrically. Ground bomb loading equipment must be employed as no built-in hoist is provided.

LONG BOMB BAY CONFIGURATIONS.

Provisions are also made for master kits providing the necessary racks and accessories to accommodate special bomb load configurations using a long bomb bay. Incorporation of the special configuration master kits involves removal of the bomb bay fuel tank and supporting structure, replacement of the basic bomb doors with bomb doors extending the full length of the bomb bay section, installation of additional bomb door actuators, and installation of fairing structure at the rear end of the bomb bay. As in the alternate configurations, normal release of the bombs is accomplished electrically and no built-in hoist is provided.

BOMB BAY SPOILER DOORS.

Three spoiler doors are provided forward of the bomb bay to prevent buffeting within the bomb bay when the



1 "K" SYSTEM AIRSPEED INDICATOR
2 ALTIMETER
3 N-1 COMPASS MASTER INDICATOR
4 N-1 COMPASS LATITUDE CORRECTION KNOB
5 "K" SYSTEM COMPASS INDICATOR
6 CLOCK
7 N-1 COMPASS SYNCHRONIZER KNOB
8 FREE AIR TEMPERATURE GAGE
9 "K" SYSTEM TIME-TO-GO INDICATOR
10 TRUE AIRSPEED INDICATOR

Figure 4-18. Observer's Instrument Panel

bomb doors are opened. Salvo, "K" system, normal or alternate bomb door switch operation will provide hydraulic actuation to automatically open the spoiler doors into the air stream, thereby deflecting the air in such a manner as to preclude buffeting which will otherwise occur. The spoiler hydraulic system incorporates a hydraulic accumulator to provide pressure isolated from the main system to insure that pressure is available for retracting the spoilers. The accumulator is equipped with a pressure gage which is located in the forward end of the bomb bay and shows spoiler system pressure or air preload pressure if spoilers have been operated and hydraulic pressure is bled down. A spoiler depressurizing valve is located in the bomb bay which allows spoiler system to be bled down by maintenance personnel. The spoiler doors will retract automatically when any switch is used to close the bomb doors.

NOTE

Spoiler doors will not open during bomb door operation on the ground.

BOMB BAY DOOR GROUND SAFETY LOCKS.

Safety locks to prevent inadvertent closing of the bomb doors on the ground and wide-open support tools to hold the bomb doors in the extreme open (horizontal) position for loading bombs are included in the airplane flyaway tool kit. Circuit breakers for the bombing system are on the radar power panel (4, figure 1-30) and the lower DC power panel (6, figure 1-30).

NOTE

Make sure all bomb door switches are placed in OFF position before installing bomb door wide-open support tools.

"K" SYSTEM BOMBING.

Unaimed selective, train, or salvo release of bombs and bomb door operation may be accomplished by means of the above described controls alone. In addition, a "K" radar bombing, navigation, and computing system provides for bomb aiming, automatic bomb door operation, and automatic selective, train, or salvo release of bombs.

BOMBING SYSTEM CONTROLS.

INDICATOR LIGHTS SWITCH. An ON--OFF indicator lights switch (8, figure 4-19) on the bomb control panel serves as a master bomb control switch. When the switch is in the ON position, power is supplied to a bomb control power switch, a nose fuse arming switch, a bomb door and release control switch, a special arming control heater, and bomb indicator lights. When the switch is in the OFF position, these circuits are deenergized.

BOMB CONTROL POWER SWITCH. An ON--OFF bomb control power switch (9, figure 4-19) is on the bomb control panel. When the switch is in the ON position, DC power is supplied to the power circuits in the bombing system and to the bomb arming control switch, and the bomb release control circuit is partially completed. When the switch is in the OFF position, these circuits are deenergized.

BOMB DOOR AND RELEASE SWITCH. A MANUAL--K2 AUTO switch (4, figure 4-19) guarded in the MANUAL position, on the bomb control panel is used to select either manual or automatic operation of the bombing system. When the switch is in the MANUAL position, the "K" system bomb door and bomb release circuits are disconnected from the bombing system. DC power is supplied to the normal bomb door control switch, and the bomb release control circuit is

energized. When the switch is in the K2 AUTO position, the "K" system bomb door and release circuits are connected to the bombing system and the normal bomb door control switch and the bomb release control circuits are deenergized.

NORMAL BOMB DOOR SWITCH. An OPEN--OFF--CLOSE switch (2, figure 4-19), spring-loaded to the OFF position, is on the bomb control panel. When the switch is actuated to the OPEN position, power is supplied to a bomb door valve which directs main hydraulic system pressure to open the bomb doors. When the switch is actuated to the CLOSED position, main hydraulic system pressure is similarly employed to close the bomb doors. When the switch is in the OFF position, the bomb door control circuit is deenergized.

ALTERNATE BOMB DOOR SWITCHES. An OPEN--OFF--CLOSE switch (3, figure 4-19) is on the bomb control panel and a similar switch (42, figure 1-9) is on the pilot's instrument panel. When in the CLOSE position, the switches are spring-loaded to OFF. When either switch is in the OPEN position, power is supplied to operate the emergency hydraulic pump and actuate an alternate bomb door valve which directs emergency hydraulic pressure to open the bomb doors. When either switch is held in the CLOSE position, emergency hydraulic pressure is similarly employed to close the bomb doors. When the switches are in the OFF position, the emergency hydraulic pump and bomb door control circuits are deenergized.

A third alternate bomb door switch is provided at the external AC power receptacle for use during ground operation. This switch has fixed OPEN, OFF, and momentary CLOSE positions. OFF and CLOSE positions are the same as the other alternate switches. When the switch is in fixed OPEN position, it prevents closing of bomb doors from any other location in the airplane.

CAUTION

All alternate bomb door switches must be placed in OFF position when not in use while bomb door wide-open support tools are installed. If a switch were left in OPEN position after installing bomb door wide-open support tools and power were restored to the airplane, the bomb doors would be damaged.

U-1 (U-2) ARMING SWITCH. A U-1 arming switch (18, figure 4-19) on the bomb control panel has ARM--OFF--SAFE positions. The switch is spring-loaded to the OFF position. When actuated to the ARM position, power is supplied to arm the 10,000-pound bomb and illuminate a U-1 armed indicator light. SAFE position of the switch deenergizes the arming circuit and U-1 armed indicator light.

U-2 ARMING KNOB. A PUSH-ARM--PULL-SAFE knob is provided on the arming control in the bomb bay for use in the event the U-1 arming switch is inoperative. When the knob is in the retracted position (pushed in), the 10,000-pound bomb is armed manually, an ARMED marking adjacent to the knob is exposed, and the U-1 armed indicator light is illuminated. When the knob is in the extended (pulled out) position, the 10,000-pound bomb is manually disarmed, a tab marked SAFE covers the ARMED marking, and the U-1 armed indicator light circuit is deenergized.

EMERGENCY BOMB ARMING SAFE HANDLE. A pull handle (1, figure 4-6) on the left sidewall of the observer's station just aft of the astral window provides an emergency means of disarming the 10,000-pound bomb in the event that the U-1 arming switch is inoperative. When the handle is pulled, the U-2 arming knob on the bomb arming control in the bomb bay is moved to the SAFE position, disarming the bomb.

U-2 RACK LOCKING WRENCH. A special wrench is attached to the airplane bomb bay structure by means of a chain. This wrench is used as an aid to cock the rack, and to lock the rack by inserting the pin end of the wrench into the locking hole provided in the rack. The wrench must be pulled out to unlock the rack prior to flight.

NOSE FUSE ARMING SWITCH. A circuit breaker type ARM--SAFE nose fuse arming switch (15, figure 4-19) is on the bomb control panel. When the switch is in the ARM position, power is supplied to arm the nose fuse of the general purpose bombs and illuminate the nose fuse armed indicator light. When the switch is in the SAFE position, the nose fuse arming and nose fuse armed indicator light circuits are deenergized.

BOMB CONTROL SELECTOR SWITCH. A NORMAL--SALVO switch (11, figure 4-19), guarded in the NORMAL position, is on the bomb control panel. When the switch is in the NORMAL position, the number of bombs to be dropped is determined by the setting on a bomb intervalometer. When the switch is in the SALVO position, all bombs will be dropped upon pressing the bomb release switch or upon impulse from the "K" system.

WARNING

When the airplane is on the ground with bomb bay doors open, actuation of any salvo switch to the SALVO position will salvo the bomb or bombs. The salvo circuit is wired directly from the battery and is independent of all other circuits.

BOMB RELEASE INTERVAL CONTROL SWITCH. A bomb release control switch on the bomb release interval control panel (36, figure 4-6) has SEL--TRAIN positions. SEL position of the switch allows general purpose bombs to be dropped singly. TRAIN position of the switch allows general purpose bombs

1 U-1 (U-2) ARMED INDICATOR LIGHT
2 NORMAL BOMB DOOR SWITCH
3 ALTERNATE BOMB DOOR SWITCH
4 BOMB DOOR AND RELEASE SWITCH
5 BOMB RELEASE SWITCH
6 BOMB DOOR POSITION INDICATOR
7 BOMB CONTROL POWER ON INDICATOR LIGHT
8 INDICATOR LIGHTS SWITCH
9 BOMB CONTROL POWER SWITCH
10 BOMB SALVO SWITCH
11 BOMB CONTROL SELECTOR SWITCH
12 BOMB SCORING TONE ON INDICATOR LIGHT
13 U-1 (U-2) RACK LOCKED WARNING LIGHT
14 BOMB SCORING TONE SWITCH
15 NOSE FUSE ARMING SWITCH
16 NOSE FUSE ARMED INDICATOR LIGHT
17 U-1 (U-2) AIR PRESSURE LOW WARNING LIGHT
18 U-1 (U-2) ARMING SWITCH

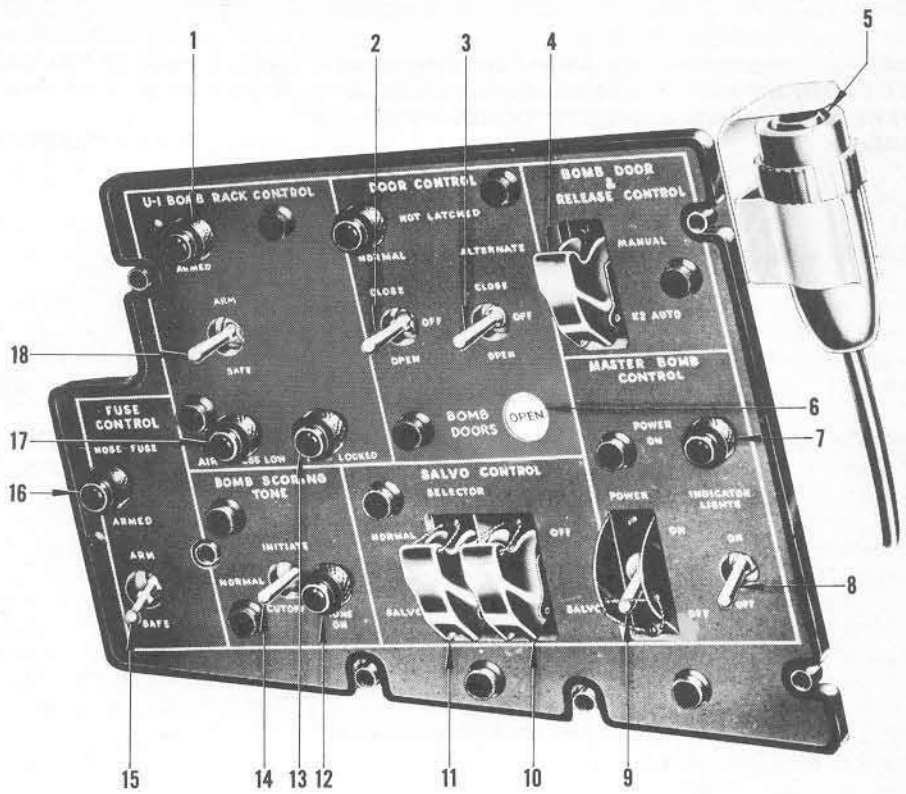


Figure 4-19. Bomb Control Panel

to be dropped in train. One minute of warm-up time should be allowed before train release.

BOMB RELEASE INTERVAL CONTROL COUNTER. A bomb release control counter on the bomb release interval control panel (36, figure 4-6) indicates the number of general purpose bombs to be released or not released. The counter is manually set to total bombs to be dropped.

BOMB RELEASE INTERVAL CONTROL GROUND SPEED AND SPACING DIAL. A ground speed and spacing dial on the bomb release interval control panel (36, figure 4-6) controls bomb interval timing. The dials are calibrated in ground speed mph and interval between bombs in feet.

BOMB RELEASE SWITCH. A push-button type bomb release switch (10, figure 4-6 and 5, figure 4-19), attached to a flexible cable, is stowed on the side of the bomb control panel. When the button is depressed with the bomb doors open, bombs as controlled by the intervalometer selector switch and/or the salvo control selector switch are released. General purpose bombs will be dropped tail-armed and nose-armed when the salvo selector switch is in NORMAL position and the nose fuse arming switch is in ARM position. With the salvo control selector switch in SALVO, the general purpose bombs will be dropped safe unless the nose fuse arming switch is in ARM position.

BOMB SALVO SWITCH. A SALVO-OFF bomb salvo switch (10, figure 4-19) is on the bomb control panel and a similar ON--OFF bomb salvo switch (2, figure 1-12) is on the pilot's ignition panel. Both switches are guarded and spring-loaded to the OFF position. When either switch is actuated to SALVO or ON position, control power is supplied directly from the battery to open the bomb doors and release the bomb load. Bombs will be dropped safe unless armed by the U-1 arming switch, U-2 arming knob, or nose fuse arming switch.

BOMB EMERGENCY RELEASE HANDLE. A pull handle (8, figure 4-6) on the observer's right sidewall just to the right of the emergency escape hatch provides a manual means for releasing the 10,000-pound bomb. When the handle is pulled, cables unlatch the bomb doors and release the 10,000-pound bomb.

BOMB BAY VACUUM PUMP SWITCHES. Stand-by and normal ON--OFF switches are on the forward bomb bay bulkhead dome light bracket. When either switch is placed in the ON position, power is supplied to a normal or alternate vacuum pump which supplies vacuum for a bomb bay vacuum system used with the 10,000-pound bomb.

BOMB SCORING TONE SWITCH. A bomb scoring tone switch (14, figure 4-19) mounted on the bomb control panel, provides for initiation and manual cutoff of a D/F tone from the VHF command radio. Placed in the INITIATE position, the amber TONE ON indicator light (12, figure 4-19) illuminates and the tone continues until the first intervalometer re-

lease impulse occurs, when the tone is automatically interrupted and the light goes out. The tone may be manually stopped after initiation by placing the switch in CUTOFF position. The switch is spring-loaded to OFF position from both INITIATE and CUTOFF positions.

BOMB SYSTEM INDICATORS.

BOMB RELEASE INTERVAL CONTROL INDICATOR LIGHT. An amber indicator light on the bomb release interval control panel (36, figure 4-6) illuminates whenever the instrument is set to pass single release impulses or timed impulses for train release of general purpose bombs.

BOMB INDICATOR LIGHTS. Sixteen amber bomb indicator lights (15, figure 4-6), one for each bomb position, are mounted to the right of the bomb control panel. Each light illuminated indicates a bomb in place on the bomb racks. When each bomb is released, its respective indicator light goes out. A bomb indicator card for each size of bomb is provided which, when placed in a holder mounted in front of the indicator lights, permits only the applicable lights for the respective bomb size to be visible.

The bomb indicator cards are stowed in a holder mounted on the left beam below the observer's emergency escape hatch.

NOTE

The indicator light for the U-2 rack cannot be relied upon for indication that a bomb is in place or has been released, since the bomb hook may assume an intermediate position other than fully open after the bomb has been released, thereby causing false indication. However, the indicator light will go out momentarily as the bomb is released.

U-1 (U-2) RACK LOCKED WARNING LIGHT. A red light (13, figure 4-19) on the bomb control panel, when illuminated, indicates that the rack for the 10,000 pound bomb is manually locked and must be unlocked manually in the bomb bay before the bomb can be dropped.

BOMB CONTROL POWER ON INDICATOR LIGHT. A green indicator light (7, figure 4-19) on the bomb control panel, when illuminated, indicates that power is supplied to the bomb door and bomb release control circuits and that sufficient main hydraulic system pressure is available for bomb door operation.

U-1 (U-2) ARMED INDICATOR LIGHT. An amber light (1, figure 4-19) on the bomb control panel, when illuminated, indicates that the nose fuses of the general purpose bombs are armed.

NOSE FUSE ARMED INDICATOR LIGHT. An amber light (16, figure 4-19) on the bomb control panel, when illuminated, indicates that the nose fuses of the general purpose bombs are armed.

BOMB RELEASE AIR PRESSURE GAGE. Pressure gages mounted in the bomb bay ceiling just aft of the forward bomb bay bulkhead indicate U-2 bomb rack release air pressure in psi.

U-1 (U-2) AIR PRESSURE LOW WARNING LIGHT. A red light (17, figure 4-19) on the bomb control panel, when illuminated, indicates that air pressure is insufficient for normal release of the 10,000-pound bomb.

BOMBS AWAY INDICATOR LIGHT. An amber light (4, figure 1-9) on the pilot's instrument panel will illuminate momentarily each time a bomb is released, except during salvo operation.

BOMB DOOR POSITION INDICATORS. A Type C-1 bomb door position indicator (6, figure 4-19) on the bomb control panel and a similar indicator (3, figure 1-9) on the pilot's instrument panel show positions of the bomb doors by means of interchangeable tabs which appear in the indicator window. When the bomb doors are closed and locked, a LOCK tab appears in the window; when the bomb doors are fully open, an OPEN tab appears; and when the doors are in any intermediate position, an alternately black and white striped tab appears.

NORMAL OPERATION OF BOMB DOORS.

Bomb doors are normally operated by door switches at the pilot's or observer's station, or by "K" system control.

a. To open the bomb doors, place the pilot's alternate bomb door switch in the OPEN position. The bomb door position indicators will show an intermediate tab while doors are opening and an OPEN tab when the doors are fully open.

b. To close the bomb doors, hold the pilot's alternate bomb door switch in the CLOSE position. The bomb door position indicators will show an intermediate tab while the doors are closing and will show a LOCK tab when the doors are fully closed and latched. When the LOCK tab appears, release the switch to the OFF position.

When the observer's station is occupied and sufficient main system hydraulic pressure is available, the bomb doors should be controlled by the normal bomb door switch.

a. Place the indicator lights and bomb control power switches in the ON position and check that the bomb control Power On indicator light illuminates.

b. Place the bomb door and release control switch in the MANUAL position.

c. To open bomb doors, actuate the normal bomb door switch to the OPEN position. The bomb door position indicator will show an intermediate tab while doors are opening and an OPEN tab when the doors are fully open.

d. To close the bomb doors, actuate the normal bomb door switch to the CLOSE position. The bomb door position indicator will show an intermediate tab while the doors are closing and a LOCK tab when the doors are fully closed and locked.

EMERGENCY OPERATION OF BOMB DOORS.

In the event the normal bomb door control circuit is inoperative, the observer may control the bomb doors with the alternate bomb door switch. Operation is identical with that for the pilot's alternate bomb door switch.

NOTE

The bomb salvo switches and the U-2 emergency bomb release provide additional means for emergency opening of the bomb doors. When either of these methods of bomb release are used, the alternate bomb door switch must be used to close the doors.

GUNNERY SYSTEM.

An A-5 tail turret is installed on the aft end of the airplane to provide defensive gunfire limited to an area aft of the airplane. The turret is controlled by gun-laying radar.

GUNNERY SYSTEM CONTROLS.

Controls for operation of the tail turret and gun-laying radar are located at the gunner's station aft of the copilot.

GUNNERY SYSTEM INDICATORS.

TURRET NOT STOWED LIGHT. A red light (3, figure 1-36) marked "Warning Turret Not Stowed" is located on the copilot's emergency landing gear control panel. When the light is illuminated, the turret is not in the stowed position.

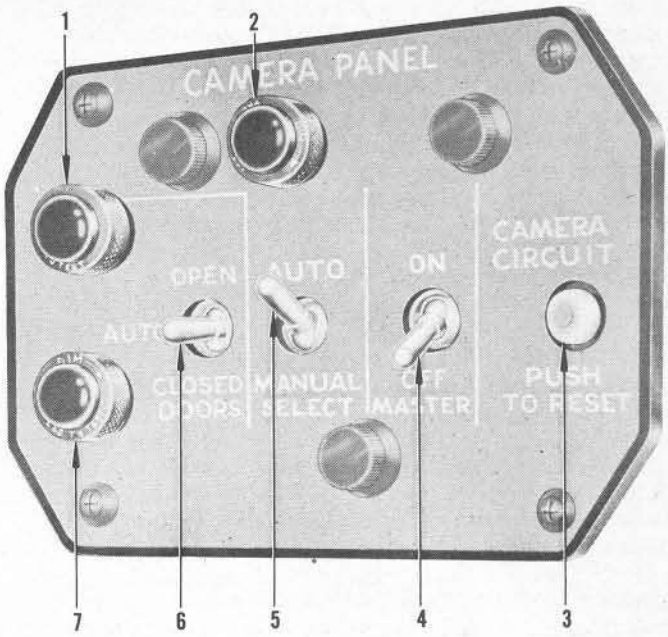
Indicators for operation of the turret and radar are located at the gunner's station aft of the copilot.

PHOTOGRAPHIC EQUIPMENT.

AERIAL CAMERA.

A type K-38 camera is installed in the bottom of the fuselage directly below the fin leading edge. In addition, provisions are made for the alternate mounting of a type K-17C or K-22A aerial camera. The camera may be used automatically in conjunction with the bombing system to record and determine the accuracy of the bomb drop or may be used independently for photo reconnaissance. Camera doors are provided which operate hydraulically through the camera door system (figure 4-21).

A camera control panel (14, figure 4-6) is on the observer's right sidewall. A remote initiation circuit, working in conjunction with the bomb release system, provides automatic strike camera operation. Automatic vacuum and heating systems are provided for the camera. Defrosting of the camera window is accomplished by ram air ducted from the fin leading edge. A camera control circuit breaker is on the radar power panel.



1 CAMERA DOOR OPEN POSITION LIGHT
2 CAMERA OPERATION INDICATOR LIGHT
3 CIRCUIT BREAKER
4 CAMERA MASTER SWITCH
5 CAMERA SELECTOR SWITCH
6 CAMERA DOOR SWITCH
7 CAMERA DOOR CLOSED POSITION LIGHT

Figure 4-20. Camera Control Panel

CAMERA MASTER SWITCH. An ON--OFF master switch (4, figure 4-20) is on the camera control panel. When the switch is in the ON position, power is supplied to energize the camera heating, camera control, camera door control, and the remote initiation circuits. When the switch is in the OFF position, these circuits are deenergized.

CAMERA DOOR SWITCH. An OPEN--AUTO--CLOSED switch (6, figure 4-20), spring-loaded to the AUTO position; is on the camera control panel. When the switch is in the AUTO position, opening of the camera doors is automatically controlled by a bomb door latch limit switch and the camera doors will open with the bomb doors. When the switch is actuated to the OPEN position, hydraulic pressure is supplied to open the camera doors. When the switch is actuated to the CLOSED position, hydraulic pressure is supplied to close the camera doors.

CAMERA SELECTOR SWITCH. An AUTO--MANUAL switch (5, figure 4-20), spring-loaded to the AUTO position, is on the camera control panel. When the switch is in the AUTO position, the camera is controlled through a camera intervalometer. When the switch is actuated to the MANUAL position, power is supplied directly to operate the camera at its runaway cycling rate.

CAMERA INTERVALOMETER. A Type B-8 camera intervalometer (13, figure 4-6) is installed above the

observer's table. The intervalometer provides a means of selecting the number of exposures to be taken and the interval between exposures. The intervalometer may be used independently or in conjunction with automatic operation by the bombing system. Controls of the intervalometer include a manual initiation switch, on-off switch, camera trip switch, exposure counter, exposure limiter dial, delay dial, and interval dial. The delay, exposure limiter, and interval dials are used to set up the type of camera operation desired.

CAMERA DOOR POSITION LIGHTS. An amber indicator light (1, figure 4-20) on the camera control panel, when illuminated, indicates that the camera doors are in the full open position. A red warning light (7, figure 4-20) on the same panel, when illuminated, indicates that the camera doors are in the full closed position. When the doors are anywhere between the open and closed positions, neither light is illuminated.

CAMERA OPERATION INDICATOR LIGHT. A green indicator light (2, figure 4-20) on the camera control panel, when illuminated, indicates that the camera is in operation.

NORMAL OPERATION OF AERIAL CAMERA. For operation independent of the bombing system, proceed as follows:

a. Place the camera master switch in the ON position.
b. Actuate the camera door switch to the OPEN position. The amber indicator light will illuminate when the doors open.
c. With the camera selector switch in the AUTO position, operate the camera through the intervalometer. The intervalometer delay, interval, and exposure limiter dials should be positioned to the type of operation desired. Place the on-off switch in ON. Camera operation is started by pressing the manual initiation switch. Camera operation may be stopped at any time by placing the on-off switch in OFF.
d. With the camera selector switch held in MANUAL position, the camera will operate at its run-away cycling rate. When using either position of the camera selector switch, camera operation is indicated by illumination of the green indicator lights.
e. To close the camera doors, hold camera door switch to the CLOSED position until red door closed indicator light illuminates.

For automatic camera operation through the bombing system, proceed as follows:

a. Place camera master switch in ON position.
b. Select the type of camera operation desired on the camera intervalometer. The intervalometer delay, interval, and exposure limiter dials should be positioned to the type of operation desired. Place the on-off switch in ON position.
c. Camera doors will open and the camera will operate automatically through the bombing system. The camera door position lights and the green operation indicator light will indicate opening of the camera doors and camera operation respectively.
d. To stop camera operation at any time, place the intervalometer on-off switch to OFF position.
e. The camera doors must be manually closed upon completion of photography by holding camera door switch in CLOSED position until red door closed indicator light illuminates.

EMERGENCY OPERATION OF AERIAL CAMERA. There are no emergency operating procedures for the aerial camera except that manual operation may be used in event of failure of automatic operation.

0-15 RADAR RECORDING CAMERA.

An 0-15 camera is provided to make photographic records of the luminous images appearing on the screen of the radar indicator. A filter assembly, visor adapter, and periscope adapter are attached on the indicator to accommodate the camera installation. The camera is operated by the observer and is protected by a 10-ampere DC circuit breaker on the radar power panel. Control of the system is provided by a remote exposure frequency control box above and to the left of the radar scope.

NORMAL OPERATION OF RADAR CAMERA. The recording camera is made operative and inoperative by the following procedure:

a. Adjust rheostat (PPI or sector scan) to the correct position for the type of radar operation desired.
b. Place the power switch in ON position.
c. To turn off the equipment, place the power switch in OFF position.

EMERGENCY OPERATION OF RADAR CAMERA. There are no emergency operating procedures for the 0-15 radar camera.

AERIAL REFUELING SYSTEM.

The airplane is equipped with an aerial refueling system to receive fuel from boom-equipped tanker airplanes. Sequence of the refueling operation is controlled automatically by an inductive-coupled electronic signal system. A receiver receptacle for the tanker boom nozzle is mounted in a slipway at the right side of the nose section. The slipway is normally closed by a flush door which, when open, forms an integral part of the slipway. When the boom nozzle is seated in the receptacle and held by the hydraulic actuated receptacle latching toggles, fuel is pumped from the tanker into the receiver refueling manifold. Rate of fuel flow is controlled by the tanker crew. In the receiver, fuel flows from the refueling manifold into the tanks as directed by refueling valves which are operated by switches on an aerial refueling panel at the copilot's station. When a tank is filled, a high level float switch automatically closes the tank refueling valve. When all refueling valves are closed, pressure builds up in the refueling manifold to cause an automatic disconnect. An automatic disconnect is also caused by the boom exceeding its envelope limits. A voluntary disconnect can be initiated by the pilot or copilot of the receiver airplane or by the tanker boom

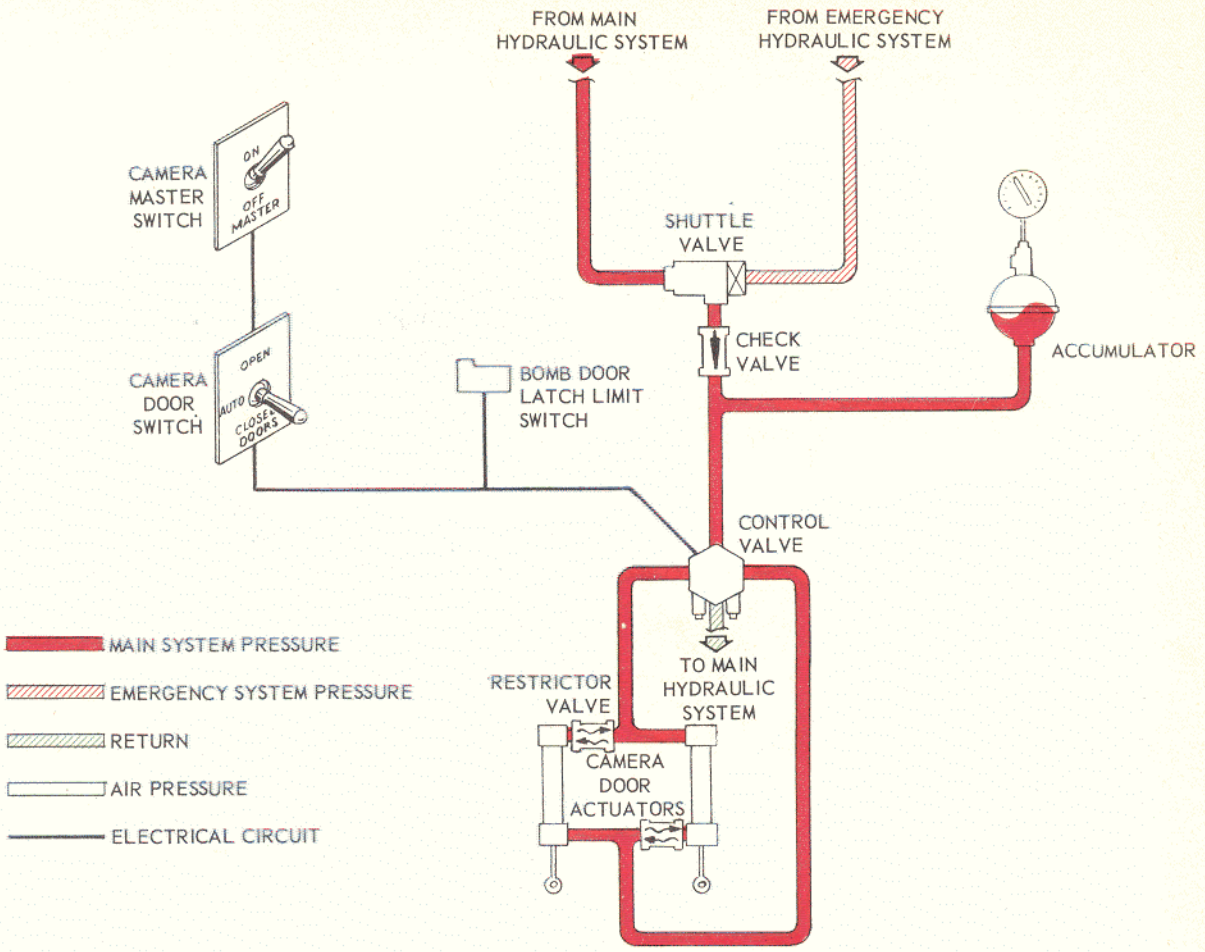


Figure 4-21. Camera Door System

operator. As a precaution against fire caused by a discharge of static electricity a static disconnect line remains attached to the boom until the boom has withdrawn approximately 3 feet at which point the line pulls loose and is automatically reeled into the receptacle. As the boom withdraws from the receptacle, the windshield wiper will operate at its maximum speed until the system is returned to "Ready for Contact" condition during normal operation or until the disconnect switches are released during emergency operation. The refueling manifold is also used for transfer of fuel from auxiliary to main tanks and for single point ground refueling. Circuit breakers for the aerial refueling system are located on the upper DC power panel.

NOTE

As the boom withdraws from the receptacle, CO_2 is automatically discharged into the slipway area. The CO_2 is a precaution against fire caused by a discharge of static electricity.

AERIAL REFUELING SYSTEM CONTROLS.

MASTER REFUEL SWITCH. The master refuel switch (6, figure 1-15) on the pilot's fuel control panel has REFUEL--NORMAL positions. For aerial refueling operations, this switch is placed in the REFUEL position to energize the refueling valve switches on the copilot's aerial refueling panel. NORMAL position of the switch permits transfer of fuel from auxiliary and bomb bay tanks to the main tanks by means of switches on the pilot's fuel control panel.

FUEL GAGE CONTROL SWITCH. A fuel gage control switch (5, figure 1-15) on the pilot's fuel control panel has COPILOT--PILOT positions. This switch, when placed in the COPILOT position, will deenergize the main and bomb bay fuel quantity gages on the pilot's fuel control panel and energize the main and bomb bay tank fuel quantity gages on the copilot's aerial refueling panel (figure 4-22) and supply power to the copilot's aerial refueling panel lights, thus permitting the copilot to read fuel quantity during aerial refueling operations or to compute fuel consumption during cruise at any time. The fuel gage control switch, when placed in the PILOT position, deenergizes the fuel quantity gages and panel lights. Fuel quantity for the main and bomb bay fuel tank is then read from the pilot's fuel control panel.

AERIAL REFUELING SYSTEM SELECTOR SWITCH. A system selector switch (12, figure 1-29), on the

forward left side of the copilot's control stand, has NORMAL IFR SYSTEM--OFF--EMERGENCY BOOM LATCHING positions. The switch controls the electronic signal system and the actuation of the holding toggles which latch the boom in the receptacle. NORMAL IFR SYSTEM position of the switch energizes the electronic signal system which automatically controls operation of the latching toggles. EMERGENCY BOOM LATCHING position deenergizes the electronic signal system and directly controls the actuation of the latching toggles. OFF position of the switch deenergizes the electronic signal system and latching toggle circuits.

AERIAL REFUELING VALVE LEVER. A lever (11, figure 1-19) with OPEN--CLOSED positions is provided at the copilot's station to open or close mechanically a shut-off valve in the refueling manifold leading to the boom receptacle. When the lever is in the OPEN position, the shut-off valve is opened. When the lever is in the CLOSED position, the valve is closed to isolate the section of the refueling manifold in the pressurized compartment from the rest of the fuel system, and this section of the manifold is then automatically drained and purged.

REFUELING VALVE SWITCHES. Shut-off valves in the refueling manifold leading to the main and auxiliary fuel tanks are controlled by eight OPEN--VALVE CLOSED switches (3, figure 4-22) on the aerial refueling panel. When a switch is placed in OPEN, the refueling valves for the corresponding tank will open. The valve is closed by placing the switch in the VALVE CLOSED position. A high-level float switch in each tank overrides the refueling valve switch and automatically closes the corresponding refueling valve when the tank becomes full.

FIRE EXTINGUISHER SELECTOR SWITCH. A rotary-type selector switch (9, figure 4-22) on the aerial refueling panel provides individual selection of four CO_2 bottles to be discharged into the slipway area. The switch has OFF--1--2--3--4 positions; a bottle is selected by placing the switch in the appropriate position. When the switch is in the OFF position, no CO_2 will be discharged.

EMERGENCY FIRE EXTINGUISHER SWITCH. CO_2 can be discharged into the slipway area at any time by positioning an emergency fire extinguisher switch to EMERGENCY ON. This switch (11, figure 4-22) on the aerial refueling panel has EMERGENCY ON--EMERG EXTING NORMAL positions and is spring-loaded to the EMERG EXTING NORMAL position. When the switch is in EMERG EXTING NORMAL, CO_2 is automatically discharged at the time the boom disconnects, if the fire extinguisher selector switch is positioned to a charged bottle.

RETURN TO READY FOR CONTACT SWITCH. A push-button switch (6, figure 4-22) on the aerial refueling panel, when depressed, resets the automatic control circuit after a disconnect has been accomplished; the aerial refueling system is then ready for another contact.

SLIPWAY DOOR SWITCH. A slipway door switch (7, figure 4-22) on the aerial refueling panel has SLIPWAY DOOR OPEN--CLOSED positions. When the switch is placed in SLIPWAY DOOR OPEN position hydraulic system pressure will unlock and open the slipway door. Placing the switch in CLOSED position will close and lock the door and also reset the electronic signal system to ready the aerial refueling system for another contact.

AERIAL REFUELING BOOM RELEASE SWITCHES. The boom can be disconnected at any time by pressing a push-button switch (2, figure 4-8) marked "IFR Boom Auto-Pilot Release" on the pilot's or copilot's control wheels. This switch when actuated will cause a disconnect even though the aerial refueling system selector switch is in the EMERGENCY BOOM LATCHING position.

FUEL QUANTITY GAGE TEST SWITCHES. Four push-button switches (4, figure 4-22) marked "Test" are adjacent to the main and bomb bay fuel quantity gages on the aerial refueling panel. The switches are provided to test the circuit continuity of the fuel quantity gages. When a switch is pressed, the gage needle will rotate toward empty.

AERIAL REFUELING EMERGENCY DOOR HANDLE. A red and white handle (24, figure 4-6) under the observer's table provides emergency manual operation of the slipway door hydraulic control valve. The handle has OPEN--OFF--CLOSE positions. The slipway door is opened or closed by pulling the handle and turning it to OPEN or CLOSE. The handle is normally left in OFF position to permit opening or closing of the slipway door by actuating of the slipway door switch (7, figure 4-22) on the aerial refueling panel.

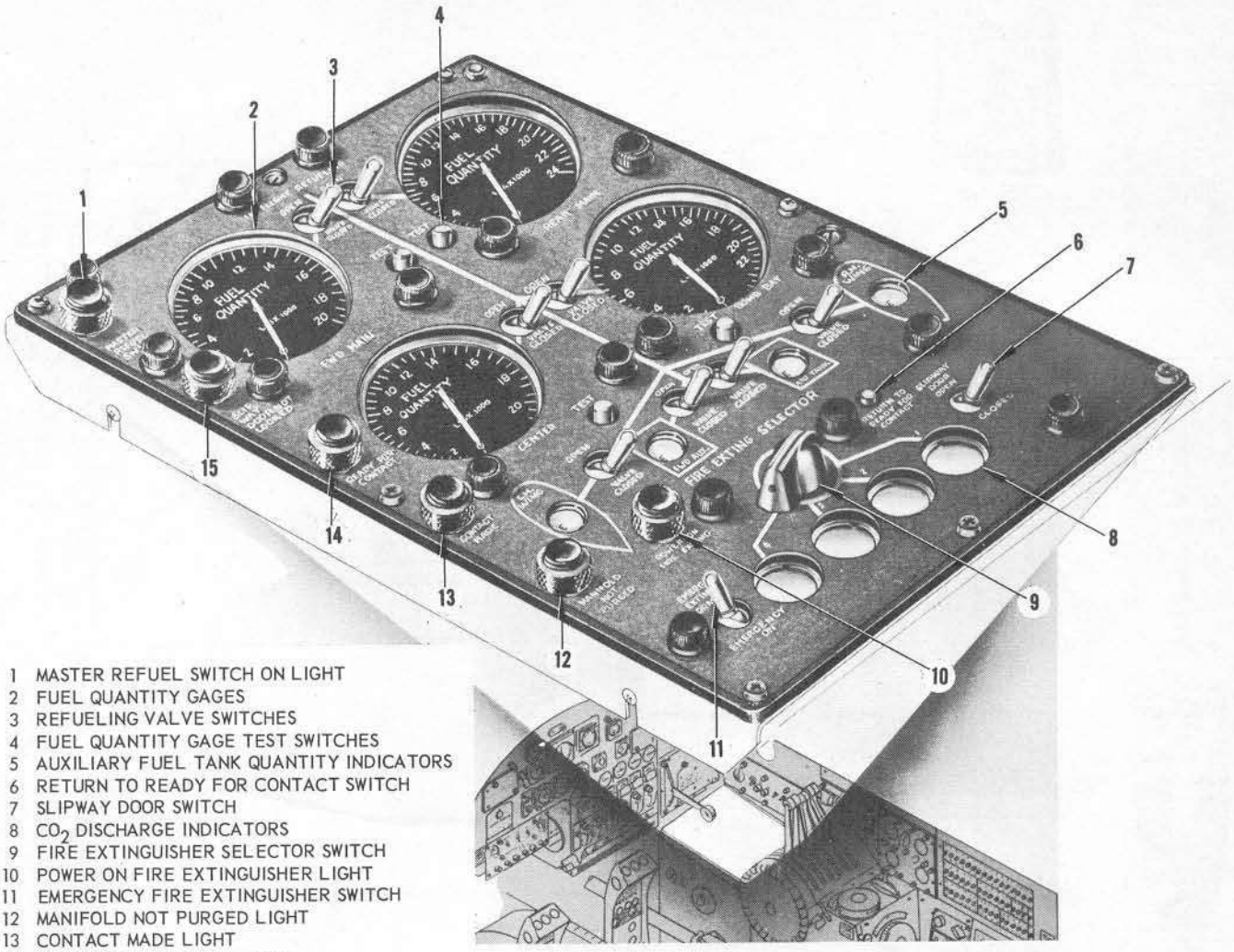
AERIAL REFUELING SYSTEM INDICATORS.

FUEL QUANTITY GAGES. Conventional fuel quantity gages (2, figure 4-22) for the forward main, center main, rear main, and bomb bay tanks are on the aerial refueling panel. Fuel quantity is indicated in pounds.

Four tab-window-type indicators (5, figure 4-22) on the aerial refueling panel show by interchangeable tabs the condition of fuel quantity in the ATO tank, forward auxiliary tank, and wing tanks. A full tank is indicated by an F tab, an empty tank by an E tab, and all intermediate quantities by a divided black and white circle tab.

CO_2 DISCHARGE INDICATORS. Four yellow discs (8, figure 4-22) on the aerial refueling panel provide an indication of CO_2 discharge from each of the four CO_2 bottles provided for slipway fire extinguishing. A discharged bottle will be indicated by an ejected or torn disc.

Four red discs on the right side of the airplane fuselage aft of the radome provide an indication of thermal discharge of CO_2 from each of the four CO_2 bottles provided for slipway fire extinguishing. A discharged bottle will be indicated by an ejected or torn disc.



1 MASTER REFUEL SWITCH ON LIGHT
2 FUEL QUANTITY GAGES
3 REFUELING VALVE SWITCHES
4 FUEL QUANTITY GAGE TEST SWITCHES
5 AUXILIARY FUEL TANK QUANTITY INDICATORS
6 RETURN TO READY FOR CONTACT SWITCH
7 SLIPWAY DOOR SWITCH
8 CO_2 DISCHARGE INDICATORS
9 FIRE EXTINGUISHER SELECTOR SWITCH
10 POWER ON FIRE EXTINGUISHER LIGHT
11 EMERGENCY FIRE EXTINGUISHER SWITCH
12 MANIFOLD NOT PURGED LIGHT
13 CONTACT MADE LIGHT
14 READY FOR CONTACT LIGHT
15 SLIPWAY DOOR NOT LOCKED LIGHT

Figure 4-22. Aerial Refueling Panel

MASTER REFUEL SWITCH ON LIGHT. A green light marked "Master Refuel Sw On" (1, figure 4-22) on the aerial refueling panel, illuminates when the aerial refueling panel controls are energized by placing the master refuel switch in REFUEL position.

SLIPWAY DOOR NOT LOCKED LIGHT. An amber light marked "Slipway Door Not Locked" (15, figure 4-22) on the aerial refueling panel illuminates when the slipway door is not closed and locked.

READY FOR CONTACT LIGHTS. An amber light marked "Ready for Contact" (14, figure 4-22) on the aerial refueling panel illuminates when the slipway door is fully open and the automatic electrical circuits are armed. When contact is made, the light will go out.

A green "Ready for Contact" light (20, figure 1-9) on the pilot's instrument panel illuminates when the slipway door is fully open and the automatic electrical circuits are armed. When contact is made, the light will go out.

CONTACT MADE LIGHT. A green light marked "Contact Made" (13, figure 4-22) on the aerial refueling panel illuminates when the boom is seated in the refueling receptacle.

MANIFOLD NOT PURGED LIGHT. An amber light marked "Manifold Not Purged" (12, figure 4-22) on the aerial refueling panel will illuminate whenever the refueling manifold is not automatically drained and purged of fuel, or if the aerial refueling valve lever (11, figure 1-19) is placed in the OPEN position.

POWER ON FIRE EXTINGUISHER LIGHT. An amber light marked "Power On Fire Exting" (10, figure 4-22) on the aerial refueling panel is illuminated whenever electrical power is being supplied to discharge a CO_2 bottle. The light will illuminate during a refueling disconnect, or whenever the emergency fire extinguisher switch (11, figure 4-22) is placed in EMERGENCY ON position.

NORMAL OPERATION.

For operation of the aerial refueling system, refer to section VII.

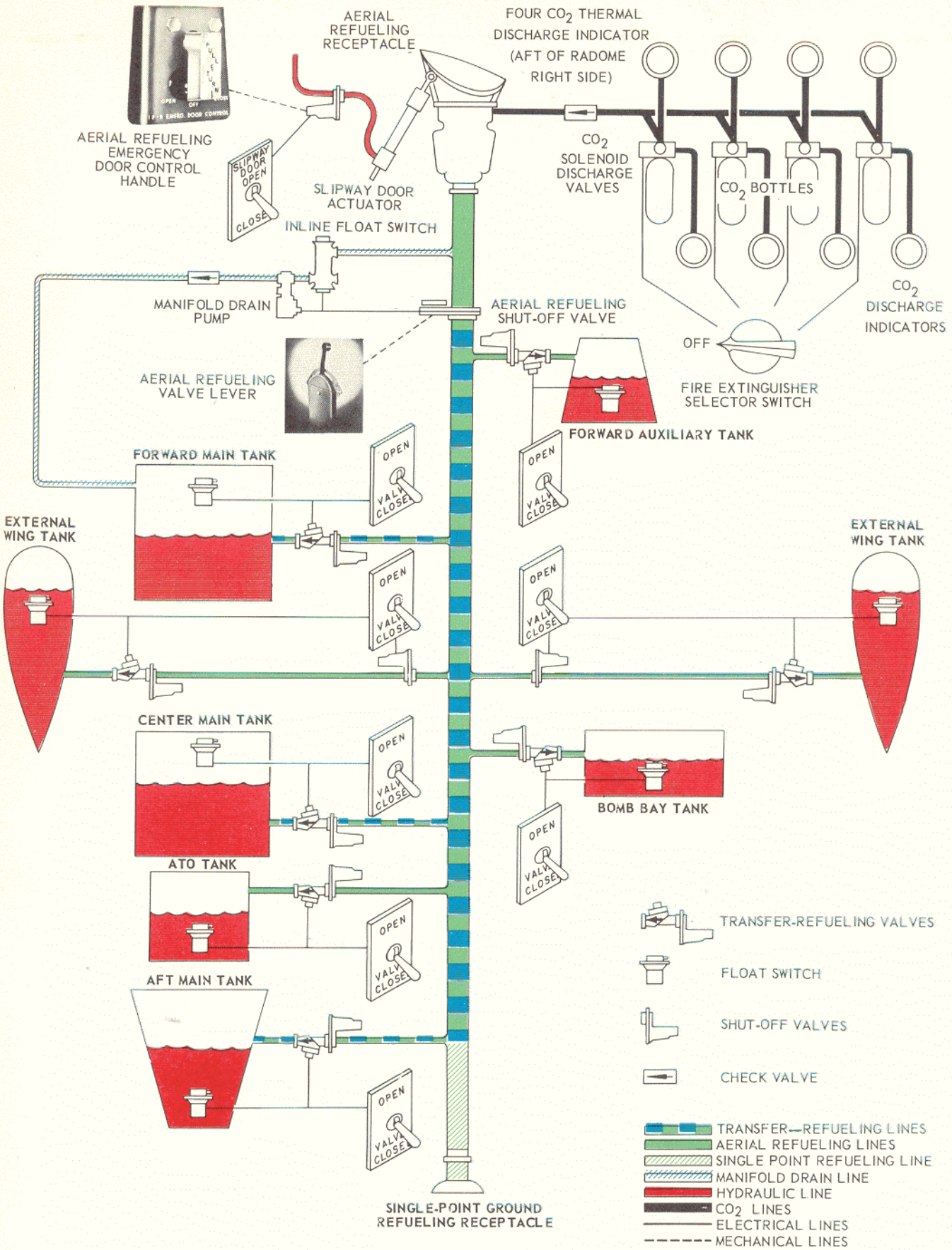


Figure 4-23. Aerial Refueling System

MISCELLANEOUS EQUIPMENT.

FLIGHT REPORT HOLDERS.

Combination flight report holders and map cases are mounted on the left sidewall opposite the pilot's and copilot's stations.

AIRPLANE CHECK LIST.

A check list is mounted on the left canopy guard at the pilot's station (7, figure 1-4) and on the right canopy guard at the copilot's station (8, figure 1-4).

PILOT'S DATA DRAWER.

A data drawer for the pilot (6, figure 4-7) is installed immediately below the left side of the pilot's instrument panel.

COPILOT'S DATA CASE.

A data case for the copilot is installed behind the copilot's seat.

ASH TRAYS.

Ash trays are mounted on the aft side of the control column for the pilot's and copilot's stations, on the observer's work table, and on the gunner's baffle.

RELIEF EQUIPMENT.

A relief tube (4, figure 1-4) for the crew is provided in the walkway at the left of the pilot's seat. Relief containers (8, figure 1-21; 21, figure 4-6; 8, figure 4-7) are installed at the pilot's station, just aft of the copilot's seat, and at the observer's station on the left inboard leg of the observer's work table.

DRINKING CONTAINERS.

Thermos bottles and a drinking cup dispenser (7, figure 1-20) are installed in the walkway directly aft of the observer's seat.

FOOD WARMING CUP.

A food warming cup (19, figure 1-8) for warming food in flight is installed on the left sidewall just aft of the observer's seat. A timer is provided for its control and an amber light indicates when it is operating. The timer and light are mounted on the warming cup supporting bracket. A 25-ampere circuit breaker on the lower DC power panel protects the equipment.

ENTRANCE LADDER.

An extension-type jettisonable ladder (29, figure 1-4) is installed inside the main entrance door to facilitate entry into the airplane.

COVERS.

Canopy, fuselage nose, pitot tube, and engine nacelle covers are stowed in the flyaway tool kit.

MOORING PROVISIONS.

Demountable mooring eyes for providing a tie-down point on the lower surface of each wing are stowed on the left-hand side of the bomb bay. A combination towing and tie-down ring is provided on the aft main gear.

TOOLS.

A flyaway tool box containing flyaway tools and equipment is installed in the bomb bay. Hand tools and a carrying case are installed on the bomb bay platform. Special bomb handling tools are installed on the forward bulkhead of the bomb bay.

BLACKOUT CURTAIN.

A curtain is installed immediately aft of the observer's station to prevent nose compartment lighting from interfering with pilot vision. Additional curtains are provided for the observer's windows and astropane.

CANOPY SUN CURTAINS.

Roller-type sun curtains units (6, figure 1-4), each containing a left and right curtain, are installed on the inside of the canopy above the pilot's and copilot's seats. Each curtain may be pulled out to a fully extended or intermediate position and secured to hooks on the canopy. The units may be removed intact by pulling back a spring-loaded knob on the forward underside of each unit and allowing that end to drop down. Storage provisions for the sun curtain units are on the left sidewall of the pilot's station above the spare amplifier rack.

WINDSHIELD WIPER.

The pilot's main windshield is provided with an electrically driven windshield wiper. The windshield wiper is normally operated by using a rheostat switch (19, figure 1-13) on the side of the pilot's control stand. The START--FAST to SLOW--OFF--PARK positions of the rheostat switch combination provide normal control of the wiper. To operate the wiper, place the switch in the START position, then adjust the switch to the desired windshield wiper operating speed. When wiper operation is no longer desired, place the rheostat switch in the PARK position and hold this position until the wiper stops with the blade "parked" at the extreme right side of the main windshield panel. PARK position of the switch is a momentary position and when released from park position the switch will return to off position. The windshield wiper is also operated automatically by the aerial refueling system at the time of aerial refueling disconnect. When the aerial refueling selector switch is in NORMAL IFR system position, the windshield wiper will operate at maximum speed whenever the aerial refueling system is in the "Disconnect" condition. When the aerial refueling system selector switch is placed in OFF, the slipway door switch placed in CLOSED, or the "Return to Ready for Contact" switch is depressed, the windshield wiper

will stop and may be parked by holding rheostat switch in PARK position. When the aerial refueling selector switch is in the EMERGENCY BOOM LATCHING position, the windshield wiper will operate at maximum speed as long as the pilot or copilot depresses the aerial refueling boom release switch on his control wheel.

CAUTION

Do not operate windshield wiper on dry or dirty glass as this can scratch or damage the windshield glass.

REAR VIEW MIRRORS.

Three rear-view-type mirrors are installed; one located on the left-hand side of the forward canopy frame, another on the left-hand side of the pressurized compartment in the vicinity of the main entry door, and a third on the aft end of the canopy jettison guide forward of the copilot's instrument panel. The pilot's mirror and the bulkhead mirror allow a visual check between pilot and copilot, while the copilot's mirror affords visual reference aft.

SECTION V

OPERATING LIMITATIONS

GENERAL.

As with all mechanical instruments, this airplane possesses certain well-defined limitations which must be observed if safety and efficiency are to be attained. Its high performance features compel a more rigid adherence to these limitations than would normally be required, for they mean that normal operations will approach these limiting factors more closely than in most airplanes. This is true of the engines and some of the auxiliary equipment, as well as of the airplane itself. It is therefore important that you study this section carefully to familiarize yourself with these limitations as shown herein by illustrations and explanatory text. The knowledge thus gained will result in more proficient operation of the airplane.

MINIMUM CREW REQUIREMENTS.

The minimum crew requirements for this airplane are a pilot and copilot. Additional crew members as required will be added at the discretion of the Commanding Officer.

ENGINE LIMITATIONS.

Engine overspeed operation exceeding 104% of rated rpm, either with or without overtemperature, requires that the engine be removed from the airplane and returned to overhaul. All cases of overspeed operation shall be entered in Form 1.

OPERATING LIMITATIONS.

Maximum Take-off (5 min)	100% (± 1%) rpm
Military Rating (30 min)	98% rpm

CAUTION

Throttles should be advanced cautiously to avoid compressor stall.

The operating limits are identical for either the recommended or alternate fuel grades.

AIRSPEED LIMITATIONS.

See figure 5-1 for limits other than those listed below.

a. LANDING GEAR
Maximum IAS for raising landing gear - 215 knots.
Maximum IAS with landing gear extended - 305 knots.
Maximum IAS for extending landing gear - 305 knots.
Maximum IAS for extending landing gear with emergency landing gear extension system - 200 knots.

b. WING FLAPS
Maximum IAS for 50% flaps - 230 knots.

c. EXTERNAL WING TANKS
The following limitations are applicable when jettisoning the external wing tanks:
Minimum IAS - 155 knots
Maximum IAS - 300 knots
Empty Tank - Flaps up only
Full Tank - Flaps up or down

d. BOMB DOORS
Maximum IAS for bomb doors open (no spoilers) - 217 knots.
Maximum IAS for bomb doors open and spoilers extended - 310 knots.

Above 20,000 feet, bomb door operation at speeds up to the design limit of the airplane is acceptable. Bomb door service life will be materially shortened by operation in the higher speed ranges below 20,000 feet.

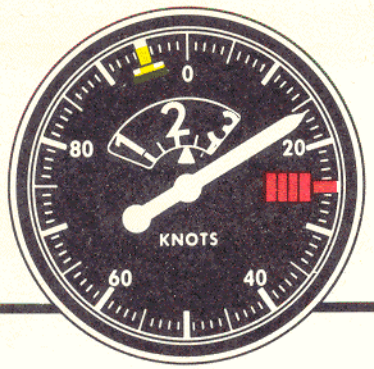
e. CANOPY
Canopy must not be opened during flight except to improve safety of operating the airplane. If it is deemed necessary to open the canopy in flight, the airspeed must not exceed 215 knots IAS, also, refer to section III, "Canopy Emergency Operation During Flight."

f. BRAKE CHUTE
Deploy brake chute only after touchdown and at speeds not to exceed 115 knots (125 knots in an emergency) to prevent brake chute failure.

g. AUTOMATIC PILOT
During operation of automatic pilot at speeds above 310 knots IAS or Mach 0.7, at altitudes below 34,000 feet, the pilot should be prepared to take over immediate control of the airplane in the event of automatic pilot malfunction

h. SURFACE POWER CONTROL
Sudden failure of surface power control may cause loss of control at a speed in excess of either of the following shown for indicating altitude:

ALTITUDE	IAS KNOTS	MACH
0	425	.64
20,000	425	.76
30,000	350	.76
34,000	280	.81
Above 34,000	Initial High Speed Buffet	



AIRSPEED INDICATOR

195 Knots FULL FLAPS

425 Knots MAXIMUM

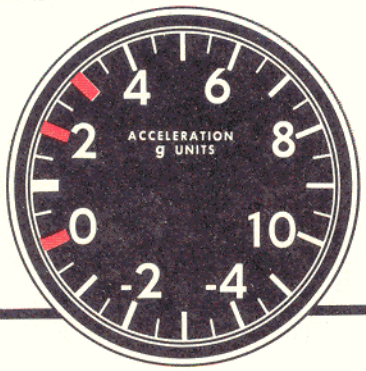
AIRSPEED INDICATOR

195 Knots FULL FLAPS

The instrument setting is such that the red pointer will move to indicate the limiting airspeed of 425 knots or the airspeed representing the limiting Mach No. of .76, whichever is less.

NOTE

.76 Mach is limiting Mach number only below 20,000 feet altitude.

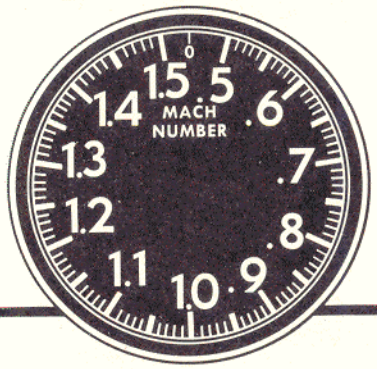


ACCELEROMETER

0g MINIMUM

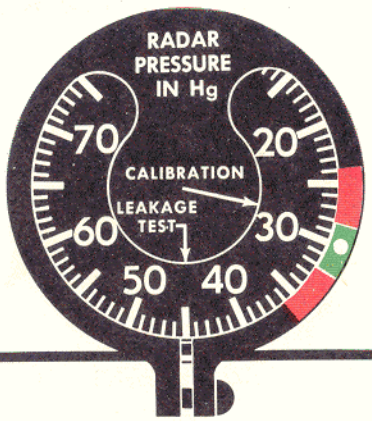
2g MAXIMUM AT MAXIMUM GROSS WEIGHT

3g MAXIMUM AT DESIGN GROSS WEIGHT



MACHMETER

No limit markings. See text for instructions.



RADAR PRESSURE

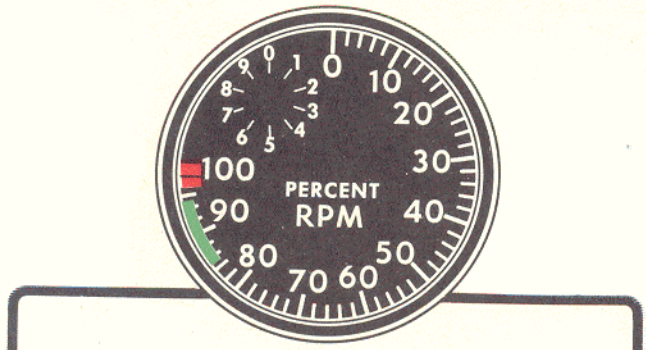
24 to 28 in. hg MARGINAL OPERATION

28 to 32 in. hg CONTINUOUS OPERATION

32 to 36 in. hg MARGINAL OPERATION

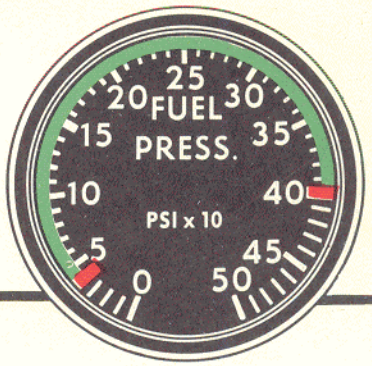
The above values assume sea level calibration of the system. Actual values will vary with the operating field elevation.

Figure 5-1. Instrument Markings (Sheet 1 of 3)



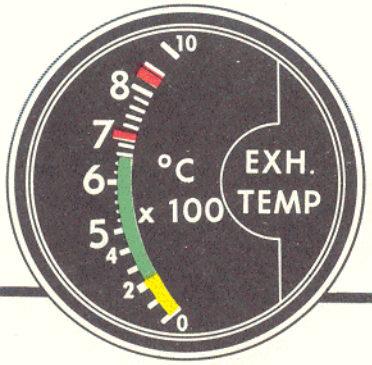
TACHOMETER

	85% to 95%	BEST CRUISING
	98% rpm	MILITARY RATING — 30 MINUTES
	100% rpm	MAXIMUM TAKE-OFF — 5 MINUTES



FUEL PRESSURE

	40 PSI	MINIMUM FOR FLIGHT
	40 to 400 PSI	CONTINUOUS OPERATION
	400 PSI	MAXIMUM FOR FLIGHT



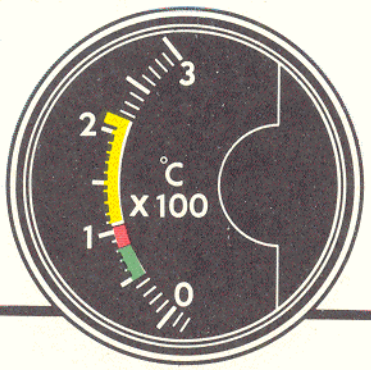
EXHAUST GAS TEMPERATURE

	0° C TO 200 C	OPERATION AT LOW POWER SETTINGS
	200° C TO 655° C	CONTINUOUS OPERATION
	690° C	MAXIMUM FOR FLIGHT
	870° C	MAXIMUM DURING STARTING AND ACCELERATION ONLY

APPLICABLE TO ANY GRADE OF FUEL

OIL PRESSURE

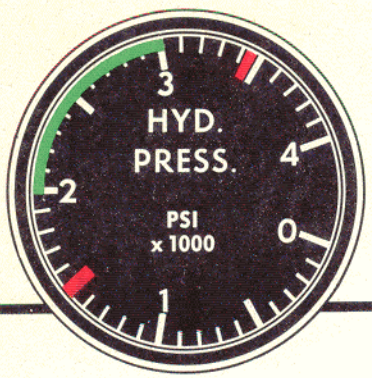
	2 TO 8 PSI	OPERATION BELOW 88% RPM
	8 PSI	MINIMUM FOR CONTINUOUS OPERATION ABOVE 88% RPM
	8 TO 18 PSI	CONTINUOUS OPERATION
	18 TO 22 PSI	OPERATION AT 100% RPM
	22 PSI	MAXIMUM FOR 100% RPM



ANTI-ICING AIR TEMPERATURE

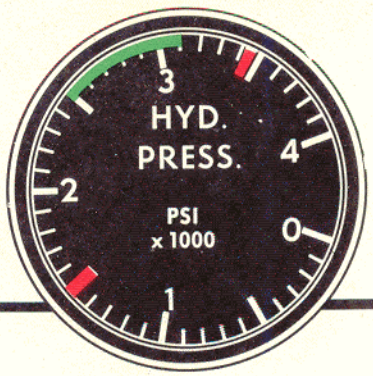
	50° C TO 80° C	NORMAL GROUND OPERATION
	80° C TO 105° C	MAXIMUM GROUND OPERATION
	105° C TO 216° C	SAFE OPERATING RANGE FOR MANUAL OPERATION IN FLIGHT
	216° C	MAXIMUM FOR MANUAL OPERATION IN FLIGHT

Figure 5-1. Instrument Markings (Sheet 2 of 3)



WARNING

PRESSURES BELOW 1500 PSI ARE ACCUMULATOR AIR PRE-LOAD PRESSURE; BELOW 1500 PSI, THE SYSTEM PRESSURE WILL BE ZERO.

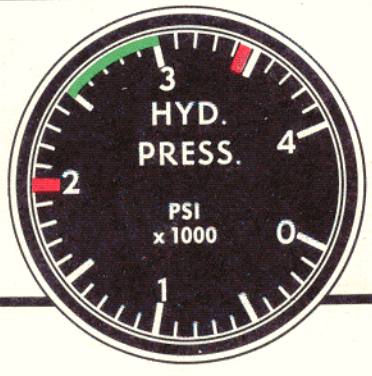


MAIN BRAKE SYSTEM HYDRAULIC PRESSURE

	1500 PSI	MINIMUM
	2000 to 3000 PSI	NORMAL
	3450 PSI	MAXIMUM

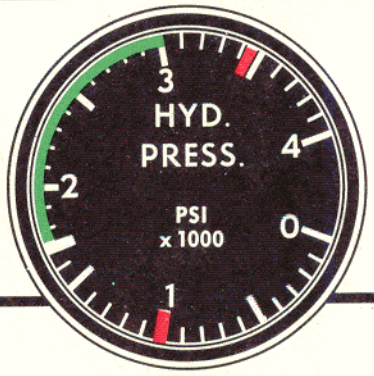
EMERGENCY SYSTEM HYDRAULIC PRESSURE

	1500 PSI	MINIMUM
	2500 to 3100 PSI	NORMAL
	3450 PSI	MAXIMUM



WARNING

PRESSURES BELOW 1000 PSI ARE ACCUMULATOR AIR PRE-LOAD PRESSURE; BELOW 1000 PSI, THE EMERGENCY BRAKE SYSTEM HYDRAULIC PRESSURE WILL BE ZERO.

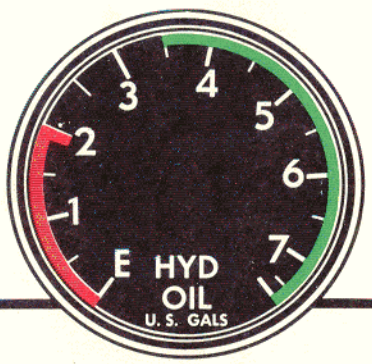


MAIN SYSTEM HYDRAULIC PRESSURE

	2000 PSI	MINIMUM
	2500 to 3000 PSI	NORMAL
	3450 PSI	MAXIMUM

EMERGENCY BRAKE SYSTEM HYDRAULIC PRESSURE

	1000 PSI	MINIMUM
	1700 PSI	ONE BRAKE APPLICATION REMAINING
	1700 to 3000 PSI	NORMAL
	3450 PSI	MAXIMUM



HYDRAULIC OIL QUANTITY

	0 to 2 Gals.	MINIMUM FOR FLIGHT
	3.5 to 7.6 Gals.	NORMAL OPERATION

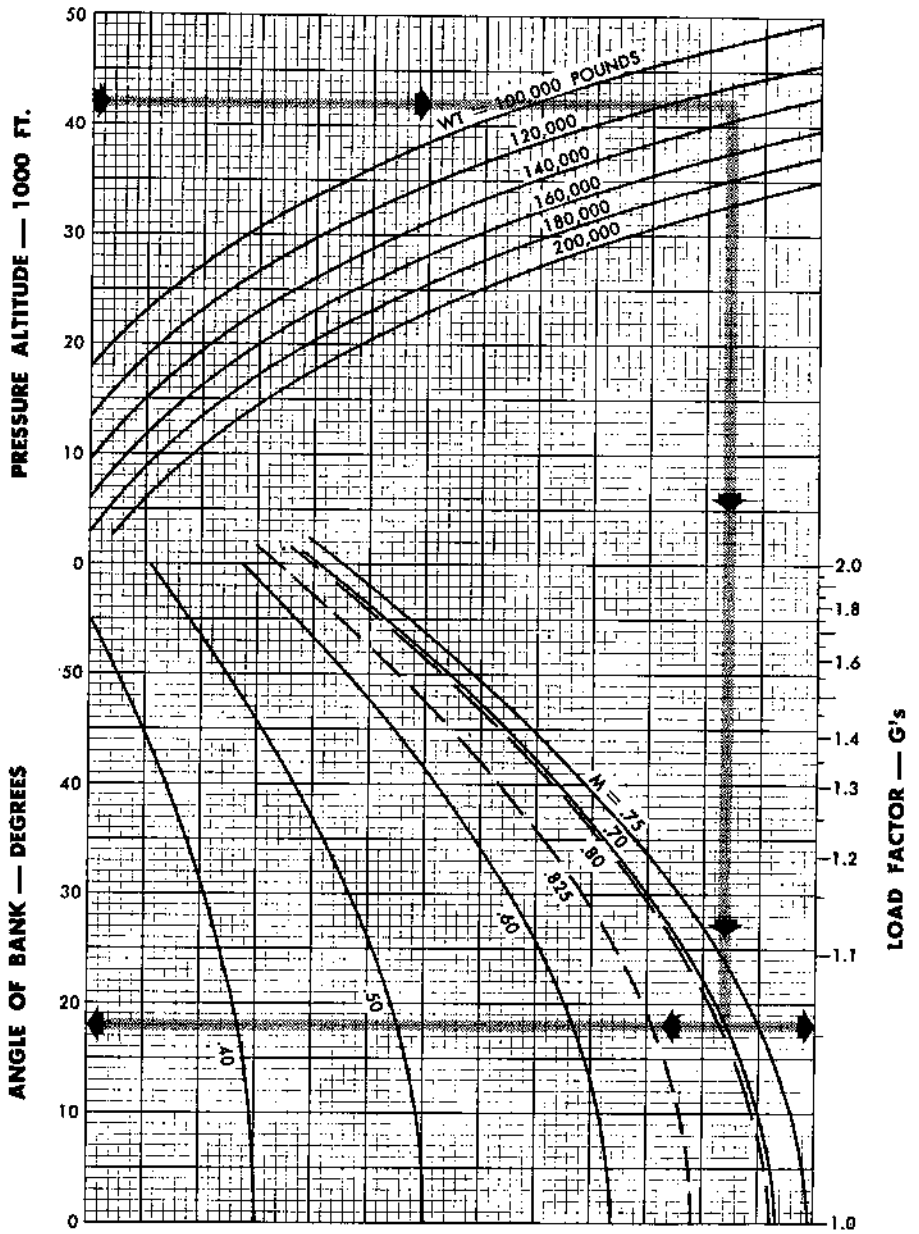
Figure 5-1. Instrument Markings (Sheet 3 of 3)

BANK ANGLE LIMITS FOR INITIAL BUFFETING

EXAMPLE:

When flying at 42,000 feet altitude at a gross weight of 130,000 pounds and at .70 Mach number, at what angle of bank and "g" load will initial buffeting be encountered?

Following through the chart as illustrated, we find that the angle of bank for initial buffet is 18° at a load factor of approximately 1.06 "g's."



CONDITIONS:
VORTEX GENERATORS INSTALLED

REMARKS:

DATE:
OCTOBER 1952

DATA BASIS:
FLIGHT TEST

Figure 5-2.

ELEVATOR POWER CONTROL FAILURE LIMITATION

FLIGHT RESTRICTED ABOVE 425 KNOTS IAS UP TO 10,000 FT. OR M.76 FROM 10,000 FT. TO 20,000 FT. OR M.81 FROM 20,000 FT TO 34,000 FT. OR INITIAL BUFFET ABOVE 34,000 FT. WHICHEVER OCCURS FIRST

REGION OF HIGH SPEED COMPRESSIBILITY BUFFET

FLIGHT PROHIBITED ABOVE LATERAL CONTROL AND FLUTTER LIMIT OF 425 KNOTS IAS

FLIGHT PROHIBITED ABOVE DESIGN STRUCTURAL LIMIT

CONDITIONS: VORTEX GENERATORS INSTALLED
DATE: OCTOBER 1952
DATA BASIS: FLIGHT TEST

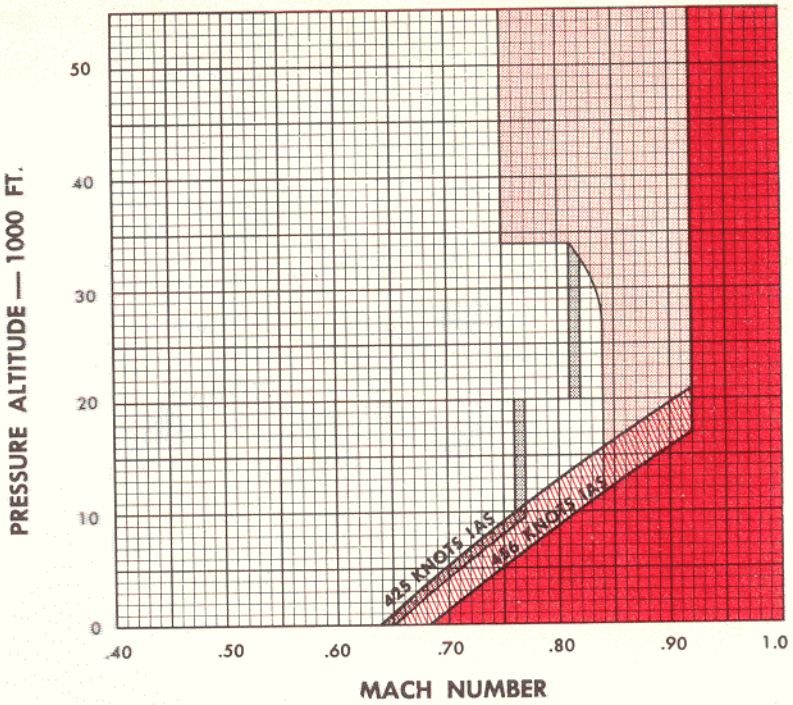


Figure 5-3. Maximum Speed Restrictions

i. FLUTTER LIMITATION
The flutter limitation speed is as follows: Maximum speed 425 knots IAS with gross weight over 140,000 pounds.

j. AILERON REVERSAL
Aileron reversal speed limitation - maximum speed 425 knots IAS under 10,000 feet.

k. MAXIMUM SPEED
The maximum speed is 425 knots or Mach .76, whichever is lower, up to 20,000 feet altitude. Between 20,000 and 34,000 feet altitude, the limit is a maximum of Mach .81. Above 34,000 feet altitude, the limit is the point of initial buffet.

PROHIBITED MANEUVERS.

Acrobatics of any kind are strictly prohibited, including intentional spins, excessively nose high stalls, flight into the stall buffet region, and steep dives, as well as any other maneuver resulting in abrupt accelerations. In case a spin is entered accidentally, use normal recovery procedure to regain normal flight. Normal stalls and very shallow dives will be discussed in section VI.

ACCELERATION LIMITATIONS.

During all high speed operations, abrupt accelerations must be avoided. Operation at high Mach numbers and high altitudes is essential for utilizing the performance advantages of this airplane. However, this will result in flying close to the buffeting limits. It is more likely that buffeting and pitch-up will be encountered while maneuvering the airplane at high altitude than in straight and level flight. The normal acceleration should be limited to that at which buffeting is first felt. The Mach number at which buf-

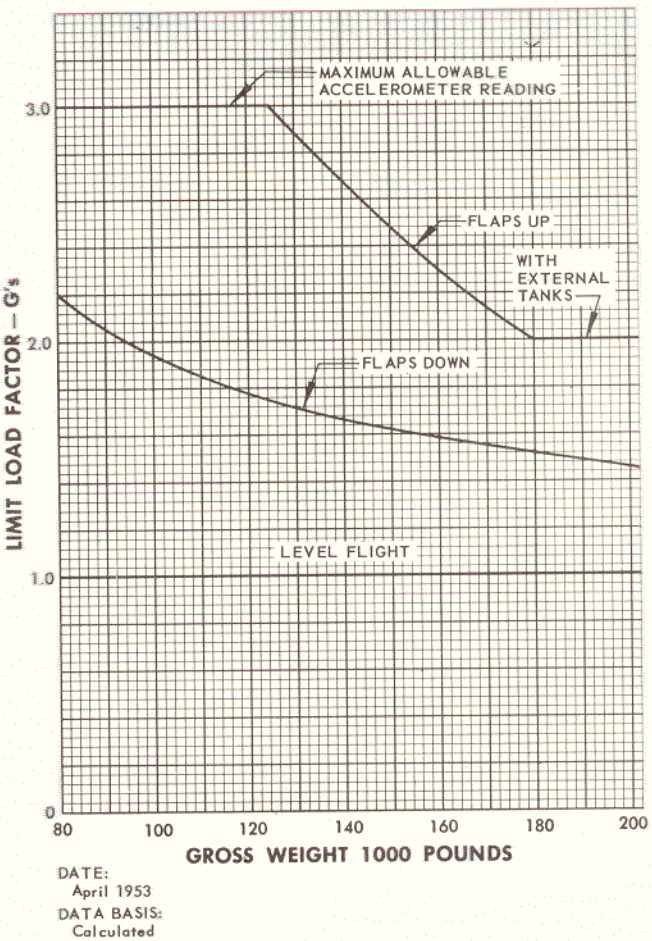


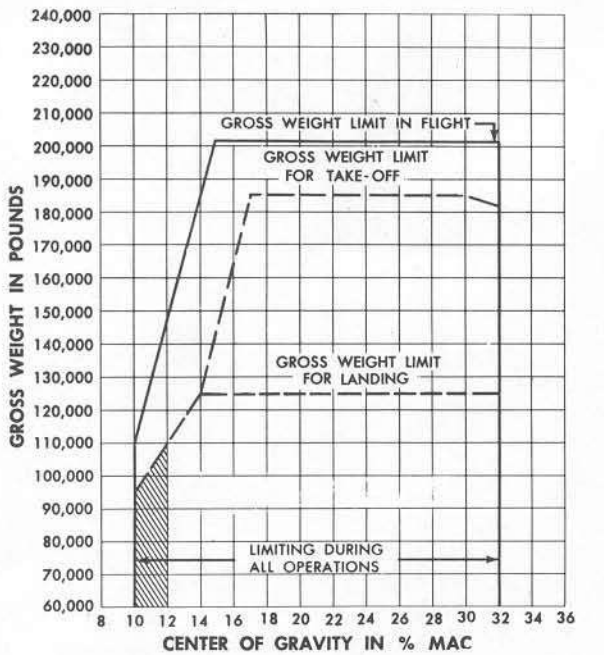
Figure 5-4. Structural Limitations

feting and pitch-up begins will vary with altitude and gross weight. A plot of the bank angle limits for initial buffeting is shown in figure 5-2. The time lag involved in establishing flow separation from the wing often enables a higher number of "g's" to be pulled in a quick pull-up than in a steady maneuver.

CAUTION

Any maneuver that will impose a negative acceleration on the airplane may result in fuel spillage from the center and aft fuel tank vents into the aft fuselage compartments. A negative acceleration may also cause a partial loss of rudder-elevator surface power control due to hydraulic pump cavitation. Because of the potentional hazards involved, any maneuvers involving negative acceleration should be avoided.

Refer to the chart in figure 5-4 for a plot of the limitation imposed on the maneuvering "g's" by the structural design of the airplane.



CONDITIONS:

DATE: OCTOBER 1951

DATA BASIS: CALCULATED

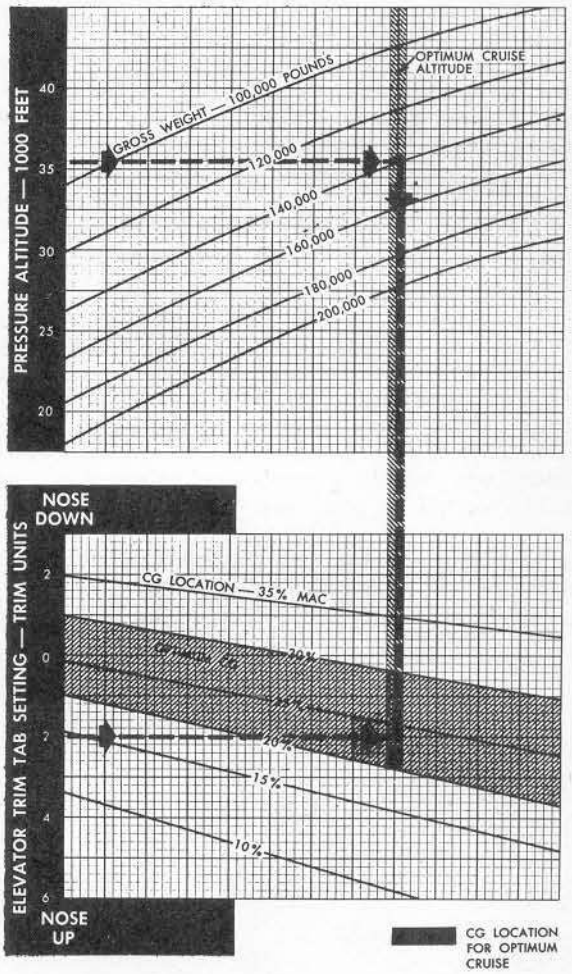
LEGEND

FLIGHT

TAKE-OFF & LANDING

LANDINGS WITH SURFACE POWER CONTROL INOPERATIVE CANNOT BE MADE WITH CONSISTENCY WITH C.G. FORWARD OF 12% M.A.C. FLAPS AND GEAR DOWN.

Figure 5-5. Center of Gravity Limits



SAMPLE:

When flying at optimum cruise altitude of 35,500 at a gross weight of 140,000 pounds at Mach .74 and 2 units nose up elevator trim, what is the center of gravity location?

Enter the chart at 35,500 and move to 140,000 pounds, drop vertically and intersect the elevator trim tab line. The point of intersection shows a cg of approximately 24% MAC which is within the area of optimum cruise.

Figure 5-6. C. G. Location at Mach .74

CENTER OF GRAVITY LIMITATIONS.

While in flight, special attention must be given to maintaining the proper cg on this airplane during fuel transfer operations, as the aft limit is imposed by stability requirements near the stall or high-speed buffeting range. The forward limit is imposed by landing requirements. The cg is usually near the aft limit at take-off and it moves forward during flight. If the total fuel required is greater than the total capacity of the main tanks, consult the "Weight and Balance Data" handbook, AN 01-1B-40, for chart on loading procedure. For fuel transfer from auxiliary to main tanks during flight, refer to section VII. The chart in figure 5-5 shows the permissible range of cg positions in flight and during take-off and landing.

During high altitude cruise at .74 Mach number, the cg in flight can be determined approximately by use of the elevator trim control indicator. The chart in figure 5-6 can be used to find the cg position by this method, or the correct elevator trim control indicator reading can be obtained for any desired cg. For minimum drag and maximum range, it is desirable that the trim be kept between 1/2 and 2 1/2 units nose-up.

WEIGHT LIMITATIONS.

The design landing gross weight is 125,000 pounds. At this weight, the airplane is designed for sinking speeds considerably in excess of those associated with a "normal" landing. (Sinking speeds up to approximately 9.5 feet per second should cause no difficulties whereas the average sinking speed in a normal landing will be less than 4 feet per second.)

The maximum allowable sinking speed reduces for increasing landing weights. Accordingly, landings at weights in excess of 125,000 pounds should not be considered for routine operation. However, even at a landing weight of 180,000 pounds, the airplane is structurally adequate for a sinking speed in excess of 6 feet per second which is sufficiently above the average sinking speed of 4 feet per second in a normal landing to make landings at high gross weights a good risk in emergencies as compared to continued flight under emergency conditions merely to decrease weight prior to landing.

The maximum gross weight for take-off is 185,000 pounds with cg travel limits of 17 to 30% MAC. Maximum gross weight for take-off is lowered to 182,600 pounds with cg travel limits of 17 to 32% MAC. See figure 5-5.

The maximum in-flight gross weight is 202,000 pounds. This gross weight may be attained in flight by aerial refueling.

SECTION VI

FLIGHT CHARACTERISTICS

GENERAL.

The airplane was designed as a high performance jet bomber having the best possible flight characteristics for a good operational airplane. Special emphasis was placed on safety features and aircraft handling qualities in the air and on the ground. Innovations such as thin-swept surfaces and the bicycle landing gear make high performance possible with no appreciable sacrifice in flying qualities. Only through complete familiarity with the airplane can full advantage of its high performance and special features be gained.

STALLS

CHARACTERISTICS

The stall characteristics of the airplane are very satisfactory and are preceded by ample stall warning, starting with a mild vibration about 10 knots above the stall and increasing to strong buffeting at the stall. (See figure 6-1.) At normal "cg's" there is no tendency to pitch until buffeting is very strong, then the airplane will pitch downward and sink at a high rate. Recovery is normal. At aft "cg's," a slight tendency to pitch up will be noticed just as the buffeting becomes strong. However, there is sufficient elevator control to prevent a severe pitch-up. Pitching tendencies are similar for both flaps up or down. The ailerons are effective throughout the stall but rolling may occur if corrective action is not prompt.

CAUTION

Complete stalls should not be conducted because severe buffeting may damage the airplane.

Flight test experience has shown that stall warning will never be encountered during a normal takeoff or landing. However, it should be kept in mind that the speed margin above first stall warning, during approach at speeds as specified for B-47, will be considerably less than with many earlier types of airplanes. Therefore, large scale corrective maneuvering should be avoided during the final stages of an approach, as excessive altitude loss will result if stall is induced at that time. IAS at which stalling is encountered increases very rapidly above bank angles of 25 to 35 degrees. Figure 6-2 clearly shows the tendency of the stall curves as the angle of bank is increased. Also the load factor in "g's" for various angles of bank during coordinated turns or pull-ups are given. The flaps down structural limit represents the maximum angle of bank at the various gross weights which will not exceed the flaps down structural limitation.

PRACTICE STALLS

No difficulty will be encountered in the execution of practice stalls provided the following procedure is observed:

CAUTION

- Practice stalls should not be conducted in an airplane having components of the bombing, navigation, and computing system installed because of possible damage to equipment from vibration.
- Practice stalls with gross weights in excess of 125,000 pounds should not be conducted.
- Practice stalls with flaps up should be terminated after mild buffeting is encountered to prevent airplane damage from severe buffeting.

a. As a safety measure, an altitude of 15,000 feet or more should be used.

b. Use the minimum obtainable rpm (for the stall altitude) and the minimum rate of approach to the stall (approximately 1 knot per second). This procedure will result in a nose-high attitude of approximately 10°. Abrupt entry or excessive nose-high attitudes will result in severe buffeting. Stall warning is adequate and will occur 8 to 12 knots prior to the complete stall depending on the approach rate (figure 6-1).

c. Recovery from stalls is normal. However, the loss in altitude at high weights will be great.

d. Stalls out of turns can be executed without the occurrence of abnormal rolling moments, provided the turn is well coordinated. Stalls out of uncoordinated turns will result in increased rolling moments although sufficient lateral control is available for recovery.

SPINS.

Intentional spins are prohibited. In case a spin is entered accidentally, use normal recovery procedure to regain normal flight.

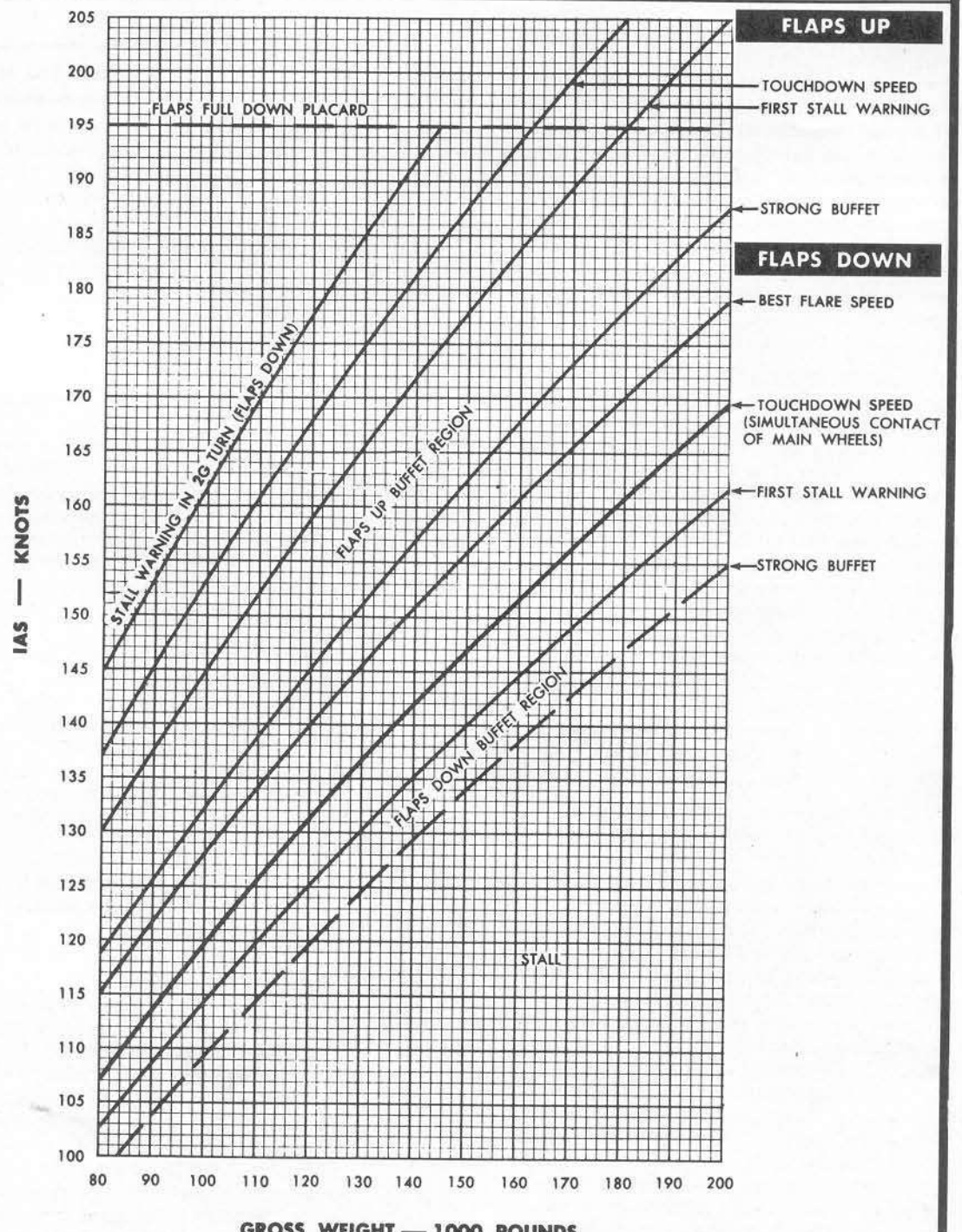
FLIGHT CONTROLS.

The design of the control system and surfaces, while generally similar to that on past large airplanes, incorporates a number of new features intended to give the best possible flying characteristics. No special techniques are required in the air. The pilot should understand the normal operation with powered controls and the emergency operation with direct cable-operated controls. Powered controls are used on all three movable surfaces to give light forces and high maneuverability. Control power-off results in high forces but is acceptable for emergency operation, the surfaces then being operated directly by the pilot.

ELEVATORS.

Elevator control forces are sufficiently light with surface power control operative so the pilot does not become fatigued in maneuvers and long turns, but heavy enough to prevent inadvertently imposing ex-

MINIMUM SPEEDS



CONDITIONS: SEA LEVEL TO 10,000 FT

DATE: DECEMBER 1952

DATA BASIS: FLIGHT TEST

REMARKS: APPROACH SPEEDS CORRECTED FOR GROUND EFFECT

Figure 6-1.

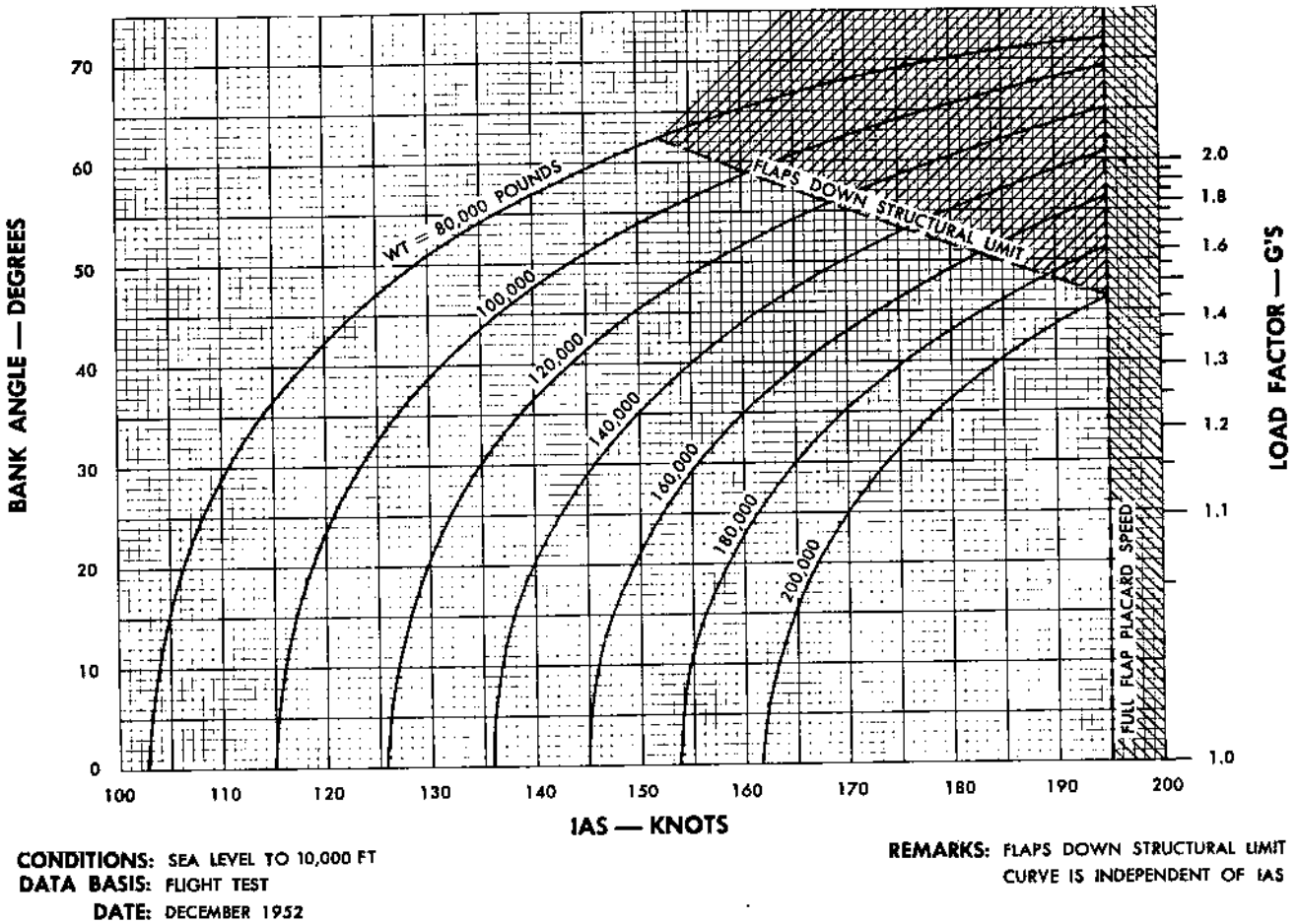


Figure 6-2. Accelerated Stalling Speeds (Flaps Down)

cessive structural loads. It is impossible to make the elevator control forces heavy enough to prevent structural damage and yet light enough for normal maneuvering and landings with a forward cg. Therefore, in rapid maneuvers, refer to the accelerometer.

Providing the proper trim coordination technique has been accomplished, the resulting forces caused by loss of the rudder-elevator surface power control will be controllable by the pilot. With the flaps up, the forces imposed upon the pilot vary widely depending upon airplane gross weight and center of gravity, altitude, indicated airspeed, and Mach number. At high speed, loss of elevator-rudder power control will result in a strong pitch-up tendency. With the flaps down, the forces are relatively light and vary little over the normal approach speed range. Flight characteristics with the surface power control off are described in section III.

AILERONS.

Aileron control forces with surface power control operative are very light with only a small centering action. This is to increase maneuverability and ease of flying. The ailerons are structurally capable of withstanding loads at the design high speed, since maximum aileron power control unit force is designed to protect the aileron structure. As a result, full aileron deflection will not be available at high indicated airspeeds. The ailerons are very effective at high altitude and also at moderate to low indicated speeds. Due to wing flexibility, aileron effectiveness decreases rapidly as the indicated airspeed is increased above approximately 400 knots IAS. Full available aileron deflection produces maximum roll rates at approximately 280 knots IAS. The available rate of roll diminishes to approximately 10° per second at 400 knots IAS, and approximately 5° per second at 425 knots IAS. The rate of roll diminishes to zero at speeds in excess of 425 knots IAS. The most effective method of increasing lateral control in an emergency is to reduce speed by reducing power. At low speeds very positive additional lateral control is provided by the flaperons when the flaps are fully extended. The loss of one aileron surface power control will result in rolling tendencies which are controllable throughout the speed range of the airplane. The magnitude of the wheel force varies depending on altitude, indicated airspeed, Mach number, and airplane gross weight. Generally at low indicated airspeed, the loss of one aileron power control causes the corresponding wing to drop. At high indicated airspeeds, a similar loss will cause that wing to rise. The largest amount of mistrim occurs with the flaps down at approach speeds. The flight characteristics with the aileron surface power control off are described in section III.

RUDDER.

Rudder control forces are moderate and are intended to protect the airplane structure from excessive yaw. The rudder is sufficiently powerful to counteract unsymmetrical power from a dead outboard engine with maximum rpm on all other engines and at all airspeeds down to the take-off and approach speeds. Very little if any mistrim results when the rudder surface power controls fail.

Small rudder deflections rather than large aileron deflections should be used at high indicated airspeeds to trim the airplane laterally level since the rudder is very effective as a lateral trim device. Attention should be directed to make sure zero yaw has been attained with the rudder because very slight yaw angles produce lateral mistrim that can require large aileron deflections. Abrupt deflections of the rudder control should be avoided. Flight characteristics with the rudder surface power control off are discussed in Section III.

TRIM TABS.

Trim tabs are provided on the control surfaces to facilitate trimming the airplane during flight with the surface power control system off. In addition, all trim tabs are linked to their respective control surface in such a manner as to move opposite to the direction of rotation of the control surface. This materially aids in the movement of the control surface by reducing the surface hinge moment.

Lateral trim is obtained through operation of a conventional trim tab in each aileron, while minor directional controls for yaw conditions is accomplished by a rudder trim tab. The elevator contains two trim tabs. The right trim tab is operated by the pilot or copilot for normal elevator trim and by the automatic pilot during automatic pilot operation. The left tab operates automatically and mechanically with the extension or retraction of the wing flaps to partially compensate for pitching tendencies during flap operation.

With surface power control on, trim tab surfaces have no effect on control surfaces due to surface power control system hydraulic pressure. Trim is accomplished by positioning the trim controls which reposition centering springs and Q-springs, moving the entire control surface to accomplish the trim.

The ailerons, rudder and elevator are each balanced by internal balance seals. These balance seals are designed in such a manner that movement of a primary surface from the trail position will result in differential pressures acting about the hinge line to aid the pilot in movement of that control surface. Thus, with surface power control off, the airplane may be controlled sufficiently at moderate airspeeds to execute required maneuvers.

Trimming is done through the pilots conventional trim wheels for both control power-on and power-off trim. Failure of power may result in the airplane being out of trim. Check your airplane frequently to make sure that the trim forces are not excessive when the power is turned off. Initial checks should be made during flight at low speeds to prevent the trim forces from being too high. If large forces are experienced, an adjustment should be made.

a. The trim tab at each flight control surface can be positioned by means of an actuator driven by a DC motor operated by one of four momentary switches on the trim tab coordination switch panel (8, figure 1-7).

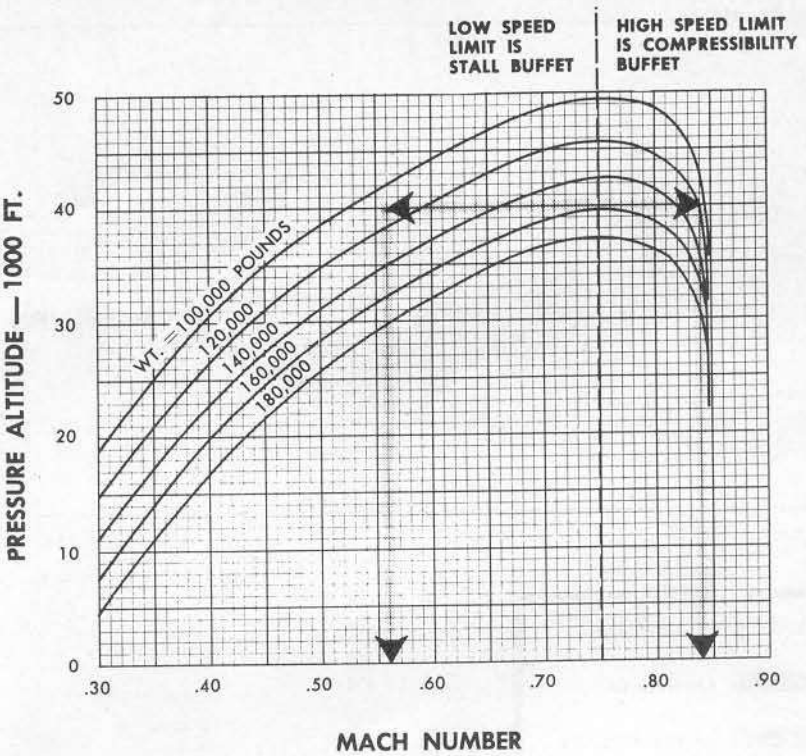
b. On the first flight after repairs or adjustments have been made to the flight control system, a trim coordination procedure must be accomplished to establish a coordination between the position of the trim tab and the neutral position of the corresponding centering springs (for ailerons) and Q-springs (for rudder and elevator).

CONTROL SURFACES BALANCE SYSTEM.

The control surfaces on this airplane are designed with an internal balance system contained within the contour of the airfoil to which the individual surface is attached. The aft section of the airfoil (wing, vertical and horizontal stabilizers) contains an open cavity, or bay. Each bay is divided into an upper and lower chamber by a balance panel which extends forward from the control surface hinge line. These chambers are sealed from each other completely by a fabric seal between the forward edge of the balance panel and the aft face of the airfoil spar. Small openings into each chamber are provided at the upper and lower aft edge of the airfoil, just forward of the control surface hinge line.

When the control surface is in a trail position, the pressure of the air entering the chambers will be equal, and hence no force will be present on the balance panel. When the control surface is deflected by the pilot, however, the pressures within the two chambers become unbalanced. For instance, deflecting the elevator down increases camber which increases velocity over the upper surface, resulting in lower surface pressures. Since the upper part of the balance cavity is vented to the upper surface at the hinge line, the pressure in the upper cavity drops, creating a pressure differential across the balance panel. Reference to figure 6-4 will show, then, how this differential in balance bay pressures acts on the balance panel to reduce the control surface hinge moment. This system compensates for approximately 80% of the normal air load on the control surfaces, the remaining 20% being overcome by the pilot during normal maneuvering. During normal flight maneuvers, the pilot is further aided by the balance action of the surface control trim tab.

The balance bays described in the above paragraph are applicable to all primary control surfaces. In addition, pitch stability of the airplane is aided by a "stability" bay in each horizontal stabilizer. These stability bays differ from the balance bays chiefly in that they are sealed at the aft edges. However, an opening at the upper and lower side of the horizontal stabilizer leading edge transmits pressure which is



DATE:
OCTOBER 1952
DATA BASIS:
FLIGHT TEST
CONDITIONS:
VORTEX GENERATORS INSTALLED

Figure 6-3. Buffet Boundary in Level Flight

ducted to the upper and lower stability bay chambers, respectively. When a gust or normal maneuvering changes the angle of attack of the airplane, a corresponding change of aerodynamic pressure will occur at the top and bottom of the leading edge. When this pressure differential is ducted into the upper and lower chamber of the stability bay, it acts on the balance panel in such a direction as to return the airplane to its trim angle of attack condition once it has been disturbed either by gust or maneuver.

A careful consideration of the principles involved in this control surface balance system will reveal the underlying causes for the condition known as "aileron overbalance." When buffeting occurs at high Mach number flight or at high angles of attack, separation of the airflow over the wing in the vicinity of the openings into the upper chamber of the balance bay creates an unbalanced pressure across the aileron balance cavities. It is therefore possible, when such a condition prevails for the ailerons to move abruptly to a new position. This aileron overbalance will not occur, however, with surface power control on and may be avoided if the recommended flight procedures for surface power control off are followed.

CAUTION

When extended operation in geographical areas where extreme low temperatures prevail (below -40° F), stiff control surface movement with surface power control off will be experienced. This is due to the type of material used in the aerodynamic balance seals and caution should be exercised when operating the aircraft. Take-off should not be attempted until elevator balance seals have been warmed. Caution should be taken during landing as a temporary loss of "stick feel" may result because of "Q" spring stiffness caused by the low temperatures.

ACROBATICS.

WARNING

Acrobatics of any kind are strictly prohibited.

BUFFETING

The speed and maneuverability of the airplane at high altitude is limited by separation of airflow over the wing. This separation occurs irregularly causing the airplane to buffet. This effect is expressed as the "buffet boundary" and is shown in figure 6-3. Smooth stabilized flight can be conducted in the area below the curve but, as the airplane approaches the buffet boundary, it is more likely that buffeting will be encountered because of gusts or slight airplane accelerations caused by maneuvering. Flight above the applicable curve would be in buffeting. The two types of buffeting encountered at high altitudes are 1) low speed stall buffeting and 2) high Mach number buffeting. The low speed stall occurs on the curve to the left of the apex of the curve, whereas high Mach number buffeting occurs to the right of the apex of the curve.

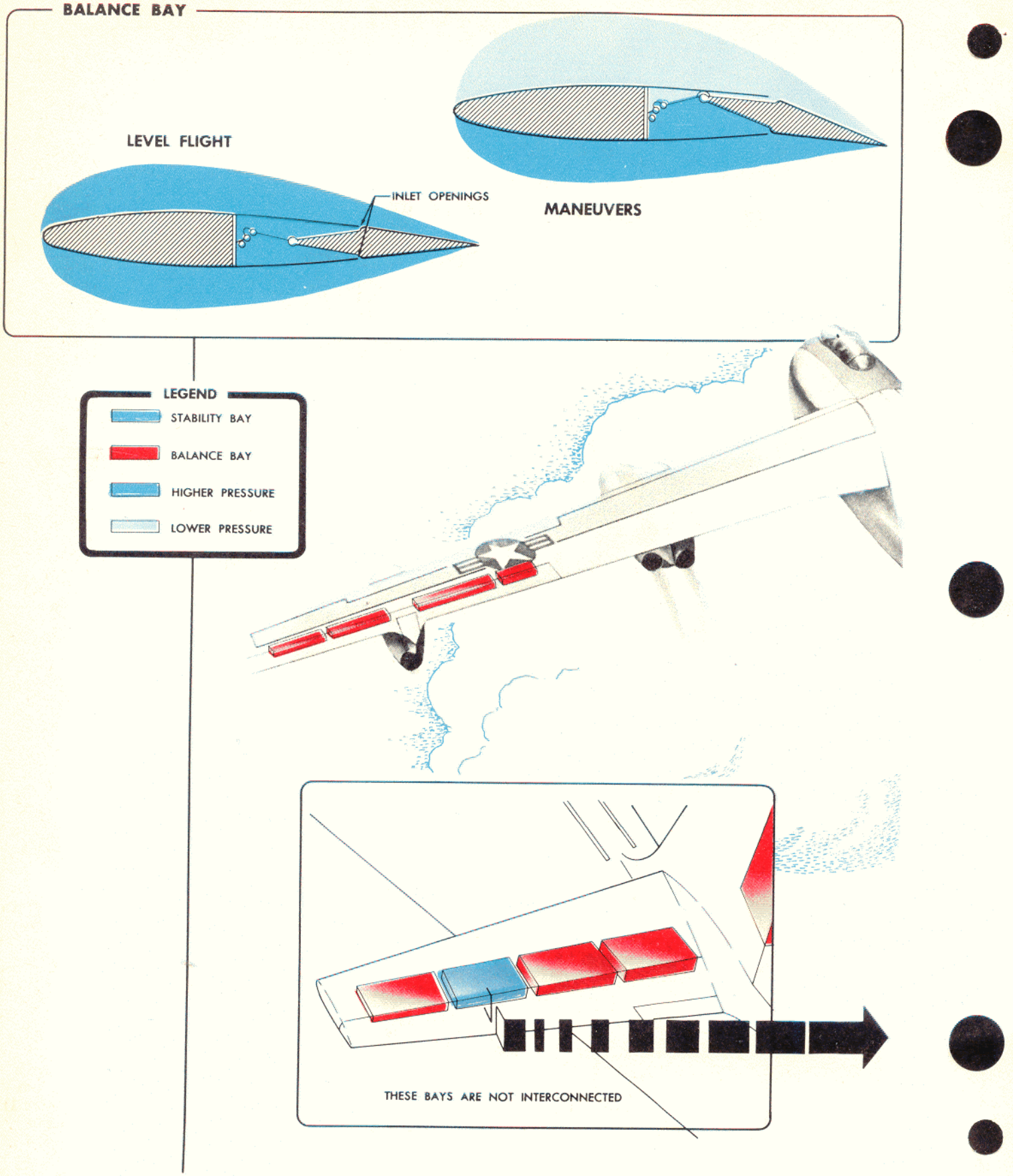


Figure 6-4. (Sheet 1 of 2)

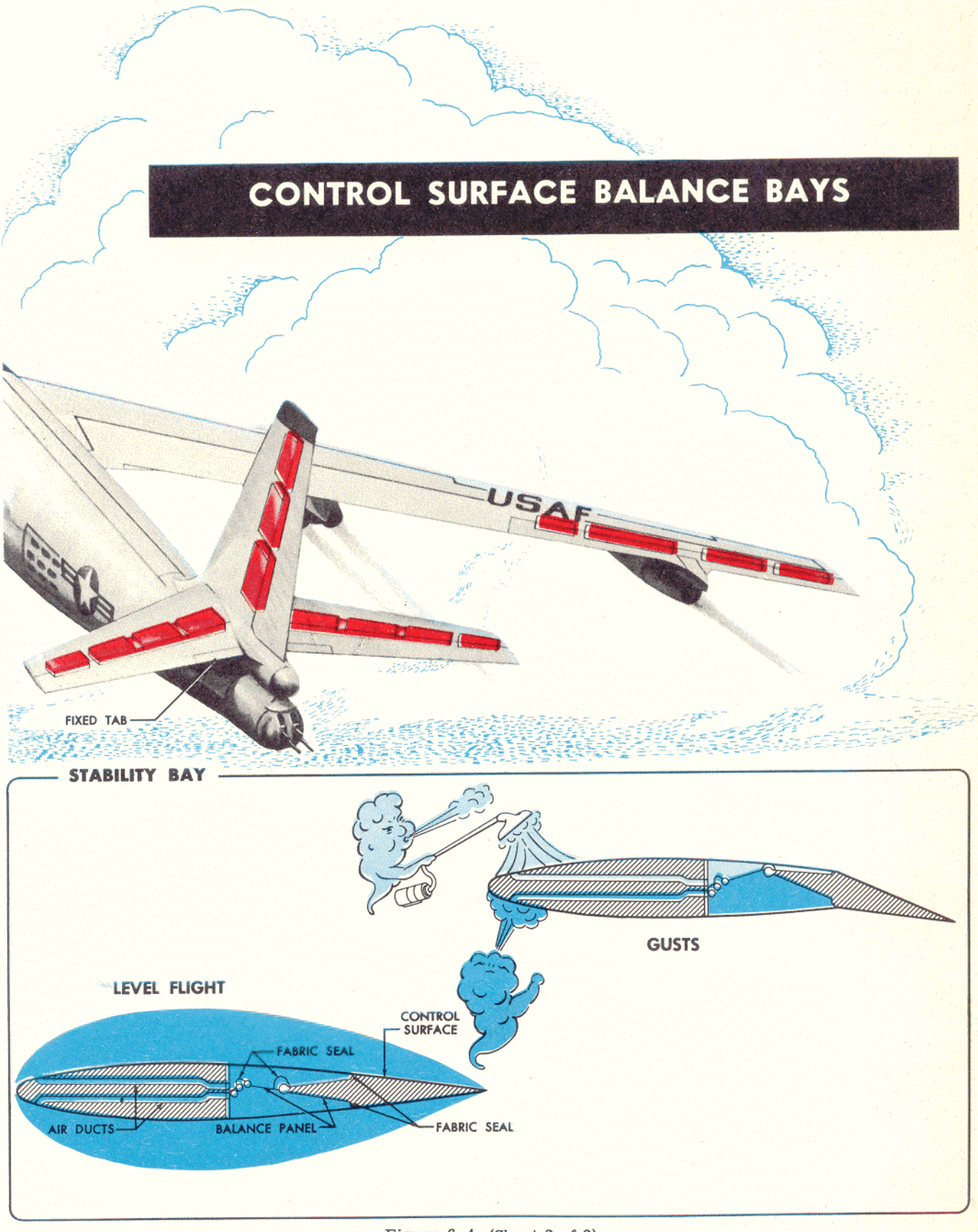


Figure 6-4. (Sheet 2 of 2)

The conditions under which buffeting can be expected to be encountered can best be presented by reference to figure 6-3 using the following conditions: An airplane weighing 110,000 pounds gross weight, cruising at Mach .75 at 40,000 feet altitude. If the speed is decreased far enough at constant altitude, buffeting will be encountered at Mach .56. The buffeting at this point is low speed stall buffeting, and is substantially the same in nature as that described in "Stalls," this section. The only difference between high altitude low-speed buffeting and that described under "Stalls" is that at high altitude, buffeting occurs at higher indicated airspeeds.

If the airspeed is increased at constant altitude, buffeting will be encountered at Mach .84. At this altitude the airplane can be flown to Mach .84 in level flight at 100% engine rpm. Initial high Mach number buffeting is noted by a very slight shaking of the airplane which increases in magnitude as the speed is increased.

WARNING

No rolling moments are encountered during buffeting; however, the separation resulting from operation at high Mach number occurs on the wing aft of the airplane center of gravity. This loss of lift causes the airplane to pitch up slightly. This condition is very unstable since the pitch-up causes further separation, hence more pitch-up. The pitch-up can be controlled with the elevator for a limited range of Mach numbers but, as the Mach number is increased, the condition becomes uncontrollable.

On airplanes equipped with vortex generators on the upper wing surface, compressibility buffet will be less spasmodic, pitch-up will be delayed to a higher wing load factor or Mach number, and the airplane will be more controllable in a buffet region.

High Mach number buffeting should be avoided because the irregular air loads cause damage to the wing trailing edge structure, flaps, flaperons and ailerons. This same damage occurs to the structure to a lesser degree during flight in low speed stall buffeting with the flaps up. If flight in buffeting is necessary for emergency decent or evasive action, the airplane is controllable and can be flown to the structural design limit, which is Mach .92 or 456 knots, whichever is lower. Careful inspection of the airplane should be conducted after extended periods of time in buffeting.

When extreme high Mach number buffeting is encountered in level flight at high altitude, it is necessary to appreciably increase the drag or decrease the thrust. Recovery from the buffeting range in level flight may be accomplished by reducing power to the idle stop and waiting for the airplane to decelerate. Under extreme conditions, extending the landing gear (with the drag control switch) is recommended to increase the drag, while reducing power is recommended to decrease thrust. Care should be exercised to avoid reducing the thrust, increasing the drag, or increasing the acceleration to a point where a low speed stall is encountered. A good rule to remember when any buffeting is encountered is to first reduce any positive acceleration, then increase or decrease the airspeed to obtain .74 Mach number.

It is more likely that buffeting will be encountered while maneuvering the airplane at high altitude than in straight and level flight. The effect of positive accelerations caused by coordinated turns or pull-ups is to increase the load factor which has the same effect as adding weight to the airplane. The angle of bank is therefore limited by buffeting since the increased load factor moves the airplane closer to buffeting. Using the previous example of 110,000 pounds gross weight at 40,000 feet with a speed of Mach .75, it is shown on figure 5-2 that initial buffet will be encountered at approximately 46° angle of bank with a load factor of approximately 1.44 "g's." The greatest margin below buffeting exists at or near the best cruising Mach number, thus this region is the best for maneuvering at high altitude. The velocity curves on figure 5-2 clearly show the rapid decrease of allowable angle of bank due to either an increase or decrease of speed from Mach .75.

The buffeting encountered during accelerated flight is essentially the same as that encountered at high Mach numbers and the same precautions should apply. Recovery from buffeting is best made by reducing the acceleration, either by rolling out of the turn or nosing over slightly, or both.

Operation near the buffeting region must be conducted with caution because of the following:

a. A reduction in airspeed is difficult to accomplish at altitude due to the high minimum obtainable rpm (approximately 90% at 40,000 feet), and due to the aerodynamic cleanness of the airplane.

b. A very slight nose-down attitude will result in increasing airspeed and will amplify the buffeting condition.

c. Positive accelerations as small as 1.1 or 1.2 "g's" caused by turbulence or maneuvering will produce considerable buffeting.

VORTEX GENERATORS.

High speed airflow separation over the wing just inboard of the outboard nacelles has restricted airplane performance due to loss of static longitudinal stability at high Mach numbers. This condition, which has been associated with buffeting, has limited top speed in level flight, ceiling, and maneuvering load factor at altitude. This results in a "wing limited" airplane. To improve the aerodynamic characteristics of the airplane, two rows or vortex generators are installed on the upper surface of each wing ahead of the point of initial separation. These vortex generators are small airfoils mounted perpendicular to the upper wing surface and as such each creates a tip vortex. These vortices conduct high velocity air into the

boundary layer, increasing its momentum and, in effect, delaying any tendency to separate, thereby reducing the intensity of buffeting when it does separate. With vortex generators installed, buffeting is encountered in the same region but of a regular nature and of sufficiently reduced magnitude as to enable the pilot to fly the airplane beyond the buffet boundary (figure 6-3) with no pitch-up instability.

The installation of upper wing surface vortex generators has eliminated pitch-up instability and has increased the maneuvering load factor at high altitude without compromising other performance characteristics. This reduces the possibility of buffeting from atmospheric disturbance and small elevator corrections when flying near the buffet boundary and enables the pilot to bank at much steeper angles. With the marked improvement in static longitudinal stability, the airplane is now "power limited" and can be maneuvered from 100% engine rpm level flight. Recovery from buffeting is best accomplished by reducing the load factor and/or speed.

FLUTTER.

Flutter is briefly defined as a vibration caused by the coupling of aircraft elastic inertia and aerodynamic loadings. Flutter, as opposed to buffeting, is usually associated with changes in airloads caused by structural deflections rather than airflow separation. Flutter limitations restrict the maximum IAS to 425 knots at weights above 140,000 pounds gross weight.

DIVING.

The extreme cleanness of this airplane with the landing gear up, and the fact that it is operating near the buffeting range in level flight, limit it to very shallow dives which must be executed with extreme care. As with all high-speed operation, abrupt accelerations must be avoided. Steeper dives and rapid descents can be made by lowering the landing gear and decreasing power to the minimum obtainable rpm.

SECTION VII

SYSTEMS OPERATION

ENGINE OPERATION.

COMPRESSOR STALL.

The rapid throttle advancement, attempting to accelerate engine rpm beyond its normal rate of acceleration, causes a stall of several middle stages of the compressor. A stalled condition causes an immediate change of air flow through the engine which the fuel regulator cannot detect in time to decrease fuel flow to prevent a rich mixture. The additional fuel being ignited in the combustion chambers results in an increase of pressure which the fuel regulator senses as an increase of air flow. The fuel regulator, sensing this condition, adds still more fuel in an attempt to achieve the rpm called for by the throttle. The burning of additional fuel further increases the combustion chamber pressure, thus aggravating this condition. This condition is commonly known as a "hot stall." If the engine is allowed to continue operation in a stalled condition, the temperatures of the burning gases will increase until serious damage to the turbine section occurs, resulting in engine failure. The indications of a compressor stall are noted, following rapid throttle advancement, as the engine rpm increases then levels off below the relative position of the throttle, and the exhaust gas temperatures (EGT) will rapidly increase.

A compressor stall, which is more common on this airplane engine installation, resulting in fuel flow equalizing in proper proportion with the reduced air flow is known as a "cold stall." A rapid increase of EGT is not noticed with a cold stall condition. Engine vibration or buffeting, however, is noticeable along with a level off or slight drop in engine rpm and a constant EGT.

In the event of a compressor stall, the corresponding throttle should be immediately retarded, thus eliminating the compressor stall. The throttle may then be advanced slowly. Refer to engine compressor stall, section III.

To help prevent engine compressor stalls an engine stall prevention switch is located on the pilot's instrument panel. With this switch in ON position, engine acceleration time is increased because pressure is bled from the sensing line between the engine compressor section and the fuel regulator of each engine. The switch should be placed in ON position for aerial refueling, formation flying, or unusual maneuvers such as practice stalls at any altitude and when flying below 10,000 feet with an OAT of 59°F (15°C) or below. With the switch in ON position at higher altitudes, a loss of rpm may be encountered (maximum obtainable rpm may be as low as 93%). With the switch in ON position at an OAT of 60°F (16°C) or above, engine acceleration time of up to approximately 30 seconds from idle to 100% rpm may be encountered on a 100°F day.

ENGINE "CHOO-CHOO"

The occurrence of engine "choo-choo" may be identified principally by the following abnormal characteristics:

1. The fuel pressure gage on the subject engine becomes erratic and undergoes rapid fluctuations, sometimes over the entire range of pressures.
2. The entire airplane is subjected to unusual vibration which all crew members can readily recognize.
3. An unusual sound effect emits from the "choo-chooing" engine. The sound resembles the sound of a locomotive and may or may not be audible by the crew members particularly if all engines are operating. Engine "choo-choo" is usually experienced during engine starting and run-up, being most likely to occur between 30 and 70% rpm. However, it may occur during flight as a result of throttle cut-back from military rated to cruise rpm. A change of rpm or fuel tank selection on the affected engine will usually eliminate this condition, but if "choo-choo" occurs during run-up the antipulsating fuel line should be checked for presence of fuel. Uncontrollable "choo-choo" during flight may make it desirable to shut down the affected engine as continued operation may result in damage to the engine or equipment.

ENGINE ICING.

During engine operation at airspeeds below approximately 250 knots TAS and at high power settings (as in a climb or go-around), the intake air will be sucked instead of rammed into the engine compressor inlet. This suction causes a decrease of air temperature. Under these conditions, air at an ambient temperature above freezing may be reduced to subfreezing temperatures as it enters the engine. Free moisture in the air may become supercooled and cause engine icing while no external surface icing would be evident. The maximum temperature drop which can occur on most current engines is approximately 5°C (9°F). The greatest temperature drop occurs at high rpm on the ground and decreases with 1) decreasing engine rpm and 2) increasing airspeed.

Ice formation in the engine inlet restricts the flow of inlet air. This causes a loss of thrust and a rapid rise in exhaust gas temperature. As the air flow decreases, the fuel-air ratio increases, which in turn raises the temperature of the gasses going into the turbine. The fuel regulator attempts to correct any loss in engine rpm by adding more fuel which aggravates the condition. Complete turbine failure from extreme overtemperature may occur in a matter of

seconds after ice builds up in the engine inlet. Even without inlet screens, serious blocking of the air passages between in the inlet guide vanes can still occur in 4 minutes or less. The following operations of non-anti-iced engines are recommended:

a. Avoid atmospheric icing conditions whenever feasible.

b. If possible, avoid take-off when the temperature is between -10° to 5°C (14° to 41°F) if fog is present or the dew point is within 4°C (7°F) of the ambient temperature. These are conditions under which jet engine icing can occur without wing icing. However, if take-off is necessary, retractable inlet screens should be retracted prior to take-off.

c. If the ambient temperature is in the range of 0° to 5°C (32° to 41°F), the speed of the airplane should be maintained at 250 knots or above to prevent inlet duct icing.

d. If icing conditions are encountered at freezing atmospheric temperatures, immediate action should be taken as follows:

1. Change altitude rapidly by climb or descent in layer clouds or vary course as appropriate to avoid cloud formations.

2. Reduce airspeed to minimize rate of ice build-up.

3. Maintain close watch of exhaust gas temperature and reduce engine rpm as necessary to prevent excessive tailpipe temperature. Engines protected by anti-icing systems are not susceptible to the icing hazard when the anti-icing system is operative.

RPM DROP OFF AT ALTITUDE

Due to fuel regulator characteristics maximum obtainable rpm at altitude may be expected to be as low as 97%.

FUEL SYSTEM MANAGEMENT

GENERAL

A fuel management system is provided to enable the pilot to control fuel distribution with a minimum amount of attention. Due to the location of the fuel cells along the longitudinal axis, proper fuel management is imperative to maintain a nominal center of gravity position. During high altitude cruise at Mach .74 and at optimum cruise altitude, a nominal center of gravity is indicated by a setting of approximately 1.8 units nose-up on the elevator trim indicator, resulting in maximum airplane performance in flight. The chart presented in figure 5-6 can be used to determine the center of gravity by this method while cruising at Mach .74 and at various altitudes and weights. The load adjuster, however, should be used in lieu of this chart when available as incorrect rigging of the elevator trim system or tolerances in the airplane structure can cause incorrect center of gravity indications. For minimum drag and maximum range during cruise at Mach .74 and at optimum cruise altitude, it is desirable that fuel management be such that the trim will be kept between .5 and 2.5 units nose-up trim. The following fuel management procedures enable the pilot to drop a 10,000-pound bomb from the forward bomb bay any time after external wing and ATO tanks are empty. Transfer of fuel from the auxiliary tanks should be conducted in the following consecutive order (see "Weight and Balance Data," T.O. 1-1B-40):

1. Both external wing tanks
2. ATO (aft auxiliary) tank
3. Bomb bay tank
4. Forward auxiliary tank

With the fuel in the forward and center main tanks equalized, the aft main tank should contain 3000 pounds more fuel than either of these tanks. Fuel should then be used equally from all main tanks, always maintaining this 3000-pound differential. This procedure is recommended so that at light gross weights, the cg will be in a more favorable position for landing than it would be if equal quantities of fuel remain in all main tanks. If it becomes necessary to operate the airplane with a bomb load in the forward bomb bay and a total fuel load below 28,000 pounds, the aft main tank should contain 5000 pounds more fuel than either of the other main tanks to keep a favorable cg location. Operation from reserve fuel in the aft main tank, after the forward and center main tanks are empty, will result in the airplane cg moving forward very rapidly.

The fuel quantity gages are calibrated for a level flight attitude, except that the full mark is calibrated for a taxi attitude. When the airplane is on the ground, the gages will read low for all quantities less than full (figure 1-17).

Since many replacement boost pumps do not have the electrical arcing hazard eliminated, the possibility of an explosion occurring during boost pump restarts, with less than 5 inches of fuel above the pump mounting flange, still exists. This condition results from an electrical arc on the pump during starting which could ignite fuel vapors if the fuel level were below the point of arcing and all other conditions necessary for combustion prevailed. To establish the safest procedure the following warning should be observed.

WARNING

- The minimum amount of fuel in pounds, necessary in the tanks for safe restarts of the boost pumps while on the ground and in cruise, is as follows:

	On Ground (pounds)	In Cruise (pounds)
Forward main	3930	1876
Center main	3292	743
Aft main	2266	3363
Bomb bay	1558	1062

- Since there are no fuel quantity gages in the auxiliary tanks, it is necessary that once boost pumps are started, they be operated continuously until the fuel quantity indicators show "E" or empty tab, or until the fuel flow indicating light comes on during transfer operation. If it is necessary to stop boost pump

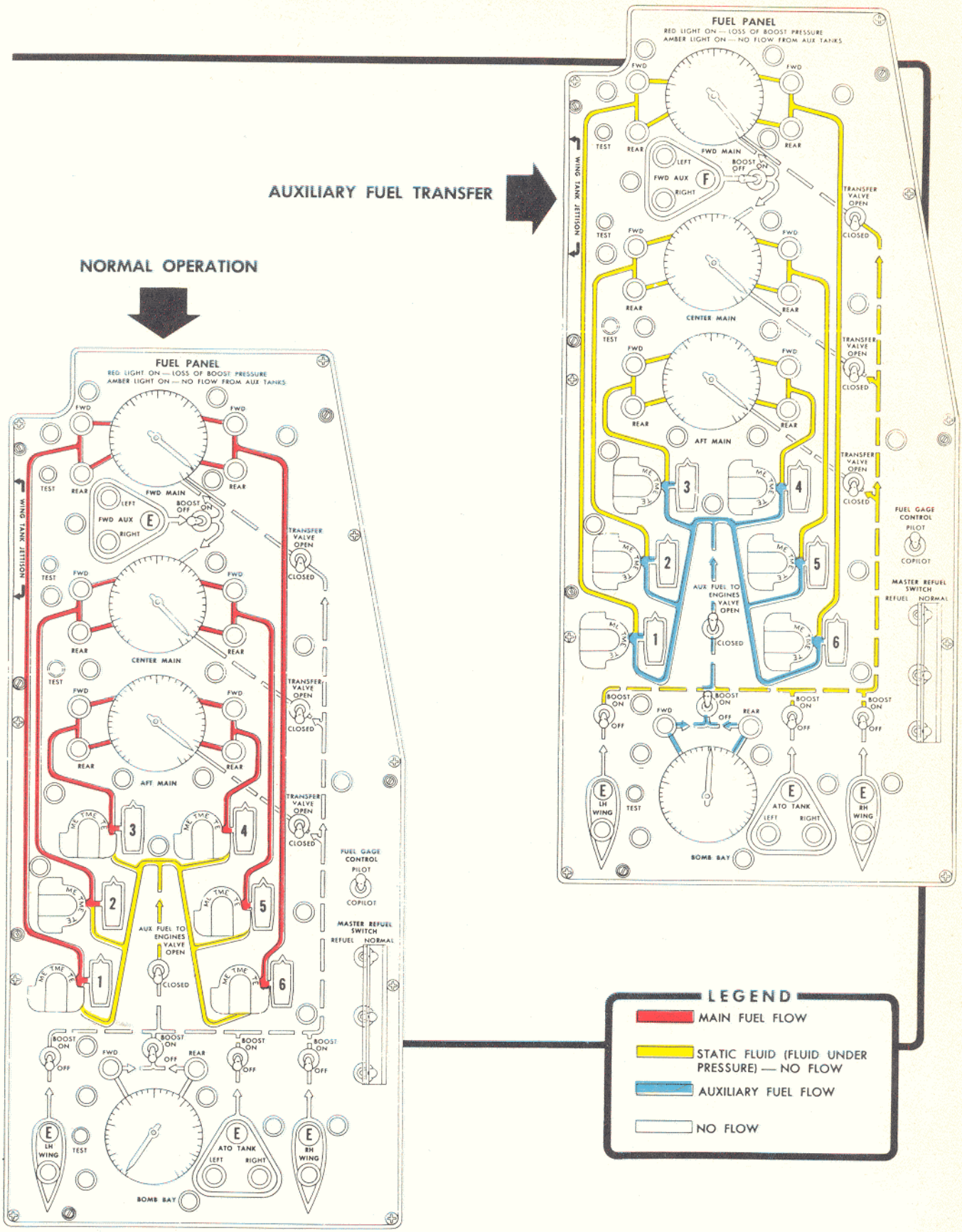


Figure 7-1. Fuel System Management

operation during fuel transfer, the pump should not be restarted if the "intermediate" tab on the fuel quantity indicator is showing.

- The direction of rotation of the fuel selector switches should be closely observed before making fuel selections since on early model airplanes the direction of rotation is counter-clockwise and is therefore directly opposite to the direction of rotation on later model airplanes which is clockwise.

FUEL TRANSFER

The fuel system provides an interconnection of the transfer-refueling manifold with the engine manifold through a cross-feed manifold. Except for the forward auxiliary fuel, the cross-feed manifold allows all auxiliary fuel to be used directly from the auxiliary tanks. The fuel from the forward auxiliary tank can only be transferred to the forward and center main tanks. Consequently, except for forward auxiliary fuel, auxiliary to main tank transfer is not normally required.

CAUTION

Auxiliary tank to main tank transfer (except for forward auxiliary fuel) should not be accomplished with this system since fuel management will be difficult and unnecessarily time consuming. In some cases that transfer might result in undesirable flight conditions or damage to fuel system equipment. However, if for some reason, transfer of auxiliary fuel to the main tanks is necessary, it can be accomplished by use of the fuel transfer valve switches.

BEFORE STARTING ENGINES

Set up the fuel system in accordance with the normal operating procedures in section II. Fuel selectors for all engines will be on TE except No. 2 engine which will be on TME in order to maintain fuel pressure in the engine manifold system. This selection is used for starting, taxiing, and takeoff so that fuel will be used evenly from all main tanks. No auxiliary fuel transfer or usage is accomplished.

DURING FLIGHT

NOTE

When an outbound flight requires aerial refueling, fuel should be used from the main tanks and bomb bay tank only prior to refueling. (See "Aerial Refueling - Fuel Management," this section.)

a. When climb is established after aerial refueling contact or during climb after takeoff when no aerial refueling is to be conducted, start auxiliary tank usage by setting all fuel selectors on TME, positioning auxiliary-fuel-to-engines switch in OPEN, and selecting the auxiliary tank first in sequence listed above and placing the respective tank valve and boost pump switch to ON. Fuel will then be supplied from the selected auxiliary tank to all engines through the manifold system. Due to the larger capacity of the auxiliary tank boost pumps, the auxiliary boost pressure overrides the main tank boost pressure and fuel flows from the auxiliary tanks. If, for some reason, auxiliary boost pressure should drop, main boost pressure will supply fuel to all engines from the main tanks. TME selection on all engines will be used for climb and cruise until all auxiliary fuel but the forward auxiliary is used.

b. As soon as the "no-flow" warning lights for the auxiliary tank being used illuminates, turn the next auxiliary fuel tank valve and boost pump switch to ON and position the empty tank switch to OFF.

NOTE

If either of the external tanks empties before the other, position the empty tank valve and boost pump switch to OFF. Do not turn the next auxiliary tank on until the other "no-flow" light is on. If the second "no-flow" light does not come on in approximately 10 minutes, assume a malfunction, select the auxiliary tank next in sequence, and place the external tank switch OFF. One boost pump in the bomb bay tank may override the other in the tank, causing its no-flow warning light to illuminate.

c. After auxiliary fuel from the external wing, ATO (aft auxiliary), and the bomb bay tank has been used, position the bomb bay tank valve and the boost pump switch to OFF and position the auxiliary-fuel-to-engines switch to CLOSE.

d. Position the fuel selectors for the aft main tank to ME. Maintain TME selection on the forward and center main tanks.

WARNING

All boost pump restarts shall be held to a minimum. When tank levels are known to be low, boost pumps should not be started after the fuel boost pressure warning lights come on.

e. Begin transfer of forward auxiliary fuel to the forward and center main tanks by positioning the forward auxiliary fuel tank valve and boost pump switch to ON. In effect, fuel for all six engines will then be supplied from the forward auxiliary tank through the forward and center main tanks and will maintain the desired fuel in the aft main tank.

f. After transfer of forward auxiliary fuel is complete, position the tank valve and boost pump switch to OFF.

g. Set all engine fuel selectors except No. 2 on TE. In order to maintain fuel pressure in the engine manifold, maintain No. 2 engine selector on TME. Monitor fuel gages frequently to insure even fuel usage from all three main tanks. If any tank shows a higher rate of fuel usage than the others, correct the condition by selecting ME on that tank and TME on the other two tanks. Maintain approximately 3000 pounds more fuel in the aft main tank at all times.

BEFORE LANDING

Set up the fuel system in accordance with normal operating procedures in section II. Fuel selectors for all engines will be on TE except that No. 2 engine will be on TME.

WARNING

In the event the total fuel quantity is 12,000 pounds or less, position all fuel selector switches to TME. Check all fuel boost pump warning lights out and transfer quantity gages to the copilot.

AERIAL REFUELING SYSTEM OPERATION.

WARNING

There should be no smoking by any crew member during refueling operation.

FUEL MANAGEMENT.

The refueling flow rates to all auxiliary fuel tanks, except the bomb bay tank, are lower than to the main tanks; therefore, to obtain minimum contact time, the auxiliary tanks should be loaded prior to take-off and not used until after air refueling has been accomplished. Allowance should be made for fuel used out of the main tanks during the take-off and climb to rendezvous. Sufficient reserve fuel to return to base should be left in the main tanks in case rendezvous is unsuccessful and mission aborted. Fuel from auxiliary tanks can be used to augment main tanks if return to base without making contact is required.

CAUTION

Due to structural limitation of wing, landing with full external wing tanks is not recommended.

NORMAL OPERATION.

READY FOR CONTACT - PILOT'S PROCEDURE. It is important that the pilot lower his seat to a position where he has an unobstructed view of the reference points on the tanker and the boom extremity near the ruddevator area.

a. Place master refuel switch to the REFUEL position.
b. Place fuel gage control switch in COPILOT position.
c. In turbulent air, place the directional damper switch to ON.
d. External lights for night usage as desired. (See "Night Operational Procedure.")
e. Aerial refueling slipway anti-icing switch as required.
f. Extend wing flaps to 20%.

READY FOR CONTACT - COPILOT'S PROCEDURE.

a. Place aerial refueling system selector switch to NORMAL IFR SYSTEM position.
b. Check pilot's master refuel switch in REFUEL position by noting the master refuel switch on light is illuminated.
c. Place refueling valve switch to OPEN as required.
d. Place slipway door switch to SLIPWAY DOOR OPEN. Note slipway door not locked light comes on and, when door has fully opened, ready for contact light comes on.

NOTE

During icing conditions where formating for an aerial refueling contact is still possible, icing within the receptacle cavity can be prevented by keeping the door closed until just prior to the contact.

e. Test fuel quantity gages by depressing fuel quantity gage test switches and note drop in indication.
f. Check that power on fire extinguisher light is off.

CAUTION

Power on fire extinguisher light must be off or an immediate discharge of CO_2 will occur.

g. Place fire extinguisher selector switch to a charged bottle.
h. Move aerial refueling valve lever to OPEN; manifold not purged light comes on.
i. Turn on aerial refueling lights as required. (See "Night Operational Procedure.")
j. Check wing flaps for 20% extension.

CONTACT MADE - COPILOT.

a. Check that the contact made light comes on and ready for contact light goes out.
b. Fill tanks in accordance with weight requirements as specified in "Weight and Balance Data," AN 01-1B-40.
c. As fuel requirements are approached in each tank, the copilot advises the tanker engineer.

NOTE

An automatic disconnect occurs as a result of high fuel pressure when all refueling valves are closed. The valves are closed either by the operation of switches on the aerial refueling panel or by high level float switches in each tank. In the event of an inadvertent disconnect, press the return to ready for contact switch to set up the system for another contact.

DISCONNECT - GENERAL. When a disconnect occurs, the tanker boom automatically retracts, CO_2 is discharged into the slipway area, the contact made light goes out, the aerial refueling disconnected light illuminates, and the windshield wiper automatically operates. The windshield wiper aids in clearing the Nesa panel when disconnect spillage occurs. When the return to ready for contact switch is operated, the windshield wiper will automatically return to a parked position.

NOTE

- To prevent operation of the windshield wiper during disconnect on dry or dirty glass it will be necessary to pull the windshield wiper circuit breaker located on the lower DC power panel (12, figure 1-19). During practice (dry) contacts this is especially desirable.

● During aerial refueling operations, it is desirable that the cabin be pressurized. This will aid in preventing fuel spray, that occurs during aerial refueling disconnects, from entering the cabin. Place master air conditioning switch ON prior to any aerial refueling contact.

DISCONNECT - PILOT.

a. Retract wing flaps.
b. Place master refuel switch to NORMAL after copilot has placed refueling valve switches in VALVE CLOSED position.
c. Place fuel gage control switch to PILOT.

DISCONNECT - COPILOT.

a. Check that flaps are retracted.
b. Place slipway door switch to the CLOSED position.

NOTE

During icing conditions, the slipway door and receptacle cavity may accumulate considerable ice; however, the receptacle and slipway door are heated sufficiently to melt the ice and after a short delay the door will melt its way closed and the slipway door not locked light will go out.

c. Place all refueling valve switches to VALVE CLOSED position.
d. Place aerial refueling valve lever to the CLOSED position.
e. When the manifold not purged light goes out, notify pilot aerial refueling procedure is completed.

NIGHT OPERATIONAL PROCEDURE.

Rendezvous may best be effected by placing the navigation light switches to FLASH and BRIGHT and have wing illumination lights ON. However, lights should be kept to a minimum when approaching contact.

Due to the difficulty in estimating closure rates, it is important to maintain lateral and vertical clearance when approaching the tanker from behind.

For night operations, the following chart may be used:

	Rendezvous	Formating	In Contact
Navigation Lights	Flash & Bright	Optional	Optional
Aerial Refueling Door and Receptacle Lights	Bright	Bright	Bright
Wing Illumination Lights	Optional	Off	Off

NOTE

Energizing the copilot's fuel quantity gages illuminates the aerial refueling panel and allows the light intensity to be regulated by the rheostat on the copilot's lighting panel.

EMERGENCY OPERATION.

EMERGENCY DISCONNECT. The receiver pilot must be prepared at all times while flying in format to "hit" his automatic pilot-aerial refueling boom release switch in case an emergency disconnect is required. Unless there is obviously a serious emergency, the receiver pilot should make every effort to stay in contact position until certain the nozzle is clear of the receptacle.

As soon as it is obvious that emergency disconnect conditions arise, the first member of the crew to recognize it will call "Break Away" and the pilot, copilot and tanker boom operator will actuate their disconnect switches. The receiver pilot will immediately retard throttles, extend the landing gear, and execute a gentle left skid, nose over, and maintain wings level to clear the tanker. The tanker pilot will increase power and pull up, wings level, and hold until clear of the receiver airplane.

It is possible, although improbable, that the tanker signal system may change to disconnect while the receiver signal system stays in contact made. In this case, the retraction limit switch on the tanker will not free the receiver from the tanker, pulling the receiver in as the boom retracts. The receiver pilot's boom release switch must be actuated to free the nozzle from the receptacle. For this remote possibility, and other emergencies which might arise, the receiver pilot must be prepared at all times to hit his boom release switch instantly.

EMERGENCY LATCHING. Emergency boom latching may be accomplished by placing the aerial refueling system selector switch in EMERGENCY BOOM LATCHING position after the boom is placed in the receptacle.

Disconnect from emergency boom latching is made by depressing and holding the boom release switch on the pilot's or copilot's control wheel until the boom nozzle is seen to leave the receptacle. Depressing this switch with the aerial refueling system selector switch in the EMERGENCY BOOM LATCHING position will cause the windshield wiper to operate at maximum speed until the switch is released. The tanker boom operator is unable to disconnect the receiver toggles during emergency latching.

CAUTION

It is possible to cause structural damage to the aerial refueling boom and slipway by severe relative movement between the two airplanes when operating with the emergency aerial refueling system as the limit switches are then deactivated.

EMERGENCY OPERATION OF SLIPWAY DOOR. The slipway door can be actuated by an aerial refueling emergency door control handle which is located under the observer's table.

AERIAL REFUELING SIGNAL AMPLIFIER FAILURE. A spare amplifier (3, figure 4-7) for the electronic signal system is provided to be used in case of failure of the installed amplifier (3, figure 4-7).

SECTION VIII
CREW DUTIES

Omitted.

SECTION IX
ALL WEATHER OPERATION

Omitted.

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PART 1

INTRODUCTION

All performance in this book is based on an NACA standard day (temperature = 59° F at sea level, decreasing uniformly to -67° F at 35,332 feet) unless other temperatures are stated. For a plot of NACA standard day temperature variation with altitude, see figure A-136.

Performance data for all flight operations, including takeoff and landing using J47-GE-25 engines is contained in this Appendix.

SYMBOLS AND DEFINITIONS

Symbols and definitions used throughout the Appendix are explained in the chart below, figure A-1.

AIRSPEED AND ALTIMETER INSTALLATION CORRECTIONS

Flight tests have shown that there is an airplane attitude and flap-down effect on the static pressure source which introduces slight discrepancies in the airspeed and altimeter readings. All curves which show indicated airspeed include information to this effect.

Above 100 feet with the flaps down and at final approach speed the altimeter consistently indicates about 15 feet higher than the true altitude. Below 100 feet, an opposing ground effect begins to offset the error caused by the flaps until at about a 20-foot altitude the instrument reads correctly. Below 20 feet, the ground effect continues to grow stronger, causing the altimeter to start reading low. At touchdown, altimeter indication is about 40 feet less than the runway altitude. Figure A-2 illustrates this point.

The indicated airspeed follows a similar pattern. Above 100 feet with the flaps down, the airspeed indicator reads about 1 knot too high. Below 100 feet, ground effect begins to neutralize the error until at 20-foot altitude the indicator reads correct values. The ground effect continues to grow until at touchdown the instrument reads about 4 knots low. Figure A-3 illustrates the airspeed indicator error.

During final approach in low visibility, the flaps-down effect should be kept in mind. The transition of instrument readings near the ground should cause no difficulty, since visual reference, rather than instrument readings, will be relied upon.

SYMBOLS AND DEFINITIONS

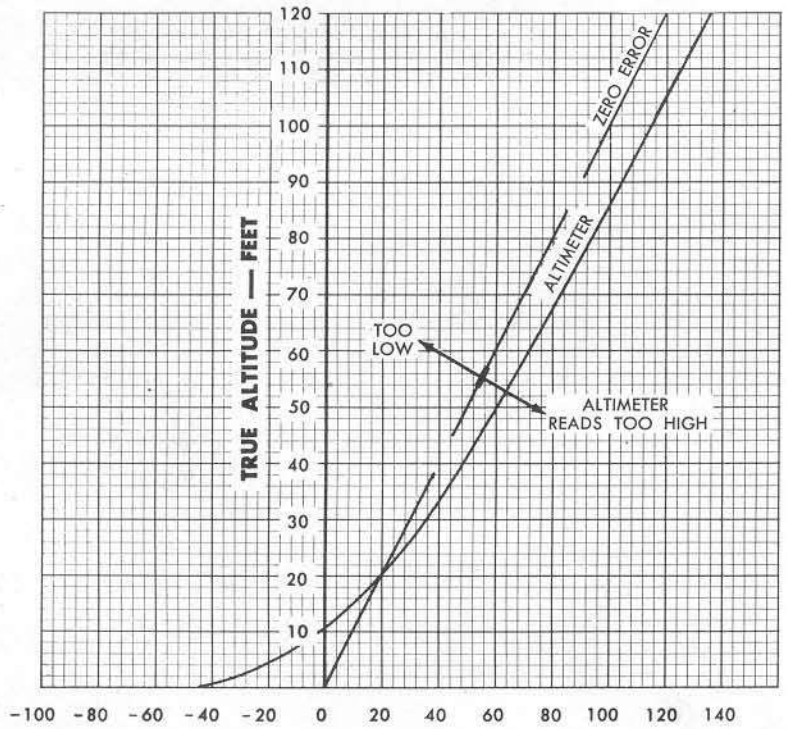
SYMBOLS	DEFINITIONS	SYMBOLS	DEFINITIONS
IAS	Indicated Airspeed - airspeed indicator reading corrected for instrument error	M max	Limiting Mach Number
		R/C	Rate of Climb
CAS	Calibrated Airspeed - indicated airspeed error corrected for position error	OAT	Outside Air Temperature
EAS	Equivalent Airspeed - calibrated airspeed corrected for compressibility	OAT Gage	Outside Air Temperature Gage - reading during flight corrected for instrument error
TAS	True Airspeed - equivalent airspeed corrected for atmospheric density	V ground	Ground Speed
ALT	Altitude	TH°	True Heading (degrees)
ATO	Assist Take-Off - solid fuel rockets	TC°	True Course (degrees)
EGT	Exhaust Gas Temperature - indicated	T-O	Take-Off
M	Mach Number	V	Velocity (indicated airspeed)
		WT	Weight

Figure A-1.

ALTIMETER READING — GROUND EFFECT
FLAPS DOWN

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: FLAPS DOWN

REMARKS: ANGLE OF ATTACK FOR TOUCHDOWN

DATE: DECEMBER 1952

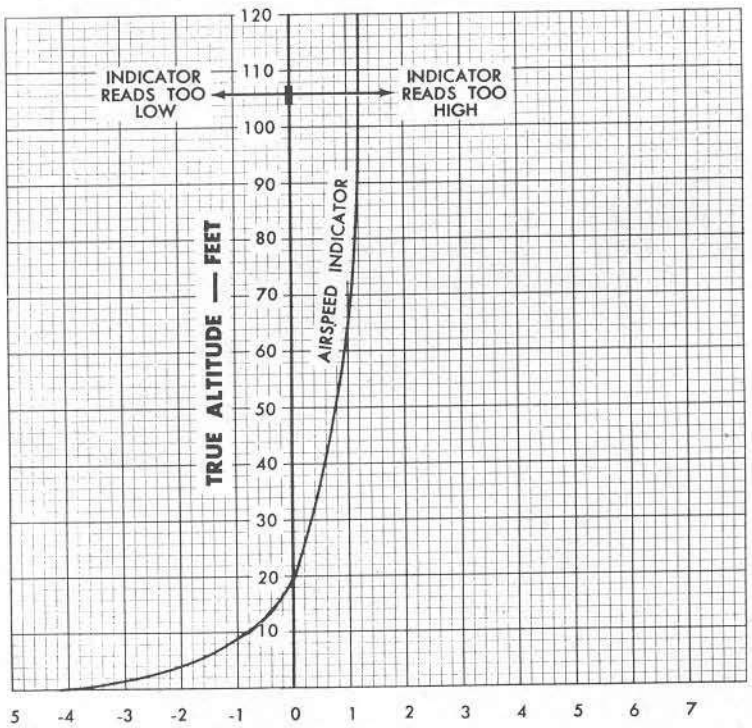
DATA BASIS: FLIGHT TEST

Figure A-2.

AIRSPEED POSITION ERROR
FLAPS DOWN

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: FLAPS DOWN

REMARKS: ANGLE OF ATTACK FOR TOUCHDOWN

DATE: DECEMBER 1952

DATA BASIS: FLIGHT TEST

Figure A-3.

PART 2

TAKE-OFF DISTANCE - NO ATO

Performance charts are presented for the J47-GE-25 engine in part 2 and show take-off distances with six engines at take-off (100% rpm, flaps extended, no take-off assist devices and engine screens retracted.

GENERAL

Close attention should be given to the correct take-off procedure for the YDB-47, since differences from reciprocating engine bombers appreciably affect ground roll. The principal new factors are:

1. Jet engine thrust (nearly constant during ground roll)
2. Bicycle landing gear (fixing the take-off angle of attack)
3. ATO (assisted take-off by solid rockets)

Minimum take-off distance is attained by maintaining military rated power (100% rpm) throughout the take-off run with the flaps fully extended. Lowering the flaps during the roll instead of at the start, as is sometimes done with propeller-driven airplanes to achieve better acceleration, is of no benefit because of the low drag flaps and the complete absence of a propeller slipstream acting against them.

To preclude any possibility of stalling and to obtain optimum control and climb after take-off, allow the airplane to fly off the ground with both gears leaving simultaneously. The elevator can be used to pull the front gear off when the airplane appears to rock between the front and rear gears. The take-off run can be shortened approximately 7% by pulling the airplane off the ground with the elevators at a lower speed than that for a normal take-off with both gears leaving the ground at the same time. However, this is not advisable since, at the lower speed, the performance reserve after take-off will be reduced.

VARIABLES AFFECTING TAKE-OFF PERFORMANCE

It should be realized that take-off performance can be accurately estimated, particularly since the bicycle landing gear practically fixes the airplane attitude at take-off and therefore eliminates the usually large factor of pilot technique on the elevator control. To accurately determine take-off distance and optimum procedures it is necessary for the pilot to know:

1. Gross weight
2. Outside air temperature (OAT) at time of take-off
3. Field length and pressure altitude
4. Wind direction and velocity
5. Tailpipe temperature (check on engine run-up).

To illustrate their relative importance, the following factors for a take-off weight of 160,000 pounds at sea level are of value.

A CHANGE OF	CHANGES TAKE-OFF DISTANCE BY APPROXIMATELY	
	NO ATO (FEET)	ATO (FEET)
1000 pounds in weight at 60° F	100	80
1000 feet in altitude at 60° F	675	500
10° C tailpipe temperature (6 engines)	200	160
10° F on 100° F day	330	300
10 mph wind	750	650

If the anti-icing system is operating during take-off, take-off distance will be increased approximately 5%.

Relative humidity, which appreciably affects reciprocating engine power, has a negligible effect on turbojet thrust and take-off distances.

TAKE-OFF PERFORMANCE - NO ATO

The possibility of an engine failure during take-off influences take-off procedures and should in all cases be considered. With an engine failure, the pilot must be able to either stop or take off safely. This is the recommended procedure. The following definitions will assist in presenting the take-off condition:

REFUSAL SPEED:

Maximum speed at which engine failure permits stopping at the end of the runway available.

DECISION SPEED:

Minimum speed at which an engine failure permits take-off on the runway available.

CRITICAL ENGINE FAILURE SPEED:

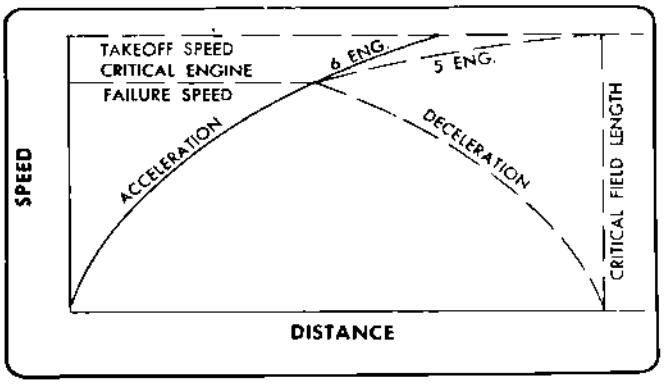
The speed at which an engine failure permits acceleration to lift off in the same distance that the airplane may be decelerated to a stop.

CRITICAL FIELD LENGTH:

The total length of runway required to accelerate on all engines to the critical engine failure speed, lose one engine, and then continue take-off or stop.

During the take-off roll, if an engine fails before the refusal speed has been attained, stopping is obviously the correct procedure. If the engine fails above the decision speed however, the airplane can and should

take off in the remaining runway distance. Under the take-off condition where refusal speed and decision speed are the same, the speed is known as critical engine failure speed and the pilot may stop if engine failure occurs before this speed or continue take-off if failure occurs after this speed. The runway length required to permit either stopping or continued take-off during the take-off roll is known as critical field length.



Normal take-off distance with no engine failure will always be less than the critical field length as shown above. Curves of critical field length and normal take-off distance are shown on figures A-4 and A-5. Refusal speeds are in part 4.

TAKE-OFF RULES - NO ATO

BEFORE STARTING ENGINES:

1. Determine the critical field length from figure A-4 and compare with actual runway available. If runway available is shorter than critical field length, ATO should be used.
2. Determine critical engine failure speed from figures A-34 through A-44 and take-off performance from figure A-5.

BEFORE STARTING THE GROUND ROLL:

1. Extend the flaps fully down.
2. Bring all engines to military rated (100%) rpm and check. Take-off will require about 2.5% more runway for each 10° C that the engine tailpipe is below the correct temperature for a properly tabbed engine. Therefore, it is important that the temperature indicating instrument be accurate.

DURING THE GROUND ROLL:

1. Hold elevator in neutral.
2. Allow airplane to fly off the ground. If it tends to rock between the front and rear gears near the take-off speed, a slight pull on the elevators should be applied.

EXAMPLE:

The following example will be used to demonstrate the use of the various charts.

Gross Weight = 150,000 pounds
Pressure Altitude = 2000 feet
OAT = 80° F
Runway Wind Velocity = 20 knots

CRITICAL FIELD LENGTH - NO WIND

On figure A-4 are curves of the critical field lengths required for take-off, allowing for a single engine failure. The pilot must first determine if the available runway length is sufficient for a take-off under this single condition. Considering the conditions of the example and referring to figure A-4, it is found that the critical field length for no wind is 8450 feet.

TAKE-OFF GROUND RUN - NO WIND

Curves for the normal take-off ground run (no engine failure) are on figure A-5. The no-wind ground run for the above example is 7300 feet.

REFUSAL SPEED - NO WIND

Using the length of the runway actually available (not the critical field length), the refusal speed is obtained from part 4. This refusal speed is the highest speed at which the pilot can stop within the runway length in event of an engine failure. An example is given in part 4.

DISTANCE OVER A 50-FOOT OBSTACLE

On figure A-6 are curves of the distance required between the take-off point and a 50-foot obstacle. These curves are for six engines operating at take-off. Allowances must be made for longer distances in the event of five-engine operation. The total take-off distance over a 50-foot obstacle is the sum of the ground run and the distance just obtained. Continuing the preceding example, the distance from the take-off point to the 50-foot obstacle is 1315 feet. The total distance from the start of take-off is then 7300 + 1315 = 8615 feet.

EFFECT OF HEADWIND

The effect of headwind is to reduce the minimum required length of runway for an engine failure and the normal take-off run with six engines. The headwind correction chart on figure A-7 can be used for both. If, however, it is necessary to convert from mph to knots, the mph-knots conversion chart on figure A-9 may be used. Ordinarily the effect of headwind during take-off should be disregarded, thus leaving any benefits which may be derived from the headwind as an added safety margin.

In the preceding example, the 20-knot headwind re-

duces the critical runway length from 8450 to 6500 feet and the no-wind normal take-off distance from 7300 to 5550 feet. The total distance over a 50-foot obstacle can be corrected for the effect of wind in exactly the same manner.

The headwind effectively reduces the take-off and stopping distances. Therefore, a higher speed can be reached before refusing the take-off than would be possible with no wind. This refusal speed is approximately the no-wind speed plus the wind speed. A 20-knot headwind increases the critical engine failure speed by about 20 knots.

TAKE-OFF SPEED

The airplane static pressure source has an error during take-off due to ground effect which affects the altimeter and airspeed indicator readings. Consequently, as the airplane gains speed, the altimeter reading decreases and the airspeed indicator reads about 4 knots too low. However, the take-off speed chart, figure A-8, has been corrected for ground effect and the speeds on it represent actual indicator readings. The ground effect error disappears rapidly as the airplane gains altitude.

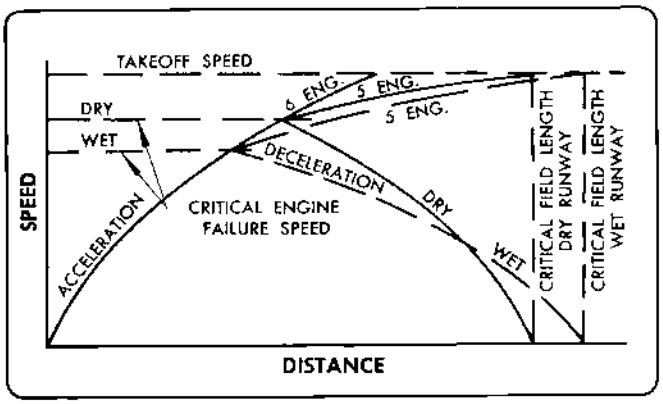
For the preceding example, the take-off speed is 147 knots IAS.

RUNWAY GRADE CORRECTION

If the airplane takes off on a slight uphill grade, the take-off distance will be longer than normal. The increase in take-off distance may be obtained approximately by multiplying the take-off distance (hundreds of feet) by the grade (feet of elevation per 1000 feet of distance). If a runway has a 7.5-foot/1000-foot grade and the normal take-off distance is 5000 feet, the increase in take-off distance due to grade is 50 x 7.5 or 375 feet if the airplane takes off uphill. The take-off distance is decreased by the same amount if the airplane takes off downhill.

EFFECT OF WET RUNWAYS

The effect of wet runways is to increase the required stopping distance in the event of refused takeoff. The speed at which the takeoff must be refused is thereby lowered, and the minimum runway required is increased as shown by the sketch below. For wet concrete runways decrease the maximum refusal speed 10 knots and increase the critical field length 25 feet for every 1000 feet of runway required (25%). The sketch below illustrates the effect of a wet runway on the estimated critical field length.



For the no ATO example condition, a wet runway with no wind would increase the critical field length approximately 25 x 8.4 or 210 feet giving a minimum runway of 8660 feet required for safe operation. Refer to the summary chart at the end of this text as a guide for the corrections due to wet runways.

SUMMARY - TAKEOFF CORRECTIONS

The following chart may be used as a guide in determining the over-all effect of several conditions which will change the takeoff performance characteristics. The corrections, where values are given, are approximate and must be used only as an index to judge whether a given set of conditions results in a greater or less safety margin of takeoff performance.

SUMMARY OF TAKEOFF PERFORMANCE VARIABLES

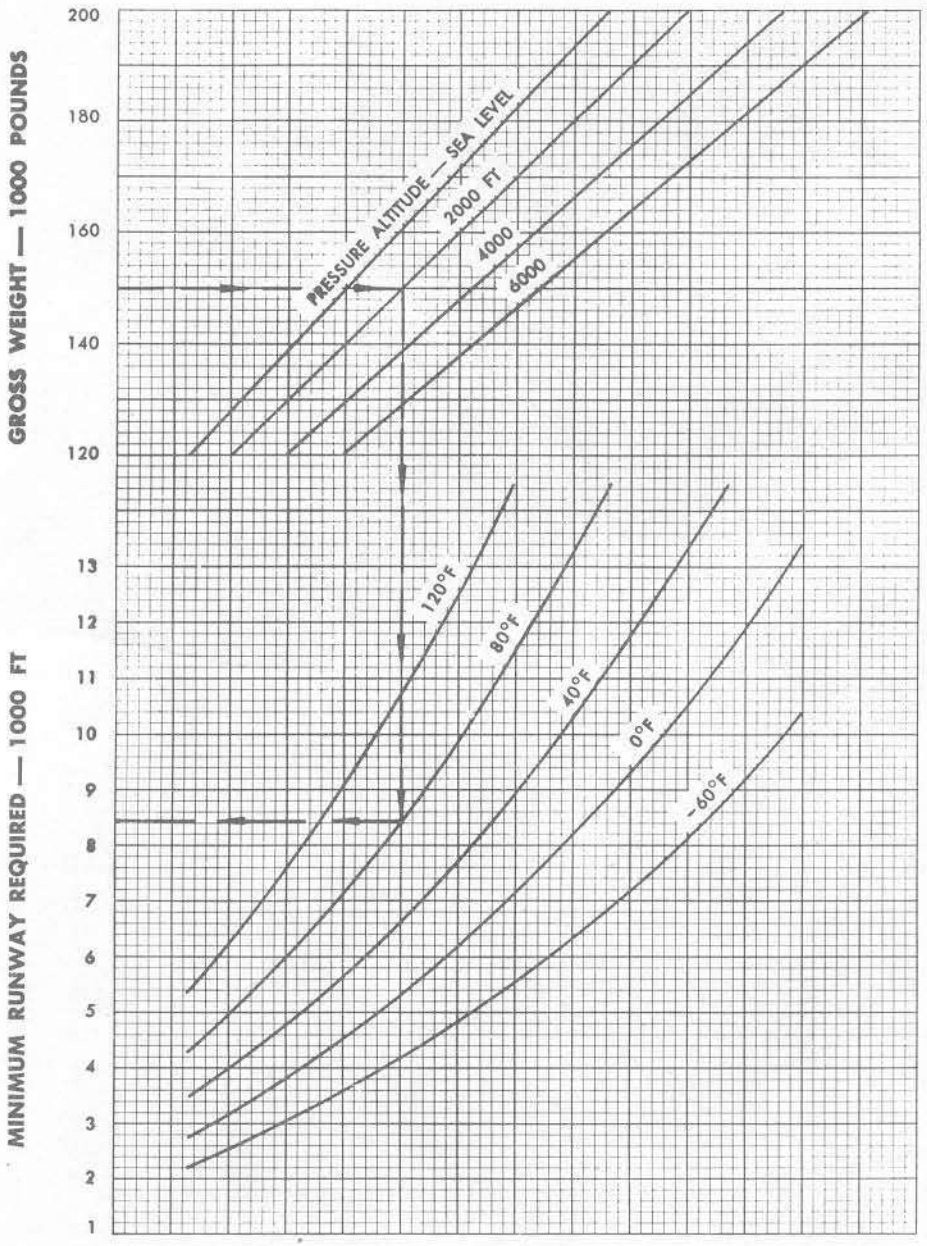
TAKEOFF PARAMETERS	CORRECTIONS					
	HEAD-WIND	WET RUNWAY	RUNWAY UPGRADE	ANTI-ICING ON	INLET SCREENS EXTENDED	LOW E.G.T. 10° ON 6 ENGS
TAKEOFF SPEED	NONE	NONE	NONE	NONE	NONE	NONE
NORMAL TAKEOFF DISTANCE	DECREASED (SEE CHART)	NONE	INCREASED (SEE TEXT)	INCREASED 5%	INCREASED 4%	INCREASED 2½%
CRITICAL FIELD LENGTH	DECREASED (SEE CHART)	INCREASED 2½%	INCREASED (SEE TEXT)	INCREASED 5%	INCREASED 4%	INCREASED 2½%
EFFECTIVE RUNWAY LENGTH	INCREASED	DECREASED	DECREASED	DECREASED	DECREASED	DECREASED
	(SHOWN FOR REFERENCE ONLY, AND WILL ALWAYS BE OPPOSITE TO THE CHANGE IN CRITICAL FIELD LENGTH. DO NOT CORRECT BOTH.)					
CRITICAL ENGINE FAILURE SPEED	NONE	DECREASED 10 KNOTS	INCREASED	INCREASED	INCREASED	INCREASED
ATO FIRING SPEED	NONE *	NONE	NONE	NONE	NONE	NONE

CRITICAL FIELD LENGTH

SINGLE ENGINE FAILURE AT CRITICAL FAILURE SPEED
NO ATO

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

DATA BASIS: FLIGHT TEST

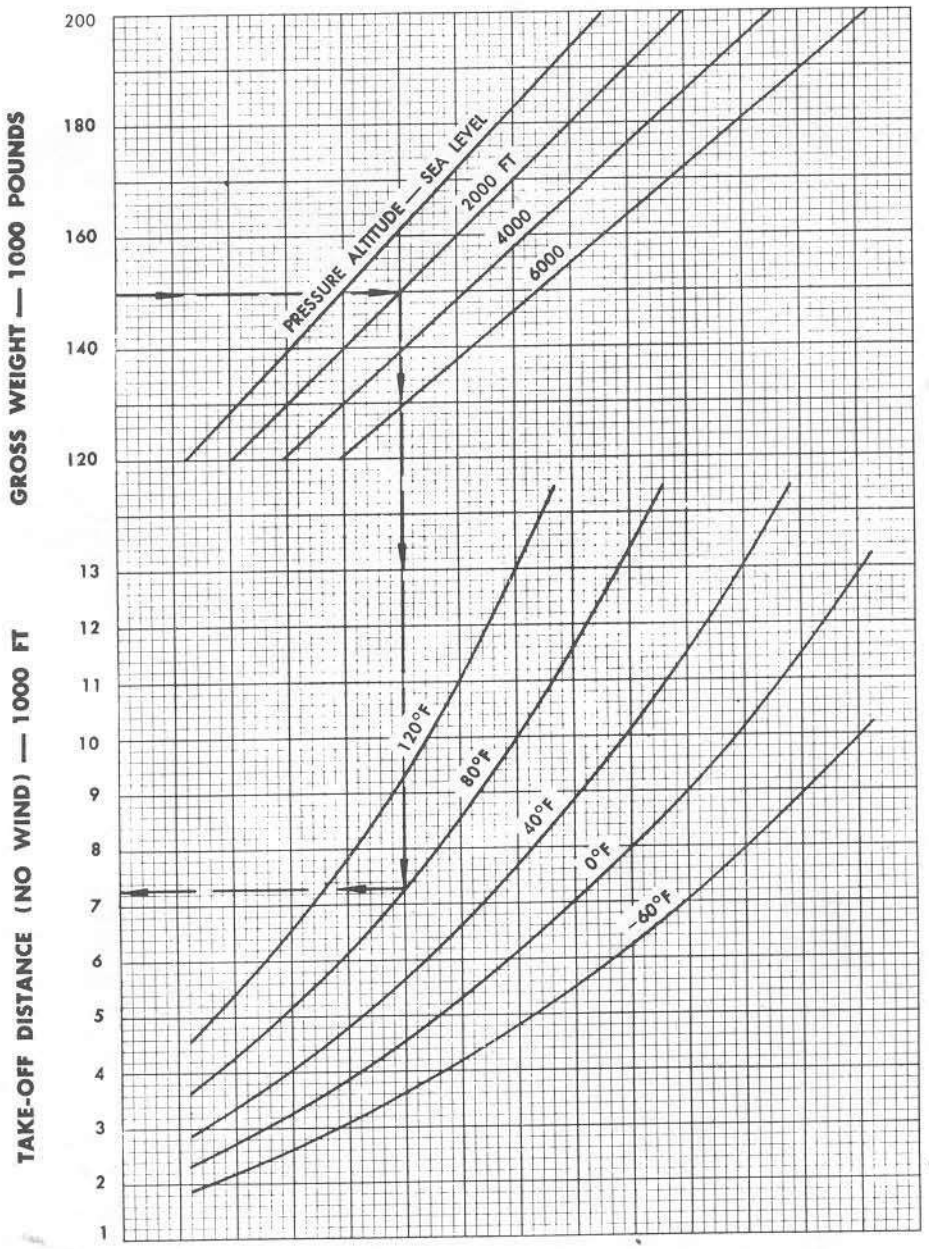
Figure A-4.

TAKE-OFF GROUND RUN

NO ATO

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

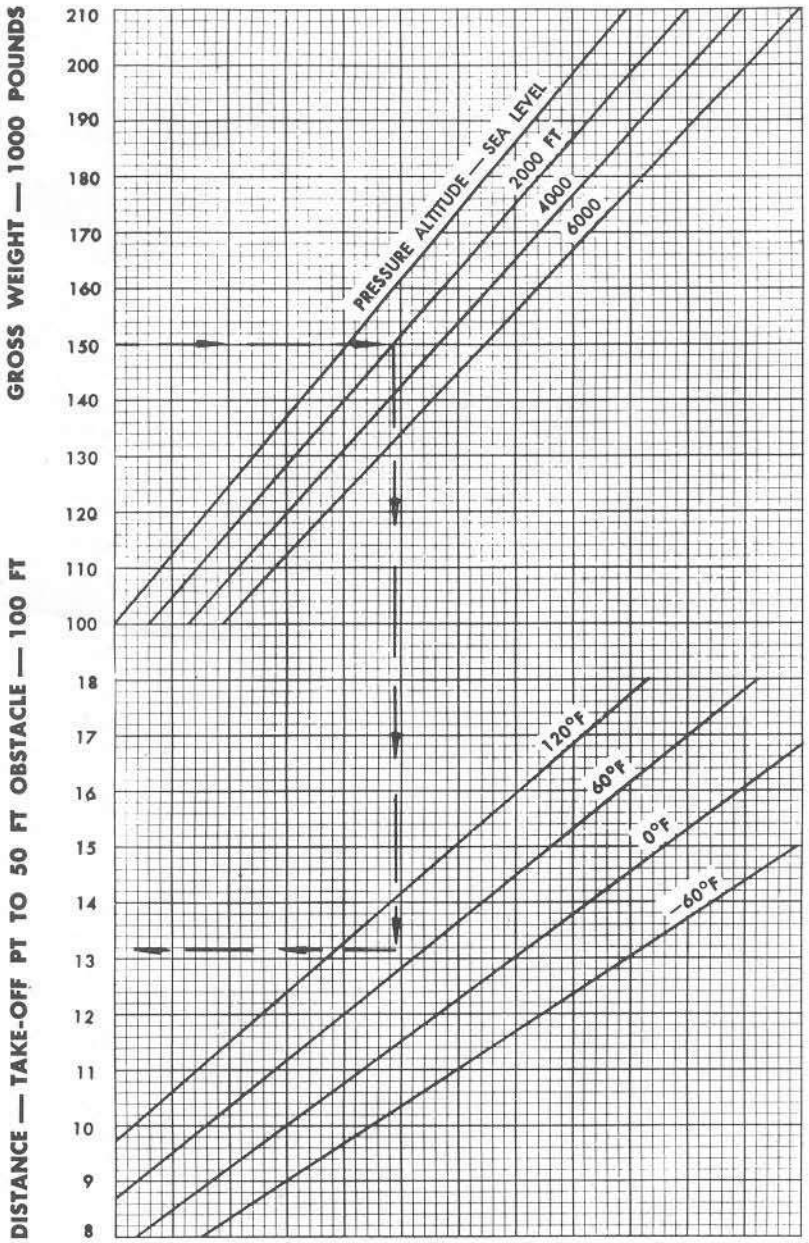
DATE OCTOBER 1952
DATA BASIS: FLIGHT TEST

Figure A-5.

MINIMUM FLIGHT DISTANCE OVER 50 FT OBSTACLE
NO ATO

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: NO WATER INJECTION

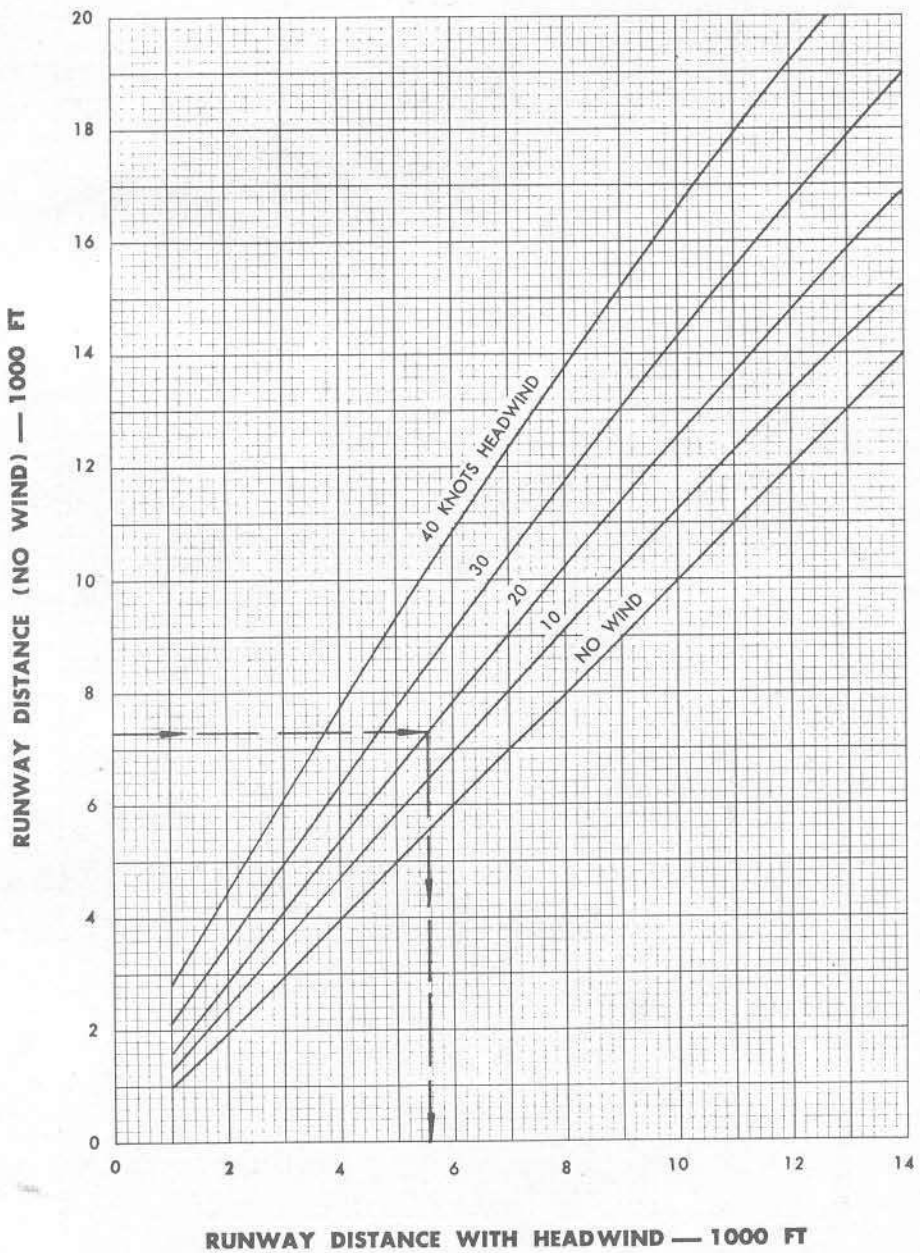
DATE: NOVEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-6.

HEAD WIND CORRECTION CHART

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

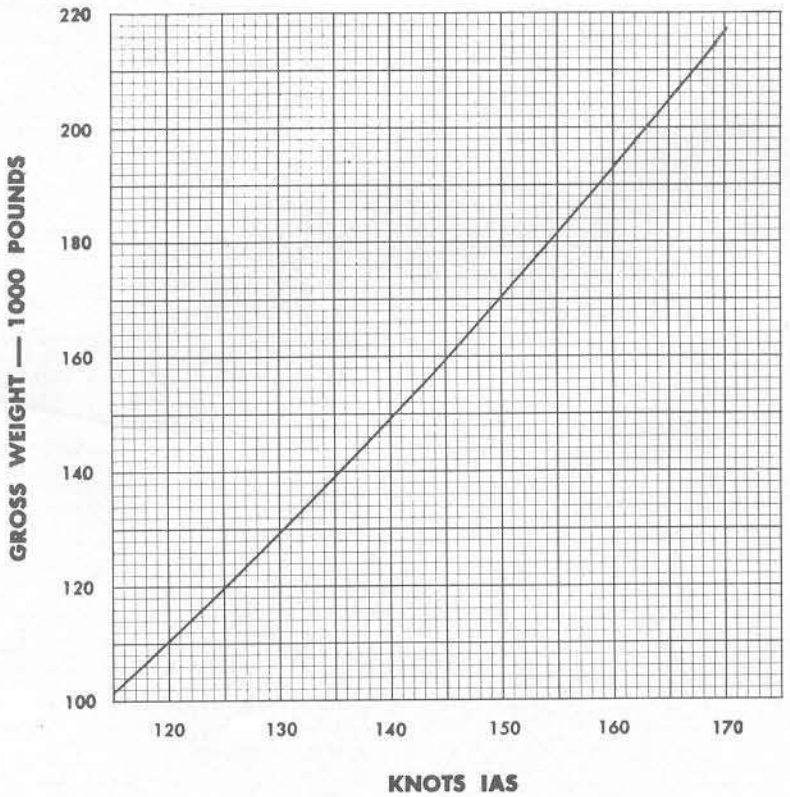
DATE: AUGUST 1951
DATA BASIS: FLIGHT TEST

Figure A-7.

TAKE-OFF SPEED
FLAPS FULL DOWN

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

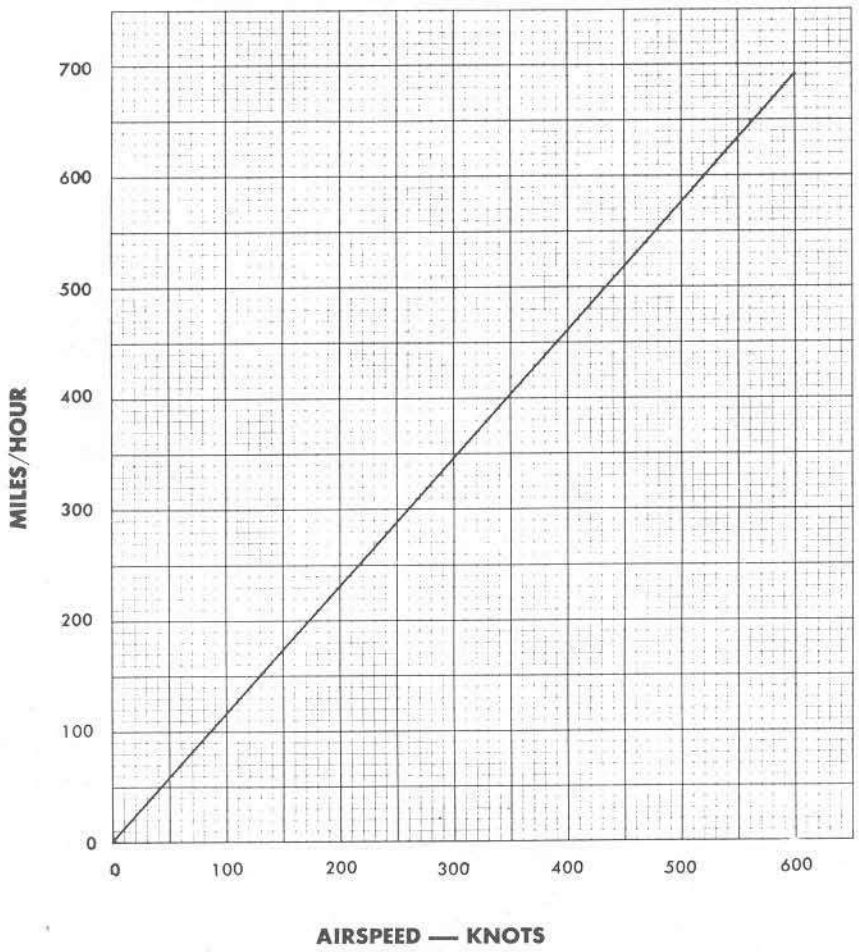
REMARKS: INDICATOR READING CORRECTED FOR GROUND EFFECT

DATE: DECEMBER 1952

DATA BASIS: FLIGHT TEST

Figure A-8.

MPH-KNOTS CONVERSION CHART



DATE: JANUARY 1953
DATA BASIS: CALCULATED

Figure A-9.

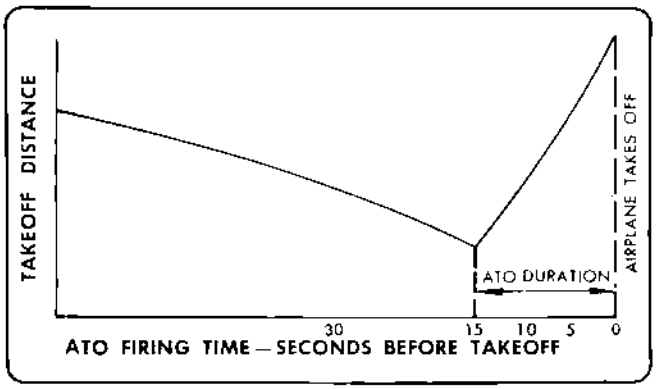
PART 3

ATO TAKE-OFF DISTANCE

The charts in this part present take-off distances, ATO requirements, and ATO firing speeds for various take-off conditions and a varying number of 1000-pound thrust 15-second duration solid fuel rockets.

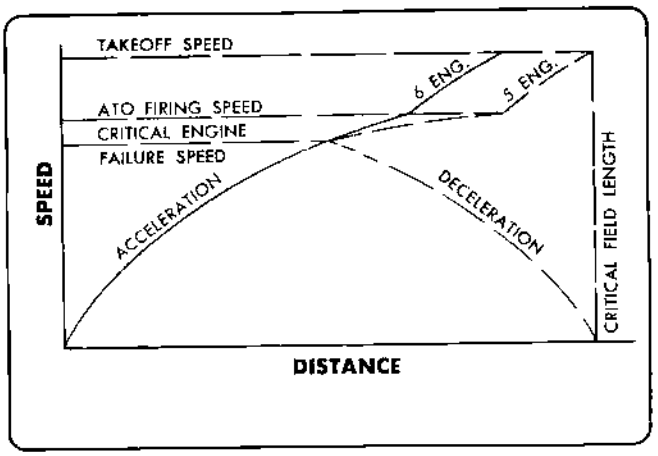
TAKE-OFF PERFORMANCE - ATO

On the YDB-47, provisions have been made for mounting 18 solid fuel rocket units. Each rocket provides 1000 pounds of thrust for 15 seconds. If necessary, ground run can be reduced considerably by proper use of ATO. Limited duration ATO thrust will be used most effectively at the end of the take-off run where speeds are highest and the airplane is not accelerating rapidly. Therefore, for minimum ground run, the rockets should be fired so they expire just as the airplane takes off. The effect of early or late firing on take-off ground distance is illustrated below.



This minimum ground run procedure should be used for emergencies only where runway lengths are too short for normal recommended operations.

The recommended procedure is to fire the ATO approximately 10 seconds before take-off, since ATO thrust for a short time after take-off is very desirable. This gives somewhat higher ground run distances, but permits partial retraction of the gear to decrease drag in the event of an engine failure during take-off. In tactical operation it may be desirable to use only the number of ATO bottles required for safe take-off operation. The consideration of engine failure during take-off is equally important when using ATO. As in the no-ATO case, the pilot should be able to stop on take-off in the event of an engine failure during the take-off run. If the engine fails before the critical engine failure speed is reached, the airplane can be stopped in the remaining runway distance. If failure occurs above the critical engine failure speed, take-off must be continued with one engine out and the rockets fired at the recommended firing speed. This is shown below:



The recommended firing speed is the same whether or not an engine fails. If more than the minimum required number of ATO rockets are used, the firing speed should remain the same.

TAKE-OFF RULES - ATO

BEFORE STARTING ENGINES:

1. Determine the critical engine failure speed from part 4, and the ATO take-off performance from figures A-10 through A-19 as necessary.

BEFORE STARTING THE GROUND ROLL:

1. Extend the flaps fully down.
2. Check the ATO light on.
3. Bring all engines to take-off 100% rpm and check.

Take-off will require about 2.5% more runway for each 10° C that the engine tailpipe is below the correct temperature for a properly tabbed engine. Therefore, it is important that the temperature indicating instrument be accurate.

DURING THE GROUND ROLL:

1. Hold the elevator in neutral.
2. Fire ATO at the recommended airspeed.
3. Allow the airplane to fly off the ground. If it tends to rock between the front and rear gears near the take-off speed, a slight pull on the elevators should be applied.

MINIMUM ATO REQUIREMENTS

On figures A-10 through A-18 are curves which show the number of ATO bottles required for take-off allowing for a single engine failure at critical engine failure speed (see part 2 for explanation of critical engine failure speed). If, from operational experience, an additional safety margin is felt necessary, more ATO bottles than the amount indicated in this part should be used.

HEADWIND CORRECTION CHART

If headwind is to be considered, the available runway length must be corrected for wind before minimum ATO requirements charts can be used. The headwind correction chart is on figure A-33. To find effective (no wind) runway length available, the horizontal scale (runway distance with headwind) is used for the true runway length and the vertical scale (runway distance - no wind) for the effective runway length. For other applications, such as finding the take-off distance with headwind when the no-wind distance is known, the chart is used in reverse manner.

EXAMPLE:

Given the following conditions and considering the possibility of an engine failure, find the minimum number of ATO bottles required for take-off.

Gross Weight = 180,000 pounds
Pressure Altitude = 1000 feet
Runway Available = 7500 feet
Wind = 20 knots
OAT = 80° F
J47-GE-25 Engines

Using the headwind correction chart, it is found that the effective no-wind runway length for a 20-knot headwind and a 7500-foot runway is about 9700 feet.

NORMAL TAKE-OFF DISTANCE - 18 BOTTLES

The normal take-off distance chart, figure A-19, gives the distance to take-off when 18 ATO bottles are fired 10 seconds before take-off, allowing 5 seconds of ATO for extra performance while the gear is being retracted. The chart is based on normal engine operation with six engines operating at full power during the entire take-off run. The normal take-off distance, using 18 bottles, for the preceding example is 8200 feet. From the headwind correction chart, normal take-off distance with a 20-knot wind is found to be 6300 feet.

The ATO firing speed chart for normal take-off with 18 bottles is found on figure A-20. Continuing the example, the firing speed for the specified conditions is 119 knots IAS.

MINIMUM FLIGHT DISTANCE OVER A 50-FOOT OBSTACLE

Since the distance from the take-off point to a 50-foot obstacle depends to a large extent upon pilot technique, the chart on figure A-32 can serve only as an approximation. Firing 18 ATO bottles, the distance from the take-off point to a 50-foot obstacle for the condition of the example is found to be 1340 feet.

RUNWAY GRADE CORRECTION

A discussion of the effect of runway grade and an approximate correction to take-off distance which can be applied are included in part 2.

Minimum ATO requirements for a 9000-foot runway are found on figure A-13, and for a 10,000-foot runway, on figure A-14. ATO requirements for these two runway lengths and the conditions of the example are 18 bottles and 12 bottles respectively. Requirements for a 9700-foot runway would then be about 14 bottles.

ATO FIRING SPEED FOR MINIMUM NUMBER OF BOTTLES

As explained in part 1, ground effect introduces about a 4-knot error in the airspeed indicator reading during take-off. The firing speeds in part 3 have been corrected for this error and therefore represent actual indicator readings.

The ATO firing speed charts on figures A-22 through A-31, are used in an identical manner as the preceding minimum ATO requirements charts. Continuing the foregoing example, the following values are obtained from the applicable firing speed charts:

9,000-foot runway: 119 knots IAS
10,000-foot runway: 126 knots IAS

Therefore, the ATO firing speed for a 9700-foot runway is about 124 knots IAS.

TAKE-OFF REFUSAL SPEED

The available runway length determines the highest speed at which the pilot can stop in the event of an engine failure. Charts of these critical engine failure speeds and a description of their functions are presented in part 4.

Since the ATO, once fired, cannot be extinguished, the take-off committed when the firing speed is attained. Consequently, if for a particular take-off the refusal speed is found to be higher than the ATO firing speed, the refusal speed must be set equal to the firing speed.

TAKE-OFF SPEED

Take-off speeds (IAS) are shown on figure A-8. For the preceding example the take-off speed is 161 knots IAS.

SUMMARY - TAKE-OFF CORRECTIONS

Refer to the chart at the end of the text of part 2 for take-off performance variables.

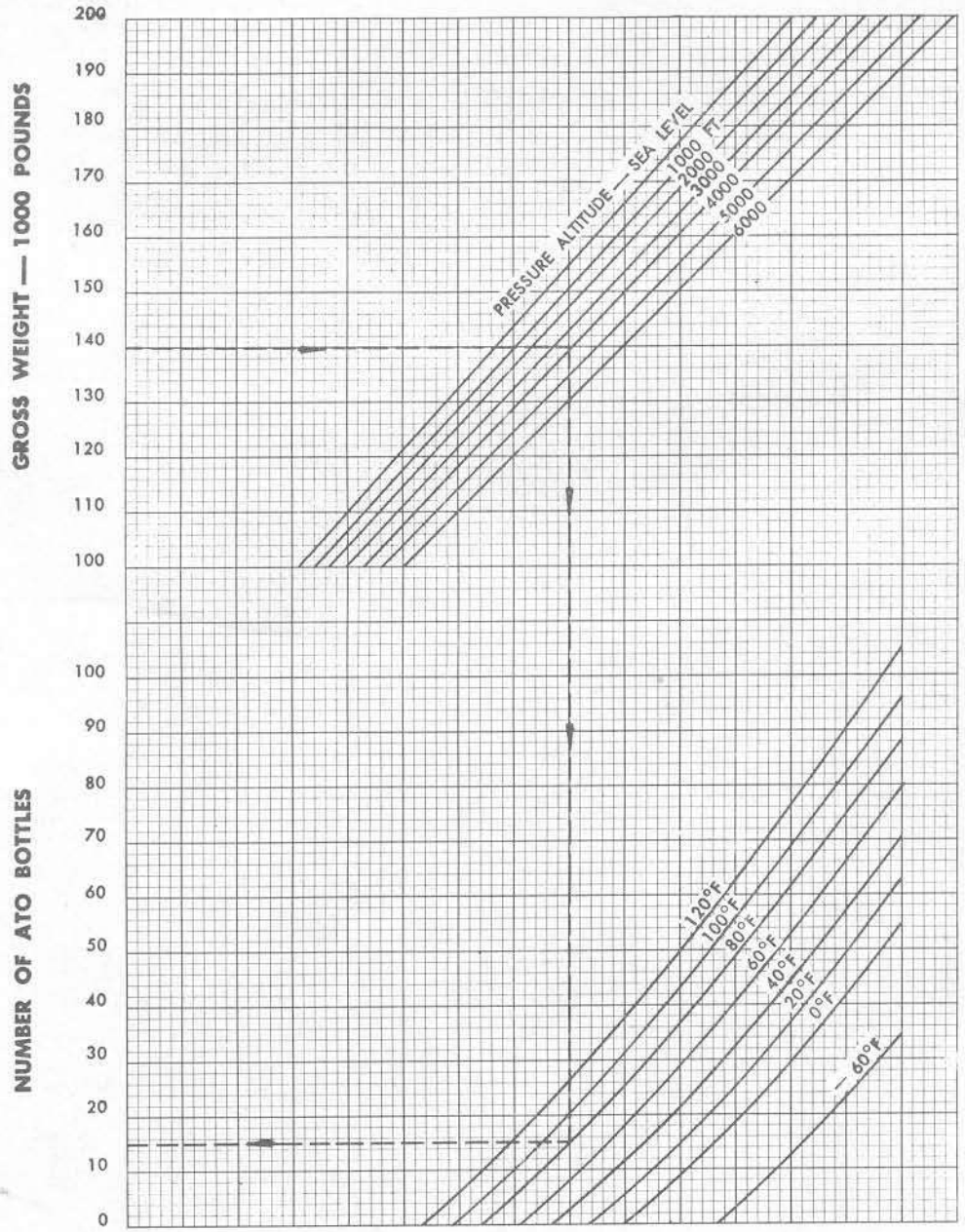
MINIMUM ATO REQUIREMENTS

SINGLE ENGINE FAILURE AT CRITICAL FAILURE SPEED

6000 FT RUNWAY

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: NO WATER INJECTION

DATE: NOVEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-10.

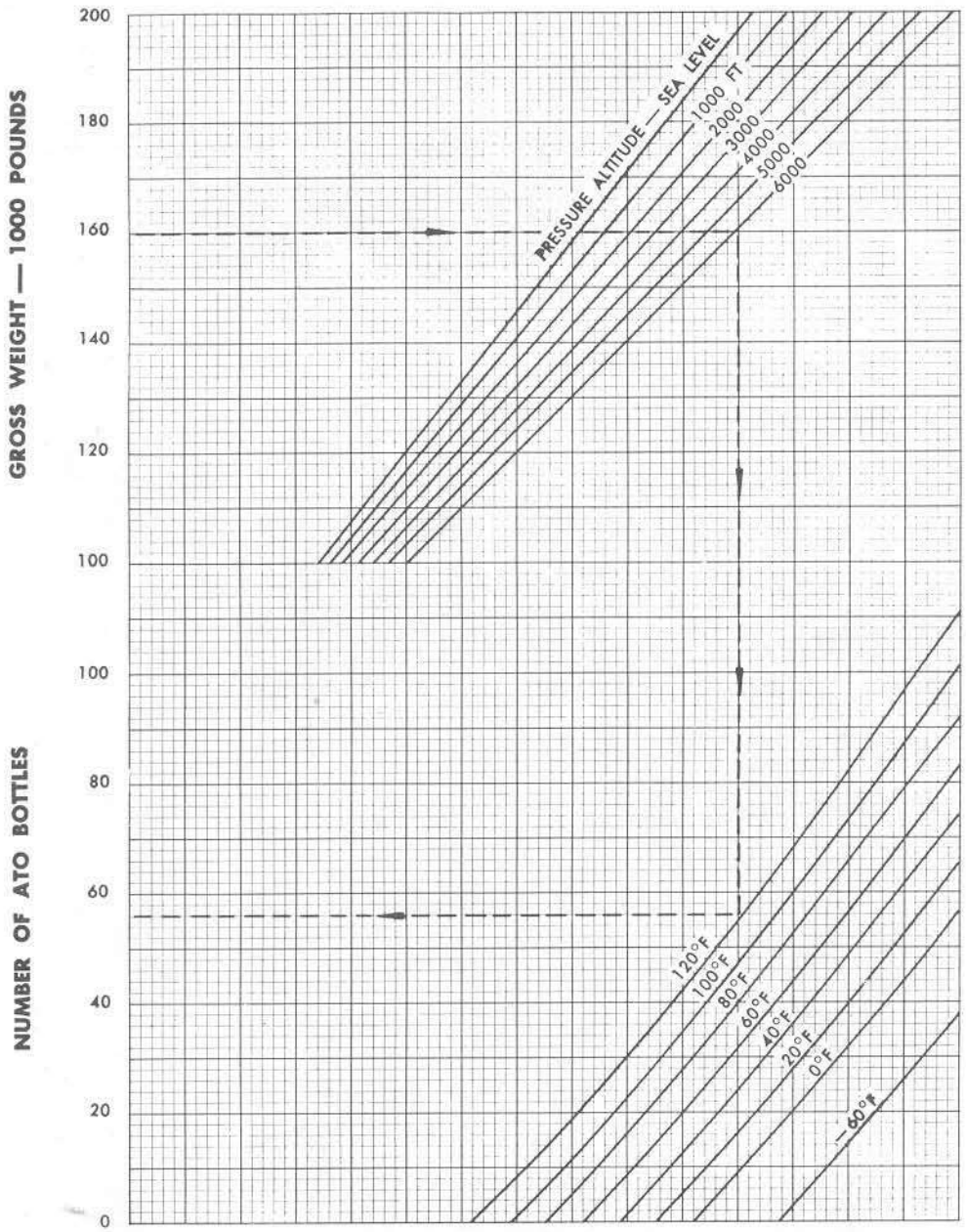
MINIMUM ATO REQUIREMENTS

SINGLE ENGINE FAILURE AT CRITICAL FAILURE SPEED

7000 FT RUNWAY

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: NO WATER INJECTION

DATE: DECEMBER 1952
DATA BASIS: FLIGHT TEST

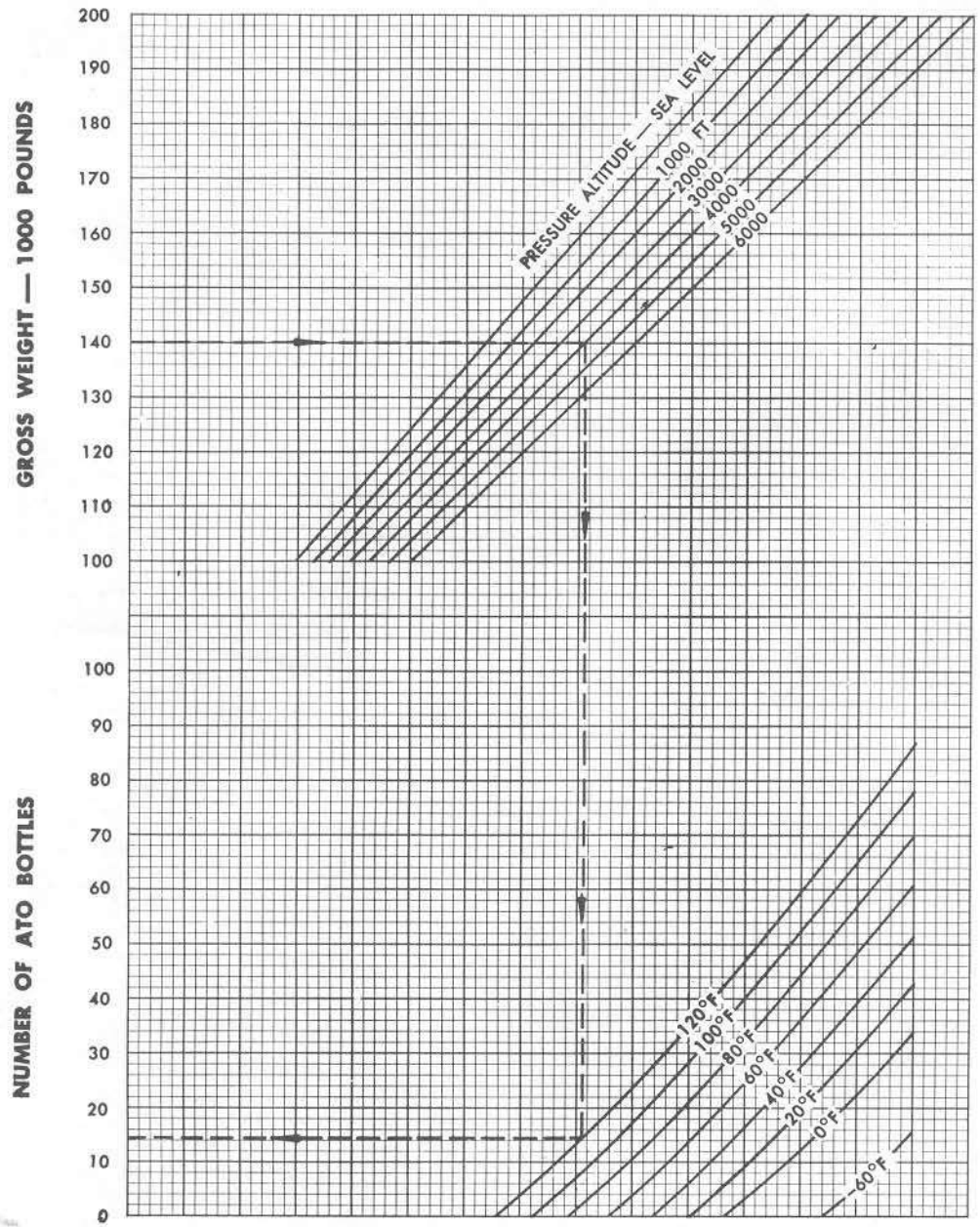
Figure A-11.

MINIMUM ATO REQUIREMENTS

SINGLE ENGINE FAILURE AT CRITICAL FAILURE SPEED
8000 FT RUNWAY

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: NO WATER INJECTION

DATE: NOVEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-12.

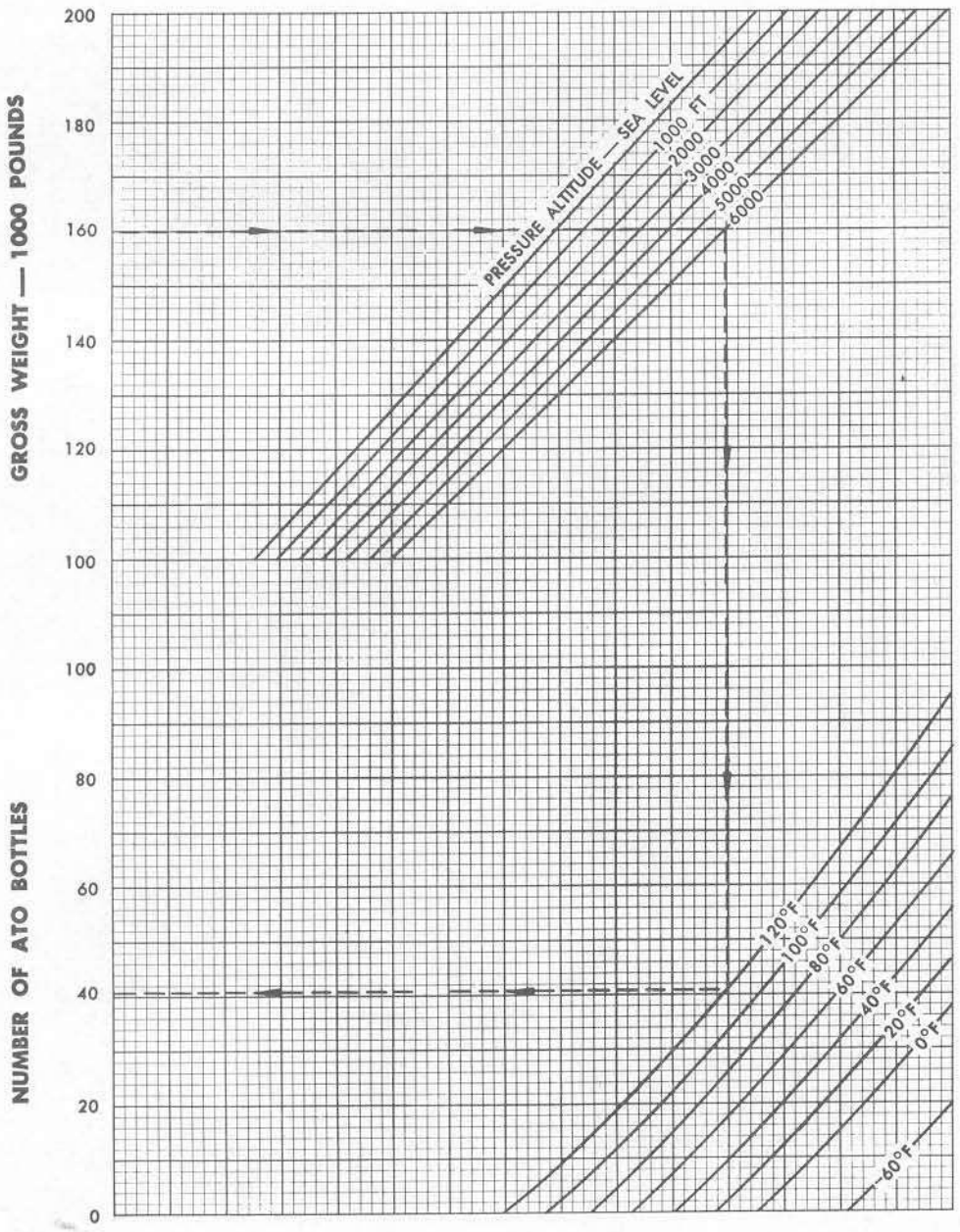
MINIMUM ATO REQUIREMENTS

SINGLE ENGINE FAILURE AT CRITICAL FAILURE SPEED

9000 FT RUNWAY

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: NO WATER INJECTION

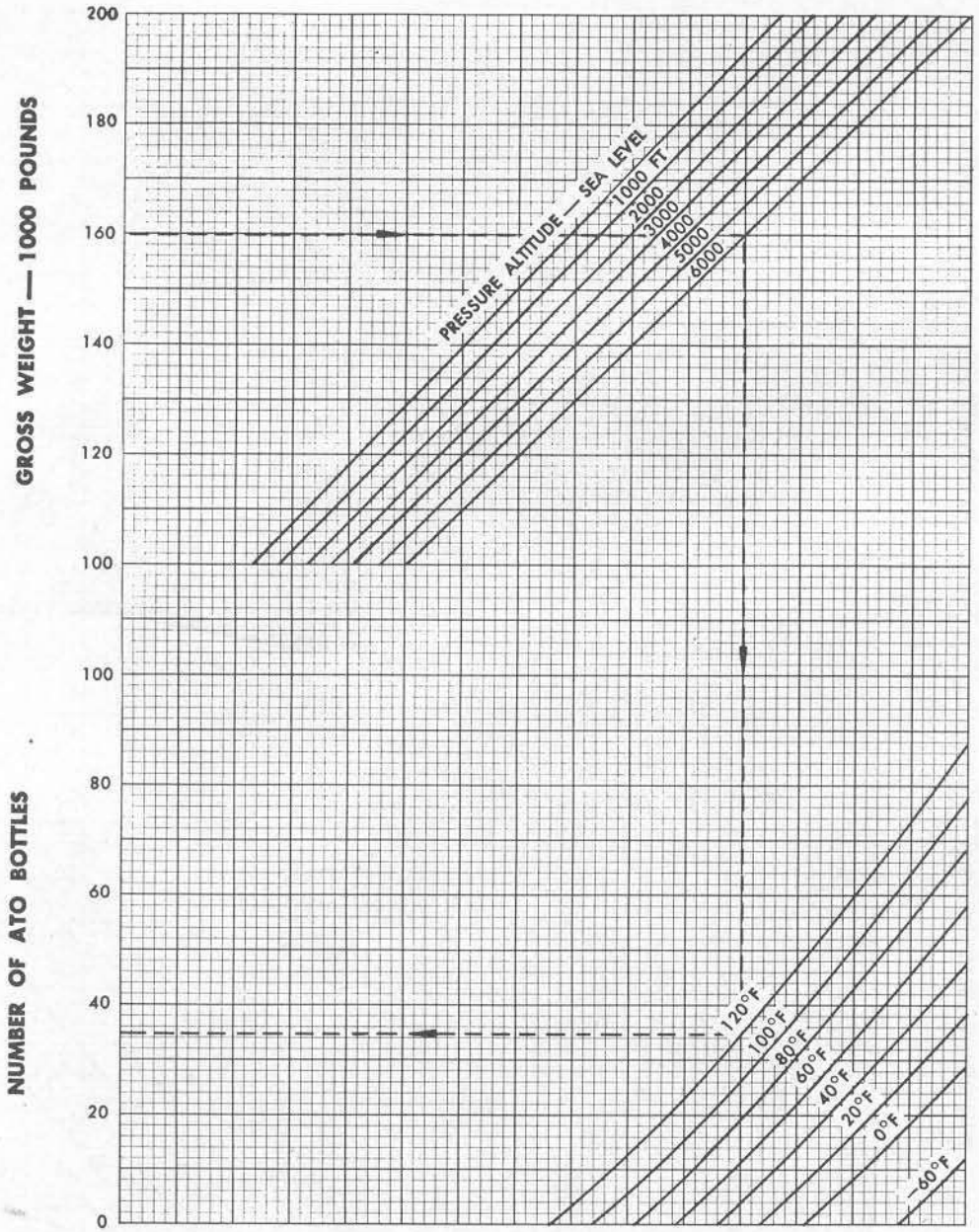
DATE: DECEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-13.

MINIMUM ATO REQUIREMENTS
SINGLE ENGINE FAILURE AT CRITICAL FAILURE SPEED
10,000 FT RUNWAY

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: NO WATER INJECTION

DATE: DECEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-14.

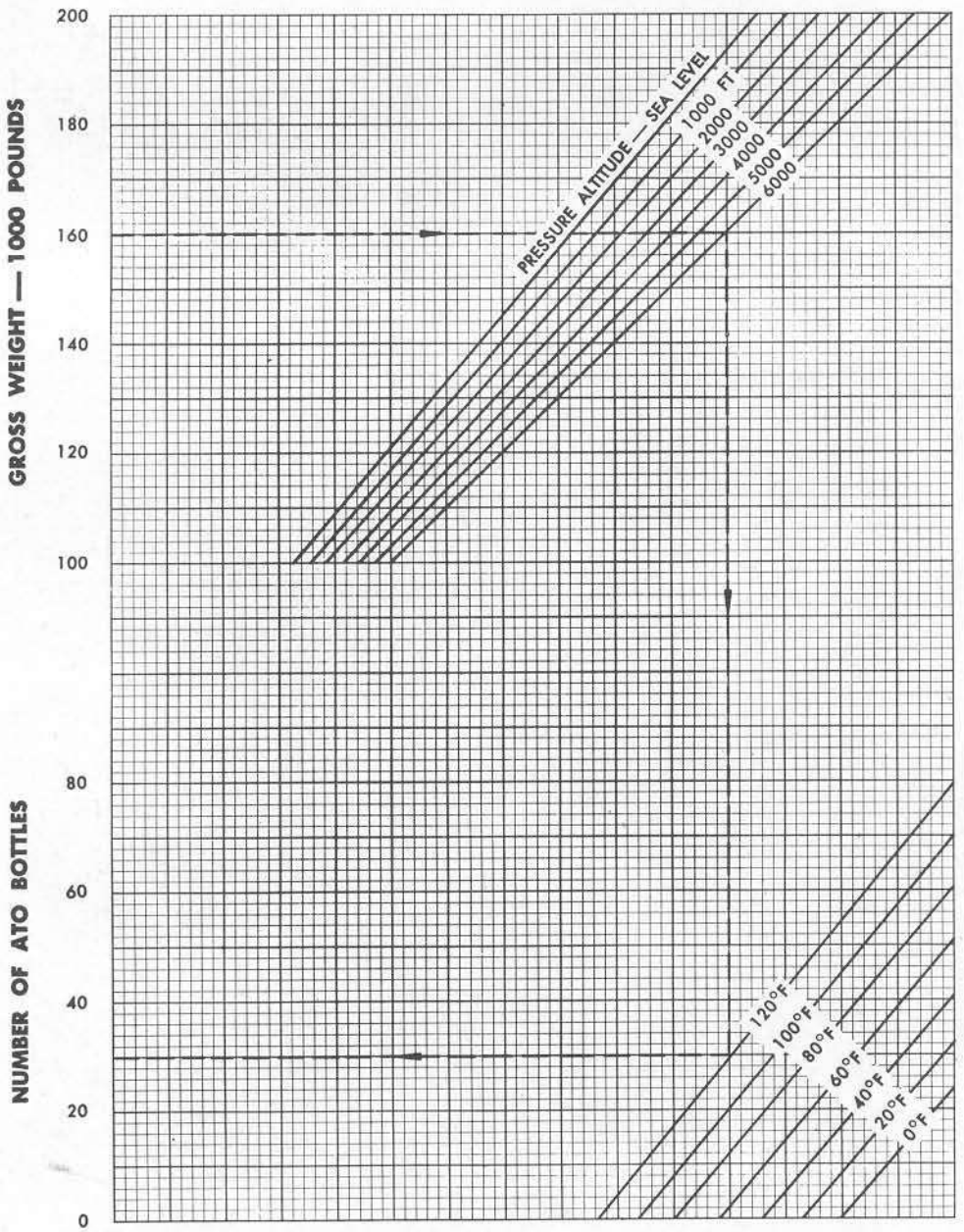
MINIMUM ATO REQUIREMENTS

SINGLE ENGINE FAILURE AT CRITICAL FAILURE SPEED

11,000 FT RUNWAY

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: NO WATER INJECTION

DATE: DECEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-15.

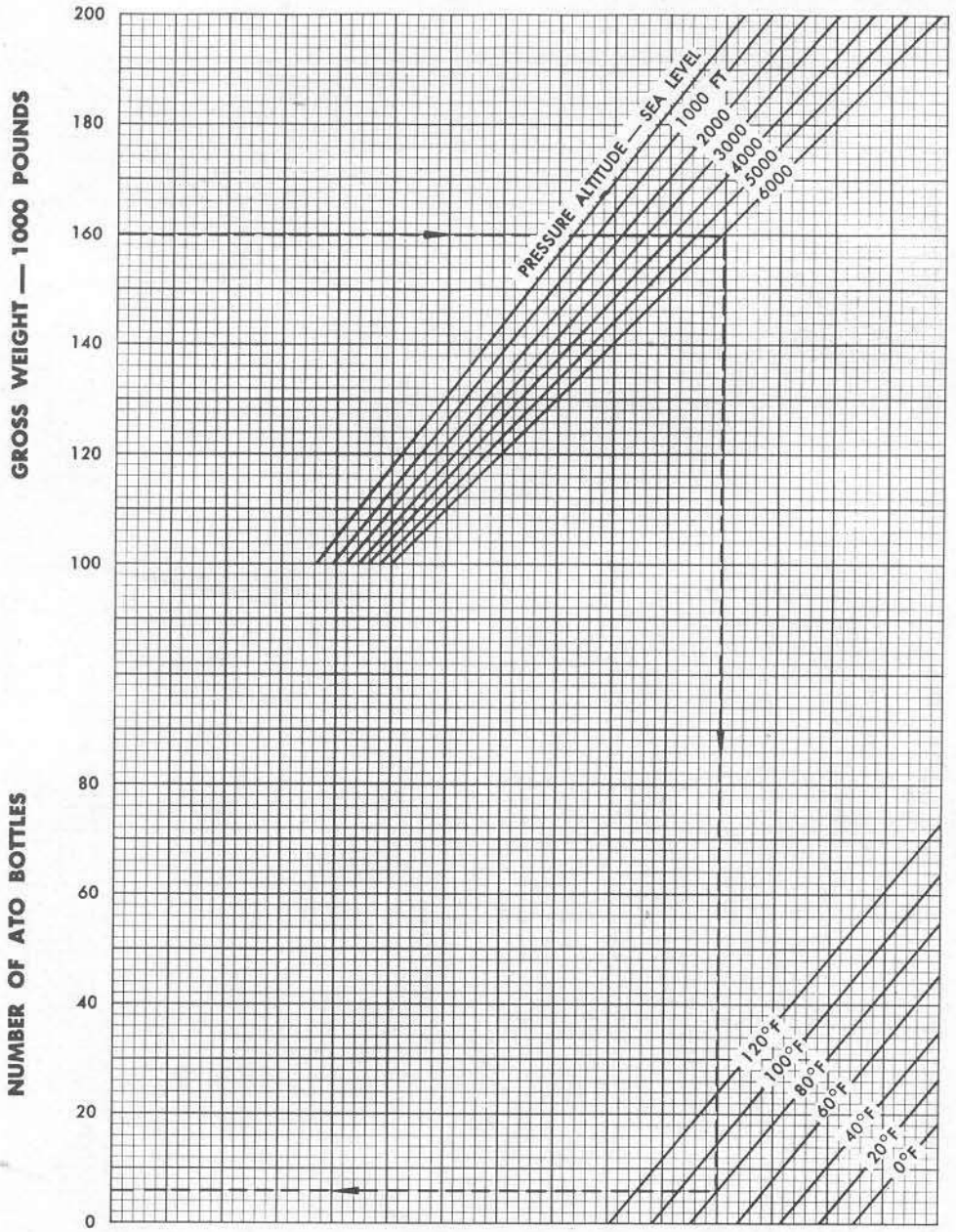
MINIMUM ATO REQUIREMENTS

SINGLE ENGINE FAILURE AT CRITICAL FAILURE SPEED

12,000 FT RUNWAY

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: NO WATER INJECTION

DATE: DECEMBER 1952

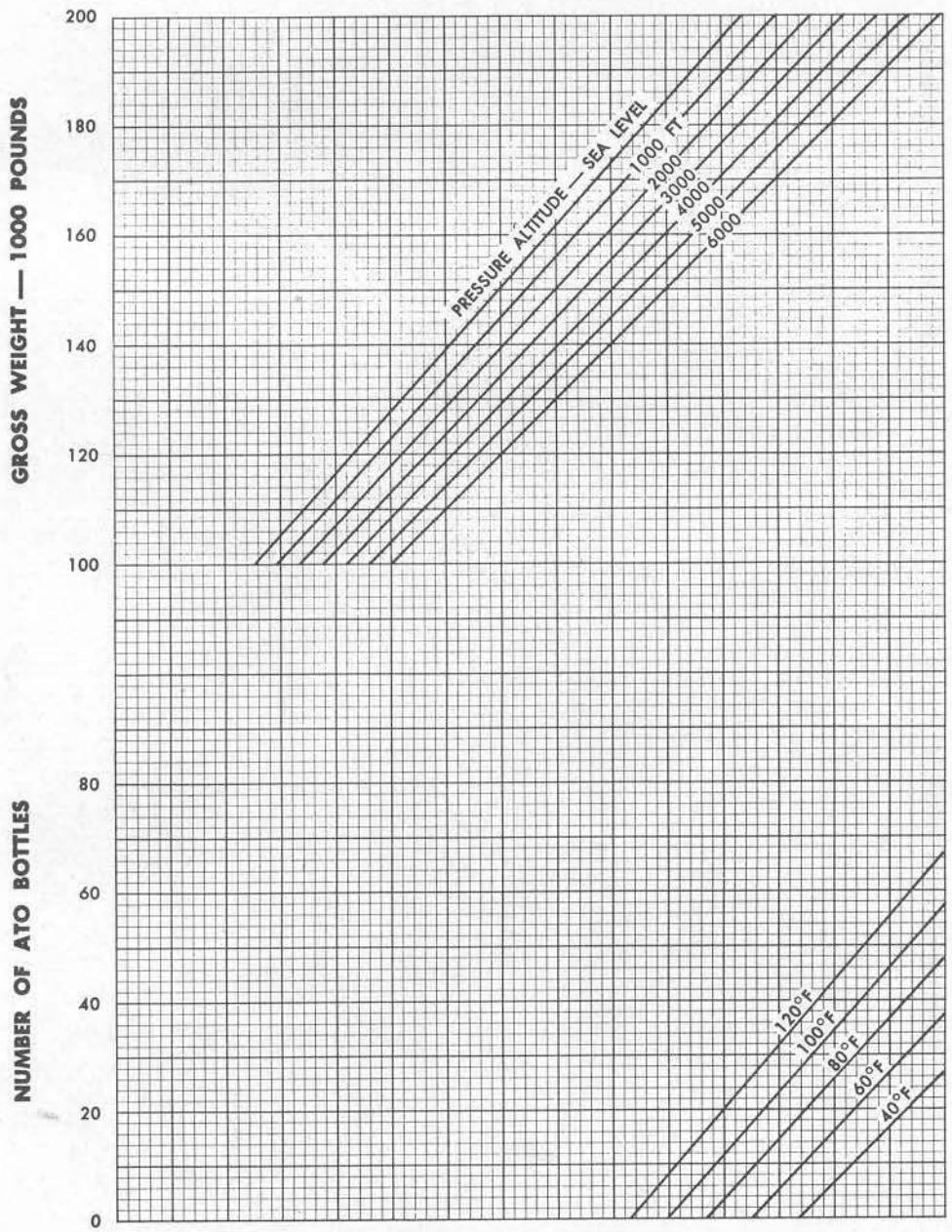
DATA BASIS: FLIGHT TEST

Figure A-16.

MINIMUM ATO REQUIREMENTS
SINGLE ENGINE FAILURE AT CRITICAL FAILURE SPEED
13,000 FT RUNWAY

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: NO WATER INJECTION

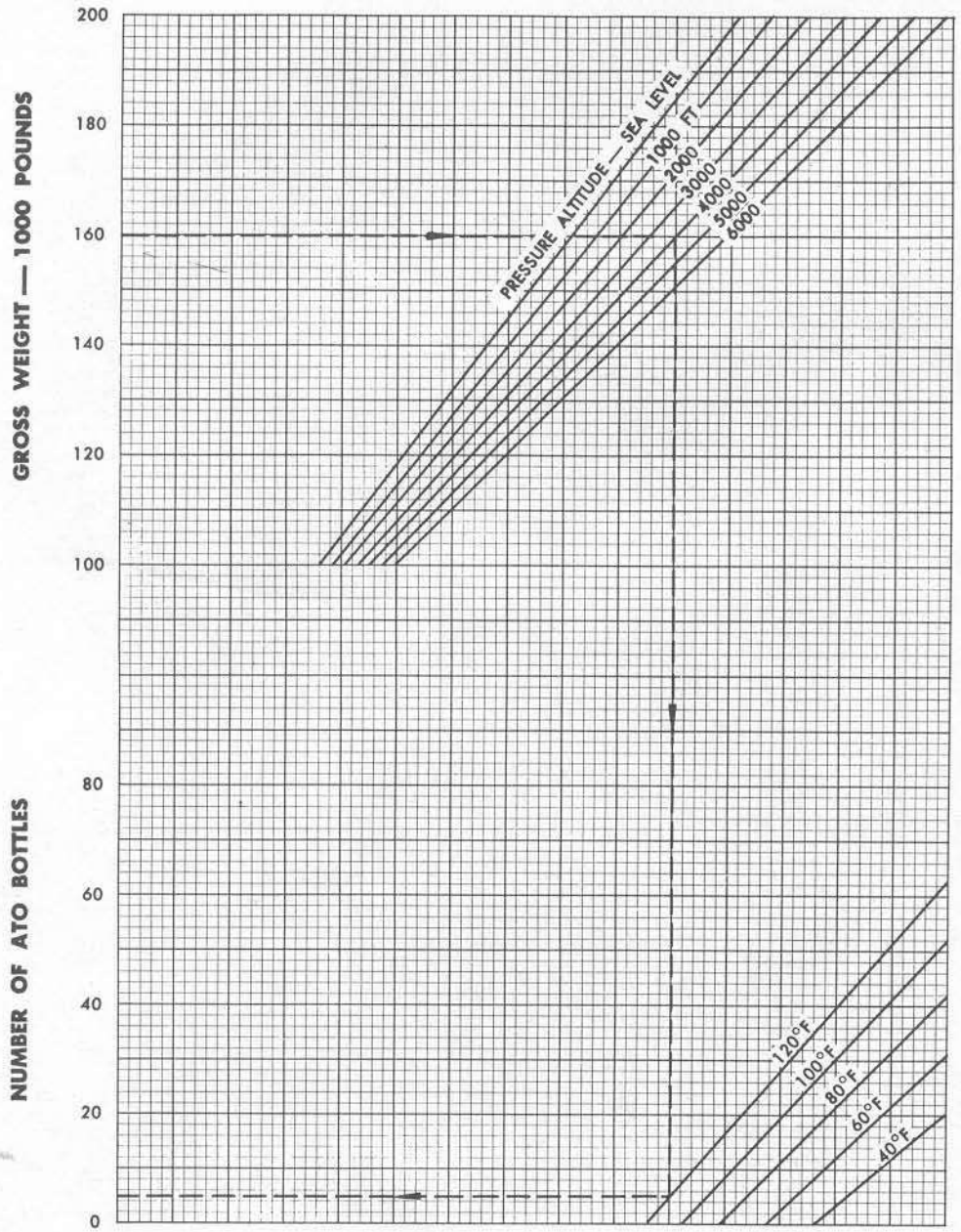
DATE: DECEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-17.

MINIMUM ATO REQUIREMENTS
SINGLE ENGINE FAILURE AT CRITICAL FAILURE SPEED
14,000 FT RUNWAY

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: NO WATER INJECTION

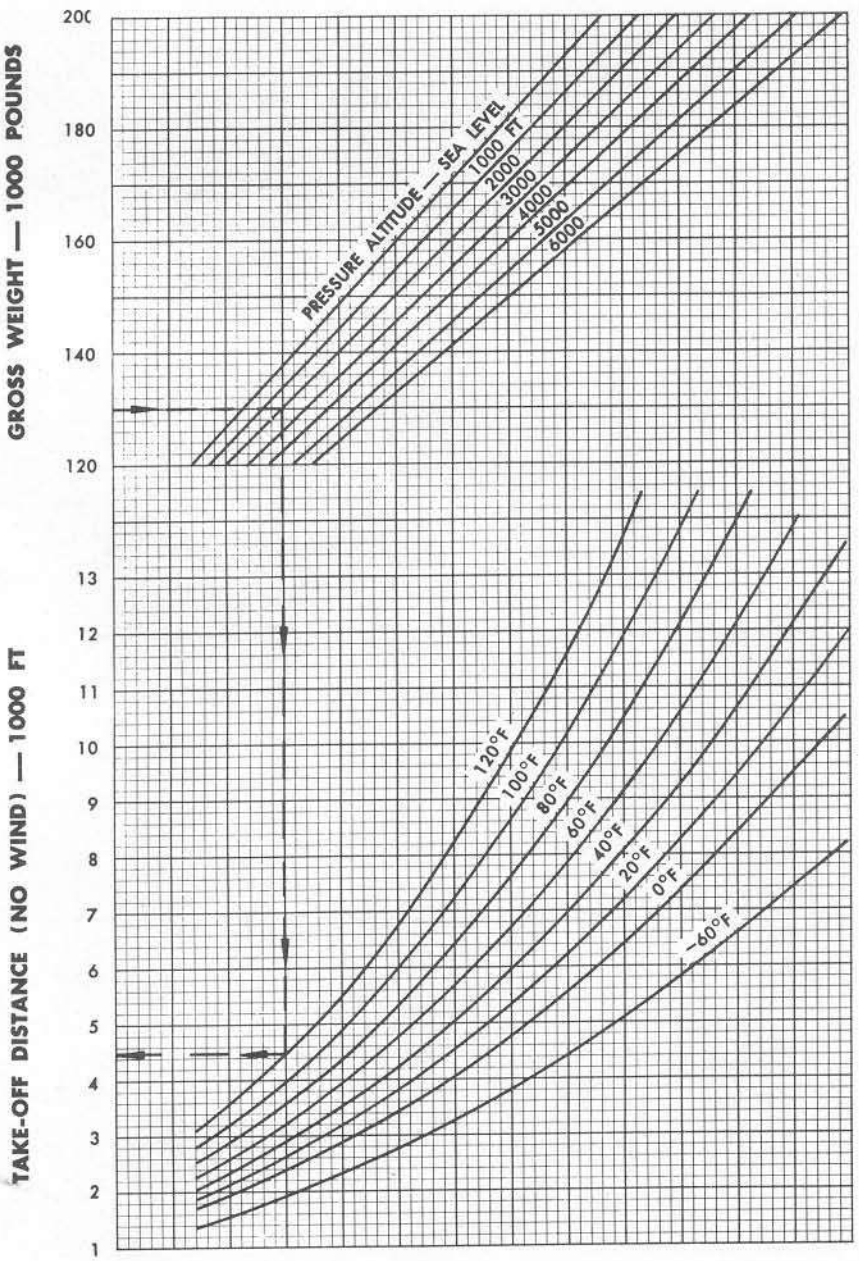
DATE: DECEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-18.

TAKE-OFF GROUND ROLL
18 ATO BOTTLES

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: NO WATER INJECTION

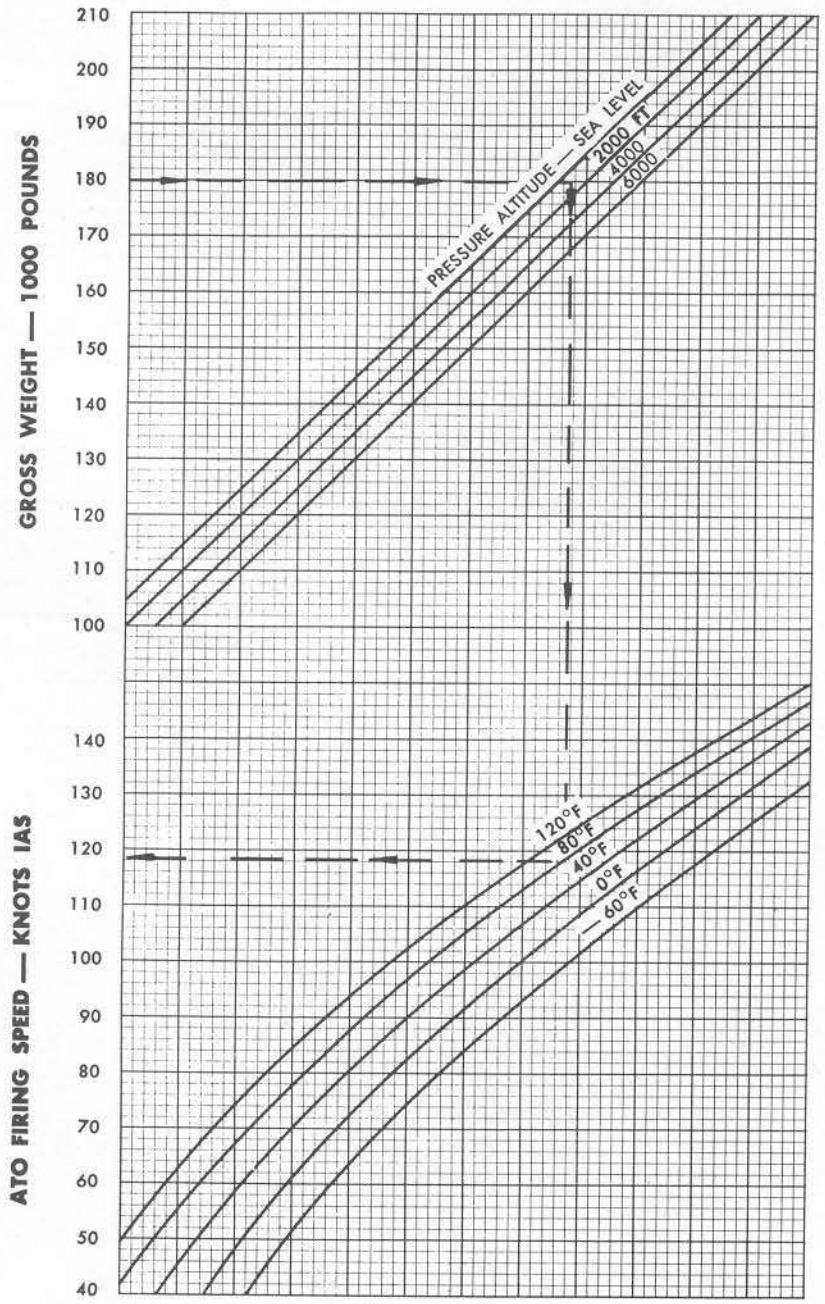
DATE: OCTOBER 1952
DATA BASIS: FLIGHT TEST

Figure A-19.

ATO FIRING SPEED FOR NORMAL TAKE-OFF DISTANCE
18 ATO BOTTLES

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: NO WATER INJECTION

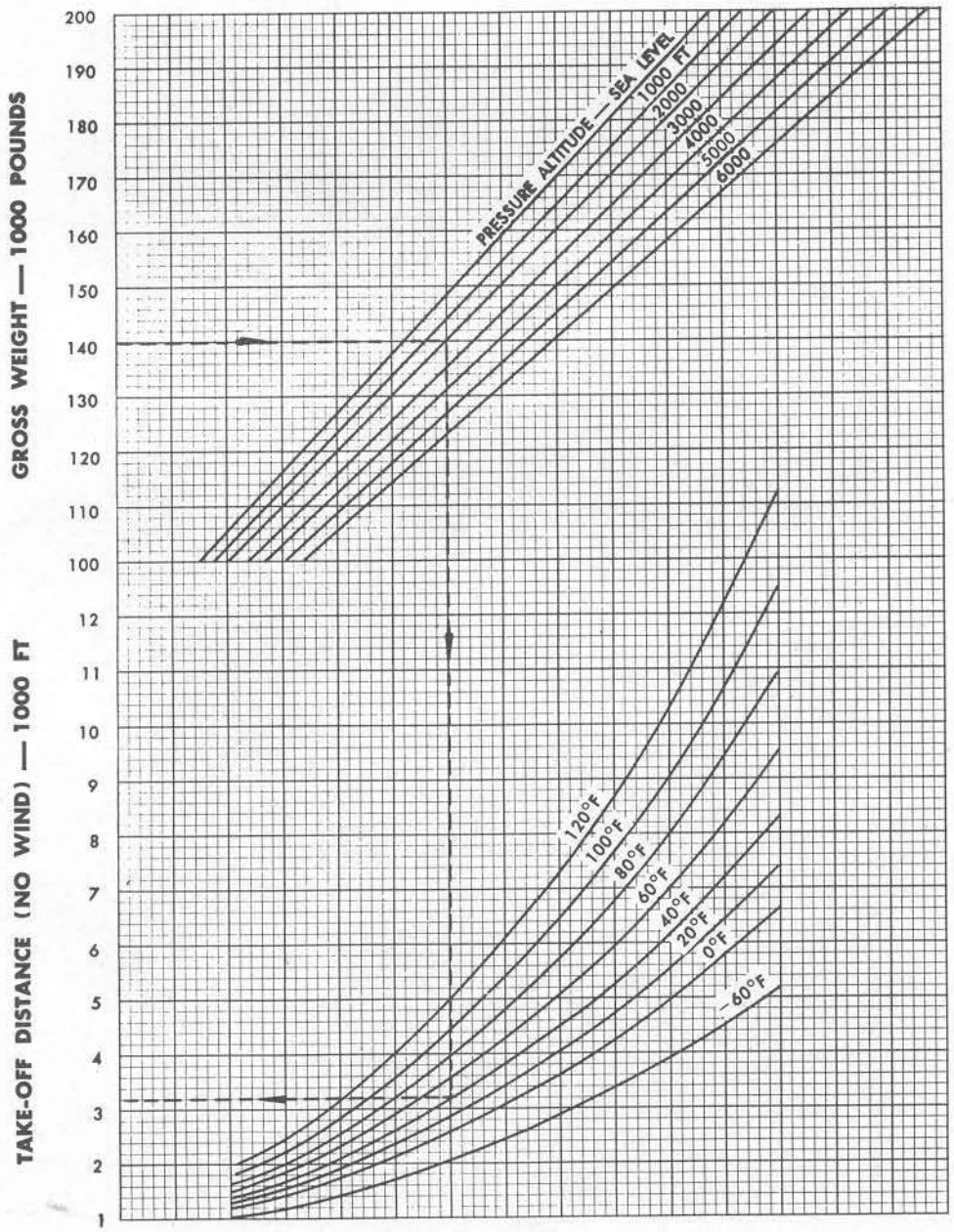
DATE: NOVEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-20.

MINIMUM TAKE-OFF DISTANCE
18 ATO BOTTLES

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: NO WATER INJECTION

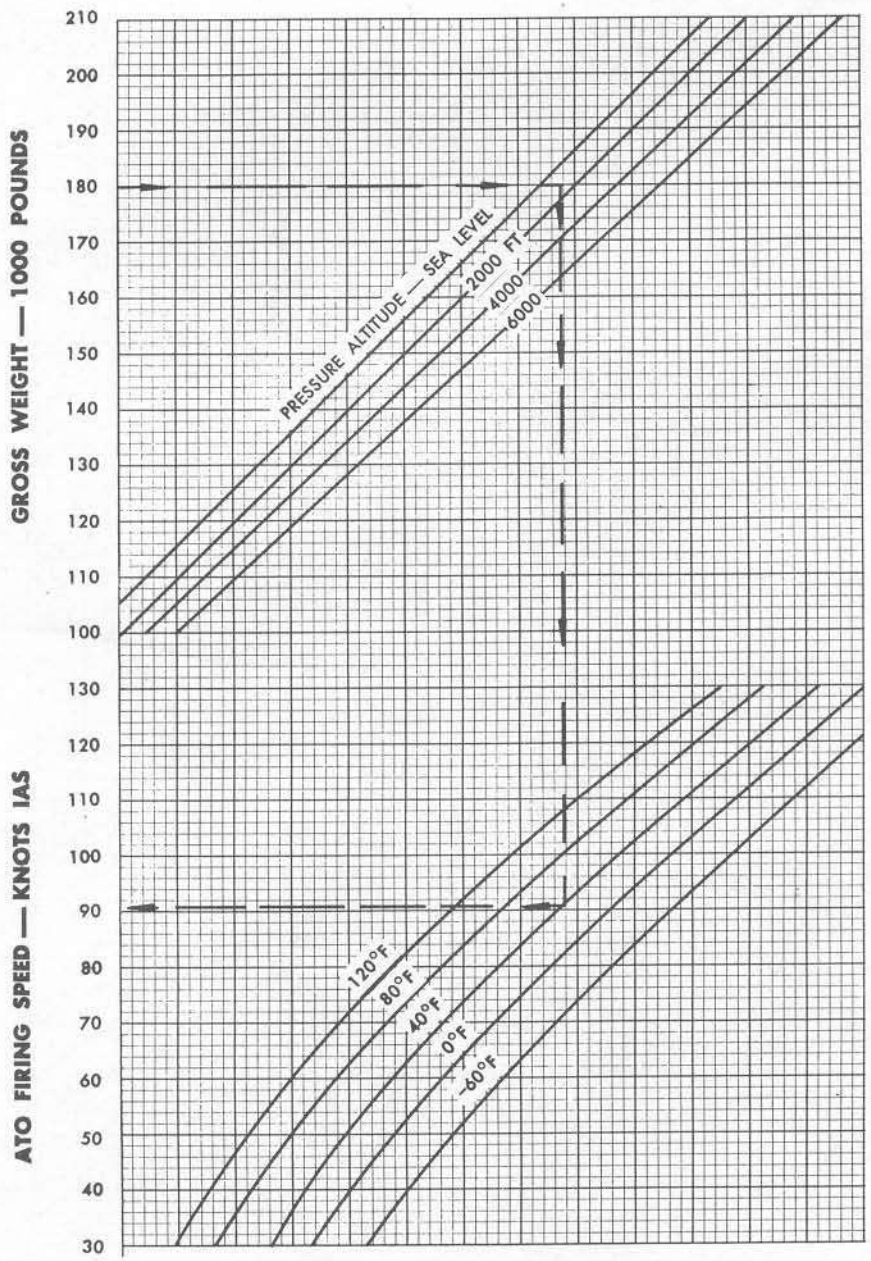
DATE: NOVEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-21.

ATO FIRING SPEED FOR MINIMUM TAKE-OFF DISTANCE
18 ATO BOTTLES

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: NO WATER INJECTION

DATE: NOVEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-22.

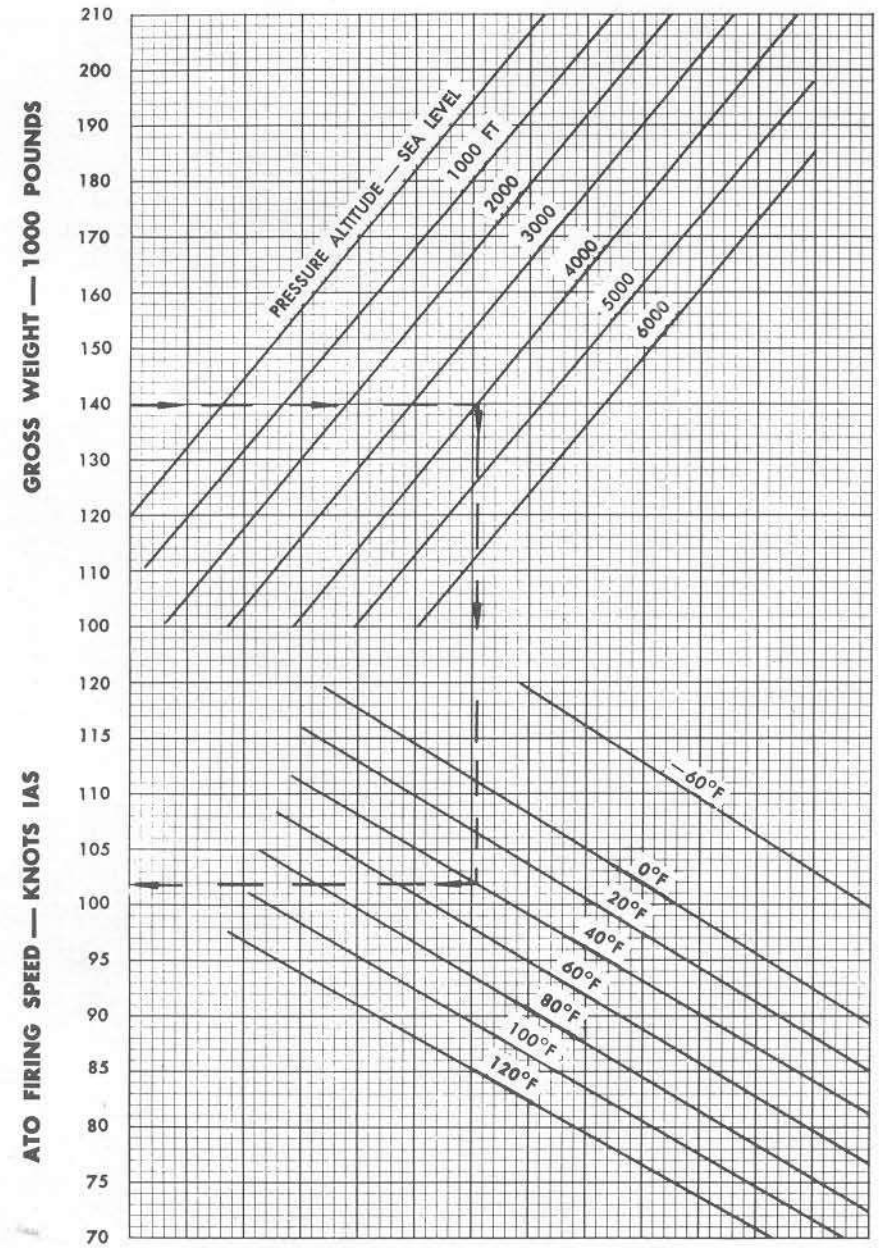
ATO FIRING SPEEDS FOR MINIMUM ATO REQUIREMENTS

SINGLE ENGINE FAILURE AT CRITICAL FAILURE SPEED

6000 FT RUNWAY

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: NO WATER INJECTION

DATE: DECEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-23.

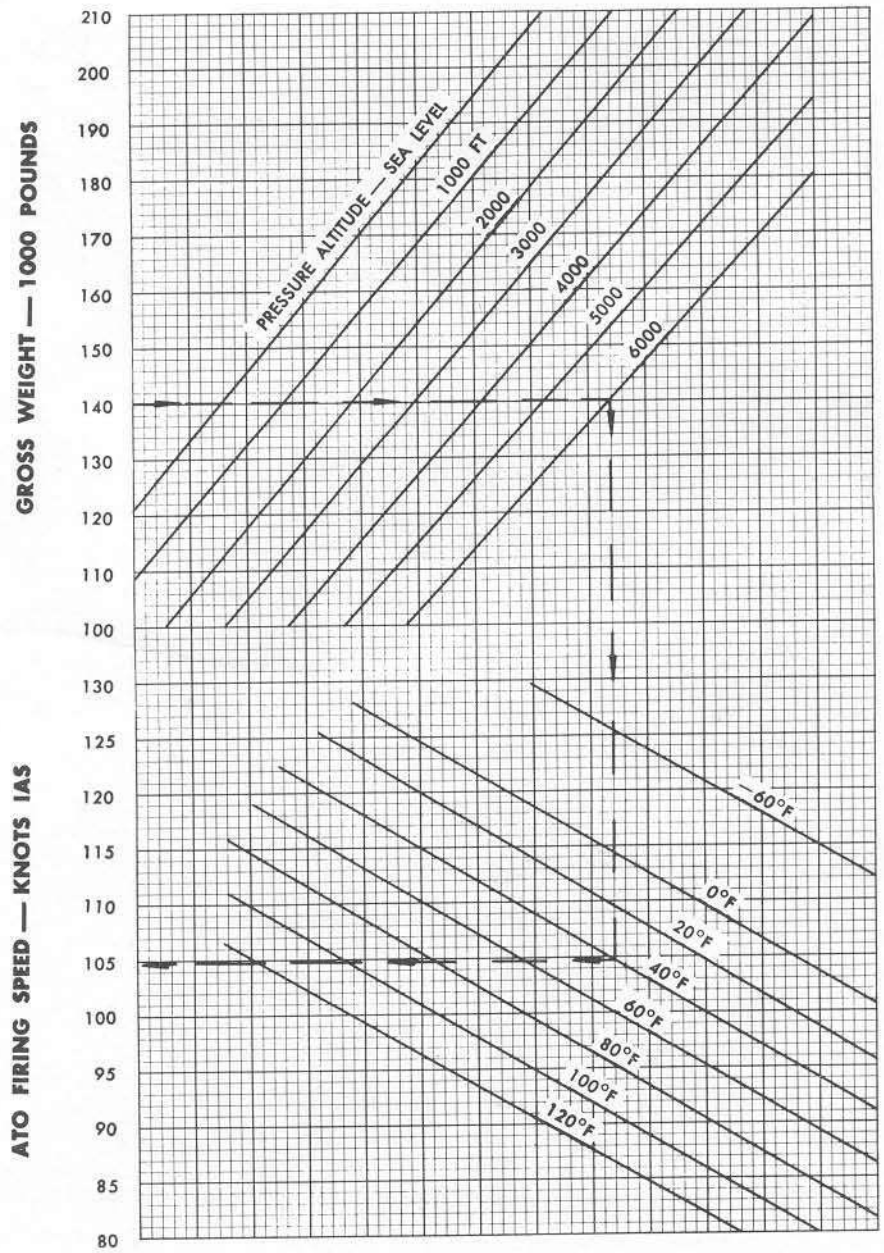
ATO FIRING SPEEDS FOR MINIMUM ATO REQUIREMENTS

SINGLE ENGINE FAILURE AT CRITICAL FAILURE SPEED

7000 FT RUNWAY

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: NO WATER INJECTION

DATE: DECEMBER 1952

DATA BASIS: FLIGHT TEST

Figure A-24.

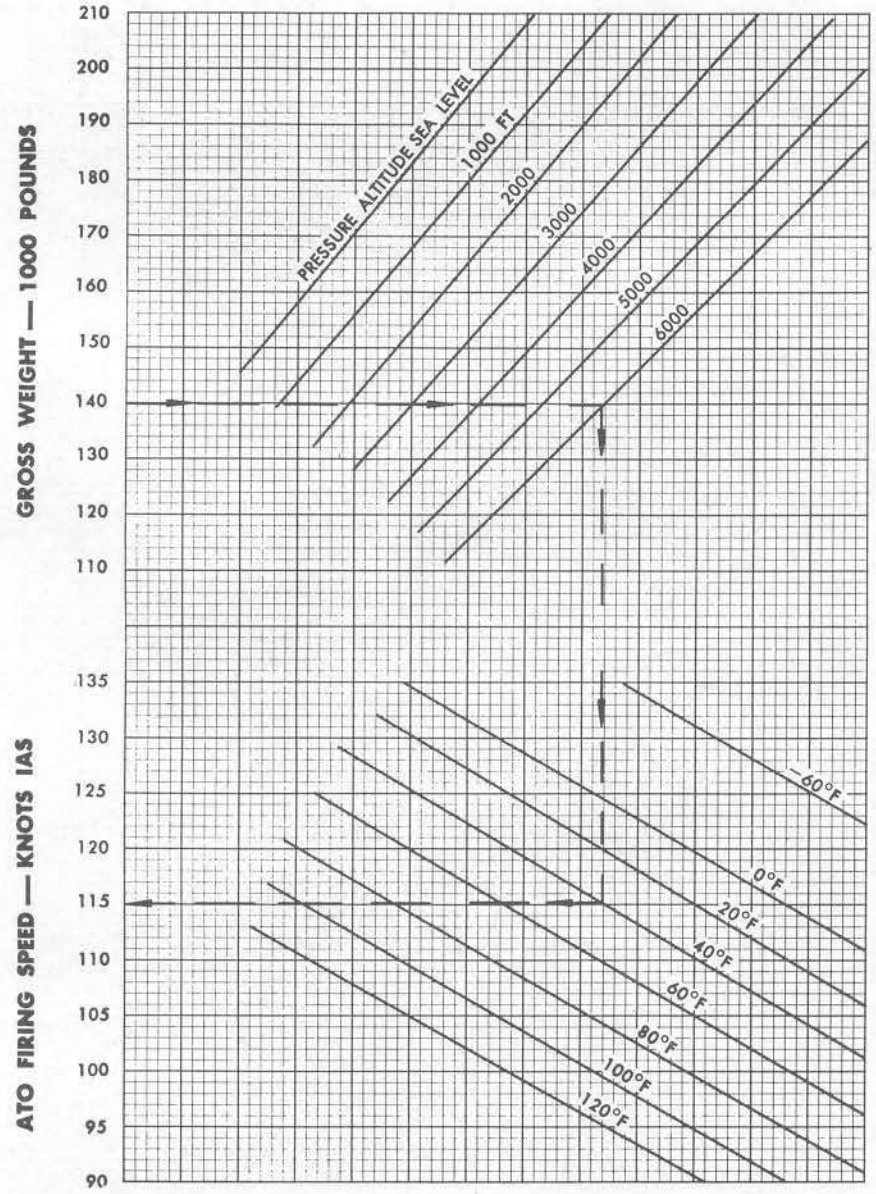
ATO FIRING SPEEDS FOR MINIMUM ATO REQUIREMENTS

SINGLE ENGINE FAILURE AT CRITICAL FAILURE SPEED

8000 FT RUNWAY

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: NO WATER INJECTION

DATE: DECEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-25.

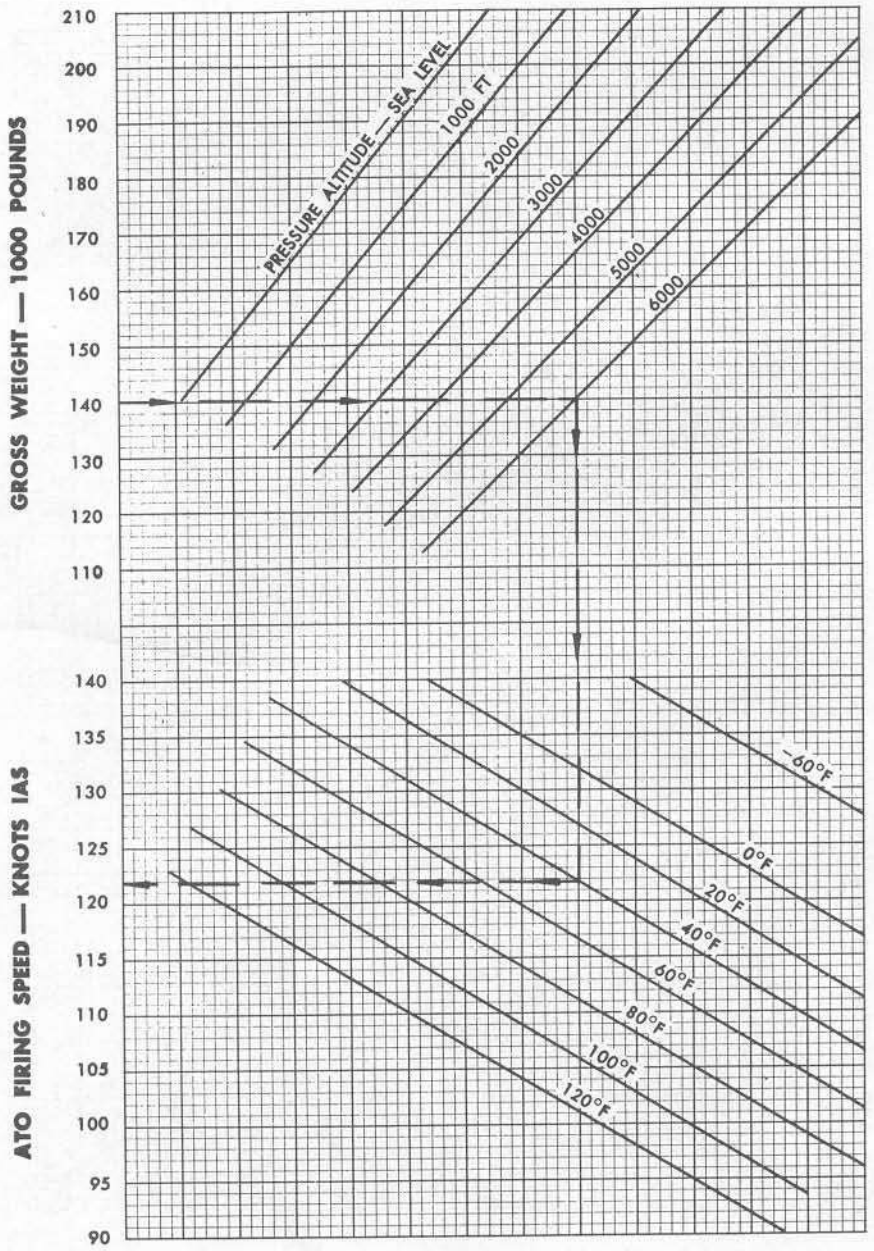
ATO FIRING SPEEDS FOR MINIMUM ATO REQUIREMENTS

SINGLE ENGINE FAILURE AT CRITICAL FAILURE SPEED

9000 FT RUNWAY

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: NO WATER INJECTION

DATE: DECEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-26.

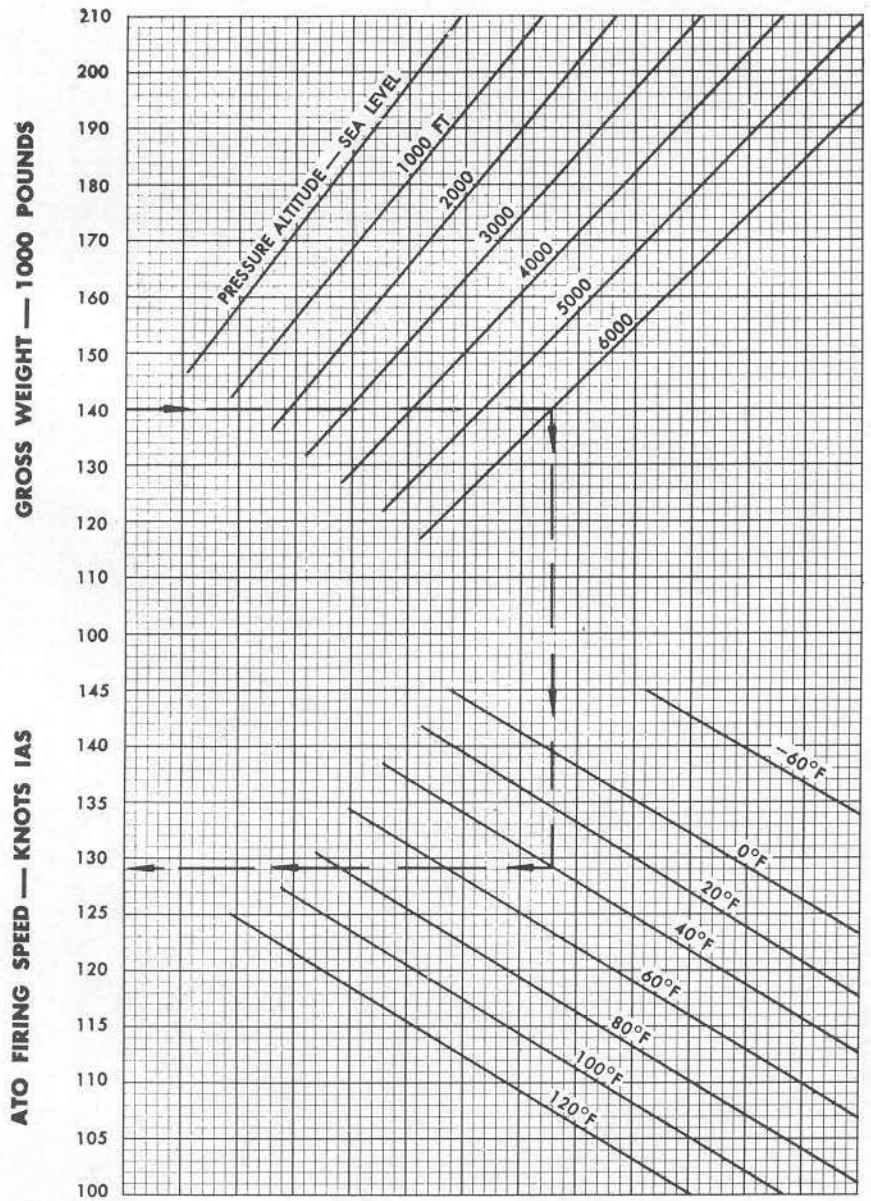
ATO FIRING SPEEDS FOR MINIMUM ATO REQUIREMENTS

SINGLE ENGINE FAILURE AT CRITICAL FAILURE SPEED

10,000 FT RUNWAY

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: NO WATER INJECTION

DATE: DECEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-27.

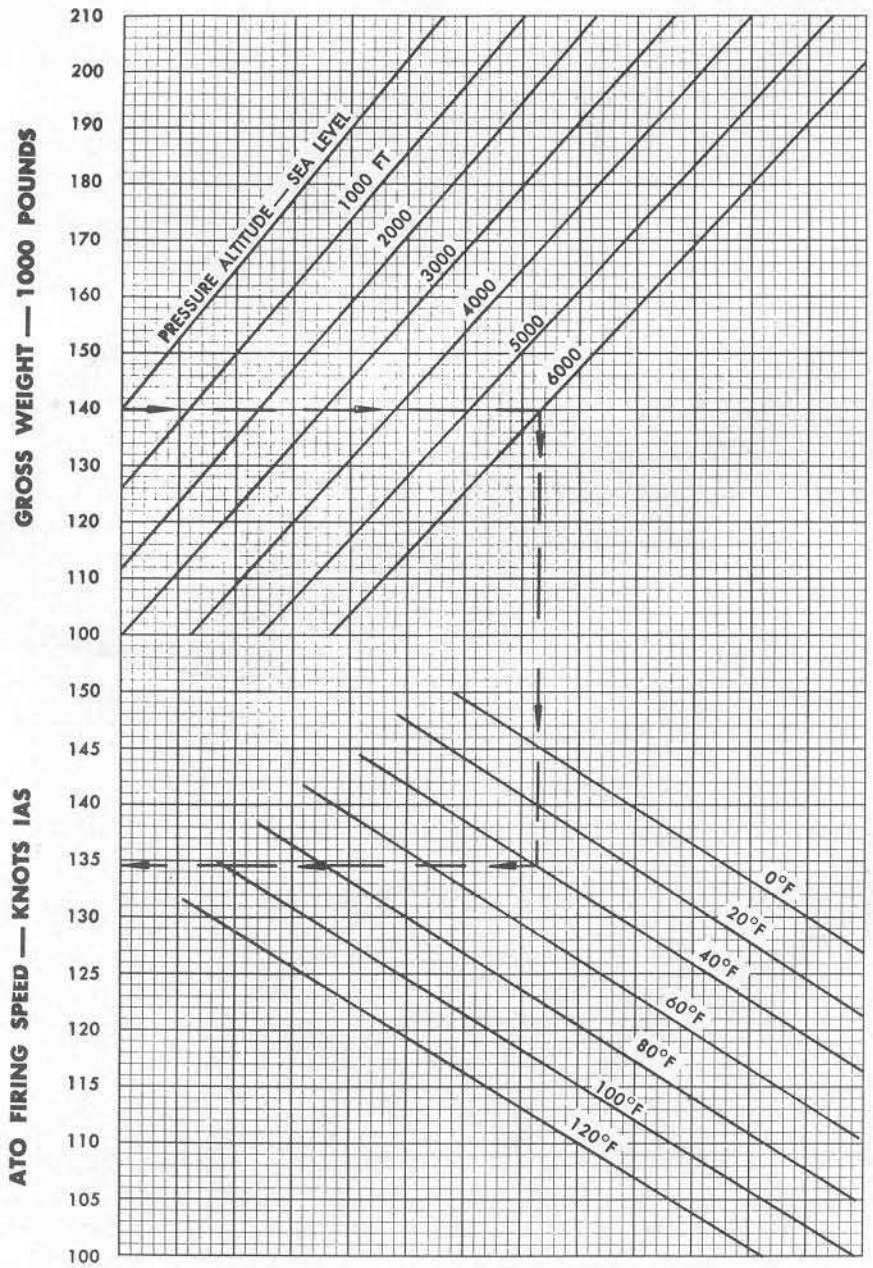
ATO FIRING SPEEDS FOR MINIMUM ATO REQUIREMENTS

SINGLE ENGINE FAILURE AT CRITICAL FAILURE SPEED

11,000 FT RUNWAY

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: NO WATER INJECTION

DATE: DECEMBER 1952

DATA BASIS: FLIGHT TEST

Figure A-28.

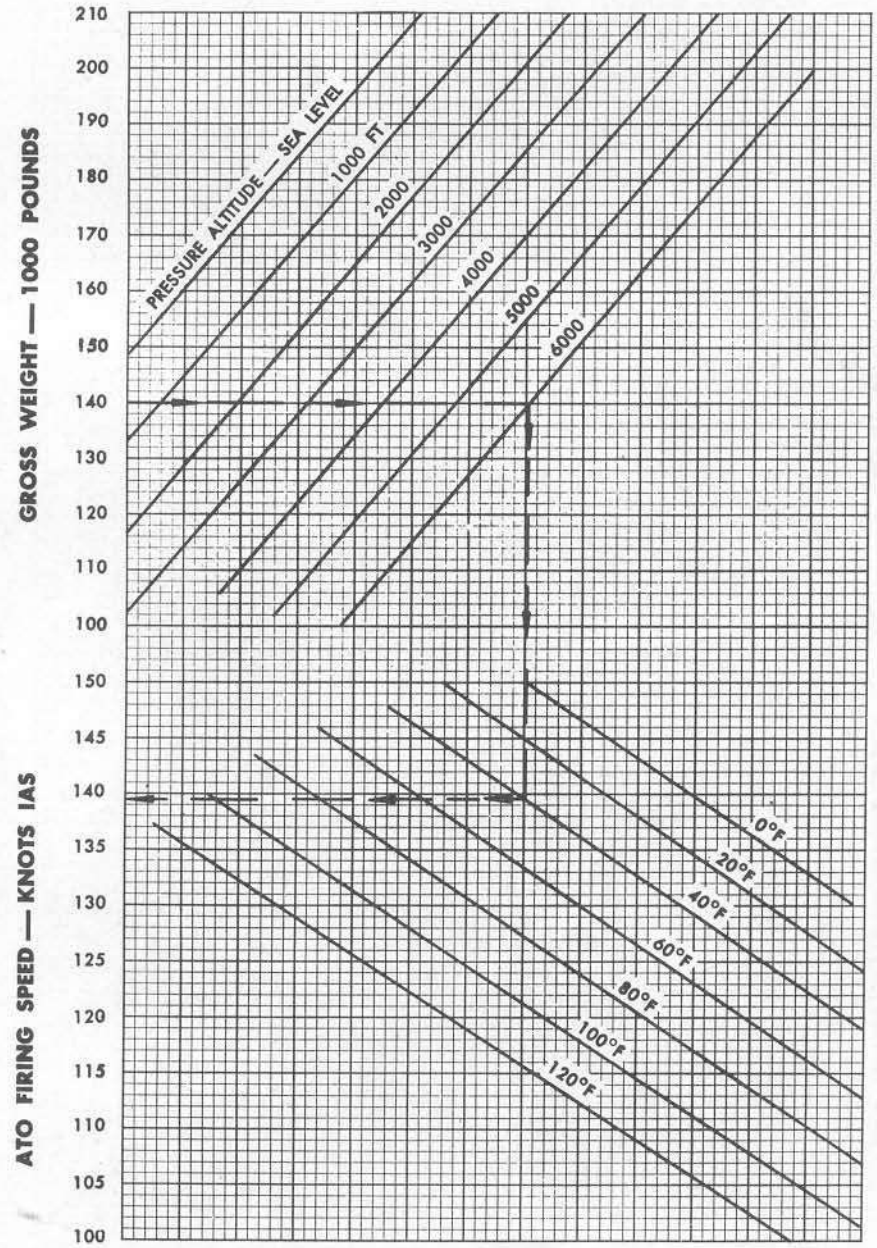
ATO FIRING SPEEDS FOR MINIMUM ATO REQUIREMENTS

SINGLE ENGINE FAILURE AT CRITICAL FAILURE SPEED

12,000 FT RUNWAY

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: NO WATER INJECTION

DATE: DECEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-29.

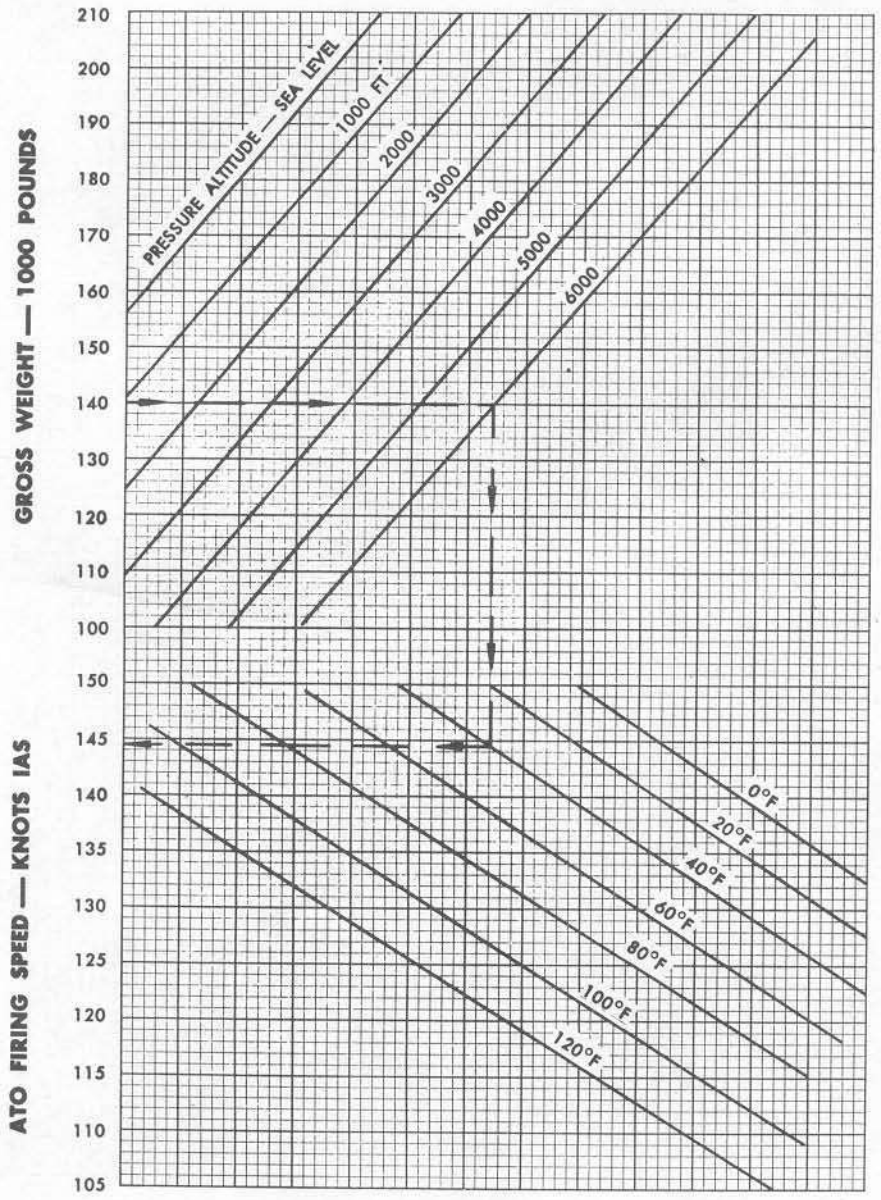
ATO FIRING SPEEDS FOR MINIMUM ATO REQUIREMENTS

SINGLE ENGINE FAILURE AT CRITICAL FAILURE SPEED

13,000 FT RUNWAY

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: NO WATER INJECTION

DATE: DECEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-30.

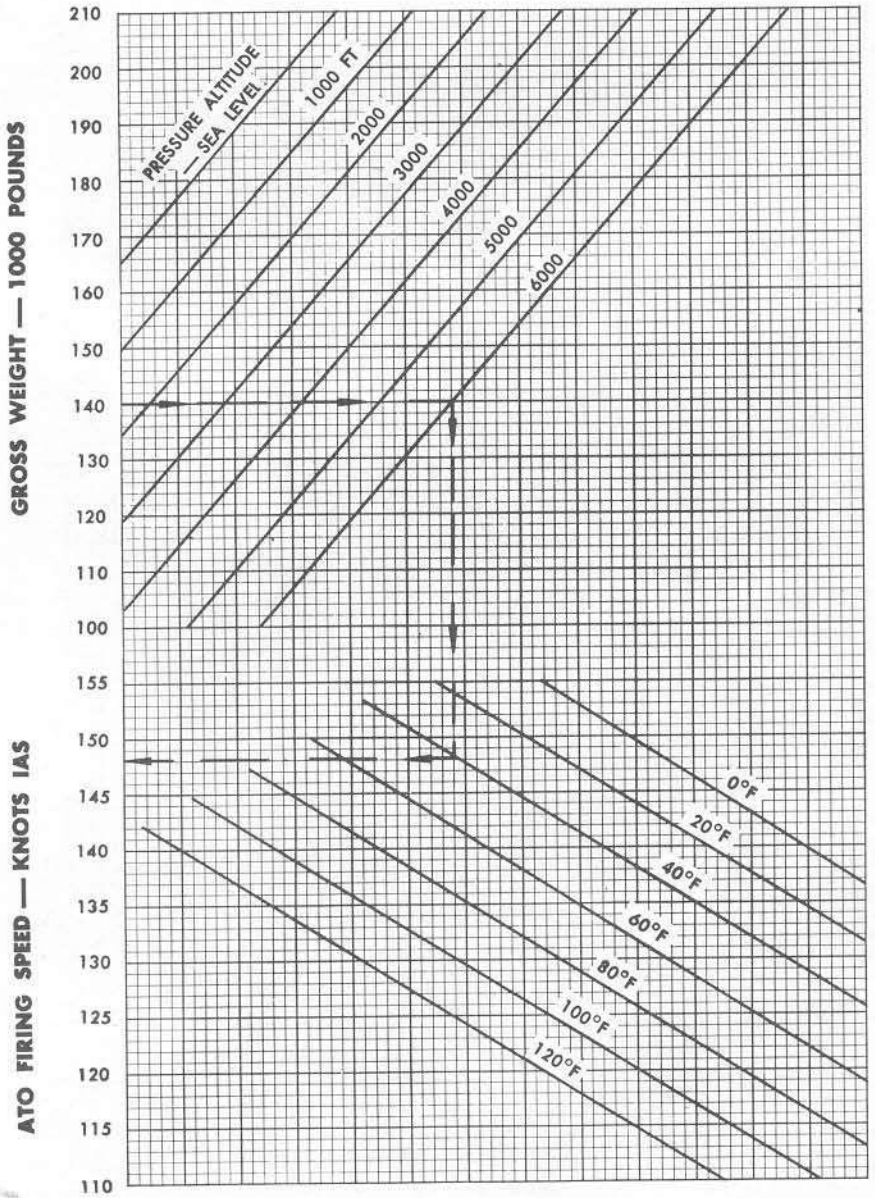
ATO FIRING SPEEDS FOR MINIMUM ATO REQUIREMENTS

SINGLE ENGINE FAILURE AT CRITICAL FAILURE SPEED

14,000 FT RUNWAY

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: NO WATER INJECTION

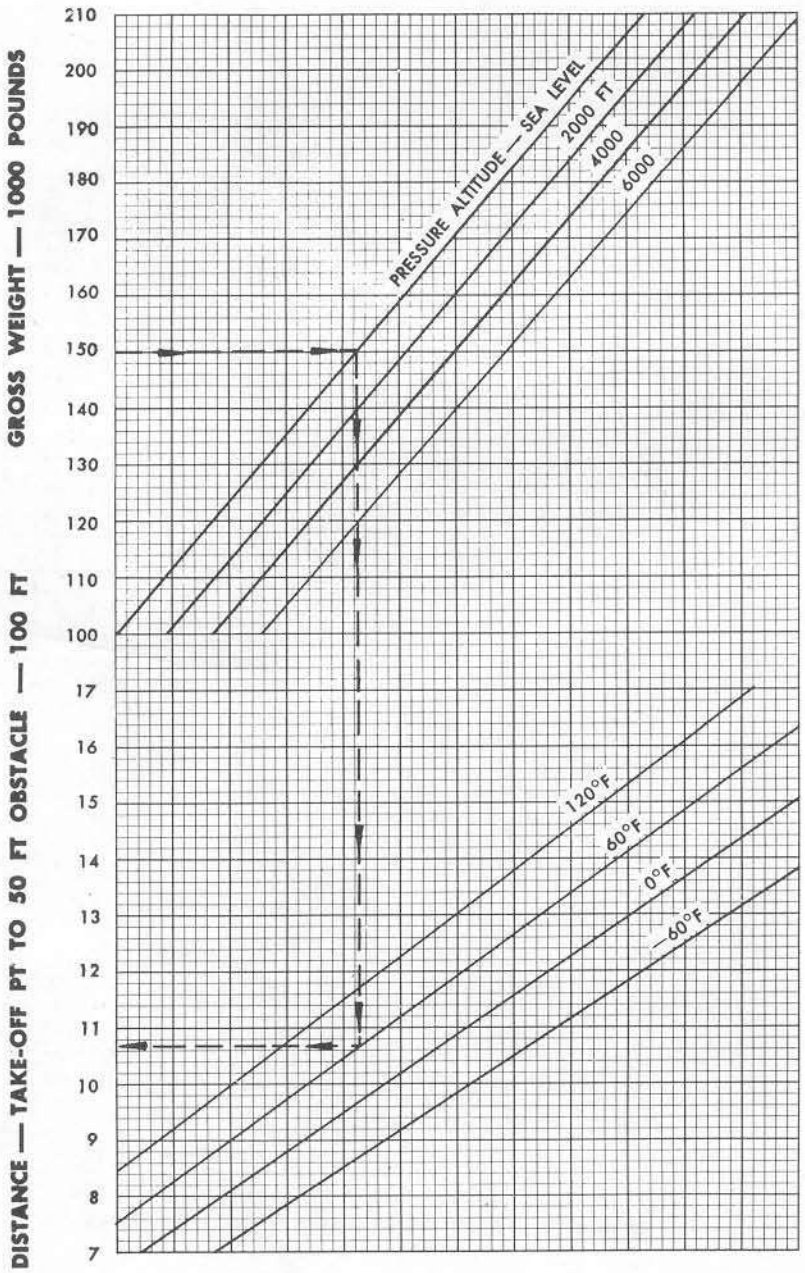
DATE: DECEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-31.

MINIMUM FLIGHT DISTANCE OVER 50 FT OBSTACLE
18 ATO BOTTLES

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: NO WATER INJECTION

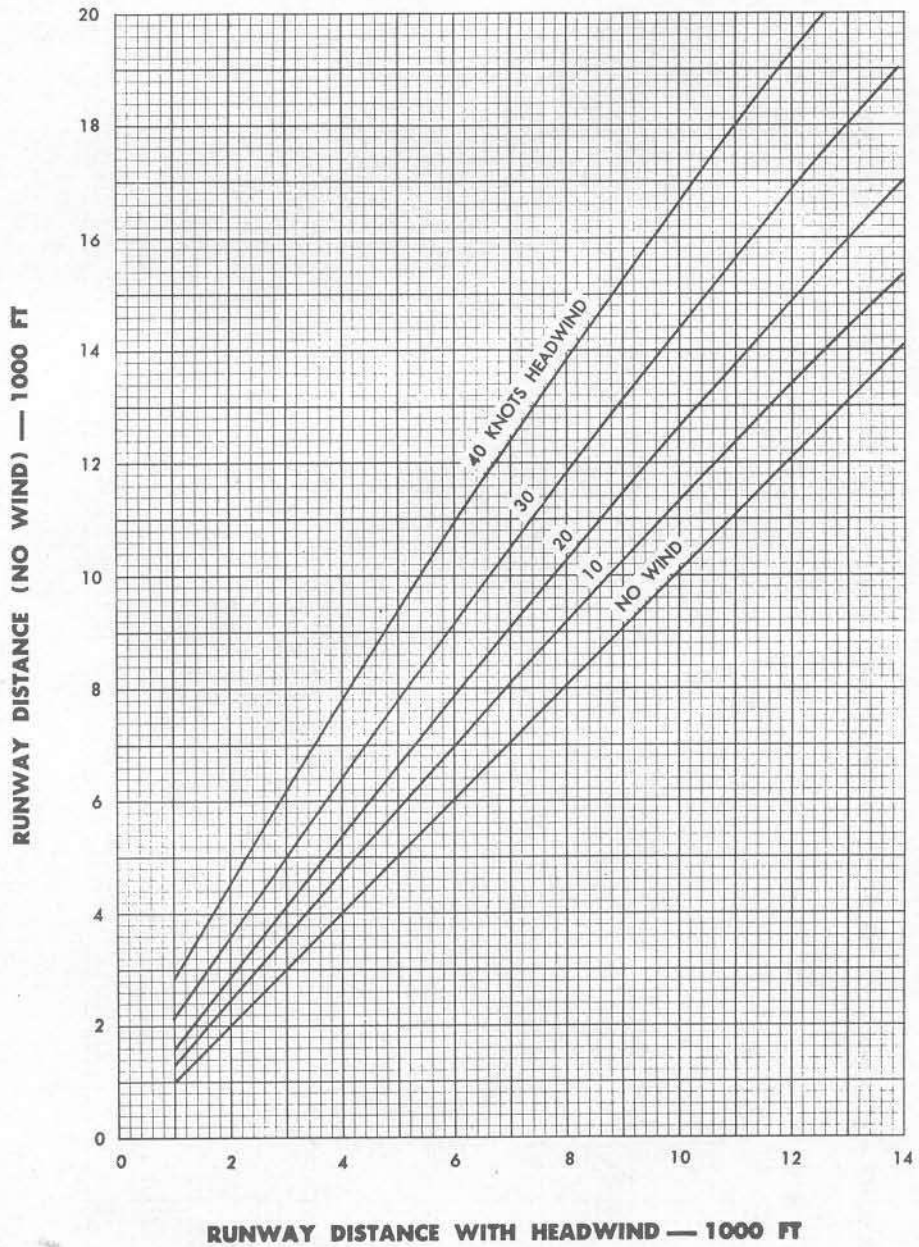
DATE: NOVEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-32.

HEAD WIND CORRECTION CHART

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

DATE: AUGUST 1951
DATA BASIS: CALCULATED

Figure A-33.

PART 4

REFUSED TAKE-OFF

The critical engine failure speed for a given length runway is the highest speed to which the airplane can be accelerated to lift off or braked to a stop at the end of the runway. Once this speed has been exceeded the take-off is usually committed, since the airplane can no longer be stopped on the runway.

Curves of the critical engine failure speed for a take-off during which an emergency stop becomes necessary are on figures A-34 through A-42. These curves are used with both the no-ATO and the ATO take-off parts and assume the following:

1. Maximum engine thrust during acceleration
2. Three seconds for pilot reaction time
3. Three seconds to deploy brake chute and apply brakes.

As explained in part 1, ground effect introduces about a 4-knot error in the airspeed indicator reading during take-off. The critical speeds in this part have been corrected for this error and represent actual indicator readings.

EXAMPLE:

Find the critical engine failure speed for an airplane taking off under the following conditions:

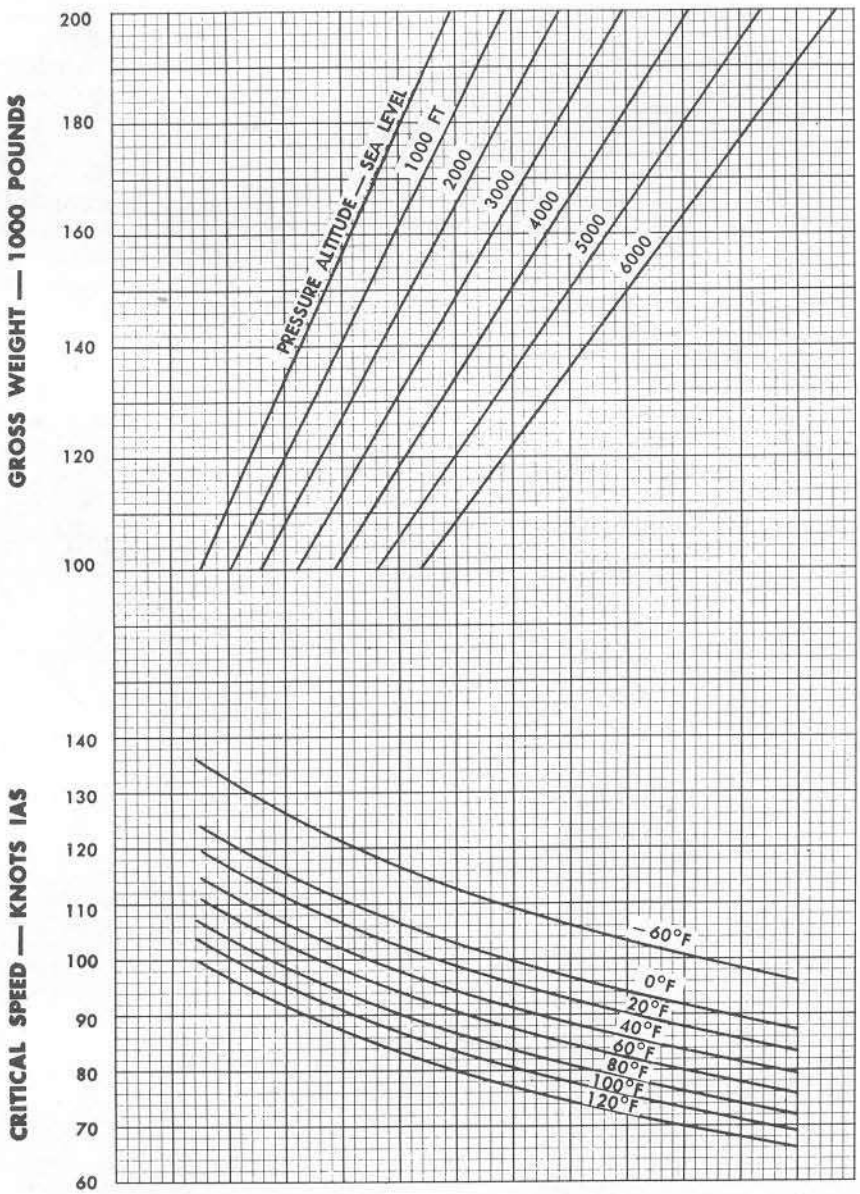
Runway Length = 9500 feet
Pressure Altitude = 2000 feet
Gross Weight = 150,000 pounds
OAT = 80° F
Runway Wind Velocity = 20 mph = 17.5 knots.

The critical engine failure speed for a 9000-foot runway is found on figure A-37, and the chart for a 10,000-foot runway is on figure A-38. Considering the conditions of the example, the critical engine failure speeds for these runway lengths are 113 and 119 knots IAS respectively. The critical engine failure speed for a 9500-foot runway would then be halfway between these two values or 116 knots. For a head-wind, the critical engine failure speed is approximately the no-wind speed plus the wind speed or 116 + 17.5 = 133.5 knots.

CRITICAL ENGINE FAILURE SPEED
6000 FT RUNWAY

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

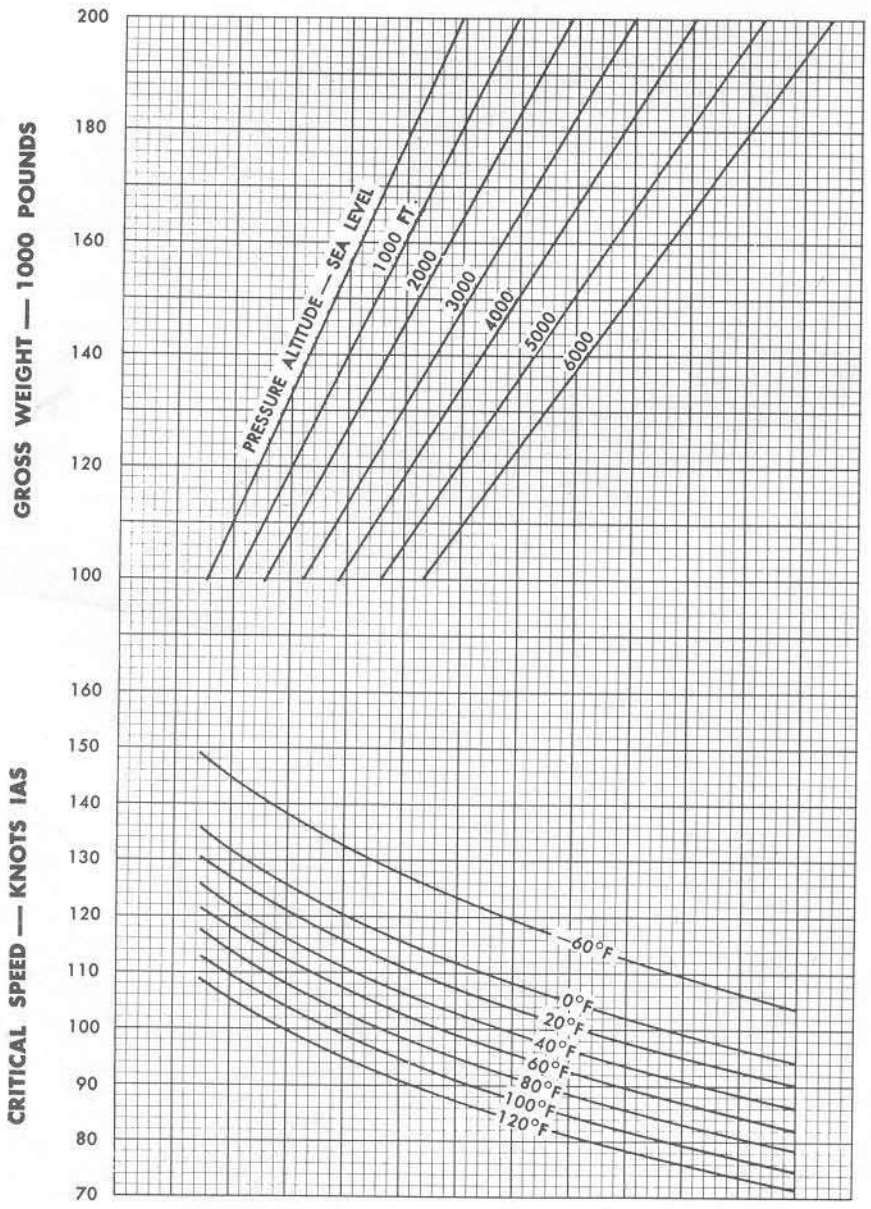
DATE: DECEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-34.

CRITICAL ENGINE FAILURE SPEED
7000 FT RUNWAY

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

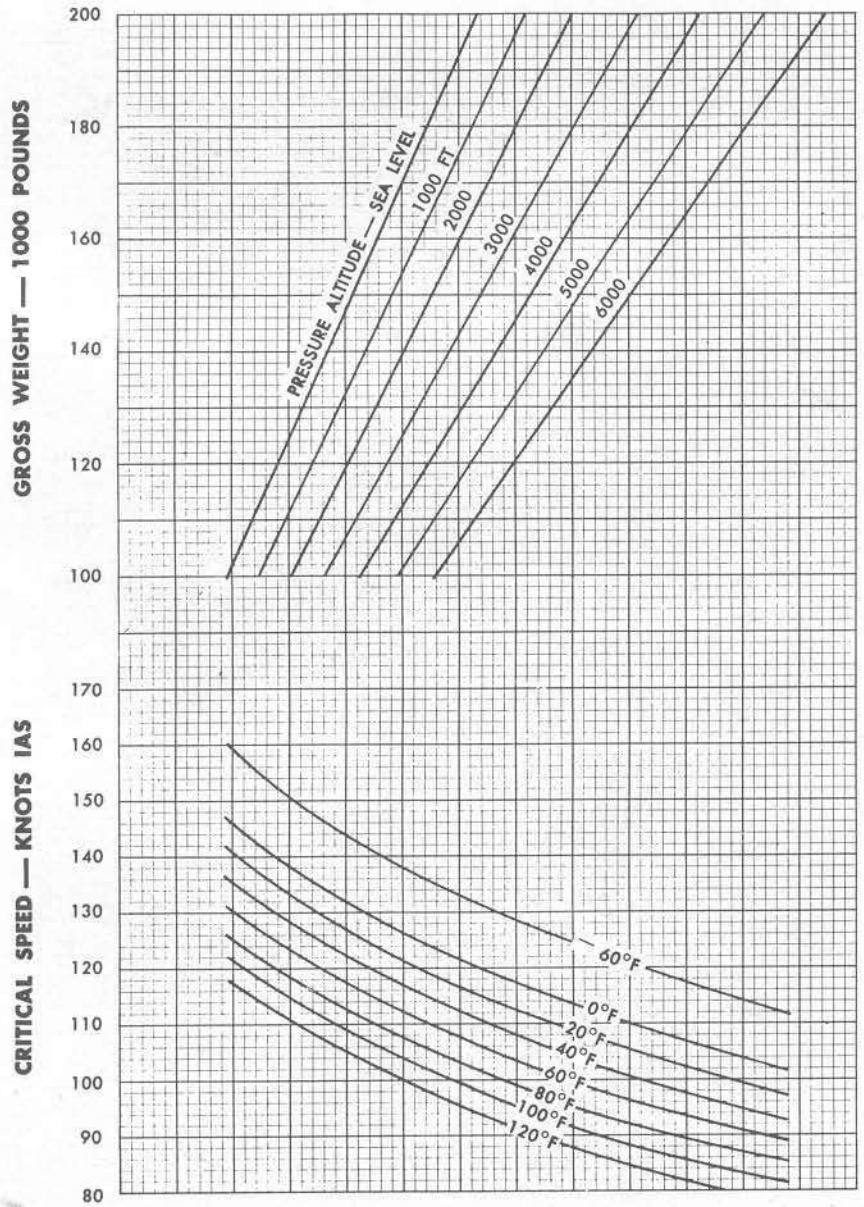
DATE: DECEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-35.

CRITICAL ENGINE FAILURE SPEED
8000 FT RUNWAY

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

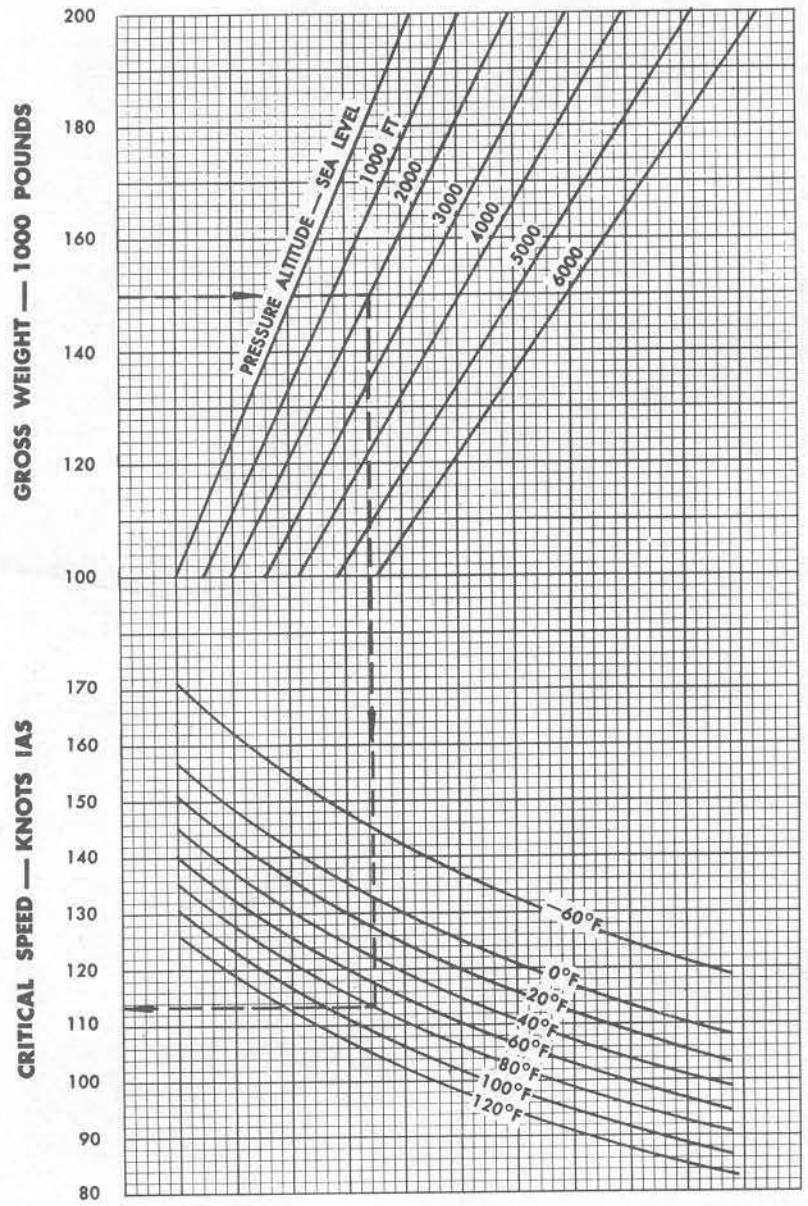
DATE: DECEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-36.

CRITICAL ENGINE FAILURE SPEED
9000 FT RUNWAY

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

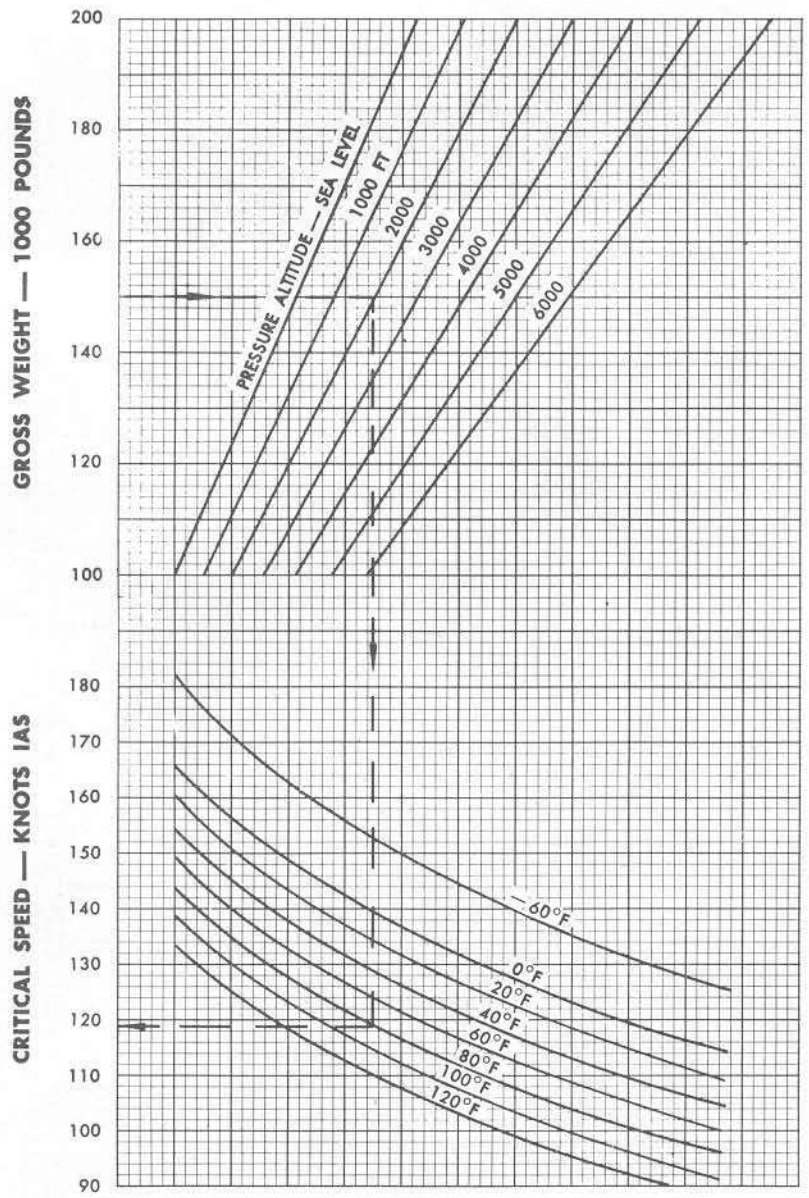
DATE: DECEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-37.

CRITICAL ENGINE FAILURE SPEED
10,000 FT RUNWAY

MODEL: YDB-47E

ENGINES. J47-GE-25



CONDITIONS:

REMARKS:

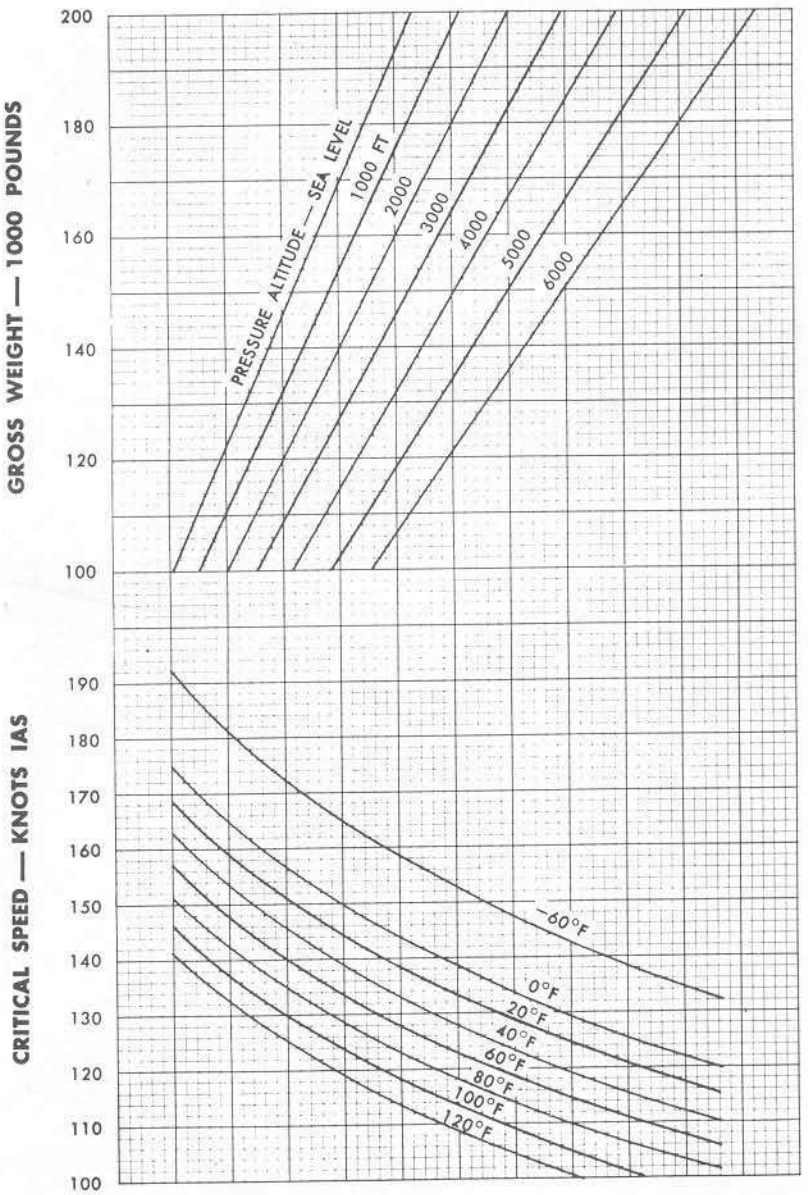
DATE: DECEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-38.

CRITICAL ENGINE FAILURE SPEED
11,000 FT RUNWAY

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

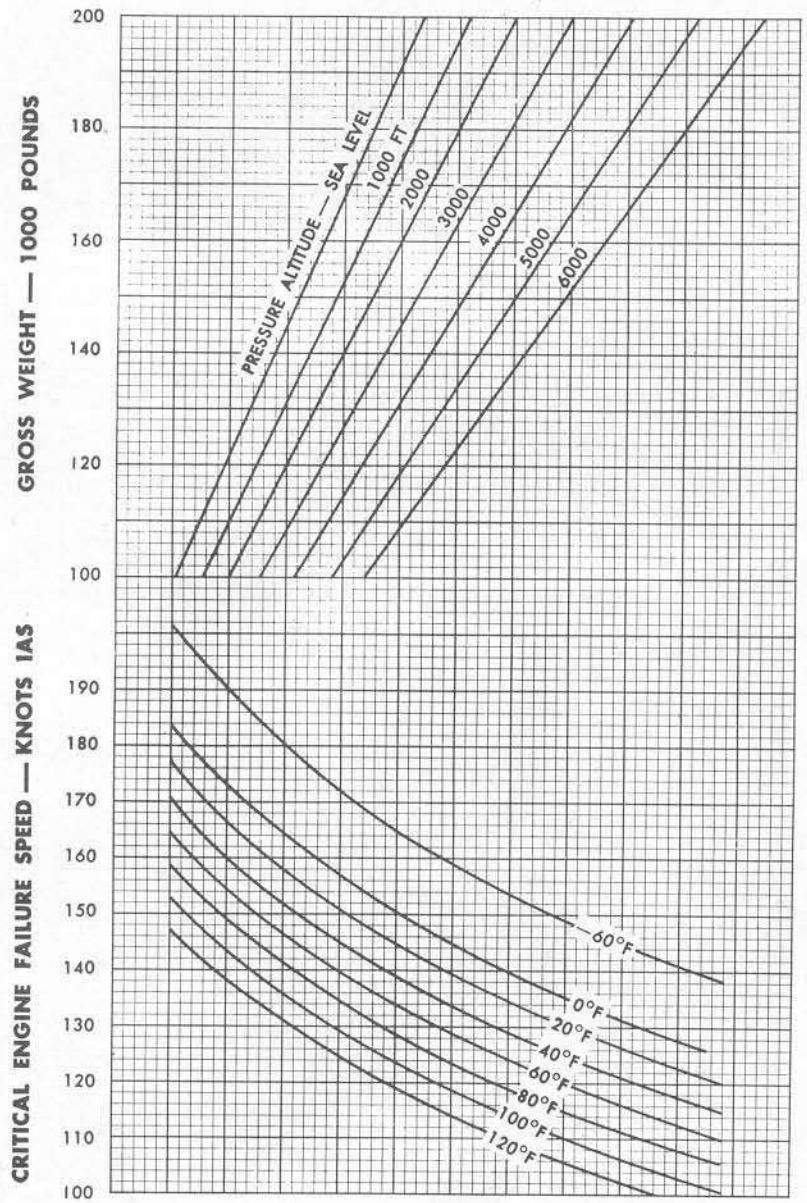
DATE: DECEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-39.

CRITICAL ENGINE FAILURE SPEED
12,000 FT RUNWAY

MODEL: YD8-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

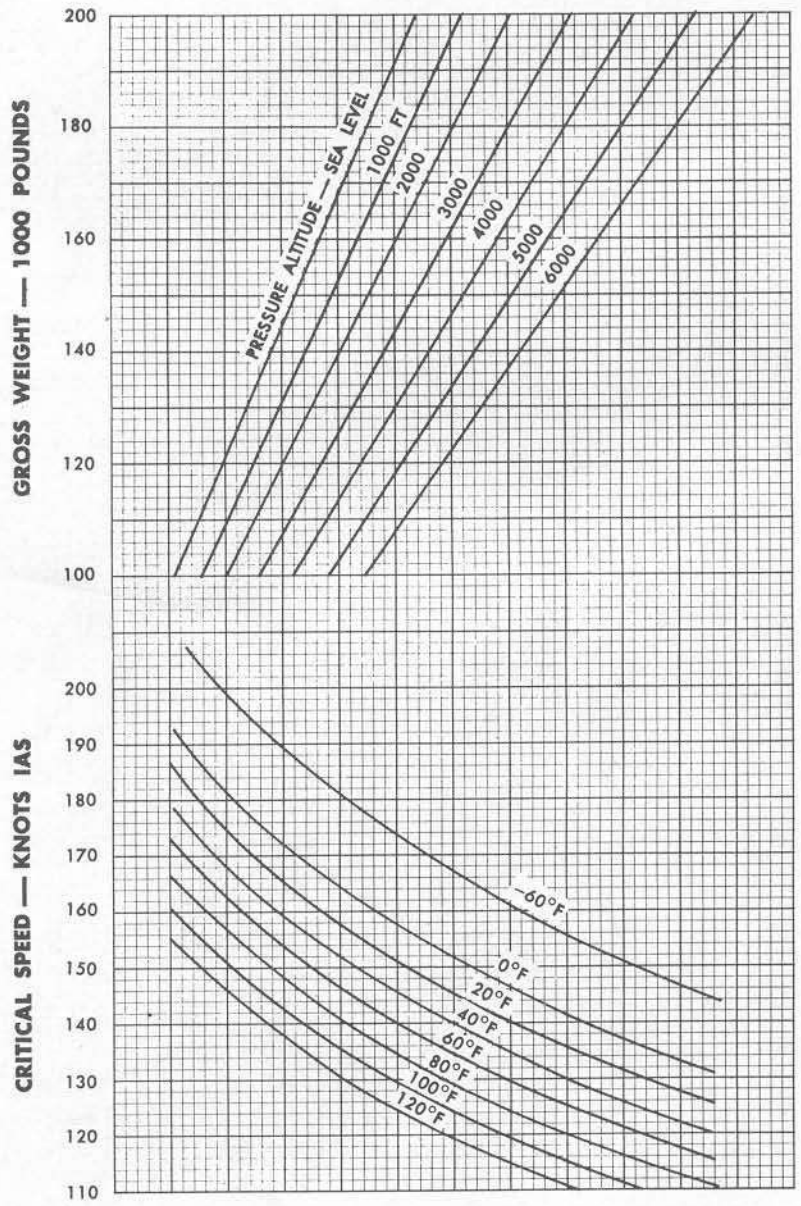
DATE: DECEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-40.

CRITICAL ENGINE FAILURE SPEED
13,000 FT RUNWAY

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

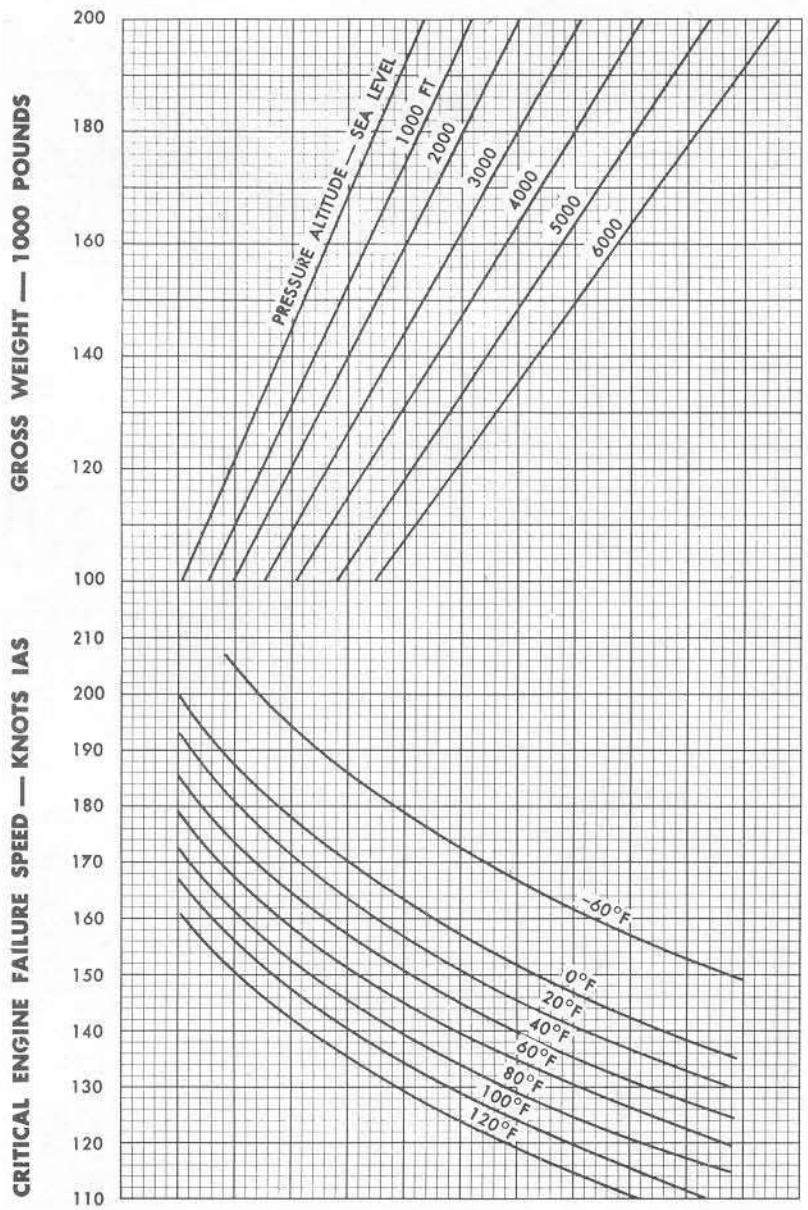
DATE: DECEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-41.

CRITICAL ENGINE FAILURE SPEED
14,000 FT RUNWAY

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITION

REMARKS:

DATE: DECEMBER 1952
DATA BASIS: FLIGHT TEST

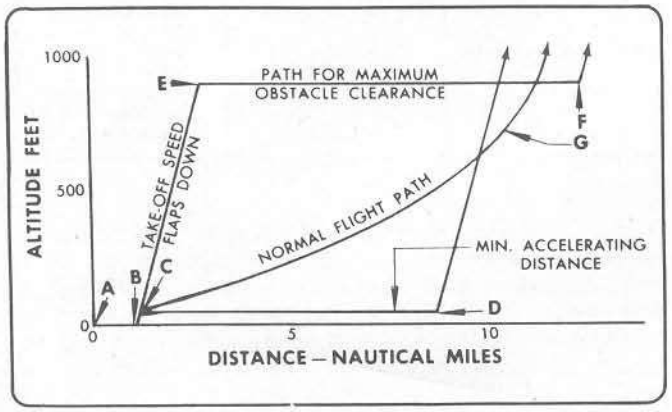
Figure A-42.

PART 5

CLIMB

FLIGHT PROCEDURES AFTER TAKE-OFF

Flight procedure immediately after take-off will depend primarily on local terrain and operating conditions. Limiting techniques prior to attaining the optimum R/C speed are illustrated below. The difference in the amounts of fuel and time involved in reaching a 1000-foot altitude is so small that it is not a determining factor in the choice of flight paths.



- A - Start take-off roll at take-off rpm flaps down.
- B - Take-off point. Start gear retraction for all conditions.
- C - Minimum desired altitude for path CD. Start flaps retraction if path CD is used.
- D, F, G - Point at which optimum rate of climb speed is obtained.
- E - Maximum desired altitude for clearing obstacle. Path CE should be at or above take-off speed with flaps fully extended. Start flap retraction at point E.

NORMAL FLIGHT PROCEDURES

Assuming no high obstacles, the normal flight path is the one which will usually be used by pilots, as it provides a reasonable altitude for turns and maneuvers as well as a fairly rapid acceleration. The gear should be retracted immediately after take-off and flap retraction should begin as soon as possible. With no initial climb, the flap retraction time is such that the airspeed will remain well above the stall and below the structural placard. With an initial climb, a slight delay in retracting the flaps will maintain this margin above the stall, the amount of delay being determined by the steepness of the climb. A good procedure is to allow the airplane to accelerate 10 knots in a slight climb before starting flap retraction. Any prolonged delay without an accompanying steepening of the climb angle may result in exceeding flap placard limits.

MINIMUM ACCELERATING DISTANCE

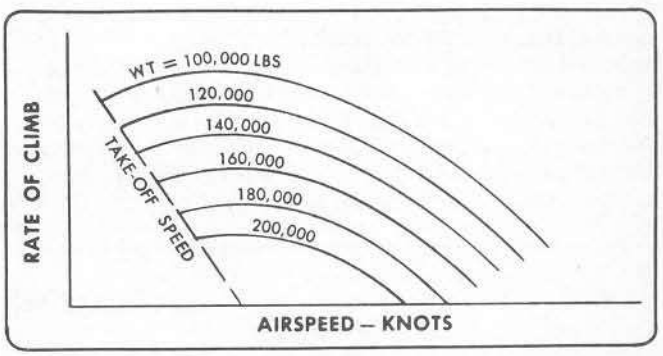
This procedure is feasible when the terrain is flat and the pilot desires to maintain a minimum altitude above the ground in order to accelerate to climb speed as quickly as possible. Under this condition, both gear and flaps should be retracted immediately after take-off. Care must be exercised not to exceed the structural limit speeds of the flaps. Limiting speeds are 195 knots IAS with flaps full down, and 230 knots with 50% flaps.

MAXIMUM OBSTACLE CLEARANCE

When it is necessary to clear an obstacle in a short distance, this procedure can be used. The gear should be retracted immediately after take-off, with the climb from C to E at not less than take-off speed, to prevent stalling and provide a reasonable margin of lift for maneuverability. For the same reason, flap retraction should not begin until point E is reached.

EMERGENCY PERFORMANCE AFTER TAKE-OFF

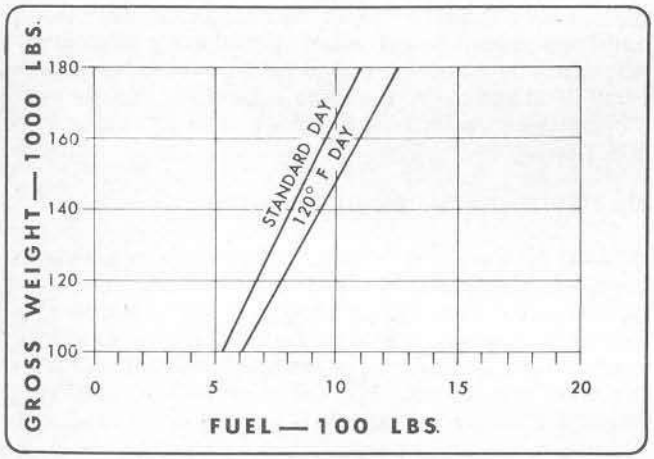
If an engine fails during the take-off operation, climb performance at high weights is marginal for high temperatures and altitudes until the gear is raised. This is the reason for saving some ATO duration for the initial climb while the gear is starting up. The following sketch shows the effect of airspeed on rate of climb available after take-off with flaps and gear down.



It shows that, for maximum rate of climb, an airspeed somewhat higher than the take-off is required. The curves are fairly flat however, indicating that rigid climb speed control is not necessary. Gear drag lowers the rate of climb approximately 300 feet per minute at take-off speeds with flaps down. An engine failure decreases the rate of climb by approximately 500 feet per minute under the same conditions. Climb performance at take-off speeds with one engine out and gear and flaps down is shown on figure A-53.

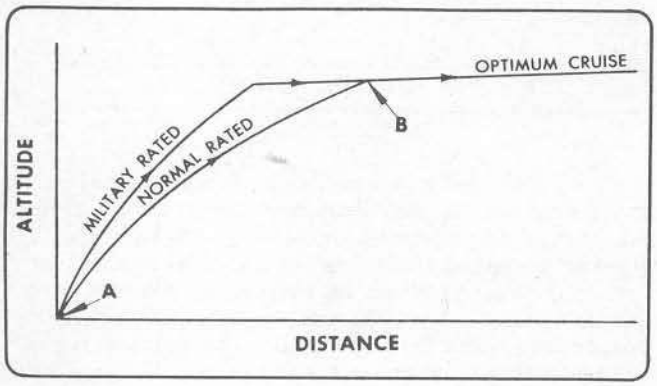
As previously mentioned, fuel consumption is not a

factor in choice of flight paths after take-off. However, to allow for fuel consumption during the acceleration period after take-off, the following plot will give fuel required for a range of gross weights for sea level standard and 120° F day. It will be satisfactory to assume that 10 nautical miles and 2 minutes are required. These figures are based on using all excess thrust after take-off for acceleration.



CLIMB PERFORMANCE

On the following pages are the charts for optimum climb performance at both military (98%) and normal (96%) rpm. Referring to the following sketch, the fuel consumption and time from point A to point B are only slightly less for a climb at military rated than at normal rated rpm. The differences for a climb to optimum cruising altitude are approximately 500 pounds of fuel and 1 minute. For most climbs, it is recommended that normal rated rpm be used, since the loss in performance is slight and engine life is influenced by turbine operating speeds and temperatures. Full anti-icing during a climb at military rated rpm may overheat the airplane structure. Climbs at less than normal rated rpm will result in a loss of range because of excessive time spent in climbing:



Other factors such as leaving throttles set at the take-off setting, etc, may make one power setting preferable to the other. During the climb speeds, ±10 knots from optimum will not materially affect performance.

The effect of OAT on climb performance is considerable, and the NACA standard day performance presented in this section should be corrected for temperature. For each 10° F that the OAT deviates from the NACA standard temperature, the average climb performance at either normal or military rated power changes approximately as follows:

TEMPERATURE	PERFORMANCE	CHANGE
EACH 10°F ABOVE STANDARD TEMPERATURE	RATE OF CLIMB	DECREASES 5%
	TIME OF CLIMB	INCREASES 6%
	CLIMB RANGE	INCREASES 6%
	CLIMB SPEED	INCREASES ½%
	CLIMB FUEL	INCREASES 2%
EACH 10°F COLDER THAN STANDARD TEMPERATURE	RATE OF CLIMB	INCREASES 5%
	TIME TO CLIMB	DECREASES 6%
	CLIMB RANGE	DECREASES 6%
	CLIMB SPEED	DECREASES ½%
	CLIMB FUEL	DECREASES 2%

If the usual procedure is to climb at normal rated power on a standard day, but a hot day occurs, the loss in performance can be overcome by increasing the power. On a very hot day, a climb at military rated power will give approximately the same rate of climb as normal rated power on a standard day.

A chart of the effect of flaps, gear, OAT, airspeed, and number of engines on rate of climb for a specific set of conditions is on figure A-53. It is useful as a reference to show the pilot the relative effect of these various factors on his climb performance.

EXAMPLE:

Assume a gross weight after take-off of 120,000 pounds and a climb at normal rated power from sea level to the best cruise altitude for maximum range. Find the climb performance on a standard day, for an airplane with J47-GE-25 engines.

EXTERNAL TANKS

External tanks increase the time to climb, climb distance, and climb fuel, and decrease the rate of climb. The over-all effect is most easily approximated by increasing the climb fuel by 7.5% and maintaining the climb distance the same as the no external tank case.

CLIMB FUEL WEIGHT

The first step is to determine the weight of fuel used during the climb. Use figure A-43. The curves are for a theoretical climb at constant gross weight but they apply if an average weight is used as follows: At an estimated average gross weight of just under 120,000 pounds, a first approximation to the climb fuel is 5400 pounds. Then the average gross weight is $120,000 - \frac{5400}{2} = 117,300$ pounds and the final gross weight is 114,600 pounds. The cruise altitude for

114,600 pounds is about 39,500 feet. The corrected fuel required to climb to 39,500 feet at an average gross weight of 117,300 pounds is 5550 pounds. The corrected average weight is then 117,225 pounds and the final weight is 114,450 pounds.

CLIMB RANGE

Similarly, using the climb range chart on figure A-44, the range to 39,500 feet, for the average gross weight of 117,225 pounds, is 114 nautical miles.

TIME TO CLIMB

From the chart on figure A-45, the time to climb is 17.2 minutes.

CLIMB SPEED

The correct airspeeds for maximum rate of climb are found on figure A-46. The indicated airspeed should decrease from 351 knots at sea level to 220 knots at 39,500 feet. Exact speeds are not critical and an airspeed error of ±10 knots will not reduce the rate of climb appreciably.

RATE OF CLIMB

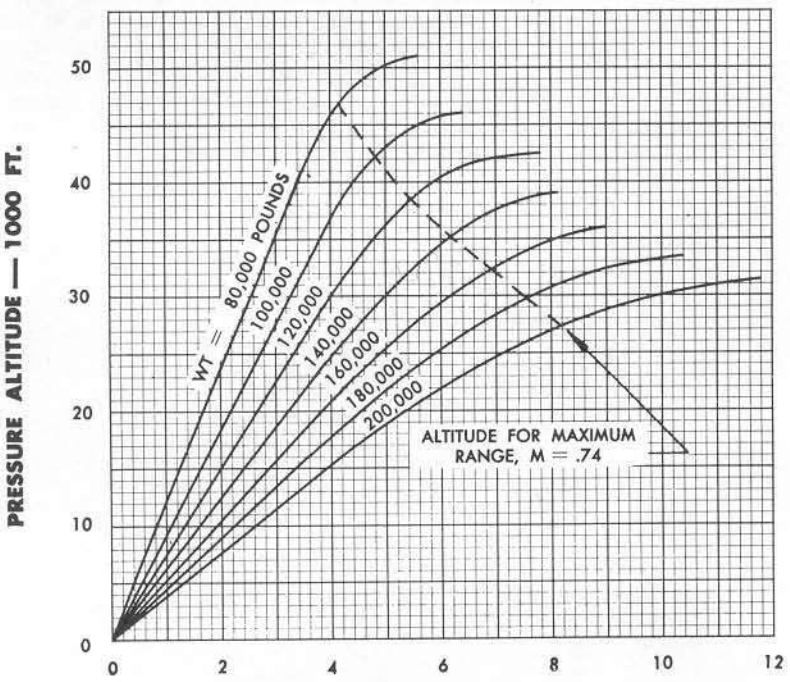
On figure A-47 is shown the variation with altitude of the maximum rate of climb at normal rated power. At sea level, the initial rate of climb at 120,000 pounds is 4200 feet per minute. At 39,500 feet and 114,450 pounds, the final rate of climb is about 750 feet per minute.

Climb performance for flap and gear down at approach and flap placard speeds at sea level is shown on figure A-55 for conditions of none, one, or two engines inoperative, with the remaining engines at take-off rpm. Performance with flaps down and gear up for the same conditions is shown on figure A-54 for operating engines at take-off rpm.

CLIMB FUEL WEIGHT
NORMAL RATED (96%) RPM

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: NACA STANDARD DAY
NORMAL RATED (96%) RPM

REMARKS:

DATE: JULY 1952

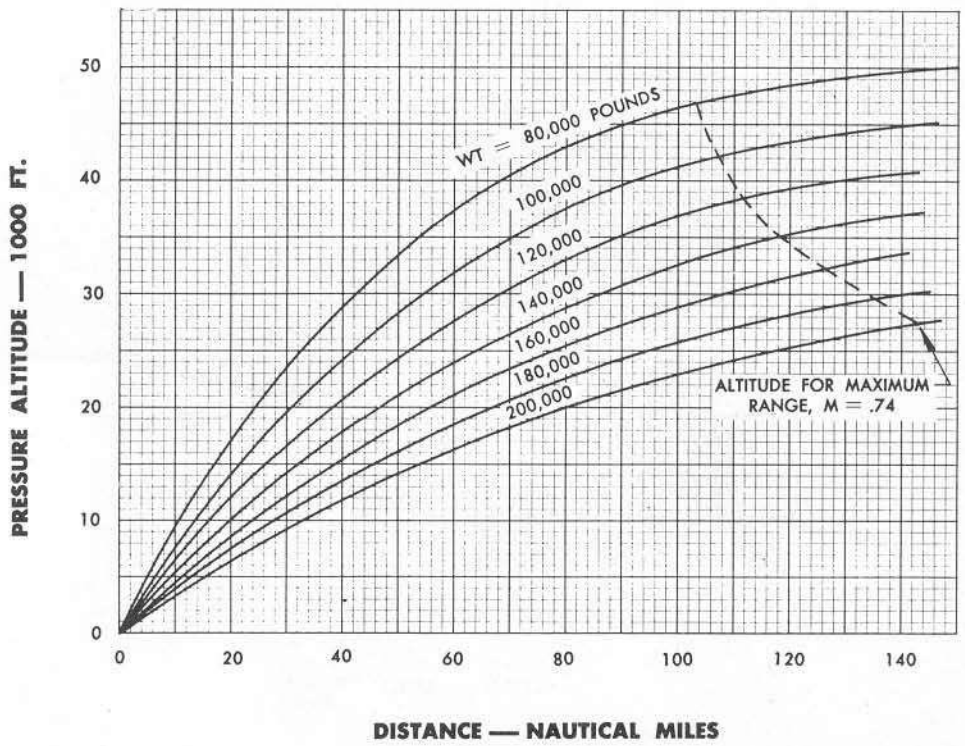
DATA BASIS: FLIGHT TEST

Figure A-43.

CLIMB RANGE
NORMAL RATED (96%) RPM

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: NACA STANDARD DAY
NORMAL RATED RPM (96%)

REMARKS:

DATE: JULY 1951

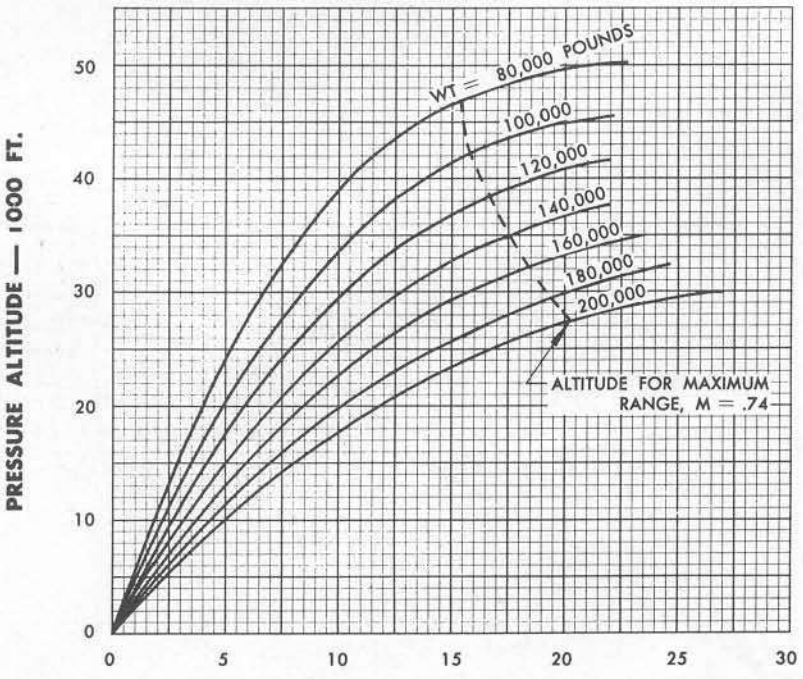
DATA BASIS: FLIGHT TEST

Figure A-44.

TIME TO CLIMB
NORMAL RATED (96%) RPM

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: NACA STANDARD DAY
NORMAL RATED (96%) RPM

REMARKS:

DATE: JULY 1952

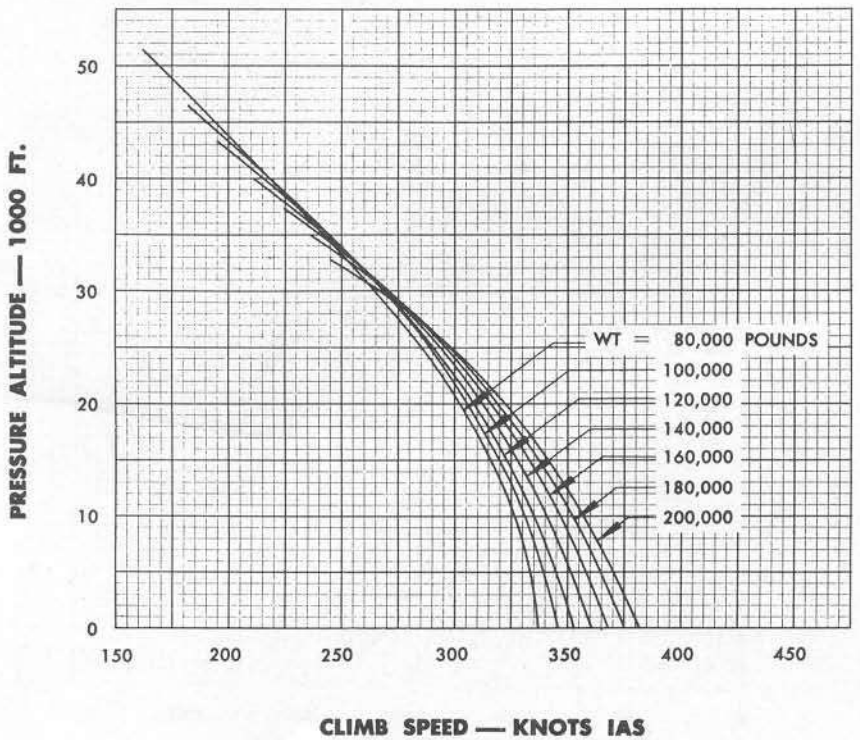
DATA BASIS: FLIGHT TEST

Figure A-45.

CLIMB SPEED
MAXIMUM RATE OF CLIMB AT NORMAL RATED (96%) RPM

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: NORMAL RATED (96%) RPM

REMARKS:

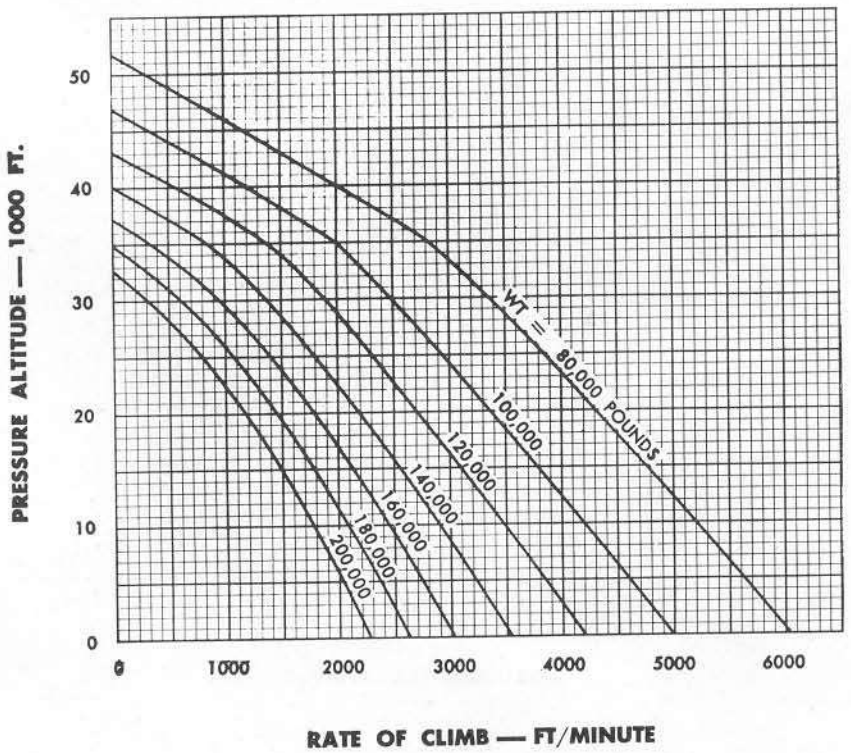
DATE: JULY 1952
DATA BASIS: FLIGHT TEST

Figure A-46.

MAXIMUM RATE OF CLIMB
NORMAL RATED (96%) RPM

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: NACA STANDARD DAY
NORMAL RATED (96%) RPM

REMARKS:

DATE: JULY 1952

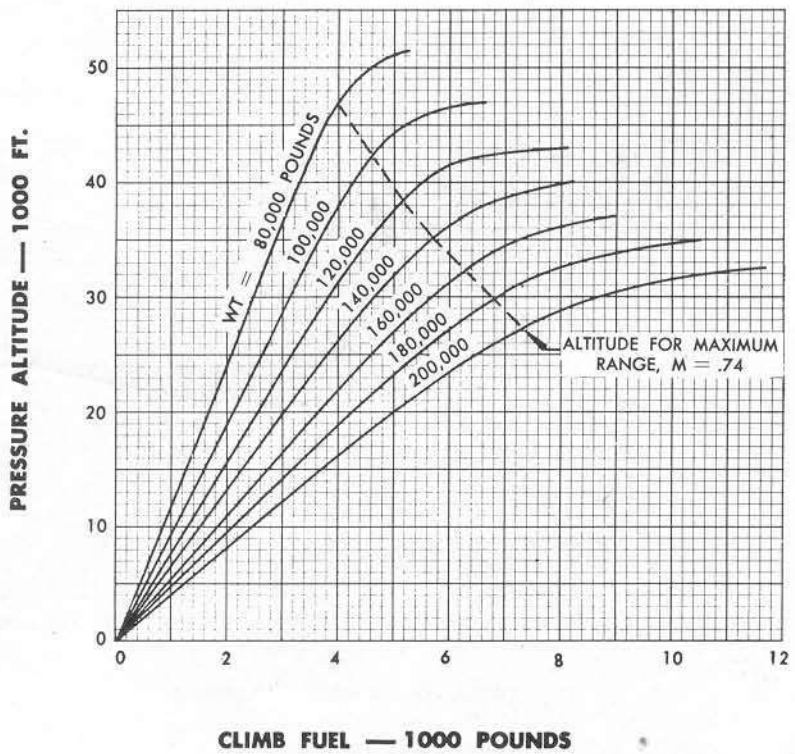
DATA BASIS: FLIGHT TEST

Figure A-47.

CLIMB FUEL WEIGHT
MILITARY RATED (98%) RPM

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: NACA STANDARD DAY
MILITARY RATED (98%) RPM

REMARKS:

DATE: SEPTEMBER 1952

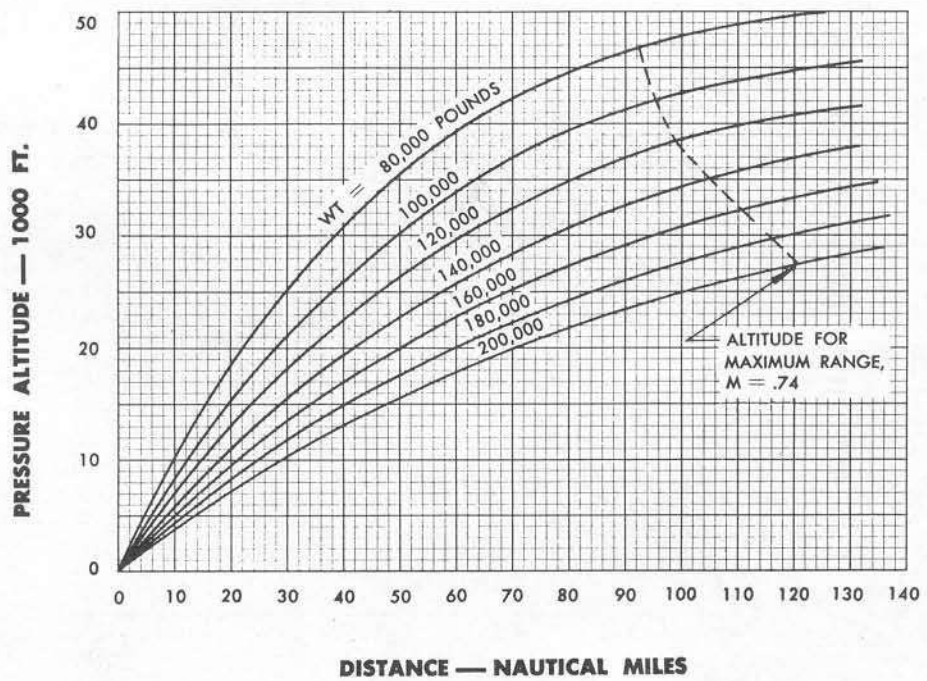
DATA BASIS: FLIGHT TEST

Figure A-48.

CLIMB RANGE
MILITARY RATED (98%) RPM

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: NACA STANDARD DAY
MILITARY RATED (98%) RPM

REMARKS:

DATE: JUNE 1952

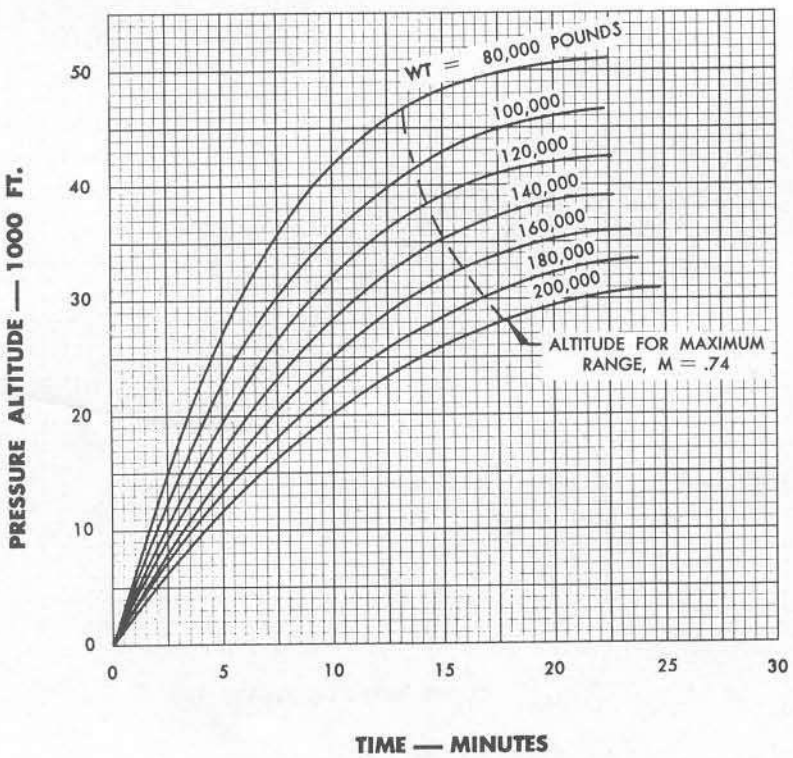
DATA BASIS: FLIGHT TEST

Figure A-49.

TIME TO CLIMB
MILITARY RATED (98%) RPM

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: NACA STANDARD DAY
MILITARY RATED (98%) RPM

REMARKS:

DATE: JUNE 1952

DATA BASIS: FLIGHT TEST

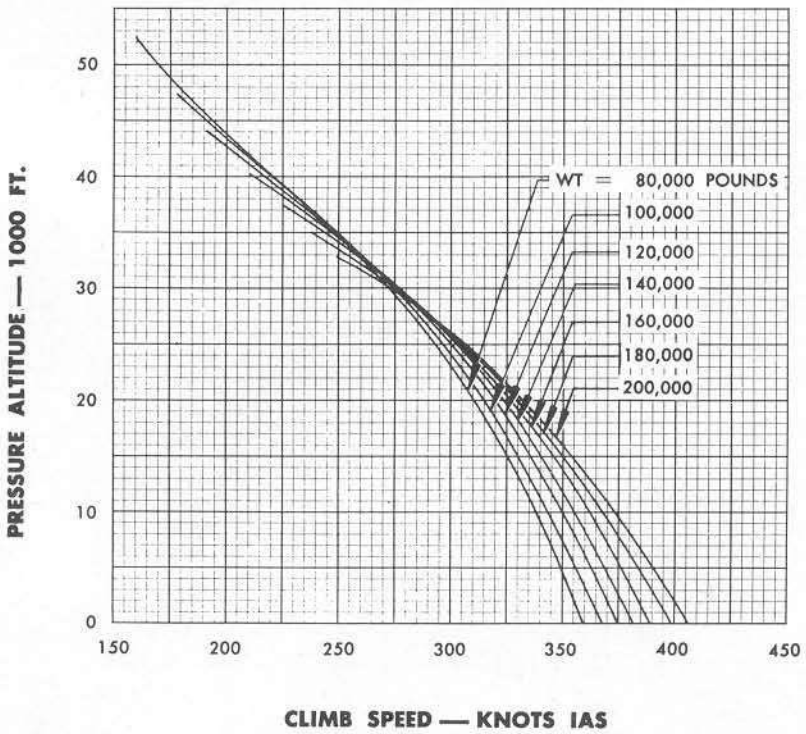
Figure A-50.

CLIMB SPEED

MAXIMUM RATE OF CLIMB AT MILITARY (98%) RPM

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: NACA STANDARD DAY
MILITARY RATED (98%) RPM

REMARKS:

DATE: JUNE 1952

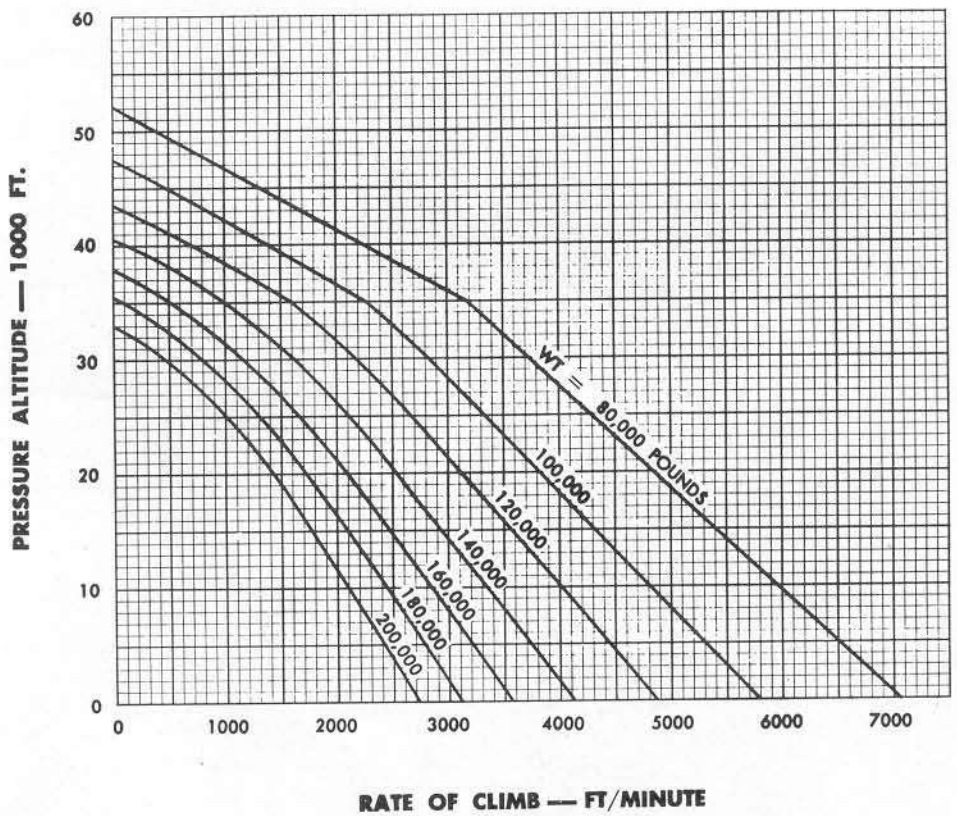
DATA BASIS: FLIGHT TEST

Figure A-51.

MAXIMUM RATE OF CLIMB
MILITARY RATED (98%) RPM

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: NACA STANDARD DAY
MILITARY RATED (98%) RPM

REMARKS:

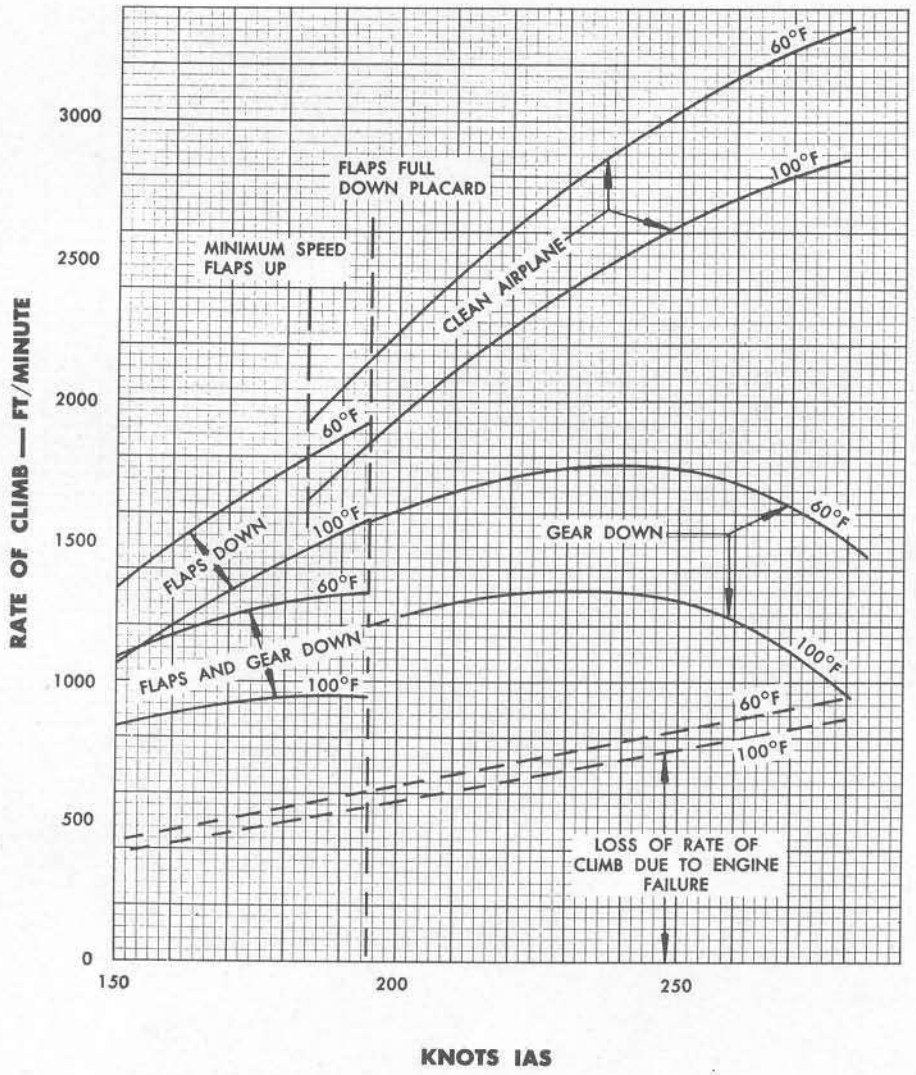
DATE: JUNE 1952
DATA BASIS: FLIGHT TEST

Figure A-52.

CLIMB PERFORMANCE AFTER TAKE-OFF

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: SEA LEVEL ALTITUDE
GROSS WEIGHT 180,000 POUNDS
TAKE-OFF (100%) RPM

DATE: OCTOBER 1952

DATA BASIS: FLIGHT TEST

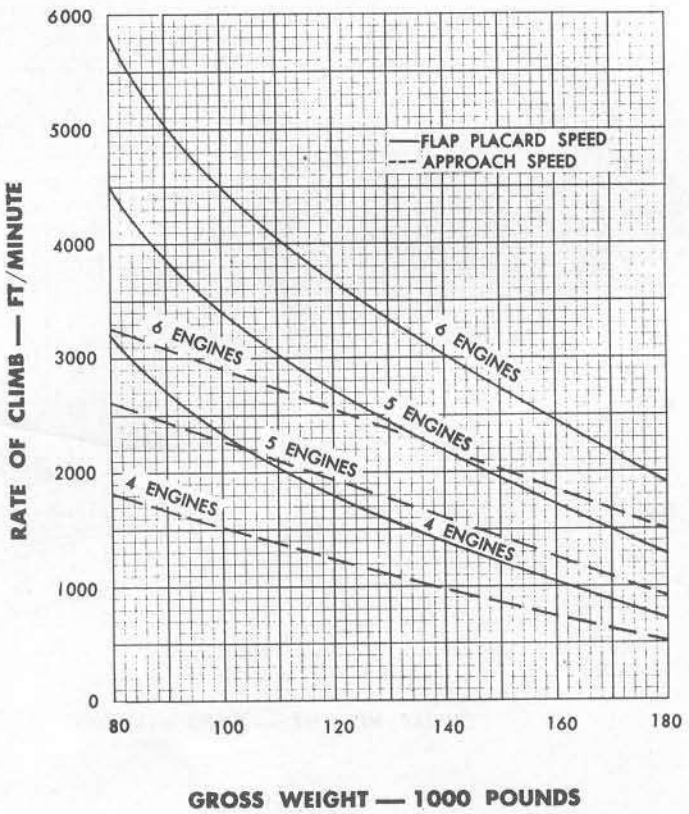
REMARKS:

Figure A-53.

RATE OF CLIMB
FLAPS DOWN

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: FLAPS DOWN GEAR UP
TAKE-OFF (100%) RPM
SEA LEVEL NACA STANDARD DAY

DATE: JULY 1952

DATA BASIS: FLIGHT TEST

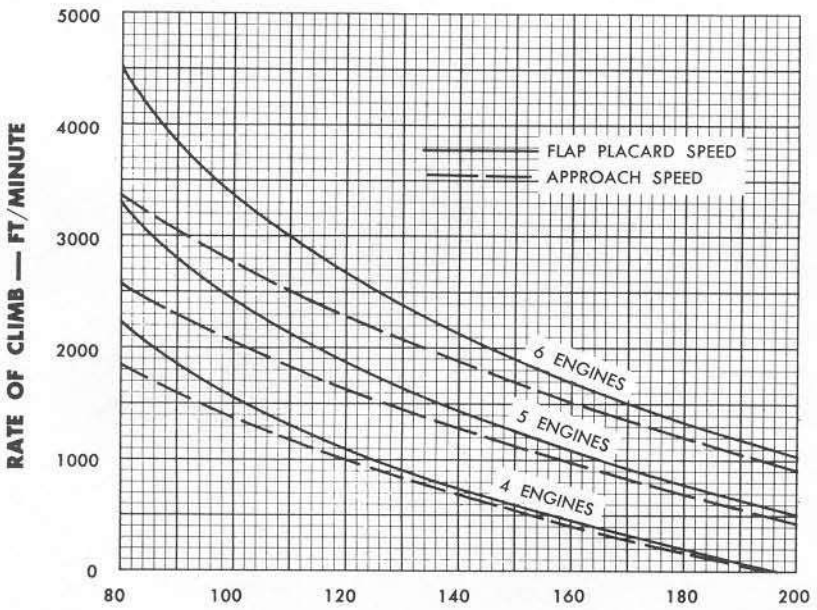
REMARKS:

Figure A-54.

RATE OF CLIMB
FLAPS AND GEAR DOWN

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: FLAPS AND GEAR DOWN
TAKE-OFF (100%) RPM
SEA LEVEL, NACA STANDARD DAY

REMARKS:

DATE: AUGUST 1952

DATA BASIS: FLIGHT TEST

Figure A-55.

PART 6

RANGE

Using the charts in this section, the range for any cruise portion of the flight can be quickly found. These charts apply only to cruising flight with six engines where the weight change is due entirely to fuel consumption and not to cargo drop. The fuel for take-off, climb, endurance, descent, etc, must be computed separately as explained in part 11. Part 12 contains charts for converting between Mach number and true or indicated airspeed.

The range charts include no conservatism factor. However, allowance has been made for the effect of standard engine accessories. Additional equipment which may be optional on some airplanes and which reduces engine thrust will obviously reduce range. Factors which may have to be considered in range calculations are:

1. EXTERNAL TANKS. If external fuel tanks are carried, the range from the charts should be reduced by approximately 7.5% for the portion of the mission before tanks are dropped.
2. PROTUBERANCES. The range charts are for a clean airplane. The range has been computed assuming flush antennas only. Surface roughness, ice, dirt, etc, all have a detrimental effect.
3. ENGINE INLET SCREENS. The range charts are based on the thrust and fuel consumption with the engine air inlet screens retracted.
4. ANTI-ICING. Range will be reduced 11% during periods in which anti-icing is on if rpm is boosted to compensate for thrust loss. It is recommended that altitude be reduced instead of increasing rpm.
5. ATO 18 INTERNAL BOTTLES. Range will be reduced approximately 2% when heavy type bottles are used.

The range data are presented in two ways.

1. Integral charts or range versus gross weight for the following types of cruise.
   a. Maximum range using a high altitude climbing flight path.
   b. Maximum altitude at high rpm.
   c. Constant altitude.
2. General miles per pound charts for all types of missions.

Integrated charts of the first type are usually most convenient, particularly over long distances. These charts are on the left-hand pages. Charts of the second type (nautical miles per thousand pounds) are on the right-hand pages.

The cruising range of an airplane is dependent upon the gross weight at the beginning and end of the cruise. All of the range charts use a gross weight of 80,000 pounds as the lower limit, so that if read directly they give only the range available with this as the final weight.

MAXIMUM RANGE OPERATION

Maximum range is obtained by flying at a constant Mach number and an rpm consistent with existing OAT, letting the airplane climb slowly as the weight decreases. Between Mach No. .71 and .75, the range obtained is maximum and nearly constant. However, cruising at less than Mach .74 is not recommended because the lower drag makes it more difficult to hold the correct combination of speed and altitude along the climbing flight path. At Mach .75 or slightly above, the higher drag makes the airplane easier to fly along the correct path and any range loss due to speed can be predicted.

Both speed and range are reduced by flying at less than Mach .71. Range drops rapidly at greater than Mach .76 but the gain in speed may make such a cruise desirable. The Mach number effect on range at a given gross weight and fuel loading is illustrated below.

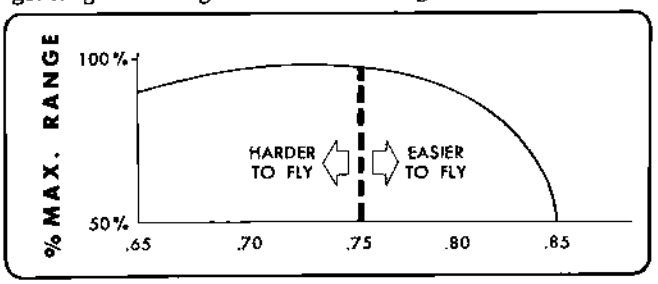


Figure A-57 contains a chart of the maximum miles per 1000 pounds of fuel that can be obtained for any weight and speed combination. It is useful for short ranges and small gross weight changes. The altitudes may be found from the top of figure A-56.

Figure A-56 is a chart showing the range available if the proper climbing flight path is flown at a constant Mach number. If the flight path follows this chart, maximum range will be obtained. The altitude schedule must be closely observed. Excessive deviation from the chart values will result in a loss of range.

The proper climbing flight path for maximum range at any Mach number is determined as follows:

1. Climb to altitude for best range.
2. Level off and establish rpm for the ambient OAT. (See paragraph "Effect of OAT on Range.")
3. Establish cruise Mach number. (As the weight decreases, the airplane will climb slightly establishing a climbing flight path.)

Hold constant Mach number for the entire cruise, readjusting the rpm whenever the OAT changes.

Experience has shown that the machmeter may not be sensitive enough to accurately control the rate of climb. To prevent loss of range due to too fast or too slow a climb, the altitude should be checked regularly against the gross weight, using the proper chart and

the sensitive airspeed indicator should be relied upon more than the machmeter. In part 12 is a chart of Mach number versus indicated airspeed which can be used to compare the two meters. If a marked discrepancy between instruments is discovered, they should be checked for calibration. The importance of instrument accuracy is apparent from the previous range-versus-speed sketch.

For some missions it may be desirable to stack the airplanes so that one plane or group is flying at the optimum Mach number (.71 to .75) while others fly above or below the optimum altitude but still follow the climbing flight plan. Assuming the same true airspeeds are desired, in order to arrive over the target on schedule, the range of the off-altitude airplanes would be decreased as follows:

DEVIATION FROM PROPER ALTITUDE FOR MAXIMUM RANGE CRUISE — FEET	% DECREASE IN RANGE FROM THE MAXIMUM OBTAINABLE
0	0%
+2000	1%
-2000	1/2%
-4000	1%
-6000	3%
-8000	7%

RANGE AT MAXIMUM ALLOWABLE RPM

These charts on figures A-60 and A-61 are to be used only when it is desired to fly at the maximum possible altitude for a specified Mach number. This means a considerable loss in range from that obtainable by the use of the maximum range cruise procedure as shown by the previous chart.

RANGE AT NORMAL (96%) RPM

These charts on figures A-58 and A-59 are to be used only when it is desired to fly at the maximum possible altitude for a given Mach number without exceeding normal rated power. This cruise procedure gives better range than does flying at maximum rpm, but it will give considerably less than the maximum obtainable range.

RANGE AT CONSTANT ALTITUDES

These charts on figures A-62 through A-75 are for use only when constant altitude operation is required for some special purpose. In general, their use will be confined to short distances since constant altitude cruise results in a loss of range from that obtainable with a high altitude climbing flight path.

Since the optimum cruise at sea level is at very low Mach numbers and gives only about one-third of the range available with a high altitude climbing flight path, this low level operation is not recommended.

CENTER OF GRAVITY

During high altitude cruise at .74 Mach number, the cg in flight can be determined by use of the elevator trim control indicator. For minimum drag and maximum range, it is desirable that the trim be kept between 1/2 unit and 2 1/2 units nose up. Incorrect rigging of the elevator trim tab system will result in incorrect cg indications; therefore if there is any reason to doubt the indications the cg should be determined by use of the load adjuster.

The chart on figure 5-9 enables determination of the cg in flight from the position of the elevator trim control indicator. Using this chart, fuel system management to obtain the proper cg location is possible. Incorrect rigging of the elevator tab system may cause errors in cg position indicated by the chart; therefore, if there is reason to doubt the cg indicated by the chart, the rigging system of the elevator should be accurately checked.

COMPARISON OF FLIGHT PROCEDURES

Review of the range charts will show that the range will decrease when:

1. The Mach number is outside the range of .71 to .75.
2. The flight plan follows other than the proper climbing path for the above Mach number range. This is particularly true of low altitude operations where the range penalty is great.

The percentage gain in speed from flying at other than optimum Mach number is small compared to the percentage loss in range. The chart contained in paragraph "Maximum Range Operation" illustrates this point.

EFFECT OF WIND AND ALTITUDE ON RANGE

The gain or loss in range due to wind or altitude can be found from the effective wind chart on figures A-76, A-77 and A-78.

As with any airplane, a small gain in range can be obtained with a tailwind by reducing speed and slightly increasing the flight time. Decreasing from M = .74 to M = .71 has a negligible effect with no wind, while with a 100-knot tailwind the range is extended by about 2%. Range begins to drop at less than M = .71.

When flying against a headwind, increasing speed to gain range is not feasible. At the high cruising speed of the YDB-47, the drag rises so rapidly that a considerable boost in power gives only a small gain in speed and this is offset by the added fuel consumption as shown on figures A-77 and A-78.

It may be best at times to fly at other than optimum altitude to utilize more favorable winds. The range loss due to flying at off altitudes can be estimated from figure A-78 and weighed against the gain due to better wind conditions.

EFFECT OF FUEL ON RANGE

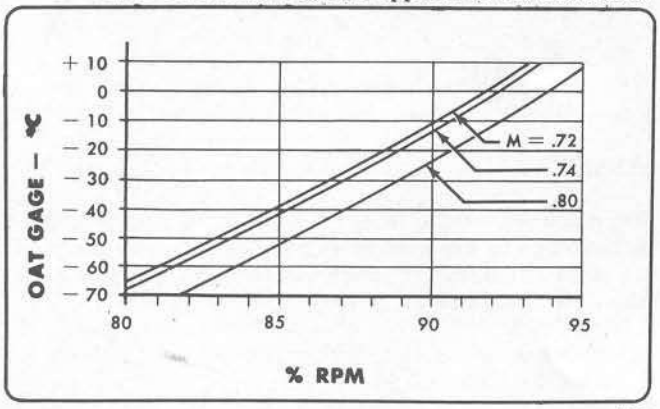
With JP-1, Specification MIL-F-5616, or JP-4, Specification MIL-F-5624A, boil-off at high altitude is negligible and range can be predicted with accuracy.

When Grade 100/130 gasoline, Specification MIL-F-5572, or JP-3, Specification MIL-F-5624, is used, considerable range may be lost through boiling away of fuel. The percentage loss is greater for high fuel temperatures at high altitudes. The table below shows the approximate loss in range due to gasoline boil-off. This does not allow for slugging of liquid fuel out the vents which may increase the loss considerably. Loss of JP-3 (RVP = 6) through boil-off will be slightly less than the loss for gasoline.

GASOLINE TEMPERATURE AT TAKE-OFF	APPROXIMATE PERCENT LOSS IN RANGE
110° F	20%
80° F	10%
50° F	0%

EFFECT OF OAT ON RANGE

Aside from fuel boil-off, the effect of outside air temperature on range is slight. Flight plans should be made on the basis of desired Mach number and altitudes. The range on this basis will be relatively unaffected by OAT. However, under high temperature conditions it will be necessary to increase rpm to establish the desired Mach number-altitude combination. For cold temperatures the rpm must be reduced. For an extremely hot day (120° F at sea level) the range is only about 1.5% less than for standard conditions. This correction can be applied at all altitudes.



A3318

The above OAT chart is based on engines tabbed to optimum thrust. Cold engines with low thrust will result in altitudes slightly lower than that shown on figure A-56 for a given weight. Such a change in altitude in this condition results in a negligible effect on range.

The following examples illustrate the use of the range curves for finding cruising data. For more complete mission problems involving fuel for take-off, climb, bombing, descent, etc, see part 11.

MAXIMUM RANGE OBTAINABLE

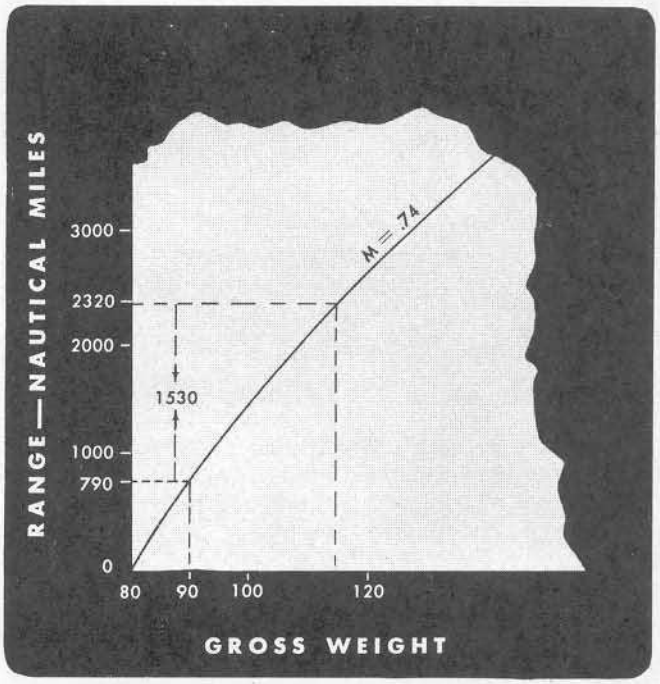
EXAMPLE 1:

Given: 1. Fuel in tanks = 25,000 pounds
2. No droppable cargo
3. Weight at end of cruise = 90,000 pounds.

Determine: 1. Maximum cruise range obtainable
2. Altitudes for maximum range.

Use the Mach .74 curve on figure A-56 for maximum range.

The gross weight at the start of the cruise is 90,000 + 25,000 = 115,000 pounds. The range available between 80,000 and 115,000 pounds is 2320 nautical miles. The range available between 90,000 and 80,000 pounds is 790 nautical miles. Then the range between the specified weights is 2320 - 790 = 1530 nautical miles.



The optimum altitude would be 39,600 feet with 25,000 pounds of fuel on board, and the climbing flight path would give an altitude of 44,500 feet at the end of the cruise at 90,000 pounds gross weight.

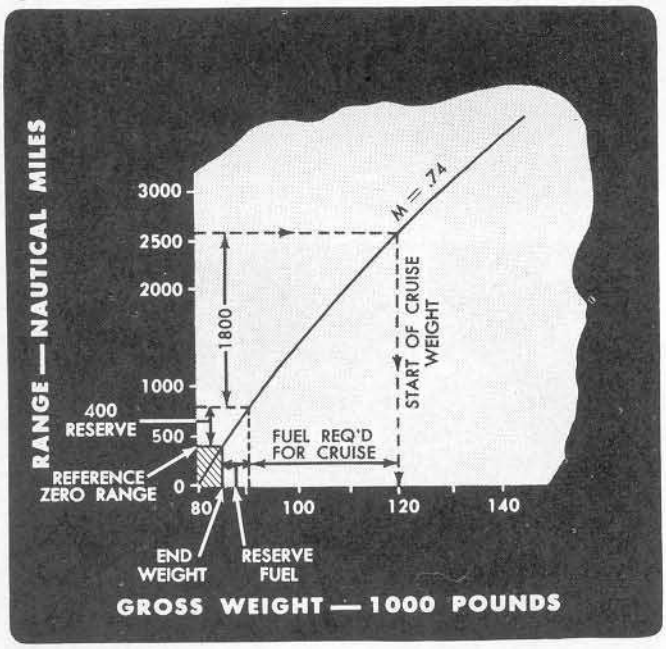
MINIMUM FUEL REQUIRED FOR CRUISE

EXAMPLE 2:

Given: 1. Desired cruise range = 1800 nautical miles
2. Desired reserve range = 400 nautical miles
3. No droppable cargo
4. Gross weight--no reserve fuel = 85,000 pounds.

Determine: 1. Minimum amount of fuel required for cruise and reserve
2. Altitudes for maximum range.

Use the Mach .74 curve on figure A-56. Using the end weight of 85,000 pounds gives a reference range figure of 400 nautical miles (the range obtainable between 85,000 and 80,000 pounds gross weight). 400 nautical miles reserve range gives the gross weight at the end of cruise, with reserve fuel, of 90,500 pounds. The reserve fuel weight is therefore 90,500 - 85,000 or 5500 pounds. 1800 nautical miles cruise distance shows a gross weight at start of cruise of 120,000 pounds gross weight (see sketch). The total fuel required is 120,000 - 85,000 = 35,000 pounds and the fuel required for cruise is 35,000 - 5,500 = 29,500 pounds.



From the altitude chart at the top of figure A-56, the altitude at the start of cruise for 120,000 pounds gross weight would be 39,600 feet and similarly for the end of cruise is 44,000 feet.

CONSTANT ALTITUDE CRUISE

EXAMPLE 3:

Given:
1. Entire low level mission at 10,000 feet
2. No droppable cargo
3. Desired cruise range = 1200 nautical miles
4. Gross weight at end of mission = 85,000 pounds.

Determine:
1. Minimum amount of fuel required for cruise
2. Mach numbers and speed for cruise
3. Gross weight at start of cruise.

Use the optimum curve on figure A-64 for best range at a constant 10,000-foot altitude. Use 85,000 pounds as gross weight with no fuel.

In a manner similar to that described above for example 2, the reference zero for 85,000 pounds basic weight is 150 nautical miles. A desired cruise range of 1200 miles gives a reference range for start of cruise of 1200 + 150 = 1350 nautical miles. The gross weight from the chart for 1350 miles is 129,400 pounds, the initial gross weight.

The Mach number at the start of cruise, if found on the curve at the point corresponding to 1350 nautical miles range, is about .58. As the airplane flies down the curve, the Mach number decreases until at 85,000 pounds gross weight it is about .53. From the Mach number-TAS conversion chart the TAS is found to change from 371 knots at the start to 340 knots at the end of the mission. If it is undesirable to fly so slowly, the speed can be increased at the expense of fuel. To fly at Mach .76, corresponding to 425 knots IAS limiting speed, 52,500 pounds of fuel are required for the same distance.

RANGE OVER SHORT DISTANCES

EXAMPLE 4:

At the end of a mission before the descent is begun, it is found that a change in the landing base is necessary due to weather.

Given:
1. Airplane gross weight without fuel = 82,000 pounds
2. Fuel in tanks - 6000 pounds
3. Flight at altitude for maximum range.

Determine:
1. Maximum reserve range remaining
2. Cruise Mach number and altitudes.

For short distances, particularly at low gross weights, the charts of miles per thousand pounds of fuel are most convenient and accurate. Using the chart on figure A-57 the maximum range is obtainable at Mach .74. At the average gross weight of $82,000 + \frac{6000}{2} =$ 85,000 pounds, there are 75 nautical miles obtainable per thousand pounds of fuel. The reserve range at cruise is then $6000 \times \frac{75}{1000} = 450$ nautical miles.

The altitude, from figure A-56, at the start of the cruise is 45,000 feet, and at the end is 47,000 feet.

EXAMPLE 5:

When within 100 nautical miles of the target it is desired to go to the maximum possible altitude for cruise at Mach .76 until the bomb is dropped. After the climb the conditions are as follows:

Gross weight = 130,000 pounds
Altitude = 42,000 feet
Mach = .76

Determine the gross weight and altitudes at the target.

Using the chart figure A-61 for maximum allowable rpm, a first estimate is as follows: For a gross weight of 130,000 pounds and Mach .76, 40 nautical miles per thousand pounds are obtained. Then $100 \times \frac{1000}{40} = 2500$ pounds are consumed in flying 100 nautical miles.

Checking by a second approximation, the average gross weight is about $130,000 - \frac{2500}{2} = 128,750$ pounds. At this average gross weight of 128,750, 40.5 nautical miles per thousand pounds of fuel are obtained. Then $100 \times \frac{1000}{40.5} = 2470$ pounds of fuel are used. For such short ranges, there obviously is no need for going beyond a first approximation. The gross weight at the target is 130,000 - 2470 = 127,530 pounds. From figure A-60, the maximum target altitude at Mach .76 is about 43,000 feet.

A chart for simplifying the use of the nautical miles per thousand pound charts has been added on figure A-79. It can be used in the above examples.

PARTIAL ENGINE OPERATION

FIVE ENGINE OPERATION results in decreased range, but this decrease may be minimized by proper cruise procedure. If a single engine failure occurs during cruise at altitude:

1. Hold Mach .72
2. Maintain an altitude 2000 feet below that specified for six engines at Mach .74 for maximum range operation.

Range will be decreased approximately 3% from that given for six-engine maximum range operation at Mach .74. Any variation from the above Mach number-altitude combination will result in greater range losses.

FOUR ENGINE OPERATION during cruise at altitude requires close observance of recommended procedures or serious penalties in range will result. If a double engine failure occurs during cruise at altitude:

1. Hold Mach .69
2. Maintain an altitude 5000 feet below that specified for six engines at Mach .74 for maximum range operation.

Range will be decreased approximately 9% from that given for six-engine operation at Mach .74. Any divergence from the above Mach number-altitude combination will result in correspondingly greater losses in range.

THREE ENGINE OPERATION results in a considerable loss in range. To obtain maximum performance:

1. Hold Mach .60
2. Reduce altitude to 15,000 feet below that specified for maximum range at Mach .74 with six engines.

Range will decrease approximately 22% from the maximum obtainable with six engines at M = .74.

"DIRTY" AIRPLANE RANGE OPERATION

For emergency conditions of flight when the bomb bay doors are open, flaps down and/or gear down, and it is impossible to close the doors or retract the flaps and gear, the range performance is shown on figure A-80. Corresponding cruise speeds and altitudes are also shown on this chart. As only optimum performance conditions are shown, any large deviation from the speeds and altitudes indicated will result in a greater range loss than indicated by the chart.

EXAMPLE:

After completing a bomb drop, it is found that the bomb doors cannot be closed. The gross weight is 120,000 pounds, with the no fuel condition weight equal to 85,000 pounds and the airplane is 2,000 nautical miles from its landing base.

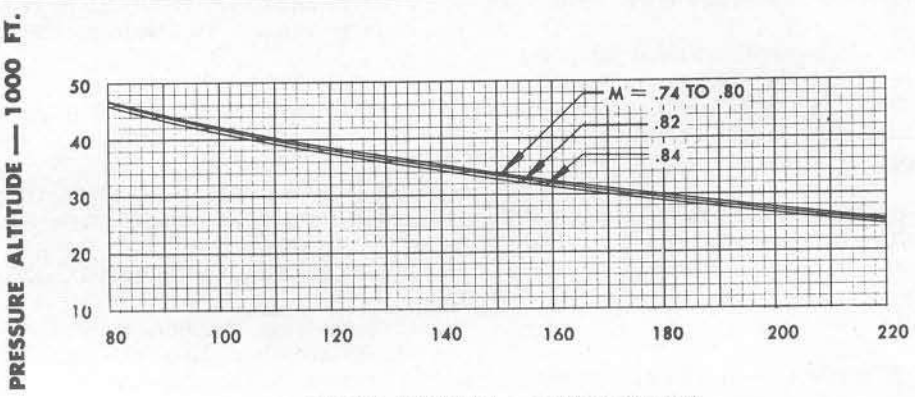
Determine if the airplane should return to its base or land at an alternate base.

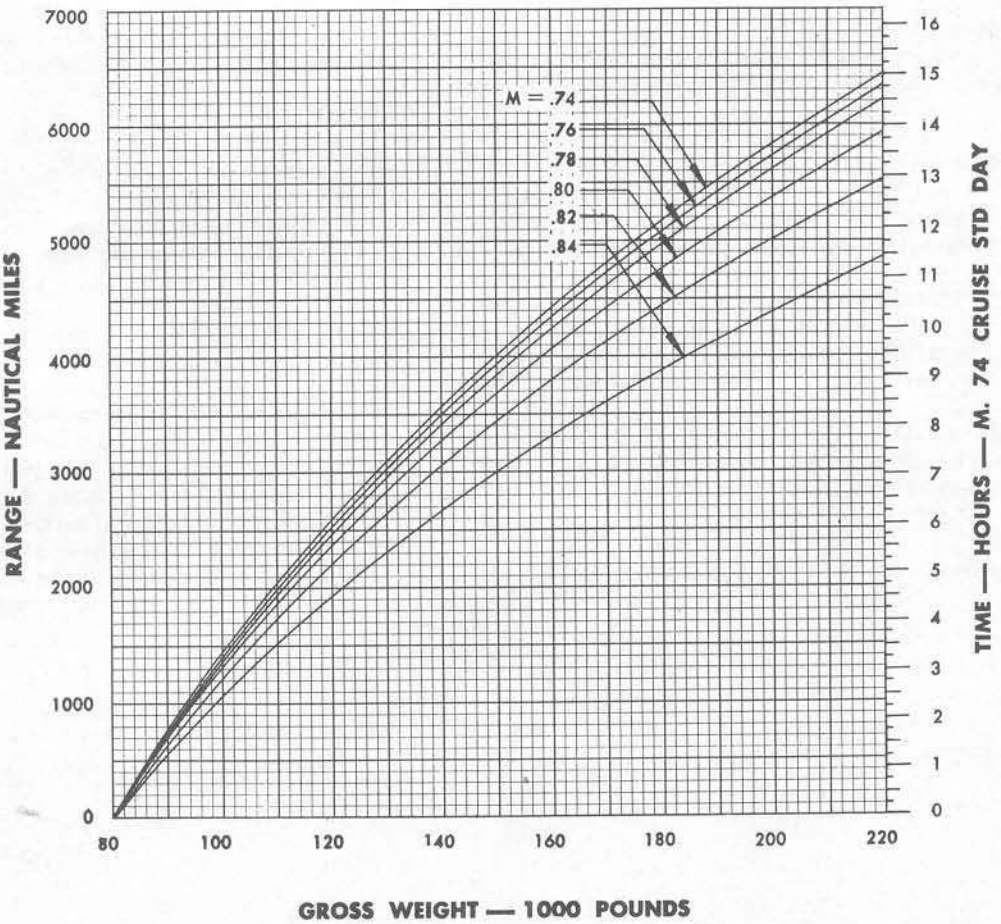
From figure A-80, at a gross weight of 120,000 pounds, the range for bomb bay open is 2100 nautical miles and the range at 85,000 pounds is 330 nautical miles; therefore, the distance the airplane can fly is 2100 - 330 = 1770 nautical miles. Thus it is evident that an alternate landing base should be selected. Flight to the alternate base should be "at altitude" starting with 37,000 feet and cruising at Mach .71.

ALTITUDE AND MAXIMUM RANGE AT CONSTANT MACH NUMBER

MODEL: YDB-47E

ENGINES: J47-GE-25





CONDITIONS: VORTEX GENERATORS INSTALLED

REMARKS:

DATE: NOVEMBER 1952
DATA BASIS: FLIGHT TEST

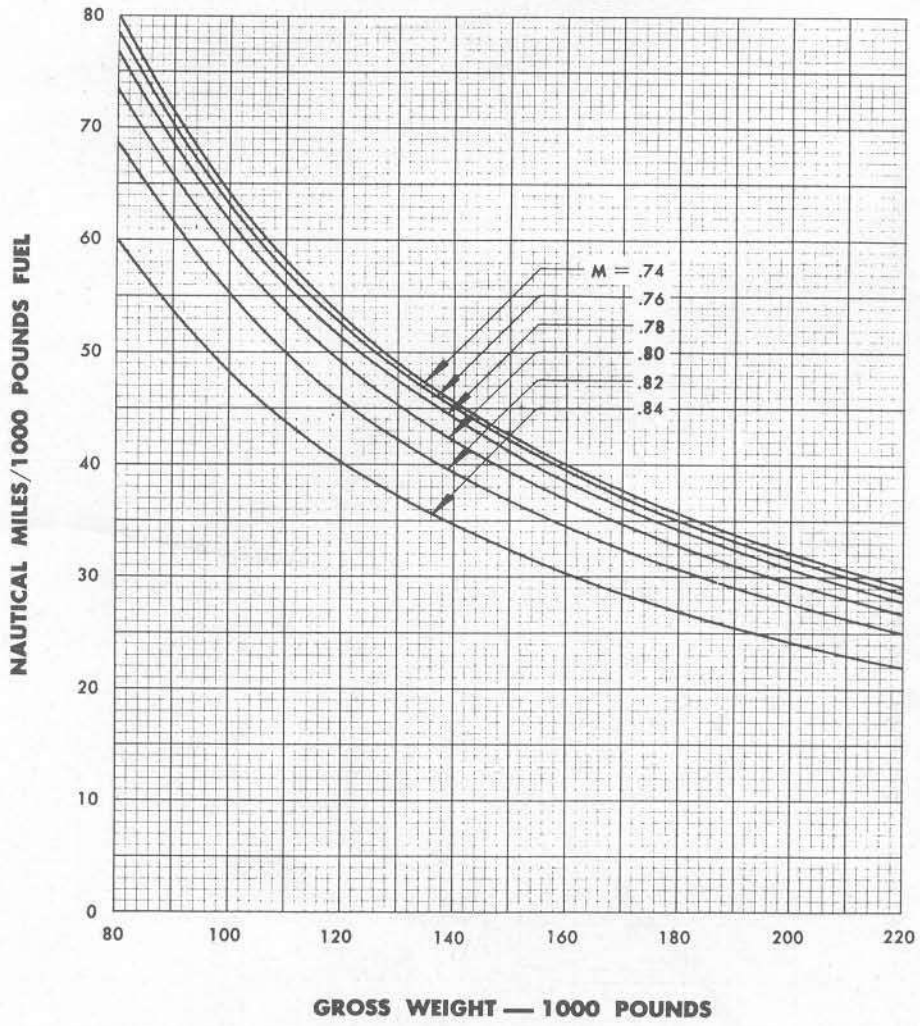
Figure A-56.

MAXIMUM RANGE OPERATION

NAUTICAL MILES/1000 POUNDS OF FUEL

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: VORTEX GENERATORS INSTALLED

REMARKS:

DATE: DECEMBER 1952

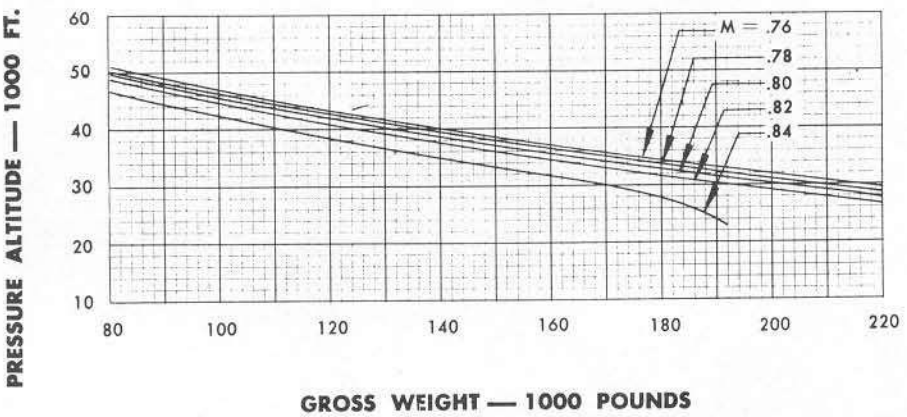
DATA BASIS: FLIGHT TEST

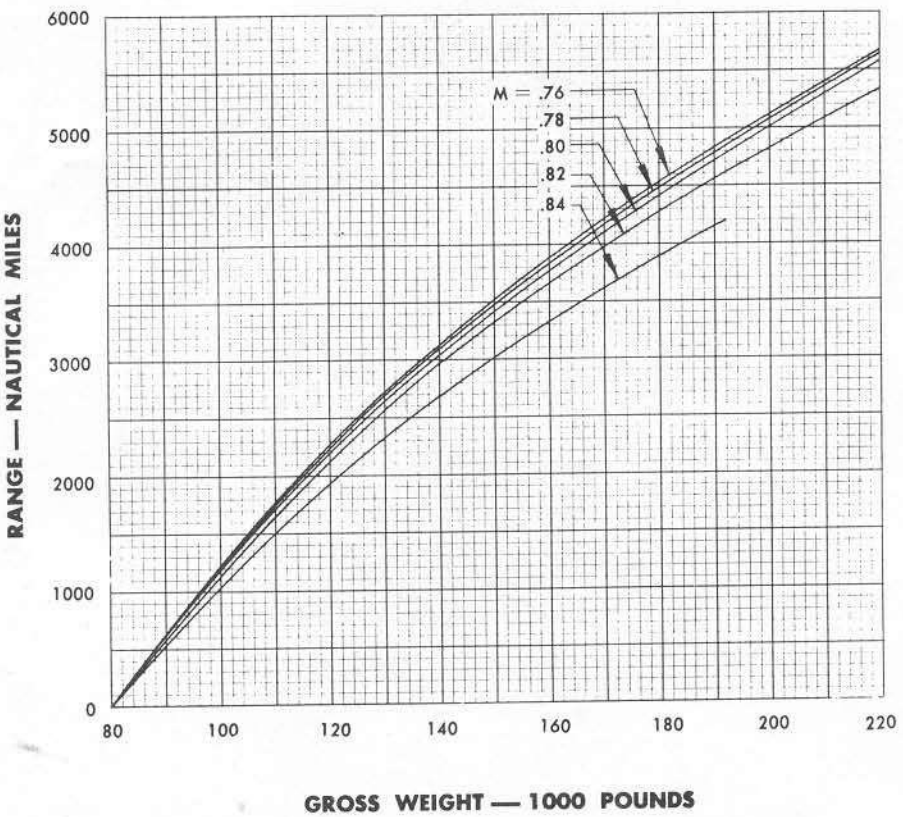
Figure A-57.

ALTITUDE AND RANGE
NORMAL RATED (96%) RPM

MODEL: YDB-47E

ENGINES: J47-GE-25





CONDITIONS: NORMAL RATED (96%) RPM
VORTEX GENERATORS INSTALLED

REMARKS:

DATE: OCTOBER 1952

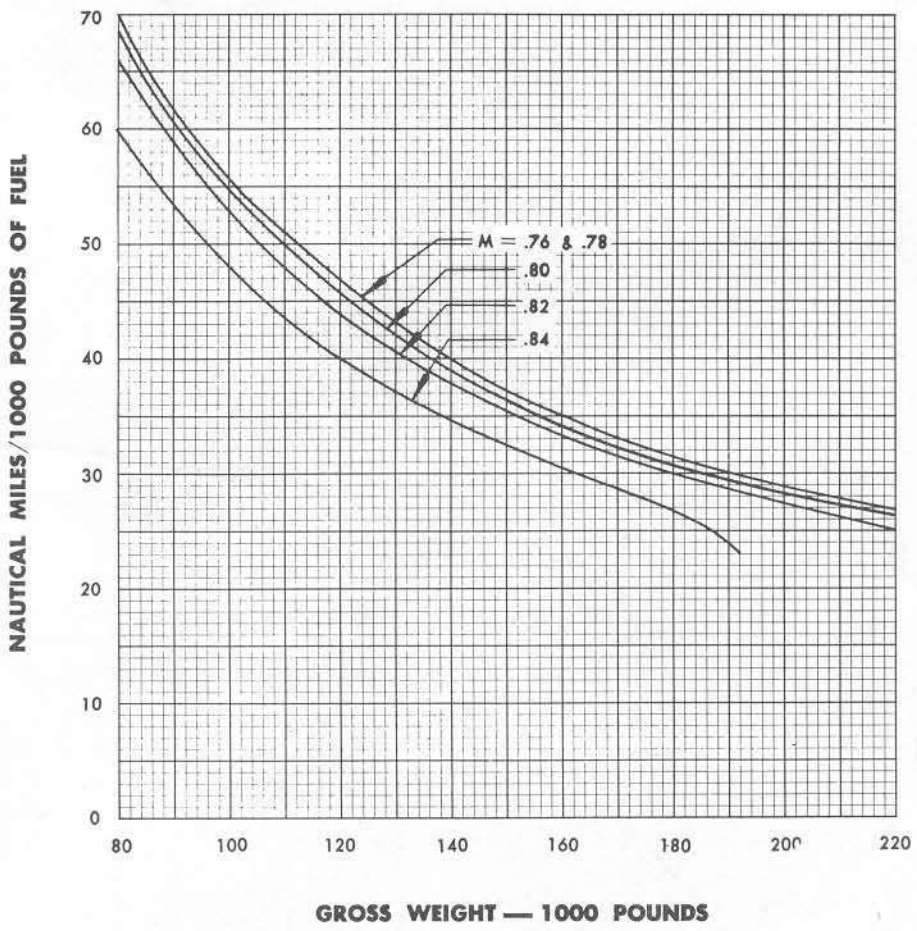
DATA BASIS: FLIGHT TEST

Figure A-58.

NAUTICAL MILES/1000 POUNDS OF FUEL
NORMAL RATED (96%) RPM

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: NORMAL RATED (96%) RPM
VORTEX GENERATORS INSTALLED

REMARKS:

DATE: DECEMBER 1952

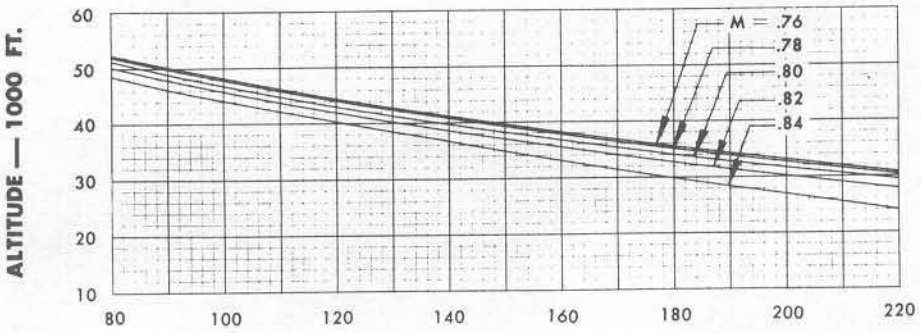
DATA BASIS: FLIGHT TEST

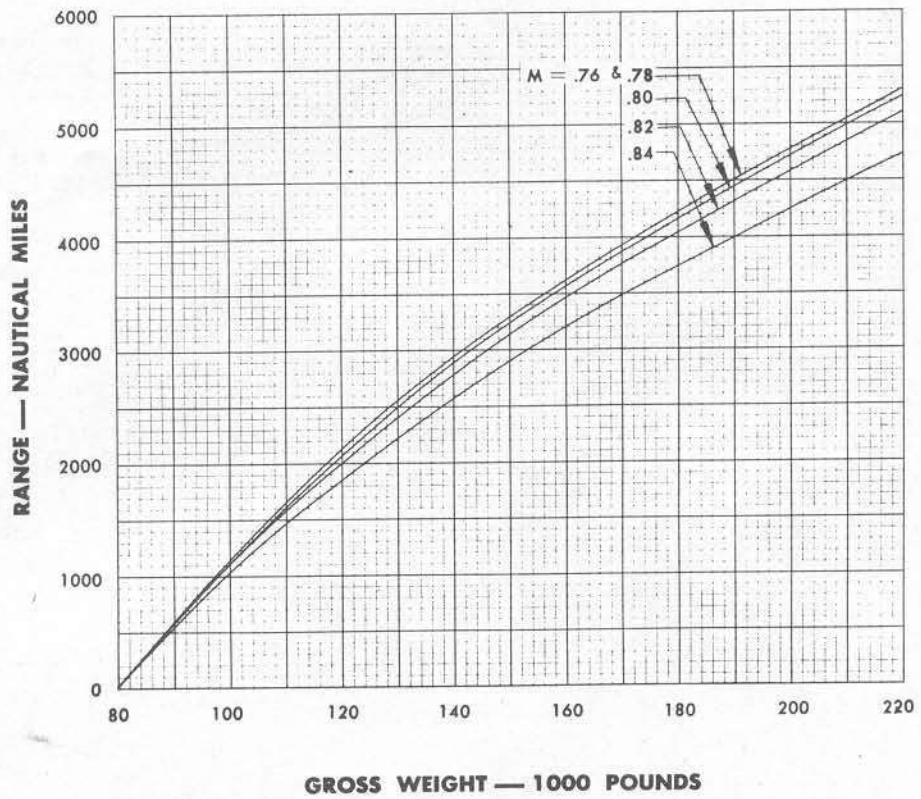
Figure A-59.

ALTITUDE AND RANGE
MILITARY RATED RPM

MODEL: YDB-47E

ENGINES: J47-GE-25





CONDITIONS: MILITARY RATED RPM
VORTEX GENERATORS INSTALLED

REMARKS:

DATE: OCTOBER 1952
DATA BASIS: FLIGHT TEST

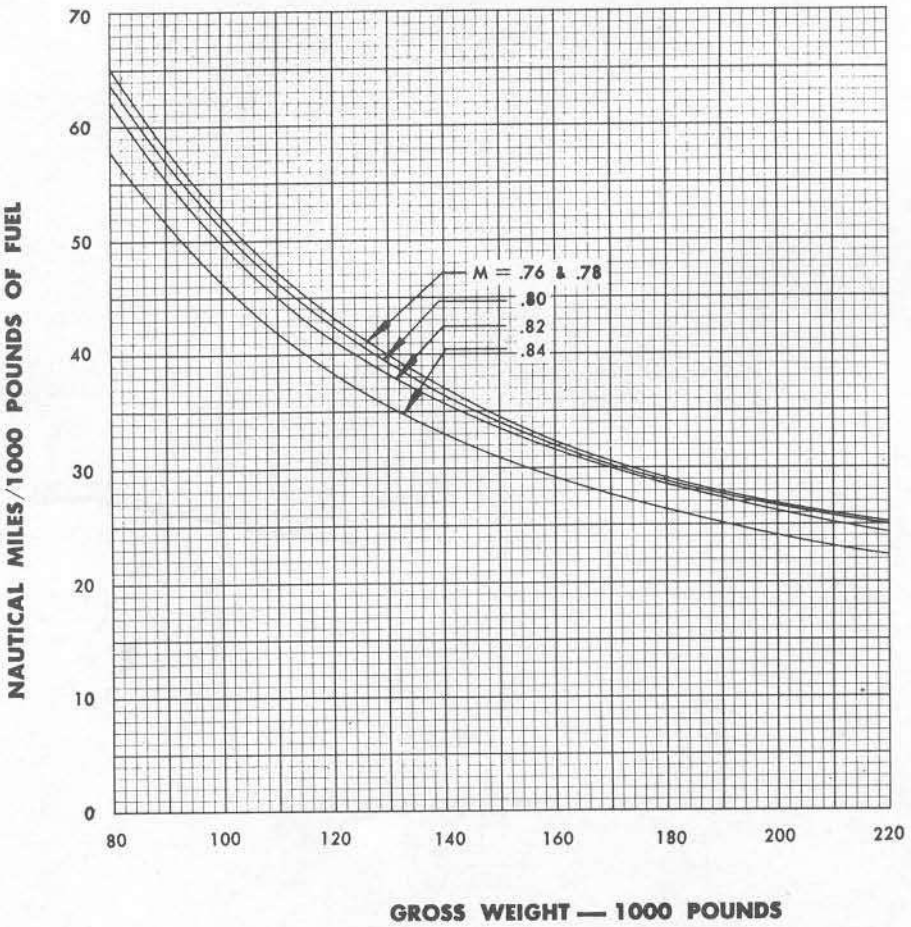
Figure A-60.

NAUTICAL MILES/1000 POUNDS OF FUEL

MILITARY RATED RPM

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: MILITARY RATED RPM
VORTEX GENERATORS INSTALLED

REMARKS:

DATE: DECEMBER 1952

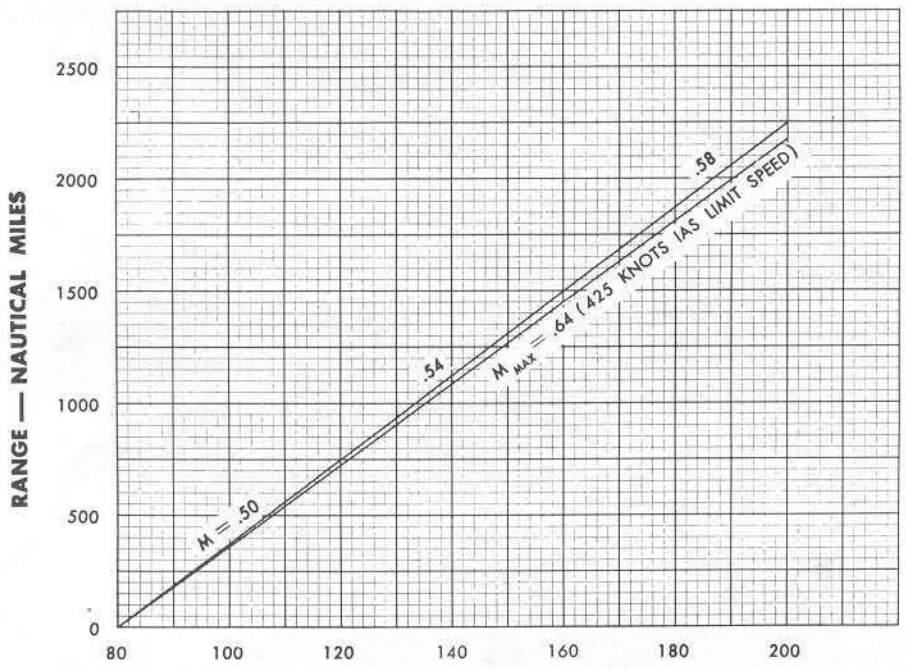
DATA BASIS: FLIGHT TEST

Figure A-61.

RANGE
SEA LEVEL

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

DATE: OCTOBER 1952
DATA BASIS: FLIGHT TEST

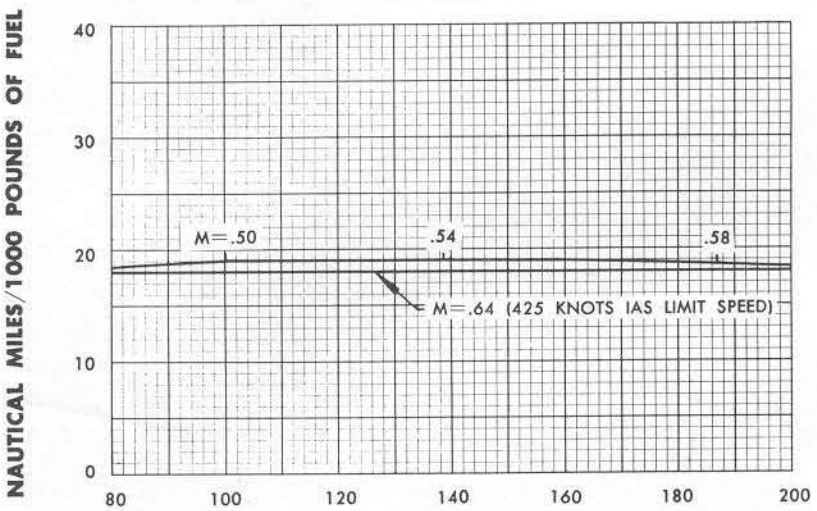
Figure A-62.

NAUTICAL MILES/1000 POUNDS OF FUEL

SEA LEVEL

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

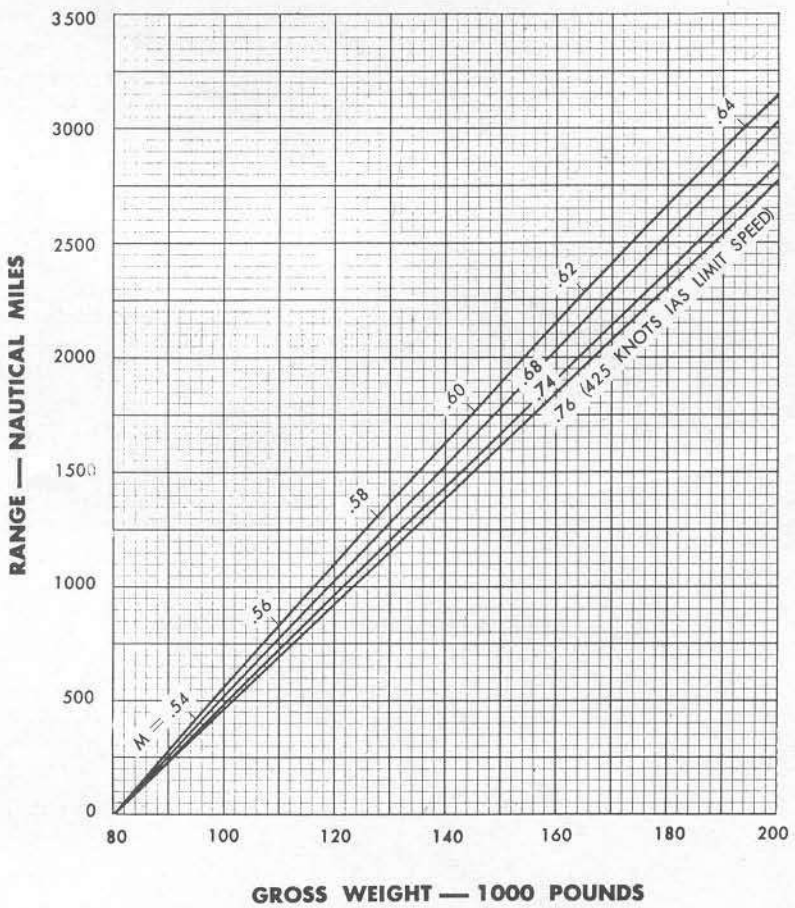
DATE: DECEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-63.

RANGE
10,000 FT ALTITUDE

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

DATE: SEPTEMBER 1952
DATA BASIS: FLIGHT TEST

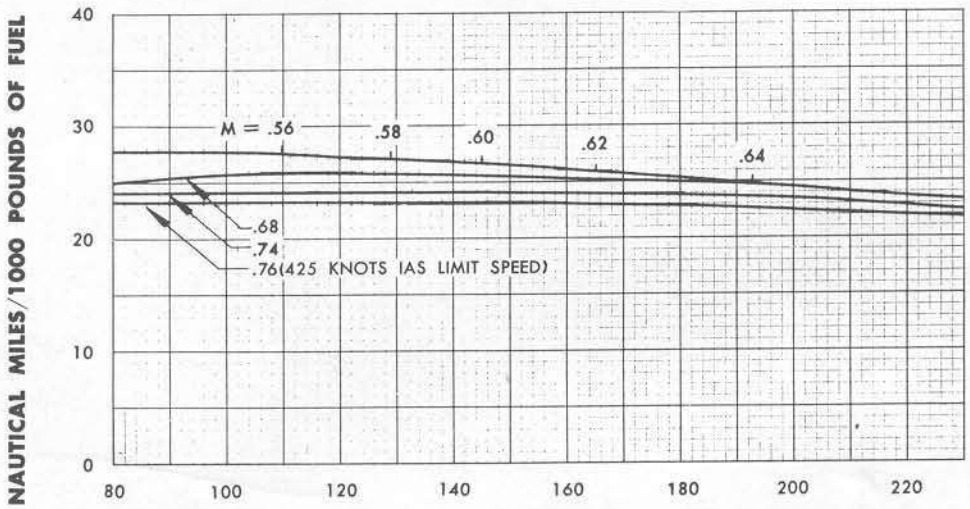
Figure A-64.

NAUTICAL MILES/1000 POUNDS OF FUEL

10,000 FT ALTITUDE

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

DATE: JULY 1952

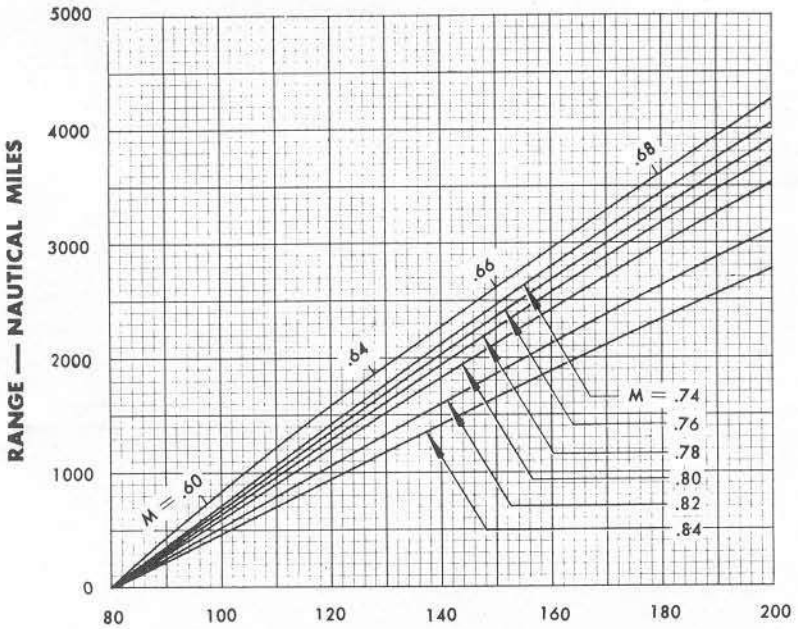
DATA BASIS: FLIGHT TEST

Figure A-65.

RANGE
20,000 FT ALTITUDE

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

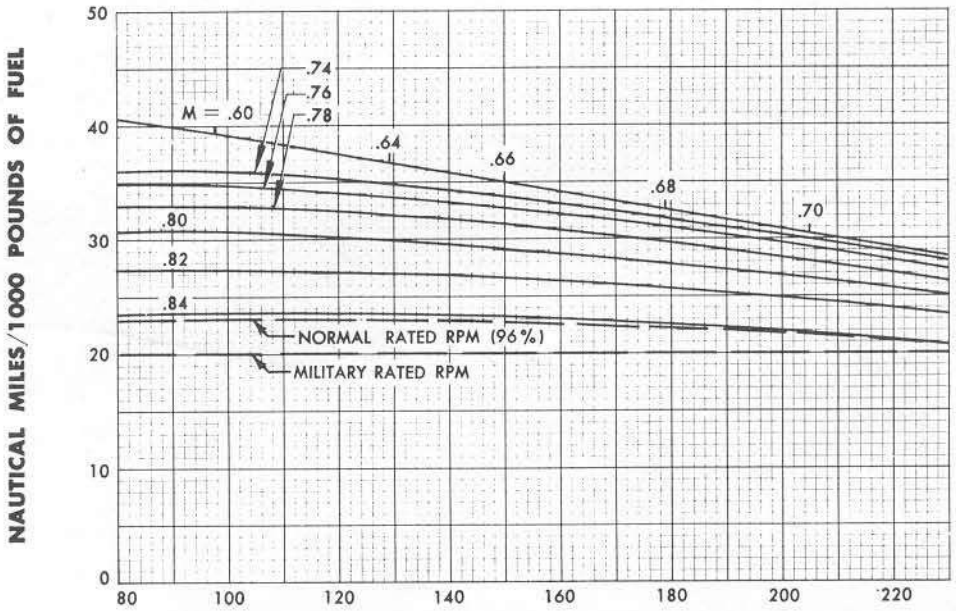
DATE: SEPTEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-66.

NAUTICAL MILES/1000 POUNDS OF FUEL
20,000 FT ALTITUDE

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: DATA FOR NORMAL RATED AND MILITARY RATED RPM IS FOR NACA STANDARD DAY TEMPERATURES.

DATE: JULY 1952

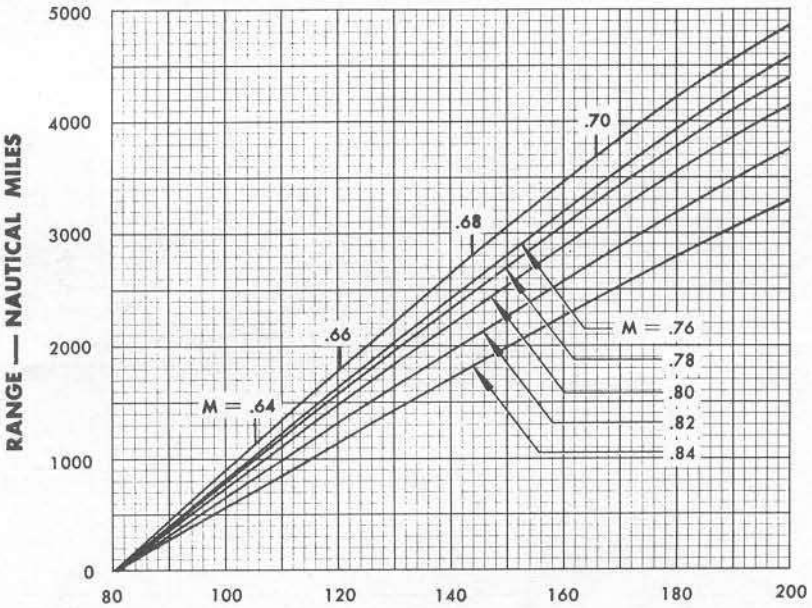
DATA BASIS: FLIGHT TEST

Figure A-67.

RANGE
25,000 FT ALTITUDE

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

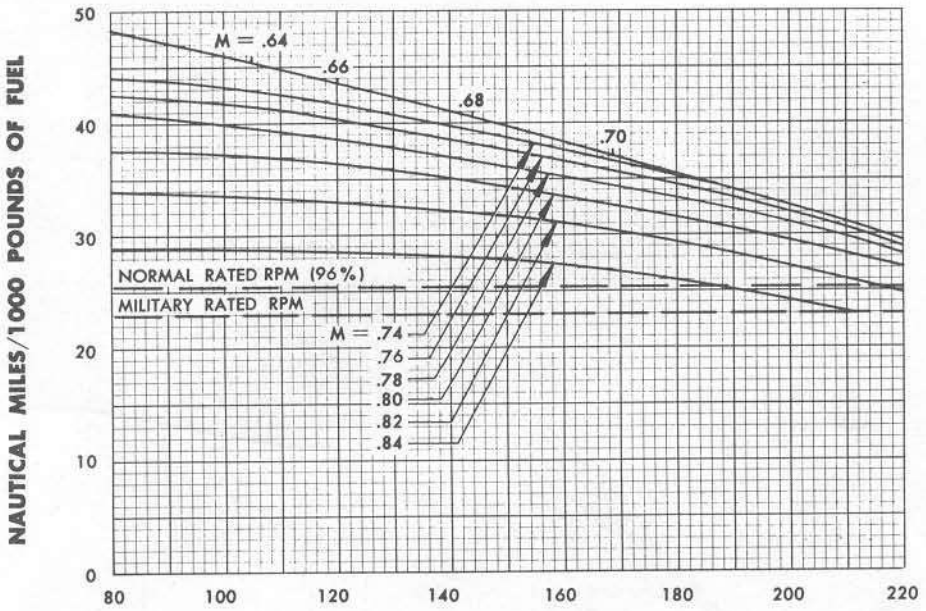
DATE: OCTOBER 1952
DATA BASIS: FLIGHT TEST

Figure A-68.

NAUTICAL MILES/1000 POUNDS OF FUEL
25,000 FT ALTITUDE

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: DATA FOR NORMAL RATED AND MILITARY RATED RPM IS FOR NACA STANDARD DAY TEMPERATURES.

DATE: JUNE 1952

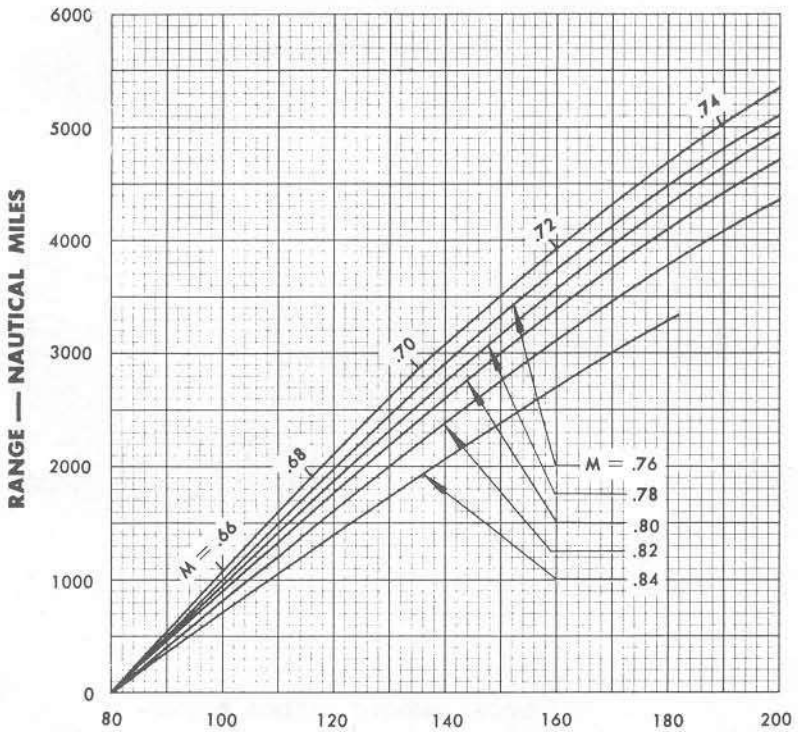
DATA BASIS: FLIGHT TEST

Figure A-69.

RANGE
30,000 FT ALTITUDE

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

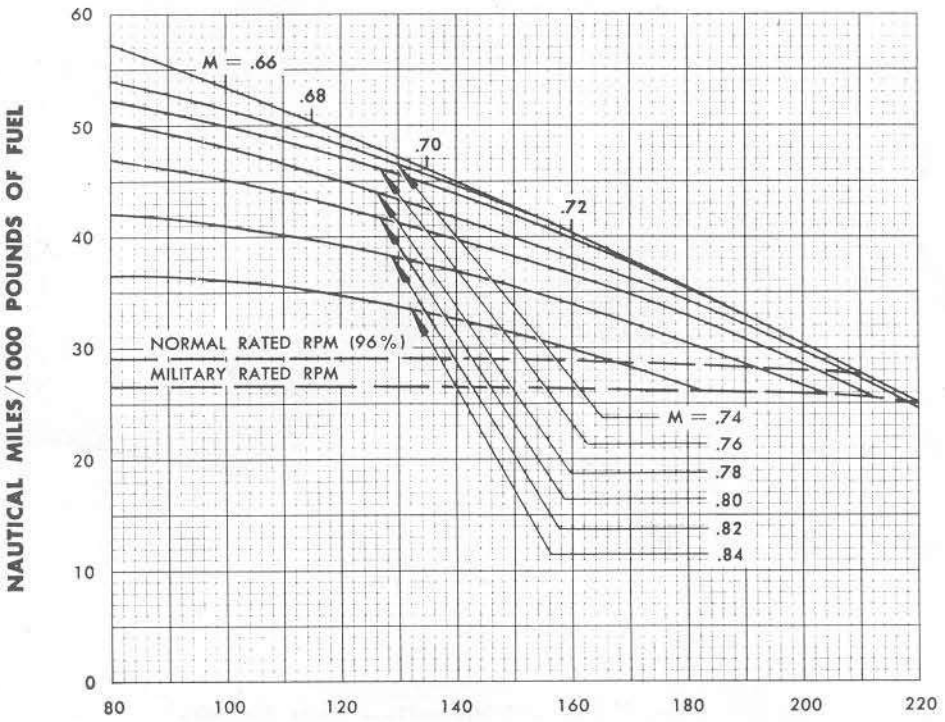
DATE: SEPTEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-70.

NAUTICAL MILES/1000 POUNDS OF FUEL
30,000 FT ALTITUDE

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: DATA FOR NORMAL RATED AND MILITARY RATED RPM IS FOR NACA STANDARD DAY TEMPERATURES.

DATE: JUNE 1952

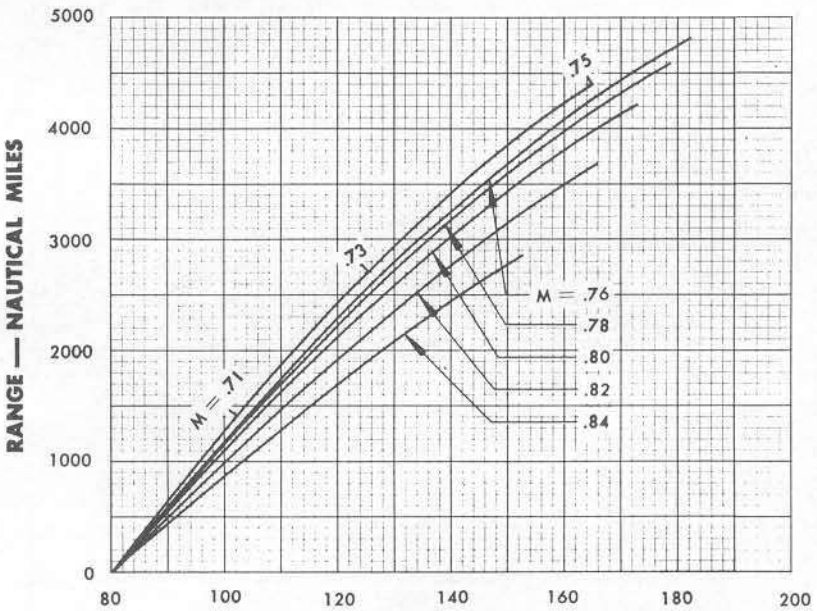
DATA BASIS: FLIGHT TEST

Figure A-71.

RANGE
35,000 FT ALTITUDE

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

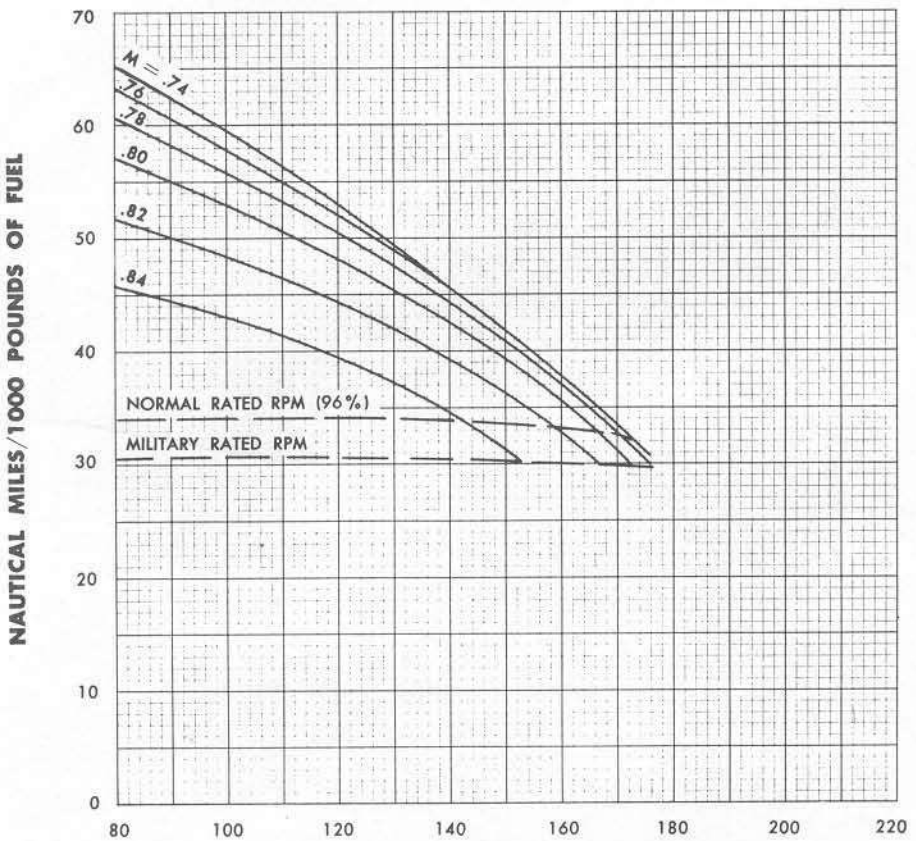
DATE: OCTOBER 1952
DATA BASIS: FLIGHT TEST

Figure A-72.

NAUTICAL MILES/1000 POUNDS OF FUEL
35,000 FT ALTITUDE

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: DATA FOR NORMAL RATED AND MILITARY RATED RPM IS FOR NACA STANDARD DAY TEMPERATURES.

DATE: JUNE 1952

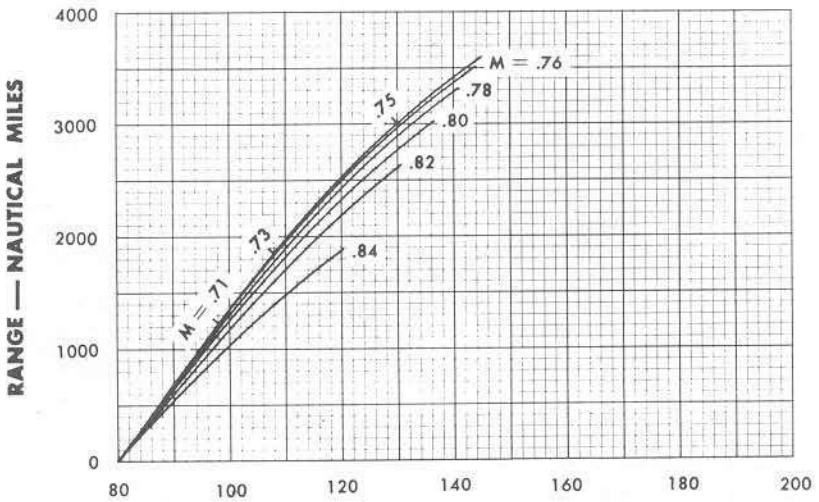
DATA BASIS: FLIGHT TEST

Figure A-73.

RANGE
40,000 FT ALTITUDE

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

DATE: SEPTEMBER 1952
DATA BASIS: FLIGHT TEST

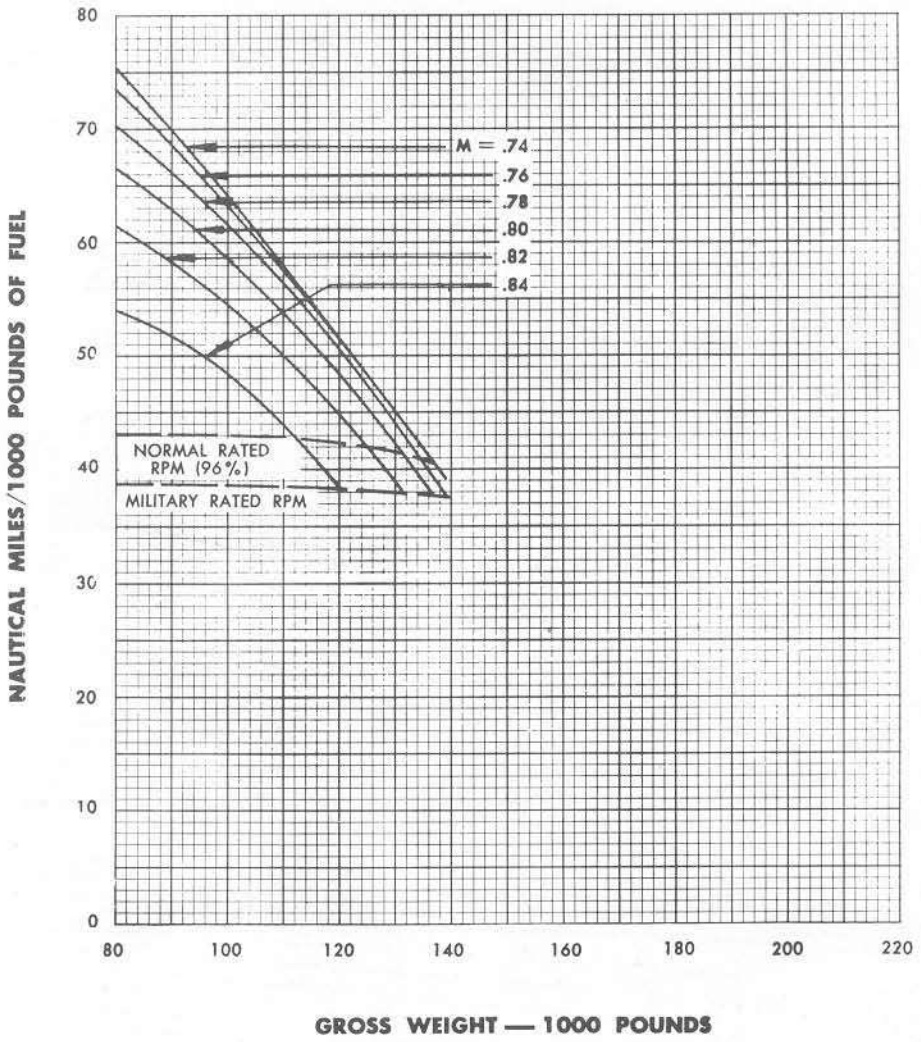
Figure A-74.

NAUTICAL MILES/1000 POUNDS OF FUEL

40,000 FT ALTITUDE

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: DATA FOR NORMAL RATED AND MILITARY RATED RPM IS FOR NACA STANDARD DAY TEMPERATURES.

DATE: JUNE 1952

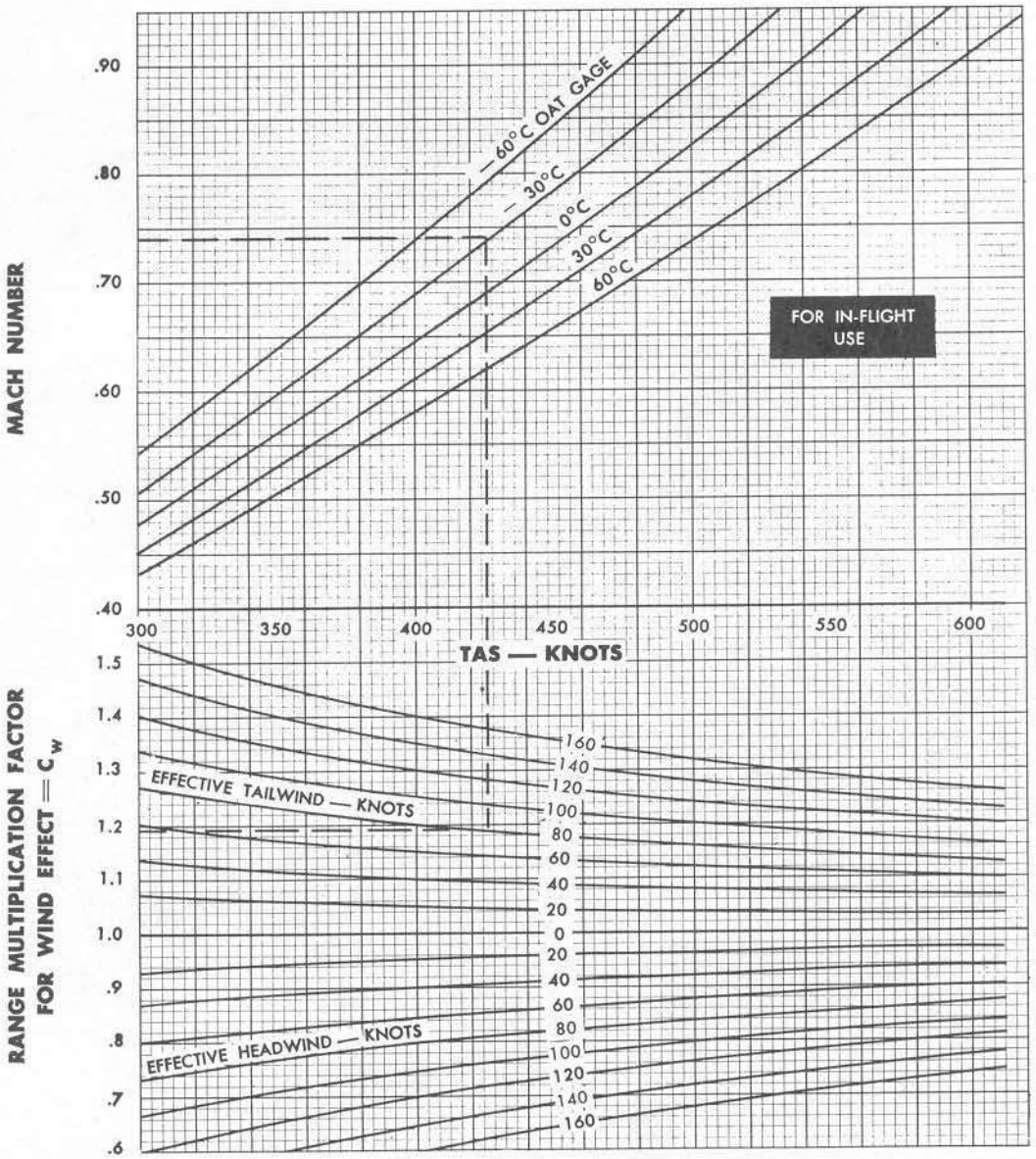
DATA BASIS: FLIGHT TEST

Figure A-75.

RANGE CORRECTION FOR WIND OVER GIVEN WEIGHT CHANGE

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: $\text{RANGE}_{(\text{WIND})} = C_w \times \text{RANGE}_{(\text{NO WIND})}$

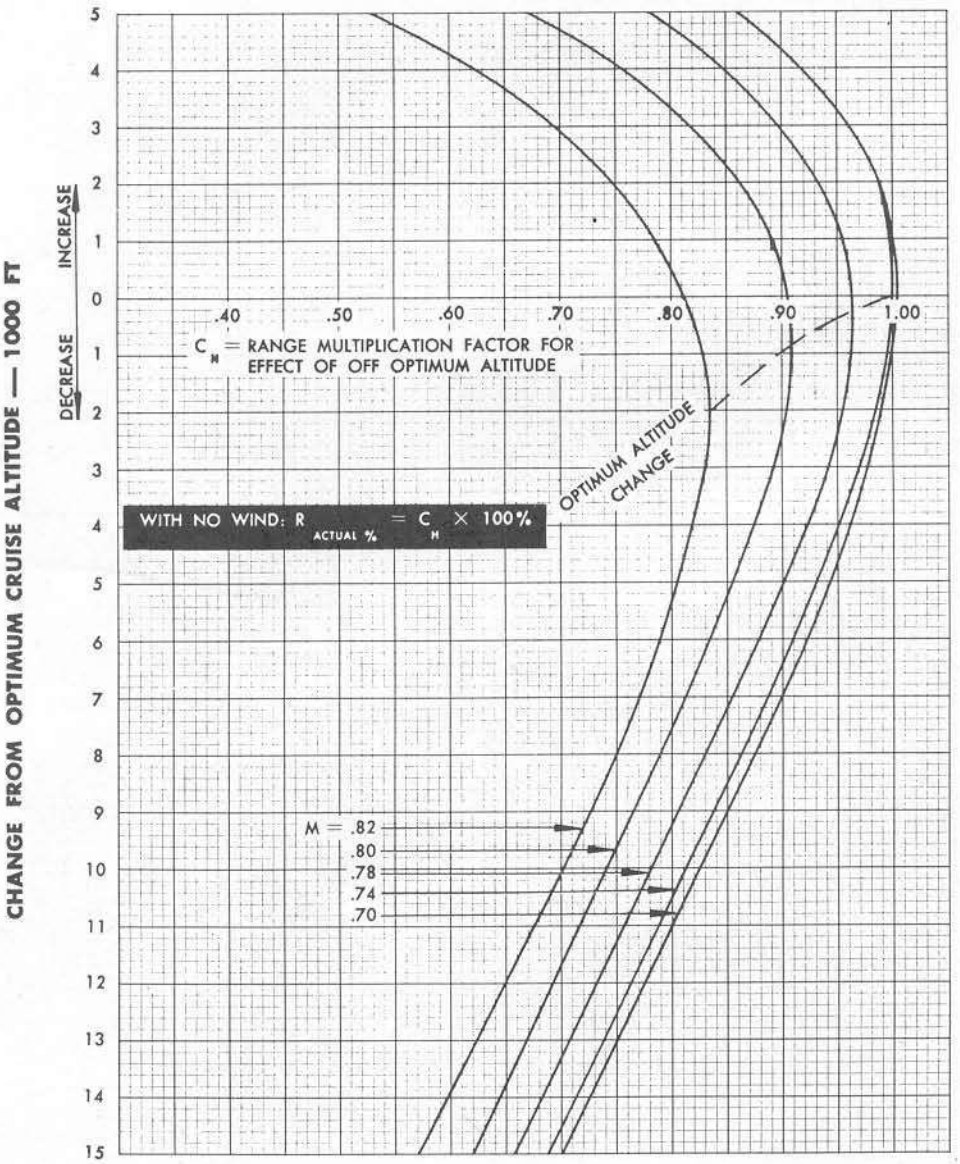
DATE: AUGUST 1951
DATA BASIS: CALCULATED

Figure A-76.

EFFECT OF ALTITUDE AND SPEED CHANGE ON RANGE

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: NACA STANDARD DAY

REMARKS: WITH NO WIND: $R_{ACTUAL\ \%} = C_H \times 100\%$

DATE: AUGUST 1951

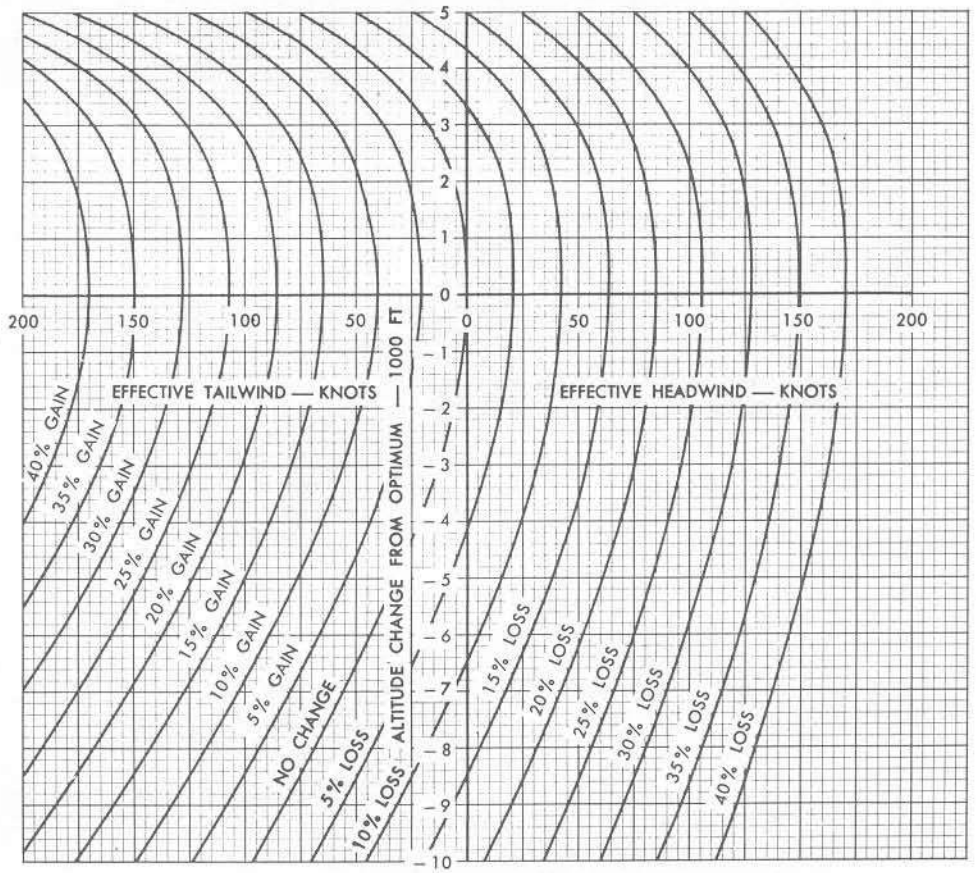
DATA BASIS: CALCULATED

Figure A-77.

EFFECT OF ALTITUDE AND WIND ON RANGE

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS: M = .74, OPTIMUM CRUISE ALTITUDE ALTITUDE ABOVE 35,000 FT. WIND EFFECT LESSENS AT LOWER ALTITUDE.

DATE: AUGUST 1951

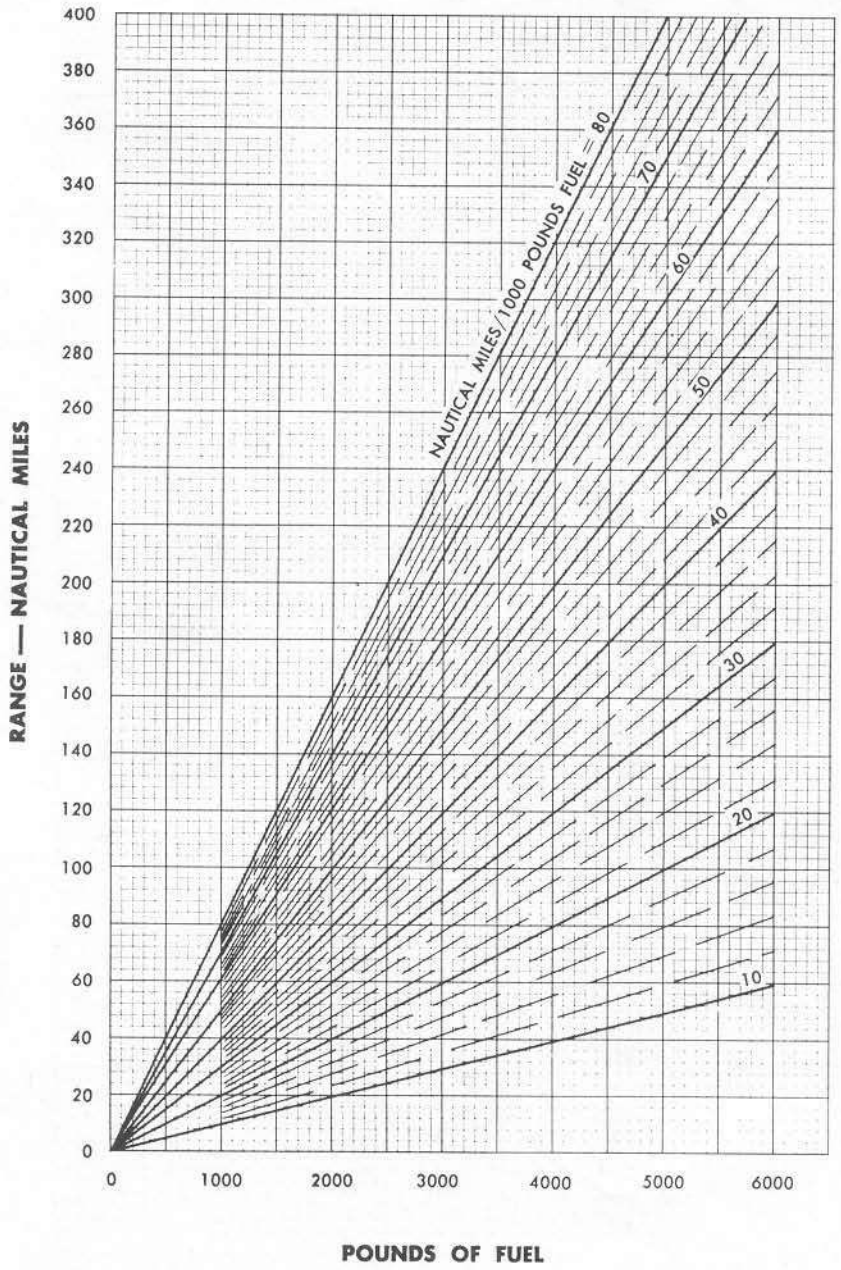
DATA BASIS: CALCULATED

Figure A-78.

FUEL DISTANCE CONVERSION

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

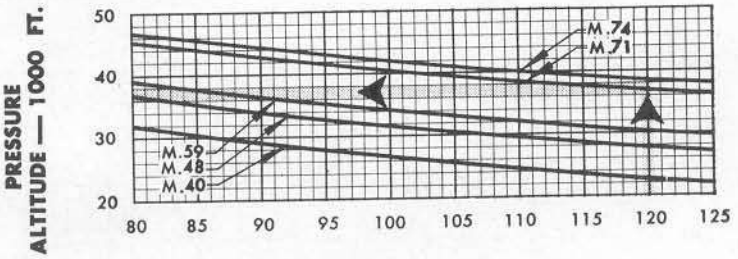
DATE: JULY 1950
DATA BASIS: CALCULATED

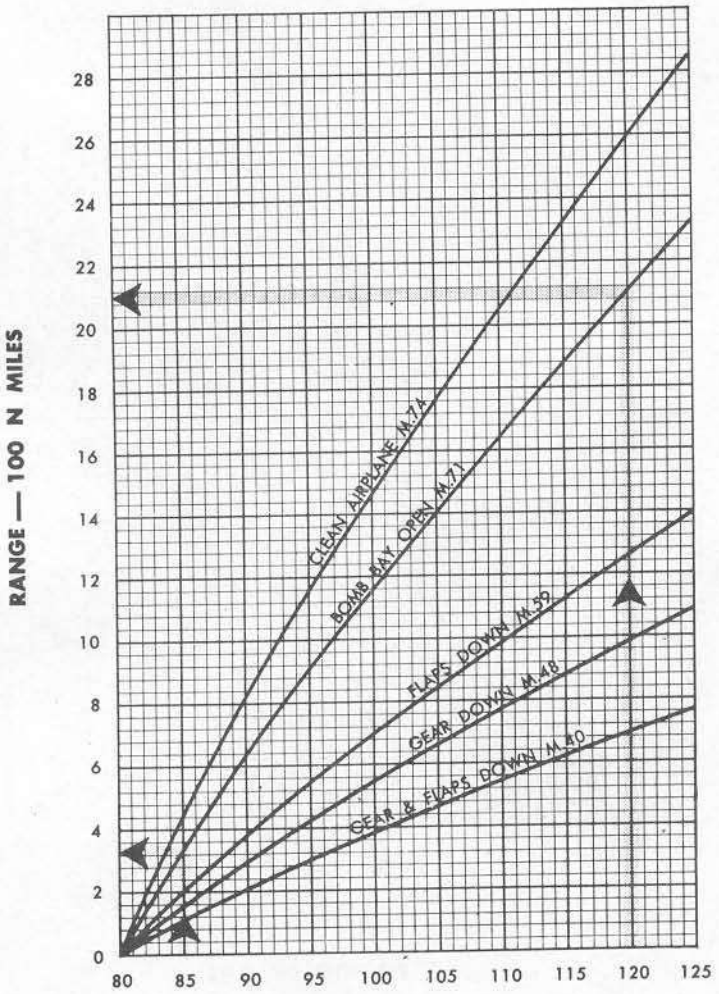
Figure A-79.

MAXIMUM RANGE FOR EMERGENCY OPERATION

MODEL: YDB-47E

ENGINES: J47-GE-25





REMARKS: SHORT BOMB BAY DOORS FULLY OPENED
ALL GEARS DOWN
FULL FLAPS

DATE: APRIL 1953
DATA BASIS: FLIGHT TEST

Figure A-80.

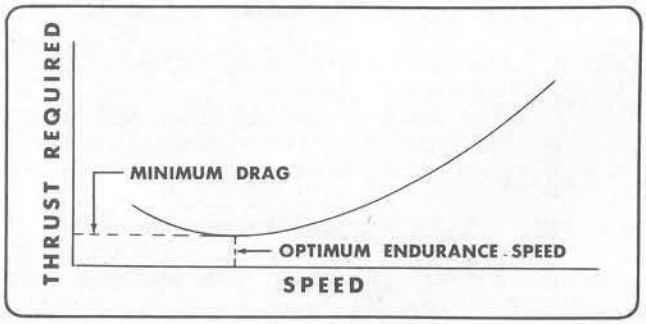
PART 7

ENDURANCE

Maximum endurance is frequently desired during operational problems such as rendezvous, air traffic clearance, and navigational checks, or to provide time to correct airplane functional difficulties. Maximum endurance may be attained only if recommended airspeeds are observed and the proper number of engines used.

MAXIMUM ENDURANCE

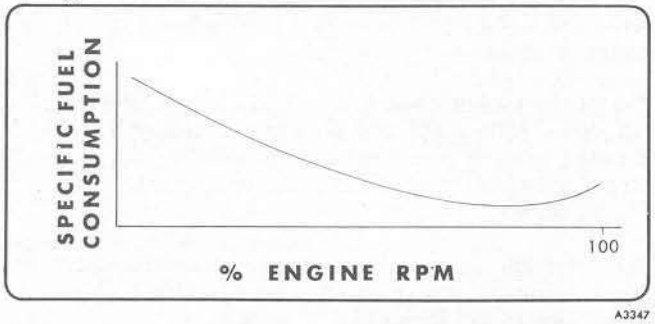
The airspeed for maximum endurance at any weight and altitude is approximately the airspeed at which airplane drag is a minimum. At that airspeed, the engine fuel consumption is minimum because the least thrust is required.



The recommended airspeeds for maximum endurance with flaps and gear up and two, four, or six engines operating are given on figure A-81.

The number of operating engines required for maximum endurance varies with altitude because of the following:

1. The thrust required to overcome airplane drag, at a given weight and at the correct maximum endurance speed, remains essentially constant at all altitudes.
2. The thrust output of jet engines at a given rpm drops off rapidly with increasing altitudes.
3. The engine rpm must be kept relatively constant (between 80% and 90% rpm) for minimum specific fuel consumption. It is apparent from the following sketch that, if too many engines are running, the rpm on all engines must be low and the fuel consumption then will be high.



Therefore, for the thrust output to equal the constant thrust required, with the rpm and indicated airspeed fixed for maximum endurance, more engines are required at high than at low altitudes. The number of engines required for maximum endurance at any altitude and weight is given in the following table (all other engines cut):

ALTITUDE	APPROXIMATE RPM PER CENT MAX.	NUMBER OF OPERATING ENGINES GROSS WT. — (1000 POUNDS)						
		80	100	120	140	160	180	200
ABOVE 30,000′	85	6	6	6	6	*	*	*
20,000′ TO 30,000′	85	4	4	5	5	6	6	6
10,000′ TO 20,000′	85	3	3	4	4	5	5	5
S L TO 10,000′	85	2	2	3	3	3	3	4

*ALTITUDE NOT PRACTICAL FOR HIGH GROSS WEIGHT.

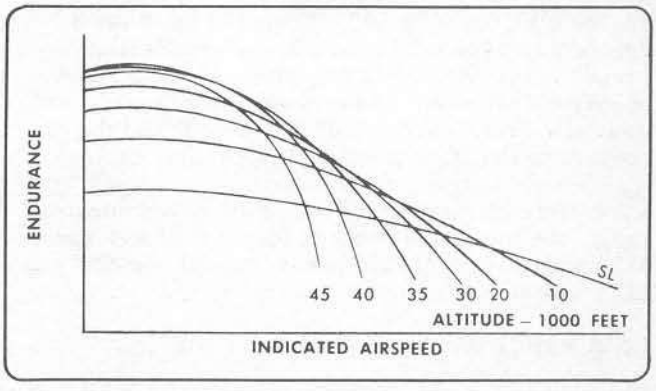
Endurance charts for both mission planning and emergency operation are contained in this section. These charts include no conservative factors or reserves.

The effect of wing tanks will be to reduce the time available from a given fuel quantity by 7.57% with no change in speed.

Endurance, like range, can be estimated from the gross weight at the start and at the end. The best endurance rate in minutes per 1000 pounds of fuel is obtained at light gross weights, high altitude, and at one particular speed for each weight.

OPTIMUM ENDURANCE AT LIGHT WEIGHT

For endurance at light weights near the end of a mission, the integrated chart on figure A-82 will be most convenient. A curve of the correct indicated airspeed for optimum endurance is also on figure A-82. The desired endurance can be attained only if the proper speeds are observed within ±10 knots. The effect of speed on endurance is most critical at high altitudes, as shown by the following sketch:

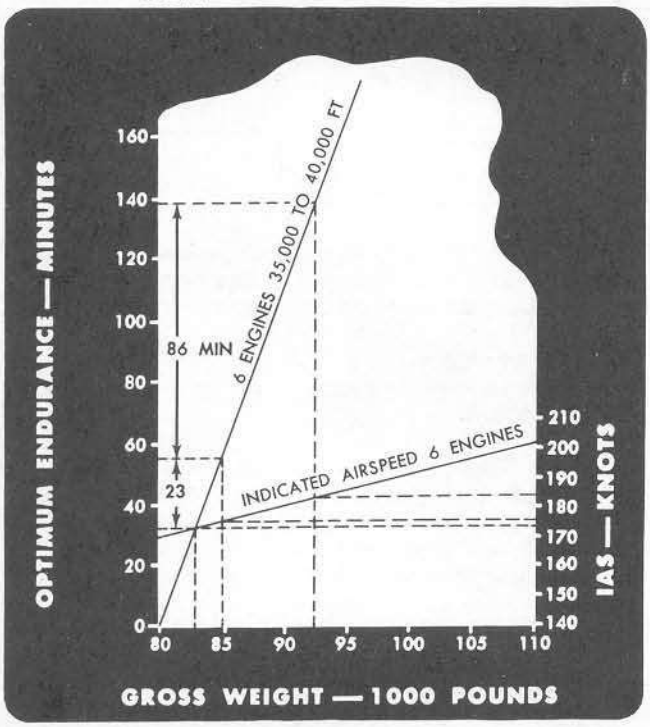


The following example demonstrates the use of the integrated chart:

EXAMPLE:

The airplane arrives over home base with 10,000 pounds of fuel remaining. The gross weight without fuel is 82,500 pounds.

Find: 1. The number of operating engines
2. The best altitude for endurance
3. The maximum time that the airplane can remain aloft before exhausting its fuel
4. The correct airspeeds
5. The maximum endurance, allowing 2000 pounds of fuel for descent and landing reserve.



Use the chart on figure A-82. When above 35,000 feet, six engines will give the best endurance. The chart on figure A-81 shows that for six engines, the altitude at the average gross weight should be about 38,700 feet.

The gross weight at the beginning of endurance is 82,500 + 10,000 = 92,500. From the sketch it is apparent that the total available endurance time between the two weights is 109 minutes. With 2000 pounds of fuel reserved for descent and landing, the minimum gross weight is 84,500 pounds and the endurance to the start of descent is 86 minutes.

From the endurance speed curve at the bottom of the chart, the IAS is 184 knots at the start of endurance, 175 knots when only 2000 pounds of fuel remain, and 173 knots at the end of endurance.

ENDURANCE AT OPTIMUM ALTITUDE

The charts on figures A-83 and A-84 show the absolute maximum endurance that can be obtained for a given number of operating engines. The correct altitude for any weight is also shown. For very long periods, where cutting engines is not desired, maximum endurance will be obtained by using the climbing flight path indicated in these charts. The same endurance can be obtained at a constant altitude by cutting engines as required. For shorter periods, constant altitude operation will result in the same endurance as obtained by a climbing flight path. It will be noted by comparison with the charts on figures A-85 through A-87 that varying from the specified altitude by plus or minus 2000 feet will not appreciably affect endurance. On figure A-81 is a plot of the indicated airspeed required at each gross weight. The following example illustrates the use of the optimum endurance charts:

EXAMPLE:

While cruising, it becomes necessary to hold for 60 minutes over a check point. The fuel gages show 60,000 pounds of fuel in the tanks and the airplane without fuel weighs 82,000 pounds.

Find: 1. The number of operating engines
2. The optimum altitude
3. Minimum fuel expended during endurance
4. The gross weight when cruise is resumed
5. Required airspeed.

From the curves on figure A-83 it is apparent that at high gross weights, six engines give nearly the same endurance time as four engines, although at a higher altitude. Therefore, if the cruise is at high altitude, less height will have to be lost and regained if the six-engine endurance is used. The fuel gained by using six engines would be slight however, since the extra fuel consumed in climbing back to altitude is nearly offset by that saved during the descent at reduced power.

The gross weight at the start of endurance is 82,000 + 60,000 = 142,000 pounds. On the six-engine curve, at this gross weight the endurance is 6.9 minutes per thousand pounds of fuel at 29,300-foot altitude.

From the curve on figure A-88, the first approximation to the fuel used (60 minutes at 6.9 minutes per 1000 pounds) is 8700 pounds. The average endurance weight is then $\frac{142,000 - 8700}{2} = 138,000$ pounds.

The average endurance at this weight, from figure A-83, is 7.1 pounds per minute at 30,000 feet. The fuel used in 60 minutes is then 8500 pounds, using figure A-88 again.

The gross weight when cruise is resumed is then 142,000 - 8500 = 133,500 pounds. Unless the endurance time is very long and the weight change very large, there is no need for going beyond a first approximation.

The optimum airspeeds are given on figure A-81. The airspeed decreases from 232 knots IAS at the start of endurance to 224 knots IAS at the end.

MAXIMUM ENDURANCE AT CONSTANT ALTITUDE

On figures A-85, A-86 and A-87 are charts showing the minutes per thousand pounds of fuel that are obtainable if the endurance operation must be made at a specified constant altitude. It will be noted that this type of operation gives less than the optimum endurance. The method of using the constant altitude charts is similar to that explained in the last example. The indicated airspeeds, from the chart on figure A-81, apply to all altitudes.

EFFECT OF OAT ON ENDURANCE

The endurance data is based on an NACA standard day. Higher outside air temperatures tend to decrease the endurance at a given altitude. For an extremely hot day (120° F at sea level) the endurance is reduced by approximately 6%. On a cold day there will be a gain in endurance time.

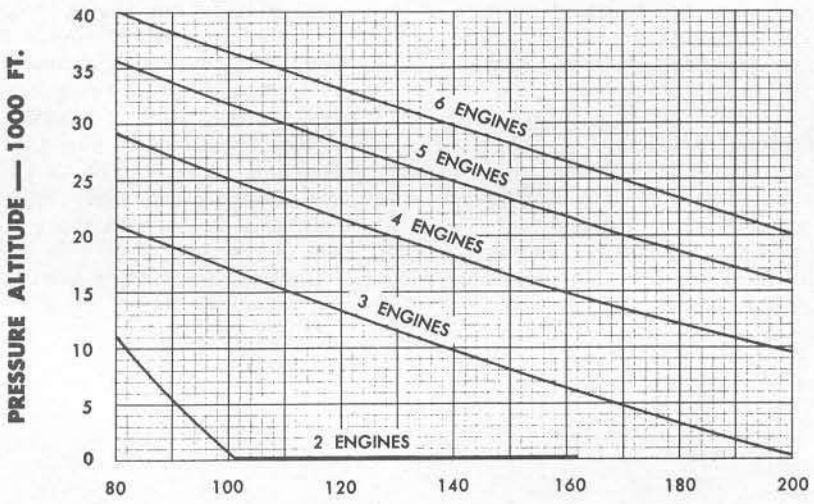
RULES FOR MAXIMUM ENDURANCE

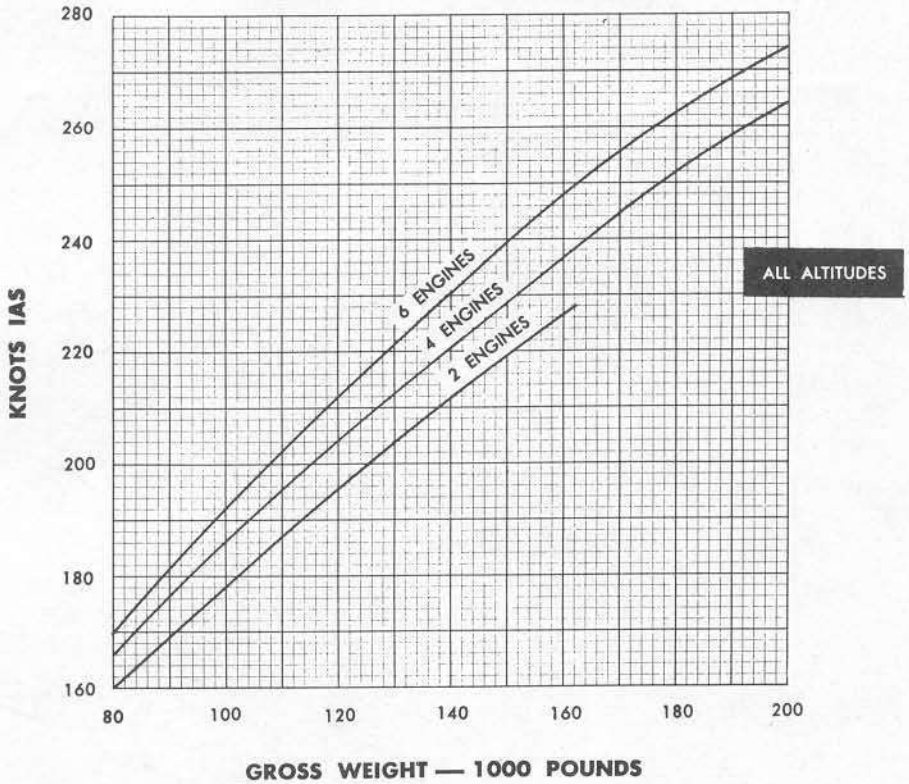
1. For endurance at the highest practical altitude use six engines. For lower altitudes cut enough engines to allow those remaining to operate at 80% to 90% rpm.
2. Fly at the altitude specified on figure A-81 for the prevailing gross weight and number of engines.
3. Always maintain the correct indicated airspeed shown in the chart on figure A-81.
4. Maintain between 80% and 90% engine rpm at the correct airspeed. The altitude can be varied somewhat if necessary to accomplish this. Reduce altitude if the rpm is too high and go to a higher altitude if the rpm is too low.
5. Flaps and gear are always up.

ALTITUDE FOR BEST ENDURANCE AND ENDURANCE SPEEDS

MODEL: YDB-47E

ENGINES: J47-GE-25





CONDITIONS:

REMARKS:

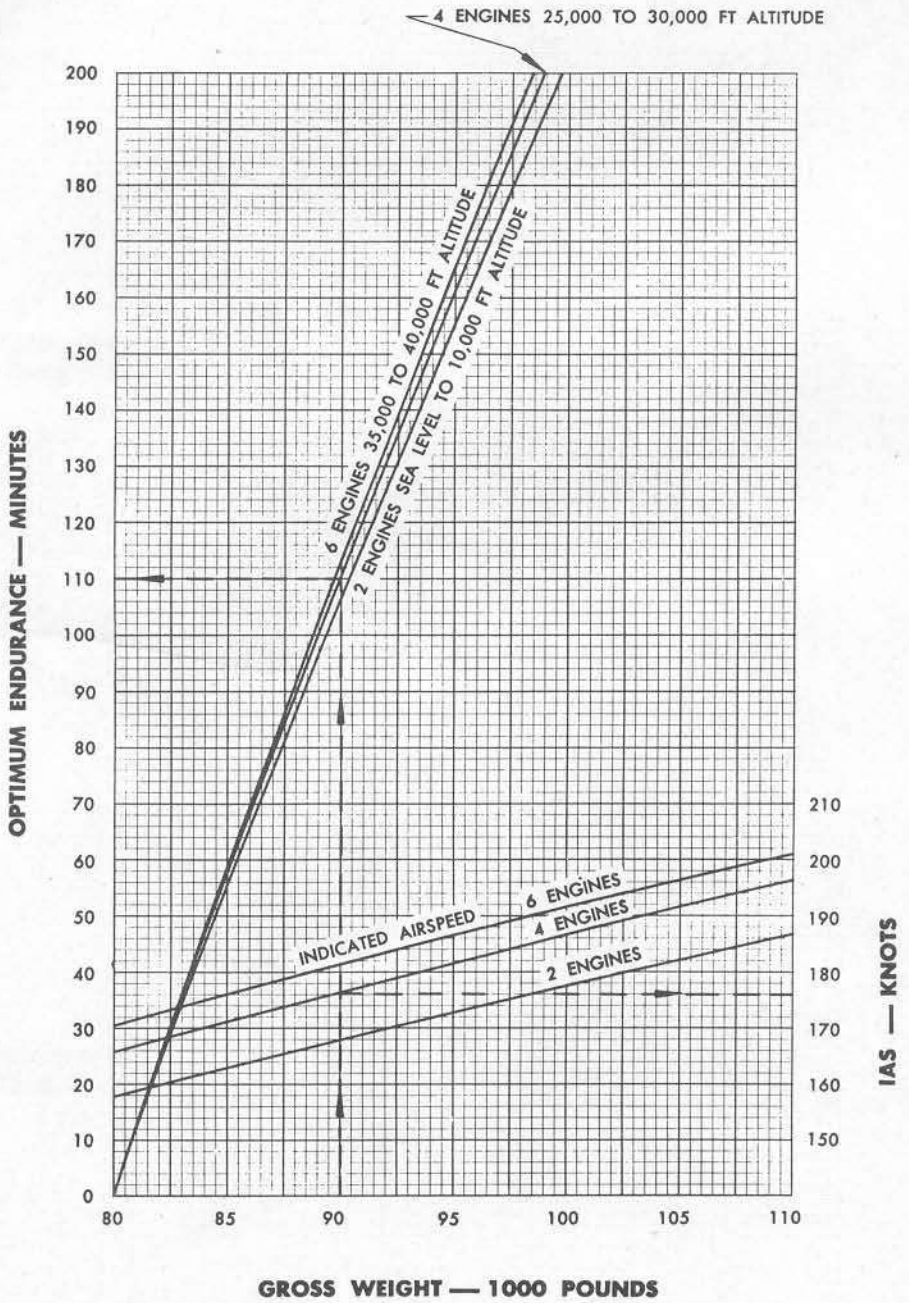
DATE: SEPTEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-81.

OPTIMUM ENDURANCE
AT LIGHT WEIGHT

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

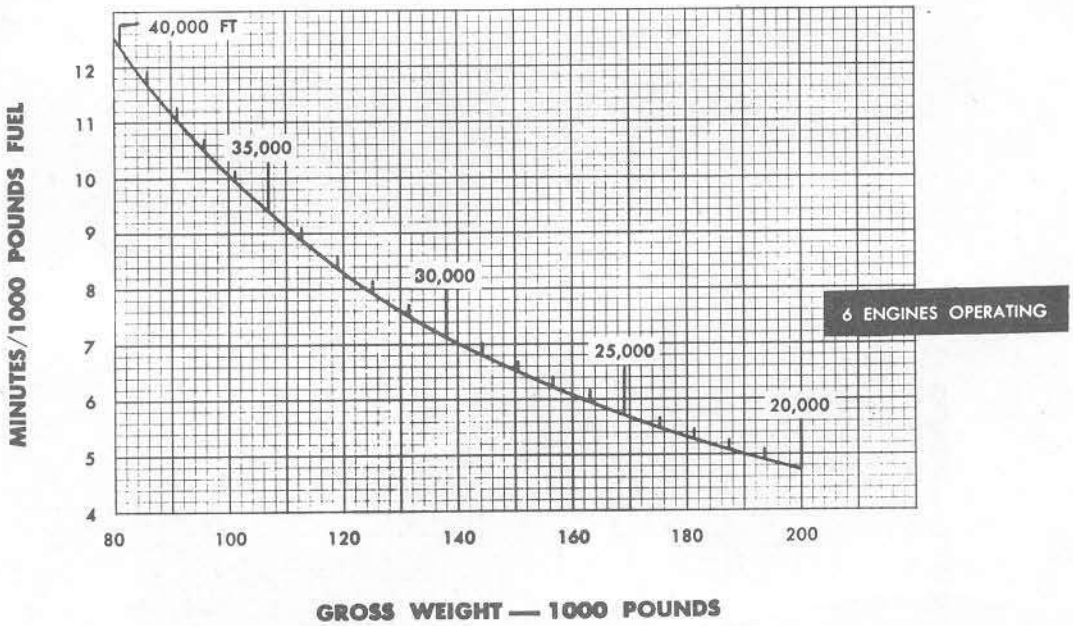
DATE: SEPTEMBER 1952
DATA BASIS: FLIGHT TEST

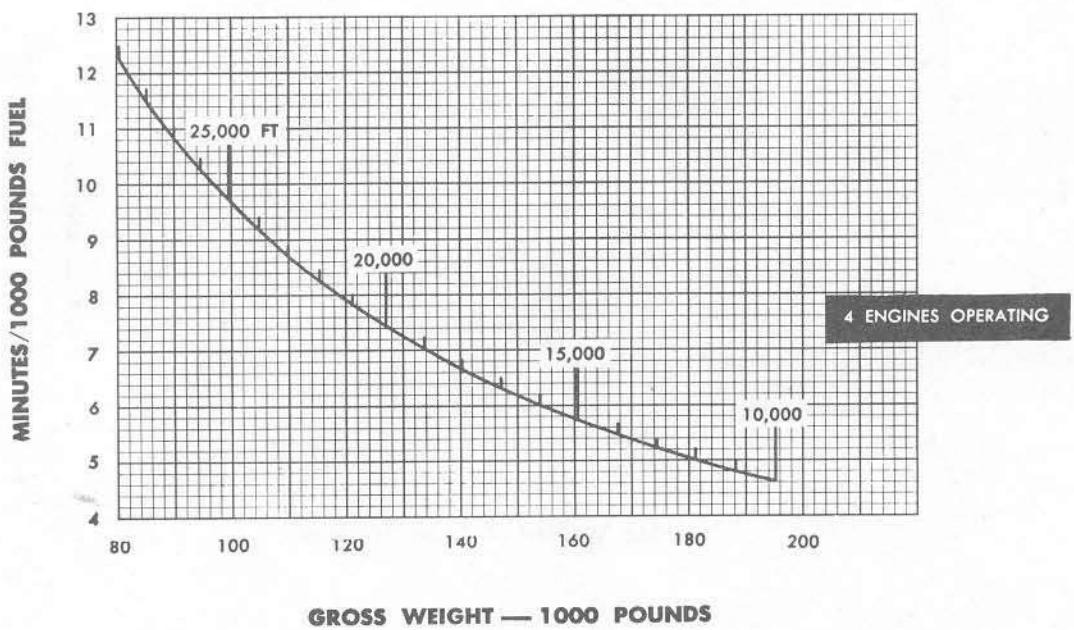
Figure A-82.

OPTIMUM ENDURANCE
4 AND 6 ENGINES

MODEL: YDB-47E

ENGINES: J47-GE-25





CONDITIONS:

REMARKS:

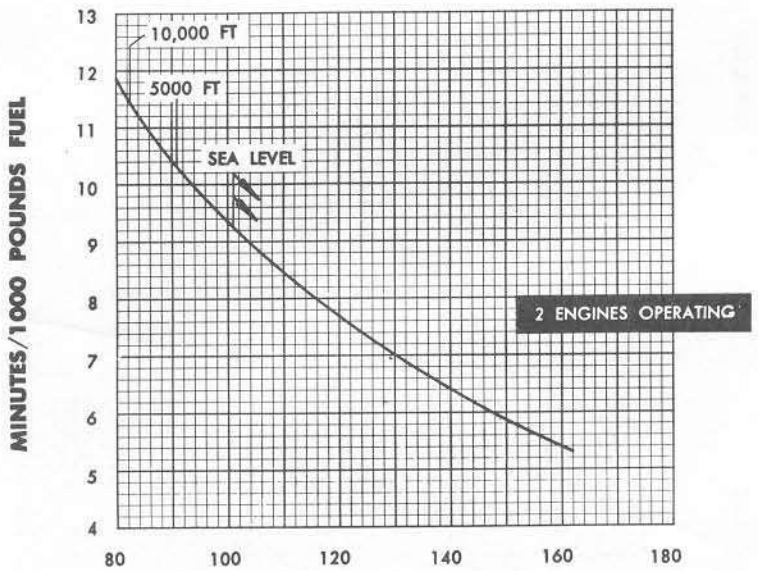
DATE: SEPTEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-83.

OPTIMUM ENDURANCE
2 ENGINES OPERATING

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

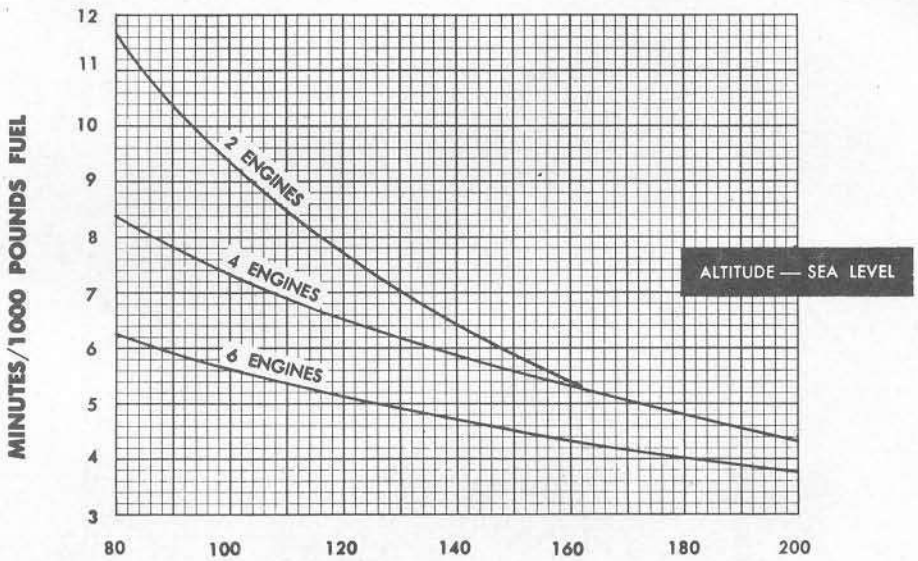
DATE: SEPTEMBER 1952
DATA BASIS: FLIGHT TEST

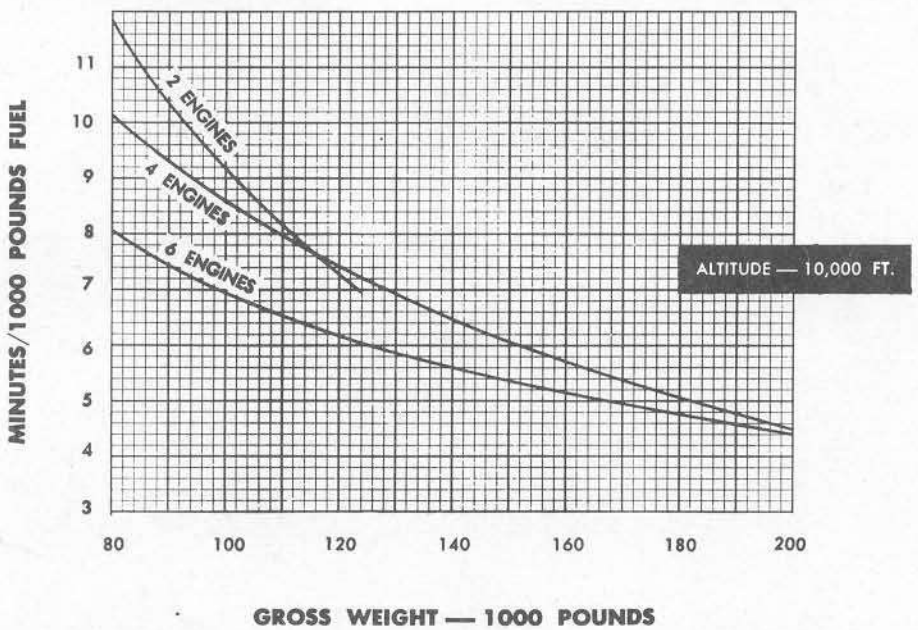
Figure A-84.

MAXIMUM ENDURANCE AT CONSTANT ALTITUDE

MODEL: YDB-47E

ENGINES: J47-GE-25





CONDITIONS:

REMARKS:

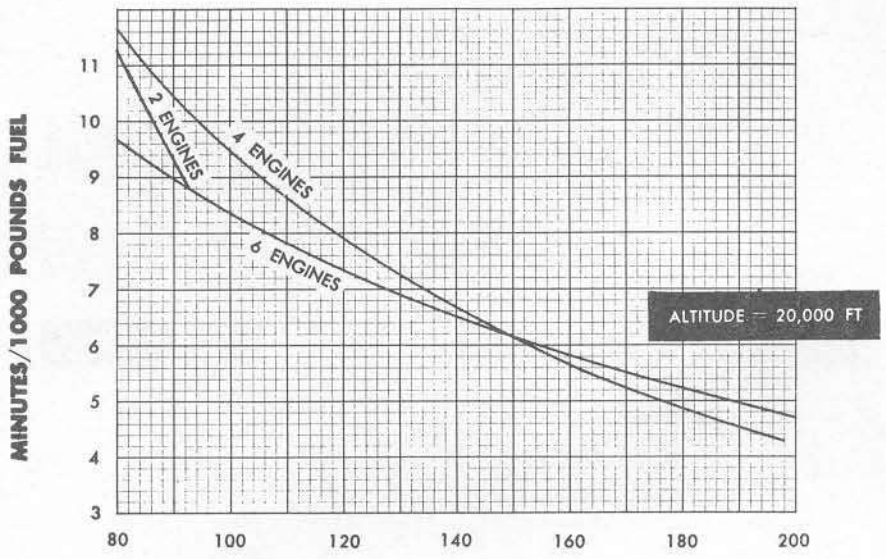
DATE: SEPTEMBER 1952
DATA BASIS: FLIGHT TEST

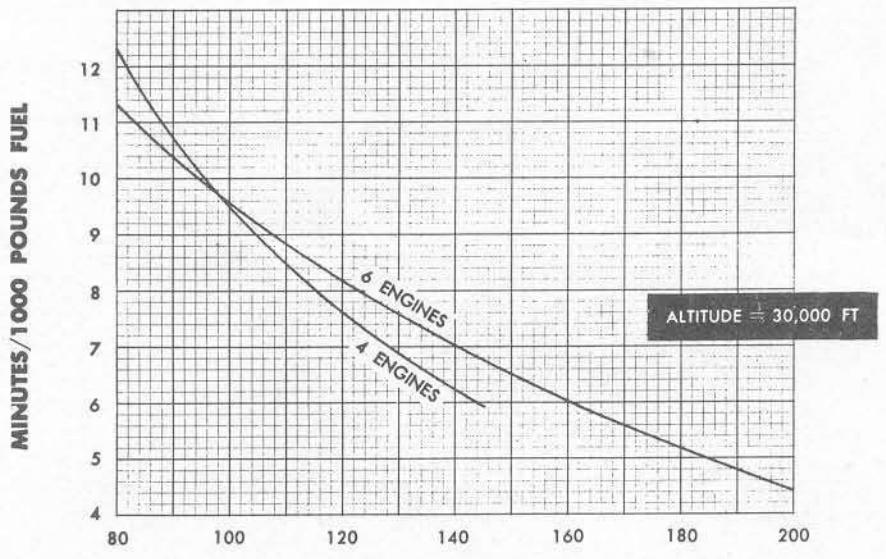
Figure A-85.

MAXIMUM ENDURANCE AT CONSTANT ALTITUDE

MODEL: YDB-47E

ENGINES: J47-GE-25





CONDITIONS:

REMARKS:

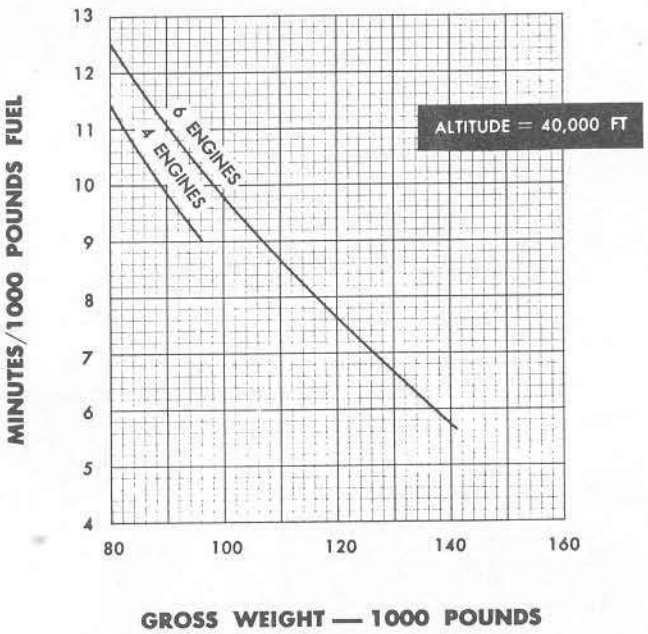
DATE: SEPTEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-86.

MAXIMUM ENDURANCE AT CONSTANT ALTITUDE

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

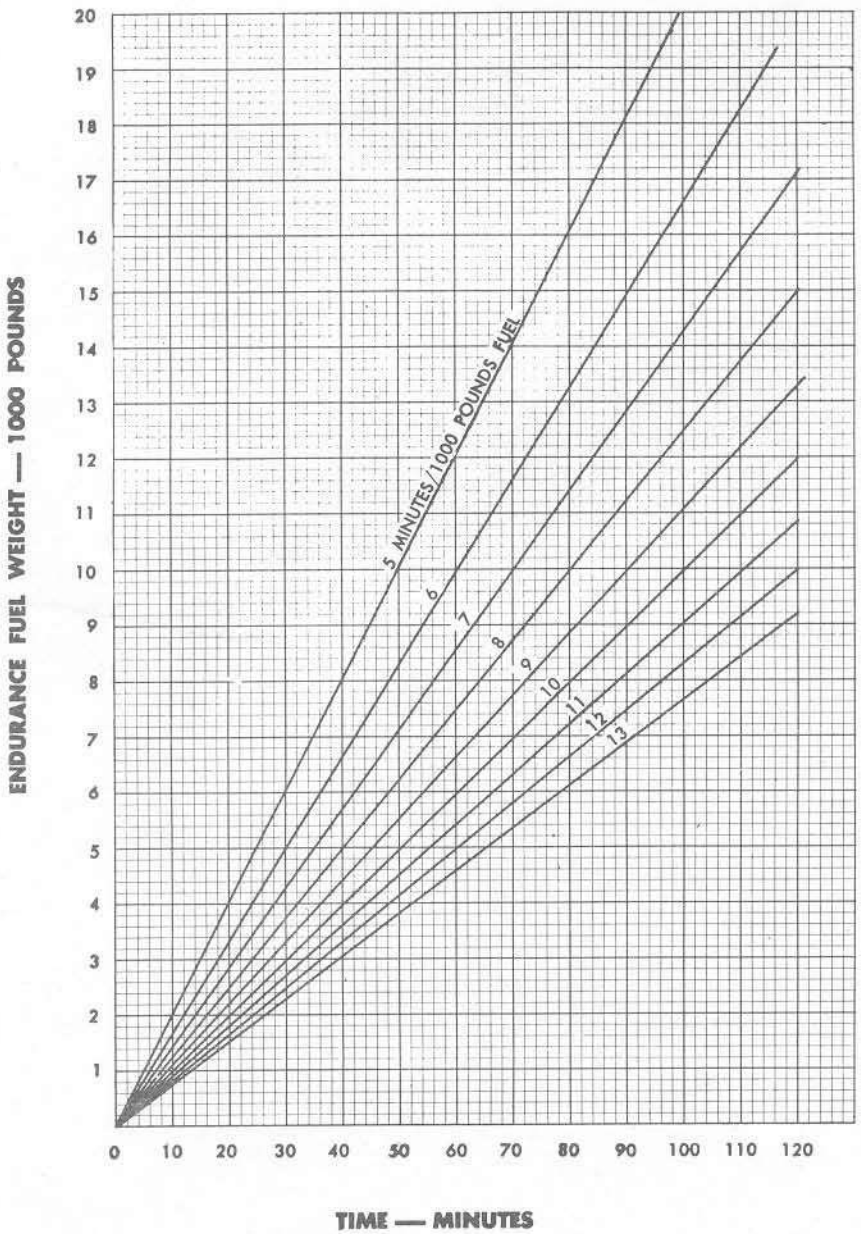
DATE: SEPTEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-87.

ENDURANCE FUEL VS TIME

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

DATE: JULY 1951
DATA BASIS: CALCULATED

Figure A-88.

PART 8

DESCENT

The high cruising altitude near the end of the mission can be converted into a small range extension by correct descent procedure. The general rule to follow is to avoid early descent. Since jet engine fuel consumption is excessive at low altitude, even at idling rpm a premature descent will result in a loss in range.

GEAR-DOWN DESCENT

1. Maintain cruising altitude until about 50 nautical miles from the landing base.
2. Extend gear.
3. Retard all engines to minimum idle. The fuel regulators will govern the minimum rpm.
4. Descent at the maximum rate but do not exceed Mach .82 above 31,000-foot altitude, or 305 knots IAS below 31,000 feet.

This is the normal descent and is preferred, as a minimum of time is consumed during descent, all engines are operating and sufficient generator output will be available for normal electrical loads, and the base is within VHF (or UHF) range before the descent is started. Such a descent normally gives the most practical gain in range and reduces the possibility of having to climb back to cruising altitude if a change is made in the landing point.

Above 31,000 feet the descent is made at Mach .82, the practical limit to avoid buffeting with the gear down. Below 31,000 feet the descent is at 305 knots IAS which is the gear-down structural limit.

This normal descent results in the following:

1. Maximum rate of descent
2. Shortest distance during descent
3. Minimum fuel consumption during descent.

This is the recommended procedure for all let-downs where there is no range emergency. Figures A-93, A-94 and A-95 show normal descent performance.

GEAR-UP DESCENT

1. Maintain cruising altitude until about 150 nautical miles from the landing base.
2. Cut engines No. 2 and 5 and retard the other throttles to the idle stop.
3. Descend at 185 knots IAS to about 10,000-foot altitude.
4. Restart the two engines at about 10,000 feet, lower the gear, and continue the descent at 305 knots IAS with all six engines idling.

This is the alternate descent (gear up). Because of the low drag, engines must be cut to obtain a practical rate of descent at the best glide angle. All operating engines are at the idle stop. Usually only engines No. 2 and 5 will be cut.

The speed is held at 185 knots IAS; the speed for the best glide angle.

This alternate descent results in the following:

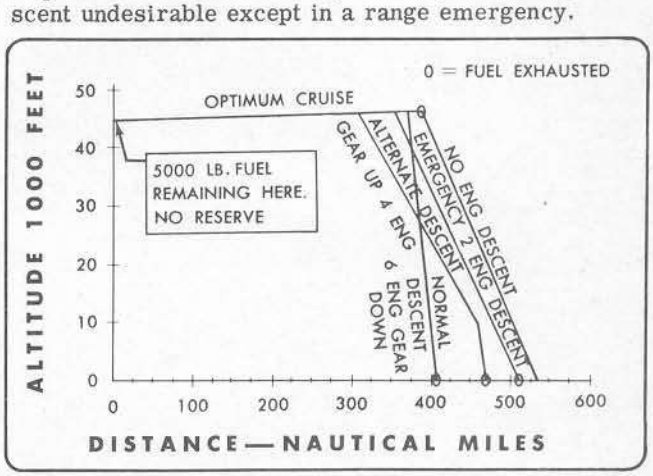
1. Minimum rate of descent
2. Maximum time of descent
3. High fuel consumption and descent distance because of the long time involved
4. Approximately the same fuel reserve, if two engines are cut, as the normal descent.

Figures A-96, A-97 and A-98 show the alternate descent performance.

EMERGENCY MAXIMUM RANGE DESCENT - GEAR UP

1. Maintain cruising altitude until about 160 nautical miles from the landing base.
2. Turn off all possible electrical equipment.
3. Cut engines No. 1, 2, 5, and 6 and retard engines No. 3 and 4 to the idle stop.
4. Descent at 185 knots IAS.

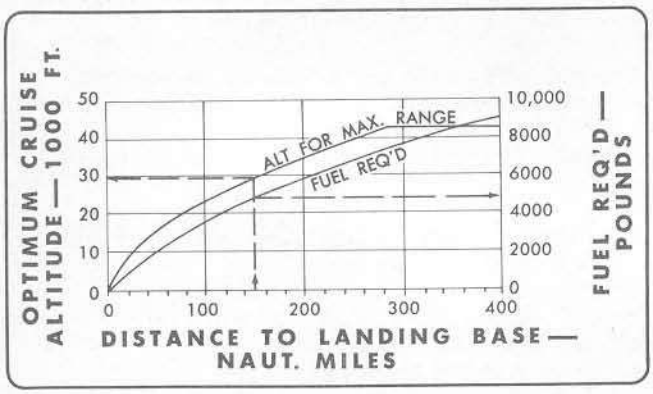
The Emergency Descent gives maximum all-out range for cases of an extremely low fuel supply. The same gear-up procedure is followed except that engines No. 1, 2, 5, and 6 are cut, with engines No. 3 and 4 retarded to the idle stop. This type of descent is to be avoided except under critical conditions. The reduced generator output is sufficient to operate only a bare minimum of essential equipment. All unnecessary electrical loads must be turned off. This descent will not be feasible under conditions requiring equipment run by the alternators on engines No. 1 and 6. Maintaining hydraulic pressure, fuel boost, and electrical requirements makes cutting four engines during descent undesirable except in a range emergency.



From the preceding sketch it is seen that the normal descent is usually the most desirable. For a given range, less fuel will be used by cruising as far as possible at high altitude (where maximum miles per pound of fuel are obtainable) and then making a step rapid descent with the gear down. Unnecessary time

spent in descending means extra fuel consumed.

If an early descent must be made to pick up ground reference points, climb back to higher altitude as soon as possible. The fuel consumption of jet engines is so great at low altitudes that less range can be obtained there than by climbing to a higher cruise altitude and then descending to the landing base. The following plot shows the optimum altitude at which to continue cruise to the landing base and total fuel required from start of climb to the landing base. Goind to either higher or lower altitude will result in more fuel being used. This chart is based on an initial climb gross weight of 100,000 pounds.



When a visual check of ground position is made at a certain altitude, continue cruise at that altitude or at the one shown by the curve, whichever is higher. The fuel used will then be reduced by the amount saved by not climbing all the way from sea level.

If forced to continue at lower altitude, use the charts in part 6.

ANTI-ICING

Under icing conditions, it is necessary to provide adequate hot air to the wing and nacelle anti-icing systems. Under severe conditions this will require such high engine rpm as to prevent anything but the normal gear down descent. The required rpm is above the schedule normally maintained by the regulators. For full anti-icing on a standard day the engine rpm must be approximately as follows:

ALTITUDE	% RPM(6ENG)
20,000	80%
10,000	70%
Sea Level	60%

There is little advantage in cutting engines to steepen the descent because those remaining in operation must be at a higher rpm for anti-icing. For four engines, gear down and 305 knots IAS, increase the rpm about 5%.

DESCENT PERFORMANCE

Descent performance is presented similarly to the climb performance in part 5, and is used in the same manner. For descent with the landing gear extended the fuel consumed, distance, and time are given by the charts on figures A-93 through A-95. Descent performance with the landing gear retracted is presented on figures A-96 through A-98.

The comparison between gear down, gear up, and emergency descent procedures is shown by figures A-89, A-90 and A-91 for a typical descent weight of 90,000 pounds. Maximum rates of descent for these conditions are shown on figure A-92.

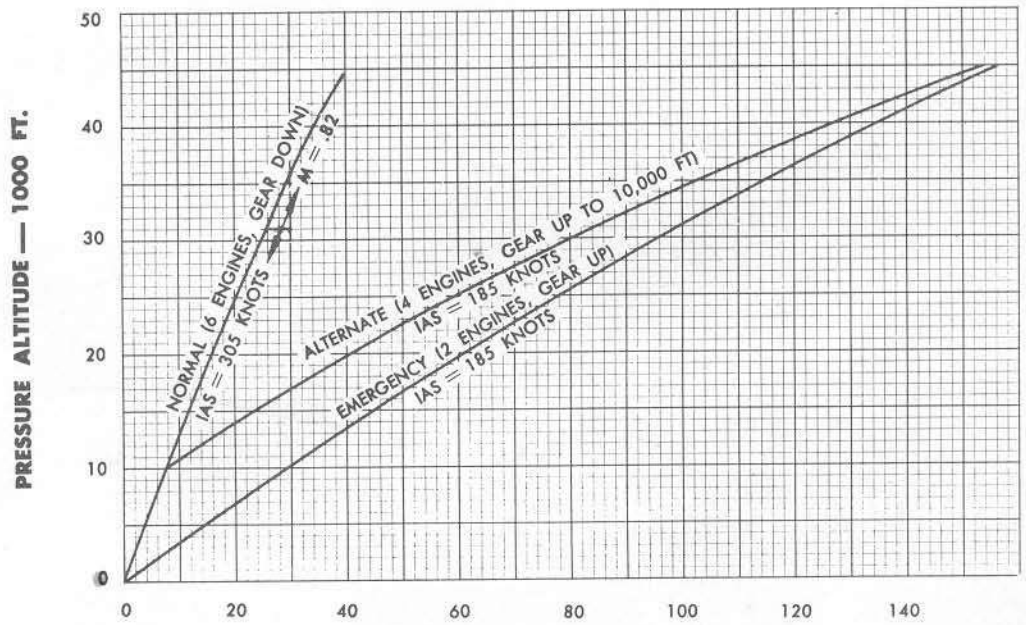
MINIMUM RPM

The fuel regulators govern the minimum rpm at altitude even though the throttles are at the idle stop. The chart on figure A-99 gives the minimum rpm schedule for descent with the throttles at the idle stop.

DESCENT RANGE

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: GROSS WEIGHT 90,000 POUNDS

REMARKS:

DATE: SEPTEMBER 1952

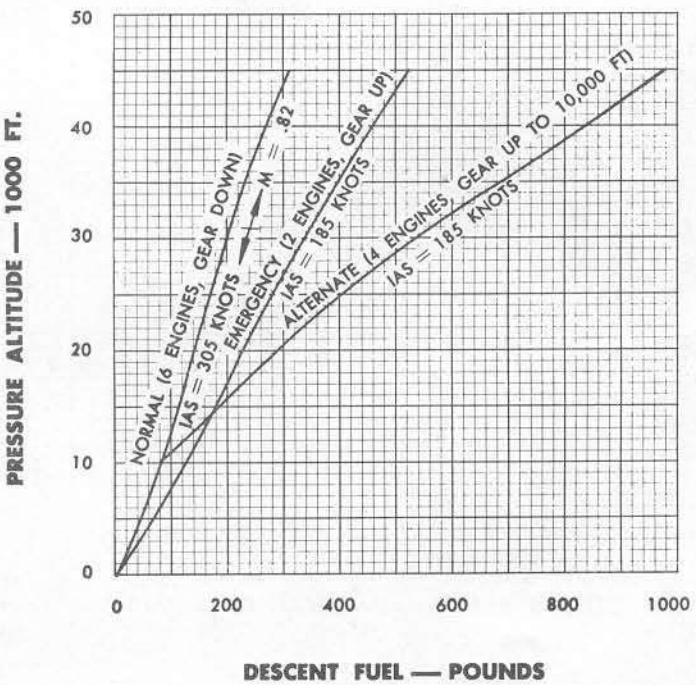
DATA BASIS: FLIGHT TEST

Figure A-89.

DESCENT FUEL CONSUMPTION

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: GROSS WEIGHT 90,000 POUNDS

REMARKS:

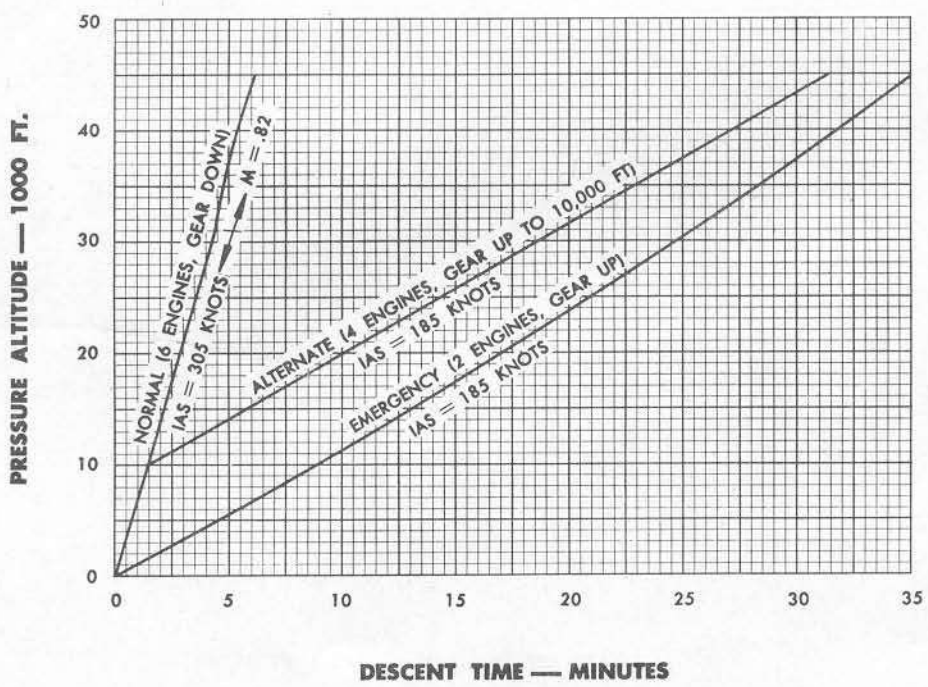
DATE: SEPTEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-90

DESCENT TIME

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: GROSS WEIGHT 90,000 POUNDS

REMARKS:

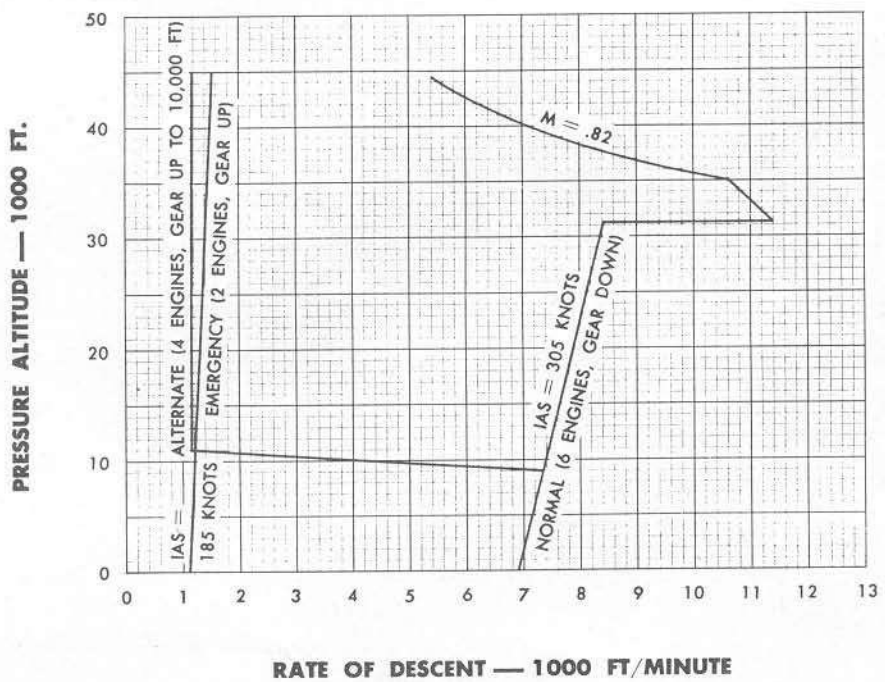
DATE: SEPTEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-91.

RATE OF DESCENT

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: GROSS WEIGHT 90,000 POUNDS

REMARKS:

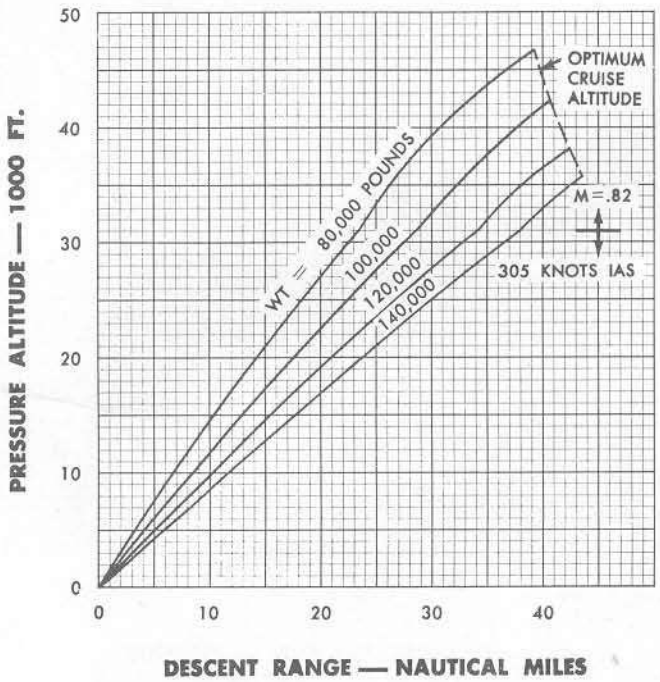
DATE: SEPTEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-92.

DESCENT RANGE
GEAR DOWN

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: 6 ENGINES AT MINIMUM IDLE
M = .82 ABOVE 31,000 FT
305 KNOTS IAS BELOW 31,000 FT

REMARKS:

DATE: AUGUST 1952

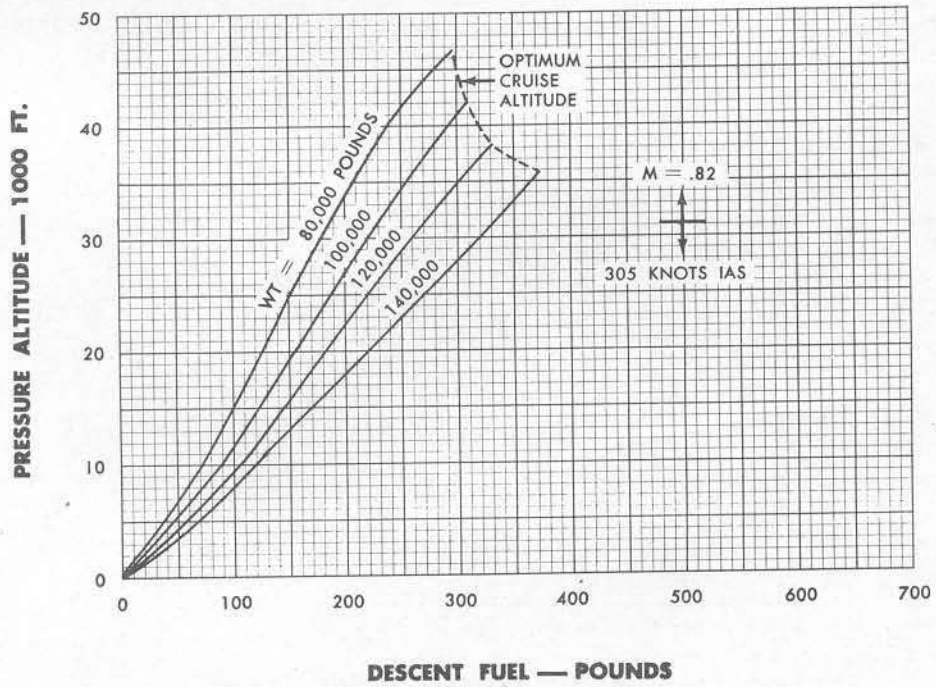
DATA BASIS: FLIGHT TEST

Figure A-93.

DESCENT FUEL
GEAR DOWN

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: 6 ENGINES AT MINIMUM IDLE — GEAR DOWN
M = .82 ABOVE 31,000 FT 305 KNOTS IAS
BELOW 31,000 FT

DATE: AUGUST 1952

DATA BASIS: FLIGHT TEST

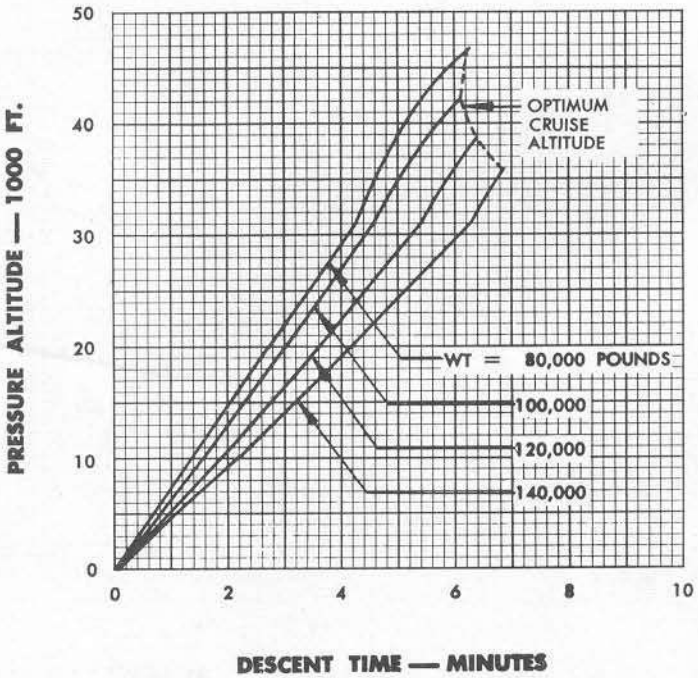
REMARKS:

Figure A-94.

DESCENT TIME
GEAR DOWN

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: GEAR DOWN NACA STANDARD DAY
6 ENGINES AT MINIMUM IDLE
M = .82 ABOVE 31,000 FT 305 KNOTS IAS BELOW 31,000 FT

REMARKS:

DATE: AUGUST 1952

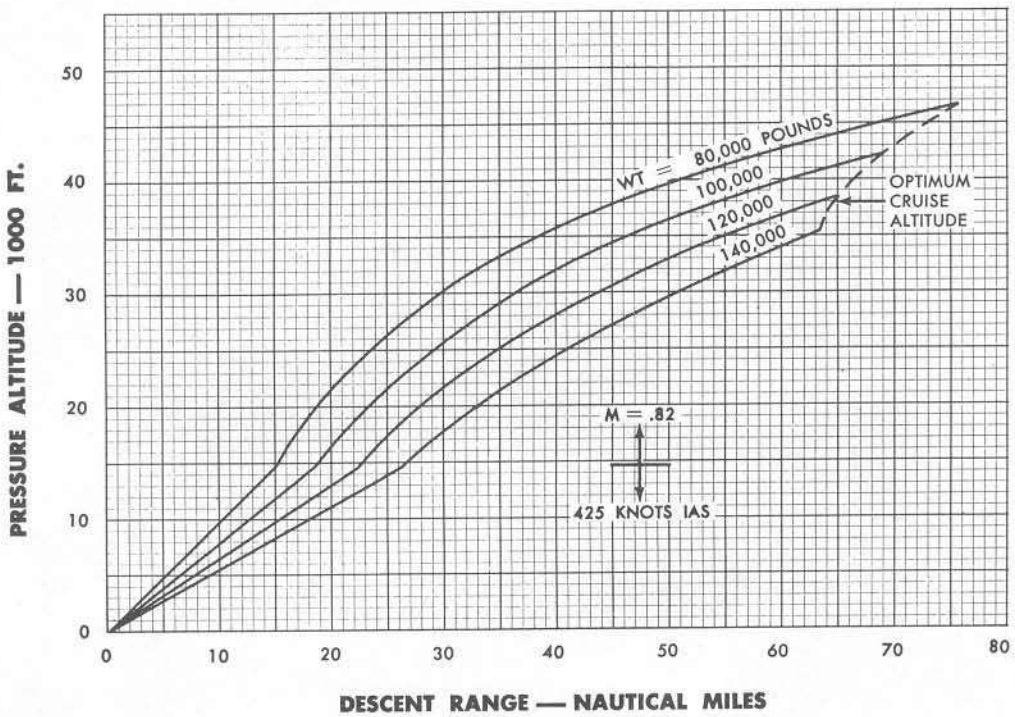
DATA BASIS: FLIGHT TEST

Figure A-95.

DESCENT RANGE
GEAR UP

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: GEAR UP
6 ENGINES AT MINIMUM IDLE
M = .82 ABOVE 14,600 FT., 425 KNOTS IAS BELOW 14,600 FT.

REMARKS:

DATE: AUGUST 1952

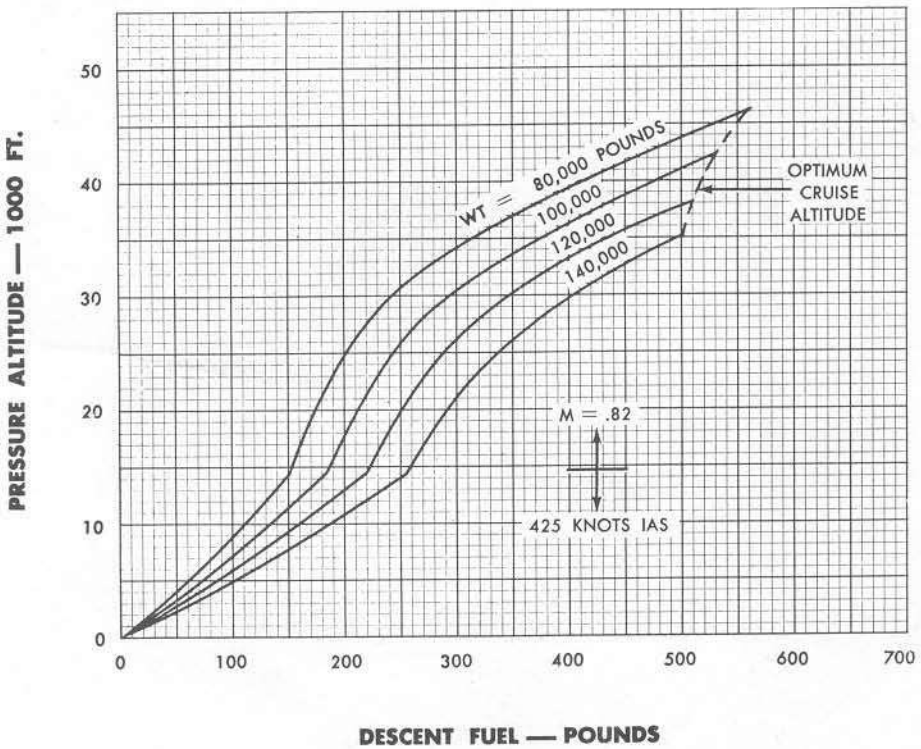
DATA BASIS: FLIGHT TEST

Figure A-96.

DESCENT FUEL
GEAR UP

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: GEAR UP
6 ENGINES AT MINIMUM IDLE
M = .82 ABOVE 14,600 FT. 425 KNOTS IAS BELOW 14,600 FT.

REMARKS:

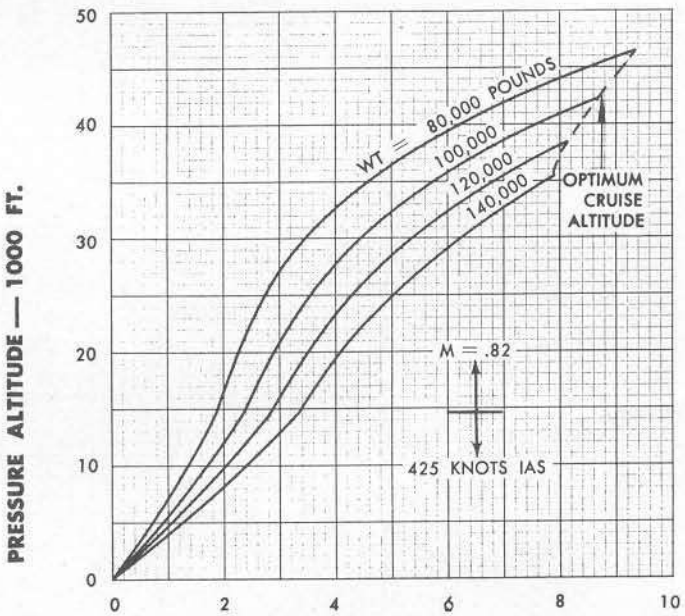
DATE: AUGUST 1952
DATA BASIS: FLIGHT TEST

Figure A-97.

DESCENT TIME
GEAR UP

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: GEAR UP
6 ENGINES AT MINIMUM IDLE
M = .82 ABOVE 14,600 FT., 425 KNOTS IAS BELOW 14,600 FT.

REMARKS:

DATE: AUGUST 1952

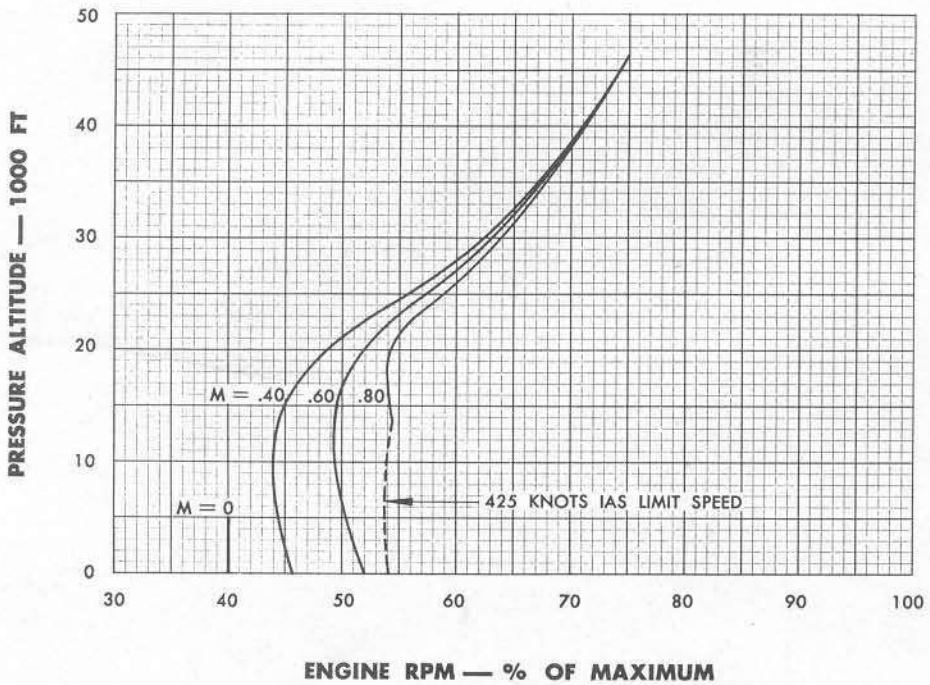
DATA BASIS: FLIGHT TEST

Figure A-98.

FUEL REGULATOR MINIMUM RPM

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

DATE: NOEVMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-99.

PART 9

AERIAL REFUELING

The data in this section provides information for planning refuel operations with the KC-97 tanker. Performance characteristics of both tanker and receiver limit the altitudes and speeds for refueling. Techniques are different from those in normal cruise operation as tanker speed limitations require refuel operations on the "backside" of the YDB-47 power curve. Refueling speeds are dependent upon a margin above stall warning in order to have sufficient speed for good control and for corrections necessary in the refuel envelope. As proficiency at refuel increases, the YDB-47 minimum refueling speeds presented may decrease as much as 10 knots. Success of refuel operations is dependent upon observing speed schedules and early position corrections when necessary.

FLAPS

Receiver flaps are lowered 20% (10° deflection) for all aerial refueling operations with KC-97 tankers. This is done in order to have lower formating speeds which result in higher refuel altitudes. The low drag flaps on the YDB-47 do not appreciably affect the rpm required at 20% flaps extended, but the reduction in minimum formating speeds is significant. Flaps up refuel may be accomplished, however, the minimum speeds are approximately 10 knots higher than for 20% flaps.

High refuel altitudes are desired for minimum deviation from cruise altitudes and to avoid the higher fuel consumption rates at lower altitudes. At times it may be necessary to conduct aerial refueling at altitudes other than initially planned, due to rough air conditions or cloud layers. Hence a thorough familiarization of the use of the charts is necessary.

LEVEL FLIGHT FORMATING

Experience to date has indicated the following techniques to be desirable. After visual rendezvous has been accomplished, the tanker establishes the contact speed with the receiver closing to a position of flying formation on the tanker. When the speeds are stabilized the receiver moves slowly into the nominal contact position (figure A-100). Contact is made by the boom operator and fuel transfer is initiated.

FORMATING IN A DESCENT

To formate for refueling in a descent, the tanker maximum speed in level flight may be less than the YDB-47 minimum formating speed at the desired altitude as indicated on the charts on figures A-102 through A-104 and A-106. The tanker initiates a descent on a predetermined heading and accelerates to the desired speed schedule. The receiver follows and slowly moves into the contact position, with the rate of closure kept low in order to prevent overrunning the tanker. Deceleration characteristics of the YDB-47 are such that rapid deceleration is impossible by throttle changes, therefore rates of closure must be low. In emergency conditions, gear may be lowered to provide rapid deceleration. Contacts have been made at rates of descent as high as 900 feet per minute; however, technique is difficult and the altitude lost in event a contact is not made on first attempt is excessive. The maximum recommended rate of descent is 300 feet per minute.

DURING CONTACT

Pilot technique during transfer is not difficult as long as basic formation rules are observed. Control changes in contact envelope should be made early in order to remain at the desired position and to avoid automatic disconnects. Corrections must be made early and at the proper time to prevent tanker and receiver motions from getting out of phase with each other.

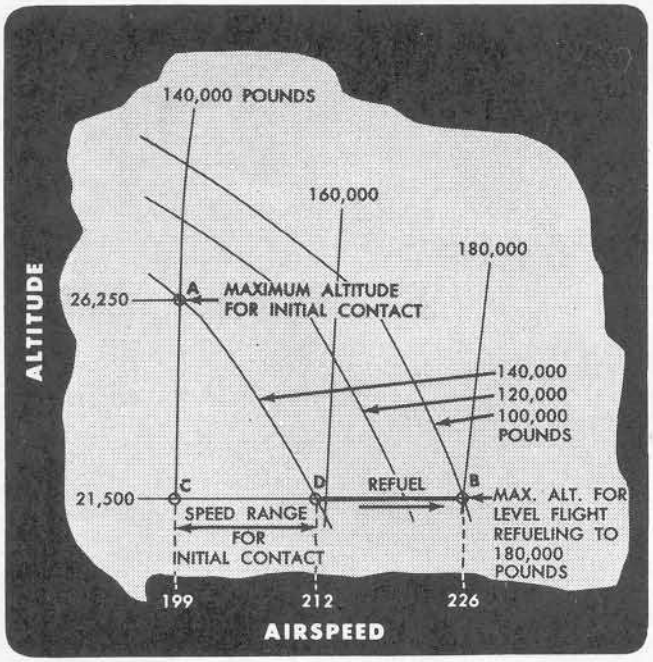
Gentle turns and banks may be made during contact without disconnects, provided no abrupt motions are made by either tanker or receiver if proper speed margin above the stall is maintained. The charts indicate the limitations to refueling altitudes and speeds, not the conditions for starting and ending all refuel operations.

EXAMPLE 1: LEVEL FLIGHT REFUEL

Given:
1. YDB-47 initial weight = 140,000 pounds
2. KC-97 initial weight = 140,000 pounds
3. YDB-47 final weight = 180,000 pounds
4. KC-97 final weight = 97,000 pounds

Determine:
1. Maximum level flight altitude
2. Speeds for refuel

Using the chart on figure A-101, the maximum altitude for contact at initial weights is 26,250 feet, as shown by point A on the example sketch. The maximum altitude and speed for contact at final weights is shown by point B, 21,500 feet and 226 knots IAS. Obviously the maximum altitude for level flight refuel is the lower value 21,500 feet altitude. The initial speed at contact may be any speed between points C and D, 199 to 212 knots IAS respectively. Point C is the minimum level flight speed for the YDB-47 at initial contact weight, and point D is the maximum level flight speed for the KC-97 at initial contact weight. For ease in formating the higher speed should be selected. Thus the refuel would be conducted at 21,500 feet altitude with an initial speed of 212 knots IAS, increasing speed gradually during transfer so the ending speed is 226 knots IAS.

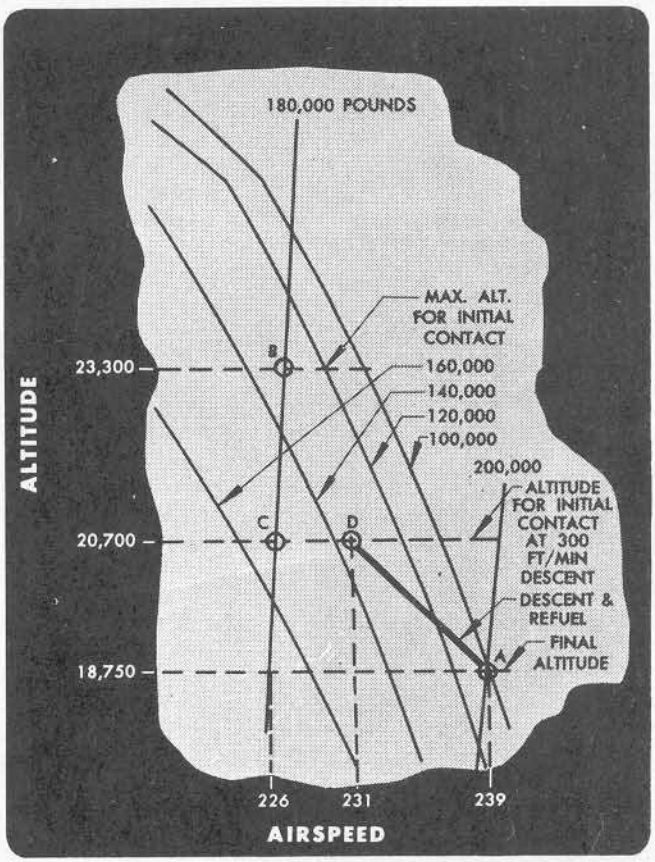


EXAMPLE 2: DESCENDING REFUEL

Given:
1. YDB-47 initial weight 180,000 pounds with external tanks on
2. KC-97 initial weight 130,000 pounds
3. Transfer rate of 600 gal/min.
4. YDB-47 final weight 200,000 pounds with external tanks on
5. KC-97 final weight 105,000 pounds

Determine:
1. Maximum refuel altitude
2. Speeds
3. Time
4. Fuel consumed

From the chart on figure A-106, the maximum altitude for the final weights is 18,750 feet at a speed of 239 knots IAS, as shown by point A of the example sketch. The maximum initial altitude is shown by point B as being 23,300 feet. However, it is necessary to determine the time required to transfer the required fuel, and estimate the altitude for initial contact to allow descent during transfer. The time to refuel is determined from figure A-108 as 5 1/2 minutes. Allowing 1 minute to establish contact, the altitude lost during descending refuel at the maximum recommended rate of 300 feet per minute will be 6 1/2 x 300 = 1950 feet. Therefore, the initial altitude will be 18,750 + 1950 = 20,700 feet. The speed for contact at 20,700 feet is shown by point C and D on the example sketch as 226 to 231 knots IAS. Again, the higher of the speeds is recommended for ease in formating. Fuel consumed during transfer is determined from figure A-107. The average rate of consumption is about 311 pounds per minute. The total fuel used during transfer is then about 2020 pounds.



EFFECT OF OAT ON REFUEL

The variations in OAT encountered will cause a change in the maximum altitudes for refuel when the maximum altitude is performance-limited by the receiver. For temperature 40° F above standard, the maximum altitude is reduced 1500 feet. If the OAT is less than standard, altitudes for refuel are increased slightly.

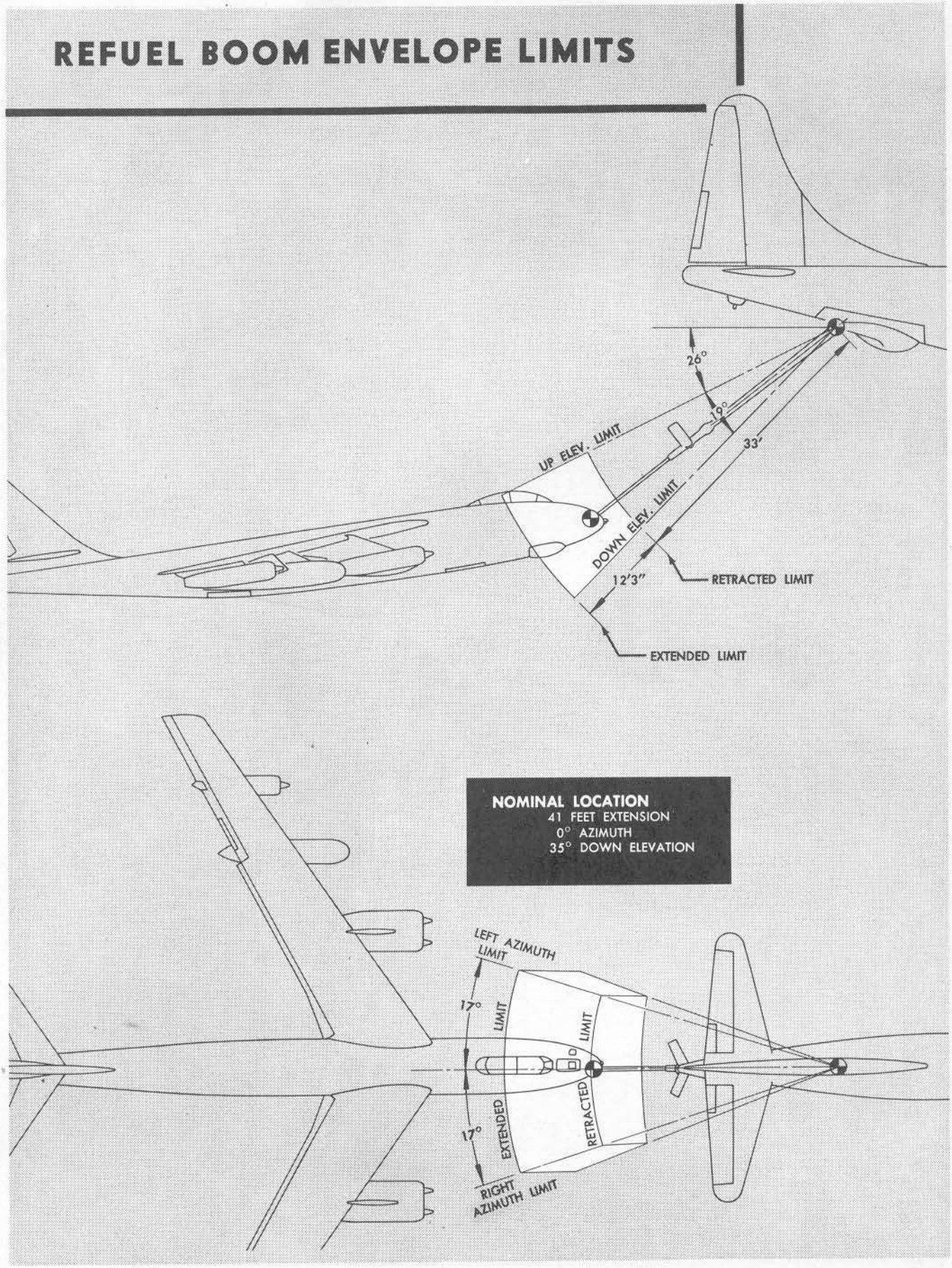
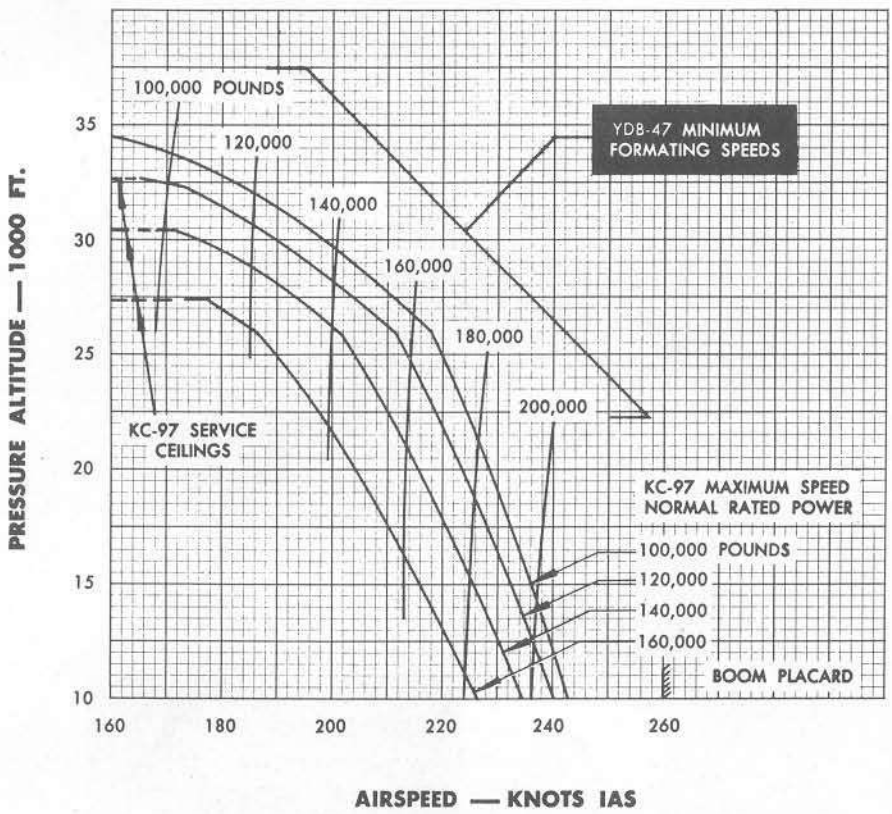

REFUEL BOOM ENVELOPE LIMITS
26°
19°
33'
UP ELEV. LIMIT
DOWN ELEV. LIMIT
12'3"
RETRACTED LIMIT
EXTENDED LIMIT
NOMINAL LOCATION
41 FEET EXTENSION
0° AZIMUTH
35° DOWN ELEVATION
LEFT AZIMUTH LIMIT
17°
LIMIT
LIMIT
EXTENDED
RETRACTED
17°
RIGHT AZIMUTH LIMIT

Figure A-100.

MAXIMUM FORMATING ALTITUDES
LEVEL FLIGHT

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: NACA STANDARD DAY
20% FLAPS DOWN

REMARKS:

DATE: SEPTEMBER 1952

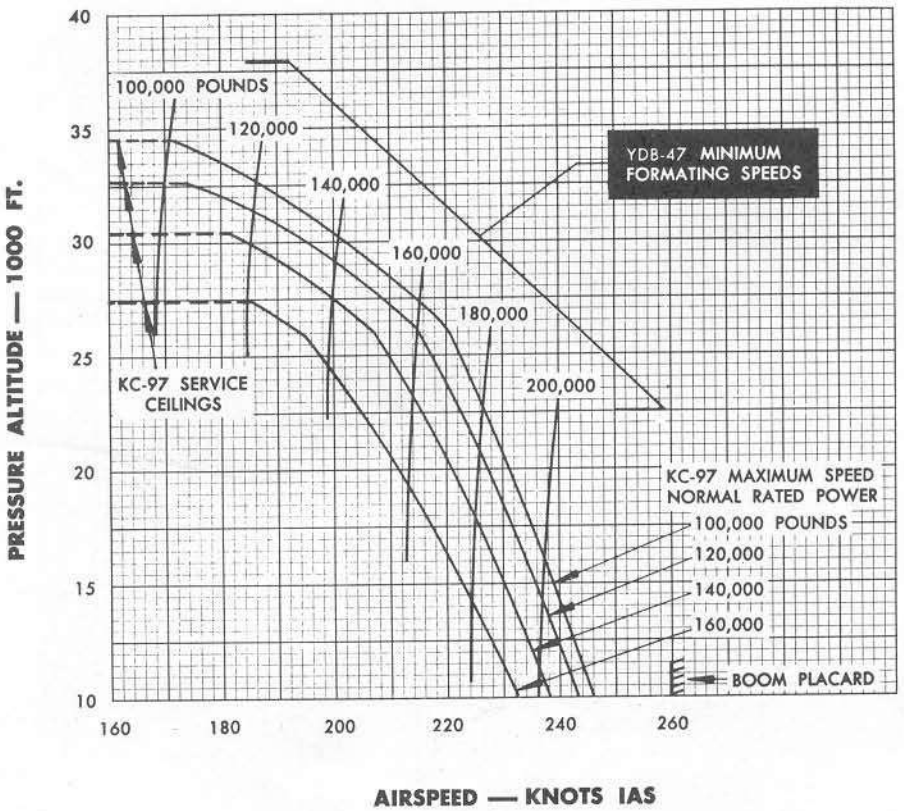
DATA BASIS: FLIGHT TEST

Figure A-101.

MAXIMUM FORMATING ALTITUDES
100 FT/MINUTE DESCENT

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: 20% FLAPS DOWN
NACA STANDARD DAY

REMARKS:

DATE: SEPTEMBER 1952

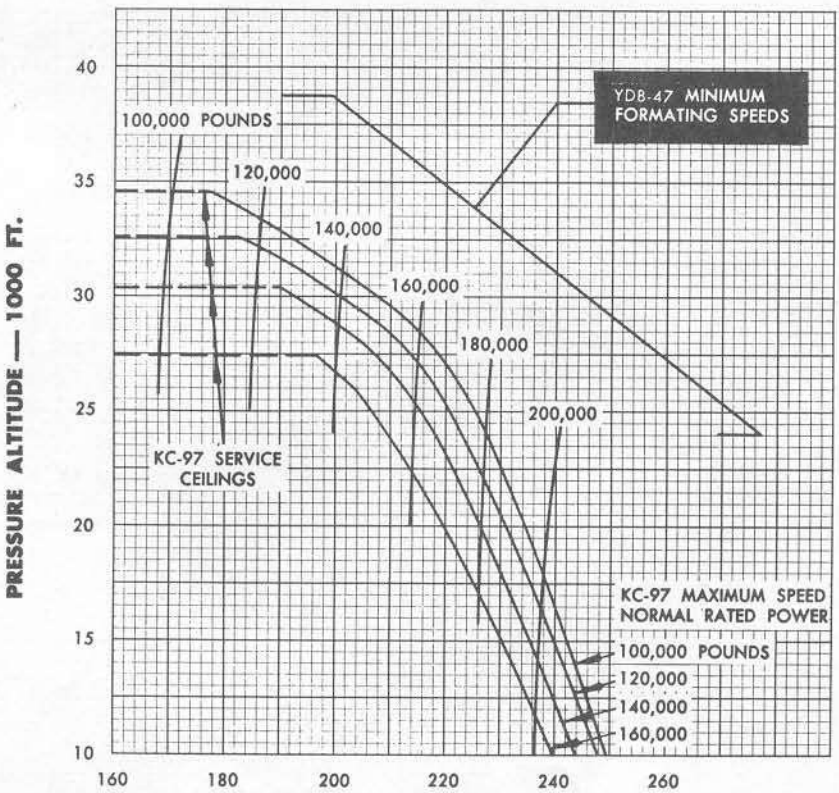
DATA BASIS: FLIGHT TEST

Figure A-102.

MAXIMUM FORMATING ALTITUDES
200 FT/MINUTE DESCENT

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: 20% FLAPS DOWN
NACA STANDARD DAY

REMARKS:

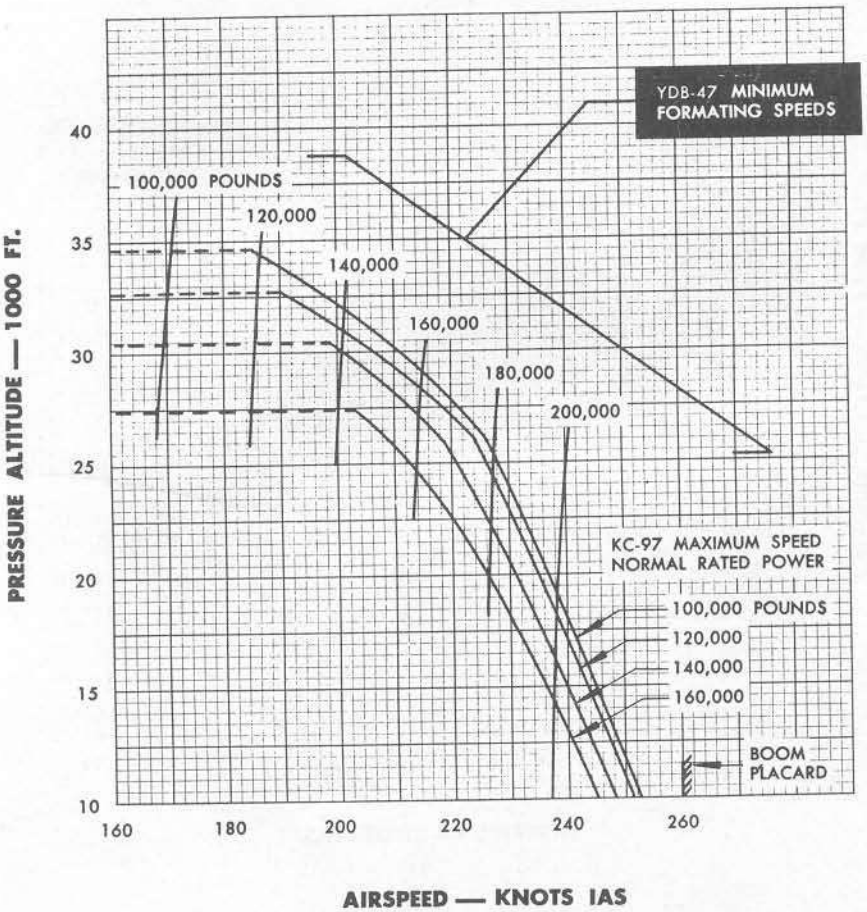
DATE: SEPTEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-103.

MAXIMUM FORMATING ALTITUDES
300 FT/MINUTE DESCENT

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: 20% FLAPS DOWN
NACA STANDARD DAY

REMARKS:

DATE: SEPTEMBER 1952

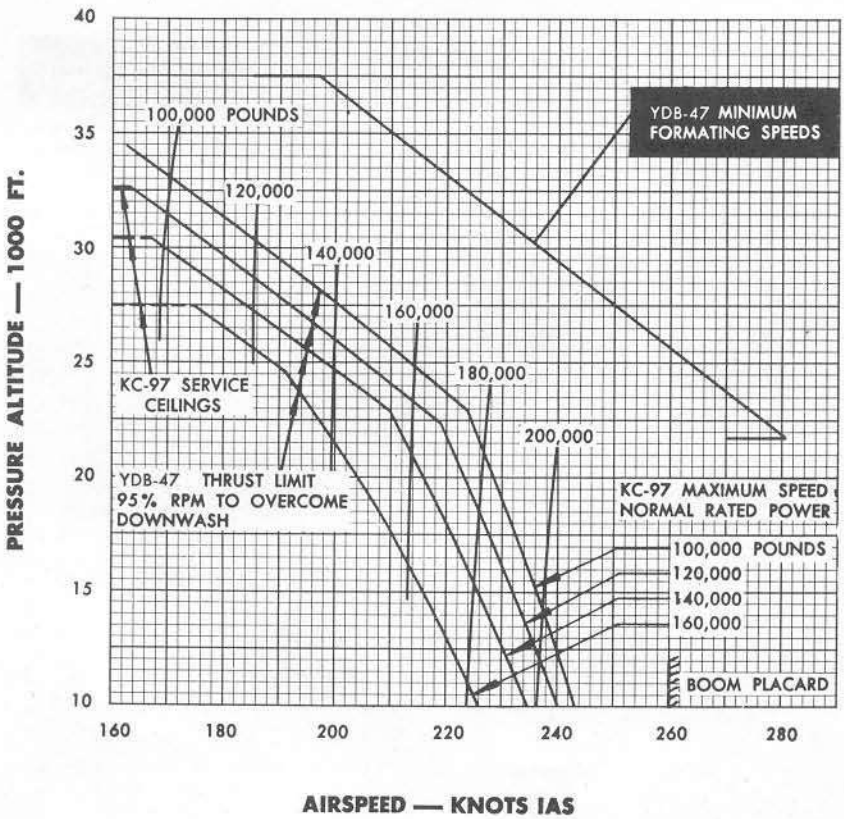
DATA BASIS: FLIGHT TEST

Figure A-104.

MAXIMUM FORMATING ALTITUDES
WING TANKS ON — LEVEL FLIGHT

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: 20% FLAPS DOWN
NACA STANDARD DAY
EXTERNAL WING TANKS ON

DATE: SEPTEMBER 1952

DATA BASIS: FLIGHT TEST

REMARKS:

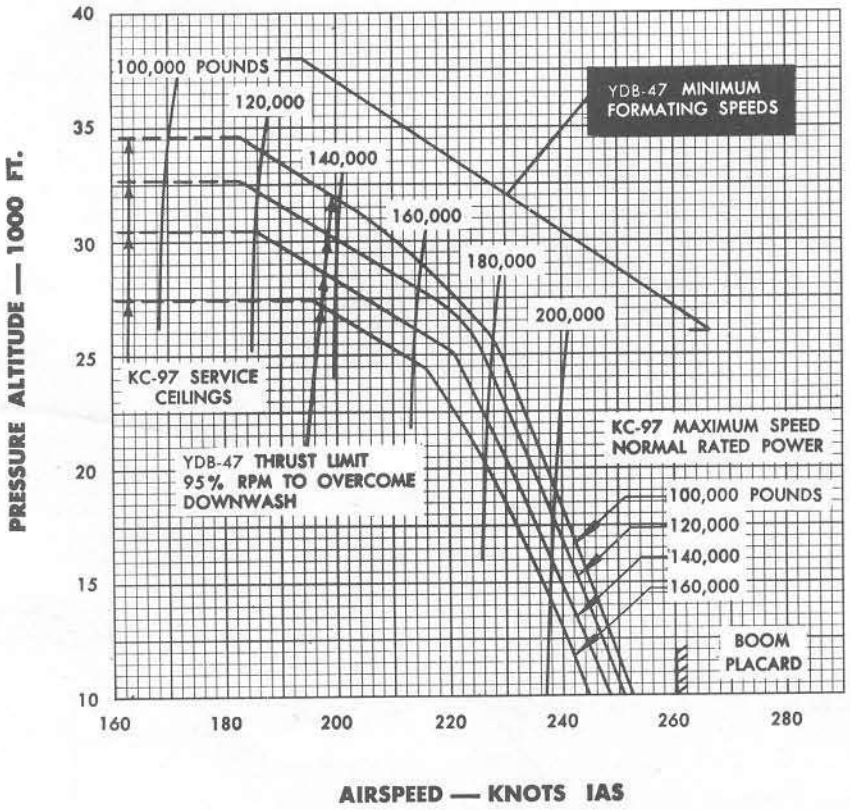
Figure A-105.

MAXIMUM FORMATING ALTITUDES

WING TANKS ON — 300 FT/MINUTE DESCENT

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: 20% FLAPS DOWN
NACA STANDARD DAY
EXTERNAL WING TANKS ON

REMARKS:

DATE: SEPTEMBER 1952

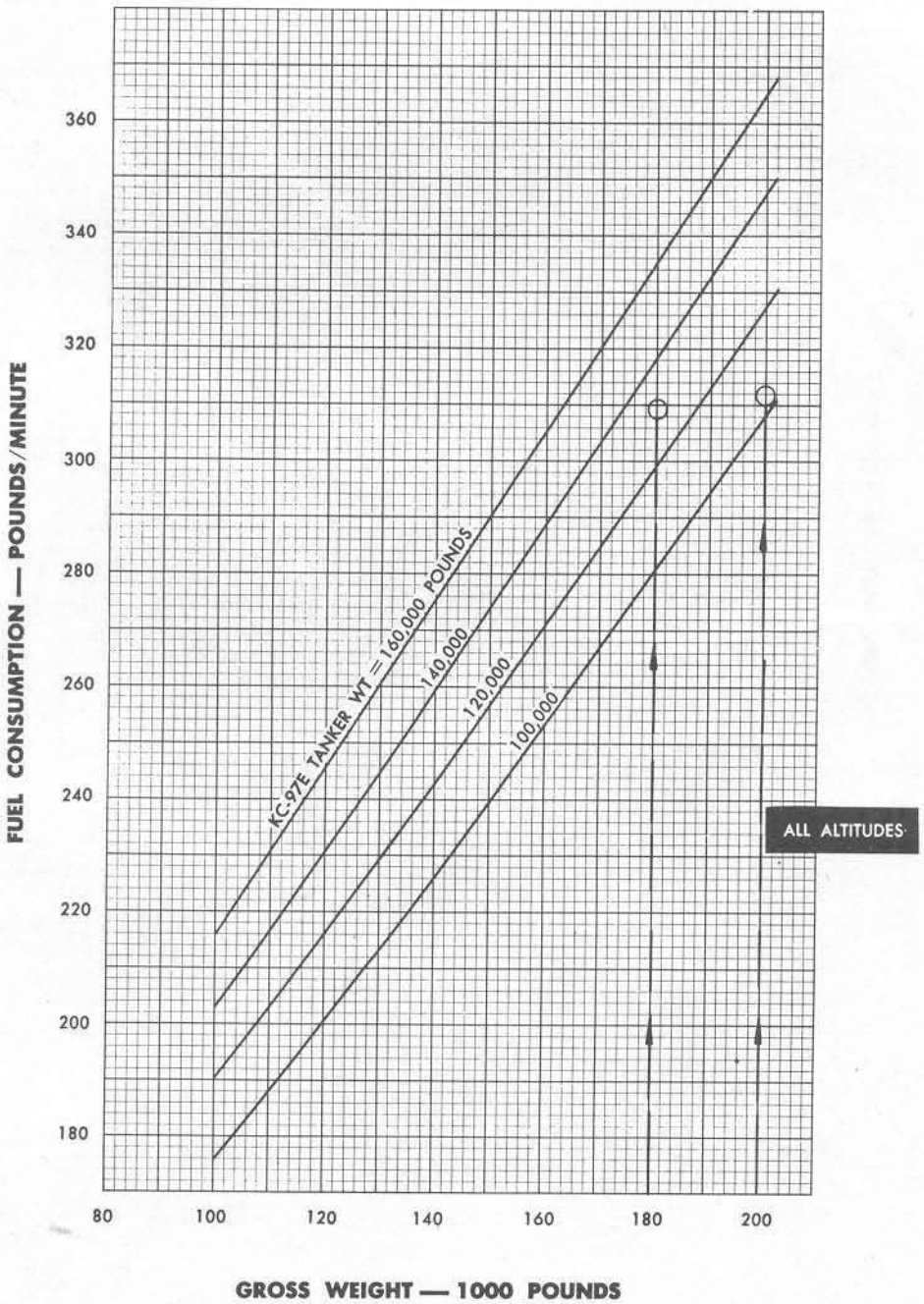
DATA BASIS: FLIGHT TEST

Figure A-106.

FUEL CONSUMPTION DURING IN-FLIGHT REFUELING

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: NACA STANDARD DAY

REMARKS:

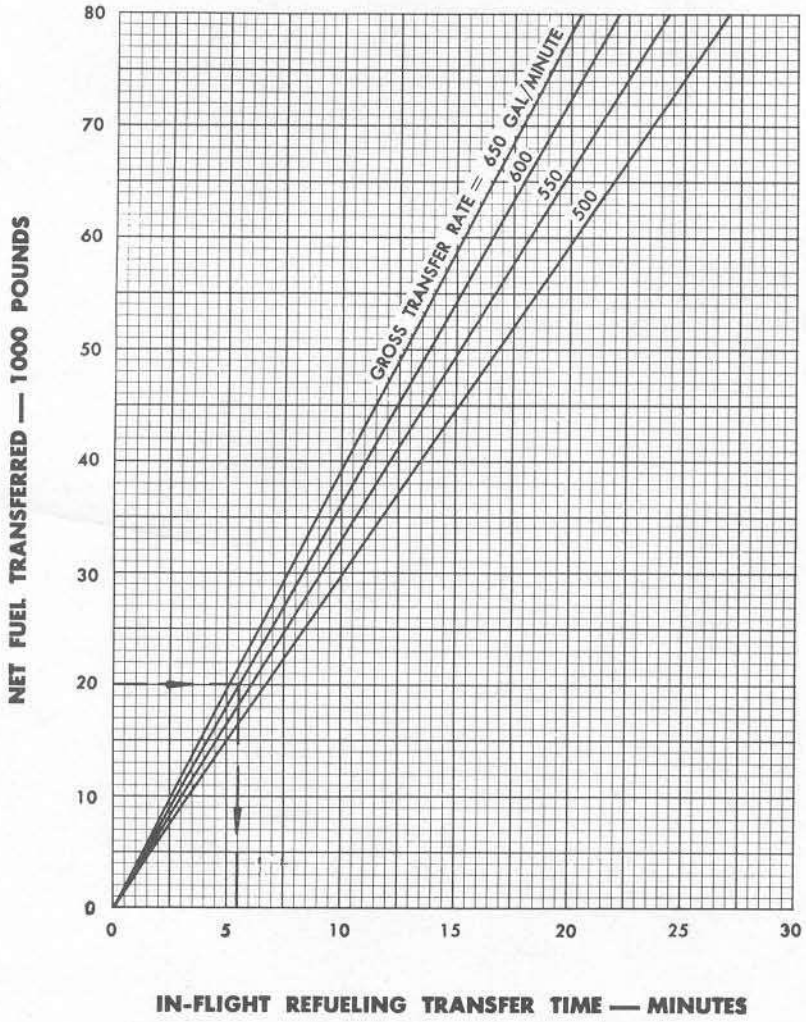
DATE: OCTOBER 1952
DATA BASIS: FLIGHT TEST

Figure A-107.

IN-FLIGHT REFUELING — FUEL TRANSFER TIME

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: BASED ON JP-4 FUEL AT 6.5 POUNDS/GALLON AND YDB-47E FUEL CONSUMPTION RATE OF 300 POUNDS/MINUTE

REMARKS:

DATE: JUNE 1952

DATA BASIS: FLIGHT TEST

Figure A-108.

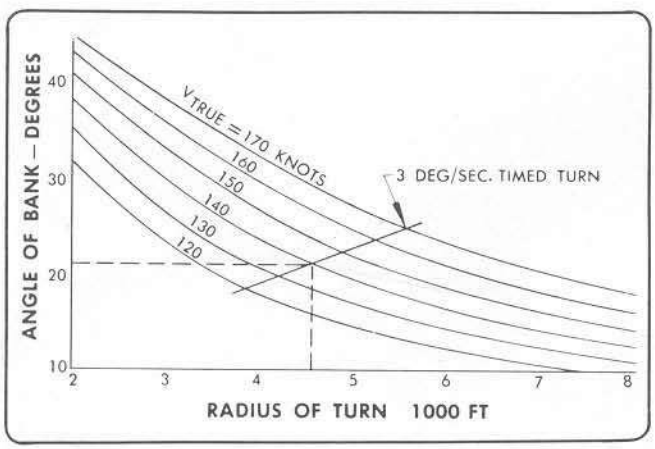
PART 10

APPROACH AND LANDING

This part contains charts which should be used in conjunction with normal operating procedures in section II. The text covers brief explanation of some factors which affect an approach and landing.

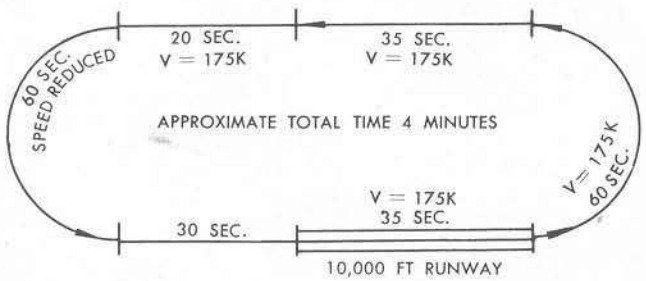
PATTERN

The following radius of turn for various speeds and bank angles is given as an aid in establishing a correct pattern. The curve applies to any airplane at any gross weight. The down wind leg for still air, constant bank, constant speed approach would be twice this distance from the runway. For an actual approach, average values can be estimated.



For example, a true airspeed of 140 knots and a double needle width turn (3° per second) will give a bank angle of about 21° and a turning radius of 4600 feet (downwind leg should be approximately 9200 feet from runway).

The following sketch shows approximately the time required for a pattern circuit and may be useful in estimating time and fuel requirements.



CG POSITION DURING APPROACH

The chart on figure A-109 gives the cg position for approach conditions enabling the pilot to determine cg during approach. However, the load adjuster, when available, will be used to determine cg in lieu of this chart. Forward cg positions may occur with a low quantity of fuel aboard and should be avoided by proper fuel management previous to approach and landing.

SPEED

The recommended speeds for the unbanked portions of the pattern are shown on figure 6-1. These curves include the position error due to the effects of flaps and airplane attitude on the static pressure source.

During cruise, the airspeed and altimeter have negligible errors due to the location of the static source. However, with flaps down the errors become measurable at the low approach speeds and should be kept in mind during low visibility approaches near the ground. These errors have been included in all operating data charts in this part and indicated airspeeds shown are corrected for static source errors.

Since a turn at constant velocity increases the angle of attack, the speed should be increased slightly during a turn to maintain a constant margin above the stall. The following values are based on a turn at the recommended approach speed. They need not be applied during a normal approach where the speed is kept high until the approach is nearly completed.

BANK ANGLE — DEGREES	SPEED INCREASE — KNOTS (FOR ALL GROSS WEIGHTS)
15	2
20	4
30	9
40	17

FLARE

Figure A-110 illustrates altitude and distance of flare for various weights. This chart is for a standard day at sea level. Typical heights for start of flare is 50 feet for a 90,000-pound airplane, increasing with gross weight to 100 feet for a 150,000-pound airplane on a standard day. OAT higher than standard tends to increase the height for start of flare.

The charts on figures A-110 and A-111 show the effect of approach rpm on flare height, landing distance over a 50-foot obstacle, the effect of gross weight on flare and go-around paths, and rpm on the slope of the approach path. The charts which are exact for a gross weight of 90,000 pounds can be used with reasonable accuracy between 80,000 and 100,000 pounds.

STOPPING DISTANCES

For most effective use, the brake chute should be fully inflated at or shortly after the touchdown point to avoid excessive use of the brakes. A good compromise, considering stopping distance and brake deterioration, is to apply the brakes at 40 knots. Flight

tests of this airplane have indicated that brakes may be applied consistently at speeds as high as 80 knots without serious brake wear.

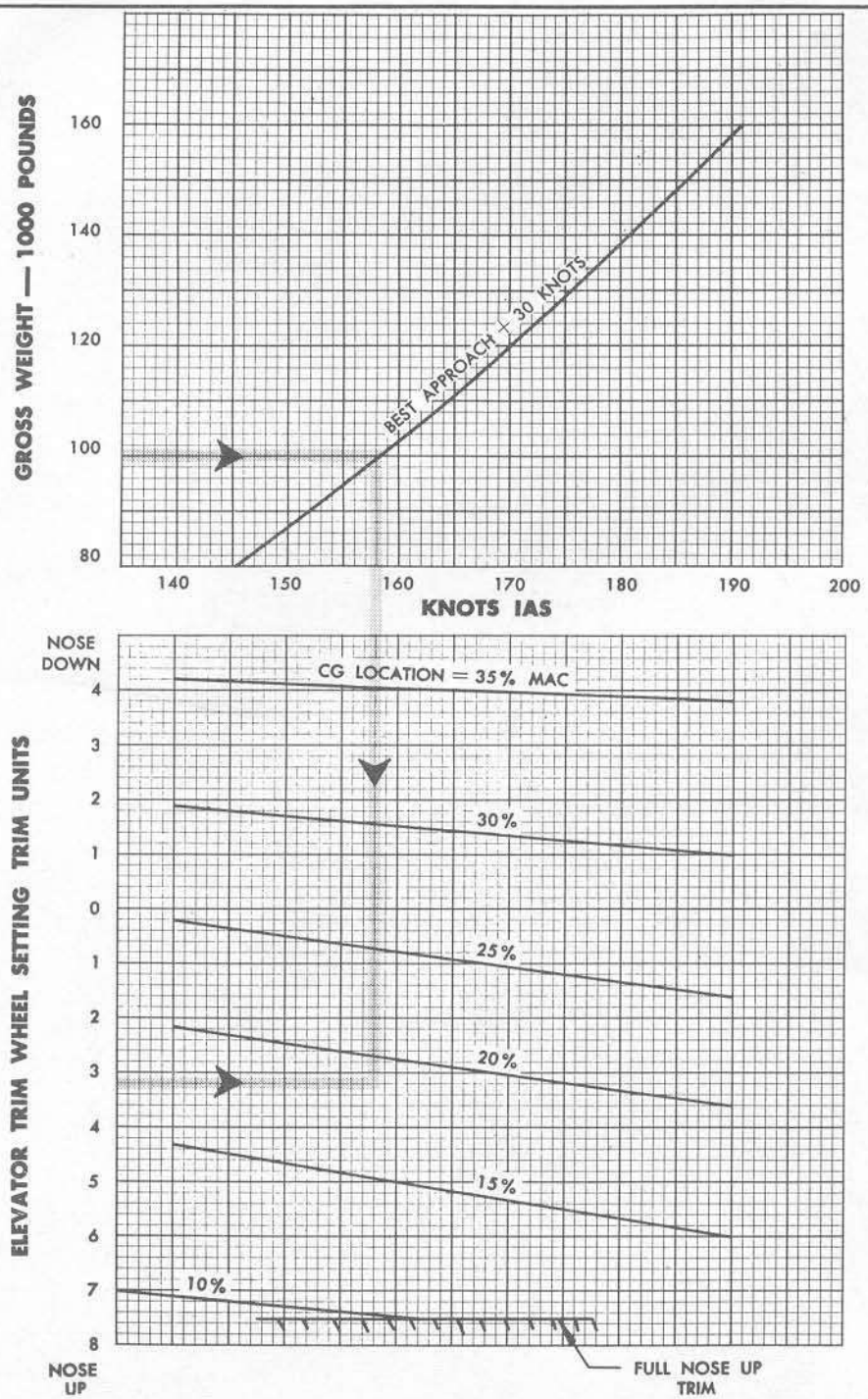
On figure A-113 is a curve showing the length of ground roll with the brake chute and full braking over the entire distance. This procedure gives minimum possible landing distances. The ground roll with full braking but without the brake chute is shown on figure A -114. The capacity of the brakes limits the number of high gross weight landings that can be made without the chute, as shown in the following table:

GROSS WEIGHT (LBS.)	DESIGN BRAKE CAPACITY (NO CHUTE)
167,000	1 LANDING
148,000	20 LANDINGS
135,000	80 LANDINGS

For all cases the large effect of secondary conditions such as runway altitude, OAT, and wet runway should be given full consideration.

APPROACH TRIM WHEEL SETTING

MODEL: YDB-47E



CONDITIONS: SEA LEVEL TO 10,000 FT ALTITUDE
ELEVATOR SURFACE POWER CONTROL ON
FULL FLAPS

DATE: APRIL 1952

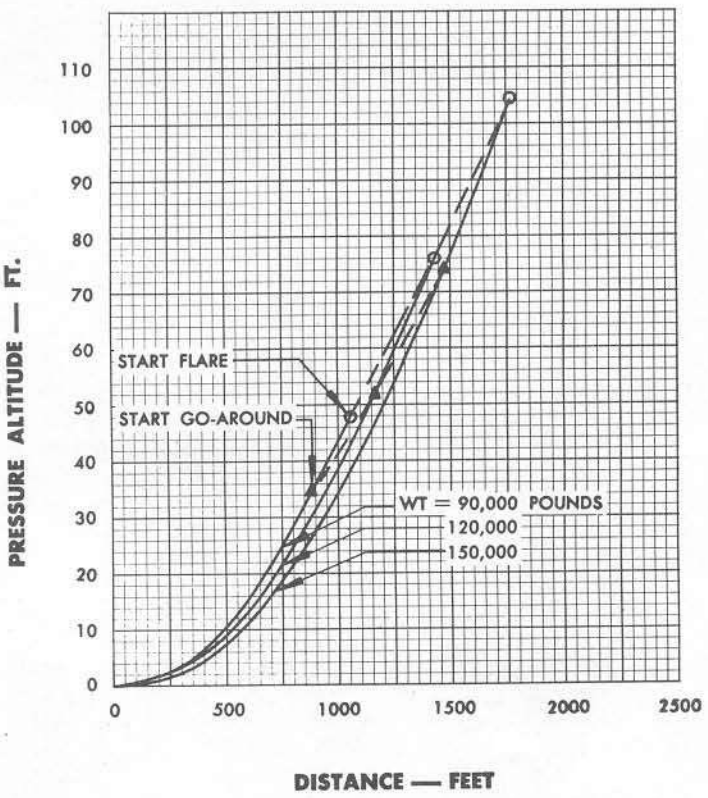
DATA BASIS: FLIGHT TEST

Figure A-109.

APPROACH AND GO-AROUND

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: CONSTANT APPROACH SPEED
45% RPM

REMARKS:

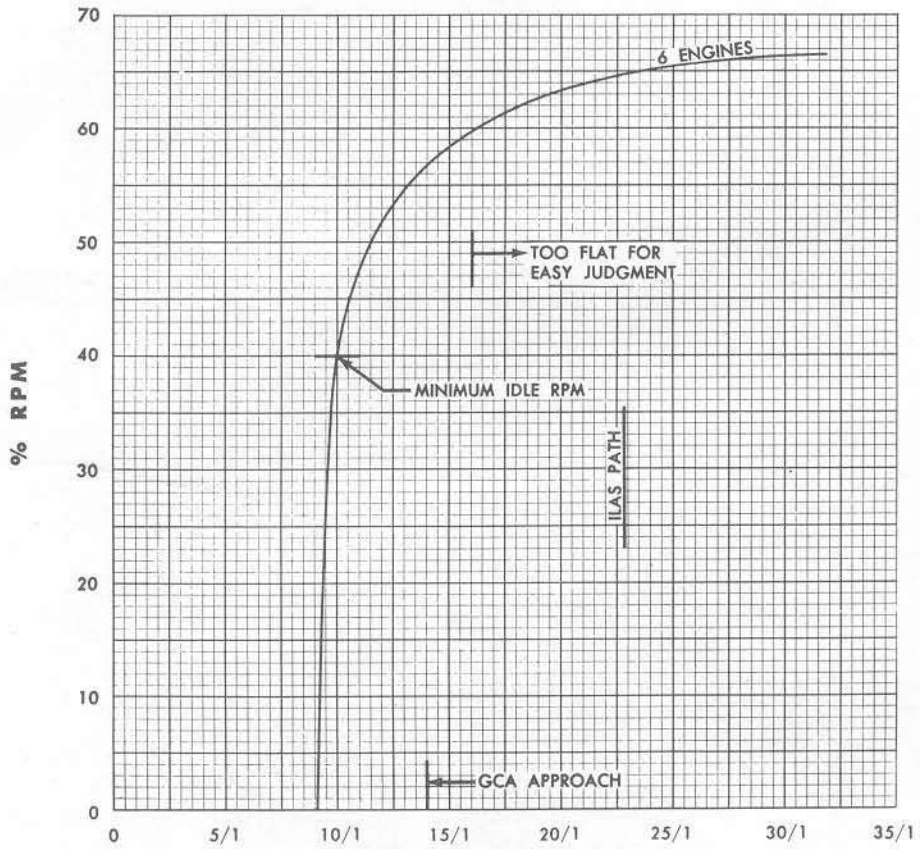
DATE: NOVEMBER 1952.
DATA BASIS: FLIGHT TEST

Figure A-110.

EFFECT OF RPM ON GLIDE ANGLE

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: FLAPS AND GEAR DOWN
NACA STANDARD DAY
WT = 80,000 — 100,000 LBS

DATE: NOVEMBER 1952

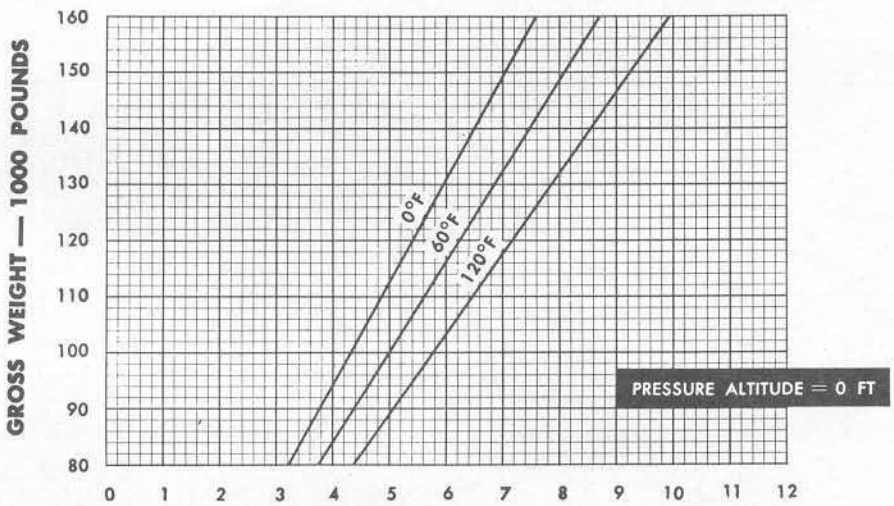
DATA BASIS: FLIGHT TEST

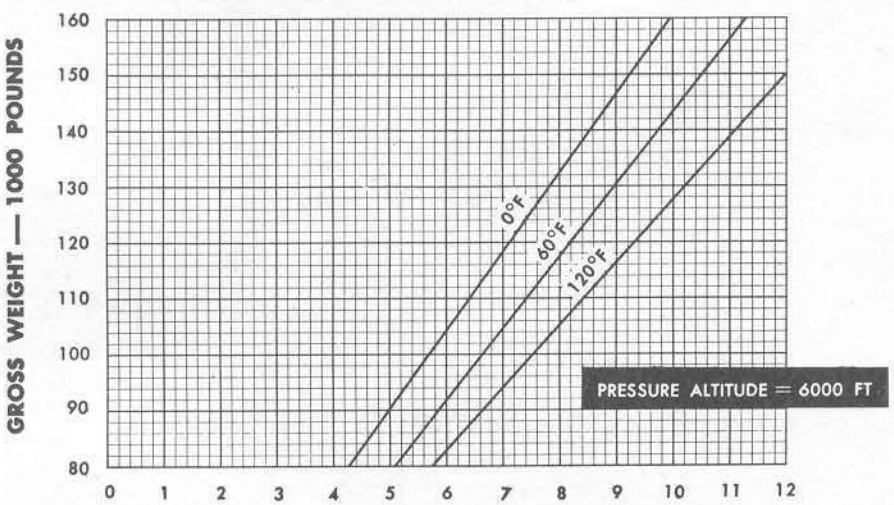
REMARKS:

Figure A-111.

NORMAL STOPPING DISTANCES
CHUTE PLUS BRAKES AT 40-0 KNOTS

MODEL: YDB-47E **ENGINES:** J47-GE-25





CONDITIONS: CHUTE FULLY OPENED AT TOUCH DOWN
BRAKES USED ONLY FROM 40 TO 0 KNOTS
NO WIND — DRY CONCRETE

DATE: NOVEMBER 1952

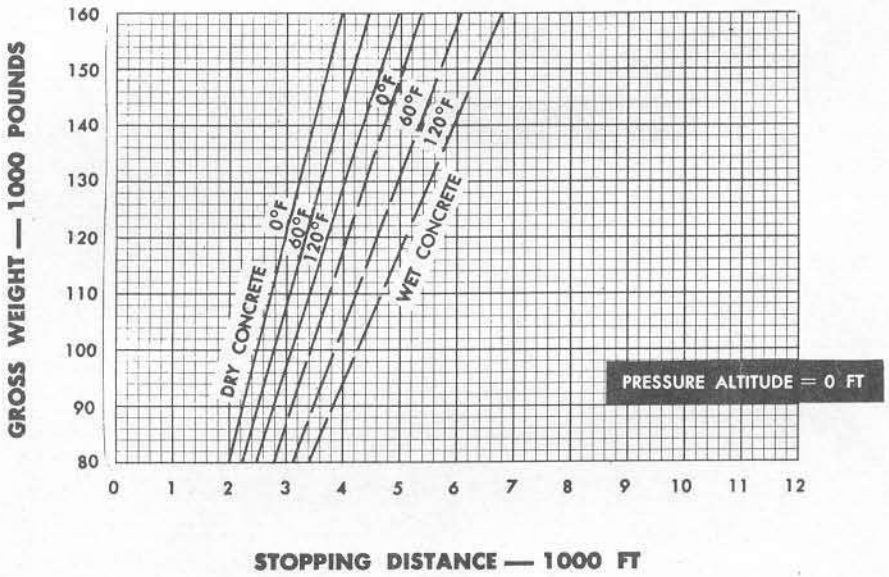
DATA BASIS: FLIGHT TEST

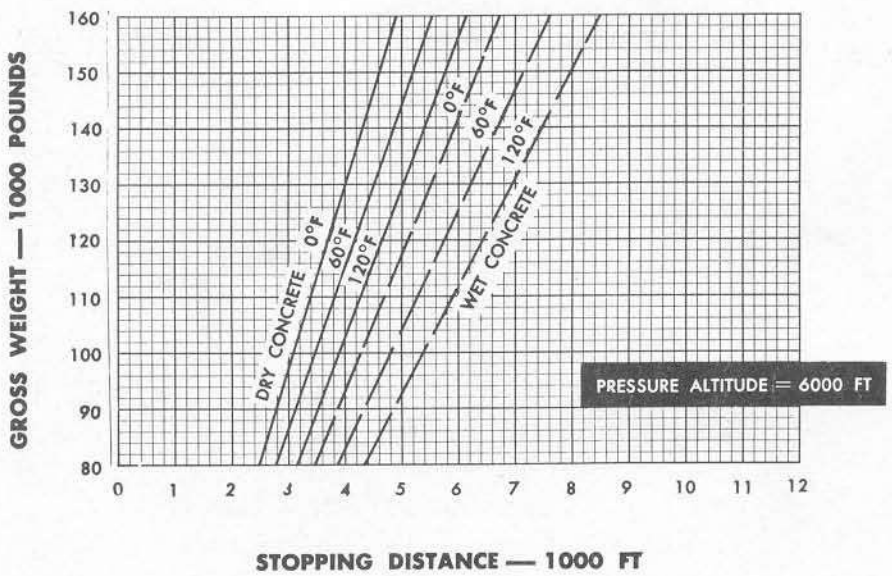
REMARKS:

Figure A- 112.

MINIMUM STOPPING DISTANCES CHUTE PLUS BRAKES

MODEL: YDB-47E **ENGINES:** J47-GE-25





CONDITIONS: CHUTE FULLY OPENED AT TOUCH DOWN
BRAKES APPLIED AT TOUCH DOWN
TWO ENGINES AT MINIMUM IDLE RPM AT TOUCH DOWN
NO WIND

REMARKS:

DATE: NOVEMBER 1952

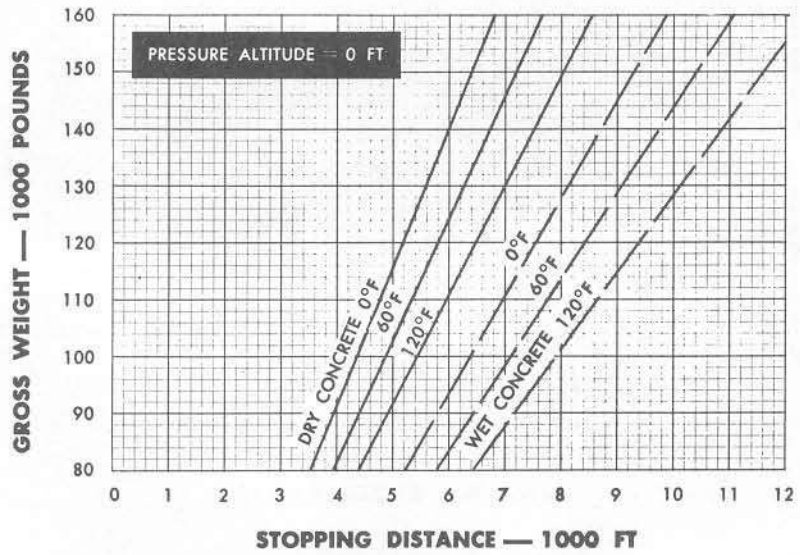
DATA BASIS: FLIGHT TEST

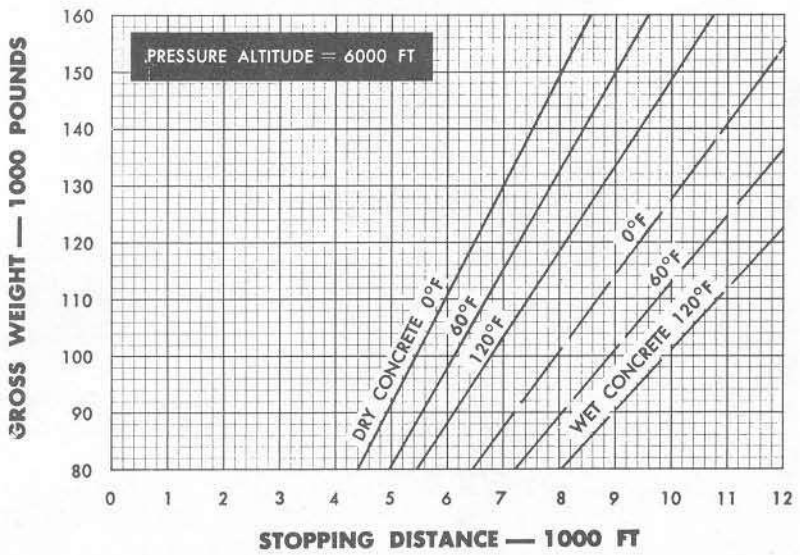
Figure A-113.

STOPPING DISTANCES — BRAKES ONLY

MODEL: YDB-47E

ENGINES: J47-GE-25





CONDITIONS: BRAKES APPLIED AT TOUCH DOWN
NO WIND, NO CHUTE

REMARKS:

DATE: NOVEMBER 1952

DATA BASIS: FLIGHT TEST

Figure A-114.

PART 11

COMPLETE MISSION PROBLEMS

Jet aircraft require special emphasis on mission planning because of the inherently high fuel consumption of jet engines and the wide range of speeds and altitudes attainable.

To avoid a long involved plan which would apply to all possible missions but which would be unnecessarily complex for the average mission, two separate mission plans are presented.

TAKE-OFF DATA

RUNWAY LENGTH _____ FT.
PRESSURE ALTITUDE _____ FT.
O.A.T. _____ °F
EFFECTIVE WIND _____ MPH

	ITEM		DATA SOURCE
1.	GROSS WT. BEFORE STARTING ENGINES, EXCLUDING ATO	LBS.	FIGURE A-116
2.	MINIMUM RUNWAY REQUIRED NO ATO (IF GREATER THAN RUNWAY AVAILABLE, ATO MUST BE USED)	FT.	PART 2
3. a.	MINIMUM NUMBER OF ATO BOTTLES REQUIRED		PART 3
b.	ATO FIRING SPEED IAS	KNOTS	PART 3
4.	CRITICAL ENGINE FAILURE SPEED IAS	KNOTS	PART 4
5.	TAKE-OFF SPEED IAS	KNOTS	PART 2
6.	TAKE-OFF DISTANCE	FT.	PART 2 OR 3

CLIMB DATA

INITIAL CRUISE ALTITUDE _____ FT.
DISTANCE DURING CLIMB _____ NAUT. MI.
TIME TO CLIMB _____ MINUTES

CLIMB SPEEDS IAS, ALTITUDE: FEET	KNOTS
S.L.	
5,000	
10,000	
15,000	
20,000	
25,000	
30,000	
35,000	

Figure A-115. Take-off and Climb Table

SIMPLIFIED MISSION PLAN

This plan is to be used for ferry flights or for missions with not more than two legs, each of which is flown at a certain specified cruise condition. A cargo or bomb drop may be included in the flight, as well as descent or climb allowance at the target. The weight of fuel required for the mission may be computed along with all required take-off data, but no space is presented for making in-flight fuel checks or for deviations from a simple constant-cruise flight. This plan will usually be most convenient for the pilot to use.

GENERAL MISSION PLAN

This plan is to be used for any mission where changes in cruise conditions occur such as climb, descent, endurance, or changing power; or where fuel available checks are desired at specified intervals. Provision is also made for cargo or bomb drop. In-flight revisions in the plan can be made as required.

The Take-Off and Climb Table on figure A-115 should be completed for all missions.

For simplicity in calculations, both mission plans are computed backward from the landing weight at the landing base to the weight at cruising altitude over the take-off base. The fuel allowances for let-down to the landing base and for acceleration and climb after take-off are as follows:

If no endurance at the end of the mission is required, the descent is begun when the airplane is the proper distance from the landing base (part 8). However, the fuel used in descending by either the normal gear-down or the alternate gear-up procedure is almost identical to that required to cruise over the same distance at light weight and high altitude. Therefore, it simplifies the calculation of take-off weight to consider the flight ended over the landing base at cruising altitude. The landing fuel is all that remains.

If endurance is required at the end of the mission, the cruise terminates over the landing base with the endurance, descent, and landing fuel still remaining.

Acceleration and Climb Fuel Allowance (figure A-118):

This allowance is the difference between the fuel actually used during these maneuvers and that which would be used to cruise at altitude from a point directly over the take-off base to the actual end of climb point. Thus, when this allowance is added to the gross weight at altitude over the take-off base, the weight directly after take-off is obtained. For actual climb fuel weight and climb range, refer to part 5.

SIMPLIFIED MISSION PLAN

OUTBOUND CRUISE

1. CONSTANT MACH = _____, ALT. = _____ TO _____.
2. CONSTANT MACH = _____, CONSTANT ALT. = _____.
3. MACH = _____ TO _____, CONSTANT ALT. = _____.

INBOUND CRUISE

1. CONSTANT MACH = _____, ALT. = _____ TO _____.
2. CONSTANT MACH = _____, CONSTANT ALT. = _____.
3. MACH = _____ TO _____, CONSTANT ALT. = _____.

	LINE NO.	ITEM	DATA SOURCE	AIR DISTANCE (NAUT. MI.)	GROSS WEIGHT (POUNDS)	FUEL WEIGHT (POUNDS)
	1. a.	LANDING WEIGHT (NO FUEL ABOARD)	AIRPLANE PAPERS			0
	b.	LANDING & GO-AROUND FUEL (NO DISTANCE CREDIT)	PART 12			
	2. a.	RESERVE FUEL ALLOWANCE (NO DISTANCE CREDIT)	OPTIONAL			
	b.	AIR DISTANCE EQUIVALENT (OPT. CRUISE) _____ N. MI	PART 6			
	c.	ENDURANCE EQUIVALENT (OPT. ENDUR) _____ MIN.	FIGURE A -122			
	d.	GROSS WEIGHT OVER LANDING BASE (AT START OF RESERVE)	LINES 1a + 1b + 2a			
	3. a.	TARGET TO LANDING BASE — FUEL WEIGHT	PART 6			
	b.	EFFECTIVE WIND SPEED _____ KNOTS	FIGURE A -119			
	c.	GROUND DIST_____N. MI. (USE TAKE-OFF TO LANDING BASE FOR FERRY MISSIONS)				
	d.	AIR DIST_____N. MI. (USE TAKE-OFF TO LANDING BASE FOR FERRY MISSIONS)	FIGURE A -121			
	e.	GROSS WEIGHT LEAVING TARGET (OVER TAKE-OFF BASE FOR FERRY MISSIONS)	LINES 2d + 3a			
OMIT FOR FERRY MISSION	f.	BOMBS DROPPED AT TARGET _____ LBS.	OPTIONAL			
	g.	GROSS WEIGHT BEFORE BOMB DROP	LINES 3e + 3f			
	4. a.	FUEL EXPENDED AT TARGET — TOTAL (NO DISTANCE CREDIT)	LINES 4b + 4c			
	b.	CLIMB OR DESCENT FUEL ALLOWANCE _____ LBS.	PART 11			
	c.	EVASIVE ACTION FUEL _____ LBS.	PART 12			
	d.	GROSS WEIGHT APPROACHING TARGET	LINES 3g + 4a			
	5. a.	OVER T. O. BASE TO TARGET — FUEL WEIGHT	PART 6			
	b.	EFFECTIVE WIND SPEED _____ KNOTS	FIGURE A-119			
	c.	GROUND DISTANCE_____ N. MI. (INCLUDES CLIMB)				
	d.	AIR DISTANCE_____N. MI. (INCLUDES CLIMB)	FIGURE A-121			
	e.	GROSS WT. AT CRUISE ALTITUDE OVER T. O. BASE	LINES 4d + 5a			
	6. a.	ACCELERATION AND CLIMB FUEL ALLOWANCE	FIGURE A-118			
	b.	GROSS WEIGHT AFTER TAKE-OFF	LINES 5e + 6a			
	7. a.	TAXI AND TAKE-OFF ENGINE FUEL ALLOWANCE	PART 12			
	b.	GROSS WT. BEFORE STARTING ENGINES (EXCLUDING ATO)	LINES 6b + 7a			
	8.	TOTAL FUEL REQUIRED	SUM OF RIGHT-HAND COLUMN			

Figure A-116.

SIMPLIFIED MISSION PLAN NOTES

The Simplified Mission Plan can be used whenever the flight consists of one or two legs, each of which is flown at a constant cruise operation. For more complicated missions where cruise conditions change, or where fuel checks are desired at enroute check points, the General Mission Plan, on figure A-117, should be used.

Complete the Simplified Mission Plan on figure A-116 as follows:

Fill in the Mach numbers and altitudes for the specified cruise conditions.

1a. Landing weight of the airplane without fuel after the mission.
b. Landing and go-around fuel allowance. Approximately 2700 pounds of fuel may be allowed as a margin for a normal approach pattern plus a go-around. Approximately 1080 pounds will be consumed in the pattern and 1620 pounds during go-around.
2. The reserve fuel allowance may be specified as pounds of fuel, nautical miles air distance, or minutes of endurance. Conversion from one to the other is explained below.

If reserve is specified as
a. Pounds of fuel: Find the equivalent air distance from the chart in part 6 of the maximum range in nautical miles per thousand pounds of fuel. Find the equivalent endurance from figure A-122.
b. Reserve air distance in nautical miles: Find the pounds of fuel from the same chart of nautical miles per thousand pounds of fuel in part 6, using the airplane weight from step 1a. Convert air distance to endurance using figure A-122.
c. Minutes of optimum reserve endurance: Find the equivalent air distance from figure A-122. Use the integrated chart for optimum endurance in part 7 to find the pounds of reserve fuel.
d. Gross weight over landing base = landing weight without fuel, plus reserve fuel, plus landing and go-around allowance (steps 1a + 1b + 2a).

3a. Fuel weight, target to landing base. (See step 3e.)
b. Effective wind speed: Knowing the true wind direction and speed, the effective wind speed is found on figure A-119.
c. Ground distance from target to landing base - specify.
d. Air distance to target: Use the average effective wind and true airspeed to compute the ground speed. Then find the air distance from the chart on figure A-121. For greatly variable winds, the leg may be divided into convenient sections, the air distance for each section found as indicated, and the sectional distances added to obtain the total air distance.
e. Gross weight leaving target: Add the gross weight over the landing base and the fuel required to cruise to the target (steps 2d + 3a). Find 3a from part 6.
f. Bomb load or cargo dropped: Calculate.
g. Gross weight before bomb drop: Add the weight of the bomb load to the gross weight leaving the target (steps 3e + 3f).

4a. Fuel weight expended in target vicinity. (Steps 4b + 4c.)
b. Fuel allowance for climb just before reaching the target vicinity is found on figure A-118 as the difference between the fuel allowance curves for the two altitudes. Descent fuel allowance can be neglected, since for both normal gear-down and alternate gear-up descents the same amount of fuel is used as for continued cruise at maximum range conditions.
c. Evasive action, or other fuel allowance can be determined from the level flight fuel consumption chart in part 12. Evasive action fuel is usually specified as the equivalent of so many minutes at a given thrust. An example would be 6 minutes fuel at normal rated thrust.
d. To compute gross weight while approaching target, add the fuel expended at the target to the gross weight before bomb drop (step 3g + 4a).

5a. Fuel weight, take-off base to target. (See step 5e.)
b. The effective wind speed is found from figure A-119, as in step 3b.
c. Specify ground distance from take-off base to target.
d. The air distance is found as in step 3d, using the ground distance and the expected effective wind velocity.
e. Using the appropriate integrated range chart, with the air distance from step 5d and with the origin at the weight given in step 4d, find the airplane gross weight over the take-off base at cruising altitude (step 5e) and the fuel used from there to the target (step 5a).

6a. Fuel weight, acceleration and climb allowance. Determine this from the curve on figure A-118 for the airplane gross weight and cruising altitude over take-off base.
b. Gross weight, take-off: Add the climb fuel allowance to the gross weight over take-off base (step 5e + 6a).

7a. Fuel weight, taxi and take-off allowance. Given as the equivalent of a specified number of minutes at a certain thrust condition. This fuel weight is found from the chart in part 12, using the estimated time and rpm during starting, taxi, run-up, and take-off.
b. Gross weight before starting engines: Add the taxi and take-off fuel allowance to the gross weight after take-off (steps 6b + 7a).

8. The total fuel weight is the sum of all the fuel weights in the right-hand column of the Mission Plan.

GENERAL MISSION PLAN NOTES

This plan, on figure A-117, is intended to facilitate the calculation of the fuel load required for all stages of a complex mission problem. Navigational data, such as courses and drift corrections, are necessarily outside its scope.

OPERATION COLUMN SYMBOLS — **GENERAL MISSION PLAN**

CLIMB C BOMB RUN B ENDURANCE E
CRUISE R EVASIVE ACTION V DESCENT D

ROW	COLUMN A → CHECK POINT	B AIRPLANE GROSS WEIGHT POUNDS	C FUEL AVAILABLE POUNDS	D ALTITUDE FEET	E OPERATION	F FUEL USED BETWEEN POINTS POUNDS	G GROUND DISTANCE BETWEEN POINTS N. MILES	H EFFECTIVE WIND KNOTS HEAD − TAIL +	J AIR DISTANCE BETWEEN POINTS N. MILES	K AVERAGE MACH NUMBER	L AVERAGE TAS KNOTS	M TIME BETWEEN POINTS HRS	M MIN	N TOTAL TIME HRS	N MIN
1	BEFORE STARTING ENGINES														
2	AFTER TAKE-OFF														
3	START CRUISE (OVER T.O. BASE)														
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16															
17															

Figure A-117. General Mission Plan

Record the known data on figure A-117 in the following order:

Column A, Check Point.

Fill in the check points, beginning with the take-off base and ending with the landing base. Enter them geographically or as "begin cruise, begin endurance, etc," each being listed only once. A check point is defined as follows:
1. A point at which a fuel check is desired.
2. A point at which an abrupt change in cruise conditions occurs, such as climb, descent, endurance, or changing power.
3. A point at which an instantaneous weight change occurs, such as the bomb drop.

Column D, Altitude.

Fill in the altitudes wherever they are known. Leave blank temporarily for check points during constant Mach number cruise on a climbing flight path, since these altitudes will be determined by the gross weight.

Column E, Type of Operation.

Specify the conditions as climb, cruise, descent, etc. by the symbols at the top of the chart.

Column G, Ground Distance.

Enter the ground distances between check points (leave blank for endurance, reserve, bomb drop, etc). Climb and descent distances will be determined later.

Column H, Effective Wind.

The expected effective wind velocity is entered here from figure A-119 (headwind minus, tailwind plus). Leave blank for endurance, reserve, bomb drop, etc.

Column K, Average Mach Number.

Wherever possible, at this time, fill in the average Mach number at which the airplane will be flown between check points.

Column L, True Airspeed.

If any portions of the cruise are at known altitudes, convert the Mach numbers to true airspeeds, using the conversion chart for a standard day in part 12. Leave blank temporarily for a climbing flight path.

Column J, Air Distance.

Add the effective wind speed to the true airspeed to obtain the ground speed between check points. Then fill in the air distances using the chart on figure A-121 (except for endurance, reserve, evasive action, etc).
1. For endurance where some useful range also is obtained, convert between pounds of fuel and minutes of endurance using part 12, and from minutes to equivalent air distance using the chart on figure A-122 or the equation: Air Distance = $\frac{\text{average TAS} \times \text{minutes}}{60}$.

2. For legs where no useful distance is gained, such as bomb drop, evasive action, holding, etc, leave the air distance blank.

The mission should now be computed backward from the known weight at the end of the flight to the initial conditions at take-off. Complete each row in the mission plan, except for the total time, before proceeding to the next one above. The following general instructions apply.

CALCULATIONS

FUEL AND GROSS WEIGHT

1. For the last check point (landing base) at the bottom of the mission plan, record the landing gross weight of the airplane without fuel. Place a zero in column C for fuel available.
2. In the next to the last row, enter the fuel reserved for let-down and landing in columns C and F. Add this to the landing weight without fuel to obtain the gross weight before let-down and record this new gross weight in column B.
3. In the third row from the bottom (arrival over landing base) enter the reserve fuel weight in column F. Calculate the fuel available and enter it in column C.

If the reserve is specified as
a. Distance at optimum cruise: Find the reserve fuel weight, using part 6, by first finding the maximum nautical miles per thousand pounds of fuel and then converting miles to pounds of fuel by means of the chart at the end of part 6. If the distance is great, use the equation:

$$\text{Pounds Fuel} = \frac{\text{nautical miles} \times 1000}{\text{nautical miles per 1000 pounds}}$$

b. Optimum endurance time: From the integrated endurance chart in part 7, find the reserve fuel weight. The endurance airspeed and altitude also are obtained from this part. Add this reserve fuel to the gross weight listed in the row below to obtain the gross weight upon arrival over the landing base. Obtain the cruise altitude over the base from the appropriate range chart in part 6. The fuel available is the sum of the reserve fuel and the fuel available in the row below.

4. In the fourth row from the bottom of the plan (departing the last check point before reaching the landing base), find the air distance at cruise. Then use the appropriate range chart in part 6 to find the fuel used on this leg and the initial gross weight. For a long distance, use the miles range versus gross weight range chart. Where the leg is too short for accuracy with this chart, use the appropriate nautical miles per thousand pounds chart and the method given in step 3a above. Calculate the fuel available and enter it in column C.

CHANGES IN CRUISE

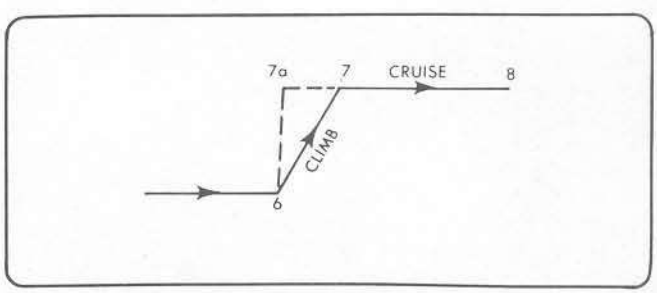
If a check point is reached where a change in cruise procedure is required, select the appropriate new range chart and use it to compute the range backward from the point where the change was made.

ENDURANCE OR RENDEZVOUS

The beginning and end of endurance should be considered as check points. For endurance at light weight, such as before landing, use the integrated chart in part 7 to find the fuel weight. If endurance is required at heavier weights, use the charts of minutes per thousand pounds in part 7 and convert from time to fuel by means of the chart at the end of that part. If distance credit is gained during the endurance, the air distance is the product of the true airspeed and the time. The ground distance can then be found from figure A-121.

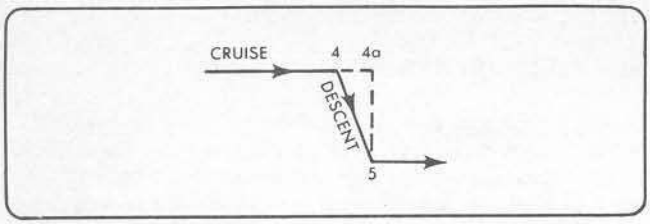
CLIMB OR DESCENT

If an altitude change is desired, such as just before or after the target, the beginning and end of change are considered as check points.
1. For climbs enroute, it is usually convenient and sufficiently accurate to consider that the cruise is continued over the check point at which the climb starts. Then find the fuel allowance for the climb between the two altitudes from figure A-118. Add this allowance to the gross weight over the check point to find the actual gross weight at the beginning of the climb. The method is similar to that for climb fuel allowance after take off. The following sketch illustrates this point.



Working backward from check point 8, find the hypothetical weight at step 7a as though the cruise began there. Add to it the climb fuel allowance, from figure A-118, to obtain the weight at check point 6. Then, if desired, find the true conditions at point 7, using part 5.

2. For a normal six-engine gear-down, or an alternate four-engine gear-up descent enroute, it will be convenient and quite accurate to assume that the same amount of fuel is used during descent as would be used in continuing the high altitude cruise.



Thus, in the above sketch, the gross weight at the end of descent (check point 5) is the same as that at step 4a, assuming that the cruise is continued to that point. This is true for the gear-down descent because of the high rate of descent and the correspondingly short distance covered. It is also true for the alternate gear-up descent because, although the rate of descent is low and the distance long, only four engines are operating.

CARGO OR BOMB DROP

When the mission has been computed back to the weight at the end of the bomb drop, the bomb load and the evasive action fuel (if any) are added to obtain the weight prior to the bombing. Since the load changes suddenly, the weights just before and just after the drop must be considered as check points.

EVASIVE ACTION

Evasive action is usually considered within the interval of the bomb drop, but may be inserted anywhere in the mission by listing its beginning and end as check points. The fuel consumption curves in part 12 are used for this fuel allowance.

BOMB RUN

The bomb run is considered as a leg, flown at high speed cruise between two check points, with the bomb drop as the end check point. The fuel can be obtained from the fuel consumption curves in part 12 if the run is specified in minutes, or from the nautical miles per 1000 pounds chart in part 6 if the length of the run is given in miles.

The remainder of the mission, back to a point over the take-off base, is calculated in the manner described above. The gross weight over the take-off base must then be corrected for the climb, take-off, and ground fuel allowances.

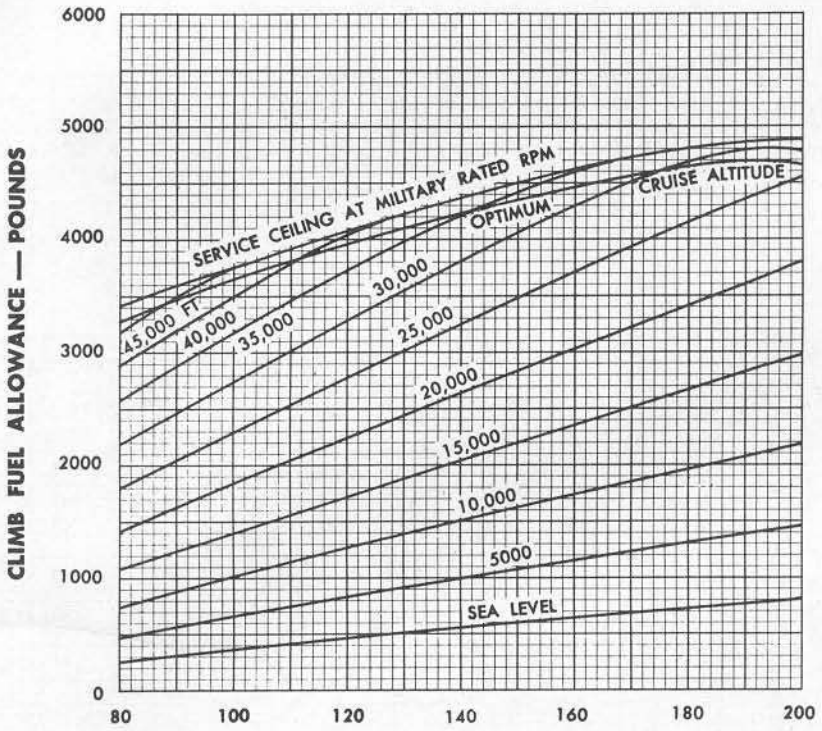
TAKE-OFF BASE CALCULATIONS

1. Acceleration and Climb Fuel Allowance: Using the gross weight and cruise altitude over the take-off base, refer to figure A-118 to find the acceleration and climb allowance as described in paragraph "Climb or Descent." For convenience in computing the mission, this fuel allowance, when added to the gross weight at cruising altitude over the take-off base, gives the true gross weight immediately after take-off. This allowance is based on a climb at normal rated (96% rpm) power.
2. Starting, Taxi, Run-Up, and Take-Off Fuel Allowance: Use the chart for ground operation in part 12. Estimate the time required for each operation and find the total ground fuel used. The fuel load on board and the gross weight before starting engines are obtained by adding this allowance to the previous fuel and gross weight.
3. If ATO is used, the weight of the fuel charge in each solid fuel rocket is 80 pounds.

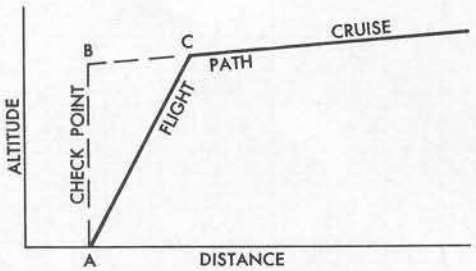
ACCELERATION AND CLIMB FUEL ALLOWANCE

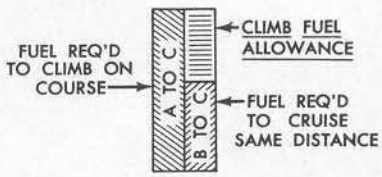
MODEL: YDB-47E

ENGINES: J47-GE-25



GROSS WEIGHT AT CHECK POINT — 1000 POUNDS
(OVER TAKE-OFF BASE AT CRUISE ALTITUDE)





CONDITIONS: NORMAL RATED RPM BELOW CRUISE ALTITUDE
MILITARY RATED RPM ABOVE CRUISE ALTITUDE
TAKE-OFF ON COURSE

REMARKS:

DATE: SEPTEMBER 1952

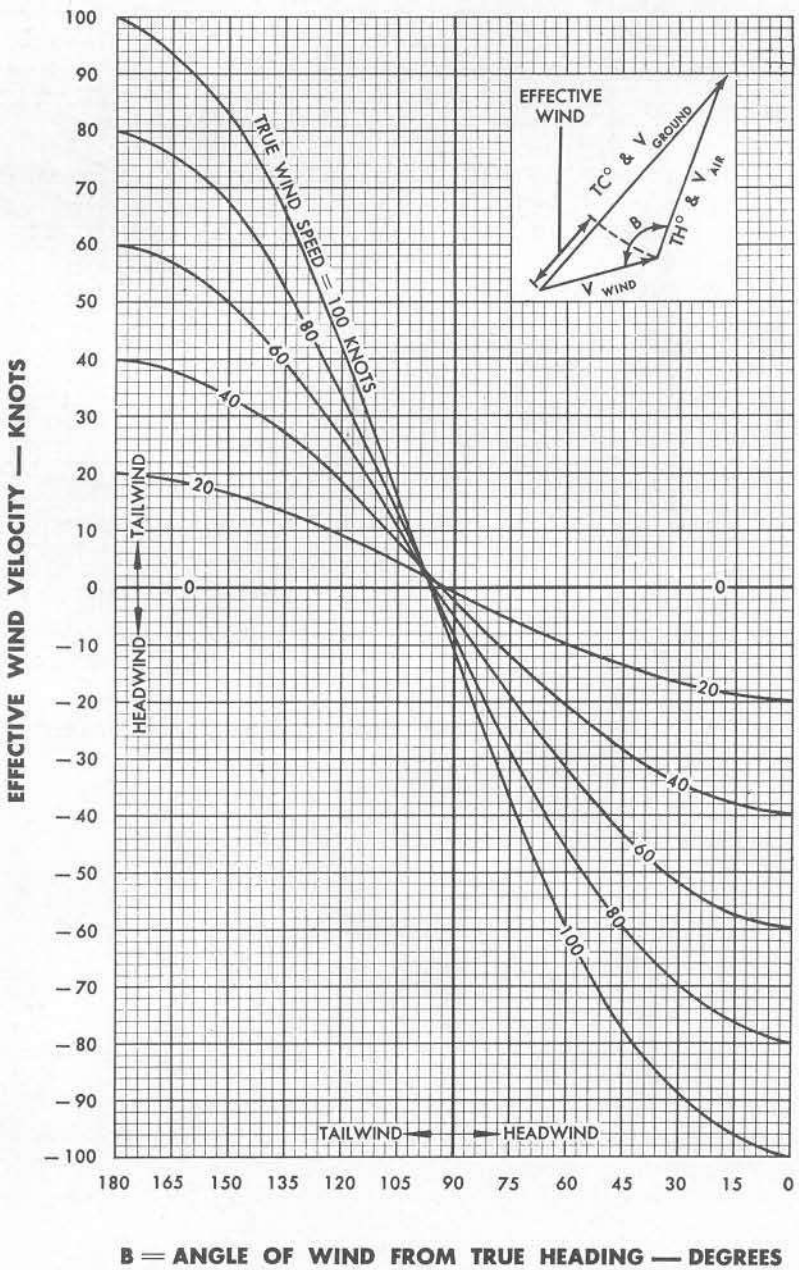
DATA BASIS: FLIGHT TEST

Figure A-118.

EFFECTIVE WIND

MODEL: YDB-47E

ENGINES:



CONDITIONS:

REMARKS:

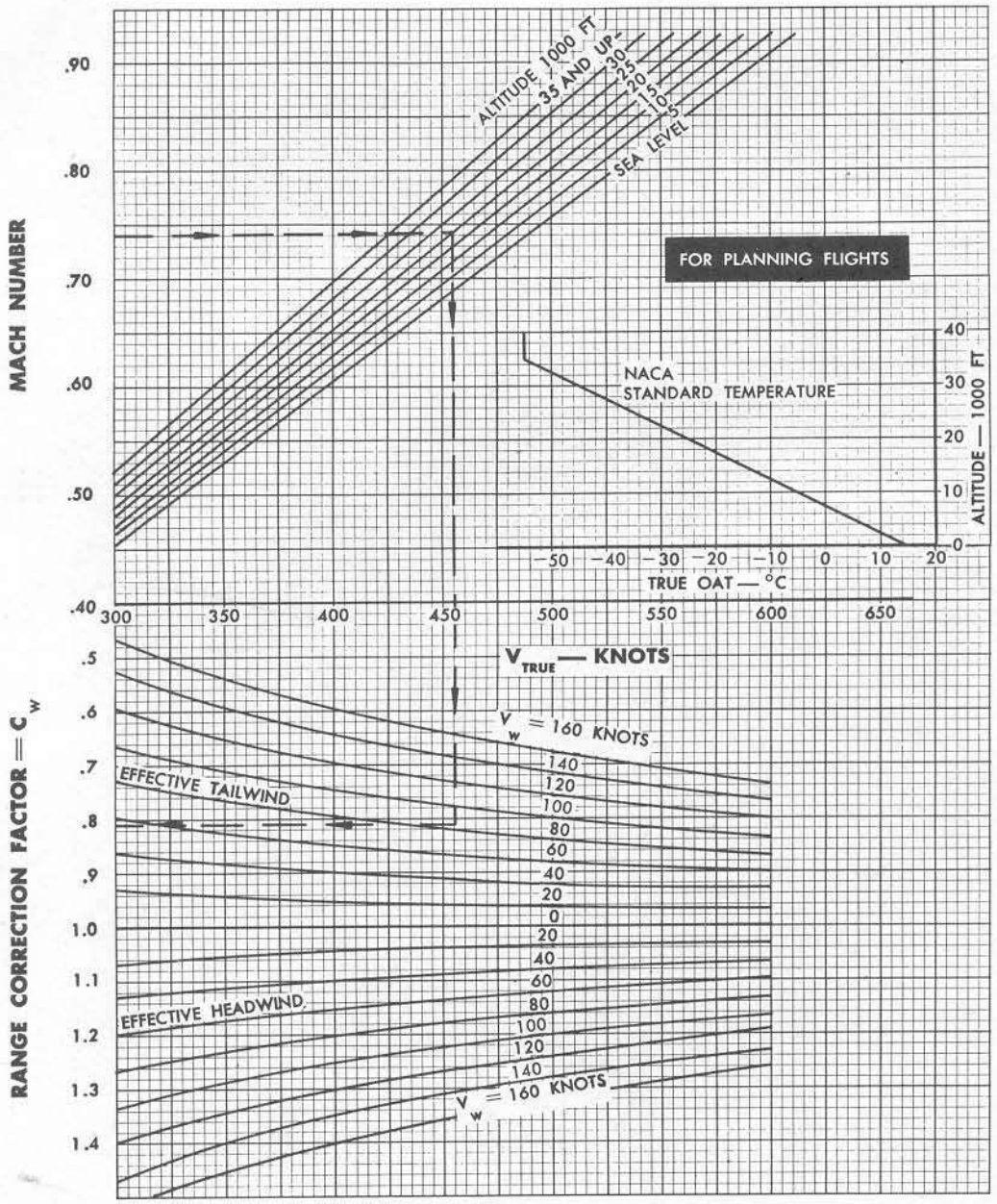
DATE: JUNE 1950
DATA BASIS: CALCULATED

Figure A-119.

RANGE CORRECTION FOR WIND OVER GIVEN WEIGHT CHANGE

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

DATE: JUNE 1951

DATA BASIS: CALCULATED

REMARKS: FACTOR APPLIED TO RANGE WITH WIND GIVES NO-WIND RANGE FOR SAME WEIGHT CHANGE APPLIES TO ANY JET AIRPLANE

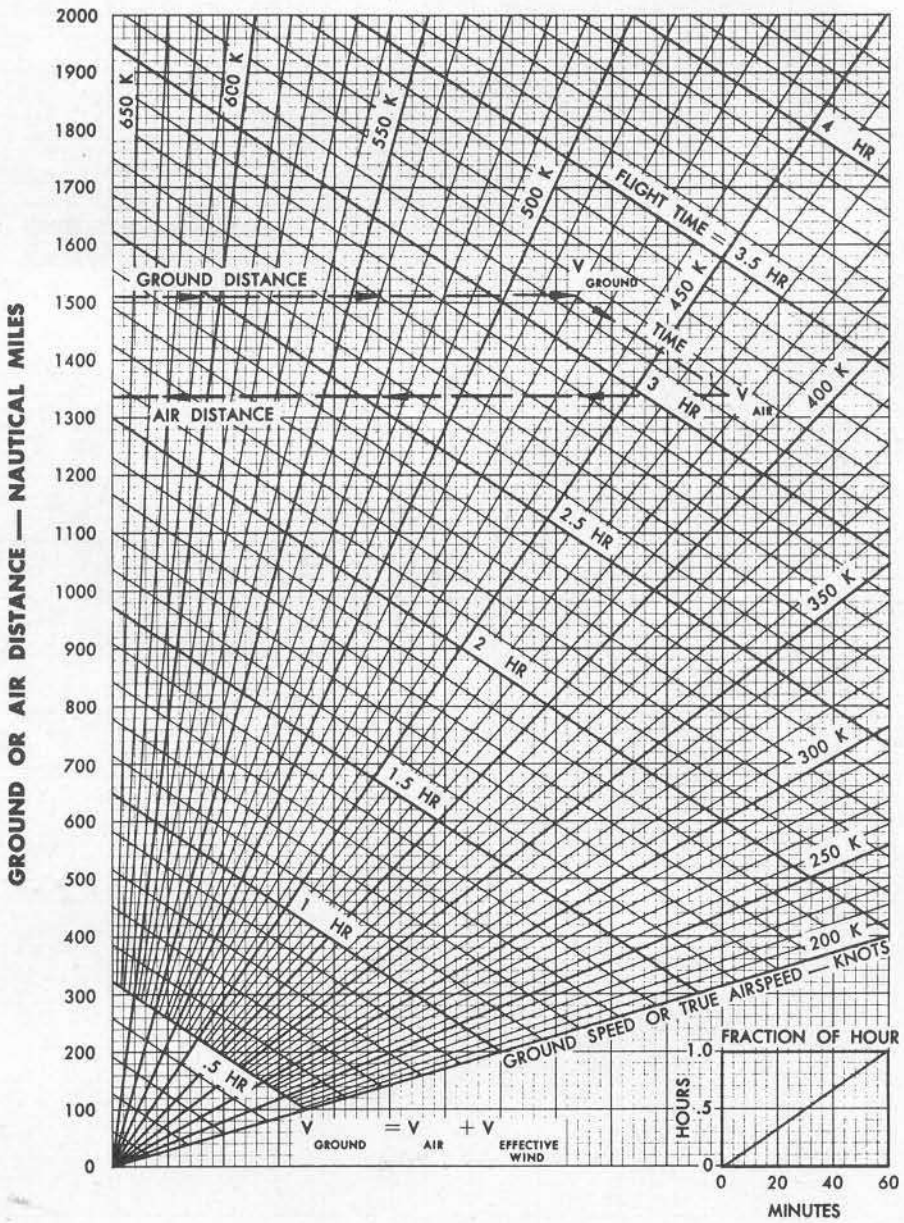
$$\text{RANGE}_{\text{NO WIND}} = C_{NW} \times \text{RANGE}_{\text{WIND}}$$

Figure A-120.

DISTANCE — SPEED — TIME

MODEL: YDB-47E

ENGINES:



CONDITIONS:

REMARKS:

DATE: JUNE 1950

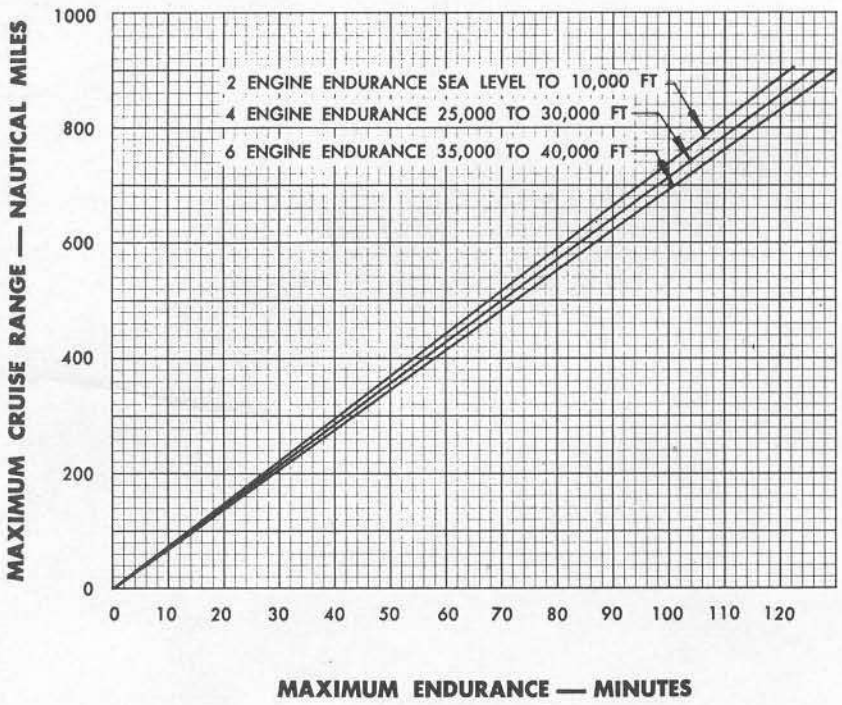
DATA BASIS: CALCULATED

Figure A-121.

RANGE-ENDURANCE CONVERSION CHART

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

DATE: DECEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-122.

PART 12

MISCELLANEOUS CHARTS

This part contains additional performance data and charts to supplement that in the preceding part.

FUEL CONSUMPTION AT LOW ALTITUDE

On figure A-123 is a chart giving the fuel flow for six engines at static conditions. It can be used for estimating the fuel allowance for operations such as warm-up, taxi, and take-off by estimating the time and rpm for these conditions. Also the chart may be used for estimating approach fuel, or for other conditions of low airspeed and low rpm.

FUEL CONSUMPTION AT ALTITUDE

The chart on figure A-124 presents the fuel flow at the higher rpm and for all altitudes. This plot does not show airplane limitations, therefore care must be taken to insure that the desired rpm-Mach number-altitude combination can be attained. Fuel consumption for most all flight operations may be estimated from this chart.

FUEL CONSUMPTION IN LEVEL FLIGHT

On figure A-125 is a chart showing the fuel flows for the more common flight conditions. The steep lines at the left side of the chart show the fuel flows at any altitude for the cruise condition giving best range. The curves peak at absolute ceiling for the weights shown. The broken line indicates the fuel flow at the maximum range climbing flight path condition at Mach .75. Higher gross weights, or above optimum rpm for any gross weight, will cause higher fuel consumption. The curves to the right show the fuel flow at military (98%) rpm and can be used for computing fuel allowances for bomb run, escape, evasive actions, etc.

FUEL GALLONS-POUNDS CONVERSION

On figure A-126 is a chart for quick conversion between pounds and gallons of fuel at various fuel densitites.

BOILING POINT OF FUELS

The chart on figure A-127 gives the altitude at which fuel boil-off starts for various fuels and temperatures.

MAXIMUM SPEEDS

The maximum level flight speeds at any altitude are shown on figure A-128. Speeds in level flight at normal rated rpm are given on figure A-129. To convert to indicated airspeed use figure A-135.

Below approximately 16,000-foot altitude, the airspeed is limited to 425 knots IAS. The maximum true airspeed below 16,000 feet then follows the 425 knot limit line and decreases from 528 knots at 16,400 feet to 425 knots at sea level.

MACH NUMBER LIMITS

At high altitudes and Mach numbers the airplane enters light buffeting which increases as the Mach number increases. There is a slight pitch-up tendency for airplanes with vortex generators, and for those without vortex generators the pitch-up is more severe. The Mach numbers at which the initial buffet occurs are shown in section V. High speed buffeting occurs to the right of the peaks of the curves with low speed buffeting or stall warning occuring to the left of the peaks of the curves.

BANK ANGLE LIMITS

The limiting bank angles for coordinated turns are shown on figure A-133. These values are based on the initial onset of buffeting during stabilized flight conditions.

SERVICE CEILINGS

Plots of the service ceilings with various numbers of engines operating at military rated rpm are on figure A-130 for flaps and gear up and on figure A-131 for flaps and gear down.

MACH NUMBER - INDICATED AIRSPEED CONVERSION

The chart on figure A-135 is used for converting between Mach number and indicated airspeed at any pressure altitude. This chart may be used in connection with a number of others which give only Mach number values. Also it should be useful for checking the airspeed indicator against the machmeter to insure instrument accuracy.

MACH NUMBER - TRUE AIRSPEED CONVERSION

On figure A-132 are charts for conversion between Mach number and true airspeed. The upper chart, for a standard atmosphere, is for use in mission planning. The lower chart is for in-flight use only, since the OAT gage reading includes the temperature rise due to compressibility at the point of measurement and is not the true ambient temperature.

TEMPERATURE

For conversion between Fahrenheit and Centigrade temperature values, the chart on figure A-134 should be used. If temperatures are beyond the range of the chart the equations given on the chart should be used.

For conversion of in-flight OAT gage reading to true outside air temperature, figure A-137 may be used. The difference in the two readings is the temperature

rise due to compressibility.

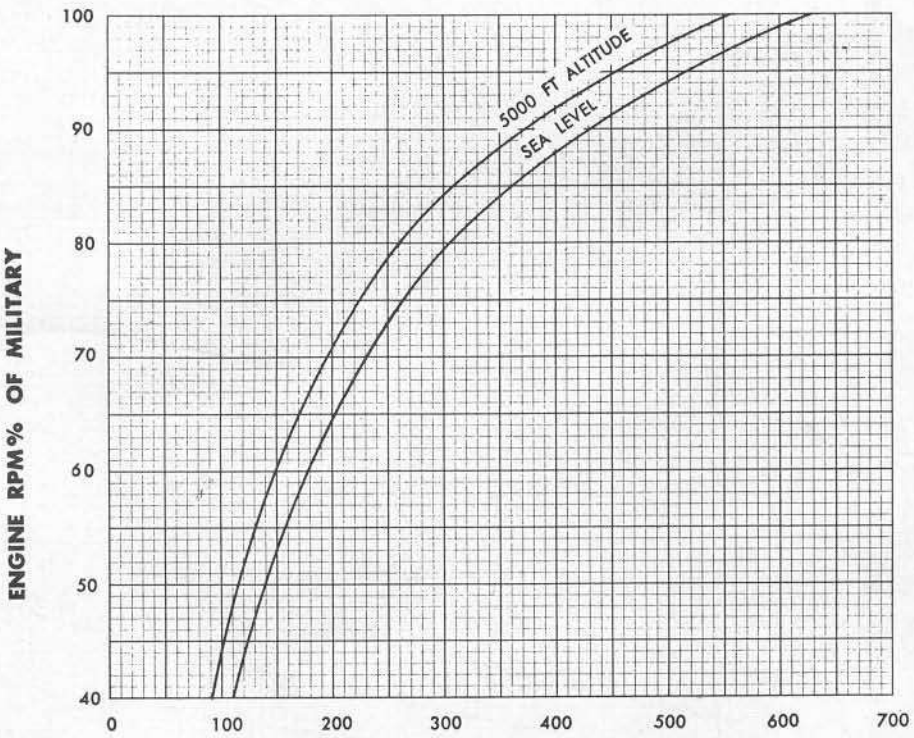
NACA STANDARD DAY

The chart on figure A-136 defines the temperature variation with altitude for a NACA standard day. All charts in this book are based upon this standard atmosphere unless other temperature conditions are specified.

FUEL CONSUMPTION

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: NACA STANDARD DAY

REMARKS:

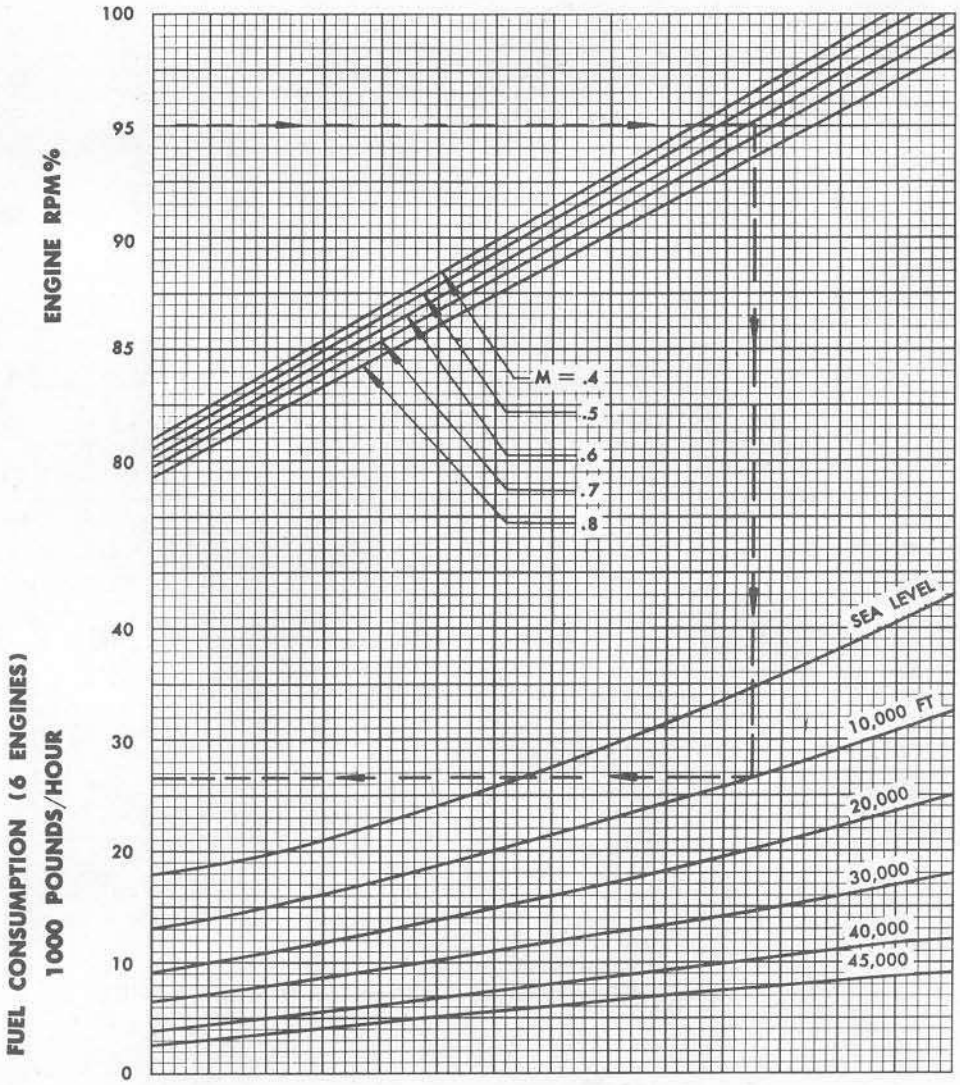
DATE: DECEMBER 1952
DATA BASIS: FLIGHT TEST

Figure A-123.

FUEL CONSUMPTION

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: NACA STANDARD DAY

REMARKS: AIRPLANE PERFORMANCE LIMIT NOT SHOWN

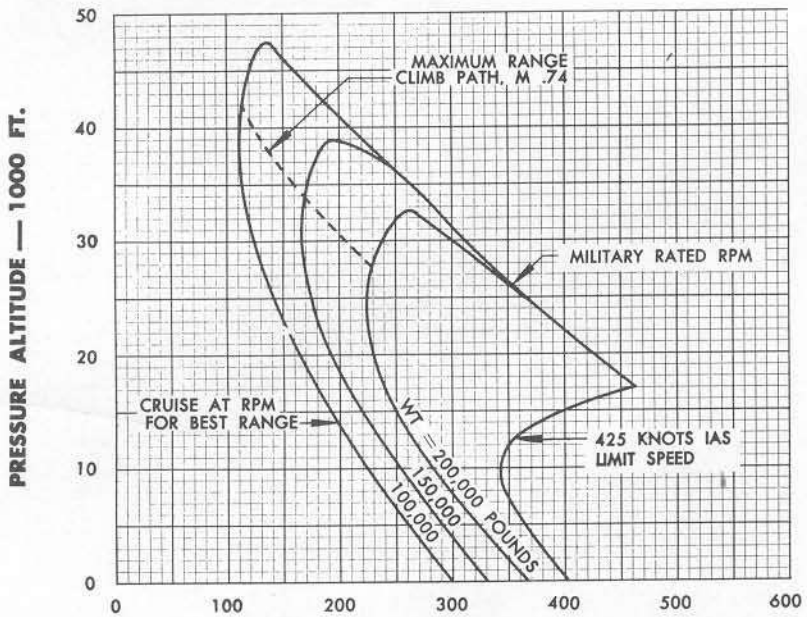
DATE: JULY 1952
DATA BASIS: FLIGHT TEST

Figure A-124.

FUEL CONSUMPTION
LEVEL FLIGHT

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

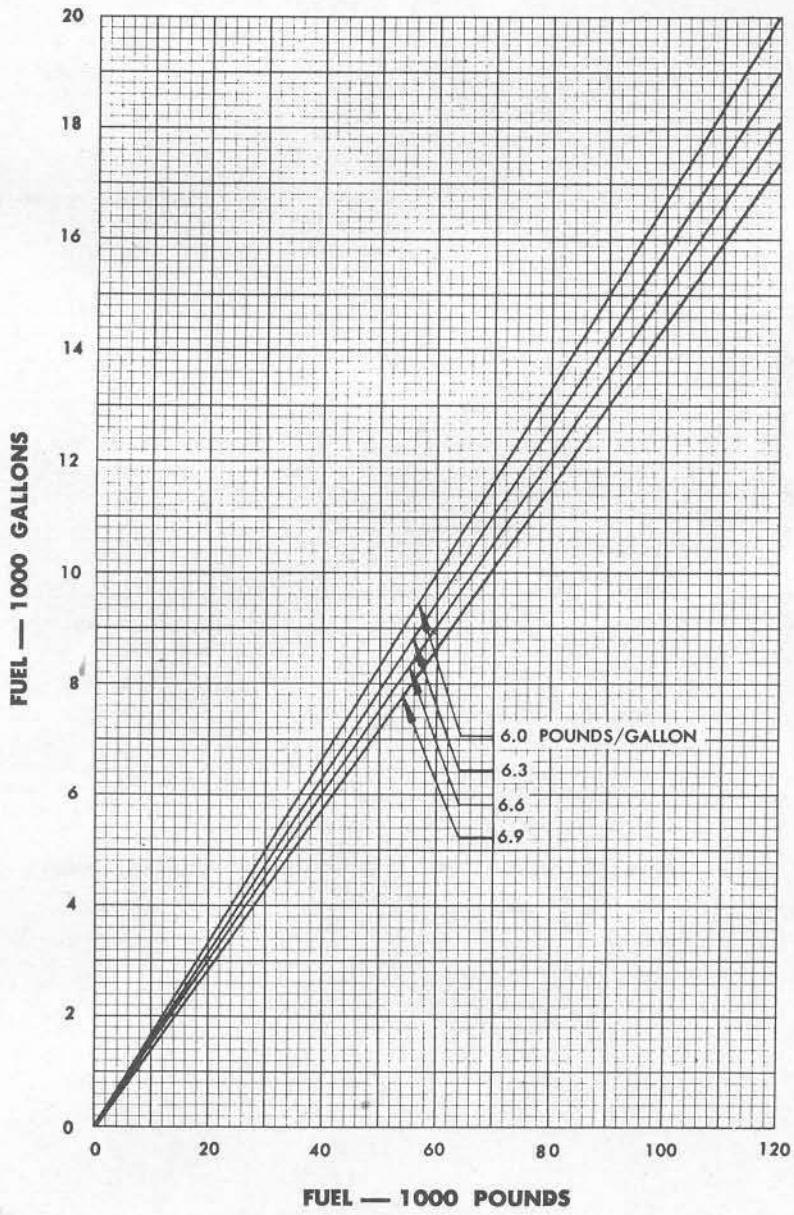
DATE: OCTOBER 1952
DATA BASIS: FLIGHT TEST

Figure A-125.

FUEL CONVERSION CHART

MODEL:

ENGINES:



CONDITIONS:

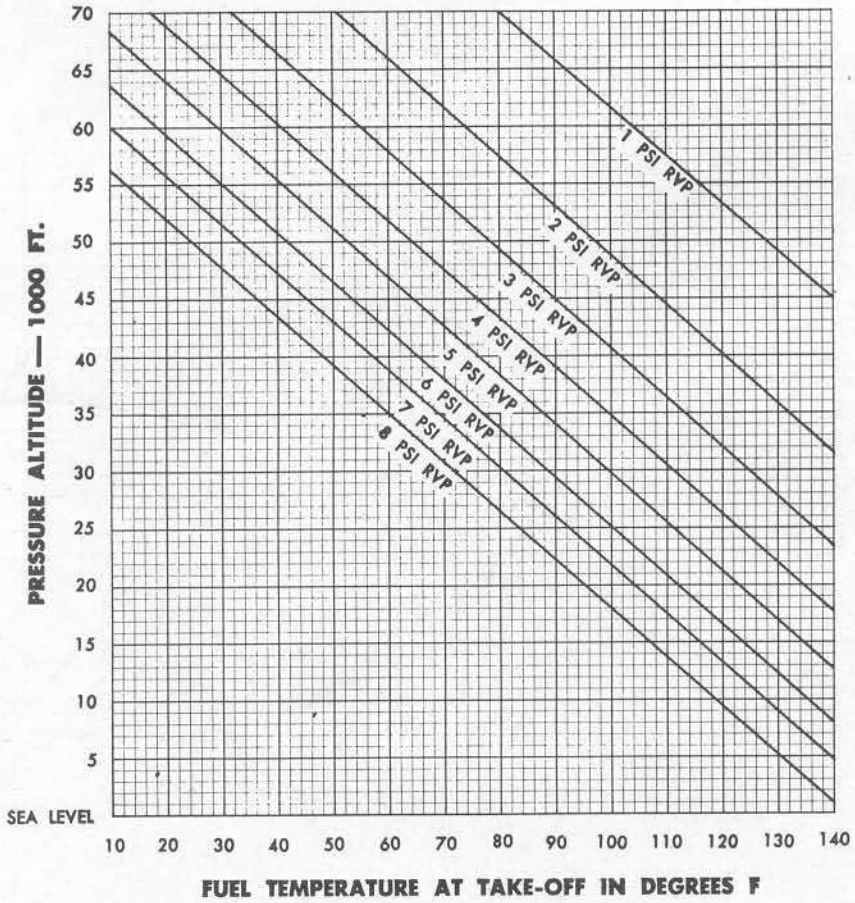
REMARKS:

DATE: DECEMBER 1952
DATA BASIS: CALCULATED

Figure A-126.

BOILING POINT OF FUELS

MODEL: ENGINES:



CONDITIONS:

DATE: DECEMBER 1952
DATA BASIS: CALCULATED

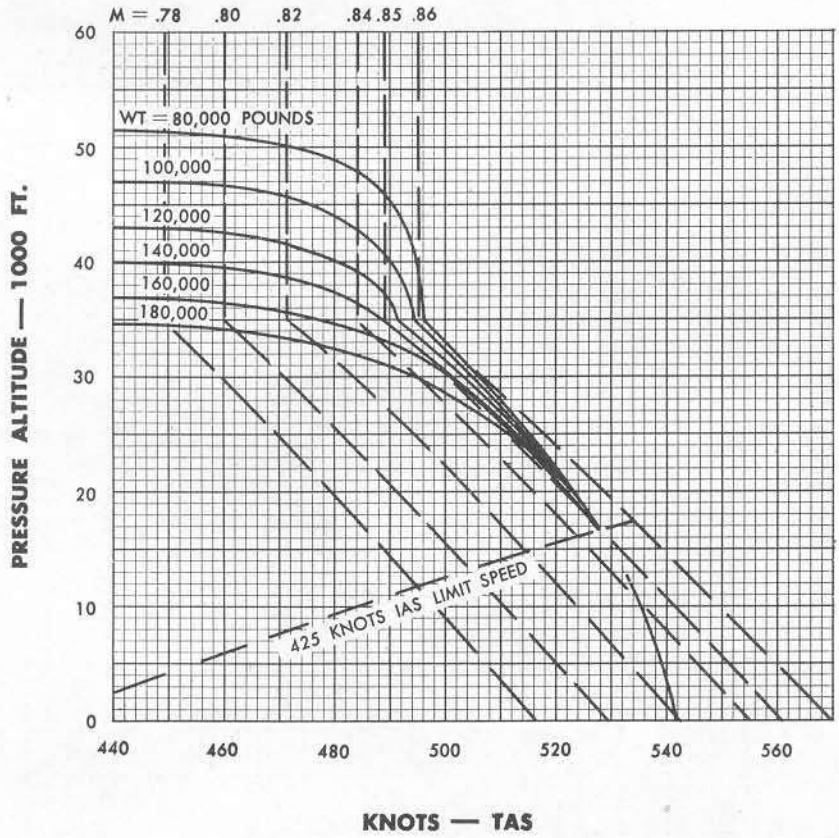
REMARKS: MIL-F-5616, GRADE JP-1 — 1 PSI RVP MAXIMUM
MIL-F-5624, GRADE JP-3 — 5 TO 7 PSI RVP
MIL-F-5572, GRADE 100/130 — 7 PSI RVP MAXIMUM
MIL-F-5624A, GRADE JP-4 — 2 TO 3 PSI RVP

Figure A-127.

MAXIMUM VELOCITY
MILITARY RATED (98%) RPM

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

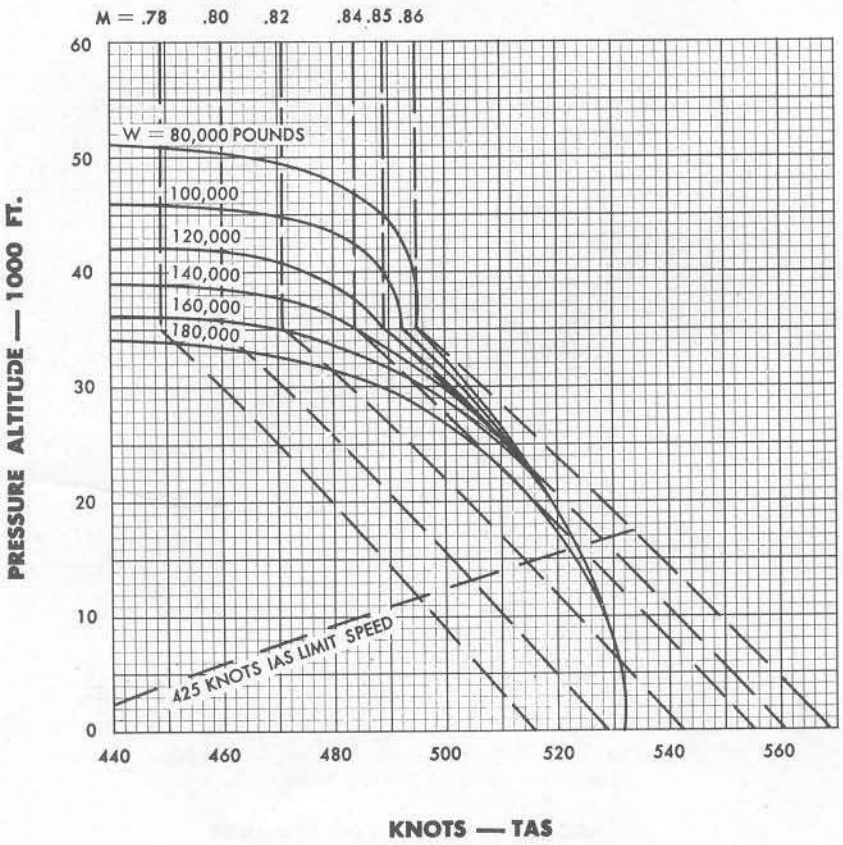
DATE: AUGUST 1952
DATA BASIS: FLIGHT TEST

Figure A-128.

MAXIMUM VELOCITY
NORMAL RATED (96%) RPM

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS:

REMARKS:

DATE: AUGUST 1952
DATA BASIS: FLIGHT TEST

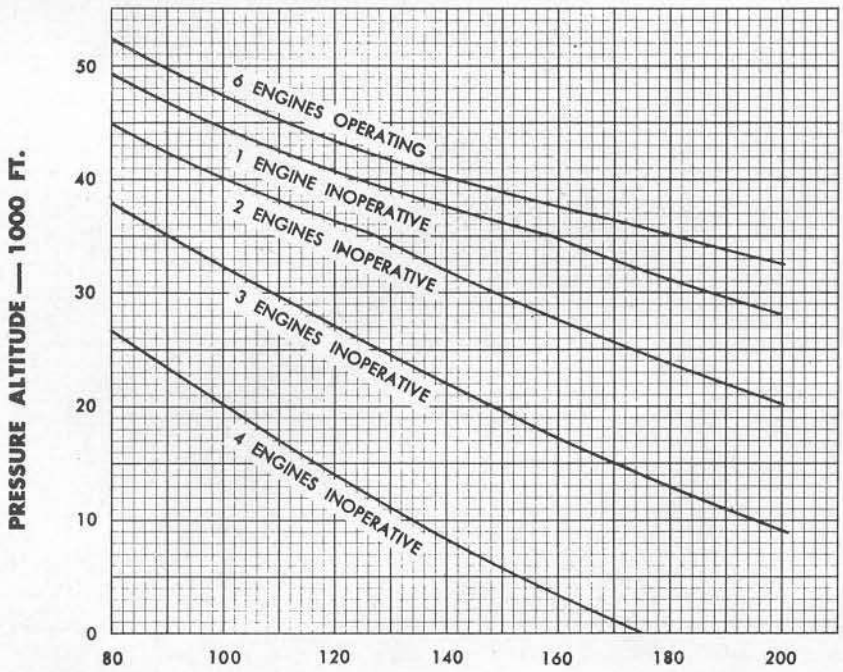
Figure A-129.

SERVICE CEILINGS

MILITARY RATED (98%) RPM
FLAPS AND GEAR UP

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: 100 FT. PER MIN. RATE OF CLIMB

REMARKS:

DATE: OCTOBER 1952
DATA BASIS: FLIGHT TEST

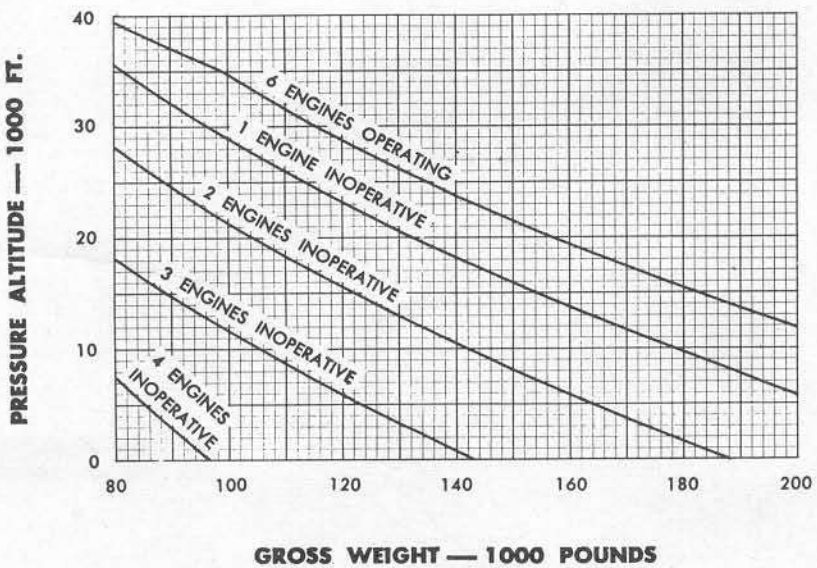
Figure A-130.

SERVICE CEILINGS

MILITARY RATED (98%) RPM
FLAPS AND GEAR DOWN

MODEL: YDB-47E

ENGINES: J47-GE-25



CONDITIONS: 100 FT. PER MIN. RATE OF CLIMB

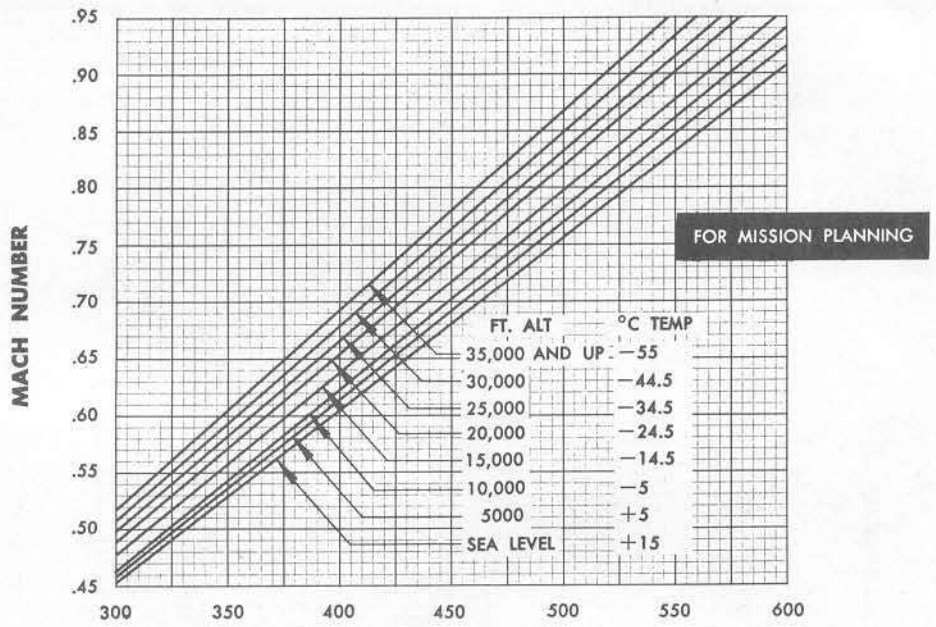
REMARKS:

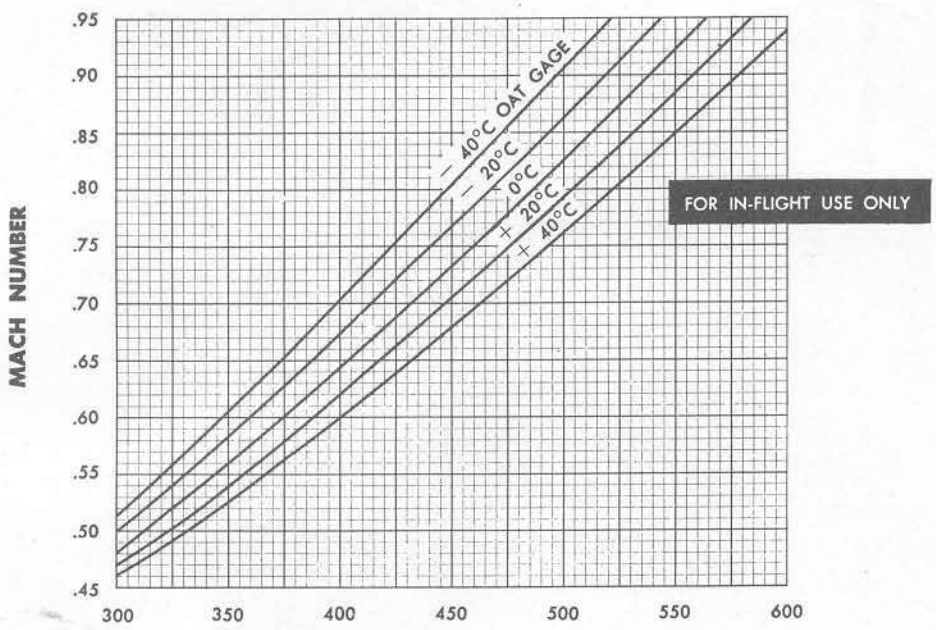
DATE: OCTOBER 1952
DATA BASIS: FLIGHT TEST

Figure A-131.

MACH NUMBER-TRUE AIRSPEED CONVERSION CHART

MODEL: YDB-47E





CONDITIONS: NACA STANDARD DAY FOR MISSION PLANNING CHART

REMARKS:

DATE: DECEMBER 1952

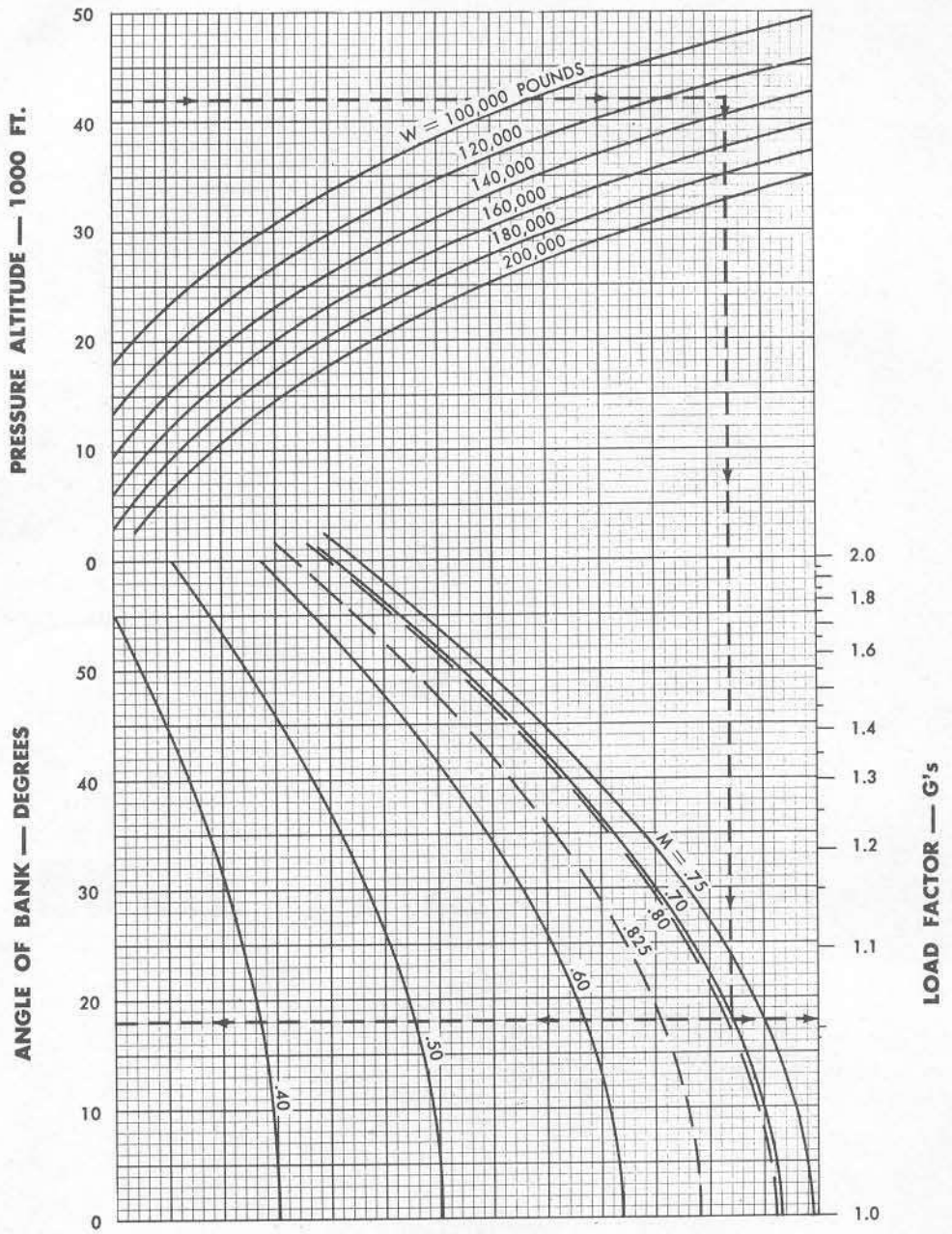
DATA BASIS: CALCULATED

Figure A-132.

BANK ANGLE LIMITS FOR INITIAL BUFFETING

MODEL: YDB-47E

ENGINES:



CONDITIONS: VORTEX GENERATORS INSTALLED

REMARKS:

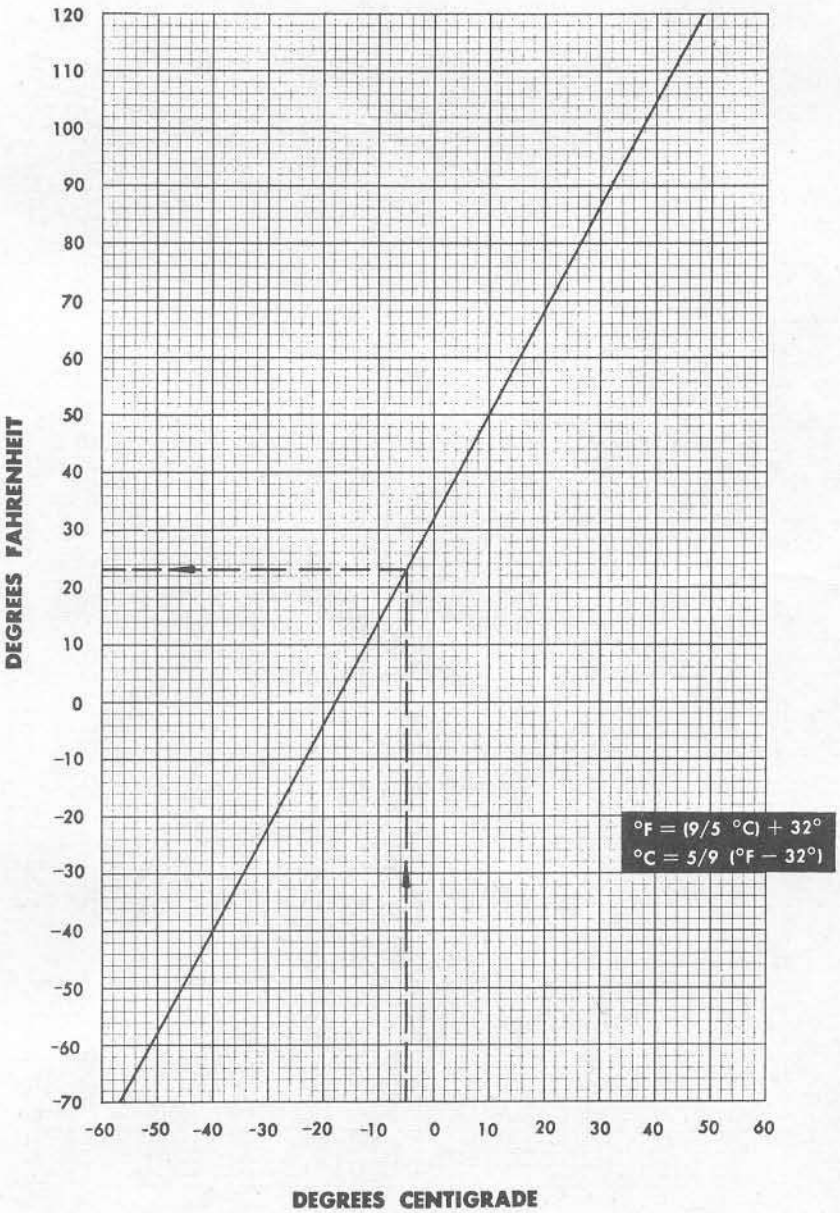
DATE: OCTOBER 1952
DATA BASIS: FLIGHT TEST

Figure A-133.

TEMPERATURE CONVERSION CHART

MODEL:

ENGINES:



CONDITIONS:

REMARKS:

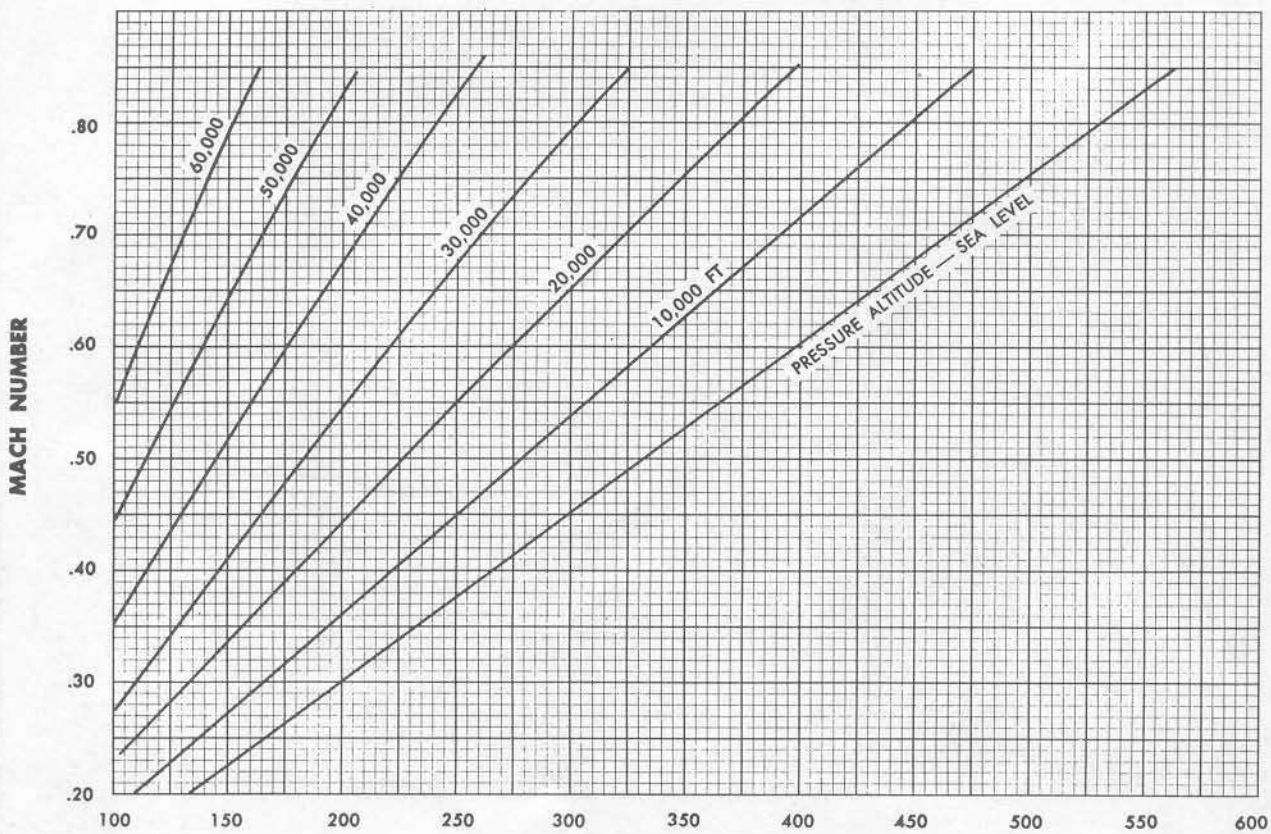
DATE: DECEMBER 1952
DATA BASIS: CALCULATED

Figure A-134.

MACH NUMBER — INDICATED AIRSPEED CHART

MODEL:

ENGINES:



CONDITIONS:

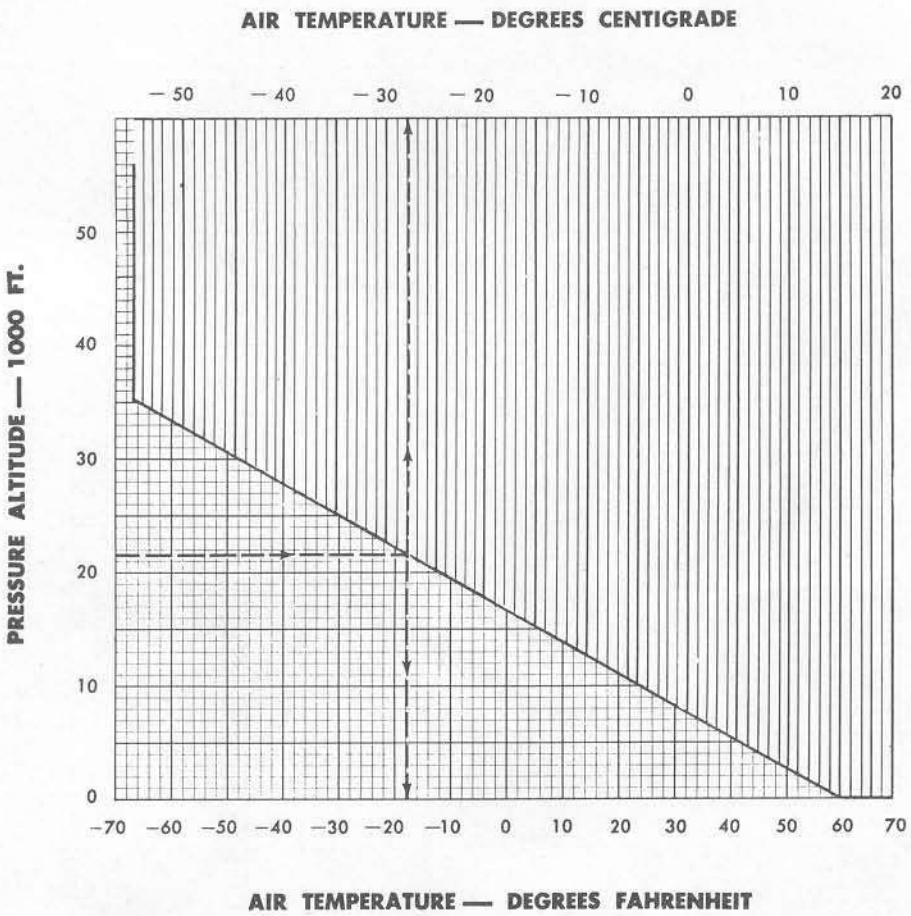
REMARKS:

DATE: DECEMBER 1952
DATA BASIS: CALCULATED

Figure A-135.

TEMPERATURE ON NACA STANDARD DAY

MODEL: ENGINES:



CONDITIONS:

REMARKS:

DATE:

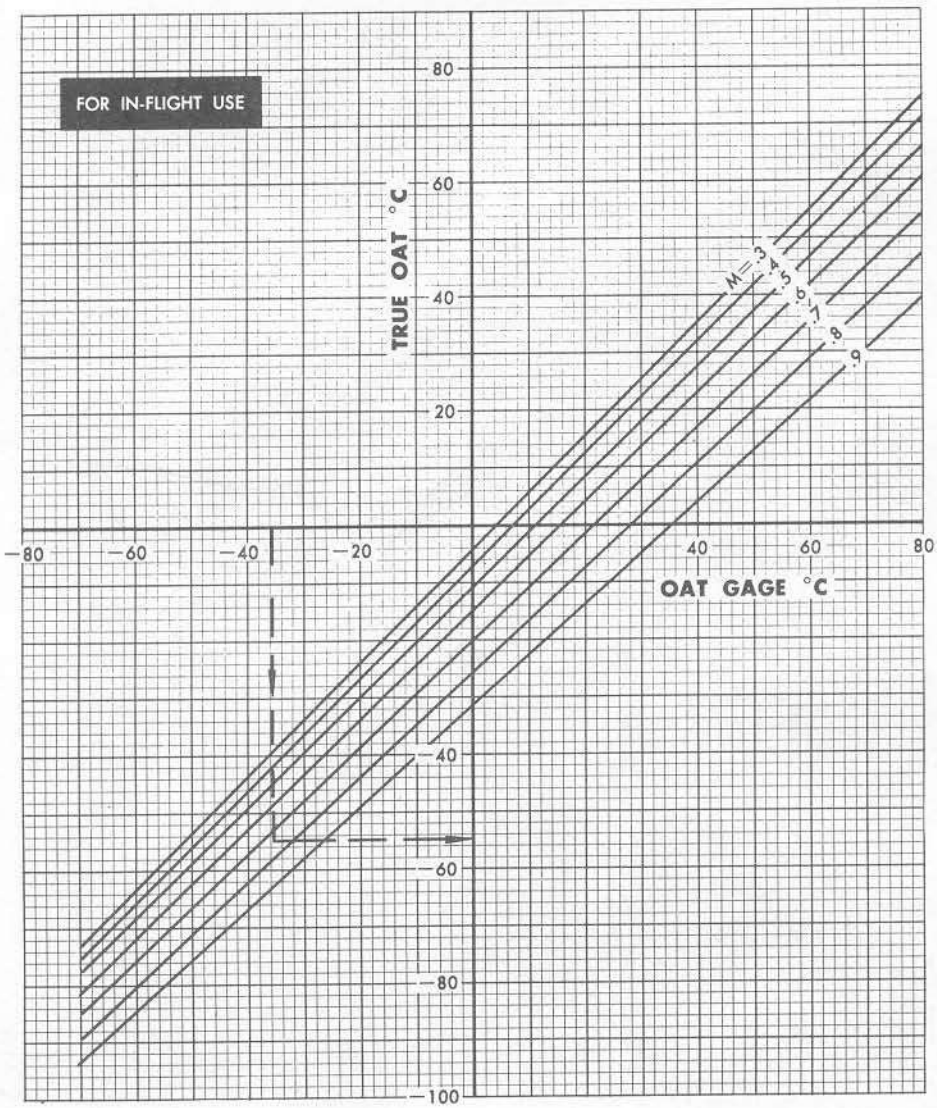
DATA BASIS: NACA

Figure A-136.

OAT GAGE VS OAT TRUE

MODEL:

ENGINES:



CONDITIONS:

REMARKS: 90% RAM RECOVERY FACTOR

DATE: MAY 1953
DATA BASIS: CALCULATED

Figure A-137.

ALPHABETICAL INDEX

*Denotes illustration or chart.

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