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NAVAIR 01-40NK-1

NATOPS
Flight Manual

NAVY MODEL
C-117D
AIRCRAFT

ISSUED BY AUTHORITY OF THE CHIEF OF NAVAL OPERATIONS
AND UNDER THE DIRECTION OF THE COMMANDER,
NAVAL AIR SYSTEMS COMMAND

1 November 1967
Changed 15 November 1971

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DEPARTMENT OF DEFENSE UNITED STATES OF AMERICA

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
WASHINGTON, D.C. -20350

LETTER OF PROMULGATION

1. The Naval Air Training and Operating Procedures Standardization Program (NATOPS) is a positive approach towards improving combat readiness and achieving a substantial reduction in the aircraft accident rate. Standardization, based on professional knowledge and experience, provides the basis for development of an efficient and sound operational procedure. The standardization program is not planned to stifle individual initiative but rather, to aid the Commanding Officer in increasing his unit's combat potential without reducing his command prestige or responsibility.

2. This manual standardizes ground and flight procedures but does not include tactical doctrine. Compliance with the stipulated manual procedure is mandatory except as authorized herein. In order to remain effective, NATOPS must be dynamic and stimulate rather than suppress individual thinking. Since aviation is a continuing progressive profession, it is both desirable and necessary that new ideas and new techniques be expeditiously evaluated and incorporated if proven to be sound. To this end Type/Fleet/Air Group/Air Wing/Squadron Commanders and subordinates are obligated, authorized and directed to modify procedures contained herein, in accordance with OPNAV Instruction 3510.9 series and applicable directives, for the purpose of assessing new ideas, in a practical way, prior to initiating recommendations for permanent changes. This manual is prepared and kept current by the users in order to achieve maximum readiness and safety in the most efficient and economical manner. Should conflict exist between the training and operating procedures found in this manual and those found in other publications, this manual will govern.

3. Checklists and other pertinent extracts from this publication necessary to normal operations and training should be made and may be carried in Naval Aircraft for use therein. It is forbidden to make copies of this entire publication or major portions thereof without specific authority of the Chief of Naval Operations.

Thomas F. Connolly

THOMAS F. CONNOLLY
Vice Admiral, USN
Deputy Chief of Naval Operations (Air)

INTERIM CHANGE SUMMARY

The following Interim Changes have been canceled or previously incorporated in this manual:

INTERIM CHANGE NUMBER(S)	REMARKS/PURPOSE
1 through 14	

The following Interim Changes have been incorporated in this Change/Revision:

INTERIM CHANGE NUMBER	REMARKS/PURPOSE
15	Handling Procedures for Mark 24 Mod 2A/3 Flares.
16	Corrects error in Figure 1-9, Fuel System.

Interim Changes Outstanding - To be maintained by the custodian of this manual:

INTERIM CHANGE NUMBER	ORIGINATOR/DATE (or DATE/TIME GROUP)	PAGES AFFECTED	REMARKS/PURPOSE

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FOREWORD

SCOPE

The NATOPS Flight Manual is issued by the authority of the Chief of Naval Operations and under the direction of Commander, Naval Air Systems Command in conjunction with the Naval Air Training and Operating Procedures Standardization (NATOPS) Program. This manual contains information on all aircraft systems, performance data, and operating procedures required for safe and effective operations. However, it is not a substitute for sound judgement. Compound emergencies, available facilities, adverse weather or terrain, or considerations affecting the lives and property of others may require modification of the procedures contained herein. Read this manual from cover to cover. It's your responsibility to have a complete knowledge of its contents.

APPLICABLE PUBLICATIONS

The following applicable publications complement this manual:

NAVAIR 01-40NK-1C (card checklist)

NAVAIR 01-40NK-1-6 (functional checkflight checklist)

HOW TO GET COPIES

AUTOMATIC DISTRIBUTION

To receive future changes and revisions to this manual or any other NAVAIR aeronautical publication automatically, a unit must be established on an automatic distribution list maintained by the Naval Air Technical Services Facility (NATSF). To become established on the list or to change existing NAVAIR publication requirements, a unit must submit a Mailing List Request for Aeronautic Technical Publications (NAVAIR Form 5605/3, Part II), to NATSF, 700 Robbins Ave., Philadelphia, Pa. 19111, listing requirements or changes thereto in accordance with the instructions contained on the request form. For additional information, refer to NAVAIRINST 5605.4 series and NAVSUP Publication 2002, Section VIII, Part C.

ADDITIONAL COPIES

Additional copies of this manual and changes thereto may be procured by submitting DD Form 1348 to Naval Publications and Forms Center, Philadelphia in accordance with NAVSUP Publication 2002, Section VIII, Part C.

UPDATING THE MANUAL

To ensure that the manual contains the latest procedures and information, NATOPS review conferences are held in accordance with OPNAVINST 3510.11 series.

CHANGE RECOMMENDATIONS

Recommended changes to this manual or other NATOPS publications may be submitted by anyone in accordance with OPNAVINST 3510.9 series.

Routine change recommendations are submitted directly to the Model Manager on OPNAV Form 3500-22 shown on the next page. The address of the Model Manager of this aircraft is:

Commanding Officer
Naval Air Station
Norfolk, Virginia 23511
Attn: C-117 NATOPS Evaluator

Change recommendations of an URGENT nature (safety of flight, etc.,) should be submitted directly to the NATOPS Advisory Group Member in the chain of command by priority message.

YOUR RESPONSIBILITY

NATOPS Flight Manuals are kept current through an active manual change program. Any corrections, additions, or constructive suggestions for improvement of its content should be submitted by routine or urgent change recommendation, as appropriate, at once.

NATOPS FLIGHT MANUAL INTERIM CHANGES

Flight Manual Interim Changes are changes or corrections to the NATOPS Flight Manuals promulgated by CNO or NAVAIRSYSCOM. Interim Changes are issued either as printed pages, or as a naval message. The Interim Change Summary page is provided as a record of all interim changes. Upon receipt of a change or revision, the custodian of the manual should check the updated Interim Change Summary to ascertain that all outstanding interim changes have been either incorporated or canceled; those not incorporated shall be recorded as outstanding in the section provided.

NATOPS/TACTICAL CHANGE RECOMMENDATION
OPNAV FORM 3500/22 (5-69) 0107-722-2002

DATE

TO BE FILLED IN BY ORIGINATOR AND FORWARDED TO MODEL MANAGER

FROM (originator)	Unit
TO (Model Manager)	Unit

Complete Name of Manual/Checklist	Revision Date	Change Date	Section/Chapter	Page	Paragraph

Recommendation (be specific)

☐ CHECK IF CONTINUED ON BACK

Justification

Signature	Rank	Title

Address of Unit or Command

TO BE FILLED IN BY MODEL MANAGER *(Return to Originator)*

FROM	DATE

TO

REFERENCE
(a) Your Change Recommendation Dated ____________

☐ Your change recommendation dated ____________ is acknowledged. It will be held for action of the review conference planned for ____________ to be held at ____________.

☐ Your change recommendation is reclassified URGENT and forwarded for approval to ____________ ____________ by my DTG ____________.

/S/ ____________ MODEL MANAGER. ____________ AIRCRAFT

CHANGE SYMBOLS

Revised text is indicated by a black vertical line in either margin of the page, adjacent to the affected text, like the one printed next to this paragraph. The change symbol identifies the addition of either new information, a changed procedure, the correction of an error, or a rephrasing of the previous material.

WARNINGS, CAUTIONS, AND NOTES

The following definitions apply to "WARNINGS", "CAUTIONS", and "NOTES" found through the manual.

WARNING

An operating procedure, practice, or condition, etc., which may result in injury or death, if not carefully observed or followed.

CAUTION

An operating procedure, practice, or condition, etc., which may result in damage to equipment, if not carefully observed or followed.

Note

An operating procedure, practice, or condition, etc., which is essential to emphasize.

WORDING

The concept of word usage and intended meaning which has been adhered to in preparing this Manual is as follows:

"Shall" has been used only when application of a procedure is mandatory.

"Should" has been used only when application of a procedure is recommended.

"May" and "need not" have been used only when application of a procedure is optional.

"Will" has been used only to indicate futurity, never to indicate any degree of requirement for application of a procedure.

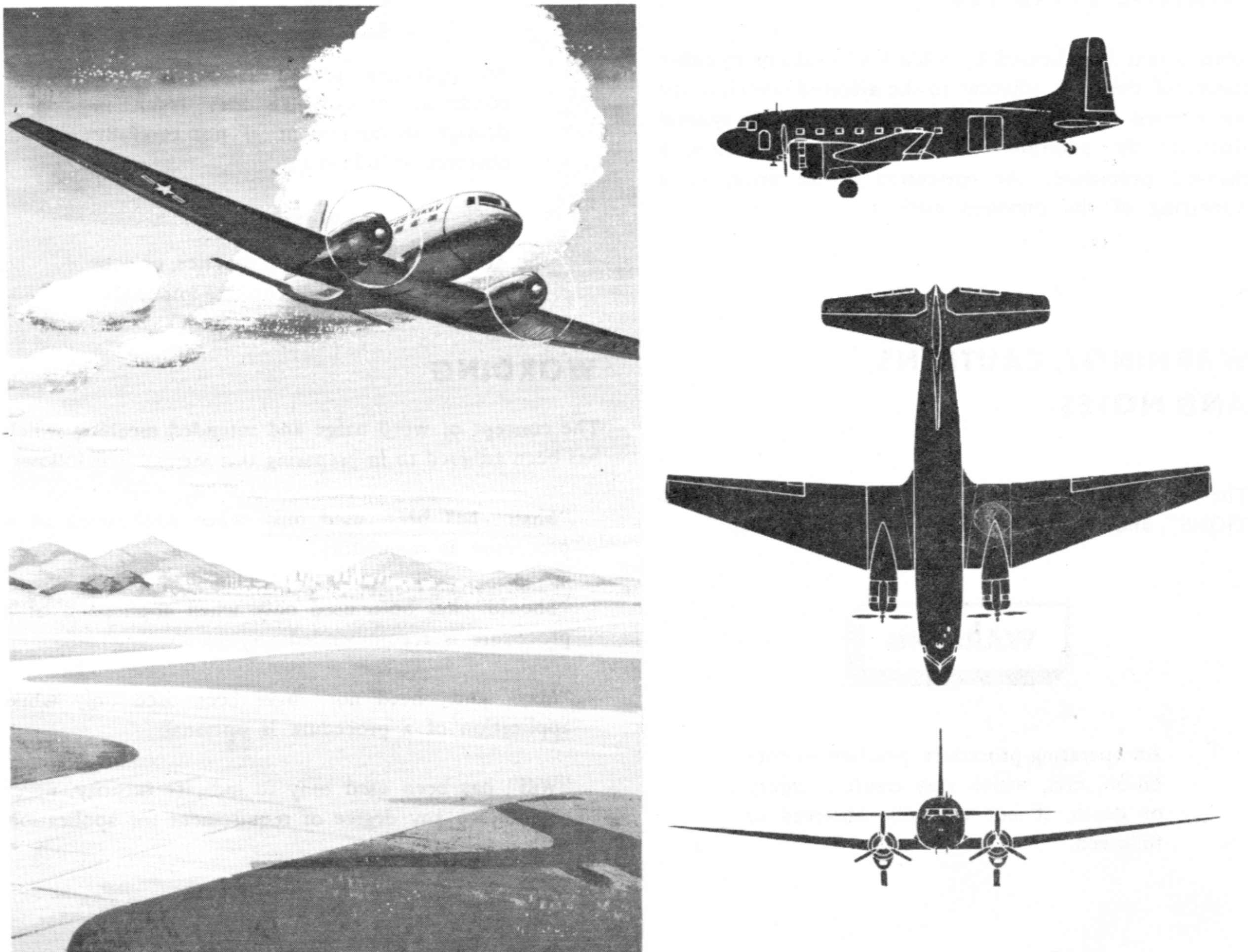

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Figure 1-1. The Aircraft

SECTION I

THE AIRCRAFT

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PART 1

GENERAL DESCRIPTION

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THE AIRCRAFT

The C-117D aircraft (figure 1-1), manufactured by Douglas Aircraft Co., is a medium-range, low-wing land aircraft, and is designed for use as a diversified cargo, personnel, or ambulance transport.

AIRCRAFT DIMENSIONS

The principal dimensions of the aircraft are:

Wing span	90 feet
Length (overall)	67 feet 8.5 in.
Height	18 feet 3 in.
Stabilizer span	38 feet

INTERIOR ARRANGEMENT

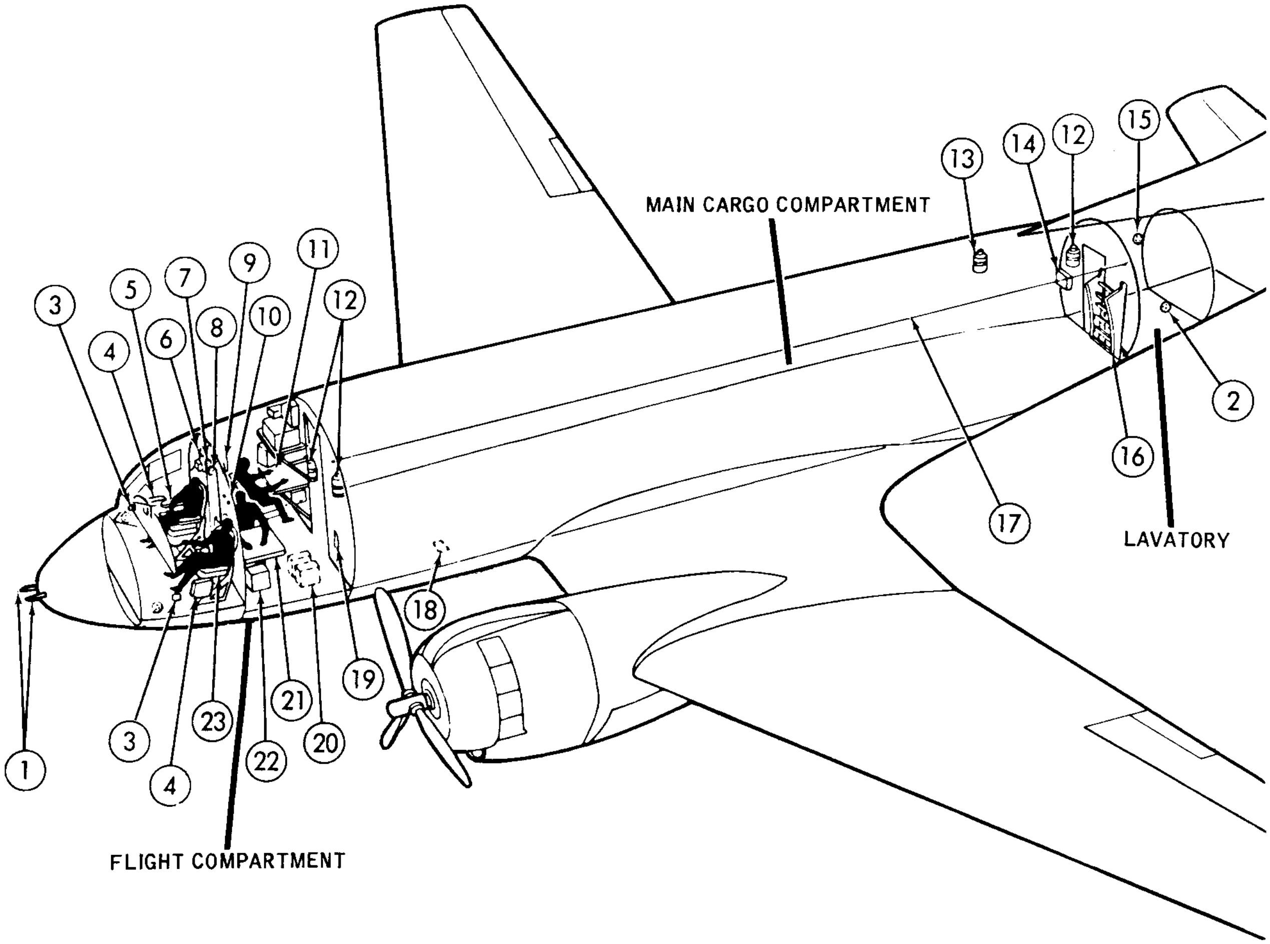
Standard C-117D aircraft are designed to be used as either personnel transports, cargo carriers or ambulance transports and can be quickly converted from one configuration to another. As a personnel transport, the aircraft has a capacity of 35 fully equipped combat troops. As a cargo carrier, the capacity is determined by the maximum structural floor capacity of 125 pounds per square foot (or a maximum of 250 pounds per square foot for a limited area). As an ambulance transport, the capacity is 27 litters and 2 attendants.

VC-117D aircraft are designed as staff transports, with a capacity of 16 passengers and 2 attendants.

TC-117D aircraft are designed as navigation trainers and can accommodate a maximum of eight students.

FLIGHT CREW

Accommodations are provided for a crew of four: pilot, copilot, radio operator, and navigator. (See figure 1-2.)



1. PITOT TUBES
2. MAIN STATIC ORIFICE
3. AIRCRAFT CHECKLIST HOLDER
4. AIRCRAFT DATA CASE
5. COPILOT'S STATION
6. HYDRAULIC RESERVOIR
7. AIRCRAFT IDENTIFICATION PLATE
8. COCKPIT ANTIGLARE CURTAIN
9. LOAD ADJUSTER
10. LANDING GEAR WARNING HORN
11. RADIO OPERATOR'S STATION
12. MAIN CABIN WATER SUPPLY
13. WATER SUPPLY TANK
14. STOWAGE -- CARGO TIEDOWN RINGS, LANDING GEAR SAFETY PINS, AND TAILWHEEL SAFETY LATCH
15. ALTERNATE STATIC ORIFICE
16. STOWAGE -- CABIN STEP
17. PARACHUTE STATIC LINE
18. EXTERNAL POWER RECEPTACLE
19. SNATCH BLOCK ATTACHING RING
20. BATTERY INSTALLATION
21. NAVIGATOR'S STATION
22. SEXTANT STOWAGE
23. PILOT'S STATION

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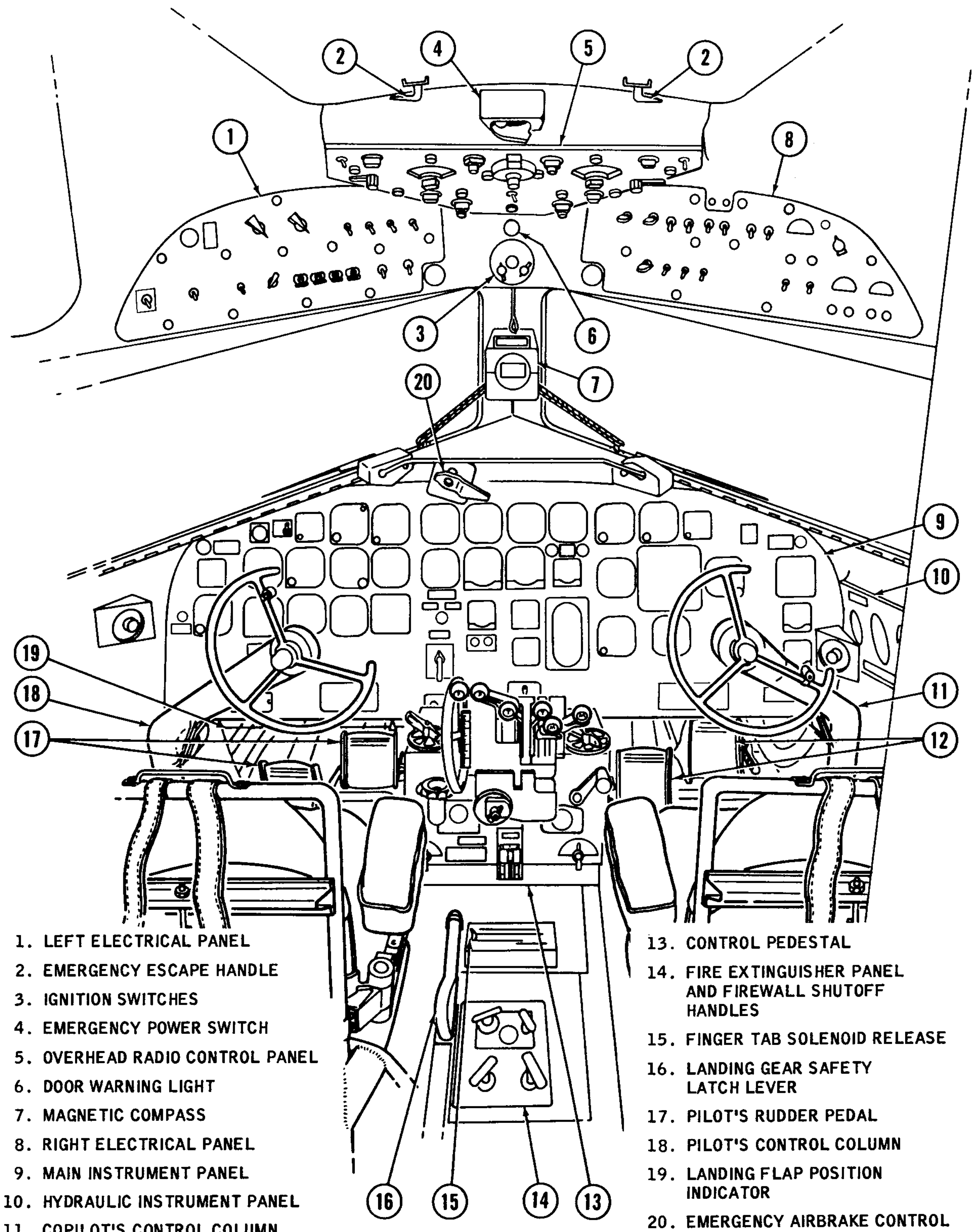
Figure 1-2. General Arrangement



1. LEFT ELECTRICAL PANEL
2. EMERGENCY ESCAPE HANDLE
3. IGNITION SWITCHES
4. EMERGENCY POWER SWITCH
5. OVERHEAD RADIO CONTROL PANEL
6. DOOR WARNING LIGHT
7. MAGNETIC COMPASS
8. RIGHT ELECTRICAL PANEL
9. MAIN INSTRUMENT PANEL
10. HYDRAULIC INSTRUMENT PANEL
11. COPILOT'S CONTROL COLUMN
12. COPILOT'S RUDDER PEDAL
13. CONTROL PEDESTAL
14. FIRE EXTINGUISHER PANEL AND FIREWALL SHUTOFF HANDLES
15. FINGER TAB SOLENOID RELEASE
16. LANDING GEAR SAFETY LATCH LEVER
17. PILOT'S RUDDER PEDAL
18. PILOT'S CONTROL COLUMN
19. LANDING FLAP POSITION INDICATOR
20. EMERGENCY AIRBRAKE CONTROL LEVER

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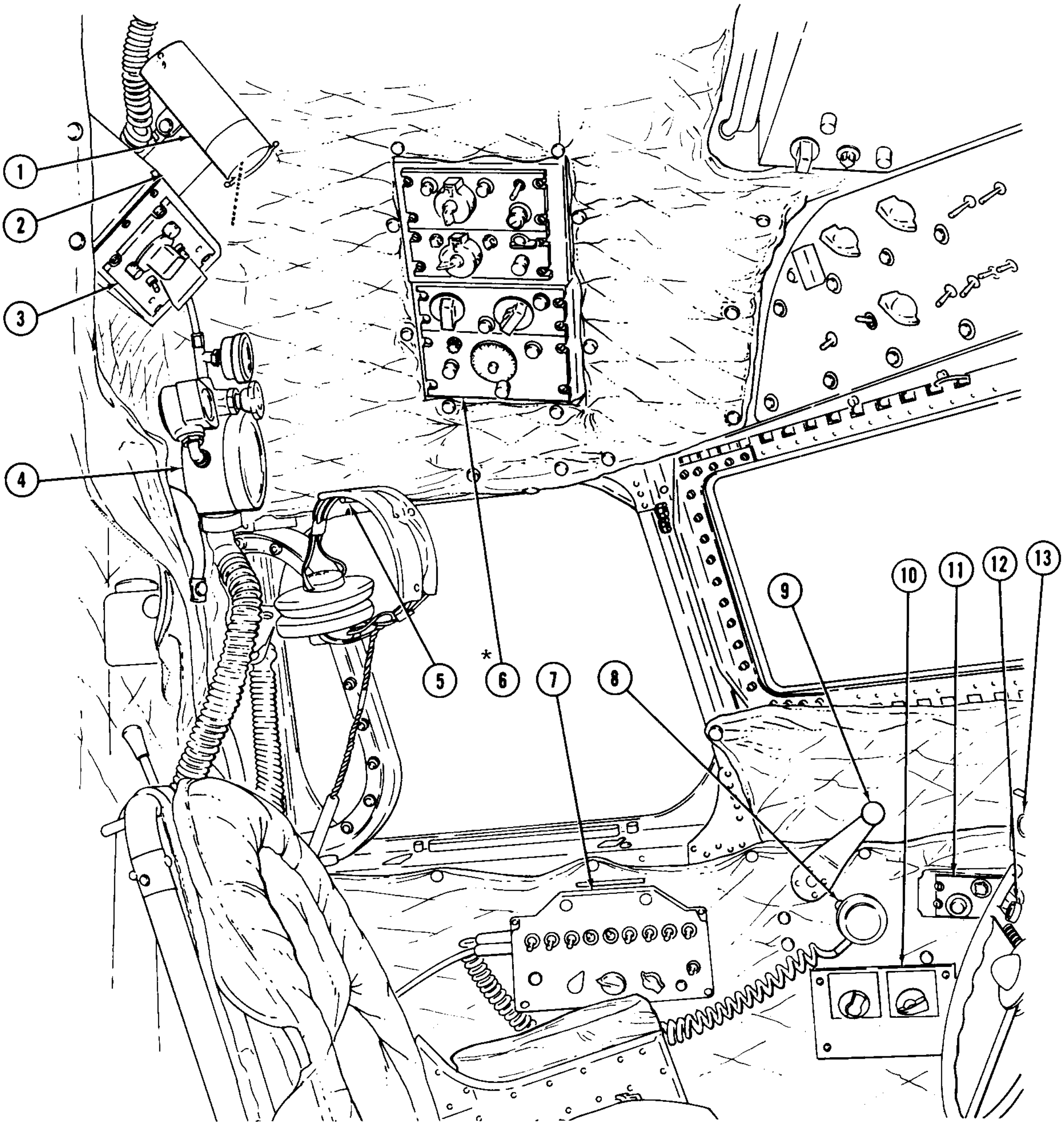
Figure 1-3. Cockpit Arrangement



1. COCKPIT SIDE LIGHT
2. WARNING HORN
3. IFF CONTROL
4. OXYGEN REGULATOR
5. HEADPHONE HOOK
6. CONTROL PANELS (*VHF NAV, TACAN, VHF COMMUNICATION, LOW FREQUENCY NAVIGATION RECEIVER)
7. INTERPHONE CONTROL BOX
8. MICROPHONE
9. SIDE WINDOW OPENING LEVER
10. INSTRUMENT PANEL AND INSTRUMENT PANEL FLOOD-LIGHT RHEOSTATS
11. ARC-38A CONTROL
12. AUTOPILOT DISCONNECT SWITCH
13. COLD AIR OUTLET

* NO. 1 VOR INSTALLED ON SOME AIRCRAFT. REF ASC 152

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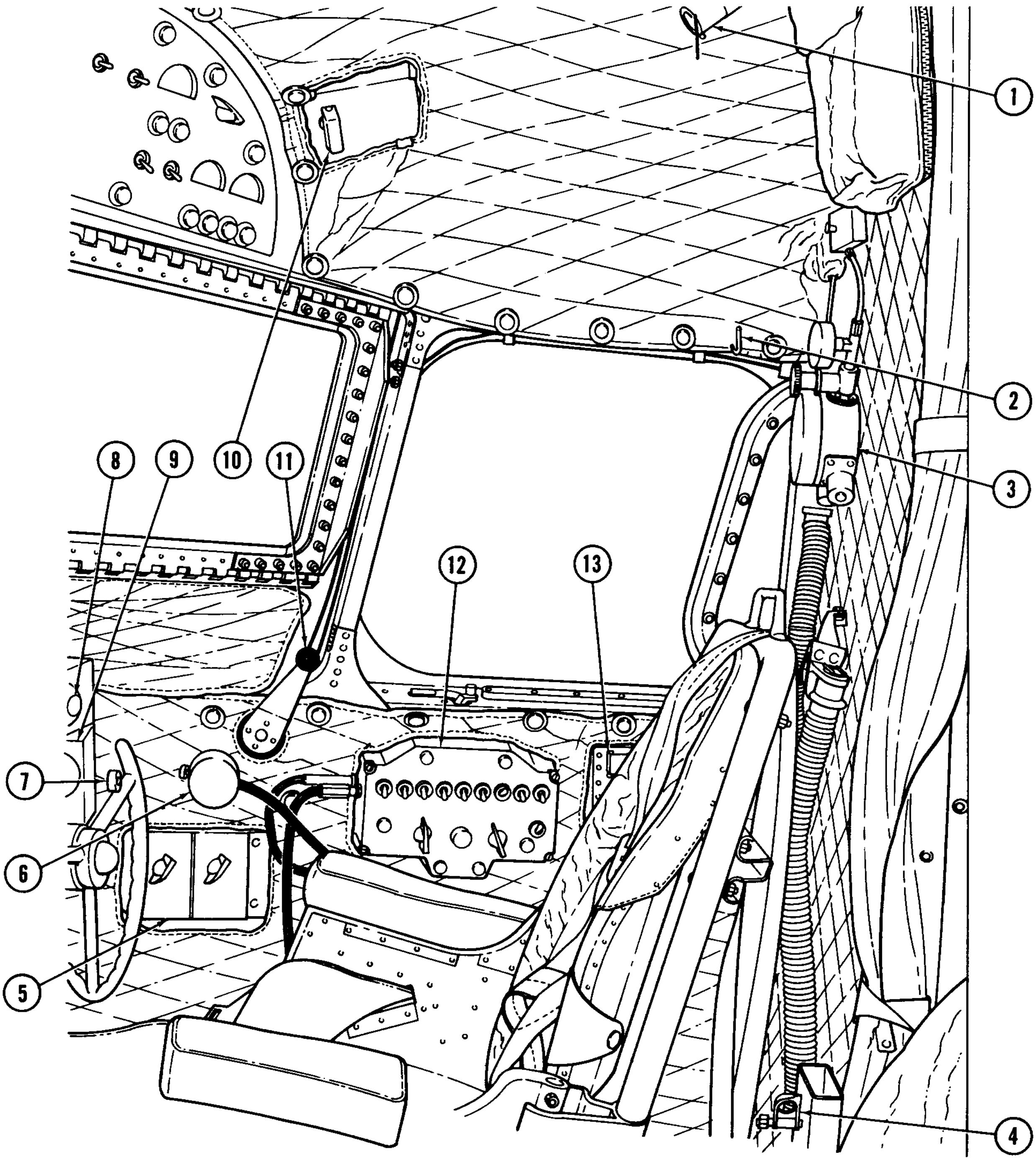
Figure 1-4. Pilot's Compartment – Left Side



1. COCKPIT SIDE LIGHT
2. HEADPHONE HOOK
3. OXYGEN REGULATOR
4. SURFACE DEICER SYSTEM CONTROL
5. INSTRUMENT PANEL AND INSTRUMENT PANEL FLOODLIGHT RHEOSTAT
6. MICROPHONE
7. AUTOPILOT DISCONNECT SWITCH
8. COLD AIR OUTLET
9. EMERGENCY AIR BRAKE PRESSURE GAGE
10. AC INTERLOCK OVERRIDE SWITCH
11. SIDE WINDOW OPENING LEVER
12. INTERPHONE CONTROL BOX
13. ALCOHOL DEICER CONTROL PANEL

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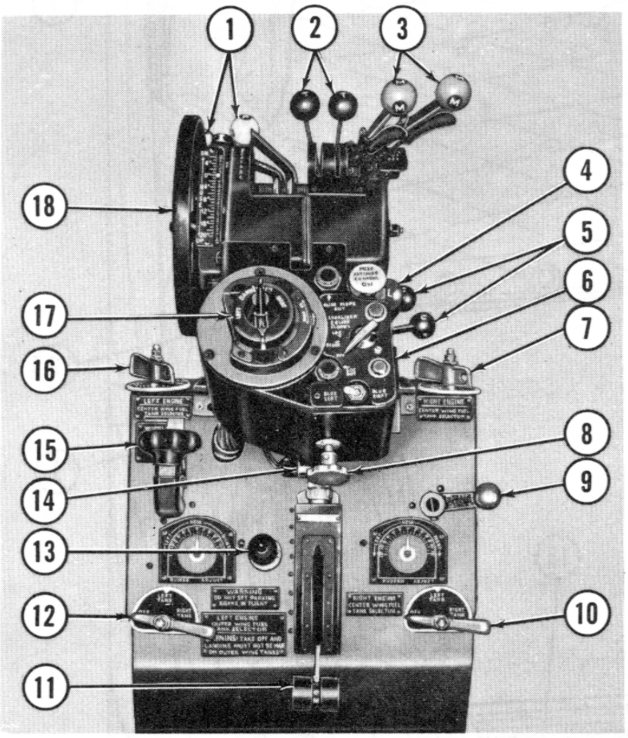
Figure 1-5. Pilot's Compartment – Right Side



1. PROPELLER CONTROL LEVERS
2. THROTTLE CONTROL LEVERS
3. MIXTURE CONTROL LEVERS
4. CARBURETOR AIR TEMPERATURE LOCK CONTROL LEVER
5. CARBURETOR AIR TEMPERATURE CONTROL LEVERS
6. AUTOMATIC APPROACH SELECTOR SWITCH
7. CENTER WING FUEL TANK SELECTOR - RIGHT ENGINE
8. THROTTLE FRICTION LOCK
9. AILERON TRIM TAB CONTROL CRANK
10. OUTER WING FUEL TANK SELECTOR - RIGHT ENGINE
11. AUTOPILOT MECHANICAL ENGAGING LEVER
12. OUTER WING FUEL TANK SELECTOR - LEFT ENGINE
13. PARKING BRAKE CONTROL LEVER
14. TAILWHEEL LOCK (ON TOP OF PEDESTAL SOME AIRCRAFT)
15. RUDDER TRIM TAB CONTROL KNOB
16. CENTER WING FUEL TANK SELECTOR - LEFT ENGINE
17. AUTOPILOT CONTROLLER
18. ELEVATOR TRIM TAB CONTROL WHEEL

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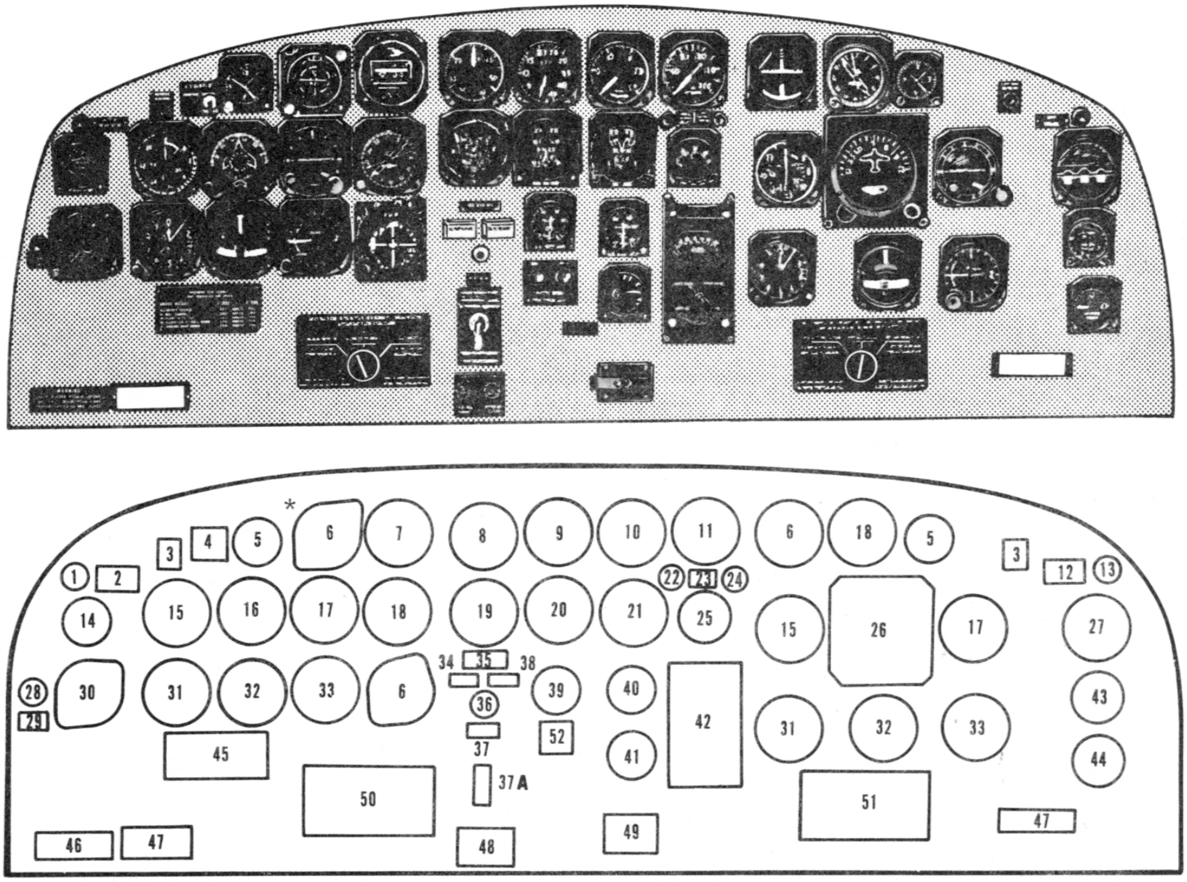
Figure 1-6. Control Pedestal



* THREE ON SOME AIRCRAFT; REF ASC 152

1. HEATER INOPERATIVE WARNING LIGHT
2. HEATER INOPERATIVE WARNING LIGHT PLACARD
3. INVERTER WARNING LIGHT (TWO)
4. G-2 COMPASS CONTROL
5. CLOCK (TWO)
*6. COURSE INDICATOR (TWO)
7. DME INDICATOR
8. MANIFOLD PRESSURE GAGE
9. TACHOMETER
10. FUEL PRESSURE GAGE
11. OIL PRESSURE GAGE
12. GEAR UNSAFE WARNING LIGHT PLACARD
13. GEAR UNSAFE WARNING LIGHT
14. HEATER TEMPERATURE GAGE
15. AIRSPEED INDICATOR (TWO)
16. MASTER DIRECTION INDICATOR
17. GYRO HORIZON INDICATOR (TWO)
18. RMI (ID-250)
19. CYLINDER TEMPERATURE INDICATOR
20. CARBURETOR AIR TEMPERATURE INDICATOR
21. OIL TEMPERATURE INDICATOR
22. FUEL PRESSURE WARNING LIGHT
23. WARNING LIGHT PLACARD
24. OIL PRESSURE WARNING LIGHT
25. OUTSIDE AIR TEMPERATURE INDICATOR
26. DIRECTIONAL GYRO INDICATOR
27. LANDING GEAR POSITION INDICATOR
28. LOW LIMIT WARNING LIGHT
29. LOW LIMIT WARNING LIGHT PLACARD
30. RADIO ALTIMETER
31. ALTIMETER (TWO)
32. TURN-AND-SLIP INDICATOR (TWO)
33. VERTICAL SPEED INDICATOR (TWO)
34. LEFT ENGINE FIRE WARNING LIGHT
35. FIRE WARNING LIGHT PLACARD
36. FIRE WARNING TEST SWITCH
37. TEST SWITCH PLACARD
37A. PILOT'S RMI SINGLE BAR SELECTOR
38. RIGHT ENGINE FIRE WARNING LIGHT
39. LEFT OUTER WING FUEL QUANTITY INDICATOR
40. RIGHT OUTER WING FUEL QUANTITY INDICATOR
41. ELEVATOR TRIM POSITION INDICATOR
42. CENTER WING FUEL QUANTITY INDICATOR
43. ALCOHOL QUANTITY INDICATOR
44. DEICER SYSTEM PRESSURE GAGE
45. AIRSPEED PLACARD
46. PLACARD
47. CARD HOLDER (TWO)
48. MANIFOLD PRESSURE PURGE VALVES
49. STATIC PRESSURE SELECTOR VALVE
50. PILOT'S RMI DOUBLE BAR SELECTOR
51. COPILOT'S RMI DOUBLE BAR SELECTOR
52. MAGNETIC CHIP DETECTORS

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Figure 1-7. Main Instrument Panel

PART 2

SYSTEMS

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ILLUSTRATIONS

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ENGINE

The aircraft is powered by two Wright Cyclone R1820-80A nine-cylinder, air cooled, radial engines. Each engine is equipped with a single-speed supercharger, a Bendix-Stromberg pressure-injection carburetor, and a direct-cranking starter. Ignition is furnished by two Bosch S9LU-2 magnetos.

THROTTLES

Two conventionally operated throttle levers are mounted on the control pedestal (figure 1-6). A throttle friction lock, located just below the autopilot controller, is rotated clockwise to increase friction (figure 1-6). The throttles have a range through the following positions:

OPEN (Forward)

CLOSE (Aft)

MIXTURE CONTROLS

Two mechanical mixture control levers are mounted on the control pedestal (figure 1-6). Each control lever has a detent lock which enables the control to be locked in the IDLE CUTOFF, AUTO LEAN, or AUTO RICH positions.

CARBURETOR AIR TEMPERATURE CONTROLS

Two mechanical carburetor air temperature control levers are mounted on the right side of the control pedestal (figure 1-6). The positions are marked COLD and HOT, with intermediate positions available. A lock lever holds the controls in the desired position (figure 1-6). As either control is moved toward the HOT position, a door in the respective engine air induction system moves to cut off part of the ram air supply, replacing it with heated air from around the engine.

ENGINE INSTRUMENTS

All engine instruments are dual-indicating instruments (figure 1-7). A direct-reading manifold pressure gage on the pilot's main instrument panel indicates the pressure in inches Hg in each engine intake manifold; with the engines inoperative, the gage readings should correspond to barometric pressure. A carburetor air temperature gage, an oil temperature gage, and a cylinder head temperature gage, all calibrated in degrees centigrade, are mounted on the main instrument panel. An oil pressure gage mounted on the main instrument panel indicates pressure (in pounds per square inch) taken from the pressure side of each engine-driven pump.

MANIFOLD PRESSURE PURGE VALVES

Two push-type purge valves are mounted below the left center section of the main instrument panel (figure 1-7) for use in purging or clearing the manifold pressure indicator supply lines of moisture. The lines should be purged prior to the first daily flight with the manifold pressure less than barometric pressure; otherwise, the lines will fill rather than purge. The manifold pressure lines can be purged in flight, provided that manifold pressure is less than barometric pressure at flight altitude.

COWL FLAPS

Two 4-position cowl flap switches are located on the left electrical control panel and have the following positions: OPEN, CLOSE, OFF, and CLIMB (figure 1-11).

CLIMB ↑	(Cowl flaps 6 degrees open)
OFF	(Actuator motor inoperative)
↙ ↘ OPEN CLOSE	(Manual control of actuator)

When the switches are left in the OPEN or CLOSE position, the cowl flaps will move to the full extreme of travel. Momentary movement of either switch to the OPEN or CLOSE position will result in relatively slight travel of the cowl flaps toward the desired position. When the switches are released to the OFF position, the flaps will be held at the position existing.

NOTE

> On the ground, approximately 20 seconds are required for the flaps to travel through their full range from OPEN to CLOSE.

IGNITION

Two ignition switches are located above the center of the windshields (figure 1-3). Each switch is marked OFF, L, R, and BOTH. A knob marked PULL OFF is used to turn off the ignition system to both engines in case of emergency.

PRIMER

One spring-loaded priming switch is mounted on the right electrical panel (figure 1-12). The priming system functions as an aid in starting the engines by injecting fuel into the carburetor. During priming, sufficient fuel pressure is supplied by operation of the fuel booster pumps.

STARTING SYSTEM

ENGINE STARTER SELECTOR SWITCH

An engine starter selector switch is mounted on the right electrical panel (figure 1-12) for use in selecting the engine to be started. Positions of the switch are marked LH ENG, OFF, RH ENG. The selector switch must be out of the OFF position before the starter or primer switches will operate.

STARTER SAFETY SWITCH

A spring-loaded starter safety switch, mounted on the right electrical panel (figure 1-12), is provided to prevent inadvertent operation of the starter, and must be depressed before the starter switch will function.

STARTER SWITCH

A spring-loaded starter switch is mounted on the right electrical panel (figure 1-12) for energizing the starter. The engine starter selector switch must be out of the OFF position and the starter safety switch must be depressed before the starter will function.

PROPELLER

Each engine is equipped with a Hamilton Standard hydromatic, full-feathering propeller. Constant propeller speeds are maintained by a governor, which changes the propeller pitch by metering the flow of oil from the engine oil system to the propeller pitch-change mechanism. The propeller controls consist of two individual rpm control levers and two individual propeller feathering buttons.

PROPELLER RPM CONTROL LEVERS

Propeller rpm is controlled mechanically by the propeller rpm control levers located on the control pedestal (figure 1-6). Synchronized rpm is attained by moving the desired propeller rpm control lever toward INCREASE RPM or DECREASE RPM until the rpm is synchronized with the opposite propeller as indicated on the tachometer or by listening to propeller beats.

PROPELLER FEATHERING BUTTONS

Red pushbutton control switches, one located on each electrical panel, are provided for each propeller feathering system (figures 1-11 and 1-12). The desired button is pushed in to feather the propeller and will pop out automatically when the propeller is feathered. The button is pushed in for unfeathering and must be held in manually until the propeller is rotating; then the button is released.

CAUTION

If the feathering button remains in for more than 90 seconds after being depressed, it should be pulled out manually to prevent overheating of the feathering pump motor. If the button is pulled out manually, the propeller may not unfeather when the button is again depressed.

TACHOMETER

One dual indicating tachometer on the pilot's main instrument panel indicates the rpm of both engines and is calibrated in increments of 100 rpm (figure 1-7).

OIL SYSTEM

An independent oil system is provided for each engine (figure 1-8). Each engine is supplied from an engine oil tank through an emergency shutoff valve. Each tank has a usable capacity of 27 3/4 US gallons. Each system has an engine-driven pump, cooler, temperature regulator, and an oil dilution system. Engine oil is also utilized for propeller governing and feathering.

CAUTION

Oil tanks should be serviced prior to any flight. When oil level falls below 15 gallons on aircraft not incorporating C-47/C-117 AFC 151, foaming may occur causing fluctuating oil pressure which could result in engine failure.

OIL SYSTEM CONTROLS

OIL COOLER DOOR CONTROL SWITCHES. Each oil cooler door is electrically controlled, either automatically or manually, by a 4-position switch on the left electrical panel (figure 1-11). The switches are spring loaded in the OPEN and CLOSE positions, but will hold in the AUTO and OFF positions. The switches are normally placed in the AUTO position to provide automatic oil temperature control. The doors may, however, be opened or closed to manually control the temperature level by momentarily holding the respective switch in the OPEN or CLOSE position, repeating the operation until the desired temperature is attained. The switches have the following positions:

AUTO ↑	(Automatic control operation)
OFF	(Oil cooler door actuator inoperative)
↙ OPEN ↘ CLOSE	(Manual control operation)

NOTE

On the ground, approximately 8 seconds are required for the doors to travel from fully open to fully closed.

OIL DILUTION SWITCH. A three-position oil dilution switch labeled RIGHT, OFF, and LEFT is mounted on the right electrical panel (figure 1-12). The switch is spring loaded to the OFF position.

OIL SYSTEM EMERGENCY SHUTOFF VALVE CONTROL. A mechanically actuated oil system emergency shutoff valve is installed aft of each nacelle firewall to shut off the flow of oil through the firewall. The valve is controlled by the firewall shutoff handle (figure 1-3 and 1-21) for each respective engine. The oil supply for propeller feathering is not affected by this valve.

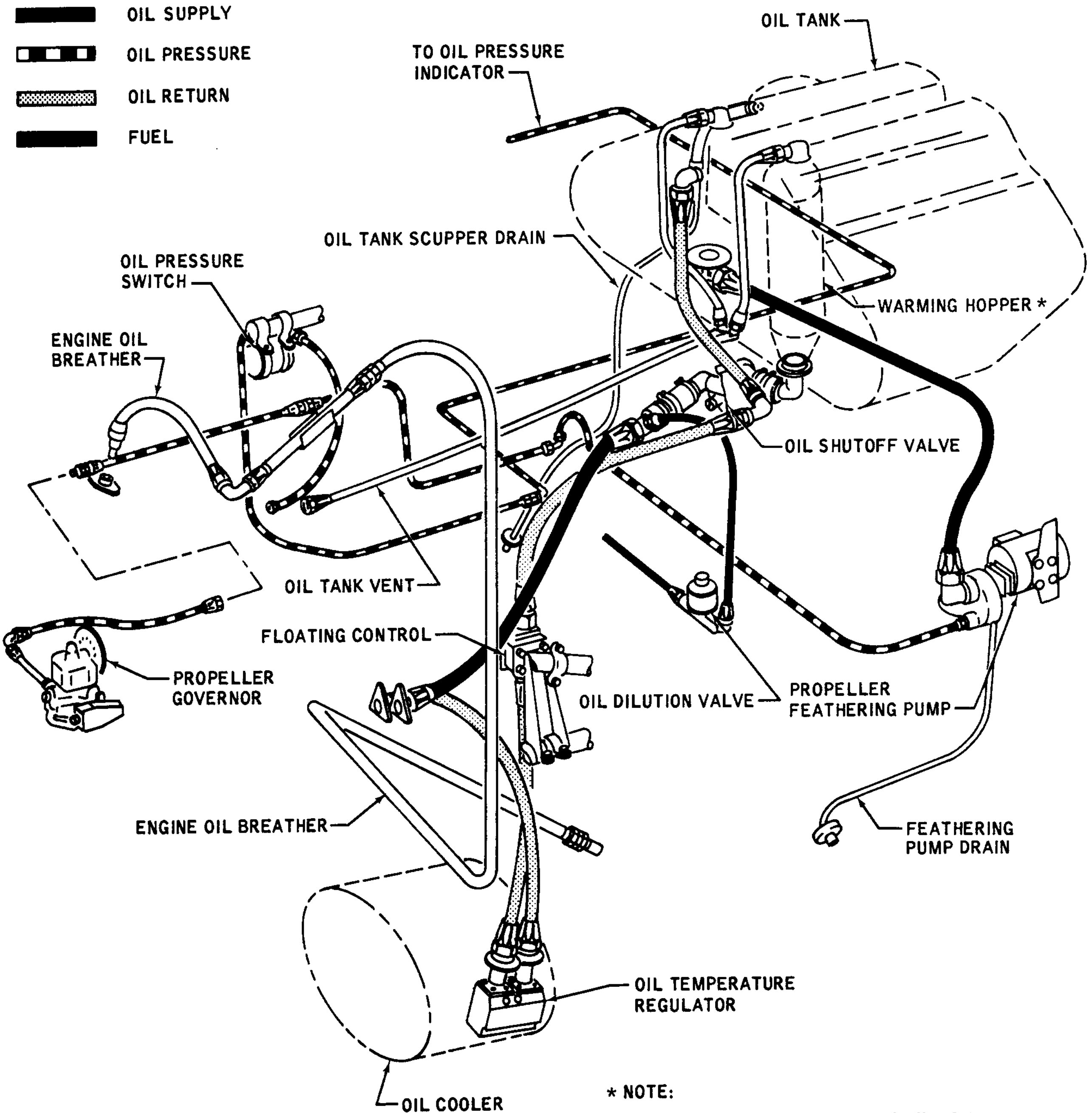
OIL PRESSURE INDICATOR. One direct reading, dual indicating oil pressure gage is mounted on the main instrument panel (figure 1-7). A red, push-to-test, oil pressure warning light is installed adjacent to the oil pressure gage.

OIL TEMPERATURE INDICATOR. A thermocouple actuated, dual indicating oil temperature indicator is mounted on the main instrument panel (figure 1-7). The instrument indicates engine inlet oil temperature in degrees centigrade.

MAGNETIC CHIP DETECTORS. A warning light for each engine is installed on the main instrument panel to warn of possible internal engine failure. The detectors are installed in the main oil sumps and supercharger housings and operate from 28-vdc power.

FUEL SYSTEM

The fuel system (figure 1-9) furnishes fuel for the engines, oil dilution, and the combustion heater. Fuel is contained in main, auxiliary, and outer wing tanks. A main and auxiliary tank is located on each side of the fuselage in the center wing section. Five, interconnected, bladder-type tanks are located in



* NOTE:

PRIOR TO INSTALLATION OF C-47/C-117 AIRFRAME CHANGE NO. 151. AIRFRAME CHANGE NO. 151 REMOVES AND REPLACES HOPPER ASSEMBLY WITH BAFFLE ASSEMBLY.

LEFT SIDE INSTALLATION
RIGHT SIDE SIMILAR

XX1-9

Figure 1-8. Oil System

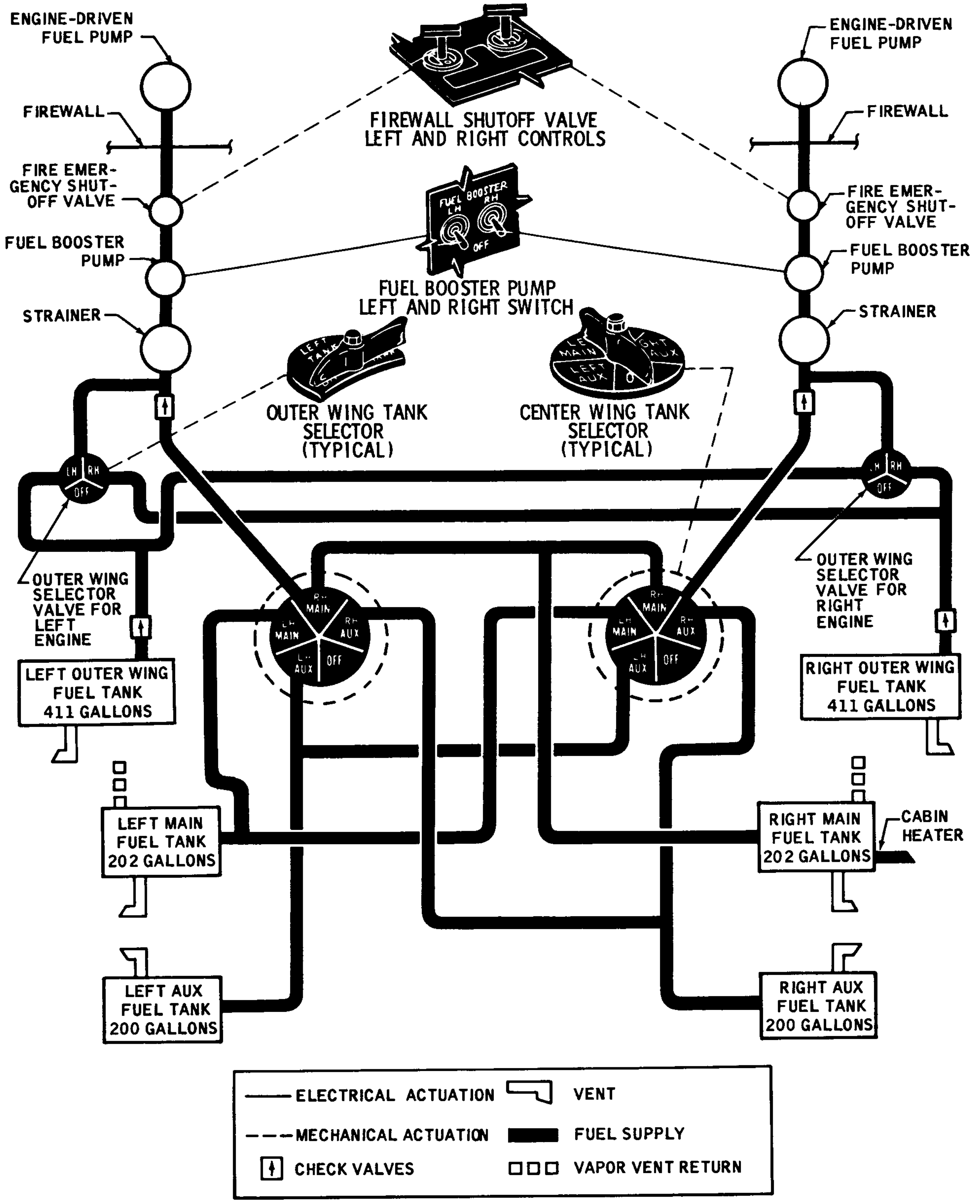


Figure 1-9. Fuel System

each outer wing. Fuel is managed by two 5-position tank selectors for the center wing tanks, and two 3-position selectors for the outer wing tanks. The system also includes two engine-driven fuel pumps, two electrically driven fuel booster pumps, fuel quantity indicators, a dual indicating pressure gage, and two fuel emergency shutoff valves. While fuel may be supplied to either engine from any of the tanks, the system is considered as consisting of two independent systems – one for each engine. All fuel tanks are vented overboard and are suitable for aromatic fuels. Each center wing main tank is connected to its respective engine carburetor by a vapor vent return line. (See Table 1-2 for fuel quantity and figure 1-44 for fuel grade.)

FUEL TANK SELECTOR VALVE CONTROLS

Four fuel tank selector valve controls are mounted on the control pedestal (figure 1-6). The center wing tank selectors are labeled OFF, RIGHT AUX, RIGHT MAIN, LEFT MAIN, and LEFT AUX. The outer wing tank selectors are labeled OFF, LEFT TANK, and RIGHT TANK. The selector valves permit fuel from any tank to be supplied to either engine.

FUEL BOOSTER PUMP SWITCHES

Two electrically driven, single-speed fuel booster pumps, one for each engine, are controlled by individual ON-OFF switches located on the right electrical panel (figure 1-12).

FUEL SYSTEM EMERGENCY SHUTOFF VALVE CONTROL

A mechanically actuated fuel emergency shutoff valve is installed aft of each nacelle firewall to shut off the flow of fuel through the firewall. The valves are controlled by the firewall shutoff handles (figure 1-3 and 1-21) for each respective engine.

FUEL SYSTEM MANAGEMENT

Transfer of fuel between tanks is not possible. For best control of cg, the main tanks should be filled first and then the auxiliary tanks. Fill the outer wing tanks last. The fuel must be loaded symmetrically and should be consumed symmetrically. Takeoff and climb should be made on the main tanks if full, so that the carburetor vent return flow to the main tanks will not cause them to overflow. If necessary, use the main tanks intermittently to maintain an adequate space for the return fuel.

WARNING

Do not takeoff or land using fuel from the outer wing tanks, and do not takeoff, climb, or land with both engines operating from one tank.

Figure 1-10 graphically shows the fuel flow and the control lever positions for various combinations of fuel system management.

Running fuel tanks dry is not recommended as a normal operating procedure. It is preferred to leave at least 20 gallons of fuel in each tank. Whenever an engine is being operated on a tank with less than 30 gallons remaining, it is important that the second engine be operated on another tank containing sufficient fuel to ensure continuous operation should the nearly empty tank run dry due to inaccurate gages. Close attention is required to prevent an air block from developing. Fluctuating fuel pressure is an indication that air is being drawn into the fuel system from the empty tank and an immediate change of fuel tanks is required to prevent complete power loss in that engine.

WARNING

If an air block is experienced in one engine, do not switch that engine to the fuel tank supplying fuel to the operating engine. Air could be introduced into the fuel system of the operable engine, causing it to lose power.

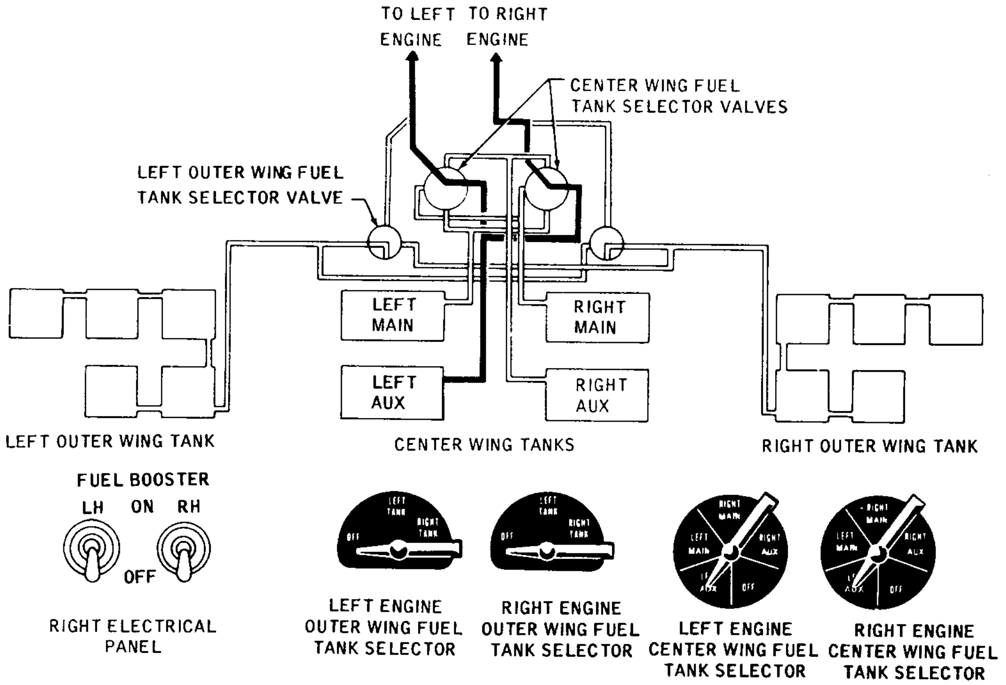
NOTE

If a power loss is experienced because of an air block, retard the throttle to prevent backfiring, surging, and over-speeding when power is regained. Select any fuel tank containing a sufficient amount of fuel except the one supplying the operating engine. Turn the boost pump ON to assist in regaining pressure.

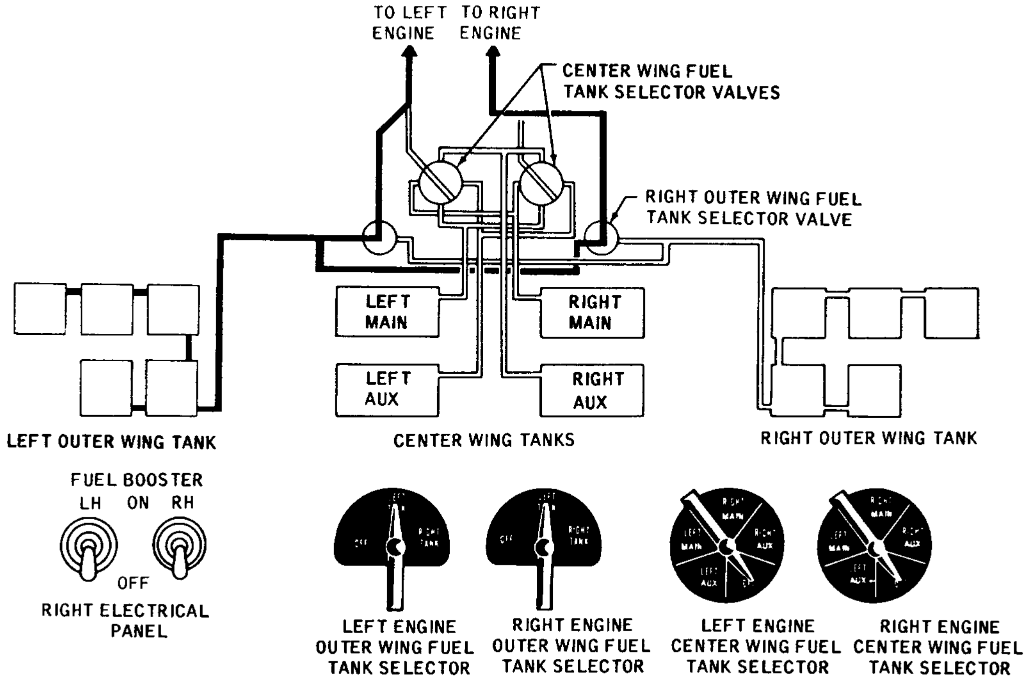
Refer to page 5-11 Emergency Procedures to regain an engine lost due to fuel starvation.

FUEL TANK SELECTION SEQUENCE

When leveled off and cruising, the outer wing tanks should be used first, then the aux tanks, and finally



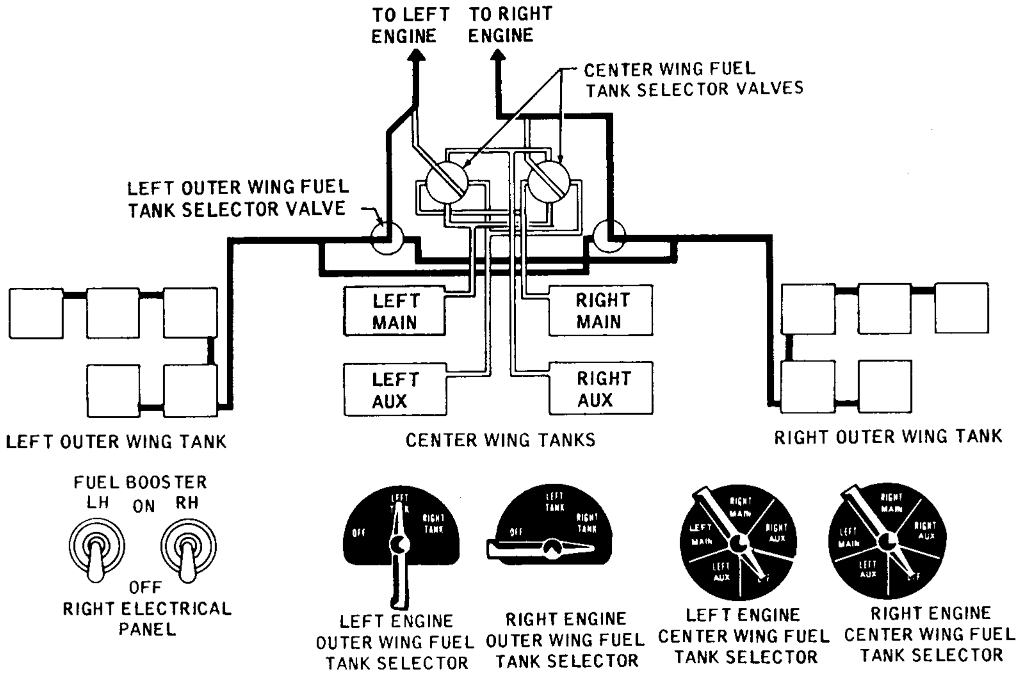
FUEL FROM LEFT AUX TANK TO BOTH ENGINES



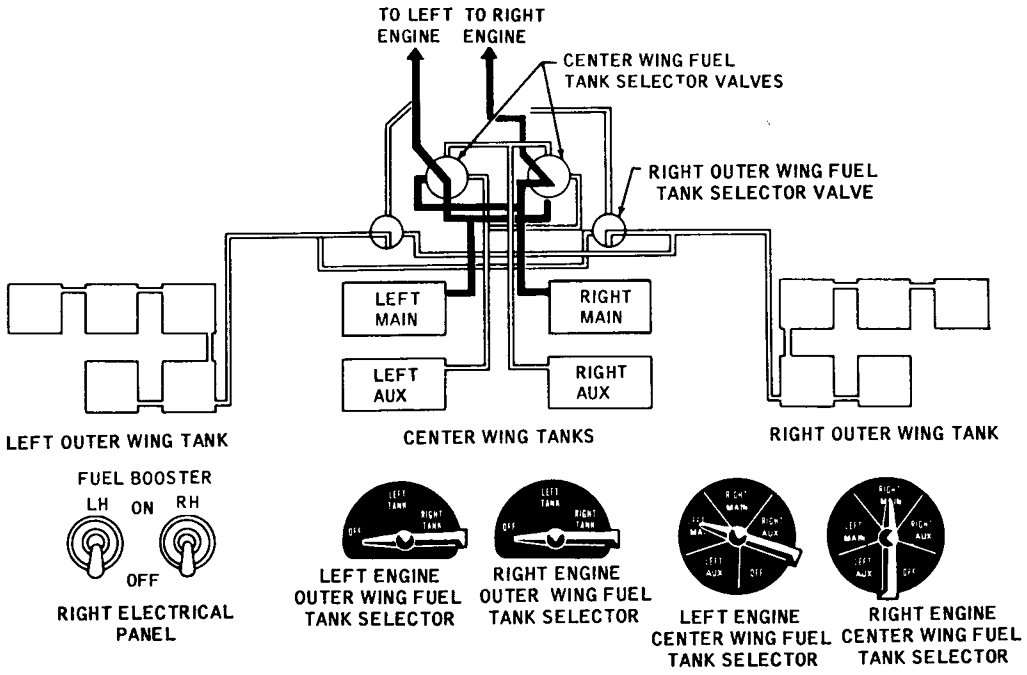
FUEL FROM LEFT OUTER WING TANK TO BOTH ENGINES

XX1-11

Figure 1-10. Fuel System Management (Sheet 1)



FUEL FROM LEFT OUTER WING TANK TO LEFT ENGINE;
FUEL FROM RIGHT OUTER WING TANK TO RIGHT ENGINE



TURN ON CENTER WING TANKS WITH GREATEST QUANTITY FOR
ALL GROUND MANEUVERING, TAKEOFFS, AND LANDINGS.
USE BOOSTER PUMPS AS NECESSARY TO MAINTAIN PRESSURE.

XX1-12

Figure 1-10. Fuel System Management (Sheet 2)

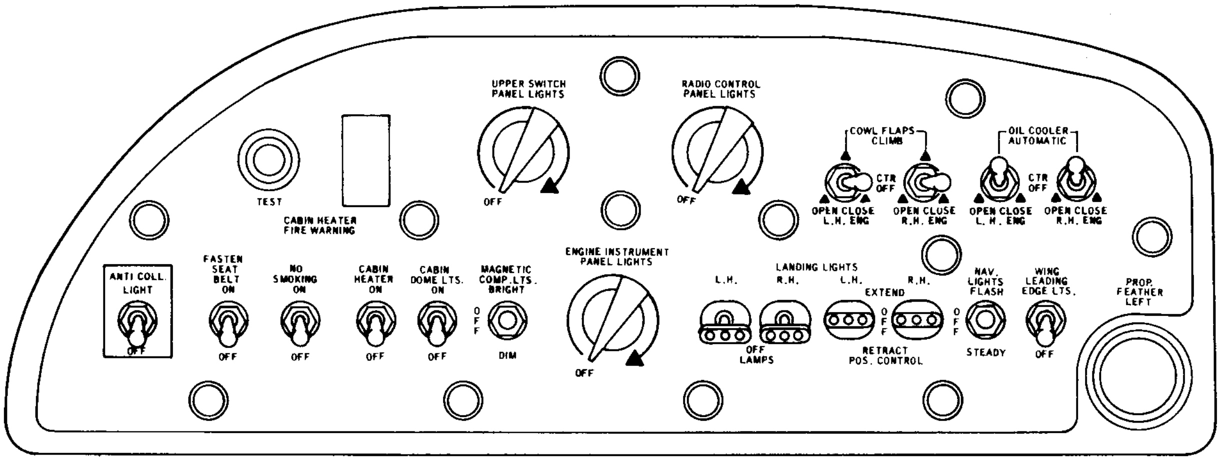


Figure 1-11. Left Electrical Panel

the main tanks. Main tanks are held to last to take advantage of any fuel returned from the carburetor vapor vent return.

GENERAL USE OF FUEL BOOSTER PUMPS

It is recommended that the fuel booster pumps be operated under the following conditions:

1. For engine start
2. For takeoff
3. During initial climb after takeoff until reaching cruising altitude
4. During climb
5. When selecting a new fuel supply
6. At any time the fuel pressure fluctuates within limits
7. All landings.

NOTE

When shutting off booster pumps in flight, always shut them off one at a time, and ensure that fuel pressure can be maintained by the engine driven pumps alone.

FUEL QUANTITY INDICATORS

A selector-type fuel quantity indicator for the four center wing tanks and a single fuel quantity indicator for each outer wing tank are mounted on the main instrument panel (figure 1-7). Fuel quantity is displayed in US gallons.

FUEL PRESSURE GAGE

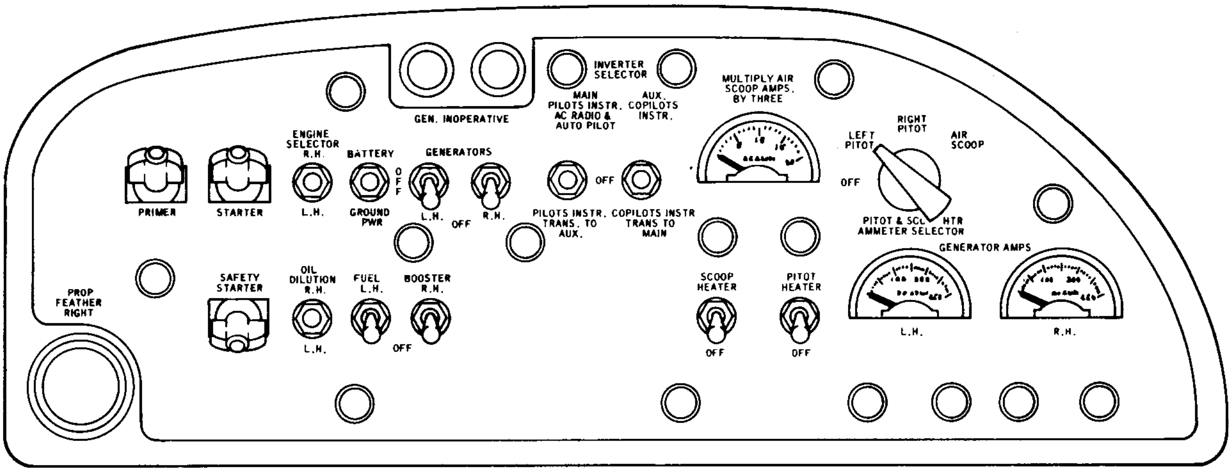
One dual-indicating fuel pressure gage is located on the main instrument panel (figure 1-7). One red push-to-test fuel pressure warning light is located adjacent to the fuel pressure gage.

VAPOR VENT RETURN SYSTEM

A vapor vent return line is connected between each carburetor and its respective main fuel tank. Each vent line returns approximately 10 gallons per hour (50 to 70 pounds). If the carburetor vapor vent system is malfunctioning, it is possible for each vent line to return approximately 50 gallons per hour.

ELECTRICAL POWER SUPPLY SYSTEM

The 24- to 28-volt electrical system (figure 1-13) is a single-wire type, in which the aircraft's structure



XX1-14

Figure 1-12. Right Electrical Panel

is used for the ground return. DC power is furnished either by two engine-driven generators connected in parallel or by two 12-volt aircraft batteries connected in series. Two inverters operated by the dc system supply 115-vac power. An external receptacle permits the use of power from an external source. Circuit protection is provided by fuses and circuit breakers (figure 1-14). An ac interlock switch (figure 1-13) automatically cuts off some of the electrical equipment when the aircraft is on the ground. This equipment can be ground checked by the use of an ac interlock override switch (figure 1-13). The heater-ground blower dc power is also automatically cut off when only one generator or the battery is the only source of dc power.

MASTER BATTERY SWITCH

A single three-position master battery switch, located on the right electrical panel (figure 1-12), connects either the aircraft's batteries or an external power supply to the main bus. The switch positions are BATTERY, OFF, and GROUND POWER. The OFF position, which is in the center, disconnects all ground and battery power from the main bus.

EMERGENCY POWER SWITCH

A guarded, two-position emergency power switch is mounted above the overhead radio control panel (figure 1-3). The switch positions are NORMAL and EMERGENCY. In the EMERGENCY position, the battery is disconnected from the main bus and the copilot's turn-and-slip indicator, the flight compartment flood lights, and the cockpit portable lights are connected directly to the battery in the event of electrical power failure at the main bus. The switch is guarded to the NORMAL position and protected by the master emergency power circuit breaker (figure 1-16).

GENERATOR SWITCHES

Each generator is connected to, and disconnected from, the main electrical bus system by an ON-OFF switch located on the right electrical panel (figure 1-12).

NOTE

> The generator blast tubes are closed when the emergency shutoff valve handles are pulled to the shutoff position.

EXTERNAL POWER RECEPTACLE

One three-pronged, polarized external power source receptacle is provided on the under surface of the

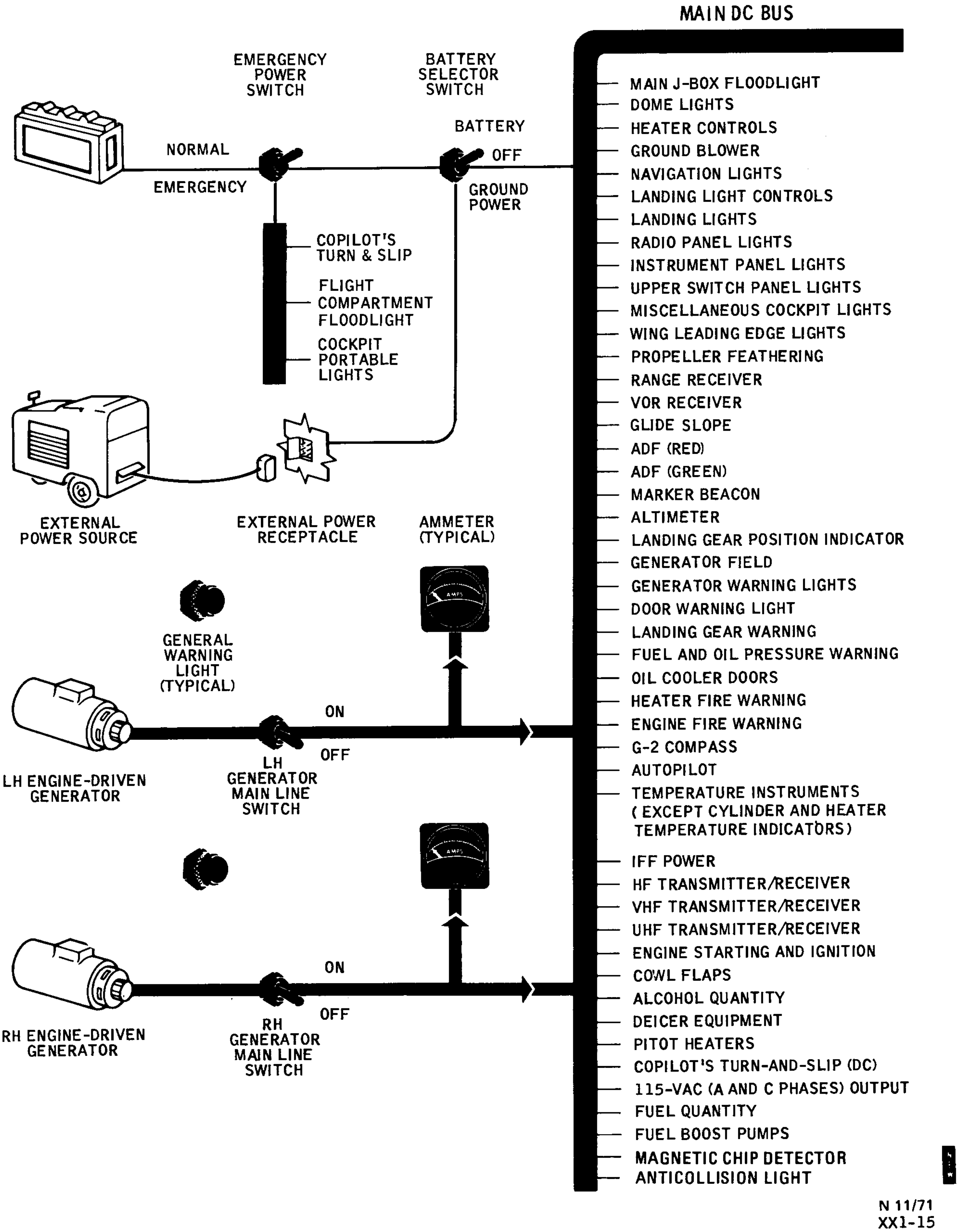
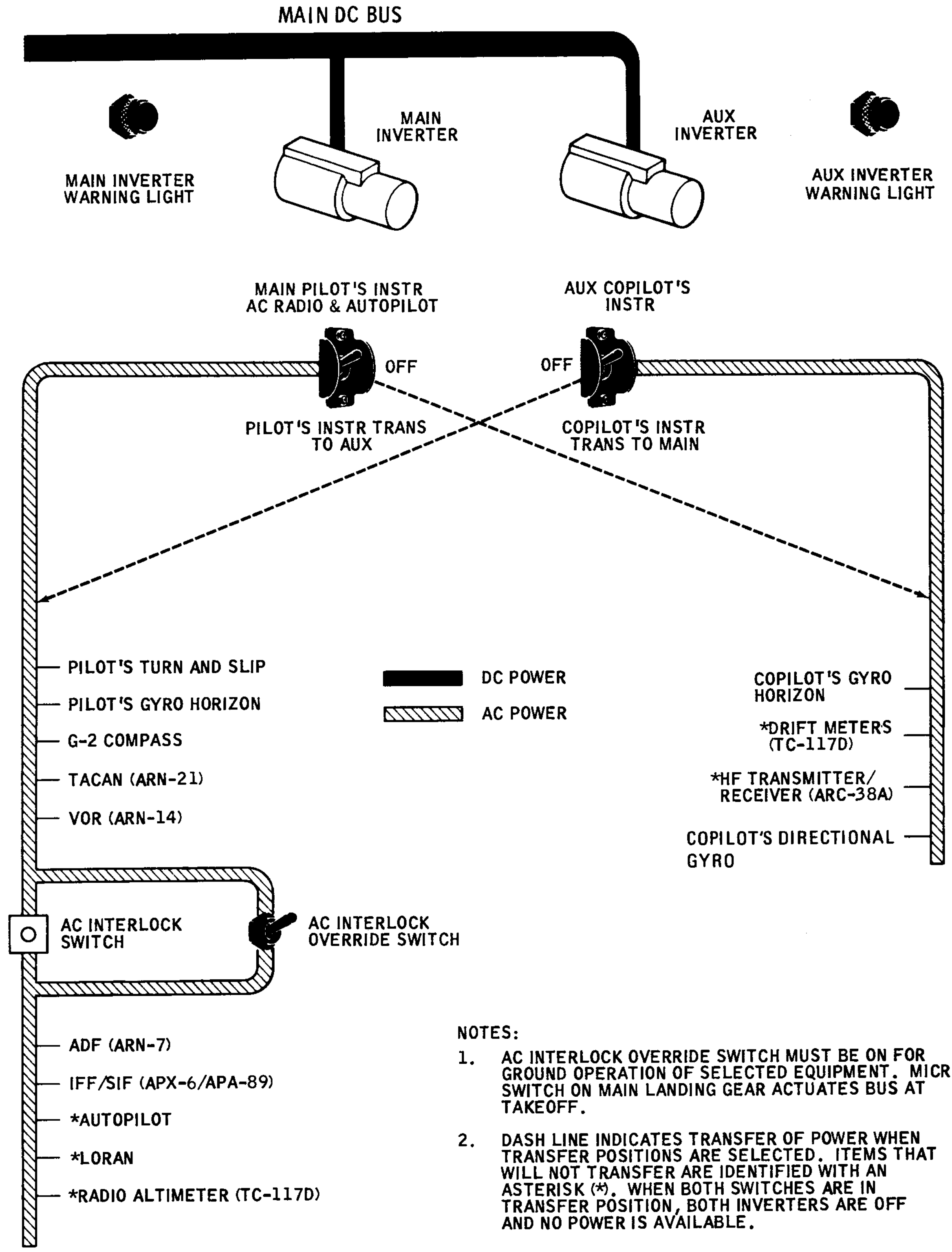


Figure 1-13. Electrical System (Sheet 1)



NOTES:

1. AC INTERLOCK OVERRIDE SWITCH MUST BE ON FOR GROUND OPERATION OF SELECTED EQUIPMENT. MICRO-SWITCH ON MAIN LANDING GEAR ACTUATES BUS AT TAKEOFF.
2. DASH LINE INDICATES TRANSFER OF POWER WHEN TRANSFER POSITIONS ARE SELECTED. ITEMS THAT WILL NOT TRANSFER ARE IDENTIFIED WITH AN ASTERISK (*). WHEN BOTH SWITCHES ARE IN TRANSFER POSITION, BOTH INVERTERS ARE OFF AND NO POWER IS AVAILABLE.

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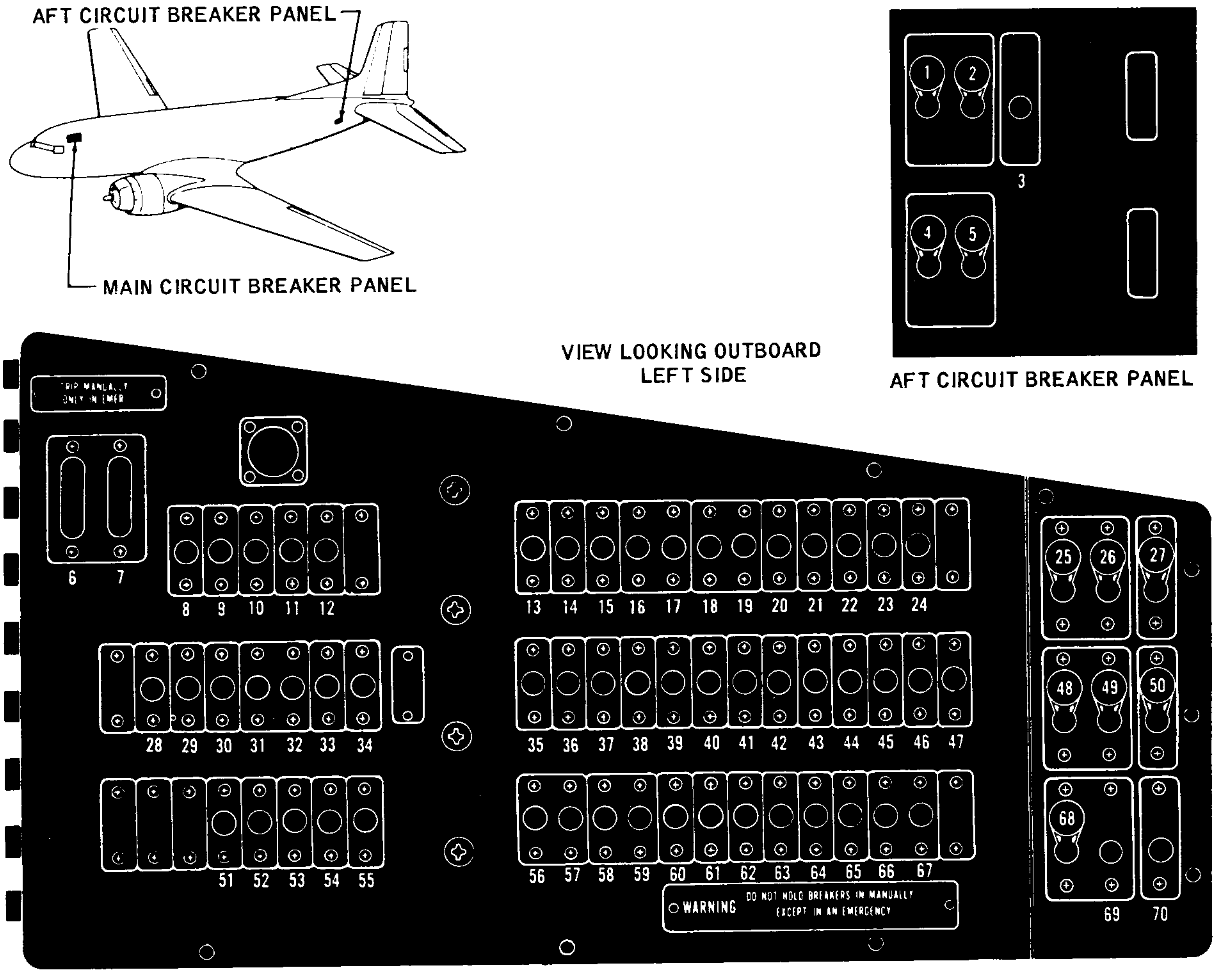
XX1-16

Figure 1-13. Electrical System (Sheet 2)



1. 115-VAC, A-PHASE MAIN INVERTER
2. 115-VAC, C- PHASE MAIN INVERTER
3. AFT DOME LIGHTS
4. 115-VAC, A-PHASE ALTERNATE INVERTER
5. 115-VAC, C-PHASE ALTERNATE INVERTER
6. LH GENERATOR FIELD
7. RH GENERATOR FIELD
8. HEATER GROUND CONTROL
9. HEATER CONTROL
10. GROUND BLOWER
11. INVERTER WARNING LIGHTS
12. 1500-VA INVERTER CONTROL
13. ANTICOLLISION LIGHTS
14. CABIN DOME LIGHT
15. NAVIGATION LIGHTS
16. RH LANDING LIGHT CONTROL
17. LH LANDING LIGHT CONTROL
18. LEFT LANDING LIGHT
19. RIGHT LANDING LIGHT
20. RADIO PANEL LIGHTS
21. PILOT INSTRUMENT AND CENTER INSTRUMENT PANEL LIGHTS
22. COPILOT INSTRUMENT AND UPPER SWITCH PANEL LIGHTS
23. MISCELLANEOUS COCKPIT LIGHTS
24. WING LEADING EDGE LIGHTS
25. LH PROP FEATHERING
26. RH PROP FEATHERING
27. COCKPIT LIGHTS TURN AND BANK
28. RANGE RECEIVER
29. VOR RECEIVER
30. GLIDE SLOPE
31. RED ADF
32. GREEN ADF
33. MARKER BEACON
34. ALTIMETER
35. LANDING GEAR POSITION INDICATOR
36. GENERATOR WARNING LIGHT
37. DOOR WARNING
38. LANDING GEAR WARNING
39. FUEL AND OIL PRESS. WARNING
40. HEATER FIRE WARNING
41. ENGINE FIRE WARNING
42. G-2 COMPASS
43. AUTOPILOT
44. TEMPERATURE INSTRUMENTS
45. FUEL QUANTITY
46. STUDENT POWER (TC-117D)
47. STUDENT POWER (TC-117D)
48. LEFT FUEL BOOSTER
49. RIGHT FUEL BOOSTER
50. COCKPIT PANEL FLOODLIGHT
51. ICS WARNING LIGHT (TC-117D)
52. IFF POWER
53. PILOT'S HF RECEIVER
54. VHF TRANS-RECEIVER
55. UHF TRANS-RECEIVER
56. LEFT OIL COOLER DOORS
57. RIGHT OIL COOLER DOORS
58. LEFT COWL FLAPS
59. RIGHT COWL FLAPS
60. LEFT ENG MAGNETIC CHIP DETECTOR
61. RIGHT ENG MAGNETIC CHIP DETECTOR
62. ENGINE START AND IGNITION
63. ALCOHOL QUANTITY
64. DEICER EQUIPMENT
65. HEATER AIRSCOOP
66. LEFT PITOT HEATER
67. RIGHT PITOT HEATER
68. COPILOT'S TURN AND SLIP (DC)
69. COCKPIT LIGHTS
70. MAIN J-BOX FLOODLIGHT

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Figure 1-14. Circuit Breaker Panels – Typical

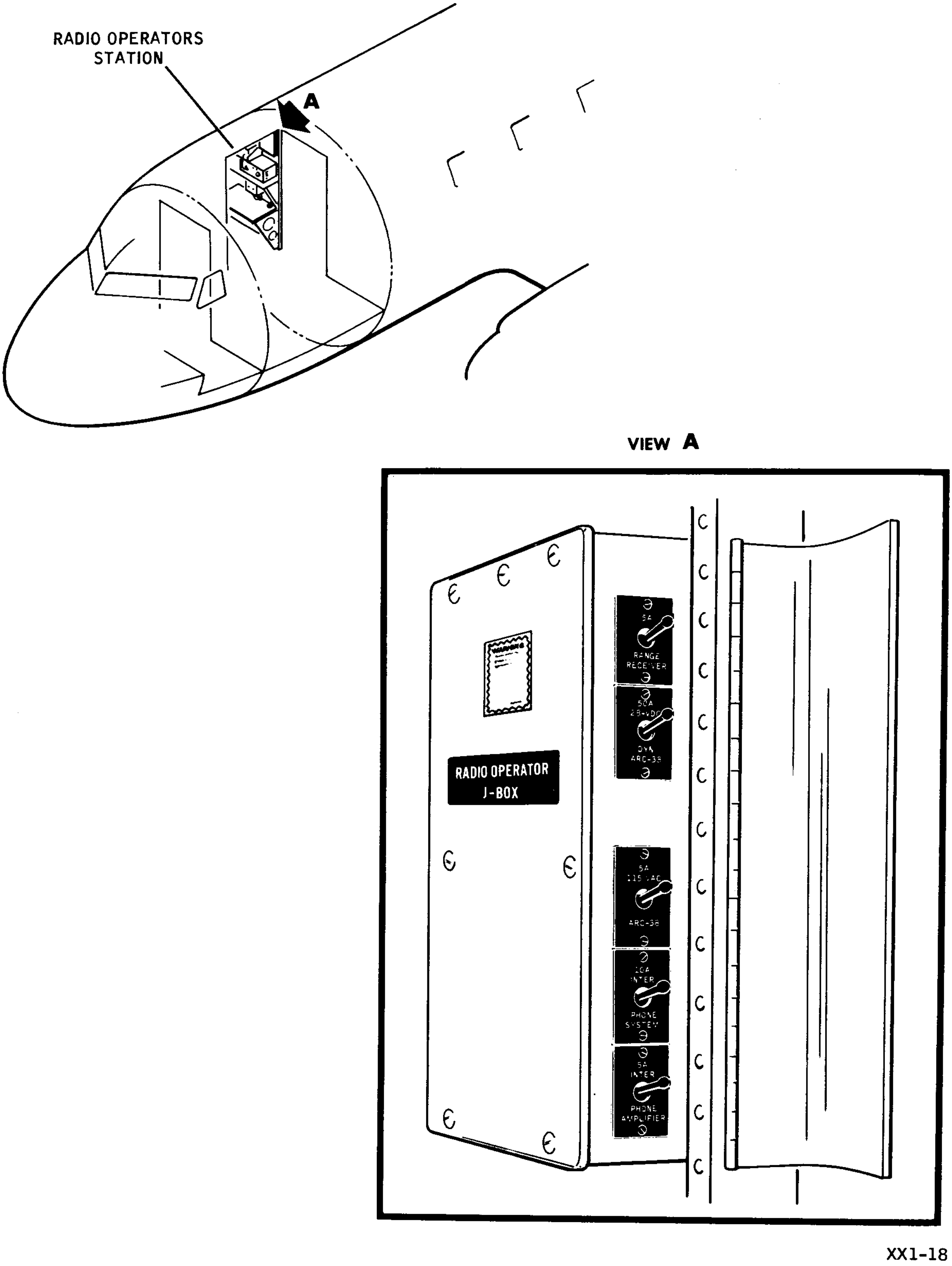


Figure 1-15. Circuit Breakers at Radio Operators J-Box

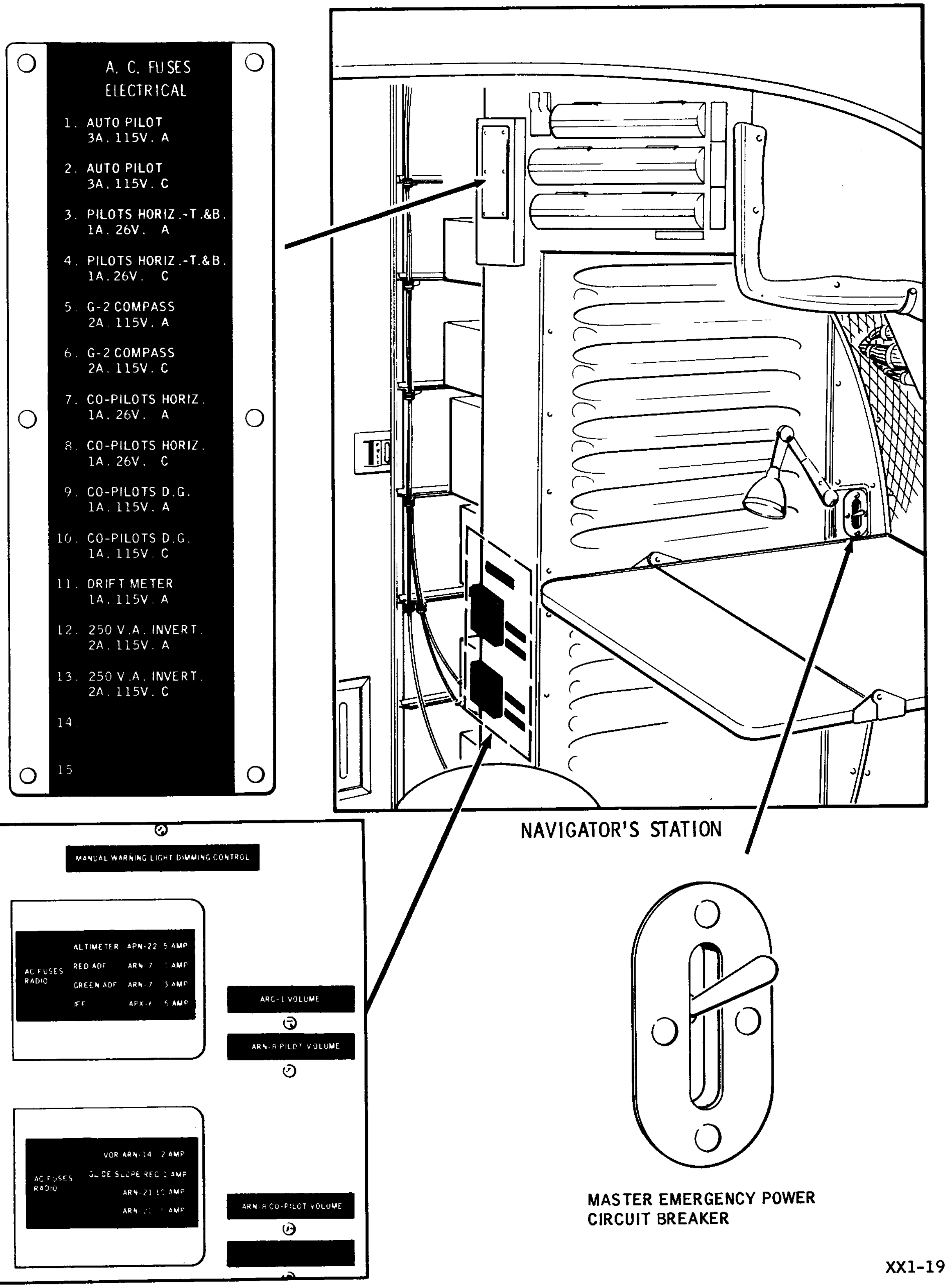


Figure 1-16. Master Emergency Power Circuit Breaker and Ac Fuses

fuselage, forward of the wing (figure 1-2), to permit the use of external power for starting the engines and for operating other equipment.

CIRCUIT PROTECTORS

Circuit protectors are located on the circuit breaker panel, which is above the main junction box (figure 1-14).

GENERATOR AMMETERS

Two generator ammeters, located on the right electrical switch panel (figure 1-12), indicate the amperage output of the respective generators.

GENERATOR WARNING LIGHTS

Two red generator warning lights, located on the right electrical panel (figure 1-12), will come on when the respective generator is inoperative or off.

INVERTER SWITCHES

Two 3-position main and auxiliary inverter switches are located on the right electrical panel (figure 1-12).

INVERTER WARNING LIGHTS

A press-to-test inverter warning light is located above the pilot's airspeed indicator and another is located above the copilot's gyro horizon indicator. When on, the warning lights indicate that ac power is not being furnished to the respective flight instruments from either the main or auxiliary inverter. When the main inverter switch is placed in the OFF position, the warning light on the pilot's side will come on. When the auxiliary inverter switch is placed in the OFF position, the warning light on the copilot's side will come on. When one inverter switch is placed in the transfer position, and the other is placed to ON, both warning lights will be off.

NOTE

> When both inverter switches are placed in the transfer positions (down), both inverters will be inoperative and both warning lights will be on.

AC INTERLOCK SWITCH

An ac interlock switch mounted on the main landing gear is actuated by the weight of the aircraft on the gear. The switch removes the RADIO ALTIMETER (TC-117D only), IFF, LORAN, AUTO PILOT and ADF from the electrical circuit, reducing the load on the generators. This prevents overheating the generators due to improper cooling while on the ground.

AC INTERLOCK OVERRIDE SWITCH

An override switch is installed to allow the RADIO ALTIMETER (TC-117D only), IFF, LORAN, AUTO-PILOT and ADF to be ground checked.

HYDRAULIC POWER SUPPLY SYSTEM

A pressure accumulator-type hydraulic power supply system operates the landing gear, brakes, landing flaps, and windshield wipers (figure 1-17). The system operates in a pressure range of 950 to 1100 psi. An engine-driven hydraulic pump, located on each engine, provides the operating pressure for the system. The pressure supply lines are tied together to ensure system operation in the event of one engine failure. The capacity of the system is sufficient to operate gear and flaps simultaneously. Relief valves are installed in the landing gear and landing flap hydraulic lines to prevent high pressures caused by thermal expansion or by gust loads during operations. The relief valves also protect the landing gear when it is being extended or retracted. The system is supplied with fluid from a reservoir, located behind the copilot's station (figure 1-18). A hand pump is provided to operate the hydraulic system when the engine-driven pumps are inoperative.

HYDRAULIC HAND PUMP

A hydraulic hand pump is located on the bottom of the hydraulic control panel (figure 1-18). When a loss of pressure occurs and it is desired to operate any of the units in the hydraulic system, move the control for that unit to the desired position, leave all other hydraulic controls in the OFF positions, and operate the hand pump. The hand pump also may be used to build up pressure in the pressure accumulator, provided that the hydraulic hand pump shutoff valve (star valve) is opened.

NOTE

> Hand pump hydraulic pressure cannot be directed specifically to any one hydraulically operated unit; the entire system will be pressurized.

HYDRAULIC HAND PUMP SHUTOFF VALVE (STAR VALVE)

The hydraulic hand pump shutoff valve is located at the center of the hydraulic panel (figure 1-18). Normally, this control is wired in the OFF position, during which time the various hydraulic units may be operated with the hydraulic hand pump if necessary. If it is desired to pump up the pressure accumulator with the hand pump, the shutoff valve control must be placed in the ON position. It should never be necessary to use the valve in flight; it should be restricted to ground use only.

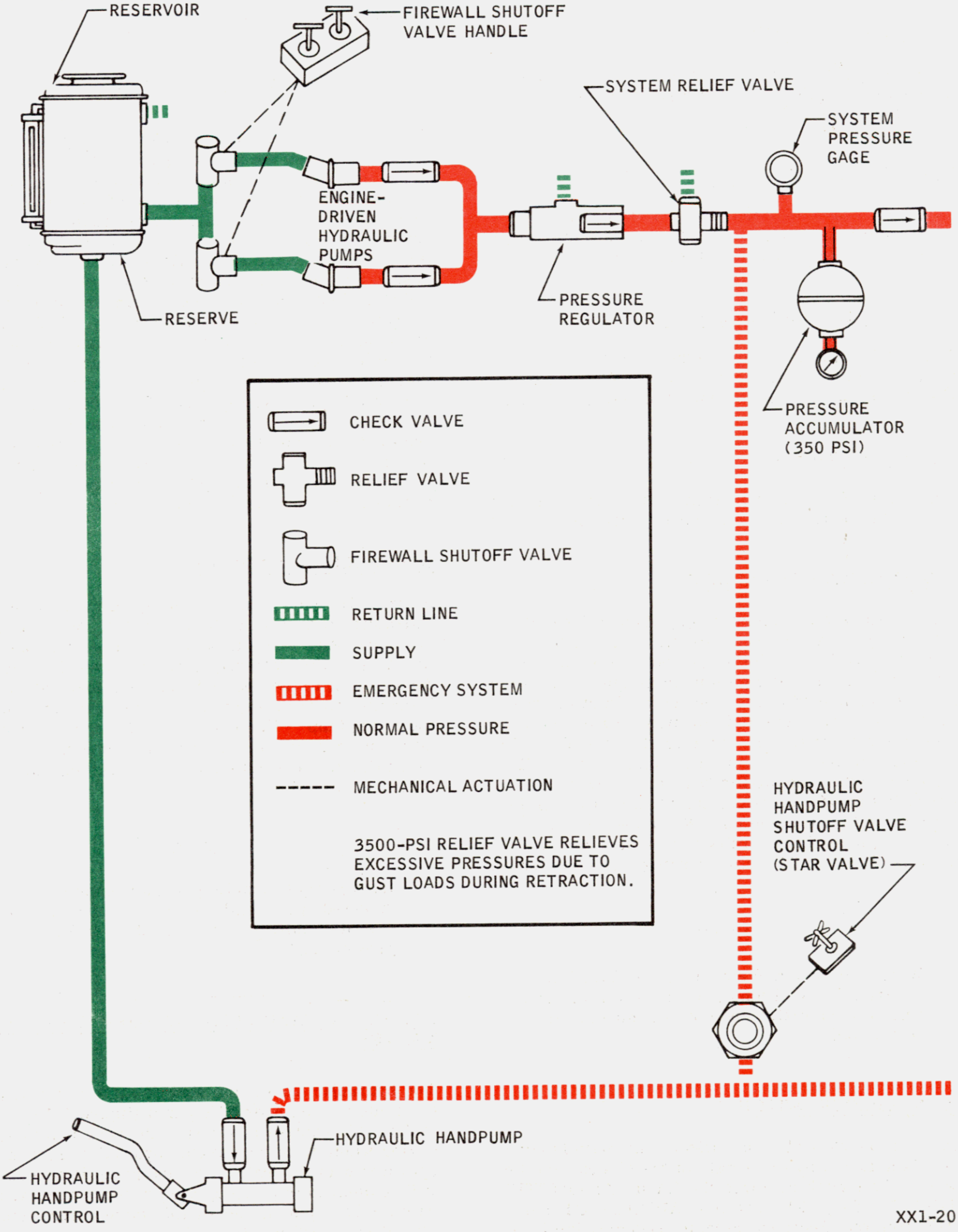


Figure 1-17. Hydraulic System (Sheet 1)

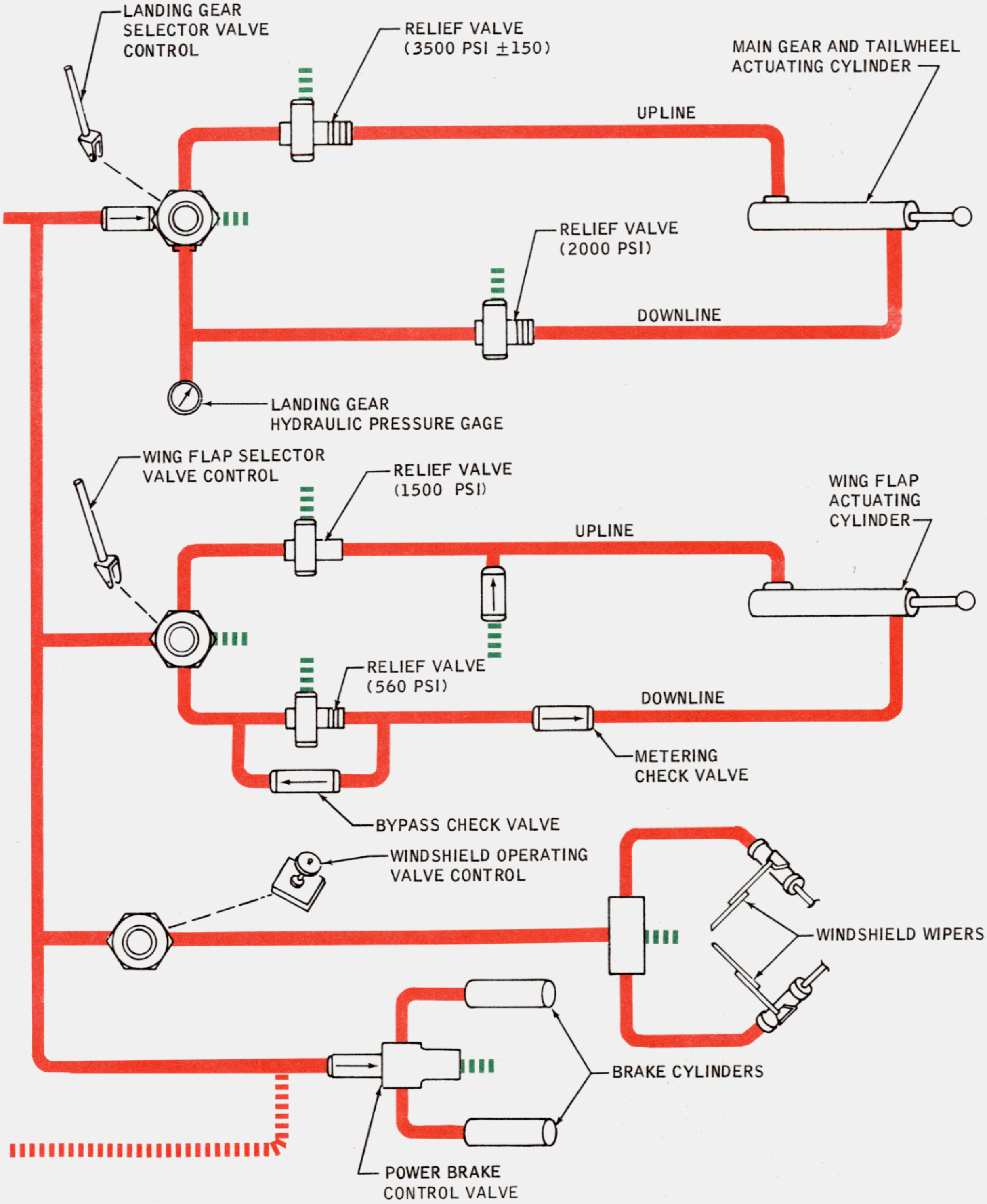


Figure 1-17. Hydraulic System (Sheet 2)

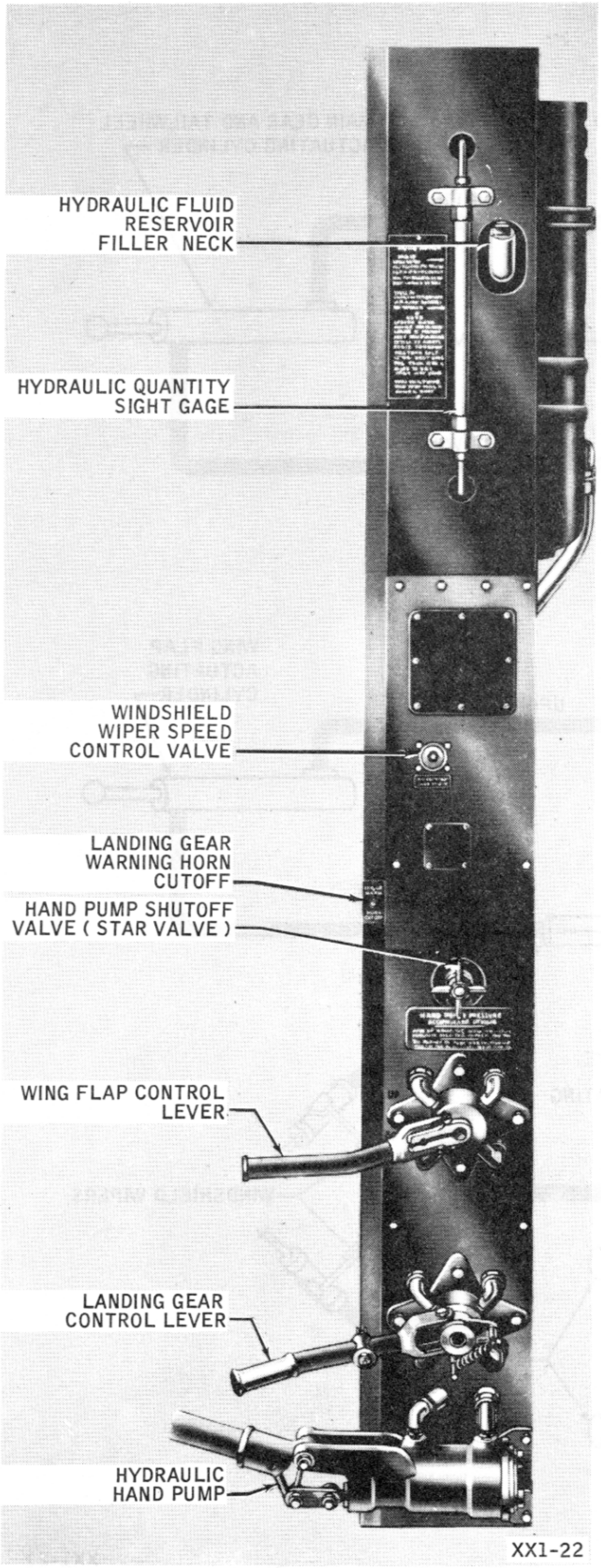


Figure 1-18. Hydraulic Control Panel

HYDRAULIC SYSTEM EMERGENCY SHUTOFF VALVE

A mechanically actuated hydraulic system emergency shutoff valve is installed aft of each nacelle firewall to shut off the flow of hydraulic fluid forward of the firewall. The valve is controlled by the emergency firewall shutoff handle (figure 1-21) for each respective engine.

HYDRAULIC SYSTEM PRESSURE GAGES

A hydraulic system pressure gage and a landing gear pressure gage are located on the hydraulic instrument panel (figure 1-19) adjacent to the copilot's seat. The hydraulic system pressure gage indicates the amount of fluid pressure in the hydraulic lines and the pressure accumulator. The landing gear pressure gage indicates the pressure in the landing gear downline, and also indicates the hand pump pressure, provided that the landing gear control is in the DOWN position and the hand pump is in operation.

HYDRAULIC SYSTEM QUANTITY GAGE

A hydraulic quantity sight gage is located at the top of the hydraulic control panel (figure 1-18). The sight gage does not indicate the amount of reserve fluid for the hydraulic hand pump. Instructions for maintaining the proper system fluid level are mounted adjacent to the gage.

LANDING FLAPS

The landing flaps are split-type and hydraulically operated. They extend from the fuselage to the inboard side of the aileron.

NOTE

> The flaps will move from the UP to the DOWN position in approximately 20 seconds and from the DOWN to the UP position in approximately 8-1/2 seconds. Refer to AIRSPEED LIMITATIONS for flap operation.

LANDING FLAP CONTROL

The landing flaps are controlled by a three-position valve located on the hydraulic control panel (figure 1-18). The control lever has three positions: DOWN, OFF, and UP. In the DOWN or UP position, the flaps move in the respective direction to the limit of travel or until the control lever is placed in the OFF position. The OFF position holds the flaps in either the UP, DOWN, or any intermediate position. The control lever should be in the OFF position when operation of the flaps is not required.

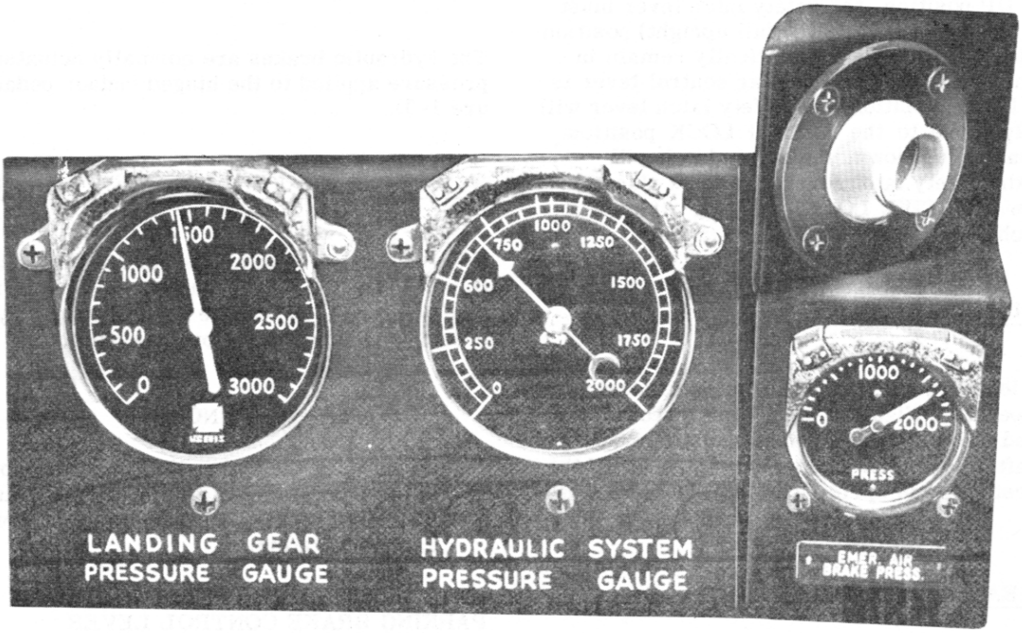


Figure 1-19. Hydraulic Instrument Panel

LANDING FLAP POSITION INDICATOR

A mechanical landing flap position indicator (figure 1-3) is located in front of the pilot's position and is marked UP, 1/4, 1/2, 3/4, and DOWN.

LANDING GEAR SYSTEM

The landing gear system is composed of two fully retractable main wheels and a partially retractable tail wheel. Both the main gear and the tailwheel extend and retract hydraulically. No uplatches are provided for the main gear; the downlatches are released mechanically by operation of the landing gear control lever. The main gear doors are mechanically actuated by the gear. The tailwheel will swivel 240 degrees and is spring loaded to center before retraction. Ground safety pins are provided to be installed in the main gear linkage to prevent inadvertent retraction of the main gear while the aircraft is on the ground. A tail gear ground safety latch is provided to prevent inadvertent tailwheel retraction. The ground safety equipment is stowed in the aircraft when not in use. A check valve is installed to hold the landing gear in the UP position in the event of hydraulic failure.

LANDING GEAR CONTROL LEVER

The landing gear control lever is located on the hydraulic panel (figure 1-18). The landing gear control lever should be left in the DOWN position while the aircraft is on the ground. During flight, the control lever should be left in the UP position. No off position is provided for normal operation; however, for emergency operation, the center position will function as an off position.

NOTE

> The landing gear will move through the full UP or DOWN travel in approximately 7 seconds. Refer to OPERATING LIMITATIONS for maximum airspeed for landing gear extension.

LANDING GEAR SAFETY LATCH LEVER

The three-positioned landing gear safety latch lever, located on the floor inboard of the pilot's station (figure 1-3), mechanically prevents moving the landing gear control lever to the UP position. The safety latch lever is also cable rigged to a spring loaded latch on each main gear to prevent inadvertent retraction when the full weight of the aircraft is on the landing gear. The safety latch lever is in turn secured in the POSITIVE LOCK (full down) position by a dog latch and solenoid pin that engages the lever. The dog latch is released manually; the solenoid is released automatically when weight is off the gear. In the event that the solenoid fails to release after takeoff, the pin can be manually retracted by means of a finger tab. Normally the solenoid is actuated by the landing gear safety switch. To release the landing gear control lever to the UP position, the safety latch lever must be pulled to the LATCH RAISED (full upright) position. The safety latch lever will automatically remain in that position. When the landing gear control lever is returned to DOWN position, the safety latch lever will automatically move to the SPRING LOCK position. When the gear is full down, the safety latch will engage and the safety latch lever should be placed in the full down (POSITIVE LOCK) position, which will lock the mechanical safety latch on each gear.

TAILWHEEL LOCK CONTROL

A tailwheel lock control is located on the underside of the control pedestal (figure 1-6). The control is spring loaded to the forward (locked) position. In some aircraft, the control is located on the top of the control pedestal and is spring loaded to the aft (locked) position.

LANDING GEAR POSITION INDICATOR

A single instrument incorporating three landing gear position indicators (one for each gear) is mounted on the main instrument panel (figure 1-7). When each gear is up and locked its indicator reads UP. When each gear is down and locked, a picture of a gear appears on its indicator. When the landing gear doors are open and the gears are either retracting or extending, a striped marker shows in each respective indicator. When no dc power is supplied, a striped marker shows in all indicators. A landing gear red warning light, located on the main instrument panel, comes on when the landing gear is in any position other than locked up or down. The warning light will also come on when the gear is down and locked if the landing gear control lever is not in the full DOWN position.

LANDING GEAR WARNING HORN

A warning horn will sound when either throttle is in the CLOSED position if any gear is not in the fully extended and locked position. The warning horn may be silenced and reset for future operation by depressing a cutoff switch (figure 1-18), adjacent to the landing gear control lever, in the event operation must be continued with the throttle closed.

BRAKE SYSTEM

The spot-type brakes on the main gear are actuated for equal or differential braking by pressure from the main hydraulic system, either by means of the engine-driven pumps or by the hand pump. If the brake hydraulic system fails, braking power is supplied by an emergency airbrake system.

HYDRAULIC BRAKE NORMAL CONTROLS

The hydraulic brakes are normally actuated by toe pressure applied to the hinged rudder pedals (figure 1-3).

HYDRAULIC BRAKE EMERGENCY CONTROL

If the normal hydraulic system fails to deliver sufficient pressure to the brakes, the hydraulic hand pump (figure 1-18) can be used to supply hydraulic pressure to operate the brake system.

NOTE

When using the hydraulic hand pump to operate the brakes, avoid excessive pumping of the brake pedals as pressure is reduced with each application.

PARKING BRAKE CONTROL LEVER

The parking brake control lever is located on the control pedestal (figure 1-6). To set the parking brakes, depress the brake pedals, noting a drop in pressure of the main hydraulic system as an indication of brake operation, pull and hold the parking brake control lever out, then release the brake pedals. The parking brake can only be operated from the pilot's side. To release the parking brake, depress the brake pedals.

NOTE

The parking brakes cannot be set unless pressure is at least 500 psi.

EMERGENCY AIRBRAKE CONTROL LEVER

The emergency airbrake control lever is located below the vee of the windshield (figure 1-3). Control lever positions are labeled ON, HOLD, and OFF. When the ON position is selected, air is introduced into the brake system for use in applying the brakes. When the HOLD position is selected, air is trapped in the system to provide the desired braking action. In the OFF position, air is dumped to release the brakes. After using the airbrakes for stopping, no attempt should be made to taxi the aircraft and ground equipment should be used to tow the aircraft from the runway. The brake hydraulic system must be bled after each operation of the emergency airbrake system to prevent erratic brake operation.

NOTE

Sufficient air pressure is available for five full applications of the emergency airbrakes.

EMERGENCY AIRBRAKE INDICATOR

The emergency airbrake pressure indicator is located on the hydraulic instrument panel (figure 1-19).

WINDSHIELD WIPERS

Two synchronized windshield wipers, one on each windshield, are operated by hydraulic pressure. A speed control valve located on the hydraulic control panel (figure 1-18) functions as an ON-OFF control and a speed regulator. The blades are locked in position when the control is turned to the OFF position.

CAUTION

Do not operate the windshield wipers on dry glass.

FLIGHT CONTROL SYSTEM

All flight controls are conventionally operated by dual wheel and rudder pedal controls. Trim tabs on each flight control are mechanically controlled.

AILERON CONTROLS

The dual control wheels are used to control the ailerons and geared tabs furnish aerodynamic boost to reduce stick force. In addition, the tab on the right aileron is used for aileron trim and is controlled by the aileron trim tab control crank.

ELEVATOR CONTROLS

The elevator is controlled by dual control columns. There are two tabs on each half of the elevator. The inboard tabs are spring tabs that furnish aerodynamic boost to reduce stick force. The outboard tabs are trim tabs controlled by the elevator trim tab control wheel.

RUDDER CONTROLS

The rudder is controlled by a duplicate set of hinged rudder pedals of the conventional suspended type. The pedals can be adjusted for length by individual foot-operated latches on the rudder pedals. Rudder force is reduced aerodynamically by a geared tab. The same tab is used for rudder trim.

AILERON TRIM TAB CONTROL CRANK

The aileron trim tab is controlled by a crank located on the right side of the control pedestal (figure 1-6). Movement of the tab is shown on an indicator below the crank.

ELEVATOR TRIM TAB CONTROL WHEEL

The outboard elevator trim tabs are controlled by a wheel located on the left side of the control pedestal (figure 1-6). Movement of the tabs are shown on an indicator located to the right of the wheel.

RUDDER TRIM TAB CONTROL KNOB

The rudder trim tab is controlled by a knob located on the left side of the control pedestal (figure 1-6). Movement of the tab is shown on an indicator located below the knob.

CONTROL SURFACE LOCKS

Five control surface locks, one for each aileron, one for each elevator, and one for the rudder are provided. When not in use, the locks are stowed in the aircraft lavatory.

OUTSIDE TEMPERATURE INDICATOR

A thermocouple actuated outside temperature indicator is mounted on the main instrument panel (figure 1-7). The instrument indicates outside air temperature and is calibrated in degrees centigrade.

AIRSPEED INDICATORS

Two airspeed indicators are installed on the main instrument panel (figure 1-7). Each indicator is actuated by ram air pressure from the pitot heads and static pressure. The indicators are calibrated in knots.

VERTICAL SPEED INDICATORS

Vertical speed indicators are installed on the main instrument panel (figure 1-7). The indicators are operated by air pressure from the main or alternate static source and are calibrated in feet-per-minute climb and descent.

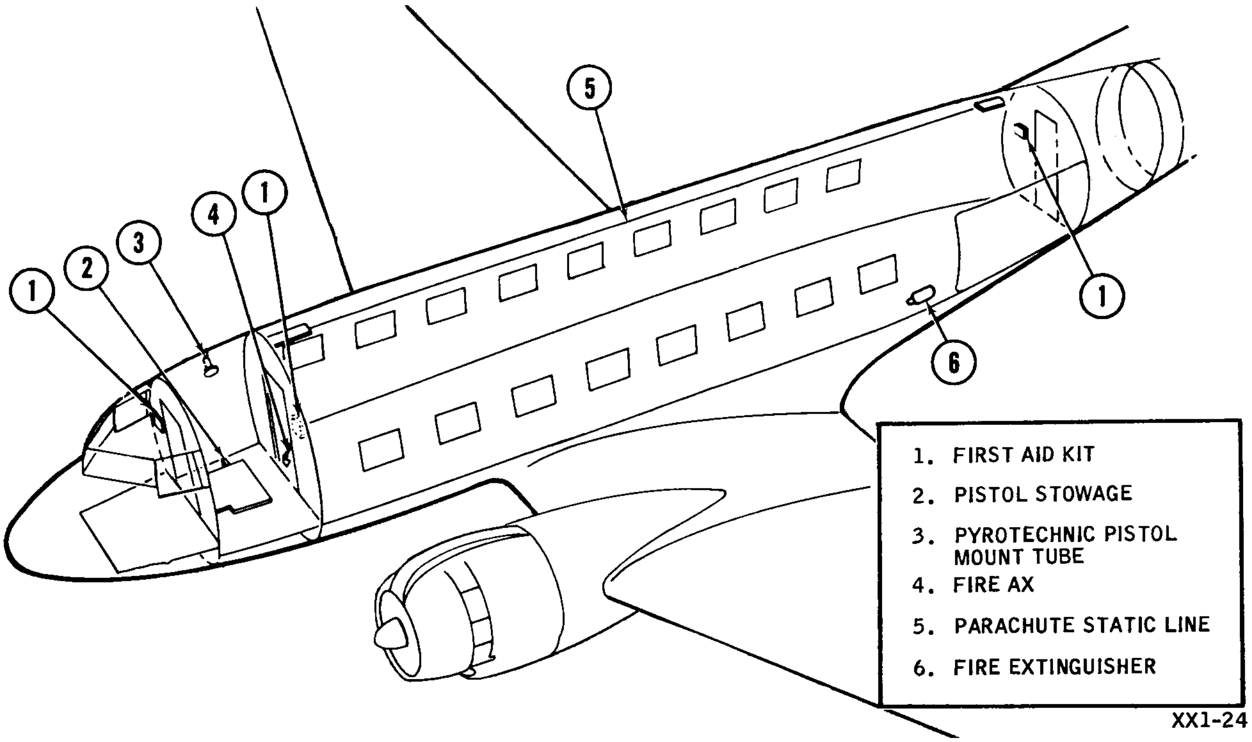


Figure 1-20. Emergency Equipment

TURN-AND-SLIP INDICATORS

Two turn-and slip indicators are installed on the main instrument panel (figure 1-7). The pilot's turn needle gyro is powered by 115 vac, and the copilot's turn needle gyro is powered by 28 vdc.

ALTIMETERS

Two altimeters are installed on the main instrument panel (figure 1-7). Each altimeter is sensitive to changes in barometric pressure and is operated by static air pressure from the main or alternate static source.

CLOCKS

Two 8-day clocks are installed on the main instrument panel (figure 1-7).

ATTITUDE INDICATORS

Two attitude indicators are installed on the main instrument panel (figure 1-7). Each provides a constant visual indication of the pitch and roll attitude of the aircraft and requires 115 vac for operation.

G-2 COMPASS

A G-2 compass is installed on the main instrument panel (figure 1-7). The compass provides a stabilized gyro compass reading by combining the advantages of the remove-indicating compass and the free directional gyro in one instrument.

DIRECTIONAL GYRO

A directional gyro is installed on the main instrument panel (figure 1-7) and when properly set, indicates the heading of the aircraft.

PITOT STATIC SYSTEM

An impact and a static pressure system, installed for operation of the airspeed, altimeter, and vertical speed instruments, consists of two pitot tubes in the fuselage nose and both a main and an ice free alternate static source. (See figure 1-2.) The pitot tubes are protected against ice accumulation by internal electrical heating elements.

STATIC SYSTEM SELECTOR VALVE CONTROL

The static system selector valve control is located on the main instrument panel (figure 1-7), and selects either the main static source or the alternate ice free static source in the tail section.

EMERGENCY EQUIPMENT

EMERGENCY FIREWALL SHUTOFF HANDLES

Two push-pull handles, one for each engine, are mounted on the floor aft of the control pedestal (figure 1-21). These handles close the fuel, oil, and hydraulic emergency shutoff valves located aft of the engine nacelle firewall shutting off the flow of fuel, oil, and hydraulic fluid forward of the firewall. The oil supply for propeller feathering is not affected by the oil emergency shutoff valve. In addition, either handle, when pulled, will close its respective generator blast tube. The handle must be pulled full UP to close the valves and blast tube.

FIRE EXTINGUISHING SYSTEM

The aircraft is equipped with a two-shot, mechanically controlled CO_2 fire extinguisher system for the protection of each engine accessory section and the cabin heater compartment. Two portable CO_2 fire extinguishers are provided to extinguish fires in the cockpit and cabin (figure 1-20). Strategically located fire detectors actuate fire warning lights on the main instrument panel. Celluloid indicators, red for discharge from thermal expansion and yellow for manual discharge of CO_2 are flush-mounted on the right side of the fuselage nose section. These indicators are visible from the ground.

SELECTOR VALVE CONTROL

A three-position fire extinguisher selector valve control is located under an access door in the floor between the pilot's and copilot's seats (figure 1-21) for selecting the area of CO_2 discharge. The three positions are LEFT ENGINE, HEATER COMPT, and RIGHT ENGINE.

CO_2 DISCHARGE CONTROLS

Two CO_2 discharge control handles, one for each CO_2 cylinder and identified as No. 1 and No. 2, are located under an access door in the floor between the pilot's and copilot's seats (figure 1-22). The No. 2 discharge control handle is equipped with a locking button which must be depressed to release the handle, in the center of the handle.

WARNING! DO NOT DISCHARGE 2ND CYL. INTO HTR. COMPT. UNTIL 3 MINUTES AFTER 1ST.

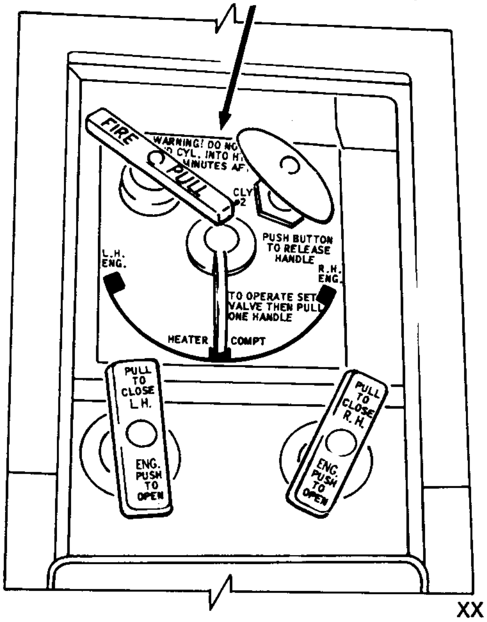


Figure 1-21. Fire Extinguisher System Controls and Emergency Firewall Shutoff Handles

WARNING

Do not discharge the second CO_2 cylinder into the heater compartment within 3 minutes of the first, unless 100% oxygen is utilized by flight personnel. A dangerous level of CO_2 will accumulate in the flight compartment if both cylinders are discharged at a lesser interval.

FIRE WARNING INDICATORS

Three dual fire warning lights are provided. Two are located on the main instrument panel (figure 1-7), one light for each engine section; and one is located on the left electrical panel (figure 1-12) for the heater compartment.

EMERGENCY ESCAPE HATCHES

An overhead ground emergency escape hatch is located overhead in the flight compartment and two

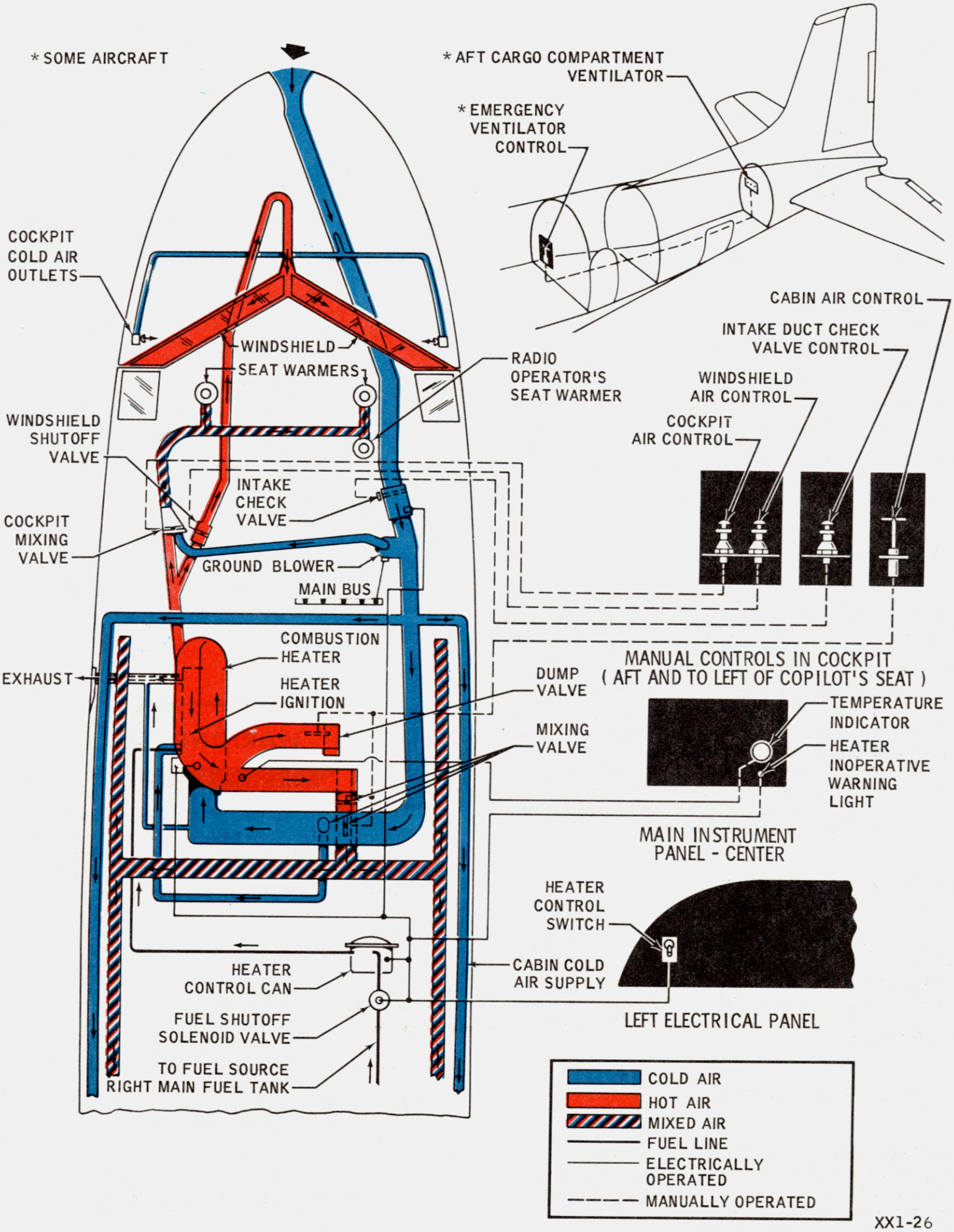


Figure 1-22. Heating, Ventilating, and Anti-Icing System

ground emergency escape hatches are provided on each side of the cabin (figure 5-1). Opening procedures are plainly decaled and in plain view.

MISCELLANEOUS EMERGENCY EQUIPMENT

Miscellaneous emergency equipment is shown in figure 1-20.

DOORS-OPEN WARNING SYSTEM

One warning light, mounted above the engine ignition switches (figure 1-3), will come on whenever the forward service door or main cabin door is open.

SEATS

PILOTS' SEATS

The pilots' seats are installed on tracks and provide fore-and-aft and vertical position adjustments. Each seat is equipped with a safety belt and shoulder harness.

PILOTS' SEATS FORE-AND-AFT CONTROL

Each seat can be adjusted fore-and-aft by pulling upward on the control located on the inboard side of each seat until the seat is free to move in either direction. Release the control lever to lock the seat in position.

PILOTS' SEATS VERTICAL CONTROL ,

Either seat can be adjusted for height by pulling up on the vertical control lever to release the lock located on the outboard side of each seat, then increasing or decreasing weight on the seat for desired adjustment.

HEATING AND VENTILATING SYSTEM

The cabin, cockpit areas, and the double-paned windshield are supplied with heated or ambient ventilating air routed through a single 150,000 BTU-per-hour heater (figure 1-22). Fuel is supplied to the heater from the right main fuel tank (figure 1-9) by the heater fuel pump located in the heater control can. The heater is protected by the same CO_2 system that protects the engines.

Combustion and ventilating air is supplied in flight through a single duct in the fuselage nose; the duct is equipped with a check valve that is normally open whenever ram air is available. On the ground, the check valve closes for ground-blower operation. The valve is equipped with a manual override to close off the supply of ram air in flight if desired. A ground blower is installed to provide air for heater operation on the ground. The temperature of the heated air delivered to the cockpit and the cabin is controlled by two mixing valves, one for the cockpit and one for the cabin. The heater is protected against excessive temperatures by a cycling switch and a dropout fuse.

GROUND BLOWER

A ground blower is installed to provide both heater combustion and ventilating air for ground operation of the heating and ventilating system. The ground blower will automatically operate when the landing gear safety switch is energized and the master battery switch is positioned to the applicable source – GROUND PWR if engines are not running, and BATTERY when both engines are operating above generator cut-in speed (approximately 800 rpm). No separate manual control is provided for the ground blower. The ground blower must be operating when using external air conditioning equipment.

HEATER SWITCH

The cabin heater ON-OFF switch on the left electrical panel (figure 1-11) energizes both the heater ignition system and the heater fuel pump, but only if the ram air duct shutoff valve is open and the heater-inoperative warning light is off.

CABIN AIR MANUAL CONTROL

The temperature of the cabin is controlled by varying the ratio of cold and heated air as selected by the cabin air manual control (figure 1-23). The manual control is a push-pull lever. A placard containing operating instructions is mounted adjacent to the control.

COCKPIT AIR MANUAL CONTROL

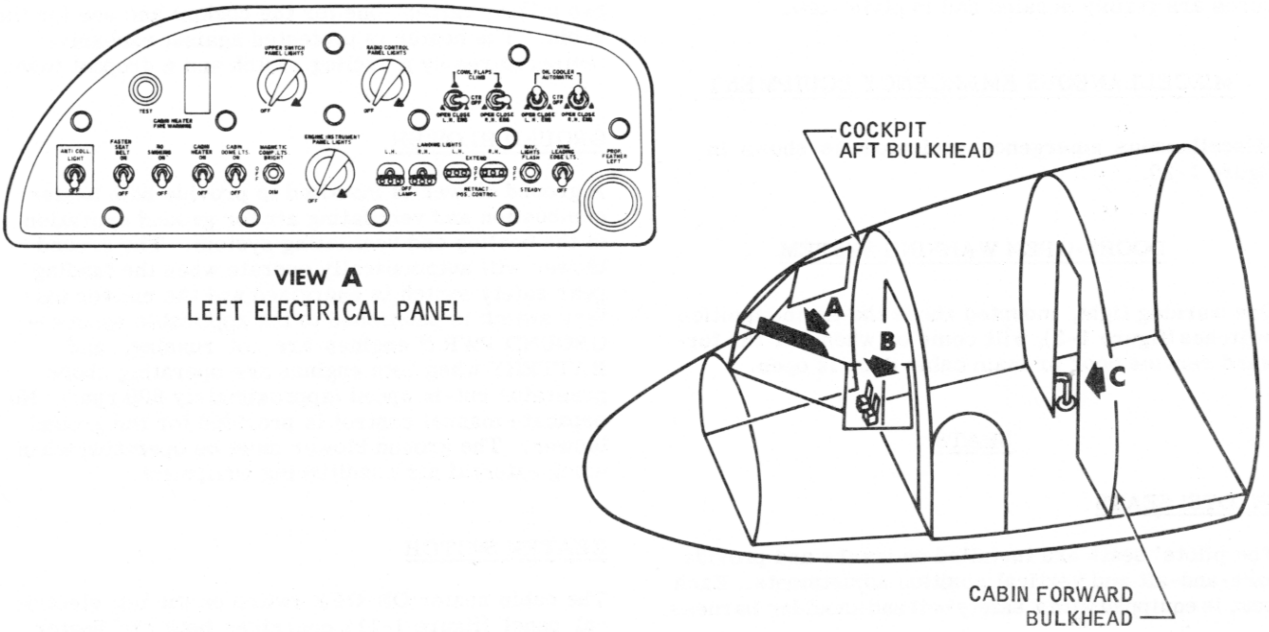
The temperature of the cockpit can be controlled by varying the ratio of cold and heater air as selected by the cockpit air manual control (figure 1-23).

MANUAL OVERRIDE VENTILATING AIR INTAKE CONTROL

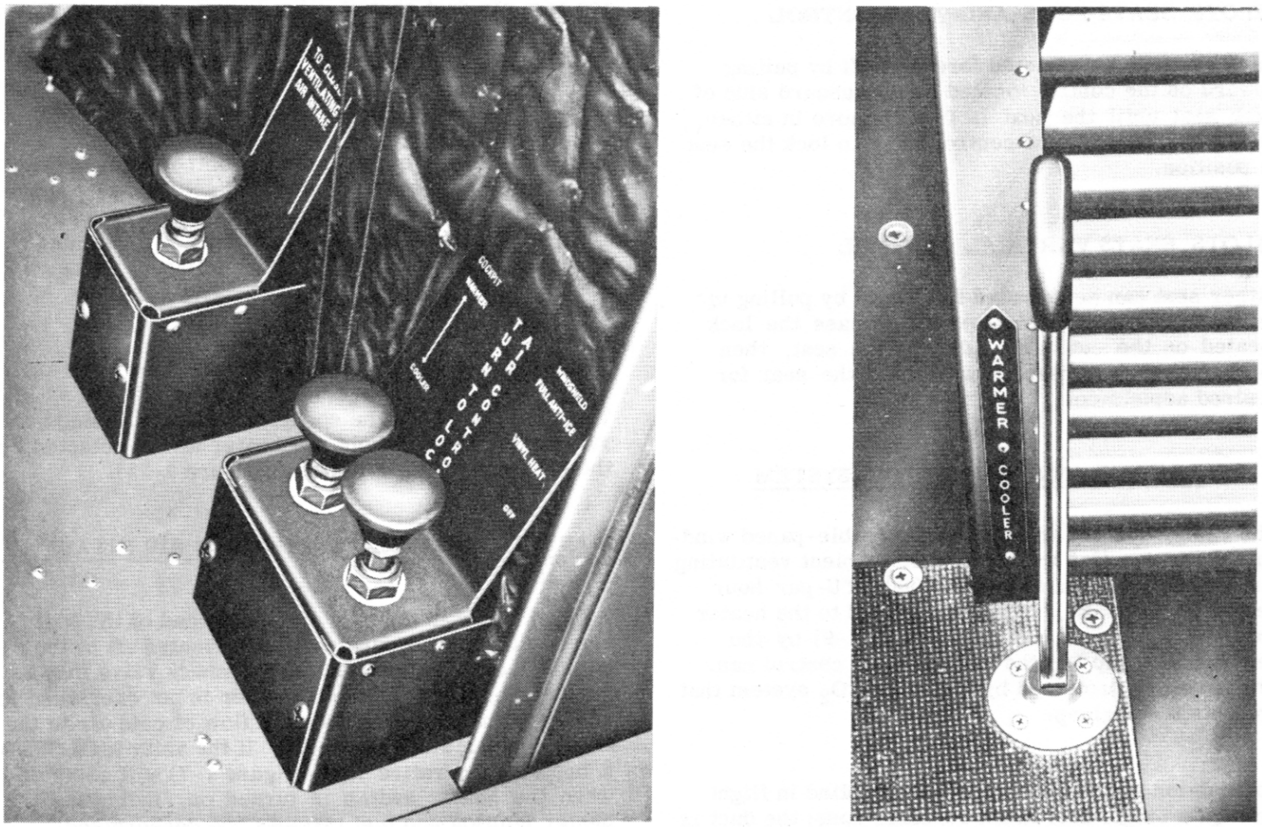
A check valve in the ram air duct ahead of the heater can be closed by a push-pull knob located aft of the copilot's seat (figure 1-23). The check vaive may be used during flight, when the heater is not operating, to shut off ram air and reduce the flow of cold air to the flight compartment and cabin. If the valve is CLOSED, a heater-inoperative light (figure 1-7) will come on when the heater switch is turned on, indicating the heater ignition and fuel circuits are deenergized.

HEATER FIRE CONTROLS

Heater CO_2 discharge controls are located under an access door in the floor between the pilot's and



VIEW A
LEFT ELECTRICAL PANEL



VIEW B
LOOKING AFT

VIEW C
LOOKING FORWARD

XX1-27

Figure 1-23. Heater Controls

copilot's seats (figure 1-21). For operation, refer to Section V.

HEATER TEMPERATURE GAGE

A heater temperature gage, marked in degrees centigrade, is mounted on the main instrument panel (figure 1-7) and registers heated air discharge temperature.

HEATER-INOPERATIVE LIGHT

A heater-inoperative light is mounted on the main instrument panel (figure 1-7) to indicate when the ram air duct valve is manually closed, or when the dropout fuse in the heater electrical circuit has blown.

GROUND OPERATION

The cockpit and cabin areas can be heated or ventilated while on the ground by performing the following:

1. Battery master switch -- GROUND PWR if engines are not running; BATTERY if engines are running above generator cut-in speed (approximately 800 rpm).

2. Heater control -- positioned for either heat or ventilation.

NOTE

> There is no separate manual control for the ground blower. The ground blower will automatically operate when the landing gear safety switch is energized, circuit breakers are set, and both generators are operating.

INFLIGHT OPERATION

The cockpit and cabin areas can be heated in the air by performing the following:

1. Heater switch -- ON

2. Heater controls -- positioned for desired condition.

If the heater fails to function properly, check as follows:

1. Heater switch -- ON

2. Heater-inoperative light -- OFF

3. Check circuit breakers

4. If the heater inoperative light is on, check that the manual override ventilating air intake control is in the OPEN position. If the control is OPEN and there is no heat, it is an indication that the thermal overheat switch has blown the heater dropout fuse and any further heater operation is impossible until the cause of heater malfunctioning has been determined and the dropout fuse has been replaced. The fuse must be replaced on the ground.

CAUTION

> When operating heater on ground, allow ground blower to operate 10 minutes after turning off heater and prior to securing either generator, or ground power equipment. Serious fires or damage can result if heater is not cooled prior to being turned off. If heater has been used prior to takeoff, allow heater and/or ground blower to continue operating until after takeoff. Turning off heater and ground blower simultaneously can cause smoke and fumes to build up in heater compartment. Release of smoke and fumes by ram air after takeoff can produce, or cause symptoms of, fuselage fire.

DEICING SYSTEMS

A wing and empennage deicing system (figure 1-24) is installed on the aircraft for the purpose of removing ice after it has formed. Rubber deicing boots are installed on the leading edge of each wing, each horizontal stabilizer, and on the vertical stabilizer. Air pressure, supplied from the pressure ports of the two engine-driven vacuum pumps (one on each engine), flows through two oil separators (to separate the oil from the air), two check valves, an air filter, and through a distributor valve to alternately expand and contract the tubes in the deicing boots (figure 1-24). One complete deicing cycle is completed every 40 seconds. Each cycle consists of five 8-second pressurizing periods. The first period: air inflates the center tubes on the right and left outboard deicer boots. Second period: the upper and lower tubes on the right and left outboard boots are inflated. Third period: the center tubes in the right and left inboard boots are inflated. Fourth period: the upper and lower tubes in the right and left inboard boots are inflated. Fifth period: both tubes in each of the three stabilizer boots are inflated. This pulsing action cracks ice formations on the boots, and the airstream blows the ice off. The distributor valve is controlled by a 28-vdc motor which opens or closes the port in the distributor valve unit. Operation of the electric motor is controlled from the cockpit. A pressure relief valve in the air filter regulates the pressure in the system. A gage located in the cockpit is connected to a line from the air filter and indicates the system air pressure. No restriction is placed on the operation of the surface deicing system, except during takeoff and landing operation the system must be OFF to prevent undesirable aerodynamic characteristics.

SURFACE DEICING SYSTEM CONTROL

The deicing boots are mechanically controlled by an ON-OFF control (figure 1-5).

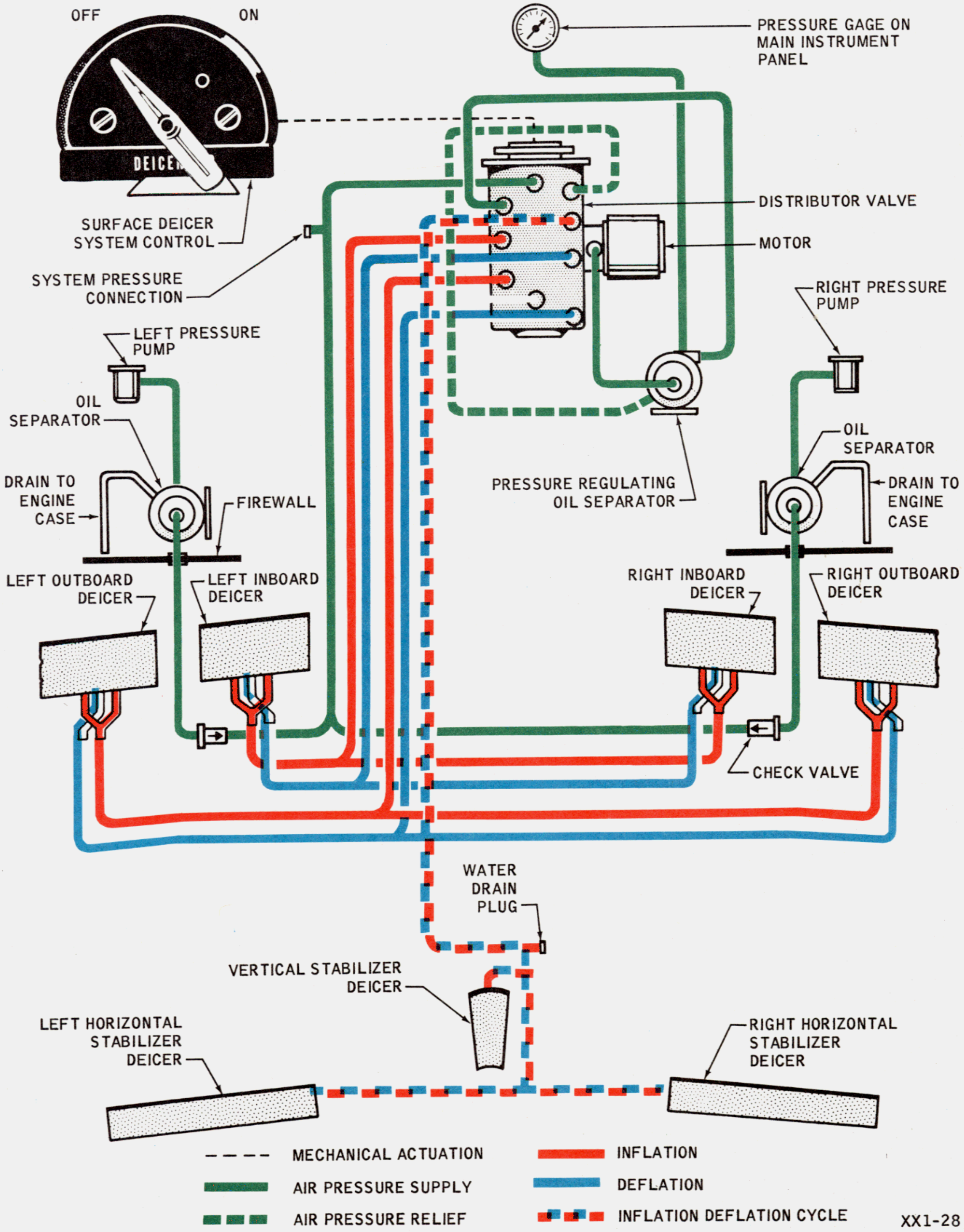


Figure 1-24. Wing and Empennage Deicing System

SURFACE DEICING SYSTEM INDICATOR

The surface deicing system indicator consists of a deicing system pressure gage (figure 1-7). The indicator registers the pounds per square inch of air pressure being supplied to the deicer boots by the engine-driven pressure pumps.

WINDSHIELD HEATED AIR DEICING SYSTEM

The double-paned windshield is protected against ice accumulation by heated air, which is supplied by the cabin heater. The heated air is passed between the inner and outer panes and exhausted overboard. The degree of heat is regulated by an air volume control.

NOTE

- Fogging between the windshield panes can be prevented by maintaining a flow of air between the panes.
- The windshield temperature should be checked occasionally when heat is being applied to make certain that it is not too hot. The vinyl content of the windshield is maintained in a birdproof condition at temperatures below 10°C (50°F) OAT by applying sufficient heat to cause the inner pane to feel warm to the hand. Excessive heat may cause the vinyl content of the windshield to melt and impair vision.

WINDSHIELD, HEATED-AIR DEICING SYSTEM CONTROL

The windshield deicing system is controlled by a push-pull control (figure 1-23), located aft of the copilot's seat.

CARBURETOR, PROPELLER, AND WINDSHIELD ALCOHOL DEICING SYSTEM

Both propellers are protected against the accumulation of ice by an alcohol deicing system that distributes alcohol along the leading edges of the propeller blades. Alcohol is supplied to the propellers through metering-type valves, which can vary the flow of alcohol. Each carburetor is supplied with alcohol at a preset and nonvariable flow. Each windshield is supplied with alcohol through a single metering-type valve.

The carburetor, propeller, and windshield alcohol deicing systems are supplied with alcohol from a single 20-gallon supply tank. The maximum total flow of alcohol with two systems in operation (carburetors and propellers) is approximately 35 US gallons per hour; when all three systems are in operation, the flow is approximately 55 US gallons per hour.

An auxiliary filler for the alcohol supply tank is located in the floor of the main cabin slightly forward of the main entrance door for inflight filling of the supply tank on flights when prolonged icing conditions are encountered.

ALCOHOL DEICING SYSTEM PUMP SWITCH

The alcohol deicing system pump is energized by an ON-OFF switch on the alcohol deicing control panel (figure 1-5). The pump must be turned ON before the propeller, carburetor, or windshield alcohol deicer systems will function.

PROPELLER DEICING SYSTEM CONTROL KNOBS

Each propeller deicing system is controlled by a metering-type valve mounted on the alcohol deicing control panel (figure 1-5). In addition to metering the amount of deicing fluid to the propeller, each valve will also shut off the flow of fluid.

CARBURETOR DEICING SYSTEM CONTROL

Each carburetor deicing system is controlled by an ON-OFF control lever mounted on the alcohol deicing control panel (figure 1-5). The flow of fluid to each carburetor is fixed and cannot be varied. The carburetor alcohol system should be used only when actually required to remove carburetor ice.

WINDSHIELD ALCOHOL DEICING SYSTEM CONTROL

The windshield alcohol deicing system is controlled by a metering-type valve mounted on the alcohol deicing control panel (figure 1-5).

PITOT DEICING SYSTEM

The pitot tube deicing system consists of electrical resistance heating elements integrally built into the units.

PITOT DEICING SYSTEM CONTROL

The pitot deicing system is controlled by an ON-OFF switch on the right electrical panel (figure 1-12).

TABLE 1-1. COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT

Type	Designation	Use
Interphone	AN/AIA-2A	Intercrew communication
UHF	AN/ARC-27	Two-way voice communication
VHF	AN/ARC-1	Two-way voice communication
HF Transmitter	AN/ARC-38A	Two-way voice and CW communication
HF Receiver	AN/ARR-41	Receiver
LF Receiver	AN/ARC-5	Range receiver
ADF (TWO)	AN/ARN-7	Navigation. Homing, code, and voice receiver
*VOR (TWO)	AN/ARN-14	Omnirange and localizer receiver
Glide Path Receiver	AN/ARN-18	Glide path receiver for ILS
TACAN	AN/ARN-21	Navigation. Distance and direction to station
Marker Beacon	AN/ARN-8	Marker beacon receiver
IFF	AN/APX-6	Identification. Transmitter and receiver
SIF	AN/APA-89	Coded identification in conjunction with AN/APX-6
RADIO Altimeter	AN/APN-1 AN/APN-22 (TC models)	RADIO altimeter
LORAN	AN/APN-70 (TC models)	Navigation
ADF	AN/ARN-6 (TC models)	Navigation. Homing, code, and voice receiver. In cabin for student usage

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*ASC 152 requires the installation of two VOR (ARN-14) on selected C-117D's and on TC-117D's.

AIRSCOOP DEICING SYSTEM

This deicing system has been removed by ASC 94. The switch should be placarded "Inoperative."

PITOT AND AIRSCOOP DEICING SYSTEM INDICATOR

Current flow to each of the pitot tubes is indicated on an ammeter on the right electrical panel (figure 1-12). An ammeter selector switch is used to select the heater current reading desired.

COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT

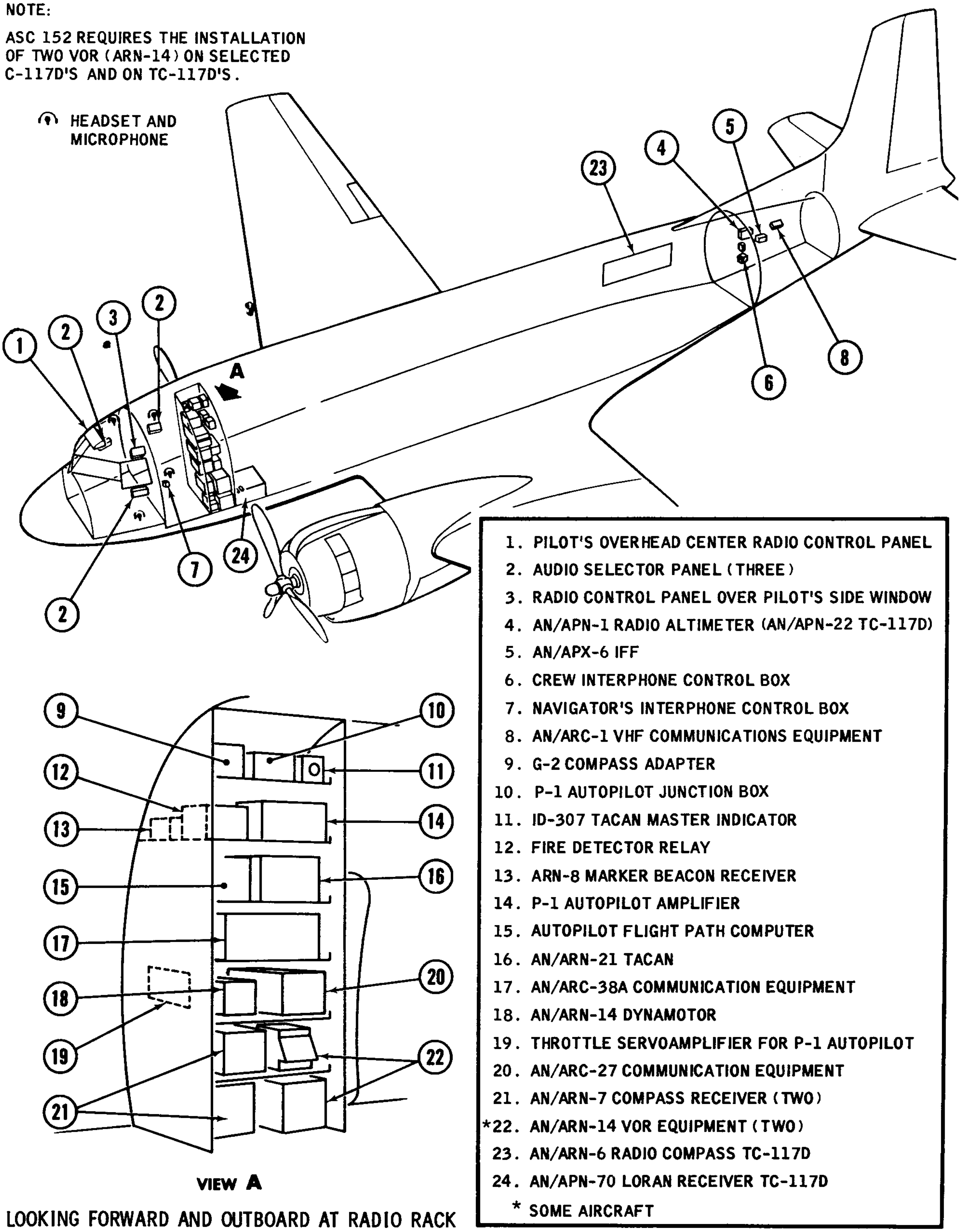
Refer to table 1-1 for list of communication and associated electronic equipment.

AUDIO SELECTOR PANELS

Audio selector panels (figures 1-25 and 1-26) are located under both the pilot's and copilot's side windows and overhead above the radio operator's station. In addition to the three audio selector panels for the pilot, copilot, and radio operator, there is an interphone control box for the navigator, located on the left side of the fuselage at the navigator's station, and there is a cabin station interphone control box, located on the bulkhead aft of the main cargo door. Each of the three audio selector panels for the pilot, copilot, and radio operator are edge-lighted. The navigator's interphone and the cabin interphone control boxes are not edge-lighted, as the only control necessary for the navigator and cabin stations is the volume and selector control for the interphone communication "crew" and interphone communication "all" stations. Each control box contains jacks for a microphone and headset; also, provisions are made for emergency operation of only one receiver at a time. Nine toggle

NOTE:

ASC 152 REQUIRES THE INSTALLATION OF TWO VOR (ARN-14) ON SELECTED C-117D'S AND ON TC-117D'S.



VIEW A

LOOKING FORWARD AND OUTBOARD AT RADIO RACK

1. PILOT'S OVERHEAD CENTER RADIO CONTROL PANEL
2. AUDIO SELECTOR PANEL (THREE)
3. RADIO CONTROL PANEL OVER PILOT'S SIDE WINDOW
4. AN/APN-1 RADIO ALTIMETER (AN/APN-22 TC-117D)
5. AN/APX-6 IFF
6. CREW INTERPHONE CONTROL BOX
7. NAVIGATOR'S INTERPHONE CONTROL BOX
8. AN/ARC-1 VHF COMMUNICATIONS EQUIPMENT
9. G-2 COMPASS ADAPTER
10. P-1 AUTOPILOT JUNCTION BOX
11. ID-307 TACAN MASTER INDICATOR
12. FIRE DETECTOR RELAY
13. ARN-8 MARKER BEACON RECEIVER
14. P-1 AUTOPILOT AMPLIFIER
15. AUTOPILOT FLIGHT PATH COMPUTER
16. AN/ARN-21 TACAN
17. AN/ARC-38A COMMUNICATION EQUIPMENT
18. AN/ARN-14 DYNAMOTOR
19. THROTTLE SERVOAMPLIFIER FOR P-1 AUTOPILOT
20. AN/ARC-27 COMMUNICATION EQUIPMENT
21. AN/ARN-7 COMPASS RECEIVER (TWO)

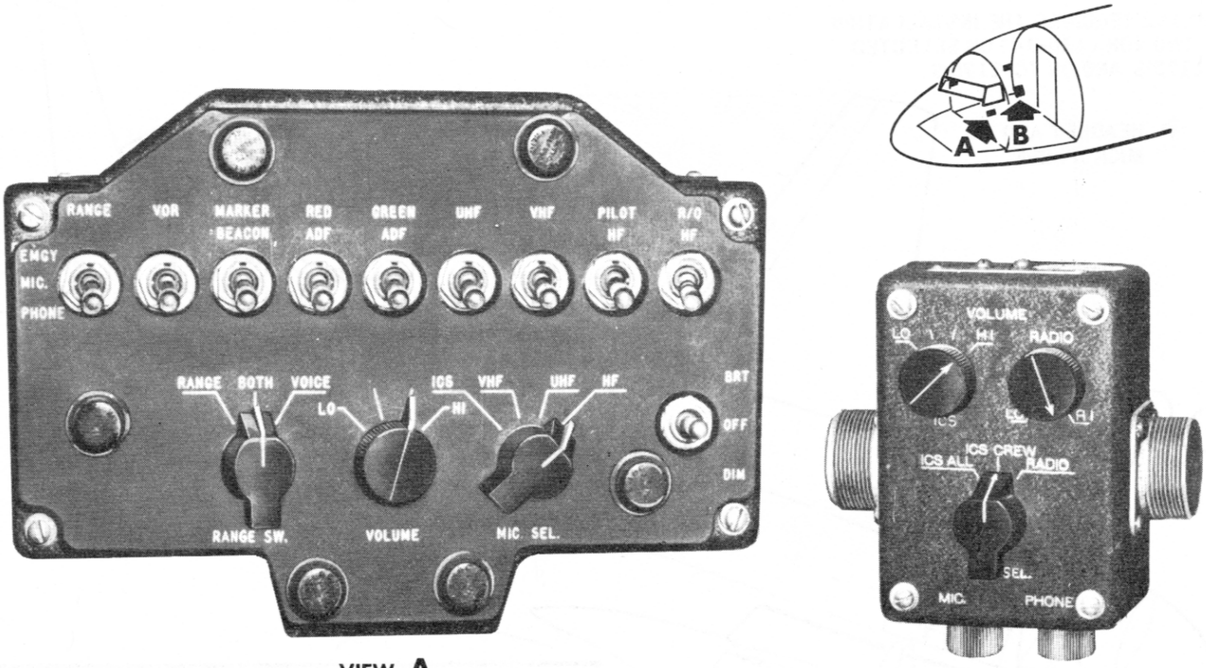
*22. AN/ARN-14 VOR EQUIPMENT (TWO)

23. AN/ARN-6 RADIO COMPASS TC-117D
24. AN/APN-70 LORAN RECEIVER TC-117D

* SOME AIRCRAFT

XX1-29

Figure 1-25. Communication and Electronic Equipment — Typical



VIEW A

PILOT, COPILOT, AND RADIO OPERATOR'S AUDIO SELECTOR PANEL

VIEW B

INTERPHONE CONTROL BOX

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Figure 1-26. Audio Selector Panel and Interphone Control Box

switches permit any combination of interphone or receiver listening desired on the pilot's, copilot's, and radio operator's audio selector panels. When the VOR switch is placed in the up (VOR) position, the VOR receiver will be monitored. If two VOR receivers are installed, a selector switch, located forward of the pilot's radio control panel above the pilot's side window (figure 1-4), is provided to allow monitoring of either the No. 1 or No. 2 VOR receiver. TACAN is also monitored when the VOR switch is selected. A range filter control is provided on each audio control box to permit the reception of either voice or range signals, or both, on the range and VOR receivers only. The navigator's and cabin area audio control boxes are identical, and contain a volume control and a control to select either the crew or all ICS. Microphone and headset jacks are located on the bottom of each of the two audio control boxes. The pilot's, copilot's, and radio operator's audio control boxes are connected directly to the interphone-radio control junction box. The volume control on these boxes is inoperative on the marker beacon and the RED ADF receivers. Both the navigator's and the cabin station interphone control boxes are connected to the interphone-radio control junction box through the main radio junction box.

AN/AIA-2A INTERPHONE SYSTEM

The AN/AIA-2A interphone equipment provides communication between all crewmembers. Dc power is supplied through circuit breakers, located on the mai circuit breaker panel and radio operator's junction box.

The interphone equipment may be ground checked as follows:

1. Power supply – ON

2. Make certain that the ON-OFF switch on the interphone amplifier is in the ON position. (Normally the switch is safety-wired ON.)

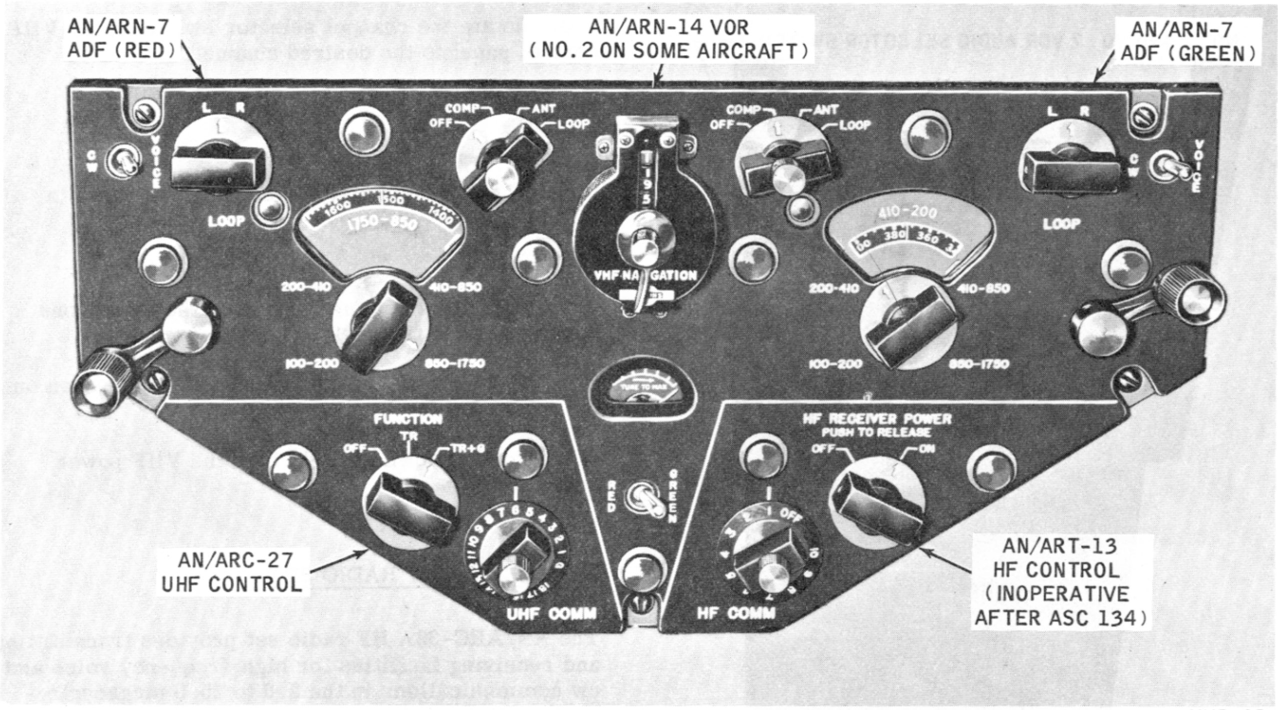
3. Set the volume control on an interphone control box for maximum output, and set the filter switch on BOTH. Plug the microphone and headset into the interphone control box jacks.

4. Turn the microphone selector switch to ICS.

5. Press the push-to-talk microphone button and talk into the microphone. A loud signal should be heard in the headset.

AN/ARC-27 UHF TRANSMITTER-RECEIVER

The AN/ARC-27 UHF communication equipment is designed to provide communication in the frequency range of 225.0 to 399.9 megacycles. The equipment provides 1750 frequency channels. The UHF



XX1-31

Figure 1-27. Pilot's Overhead Radio Control Panel

transmitter-receiver is operated from the pilot's overhead radio panel (figure 1-27) and through the audio selector control panels for the pilot, copilot, and radio operator. A UHF local channel selector is located at the radio operator's station (figure 1-30).

Any of the 18 channel preset frequencies, plus guard, may be selected from the pilot's remote control and any of the 1750 frequencies can be selected or the preset frequencies changed by the radio operator on the local channel selector. The equipment operates on 28-vdc power through a circuit breaker located on the main circuit breaker panel.

OPERATION OF UHF RADIO

To turn the equipment on, rotate the function switch to the desired type of operation.

CAUTION

To preclude damage to the equipment, allow at least 1 minute for the set to warm up before operating.

SWITCH POSITION	FUNCTION
OFF	Transmitter-receiver off
T/R	Transmitter on in standby Main receiver on Guard receiver off
T/R & G	Transmitter on in standby Main receiver on Guard receiver on

NOTE

If all 18 channels are preset to required frequencies, the local control should be set to LOCAL prior to changing frequencies (figure 1-30). The use of two blank adjacent channels is recommended for frequency selection during IFR operations.

AN/ARC-1 VHF COMMUNICATION TRANSMITTER-RECEIVER

The AN/ARC-1 VHF communication equipment (figure 1-28) is a transmitter-receiver operating in VHF range of 108 to 155.88 megacycles on multiple

Figure 1-28. Pilot's Radio Control Panel

fixed-frequency, crystal-controlled channels and on one guard channel. The distance over which communication can be conducted with this equipment varies considerably. Under normal conditions, reliable communication may be expected over line-of-sight distances. The receiver section features background noise-squelch operating from a predetermined noise level and modified or delayed AVC, allowing reception on the selected main-channel frequency, plus monitoring of a separate guard channel frequency. While the equipment is in service, a cover on the front panel protects the crystal units, the control knobs, the radio receiver sensitivity adjustment, the squelch-disabling switch, the test jacks, and a secondary power control switch. The transmitter-receiver, located in the aft compartment, includes all of the equipment necessary for transmission and reception of voice signals in the VHF range. The transmitter-receiver is controlled from the pilot's overhead VHF control unit, located above the pilot's side window, and operates through the audio selector panels. Electrical power for the VHF communication equipment is supplied by the 28-vdc circuit through a circuit breaker on the main circuit breaker panel.

This equipment is operated from the VHF command radio control panel (figure 1-4), located above the pilot's side window as follows:

1. VHF power switch – ON

2. Receiver toggle switch on interphone control box – VHF. Microphone selector switch – VHF

3. Rotate the channel selector switch on the VHF control panel to the desired channel.

NOTE

Allow approximately 30 seconds for radio to warm up.

4. Adjust the volume control on the interphone control box for the desired output.

5. To transmit, press the push-to-talk button on the microphone.

6. To shut down the set, turn the VHF power switch OFF.

AN/ARC-38A HF RADIO SET

The AN/ARC-38A HF radio set provides transmitting and receiving facilities for high-frequency voice and cw communications in the 2.0 to 25.0 megacycle range. Frequencies from 2.0 to 14.2495 megacycles may be selected in 500-cps steps. From 14.250 to 25.0 megacycles, frequencies are available in increments of 1000 cps. Twenty individual frequencies may be preset and selected as channels at the radio operators C-1398/ARC-38A control unit. The communications facilities provided by this set are also available to the pilots through a remote control panel, located on the pilot side panel (figure 1-4), and through their interphone system controls. The set utilizes the overhead wire antenna for both the transmission and reception of radio signals. Dc and ac are supplied through circuit breakers located on the radio operator's junction box.

The AN/ARC-38A HF radio set provides reception of amplitude modulated, single-sideband, frequency shift keying, and cw radio signals. Provision is made to transmit a single sideband, suppressed carrier signal or an equivalent AM signal (AME). This type of signal can be received on a conventional AM receiver.

A meter switch is located on the receiver-transmitter and is used to select the circuit to be connected to the meter during equipment checks.

PILOT'S AN/ARC-38A RADIO CONTROL PANEL

The pilot's AN/ARC-38A radio control panel (figure 1-29) is located forward of the pilot's side window opening lever (figure 1-4). Controls on the panel consist of the power switch, channel selector, volume control, and sensitivity control.

NOTE:

ARC-38A PILOT'S CONTROL LOCATED ON PILOT'S SIDE PANEL.

* APPLIES TO AIRCRAFT REWORKED PER ASC 134 AND GENERAL AIRFRAME CHANGE 2.

Figure 1-29. Pilot's AN/ARC-38A Radio Control Panel

POWER SWITCH. The power switch is a two-position toggle switch with positions marked PWR and OFF. The switch is used to control the application of power to the set and is effective only when the MAN-LOCAL-REMOTE switch (on the radio operator's panel) is in the REMOTE position.

CHANNEL SELECTOR. The channel selector is a rotary-type switch that is used to select any one of 20 preset channels. The switch is effective only when the MAN-LOCAL-REMOTE switch is in the REMOTE position.

VOLUME CONTROL. The volume control knob controls the audio gain of the receiver during phone AME (PH position for AN/ARC-38 installations) or SSB/FSK operation.

SENSITIVITY CONTROL. The sensitivity control knob controls the rf gain of the receiver during phone AME (PH position for AN/ARC-38 installations) or SSB/FSK operation.

RADIO OPERATOR'S AN/ARC-38 OR AN/ARC-38A CONTROL PANEL.

The following controls are located on the control unit of the C1398/ARC-38 or C3428/ARC-38A at the radio operator's station, (figure 1-30).

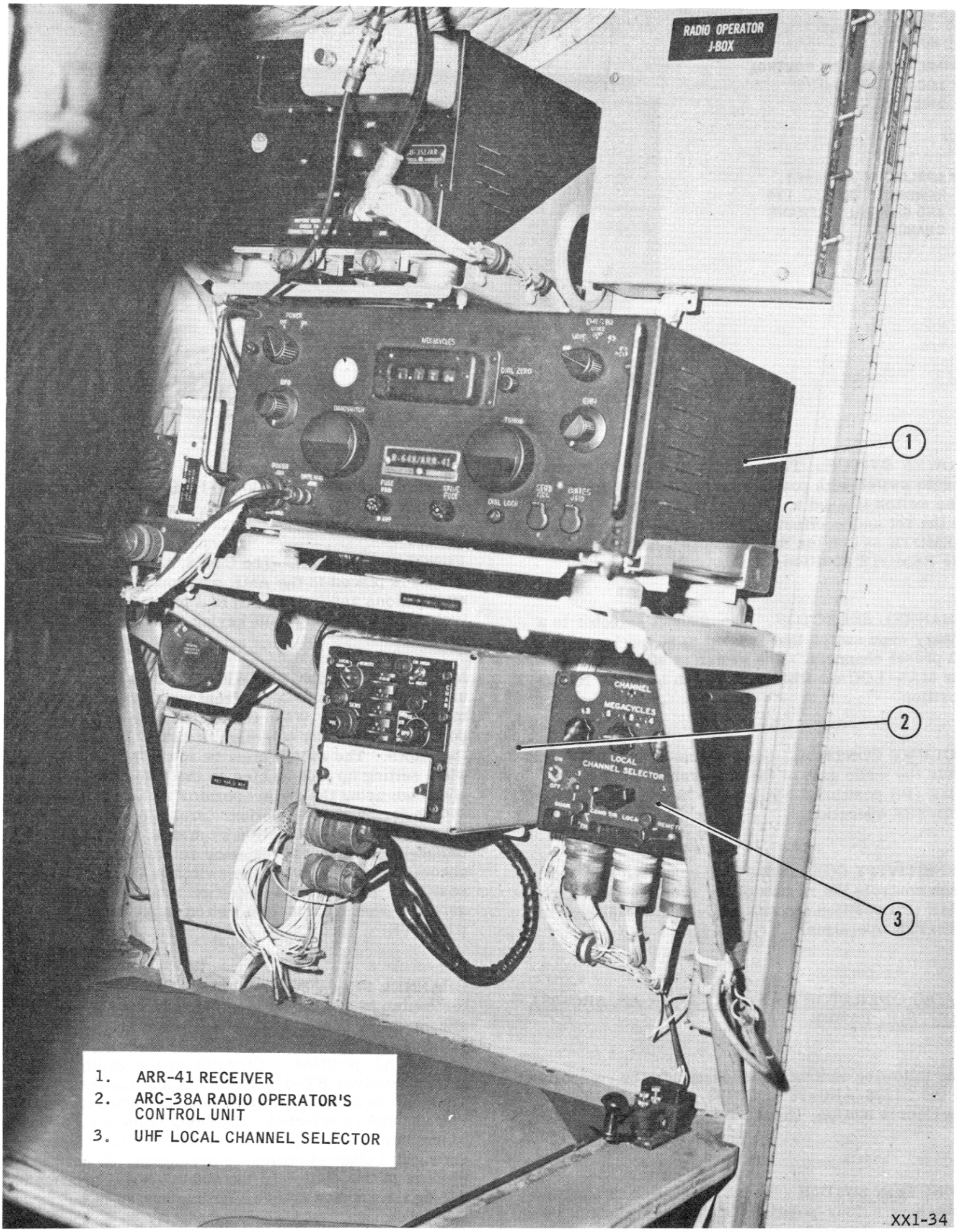
FUNCTION SWITCH. The C1398/ARC-38 function switch is a four-position, rotary-type switch used to control the application of power to the set and to select the type of emission. The switch must be placed in the PH position for voice communications, and in either of the CW positions for cw transmissions. PH operation is automatically selected when the man-local-remote switch is in the REMOTE position.

FUNCTION SWITCH. The C3428/ARC-38A function switch is placed in the AME position for voice communications and in the SSB/FSK for single sideband (voice) or frequency shift keying (teletype).

MAN-LOCAL-REMOTE SWITCH. This switch is used to select the location from which frequencies may be selected. When the switch is in the REMOTE position, frequency selection is under the control of the pilots. The switch must be in the LOCAL position when setting up frequencies on the "memory drum" and when using the radio operator's channel selector switch for channel selection (preset frequency). Manual frequency selection by means of the four thumb-wheel manual frequency selectors can be accomplished only when the switch is in the MAN position. AME or SSB operation is automatically selected when the function switch is placed in REMOTE.

CHANNEL SELECTOR SWITCH. The channel selector switch is a thumb-wheel which is used to select any one of 20 preset frequencies. For the switch to be effective, the man-local-remote switch must be in the LOCAL position. Circuits in the radio transmitter receiver RT-594/ARC-38A automatically tune the equipment to the proper frequency whenever a new channel is selected. Changing from one channel to another is accomplished normally within 15 seconds. If a channel change is necessary, do not attempt to transmit until the 400-cps note, produced during the antenna coupler loading cycle, is no longer heard.

MANUAL FREQUENCY SELECTORS. The manual frequency selectors consist of four thumb-wheels



1. ARR-41 RECEIVER
2. ARC-38A RADIO OPERATOR'S CONTROL UNIT
3. UHF LOCAL CHANNEL SELECTOR

Figure 1-30. Radio Operator's Station – Typical arranged vertically in the upper half of the control unit. These thumb-wheels are used for manual frequency selection in accordance with instructions contained in the operating manual, which is located in a slot under the hinged door of the control unit. (The manual contains a list of all available frequencies from 2.0 to 25.0 megacycles, memory drum settings, and manual switch setting for each frequency listed.) The man-local-remote switch must be in the MAN position during manual frequency selection.

CW XMSN-CW RECPT SWITCH. This switch is used to disable the dynamotor (when in the CW RECPT position) to permit monitoring the received radio signal without operating the dynamotor. Since the dynamotor is used during CW transmissions only, this switch provides a means of shutting off the dynamotor to preclude unnecessary operation of the unit. When a transmission is to be made, the switch must be moved to the CW XMSN position which places the dynamotor in operation.

VOLUME CONTROL. This control is used to adjust audio gain when the function switch is in the PH, AME, or SSB/FSK position, or to adjust rf gain when the function switch is in one of the CW positions.

AN/ARR-41 RECEIVING SET

The AN/ARR-41 receiving set (figure 1-30) is a superheterodyne receiver that provides continuous reception of rf signals within the frequency ranges of 190 to 550 kilocycles and 2.0 to 25.0 megacycles. The set will receive both voice and cw signals. All operating controls are located on the front panel of the receiver which is installed in the radio operator's station (figure 1-30). Frequency selection is accomplished manually by the radio operator; incoming signals can be monitored by the pilots by means of audio selector switches on their interphone master control boxes. The set requires dc power, which is supplied through the AN/ARR-41 circuit breaker on the main circuit breaker panel, for operation.

AN/ARR-41 CONTROL PANEL

All operating controls for the AN/ARR-41 receiving set (figure 1-30) are located on the front panel of the receiver.

POWER SWITCH. The power switch is a two-position (ON-OFF) switch that functions as the primary control for the application of power to the set.

EMISSION SWITCH. This five-position switch is used to select voice, cw, or calibrate mode of receiver operation. For radiotelephone reception, a broad-band (9.4 kcs) filter is connected when the switch is in the VOICE position and a narrow-band (1.4 kc) filter is connected when it is in the VOICE SHP position. For cw reception, either a broad-band or a narrow-band filter is connected when the switch is in either the CW or the CW SHP position. Receiver selectivity is increased to filter out interference when the emission switch is in either of the SHP positions, VOICE or CW. The proper circuitry is connected for receiver frequency calibration when the switch is in the CAL position.

BAND SWITCH. The band switch is used to select the reception frequency in one-megacycle increments. It operates the extreme left wheel of the megacycles indicator. When the band switch is operated within the frequency range of 4 through 8 megacycles, two detent positions are required to change the frequency one megacycle. Do not attempt to tune the receiver with the frequency indicator at half-megacycle positions.

TUNING CONTROL. The tuning control operates the three right counter wheels of the megacycles indicator for frequencies less than 1 megacycle. Interpolation to within 0.1 kilocycles is possible with the use of the arrow located at the right of the extreme right counter wheel. The tuning control should be rotated in a counterclockwise direction to increase frequency when tuned below 4 megacycles and clockwise when tuned above 4 megacycles. A certain amount of overlap is obtained when the tuning control is rotated to either the maximum clockwise or the maximum counterclockwise positions. Within the range of this overlap, which is approximately 20 kilocycles, the reading on the megacycles indicator is meaningless. Care should be taken not to mistake this overlap range with the correct frequency range. If the tuning control is ever rotated to either maximum position, an error may result in the megacycles indicator, necessitating recalibration.

DIAL LOCK. This control is used to lock the tuning control at a desired frequency. Turn in a clockwise direction to lock the tuning control.

GAIN CONTROL. The gain control is used to adjust the amplitude of the received audio signal.

SENSITIVITY ADJUSTMENT CONTROL. During normal operation, the control is set for maximum sensitivity (full clockwise direction). During reception of strong signals, interference can be cut down by rotating this control slightly in a counterclockwise direction which desensitizes the receiver.

BFO CONTROL. This control is used to adjust the tone of the beat signal during cw reception.

MEGACYCLES INDICATOR. The megacycles indicator consists of a narrow window behind which are four counter wheels that indicate the reception frequency. The extreme left-hand wheel is controlled by the bandswitch and indicates frequency in 1 megacycle increments. The three right-hand wheels are controlled by the tuning control and indicate frequencies less than 1 megacycle.

AN/ARC-5 RANGE RECEIVER

Low-frequency range signals are received by the range receiver equipment. The range receiver and dynamotor unit is located on the floor at the radio operator's position and is controlled by the pilot from a control panel (figure 1-4) located above the pilot's side window. The range receiver radio control panel (figure 1-28) contains a mechanical tuning control for the range receiver and a sensitivity control. An audio selector switch is installed on the pilot's, copilot's, and radio operator's audio selector panels. Power is supplied to the range receiver equipment from the aircraft's 28-vdc circuit through a circuit breaker located on the main circuit breaker panel. The equipment is on whenever dc power is available on the aircraft.

AN/ARN-7 AUTOMATIC RADIO COMPASSES – RED AND GREEN

Two AN/ARN-7 automatic radio compasses are installed in the aircraft. One radio compass is designated as the RED radio compass and the other is designated as the GREEN radio compass. The frequency range of each radio compass unit is 100 to 1750 kilocycles covered in four bands. The RED compass receiver is located on the bottom shelf of the main radio rack. The GREEN compass receiver is located on the shelf above the RED compass receiver.

Two separate controls are installed on the pilot's overhead radio control panel (figure 1-27) for mechanical tuning of the two compasses. Both loop and sense antennas are used in the operation of the two receivers. Dc power is supplied through circuit breakers on the main circuit breaker panel and ac power is supplied through fuses in the ac radio fuse box.

The automatic compasses may be operated by either pilot. The automatic radio compass control panels are located on the pilot's overhead radio control panel (figure 1-27). A bearing indicator is installed for each pilot. Operate the automatic radio compass as follows:

1. Power switch – ON
2. Receiver toggle switch on interphone control box – RED ADF or GREEN ADF
3. Function switch on automatic compass control panel – COMP, ANT, or LOOP, as desired.
4. Select desired frequency by use of frequency selector control.
5. Turn power switch OFF to turn off equipment.

AN/ARN-14A (VHF NAVIGATION RECEIVERS (TWO-SOME AIRCRAFT)

The AN/ARN-14A (VHF) navigation receiver with the associated indicators provides the pilot, copilot, and navigator with reception of all omnirange, localizer, and visual-aural navigation frequencies in the range of 108.0 to 135.9 megacycles. The receiver also provides reception of voice facilities. The navigation information is observed on the course indicators mounted on the main instrument panel. The remote controls for operation of the receiver are located on the pilot's overhead radio control panel (figure 1-27) and on the radio control panel above the pilot's side window when two receivers are installed (figure 1-4). Electrical power for operation of the navigation equipment is supplied by both the 115-vac and 28-vdc power supply systems through circuit breakers on the main circuit breaker panel and radio ac fuse box.

AN/ARN-14A CONTROLS

VHF NAVIGATION SELECTOR CONTROLS. The VHF navigation selector controls on the pilot's overhead radio control panel and the control panel above the pilot's side window provide for selection of frequencies in megacycles and tenths of megacycles. The small knob in the center of the selector control turns the receiver ON and provides volume control.

AN/ARN-18 GLIDE PATH RECEIVER

The AN/ARN-18 glide path equipment, consisting of a receiver and an antenna, provides vertical guidance during an ILS approach. The signal received from the glide path transmitter on the ground operates the horizontal pointer on the ID-249A course indicator to provide a continuous indication of the established glide path. When two VOR receivers are installed, the ILS glide path indication is displayed on the No. 2 ID-249. When the VHF navigation selector on the pilot's center overhead radio control panel is tuned to the desired localizer frequency, the companion glide path frequency is automatically selected. Dc power is supplied through a circuit breaker located on the main circuit breaker panel.

AN/ARN-21 RADIO SET (TACAN)

AN/ARN-21 radio set (TACAN) is designed to operate in conjunction with a surface navigation beacon. The airborne and surface equipments form a radio navigation system which enables an equipped aircraft to obtain continuous indications of its distance and bearing from any selected surface beacon located within a line-of-sight distance from the aircraft up to 195 nautical miles. Distance information is displayed on the ID-310/ARN-21 range indicator and bearing information is displayed on ID-250/ARN radio magnetic indicator and the No. 2 ID-249. When two VOR receivers are installed, the TACAN bearing indication is displayed on the No. 2 ID-249. The radio control panel is installed on the radio control panel over the pilot's side window (figure 1-4). Dc power is supplied through a circuit breaker on the main circuit breaker panel and ac power is supplied through a fuse in the radio fuse box.

NOTE

Allow 90 seconds for the radio set to warm up in the receive (REC) position prior to selecting the transmit (T/R) position.

AN/ARN-21 CONTROLS

CHANNEL SELECTOR. The channel selector consists of a coaxial rotary switch for selecting the desired navigation beacon channel. The outer dial selects the tens and hundreds figures of the beacon channel number and the inner knob selects the units figures of the beacon channel number. Combinations of dial settings may be made from 00 to 129. The equipment, however, only operates on channels 01 to 126, a total of 126 channels. (No attempt should be made, at any time, to set the channel selector dial below 01 or above channel 126).

VOLUME CONTROL. This volume control adjusts the volume level of an audio identification signal received from the beacon. The identification signal, audible in the pilot headphones when they are connected to the regularly used audio jack, consists of a two or three letter tone signal in international morse code. The VOR switch must be selected on the interphone control box. VOR and TACAN identification will be received.

ID-310A/ARN RANGE INDICATOR. The ID-310A/ARN range indicator is installed in the pilot instrument panel and has a single window through which distance is indicated in nautical miles between the aircraft and the surface beacon. The numerals in the window are electronically controlled by the receiver-transmitter range circuits and serve to display the results computed electronically by these circuits. The maximum range is 195 nautical miles. While the indicator is searching for the correct range, the rapidly rotating numbers are partially covered by a red flag which warns the operator against reading incorrect distance indications.

FALSE LOCK-ON

TACAN equipment will occasionally lock-on to a false bearing 40 degrees or a multiple of 40 degrees in error. These errors can be on either side of the correct bearing. To check for false lock-on or when it is suspected, proceed as follows:

1. When using TACAN, cross-check for false lock-on with ground radar, airborne radar, VOR, dead reckoning, or other available means. These cross-checks are especially important when switching channels or when turning set on.

2. If a false lock-on is suspected, switch to another channel, check it for correct bearing, and then switch back to desired channel.

3. Check for correct lock-on.

4. If false lock-on is still suspected, turn set OFF and then to REC.

5. Recheck for correct lock-on.

6. If false lock-on persists, utilize other equipment or aids available.

NOTE

TACAN can be utilized during an emergency if the magnitude and direction of error can be determined.

AN/ARN-8 MARKER BEACON RECEIVER

The AN/ARN-8 marker beacon receiver is designed to receive signals transmitted from a 75-megacycle ground beacon transmitter, and to deliver an aural and visual indication of the received signal to the pilot and copilot. From these indications, aircraft position can be accurately checked. Marker beacon indicator lights, one mounted on the ID-249A course indicator and another on the ID-48 deviation indicator, will illuminate each time a marker beacon signal is received. Aural signal indication is provided by the audio selector switch on the audio selector panel. The marker beacon receiver is automatically turned on when power is supplied to the aircraft's dc bus. Power is supplied through a circuit breaker on the main circuit breaker panel.

AN/ARN-8 CONTROLS

AUDIO SELECTOR SWITCHES. The marker beacon audio selector switches, located on the audio selector panel (figure 1-26) at the pilot's, copilot's and radio operator's stations, connects the audio output of the receiver to the respective headphones when the switch is placed in the UP position.

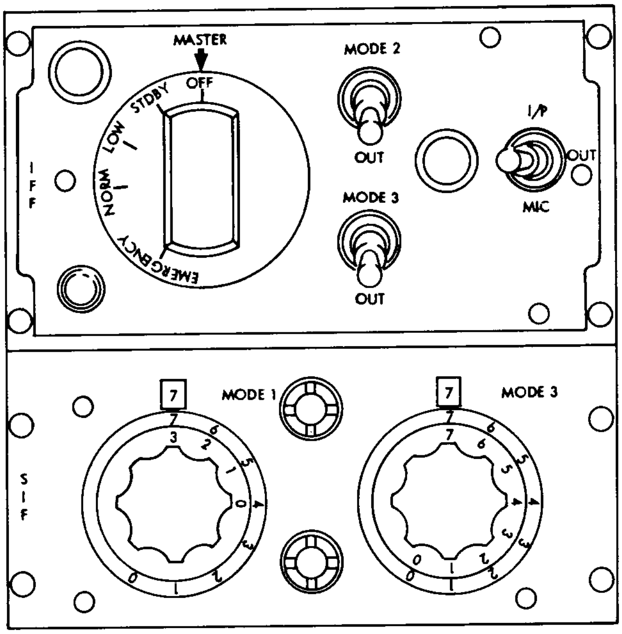


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Figure 1-31. AN/APX-6 and AN/APA-89 Control Panels

MARKER BEACON INDICATOR LIGHTS. Two (three on some aircraft) marker beacon indicator lights are mounted on the main instrument panel, one (two on some aircraft) at the pilot's station and one at the copilot's station. While the aircraft is flying over a marker beacon transmitter, the indicator light should remain on or flash regularly, depending upon the type of transmission received.

AN/APX-6 RADAR IDENTIFICATION SET

The purpose of the AN/APX-6 radar identification set is to provide automatic radar identification transmissions of the aircraft when the aircraft is challenged by surface or airborne Mark 10 radar sets using specific coded-pulse transmission. In addition, the set provides transmission of an emergency reply in which a special coded aircraft identification is transmitted in response to compatible interrogations.

The AN/APX-6 operates in conjunction with the AN/APA-89 video coder which is capable of being interrogated in three modes. The control panel (figure 1-31) is located above and behind the pilot's seat. The AN/APX-6 receives dc power through a circuit breaker located on the main circuit breaker panel and ac power through a fuse located in the radio fuse box.

AN/APX-6 CONTROLS

MASTER CONTROL SWITCH. The master control switch has five positions: OFF, STDBY, LOW, NORM, and EMERGENCY. In the OFF position the identification set is deenergized; in the STBY position power is supplied to the set, but the receiver portion is not sensitized and no replies can be transmitted. Selecting the LOW position causes the receiver to operate at reduced sensitivity, and replies will be transmitted upon receipt of strong mode 1 interrogation signals.

Positioning the switch to NORM selects maximum receiver sensitivity and the transponder will reply to normal mode 1 interrogations. When in the EMERGENCY position, the receiver has maximum sensitivity and a distinctive signal is transmitted only upon receipt of mode 1 interrogations.

Mode-2/OUT SWITCH. The two-position MODE-2/OUT switch is used to select mode-2 interrogations and responses.

MODE-3/OUT SWITCH. The MODE-3/OUT switch is used to select mode 3 interrogations and responses.

I-P/OUT/MIC SWITCH. The I-P/OUT/MIC switch is spring loaded in the IP position and is used to select the type of radar set interrogation and response. Positioning the switch to I-P causes a double reply in mode 1 to a mode 1 interrogation while switch is being held and for 30 seconds after release. Selecting the MIC position causes a double reply in mode 1 to a mode 1 interrogation when the UHF radio communications transmitter is being operated by the pilot. The OUT position is neutral.

AN/APA-89 VIDEO CODER GROUP

The purpose of the AN/APA-89 video coder group is to operate in conjunction with and modify the characteristics of the AN/APX-6 radar identification set. The video coder group provides a selective identification feature (SIF) for the Mark 10 IFF system. Pulse-train coded replies are provided by the video group for transmission by the radar identification set operating in any one of its operational modes. These pulse-train signals enable the aircraft to identify itself automatically as friendly whenever it is properly challenged by friendly surface and airborne equipment. In addition, the coder provides a two-train coded reply automatically for pilot identification, and a four-train coded reply to interrogations during the emergency mode of operation. The control panel for the AN/APA-89 video coder is located below the AN/APX-6 control. The APA-89 receives power through the APX-6.

MODE-1 AND MODE-3 SELECTOR SWITCHES. The mode-1 and mode-3 coaxial-type rotary selector switches, placarded MODE-1 and MODE-3, consist of dual concentric knobs which actuate inner and outer shafts. The skirts of these knobs contain translucent numerals which mark the setting of the selected two number code opposite the fixed arrow marker. Starting and stopping the coder group is accomplished by operating the AN/APX-6 radar identification set.

AN/APN-1 RADIO ALTIMETER

The AN/APN-1 radio altimeter equipment provides direct measurement of absolute altitude during flight from 0 to 4000 feet. The altitude indicator is located on the left side of the pilot's instrument panel. The altitude indicator is calibrated in feet and operates on a low or high scale selected by the range switch, located on the altitude indicator. The low setting of the range switch selects a scale of 0 to 400 feet on the indicator. The high setting of the range switch operates the indicator on a scale of 0 to 4000 feet. An altitude limit switch is located on the pilot's instrument panel below the radio altimeter indicator. A predetermined minimum altitude setting may be selected by the switch. During flight, the red indicator light located on the pilot's instrument panel will be ON when the terrain is below the minimum altitude setting on the switch The low limit indicator light is connected to the dimming relay assembly in the main electrical junction box. Electrical power for the radio altimeter is supplied by dc power through a circuit breaker located on the circuit breaker panel.

The AN/APN-1 radio altimeter equipment is operated from the pilot's station as follows:

1. Turn power switch on radio altimeter indicator ON.

2. Allow 1 minute for tubes to heat and observe that indicator has moved from stop position to some other position indicating that equipment is energized.

3. Set range switch to desired altitude range.

WARNING

Do not use 4000-foot range below 400 feet. The high range of the AN/APN-1 radio altimeter cannot be relied upon below 500 feet over water and 600 feet over land. Below these altitudes, when in high range, the indicator will usually read high and may fail to read below 400 feet no matter how close to the terrain the aircraft may actually be flying. Therefore, when flying under conditions of poor visibility, the AN/APN-1 indicator should always be in low range.

4. Set altitude limit switch for desired preset altitude.

AN/APN-22 RADIO ALTIMETER (TC-117D)

The AN/APN-22 radio altimeter is a microwave altimeter that measures the terrain clearance of the aircraft and will provide reliable operation within ranges of 0 through 10, 000 feet over land and 0 through 20, 000 feet over water. The accuracy of indication is within 2 feet from 0 to 40 feet and within 5 percent of the indicated altitude from 40 to 20, 000 feet. The dropout altitude (the altitude at which the signal becomes too weak to operate the system) is above 10, 000 feet when flying over land and above 20, 000 feet when flying over water. The altitude of the aircraft is displayed on a single-turn type indicator. A reliability circuit disables the indicator and puts the needle behind a mask to prevent the pilot from using the indication when the signal is too weak to provide reliable operation. An adjustable bug pointer at the outside of the calibrated scale can be preset to any desired altitude and used as a reference for flying at fixed altitudes. The altitude of the aircraft is then easily maintained by observing the position of the pointer with respect to the bug without considering the actual scale calibrations or by observing the red light that shows at the front of the indicator. The red light is actuated by the limit indicator system to indicate flight at or below a preset altitude. The limit altitude is indicated by the movable bug pointer which is set to the desired altitude by rotating the ON-LIMIT control on the front of the indicator. Power is supplied through a circuit breaker on the main circuit breaker panel and the ac radio fuse box.

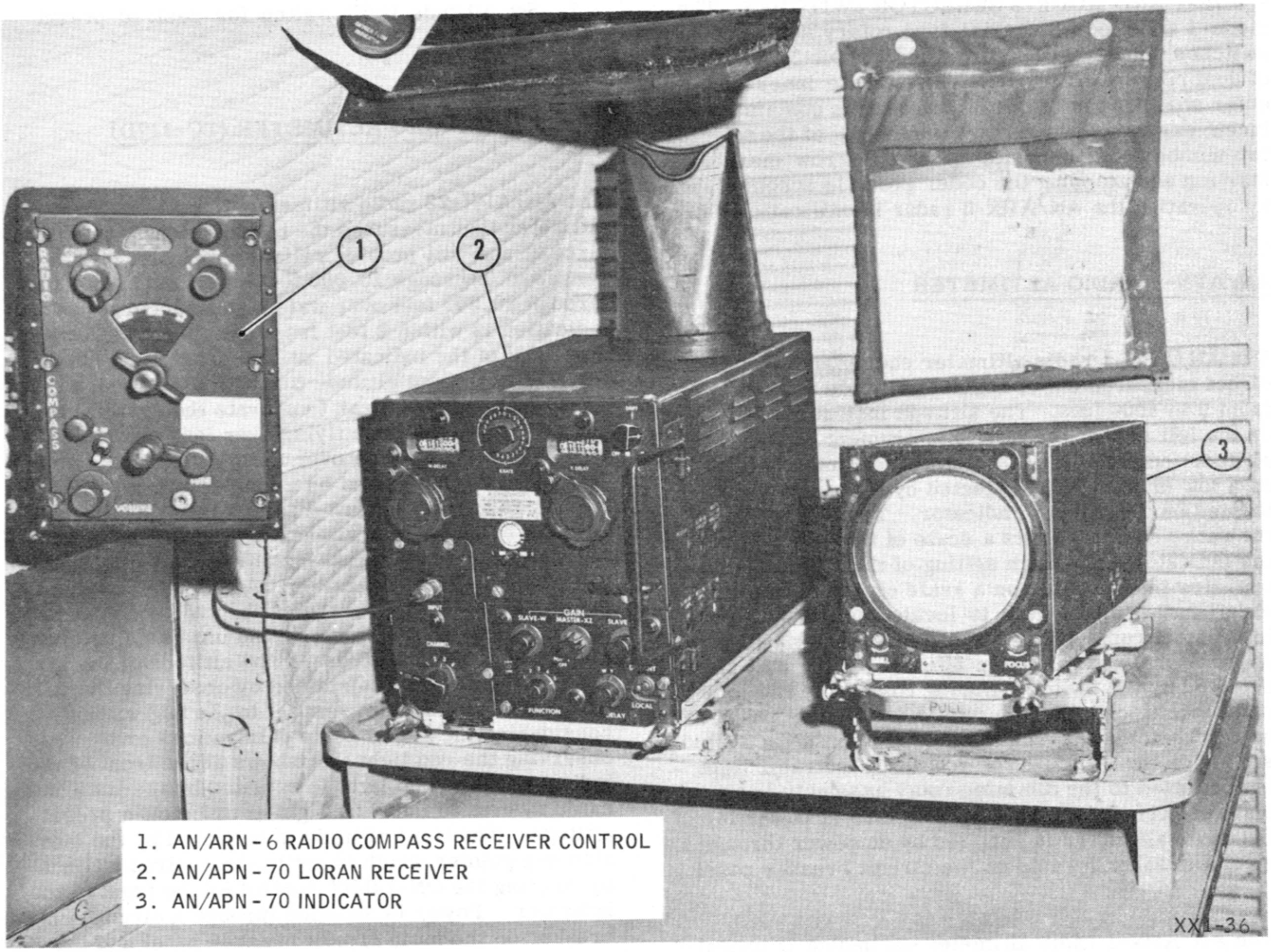
AN/APN-22 ON-LIMIT CONTROL. The on-limit control turns the set on and selects the limit altitude for the limit indicator system.

AN/APN-22 LIMIT INDICATOR LIGHT. The limit indicator light on the indicator is energized by the limit indicator system when flying at or below the preset altitude.

AN/APN-70 LORAN RECEIVER (TC-117D)

The AN/APN-70 Loran receiver is airborne equipment which includes a receiver, a 5-inch cathode ray tube indicator (figure 1-32), and an antenna coupler. This equipment enables the operator to identify pairs of Loran transmitting stations and to measure the microsecond time difference in the signals received from these stations.

Using this information, the operator can determine the aircraft line of position by referring to his Loran Navigation Chart. The geographical location of the



1. AN/ARN-6 RADIO COMPASS RECEIVER CONTROL
2. AN/APN-70 LORAN RECEIVER
3. AN/APN-70 INDICATOR

Figure 1-32. Forward Student's Station TC-117D

aircraft is fixed by obtaining such lines of position from two pairs (or a triad) of Loran transmitters and noting their point of intersection. A dual delay system allows one reading to be retained while the other is being taken. The six-channel (preset) crystal controlled superheterodyne receiver provides RF amplification, detection and video amplification of the received Loran signal. The receiver operates over the standard high frequency Loran band from 1700 kilocycles to 2000 kilocycles and on the low frequency bands of 90 kilocycles to 110 kilocycles and 170 to 190 kilocycles.

NOTE

Low frequency (100 to 180 kilocycles) channels are not used at the present time.

The present Loran operating frequencies in these bands are preset and designated as follows:

High Frequency Loran

Channel 1 - 1950 kilocycles

Channel 2 - 1850 kilocycles

Channel 3 - 1900 kilocycles

Channel 4 - 1750 kilocycles

Power is supplied through circuit breakers located on the right forward cabin fuse panel.

AN/APN-70 CONTROLS

MASTER-XZ GAIN CONTROL. The master-XZ gain control functions as a power switch and a gain control. Power is applied to the receiver when the control is rotated away from the POWER OFF position. Further rotation of the control in a clockwise direction increases the amplitude of the master signals.

SLAVE-W GAIN CONTROL. The slave-W gain control increases or decreases the amplitude of the slave signals, providing the HF-delay control is in the W position during high frequency operation (Channels 1 through 4). During low frequency operation (Channels 5 and 7), the slave-W gain control regulates the amplitude of the received signals in the W-gain portion of the lower trace on the indicator screen.

SLAVE-Y GAIN CONTROL. During high frequency operation, the slave-Y gain control regulates the amplitude of the slave signals, providing the HF-delay control is in the Y position. During low frequency operation, it regulates the amplitude of the Y-gain portion of the upper trace on the indicator screen.

HF-DELAY CONTROL. The HF-delay control is used to select either the W-delay or the Y-delay system of the receiver during high frequency operation. The selection of either system by the operator is optional. The control provides the operator with a means of retaining one Loran reading while another is being taken on the alternate delay system. This arrangement in effect, provides the operator with two Loran receivers whereby he can obtain almost simultaneous readings on two pairs of Loran transmitters, and, in addition, provides a standby delay timer system in the event that the other fails. During low frequency operation both delay systems are automatically utilized and the HF-delay control is inoperative.

CHANNEL SELECTOR SWITCH. The channel selector is a six-position, rotary-type switch used to select a desired Loran channel. The channel positions are divided into an HF band with four positions (channels 1 through 4) and an LF band with two positions (channels 5 and 7).

FUNCTION SWITCH. The five-position, rotary-type function switch is used to select five separate indicator displays. In FUNCTION 1, the indicator displays all signals received on the selected frequency channel. In FUNCTION 2, the sweep is expanded to cover the pedestal portions of the traces seen in FUNCTION 1. In this function only those signals on the pedestal tops will be seen. In FUNCTION 3, the sweep is further expanded to cover only the first third of the previous pedestal presentation and the master and the slave traces are superimposed for use in taking a fix on the pair of Loran transmitters. FUNCTION 4 is similar to FUNCTION 2 but uses less trace separation and is more suitable for navigation (homing) along a fixed line of position. With the switch in FUNCTION 5, an interval marker source is coupled into the deflection circuits for self-checking of the system.

R-RATE SELECTOR SWITCH. The R-rate selector switch is a rotary-type switch, which is used to select the pulse repetition rate of the chosen Loran channel as determined from the operator's Loran Chart.

ADC SWITCH. The ADC switch is used to turn on the automatic drift control feature of the Loran receiver. The ADC causes the received pulses to lock on the leading edge of the nearest pedestal. If two pulses appear on one trace, the master pulse should be moved to the master pedestal by means of the L-R switch.

DRIFT CONTROL. The drift control consists of the rotary knob located above the ADC switch. The control is used to cause the pulse to drift to the right or left, or, when in the center position, to stand still. When used in conjunction with the ADC, it may be used to cause the signal to drift right or left to the leading edge of a pedestal where it will lock on.

L-R SWITCH. The L-R switch is a spring-loaded, two-position, toggle switch that is used to move the pulses right or left, as required, to the pedestals.

W-DELAY AND Y-DELAY CONTROLS. The W-delay and Y-delay controls are used to adjust the receiver variable delay system to equal the elapsed-time interval of the received pair of Loran transmitters under measurement. The value of the indicated time difference is displayed on decade-type revolution counters, which are mechanically linked to the W-delay and Y-delay controls. This indicated time difference is obtained by comparing the elapsed-time interval between the received master and slave pulses to a variable time interval generated within the receiver. Movement of the delay controls causes the slave pedestal to move left or right, as required, to place the pedestal under the slave pulse. During high frequency operation, use of either the W-delay or the Y-delay control is determined by the setting of the HF delay control.

IP-58/APN-70 INDICATOR

The IP-58/APN-70 indicator (figure 1-32) is remote from the R-277/APN-70 receiver. The indicator uses a 5-inch cathode ray tube for the display of two sweeps and signals when present. The intensity and focus for the sweeps is controlled by respective screwdriver-adjustment controls.

AN/ARN-6 RADIO COMPASS RECEIVER (TC-117D)

The AN/ARN-6 radio compass installation (ADF) provides visual and aural reception of radio signals for navigation purposes. The receiver is remotely controlled from the forward student stations by control panels. (figure 1-32). The AN/ARN-6 is equipped with a radio magnetic indicator (ID-250/ARN), installed in the navigator's instrument panels. Dc and ac power are provided through circuit breakers on the main circuit breaker panel and ac fuse located forward in the cabin.

VOR-ADF-TACAN SELECTOR SWITCHES

Two VOR-ADF-TACAN selector switches are located on the main instrument panel and are placarded "Pilot's RMI Double bar selector" and "Copilot's RMI Double bar selector".

PILOT'S RMI SINGLE BAR SELECTOR (SOME AIRCRAFT)

A selector switch is located on the main instrument panel to control the instrument presentation on the pilot's No. 1 VOR CDI and No. 1 needle of the pilot's RMI.

ID-250 RADIO MAGNETIC INDICATORS

Two ID-250 radio magnetic indicators are mounted on the main instrument panel, one at the pilot's station and one at the copilot's station. The magnetic heading is indicated on the circular scale by the fixed index at the top of the indicator.

ID-249A COURSE INDICATOR (TWO - SOME AIRCRAFT) AND ID-48 DEVIATION INDICATOR (CROSS-POINTERS)

The ID-249A course indicator, mounted on the main instrument panel at the pilot's station, displays information from the AN/ARN-14, AN/ARN-21 and AN/ARN-18 receivers. On aircraft equipped with two VOR receivers, the No. 1 ID-249 is associated to the No. 1 VOR; the No. 2 ID-249 is associated with the No. 2 VOR, TACAN, and ILS glide path receiver. The course selected by the SET control knob is indicated in the COURSE window, and a TO FROM window indicates whether the course is to or from the omnirange station. In the event the omnirange signal fails, the TO FROM indicator will assume a centered position, indicating neither TO nor FROM. Flag-type indicators will indicate OFF if the signals are unreliable. A relative heading pointer indicates the angle between the heading of the aircraft and the course set into the COURSE window. In addition to the course indicator at the pilot's station, an ID-48 deviation indicator is installed on the copilot's side of the main instrument panel, and provides the same function as the pilot's No. 2 course indicator, except that the course cannot be selected.

PILOT'S NAVIGATION RADIO INSTRUMENT PRESENTATION

The No. 2 (double bar) needle on the pilot's RMI (figure 1-33) displays either VOR, co-pilot's (Green) ADF, or TACAN information, as selected by the pilot's RMI double bar selector. The pilot's CDI will display VOR information with the double bar selector in either the VOR or ADF position. TACAN information will be displayed with the double bar selector in the TACAN position.

On aircraft equipped with two VORs, the pilot's No. 1 CDI always displays information from the No. 1 VOR. The No. 1 (single bar) needle on the pilot's RMI displays information from either the No. 1 VOR or the pilot's (Red) ADF, as selected with the pilot's RMI single bar selector switch. The pilot's No. 2 CDI will display No. 2 VOR information with the double bar selector switch in either the No. 2 VOR or copilot's ADF positions. TACAN information will be displayed with the double bar selector switch in the TACAN position. The glide slope indicator on the No. 2 CDI will be operative whenever an ILS station pair is tuned on the No. 2 VOR.

WARNING

With the pilot's double bar selector switch in the TACAN position and an ILS station pair tuned on the VOR, it is possible to attempt an ILS approach using TACAN course information and ILS glide slope information.

COPILOT'S NAVIGATION RADIO INSTRUMENT PRESENTATION

The No. 1 needle on the copilot's RMI always displays copilot's (Green) ADF information. The No. 2 needle on the copilot's RMI displays either VOR, pilot's (Red) ADF, or TACAN information as selected with the copilot's RMI double bar selector switch. The copilot's CDI repeats information displayed on the pilot's CDI.

On aircraft equipped with two VORs, the copilot's CDI repeats information displayed on the pilot's No. 2 CDI.

ANTENNAS

All antennas are externally mounted (figure 1-34).

LIGHTING EQUIPMENT

All lights are wired to the 24- to 28-vdc power supply through their respective circuit breakers and on-off switches or rheostats.

EXTERIOR LIGHTING

WING LEADING EDGE LIGHTS

Two lights are installed, one on each side of the fuselage to illuminate the leading edges of the wing to detect ice formation. The lights are controlled by an ON-OFF switch on the left electrical panel (figure 1-11).

LANDING LIGHTS

A sealed beam, electrically actuated, retractable landing light is installed on the under side of each outer wing panel. Each light is controlled by a three-position switch marked EXTEND, OFF, and RETRACT, and an ON-OFF switch located on the left electrical panel (figure 1-11).

CAUTION

Protracted operation of the landing lights while on the ground should be avoided, as the lack of a cooling airstream may cause damage to the lights. For maximum airspeed for landing light extension, refer to Operating Limitations.

NAVIGATION POSITION LIGHTS

The navigation position lights consist of a green light on the right wingtip, a red light on the left wingtip, a red and a white light in the tail cone tip, and a top and bottom fuselage white light that are controlled by a three-position switch on the left electrical panel (figure 1-11). The switch positions are STEADY, OFF, and FLASH. When the switch is placed in the FLASH position, the wingtip lights and white tail light flash on and off alternately with the red light in the tail cone and the top and bottom fuselage lights. When the switch is placed in STEADY position, the wingtip lights and the white tail light will be on continuously.

NOTE

Failure of the flasher mechanism will result in a steady illumination of the wingtip lights and the white light in the tail cone.

ANTICOLLISION LIGHT

A rotating red light is installed on top of the vertical stabilizer as part of the navigation light system. A circuit breaker on the main circuit breaker panel protects the circuit. An anticollision light ON-OFF switch is located on the pilot's left electrical panel.

INTERIOR LIGHTING

FLIGHT COMPARTMENT FLOODLIGHTS

Red floodlights are installed on the pilot's, copilot's, and control pedestal positions. The pilot's and control pedestal floodlights are controlled from one dimming rheostat control located on the side of the fuselage below the pilot's windshield, and the copilot's floodlight is controlled from another located on the side of the fuselage below the copilot's windshield (figures 1-4 and 1-5). A white floodlight is installed for the main junction box and circuit breaker panel and is controlled by a switch-type circuit breaker on the circuit breaker panel. A portable light is mounted above the pilot's and copilot's stations.

INSTRUMENT LIGHTING

All instruments on the main instrument panel are equipped with individual masked lights, controlled by three rheostats. Each pilot's flight panel lighting is controlled by a rheostat under the windshield (figure 1-4 and figure 1-5) and the engine panel is controlled by a rheostat on the left electrical panel (figure 1-11). The magnetic compass light is controlled by a dimming switch on the left electrical panel (figure 1-11).

ELECTRICAL PANEL LIGHTING

Both electrical panels are provided with edge lighting controlled by a rheostat on the left electrical panel (figure 1-11). The interphone control panels have panel lights controlled by a dimming switch at each panel.

FLEXIBLE TABLE LAMPS

Flexible table lamps, each equipped with a dimming rheostat, are provided for the radio operator and navigator.

DOME LIGHTS

CABIN DOME LIGHTS. Five dome lights are mounted down the center of the cabin, four of which are controlled by a rheostat located overhead at the forward end of the cabin. The entrance dome light is controlled by a rheostat located adjacent to the light.

LAVATORY DOME LIGHT. One dome light is installed in the lavatory and is controlled by an ON-OFF switch adjacent to the light.

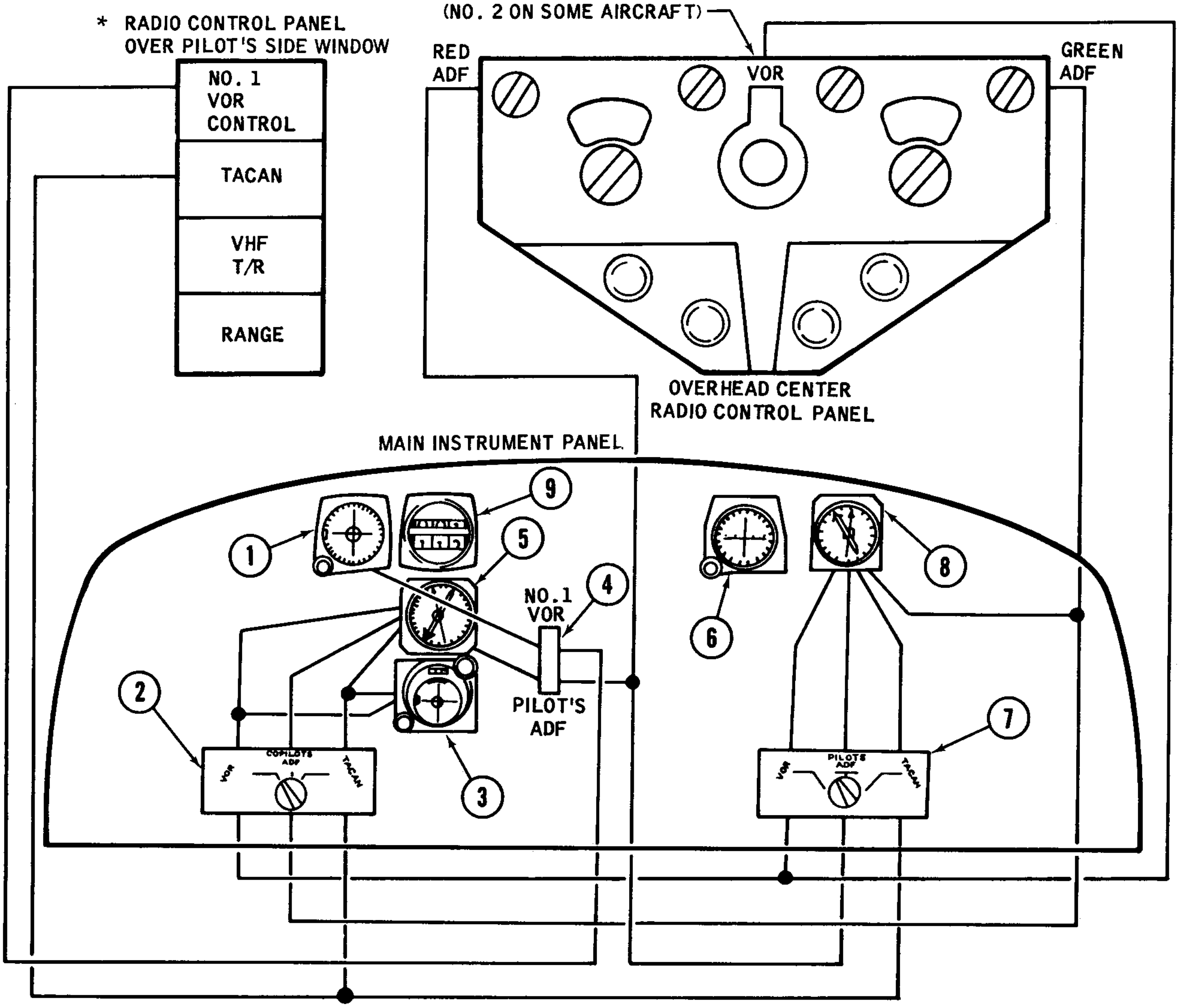
PASSENGER AIRCRAFT CABIN LIGHTING

On VC-117D aircraft, there are eight reading lights, which are controlled by individual switches mounted on the base of each light, on each side of the cabin. There are six dome lights controlled by two two-way switches from the cockpit or buffet (figures 1-11 and 1-41). The four forward dome lights also may be controlled by individual switches.

OXYGEN SYSTEM

CREW COMPARTMENT OXYGEN SYSTEM

Oxygen for the pilot, copilot, and radio operator is supplied by one 514-cubic inch manual shutoff cylinder located behind the pilot's seat and one 514-cubic



1. * PILOT'S NO. 1 VOR CDI ID-249
2. PILOT'S RADIO MAGNETIC INDICATOR DOUBLE BAR SELECTOR
3. PILOT'S NO. 2 VOR CDI ID-249
4. * PILOT'S RMI SINGLE BAR SELECTOR
5. PILOT'S RMI ID-250
6. COPILOT'S CDI REPEATS PILOT'S NO. 2 VOR CDI SELECTION ID - 48
7. COPILOT'S RADIO MAGNETIC INDICATOR DOUBLE BAR SELECTOR
8. COPILOT'S RMI ID-250 (SINGLE BAR NO. 1 NEEDLE COPILOT'S ADF ONLY)
9. TACAN DME ID-310

NAVIGATION RADIO INSTRUMENT PANEL DIAGRAM

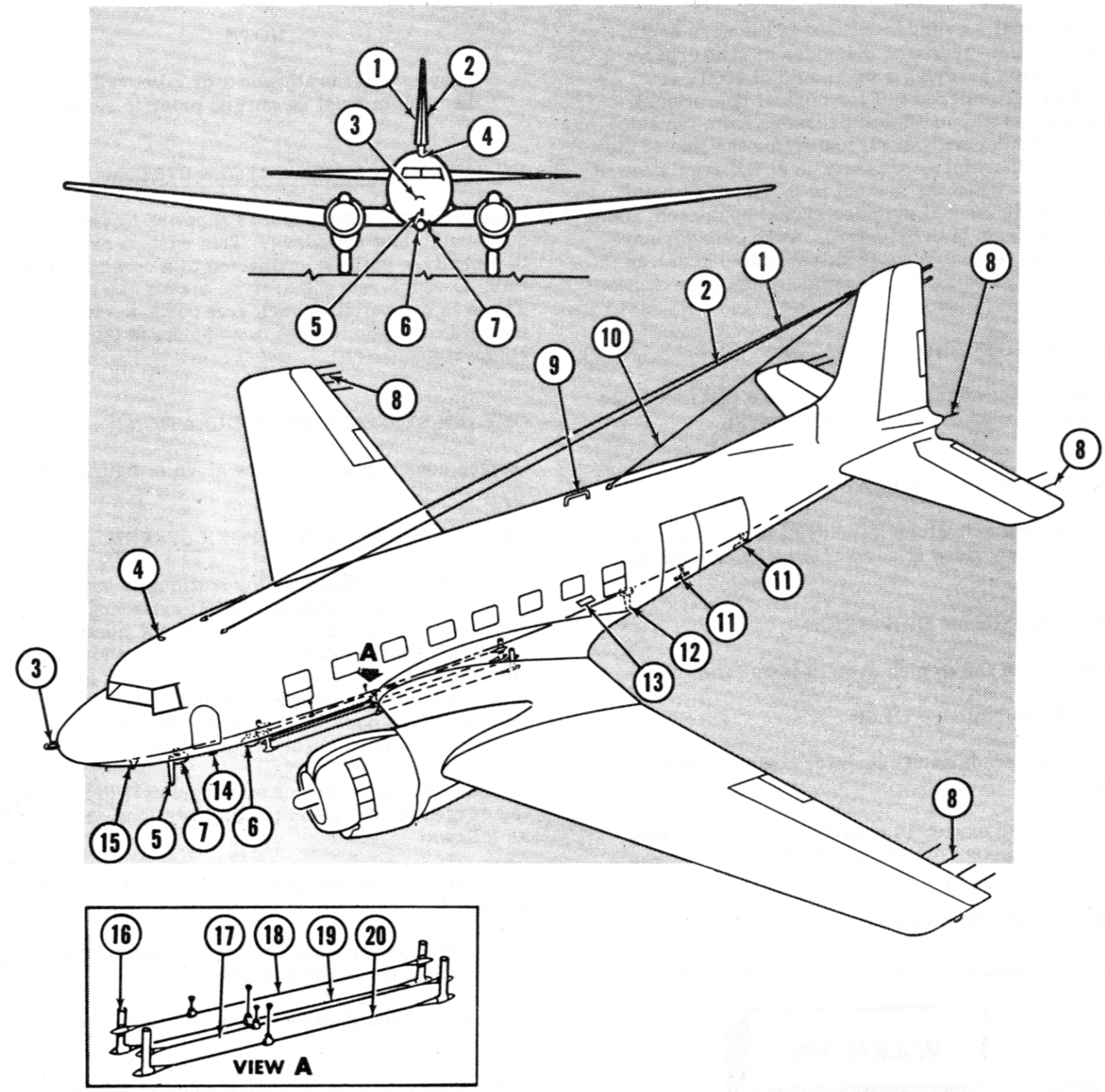
ILS LOCALIZER AND GLIDEPATH DISPLAYED ON NO. 2 VOR CDI AND COPILOT'S CDI WHENEVER PILOT'S RMI DOUBLE BAR SELECTOR IS SET TO VOR OR ADF POSITION. IT IS POSSIBLE TO USE THE GREEN ADF ON THE DOUBLE BAR (NO. 2 NEEDLE) WHEN FLYING AN ILS APPROACH.

*NOT INSTALLED ON ALL AIRCRAFT. WHEN TWO VORS ARE INSTALLED, THE FOLLOWING NOTES APPLY:

1. COPILOT UNABLE TO DISPLAY ANY NO. 1 VOR INFORMATION.
2. ILS GLIDEPATH INFORMATION DISPLAYED ON NO. 2 VOR CDI (ID-249) AND COPILOT'S CDI (ID-48) ONLY.

XX1-37

Figure 1-33. Navigation Radio Instrument Panel Diagram



1. HF LIAISON ANTENNA
2. LORAN ANTENNA (TC MODEL)
3. GLIDEPATH ANTENNA
4. VOR ANTENNA
5. VHF COMMAND ANTENNA
6. ADF LOOP ANTENNA (GREEN)
7. ADF LOOP ANTENNA (RED)
8. STATIC DISCHARGERS
9. ADF LOOP (TC MODEL)
10. SENSE ANTENNA (TC MODEL ARN-6)
11. ALTIMETER ANTENNAS
12. IFF RADIO MAST INSTALLATION
13. MARKER BEACON ANTENNA
14. TACAN ANTENNA
15. UHF COMMAND ANTENNA
16. ANTIPRECIPITATION STATIC ANTENNA MAST
17. RANGE ANTENNA
18. GUY WIRE
19. SENSE ANTENNA (RED)
20. SENSE ANTENNA (GREEN)

XX1-38

Figure 1-34. Radio Antennas

inch automatic cylinder located in the nose section. Both are high-pressure cylinders of shatterproof construction carrying a maximum of 2000 psi (1800 psi considered full for normal operations). There is no way to shutoff pressure from the automatic cylinder without disconnecting the line at the cylinder; therefore, pressure is at the regulators at all times. When the system is in use, the shutoff valve on the manual cylinder should be opened, using pressure from both cylinders. Both cylinders are recharged through a filler valve located under an inspection plate on the underside of the nose section.

DILUTER-DEMAND REGULATORS

Three diluter-demand regulators are installed, one at each regular crew member's station.

OXYGEN SYSTEM INDICATORS

Oxygen flow indicators (blinker gage) and pressure gages are provided at each crewmember's station.

OXYGEN SYSTEM OPERATION

Operation of the oxygen system is as follows:

1. Shutoff valve – OPEN

2. Diluter-demand regulator control – NORM OXYGEN

3. If pure oxygen is required, diluter-demand regulator control – 100% OXYGEN.

OXYGEN SYSTEM SUPPLY DURATION

Oxygen consumption data are given in figure 1-35.

WARNING

- Smoking is not permitted when oxygen is being used on aircraft.

- Do not allow oil or grease to come in contact with oxygen storage, or regulating and using equipment.

NOTE

Cylinders should be serviced prior to flight when pressure is less than 1200 psi.

PRESSURE LIMITS

FULL	1800 ± 50 psi
NORMAL	1200 to 1800 psi
MINIMUM (prior to flight)	1200 psi
MINIMUM (during flight)	250 psi

NOTE

If any cylinder is allowed to drop below 250 psi, the system must be purged prior to reuse.

VC-117D MAIN CABIN OXYGEN SYSTEM

Oxygen for the main cabin is supplied by two 63.7-cubic foot cylinders. This system has 21 bayonet-type outlets, connected to a common supply line, to which rebreather-type masks can be attached. There is one outlet at each seat position, including the lavatory, and the two crew bunks in the aftermost compartment.

OXYGEN SYSTEM SUPPLY DURATION

Oxygen consumption data are given in figure 1-36.

TC-117D MAIN CABIN OXYGEN SYSTEM

Oxygen for the cabin training stations is supplied by six 514-cubic inch manual shutoff cylinders of the same construction as those used in the cockpit. A filler valve and system pressure gage is located adjacent to the cylinders. When not being used for flight, all manual cylinders should be turned off and the regulators positioned to 100% OXYGEN. Hoses should be clamped to the strap provided.

To check the pressure of individual cylinders supplying oxygen for the cabin training stations, proceed as follows:

1. Ensure that all cylinder shutoff valves are turned off.

2. Bleed off pressure at any regulator by pushing in on bulb at center of regulator.

3. Open shutoff valve at one cylinder, and then turn it off.

4. Note pressure on gage located at any of regulator positions.

5. Bleed off pressure as noted in step 2.

6. Check remaining cylinders as noted in steps 3 through 5.

To check for leaks, turns one or all of the cylinder shutoff valves on and then off. Monitor the pressure gage at any regulator. There should be no pressure drop within 5 minutes.

OXYGEN SYSTEM SUPPLY DURATION

To determine the oxygen capacity in man hours multiply the oxygen duration (hours) shown in figure 1-35 by three. Divide by the number of students or passengers (figure 1-36) to find oxygen duration per person.

CREWMEMBER'S
OXYGEN DURATION
(HOURS)

To obtain per crewmember oxygen duration, divide by the number of crewmembers

Numbers underlined indicate regulators set to 100%

CYLINDER PRESSURE (PSI)	ALTITUDE (THOUSAND FEET)		
	5	10	15
1800	15.2	17.6	16.6
	2.0	2.2	2.8
1600	13.6	15.6	14.8
	1.8	2.0	2.4
1400	11.8	13.6	13.0
	1.6	1.8	2.2
1200	10.2	11.8	11.0
	1.4	1.4	1.8
1000	8.4	9.8	9.2
	1.2	1.2	1.6
800	6.8	7.8	7.4
	0.8	1.0	1.2
600	5.0	5.8	5.6
	0.6	0.8	1.0
400	3.4	3.8	3.6
	0.4	0.4	0.6

Figure 1-35. Crew's Oxygen Consumption

PASSENGER'S
OXYGEN DURATION
(HOURS)

Oxygen Supply:
127.4 cubic feet
at 1800 psi

Note:

To obtain per passenger oxygen duration, divide by the number of passengers

CYLINDER PRESSURE (PSI)	ALTITUDE (THOUSAND FEET)			
	10	15	20	25
1800	30	28.3	23.	13.9
1500	24.3	22.6	16.5	11.
1200	17.9	16.8	13.9	8.1
900	12.1	11.6	9.3	5.8
600	5.8	5.8	4.7	2.9
300	DESCEND BELOW 10,000 FEET			

Figure 1-36. Cabin Oxygen Consumption

AUTOPILOT

The Pioneer P-1 autopilot is a gyroscopically controlled, electrically energized system, which automatically operates the flight control cable systems to maintain any desired magnetic heading and a normal stabilized attitude. In addition to the normal functions of the autopilot, the system provides a means of manual control of the automatic system for coordinated turns or for a change in bank or pitch attitude. The autopilot should be engaged with, or disengaged from the flight control system when the aircraft is in level flight. The electrical controls for manual operation of the autopilot in maneuvering the aircraft are grouped on the controller unit attached to the control pedestal (figure 1-6), and should be centered before engaging the autopilot. The autopilot electrical system is turned on whenever the main inverter switch is positioned to PILOT'S INSTR AC RADIO AND AUTOPILOT.

NOTE

> The autopilot system will not operate when the auxiliary inverter is the only source of ac power.

AUTOPILOT CONTROLS

MECHANICAL ENGAGING LEVER

The autopilot servos are mechanically engaged with the control surface cable systems by the single engaging lever on the control pedestal (figure 1-6). The lever has two positions: ENGAGE and DISENGAGE, and is spring loaded to prevent any intermediate positioning.

PITCH TRIM CONTROL

Aircraft pitch attitude is controlled by the pitch trim control knob (figure 1-37). Rotating the pitch trim control knob up results in a noseup attitude; rotating the knob down results in a nosedown attitude.

BANK TRIM CONTROL

The aircraft is controlled about the roll axis by the bank trim control knob (figure 1-37).

TURN CONTROL KNOB

The turn control knob (figure 1-37) produces coordinated turns of the aircraft at any speed.

AUTOPILOT DISCONNECT SWITCH

The autopilot may be instantly disengaged by depressing the autopilot disconnect switch on either control wheel (figure 1-4 and figure 1-5).

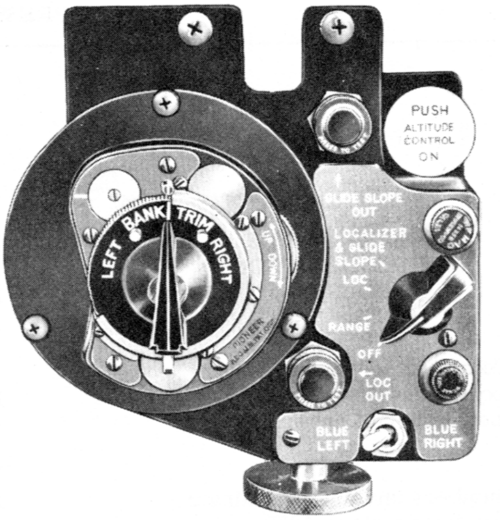


Figure 1-37. Autopilot Controller and Automatic Approach Selector Switch

NOTE

- If the main inverter switch is moved out of the PILOT'S INSTR AC RADIO AND AUTOPILOT position to either of the two remaining positions, the autopilot will automatically disengage.
- Gaging the pilot's gyro horizon will also disengage the autopilot.

ALTITUDE CONTROL SWITCH

The altitude of the aircraft may be automatically maintained by placing the altitude control switch ON. An interlock system prevents operation of the switch when the autopilot mechanical engaging lever is not in the ENGAGE position. Pitch trim shall not be adjusted with altitude control engaged.

AUTOPILOT OPERATION

TURNING ON AUTOPILOT

1. Make certain that main inverter is positioned at PILOT'S INSTR AC RADIO AND AUTOPILOT.

2. Center autopilot attitude and turning indices.

3. Mechanical engaging lever – ENGAGE. (Push full down, then full up to ENGAGE.)

NOTE

The autopilot should be disengaged for aircraft trimming purposes.

TURNING OFF AUTOPILOT

Mechanical engaging lever – DISENGAGE.

AUTOMATIC RANGE AND APPROACH EQUIPMENT

The automatic range and approach equipment is used to couple the autopilot and flux gate compass with radio signals from the AN/ARN-14A omnirange and localizer receiver and the AN/ARN-18 glide slope receiver to provide either automatic VOR range flight or automatic ILS approach.

AUTOMATIC APPROACH SELECTOR SWITCH

An automatic approach selector switch (figure 1-6) with positions OFF, RANGE, LOC, and LOCALIZER AND GLIDE SLOPE, is located adjacent to the autopilot controller unit (figure 1-37) on the aft face of the control pedestal. When the switch is in the OFF position, the automatic range and approach equipment is not coupled with the autopilot. When the switch is in the RANGE position, the automatic range and approach equipment couples the autopilot and VOR range signal, as selected on the pilot's overhead radio control panel, to maintain a selected radial course toward or away from the omnirange station. Placing the switch in the LOC position couples the autopilot with the selected localizer frequency to maintain center of course flight inbound toward the localizer transmitter. When the switch is in the LOCALIZER AND GLIDE SLOPE position, the autopilot is coupled with the selected localizer frequency to maintain center of course flight inbound toward the localizer transmitter. Power and controls are coordinated, when the glide slope is intercepted, to permit automatic descent on the ILS approach.

NOTE

Glide slope frequencies are paired with their respective localizer frequencies and are selected automatically.

BLUE RIGHT-BLUE LEFT SWITCH

A BLUE RIGHT-BLUE LEFT switch is located adjacent to the automatic approach selector switch (figure 1-37) on the aft face of the control pedestal. This switch permits the use of back course automatic approaches to the ILS stations. It reverses the signals to put the blue quadrant on the left, when inbound on the back course of an ILS station. The switch should be safetied in the BLUE RIGHT position, since there are few stations where back course ILS approaches are possible, and a normal approach cannot be made unless the switch is in the BLUE RIGHT position.

NOTE

The BLUE RIGHT-BLUE LEFT switch controls the input to the autopilot only. The pilot's visual indications do not change.

LOCALIZER OUT WARNING LIGHT

A 28-vdc red warning light, placarded LOC OUT, is located adjacent to the automatic approach selector switch (figure 1-37) on the aft face of the control pedestal. The warning light comes on when a malfunction occurs in either the localizer transmitting equipment or the aircraft localizer receiving equipment.

GLIDE SLOPE OUT WARNING LIGHT

A 28-vdc red warning light, placarded GLIDE SLOPE OUT, is located adjacent to the automatic approach selector switch (figure 1-37) on the aft face of the control pedestal. The warning light comes on when a malfunction occurs in either the glide slope transmitting equipment or the aircraft glide slope receiving equipment, or when the aircraft throttle friction lock is not completely released.

NAVIGATION EQUIPMENT

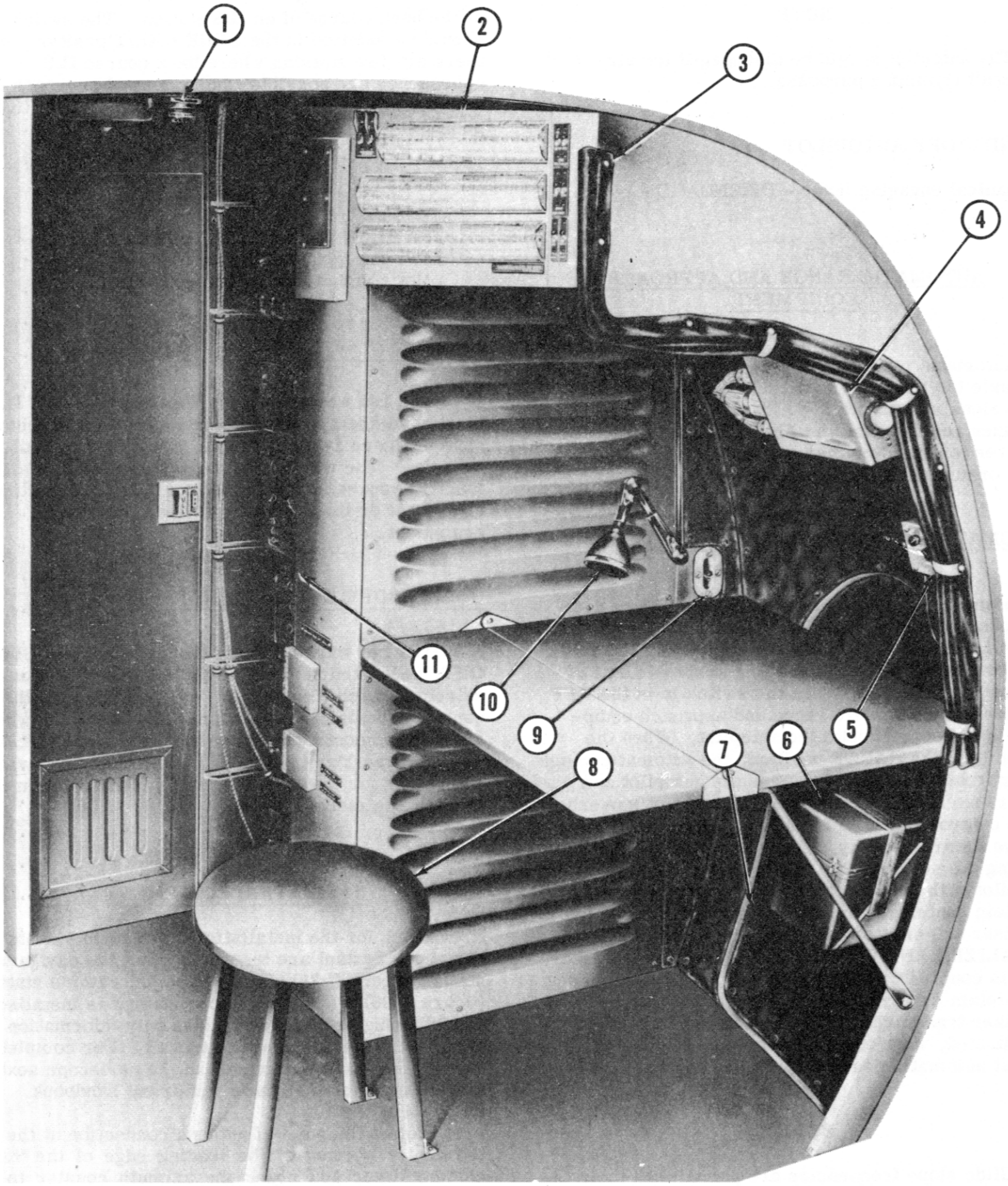
Provisions for the installation of a driftmeter and a periscope sextant are incorporated at the navigator's station (figure 1-38) and the radio operator's station (figure 1-30). If the periscope sextant is installed, the following procedure includes only information pertinent to this particular aircraft. For complete information on the alignment of the periscope sextant mount, refer to applicable equipment handbook.

1. Select the point of antenna connection at the top center portion of the leading edge of the vertical stabilizer and crank the azimuth counter to read 180.4 degrees.

2. When sighting on the object described above, the vertical reticle, target, and zero degrees (or N) on the azimuth scale should coincide within 1/4 degree, and the azimuth counter should have the reading of 180.4 degrees previously set in.

TC-117D CABIN ARRANGEMENT

The cabin is designed for training student navigators and is equipped with eight navigator tables.



1. PERISCOPIC SEXTANT MOUNT
2. MAIN CIRCUIT BREAKER PANEL
3. ANTIGLARE CURTAIN
4. JUNCTION BOX
5. INTERPHONE CONTROL BOX
6. SEXTANT STOWAGE
7. EMERGENCY ESCAPE DOOR
8. STOOL
9. MASTER EMERGENCY POWER CIRCUIT BREAKER SWITCH
10. FLEXIBLE TABLE LAMP
11. RADIO RACK

XX1-40

Figure 1-38. Navigator's Station

Three centerline periscopic sextant mounts are provided. Three type B-3 driftmeters are installed and are checked for alignment by sighting on the trailing tip of the aft AN/ARN-7 loop antenna. The bearing should be as follows:

DRIFTMETER POSITION	RELATIVE BEARING
Right	347-3/4 degrees
Left (forward)	011 degrees
Left (aft)	008 degrees

An AN/ARN-6, with two control panels located forward in the cabin, and one APN-70 Loran are also installed.

CARGO LOADING EQUIPMENT

Provisions for the use of a snatch block, an idler pulley, and a ring for securing an additional snatch block are installed to facilitate the loading of heavy cargo. The idler pulley is attached to the cargo door sill when in use. When not in use, the pulley is stowed on the main cargo compartment aft bulkhead.

TIEDOWN FITTINGS AND RINGS

Provision is made for tiedown rings, installed along the sides of the main cabin, and male tiedown fittings are used for securing cargo.

LOADING RAMPS

Provisions for the use of loading ramps are provided for the loading of heavy equipment. Holes for the attachment of the ramps are provided in the main cargo loading door sill.

TROOP CARRYING EQUIPMENT

Troop transport facilities are provided when seats for 35 troops are installed (figure 1-40). When the seats are installed for use they form two rows in the main cabin and a single row down each side. When the aircraft is not being used for transporting troops, the seats are secured against the sides of the fuselage by means of storage straps (figure 1-40).

PASSENGER TRANSPORTS

The VC-117D aircraft are designed as passenger transports and differ from the standard C-117D in the main cabin interior only (figure 1-39).

PASSENGER INTERIOR

There are provisions for carrying 16 passengers and 2 cabin attendants. Four divans are installed in the forward portion of the main cabin (figure 1-39), two on each side, separated by cabinets. The cabinet on the right is equipped with a modified broadcast receiver. Seven speakers are located throughout the cabin area, with individual volume controls installed on each speaker. The cabinet on the left has provisions for the storage of bottled beverages and glasses. Magazine racks, ash trays, and armrests are built into the divans. Removable sliding curtains are provided to give privacy to the occupants when the divans are made into beds. Storage space is provided under the divans for stowage of loose items, blankets and pillows. In the center section of the cabin, four reclining 360-degree swivel lounge chairs are installed. Provisions for installing a removable table in the center of the four chairs on the centerline of the aircraft are made. Trays also are provided for each chair. Immediately aft of the rear left swivel chair, a sliding telescopic leaf-type desk is installed, with a cabin interphone station. Individual reading lights and cold-air outlets are installed at each seat. Cabin attendant's call buttons are installed at each seat. A bulkhead is installed, with sliding doors, to separate the rear vestibule area from the rest of the cabin.

BUFFET

A buffet is installed in the vestibule area on the left side of the fuselage just to the left of the entrance door (figure 1-41). The buffet contains a top-loading ice-refrigerator, two hot cups, four stainless steel thermos bottles, two hot plates, and an interphone. Storage space is provided under the buffet for glasses, service and lunches. A cabin attendant's call chime and signal light are installed in the buffet.

MAIN CABIN WATER SUPPLY

These aircraft are provided with a 14-gallon heated water supply for washing purposes and for buffet uses (figure 1-2).

LAVATORY

A lavatory is installed on the right side of the fuselage directly across from the buffet (figure 1-39). A wash basin, a chemical-type flushing toilet, a vanity shelf, and mirror are installed in the lavatory. Dispensers for toilet paper, tissues, soap, and towels are provided. A 110-volt, 60-cycle converter is also installed for use with electric shavers, etc.

PARACHUTE RACK

A parachute rack is installed immediately aft of the lavatory (figure 1-39).

COATROOM

A cap and coatroom is installed aft of the parachute rack and has a longitudinal rod under a fixed shelf;

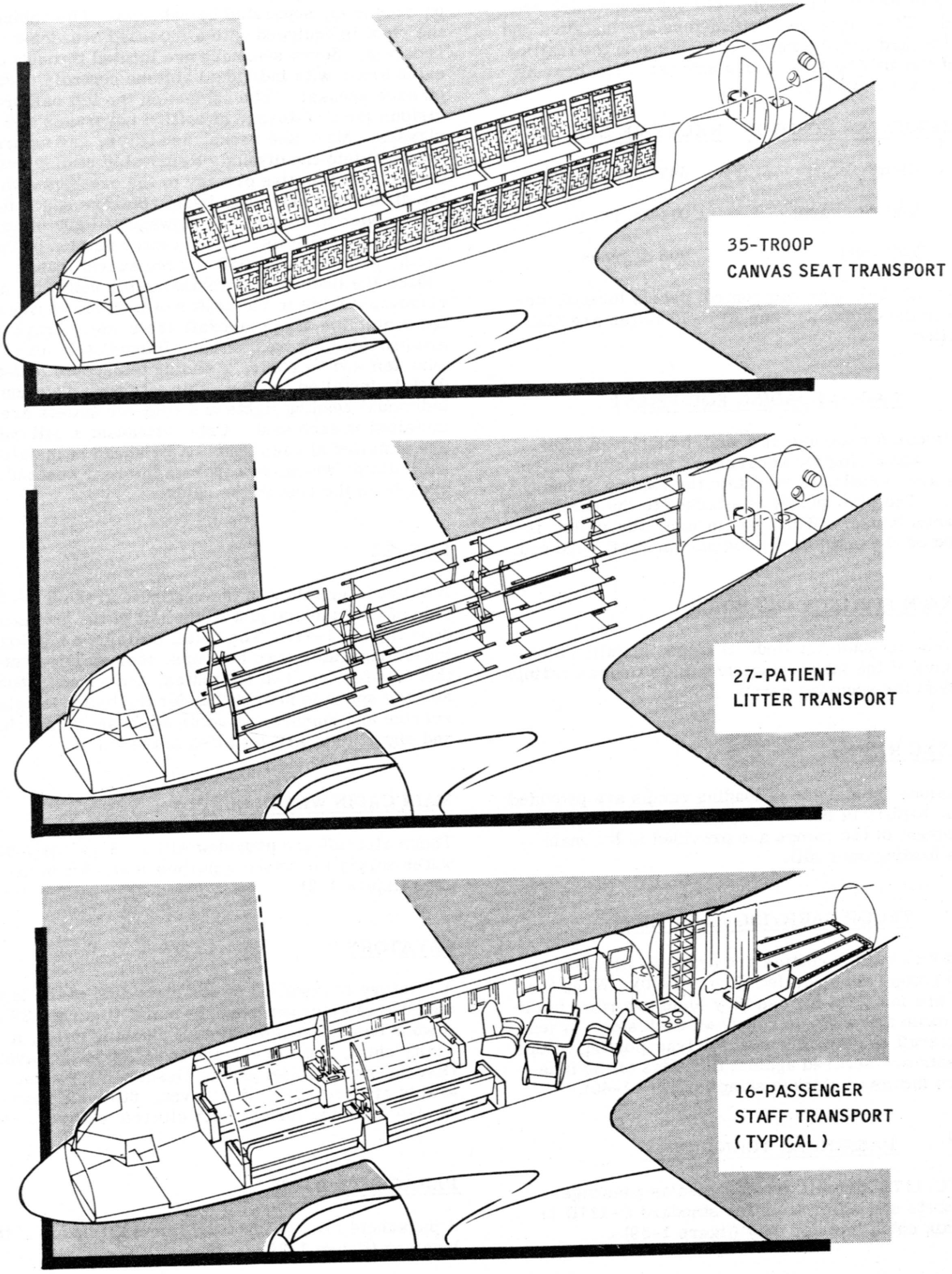
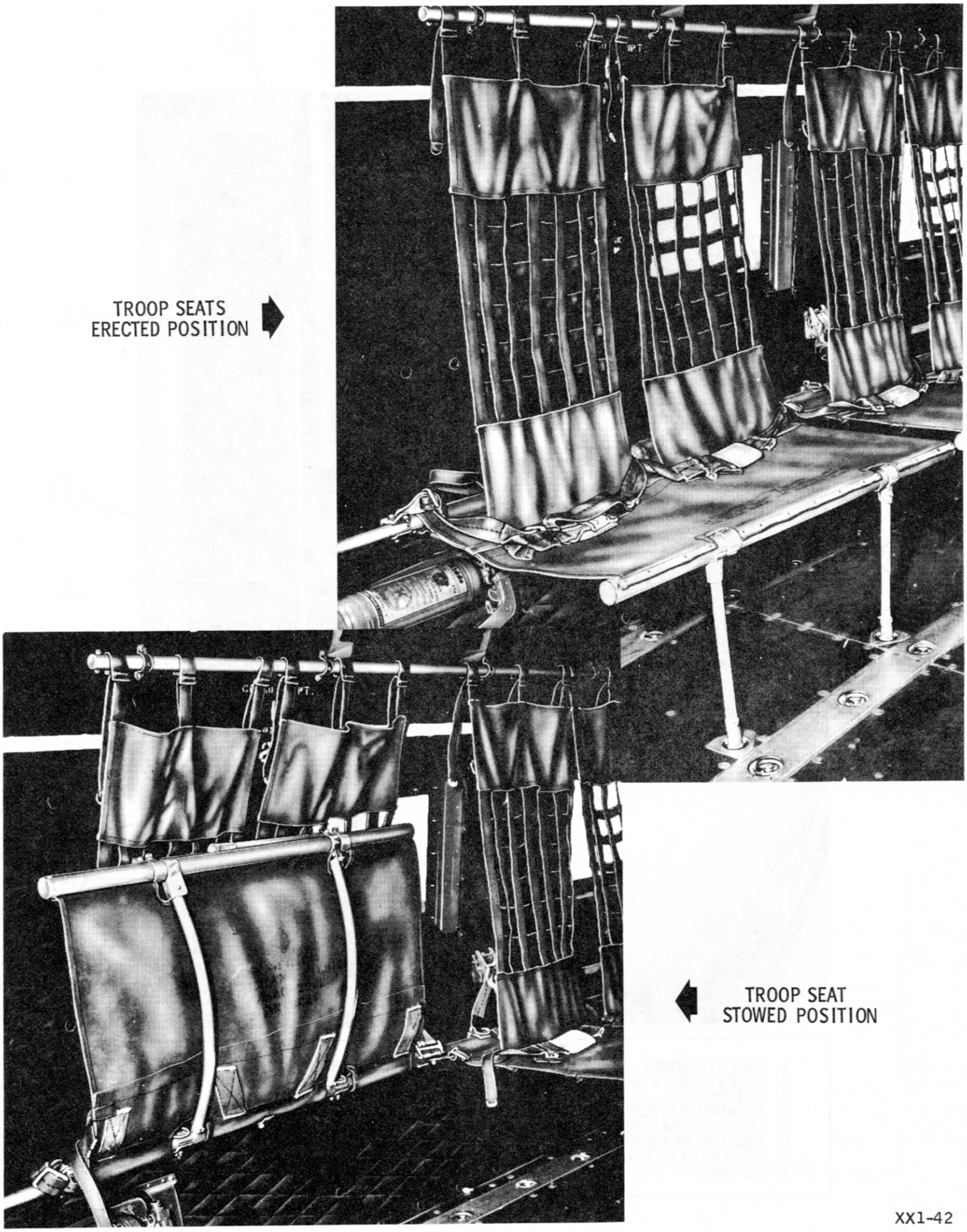
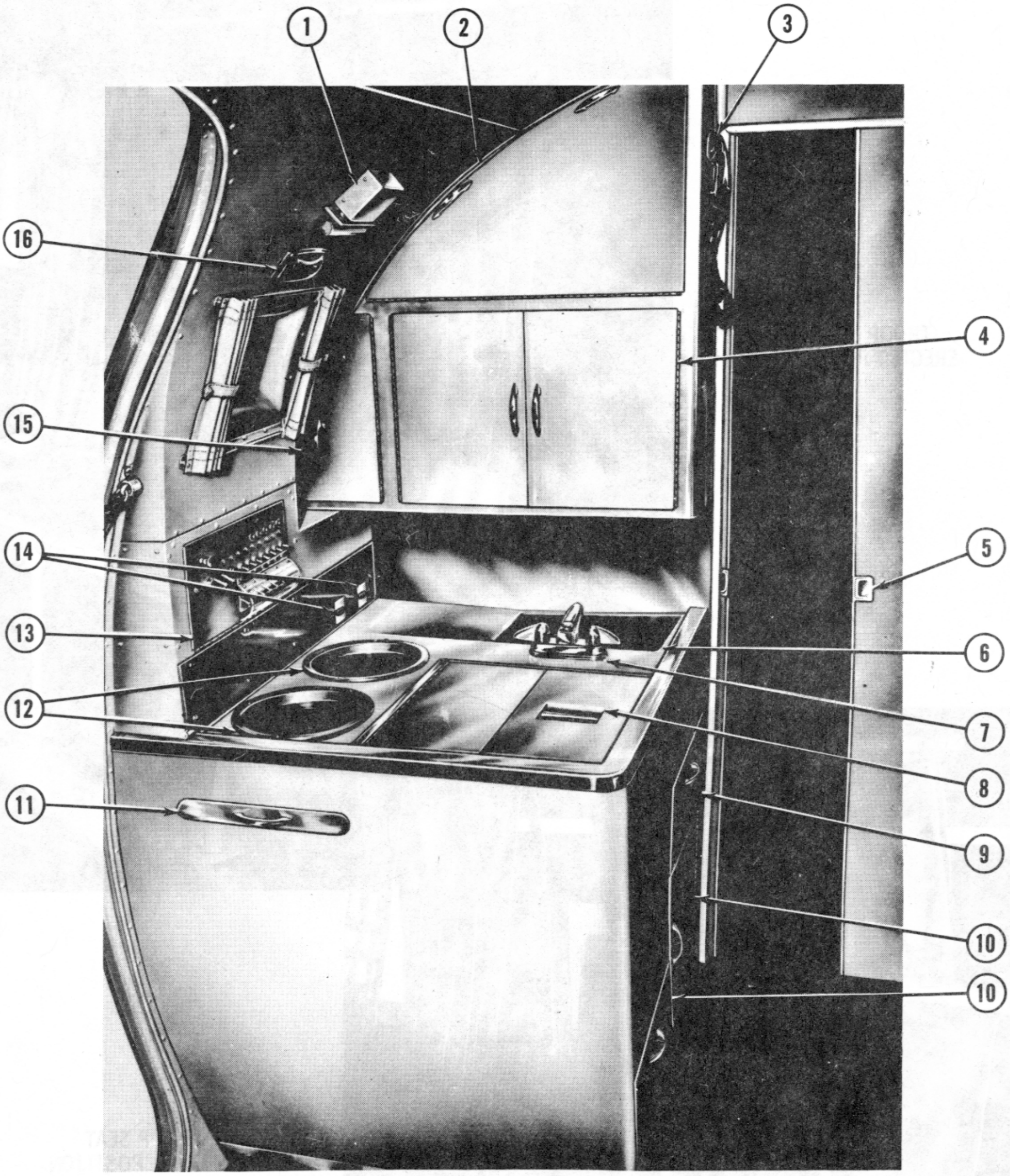


Figure 1-39. Interior Arrangements



XX1-42

Figure 1-40. Troop Seat Installation



1. BUFFET CHIMES
2. UPPER UTILITY CABINET
3. INTERPHONE
4. THERMOS BOTTLE CABINET
5. SLIDING DOOR HANDLES
6. SINK AND DRAIN OUTLET
7. HOT AND COLD WATER FAUCETS
8. ICE CHEST
9. UTILITY DRAWER
10. LOWER UTILITY CABINET
11. CRUMB AND GREASE TRAY
12. ELECTRIC HEATING ELEMENTS
13. BUFFET CONTROL PANEL
14. HOT CUP PLUGS
15. UTILITY CABINET
16. BUFFET LIGHT

XX1-43

Figure 1-41. Buffet Installation – VC-117D Aircraft the shelf is provided for the storage of hats, etc. A full-length drape provides cover for the coatroom (figure 1-39).

CABIN ATTENDANT'S STATION

A two-place folding bench is installed directly across from the coatroom for the cabin attendants (figure 1-39).

REAR CARGO COMPARTMENT

Two bunks are installed in the area directly aft of the vestibule area (figure 1-39) for use by the cabin attendants. Both bunks can be folded and stowed on the side of the aircraft; radio equipment is installed under the right bunk, and an inverter under the left bunk.

FLOOR COVERING

The passenger section of the main cabin floor is covered by a rug. The vestibule area and the lavatory are covered with linoleum flooring. The rear cargo compartment door is covered with rubber matting.

CASUALTY CARRYING EQUIPMENT

There are provisions made for 27 litters and 2 attendants, when it is necessary to use the aircraft as an ambulance transport (figure 1-39). Litter straps are stowed in canvas bags attached to the cabin sidewall.

MISCELLANEOUS EQUIPMENT

PROTECTIVE COVERS

Protective covers for the pitot tubes and the engines are stowed in the aircraft.

PART 3

AIRCRAFT SERVICING

TABLE OF CONTENTS

TEXT

ILLUSTRATIONS

GROUND HANDLING PROCEDURES

AIRCRAFT TOWING

Towing of aircraft shall be done under the direction of a qualified director who will be in charge and also act as nose or tail walker when required. During towing operations in congested areas there will be one man on each wingtip. A qualified man will be in the cockpit during all towing operations. The following procedures shall be observed by the members of the towing crew:

COCKPIT MAN

1. Check emergency airbrake pressure (1590 psi).

2. Check hydraulic system pressures (minimum 500 psi).

3. Turn the wing and tail lights on FLASH at night.

4. Notify director that aircraft is ready to tow.

5. Release parking brake and unlock tail wheel when ordered to do so by director.

6. Standby brakes and emergency hydraulic pump.

WINGMEN

1. Remove chocks when ordered to do so by director.

2. Keep a careful watch on wings and empennage and make an immediate report if there is any danger of collision.

3. At night, carry a flashlight and ascertain that wing and tail lights are ON.

4. Wingwalkers and each towing crewmember will be equipped with a whistle.

TRACTOR DRIVER

Move aircraft as directed by director.

DIRECTORS

1. Ascertain that aircraft is clear of all obstructions, workstands, platforms, etc., before giving word to move it.

2. Ascertain that fully qualified men are assigned to each post.

3. Coordinate and direct towing crew.

4. Limit turning radius of aircraft to prevent twisting main mount on one spot.

5. Maintain good visual contact with cockpit man and wingwalkers at all times.

6. Tow very slowly and keep a sharp lookout for approaching vehicles or other aircraft.

TOWBAR INSTALLATION

Towbar installation is shown in figure 1-42.

TURNING RADIUS

Turning radius of aircraft during towing operations is shown in figure 1-43.

QUALIFICATIONS REQUIRED FOR TAXI PILOTS

Copilots qualified in the left seat are authorized to taxi the aircraft. Enlisted personnel may be designated as taxi pilots in accordance with OPNAV INST 3710.7 series provided they meet the following requirements:

1. Be a designated flight crew plane captain.

2. Demonstrate a complete knowledge of all standard taxi signals.

3. Demonstrate a complete knowledge of existing requirements and safety precautions to be observed when taxiing aircraft.

4. Demonstrate ability to properly taxi aircraft under supervision of an aircraft commander who is a member of the Squadron Standardization Board.

USE OF VEHICLES

Vehicles, forklifts, etc., shall not be permitted near the aircraft without a safety observer to direct the driver. Motorized vehicles will not be driven under any part of the aircraft.

AIRCRAFT SERVICING

Aircraft shall be serviced in accordance with NAVAIR Maintenance Requirement Cards.

The aircraft servicing diagram, tire inflation chart, and batten installation are shown in figures 1-44 through 1-46, respectively.

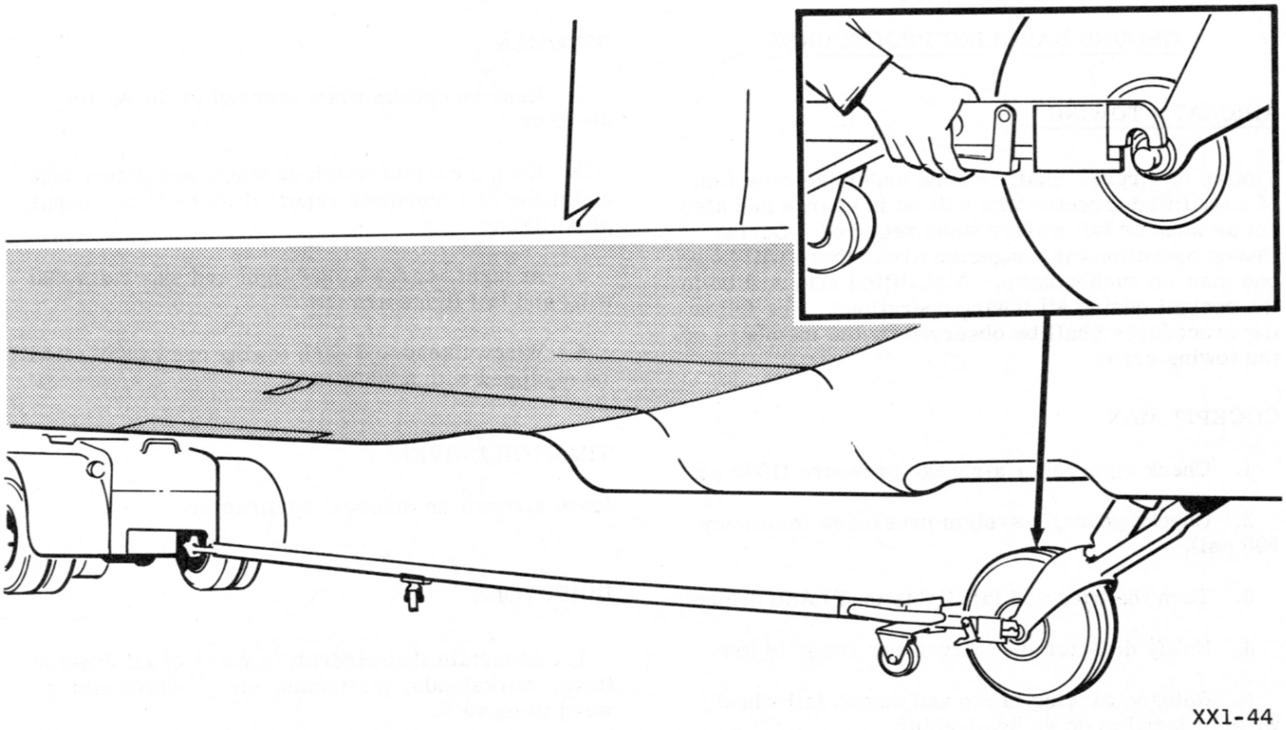
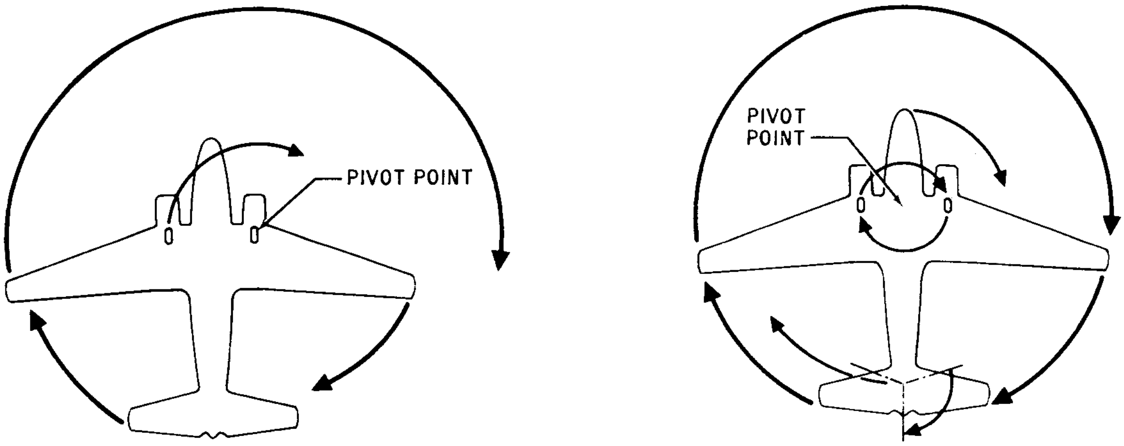
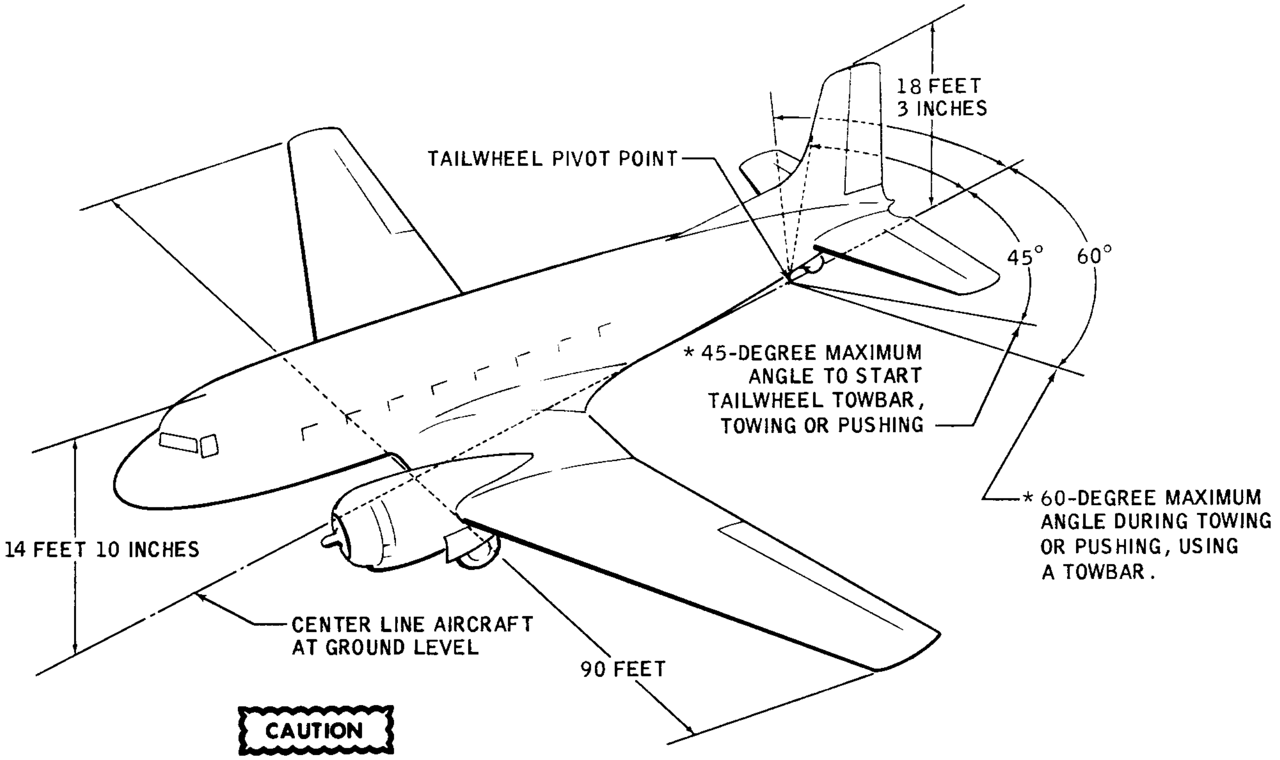


Figure 1-42. Towbar Installation



WITH THE AIRCRAFT PIVOTING ON ONE MAIN GEAR, THE TURNING AREA REQUIRED IS A CIRCLE 108 FEET 6 INCHES IN DIAMETER.

WITH THE TAIL GEAR TURNED AT RIGHT ANGLES TO THE CENTERLINE OF THE AIRCRAFT, A TURN CAN BE MADE AROUND A PIVOT POINT, MIDWAY BETWEEN THE TWO MAIN GEARS. THE TURNING AREA REQUIRED IS A CIRCLE 90 FEET IN DIAMETER.



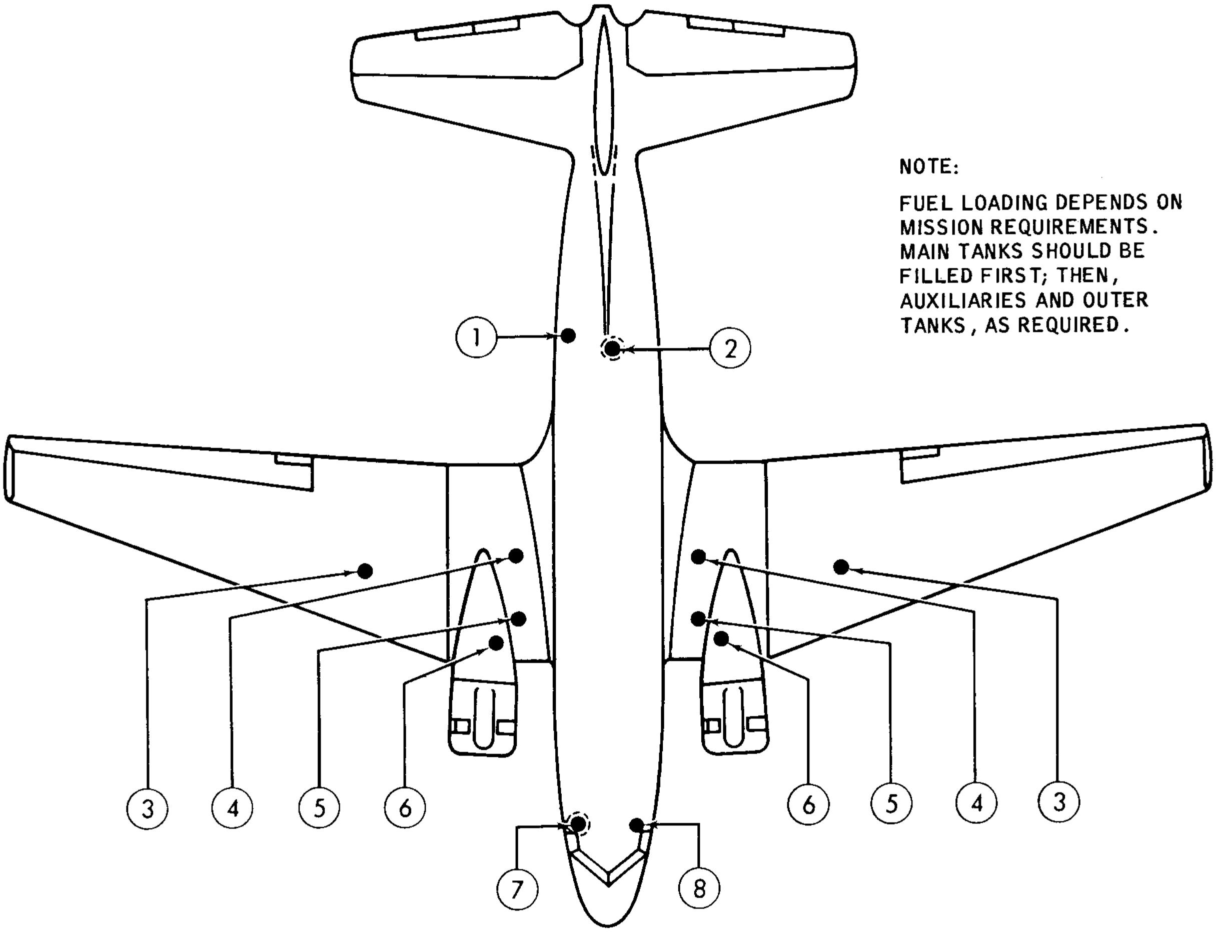
CAUTION

THE AIRCRAFT IS TOWED BY THE TAIL BY ATTACHING A TOWBAR TO THE TAILWHEEL AXLE. DURING TOWING OPERATIONS THERE SHOULD ALWAYS BE ONE MAN IN THE PILOT'S COMPARTMENT TO OPERATE THE BRAKES AND A MAN AT EACH WINGTIP WHEN TOWING NEAR OBSTACLES. THE TAILWHEEL MUST BE IN THE UNLOCKED POSITION FOR ALL TOWING OPERATIONS. TOWING FROM THE TAIL OVER SOFT, BOGGY, OR ROUGH GROUND SHOULD BE AVOIDED. USE LOW SPEED AND AVOID SUDDEN STOPS, ESPECIALLY WHEN AIRCRAFT IS BEING TOWED.

* TOWBAR DESIGN LOAD OF 5000 POUNDS (SHEAR BOLT LIMIT) NOT TO BE EXCEEDED.

XX1-45

Figure 1-43. Turning Radius of Aircraft, Towing Operation



NOTE:

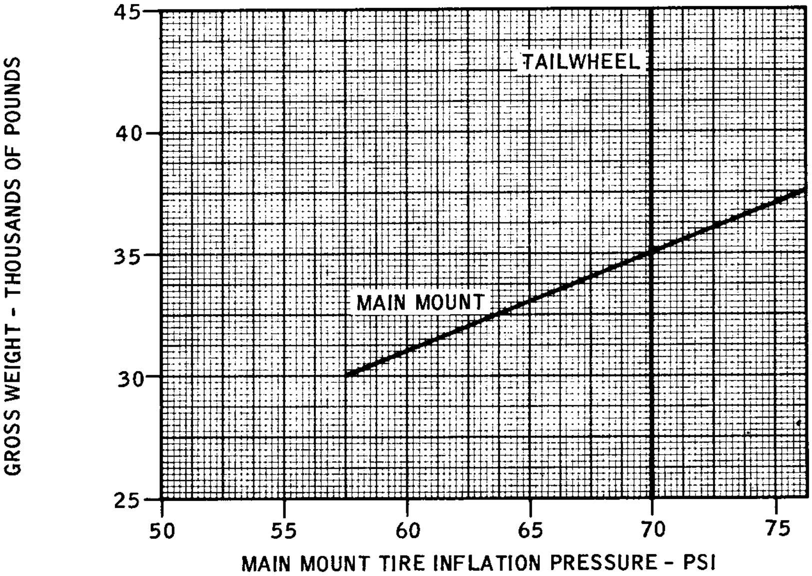
FUEL LOADING DEPENDS ON MISSION REQUIREMENTS. MAIN TANKS SHOULD BE FILLED FIRST; THEN, AUXILIARIES AND OUTER TANKS, AS REQUIRED.

TYPE OF TANK	NO. OF TANKS	FLUID CAPACITY (EACH TANK)	FLUID SPECIFICATION
ENGINE OIL	2	27 3/4 GALLONS	MIL-L-22851 GRADE 1065 WINTER
HYDRAULIC FLUID	1	(AS REQUIRED)	MIL-H-5606
DEICER ALCOHOL	1	20 GALLONS	TT-I-735A
FUEL MAIN AUXILIARY OUTER WING	 2 2 2	 202 GALLONS 200 GALLONS 411 GALLONS	 GRADE 115/145 * MIL-G-5572
* ALTERNATE FUEL GRADE 100/130 (MIL-G-5572)			

1. DEICING ALCOHOL TANK FILLER NECK
2. INTERIOR DEICING ALCOHOL TANK FILLER NECK
3. OUTER WING FUEL TANK FILLER NECK
4. CENTER WING AUX FUEL TANK FILLER NECK
5. CENTER WING MAIN FUEL TANK FILLER NECK
6. LH AND RH NACELLE OIL TANK FILLER NECK AND DIP STICK
7. HYDRAULIC FLUID RESERVOIR FILLER NECK (INTERIOR)
8. OXYGEN SERVICING VALVE

XX1-46

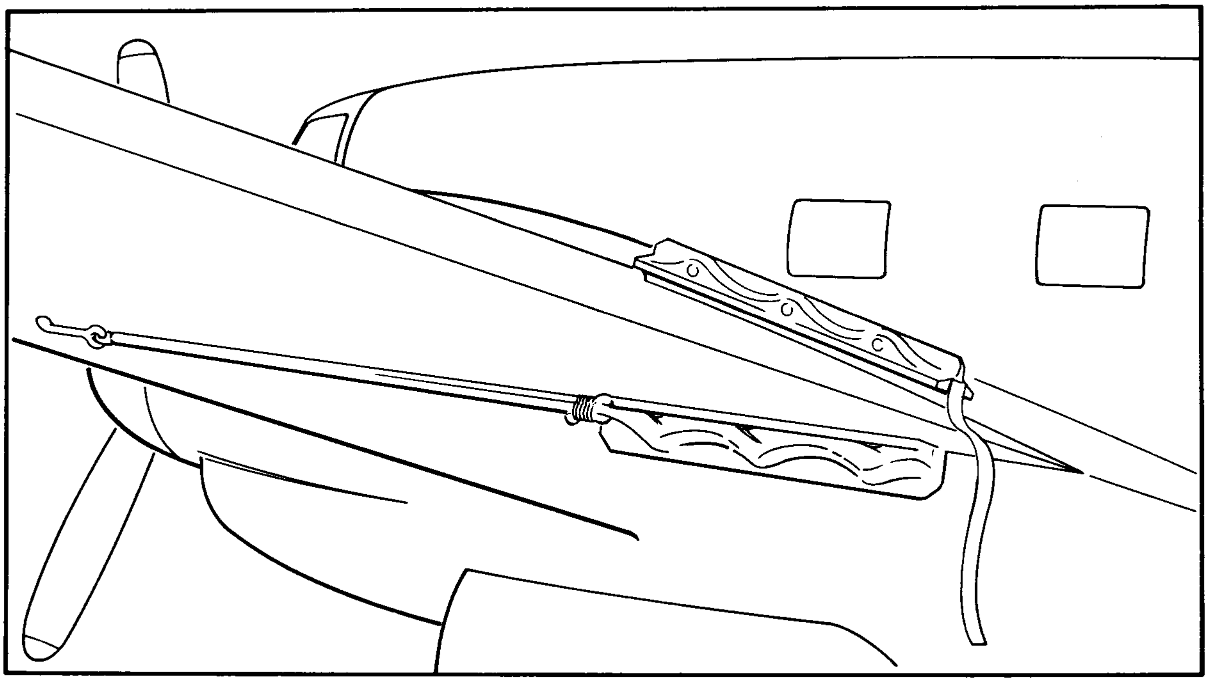
Figure 1-44. Servicing Diagram



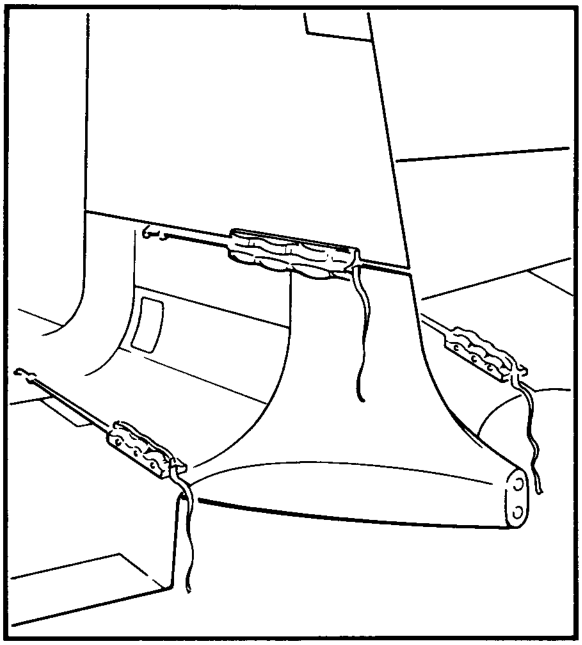
NOTE: TAILWHEEL TIRE INFLATION PRESSURE
70 PSI (ALL OPERATIONS IRRESPECTIVE
OF GROSS WEIGHT)

XX1-47

Figure 1-45. Tire Inflation Chart



AILERON BATTENS INSTALLED



RUDDER AND ELEVATOR
BATTENS INSTALLED

CAUTION

AILERON BATTENS CAN BE REVERSED AND INSTALLED ON THE WRONG WINGS. IF FLAPS ARE DROPPED WITH BATTENS INSTALLED IN THIS CONDITION, DAMAGE TO THE AIRCRAFT WILL RESULT.

CAUTION

ALL BATTENS ARE TO BE PAINTED RED AND HAVE RED WARNING FLAGS ATTACHED. TO PREVENT REVERSED INSTALLATION, OUTER SURFACES OF BATTENS, AND THEIR ADJACENT CONTROL SURFACES, SHALL BE COLOR CODED AS FOLLOWS:

LEFT AILERON - RED
RIGHT AILERON - GREEN
ELEVATOR - BLUE
RUDDER - YELLOW

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Figure 1-46. Batten Installation

PART 4

OPERATING LIMITATIONS

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TEXT

ILLUSTRATIONS

TABLES

INTRODUCTION

This section includes the engine and aircraft limitations that must be observed during normal operation. Notice must be taken of instrument markings (figure 1-47), since the limitations stated thereon are not repeated in the text.

ENGINE OPERATING LIMITATIONS

Refer to table 1-2.

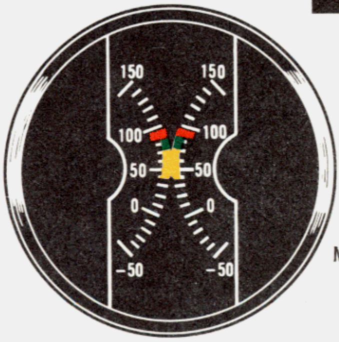
RPM LIMITATIONS

Engine operation in excess of takeoff rpm is generally considered abnormal and shall be entered on the aircraft yellow sheet. "Momentary" overspeed as a result of abnormally fast throttle movement is permissible, within the inspection required range; however, unusually fast throttle movement to the full open position should be avoided when possible.

Engine	RPM Overspeed - Inspection Required	RPM Overspeed - Engine Removal Required
1820-80A	3000 to 3200	3200

FUEL GRADE
115/145

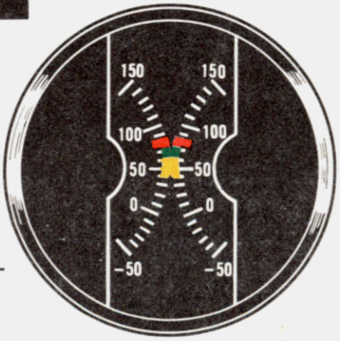
MIL-L-22851 LUBRICATING OIL



ENGINE OIL TEMPERATURE

(USING GRADE 1100 OIL)

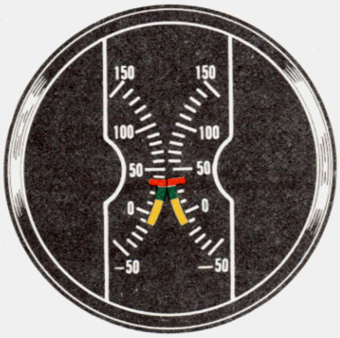
🟨 MINIMUM - 40°C
🟩 NORMAL - 75°C TO 90°C
🟥 MAXIMUM - 95°C



ENGINE OIL TEMPERATURE

(USING GRADE 1065 OIL)

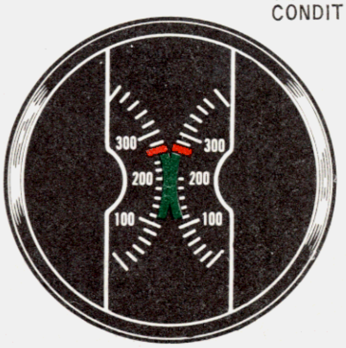
🟨 MINIMUM - 40°C
🟩 NORMAL - 65°C TO 75°C
🟥 MAXIMUM - 80°C



CARBURETOR AIR TEMPERATURE

🟨 -10°C TO +15°C - DANGER OF ICING
🟩 +15°C TO +38°C - CONTINUOUS OPERATION
🟥 +38°C MAXIMUM

A MINIMUM OF PLUS 20°C CARBURETOR AIR TEMPERATURE IS RECOMMENDED WHEN CONDITIONS FAVORABLE TO ICING EXIST.



CYLINDER HEAD TEMPERATURE

🟩 120°C - MINIMUM FOR TAKEOFF
🟩 120°C TO 246°C - CONTINUOUS OPERATION
🟩 160°C - MAXIMUM FOR ENGINE SHUTDOWN
🟥 260°C - MAXIMUM
🟩 200°C - RECOMMENDED CRUISE

MANIFOLD PRESSURE

🟩 20 TO 45.5 INCHES - CONTINUOUS OPERATION
🟨 45.5 TO 54.5 INCHES - OPERATION LIMITED TO 5 MINUTES
🟥 54.5 INCHES - TAKEOFF

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Figure 1-47. Instrument Markings (Sheet 1)

FUEL GRADE
115/145

ENGINE FUEL PRESSURE

🟥 15 PSI MINIMUM FOR GROUND OR FLIGHT
🟨 15 TO 19 PSI SAFE FOR GROUND OR FLIGHT
🟩 19 TO 21 PSI NORMAL OPERATING RANGE
🟨 21 TO 25 PSI SAFE FOR FLIGHT - RESET RELIEF VALVE TO NORMAL OPERATING RANGE AFTER FLIGHT

THE FUEL PRESSURE WARNING LIGHT WILL COME ON AT 16 PSI WHEN PRESSURE IS FALLING AND GO OFF AT 18 PSI WHEN PRESSURE IS RISING.

ENGINE OIL PRESSURE

🟥 50 PSI MINIMUM FOR FLIGHT
🟨 15 PSI MINIMUM AT IDLE
🟩 65 TO 75 PSI IS DESIRED
🟥 90 PSI MAXIMUM

THE OIL PRESSURE WARNING LIGHT WILL COME ON AT 50 ± 5 PSI.

AIRSPEED INDICATOR

MAX. KIAS AT:	31,000#	36,000#
MAX. PERMISSIBLE	260	260
MAX. CRUISE	202	169
FLAPS 1/4	127	127
FLAPS 1/4 TO FULL	115	115
GEAR DOWN	144	144
LANDING LIGHTS EXTENDED	148	148
PROPELLER UNFEATHERING	135	135

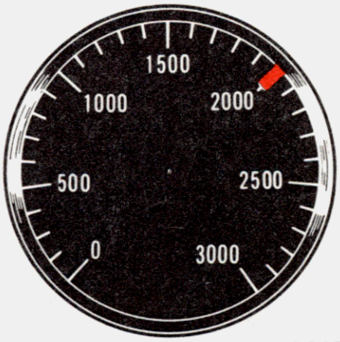
TACHOMETER

🟩 1800 TO 2150 RPM AND 2500 RPM - NORMAL RANGES FOR CONTINUOUS OPERATION
🟨 1400 TO 1800 RPM, 2150 TO 2500 RPM, AND 2650 TO 2800 RPM - CONTINUOUS OPERATION IN THESE RANGES SHALL BE AVOIDED
🟥 2800 RPM TAKEOFF (NEVER EXCEED) - CONTINUOUS OPERATION FOR MORE THAN 5 MINUTES SHALL BE AVOIDED

XX1-50

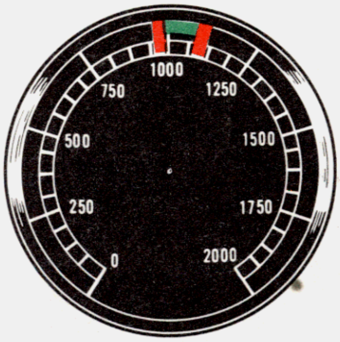
Figure 1-47. Instrument Markings (Sheet 2)

FUEL GRADE
115/145



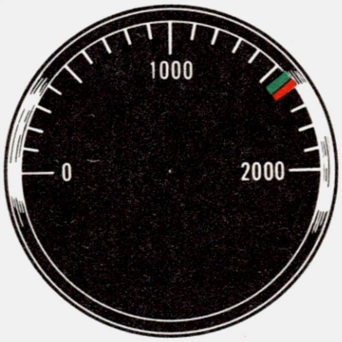
LANDING GEAR PRESSURE GAGE

🟥 MAXIMUM 2000 PSI



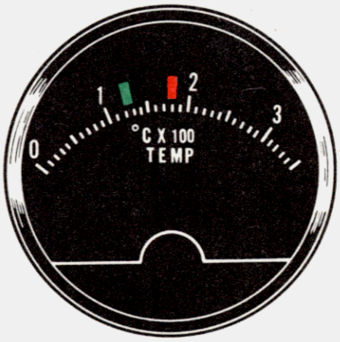
HYDRAULIC SYSTEM PRESSURE GAGE

🟩 NORMAL RANGE 950 TO 1100 PSI



EMERGENCY AIR BRAKE PRESSURE GAGE

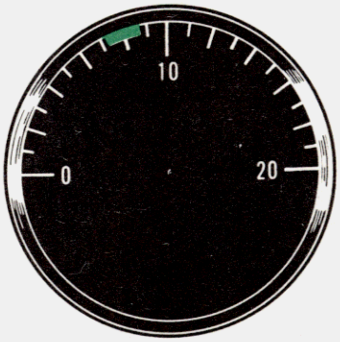
🟩 NORMAL 1590 PSI



HEATER TEMPERATURE GAGE

🟩 NORMAL- 120°C TO 130°C

🟥 MAXIMUM- 180°C



DEICING PRESSURE GAGE

🟩 NORMAL RANGE- 7.5 TO 8.5 PSI

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Figure 1-47. Instrument Markings (Sheet 3)

TABLE 1-2. ENGINE OPERATING LIMITS

Fuel Grades: 100/130, 115/145

Engines: (2) R-1820-80A
(PD12K18 Carburetors)

H/P per eng	2 Eng gal/hr	2 Eng lbs/hr	RPM	S/L	Manifold Pressure Allowable per 1000 Feet Pressure Altitude												
					1	2	3	4	5	6	7	8	9	10	11	12	13
1475	369	2214	2800	54.5	54.2	53.0	51.1	49.8	48.1	46.4	TAKEOFF POWER						
1275	312	1872	2500	46.5	46.0	45.8	45.5	45.0	43.2	Normal Rated (METO) Power							
820	142	850	2150	34.0	33.5	33.4	33.1	33.0	32.8	32.5	32.2	32.0	31.8	31.5			
755	120	720	2100	32.6	32.3	32.1	31.9	31.7	31.5	31.3	31.0	30.7	30.5	30.2	30.0		
705	110	660	2050	31.8	31.6	31.3	31.2	30.9	30.7	30.3	30.0	29.8	29.5	29.3	29.0	28.8	28.0
665	104	620	2000	31.5	31.1	30.8	30.5	30.2	29.8	29.6	29.4	29.0	28.7	28.5	28.2	27.8	27.6
650	100	600	1950	31.2	30.9	30.7	30.3	30.0	29.7	29.4	29.1	28.7	28.5	28.2	27.9	27.6	27.0
630	97	580	1900	31.1	30.8	30.5	30.2	29.8	29.5	29.3	28.9	28.6	28.3	28.0	27.7	27.3	26.5
610	93	560	1850	31.0	30.7	30.3	30.0	29.6	29.3	29.0	28.7	28.3	28.1	27.7	27.4	27.0	26.0
600	91	545	1800	30.8	30.6	30.2	29.8	29.6	29.2	28.9	28.5	28.2	27.9	27.5	27.2	26.5	25.5
STANDARD C° TEMPERATURE				15	13	11	9	7	5	3	1	-1	-3	-5	-7	-9	-11

NOTE

The tabulated values of manifold absolute pressure (MAP) are the maximum authorized limits for the various combinations of engine speeds (rpm) and carburetor mixture. These values are for standard atmosphere conditions and for normal mixtures, except takeoff (2800 rpm) which is rich mixture. These values have been adjusted for ram effect, excepting takeoff, and should not be exceeded except as outlined below:

Takeoff Power

1. Upward adjustment of takeoff MAP values for carburetor air temperatures (CAT) above altitude standard temperatures is not permitted.
2. When CAT is below altitude standard temperature, takeoff MAP values must be decreased 1/2 inch Hg for each 6°C (10°F) below that temperature.
3. A vapor pressure correction equal to twice the actual vapor pressure may be added to the allowable takeoff MAP values.

Normal Rated Power

Upward adjustment of MAP values is not permitted when at normal rated powers. Downward adjustment is not required except when CAT exceeds 38°C.

Powers Excepting Takeoff and Normal Rated

1. For each 6°C deviation of CAT above altitude standard temperature, the allowable MAP values may be increased by 1/4 inch Hg, with a maximum permissible increase of 1 inch Hg.
2. For each 6°C deviation of CAT below altitude standard temperature, the allowable MAP values should be decreased by 1/4 inch Hg.

All Powers

If CAT is above 38°C, the allowable MAP must be decreased by 1 inch Hg for each 6°C that 38°C is exceeded.

To avoid excessive flight vibration loads, the engines should be operated only in the range of 1800 to 2150 rpm and 2500 to 2800 rpm. Transient engine speed operation is authorized.

OVERBOOST LIMITATIONS

Concerted effort should be made at all times to stay within established engine limitations. Overboost may cause detonation and/or preignition with resulting engine damage. Refer to the latest revision to General Reciprocating Engine Bulletin 197, for overboost MAP and time limitations that are causes for inspection and/or removal of the engine. If overboost occurs, make yellow sheet entry of duration, RPM, CHT, CAT, MAP, oil pressure, and oil temperature.

HIGH RPM/LOW MAP OPERATION

Operation at high rpm and low MAP is one of the major causes of master rod bearing, piston, and ring failure. Therefore a minimum of 1 inch of MAP for each 100 rpm shall be maintained during periods of rapid or prolonged descent (normal landing excepted).

AIRSPEED LIMITATIONS

The maximum permissible indicated airspeeds are as follows:

In smooth or moderately turbulent air	260 knots
With landing gear extended	144 knots
With 1/4 wing flaps extended	127 knots
With more than 1/4 wing flaps extended	115 knots
Propeller unfeathering	135 knots
With landing lights extended	148 knots

SEVERE TURBULENCE

The aircraft should not be operated in conditions of severe turbulence as found in mature stages of thunderstorm cells because the gusts encountered may impose loads greater than the design limits of the aircraft. However, if flight in severe turbulence cannot be avoided, indicated airspeeds from 120 to 140 knots are recommended for penetration.

PROHIBITED MANEUVERS

In-flight maneuvers are restricted as follows: The angle of bank shall not exceed 60 degrees. The flight controls shall not be moved abruptly. Slipping or skidding shall be avoided at indicated airspeeds in excess of 172 knots. At indicated airspeeds below 172 knots, slipping or skidding is permitted as required in asymmetric powered flight and landing approaches.

ACCELERATION LIMITATIONS

The maximum permissible acceleration for flight in smooth air at a gross weight of 35, 000 pounds or less is 3.5 g. When flying in conditions of moderate turbulence, it is essential that accelerations, because of deliberate maneuvers, be limited to 1.5 g's at gross weights of 35, 000 pounds or less to minimize the possibility of overstressing the aircraft as a result of the combined effects of gust and maneuvering loads. As gross weights are increased above 35, 000 pounds, the permissible accelerations decrease. To determine the maximum permissible accelerations at gross weights in excess of 35, 000 pounds, multiply the acceleration previously noted for smooth air or that previously noted for moderate turbulence by the ratio of 35, 000 pounds to the new gross weight.

CENTER OF GRAVITY LIMITS

Aft limit (gear down)	37% MAC
Aft limit (gear up)	36% MAC
Forward limit (gear down)	10% MAC
Forward limit (gear up)	7% MAC

WEIGHT LIMITATIONS

There are no structural minimum fuel requirements for this aircraft.

Maximum gross weight is as follows:

Takeoff and Landing	36, 800 lbs

NOTE

At gross weights in excess of 31,000 pounds, the aircraft does not comply with all the FAA minimum airworthiness standards. During preflight planning the aircraft commander shall adjust payload to ensure that a 50 fpm rate of climb can be established with one propeller windmilling (figure 11-16) at best single-engine climb speed (figure 11-15).

NOTE

For cargo loading limitations, refer to the Cargo Loading Handbook C-117D.

CROSSWIND COMPONENT LIMITATIONS

Landings and takeoffs under crosswind conditions resulting in a 90 degree crosswind component in excess of 15 knots is not recommended.

SECTION II

INDOCTRINATION

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TEXT

MINIMUM CREW

LOCAL TRAINING FLIGHTS

Pilot - qualified aircraft commander
Copilot - a designated aviator
Crew Chief/Plane Captain - qualified crewmember able to set UHF channels on the AN/ARC-27 master control located in the radio operators compartment.

PASSENGER/CARGO FLIGHTS

Same as for training flights with the exception that the copilot will be a qualified T3P or higher.

EXTENDED OVER-WATER FLIGHTS

Same as for passenger/cargo flights, as applicable. In addition, a Flight Communications Operator and a qualified navigator shall be part of the crew.

POST MAINTENANCE CHECK FLIGHTS

Post Maintenance Check Flights shall be conducted with the minimum crew required for safe and thorough conduct of the check flight. A minimum crew is considered to be a qualified Post Maintenance Check pilot, a qualified copilot (at least T3P), and a qualified Crew Chief/Plane Captain. Passengers or additional special crew shall not be carried on such flights except that appropriate and essential maintenance and/or quality assurance personnel may be utilized as required.

INDOCTRINATION

Flight safety is paramount. Command attention is necessary to ensure that each pilot has a thorough knowledge of inflight systems operations, engine and airframe capabilities and limitations, and emergency operations of equipment, as well as emergency flight procedures. Pilots should understand the reason or basis for each procedure.

FLIGHT CREW QUALIFICATIONS

GENERAL REQUIREMENTS

Comply with OPNAVINST 3710.7 series.

SPECIFIC REQUIREMENTS

The following requirements are to be met by pilots qualifying in C-117 model aircraft. It must be emphasized that the hours specified are the minimum required. This does not preclude individual commanding officers from prescribing more stringent requirements based upon their own judgement. Waivers may be granted in accordance with OPNAVINST 3510.9 series.

1. Third Pilot (T3P). To be qualified as a third pilot, an individual must:

a. Have a minimum of 250 hours total individual pilot time

b. Have at least 10 hours of pilot time in class and model, or more, as required by the Commanding Officer or higher authority, and demonstrate a satisfactory level of skill in the following:

(1) Ground handling

(2) Flight technique in normal and emergency procedures

(3) Radio navigation

c. Have accumulated at least 10 landings of which two must be night landings

d. Demonstrate thorough knowledge through oral and written examinations on the following subjects:

(1) All C-117 systems and equipment (NATOPS Flight Manual)

(2) Weight and balance

(3) Survival and first aid

(4) Applicable technical publications

(5) Search and rescue procedures

(6) Communications

(7) Unit mission

(8) Navigation

(9) Flight planning

(10) Local and area flight rules

(11) Flight safety

e. Possess a current instrument rating

f. Satisfactorily complete a NATOPS evaluation in model.

g. Be designated in writing by the Commanding Officer

2. Second Pilot (T2P). To be qualified as a second pilot, an individual must:

a. Have completed the requirements for and possess to an advanced degree the knowledge, skill, and capabilities required of a third pilot

b. Have a minimum of 500 hours total individual pilot time

c. Have pilot time in class and model as required by the Commanding Officer or higher authority

d. Have accumulated at least 25 landings in model of which five must be night landings

e. Have completed at least three precision and three non-precision instrument approaches in model

f. Have accumulated at least 10 instrument hours in model

g. Have accumulated at least 30 hours of night time of which at least 10 hours must be in model

h. Possess a current instrument rating

i. Satisfactorily complete a NATOPS evaluation in model

j. Demonstrate thorough knowledge of pilot responsibilities of administrative functions applicable to the transport mission

k. Be designated in writing by the Commanding Officer

3. Plane Commander (TPC). To be qualified as a Plane Commander, an individual must:

a. Have completed the requirements for and possess to an advanced degree the knowledge, skill and capabilities of a second pilot

b. Have a minimum of 100 hours pilot time in class and be NATOPS qualified in model

c. Have a minimum of 700 hours total individual pilot time

d. Have completed a minimum of 10 night landings in model

e. Have completed at least 10 precision and 10 non-precision instrument approaches in model

f. Possess a current instrument rating

g. Have accumulated at least 50 hours of total night time

h. Demonstrate positive ability to command and train the officers and men of the flight crew including enforcement of proper air discipline

i. Demonstrate the qualities of leadership required to conduct advanced base or detached unit operations as Officer-in-Charge

j. Be designated in writing by the Commanding Officer

4. Post Maintenance Checkflight Pilot. All Post Maintenance Checkflight Pilots shall be chosen from designated Transport Plane Commanders (TPC). Checkflight Pilots will be designated in writing by the Commanding Officer. Such pilots will be completely aware of the requirements for post maintenance checkflights as contained in OPNAVINST 4790.2 series.

5. Aircrewman Qualification. As per current OPNAVINST 3710.7 series.

CURRENCY REQUIREMENTS

A pilot shall be considered current in his particular qualification (TPC, T2P/T3P) when the following minimums, in model, have been met within the preceding 90 days:

Day VFR - TPC must have logged, in model, 5 hours of first pilot time and two takeoffs/landings.

Night VFR - TPC must be currently day qualified and, in addition, have logged, in model, 2 hours of night first pilot time and two night takeoffs/landings.

Instrument Flight -	TPC	T2P/T3P
First Pilot Time	10	5
Approaches		
Precision	2	1
Non-Precision	2	1
Instrument Time	3	3

If pilot currency lapses, it may be reestablished by satisfactorily completing a NATOPS evaluation.

GROUND TRAINING SYLLABUS

The syllabuses contained herein establish minimum requirements by subject. They are intended to provide the training essential for a high standard of proficiency.

PILOT GROUND TRAINING SYLLABUS

This syllabus is intended to qualify personnel as student pilots in the C-117D. It is used in conjunction with this flight manual, OPNAV instructions, the handbook of maintenance instructions, and other pertinent publications. The number of hours allocated to each subject is a command decision.

Aircraft Systems Phase

1. Aircraft preflight inspection using daily maintenance requirements
2. Power plants: description of the R-1820-80A engine and accessories
3. Power charts and cruise control: discussion of performance charts
4. Fuel and oil system: operation of the fuel and oil system
5. Propellers: operation of controls and feathering
6. Heaters, anti-icing, deicing, ventilation, and lighting systems: operation of the systems
7. Fire extinguishing system: operation
8. Hydraulic system: operation and components
9. Electrical system: operating and troubleshooting the system
10. Emergency and survival equipment: use of survival equipment aboard aircraft
11. Emergency procedures: review use of Checklist
12. Navigational equipment: location and use
13. Communications cockpit checkout: location and use of communication equipment
14. Use of flight packets
15. Passenger briefing
16. Oxygen: system
17. Weight and balance: use of load adjuster, computing weight distribution and center of gravity; review compartmentation
18. All weather operations
19. Review
20. Examination.

CREWMEMBER GROUND TRAINING SYLLABUS

The air crewmember selected for training must meet the established physical and psychological requirements. Air crewmembers are designated in accordance with OPNAVINST 3710.7 series upon completion of the training program and when considered qualified. The number of hours allotted to each subject is a command decision.

Flight Crew Plane Captain/Crew Chief Syllabus

1. Introduction to aircraft
2. Daily preflight of aircraft
3. Servicing the aircraft
4. Cockpit fam and turnup check
5. Daily inspection
6. Fuel system management
7. Oil system
8. Hydraulic system
9. Electrical systems
10. Control systems
11. Radios
12. Engine controls
13. Engine components
14. Autopilot and components
15. Oxygen system
16. Deicing and anti-icing system
17. Tiedown instructions
18. Technical publications
19. Yellow sheet, DD 1150, and DD Form 1348
20. GREB's, LEB's, ATB's (etc.)
21. SOP's for loading cargo and passengers, weight and balance
22. Examination as applicable.

Radio Operators and Navigators

Commanding officers will ensure that navigators and radio operators are proficient in the use of radio and navigation equipment aboard the C-117D.

NEW

FLIGHT TRAINING SYLLABUS

The flight syllabus outlined will be utilized initially to acquaint pilots and air crewmembers with the aircraft. The following should be taken into consideration:

1. Air crewmember training should be conducted in conjunction with pilot training where possible.

2. Full advantage should be taken of the pilot's previous experience in the aircraft, if any, and/or his general background and proficiency.

PILOT FLIGHT TRAINING SYLLABUS

The geographic location, the specific flight training concept, and local command requirements will influence the actual flight syllabus and the sequence in which it is completed. There is a continuing requirement for the maintenance of pilot and crewmember performance records. In the case of transport third pilots and transport second pilots, individual flight performance records shall be maintained through the transport plane commander check. Subsequent flight performance will be evaluated periodically. Flight performance record requirements for the remainder of the air crewmembers will be determined by the commanding officer.

The FAM syllabus shall include:

1. Exterior and interior preflight
2. Crew coordination
3. Use of checklists
4. Starting engines
5. Taxiing
6. Engine runup
7. Pretakeoff
8. Takeoff
9. Climb and cruise
10. Airwork
11. Approach
12. Descent
13. Landing:
    a. Normal landings
    b. Full-flap landings
    c. 1/4 flap landings
    d. 3/4 flap landings
    e. No-flap landings
    f. Single-engine landings (simulated)
    g. Touch-and-go procedures

   h. Waveoff
14. Icing (simulated)
15. Night flying
16. Emergencies: (simulated)
   a. Aborted takeoff
   b. Brake failure
   c. Brake fire
   d. Engine failure
   e. Engine fire, ground and in flight
   f. Hydraulic failure
   g. Unsafe gear warnings
   h. Cabin fire (electrical and other)
   i. Instrument power failure
   j. Fuel starvation
   k. Runaway propeller, takeoff and cruise
   l. AC power failure
   m. Generator failure
   n. Smoke removal
   o. Ditching and bailout
   p. Emergency descent
17. Utilization of flight publications
18. Instrument airwork:
   a. Full panel
   b. Partial panel
   c. Steep banked reversals
19. Clearance and departures
20. Holding procedures
21. OMNI range and TACAN
22. PAR/ASR
23. Instrument landing system approaches
24. Low-visibility/circling approaches
25. Crosswind takeoffs/landings
26. Distress procedures (simulated).

PERSONAL FLYING EQUIPMENT REQUIREMENTS

Safety and survival equipment shall be used as prescribed by the current editions of OPNAV INST 3710.7 series. Aircraft commanders will ensure that crewmembers and passengers are instructed in the use of this equipment.

SECTION III

NORMAL PROCEDURES

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NEW

PART 1

BRIEFING/DEBRIEFING

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TEXT

SCHEDULING

The commanding officer or his designated representative is responsible for the promulgation of the flight schedule. The flight schedule becomes an order of the commanding officer and must, therefore, be followed as promulgated. Should circumstances require a variation, such a change must be approved by the commanding officer or his designated representative.

CREW DUTY TIMES

Crew duty time begins when the crew reports to a designated place of duty to begin initially the preparation for a flight. In the event a crewmember is assigned other duties prior to his reporting for preparation of a flight, the crew duty time will be computed from the time he initially reports for those duties. Crew duty time ends when the engines are cut at the end of a flight or a series of flights.

Post flight duties are not included in crew duty times but are considered for computing the start of crew rest time. Maximum crew duty time for the C-117 aircraft is 12 hours with or without an operating auto-pilot, over land or over water.

Crew rest begins upon completion of postflight duties and will be that time which will allow for normal sleep requirements (8 hours), meals, and travel to/from the place of duty. Additionally, crew rest may be declared anytime it becomes necessary to prevent undue fatigue. In the event of enroute delays, when the crew is able to obtain some rest, due consideration to maximum crew duty time must be given. Under such circumstances, crew duty time may be extended to 14 hours.

BRIEFING

Aircraft commanders will ensure that their pilots and crewmembers are briefed as necessary to accomplish properly and safely their assigned mission.

BRIEFING OUTLINES

CREW/PASSENGER BRIEFING

1. Introduction of aircraft commander, pilot, and plane captain.

2. Roll call, identification check

3. Care of aircraft and related equipment

   a. Care and stowage of chutes and harness

   b. Location of airsickness bags, relief tube, and toilet.

   c. Policing aircraft before leaving

      (1) Ash trays, box lunches, and trash

      (2) Lights, switches, and electrical equipment OFF

      (3) Seat belts STOWED

4. Emergency equipment

   a. Hand fire extinguisher

   b. Escape hatches

   c. Crash axes

   d. First aid kits

   e. Chutes

5. Emergency procedures

   a. Crash landing/ditching

      (1) Crew position: SEAT BELTS FASTENED

      (2) On takeoff or landing verbal command or one ring on alarm bell

ALL PASSENGERS WILL BE IN CRASH LANDING POSITION DURING ALL TAKEOFFS AND LANDINGS.

(3) From altitude verbal command or six short rings on alarm bell

CLEAR AISLE.

ALL LOOSE EQUIPMENT WILL BE JETTISONED THROUGH THE REAR DOOR, OR STOWED. ESCAPE HATCHES UNLATCHED.

CREW WILL ASSUME CRASH LANDING POSITION.

VERBAL COMMAND JUST BEFORE TOUCHDOWN.

REMAIN IN SEATS WITH SAFETY BELTS FASTENED UNTIL AIRCRAFT IS COMPLETELY STOPPED.

b. Bailout verbal command or three short rings on alarm bell

(1) CLEAR AISLES.

(2) RETURN TO ASSIGNED POSITION:

TIGHTEN LEG STRAPS.

BUCKLE ON CHUTE.

FASTEN FIRST AID KIT ON HARNESS.

TAKE SEATS.

(3) Bailout signal verbal command or one ring on alarm bell

PLANE CAPTAIN WILL ACT AS JUMPMASTER. NOTIFY PILOT WHEN ALL PASSENGERS ARE CLEAR.

c. Fires in flight

(1) CLEAR AISLES.

(2) RETURN TO ASSIGNED POSITION.

(3) PREPARE FOR BAILOUT.

(4) ASSIST IN FIREFIGHTING AS DIRECTED.

6. Smoking: IN ACCORDANCE WITH AIRCRAFT COMMANDER'S INSTRUCTIONS.

7. TRANSISTOR RADIOS WILL REMAIN OFF.

8. LOADED FIREARMS, AMMUNITION, AND FLASH BULBS WILL NOT NORMALLY BE CARRIED.

9. PASSENGERS WILL REMAIN IN THEIR SEATS DURING ALL GROUND OPERATIONS. LIFE PRESERVERS WILL BE WORN DURING ALL OVERWATER OPERATIONS. AT LEAST ONE PERSON WILL MONITOR THE INTERPHONE DURING THE ENTIRE FLIGHT.

10. ABOVE 5000 FEET TERRAIN CLEARANCE THE LIFE PRESERVER MAY BE REMOVED AT THE DISCRETION OF THE AIRCRAFT COMMANDER.

DEBRIEFING

Debriefing will depend on the type of mission flown and the command in which it is flown.

The aircraft commander and the flight crew plane captain should discuss with a maintenance representative discrepancies noted during the flight and ensure they are entered on part B of the yellow sheet (OPNAV Form 3760-2).

PART 2

MISSION PLANNING

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MISSION PLANNING

a. General. The degree of planning for each assigned mission will vary with the nature of the specific task to be accomplished and will be governed by individual command directives or those of higher authority.

b. The basic factors required for mission planning should be included in the flight schedule or the briefing sheet.

c. Navigation. Normally, flights will be conducted in areas where radio aids to navigation, exclusive of LORAN, are available to accurately determine the aircraft's position once each hour. However, when LORAN is installed and fully operable, with one of the pilots qualified in its operation, flights may be made in areas covered by LORAN where radio aids to navigation exclusive of LORAN are available once every 2 hours. For flights where radio aids are not available exclusive of LORAN for any portion of the flight for a period greater than 2 hours, celestial capabilities (and/or LORAN) are required, plus a fully qualified navigator.

AIRCRAFT LIMITATIONS

For aircraft flight limitations, refer to Section I.

CRUISE CONTROL

Fuel, airspeed, power settings, etc to complete the mission can be determined using the data contained in Section XI.

WEIGHT AND BALANCE

Ensure that computed weight and balance is satisfactory for all flight conditions. Refer to Section I, Part 4, for aircraft weight and center of gravity limits. For loading information, refer to Handbook of Weight and Balance Data AN-01-1B-40 and the Cargo Loading Handbook NAVAIR 01-40NK-509.

AIRCRAFT RECORDS (OPNAV FORM 3760-2)

Ensure that required maintenance has been performed by checking at least ten, part B, discrepancy sheets if available. Check the current part A to ensure that the preflight has been performed and for the proper servicing.

TAKEOFF AND LANDING DATA

Takeoff and landing data need not be specifically calculated for each takeoff and landing if operating with known conditions and standard aircraft loading. If operating in nonstandard conditions or if doubt exists, a takeoff and landing data card shall be computed using data in Section XI.

PART 3

SHORE-BASED PROCEDURES

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TEXT

ILLUSTRATIONS

PREFLIGHT INSPECTION

The preflight inspection shall be conducted by the pilot prior to flight. This inspection shall be conducted in addition to the plane captain/crew chief inspection. Control surface battens should be removed upon arrival of the pilot and prior to his inspection. High wind conditions may warrant delay until one of the crewmembers is stationed in the cockpit.

INTERIOR INSPECTION CHECKLIST

1. Landing Gear – DOWN AND POSITIVE LOCKED

2. Trim tabs – NEUTRAL

3. Ignition switches/master ignition - OFF

4. Hydraulic pressure/sight gage - CHECKED

NOTE

A minimum of 500 psi hydraulic pressure must be available prior to setting the parking brake. If less than 500 pounds pressure is indicated, the pressure may be built up by opening the star valve, pumping the hydraulic hand pump until 500 pounds pressure is indicated, and securing the star valve. The parking brake must be set prior to checking the brake pin tolerance on the exterior position.

5. Parking brakes - SET

6. Emergency airbrake handle - OFF AND SAFETIED

7. Emergency airbrake pressure - CHECKED

NOTE

Minimum pressure 1590 psi.

8. Star valve - OFF AND SAFETIED

9. Cowl flaps/oil coolers - OPEN

10. Battery switch - OFF

11. A.C. interlock override - OFF

12. Emergency power switch - OFF AND SAFETIED

13. Oxygen system - CHECKED

NOTE

1200 psi minimum and masks available.

14. Radio equipment - SECURED (in racks)

15. Circuit breakers - CHECKED/SET

NOTE

Check all circuit breakers set, with the following exceptions:

a. Heater ground control
b. Heater control
c. Ground blower
d. Main J box flood light

16. Aircraft publications - CHECKED

17. Fuel and oil covers - SECURED

18. Emergency exits - SECURED

19. Drift sights - CAGED AND TRAILED (TC-117D)

20. Safety and survival equipment - SPOT CHECKED

a. Fire extinguishers
b. First aid kits
c. Emergency water container
d. Life preservers
e. Parachutes and harnesses
f. Oxygen regulators
g. Crash axes

21. Spare hydraulic/alcohol quantities - AS REQUIRED

NOTE

A minimum of one gallon hydraulic and sufficient alcohol for mission.

22. Tail cone - CHECKED

a. Cables and pulleys
b. Alternate static source
c. General conditions

23. Main entrance door - CHECKED

a. Emergency release pins
b. General conditions

EXTERIOR INSPECTION

While checking the items in this checklist, check that doors and inspection plates are closed, check for fluid leaks, indications of defective or insecure installations, and the general overall appearance of the aircraft. Check for accumulation of ice, snow, and frost; refer to Section VI for Cold Weather procedure.

Refer to figure 3-1.

1. Underside of fuselage – CHECKED

a. Drift sights for condition
b. Antennas for security

2. Flaps – CHECKED

3. Aileron – CHECKED

a. Condition of fabric
b. Static discharge wicks
c. Freedom of movement

4. Wingtip – CHECKED
    a. Light and reflector
    b. General condition
5. Leading edge and underside of wing – CHECKED
    a. Landing lights
    b. Deicer boot
6. Left main landing gear – CHECKED
    a. Tire for slippage – 1/2 inch for maximum
    b. Brake pins – 1/4 inch below shoulder of torque nut maximum depression for flight
    c. Microswitch
    d. Struts – approximately 4-inch extension at normal weights
    e. General condition
    f. Chocks installed
7. Left wheel well – CHECKED
    a. Landing gear pin – INSTALLED
    b. General condition
8. Left nacelle – CHECKED
9. Left propeller – CHECKED
10. Nose section – CHECKED
    a. Pitot tube covers removed
    b. CO_2 popout disks
11. Right propeller – CHECKED
12. Right nacelle – CHECKED
13. Right wheel well – CHECKED
    a. Landing gear pin – INSTALLED
    b. General condition
14. Right landing gear – CHECKED
    a. Tire for slippage – 1/2 inch maximum
    b. Brake pins – 1/4 inch below shoulder of torque nut maximum depression for flight
    c. Microswitch
    d. Struts - approximately 4-inch extension at normal weights
    e. General condition
    f. Chocks installed
15. Leading edge and underside of wing
    a. Landing lights
    b. Deicer boot
16. Wingtip – CHECKED
    a. Light and reflector
    b. General condition
17. Aileron – CHECKED
    a. Condition of fabric
    b. Static discharge wicks
    c. Freedom of movement
18. Flaps – CHECKED
19. Alcohol quantity – CHECKED
20. Tail section – CHECKED
    a. Wrinkled skin
    b. Popped rivets
    c. Deicer boot
    d. Tire for slippage
21. Static discharge wicks
    Fabric
    Tail light
22. Freedom of movement of controls
    Trim tabs
    Fabric
23. Wrinkled skin
    Popper rivets
    Tailwheel
    Tailwheel ground safety latch
    Microswitch
    Ground wire
    Strut – approximately 1 inch minimum
    Deicer boot.

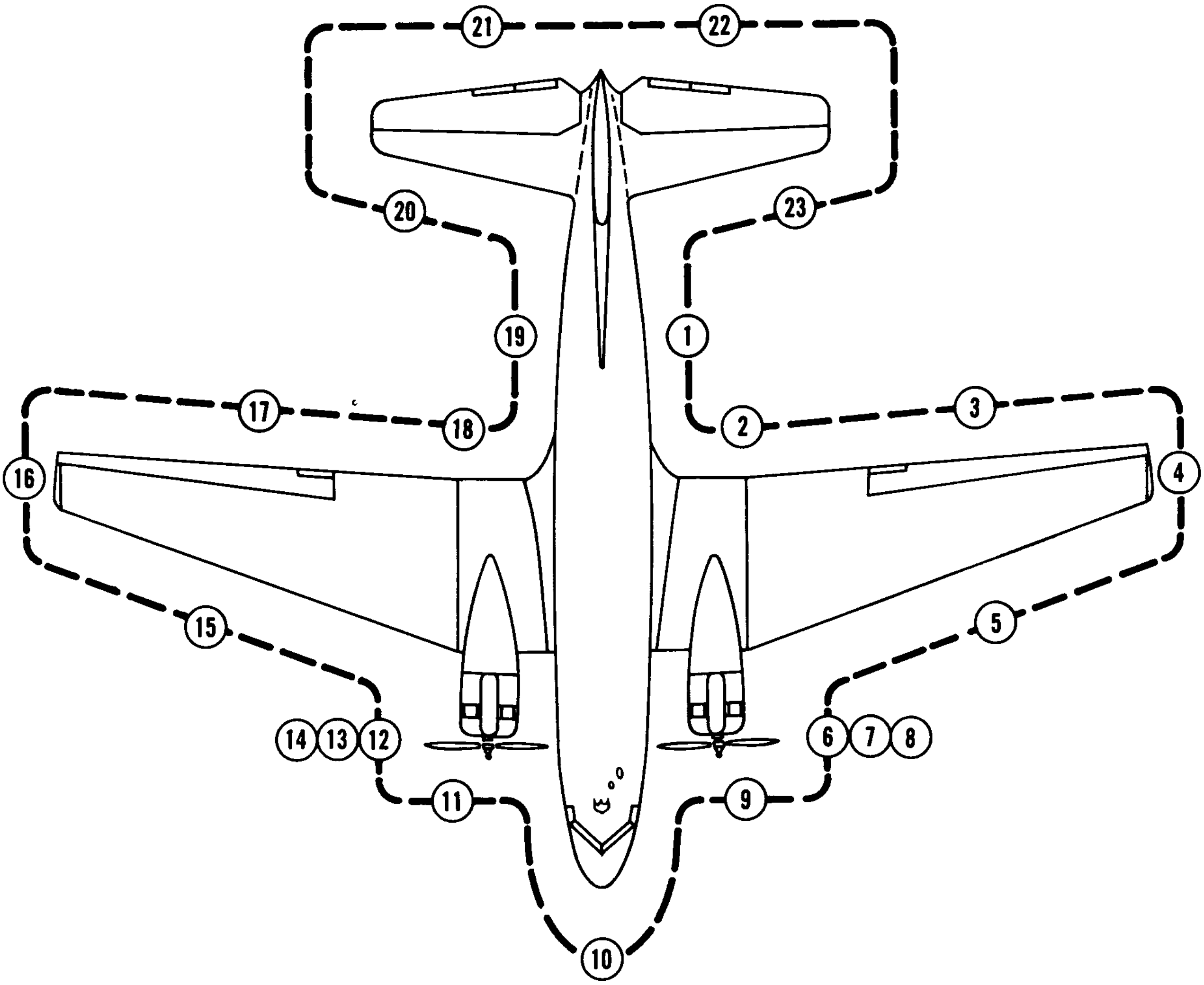

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Figure 3-1. Exterior Inspection

BEFORE STARTING ENGINES CHECKLIST

NOTE

*On through flights when the crew has not left the aircraft, and maintenance has not been performed, only those items marked by an asterisk need be accomplished: On the before start, before taxi, taxi, runup.

1. Seat and rudder pedals - SET P-CP

*2. Landing gear handle - DOWN AND POSITIVE LOCK CP

3. Wing flap/handle - NEUTRAL CP

4. Fire extinguisher system - CHECKED P

   a. Firewall shutoff valves - DOWN

NOTE

The fire extinguisher selector will normally be set to the heater compartment position. The two discharge handles should be fully seated.

*5. Parking brake - SET P

6. Carburetor air control - COLD AND LOCKED CP

*7. Fuel selectors - ON/OUTBOARD OFF P-CP

NOTE

Fuel selectors should be set to the inboard tanks which will not be used for takeoff to check fuel flow, normally the aux. If the main tanks are full, excessive running time on the aux may cause the main tanks to overflow due to carburetor vent return. This may occur when there is excessive delay in completing the Before Taxi Check after engine start. Delay should be avoided or tanks switched to mains to prevent this overflow.

*8. Mixtures – IDLE CUTOFF P

*9. Throttles – SET P

NOTE

The throttles should be cracked toward the open position approximately 1/2 inch.

*10. Propellers – FULL INCREASE P

*11. Left/right electrical panel - SET P-CP

Left

a. Cabin heater – OFF
b. Cowl flap switches – OPEN
c. Oil cooler switches – AUTOMATIC
d. All lighting services as required
e. No smoking/seat belts - ON

Right

All switches - OFF

*12. Ignition switches/master ignition - OFF/ON P

13. Navigation radios - OFF CP

14. Attitude indicators - CAGED P-CP

15. Manifold pressure - NOTED P

16. Static selector - NORMAL P

17. Deicing systems - OFF CP

*18. Battery selector sw - GROUND POWER (BATTERY IF GND PWR IS NOT AVAILABLE) CP

*19. UHF - ON CP

NOTE

Normally the UHF radio should be checked prior to engine start to ensure that radio contact is available in the event of an emergency. Allow a minimum of one minute for warmup.

*20. Engine fire warning system/warning lights - CHECKED P-CP

a. Inverter
b. Fuel pressure
c. Oil pressure
d. Landing gear
e. Autopilot
f. Heater
g. Generators
h. Magnetic chip detectors
i. Marker beacons

*21. Fuel quantity - CHECKED CP

22. Alcohol quantity - CHECKED CP

*23. Landing gear pins - REMOVED CC/PC

*24. Anti-collision light - ON P

STARTING ENGINES CHECKLIST

1. Area and fire guard right - CHECKED/SET CP

2. Right engine start select/boost pump - SET CP

3. Right engine – START CP

a. Starter and starter safety switch engaged.

b. Ignition switch on after nine blades.

NOTE

Crank the engine over a minimum of nine blades to check for hydraulic lock and to preoil the engine. If no indication of hydraulic lock is evident continue cranking.

c. Prime as required until the engine starts and then hold steady prime and adjust throttle until the engine stabilizes at 1000 rpm. Normally the primer may be held on steady from the beginning of the start sequence. If the engine is hot, intermittent prime may be required until the engine starts.

CAUTION

If engine does not start after cranking for 30 seconds, release starter and allow it to cool for at least 1 minute. If engine fails to start on second attempt, secure all switches and investigate cause. Mixture control must not be moved out of IDLE CUTOFF position until engine starts and is running smoothly, as a successful start may not be accomplished and there is danger of fire and/or fuel lock.

NOTE

For procedures to be followed in event of engine fire during start, refer to Emergency Procedures, Section V.

d. Release starter and starter safety switch.

e. Oil pressure – INDICATION NOTED

f. When engine is running smoothly, advance mixture control to AUTO RICH.

g. Release prime when a drop of approximately 200 rpm is noted.

h. Oil pressure – NOTED

NOTE

Oil pressure should indicate 40 psi within 30 seconds. It is recognized that under extremely cold conditions it may take longer than 30 seconds. In this case it is permissible to continue IDLE provided that at least 15 psi is available within 40 seconds and engine rpm remains at or below 1000 rpm until 40 psi is observed. If these indications are not observed the engine should be secured.

4. Right engine boost pump - OFF CP

5. Wing flaps/hydraulic pressure - CYCLE/CHECKED CP

NOTE

The right engine-driven hydraulic pump is tested by lowering the flaps prior to starting the left engine. Hydraulic pressure should indicate 950 to 1100 psi.

6. External power - CLEAR P

7. Battery selector switch - BATTERY CP

8. Right generator - ON/CHECKED CP

9. Doors open warning light - OFF P

WARNING

The cabin door should be closed prior to starting the left engine to prevent injury to personnel when closing this door in prop blast.

10. Area and fire guard left - CHECKED/SET P

11. Repeat items 2 through 4 for left engine P

CAUTION

DO NOT EXCEED 1400 rpm until 40°C oil temperature has been reached. Do not close the cowl flaps to shorten the engine warmup period.

12. Left generator - ON/CHECKED CP

13. Start selector - OFF CP

BEFORE TAXI CHECKLIST

*1. Generators - ON/CHECKED CP

CAUTION

Maximum generator load for prolonged ground operation shall not exceed 135 amps.

*2. MAP lines - DRAINED P

*3. Engine fire warning - CHECKED P

*4. Inverters - ON/CHECKED CP

*5. Navigation radios - ON P-CP

NOTE

Inverters should be checked for transfer of power and then switches should be placed in normal ON position.

*6. Fuel selectors/gages - MAIN P-CP

NOTE

Fuel selectors should be set to the tanks to be used for takeoff, normally the main tanks to allow for carburetor vent return but in no case the outboards.

*7. Navigation/flight instruments - CHECKED/SET P-CP

a. Check clocks/compass/altimeters/ airspeed/VSI/VGI

8. Magneto ground check - COMPLETE P

NOTE

Accomplish the ignition ground check at IDLE rpm. Master ignition OFF, and then ON. Each magneto switch individually from BOTH to L, to R, to OFF momentarily and then back to BOTH. If the engines cease firing when the switch is set to either L or R positions, do not proceed with the engine runup checklist.

WARNING

If the engine does not cease firing in the OFF position, personnel should be warned to stay clear of the propeller, after engine shutdown until the discrepancy has been corrected.

9. Plane captain/crew chief report - COMPLETE CC/PC

The plane captain/crew chief's report shall include the following information:

a. Landing gear pins removed and stowed
b. Battens removed and stowed
c. Measured quantity of fuel and oil onboard
d. Total number of personnel onboard.

*10. Chocks - PULLED P-CP

TAXI

NOTE

Before unlocking the tailwheel, the aircraft should be rolled forward slightly to relieve the locking pin from possible side loads.

It is preferable to maneuver the aircraft by the use of differential engine power, assisted by the rudder. Do not turn the aircraft with full brake applied to one wheel as this may grind a flat spot on the tire. Anticipate the turn, so that the inner wheel may roll during the turn. Use only sufficient rpm for taxiing speed. Use of the brakes against excessive rpm will heat the brakes and shorten brake life. (See figure 3-2.)

When extended crosswind taxi is anticipated it is advisable to align the aircraft with the taxiway and lock the tailwheel to avoid excessive use of the brakes for directional control.

CAUTION

Do not exceed 1400 rpm until an oil inlet temperature of 40°C has been reached.

TAXI CHECKLIST

1. Pilot's/copilot's brakes - CHECKED P-CP

*2. Directional indicators - CHECKED P-CP

a. Turn and slip indicators
b. Wet compass
c. G-2
d. RMI's

*3. Navigational radios/IFF - ON AND CHECKED P-CP

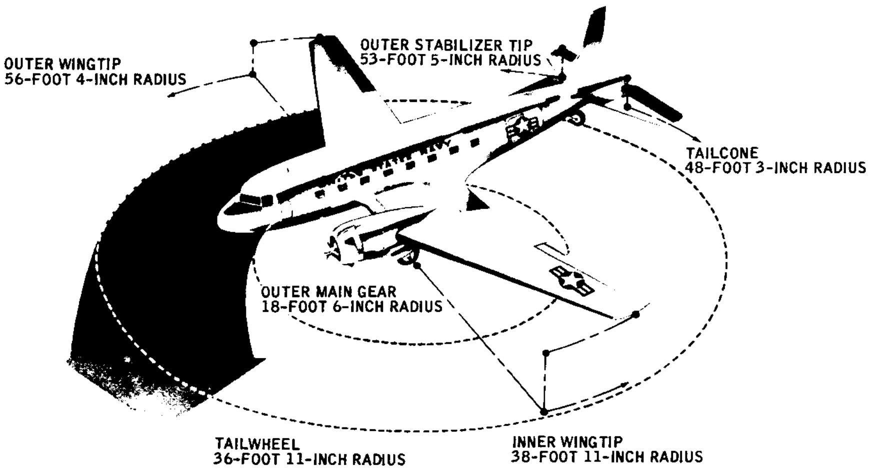


Figure 3-2. Turning Radius of the Aircraft - Taxi Operation

ENGINE RUNUP CHECKLIST

CAUTION

The yoke shall be held aft of neutral during engine runups and during full power checks to ensure that the tailwheel remains on the ground.

NOTE

*On through flights when the crew has not left the aircraft and maintenance has not been performed, only those items marked by an asterisk need be accomplished.

*1. Tailwheel - LOCKED P

*2. Parking brakes - SET P

*3. Mixtures - AUTO RICH CP

*4. Engine instruments - WITHIN LIMITS P-CP

*5. Rpm - 1500 P

*6. Propellers - EXERCISED P

NOTE

Place propeller controls in full decrease rpm position. Note drop in rpm. Normally rpm will stabilize between 1200 and 1300. Rpm should not drop below 1200. Return controls to full increase and note rpm return to 1500. Propellers should be exercised twice when normal temperatures prevail. During cold weather operation, exercise the propellers three or four times to circulate warm oil through the system and prevent overspeeding on takeoff.

7. Deicing system - CHECKED CP

Check pressure gage for indication of 7.5 to 8.5 psi. Check each boot, inboard, outboard and empennage, for sequential cycling.

8. Carburetor air - CHECKED CP

Release carburetor air control handle lock. Pull carburetor air control handles aft and note increase in carburetor air temperatures. Return handles to normal and lock them. Note carburetor air temperature return to normal. If icing conditions are anticipated, a check of the carburetor alcohol system should be completed at this time.

a. Apply carburetor preheat. Do not exceed 38°C.

b. Set alcohol pump to ON, and depress carburetor alcohol levers.

c. Note decrease in carburetor air temperature.

d. Return all switches and controls to normal.

*9. Feathering - CHECKED P

With 1500 rpm set, depress left feathering button. Note approximately 200 rpm decrease and electrical load increase. Pull button to normal and note increase to 1500 rpm and electrical load decrease to normal. Continue the check for the right engine. Upon completion of the feathering check, the propellers should be exercised to displace any cold oil added to the prop domes by the feathering pump.

While performing the feathering check, the ammeters should be observed for load increases when the feathering pump is operating. The generators should share the load within 10 percent of one half the total load.

NOTE

> Copilot or crew chief standby to switch battery and generator OFF if feathering button fails to release.

*10. Power - CHECKED P

Advance left throttle to field barometric pressure and note rpm. Limitation 2350±50 rpm.

*11. Ignition - CHECKED P

With MAP set to field barometric pressure, set left magneto switch to left and note rpm drop. Return switch to BOTH and note rpm increase. Set switch to right and note drop. Return switch to BOTH and note rpm increase. Some drop should be noted in left and right positions, but drop should not exceed 100 rpm and the difference in drop between left and right magneto should not exceed 40 rpm. Retard throttle to 1500 rpm.

When right engine ignition check is being conducted, copilot should note smoothness of engine and visually check unusual torque (which may not show an rpm drop); when left ignition check is being conducted, pilot should do the same.

*12. Repeat items 10 and 11 for right engine - COMPLETE CP

SPARK PLUG DEFOULING

Carbon or lead fouling of spark plug electrodes can occur during periods of prolonged idling of the engine. If fouling occurs, excessive rpm drops will be noted on the ignition check. To remedy fouling, a ground burnout may be attempted. A low power burnout is generally the most satisfactory and will be used prior to attempting a high power burnout.

LOW POWER PROCEDURE

a. Idle the engine at 1200 rpm.

b. Momentarily energize the primer. If either an rpm drop or less than 25 rpm rise is observed, manually lean the mixture to at least a 25 rpm drop, but less than a 50 rpm drop. Mixtures richer than a 25 rpm drop from best power will be ineffective. Operate the engine at this setting for approximately 2 minutes.

HIGH POWER PROCEDURE

a. Set MAP at field barometric pressure plus 5 inches and set mixture controls to AUTO LEAN.

b. Operate at this power for 1 minute.

BEFORE TAKEOFF CHECKLIST

1. Carburetor air - CLIMATIC P

Carburetor heat may be used for takeoff if required. Refer to Cold Weather Procedures, Section VI.

2. Throttle friction - SET P

3. Trim tabs - SET P

For normal 0-flap takeoff the trim tabs should be set as follows:

Elevator – 2 to 3 degrees noseup
Rudder – 0
Aileron – 0

4. Flaps - AS REQUIRED P-CP

For takeoff under normal conditions, no flaps will be used.

5. Hatches/doors/windows - SECURED P-CP-CC/PC

6. A.C. interlock override - ON/OFF CP

WARNING

> If autopilot fuse failed prior to takeoff, pilot's flight gyros will lose power as soon as ac interlock becomes operative at lift-off. If fuse has failed, pilot's inverter warning light will come on when ON (override) position is selected; takeoff should not be attempted until discrepancy is corrected.

7. Seat belts/shoulder harness - SET P-CP-CC/PC

8. Deicing equipment - SET/BOOTS OFF CP

a. Pitot heat – AS REQUIRED

b. Deicing boots – OFF

WARNING

> Deicer boots shall not be used for takeoff. Undesirable flight characteristics at low airspeeds may result.

c. Heater – AS REQUIRED FOR WINDSHIELD DEICING

d. Alcohol System – As required for propeller and windshield deicing. Carburetor alcohol – OFF

9. Crew and passenger briefing - COMPLETE P

Crew Briefing

a. Takeoff speed
b. Refusal speed
c. Intentions in emergency situations (if other than abort prior to refusal or fly after refusal)
d. Abort information (airfield, pattern, single engine climb speed)
e. Crew duties in emergency
f. Instrument departure (if applicable)

10. Flight controls/autopilot - CHECKED/OFF P

Flight controls should be checked for free movement to extremes and visually checked.

11. Propellers - FULL INCREASE P

12. Mixtures - AUTO RICH CP

13. Boost pumps - ON CP

14. Cowl flaps - CLIMB P

15. Gear latch lever - SPRING LOCK P

16. Tail wheel - LOCKED P

17. Attitude/directional indicator/radio altimeter - CHECKED P-CP

TAKEOFF

When cleared the pilot will align the aircraft on the runway and complete items 12 through 17 of the Before Takeoff Checklist. After a final check of the engine instruments, release the brakes and advance the throttles to maximum power. The yoke should be held slightly aft to hold the tailwheel down for directional control on the initial portion of the takeoff roll. At approximately 40 KIAS the tail will rise and directional control should be maintained with the rudder. The use of brakes for directional control should be avoided because the takeoff roll may be considerably increased. The copilot will backup the throttles for the pilot. The pilot will not release the throttles until safely airborne. When takeoff speed is reached, fly the aircraft off the ground. Voice and hand signals will be used, after takeoff, for gear and flap retraction. If terrain conditions warrant high rate of climb, maintain best single engine climb speed until safe altitude is reached. (See figure 3-3.)

CROSSWIND TAKEOFF

Takeoff directional control on the runway is primarily maintained by the use of differential power. Applying less power on the downwind engine helps to counteract the wind force being applied to the vertical stabilizer. To assist in maintaining directional control, the ailerons should be held wing down into the wind. As the speed of the aircraft increases, the aileron deflection is lessened until neutral aileron is reached at lift off. When sufficient speed has been attained for effective rudder control, the power on the downwind engine may be increased proportionately. Throttles will be equalized at maximum power immediately upon lift-off. Refer to Section I, Part 4, for Maximum Crosswind Operations.

AFTER TAKEOFF CLIMB CHECKLIST

1. Gear/flaps/lights - UP CP-P

2. Power - SET P

Normal rated power (METO) will be used for climb. Set 2500 rpm and approximately 45 inches MAP.

3. Crew chief/plane captain report - COMPLETE CC/PC

The plane captain/crew chief will check engines and wings for evidence of fuel leaks, oil leaks, or other abnormal indications. He will also check cabin for fumes, etc. Minimum altitude for this inspection is 1000 feet AGL.

4. Deicing equipment - SET/AS REQUIRED P

5. No smoking/seat belts - AS REQUIRED P

The crew and passengers may move about at the pilot's discretion, but in no case below 1000 feet AGL.

CLIMBOUT

After completing the takeoff, a climb speed of 120 KIAS is maintained until reaching cruise altitude. Airspeed may be increased to maintain the cylinder head temperatures in limits during hot weather operations. When passengers are being transported, climb airspeed may be increased to 130 KIAS if this will provide an acceptable angle of climb.

CRUISE CHECKLIST

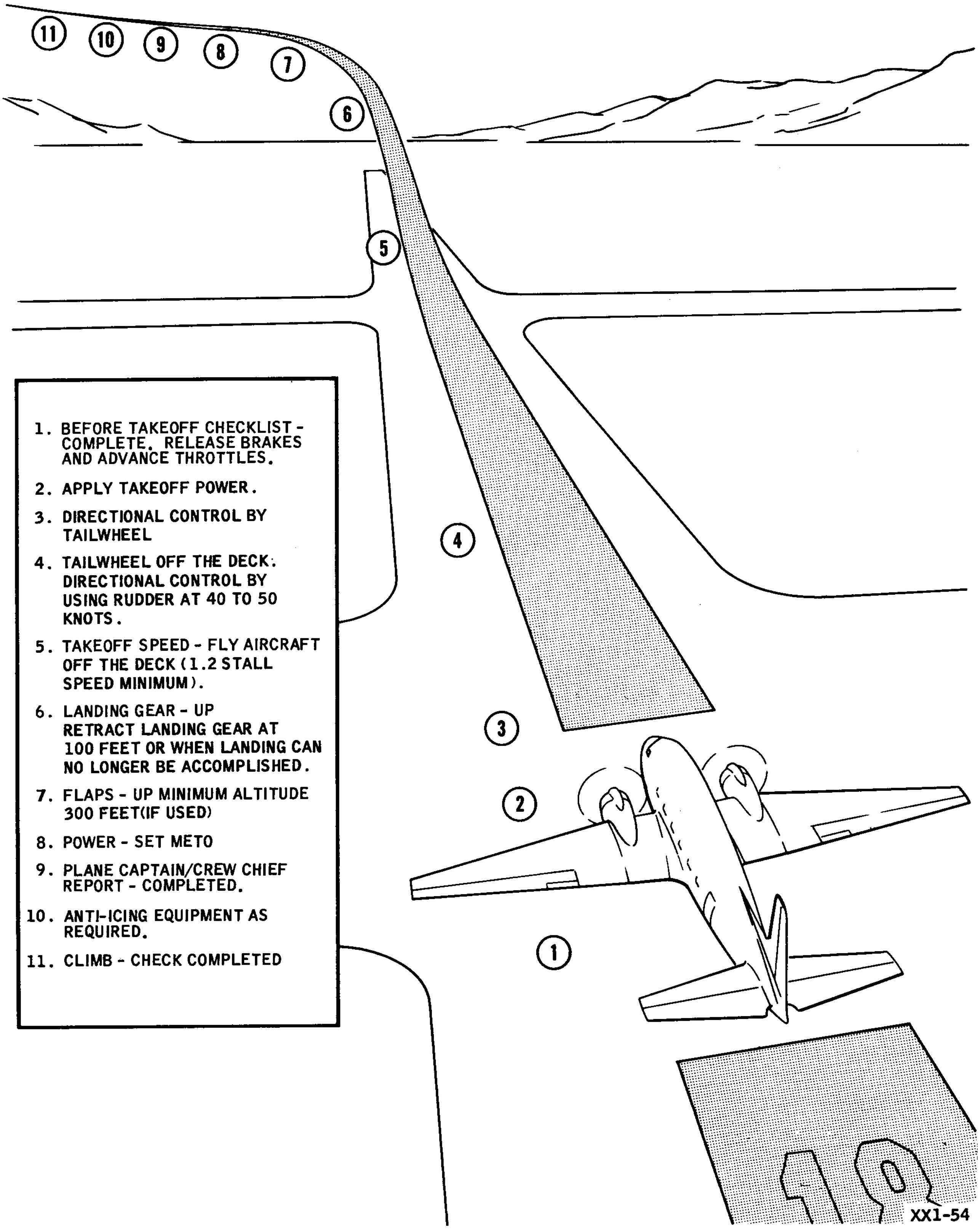
1. Cruise power/mixtures - SET/AUTO LEAN P

2. Cowl flaps - SET P

3. Carburetor air temp - CHECKED CP

4. Fuel selectors/boost pumps - SET P-CP

Turn fuel pumps off one at a time and check fuel pressure within limits. Fuel pressure may fluctuate within limits after level off for an indefinite period due to fuel vaporization. Use of the boost pumps is recommended during this period. If full pressure falls below normal limits, refer to Section V, Fuel Pressure Drop.



1. BEFORE TAKEOFF CHECKLIST - COMPLETE. RELEASE BRAKES AND ADVANCE THROTTLES.
2. APPLY TAKEOFF POWER.
3. DIRECTIONAL CONTROL BY TAILWHEEL
4. TAILWHEEL OFF THE DECK. DIRECTIONAL CONTROL BY USING RUDDER AT 40 TO 50 KNOTS.
5. TAKEOFF SPEED - FLY AIRCRAFT OFF THE DECK (1.2 STALL SPEED MINIMUM).
6. LANDING GEAR - UP RETRACT LANDING GEAR AT 100 FEET OR WHEN LANDING CAN NO LONGER BE ACCOMPLISHED.
7. FLAPS - UP MINIMUM ALTITUDE 300 FEET(IF USED)
8. POWER - SET METO
9. PLANE CAPTAIN/CREW CHIEF REPORT - COMPLETED.
10. ANTI-ICING EQUIPMENT AS REQUIRED.
11. CLIMB - CHECK COMPLETED

Figure 3-3. Takeoff and Initial Climb (Normal Conditions)

NOTE

If takeoff has been made with full inboard tanks, fuel should be used from the main tanks until approximately 130 gallons is remaining in each main tank and then sequence tanks to OUTBOARD/AUX/MAIN to allow for carburetor vent return and best cg location for landing. A periodic check of the fuel quantity in the main tanks is recommended to check the carburetor vent return system and prevent overflow of these tanks. (Refer to Section I.)

ENROUTE CLIMB

Set the Mixture controls to AUTO RICH prior to setting normal rated power for climb.

1. Mixtures – AUTO RICH CP
2. Boost Pumps – ON CP
3. Cowl Flaps – AS REQUIRED. P

DESCENT

Retard throttle to 22 to 25 inches for 500 fpm rate of descent, clean. With passengers aboard, a rate of descent of 500 fpm is desired. If a greater rate of descent is necessary, slow the aircraft to 144 KIAS and extend the landing gear. Mixtures should be set to AUTO RICH for all descents.

CAUTION

Operation at high rpm and low MAP is one of the major causes of master rod bearing, piston, and ring failures. Therefore, a minimum of 1 inch of MAP for each 100 rpm should be maintained during periods of rapid or prolonged descent.

DESCENT CHECKLIST

The descent check shall be completed prior to landing pattern entry or passing initial approach fix.

1. Mixtures – AUTO RICH CP
2. Boost pumps – ON CP
3. Carburetor air - SET CP
4. Fuel selectors - SET P/CP
Select fullest tanks, MAIN or AUX
5. Heater and deicing equipment - SET P-CP

NOTE

It may be necessary to turn on the heater to prevent the inner pane of the pilot's and copilot's windshield from fogging.

6. Altimeters/radio altimeter - SET P-CP
7. Crew briefing - COMPLETED P
8. NO SMOKING/SEAT BELTS sign - ON P
9. Seat belts/shoulder harness - SET P
10. Drift sights - CAGED AND TRAIL CC/PC

LANDING CHECKLIST

1. Autopilot - OFF P
2. Wing flaps - AS REQUIRED P
3. Landing gear - DOWN/POSITIVE LOCK P-CC/PC

NOTE

Check handle down and latch lever positive lock, pressure checked, and light off.

4. Landing lights - AS REQUIRED P
5. Deicing boots - OFF CP
6. Propellers - FULL INCREASE P

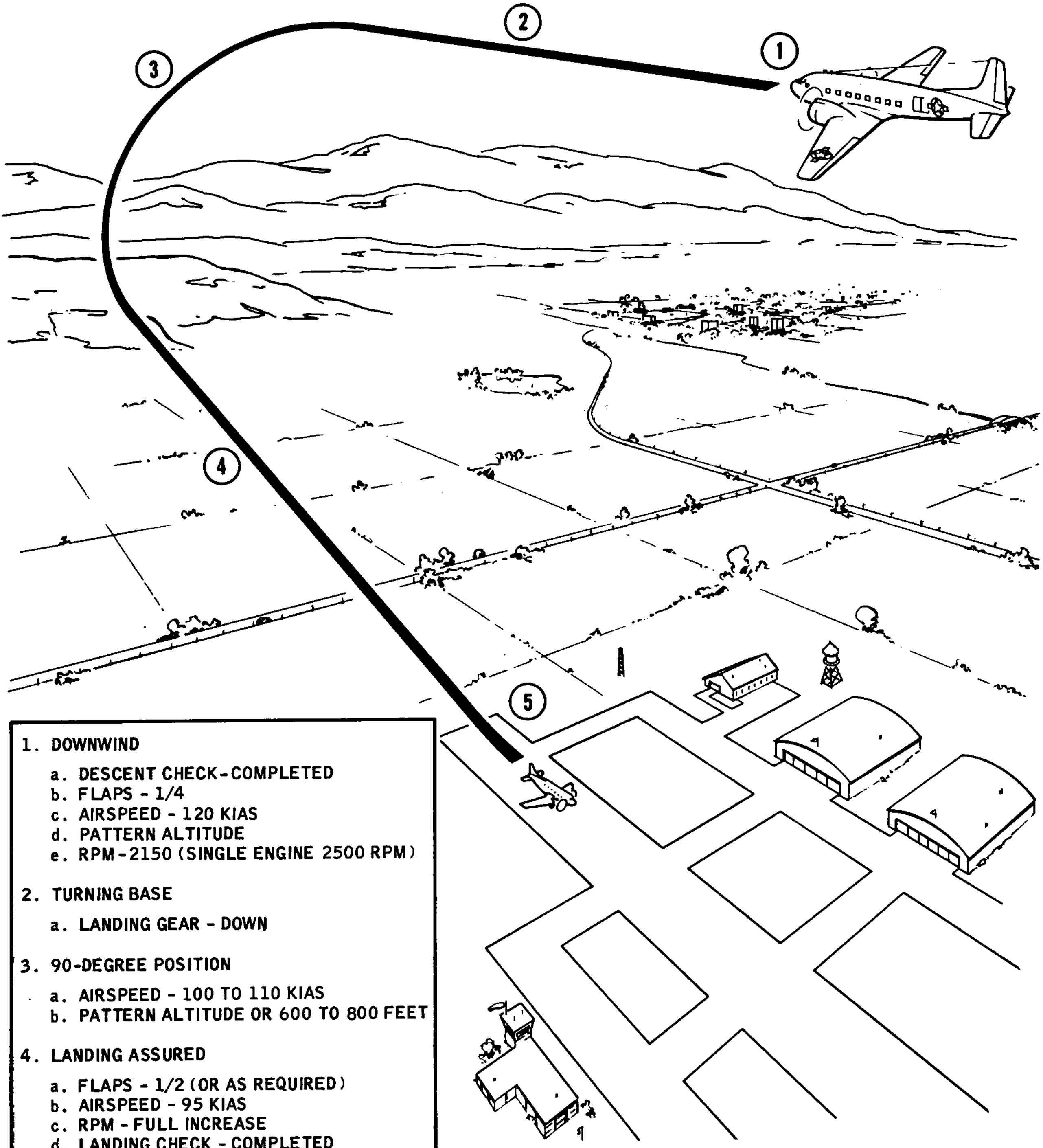
NORMAL LANDING

Consistently good landings can be made if the final approach is made at 1.2 stall speed and a 300 fpm rate of descent. Land on the main gear with the tail slightly low. Upon contact with the runway, a slight forward motion on the elevator control will keep the aircraft on the ground. Do not attempt to pull the tail down as this may result in a porpoise. The tailwheel will settle to the runway as speed decreases. (See figure 3-4.)

MINIMUM RUN LANDING

The procedure for a minimum run landing is the same as for a normal landing, with the following exceptions:

1. After clearing obstructions, endeavor to get the aircraft onto the ground as soon as possible.
2. Apply brakes as soon as possible.



1. DOWNWIND
    - a. DESCENT CHECK-COMPLETED
    - b. FLAPS - 1/4
    - c. AIRSPEED - 120 KIAS
    - d. PATTERN ALTITUDE
    - e. RPM-2150 (SINGLE ENGINE 2500 RPM)
2. TURNING BASE
    - a. LANDING GEAR - DOWN
3. 90-DEGREE POSITION
    - a. AIRSPEED - 100 TO 110 KIAS
    - b. PATTERN ALTITUDE OR 600 TO 800 FEET
4. LANDING ASSURED
    - a. FLAPS - 1/2 (OR AS REQUIRED)
    - b. AIRSPEED - 95 KIAS
    - c. RPM - FULL INCREASE
    - d. LANDING CHECK - COMPLETED
5. OVER TOUCHDOWN
    - a. 1.2 STALL SPEED MINIMUM

NOTE: DURING SINGLE-ENGINE APPROACH, LOWERING OF LANDING GEAR MAY BE DELAYED UNTIL LANDING IS ASSURED.

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Figure 3-4. Normal Landing

CROSSWIND LANDING

For crosswind landings, make a longer straightaway on final to determine the amount of drift correction required prior to touchdown. Correct for drift by applying sufficient wing down into the wind and opposite rudder to maintain runway heading and lineup. The landing should be made on the upwind wheel first allowing the other wheel to settle to the runway as speed decreases. Raise the flaps when both main wheels are on the runway. Directional control should be maintained by judicious use of the throttles, rudder, and aileron rolled into the wind. As speed decreases, downwind brake application may be necessary. (Refer to Section I, Part 4, for Maximum Crosswind Limitations.)

TOUCH AND GO LANDINGS

Normal procedures will be used until touchdown. Sufficient speed should be maintained to keep the tailwheel in the air. The copilot will retract the flaps, adjust the trim, and report. The pilot will advance the throttles and continue with normal takeoff procedures. Throttles should be applied smoothly to avoid overspeed. The Prelanding and Landing Checks must be completed prior to the next touch and go.

NOTE

The gear latch lever will be in the positive locked position on takeoff and must be released prior to landing gear retraction after lift-off.

WAVEOFF

It is prudent to use no more than half flaps prior to final commitment to land. A waveoff with half flaps is a relatively simple maneuver, whereas a considerable amount of drag must be overcome with full flaps extended. In the event of a waveoff, advance the propellers and throttles to maximum power, establish a climbing attitude, maintain 1.2 stall speed minimum, call for gear up and retract flaps in small increments as airspeed increases. (See figure 3-5.)

WARNING

If taking a waveoff from an extremely low altitude, do not retract the gear until you are sure that the aircraft will not settle to the runway.. Do not retract the flaps until a positive rate of climb is established.

NOTE

Advance the throttles slowly until rpm "stabilizes" at 2800. The rpm will normally stabilize as the MAP is increased through the 35- to 38-inch range. Throttles may then be advanced normally.

AFTER LANDING CHECKLIST

On the landing roll, raise the flaps on the pilot's command. The tailwheel shall not be unlocked until speed has decreased for safe taxi. The after landing check shall be completed after clearing the active runway.

1. Wing flaps - UP	CP
2. Boost pumps - OFF	CP
3. Cowl flaps/oil coolers - OPEN	P
4. IFF/NAV radios/radio altimeter - OFF	CP-CC/PC
5. Carb air/deicing equip - COLD/OFF	CP-CC/PC
6. Trim tabs - ZEROED	P
7. Landing lights - RETRACTED/OFF	CC/PC

POST FLIGHT CHECKLIST

(As mission permits, prior to Engine Shutdown after last flight of the day)

1. Tailwheel - LOCKED	P
2. Parking brake - SET	P
3. Power - CHECKED	P
4. Ignition - CHECKED	P

ENGINE SHUTDOWN CHECKLIST

1. Tailwheel - LOCKED	P
2. Attitude indicators - CAGED	P-CP
3. Inverters - OFF	CP
4. Parking brake - SET	P
5. RPM for scavenging - SET	P

NOTE

1200 rpm should be set and maintained for a minimum of 1 minute for oil scavenging.

6. Magneto ground check - COMPLETE	P

NOTE

Accomplish the ignition ground check at idle rpm. Master ignition OFF and then ON. Each magneto switch individually from BOTH to L to R to OFF momentarily and then back to BOTH.

1. ADVANCE PROPELLER CONTROLS TO FULL INCREASE.

2. ADVANCE THROTTLES TO MAXIMUM POWER

NOTE

ADVANCE THROTTLES SLOWLY UNTIL RPM STABILIZES AT 2800. THE RPM WILL NORMALLY STABILIZE AS THE MAP IS INCREASED THROUGH THE 35-TO 38- INCH RANGE. THROTTLES MAY THEN BE ADVANCED NORMALLY.

3. ESTABLISH CLIMBING ATTITUDE, MAINTAIN 1.2 STALL SPEED MINIMUM, CALL FOR GEAR UP, AND RETRACT FLAPS IN SMALL INCREMENTS AS AIRSPEED INCREASES.

WARNING

IF TAKING A WAVEOFF FROM AN EXTREMELY LOW ALTITUDE, DO NOT RETRACT THE GEAR UNTIL YOU ARE SURE THAT THE AIRCRAFT WILL NOT SETTLE TO THE RUNWAY. DO NOT RETRACT THE FLAPS UNTIL A POSITIVE RATE OF CLIMB IS ESTABLISHED.

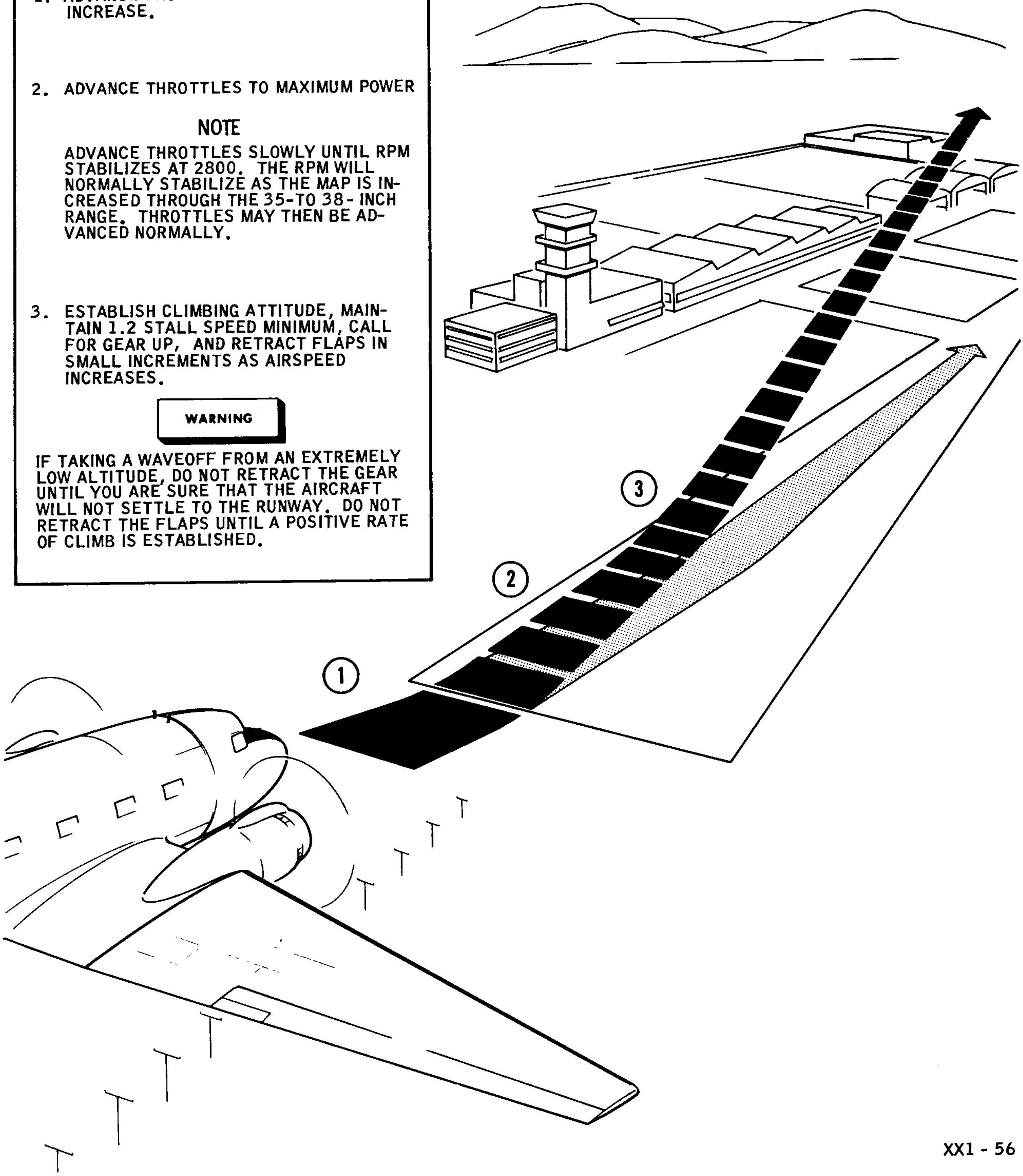

Figure 3-5. Waveoff

WARNING

If the engine does not cease firing in the OFF position, personnel should be warned to stay clear of the propeller, after engine shutdown, until discrepancy has been corrected.

7. Right engine mixture - IDLE CUTOFF CP

Rpm should be monitored while cutting the mixture. Maximum of 25 rpm rise is permitted for the idle mixture check.

CAUTION

Maximum CHT for engine shutdown is 160° C.

8. Wing flaps/hydraulic pressure - CYCLE/CHECKED CP

NOTE

During normal operations the right engine is secured first to check the left engine-driven, hydraulic pump.

9. Left engine mixture - IDLE CUTOFF CP
10. Magneto/master ignition switch - OFF P

The magneto switches shall not be turned off until the propellers have stopped rotating.

11. Navigation/wing/anti-collision lights - OFF P
12. Radios - OFF CP-CC/PC
13. Fuel selectors - OFF CP
14. Generators - OFF CP
15. Battery - OFF CP

The plane captain/crew chief shall install the gear pins and control battens.

NIGHT FLYING

Landing lights will normally be used for all night takeoffs and landings. A red-lens flashlight shall be available for each pilot.

With the cabin lights on, the cockpit door should be kept closed as much as possible.

PART 5

FUNCTIONAL CHECKFLIGHT PROCEDURES

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TEXT

GENERAL

CHECK PILOTS

The most important factor in obtaining good checkflights on the aircraft is to select experienced, conscientious check pilots. Commanding Officers will designate, in writing, those pilots within their command who are currently eligible to perform this duty.

CHECKFLIGHTS AND FORMS

Checkflights will be performed when directed by, and in accordance with, OPNAVINST 4790.2 series and the directions of NAVAIRSYSCOM Type Commanders, or other appropriate authority. Functional checkflight requirements and applicable minimums are described below. Functional checkflight checklists are promulgated separately.

CONDITIONS REQUIRING FUNCTIONAL CHECKFLIGHTS

Checkflights are required under the following conditions (after the necessary ground check and prior to the release of the aircraft for operational use):

A. At the completion of aircraft rework and all calendar inspections (all checkflight items required are prefixed A).

B. After the installation or reinstallation of an engine, carburetor, major fuel system components or any components which cannot be checked in ground operation (minimum required are prefixed B).

C. After the installation or reinstallation of a propeller or propeller govenor (minimum required are prefixed C).

D. When fixed flight surfaces have been installed or reinstalled, or when movable flight surfaces or flight controls or landing gear components have been installed, reinstalled, adjusted, or re-rigged and improper adjustments or replacement of such components could cause an unsafe operating condition (minimum required are prefixed D).

PROCEDURES

The following items provide a detailed description of the functional checks, sequenced in the order in which they should be performed. In order to complete the required checks in the most efficient and logical order, a flight profile has been established for each checkflight condition and identified by the letter corresponding to the purpose for which the checkflight is being flown; i.e., A through D above. The applicable letter identifying the profile prefixes each check both in the following text and in the Functional Checkflight Checklist. Checkflight personnel will familiarize themselves with these requirements prior to the flight. NATOPS procedures will apply during the entire checkflight unless specific deviation is required by the functional check to record data or ensure proper operation within the approved aircraft envelope. A daily inspection is required prior to the checkflight.

PROFILE	
	PRE-START
A B C D	1. Interior Inspection. Check for proper operation of switches, controls, lights, and instruments. Check specifically for missing hardware, decals, instruction plates, and all deviations from standard acceptable conditions. Specifically ascertain that all escape hatches, doors, and mechanisms are in order. Also check for loose or misplaced hardware and equipment in crew and passenger areas. Note condition of windshield double panes and glass windows. Check rudder pedals and seat adjustments.
A B C D	2. Exterior Inspection. During the walk-around inspection, check specifically for and record: Hydraulic leaks, fuel leaks, oil leaks, condition of tires, pitot heads, carburetor intake ducts, exhaust stacks, oil cooler inlet and oil cooler core, carbon dioxide popout discs, static ports, control surfaces, antennas, security of doors, skin irregularities, and general aircraft condition.
A D	3. Flight Controls. Remove battens and move control column slowly back, then push forward and return to neutral. Check rudder pedals and surface travel. Ascertain that control surfaces deflect correctly for the applied control deflection, and there is no evidence of binding or excessive friction.
	PRE-TAKEOFF
A B C D	4. Brakes. Check hydraulic pressure for 950 to 1100 psi.
	CAUTION Do not turn the aircraft with full brake applied to one wheel as this may damage the tire.
A B C D	5. Tailwheel Unlock. Be certain tailwheel trails in turns.
A	6. Directional Indicators. (in turns) a. Turn and slip indicators. Check that the needle moves in direction of turn and ball is free in race. b. Wet compass, G-2 and RMI's. Check for freedom of movement.
A B	7. Carbon Monoxide. Measure concentration at pilot's breathing level with aircraft heading 0, 90, 180, and 270 degrees relative to the wind. Maximum concentration allowable is .005 per cent.
A B C D	8. Engine Runup. Perform engine runup check. Record instrument readings not within limits.
	TAKEOFF
A B C	9. Engine performance. a. RPM - 2800. b. MAP - 54.5 in. Hg. c. CHT - 120 to 246 degrees C.; 260 degrees C. maximum.

PROFILE	
A B C (cont)	d. Oil Pressure - 65 to 75 psi. e. CAT - 15 to 38 degrees C. f. Oil temperature - 40 to 90 degrees C.; 95 degrees C. maximum.
	CLIMB
A B	10. Boost Pump Fuel Pressure. Check for 20. 5 to 21. 5 psi.
A	11. Pressure Altimeters. Should respond smoothly, indicate within 500 feet of each other.
A	12. Rate-of-Climb Indicator. Check for proper operation.
A	13. Alternate Static Source. Select alternate static source; static controlled instruments should restabilize and continue to function normally.
A B	14. Carbon Monoxide. Check cabin and cockpit heater outlets.
	LEVEL (6500 feet)
A B	15. Oil Cooler Doors. Check manual and automatic operation of the oil cooler doors.
A D	16. Flight Controls. Check flight controls, including trim tabs, for proper response.
A	17. Flight Instruments. Check proper operation of gyro horizon, turn and slip indicators, directional gyro, G-2 compass, wet compass, and airspeed indicators.
A B	18. Fuel Pressure. Check for 19 to 25 psi.
A B	19. CHT Check for 120 to 246 degrees C.
A C	20. Propeller feather and unfeather. Check as required for proper operation.
A D	21. Autopilot. Trim aircraft for level flight; engage autopilot. a. Check pitch trim, turn trim and bank controls for correct operation. b. Altitude control switch to ON; check for smooth transition and proper altitude hold. c. Check control wheel disconnects for proper operation.
A B	22. Fuel System. (outboard tanks) Select outboard tanks; fuel pressure should remain normal.
A	23. Heaters. Check cabin heater and associated controls for proper operation, including windshield vinyl heat.

PROFILE	
A	24. Driftsight. Check for proper mechanical and electrical operation.
A	25. Sextant Mount. Check for security.
A	26. Cockpit electronics.
	a. AIA-2A ICS for proper operation.
	b. APX-6 and APA-89 IFF/SIF for proper operation all modes.
	c. ARC-1 or ARC-101 VHF for proper operation.
	d. ARC-27 UHF for proper squelch action and operation.
	e. ARN-7 red and green ADF's for adequate signal levels, proper loop action and bearing accuracy plus or minus 2 degrees.
	f. ARN-8 marker beacon for audio and visual indication of signal.
	g. ARN-14 VOR for proper audio, course and deviation indications.
	h. ARN-18 glideslope for proper operation.
	i. ARN-21 TACAN for proper bearing, ranging, and tone.
A	27. Cabin Electronics. (installed equipment)
	a. AIA-2A ICS for proper operation.
	b. APN-70 LORAN for proper operation.
	c. ARC-38A for proper loading and reception.
	d. ARN-6 ADF for adequate signal levels, proper loop action and bearing accuracy.
	e. ARR-15 HF receiver for proper operation.
	f. ARR-41 HF receiver for proper operation.
	g. ART-13 HF transmitter for proper operation.
	h. BC-348 HF receiver for proper operation.
	CLIMB
A	28. Windshield Alcohol. Check for proper operation.
A	29. Windshield Wipers. Check for proper operation.
A D	30. Surface Deicing System. System pressure 7. 5 to 8. 5 psi; check boots for proper operation.
A	31. Oxygen. Check for proper operation of regulator.
A B	32. Boost Pump Fuel Pressure. Check for 20. 5 to 21. 5 psi.

PROFILE	
	LEVEL (11, 500 feet)
A B	33. Fuel Pressure. Check for 19 to 25 psi.
A B	34. Fuel System. Select auxiliary tanks; fuel pressure should remain normal.
A B	35. Oil Temperature. Check for 40 to 90 degrees C.; 95 degrees C. maximum.
A B	36. Oil Pressure. Check for 65 to 75 psi.
A B	37. CHT. Check for 120 to 246 degrees C.
A B	38. CAT. Check for 15 to 38 degrees C.
A B	39. Hydraulic Pressure. Check for 950 to 1100 psi.
	DESCENT
A	40. Radar Altimeter. Check APN-1 at 4000 feet over level terrain and at 400 feet on landing approach. If APN-22 is installed, check at 6000 feet and 400 feet levels.
A D	41. Wing Flaps. Exercise flaps - full extension should take approximately 20 seconds, retraction approximately 8. 5 seconds.
A	42. Cockpit and Cabin Ventilation. Check manual air controls for proper operation.
A D	43. Landing Gear. Extend gear, check indicator lights and warning horn for proper operation.
	LANDING
A B C D	44. Brakes. Check for proper operation.

SECTION IV

FLIGHT CHARACTERISTICS

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FLIGHT CHARACTERISTICS

GENERAL

The flight characteristics are normal for a twin engine transport. The aircraft is very stable, trims out easily, and little change in trim is required to maintain the desired aircraft attitude. Maneuvering and controlling the aircraft does not require undue force by the pilot. Rudder and aileron control is excellent. Elevator forces are normal at both low and high speeds.

STALLS

The stalling characteristics are normal. Stall warning comes in the form of a comparatively mild buffeting. Stalling speed increases with the degree of bank and increase in gross weight as shown in table 4-1. The ailerons are effective up to the point of stall. No violent rolling action either precedes or accompanies the power-off stall under any flap setting. However, as in the case of all multiengine aircraft, stall encountered with power on will probably cause violent rolling movements.

NOTE

The extended landing gear has no appreciable effect on the stalling characteristics.

Recovery from a stall should always be made by nosing the aircraft down. Avoid abrupt pullouts.

SPINS

Spins are one of the prohibited maneuvers and must never be done intentionally. However, in case a spin is entered accidentally, use normal recovery procedure to regain level flight; that is, nosedown and apply corrective rudder to stop the spin.

FLIGHT CONTROLS

The flight controls are very effective under all conditions of normal flight.

DIVING

For diving speed limitations, refer to Section I, Part 4. Avoid abrupt pullouts at any time.

OPERATIONS IN HIGH CROSSWIND

When operating in high crosswinds, be extremely cautious during the start of the takeoff and toward the end of the landing run due to the marginal rudder effectiveness at low speeds.

TABLE 4-1. STALLING SPEEDS

APPROXIMATE STALLING SPEEDS ● KIAS ● POWER OFF

Gross Weight (Pounds)		Flaps Up		Landing Flaps 45°	
		Level Flight	30° Bank	Level Flight	30° Bank
25,000	KNOTS	68	73	61	66
27,000	KNOTS	72	78	65	68
29,300	KNOTS	74	80	66	71
31,000	KNOTS	76	82	68	73
33,000	KNOTS	79	85	70	75
36,800	KNOTS	83	89	74	80
42,000	KNOTS	89	96	79	85

Data as of: 6/22/54 Based on: Flight Test.

SECTION V

EMERGENCY PROCEDURES

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ILLUSTRATIONS

EMERGENCY PROCEDURES

GENERAL

The ability to react promptly and correctly in an emergency requires a thorough knowledge of the aircraft and its systems. Frequent study of this manual, supplemented by frequent simulation of emergencies, will result in a familiarity with procedures required to cope with most any emergency or unusual situation that might arise.

NOTE

Checklist items listed in capital letters (BOOST PUMPS-OFF) will be memorized by applicable crewmembers. During an emergency, the pilot will call out these items and the applicable crewmember will take the necessary action. Following completion of items listed in capital letters, the remaining items of the checklist will be completed in their entirety, time permitting.

GROUND EMERGENCIES

ENGINE FIRE DURING START

In the event of an engine fire during start, open the throttle and continue to crank for a few seconds. Attempt to draw the fire into the engine to extinguish it. If the fire continues, complete the Engine Fire Checklist.

FUEL PRESSURE DROP DURING GROUND OPERATION-ENGINE OPERATING NORMALLY

Fuel pressure that drops below minimum operating limits while the engine continues to operate normally, constitutes an operational emergency due to the potential fire hazard of leaking fuel. Continued operation under these conditions could result in an avoidable engine fire. Do not turn on the fuel boost pumps. Proceed with the items listed in the Fuel Pressure Drop Checklist.

ENGINE FIRE/FUEL PRESSURE DROP GROUND OPERATIONS

If taxiing, stop aircraft and request fire equipment.

1. MIXTURES – IDLE CUTOFF
2. FIREWALL SHUTOFF VALVE – PULL
3. FUEL SELECTORS – OFF
4. BOOST PUMPS – OFF
5. ALCOHOL – OFF
6. COWL FLAP – CLOSED
7. FIRE EXTINGUISHER – Selected and discharged if fire exists.

NOTE

Complete items 6 and 7 if ground firefighting equipment is not available or fails to extinguish the fire.

8. Ignition switches – OFF
9. Battery – OFF
10. Evacuate the aircraft, if required.

BRAKE SYSTEM FAILURE

Brakes can be operated by pumping the hydraulic hand pump. Excessive pumping of the brake pedals should be avoided as pressure is reduced with each application. If there is no hydraulic fluid available to operate the hand pump, the emergency airbrake system can be used as follows:

1. Turn the emergency brake handle clockwise to apply brakes.

2. Return the handle to the HOLD Position when desired braking action occurs.

3. Returning the handle to the OFF position will release the brake pressure.

4. There is sufficient air pressure available with a fully charged bottle to make five full brake applications.

NOTE

> When using the emergency airbrake system, differential brake application is not possible. The air should be applied cautiously.

BRAKE FIRE/HOT BRAKES

In most cases a hot brake is caused by landing or taxiing crosswind. Attempt to stop the aircraft straight ahead with the tailwheel locked and the unaffected brake.

1. Stop aircraft.
2. Apply power on affected side to cool brake.
3. If fire exists, call for assistance.
4. Secure engines and evacuate aircraft if necessary.

WARNING

> Do not taxi into line/parking area with hot brakes. Do not allow unqualified personnel to attempt to extinguish brake fires.

FUSELAGE FIRE – GROUND OPERATIONS

1. RADIO CALL – COMPLETED
2. HEATER – OFF
3. MIXTURES – IDLE CUTOFF
4. FUEL SELECTORS – OFF
5. IGNITION SWITCHES – OFF
6. BATTERY – OFF
7. Fight fire
8. Abandon aircraft, if required.

ELECTRICAL FIRE – GROUND OPERATIONS

1. RADIO CALL – COMPLETED
2. BATTERY AND GENERATOR SWITCHES OFF
3. Use hand fire extinguishers to combat fire.
4. Secure engines, if required.
5. Abandon aircraft, if required.

WARNING

> Carbon tetrachloride and bromochloromethane (CB) are toxic. When sprayed on fire or heated surfaces, these chemicals produce very toxic gases that are harmful, even in small amounts, and that can prove fatal if inhaled in sufficient quantities.

INFLIGHT EMERGENCIES

ENGINE FAILURE

The single-engine flight performance characteristics of the aircraft are excellent.

With proper understanding of the single-engine flight principles and a full mastery of single-engine procedures, the aircraft can be flown and landed safely with only one engine operative. It should be noted that the key factors in safe single-engine flight are airspeed and directional control; the unbalanced engine thrust, which has a tendency to yaw the aircraft into the dead engine, must be neutralized by holding rudder or by trimming the rudder the necessary amount. More rudder deflection is necessary to counteract the unbalanced thrust as airspeed is decreased.

NOTE

The minimum control speed for this aircraft is 76 KIAS.

ENGINE FAILURE ON TAKEOFF

Normally, if an emergency occurs prior to gear retraction, the takeoff should be aborted if sufficient runway is available. If takeoff is continued, the gear and flaps must be retracted when safely airborne and the propeller must be feathered.

SAFE SINGLE-ENGINE CLIMB-OUT AIRSPEED

WARNING

While it is calculated that takeoff may be continued at the specified speeds, a successful climbout may not be possible if there is an obstacle to clear. Under No Circumstances Should Takeoff Be Continued At Airspeeds Below 76 KIAS.

(Based upon calculated data under the following conditions: 1.2 percent power off stalling speed; flaps up; propeller windmilling; landing gear up or down; no wind; standard day temperature; and takeoff power.)

Gross Weight (Pounds)	KIAS
25,000	84
29,300	91

NOTE

At weights in excess of 29,300 pounds, the landing gear must be retracted to execute a safe single-engine climbout. In a single-engine takeoff, the landing gear should be retracted immediately after liftoff, regardless of the weight.

31,500	94

NOTE

To attain a safe single-engine climbout at gross weights in excess of 31,500 pounds, the propeller must be feathered and the landing gear retracted.

34,000	98
36,800	102

ENGINE MALFUNCTION AND ENGINE SECURE CHECKLIST

FUEL PRESSURE DROP INFLIGHT-ENGINE OPERATING NORMALLY

The fuel pressure-low warning light serves both engines. If the light comes on, check the fuel pressure gages to determine which engine is affected. If the fuel pressure drops below operating limits during flight, but the engine continues to operate normally, the cause may be one or more of the following: primer leakage, oil dilution solenoid leakage, engine-driven fuel pump leakage, instrument failure, or line leakage. The first concern must be to guard against engine fire. A fire may not exist at the time the fuel pressure drop is noticed or after several hours of flight; but, when the throttle is retarded (as in preparation for landing), an engine fire develops. Any change in airflow pattern, such as feathering the propeller or entering a climb, can start a fire if a fuel leak exists. Increasing the power is less likely to start a fire since airspeed will be increased, but there is a possibility of fire since the exhaust heat and flame pattern may change sufficiently to outweigh the increase in cooling airflow. The crew must eliminate the fuel before any change is made to the airflow or exhaust pattern. The most effective way of accomplishing this is by moving the mixture control to IDLE CUTOFF before any throttle reduction, propeller feathering, or any other engine shutdown procedure is initiated. Moving the mixture control to IDLE CUTOFF provides the most rapid means of eliminating exhaust stack flames and reducing exhaust heat. Do not turn on the fuel boost pump. Possible courses of action, depending on the cause of the fuel pressure drop, are listed below:

1. Shut down engine immediately. If power is not necessary to sustain flight or to reach a safe destination, shut down engine immediately.

2. Keep affected engine in operation at or above cruising speed while maintaining watch for fire. If it cannot be determined whether leak exists and if the engine is needed to sustain flight or to maintain required altitude to reach a safe destination, keep affected engine operating at or above cruise speed while maintaining watch for fires. Prior to power reduction for entry into landing pattern, shut down

affected engine by means of mixture control (not by retarding throttle), and accomplish a single-engine landing unless the power is absolutely essential for a safe landing.

3. Continue operating engine normally. If it can be determined that the indicated fuel pressure drop was not caused by a fuel leak, continue operating the engine normally.

NOTE

Shutting down the engine immediately is generally the best course. However, such factors as the condition of the aircraft and the remaining engine, stage and requirements of the mission, and power requirements should be considered.

ENGINE FAILURE/FUEL PRESSURE DROP – INFLIGHT

In the event of engine failure inflight, retract the gear and flaps at pilot's descretion and proceed with engine secure procedures.

CAUTION

In event of fuel pressure drop below operating limits, DO NOT change airspeed, altitude, or move any engine controls until the mixture control on the affected engine has been moved to IDLE CUTOFF.

ENGINE FIRE

Safety of personnel and the aircraft requires the use of optimum fire control procedures in combating an inflight engine fire. Elapsed time from engine fire detection to initiation of fire control actions must be kept to a minimum. Tests have demonstrated that the effectiveness of fire extinguishing agents is maximum when the engine fluid pumps are not actuating as a result of propeller feathering. Accordingly, initiation of feathering action cannot be delayed upon detection of an engine fire.

ENGINE SECURE CHECKLIST

1. MIXTURE – IDLE CUTOFF
2. PROPELLER – FEATHER
3. FIREWALL SHUTOFF – PULL
4. ALCOHOL – OFF
5. COWL FLAPS - CLOSED (feathered engine)
6. FIRE EXTINGUISHER - Selected and ON if fire exists.

Complete the remainder of the checklist, time permitting.

7. Fuel Selector - OFF (feathered engine)
8. Boost Pump - OFF
9. Generator – OFF
10. Electrical load – MINIMUM
11. Ignition – OFF
12. Oil cooler – CLOSED
13. Cowl flaps (operating engine) - AS REQUIRED
14. Checklist – COMPLETE

NOTE

If the engine is to be temporarily secured at altitude for the purpose of training or for the purpose of a post maintenance functional check, the engine secure checklist should be preceded by reducing the throttle to idle and by moving the propeller control lever into the full decrease position.

RESTARTING ENGINE

CAUTION

Do not attempt to restart an engine unless it is safe to do so. It is safer to make a single-engine landing than to take a chance on starting an engine fire in flight.

1. Airspeed – 135 KIAS OR BELOW
2. Propeller – DECREASE
3. Mixture – IDLE CUTOFF
4. Throttle – CLOSED
5. Firewall Shutoff Valve – OPEN (push)
6. Fuel selector – ON
7. Ignition – OFF
8. Starter – ENGAGED 6 BLADES

NOTE

The applicable engine should be selected. The starter should be engaged and the engine turned through 6 blades as a check for hydraulic lock and to preoil the engine. The starter should then be released.

9. Ignition – ON
10. Boost pumps – ON
11. Feathering button – DEPRESS (Release after 600 to 800 rpm is indicated.)
12. Oil pressure – 40 PSI WITHIN 30 SECONDS
13. Mixtures – AUTO RICH (After rpm stabilizes)
14. Power for warmup – 1500 RPM and 20 inches MAP
15. Generator – ON
16. Cowl flap – AS REQUIRED
17. Oil cooler – AUTOMATIC
18. Cruise power – SET (After cylinder temperature reaches 120°C minimum and oil temperature is 40°C minimum.)
19. Cruise checklist to be completed as applicable.

SINGLE ENGINE PRACTICE MANEUVERS

Practice the following single-engine procedures until completely familiarized with single-engine characteristics of the aircraft. It is recommended that instead of feathering the engine, one engine throttle be retarded to 12 inches Hg, which will keep the cylinder head temperature within the normal operating range and also allow use of the simulated inoperative engine.

SINGLE-ENGINE FAILURE ON TAKEOFF BEFORE GAINING SAFE SINGLE-ENGINE AIRSPEED

Simulate takeoff conditions at altitude using 2500 rpm, 35 inches Hg, gear down, at 70 KIAS. Cut one throttle back completely and notice that to maintain directional control, it is necessary to reduce power on the other engine with a consequent loss of altitude which would require discontinuing the takeoff.

NOTE

The reduced power settings used to simulate takeoff conditions eliminate unnecessary engine wear without affecting the validity of the maneuver.

SINGLE-ENGINE FAILURE ON TAKEOFF AFTER GAINING SAFE SINGLE-ENGINE AIRSPEED

Simulate takeoff conditions at altitude using 2500 rpm, 35 inches Hg, gear up, airspeed 85 KIAS. Cut one throttle, go through the motions of performing steps under Engine Failure, and continue takeoff. With minimum practice, this procedure can be accomplished with little or no loss of altitude. This clearly demonstrates the advisability of leveling off after takeoff to gain safe single-engine airspeed, and illustrates the ease with which the takeoff can be continued.

SINGLE-ENGINE TURNS

After becoming proficient in the two preceding maneuvers, practice single-engine turns. Single-engine turns can be made safely in either direction if single-engine airspeed is maintained.

1. Roll into turn smoothly and slowly.
2. Throughout turn, maintain airspeed used prior to turn. The value of constant airspeed cannot be overemphasized, as it is the key to safe single-engine turns. As long as constant airspeed is maintained, the thrust of the one engine is balanced by the trimmed rudder.
3. Practice turns in both directions at shallow and medium angles of bank.

EFFECT OF PROPELLER PITCH ON TRIM

If it is impossible to feather the propeller for one reason or another, much of the drag can be removed by moving the dead engine propeller rpm control to full DECREASE RPM. To determine the effect on trim from an unfeathered propeller, retard one throttle and move propeller rpm control to full back position, good engine at 2500 rpm and 35 inches Hg, and trim the aircraft. Then advance the dead engine propeller rpm control to 2500 rpm, as the propeller changes toward low pitch, the additional drag causes the aircraft to turn toward the dead engine, necessitating a change in trim.

EFFECT OF AIRSPEED ON TRIM

The importance of airspeed in single-engine flight may be demonstrated as follows: Simulate single-engine flight and trim the aircraft at a constant airspeed and power setting. With feet on the floor, ease back on the control column. As the airspeed decreases, the trim becomes less effective because of decreased flow of air over the control surfaces, and the aircraft will turn into the dead engine. Push the control column forward until the original airspeed is exceeded and, as the trim becomes more effective with the increased airflow over the control surfaces, the aircraft will turn into the good engine.

EFFECT OF POWER REDUCTION ON TRIM

Practice directional control in single-engine flight by using the throttle only. Simulate single-engine flight and trim the aircraft. Place feet on floor and pull control column back slowly. As speed decreases, gradually reduce power on the good engine to prevent the aircraft from turning into the dead engine.

It is possible to maintain directional control in this manner up to the point of stall. This demonstrates the importance of reducing power to maintain directional control in case of engine failure during takeoff or slow flying when the airspeed is below safe single-engine airspeed.

SINGLE-ENGINE APPROACH TO STALLS

Single-engine approach to stalls may be accomplished if power is reduced to maintain directional control.

SIMULATED SINGLE-ENGINE LANDING

Practice single-engine landings applying the principals discussed in the previous paragraphs.

SIMULATED SINGLE-ENGINE GO-AROUND

Practice simulated single-engine approaches and go-arounds at altitude. During these maneuvers, notice the altitude lost and the amount of power used while maintaining directional control.

1. Set up landing approach.

2. At 500 feet above simulated field elevation, start go-around by applying power to the good engine.

3. Raise the gear and flaps. Retrim the aircraft.

4. Never allow airspeed to drop below minimum control speed.

5. Notice that when proper technique is used, only 100 to 200 feet altitude is lost.

To illustrate an attempt to go-around below 300 feet with full flaps and below safe single-engine airspeed:

1. Set up landing approach.

2. At 300 feet above simulated field elevation, lower full flaps, reduce power and slow aircraft below safe single-engine airspeed.

3. Start go-around by applying power to good engine but not so much that directional control is lost – maintain heading.

4. Raise the gear and flaps, and gain safe single-engine airspeed as soon as possible.

5. Notice loss of altitude – 500 to 600 feet will probably be lost, which should emphasize the importance of maintaining safe single-engine airspeed and using only half flaps until landing is ensured.

PROPELLER FAILURE

PROPELLER FEATHERING CIRCUIT BREAKERS

Circuit breakers for the propeller feathering circuits are located adjacent to the main junction box and should be ON at all times.

ENGINE HUNTING OR SURGING

If an engine is hunting or surging, try to bring it back to synchronization as follows:

1. After reaching a safe altitude, reduce throttle on affected engine.

2. On engine hunting or surging, adjust propeller control lever to INCR rpm and then DECR rpm three or four times.

3. Check fuel supply; if low, change to another tank.

4. If above steps do not correct trouble and hunting or surging is excessive, feather propeller.

PROPELLER OVERSPEEDING

Attempt to control rpm with propeller control. If unable, reduce throttle, decrease airspeed to 120 knots placing load on propeller. If rpm remains uncontrollable, shut down the engine in accordance with the Engine Failure Checklist.

FAILURE TO FEATHER

Place propeller control in full DECR rpm position.

Pulling the engine emergency firewall shutoff handle shuts off the supply of fuel, oil, and hydraulic fluid to the affected engine. If the propeller fails to feather and it can be determined that a fire or fire hazard does not exist, leave the emergency firewall shutoff handle IN. This may prevent damage to the engine that could result from windmilling without lubrication.

FUSELAGE FIRE INFLIGHT

In the event of smoke or fire in the cockpit, cabin, or heater compartment, perform the following steps immediately. After these preliminary steps have been taken, subsequent operations will depend upon the type of fire.

1. Alert crew/passengers – ICS/VERBALLY

2. Oxygen masks – ON, REGULATORS 100%

NOTE

All cockpit crewmembers should put on oxygen masks before, or simultaneously with, the discharge of CO_2. The crewmember delegated to discharge CO_2 to the fire zone may delay putting on his mask until after this operation is accomplished.

3. Heater – OFF

4. Ventilating air check valve control – OPEN

5. Cockpit and windshield temperature control – COLD

6. Cabin temperature control – OFF

7. Fuel booster pumps – OFF

8. Crew - FIGHT FIRE/PREPARE FOR BAILOUT

9. Passengers - PREPARE FOR BAILOUT/THEN TAKE SEATS

HEATER COMPARTMENT FIRE

If a fire occurs in the heater or the heater compartment, proceed as follows, after completing the preliminary steps under FUSELAGE FIRE INFLIGHT.

1. Start emergency descent to the lowest safe altitude.

2. CO_2 selector control – HEATER COMPT

3. CO_2 discharge handle – PULL UP

4. Land as soon as practicable.

ELECTRICAL FIRE (UNDETERMINED SOURCE)

1. Alert crew and passengers. Order use of oxygen (100%). Designate crewmember to direct firefighting.

2. Battery and generator switches – OFF

3. Inverter switches - OFF NEW

4. Emergency power switch – EMERGENCY

5. EXECUTE SMOKE ELIMINATION PROCEDURES IF APPROPRIATE.

6. All circuit breakers – TRIPPED

NOTE

The preceding steps will eliminate electrical power in all electrical circuits. The following steps should be initiated progressively to determine the defective electrical circuit.

7. Battery – ON

8. Generator switches (one at a time) – ON

9. Emergency power switch – NORMAL

10. Inverter switches - ON

11. Circuit breakers (one at a time, starting with the most essential) – SET

NOTE

Observe for recurrence of smoke or fire while resetting the circuit breakers. When found, leave the defective circuit inoperative and restore power to the remaining circuit breakers.

SMOKE ELIMINATION

After a fire has been extinguished, the following procedures should be used, if required, to dissipate smoke and/or fumes from various sections of the aircraft.

SMOKE IN FLIGHT COMPARTMENT

To eliminate smoke concentrations in the flight compartment perform the following, after completing the preliminary steps under Fuselage Fire.

1. Door between cabin and flight compartment – CLOSED

2. Cockpit side windows – CLOSED

3. Door at navigator's station – TRAILED.

SMOKE IN MAIN CABIN

To eliminate smoke in the main cabin area, perform the following, after completing the preliminary steps under FUSELAGE FIRE INFLIGHT.

1. Door between cabin and flight compartment – CLOSED

2. Cockpit side windows – CLOSED

3. Parachute door – unlock the two latches and open the door approximately 45-degrees (figure 5-5).

SMOKE IN INVERTER COMPARTMENT (TAIL SECTION)

Smoke from this area will dissipate rapidly through openings provided in the inverter compartment aft bulkhead.

EMERGENCY DESCENT PROCEDURE

When in an emergency a rapid descent from altitude is necessary, use one of the following procedures:

1. Close throttles and descend as rapidly as possible with gear and flaps up, observing maximum airspeed limitation.

2. Close throttles, lower gear and flaps, and descend as rapidly as possible, observing maximum gear and flaps down airspeed limitations.

AIRCRAFT SYSTEMS

HYDRAULIC SYSTEM FAILURE

Failure of the normal hydraulic system will usually be indicated by the loss of both system pressure and of fluid in the sight gage on the hydraulic control panel.

NOTE

The hydraulic fluid reserve of 3.2 quarts does not show on the sight gage.

In the event of system failure, reduce airspeed, place the controls of all hydraulically operated units to the OFF position, and proceed as follows:

1. To lower the landing gear, reduce airspeed below 144 KIAS, place the landing gear control lever down, and operate the hydraulic hand pump to extend and lock the gear. If the gear does not lock down in this manner, it can be locked by applying a force equivalent to that of a normal 30-degree banked turn.

2. To lower the landing flaps, reduce airspeed below 114 KIAS, place the landing flap control down, and operate the hydraulic hand pump. Approximately 11 cycles of the hand pump are required to fully extend the landing flaps.

3. To operate the brakes, make a normal landing and operate the hydraulic hand pump for the required braking action. Avoid pumping the brakes as pressure will be lost with each pump. (If necessary, use airbrakes.)

NOTE

When using emergency air, differential braking is not possible.

ELECTRICAL SYSTEM FAILURE

CIRCUIT BREAKERS

If a circuit breaker opens, disconnecting power to any circuit, an overload or short in that circuit is indicated. If the circuit breaker reopens after being reset, do not use that circuit unless the safety of the aircraft depends on its continued operation; in which case, manually hold the circuit breaker closed.

GENERATORS

If there is no indication on one ammeter, but the other indicates a normal reading, make the following check:

1. If the switch for the malfunctioning generator is ON, turn it OFF and notice whether the reading of the other ammeter increases. If it does, the trouble may be attributed to the ammeter. Turn the generator switch back to ON.

2. Check the field circuit breaker on the circuit breaker panel. If it has tripped, reset it. If it immediately retrips, leave it off and turn the generator switch OFF.

NOTE

> If the generator fails, serious consideration should be given to feathering the propeller, unless it is essential for safe flight. In any event, maintain a watch for fire and make a landing at the nearest suitable airfield.

INVERTERS

If both inverters fail, the copilot's turn-and-slip indicator and the temperature and quantity indicators (dc operated instruments) will remain in operation. **In addition, the course deviation indicator on the ID-249 will continue to indicate deviation from a selected VOR course.**

ELECTRICAL POWER FAILURE AT MAIN BUS

In the event of an electrical power failure at the main bus, place the emergency power switch to the EMERGENCY position. This will disconnect the battery from the main bus, connect the copilot's turn-and-slip indicator, the flight compartment flood lights, and the cockpit portable lights directly to the battery.

FUEL SYSTEM FAILURE

FUEL STOPPAGE IN FLIGHT

If an engine fails in flight because of fuel starvation, immediately perform the following steps to return the engine to operation:

1. Close throttle
2. Switch to tank with adequate fuel
3. Switch fuel booster pump ON
4. Attempt to regain power with throttle
5. If this does not immediately bring the pressure up, a failure other than that of the engine-driven fuel pump is indicated, and the failed engine should be secured.

ENGINE OIL SYSTEM FAILURE

The indications of oil system failure that may lead to engine failure are loss of oil pressure, oil temperature increase, and/or loss of oil.

A high or low oil temperature may result from failure of the oil cooler floating control unit to function in AUTOMATIC. Manually position the oil cooler door control switch to OPEN or CLOSE as necessary to bring oil temperature back to the desired operating range. Thereafter, control the oil temperature manually.

MAGNETIC CHIP DETECTOR INDICATION

If a magnetic chip detector light comes on in flight, land at the nearest suitable field and investigate the cause. Monitor the engine instruments and the engine. Do not secure the engine unless there are additional indications of impending engine failure such as high cylinder head temperature or low oil pressure, etc.

DITCHING

DITCHING PROCEDURE

Ditching drill must be practiced until each crewmember's actions become automatic, and effective.

The pilot must decide whether to ditch or bailout. Resort to bailout only if surface ships are on the spot or if there is no chance of ditching successfully. Ditching is preferred because more equipment would be available for survival; several rafts would provide a better chance of attracting rescuers.

Prior to any overwater flight, each item of emergency survival equipment carried in the aircraft or worn by crew and other personnel shall be inspected. Ditching bill placards will be prepared and posted in the aircraft by the operating units. It is the responsibility of the aircraft commander to ensure that all flight personnel are familiar with the contents of the ditching bill, their assigned duties, and location of emergency equipment.

PREPARATION FOR DITCHING

Use the following procedure in preparation for ditching:

1. Alert crew and passengers.
2. Transmit distress signals – IFF/SIF SET TO EMERGENCY
3. Escape hatches – OPEN (figures 5-1 and 5-2)

WARNING

The aft cargo door must not be released while in flight.

4. Jettison loose equipment
5. Crew/passengers – DITCHING STATIONS.

APPROACH AND CONTACT

1. Landing gear – UP
2. Flaps – 1/2.

DITCHING POSITIONS

After accomplishing assigned duties in preparation for ditching, each crewmember will go to his assigned ditching station at once, reporting by interphone to the pilot that his assigned duties have been accomplished. Unbuckle parachutes, but use for protection and support if necessary. Fasten safety belt and shoulder harness, but remove any other entangling equipment which might delay exit. When impact warning is given, brace for impact and do not relax until aircraft has come to rest. Do not mistake impact of the tail for the much greater shock which occurs subsequently as the nose strikes the water.

WARNING

Serious casualties have occurred in cases where crewmembers have not taken proper ditching stations, or have relaxed before final impact.

HANDLING THE AIRCRAFT

NORMAL POWER ON DITCHING

Experience gained in ditching has shown that best results are obtained by the following:

If possible, use up most of the fuel supply to lighten the aircraft and reduce stalling speed. Empty tanks also contribute to flotation.

Ditch while power is available. Power will allow the pilot to choose the spot for ditching, to obtain the best possible sea conditions, and to select the most favorable landing position and attitude.

At time of contact, have the lowest possible forward speed consistent with safe control of the aircraft; this will reduce the landing impact. Under no circumstance should the aircraft be stalled in, as this will result in severe impact and cause the aircraft to nose into the water.

Ditch at the lowest possible rate of descent.

Ditch the aircraft approximately 5 degrees nose high. This attitude gives best distribution of landing shock.

One half flap setting should be used in most cases; however, with a very heavy aircraft, the stall speed will be high and full flaps may be necessary.

In daylight, it is recommended that the aircraft be ditched along the top of the swell, parallel to the rows of the swells, if the wind does not exceed 30 knots. In high winds, it is recommended that ditching be

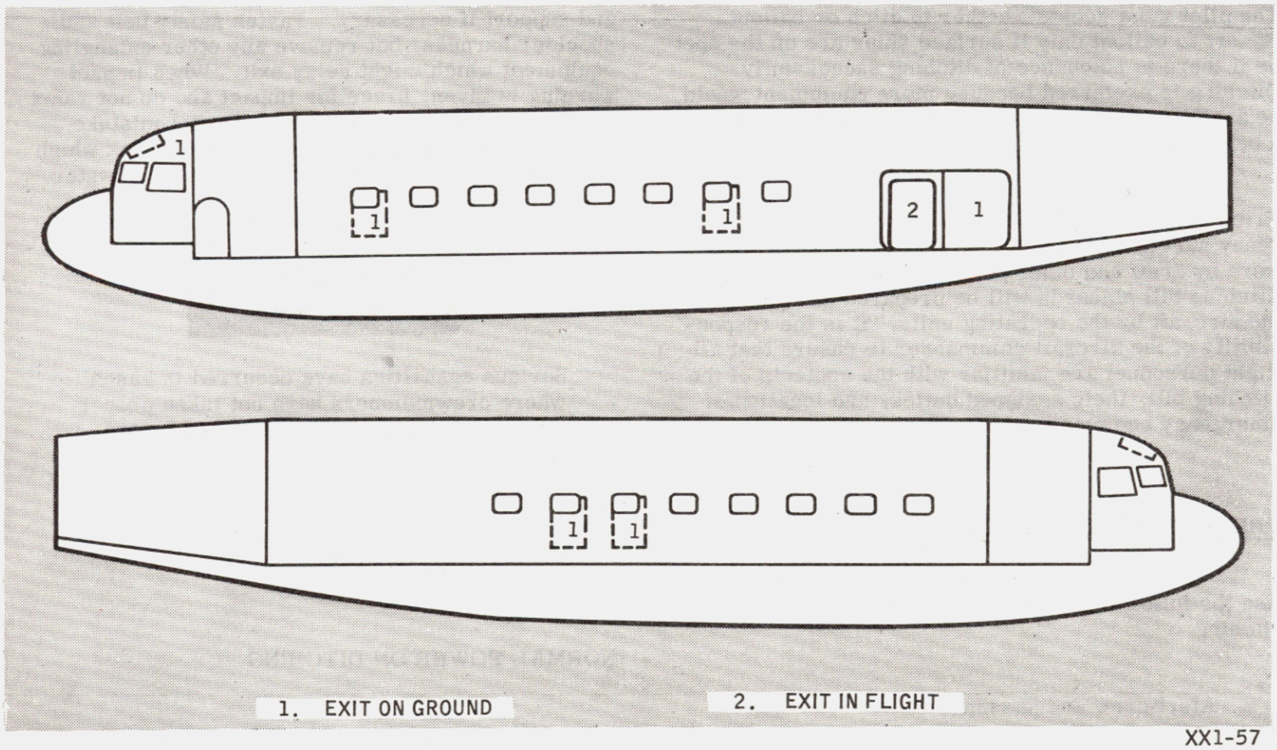


Figure 5-1. Emergency Exits

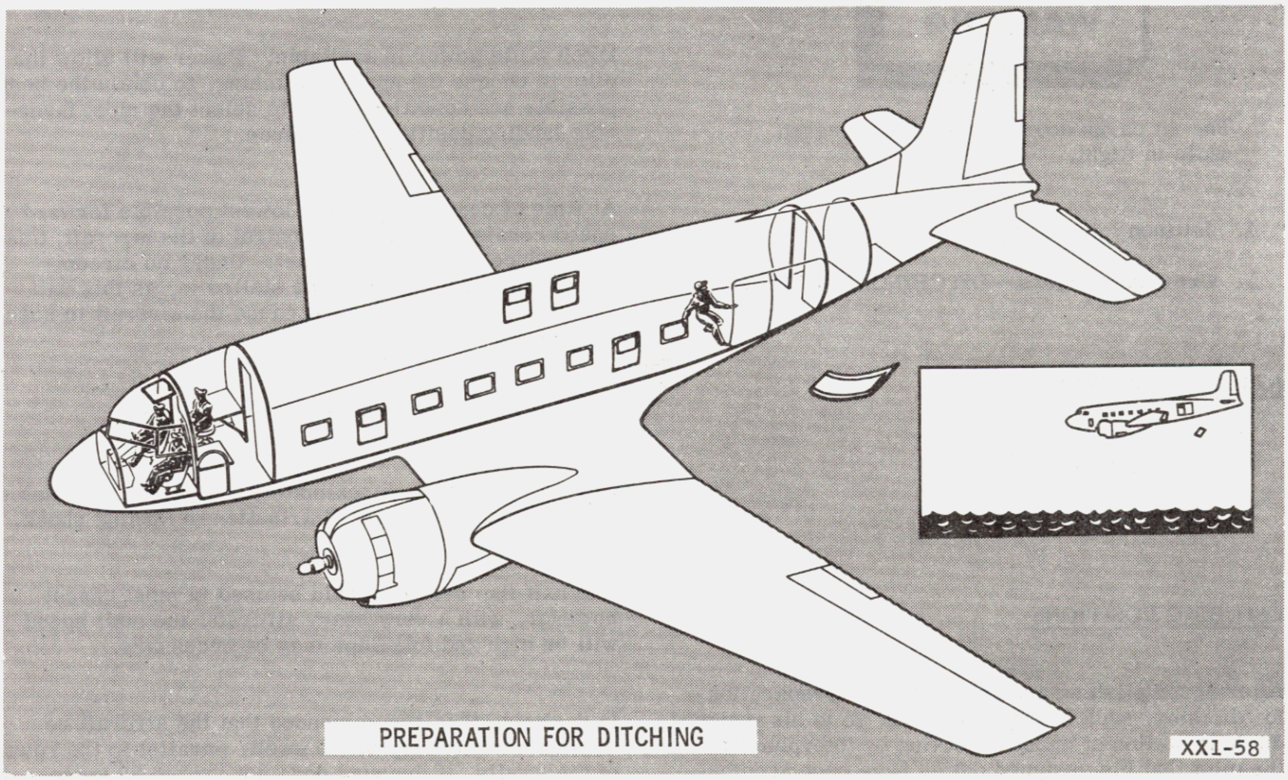


Figure 5-2. Preparation for Ditching

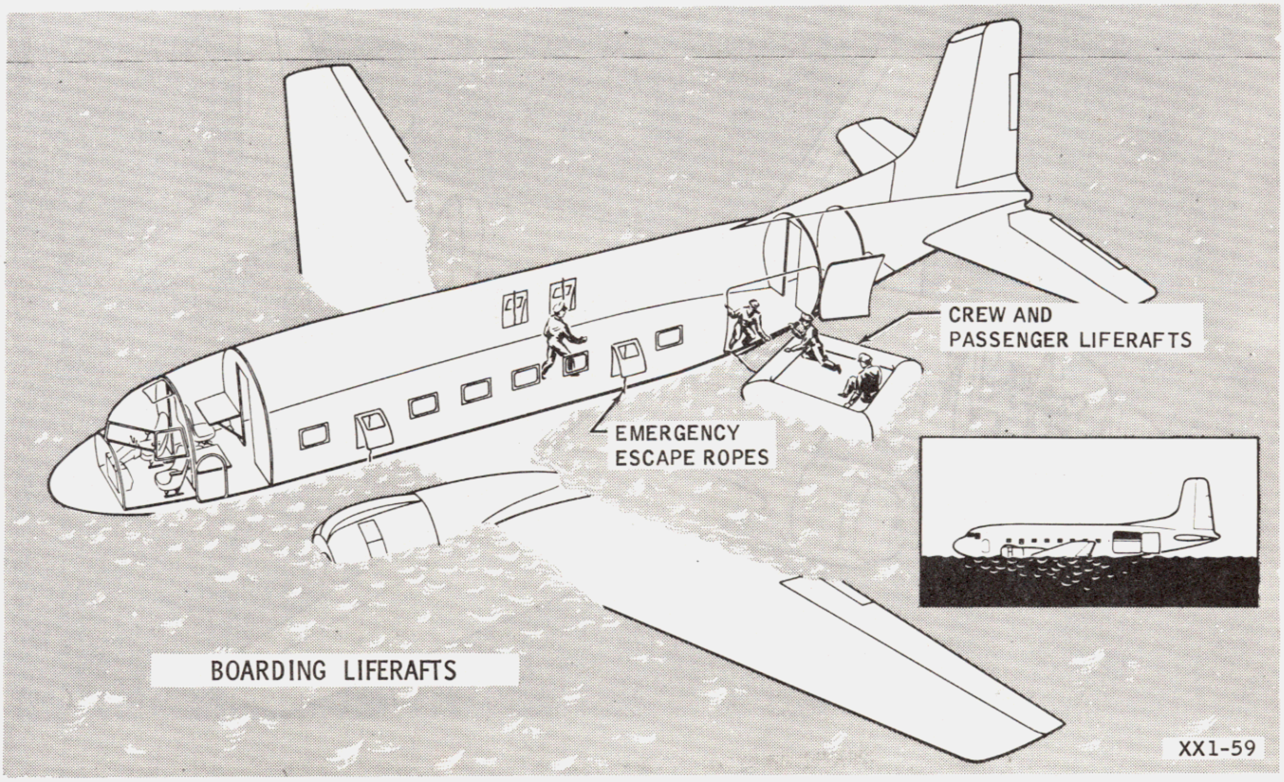


Figure 5-3. Ditching

conducted upwind to take advantage of lower forward speed. However, it must be remembered that the possibility of ramming nose on into a wave is increased, as is the possibility of striking the tail on a wave crest and nosing in.

CROSSWIND DITCHING

The basic rules for ditching will apply in addition to the following:

1. Land aircraft with as little drift as possible.

2. Land on downwind side of swell or wave.

UPWIND DITCHING

The basic rules for ditching will apply in addition to the following:

1. Maintain a noseup attitude and avoid nose striking a wave face.

2. Touch down immediately before the crest of a rising wave.

3. Hold the nose up after first impact.

NIGHT DITCHING

In ditching at night, the following procedure should be followed:

1. Make an instrument letdown, holding airspeed 20 knots above stalling speed, and at lowest possible rate of descent.

2. Use landing flares and landing lights as necessary.

3. Landing attitude should be 5 degrees nose high, with half flaps.

<u>ABANDONING THE AIRCRAFT</u> (Figure 5-3)

Hold ditching positions until the aircraft comes to rest; then proceed as follows:

1. Abandon the aircraft as quickly as possible. Do not overlook necessary equipment or assigned duties.

2. Crewmembers detailed to life raft removal shall remove life rafts through main cabin door and inflate them.

3. Each crewmember and other personnel exit through assigned escape hatch and upon emerging, inflate life jackets (figure 5-3).

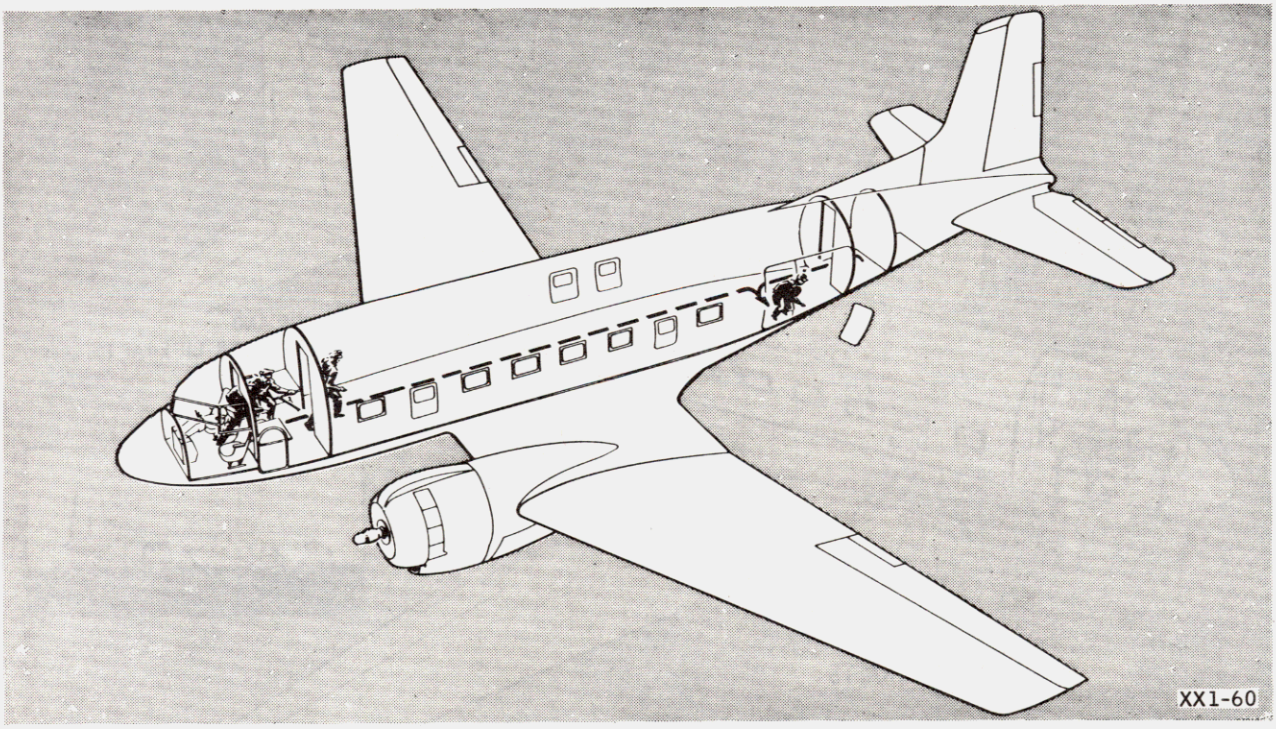


Figure 5-4. Bailout Routes

BAILOUT

BAILOUT PROCEDURE

When decision is made to abandon the aircraft in flight, the following procedure should be used:

1. Alert crew and passengers.
2. Transmit distress signals – IFF/SIF SET TO EMERGENCY.
3. Airspeed – 100 KIAS, IF POSSIBLE.
4. Flaps – 1/2
5. Parachute door – OPEN
6. Give command to bailout.

See Figure 5-4 for bailout routes.

WARNING

Do not, under any circumstances, use the escape hatch over the pilot's seats, the door at the navigators station, or the ground emergency exits for bailout.

LANDING EMERGENCIES

SINGLE-ENGINE LANDING

Normal landing procedures will be used for single-engine landings, except as noted on the landing and approach diagrams.

When a crosswind is present and several runways are available, select a runway that will place the operating engine on the upwind side of the aircraft. Adjust rudder tab to neutral on final approach to avoid skidding as power is reduced on landing.

LANDING GEAR SAFETY LATCH FAILURE

The aircraft may be safely landed even though the landing gear safety latches are not engaged, providing the landing gear is fully down, the hydraulic system pressure is within limits, and the landing gear lever is in the down position. Pressure in the landing gear actuating struts is indicated on the landing gear pressure gage. When landing under these conditions, the gear is held in the extended position by hydraulic pressure against the retracting strut pistons. When the brakes are applied, the resulting rotative force will have a tendency to cause the gear to retract, resulting in increased pressure in the landing gear downlines. To eliminate the possibility of a line failure, the brakes should be used only when absolutely necessary to stop the aircraft on the remaining runway.

CAUTION

When brakes are applied under these conditions, do not allow the landing gear downline pressure to exceed 1500 psi.

LANDING WITH THE TAILWHEEL RETRACTED

If all attempts to extend the tailwheel fail, a landing may be accomplished with the tailwheel in the retracted position. Complete a normal landing, roll out straight ahead, and do not attempt to turn off the runway.

CAUTION

The tailwheel will not swivel in the retracted position. If a turn is attempted, structural damage will result.

LANDING WITH ONE MAIN GEAR RETRACTED

If possible, retract the other gear and make a gear up landing. If the gear cannot be retracted, land on the extended gear, holding the opposite wing up as long as possible.

GEAR UP LANDING

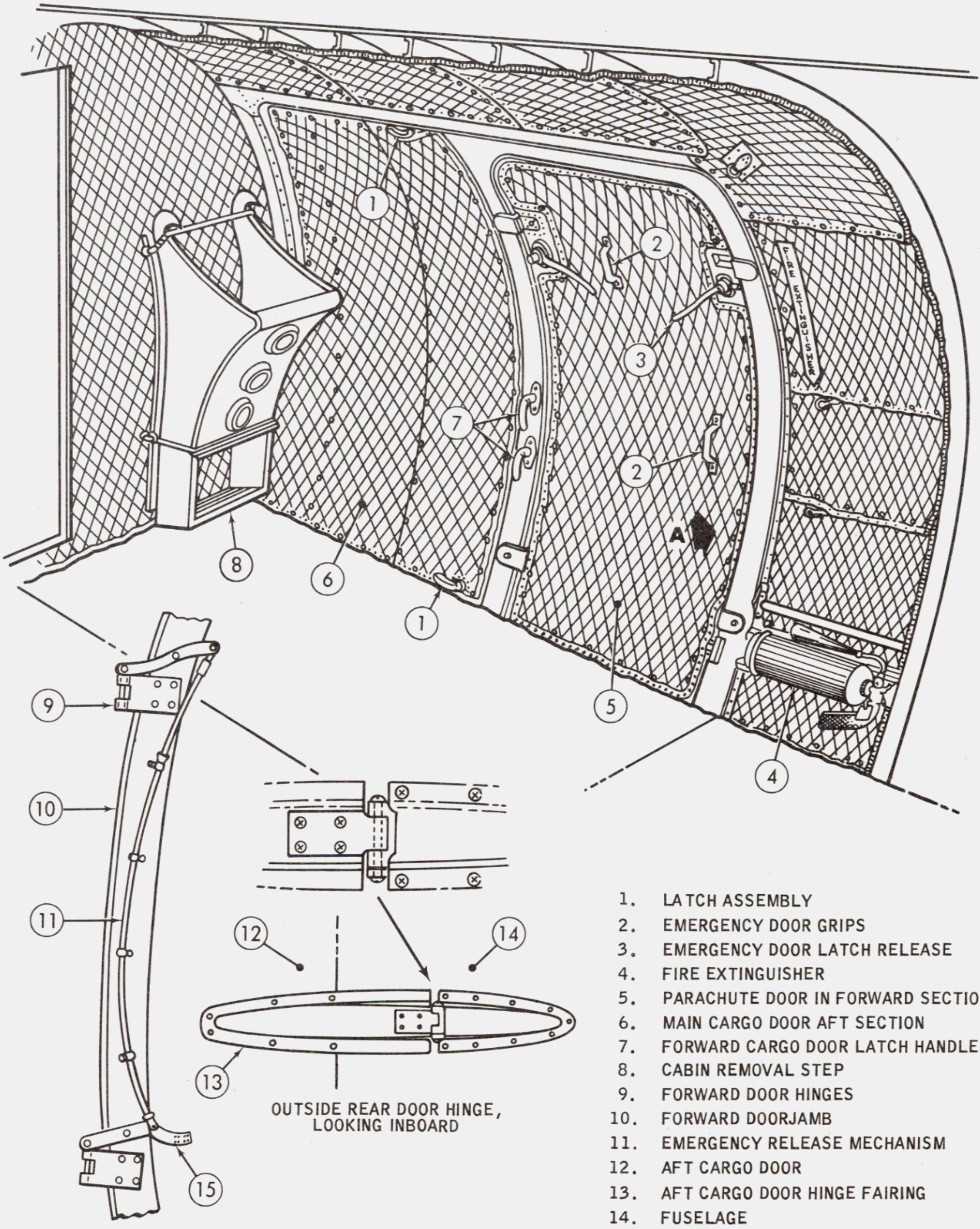
There may be a tendency to overshoot during a gear up landing because of the reduction of drag resulting from the gear being fully retracted. Before making a gear up landing, perform the following:

If feasible, circle the landing area until most of the fuel has been used and runway foamed.

1. Open emergency exits (figure 5-1).
2. Jettison all loose cargo and/or equipment.
3. Warn all crewmembers to assume crash stations.
4. Fasten seat belts and shoulder harness.
5. Make normal approach.
6. Landing flaps – FULL DOWN AS SOON AS LANDING ON THE FIELD IS ENSURED.
7. Throttles – CLOSE, JUST PRIOR TO GROUND CONTACT
8. Ignition, battery, and generator switches – OFF
9. Emergency shutoff valves – PULL UP, JUST PRIOR TO GROUND CONTACT
10. Be prepared to discharge CO_2 to either engine in case of fire.

EMERGENCY ENTRANCE

Areas inside and outside of the fuselage are outlined in yellow and are designed to be chopped through in case of emergency. (See figure 5-1.)



1. LATCH ASSEMBLY
2. EMERGENCY DOOR GRIPS
3. EMERGENCY DOOR LATCH RELEASE
4. FIRE EXTINGUISHER
5. PARACHUTE DOOR IN FORWARD SECTION
6. MAIN CARGO DOOR AFT SECTION
7. FORWARD CARGO DOOR LATCH HANDLES
8. CABIN REMOVAL STEP
9. FORWARD DOOR HINGES
10. FORWARD DOORJAMB
11. EMERGENCY RELEASE MECHANISM
12. AFT CARGO DOOR
13. AFT CARGO DOOR HINGE FAIRING
14. FUSELAGE
15. EMERGENCY RELEASE HANDLE FOR MAIN CARGO DOOR FORWARD SECTION

OUTSIDE REAR DOOR HINGE, LOOKING INBOARD

VIEW A
DOORJAMB
EMERGENCY RELEASE MECHANISM,
LOOKING FORWARD

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Figure 5-5. Cargo Door with Parachute Door

SECTION VI

ALL-WEATHER OPERATION

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TEXT

ILLUSTRATIONS

ALL WEATHER PROCEDURES

INTRODUCTION

This section contains only those procedures which differ from or are in addition to the normal operating procedures except where repetition is necessary for emphasis, clarity, and continuity of thought. Refer to NATOPS Instrument Flight Manual for general information.

OPERATION UNDER INSTRUMENT CONDITIONS

The aircraft is very stable in all axes and will fly hands off. Before attempting any instrument flight, check that all radios and flight instruments are operating properly.

INSTRUMENT TAKEOFF

1. Check all radios, flight instruments, and pitot heat for proper operation.

2. When takeoff clearance is received, align the aircraft on the center line of the runway.

3. Release brakes, smoothly apply power, and accelerate to takeoff speed.

4. When takeoff speed is reached, fly the aircraft off the ground. When positive climb is established, retract the landing gear.

INSTRUMENT CLIMB

Climbing airspeed and attitude are easily maintained. Climbing turns should be limited to 30 degrees of bank.

CRUISING UNDER INSTRUMENT CONDITIONS

The aircraft should be handled in the same manner as during VFR flight. In addition, a periodic check should be made of directional gyros and attitude gyros. Pitot heat should be applied prior to entering actual instrument conditions.

DESCENT

Descent should be made using the same procedures as during a VFR letdown.

HOLDING

There are no special precautions to be observed in the handling of the aircraft during holding.

The following is the recommended aircraft configuration:

1. Maintain airspeed of 120 KIAS.
2. Set rpm to 2150.
3. Gear UP
4. Flaps UP.

INSTRUMENT APPROACHES

The general instrument approach qualities and capabilities of the aircraft are very satisfactory. See figure 6-1 through 6-3 for procedures to be followed.

ILS CAPABILITY LIMITATIONS. The AN/ARN-14 and the AN/ARN-18 incorporated in the C-117D have been excluded from AVIONICS change 439 of 15 November 1965. The station pairings may or may not agree with ICAO, commercial, or military pairings. Operating units shall check station pairings for facilities in use and ensure that these pairings are available and promulgated to all pilots if any ILS capability is desired or required.

AUTOMATIC APPROACH. The procedure to be used when flying an automatic approach is as follows:

1. Select correct localizer frequency.

2. Make certain automatic range and approach selector switch is in OFF position before engaging the autopilot.

3. Trim aircraft and engage autopilot.

4. Altitude control switch – ON (if desired).

5. BLUE LEFT-BLUE RIGHT switch – BLUE RIGHT position.

6. Fly aircraft on a heading to intersect the localizer course inbound at a 45-degree angle or less.

7. Maintain the intersect course heading until the vertical needle on the cross pointer begins to move toward center, then turn the automatic range and approach selector switch to LOC position.

8. Position the gear down, use 2150 rpm and 1/4 flaps, and set power to maintain 120 KIAS. (This should be accomplished prior to intersecting the glide slope so that enough time is allowed for the autopilot trim servos to trim the aircraft. If sufficient time is not allowed for automatic trimming, the autopilot should be disengaged and the aircraft should be trimmed manually. If this is done, re-engage the autopilot and continue the automatic approach.)

9. Prior to intersecting the glide slope, release the throttle friction lock completely.

NOTE

When the throttle friction lock is completely released, a throttle lock switch is actuated which connects the glide slope radio signal to the automatic approach coupler and energizes the automatic throttle setting system.

10. When the horizontal needle on the cross pointer moves to center, turn the automatic range and approach selector switch to LOCALIZER AND GLIDE SLOPE position.

11. When visual contact has been established, the aircraft controls should be monitored by the pilot until disconnect. (The autopilot is disconnected by momentarily pressing the disconnect switch (figure 1-4) on the control wheel.)

NOTE

The throttles are unlocked.

12. Complete a normal approach to touchdown.

FLIGHT IN TURBULENCE AND THUNDERSTORMS

The aircraft should not be operated in severe turbulence. If flight through thunderstorms or turbulence cannot be avoided, indicated airspeeds in the range of 120 to 140 knots are recommended for penetration. Check the following items:

1. Pitot heat – ON

2. Carburetor air – AS REQUIRED

3. Passengers and crew – BRIEFED, SAFETY BELTS FASTENED

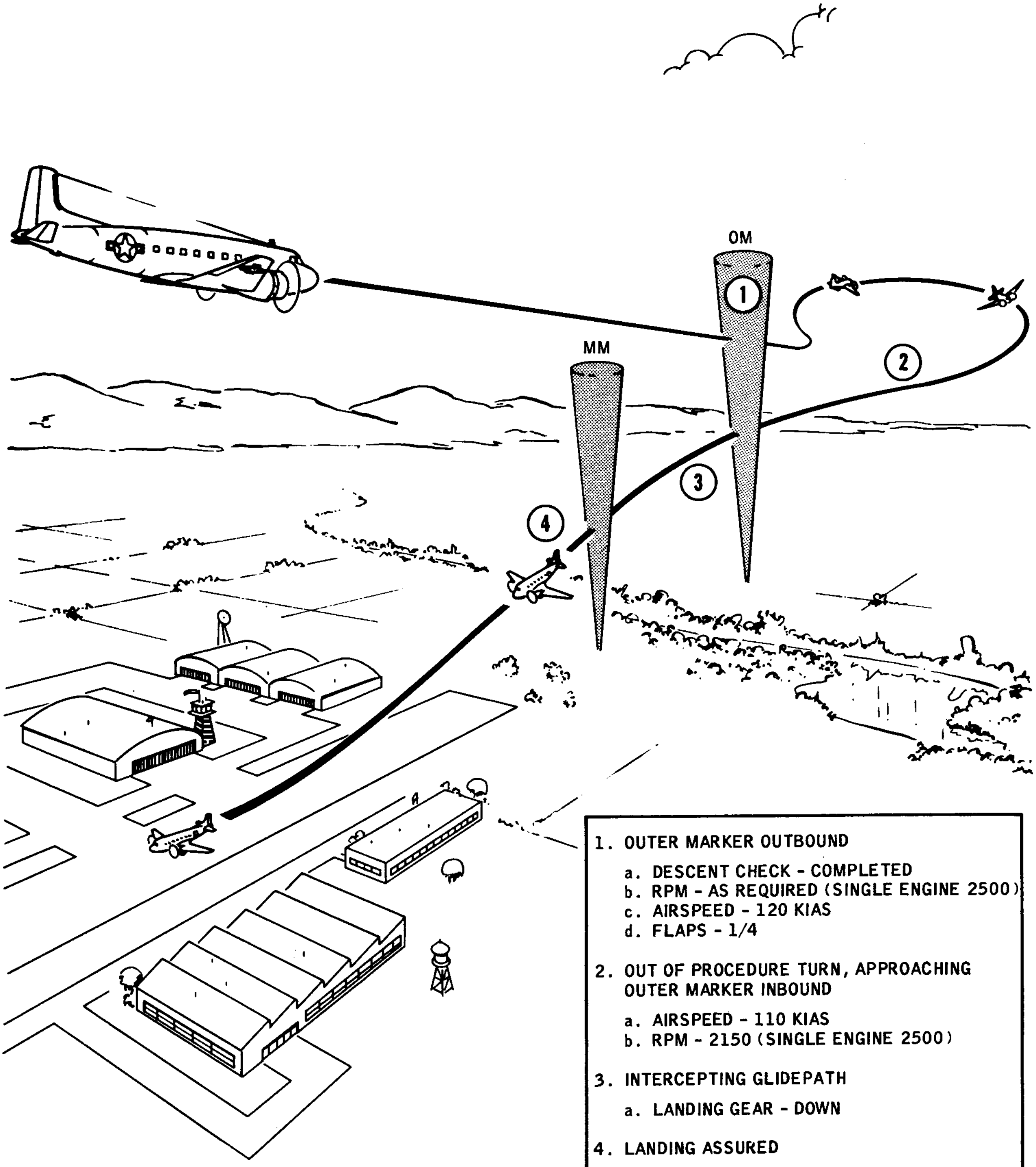
4. Landing gear and flaps – UP

5. At night, cockpit lights on full bright to minimize the effect of lightening.

The following procedures should be utilized:

1. Use as little elevator control as possible in maintaining attitude to minimize the stresses imposed on the aircraft.

2. Maintain power setting and pitch attitude throughout the storm and the airspeed will remain approximately constant regardless of the airspeed indications.



1. OUTER MARKER OUTBOUND
   - a. DESCENT CHECK - COMPLETED
   - b. RPM - AS REQUIRED (SINGLE ENGINE 2500)
   - c. AIRSPEED - 120 KIAS
   - d. FLAPS - 1/4
2. OUT OF PROCEDURE TURN, APPROACHING OUTER MARKER INBOUND
   - a. AIRSPEED - 110 KIAS
   - b. RPM - 2150 (SINGLE ENGINE 2500)
3. INTERCEPTING GLIDEPATH
   - a. LANDING GEAR - DOWN
4. LANDING ASSURED
   - a. RPM - FULL INCREASE
   - b. FLAPS - 1/2 OR AS REQUIRED
   - c. LANDING CHECK-COMPLETED

NOTE: DURING SINGLE-ENGINE APPROACH, LOWERING OF LANDING GEAR MAY BE DELAYED UNTIL LANDING IS ASSURED.

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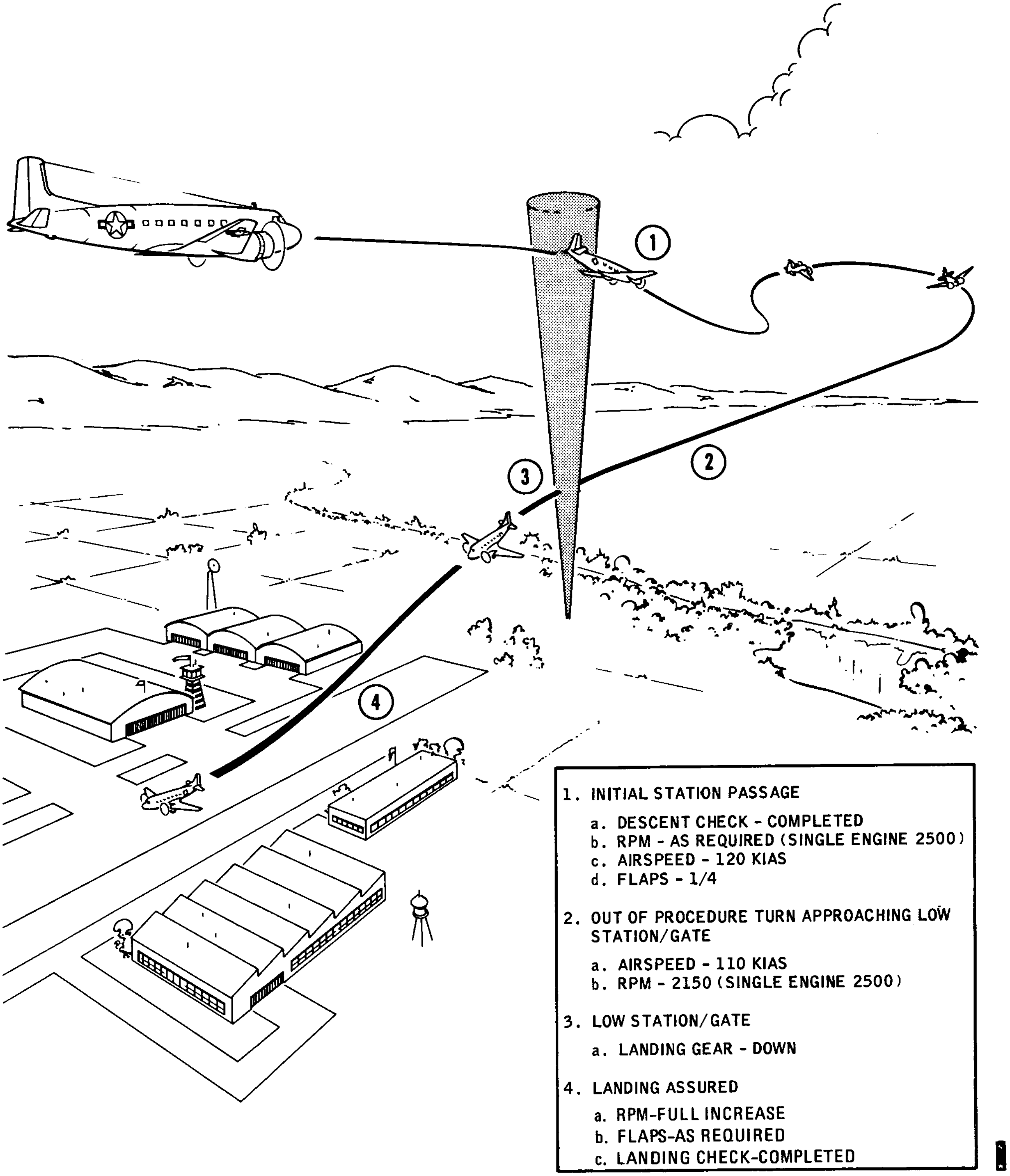
Figure 6-1. ILS Approach



1. INITIAL STATION PASSAGE
   - a. DESCENT CHECK - COMPLETED
   - b. RPM - AS REQUIRED (SINGLE ENGINE 2500)
   - c. AIRSPEED - 120 KIAS
   - d. FLAPS - 1/4
2. OUT OF PROCEDURE TURN APPROACHING LOW STATION/GATE
   - a. AIRSPEED - 110 KIAS
   - b. RPM - 2150 (SINGLE ENGINE 2500)
3. LOW STATION/GATE
   - a. LANDING GEAR - DOWN
4. LANDING ASSURED
   - a. RPM-FULL INCREASE
   - b. FLAPS-AS REQUIRED
   - c. LANDING CHECK-COMPLETED

NOTE: DURING SINGLE-ENGINE OR CIRCLING APPROACH, LOWERING OF LANDING GEAR MAY BE DELAYED UNTIL LANDING IS ASSURED.

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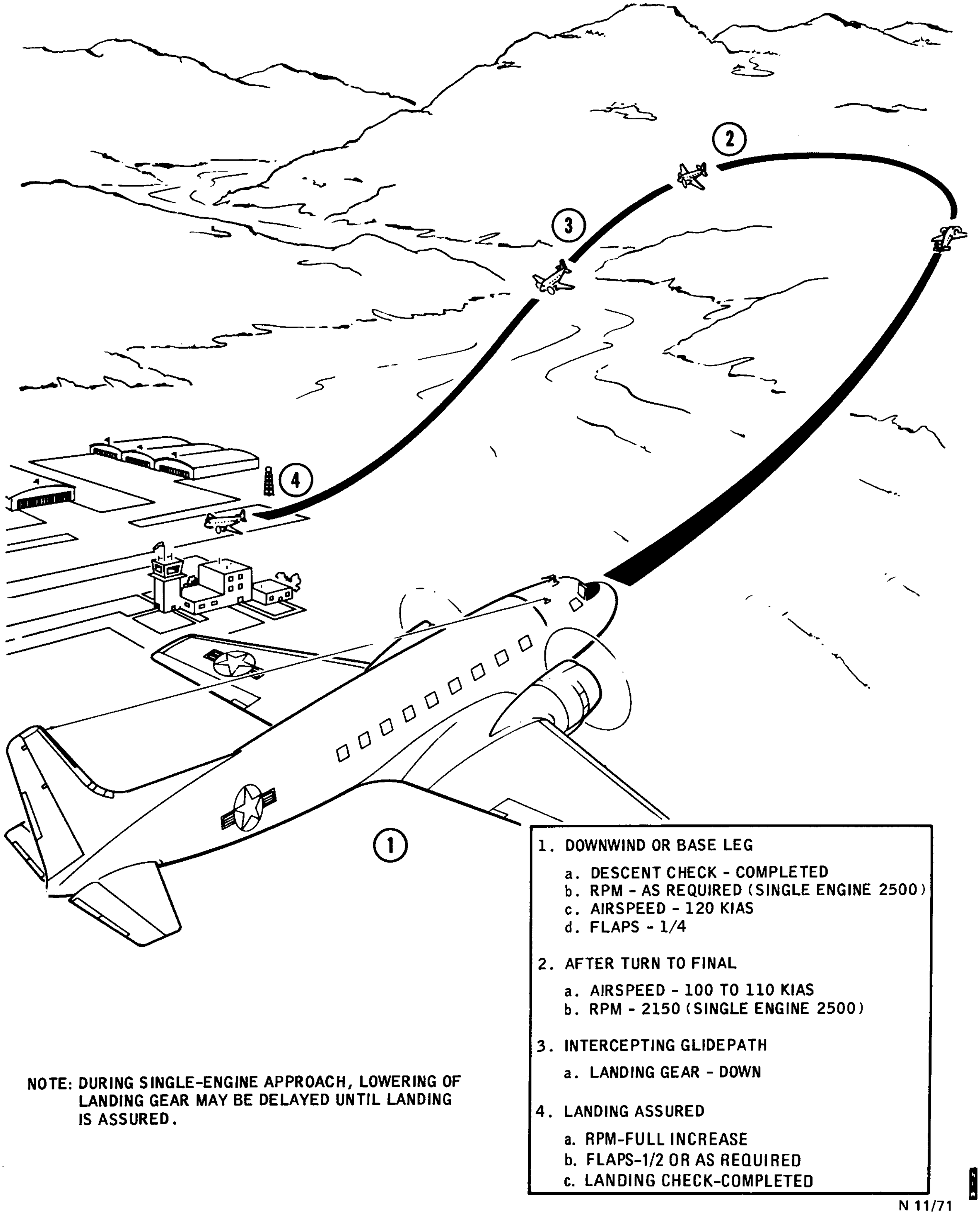
Figure 6-2. ADF, VOR, TACAN Approach



1. DOWNWIND OR BASE LEG
    - a. DESCENT CHECK - COMPLETED
    - b. RPM - AS REQUIRED (SINGLE ENGINE 2500)
    - c. AIRSPEED - 120 KIAS
    - d. FLAPS - 1/4
2. AFTER TURN TO FINAL
    - a. AIRSPEED - 100 TO 110 KIAS
    - b. RPM - 2150 (SINGLE ENGINE 2500)
3. INTERCEPTING GLIDEPATH
    - a. LANDING GEAR - DOWN
4. LANDING ASSURED
    - a. RPM-FULL INCREASE
    - b. FLAPS-1/2 OR AS REQUIRED
    - c. LANDING CHECK-COMPLETED

NOTE: DURING SINGLE-ENGINE APPROACH, LOWERING OF LANDING GEAR MAY BE DELAYED UNTIL LANDING IS ASSURED.

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Figure 6-3. Radar Approach PAR/ASR

3. Maintain original heading. Do not make any turns unless necessary.

4. The altimeter is unreliable in severe turbulence. A gain or loss of several thousand feet may be expected, and allowance for this loss must be made in determining minimum safe altitude.

NOTE

Altitudes between 10,000 and 20,000 feet are usually the most turbulent areas in a thunderstorm. Therefore, altitudes below 10,000 feet are recommended for thunderstorm penetration. If possible, select an altitude of 6,000 feet above the ground.

COLD WEATHER PROCEDURES

NOTE

Aircraft operation is limited to -40°C (-40°F) due to hydraulic system installation.

Most cold weather operating difficulties are encountered on the ground. The most critical periods are the postflight and preflight. Proper diligence of crewmembers concerning ground operation is the most important factor in successful arctic operation.

WARNING

Before takeoff in cold weather, remove all snow and ice accumulation from wings, control surfaces, control surface hinges, propellers, pitot tubes, and heater air ducts. Depending on the weight of snow and ice accumulated, takeoff distances and climb-out performance can be seriously affected. The roughness and distribution of the ice and snow could vary stall airspeeds and characteristics to an extremely dangerous degree. Loss of an engine shortly after takeoff is a serious enough problem without the added and avoidable hazard of snow and ice on the wings. In view of the unpredictable and unsafe effects of such a practice, the ice and snow must be removed before flight is attempted.

BEFORE ENTERING AIRCRAFT

1. Apply external heat to the engines and accessory sections. The time requirements on the following list are rough estimates for engine heating at various temperatures. These requirements will vary with wind velocities and percentage of engine oil dilution. The tabulation below is based on an oil dilution of approximately 25 percent and no wind.

-6.7° to -18°C (20° to 0°F)	1/2 hour (approx)
-18° to -32°C (0° to -25°F)	1/2 to 1 hour
-32° to -40°C (-25° to -40°F)	1 1/2 to 2 1/2 hours

2. Check the oil drains for oil flow. If no oil flow is obtainable, apply heat to the drains and oil tanks. In addition to external heating, oil immersion heaters may be used; however, no special fittings are provided in the oil tanks for immersion heaters. If the immersion heaters are to be effective, they should be placed in the oil tanks immediately after landing.

3. Start cabin heater to heat flight instruments, defrost windshields, warm radios, dynamotors, inverters, and other equipment within aircraft.

NOTE

Make sure ground blower flapper doors are operating freely.

4. Remove all external coverings, pitot head covers, wing covers, etc.

5. Clean shock struts and landing gear actuating cylinders of ice and dirt and check struts for proper inflation. The hydraulic system is limited to -40°C (-40°F) and will not operate below this temperature.

6. Check for engine stiffness periodically to determine when sufficient heat has been applied. Generally, if an engine requires more than three men to move the propeller, it is considered too stiff to start.

ON ENTERING AIRCRAFT

Make checks given in Section III.

BEFORE STARTING ENGINES

Before starting the engines, perform the following:

1. Remove oil immersion heaters.

2. Remove ground heater ducts.

3. Remove engine nacelle shields (or covers, if installed).

4. Turn propellers through with starter at least nine blades.

STARTING ENGINES

1. Open cowl flaps.

2. Start the engines in the normal manner.

3. If oil pressure is not within limits after 30 seconds running, or if pressure drops after a few minutes of ground operation, shut down and check for blown lines or coolers and recheck for congealed oil or ice at drains.

NOTE

> Although this aircraft is equipped with free-flow oil coolers, congealing may occasionally be encountered. Oil congealing in a radiator produces unusual and often misleading indications. The usual indication is high oil temperature together with a reduction in pressure, often followed by a sudden drop in oil temperature accompanied by high pressure as the congealed oil is forced into the system. Closing the oil cooler door for a short period will aid in alleviating this condition.

4. Carburetor air preheat, not to exceed 38°C (100°F) carburetor air temperature, should be applied immediately after starting to assist vaporization and combustion.

5. Check all instruments for proper operation.

6. Operate landing flaps at least once.

ENGINE RUNUP PROCEDURES

Use the procedure outlined in Section III.

TAXIING PROCEDURES

WARNING

> **When slush accumulation on the runway is in excess of one-half inch in depth, takeoff shall not be attempted.**

Use the same procedure outlined in Section III only taxi more slowly and be more cautious when applying brakes.

BEFORE TAKEOFF

Make a thorough check of all controls important to a cold weather takeoff for ease and proper operation. These controls include carburetor heat, cowl flaps, oil cooler, and cabin heater.

TAKEOFF

1. Carburetor heat may be required so that the fuel will vaporize properly at extremely low temperatures. Regulate the carburetor heat to maintain carburetor air temperature within the proper limits throughout engine runup, takeoff, climb, and cruise.

NOTE

> Carburetor heat will reduce the amount of takeoff power available and will consequently increase the required takeoff run.

2. The heater should be operating so that the windshield anti-icing system can be utilized during takeoff, if necessary, and so that the flight instruments will not cool and give erroneous indications.

3. Pitot heaters should be ON if precipitation is encountered or if icing conditions are anticipated immediately after takeoff.

4. Flight indicators are not very reliable at temperatures below -43°C (-45°F). All flight instruments should be cross checked.

CAUTION

> **The landing gear should be cycled after takeoff from a slush covered runway because of the possibility of the doors freezing shut as a result of slush pickup on the doors. If the wheels are lowered with the doors frozen shut, structural damage to the doors will occur.**

DURING FLIGHT

Carburetor preheat will normally be used to prevent induction system icing. The use of carburetor alcohol requires considerable skill acquired only through experience. If critical altitude requirements are such that carburetor preheat cannot be used, alcohol may be required in the event of induction system icing.

INFLIGHT USE OF CARBURETOR ALCOHOL

When instability is observed, use intermittent applications of alcohol for periods of 3 to 5 seconds. Notice engine response to determine effectiveness.

COWL FLAPS

Adjust the cowl flaps as required, to maintain proper cylinder head temperature (figure 1-11). Cross-check all flight instruments and be alert for any erroneous indications.

OIL COOLERS

To prevent oil congealing in the oil cooler when the outside air temperature reaches -20°C (-4°F), close the oil cooler doors by holding the oil cooler switches in the CLOSE position until the oil temperature reaches 85°C (185°F). Maintain oil temperatures between 77°C (171°F) and 82°C (180°F) by momentarily placing the switches in the OPEN position, until the temperature stabilizes.

APPROACH AND LANDING

1. Follow normal prelanding procedures. Apply carburetor heat as required, to prevent carburetor icing and to keep the engines running smoothly.

2. At extremely low temperatures it is wise to use a power on approach, thus helping to keep the cylinder head temperature from becoming critically low. Whenever carburetor heat is used, allowance must be made for the power loss associated with application of heat.

3. Immediately after landing, the oil cooler doors should be opened to allow the oil to cool sufficiently for oil dilution.

4. Drain water supply systems.

5. Check and clean all oil screens, if oil dilution was used prior to previous flight.

STOPPING OF ENGINES

Use normal shutdown procedure unless engine oil is to be diluted. If temperatures below -4°C (+25°F) are expected prior to the next start when using MIL-L-22851 oil; or below -18°C(0°F) when using Grade 1065 oil, and preheat is not available, use oil dilution.

OIL DILUTION PROCEDURE

The aircraft is equipped with an engine oil dilution system to facilitate cold weather starting. When a cold weather start is anticipated, the engine oil should be diluted with fuel before the engines are stopped, provided that the engine oil temperature is maintained below 50°C (122°F). Above this temperature, dilution is not effective, because the fuel introduced into the system will evaporate.

When the oil temperature exceeds 50°C (122°F) during the dilution period, stop the engine and wait until oil temperatures have fallen below 40°C (104°F) before again starting the engine and resuming the dilution operation. During conditions of extremely low OAT it may be necessary to break the dilution period up into two or more short periods.

If it is necessary to service the oil tanks, the oil dilution period must be divided so that part of the dilution is accomplished before the oil tanks are serviced and the remainder after the tanks are serviced. If the oil tank is full and more than 3 minutes dilution time is required, some oil should be drained from the tank to prevent overflowing during the dilution period or subsequent engine run.

Perform the oil dilution operation as follows (operation of the oil dilution system is indicated by a drop in fuel pressure, followed later by a drop in oil pressure):

1. Operate each engine at 1000 to 1200 rpm.

2. Maintain oil temperatures below 50°C (122°F), stopping an engine for a short period if the temperature exceeds this limit.

3. Operate the oil dilution solenoid switches for the following periods for anticipated temperatures:

4° to -12°C (40° to 10°F)	3 minutes
-12° to -29°C (10° to -20°F)	6 minutes
-29° to -46°C (-20° to -50°F)	9 minutes

4. Change from INCR RPM to DECR RPM three or four times to dilute oil in propeller domes.

5. A short acceleration period of approximately 10 seconds at the end of the dilution run will usually clear the spark plugs of any fouling condition resulting from the prolonged idling.

6. When dilution is complete, shut the engine down in a normal manner, continuing to hold the oil dilution switch ON until the engine has stopped.

7. When warming an engine up after oil dilution, it is preferable to allow the oil temperature to rise above 65°C (149°F). Increase engine speed during the runup to dissipate the dilutant fuel and allow the oil to return to its normal viscosity. Below this temperature and at low engine speeds, very little gasoline will evaporate out of the oil.

DESERT PROCEDURES

Windblown sand is the main concern of operation in the desert. Many of the malfunctions which occur originate because of improper care on the ground. Since most of the procedures in Section III apply as well to desert procedures, only specific information for care of the aircraft will be given in this section.

GROUND OPERATION

The aircraft must be given special treatment if the operation is to be successful. The following should be adhered to, to minimize costly maintenance.

1. Hold ground operation of the aircraft to a minimum.

2. Cover all air intakes and ducts as soon as possible after landing to prevent entrance of blowing sand.

3. Keep all equipment free of sand, dirt, or moisture.

4. Keep the aircraft dispersed as much as possible. The engines of one aircraft can add hours of maintenance problems to other aircraft when proper precautions during taxiing or ground operations are not followed.

FLIGHT OPERATIONS

During hot weather operation, be more cautious of stalling speeds and temperature limitations. Keep the following in mind when operating in hot weather:

1. Longer takeoff distances are required.
2. Use brakes sparingly.

SECTION VII

COMMUNICATIONS PROCEDURES

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TEXT

COMMUNICATIONS

GENERAL

The primary means of communications in the C-117D aircraft is voice radio. It is, of course, limited by the condition of the equipment, frequencies, channels available, and operating conditions. Radio equipment carried in the aircraft is described in detail in Section I. It is essential that all pilots know and understand the use of the radio equipment.

Operation of the equipment will be in accordance with current applicable directives, depending upon the type of flight and the area in which the flight is conducted. Communications procedures are outlined in Federal Aviation Regulations, FLIP Publications, the Flight Information Manual, ICAO Regulations, Air Traffic Control Procedures, OPNAV Instructions, Fleet Commander Instructions, and applicable ACP, JANAP, and NWP's.

RADIO COMMUNICATIONS

The aircraft commander is responsible for all communications transmitted from the aircraft. He is responsible for ensuring a continuous watch on appropriate radio frequencies, position reporting procedures, and requirements outlined in appropriate directives, or as required by the agency controlling the flight.

VISUAL SIGNALS

Pilots shall be familiar with standard visual signals, such as airport lighting, tower traffic control signals, and standard signals from downed aircraft and liferafts. For standard hand signals refer to applicable NWP-41 series.

SECTION VIII

SPECIAL MISSIONS

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MK 24 MOD 2A/3 FLARES

PREPARATION OF FLARES PRIOR TO LOADING IN AIRCRAFT

1. Take each flare in turn, ensure that the safety cotter pin is in place and then remove the plastic cap and certify that the pin is properly engaged.

2. Set ignition and ejection delay fuses to values desired in accordance with procedures in Ordnance Pamphlet OP-2213, First Revision dated 1 October 1965.

3. Re-coil lanyard and replace plastic cap; place flares in storage containers (remove flare from foam shipping container and place in wood/metal container of local manufacture of a size to contain ten flares in two rows of five flares per row).

LOADING AND STOWAGE OF STORAGE CONTAINERS WITH FLARES

1. Ensure that boiler plate or other suitable armor type protection is placed on floor of aircraft where flares will be stowed.

2. Ensure that all flare container boxes are placed on rollers to enable rapid jettisoning in case of emergency. (Cargo rollers: conveyor, wheel, gravity, FSN 3910-248-9403).

3. Load storage containers aboard aircraft with flares standing vertical along the port side of the aircraft with the fuse end up, in quantity required for the mission.

4. Ensure that all flare container boxes are properly secured to the deck of the aircraft with 10,000 pound test tiedown straps.

HUMAN SAFETY PRECAUTIONS FOR FLARE HANDLING AND DISPENSING CREW

1. Ensure adequate level of lighting.

2. Ensure that no obstructions, cables, lines, or stores exist between the flare storage containers and the starboard side of the aircraft.

3. All personnel involved in the dispensing operation shall be equipped with a gunner type safety harness which shall be attached to a high strength cargo tiedown ring and snubbed up to prevent inadvertent egress from the aircraft. In addition, all flare dispensing personnel shall wear a backpack parachute.

4. A static line of sufficient length to permit a 3 foot stream from the hatch with a 100 pound strength (minimum) snap hook shall be provided and affixed to the aircraft at the hatch opening.

5. Ensure that adequate safety equipment is on board the aircraft, immediately available for use, and to include two pressurized water fire extinguishers, one snow type shovel and one pair of asbestos gloves for handling any flares that might ignite aboard the aircraft.

FLARE DISPENSING PROCEDURES

Flare dispensing operations require a minimum crew of five men supervised by a responsible senior NCO.

1. Man No. 1 (ordnanceman) is responsible for removal of the plastic cap from each flare and making sure of the proper fuse setting in accordance with the procedures in Ordnance Pamphlet OP-2213, First Revision dated 1 October 1965.

2. Man No. 2 (handler) will take the flare from the ordnanceman and pass the flare to the lanyard man.

3. Man No. 3 (lanyard man) will ensure that both ignition and ejection dials are properly set, that the flare lanyard is in good working order, and that the lanyard is securely attached to the aircraft.

4. Man No. 4 (kicker) ejects the flare from the aircraft upon signal from the aircraft commander. Immediately prior to ejection, he will accomplish final arming of the flare by pulling the ignition cotter pin.

5. Man No. 5 (intercom talker) will maintain communications with the aircraft commander and pass all required information to the flare crew supervisor or to the flare crew as appropriate.

PARACHUTE OPERATIONS

GENERAL

Parachute operations can be successfully conducted from C-117D aircraft. Live parachute operations are always preceded by at least two streamer drops for wind and drift analysis.

PATTERN

The primary pattern is flown with left hand turns in order to allow the jumpmaster the opportunity to keep the Drop Zone in constant view. Normal aircraft configuration consists of parachute door removed, 100 knots and 1/4 flaps. Pattern altitude for wind streamer drops is normally 2500 feet AGL or as requested by the jumpmaster.

COORDINATION

Normally, the initial run-in heading for the first wind streamer drop will be as close into the windline as possible or as requested by the jumpmaster, whichever is applicable. Subsequent heading changes will be requested by the jumpmaster. On each run-in, after the establishment of the aircraft on the prescribed heading, the jumpmaster will indicate 5 degree heading corrections to the pilot. These corrections will be received by the aircraft commander either aurally through the ICS system or through hand signals and verbal relay from the jumpmaster through the copilot or plane captain/crew chief.

CLEARANCE

Clearance to drop (through the center, tower, or Drop Zone Coordinator) should be requested 2 minutes prior to either wind streamer release or live paradrops. If clearance to drop is received, this information will be relayed to the jumpmaster by intercom or by light signal system (if installed). In addition, the execution of good lookout procedures on the part of the aircraft crew is mandatory for the safety of the parachutists. The aircraft commander shall use any means at his disposal for signaling the jumpmaster to cease jump operations should a dangerous situation develop.

CAUTION

When performing aerial delivery/paradrops, utilize only the parachute door in the forward section of the cargo door.

NOTE

With parachute door or entire cargo door removed, the maximum permissable airspeed is 140 knots.

SECTION IX

FLIGHT CREW COORDINATION

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CREW DUTIES AND RESPONSIBILITIES

AIRCRAFT COMMANDER

The aircraft commander shall be in command of the aircraft and responsible for the safe and orderly conduct of the flight. His responsibility exists from the time he enters the aircraft preparatory to flight until he is relieved from duty by proper authority.

The aircraft commander will be thoroughly familiar with the NATOPS Flight Manual, unit manuals and directives, and all other pertinent directives from higher authority. He has authority to delay or discontinue a flight when, in his opinion, conditions are unsafe for starting or continuing. He shall make all final decisions affecting the operation of the aircraft.

COPILOT

1. The copilot is second in command and is responsible for assisting the aircraft commander in the performance of his duties and such other duties as as may be assigned.

2. When in control of the aircraft, in the absence of the aircraft commander from the cockpit, the copilot will ensure the safe conduct of the flight and will notify the aircraft commander immediately of any unusual events or circumstances.

3. In the event of disability of the aircraft commander during flight, the copilot with the highest designation will take command of the flight and assume the authority. duties, and responsibilities of the aircraft commander to the next enroute station or a closer alternate, as the situation warrants.

4. The copilot shall monitor all maneuvers of the pilot, paying particular attention to takeoffs and approaches under instrument conditions. He shall also be familiar with and monitor all departure, climbout, and approach procedures.

5. The copilot shall handle all communications, copy clearances, maintain enroute navigation logs, set power as directed, lean mixtures, and maintain carburetor heat as required. He shall also call out when 100 feet from assigned altitudes, 10 degrees from assigned headings, and when conducting low instrument approaches, approaching instrument minimums, at minimums, approach lights visual, runway in sight, and runway position in relation to the nose of the aircraft.

RADIO OPERATOR (WHEN REQUIRED)

The radio operator, in addition to making an equipment checkout as outlined in Section I, will accomplish the following:

1. Have thorough knowledge of emergency equipment.

2. Be familiar with procedures to be followed in event of emergency.

NAVIGATOR (WHEN REQUIRED)

The navigator will aid the pilot in all matters pertaining to flight planning and perform any other duties assigned.

FLIGHT CREW PLANE CAPTAIN/CREW CHIEF

1. Verify fuel load and obtain any special instructions from aircraft commander prior to flight.

2. Check aircraft logbook for previous discrepancies, noting corrective action taken.

3. Preflight and post flight aircraft in accordance with current instructions.

4. Ensure all doors and hatches remain CLOSED until aircraft has come to a complete stop and aircraft commander has authorized them to be opened.

5. Be familiar with FLIP, approach charts, and other publications to provide assistance to pilots.

6. Install landing gear safety pins and pitot covers, when utilized.

7. Have a thorough understanding of use of power charts and cruise power settings.

8. Make wing, engine, and cabin checks hourly, reporting results to pilot on duty in left seat.

9. Keep a record of discrepancies as they occur and conduct a thorough post flight inspection.

10. Write a detailed report to maintenance officer on replacements, failures, or unusual incidents which might affect subsequent operations.

11. Other duties as assigned by aircraft commander.

COCKPIT DISCIPLINE

Decisions of the aircraft commander are final. However, to provide necessary training for upgrading and to conform to the physical demands of the cockpit, when the aircraft commander is in the right seat he shall normally perform copilot cockpit duties. The pilot occupying the left seat shall normally perform pilot cockpit duties.

Except as authorized by the aircraft commander, no person other than the pilot or copilot shall move any switch or lever in the cockpit.

USE OF CHECKLISTS

The challenge-and-reply method shall be used. Checklists shall be executed when ordered by the pilot. The reply shall be given after the item is set/checked. Standard terminology as shown on the checklist shall be used. The "items to go" procedure shall not be used; however, a checklist may be held at any point, and when continued, the last item completed shall be repeated. Individual items on any checklist may be executed prior to the reading of the checklist. However, each item shall be rechecked when read off.

TUNING RADIOS

All stations tuned in shall be aurally identified. Each pilot shall advise the other of each station selected. Both pilots shall identify the station on the receiver in use for an actual instrument approach.

SECTION X

NATOPS EVALUATION

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TEXT

ILLUSTRATIONS

CONCEPT

The standard operating procedures prescribed in this manual represent the optimum method of operating C-117D aircraft. The NATOPS Evaluation is intended to evaluate compliance with NATOPS procedures by observing and grading individuals and units. This evaluation is tailored for compatability with various operational commitments and missions of both Navy and Marine Corps units. The prime objective of the NATOPS Evaluation program is to assist the unit commanding officer in improving unit readiness and safety through constructive comment. Maximum benefit from the NATOPS program is achieved only through the vigorous support of the program by commanding officers as well as flight crewmembers.

IMPLEMENTATION

The NATOPS Evaluation program shall be carried out in every unit operating naval aircraft. The various categories of flight crewmembers desiring to attain/retain qualification in the C-117D shall be evaluated in accordance with OPNAV Instruction 3510.9 series. Individual and unit NATOPS Evaluations will be conducted annually; however, instruction in and observation of adherence to NATOPS procedures must be on a daily basis within each unit to obtain maximum benefits from the program. The NATOPS Coordinators, Evaluators, and Instructors shall administer the program as outlined in OPNAV Instruction 3510.9 series. Evaluees who receive a grade of unqualified on a ground or flight evaluation shall be allowed 30 days in which to complete a reevaluation. A maximum of 60 days may elapse between the date the initial ground evaluation was commenced and the date the flight evaluation is satisfactorily completed.

DEFINITIONS

The following terms, used throughout this section, are defined as to their specific meaning within the NATOPS program.

NATOPS EVALUATION

A NATOPS Evaluation is a periodic evaluation of individual flight crewmember standardization consisting of an open book examination, a closed book examination, an oral examination, and a flight evaluation.

NATOPS REEVALUATION

A NATOPS reevaluation is a partial evaluation administered to a flight crewmember who has been placed in an unqualified status by receiving an unqualified grade for any of his ground examinations or the flight evaluation. Only those areas in which an unsatisfactory level was noted need be observed during a reevaluation.

QUALIFIED

Qualified status is that degree of standardization demonstrated by a very reliable flight crewmember who has a good knowledge of standard operating procedures and a thorough understanding of aircraft capabilities and limitations.

CONDITIONALLY QUALIFIED

Conditionally qualified status is that degree of standardization demonstrated by a flight crewmember who meets the minimum acceptable standards. He is considered safe enough to fly as a pilot in command or to perform normal duties without supervision but more practice is needed to become qualified.

UNQUALIFIED

Unqualified status is that degree of standardization demonstrated by a flight crewmember who fails to meet minimum acceptable criteria. He should receive supervised instruction until he has achieved a grade of qualified or conditionally qualified.

AREA

Area is a term used to designate a routine of preflight, flight, or post flight.

SUBAREA

Subarea is a term used to describe a performance subdivision within an area, which is observed and evaluated during an evaluation flight.

CRITICAL AREA/SUBAREA

Critical area/subarea is a term used to describe any area or subarea which covers items of significant importance to the overall mission requirements, the marginal performance of which would jeopardize safe conduct of the flight.

EMERGENCY

Emergency is a term used to describe an aircraft component, system failure, or condition which requires instantaneous recognition, analysis, and proper action.

MALFUNCTION

Malfunction is a term used to describe an aircraft component or system failure or condition which requires recognition and analysis, but which permits more deliberate action than that required for an emergency.

GROUND EVALUATION

Prior to commencing the flight evaluation, an evaluee must achieve a minimum grade of qualified on the open book and closed book examinations. The oral examination is also part of the ground evaluation but may be conducted as part of the flight evaluation. To ensure a degree of standardization between units, the NATOPS Instructors may use the bank of questions contained in this section in preparing portions of the written examinations.

OPEN BOOK EXAMINATION

Questions may be taken from the question bank. The number of questions on the examination will not exceed 40 or be less than 20. The purpose of the open book examination portion of the written examination is to evaluate the crewmember's knowledge of appropriate publications and the aircraft. There is no specified time limit for this examination.

CLOSED BOOK EXAMINATION

Questions may be taken from the question bank and shall include questions concerning normal procedures and aircraft limitations. The number of questions on the examination will not exceed 40 or be less than 20. Questions designated critical will be so marked. An incorrect answer to any question in the critical category will result in a grade of unqualified being assigned to the examination. There is no specified time limit for this examination.

ORAL EXAMINATION

The questions may be taken from this manual and drawn from the experience of the Instructor/ Evaluator. Such questions should be direct and positive and should in no way be opinionated.

GRADING INSTRUCTIONS

Examination grades shall be computed on a 4.0 scale and converted to an adjective grade of qualified or unqualified.

1. Open Book Examination

   To obtain a grade of qualified, an evaluee must obtain a minimum score of 3.5.

2. Closed Book Examination

   To obtain a grade of qualified, an evaluee must obtain a minimum score of 3.3.

3. Oral Examination

   A grade of qualified or unqualified shall be assigned by the Instructor/Evaluator.

FLIGHT EVALUATION

The number of flights required to complete the flight evaluation should be kept to a minimum; normally one flight. The areas and subareas to be observed and graded on a flight evaluation are outlined in the grading criteria. Subarea grades will be assigned in accordance with the grading criteria. These subarea grades shall be combined to arrive at an overall grade for the flight. Area grades, if desired, shall also be determined in this manner.

NOTE

All areas and subareas are critical.

FLIGHT EVALUATION GRADE DETERMINATION

The following procedure shall be used in determining the flight evaluation grade: A grade of unqualified in any critical area/subarea will result in an overall grade of unqualified for the flight. Otherwise, flight evaluation (or area) grades shall be determined by assigning the following numerical equivalents to the adjective grade for each subarea. Only the numerals 0, 2, or 4 will be assigned in subareas. No interpolation is allowed.

Unqualified – 0.0

Conditionally qualified – 2.0

Qualified – 4.0

To determine the numerical grade for each area and the overall grade for the flight, add all the points assigned to the subareas and divide this sum by the number of subareas graded. The adjective grade shall then be determined on the basis of the following scale:

0.0 to 2.10 – Unqualified

2.2 to 2.99 – Conditionally qualified

3.0 to 4.0 – Qualified

EXAMPLE: (Add Subarea numerical equivalents)

$$\frac{4+2+4+2+4}{5} = \frac{16}{5} = 3.20 \text{ Qualified}$$

FINAL GRADE DETERMINATION

The final NATOPS Evaluation grade shall be the same as the grade assigned to the flight evaluation. An evaluee who receives an unqualified on any ground examination or the flight evaluation shall be placed in an unqualified status until he achieves a grade of conditionally qualified or qualified on a reevaluation.

RECORDS AND REPORTS

A NATOPS Evaluation Report (OPNAV Form 3510-8) shall be completed for each evaluation and forwarded to the evaluee's commanding officer. This report shall be filed in the individual flight training record and retained therein for 18 months. In addition, an entry shall be made in the pilot/NFO flight logbook under "Qualifications and Achievements" as follows:

QUALIFICATION			DATE	SIGNATURE	
NATOPS EVAL	(Aircraft Model)	(Crew Position)	(Date)	(Authenticating Signature)	(Unit which Administered Eval)

In the case of enlisted crewmembers, an entry shall be made in the Administrative Remarks of his Personnel Record upon satisfactory completion of the NATOPS Evaluation as follows:

(Date) Completed a NATOPS Evaluation in (aircraft designation) as (flight crew position) with an overall grade of (qualified or conditionally qualified).

NATOPS EVALUATION FORMS

In addition to the NATOPS Evaluation Report, (figure 10-1) NATOPS Flight Evaluation Worksheets, OPNAV FORMS 3510/18 and 3510/18A, are provided for use by the Evaluator/Instructor during the evaluation flight. All of the flight areas and subareas are listed on the worksheet with space allowed for related notes.

FLIGHT EVALUATION GRADING CRITERIA

The standardization evaluation flight check is intended to evaluate individual compliance with approved standard operating procedures. The successful completion of all ground checks and examinations is required before commencement of the flight evaluation. The flight evaluation check should conform to any syllabus or mission flight. Only those areas observed, or required by the mission assigned, will be evaluated. The flight evaluation grade will be attained by comparing the degree of pilot adherence to standard operating procedures with the objective rating as outlined for the individual areas and subareas of this section. Momentary deviations from standard operating procedures should not be considered as unqualifying provided such deviations do not jeopardize flight safety and the evaluee applies prompt corrective action.

The determination of the final flight evaluation grade will be made as outlined in this section.

AIRCRAFT COMMANDER, SECOND PILOT, THIRD PILOT – FLIGHT EVALUATION

PREPARATION FOR FLIGHT

(1) MISSION PLANNING

Qualified

Clearance forms completed and accurate without omission or error. Publications and directives complied with. Enroute navigation charts, letdown plates, and NOTAMS reviewed for information that would affect the mission.

Conditionally Qualified

The same as Qualified, but with discrepancies that would not adversely affect the successful completion of the mission or jeopardize safety.

Unqualified

Discrepancies that would preclude the successful completion of the mission or that would jeopardize safety.

(2) BRIEFING

Qualified

The briefing was conducted in an orderly, well-organized manner, with ample time to ensure digestion of the material presented.

Conditionally Qualified

The briefing was conducted in an orderly manner, but the time allotted was inadequate. Not more than one applicable item was omitted from the briefing checklist. The material presented was not in accordance with what was actually planned for the flight.

Unqualified

Unprepared for briefing. Briefing was inadequate to safely complete the mission.

(3) RECORD CHECK (Yellow Sheet)

Qualified

Consulted the yellow sheet for the status of the aircraft and ensured that it was complete and accurate. Reviewed the 10 previous yellow sheets for discrepancies and ascertained that the required maintenance had been completed. Filled out the yellow sheet without errors or omissions.

Conditionally Qualified

Consulted the yellow sheet for status of the aircraft but failed to avail himself of all the information contained therein and/or neglected to review the 10 previous yellow sheets.

Unqualified

Failed to sign the acceptance of the aircraft and/or failed to ascertain that all discrepancies had been corrected. Accepted an aircraft that was not ready for flight.

(4) PREFLIGHT CHECK

Qualified

Accomplished the preflight inspection as outlined in this manual. Ensured proper servicing of the aircraft in accordance with the planned mission.

NATOPS EVALUATION REPORT
OPNAV Form 3510-8 (8-65) 0107-723-0000

Name (Last, first initial)	Grade	Service Number
Squadron/Unit	Aircraft Model	Crew Position
Total Pilot/Flight Hours	Total Hours in Model	Date of Last Evaluation

NATOPS EVALUATION

REQUIREMENT	DATE COMPLETED	GRADE		
		Q	CQ	U
Open Book Examination			▨	
Closed Book Examination			▨	
Oral Examination			▨	
*Evaluation Flight				

Flight Duration	Aircraft Buno	Overall Final Grade

Remarks or Evaluator/Instructor

☐ Check if continued on reverse side

Grade, Name of Evaluator/Instructor	Signature	Date
Grade, Name of Evaluee	Signature	Date

Remarks of Unit Commander

Rank, Name of Unit Commander	Signature	Date

*WST, OFT, COT, or cockpit check in accordance with OPNAVINST 3510.9 (effective edition).

Figure 10-1. NATOPS Evaluation Report – Sample Form

Conditionally Qualified

Accomplished the preflight inspection as outlined in this manual, with minor omissions or errors, none of which would affect the safety of the flight.

Unqualified

Performed the preflight inspection, but with errors and/or omissions that could affect the safety of the flight. Failed to verify that the aircraft was serviced and ready for flight.

(5) PERSONNEL EQUIPMENT

Qualified

Properly used all required personal equipment.

Conditionally Qualified

In possession of all required equipment, but failed to use all required equipment at all times.

Unqualified

Showed complete disregard for personal equipment. Not in possession of two or more items of required equipment.

ENGINE START/TAXI/RUNUP

(1) TAXI

Qualified

Procedures and checkoff list were followed without error and/or omission. Desired directional control was maintained without abrupt changes. The tailwheel was locked and unlocked at proper times.

Conditionally Qualified

Procedures were followed, but with deviations, none of which jeopardized safe operation. Directional control was erratic. The tailwheel was locked and unlocked at proper times.

Unqualified

Taxied with excessive speed and/or with insufficient clearance from obstacles. The tailwheel was not locked and unlocked at proper times.

(2) ENGINE RUNUP

Qualified

Procedures were followed. The prescribed checks were performed without errors or omissions within engine operating limitations.

Conditionally Qualified

Procedures were followed, but with slight deviations that would not jeopardize the mission.

Unqualified

Proper procedures were not used. Did not use the checklist and failed to perform the magneto check.

(3) CREW BRIEFING

Qualified

Briefed crew on normal and emergency cockpit procedures, ensured radios were tuned to facilities associated with initial climbout and/or emergency return, and aircraft performance, including takeoff speeds.

Conditionally Qualified

Same as qualified but omitted some minor items in the crew briefing.

Unqualified

Omitted one or more major items from the crew briefing.

TAKEOFF/CLIMB

(The following criteria shall apply to normal and crosswind takeoffs.)

(1) TAKEOFF

Qualified

Received and acknowledged takeoff clearance. Properly positioned aircraft and completed final checks. Maintained good directional control on takeoff run. Utilized takeoff performance data. Made smooth transition to climb attitude.

Conditionally Qualified

Same as qualified, except for minor deviations in procedure and technique not detrimental to flight safety.

Unqualified

Did not receive and acknowledge takeoff clearance. Exhibited poor or unsafe technique in either directional control, lift-off, transition, or in establishing climb.

(2) EMERGENCY RETURN (Includes Abort)

Qualified

Maintained positive control of the aircraft, completed emergency checklists in accordance with standard procedures, and affected smooth transition to final approach and landing. Ensured adequate briefing was given crew, passengers, and traffic controller.

Conditionally Qualified

Carried out items listed in qualified, but with some delay in executing checks.

Unqualified

Jeopardized flight safety by failing to cope with emergency in timely fashion, or used improper sequence of checks causing confusion in cockpit compounding the emergency.

(3) CLIMBOUT PROCEDURES

Qualified

Proper use of climb checklist. Aircraft checks complete and crew reports received. Maintained correct climb power setting. Climb airspeed maintained within plus or minus 5 knots. Prescribed headings within plus or minus 5 degrees.

Conditionally Qualified

Aircraft checks complete, but reports not received. Established but did not maintain correct climb power setting. Climb airspeed maintained within plus or minus 10 knots. Prescribed headings within plus or minus 10 degrees.

Unqualified

Failed to complete climb checklist. Report was not received. Did not establish correct climb power. Failure to satisfy requirements listed under conditionally qualified.

ENROUTE

(1) CRUISE PROCEDURES

Qualified

Aircraft checks were complete and crew reports received. (Headings were maintained within plus or minus 5 degrees.) Altitude was maintained within plus or minus 100 feet. Cruise power setting was properly maintained and the correct procedure was used for leaning the mixture.

Conditionally Qualified

Cruise airspeed maintained within plus or minus 10 knots, heading within plus or minus 10 degrees, and altitude within plus or minus 200 feet.

Unqualified

Failed to satisfy requirements listed under conditionally qualified.

(2) ICING CONDITION PROCEDURES

Qualified

Had a thorough knowledge of anti-icing procedures and utilized pitot, propeller, and wing deicing properly. Maintained cylinder head and carburetor air heat in proper tolerance.

Conditionally Qualified

Demonstrated adequate knowledge of anti-icing procedures to maintain temperatures within tolerance and did not jeopardize safety of flight.

Unqualified

Did not manage anti-icing equipment properly, jeopardizing the safety of the flight.

EMERGENCIES

(The following criteria applies to all emergencies.)

Qualified

Demonstrated proper technique, coordination, and knowledge of aircraft's emergency and distress procedures.

Conditionally Qualified

Same as qualified, except for minor deviations.

Unqualified

Inadequate knowledge or poor technique in executing emergency procedures.

APPROACHES

(The following criteria shall apply to PAR/ASR, ILS, ADF, VOR, and TACAN approaches.)

Qualified

Followed procedures as published, and complied with approach controller instructions. Maintained airspeed within 10 knots. Maintained assigned altitude and heading. Did not descend below minimum altitudes, as published. Demonstrated good tracking technique. Minor deviations in glide slope and alignment. Indicated time over airport within 20 seconds. Maintained field altitude minimums.

Conditionally Qualified

Followed procedures as published and complied with approach control instructions. Maintained airspeed within 15 knots. Tracking was erratic and no apparent correction for wind was applied. Large deviations in glide slope and alignment, but could have completed a successful approach. Maintained field altitude minimums within plus 150 feet.

Unqualified

Unsafe procedures and/or failed to comply with approach control instructions. Failed to meet airspeed, altitude, and time criteria specified above. Failed to maintain field altitude minimums within the above criteria. Safety of crew and aircraft was jeopardized, and landing was highly improbable.

TRANSITION TO LANDING

Qualified

Entered and flew traffic pattern in accordance with the appropriate governing directives. Proper execution of descent and before-landing checklists. Flew the traffic pattern within altitude and airspeed range.

Conditionally Qualified

Entered and flew traffic pattern in accordance with the appropriate directives, but with deviations that did not interfere with traffic or jeopardize safety. Late calling for or completing checklist. Flew traffic pattern with minor deviations in altitude and/or airspeed range.

Unqualified

Deviated from prescribed pattern and interferred with other traffic or jeopardized safety. Failed to call for or to complete before landing checklist. Exceeded limitations for conditionally qualified.

VFR LANDING PATTERN

(1) NORMAL

Qualified

Maintained positive control of speed, power, and rate of descent. Aircraft aligned with runway throughout final approach. Maintained aircraft in trim. Normal touchdown in first third of runway. Maintained directional control during rollout. Smooth and effective use of brakes.

Conditionally Qualified

Had minor difficulty with transition. Handled aircraft roughly and used poor technique in either flare, landing, or rollout.

Unqualified

Had serious difficulty with transition. Failed to maintain positive control of aircraft during either flare, landing, or rollout. Did not touch down in first third of runway. Landed hard. Jeopardized safety.

(2) CROSSWIND

Qualified

Properly executed crosswind tehcnique, maintaining positive directional control throughout the flare, touchdown, and rollout. Wing flap settings and differential power weighed in judgment of actual landing.

Conditionally Qualified

Insufficient measures were taken to correct drift on final approach or touchdown, improper technique used to maintain directional control, or aircraft landed in slight skid.

Unqualified

Safety of flight endangered by poor judgment of crosswind situation, or dangerous drift existent on touchdown.

(3) NO-FLAP

Qualified

Maintained correct attitude, airspeed, and properly coordinated power settings.

Conditionally Qualified

Attitude, airspeed and power settings correct, except for minor deviations.

Unqualified

Unsatisfactory control of airspeed, attitude, and power settings resulting in go-around.

LANDING WITH EMERGENCY (ENG. HYD. ETC.)

Qualified

Emergency analyzed correctly and corrective action taken so as to issue safe approach and landing.

Conditionally Qualified

Minor discrepancies in handling emergency situation, but safe approach and landing accomplished.

Unqualified

Incorrect technique in handling emergency. Unsafe approach or landing.

SHUTDOWN AND POSTFLIGHT PROCEDURES

Qualified

Completed appropriate checklists without omissions, visual exterior inspection conducted, completed necessary logs and forms. Ensured that flight plan was closed out.

Conditionally Qualified

Omitted checklist items and exterior inspection. Failed to note obvious maintenance discrepancies, none of which were considered unsafe.

Unqualified

Major checklist items omitted; improper knowledge and use of postflight forms. No postflight inspection.

CREW COORDINATION

Qualified

Crew was well coordinated and pilot was aware of the duties and responsibilities of each crewmember. Crew's performance as a team reflected pilot's emphasis on conformance to standard procedures by all crewmembers.

Conditionally Qualified

Crew was coordinated in actions and pilot was generally aware of crew duties and responsibilities. Performance as a team did not jeopardize safety or crew's ability to complete mission. Did not require crew to perform tasks in accepted manner.

Unqualified

Crew performance showed complete lack of coordination by the pilot. Tasks were performed in violation of accepted publications.

USE OF CHECKLISTS

Qualified

Timely calling for and proper execution of checklists.

Conditionally Qualified

Late calling for or completion of checklists. Minor deviations or omissions noted.

Unqualified

Failed to call for or to complete checklists.

FLIGHT CREW PLANE CAPTAIN/CREW CHIEF

PREFLIGHT

(1) AIRCRAFT SERVICING

Qualified

Demonstrated a thorough knowledge of requirements and proficiency in refueling and securing the aircraft. All requirements as outlined in approved manuals and directives were accomplished in a highly professional manner. All safety precautions were observed.

Conditionally Qualified

Refueling and securing were accomplished in accordance with approved manuals and directives, with minor deviations. Such deviations were not detrimental to safety. Aircraft not considered as completely secured, but not endangered.

Unqualified

Refueling and securing were not accomplished or were accomplished in an unsatisfactory manner. Safety precautions were partially or completely disregarded. Showed need for instruction and/or supervision.

(2) PREFLIGHT INSPECTION AND DUTIES

Qualified

Checked log and records thoroughly prior to preflight. Checked over work performed on previous discrepancies. Thorough and proficient exterior and interior inspection utilizing approved checklist. Demonstrated thorough knowledge of inspection requirements.

Conditionally Qualified

Check of aircraft log and records was not as thorough as above. Insufficient research of work performed on the aircraft as a result of previous discrepancies (not to the point of detriment to flight safety, however). Performance of interior and exterior inspection in accordance with approved checklist, with minor deviations.

Unqualified

No check of log or previously performed work on aircraft. Failed to complete interior and exterior inspection or to utilize an approved checklist. Inspection was such that safe flight operation was doubtful.

(3) APU OPERATION

Qualified

Demonstrated ability to properly inspect APU prior to starting. Used correct starting procedure with above minimum voltage specified for starting; correctly monitored unit while it was in operation.

Conditionally Qualified

Same as qualified, except minor deviations in starting procedure not considered hazardous to aircraft or APU.

Unqualified

Failed to start APU; allowed unit to run without being monitored.

(4) TURNUP PROCEDURES

Qualified

Start was accomplished in prescribed manner, utilizing approved checklist; all limitations were observed. All switches and controls were operated properly and all required checks were accomplished. Demonstrated a thorough knowledge of normal and emergency procedures during start. Start and turnup were performed in a professional manner.

Conditionally Qualified

Start was accomplished in prescribed manner. Observation of limitations and operation of switches and controls were normal. Use of checklist created some doubt as to its usefulness. Weak knowledge of normal and emergency procedures. Room for improvement.

Unqualified

Errors were made during start, endangering aircraft (e.g. possible engine fire). Did not know or was weak on limitations and/or procedures. Checklist was not utilized.

(5) CARGO LOADING AND TIEDOWN

Qualified

Loaded aircraft within allowable weight-and-balance and load limits in accordance with the Cargo Loading Handbook C-117D. Ensured adequate amount and application of tiedowns.

Conditionally Qualified

Loaded aircraft within allowable limits, but used poor loading planning, resulting in wasted space or undesirable MAC.

Unqualified

Exceeded allowable cabin load or compartment limits. Failed to load within allowable MAC. Failed to apply proper restraint to cargo.

(6) TAXI ABILITY (AS APPLICABLE) AIRCRAFT HANDLING/TOWING

Qualified

Complied with procedures required by this manual; taxi director's signal men utilized; power and speeds regulated closely; watches properly posted; all lights and taxi aids utilized as necessary; checklists completed; smooth on power and brakes; complied with tower instructions.

Conditionally Qualified

Standard procedures accomplished with omissions, deviations or discrepancies which did not either adversely affect successful completion of the mission, jeopardize safety, or cause delay.

Unqualified

Any omission or discrepancy which either precluded successful completion of mission, jeopardized safety, or caused delay. Taxied in rough and hazardous manner; improper use of checklists.

FLIGHT

(1) COCKPIT DISCIPLINE

Qualified

Carried out tasks assigned by aircraft commander in a prompt and efficient manner, with unnecessary conversation held to a minimum.

Conditionally Qualified

Carried out assigned tasks in accordance with the briefing.

Unqualified

Failed in or performed improperly the assigned tasks, to the detriment of safety.

(2) FUEL SYSTEM

Qualified

Possessed thorough knowledge of fuel system and its operation. Was able to explain, in detail, entire system, its operation, and limits.

Conditionally Qualified

Possessed a working knowledge of fuel system and its operation. Was able to explain system, its operation and limitations. Minor errors were noted, though not detrimental to safety or operation.

Unqualified

Did not know the system.

(3) HYDRAULIC SYSTEM

Qualified

Possessed a thorough knowledge of hydraulic system, its operation, and limits. Was able to explain, in detail, system and its components.

Conditionally Qualified

Possessed a good knowledge of system and its operation. Minor errors were noted, not detrimental to system.

Unqualified

Did not understand system. Showed a marked need for further instruction.

(4) ELECTRICAL SYSTEM

Qualified

Demonstrated an excellent knowledge of system, its operation, and limitations. Thoroughly familiar with all switches and controls. Had a thorough knowledge of both ac and dc circuits.

Conditionally Qualified

Demonstrated a good knowledge of system. Minor errors were noted, not detrimental to electrical system or safety. Further instruction is needed.

Unqualified

Did not know the electrical system. Showed marked need for further instruction.

(5) AUXILIARY EQUIPMENT

Qualified

Had a thorough knowledge of and was well checked out in use of auxiliary equipment, such as loading equipment, heating, oxygen, anti-icing, deicing, communications, lighting, autopilot, etc.

Conditionally Qualified

Demonstrated a general knowledge of auxiliary equipment and its use. Minor discrepancies were noted.

Unqualified

Showed a limited amount of knowledge of equipment. More study definitely needed.

(6) POWER CHARTS

Qualified

Demonstrated a thorough knowledge of the power charts and their use. Excellent ability demonstrated in fast and accurate usage of charts.

Conditionally Qualified

Demonstrated a satisfactory knowledge of power charts, slow to arrive at accurate power settings.

Unqualified

Indicated lack of knowledge of power charts or arrived at unsafe or undesirable power settings. Demonstrated a marked need for instruction in use of the power charts.

(7) DITCHING AND BAILOUT/EMERGENCIES

Qualified

Demonstrated a thorough knowledge of ditching, bailout, and emergency procedures. Explained, in detail, all actions required for ditching, in proper sequence. Was able to execute drills expeditiously, safely, and correctly, requiring no supervision.

Conditionally Qualified

Demonstrated a satisfactory knowledge of ditching, bailout, and emergency procedures. Was able to explain actions required in ditching. Minor errors were noted, not detrimental to safety.

Unqualified

Did not know ditching and bailout procedures or left doubt that he would survive ditching or bailout if left to his own devices.

(8) USE OF SURVIVAL EQUIPMENT

Qualified

Demonstrated a thorough knowledge of all survival equipment normally carried in the plane in regard to its use, care, and stowage locations; knew how and when to launch rafts, properly inflate them, board them, etc.

Conditionally Qualified

Demonstrated a satisfactory knowledge of survival equipment, its use, care and stowage. Minor errors or deviations, not considered to be unsafe.

Unqualified

Demonstrated lack of knowledge of survival equipment.

POST FLIGHT

(1) INSPECTION

Qualified

Thorough and competent in accomplishing the required inspection. Advised pilot of aircraft discrepancies so that a complete and accurate aircraft status was determined.

Conditionally Qualified

Completed required inspection with minor deviations. Advised pilot of discrepancies, but was slightly vague. Overall performance left room for improvement.

Unqualified

Did not, or was unable, to perform postflight duties. Failed to inform pilot of aircraft discrepancies; consequently, true status of aircraft was unknown. Needed supervision and further instruction.

(2) SERVICING AND SECURING

Qualified

Demonstrated ability to properly service and secure aircraft after flight. Ensured tiedown complete and aircraft clean. Completed maintenance forms properly, and discussed defects with ground crew.

Conditionally Qualified

Omitted minor items mentioned above, none of which would jeopardize security and readiness of aircraft and comfort of crew.

Unqualified

Missed securing checklist items of paramount importance. Did not write up discrepancies.

(3) AIRCRAFT CLEANLINESS

Qualified

Maintained a maximum standard of cleanliness and neatness at all times. Ensured that cabin was cleaned thoroughly at regular intervals and that all waste receptacles were serviced at each stop enroute. Displayed initiative in maintaining a high degree of aircraft cleanliness at all times.

Conditionally Qualified

Same as qualified, but with minor deviations.

Unqualified

Neglected to empty waste receptacles at enroute stops. Lack of concern and effort in keeping cabin spaces neat and clean. Failure to inspect aircraft for cleanliness or to correct discrepancies that existed.

CREW COORDINATION

Qualified

Coordinated actions/requirements smoothly and effectively with all crewmembers. Anticipated demands upon crew position. The overall performance of crew was enhanced by his continual alertness to needs of others in performing their assigned duties.

Conditionally Qualified

Attempted to coordinate action/requirements, but lacked desired effect. Intercommunications discipline at times interferred with crew. Responses to checklist items were made with only minor deviations. Did not jeopardize mission.

Unqualified

Displayed undesirable traits related to crew coordination. Intercommunications discipline was nonexistent. Performance hindered smooth accomplishment of the mission.

MILITARY COURTESY

Qualified

Rendered proper military courtesy to crew, passengers, and ground personnel. Polite and cheerful in dealing with all passengers.

Conditionally Qualified

Occasionally neglected to render proper courtesies.

Unqualified

Consistently lacking in military courtesy. Disagreeable or rude to officers, crew, passengers, or ground personnel.

USE OF FORMS

Qualified

Thorough and competent in completion of all required forms.

Conditionally Qualified

Did not understand completely all the different supply forms that are required. Knowledge and approved procedures were marginal.

Unqualified

Displayed a lack of knowledge in completing any of the required forms.

NATOPS EVALUATION QUESTION BANK

1. A WARNING paragraph contains:

   (a) an operating procedure, condition, etc., which is essential to emphasize.

   (b) an operating procedure, practice, etc., which if not strictly observed, may damage equipment.

   (c) an operating procedure, practices, etc., which may result in injury or death, if not carefully followed.

2. The principal dimensions of the C-117D are:

   (a) wing span 90 feet, height 18 feet 3 inches, length 67 feet 8.5 inches

   (b) wing span 91 feet 3 inches, height 27 feet 9 inches, length 38 feet

   (c) wing span 90 feet 9 inches, height 18 feet 3 inches, length 38 feet

   (d) wing span 91 feet 9 inches, height 27 feet 3 inches, length 74 feet 8 inches.

3. The starter safety switch:

   (a) is disconnected and should be placarded "Inoperative."

   (b) must be depressed before the starter switch will function.

   (c) is automatically depressed when the engine starter selector switch is positioned to either engine.

4. The firewall shutoff handles are located:

   (a) on the main instrument panel below the emergency airbrake handle.

   (b) on the control pedestal.

   (c) between the pilot's and copilot's seats in the deck.

   (d) behind the copilot's seat.

5. The four-position cowl flap switches have the following positions:

   (a) OFF, OPEN, CLOSED, TRAIL.

   (b) OFF, OPEN, CLOSED, ON.

   (c) OFF, OPEN, CLOSED, CLIMB.

   (d) OFF, ON, CLOSED, TRAIL.

6. The maximum operating time limit for the feathering pump is:

   (a) 30 seconds

   (b) 60 seconds

   (c) 90 seconds

   (d) not significant because the pump will eventually burn out by itself.

7. To unfeather a propeller, the feathering button must be:

   (a) pulled until the propeller unfeathers (600 to 800 rpm).

   (b) pushed in until the propeller unfeathers (600 to 800 rpm).

8. The oil cooler switches are spring loaded in the:

   (a) AUTO and OFF positions.

   (b) AUTO and CLOSED positions.

   (c) AUTO and OPEN positions.

   (d) OPEN and CLOSED positions.

9. Each oil tank has a useable capacity of ______ gallons of oil.

   (a) 18-1/2

   (b) 27-3/4

   (c) 55-1/2

   (d) 60

10. When the firewall shutoff handle is pulled, the propeller feathering oil for the affected engine is shutoff at the firewall.

    (a) True

    (b) False

11. The fuel system is considered as consisting of two independent systems and is managed by the use of:

    (a) four 5-position selectors for the outer wing and center wing tanks.

    (b) two 3-position selectors.

    (c) two 5-position selectors for the center wing tanks and two 3-position selectors for the outer wing tanks.

    (d) two 3-position selectors for the center wing tanks and two 5-position selectors for the outer wing tanks.

12. When all fuel tanks are full, the main tanks should be selected for takeoff:

    (a) to provide best cg location as fuel is consumed.

    (b) to prevent overflow of these tanks due to carburetor vent return.

    (c) to allow use of the cabin heater after takeoff.

13. The cabin heater receives fuel from:

    (a) the left auxiliary fuel tank.

    (b) the right auxiliary fuel tank.

    (c) the right main fuel tank.

    (d) a fuel line forward of the right fuel strainer.

14. Pulling the right firewall shutoff handle shuts off fuel to the cabin heater.

    (a) True

    (b) False

15. The carburetor vent return system for each carburetor is designed to return approximately_____of fuel to the main fuel tank.

    (a) 10 to 15 pounds per hour (2 gallons)

    (b) 20 to 30 pounds per hour (6 gallons)

    (c) 50 to 70 pounds per hour (10 gallons)

    (d) 180 to 200 pounds per hour (20 gallons)

16. Takeoff and landing should be made using fuel from the outer wing tanks if they contain more fuel than the center wing tanks.

    (a) True

    (b) False

17. When the EMERGENCY position is selected with the emergency power switch:

    (a) the battery is disconnected from the main bus.

    (b) the pilot's turn-and-slip indicator will continue to operate.

    (c) the copilot's turn-and-slip indicator continues to function because it is driven by air pressure from the air pressure pumps.

    (d) all of the above are true.

18. When both inverter switches are set to the transfer position, both inverters are off and no power is available.

    (a) True

    (b) False

19. The emergency power circuit breaker is located:

    (a) on the radio operators "J" box.

    (b) above the navigation table.

    (c) on the main circuit breaker panel.

    (d) none of the above.

20. When an inverter warning light comes on inflight, it indicates that:

    (a) no power is being supplied to the respective flight instruments.

    (b) an inverter has failed.

    (c) an inverter switch has been set to the transfer position.

    (d) a and b above complete the statement.

    (e) a, b and c above are true.

21. An ac interlock switch is provided:

    (a) to allow the radios to be used during ground operations.

    (b) to prevent the generators from overheating during ground operations.

    (c) to prevent the inverters from overheating during ground operations.

    (d) none of the above.

22. The hydraulic system has sufficient capacity to operate the gear and flaps simultaneously.

    (a) True

    (b) False

23. When operating various hydraulically actuated units with the hydraulic hand pump, it is necessary to open the hydraulic hand pump shutoff valve.

    (a) True

    (b) False

24. The hydraulic fluid reserve of 3.2 quarts for the hand pump is indicated at the lower mark on the hydraulic system quantity sight gage.

    (a) True

    (b) False

25. The tailwheel is designed to swivel through an arc of:

    (a) 60 degrees

    (b) 90 degrees

    (c) 180 degrees

    (d) 240 degrees

26. If a hydraulic system fails, the landing gear will:

    (a) free fall to the down position because no uplatches are installed.

    (b) remain in the up position until the down position is selected with the landing gear control lever which opens the main gear doors.

    (c) remain in the up position because of a check valve located in the pressure line.

    (d) remain in the last position selected until hand cranked to a desired position.

27. The landing gear safety latch lever:

    (a) is connected to the landing gear handle only.

    (b) is cable rigged to the spring-loaded latch on each main gear.

    (c) must be placed in the spring-lock position after the landing gear handle is placed in the down position.

    (d) does not have to be checked by the pilot prior to touchdown because it is the copilots responsibility.

28. The landing gear safety latch is:

    (a) set to the up (latch raised) position prior to retracting the gear and set to the "positive locked" position prior to extending the gear.

    (b) set to the up (latch raised) position prior to retracting the gear and set to the "positive lock" position when the gear indicates down and locked.

    (c) not normally used on some aircraft.

    (d) left in the spring-locked position for a touch-and-go landing.

29. When setting the parking brake:

    (a) there must be a minimum of 500 psi hydraulic pressure on the hydraulic system pressure gauge.

    (b) the hydraulic pressure gauge should be monitored and a drop in pressure should be noted as the brakes are set.

    (c) the star valve should be opened and pressure should be built up in the accumulator if the pressure is less than the minimum for parking brake operation.

    (d) all of the above are true.

30. The ground blower is energized by the heater switch when the aircraft is on the ground.

    (a) True

    (b) False

31. After heater shutdown, during ground operations, the ground blower should be operated for______ minutes to dissipate heat from the heater compartment.

    (a) 5

    (b) 10

    (c) 15

    (d) no time limit is specified.

32. The door-open warning light will come on whenever the forward service door or the main cabin door is open.

    (a) True

    (b) False

33. The alternate static source is located:

    (a) on the right side of the fuselage.

    (b) under the instrument panel.

    (c) in the cabin near the cabin air manual control lever.

    (d) in the tail section.

34. Fogging of the inner windshield panes can be prevented by:

    (a) a rapid descent from altitude.

    (b) pulling the windshield heated air deicing control to maintain a flow of air between the panes.

    (c) operating the windshield alcohol deicing system at intervals throughout the flight.

    (d) pushing the windshield heated air deicing control (OFF) to stop the flow of air between the panes.

35. The propeller deicing system is operated by:

    (a) 28-vdc power supplied to the propeller boots.

    (b) applying a fixed flow of alcohol to the propeller.

    (c) applying a metered – flow of alcohol to the propeller.

    (d) 115 vac from the main inverter.

36. When changing UHF frequencies and all 18 channels are preset to required frequencies, the local control at the radio operator's station should be set to:

    (a) OFF

    (b) LOCAL

    (c) REMOTE

    (d) AUTO LOAD

37. When the pilot's RMI double bar selector switch is set to the TACAN position:

    (a) TACAN information is the only information displayed on the instrument panel.

    (b) TACAN course information and ILS glide path information may be displayed on the applicable CDI.

    (c) ILS information will not be displayed until the switch is set to the VOR position.

    (d) the copilot's deviation indicator ID-48 will continue to display VOR information.

38. The autopilot:

    (a) will automatically disengage when the copilot's gyro horizon is caged.

    (b) is operated from 115-vac power from the main inverter only.

    (c) corrects the pilot's ILS visual indications when the BLUE RIGHT – BLUE LEFT is set to the BLUE LEFT position during an automatic ILS approach.

    (d) all of the above are true.

39. Maximum fuel capacity is:

    (a) 813 gallons

    (b) 1000 gallons

    (c) 1248 gallons

    (d) 1626 gallons

40. To avoid excessive vibration loads, the engines should not be operated for prolonged periods in the following ranges.

(a) 1800 to 2150 and 2500 to 2800 rpm

(b) 1400 to 1800 and 2150 to 2500 rpm

(c) 1750 to 2100 and 2500 to 2800 rpm

(d) 1850 to 2100 and 2500 to 2650 rpm

41. Maximum airspeed for unfeathering a propeller is:

(a) 115 KIAS

(b) 127 KIAS

(c) 135 KIAS

(d) 144 KIAS

42. Maximum airspeed with 1/4 wing flaps extended is:

(a) 115 KIAS

(b) 127 KIAS

(c) 144 KIAS

(d) 148 KIAS

43. Maximum airspeed with landing gear extended is:

(a) 148 KIAS

(b) 144 KIAS

(c) 127 KIAS

(d) 115 KIAS

44. Maximum airspeed for landing light extension is:

(a) 202 KIAS

(b) 148 KIAS

(c) 144 KIAS

(d) 127 KIAS

45. If flight through turbulence cannot be avoided, the recommended airspeed range is:

(a) 110 - 130 KIAS

(b) 115 - 145 KIAS

(c) 115 - 125 KIAS

(d) 120 - 140 KIAS

46. Minimum cylinder head temperature for takeoff is:

(a) 100°C.

(b) 120°C.

(c) 160°C.

(d) 200°C.

47. Desired oil pressure range during cruise is:

(a) 45 to 65 psi

(b) 50 to 75 psi

(c) 65 to 75 psi

(d) 65 to 85 psi

48. Allowable takeoff gross weight is:

(a) 34,500 pounds

(b) 33,000 pounds

(c) 31,500 pounds

(d) determined from performance data.

49. Maximum allowable MAP at sea level, standard day, 2800 rpm, is:

(a) 52.5 inches

(b) 53.5 inches

(c) 54.5 inches

(d) 56.5 inches

50. Maximum MAP at 6000 feet, 2000 rpm, standard day is:

(a) 30.5 inches

(b) 29.6 inches

(c) 29.0 inches

(d) 27.5 inches

51. Center of gravity limits are:

(a) aft limit 36% gear down, forward limit 7% gear down

(b) aft limit 30% gear down, forward limit 18% gear down

(c) aft limit 31% gear down, forward limit 17% gear down

(d) aft limit 37% gear down, forward limit 10% gear down

52. Minimum carburetor air temperature when conditions favorable to icing exist is:

(a) +10°C.

(b) +15°C.

(c) +20°C.

(d) +38°C.

53. The oil pressure warning light is adjusted to come on at a minimum oil pressure of:

(a) 40 ± 5 psi

(b) 50 ± 5 psi

(c) 65 ± 5 psi

(d) 90 ± 5 psi

54. The heater temperature when the heater is in operation, should stabilize between:

(a) 16 to 18°C

(b) 120 to 130°C

(c) 150 to 180°C

(d) 950 to 1100°C

55. The cabin heater is protected against excessive temperatures by the:

(a) flapper type combustion and ventilation system.

(b) cabin heat control valve.

(c) cycling switch and dropout fuse.

(d) structural overheat limit switch.

56. The maximum recommended crosswind component for safe operation is:

(a) 25 knots at 90 degrees

(b) 20 knots at 90 degrees

(c) 15 knots at 90 degrees

(d) 10 knots at 90 degrees

57. The brake pucks must be changed prior to flight if the adjusting pins:

(a) are flush with the shoulder of the torque nuts.

(b) have retracted to greater than 1/16 inch from the shoulder of the torque nut.

(c) have retracted to greater than 1/4 inch below the shoulder of the torque nut.

58. The emergency brake air pressure bottle is located behind the copilot's seat and should be serviced to approximately____psi prior to flight.

(a) 500

(b) 1450

(c) 1590

(d) 2950

59. After engine start, engine operation is limited to 1400 rpm until oil temperature is a minimum of:

(a) 20°C.

(b) 30°C.

(c) 40°C.

(d) 50°C.

60. The override position should be selected, momentarily, with the ac interlock switch prior to takeoff to check the:

(a) inverter warning lights.

(b) autopilot fuse.

(c) electrical load.

(d) position of the switch prior to takeoff roll.

61. Normal climb airspeed is:

(a) 120 KIAS

(b) 130 KIAS

(c) 135 KIAS

(d) 140 KIAS

62. Using optimum crosswind landing technique, the pilot should:

(a) apply differential power on final to maintain runway heading.

(b) apply sufficient wing down into the wind and opposite rudder to maintain runway heading landing on the upwind wheel first.

(c) apply differential power and wing down into the wind on final to maintain runway heading.

63. Stall speed at 33,000 pounds, level flight, flaps up is:

(a) 68 KIAS

(b) 76 KIAS

(c) 79 KIAS

(d) 89 KIAS

64. Minimum single engine control speed is:

(a) 68 KIAS

(b) 76 KIAS

(c) 79 KIAS

(d) 89 KIAS

65. Safe single engine climbout airspeed at a gross weight of 31,500 pounds is:

(a) 76 KIAS

(b) 91 KIAS

(c) 94 KIAS

(d) 102 KIAS

66. Recommended flap setting for a water ditching is:

(a) no flap

(b) 1/4 flap

(c) 1/2 flap

(d) full flap

67. Recommended airspeed for bailout is:

(a) 76 KIAS

(b) 94 KIAS

(c) 100 KIAS

(d) 115 KIAS

68. When a magnetic chip detector light comes on, it indicates that:

(a) the affected engine should be secured immediately.

(b) the affected engine should be closely monitored for other indications of impending engine failure.

(c) the circuit is defective and the circuit breaker should be tripped.

69. When executing smoke removal procedures, the cockpit side windows should remain closed.

(a) True

(b) False

70. A reserve of 3.2 quarts of hydraulic fluid is available for use with the hydraulic hand pump and may be used to operate the brakes in the event of engine-driven hydraulic pump failure.

(a) True

(b) False

71. When a single engine landing is required, crosswind is not a factor because differential power is not available.

(a) True

(b) False

72. When climbing under instrument conditions, turns should be limited to____degrees angle of bank.

(a) 10

(b) 15

(c) 30

(d) 45

73. Pitot heat should be applied:

(a) prior to entering actual instrument conditions.

(b) after entering actual instrument conditions.

(c) when flight instruments become erratic during actual instrument conditions.

74. When using the challenge and reply checklist:

(a) the copilot shall state the items to go, i.e. "Checklist completed. Props and flaps to go."

(b) the checklist may be held at any point, and when continued, the last item read shall be repeated.

75. An increase in specific humidity represents an increase in takeoff ground roll distance.

(a) True

(b) False

76. Best rate of climb, single engine, flaps up, gear up, and propeller windmilling, at a gross weight of 29,000 pounds, is obtained at approximately:

    (a) 80 KIAS

    (b) 105 KIAS

    (c) 120 KIAS

    (d) 130 KIAS

77. With the following conditions given, what is the expected rate of climb?

    (a) single engine, propeller windmilling

    (b) gross weight 32,500

    (c) pressure altitude 1000 feet

    (d) relative humidity 60 percent

    (e) temperature 75°F

        (1) -50 fpm

        (2) +50 fpm

        (3) +180 fpm

        (4) +425 fpm

78. Emergency ceiling, one engine operation, at a gross weight of 32,000 pounds is approximately:

    (a) 13,000 feet

    (b) 11,000 feet

    (c) 7000 feet

    (d) 5000 feet

79. Minimum landing speed, 1.2 stall speed, flaps full down, 31,000 pounds gross weight, is approximately:

    (a) 76 KIAS

    (b) 83 KIAS

    (c) 94 KIAS

    (d) 115 KIAS

80. Minimum landing distance ground roll at 31,000 pounds, full flaps, sea level, standard day, no wind, is approximately:

    (a) 800 feet

    (b) 1050 feet

    (c) 1300 feet

    (d) 2000 feet

SECTION XI

PERFORMANCE DATA

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PART 1

GENERAL

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TEXT

ILLUSTRATIONS

EXPLANATION OF AIRCRAFT PERFORMANCE CHARTS (PD12K18 CARBURETORS)

The performance charts are presented in both tabular and graphical form and are based almost entirely on data obtained during flight tests of a similar model aircraft.

The takeoff charts are presented so that the performance may be determined for any set of atmospheric conditions. The climb and range performance data is presented for NACA standard day atmospheric conditions. Range performance may be determined for any atmospheric temperature condition by considering the altitude specified in the charts to be density altitude.

The performance charts are identified according to their type and condition of operation by colored page borders conforming to the following code:

Normal operation	Neutral
Emergency operation	Red

AIRSPEED CALIBRATION AND ATMOSPHERIC DATA

The airspeed calibration charts are presented for two configurations of the aircraft: (1) clean configuration,

(2) flaps down and gear down. The following data is also included in this section:

Temperature correction for compressibility

Density altitude chart

Standard altitude table

Airspeed terminology used in this section is as follows:

Term	Abbreviation	Definition
Indicated Airspeed	KIAS	Instrument reading uncorrected*
Calibrated Airspeed	CAS	Indicated airspeed corrected for instrument and position errors
Equivalent Airspeed	EAS	Calibrated airspeed corrected for compressibility
True Airspeed	TAS	$TAS = EAS \times \frac{1}{\sqrt{\sigma}}$

*KIAS is used in this section as though mechanical error in the instrument is zero.

POWER PLANT CHARACTERISTICS

Power plant characteristics are presented in the engine operating limits curve for the "no ram" condition. Note that the range data is based on this power plant data with the addition of level flight ram effects. The effect of ram is to increase the engine critical altitude for any rpm. This makes it possible to maintain a given power at a specified rpm to a slightly higher altitude than that shown on the no ram charts. Likewise, for constant altitude full throttle operation, a given power can be maintained at a lower rpm than shown on the no ram charts.

Recommended rpm and manifold pressure settings for desired cruising powers are given on the specific range graphs and the flight operation instruction charts. Climb settings are given on the climb charts. These settings are based on standard atmospheric conditions.

All flight performance is based on carburetor heat control being in the COLD position. If carburetor heat is applied, engine power will be decreased at constant manifold pressure because of the higher carburetor air temperature. In addition, the normal air induction system is partially restricted and the carburetor air is taken from a location behind the cylinders. This air, having passed over the engine section, has less ram energy remaining so that lower manifold pressures will be obtained with a fixed throttle setting.

The power losses attributable to atmospheric conditions may be estimated. The effect of temperature on brake horsepower can be approximated by the following equations:

$$\frac{bhp_{std}}{bhp\ T_1} = \sqrt{\frac{T_1}{T_{std}}}$$ For constant manifold pressure operation

where T_1 and T_{std} are absolute temperature.

The following rules of thumb may be used to quickly approximate the effect of temperature on power:

1. For constant manifold pressure operation, a 10°C temperature increase above standard results in approximately 1.7 percent power loss. Similarly, a 10°C temperature decrease below standard results in approximately 1.7 percent power gain.

2. The variation in manifold pressure with temperature to maintain constant power is approximately 1/2 inch of Hg increase for every 10°C above standard. (Not applicable above 46.5 inches Hg manifold pressure at 2500 rpm or 54.5 inches Hg manifold pressure at 2800 rpm.) To maintain constant power for cold day operation, the manifold pressure should be decreased approximately 1/2 inch Hg for every 10°C below standard.

For operation above 38°C, the limit manifold pressure is reduced 1 inch Hg per 6°C above 38°C.

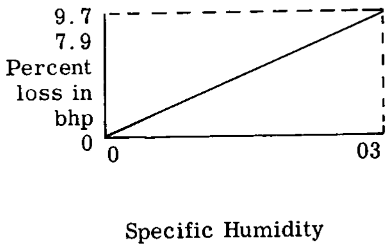
The effect of humidity on engine output can be shown as a result of the following items:

1. Effective pressure and density altitudes are increased because of the presence of vapor pressure.

2. Fuel air ratio is increased because fuel is metered on total flow through the venturi, and the total flow includes water vapor as well as air.

3. The thermal efficiency of the combustion process is reduced because of the presence of water vapor.

The effect of humidity on power output is shown on the following plot:



RECOMMENDATIONS FOR CONTINUOUS CRUISE OPERATION

Although continuous operation at powers up to maximum continuous power may be used under emergency conditions, the maximum recommended power for normal continuous cruise operation is 750 bhp per engine at 2150 rpm.

TAKEOFF PERFORMANCE

The takeoff performance is based entirely on flight test data corrected to standard values of bhp, which are taken from the engine manufacturer's specification. Head wind, specific humidity, and nonstandard atmospheric conditions may all be taken into account by use of the correction plots on the takeoff chart. An example is included on the chart.

A table of takeoff ground roll distance and distance to reach a 50-foot height is included. Values are listed for 0- and 30-knot head winds for various air temperatures.

The takeoff performance is presented for a flap setting of zero degrees. For all data presented in this section, the lift-off speed and the speed at the 50-foot height is 120 percent of the power-off stalling speed. Curves are included for takeoff ground run.

TAKEOFF AND LANDING DATA

The data indicated by an asterisk (*) must be obtained prior to entering the performance data section for takeoff data:

*Gross weight ______________________________

*Altimeter setting ______________________________

Pressure altitude (Figure 11-4) ____________________

*Outside air temperature ____________________

Density altitude (Figure 11-6) ____________________

*Dew point ______________________________

Specific Humidity (Figure 11-7) ____________________

*Runway length ______________________________

*Reported wind ______________________________

Headwind component (Figure 11-8) ______________

*Relative humidity ______________________________

TAKEOFF

Map (Figure 11-10) ______________________________

Takeoff speed (Figure 11-11) ____________________

Takeoff ground roll (Figure 11-12) ______________

Refusal speed (Figure 11-13) ____________________

Refusal distance (Figure 11-13) ____________________

Single engine climb speed (Figure 11-15) __________

Single engine rate of climb (Figure 11-16) __________

Single engine ceiling (Figure 11-17) ______________

LANDING

Speed (Figure 11-40) ______________________________

Landing ground roll (Figure 11-41) ______________

CLIMB PERFORMANCE

The climb charts are used for predicting time, fuel for climb, and the horizontal distance travelled during climb. Curves are included for both one- and two-engine operation with normal rated power and for two-engine operation with maximum cruise power. Several guide lines indicating the momentary weights during climb are included on these charts to provide a measure of fuel consumption and weight reduction during climb.

A curve of emergency ceiling is included for both one- and two-engine operation.

Tables listing rate of climb, time-, fuel- and distance-to-climb, manifold pressure, and airspeed for various weights and altitudes are presented for both one- and two-engine operation at normal rated power.

SINGLE ENGINE PERFORMANCE

To ensure an adequate rate of climb at maximum takeoff gross weight in the event of an engine failure after having reached best climb speed, the four curves in figure 11-16 may be used to provide the following data:

Curve 1 Reduction in rate of climb due to altitude

Curve 2 Reduction in rate of climb due to temperature and humidity

Curve 3 Rate of climb vs gross weight with flaps up, gear up, and inoperative propeller feathered

Curve 4 Rate of climb vs gross weight with flaps up, gear up, and inoperative propeller windmilling

EXAMPLE

(See figure 11-16.)

At what weight can takeoff be made safely under the following field conditions if an engine fails after having reached best climb speed?

Field altitude - 3500 feet

Temperature - 77°F

Relative humidity - 70 percent

Step 1. Obtain from Curve 1 a reduction in rate of climb due to the field altitude. At 3500 feet the reduction (-) in rate of climb = -92 fpm.

Step 2. Obtain from Curve 2 a reduction in rate of climb due to temperature and humidity at 77°F and 70 percent relative humidity. Reduction in rate of climb = -96 fpm.

Step 3. Add Steps 1 and 2 and get a total change in rate of climb. (-92 fpm) + (-96 fpm) = -188 fpm.

Step 4. Select a rate of climb considered adequate for the surrounding terrain. Two hundred fpm is chosen as adequate. Enter Curve 3 or Curve 4 at the desired rate of climb. (In this case Curve 4 was chosen, the inoperative prop is windmilling and will result in a more conservative answer.) Project to the right and at this point subtract Step 3 from the selected rate of climb (200 - 188 = 12) and project downward to 12 fpm. Then project upwards and to the left, paralleling the original curve until the 200 fpm point, which was chosen, is attained. Here project downward getting a maximum takeoff weight of 27,600 pounds for the given conditions.

These curves can also be used to find the rate of climb for a given weight, altitude, temperature, and humidity.

For best single engine climb speeds, refer to Single Engine Emergency Climb Curve, figure 11-15.

RANGE PERFORMANCE

The range performance is presented as three types of curves, including nautical miles per pound of fuel, long-range summary, and long-range prediction. A maximum endurance chart also is given.

The charts showing nautical miles per pound of fuel indicate the nautical miles that can be traveled for each pound of fuel consumed and the airspeed that can be expected for various gross weights and altitudes. Curves are included for both one- and two-engine operation. A line of recommended long-range cruising speeds is included on the charts, and the manifold pressure and rpm are also indicated.

The maximum range-power conditions curves summarize the recommended long-range operating conditions. Curves for one- and two-engine operation are included. The curves summarize the nautical miles per pounds of fuel, pounds of fuel per hours per engine, manifold pressure, rpm, bhp, and cruising speeds versus gross weight for various cruising altitudes.

The long-range prediction curves are used to predict distance traveled and cruising time when the conditions of operations are as recommended for long-range operation. Curves are presented for one- and two-engine operation.

The maximum endurance curves summarize the recommended operating conditions for maximum endurance. Fuel flow, manifold pressure, rpm, bhp, and cruising speed for both one- and two-engine operation are given versus gross weight at various cruising altitudes. These curves are based on operation at a cruising speed that is 115 percent of the speed for minimum power.

The range charts are presented in the order listed:

1. Nautical miles per pound of fuel
2. Maximum range power conditions
3. Maximum endurance
4. Long range prediction.

These curves are presented first for two-engine operation and followed by the one-engine operation curves in the same order as listed above.

EXAMPLE PROBLEM

1. The following example problem is provided to clarify the use of long-range charts.

ATMOSPHERIC CONDITION – NACA STANDARD DAY

Takeoff gross weight	36,000 pounds
Aircraft operating weight empty (gross weight, less fuel and cargo)	20,589 pounds
Distance to be traveled (long-range conditions, two-engine operation)	2000 nautical miles
Reserve fuel (long-range speeds)	3 hours holding at destination
Takeoff and landing	Sea level
Cruising altitude	12,000 feet

Determine the fuel and time required for flight and the amount of cargo that can be transported.

2. See sample (dotted lines) on time to climb curve (figure 11-21), and distance to climb curve (figure 11-22).

Takeoff gross weight	36,000 pounds
Fuel for warmup, taxi, and takeoff (10 minutes at normal rated power)	330 pounds
Initial climb weight	35,670 pounds
Time to climb to 12,000 feet	0.23 hours
Distance to climb to 12,000 feet	28 nautical miles
Fuel for climb	350 pounds
Total fuel to 12,000 feet	680 pounds

The gross weight after climb is 35,320 pounds and the distance remaining to be traveled is 1972 nautical miles.

3. To determine the amount of fuel and time required for flight, enter the long-range distance prediction curve (figure 11-35), at 35,320 pounds gross weight and 12,000 feet altitude. Find the gross weight, after cruising for a distance of 1971 nautical miles, to be 28,800 pounds. For time prediction curve (figure 11-37), for 12,000 feet, read the increment of cruising time between the gross weights of 35,292 pounds and 28,800 pounds.

Cruising time	12.7 hours
Total time for flight (includes time required to reach cruising altitude of 12,000 feet)	12.93 hours
Total fuel consumed in flight (difference between 36,000 pounds takeoff gross weight and final cruising weight of 28,800 pounds)	7200 pounds

4. To determine the amount of cargo that can be transported, the reserve fuel must be known. The reserve fuel for this example has been assumed as 3 hours holding at destination at long-range speeds. If the cruising time is extended 3 hours (figure 11-37), the landing gross weight will be 27,450 pounds. The reserve is then 28,800 pounds less 27,450 pounds, i.e., 1350 pounds, and the cargo carried is 27,450 pounds less 20,589 pounds (gross weight less fuel and cargo) or 6861 pounds.

5. A zero head wind is assumed. If the wind velocity is known, the equivalent air miles is required before entering the charts to determine the fuel required. To obtain air miles, multiply ground miles by the ratio of average true airspeed to average true ground speed. The example is also based on long-range cruising operation; therefore, it is essential that conditions of the maximum range power conditions curves are followed. Power settings should be changed every hour so that range and time performance on the long-range prediction curves can be attainable.

Tabular data listing power and speed conditions for various ranges at various weights and altitudes are included. These data provide simplified flight planning on a conservative basis.

A tabulation of maximum endurance power conditions is given to facilitate holding operations.

EFFECT OF WIND ON RANGE PERFORMANCE

In the event of encountering a moderate to high wind en route, some gain in maximum range capabilities may be made by changing the cruising airspeed. As a general rule, the maximum range indicated airspeed, while flying in a wind, may be obtained by adjusting the "no wind" indicated airspeed for maximum range by adding or subtracting 1/4 of the indicated headwind or tailwind respectively.

EXAMPLE PROBLEM

1. The following example problem is provided to clarify the wind correction to indicated airspeed for maximum range. In this problem, the pilot is interested in determining the indicated speed for maximum range with wind so that he may properly set his power to obtain this speed.

Instantaneous weight = 31,000 pounds

Cruising altitude = 12,000 feet

Two-engine operation
Headwind = 30 knots

2. From the two-engine maximum range power condition curve (figure 11-31), the zero wind maximum range indicated airspeed is 130 knots.

3. The indicated wind speed is obtained by dividing the true wind speed by $1/\sqrt{0}$ (figure 11-31).

$$1/\sqrt{o} = 1.2012$$

indicated wind speed = 30/1.2012 = 25 knots

4. The indicated speed for maximum range with wind is 130 + 25/4 = 136 knots.

The wind correction to obtain ground miles per pound and ground speed for constant power operation may be determined from the specific range curves (figures 11-26 through 11-30 and 11-32 through 11-34) by adding the tail wind or subtracting the head wind from the no wind true airspeed along the constant power setting (constant fuel flow) lines and reading the ground miles per pound from the ordinate, and the ground speed from the abscissa.

EXAMPLE PROBLEM

1. The following example is given to illustrate the method of obtaining ground miles per pound and ground speed at constant power in a wind. In this problem, the pilot is flying at a given power condition and is interested in determining his true ground speed and true miles per pound under these conditions.

Instantaneous weight = 31,000 pounds

Cruising altitude = 10,000 feet

Two-engine operation at 2100 rpm and 30.3 inches Hg manifold pressure

Tail wind = 20 knots

2. From the two-engine specific range chart (figure 11-28), the zero wind true airspeed is found to be 189 knots.

3. Sliding along the line of constant power to a true airspeed of 189 + 20, the ground speed is 209 knots and the ground nautical miles per pound is read as 0.2815.

LANDING PERFORMANCE

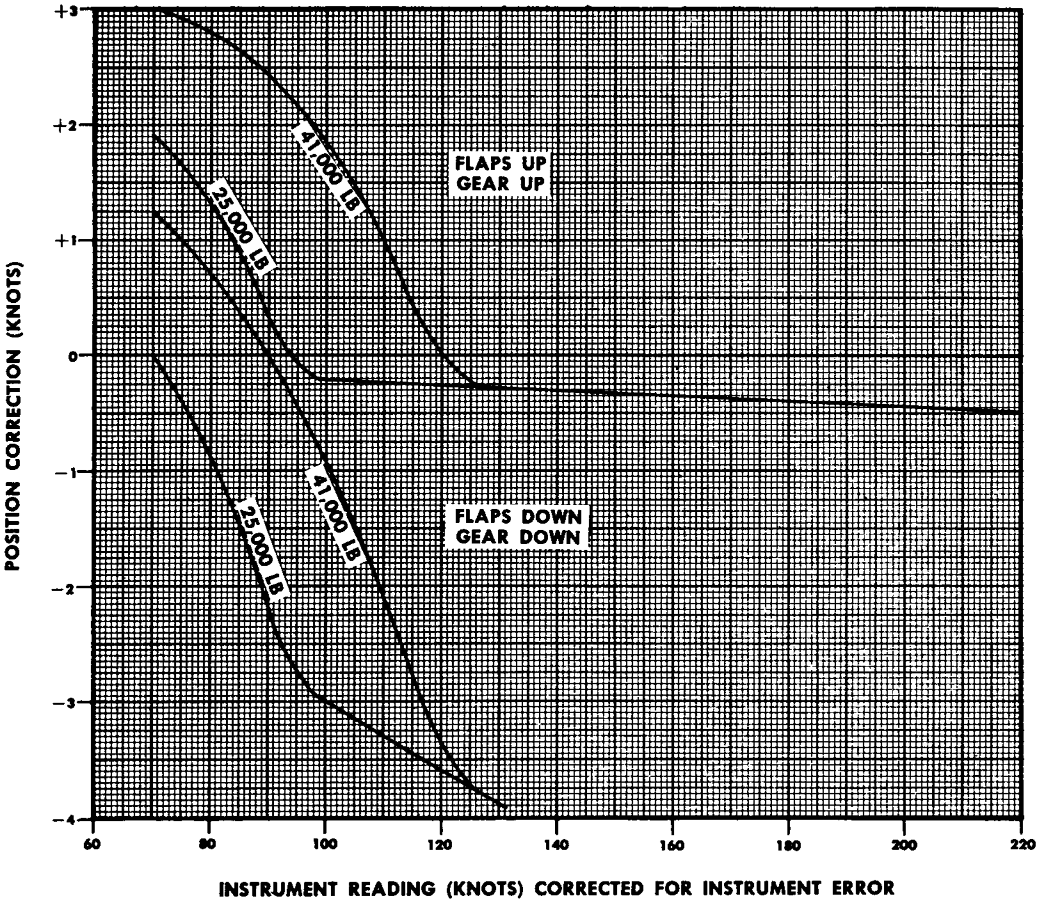
The landing performance charts present the landing ground roll distance versus altitude with a correction scale to account for head wind. The ratio of 50-foot clearance distance to ground roll is noted on the charts. Operational landing speeds are as follows: (1) over the 50-foot obstacle, 130 percent of the power off stalling speed; (2) at contact with the ground, 120 percent of power off stalling speed. A table listing both landing ground roll distance and distance-to-land from a 50-foot height is presented for various weights and altitudes.

MODEL C-117D

AIRSPEED POSITION ERROR CORRECTION

FOR NOSE PITOT AND SKIN STATIC INSTALLATION
POWER FOR LEVEL FLIGHT WITH FLAPS AND GEAR UP
ZERO THRUST WITH FLAPS AND GEAR DOWN

Note: Add correction to indicated airspeed (instrument reading corrected for instrument error) to obtain calibrated airspeed.



DATA AS OF: 6-22-53

DATA BASIS: FLIGHT TEST

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Figure 11-1. Airspeed Position Error Correction for Nose Pitot and Skin Static Installation

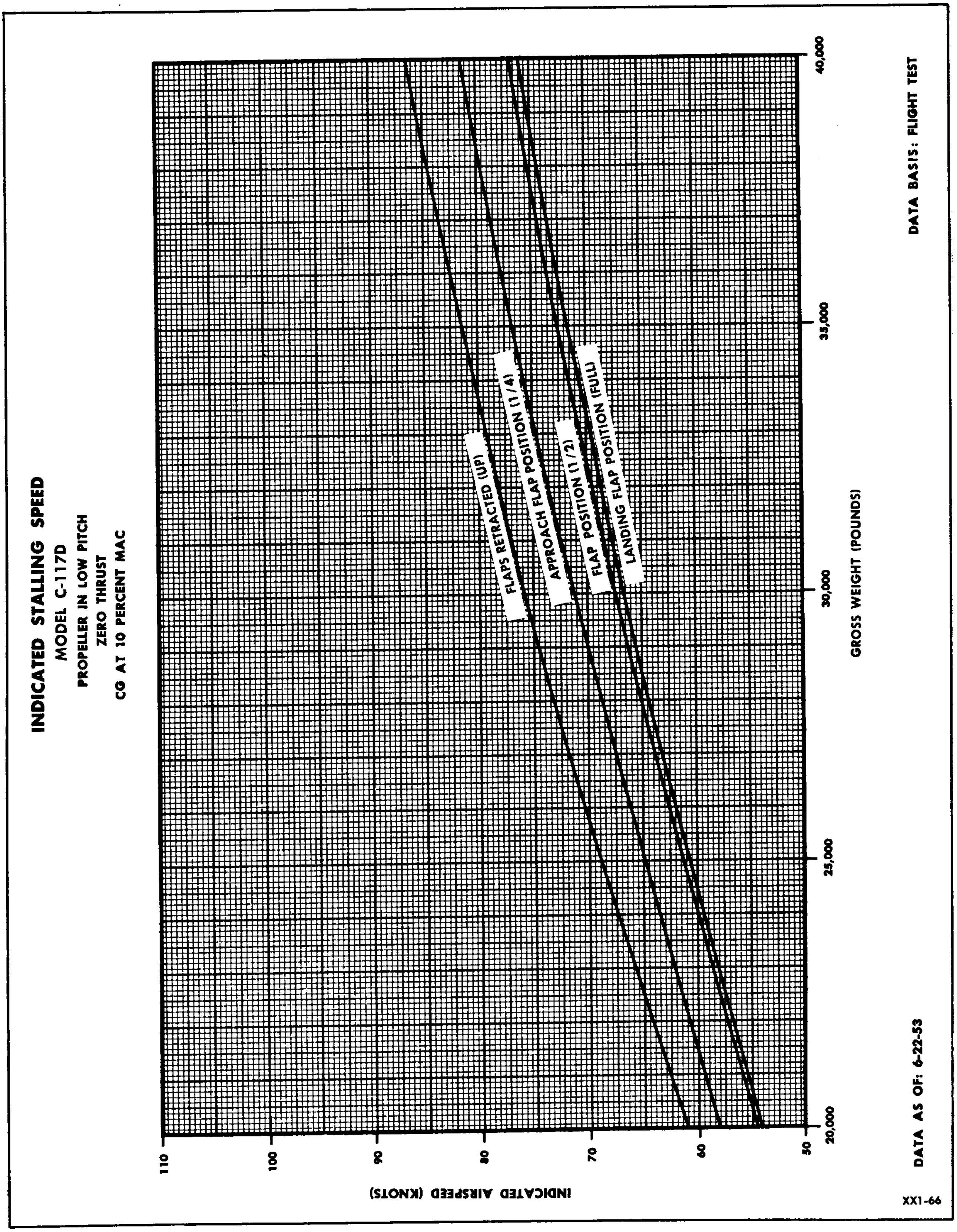

Figure 11-2. Indicated Stalling Speed

Fuel Temperature		Fuel Density
C	F	Lb/Gal
50	122	5.67
40	104	5.73
30	86	5.80
20	69	5.87
10	50	5.93
0	32	6.00
-10	14	6.07
-20	-4	6.14
-30	-22	6.21
-40	-40	6.27
-50	-58	6.34

Figure 11-3. Fuel Density Table (100/130 and 115/145 Grade Fuel)

Pressure Altitude = Field Elevation + Δ Altitude													
Alti-meter Setting In. Hg	Δ Alt Ft	Alti-meter Setting In. Hg	Δ Alt Ft	Alti-meter Setting In. Hg	Δ Alt Ft	Alti-meter Setting In. Hg	Δ Alt Ft	Alti-meter Setting In. Hg	Δ Alt Ft	Alti-meter Setting In. Hg	Δ Alt Ft	Alti-meter Setting In. Hg	Δ Alt Ft
28.00	1824	28.20	1630	28.40	1436	28.60	1244	28.80	1053	29.00	863	29.20	673
.01	1814	.21	1620	.41	1427	.61	1234	.81	1043	.01	853	.21	664
.02	1805	.22	1610	.42	1417	.62	1225	.82	1034	.02	844	.22	655
.03	1795	.23	1601	.43	1407	.63	1215	.83	1024	.03	834	.23	645
.04	1785	.24	1591	.44	1398	.64	1206	.84	1015	.04	825	.24	636
.05	1776	.25	1581	.45	1388	.65	1196	.85	1005	.05	815	.25	626
.06	1766	.26	1572	.46	1378	.66	1186	.86	995	.06	806	.26	617
.07	1756	.27	1562	.47	1369	.67	1177	.87	986	.07	796	.27	607
.08	1746	.28	1552	.48	1359	.68	1167	.88	976	.08	787	.28	598
.09	1737	.29	1542	.49	1350	.69	1158	.89	967	.09	777	.29	589
28.10	1727	28.30	1533	28.50	1340	28.70	1148	28.90	957	29.10	768	29.30	579
.11	1717	.31	1523	.51	1330	.71	1139	.91	948	.11	758	.31	570
.12	1707	.32	1513	.52	1321	.72	1129	.92	938	.12	749	.32	560
.13	1698	.33	1504	.53	1311	.73	1120	.93	929	.13	739	.33	551
.14	1688	.34	1494	.54	1302	.74	1110	.94	919	.14	730	.34	542
.15	1678	.35	1484	.55	1292	.75	1100	.95	910	.15	721	.35	532
.16	1668	.36	1475	.56	1282	.76	1091	.96	900	.16	711	.36	523
.17	1659	.37	1465	.57	1273	.77	1081	.97	891	.17	702	.37	514
.18	1649	.38	1456	.58	1263	.78	1072	.98	881	.18	692	.38	504
.19	1639	.39	1446	.59	1254	.79	1062	.99	872	.19	683	.39	495

Figure 11-4. Pressure Altitude Table (Sheet 1 of 2)

Pressure Altitude = Field Elevation + Δ Altitude													
Altimeter Setting In. Hg	Δ Alt Ft	Altimeter Setting In. Hg	Δ Alt Ft	Altimeter Setting In. Hg	Δ Alt Ft	Altimeter Setting In. Hg	Δ Alt Ft	Altimeter Setting In. Hg	Δ Alt Ft	Altimeter Setting In. Hg	Δ Alt Ft	Altimeter Setting In. Hg	Δ Alt Ft
29.40	485	29.80	112	30.20	-257	30.60	-622	31.00	-983				
.41	476	.81	103	.21	-266	.61	-631	.01	-992				
.42	467	.82	94	.22	-275	.62	-640	.02	-1001				
.43	457	.83	85	.23	-284	.63	-649	.03	-1010				
.44	448	.84	75	.24	-293	.64	-658	.04	-1019				
.45	439	.85	66	.25	-303	.65	-667	.05	-1028				
.46	429	.86	57	.26	-312	.66	-676	.06	-1037				
.47	420	.87	47	.27	-321	.67	-685	.07	-1046				
.48	410	.88	38	.28	-330	.68	-694	.08	-1055				
.49	401	.89	29	.29	-339	.69	-703	.09	-1064				
29.50	392	29.90	20	30.30	-348	30.70	-712	32.00	-1073				
.51	382	.91	10	.31	-358	.71	-721						
.52	373	.92	1	.32	-367	.72	-730						
.53	364	.93	-8	.33	-376	.73	-740						
.54	354	.94	-17	.34	-385	.74	-749						
.55	345	.95	-26	.35	-394	.75	-758						
.56	336	.96	-36	.36	-403	.76	-767						
.57	326	.97	-45	.37	-412	.77	-776						
.58	318	.98	-54	.38	-421	.78	-785						
.59	308	.99	-63	.39	-431	.79	-794						
29.60	298	30.00	-73	30.40	-440	30.80	-803						
.61	289	.01	-82	.41	-449	.81	-812						
.62	280	.02	-91	.42	-458	.82	-821						
.63	270	.03	-100	.43	-467	.83	-830						
.64	261	.04	-110	.44	-476	.84	-839						
.65	252	.05	-119	.45	-485	.85	-848						
.66	242	.06	-128	.46	-494	.86	-857						
.67	233	.07	-137	.47	-504	.87	-866						
.68	224	.08	-146	.48	-513	.88	-875						
.69	215	.09	-156	.49	-522	.89	-884						
29.70	205	30.10	-165	30.50	-531	30.90	-893						
.71	196	.11	-174	.51	-540	.91	-902						
.72	187	.12	-183	.52	-549	.92	-911						
.73	177	.13	-192	.53	-558	.93	-920						
.74	168	.14	-202	.54	-567	.94	-929						
.75	159	.15	-211	.55	-576	.95	-938						
.76	149	.16	-220	.56	-585	.96	-947						
.77	140	.17	-229	.57	-594	.97	-956						
.78	131	.18	-238	.58	-604	.98	-965						
.79	122	.19	-248	.59	-613	.99	-974						

Figure 11-4. Pressure Altitude Table (Sheet 2 of 2)

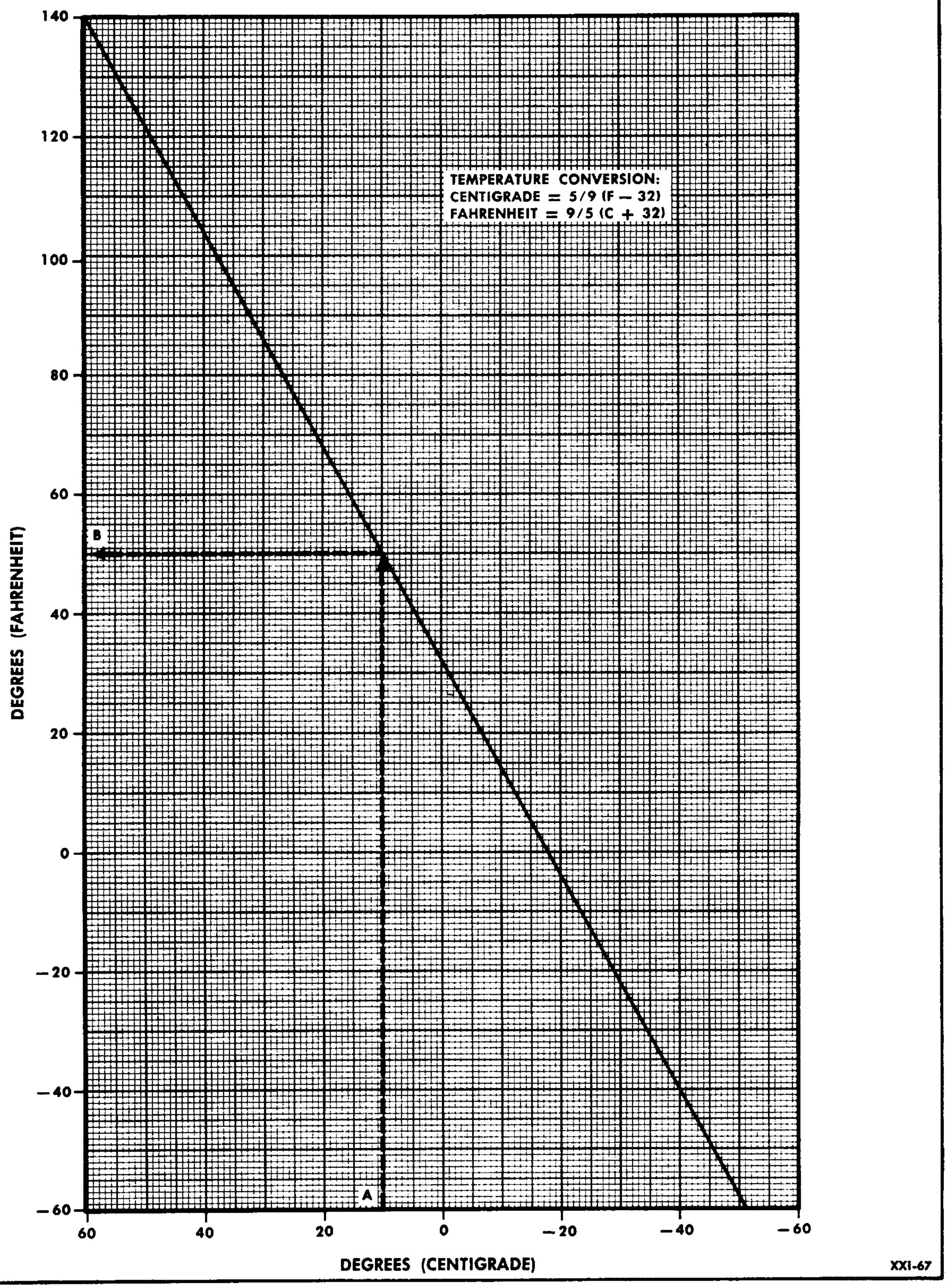

Figure 11-5. Temperature Conversion Chart

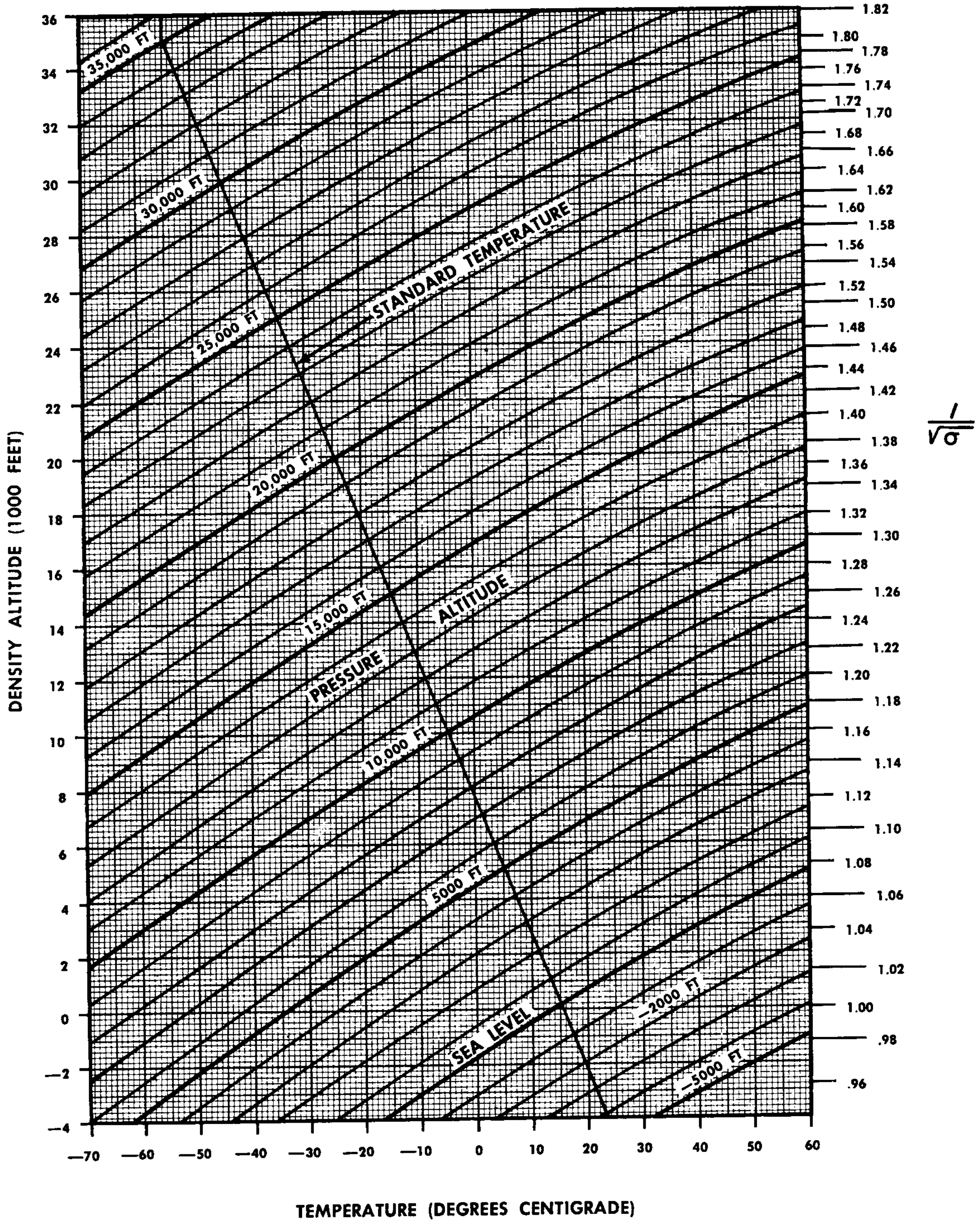

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Figure 11-6. Density Altitude Chart

SPECIFIC HUMIDITY
MODEL C-117D
SEA LEVEL

Note:

Specific humidity at any altitude is approximately equal to the specific humidity at sea level multiplied by the ratio 29.92 barometric pressure at altitude.

EXAMPLE:

This chart may be entered with either dew point temperature or wet and dry bulb temperatures;

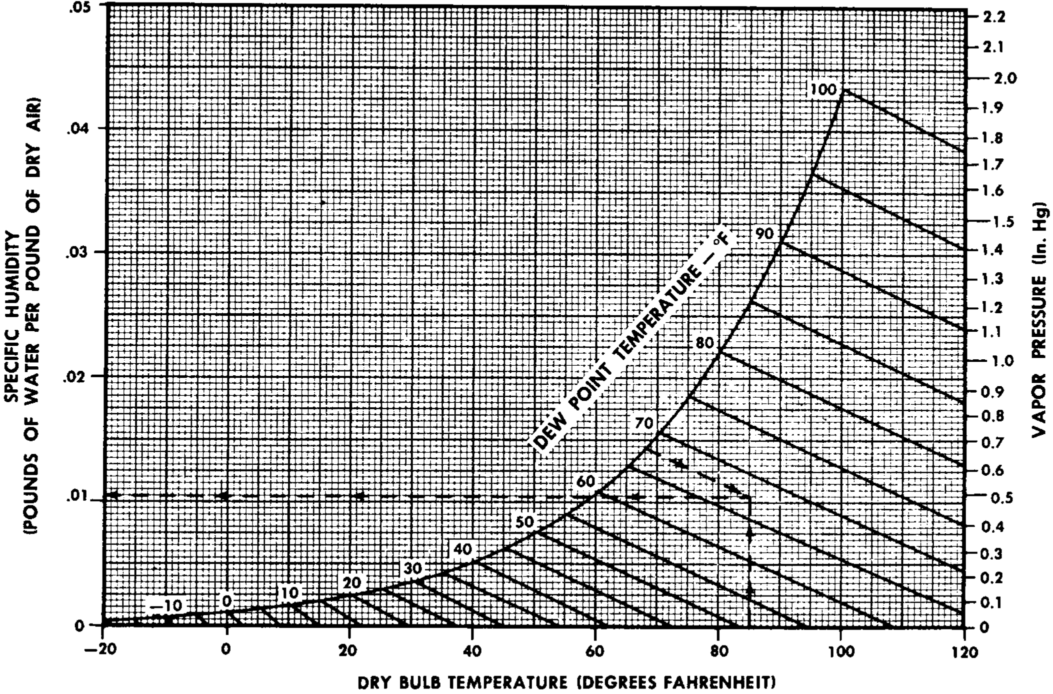
GIVEN:

Dew point temperature	59°F
Specific humidity	0.0105

or

GIVEN:

Dry bulb temperature	85°F
Wet bulb temperature	67.5°F
Specific humidity	0.0105



DATA AS OF: 6-22-53

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Figure 11-7. Specific Humidity

PART 2

TAKEOFF

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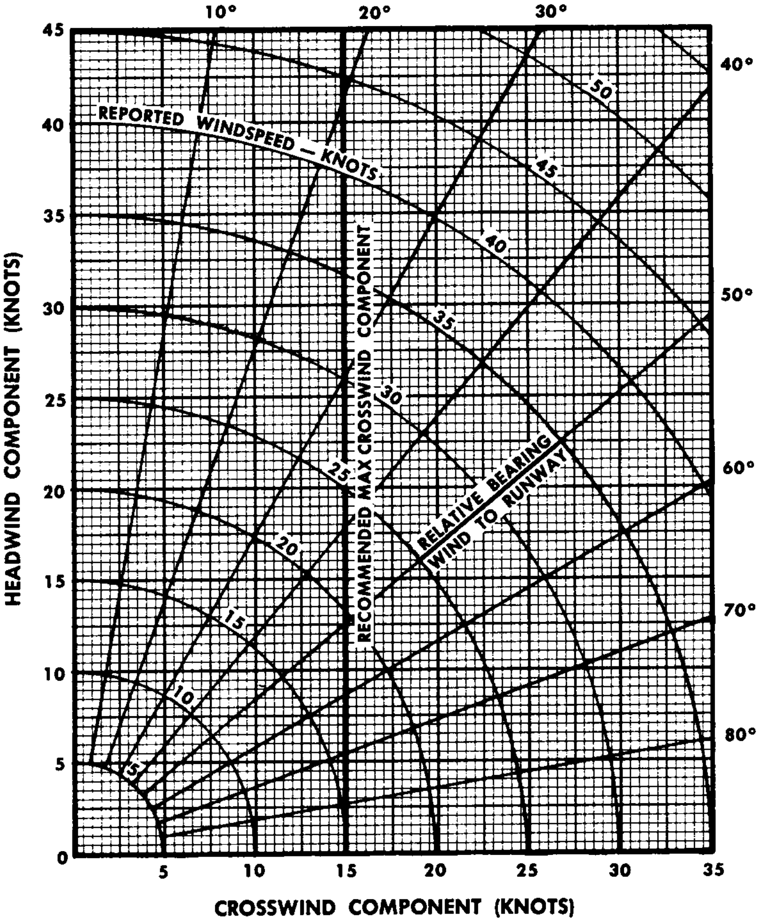

INSTRUCTIONS

To determine crosswind component: (1) locate reported windspeed on relative bearing line; (2) from intersection of windspeed and bearing, drop vertically to baseline to find crosswind component; (3) from intersection, project a line horizontally to find headwind component.

Example:

Reported wind of 35 knots, 20 degrees off runway
Crosswind component = 12 knots
Headwind component = 33 knots

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Figure 11-8. Takeoff and Landing Crosswind Chart

FUEL GRADE 100/130 - 115/145

AIRCRAFT
MODEL C-117D

ENGINES
WAC R1820-80A

FUEL DENSITY = 6.0 LB/GAL

Pressure Altitude (Feet)	-5°C		+15°C		+35°C		+55°C	
	RPM	MP (In. Hg)	RPM	MP (In. Hg)	RPM	MP (In. Hg)	RPM	MP (In. Hg)
SL	2800	54.5	2800	54.5	2800	54.5	2800	52.6
1000	2800	54.2	2800	54.2	2800	54.0	2800	52.6
2000	2800	53.6	2800	53.0	2800	52.0	2800	51.5
3000	2800	52.2	2800	51.1	2800	50.1	2800	49.4
4000	2800	50.4	2800	49.3	2800	48.4	2800	47.7
5000	2800	48.7	2800	47.6	2800	46.8	2800	46.1

Figure 11-9. Takeoff Power Schedule

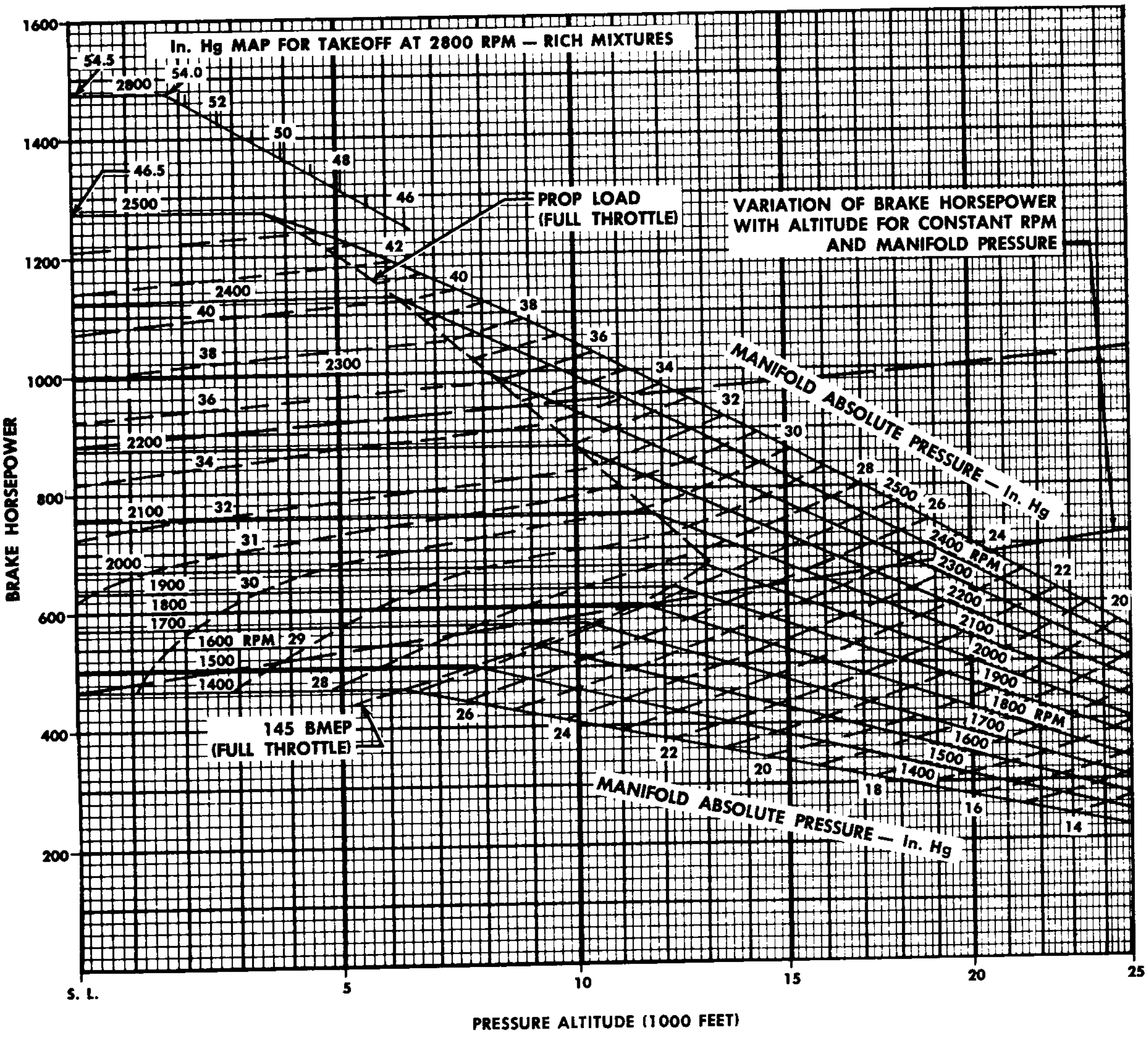
ENGINE OPERATING LIMITS CURVE

MODEL C-117D

WAC R1820-80A ENGINES

STANDARD ATMOSPHERIC CONDITIONS, NO RAM

FUEL: 115/145—100/130



DATA AS OF: 6-22-53

Based On: WAC R1820-80 ENGINES or R1820-80A ENGINES Operating Instructions (October 1952) (Spec. No. SP-964)

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Figure 11-10. Engine Operating Limits Curve

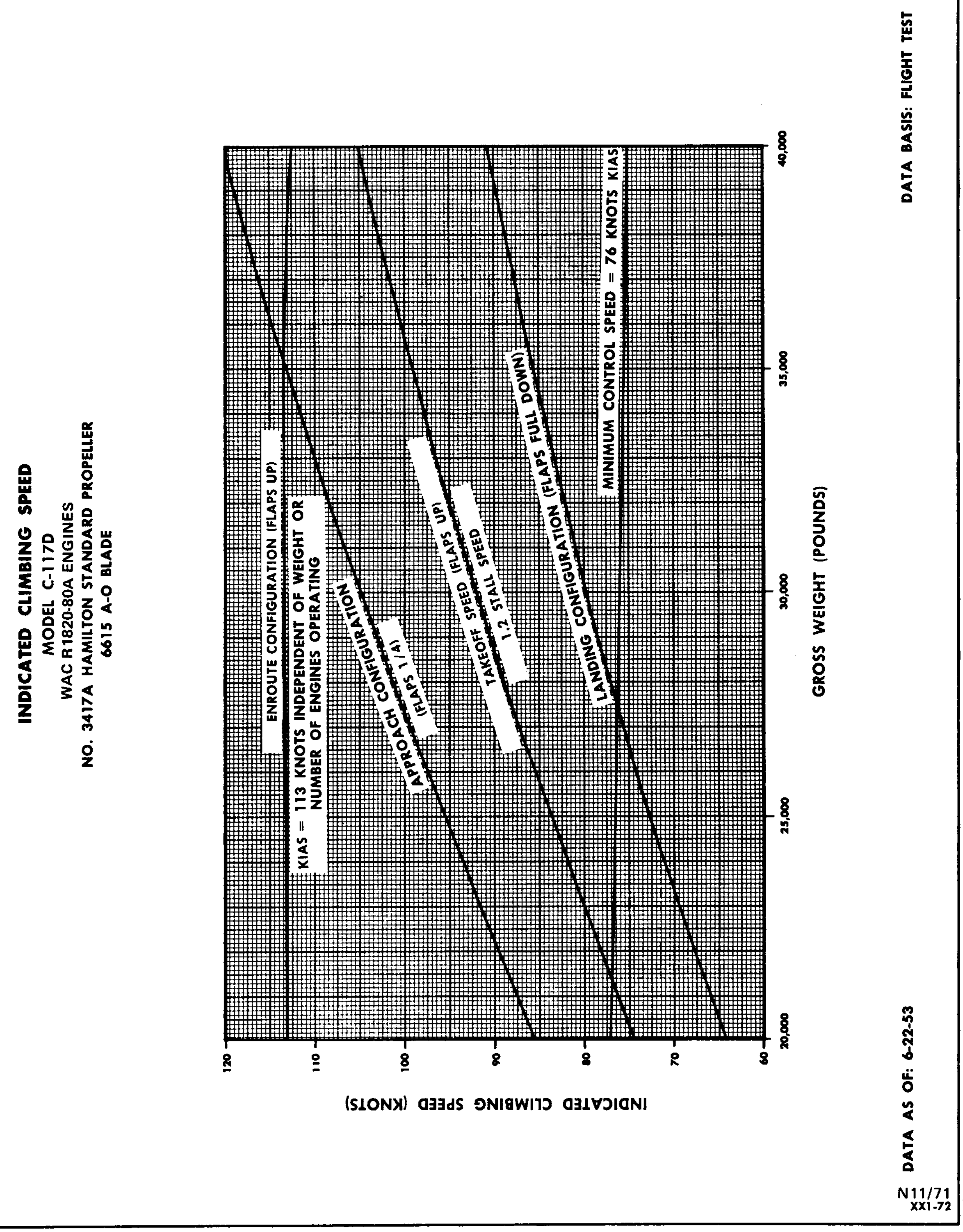
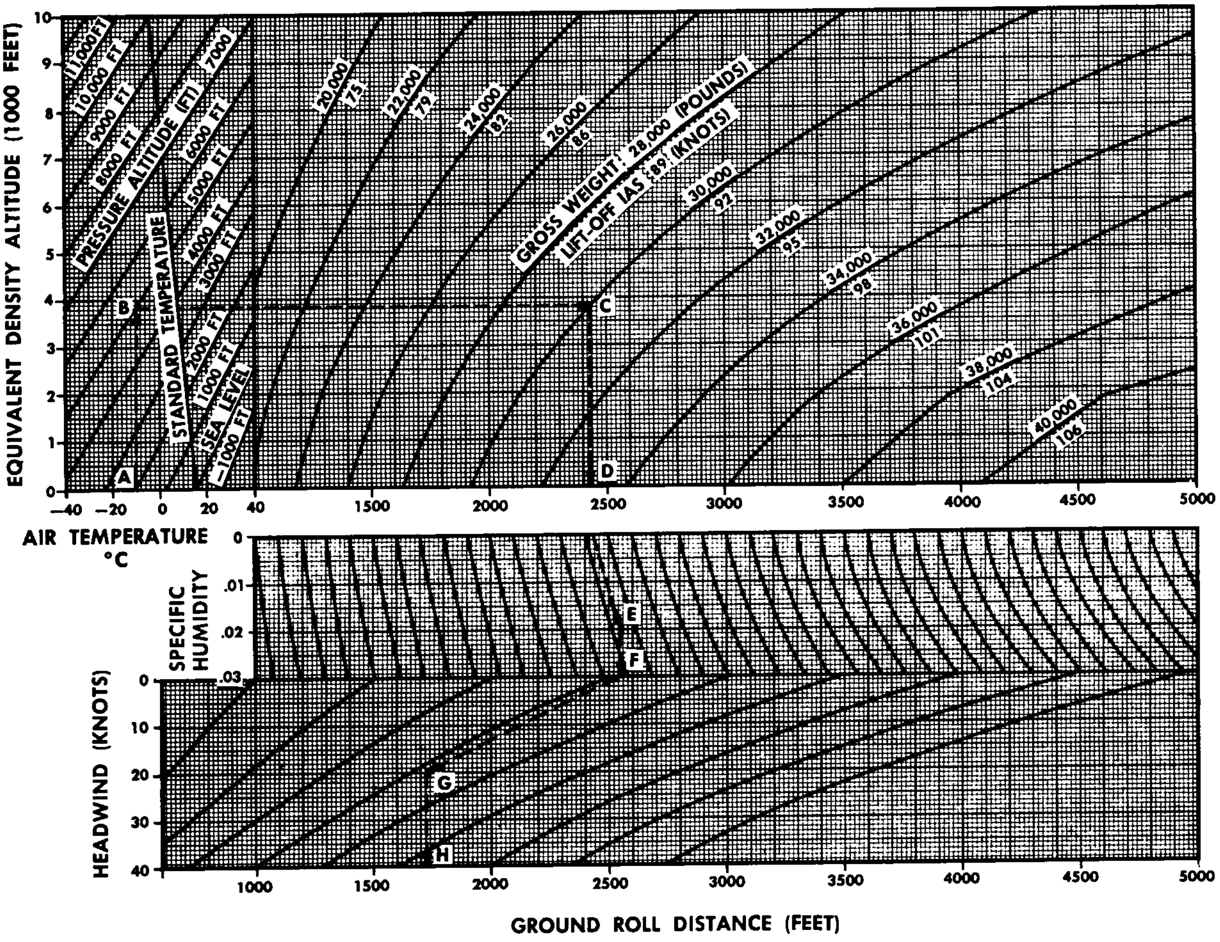


Figure 11-11. Takeoff Speed and Indicated Climbing Speeds

TAKEOFF GROUND ROLL DISTANCE CHART

MODEL C-117D
WAC R1820-80A ENGINES
NO. 3417A HAMILTON STANDARD PROPELLERS
6615A-O BLADES
FUEL GRADE: 100/130—115/145
FUEL DENSITY: 6.0 LB/GAL



1. Total distance to takeoff and clear a 50 foot obstacle is approximately 120 percent of ground roll distance.
2. Distances are aircraft requirements during normal service operations.

CONDITIONS

1. Wing flap setting — UP
2. V_{CL} — 1.20 Vs (power off)
3. Takeoff power schedule given in figure 11-10.

EXAMPLE

(A) Air temperature — 10°C
(B) Pressure altitude 5000 Feet
(C) Gross weight 30,000 Pounds
(D) Takeoff ground roll distance, no wind 2440 Feet
(E) Specific humidity 0.02
(F) Takeoff ground roll distance with no wind and specific humidity 0.02 2550 Feet
(G) Headwind 20 Knots
(H) Takeoff ground roll distance with 20-knot headwind and specific humidity 0.02 1720 Feet

DATA AS OF: 6-22-53

DATA BASIS: FLIGHT TEST

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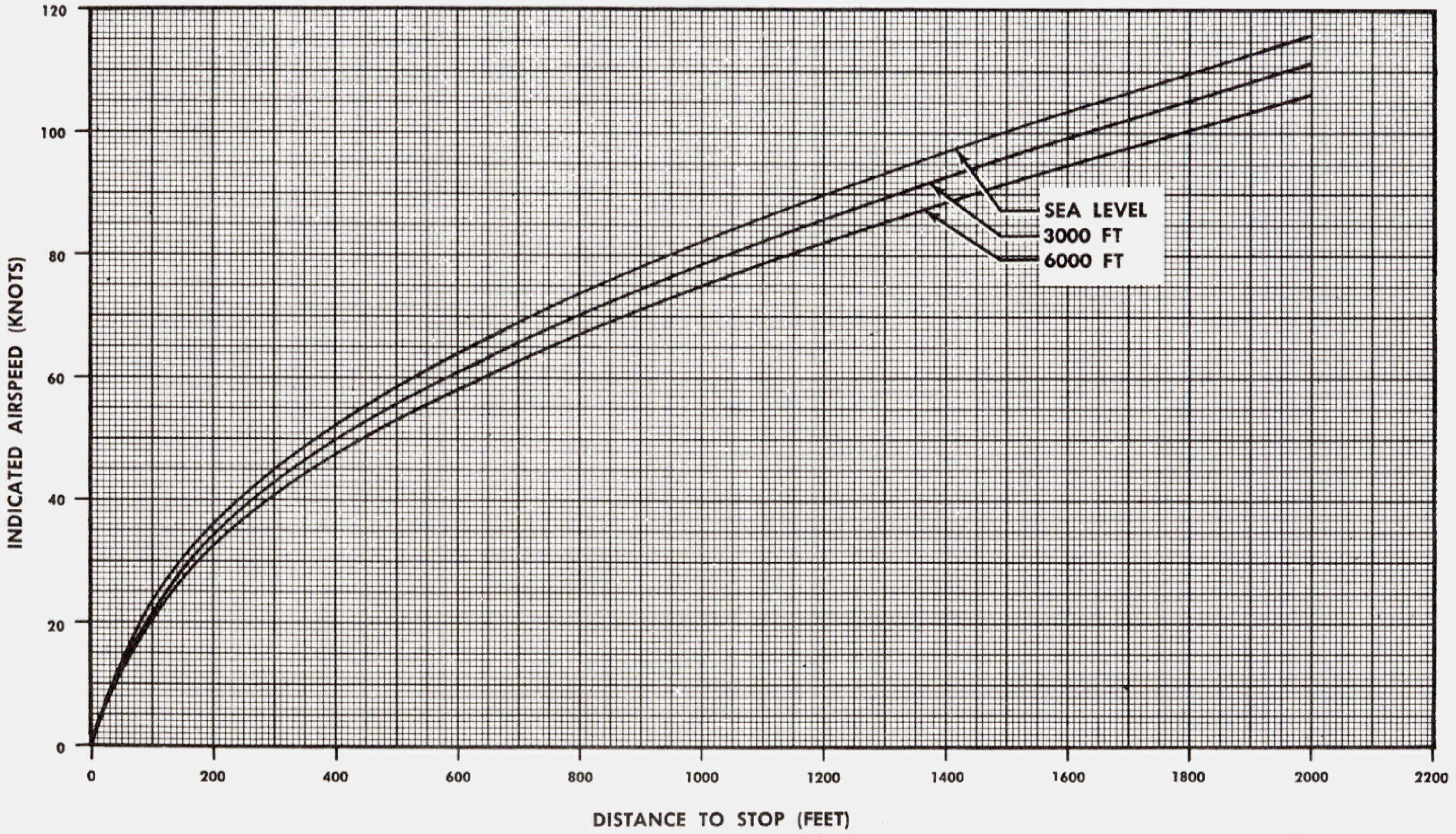
Figure 11-12. Takeoff Ground Roll Distance Chart

NOTES:

1. Zero wind
2. Refer to Section III for emergency procedures.

TAKEOFF PERFORMANCE STOPPING DISTANCE

MODEL C-117D



Determine the takeoff ground roll from the Takeoff Ground Roll Distance Chart (figure 11-12). Subtract the takeoff ground roll from runway length available and enter the chart with this figure to determine refusal speed.

EXAMPLE

Sea level runway available 4000 feet
Takeoff ground roll 3000 feet

Enter the chart at 1000 feet. Distance to stop, proceed up to the sea level line, and left to find refusal speed of 82 knots. If the refusal speed is less than takeoff speed, there is insufficient runway to stop the aircraft if one engine should fail after passing refusal speed. There may not be sufficient runway available to continue takeoff.

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Figure 11-13. Takeoff Performance – Stopping Distance

PART 3

CLIMB

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ILLUSTRATIONS

ESTIMATED TWO-ENGINE EMERGENCY CLIMB

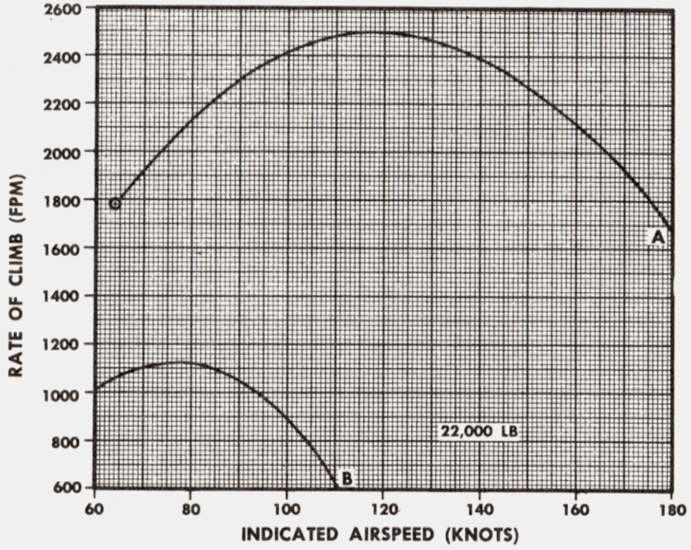
MODEL C-117D
WAC R1820-80A ENGINES
HAMILTON STANDARD PROPELLER NO. 3417A, BLADE NO. 6615A-0
STANDARD ATMOSPHERIC CONDITIONS
SEA LEVEL

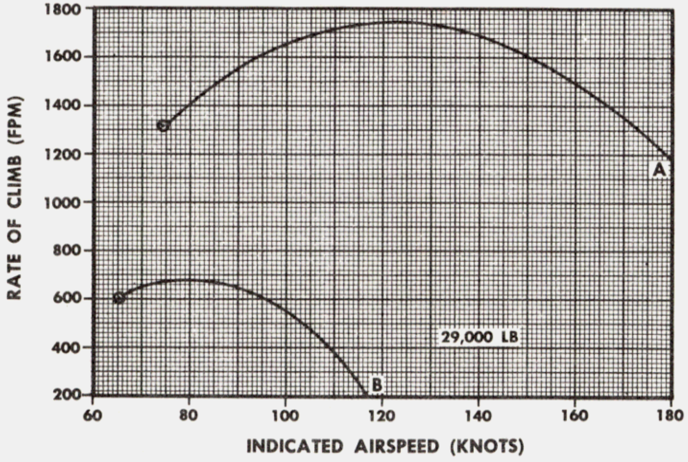
CONDITIONS

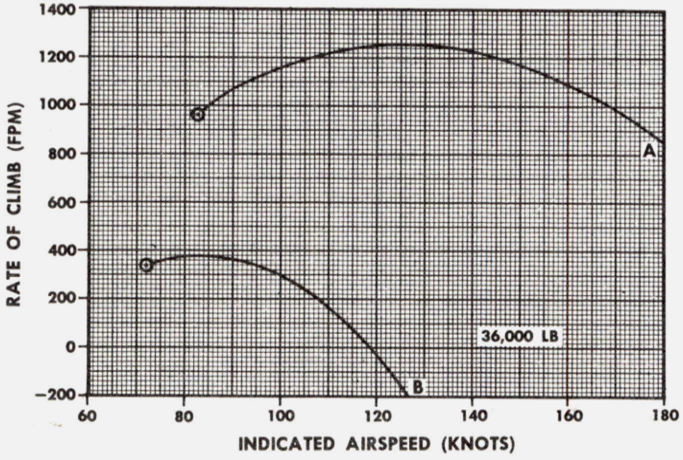
1. Cowl flaps open to +6 degrees
2. 1475 BHP—2800 RPM

CONFIGURATION

A. Flaps up, gear up
B. Flaps full down, gear down
⊙ DENOTES STALLING SPEED







DATA AS OF: 6-22-53

BASED ON: CALCULATED DATA

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Figure 11-14. Estimated Two-Engine Emergency Climb

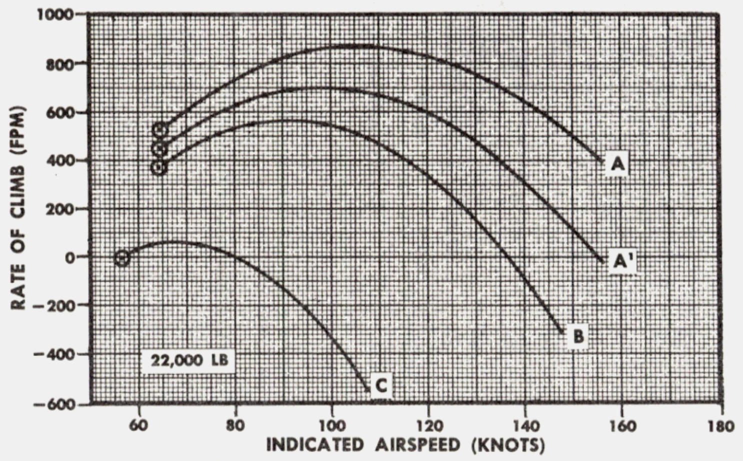
ESTIMATED SINGLE-ENGINE EMERGENCY CLIMB
MODEL C-117D
WAC R1820-80A ENGINES
HAMILTON STANDARD PROPELLER NO. 3417A, BLADE NO. 6615A-0
STANDARD ATMOSPHERIC CONDITIONS
SEA LEVEL
FUEL GRADE: 100/130—115/145
FUEL DENSITY: 6.0 LB/GAL

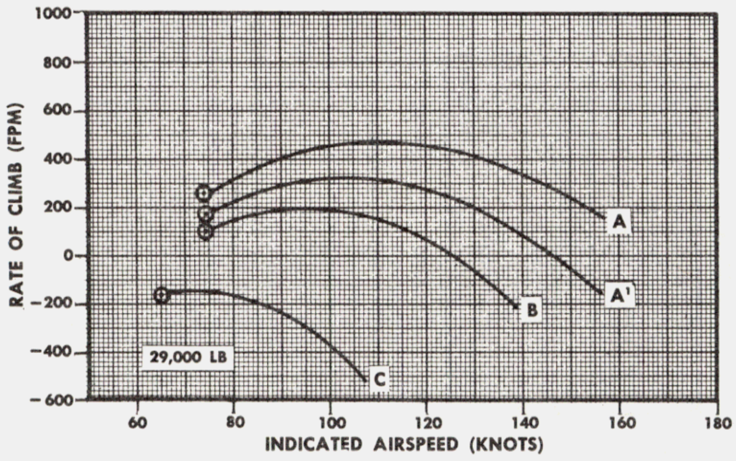
CONDITIONS: 1475BHP—2800 RPM

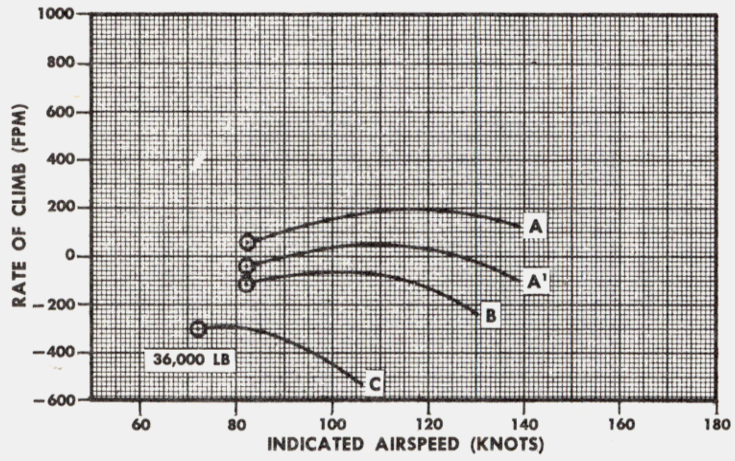
⊙ DENOTES STALLING SPEED

CONFIGURATION

CURVE	FLAP SETTING	GEAR POSITION	INOPERATIVE ENGINE	
			PROPELLER	COWL FLAPS
A	UP	UP	FEATHERED	+ 6 DEG
A'	UP	UP	WINDMILLING	+ 6 DEG
B	UP	DOWN	FEATHERED	+ 6 DEG
C	FULL DOWN	DOWN	FEATHERED	+ 6 DEG







DATA AS OF: 6-22-53

BASED ON: CALCULATED DATA

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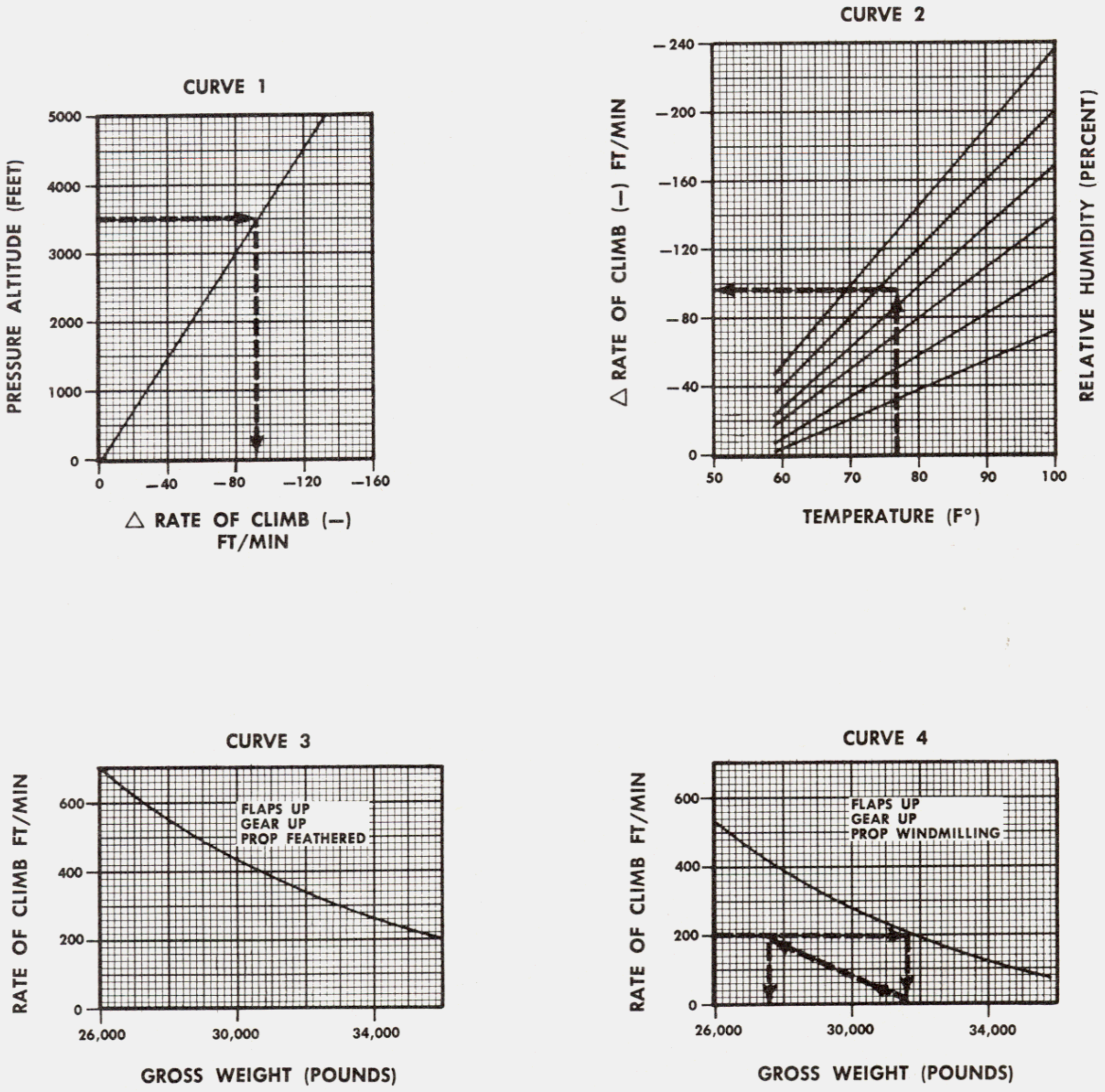
Figure 11-15. Estimated Single-Engine Emergency Climb



1. Rate of climb figures for curves 3 and 4 are limited to 5 minutes at maximum power.
2. Rate of climb figures for curves 3 and 4 are at best climb speed.

Based on: Estimated Data

Date: 23 August 1960

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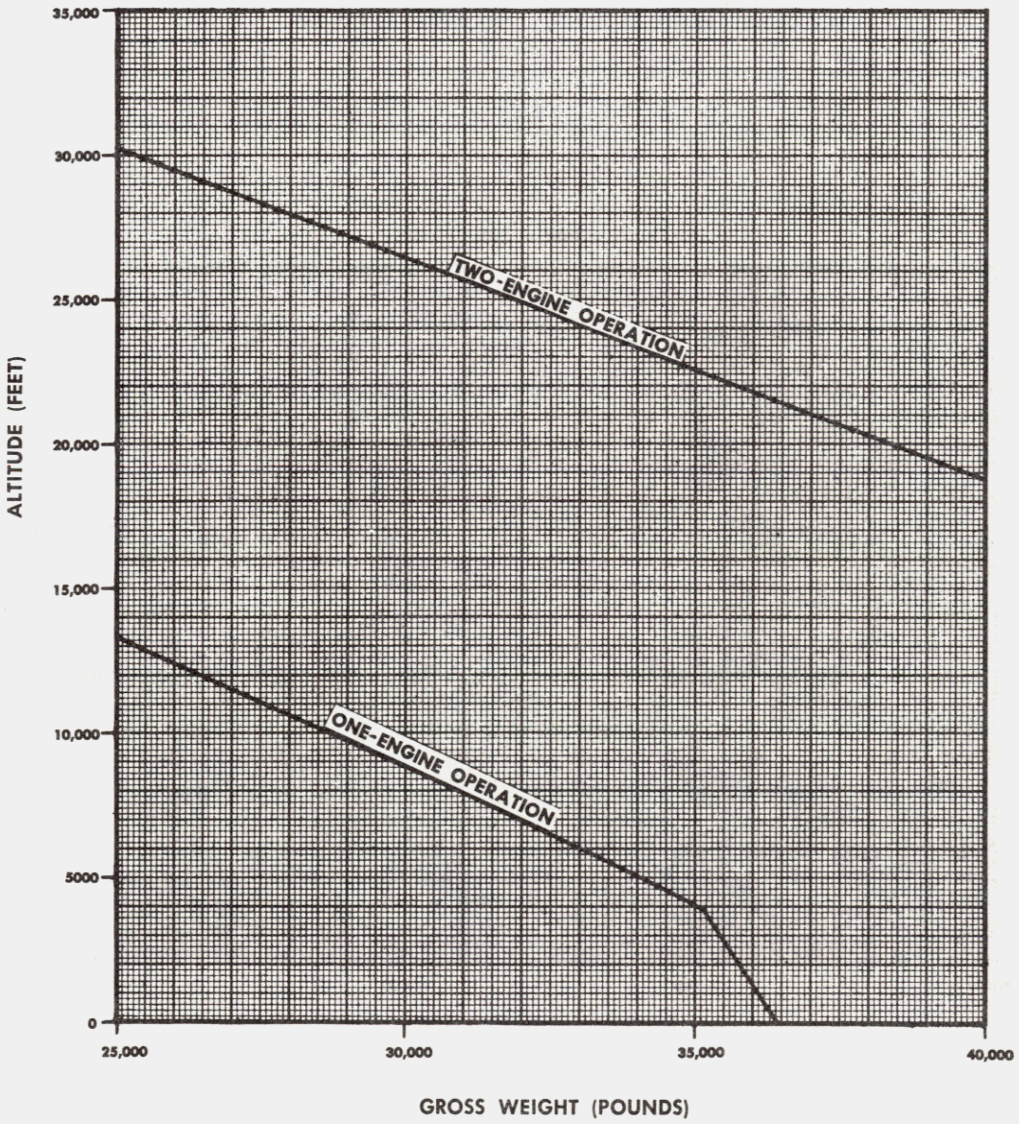
Figure 11-16. Rate of Climb vs Gross Weight – Limited by Single-Engine Performance

EMERGENCY CEILING
MODEL C-117D
WAC R1820-80A ENGINES
PD12K18 391361 CARBURETOR
NO. 3417A HAMILTON STANDARD PROPELLER
6615 A-O BLADES
STANDARD DAY
SERVICE CEILING (RATE OF CLIMB = 100 FT/MIN)
WITH NORMAL POWER OPERATION
FUEL GRADE: 100/130—115/145
FUEL DENSITY: 6.0 LB/GAL



DATA AS OF: 6-22-53

DATA BASIS: FLIGHT TEST

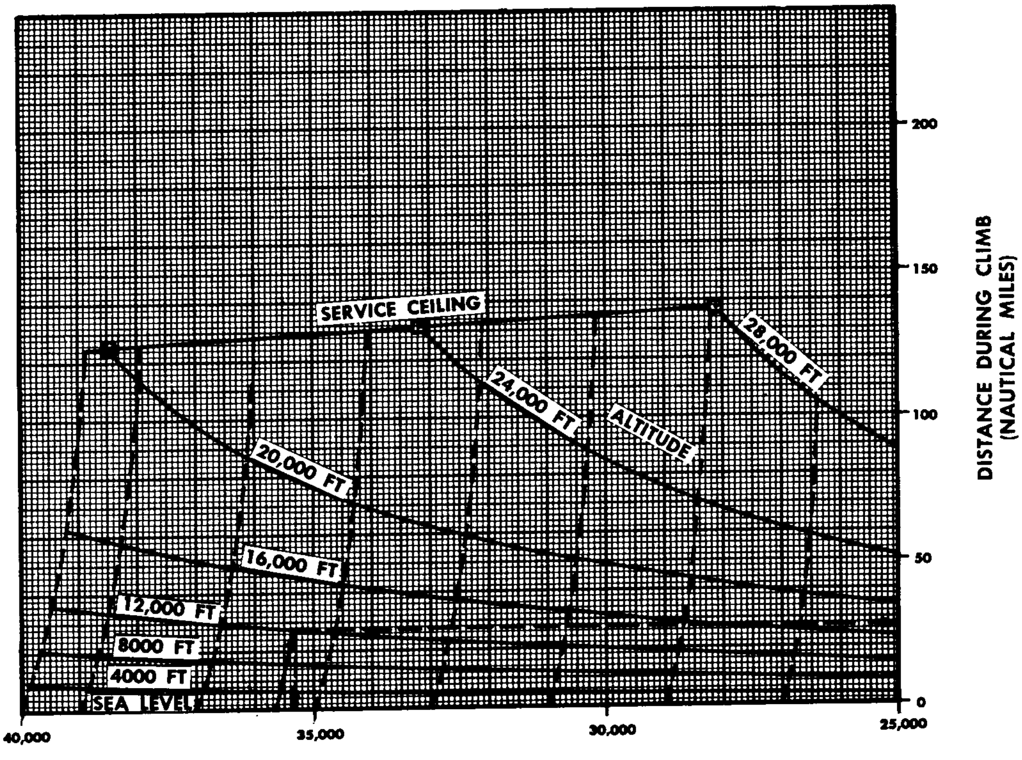
N11/71
XX1-78

Figure 11-17. Emergency Ceiling

TWO-ENGINE CLIMB CURVE
DISTANCE DURING CLIMB

MODEL C-117D
WAC R1820-80A ENGINES
PD12K18 391361 CARBURETOR
NO. 3417A HAMILTON STANDARD PROPELLER
6615 A-O BLADES
ENGINES OPERATING AT NORMAL RATED POWER
WING FLAPS RETRACTED, LANDING GEAR RETRACTED
STANDARD ATMOSPHERIC CONDITIONS
FUEL GRADE: 100/130—115/145 FUEL DENSITY: 6.0 LB/GAL

▣ RATE OF CLIMB = 100 FT/MIN



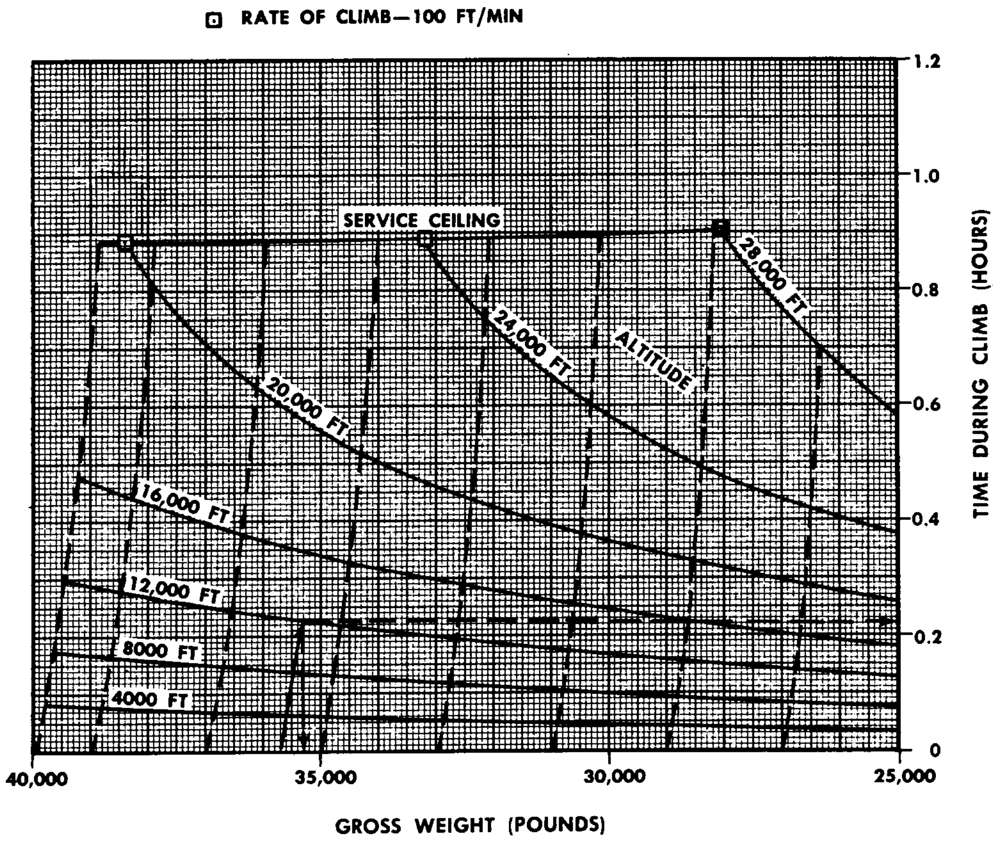
DATA AS OF: 6-22-53

DATA BASIS: FLIGHT TEST
N11/71 XX1-79

Figure 11-18. Two-Engine Climb Curve – Distance During Climb – Normal Rated Power

TWO—ENGINE CLIMB CURVE
TIME DURING CLIMB

MODEL C-117D
WAC R1820-80A ENGINES
PD 12K18 391361 CARBURETOR
NO 3417A HAMILTON STANDARD PROPELLER
6615A-O BLADES
ENGINES OPERATING AT NORMAL RATED POWER
WING FLAPS RETRACTED, LANDING GEAR RETRACTED
STANDARD ATMOSPHERIC CONDITIONS
FUEL GRADE: 100/130—115/145 FUEL DENSITY: 6.0 LB/GAL



DATA AS OF: 6-22-53

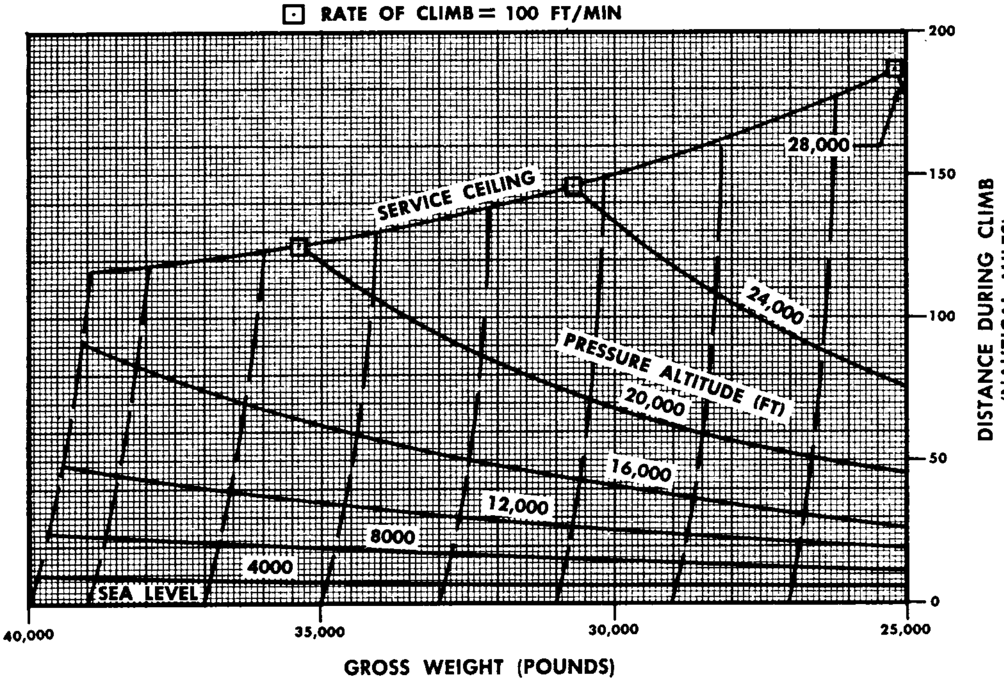
DATA BASIS: FLIGHT TEST

N11/71XX1-80

Figure 11-19. Two-Engine Climb Curve – Time During Climb – Normal Rated Power

TWO-ENGINE CLIMB CURVE
DISTANCE TO CLIMB

MODEL C-117D
WAC R1820-80A ENGINES
PD12K18-391361 CARBURETOR
NO. 3417A HAMILTON STANDARD PROPELLER
6615A-0 BLADES
ENGINES OPERATING AT NORMAL RATED POWER
WING FLAPS RETRACTED, LANDING GEAR RETRACTED
40° F ABOVE NACA STANDARD TEMPERATURE
FUEL GRADE: 100/130—115/145 FUEL DENSITY: 6.0 LB/GAL



DATA AS OF: 3-17-54

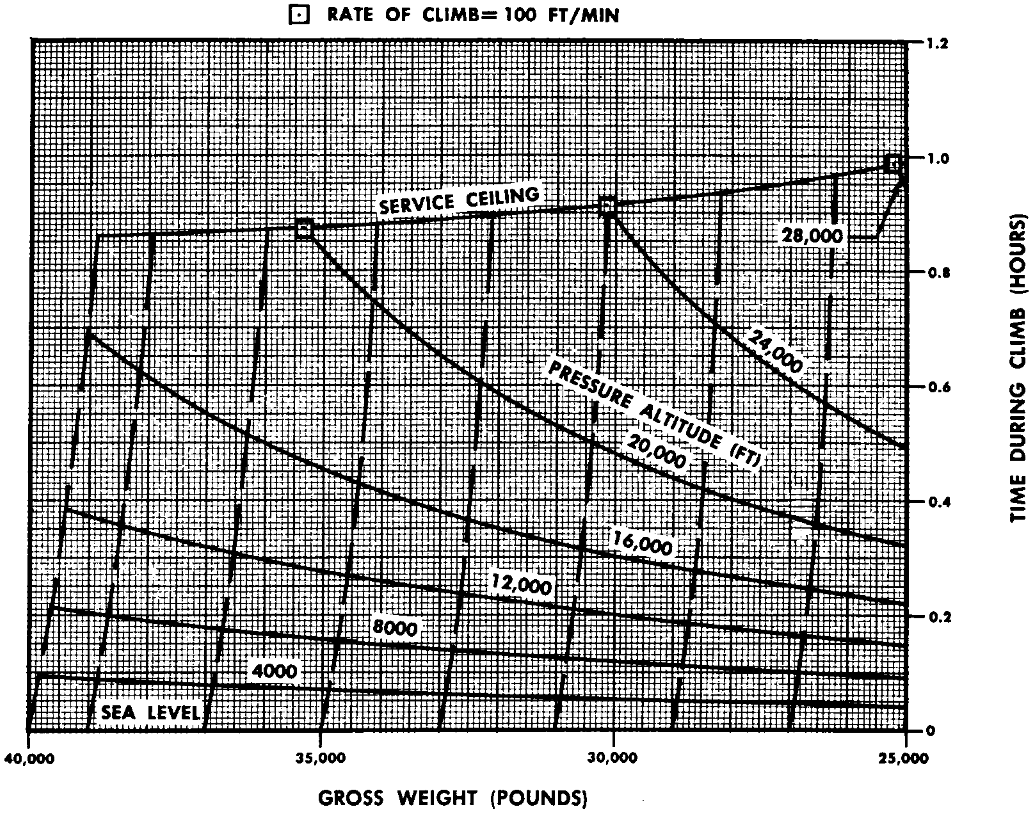
BASED ON: FLIGHT TEST

N11/71
XX1-81

Figure 11-20. Two-Engine Climb Curve — Distance to Climb — Normal Rated Power — Hot Day

TWO-ENGINE CLIMB CURVE
TIME TO CLIMB

MODEL C-117D
WAC R1820-80A ENGINES
PD12K18-391361 CARBURETOR
NO. 3417A HAMILTON STANDARD PROPELLER
6615A-0 BLADES
ENGINES OPERATING AT NORMAL RATED POWER
WING FLAPS RETRACTED, LANDING GEAR RETRACTED
40° F ABOVE NACA STANDARD TEMPERATURE
FUEL GRADE: 100/130—115/145 FUEL DENSITY: 6.0 LB/GAL



DATA AS OF: 3-17-54

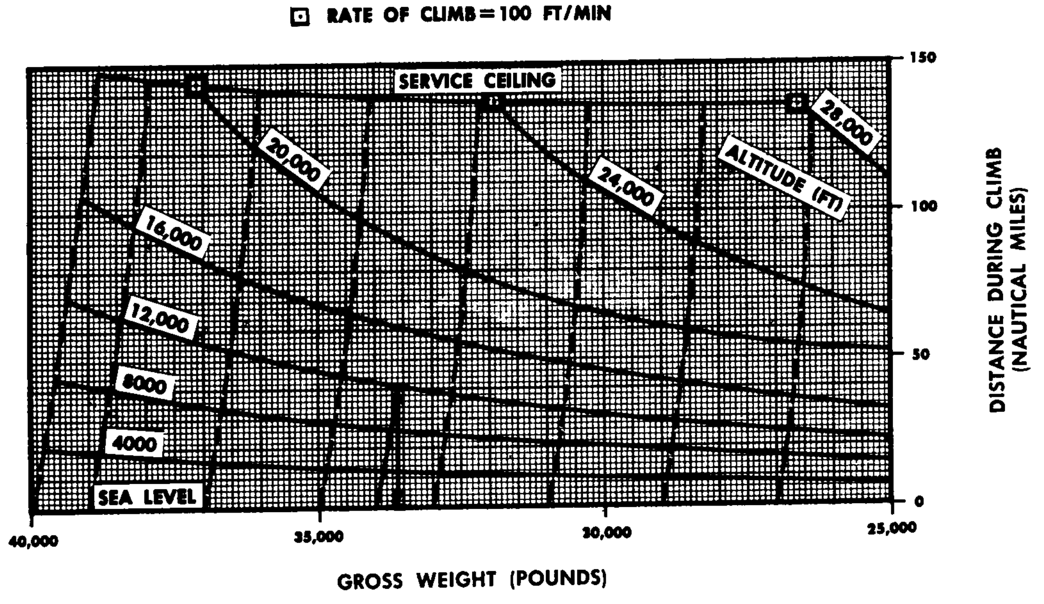
BASED ON: FLIGHT TEST

N11/71
XX1-82

Figure 11-21. Two-Engine Climb Curve — Time to Climb — Normal Rated Power — Hot Day

TWO-ENGINE CLIMB CURVE

DISTANCE TO CLIMB
MODEL C-117D
WAC R1820-80A ENGINES
PD 12K18 391361 CARBURETOR
NO. 3417A HAMILTON STANDARD PROPELLER
6615A-O BLADES
ENGINES OPERATING AT MAXIMUM CRUISE POWER
WING FLAPS RETRACTED, LANDING GEAR RETRACTED
STANDARD ATMOSPHERIC CONDITIONS
FUEL GRADE: 100/130—115/145 FUEL DENSITY: 6.0 LB/GAL



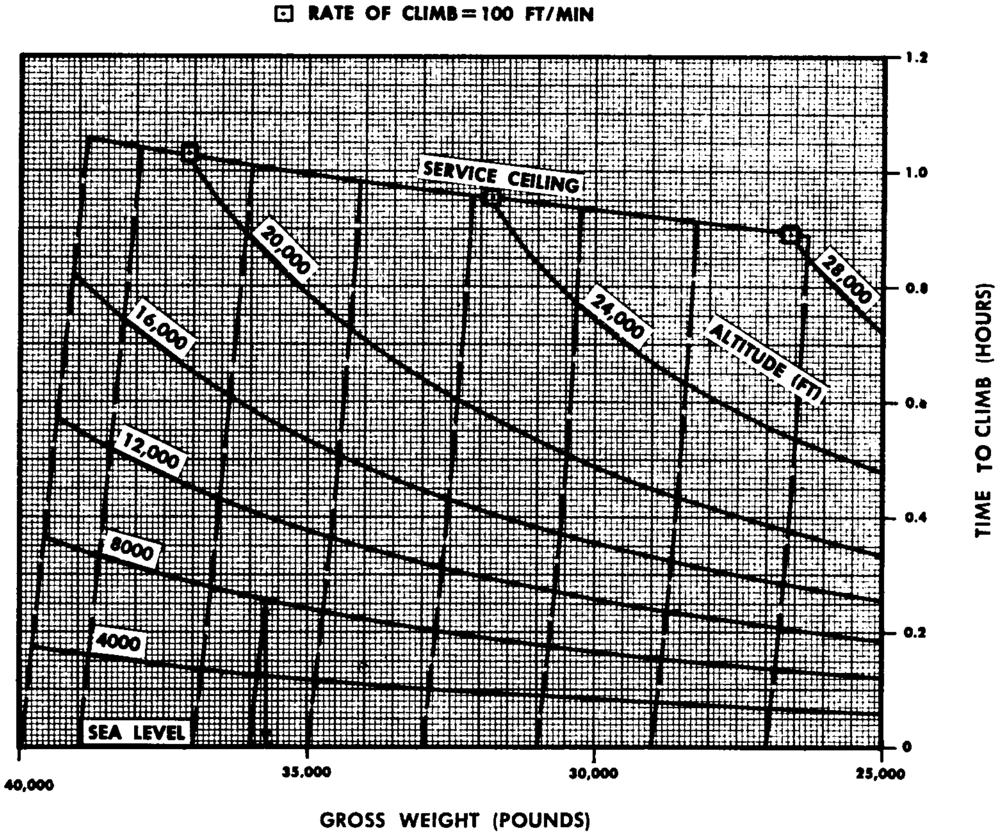
DATA AS OF: 2-1-56

DATA BASIS: FLIGHT TEST

N11/71 XX1-83

Figure 11-22. Two-Engine Climb Curve – Distance to Climb – Maximum Cruise Power

TWO-ENGINE CLIMB CRUISE
TIME TO CLIMB
MODEL C-117D
WAC R1820-80A ENGINES
PD12K18 391361 CARBURETOR
NO. 3417A HAMILTON STANDARD PROPELLER
6615A-0 BLADES
ENGINES OPERATING AT MAXIMUM CRUISE POWER
WING FLAPS RETRACTED, LANDING GEAR RETRACTED
STANDARD ATMOSPHERIC CONDITIONS
FUEL GRADE: 100/130—115/145 FUEL DENSITY: 6.0 LB/GAL



DATA AS OF: 2-1-56

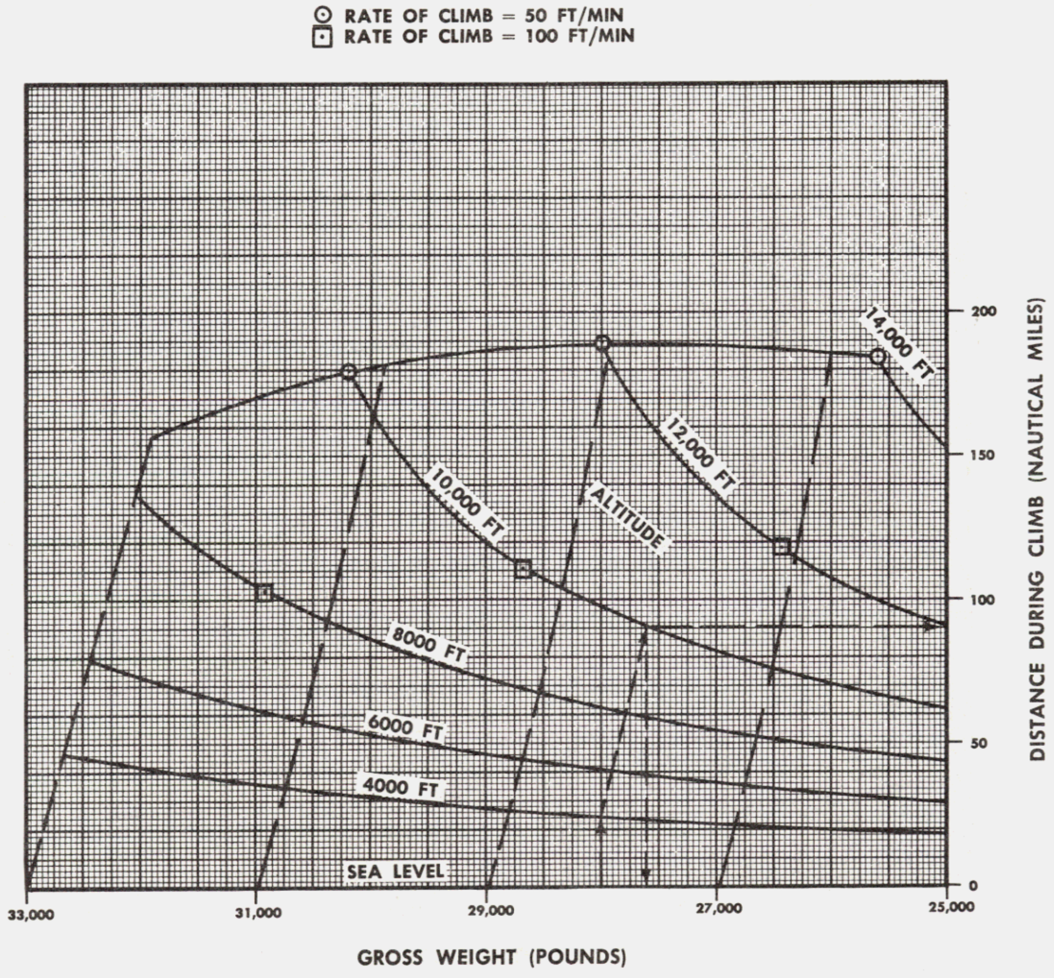
DATA BASIS: FLIGHT TEST

N11/71
XX1-84

Figure 11-23. Two-Engine Climb Curve — Time to Climb — Maximum Cruise Power

SINGLE-ENGINE CLIMB CURVE
DISTANCE DURING CLIMB

MODEL C-117D
WAC R1820-80A ENGINES
PROPELLER: HAM. STD. 3417A
BLADE: 6615A-0
ONE ENGINE OPERATING
NORMAL RATED POWER
WING FLAPS AND LANDING GEAR RETRACTED
STANDARD DAY
PD12K18 391361 CARBURETOR
FUEL GRADE: 100/130—115/145
FUEL DENSITY: 6.0 LB/GAL



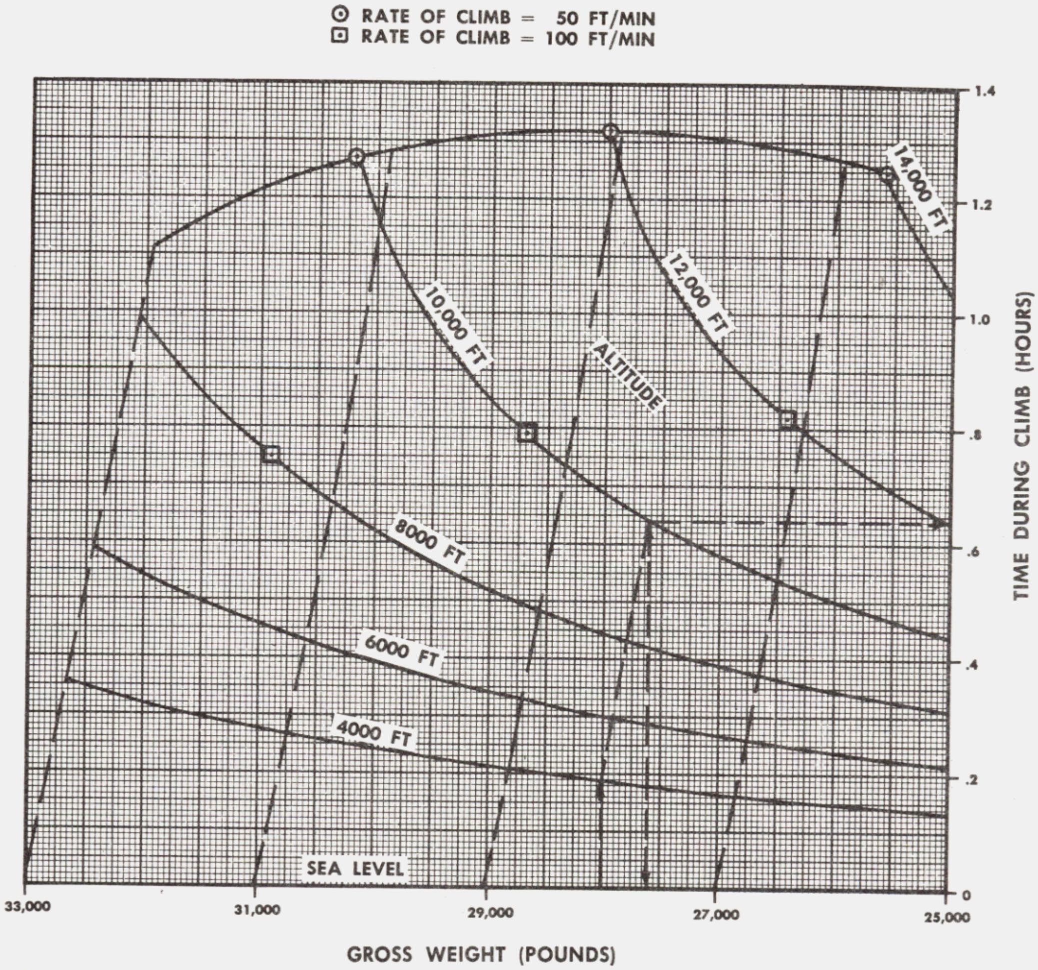
DATA AS OF: 6-22-53

DATA BASIS: FLIGHT TEST

N11/71 XX1-85

Figure 11-24. Single-Engine Climb Curve — Distance During Climb

SINGLE-ENGINE CLIMB CURVE
TIME DURING CLIMB
MODEL C-117D
WAC R1820-80A ENGINES
PROPELLER: HAM. STD. 3417A
BLADE: 6615A-O
ONE ENGINE OPERATING
NORMAL RATED POWER
WING FLAPS AND LANDING GEAR RETRACTED
STANDARD DAY
PD 12K18 391361 CARBURETOR
FUEL GRADE: 100/130—115/145
FUEL DENSITY: 6.0 LB/GAL



DATA AS OF: 6-22-53

DATA BASIS: FLIGHT TEST

N11/71 XX1-86

Figure 11-25. Single-Engine Climb Curve — Time During Climb

PART 4

RANGE

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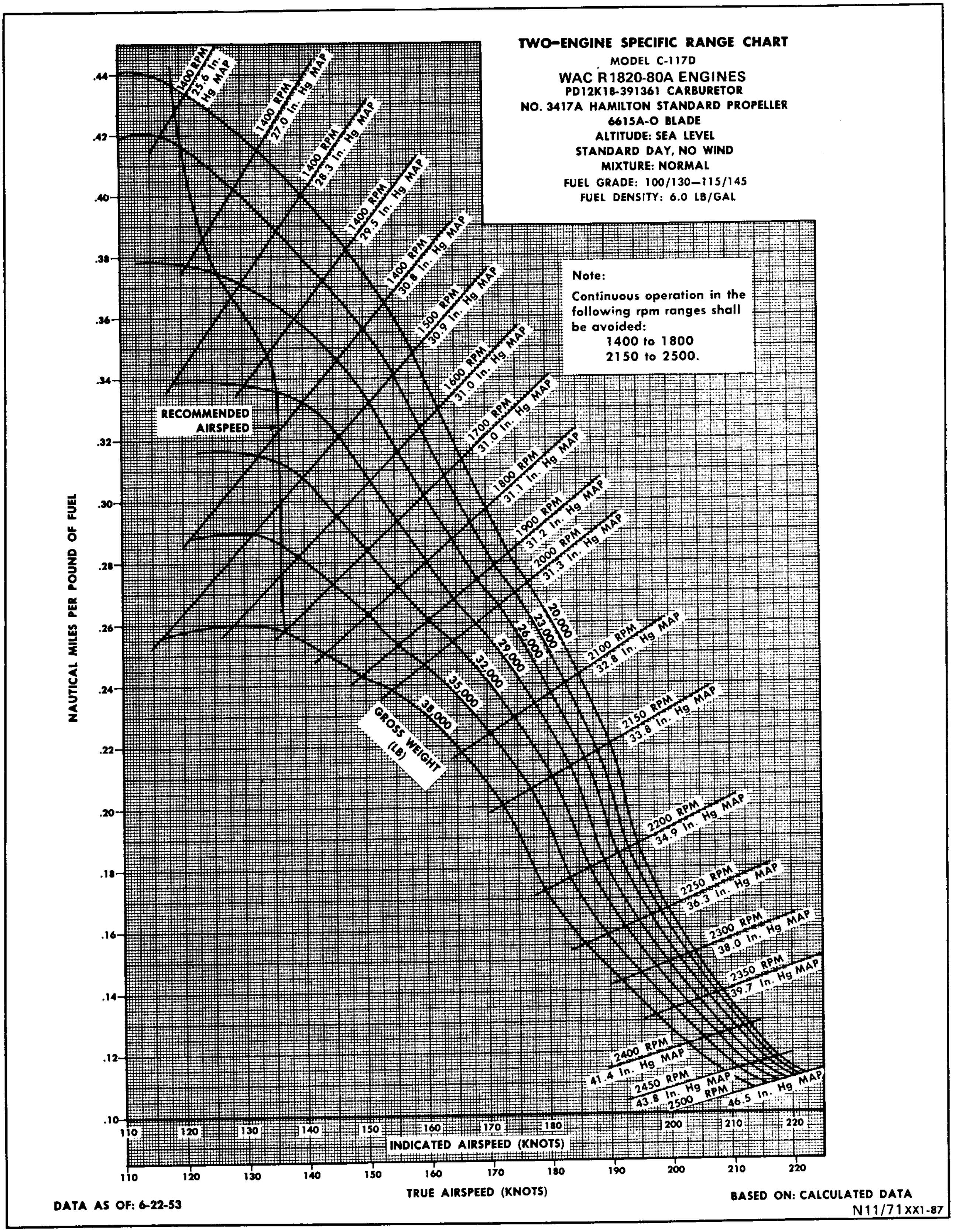
ILLUSTRATIONS



TWO-ENGINE SPECIFIC RANGE CHART

MODEL C-117D
WAC R1820-80A ENGINES
PD12K18-391361 CARBURETOR
NO. 3417A HAMILTON STANDARD PROPELLER
6615A-O BLADE
ALTITUDE: SEA LEVEL
STANDARD DAY, NO WIND
MIXTURE: NORMAL
FUEL GRADE: 100/130—115/145
FUEL DENSITY: 6.0 LB/GAL

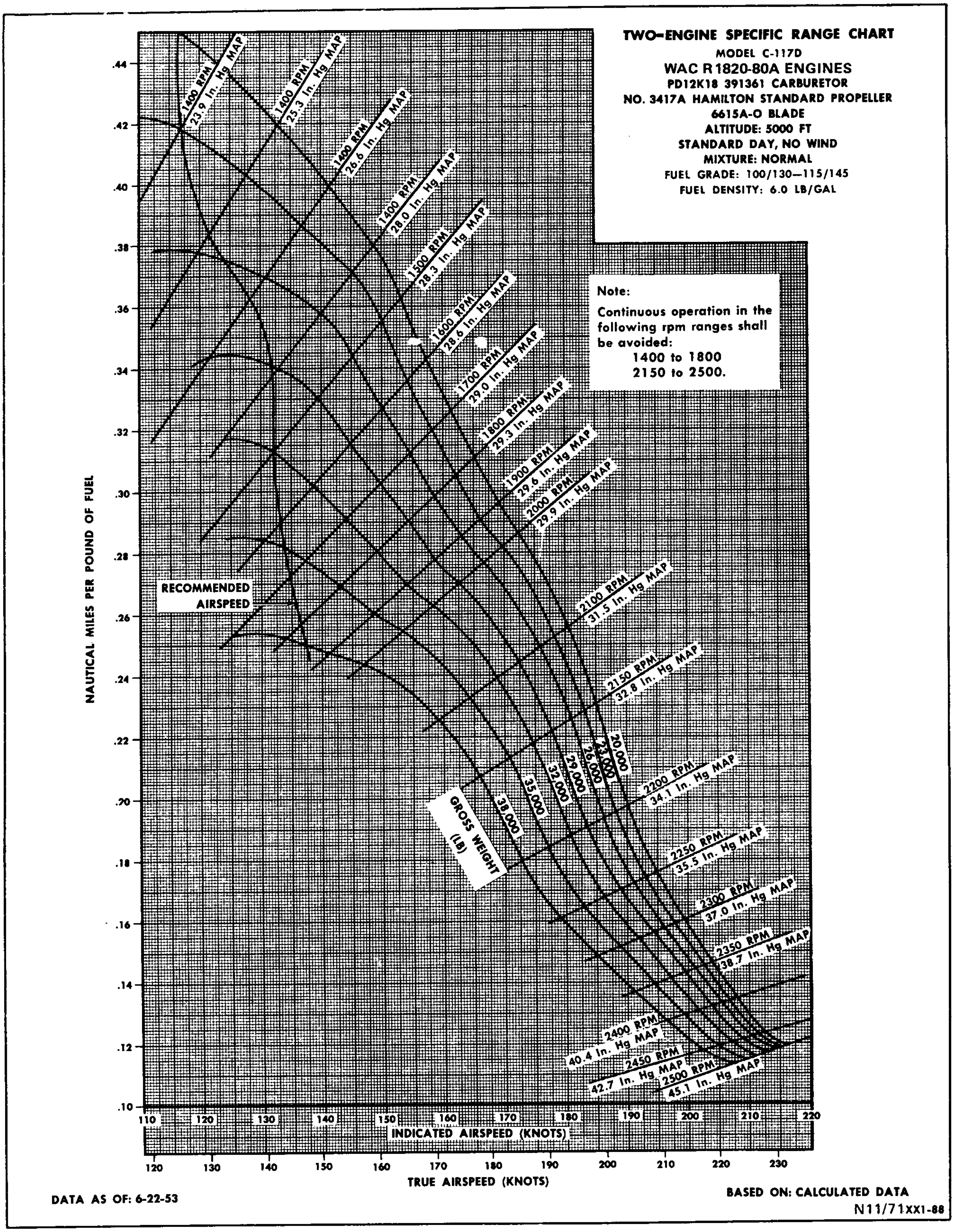
Note:
Continuous operation in the following rpm ranges shall be avoided:
1400 to 1800
2150 to 2500.

DATA AS OF: 6-22-53

BASED ON: CALCULATED DATA

N11/71XX1-87

Figure 11-26. Two-Engine Specific Range – Sea Level



TWO-ENGINE SPECIFIC RANGE CHART
MODEL C-117D
WAC R1820-80A ENGINES
PD12K18 391361 CARBURETOR
NO. 3417A HAMILTON STANDARD PROPELLER
6615A-O BLADE
ALTITUDE: 5000 FT
STANDARD DAY, NO WIND
MIXTURE: NORMAL
FUEL GRADE: 100/130—115/145
FUEL DENSITY: 6.0 LB/GAL

Note:
Continuous operation in the following rpm ranges shall be avoided:
1400 to 1800
2150 to 2500.

DATA AS OF: 6-22-53

BASED ON: CALCULATED DATA

N11/71XX1-88

Figure 11-27. Two-Engine Specific Range — 5000 Feet

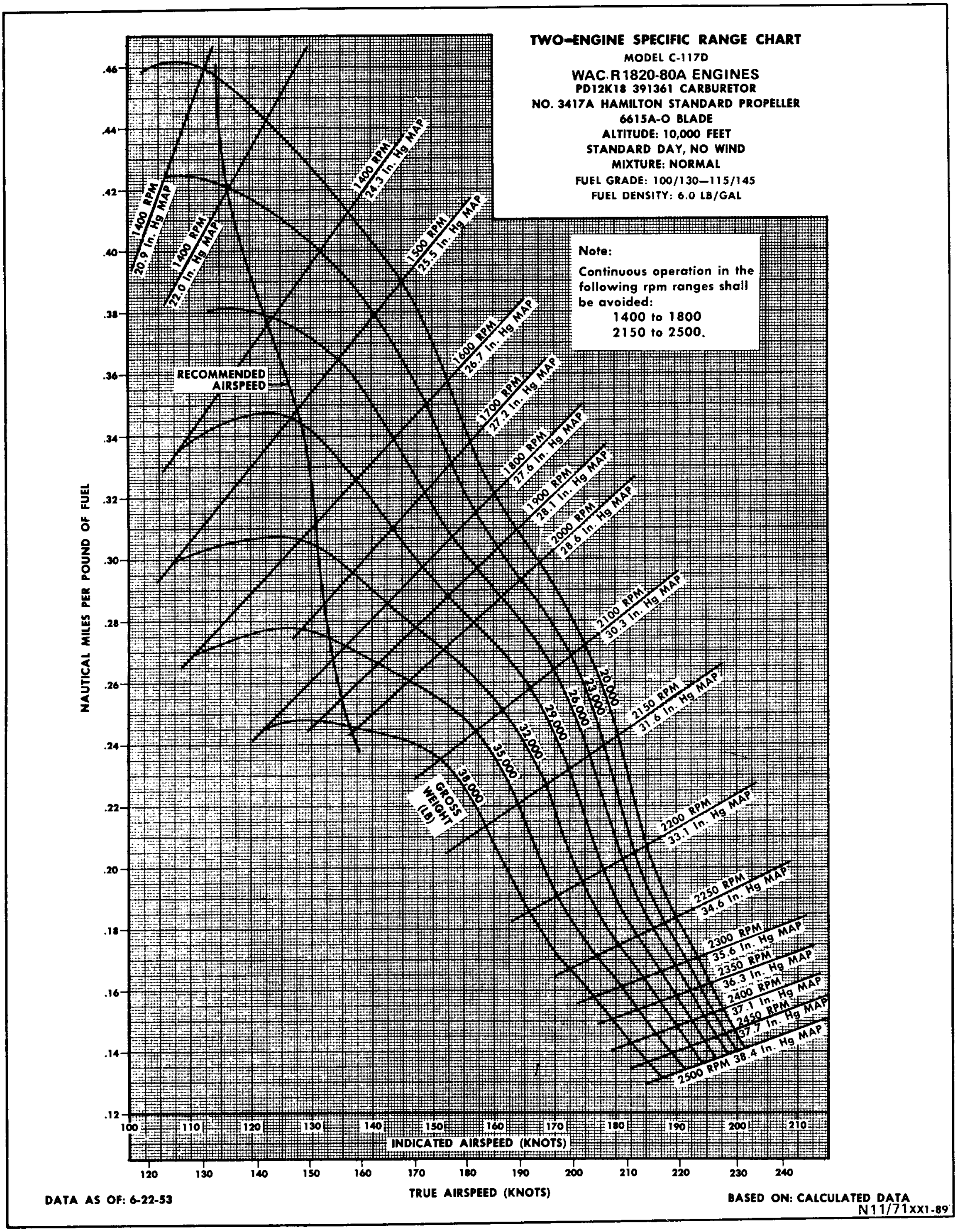


Figure 11-28. Two-Engine Specific Range — 10,000 Feet

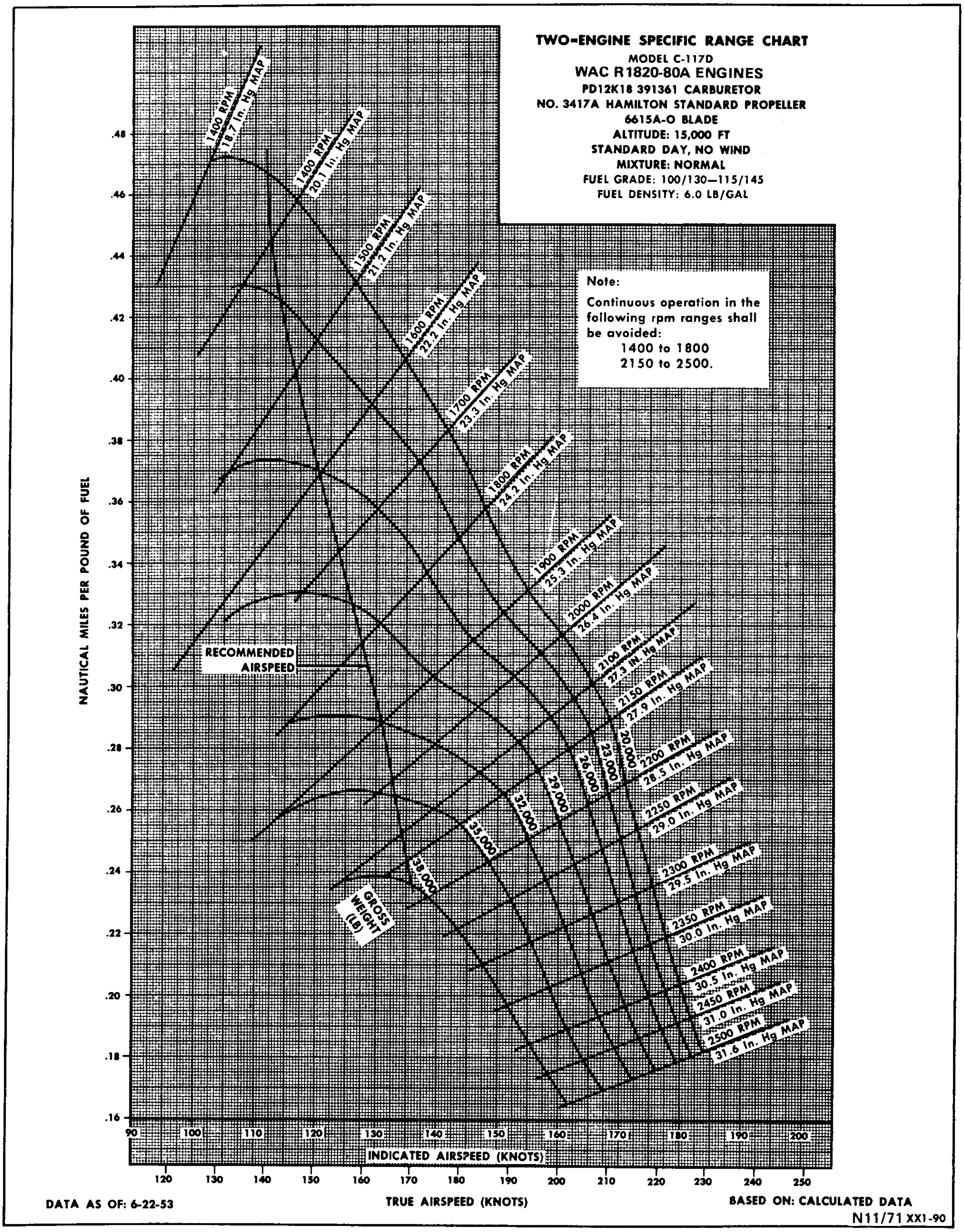
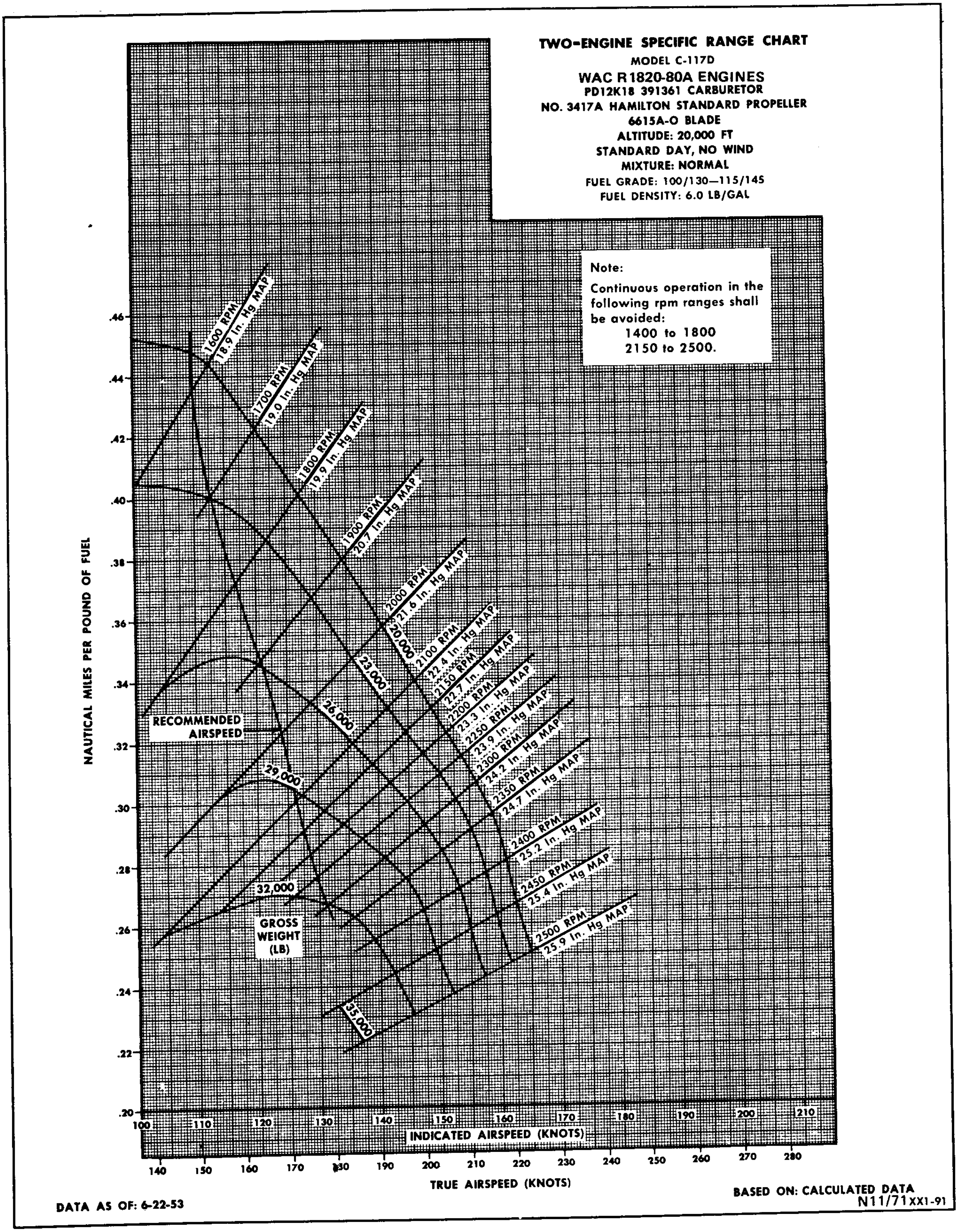


Figure 11-29. Two-Engine Specific Range — 15,000 Feet



TWO-ENGINE SPECIFIC RANGE CHART
MODEL C-117D
WAC R1820-80A ENGINES
PD12K18 391361 CARBURETOR
NO. 3417A HAMILTON STANDARD PROPELLER
6615A-O BLADE
ALTITUDE: 20,000 FT
STANDARD DAY, NO WIND
MIXTURE: NORMAL
FUEL GRADE: 100/130—115/145
FUEL DENSITY: 6.0 LB/GAL

Note:
Continuous operation in the following rpm ranges shall be avoided:
1400 to 1800
2150 to 2500.

DATA AS OF: 6-22-53

BASED ON: CALCULATED DATA
N11/71XX1-91

Figure 11-30. Two-Engine Specific Range — 20,000 Feet

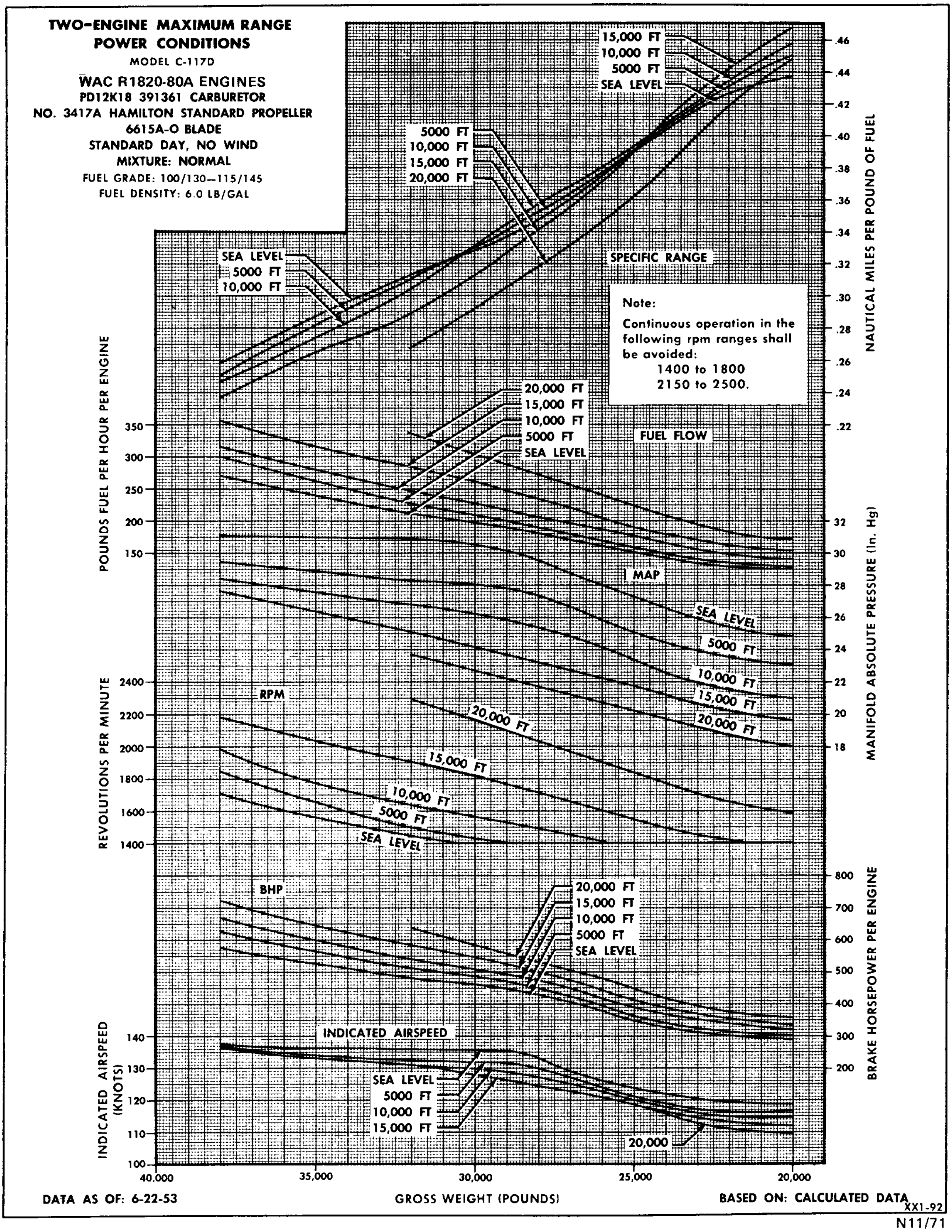
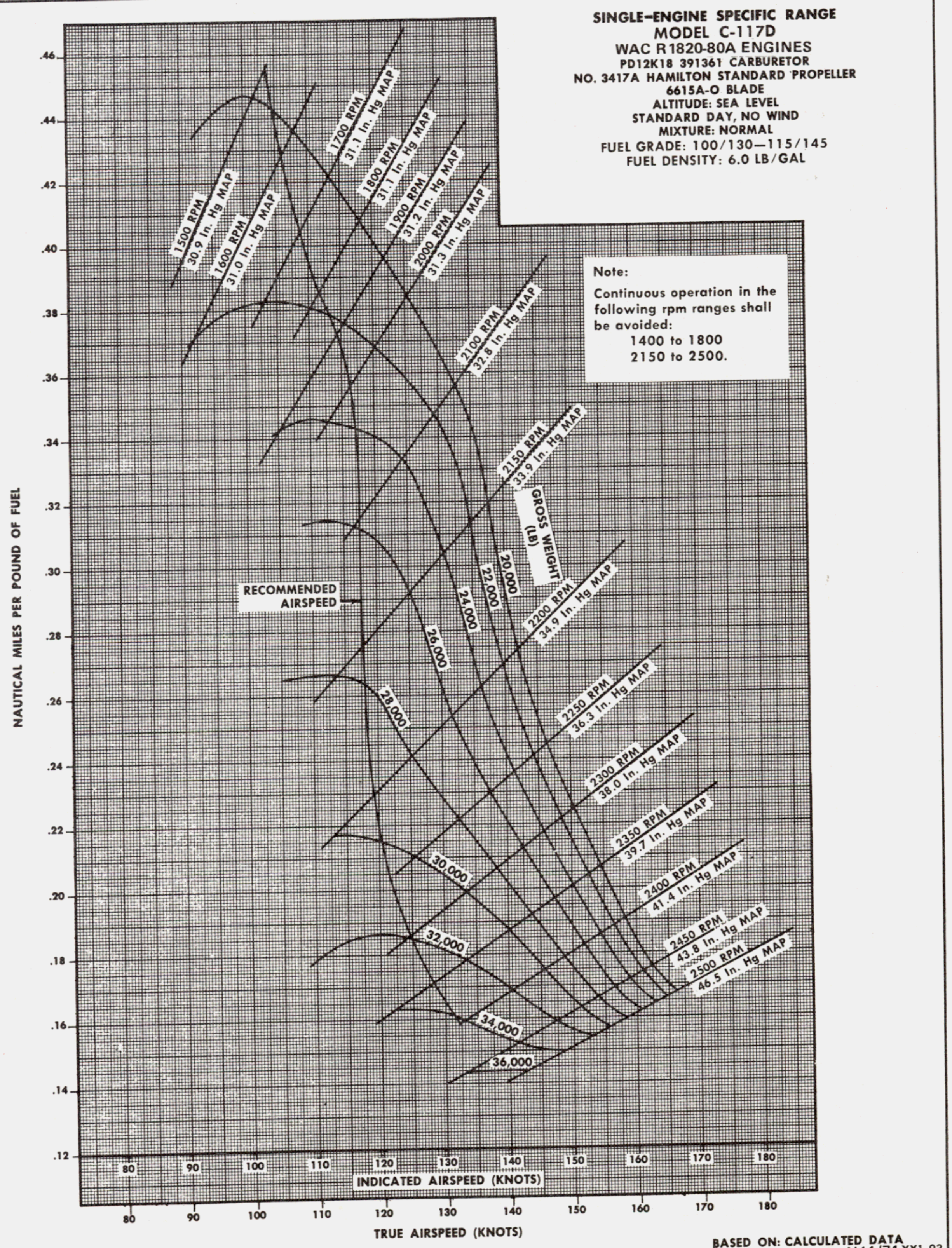


Figure 11-31. Two-Engine Maximum Range Power Conditions

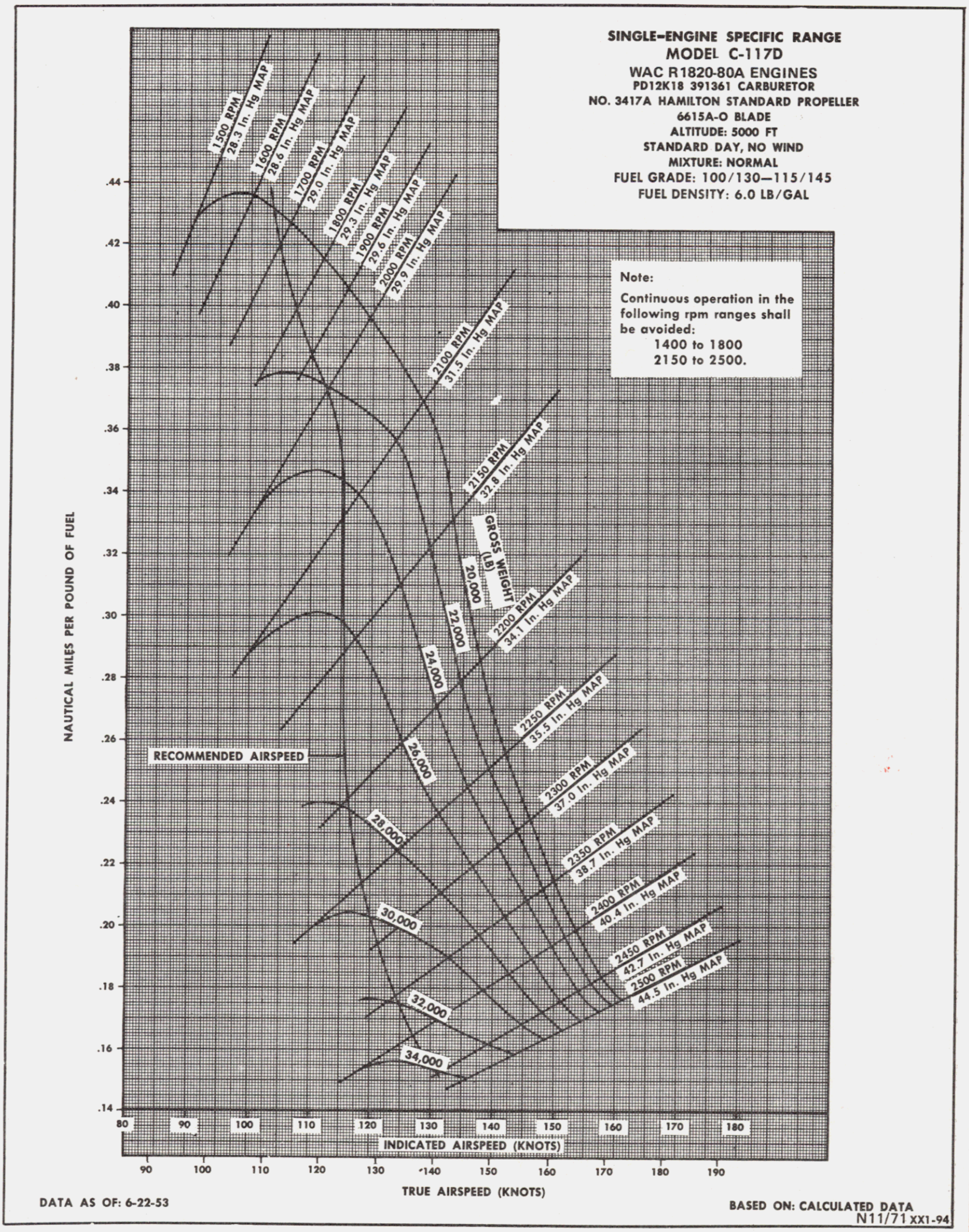


DATA AS OF: 6-22-53

BASED ON: CALCULATED DATA

N11/71 XX1-93

Figure 11-32. Single-Engine Specific Range — Sea Level



SINGLE-ENGINE SPECIFIC RANGE
MODEL C-117D
WAC R1820-80A ENGINES
PD12K18 391361 CARBURETOR
NO. 3417A HAMILTON STANDARD PROPELLER
6615A-O BLADE
ALTITUDE: 5000 FT
STANDARD DAY, NO WIND
MIXTURE: NORMAL
FUEL GRADE: 100/130—115/145
FUEL DENSITY: 6.0 LB/GAL

Note:

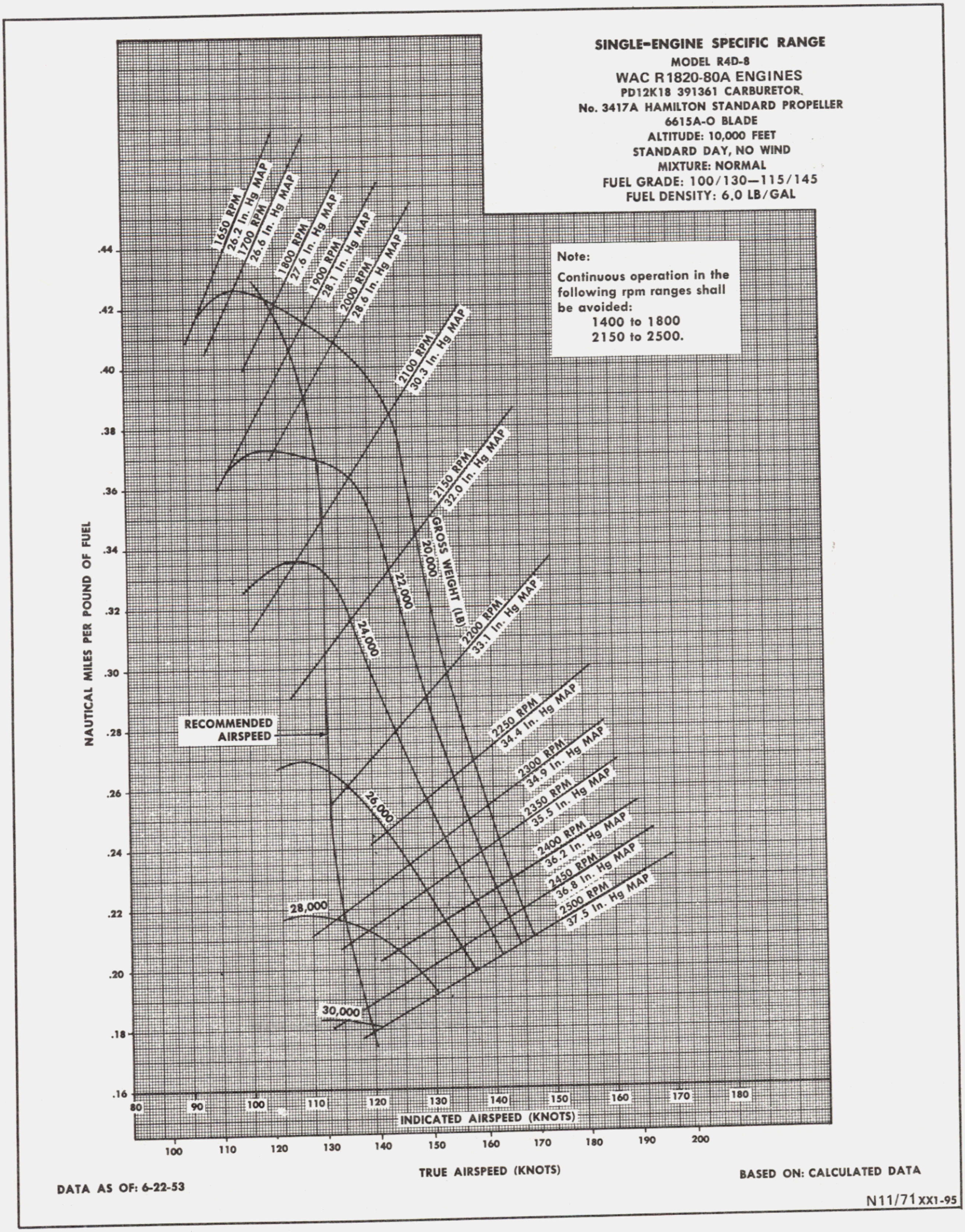
Continuous operation in the following rpm ranges shall be avoided:
1400 to 1800
2150 to 2500.

DATA AS OF: 6-22-53

BASED ON: CALCULATED DATA

N11/71 XX1-94

Figure 11-33. Single-Engine Specific Range – 5000 Feet



SINGLE-ENGINE SPECIFIC RANGE
MODEL R4D-8
WAC R1820-80A ENGINES
PD12K18 391361 CARBURETOR.
No. 3417A HAMILTON STANDARD PROPELLER
6615A-O BLADE
ALTITUDE: 10,000 FEET
STANDARD DAY, NO WIND
MIXTURE: NORMAL
FUEL GRADE: 100/130—115/145
FUEL DENSITY: 6.0 LB/GAL

Note:
Continuous operation in the following rpm ranges shall be avoided:
1400 to 1800
2150 to 2500.

DATA AS OF: 6-22-53

BASED ON: CALCULATED DATA

N11/71 XX1-95

Figure 11-34. Single-Engine Specific Range – 10,000 Feet

Changed 15 November 1971

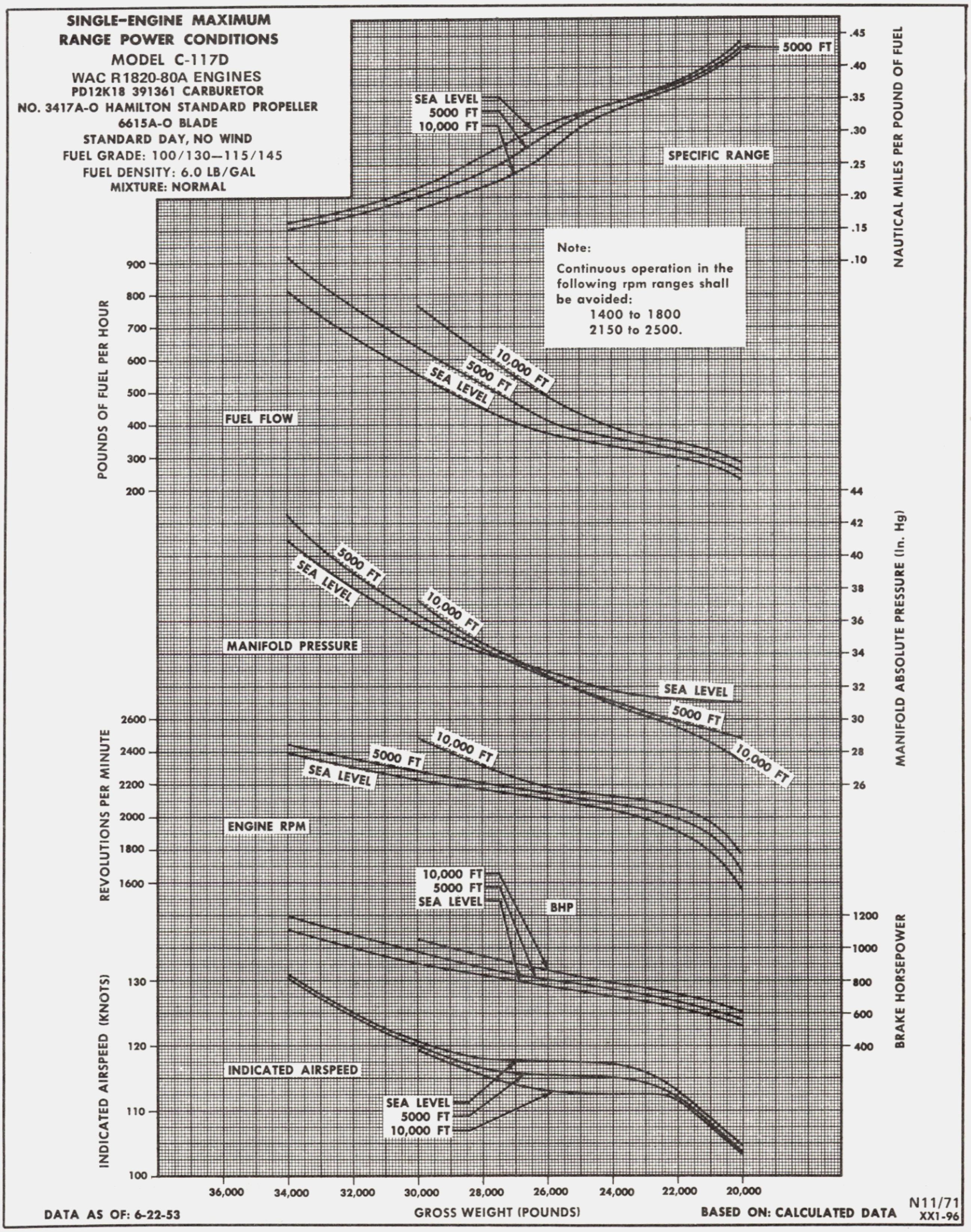
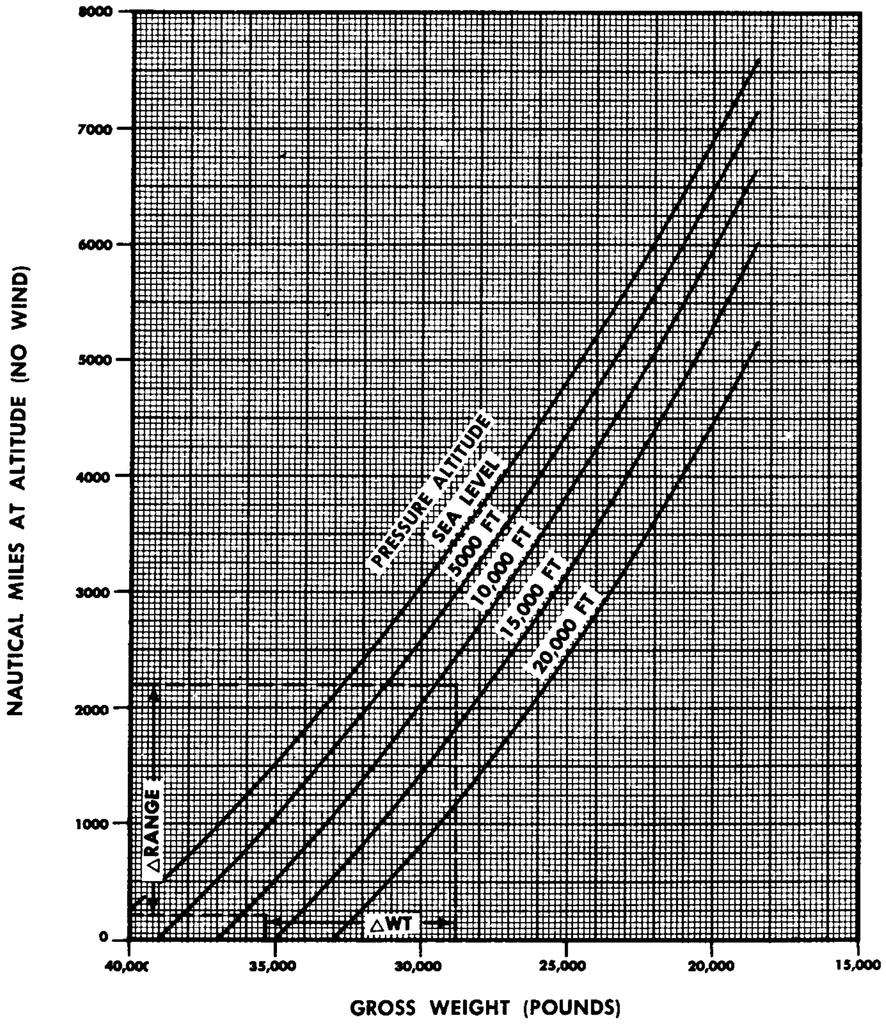


Figure 11-35. Single-Engine Maximum Range Power Conditions

LONG-RANGE DISTANCE PREDICTION CHART

MODEL C-117D
WAC R1820-80A ENGINES
PD12K18 391361 CARBURETOR
NO. 3417A HAMILTON STANDARD PROPELLER
6615A-O BLADE
BOTH ENGINES OPERATING
STANDARD DAY, NO WIND
FUEL GRADE: 100/130—115/145
FUEL DENSITY: 6.0 LB/GAL



DATA AS OF: 6-22-53

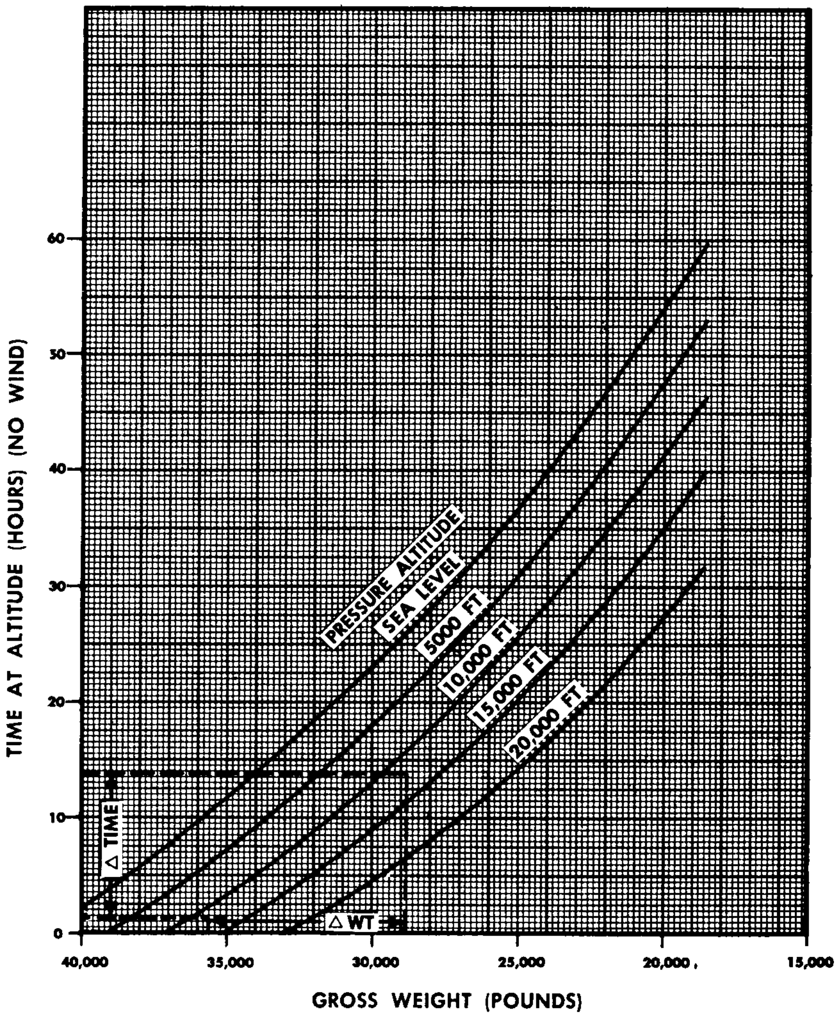
BASED ON: CALCULATED DATA

N11/71 XX1-97

Figure 11-36. Long-Range Distance Prediction Chart – Two Engines

LONG-RANGE TIME PREDICTION CHART

MODEL C-117D
WAC R1820-80A ENGINES
PD12K18 391361 CARBURETOR
NO. 3417A HAMILTON STANDARD PROPELLER
6615 A-O BLADE
BOTH ENGINES OPERATING
STANDARD DAY, NO WIND
FUEL GRADE: 100/130—115/145
FUEL DENSITY: 6.0 LB/GAL



DATA AS OF: 6-22-53

BASED ON: CALCULATED DATA

N11/71
XX1-98

Figure 11-37. Long-Range Time Prediction Chart — Two Engines

PART 5

ENDURANCE

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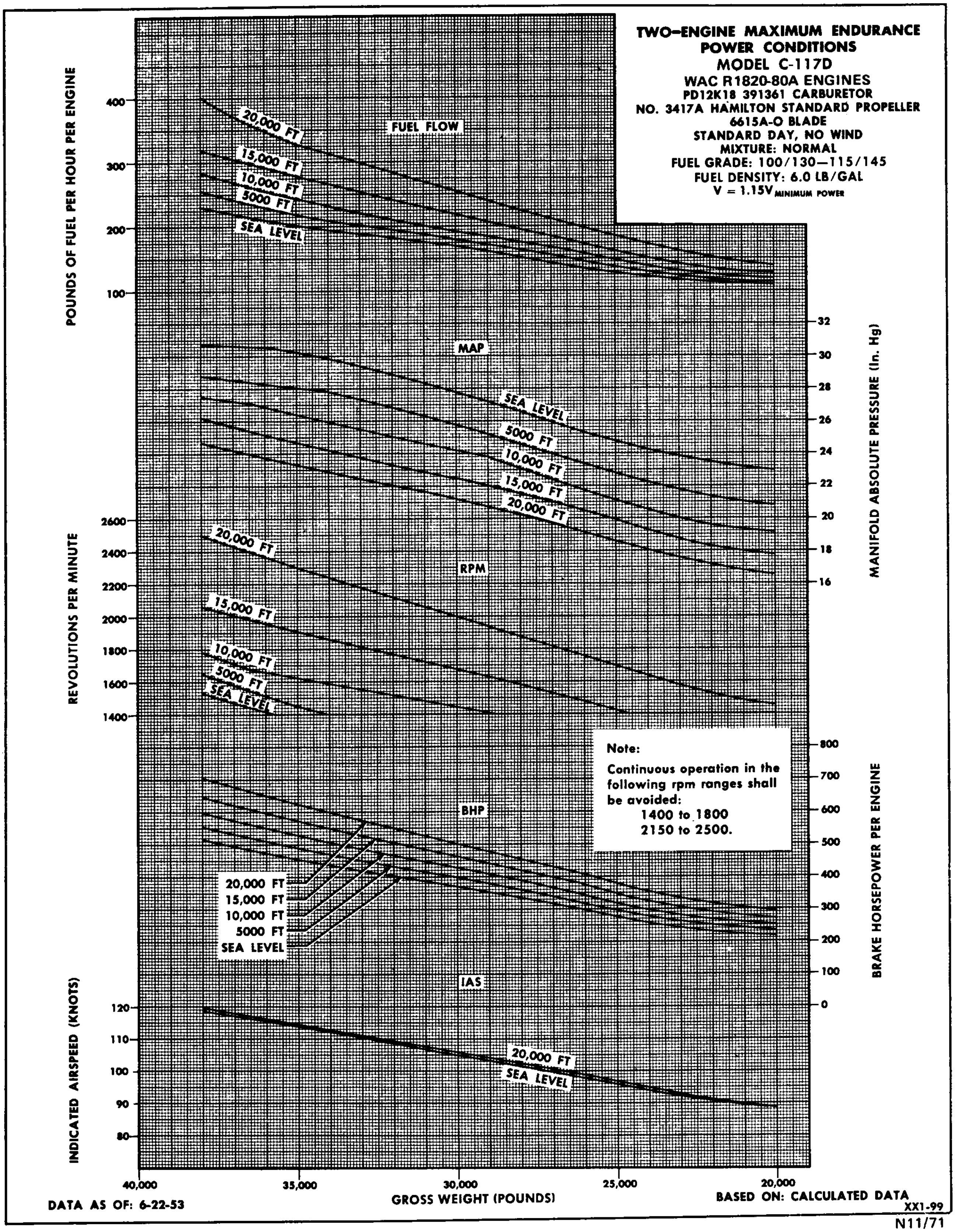
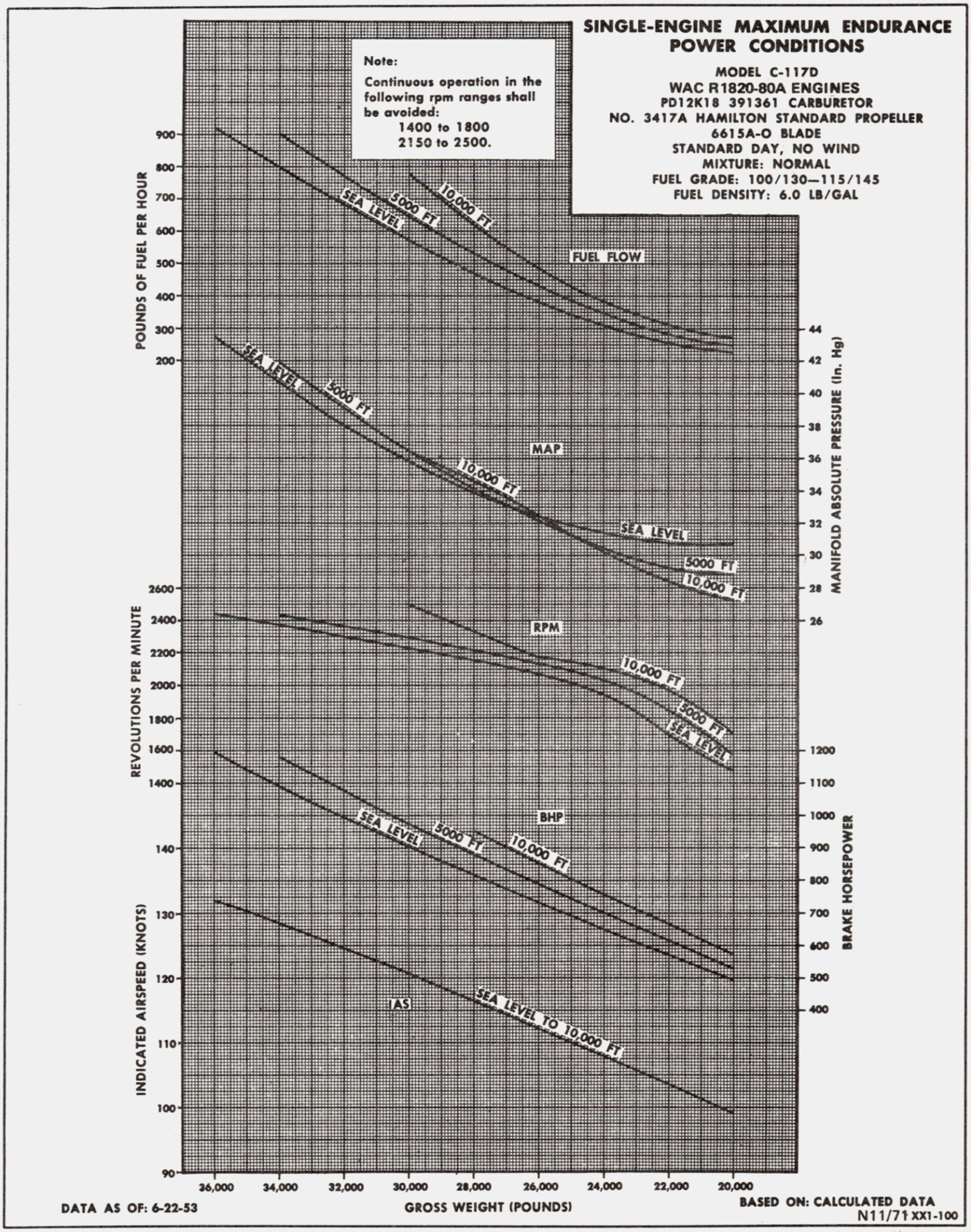
ILLUSTRATIONS



N11/71

Figure 11-38. Two-Engine Maximum Endurance Power Conditions



SINGLE-ENGINE MAXIMUM ENDURANCE POWER CONDITIONS

MODEL C-117D
WAC R1820-80A ENGINES
PD12K18 391361 CARBURETOR
NO. 3417A HAMILTON STANDARD PROPELLER
6615A-O BLADE
STANDARD DAY, NO WIND
MIXTURE: NORMAL
FUEL GRADE: 100/130—115/145
FUEL DENSITY: 6.0 LB/GAL

Note:

Continuous operation in the following rpm ranges shall be avoided:
1400 to 1800
2150 to 2500.

DATA AS OF: 6-22-53

BASED ON: CALCULATED DATA

N11/71-XX1-100

Figure 11-39. Single-Engine Maximum Endurance Power Conditions

PART 6

LANDING

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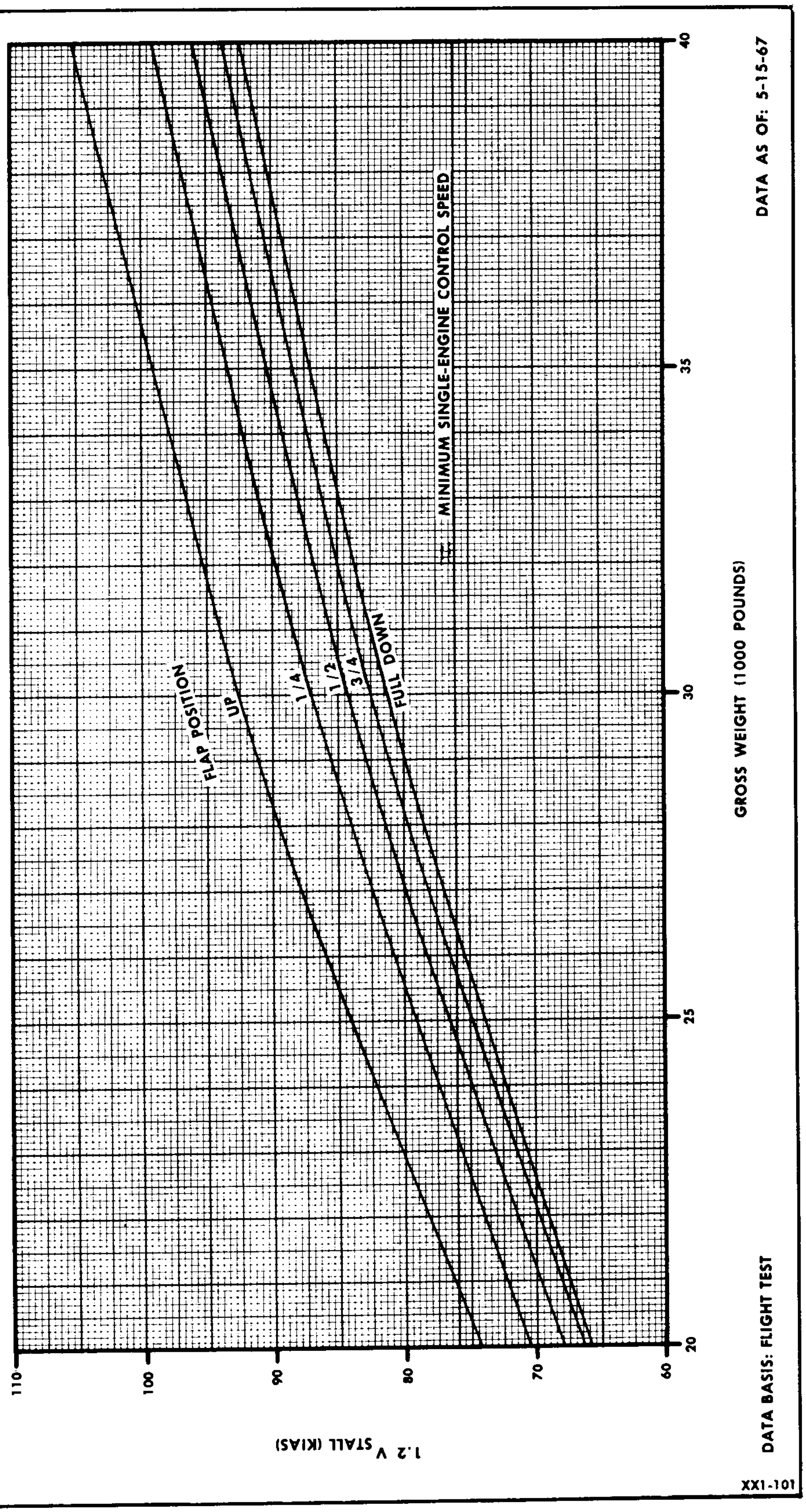
ILLUSTRATIONS

1.2 STALL SPEEDS

MODEL C-117D



DATA AS OF: 5-15-67

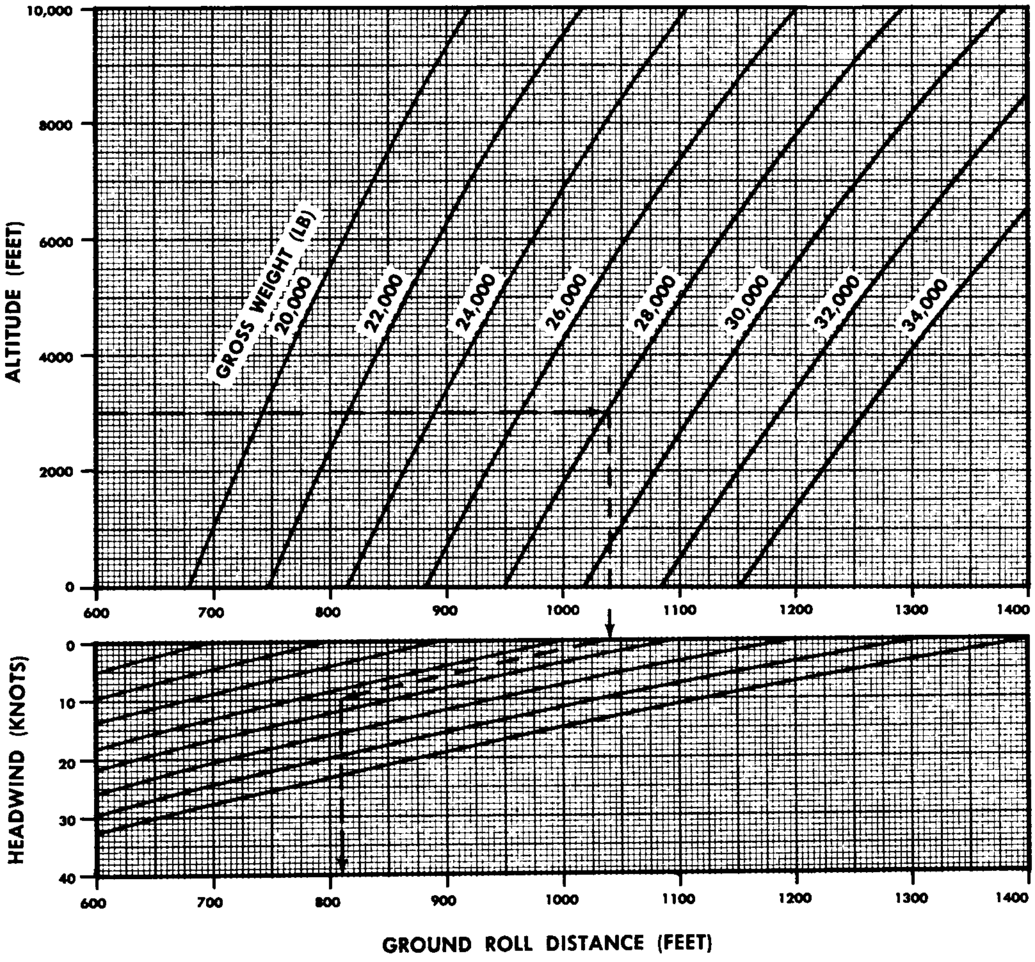
DATA BASIS: FLIGHT TEST

XX1-101

Figure 11-40. 1.2 Stall Speed

MINIMUM LANDING GROUND ROLL DISTANCE

MODEL C-117D
HARD SURFACE RUNWAY



NOTES:

1. V_{50} = 1.3 Stall Speed
2. $V_{CONTACT}$ = 1.2 Stall Speed
3. Wing Flaps = Full Down
4. Total distance to clear a 50-foot obstacle, including ground roll, is approximately 180 percent of ground roll distance.
5. Increase distance by 37 percent for each 10°C above Standard Temperature.
6. Normal technique.
7. Actual Headwind at 6-Foot Height is Used in determining effect of wind.

DATA AS OF: 6-22-53

DATA BASIS: FLIGHT TEST

XX1-102

Figure 11-41. Minimum Landing Ground Roll Distance

PART 7

TABULATED PERFORMANCE DATA

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ILLUSTRATIONS

TAKEOFF DISTANCES (FEET)

MODEL C-117D

WAC R1820-80A ENGINES

FLAPS UP – HARD-SURFACE RUNWAY

Gross Weight (Pounds)	Pressure Altitude (Feet)	-5 Degrees C				+15 Degrees C				+35 Degrees C				+55 Degrees C			
		Zero Wind		30-Knot Wind		Zero Wind		30-Knot Wind		Zero Wind		30-Knot Wind		Zero Wind		30-Knot Wind	
		Ground Run	Clear 50 Ft	Ground Run	Clear 50 Ft	Ground Run	Clear 50 Ft	Ground Run	Clear 50 Ft	Ground Run	Clear 50 Ft	Ground Run	Clear 50 Ft	Ground Run	Clear 50 Ft	Ground Run	Clear 50 Ft
40,000	Sea Level	3490	4120	1950	2320	4090	4805	2460	2873	4760	5570	3010	3471				
	1000	3900	4560	2250	2635	4420	5168	2670	3100								
	2000	4230	4915	2580	2978	4650	5440	2840	3291								
	3000	4570	5300	2870	3290												
	4000																
	5000																
35,000	Sea Level	2410	2865	1220	1502	2800	3308	1490	1798	3180	3755	1720	2062	4000	4687	2370	2769
	1000	2665	3135	1400	1689	3015	3545	1620	1939	3460	4055	1930	2282	4040	4780	2400	2775
	2000	2890	3380	1510	1809	3265	3825	1810	2145	3820	4475	2260	2642	4610	5458	2800	3280
	3000	3110	3630	1720	2034	3595	4213	2080	2444	4270	4992	2630	3046				
	4000	3440	4020	1935	2280	3975	4657	2330	2726	4660	5462	2900	3357				
	5000	3840	4479	2260	2635	4460	5210	2690	3121								
30,000	Sea Level	1720	2045	860	1075	1930	2290	940	1174	2150	2550	1050	1304	2680	3145	1380	1667
	1000	1860	2200	940	1163	2045	2417	1030	1270	2310	2720	1240	1499	2830	3270	1490	1765
	2000	1980	2325	970	1196	2200	2590	1130	1379	2520	2965	1340	1616	2980	3545	1590	1927
	3000	2100	2465	1040	1276	2390	2812	1250	1515	2785	3275	1490	1790	3280	3905	1860	2227
	4000	2300	2700	1200	1454	2610	3073	1400	1686	3010	3545	1610	1932	3500	4190	1970	2370
	5000	2530	2968	1340	1613	2890	3395	1550	1856	3350	3940	1900	2250	3890	4673	2300	2748
25,000	Sea Level	1120	1380	510	688	1270	1543	590	776	1425	1715	680	876	1760	2080	830	1043
	1000	1220	1485	560	741	1360	1638	650	838	1530	1825	740	938	1850	2180	880	1100
	2000	1310	1580	610	794	1460	1745	700	893	1660	1970	800	1007	1935	2310	940	1502
	3000	1395	1670	660	847	1580	1880	740	942	1815	2147	920	1139	2110	2518	1040	1299
	4000	1530	1820	750	946	1715	2033	800	1012	1950	2305	970	1201	2220	2662	1080	1355
	5000	1670	1975	800	1004	1880	2221	940	1163	2165	2550	1070	1316	2410	2905	1285	1587

REMARKS: Takeoff distances are aircraft requirements under normal service conditions.
Military maximum overload takeoff gross weight = 36,800 pounds. See figure A-9 for takeoff power schedule.

Fuel Grade: 115/145
Fuel Density: 6 lb/gal.

Data as of: 7-15-54

Based on: Flight Test Data

Figure 11-42. Takeoff Distance – Feet – Zero Degree Flaps – Hard-Surface Runway

CLIMB CHART FOR NORMAL RATED POWER
TWO-ENGINE OPERATION
MODEL C-117D
WAC R1820-80A ENGINES
PD 12K18 391361 CARBURETOR
STANDARD DAY

TAKEOFF WEIGHT: 40,000 POUNDS							TAKEOFF WEIGHT: 35,000 POUNDS					
	Approximate			MAP In. Hg	KIAS	Pressure Altitude (Feet)	KIAS	MAP In. Hg	Approximate			
	From Sea Level								From Sea Level			
Rate Climb	Dist	Time	Fuel						Fuel	Time	Dist	Rate Climb
850	0	0	55	46.5	112	Sea Level	113	46.5	55	0	0	1200
820	9	5	82	F.T.	112	4000	113	F.T.	75	4	6	1100
670	21	10	110	F.T.	112	8000	113	F.T.	97	8	16	920
490	36	18	144	F.T.	112	12,000	114	F.T.	120	13	27	720
290	63	29	183	F.T.	113	16,000	114	F.T.	145	20	43	500
90	133	57	255	F.T.	113	20,000	114	F.T.	172	31	71	280
						24,000	114	F.T.	235	61	152	80
						28,000						

TAKEOFF WEIGHT: 30,000 POUNDS							TAKEOFF WEIGHT: 25,000 POUNDS					
	Approximate			MAP In. Hg	KIAS	Pressure Altitude (Feet)	KIAS	MAP In. Hg	Approximate			
	From Sea Level								From Sea Level			
Rate Climb	Dist	Time	Fuel						Fuel	Time	Dist	Rate Climb
1450	0	0	55	46.5	113	Sea Level	113	46.5	55	0	0	1900
1420	5	3	71	F.T.	113	4000	113	F.T.	67	2	4	1880
1220	12	6	87	F.T.	113	8000	113	F.T.	78	5	9	1620
1000	20	10	103	F.T.	114	12,000	114	F.T.	91	8	15	1370
750	31	14	120	F.T.	114	16,000	114	F.T.	103	11	23	1070
500	48	21	137	F.T.	114	20,000	114	F.T.	115	15	34	790
280	79	33	160	F.T.	114	24,000	114	F.T.	128	22	51	520
60	171	65	215	F.T.	114	28,000	114	F.T.	146	33	83	280
						32,000						

REMARKS:

1. Climb at EAS = 113 knots
2. Allowance for taxi and takeoff = 55 gallons.
3. Subtract 43 fpm for each 5°C above standard temperature

Rate of Climb = Ft/Min.
Time = Minutes
Fuel = Gallons
Distance = Nautical Miles

F.T. = Full Throttle
Fuel Grade = 115/145
Fuel Density = 6.0 lb/gal.

Data as of: 6-22-53

Based on: Flight Test Data

Figure 11-43. Climb Chart – Normal Rated Power – Two Engines

CLIMB CHART FOR NORMAL RATED POWER
ONE-ENGINE OPERATION
MODEL C-117D
WAC R1820-80A ENGINES
PD 12K18 391361 CARBURETOR
STANDARD DAY

TAKEOFF WEIGHT: 33,000 POUNDS — TAKEOFF WEIGHT: 31,000 POUNDS

Approximate				MAP In. Hg	KIAS	Pressure Altitude (Feet)	KIAS	MAP In. Hg	Approximate			
	From Sea Level								From Sea Level			
Rate Climb	Dist	Time	Fuel						Fuel	Time	Dist	Rate Climb
210	0	0	55	46.5	113	Sea Level	113	46.5	55	0	0	270
170	47	21	110	F.T.	113	4000	113	F.T.	97	16	36	230
100	80	35	148	F.T.	113	6000	113	F.T.	123	26	58	160
40	138	59	215	F.T.	114	8000	114	F.T.	158	40	93	100
						10,000	114	F.T.	226	69	165	20
						12,000						
						14,000						
						16,000						

TAKEOFF WEIGHT: 28,000 POUNDS — TAKEOFF WEIGHT: 25,000 POUNDS

Approximate				MAP In. Hg	KIAS	Pressure Altitude (Feet)	KIAS	MAP In. Hg	Approximate			
	From Sea Level								From Sea Level			
Rate Climb	Dist	Time	Fuel						Fuel	Time	Dist	Rate Climb
380	0	0	55	46.5	113	Sea Level	113	46.5	55	0	0	510
350	24	11	82	F.T.	113	4000	113	F.T.	77	8	18	470
270	39	17	97	F.T.	113	6000	113	F.T.	88	13	29	390
200	60	26	118	F.T.	114	8000	114	F.T.	103	18	42	310
120	89	37	145	F.T.	114	10,000	114	F.T.	118	26	60	230
50	145	58	192	F.T.	114	12,000	114	F.T.	138	35	85	150
						14,000	114	F.T.	172	52	130	70
						16,000						

REMARKS:

1. Climb at EAS = 113 knots
2. Allowance for taxi and takeoff = 55 gallons
3. Subtract 17 fpm for each 5°C above standard temperature

Rate of Climb = Ft/Min.
Time = Minutes
Fuel = Gallons
Distance = Nautical Miles

F.T. = Full Throttle
Fuel Grade = 115/145
Fuel Density = 6.0 lb/gal.

Data as of: 6-22-53

Based on: Flight Test Data

Figure 11-44. Climb Chart – Normal Rated Power – One Engine

WAC R1820-80A ENGINES PD 12K18 391361 CARBURETOR	FLIGHT OPERATION INSTRUCTION CHART MODEL C-117D STANDARD DAY CHART WEIGHT LIMITS: 24,000 TO 20,000 POUNDS	EXTERNAL LOAD ITEMS: NONE NUMBER OF ENGINES OPERATING: 1

INSTRUCTIONS FOR USING CHART. Select figure in fuel column equal to or less than amount of fuel to be used for cruising.* Move horizontally to right or left and select range value equal to or greater than the statute or nautical air miles to be flown. Vertically below, and opposite value nearest desired cruising altitude (ALT) read RPM, manifold pressure (MP) and mixture (MIX.) setting required.

NOTES: Column I is for emergency high-speed cruising only. Columns II, III, IV, and V give progressive increase in range at sacrifice in speed. Air miles per gallon (MI/GAL.) (NO WIND), gallons per hour (GPH) and true airspeed (TAS) are approximate values for reference. Subtract fuel allowances not available for cruising.

COLUMN I		FUEL	COLUMN II		COLUMN III		COLUMN IV		FUEL	COLUMN V	
Range in Air Miles		US.	Range in Air Miles		Range in Air Miles		Range in Air Miles		US.	Range in Air Miles	
Nautical 5000 Ft	Nautical Sea Level	GAL.	Statute	Nautical	Statute	Nautical	Statute	Nautical	GAL.	Statute	Nautical
		1600							1600		
		1400							1400		
		1200							1200		
		1000							1000		
		800							800		
615	588	600	852	744	1026	894	1200	1044	600	1380	1200
409	392	400	568	496	684	596	800	696	400	920	800
205	196	200	284	248	342	298	400	348	200	460	400

[1.13 Stat (0.98 Naut) MI/GAL.]						PRESS. ALT FEET	[1.42 Stat (1.24 Naut) MI/GAL.]						[1.71 Stat (1.49 Naut) MI/GAL.]						[2.00 Stat (1.74 Naut) MI/GAL.]						PRESS. ALT FEET	[2.30 Stat (2.00 Naut) MI/GAL.]					
R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS		R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS	R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS	R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS		R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS
						20,000																			20,000						
						15,000																			15,000						
2500	F.T.	N	132	163	141	10,000	2490	F.T.	N	132	163	141	2280	F.T.	N	101	151	131	2180	32.6	N	81	141	122	10,000	2120	30.9	N	66	130	112
2500	F.T.	N	163	169	157	5,000	2360	38.9	N	127	157	146	2240	35.2	N	97	145	135	2170	33.3	N	78	136	127	5,000	2080	31.1	N	60	123	115
2500	46.5	N	165	163	163	S.L.	2330	39.2	N	121	149	149	2230	35.7	N	93	139	139	2160	34.3	N	76	133	133	S.L.	2040	31.7	N	56	117	117

REMARKS:

*Make allowance for warmup, takeoff and climb plus allowance for wind, reserve, and combat as required.

See Section I for RPM limitations.

EXAMPLE

At 24,000 pounds gross weight with 600 gallons of remaining usable fuel, to fly 1200 nautical air miles at 5000 feet altitude, maintain 2080 rpm and 31.1 inches manifold pressure with mixture set NORMAL.

LEGEND

ALT:	Pressure Altitude	MIX.:	Mixture
MP:	Manifold Pressure	N:	Normal
GPH:	US. Gallons per Hour	KTS.:	Knots
TAS:	True Airspeed	F.T.:	Full Throttle
IAS:	Indicated Airspeed	S.L.:	Sea Level

Data as of: 7-15-54

Based on: Calculated Data

Figure 11-45. Flight Operation Instruction Chart – One Engine – 24,000 to 20,000 Pounds

WAC R1820-80A ENGINES PD 12K18 391361 CARBURETOR	FLIGHT OPERATION INSTRUCTION CHART MODEL C-117D STANDARD DAY CHART WEIGHT LIMITS: 28,000 TO 24,000 POUNDS	EXTERNAL LOAD ITEMS: NONE NUMBER OF ENGINES OPERATING: 1

INSTRUCTIONS FOR USING CHART. Select figure in fuel column equal to or less than amount of fuel to be used for cruising.* Move horizontally to right or left and select range value equal to or greater than the statute or nautical air miles to be flown. Vertically below, and opposite value nearest desired cruising altitude (ALT) read RPM, manifold pressure (MP) and mixture (MIX.) setting required. Refer to corresponding column and altitude for new power settings when gross weight falls below limits of this chart.

NOTES: Column I is for emergency high-speed cruising only. Columns II, III, IV, and V give progressive increase in range at sacrifice in speed. Air miles per gallon (MI/GAL.) (NO WIND), gallons per hour (GPH) and true airspeed (TAS) are approximate values for reference. Subtract fuel allowances not available for cruising.

COLUMN I		FUEL	COLUMN II		COLUMN III		COLUMN IV		FUEL	COLUMN V	
Range in Air Miles		US.	Range in Air Miles		Range in Air Miles		Range in Air Miles		US.	Range in Air Miles	
Nautical		GAL.							GAL.		
5000 Ft	Sea Level		Statute	Nautical	Statute	Nautical	Statute	Nautical		Statute	Nautical
		1600							1600		
		1400							1400		
1228	1165	1200	1562	1356	1780	1546	2001	1738	1200	2225	1932
1006	966	1000	1274	1106	1437	1248	1600	1389	1000	1763	1531
799	770	800	988	858	1094	950	1199	1041	800	1305	1133
597	576	600	720	624	780	678	840	726	600	894	780
398	384	400	480	416	520	452	560	484	400	596	520
200	192	200	240	208	260	226	280	242	200	298	260

[1.11 Stat (0.96 Naut) MI/GAL.]						PRESS.	[1.20 Stat (1.04 Naut) MI/GAL.]						[1.30 Stat (1.13 Naut) MI/GAL.]						[1.40 Stat (1.21 Naut) MI/GAL.]						PRESS.	[1.49 Stat (1.30 Naut) MI/GAL.]					
R P M	MP IN. Hg	M I X.	Approx			ALT	R P M	MP IN. Hg	M I X.	Approx			R P M	MP IN. Hg	M I X.	Approx			R P M	MP IN. Hg	M I X.	Approx			ALT	R P M	MP IN. Hg	M I X.	Approx		
			GPH Per Eng	Airspeed (Knots)						GPH Per Eng	Airspeed (Knots)					GPH Per Eng	Airspeed (Knots)					GPH Per Eng	Airspeed (Knots)						GPH Per Eng	Airspeed (Knots)	
				TAS	IAS	FEET					TAS	IAS					TAS	IAS					TAS	IAS	FEET					TAS	IAS
						20,000																			20,000						
						15,000																			15,000						
2500	F.T.	N	132	151	131	10,000													2430	F.T.	N	121	146	126	10,000	2310	F.T.	N	104	133	115
2500	F.T.	N	163	163	152	5000	2440	42.2	N	151	157	147	2380	39.8	N	135	152	141	2330	38.1	N	120	145	135	5000	2200	34.3	N	88	125	116
2500	46.5	N	165	159	159	S.L.	2420	42.4	N	145	151	151	2370	40.2	N	129	145	145	2320	38.4	N	116	140	140	S.L.	2170	34.1	N	75	118	118

REMARKS:

*Make allowance for warmup, takeoff and climb plus allowance for wind, reserve, and combat as required.

See Section I for RPM limitations.

EXAMPLE

At 25,000 pounds gross weight with 800 gallons of remaining usable fuel, to fly 950 nautical air miles at 5000 feet altitude, maintain 2380 rpm and 39.8 inches manifold pressure with mixture set NORMAL. When weight decreases below 24,000 pounds, refer to the 24,000 to 20,000 pounds chart, under column III, at 5000 feet.

LEGEND

ALT:	Pressure Altitude	MIX.:	Mixture
MP:	Manifold Pressure	N:	Normal
GPH.:	US. Gallons Per Hour	KTS:	Knots
TAS:	True Airspeed	F.T.:	Full Throttle
IAS:	Indicated Airspeed	S.L.:	Sea Level

Data as of: 7-15-54

Based on: Calculated Data

Figure 11-46. Flight Operation Instruction Chart – One Engine – 28,000 to 24,000 Pounds

WAC R1820-80A ENGINES
PD 12K18 391361 CARBURETOR

FLIGHT OPERATION INSTRUCTION CHART
MODEL C-117D
STANDARD DAY
CHART WEIGHT LIMITS: 32,000 TO 28,000 POUNDS

EXTERNAL LOAD ITEMS: NONE
NUMBER OF ENGINES OPERATING: 1

INSTRUCTIONS FOR USING CHART. Select figure in fuel column equal to or less than amount of fuel to be used for cruising.* Move horizontally to right or left and select range value equal to or greater than the statute or nautical air miles to be flown. Vertically below, and opposite value nearest desired cruising altitude (ALT) read RPM, manifold pressure (MP) and mixture (MIX.) setting required. Refer to corresponding column and altitude for new power settings when gross weight falls below limits of this chart.

NOTES: Column I is for emergency high-speed cruising only. Columns II, III, IV, and V give progressive increase in range at sacrifice in speed. Air miles per gallon (MI/GAL.) (NO WIND), gallons per hour (GPH) and true airspeed (TAS) are approximate values for reference. Subtract fuel allowances not available for cruising.

COLUMN I		FUEL	COLUMN II		COLUMN III		COLUMN IV		FUEL	COLUMN V	
Range in Air Miles		US. GAL.	Range in Air Miles		Range in Air Miles		Range in Air Miles		US. GAL.	Range in Air Miles	
Nautical			Statute	Nautical	Statute	Nautical	Statute	Nautical		Statute	Nautical
5000 Ft	Sea Level										
1572	1520	1600	1912	1660	2076	1803	2247	1951	1600	2413	2095
1383	1323	1400	1625	1411	1735	1507	1844	1601	1400	1952	1695
1164	1125	1200	1375	1194	1451	1260	1526	1325	1200	1600	1389
964	934	1000	1137	987	1192	1035	1246	1082	1000	1300	1129
766	746	800	898	780	933	810	965	838	800	1001	869
568	552	600	660	570	678	588	702	606	600	720	624
378	368	400	440	380	452	392	468	404	400	480	416
189	184	200	220	190	226	196	234	202	200	240	208

[1.06 Stat (0.92 Naut) MI/GAL.]						PRESS. ALT FEET	[1.10 Stat (0.95 Naut) MI/GAL.]						[1.13 Stat (0.98 Naut) MI/GAL.]						[1.17 Stat (1.01 Naut) MI/GAL.]						PRESS. ALT FEET	[1.20 Stat (1.04 Naut) MI/GAL.]					
RPM	MP IN. Hg	MIX.	Approx				RPM	MP IN. Hg	MIX.	Approx			RPM	MP IN. Hg	MIX.	Approx			RPM	MP IN. Hg	MIX.	Approx				RPM	MP IN. Hg	MIX.	Approx		
			GPH Per Eng	Airspeed (Knots)						GPH Per Eng	Airspeed (Knots)					GPH Per Eng	Airspeed (Knots)					GPH Per Eng	Airspeed (Knots)						GPH Per Eng	Airspeed (Knots)	
				TAS	IAS						TAS	IAS					TAS	IAS					TAS	IAS						TAS	IAS
						20,000																			20,000						
						15,000																			15,000						
						10,000																			10,000						
2500	F.T.	N	163	154	144	5000	2490	43.6	N	160	152	142	2430	42.0	N	149	146	136	2400	40.4	N	139	141	131	5000	2360	38.9	N	128	134	124
2500	46.5	N	165	153	153	S.L.	2450	43.8	N	154	147	147	2430	42.5	N	146	144	144	2400	41.4	N	139	140	140	S.L.	2300	38.1	N	112	125	125

REMARKS:

*Make allowance for warmup, takeoff and climb plus allowance for wind, reserve, and combat as required.

See Section I for RPM limitations.

Data as of: 7-15-54

EXAMPLE

At 30,000 pounds gross weight with 1000 gallons of remaining usable fuel, to fly 1120 nautical air miles at 5000 feet altitude, maintain 2360 rpm and 38.9 inches manifold pressure with mixture set NORMAL. When weight decreases below 28,000 pounds, refer to the 28,000 to 24,000 pounds chart, under column V at 5000 feet.

LEGEND

ALT:	Pressure Altitude	MIX:	Mixture
MP:	Manifold Pressure	N:	Normal
GPH:	US. Gallons Per Hour	KTS:	Knots
TAS:	True Airspeed	F.T.:	Full Throttle
IAS·	Indicated Airspeed	S.L.:	Sea Level

Based on: Calculated Data

Figure 11-47. Flight Operation Instruction Chart – One Engine – 32,000 to 28,000 Pounds

WAC R1820-80A ENGINES
PD 12K18 391361 CARBURETOR

FLIGHT OPERATION INSTRUCTION CHART
MODEL C-117D
STANDARD DAY
CHART WEIGHT LIMITS: 24,000 TO 20,000 POUNDS

EXTERNAL LOAD ITEMS: NONE
NUMBER OF ENGINES OPERATING: 2

INSTRUCTIONS FOR USING CHART. Select figure in fuel column equal to or less than amount of fuel to be used for cruising.* Move horizontally to right or left and select range value equal to or greater than the statute or nautical air miles to be flown. Vertically below, and opposite value nearest desired cruising altitude (ALT) read RPM, manifold pressure (MP) and mixture (MIX.) setting required.

NOTES: Column I is for emergency high speed cruising only. Columns II, III, IV, and V give progressive increase in range at sacrifice in speed. Air miles per gallon (MI/GAL.) (NO WIND), gallons per hour (GPH) and true airspeed (TAS) are approximate values for reference.
Subtract fuel allowances not available for cruising.

COLUMN I Range in Air Miles Nautical 5000 Ft	COLUMN I Range in Air Miles Nautical Sea Level	FUEL US. GAL.	COLUMN II Range in Air Miles Statute	COLUMN II Range in Air Miles Nautical	COLUMN III Range in Air Miles Statute	COLUMN III Range in Air Miles Nautical	COLUMN IV Range in Air Miles Statute	COLUMN IV Range in Air Miles Nautical	FUEL US. GAL.	COLUMN V Range in Air Miles Statute	COLUMN V Range in Air Miles Nautical
		1600							1600		
		1400							1400		
		1200							1200		
		1000							1000		
		800							800		
425	402	600	738	642	1020	888	1296	1128	600	1572	1368
283	268	400	492	428	680	592	864	752	400	1048	912
141	134	200	246	214	340	296	432	376	200	524	456

[0.77 Stat (0.67 Naut) MI/GAL.]						PRESS.	[1.23 Stat (1.07 Naut) MI/GAL.]						[1.70 Stat (1.48 Naut) MI/GAL.]						[2.16 Stat (1.88 Naut) MI/GAL.]						PRESS.	[2.62 Stat (2.28 Naut) MI/GAL.]					
R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS	ALT FEET	R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS	R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS	R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS	ALT FEET	R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS
2500	F.T.	N	73	217	160	20,000							2500	F.T.	N	74	217	160	2200	F.T.	N	53	197	145	20,000	1770	F.T.	N	35	156	115
2500	F.T.	N	103	226	181	15,000							2260	F.T.	N	72	212	170	1970	F.T.	N	51	192	153	15,000	1500	F.T.	N	30	146	116
2500	F.T.	N	139	229	199	10,000	2260	34.8	N	102	217	188	2140	31.2	N	69	203	176	1800	27.6	N	48	180	156	10,000	1400	F.T.	N	28	137	118
2500	F.T.	N	164	231	215	5000	2240	35.0	N	96	205	191	2110	31.8	N	65	191	178	1720	29.1	N	45	170	158	5000	1400	24.4	N	25	128	119
2500	46.5	N	165	221	221	S.L.	2220	35.3	N	91	194	194	2080	32.4	N	61	180	180	1650	31.0	N	43	160	160	S.L.	1400	26.5	N	24	122	122

REMARKS:

*Make allowance for warmup, takeoff and climb plus allowance for wind, reserve, and combat as required. See Section I for RPM limitations.

Data as of: 7-15-54

EXAMPLE

At 23,000 pounds initial cruise gross weight with 200 gallons of usable fuel (after deducting an allowance of 55 gallons for warmup, taxi, and takeoff, plus an additional allowance of 13 gallons for climb to cruise altitude, during which the aircraft flies 4 nautical air miles), to fly an additional 456 nautical air miles at 5000 feet altitude, maintain 1400 rpm and 24.4 inches manifold pressure with mixture set NORMAL. Additional allowance for reserve is 10 percent of initial fuel or 30 gallons.

LEGEND

ALT: Pressure Altitude
MP: Manifold Pressure
GPH.: US. Gallons Per Hour
TAS: True Airspeed
IAS: Indicated Airspeed
MIX: Mixture
N: Normal
KTS: Knots
F.T.: Full Throttle
S.L.: Sea Level

Based on: Calculated Data

Figure 11-48. Flight Operation Instruction Chart – Two Engines – 24,000 to 20,000 Pounds

WAC R1820-80A ENGINES
PD 12K18 391361 CARBURETOR

FLIGHT OPERATION INSTRUCTION CHART
MODEL C-117D
STANDARD DAY
CHART WEIGHT LIMITS: 28,000 TO 24,000 POUNDS

EXTERNAL LOAD ITEMS: NONE
NUMBER OF ENGINES OPERATING: 2

INSTRUCTIONS FOR USING CHART. Select figure in fuel column equal to or less than amount of fuel to be used for cruising.* Move horizontally to right or left and select range value equal to or greater than the statute or nautical air miles to be flown. Vertically below, and opposite value nearest desired cruising altitude (ALT) read RPM, manifold pressure (MP) and mixture (MIX.) setting required. Refer to corresponding column and altitude for new power settings when gross weight falls below limits of this chart.

NOTES: Column I is for emergency high speed cruising only. Columns II, III, IV, and V give progressive increase in range at sacrifice in speed. Air miles per gallon (MI/GAL.) (NO WIND), gallons per hour (GPH) and true airspeed (TAS) are approximate values for reference. Subtract fuel allowances not available for cruising.

COLUMN I		FUEL	COLUMN II		COLUMN III		COLUMN IV		FUEL	COLUMN V	
Range in Air Miles		US.	Range in Air Miles		Range in Air Miles		Range in Air Miles		US.	Range in Air Miles	
Nautical 5000 Ft	Nautical Sea Level	GAL.	Statute	Nautical	Statute	Nautical	Statute	Nautical	GAL.	Statute	Nautical
		1600							1600		
		1400							1400		
847	800	1200	1404	1219	1894	1645	2367	2055	1200	2856	2480
707	666	1000	1156	1004	1555	1350	1935	1680	1000	2332	2025
565	532	800	909	789	1209	1050	1503	1305	800	1808	1570
422	396	600	672	582	888	768	1104	960	600	1320	1146
283	264	400	448	388	592	512	736	640	400	880	764
141	132	200	224	194	296	256	368	320	200	440	382
[0.76 Stat (0.66 Naut) MI/GAL.]			[1.12 Stat (0.97 Naut) MI/GAL.]		[1.48 Stat (1.28 Naut) MI/GAL.]		[1.84 Stat (1.60 Naut) MI/GAL.]			[2.20 Stat (1.91 Naut) MI/GAL.]	

R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS	PRESS. ALT FEET	R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS	R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS	R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS	PRESS. ALT FEET	R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS
2500	F.T.	N	73	209	154	20,000													2400	F.T.	N	63	202	149	20,000	2040	F.T.	N	45	170	125
2500	F.T.	N	103	221	177	15,000							2350	F.T.	N	83	212	169	2170	F.T.	N	63	200	160	15,000	1700	F.T.	N	39	156	125
2500	F.T.	N	139	227	197	10,000	2330	35.9	N	113	219	190	2180	32.4	N	80	204	177	2080	29.8	N	60	191	165	10,000	1480	F.T.	N	34	146	127
2500	F.T.	N	164	229	213	5000	2280	36.3	N	106	207	193	2160	33.1	N	75	193	180	2020	30.2	N	56	178	166	5000	1400	27.2	N	32	139	130
2500	46.5	N	165	219	219	S.L.	2250	36.4	N	101	195	195	2150	33.8	N	72	184	184	1940	31.2	N	52	167	167	S.L.	1400	29.5	N	30	133	133

REMARKS:

*Make allowance for warmup, takeoff and climb plus allowance for wind, reserve, and combat as required

See Section I for RPM limitations.

Data as of: 7-15-54

EXAMPLE

At 27,000 pounds initial cruise gross weight with 600 gallons of usable fuel (after deducting an allowance of 55 gallons for warmup, taxi, and takeoff, plus an additional allowance of 16 gallons for climb to cruise altitude, during which the aircraft flies 6 nautical air miles), to fly an additional 582 nautical air miles at 5000 feet altitude, maintain 2280 rpm and 36.3 inches manifold pressure with mixture set NORMAL. Additional allowance for reserve is 10 percent of initial fuel or 75 gallons. When weight decreases below 24,000 pounds, refer to the 24,000 to 20,000 pounds chart, under column II, at 5000 feet.

LEGEND

ALT: Pressure Altitude
MP: Manifold Pressure
GPH.: US. Gallons Per Hour
TAS: True Airspeed
IAS: Indicated Airspeed
MIX.: Mixture
N: Normal
KTS: Knots
F.T.: Full Throttle
S.L.: Sea Level

Based on: Calculated Data

Figure 11-49. Flight Operation Instruction Chart – Two Engines – 28,000 to 24,000 Pounds

WAC R1820-80A ENGINES
PD 12K18 391361 CARBURETOR

FLIGHT OPERATION INSTRUCTION CHART
MODEL C-117D
STANDARD DAY
CHART WEIGHT LIMITS: 32,000 TO 28,000 POUNDS

EXTERNAL LOAD ITEMS: NONE
NUMBER OF ENGINES OPERATING: 2

INSTRUCTIONS FOR USING CHART. Select figure in fuel column equal to or less than amount of fuel to be used for cruising.* Move horizontally to right or left and select range value equal to or greater than the statute or nautical air miles to be flown. Vertically below, and opposite value nearest desired cruising altitude (ALT) read RPM, manifold pressure (MP) and mixture (MIX.) setting required. Refer to corresponding column and altitude for new power settings when gross weight falls below limits of this chart.

NOTES: Column I is for emergency high speed cruising only. Columns II, III, IV, and V give progressive increase in range at sacrifice in speed. Air miles per gallon (MI/GAL.) (NO WIND), gallons per hour (GPH) and true airspeed (TAS) are approximate values for reference. Subtract fuel allowances not available for cruising.

COLUMN I Range in Air Miles Nautical 5000 Ft	COLUMN I Range in Air Miles Nautical Sea Level	FUEL US. GAL.	COLUMN II Range in Air Miles Statute	COLUMN II Range in Air Miles Nautical	COLUMN III Range in Air Miles Statute	COLUMN III Range in Air Miles Nautical	COLUMN IV Range in Air Miles Statute	COLUMN IV Range in Air Miles Nautical	FUEL US. GAL.	COLUMN V *Range in Air Miles Statute	COLUMN V *Range in Air Miles Nautical
1121	1060	1600	1762	1530	2310	2006	2841	2467	1600	3391	2945
979	928	1400	1514	1315	1970	1711	2403	2087	1400	2867	2490
838	792	1200	1281	1112	1659	1441	2029	1762	1200	2401	2085
698	660	1000	1054	915	1366	1186	1666	1447	1000	1963	1705
556	526	800	829	720	1072	931	1302	1131	800	1520	1320
416	396	600	618	534	786	678	948	822	600	1110	960
277	264	400	412	356	524	452	632	548	400	740	640
139	132	200	206	178	262	226	316	274	200	370	320

[0.76 Stat (0.66 Naut) MI/GAL.]						PRESS. ALT FEET	[1.03 Stat (0.89 Naut) MI/GAL.]						[1.31 Stat (1.13 Naut) MI/GAL.]						[1.58 Stat (1.37 Naut) MI/GAL.]						PRESS. ALT FEET	[1.85 Stat (1.60 Naut) MI/GAL.]					
R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS		R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS	R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS	R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS		R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS
2500	F.T.	N	72	197	145	20,000																			20,000	2290	F.T.	N	56	178	131
2500	F.T.	N	103	215	172	15,000							2420	F.T.	N	93	210	168	2280	F.T.	N	73	200	160	15,000	1900	F.T.	N	48	164	131
2500	F.T.	N	138	224	194	10,000	2400	37.0	N	123	219	190	2220	33.6	N	90	204	176	2150	31.5	N	71	195	168	10,000	1640	F.T.	N	41	152	131
2500	F.T.	N	163	226	211	5000	2320	37.6	N	116	208	194	2200	34.1	N	86	193	180	2130	32.2	N	68	185	172	5000	1500	28.3	N	38	142	132
2500	46.5	N	165	218	218	S.L.	2290	37.7	N	110	197	197	2180	34.4	N	81	184	184	2100	32.8	N	64	174	174	S.L.	1440	30.8	N	35	136	136

REMARKS:

*Make allowance for warmup, takeoff and climb plus allowance for wind, reserve, and combat as required.

See Section I for RPM limitations.

EXAMPLE

At 29,000 pounds initial cruise gross weight with 1400 gallons of usable fuel (after deducting an allowance of 55 gallons for warmup, taxi, and takeoff, plus an additional allowance of 74 gallons for climb to cruise altitude, during which the aircraft flies 45 nautical air miles), to fly an additional 2490 nautical air miles at 20,000 feet altitude, maintain 2290 rpm and F.T. manifold pressure with mixture set NORMAL. Additional allowance for reserve is 10 percent of initial fuel or 170 gallons. When weight decreases below 28,000 pounds, refer to the 28,000 to 24,000 pounds chart, under Column V, at 20,000 feet.

LEGEND

ALT:	Pressure Altitude	MIX.:	Mixture
MP:	Manifold Pressure	N:	Normal
GPH.:	US Gallons Per Hour	KTS:	Knots
TAS:	True Airspeed	F.T.:	Full Throttle
IAS:	Indicated Airspeed	S.L.:	Sea Level

Data as of: 7-15-54

Based on: Calculated Data

Figure 11-50. Flight Operation Instruction Chart – Two Engines – 32,000 to 28,000 Pounds

WAC R1820-80A ENGINES
PD 12K18 391361 CARBURETOR

FLIGHT OPERATION INSTRUCTION CHART
MODEL C-117D
STANDARD DAY
CHART WEIGHT LIMITS: 36,000 TO 32,000 POUNDS

EXTERNAL LOAD ITEMS: NONE
NUMBER OF ENGINES OPERATING: 2

INSTRUCTIONS FOR USING CHART. Select figure in fuel column equal to or less than amount of fuel to be used for cruising.* Move horizontally to right or left and select range value equal to or greater than the statute or nautical air miles to be flown. Vertically below, and opposite value nearest desired cruising altitude (ALT) read RPM, manifold pressure (MP) and mixture (MIX.) setting required. Refer to corresponding column and altitude for new power settings when gross weight falls below limits of this chart.

NOTES: Column I is for emergency high speed cruising only. Columns II, III, IV, and V give progressive increase in range at sacrifice in speed. Air miles per gallon (MI/GAL.) (NO WIND), gallons per hour (GPH) and true airspeed (TAS) are approximate values for reference. Subtract fuel allowances not available for cruising.

COLUMN I		FUEL	COLUMN II		COLUMN III		COLUMN IV		FUEL	COLUMN V	
Range in Air Miles		US.	Range in Air Miles		Range in Air Miles		Range in Air Miles		US.	Range in Air Miles	
Nautical 5000 Ft	Nautical Sea Level	GAL.	Statute	Nautical	Statute	Nautical	Statute	Nautical	GAL.	Statute	Nautical
1108	1048	1600	1628	1414	2074	1801	2501	2172	1600	2988	2595
966	917	1400	1404	1219	1780	1546	2141	1859	1400	2551	2215
827	785	1200	1197	1039	1510	1311	1807	1569	1200	2159	1875
689	654	1000	995	864	1245	1081	1490	1294	1000	1785	1550
551	522	800	788	684	986	856	1173	1019	800	1416	1230
411	390	600	582	510	726	630	864	750	600	1056	918
276	260	400	388	340	484	420	576	500	400	704	612
137	130	200	194	170	242	210	288	250	200	352	306

[0.75 Stat (0.65 Naut) MI/GAL.]						PRESS. ALT FEET	[0.97 Stat (0.85 Naut) MI/GAL.]						[1.21 Stat (1.05 Naut) MI/GAL.]						[1.44 Stat (1.25 Naut) MI/GAL.]						PRESS. ALT FEET	[1.76 Stat (1.53 Naut) MI/GAL.]					
RPM	MP IN. Hg	MIX.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS		RPM	MP IN. Hg	MIX.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS	RPM	MP IN. Hg	MIX.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS	RPM	MP IN. Hg	MIX.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS		RPM	MP IN. Hg	MIX.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS
2500	F.T.	N	73	181	133	20,000																			20,000						
2500	F.T.	N	103	206	165	15,000							2460	F.T.	N	97	203	163	2320	F.T.	N	77	193	154	15,000	2080	F.T.	N	55	168	134
2500	F.T.	N	139	220	190	10,000	2430	37.4	N	128	216	187	2240	34.2	N	95	200	173	2160	32.0	N	76	190	164	10,000	1820	27.8	N	49	155	134
2500	F.T.	N	164	224	209	5000	2340	38.4	N	122	206	192	2220	34.4	N	91	190	177	2150	32.8	N	73	182	170	5000	1710	29.0	N	46	145	135
2500	46.5	N	165	215	215	S.L.	2320	38.8	N	116	196	196	2210	35.6	N	89	186	186	2140	33.6	N	70	174	174	S.L.	1600	31.0	N	41	136	136

REMARKS:

*Make allowance for warmup, takeoff and climb plus allowance for wind, reserve, and combat as required.

See Section I for RPM limitations.

EXAMPLE

At 35,000 pounds initial cruise gross weight with 800 gallons usable fuel (after deducting an allowance of 55 gallons for warmup, taxi, and takeoff, plus an additional allowance of 75 gallons for climb to cruise altitude, during which the aircraft flies 39 nautical air miles), to fly an additional 856 nautical air miles at 15,000 feet altitude, maintain 2460 rpm and F.T. manifold pressure with mixture set NORMAL. Additional allowance for reserve is 10 per cent of initial fuel or 103 gallons. When weight decreases below 32,000 pounds, refer to the 32,000 to 28,000 pounds chart, under column III, at 15,000 feet.

LEGEND

ALT:	Pressure Altitude	MIX.:	Mixture
MP:	Manifold Pressure	N:	Normal
GPH.:	US. Gallons Per Hour	KTS:	Knots
TAS:	True Airspeed	F.T.:	Full Throttle
IAS:	Indicated Airspeed	S.L.:	Sea Level

Data as of: 7-15-54

Based on: Calculated Data

Figure 11-51. Flight Operation Instruction Chart – Two Engines – 36,000 to 32,000 Pounds

WAC R1820-80A ENGINES PD 12K18 391361 CARBURETOR	FLIGHT OPERATION INSTRUCTION CHART MODEL C-117D STANDARD DAY CHART WEIGHT LIMITS: 40,000 TO 36,000 POUNDS	EXTERNAL LOAD ITEMS: NONE NUMBER OF ENGINES OPERATING: 2

INSTRUCTIONS FOR USING CHART. Select figure in fuel column equal to or less than amount of fuel to be used for cruising.* Move horizontally to right or left and select range value equal to or greater than the statute or nautical air miles to be flown. Vertically below, and opposite value nearest desired cruising altitude (ALT) read RPM, manifold pressure (MP) and mixture (MIX.) setting required. Refer to corresponding column and altitude for new power settings when gross weight falls below limits of this chart.

NOTES: Column I is for emergency high speed cruising only. Columns II, III, IV, and V give progressive increase in range at sacrifice in speed. Air miles per gallon (MI/GAL.) (NO WIND), gallons per hour (GPH) and true airspeed (TAS) are approximate values for reference. Subtract fuel allowances not available for cruising.

COLUMN I		FUEL US. GAL.	COLUMN II		COLUMN III		COLUMN IV		FUEL US. GAL.	COLUMN V	
Range in Air Miles			Range in Air Miles		Range in Air Miles		Range in Air Miles			Range in Air Miles	
Nautical 5000 Ft	Nautical Sea Level		Statute	Nautical	Statute	Nautical	Statute	Nautical		Statute	Nautical
1088	1035	1600	1520	1320	1900	1650	2257	1960	1600	2654	2305
952	903	1400	1324	1150	1635	1420	1935	1680	1400	2292	1990
813	770	1200	1129	980	1387	1204	1641	1425	1200	1935	1680
675	640	1000	939	815	1146	995	1353	1175	1000	1583	1375
538	512	800	737	640	904	785	1059	920	800	1232	1070
403	384	600	558	480	666	581	781	678	600	894	780
270	256	400	372	320	444	387	521	452	400	596	520
138	128	200	186	160	222	194	260	226	200	298	260
[0.74 Stat (0.64 Naut) MI/GAL.]			[0.93 Stat (0.80 Naut) MI/GAL.]		[1.11 Stat (0.97 Naut) MI/GAL.]		[1.31 Stat (1.13 Naut) MI/GAL.]			[1.49 Stat (1.30 Naut) MI/GAL.]	

R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS	PRESS. ALT FEET	R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS	R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS	R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS	PRESS. ALT FEET	R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS
						20,000																			20,000						
2500	F.T.	N	102	196	157	15,000													2360	F.T.	N	82	186	149	15,000	2310	F.T.	N	68	174	139
2500	F.T.	N	139	214	185	10,000	2450	37.8	N	132	211	183	2260	35.0	N	103	198	171	2190	32.8	N	82	186	161	10,000	2150	28.9	N	57	161	139
2500	F.T.	N	164	221	206	5000	2350	39.1	N	127	204	190	2240	35.3	N	97	188	175	2170	33.5	N	79	179	166	5000	2000	29.8	N	55	149	139
2500	46.5	N	165	212	212	S.L.	2330	39.3	N	120	193	193	2220	35.6	N	93	179	179	2160	34.1	N	75	171	171	S.L.	1840	31.0	N	51	139	139

REMARKS

*Make allowance for warmup, takeoff and climb plus allowance for wind, reserve, and combat as required.

See Section I for RPM limitations.

EXAMPLE

At 38,000 pounds initial cruise gross weight with 1000 gallons of usable fuel (after deducting an allowance of 55 gallons for warmup, taxi, and takeoff, plus an additional allowance of 29 gallons for climb to cruise altitude, during which the aircraft flies 10 nautical air miles), to fly an additional 1175 nautical miles at 5000 feet altitude, maintain 2170 rpm and 33.5 inches manifold pressure with mixture set NORMAL. Additional allowance for reserve is 10 percent of initial fuel or 120 gallons. When weight decreases below 36,000 pounds, refer to the 36,000 to 32,000 pounds chart, under column IV, at 5000 feet.

LEGEND

ALT:	Pressure Altitude	MIX.:	Mixture
MP:	Manifold Pressure	N:	Normal
GPH.:	US. Gallons Per Hour	KTS:	Knots
TAS:	True Airspeed	F.T.:	Full Throttle
IAS:	Indicated Airspeed	S.L.:	Sea Level

Data as of: 7-15-54

Based on: Calculated Data

Figure 11-52. Flight Operation Instruction Chart – Two Engines – 40,000 to 36,000 Pounds

MAXIMUM ENDURANCE
MODEL C-117D
WAC R1820-80A ENGINES
PD 12K18 391361 CARBURETOR
STANDARD DAY

TWO ENGINES – Gross Weight: 38,000 Pounds						ONE ENGINE – Gross Weight: 32,000 Pounds				
Approximate				KIAS	Altitude (Feet)	KIAS	Approximate			
Lb/Hr	Mix.	RPM	MP (In. Hg)				MP (In. Hg)	RPM	Mix.	Lb/Hr
460	N	1530	30.8	119	Sea Level	125	38.0	2300	N	680
510	N	1650	28.8	119	5000	125	39.1	2360	N	770
570	N	1780	27.5	119	10,000					
640	N	2060	26.2	119	15,000					
800	N	2500	24.7	120	20,000					
TWO ENGINES – Gross Weight: 34,000 Pounds						ONE ENGINE – Gross Weight: 29,000 Pounds				
Approximate				KIAS	Altitude (Feet)	KIAS	Approximate			
Lb/Hr	Mix.	RPM	MP (In. Hg)				MP (In. Hg)	RPM	Mix.	Lb/Hr
390	N	1400	29.8	112	Sea Level	119	34.8	2190	N	520
420	N	1400	27.8	112	5000	119	35.3	2260	N	585
460	N	1590	26.0	112	10,000	119	35.5	2410	N	695
530	N	1860	24.2	113	15,000					
630	N	2240	22.9	113	20,000					
TWO ENGINES – Gross Weight: 30,000 Pounds						ONE ENGINE – Gross Weight: 26,000 Pounds				
Approximate				KIAS	Altitude (Feet)	KIAS	Approximate			
Lb/Hr	Mix.	RPM	MP (In. Hg)				MP (In. Hg)	RPM	Mix.	Lb/Hr
340	N	1400	27.8	105	Sea Level	112	32.4	2070	N	380
360	N	1400	25.8	105	5000	112	32.1	2135	N	430
385	N	1440	24.2	105	10,000	112	32.4	2175	N	485
440	N	1670	22.5	106	15,000					
510	N	2000	21.2	106	20,000					
TWO ENGINES – Gross Weight: 26,000 Pounds						ONE ENGINE – Gross Weight: 23,000 Pounds				
Approximate				KIAS	Altitude (Feet)	KIAS	Approximate			
Lb/Hr	Mix.	RPM	MP (In. Hg)				MP (In. Hg)	RPM	Mix.	Lb/Hr
270	N	1400	25.3	98	Sea Level	106	31.0	1840	N	280
290	N	1400	23.4	98	5000	106	29.8	1960	N	310
320	N	1400	21.8	98	10,000	106	29.3	2050	N	340
350	N	1480	20.5	99	15,000					
400	N	1750	19.2	99	20,000					
TWO ENGINES – Gross Weight: 22,000 Pounds						ONE ENGINE – Gross Weight: 20,000 Pounds				
Approximate				KIAS	Altitude (Feet)	KIAS	Approximate			
Lb/Hr	Mix	RPM	MP (In. Hg)				MP (In. Hg)	RPM	Mix.	Lb/Hr
230	N	1400	23.5	91	Sea Level	99	30.7	1480	N	225
240	N	1400	21.4	91	5000	99	28.8	1570	N	245
250	N	1400	19.6	91	10,000	99	27.2	1700	N	270
270	N	1400	18.3	91	15,000					
305	N	1530	17.2	91	20,000					

Data as of: 6-22-53

NOTE

Continuous operation in the following rpm ranges shall be avoided: 1400 – 1800, 2150 – 2500.

N = Normal

Fuel Grade = 115/145

Fuel Density = 6.0 lb/gal.

Based on: Calculated Data

Figure 11-53. Maximum Endurance – Two Engines 22,000 to 38,000 Pounds, One Engine 20,000 to 32,000 Pounds

LANDING DISTANCE (FEET)

MODEL C-117D

WAC R1820-80A ENGINES

FULL FLAPS – HARD SURFACE – NO WIND

STANDARD DAY

Gross Weight (Pounds)	At Sea Level		At 2000 Ft		At 4000 Ft		At 6000 Ft	
	Ground Roll	Clear 50 Ft	Ground Roll	Clear 50 Ft	Ground Roll	Clear 50 Ft	Ground Roll	Clear 50 Ft
20,000	680	1320	720	1380	765	1440	810	1505
22,000	745	1415	790	1480	840	1545	890	1615
24,000	815	1505	865	1575	915	1650	970	1730
26,000	880	1600	935	1675	990	1755	1055	1840
28,000	950	1690	1005	1770	1065	1860	1135	1950
30,000	1015	1780	1080	1865	1145	1965	1215	2060
32,000	1080	1870	1150	1960	1220	2070	1295	2170
34,000	1150	1960	1220	2055	1295	2175	1375	2285

REMARKS:

1. Landing distances are aircraft requirements under normal service conditions.
2. Recommended KIAS over approach end of runway, full flaps:

    82 knots at 26,000 pounds
    88 knots at 30,000 pounds
    93 knots at 34,000 pounds

Data as of: 6-22-53

Based on: Flight Test Data

Figure 11-54. Landing Distance – Feet

ALPHABETICAL INDEX

Primary heads are listed flush with left-hand margin. Secondary subjects are indented under related subjects. The number following subject indicates page on which text appears. Items underlined indicate tables and illustrations contained in the text, followed by page on which they appear.

U.S. GOVERNMENT PRINTING OFFICE: 1972-483—680/53

[redacted]

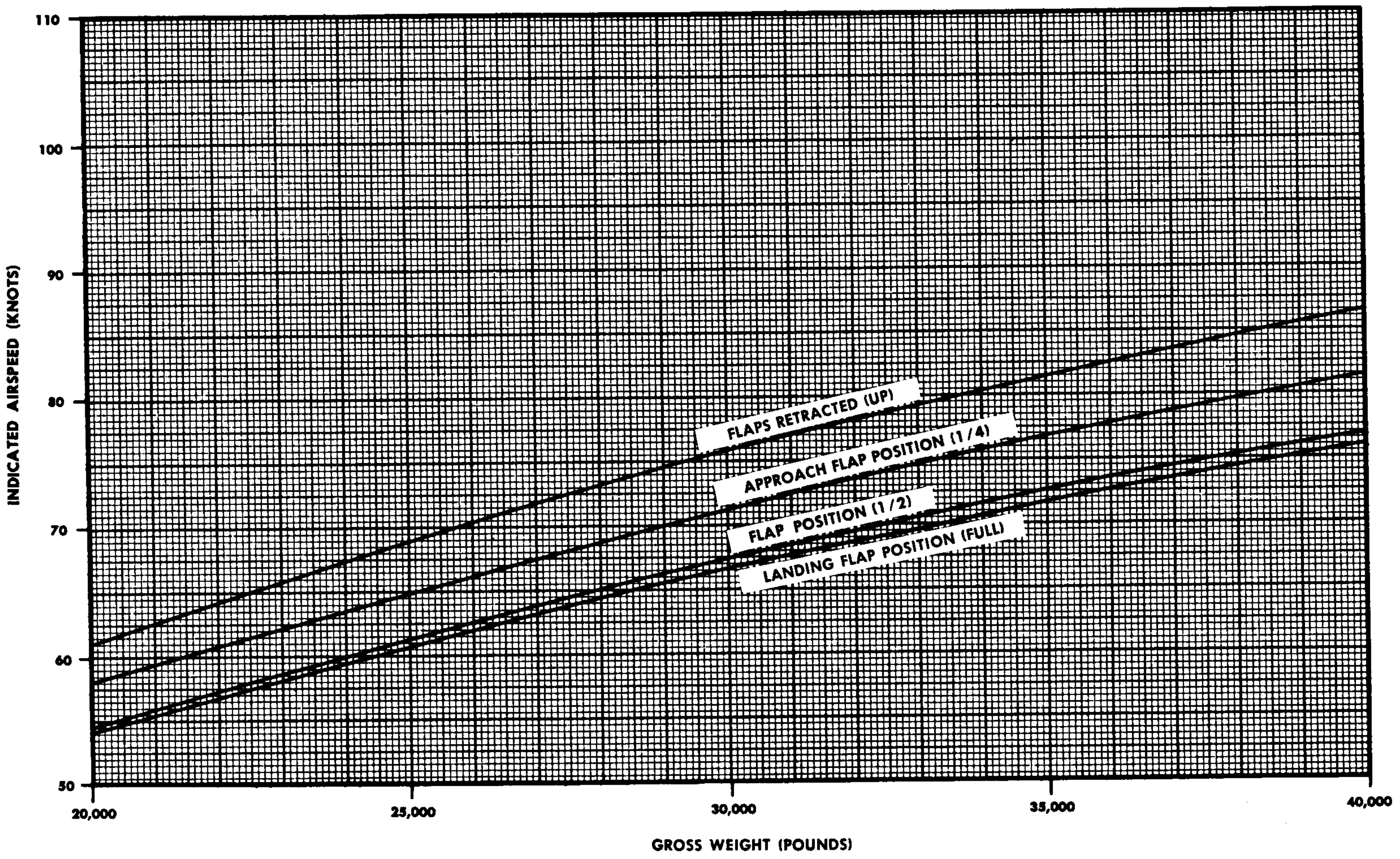
INDICATED STALLING SPEED

MODEL C-117D

PROPELLER IN LOW PITCH

ZERO THRUST

CG AT 10 PERCENT MAC



DATA AS OF: 6-22-53

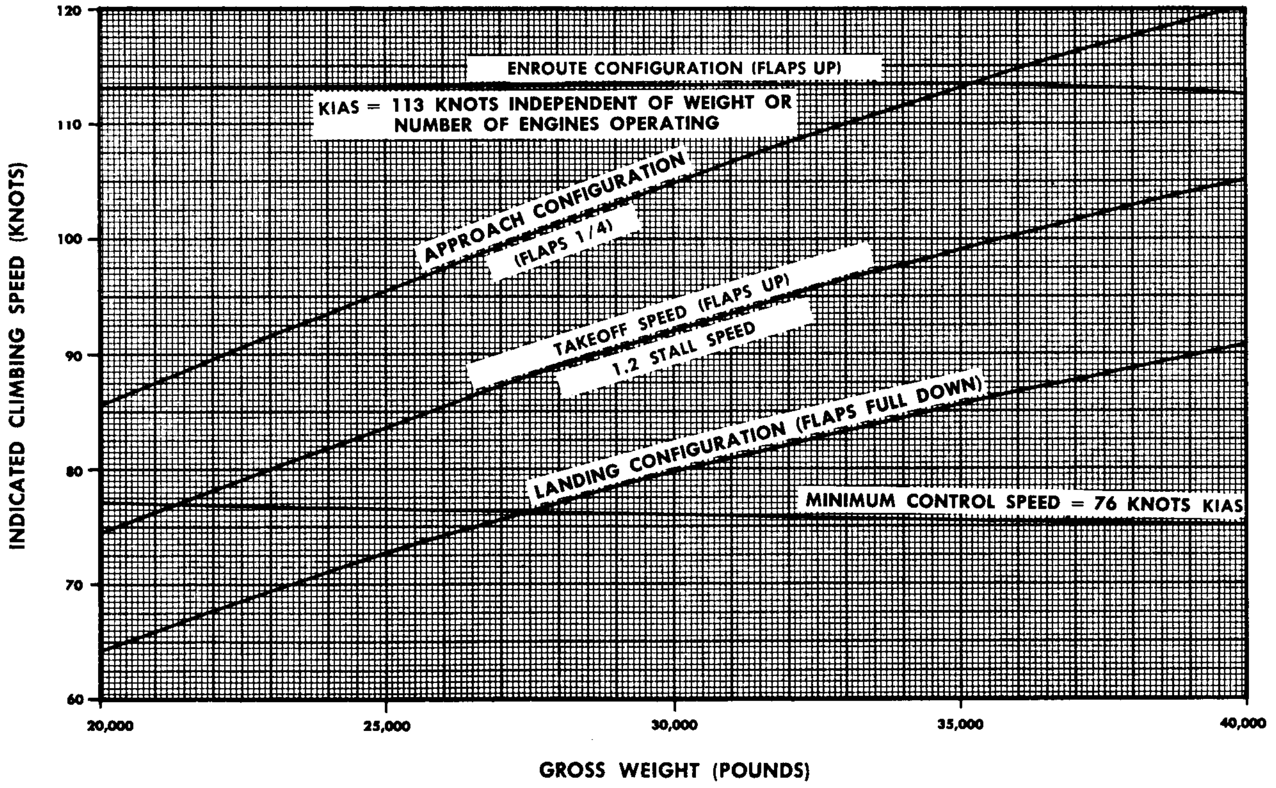
DATA BASIS: FLIGHT TEST

99-IXX

Figure 11-2. Indicated Stalling Speed

INDICATED CLIMBING SPEED

MODEL C-117D
WAC R1820-80A ENGINES
NO. 3417A HAMILTON STANDARD PROPELLER
6615 A-O BLADE



N11/71
XXI-72

DATA AS OF: 6-22-53

DATA BASIS: FLIGHT TEST

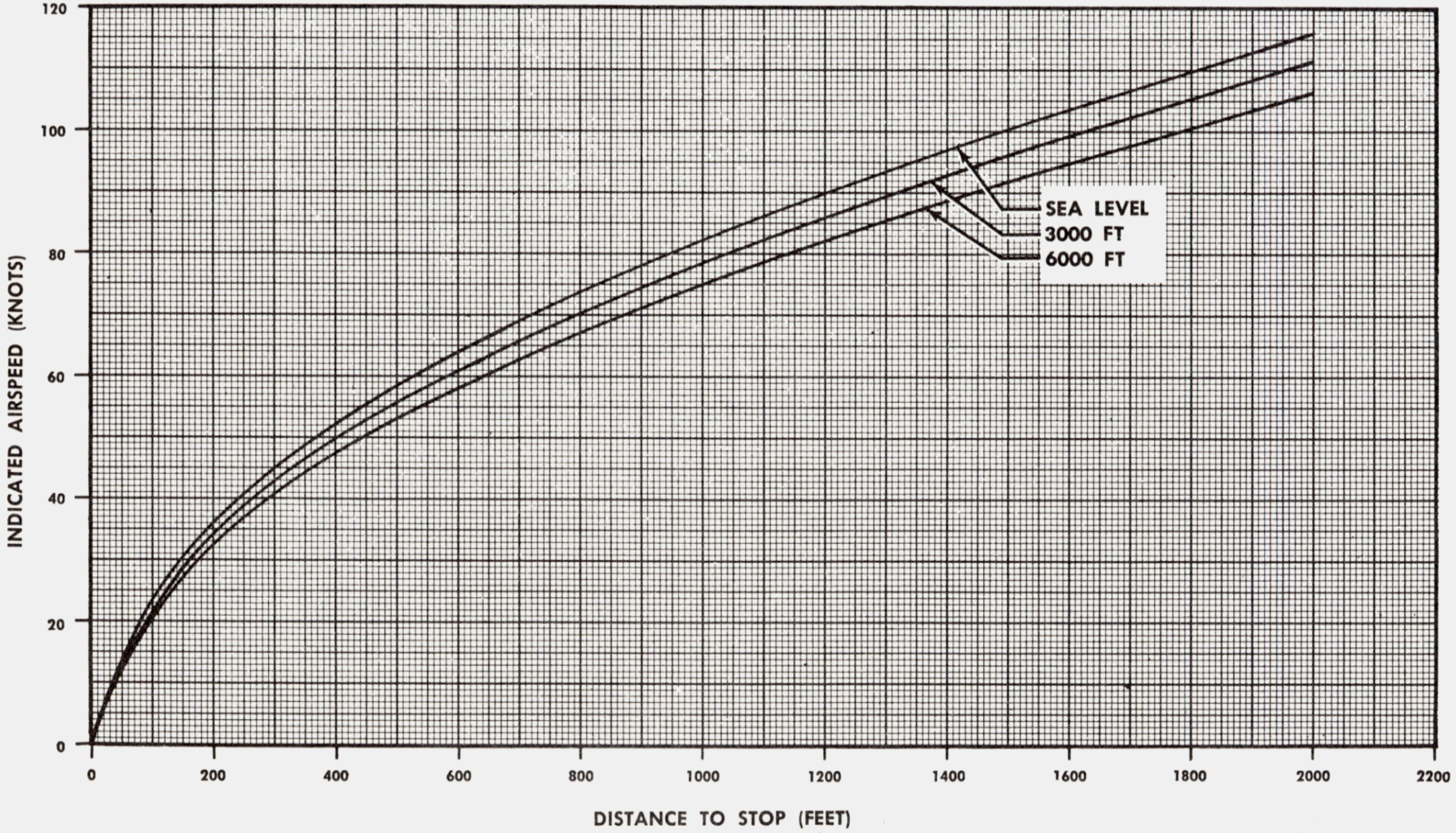
Figure 11-11. Takeoff Speed and Indicated Climbing Speeds

NOTES:

1. Zero wind
2. Refer to Section III for emergency procedures.

TAKEOFF PERFORMANCE STOPPING DISTANCE

MODEL C-117D



Determine the takeoff ground roll from the Takeoff Ground Roll Distance Chart (figure 11-12). Subtract the takeoff ground roll from runway length available and enter the chart with this figure to determine refusal speed.

EXAMPLE

Sea level runway available 4000 feet
Takeoff ground roll 3000 feet

Enter the chart at 1000 feet. Distance to stop, proceed up to the sea level line, and left to find refusal speed of 82 knots. If the refusal speed is less than takeoff speed, there is insufficient runway to stop the aircraft if one engine should fail after passing refusal speed. There may not be sufficient runway available to continue takeoff.

XX1-74

Figure 11-13. Takeoff Performance – Stopping Distance

ESTIMATED TWO-ENGINE EMERGENCY CLIMB

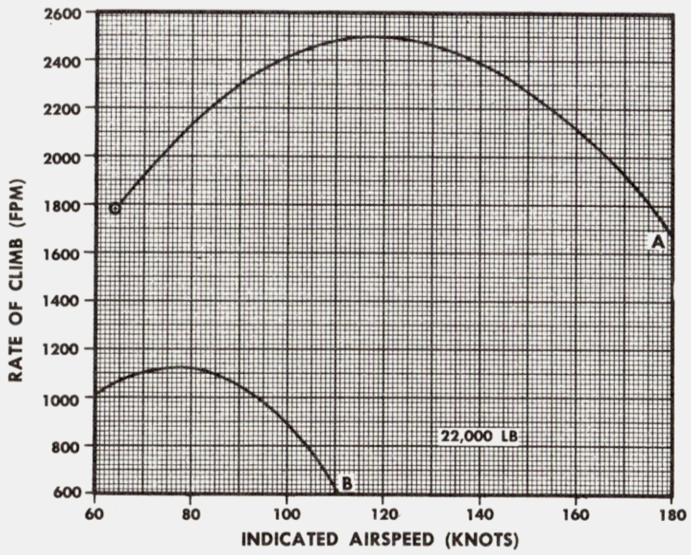
MODEL C-117D
WAC R1820-80A ENGINES
HAMILTON STANDARD PROPELLER NO. 3417A, BLADE NO. 6615A-0
STANDARD ATMOSPHERIC CONDITIONS
SEA LEVEL

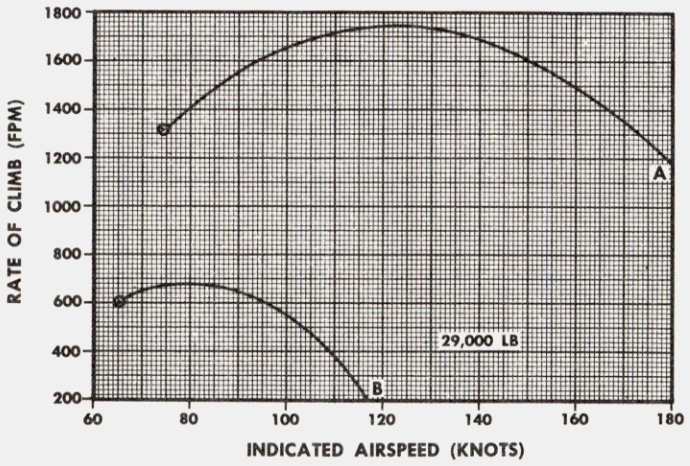
CONDITIONS

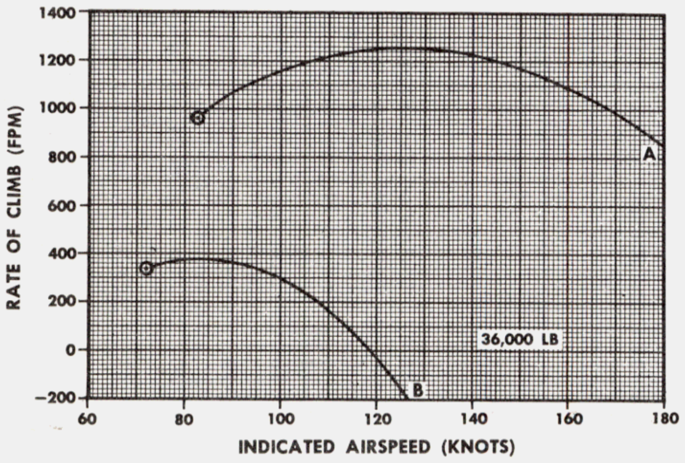
1. Cowl flaps open to +6 degrees
2. 1475 BHP—2800 RPM

CONFIGURATION

A. Flaps up, gear up
B. Flaps full down, gear down
⊙ DENOTES STALLING SPEED







DATA AS OF: 6-22-53

BASED ON: CALCULATED DATA

N11/71
XX1-75

Figure 11-14. Estimated Two-Engine Emergency Climb

ESTIMATED SINGLE-ENGINE EMERGENCY CLIMB

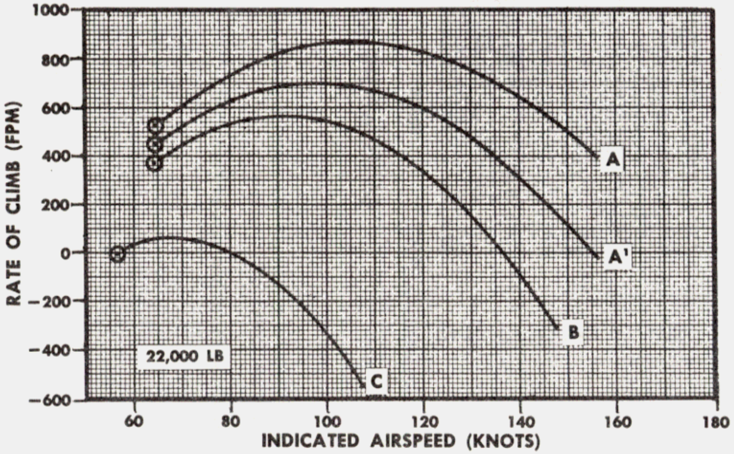
MODEL C-117D
WAC R1820-80A ENGINES
HAMILTON STANDARD PROPELLER NO. 3417A, BLADE NO. 6615A-0
STANDARD ATMOSPHERIC CONDITIONS
SEA LEVEL
FUEL GRADE: 100/130—115/145
FUEL DENSITY: 6.0 LB/GAL

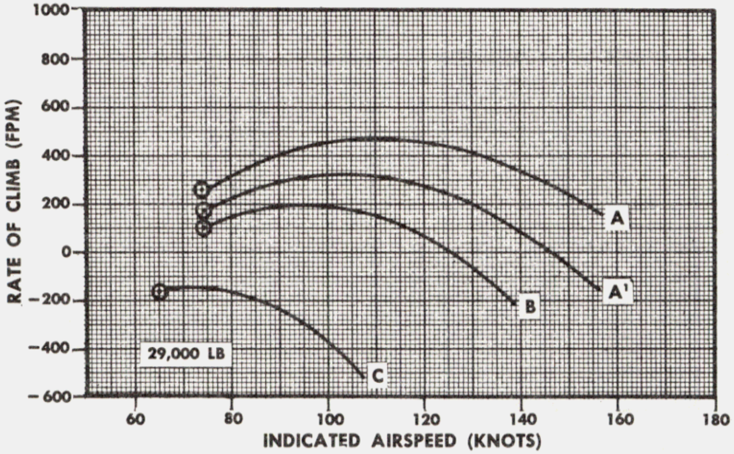
CONDITIONS: 1475BHP—2800 RPM

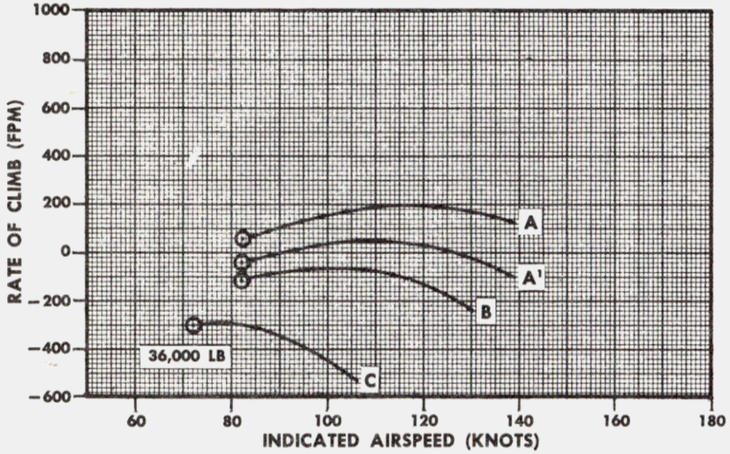
⊙ DENOTES STALLING SPEED

CONFIGURATION

CURVE	FLAP SETTING	GEAR POSITION	INOPERATIVE ENGINE	
			PROPELLER	COWL FLAPS
A	UP	UP	FEATHERED	+ 6 DEG
A'	UP	UP	WINDMILLING	+ 6 DEG
B	UP	DOWN	FEATHERED	+ 6 DEG
C	FULL DOWN	DOWN	FEATHERED	+ 6 DEG







N11/71
XX1-76

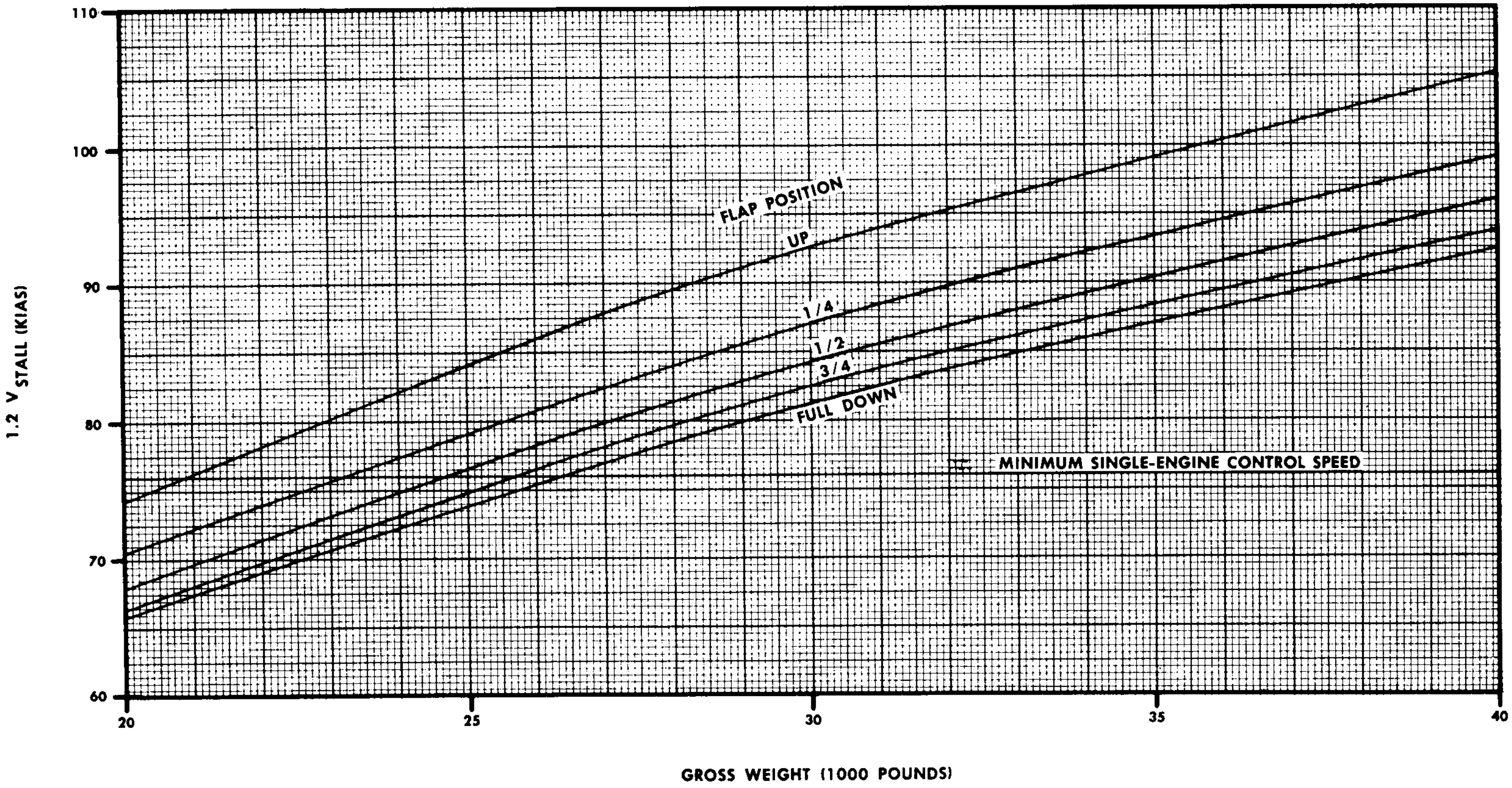
DATA AS OF: 6-22-53

BASED ON: CALCULATED DATA

Figure 11-15. Estimated Single-Engine Emergency Climb

1.2 STALL SPEEDS

MODEL C-117D



XX1-101

DATA BASIS: FLIGHT TEST

DATA AS OF: 5-15-67

Figure 11-40. 1.2 Stall Speed

TAKEOFF DISTANCES (FEET)
MODEL C-117D
WAC R1820-80A ENGINES
FLAPS UP – HARD-SURFACE RUNWAY

Gross Weight (Pounds)	Pressure Altitude (Feet)	-5 Degrees C				+15 Degrees C				+35 Degrees C				+55 Degrees C			
		Zero Wind		30-Knot Wind		Zero Wind		30-Knot Wind		Zero Wind		30-Knot Wind		Zero Wind		30-Knot Wind	
		Ground Run	Clear 50 Ft	Ground Run	Clear 50 Ft	Ground Run	Clear 50 Ft	Ground Run	Clear 50 Ft	Ground Run	Clear 50 Ft	Ground Run	Clear 50 Ft	Ground Run	Clear 50 Ft	Ground Run	Clear 50 Ft
40,000	Sea Level	3490	4120	1950	2320	4090	4805	2460	2873	4760	5570	3010	3471				
	1000	3900	4560	2250	2635	4420	5168	2670	3100								
	2000	4230	4915	2580	2978	4650	5440	2840	3291								
	3000	4570	5300	2870	3290												
	4000																
	5000																
35,000	Sea Level	2410	2865	1220	1502	2800	3308	1490	1798	3180	3755	1720	2062	4000	4687	2370	2769
	1000	2665	3135	1400	1689	3015	3545	1620	1939	3460	4055	1930	2282	4040	4780	2400	2775
	2000	2890	3380	1510	1809	3265	3825	1810	2145	3820	4475	2260	2642	4610	5458	2800	3280
	3000	3110	3630	1720	2034	3595	4213	2080	2444	4270	4992	2630	3046				
	4000	3440	4020	1935	2280	3975	4657	2330	2726	4660	5462	2900	3357				
	5000	3840	4479	2260	2635	4460	5210	2690	3121								
30,000	Sea Level	1720	2045	860	1075	1930	2290	940	1174	2150	2550	1050	1304	2680	3145	1380	1667
	1000	1860	2200	940	1163	2045	2417	1030	1270	2310	2720	1240	1499	2830	3270	1490	1765
	2000	1980	2325	970	1196	2200	2590	1130	1379	2520	2965	1340	1616	2980	3545	1590	1927
	3000	2100	2465	1040	1276	2390	2812	1250	1515	2785	3275	1490	1790	3280	3905	1860	2227
	4000	2300	2700	1200	1454	2610	3073	1400	1686	3010	3545	1610	1932	3500	4190	1970	2370
	5000	2530	2968	1340	1613	2890	3395	1550	1856	3350	3940	1900	2250	3890	4673	2300	2748
25,000	Sea Level	1120	1380	510	688	1270	1543	590	776	1425	1715	680	876	1760	2080	830	1043
	1000	1220	1485	560	741	1360	1638	650	838	1530	1825	740	938	1850	2180	880	1100
	2000	1310	1580	610	794	1460	1745	700	893	1660	1970	800	1007	1935	2310	940	1502
	3000	1395	1670	660	847	1580	1880	740	942	1815	2147	920	1139	2110	2518	1040	1299
	4000	1530	1820	750	946	1715	2033	800	1012	1950	2305	970	1201	2220	2662	1080	1355
	5000	1670	1975	800	1004	1880	2221	940	1163	2165	2550	1070	1316	2410	2905	1285	1587

REMARKS: Takeoff distances are aircraft requirements under normal service conditions.
Military maximum overload takeoff gross weight = 36,800 pounds. See figure A-9 for takeoff power schedule.

Fuel Grade: 115/145
Fuel Density: 6 lb/gal.

Data as of: 7-15-54

Based on: Flight Test Data

Figure 11-42. Takeoff Distance – Feet – Zero Degree Flaps – Hard-Surface Runway

WAC R1820-80A ENGINES PD 12K18 391361 CARBURETOR	FLIGHT OPERATION INSTRUCTION CHART MODEL C-117D STANDARD DAY CHART WEIGHT LIMITS: 24,000 TO 20,000 POUNDS	EXTERNAL LOAD ITEMS: NONE NUMBER OF ENGINES OPERATING: 1

INSTRUCTIONS FOR USING CHART. Select figure in fuel column equal to or less than amount of fuel to be used for cruising.* Move horizontally to right or left and select range value equal to or greater than the statute or nautical air miles to be flown. Vertically below, and opposite value nearest desired cruising altitude (ALT) read RPM, manifold pressure (MP) and mixture (MIX.) setting required.

NOTES: Column I is for emergency high-speed cruising only. Columns II, III, IV, and V give progressive increase in range at sacrifice in speed. Air miles per gallon (MI/GAL.) (NO WIND), gallons per hour (GPH) and true airspeed (TAS) are approximate values for reference. Subtract fuel allowances not available for cruising.

COLUMN I		FUEL US. GAL.	COLUMN II		COLUMN III		COLUMN IV		FUEL US. GAL.	COLUMN V	
Range in Air Miles			Range in Air Miles		Range in Air Miles		Range in Air Miles			Range in Air Miles	
Nautical 5000 Ft	Nautical Sea Level		Statute	Nautical	Statute	Nautical	Statute	Nautical		Statute	Nautical
		1600							1600		
		1400							1400		
		1200							1200		
		1000							1000		
		800							800		
615	588	600	852	744	1026	894	1200	1044	600	1380	1200
409	392	400	568	496	684	596	800	696	400	920	800
205	196	200	284	248	342	298	400	348	200	460	400

[1.13 Stat (0.98 Naut) MI/GAL.]						PRESS. ALT FEET	[1.42 Stat (1.24 Naut) MI/GAL.]						[1.71 Stat (1.49 Naut) MI/GAL.]						[2.00 Stat (1.74 Naut) MI/GAL.]						PRESS. ALT FEET	[2.30 Stat (2.00 Naut) MI/GAL.]					
R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS		R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS	R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS	R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS		R P M	MP IN. Hg	M I X.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS
						20,000																			20,000						
						15,000																			15,000						
2500	F.T.	N	132	163	141	10,000	2490	F.T.	N	132	163	141	2280	F.T.	N	101	151	131	2180	32.6	N	81	141	122	10,000	2120	30.9	N	66	130	112
2500	F.T.	N	163	169	157	5,000	2360	38.9	N	127	157	146	2240	35.2	N	97	145	135	2170	33.3	N	78	136	127	5,000	2080	31.1	N	60	123	115
2500	46.5	N	165	163	163	S.L.	2330	39.2	N	121	149	149	2230	35.7	N	93	139	139	2160	34.3	N	76	133	133	S.L.	2040	31.7	N	56	117	117

REMARKS:

*Make allowance for warmup, takeoff and climb plus allowance for wind, reserve, and combat as required.

See Section I for RPM limitations.

EXAMPLE

At 24,000 pounds gross weight with 600 gallons of remaining usable fuel, to fly 1200 nautical air miles at 5000 feet altitude, maintain 2080 rpm and 31.1 inches manifold pressure with mixture set NORMAL.

LEGEND

ALT: Pressure Altitude
MP: Manifold Pressure
GPH: US. Gallons per Hour
TAS: True Airspeed
IAS: Indicated Airspeed
MIX.: Mixture
N: Normal
KTS.: Knots
F.T.: Full Throttle
S.L.: Sea Level

Data as of: 7-15-54

Based on: Calculated Data

Figure 11-45. Flight Operation Instruction Chart – One Engine – 24,000 to 20,000 Pounds

WAC R1820-80A ENGINES PD 12K18 391361 CARBURETOR	FLIGHT OPERATION INSTRUCTION CHART MODEL C-117D STANDARD DAY CHART WEIGHT LIMITS: 28,000 TO 24,000 POUNDS	EXTERNAL LOAD ITEMS: NONE NUMBER OF ENGINES OPERATING: 1

INSTRUCTIONS FOR USING CHART. Select figure in fuel column equal to or less than amount of fuel to be used for cruising.* Move horizontally to right or left and select range value equal to or greater than the statute or nautical air miles to be flown. Vertically below, and opposite value nearest desired cruising altitude (ALT) read RPM, manifold pressure (MP) and mixture (MIX.) setting required. Refer to corresponding column and altitude for new power settings when gross weight falls below limits of this chart.

NOTES: Column I is for emergency high-speed cruising only. Columns II, III, IV, and V give progressive increase in range at sacrifice in speed. Air miles per gallon (MI/GAL.) (NO WIND), gallons per hour (GPH) and true airspeed (TAS) are approximate values for reference.
Subtract fuel allowances not available for cruising.

COLUMN I		FUEL US. GAL.	COLUMN II		COLUMN III		COLUMN IV		FUEL US. GAL.	COLUMN V	
Range in Air Miles			Range in Air Miles		Range in Air Miles		Range in Air Miles			Range in Air Miles	
Nautical											
5000 Ft	Sea Level		Statute	Nautical	Statute	Nautical	Statute	Nautical		Statute	Nautical
		1600							1600		
		1400							1400		
1228	1165	1200	1562	1356	1780	1546	2001	1738	1200	2225	1932
1006	966	1000	1274	1106	1437	1248	1600	1389	1000	1763	1531
799	770	800	988	858	1094	950	1199	1041	800	1305	1133
597	576	600	720	624	780	678	840	726	600	894	780
398	384	400	480	416	520	452	560	484	400	596	520
200	192	200	240	208	260	226	280	242	200	298	260

[1.11 Stat (0.96 Naut) MI/GAL.]						PRESS. ALT FEET	[1.20 Stat (1.04 Naut) MI/GAL.]						[1.30 Stat (1.13 Naut) MI/GAL.]					
R P M	MP IN. Hg	M I X.	Approx				R P M	MP IN. Hg	M I X.	Approx			R P M	MP IN. Hg	M I X.	Approx		
			GPH Per Eng	Airspeed (Knots)						GPH Per Eng	Airspeed (Knots)					GPH Per Eng	Airspeed (Knots)	
				TAS	IAS						TAS	IAS					TAS	IAS
						20,000												
						15,000												
2500	F.T.	N	132	151	131	10,000												
2500	F.T.	N	163	163	152	5000	2440	42.2	N	151	157	147	2380	39.8	N	135	152	141
2500	46.5	N	165	159	159	S.L.	2420	42.4	N	145	151	151	2370	40.2	N	129	145	145

[1.40 Stat (1.21 Naut) MI/GAL.]						PRESS. ALT FEET	[1.49 Stat (1.30 Naut) MI/GAL.]					
R P M	MP IN. Hg	M I X.	Approx				R P M	MP IN. Hg	M I X.	Approx		
			GPH Per Eng	Airspeed (Knots)						GPH Per Eng	Airspeed (Knots)	
				TAS	IAS						TAS	IAS
						20,000						
						15,000						
2430	F.T.	N	121	146	126	10,000	2310	F.T.	N	104	133	115
2330	38.1	N	120	145	135	5000	2200	34.3	N	88	125	116
2320	38.4	N	116	140	140	S.L.	2170	34.1	N	75	118	118

REMARKS:

*Make allowance for warmup, takeoff and climb plus allowance for wind, reserve, and combat as required.

See Section I for RPM limitations.

EXAMPLE

At 25,000 pounds gross weight with 800 gallons of remaining usable fuel, to fly 950 nautical air miles at 5000 feet altitude, maintain 2380 rpm and 39.8 inches manifold pressure with mixture set NORMAL. When weight decreases below 24,000 pounds, refer to the 24,000 to 20,000 pounds chart, under column III, at 5000 feet.

LEGEND

ALT: Pressure Altitude
MP: Manifold Pressure
GPH.: US. Gallons Per Hour
TAS: True Airspeed
IAS: Indicated Airspeed
MIX.: Mixture
N: Normal
KTS: Knots
F.T.: Full Throttle
S.L.: Sea Level

Data as of: 7-15-54

Based on: Calculated Data

Figure 11-46. Flight Operation Instruction Chart – One Engine – 28,000 to 24,000 Pounds

WAC R1820-80A ENGINES PD 12K18 391361 CARBURETOR	FLIGHT OPERATION INSTRUCTION CHART MODEL C-117D STANDARD DAY CHART WEIGHT LIMITS: 32,000 TO 28,000 POUNDS	EXTERNAL LOAD ITEMS: NONE NUMBER OF ENGINES OPERATING: 1

INSTRUCTIONS FOR USING CHART. Select figure in fuel column equal to or less than amount of fuel to be used for cruising.* Move horizontally to right or left and select range value equal to or greater than the statute or nautical air miles to be flown. Vertically below, and opposite value nearest desired cruising altitude (ALT) read RPM, manifold pressure (MP) and mixture (MIX.) setting required. Refer to corresponding column and altitude for new power settings when gross weight falls below limits of this chart.

NOTES: Column I is for emergency high-speed cruising only. Columns II, III, IV, and V give progressive increase in range at sacrifice in speed. Air miles per gallon (MI/GAL.) (NO WIND), gallons per hour (GPH) and true airspeed (TAS) are approximate values for reference. Subtract fuel allowances not available for cruising.

COLUMN I		FUEL	COLUMN II		COLUMN III		COLUMN IV		FUEL	COLUMN V	
Range in Air Miles		US.	Range in Air Miles		Range in Air Miles		Range in Air Miles		US.	Range in Air Miles	
Nautical		GAL.							GAL.		
5000 Ft	Sea Level		Statute	Nautical	Statute	Nautical	Statute	Nautical		Statute	Nautical
1572	1520	1600	1912	1660	2076	1803	2247	1951	1600	2413	2095
1383	1323	1400	1625	1411	1735	1507	1844	1601	1400	1952	1695
1164	1125	1200	1375	1194	1451	1260	1526	1325	1200	1600	1389
964	934	1000	1137	987	1192	1035	1246	1082	1000	1300	1129
766	746	800	898	780	933	810	965	838	800	1001	869
568	552	600	660	570	678	588	702	606	600	720	624
378	368	400	440	380	452	392	468	404	400	480	416
189	184	200	220	190	226	196	234	202	200	240	208

[1.06 Stat (0.92 Naut) MI/GAL.]						PRESS.	[1.10 Stat (0.95 Naut) MI/GAL.]						[1.13 Stat (0.98 Naut) MI/GAL.]						[1.17 Stat (1.01 Naut) MI/GAL.]						PRESS.	[1.20 Stat (1.04 Naut) MI/GAL.]					
R P M	MP IN. Hg	M I X.	Approx			ALT	R P M	MP IN. Hg	M I X.	Approx			R P M	MP IN. Hg	M I X.	Approx			R P M	MP IN. Hg	M I X.	Approx			ALT	R P M	MP IN. Hg	M I X.	Approx		
			GPH Per Eng	Airspeed (Knots)						GPH Per Eng	Airspeed (Knots)					GPH Per Eng	Airspeed (Knots)					GPH Per Eng	Airspeed (Knots)						GPH Per Eng	Airspeed (Knots)	
				TAS	IAS	FEET					TAS	IAS					TAS	IAS					TAS	IAS	FEET					TAS	IAS
						20,000																			20,000						
						15,000																			15,000						
						10,000																			10,000						
2500	F.T.	N	163	154	144	5000	2490	43.6	N	160	152	142	2430	42.0	N	149	146	136	2400	40.4	N	139	141	131	5000	2360	38.9	N	128	134	124
2500	46.5	N	165	.153	153	S. L.	2450	43.8	N	154	147	147	2430	42.5	N	146	144	144	2400	41.4	N	139	140	140	S. L.	2300	38.1	N	112	125	125

REMARKS:

*Make allowance for warmup, takeoff and climb plus allowance for wind, reserve, and combat as required.

See Section I for RPM limitations.

Data as of: 7-15-54

EXAMPLE

At 30,000 pounds gross weight with 1000 gallons of remaining usable fuel, to fly 1120 nautical air miles at 5000 feet altitude, maintain 2360 rpm and 38.9 inches manifold pressure with mixture set NORMAL. When weight decreases below 28,000 pounds, refer to the 28,000 to 24,000 pounds chart, under column V at 5000 feet.

LEGEND

ALT: Pressure Altitude
MP: Manifold Pressure
GPH: US. Gallons Per Hour
TAS: True Airspeed
IAS· Indicated Airspeed

MIX: Mixture
N: Normal
KTS: Knots
F.T.: Full Throttle
S.L.: Sea Level

Based on: Calculated Data

Figure 11-47. Flight Operation Instruction Chart – One Engine – 32,000 to 28,000 Pounds

WAC R1820-80A ENGINES
PD 12K18 391361 CARBURETOR

FLIGHT OPERATION INSTRUCTION CHART
MODEL C-117D
STANDARD DAY
CHART WEIGHT LIMITS: 24,000 TO 20,000 POUNDS

EXTERNAL LOAD ITEMS: NONE
NUMBER OF ENGINES OPERATING: 2

INSTRUCTIONS FOR USING CHART. Select figure in fuel column equal to or less than amount of fuel to be used for cruising.* Move horizontally to right or left and select range value equal to or greater than the statute or nautical air miles to be flown. Vertically below, and opposite value nearest desired cruising altitude (ALT) read RPM, manifold pressure (MP) and mixture (MIX.) setting required.

NOTES: Column I is for emergency high speed cruising only. Columns II, III, IV, and V give progressive increase in range at sacrifice in speed. Air miles per gallon (MI/GAL.) (NO WIND), gallons per hour (GPH) and true airspeed (TAS) are approximate values for reference.
Subtract fuel allowances not available for cruising.

COLUMN I		FUEL	COLUMN II		COLUMN III		COLUMN IV		FUEL	COLUMN V	
Range in Air Miles		US.	Range in Air Miles		Range in Air Miles		Range in Air Miles		US.	Range in Air Miles	
Nautical		GAL.	Statute	Nautical	Statute	Nautical	Statute	Nautical	GAL.	Statute	Nautical
5000 Ft	Sea Level										
		1600							1600		
		1400							1400		
		1200							1200		
		1000							1000		
		800							800		
425	402	600	738	642	1020	888	1296	1128	600	1572	1368
283	268	400	492	428	680	592	864	752	400	1048	912
141	134	200	246	214	340	296	432	376	200	524	456

[0.77 Stat (0.67 Naut) MI/GAL.]						PRESS.	[1.23 Stat (1.07 Naut) MI/GAL.]						[1.70 Stat (1.48 Naut) MI/GAL.]						[2.16 Stat (1.88 Naut) MI/GAL.]						PRESS.	[2.62 Stat (2.28 Naut) MI/GAL.]					
R P M	MP IN. Hg	M I X.	Approx			ALT FEET	R P M	MP IN. Hg	M I X.	Approx			R P M	MP IN. Hg	M I X.	Approx			R P M	MP IN. Hg	M I X.	Approx			ALT FEET	R P M	MP IN. Hg	M I X.	Approx		
			GPH Per Eng	Airspeed (Knots)						GPH Per Eng	Airspeed (Knots)					GPH Per Eng	Airspeed (Knots)					GPH Per Eng	Airspeed (Knots)						GPH Per Eng	Airspeed (Knots)	
				TAS	IAS						TAS	IAS					TAS	IAS					TAS	IAS						TAS	IAS
2500	F.T.	N	73	217	160	20,000							2500	F.T.	N	74	217	160	2200	F.T.	N	53	197	145	20,000	1770	F.T.	N	35	156	115
2500	F.T.	N	103	226	181	15,000							2260	F.T.	N	72	212	170	1970	F.T.	N	51	192	153	15,000	1500	F.T.	N	30	146	116
2500	F.T.	N	139	229	199	10,000	2260	34.8	N	102	217	188	2140	31.2	N	69	203	176	1800	27.6	N	48	180	156	10,000	1400	F.T.	N	28	137	118
2500	F.T.	N	164	231	215	5000	2240	35.0	N	96	205	191	2110	31.8	N	65	191	178	1720	29.1	N	45	170	158	5000	1400	24.4	N	25	128	119
2500	46.5	N	165	221	221	S.L.	2220	35.3	N	91	194	194	2080	32.4	N	61	180	180	1650	31.0	N	43	160	160	S.L.	1400	26.5	N	24	122	122

REMARKS:

*Make allowance for warmup, takeoff and climb plus allowance for wind, reserve, and combat as required. See Section I for RPM limitations.

Data as of: 7-15-54

EXAMPLE

At 23,000 pounds initial cruise gross weight with 200 gallons of usable fuel (after deducting an allowance of 55 gallons for warmup, taxi, and takeoff, plus an additional allowance of 13 gallons for climb to cruise altitude, during which the aircraft flies 4 nautical air miles), to fly an additional 456 nautical air miles at 5000 feet altitude, maintain 1400 rpm and 24.4 inches manifold pressure with mixture set NORMAL. Additional allowance for reserve is 10 percent of initial fuel or 30 gallons.

LEGEND

ALT: Pressure Altitude
MP: Manifold Pressure
GPH.: US. Gallons Per Hour
TAS: True Airspeed
IAS: Indicated Airspeed
MIX: Mixture
N: Normal
KTS: Knots
F.T.: Full Throttle
S.L.: Sea Level

Based on: Calculated Data

Figure 11-48. Flight Operation Instruction Chart – Two Engines – 24,000 to 20,000 Pounds

WAC R1820-80A ENGINES PD 12K18 391361 CARBURETOR	FLIGHT OPERATION INSTRUCTION CHART MODEL C-117D STANDARD DAY CHART WEIGHT LIMITS: 28,000 TO 24,000 POUNDS	EXTERNAL LOAD ITEMS: NONE NUMBER OF ENGINES OPERATING: 2

INSTRUCTIONS FOR USING CHART. Select figure in fuel column equal to or less than amount of fuel to be used for cruising.* Move horizontally to right or left and select range value equal to or greater than the statute or nautical air miles to be flown. Vertically below, and opposite value nearest desired cruising altitude (ALT) read RPM, manifold pressure (MP) and mixture (MIX.) setting required. Refer to corresponding column and altitude for new power settings when gross weight falls below limits of this chart.

NOTES: Column I is for emergency high speed cruising only. Columns II, III, IV, and V give progressive increase in range at sacrifice in speed. Air miles per gallon (MI/GAL.) (NO WIND), gallons per hour (GPH) and true airspeed (TAS) are approximate values for reference.
Subtract fuel allowances not available for cruising.

COLUMN I		FUEL	COLUMN II		COLUMN III		COLUMN IV		FUEL	COLUMN V	
Range in Air Miles		US.	Range in Air Miles		Range in Air Miles		Range in Air Miles		US.	Range in Air Miles	
Nautical		GAL.							GAL.		
5000 Ft	Sea Level		Statute	Nautical	Statute	Nautical	Statute	Nautical		Statute	Nautical
		1600							1600		
		1400							1400		
847	800	1200	1404	1219	1894	1645	2367	2055	1200	2856	2480
707	666	1000	1156	1004	1555	1350	1935	1680	1000	2332	2025
565	532	800	909	789	1209	1050	1503	1305	800	1808	1570
422	396	600	672	582	888	768	1104	960	600	1320	1146
283	264	400	448	388	592	512	736	640	400	880	764
141	132	200	224	194	296	256	368	320	200	440	382

[0.76 Stat (0.66 Naut) MI/GAL.]						PRESS. ALT FEET	[1.12 Stat (0.97 Naut) MI/GAL.]						[1.48 Stat (1.28 Naut) MI/GAL.]					
RPM	MP IN. Hg	MIX.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	IAS		RPM	MP IN. Hg	MIX.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	IAS	RPM	MP IN. Hg	MIX.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	IAS
2500	F.T.	N	73	209	154	20,000												
2500	F.T.	N	103	221	177	15,000							2350	F.T.	N	83	212	169
2500	F.T.	N	139	227	197	10,000	2330	35.9	N	113	219	190	2180	32.4	N	80	204	177
2500	F.T.	N	164	229	213	5000	2280	36.3	N	106	207	193	2160	33.1	N	75	193	180
2500	46.5	N	165	219	219	S.L.	2250	36.4	N	101	195	195	2150	33.8	N	72	184	184

[1.84 Stat (1.60 Naut) MI/GAL.]						PRESS. ALT FEET	[2.20 Stat (1.91 Naut) MI/GAL.]					
RPM	MP IN. Hg	MIX.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	IAS		RPM	MP IN. Hg	MIX.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	IAS
2400	F.T.	N	63	202	149	20,000	2040	F.T.	N	45	170	125
2170	F.T.	N	63	200	160	15,000	1700	F.T.	N	39	156	125
2080	29.8	N	60	191	165	10,000	1480	F.T.	N	34	146	127
2020	30.2	N	56	178	166	5000	1400	27.2	N	32	139	130
1940	31.2	N	52	167	167	S.L.	1400	29.5	N	30	133	133

REMARKS:

*Make allowance for warmup, takeoff and climb plus allowance for wind, reserve, and combat as required

See Section I for RPM limitations.

Data as of: 7-15-54

EXAMPLE

At 27,000 pounds initial cruise gross weight with 600 gallons of usable fuel (after deducting an allowance of 55 gallons for warmup, taxi, and takeoff, plus an additional allowance of 16 gallons for climb to cruise altitude, during which the aircraft flies 6 nautical air miles), to fly an additional 582 nautical air miles at 5000 feet altitude, maintain 2280 rpm and 36.3 inches manifold pressure with mixture set NORMAL. Additional allowance for reserve is 10 percent of initial fuel or 75 gallons. When weight decreases below 24,000 pounds, refer to the 24,000 to 20,000 pounds chart, under column II, at 5000 feet.

LEGEND

ALT:	Pressure Altitude	MIX.:	Mixture
MP:	Manifold Pressure	N:	Normal
GPH.:	US. Gallons Per Hour	KTS:	Knots
TAS:	True Airspeed	F.T.:	Full Throttle
IAS:	Indicated Airspeed	S.L.:	Sea Level

Based on: Calculated Data

Figure 11-49. Flight Operation Instruction Chart – Two Engines – 28,000 to 24,000 Pounds

WAC R1820-80A ENGINES PD 12K18 391361 CARBURETOR	FLIGHT OPERATION INSTRUCTION CHART MODEL C-117D STANDARD DAY CHART WEIGHT LIMITS: 32,000 TO 28,000 POUNDS	EXTERNAL LOAD ITEMS: NONE NUMBER OF ENGINES OPERATING: 2

INSTRUCTIONS FOR USING CHART. Select figure in fuel column equal to or less than amount of fuel to be used for cruising.* Move horizontally to right or left and select range value equal to or greater than the statute or nautical air miles to be flown. Vertically below, and opposite value nearest desired cruising altitude (ALT) read RPM, manifold pressure (MP) and mixture (MIX.) setting required. Refer to corresponding column and altitude for new power settings when gross weight falls below limits of this chart.

NOTES: Column I is for emergency high speed cruising only. Columns II, III, IV, and V give progressive increase in range at sacrifice in speed. Air miles per gallon (MI/GAL.) (NO WIND), gallons per hour (GPH) and true airspeed (TAS) are approximate values for reference. Subtract fuel allowances not available for cruising.

COLUMN I		FUEL US. GAL.	COLUMN II		COLUMN III		COLUMN IV		FUEL US. GAL.	COLUMN V	
Range in Air Miles			Range in Air Miles		Range in Air Miles		Range in Air Miles			*Range in Air Miles	
Nautical 5000 Ft	Nautical Sea Level		Statute	Nautical	Statute	Nautical	Statute	Nautical		Statute	Nautical
1121	1060	1600	1762	1530	2310	2006	2841	2467	1600	3391	2945
979	928	1400	1514	1315	1970	1711	2403	2087	1400	2867	2490
838	792	1200	1281	1112	1659	1441	2029	1762	1200	2401	2085
698	660	1000	1054	915	1366	1186	1666	1447	1000	1963	1705
556	526	800	829	720	1072	931	1302	1131	800	1520	1320
416	396	600	618	534	786	678	948	822	600	1110	960
277	264	400	412	356	524	452	632	548	400	740	640
139	132	200	206	178	262	226	316	274	200	370	320

[0.76 Stat (0.66 Naut) MI/GAL.]						PRESS. ALT FEET	[1.03 Stat (0.89 Naut) MI/GAL.]						[1.31 Stat (1.13 Naut) MI/GAL.]						[1.58 Stat (1.37 Naut) MI/GAL.]						PRESS. ALT FEET	[1.85 Stat (1.60 Naut) MI/GAL.]					
R P M	MP IN. Hg	M I X.	Approx				R P M	MP IN. Hg	M I X.	Approx			R P M	MP IN. Hg	M I X.	Approx			R P M	MP IN. Hg	M I X.	Approx				R P M	MP IN. Hg	M I X.	Approx		
			GPH Per Eng	Airspeed (Knots)						GPH Per Eng	Airspeed (Knots)					GPH Per Eng	Airspeed (Knots)					GPH Per Eng	Airspeed (Knots)						GPH Per Eng	Airspeed (Knots)	
				TAS	IAS						TAS	IAS					TAS	IAS					TAS	IAS						TAS	IAS
2500	F.T.	N	72	197	145	20,000																			20,000	2290	F.T.	N	56	178	131
2500	F.T.	N	103	215	172	15,000							2420	F.T.	N	93	210	168	2280	F.T.	N	73	200	160	15,000	1900	F.T.	N	48	164	131
2500	F.T.	N	138	224	194	10,000	2400	37.0	N	123	219	190	2220	33.6	N	90	204	176	2150	31.5	N	71	195	168	10,000	1640	F.T.	N	41	152	131
2500	F.T.	N	163	226	211	5000	2320	37.6	N	116	208	194	2200	34.1	N	86	193	180	2130	32.2	N	68	185	172	5000	1500	28.3	N	38	142	132
2500	46.5	N	165	218	218	S.L.	2290	37.7	N	110	197	197	2180	34.4	N	81	184	184	2100	32.8	N	64	174	174	S.L.	1440	30.8	N	35	136	136

REMARKS:

*Make allowance for warmup, takeoff and climb plus allowance for wind, reserve, and combat as required.

See Section I for RPM limitations.

Data as of: 7-15-54

EXAMPLE

At 29,000 pounds initial cruise gross weight with 1400 gallons of usable fuel (after deducting an allowance of 55 gallons for warmup, taxi, and takeoff, plus an additional allowance of 74 gallons for climb to cruise altitude, during which the aircraft flies 45 nautical air miles), to fly an additional 2490 nautical air miles at 20,000 feet altitude, maintain 2290 rpm and F.T. manifold pressure with mixture set NORMAL. Additional allowance for reserve is 10 percent of initial fuel or 170 gallons. When weight decreases below 28,000 pounds, refer to the 28,000 to 24,000 pounds chart, under Column V, at 20,000 feet.

LEGEND

ALT:	Pressure Altitude	MIX.:	Mixture
MP:	Manifold Pressure	N:	Normal
GPH.:	US Gallons Per Hour	KTS:	Knots
TAS:	True Airspeed	F.T.:	Full Throttle
IAS:	Indicated Airspeed	S.L.:	Sea Level

Based on: Calculated Data

Figure 11-50. Flight Operation Instruction Chart – Two Engines – 32,000 to 28,000 Pounds

WAC R1820-80A ENGINES PD 12K18 391361 CARBURETOR	FLIGHT OPERATION INSTRUCTION CHART MODEL C-117D STANDARD DAY CHART WEIGHT LIMITS: 36,000 TO 32,000 POUNDS	EXTERNAL LOAD ITEMS: NONE NUMBER OF ENGINES OPERATING: 2

INSTRUCTIONS FOR USING CHART. Select figure in fuel column equal to or less than amount of fuel to be used for cruising.* Move horizontally to right or left and select range value equal to or greater than the statute or nautical air miles to be flown. Vertically below, and opposite value nearest desired cruising altitude (ALT) read RPM, manifold pressure (MP) and mixture (MIX.) setting required. Refer to corresponding column and altitude for new power settings when gross weight falls below limits of this chart.

NOTES: Column I is for emergency high speed cruising only. Columns II, III, IV, and V give progressive increase in range at sacrifice in speed. Air miles per gallon (MI/GAL.) (NO WIND), gallons per hour (GPH) and true airspeed (TAS) are approximate values for reference. Subtract fuel allowances not available for cruising.

COLUMN I		FUEL US. GAL.	COLUMN II		COLUMN III		COLUMN IV		FUEL US. GAL.	COLUMN V	
Range in Air Miles			Range in Air Miles		Range in Air Miles		Range in Air Miles			Range in Air Miles	
Nautical 5000 Ft	Nautical Sea Level		Statute	Nautical	Statute	Nautical	Statute	Nautical		Statute	Nautical
1108	1048	1600	1628	1414	2074	1801	2501	2172	1600	2988	2595
966	917	1400	1404	1219	1780	1546	2141	1859	1400	2551	2215
827	785	1200	1197	1039	1510	1311	1807	1569	1200	2159	1875
689	654	1000	995	864	1245	1081	1490	1294	1000	1785	1550
551	522	800	788	684	986	856	1173	1019	800	1416	1230
411	390	600	582	510	726	630	864	750	600	1056	918
276	260	400	388	340	484	420	576	500	400	704	612
137	130	200	194	170	242	210	288	250	200	352	306

[0.75 Stat (0.65 Naut) MI/GAL.]						PRESS. ALT FEET	[0.97 Stat (0.85 Naut) MI/GAL.]						[1.21 Stat (1.05 Naut) MI/GAL.]						[1.44 Stat (1.25 Naut) MI/GAL.]						PRESS. ALT FEET	[1.76 Stat (1.53 Naut) MI/GAL.]					
RPM	MP IN. Hg	MIX.	Approx				RPM	MP IN. Hg	MIX.	Approx			RPM	MP IN. Hg	MIX.	Approx			RPM	MP IN. Hg	MIX.	Approx				RPM	MP IN. Hg	MIX.	Approx		
			GPH Per Eng	Airspeed (Knots)						GPH Per Eng	Airspeed (Knots)					GPH Per Eng	Airspeed (Knots)					GPH Per Eng	Airspeed (Knots)						GPH Per Eng	Airspeed (Knots)	
				TAS	IAS						TAS	IAS					TAS	IAS					TAS	IAS						TAS	IAS
2500	F.T.	N	73	181	133	20,000																			20,000						
2500	F.T.	N	103	206	165	15,000							2460	F.T.	N	97	203	163	2320	F.T.	N	77	193	154	15,000	2080	F.T.	N	55	168	134
2500	F.T.	N	139	220	190	10,000	2430	37.4	N	128	216	187	2240	34.2	N	95	200	173	2160	32.0	N	76	190	164	10,000	1820	27.8	N	49	155	134
2500	F.T.	N	164	224	209	5000	2340	38.4	N	122	206	192	2220	34.4	N	91	190	177	2150	32.8	N	73	182	170	5000	1710	29.0	N	46	145	135
2500	46.5	N	165	215	215	S.L.	2320	38.8	N	116	196	196	2210	35.6	N	89	186	186	2140	33.6	N	70	174	174	S.L.	1600	31.0	N	41	136	136

REMARKS:

*Make allowance for warmup, takeoff and climb plus allowance for wind, reserve, and combat as required.

See Section I for RPM limitations.

EXAMPLE

At 35,000 pounds initial cruise gross weight with 800 gallons usable fuel (after deducting an allowance of 55 gallons for warmup, taxi, and takeoff, plus an additional allowance of 75 gallons for climb to cruise altitude, during which the aircraft flies 39 nautical air miles), to fly an additional 856 nautical air miles at 15,000 feet altitude, maintain 2460 rpm and F.T. manifold pressure with mixture set NORMAL. Additional allowance for reserve is 10 per cent of initial fuel or 103 gallons. When weight decreases below 32,000 pounds, refer to the 32,000 to 28,000 pounds chart, under column III, at 15,000 feet.

LEGEND

ALT:	Pressure Altitude	MIX.:	Mixture
MP:	Manifold Pressure	N:	Normal
GPH.:	US. Gallons Per Hour	KTS:	Knots
TAS:	True Airspeed	F.T.:	Full Throttle
IAS:	Indicated Airspeed	S.L.:	Sea Level

Data as of: 7-15-54

Based on: Calculated Data

Figure 11-51. Flight Operation Instruction Chart – Two Engines – 36,000 to 32,000 Pounds

[redacted]

WAC R1820-80A ENGINES PD 12K18 391361 CARBURETOR	FLIGHT OPERATION INSTRUCTION CHART MODEL C-117D STANDARD DAY CHART WEIGHT LIMITS: 40,000 TO 36,000 POUNDS	EXTERNAL LOAD ITEMS: NONE NUMBER OF ENGINES OPERATING: 2

INSTRUCTIONS FOR USING CHART. Select figure in fuel column equal to or less than amount of fuel to be used for cruising.* Move horizontally to right or left and select range value equal to or greater than the statute or nautical air miles to be flown. Vertically below, and opposite value nearest desired cruising altitude (ALT) read RPM, manifold pressure (MP) and mixture (MIX.) setting required. Refer to corresponding column and altitude for new power settings when gross weight falls below limits of this chart.

NOTES: Column I is for emergency high speed cruising only. Columns II, III, IV, and V give progressive increase in range at sacrifice in speed. Air miles per gallon (MI/GAL.) (NO WIND), gallons per hour (GPH) and true airspeed (TAS) are approximate values for reference. Subtract fuel allowances not available for cruising.

COLUMN I		FUEL US. GAL.	COLUMN II		COLUMN III		COLUMN IV		FUEL US. GAL.	COLUMN V	
Range in Air Miles			Range in Air Miles		Range in Air Miles		Range in Air Miles			Range in Air Miles	
Nautical 5000 Ft	Nautical Sea Level		Statute	Nautical	Statute	Nautical	Statute	Nautical		Statute	Nautical
1088	1035	1600	1520	1320	1900	1650	2257	1960	1600	2654	2305
952	903	1400	1324	1150	1635	1420	1935	1680	1400	2292	1990
813	770	1200	1129	980	1387	1204	1641	1425	1200	1935	1680
675	640	1000	939	815	1146	995	1353	1175	1000	1583	1375
538	512	800	737	640	904	785	1059	920	800	1232	1070
403	384	600	558	480	666	581	781	678	600	894	780
270	256	400	372	320	444	387	521	452	400	596	520
138	128	200	186	160	222	194	260	226	200	298	260
[0.74 Stat (0.64 Naut) MI/GAL.]			[0.93 Stat (0.80 Naut) MI/GAL.]		[1.11 Stat (0.97 Naut) MI/GAL.]		[1.31 Stat (1.13 Naut) MI/GAL.]			[1.49 Stat (1.30 Naut) MI/GAL.]	

RPM	MP IN. Hg	MIX.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS	PRESS. ALT FEET	RPM	MP IN. Hg	MIX.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS	RPM	MP IN. Hg	MIX.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS	RPM	MP IN. Hg	MIX.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS	PRESS. ALT FEET	RPM	MP IN. Hg	MIX.	Approx GPH Per Eng	Approx Airspeed (Knots) TAS	Approx Airspeed (Knots) IAS
						20,000																			20,000						
2500	F.T.	N	102	196	157	15,000													2360	F.T.	N	82	186	149	15,000	2310	F.T.	N	68	174	139
2500	F.T.	N	139	214	185	10,000	2450	37.8	N	132	211	183	2260	35.0	N	103	198	171	2190	32.8	N	82	186	161	10,000	2150	28.9	N	57	161	139
2500	F.T.	N	164	221	206	5000	2350	39.1	N	127	204	190	2240	35.3	N	97	188	175	2170	33.5	N	79	179	166	5000	2000	29.8	N	55	149	139
2500	46.5	N	165	212	212	S.L.	2330	39.3	N	120	193	193	2220	35.6	N	93	179	179	2160	34.1	N	75	171	171	S.L.	1840	31.0	N	51	139	139

REMARKS

*Make allowance for warmup, takeoff and climb plus allowance for wind, reserve, and combat as required.

See Section I for RPM limitations.

EXAMPLE

At 38,000 pounds initial cruise gross weight with 1000 gallons of usable fuel (after deducting an allowance of 55 gallons for warmup, taxi, and takeoff, plus an additional allowance of 29 gallons for climb to cruise altitude, during which the aircraft flies 10 nautical air miles), to fly an additional 1175 nautical miles at 5000 feet altitude, maintain 2170 rpm and 33.5 inches manifold pressure with mixture set NORMAL. Additional allowance for reserve is 10 percent of initial fuel or 120 gallons. When weight decreases below 36,000 pounds, refer to the 36,000 to 32,000 pounds chart, under column IV, at 5000 feet.

LEGEND

ALT:	Pressure Altitude	MIX.:	Mixture
MP:	Manifold Pressure	N:	Normal
GPH.:	US. Gallons Per Hour	KTS:	Knots
TAS:	True Airspeed	F.T.:	Full Throttle
IAS:	Indicated Airspeed	S.L.:	Sea Level

Data as of: 7-15-54

Based on: Calculated Data

Figure 11-52. Flight Operation Instruction Chart – Two Engines – 40,000 to 36,000 Pounds