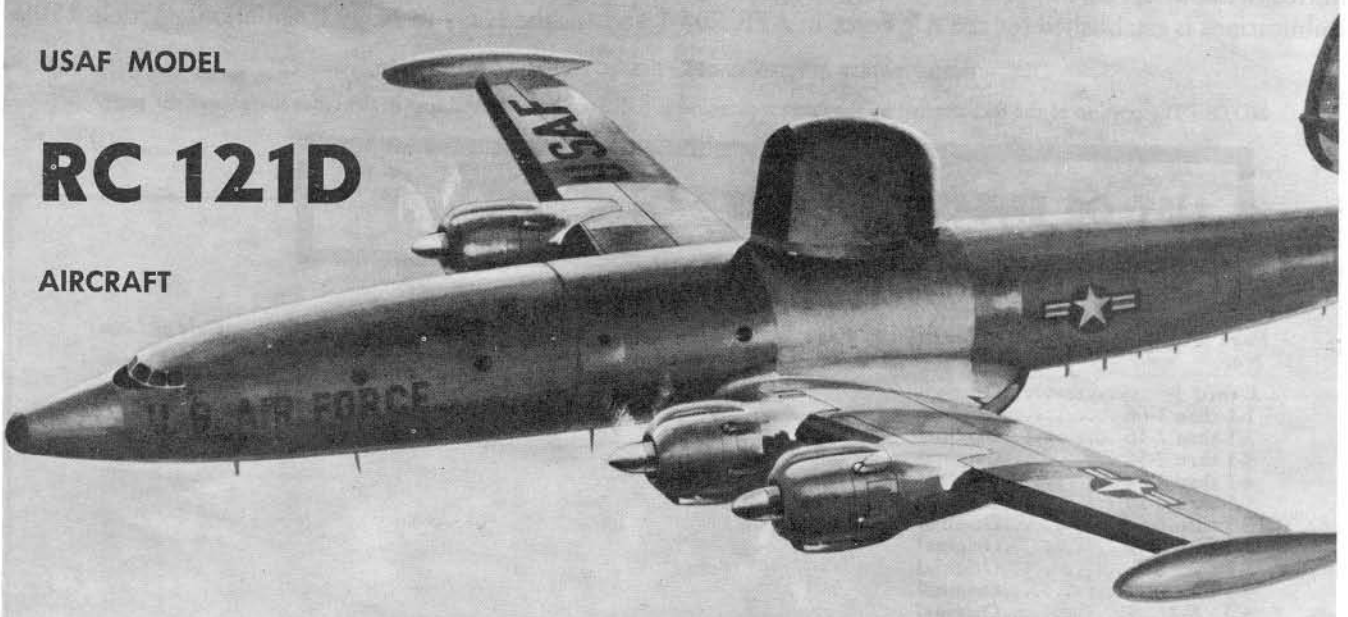
FLIGHT HANDBOOK

USAF MODEL

RC 121D

AIRCRAFT



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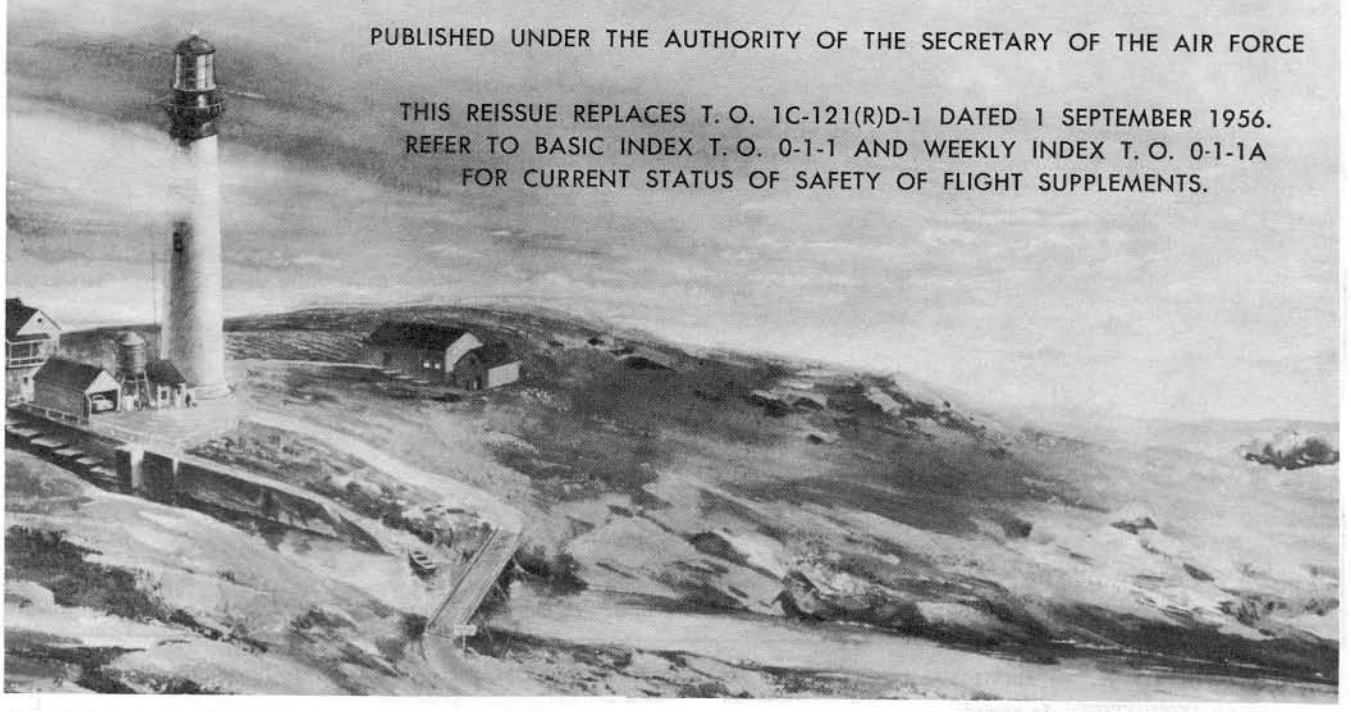

PUBLISHED UNDER THE AUTHORITY OF THE SECRETARY OF THE AIR FORCE

THIS REISSUE REPLACES T. O. 1C-121(R)D-1 DATED 1 SEPTEMBER 1956.
REFER TO BASIC INDEX T. O. 0-1-1 AND WEEKLY INDEX T. O. 0-1-1A
FOR CURRENT STATUS OF SAFETY OF FLIGHT SUPPLEMENTS.

A.F. SMAMA 4/21/58—2M

15 FEBRUARY, 1958

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DON'T TAKE-OFF . . .

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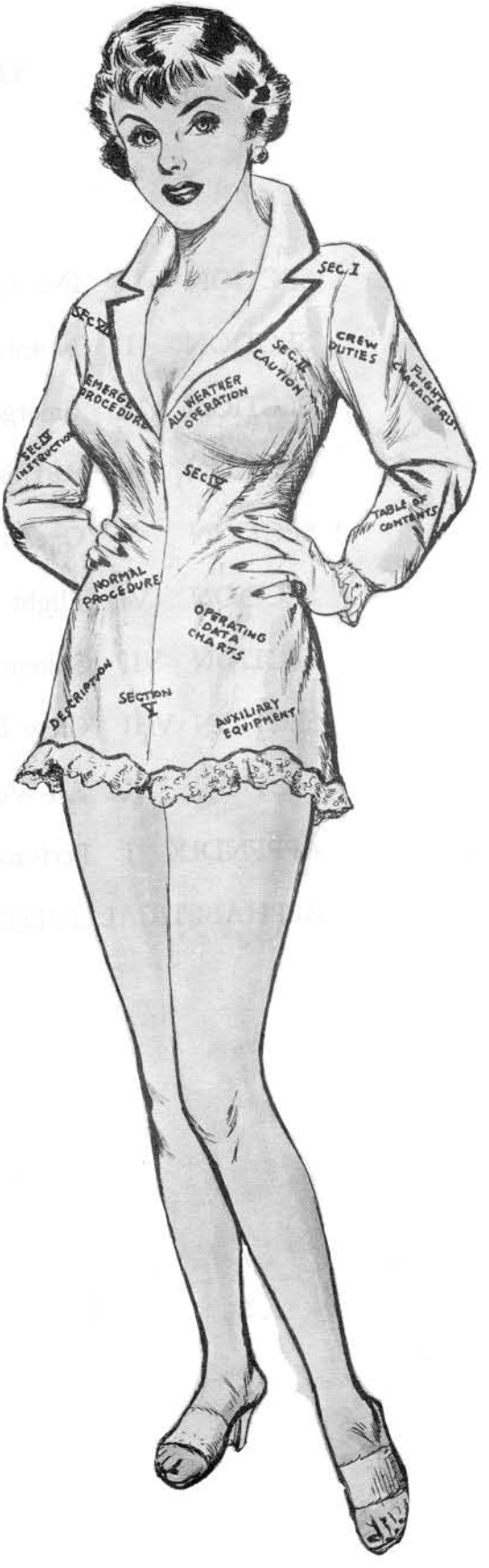

SCOPE. This handbook contains all the information necessary for safe and efficient operation of the RC121D. These instructions do not teach basic flight principles, but are designed to provide you with a general knowledge of the airplane, its flight characteristics, and specific normal and emergency operating procedures. Your flying experience is recognized, and elementary instructions have been avoided.

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

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

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

ARRANGEMENT. The handbook has been divided into 10 fairly independent sections each with its own table of contents. The objective of this subdivision is to make it easy both to read the book straight through when it is first received and thereafter to use it as a reference manual. The independence of these sections also makes it possible for the user to rearrange the book to satisfy his personal taste and requirements. The first 3 sections cover the minimum information required to safely get the airplane into the air and back

down again. Before flying any new aircraft these 3 sections must be read thoroughly and fully understood. Section IV covers all equipment not essential to flight but which permits the aircraft to perform special functions. Sections V and VI are obvious. Section VII covers lengthy discussions on any technique or theory of operation which may be applicable to the particular aircraft in question. The experienced pilot will probably not need to read this section but he should check it for any possible new information. The contents of the remaining sections are fairly obvious.

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

PERSONAL COPIES, TABS AND BINDERS. In accordance with the provisions of AFR 5-13, flight crew members are entitled to have personal copies of the Flight Handbooks. Flexible, loose leaf tabs and binders have been provided to hold your personal copy of the Flight Handbook. These good-looking, simulated leather binders will make it much easier for you to revise your handbook as well as to keep it in good shape. These tabs and binders are secured through your local materiel staff and contracting officers.

HOW TO GET COPIES. If you want to be sure of getting your handbooks on time, order them before you need them. Early ordering will assure that enough copies are printed to cover your requirements. Technical Order 0-5-2 explains how to order Flight Handbooks so that you automatically will get all revisions, reissues, and Safety of Flight Supplements. Basically, all you have to do is order the required quantities in the Publication Requirements Table (T. O. 0-3-1). Talk to your Senior Materiel Staff Officer — it is his job to fulfill your Technical Order requests. Make sure to establish some system that will rapidly get the books and Safety of Flight Supplements to the flight crews once they are received on the base.

SAFETY OF FLIGHT SUPPLEMENTS. Safety of Flight Supplements are used to get information to you in a hurry. Safety of Flight Supplements are the same number as your Flight Handbook, except for the addition of a suffix letter. Supplements covering loss of life will get to you in 48 hours; those concerning serious damage to equipment will make it in 10 days. You can determine the status of Safety of Flight Supplements by referring to the Index of Technical Publications (T. O. 0-1-1) and the Weekly Supplemental Index (T. O. 0-1-1A). This is the only way you can determine whether a supplement has been rescinded. The title page of the Flight Handbook and title block of each Safety of Flight Supplement should also be checked to determine the effect that these publications may have on existing Safety of Flight Supplements. It is critically important that you remain constantly aware of the status of all supplements — you must comply with all existing supplements but there is no point in restricting the operation of your aircraft by complying with a supplement that has been replaced or rescinded. If you have ordered your Flight Handbook on the Publication Requirements Table, you automatically will receive all supplements pertaining to your airplane. Technical Order 0-5-1 covers some additional information regarding these supplements.

WARNINGS, CAUTIONS, AND NOTES. For your information, the following definitions apply to the "Warnings", "Cautions", and "Notes" found throughout the handbook:

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

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

NOTE — An operating procedure, condition, etc, which it is essential to emphasize.

COMMENTS AND QUESTIONS. Comments and questions regarding any phase of the Flight Handbook program are invited and should be forwarded through your Command Headquarters to Commander, Detachment #1, Hq Air Research and Development Command, Wright-Patterson AFB, Ohio, ATTN: RDZSPH.

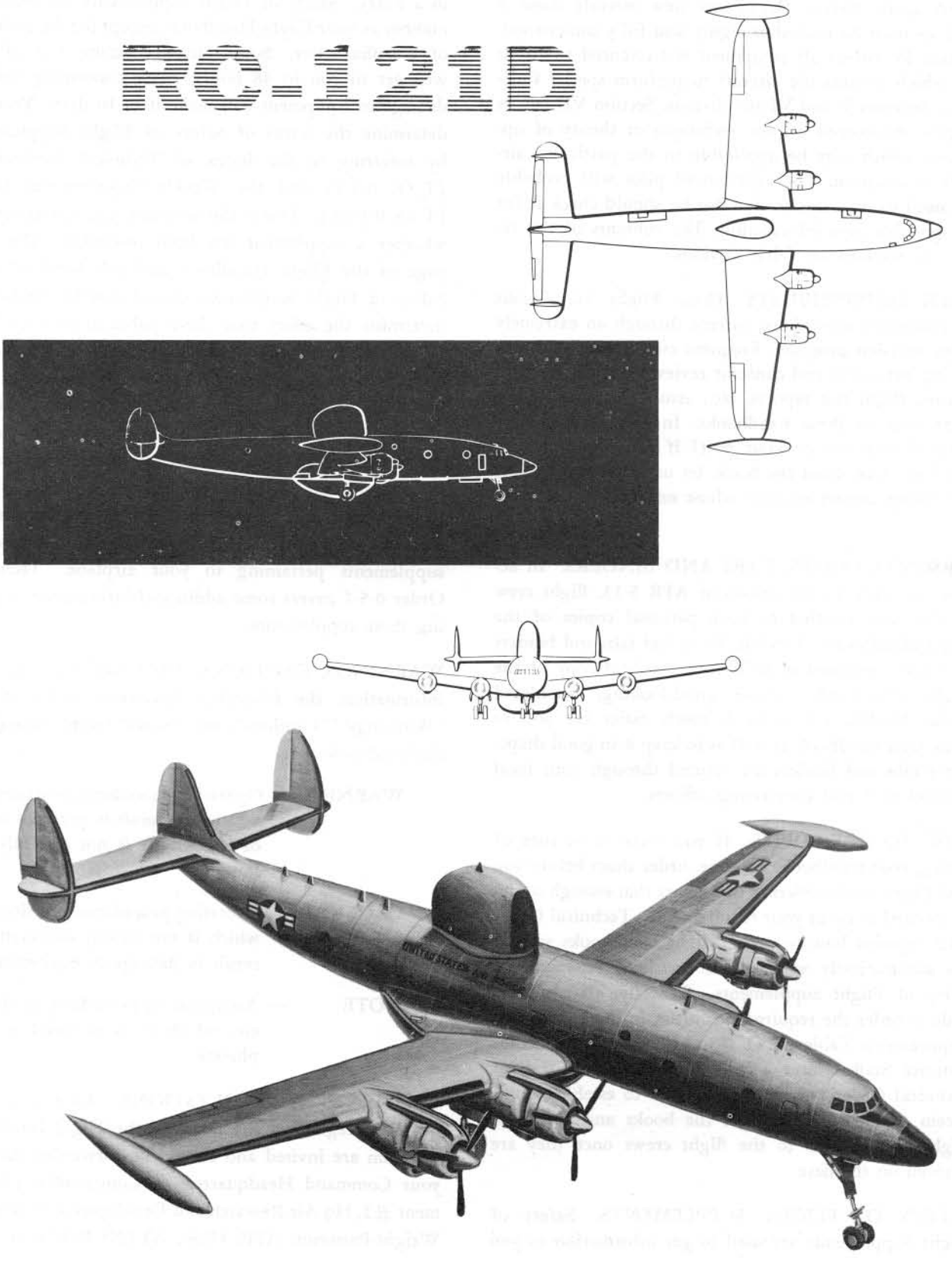

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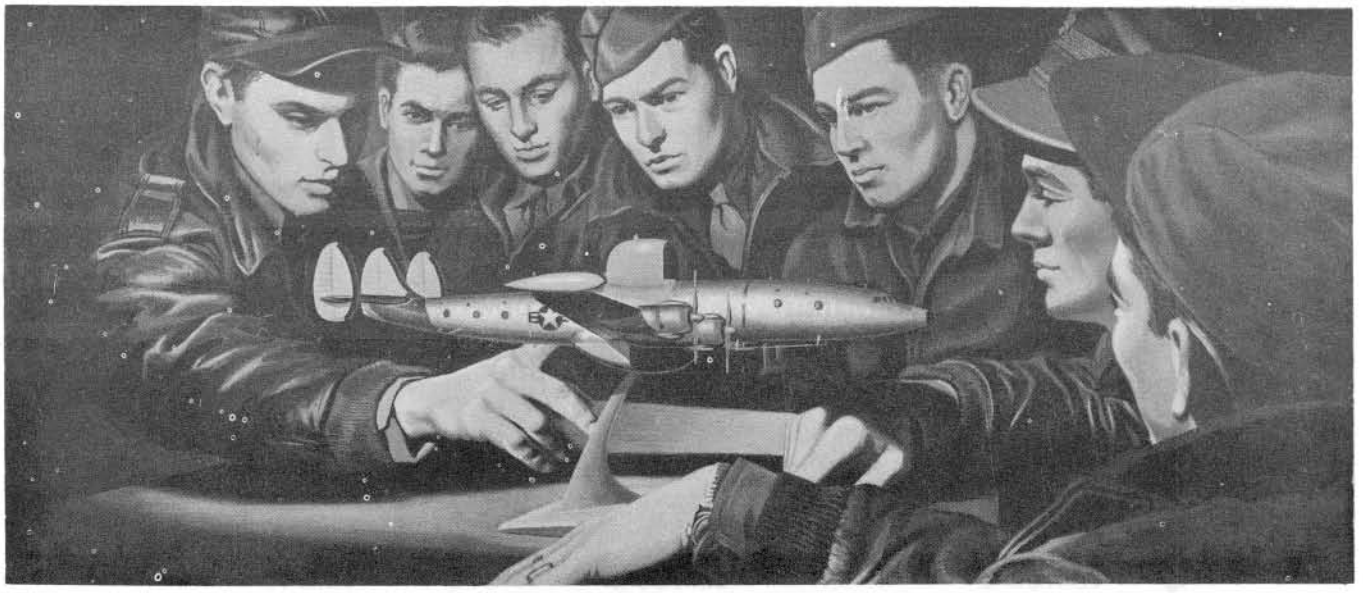
Figure 1-1. The Aircraft



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THE AIRCRAFT.

The RC-121D is a four-engine, low wing monoplane designed for patrol operation, as a special search and airborne early warning aircraft. Distinguishing external features are three vertical fins and rudders, dual-wheel tricycle landing gear, and characteristically shaped fuselage with the extended radomes which house the radar antennas. These aircraft are powered by turbo-compound R3350-91 engines. Each engine is equipped with a three-blade, full-feathering, reversible-pitch Hamilton Standard hydromatic propeller. The flight controls incorporate hydraulic boosters to assist in the movement of the control surfaces, and an automatic pilot is provided for automatic control of the aircraft. The semi-monocoque

	RC-121D	C-121A	RC-121C	C-121C	VC-121E	YC-121F
INTERIOR	SPECIAL RADAR EQUIPMENT	CONVERTIBLE PASSENGER CARGO AND LITTER	SPECIAL RADAR EQUIPMENT	CONVERTIBLE PASSENGER, CARGO AND LITTER	EXECUTIVE	CONVERTIBLE PASSENGER, CARGO AND LITTER
LENGTH	116' 2"	94' 11"	116' 2"	116' 2"	116' 2"	116' 2"
ENGINES	TURBO-COMPOUND		TURBO-COMPOUND	TURBO-COMPOUND	TURBO-COMPOUND	TURBO PROP
WINDOWS (FUSELAGE)	ROUND	ROUND	ROUND	SQUARE	SQUARE	ROUND
RADOMES	NOSE AND FUSELAGE	NOSE	NOSE AND FUSELAGE	NOSE	NOSE	NOSE
WING TIP TANKS	YES	NO	NO	NO	NO	YES

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Figure 1-2. Main Difference Table

fuselage is sealed for pressurization between the forward and aft pressure bulkheads.

GENERAL ARRANGEMENT.

The forward bulkhead separates the flight station from the nose radome; the aft bulkhead is the rear wall of the cabin. All doors in the lower sides and bottom of the fuselage have additional sealing to minimize water leakage in the event of ditching. The interior of the fuselage is divided by the station 260 bulkhead into the flight station and the cabin. One cargo loading door, with an integral personnel door, is located on the left side aft of the wing. A crew door is located on the right side immediately forward of the station 260 bulkhead.

Crew Stations

The active crew stations include the following: pilot, copilot, flight engineer, navigator, radio operator, senior director, duty director, 3 search radar operators, surveilance supervisor, plotter, teller-recorder, height finder operator, and 2 radar technicians. Additional crew and relief crew members are assigned in accordance with the mission involved.

Lavatories.

Two lavatories are installed, one in the aft cabin on the right side, and one in the forward cabin on the left side. A galley is installed on the right side aft of the forward cabin.

AIRCRAFT DIMENSIONS.

The over-all dimensions of the aircraft are as follows:

Length ..... 116′ 2″
Height (to tops of fins) ..... 24′ 9″
Height (to top of radome) ..... 26′ 11.6″
Wing Span (without tip tanks) ..... 123′ 0″
Wing Span (with tip tanks) ..... 126′ 2″

GROSS WEIGHTS.

This aircraft is in the 130,000 to 152,500 lb. gross weight category. Refer to Section V for weight limitations.

ENGINES.

The four engines installed on the aircraft are turbo-compound, 18-cylinder, air-cooled R3350-91 engines. The total horsepower output of each engine is increased by the installation of three power recovery turbines, each of which is driven by the combined exhaust from six of the eighteen cylinders. Turbine energy is geared back to the engine crankshaft through a fluid coupling. Turbine speed is proportional to engine speed and requires no control. Each engine also incorporates a fuel injection system, a two-speed supercharger and a low-tension ignition system.

THROTTLE LEVERS.

One set of four throttle levers is located on the pilots' center control stand (5, fig. 1-11) and another set of four throttle levers is located on the flight engineer's control quadrant (5, fig. 1-14). The corresponding levers are mechanically interconnected to the carburetor butterfly shafts by cable, pulley and linkage systems. The throttle levers also are electrically (d.c.) connected to the propeller automatic feathering arming circuit and landing gear warning horn circuit.

Reverse Pitch Throttle Levers.

The pilots' throttle levers incorporate an additional set of four reverse pitch throttle levers (4, fig. 1-11) hinged on the main throttle arms. The reverse levers normally are folded forward and below the main throttle knobs so that they do not interfere with normal throttle operation. The reverse pitch throttle levers are connected by a linkage mechanism to the same cable system as the main throttle levers. A spring-loaded mechanical lock prevents inadvertent movement of the reverse throttle while in flight. The lock normally is released by a 28-volt d.c. reverse actuator controlled by landing gear microswitches. It can be released manually by depressing the reverse lock overrride lever (flag) (6, fig. 1-11) located on the center control stand. When the main throttle levers are retarded to the full aft position, the reverse pitch throttle levers may be lifted upward and pulled aft, provided the reverse throttle lock has been released. This action energizes the propeller governor solenoid valves which release the low pitch stop levers of the propellers, thus turning the blades to the fixed reverse pitch stop position. As the reverse pitch throttle levers are moved aft the engine throttle valves are opened to increase power. The maximum travel of the carburetor butterfly valve is limited in the reverse range to approximately METO power.

FUEL MASTER CONTROL (CARBURETOR)

Each engine utilizes a direct fuel injection system which consists of a carburetor (master control unit), two injection pumps and a fuel injection nozzle for each cylinder. The carburetor unit senses the amount of air passing through it and meters the correct proportion of fuel from the fuel pressure chamber of the carburetor to the two injection pumps that are mounted on each side of the rear crankcase section of each engine. Each injection pump is geared to the engine and contains nine plungers which time and distribute the metered fuel to the cylinder combustion chambers. A synchronizing bar connects the fuel injection pumps to assure equal metering of fuel. Spring-loaded poppet valves in the fuel injection nozzles, one of which is located in each cylinder head, are opened by the pressure of the fuel and the nozzle sprays the fuel into combustion chamber.

Carburetor Alternate Fuel Source.

An alternate fuel source is provided within the fuel master control (carburetor) to supply a positive increase in fuel flow when the normal metering differential pressure is partially or totally lost, such as might occur during icing conditions. The alternate fuel source functions as a standby and not as a replacement for the normal alternate air, pre-heat and alcohol procedures recommended for combating ice.

Carburetor Alternate Fuel Switches. Four circuit-breaker type switches are located on the MJB No. 2 switch panel (13, fig. 1-27). The carburetor alternate fuel source switches have EMERGENCY (up) and NORMAL (down) positions. Moving a switch to the EMERGENCY position energizes a d.c. solenoid which opens a valve to supply a direct unmetered fuel flow to the selected engine.

ALTERNATE AND RAM AIR INDUCTION SYSTEM.

A ram-type induction scoop for directing air to the carburetor (fig. 1-5) is located in the top of all modified nacelles. The duct directs either ram air from the front of the cowl or alternate air which has passed through an ice screen and up into the duct from under the cowl. This permits selection of the alternate air source during icing conditions. A variable position door is also located in this duct ahead of the carburetor to mix hot air from behind the cylinders with the induction air.

Carburetor Alternate Air Switches.

Four toggle switches, located on the left side of the flight engineer's lower switch panel, (1, fig. 14) are used to

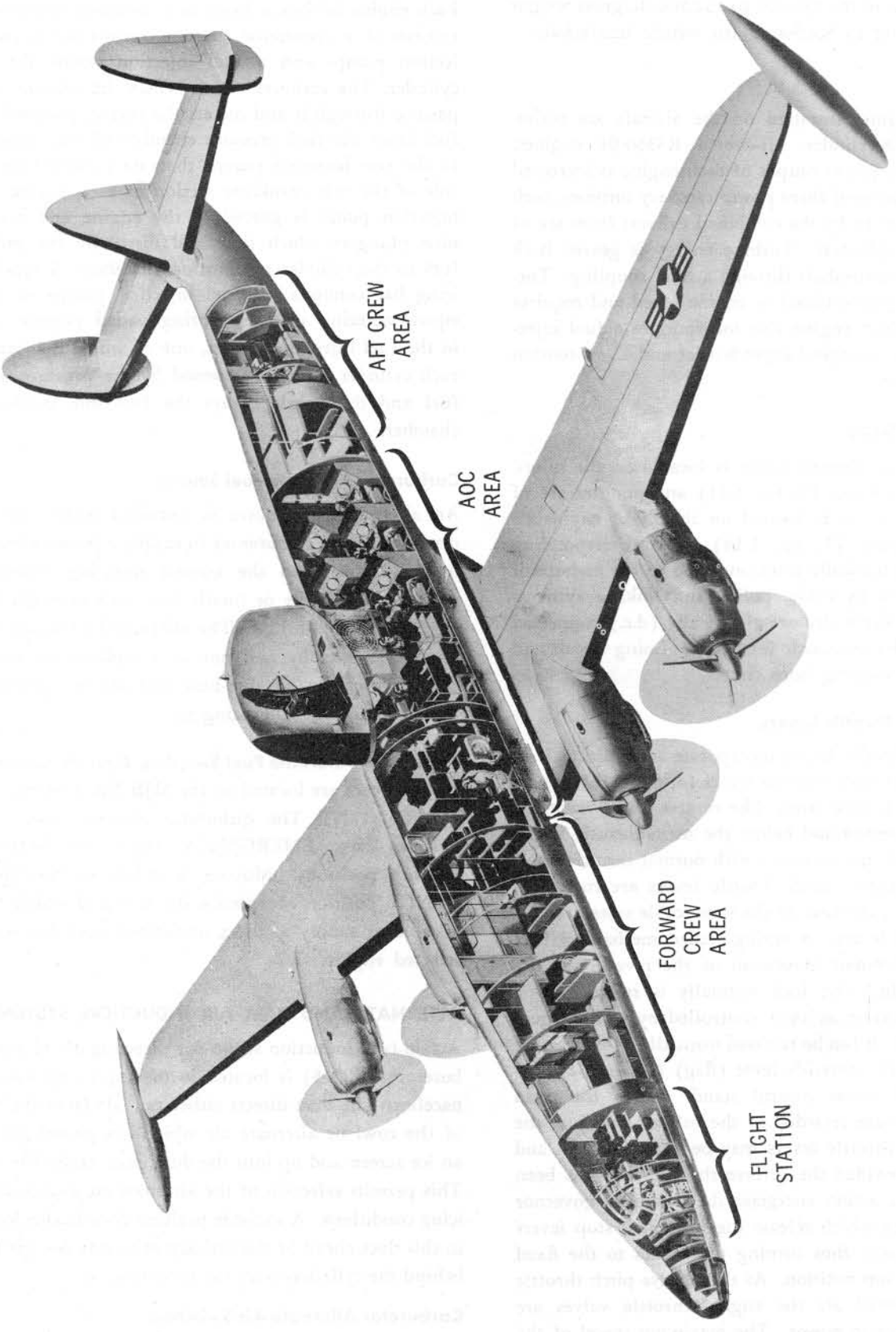
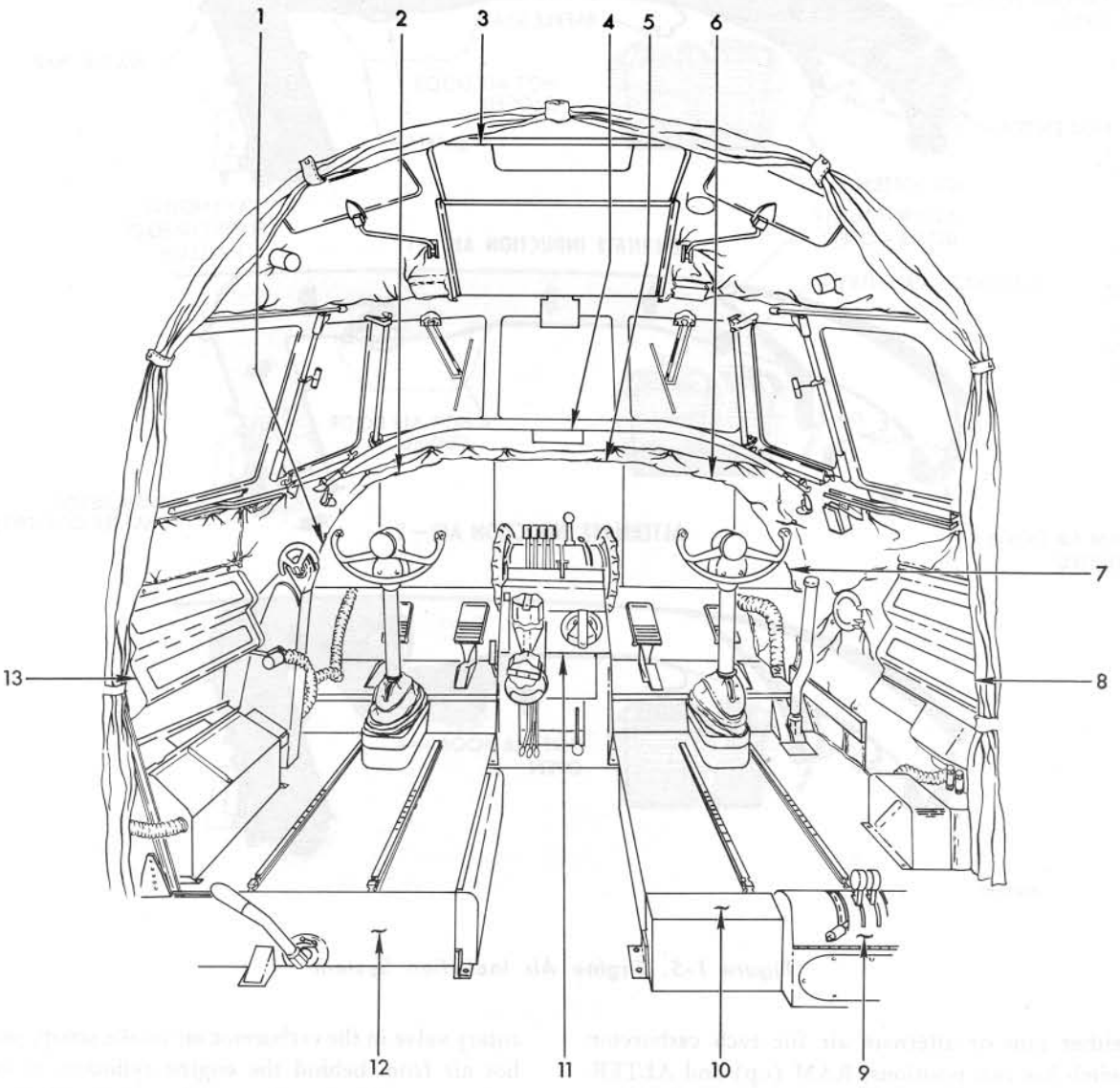


Figure 1-3. General Arrangement



1 PILOT'S AUXILIARY INSTRUMENT PANEL
2 PILOT'S INSTRUMENT PANEL
3 PILOT'S OVERHEAD PANEL
4 GLARE SHIELD PANEL
5 PILOT'S CENTER INSTRUMENT PANEL
6 COPILOT'S INSTRUMENT PANEL
7 COPILOT'S AUXILIARY INSTRUMENT PANEL
8 COPILOT'S SIDE PANEL
9 FLIGHT ENGINEER'S AUXILIARY CONTROL QUADRANT
10 IGNITION ANALYZER CONTROL PANEL
11 CENTER CONTROL STAND
12 HYDRAULIC RESERVOIR REPLENISHING CONTROLS PANEL
13 PILOT'S SIDE PANEL

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Figure 1-4. Pilots' Station (Typical)

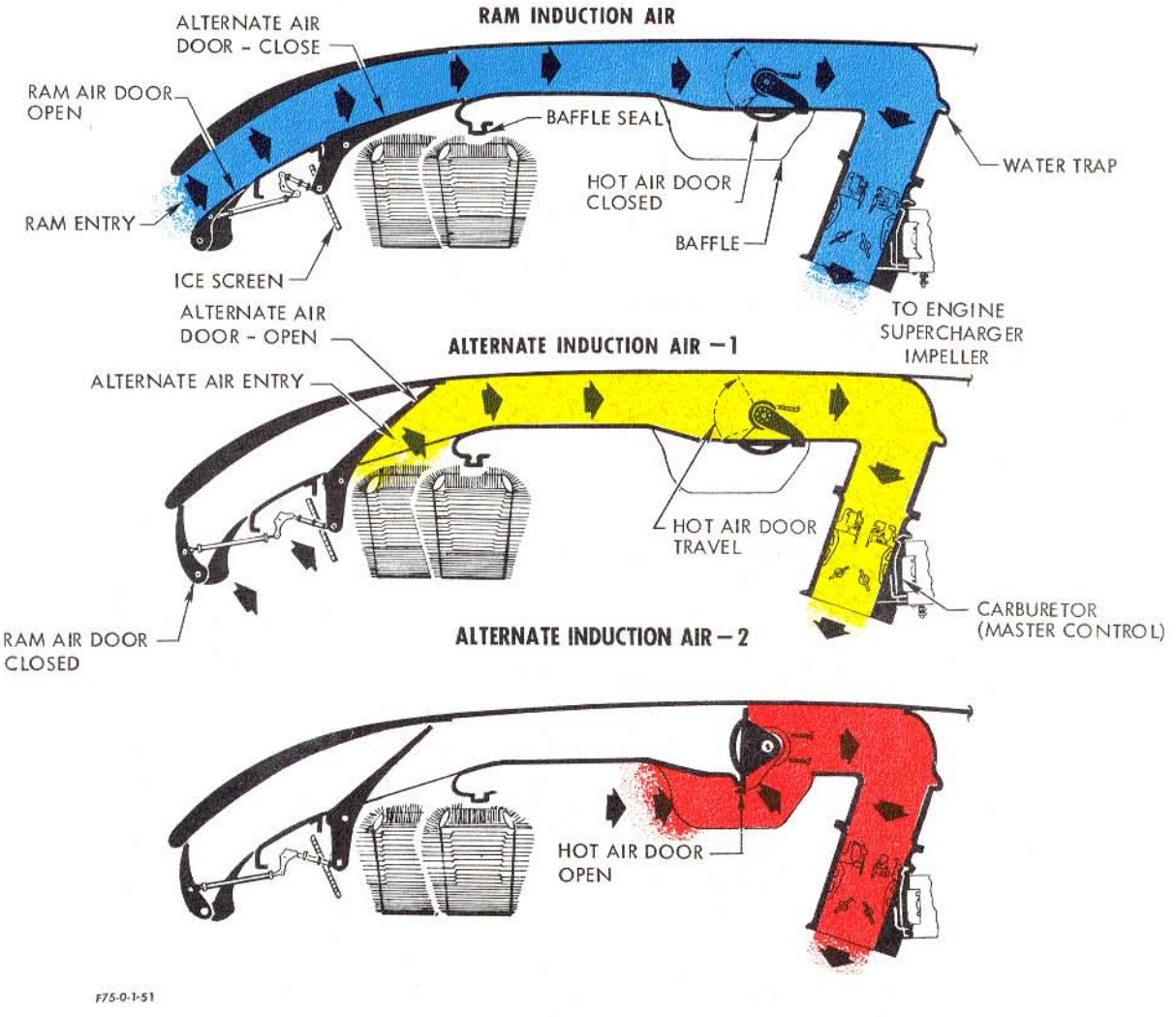


Figure 1-5. Engine Air Induction System

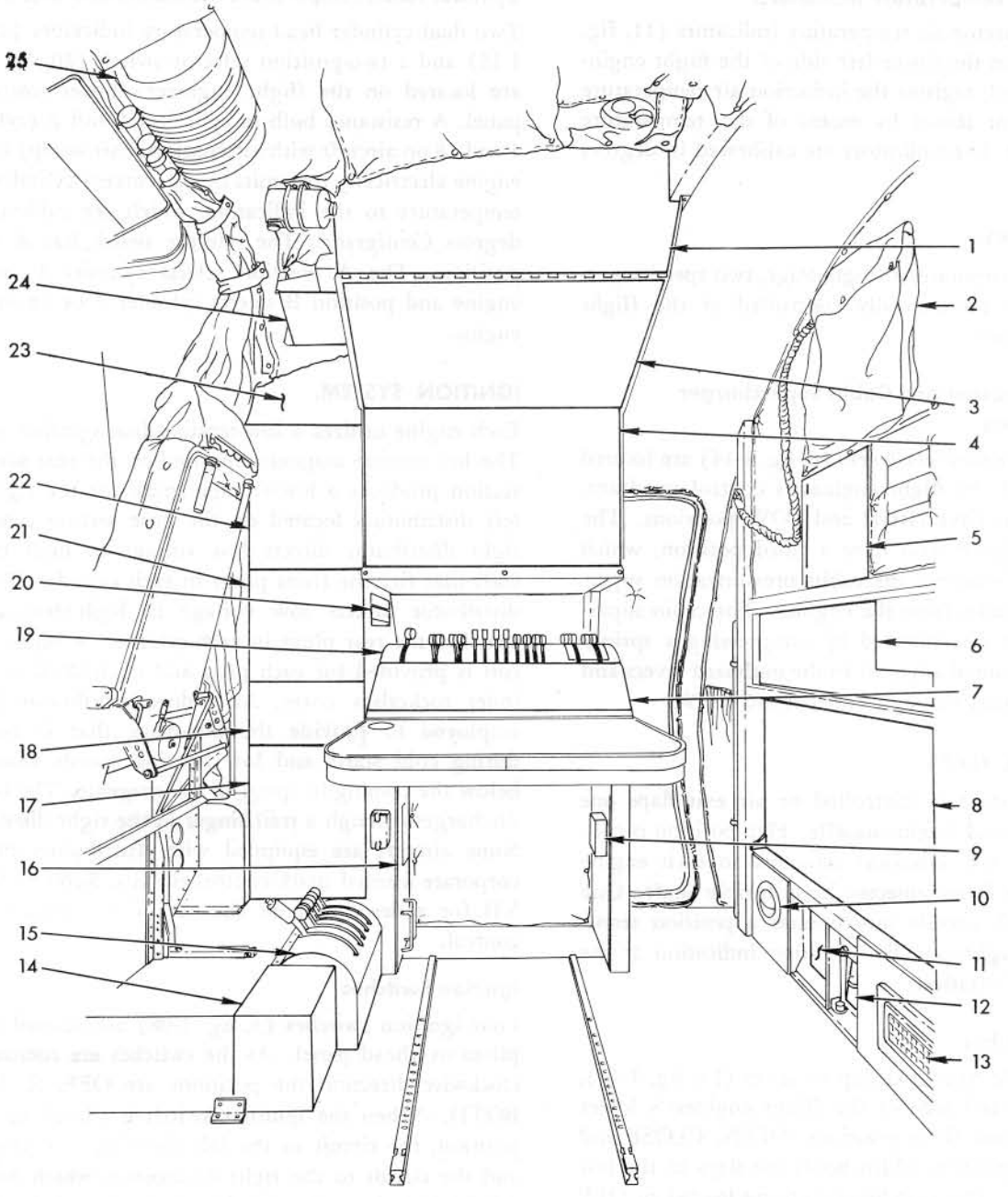
select either ram or alternate air for each carburetor. Each switch has two positions; RAM (up) and ALTERNATE (down). In the RAM (normal) position, an electric (d.c.) reversible motor opens the forward ram air scoop and simultaneously closes the aft door in the induction duct. This allows ram air to pass directly to the carburetor. In the ALTERNATE position, the electrically-operated motor closes the forward ram air opening and simultaneously opens the aft door, admitting to the carburetor sheltered air which has passed through an ice screen.

Carburetor Air Switches.

Four toggle-type switches (1, fig. 1-14) are located on the left side of the flight engineer's lower switch panel. Each switch has three positions, OFF, COLD, and HOT, and is spring-loaded from HOT to OFF. Holding the switch in the HOT position electrically actuates (dc.) a rotary valve in the carburetor air intake scoop, permitting hot air from behind the engine cylinders to enter the carburetor. Moving the switch to the COLD position rotates the valve to permit unheated air to enter the carburetor. The valve may be stopped in any position by moving the switch to OFF. Limit switches stop the valve automatically when it reaches either the full hot or full cold position.

Mixture Control Levers.

Four mixture control levers (8, fig. 1-14) are located on the flight engineer's control quadrant and are mechanically linked to the carburetor mixture control valves. The mixture control quadrant is marked OFF, AUTO LEAN and AUTO RICH but incorporates continuously serrated detent plates to permit setting the control at intermediate positions for best power and economy. See MANUAL LEANING in Section VII for procedures.



1	UPPER SWITCH PANEL	10	CREW DOOR LIGHT	18	MJB NO. 2A PANEL
2	DITCHING ROPE AND CONTAINER	11	DITCHING VALVE RELEASE HANDLE	19	FLIGHT ENGINEER'S CONTROL QUADRANT
3	UPPER INSTRUMENT PANEL	12	CABIN HEATER FIRE EXTINGUISHING CONTROL PANEL	20	UPPER MJB 212 PANEL
4	LOWER INSTRUMENT PANEL	13	260 AIR OUTLET	21	MJB NO. 2 PANEL
5	ENGINE FIRE EXTINGUISHER CONTROL PANEL	14	IGNITION ANALYZER CONTROL PANEL	22	MJB NO. 1 PANEL
6	260 UPPER PANEL	15	AUXILIARY FLIGHT ENGINEER'S CONTROL QUADRANT	23	UPPER MJB PANEL
7	TOWER SWITCH PANEL	16	LOWER MJB 212 PANEL	24	RADIO SELECTOR BOX
8	AIR CONDITIONING CONTROL PANEL	17	MJB NO. 3 PANEL	25	EMERGENCY SHUT-OFF LEVERS AND QUADRANT
9	238 CIRCUIT BREAKER PANEL				

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Figure 1-6. Flight Engineers' Station

Carburetor Air Temperature Indicators.

Two dual carburetor air temperature indicators (11, fig. 1-16), located on the lower left side of the flight engineer's upper panel, register the induction air temperature at the carburetor throat by means of d.c. temperature resistance bulbs. The indicators are calibrated in degrees Centigrade.

SUPERCHARGERS.

Each engine incorporates a single stage, two speed supercharger that is mechanically controlled at the flight engineer's station.

Engine Supercharger and Cabin Supercharger Disconnect Levers.

Four engine supercharger levers (6, fig. 1-14) are located at the center of the flight engineer's control quadrant. All of the levers have HIGH and LOW positions. The two outboard levers also have a third position, which mechanically disconnect the cabin pressurization supercharger drive shafts from the engines. The cabin superchargers can be disconnected by compressing a spring-loaded lock mounted adjacent to the outboard levers and pushing the levers through and beyond LOW.

ENGINE COWL FLAPS.

Engine temperature is controlled by air exit flaps one on each side of each engine nacelle. Flap position is controlled by two d.c. electrical actuators in each engine nacelle that are interconnected by a flexible shaft. One actuator in each nacelle incorporates a position transmitter which registers a flap position indication at the flight engineer's station.

Cowl Flap Switches.

The four paddle-type cowl flap switches (14, fig. 1-14), located on the left side of the flight engineer's lower switch panel, have three positions: OPEN, CLOSE and center (OFF) position which holds the flaps in the last preset position. The switches are spring-loaded to OFF from the CLOSE position. The OPEN position is a steady-on position. Either OPEN or CLOSE position provides d.c. electrical power to the cowl flap actuators in each nacelle. Limit switches are installed to automatically stop the cowl flaps at the full OPEN or the full CLOSED position.

Cowl Flap Position Indicators.

Two dual cowl flap position indicators (19, fig. 1-15) are located on the flight engineer's lower instrument panel and are marked from 0 to 100%. These indicators are actuated by magnasyn transmitters attached to the right actuator in each engine nacelle and are powered by 26-volt, 400 cycle a.c. current.

Cylinder Head Temperature Indicators and Selector.

Two dual cylinder head temperature indicators (21, fig. 1-15) and a two-position selector switch (20, fig. 1-15) are located on the flight engineer's lower instrument panel. A resistance bulb in cylinders 1 and 2 (cylinders 1 and 18 on aircraft with alternate ram air scoop) of each engine electrically transmits by d.c. current cylinder head temperature to the indicators, which are calibrated in degrees Centigrade. The selector switch has A and B positions. The A position selects cylinder 1 on each engine and position B selects cylinder 2 or 18 on each engine.

IGNITION SYSTEM.

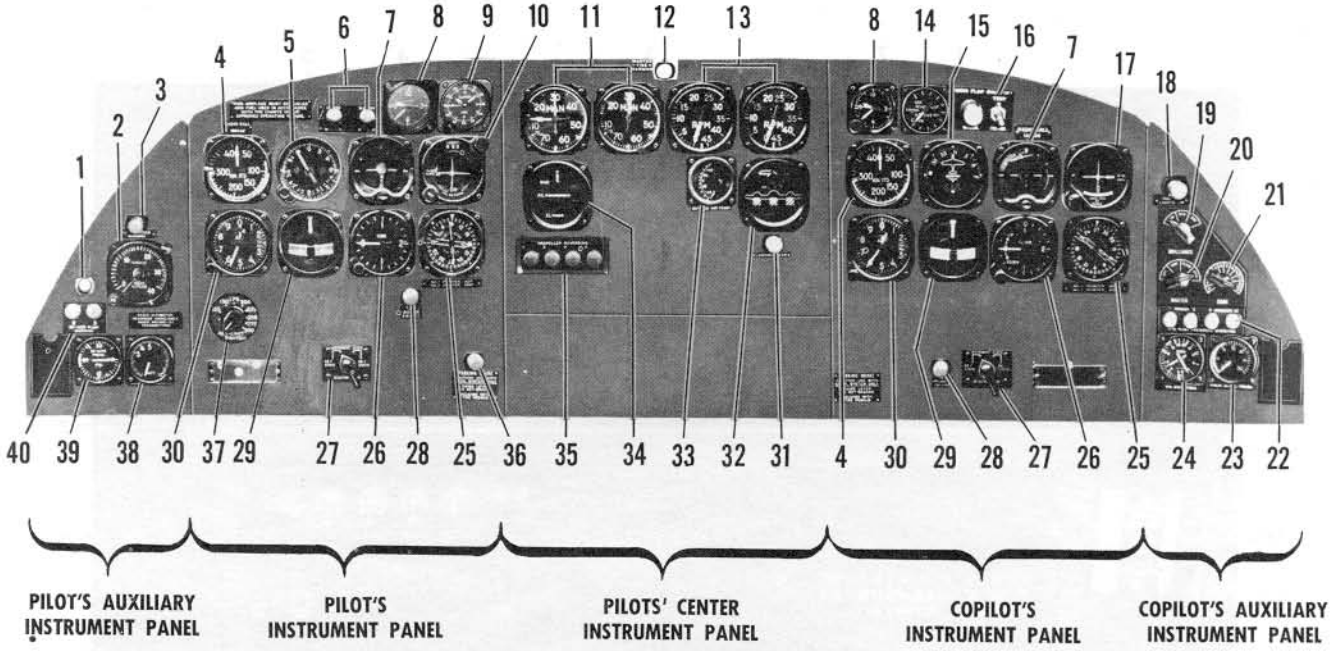
Each engine utilizes a low-tension dual ignition system. The low-tension magneto installed on the rear accessory section produces a low-voltage spark for the right and left distributors located on the nose section case. The right distributor directs low voltage to high tension coils that fire the front plugs in each cylinder. The left distributor directs low voltage to high-tension coils that fire the rear plugs in each cylinder. A high-tension coil is provided for each plug and is attached to a cylinder rockerbox cover. An induction vibrator is also employed to provide the hot-spark that is required during cold starts and low starting speeds which are below the coming-in speed of the magneto. The booster discharges through a trail finger in the right distributor. Some aircraft are equipped with distributors that incorporate manual spark control circuits. Refer to Section VII for a description of the use of the manual spark control.

Ignition Switches.

Four ignition switches (3, fig. 1-08) are located on the pilots overhead panel. As the switches are rotated in a clockwise direction the positions are OFF, R, L, and BOTH. When the ignition switch is placed in the R position, the circuit to the left distributor is grounded and the circuit to the right distributor, which fires the front plugs in each cylinder, is ungrounded. The L position grounds the right distributor circuit and ungrounds the left distributor circuit which fires the rear plugs in each cylinder. The BOTH position ungrounds the circuits ot both the left and the right distributors and the OFF position grounds both circuits.

Spark Control Switch.

A single spark control switch, located on the flight engineer's lower switch panel (13, fig. 1-14) controls the ignition timing for the four engines simultaneously. A movable guard covers the switch and opens downward. The two positions are placarded RETARD (up) and ADVANCE (down). When the guard is closed, the switch is moved to the RETARD position.



1. AUTOMATIC FEATHER ARMING LIGHT
2. RADIO ALTIMETER INDICATOR
3. LOW ALTITUDE WARNING LIGHT
4. AIRSPEED INDICATOR
5. CGRS COURSE INDICATOR
6. LOCALIZER AND GLIDE PATH - INOPERATIVE
7. ATTITUDE INDICATOR
8. CLOCK - 8 DAY
9. CLOCK - ELAPSED TIME
10. CROSSPOINTER INDICATOR - PILOT'S
11. MANIFOLD PRESSURE INDICATOR
12. MASTER FIRE WARNING LIGHT
13. TACHOMETER INDICATOR
14. WING FLAP ASYMMETRY INDICATOR
15. FLUXGATE MASTER DIRECTION INDICATOR
16. WING FLAP SHUT-OFF SWITCH AND WARNING LIGHT
17. CROSSPOINTER INDICATOR - CO-PILOT'S
18. RADOME WARNING LIGHT
19. POSITION LIGHTS BRILLIANCE CONTROL
20. EXTERIOR LIGHTS MASTER SWITCH
21. FUSELAGE LIGHTS CODE SELECTOR SWITCH
22. HYDRAULIC PUMPS - LOW PRESSURE WARNING LIGHTS
23. EMERGENCY BRAKE PRESSURE INDICATOR
24. HYDRAULIC SYSTEM PRESSURE INDICATOR
25. RADIO MAGNETIC INDICATOR
26. VERTICAL SPEED INDICATOR
27. CO-PILOTS STATIC SELECTOR
28. TURN AND SLIP POWER FAILURE WARNING LIGHTS
29. TURN AND SLIP INDICATOR
30. ALTIMETERS
31. LANDING GEAR WARNING LIGHT
32. LANDING GEAR AND WING FLAP POSITION INDICATOR
33. OUTSIDE AIR TEMPERATURE INDICATOR
34. THREE AXIS TRIM INDICATOR
35. PROPELLER REVERSING LIGHTS
36. PARKING BRAKE INDICATOR LIGHT
37. RADIO ALTIMETER ALTITUDE SELECTOR
38. VACUUM INDICATOR
39. DE-ICER PRESSURE INDICATOR
40. VACUUM WARNING LIGHTS

Figure 1-7. Pilots Instrument Panels (Typical)

Spark Control Circuit-Breaker Switches.

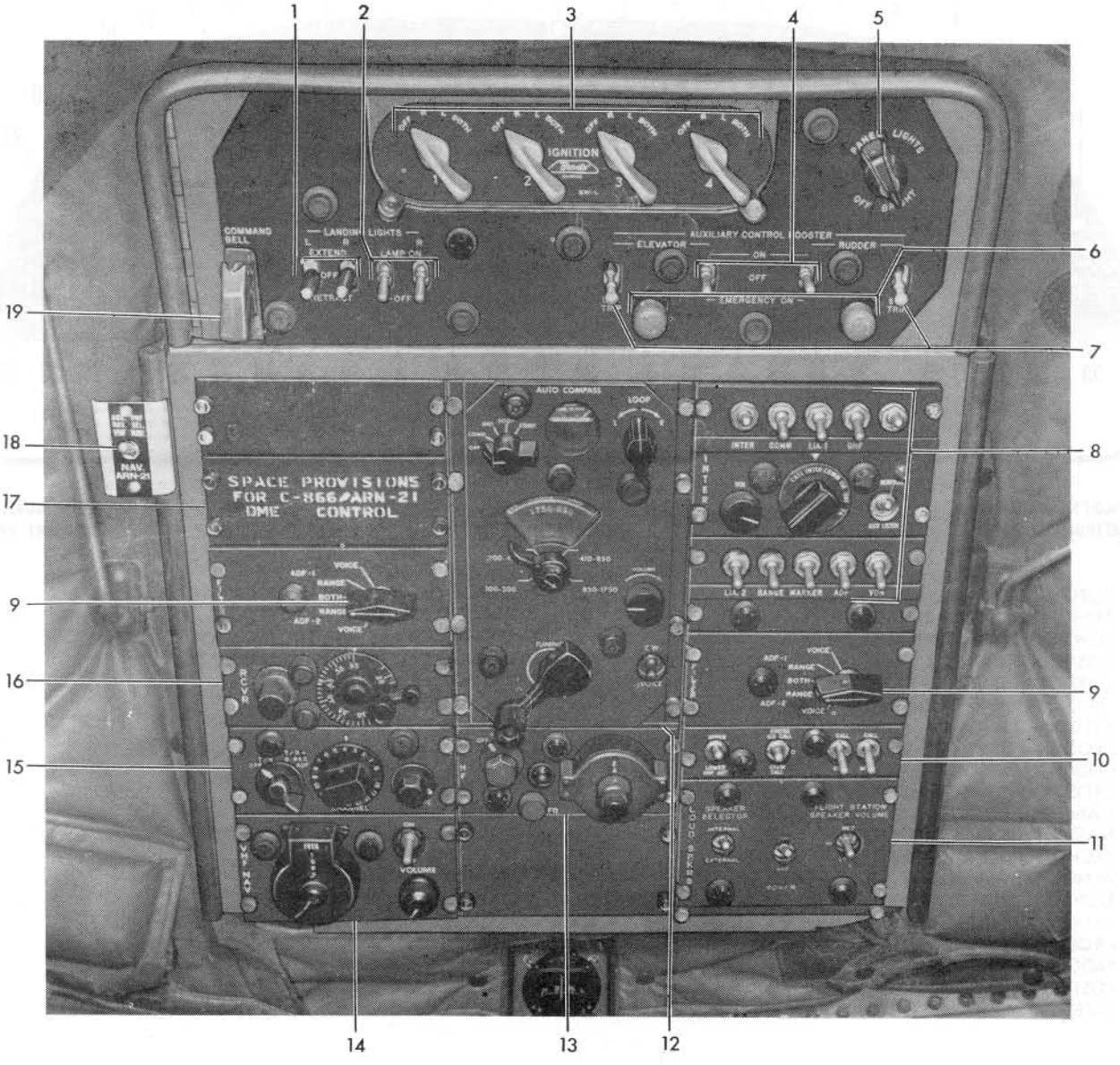
Four circuit breaker type switches (4, fig. 1-17) are located on the flight engineer's upper switch panel. These switches have two positions placarded NORMAL (up) and RETARD (down). The spark control circuit will not be complete unless these switches are in the NORMAL position. If the circuit of any engine is shorted the circuit breaker for that engine will automatically snap to the RETARD position. The circuit for any engine can be interrupted by manually placing the switch for that engine in the RETARD position.

PRIMING SYSTEM.

Fuel for priming is supplied by the auxiliary fuel pumps through the solenoid priming valve, mounted on the housing of each carburetor pressure chamber. The solenoid valve is actuated by d.c. current through a momentary-contact switch. Priming fuel is discharged from the fuel inlet chamber directly to the engine induction passage.

Engine Primer Switch.

A single priming switch (18, fig. 1-27), located on the MJB No. 2 switch panel, is a momentary-contact push



1. LANDING LIGHT EXTEND-RETRACT SWITCH
2. LANDING LIGHT SWITCHES
3. IGNITION SWITCHES
4. ELEVATOR AND RUDDER AUXILIARY BOOST SWITCHES
5. PANEL LIGHT RHEOSTAT
6. ELEVATOR AND RUDDER WARNING LIGHTS
7. ELEVATOR AND RUDDER AUXILIARY BOOSTER CIRCUIT BREAKERS
8. AN/AIC-10 INTERCOM CONTROL PANEL
9. RANGE FILTER SWITCH
10. AUXILIARY INTERCOM CONTROL PANEL
11. P.A. CONTROL PANEL
12. AN/ARN-6 RADIO COMPASS
13. 618S-1 COMMAND CONTROL PANEL
14. AN/ARN-14 VOR RECEIVER CONTROL PANEL
15. AN/ARC-27 UHF CONTROL PANEL
16. R23A/ARC-5 L.F. RECEIVER CONTROL PANEL
17. AN/ARN-21 CONTROL PANEL
18. VHF NAV AND ARN-21 SELECTOR SWITCH
19. COMMAND BELL SWITCH.

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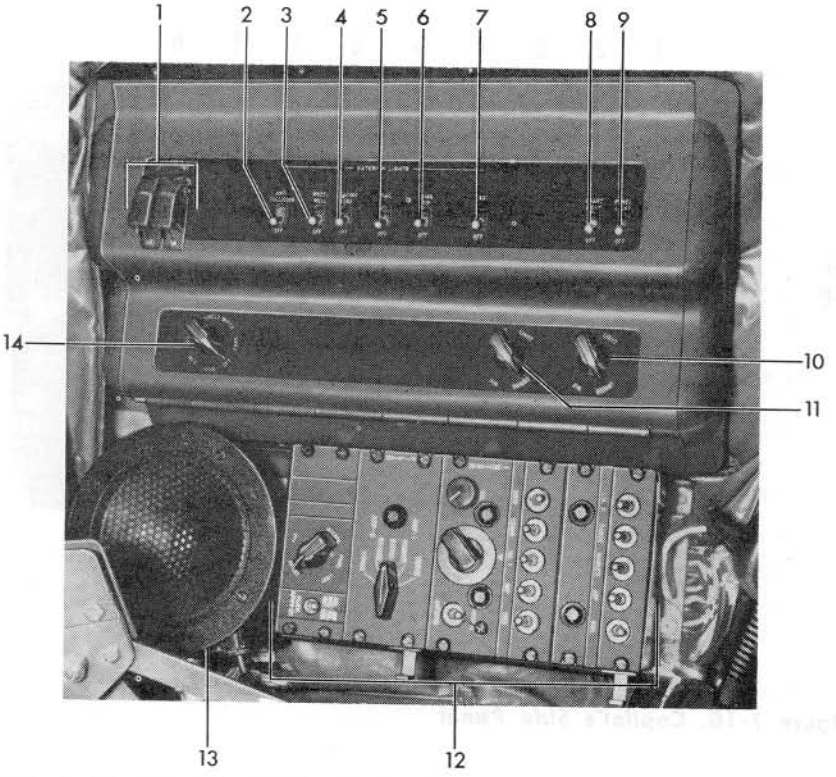
Figure 1-8. Pilots' Overhead Panel (Typical)



1 FLARE RELEASE SWITCHES
2 ANTI-COLLISION LIGHT SWITCH
3 WHEEL WELL LIGHT SWITCH
4 LEADING EDGE LIGHTS SWITCH
5 TAIL LIGHT SWITCH
6 WING TIP LIGHTS SWITCH
7 TAXI LIGHT SWITCH
8 CHART LIGHT SWITCH
9 PANEL LIGHT SWITCH
10 PANEL LIGHT RHEOSTAT
11 CHART LIGHT RHEOSTAT
12 RADIO AND ICS PANEL
13 LOUDSPEAKER
14 WINDSHIELD WIPER RHEOSTAT

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Figure 1-9. Pilot's Side Panel

button which electrically operates a solenoid primer valve on the carburetor to discharge fuel directly into the engine induction passage. Selection of the solenoid primer valve and the engine to be primed is controlled by the engine starter selector switch. The fuel auxiliary boost switches also must be on.

STARTING SYSTEM.

Each engine is equipped with a direct cranking d.c. electric starter mounted on the engine accessory section. The starter incorporates a disc-type clutch which will slip when the engine offers abnormal resistance to cranking during starting, such as that caused by a hydraulic lock.

Engine Starter Switches.

Two switches for the starting system are located on the MJB No. 2 switch panel. One switch is the engine starter selector (15, fig. 1-27). It is a rotary-type switch with five positions; engine 1, 2, OFF, 3, and 4. The other switch is a momentary-contact type push button (16, fig. 1-27) which energizes the selected engine starter.

ENGINE INDICATORS.

Tachometer Indicators.

Engine rotational speed is transmitted by tachometer generators mounted on the rear case of each engine to four dual self energized electric indicators. Two are located on the pilots' instrument panel (13, fig. 1-7), and two are located on the flight engineer's lower instrument panel (16, fig. 1-15). The indicators are calibrated to read in revolutions per minute.

Manifold Pressure Indicators.

Two dual manifold pressure indicators (11, fig. 1-7), located on the pilots' instrument panel, and two dual indicators (18, fig. 1-15), located on the flight engineer's lower instrument panel register the air induction pressures in the engine manifolds. The instruments are calibrated in inches of mercury and are operated by a.c. power.

Torquemeters (BMEP Indicators).

Two dual a.c.-operated torquemeter indicators (4, fig.

1. PANEL LIGHT SWITCH
2. CHART LIGHT SWITCH
3. PEDESTAL REAR LIGHT SWITCH
4. LEFT PITOT HEATER SWITCH
5. LEFT PITOT HEATER INDICATOR LIGHT
6. RIGHT PITOT HEATER INDICATOR LIGHT
7. RIGHT PITOT HEATER SWITCH
8. WINDSHIELD DEFOGGER HEATER SWITCH
9. WINDSHIELD DEFOGGER BLOWER SWITCH
10. NESA SYSTEM SWITCH
11. NESA SYSTEM POWER-ON LIGHT
12. NESA CYCLING LIGHT
13. NESA RESET SWITCH
14. COMPASS LIGHT RHEOSTAT
15. CHART LIGHT RHEOSTAT
16. PANEL LIGHT RHEOSTAT

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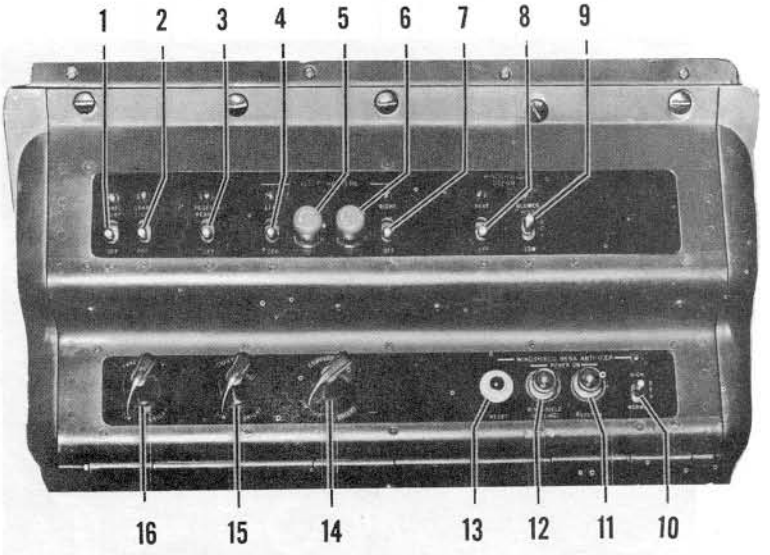


Figure 1-10. Copilot's Side Panel

1-15), located on the flight engineer's lower instrument panel, measure the torque at the propeller shaft. The indicators are calibrated in BMEP.

Torquemeter Line Heater Switches. Four switch-type circuit breakers (8, fig. 1-17) are located on the flight engineer's upper switch panel and are placarded ENG 1, ENG. 2, ENG. 3, and ENG. 4 (On some aircraft these switches are placarded INOPERATIVE because internal torquemeter lines are provided and heater switches are not required.) These switches supply d.c. electrical power to the heating element in each of the external torquemeter lines. In the event a short circuit occurs in the line heater, the switch-type circuit breaker will open, interrupting the d.c. electrical current to the heating element. Since each torquemeter line is external and exposed to low ambient temperature, the line heatrs tend to prevent slow or sluggish BMEP indications. These switches should be on at all times during engine operation.

Oil Pressure Indicators.

Two dual oil pressure indicators (9, fig. 1-15) are located on the right side of the flight engineer's lower instrument panel and register pressure in pounds per square inch. The oil pressure transmitters are located near the oil cooler assembly in each engine nacelle. Immediately below the oil pressure indicators are the four oil low-pressure warning lights (9, fig. 1-15) which glow when the pressures drop to 55 $\pm$5 psi.

Oil Temperature Indicators.

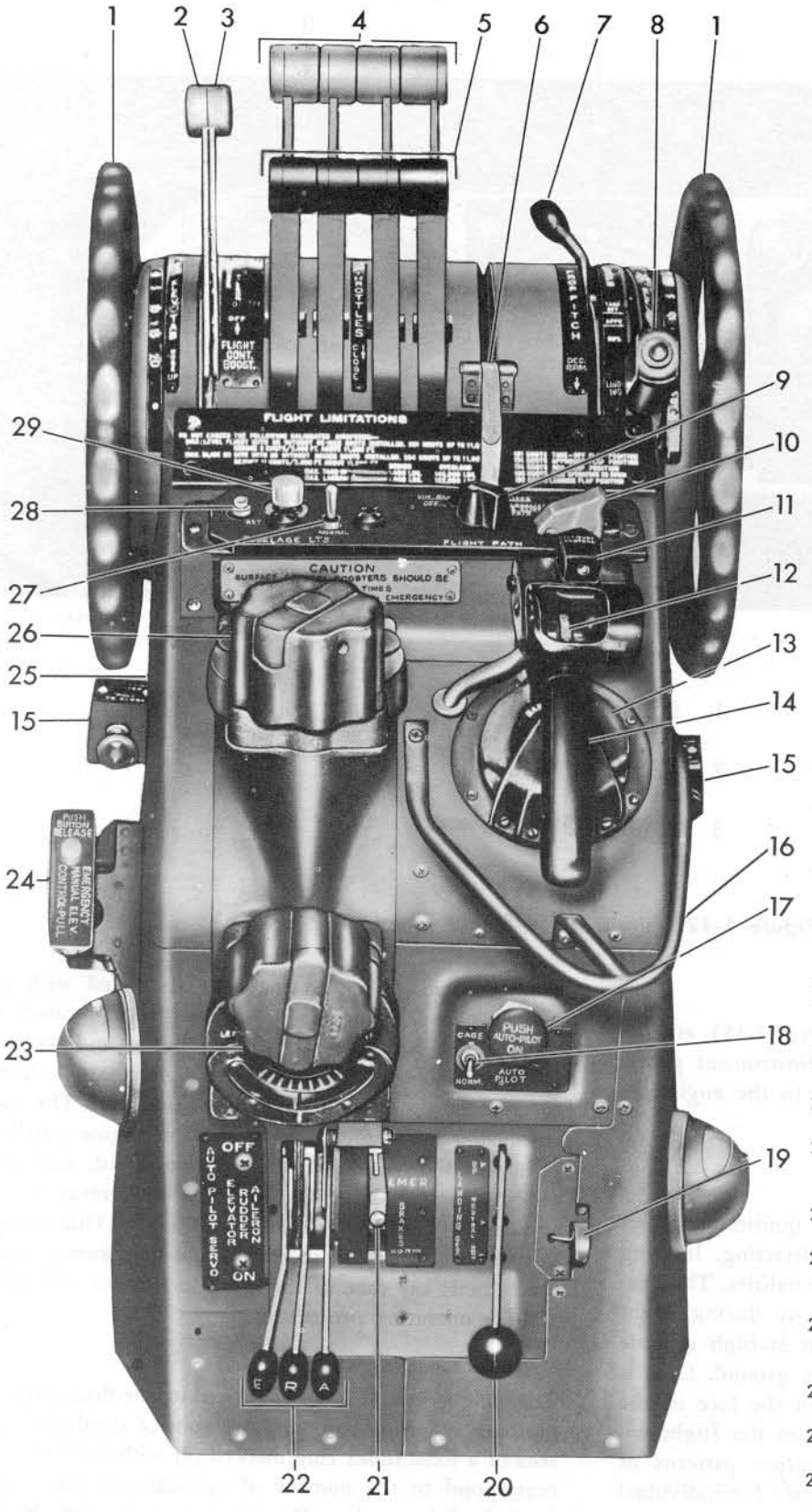
Four dual oil temperature indicators are located on the flight engineer's upper and lower instrument panels and are calibrated in degrees Centigrade. Two of these indicators (4, fig. 1-16) register the oil outlet temperature of the four engines by bulbs located in the oil-out line housing fittings near the engine oil sump cases. The other two indicators (8, fig. 1-15) register the oil inlet temperatures of the four engines after the oil has passed through the oil cooler system and supply tanks. The oil-in temperature bulbs are located in the engine oil tank sumps. Signals are transmitted electrically from the bulb transmitters to the panel indicators.

Fuel Pressure Indicators.

Two dual fuel pressure indicators (9, fig. 1-15) are located on the engineer's lower instrument panel and provide an indication of fuel pressure at the carburetors.

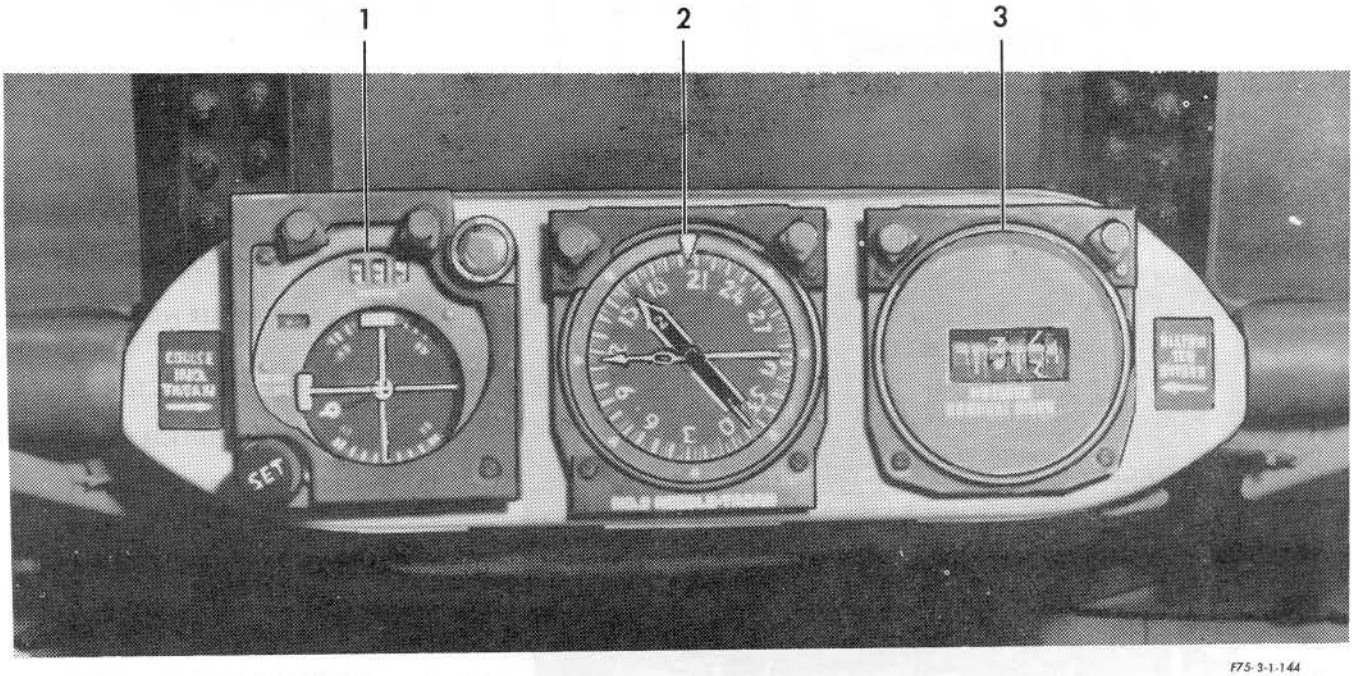
Fuel Low Pressure Warning Lights.

Four fuel low-pressure warning lights (10, fig. 1-15) are located on the flight engineer's lower instrument panel below the fuel pressure indicators. They glow red when the fuel pressure measured at the carburetors drops to the allowable minimum (approx. 19 psi).



1. ELEVATOR TRIM TAB CONTROL WHEELS
2. RUDDER BOOSTER CONTROL LEVER
3. AILERON BOOSTER CONTROL LEVER
4. REVERSE PITCH THROTTLE LEVERS
5. THROTTLE LEVERS
6. REVERSE LOCK OVERRIDE LEVER
7. MASTER PROPELLER PITCH CONTROL LEVER
8. WING FLAP CONTROL LEVER
9. FLIGHT PATH SELECTOR
10. FLIGHT PATH DIRECTION FINDER
11. AUTOMATIC PILOT ALTITUDE CONTROL
12. AUTOMATIC PILOT PITCH TRIM CONTROL
13. AUTOMATIC PILOT BANK TRIM CONTROL
14. AUTOMATIC PILOT PISTOL GRIP TURN CONTROL
15. VENTILATION DAMPER CONTROL
16. LANDING GEAR SOLENOID LOCK RELEASE (hidden)
17. AUTOMATIC PILOT CLUTCH SWITCH
18. AUTOMATIC PILOT FLUX GAGE CAGING SWITCH
19. LANDING GEAR LEVER RELEASE TRIGGER
20. LANDING GEAR LEVER
21. BRAKE SELECTOR LEVER
22. AUTOMATIC PILOT SERVO DISCONNECT LEVERS
23. AILERON TRIM TAB
24. EMERGENCY ELEVATOR BOOSTER SHIFT CONTROL
25. LANDING GEAR WARNING HORN RELEASE (hidden)
26. RUDDER TRIM TAB
27. FUSELAGE LIGHTS KEY SELECTOR
28. FUSELAGE LIGHTS KEY SWITCH
29. FUSELAGE LIGHTS KEY INDICATOR

Figure 1-11. Pilots' Center Control Stand (Typical)



1 COURSE INDICATOR

2 AZIMUTH INDICATOR

3 RANGE INDICATOR

Figure 1-12. Pilot's Glare Shield Panel

Fuel Flow Indicators.

Two dual fuel flow indicators (2, fig. 1-15) are located on the flight engineer's lower instrument panel. They indicate the rate of fuel flow to the engine in pounds per hour.

IGNITION ANALYZER.

This aircraft incorporates a Sperry ignition analyzer which provides a visual means of detecting, locating and identifying engine ignition abnormalities. The analyzer can be used on the ground or during flight and will reveal ignition malfunctions at high altitude that normally are not evident on the ground. Data is presented in the form of patterns on the face of the cathode ray tube indicator mounted on the flight engineer's table. The characteristic ignition patterns of each engine may be examined singularly for individual cylinders or simultaneously for all cylinders. Any ignition malfunction during engine operation will alter the characteristic pattern and change its contour. Each engine pattern can be identified with the number of the cylinder, spark plug, or magneto associated with the malfunction. The power supply amplifier, located aft of the pilots seat operates on a.c. power and contains the electronic circuits that provide neceesary voltages to operate the cathode ray tube indicator. The synchronizing generator is driven by the engine auxiliary tachometer drive at one-half engine speed, and provides 3-phase voltage for timing the patterns to the angular position of the engine crankshaft. This voltage initiates and produces the horizontal base sweep across the cathode ray tube of the indicator. Refer to Section VII for operating procedures.

Cycle Switch.

The cycle switch, (fig. 1-13) located on the floor adjacent to the flight engineers auxiliary control quadrant, consists of a fixed index ring marked off with numbers that correspond to the number of cylinders of the engine in their firing order. The inner rotatable switch dial is marked with an index line and abbreviations at specific points which indicate events occurring during a complete engine cycle. The following abbreviated posi-

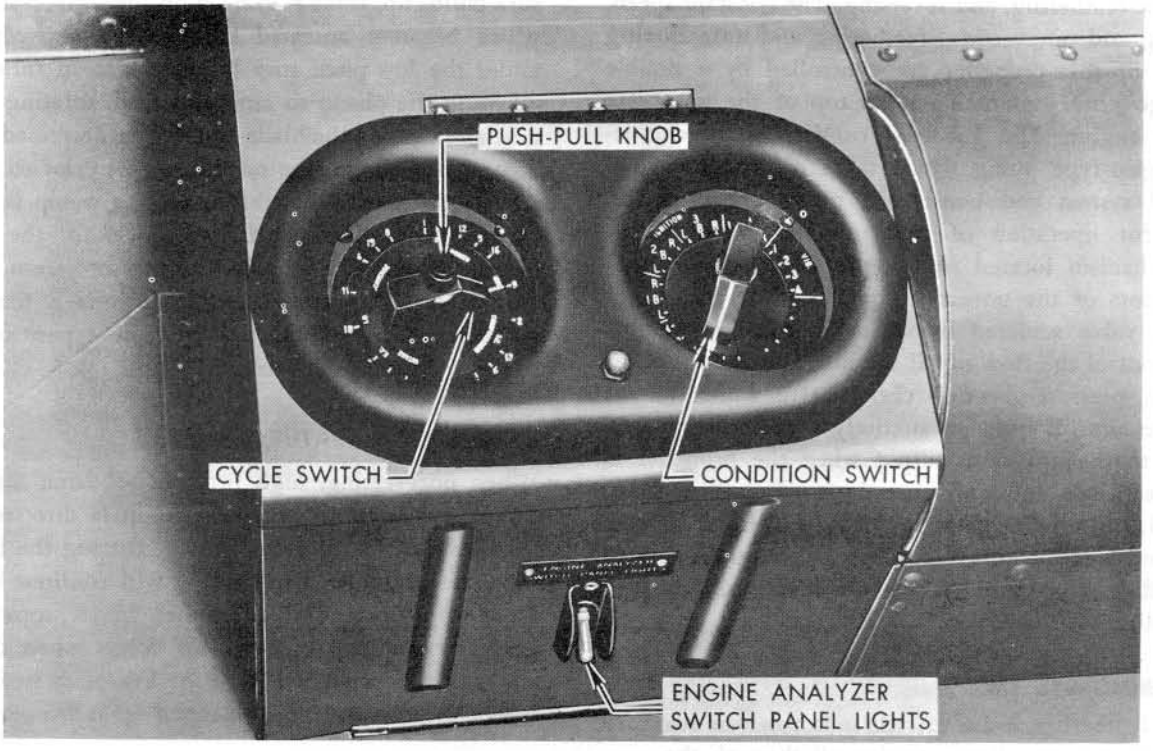


Figure 1-13. Ignition Analyzer Controls

tions are inoperative on this unit because vibration pick-ups are not installed: I.O. (intake opens), E.C. (exhaust closes, I.C. (intake closes), E.O. (exhaust opens). The IGN (ignition position), however, is used. The center selector switch incorporates a push-pull knob that controls the sweep of the horizontal pattern on the cathode ray tube indicator. The IGN position is aligned with any cylinder designation on the fixed ring dial, and the operator may choose the pattern presentation. The number of patterns that will be seen is contingent upon the position of the push-pull knob. In the "pushed-in" position (fast sweep), two complete patterns will appear on the indicator, beginning with the ignition diagram of the cylinder on which the cycle switch is indexed, and will conclude with that of the next cylinder in firing order. In the "pulled-out" position (slow sweep), the patterns of all cylinders will appear, beginning with that of the cylinder on which the IGN is indexed. Some typical patterns are illustrated in Section VII.

Condition Switch.

The condition switch, located on the flood adjacent to the flight engineer's auxiliary control quadrant, functions as a selector for a specific engine for either ignition analysis or for checking the speed synchronism between engines. It also selects either left, right, or both magnetos for observation. The inner rotatable dial has a single index mark which is rotated to the desired indices engraved on the fixed outer ring. The fixed ring is divided into five general sections which are engraved as follows: SYN, 2, 3, 4, and VIB (inoperative) for checking synchronization of respective engines with No. 1 engine; IGNITION, 1, 2, 3, and 4 for ignition analysis of the respective engines and B (both), L (left) and R (right) magnetos.

Cathode Ray Tube Indicator and Controls.

The indicator assembly is a housing which encloses a 3-inch cathode ray tube. The assembly is mounted face-up in the flight engineer's table. The power supply amplifier provides the adjustments of the indicator such as focus, gain and horizontal centering, and intensity. However, when these controls are set, they should not require frequent readjustment.

PROPELLERS.

A Hamilton Standard hydromatic, three-bladed, full-feathering and reversible pitch propeller is installed on each engine. Each propeller incorporates a fluid anti-icing distribution system. A propeller control system is provided for constant speed, synchronization,

individual selector controls, a master control for changing rpm of all engines simultaneously, manual and automatic feathering, and reversing. The constant speed, reversing and unreversing, feathering and unfeathering features of this propeller are controlled by a double acting governor mounted on the top of the nose case of each engine. The governor consists of an engine-driven gear-type pump which takes oil from the engine oil system and boosts the pressure to that required for operation of the propeller pitch changing mechanism located in the propeller dome. Other components of the governor consist of the following: A pilot valve actuated by spring-balanced flyweights which control the flow of oil to and from the propeller dome; a pressure-operated check valve which allows high pressure oil from an auxiliary (feathering) pump to add to the governor output when the propeller is being feathered and unfeathered, or reversed and unreversed; and a relief valve system which limits the output pressure of the governor pump, yet allows it to provide sufficient operating force to control the propeller under all conditions.

FEATHERING SYSTEM.

During feathering, a d.c. electric motor-driven auxiliary (feathering) pump directs engine oil through the governor, which distributes and augments oil pressures through the propeller shaft to the forward side of the dome piston. As the piston is forced aft, a slotted cam gear is rotated which, in turn, rotates each of the three blades so that the blades move up to the feathered positions. Displaced oil from the aft side of the piston is forced back through the propeller shaft to the propeller governor to be recirculated in the system as long as the propeller feathering button is in the depressed position.

UNFEATHERING SYSTEM.

During unfeathering, the motor-driven auxiliary (feathering) pump and the solenoid valve in the governor, directs oil pressure to position the governor pilot valve in the decrease pitch position. The oil flows through the decrease pitch passages to the aft side of the propeller dome piston. The piston is forced forward, turning the blades toward low pitch. The oil on the forward side of the piston is forced back through the propeller shaft to the intake side of the propeller governor.

REVERSING FEATURES.

When reverse thrust braking is used, the motor-driven auxiliary (feathering) pump and the solenoid valve in the governor are energized and send high pressure oil through the propeller shaft to the aft side of the dome piston, moving it forward until the piston sleeve contacts the low-pitch stop levers. As additional oil pressure builds up, force is exerted on the servo piston valve which becomes unseated and moves the wedge from under the low-pitch stop levers, which in turn retract, allowing the piston to move forward, rotating the cam gear and causing the blade angle to be decreased through zero pitch and into the reverse angle. Prior to reaching the reverse pitch stop, the feathering pump is shut off by the blade angle switch and power for the last few degrees of travel is supplied by pressure from the governor. The full reverse angle stop is a fixed pitch position, and the blade is held in that position by oil pressure from the governor pump.

UNREVERSING FEATURES.

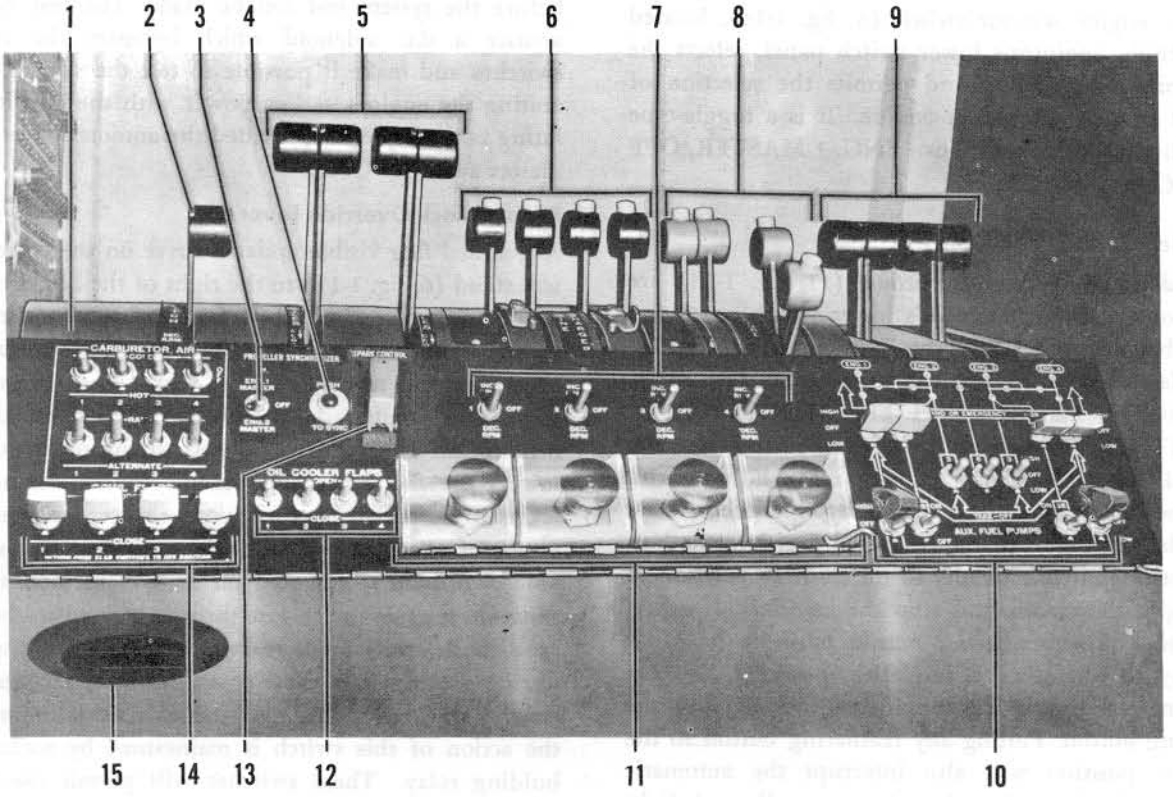
When unreversing, high pressure oil from the motor-driven auxiliary (feathering) pump is directed to the forward side of the dome piston, forcing the blades to the positive angle. Unreversing will continue until the blade cam contacts a blade switch which stops the auxiliary (feathering) pump. This occurs when the blade angle reaches a point before the low-pitch stop setting, where the constant speed control takes over.

SYNCHRONIZING FEATURES.

The synchronizer system provides a means of synchronizing the speed of all engines below take-off rpm down to 1350 rpm. Synchronization by 3% increments of existing rpm of the particular master engine (1 or 2) may be accomplished by depressing and releasing a synchronize button until synchronization is reached. However, it is recommended that separate adjustment of each propeller governor be made by use of its individual control switch when the difference in rpm is beyond the 3% range. Failure of either master engine (1 or 2) will not decrease the rpm of the slave engine by more than 3%.

AUTOMATIC FEATHERING FEATURES.

The automatic feathering system will feather the propeller of an engine automatically if the BMEP drops to approximately 90-104 BMEP or less and remains there from 1½ to 2 seconds, provided the system is turned on. This delay is introduced to prevent automatic feathering in the event of momentary power losses and to prevent automatic feathering if the throttle is advanced rapidly enough to close the throttle switch before the BMEP has risen above the setting of the torque pressure switch. A blocking relay will disconnect the entire automatic feathering system after one propeller has feathered automatically.



1. CARBURETOR AIR CONTROL SWITCHES
2. MASTER PROPELLER CONTROL LEVER
3. MASTER ENGINE SELECTOR SWITCH
4. RESYNCHRONIZER BUTTON
5. THROTTLE LEVERS
6. ENGINE SUPERCHARGER CONTROL LEVERS
7. PROPELLER GOVERNOR CONTROL SWITCHES
8. MIXTURE CONTROL LEVERS
9. FUEL TANK SELECTOR LEVERS
10. AUXILIARY FUEL PUMP SWITCHES
11. PROPELLER FEATHERING BUTTONS & LIGHTS
12. OIL COOLER FLAP SWITCHES
13. MANUAL SPARK CONTROL SWITCH
14. COWL FLAP SWITCHES
15. IGNITION ANALYZER INDICATOR

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Figure 1-14. Flight Engineer's Lower Switch Panel (Typical)

Propeller Master Levers.

Propeller master levers are located on the pilots' center control stand (7, fig. 1-11), and on the flight engineer's control quadrant (2, fig. 1-14). These levers mechanically reset all four propeller governors simultaneously throughout the governing range, and at the take-off rpm position actuate the calibrate switch which disconnects the synchronizer from the system and sets the governors to maximum rpm. These two levers are mechanically linked with no over-riding feature for either the pilot or the flight engineer.

Propeller Governor Switches.

Four individual governor switches (7, fig. 1-14) are located on the flight engineer's lower switch panel and are numbered from left to right. Each switch has three positions, INC. RPM, OFF, and DEC. RPM, and is spring-loaded to the OFF position. Holding the switch in either the INC. RPM or DEC. RPM position provides momentary d.c. electrical contact to the propeller governor to effect changes in pitch, as desired.

Master Engine Selector Switch.

A master engine selector switch (3, fig. 1-14), located on the flight engineer's lower switch panel, selects the synchronization function and permits the selection of engine 1 or 2 as the master engine. It is a toggle-type switch that has three positions: ENG. 1 MASTER, OFF and ENG. 2 MASTER.

Feathering Buttons and Lights.

Four individual feathering buttons (11, fig. 1-14) are located on the flight engineer's lower switch panel and are numbered from left to right. Each button is protected by a plastic cover to prevent inadvertent feathering. Each cover is marked PUSH FEATHER and PULL UNFEATHER. Pressure on the selected button energizes the auxiliary (feathering) pump, and a holding coil holds the button in during feathering operation. After the blades have reached the feathered position, the button must be pulled manually to the midway position to de-energize the circuit and stop the auxiliary (feathering) pump. The feathering button must be held out manually to unfeather a propeller; however, the unfeathering action can be terminated by releasing the feathering button. Pulling any feathering button to the unfeather position will also interrupt the automatic feathering circuit of the other three propellers. A light is incorporated in each feathering button that glows when the auxiuiary (feathering) pump circuit is energized.

Synchronize Button.

The synchronize button (4, fig. 1-14) is located on the flight engineer's lower switch panel. Pushing and releasing this button will release automatically a d.c. solenoid which will synchronize the propellers to the existing rpm indicated on the selected master engine tachometer, provided the deviation is less than 3% from the master. When the button is depressed, synchronization is disconnected and the range limitation feature is released so that it can recenter. Releasing the button reconnects the synchronization or makes the off-speed governors run up to 3% toward the master tachometer.

Automatic Feathering Master Switch.

This is a guarded switch (16, fig. 1-17) located on the flight engineer's upper switch panel. When this switch is placed in the ON position, a d.c. holding coil energizes the automatic feathering system. The automatic feathering system is completely armed when this switch is turned on and the throttles are advanced beyond the 50% position.

Automatic Feathering Test Switches.

Four automatic feathering test switches (14, fig. 1-17) are located on the flight engineer's upper switch panel. Each switch is protected by a guard which must be lifted before the system test can be made. The test switches actuate a d.c. solenoid which bypasses the throttle switches and make it possible to test the system by operating the engines at low power with the circuit simulating take-off power, provided the automatic feathering master switch is ON.

Reverse Lock Override Lever.

A guarded flag visible under a cover on the center control stand (6, fig. 1-11) to the right of the No. 4 throttle lever, indicates when the reverse throttle levers are locked. This flag lever may be pushed down manually to release the reverse throttle lock. The reverse lock actuator is connected by cables to the reverse throttle locking bar which, when turned to the open position, lowers the flag lever and permits the reverse throttle levers to be pulled aft for reverse thrust. An automatic means of releasing the reverse throttle lock is also provided. A switch, mounted on each main landing gear fulcrum, releases the reverse throttle lock when the main gear shock struts pivot rearward as brakes are applied during a rejected take-off or as the wheels contact the runway during landing. As this contact is momentary, the action of this switch is maintained by means of a holding relay. These switches will permit use of the reverse thrust power with partial weight on the main gear, and the scissors switch on the left main gear permits the use of reverse thrust power when full weight is on the landing gear. The throttle reverse lock is reset when both outboard throttles are advanced to the minimum take-off power and the aircraft weight on the left main landing gear is partially reduced.

Reverse Pitch Throttle Levers.

These levers control the reverse power range and are discussed under Throttles.

Reverse Pitch Indicator Lights.

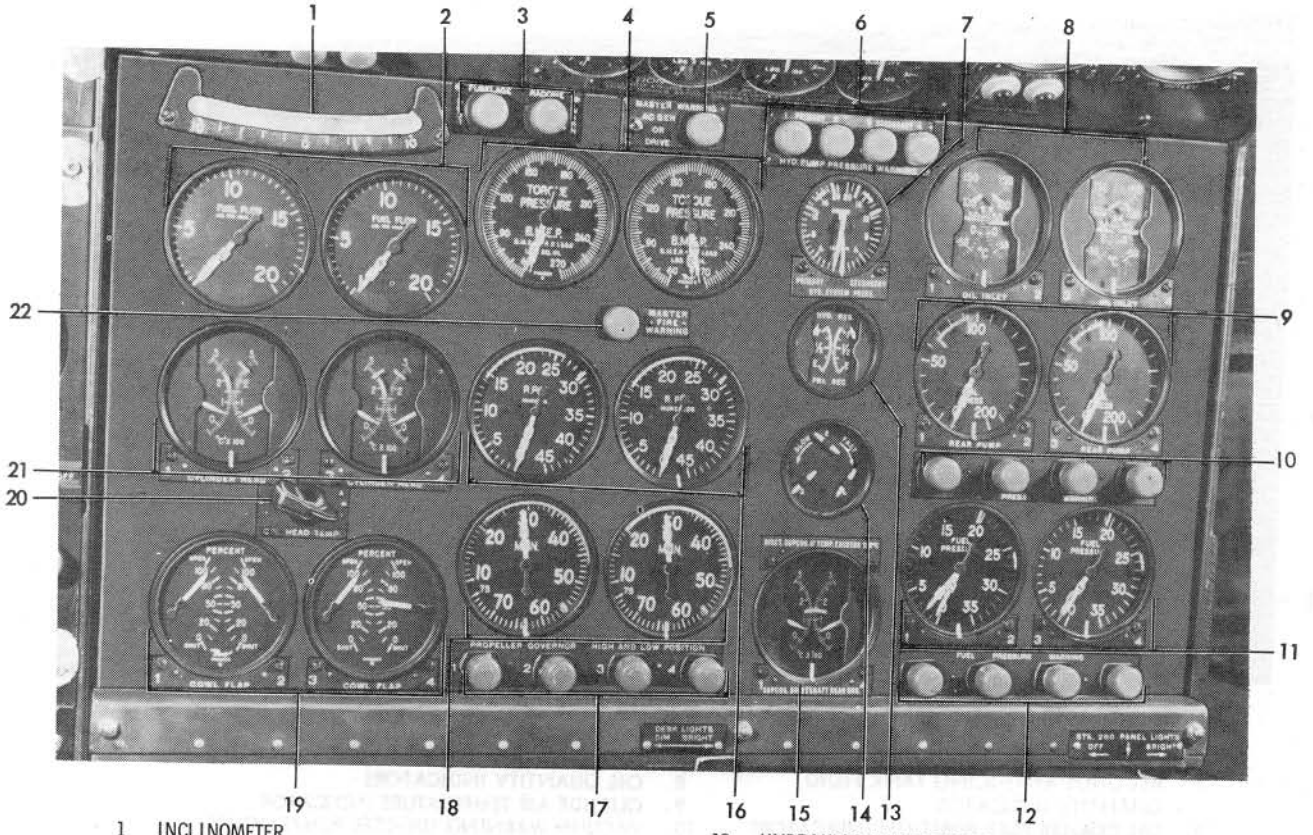
Four d.c. operated reverse pitch indicator lights (31, fig. 1-7) are mounted on the pilots' center instrument panel. These lights are set to come on 5° before the reverse pitch stops are reached and to go out when unreversing is initiated.

Propeller Governor High and Low Pitch Position Lights.

Four d.c. operated indicator lights (17, fig. 1-15) are located on the flight engineer's lower instrument panel. These lights are set to glow whenever the propeller governors are operating at either the high or low rpm pitch limit setting.

Automatic Feathering Arming Light.

The automatic feathering arming light is installed (15, fig. 1-17) on the flight engineer's upper switch panel and also (1, fig. 1-07). This light is d.c. operated and set to glow when the automatic feathering system



1 INCLINOMETER
2 DUAL FUEL FLOW INDICATORS
3 DOOR WARNING LIGHTS
4 TORQUEMETERS (BMEP INDICATORS)
5 A.C. GENERATOR MASTER WARNING LIGHT
6 HYDRAULIC PUMP PRESSURE WARNING LIGHT
7 HYDRAULIC SYSTEM PRESSURE INDICATOR
8 OIL TEMPERATURE INDICATORS
9 OIL PRESSURE INDICATORS
10 OIL LOW-PRESSURE WARNING LIGHTS
11 FUEL PRESSURE INDICATORS
12 FUEL LOW-PRESSURE WARNING LIGHTS
13 HYDRAULIC FLUID QUANTITY INDICATOR
14 SYNCHROSCOPE
15 CABIN SUPERCHARGER DRIVE SHAFT REAR BEARING TEMPERATURE INDICATOR
16 TACHOMETER INDICATORS
17 PROPELLER GOVERNOR HIGH AND LOW POSITION INDICATOR LIGHTS
18 MANIFOLD PRESSURE INDICATORS
19 DUAL COWL FLAP POSITION INDICATORS
20 CYLINDER HEAD TEMPERATURE SELECTOR SWITCH
21 DUAL CYLINDER HEAD TEMPERATURE INDICATORS
22 MASTER FIRE WARNING LIGHT

Figure 1-15. Flight Engineer's Lower Instrument Panel (Typical)

master switch is ON. When the feathering system is energized manually, the light in the feathering button will come on and the automatic feathering arming light will go out. When feathering is started automatically, the feathering button light will come on, and when the feathering button is pulled out, the feathering button light and the automatic propeller feathering arming light will go out.

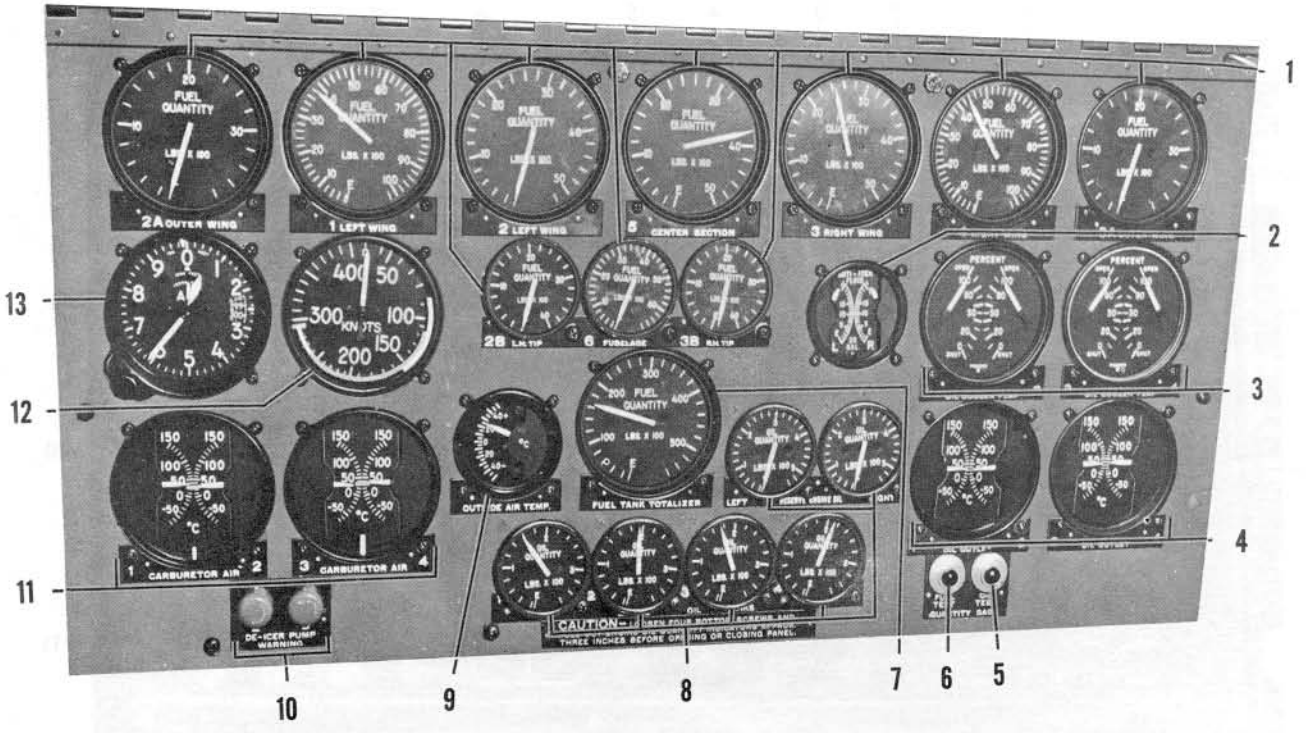
Synchroscope.

The synchroscope, located on the flight engineer's lower instrument panel (14, fig. 1-15, provides indications for synchronizing the four propellers. It is an a.c. electrical differential motor-type indicator that shows the frequency differences between the tachometer generator output of engine 1, and the output of engine tachometer generators 2, 3, and 4. Since the frequency is proportional to the engine speed, the synchroscope provides a visual comparison of the engine speeds. The three needles on the face of the instrument indicate the rpm of engines 2, 3, and 4 relative to engine 1. They rotate either clockwise or counterclockwise, depending upon whether the engine speed is faster (clockwise) or slower (counterclockwise) than engine 1. When the speeds of engines 2, 3, and 4 are synchronized with engine 1, the needles will be stationary.

OIL SYSTEM.

ENGINE OIL SYSTEM.

Separate oil systems provide lubrication for each engine.



1. FUEL QUANTITY INDICATORS
2. ALCOHOL ANTI-ICING TANK FLUID QUANTITY INDICATOR
3. OIL COOLER FLAP POSITION INDICATORS
4. OIL TEMPERATURE INDICATORS (OIL OUT)
5. OIL QUANTITY INDICATORS TEST SWITCH
6. FUEL QUANTITY INDICATORS TEST SWITCH
7. FUEL QUANTITY TOTALIZER INDICATOR
8. OIL QUANTITY INDICATORS
9. OUTSIDE AIR TEMPERATURE INDICATOR
10. VACUUM WARNING (DE-ICER PUMP) LIGHTS
11. CARBURETOR AIR TEMPERATURE INDICATOR
12. AIRSPEED INDICATOR
13. ALTIMETER

F75-3-1-21

Figure 1-16. Flight Engineer's Upper Instrument Panel (Typical)

Oil flows from the engine oil tank to the engine oil pressure pump which pumps oil through the engine oil passages. After circulating through the engine, the oil is returned by an engine scavenging pump to the oil radiator for cooling. From the radiator, the oil flows through the return line and back into the engine oil tank. Refer to the Servicing Diagram, (figure 1-45), for oil grades and specifications.

Engine Oil Tanks.

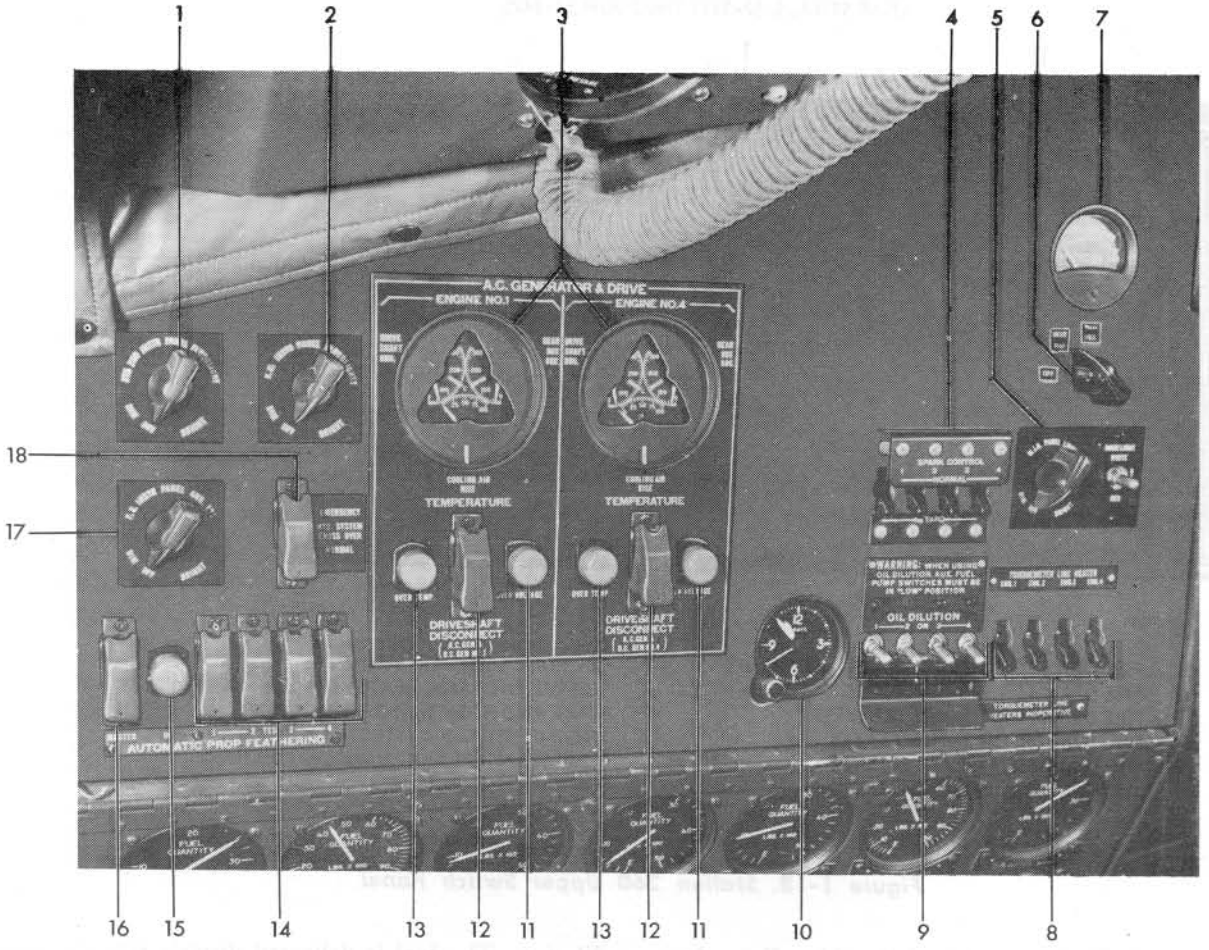
The oil tank for each outboard engine is located in the engine nacelle aft of the firewall, and the oil tank for each inboard engine is located in the center section leading edge, inboard of the engine nacelle. Each engine oil tank has a total volume of 54 gallons which includes an 11.5-gallon expansion and foaming space. The total oil content for each tank is 42.5 gallons and includes an oil reserve of 2.5 gallons (which cannot be used by the engine) for feathering of each propeller. External filling beyond the prescribed amount or filling of the expansion space is impossible because of the design and shape of the filter unit. A capacitance-type oil quantity indicating system is installed in each tank to indicate the amount of usable oil. Each tank also is provided with a dip stick, calibrated in U.S. gallons, encased in a foam-proof tube which is a part of the tank filler unit.

Oil Cooler Radiators and Control Valves.

An oil cooler unit is installed on the underside of each engine nacelle. Ram air enters a scoop, passes through the oil radiator and exits past an oil cooler flap which controls the amount of air necessary for cooling. A control valve, mounted on the oil radiator, automatically routes the flow of oil in one of the following ways:

1. Straight through the valve, bypassing the radiator.
2. Around the jacket of the oil cooler radiator.
3. Through the core of the radiator.

When the engine is started at low ambient temperature, the viscosity of the oil in the cooler prevents the flow of oil through the radiator. Oil pressure builds up in the control valve until the pressure opens the surge valve. When the surge valve is open, the oil cooler radiator is bypassed. As the temperature rises and the oil in the jacket of the radiator becomes more fluid, the pressure de-



1. STA 260 INST. PANEL FLOODLIGHT SWITCH
2. FLIGHT ENGINEER'S INSTR. PANEL FLOOD LIGHT SWITCH
3. A.C. GENERATOR TEMPERATURE INDICATORS
4. SPARK CONTROL SWITCHES
5. FLIGHT ENGINEER'S STATION LIGHT SWITCHES
6. INVERTERS FREQUENCY SELECTOR SWITCH
7. INVERTER FREQUENCY METER
8. TORQUEMETER LINE HEATER SWITCHES
9. OIL DILUTION SWITCHES
10. CLOCK
11. A.C. GENERATOR OVER VOLTAGE WARNING LIGHTS
12. A.C. GENERATOR DRIVE SHAFT DISCONNECT SWITCHES
13. A.C. GENERATOR OVER TEMPERATURE WARNING LIGHTS
14. AUTO FEATHERING TEST SWITCHES
15. AUTO FEATHER ARMING LIGHT
16. AUTO FEATHER MASTER SWITCH
17. FLIGHT ENGINEER'S INSTRUMENT PANEL AUX. LIGHTS
18. HYDRAULIC SYSTEM CROSS OVER SWITCH

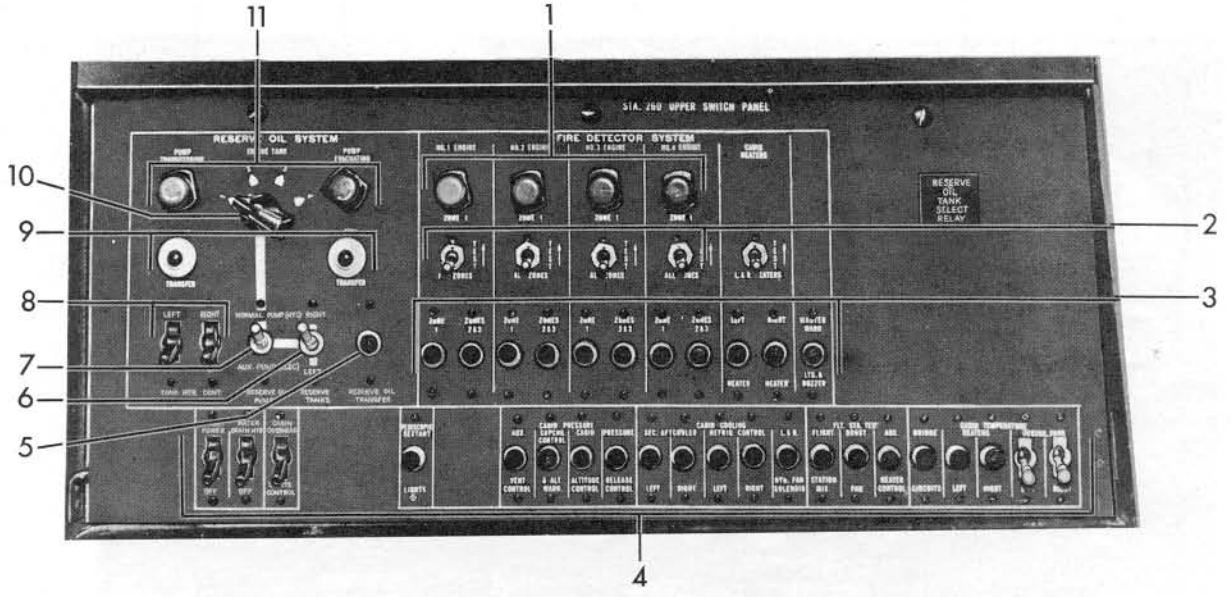
Figure 1-17. Flight Engineer's Upper Switch Panel (Typical)

creases and the surge valve closes. The bypass valve to the jacket is opened and as oil is circulated through the jacket, the oil in the core is heated and becomes more fluid until the rate of oil flow is increased and the pressure drops below the closing point of the bypass valve. When the bypass valve is completely closed, the oil is circulated directly through the core of the radiator, back into the control valve, and then out through the exit port to the oil tank return line. Under cruise conditions, oil temperature is further controlled by actuating the oil cooler flap which regulates the amount of air passing through the radiator.

Oil Cooler Flap Switches. The switches that operate the cooler flaps (12, fig. 1-14) are located on the left side of the flight engineer's lower switch panel. These switches are spring-loaded from the OPEN and CLOSE positions to the OFF position. The cooler flap is moved to the desired position by holding the switch in either the OPEN or CLOSE position, and is stopped at any setting by releasing the switch.

Emergency Shut-off Levers. Movement of this lever to the fourth detent position will shut off engine oil. Refer to Emergency Equipment, this Section.

USAF SERIALS 52-3411 THROUGH 52-3425



1 FIRE DETECTOR - ZONE WARNING LIGHTS
2 FIRE DETECTOR TEST SWITCHES
3 FIRE DETECTOR CIRCUIT BREAKERS
4 STATION 260 CIRCUIT BREAKERS
5 OIL TRANSFER CIRCUIT BREAKER
6 RESERVE TANK SELECTOR SWITCH
7 OIL PUMP SELECTOR SWITCH
8 RESERVE OIL TANK HEATER SWITCH
9 START AND STOP TRANSFER SWITCHES
10 ENGINE OIL TANK SELECTOR SWITCH
11 PUMP TRANSFER AND PUMP EVACUATING INDICATOR LIGHTS

Figure 1-18. Station 260 Upper Switch Panel

Oil Quantity Indicators and Test Switch. Four d.c. electrically operated oil quantity indicators (8, fig. 1-16) are located on the lower side of the flight engineer's upper instrument panel. These indicators register the oil quantity of each engine tank, and are calibrated in pounds. A test switch button is installed on the flight engineer's upper instrument panel which, when depressed, allows the indicating needle to drop to zero; when released, the needle will return to the accurate quantity reading.

Oil Cooler Flap Position Indicators. Two dual oil flap position indicators (3, fig. 1-16) are located on the right side of the flight engineer's upper instrument panel and are marked to register the position of the flaps in percentage of travel from the full open (100 per cent) position.

Oil Dilution.

Oil dilution is provided for each engine oil system and is controlled separately or collectively by switches located on the flight engineer's upper switch panel. The oil dilution solenoid valves are located aft of the firewall in each nacelle. Since the connections to the fuel lines are on the suction side of the engine-driven fuel pumps, the auxiliary fuel pumps must be operating while diluting. The fuel is delivered directly into the engine oil-in line.

Oil Dilution Switches. Four d.c. operated switches (9, fig. 1-17) are located on the flight engineer's upper switch panel. They are spring-loaded to the OFF position. In the ON position, each switch opens a solenoid valve which admits fuel into the corresponding engine oil inlet line when the fuel boost pumps are on.

CAUTION

Oil dilution should not be accomplished by the flight crew. The engine oil tanks do not include hoppers.

RESERVE OIL SYSTEM.

A reserve oil system (fig. 1-19) permits the selective addition of oil to each engine oil tank from two reserve oil supply tanks. These supply tanks are insulated cell-type bladder tanks and have a usable fluid capacity of 67 gallons. These cells are located in the outer bays of the center section aft of the front beam. The filler units are located in each wing-to-fuselage fillet and contain air vent shut-off valves and dip sticks calibrated in gallons. Each tank unit includes internal thermostatically

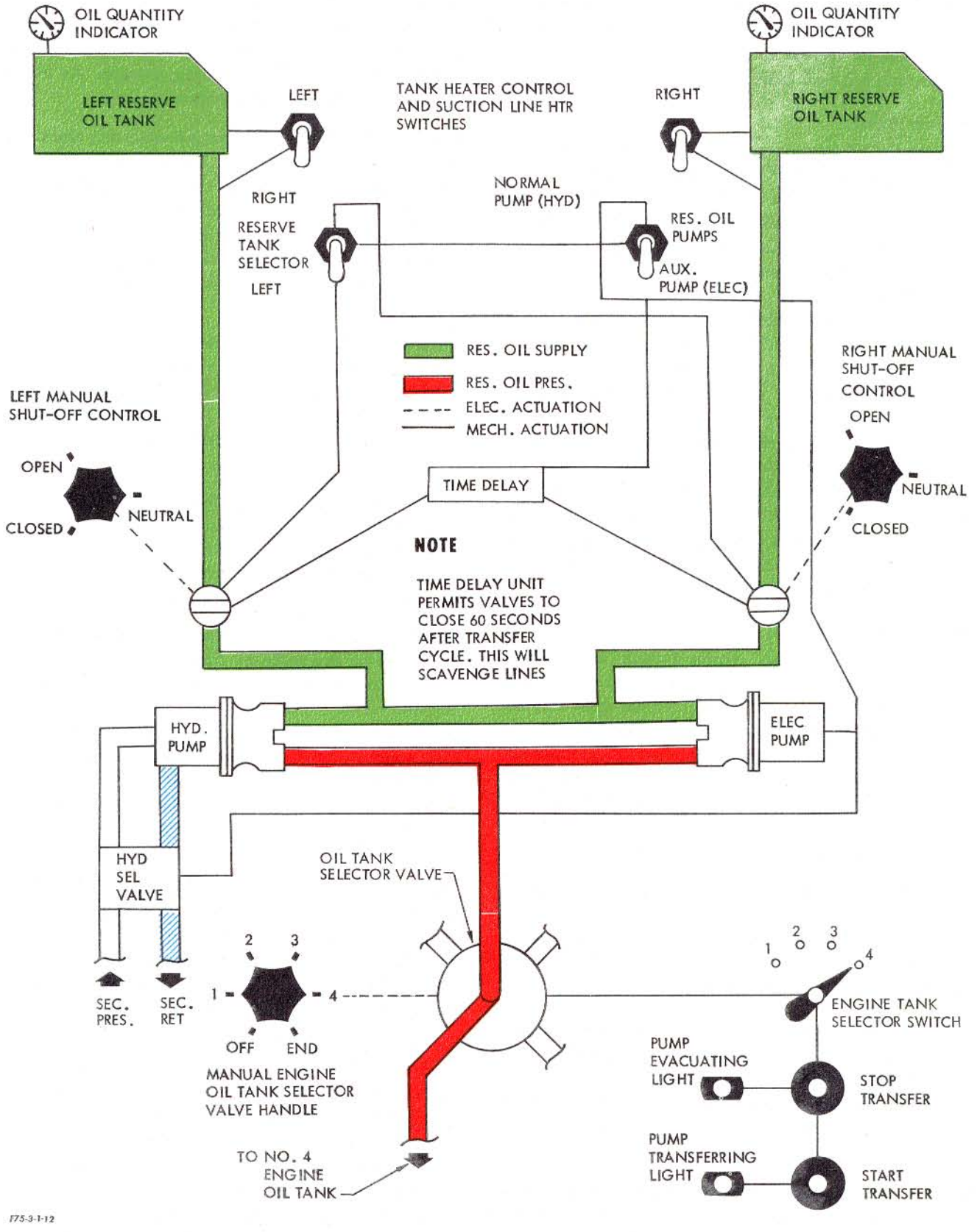


Figure 1-19. Reserve Engine Oil System

controlled heating elements laced to the cell walls and suspended approximately one inch above the bottom of each cell. The thermostats are set to maintain an oil temperature of 70-100° F. Oil quantity transmitters are also provided in each tank.

Transfer Pumps.
The reserve oil system includes a d.c. electric motor-driven engine tank selector valve with a manual override control to preselect the engine tank that requires replenishing. One reversible electrically-operated pump and one reversible hydraulically-operated pump are installed in the forward cargo compartment just forward of the front wing beam. Either pump will transfer oil to an engine tank at the rate of 3 gallons per minute at an oil temperature of 70° F. The reversing feature of these pumps is for the purpose of evacuating the system lines after transfer operation in order to prevent the oil from congealing in the lines. Integral relief valves are provided in each pump for system protection. A float switch is installed to reverse the pump automatically for the evacuating operation which is set for 60 seconds duration. An additional oil float shut-off valve is also installed in each engine oil tank and is set to automatically close the inlet valve when the maximum filling level has been reached.

Auxiliary Transfer Panel.
In the event of electrical power failure, an auxiliary manual oil transfer control panel (fig. 1-20) is provided for operation of the system which includes three manual override controls to actuate the hydraulically-driven oil pump and valves. This panel is located under the floor forward of the front wing beam and access to the panel is gained through a hatch on the floor between the emergency exits. Refer to Section VII for sequence of operation of the auxiliary manual system.

Engine Tank Selector Switch. This switch is located on the station 260 upper switch panel (10, fig– 1-18) and has four positions: 1, 2, 3 and 4. This switch actuates a d.c. motor to select the engine oil tank that is to be supplied from either reserve oil tank.

Start Transfer Button and Pump Transferring Light. The start transfer button is located on the station 260 upper switch panel (9, fig. 1-18). This button is depressed to start the transfer operation. The pump transferring light (11, fig. 1-18) glows as long as the system is transferring oil.

Reserve Oil Tank Heater Control and Suction Line Heater Switches. These switches are located on the station 260 upper switch panel (8, fig. 1-18) and have two positions: LEFT and OFF, and RIGHT and OFF. When these switches are placed in the LEFT and RIGHT (on) positions, the tank heating element will raise the oil temperature in the reserve oil tanks to the maximum set limit of the heating element thermostat (100° F). When the maximum limit has been reached, the thermostat will automatically shut off the heating element. As long as the switch is ON it will continue to cycle.

Stop Transfer Button and Pump Evacuating Light. The stop transfer button, located on the station 260 upper switch panel (9, fig. 1-18), is depressed to stop the oil transfer operation. This switch overrides the tank float switch. The pump evacuting light (11, fig. 1-18) indicates that the transfer operation has stopped and that the pump has reversed and is evacuating oil from the lines.

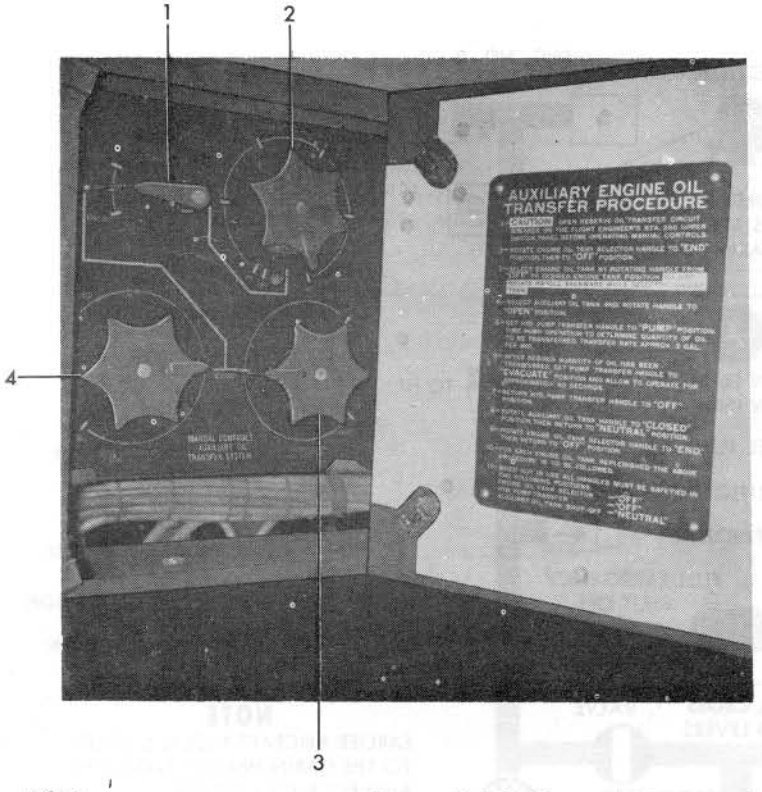
Reserve Oil Pump Selector Switch. This switch is located on the station 260 upper switch panel (7, fig. 1-18) and has two positions: NORMAL PUMP (HYD.), and AUX. PUMP (ELEC.). It is used to select by a d.c. electric actuator either the electric or hydraulic transfer pump.

Reserve Oil Tank Selector Switch. This switch is located on the station 260 upper switch panel (6, fig. 1-18) and has two positions: LEFT and RIGHT. It is used to select by a d.c. electric actuator, either the right or left reserve tank.

Manual Engine Oil Tank Selector Handle. This handle is located on the auxiliary transfer panel (2, fig. 1-20) and is used to override the motor-driven engine tank selector valve. When this handle is used it must be rotated from the OFF position through the four engine tank stops to the END position, back to OFF, and then to the desired engine tank number. The purpose for this procedure is to properly sequence the cam linkage arrangement to mechanically assure positive and correct tank selection.

Manual Hyd. Pump Transfer Handle. This handle is located (1, fig. 1-20) under the cabin floor of the front wing beam and can be used to manually control the direction of rotation of the hydraulic pump that pumps the engine oil from the reserve oil tank. It has three positions: OFF, PUMP and EVACUATE.

Manual Auxiliary Oil Tank Shut-off Handles. The manual auxiliary oil tank shut-off handles (3-4, fig. 1-20) are located under the cabin floor forward of the front wing beam. These handles are used to mechanically select either the right or left reserve oil tank. They are labeled OPEN, NEUTRAL and CLOSED. Use of the handles manually overrides the motor-driven shut-off valves. The NEUTRAL position restores electrical control. In the event the normal transfer panel (station 260 panel) is inoperative, the circuit breakers must be pulled before operating the manual transfer panel.



1. HYDRAULIC PUMP TRANSFER SELECTOR
2. ENGINE OIL TANK SELECTOR
3. LEFT AUXILIARY OIL TANK SHUTOFF
4. RIGHT AUXILIARY OIL TANK SHUTOFF

Figure 1-20. Manual Reserve Oil System Controls

Reserve Oil Quantity Indicators. Two oil quantity indicators are located on the flight engineer's upper instrument panel (8, fig. 1-16). These indicators register by a.c. transmitters, the oil quantity in pounds.

FUEL SYSTEM.

Fuel is carried in six integral wing tanks (Nos. 1, 2, 2A, 3, 3A, and 4), one bladded-type center section tank (No. 5), one fuselage tank (No. 6) and two wing tip tanks (Nos. 2B and 3B). A fuel crossfeed system is installed to provide fuel flow from tanks 1, 2, 2A, 3 3A, 4, and 5 to any engine. Refer to figure 1-12.

Note

The recommended fuel consumption sequence is given in Section VII.

Submerged fuel boost pumps are installed in all tanks. Tanks 2A, 3A, 1, and 4 are provided with float valves that automatically open when the fuel level in these tanks reaches a predetermined level (approx. 150 gallons below the full level) allowing fuel to be pumped from tanks 2B, 3B, and 6 to replenish tanks 2A, 3A, 1, and 4. For fuel tank capacities refer to Fuel Quantity Data Table (fig. 1-22) and refer to the Servicing Diagram for fuel grades and specifications. Fuel for cabin heaters is supplied from engines 2 and 3 feed lines.

FUEL SYSTEM COMPONENTS.

A surge box that traps fuel when the attitude of the aircraft is other than straight and level is located in the inboard, aft corner of each integral wing tank. From the surge box, fuel flows to an electric motor-driven, submerged, auxiliary fuel pump located in the aft, inboard corner of each tank. The auxiliary fuel pump for tank 5 is located in the right, outboard cell of that tank. Tank 6 has two submerged fuel pumps. Each pump is remotely controlled from the flight engineer's lower switch panel and pumps fuel, under pressure, to tanks 1 and 4. There are five tank selector valves in the system; the three, serving tanks 1, 5 and 4, are two-way valves; the other two, serving tanks 2A and 2, and 3A and 3, are three-way valves. From the selector valves fuel flows through micronic filters to the four two-way cable-operated crossfeed valves. When the crossfeed valves are closed, fuel will flow directly to the engine associated with each tank after passing through one of the four cable-operated emergency shut-off valves, engine-driven fuel pumps, fuel-flow transmitters and carburetors. A thermal relief valve is located in the crossfeed line to relieve pressure resulting from expansion when the crossfeed valves are closed. An additional thermal relief valve is incorporated downstream of each emergency shut-off valve to relieve pressure in the fuel lines caused by fuel expansion when the emergency shut-off valves are closed. Water drain valves are located at low points in the system.

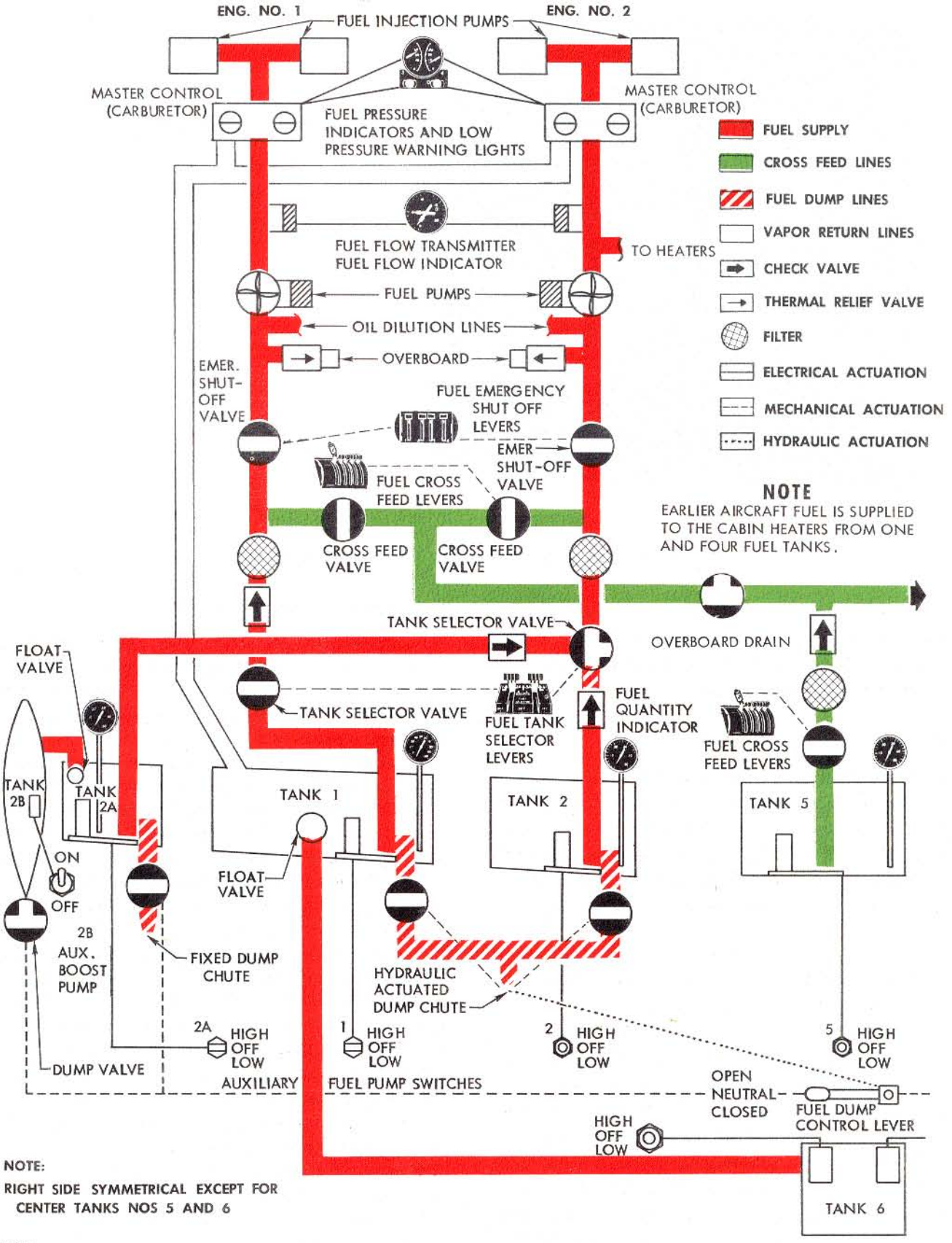


Figure 1-21. Fuel System

TANK NO.		USABLE FUEL (Level Flight Attitude) Pounds	Gallons	FULLY SERVICED (Ground Rest Attitude) Pounds	Gallons
2B	Left Tip Tank	3600	600	3606	601
2A	Left Outboard Tank	3390	565	3420	570
1	Left Mid-Wing Tank	9330	1555	9390	1566
2	Left Inboard Tank	4740	790	4836	806
5	Center Section Tank	4380	730	4446	741
6	Fuselage Tank	6108	1018	6138	1023
3	Right Inboard Tank	4740	790	4836	806
4	Right Mid-Wing Tank	9330	1555	9390	1566
3A	Right Outboard Tank	3390	565	3420	570
3B	Right Tip Tank	3600	600	3606	601
			Total 8768		Total 8850

Note: Figures in the pounds column are based on Standard Day Temperature, (6 pounds per Gal.) The Fully Serviced Column figures are calculated and are approximate.

Figure 1-22. Fuel Quantity Table

FUEL TANKS.

Tanks 1, 2, 3, and 4 are located in the inner wing panels. Tanks 2A and 3A are in the outer wing panels. A center section tank, No. 5, is located between the front and rear wing beams. It is lined with a bladder type cell that, once it has been filled with gasoline, will tend to weather and crack if left dry. Although all but 11 gallons of fuel can be used, it is advisable, for cell preservation, to leave 50 gallons in the tank if it is not to be used for ten days or longer. Tank 6 is located in the fuselage under the cabin floor, immediately aft of the wing trailing edge. The wing tip tanks 2B and 3B are not jettisonable but are detachable. A different wing tip must be installed when the tip tanks are removed.

FUEL DUMP SYSTEM.

Fuel from tank 6 may be pumped to tanks 1 and 4 from which fuel may be dumped. Fuel may be dumped simultaneously from all integral wing tanks and tanks 2B and 3B by movement of a single dump control lever (1, fig. 1-24) located under the station 260 step. Fuel from tanks 1, 2, 3 and 4 flows through two retractable dump chutes, one located in each inboard engine nacelle tailcone. Each of these tanks has an independent valve that is opened or closed mechanically by means of a linkage system connected to the dump chute hydraulic actuating cylinder. Fuel from tanks 2A and 3A flows through two fixed dump chutes located at the trailing edge of each outer wing panel. Tanks 2B and 3B each have a fixed dump chute. The dump valves for tanks 2A, 3A, 2B, and 3B are hydraulically operated. Standpipes are installed in fuel tanks 2A, 1, 4, and 3A to limit the amount of fuel that can be dumped from these tanks. There are no provisions for dumping fuel from tank 5.

On USAF Serials 52-3411 through 52-3424, the usable fuel remaining after dumping is as follows: Tanks 2B and 3B, 24 gallons each; Tanks 2A and 3A, 149 gallons each; Tanks 1 and 4, 145 gallons each; Tanks 2 and 3, 134 gallons each.

On USAF Serials 52-3425, 53-533 and subsequent, the fuel remaining in tanks 2 and 3 after dumping is 122 gallons each.

FILLER WELLS AND DIP STICKS.

Each integral fuel tank has a filler well located in the upper surface of the wing and must be filled separately. The filler well for tank 5 is located in the upper surface of the right wing fillet. Tank 6 filler well is located on the right side of the fuselage, aft of the wing trailing edge. Two plastic fuel measuring dip sticks are stowed in the flight station on the station 260 bulkhead near the crew door. One dip stick is calibrated for use in tanks 1, 2, 3, 4, 5, 2A and 3A. The other dip stick is calibrated for tanks 6, 2B and 3B. These dip sticks are used in the tank filler wells and, because of wing dihedral, will not record low fuel levels.

VAPOR RETURN LINES.

The vapor return lines from engines 1 and 2 are routed to fuel tank 1 and the lines from engines 3 and 4 are routed to tank 4.

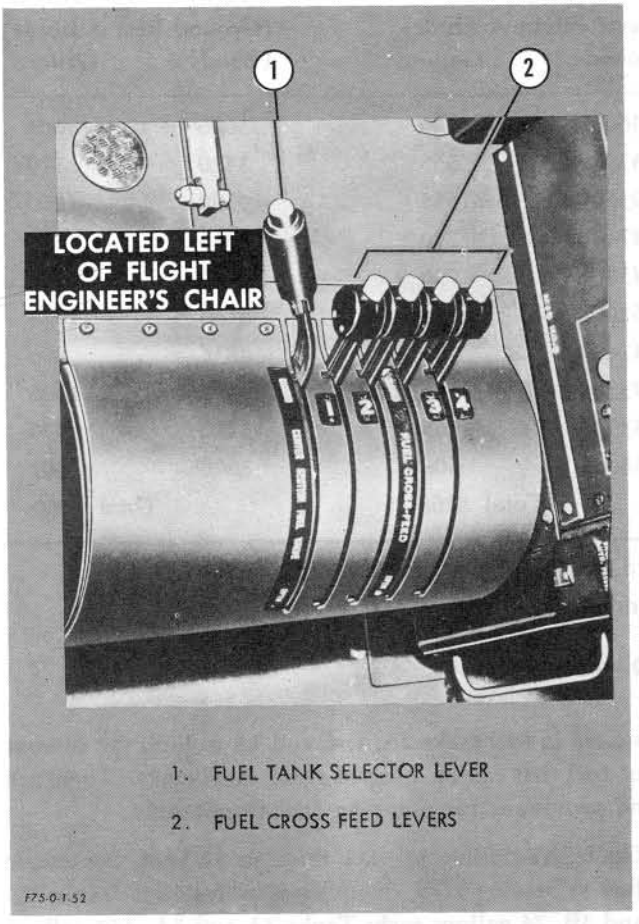


Figure 1-23. Flight Engineer's Auxiliary Control Quadrant

FULL TANK VENTS.

Fuel is vented from each wing tank through vent lines to a common flush-type vent in the lower surface of the outer wing panels. Separate overboard lines are teed into the vent lines which incorporate pressure and suction relief valves to prevent any possibility of excessive pressure existing in the tanks if icing should close the flush-type vent. The vent line from tank 5 extends to the flush vent on the left wing. A suction relief inlet for this tank is located beneath the fuselage, and the pressure relief scarf-type vent is located inboard of the left wing tank scarfed vents. Tank 6 vents from a small mast several feet aft of the lower radome on the fuselage centerline and incorporates a suction relief valve at the high point of the vent line. Each tip tank has its own vent system including the sniffle valve, float shut-off valve, flush ram scoop and scarfed-type overboard line.

Fuel Tank Selector Lever.

There are five fuel tank selector levers that mechanically control the opening and closing of the fuel tank shut-off valves. Four of these levers (9, fig. 1-14) are located on the flight engineer's control quadrant. The two outside levers of these four, have two positions, ON and OFF, and control tanks 1 and 4. The inside levers have three positions. The left inside lever is placarded OFF, No. 2, and No. 2A. The right inside lever is placarded OFF, No. 3 and No. 3A. Either of the two tanks placarded on each inside lever quadrant may be selected, but not both at the same time. The lever for the center section fuel tank (tank 5) is located on the flight engineer's auxiliary control quadrant (1, fig. 1-23), inboard of the fuel crossfeed levers. This is a two-position lever, OPEN and CLOSED, that mechanically controls the tank shut-off valves from tank 5 to the crossfeed line.

Fuel Crossfeed Levers.

Four, two-position fuel crossfeed levers (2, fig. 1-23), are located on the flight engineer's auxiliary control quadrant. They are placarded OPEN and CLOSED and are numbered to correspond to the engine positions. These levers are used to direct fuel from the tanks to any engine combination. They mechanically operate the fuel crossfeed valves through control cables.

Auxiliary Fuel Pump Switches.

Eleven auxiliary fuel pump control switches (10, fig. 1-14) are located on the right side of the flight engineer's lower switch panel. These switches are arranged on the panel according to the fuel tank locations. The switches for tanks 2B and 3B are labeled ON and OFF. All other auxiliary fuel pump switches have three positions: HIGH, OFF and LOW. The HIGH and LOW positions control the d.c. pump operating speeds.

Note

The switches for tanks 6R and 6L should not be placed in HIGH position except during fuel dumping operations. In the event of a float valve malfunction in tanks 1 or 4, the HIGH position will deliver pressure to tanks 1 and 4 in excess of their design strength.

Emergency Shut-off Levers.

Moving these levers to the third detent position, shuts off the fuel. Refer to Emergency Equipment, this Section.

Fuel Quantity Indicators and Test Switch.

Eleven capacitance-type fuel quantity indicators (1, fig. 1-16) are located on the flight engineer's upper instrument panel. Individual indicators for the ten fuel tanks are provided and a totalizer indicator is provided to indicate the sum total of fuel in all tanks. These indicators show the weight of fuel in the tanks in pounds. There is a push-button fuel quantity test switch (6, fig. 1-16) located on the flight engineer's upper instrument

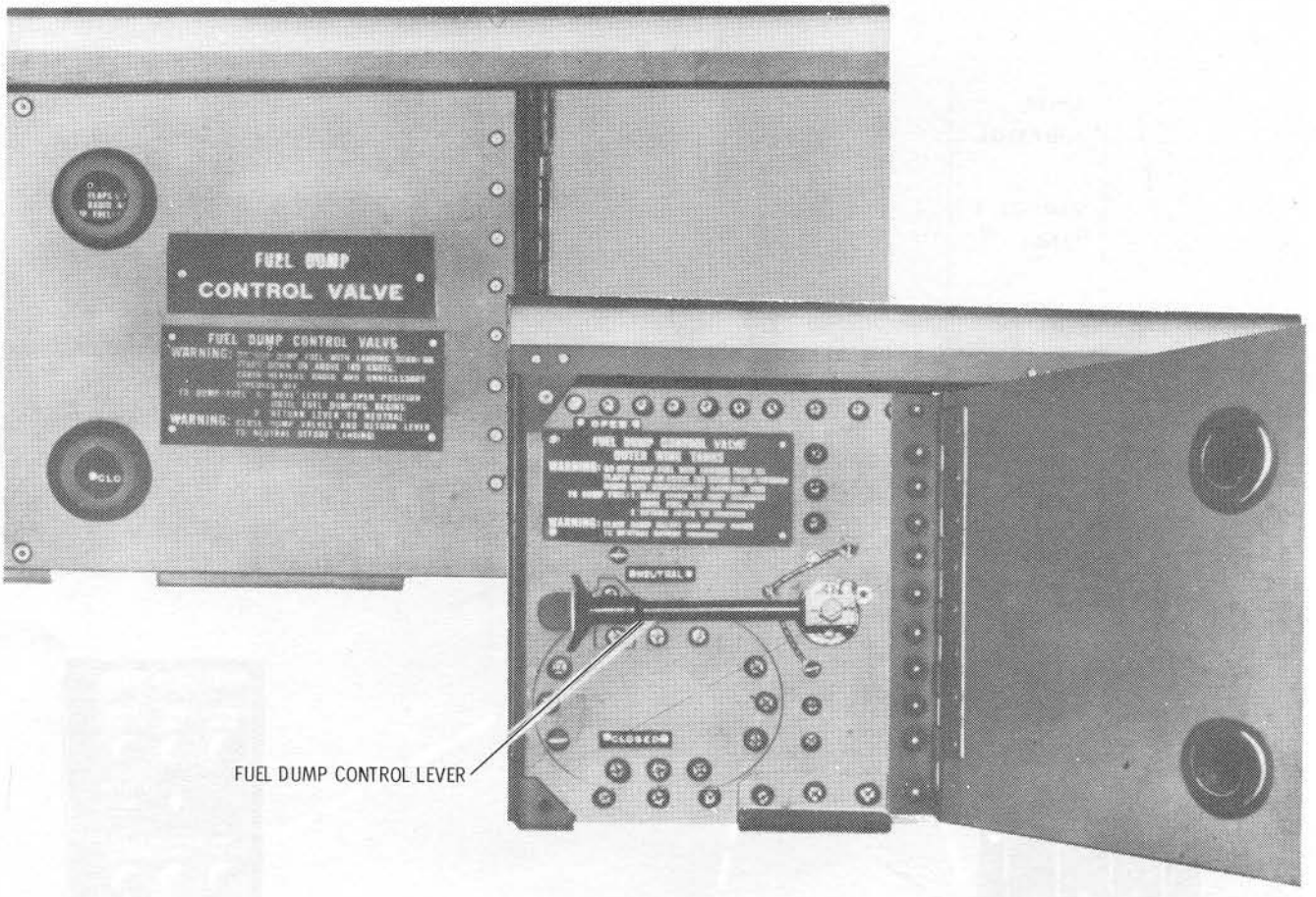


Figure 1-24. Fuel Dump Control Lever (Station 260)

panel. When pushed in, it disconnects the electrical circuit from the fuel quantity indicators and the needles should move toward the empty position. When released, the needles should return to the original readings. This provides a check that will show whether the indicators are sticking or giving erroneous readings.

Fuel Dump Lever (Sta 260).

The fuel dump control lever (figure 1-24) is located in the flight station step at station 260, and is accessible through a hinged door. The lever is placarded OPEN, NEUTRAL and CLOSED. When the lever is in the OPEN position, secondary hydraulic system pressure operates actuating cylinders which open the dump valves for tanks 2A, 2B, 3B, and 3A, and extend the dump chutes for tanks 1, 2, 3, and 4. When the lever is in the NEUTRAL position, secondary hydraulic system pressure is relieved from the actuating cylinders. The CLOSE position of the lever reverses the direction of hydraulic fluid flow to the actuating cylinders which retract the dump chutes for tanks 1, 2, 3, and 4 and close the dump valves for tanks 2A, 3A, 2B, and 3B. Gravity provides the force for dumping.

Fuel Dump Lever (Emergency).

In the event secondary hydraulic system pressure is not available, fuel may be dumped by the use of the emergency hydraulic system. A fuel dump selector lever (1, fig. 1-31) is located near the floor at the right of the copilot's seat. This lever has two positions: L. G. EMER. EXT. and FUEL DUMP. When the lever is in the FUEL DUMP position and the hand pump selector lever is in the aft (EMER. GEAR) position, the hand pump can be used to supply hydraulic pressure for the dumping operation, provided fuel dump lever at station 260 is positioned properly. In the event secondary hydraulic system pressure is not available, fuel may be dumped without the use of the emergency hydraulic system by use of the hydraulic system crossover switch. Refer to Hydraulic System Crossover Valve, this section.

ELECTRICAL POWER SYSTEM.

Basic electrical power is furnished by two primary systems, a 28-volt d.c. system and a 115/208-volt a.c.

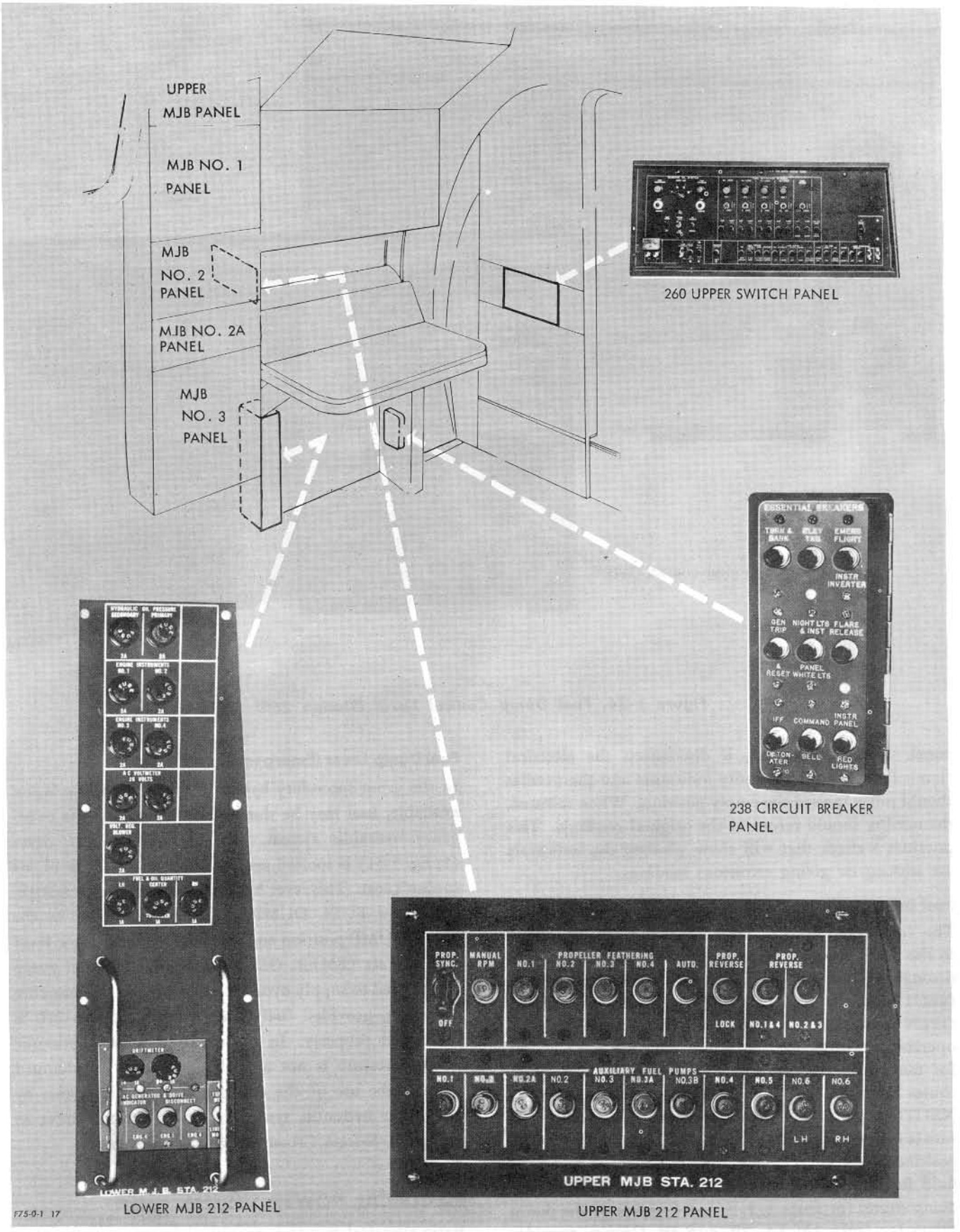


Figure 1-25. Circuit Breaker Panels

system. Six d.c. generators, two a.c. generators and four basic inverters provide power for the various electrical systems (refer to figure 1-26). Each inboard engine drives two d.c. generators and each outboard engine incorporates a driveshaft which drives a gear box on which one d.c and one a.c. generator is mounted. These gear boxes can be disconneted from the engines. Three battery cart receptacles are located right of centerline on the fuselage underside, forward of the lower radome. This installation will provide separate ground power facilities.

D.C. ELECTRICAL POWER SYSTEM.

The direct current electrical system is a single wire, grounded circuit with power supplied by six engine-driven d.c. generators (1, 2, 2A, 3, 3A, and 4) and two 24 volt storage batteries installed in the nose wheel well. The d.c. generators can be controlled individually and connected for parallel operation. A differential reverse current relay and a voltage regulator are provided for each d.c. generator and its protective system. The regulators are located just aft of the pilot's and copilot's seats beneath the floor, and the differential voltage reverse current relays are located in the forward underfloor compartment. Three a.c. motor-driven blowers provide cooling air for the voltage regulators whenever the inverters are operating.

Generator Switches.

Each d.c. generator is controlled by a three-position switch (6, fig. 1-27) that is located on the MJB No. 1 switch panel. The switch has three positions: ON (up), OFF (center), and a RESET (down) position. Each switch is spring-loaded from the down to the OFF position. When a generator switch is placed in the ON position, output of the generator will be connected to the main d.c. bus provided load and special conditions are correct. The down position is a momentary contact position, which resets the field relay if it is tripped by overvoltage or by generator reversed polarity or was inadvertently left in the tripped position. If the relay was tripped by a feeder fault, it cannot be reset until the fault-sensing relay, located in the forward cargo compartment, is reset. This must not be done until the fault is located and cleared. In the OFF position the generator is disconnected from the d.c. bus, but the field is not de-energized.

Generator Field Circuit Breakers.

Each generator is provided with a switch-type circuit breaker for emergency use. These circuit breakers (9, fig. 1-27) are located on the MJB No. 1 switch panel and are guarded in the ON position. These circuit breakers should be placed in the OFF position only when necessary to de-energize the generators completely, as in an emergency landing or in the event that the protection system malfunctions. They should not be used as generator switches and should be opened or closed only when the associated generator switch is in the OFF position.

Ship Battery Switch.

A two-position switch (27, fig. 1-27), with SHIP BATTERY (up) and OFF (down) positions, is located on the MJB No. 1 switch panel. Moving the switch to the SHIP BATERY position connects the aircraft batteries to the main d.c. bus.

Cart Battery Switches.

These switches (28, fig. 1-27) are located on the MJB No. 1 switch panel and have CART BATTERY (up) and OFF (down) positions. In the CART BATTERY position, the short prong of the cart receptacle closes the cart relay, and power from the cart is connected to the main d.c. bus. A cart relay is installed in the cart power circuit to provide automatic protection for reversed polarity, differential voltage and reversed current.

Note

It is possible to have the cart battery switch and the ship battery switch ON at the same time to charge the aircraft batteries from a ground power supply in an emergency. *However, extreme care should be exercised by qualified personnel to prevent battery explosions, boiling dry, acids dripping from vents, fire from resulting short circuits, etc.* Normally, the two switches should never be ON at the same time for longer than the few seconds necessary to switch from the aircraft batteries to cart system or vice versa.

Generator Field Relays Tripped Warning Lights.

A red warning light (7, fig. 1-27), which is set to glow when a generator field relay has been tripped is located on the MJB No. 1 panel. If a generator is tripped by a feeder fault, the light will stay on when the generator switch is placed in the (down) RESET position. If the cause was overvoltage or reverse polarity, the light will go out. If the cause of the trip persists, the light will immediately come on again and stay on even if the switch is held down.

Generator Overheat Warning Lights.

Beneath each generator switch and beside each field relay warning light is a red generator overheat warning light (8, fig. 1-27). Overheating of a generator that causes one of these lights to glow may be caused by an electrical

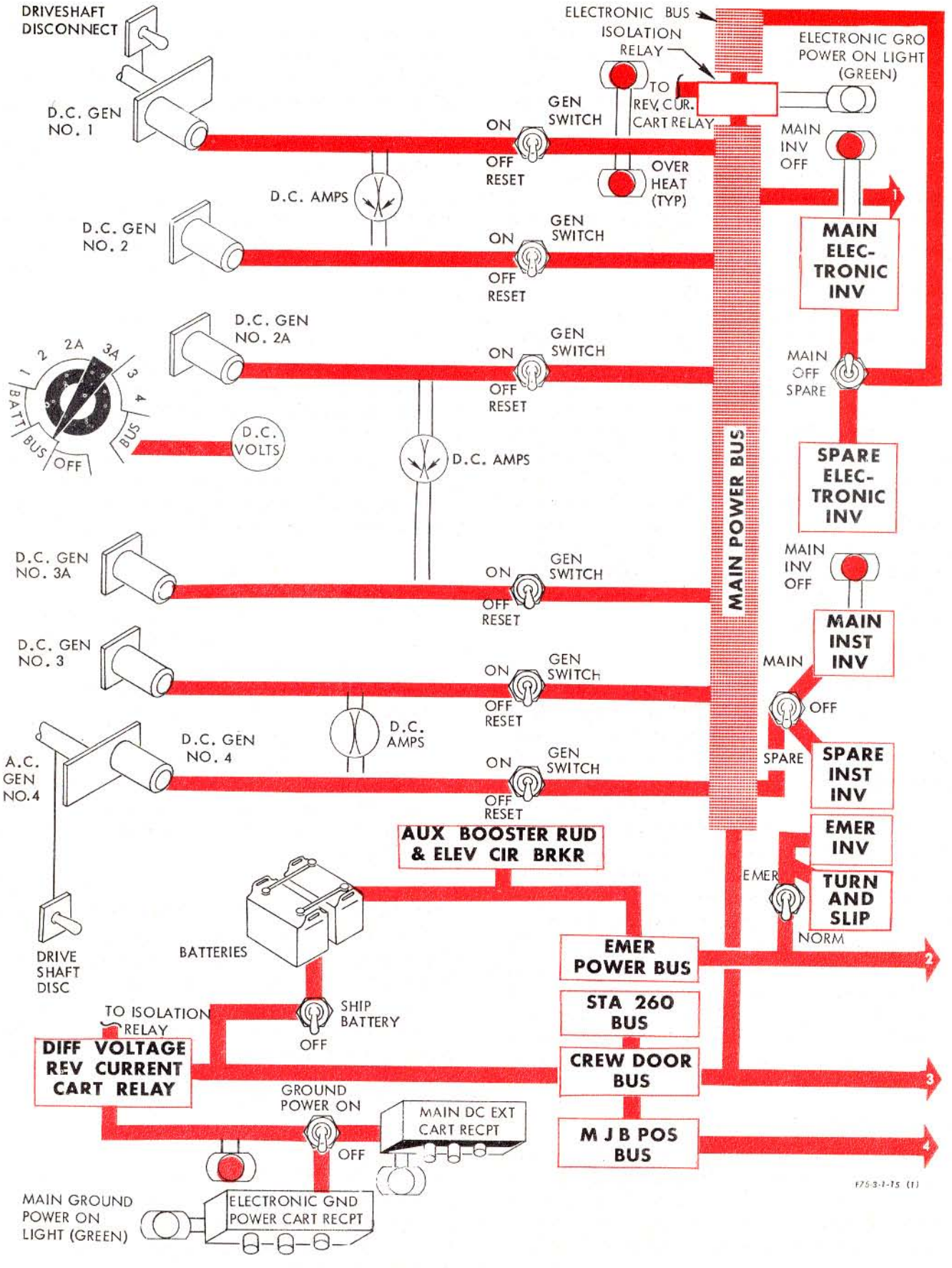


Figure 1-26. D.C. Electrical Power System (Sheet 1 of 2)

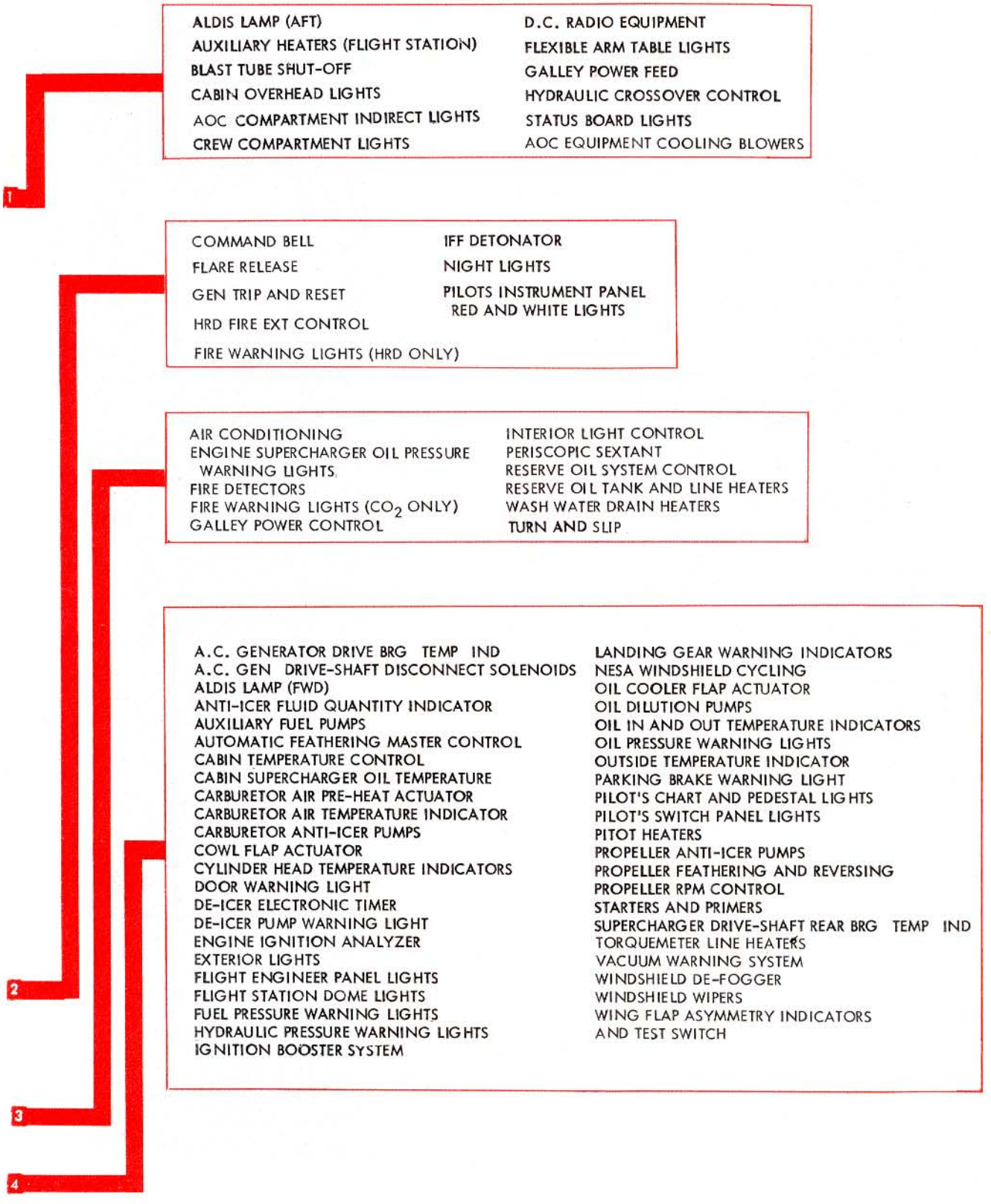


Figure 1-26. D.C. Electrical Power System (Sheet 2 of 2)

1. D.C. TEST PLUGS
2. GENERATOR FIELD TRIP AND RESET RELAYS
3. A.C. VOLTMETER
4. D.C. VOLTAGE SELECTOR SWITCH
5. D.C. AMMETERS
6. D.C. GENERATOR SWITCHES
7. D.C. GENERATOR FIELD RELAYS (TRIPPED) WARNING LIGHTS
8. D.C. GENERATOR OVERHEAT WARNING LIGHTS
9. D.C. GENERATOR FIELD CIRCUIT BREAKERS
10. FLIGHT ENGINEER'S DESK LIGHT RHEOSTAT
11. FUSELAGE RELAY (CLOSED) INDICATOR LIGHTS
12. NACELLE RELAY (CLOSED) INDICATOR LIGHTS
13. CARBURETOR ALT. FUEL SOURCE SWITCHES
14. CARBURETOR ANTI-ICER SWITCHES
15. ENGINE STARTER SELECTOR SWITCH
16. ENGINE STARTER SWITCH (BUTTON)
17. FLIGHT INSTRUMENT EMERGENCY POWER SWITCH
18. ENGINE PRIMER SWITCH (BUTTON)
19. ENGINE STARTER SELECTOR SWITCH WARNING LIGHT
20. PROPELLER ANTI-ICER SWITCHES
21. NESA POWER SELECTOR SWITCH
22. NESA POWER FAILURE INDICATOR LIGHT
23. INSTRUMENT INVERTER SELECTOR SWITCH
24. MAIN INVERTER (OFF) WARNING LIGHT
25. DEAD BUS WARNING LIGHT
26. FLIGHT ENGINEER'S DESK LIGHTS SELECTOR SWITCH
27. SHIP BATTERY SWITCH
28. CART BATTERY SWITCH
29. GROUND POWER (ON) INDICATOR LIGHTS
30. A.C. VOLTAGE SELECTOR SWITCH
31. D.C. VOLTMETER

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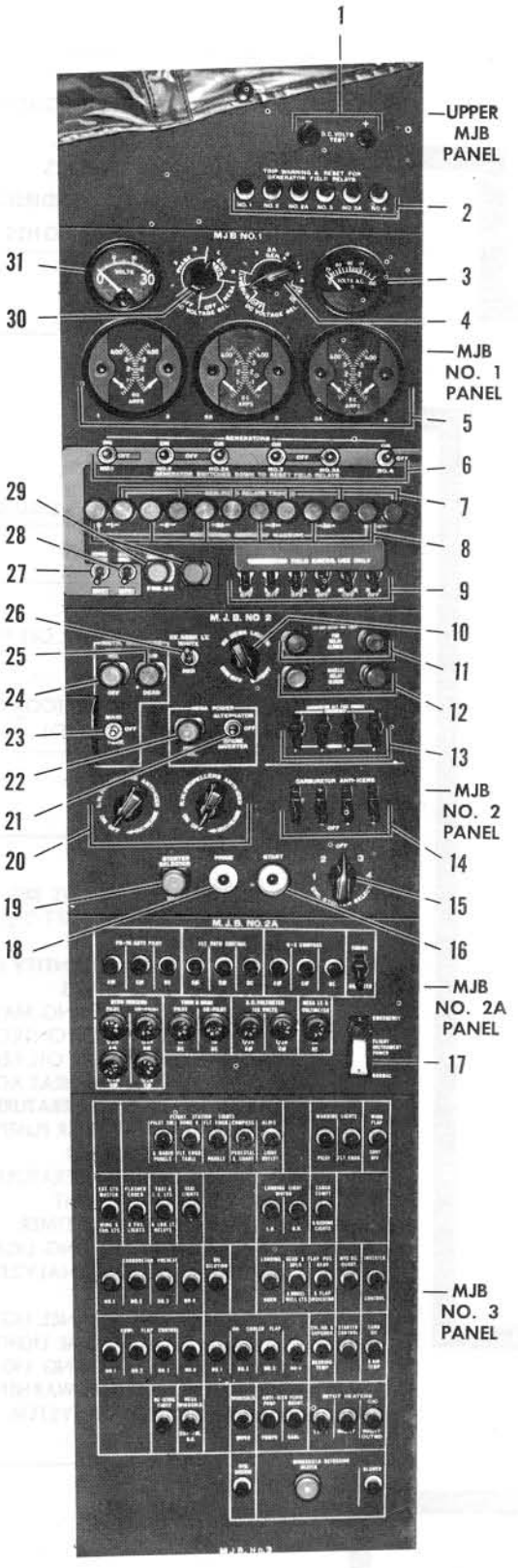


Figure 1-27. MJB Panels (Typical)

overload or failure of the generator. If the overheat condition is caused by an electrical overload on the system, the generator should not be shut off until the electrical load has been reduced because it is likely that the resulting increased load on the generators will cause them to overheat also.

Relay Closed Indicator Lights.

Two amber and two red indicator lights (11, fig. 1-27) are located on the MJB switch panel 2. They function as warning devices to indicate improper operation of relays connected to the wing buses. An amber fuselage relay indicator light and a red nacelle relay closed indicator light are provided for the left and right wing buses of the aircraft. These indicator lights are connected in such a manner that when an amber light is bright, the sectionalizing relay is closed and the wing bus is energized. When the relays are open, both the amber and the red lights should be dim and have equal brilliance. If, after one of the sectionalizing relays has operated, the amber light does not return to original brilliance, the sectionalizing relay has not opened. This does not represent any direct hazard to flight, but the condition should be corrected at the earliest opportunity. If the red light becomes brighter after propeller feathering, unfeathering, reversing, or unreversing is completed, the propeller feathering pump relay has remained closed. Subsequent operation of cowl flaps, engine starters, or propeller feathering, unfeathering, reversing or unreversing on that side of the aircraft will energize the feathering pump of the propeller whose previous operation caused the red light to burn brighter.

WARNING

If the propeller feathering pump remains closed in flight, notify the pilot immediately.

If this condition occurs while the aircraft is on the ground, it must be rectified before flight.

If, after engine starter or cowl flap operation, one of the red lights becomes brighter, operation of the same engine starter or cowl flap will occur if engine starters, cowl flaps, or propeller feathering, unfeathering, reversing, or unreversing electrical circuits on the same side of the aircraft are energized.

Note

If this condition occurs on the ground, notify the ground crew.

D.C. Voltmeter and Selector Switch.

A d.c. voltmeter located on the MJB switch panel 1, indicates the output of the generators, batteries and bus voltage. A ten-position switch (4-31, fig. 1-27), located on the MJB No. 1 switch panel, provides selections of generators 1, 2, 2A, 3, 3A, 4, BAT., two BUS. positions, and OFF. Parallel operation of the generators and batteries necessitates that each be disconnected individually from the bus to indicate its potential.

Ground Power Indicator Lights.

Two green lights (29, fig. 1-27) are located on the MJB switch panel 1 to indicate that ground power is connected to the aircraft even though the cart switch may be OFF. Two indicator lights are located adjacent to the ground power receptacles and glow whenever the ground power supply is connected to the d.c. bus.

D.C. Ammeters.

Three dual ammeters (5, fig. 1-27) are installed in the MJB switch panel 1. The ammeters indicate the direct load on each generator.

A.C. ELECTRICAL POWER SYSTEM.

The basic a.c. electrical power system (fig. 1-28) includes four 115/208-volt, three-phase inverters, and two a.c. generators. One inverter provides power for the basic aircraft loads and one is a standby. Another inverter supplies power for the electronic loads and one is a standby. The two standby inverters are provided with automatic and manual transfer to their standby loads. One additional 115-volt, three-phase inverter operates as an emergency standby for the a.c. flight instruments. This inverter is powered directly from the emergency d.c. bus when in operation. One a.c. generator is mounted on the gear box housing of each outboard engine.

Instrument Inverter Switch and Warning Lights.

An instrument inverter switch (23, fig. 1-27) is located on the MJB panel 2 and is placarded MAIN INV., OFF and SPARE. Two warning lights are installed above this switch. One will light when the switch is off or when a.c. power from the main inverter is interrupted. The other light will come on when electrical power is not being supplied to the a.c. bus. When the main inverter fails, a change-over relay will automatically transfer the instrument load to the remaining inverter. In this case, the warning light will glow but will go out when the inverter power is restored.

Nesa Power Selector Switch.

This switch (21, fig. 1-27) is located on the MJB No. 2 panel. It permits selection of the a.c. generators or the spare inverter as a power source for the Nesa system.

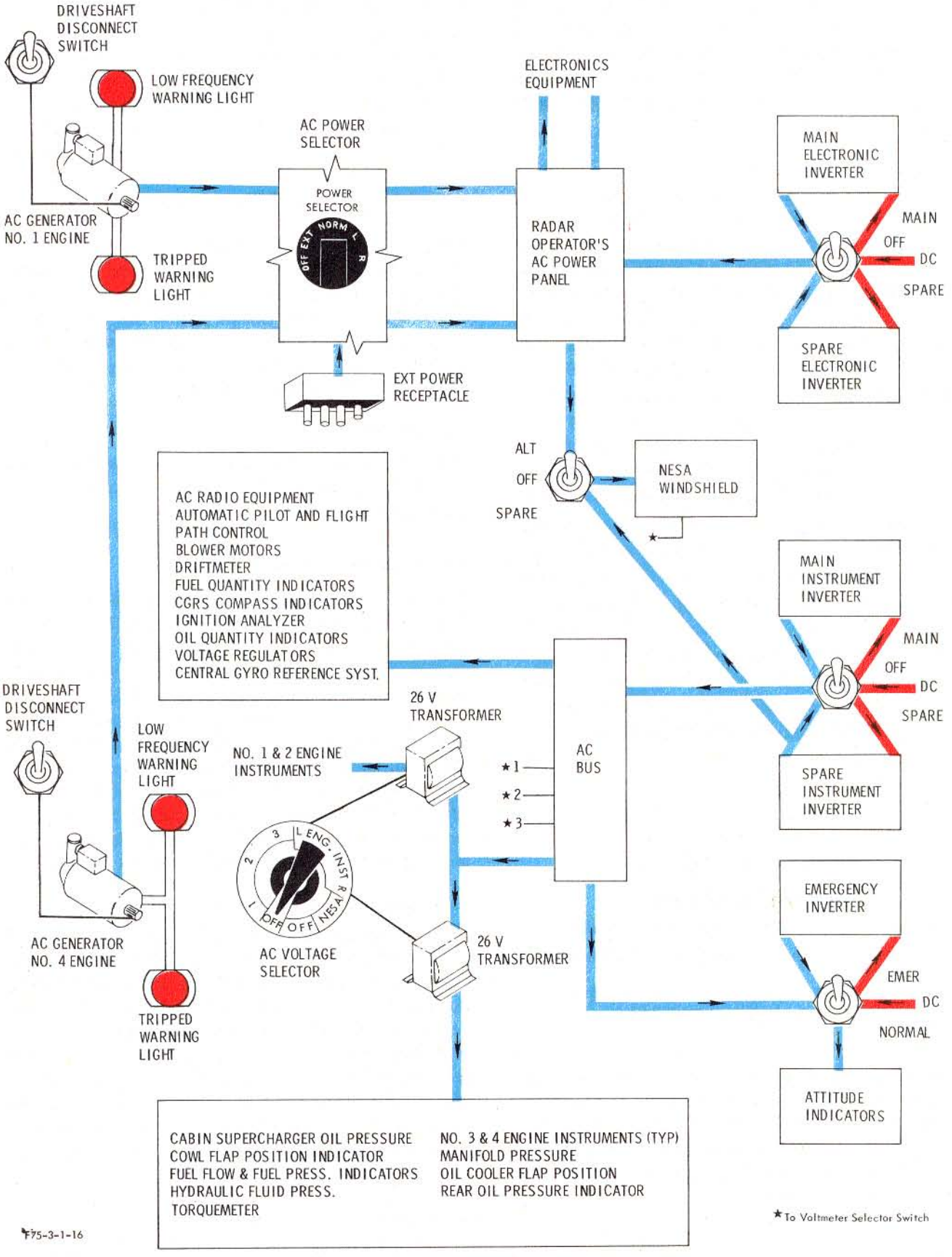


Figure 1-28. A.C. Electrical Power System

When the switch is in the ALTERNATOR position, Nesa power is supplied by the a.c. generators. If one a.c. generator is not operative, a.c. power may be transferred from the other a.c. generator. If neither a.c. generator is available, the spare inverter can be selected by moving the switch to the SPARE INVERTER position. The OFF position provides disconnect when Nesa power is not required. A power failure warning light adjacent to the switch will glow when a.c. power is not available from either a.c. generator or the spare inverter.

A.C. Generator Drive Shaft Disconnect Switches.

Two a.c. generator disconnect switches (12, fig. 1-17) are located on the flight engineer's upper switch panel, and are placarded DRIVESHAFT DISCONNECT (A. C. GEN. & D.C. GEN. NO. 1) for engine 1 and DRIVESHAFT DISCONNECT (A.C. GEN. & D.C. GEN. NO. 4) for engine 4. These switches are protected by a red guard cover. When either switch is actuated, the driveshaft is mechanically disconnected from the engine by a d.c. solenoid.

Flight Instrument Emergency Power Switch.

This switch (17, fig. 1-27) is located on the MJB switch panel 2A and has NORMAL and EMERGENCY positions. When the switch is in the NORMAL position, power for the attitude indicators is supplied by the a.c. bus. When the switch is placed in the EMERGENCY position, power for the attitude indicators is obtained from the emergency flight instrument inverter which operates directly from the emergency d.c. bus. This switch also transfers the turn and slip indicators to the emergency bus.

A.C. Drive Shaft Over Temperature and Over Voltage Warning Lights.

Two warning lights (11-13, fig. 1-17) are located adjacent to each a.c. generator disconnect switch. One is placarded OVER TEMP. which measures the operating temperature of the generator, and the other OVER VOLTAGE. In addition, a single master A.C. GEN. OR DRIVE warning light (5, fig. 1-15) is installed on the flight engineer's lower instrument panel. Above each switch is a single-gage (3, fig. 1-17) with three half-moon dials, indicating DRIVESHAFT BRG. temperature, GEAR BOX BRG. temperature, and COOLING AIR RISE which measures the rise in cooling air to the generator.

A.C. Voltmeter and Selector Switch.

An a.c. voltmeter (3, fig. 1-27) and a selector switch (30, fig. 1-27) are located on the MJB switch panel. The selector switch selects any phase of the three-phase, 115-volt a.c. bus, the Nesa power supply, or the output voltage from the left and right 26-volt, single-phase engine instrument transformers. The selector switch also has an OFF position.

HYDRAULIC POWER SUPPLY SYSTEM.

Four variable-displacement hydraulic pumps, one driven by each engine, provide operating power up to 1700 psi for the various hydraulically operated unit. Hydraulic power is divided into two systems — primary and secondary — each of which obtains fluid from the main hydraulic reservoir, located in the left center section leading edge. The reservoir is divided vertically into two compartments up to approximately ⅔ its height and is pressurized with air by means of an aspirator. As hydraulic fluid passes through the aspirator at normal pressure, air is bled into the return system downstream from the aspirator orifice, thereby providing pressure in the reservoir. The reservoir partition separates secondary system fluid from the primary system fluid and each system draws fluid from its respective compartment. The hydraulic system incorporates pressure operated by-pass valves. Loss of fluid pressure at any by-pass valve will permit tension of an internal spring in the valve to position a poppet valve so that return fluid is directed to the compartment of the reservoir which is supplying fluid. The primary and secondary hydraulic power systems are interconnected by means of a crossover valve which allows the secondary system to supply power to the primary system in the event of partial or total loss of primary system pressure. The primary system also will supply pressure to the secondary system by means of the hydraulic system crossover valve. A separate emergency hand pump power system, with its own reservoir, provides pressure for emergency braking, emergency landing gear extension and emergency fuel dumping.

PRIMARY HYDRAULIC SYSTEM.

The primary hydraulic system supplies pressure to operate the surface control boosters and left wing secondary heat exchanger fan motor. The hydraulic pumps on engines 1 and 2 furnish the volume and pressure required for operation of the primary system. Return lines from all primary units are manifolded into the common return line through the main primary filter to the primary return port of the main hydraulic reservoir.

SECONDARY HYDRAULIC SYSTEM.

The secondary hydraulic system supplies pressure to operate the landing gear, brakes, nose wheel steering, aspirator, wing flaps, fuel dump system, oil pump for the

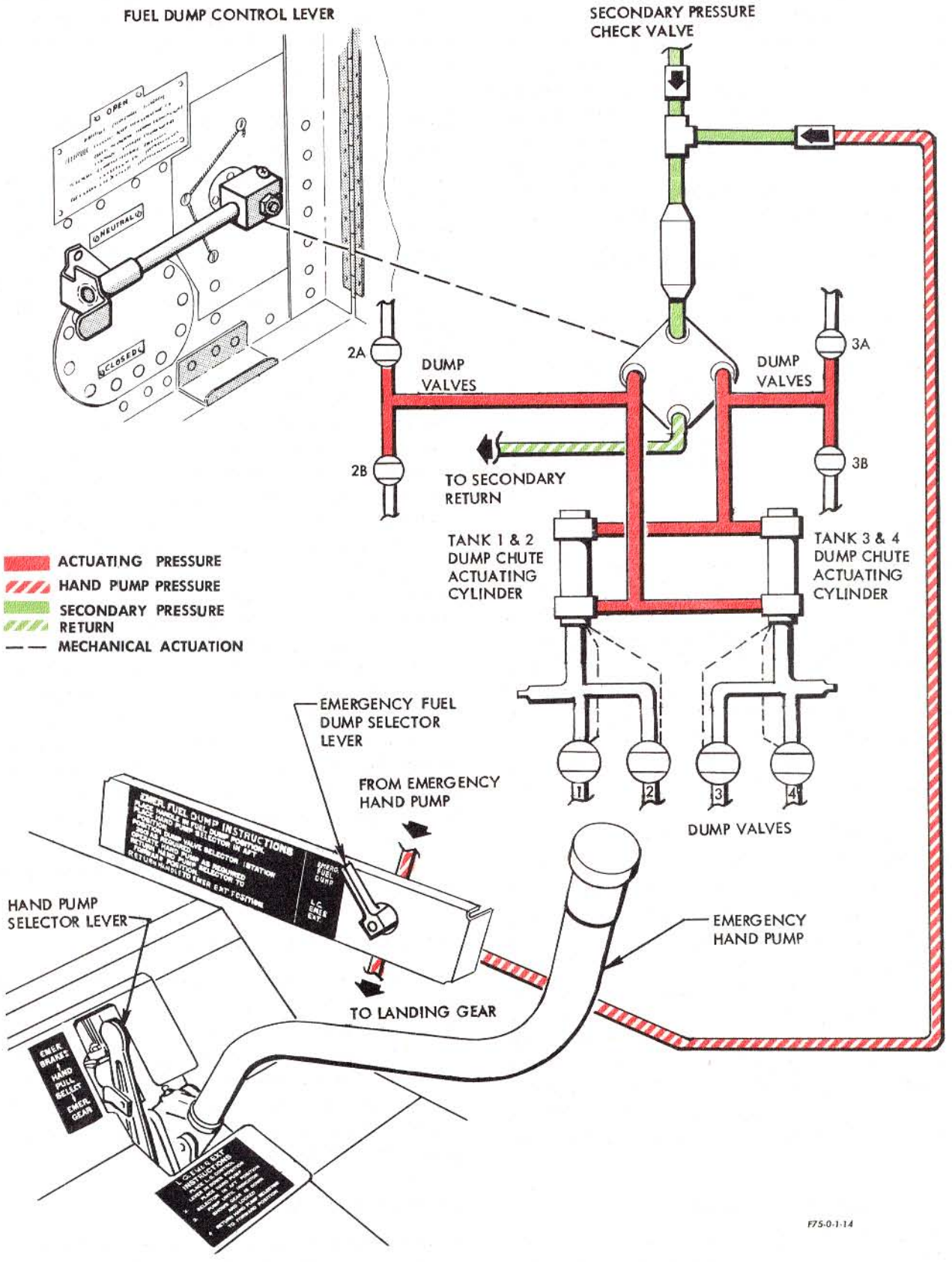


Figure 1-29. Emergency Hydraulic System (Fuel Dump)

reserve oil system, and the right wing secondary heat exchanger fan motor. Pressure for the secondary system is supplied by the pumps on engines 3 and 4. Return lines from all of the secondary system units are manifolded into a common line through the main secondary filter to the secondary return port of the main hydraulic reservoir.

RESTRICTION CONTROL VALVE.

The restriction control valve operates as a fluid flow control valve and is adjusted to a preset value. If the secondary pressure is reduced or drops to this preset value, the valve will automatically divert remaining pressure and give priority to more vital system services such as the flight control boosters, brakes, nosewheel steering, and fuel dumping. The flow is reduced to the wing flap motors, landing gear, and oil transfer pumps. The heat exchanger fan motors are not affected by the restriction control valve since they are operated directly from number 1 and 4 engine-driven pump lines.

HYDRAULIC SYSTEM CROSSOVER VALVE

An electric motor-driven crossover valve is installed in the hydraulic system to connect the primary and secondary systems in the event of failure of either system. Should a loss of system pressure occur in either the primary or secondary system, pressure from either system may be used by opening the crossover valve. Opening this valve allows primary system pressure to feed secondary services as well as the booster systems, or will allow the secondary system pressure to feed the booster systems as well as secondary services. However, operation time of some of the secondary system units may be slower. Booster return bypass valves automatically direct return hydraulic fluid from the primary and secondary systems to their respective side of the main hydraulic reservoir during normal operation. In the event of system pressure loss of either the primary or secondary system, the booster return bypass valves will continue to direct return hydraulic fluid to its respective side of the main reservoir until the crossover valve is opened. The operating system will then supply pressure for both systems and the return hydraulic fluid will be directed automatically by the booster return bypass valves to the reservoir of the system supplying the pressure.

WARNING

Before opening the crossover valve in the event of loss of system pressure from either the primary or secondary system, it should first be determined that opening the valve will not result in loss of the remaining system pressure fluid.

EMERGENCY HAND PUMP POWER SYSTEM.

The emergency hand pump power system (fig. 1-29) consists of a separate fluid reservoir (emergency extension tank), located forward of the pilot's rudder pedals, and a combined hand pump and selector valve. The system provides an auxiliary source of fluid and pressure, independent of the normal hydraulic system, for emergency braking, landing gear extension, and fuel dumping in the event of normal system failure. A separate and independent set of lines, connected to the downside of the landing gear actuating cylinders, is used during emergency gear extension. During emergency braking, fluid is directed to the brake selector valve. (Refer to Brake System, this section.) Other components of the emergency hand pump system include provisions for replenishing the system with fluid. These components consist of a hand wobble pump with a capped inlet line (to be attached to a portable fluid container) and an outlet line that connects the wobble pump to a filler selector valve which directs replenishing fluid to the emergency extension tank or to the main system hydraulic reservoir. If neither primary nor secondary system pressure is available, the emergency hand pump power system may be used.

PUMP CONTROL VALVE.

A multiple-function pump control valve is installed with each engine-driven hydraulic pump. It acts as a manual emergency shut-off valve, a thermal relief valve, a pressure relief valve and a pressure switch. The manual shut-off valve consists of a cam-operated poppet valve acting against a suction inlet port of the control valve. The thermal relief valve automatically bypasses the hydraulic fluid from the pressure side to the suction side of the control valve when the fluid pressure, because of high temperature, reaches the high limit. The pressure relief valve operates automatically when system pressure reaches the maximum limit by allowing a valve piston to open which diverts fluid to the suction side of the control valve. The pressure switch consists of a spring-loaded piston which actuates an electric switch that closes the circuit to the indicator light located in the flight station, when the hydraulic pressure drops to the minimum limit.

Emergency Hand Pump Selector Lever.

The emergency hand pump and selector lever (3, fig. 1-31) are located on the flight station floor, outboard

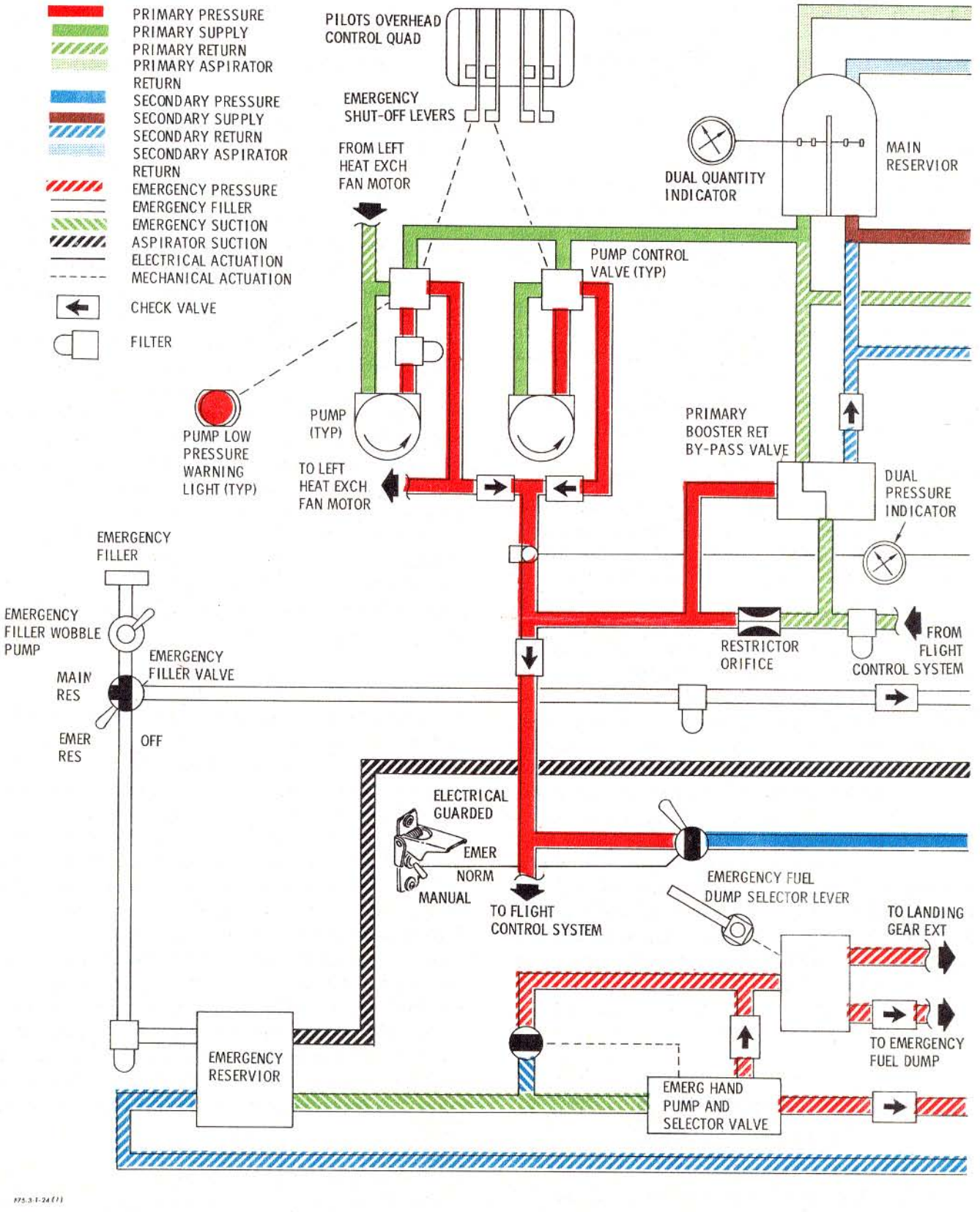


Figure 1-30. Hydraulic Power System (Sheet 1 of 2)

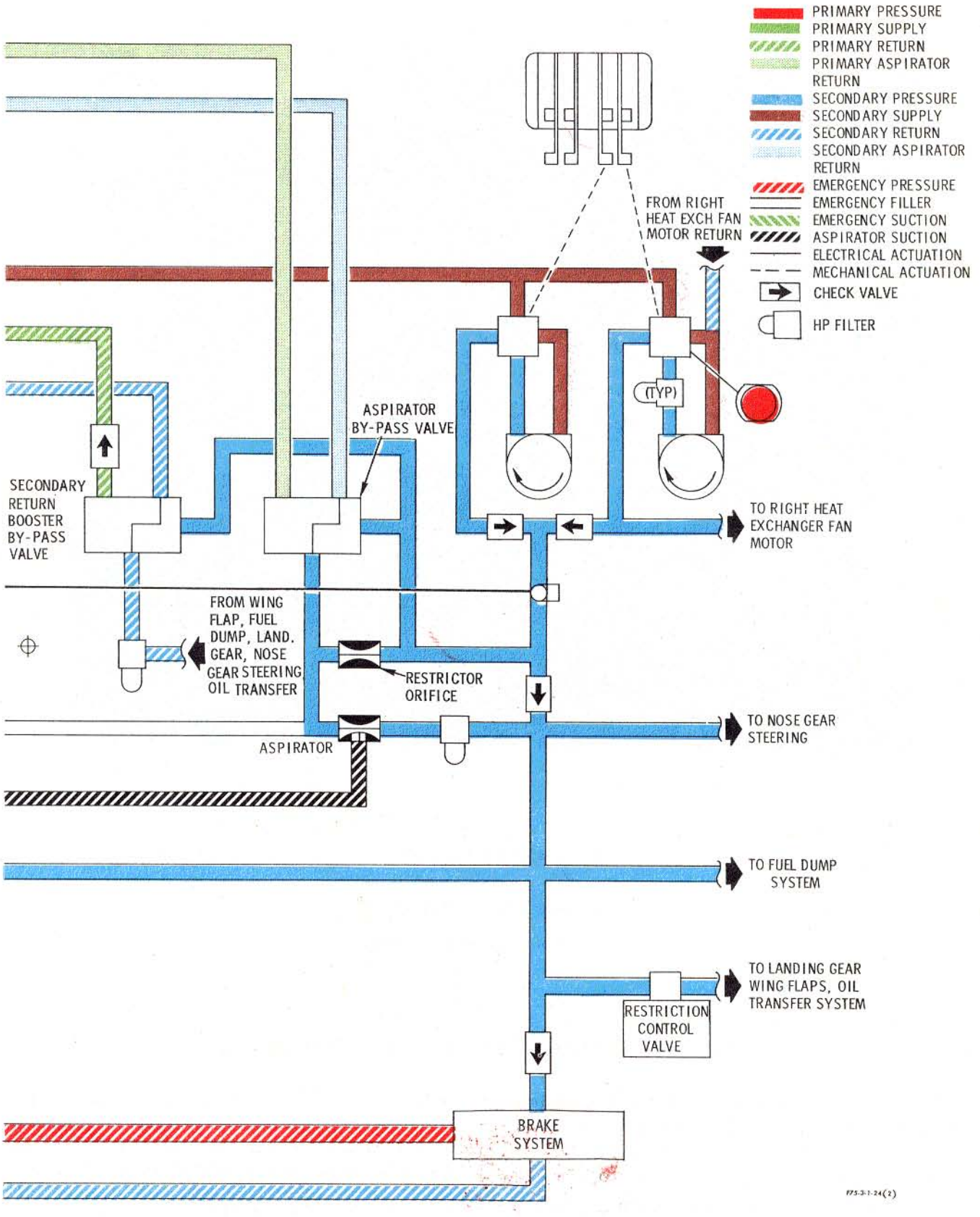
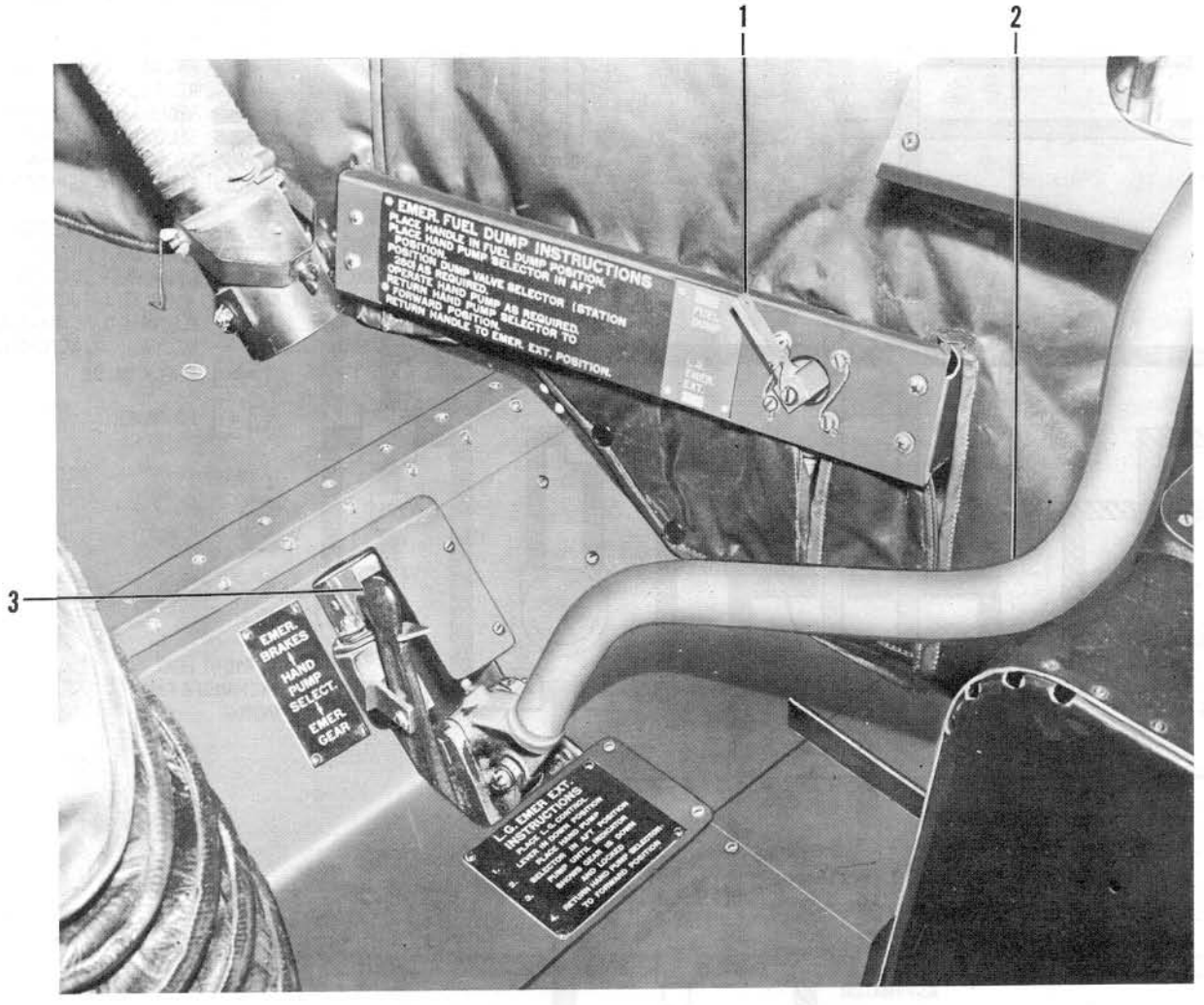


Figure 1-30. Hydraulic Power System (Sheet 2 of 2)



1. EMERGENCY FUEL DUMP SELECTOR LEVER
2. EMERGENCY HAND PUMP
3. HAND PUMP SELECTOR LEVER

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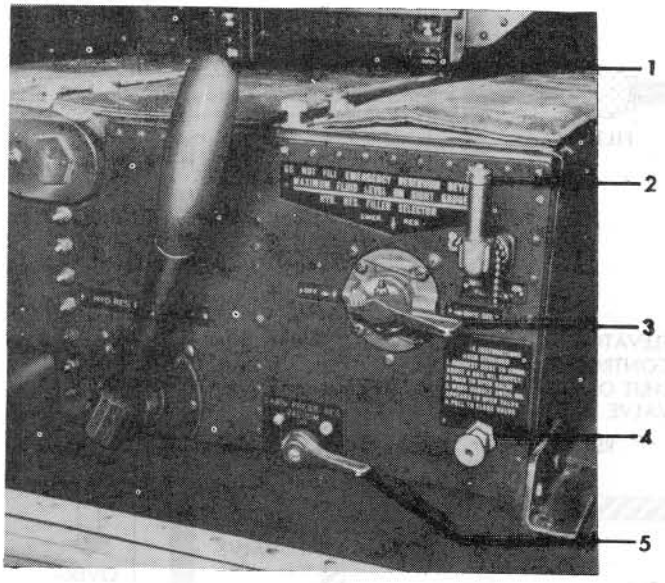
Figure 1-31. Emergency Hand Pump and Selector Levers

of the copilot's seat. The selector lever has two positions, EMER. BRAKES and EMER. GEAR. When the lever is in the EMER. BRAKES position, the hand pump may be used to direct fluid and pressure to the brake selector valve located in the normal brake system. (Refer to Brake System, this section.) When the selector lever is placed in the EMER. GEAR position, the hand pump lever may be used to supply pressure through an independent system of lines to the downside of the landing gear actuating cylinders or the emergency fuel dumping. If this lever is left in the EMER. GEAR position, the landing gear cannot be retracted by the normal system.

Emergency Shut-off Valve Levers.

Moving this lever to the second detent position shuts off the hydraulic fluid. (Refer to Emergency Equipment, this Section.)



1 HYDRAULIC RESERVIOR FILLER WOBBLE PUMP HANDLE

2 HOSE CONNECTION FILLER PUMP

3 HYDRAULIC RESERVIOR FILLER SELECTOR

4 PUMP BLEED VALVE

5 CABIN PRESSURE REGULATOR VACUUM SHUT-OFF LEVER

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Figure 1-32. Hydraulic Reservoir Filler Controls

Hydraulic Reservoir Filler Pump.

A wobble pump (1, fig. 1-32) is located on the flight station floor offset behind the pilot's seat. This pump is used to transfer hydraulic fluid from a portable container to the emergency reservoir through a selector valve.

Hydraulic Reservoir Filler Selector.

This selector lever, (3, fig. 1-32) labeled OFF, EMER. RES., and MAIN, operates mechanically and is located near the hydraulic reservoir filler pump. The EMER. RES. position permits hydraulic fluid to be transferred from the portable container to the emergency reservoir. The MAIN position provides a means of replenishing the normal reservoirs.

Hydraulic System Crossover Switch.

The hydraulic system crossover switch (18, fig. 1-17) is installed at the flight engineer's station and has two positions, NORMAL and EMERGENCY. The NORMAL position is the closed position. When the switch is in the EMERGENCY position, a d.c. motor rotates the valve and the primary and secondary hydraulic systems are interconnected.

Hydraulic Fluid Quantity Indicator.

The main hydraulic fluid quantity indicator is located on the flight engineer's lower instrument panel (13, fig. 1-15). This is a dual d.c. operated indicator actuated by two Liquidometer transmitters, one in the primary side of the main hydraulic reservoir and one in the secondary side. The dial is calibrated in quarters from empty to full.

Hydraulic System Pressure Indicators.

Two dual hydraulic oil pressure indicators are installed, one on the copilot's auxiliary instrument panel (24, fig. 1-7) and one on the flight engineer's lower instrument panel (7, fig. 1-15). These indicators are calibrated in psi. One needle in each instrument indicates the hydraulic pressure in the primary system and the other needle indicates the pressure in the secondary system. Each indicator is electrically (a.c.) connected to a pressure transmitter located in the pressure lines of each system.

Hydraulic Pump Low Pressure Warning Lights.

Four pump low-pressure warning lights are installed on the flight engineer's lower instrument panel (6, fig. 1-15) and on the copilot's auxiliary instrument panel (22, fig. 1-7). These lights are numbered from left to right and are electrically (d.c.) connected to the pressure side of their respective pump control valves. When the pump pressure decreases to the low limit, the pump control valve pressure switch will close the circuit to the respective light on each panel.

Emergency Hydraulic Reservoir Sight Gage.

A sight gage, mounted on the emergency extension reservoir, is visible from the flight engineer's station and is marked at the MAX. and MIN. fluid levels.

FLIGHT CONTROL SYSTEM.

The elevators, rudders and ailerons are actuated by cable and pulley systems which incorporate tension regulators that automatically maintain constant tension in the cable systems. Each outboard rudder, each elevator and each aileron is provided with a cable-operated trim tab that is controlled from the flight station. Hydraulic booster units are built into the elevator, rudder and aileron cable systems to assist the pilot in moving the control surfaces. The characteristic control "feel" is retained throughout movement of all controls. The elevator and the rudder booster systems incorporate a complete electrical power unit that will provide an auxiliary source of hydraulic power to the booster assemblies in the event of primary or secondary hydraulic system failure. Electrical power is obtained from the emergency d.c. bus. There is no source of auxiliary hydraulic power for the aileron booster system.

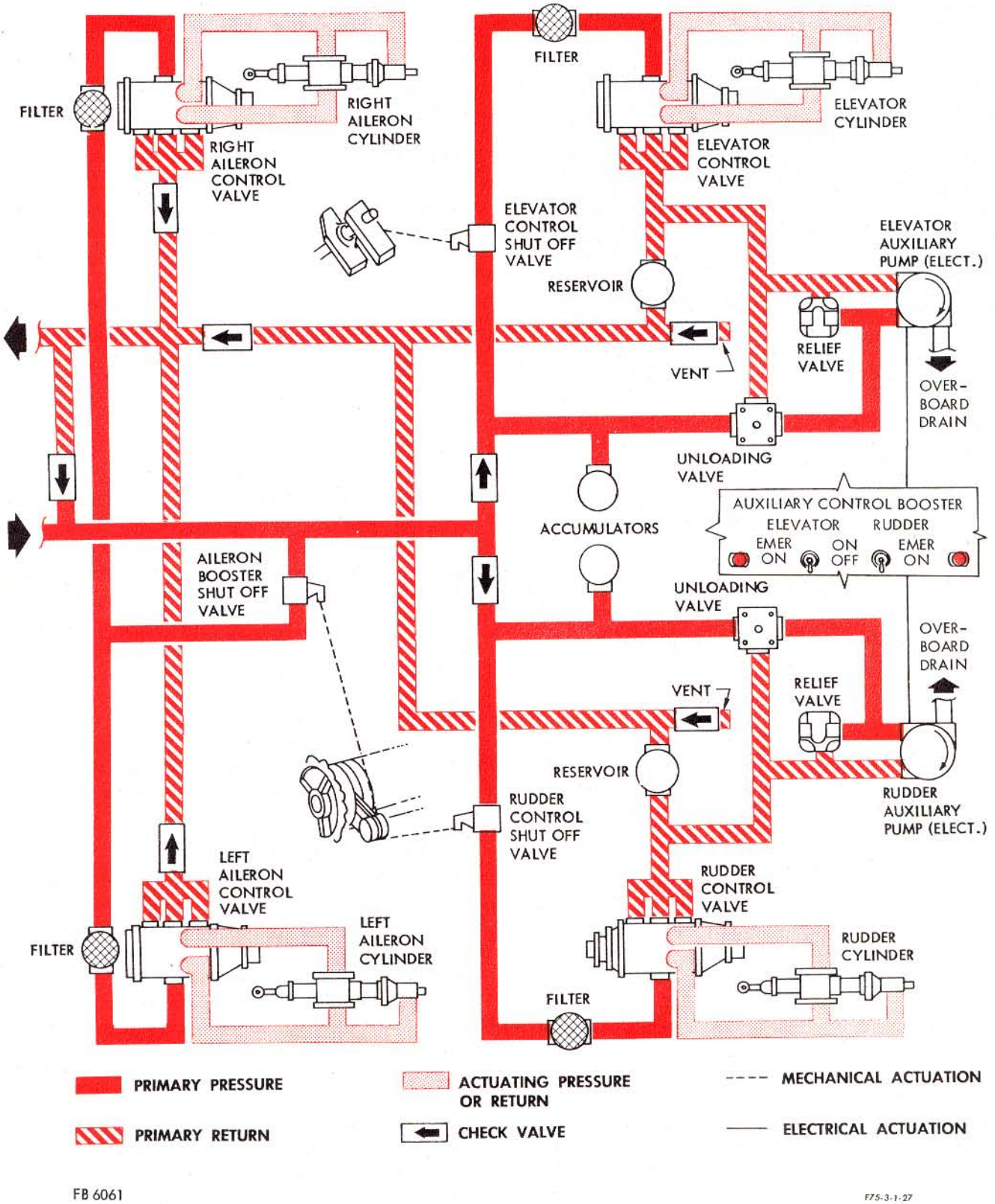

Figure 1-33. Flight Control Hydraulic System

FLIGHT CONTROL BOOSTERS.

Hydraulic pressure for the flight control boosters normally is supplied by the primary hydraulic system. In the event of failure of the primary system, hydraulic pressure from the secondary system can be supplied to the flight control boosters through the hydraulic crossover valve.

Each booster assembly includes a hydraulic actuating cylinder which applies the force and a four-way control valve which regulates the speed and direction of movement of the actuating cylinder piston. Any movement of the rudder pedals or control wheel opens the control valve, or valves, which direct hydraulic pressure to the actuating cylinder, or cylinders.

SURFACE CONTROL LOCK.

The effect of surface control locks is achieved by engaging the flight control boosters while the aircraft is parked. The boosters provide sufficient resistance in the system to absorb the impact loads caused by gusts.

AILERON CONTROL SYSTEM.

The aileron control system consists of a cable and pulley system that connects the pilots' control wheels to the ailerons and aileron booster assemblies located in the wing forward of each aileron. As the control wheel is rotated, push rods mechanically force the ailerons and the aileron booster control valves which hydraulically boost control wheel action.

Aileron Trim Tabs.

A trim tab is located in the trailing edge of each aileron and is controlled mechanically through a cable system. Movement of the cables is converted by a tab actuating unit, located in the outer wing structure, into rod linkage servo-action. The rod linkage is connected to the tab and passes through the aileron to the aileron tab actuating unit.

Aileron Trim Tab Handcrank and Indicators.

The aileron trim tab handcrank (23, fig. 1-11) is located on the center control stand and is rotated to actuate a cable system to each aileron tab. Internal stops limit the number of turns of the handcrank in each direction from the neutral position. Tab position is shown by a needle forward of the handle and by a dial indicator below the handcrank. The needle on the lower dial gives the most sensitive indication and moves from the neutral position toward either the LEFT or RIGHT extremities as the handcrank is rotated.

Aileron Booster Control Lever.

The aileron booster control lever (3, fig. 1-11) is located on the center control stand to the left of the throttle controls. When the booster control lever is pulled to the OFF (aft) position, a cable system actuates a hydraulic shut-off valve and opens a bypass valve in each aileron actuating cylinder. Fluid from the hydraulic system is then shut off from the boosters, and the bypass valves in each cylinder allow the fluid to flow freely from one end of the cylinder to the other as the ailerons are moved. When the boosters are shut off, control wheel forces are transmitted to the ailerons through the mechanical system of cables and linkage.

RUDDER CONTROL SYSTEM.

The rudder pedals are connected by cable to a quadrant assembly, located in the aft fuselage section. The quadrant assembly is connected by push-pull rods to the center rudder. Another set of push-pull rods interconnect the center rudder with each outboard rudder. Linkage also connects the cable quadrant to the rudder booster assembly, which is different in mechanical arrangement from the aileron and elevator booster assemblies in that it incorporates a trail center valve.

Rudder Trim Tabs.

The flight station trim tab control is connected by cable to each outboard rudder tab actuating unit. The center rudder is not provided with a trim tab. The tab actuating units are connected to the tabs by adjustable link rods which screw forward and aft by action of the actuator, thus deflecting the tabe. The rudder trim tabs have no servo action.

Rudder Booster Control Lever.

The rudder booster control lever (2, fig. 1-11) is located on the center control stand to the left of the throttles. When the booster control lever is pulled to the OFF (aft) position, a control cable actuates a hydraulic shut-off valve and opens a bypass valve in the rudder actuating cylinder. Fluid from the hydraulic system is then shut off from the booster, and the bypass valve in the cylinder opens and allows the fluid to flow freely from one end of the cylinder to the other as the rudder is moved. When the rudder booster is shut-off, rudder pedal forces are transmitted to the rudders through the mechanical system of cables and linkage.

Rudder Auxiliary Booster Switch.

The rudder auxiliary booster switch (4, fig. 1-8), located on the pilots' overhead panel, has three positions, ON, OFF and EMERGENCY ON. It is spring-loaded to OFF from the EMERGENCY ON position. When the switch is moved to the ON position, the electrically operated hydraulic pump is energized which supplies auxiliary hydraulic power to the rudder booster in the event normal hydraulic power is not available. When the switch is held in the EMERGENCY ON position,

electrical power is supplied directly to the auxiliary motor from the d.c. bus or, if that bus is dead, directly from the aircraft batteries without the protection of circuit breakers.

Rudder Tab Handcrank and Indicator.

The rudder tab handcrank (26, fig. 1-11) is located on the center control stand and is rotated to drive a drum in the control unit. This drum is connected by cables to a similar drum in each of the two tab-actuating units located in the outboard rudders. Internal stops limit the number of turns of the handcrank in each direction from the neutral position. Tab position is shown by a dial indicator forward of the handcrank. The needle on the dial moves from the neutral position toward either the LEFT or RIGHT extremities as the handcrank is rotated.

Rudder Auxiliary Booster Indicator Light.

The rudder auxiliary booster indicator light (6, fig. 1-8) is located on the pilot's overhead panel adjacent to the rudder auxiliary booster switch. The indicator light glows amber whenever the auxiliary boost pump is in operation.

ELEVATOR CONTROL SYSTEM.

The control columns are connected by cable to an elevator walking beam which is connected by a linkage system to the elevators. Direct linkage connects the elevators and the hydraulic booster assembly. The booster assembly is similar to the aileron booster in principle of operation. An actuating cylinder, a control valve and connecting linkage are the essential parts of the booster assembly. Elevator booster operation can also be provided by an auxiliary d.c. electrically driven hydraulic pump which supplies hydraulic power to the booster unit in the event of normal hydraulic system failure. An emergency elevator booster shift control is provided to shut off the booster and to alter the leverage ratio between the flight station controls and the booster mechanism.

Elevator Trim Tab Control Wheels and Indicator.

The elevator trim tabs may be controlled manually by control wheels (1, fig. 1-11) located on each side of the pilots' center control stand. They are interconnected by a shaft which drives a drum pulley. A control cable connects the drum pulley in the stand with the tab actuating units. The control wheel is rotated forward for nose-down and aft for nose-up trim. A dial needle indicator, driven by the drum shaft by means of gears, is mounted inboard of the wheels on the control stand and indicates the relative position of the tabs.

Emergency Elevator Booster Shift Control.

The elevator booster shift control (24, fig. 1-11) is located on the left side of the center control stand and consists of a shaft with a push-button lock on the handle grip. Normally, the control is in the forward and downward position for boost ON. It is pulled upward and aft for boost OFF. In the event of elevator booster system failure, the elevators may be actuated manually by use of the emergency elevator booster shift control. When this shift lever is pulled upward, it shuts off and bypasses the normal and the auxiliary booster systems and alters the leverage ratio between the control columns and the elevator. This provides the pilots with sufficient mechanical advantage to actuate the elevators manually during the boost-off operations. The amount of elevator travel in relation to control column movement is reduced approximately 3 to 1, and there is approximately 1½ inches of free movement in the control column before elevator movement is affected.

Elevator Auxiliary Booster Switch.

The auxiliary booster toggle switch, located on the pilots' overhead panel (4, fig. 1-8), has three positions, ON, OFF and EMERGENCY ON. It is spring-loaded to OFF from the EMERGENCY ON position. When the switch is placed in the ON position, the electrically-driven auxiliary hydraulic motor is energized and supplies hydraulic power to the booster. In the event of electrical system failure, the switch can be held in the EMERGENCY ON position to energize the auxiliary booster. The electrical circuit to the EMERGENCY ON position is direct from the aircraft batteries and is not protected by circuit breakers.

CAUTION

The rudder and elevator boost levers must be ON before the auxiliary elevator and rudder boost switches are effective.

WING FLAPS.

The wing flaps are Fowler-type, and flap motion during extension is a combination of an aft and a downward tilting movement. There are ten flap sections located in the inner wing panels (five in each wing). The flap control unit consists of a hydraulic selector valve and a follow-up mechanism that controls two hydraulically-driven flap motors which supply the driving force for the wing flaps. The control unit also allows prepositioning of the flaps and changing of the flap movement at any time without completing a selected cycle. The two hydraulic motors are located on the rear wing beam in the center section and normally are pow-

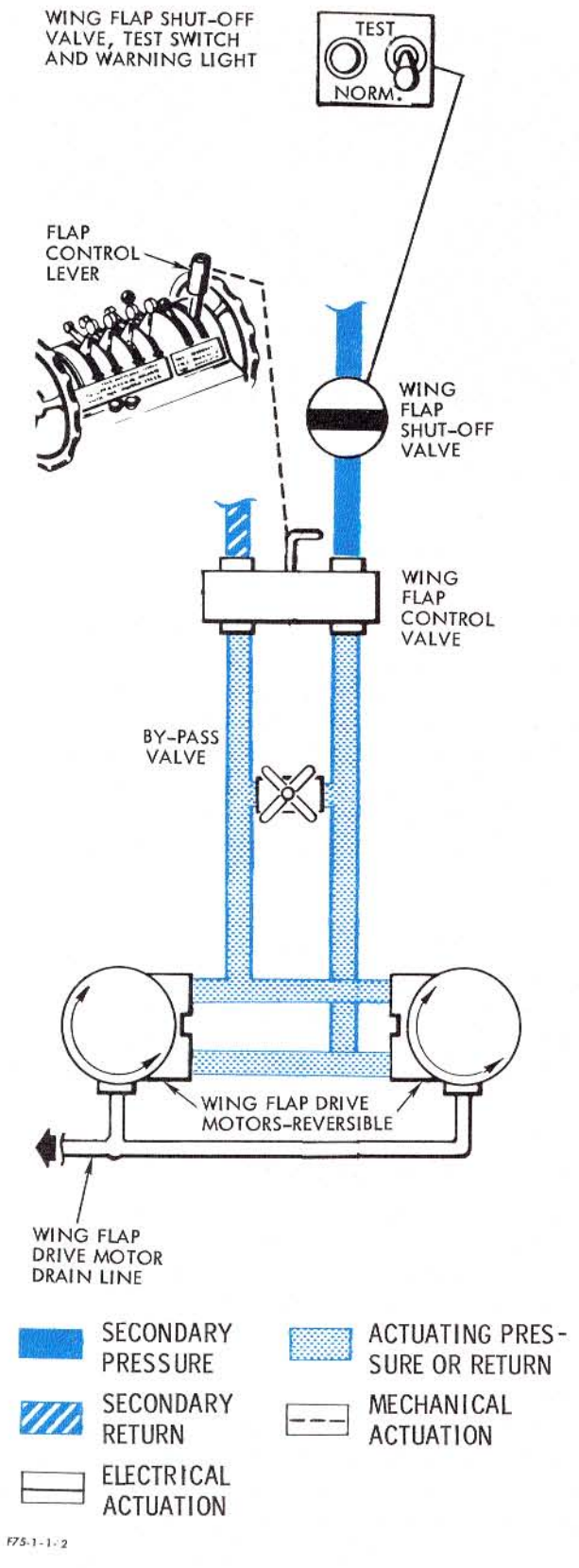

Figure 1-34. Wing Flap Motor Hydraulic System

ered by the secondary hydraulic system. Output of the hydraulic motors is transmitted by a main drive shaft to drive shafts that extend into each inner wing panel to operate separate intermediate drive units. There are twelve intermediate drive units bolted to carriage track ribs and to brackets on the wing rear beam. The intermediate drive units turn sprockets that are connected by chains and cables to the wing flap carriages. The carriages are attached to the wing flap sections and roll on tracks riveted to adjacent wing ribs. Spring units take up the slack on the loose side of the chains to prevent jamming. In the event that the wing flaps fail to operate by normal means, the flaps may be extended or retracted manually. Access to the shaft-and-gear mechanism is through the flap emergency access door, centrally located in the main cabin floor.

WING FLAP ASYMMETRY PROTECTION SYSTEM.

The wing flap asymmetry protection system consists of cam-operated switches mounted on the wing flap gear box drive located on each extreme outboard flap mechanism. These switches are adjusted so that an open circuit exists during normal operation of the wing flaps. Should an asymmetrical wing flap condition occur, the open circuit is closed by the failure in rotation of the opposite cam driven switch. This completed electrical circuit then trips a mechanical latching relay, which in turn energizes an asymmetrical wing flap warning light and closes a d.c. electric motor-driven hydraulic shut-off valve. This valve shuts off hydraulic pressure to the wing flap motors and stops travel of the wing flaps.

Wing Flap Shut-off Valve Test Switch and Warning Light.

A two-position wing flap shut-off valve test switch (16, fig. 1-7) and an asymmetrical wing flap warning light are located on the copilot's instrument panel. The The test switch is spring-loaded from the TEST to the NORMAL position. The test switch provides a means of testing the asymmetrical wing flap warning light and the operation of the hydraulic shut-off valve without energizing the d.c. latching relay. With the switch in the TEST position, the warning light is energized and the shut-off valve is closed. With the test switch in the NORMAL position, the warning light will be out and the shut-off valve open.

Wing Flap Lever.

The wing flap lever (8, fig. 1-11) is located on the top, right side of the center control stand. There are four placarded positions on the quadrant: TAKE-OFF, APPROACH, 80%, and LANDING. When the lever is full forward, the flaps are retracted or are in the up

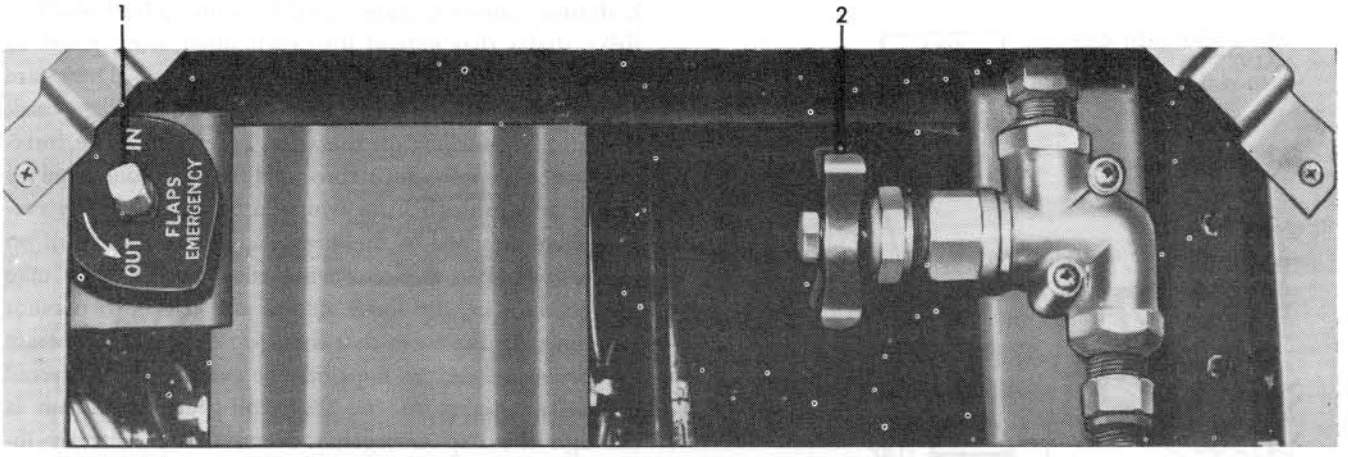

Figure 1-35. Wing Flaps Emergency Extension Controls

position. Moving the flap lever progressively aft permits the following flap extensions:

TAKE-OFF	(60% extension)
APPROACH	(66% extension)
80%	(80% extension)
LANDING	(100% extension)

Note

There is no detent at the APPROACH position; however, the lever will remain at that position.

A switch is installed on later production aircraft in the wing flap follow-up mechanism and is wired to the landing gear warning horn. This switch is wired in parallel with the landing gear warning horn throttle switches and will energize the warning horn circuit when the wing flap selector lever is placed in the APPROACH or LANDING positions and the landing gear is not down and locked.

Emergency Extension Handcrank.

The emergency extension handcrank is strapped on the aft side of the bulkhead opposite the galley. It fits onto the emergency extension crank square drive socket located below the wing flap emergency extension access door.

Wing Flap Motor By-Pass Valve.

This control valve (1, fig. 1-35) permits hydraulic fluid to circulate through the hydraulic flap motor preventing a hydraulic lock during emergency wing flap extension. Turning the control valve counterclockwise opens the valve. (Refer to Section III for emergency procedures.)

Wing Flap and Landing Gear Position Indicator.

The wing flap and landing gear position indicator (14, fig. 1-7) is d.c. operated and is located on the pilots' center instrument panel. The upper portion of the indicator shows flap position by illustrating a flap in the UP, DOWN, or intermediate positions. The DOWN position corresponds to 100% extension. The lower portion of the indicator shows landing gear position.

Wing Flap Asymmetry Indicator.

The wing flap asymmetry indicator (14, fig. 1-7) is operated by 26V a.c. current and is located on the co-pilot's instrument panel adjacent to the wing flap shut-off valve test switch. It is a dual indicator, placarded UP and DOWN, showing the position of each wing flap.

LANDING GEAR SYSTEM.

The aircraft is equipped with a fully retractable, tricycle landing gear. When the gear retracts, the nose gear pivots aft into the underside of the fuselage, and the main gears pivot forward into the nacelle wheel wells. Landing gear doors, which are mechanically operated by the gear oleo pneumatic shock struts, lie flush with the airplane contour when the gears are retracted. The secondary hydraulic system provides hydraulic pressure to operate the uplocks, downlocks and actuating cylinders which extend and retract the landing gear. The nose and main gears have oleo pneumatic shock struts which utilize air and hydraulic fluid to give controlled resistance to taxiing, take-off and landing shocks. Dual wheels are mounted on each landing gear shock strut. The nose gear wheels are cambered 12 degrees to help

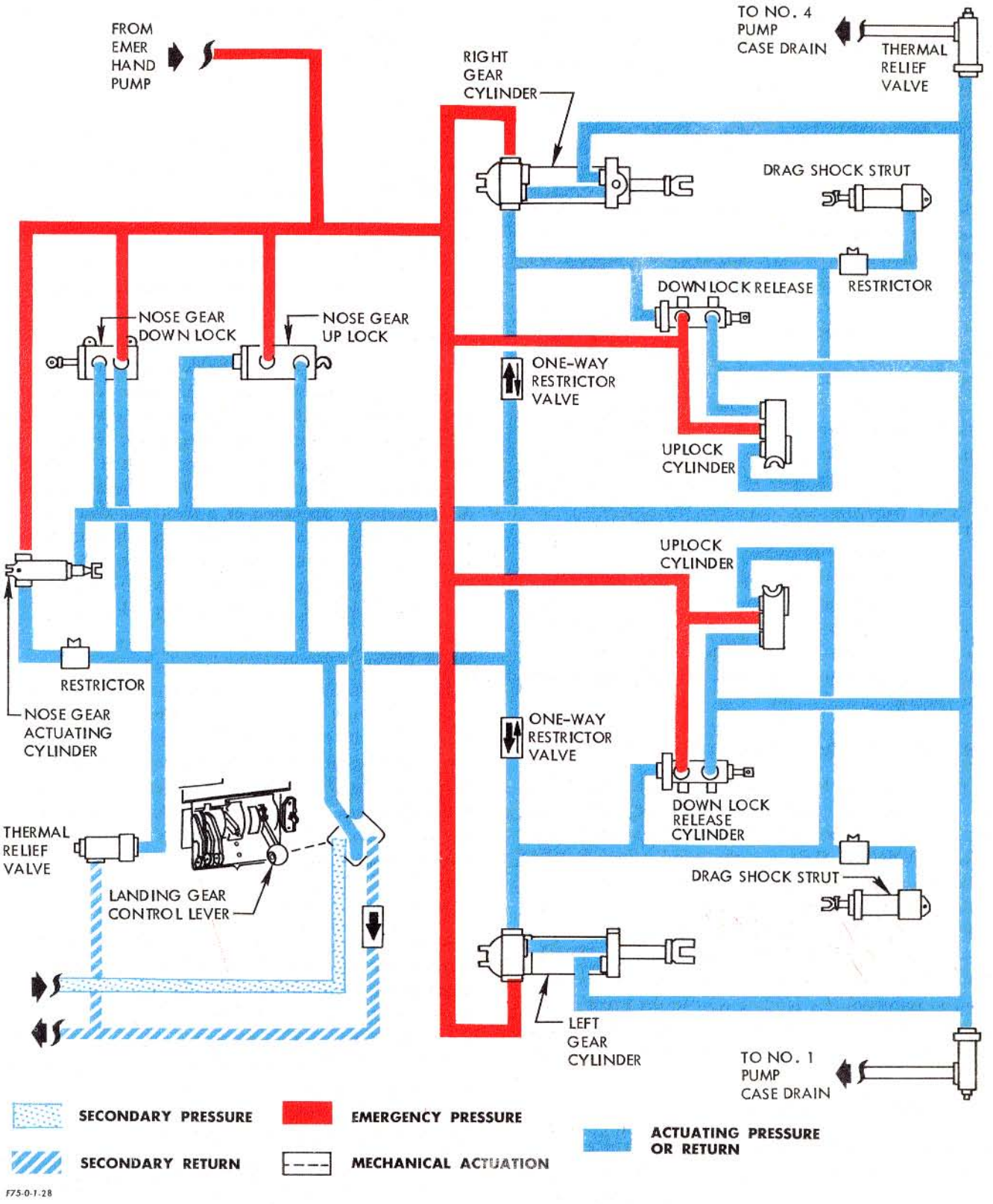

Figure 1-36. Landing Gear Hydraulic System

forward castering. A centering saddle cam is built into the nose gear shock strut to align the gear when there is no weight on it. Scissor links keep the landing gear shock strut pistons and cylinders in alignment. For ground handling, the nose gear scissor link may be quickly disconnected by removing the center pivot bolt.

LANDING GEAR HYDRAULIC SYSTEM.

(Refer to figure 1-36).

A cable-actuated hydraulic selector valve, located in the aft end of the forward cargo compartment, directs secondary hydraulic system pressure to either the retracting or extending end of the landing gear actuating cylinders and to the uplocks or downlocks. The main gear actuating cylinders, which are located on each upper drag strut assembly, have a run-around valve which allows hydraulic fluid to pass from one side of the actuating cylinder pistons to the other without returning the fluid to the hydraulic reservoir when the gears extend, thereby reducing operating time. The right wing secondary heat exchanger fan motor receives hydraulic fluid from the secondary hydraulic system. On later aircraft, USAF Serials 55-118 and subsequent, the right heat exchanger fan motor receives pressure directly from the No. 4 engine driven hydraulic pump. Normally, the motor is shut off by a main gear scissors switch during retraction of the gear. In the event of failure of this switch, landing gear operating time may be increased because the flow of fluid to the fan motor will tend to starve the landing gear system.

EMERGENCY LANDING GEAR EXTENSION.

In the event that the secondary hydraulic system does not supply sufficient pressure, on early aircraft, the landing gear can be extended by means of a hand pump system. Hydraulic fluid for the hand pump is taken from an emergency extension hydraulic reservoir and is directed to the uplocks, gear actuating cylinders, and downlocks through separate hydraulic lines. No emergency means is provided for gear retraction. The hydraulic system crossover valve provides means of extending and retracting the landing gear in the event normal secondary hydraulic system pressure is not available. (Refer to Hydraulic System Crossover Valve, this section.

MAIN GEAR DRAG STRUTS.

The main gear drag strut assembly consists of an upper and lower drag strut. The upper strut is composed of two rigid triangular forgings, which are bolted together with pivot points at each end. The lower drag strut is a hydraulic cylinder that absorbs forward and aft shock loads of landing and taxiing by the combined action of an internal spring and a metering orifice. There is no circulation of fluid through the lower drag strut, but when the landing gear lever is in the DOWN position, pressure from the secondary hydraulic system is used to maintain hydraulic fluid in the lower drag strut.

UPLOCKS.

The main gear uplocks are mechanically latched to the landing gears which trip the uplock triggers when they are completely retracted. The locks are released by hydraulic pressure and are held open by springs and pressure as the gear extends. The nose gear uplock operation is similar to that of the main gear. The gears cannot be released from the uplocks by maneuvering loads.

DOWNLOCKS.

When each main gear is in the down position, a downlock strut prevents the drag strut from folding. One end of the downlock strut connects to the pivot that connects the upper and lower drag struts, and the other end hooks over a lock shaft mounted in the wheel well. A spring-loaded latch in the hook prevents disengagement except by operation of a hydraulic downlock release cylinder. The nose gear downlock is a mechanical cam that locks the drag strut in the extended position. The gear cannot retract until the cam is released by the nose gear downlock release hydraulic cylinder.

GEAR PINS.

When the aircraft is parked, ground safety pins must be inserted through the downlock mechanism (fig. 1-37). These pins will prevent accidental folding of the gears should inadvertent downlock release occur because of mispositioning of the landing gear lever when secondary hydraulic system pressure is available. These pins cannot be removed if hydraulic pressure is directed to the upside of the cylinders.

Landing Gear Lever and Solenoid Lock Release.

The landing gear lever (20) fig. 1-11) is located on the right aft face of the center control stand and actuates the landing gear selector valve by control cables. It has three positions, UP, DOWN and NEUTRAL. The lever is moved to the UP position to retract the landing gear and to the DOWN position to extend it. There is a detent in the NEUTRAL position (midway between the UP and DOWN positions). The landing gear lever must be pulled out to move it toward the UP position. The release trigger to the right of the lever must be held toward the lever to move it past the NEUTRAL position and into the UP position. After the landing gear has been retracted, the lever should be moved to the NEUTRAL position to decrease the possibility of leaks occurring in the landing gear system during flight by

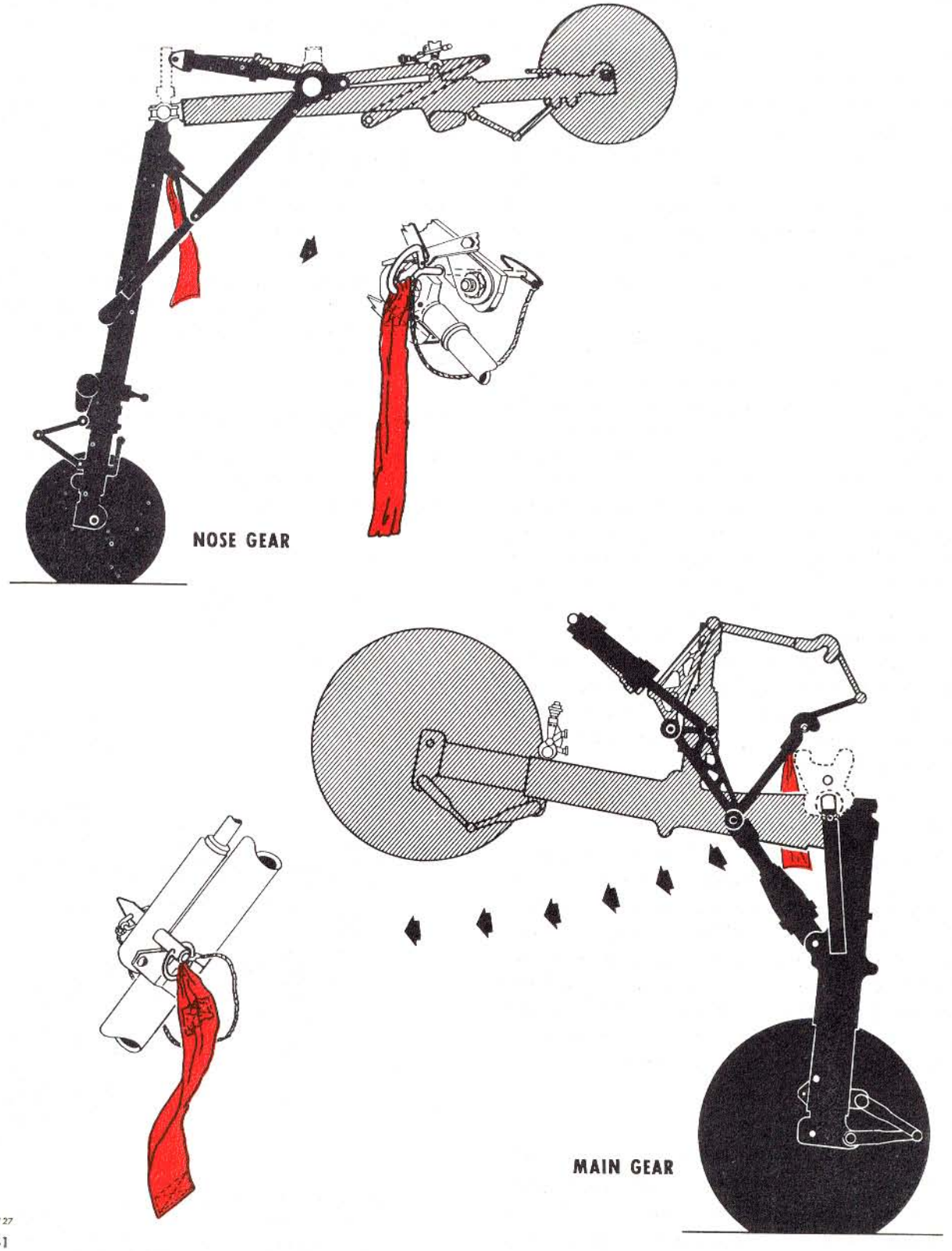

Figure 1-37. Landing Gear Safety Pins

shutting off unnecessary hydraulic pressure. The uplocks and downlocks are automatically positioned by hydraulic pressure. The uplocks hold the gear in the retracted position. When the landing gear is extended, the landing gear lever must left in the DOWN position so that hydraulic pressure in the actuating cylinders will supplement the downlocks. A solenoid lock prevents accidental movement of the lever to the UP position when the weight of the aircraft is on the gear. The solenoid lock is operated by a d.c. series circuit through both main gear scissors switches. The solenoid lock may be released manually by depressing the landing gear lock solenoid lock release which is accessible through a hole in the right side of the center control stand.

Emergency Hand Pump and Selector Lever.

The emergency hand pump and selector lever (3, fig. 1-31) are located on the flight station floor outboard of the copilot's seat. The selector lever has two positions, EMER. BRAKE and EMER. GEAR. When the selector lever is in the EMER. GEAR (aft) position, the hand pump may be used to supply pressure through independent emergency extension lines to the uplocks, actuating cylinders and downlocks, provided the landing gear lever is in the DOWN position to permit return fluid to flow to the reservoir. The selector lever is spring-latched to the EMER. BRAKE (forward) position. If the emergency hand pump selector lever is in the EMER. GEAR position and normal hydraulic pressure is available, it may not be possible to retract the landing gear since hydraulic pressure is not directed to the upside of the landing gear actuating cylinders.

Landing Gear Position Indicators.

A combination landing gear and wing flaps position indicator (32, fig. 1-7) is located on the pilot's center instrument panel. This indicator shows, individually, the position of all three wheels. When the word UP appears in an indicator window, the landing gear is up and locked. When the picture of a wheel appears, the gear is down and locked. When a red and white flag appears, the gear is somewhere between the two positions or the aircraft d.c. electrical system is inoperative.

Landing Gear Warning Light.

This light (31, fig. 1-7) is located near the landing gear position indicator. The d.c. light glows (red) whenever the landing gear is in an unlocked or an unsymmetrical position. It goes out when all gears are in the full retracted position or the extended and locked position. The "push-to-test" feature of this light is not operative when the gears are down and locked.

Landing Gear Warning Horn and Release Lever.

A landing gear warning horn is operated by four throttle switches connected in parallel, and the unlock contacts of the downlock switches are also connected in parallel. This horn will sound if one or more of the throttles is retarded beyond a critical setting and all gears are not down and locked. The landing gear warning horn can be silenced either by locking the landing gear down, by advancing the throttles, or by raising the horn release lever, located on the left side of the center control stand. If the horn has been silenced by the release lever, the d.c. circuit will be reset when the throttles are advanced. On USAF Serials 52-3415 and subsequent, a switch is installed in the wing flap follow-up mechanism and is wired in parallel with the landing gear warning horn throttle switches. (Refer to WING FLAP LEVER, this Section.)

NOSE GEAR STEERING SYSTEM.

When the nose gear is extended it can be turned by the small control wheel located on the left side of the pilot's station. Turning the control wheel operates the

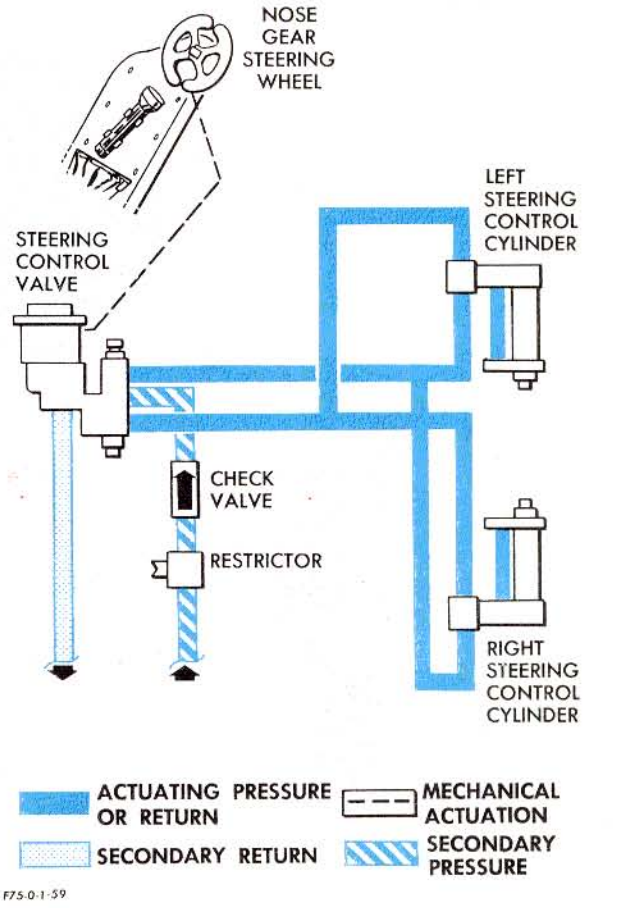

Figure 1-38. Nose Gear Hydraulic Steering System

control cables which actuate the steering control valve. This valve directs secondary hydraulic system pressure to the left or the right steering control actuating cylinder to turn the nose gear. (Refer to figure 1-38) The control wheel must be held to keep the nose gear turned and, when the wheel is released, the nose gear will return to the neutral (central) position. Approximately 1½ turns of the control wheel will deflect the nose gear approximately 58½ degrees, which is the maximum. When the nose gear is turned that amount, the inside main gear shock strut will turn on a radius of 12 feet. Oscillations are dampened by orifices in the steering control actuating cylinders that restrict the flow of hydraulic fluid; these cylinders serve as shimmy dampers when the nose gear is in the neutral position. The control wheel folds along its diameter so that it will clear full forward and aft movement of the pilot's control column. A shutoff valve in the hydraulic line is linked to the nose gear strut to shut off hydraulic pressure to the steering control valve when the nose gear is approximately 37 degrees from the fully retracted position.

BRAKE SYSTEM.

Each of the four main landing gear wheels is equipped with an inner and an outer hydraulically powered brake. These brakes are actuated by the pilot's and copilot's toe pedals which, when depressed, meter hydraulic fluid through either the normal brake system or the emergency brake system. The two systems employ separate valving and plumbing between the brake selector valve and the shuttle valves. The normal brake system is operated by secondary hydraulic system pressure. The emergency brake system also is operated by secondary hydraulic system pressure and, in addition, may be operated by accumulator pressure. If neither secondary hydraulic system pressure nor accumulator pressure is available, and if time permits, the emergency brake system may be operated by pressure supplied by the emergency hand pump. The hydraulic system crossover valve may permit normal operation of the brake system. The aircraft is equipped with an emergency brake lockout debooster bleed system which bleeds fluid from the normal brake system into the emergency brake system plumbing, downstream of the lockout deboosters, whenever the brakes are applied with the brake selector in the NORM position. The plumbing of this system precludes effective use of the emergency hand pump to operate the brakes with the brake selector in the NORM position. When the brake pedals are released, the excess hydraulic fluid returns from the brake control valves to the emergency extension reservoir.

NORMAL BRAKE SYSTEM.

The normal brake system is selected by placing the brake selector in the NORM position. When the toe pedals are depressed, pressure from the secondary hydraulic system is transmitted through the brake selector valve and through the normal side of the dual brake control valves to the deboosters. From the deboosters, pressure, reduced for optimum braking action, is transmitted through the shuttle valves to the brakes. Brake relief valves are installed, one in the outboard brake and one in the inboard brake common lines, to provide protection against excessive pressures in the common pressure lines that may damage the brakes.

EMERGENCY BRAKE SYSTEM.

The emergency brake system is selected by placing the brake selector in the EMER. position. When the toe pedals are depressed, secondary hydraulic system pressure, accumulator pressure, or pressure supplied by the emergency hand pump is transmitted through the emergency porting of the brake selector valve and through the emergency side of the dual brake control valves to the lockout deboosters. From the lockout deboosters, pressure, reduced to the optimum for braking action, is transmitted through the shuttle valves to the brakes. There are two lockout deboosters for each pair of wheels. They differ from the deboosters in the normal brake system in that they isolate the low pressure section of the brake system from the high pressure hydraulic system. Each lockout debooster controls one of the dual brakes on each wheel, thus insuring hydraulic pressure to one brake on each wheel in the event of a leak downstream from the other lockout debooster. With secondary hydraulic system pressure available, brake operation with the brake selector in the EMER. position is similar to operation with the brake selector in the NORM position except that secondary hydraulic system pressure is directed to the brakes through the emergency system valving and plumbing instead of through the normal brake system. Without secondary hydraulic system pressure, but with accumulator pressure, brake operation with the brake selector in the EMER position is also similar to operation with the brake selector in the NORM position, except that accumulator pressure, instead of secondary hydraulic system pressure, is directed to the brakes through the emergency system valving and plumbing, and the number of brake applications is limited by the pressure stored in the accumulators as indicated by the emergency brake pressure gage. When the accumulators are the sole source of pressure, some pressure should be maintained in the accumulators during braking by operating the emergency hand pump with the brake selector in the EMER position.

In the event that neither the primary nor the secondary hydraulic systems is available, the emergency hand pump system may be used. If the two main hydraulic power

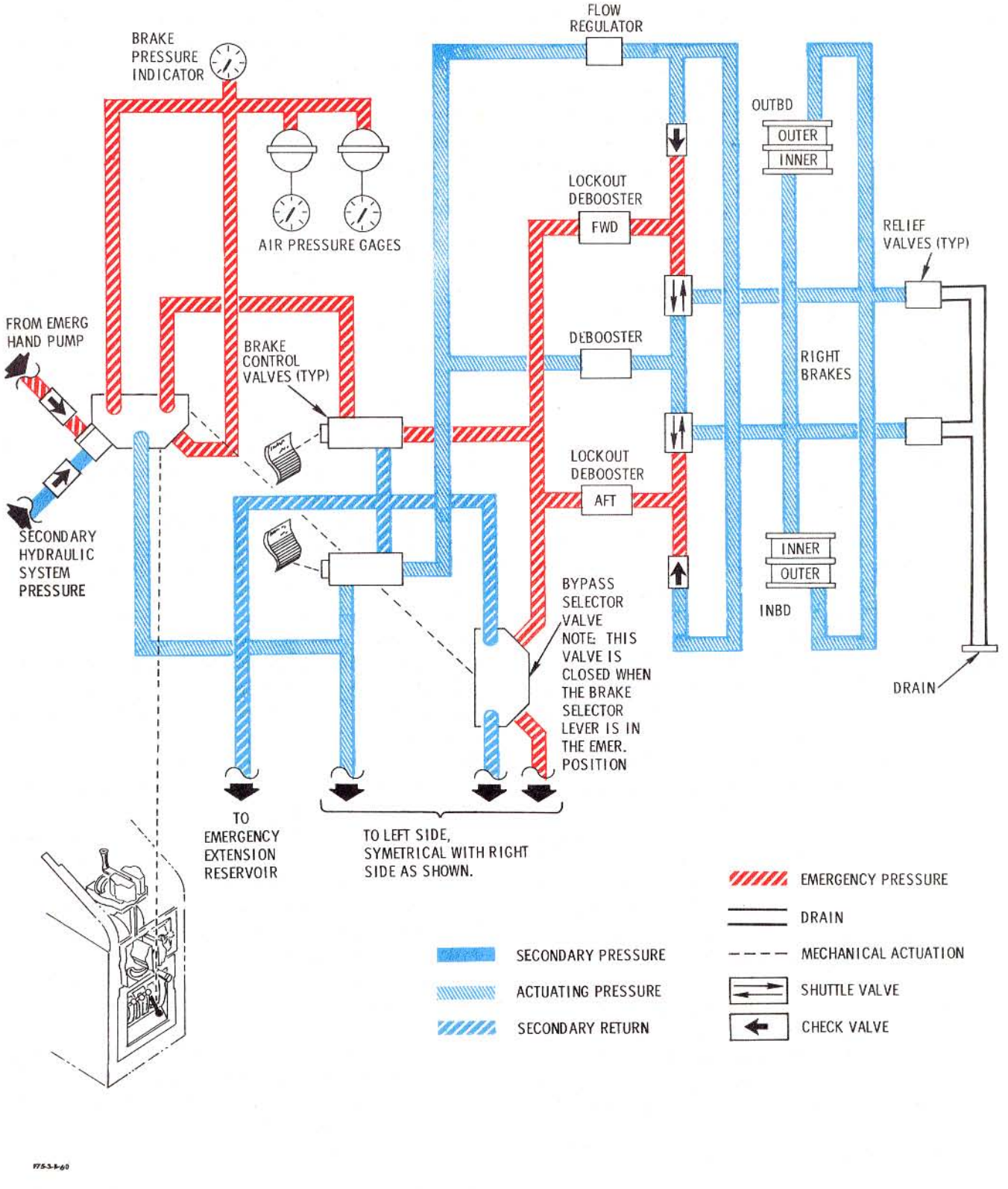

Figure 1-39. Brake System

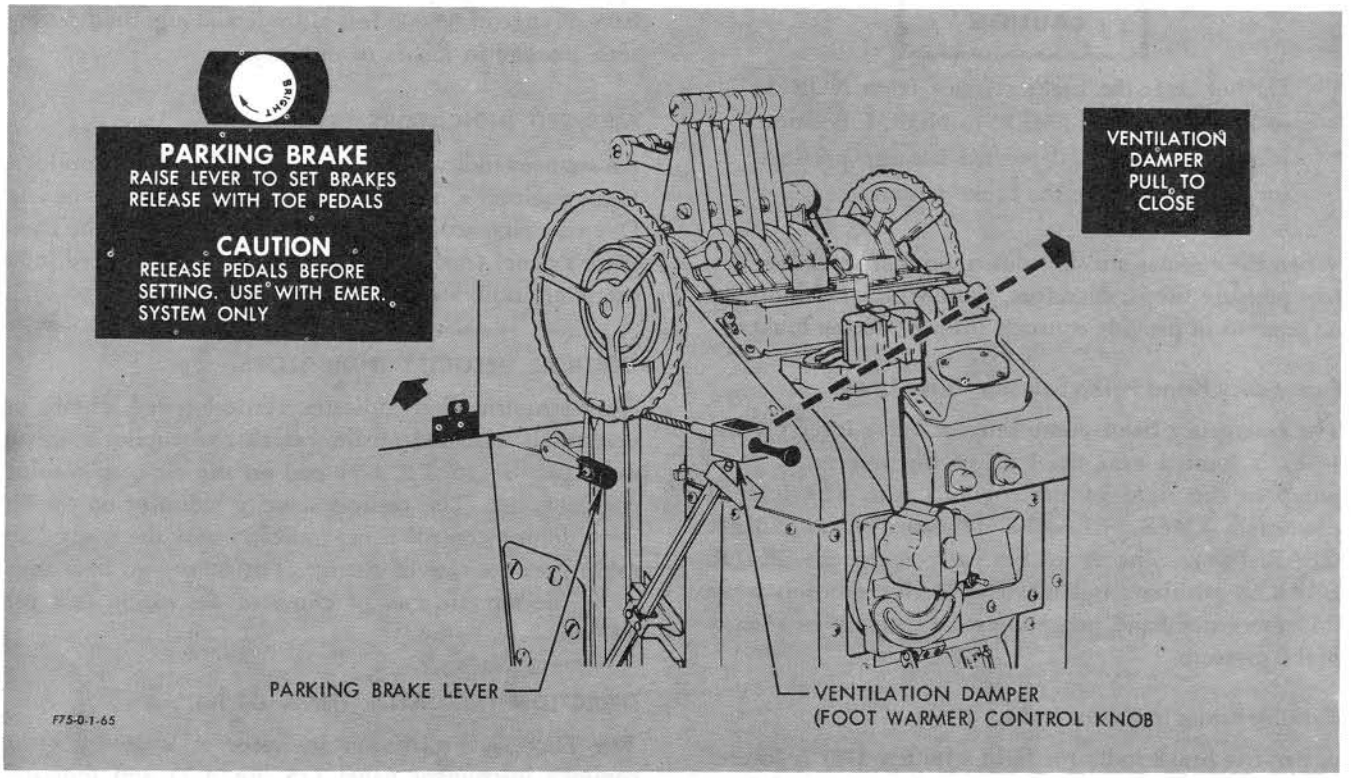

Figure 1-40. Parking Brake Lever and Ventilation Damper

sources fail, hydraulic pressure to operate the brakes can be built up with the emergency hand pump with the brake selector in the EMER position. In this configuration, pressure from the emergency hand pump is directed to the brakes through the emergency brake system valving and plumbing. This procedure should be used as a last resort because of the time required to build up pressure manually.

Brake Pedals.

The brakes are controlled by the toe portion of the rudder pedals, which are connected to the brake control valves. The pilot's and copilot's brake pedals are interconnected by cables. Slack take-up springs are installed on each cable to take up the slack when the brake pedals are applied. The linkage is so arranged that the toe pedals can be depressed 5° before pressure is fed to the brakes. As the pedals are depressed beyond 5°, the pressure increases. The rudder pedals are hinged, and geometry of the linkage is such that pedal movement for rudder control does not actuate the brake valve unless the pedals are tilted forward by toe pressure.

Parking Brake Handle.

There are two parking brake handles, (fig. 1-40) one on each side of the center control stand. They are both connected to a lever at the rear of the control stand. With the parking brake handle in the lowered position, the parking brake is off. When raised after the toe pedals have been depressed, the mechanical linkage holds the brake valves in the open position. The parking brakes are released by depressing the toe pedals.

Brake Selector Valve Lever.

The brake selector valve lever (21, fig. 1-11) is located on the aft face of the center control stand and has two positions, NORM. (down) and EMER. (up). The lever is mechanically connected to the brake selector valve which directs hydraulic pressure through the normal or emergency hydraulic brake lines. When the lever is in the NORM. position and the brake pedals are depressed, secondary hydraulic system pressure is directed to the normal brake lines. When the lever is placed in the EMER. position while secondary hydraulic system pressure is available, the brake accumulators are charged and hydraulic fluid flows through the emergency brake lines. If secondary hydraulic system pressure is not available, the hydraulic power necessary to operate the brakes is provided by the charged brake accumulators or by operating the emergency hand pump (which charges the brake accumulators when the brake selector lever is in the EMER. position).

CAUTION

Do not shift the brake selector from NORM. to EMER. or from EMER. to NORM. position with brake pedals depressed because pressure surges may damage the brake system.

When the engines are shut down, normal secondary system pressure drops; therefore, the EMER. position must be selected to provide constant pressure to the brakes.

Emergency Hand Pump Selector Valve Lever.

The emergency hand pump selector valve lever (3, fig. 1-31) is located near the base of the emergency hand pump to the right of the copilot's seat. The lever is placarded EMER. BRAKES (forward) and EMER. GEAR (aft). The lever normally is in the EMER. BRAKES position, and must be in this position when the emergency hand pump is used to supply emergency brake pressure.

Parking Brake Indicator Light.

A parking brake indicator light (36, fig. 1-7) is located on the pilot's instrument panel and is operated by a microswitch that is actuated by the parking brake lever.

CAUTION

The parking brake warning light merely indicates that the parking brake handle is raised and does not indicate that the brakes are locked sufficiently to keep the aircraft from rolling.

Emergency Brake Pressure Indicator.

The emergency brake pressure indicator (23, fig. 1-7) is located on the copilot's auxiliary instrument panel. The indicator is a direct pressure instrument calibrated in psi and actuated by hydraulic pressure in the lines near the brake accumulators.

INSTRUMENTS.

Instruments are grouped on the pilot's, flight engineer's, and the navigator's instrument panels and on the air conditioning control panel. The instruments that are not discussed in the following paragraphs are those that are a part of a complete system and are discussed with the appropriate system.

ALTIMETERS.

Five sensitive altimeters are mounted in the aircraft. One is located on the air conditioning control panel and one is installed in the pilot's, co-pilot's, flight engineer's upper and navigator's instrument panels. The altimeters have a range of 50,000 feet altitude and a ground setting scale marked in inches of mercury.

AIRSPEED INDICATORS.

An airspeed indicator is mounted on the pilot's, copilot's, flight engineer's, navigator's and senior director's panels. One true airspeed indicator also is mounted on the navigator's panel (not normally visible). The airspeed indicators are calibrated in knots.

VERTICAL VELOCITY INDICATORS.

An instrument that indicates vertical speed, climb, or descent, is mounted on the pilot's and copilot's instrument panels (26, fig. 1-7) and on the air conditioning control panel. The vertical velocity indicator on the air conditioning control panel indicates only the equivalent cabin pressure rate of change. The other two indicators show the aircraft rate of climb or descent in feet per minute.

DIRECTION INDICATOR (FLUX GATE).

The Flux Gate direction indicator is located on the copilot's instrument panel (15, fig. 1-7) and indicates the magnetic heading of the aircraft. The azimuth dial is directly connected through gears and linkage to an induction motor which operates both directionally and proportionally to changes of the magnetic heading of the aircraft. The gyro Flux Gate transmitter, mounted in the left outer wing, senses the aircraft heading changes, because of its change of position in the earth's magnetic field, and transmits an electrical signal to the Flux Gate direction indicator. The sensing signal of the Flux Gate transmitter also originates a course signal impulse for the automatic pilot control. (Refer to Automatic Pilot Controls, Section IV.) Power for operation of the Flux Gate direction indicator system is supplied by the aircraft a.c. and d.c. electrical systems.

ATTITUDE INDICATOR.

An attitude indicator (7, fig. 1-7), powered by alternating current, is mounted on the pilot's and copilot's instrument panels. Each indicator is an electrically driven vertical seeking gyro, coupled with a bank marker, and a horizontal reference bar. A knob on the instrument provides adjustment of the horizontal reference bar to correspond to different pitch attitudes. Quick erection of the gyro is accomplished in this indicator by means of a mechanical caging device. The gyro must be caged immediately after power is applied to the indicator by pulling out the caging knob on the front bezel. The knob should be held in the extended position until the horizontal bar and the bank index cease to oscillate, at which time they should indicate zero roll

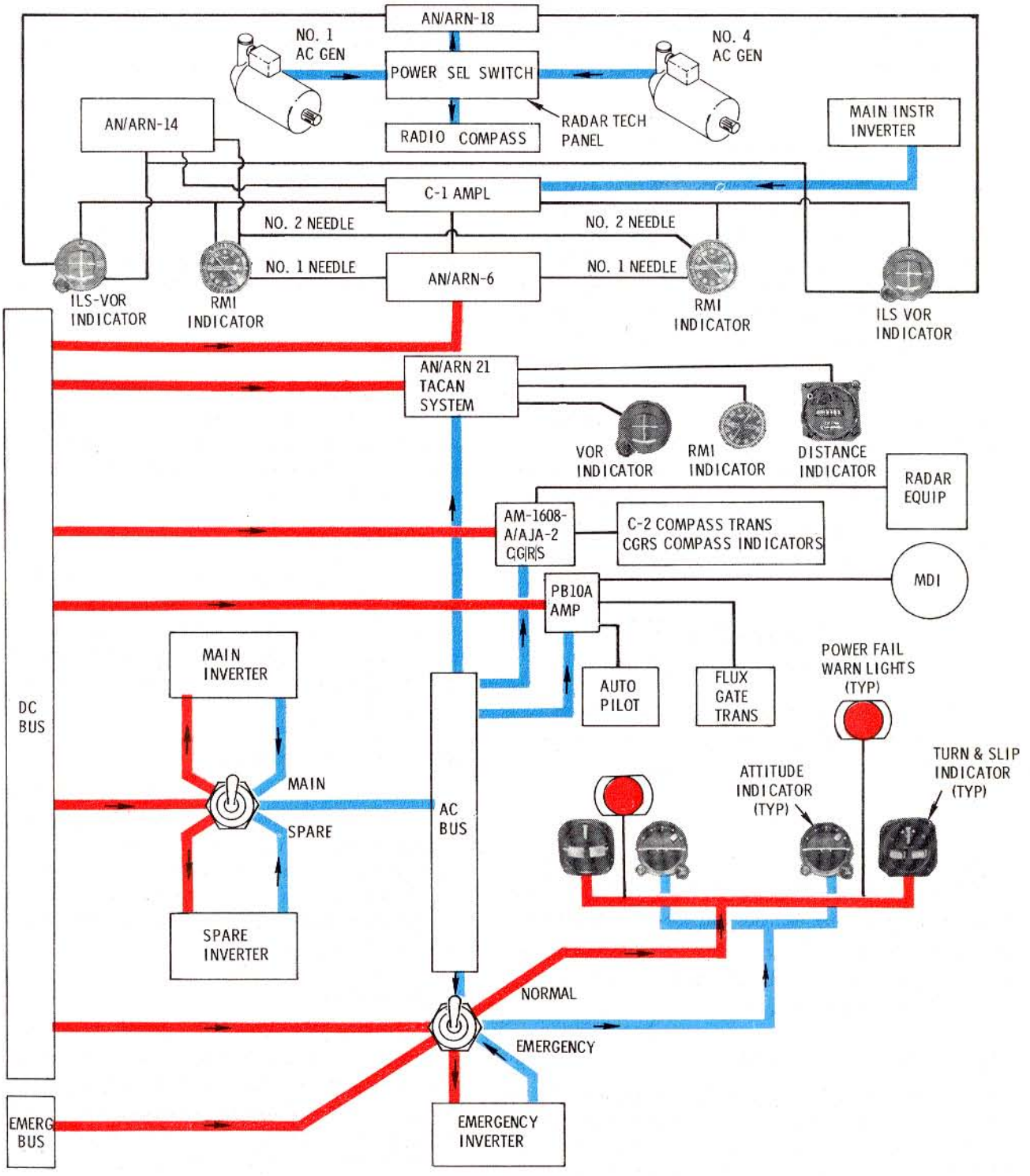

Figure 1-41. Flight Instrument Electrical Power System

and pitch within approximately three degrees. The caging time will depend upon the position of the gyro; however, the longest time will be approximately ten seconds. Instantaneous erection may be obtained by holding the caging knob in the extended position when the power is turned on.

WARNING

Since the caging device cages the gyro to the true attitude of the aircraft and not to the true vertical, the indicator should not be caged in flight unless the aircraft is known to be in straight and level flight during the caging procedure. Before take-off erect gyro in the right side up position.

The indicator is equipped with a power warning flag that is visible whenever the power supply is shut-off, whenever there is an improper-phase rotation, or whenever there is an open or short circuit in the instrument. The flag will disappear under normal circumstances, indicating that the power supply is on and is satisfactory.

WARNING

The pilot should not rely upon the indicator for flight indications if the power warning flag is visible in the face of the instrument.

TURN & SLIP INDICATOR.

A turn and slip indicator (29, fig. 1-7) is mounted on the pilot's and copilot's instrument panels. The indicators are powered by d.c. current. Power failure warning lights (28, fig. 1-7), that glow red when the electrical power is interrupted, are installed on the pilot's and copilot's instrument panels.

CGRS COMPASS INDICATOR.

There are three CGRS compass indicators installed in the aircraft. They are located, one on the pilot's instrument panel, (5, fig. 1-7) one on the navigator's intsrument panel and one on the senior director's instrument panel. The CGRS compass indicator indicates the magnetic heading of the aircraft. It has a dial face calibrated from zero to 360 degrees. The dial face is set by a knob on the indicator. It has a single centrally pivoted pointer, and is actuated by electrical signals from the CGRS system.

COMPASS (STANDBY).

The standby compass is mounted above the center windshield panel. It contains a graduated card that reads in degrees and indicates the direction of flight with reference to magnetic north. A compass correction card is mounted on the pilot's and copilot's auxiliary instrument panels and each card shows compass deviation corrections.

FREE AIR TEMPERATURE INDICATOR.

An air temperature indicator is mounted on the pilot's, flight engineer's upper and the navigator's instrument panels. The indicators are energized by d.c. electrical resistance bulbs located in the right side of the nose wheel well.

CLOCKS.

Eight-day clocks with sweep second hands are installed on the pilot's, copilot's, flight engineer's, senior director's, navigator's and radio operator's panels. In addition, the pilot's and senior director's panels are provided with elapsed time clocks.

INCLINOMETERS.

Three inclinometers are installed, one on the flight engineer's lower instrument panel (1, fig. 1-15), one on the radar technicians panel, and one at the height finders station. The instruments are ball-bank type and indicate the pitch attitude of the aircraft about the lateral axis.

PITOT-STATIC SYSTEM.

The pitot-static system includes the pitot system through which impact air pressure is transmitted to the airspeed indicators and the static system through which outside static air pressure is transmitted to the altimeters, airspeed indicators, vertical speed indicators, cabin differential pressure indicator, and altitude control of the automatic pilot. (Figure 1-42).

PITOT SYSTEM.

Two separate pitot systems are provided, each of which includes a total head installed on the lower fuselage nose. The left total head supplies impact air pressure for the pilot's and navigator's airspeed indicators, and the right total head supplies impact air pressure for the copilot's and the flight engineer's airspeed indicators.

STATIC SYSTEM.

Flush-type static openings on each side of the fuselage nose are the source of static air pressure. Two separate systems, first static and second static, are installed to provide separate and alternate static selection to both

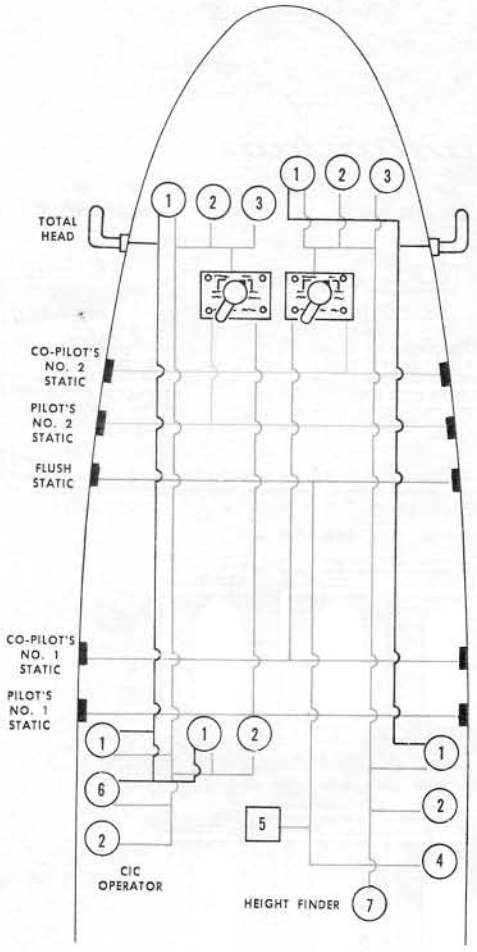

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Figure 1-42. Pitot Static System

the pilot and copilot in an emergency. The selection of either system is controlled by the static selector valves (27, fig. 1-7) on the pilot's and copilot's instrument panels. Two separate sources are available to either the pilot's or copilot's instruments.

EMERGENCY EQUIPMENT.

The following equipment consists of fixed systems and loose equipment that contribute to safety of flight.

EMERGENCY SHUT-OFF LEVERS.

Four emergency shut-off levers are located on the control quadrant aft of the pilot's overhead panel. These levers actuate valves that shut off hydraulic oil, fuel, generator blast air, and lubricating oil to the engines. Each lever has four notched positions on the control quadrant. The full forward position is ALL ON; the next position shuts off hydraulic oil; the third position shuts off fuel and generator blast air; the last and full aft position shuts off engine oil. However, oil is still available for feathering the propeller. These levers mechanically operate cam arrangements through cable and pulley systems, which in turn actuate the hydraulic, fuel, and oil shut-off valves. As the lever enter the third position on the quadrant, it trips a switch that energizes a small d.c. electrical actuator, mounted on the aft face of the firewall, that shuts off the blast air.

FIRE DETECTION SYSTEM.

Heat-sensitive fire detector switches are installed in each zone of all engine nacelles and in each cabin heater compartment. These switches close and complete the electric circuits to the fire warning buzzer if the temperature in any of these areas rises to the setting of the switches. The switches in zone 1 are set at approximately 316° C and all other switches are set at approximately 232° C. They reset themselves automatically after cooling below this temperature. Each circuit is a double loop with two-wire (ungrounded) detectors in parallel between the loops. There is one circuit for zone 1 and one circuit for zones 2 and 3 of each nacelle. There is also one circuit for each cabin heater installation. A resistor is connected in parallel with each individual area warning light and master relay coil, so that the system will not be rendered inoperative by a defective bulb or a master relay coil open circuit. If a short to ground occurs any place in the fire warning system, the circuit breaker will trip to prevent any false warning and neither the warning lights nor the warning buzzer will operate. A short circuit within the detector switches will activate both buzzer and lights. There is one test switch for each nacelle and one for both of the heaters. These switches break both loops and connect them in series around the fire detector switches.

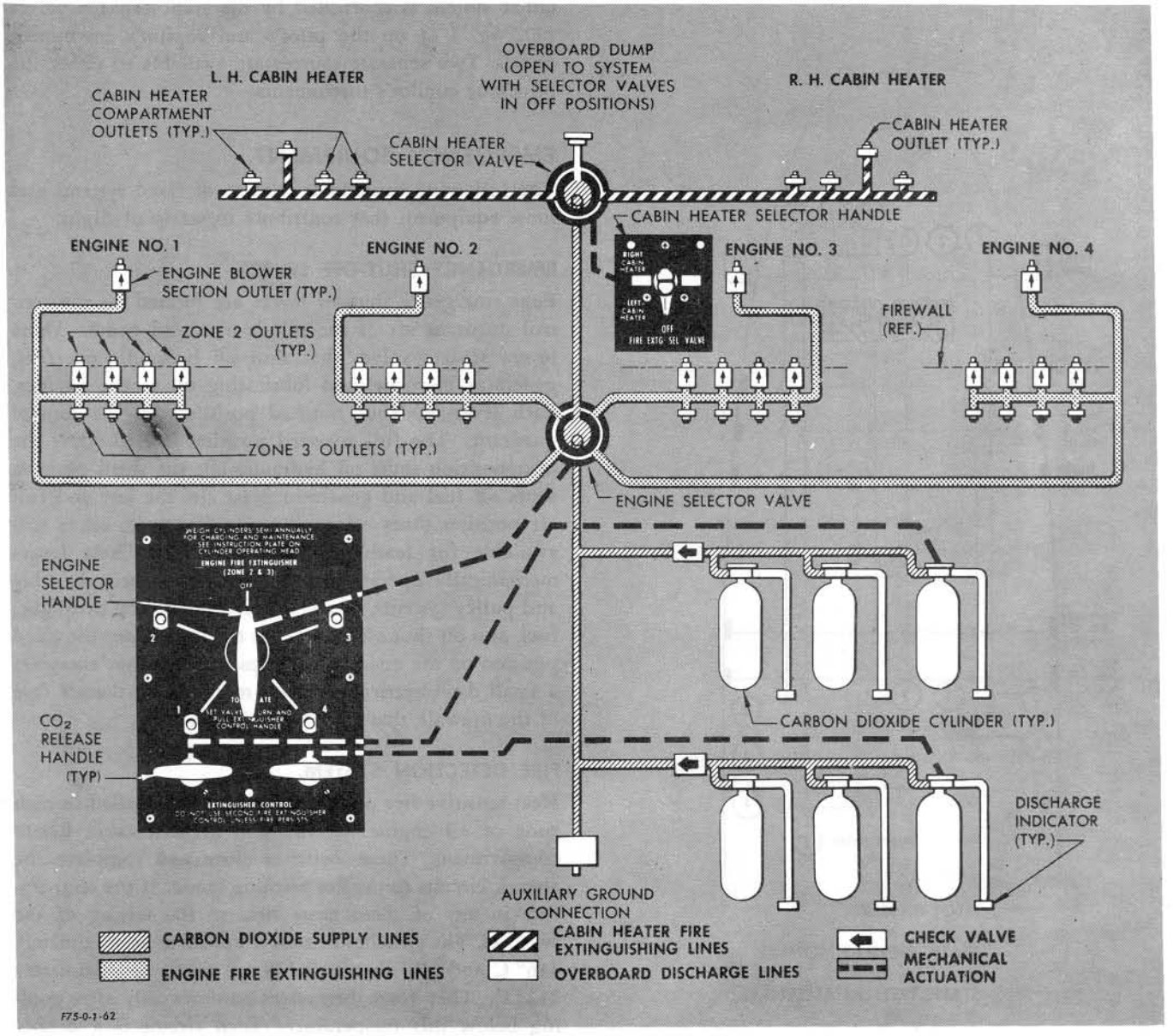

Figure 1-43. Fire Extinguishing System (CO_2) (USAF Serials 52-3411 through 52-3425)

Master Fire Warning Lights and Buzzer.

A master fire warning light is located in the top center of the pilot's instrument panel (12, fig. 1-7) and on the flight engineer's lower instrument panel (22, fig. 1-15). The fire warning buzzer is located on the bulkhead behind the copilot's seat. These lights and the buzzer are energized simultaneously by the d.c. electrical system and actuated when one or more fire detector switches close. Each warning light can be tested by pressing its cap.

Individual Area Fire Warning Lights.

Zone 2 and 3 fire warning lights (d.c. operated) are located adjacent to the engine fire extinguisher selector handle on the station 20 bulkhead. Zone 1 engine fire warning lights are located on the station 260 circuit breaker panel. Fire warning lights for the left and right cabin heater compartments are located adjacent to the cabin heater fire extinguisher selector handle near the floor on the station 260 bulkhead. Each of the warning lights may be pressed to test. The master warning lights on the flight engineer's lower instrument panel and on the pilot's center instrument panel will glow, and the fire warning buzzer will sound whenever one or more of the area warning lights are energized, either for test or by fire.

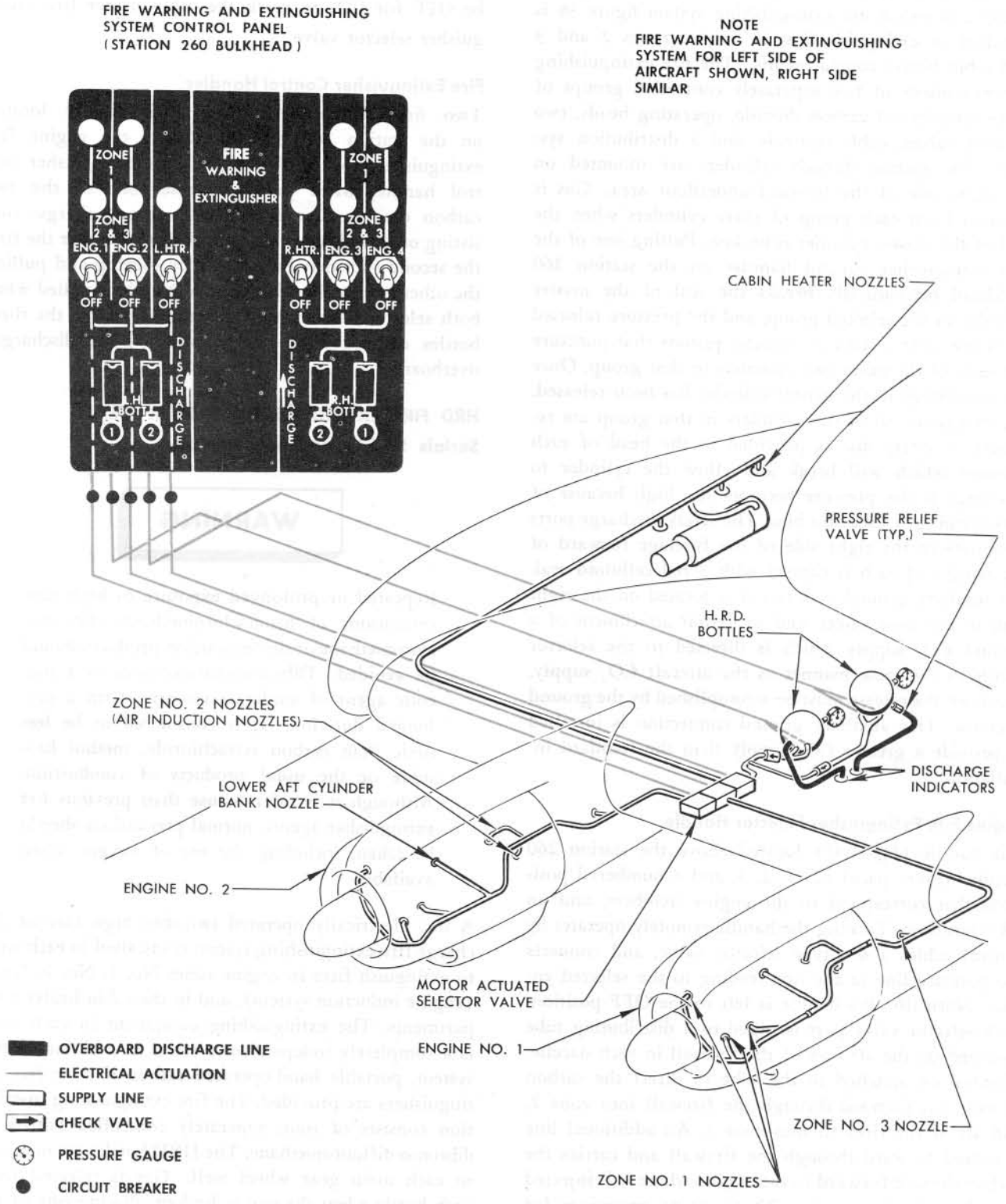

Figure 1-44. Fire Extinguishing System (HRD) (USAF Serials 53-533 and Subsequent)

FIRE EXTINGUISHING SYSTEM (CO_2).

(USAF Serials 52-3411 through 52-3425)

On early aircraft (USAF Serials 52-3411 through 52-3425) a two-shot fire extinguishing system figure 38 is installed to extinguish fires in engine zones 2 and 3 and cabin heater compartments. The fire extinguishing system consists of two separately controlled groups of three cylinders of carbon dioxide, operating heads, two selector valves, cable controls, and a distribution system. The carbon dioxide cylinders are mounted on the right side of the forward underfloor area. Gas is released from each group of three cylinders when the seal of the master cylinder is broken. Pulling one of the fire extinguisher control handles on the station 260 bulkhead mechanically breaks the seal of the master cylinder in the selected group, and the pressure released from the master cylinder actuates pistons that puncture the seals of the other two cylinders in that group. Once the gas charge in the master cylinder has been released, the charges in all of the cylinders in that group are released. A safety disc is provided in the head of each cylinder which will break and allow the cylinder to discharge if the pressure becomes too high because of overcharging or excessive heat. The safety discharge ports terminate in the right side of the fuselage forward of the wing and each is capped with a red celluloid seal. An auxiliary ground connection is located on the right wall of the nose wheel well to permit attachment of a ground CO_2 supply which is directed to the selector valves in the same manner as the aircraft CO_2 supply. However, the release must be accomplished by the ground operator. This auxiliary ground connection is installed to provide a greater CO_2 supply than the standard installation.

Engine Fire Extinguisher Selector Handle.

The handle (fig. 1-43) located above the station 260 circuit breaker panel has 1, 2, 3, and 4 numbered positions that correspond to the engine numbers, and an OFF position. Turning the handle remotely operates by control cables a disc-type selector valve, and connects the pressure line to the line leading to the selected engine. Normally, the handle is left in the OFF position. Each selector valve port is piped to a distributing tube mounted on the aft face of the firewall in each nacelle. Nozzles are attached to the tube to direct the carbon dioxide gas forward through the firewall into zone 2, and aft of the firewall into zone 3. An additional line is routed forward through the firewall and carries the carbon dioxide forward to the engine where it is injected into the induction section. There are no provisions for releasing carbon dioxide into zone 1.

Cabin Heater Fire Extinguisher Selector Handle.

The handle, located on the station 260 bulkhead near the floor, has the following three positions: LEFT CABIN HEATER, RIGHT CABIN HEATER, and OFF. The engine fire extinguisher selector handle must be OFF for CO_2 to reach the cabin heater fire extinguisher selector valve.

Fire Extinguisher Control Handles.

Two fire extinguisher control handles are located on the station 260 bulkhead below the engine fire extinguisher selector handle. Each fire extinguisher control handle, when pulled, releases one of the two carbon dioxide charges available. If one charge, consisting of three bottles, is insufficient to smother the fire, the second shot may be released by turning and pulling the other handle. If either control handle is pulled when both selector handles are OFF, the CO_2 from the three bottles controlled by that handle will be discharged overboard.

HRD FIRE EXTINGUISHING SYSTEM (USAF Serials 53-533 and Subsequent).

WARNING

Repeated or prolonged exposure to high concentrations of bromocloromethane, dibromocloromethane or decomposition products should be avoided. Dibromo-cloromethane is a narcotic agent of moderate intensity with a prolonged duration. It is considered to be less toxic than carbon tetrachloride, methol bromide or the usual products of combustion. Although it is safer to use than previous fire extinguisher agents, normal precautions should be taken, including the use of oxygen when available.

A d.c. electrically operated two-shot high rate of discharge fire extinguishing system is installed in each wing to extinguish fires in engine zones No. 1, No. 2, No. 3 (engine induction system), and in the cabin heater compartments. The extinguishing equipment in each wing is a completely independent system. In addition to this system, portable hand-operated carbon dioxide fire extinguishers are provided. The fire extinguishing installation consists of four, separately controlled bottles of dibromo-difluoromethane. The HRD bottles are mounted in each main gear wheel well. Gas is released from each bottle when the seal is broken. Placing one of the guarded discharge switches located on the station 260 bulkhead in the UP position electrically breaks the seal in the selected bottle. The selector switches provide independent selection of each engine and each cabin

heater. Electric power for this system comes from the emergency d.c. bus and is then routed through the fire extinguisher circuit breaker panel located on the lower part of the 260 bulkhead.

Safety Valves.

A safety valve is provided in each bottle which will break and allow the bottle to discharge overboard if the pressure becomes too high because of overcharging or excessive heat. Two safety discharge ports terminate on the aft outboard side of each inboard nacelle, and each is capped with a red celluloid seal. If the bottle discharges the seal will break. A broken seal indicates that the system should be checked, the trouble corrected and the bottle replaced. Auxiliary ground connections that permit refilling of bottles are not provided in this system. Empty bottles are to be replaced with pre-filled bottles.

Engine Fire Extinguisher Selector Switches (HRD).

The selector switches (fig. 1-44); located above the station 260 upper switch panel, are numbered ENG. 1, ENG. 2, ENG. 3, ENG. 4, representing the ON position. Each selector switch has an OFF position. Lifting the selector switches operates a remote, d.c. electric-motor-driven selector valve which connects the pressure line to the line leading to the selected engine. Normally, the switch is left in the OFF position. Each selector valve port is piped to a distributing tube routed to each engine. Nozzles are attached to the tubes to direct the agent simultaneously to zones No. 1, No. 2, and No. 3. Warning lights are located above the selector switches for the purpose of indicating fire in a particular engine and engine zone.

Cabin Heater Fire Extinguisher Selector Switch.

Two cabin heater fire extinguisher selector switches are mounted on the same panel with the engine selector switches, and have the following positions: L. HTR., R. HTR., and OFF. Warning lights are d.c. operated located above each switch for the purpose of indicating fire in each heater compartment.

Fire Extinguisher Control Switches.

Four, momentary-contact fire extinguisher control or discharge switches are located beneath the selector switches. Each discharge switch releases one bottle when the guard is raised and the switch turned on. If one charge, consisting of one bottle, is insufficient to smother the fire, the second bottle may be released by actuating the second guarded switch.

Individual Area Fire Warning Lights (HRD).

Fire warning lights (fig. 1-44) for each nacelle are d.c. operated and cabin heater are located on the fire extinguisher electric control switch panel mounted on the station 260 bulkhead. These warning lights are arranged to indicate the presence of fire in each engine zone, 1, or 2 and 3, and each cabin heater. Each warning light may be pressed to test. The master warning lights on the flight engineer's lower instrument panel and on the pilot's center instrument panel will glow, and the fire warning buzzer will sound whenever one or more of the area warning lights is energized, either for test or by fire.

MISCELLANEOUS EMERGENCY EQUIPMENT.

CARBON DIOXIDE HAND EXTINGUISHERS.

Seven A-20 type hand fire extinguishers are provided; one is clamped in supports on the left sidewall forward of the radio rack in the flight station, two are clamped to the aft face of the partition opposite the galley, and one is clamped to the technician's table. Three extinguishers are located in the under floor area and are accessible through floor hatches. Refer to Fig. 3-1.

FIREMANS AXES.

Three firemans axes are provided, one on the aft side of the radio rack partition, one on the aft face of the partition opposite the galley and one on the forward face of the technician's bench.

EMERGENCY LIGHTS.

Three dry-battery operated emergency lights, with integral switches, are installed in swivel bases. One is located on the ceiling of the flight station, and the other two are located on the cabin overhead duct opposite the forward and the aft cabin doors. These lights may be used to illuminate the doors or escape areas during an emergency.

FLASHLIGHTS.

Two flashlights, equipped with dry batteries, are installed in the aircraft. One is clipped under the front edge of the copilot's seat, and the other is clipped to the nose wheel steering column.

PARACHUTES.

Provisions for stowing 32 chest pack parachutes are provided in the main cabin.

LADDER AND ESCAPE ROPES.

One telescoping metal ladder is installed on the left side at the aft personnel door.

CAUTION

When the ladder is extended for use, be certain to check that the latching lugs are in place.

Four escape ropes are installed as follows: One over the

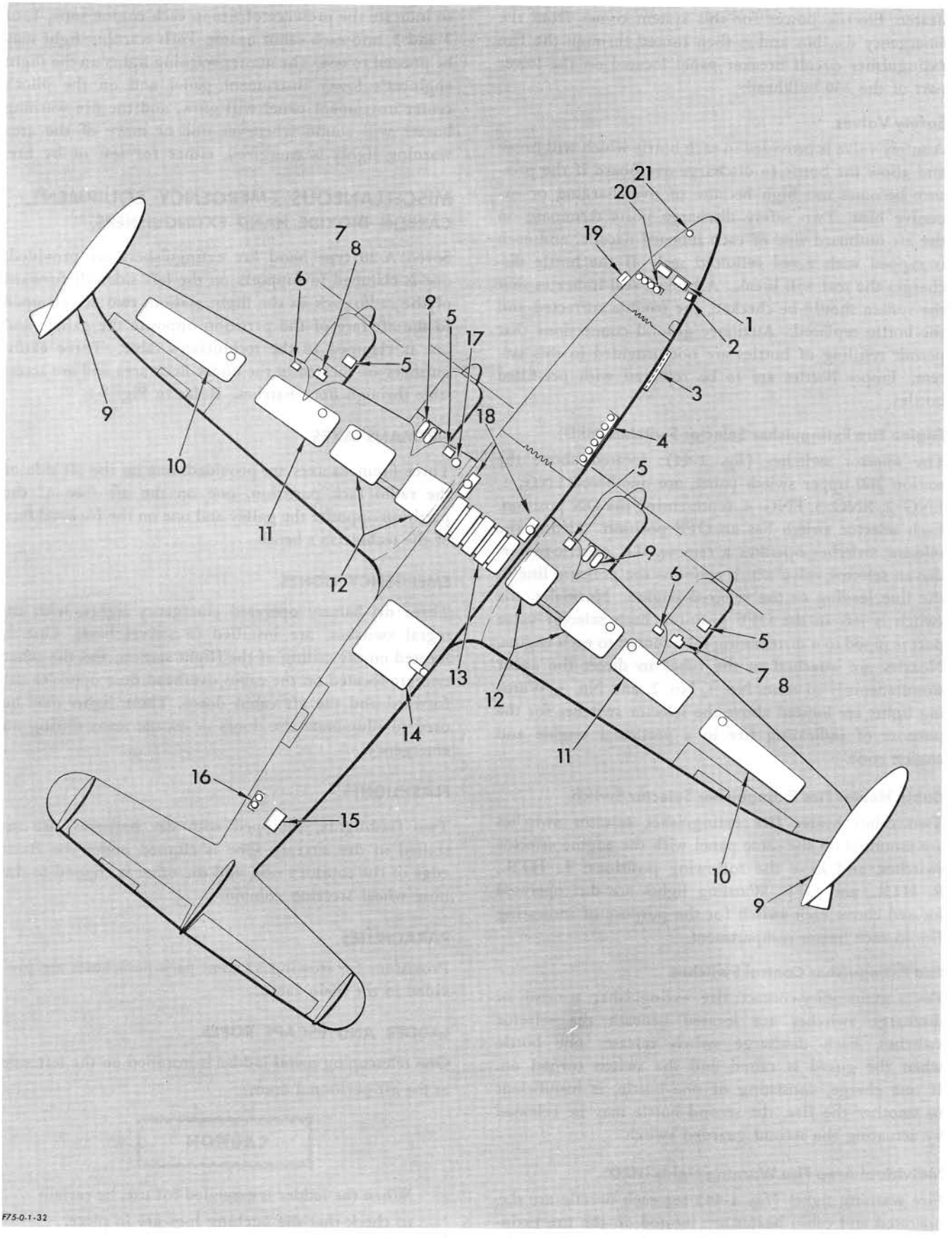

Figure 1-45. Servicing Diagram (Sheet 1 of 2)

REF	PART	NO. OF POINTS	REPLENISH WITH	REF	PART	NO. OF POINTS	REPLENISH WITH
1	Batteries	2	Distilled water	12	Fuel tanks 2 and 3	1 each	Grade 115/145* MIL-F-5572
2	Oxygen filler valve	1		13	Fuel tank No. 5	1	Grade 115/145* MIL-F-5572
3	Indicators, CO_2 overboard safety discharge	6	Celluloid seal	14	Fuel tank 6	1	Grade 115/145* MIL-F-5572
4	CO_2 cylinders, fixed fire extinguishing system	6	Carbon dioxide	15	Water tank	2	Water
5	Engine oil tanks	4	Grade 1100 (Above 35°F) MIL 6082	16	Flares	2	Aluminum seal
6	De-icing fluid tank	2	MIL-A-6091	17	Main Hydraulic reservoir	1	MIL-O-5606
7	Cabin supercharger oil tank	2	Aeroshell 1 AC	18	Reserve engine oil tank	2 each	Grade 1100 MIL 6082
8	Cabin supercharger drive shaft disconnect housing	2	Aeroshell 1 AC (or SAE 10W)	19	Indicator, oxygen overboard discharge	1	
9	Fuel tanks 2B and 3B	1 each	Grade 115/145* MIL-F-5572	20	Oxygen system supply cylinders	4	Oxygen BB-O-925
10	Fuel tanks 2A and 3A	1 each	Grade 115/145* MIL-F-5572	21	Emergency hydraulic reservoir	1	MIL-O-5606 (AN-O-366)
11	Fuel tanks 1 and 4	1 each	Grade 115/145* MIL-F-5572	22	HRD system		

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*Grade 100/130 fuel may be used as an alternate

Figure 1-45. Servicing Diagram (Sheet 2 of 2)

upper station 260 switch panel, one over each emergency exit window, and one over the forward dege of the aft personnel door. (Refer to emergency equipment diagram, figure 3-1).

DITCHING PANELS.

Ditching panels of metal-faced honeycomb construction are provided for eleven crew members at the following positions: aft face of the vertical plotting board table (two persons), aft face of the ACO Nos. 1, 2, and 4 consoles (two persons each), aft end of the three-tier fixed bunk and aft of the tables and benches in the aft crew quarters. (For other ditching stations, refer to Section III).

FIRST AID KITS.

Two first aid kits are located as follows: one on the flight station left sidewall forward of the radio rack, and one on the aft face of the partition forward of the radio operation's station.

LIFE RAFTS.

Two 20-man life rafts are installed, one in each inner wing panel aft of the inboard engine nacelles. On USAF Serials 52-3411 through 53-542, two release handles are located in the flight station step. On USAF Serials 53-542 and subsequent, the release handles are located in the overwing emergency exits. When these handles are pulled, the life rafts are released from the wing compartments and are automatically inflated.

Life Raft Radio Transmitter.

One life raft radio transmitter (AN/CRT-3) is located on the floor beneath the right side emergency exit window. Provisions are made for stowing a second transmitter at the aft entrance cabin door.

EMERGENCY ALARM BELL AND COMMAND BELL SWITCH.

Two emergency alarm bells are installed, one on the forward AOC compartment bulkhead and one on the aft AOC compartment ceiling near the aft cabin door. The command bell switch is located on the pilots overhead switch panel and is guarded in the open position. When the guard is raised and the switch is closed, the command bells sound a warning. The electrical circuit is energized by the emergency d.c. bus.

SURVIVAL EQUIPMENT.

A total of 22 survival equipment containers are installed, one at each personnel station.

PYROTECHNIC EQUIPMENT.

A pyrotechnic pistol and a container for carrying twelve rounds of ammunition are clipped to the partition forward of the radio operator's station. A pressure trap mount is provided for firing the pyrotechnic pistol during pressurized flight and is located in the ceiling of the fuselage aft of the navigator's station.

Flares.

Two flares are installed in separate chutes located in the aft fuselage aft of the pressure bulkhead. Each flare is provided with a parachute which allows it to descend at the rate of approximately 360 feet per minute. Burning time of the flare is approximately three minutes and the light output is 300,000 to 400,000 candlepower. The release and triggering provisions consist of release switches, cover latch, lanyard and d.c. operated solenoids. When the release switches are actuated, the solenoid triggers the latch and the flare drops through the flare chute.

Note

The cover plate is a thin sheet of aluminum alloy and is pushed out by the weight of the falling flare.

The flare will not ignite, nor will the parachute be ejected if the release switch is inadvertently closed when the aircraft is on the ground, because the lanyard is long enough to permit the flare to drop to the ground without tripping the parachute release and flare ignition mechanism. In flight the flare falls a considerable distance below the aircraft before the parachute is ejected and the flare is ignited.

FLARE RELEASE SWITCHES. Flare release switches are located near the top and aft end of the pilot's side panel (1, fig. 1-9). Guards cover the flare release switches and are safetied in the closed position. The circuit breaker is located on the station 238 circuit breaker panel.

Note

Flares should be released at or near approach speeds to provide an advantage of illumination time.

ENTRANCE DOORS.

CREW DOOR.

The crew door is located on the right side forward of station 260. The door is opened from the outside by turning the exterior latch handle and pushing inward, then lifting upward. The door is opened from the inside by turning the interior latch handle, and pulling the door inwards then lifting upward. (Refer to Section IV for the rear entrance door).

CREW SEATS.

PILOTS SEATS.

The pilot's and copilot's seats are track-mounted to provide fore-and-aft positioning. They have tilting backs, and are adjustable for height. Each seat is equipped with folding arm rests, a removable head rest and a shoulder harness connected to an inertia reel. The inertia reels are mounted on the backs of the seats.

Pilots Seat Controls.

Levers for tilting the backs and for adjusting the height of the pilot's seats are located on the outboard side of each seat. The handles for releasing the seats for fore-and-aft movement and for locking them in position are located on the inboard sides near the floor. Height adjustment is accomplished by overcoming the up-spring action when the control lever is lifted to release the position lock. The inertia reel control lever is located on the inboard side of each seat near the forward end of the cushion. It has detents in two positions; LOCKED and UNLOCKED. In the LOCKED position, the inertia reel holds the shoulder harness so that the pilot cannot lean forward. In the UNLOCKED position the harness will not restrict movement but is set for inertia action. When set for inertia action, the reel automatically restrains the shoulder harness when the aircraft encounters an impact force of from 2 to 3 G's. When the reel is locked by impact force it must be released by moving the control lever to the LOCKED position, then to the UNLOCKED position.

FLIGHT ENGINEERS CHAIR.

The flight engineer's chair is mounted on a track and arranged to swivel and lock in the aft facing position. Vertical and tilting adjustments are not provided. A special removable ditching headrest is provided.

SAFETY BELTS.

Lap type safety belts are provided for all crew seats, seat-bunks, and fixed bunks. Fittings are installed to permit the seat-bunk belts to be used as bunk safety belts.

AUXILIARY EQUIPMENT.

Auxiliary equipment, such as the air conditioning, communication, electronic, lighting, oxygen, automatic pilot, and navigation are discussed in Section IV of this handbook.

Last Page of Section I.

SECTION II NORMAL OPERATING PROCEDURES

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PREPARATION FOR FLIGHT.

A check should be made of the take-off and anticipated landing gross weights, and that the grades and weight of fuel, oil, and special equipment carried is suited to the mission to be performed.

FLIGHT RESTRICTIONS.

Refer to Section V for the information concerning Operating Limitations.

FLIGHT PLANNING.

Flight Planning and cruise control information for the complete flight regime is presented in Appendix I. It is recommended that operational charts be prepared from this basic information, favoring reduced power operation whenever possible. Use a Power Schedule derived from the Long Range Cruise Performance Charts, reducing power for every 3000 lbs. reduction in airplane gross weight, whenever practical.

WEIGHT AND BALANCE.

It is the responsibility of the pilot in command to ascertain that the aircraft is properly loaded and balanced and that center of gravity limits are not exceeded. To obtain further loading information, refer to the Operating Limitations in Section V and to the Handbook of Weight and Balance, AN 01-1B-40. A balance computer is supplied which is to be used in conjunction with the weight handbook for computing proper loadings. Be certain that the basic weight being used applies to the aircraft assigned for the flight. It is possible that the aircraft has undergone modifications that may affect the basic weight.

CREW ENTRANCE.

Crew entrance normally is gained through the rear cabin door.

BEFORE INTERIOR INSPECTION.

Check the DD Form 871 for status of the aircraft. It will be the responsibility of the pilot to conduct an exterior visual inspection as outlined (see figure 2-1 for recommended inspection route), and to insure that a PREFLIGHT or THRU FLIGHT inspection as required by the *Handbook of Inspection Requirements, T. O. 1C-121D-6,* has been performed. It also will be the responsibility of the pilot to insure that each crew member has accomplished his individual inspection requirement as outlined in Section II and Section VIII of this handbook.

Note

The air crew visual inspection procedures outlined in this section are predicated on the assumption that maintenance personnel have completed all of the requirements of the *Handbook of Inspection Requirements, T. O. 1C-121D-6,* for PREFLIGHT or THRU FLIGHT; therefore, duplicate inspections and operational checks of systems by air crew members have been eliminated, except for certain items required in the interest of FLYING SAFETY.

Prior to the INTERIOR INSPECTION, the pilot will make a cursory visual inspection to determine that the area is free of obstructions, that the gear pin flags are displayed, and that the wheel chocks are in place. The flight engineer will check the operation of the alarm bell with the ground power OFF. The ground power switch should be returned to the external source after this check.

INTERIOR INSPECTION BY PILOT.

The interior aircraft inspection should be conducted at each crew position as assigned by the pilot and in accordance with the following items.

PILOT POSITION.

1. DD Form 781—check for discrepancies. Sign exceptional release, if required.
2. Landing gear lever—DOWN.

3. Brake selector lever—EMER.
4. Trim tabs—checked and set to zero.
5. Emergency brake pressure gage—check.
6. Parking brake—set.

Note

If necessary, raise pressure with hand pump until parking brake can be set.

7. Ignition switches—OFF.
8. Seat, safety belt, rudder pedals—adjusted.
9. Windshield and side windows—check for cracks, discoloration, and crazing.
10. Oxygen mask and flow—check.
11. De-icer boot cycle selector switch—OFF.
12. De-icer air pump selector switches—VAC.
13. Windshield wipers—check operation, then OFF.
14. Flare switches—safetied.
15. Warning and indicator lights—push-to-test.
16. Pressure altimeter—set.
17. Static selector—No. 1 static.
18. Elevator booster shift lever—check OFF, then set to ON.
19. Aileron and rudder booster levers—check OFF, then set to ON.
20. Flight path control switches—OFF.
21. Auto pilot servo disconnect levers—OFF.
22. Auxiliary booster switches—check elevator and rudder operation in ON position—check operation in EMER. position with circuit breakers OFF—set switches OFF, then circuit breakers ON.
23. Radios—UHF set on tower frequency. All other radios OFF.

COPILOT POSITION.

1. Seat, safety belt, rudder pedals—adjusted.
2. Windshield and side windows—check for cracks, discoloration, and crazing.
3. Oxygen mask and flow—check.
4. Nesa system switches—OFF.
5. Windshield defogger switches—check then OFF.
6. Pitot heater switches—OFF.
7. Emergency fuel dump lever—L. G. EMER. EXT.
8. Hand pump selector lever—check freedom of movement, then place in EMER. BRAKES (forward).
9. Warning lights and indicators—push-to-test.
10. Pressure altimeter—set.
11. Static selector—No. 1 static.

12. Windsheild wipers—check operation, then OFF.
13. P. A. system—check operation.
14. Flight controls—check free and correct movement.

Note

A crew member should be on the ground to coordinate this check.

Night Operation.

1. Instrument panel lights—set.
2. Side panel light switches—set.
3. Anti-collision light—check operation, then OFF.
4. Tail light switch—ON.
5. Wing tip light switch—ON.
6. Exterior lights master switch—check operation of FLASH and STEADY, leave on FLASH.
7. Position lights brilliance switch—set BRIGHT.
8. Fuselage lights key selector switch (if installed)—check operation, leave on NORMAL.
9. Landing light switches—EXTEND, check ON, OFF, and RETRACT.
10. Aldis lamp—check operation.
11. Wheel well lights switch—ON.
12. Leading edge lights switch—check operation, then OFF.
13. Taxi light switch—check operation.
14. Chart light switches—check operation.
15. Pedestal light switch—ON.
16. Compass light switch—ON.
17. Radio panel light switches—ON.
18. De-icer control panel light switch—check operation, then OFF.
19. Flashlights—aboard and operating.

FORWARD CABIN AREA.

1. Fire axe—stowed.
2. Spare hydraulic fluid—check quantity (min. as required), filler hose, and wrench stowed.
3. Windows—check for cracks, discoloration, and crazing.
4. Interior and furnishings—general condition.
5. "G" file and publications—complete.
6. Galley area—general condition and cleanliness.
7. Forward lavatory—general condition and cleanliness.
8. Water supply and fittings—checked.

AOC COMPARTMENT.

1. Wing flap handcrank—stowed.
2. First aid kit—check inspection date and condition.

3. Pyrotechnic pistol and cartridges—aboard.
4. Fire axe—stowed.
5. Portable fire extinguishers—inspected.
6. Manual oil transfer system—control positioning.
7. Inspection doors, hatches, and panels—secure.
8. Emergency lights—check operation.
9. Liaison and command transmitters and receivers—as required. (Command transmitter on REMOTE, if applicable).
10. Emergency keyer—OFF and safetied.
11. Pilot's UHF control box—LOCAL-REMOTE switch on REMOTE.
12. Circuit breakers and switches at radio operator's station—as required.
13. Manual hydraulic cross-over valve—check condition and operation.
14. Portable emergency transmitter—stowed.
15. URC-4—in possession of navigator and radio operator.
16. Escape ropes—stowed.
17. Circuit breakers and switches at radar technician's station—as required.
18. Emergency flap extension bypass valve—CLOSED.
19. Right secondary heat exchanger hydraulic fan valve—NEUTRAL (if applicable).

AFT CABIN AREA.

1. Furnishings—general condition.
2. Escape rope—stowed.
3. Emergency light—check operation.
4. Rear main entrance door—condition and operation.
5. Hydraulic by-pass valve for cargo door control—OPEN.
6. Portable fire extinguisher—inspected.
7. Fire axe—stowed.
8. Ladder—condition and stowed.
9. Water supply and fittings—checked.
10. Aft lavatory—general condition and cleanliness.

EXTERIOR INSPECTION BY PILOT.

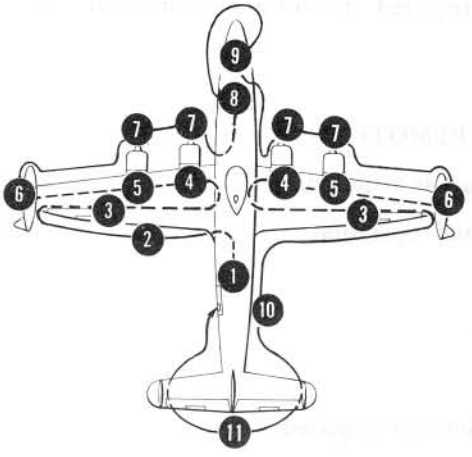
A visual inspection should be conducted by the pilot in accordance with the following items. The identifying numbers on figure 2-1 indicate the area to be checked. The lettered subjects are the points to be checked in those areas.

1. AFT FUSELAGE UNDERSIDE.

a. Skin condition—Check.

b. Lower antennas—general condition.

c. Lower radome—condition and mounting bolts, vents open and free of fuel. Radome interior for leaks, foreign articles, and general condition.



WARNING

IF THERE IS ANY EVIDENCE OF FUEL LEAKS OR VAPORS IN THE LOWER RADOME, OR LEAKS WHICH MIGHT ENTER THE LOWER RADOME, DO NOT ATTEMPT FLIGHT.

NOTE

WHEN THE FWD ENTRANCE DOOR IS USED EXTERIOR INSPECTION MAY START THERE

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1. AFT FUSELAGE UNDERSIDE.
   - (A) SKIN CONDITION -- CHECK
   - (B) LOWER ANTENNAS -- GENERAL CONDITION
   - (C) LOWER RADOME--CONDITION AND MOUNTING BOLTS, VENTS OPEN AND FREE OF FUEL, INTERIOR FOR LEAKS AND FOREIGN ARTICLES, GENERAL CONDITION.
2. WING TRAILING EDGE
   - (A) WING FLAPS, AILERONS, TRIM TABS -- GENERAL CONDITION
   - (B) FUEL DUMP CHUTES -- CONDITION
   - (C) TRAILING EDGE SKIN -- GENERAL CONDITION
3. UNDERSIDE WING SUFRACE
   - (A) SKIN CONDITION -- CHECK
   - (B) FUEL TANKS SURFACES -- CHECK FOR LEAKS
   - (C) CABIN SUPERCHARGER ACCESS DOOR AND SCOOPS -- SECURE
   - (D) HEAT EXCHANGER SCOOPS -- CLEAR
   - (E) LANDING LIGHTS -- CHECK CONDITION
   - (F) INSPECTION PLATES -- INTACT
   - (G) FUEL DUMP CHUTES -- CHECK
4. INBOARD ENGINE NACELLE AND MAIN GEAR
   - (A) RADOME--CONDITION AND MOUNTING BOLTS
   - (B) FLUID LEAKS -- CHECK
   - (C) ACCESS PANELS -- SECURE
   - (D) AUX. VENT. INTAKE -- CLEAR
   - (E) ENGINE NACELLE AND SHIELDING -- CONDITION AND SECURITY
   - (F) BREATHER LINES -- CLEAR
   - (G) DRAIN LINES -- CHECK FOR EXCESSIVE LEAKS
   - (H) EXHAUST SYSTEM -- CONDITION AND SECURITY
   - (I) ENGINE COWLING, COWL FLAPS, AND STAY RODS -- CONDITION AND SECURE
   - (J) GEAR DOORS -- CONDITION AND SECURE
   - (K) GEAR UPLOCKS -- OPEN
   - (L) GEAR PINS--SECURE
   - (M) DOOR CARRIAGE HOOKS -- FULL DOWN
   - (N) DEBOOSTER AND LOCKOUT DEBOOSTERS -- INDICATION OF LEAKS
   - (O) HRD FIRE EXTINGUISHER BLOWOUT DISCS -- CHECK INTACT AND NOTE PRESSURE
   - (P) HYDRAULIC SHUT-OFF STAR VALVE -- SAFETIED OPEN
   - (Q) STATIC GROUND -- CONTACT
   - (R) MAIN GEAR STRUT -- CHECK FOR INFLATION AND LEAKAGE
   - (S) DRAG SHOCK STRUT -- CONDITION AND LEAKAGE
   - (T) ACTUATING CYLINDERS -- CONDITION AND LEAKAGE
   - (U) TIRES -- INFLATION AND CONDITION
   - (V) BRAKE HYDRAULIC LINES -- CONDITION AND LEAKS
   - (W) OIL COOLER DOOR -- CONDITION AND SECURE
5. OUTBOARD ENGINE NACELLE
   - (A) BREATHER LINES -- CLEAR
   - (B) DRAIN LINES -- CHECK FOR EXCESSIVE LEAKS
   - (C) EXHAUST SYSTEM -- CONDITION AND SECURITY
   - (D) ENGINE COWLING, COWL FLAPS, AND STAY RODS -- CONDITION AND SECURE
6. OUTER WING AND TIP TANKS
   - (A) ACCESS PANELS -- SECURE
   - (B) SKIN CONDITION AND SURFACES -- CHECK FOR LEAKS
   - (C) TIP TANKS -- LEAKAGE AND CONDITION
   - (D) DE-ICER BOOTS -- CONDITION
   - (E) LIGHTS -- INTACT AND CONDITION
7. PROPELLERS AND FORWARD NACELLE
   - (A) PROPELLER BLADES -- CHECK FOR NICKS AND POSITIVE PITCH AND BOOTS
   - (B) PROPELLER DOME AND FAIRINGS -- SECURITY AND LEAKS
   - (C) OIL COOLER AND CARBURETOR SCOOPS -- CLEAR
8. FORWARD UNDER FUSELAGE AREA.
   - (A) FUSELAGE - GENERAL CONDITION
   - (B) STATIC PORTS - CLEAR.
   - (C) DITCHING VALVES - OPEN.
   - (D) OXYGEN DISCHARGE DISCS - INTACT.
   - (E) FORWARD WATER FILLER - SECURE.
   - (F) EXTERNAL POWER RECEPTACLE COVER - SECURE
   - (G) OXYGEN FILLER COVER - SECURE.
   - (H) FORWARD ANTENNAS - GENERAL CONDITION.
   - (I) CO_2 DISCHARGE DISCS - INTACT.
9. NOSE GEAR AND WHEEL WELL.
   - (A) NOSE RADOME - GENERAL CONDITION.
   - (B) NOSE WHEEL TIRES - GENERAL CONDITION.
   - (C) NOSE WHEEL STRUT - INFLATION AND CONDITION.
   - (D) NOSE WHEEL STEERING - LEAKS AND GENERAL CONDITION
   - (E) PITOT COVERS - REMOVED.
   - (F) TAXI LIGHTS - LENS INTACT AND CONDITION.
   - (G) NOSE GEAR AND SAFETY PIN - CHECK.
   - (H) UP-LOCK - OPEN.
   - (I) ACTUATING CYLINDERS AND LINES - CONDITION AND LEAKAGE.
   - (J) BATTERIES, DRAINS AND SUMP JARS - SECURE AND CONDITION.
   - (K) HYDRAULIC SHUT-OFF VALVE - SAFETIED OPEN.
   - (L) LOWER CARGO DOOR - SECURE LATCH AND CONDITION.
   - (M) NOSE WHEEL WELL DOORS - CONDITION.
10. RIGHT AFT FUSELAGE AREA.
    - (A) FUSELAGE SKIN - GENERAL CONDITION.
    - (B) ANTENNAS - GENERAL CONDITION.
    - (C) STABILIZER DE-ICER BOOTS - GENERAL CONDITION.
    - (D) AUX. VENT. EXIT VALVE - CONDITION.
    - (E) AFT WATER FILLER AND DRAINS - SECURE.
    - (F) NO. 6 TANK FILLER COVER - INTACT.
11. TAIL CONE AREA.
    - (A) STABILIZER, CONTROL SURFACES AND TRIM TABS - GENERAL CONDITION
    - (B) TAIL CONE - GENERAL CONDITION.
    - (C) CONTROL BOOSTER DRAIN - LEAKAGE.
    - (D) FLARE CHUTE COVERS - INTACT.

Figure 2-1 Exterior Inspection.

2. WING TRAILING EDGE.

a. Wing flaps, ailerons, trim tabs—general condition.

b. Fuel dump chutes—condition.

c. Trailing edge skin—general condition.

3. UNDERSIDE WING SURFACE.

a. Skin condition—check.

b. Fuel tanks surfaces—check for leaks.

c. Cabin supercharger access door and scoops—secure.

d. Heat exchanger scoops—clear.

e. Landing light—check condition.

f. Inspection plates—intact.

g. Fuel dump chutes—check.

4. INBOARD ENGINE NACELLE AND MAIN GEAR.

a. Radome—condition and mounting bolts.

b. Fluid leaks—check.

c. Access panels—secure.

d. Aux. vent. intake—clear.

e. Engine nacelle and shielding—condition and security.

f. Breather lines—clear.

g. Drain lines—check for excessive leaks.

h. Exhaust system—condition and security.

i. Engine cowling, cowl flaps, and stay rods—condition and secure.

j. Gear doors—condition and secure.

k. Gear uplocks—open.

l. Gear pins—secure.

m. Door carriage hooks—full down.

n. Hydraulic shut-off star valve—safetied open.

o. Debooster and lockout deboosters—indication of leaks.

p. HRD fire extinguisher blowout discs—intact and note pressure.

q. Static ground—contact.

r. Main gear strut—inflation and leakage.

s. Drag shock strut—condition and leakage.

t. Actuating cylinders—condition and leakage.

u. Tires—inflation and condition.

v. Brake hydraulic lines—condition and leaks.

w. Oil cooler door—condition and secure.

5: OUTBOARD ENGINE NACELLE.

a. Breather lines—clear.

b. Drain lines—check for excessive leaks.

c. Exhaust system—condition and security.

d. Engine cowling, cowl flaps, and stay rods—condition and secure.

6. OUTER WING AND TIP TANKS.

a. Access panels—secure.
b. Skin condition and surfaces—check for leaks.
c. Tip tanks—leakage and condition.
d. De-icer boots—condition.
e. Lights—lens intact and condition.

7. PROPELLERS AND FORWARD NACELLE.

a. Propeller blades—check for nicks, positive pitch, and boots.
b. Propeller dome and fairings—security and leaks.
c. Oil cooler and carburetor scoops—clear.

8. FORWARD UNDER FUSELAGE AREA.

a. Fuselage—general condition.
b. Static ports—clear.
c. Ditching valves—open.
d. Oxygen discharge discs—intact.
e. Forward water filler—secure.
f. External power receptacle cover—secure.
g. Oxygen filler cover—secure.
h. Forward antennas—general condition.
i. CO_2 discharge discs—intact.

9. NOSE GEAR AND WHEEL WELL.

a. Nose radome—general condition.
b. Nose wheel tires—general condition.
c. Nose wheel strut—inflation and general condition.
d. Nose wheel steering—leaks and general condition.
e. Pitot covers—removed.
f. Taxi light—lens intact and condition.
g. Nose gear and safety pin—check.
h. Up-lock—open.
i. Actuating cylinders and lines—condition and leakage.
j. Batteries, drains, and sump jars—secure and condition.
k. Hydraulic shut-off valve—safetied open.
l. Lower cargo door—latch secure and condition.
m. Nose wheel well doors—condition.

10. RIGHT AFT FUSELAGE AREA.

a. Fuselage skin—general condition.
b. Antennas—general condition.
c. Stabilizer de-icer boots—general condition.
d. Aux. vent. exit valve—condition.
e. Aft water filler and drains—secure.
f. No. 6 tank filler cover—intact.

11. TAIL CONE AREA.

a. Stabilizer, control surfaces, and trim tabs—general condition.

b. Tail cone—general condition.

c. Control booster drain—leakage.

d. Flare chute covers—intact.

EXTERIOR INSPECTION BY FLIGHT ENGINEER.

TOP WING.

The flight engineer should make a top wing inspection in accordance with the following items.

1. Fuel tanks—check fuel quantity and cap secure.
2. Engine oil tanks—check oil quantity and caps secure.
3. De-icer tank cover and cap—secure.
4. Wing and nacelles—general condition.
5. Aileron hinges—check condition.
6. De-icer boots—check condition.
7. Life raft hatches and latches—secure and safetied.
8. Upper radome—general condition.
9. Reserve oil tank—check quantity, secure cap and cover.
10. Main hydraulic reservoir—check dipstick, cap and cover secure. (left wing only).
11. Life raft release handles—safetied (if applicable).
12. Emergency exit hatches—secure.

INTERIOR INSPECTION BY FLIGHT ENGINEER.

EQUIPMENT OPERATIONAL CHECK.

1. Flight station and all cabin lights—as required.
2. Pitot heat—check operation.
3. Cowl flaps—full CLOSED, then OPEN.

Note

Stay rod must be removed and stowed before operating flaps.

4. Oil cooler flaps—full CLOSED, then OPEN.
5. After cooler scoops and exits—full CLOSED, then OPEN.
6. Propeller de-icing alcohol—check.
7. Inverter operation—check.
8. Emergency bus operation—check.
9. Log and form entries—prepared for flight.

FLIGHT STATION CHECK.

1. Emergency hydraulic extension tank fluid level—check.
2. Spare fuses and bulbs—check.
3. Fixed oxygen bottles—valve open and check supply.

4. Oxygen mask and regulator—check.
5. Portable fire extinguisher inspection date and condition—check.
6. Hyrdaulic tank replenishing system—check.
7. Cabin pressure regulator vacuum shut-off—OPEN.
8. First aid kit—check inspection date and condition.
9. Fuses and circuit breakers—check and set.
10. All warning and indicator lights—check operation.
11. Instruments—check markings and general condition.
12. Engine controls—check freedom of movement and position.
13. MJB panel switches and selectors—set.
14. Tank No. 5 and fuel cross-feed controls—check operation.
15. Emergency shut-off levers—check operation.
16. Escape rope—attached.
17. 260 panel—check condition and operation.
18. Fire detection system—test warning lights and buzzer.
19. CO_2 system—free handle movement; HRD system—off.
20. Ditching valve handle—safetied.
21. Fuel dump lever—NEUTRAL and safetied.
22. Life raft release handle—safetied.
23. Flight engineer seat headrest—stowed.
24. Flight station lighting—as required.
25. Ditching light—check.

FORWARD BAGGAGE COMPARTMENT.

1. Inverters—check operation.
2. CO_2 bottles—check security and condition (if applicable).
3. Electrical wiring, circuit breakers, and fuses—check.
4. Electrical units—check condition and security.
5. Hydraulic valves, lines, and fittings—check.
6. Cabin pressurization units—check.
7. Forward compartment door—secure.

AFT BAGGAGE COMPARTMENT.

1. Wing flap drive—check condition.
2. Wing flap assymetry shut-off valve—check condition and operation.
3. Hydraulic lines and fittings—check.
4. Electrical cables—check condition and security.
5. Tank 6—check condition.
6. General condition of area—check.

TAIL CONE AREA.

1. Auxiliary booster accumulator—check condition and pressure.
2. Servos and controls—check condition.
3. Hydraulic lines and fittings—check condition.
4. Flare chutes—check condition.
5. Aft bulkhead door—check condition and security.
6. Emergency cabin pressure valve—check condition and operation.
7. Cabin negative pressure relief valve—check condition and freedom.

BEFORE STARTING ENGINES.

The following items should be read aloud by the copilot from the check list. The letters, P, CP, E, following each item refer to PILOT, COPILOT, and FLIGHT ENGINEER. For those items that have been accomplished during the INTERIOR INSPECTION, it is necessary only that they be pointed to or touched and verbally acknowledged by the crew member.

CAUTION

The CGRS fast erect light must be on before taxiing. Damage to the gyros may result.

BEFORE STARTING ENGINES

ITEM	VERBAL RESPONSE	CREW MEMBER
1. UHF radio	ON tower frequency	P
2. Landing gear lever.	DOWN	CP
3. Ignition switches	OFF	CP
4. Circuit breakers and switches	Set	E
5. Battery switch	CART check d.c. bus voltage and green light on.	E
6. Battery voltage	——volts, return selector to BUS position	E
7. Generator switches	ON	E
8. Instrument inverter switch	MAIN	E
9. Flight instrument power switch	check EMER on NORMAL	E

Note

This switch should be moved slowly so that the pilots may observe the flag operation on the attitude indicators.

10. Fuel dump lever	NEUTRAL and safetied	E
11. Emergency fuel dump lever	L. G. EMER. EXT.	CP
12. Hand pump selector lever	EMER. BRAKES	CP
13. Brake selector lever	EMER.	CP
14. Parking brake	set	P

CONTINUED

BEFORE STARTING ENGINES
(CONTINUED)

15. Emergency brake pressure	——psi	CP
16. Aileron and rudder booster levers	checked and ON	P
17. Elevator booster shift lever	checked and ON	P
18. Aux. booster switches	checked and OFF	P

Note

The elevator and rudder booster levers must be ON to utilize the auxiliary boost system.

19. Flight path control switches	OFF	P
20. De-icers	OFF	P CP E
21. De-icer air pump selector switches	VAC.	P
22. Vacuum shut-off lever	OPEN	E
23. Emergency shut-off levers	all full ON	E
24. Carburetor alternate fuel switches	NORMAL	E
25. Tank 5 selector and crossfeed levers	CLOSED	E
26. Master propeller pitch lever	full INC. RPM., (check indicator light on).	E
27. Engine supercharger levers	LOW	E
28. Fuel tank selector levers	ON. (Take-off tanks).	E

Note

Select tanks 1, 2, 3, and 4. If tanks 2 and 3 contain less than a dippable amount of fuel, select 1, 2A, 3A, and 4.

29. Carburetor air switches	COLD	E

Note

Allow sufficient time for doors to fully open (approximately 3 to 5 seconds). Return switch to neutral.

30. Alternate air switches	RAM	E
31. Cowl flap switches	OPEN (check indicators).	E
32. Oil cooler flap switches	OPEN (check indicators).	E
33. Manual spark control	RETARD	E

WARNING

The manual spark control override switch must be placed in the RETARD position for all ground operation.

34. Master engine selector switch	ON No. 1 or No. 2	E
35. Hydraulic reservoirs and reserve	full	E

CONTINUED

BEFORE STARTING ENGINES (CONTINUED)

36. Engine oil and reserve oil quantity	———— gals. (Check with stick reading)	E
37. De-icer fluid	———— gals.	E
38. Fuel quantity	———— gals. (Check with stick reading)	E
39. Crew oxygen	checked	P CP E
40. Take-off and landing data card	complete	E
41. Hydraulic system cross-over switch	normal	E
42. Fire warning system	checked (test switch ON, by flight engineer).	PE
43. Air conditioning panel	position A and panel set	E

Note

Paddle switches should be adjusted so that refrigeration is not called for until after engines are started. This prevents secondary heat exchanger fans from making a heavy demand on the hydraulic system until after accumulators have been charged and system pressure has built up. Set cabin altitude selector to 1500′ above field elevation, rate-of-change as desired (approximately 300′/min.), and position auxiliary vent. knob to position "A" to prevent fumes from entering cabin during engine starting, reversing, or ground heating. All test and emergency switches in normal position.

STARTING ENGINES.

If using alternate grade fuel consult alternate fuel grade operating limit data in Section V. Before starting, the engines must be turned over a minimum of 8 blades with the starter while the ignition switch is off to check for a liquid lock which could seriously damage the engine. If a liquid lock exists, the lower cylinder spark plugs must be removed and the propeller again rotated to remove the oil from the cylinder.

WARNING

The propellers should not be moved by hand and must never be moved opposite to normal engine rotation.

Note

- In order to prevent movement of ground personnel through the propeller plane of rotation when pulling the ground power leads, the engine starting sequence is No. 4, 1, 2, and 3.
- When starting without external power, start engines No. 3, 4, 2, and 1. Minimize the electrical load and use No. 3 and No. 3A generators as soon as possible at 1400 rpm for added power.

STARTING ENGINES

1. Area	all clear	E
2. No. 4 engine	start	PE

CONTINUED

STARTING ENGINES
(CONTINUED)

a. Fire extinguisher (CO_2)	set to No. 4 engine	E

Note

Visually check HRD (if installed) but do not select engine to preclude excessive use of motor control valve.

b. Engine starter selector switch	set to No. 4 Engine	E
c. Throttle lever	set to approx. 1200 rpm	E
d. Auxiliary fuel pumps	set No. 4 to LOW	E
e. Mixture lever	OFF	E
f. Starter switch	engage	E
g. Ignition switch	pilot stands by, then No. 4 to BOTH	P

Note

The ignition switch should be turned ON after the propeller has turned 8 blades. Avoid throttle movement until engine is running smoothly. Do not exceed 1400 rpm on start.

h. Mixture lever	as required	E

Note

Engage starter then move mixture lever to AUTO-RICH after the ignition switch is on. If engine does not fire within a short period after the ignition switch is activated, place mixture in OFF momentarily to prevent afterburning.

Cold Engine . . . Cold weather starts should be made with closed throttle, using either mixture control or primer for fuel control. If primer starts are made, the mixture control should remain in OFF until a positive start with smooth operation is obtained.

Simultaneous use of both primer and mixture control during starting often results in exhaust system fires.

Following initial firing, and disengagement of the starter, the engine will often "motor" at low speed, rather than accelerate to normal idle speed. Allow the engine to run at this condition until speed increases to normal idle speed. Premature application of throttle or attempts to vary the mixture will stop the engine. A false start of this nature results in iced spark plugs and prevents successful starting on following attempts.

Warm Engine . . AUTO-RICH prior to activating ignition. (Optimum point depends on engine temperature). If engine does not fire within two revolutions after ignition, or if engine loads up, move mixture control to OFF momentarily.

Hot Engine . . . MIXTURE—OFF until engine fires or until after two revolutions after ignition, then advance mixture control to AUTO-RICH. If engine does not fire within a short period in AUTO-RICH, return mixture lever to OFF.

If engine fails to start within 30 seconds, discontinue starting attempt and allow starter to cool before repeating starting procedure.

3. Crossover valve operation	check	E
4. Wing flap shut-off valve	test	CP

CONTINUED

STARTING ENGINES
(CONTINUED)

Note

After engine No. 4 has started, the wing flap lever should be placed in the UP position and the hydraulic crossover switch placed in the EMERGENCY position. The flight controls should then be moved through a complete cycle to insure proper operation of the crossover valve. After the switch is returned to NORMAL position, recheck for high flight control forces to determine that the crossover valve has closed.

5. Engine No. 1	start	E
6. Engines No. 1 and 4	1200 rpm	E
7. Ships battery switch	ON	E
8. Cart switch	OFF	E
9. External power	removed	E
10. Gear pins and pitot covers	aboard	E
11. Engines No. 2 and 3	start	E
12. Mechanics ICS switch, ground crew headset and mic.	OFF and removed	E
13. Engine starter selector switch	OFF	E

CAUTION

Check for a rise in engine oil pressure. If it does not register within 10 seconds, or reach 40 psi within 20 seconds, shut down engine. Check for a rise in cabin supercharger oil pressure.

14. Auxiliary fuel pumps	OFF	E

Note

Warm engines at 1200 to 1400 rpm until a 6-degree rise is indicated on the oil inlet temperature gage.

15. CO_2 fire extinguisher (if applicable)	OFF	E

BEFORE TAXIING

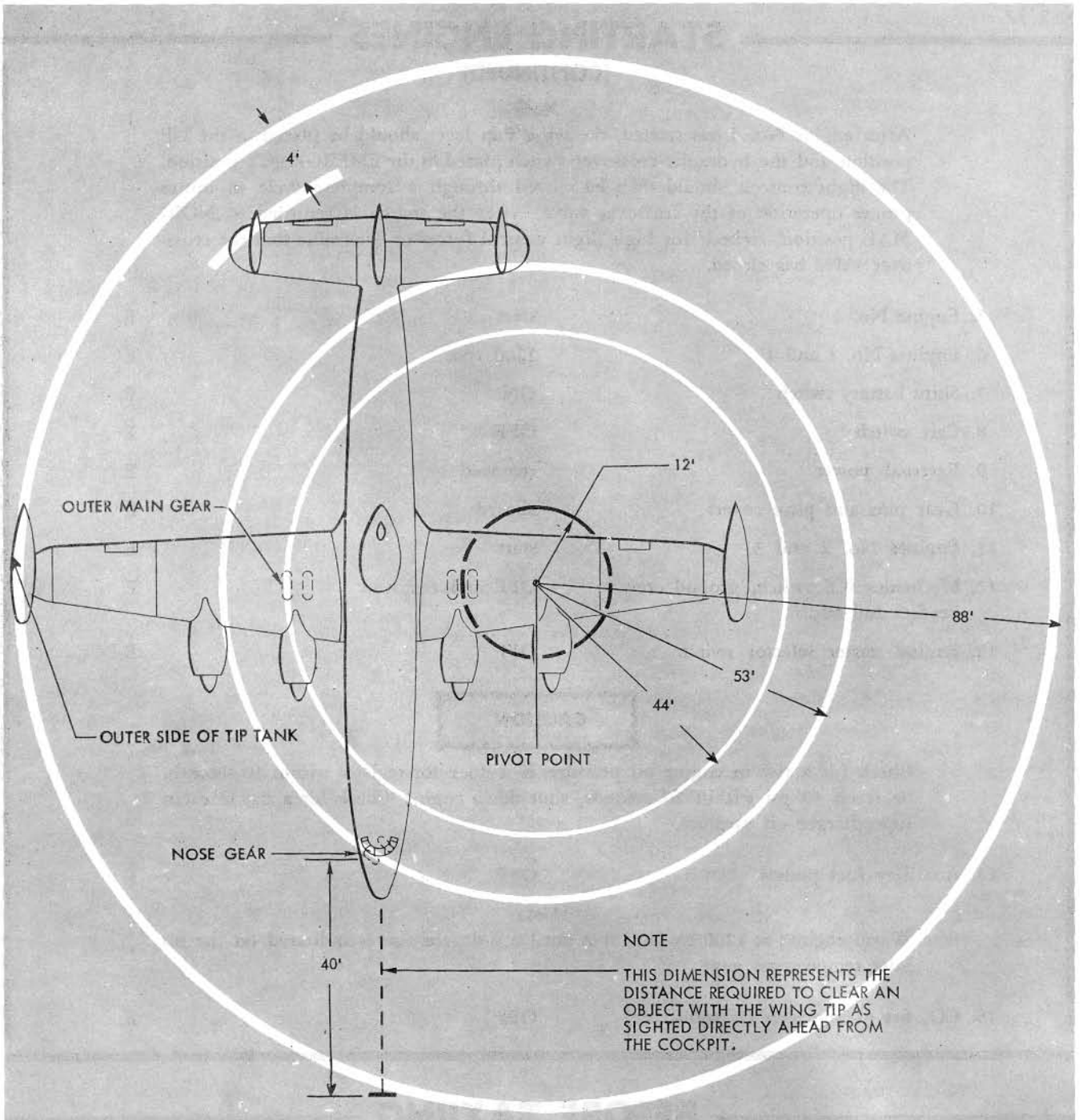
1. Taxi clearance and instructions	received	CP
2. Vacuum system	checked	P
3. Engine and flight instruments	checked and set	P CP E

Note

Gyros should be erected, attitude indicators uncaged, and compasses, clocks, and altimeters set.

4. Hydraulic system: pressure	primary, secondary and emergency checked	C P

CONTINUED



VERTICAL CLEARANCES

VERTICAL STABILIZER TIP	24 FT.	10 IN.
TIP TANK	15 FT.	(APPROX.)
FUSELAGE	5 FT.	0 IN.
PROPELLER INBOARD	1 FT.	8 IN.
PROPELLER OUTBOARD	3 FT.	7 IN.

F-75-0-2-34

Figure 2-2 Turning Radius.

BEFORE TAXIING

(CONTINUED)

5. Carburetor air switches	checked and COLD (heat rise then COLD)	E
6. Carburetor de-icing switches	checked (ON until rpm drop. Do not exceed 10 seconds, then OFF)	E

CAUTION

Do not check carburetor de-icing and heat at the same time because fire or faulty indication may occur.

7. PA system and alarm bell	checked (alarm bell ON. Advise crew of intention to taxi)	P
8. Wheel chocks	removed	E

TAXIING.

Pilot instructs flight engineer on required throttle settings for taxiing, or advises that he will handle throttles. Pilot will release brakes and call for taxiing checklist when clear of congested area. If the flight engineer sets the power (1000 rpm) manually lean to rpm rise (best power) and then to 25 rpm drop.

If low power is required for taxiing, it is preferable to retard the throttles of the inboard and advance the throttles of the outboard engines to assure adequate generator output and ground refrigeration, if the latter is required. Sharp turns at high speed impose excessive forces on the inside nose wheel tire, strut components, and aircraft structure. Side loads imposed during a high speed turn may be sufficient to pull the inside tire off the wheel.

Stopping the Aircraft.

Use a power-on stop when engine run-up is to be accomplished and a power-off stop at station arrival, or whenever it is desirable to stop with the engines idling. The action of the hydraulic drag struts installed on the main gears can induce a rocking motion of the aircraft during either a power-on or power-off stop unless proper braking techniques are employed.

To make a power-on stop ease the aircraft to a normal stop while applying approximately 1700 rpm to all four engines. This is ample power to prevent the aircraft from rocking rearward. Maintain this minimum power setting during run-up. If it is necessary to hold before take-off, and it is desired to reduce power to idle rpm, release the brakes as the throttles are closed and allow the gear to move forward; then reapply the brakes.

To make a power-off stop, apply the brakes in a normal manner, but release and reapply them as the aircraft stops. This will allow the gear to move forward and prevent the aircraft from rocking rearward. If it is desired to run-up after a power-off stop, allow the aircraft to roll forward slightly and make a power-on stop as described above.

The aircraft should be parked with the nose wheel straight to avoid side loads and strains on the nose wheel and struts. If the nose wheel is deflected in either direction, apply power until the aircraft starts rolling before using nose wheel steering.

Note

When unparking, release parking brake lever and pedals before moving brake selector lever from EMER. to NORM.

TAXIING

1. Throttles	power as required	P
2. Brake system	check	P CP

Note

The pilot will check the brake pedal reaction with the brake selector lever in EMER position and then advise the copilot to switch the selector lever to NORMAL and recheck. The brake pressure gage should be checked for proper pressure in each case.

3. Turn indicators and compasses	checked	P CP

Note

Pilot will make a left turn during taxi and check turn indicator and compasses. Copilot will recheck indicators when the procedure is repeated for right turn.

4. Air conditioning panel	set	E

Note

Position auxiliary vent knob to CLOSED; move paddle switches to full cooler position; note that all primary and secondary scoop door indicator lights come on; check for rise in supercharger duct discharge pressure; check for decrease in refrigeration discharge duct temperature; leave paddle switches in full COOLER position after scoop door lights are on to allow mixing valve to go to full cold position. Refrigeration may be used during taxiing and engine run-up if required. Before take-off, however, auxiliary vent control knob should be in position A, paddle switches in full WARMER position until doors are closed and indicator lights are out, and then returned to STEADY position.

5. Nesa system switch	as required	CP
6. Nesa power switch	SPARE inverter	E
7. Wheel well lights	OFF	P
8. Propeller reversing	check	PE
a. Advise flight engineer that reverse check is to be made		P
b. Aux vent knob	position A	E

Note

- Reverse 2 engines at a time. (Engines 2 and 3, and 1 and 4).
- Very little power (approximately 1000 rpm) should be applied in reverse range and then only for a short duration to minimize the blowing of dust and pebbles into propellers. Reversing at low speeds also has an adverse effect on engine cooling.
- Use of reverse thrust is not recommended to back the aircraft.

c. Reverse throttle levers	reverse range	P
d. Feathering button lights	check on	E
e. Reverse pitch indicator lights	check on	P

Note

The feathering button lights should go off when the reverse pitch lights come on.

CONTINUED

TAXIING
(CONTINUED)

f. Reverse throttle levers	forward range	P
g. Reverse pitch indicator lights	check out	PE

ENGINE RUN-UP

Note

- Make a power-on stop smoothly and keep nose wheel straight so that severe side loads will not be imposed on tires and struts. Head the aircraft into the wind.
- The engine analyzer should be ON during all engine checks to aid in determining the location and extent of possible malfunction. The pilot will advise the flight engineer when ready for run-up.

1. Parking brake	set	P
2. Auto pilot	checked and OFF	P
a. Neutralize control surfaces and trim tabs		P
b. Auto pilot	engage	P
c. Pitch and turn controllers	move control surfaces to each extreme	P

Note

Determine that control wheel and rudder movement can be stopped by moderate hand effort.

d. All disconnects	check	P CP

Note

The auto pilot cannot be engaged with the altitude control ON.

e. Auto pilot	OFF	P
3. De-icer boots	checked and OFF	P
a. Cycle selector switch	check NORMAL operation and pressures	P

Note

With the cycle selector switch ON, note vacuum and pressure readings and electric timer indicator lights.

b. Cycle selector switch	OFF, note pressure drop	P
4. Radios	checked and set	P CP
a. Command transmitter	set	CP
b. ADF	check ANT, LOOP, and COMP	CP
c. VOR and LF range receiver	check and set	P
5. Propellers	checked and full INC.	PE
a. Master pitch lever	INC. RPM	E
b. Throttle levers	set for 1700 rpm	E
c. Propeller switches	toggle to full DEC	E

CONTINUED

ENGINE RUN-UP
(CONTINUED)

Note

Hold the manual switches in the DEC. position until the limit light comes on and the rpm stabilizes to 1350, plus or minus 50 rpm.

d. Manual selector switches	move toward INC position and note limit lights off	E
e. Master propeller pitch lever	move toward DEC. position and note that limit light comes on and return lever to full INC. Note that rpm returns to 1700.	E
f. Master propeller pitch lever	full DEC position and note limit lights go out and then come on again denoting low limit. The rpm should stabilize at 1350.	E

Note

The low limit lights going off at this time can be attributed to synchronizer action where the slave governor settings are lower than the master governor setting.

g. Master propeller pitch lever	set 1600 rpm on master engine	E
h. Synchronizer button	push and note that slave engines synchronize with master.	E

Note

Reduce master engine to 1000 rpm with throttle and note that slave engines follow by approximately 3%. Press synchronizer button and note rpm drop of slave engines. Open master engine throttle to 1600 rpm and note that slave engines follow. Press synchronizer button for across-the-board synchronization at 1600 rpm. Select No. 2 engine as the master and repeat the synchronization checks.

i. Master propeller pitch lever	full INC.	E
6. Auto feathering	checked and armed	PE
a. Auto feathering master switch	ON and check light on	E
b. Throttles	set all throttles to 105 bmep.	E
c. Auto feathering test switches	all ON	E
d. Throttles	retard to 90 bmep	E
e. Note that none of the propellers feather		E

Note

If a feathering button light comes on, indicating that a propeller is feathering, reject the feathering cycle and investigate.

CONTINUED

ENGINE RUN-UP

(CONTINUED)

f. Auto feathering master switch	OFF	E
g. Throttles	retard all throttles to 90 bmep	E
h. Auto feathering master switch	ON	E

Note

One propeller should begin to feather after a two second time delay. Reject the feathering cycle by pulling feathering button to neutral.

i. Auto feathering test switch	OFF on propeller that has started feathering cycle.	E

Note

When the auto feathering master switch is reset, another propeller should start to feather. Repeat the procedures on remaining propellers. After all propellers have been checked, without resetting the master switch, turn on all four test switches. The auto feathering indicator light should be out and no feathering should occur. When auto feathering is not required, a manual feathering check may be accomplished.

7. Alternate fuel	checked and NORMAL	E
a. Engine speed	set to 1600 rpm or more	E
b. Alternate fuel switches	EMERGENCY	E
c. Fuel flow	check for increase	E

Note

If these switches are left in EMERGENCY too long, an excessively rich mixture may result.

d. Alternate fuel switches	NORMAL	E
8. Manual spark	checked and RETARD	E

Note

The manual spark must be in RETARD position for all of the following conditions: MAX power, METO power, CLIMB power, abnormal or emergency power, starting and ground operation. ADVANCE spark is to be used only during cruise power or descent and will be selected prior to manual leaning. All checks should be made with the master switch armed and the individual circuit breaker type switches used for each engine check to prevent excessive operation of the advance spark relays.

With the Ignition Analyzer in Operation.

a. Master pitch lever	full INC. rpm	E
b. Mixture levers	AUTO RICH	E
c. Throttles	1600 rpm	E
d. Spark control switches	RETARD	E
e. Analyzer condition switch	BOTH (on No. 1 engine, fast sweep)	E
f. Manual spark master switch	ADVANCE	E

CONTINUED

ENGINE RUN-UP
(CONTINUED)

g. Spark control switches	NORMAL	E
h. Spark control switches	RETARD	E

Note

Observe patterns on analyzer scope as the spark control switch is placed from NORMAL to RETARD. In NORMAL position the pattern should shift to the left approximately 5° and to the right in RETARD. Check pattern for evidence that both distributors advance. Repeat procedures on remaining engines.

With Analyzer Inoperative.

a. Throttles	2000 rpm	E
b. Mixture levers	manually lean until rpm drops to 1900	E
c. Manual spark master switch	ADVANCE	E
d. Ignition switch	LEFT to RIGHT, and BOTH	P

Note

When checking the manual spark in either the LEFT or RIGHT position, there should be a definite rise in rpm or bmep (25 rpm and 2 to 4 bmep) when switching from RETARD to ADVANCE position. If no change in rpm or bmep occurs, it is impossible to determine whether the manual spark is locked in the ADVANCE or RETARD position; therefore, this malfunction must be corrected before take-off. If the advance mechanism fails in flight, place spark in RETARD and continue flight.

e. Manual spark master switch	RETARD	E
9. Engine superchargers	checked and LOW	E

Note

The supercharger shift is to be accomplished only if HIGH position is required during flight.

a. Throttle levers	set to 1600 rpm	E
b. Engine supercharger levers	No. 1 and 4 shift to HIGH	E
c. Throttles	set to 30 in. MAP. on engines 1 and 4	E

Note

Check engine instruments and 260 panel for possible malfunctions in cabin superchargers. If the engine oil pressure drops or fluctuates as rpm is increased, extend the warm-up period.

d. Engine supercharger levers	shift to LOW and note 1 to 2 in. MAP. drop	E

CAUTION

Do not shift to HIGH ratio more than once in any five minute period.

CONTINUED

ENGINE RUN-UP
(CONTINUED)

e. Repeat procedures on engines 2 and 3		E
10. Magnetos	checked	E
a. Throttles	Engines 1 and 4 set to field barometric pressure and note rpm and bmep.	E

Note

Symmetrical engines should turn within 100 rpm of each other at the magneto check power setting. A difference of more than 100 rpm should be investigated before flight. A dead cylinder, propeller low pitch stop setting off, exhaust turbine malfunction, fuel metering, and failure to park headed into the wind are some of the causes for rpm differences. This is in addition to accountability for cabin superchargers and alternators on engines 1 and 4. The pilots and flight engineers tachometers should be cross-checked.

b. Ignition switch	L and note rpm mbep change	PE
c. Ignition switch	return to BOTH and allow rpm to stabilize	P
d. Ignition switch	repeat procedure for R position	PE
e. Repeat procedure on engines 2 and 3		PE

Note

- Atmospheric conditions and spark timing will influence the readings obtained. A drop of 75 rpm or less on one magneto is satisfactory provided no engine roughness is encountered. The use of bmep as a measure of power loss is recommended to substantiate the rpm variation. A drop of 7 to 8 bmep is considered equivalent to a drop of 75 rpm.
- In cases of known richer than normal carburetion and/or the presence of high atmospheric absolute humidity which effectively richens the fuel air ratio, the following is recommended, if the above limits are exceeded.

a. Throttle	set to field barometric pressure	E
b. Mixture levers	lean to best power (max. bmep)	E
c. Magnetos	check as before	PE

Note

If the above limits continue to be exceeded, the conditions should be investigated.

11. Generators	checked and ON	E
a. Throttles	1500 rpm and check amperage and voltage for even distribution of load	E

Note

If a departure delay is expected, the pilot should instruct the engineer return mixtures to the best lean power configuration (idle best power) until take-off clearance is received.

DATA FOR TAKE-OFF PATTERN DIAGRAM

CALIBRATED AIRSPEEDS - KNOTS BASED ON POWER FOR ZERO THRUST AT 1.1 X VSTALL, ZERO BANK ANGLE, 1-G VERTICAL ACCELERATION.				
FLAPS 60% - GEAR UP				
STALL SPEED X	1.4	1.3	1.15[1]	1.0
120,000 LB.	144	133	118	103
130,000 LB.	149	139	123	107
140,000 LB.	155	144	127	111
150,000 LB.	160	148	131	114
152,500 LB.	162	150	133	115
FLAPS AND GEAR UP				
STALL SPEED X	1.4	1.3	1.15	1.0
120,000 LB.	172	159	141	122
130,000 LB.	179	165	147	127
140,000 LB.	185	172	152	132
150,000 LB.	192	178	158	137
152,500 LB.	193	180	159	138

[1]NORMAL TAKE-OFF AND 3 ENGINE CLIMB-OUT SPEED

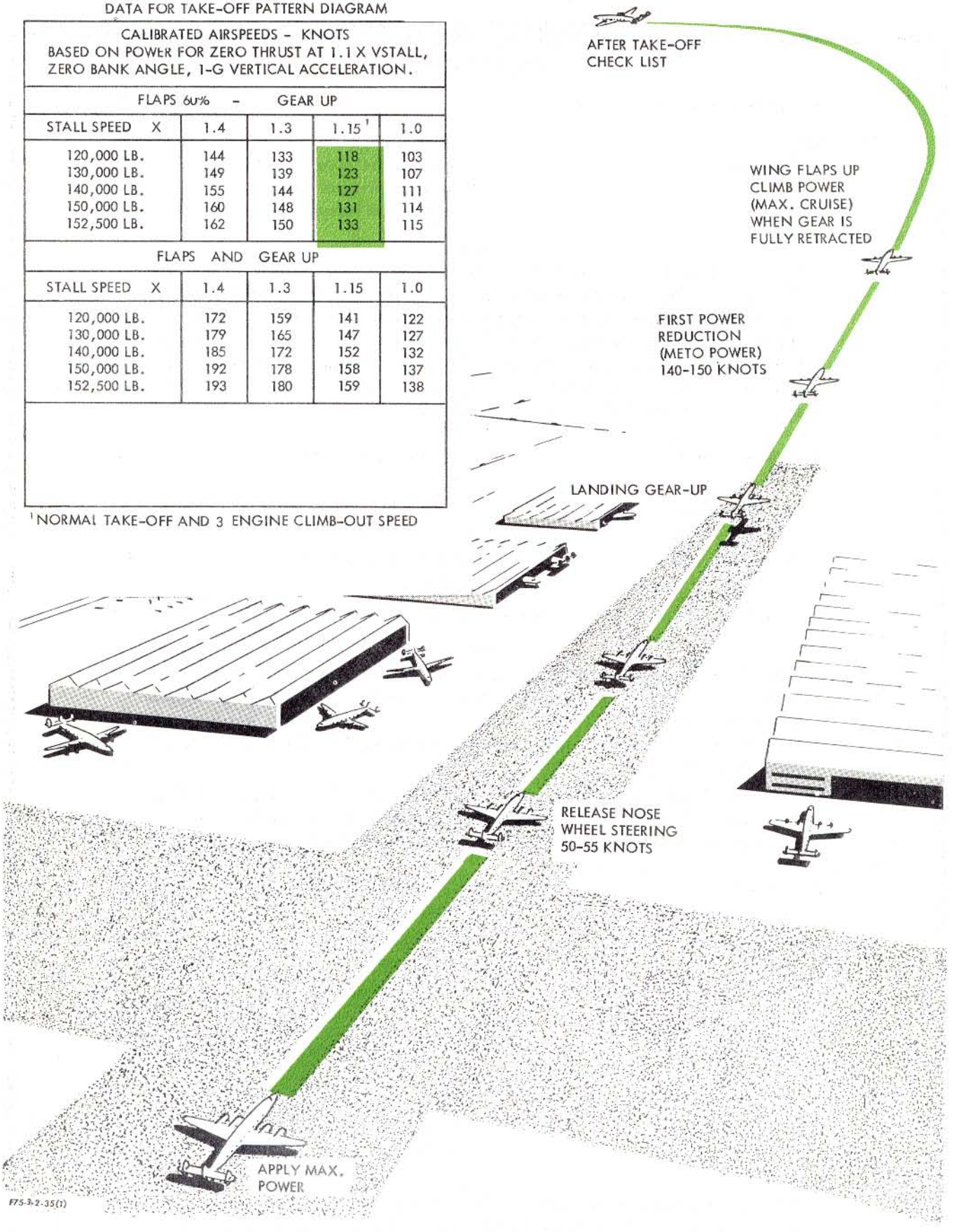
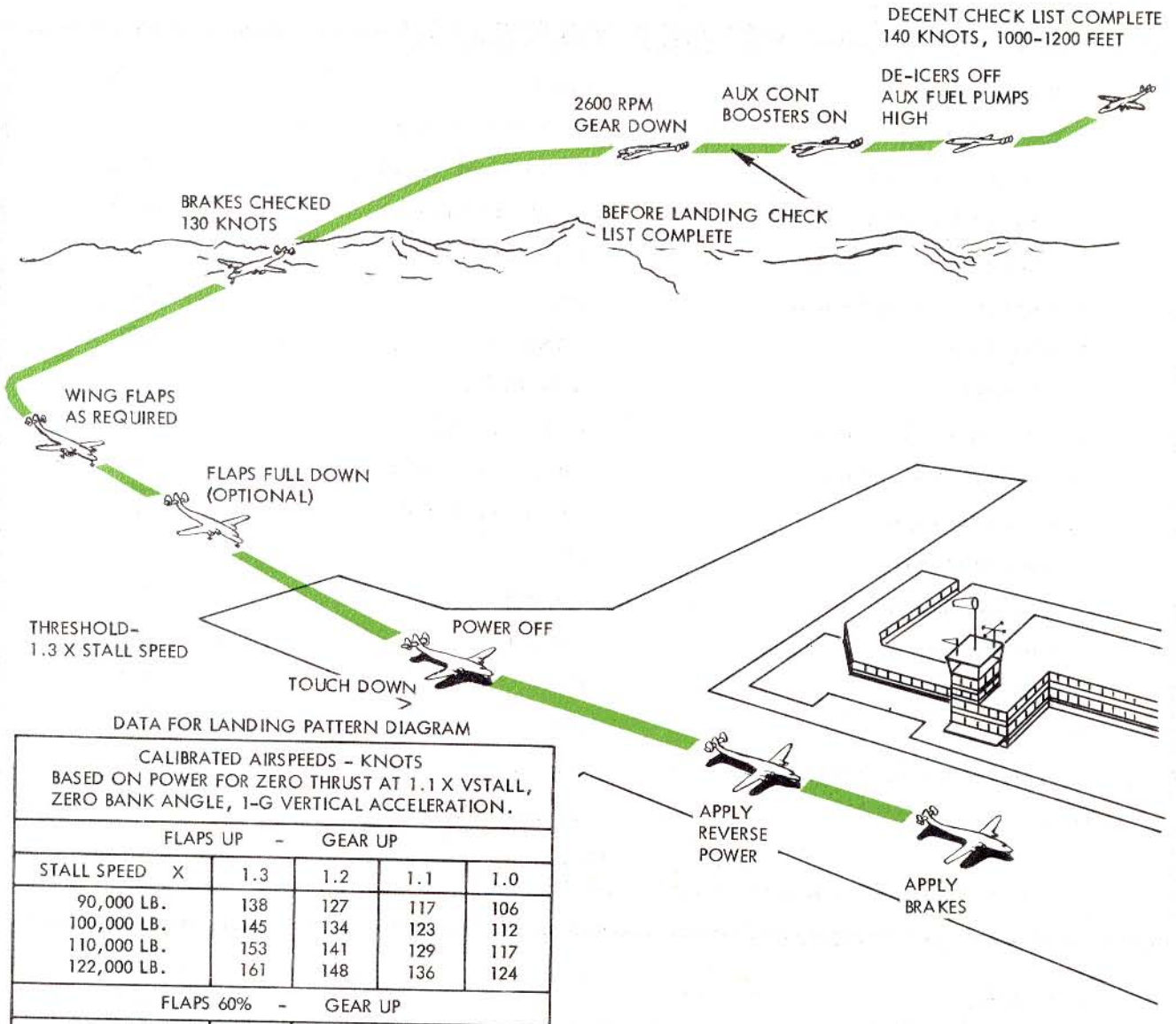


Figure 2-3. Take-off and Landing Pattern (Sheet 1 of 2).



DATA FOR LANDING PATTERN DIAGRAM

CALIBRATED AIRSPEEDS - KNOTS BASED ON POWER FOR ZERO THRUST AT 1.1 X VSTALL, ZERO BANK ANGLE, 1-G VERTICAL ACCELERATION.				
FLAPS UP - GEAR UP				
STALL SPEED X	1.3	1.2	1.1	1.0
90,000 LB.	138	127	117	106
100,000 LB.	145	134	123	112
110,000 LB.	153	141	129	117
122,000 LB.	161	148	136	124
FLAPS 60% - GEAR UP				
STALL SPEED X	1.3	1.2	1.1	1.0
90,000 LB.	115	106	97	89
100,000 LB.	121	112	102	93
110,000 LB.	127	118	108	98
122,000 LB.	134	124	114	103
FLAPS 80% - GEAR DOWN				
STALL SPEED X	1.3	1.2	1.1	1.0
90,000 LB.	109	101	93	84
100,000 LB.	115	106	98	89
110,000 LB.	121	112	102	93
122,000 LB.	127	118	108	98
FLAPS 100% - GEAR DOWN				
STALL SPEED X	1.3	1.2	1.1	1.0
90,000 LB.	107	98	90	82
100,000 LB.	112	104	95	86
110,000 LB.	118	109	100	91
122,000 LB.	124	115	105	96

RECOMMENDED SPEED AT 50 FEET

Figure 2-3 Take-off and Landing Pattern. (Sheet 2 of 2).

BEFORE TAKE-OFF

1. Engine run-up	completed	PCPE
2. Radar altimeter	set limit to 50 feet	P
3. Seat belt and seat	adjusted and locked	PCPE
4. Doors and windows	closed and locked	PCPE
5. Trim tabs	1, 2 and 3 set	P CP
6. Auxiliary control boosters	ON	CP
7. Wing flaps	TAKE-OFF	CP
8. Mixture levers	AUTO-RICH	E
9. Air conditioning panel	set for take-off	E
10. Auxiliary fuel switches	take-off-tanks HIGH	E
11. Oil cooler flaps	set (normally 40%)	E
12. Auto feathering	ON	E
13. Take-off clearance	received	CP
14. Crew briefing	complete	P
15. Pitot heaters	ON	CP
16. Controls	free	P
17. Temperatures and pressures	normal	E
18. Cowl flaps	set (normally 30%)	E

Note

Cylinder head temperatures should be below 200°C.

TAKE-OFF.

The pilot will brief the crew on take-off procedure prior to taxiing on to the active runway. If there are no special instructions and take-off procedures are to be standard, the crew should be so advised. During standard take-off, the pilot will advance the throttles to 35 in Hg, then advise the flight engineer to take over and advance the throttles to MAX. power. The pilot will hold the brakes until 35 in. Hg is reached and then release as the flight engineer acknowledges taking over the power. The pilot will ask the flight engineer to monitor the panel and make a power check during the initial phase of the take-off run. In the event an engine malfunction occurs, the flight engineer will call out, using the term, REJECT, ENG. No.—— In case of a rejected take-off, the pilot will take over the throttles.

The copilot will standby to take over the yoke and the propeller reverse flag in the event of a rejected take-off. The copilot will also call out the critical speed for engine failure (V1), and the take-off and 3-engine climb out speed (V2).

Note

The refusal speeds and refusal distance charts are based on the technique of applying take-off power before the brakes are released. This procedure should be used when take-off performance is critical because of high gross weights, short runways, or power deviations.

When airspeed reaches 60 to 70 knots, the pilot will release nose wheel steering and maintain directional control by means of the rudders. In the event of a rejected take-off, the pilot will call RE-

JECT, close throttles, and reverse. The copilot will insure that the propeller reversing flag is pushed in and will hold the yoke forward to minimize control buffeting and increase the effectiveness of nose wheel steering. At all take-off gross weights allow the aircraft to roll with nose wheel on the runway until an airspeed of 10 knots below V2 airspeed is reached. Apply slight back pressure on the yoke to relieve the weight from the nose wheel. The aircraft should be airborne at V2 airspeed.

AFTER TAKE-OFF.

Maintain a constant climbing attitude. After becoming airborne, do not lower the nose to gain speed. When well established in the climb, the pilot will call for gear up and give the closed-fist, thumb-up signal. After night take-off wait for red light on radio altimeter to go out before retracting the landing gear.

CAUTION

Do not apply the brakes to stop wheel rotation during gear retraction. Application of brakes will cause unnecessary stress on the gear structure.

Note

Gear retraction time is approximately 14 seconds.

The copilot will acknowledge the gear up command and move the landing gear lever to the UP position.

Note

If the gear lever will not go past the NEUTRAL position, insert a finger through the hole in the right side of the pedestal and push the solenoid pin out of the way.

When airspeed reaches 140 knots, the pilot will call for METO power which the flight engineer will acknowledge and set. The flight engineer will then close the aux. vent knob and set the paddle switches to the desired cabin temperature. The second flight engineer, or a designated crew member, should conduct an over-wing and fume inspection.

When the gear is up, airspeed is at least 140 knots, and rate of climb is established, the flaps should be retracted. The copilot will insure that the flaps are fully retracted before removing his hand from the flap lever. Flap retraction time is approximately 15 seconds. To keep the aircraft from settling, during flap retraction, maintain the established airspeed until the flaps are up, then accelerate to climb airspeed (155 knots). The ignition analyzer should be operating and frequent checks made during the climb. Maintain maximum allowable bmep throughout the climb and take advantage of bmep increase with altitude.

AFTER TAKE-OFF

1. Landing gear lever	NEUTRAL	CP
2. Wing flap lever	UP	CP
3. Landing lights	OFF and reracted	CP
4. Auxiliary fuel pumps	LOW	E
5. Auto feathering	OFF	E
6. Auxiliary control boosters	OFF	CP
7. Pressures and temperatures	normal	PCPE

CONTINUED

AFTER TAKE-OFF

(CONTINUED)

Note

Monitor instruments closely during climb and maintain cleanest configuration possible without exceeding engine operating limits. Manual leaning to reduce high fuel flow is permissable only if calibration cards are installed.

8. Over-wing and fumes	checked	E

Note

When METO power is set, the flight engineer, or a designated crew member will inspect the over-wing area for engine condition, fuel siphoning, covers secure, and the forward and aft baggage compartments for fumes and leaks.

9. Nesa power	ALTERNATOR	E

Note

The a. c. power selector switch should be positioned to NESA and the voltage checked. If voltage is normal, move the nesa selector switch from SPARE to ALTERNATOR. Check that the nesa failure light is out after alternators are on the line.

INTERMEDIATE CLIMB.

10. Manual spark	RETARD	E
11. Cowl flaps and oil cooler flaps	climatic	E
12. Climb power	set	E

CLIMB.

The engine superchargers should be shifted from LOW to HIGH when the bmep value at full throttle of the inboard engines has dropped to 200 bmep. The flight engineer will notify the pilot when the shift is required and the pilot will advise the AOC crew. The aircraft should be leveled and airspeed allowed to increase to 170 knots. Reduce power on all engines to 20 in. Hg and 1600 rpm, shift superchargers in pairs (engines 1 and 4, 2 and 3) to HIGH, then resume required power.

CAUTION

Power reduction and subsequent re-application will be handled in an expeditious manner but not so quickly that harmful engine deceleration or acceleration forces are encountered. If failure to shift to HIGH is indicated during shift or after power resumption, immediately move the lever of the affected supercharger to LOW and reduce power on that engine. Continue flight in LOW.

CRUISE.

Cruise powers, above maximum cruise in the best economy range should not be used except in an emergency. Mixture will be placed in AUTO LEAN, the cleanest possible configuration established, and pressures and temperatures stabilized before manual leaning. Power settings should not be greater than those required for recommended long range cruise except when icing or emergency conditions are encountered.

Headwinds of more than 50 knots will require correction in power to make good the most ground nautical miles per pound of fuel. During airway flying, pilots should monitor the weather sequence

broadcasts from radio range stations to keep informed of the existing weather trend along the route being flown. On over water flights, obtain the weather broadcasts periodically on designated frequencies. Turbulence should be avoided as much as practicable. Continuous radar surveillance should be maintained during instrument conditions in order to circumnavigate thunderstorm areas.

Upon reaching the desired cruising altitude, level off and maintain climb power until cruise speed is obtained. The pilot will then call for cruise power which the flight engineer will acknowledge and set. Refer to Appendix I for cruise control data, and Section VII for information regarding manual leaning, systems operation, fuel systems management, and pressurization system operation.

The pilot should inspect logs, charts, and the weather every hour so that he is well informed on the current status of the aircraft and the mission.

Frequently check the auto pilot heading against the magnetic compass. You could end up going in the wrong direction because of a malfunctioning fluxgate compass.

Whenever power conditions are changed, or whenever the auto pilot seems to cause the aircraft to porpoise during cruise, turn the auto pilot off, and retrim the aircraft; carefully reset and re-engage the auto pilot.

During cruise flight, crew members should mentally review the procedures for coping with various emergencies that might be encountered.

DESCENT.

The pilot should notify the crew prior to starting a descent. Descent should be planned at a sufficient distance from destination so as to reach the desired altitude at the proper time without the use of flaps. If a high rate of descent is desired, a power setting of 1700 rpm and approximately 110 bmep will usually allow 1000 feet per minute descent rate without exceeding placarded airspeeds. When leaving an altitude requiring high blower operation and descending to an altitude in the low blower range, the shift from HIGH to LOW will be made upon reaching an altitude that can be maintained in LOW. During normal descent 1 in. Hg should be maintained for each 100 rpm. Under normal descent conditions, the mixtures may be left in manual lean position. Even if power is reduced while maintaining the fixed manual lean position, there will be little change in mixture strength. The pressurization controls should be adjusted to insure a comfortable rate of depressurization (usually 300 feet per minute)so that cabin altitude will reach 1000 to 1500 feet above the pressure altitude of the field by the time the aircraft reaches that level.

The flight engineer should refill by transfer all engine oil tanks to a minimum of 20 gallons so that it will be necessary to service only the auxiliary oil tanks upon completion of the flight.

DESCENT

1. Auto pilot	OFF	P
2. Altimeters	set	PCPE
3. Engine superchargers	LOW	E
4. Fuel tank selectors	(landing tanks) set	E

Note

During training or frequent landings, tanks 1, 2, 3, and 4 may be used to prevent undesirable fuel loading.

5. Tank 5 and crossfeed levers	CLOSED	E
6. Air conditioning panel	set for landing	E
7. Take-off and landing data card	check	PE

CONTINUED

DESCENT
(CONTINUED)

Note

The flight engineer will estimate the landing gross weight and cg from the log form. From this information the pilot will determine the minimum approach and flare-out speeds. Compute the minimum landing runway length required if this is critical. Take-off and Landing Data card should be corrected, if required.

8. Cowl flaps	climatic	E
9. Oil cooler flaps	as required	E
10. Crew	notified	CP
11. Wing flaps	TAKE-OFF (60%)	CP
12. Mixture levers	AUTO-RICH	E

Note

Always move the mixture controls one at a time to preclude loss of all engines should the levers inadvertently be placed in the OFF position instead of AUTO-RICH.

13. Manual spark	RETARD	E

Note

The ignition analyzer should be on to check operation of the manual spark.

14. Carburetor air	as required	E

Note

The carburetor air switches normally should be in the COLD position. However, if icing conditions are present carburetor heat should be used until touchdown.

CAUTION

In the event a go-around is necessary, it is not recommended that full cold carburetor air be applied after heat has been used during approach, particularly not on all four engines simultaneously.

15. Carburetor alternate air	RAM	E
16. Alternate fuel	NORMAL	E
17. Propeller pitch	2400 rpm	E

Note

The pilot will brief the copilot on the approach procedure to be used. The copilot will call out minimum altitudes, abnormal airspeeds, etc. The pilot will advise the flight engineer when he is taking over throttle operation. Prior to entering the traffic pattern, slow the aircraft to 140 knots and request Before Landing Check List.

BEFORE LANDING

1. De-icer boots	OFF	P
2. Auxiliary fuel pumps	(landing tanks) HIGH	E
3. Auxiliary control booster switches	ON	CP
4. Propellers	2600 rpm	E
5. Landing gear lever	DOWN and checked	CP

Note

Pilot will visually check the gear position indicator for a down and locked indication.

6. Brakes	checked and NORMAL	P

Note

After the landing gear is down and locked, place the brake selector lever in EMER. position, depress pedals and note emergency pressure gage for a drop then build up of pressure. This checks the emergency brake system and charges the accumulators. Place the brake selector in NORMAL position and depress brake pedals for about 5 seconds. This procedure not only checks the normal brake system, it also replenishes the fluid downstream of the lockout deboosters in the emergency brake system.

7. Landing lights	as required	CP

LANDING PROCEDURES.

Note

Every approach and landing should be planned as though propeller reversing is not available.

After the wing flaps have been extended to the 60% position and the downwind portion of the traffic pattern has been entered, airspeed should be 140 knots, which is the recommended airspeed for level flight in the traffic pattern. Downwind leg altitude is 1000 to 1200 feet above terrain, or as applicable to local airport traffic regulations.

Under normal conditions the pilot will always advise the flight engineer when he desires to set his own power during let down and landing, or at any time that he deems it advisable. Standard procedure is for the pilot to call for fixed power settings, such as MAX power, METO climb power, or cruise power.

On down wind leg, flight engineer will close all scoop doors, set cowl flaps as desired, and oil cooler flaps as required to maintain 70 to 85 degrees C. oil-in temperature. Over the boundary, turn off pitot heaters, recirculating and flight station fans, and turn auxiliary vent knob to position "A". The pilot will handle the throttles during the final approach and landing, unless he considers it advisable to have the copilot handle them.

Start a descending turn onto the base leg and reduce airspeed to 130 knots. Taper final approach airspeed from 130 knots to 1.3 Vs over field boundary. Airspeed should be maintained at 130 knots until the desired amount of wing flaps for landing is extended. Beware of getting low and slow on the final approach. When adding power to prevent such a situation, don't be stingy. It's better to add too much than too little.

Before landing, the pilot should assure that all crew members are seated with seat belts fastened. Shoulder harnesses should be worn if unusual conditions make it advisable.

A gradual reduction of the power after initial flare out should be made at a rate commensurate with air speed and gross weight. Better landings usually can be made if a little power is left on

until touch down. Gear warning horn may be inoperative with throttles advanced. Power normally should never be all the way off until flare is completed. Be alert for rapid settling of the aircraft during flare-out.

The touch down should be made in a slightly nose-high attitude. After touch down, retard all power and ease the nose wheel to the runway as expeditiously as possible without allowing it to hit too hard. When the nose wheel touches, place the left hand on the nose wheel steering wheel and the right hand on the reversing throttles. Remember that the rudder is a more effective means of directional control than nose wheel steering as speeds above approximately 70 knots. Premature reliance on nose wheel steering may cause it to skip sideways.

When landing on wet runways, apply the brakes lightly and intermittently during the initial phase of the landing run. After most of the weight is on the landing gear, more brake pedal may be used, but the applications must continue to be intermittent. Flaps shall be raised as soon as the wheels are solidly on the ground. It should be remembered that braking efficiency increases as weight on the wheels increases. Furthermore as the weight on the landing gear increases the tires tend to flatten out and force the water out from under them, thereby greatly increasing their traction. Reversing also helps to put a load on the main wheels.

The co-pilot will note the hydraulic system and brake accumulator gage readings immediately after the first brake application upon landing and be prepared to operate the hand pump immediately for brake pressure. In the event of loss of braking, or of secondary system pressure or fluid, the brake selector lever should be placed to EMER. immedately so that accumultor pressure and the lockout feature of emergency brakes can be utilized. Additional pressure should be supplied with the hand pump.

The auxiliary control boosters should be turned off as soon as possible after touch down to reduce the electrical load.

After reversing and after the feathering button lights come on, the flight engineer will advise the pilot that these lights are on. If one should fail to light, he will use the term NO LIGHT ON No. ———.

The cowl flaps should be opened, the master propeller pitch lever moved to full INC. position, the oil cooler flaps opened, and the auxiliary fuel pumps turned OFF.

The flight engineer will monitor engine instruments during reversing and unreversing to prevent over boost or loss of engines. Loading up of engines may cause one to die during the reversing and unreversing cycle.

CROSSWIND LANDINGS.

Except in an emergency, 30 knots is the maximum allowable perpendicular component. In making crosswind landings, the following variations must be taken into consideration:

1. Velocity of the wind.
2. Condition and length of the runway.
3. Wind component.
4. Gustiness of the wind.

The three approved methods of making crosswind approaches are:

1. Lower the upwind wing.
2. Crab into the wind.
3. Combination of the first two methods.

Landings in crosswind conditions require careful attention and skillful handling on the part of the pilot. Make the approach slightly longer and lower than usual. This will aid in establishing

a definite ground track in line with the runway center line. Maintain a safe margin of speed. Extend wing flaps as desired. In strong or gusty crosswinds it may be desirable to use less than 100 per cent flaps. Remove crab just before contact with the runway. Pilots must be careful not to overcontrol on the rudder when straightening out from the heading used to correct for drift. Land airplane on the main wheels first. It is preferable to set the aircraft down on the upwind landing gear rather than allowing it to strike the runway in a crab. Place the nose wheel on the runway and exert forward pressure on the yoke. Keep sufficient aileron rolled in to hold the upwing wing down.

Note

The high angle dihedral in the wing exposes the upwind wing to lifting which introduces the possibility of dragging the opposite wing during a crosswind landing. Prior to landing, the copilot should be instructed to hold the ailerons during the roll out so that the upwind wing will not be lifted by the wind. Flaps should be raised as soon as the wheels are on the ground.

NO FLAP LANDINGS.

When making a no flap approach and landing, the air speed downwind should be maintained at 150 knots. The power required for this airspeed for normal landing weights is approximately 25 in. Hg MAP. At the midway point of the downwind leg call for the Before Landing Check list. Make the turn to base leg so that the final approach will be longer than normal. Speed throughout the base leg and on the long final should be maintained at 135 to 145 knots, depending upon gross weight. Flare at 130 knots, using power as necessary. Do not allow the aircraft to float. Fly it on and commence reversing as soon as possible while the speed is high.

SHORT FIELD LANDINGS.

The following procedre shall be used for short field landings:

1. The approach air speed will be 1.3 times the stalling speed.
2. Make the approach lower with power on, using 100 per cent wing flaps.
3. Aim for a spot slightly short of the runway so that the flare out will carry the aircraft over the end of the runway. This will result in a touchdown within the first available part of the runway instead of within the first third, as in a normal landing.
4. Get the nose wheel on the runway and reverse as soon as possible.
5. To obtain maximum braking, first apply reverse thrust (this increases weight on the wheels), then apply brakes by partly depressing the brake pedals and gradually increasing braking pressure up to the maximum possible without sliding the tires.
6. For landing distance over a fifty foot obstacle, refer to Appendix I.

HEAVY LANDING.

1. In the event an overgross landing is *necessary,* make a power-on approach at airspeeds of 1.33 times the stall speed.
2. Make a power-on landing.
3. During the landing roll use propeller reversing and brakes to decelerate.

PROPELLER REVERSING

Reversing is most effective at speeds above eighty knots and should, therefore, be initiated as soon as possible after the nose wheel touches the runway. Pull reversing throttles on for a small amount of power until the lights come on; then apply power evenly and positively. Don't be too slow applying reverse power—an engine may die.

WARNING

If a propeller fails to go into reverse, (usually indicated by a failure of reversing light to come on) forward thrust will be applied when the reverse throttle is pulled back.

Under normal circumstances, applying reverse power to about 1200 to 1500 rpm will be sufficient. (This will give approximately sixty per cent of full braking effectiveness, provided the power is applied at relatively high ground speed.)

After the aircraft has decelerated to 50 knots, ease the throttles out of reverse so as to have all propellers in positive pitch to prevent overheating during operation at lower speeds. Full reversing throttle may be utilized if circumstances require maximum reverse braking.

CAUTION

If difficulty is encountered in maintaining directional control during the reversing period because of improper technique or failure of the reversing system, move the throttles to forward thrust idle immediately.

If a propeller will not unreverse and there is sufficient rpm to provide normal electrical power, depress the feathering button. If this does not bring the propeller out of reverse, apply full decrease rpm, while slowly opening the throttle until the governor setting is exceeded. At this point rpm will rise rapidly and then fall. Open the throttle further to assure that the propeller is in forward pitch.

After reversing is completed, the flight engineer will turn the recirculating and flight station fans on, if required.

GO-AROUND

1. Throttles	advance and request METO power	P
a. Power	set and trim to METO	E
2. Wing flaps	TAKE-OFF	CP

Note

The pilot will maintain at least V_2 airspeed, after the flaps have been retracted to the TAKE-OFF (60%) position. The pilot will call for gear up only after the flaps are set at TAKE-OFF and after it is certain that the aircraft will not settle to the runway. The copilot will acknowledge the order for gear up and place the landing gear lever in the UP position. If maximum climb performance is required, climb at V_2 airspeed during aircraft clean-up. After the landing gear has retracted and after 140 knots has been obtained, the flaps may be fully retracted or left in the TAKE-OFF position, depending upon the course of action the pilot decides to take. If the pilot decides to remain in the traffic pattern for another approach and landing (or another instrument approach), more stable flight characteristics will be realized if the flaps are left at TAKE-OFF while flying the pattern at 140 knots. If the pilot decides to proceed enroute the flaps may be fully retracted. Allow airspeed to increase to enroute-climb speed (155 knots) as the flaps retract.

CONTINUED

GO-AROUND
(CONTINUED)

3. Landing gear lever	UP (after flaps are at take-off)	CP

Note

The flaps are retracted to TAKE-OFF position before raising the gear because flap drag is greater than gear drag when the flaps are extended beyond TAKE-OFF. If the gear and flaps are retracted simultaneously, both are slowed in retraction time because of the large demand placed on the hydraulic system.

4. Cowl flaps and oil cooler flaps	climatic	E
5. Power	adjust when safe airspeed is reached	E

AFTER LANDING

1. Cowl flaps	OPEN	E
2. Propellers	full INC.	E
3. Oil cooler flaps	OPEN	E
4. Wing flaps	UP	CP

Note

Wing flaps may be left in TAKE-OFF position if another take-off is to be made. They also may be left down if the aircraft is to be parked.

CAUTION

When landing on gravel runways, it is possible for rocks and gravel to be carried into the wing flap well and jam the flap mechanism upon retraction. Under these conditions, the flaps should be left in whatever position was used for landing until the flap tracks and chains can be inspected and cleaned if necessary. After inspection and/or cleaning, the flaps may be retracted.

5. Auxiliary control boosters	OFF	CP
6. Auxiliary fuel pumps	OFF	E
7. Nesa windshield	OFF	CP E
8. Pitot heaters	OFF	CP

POST FLIGHT CHECK. (If engine malfunction is indicated).

If any engine malfunction was evident during descent and the ignition analyzer was not in operation, a magneto check should be made prior to engine shut-down. The entire ENGINE RUN-UP procedure outlined in this Section should be accomplished. Note all discrepancies on the DD-781 form. The engines should be idled at 1000 rpm for a minimum of 2 minutes to permit crankcase scavenging to reduce the possibility of hydraulic lock. (Taxi time can be counted as a portion of this two-minute period.) The ignition switch should be placed to OFF momentarily to check for possible grounded circuit.

ENGINE SHUT-DOWN

1. Brake selector lever	EMER	P

CAUTION

If the aircraft is stopped and the brake selector lever is inadvertently left in the NORM position, release the brakes, move the lever to EMER., and re-apply the brakes. Never move the selector lever with brakes on.

2. Parking brake	set	P

Note

Illumination of the parking brakes light is not a definite indication that the parking brakes are set because the parking brakes lever merely operates a microswitch which closes the circuit to the light. Brake hydraulic pressure must be up before the parking brakes will hold. The parking brakes can be set with the brake selector lever in NORMAL provided the engines are running and normal hydraulic system pressure is up. If the parking brakes are set after the engines are shut down, the brake selector lever must be in the EMER. position. The parking brakes are released by applying toe pressure to the rudder pedals. The parking brakes light should go out after the brakes are released.

3. Wing flaps lever	LANDING position	CP
4. Mixture levers	OFF	E
5. Ignition switches	OFF (after engines are stopped)	CP
6. All unecessary switches	OFF (except generators)	PCPE

BEFORE LEAVING AIRCRAFT

1. Wheel chocks	in place	E
2. Parking brakes	off (after chocks are placed)	
3. Gear pins and pitot covers	installed	E

Note

When any aircraft lights are to be left on, place the battery switch in the CART position.

CONDENSED CHECK LISTS.

The check lists presented on pages 2-37 through 2-46 are condensed versions of the operational check lists in this section. These condensed check lists comprise the final pages of Section II and may be removed without destroying the continuity of the handbook. The condensed check lists are arranged so that you can make them into a flip-pad for convenient use. They contain the same procedural steps as the expanded check lists and lack only the explanations and amplifications contained in the expanded versions. Presentation of the condensed check lists does not, imply however, that you do not have to read and thoroughly understand the expanded check lists.

Last Page of Section II.

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RC121D CONDENSED CHECK LIST

BEFORE STARTING ENGINES.

1. UHF radio	On tower frequency	P
2. Landing gear lever	DOWN	CP
3. Ignition switches	OFF	CP
4. Circuit breakers and switches	Set	E
5. Battery switch	CART Check d.c. bus voltage and green light on	E
6. Battery voltage	——volts, return selector to bus position	E
7. Generator switches	ON	E
8. Instrument inverter switch	MAIN	E
9. Flight instrument power switch	Check EMER on NORMAL	E
10. Fuel dump lever	NEUTRAL and safetied	E
11. Emergency fuel dump lever	L. G. EMER. EXT.	CP
12. Hand pump selector lever	EMER. BRAKES	CP
13. Brake selector lever	EMER.	CP
14. Parking brake	set	P
15. Emergency brake pressure	———psi	CP
16. Aileron and rudder booster levers	checked and ON	P
17. Elevator booster shift lever	checked and ON	P
18. Aux. booster switches	checked and OFF	P
19. Flight path control switches	OFF	P
20. De-icers	OFF	P CP E
21. De-icer air pump selector switches	VAC.	P
22. Vacuum shut-off lever	OPEN	E
23. Emergency shut-off levers	all full ON	E
24. Carburetor alternate fuel switches	NORMAL	E

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25. Tank 5 selector and crossfeed levers	CLOSED	E
26. Master propeller pitch lever	full INC. RPM., (check indicator light on).	E
27. Engine supercharger levers	LOW	E
28. Fuel tank selector levers	ON. (take-off tanks).	
29. Carburetor air switches	COLD	E
30. Alternate air switches	RAM	E
31. Cowl flap switches	OPEN (check indicators).	E
32. Oil cooler flap switches	OPEN (check indicators).	E
33. Manual spark control	RETARD	E
34. Master engine selector switch	ON No. 1 or No. 2	E
35. Hydraulic reservoirs and reserve	full	E
36. Engine oil and reserve oil quantity	———gals. check with stick reading).	E
37. De-icer fluid	———gals.	E
38. Fuel quantity	———gals. (check with stick reading).	E
39. Crew oxygen	checked	P CP E
40. Take-off and landing data card	complete	E
41. Hydraulic system cross-over switch	normal	E
42. Fire warning system	checked (test switch ON, by flight engineer).	PE
43. Air conditioning panel	position A and panel set	E

STARTING ENGINES.

1. Area	all clear	E
2. No. 4 engine	start	PE
3. Crossover valve operation	check	E
4. Wing flap shut-off valve	test	CP
5. Engine No. 1	start	E
6. Engines No. 1 and 4	1200 rpm	E
7. Ships battery switch	ON	E
8. Cart switch	OFF	E

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9. External power	removed	E
10. Gear pins and pitot covers	aboard	E
11. Engines No. 2 and 3	start	E
12. Mechanics ICS switch, ground crew headset and mic.	OFF and removed	E
13. Engine starter selector switch	OFF	E
14. Auxiliary fuel pumps	OFF	E
15. CO_2 fire extinguisher (if applicable)	OFF	E

BEFORE TAXIING.

1. Taxi clearance and instructions	received	CP
2. Vacuum system	checked	P
3. Engine and flight instruments	checked and set	P CP E
4. Hydraulic system pressure	primary, secondary and emergency checked	CP
5. Carburetor air switches	checked and COLD (heat rise then COLD)	E
6. Carburetor de-icing switches	checked (ON until rpm drop. Do not exceed 10 seconds, then OFF).	E
7. PA system and alarm bell	checked (alarm bell ON. advise crew of intention to taxi).	P
8. Wheel chocks	removed	E

TAXIING.

1. Throttles	power as required	P
2. Brake system	check	P CP
3. Turn indicators and compasses	checked	P CP
4. Air conditioning panel	set	E
5. Nesa system switch	as required	CP
6. Nesa power switch	SPARE inverter	E
7. Wheel well lights	OFF	P
8. Propeller reversing	check	P E

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ENGINE RUN-UP.

1. Parking brake	set	P
2. Auto pilot	checked and OFF	P
3. De-icer boots	checked and OFF	P
4. Radios	checked and set	P CP
5. Propellers	check and full INC.	P E
6. Auto feathering	checked and armed	P E
7. Alternate fuel	checked and normal	E
8. Manual spark	checked and RETARD	E
9. Engine superchargers	checked and LOW	E
10. Magnetos	checked	E
11. Generators	checked and ON	E

BEFORE TAKE-OFF.

1. Engine run-up	completed	P CP E
2. Radar altimeter	set limit to 50 feet	P
3. Seat belt and seat	adjusted and locked	P CP E
4. Doors and windows	closed and locked	P CP E
5. Trim tabs	1, 2 and 3 set	P CP
6. Auxiliary control boosters	ON	CP
7. Wing flaps	TAKE-OFF	CP
8. Mixture levers	AUTO-RICH	E
9. Air conditioning panel	set for take-off	E
10. Auxiliary fuel switches	take-off tanks HIGH	E
11. Oil cooler flaps	set (normally 40%)	E
12. Auto feathering	ON	E
13. Take-off clearance	received	CP
14. Crew briefing	complete	P
15. Pitot heaters	ON	CP
16. Controls	free	P
17. Temperatures and pressures	normal	E
18. Cowl flaps	set (normally 30%)	E

AFTER TAKE-OFF.

1. Landing gear lever	NEUTRAL	CP
2. Wing flap lever	UP	CP

CUT HERE

3. Landing lights	OFF and retracted	CP
4. Auxiliary fuel pumps	LOW	E
5. Auto feathering	OFF	E
6. Auxiliary control boosters	OFF	CP
7. Pressures and temperatures	normal	P CP E
8. Over-wing and fumes	checked	E
9. Nesa power	ALTERNATOR	E

INTERMEDIATE CLIMB.

10. Manual spark	RETARD	E
11. Cowl flaps and oil cooler flaps	climatic	E
12. Climb power	set	E

DESCENT.

1. Auto pilot	OFF	P
2. Altimeters	set	E
3. Engine superchargers	LOW	E
4. Fuel tank selectors	(landing tanks) set	E
5. Tank 5 and crossfeed levers	CLOSED	E
6. Air conditioning panel	set for landing	E
7. Take-off and landing data card	check	P E
8. Cowl flaps	climatic	E
9. Oil cooler flaps	as required	E
10. Crew	notified	CP
11. Wing flaps	TAKE-OFF (60%)	CP
12. Mixture levers	AUTO-RICH	E
13. Manual spark	RETARD	E
14. Carburetor air	as required	E
15. Alternate carburetor air	RAM	E
16. Alternate fuel	NORMAL	E
17. Propeller pitch	2400 rpm	E

BEFORE LANDING.

1. De-icer boots	OFF	P
2. Auxiliary fuel pumps	(landing tanks) HIGH	E

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3. Auxiliary control booster switches	ON	CP
4. Propellers	2600 rpm	E
5. Landing gear lever	DOWN and checked	CP
6. Brakes	checked and NORMAL	P
7. Landing lights	as required	CP

GO-AROUND.

1. Throttles	advance and request METO power	P
2. Wing flaps	TAKE-OFF	CP
3. Landing gear lever	UP (after flaps are at take-off)	CP
4. Cowl flaps and oil cooler flaps	climatic	E
5. Power	adjusted when safe airspeed is reached	E

AFTER LANDING.

1. Cowl flaps	OPEN	E
2. Propellers	full INC.	E
3. Oil cooler flaps	OPEN	E
4. Wing flaps	UP	CP
5. Auxiliary control boosters	OFF	CP
6. Auxiliary fuel pumps	OFF	E
7. Nesa windshield	OFF	CP E
8. Pitot heaters	OFF	CP

ENGINE SHUT-DOWN.

1. Brake selector lever	EMER	P
2. Parking brake	set	P
3. Wing flaps lever	LANDING position	CP
4. Mixture levers	OFF	E
5. Ignition switches	OFF (after engines are stopped)	CP
6. All unnecessary switches	OFF (except generators)	P CP E

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BEFORE LEAVING AIRCRAFT.

1. Wheel chocks	in place	E
2. Parking brakes	off (after chocks are placed)	E
3. Gear pins and pitot covers	installed	E

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TAKE-OFF DATA

CONDITIONS

Gross Weight @ Take-Off _____

C.G. Location — % MAC _____

Runway Length Available _____

Runway Wind _____

Runway Air Temperature _____

Field Pressure Altitude _____

Dew Point _____

Runway Slope _____

Data Resulting from Conditions

BMEP — Expected_____ Minimum_____

Normal 4 Engine Take-Off Distance_____ Speed_____

Refusal Distance_____ Refusal Speed_____

Acceleration Check Point Distance_____ Speed @ Check Point_____

Critical Field Length_____ Critical Speed for Engine Failure_____

Three Engine Climb Speed_____

LANDING DATA

Gross Weight @ Landing _____

Normal Landing Distance _____

Landing Speed — @ 50 Foot Height_____ @ Touch-Down_____

Last Page of Condensed Checklist.

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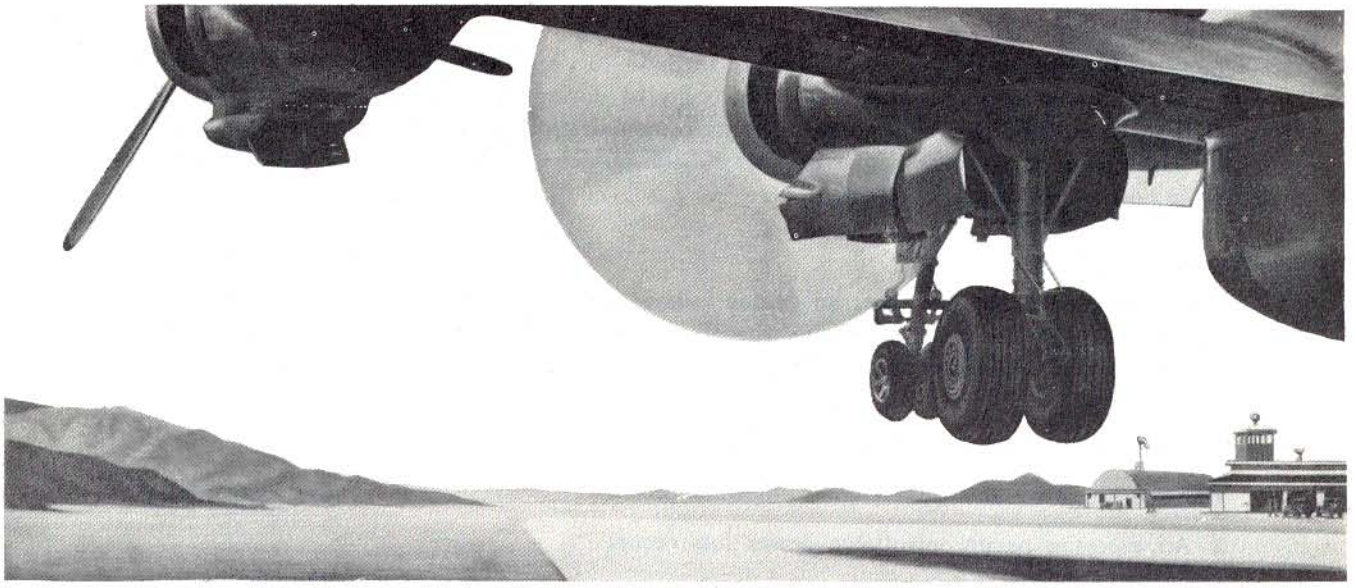

SECTION III EMERGENCY PROCEDURES

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INTRODUCTION.

A complete knowledge of the procedures set forth in this section will enable the flight crew to cope with various emergencies that may be encountered during take-off, flight and landing. After it has been determined that an emergency exists, communications should be established immediately with surface craft or stations so that the Air Rescue Service can be advised of the flight progress. Accurate position reporting is essential.

ENGINE FAILURE.

The corrective action required after an engine failure consists of shutting down the failed engine, feathering the propeller, and retrimming the aircraft to continue flight. The longer the delay between the detection of a malfunction and the actual feathering the more severe the damage to the engine will be.

Feather the propeller and stop the engine when:

1. An extreme or abnormal engine vibration occurs.
2. An excessive or uncontrollable power loss occurs.
3. A sudden or uncontrollable rise in oil temperature occurs.
4. A sudden or uncontrollable drop in oil pressure occurs.
5. A sudden and uncontrollable rise of cylinder head temperature occurs.
6. A heavy discharge of oil is seen to emit from the engine breather or exhaust system.
7. In the event of turbine malfunction, which is usually evidenced by discharge of smoke, heavy orange flame and sparks from or around the exhaust flight hood.
8. A loss of BMEP occurs (refer to Section VII).
9. Any other condition that indicates feathering is advisable.

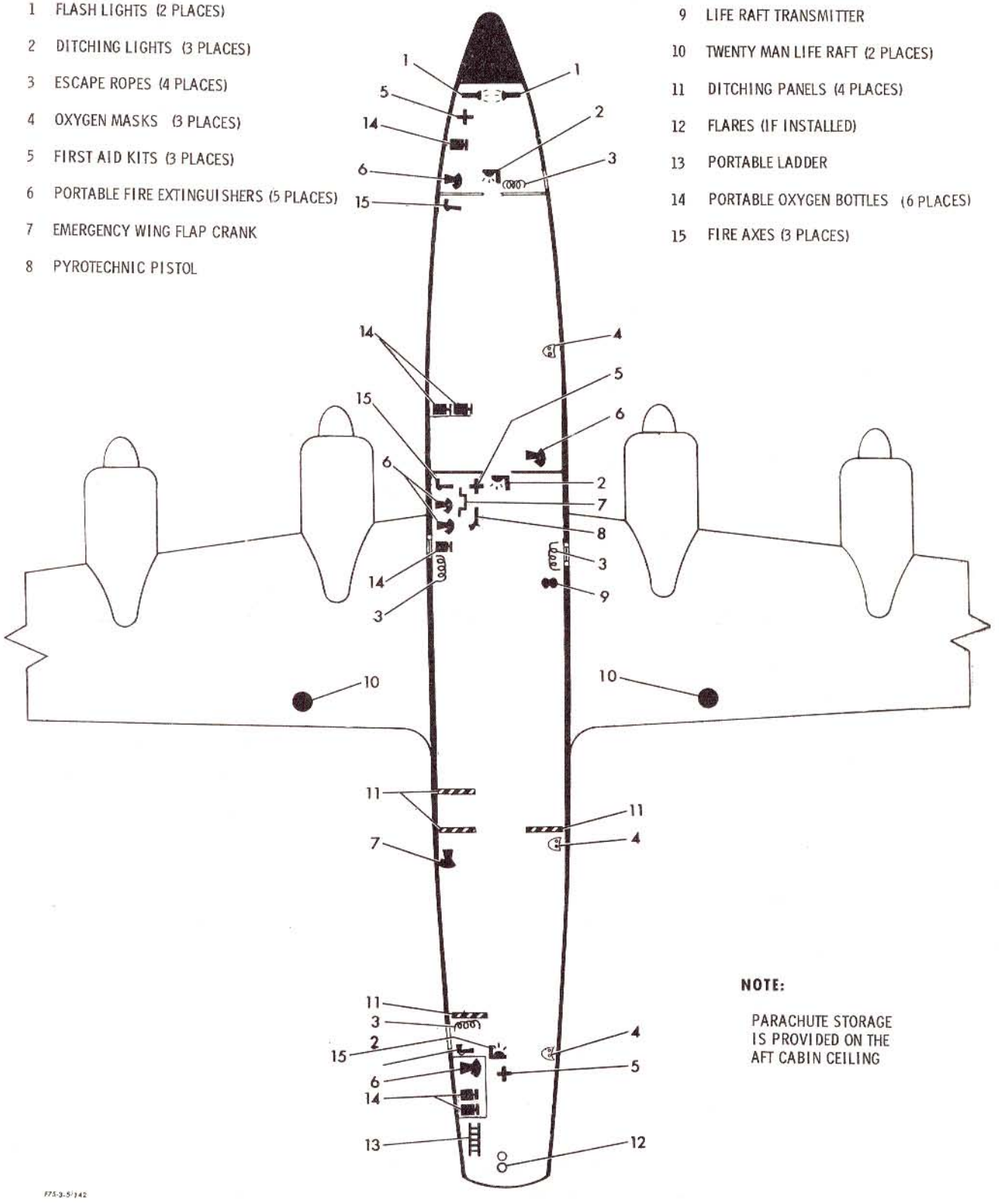
When continued operation of an engine evidencing any of the foregoing conditions of malfunction is considered imperative in the interest of safety of the aircraft and crew, such operation shall be performed at the discretion of the pilot. If these conditions exists, it is recommended that operation of the engine be conducted with caution and at the minimum power consistent with requirements.

Upon detecting an engine malfunction, the flight engineer will notify the pilot of the type, location, and degree of the malfunction. The engine will be shut down at the pilots discretion. The pilot upon detecting an engine failure, will request a report from the flight engineer. The flight engineer will advise the loss of power on number—— engine. The pilot will order the flight engineer to feather number—— engine and the pilot or copilot will assume control of the power. The pilot will instruct the copilot to adjust power as required for the conditions existing at the time. The flight engineer will report to the pilot when the engine is feathered. If the emergency requires action by the flight engineer, he will not make any power change unless directed to do so by the pilot or the pilot in command. All power changes must be made by the pilot or copilot using the pilot's throttles and master propeller pitch lever.

FLIGHT CHARACTERISTICS UNDER PARTIAL POWER CONDITIONS.

Flight characteristics of this aircraft with either inboard engine inoperative remain unchanged and rapid trim changes are not required. With either outboard engine inoperative, a slight yawing of the aircraft may be noticeable to the pilot and rudder trim may be required. The BMEP indicators should quickly indicate to the flight engineer which engine has failed. The aircraft is fully controllable with the loss of any one engine, but as a precaution, the wing flaps should not be extended to the full position during final approach until the landing is assured.

1 FLASH LIGHTS (2 PLACES)
2 DITCHING LIGHTS (3 PLACES)
3 ESCAPE ROPES (4 PLACES)
4 OXYGEN MASKS (3 PLACES)
5 FIRST AID KITS (3 PLACES)
6 PORTABLE FIRE EXTINGUISHERS (5 PLACES)
7 EMERGENCY WING FLAP CRANK
8 PYROTECHNIC PISTOL
9 LIFE RAFT TRANSMITTER
10 TWENTY MAN LIFE RAFT (2 PLACES)
11 DITCHING PANELS (4 PLACES)
12 FLARES (IF INSTALLED)
13 PORTABLE LADDER
14 PORTABLE OXYGEN BOTTLES (6 PLACES)
15 FIRE AXES (3 PLACES)



NOTE:

PARACHUTE STORAGE IS PROVIDED ON THE AFT CABIN CEILING

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Figure 3-1. Emergency Equipment Locations

ENGINE FAILURE OR FIRE DURING TAKE-OFF.

If an engine fails or a fire is detected during take-off and adequate runway is left in which to stop the aircraft with the brakes and propeller reversing, close the throttles and stop. If the automatic feathering system has been turned on, the propeller should feather automatically. The following procedure should be accomplished if engine failure is encountered before reaching the critical speed for engine failure (V1 speed).

Note

The flight engineer will advise the pilot of any engine malfunction immediately during take-off run using the term,—REJECT ENGINE NO. ———.

a. Throttle levers	close	P
b. Reverse throttle levers	reverse range (on good engines)	P
c. Stop aircraft with brakes		P
d. Emergency shut off lever	OFF (on inoperative engine)	E
e. Ignition switch	OFF	P
f. Fire extinguisher	stand-by	E

ENGINE FAILURE OR FIRE AFTER TAKE-OFF.

If an engine fails or a fire is detected after reaching V1 speed the take-off should be continued. If the automatic feathering system has been turned on, the propeller should feather automatically. The following procedures are recommended before a landing is attempted.

ENGINE FAILURE OR FIRE AFTER TAKE-OFF

1. Gear and flaps	UP (at pilots descretion)	CP
2. Throttle lever	close	E
3. Feathering button	push, if propeller does not automatically feather (check light on)	E
4. Mixture lever	OFF	E
5. Emergency shut-off lever	full OFF	E

Note

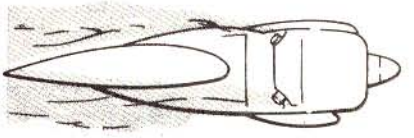
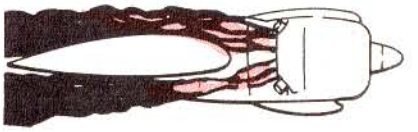
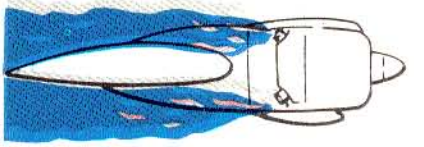
Hydraulic fluid, fuel, blast air, and engine oil off. Return to third detent (Hydraulic fluid, fuel, and blast air OFF) when it has been determined that there is no fire.

6. Engine fire extinguisher selector	select engine	E
7. Fire extinguisher discharge switch or handle	DISCHARGE (if fire exists)	E

WARNING

Do not release second charge until it is definitely determined that the first charge did not smother the fire.

CONTINUED

CAUSE	ACTION	
SMOKE: POWER RECOVERY TURBINE BEARING FAILURE. EXHAUST VALVE OPEN. HOLE IN PISTON.	SHUT-DOWN ENGINE PROCEDURE.	BLUE-GREY SMOKE FROM ONE EXHAUST ONLY
SMOKE: OIL LEAKING ONTO EXHAUST STACKS AND VAPORIZING. NOT A DANGEROUS CONDITION PROVIDING OIL LEAK IS NOT EXCESSIVE. NO INSTRUMENT INDICATIONS EXCEPT FOR POSSIBLE DROP IN OIL QUANTITY.	NORMALLY, NO ACTION IS NECESSARY UNLESS FIRE DEVELOPS. IF FIRE OCCURS, FOLLOW EMERGENCY ENGINE FIRE PROCEDURE.	THIN WISPS OF BLUISH-GREY SMOKE FROM EXHAUST AND COWL FLAP AREA
SMOKE: ON GROUND AT IDLING SPEEDS, INDICATES MIXTURE TOO RICH. IN FLIGHT, USUALLY AT HIGH POWER SETTINGS, THIS CAN OCCUR AND INDICATES TOO RICH MIXTURE. THERE WILL BE NO INSTRUMENT INDICATIONS.	ON GROUND, INCREASE THROTTLE. IN FLIGHT, LEAN MIXTURE ACCORDING TO THE APPROVED MANUAL LEANING PROCEDURE.	 GREY-BLACK SMOKE COMING FROM EXHAUST
SMOKE: DAMAGED OR WORN-OUT PISTON RINGS PERMITTING CYLINDER TO PUMP OIL. AT NIGHT, THIS CONDITION APPEARS AS FIRE, HOWEVER, IT IS ONLY HOT OIL BURNING IN EXHAUST STACK AND EXHAUST STREAM. NO INSTRUMENT INDICATIONS ON THE GROUND. IN FLIGHT, CHECK FUEL FLOW FOR INDICATION.	MONITOR CONDITION AND RECORD IN DD FORM 781 (FORMERLY FORM 1).	BLACK SMOKE COMING FROM EXHAUST
SMOKE AND FIRE: FIRE CAUSED BY OIL LEAK IN ACCESSORY SECTION. FIRE DETECTOR LIGHTS FOR ZONE 2 AND 3 WILL COME ON IF FIRE OCCURS.	FOLLOW EMERGENCY ENGINE FIRE PROCEDURE.	BLACK SMOKE COMING FROM ACCESSORY SECTION
SMOKE AND FIRE: FUEL FIRE IN ACCESSORY SECTION GENERALLY CAUSED BY BROKEN FUEL LINE. LOW FUEL PRESSURE MAY BE INDICATED. FIRE WARNING LIGHTS, ZONE 2 AND 3 WILL COME ON.	FOLLOW EMERGENCY ENGINE SHUT-DOWN PROCEDURE. PREPARE TO ABANDON AIRCRAFT IF FIRE DOES NOT GO OUT.	 BLACK SMOKE WITH ORANGE-YELLOW COMING FROM ACCESSORY SECTION
SMOKE AND FIRE: DETONATION, FOULED SPARK PLUGS OR FOULED FUEL INJECTION NOZZLE. IF DETONATION CONTINUES, ENGINE FAILURE MAY BE IMMINENT.	ENRICH MIXTURE. INCREASE COWL FLAP SETTING IF CHT IS HIGH. IF ENGINE CONTINUES TO BE ROUGH AND LOW ON POWER SHUT-DOWN ACCORDING TO APPROVED SHUT-DOWN PROCEDURE.	 BLUE-BLACK SMOKE WITH FLASHES OF ORANGE COMING FROM EXHAUST

F75-3-3-36

Figure 3-2. Engine Fire and Smoke Chart

ENGINE FAILURE OR FIRE AFTER TAKE-OFF (CONTINUED)

8. Cowl flaps	30% (if no fire exists, 10%)	E
9. Fuel tank selector lever	OFF	E
10. Auxiliary fuel pump switch	OFF	E
11. Ignition switch	OFF	P
12. Generator switch	OFF	E
13. Feathering button	neutral (after propeller has feathered)	E

Note

Visually check propeller after feathering operation and at frequent intervals thereafter to see that the propeller remains unfeathered.

14. Propeller switch	full DEC. rpm	E
15. Oil cooler flap	22%	E
16. Cowl flaps	10% (after fire is out)	E

WARNING

Do not attempt an engine restart unless a greater emergency exists.

ENGINE FAILURE OR FIRE DURING FLIGHT.

If an engine fails or an engine fire is detected during flight, shut down the inoperative engine as described in the following procedure. If the flight can be continued, refer to Appendix I for cruise control with one or more engines inoperative. The minimum control speed in the air with one outboard engine inoperative, the propeller windmilling in low pitch, take-off power on the remaining three engines, the wing flaps in TAKE-OFF position, and with the landing gear either retracted or extended, is 91 knots.

ENGINE FAILURE OR FIRE DURING FLIGHT

1. Throttle lever	close	E
2. Feathering button	push (check light on)	E
3. Mixture lever	OFF	E
4. Emergency shut-off lever	full OFF	E

Note

Hydraulic fluid, fuel, blast air, and engine oil OFF. Return to third detent Hydraulic fluid, fuel, blast air OFF) when it has been determined that there is no fire.

5. Engine fire extinguisher selector	select engine	E
6. Fire extinguisher discharge switch or handle	DISCHARGE (if fire exists)	E

CONTINUED

ENGINE FAILURE OR FIRE DURING FLIGHT
(CONTINUED)

WARNING

Do not release second charge until it is definitely determined that first charge did not smother the fire.

7. Cowl flaps	30% (if no fire exists, 10%)	E
8. Fuel tank selectors	tank to engines (operating engines)	E
9. Auxiliary fuel pump switch	OFF	E
10. Fuel tank selector	OFF	E
11. Mixture levers	AUTO-RICH (on operating engines above 2400 rpm)	E
12. Manual spark	RETARD (on operating engines above 2400 rpm)	E
13. Ignition switch	OFF	P
14. Fuel crossfeed levers	CLOSED	E
15. Tank 5 selector lever	CLOSED	E
16. Propeller de-icer master control and switches	OFF	E
17. Generator switch	OFF	E
18. Feathering button	neutral (after propeller has feathered)	E

Note

Visually check propeller after feathering operation and at frequent intervals thereafter to see that the propeller remains feathered.

19. Propeller switch	full DEC rpm	E
20. Oil cooler flap	22%	E
21. Cowl flaps	10% (after fire is out)	E
22. Fuel crossfeed levers and tank 5	reposition to equalize fuel load	E

WARNING

Do not attempt to restart engine unless a greater emergency arises.

FAILURE OF TWO ENGINES IN FLIGHT.

Because of the manner in which associated systems are integrated between the engines, the effect of losing various combinations of engines must be understood and anticipated. In all combinations of two engine failures, generator loading must be watched. If it is too high, shut-off electrical equipment as required to keep loading within the range of available generator output.

ENGINES NO. 1 AND NO. 4 INOPERATIVE

CAUTION

A descent to a safe altitude is necessary if engines Nos. 1 and 4 are inoperative because pressurization is not available.

1. Engines	shut down and feather	E
2. Left and right refrigerator cooling fan switches	OFF	E
3. Paddle switches	WARMER (until lights are out)	E
4. Nesa power	SPARE	E
5. Auxiliary vent knob	as required	E

Note

The hydraulic pump driven by number 3 engine will supply hydraulic pressure for those units normally operated by the secondary system. The restriction control valve may slow the operation of the wing flaps and the landing gear while giving priority to the other systems. The hydraulic pump driven by number 2 engine will supply hydraulic pressure for the operation of the flight control boosters. d.c. generators 1 and 4 and the two a.c. generators will be inoperative.

ENGINES NO. 2 AND NO. 3 INOPERATIVE

1. Engines	shut-down and feather	E
2. Electrical load	monitor	E

Note

With engines 2 and 3 inoperative, the vacuum system will not operate and suction for the de-icer boots will not be available. The hydraulic pump driven by engine No. 4 will supply hydraulic pressure for those units normally operated by the secondary system. The restriction control valve may slow operation of the wing flaps and landing gear while giving priority to the other systems. The hydraulic pump driven by engine No. 1 will supply hydraulic pressure for the operation of the flight control boosters.

ENGINES NO. 3 AND NO. 4 INOPERATIVE

1. Engines	shut-down and feather	E
2. Left and right refrigerator cooling fan switches	OFF	E
3. Hydraulic system crossover switch	EMER	E

CONTINUED

ENGINES NO. 3 AND NO. 4 INOPERATIVE (CONTINUED)

4. Paddle switches	WARMER (until lights are out)	E
5. Electrical load	monitor	E

ENGINES NO. 1 AND NO. 2 INOPERATIVE

1. Hydraulic system cross over switch	EMER	E
2. Engines	shut-down and feather	E
3. Paddle switches	WARMER (until lights are out)	E
4. Left and right refrigerator cooling fan switches	OFF	E
5. Electrical load	monitor	E

Note

With engines 1 and 2 inoperative, primary hydraulic system pressure will not be available. However, the surface control boosters will be operated by hydraulic pressure supplied by the secondary hydraulic system through the crossover valve. The a. c. generator and the d. c. generators Nos. 1, 2, and 2A will be inoperative.

ENGINES NO. 1 AND NO. 3 OR NO. 2 AND NO. 4 INOPERATIVE

1. Engines	shut-down and feather	E
2. Paddle switches	WARMER (until lights are out)	E
3. Electrical load	monitor	E

Note

With either of these two combinations of inoperative engines, hydraulic power will be available but flow will be reduced. One air pressure pump and one suction pump in the wing empennage de-icing system will be inoperative.

UNFEATHERING AND RESTART DURING FLIGHT

1. Ignition switch	check OFF	P
2. Airspeed	140 knots desired (do not exceed 155 knots)	P
3. CO_2 fire extinguisher selector	set to engine being started	E
4. Emergency shut-off lever	ALL ON position	E
5. Throttle lever	closed	E
6. Engine supercharger lever	LOW	E
7. Mixture lever	OFF	E

CONTINUED

UNFEATHER AND RESTART DURING FLIGHT (CONTINUED)

8. Manual spark	RETARD	E
9. Propeller switch	full DEC rpm (indicator light on)	E
10. Starter switch	engage (turn propeller eight blades and check for liquid lock)	E

Note

The pilot will notify the flight engineer when the propeller has turned eight blades. If a liquid lock is evident make no further attempt to start.

11. Auxiliary fuel pump	LOW	E
12. Fuel tank selector	ON	E
13. Ignition switch	BOTH	P
14. Feathering button	pull out	E

CAUTION

The propeller should be under observation by some crew member while being unfeathered.

15. Mixture lever	AUTO-RICH (at 500-600 rpm)	E

Note

- After the propeller is governing, advance the throttle gradually until power is indicated on the BMEP gage. When engine oil-in temperature has risen and oil pressure has stabilized, gradually increase rpm and power to correspond with the other engines.
- On engines equipped with reverse flow torquemeters the BMEP will not read correctly until a minimum of 60°C oil-in temperature is reached.

16. Generator switch	ON	E
17. Cowl and oil cooler flaps	climatic	E

FUEL PRESSURE DROP—ENGINE OPERATING NORMALLY.

DURING GROUND OPERATION.

If the fuel pressure drops below the operating limits, but the engine continues to operate normally, stop the aircraft, stand by to release fire extinguishing agent to the affected engine, and shut down immediately. Investigate and correct the cause before take-off.

DURING FLIGHT.

If fuel pressure drops below normal operating limits but the engine continues to operate normally, the cause may be fuel line leakage, primer solenoid leakage, oil dilution leakage, engine-driven fuel pump bypass valve leakage, clogged pressure line, or instrument failure. The action to be taken depends upon the circumstances existing at the time. Such factors as known aircraft condition, power requirements, and flight conditions must be considered. All factors being equal, any one of the following procedures are recommended:

1. Shut down the engine immediately if power from the affected engine is not necessary to sustain flight or to reach a safe destination;

2. Continue to operate the engine normally. This may be done if it can be unquestionably determined that the indicated pressure drop has not resulted from a fuel leak.

3. Keep the affected engine in operation at or above normal cruising speed while maintaining a constant watch for fire. This can be done if it cannot be determined that a leak exists and the engine power is required either to sustain flight or to maintain the required altitude for arrival at a safe destination. However, prior to power reduction for entrance to the landing pattern, shut down the affected engine completely by means of the mixture control *not by retarding the throttle)* and accomplish a three-engine landing unless the added power is absolutely essential to effect a safe landing. Do not reduce airspeed until the affected engine is shut down. This procedure is based on the fact that the cooling effect of the airflow over the engine and nacelle will frequently keep a fire from starting, even though a fuel leak exists, until aircraft speed is reduced sufficiently as during landing.

LANDING WITH ONE OR MORE ENGINES INOPERATIVE.

The following notes and procedures are in addition to the normal landing procedures. It is assumed that the landing area is within landing range and that feathering procedure check lists have been completed. Landing with only one engine inoperative will not seriously affect the normal flight characteristics of the aircraft. When landing with one engine out, the hydraulic crossover valve should be opened to provide immediate hydraulic pressure if another engine on the same side fails during the approach. However, with engine No. 3 or No. 4 inoperative, the reduction in output to the secondary hydraulic system may cause the landing gear and wing flap operation to be slower than normal. After landing, the wing flaps should not be raised until after full use of nose wheel steering and full use of the brakes is not critical. When landing with any two engines feathered, the windmilling drag is reduced by one-half and deceleration with closed throttles is less than normal. Hence, excessive speed on approach should be anticipated and avoided. However, a slightly high final approach with low power is considered good practice. With two engines operating at METO power, the propellers feathered on the inoperative engines, and the aircraft not exceeding recommended landing weights, the wing flaps may be lowered to TAKE-OFF without loss of altitude up to approximately 10,000 feet. The airspeed during final approach should be 130 knots at maximum landing weight, and until the landing is assured, no more than TAKE-OFF flaps should be used. The rate of descent with the gear extended and the wing flaps in TAKE-OFF position will be approximately 500 feet per minute.

LANDING WITH ENGINES NO. 1 AND NO. 2 INOPERATIVE

1. Hydraulic system crossover switch	EMER.	E
2. Paddle switches	WARMER (until lights are out)	E

Note

With engines 1 and 2 inoperative, primary hydraulic system pressure will not be available. However, the surface control boosters will be operated by hydraulic pressure supplied by the secondary system through the crossover valve. The a. c. generator and d. c. generators Nos. 1, 2, and 2A will be inoperative.

LANDING WITH ENGINES NO. 2 AND NO. 3 INOPERATIVE

1. Paddle switches	WARMER (until lights are out)	E

Note

With engines 2 and 3 inoperative, the vacuum system will not operate and suction for the de-icer boots will not be available. The hydraulic pump driven by engine No. 4 will supply pressure for those units normally operated by the secondary system. The restriction control valve may slow operation of the wing flaps and landing gear while giving priority to the other systems. The hydraulic pump driven by engine No. 1 will supply hydraulic pressure for operation of the flight control boosters.

LANDING WITH ENGINES NO. 3 AND NO. 4 INOPERATIVE

Note

Actuating the hydraulic system crossover switch will provide normal operation of those units normally supplied by the secondary system.

CAUTION

Use propeller reversing with caution because of possible control difficulties.

1. Left and right refrigerator cooling fan switches	OFF	E
2. Hydraulic system crossover switch	EMER.	E
3. Paddle switches	WARMER (until the lights are out)	E

LANDING WITH ENGINES NO. 1 AND NO. 4 INOPERATIVE

Note

The hydraulic pump driven by engine No. 3 will supply hydraulic pressure for those units normally operated by the secondary system. The restriction control valve may slow operation of the wing flaps and landing gear while giving priority to the other systems. The hydraulic pump driven by engine No. 2 will supply hydraulic pressure for operation of the flight control boosters. D. C. generators Nos. 1 and 4 and the two a. c. generators will be inoperative.

1. Left and right refrigerator cooling fan switches	OFF	E
2. Paddle switches	WARMER (until the lights are out)	E

GO-AROUND WITH ONE OR MORE ENGINES INOPERATIVE.

GO-AROUND, THREE ENGINES OPERATING, FLIGHT CONTROL BOOSTERS ON.

A go-around at not more than the recommended landing weight can be accomplished if altitude is more than 100 feet and the true indicated airspeed is more than 113 knots. If engines 3 and 4 are inoperative, operation of the gear and flaps will be slower.

GO-AROUND, TWO ENGINES OPERATING, FLIGHT CONTROL BOOSTERS ON.

In general, a two-engine go-around is not recommended. It can be accomplished however, if altitude is not less than 400 feet and airspeed is not less than 130 knots.

If engines 1 and 2 are inoperative, the hydraulic system crossover valve must be open for boost on operation.

If engines 3 and 4 are inoperative, the hydraulic system crossover valve must be open to extend and retract the landing gear and wing flaps.

GO-AROUND TWO ENGINES OPERATING CONTROL BOOST ON

1. Throttles	power as required	P
2. Airspeed	130 knots	P
3. Landing gear lever	UP	CP
4. Wing flap lever	UP (raise flaps slowly)	CP
5. Airspeed	accelerate to 152 knots	P
6. Throttles	adjust power as required	E

CAUTION

At 152 knots the sea level rate of climb is approximately 400 feet per minute at recommended landing weight, with the wing flaps up, and landing gear retracted. Between 130 knots and 152 knots the rate of climb is essentially zero, therefore, during the go-around no altitude can be gained until 152 knots is reached. It takes several minutes (depending upon whether any altitude loss is permissible, turbulence, etc.) to accelerate from 130 to 152 knots. Therefore, terrain clearance must be considered.

PRACTICE MANEUVERS, ONE OR MORE ENGINES INOPERATIVE.

Note

- An intentional three-engine take-off is possible. A procedure will be supplied when tests and studies are completed.

- It should be understood that during practice maneuvers the simulation of engine failures and various systems failures require thorough knowledge of resulting conditions. Therefore, cogniance of military regulations and other sections of this handbook is essential. Practice maneuvers involving more than one engine in-

operative should be accomplished by feathering only one engine and simulating zero thrust with the second engine (set 20 inches Hg and 2000 rpm). Practice maneuvers involving the actual feathering of one engine and the throttling (zero thrust) of an additional engine should be confined to altitudes which comply with military regulations. The following information is based on a gross weight of 110,000 pounds.

PRACTICE MANEUVERS, WITH ONE OR MORE ENGINES INOPERATIVE

CAUTION

Turns should not exceed 45 degrees of bank during simulated two engine failure because of undue control forces. During training, when emergencies are being practiced and an actual emergency has not occured, the commands of execution will be preceded by the word SIMULATE. It is much easier for the instructor pilot to countermand this order in case of an actual emergency than it is to correct actual commands of execution which have already been given.

1. First engine	shut down and feather	E
2. Second engine	simulate engine failure by producing zero thrust (2000 rpm and 20 in Hg MAP.)	P
3. Power	as required	P

WARNING

During practice maneuvers, the simulated failure of more than two engines is prohibited. There are no restrictions on combinations of two engine failures.

BOOST-OUT LANDINGS.

In the event an actual emergency go-around is required during practice with boost-out, do not shift the elevator boost lever to ON position. The aileron and rudder boost levers, however, should be moved to ON. Ample elevator control is available for go-around provided excessive elevator trim has not been used during approach and the c. g. limit is within the recommended boost-out range.

WARNING

A critical flight condition is a combination of high power, low speed and a nose-up attitude. When applying power, make certain that airspeed increases as power is applied, and maintain a minimum attitude change because of undue control forces and controlability.

PROPELLER FAILURE

1. Propeller switches	DEC rpm	E

Note

Monitor propeller pitch indicator lights. Do not release switch if light remains on.

2. Airspeed	maintain safe value	P
3. Throttle	close	E

Note

Retarding the throttle on the overspeeding engine will tend to hold the rpm within operating limits.

4. Feathering button	push (if throttle does not hold rpm)	E

Note

At a safe altitude, the propeller may be unfeathered provided a safe condition exists.

PROPELLER OVERSPEEDING IN FLIGHT

1. Throttle lever	close	P
2. Propeller switch	DEC rpm	E

Note

Monitor propeller indicator light. Do not release switch if light remains on.

3. Airspeed	maintain safe value	P
4. Feathering button	push (if overspeeding can not be controlled)	E

Note

If overspeeding cannot be controlled, move personnel away from the area of propeller plane rotation and descend to a safe altitude.

INADVERTENT REVERSING IN FLIGHT

1. Throttle	close	P
2. Propeller reverse circuit breaker	pull out	E
3. Feathering button	push (complete engine shut down)	E

FAILURE TO UNREVERSE

Note

A propeller that fails to unreverse normally usually can be taken out of reverse by one of two methods. Failure to unreverse is commonly due to a malfunctioning relay in the propeller control circuit, therefore, proceed as follows.

CONTINUED

FAILURE TO UNREVERSE (CONTINUED)

1. Throttle	close	P
2. Feathering button	push	E
3. Feathering button	pull out (when the propeller is in normal governing range)	E

Note

The above procedure will cause the feathering pump to take the propeller out of reverse and start it toward the feathered position; however, if an inoperative feathering pump is indicated by non-operation of the feathering pump light, use the following second method.

FAILURE TO UNREVERSE—ALTERNATE METHOD

1. Propeller switch	full DEC. rpm	E
2. Throttle	open to approximately 1500 rpm	E

Note

Obtain approximately 1500 rpm and reduce throttle opening while propeller goes through flat pitch.

3. Propeller switch	INC rpm (after propeller comes out of reverse range)	E

FIRE.

ENGINE FIRE.

Judgement and precision are more important than speed when putting out an engine fire. Closing a wrong valve could cause more trouble than a few seconds delay in controlling the fire. The procedures vary for fires which occur during and after starting, and in flight.

ENGINE FIRE DURING START

1. Discontinue priming		E
2. Continue cranking to draw fire through the engine		E
3. If fire continues, or spreads, stop cranking the engine		E
4. All mixture levers	OFF	E
5. Smother fire by a ground source and/or by the aircraft fire extinguisher system		E
6. Auxiliary fuel pump switches	OFF	E
7. All ignition switches	OFF	P

ENGINE FIRE AFTER START

1. All mixture levers	OFF	E
2. Emergency shut-off lever	full OFF	E
3. All ignition switches	OFF	P
4. Smother fire by a ground source and/or by the aircraft fire extinguisher system		E
5. Auxiliary fuel pump switches	OFF	E
6. Fuel tank selectors	OFF	E

CAUTION

Do not attempt to restart engine until cause of the fire has been determined and corrected.

FUSELAGE FIRE.

Cabin Fire.

Anytime smoke is noticed or a fire occurs in the aircraft, the crew should breathe 100% oxygen, the recirculating fans shut-off, and a passageway between the cabin and flight station kept open. These steps will protect the flight crew and help to prevent the fire from spreading. If smoke should become dense, follow the Smoke Removal procedure given in this section. If an open fire occurs in the cabin or flight station, it may be controlled by smothering it with one of the portable fire extinguishers. If smoke or fire originates beneath the floor, attempt to isolate the cause and shut off any fluids that may be feeding it. The proceed as follows:

CABIN FIRE

1. Close throttles and descend if terrain permits — P

CAUTION

Because the under-floor areas are not equipped with fire detctors nor fixed fire extinguishers, the hand extinguishers must be used. Use extreme caution when opening floor hatches.

Note

Auxiliary boost will still be available for rudders and elevators and should be turned ON if the hydaulic system has been turned OFF. Aileron boost should be bypassed to reduce forces. The auxiliary boost motors will deplete the batteries very rapidly and, since the batteries may be the only power available for operation of the propellers, radio, instruments, etc., auxiliary boost should be turned OFF as soon as safety permits. To reduce control forces, the rudder boost should then be bypassed and the emergency manual elevator control pulled out and locked.

2. Radar blower fan switch — OFF — RT

CONTINUED

CABIN FIRE
(CONTINUED)

3. Recirculating and flight station fan switches	OFF	E

Note

If a fire should occur under the cabin floor during pressurized flight, the cabin recirculating fans may draw some of the smoke into the cabin. It is very important, therefore, to shut off the recirculating fans immediately to minimize smoke accumulation in the cabin and to reduce the possibility of fanning the fire.

4. Flight station mixing valve switch	COOL	E
5. Reduce cabin differential pressure to a minimum		E
6. Aux vent. knob	position B (at 1 in. cabin differential)	E

Note

Position B on the aux. vent knob dumps the cabin superchargers and puts them in minimum flow, opens the cabin safety relief and dump valve, partially opens the aux. vent inlet and exit valves, and closes the recirculation dampers. Although this configuration reduces the volume of ventilation, some ventilation nevertheless, is supplied that will aid in keeping the cabin and flight station clear.

7. Fuel tank selector levers	Tank to engine	E
8. All fuel crossfeed levers and tank No. 5 selector	OFF	E

Note

If it is definitely known that the hydraulic or electrical systems are not involved in the fire, step 9 below may be omitted.

9. All emergency shut-off levers—HYD. OIL	OFF (first detent position)	E

Note

If the fire is known to originate in the electrical system, proceed as outlined under title of ELECTRICAL FIRE.

CABIN HEATER FIRE

Note

If a fire occurs in the cabin heaters or cabin heater compartments, the fire detectors will energize the warning lights and the fire can be extinguished with the integral fire extinguishing system.

1. Cabin heater switches	OFF	E
2. Left and right recirculating fan switches	OFF	E
3. Flight station fan switch	OFF	E
4. Flight station mixing valve switch	COOL	E
5. Engine fire selector	OFF	E

CONTINUED

CABIN HEATER FIRE
(CONTINUED)

6. Cabin heater fire selector	set (fire location)	E
7. Fire extinguisher	discharge	E

WARNING

Do not release the second charge until it is certain that the first charge did not smother the fire.

ELECTRICAL FIRE.

Electrical Fire Detection.

It is recommended that when smoke or the odor of burning insulation is detected in the aircraft, the following detection procedure be used to locate the defective equipment. Instruct each AOC crew member to open the shrouds enclosing respective electronic equipment racks and inspect. Instruct that underfloor area be inspected through the viewing windows and, if necessary remove floor hatches and inspect.

Note

When smoke or fumes first become apparent, the radar technician should be notified so that the blower switches on the radar technician's panel may be turned off.

WARNING

Search for the affected or faulty equipment should be confined to a visual inspection since fumes may be toxic.

ELECTRICAL FIRE DETECTION

1. Radar blower fan switch	OFF	RT
2. Left and right recirculating fan switches	OFF	E
3. Flight station fan switch	OFF	E
4. Flight station mixing valve	COOL	E

WARNING

If the fire or source of smoke is located in the underfloor area, use extreme caution when opening floor hatches and use 100% oxygen for protection against smoke and fumes.

CONTINUED

ELECTRICAL FIRE DETECTION
(CONTINUED)

Note

If the faulty equipment can be detected immediately, proceed as follows:

1. Affected equipment	disconnect	RT
2. Portable fire extinguisher	discharge	RT

WARNING

Repeated or prolonged exposure to high concentrations of bromocloromethane or decomposition products should be avoided.

WARNING

If the concentration of smoke or fumes becomes heavy, proceed as outlined in SMOKE ELIMINATION, this Section.

Short Circuit Fire.

Fires resulting from an active short circuit cannot be extinguished until the circuit involved is dead. It is essential, therefore, to locate the fire and interrupt any circuits which may be involved as quickly as possible. If it is necessary to shut off the electrical system, the generator field circuit breakers should be opened to prevent the generators from developing any electrical potential.

CAUTION

The generator switches must be OFF before the field circuit breakers are opened to prevent the generators from developing any electrical potential.

ELECTRICAL FIRE EXTINGUISHING PROCEDURE

Note

If the source of the fire cannot be determined with a minimum loss of time, proceed as follows:

1. Automatic pilot	OFF	P
2. Flight instrument power switch	EMER.	E

Note

Monitor a. c. generator over-voltage and over-temperature warning lights. If either light is on or if the master a. c. generator warning light is on, disconnect the affected generator by means of the driveshaft disconnect switch. If either of these lights gives indication of malfunction, then proceed as follows:

3. A. C. generator	TRIP position	RT
4. Ship battery switch	OFF	E

CONTINUED

ELECTRICAL FIRE EXTINGUISHING PROCEDURE
(CONTINUED)

5. All d. c. generator switches	OFF	E
6. All generator circuit breakers	OFF	ERT

CAUTION

When the battery switch and all d. c. generator switches are OFF, the fire detection system (CO_2) propeller feathering, and a. c. generator drive-shaft disconnect will be inoperative.

7. Portable fire extinguisher	discharge	E

WARNING

Repeated or prolonged exposure to high concentrations of bromocloromethane or decomposition products should be avoided.

8. Affected circuit	identify and isolate from main bus. (if possible)	E
9. Circuit breakers (affected circuit)	OFF	E

CAUTION

Conservation of battery power for necessary flight instruments, radio communication, and auxiliary booster operation for landing is of vital importance.

TO RESTORE UNAFFECTED CIRCUITS

1. D. C. generator field circuit breakers	ON (one at a time)	E
2. D. C. generator switches	ON (one at a time)	E

CAUTION

Before turning the battery and generator switches ON, it is imperative that the source of trouble be located and the affected circuit isolated from the main bus.

3. Battery switch	ON	E
4. A. C. generator switches	RESET	RT

SMOKE AND FUME ELIMINATION— PRESSURIZED FLIGHT

WARNING

Sound judgment is required when measuring the relative danger involved in fanning the fire with fresh air and subjecting the crew to high altitude as against the alternate danger of asphyxiation. If immediate smoke removal is felt to be necessary, the following procedure may be initiated:

1. Aux vent. knob	full OPEN then to position A (when cabin differential is in 1 in. Hg)	E

Note

Position A of the aux. vent. knob supplies no ventilating air to the flight station and cabin through the normal ventilating system; therefore, the use of position A should be limited to situations wherein windows may be opened for ventilation.

2. Airspeed	reduce to 175 knots or less	P
3. Recirculating and flight station fan switches	OFF	E
4. Emergency exits	OPEN	RT

WARNING

Never open a vent or window in the flight station before there is an opening in the cabin over the wing. The pressure outside of the flight station is low and an open vent in this area will cause air to be sucked forward into the flight station. By first opening a vent over the wing, where the pressure is even lower, air from the flight station will be sucked aft and out over the wing.

5. Throttles	close and execute rapid descent procedure	P
6. Pilots windows	OPEN	PCP

Note

- If, *after cabin has been depressurized,* it is not possible to open an emergency exit, break window by using an axe or heavy object. Personnel should stay clear of the opening.
- The procedure for smoke and fume elimination during unpressurized flight is the same as recommended for pressurized flight except that in step 1 the aux vent knob should go directily to position A, and step 5 should be executed with caution, since terrain and low altitude may not permit a complete rapid descent procedure.

EMERGENCY DESCENT PROCEDURES.

Emergency rapid descent from high altitudes may be made in either the clean configuration or with landing gear down and wing flaps extended. Descent in the clean configuration can be made at speeds up to placarded limits. The most rapid rate of descent can be made in this configuration. Refer to Section V for operating limitations.

RAPID DESCENT (CLEAN CONFIGURATION)

1. Auto pilot	OFF	P
2. Engine superchargers	LOW	E
3. Mixture levers	AUTO-RICH	E
4. Manual spark	RETARD	E
5. Aux. vent knob	full OPEN, then to position A	E
6. Propellers	2600 rpm	E
7. Throttles	close smoothly	P
8. Cowl and oil cooler flaps	climatic	E

EMERGENCY DESCENT WITH GEAR AND FLAPS EXTENDED.

Descent with gear DOWN and flaps in TAKE-OFF position may be made at speeds up to the landing gear extended placarded limits; similarly, descent with landing DOWN and the flaps in LANDING position may be made at speeds up to the wing flap extended placarded limits. With landing gear and flaps extended the angle of descent will be greater than when descending in a clean configuration, but the rate of descent is lower because of the lower airspeed necessitated by the landing gear extended or the wing flaps extended limits.

RAPID DESCENT WITH GEAR AND FLAPS EXTENDED

Note

If proximity of the landing area, rough air, or the possibility of structural damage indicates the advisabliity of descending at low airspeed, rapid loss of altitude can be achieved at relatively low airspeeds with the landing gear down and the wing flaps extended. This configuration will also permit smoke removal during descent, if necessary.

1. Automatic pilot	OFF	P
2. Supercharger levers	LOW	E
3. Mixture levers	AUTO-RICH	E
4. Manual spark	RETARD	E
5. Propellers	2600 rpm	E
6. Throttle levers	close smoothly	P
7. Cowl and oil cooler flaps	100% open	E
8. Auxiliary vent knob	full open and then to position A	E
9. Wing flaps	TAKE-OFF or LANDING (or as necessary)	CP
10. Landing gear	DOWN	CP

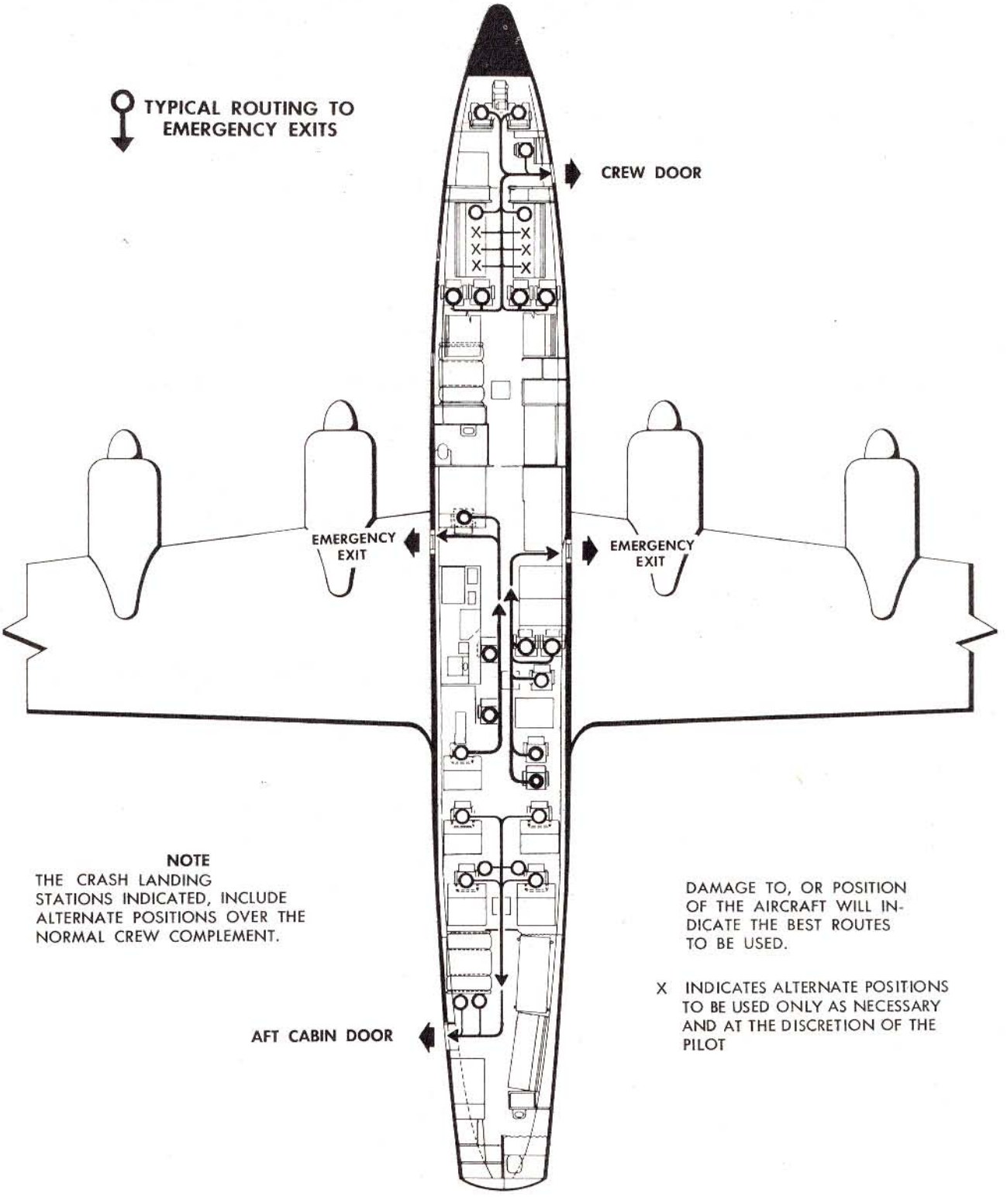


Figure 3-3. Emergency Escape Routes—Land

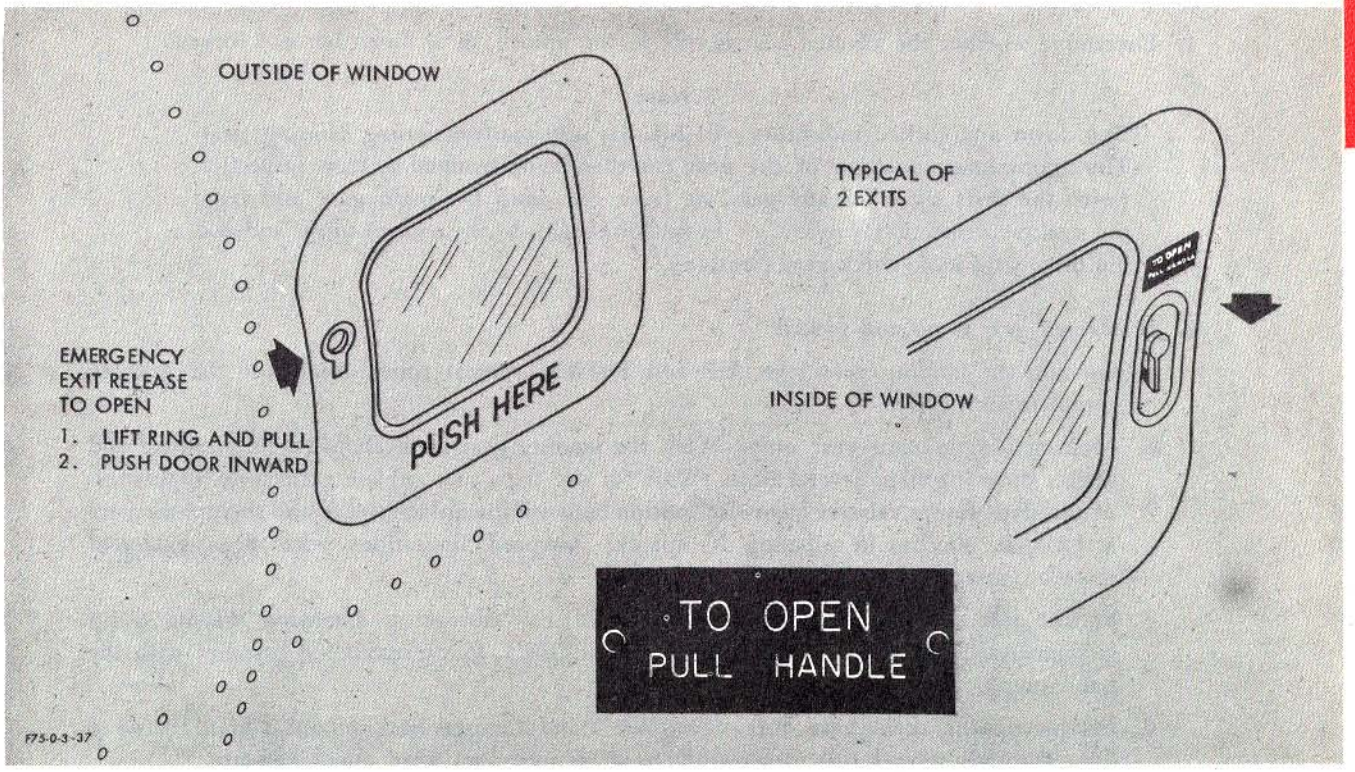


Figure 3-4. Emergency Exit Operation

LANDING EMERGENCIES (EXCEPT DITCHING).

LANDING ON SOFT GROUND OR UNPREPARED RUNWAYS.

If it is necessary to land on soft ground or on an unprepared runway, the landing should be made with the landing gear retracted.

LANDING WITH A FLAT TIRE.

Since each gear of this aircraft is equipped with dual wheels, a flat tire does not present an emergency and a normal landing can be made. If both tires are known to be flat use differential power for directional control during the landing roll-out.

LANDING WITHOUT ALL GEARS EXTENDED.

In the event that all gears can neither be extended nor retracted, land with the aircraft level and hold it that way as long as possible after the extended gear contacts the runway. If only the nose gear comes down, retract gear and make a belly landing.

LANDING GEAR SYSTEM MALFUNCTION PROCEDURES.

The following procedures are recommended for extension of the landing gear after an unsafe gear indication. After the landing gear is extended, if any of the landing gear warning devices indicate an unsafe condition of the gear, it should be considered that the gear is unsafe for landing and not that there is a malfunction of the warning system, unless definitely proven otherwise. These warnings are: glowing of the gear unlocked warning light, unlocked indication of any of the gear down and locked lights or indicators, and the sounding of the landing gear warning horn. The following procedures are based upon the assumption that normal hydraulic system pressure is avail-

able; however, certain portions of these procedures will still apply if only the emergency extension system is operating. The procedures apply to malfunctioning nose or main gear unless specified otherwise.

1. Determine whether the affected gear is still on the uplock, or is down but not locked.

Note

The down and locked indicators will identify the malfunctioning landing gear. The approximate position of the gear can then be determined by crew inspection (with the drift sight for any gear, or from the cabin for main gear and from the cockpit inspection window or by making a pass by the control tower and asking the operators to check gear position).

2. If affected gear is up and locked:
   a. Operate the landing gear lever UP and DOWN several times. Wait for the gear to complete each cycle.
   b. Malfunctioning main gear only—With the landing gear lever DOWN, fully extend and retract the wing flaps several times. Wait for the flaps to complete each cycle. Operation of the flaps causes relative spanwise motion between the uplock sleeve and the uplock jaws and may be effective in releasing the uplock. Airspeed limitations with flaps extended must be observed.
   c. Retract gear and try extending it by means of the emergency extension system, using recommended procedures (No. 3 and 4 pumps OFF). Pump maximum pressure with the hand pump.
   d. Malfunctioning main gear only—Turn No. 3 and 4 pumps back on and operate the wing flaps through several full cycles while holding maximum hand pump pressure.
   e. Make alternate push-overs and pullups while holding maximum hydraulic pressure with hand pump and normal system. Use caution to avoid exceeding aircraft structural limitations.
   f. Repeat the preceding steps as necessary. Past experience with cases of this type has shown that repeated cycling of the gear will usually result in a successful gear extension.
3. If affected gear is down but not locked:
   a. Operate landing gear control lever UP and DOWN several times. Wait for the gear to complete each cycle.
   b. Make alternate push-overs and pullups while using normal system pressure to hold gear down. Use maximum hand pump pressure if normal system pressure is not available.
   c. Extend gear with emergency extension system using recommended procedures, and pump maximum pressure with the hand pump.
   d. Repeat the preceding steps as necessary.

LANDING WITH A GEAR FULLY EXTENDED BUT NOT LOCKED:

If the procedures outlined in Item 3 above fail to lock the gear down and a landing must be made, it is still possible to land safely while holding the gear in the extended position by hydraulic pressure. To maintain sufficient pressure, it is essential to keep engines operating at an adequate rpm and to refrain from actuating other hydraulically-operated units that might cause pressure to drop in the landing gear hydraulic lines. Specifically, the following procedure is recommended:

   a. Place brake selector lever in EMER.
   b. Turn refrigerator cooling fan switches OFF; paddle switches to WARMER until secondary scoop lights are out.
   c. If certain that both hydraulic systems are operating normally, place hydraulic crossover shut-off switch in EMER (open).

d. Make a normal landing, or slightly flatter than normal, if runway length is adequate; however, it must be remembered that use of propeller reverse should be avoided, and that the aircraft, therefore, will require more landing distance than normal. Do not make an extremely slow, nose-high landing as the impact forces, if the plane should drop in a stalled condition, could tend to collapse the gear.

e. Do not use propeller reversing.

Note

Because of the geometry of the main gear, the forward motion of the aircraft being opposed by the wheel brakes will tend to hold the gear extended. This may not be true if propeller reversing is used for braking.

f. Do not use nose wheel steering unless unable to steer the aircraft by differential wheel braking. Do not turn off the runway.

g. Do not raise the flaps. Operation of the flaps will reduce hydraulic pressure which may allow the gear to collapse.

h. Maintain 1,000 to 1,200 rpm on all four engines and gradually apply the brakes. Just before the aircraft comes to a complete stop, release the brakes momentarily to allow the lower drag shock to retract and then bring the aircraft to a smooth stop. Hold position with the brakes.

Note

An rpm of 1,000 to 1,200 will give full hydraulic pressure as long as no hydraulic system units are operated. This is considerably more pressure than is required to keep the gear extended. Also, at this rpm the lower drag shock strut normally will remain retracted as the aircraft stops. It is recognized that at times the airplane will rock backward as it stops in spite of the pilot's best efforts to stop with the lower drag shock struts retracted; however, this condition is not critical as long as full hydraulic pressure is maintained and rpm is in the recommended range. Stopping with the drag shock struts retracted is recommended since it facilitates ground action in making the gear safe as explained below.

1. The hydraulic force imposed by the landing gear hydraulic cylinder acts to pull the downlock hook onto the shaft. If the lower drag shock strut is extended the tension in the drag shock strut opposes the force exerted by the landing gear hydraulic cylinder and tends to raise the downlock hook off the shaft. This may make it difficult or impossible to move the latch to the locked position in order to insert the ground safety pin.

2. If the down lock strut is broken, the landing gear hydraulic cylinder will extend until it bottoms, which will put the upper and lower drag struts in an overcenter (stable) condition. If the lower drag shock strut is extended, the tension produced opposes the force exerted by the landing gear hydraulic cylinder. This tends to pull the upper and lower drag struts back into a straight line, or on-center position, and makes it more difficult to insert bracing to hold the gear extended.

   i. Have the landing gear safety pins inserted. It may be necessary to move the downlock latch to the locked position manually. If a main gear downlock or downlock latching mechanism is damaged, thus preventing the insertion of the safety pin or rendering its insertion ineffective, block the nose wheels and jack the aircraft with a wing jack. Blocking the nose wheels will prevent the airplane from rocking off the jack when engine power is reduced should the lower drag shock struts retract at that time.

WARNING

Ground personnel should be alerted to the possibility of the landing gear collapsing while the ground safety pins are being inserted or while the aircraft is being jacked. It may be considered desirable to back a heavy truck under the wing box beam; however, to be of any help, the truck must have sufficient bearing area and strength to support the aircraft. Use of small equipment is not recommended since it will not protect personnel and will increase the damage to the aircraft if the gear does collapse.

j. Do not reduce engine rpm until either the landing gear is safely locked down or the aircraft is on jacks. When safe to do so, reduce rpm gradually to idle prior to cutting engines. Do not move the aircraft until the landing gear is safely locked.

LANDING WITH GEAR RETRACTED.

In an emergency it is possible to land this aircraft with gear retracted without serious damage. With the exception of those procedures which are obviously peculiar to ditching, the procedures for a gear-up landing are very similar to those recommended for ditching. Escape routes are shown on figure 3-3. The recommended landing procedure is given in the following steps.

Note

The pilot in command should designate a crew member to open all emergency exits prior to touchdown.

LANDING WITH GEAR RETRACTED

1. Notify crew of intention to make a gear-up landing.	P
2. Notify ground stations giving position.	P
3. Reduce gross weight of aircraft by dumping fuel.	E
4. If possible, move center of gravity to approximately 25% to 30% MAC.	P
5. All electronic equipment (radar technician's station)—OFF.	RT
6. Secure or stow loose equipment.	AOC CREW
7. Open all doors; remove and stow securely all emergency exit covers.	AOC CREW
8. Advise AOC crew to assume crash landing stations.	SD
9. Make a wide enough approach to permit feathering and positioning of inboard propellers before starting the downwind leg.	P
10. Feather propellers 2 and 3 and position them with one blade up by means of the engine starters.	E

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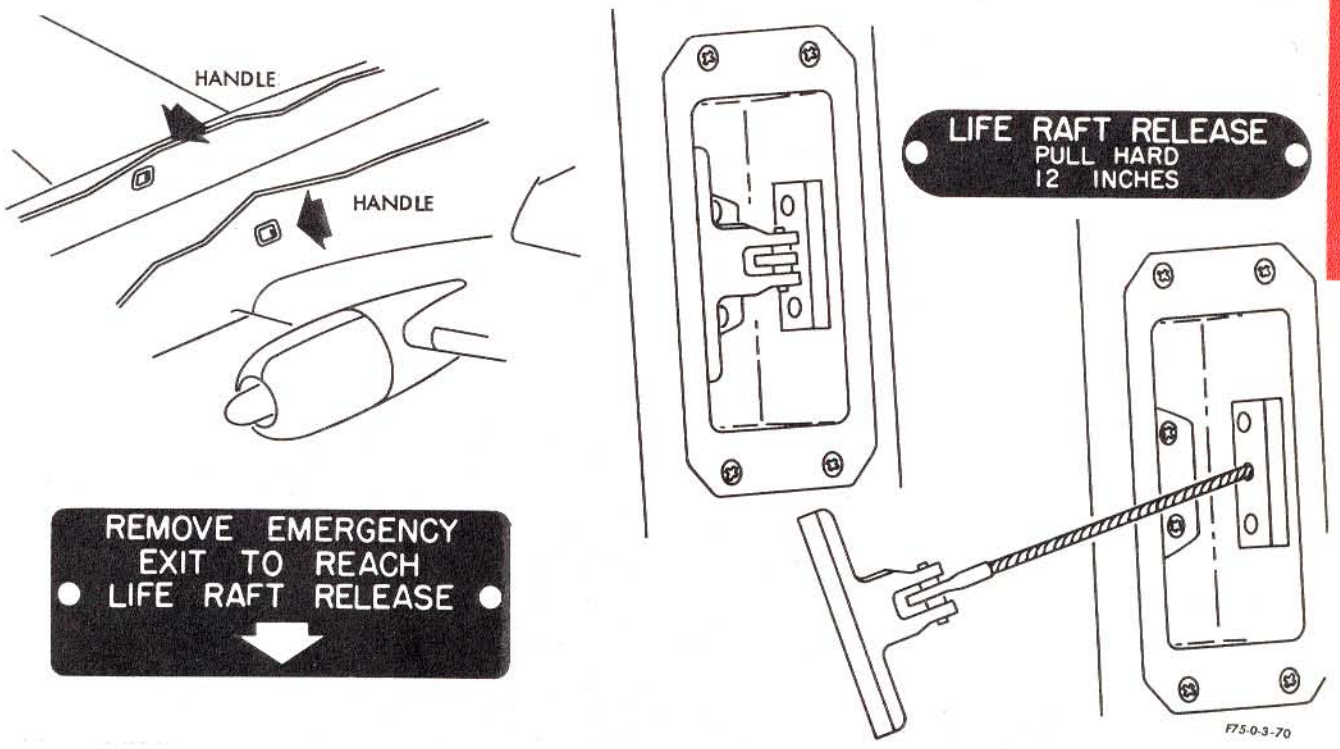


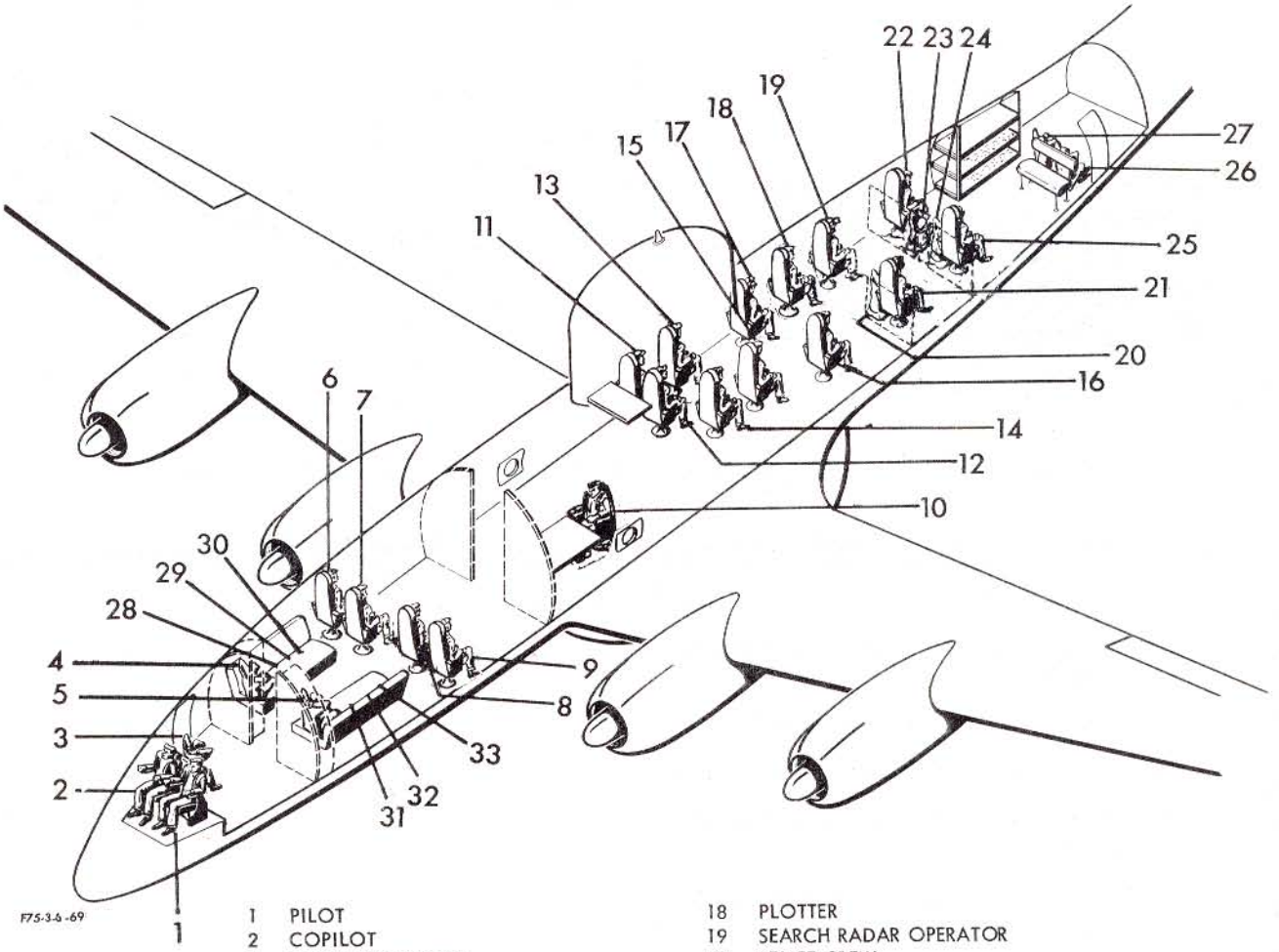
Figure 3-5. Exterior Life Raft Release (USAF Serials 53-543 and Subsequent)

LANDING WITH GEAR RETRACTED
(CONTINUED)

11. Emergency shut-off levers (for feathered engines)—all OFF.	E
12. Ignition (on feathered engines)—OFF.	CP
13. All auxiliary fuel booster pumps—OFF.	E
14. Rudder and elevator auxiliary booster switches—ON.	CP
15. Wing flaps—extend to LANDING position as soon as it is certain landing area can be reached.	CP
16. Give order to brace 30 seconds before contact.	CP
17. Mixture levers, engines 1 and 4—OFF.	E
18. Fuel tank selector levers—OFF.	E
19. Ignition switches—OFF.	CP
20. All electrical power (batteries, generators, and generator field circuit breakers)—OFF, as soon as possible after contact with ground.	E

EMERGENCY ENTRANCE.

If it is necessary to enter the aircraft to rescue trapped personnel, open the emergency exits or the aft cabin door, all of which are operable from the inside and outside. Otherwise it is necessary to chop through the fuselage at the marked cut-in areas.



1	PILOT
2	COPILOT
3	FLIGHT ENGINEER
4	RELIEF CREW
5	RELIEF CREW
6	RELIEF CREW
7	FIRST NAVIGATOR
8	SECOND NAVIGATOR
9	RELIEF CREW
10	RADIO OPERATOR
11	RELIEF CREW
12	RELIEF CREW
13	HEIGHT FINDER
14	RADAR TECHNICIAN
15	SENIOR DIRECTOR
16	DUTY DIRECTOR
17	TALKER
18	PLOTTER
19	SEARCH RADAR OPERATOR
20	RELIEF CREW
21	SURVEILLANCE SUPERVISOR (AOC NO. 1)
22	SEARCH RADAR OPERATOR
23	RELIEF CREW
24	RELIEF CREW
25	SEARCH RADAR OPERATOR
26	RELIEF CREW
27	RELIEF CREW
28, 29, 30, 31, 32, 33	ALTERNATE POSITIONS TO BE USED ONLY AS NECESSARY AND AT DISCRETION OF PILOT

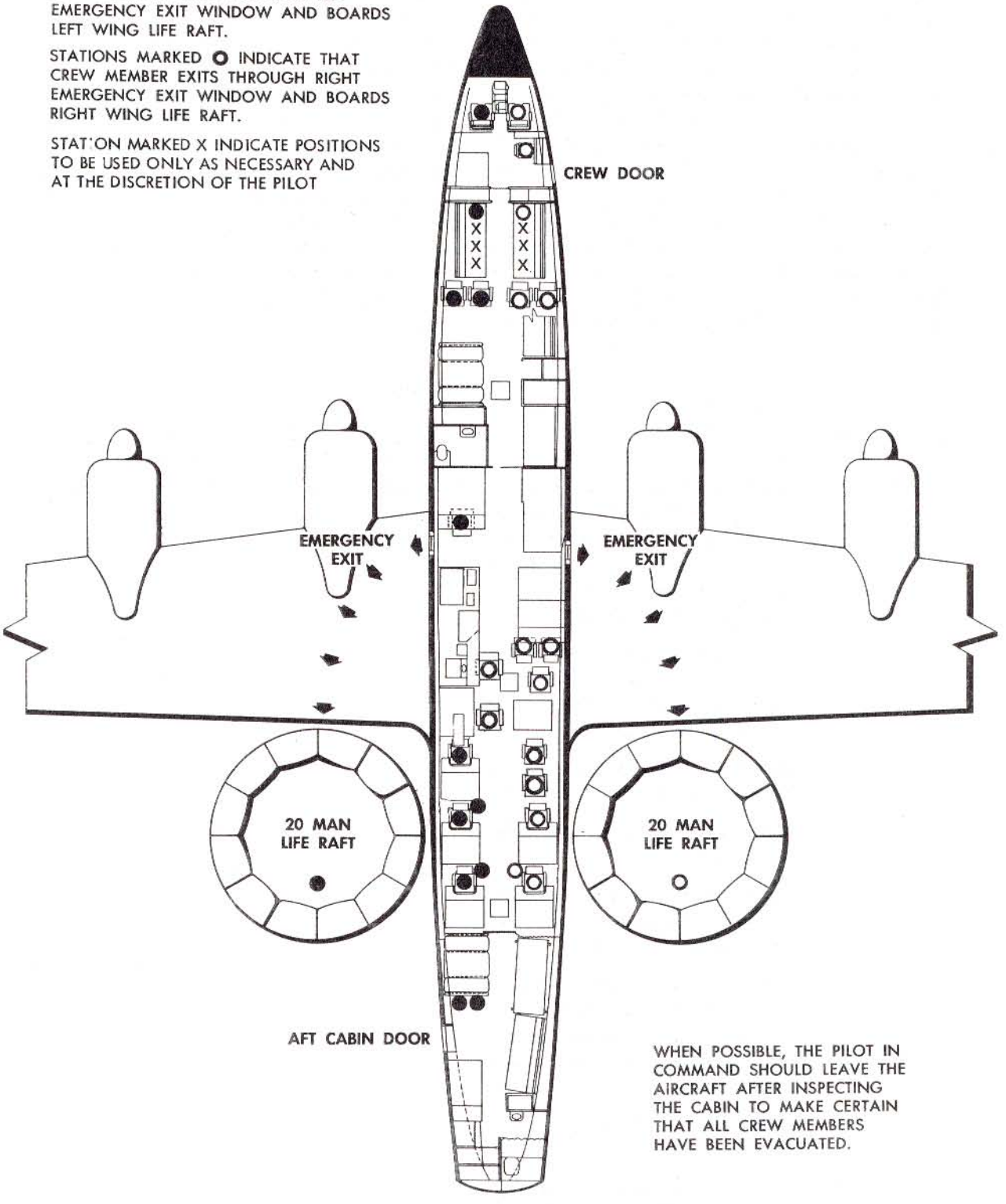
Figure 3-6. Ditching and Crash Landing Positions

NOTE

STATIONS MARKED ● INDICATE THAT CREW MEMBER EXITS THROUGH LEFT EMERGENCY EXIT WINDOW AND BOARDS LEFT WING LIFE RAFT.

STATIONS MARKED ○ INDICATE THAT CREW MEMBER EXITS THROUGH RIGHT EMERGENCY EXIT WINDOW AND BOARDS RIGHT WING LIFE RAFT.

STATION MARKED X INDICATE POSITIONS TO BE USED ONLY AS NECESSARY AND AT THE DISCRETION OF THE PILOT



WHEN POSSIBLE, THE PILOT IN COMMAND SHOULD LEAVE THE AIRCRAFT AFTER INSPECTING THE CABIN TO MAKE CERTAIN THAT ALL CREW MEMBERS HAVE BEEN EVACUATED.

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Figure 3-7. Emergency Escape Routes—Water

DITCHING.

Ditching is the term used to describe an emergency landing and abandonment of an aircraft on water. Extensive tests have been made with models to determine the probable stresses which would develop under such conditions. Since the skin on the bottom of the fuselage may be damaged enough by a hard landing on rough water to start leaks, all efforts must be directed toward a prompt and orderly abandonment of the aircraft as soon as it decelerates. (Refer to figure 3–7). It is essential that each crew member be thoroughly familiar with ditching procedures, and with his duties and the duties of all other crew members, so that in case of injury to one, the duties of the injured crew member may be assigned to or assumed by another. Responsibility for each piece of equipment to be removed from the aircraft should be assigned to various regular crew members. Periodic drills will insure orderly operation when an emergency occurs, and will familiarize flight personnel with the location of all emergency equipment. The following procedures are based on tests made on a scale strength model of the earlier Constellation (without radomes) by the NACA in the Langley Aeronautical Laboratory tank, and upon the experiences of military personnel who have ditched other four-engine aircraft successfully. A description of each crew member's duties and other helpful information is listed on the ditching chart.

DITCHING CHART

Crew Member	DUTY	PROVIDE	POSITION	EXIT
PILOT:	Give the proper alarm bell warning followed by announcement on emergency ICS of the existing emergency condition and intentions. Announce the estimated time prior to ditching.	Flashlight, one-man life raft.	Station No. 1	Left emergency exit.
	Set course to the nearest land or surface vessel. (Information furnished by the Navigator and/or Senior Director.)			
	Order fuel to be dumped, if necessary, if no fire is involved.			
	Order flight engineer to depressurize cabin.			
	Order copilot to don necessary survival equipment; adjust and fasten shoulder harness.			
	Order copilot to take over control of the aircraft and don necessary survival equipment; adjust and fasten shoulder harness and safety belt.			
	Jettison or use flares (if installed).			
	Order copilot to give 3-minute warning on PA system and interphone.			
	Order copilot to give one long ring on alarm bell immediately prior to impact. After assuring			

	that all personnel have left the aircraft assume command of the left life raft.			
CO-PILOT:	Send emergency message with UHF on guard channel. Secure all loose equipment in flight station. Don necessary survival equipment and place pilot's survival equipment advantegeous to his station. Adjust and fasten shoulder harness and safety belt. Give three-minute warning on emergency ICS on order from the pilot. Assist pilot as required. Render one long ring on alarm bell immediately prior to impact when ordered by the pilot. Confirm that the life rafts have been released and are inflated. (Note: Life raft release handles are located at emergency escape hatches on USAF Serials 53-539 and subsequent.) Assume command of the right life raft.	Flashlight, one-man life raft, first aid kit.	Station No. 2	Right emergency exit.
FLIGHT ENGINEER:	Dump fuel at pilot's order. Depressurize cabin at pilot's order. Pull ditching valve release handle and close auxiliary ventilation valves. (Position A). Turn paddle switches to warm. (Lights out). Don necessary survival equipment. Pass loose gear aft for jettisoning. Turn the emergency flight instrument inverter ON. Turn emergency ditching light ON. Turn seat aft, install headrest, and fasten safety belt.	Flashlight, one-man life raft, first aid kit.	Station No. 3 Turn seat aft and install head-rest.	Right emergency escape hatch.

	Brace for impact. Turn battery and generator switches OFF after impact. Turn ON all fire extinguisher selectors and switches (HRD system) after impact. Release life rafts (if applicable).			
FIRST NAVIGATOR:	Acknowledge warning announcement. Give pilot heading and distance to the nearest land or surface vessel. Establish position and pass report to pilot, radio operator, and the senior director. Report shall include position, time, course, speed, and altitude. If time permits add estimated ditching position or time. Stow all loose equipment forward of radio rack or in the forward lavatory. Turn ON emergency ditching light. Prepare kit with necessary plotting equipment, charts, and aeronautical publications. Stow kit and periscopic sextant under navigation table. Don necessary survival equipment (including URC-4 radio). Remove right emergency escape hatch and stow forward of the radio rack. Loosen emergency escape rope over emergency exit. Assume ditching position at 3-minute warning and brace for impact.	Navigation kit, periscopic sextant, URC-4, one-man life raft.	Station No. 7	Right emergency exit.
SECOND NAVIGATOR:	Don necessary survival equipment. Assume ditching position and brace for impact. Direct removal of food and water from galley, use personnel ditching in the forward crew area.	First aid kit Pyrotechnic pistol and cartridges, one-man life raft.	Station No. 8	Left emergency exit.

	Distrubute supplies to crew departing from both exits.		
RADIO OPERATOR:	Acknowledge warning announcement. Turn IFF to emergency. Send emergency message to appropriate ground station. Don necessary survival equipment (including the URC-4 radio). Stow or jettison loose equipment. Remove left emergency escape hatch and stow it forward of the radio rack. Loosen emergency escape rope over left emergency exit. Continue sending emergency message. Turn on automatic keyer device or lock key down, if applicable, at the three-minute warning announcement. Assume ditching position and brace for impact. Release life raft. Throw ditching rope out on the wing. Hold raft clear of torn metal and in position for boarding.	URC-4 flashlight, one-man life raft.	Station No. 10 Left emergency exit.
FIRST RADAR TECHNICIAN:	Turn cabin lights on BRIGHT. Stow or jettison all loose equipment. Turn OFF electronics equipment and inverter upon notification from the senior director. Note: Leave A. C. generator ON. Don necessary survival equipment. Turn seat aft and fasten safety belt. Brace for impact. Push radar technician's chair full forward against table after aircraft comes to rest.	One-man life raft.	Station No. 15 Left emergency exit.

SENIOR DIRECTOR:	Acknowledge warning announcement. Advise pilot of heading and range to the nearest land and/or surface vessel, as determined by radar equipment. Continue UHF communication on any channel other than guard. Don necessary survival equipment and supervise the following: Cabin and emergency lights on BRIGHT. Electronic equipment OFF when ordered by the pilot. Have loose equipment stowed in lavatories and empty bunks. Curtain removal and distribution for use as blankets. Escape hatches open. Insure that crew members are in ditching positions. Notify the pilot that the cabin is ready. Assume ditching position. Brace for impact. Supervise evacuation of personnel from aft cabin area.	One-man life raft, CRT-3 (Gibson Girl).	Station No. 15	Left emergency exit.
ADDITIONAL CREW MEMBERS:	Assist in preparing aircraft for ditching as directed. Don necessary survival equipment. Check immediate area for loose gear, stow in lavoratories and in empty bunks. Assume ditching position. Brace for impact.	One-man life raft.	Assigned ditching positions.	Emergency exit on same side of aircraft as ditching position.

DITCHING PROCEDURES

Note

The relief crew members will perform such duties as the pilot may direct. Do not attempt to open emergency exits until the cabin is depressurized, except under extreme circumstances. If it is necessary to dump pressure in a hurry and in order to get emergency exits opened, break window and stay clear of opening.

1. Crew	alert and don life vests	P

WARNING

Do not inflate life vests inside the aircraft. Be certain that all crew members are so instructed. In the event of rapid submersion, an inflated life vest will make it impossible for the wearer to dive to the exit level to escape from the sinking aircraft.

2. Electronic equipment	OFF	SDRT
3. Flares	jettison	P

WARNING

Do not jettison flares while dumping fuel.

4. Fuel	dump	E

Note

Reduce fuel load to the lowest practical minimum before ditching. Empty, or nearly empty, fuel tanks will provide extra buoyancy.

WARNING

Make certain that fuel dump valves are closed before making contact with the water, and close all openings below waterline. This includes two cabin doors, flight station door, and auxiliary ventilation intakes and exits.

5. Ditching valve	close	E

Note

The emergency exits should be opened prior to touchdown.

6. Paddle switches	WARMER (until lights are out)	E
7. Aux. vent. knob	position A	E

Note

- If possible, ditch while power is still available. If ditching without power, plan to touchdown in a nose-high attitude.

CONTINUED

DITCHING PROCEDURES
(CONTINUED)

- Surface stations and ships should be informed of the existence of the emergency as soon as it arises. This should be done even if it is not certain that the aircraft will have to be ditched.
- It is difficult to judge height above the water when the sea is calm. At night landing lights may make the estimation of distance above water even more difficult.
- Alight near the crest and parallel to the swell, unless there is a strong crosswind of 30 mph or more. If there is a strong crosswind, alight into the wind, making contact on upslope of a swell near the top.
- Wave motion is indicative of wind direction, but swells do not necessarily move with the wind. Conditions of water surface are indicative of wind speed. The following table may be helpful:

Surface Condition	*Approx. Wind Velocity*	
	Knots	*MPH*
Few white crests	9-17	10-20
Many white crests	17-26	20-30
Streaks of foam from crests	26-35	30-40
Spray blown from tops of waves	35-43	40-50

8. Power (if available)	as desired (to point of contact)	P

Note

Descend at a minimum safe rate in a flattened approach attitude.

9. Flaps	LANDING	CP
10. Landing gear	UP	CP

WARNING

Keep flight station windows closed because the aircraft has a tendency to nose under as it loses forward speed on water.

ABANDONMENT.

Unless the bottom has been seriously damaged, leakage should be slow, and the aircraft should float long enough to evacuate all flight personnel safely. Evacuation must be conducted in an orderly manner as shown in figure 3–8. After the life rafts have been loaded, and if it appears safe to do so, salvage any additional equipment and valuables which can be transported without jeopardizing the comfort and safety of the crew members aboard the life rafts. Any coats and blankets which can be carried into the life rafts will provide welcomed protection. Space limitations will dictate how much extra equipment can be taken.

AFTER DITCHING.

The forward crew door and the aft cabin door provide the easiest means of exit; however, the window exits must be used to board the wing life rafts. These exits are convenient for evacuation. because the wings provide a pier from which the rafts may be boarded. Emergency supplies should be distributed among the rafts and tied down in the center of the rafts to prevent them from being

lost in case the raft should capsize. After all crew members have been evacuated, move the rafts out from under any part of the aircraft which might strike them as it sinks. Rope the rafts together so that they will not drift apart or become separated and complicate rescue. Remain in the vicinity of the aircraft as long as it remains afloat.

WARNING

Do not open any doors if their sills are below water. Use emergency exits.

BAIL OUT.

When the decision is made to abandon the aircraft while in flight, the pilot will advise the crew of his intensions over the interphone and P. A. system, and sound the alarm bell. If over land, the pilot will turn the aircraft and head for an uninhabited area in a slightly nose-down attitude. If over water, the pilot will execute a 360-degree turn to the left in a slightly nose-down attitude until all crew members have abandoned the aircraft. The duty director will be designated jump master on all AOC missions.

BAIL OUT

1. Alarm bell	sound (three short rings—prepare for bail out)	P

Note

Crew members will don their survival equipment and remain at their station until the final bell signal is given.

2. AOC crew	acknowledgement	all crew members
3. Airspeed	reduce (if possible)	P
4. Aircraft trim	slightly nose down	P
5. Alarm bell	sound (one long ring-bail-out)	P

Note

The automatic pilot may be engaged to maintain course and stability for crew abandonment.

FUEL DUMPING

1. Alert AOC crew		P
2. Radar equipment	STANDBY	SD
3. Wing flaps	UP	CP
4. Landing gear	UP	CP
5. Airspeed	150 to 165 knots; do not exceed 190 nor reduce to less than 140 knots	P
6. Cabin heaters	OFF	E

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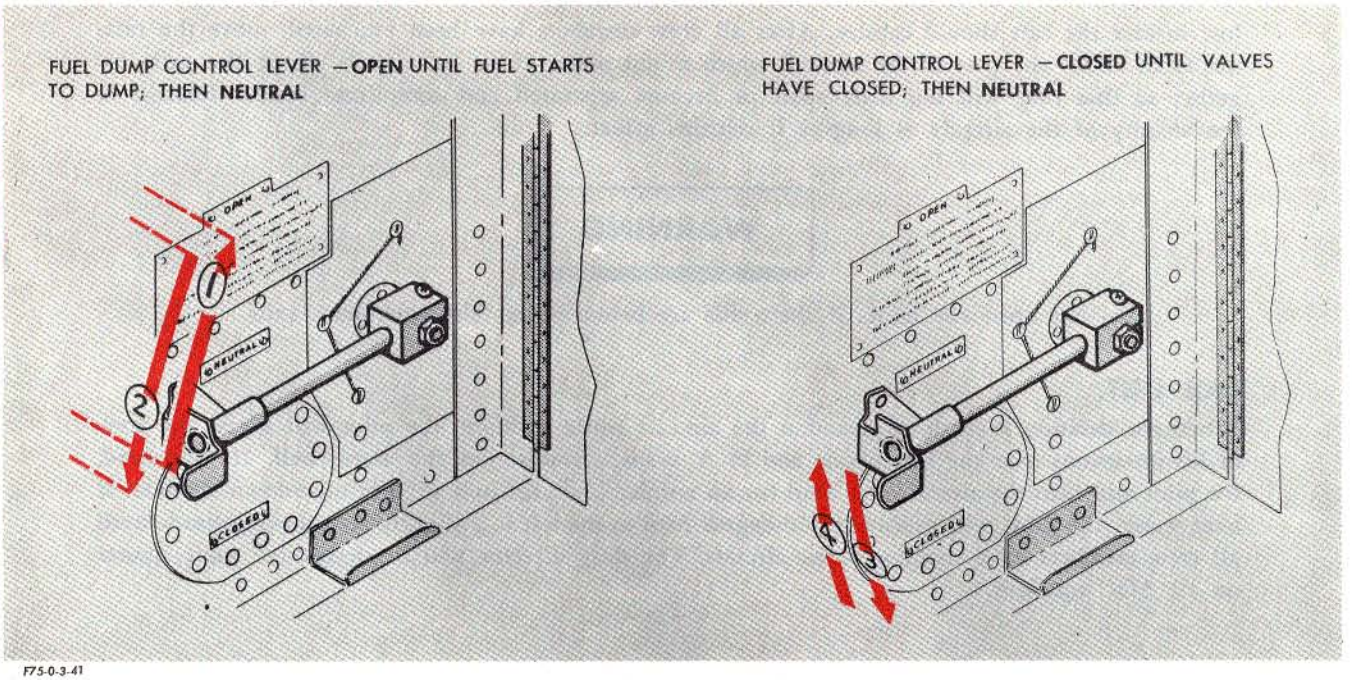


Figure 3-8. Fuel Dumping Procedures

FUEL DUMPING
(CONTINUED)

7. Fuel dump lever	OPEN. (When fuel starts to dump, move to NEUTRAL)	E
8. Auxiliary fuel pumps for tank 6 (6L and 6R)	HIGH (only after fuel has started to dump)	E
9. Fuel dump lever	CLOSED. (When valves are closed, move to NEUTRAL)	E

Note

In order to dump the fuel in tank 6, it first must be transferred into tanks 1 and 4 by use of the auxiliary fuel booster pumps (6R and 6L).

CAUTION

Auxiliary booster pumps 6R and 6L should never be in the HIGH position except during fuel dumping operations. Refer to Fuel Dump Rates.

AIRCRAFT SYSTEMS FAILURE.

ELECTRICAL POWER SYSTEM FAILURES.

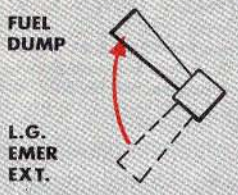
It is extremely difficult to anticipate all of the possible failures and plan corrective action for each individual failure. A broad analysis of the situation indicates that electrical failures fall into three possible categories as follows.

LOSS OF PRIMARY POWER SOURCE

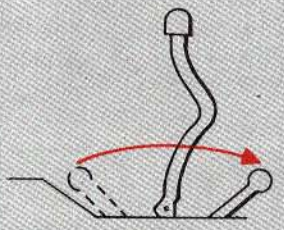
If a field relay circuit breaker switch trips, reset and check for overload. If the field relay trips again, do not reset until the source of trouble is located and corrected. To provide further feeder protection open the field circuit breakers.

TO DUMP

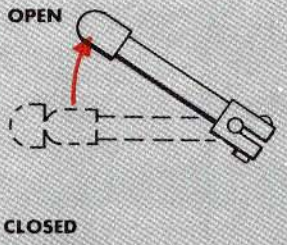
1. Emergency fuel dump lever—**FUEL DUMP** position.



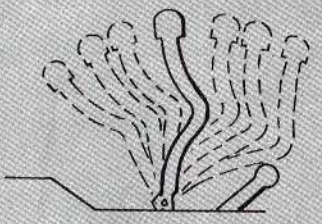
2. Emergency hand pump selector lever—**EMER. GEAR** (aft position).



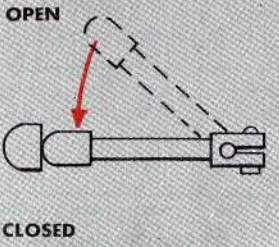
3. Fuel dump control valve lever (sta. 260)— **OPEN.**



4. Emergency hand pump—Operate until fuel starts to dump.

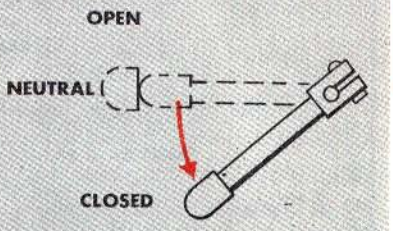


5. Fuel dump control valve lever (sta. 260)— **NEUTRAL.**

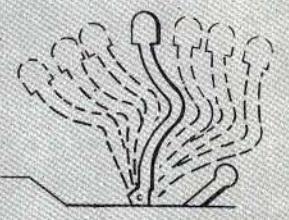


AFTER DUMPING

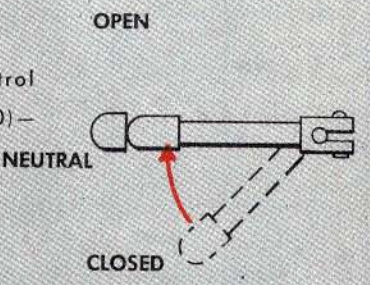
6. Fuel dump control valve lever —**CLOSED.**



7. Emergency hand pump—Operate until dump valves are closed and the inboard dump chutes are retracted.



8. Fuel dump control valve lever (sta. 260)— **NEUTRAL.**



9. Emergency hand pump selector lever—**EMER. BRAKES** (forward position).

10. Emergency fuel dump lever—**L. G. EMER. EXT.** position.

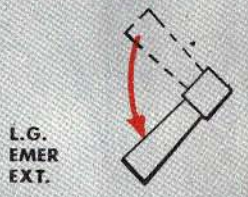


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Figure 3-9. Fuel Dumping Emergency Hand Pump Operation

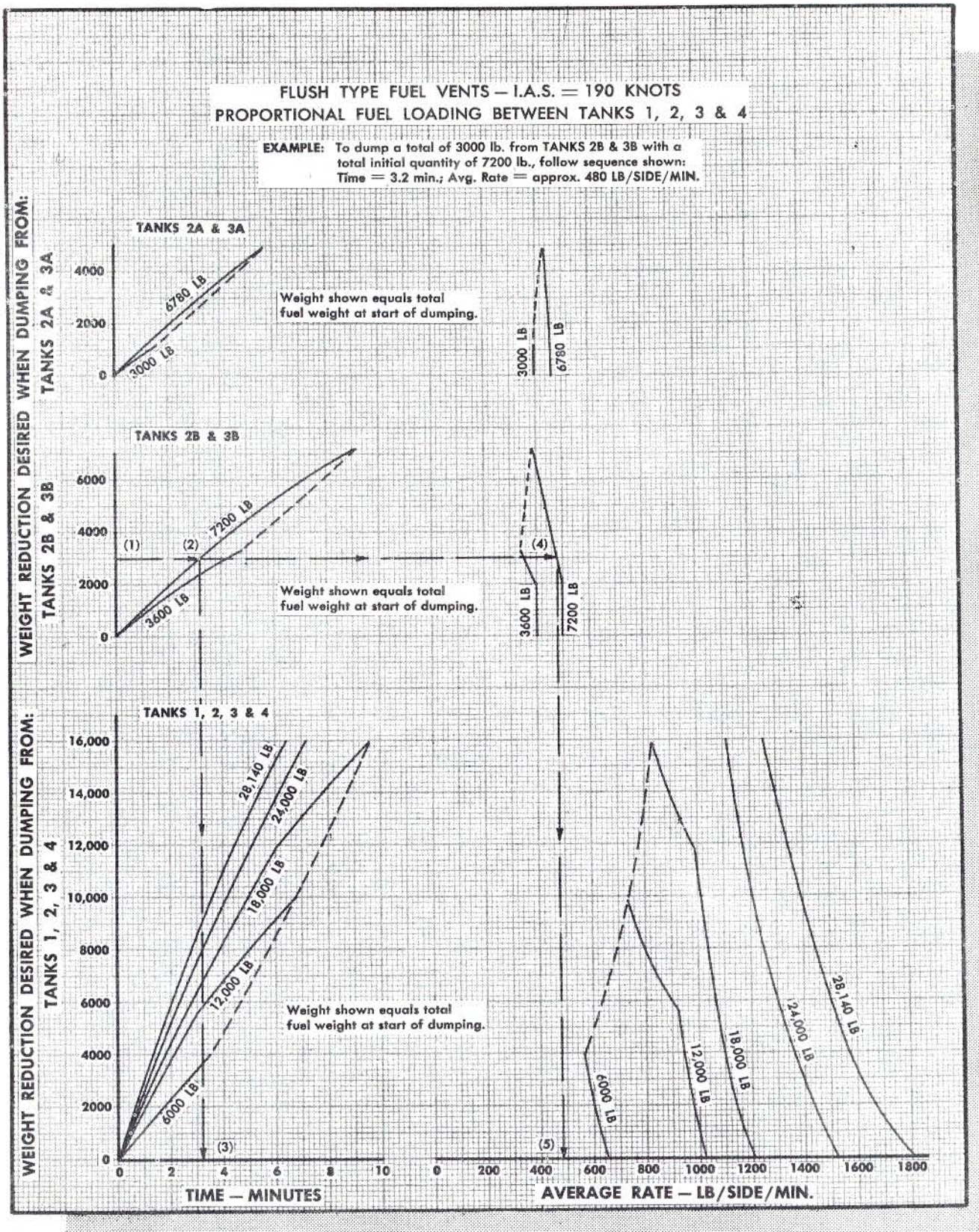

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Figure 3-10. Fuel Dump Rates

FAILED GENERATOR

1. Operating generators	monitor load so that ratings will not be exceeded.	E
2. Generator switch	OFF (inoperative generator)	E
3. Generator voltage	check	E

CAUTION

If the generator overheat warning light remains on and voltage is erratic, or the field relay trip light comes on, feather the engine.

Note

- Generators driven by engines No. 1 and No. 4 can be disengaged by means of the drive shaft disconnect.
- If the generator overheat light remains on and the voltage and field relay trip light is normal, the overheat condition could be caused by a blocked air duct or shorted warning light circuit. Leave the generator switch off.

LOSS OF ALL GENERATORS

1. Flight instrument switch—EMER.
2. Generator switches—OFF.
3. Ship battery switch—OFF.

Note

If fuel requirements are not critical, engine rpm should be increased to a value that will permit ample power for a go-around, before battery power is depleted.

Equipment and Distribution System Faults.

If one or more items of electrical or electronic equipment should fail, isolate the faulty item by opening the fuse or circuit breaker. Faults on the distribution system should clear through the action of circuit breakers, fuses, limiters, and generator protection systems. They may result in smoke and require some emergency corrective action. Refer to ELECTRICAL FIRE. Faults on the bus or complete loss of d. c. system from other causes are unlikely.

A.C. Generator Drive-Shaft Disconnect

When the over-voltage warning light glows, the flight engineer should have the AOC crew monitor the electrical load and reduce it as necessary to relieve the situation. Reset the tripped generator. If the generator trips again do not reset until the fault has been corrected. If the over-temperature warning light glows have the AOC crew remove part of the associated a. c. generator load. If the temperature cannot be lowered sufficiently, trip the generator from the bus. If this action does not lower the temperatures to within tolerance, disconnect the drive shaft to the associated generator.

Note

- If the a.c. generator drive shaft is disconnected, it cannot be reconnected in flight.

- Since each gear box drives one a.c. generator and one d. c. generator, both will be disconnected and monitoring of the d. c. loads will be required.

HYDRAULIC SYSTEM FAILURE.

It is not advisable to operate the hydraulic system crossover valve, it will be necessary to power the brakes with the emergency brake system, extend the gear with the emergency extension system, extend the flaps by emergency handcrank, and dump fuel by means of the emergency system. This valve should be opened only when the primary system becomes inoperative without loss of hydraulic fluid indicated on the reservoir gage (engines 1 and 2 are feathered or both primary system pumps are inoperative) *or* when the secondary system becomes inoperative due to shut-down of engines 3 and 4 and the secondary pressure is essential for landing gear, wing flap, nose wheel steering, and brake operation.

WARNING

Do not place the hydraulic system crossover valve in the EMERGENCY position until it has been determined that a complete loss of the remaining hydraulic fluid will not occur.

LOSS OF BOOSTERS IN FLIGHT

1. Automatic pilot—	OFF	P
2. Aircraft	retrim	P
3. Hydraulic system	trouble shoot	E

Note

Reduce airspeed to 155 knots or less before opening the crossover valve.

4. Hydraulic system crossover switch	EMER	E

CAUTION

Do not move the hydraulic system crossover switch to the EMERGENCY position until it has been determined that a complete loss of the remaining fluid will not occur.

BOOST OFF LANDING.

When a boost-off landing is necessary, aircraft loading should be arranged to give a gear-down CG of 23% to 30% MAC. The forward GC position is limited by inability to flare for landing because of reduced elevator travel (elevator shift lever pulled out to EMER. position). The aft CG position is limited by the possiblity of experiencing insufficient down elevator in case it is necessary to use full power at low airspeed in rough air. The wing flaps should be placed in the TAKE-OFF position, and the approach speed should be slightly higher (140 knots) than that normally used for boost-on landing. This is necessary to counteract the effect of the higher stalling speed with the reduced elevator travel. A longer, flatter approach with more power is desirable since a lesser amount of flare and attitude change will be required than when a higher and steeper approach is made. If difficulty is encountered in flaring, power may be used to pull the nose up. Ailerons or differential power may be used to raise the wings. Rudders and/or differential power may be used for directional control. Turns may be made either with rudder, or ailerons or differential power.

Note

Should trouble shooting disclose that actuation of the hydraulic system crossover switch would result in complete loss of the secondary hydraulic system, the aircraft should be operated, at the pilot's discretion, with either the rudder and elevator auxiliary booster switches ON and the aileron booster lever OFF, or all boosters OFF.

Failure of Both Hydraulic Systems.

In the event that a hydraulic system failure disables both the primary and secondary hydraulic systems, the automatic pilot (operated with boost off) may be used in preference to the auxiliary electrically-driven booster system while cruising, particularly during a long flight. Under these conditions, the use of the automatic pilot would save the auxiliary booster motors for landing at the end of the flight. Use of the automatic pilot in preference to manual flying of the aircraft with boost off also presents an obvious advantage to the pilot. The automatic pilot should never be used under conditions wherein the boosters are being shifted off and on. It is very important to make certain that the automatic pilot is disconnected before shifting the boosters either from OFF to ON, or ON to OFF. In rough air, if the automatic pilot is used with the surface control boosters off, it is important to realize that the automatic pilot cannot control the aircraft properly; hence, a gust of wind can cause the aircraft to be placed in an unusual attitude if too much reliance is placed on the automatic pilot. Therefore, the human pilot should monitor the controls very closely under these conditions. No automatic pilot malfunction tests have been conducted with the surface control boosters OFF. In the event of an automatic pilot malfunction, the forces applied to the surface controls by the automatic pilot are not great enough to cause a quick change in the aircraft attitude. However, it is possible that an automatic pilot malfunction could cause a very slow and gradual maneuver, such as a diving spiral. Boost off recovery from such a maneuver, should it become well developed before corrective action is initiated, could become very difficult. Therefore, the pilot should be prepared at all times to take corrective action immediately should a malfunction occur. Use of the automatic pilot with the surface control boosters off is approved; however, it is not necessarily recommended for all conditions. When using the automatic pilot with boosters off, the various limitations described in these paragraphs should be clearly understood.

TURNING BOOSTERS ON IN FLIGHT

CAUTION

Once the boosters have been turned off, they should not be turned on again unless it is definitely known that the cause of the malfunction no longer exists. If the decision is made to turn the boosters on the following procedure must be used:

1. Airspeed	130 to 155 knots	P

Note

With the airspeed in this range, an abrupt control surface deflection is not likely to cause a serious change in attitude, and consequently will not subject the aircraft structure to as large loads as would be the case at higher speeds.

2. Altitude	as required	P

Note

Maintain sufficient altitude to permit recovery from any inadvertent attitude change.

CONTINUED

TURNING BOOSTERS ON IN FLIGHT (CONTINUED)

3. Automatic pilot	OFF	P

Note

Trim the aircraft longitudinally, laterally, and directionally for hands-off, straight and level flights. Even though the aircraft is trimmed for hands-off flight with boost off, it is possible that a boost control valve may be slightly open, and when the boost is turned on, may cause an abrupt change in control surface position. For this reason, airspeed should be held within the range noted in step 1.

CAUTION

Do not apply any force to the rudders, elevators, or ailerons, but merely hold the controls lightly. This is important because the application of pressure to any of the controls will open the booster control valve which, when boost is turned on, will result in large deflection of the control surface.

4. Boost control levers	ON (move slowly)	P

Note

Positioning the control levers slowly has the effect of turning on hydraulic pressure slowly, which, if a booster control valve is slightly open, will preclude the possibility of an abrupt surface control deflection. In the event there is some misrigging between the aileron booster units, turning the aileron booster on slowly may cause the aircraft to rock laterally.

EMERGENCY LANDING GEAR EXTENSION.

Refer to figure 0_00 for emergency gear extension procedures. The landing gear uplocks and downlocks must be operated by hydraulic pressure. When the landing gear lever is placed in the DOWN position, the weight of the gear and the slipstream may force the gear to the extended position but it may not lock. Therefore, the emergency extension system must be used to assure locking in the down position. If after all normal and emergency procedures for extending and locking the gears do not give a down and locked indication, maintain engine rpm between 1000 and 1200 after landing until landing gear ground lock pins have been installed (refer to LANDING WITH UNLOCK GEAR INDICATION).

EMERGENCY LANDING GEAR EXTENSION

1. Landing gear lever	DOWN	CP
2. Emergency fuel dump lever	L. G. EMER. EXT	CP
3. Emergency hand pump selector	EMER. GEAR (aft)	CP
4. Emergency hand pump	pump (until gear is down and locked)	CP
5. Landing gear position indicator	check (down & locked)	P
6. Emergency hand pump selector	EMER. BRAKES (forward)	CP

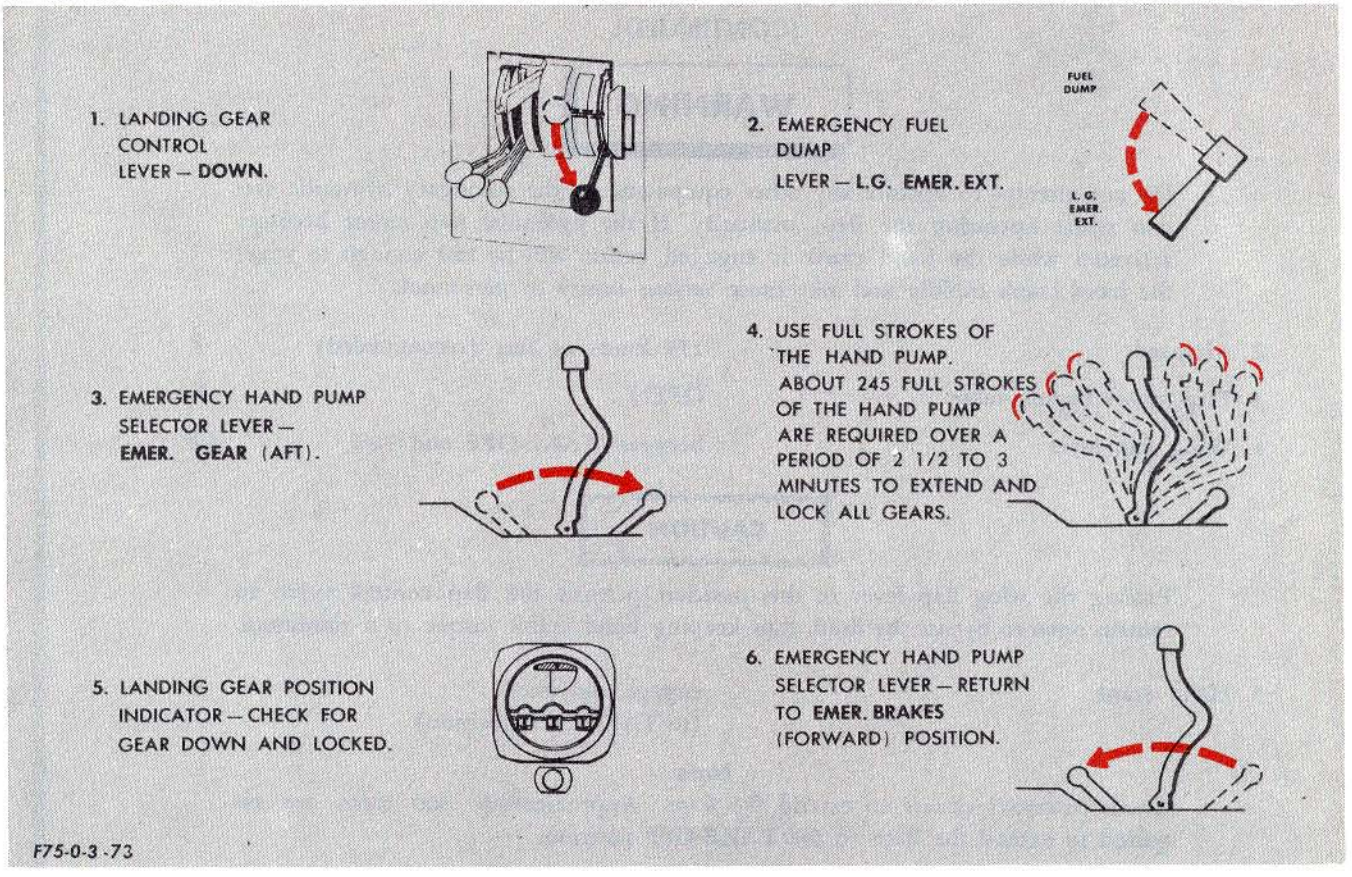

Figure 3-11. Emergency Gear Extension

EMERGENCY WING FLAP OPERATION.

The wing flaps may be extended or retracted manually in the event of failure of the secondary hydraulic system. However, movement of the wing flaps is very slow when powered by the hand crank.

For this reason, normal extension beyond the TAKE-OFF position in flight is not recommended, and manual retraction is not considered, although it is possible.

WARNING

Do not retract flaps or otherwise use secondary hydraulic system.

EMERGENCY WING FLAP OPERATION

1. Emergency shut-off levers (No. 3 and 4) — HYD. OIL OFF (first detent) — E

Note

When the emergency shut-off levers for engines 3 and 4 are placed in the HYD. OIL OFF position, the secondary hydraulic system will be inoperative. Actuation of the hydraulic system cross-over switch will permit use of primary hydraulic system pressure for normal wing flap operation.

CONTINUED

EMERGENCY WING FLAP OPERATION
(CONTINUED)

WARNING

Do not attempt to operate any other equipment on the secondary hydraulic system while operating the flaps manually. If the hydraulic flap motor becomes activated while the hand crank is engaged, action will be fast enough to whirl the hand crank rapidly and may cause serious injury to personnel.

2. Airspeed	175 knots or less (recommeded)	P
3. Flap motor bypass valve	OPEN	E
4. Wing flap lever	between TAKE-OFF and 70%	CP

CAUTION

Placing the wing flap lever in this position permits the flap control valve to remain open to bypass the fluid, thus keeping hand crank torque to a minimum.

5. Hand crank	engage and crank (to TAKE-OFF position)	E

Note

Crank counterclockwise to extend the flaps. Approximately 360 turns are required to extend the flaps to the TAKE-OFF position.

WARNING

Never engage hand crank unless the emergency shut-off levers for engines 3 and 4 are in the HYD. OIL OFF position. Never engage hand crank unless the flap motor bypass valve is OPEN.

6. Wing flaps	visually check	E
7. Hand crank	remove	E

Note

After manual flap extension or retraction has been completed, the following procedure is recommended to restore the secondary hydraulic system.

a. Wing flap lever	TAKE-OFF	E
b. Flap motor bypass valve	CLOSED	E
c. Emergency shut-off levers (Nos. 3 and 4)	ALL ON	E

EMERGENCY BRAKE OPERATION.

Note

When the brake accumulators are charged normally, approximately ten applications are available. Brake selector lever must be in EMER. before the accumulator can be charged.

If a brake emergency occurs after touchdown in which little or no braking action can be developed by any of the following emergency procedures, propeller reversing is available for aerodynamic braking. However, reversing should be used judiciously if the secondary hydraulic system is inoperative because nose wheel steering will not be available. If the accumulator pressure has been depleted, hold brake pedals down and use emergency hand pump.

WITH SECONDARY SYSTEM PRESSURE ONLY

Note

If there is no braking action with the brake selector lever in NORM position:

1. Brake selector lever	EMER	CP
2. Emergency hand pump	standby	CP

WITH SECONDARY SYSTEM PARTIALLY INOPERATIVE

Note

With propeller feathered on either No. 3 or No. 4 engine, or with the hydraulic pump on either of these engines shut down, landing gear actuation, wing flap drive, and operation of the right secondary heat exchanger fan motor may be slower than normal. If there is no braking action with the selector lever in the NORM. position:

1. Hydraulic system cross-over switch	EMER	E
2. Paddle switches	WARMER (until lights are out)	E

WITH SECONDARY SYSTEM COMPLETELY INOPERATIVE

Note

Actuation of the hydraulic system crossover switch will permit primary system pressure to replace secondary system pressure which will provide normal hydraulic system operation.

WARNING

In the event secondary hydraulic system failure is due to loss of hydraulic fluid which may be indicated by the illumination of either secondary system pump warning light closely followed by illumination of the other, (No. 4 and then No. 3), opening of the hydraulic system crossover valve may cause loss of primary system fluid. If a noticeable loss of fluid is indicated by the primary system fluid quantity reservoir gage, the hydraulic system crossover switch should be returned to NORMAL position immediately to prevent complete loss of fluid.

CONTINUED

WITH SECONDARY SYSTEM COMPLETELY INOPERATIVE (CONTINUED)

1. Emergency extension tank—check fluid level.

Note

Sight gage should show fluid at or above minimum fluid level. Fluid may be added, if necessary, from the filler reservoir by positioning the emergency hydraulic supply filler selector valve handle at EMER. RES. and operating the wobble pump.

PRIOR TO LANDING

Note

Accomplish the following after the gear has been extended and locked by means of the emergency system.

1. Emergency hand pump selector lever	EMER. BRAKES	CP
2. Brake selector lever	EMER.	CP
3. Emergency brake pressure	check (minimum 1250 psi)	CP

Note

If pressure is down, use hand pump until positive pressure rise is obtained and maintain pressure until landing is completed.

4. Hand pump	STAND-BY (maintain 1250 psi)	CP

Note

Avoid pumping the toe pedals because this will reduce the number of useful brake applications.

CHECK LISTS.

The check lists presented on pages 3-51 through 3-56 are condensed versions of the emergency procedures in this section.

End of Section III.

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RC121D CONDENSED CHECK LIST

EMERGENCY PROCEDURES

ENGINE FAILURE OR FIRE AFTER TAKE-OFF.

1. Gear and flaps	UP (at pilot's discretion)	CP
2. Throttle lever	close	E
3. Feathering button	push, if propeller does not automatically feather (check light on)	E
4. Mixture lever	OFF	E
5. Emergency shut-off lever	full OFF	E
6. Engine fire extinguisher selector	select engine	E
7. Fire extinguisher discharge switch or handle	DISCHARGE (if fire exists)	E
8. Cowl flaps	30% (if no fire exists, 10%)	E
9. Fuel tank selector lever	OFF	E
10. Auxiliary fuel pump switch	OFF	E
11. Ignition switch	OFF	P
12. Generator switch	OFF	E
13 Feathering button	neutral (after propeller has feathered)	E
14. Propeller switch	full DEC. rpm	E
15. Oil cooler switch	22%	E
16. Cowl flaps	10% (after fire is out)	E

ENGINE FAILURE OR FIRE DURING FLIGHT.

1. Throttle lever	close	E
2. Feathering button	push (check light on)	E
3. Mixture lever	OFF	E
4. Emergency shut-off lever	full OFF	E
5. Engine fire extinguisher selector	select engine	E

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6. Fire extinguisher discharge switch or handle	DISCHARGE (if fire exists)	E
7. Cowl flaps	30% (if no fire exists, 10%)	E
8. Fuel tank selectors	tank to engines (operating engines)	E
9. Auxiliary fuel pump switch	OFF	E
10. Fuel tank selector	OFF	E
11. Mixture levers	AUTO-RICH (on operating engines above 2400 rpm)	E
12. Manual spark	RETARD (on operating engines above 2400 rpm)	E
13. Ignition switch	OFF	P
14. Fuel crossfeed levers	CLOSED	E
15. Tank 5 selector lever	CLOSED	E
16. Propeller de-icer master control and switches	OFF	E
17. Generator switch	OFF	E
18. Feathering button	neutral (after propeller has feathered)	E
19. Propeller switch	full DEC rpm	E
20. Oil cooler flap	22%	E
21. Cowl flaps	10% (after fire is out)	E
22. Fuel crossfeed levers and tank 5	reposition to equalize fuel load	E

UNFEATHERING AND RESTART DURING FLIGHT.

1. Ignition switch	check OFF	P
2. Airspeed	140 knots desired (do not exceed 155 knots)	P
3. CO_2 fire extinguisher selector	set to engine being started	E
4. Emergency shut-off lever	ALL ON position	E
5. Throttle lever	closed	E
6. Engine supercharger lever	LOW	E
7. Mixture lever	OFF	E
8. Manual spark	RETARD	E

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9. Propeller switch	full DEC rpm (indicator light on)	E
10. Starter switch	engage (turn propeller eight blades and check for liquid lock)	E
11. Auxiliary fuel pump	LOW	E
12. Fuel tank selector	ON	E
13. Ignition switch	BOTH	P
14. Feathering button	pull out	E
15 Mixture lever	AUTO-RICH (at 500-600 rpm)	E
16. Generator switch	ON	E
17. Cowl and oil cooler flaps	climatic	E

CABIN FIRE.

1. Close throttles and descend if terrain permits		P
2. Radar blower fan switch	OFF	RT
3. Recirculating and flight station fan switches	OFF	E
4. Flight station mixing valve switch	COOL	E
5. Reduce cabin differential pressure to a minimum		E
6. Aux vent. knob	position B (at 1 in. cabin differential)	E
7. Fuel tank selector levers	tank to engine	E
8. All fuel crossfeed levers and tank No. 5 selector	OFF	E
9. All emergency shut-off levers—HYD. OIL	OFF (first detent position)	E

CABIN HEATER FIRE.

1. Cabin heater switches	OFF	E
2. Left and right recirculating fan switches	OFF	E
3. Flight station fan switch	OFF	E

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4. Flight station mixing valve switch	COOL	E
5. Engine fire selector	OFF	E
6. Cabin heater fire selector	set (fire location)	E
7. Fire extinguisher	discharge	E

ELECTRICAL FIRE EXTINGUISHING PROCEDURE.

1. Automatic pilot	OFF	P
2. Flight instrument power switch	EMER.	E
3. A. C. generator	TRIP position	RT
4. Ship battery switch	OFF	E
5. All d.c. generator switches	OFF	E
6. All generator circuit breakers	OFF	E RT
7. Portable fire extinguisher	discharge	E
8. Affected circuit	identify and isolate from main bus. (if possible)	E
9. Circuit breakers (affected circuit)	OFF	E

SMOKE AND FUME ELIMINATION — PRESSURIZED FLIGHT.

1. Aux vent. knob	full OPEN then to position A (when cabin differential is 1 in Hg)	E
2. Airspeed	reduce to 175 knots or less	P
3. Recirculating and flight station fan switches	OFF	E
4. Emergency exits	OPEN	RT
5. Throttles	close and execute rapid descent procedure	P
6. Pilots windows	OPEN	P CP

FUEL DUMPING.

1. Alert AOC crew		P
2. Radar equipment	STANDBY	SD
3. Wing flaps	UP	CP

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4. Landing gear	UP	CP
5. Airspeed	150 to 165 knots; do not exceed 190 nor reduce to less than 140 knots	P
6. Cabin heaters	OFF	E
7. Fuel dump lever	OPEN. (When fuel starts to dump, move to NEUTRAL)	E
8. Auxiliary fuel pumps for tank 6 (6L and 6R)	HIGH (only after fuel has started to dump)	E
9. Fuel dump lever	CLOSED. (When valves are closed, move to NEUTRAL.	E

EMERGENCY LANDING GEAR EXTENSION.

1. Landing gear lever	DOWN	CP
2. Emergency fuel dump lever	L. G. EMER. EXT	CP
3. Emergency hand pump selector	EMER. GEAR (aft)	CP
4. Emergency hand pump	Pump (until gear is down and locked)	CP
5. Landing gear position indicator	check (down & locked)	P
6. Emergency hand pump selector	EMER. BRAKES (forward)	CP

EMERGENCY WING FLAP OPERATION.

1. Emergency shut-off levers (No. 3 and 4)	HYD. OIL OFF (first detent)	E
2. Airspeed	175 knots or less (recommended)	P
3. Flap motor bypass valve	OPEN	E
4. Wing flap lever	between TAKE-OFF and 70%	CP
5. Hand crank	engage and crank (to TAKE-OFF position)	E
6. Wing flaps	visually check	E
7. Hand crank	remove	E

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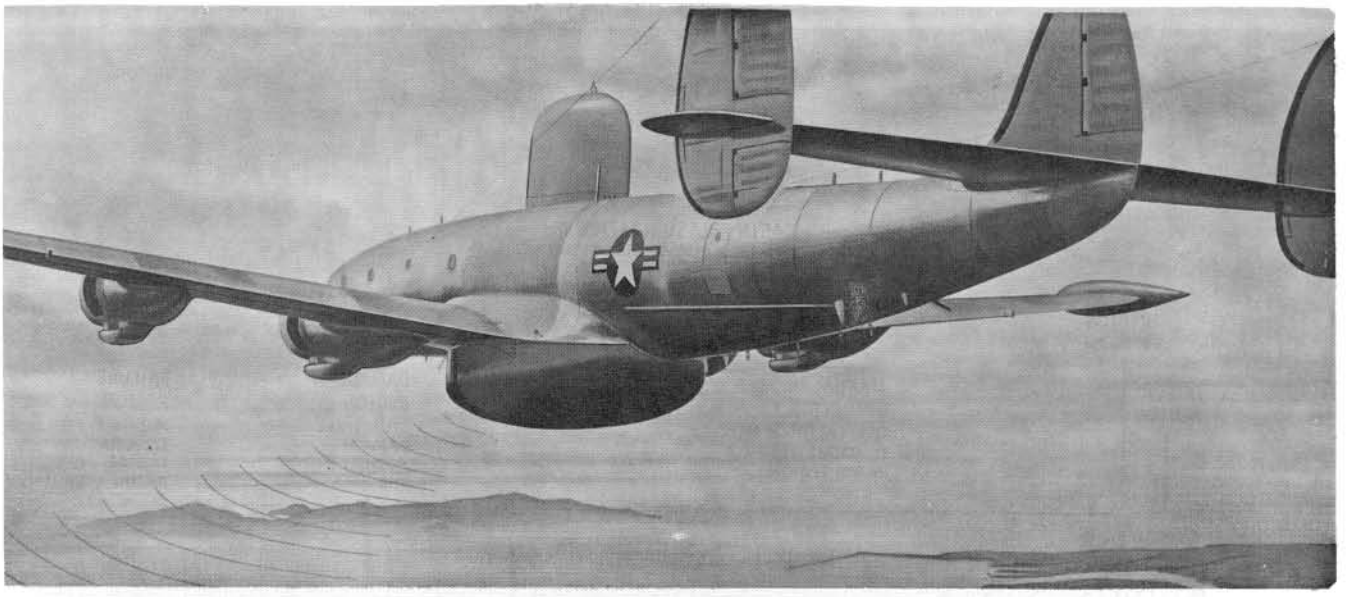
EMERGENCY BRAKE OPERATION.

1. Emergency hand pump selector lever	EMER. BRAKES	CP
2. Brake selector lever	EMER.	CP
3. Emergency brake pressure	check (minimum 1250 psi)	CP
4. Hand pump	STAND-BY (maintain 1250 psi)	CP

Last Page of Condensed Checklist.



SECTION IV DESCRIPTION AND OPERATION OF AUXILIARY EQUIPMENT

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AIR CONDITIONING SYSTEM.

The heating, ventilating, cooling and pressurization system on this aircraft are so united and controlled that they will be considered as one system.

HEATING.

Heated air for the cabin is supplied by two 125,000 btu combustion heaters located in each wing fillet. Each heater package, or assembly, contains its own ignition system and individual units for supplying the combustion fuel/air mixture. Fuel is supplied to the heaters from the No. 2 and No. 3 engine fuel systems. On USAF Serials 52-3411—54-2308, fuel is supplied from Nos. 1 and 4 tanks. The heaters, during auxiliary ventilation operation, heat outside ram air. During pressurized operation, recirculated cabin air from the recirculation fans is heated. The recirculated air is picked up by the fans through the recirculation check valves from the area around the outside of the aft cargo compartment liner. A mixture of heated and unheated air from the output side of the heaters is then mixed with fresh air from the cabin superchargers before entering the cabin distribution system. Heated air for the flight station may be recirculated cabin air, or by positioning the flight station mix valve, a mixture of fresh air and recirculated air or all fresh air. If the air is not as warm as desired, it can be further heated by operation of the pilots' electric auxiliary heater.

AUXILIARY VENTILATION.

Ambient air for auxiliary ventilation is provided by circulating ram air from inlets in the leading edges of the left and right wing center sections. The ram air is directed from the inlets to the cabin recirculating fans, then to the cabin distributing system. The air from the cabin is exhausted overboard through the auxiliary ventilation exit valve and the cabin safety relief and dump valve. Ventilation on the ground is furnished by the recirculation fans drawing air through the auxiliary ventilation inlet valves and distributing it to the cabin in the same manner as during flight operation.

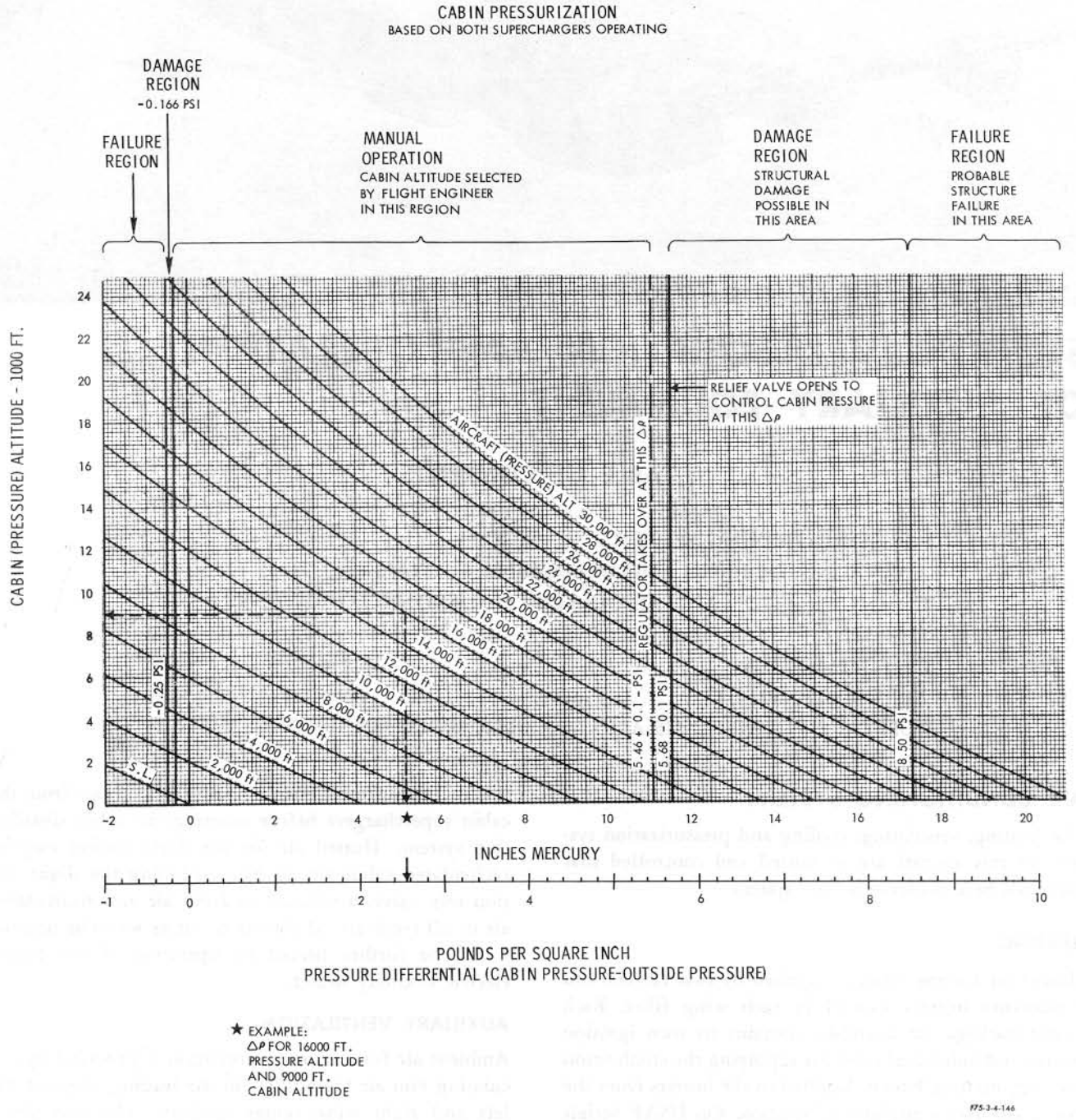

Figure 4-1. Cabin Pressurization vs. Altitude

REFRIGERATION.

Cooled or refrigerated air is supplied to the cabin and flight station from equipment in both wing panels. Partial cooling may be accomplished by positioning the cabin air mixing and selector valve toward the cool position which forces supercharged air to pass through the primary heat exchanger before reaching the fuselage. Heat transfer from the supercharged air within the tubes is made to the cooling ram air around the tubes. The cooling ram air is carried away through the exit door in the upper surface of the wing panel. Modulation of the amount of cooling is then determined by the position of the primary heat exchanger ram air scoop. Full cooling and refrigeration may be accomplished by positioning the cabin air mixing and selector toward the cool position which forces air to be refrigerated to pass through the primary heat exchanger as in cooling. From the outlet side of the primary heat exchanger, the air flows into the compressor turbine of the cooling unit. From this turbine, the air passes through the secondary heat exchanger, then back into the expansion turbine of the cooling unit. From this turbine the air flows through the water separator to the air mixing and selector valve which directs it into the fuselage duct. Duct temperature, just downstream of the air mixing and selector valve, is continuously registered on a temperature indicator. This permits the controls to be positioned for a desired discharge temperature within the capacity of the equipment.

PRESSURIZATION.

Ambient air is ducted from inlets in the leading edge of the wings to the cabin superchargers, which are located in the outboard nacelles. It is then compressed and passed through the refrigeration and cooling equipment located in the wings (the path through this equipment is dependent upon cabin temperature selection and position of the cabin air mixing valve) and then introduced into the fuselage structure to pressurize and ventilate this area when the auxiliary ventilation system is closed. A cabin pressure equivalent to that at sea level may be maintained up to an altitude of 12,300 feet. Any further increase in altitude will cause a proportional decrease in cabin pressure. At 25,000 foot altitude, the cabin pressure can be maintained at a pressure equivalent to 10,600 feet. The amount and rate at which the cabin air is exhausted overboard to maintain selected cabin pressure are determined by the auxiliary pressure regulator valves, the master pressure regulator valve, the altitude selector and the rate-of-change selector. The auxiliary pressure regulator valves automatically meter the outflow of cabin air in response to variable pneumatic control forces from the master pressure regulator control valve. This valve varies the pneumatic control forces in response to the manually selected positions of the latitude and rate-of-change selectors. These instruments provide for remote positioning of the isobaric section of the valve, permitting selective automatic operation up to a pressure differential of 10.92 inches mercury (5.36 psi). If the range of the isobaric section is exceeded, the differential section of the valve provides for non-selective automatic operation up to a maximum pressure differential of 11.32 inches mercury (5.46 psi). A cabin pressure safety relief and dump valve is installed on the aft pressure bulkhead. The valve acts as a pressure safety relief valve and a pressure dump valve. A vacuum or negative pressure relief valve is also installed on the aft pressure bulkhead, adjacent to the cabin pressure safety relief and dump valve. This valve is hinge-mounted from the top to permit it to swing inward if outside pressure is greater than inside pressure. In addition the outflow valves act as negative relief valves.

CABIN HEATER SWITCHES (LEFT AND RIGHT).

The cabin heater switches (4, fig. 4-4) are two position switches labeled ON (up) and OFF (down). The ON position permits operation of the cabin heaters provided the recirculating fan switches are ON; The cabin temperature selector switch is set above a specified temperature; and the number 2 and number 3 engine fuel pumps, or the auxiliary boost pumps are operating. This automatic type electrical system is protected by several cabin temperature circuit breakers located on the upper 260 panel. Power for the various heater components is routed through the 260 bus and the main d.c. bus.

CABIN HEATER TEMPERATURE CONTROL OVERRIDE SWITCHES (LEFT AND RIGHT).

These two-position guarded switches (5, fig. 4-4) are labeled OVERRIDE (up), and NORMAL (guarded, down). The OVERRIDE position of each switch provides for higher heater output if the cabin temperature control rheostat fails to supply sufficient cabin heat. A bridge circuit breaker, located on the 260 upper switch panel, protects this phase of the cabin heater system. Electric power is routed through the 260 d.c. bus.

CABIN HEATER COMBUSTION AIR BLOWER SWITCH.

This two-position switch (38, fig. 4-4) is labeled OVERRIDE (up) and NORMAL (down). The OVERRIDE position permits operation of both combustion air blowers, which supply air for combustion in the cabin heaters, when ram air is insufficient because of ice accumulation in the aux. vent inlets. In the NORMAL position, the combustion air blower is inoperative unless the cabin pressurization system is operating on the ground. The blower will be then turned on automatically through a pressure switch. This phase of the cabin heater

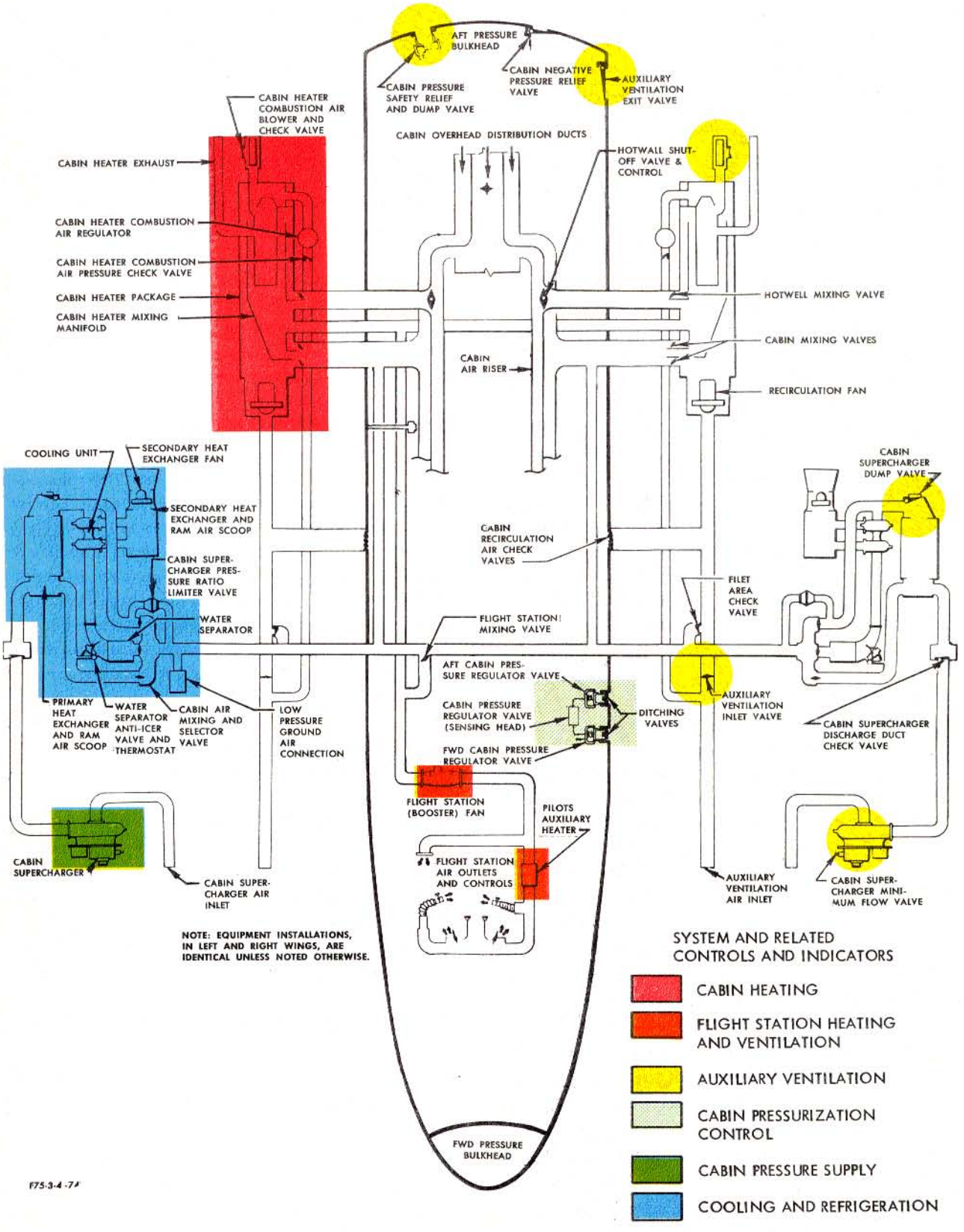

Figure 4-2. Air Conditioning System

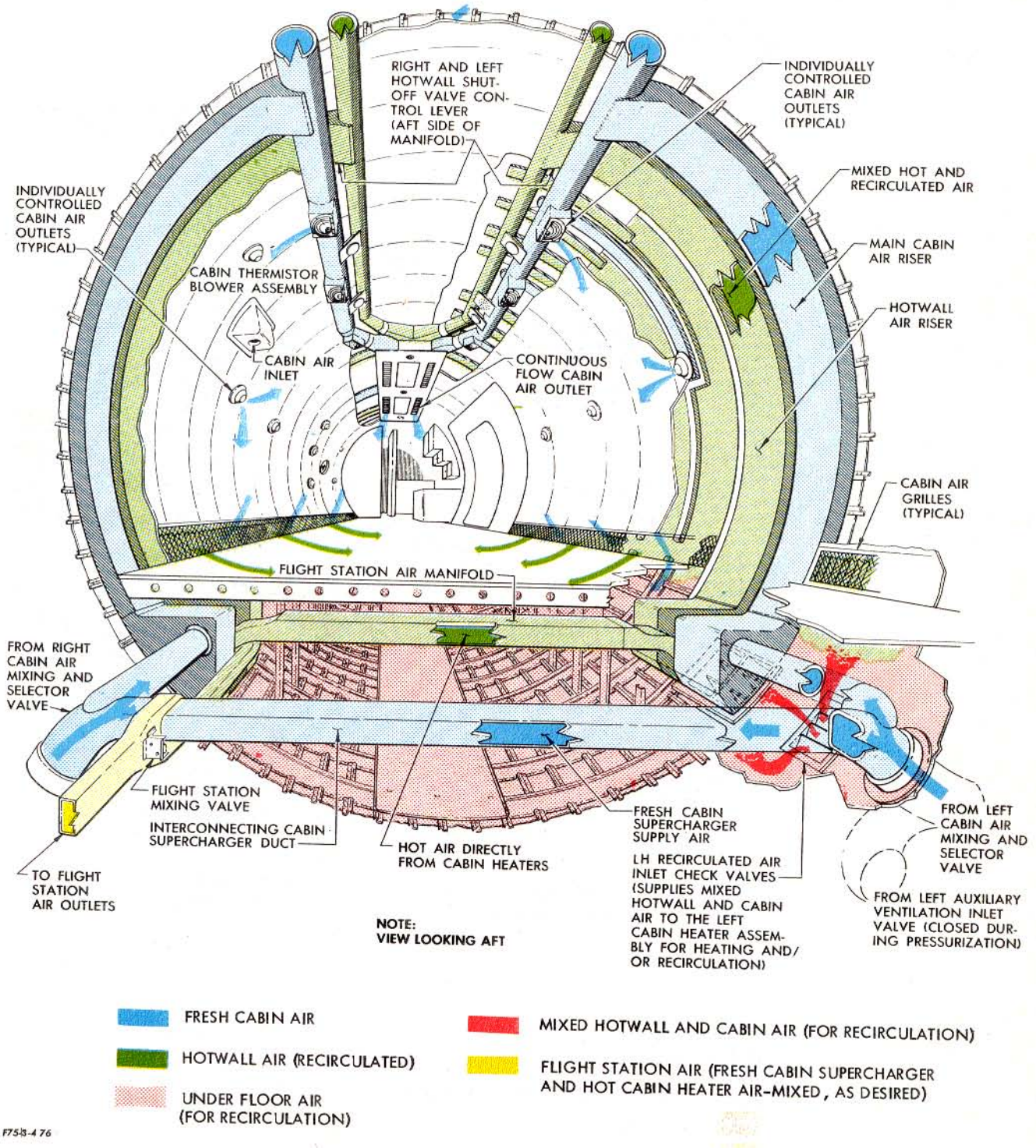

Figure 4-3. Air Conditioning Ducting (Sheet 1 of 3)

NOTE
RIGHT INNER WING AND NACELLE EQUIPMENT IDENTIFIED, LEFT SIDE IDENTICAL EXCEPT FOR LOW PRESSURE GROUND AIR CONNECTION

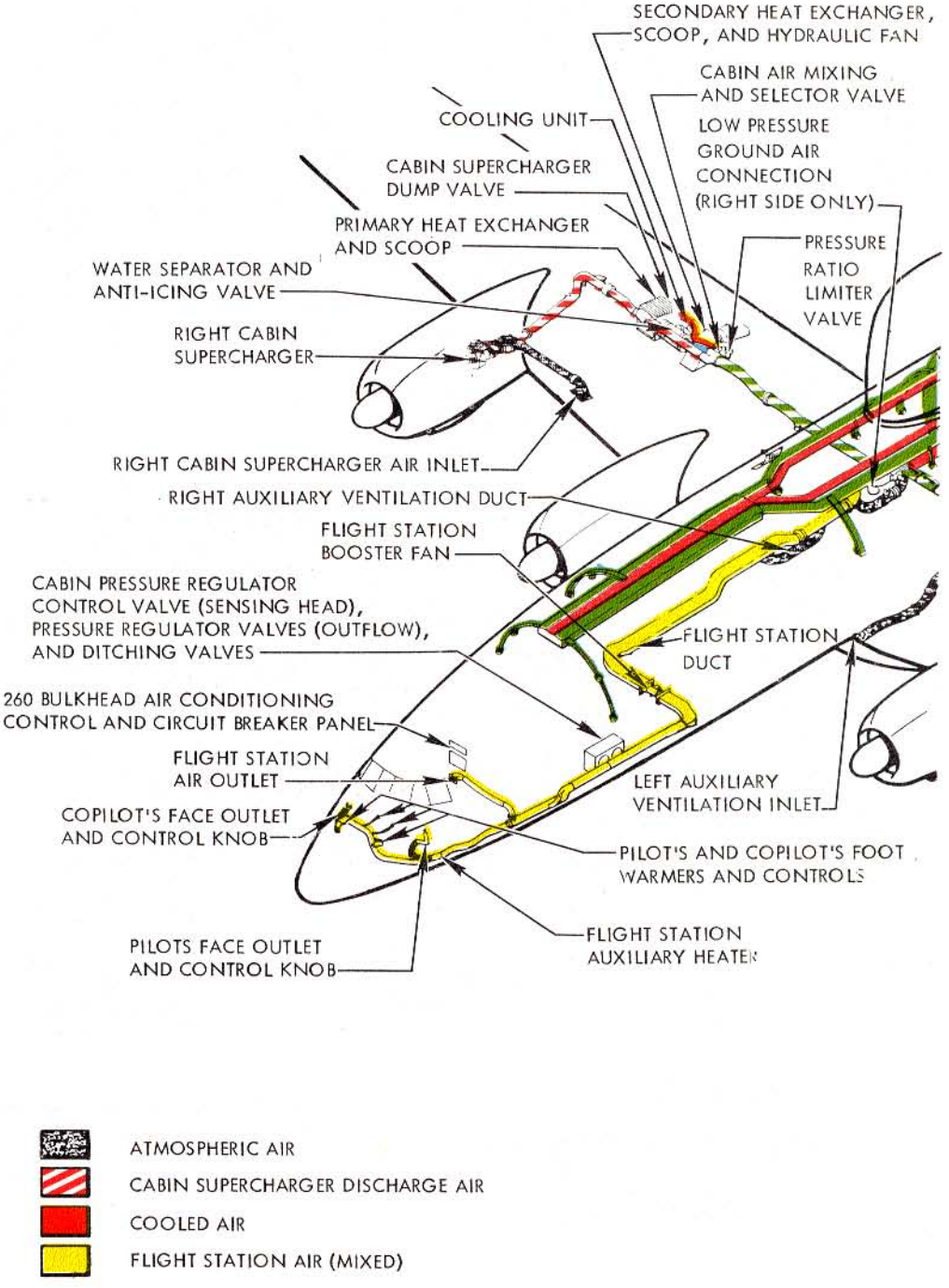

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Figure 4-3. Air Conditioning Ducting (Sheet 2 of 3)

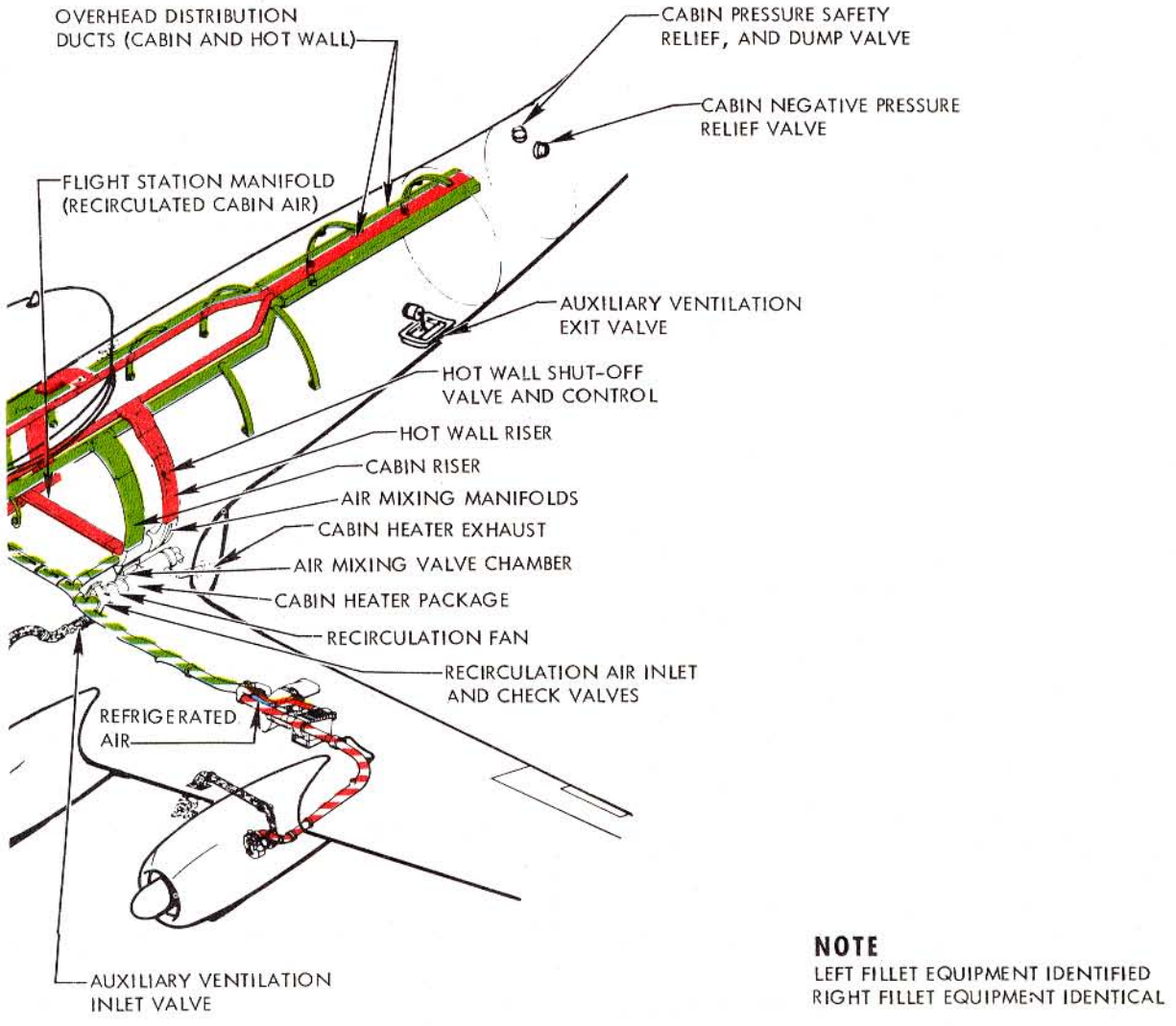


Figure 4-3. Air Conditioning Ducting (Sheet 3 of 3)

electrical system is protected by the recirculating fan circuit breakers located on the 260 upper switch panel. Electric power for the combustion air blower switch is routed through the 260 d.c. bus and the main d.c. bus.

CABIN HEATER EMERGENCY IGNITION SWITCHES (LEFT AND RIGHT).

These two-position guarded switches (34, fig. 4-4) are labeled EMERGENCY (up) and NORMAL (guarded, down). The EMERGENCY position permits selection of an alternate set of ignition points if the first set of ignition points malfunction. The NORMAL position selects the first set of ignition points. The cabin heater circuit breakers, located on the 260 upper switch panel, protects the emergency ignition switches.

RECIRCULATING FAN SWITCHES (LEFT AND RIGHT).

The recirculating fan switches (34, fig. 4-4) are two-position switches labeled ON (up) and OFF (down). The ON position permits operation of the electric fans, which circulate hot or cold air throughout the cabin. The fans are located on the forward end of each heater. Recirculating fan circuit breakers, located on the 260 upper switch panel, protect this system. Electric power for these switches is routed through the 260 d.c. bus.

CABIN TEMPERATURE SELECTOR SWITCH.

This switch (25, fig. 4-4) is a rheostat type switch and is labeled 1 through 10 with the word DECREASE pointing to the low number. The 1 through 10 positions are relative and permit selection of various cabin temperatures, provided the heater switches and recirculating fan switches are ON. Cabin thermistors are provided to automatically control selected temperatures. A bridge circuit breaker, located on the 260 upper switch panel, protects this phase of the cabin heater electrical system. Electrical power is routed through the 260 d.c. bus.

PILOTS' AUX. HEATER SWITCH.

The pilots' auxiliary heater switch (35, fig. 4-4) is a four-position dual wafer-type switch located on the 260 instrument panel. The four positions are: OFF, all circuits open; LOW, 1 kw heater output energized; MEDIUM, 2 kw heater output energized; HIGH, 1 kw and 2 kw (3 kw total) heater output energized. LOW, MEDIUM and HIGH switch positions arm the overheat warning light, thermal switches, and overheat lockout relay circuits which prevents excessive heater temperatures. The pilots' heater vent should be in the open position during heater operation to preclude actuating overheat lockout relay. Operating power is drawn from the main d.c. bus bar (fwd cargo comp.), and the 260 d.c. positive bus which is activated by the flight station fan switch.

FLIGHT STATION FAN SWITCH.

The flight station fan switch (37, fig. 4-4) is an electrically actuated, two-position, ON and OFF switch that arms the pilots' auxiliary heater and controls the flight station fan. When on, air circulation in the flight station is increased and heat from the pilots' auxiliary heater is dissipated. Circuit protection is afforded by the booster fan circuit breaker (260 switch panel), and operating power is drawn from the 260 d.c. positive bus.

FLIGHT STATION MIXING VALVE SWITCH.

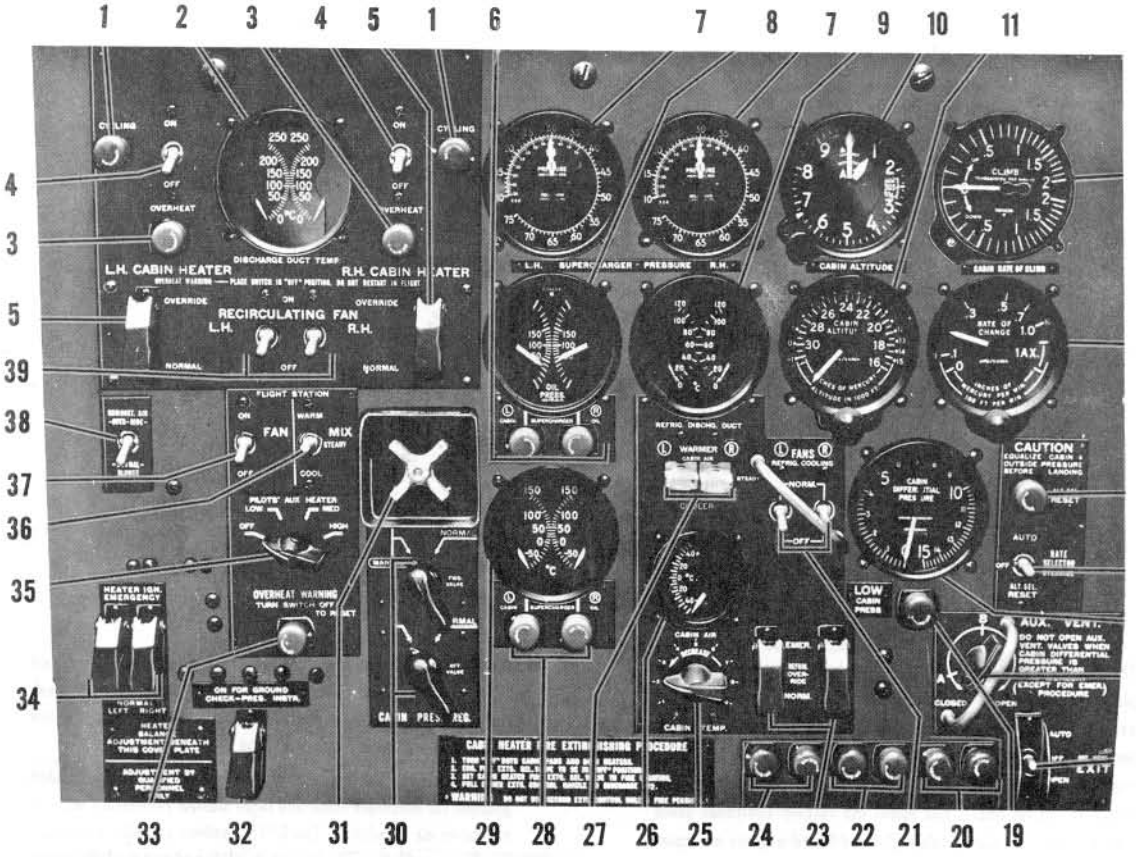
This control is a three-position switch (36, fig. 4-4) labeled WARM (up), STEADY (center), and COOL (down). The WARM or COOL position actuates the flight station mixing valve. The mixing valve moves to provide a mixture of recirculated cabin air and fresh supercharger discharge air during pressurized operation. During auxiliary vent. operation, the mixing valve moves to provide a mixture of fresh auxiliary vent air, and heated fresh air (if desired) from the cabin heaters. The mixing valve ceases to change position when the switch is returned to the STEADY position. Note that the full-warm position supplies no fresh air, but recirculated heated air only. This circuit is afforded protection by the flight station mix circuit breaker (260 switch panel). Power is drawn from the 260 d.c. positive bus.

CABIN AIR PADDLE SWITCHES (LEFT AND RIGHT).

The three-position paddle switches (27, fig. 4-4) are labeled WARMER (up), STEADY (center) and COOLER (down). The WARMER and COOLER positions electrically energize a cam arrangement which allows a continuous cam-travel to the full-cool or full-warm positions, as selected, unless interrupted by the paddle switches being positioned to STEADY for a desired intermediate air temperature. These cams in turn control, electrically, the operation of the cabin air mixing and selector valves, the primary and secondary heat exchanger scoops, and the primary heat exchanger exit door, which provide air of the selected temperature to the cabin. All circuits involved are protected by the left and right refrigeration control circuit breakers, the left and right secondary aft cooler circuit breakers, the left and right fan solenoid circuit breaker, and draw power from the crew door bus. All circuit breakers are located on the 260 switch panel.

REFRIGERATOR COOLING FAN SWITCHES (LEFT AND RIGHT).

The cooling fan switches (21, fig. 4-4) have two positions which are labeled NORM and OFF, and are for ground operation of refrigerated air system only. On some modified aircraft, these switches are spring-loaded in the ON position.



1. CABIN HEATER CYCLING LIGHTS (LEFT & RIGHT)
2. CABIN HEATER DISCHARGE DUCT TEMPERATURE INDICATOR
3. CABIN HEATER OVERHEAT WARNING LIGHTS (LEFT & RIGHT)
4. CABIN HEATER SWITCHES (LEFT & RIGHT)
5. CABIN HEATER TEMPERATURE OVERRIDE SWITCHES (LEFT & RIGHT)
6. CABIN SUPERCHARGER LOW OIL PRESSURE WARNING LIGHTS (LEFT & RIGHT)
7. CABIN SUPERCHARGER DIFFERENTIAL AIR PRESSURE INDICATORS (LEFT & RIGHT)
8. CABIN SUPERCHARGER OIL PRESSURE INDICATOR
9. REFRIGERATION DISCHARGE DUCT TEMPERATURE INDICATOR
10. CABIN ALTITUDE INDICATOR
11. CABIN ALTITUDE SELECTOR SWITCH
12. CABIN RATE OF CLIMB INDICATOR
13. CABIN RATE OF CHANGE SELECTOR SWITCH
14. CABIN ALTITUDE SELECTOR RESET LIGHT
15. RATE SELECTOR OVERRIDE SWITCH
16. CABIN DIFFERENTIAL PRESSURE INDICATOR
17. AUXILIARY VENT. KNOB
18. AUXILIARY VENT. EXIT SWITCH
19. LOW CABIN PRESSURE WARNING LIGHT
20. SECONDARY SCOOP OPEN INDICATOR LIGHTS (LEFT & RIGHT)
21. REFRIGERATOR COOLING FAN SWITCHES (LEFT & RIGHT)
22. PRIMARY EXIT OPEN INDICATOR LIGHTS (LEFT & RIGHT)
23. REFRIGERATOR OVERRIDE SWITCHES (LEFT & RIGHT)
24. PRIMARY SCOOP OPEN INDICATOR LIGHTS (LEFT & RIGHT)
25. CABIN TEMPERATURE SELECTOR SWITCH
26. CABIN AIR TEMPERATURE INDICATOR
27. CABIN AIR PADDLE SWITCHES (LEFT & RIGHT)
28. CABIN SUPERCHARGER HIGH OIL TEMPERATURE WARNING LIGHTS (LEFT & RIGHT)
29. CABIN SUPERCHARGER OIL TEMPERATURE INDICATOR
30. CABIN PRESSURE REGULATOR SELECTOR VALVE (FWD. & AFT)
31. CABIN PRESSURE REGULATOR CONTROL VALVE
32. GROUND CHECK SWITCH
33. PILOT'S AUXILIARY HEATER OVERHEAT WARNING LIGHT
34. CABIN HEATER EMERGENCY IGNITION SWITCH
35. PILOT'S AUXILIARY HEATER SWITCH
36. FLIGHT STATION MIXING VALVE CONTROL SWITCH
37. FLIGHT STATION FAN SWITCH
38. CABIN HEATER COMBUSTION AIR BLOWER SWITCH
39. RECIRCULATING FAN SWITCHES (LEFT & RIGHT)

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Figure 4-4. Air Conditioning Control Panel

In the NORM position, the hydraulically driven cooling air fans, which are located on the aft sides of the secondary heat exchanger, operate and supply cooling air for the secondary heat exchanger when actuated by the landing gear scissors switch. Note that this setting is for all normal operations. The circuit is protected by the left and right fan solenoid circuit breaker, located on the 260 upper switch panel, and the fan switches draw power from the crew door bus.

REFRIGERATOR OVERRIDE SWITCHES (LEFT AND RIGHT).

These guarded switches (23, fig. 4-4) have two positions: NORM (down) and EMER (up). In the EMER position, these switches bypass the sequence switches in the cabin air mixing and selector valve actuator, disconnecting the primary heat exchanger scoop from the cabin air mixing valve control cycle . This allows the cabin air mixing and selector valve to be positioned in

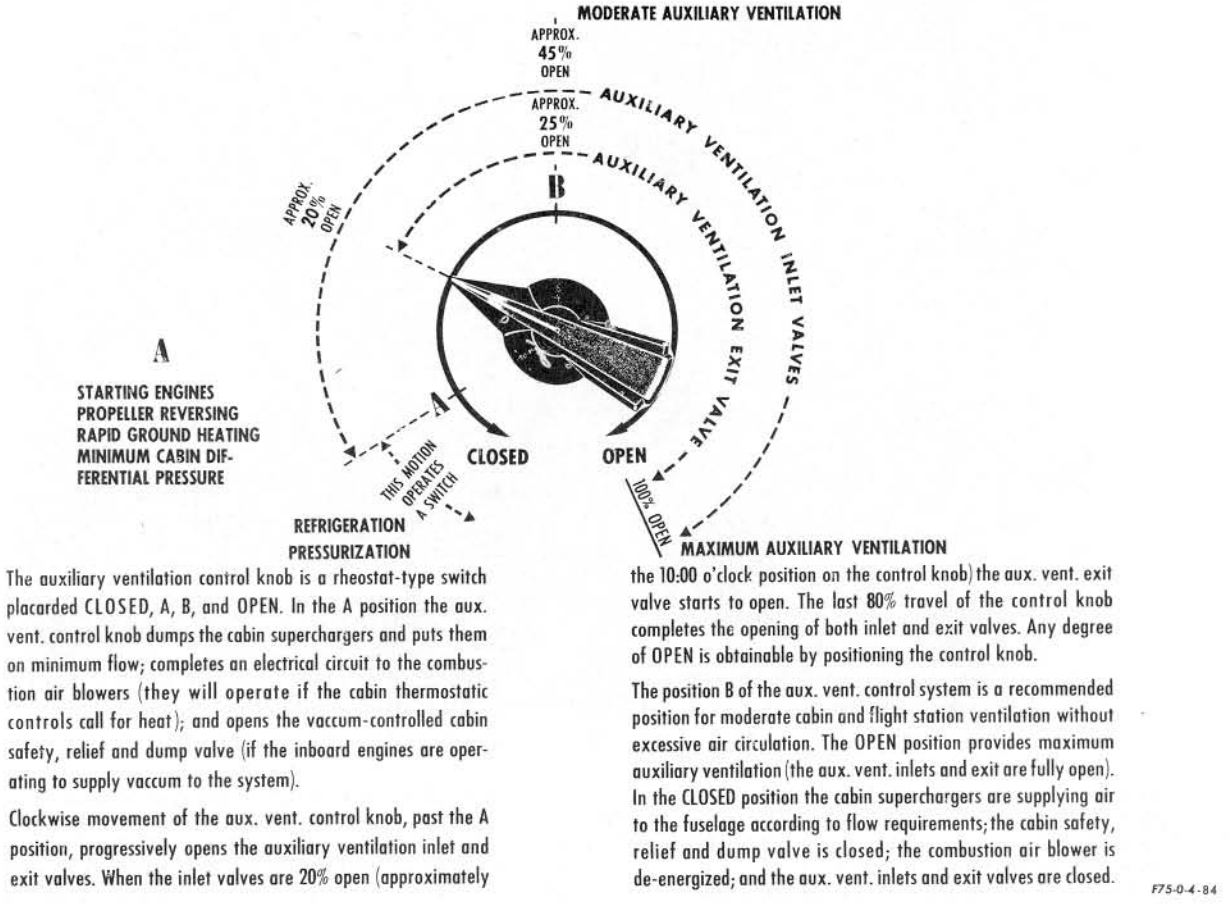


Figure 4-5. Auxiliary Vent Control Knob

the event that the primary heat exchanger scoop is malfunctioning.

AUXILIARY VENTILATION CONTROL SWITCH. The auxiliary ventilation control knob switch (17, fig. 4-4) is a rheostat switch circularly labeled CLOSED, A, B, and OPEN. This switch is mechanically interconnected with the supercharger control and altitude warning switch (which also completes an electrical circuit to the combustion air blowers); the pressurization control switch; and is electrically connected to micropositioners, which, in turn, control the left and right auxiliary ventilation inlets, and the auxiliary ventilation exit. The switch in the A position dumps the cabin supercharger discharge air and places the supercharger air setting to minimum flow; arms the combustion air blowers circuit, (they will operate if the cabin heater control calls for heat); and opens the vacuum-controlled cabin safety relief and dump valve, (with inboard engines operating to supply system vacuum). Clockwise movement of the auxiliary ventilation control knob switch, past the A position progressively opens the auxiliary ventilation inlet and exit valves by energizing the micropositioners, however, the inlet valves open 20% prior to the initial opening of the exit valves. Any degree of opening of the auxiliary ventilation inlet and exit valves is obtainable according to the positioning of the switch. Position B of the switch provides moderate cabin and flight station ventilation without excessive air circulation. The OPEN position of the switch provides maximum auxiliary ventilation, (the auxiliary ventilation inlets and exit are fully open). The CLOSED position of the switch provides cabin supercharger discharge air to the fuselage, according to flow requirements; closes the cabin safety relief and dump valve; de-energizes the combustion air blower; and closes the auxiliary ventilation inlet valves and exit valve. All circuits are protected by the auxiliary ventilation control circuit breaker, the supercharger control and altitude warning circuit breaker, the cabin altitude control circuit breaker, and the pressure release control circuit breaker. All circuit breakers are located on the 260 upper switch panel. Power is derived from the 260 d.c. bus.

FUSELAGE FIRE PROCEDURE

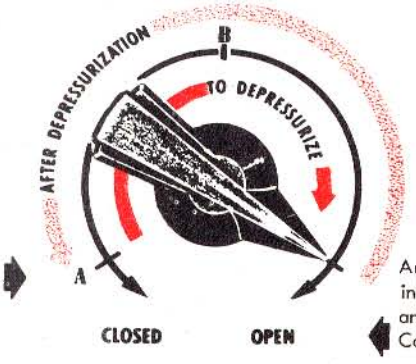
The cabin superchargers are dumped and put on minimum flow; the cabin safety, relief and dump valve is opened; and the auxiliary ventilation inlet and exit valves are closed.

Auxiliary ventilation inlet valves are approximately 45% open; the auxiliary ventilation exit valve is approximately 25% open; the air recirculation check valves are closed.

Depressurization, without excessive air circulation that might fan a fire, is accomplished by placing the auxiliary ventilation control knob in the "B" position.

★ If the cabin is not occupied and oxygen is available for crew members, the aux vent knob is to be placed in the A position (after depressurization) to minimize air circulation. If the cabin is occupied, the auxiliary ventilation control knob is to be left in the "B" position as it affords moderate auxiliary ventilation.

SMOKE REMOVAL

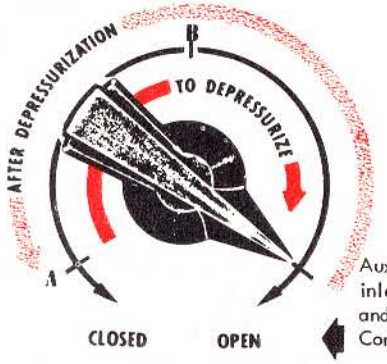


After depressurization, the auxiliary ventilation control knob is placed at position "A" so that the auxiliary ventilation system is closed and will not circulate smoke through the cabin or flight station.

Aux vent. inlet valves and exit valve-- Completely OPEN

Auxiliary ventilation inlet valves and exit valve are closed; the cabin superchargers are dumped and put on minimum flow; the cabin safety, relief and dump valve is open.

EMERGENCY DEPRESSURIZATION



Auxiliary ventilation inlet valves and exit valve are closed; the cabin superchargers are dumped and put on minimum flow; the cabin safety, relief and dump valve is open.

Aux vent. inlet valves and exit valve-- Completely OPEN

After depressurization, the auxiliary ventilation control knob is placed at position "A" so that the auxiliary ventilation system will be closed and will not partially pressurize the airplane. Partial pressurization could interfere with the opening of windows and doors.

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Figure 4-6. Auxiliary Vent Control Operation

AUXILIARY VENTILATION EXIT VALVE OVERRIDE SWITCH.

The auxiliary ventilation exit valve override switch (18, fig. 4-4) is a three-position switch labeled AUTO (up), Off (center), and OPEN (down). The normal position is AUTO (up) which allows control of the auxiliary ventilation exit and inlets by the auxiliary ventilation control knob switch. The OFF position, the auxiliary ventilation exit door is removed from the circuit, thereby preventing movement from the last selected position. The OPEN position of the override switch bypasses the auxiliary ventilation exit micropositioner, and actuates the exit to the full-open position.

CABIN ALTITUDE SELECTOR.

The cabin altitude selector knob (11, fig. 4-4) operates a needle type indicator mounted on a dial that is calibrated both in inches-of-mercury and in thousands-of-feet. The knob (and needle) is mechanically connected to a potentiometer in such a manner that selection of an altitude on the dial mechanically positions the arm of the potentiometer so that each selected altitude is equal to a certain resistance value on the potentiometer. An isobaric changer potentiometer is connected to the selector potentiometer relay coil so that when an altitude is selected, and the selector potentiometer moves to put the circuit in an unbalanced condition, the micropositioner moves the isobaric changer potentiometer, which actuates the isobaric spring tension-motor to correspond to the altitude selected, resulting in an increase or decrease in the sensing head valve release pressure, until the circuit is again in balance. This circuit is protected by the cabin altitude control circuit breaker, located on the 260 switch panel, and draws power from the 260 d.c. bus.

CABIN PRESSURE RATE-OF-CHANGE SELECTOR.

The cabin rate-of-change selector knob (13, fig. 4-4) operates a needle-type indicator mounted on a dial that is calibrated both in inches-of-mercury per min., and in hundreds-of-ft. per min. The knob (and needle) is mechanically connected to a moveable brush making electrical contact with a plastic cylinder having a wedge-shaped contact inlay in its outer surface. This contact completes the circuit to the sensing head valve. A constant-speed electric motor causes the contact-cylinder to revolve, resulting in the interruption of this circuit. Rate-of-change in cabin pressure varies directly with the width of the contact-inlay which is determined by selection on the instrument (and, as a result, on the moveable brush). This circuit is protected by the cabin altitude control circuit breaker, located on the 260 switch panel, and draws power from the 260 d.c. bus.

RATE SELECTOR OVERRIDE SWITCH AND ALTITUDE SELECTOR RESET LIGHT.

The rate selector override switch (15, fig. 4-4) is a three-position dual switch labeled AUTO (up), OFF (center) and ALT. SEL. RESET (down). AUTO is the position for all normal flight conditions. The OFF position will stop the changer assembly at the existing condition, and ALT. SEL. RESET position will bypass the cabin rate-of-change selector for an approximate 2500 ft. rate of change. The reset light (14, fig. 4-4) will glow when the switch is in the ALT. SEL. RESET position until the cabin altitude selector setting has been obtained. This switch and light are part of the cabin rate-of-change selector circuit.

CABIN PRESSURE REGULATOR SELECTOR VALVES (FWD AND AFT).

The two fwd. and aft cabin pressure regulator selector valves (30, fig. 4-4) are mechanically operated two-position valves labeled NORMAL (right) and MANUAL (left). The NORMAL positions permit control of the cabin pressure outflow valves by the cabin altitude selector. The MANUAL positions permit direct mechanical control of the cabin pressure outflow valves by the emergency cabin pressure regulator control valve, (located directly above the regulator selector valves).

CABIN PRESSURE REGULATOR CONTROL VALVE.

The cabin pressure regulator control valve (31, fig. 4-4), labeled DEPRESSURIZE (with an arrow pointing left), is a needle-valve that meters a source of true ambient air pressure to the cabin pressure outflow valves. The clockwise movement of this valve handle will cause the cabin to pressurize, and counterclockwise movement will cause the cabin to depressurize. The valve is effective only when the cabin pressure regulator selector is in the MANUAL position.

GROUND CHECK TEST SWITCH.

This switch (32, fig. 4-4) is guarded and is labeled ON FOR GROUND CHECK-PRES. INSTR. In the ON position it permits pressurization tests on the ground by removing the vacuum source from the cabin pressure safety relief valve which allows it to close. The OFF position is for all other operating conditions.

HOTWALL SHUT-OFF VALVES (LEFT AND RIGHT).

A hotwall shut-off valve is located in each hotwall cabin air riser approximately six feet above the cabin floor. These valves are labeled OPEN (down) and SHUT (up). The OPEN position is for all normal operations. The CLOSED position is for maximum ground refrigeration or when operating in-flight with the failure of one cabin heater at low ambient air temperatures.

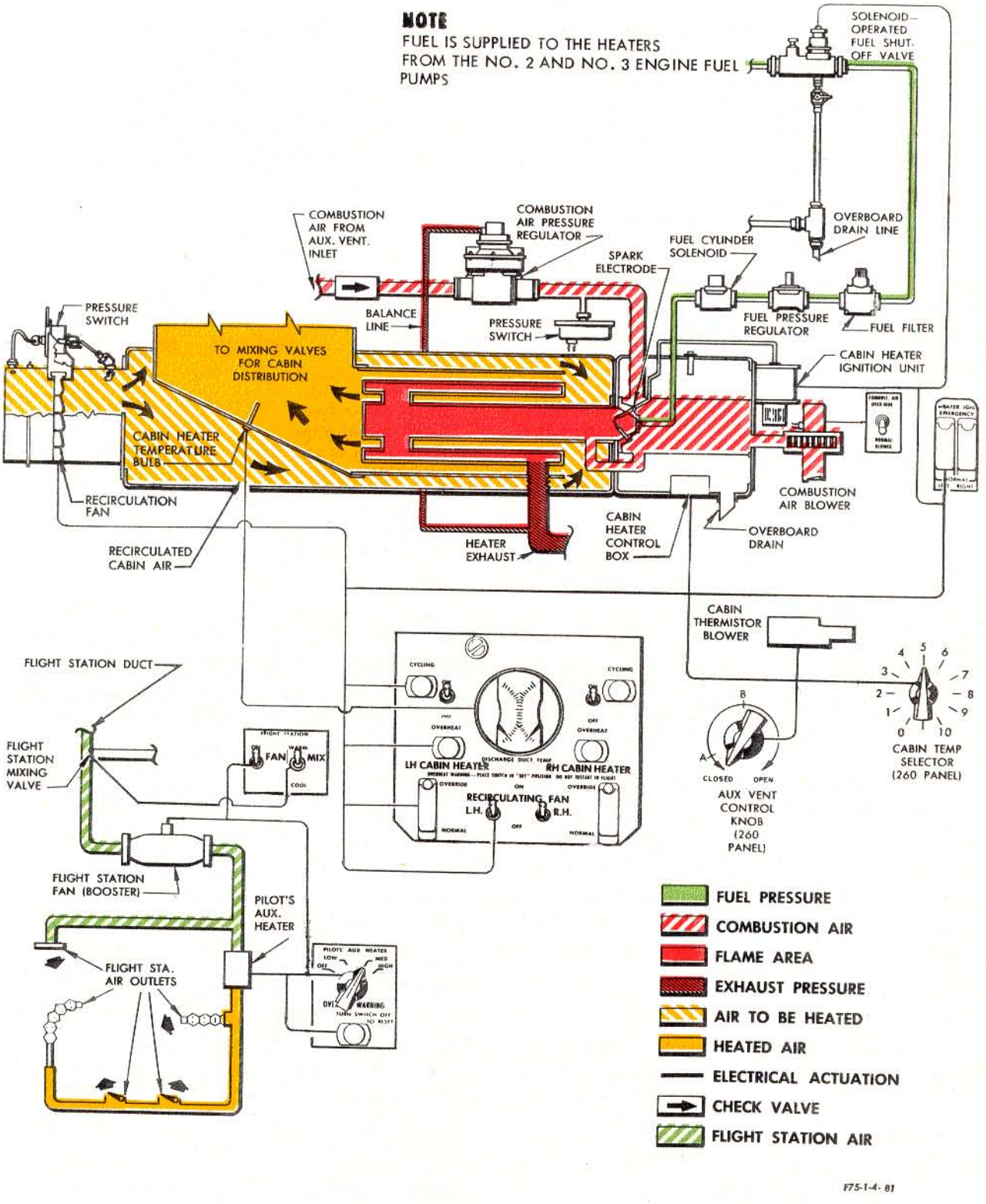


Figure 4-7. Heating System

CABIN SUPERCHARGERS DRIVE SHAFT DISCONNECT LEVERS.

The cabin superchargers drive shaft disconnect levers (6, fig. 1-14), (same as No. 1 and No. 4 engine supercharger control levers), are labeled EMERGENCY CABIN SUPCHGR. DISCONNECT with an arrow pointing outboard and are located on the flight engineer's control quadrant. The full outboard, or quadrant-stop, position is the drive shaft disconnect position. The spring-loaded gate-lever is provided to prevent inadvertent disconnection of the supercharger drive shaft when operating the supercharger levers.

Note

The cabin supercharger drive shafts cannot be reconnected in flight.

DITCHING VALVE RELEASE HANDLE.

The ditching valve release handle (fig. 4-10), located behind a door under the air conditioning control panel, is a T-handle that, when pulled, releases the spring-loaded ditching valve located in the discharge manifold of each cabin air outflow valve. This prevents water from entering the fuselage through the outflow valves. These valves cannot be reset in flight.

CABIN HEATER CYCLING LIGHTS (LEFT AND RIGHT).

The cabin heater cycling lights (1, fig. 4-4) flicker amber whenever cabin heaters are being operated.

CABIN HEATER DISCHARGE DUCT TEMPERATURE INDICATOR.

The discharge duct temperature indicator (2, fig. 4-4) is a dual gage providing a continuous indication of cabin discharge air temperatures in degrees of centigrade.

CABIN HEATER OVERHEAT WARNING LIGHTS (LEFT AND RIGHT).

The cabin heater overheat warning lights (3, fig. 4-4) glow red whenever the cabin heaters reach an unsafe temperature. When one of these lights glows, it also indicates that the cabin heater is in a "locked-out" off, condition.

PILOTS' AUXILIARY HEATER OVERHEAT WARNING LIGHT.

The pilots' auxiliary heater warning light (33, fig. 4-4) glows red whenever the pilots' auxiliary heater temperature exceeds a safe value. When this light glows, it also indicates that the heater is in a "lock-out" condition.

CABIN SUPERCHARGER DIFFERENTIAL AIR PRESSURE INDICATORS (LEFT AND RIGHT).

The direct reading cabin supercharger differential air pressure indicators (7, fig. 4-4) provide a continuous indication of the pressure differential, in inches-of-mercury (absolute), existing between the inlet and outlet ducts of the cabin superchargers.

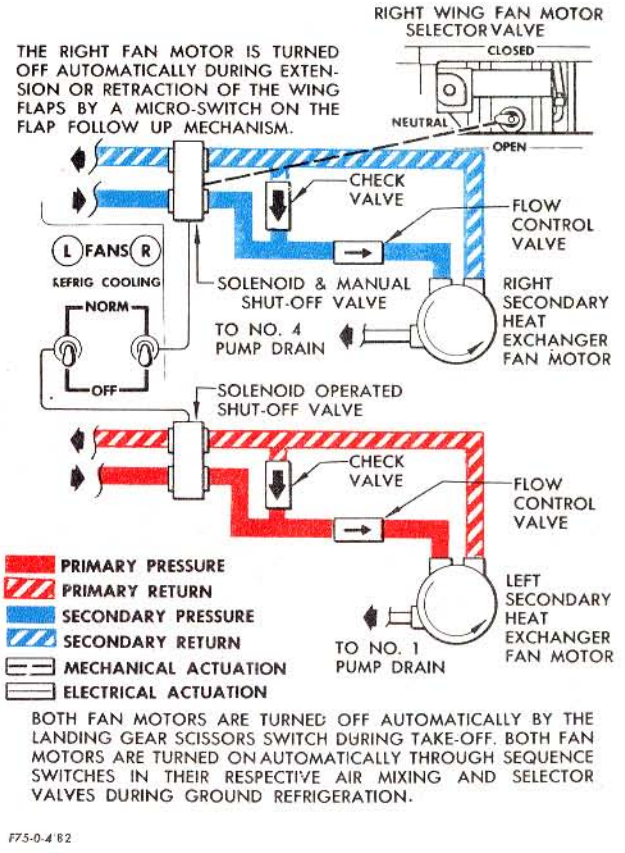


Figure 4-8. Heat Exchanger Hydraulic System

CABIN SUPERCHARGER OIL TEMPERATURE INDICATOR.

The cabin supercharger oil temperature indicators (29, fig. 4-4) is a dual d.c. operated indicator providing the "oil-in" temperature of the cabin superchargers in degrees Centigrade.

CABIN SUPERCHARGER HIGH OIL TEMPERATURE WARNING LIGHTS (LEFT AND RIGHT).

The d.c. operated cabin supercharger high oil temperature warning lights (28, fig. 4-4) glow red whenever the "oil-in" temperature exceeds a safe (90°C) value. When one of these lights glows, the associated cabin supercharger should be disconnected, if confirmed by reading on the temperature indicator.

CABIN SUPERCHARGER OIL PRESSURE INDICATOR.

The 26 volts a.c. operated cabin supercharger oil pressure indicator (8, fig. 4-4) is a dual gage providing a con-

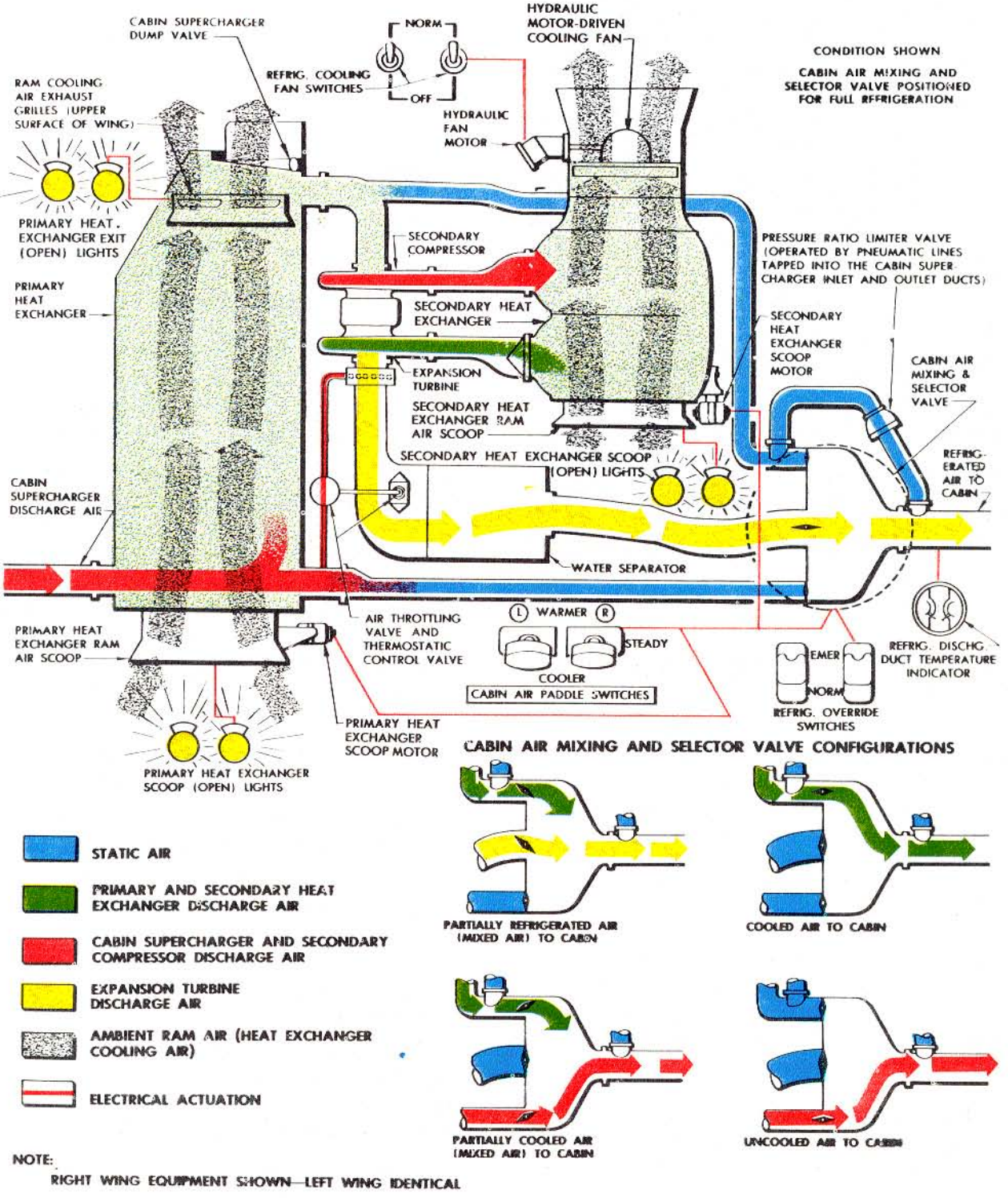


Figure 4-9. Cabin Air Cooling System

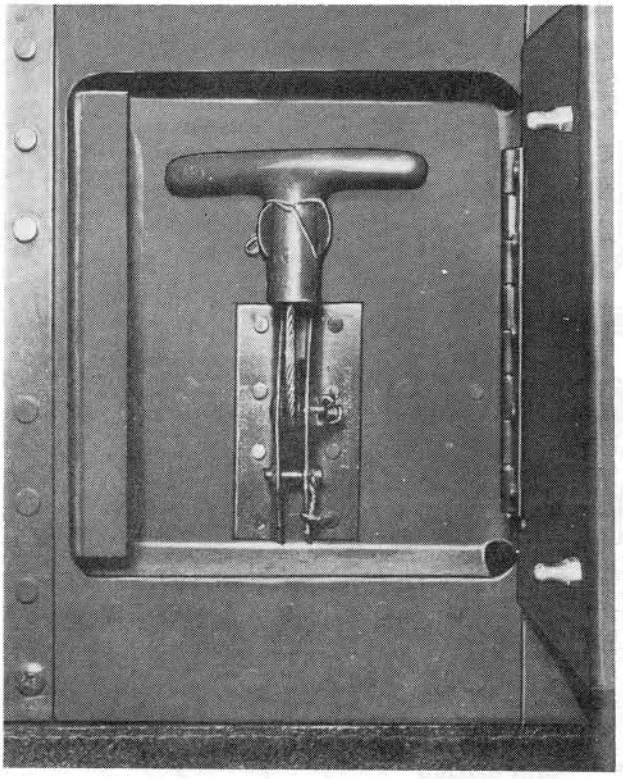


Figure 4-10. Ditching Valve Release Handle

tinuous indication of the cabin supercharger "oil-in" pressure in pounds per square inch.

CABIN SUPERCHARGER LOW OIL PRESSURE WARNING LIGHTS (LEFT AND RIGHT).

The d.c. operated cabin supercharger low oil pressure warning lights (6, fig. 4-4) glow red whenever the "oil-in" pressure is below a safe (35 ±5 psi) value. The affected cabin supercharger should be disconnected when the light glows and if confirmed by the oil pressure indicator.

CABIN DIFFERENTIAL PRESSURE INDICATOR.

The cabin differential pressure indicator (16, fig. 4-4) provides a continuous indication, in inches-of-mercury, of the differential pressure between cabin and atmospheric pressure.

LOW CABIN PRESSURE WARNING LIGHT.

The low cabin pressure warning light (19, fig. 4-4) glows red whenever the cabin altitude is 10,300 feet or above.

CABIN ALTITUDE INDICATOR.

The cabin altitude indicator (10, fig. 4-4) provides a continuous indication of the equivalent cabin pressure altitude in feet.

CABIN VERTICAL VELOCITY INDICATOR.

The cabin vertical velocity indicator (12, fig. 4-4) provides a continuous indication of changes in the cabin pressure. The cabin rate of ascent and descent is indicated in feet per minute.

ALTITUDE SELECTOR RESET INDICATOR LIGHT.

Refer to rate selector override switch under Air Conditioning Controls.

CABIN SUPERCHARGER DRIVE SHAFT REAR BEARING TEMPERATURE INDICATOR.

The cabin supercharger drive shaft rear bearing temperatures are sensed by d.c. electrical resistance-type bulbs connected to the rear bearing temperature indicator (15, fig. 1-15) located in the flight engineer's lower instrument panel. This indicator is a dual gage.

CABIN AIR TEMPERATURE INDICATOR.

The d.c. operated cabin air temperature indicator (26, fig. 4-4) provides a continuous indication of cabin air temperature. It is calibrated in degrees Centigrade.

REFRIGERATION DISCHARGE DUCT TEMPERATURE INDICATOR.

The d.c. operated refrigeration discharge duct temperature indicator (9, fig. 4-4) is a dual gage providing a continuous indication of the inner wing duct air temperature downstream of the cabin air mixing and selector valve. This instrument indicates the duct temperature of refrigerated, cooled, or uncooled air to the cabin distribution system.

CAUTION

The water eliminator tubes may be damaged by freezing if duct temperature drops below 2°C. The refrigeration should be turned off if duct temperature cannot be maintained at 2°C or above.

PRIMARY SCOOP INLET OPEN LIGHTS (LEFT AND RIGHT).

The primary heat exchanger scoop open lights (24, fig. 4-4) glow amber whenever the scoops begin to open, thus enabling the operator to modulate the position of the scoop (during flight) from CLOSED to 66% open.

PRIMARY EXIT OPEN LIGHTS (LEFT AND RIGHT).

The primary heat exchanger exit door lights (22, fig. 4-4) glow amber whenever the exit doors are open. Inasmuch as the exit doors are indirectly connected to the primary heat exchanger scoops, the exit doors will not

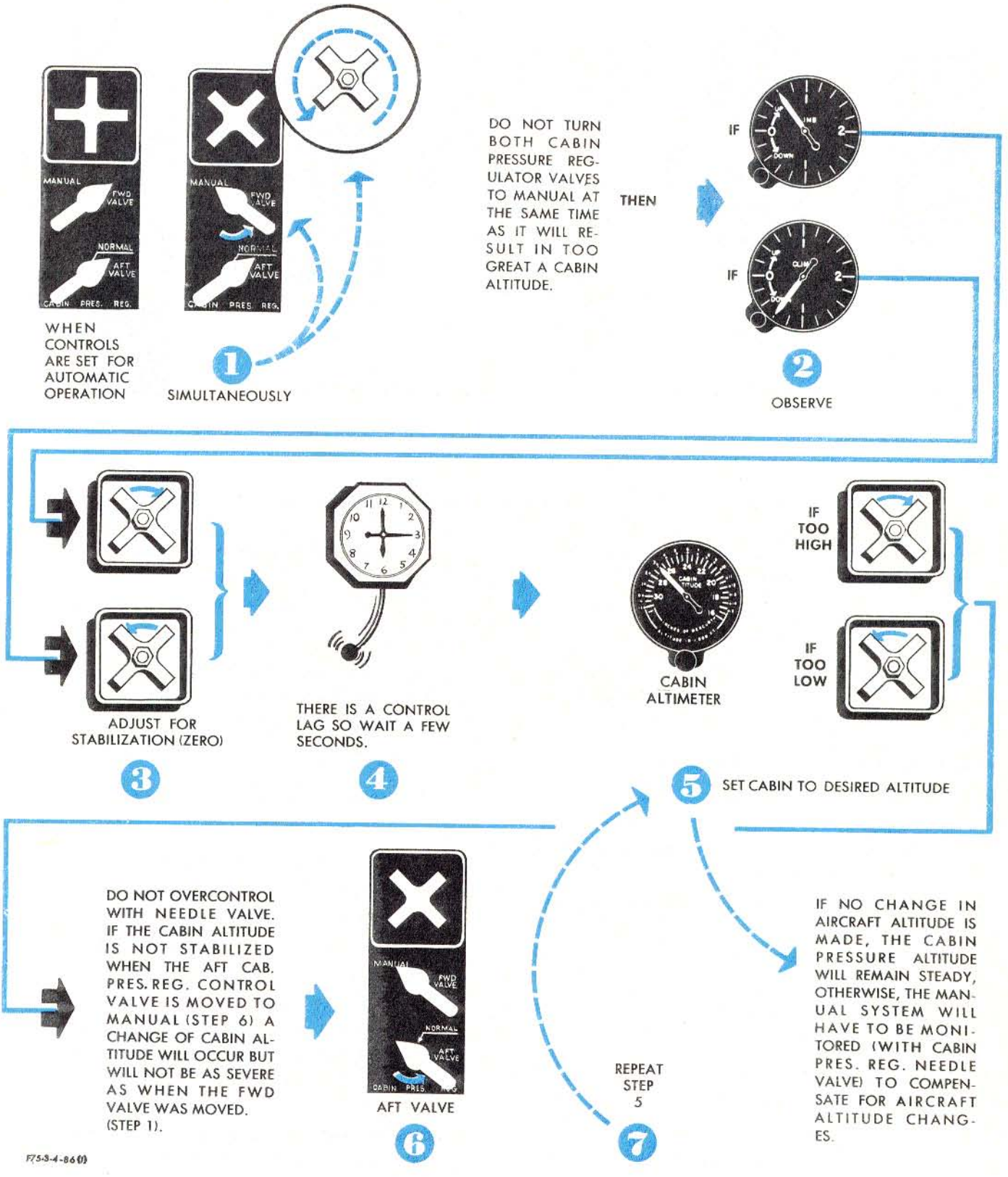


Figure 4-11. Pressurization Control — Automatic to Manual (Sheet 1 of 2)

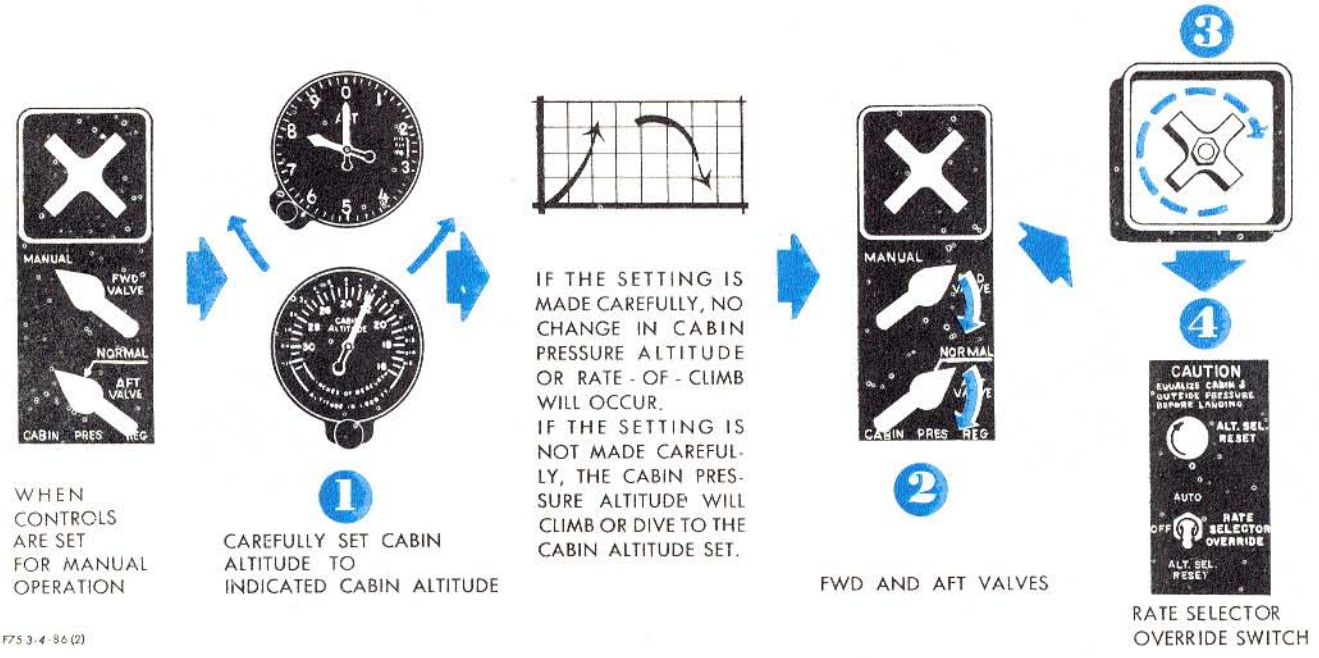


Figure 4-11. Pressurization Control — Manual to Automatic (Sheet 2 of 2)

begin to open or the lights to come on until the primary scoops reach the OPEN position.

SECONDARY SCOOP OPEN LIGHTS (LEFT AND RIGHT).

The secondary heat exchanger scoop open lights (20, fig. 4-4) glow amber whenever the secondary heat exchanger scoops are in the full open position.

NORMAL OPERATING PROCEDURES.

Ground Truck Heating or Cooling.

The flight compartment and cabin areas may be heated or cooled on the ground without engines operating by by performing the following steps:

1. Attach low-pressure truck to the ground-air connection.
2. Attach electrical ground power cart.
3. Recirculating fan switches—ON.
4. Aux. vent. control knob—POSITION A.
5. Cabin heater switches—OFF.
6. Flight station air outlets—OPEN.
7. Flight station fan switch—ON.
8. Flight station mixing valve—COOL.
9. If additional flight compartment heat is required:
   a. Pilots' aux. heater—position to heat required.

Heating and Cooling During Ground Operation.

The flight compartment and cabin areas may be heated or cooled on the ground during engine operation by performing the following steps:

1. Recirculating fan switches—ON.
2. Flight station fan—as desired.
3. All windows and doors—closed.

If ground heating is required:

1. Aux. vent. control knob—OPEN.
2. Cabin air paddle switches—WARMER.
3. If additional heat is required:
   a. Auxiliary fuel pump switches for tanks 2 and 3—LOW.
   b. Cabin heater temperature selector—as required.
   c. Cabin heater switches—ON.
4. If additional flight compartment heat is required:
   a. Flight station mix valve—WARM.
   b. Flight station fan switch—ON.
   c. Pilots' aux. heater—position to heat required.

If ground cooling or refrigeration is required:

Note

- Retard outboard engines to 1000 rpm to place superchargers in low ratio before going on refrigeration.
- When refrigeration is necessary during taxiing, operate the outboard engines at 1200 rpm and idle the inboard engines. This will provide the necessary rpm for the cabin superchargers without resulting in high taxi speed.

1. Altitude selector—set 1000-1500 feet above field elevation.
2. Aux. vent. control knob—CLOSED.

3. Cabin air paddle switches—COOLER.
4. Flight station mixing valve—position as required.

CAUTION

The refrigerator cooling fan switches must be in the NORMAL position during ground refrigeration.

Heating and Cooling During Flight.

The flight compartment and cabin areas may be heated or cooled during flight as follows:

1. Recirculating fan switches—ON.

If heating is required:

1. Cabin air paddle switches—WARMER.
2. Cabin temperature selector — set to temperature required.
3. Cabin heater switches—ON.

If additional flight compartment heat is required:

1. Flight station mix valve—WARM.
2. Flight station fan switch—ON.
3. Pilots' aux. heater—position to heat required.

If cooling or refrigeration is required:

1. Cabin air paddle switches—COOLER as required.

If additional flight compartment cooling is required:

1. Flight station fan switch—ON.
2. Flight station mix valve—COOL.

Note

If only partial refrigeration is required while using both superchargers, an increase of 3 to 5 knots can be realized if one secondary heat exchanger door is closed and desired cabin temperature is maintained with the supercharger.

Auxiliary Ventilation During Ground Operation.

The flight compartment and cabin areas may be ventilated on the ground during engine operation by performing the following steps:

1. Aux. vent. control knob—OPEN.
2. Aux. vent. exit valve switch—AUTO.
3. Altitude selector—set to 1000-1500 feet above field elevation.
4. Rate-selector-override switch—AUTO.
5. Cabin pressure regulator valves—NORMAL.
6. Cabin pressure regulator needle valve—closed.
7. Recirculating fan switches—ON.
8. Flight station fan—as required.
9. All windows and doors—closed.

Auxiliary Ventilation During Flight.

The flight compartment and cabin areas may be ventilated during flight as follows:

1. Before take-off.
   a. Recirculating fans—ON.
   b. Aux. vent. control knob—OPEN.
   c. Altitude selector—set to 1000-15000 feet above field elevation.
2. During flight.
   a. Aux. vent. exit switch—OPEN.
   b. Aux. vent. control knob—as required to maintain adequate ventilation.
   c. Flight station mix valve—as desired.
   d. Flight station fans—ON.
3. Before landing.
   a. Aux. vent. exit valve switch—OPEN.
   b. Aux. vent. control knob—position A.

Pressurization Control.

The flight compartment and cabin areas may be pressurized for flight operation by performing the following steps:

1. Before starting engines.
   a. Ground test switch—OFF (down).
   b. Cabin altimeter—set 29.92″ Hg and correlate with other aircraft altimeters.
   c. Cabin altitude selector—set to 1000-1500 feet above field altitude.
   d. Rate selector override switch—ALT. SEL. RESET until cabin altitude selector reset light goes out, then move switch to AUTO position.
   e. Aux. vent. control knob— position A.
   f. Aux. vent. exit valve switch— AUTO.
   g. Cabin air paddle switches— as required.
   h. Rate-of-change selector—300 feet per minute.
   i. Cabin pressure regulator valves—NORMAL.
   j. Cabin pressure regulator needle valve—1½ turns open.
2. During engine operation (before taxiing).
   a. Recirculating fans switches—ON.
   b. Flight station fan switch—ON.
   c. All windows and doors—closed.
   d. Aux. vent. control knob—CLOSED.
3. During climb.
   a. Cabin altitude selector—during climb select desired cabin altitude.
4. Descent.
   a. At the start of descent, reset cabin altitude selector to 1000-1500 feet above field altitude. Control rate-of-change as aircraft descends.

Note

If, during descent, it appears that the altitudes will not meet at approximately 1500 feet above the field, increase or decrease the cabin rate-of-change setting, as required.

5. Before landing.

a. Cabin heater switches—OFF.

b. Aux. vent. control knob—position A for propeller reversing.

Note

Refer to paragraphs on heating, cooling and refrigeration for procedure to be followed to maintained required cabin and flight station temperatures.

EMERGENCY OPERATING PROCEDURES.

Cabin Heater Malfunction.

If the heater does not operate properly, as indicated by the cycling lights not glowing or by low cabin temperature, accomplish the following:

1. Check the recirculating fans and circuit breakers. Be sure they are ON.

2. Turn the cabin temperature selector to a higher setting (toward 10). If heaters still do not cycle, place the emergency override switches on OVERRIDE.

3. Switch to alternate ignition points by placing the cabin heater emergency ignition switches on EMERGENCY.

4. Place combustion air blower on OVERRIDE.

5. Each cabin heater is protected by a Fenwal overheat switch. Should both the cycling controls fail or some other unit malfunction, causing the heater to overheat, the Fenwal switch will shut off the heater and electrically lock it off at an indicated temperature of approximately 180°C. Occasionally, under extreme conditions of air flow, a rapid rise of the combustion chamber temperature may also cause a heater to lock "off' with an indicated temperature that does not seem excessive.

6. To re-energize heater circuit, place heater switch to OFF position, then return switch to the ON position. If the Fenwal switch has cooled, the heater will start.

CAUTION

If the heater circuit locks OFF twice in succession, it should not be reset until the cause has been determined.

Pilots' Aux. Heater Inoperative.

When the pilots' aux. heater overheat warning light comes ON, the heater is in a "lock-out" (off) condition The heater may be reset:

1. Pilots' aux. heater switch—OFF.

Note

Allow time for heater to cool.

2. Pilots aux. heater switch—ON as required.

CAUTION

The face and foot air outlets should be partially or fully open to assure adequate air flow over the pilots' heater elements or the heater will lock-out again.

Emergency Depressurization.

(Refer to fig. 4-6).

1. Place the aux. vent. control knob in the full OPEN position. Return the knob to position A as soon as the cabin differential pressure is one inch of mercury. The aux. vent. control knob must be returned to position A to prevent partial pressurization of the cabin by the auxiliary ventilation system, which is sufficient to interfere with the opening of windows and doors.

CAUTION

Electrical power must be available for emergency depressurization with the aux. vent. control knob.

2. Cabin heater switches—OFF.
3. Recirculating fan switches—OFF.
4. Pilots' aux. heater switch—OFF.
5. Flight station fan switch—OFF.
6. Descent to a low, safe altitude.

Pressurization With One Cabin Supercharger Inoperative.

In the event it becomes necessary to maintain cabin pressurization on one cabin supercharger, it should be understood that operation with cabin pressurized at full differential from the output of one cabin supercharger is marginal and is dependent upon the cabin differential required and the rate of leakage from the cabin through normal deterioration of seals with service use. Therefore, if operation with only one cabin supercharger connected, and full differential is required, it is recommended that the following steps be performed.

1. Galley venturi—closed.

2. Radio rack venturi—closed, if it is still impossible to maintain desired cabin pressure.

CAUTION

If difficulty is experienced in maintaining cabin pressure up to the maximum differential with both venturis closed, descend to a cruising altitude where the cabin altitude can be maintained at 10,000 feet or less.

Cabin Supercharger Drive Shaft Disconnect.

CAUTION

If the cabin supercharger driveshaft bearing temperature starts rising rapidly and continues to rise beyond 125°C, the cabin supercharger should be disconnected before a temperature of 150°C is exceeded.

1. Release hook-type lock on No. 1 and/or No. 4 engine supercharger control lever.

2. Move control lever past the LOW position to the end of its travel.

3. Return lever to desired engine supercharger position.

CAUTION

Do not make more than one shift from LOW to HIGH within a five minute interval or the engine may be damaged.

When the cabin supercharger drive shaft is completely disconnected, one or more of the following indications will be noted:

1. A drop in cabin supercharger oil temperature (this may require several minutes).

2. Oil pressure warning light, if not already on, will come on as soon as the drive shaft is disengaged from the engine.

3. No pressure differential on the dual pressure gage.

4. No oil pressure on the oil pressure indicator.

CAUTION

The propeller of the affected engine should be feathered immediately if the cabin supercharger does not disconnect.

ANTI-ICING, DE-ICING AND DEFOGGING SYSTEMS.

Anti-icing or de-icing facilities are provided for the leading edges of the wing, empennage, upper and lower radomes, windshield, carburetors, propellers, and pitot heads. Defogging facilities are provided for the four aft windshield panels and the cabin windows. The pilot's and copilot's forward windshield panels are equipped with wipers.

WING, EMPENNAGE AND RADOME DE-ICING SYSTEM.

Ice may be removed after it has formed on the leading edges of the wing, empennage and the upper and lower radome by electronic-timed, pneumatic inflation and deflation of rubber boots cemented to those surfaces. Pressure and vacuum for the pneumatic system are supplied by four engine-driven air pumps. (Refer to fig. 4-22).

De-icer Boots.

The de-icer boots are made in segments designed for and firmly bonded to the leading edges of the wing, empennage and radomes. Each segment incorporates two separate systems of tubes with independent connections to their respective distributor valves except those segments attached to the tips of the stabilizer and to the fins, each of which has one system of cells. The boots are surfaced with a conductive coating to prevent the accumulation of static electricity, which when discharged, would interfere with radio reception.

De-icer System Pumps.

Four rotary, four-vane, positive displacement type, engine-driven air pumps, one mounted on each engine, supply air pressure and vacuum for the pneumatic de-icer system. The two outboard pumps supply pressure; the two inboard pumps supply vacuum for normal operation, but can be used as pressure sources in an emergency. Air for the pneumatic system is drawn from the cabin supercharger air ducts, and cooling air for the pumps is drawn from the oil cooler scoop ahead of the radiator.

Suction Pumps.

The two inboard pumps supply suction for the de-icer boot, the cabin pressure regulator valves, and the cabin pressure safety relief and dump valve. Normally, the output from the pressure side of the two pumps which supply vacumm is by-passed around the air regulator and filter, and is vented overboard. In an emergency, the vacuum pumps may be used as a source of pressure.

Pressure Pumps.

Pneumatic pressure from the two outboard pumps is directed through oil separators to pressure regulators

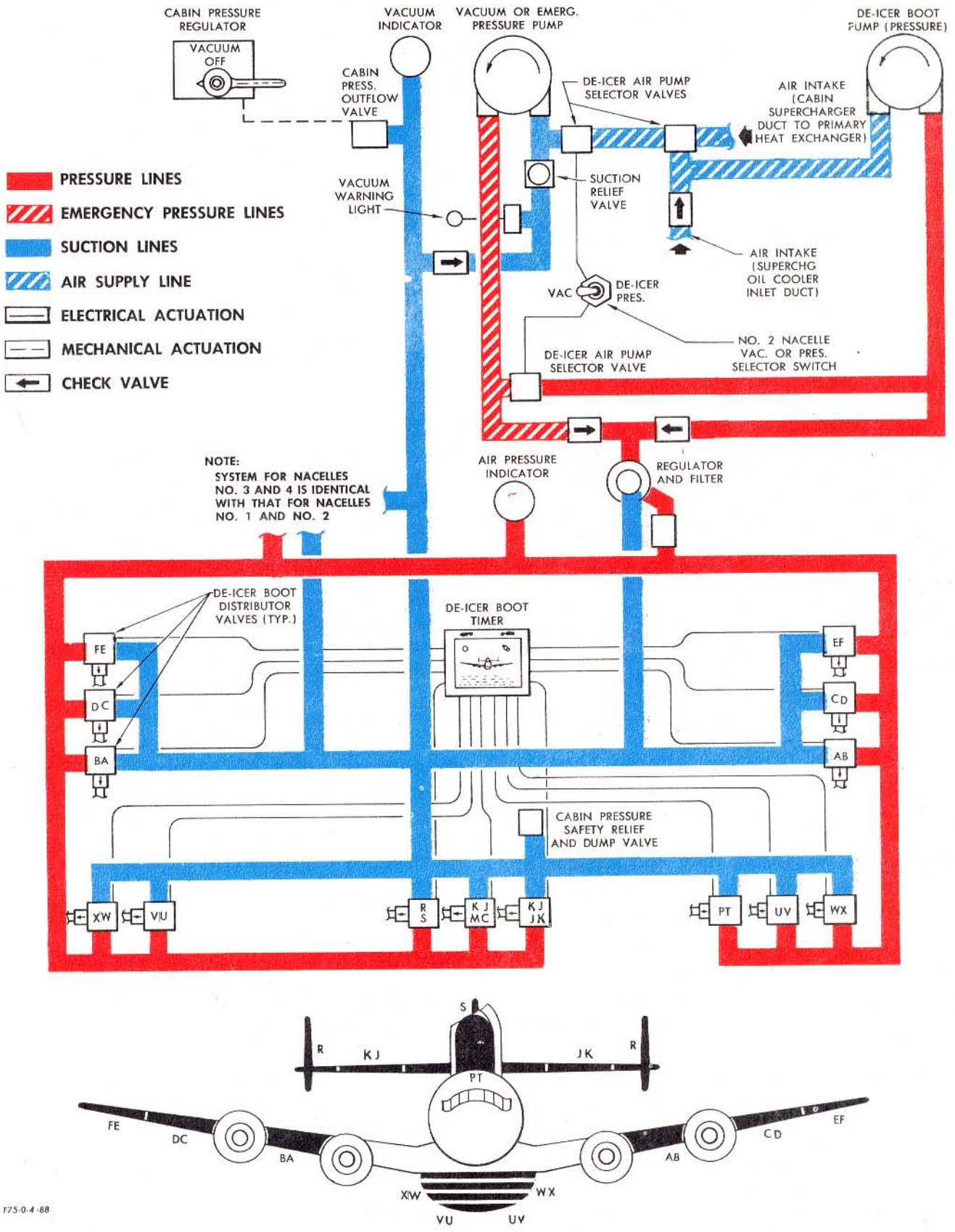


Figure 4-12. Pneumatic De-icing System

and filters. Solenoid valves in the regulators maintain approximately 22 pounds per square inch at the outlet ports, discharging excess air overboard. Relief valves between the pumps and regulators protect the regulators from pressure surges of approximately 24 pounds per square inch or above. Check valves downstream from the oil separators prevent loss of system presure in the event of failure of either pump. From the regulators, the compressed air passes to the main pressure line. Branches from the main pressure line extend to the nine distributor valves from which pressure is delivered to the de-icer boot segments in metered pulsations.

Distributor Valves.

The 14 solenoid-operated manifold de-icer distributor valves deliver alternate pressure and vacuum to the de-icer boot segments. Each valve has five ports; two inlets, two outlets, and one overboard vent. The outlet ports serve individual boot tube systems. Air pressure is supplied through one of the inlet ports and dumped through the overboard vent. Vacuum is applied through the other inlet port. When the solenoid is energized, air pressure flows through the outlet port to the associated boot segment. When the solenoid is deenergized pressure is relieved overboard until the pressure drops to approximately one inch of mercury, then four inches of mercury suction is applied through the vacuum port to evacuate the tubes and flatten the boot segment against the leading edge surface.

De-icer Boot Pneumatic Control Selector Switch.

The d. c. electronic timer is controlled by a 3-position switch (3, fig. 4-13) located on the timer control panel, and is placarded EXTENDED CYCLE, NORMAL CYCLE, and OFF. When the switch is placed in either EXTENDED or NORMAL CYCLE position, the system will warm up within 20 seconds, and the cycling lights will flash in sequence with the inflation-deflation cadence of the de-icer boot segments. In NORMAL position, the inflation cycle requires 90 seconds; in the EXTENDED position, it requires 135 seconds. The selector switch may be turned OFF at any stage of cycling sequence, and a stepper relay will return the electronic timer to its starting position. The timer is designed for continuous duty in flight, and receives its power from the MJB positive bus.

De-icer Boot Segment Switches and Cycling Lights.

Nine 3-position switches (5, fig. 4-13), located on the control panel between the two rows of cycling lights, permit out-of-sequence inflation of any individual boot segment. These switches are placarded with the identification letters of the inflation tube groups they control. A schematic digram etched on the face of the control panel shows the corresponding location of each tube group. When any individual switch is moved to either of its on positions, the adjacent cycling light will flash to show that the individual circuit is closed and the selected boot tube group is inflated. When more than one switch is closed, the one to the left will control, and until it is released, the switches to the right of it will be inoperative. Energizing the individual boot segment switches does not affect the cadence of the inflation-deflation cycle.

De-icer Air Pump Selector Switches.

Two 2-position toggle switches (4, fig. 4-13), located forward of the electronic timer control panel, operate the de-icer pump selector valves which permit the use of either or both of the vacuum pumps as sources of de-icer boot pressure. The valves are positioned by electric motors mounted on the valves. The switches are placarded VAC. and DE-ICER PRES. and are normally positioned VAC. In this position, the valves dump the pressure output overboard. When the switches are positioned at DE-ICER PRES., air is vented to the vacuum line upstream from the pump, and the output is routed around the overboard dump into the de-icer boot pressure system. In this switch position, the vacuum system is isolated from the pump. Either or both vacuum pumps may be used to supply de-icer boot pressure.

Cabin Pressure Regulator Vacuum Shut-off Lever.

Located on the offset in the flight station floor behind the pilot's seat is the cabin pressure vacuum shut-off lever. This lever controls the valve that shuts off the suction from the cabin pressurization system controls in the event that all of the available vacuum system suction is required to operate the de-icer boots.

De-icer Pressure Indicator.

One direct reading pressure gage (39, fig. 1-7) is mounted on the pilot's auxiliary instrument panel. It registers the pressure in pounds per square inch available in the de-icer pressure system.

Vacuum Indicator.

Adjacent to the de-icer pressure gage (38, fig. 1-7) is the vacuum gage which registers the vacuum in the system in inches of mercury.

Vacuum Warning Lights.

A warning light for each vacuum pump is located on the pilot's auxiliary panel (40, fig. 1-7) above the de-icer pressure gage and on the flight engineer's upper instrument panel (10, fig. 1-16). They are energized by vacuum warning units in the vacuum lines upstream of the suction relief valves and glow whenever the vacuum drops below 4 inches of mercury.

Electronic Timer Indicator Lights.

When the electronic timer switch is placed in either NORMAL or EXTENDED CYCLE position, a d. c. operated indicator light (1, fig. 4-13) in the upper left corner of the timer control panel will glow. This light may be dimmed or brightened by turning its cover. The double bank of lights at the bottom of the control panel are the cycling lights which indicate the progress of the pressure vacuum cycle through the de-icer boot segments.

NORMAL OPERATING PROCEDURES.

Rime ice may be eliminated more effectively from the leading edges of the wing, empennage and radomes if it is permitted to build up to between ⅜ and ¾ inch in thickness before the de-icer boots are turned on. Clear or glaze ice may be allowed to build up to approximately ¼ inch. A thin film of ice may be flexible, but when it thickens, the expansion and contraction of the boots will crack it and permit it to be blown off. For the same reason, the use of EXTENDED CYCLE is more effective when ice accumulation is slow. The extended interval between pulsations permits the ice to build up to the point at which it will crack under flexure. When ice conditions are encountered, permit the ice to accumulate then place the system in operation as follows:

1. De-icer boot cycle selector switch (pneumatic control)—NORMAL CYCLE or EXTENDED CYCLE depending upon rate of icing.

CAUTION

Pressure pumps are supercharged by the cabin supercharger to lower the operating pressure ratio of the pumps. Do not operate boots continuously with cabin altitude above the normal operating range (10,000 ft. cabin). Recommended operation for this condition is aproximately two minutes ON and two minutes OFF.

Wing and empennage de-icer must be turned OFF prior to landing.

EMERGENCY OPERATING PROCEDURES.

De-icer Pump Failure.

The de-icer air pump selector switches permit the use of either of the vacuum pumps as a pressure source if one of the pressure pumps fail. De-icing may be accomplished as follows:

1. De-icer air pump selector valve switches—No. 2 NACELLE—VAC. and No. 3 NACELLE—DE-ICER PRES.

Note

The positions of the de-icer air pump selector valve switches may be reversed at the descretion of the pilot.

If both pressure pumps have failed and inadequate pressure is available with only one pump, switch both vacuum pumps from VAC. to DE-ICER PRES. Return to VAC. when need for pressure no longer exists, or when vacuum is required.

2. De-icer boot cycle selector switch (pneumatic control)—EXTENDED CYCLE.

Note

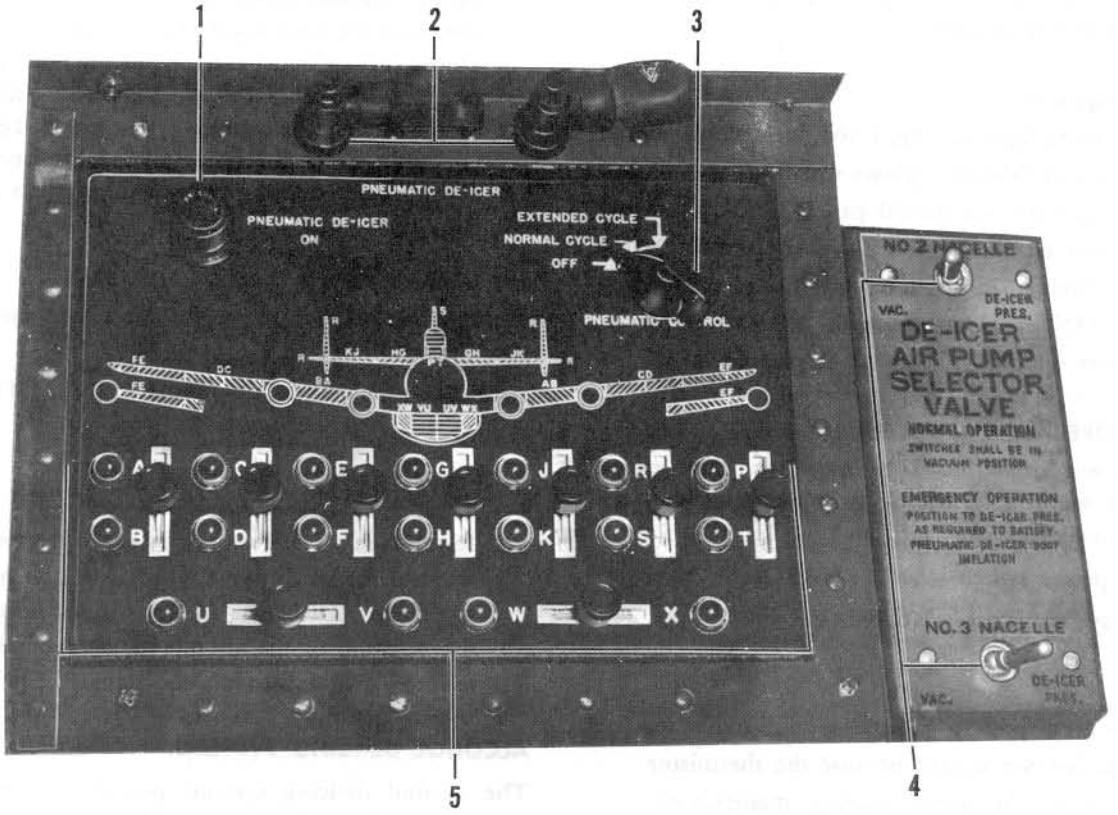
In the event of uneven icing, or in case ice fails to come off any boot segment, move the appropriate segment switch up or down as required.

ELECTRICAL WINDSHIELD ANTI-ICING SYSTEM.

The three center windshield panels can be warmed by electrically generated heat to prevent the formation of ice on the exterior surfaces. Current for heating the windshield glass is normally supplied by alternator power. A three-phase inverter driven by power from the main d. c. bus is installed as a source for auxiliary power in the event of alternator failure. Normal power provides adequate heat in the windshield panels to handle most conditions where anti-icing is required and to maintain the temperature of the vinyl layer within the range in which it possesses its maximum resistance to shattering due to impact. Normal power will also assist the defogging air system in keeping the inner windshield surfaces free of fog.

Panels.

The electrically heated panels are a laminated product consisting of a ¼ inch layer of vinyl plastic between two sheets of glass. The outside sheet is $\frac{3}{16}$ inch thick; the inside sheet is ⅜ inch thick, and is structurally designed to contain maximum cabin differential pressure in the event of fracture or delamination of the outer sheet of glass. The inner surface of the outside layer of glass is coated with a transparent conductive coating which generates heat when electric current is passed through it. Bus bars, imbedded in the top and bottom of the panels, distribute electric current to the conductive coating. Thermistors, one imbedded in the vinyl layer of each panel, connected in parallel, control the application of power to the panels. The cycling of alternating



1. PNEUMATIC DE-ICER ON LIGHT
2. PANEL LIGHTS
3. CYCLE SELECTOR SWITCH
4. DE-ICER VACUUM PUMP SELECTOR VALVE SWITCHES
5. DE-ICER BOOT SEGMENT SWITCHES AND CYCLING LIGHTS

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Figure 4-13. De-icer Boot Timer

current through the three windshield panels is accomplished by a wheatstone bridge control energized by direct current from the MJB bus. The resistance variation of the thermistors with temperature, provides the bridge unbalance necessary to produce the cycling action that automatically controls the temperature of the windshield panels.

Nesa Power Selector Switch.

The nesa power selector switch (21, fig. 1-27) is located on the MJB No. 2 panel and permits selection of either the ALTERNATOR or SPARE INVERTER as a power source for the electrically heated windshield anti-icing system.

Nesa System Switch.

A three-position Nesa system power switch is located on the copilot's side panel (10, fig. 1-10). It is placarded HIGH, OFF, and NORMAL; in the HIGH position a more rapid and greater temperature rise in the outer sheet of glass is possible. The NORMAL position is recommended for routine use in all conditions and provides 40% of the HIGH power output.

Nesa Reset Switch.

The spring-loaded, push-button Nesa RESET switch, located near the Nesa system switch on the copilot's switch panel (13, fig. 1-10), performs two functions. First, it permits restart of heating as soon as the thermistors cool as much as 3°C. Second, it initiates the start of cycling when the windshield is so cold (approximately —40°C, that high thermistor resistance prevents application of heating current.

Nesa System Power-On Light.

This light, located adjacent to the Nesa system switch (11, fig. 1-10), is illuminated whenever power for the system is available. It will come on whenever the Nesa inverter switch is in either the ALTERNATOR or the EMERGENCY position.

Nesa Cycling Light.

The Nesa cycling light (12, fig. 1-10), located adjacent to the system power-on-lights, glows whenever the conductive material in the windshield panels is energized and goes off when current to the panels is interrupted by the cycling circuit. In flight at low OAT, the cycling light stays ON continuously with NORMAL power. This indicates marginal ability of normal power.

NORMAL OPERATING PROCEDURES.

The use of windshield heat is recommended at all times. The electric windshield heating system should be placed in operation as follows:

1. Nesa power switch—ALTERNATOR.
2. Nesa system switch—NORMAL.

Note

If the Nesa cycling light does not come on, heating has not started because the thermistor is too cold. To initiate heating, maintain occasionally interrupted pressure on the reset switch until release of pressure does not cause the cycling light to go off.

HIGH POWER OPERATION.

It is recommended that HIGH power be used under the following conditions:

1. When ice begins to form on the windshield panels when using NORMAL power.
2. At 10,000 feet altitude, during descent into areas where birds are numerous.
3. When icing is anticipated at outside temperatures near the low end of the icing range —25°C to 0°C.
4. At 10,000 feet altitude during descent into areas of high temperature — high humidity conditions.

Note

To maintain windshield heat for defogging in high temperature, high humidity conditions, maintain pressure on the Nesa reset switch until the cycling light comes on. This will raise the lower limit within 3°C of the upper limit.

CAUTION

If HIGH power is used without prior warming of the panels with NORMAL power, the resultant thermal shock may cause local delamination of the outer layer of glass from the vinyl plastic core or in the cracking of the outer layer of glass. If visibility is not impaired, cracking of the outer layer of glass is not an emergency condition, since the inner layer is structurally capable of containing the miximum cabin pressure differential.

EMERGENCY OPERATING PROCEDURES.

In the event of failure of the Nesa alternator power proceed as follows:

1. Nesa power switch—SPARE INVERTER.

CAUTION

In the event of sparking or arcing in the electric windshield panels leave, or change, the power setting to NORMAL. Make only such changes in operation of the aircraft as are required by reduced vision through the damaged panel.

ALCOHOL DE-ICING SYSTEMS.

The alcohol de-icing systems provide the means for removing ice from the carburetors, and propellers. With the exception of the alcohol tanks, the systems are independent. (Refer to fig. 4-14.)

Tanks.

One 20-gallon alcohol tank is mounted in the aft end of each outboard engine nacelle. The filler walls are located in the upper surface of the wing and are equipped with drains leading overboard. The carburetors and propellers are supplied from the tank located on their respective sides of the aircraft.

PUMPS.

Three d.c. electrically driven de-icing pumps are mounted side by side, aft of the alcohol tank in each outboard engine nacelle. One pump from each outboard nacelle supplies alcohol to the inboard and outboard propellers; the second pump supplies alcohol to the outboard engine carburetors, and the third pump supplies alcohol to the inboard engine carburetors. The pump serving the propellers delivers a minimum of five gallons per hour (2.5 gallons per propeller); and a minimum of 3.6 gallons per hour (1.8 gallons per propeller). Each pump serving the carburetors is capable of delivering approximately 26 gallons per hour at 20 psi.

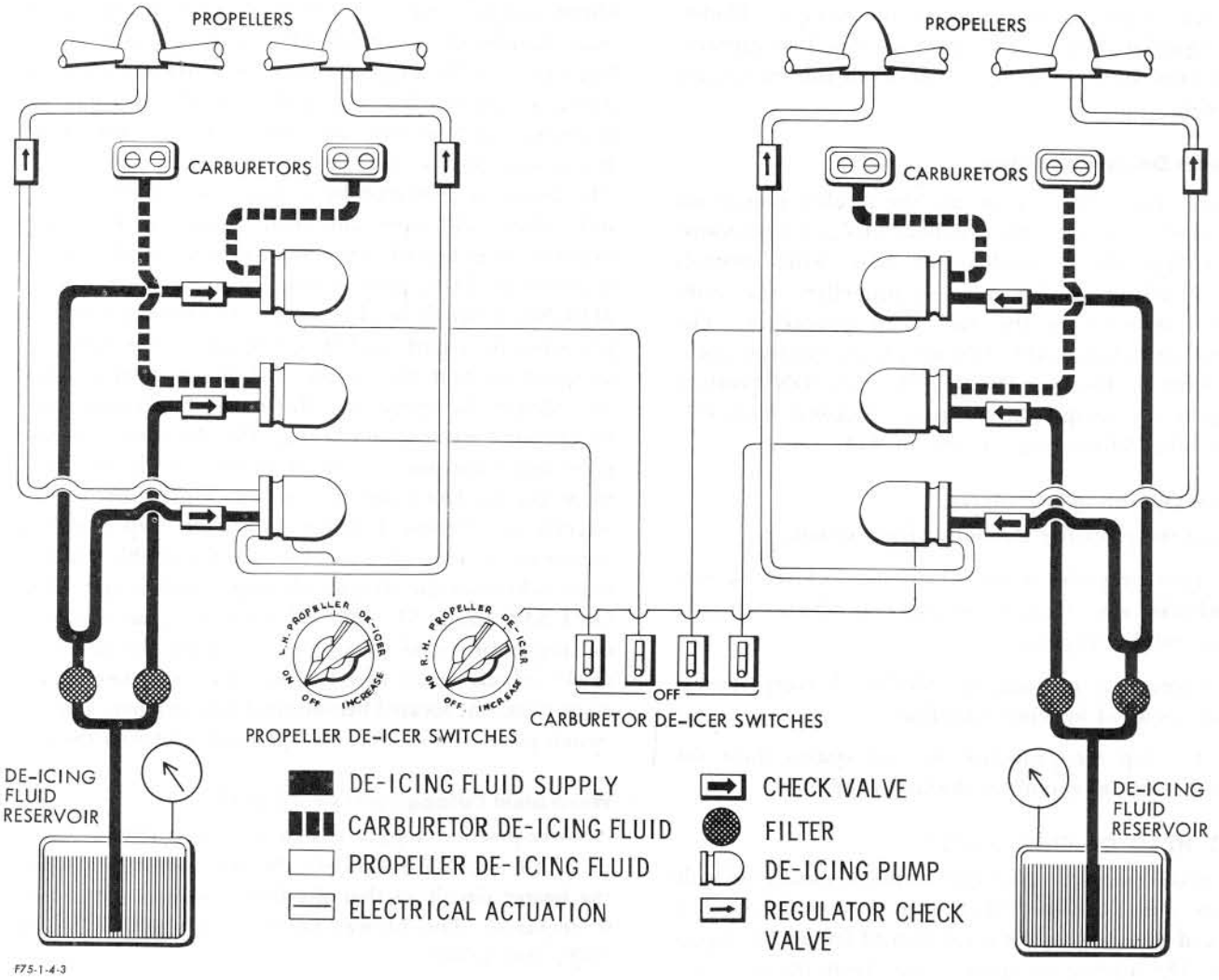


Figure 4-14. Alcohol De-icing System

Alcohol Tank Fluid Quantity Indicator.
Each alcohol tank is equipped with a d.c. electrically operated Liquidometer-type, fluid quantity transmitter which registers alcohol quantity in gallons on a dual indicator mounted on the flight engineer's upper instrument panel (2, fig. 1-20).

CARBURETOR ALCOHOL DE-ICING SYSTEM.

Alcohol may be used to dislodge ice after it has formed in the carburetors. The carburetor alcohol de-icing system delivers alcohol to the carburetors through three dual outlets in each throat, each positioned to provide adequate coverage of the critical carburetor icing area.

Carburetor De-icing Switches.
The four carburetor de-icing system alcohol pumps are individually controlled and d.c. operated by momentary switch-type circuit breakers (14, fig. 1-27) which are spring-loaded to OFF. The switches are mounted on the MJB No. 2 switch panel.

NORMAL OPERATING PROCEDURES.

When alcohol injection is necessary to combat carburetor icing, momentary application (from 3 to 5 seconds) is usually sufficient. If more alcohol is necessary to control heavy or continued icing, it should be injected intermittently. Refer to Section VII, Carburetor Icing, for further discussion of this procedure.

1. Close the appropriate switch or switches momentarily, and release.

2. Repeat, if necessary, until engine power is stabilized.

PROPELLER ALCOHOL DE-ICING SYSTEM.

One of the two outlets of each propeller de-icing pump supplies the outboard propeller, and the other supplies the inboard propeller. Alcohol is delivered by the pumps to the propeller slinger rings. Centrifugal force propels the alcohol to the outside of the slinger ring and through fedder tubes to the grooved boots

mounted on the leading edges of the propeller blades. The regulator check valve in the alcohol line prevents the alcohol from escaping except when the pumps are operating.

Propeller De-icing Switches.

The regulator check valves and the alcohol pumps are controlled by two rheostat switches (20, fig. 1-27) located on the MJB No. 2 switch panel. One switch controls alcohol delivery to the two left propellers, the other controls delivery to the two right propellers. The switches are labeled OFF, ON and, at the extreme clockwise limit of the arc, INCREASE. The ON position energizes the pumps; the positions clockwise from ON control the delivery rate of the alcohol.

Normal Operating Procedures.

To start the propeller alcohol de-icing system:

1. Turn propeller de-icer rheostats clockwise to full INCREASE, then back to the position which will give the desired delivery rate.

2. Increase or decrease the alcohol delivery rate as may be required by icing conditions.

3. To stop the propeller de-icing system, turn the rheostat switches counterclockwise to OFF.

PITOT HEAD DE-ICING SYSTEM.

Electrically energized resistance elements mounted inside the two pitot heads provide heat to prevent the accumulation of moisture or the formation of ice in the impact tubes. The heating elements operate from the d. c. electrical system and are energized, as required, through the pitot heat switches.

Pitot Head Switches and Indicator Lights.

A two-position toggle switch (4, fig. 1-10) for each pitot heater is mounted on the copilot's side panel. These two switches are placarded LEFT or RIGHT, and OFF. The heaters are d. c. energized when the switches are in the up position. Two indicator lights (5, fig. 1-10), mounted between the switches, glow when the pitot heaters are energized and operating normally. The lights will go out if an open circuit occurs.

CAUTION

Pitot heaters must be turned OFF when the aircraft is on the ground to avoid burning ground personnel and to prevent damage to the pitot heads when covered.

WINDOW DEFOGGING SYSTEM.

The two aft windshield panels on each side of the flight station, which are not Nesa glass, are equipped with distributor manifolds (fig. 4-15) through which heated air may be directed against the inner surface of the panels to prevent fogging. A d.c. electrically energized heater-blower assembly, mounted forward of the pilot's instrument panels, supplies warm air for the system. The heater is protected by a special low-melting alloy link which will open the relay circuit if the heater becomes over-heated. In addition, the heater circuit is protected by a push-to-reset circuit breaker on the MJB No. 3 circuit breaker panel. The blower circuit is protected by a push-pull circuit breaker. The circuit is designed so that the heater will function only when the blower is operating. However, the blower may be operated without the heater. The space between the inner and outer panes of the cabin windows is ventilated by warm air from the air conditioning system of the aircraft to prevent fogging and icing. Operation is automatic, and air circulates between the double window panes whenever the air conditioning system is operating. On USAF serials 52-3425 and subsequent, an overhead ducting is provided to supply heated air for all windshield panels from two 28 volt d.c. operated heater assemblies, one located behind the flight engineer's upper switch panel and one on the left hand side wall ceiling.

Windshield Defogging Blower Switch.

A three-position toggle switch on the copilot's switch panel (9, fig. 1-10) controls the d.c. blower and arms the heater circuit so that the heater may be turned on if required. The blower switch is placarded HIGH, OFF, and LOW.

Windshield Defogging Heater Switch.

A two-position, HEAT and OFF, windshield defogging heater switch (8, fig. 1-10) is located on the copilot's side panel.

Windshield Spot Defogger.

For spot defogging of any windshield areas, a flexible hose has been provided which can be attached to the pilot's foot or face air duct outlets, and warm air from the air conditioning system of the aircraft can be directed against the windshield. When not in use, the hose is coiled and stowed in a canvas sling attached to the flight station canopy.

Normal Operating Procedures.

When fogging occurs on the windshield panels, place the system in operation as follows:

1. To start, move the blower switch to HIGH or LOW, as required.

2. If heat is necessary, move the heater switch to HEAT.

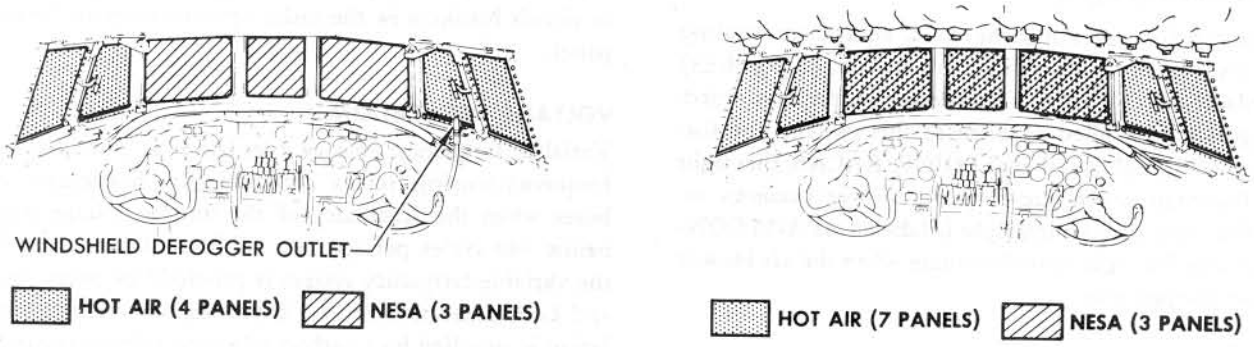


Figure 4-15. Windshield Anti-icing and Defogging

3. When defogging is no longer necessary, heater switch—OFF. After 30 seconds, blower switch—OFF.

CAUTION

Leave the windshield defogging blower switch on at least 30 seconds after turning off heater switch or residual heat in the heater may open the heater fusible links.

COMMUNICATIONS AND ASSOCIATED ELECTRONIC SYSTEM.

Note

The following text will refer to certain stations, positions, switch labeling and crew members in nomenclature other than that placarded. The following comparison list will indicate the altered terminology. Although the Passive Detection Equipment is described in the following text, reference to the PD operator has been deleted.

Combat Information Center (CIC)	Airborne Operations Center (AOC)
Combat Information Center Officer (CICO)	Senior Director (SD)
Assistant Combat Information Center Officer (ACICO)	Duty Director (DD)
Electronic Counter Measure (ECM)	Passive Detection Operator (PD)
Radar Operator	Radar Technician
Air Control Officer (ACO)	Search Radar Operator (SRO)
Talker	Teller

Communication and electronic equipment consists of radio and interphone equipment that provides aircraft to aircraft communication, aircraft to ground communication, interphone communication between flight crew members and AOC crew members, navigation equipment for guidance and blind landings, and various specialized functions in connection with radar sets for search, identification and relay operations in connection with the aircraft's function as a AOC aircraft. This is in addition to other electronic equipment such as automatic pilot, electronic fuel gage timers, etc., which are described in other sections of this handbook. Equipment described is grouped in broad classifications of power distribution system, antenna, intercommunication, navigational, radar search, identification, and other specialized equipment. A functional breakdown of the equipment in the aircraft is listed in the Table of Communications and Associated Electronic Equipment (fig. 4-16) and operation of the primary controls is listed in the FLIGHT CREW and AOC CREW Electronic Facilities Tables (fig. 4-17).

AOC EQUIPMENT COOLING SYSTEM.

The AOC equipment cooling system consists of two separate ducting systems and two 28 volt powered blowers. The forward system draws heated air from under the shrouds surrounding the equipment at the radio operator's station, Navigator's station, passive detection operator's station, radar technician's station and the senior director's station. The aft system draws the heated air from inside the APS-56 consoles at the five search radar operators stations and the height finders station. The heated air from both systems is ducted into the under floor area for cooling. Both blowers are operated by one two-position switch (6, fig. 4-33).

AOC Equipment Cooling System Switch and Blower Warning Lights.

The switch for operating the AOC equipment cooling system is located on the technician's station: (6, fig. 4-33) it is placarded ON-OFF. Two blower inoperative warning lights are installed adjacent to this switch. The forward warning light is labeled EQUIP. RACKS, this light will illuminate when the forward blower becomes inoperative. The aft warning light is labeled APA-56 CONSOLES and this light will illuminate when the aft blower becomes inoperative.

WARNING

If either blower inoperative warning light illuminates the affected equipment should be turned off to avoid overheating.

POWER DISTRIBUTION SYSTEM.

Power for radio and other electronic equipment is obtained from the 28-volt d. c. bus, two 115/200-volt, 3-phase 400-cycle inverter systems which furnish fixed-frequency alternating-current and two variable-frequency a. c. generators which feed two 3-phase a. c. buses. The fixed-frequency inverters are installed for electronic equipment having 380 to 420 cycle a. c. requirements. One of these inverters is used as a main inverter with the other as a spare. Change-over to spare inverter is automatic or may be accomplished manually. The variable frequency a. c. generators are installed on an engine-driven gearbox in each outboard nacelle and supply a.c. power to either or both a.c. buses. Direct and alternating current power is supplied to the radio equipment through circuit breakers on the radio operators circuit breaker panel. The direct current bus in the radio operators circuit breaker panel is supplied through two 130 amp current limiters at the main direct current power bus in the forward lower compartment. Direct current power is supplied to the Radar technicians direct current bus through one 150 amp current limiter at the main direct current bus. This feeder line supplies d.c. power through a switch type circuit breaker, located in the radar technicians circuit breaker panel, to the AOC interphone system. Fixed and variable frequency alternating current power is supplied to the radio operators circuit breaker panel from the three phases of the instrument inverters and phase C of the alternating current generators, respectively. Fixed frequency, alternating current power is supplied through fuses in the alternating current fuse panel in the forward lower compartment. Variable frequency alternating current power is supplied through a circuit breaker on the radar technicians circuit breaker panel. Voltage is subsequently fed to circuit breakers in the radio operators circuit breaker panel.

VOLTAGE REGULATION.

Variable frequency voltage regulation is provided and frequency-sensing relays automatically de-energize the buses when the frequency of the output voltage drops below 380 cycles per second. Additional protection for the variable-frequency system is provided by overvoltage and fault protection relays. Direct current voltage regulation is supplied by a carbon pile type voltage regulator for each direct current generator, located beneath the floor at the flight station.

EXTERNAL POWER RECEPTACLE.

The external a. c. power receptacle circuit is protected against frequencies below 380 cycles and against reverse phase-sequences by means of low-frequency and phase-sensing relays.

JUNCTION BOXES.

Five main junction boxes are employed. These boxes are defined as follows: forward radio junction box, main radio junction box, auxiliary radar junction box, PDO junction box, and AOC interphone junction box. The forward radio junction box contains the auxiliary IFF relay and two relays and two capacitors for use with automatic approach equipment, public address system relays, signal attenuating resistors for use with the VOR, ADF, and C-1 equipment, an audio resistor panel, and ICS switch, and VOR test receptacle. This box is located on the forward side of the rack and covers the upper half of the rack. The main radio junction box contains two 618S radio noise filters, HF muting relay, three AN/ARC-27 radio noise filters, and two signal attenuating resistors used with the ID-250/ARN indicators. This box also contains the a.c. and d.c. circuit breakers for the radio and interphone equipment. The box is located under the radio operator's table on the aft side of the main radio rack. Extending aft along the aisle side of the table is the box containing the radio equipment circuit breakers. This box is connected to the main radio box and is similarly identified. The circuit breaker panel is on the aft side of this box. The auxiliary radar junction box is located on the aisle side of the auxiliary radar equipment rack. The PDO junction box is located on the aisle side of the PDO equipment rack. The AOC interphone junction box contains the PA system emergency relays, the interphone dynamotor-relays, the PA relay and dynamotor switch-type circuit breakers, and the top-mounted fuse panel containing the fuses in the individual AOC interphone circuits. This box is located adjacent to the plotters station.

Type	*Designation*	*Function*	*Range*	*Location of Controls*
COMMUNICATIONS				
Interphone system	AN/AIC-10	Inter-crew communication, audio distribution, microphone function	Crew stations within aircraft and mechanics' stations	Pilots', radio operator's, navigator's stations Engineer each engine nacelle, forward and aft baggage compartments, galley, tail cone, lower radome and nose wheel well
Public address system	MI-36A	All crew stations	Crew stations within the aircraft	SD officer and pilots
UHF transmitter-receiver	AN/ARC-27	Short-range, two-way voice communication	Line of sight	Pilots' radio operator's, SRO No. 1 thru No. 5 stations
HF liasion transmitter/receiver	618 S-1	Voice, CW or MCW transmission	250 to 2,000 miles	Radio operator's station
HF command transmitter/receiver	618 S-1	Voice, CW or MCW transmission	250 to 2,000 miles	Pilots' station
HF liasion receiver	AN/ARR-15A	Reception of voice, CW or MCW communication	1,000 miles	Radio operator's station
LF range receiver	R-23A/ARC-5	Reception of low frequency communication and radio ranges	100 to 300 miles	Pilots' station
NAVIGATION				
Radio Compass	AN/ARN-6	Reception of voice or code signals for direction finding and bearings	300 miles	Pilots' and navigator's stations
Navigation receiver	AN/ARN-14A	Reception of VOR, VAR and localizer signals	Line of sight	Pilots' station
Marker beacon receiver	AN/ARN-12	Reception of location marker and marker beacon signals		Pilots' station
Loran receiver	AN/APN-70	Reception of long-range radio navigation signals	Day—700 miles Night—1400 miles	Navigator's station

Figure 4-16. Table of Communications and Associated Electronics Equipment (Sheet 1 of 3)

Type	*Designation*	*Function*	*Range*	*Location of Controls*
NAVIGATION (Continued)	AN/ARN-21	Reception of VOR signals, gives bearings and distances information	195 nautical miles	Pilots station
Glide slope receiver	AN/ARN-18	Reception of glide slope signals from ILS stations	30 miles	Pilots station
Radar altimeter	AN/APN-22	Indicates altitude above terrain	10,000 feet over land 20,000 feet over water	Pilots' and navigator's stations
Radar altimeter (high alt)	SCR-718D	Indicates altitude above terrain	40,000 feet	Navigator's station
UHF direction finder	AN/ARA-25	Reception of UHF signals for direction finding and homing	Line of sight	Pilots' stations
AOC SPECIALIZED EQUIPMENT				
Search radar	AN/APS-20E	High power, long-range CIC search radar		Radar tech and navigator's stations
Height finding radar	AN/APS-45	Obtains alt. of targets detected by APS-20 radar		Height finders station
Repeater indicator equipment	AN/APA-56	PPI, video information, recording camera indicator		SRO No. 1 thru No. 5 stations, scope camera.
Radar relay transmitter	AN/ART-28	Relays radar information to surface control station	Line of sight	Radar tech and SD stations
Radar relay receiver	AN/ARR-27A	Relays video, IFF, azimuth information	Line of sight	SD station
PD direction finder	AN/APA-69 or AN/ALA-6	Provides bearing of received radio-radar signals		PD operator's station
ECM receiver	AN/APR-9B	Reception of radio-radar signals		PD operator's station
Pulse analyzer	AN/APA-74	Analize radio and radar signals		PD operator's station

Figure 4-16. Table of Communications and Associated Electronics Equipment (Sheet 2 of 3)

Type	*Designation*	*Function*	*Range*	*Location of Controls*
CIC SPECIALIZED EQUIPMENT (Continued)				
Ground position indicator	AN/APA-57B	Gives continuous indication of aircraft's ground position		Navigator's and SD stations
Range-azimuth indicator equipment	AN/APA-81	Gives PPI display, syncronized azimuth, radar video, IFF signals		SD station
Identification set	AN/APX-6A or AN/APX-25	Reception and transmission of identification signals	Line of sight	Radio operator's station
Coder	AN/APA-89	(Provisions)		
Recognition	AN/APX-7			SD station and all SRO stations
Recording camera	O-15	Photograph indicator display		SRO No. 1

Figure 4-16. Table of Communications and Associated Electronics Equipment (Sheet 3 of 3)

RADIO EXHAUST DUCT.
The heat generated by the electronic equipment in the forward radio rack is exhausted through a venturi in the skin of the fuselage, outboard of the rack.

RADIO EXHAUST BUTTON.
Exhausting is controlled by a pull-type button, containing a center-mounted, push-type release mechanism, mounted on the second shelf of the forward radio rack. This button is connected by a sheathed wire to a bell crank which actuates a butterfly valve in the throat of the venturi.

ANTENNA SYSTEM.
The antenna system is installed as shown on (fig. 4-22).

INTERCOMMUNICATION SYSTEMS AN/AIC-10.
Two separate interphone systems and a public address system are installed in the aircraft. The two interphone systems are designated as FLIGHT CREW and the AOC CREW. The flight crew interphone system also includes service and radio facilities with the flight crew and mechanics' stations connected by a conventional push-to-talk system with call facilities. The flight crew interphone system receives and distributes audio signals for each of the stations connected to the system. The AOC crew interphone system is separate from the flight crew interphone system and basically provides separate channel communication between any two AOC crew stations. Any AOC crew member may signal any other AOC crew member, and a AOC crew member may accept or reject, at his option, any call from any station. The only signal which all AOC stations are forced to accept is pilot's transmission when the public address system is used for emergency announcements by the pilot. The MI-36A public address system is controlled by the AOC officer with emergency override provision for the pilot.

RADIO SELECTOR BOXES.
The selector boxes provide a means of selecting the audio output of any one of several receivers and interphone communications, and a means of connecting the microphone to a desired transmitter.

SELECTOR BOX CONTROL PANEL C-824.
The pilot, copilot, navigator, radio operator, and flight engineer stations are equipped with this control panel.

Microphone Selector Switch.
This switch is located at the lower center of the panel (8, fig. 1-8) and is a rotary type switch. The switch provides six possible positions which control the mode of transmission. The CALL position is used to alert any or all stations in the intercommunications system. The microphone selector switch is spring loaded to rotate to INTER position from the CALL position when the switch is released. The INTER position is used for

AOC CREW ELECTRONICS FACILITIES TABLE

	PRIMARY* CONTROL							TRANSMITTING FACILITIES (No Freq. Sel.)									RECEIVING FACILITIES (No Freq. sel.)								
	SD	RADAR TECH.	SRO #1 (DD)	SRO #2	SRO #3	SRO #4	SRO #5	HT. FINDER OP.	RADAR TECH.	SD	SRO #1 (DD)	SRO #2	SRO #3	SRO #4	SRO #5	TELLER	HT. FINDER OP. PLOTTER	RADAR TECH.	SD	SRO #1 (DD)	SRO #2	SRO #3	SRO #4	SRO #5	TELLER	HT. FINDER OP. PLOTTER
AN/APS-20E Radar		x																x	x	†	†	†	†	†		
AN/ART-28 Relay Trans.		x							x																	
AN/ARR-27A Relay Recr.	x																		x							
AN/APS-45 Ht. Finder								x												†	†	†	†	†		x
AN/APX-7 IFF		x								x	x	x	x	x	x											
618S-1 Command									x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
618S-1 Liaison									x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
AN/ARR-15A Liaison																		x	x	x	x	x	x	x	x	x
AN/ARC-27 UHF #1			x						x	x		x	x	x	x	x	x	x	x		x	x	x	x	x	x
AN/ARC-27 UHF #2				x					x	x	x		x	x	x	x	x	x	x	x		x	x	x	x	x
AN/ARC-27 UHF #3					x				x	x	x	x		x	x	x	x	x	x	x	x		x	x	x	x
AN/ARC-27 UHF #4						x			x	x	x	x	x		x	x	x	x	x	x	x	x		x	x	x
AN/ARC-27 UHF #5									x	x	x	x	x	x		x	x	x	x	x	x	x	x		x	x

x Indicates one facility is provided.

* Includes tuning, frequency selection, on/off, etc.

† Via APA-56 System.

Figure 4-17. AOC Crew Electronics Facilities Table (Sheet 1 of 2)

AOC CREW ELECTRONICS FACILITIES TABLE (Cont'd)

	PRIMARY* CONTROL							TRANSMITTING FACILITIES (No Freq. sel.)									RECEIVING FACILITIES (No Freq. sel.)									
	SD	RADAR TECH.	SRO #1 (DD)	SRO #2	SRO #3	SRO #4	SRO #5	HT. FINDER OP.	RADAR TECH.	SD	SRO #1 (DD)	SRO #2	SRO #3	SRO #4	SRO #5	TELLER	HT. FINDER OP.	PLOTTER	RADAR TECH.	SD	SRO #1 (DD)	SRO #2	SRO #3	SRO #4	SRO #5	TELLER	HT. FINDER OP.	PLOTTER
AOC ICS System:																											
ICS Control Panel									x		x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
HS-33A Headset																			x		x	x	x	x	x	x	x	x
M-3A Microphone									x		x	x	x	x	x	x	x	x										
CX-1301 (Mod) Cord									x		x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
PD Equipment																												
MI-36A P.A. System										x	x																	
AN/APA-81 Radar	x																			x								

x Indicates one facility is provided.

* Includes tuning, frequency selection, on/off, etc.

† Via APA-56 System.

Figure 4-17. AOC Crew Electronics Facilities Table (Sheet 2 of 2)

interphone communication between the various stations in the aircraft. The remaining four positions are labeled according to the function provided at the various stations. The COMM position directs transmission through one of the 618-S transmitters. The LIA position utilizes the alternate 618-S transmitter. The UHF position directs transmission through the ARC-27 equipment. When microphone output is to be directed through a radio transmitter, it is necessary to set up the desired frequency on the control panel for the individual radio.

Monitoring Switches.

Five toggle switches are arranged horizontally across the top of the panel. These switches control the choice of aural reception coming through the headphones. Placing any switch in the down position cuts off audible sound from the related circuit. Placing any switch in the up position connects the audio output from the related receiver or interphone circuit to the headphones. Any combination of circuits may be monitored simultaneously.

Normal-Aux. Listen Switch.

This switch is a toggle type switch located to the right of the microphone selector switch. This switch is safetied in the up or NORMAL position. The AUX LISTEN position is for emergency use only.

Volume Control.

The VOL control is located to the left of the microphone selector switch and regulates the audio level of the signal heard in the headphones. This control does not regulate volume when CALL facility is being used.

FLIGHT CREW ELECTRONICS FACILITIES TABLE

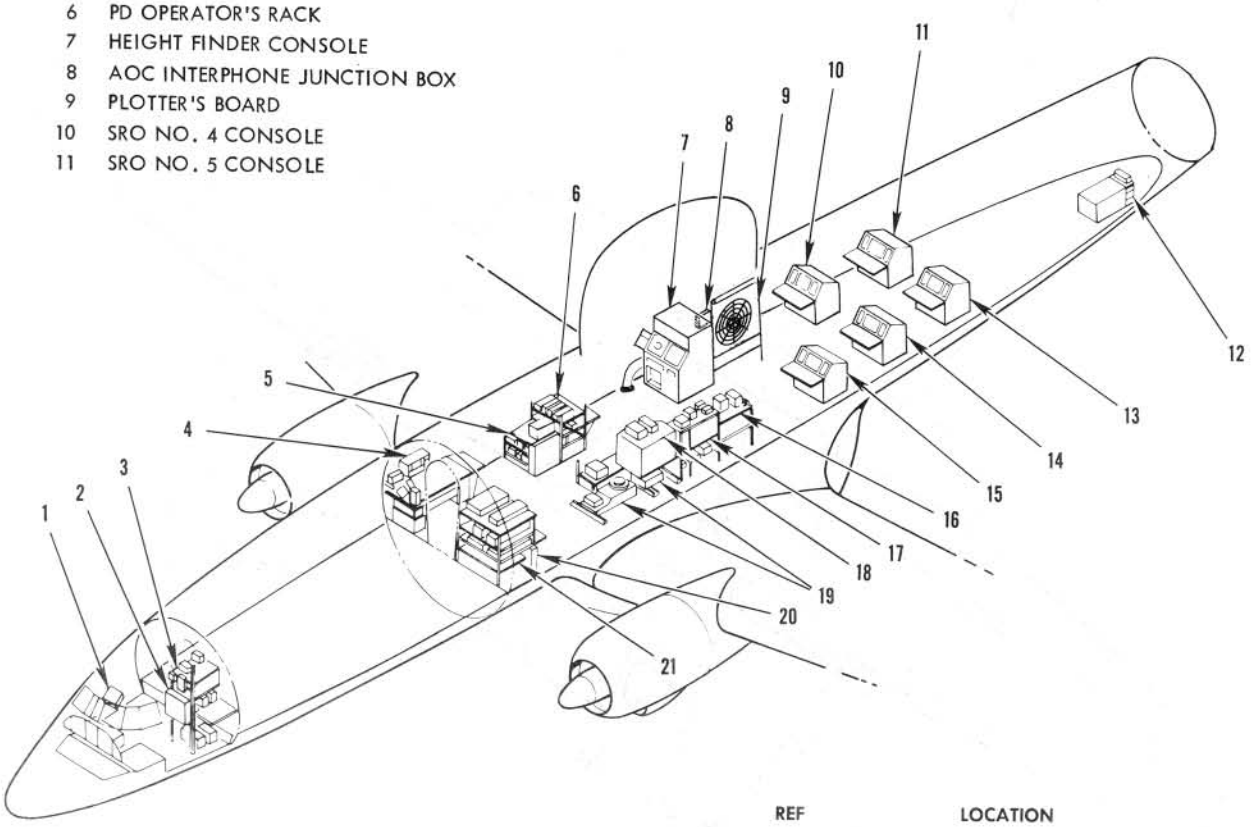
	PRIMARY* CONTROL				TRANSMITTING FACILITIES					RECEIVING FACILITIES					INDICATORS		
	PILOT	COPILOT	RADIO OP.	NAVIGATOR	PILOT	COPILOT	FLT. ENGR.	RADIO OP.	NAVIGATOR	PILOT	COPILOT	FLT. ENGR.	RADIO OP.	NAVIGATOR	PILOT	COPILOT	NAVIGATOR
AN/APX-6A IFF			x														
AN/APS-20E Search Radar																	x
AN/APA-57B Grd. Pos. Indicator				x													x
AN/ARC-5 LF Recr. (Liaison)	x	x								x	x		x	x			
AN/ARN-6 ADF Receiver	x	x		x						x	x		x	x	x	x	x
618-S Command	x	x				x	x			x	x		x	x			
618-S (Liaison)			x					x		x	x		x	x			
AN/ARR-15A			x							x	x		x	x			
AN/ARC-27 UHF #6 (Pilots)	x	x				x	x			x	x		x	x			
AN/ARC-27 UHF #7 (Relay)			x			x	x		x	x	x		x				
AN/ARC-27 UHF #8 (Relay)			x			x	x		x	x	x		x				
AN/ARN-12 Marker Beacon										x	x		x	x		x	x
AN/APN-22 Radar Altimeter	x			x												x	x
AN/APN-70 Loran Receiver				x													x
AN/AIC-10 Flt. Crew ICS:																	
H-78 Mic. Hdst. Boom						x	x	x	x	x	x	x	x	x			
C-826 Control Panel										x	x		x	x			
C-824 Control Panel						x	x	x	x	x	x	x	x	x			
F-90 Range Filter										x	x			x			
M-34 H. H. Microphone						x	x		x	x							
C-823 Control																	
LS-184 Loud Speaker										x	x	x	x	x			
AN/ARA-26 Emergency Keyer			x														
AN/ARN-18 Glide Slope Recr.	x	x														x	x
AN/ARN-14A VOR Receiver	x	x								x	x		x	x		x	x
P. A. System	x	x				x	x										
AN/ARA-25 Direction Finder	x															x	

x Indicates one facility is provided.

* Includes tuning, frequency selection, on/off, etc.

Figure 4-18. Flight Crew Electronics Facilities Table

REF	LOCATION
1	PILOT'S OVERHEAD RADIO CONTROL PANEL
2	FORWARD RADIO JUNCTION BOX
3	FORWARD RADIO RACK
4	NAVIGATOR'S RADIO RACK
5	AN/APA-56 EQUIPMENT RACK
6	PD OPERATOR'S RACK
7	HEIGHT FINDER CONSOLE
8	AOC INTERPHONE JUNCTION BOX
9	PLOTTER'S BOARD
10	SRO NO. 4 CONSOLE
11	SRO NO. 5 CONSOLE

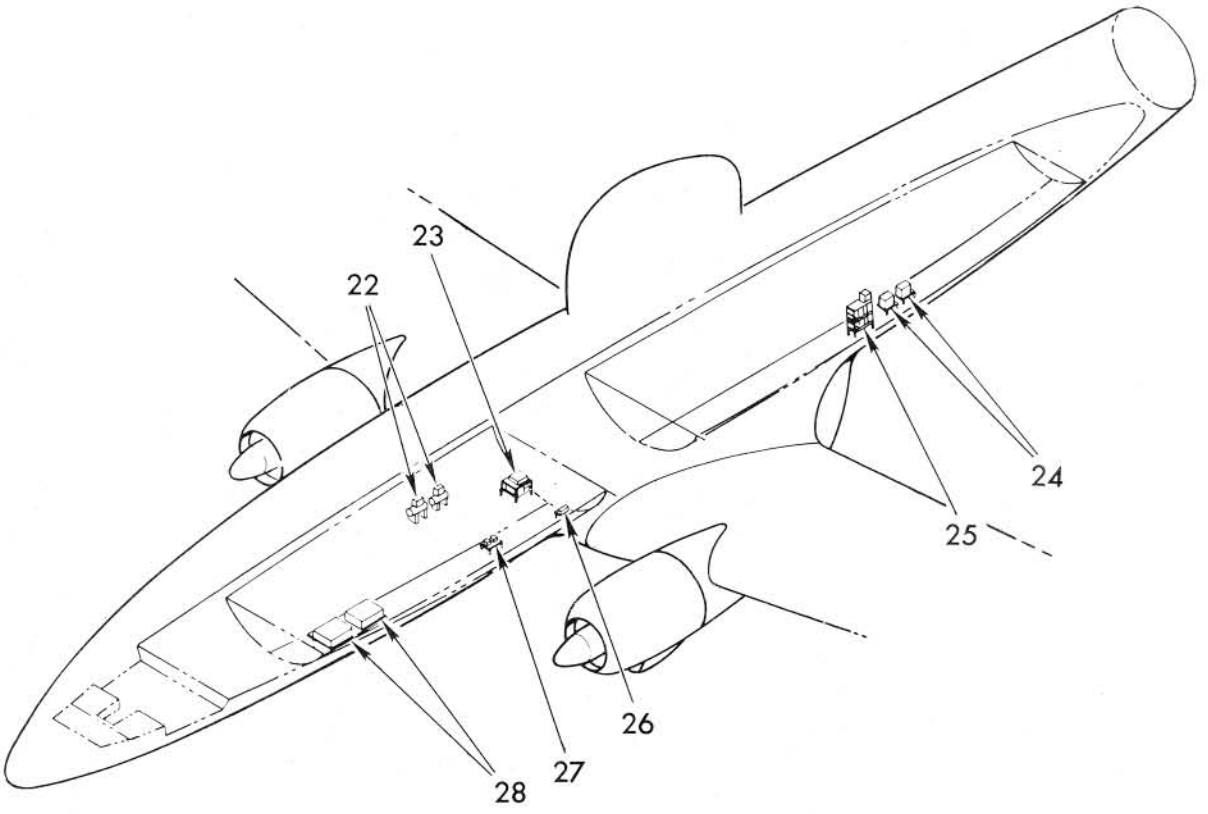


REF	LOCATION
12	TECHNICIAN'S TABLE RACK
13	SRO NO. 3 CONSOLE
14	SRO NO. 2 CONSOLE
15	SRO NO. 1 CONSOLE
16	SENIOR DIRECTOR'S EQUIPMENT RACK
17	RADAR TECHNICIAN EQUIPMENT RACK
18	A-C GENERATOR CONTROL EQUIPMENT
19	AN/APS-20B OR E RADAR EQUIPMENT
20	RADIO OPERATOR'S JUNCTION BOX
21	RADIO OPERATOR'S EQUIPMENT RACK

F75-3-4-103 (1)

Figure 4-19. Electronic Equipment Locations (Typical) (Sheet 1 of 2)

REF	LOCATION
(cont) 22	ELECTRONIC INVERTERS (2)
23	AN/APS-20B OR E ANTENNA STABILIZING EQUIPMENT
24	AN/ARC-27 UHF RADIO SET (2)
25	CIC INTERPHONE AMPLIFIERS



REF	LOCATION
26	AN/APS-20B TRANSMITTER COOLING EQUIPMENT
27	DY-13 618-S DYNAMOTOR (2)
28	AN/ARC-27 UHF RADIO SET (2)

F75-3-4-103(2)

Figure 4-19. Electronics Equipment Locations (Typical) (Sheet 2 of 2)

SELECTOR BOX CONTROL PANEL C-823.

This panel provides facilities for communication on the interphone circuit only, and is used for stations other than flight crew.

Call Button.

This button is protected by a cover which must be unscrewed in order to press the button. Pressing the CALL button interrupts all communications in the systemtem including radio reception except at the pilots station and is designed for initiating a call only.

Normal Aux. Listen Switch.

This switch is a two position toggle switch located on the right side of the panel. This switch is safetied in the NORMAL position which provides communication with all interphone stations. When the switch is in the AUX. position it provides communication with the AOC stations only.

Volume Control.

The VOLUME control is located below the NORMAL AUX LISTEN switch on the right side of the panel. The volume control on this panel does regulate audio level when CALL facility is being used.

FLIGHT CREW INTERCOMMUNICATION SYSTEM.

This equipment provides voice and signal communication at all altitudes. It incorporates four facilities: intercommunication within the aircraft; communication beyond the aircraft by means of radio equipment, monitoring of received radio signals, including simultaneous monitoring of a number of radio receivers; a call facility for use in establishing communication between stations of the aircraft intercom system. Intercommunication stations are provided at the following locations: Pilot, copilot, navigator, radio operator, flight engineer, forward crew compartment, aft crew compartment, forward and aft lower compartments, each engine nacelle, nose gear compartment, and tail cone position. The mechanics interphone stations comprise the forward lower compartment, aft lower compartment, the four engine nacelles, nose gear compartment, lower radome and tail cone. Each station includes a J-16 jack box. The mechanics stations' circuits are wired through external terminal strips so that all circuits to these stations may be disconnected from the system by throwing a toggle switch located on the forward radio junction box, directly behind the pilot's station. However, the two mechanics stations located in the forward and aft crew compartments cannot be disconnected. Primary power for operating this equipment is supplied from the main d. c. bus through the radio junction box at 28 volts. The system is powered when the d. c. bus is energized.

To put the equipment into operation:

1. Aircraft power supply—ON.
2. Circuit breakers—ON.

To turn equipment OFF—Normal:

1. Equipment turns OFF when power supply is removed or turned OFF.

To turn equipment OFF—Emergency:

1. Trip the circuit breakers in the radio junction box.

AOC INTERCOMMUNICATION SYSTEM.

The AOC intercommunication system provides interphone facilities for the SD, DD, (No. 1) AOC, height finder, radar operator, poster, teller and plotter. In addition to interphone facilities the system also provides radio facilities for the AOC crew members except the plotter. AOC crew members may use all radio and ICS equipment available to them without changing connections to their respective headsets and microphones. The system comprises 12 identical AOC-ICS control units. A master interphone junction box, three dynamotors with radio noise filters, two operating and one standby. Each station has a control box and amplifier. The system is capable of communicating with any individual position, any combination of these positions, or all of these positions. Six independent two-way conversations may be conducted without interference. The pilot's position is provided with a switch to activate call-lights at the SD and DD positions. Through switches at the latter stations, the pilot can communicate with the SD and DD, and it is possible for the pilot to hear all conversations conducted by the SD. The radio operator's and navigator's positions are provided with switches to activate call-lights at the SD, DD, and plotter's positions.

To put the equipment into operation:

1. Aircraft power supply—ON.
2. Circuit breakers—ON.

To turn equipment OFF—Normal:

1. Equipment turns OFF when power supply is removed or turned OFF.

To turn equipment OFF—Emergency:

1. Trip circuit breakers in the AOC junction box.

MI-36A PUBLIC ADDRESS SYSTEM.

The public address system is operated by a.c. and d.c. power. The system provides announcements to the flight crew and AOC personnel or to ground personnel. The pilot, copilot, senior director and the duty director may make public address announcements by priority.

1. IP-41/ARR-27 INDICATOR
2. INSTRUMENT PANEL
3. RADIO PANEL
4. C-750/ARR-27A RECEIVER CONTROL
5. PUBLIC ADDRESS SYSTEM CONTROL
6. INTERCOMMUNICATION CONTROL PANEL
7. IP-67/APA-81 INDICATOR
8. DISPLAY BOARD

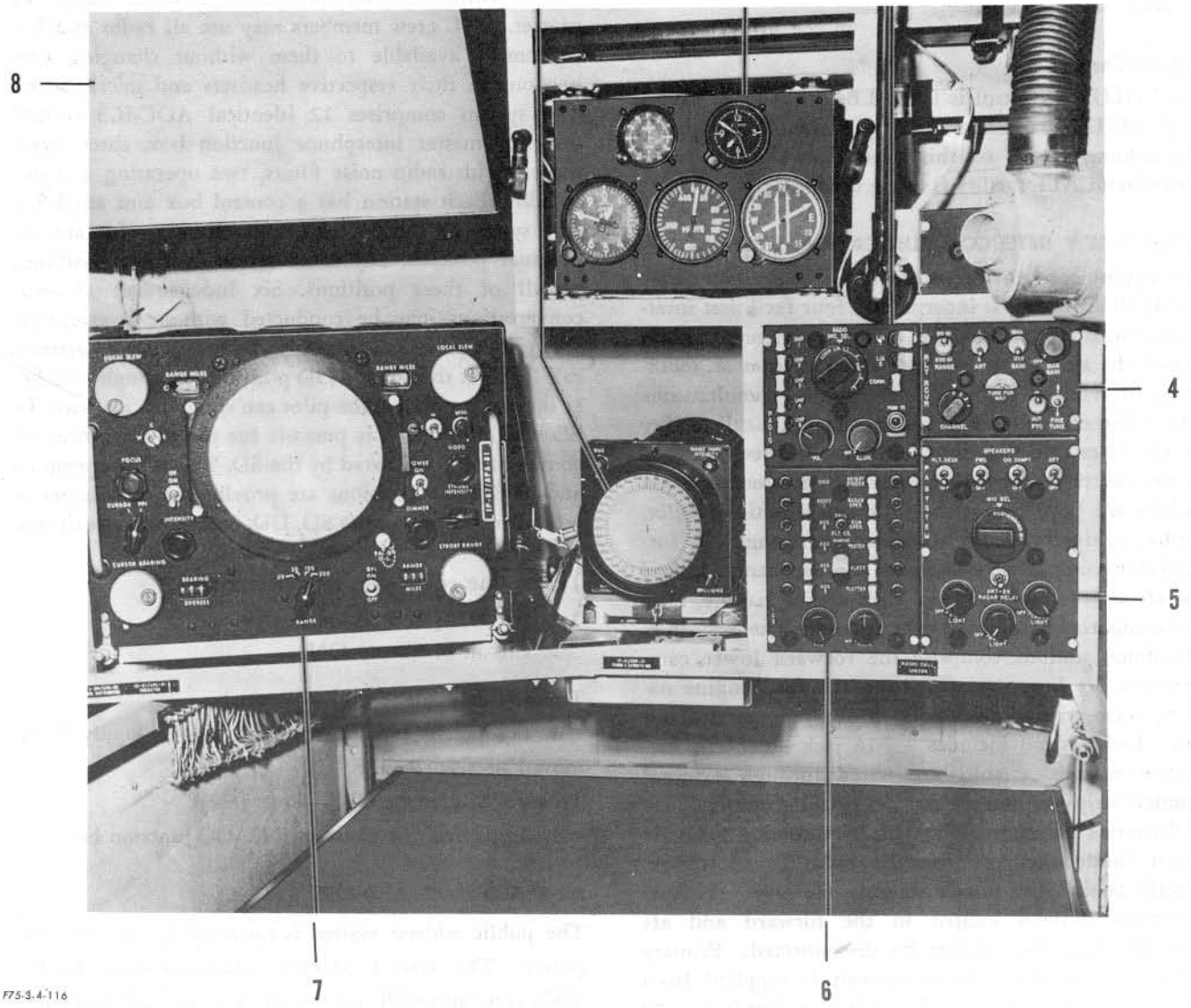


Figure 4-20. Senior Director's Station

The pilot and the copilot have priority operation of the public address system, with the senior director having normal control for announcements to the AOC crew. The duty director also has normal control of the system when selected by the senior director. The public address system has 14 loudspeakers, three in the flight station, three in the forward crew area, five in the AOC area, two in the aft crew area and one in the nose wheel well. To put this equipment in operation:

1. Aircraft d.c. power supply—ON.
2. PA circuit breakers—ON.
3. Main instrument inverter—ON.

To turn this equipment OFF:

1. PA circuit breakers—OFF.

Pilots Public Address Control Panel.

The pilots public address control panel is located on the pilots overhead panel (0, fig. 00). The panel includes one two position (ON and OFF) power switch, one three position (LOW, HIGH and MED.) flight station speaker volume switch and one two position (INTERNAL and EXTERNAL) speaker selector switch. When the power switch is in the ON position the pilot or copilot may transmit through the PA system. The volume control switch controls the volume to the three loudspeakers in the flight station. The speaker selector switch allows the pilot or copilot to transmit to the ground crew by placing the switch in the external position and by placing the switch in the internal position the pilot or copilot may transmit to flight crew and the AOC crew.

Senior Directors Public Address Control Panel.

The senior directors control panel is located on the senior directors intercommunication control panel (5, fig. 4-20). The panel includes four separate two position speaker switches (FLIGHT DECK, FWD, AOC AREA and AFT.) These switches provide the SD or the DD to transmit to any one station individually or collectively. The microphone selector switch is a four position type switch (OFF, SD, DD and PILOT). When this switch is placed in the OFF position the system can only be operated by the pilot or copilot. When the selector is placed in the SD position the system can be operated by the SD or the pilot or copilot. When the microphone selector is placed in the DD position by the SD the DD has control of the system. Regardless of what position the selector is in, the pilots have priority to operate the system.

Pilots Emergency Interphone and Public Address Operation.

In an emergency, the pilots microphone transmissions may be connected to all of the interphone stations in the airplane and to the public address system, interrupting all other interphone and public address operations. Emergency interphone operation is conducted by the pilot placing the "EMERG. ICS CALL-CREW CALL" switch on the pilots emergency interphone control panel (8, fig. 1-8) in the "EMERG. ICS CALL" position.

AN/ARC-27 UHF Transmitter-Receiver Sets.

Eight AN/ARC-27 transmitter-receiver sets are installed in the aircraft and operate on 28 volts d.c. power from the radio operator's junction box. These sets provide short range communication between aircraft and between the aircraft and ground stations. Normally, the No. 6 AN/ARC-27 transceiver is available to the pilot. If the pilot's AN/ARC-27 UHF set becomes inoperative or if conditions warrant the use of a back-up transceiver, the No. 7 or No. 8 AN/ARC-27 UHF sets are available to the pilot upon request. It should be kept in mind that it is possible to transmit on two separate frequencies when using the back-up transceiver, if the pilot fails to turn off his No. 6 UHF set before transmitting. However, it is not possible to transmit on two separate frequencies simultaneously when using the No. 7 or No. 8 UHF sets because it is not possible to select both sets at the same time. The radio operator will set up the transceiver, channel, and volume as requested by the pilot. The radio operator will acknowledge the request after positioning the relay selector on the AN/ARC-27 control panel.

To place equipment in operation:

1. Aircraft Power Supply—ON.
2. LOCAL-REMOTE switch—REMOTE.
3. Function selector switch—T/R or T/R & G Rec.
4. TONE VOICE Switch—VOICE.
5. Receiver toggle switch on ICS Control Panel—UHF, Microphone selector switch—UHF.
6. Rotate the channel selector switch on the UHF panel to the desired channel, allow approximately 30 seconds for the set to warm up.
7. Adjust volume control on the UHF control panel and the ICS control panel for desired output.

AN/ARR-15A HF RADIO RECEIVER.

The AN/ARR-15A is operated from the radio operator's station. The equipment provides long-range code and voice reception with ground stations and other aircraft. This receiver is powered by DC Bus.

1. POWER SUPPLY AND RANGE PANEL
2. SWEEP CONTROL PANEL
3. CONSOLE FUNCTION PANEL
4. ICS CONTROL PANEL
5. C-626/ARC-27 UHF CONTROL PANEL
6. RADIO CONTROL PANEL
7. RHI (RANGE HEIGHT INDICATOR) ASSIGNMENT PANEL

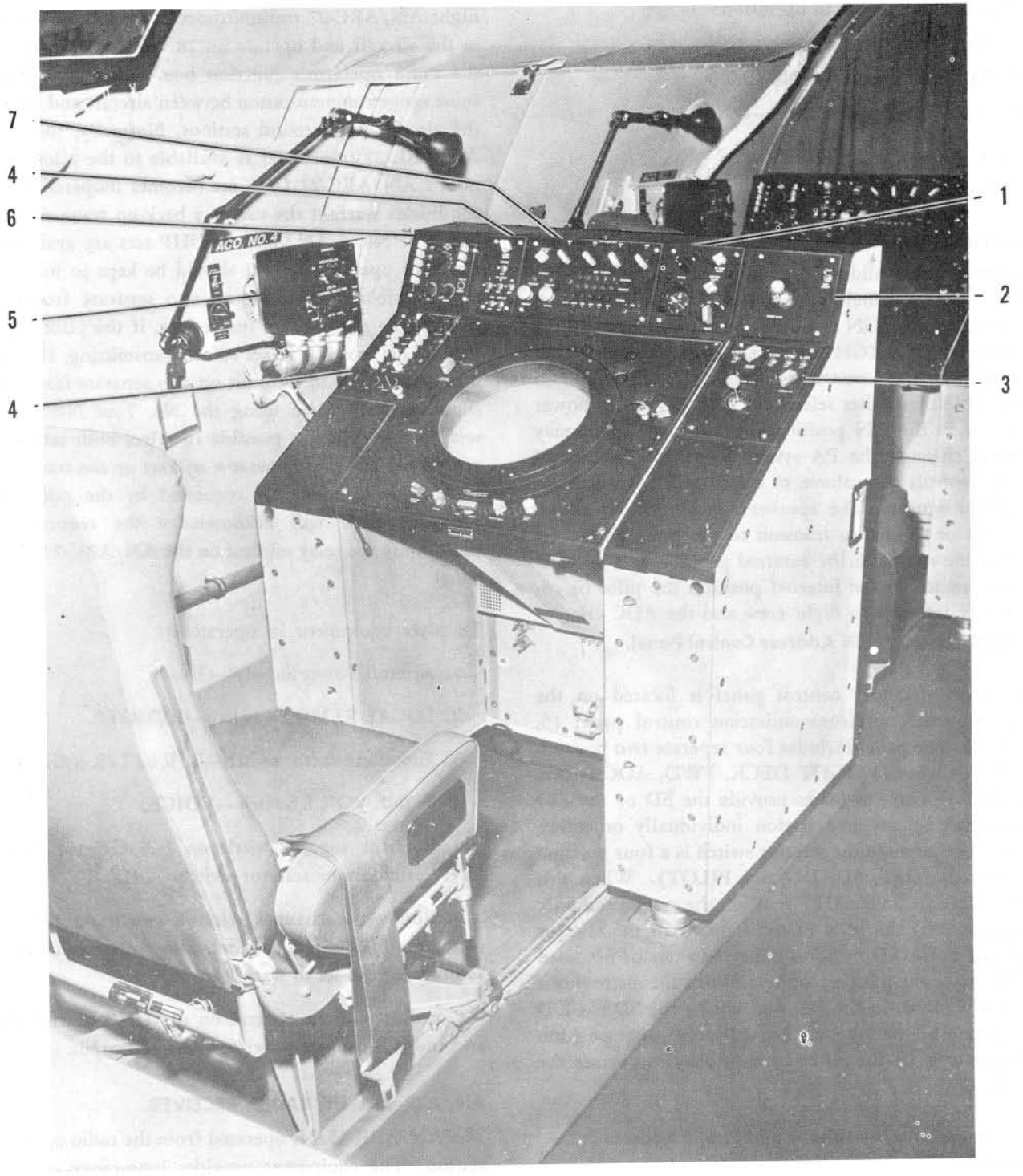


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Figure 4-21. Search Radar Operator's Station (Typical)

To put this equipment into operation:

1. Aircraft power supply—ON.
2. Power ON and OFF switch—ON.
3. CW-MGW-CAL switch—select desired type of reception.
4. Receiver toggle switch on intercommunication control panel—HF.
5. After the set has warmed up (approximately 30 seconds), advance the volume control knob until a slight back-ground noise is heard.
6. Set the band switch to the frequency desired.

To turn equipment OFF:

1. Power ON-OFF switch—OFF.

618 S-1 H.F. TRANSMITTER/RECEIVERS.

Two 618S-1 H.F. transmitter/receivers (1-12, fig. 4-28) sets designated command and liaison, provide both transmitting and receiving facilities up to 1444 crystal control channels in the frequency range of 2.0 to 25.0 MC. The transmitter/receivers are located on the radio operators station. The transmitter/receivers use two 180L-2 tuning units which automatically make all antenna tuning adjustments when the desired channel is selected. The command transmitter/receiver is operated by the pilots by remote controls (13, fig. 1-8) on the pilot overhead panel. The liaison transmitter/receiver is operated by the radio operator by remote controls on the radio operator's HF control panel (4, fig. 4-28). The system operates on DC and AC power.

To put into operation:

1. Aircraft DC and AC power supply—ON.
2. Power OFF-PHONE-CW switch—PHONE or CW.
3. Allow the system to warm up (approximately 30 seconds).
4. Set the band switch to the frequency desired.

To turn equipment OFF:

1. Power OFF-PHONE-CW switch—OFF.

LF Range Receiver AN/ARC-5.

The 28-volt d. c. equipment is operated from the pilots' stations and is used for radio range reception.

To put into operation:

1. Aircraft power supply—ON.
2. Circuit breaker—ON.
3. Receiver toggle switch Liaison 3 on ICS control panel—ON.
4. Rotate tuning crank to desired frequency range.

To turn equipment OFF:

1. Circuit breaker—OFF. (Emergency).

AN/ARN-14A Navigation Receiver.

The VHF omni-directional navigational system is operated from the pilots' overhead control panel. The navigation information is visual and is observed on indicator units at the pilot, copilot and navigators stations. Power is supplied to the equipment from the aircraft 28-volt d.c. system, 26V a.c. for the indicators from the C-1 amplifier and from the 115-volt a.c. inverter system.

To put into operation:

1. Aircraft power supply, a.c. and d.c.—ON.
2. Power switch on pilots overhead VHF NAV control panel—ON.
3. Receiver toggle switch VOR on intercommunication control panel—ON.
4. Rotate the channel selector switch on the VHF NAV control panel to the desired channel.
5. Adjust the volume control on VHF NAV control panel and intercommunication control box for the desired output.

To turn equipment OFF:

1. Power switch on pilots' overhead VHF NAV control panel—OFF.

AN/ARN-21 TACAN SYSTEM.

The AN/ARN-21 is airborne equipment designed to operate in conjunction with a surface navigation beacon; it provides the pilots with continuous indications of distance and bearing for any selected surface beacon located within a line of sight up to 195 nautical miles. The bearing and distance information are displayed on two separate indicators, the ID-250/ARN-14 radio magnetic indicator and the ID-310/ARN-21 distance indicator. A control panel (17, fig. 1-9) is located on the pilots overhead panel. The audio output is available for the pilot and copilot only. Power is supplied to the equipment from the 28 volt d.c. system and from the 115 volt a.c. inverter system.

Audio Selector Switch.

Two audio selector switches, one on the left hand side of the pilots overhead panel and one on the pilots auxiliary side panel selects either the ARN-21 audio or the VHF NAV audio. These switches are a two position type and are placarded VHF NAV and NAV ARN-21.

Function Switch.

The OFF, REC, T/R switch is a three position toggle switch. The down or OFF position de-energizes all

AN/ARN-21 equipment. The center or REC position, places only the receiver portion of the receiver-transmitter into operation. When the switch is in this position only bearing information is furnished. When the switch is in the up or T/R position the AN/ARN-21 interrogates and receives a signal which produces both distance and bearing information on the respective indicators.

Channel Selector.

The CHAN. selector consists of two rotary switches with knobs and dial skirts for selecting the desired navigation beacon channel. The left-hand knob selects the tens and hundreds figures of the beacon channel number and the right hand knob selects the units figures of the beacon channel number. Combinations of dial settings may be made from 00 to 129. However, the equipment only operates on 01 to 126, a total of 126 channels.

CAUTION

No attempt should be made at any time, to set the CHAN dial below channel 01 or above channel 126.

Volume Control.

This is a volume control which is used to adjust the volume of an audio identification signal received from the beacon. The identification signal, audible in the pilot's headphones when they are connected to the regularly used audio jack, consists of a two or three letter tone signal in International Morse Code.

ID-310/ARN Range Indicator.

The ID-310/ARN indicator is installed in the pilot's glare shield panel (3, fig. 1-14) 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. While the indicator is "searching" for the correct range, the rapidly rotating numbers are partially covered by a red flag which warns the pilots against reading incorrect distance indications.

Radio Magnetic Indicator.

The radio magnetic indicator (ID-250/ARN) is installed on the pilots glare shield panel (2, fig. 1-14). The number two needle is operated by the AN/ARN-21; the number one needle is not connected and will swing free.

ID-249/ARN Course Indicator.

The ID-249/ARN course indicators are mounted on the pilot's and copilot's instrument panels and one on the pilots glare shield panel (1, fig. 4-14). The course indicator combines the functions of a cross-pointer indicator, an aircraft relative heading indicator, a bearing selector and a marker beacon indicator. The bearing selector knob establishes any magnetic course in whole degrees measured to or from a VOR station. The vertical pointer indicates lateral position deviation from the course set in the window on top of the instrument or from an "on course" runway localizer signal. The magnetic heading information is derived from the PB-10 Flux Gate compass system. The horizontal pointer indicates position deviation from an on-course glide path signal, when the ILS is in use. A TO-FROM indicator designates whether the VOR bearing selected is to or from the station.

If either the reference or the variable signal strength for a VOR or glide slope receiver falls below a safe level, a red flag moves in front of the corresponding cross pointers.

Note

The horizontal pointer indicator and the marker beacon indicator are inoperative on the ID-249/ARN course indicator mounted on the pilots glare shield panel.

AN/APN-70 Loran Receiver.

This (AN/APN-70) equipment is operated from the navigators station and is used for long-range navigation. Power is supplied to the equipment from the aircraft's 28-volt d.c. system and from the 115-volt a.c. system.

To put into operation:

1. Aircraft power supply, a.c. and d.c.—ON.

2. Rotate the master-XZ gain control clockwise until the panel lettering is illuminated. Allow five minutes for the set to warm up.

To turn equipment OFF:

1. Turn the master-XZ gain control to POWER OFF and see that panel lettering light is out. Also see that the pattern on the indicator screen has disappeared.

AN/APX-6 or AN/APX-25 Radar Identification Transponder.

The purpose of the AN/APX-6 or AN/APX-25 is to identify the aircraft as friendly when correctly challenged by a friendly shore, shipboard and airborne radars, and to permit surface tracking and control of aircraft in which it is installed. Provisions are also incorporated for destroying the equipment to prevent its falling into enemy hands. The AN/APX-6 or AN/APX-25 control panel is located at the radio operator's station.

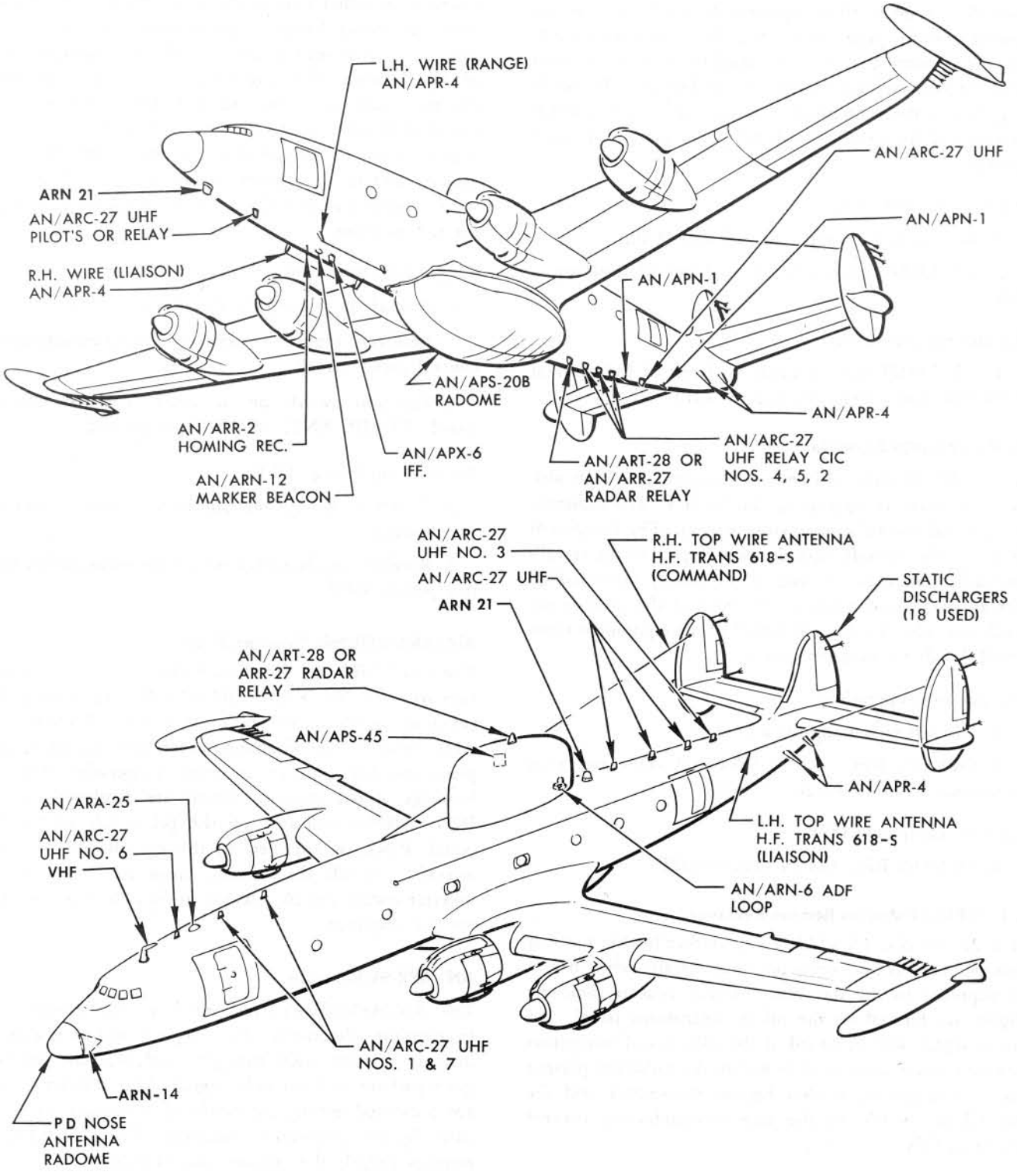

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Figure 4-22. Antenna Locations Diagram (Typical)

AN/APN-22 Radar Altimeter.

The AN/APN-22 radar altimeter is designated a low altitude altimeter (0 to approx. 20,000 ft.), it is operated from the pilots station and the navigator's station. The equipment gives a visual indication of the aircraft altitude with respect to the terrain beneath. Power is supplied to the equipment from the aircraft 28-volt d.c. system and from the 115 volt a.c. generator and inverter system.

To put into operation:

1. Aircraft power supply a.c. and d.c.—ON.

2. ON-LIMIT control knob on front of indicator—ON.

To turn equipment off:

1. ON-LIMIT control knob on front of indicator at both pilot and navigator's station—OFF.

SCR-718 Radio Altimeter.

The SCR-718 radio altimeter is designated a high altitude altimeter (0 to approx. 40,000 ft.). The indicator is operated from the navigators station. The equipment indicates the aircraft altitude with respect to the terrain beneath. The measurement is graphically exhibited by the appearance of a lobe on the face of the cathode-ray indicator tube. Power is supplied to the equipment from the 115-volt a.c. inverter system.

To put into operation:

1. Aircraft power supply, a.c.—ON.

2. OFF-ON REC. GAIN SWITCH—ON and turn clockwise to adjust height of lobes.

To turn equipment OFF:

1. OFF-ON REC. GAIN switch—OFF.

AN/ARN-12 Marker Beacon Receiver.

The 28-volt d. c. (AN/ARN-12) marker beacon receiver has no controls but comes on automatically when power is supplied to the d.c. bus. Marker beacon indicator lights are located on the pilots' instrument panel. An aural signal will be heard at the pilots' and navigators stations when the aircraft is within the radiation pattern of a 75-megacycle marker beacon transmitter and the MARKER switch on the intercommunication control panel is ON.

AN/ARN-18 Glide Slope Receiver.

The glide slope receiver R-322/ARN-18 is installed in the flight station radio rack. The receiver is connected to a glide slope antenna located in the nose radome. The receiver detects 90/150 cps tone modulated signals in the UHF range between 329.3 to 335 mc.

AN/ARN-6 Automatic Radio Compass.

The (AN/ARN-6) automatic radio compass may be operated by either pilot or by the navigator. The pilots' automatic radio compass control panels are located on the pilots' overhead control panel; the navigator's is at his station. Receiving facilities also are provided for the radio operator. An indicating instrument is installed at each pilot's station and at the navigator's station. Power is supplied to the equipment from the aircraft 28-volt d.c. system, from the 115-volt a.c. inverter system and 26 volts a.c. to the indicators through the C-1 amplifier.

To put into operation:

1. Aircraft power supply, d.c. and a.c.—ON.

2. Receiver toggle switch on intercommunication control panel—ADF.

3. Function switch on automatic compass control panel—COMP, ANT, or LOOP, as desired.

To turn equipment OFF.

1. Function switch on automatic compass control panel—OFF.

2. Receiver toggle switch on intercommunication control panel—OFF.

AN/ARA-25(UHF) Direction Finder.

The (AN/ARA-25) direction finder is used in conjunction with the No. 6 AN/ARC-27 UHF set. Placing the function switch of the pilots AN/ARC-27 control to ADF connects the direction finder antenna relay, and places the AN/ARA-25 amplifier in operation. Relative bearings of the received signals are displayed on the ID-91/ARN-6 indicator on the pilots left instrument panel. Power is supplied to the equipment from the aircraft's 28-volt d.c. system, from the 115-volt a.c. inverter system and 26 volts a.c. to the indicators through the C-1 amplifier.

AN/APR-9B Receiver.

The AN/APR-9B PD receiver is a search unit used to monitor, determine the presence and modulation, indicate relative field strength, and measure the frequency of any radio or radar signal. The received signals are presented aurally by means of a headset, and visually by the panoramic indicator. The AN/APR-9B receives 28-volt d. c. power and 115-volt a. c. variable frequency power.

To put into operation:

1. Aircraft power supply, a.c. and d.c.—ON.

2. Power switch on APR-9 remote control panel—ON.

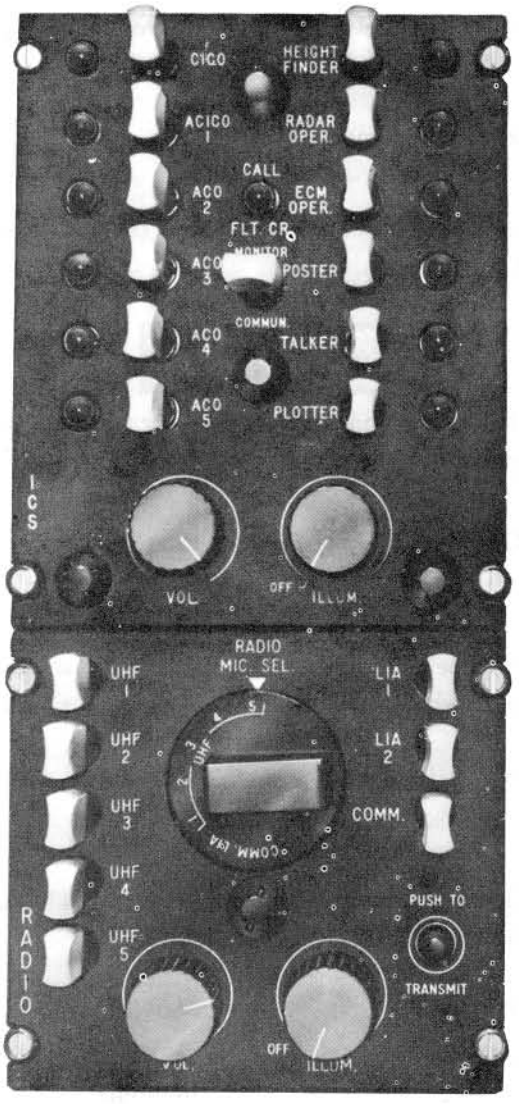

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Figure 4-23. Radar Technician's ICS Panel

To turn equipment OFF:

1. Power switch on the APR-9 remote control panel—OFF.

AN/APA-74 PD Signal Analyzer.

The (AN/APA-74) signal analyzer is used to resolve the video signal received by the AN/APR-9B receiver. Pulse analysis information is displayed on all the traces of a five-gun cathode ray tube contained in the IP-37/APA-74 indicator. Power is supplied from the aircraft's 28-volt d. c. system and from the 115-volt inverter system.

To put into operation:

1. Aircraft power supply, a.c. and d.c.—ON.
2. Power switch on IP-37/APA-74 indicator—PWR.

To turn equipment OFF:

1. Power switch on IP-37/APA-74 indicator—OFF.

AN/APA-69 or AN/ALA-6 Direction Finder.

The AN/APA-69 direction finder equipment is used with the APR-9 receiving set to provide visual indication on its cathode-ray screen of the bearing of received radio and radar signals within the frequency range of the receiver. Power is supplied from the aircrafts 28-volt d.c. system and from the 115-volt a. c. inverter system.

To put into operation:

1. Aircraft power supply, a.c. and d.c.—ON.
2. Power-Off switch on direction finder control panel —ON.

To turn equipment OFF:

1. Power-Off switch on direction finder control panel —OFF.

CENTRAL GYRO REFERENCE SYSTEM.

The central gyro reference system is an airborne flight attitude control and reference system, designed for continuous duty in long-range aircraft operating over any area of the earth. It provides simultaneously accurate attitude data in azimuth, pitch, and roll. Heading information is magnetic, directional gyro, or true, as determined by the selected mode of operation. The central gyro reference system is subject to malfunction unless certain precautions are observed in operation of the system.

CAUTION

There are no electrical or mechanical caging devices within the gyro assembly; therefore, the a.c. circuit breakers should be ON and the main instrument inverter turned on during all periods of engine run-up, taxi, and flight. This will supply electrical power to the gyro motors and prevent damage from mechanical shock.

To put into operation:

1. Knot dial	zero
2. Lat-Kin selector switch	MAN

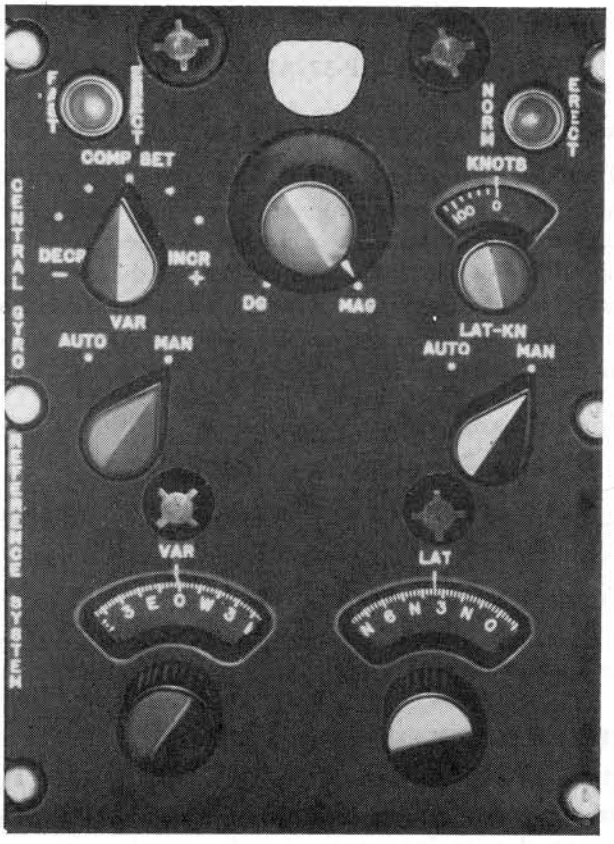


Figure 4-24. Navigator's CGRS Control Panel

3. VAR dial	zero
4. LAT dial	local latitude
5. VAR selector switch	MAN
6. DG-MAG selector	MAG
7. D. C. power	ON
8. Main instrument inverter	ON
9. CGRS circuit breaker	ON

Note

Allow ten minutes for system to reach normal operating conditions.

10. X-AXIS integrator	press
11. Y-AXIS integrator	press

Note

Corresponding dials should rotate at the rate of approximately fifteen white sectors in fifteen seconds.

12. Platform alignment switch	press

Note

Z-AXIS dial should rotate and come to rest at zero degrees.

CAUTION

Platform alignment switch is not for inflight operation. Do not press while in flight.

13. COMPT. SET knob	rotate (max rotation)

Note

True heading dial on serve-amplifier should rotate at the rate of approximately four rpm.

14. Knot dial	set (desired speed)

Note

Check ground speed dial on servo-amplifier, should indicate this same speed.

15. VAR selector	MAN
16. VAR dial	set (desired heading)

Note

Check the true heading dial on servo-amplifier for corresponding change. Cross check true heading dial with magnetic compass. Difference between the two readings should equal pre-selected variation.

17. Z-AXIS	press

Note

Check the smallest dial in the Z-AXIS window which rotates at a minimum rate of six black or white sections past a reference point in one minute.

CAUTION

After switching inverters, or when switching from ground to the aircraft's inverters, the system operation should be checked as follows:

1. Check compass section of the system by observing the annunciator on the control panel. If it is not centered, rotate COMP SET knob or positions as indicated by the annunciator. Release when annunciator on control panel is aligned.

2. Check verticality of the platform by observing the dial marked ROLL and dials marked PITCH. These dials should indicate approximately the attitude of the aircraft. If the dials do not indicate properly, repeat the erection cycle by switching the d.c. circuit breakers OFF for five minutes and then to the ON position.

Note

In order to prevent a d.c. voltage drop sufficient to cause the CGRS system to recycle, it is imperative that both outboard engines be running before switching from ground power to the aircraft's d.c. power. A positive load must be indicated on the ammeters for both generators before switching is accomplished. On aircraft that has two d.c. buses, both buses must be checked before switching.

Test Equipment.

The UPM/44 test set and the OS-4/AP test scope are located at the radar technician's station (2-3, fig. 4-33).

The PSM-6 multimeter and the AN/USM-3 test tool set are located at the technician's table. TS-147/UP test set has been installed on the floor forward of the left hand airline seats.

AN/APS-45 Height Finder.

The (AN/APS-45) height finder radar system used in conjunction with the height finder data transmission system indicators, located at each SRO crew station, to present on the counter the absolute altitude of the target as determined by the height finder operator. Power is supplied to the equipment from the aircraft's 28-volt d.c. system, the 115-volt a.c. inverter system and a.c. generators.

To put into operation:

1. Monitor input voltages on OA-295/APS-45 control panel.

2. Turn "MASTER" and "STANDBY" switches—ON.

3. Check magentron blower operation.

4. Pressure lights should be out.

5. When ready lights come on press START button.

6. Raise transmitter current to a maximum of 38 ma.

7. Tune receiver.

8. Check MDS and power output.

To turn OFF.

1. Push stop button.

2. Turn "STANDBY" and "MASTER" switches OFF.

AN/APX-7 Radar Recognition Set.

This equipment functions as the IFF airborne interrogator-responder. The primary purpose of this equipment is to challenge unidentified targets to determine whether they are friend or foe. Controls are located at the radar technician station.

AN/APA-57B Ground Stabilized Equipment.

The AN/APA-57B ground position indicator is an airborne, dead-reckoning computor having two main functions. First, and more important, it supplies to the PPI's, two d. c. voltages which vary in proportion to the N-S, E-W distance traveled by the aircraft, which ground stabilizes the PPI presentation. Second, it indicates on counters, on the front panel of the C-1060/APA -57B control unit, the N-S and E-W distances of the aircraft in nautical miles with respect to a fixed ground reference point. Power is supplied to the equipment from the aircraft's 28-volt d. c. system and from the 115-volt a. c. inverter system.

To put into operation:

1. Aircraft a.c. inverters and d.c. power—ON.

2. Power switch on C-1060/APA57B control unit—ON.

To turn equipment OFF:

1. Turn power switch on the C-1060 control unit—OFF.

Note

A standby, operate switch is located at the senior director's station. In the standby position there will be no movement of the counters on the C-1060 APA/57E control unit and no ground stabilization of the PPI indicators. The CV-78/APA-56 stabilization is not affected by this standby switch.

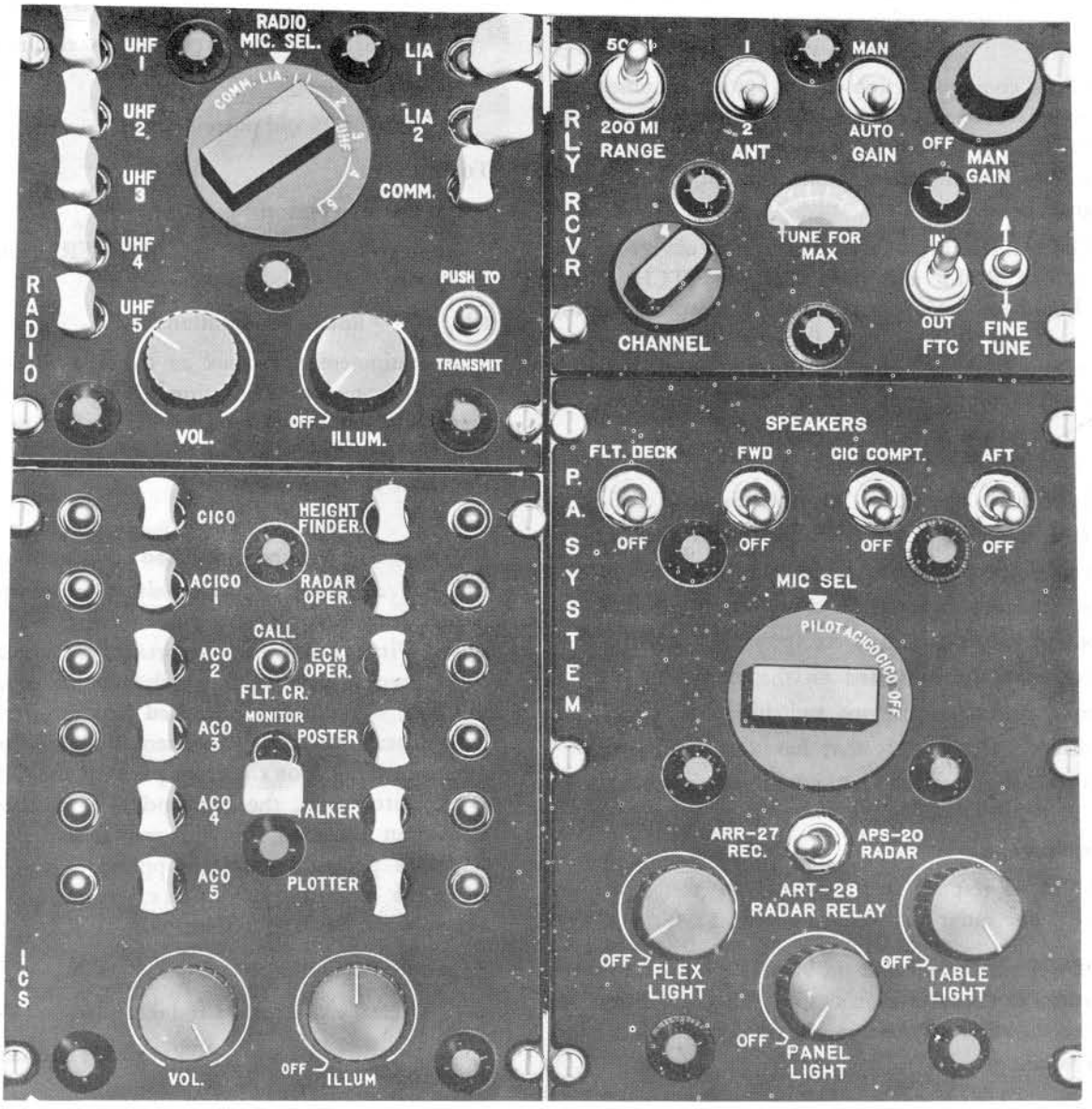


Figure 4-25. Senior Director's ICS Panel

AN/APA-81 Indicator Group.

The airborne Indicator Group (AN/APA-81) operates in conjunction with the AN/APA-57 ground position indicator, AN/APA-56 remote indicator system and the AN/APS20E search radar to provide remote off-center ground stabilized PPI display of radar video information. The AN/APA-81 will present a magnified presentation of any sector of the AN/APS-20B range and azimuth indicator display. The AN/APA-47 equipment furnishes the AN/APA-81 indicator with d.c. voltages which are proportional to the N-S and E-W distances from some fixed geographical location. The AN/APS20E equipment supplies radar video, which is presented on the AN/APA-81 indicator. Synchronizing azimuth voltages are supplied by the IP-230/AN/APA-56. If desired, the AN/APA-81 equipment may be used as a normal repeat indicator for the AN/APS-20E search radar. Power is supplied to the equipment from the aircraft 115-volt a.c. inverter system, the 28 volts d.c. and a.c. generators.

Figure 4-26. C-626/ARC-27 Master Control Panel

To put into operation:

1. Aircraft power supply, a.c.—ON.

2. Power switch on AN/APA-81 control indicator panel—ON.

To turn equipment OFF:

1. Power switch on AN/APA-81 control indicator panel—OFF.

AN/APS-20E Search Radar.

The AN/APS-20E search radar is part of the AOC system. It operates in conjunction with other airborne and surface components to extend the normal radar horizon of surface equipment. Radar energy is transmitted and received via a rotating antenna located in the lower radome. This information is presented on the screens of indicators at the radar operator's, navigator's, and AOC operator's stations. Power is supplied to the equipment from the aircraft's 28-volt d. c. system and from the 115-volt a.c. inverter system and a.c. generators.

AN/APS-20() Antenna Tilt Indicator.

The AN/APS-20 antenna tilt indicator is located on the radar technician's station (1, fig. 4-33) and indicates the angle of the antenna beam tilt relative to the aircraft. It also indicates the angle of beam tilt with respect to the earth surface. A switch is installed below the dial indicator, placarded 5° TRUE—20° REL. When this switch is placed in the 5° TRUE position the angle of the antenna beam is indicated with respect to the earth surface and the degree of tilt is read on the lower scale of the dial indicator. When the switch is placed in the 20° REL position the angle of beam tilt is indicated relative to the aircraft, the degrees of tilt is read on the upper scale of the dial indicator. Two indicator lights are installed below and one on each side of the dial indicator. One is labeled TILT—LIMIT; this light illuminates when the antenna reaches its maximum up or down mechanical tilt. The second indicator light is labeled STAB; this light illuminates when the antenna selector switch on the AN/APS-20 is placed in the STAB position.

To put into operation:

1. Monitor input voltages to radar set control C-1449/APS-20E.

2. Turn APS-20E master system switch to "STANDBY."

3. Overload light "ON" (APS-20E set control) should go out in approximately 15 minutes.

4. Heat light "ON" should go out in approximately 10 seconds.

5. Air light "ON" should go out when 15 psi is indicated on the pressure gauge.

6. Monitor raise of magnetron filament voltage.

7. PRF switch to LOW.

8. Pulse width switch to WIDE.

9. Receiver manual AFC switch to MANUAL.

10. Check PRF.

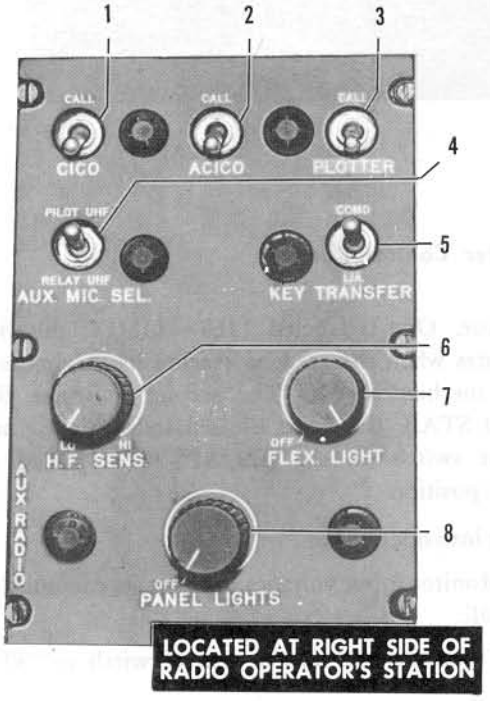
11. When the overload light goes out turn APS-20E to OPERATE.

12. Raise APS-20E transmitter magnetron current to 30 ma.

13. Open crystal shutter.

14. Raise APS-20E transmitter magnetron current to 51 ma. approximately 280 ma modulator current.

15. Put antenna control to STAB.



1 S D CALL SWITCH
2 D D CALL SWITCH
3 PLOTTER CALL SWITCH
4 UHF MICROPHONE SELECTOR SWITCH
5 KEY TRANSFER SWITCH
6 HIGH FREQUENCY SENSITIVITY
7 FLEX. LIGHT RHEOSTAT
8 PANEL LIGHTS RHEOSTAT

F75-0-4-106

Figure 4-27. Radio Operator's ICS Panel

16. Check reverse and forward currents of receiver crystals.

17. With radar receiver in AFC, tune local oscillator until AFC locks on with maximum AFC crystal current.

18. Check AFC operation by varying radar local oscillator while watching radar AFC crystal current, AFC should not unlock until crystal current falls below 15 ma on each side of center.

19. Take normal MDS power and spectrum check.

20. Turn antenna rotation to assigned rpm (20 turns).

21. Turn antenna tilt to assigned degree.

To turn equipment OFF:

1. Antenna rotation—OFF.
2. Antenna to—STOW.
3. Magnetron current to lower limit.
4. Close receiver crystal shutter.
5. System switch—OFF.

AN/ARR-27 Radar Relay Receiving Set.

The radio receving set (AN/ARR-27A) is an airborne radar relay receiving set for AOC Systems. The purpose of this system is to receive video, IFF, and azimuth sync information originating in a remote search radar AN/APS-20E and transmitted by radar relay transmitter AN/ART-28. It serves in conjunction with radar transmitter as part of a relay station. In this function the video, IFF, and azimuth sync information is transmitted, extending the range of the basic radar. It will also serve as remote indicators by presenting the information from the basic radar on a PPI scope at the receiver location. The remote presentation is identical with that on the basic radar scope. Power is supplied to the equipment from the aircraft's 28-volt d. c. system and from the 115-volt a. c. inverter system.

To put into operation:

1. Aircraft power supply, a.c. and d.c.—ON.
2. MAN GAIN-OFF control—turn clockwise from detent (OFF) position.

To turn equipment OFF:

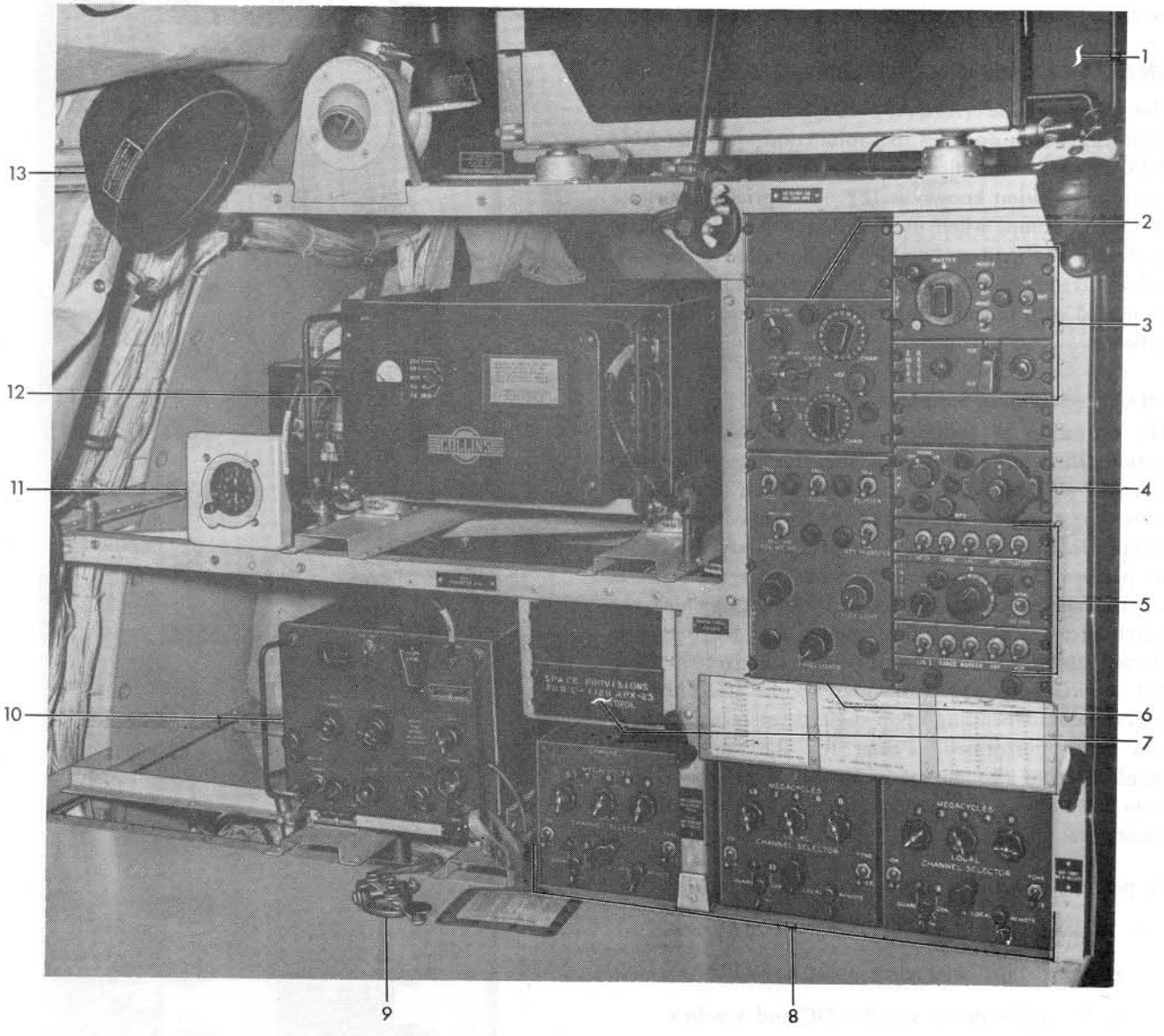
1. MAN GAIN-OFF control—turn counterclockwise to detent (OFF) position.

AN/ART-28 Radar Relay Transmitting Set.

This transmitting equipment is primarily designed for the relay of radar information from the radar set on a AOC aircraft to the receiving and indicating equipment in a surface control station. The radio operator controls the set. The AN/ART-28 is intended for use with AOC equipment such as AN/APS-20E radar, and AN/ARR-27A radio relay receiver. Power to the equipment is supplied from the aircraft 115-volt a.c. inverter system.

T-271/ART-28 Radio Transmitter.

This T-271/ART-28 (fig. 4-34) is a master-oscillator power amplifier transmitter capable of re-transmitting radar relay signals on any one of four pre-calibrated channels in the frequency band of 460 to 510 megacycles per second. The pratical range of the instrument is approximately line-of-sight. The particular channel



1. 618S-1 H.F. TRANS/RECEIVER
2. C-853/ARC-27 UHF CONTROL PANEL
3. IFF CONTROL PANEL
4. 618S-1 LIAISON CONTROL PANEL
5. RADIO AND ICS CONTROL PANEL
6. AUXILIARY RADIO CONTROL PANEL
7. SPACE FOR C-1128 APX-25 CONTROL
8. C-626/ARC-27 MASTER CONTROL UNIT
9. KEY
10. AN/ARR-15 RECEIVER
11. CLOCK
12. 618S-1 H.F. TRANS/RECEIVER
13. P.A. LOUD SPEAKER

F75-3-4-138

Figure 4-28. Radio Operator's Station (Typical)

to be used is under the control of the SD. Power to the equipment is supplied fram the aircraft 115-volt a. c. inverter system.

AN/APA-89 Coder Group (Provisions Only).

The coder ground (AN/APA-89) is an airborne electronic set which operates in conjunction with the AN/APX-25 radar identification set to provide coded electronic recognition known as IFF. The primary purpose of Coder Group, when used with the AN/APX-25, is to identify the airplane in which it is installed as friendly, when correctly challenged by an interrogator-responder associated with friendly radars that are ground based, or airborne.

AN/APA-56 Signal Indicator Assembly.

The operation of Indicator Assembly AN/APA-56 is accomplished primarily from the five range azimuth indicator IP-229/APA-56 consoles. Each console requires one operator, and each of the five may be operated independently. Although several auxiliary functions are performed from some of the other units, the consoles are the center of operations. At these consoles the search areas is combed for targets, and these targets plotted and tracked when they are discovered. Control of intercepter operations may also be affected from the consoles, depending upon the type of tactical operation being performed. Power for the equipment is supplied from the aircraft's 28-volt d. c. system and from the 115-volt a.c. inverter system and 115-volt a.c. generators.

To put into operation:

1. VOLTAGE REGULATOR CN-212/APA-56.

   a. Normal-off-emergency switch—NORMAL.

   b. DC and synchro switch—DC and synchro.

   c. Input-output switch—Input ϕA, ϕB, and ϕC, in turn. (Panel meter should read between 105 and 125 at each position).

   d. Input-output switch—Output ϕA. (Panel meter should read 115. Adjust with voltage adjust control as necessary).

   e. Input-output switch—Output ϕB. (Panel meter should read 115. Adjust with voltage adjust control as necessary).

   f. Input-output switch—Output ϕC. (Panel meter should read 115. Adjust with voltage adjust control as necessary).

To turn equipment off:

a. Normal—OFF—emergency switch—OFF.

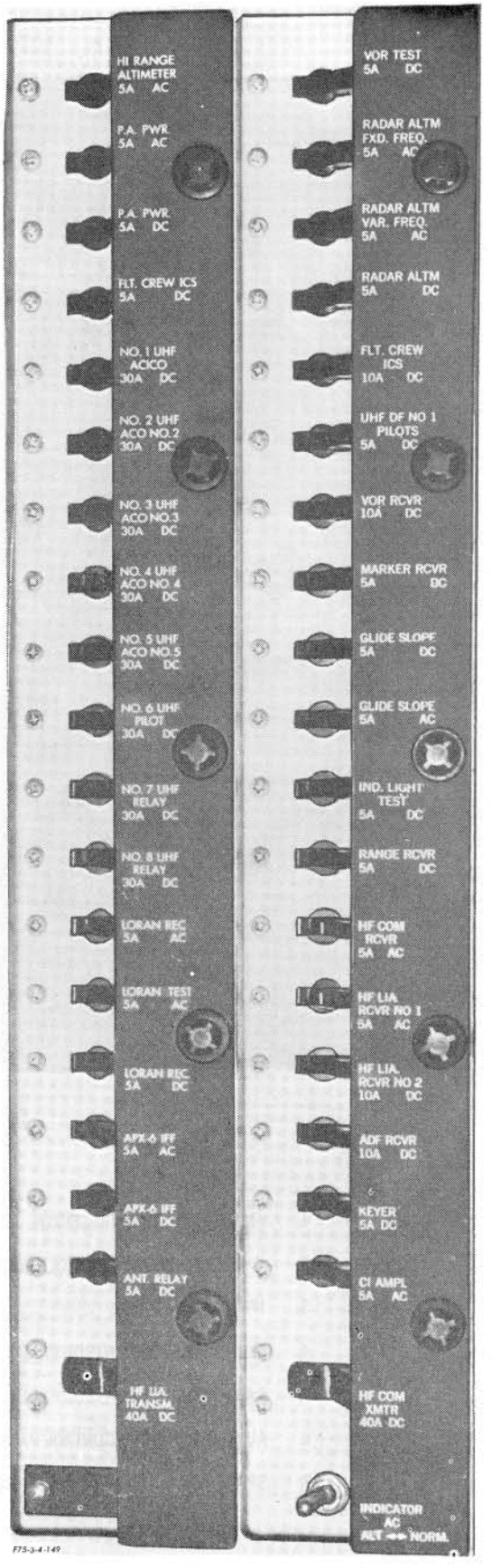


Figure 4-29. Radio Operator's Circuit Breaker Panel

2. SIGNAL DISTRIBUTOR J-294/APA-56.

a. Power switch—ON.

b. Meter switch— +220, —220. (Panel meter should read 220 each position).

3. AZIMUTH AND RANGE INDICATOR IP-230/APA-56.

a. Power switch—ON.

b. Intensity control—Clockwise until sweep just appears.

c. Focus control—Adjust for sharpest sweep line.

d. Intensity control—Counterclockwise until sweep is barely visible.

e. Range marks selector switch—10.

f. Video control—Clockwise for desired intensity.

g. Range selector switch—50, 100, and 250 in turn. (Sweep should fill tube face at all ranges. 10 mile range marks visible).

4. AZIMUTH AND RANGE INDICATOR IP-229/APA-56.

a. Power switch—ON.

b. Meter switch (Under leftside console)— +220 then —220. (Meter should read 220 each position).

c. Control illumination — Clockwise until panel markings are at desired level.

d. Sweep brilliance control—Clockwise until sweep is just visible.

e. Focus control—Adjust for sharpest sweep line.

f. Sweep brilliance control—Counterclockwise until sweep is barely visible.

g. Cursor selector—Centered.

h. Range marks selector switch—10.

i. Cursor brilliance—Clockwise to desired intensity.

j. Video gain control—Clockwise for desired intensity of range marks.

k. Range selector switch—20, 50, 100, and 250 in turn (Sweep should fill tube face at all ranges. 10 mile range marks should be visible).

l. Priority illumination—Clockwise until RHI Assignment panel markings are at desired level. (DD console will get full illumination but SRO consoles will get only partial illumination of markings).

m. L. and Rt. desk illumination controls—Clockwise until desired illumination of desk is obtained.

n. Plotter illumination control—Clockwise until desired illumination of the plotter is obtained.

o. Interphone and radio controls—check as desired.

5. VIDEO CONVERTER CV-78/APA-56.

a. On-off switch—ON.

Note

For the following three steps the navigator's APS-20E indicator must be in operation and able to receive grid map video.

b. Pos-Neg switch (Inside upper front panel)—Pos or neg depending upon which type of map plate is being used. (Normal grid map lines should appear on navigator's indicator).

c. Focus control—Adjust for sharper grid lines if necessary.

d Intensity control—Clockwise to increase intensity of grid lines if necessary.

Note

Converter control C-1216/APA-56 requires no preliminary operations to prepare it for use.

Upon completion of the above, the APA-56 equipment will be in standby condition. For actual operation it will be necessary to select radar video, IFF video, grid map, etc. depending upon the console operator's requirements.

TO STOP THE EQUIPMENT.

1. AZIMUTH AND RANGE INDICATOR IP-229/APA-56.

a. Intensity controls—Full counterclockwise.

b. Power switch—OFF.

c. All video and function switches—OFF.

2. AZIMUTH AND RANGE INDICATOR IP-230/APA-56.

a. Intensity controls—Full counterclockwise.

b. Power switch—OFF.

c. All video and function switches—OFF.

3. VIDEO CONVERTER CV-78/APA-56.

a. ON-OFF switch—OFF.

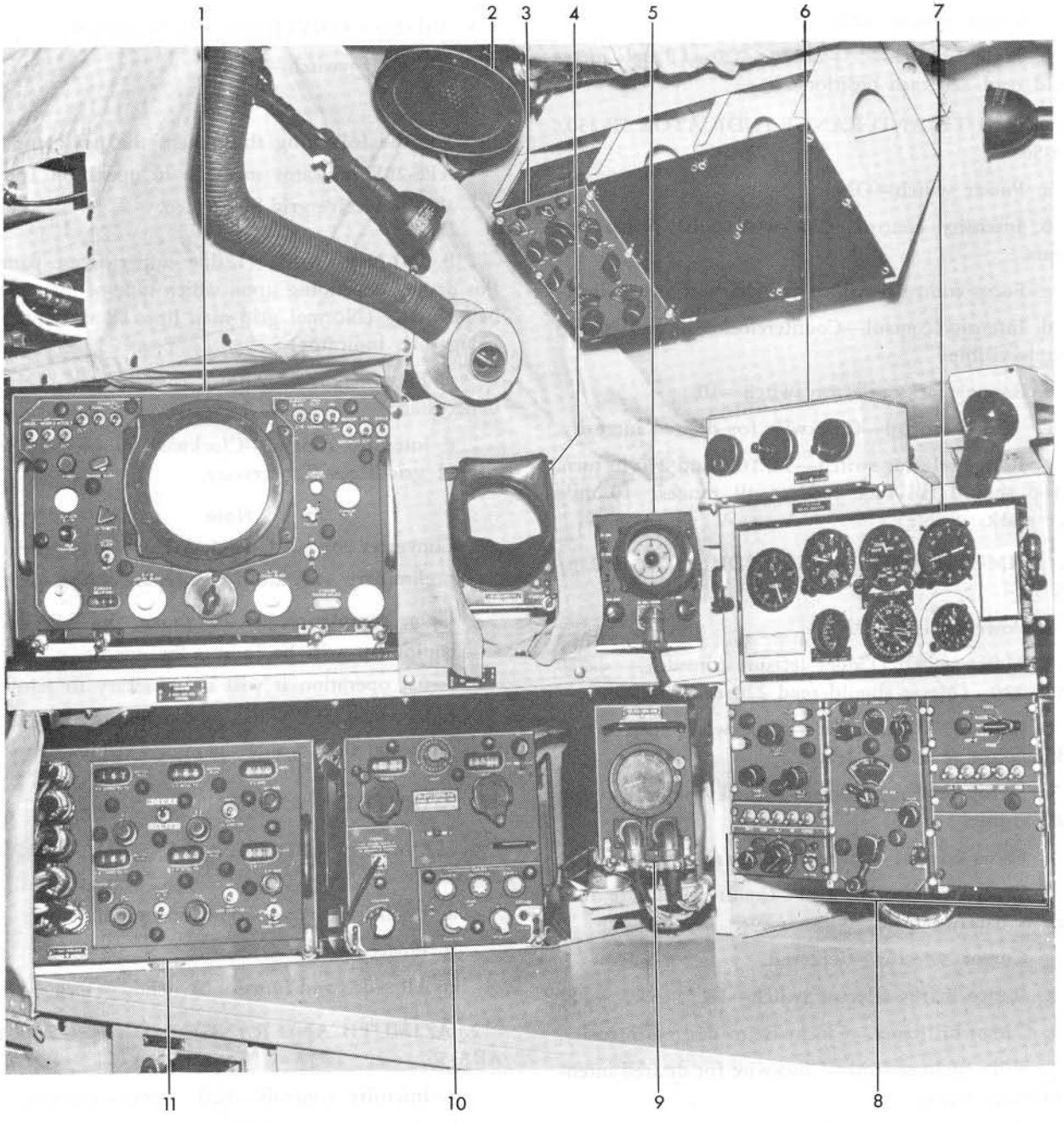
4. SIGNAL DISTRIBUTOR J-294/APA-56.

a. Power switch—OFF.

5. VOLTAGE REGULATOR CN-212/APA-56

a. Normal-Off-Emergency switch—OFF.

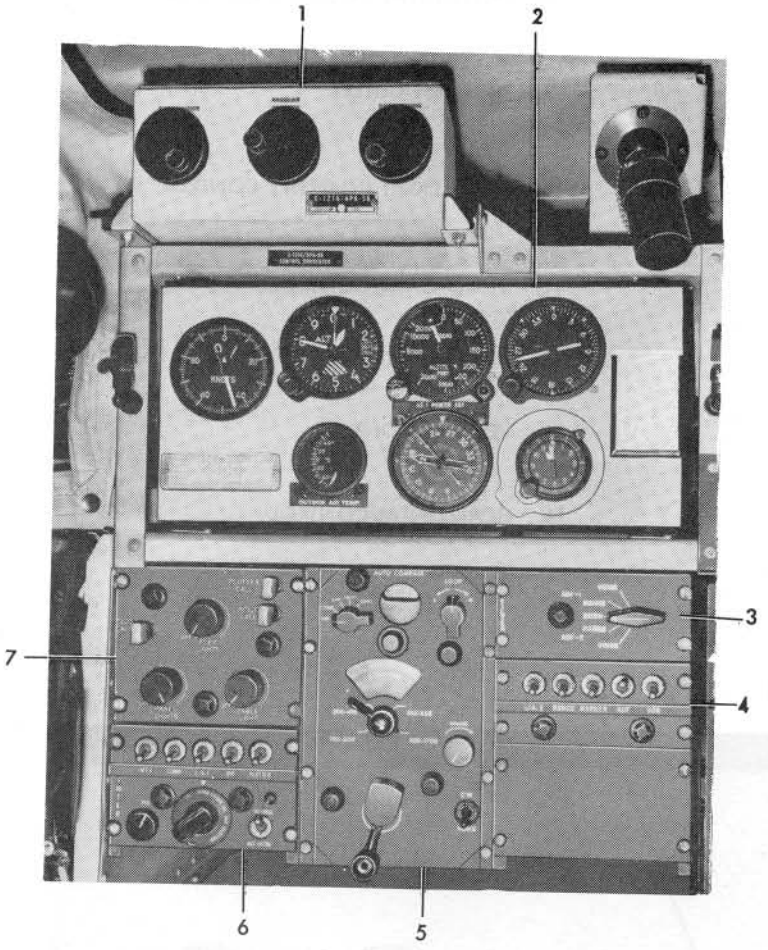
b. DC and Synchro switch—OFF.



1. APS-20B RADAR REPEATER
2. PUBLIC ADDRESS SYSTEM SPEAKER
3. CGRS CONTROL PANEL
4. APN-70 LORAN INDICATOR - SCOPE
5. RADIO ALTIMETER
6. APA -56 CONTROL CONVERTER
7. NAVIGATOR'S INSTRUMENT PANEL
8. RADIO AND ICS PANEL
9. CP-131/APA-57
10. APN-70 LORAN RECEIVER
11. APA-57 GROUND POSITION INDICATOR

F75-3-4-133

Figure 4-30. Navigator's Station (Typical)



1 APA-56 CONTROL CONVERTER
2 FLIGHT INSTRUMENT PANEL
3 RANGE FILTER SWITCH
4 AUXILIARY RADIO PANEL
5 APA-19 RADIO COMPASS REMOTE CONTROL UNIT
6 RADIO AND ICS CONTROL PANEL
7 AUXILIARY ICS PANEL

P95-3-4-134

Figure 4-31. Navigator's Instrument Panel (Typical)

Note

To shut down the equipment in an emergency, throw the normal-off-emergency switch to off. If it becomes necessary to operate the equipment in spite of failure of the voltage regulator regulating circuits, turn the normal-off-emergency switch to emergency.

AN/APS-42–NAVIGATION RADAR.

This radar set is designed for use as a navigational aid, as an anti-collision warning device, and as a search instrument. Either a pencil-beam pattern or a cosecant-squared beam may be formed by the reflector. The antenna, which is located in the nose of the aircraft, is pitch-and-roll stabilized so that it maintains an essentially constant inclination in adverse flying conditions. The nose radome is unheated and unpressurized, therefore auxiliary heating and pressurization are provided for some components within the radome. Two indicators may be used at one time. One may be located at the navigator's station and the other on the pedestal floor between the pilot and copilot in accordance with operational requirements. The radar uses both a.c. and d.c. power. The a.c. power is furnished by a 2500 VA inverter. The control unit contains all of the operating controls for the radar as well as the tilt indicator. The control unit is located on the pilot's overhead panel.

Function Switch.

The function switch energizes the equipment, starts the inverter, and selects SEARCH, BEACON, or WEATHER operation.

Obs-Map Switch.

This switch operates the beam-pattern change motor in the antenna assembly. The OBS position provides the pencil beam and the MAP position provides the cosecant-squared beam.

Htr Switch.

This switch turns on the heater in the antenna assembly. The heater will not operate unless the function switch

1. INCLINOMETER
2. RADIO CONTROL PANEL
3. ALTIMETER
4. ALTIMETER LIGHT
5. TILT INDICATOR
6. POWER SUPPLY INDICATING LIGHT
7. AN/APS-45 CONTROL PANEL
8. PANEL LIGHT INTENSITY CONTROL
9. RCVR TEST OUTLET
10. PANEL LIGHT INTENSITY CONTROL
11. VIDEO-GAIN CONTROL
12. AN/APS-45 INDICATOR CONTROL PANEL
13 VERTICAL CONTROL
14 HORIZONTAL CONTROL
15 ICS CONTROL PANEL

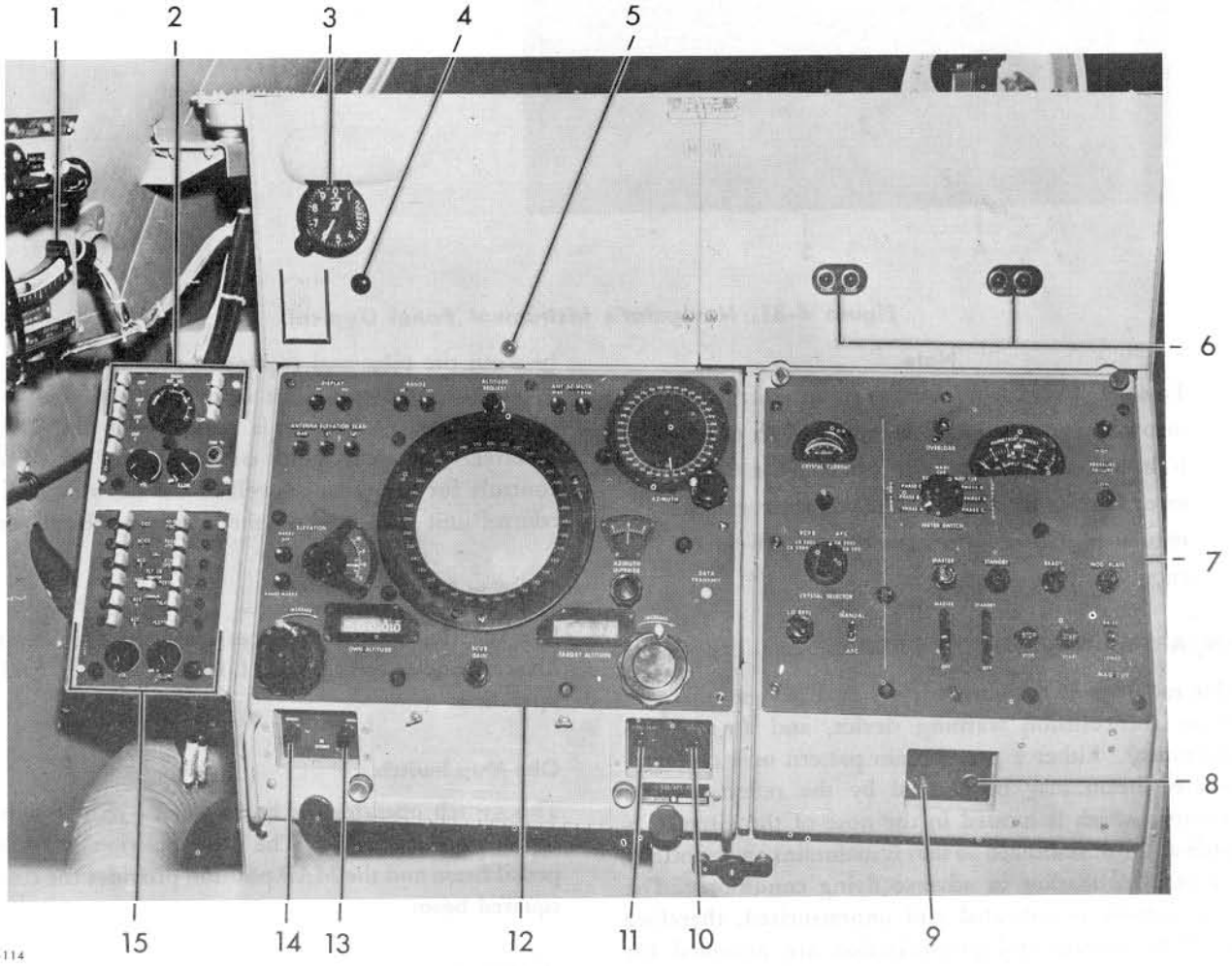


Figure 4-32. Height Finder's Station

is moved to STANDBY to energize the primary power relay in the control unit and start the inverter.

CAUTION

When ambient temperature is below —10°C always use auxiliary heater before operating radar.

Scan Switch.

The scan switch controls the rotation of the antenna. The FULL position rotates the antenna 240 degrees in azimuth centered along the airplane longitudinal axis and the SECTOR position rotates the antenna 120 degrees. The apex of the sector is automatically offset on SECTOR position for all ranges except the 200 mile position, thus giving a larger size sweep on the scope.

Range Switch.

This switch has 5, 10, 30, 100, 200 mile and TD positions and is used to select the minimum operating range of the equipment.

Gain Switch.

The gain switch adjusts the sensitivity of the radar set and should be adjusted to the point at which the target has the clearest presentation.

Tune Switch.

This switch has AFC and MAN positions. When the switch is in the MAN position the switch must be turned until the targets come in clear. Normally the switch is left in the AFC (Automatic Frequency Control) position and the tuning is automatic.

A-J Switch.

This switch has OUT, FTC, and IAGC positions. In the OUT position the FTC (Fast Time Constant) and IAGC (Instantaneous Automatic Gain Control) circuits in the receiver are inoperative. In the FTC position, the FTC circuit is operative, reducing clutter and sharpening up targets as presented on the PPI. In the IAGC position, both the FTC and IAGC circuits are operative. Clutter is practically eliminated and all targets are sharpened.

Stc. Switch.

This switch has OUT and ON positions. In the OUT position of the STC (Sentivity Time Control) switch, the STC circuits are inoperative, with the receiver gain functioning normally. In the ON position, the STC circuits are operative, thereby reducing the intensity of presentation of targets and clutter effective in the first 3 to 4 miles of range.

Stab. Switch.

This switch has STAB and OUT positions. When the switch is in the STAB (normal) position, the radar antenna is stabilized by gyros to compensate for pitch and roll of the aircraft so that the target will not be lost.

Delay Switch.

This switch provides a movable range spot, variable between 5 and 175 miles, on the first five positions of the range switch. On the sixth or TD position of the range switch, the movable range spot becomes the start of the 30 mile expanded sweep. The 30 mile expanded sweep can be started between 5 and 175 miles from the aircraft by means of the delay control. These indicators have the following five adjustments: edge light dimmer, focus control, cursor knob, video gain control and an intensity control.

Edge Lights Dimmer.

This control is used to adjust the illumination of the indicator lights to the desired brilliance.

Focus Control.

The focus control is used to obtain a clear presentation.

Cursor Knob.

This knob turns the cursor that is calibrated in degrees so that bearings to targets can be determined.

Video Gain Control.

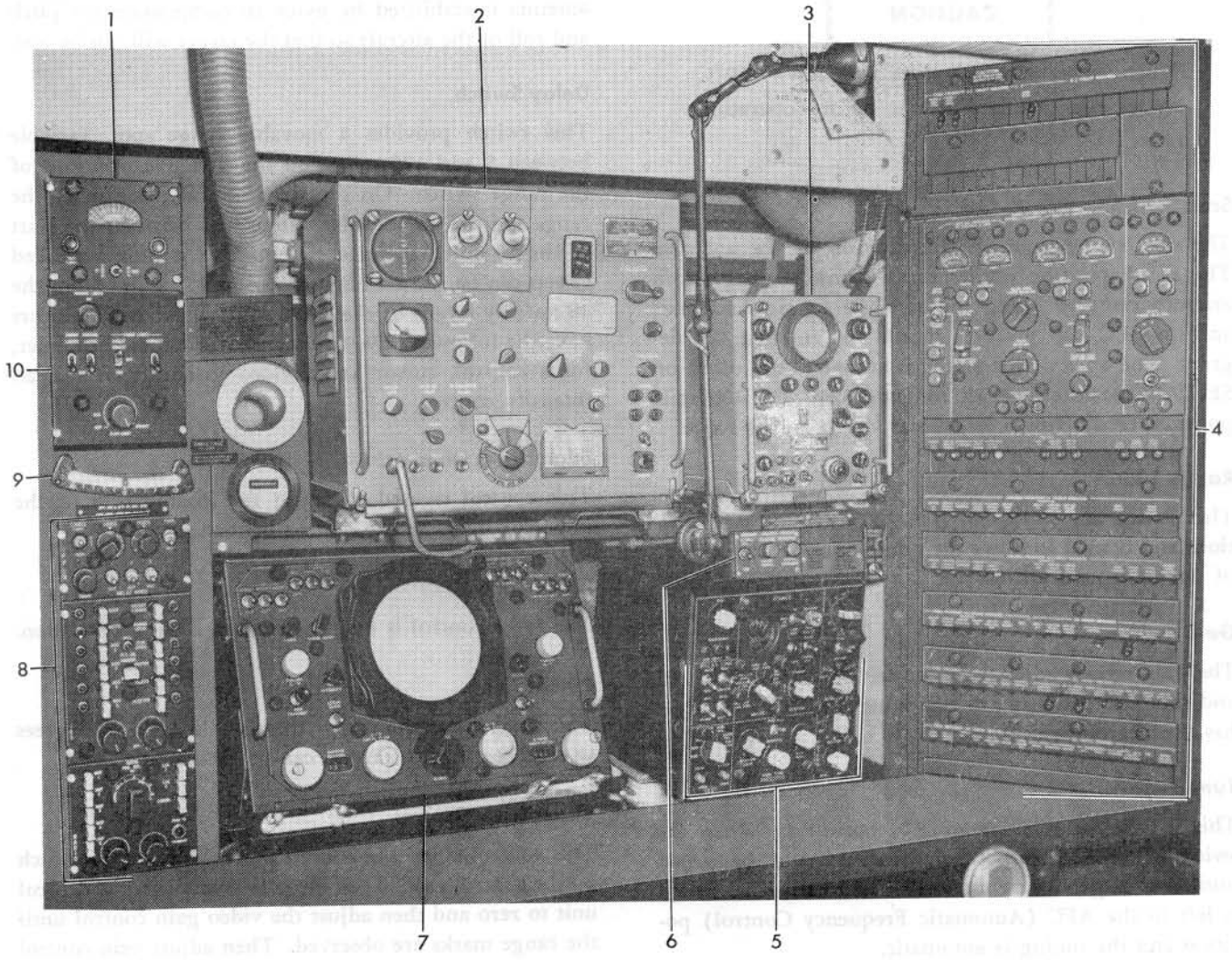
This control is used in conjunction with the gain switch on the control unit. Turn the gain control on the control unit to zero and then adjust the video gain control until the range marks are observed. Then adjust gain control on the control unit until the target is clear.

Intensity Control.

This control is used to adjust brilliancy of the trace.

AN/APS-42 Radar Pressurization System.

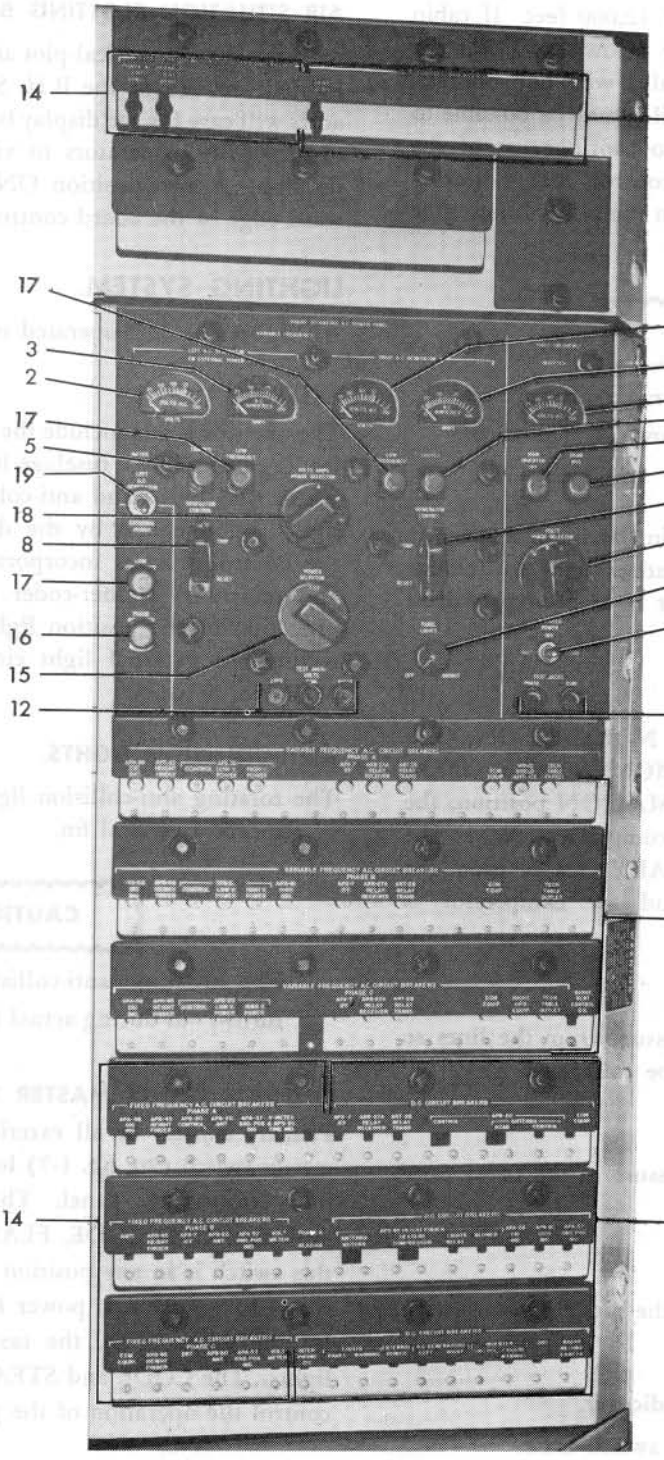
The radar pressurization system is designed to maintain an air pressure approximately equal to that of the atmosphere at sea level in the AN/APS-42 radar transmitter-receiver and associated wave guides. A pressure switch automatically energizes the air compressor when the line pressure drops below 28 inches of mercury (absolute) and stops the air compressor at about 32 inches. A check valve at the air compressor outlet retains pressure in the line after the compressor is stopped. This system is capable of pressurization, at any altitude within the limits of the aircraft. However, the cabin superchargers are able to maintain sea level pressure within the pressurized sections of the aircraft, thence through lines



1. 1P-203/APS-20E ANTENNA TILT INDICATOR
2. UMP-44 TEST SET
3. OS-4/AP OSCILLOSCOPE
4. AC POWER AND CIRCUIT BREAKER PANEL
5. C-5II/APS-20E CONTROL PANEL
6. RADAR BLOWER SWITCHES
7. 1P-203 APS 20E INDICATOR
8. RADIO AND ICS PANEL
9. INCLINOMETER
10. RADAR DOME LIGHT PANEL

FTS-3-4-143

Figure 4-33. Radar Technician's Station (Typical)



1 DC CIRCUIT BREAKERS
2 VOLTMETERS
3 AMMETERS
4 FIXED FREQUENCY VOLTMETER
5 TRIPPED WARNING LIGHTS
6 MAIN INVERTER OFF WARNING LIGHT
7 DEAD BUS WARNING LIGHT
8 GENERATOR CONTROL SWITCHES
9 VOLT PHASE SELECTOR SWITCH
10 PANEL LIGHT RHEOSTAT
11 INVERTER POWER SWITCH
12 TEST JACKS
13 VARIABLE FREQUENCY AC CIRCUIT BREAKERS
14 FIXED FREQUENCY AC CIRCUIT BREAKERS
15 AC POWER SELECTOR SWITCH
16 PHASE REVERSED WARNING LIGHTS
17 LF WARNING LIGHTS
18 VOLT AMPS PHASE SELECTOR
19 METER SWITCH

F75-3-4-136

Figure 4-34. Radar Technician's A.C. Power Panel

to the radar, up to an altitude of 12,000 feet. If cabin pressure is maintained at a value below 2,000 feet the radar pressurization system usually will not operate, therefore, if this system should fail it may be possible to pressurize the cabin sufficiently to continue use of the radar. The radar pressurization controls and indicators are mounted on a panel located on the pilots interphone control unit panel overhead.

CAUTION

Do not operate radar when radar pressure indicator shows pressure below 26 inches of mercury.

A silica gel dehydrator, located in the flight station, is installed in the radar pressurization lines to remove moisture from the cabin air that is used to pressurize the radar components.

Radar Pressurization Switch.

This switch has three positions: NORMAL, ON, OFF and is spring-loaded from the MOMENTARY ON to the OFF position. In the NORMAL ON position, the pressure switch controls the air compressor. When the switch is held in the MOMENTARY ON position, the pressure switch is bypassed and the compressor is energized.

Bleed Button.

This button is used to bleed pressure from the lines so that the pressure indicator can be calibrated.

Radar Pressure Indicator.

This indicator shows the air pressure in the radar pressurization lines.

Radar Pressure Indicator Light.

This indicator glows whenever the radar pressurization pump is operating.

Calibration of Radar Pressure Indicator.

1. Turn radar pressurization switch OFF.

2. Turn the dial shield to point the calibration arrow at approximately sea level pressure (29.92 on the instrument).

3. Depress the bleed button and hold until any existing pressure differential is equalized. The pressure gage should then indicate the barometric pressure of the station at which the aircraft is located. If this barometric pressure is unknown, the average reading of the supercharger pressure ratio indicators may be used as the true barometric reading while the aircraft is on the ground.

AIR SITUATION PLOTTING BOARD

An edge-lighted vertical-plot air situation plotting board, located forward of the R.H. SRO consoles. Two operators will care for the display board and post information to allow SRO operators to view air situations as they develop. A two position ON-OFF switch on the forward edge of the board controls the board lighting.

LIGHTING SYSTEM.

All lights are d. c. operated unless otherwise indicated.

EXTERIOR LIGHTS.

The exterior lights include the landing lights, taxi lights, leading edge lights, fuselage lights, wing tip, tail lights, wheel well lights and anti-collision lights. All of these lights are operated by the d. c. electrical system, and the control systems incorporate the necessary switches and relays. A flasher-coder assembly is provided for operation of the position lights. Circuit breakers, protecting the external light circuits, are located on the MJB No. 3 panel.

ANTI-COLLISION LIGHTS.

The rotating anti-collision light is installed, on the top of the center vertical fin.

CAUTION

The rotating anti-collision light should be turned out during actual instrument conditions.

EXTERIOR LIGHTS MASTER SWITCH.

Primary control of all exterior lights is provided by a master switch (20, fig. 1-7) located on the copilot's auxiliary instrument panel. The master switch has four positions: OFF, CODE, FLASH, and STEADY. When this switch is in any position but OFF, the master relay closes to supply d. c. power for steady operation of the leading edge lights, the taxi lights, and the landing lights. The CODE and STEADY and FLASH positions control the operation of the position lights.

FUSELAGE LIGHTS CODE SELECTOR SWITCH.

A switch (21, fig. 1-7), located on the copilot's auxiliary instrument panel, allows the selection of an alphabetical letter (A, D, G, I, K, M, N, O, R, S, U, or W) to be automatically flashed in Morse code by the fuselage lights. The master switch, located to the left of this switch, must be in the CODE position for this operation.

Fuselage Lights Key Selector Switch.

A switch (27, fig. 1-11), labeled NORMAL and KEY,

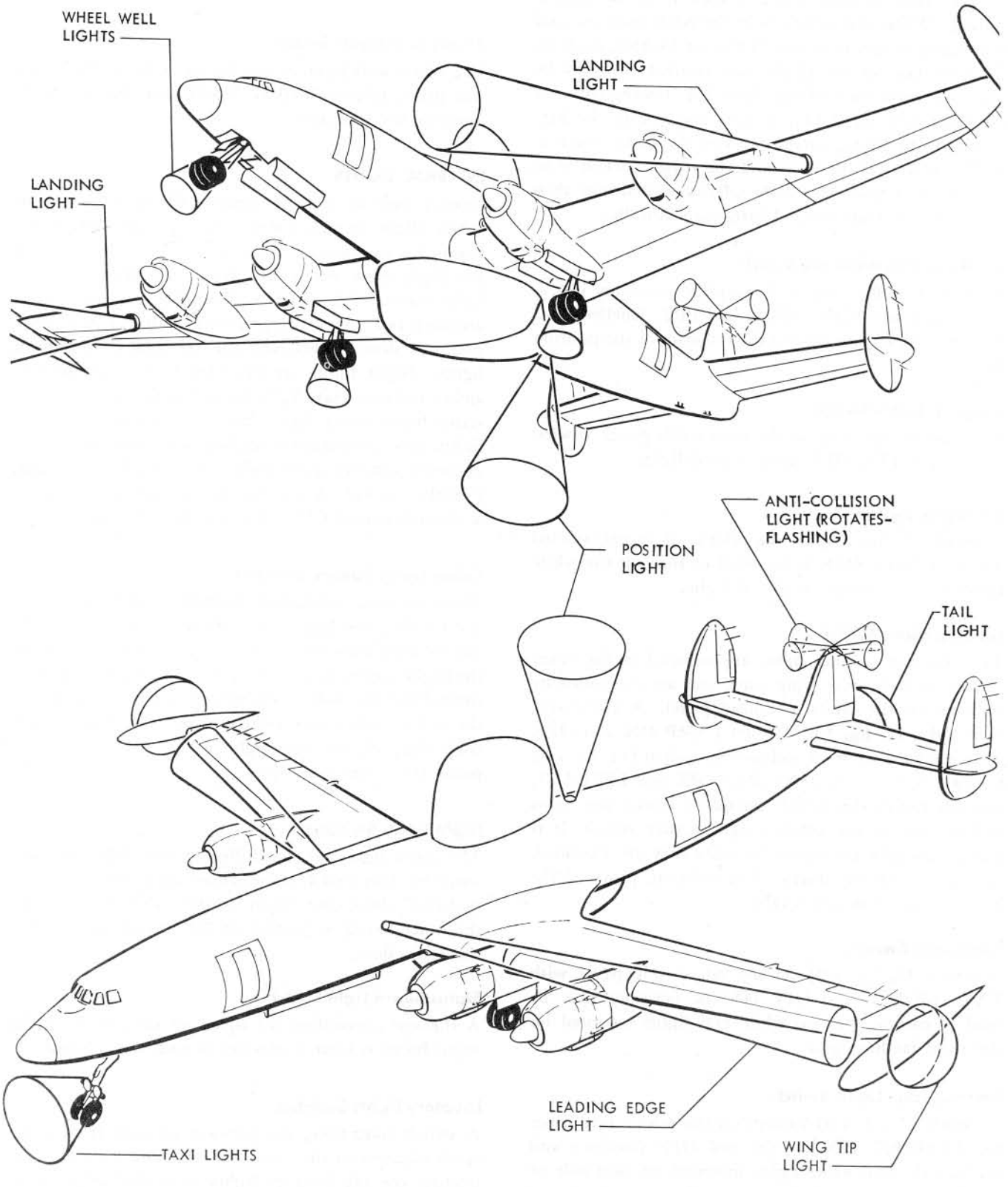


Figure 4-35. Exterior Light Arrangement

located on the flight path control box which is installed on the center control stand, is used to allow manual coding. When this switch is in the KEY position, and the master switch is in the CODE or FLASH position, the code key on the flight path control box may be used to control the fuselage lights for flashing code. A red light (29, fig. 1-11), located adjacent to the key, monitors the keying circuit. When the code switch is in the NORMAL position and the master switch is in the CODE position, the code selector switch may then be used to flash any selected letter automatically.

Position Lights Brilliance Switch.

A switch (19, fig. 1-9) on the copilot's auxiliary instrument panel with DIM, MED., and BRT, labelled positions may be used to control the intensity of the position lights.

Wing Tip Lights Switch.

A switch (6, fig. 1-9) on the pilot's side panel, labeled WING TIP LTS., OFF turns on these lights.

Tail Lights Switch.

A switch (5, fig. 1-9) on the pilot's side panel, labeled TAIL LIGHTS, OFF, is installed to turn on the white (bottom) and amber (top) tail lights.

Landing Lights Switch.

Two 600-watt landing lights are installed in the lower surface of each outer wing panel and are controlled by switches on the pilots' overhead panel. A switch for each light, (2, fig. 1-8) labeled LAMP ON and OFF, turns the light on or off and another switch (11, fig. 1-8) for each light, labeled EXTEND, OFF and RETRACT, controls the motors which extend or retract the lights independent of the exterior light master switch. It is possible to turn the lights on while they are extended, retracted, or in any intermediate position, provided the exterior master switch is ON.

Taxi Lights Switch.

A switch (7, fig. 1-9) on the pilot's side panel with TAXI LIGHTS and OFF labelled positions may be used to control the two white taxi lights mounted on the nose landing gear.

Leading Edge Lights Switch.

A switch (4, fig. 1-9) located on the pilot's side panel has LEADING EDGE LTS. and OFF positions and controls the two white lights mounted on each side of the fuselage. These lights are used to illuminate the wing leading edge for detection of ice, etc.

Anti-Collision Light Switch.

The anti-collision light switch is located on the pilot's side panel (2, fig. 1-9) and is placarded ANTI-COLLISION and OFF.

Wheel Well Lights Switch.

The wheel well light switch (3, fig. 1-9) on the pilot's side panel, labeled WHEEL WELL, may be used to illuminate the well area.

INTERIOR LIGHTS.

Interior lighting provides general illumination for the cabin, flight station, cargo compartments and illumination for the controls and control panels provided for the flight crew and radar crew. The cabin overhead lights consist of three sets, individually controlled. They are the forward crew compartment lights, the AOC compartment direct lights, and the aft crew compartment lights. Night lights are provided and consist of two amber and two white lights located in the cabin. Twenty status board white lights are also provided. Lavatory lights, crew compartment reading lights, and AOC compartment indirect green lights are provided. A white, flexible arm light is installed at each operator's station, at the technician's table, and near the driftmeter.

Cabin Lights Control Switches.

Three switches, placarded BRIGHT, OFF, and DIM control the cabin lights. One of the switches controlling the forward crew compartment lights is located above the flight station door on the cabin side; another rheostat controlling the AOC compartment lights is located on the radar technicians switch panel; the third switch controlling the aft cabin lights is located on the switch panel aft of the cabin door.

Night Lights Switches.

The night lights are controlled by two ON and OFF switches. One switch is located on the cabin side of the partition above the flight station-to-cabin door and the other switch is located on the switch panel aft of the cabin door.

Status Board Light Switches.

A rheostat controlling the lights on the left and right status board is located adjacent to each status board.

Lavatory Lights Switches.

A switch controlling the forward lavatory light is located adjacent to the cabin doorway and a switch controlling the aft lavatory lights is located adjacent to the doorway in the aft lavatory compartment.

Crew Reading and Galley Light Switches.

These switches are located on the light panel.

AOC Compartment Indirect Lights Switch.

A switch controlling the indirect lights is located on the radar technicians switch panel.

Flex Light Switches.

A rheostat is installed at each operator's station to control the illumination of the flex arm light in that station.

Pilot's Instrument Panel Lights Rheostat.

Direct red and direct white lighting is provided for the pilot's instrument panels. The three rheostats controlling these lights are located under the glare shield on copilot's side and are labeled PILOT'S RED, EMERGENCY WHITE, and COPILOT'S RED.

Flight Station Dome Light and Switch.

A combination red-white dome light is provided in the flight station for general illumination. The switch (5, fig. 1-17) for controlling this light is located on the flight engineer's upper switch panel and is labeled DOME LIGHT and is placarded WHITE—OFF and RED.

Pilots' Switch Panels Lights Switches.

A switch (9, fig. 1-9), located on each pilot's side panel, labeled PANEL LIGHT, OFF, controls the respective switch panel lights. A rheostat type switch (10, fig. 1-9), located directly below the panel light switch, controls the intensity of these lights. The switch is labeled PANEL LIGHT, DIM, BRIGHT.

Chart Lights and Switches.

The chart light switches are located on each pilots side panel (8, fig. 1-9) and (2, fig. 1-10). They are placarded CHART LIGHT and OFF. Also on these panels are the chart light rheostats (11, fig. 1-9) and (15, fig. 1-10) which controls the intensity of illumination desired. The rheostats are placarded DIM and BRIGHT. The lights are located over and slightly behind each pilot. Each light has a removable red lens and both chart lights may be removed from their bases to be used as a hand light.

Pedestal Light Switch.

A light, controlled by a two-position toggle switch (3, fig. 1-10) on the copilot's side panel, labeled PEDESTAL REAR LT., illuminates the area between the pilots' seats, aft of the center control stand.

Compass Light Switch.

A switch (14, fig. 1-10) located on the copilot's side panel labeled COMPASS LIGHT, DIM, OFF, BRIGHT, may be used to turn on the light in the standby compass and to control its intensity.

Pilots' Radio Remote Control Panel Lights Switches.

The pilot's and copilot's radio remote control panels are illuminated by small red floodlights installed directly above each box. The lights contain integral switches that can be rotated in either direction to turn on or off.

Pilots' Overhead Panel Lights Switch.

Red edge lighting is provided for the pilots' overhead panel. The control switch (5, fig. 1-8) is located on the right side of the overhead switch panel and has OFF and BRIGHT positions.

De-icer Control Panel Lights Switches.

The pneumatic de-icer panel, located to the left of the pilot, is illuminated by direct red incandescent floodlights (2, fig. 4-11) with integral switches.

Cargo and Tail Section Inspection Lights Switch.

A switch, located on the radar technician's switch panel, labeled CARGO LIGHTS and RADOME LIGHTS, controls the five overhead lights in the forward and aft cargo compartments and radome lights. These lights are automatically energized when the cargo compartment doors are opened, regardless of the position of the inspection lights switch. The cargo door switches also actuate the door warning light located on the flight engineer's lower instrument panel.

Flight Engineer's Instrument Panels Floodlights Switch.

A switch (2, fig. 1-17), located on the flight engineer's upper switch panel, may be used to illuminate the flight engineer's instrument panels with either red or white floodlights. The switch is labeled F. E. INSTR. PANEL FLOODLIGHT.

Flight Engineer's Instrument Panel Auxiliary Light Switch.

A switch (17, fig. 1-17), located on the flight engineer's upper switch panel, controls the small incandescent lights installed in a glare shield below the instrument panels. The switch is labeled F. E. INSTR. PANEL AUX. LTS. and has DIM, OFF, and BRIGHT positions.

Station 260 Instrument Panel Floodlight Switch.

A switch (1, fig. 1-17), installed on the flight engineer's upper switch panel, controls the floodlight that illuminates the station 260 panel. This switch is labeled STA. 260 INSTR. PANEL FLOODLIGHT.

Station 260 Instrument Panel Light Switch.

A rheostat installed under the flight engineer's lower instrument panel, controls illumination of the station 260 panel. This switch is labeled STA. 260 PANEL LIGHTS.

Flight Engineer's Desk Lights and Switches.

The flight engineer's desk lights are controlled by two rheostats; one located on the MJB #2 panel (10, fig. 1-27). It is placarded OFF-DIM-BRIGHT; and one under the flight engineer's lower instrument panel, it is placarded DIM-BRIGHT. These rheostats control the intensity of illumination desired. There are four lights under the flight engineer's lower instrument panel, two are red and two are white. The selector switch for these lights is on the MJB #2 panel and it is placarded RED and WHITE.

Master Junction Box Panel Lights Switch.

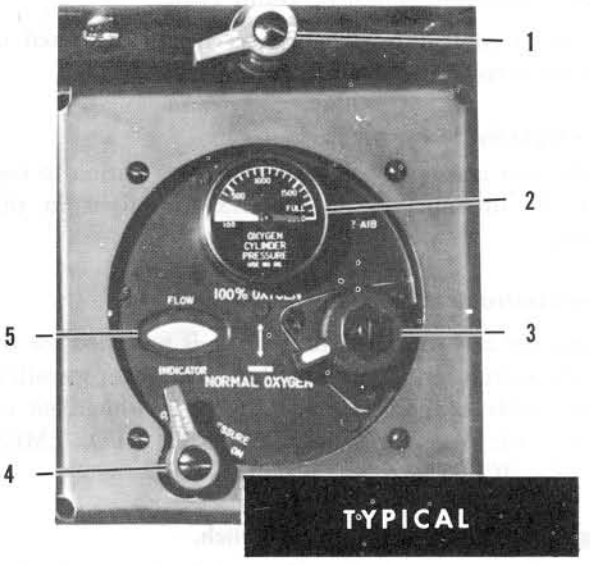
A switch (5, fig. 1-17), located on the flight engineer's upper switch panel with positions labeled DIM, OFF, and BRIGHT, controls the lights that illuminate the MJB panels.

OXYGEN SYSTEM.

The oxygen system consists of a fixed system available to all crew stations and portable bottles to supplement the fixed system. All oxygen containers are charged with the gaseous type.

FIXED OXYGEN SYSTEM.

A high pressure gaseous oxygen system that supplies 29 cabin crew members and three flight station crew members is installed in the aircraft. The system is supplied from four high pressure oxygen cylinders located aft of the pilot's station. Three of the oxygen cylinders are plumbed together to supply the radar crew. These cylinders may also be used to supply the flight crew by means of a line shut-off valve (crew valve) and bypass check valve which are plumbed between the radar supply line and flight crew pressure reducer. The fourth cylinder supplies only the flight crew. The oxygen cylinders are recharged through a filler assembly located forward of the crew door. Refer to oxygen duration chart, (fig. 4-37). Oxygen is routed from the three radar crew cylinders to a high pressure cylinder gage, pressure reducer, and low pressure system gage. From the pressure reducer, the line is "teed" to a relief valve. One end of the "T" is plumbed to the flight station supply line. The other end of the "T" is plumbed to three automatic, continuous flow regulators and then to the radar crew manifolds. Oxygen from the flight station cylinder is routed in a similar manner to the pilot's, copilot's, and flight engineer's diluter demand regulators. The relief valves, from the radar crew system and flight station system, are plumbed together and join the oxygen cylinder's overboard discharge line which discharges through a flush fuselage skin fitting immediately aft of the main cylinders. The relief valves discharge the oxygen overboard in the event of pressure reducer regulator failure. Each oxygen supply cylinder is equipped with a retainer safety disc that includes a fusible metal plug which will melt at 100°C to discharge the oxygen overboard.



1. Oxygen supply control lever
2. Regulator pressure gage
3. Air valve control lever
4. Safety pressure control lever
5. Flow indicator

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Figure 4-36. Diluter Demand Oxygen Regulator

PORTABLE OXYGEN SYSTEM.

Provisions for six individual portable oxygen cylinders are supplied; one in the flight station and five in the main cabin. Each cylinder is equipped with a diluter demand oxygen regulator with an oxygen flow indicator, a carrying strap, breathing tube with quick disconnect coupling, a clothing clamp, a shut-off valve, and cylinder pressure gage. Refer to (fig. 4-36). The oxygen regulator will reduce the cylinder pressure to approximately 65 psi if the pressure reducer should fail. Refer to oxygen duration chart, (fig. 4-37).

Oxygen Cylinder Shut-off Valve Controls.

Each of the four main oxygen supply cylinders, clamped to the forward radio rack behind the pilot's seat, are equipped with a poppet-type shut-off valve. The shut-off valves control the flow of oxygen to the system and should be off when oxygen is not being used.

Radar-Flight Crew Shut-off Valve.

A crew valve is located on the oxygen control panel above the oxygen cylinders. When this valve is opened,

OXYGEN DURATION CHART

FLIGHT CREW OXYGEN DURATION

HOURS FOR 3 FLIGHT CREW MEMBERS, 1 LAC 654114 OXYGEN CYLINDER

CABIN ALTITUDE IN FEET	GAGE PRESSURE — PSI 1800	1500	1200	900	600	300
25,000	1.4 .8	1.1 .6	.8 .5	.5 .3	.3 .2	EMERGENCY
20,000	2.3 .6	1.8 .5	1.4 .4	.9 .2	.5 .1	
15,000	2.8 .5	2.3 .4	1.7 .3	1.1 .2	.6 .1	DESCEND BELOW 10,000 FEET
10,000	3.0 .4	2.4 .3	1.8 .2	1.2 .2	.6 .1	
HOURS FOR 2 FLIGHT CREW MEMBERS, 4 LAC 654114 OXYGEN CYLINDERS						
5,000	15.6 1.9	12.4 1.5	9.4 1.1	6.2 .8	3.1 .4	EMERGENCY

BLACK FIGURES INDICATE DILUTER DEMAND LEVER "NORMAL OXYGEN."
RED FIGURES INDICATE DILUTER DEMAND LEVER "100% OXYGEN."

CABIN CREW OXYGEN DURATION

HOURS FOR 30 CREW MEMBERS, 3 LAC 654114 OXYGEN CYLINDERS

CABIN ALTITUDE IN FEET	GAGE PRESSURE — PSI 1800	1500	1200	900	600	300
25,000	.85	.62	.46	.31	.16	
20,000	.92	.77	.54	.38	.16	
15,000	1.23	1.0	.77	.46	.23	EMERGENCY
10,000	1.84	1.46	1.1	.69	.38	

ABOVE FIGURES BASED UPON "CONTINUOUS-FLOW OXYGEN."

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Figure 4-37. Oxygen Duration Chart

the flight station oxygen is supplied from three radar crew cylinders to all radar crew stations.

Air Valve Control Lever.

The air valve control lever (3, fig. 4-36), mounted on the oxygen regulator, can be set to NORMAL OXYGEN or 100% OXYGEN. In the NORMAL OXYGEN position, a mixture of air and oxygen is delivered to the mask as required. In the 100% OXYGEN position, undiluted oxygen is delivered to the mask.

Oxygen Supply Control Lever.

The oxygen supply control lever, 1, fig. 4-36) mounted on the oxygen regulator is used to open or close the incoming oxygen supply line that is connected to the regulator. The oxygen supply lever should be left in the OFF position when oxygen is not being used.

Safety Pressure Control Lever.

When the safety pressure control lever, mounted on the oxygen regulator (4, fig. 4-36), is in the ON position, it allows a slight pressure to be built up inside the mask. This prevents outside air from being drawn into the mask when inhaling.

High Pressure Gages.

One high pressure gage for the radar crew oxygen system and one for the flight crew oxygen system (fig. 4-38) are located on the oxygen control panel above the oxygen cylinders. Each gage is calibrated from 0 to 3000 psi and registers 1800 psi at 21°C when fully charged.

Low Pressure Gages.

Two low pressure oxygen gages (fig. 4-38) are located adjacent to the high pressure gages, downstream of the flight station and radar crew system pressure reducers. These gages are calibrated from 0 to 200 psi and indicate system pressure. Normal pressure is 65 psi.

Flow Indicators.

Each diluter demand regulator incorporates an oxygen flow indicator (5, fig. 4-36). The flow of oxygen through the demand valve is indicated by the oscillation of a plate under the glass of the flow indicator.

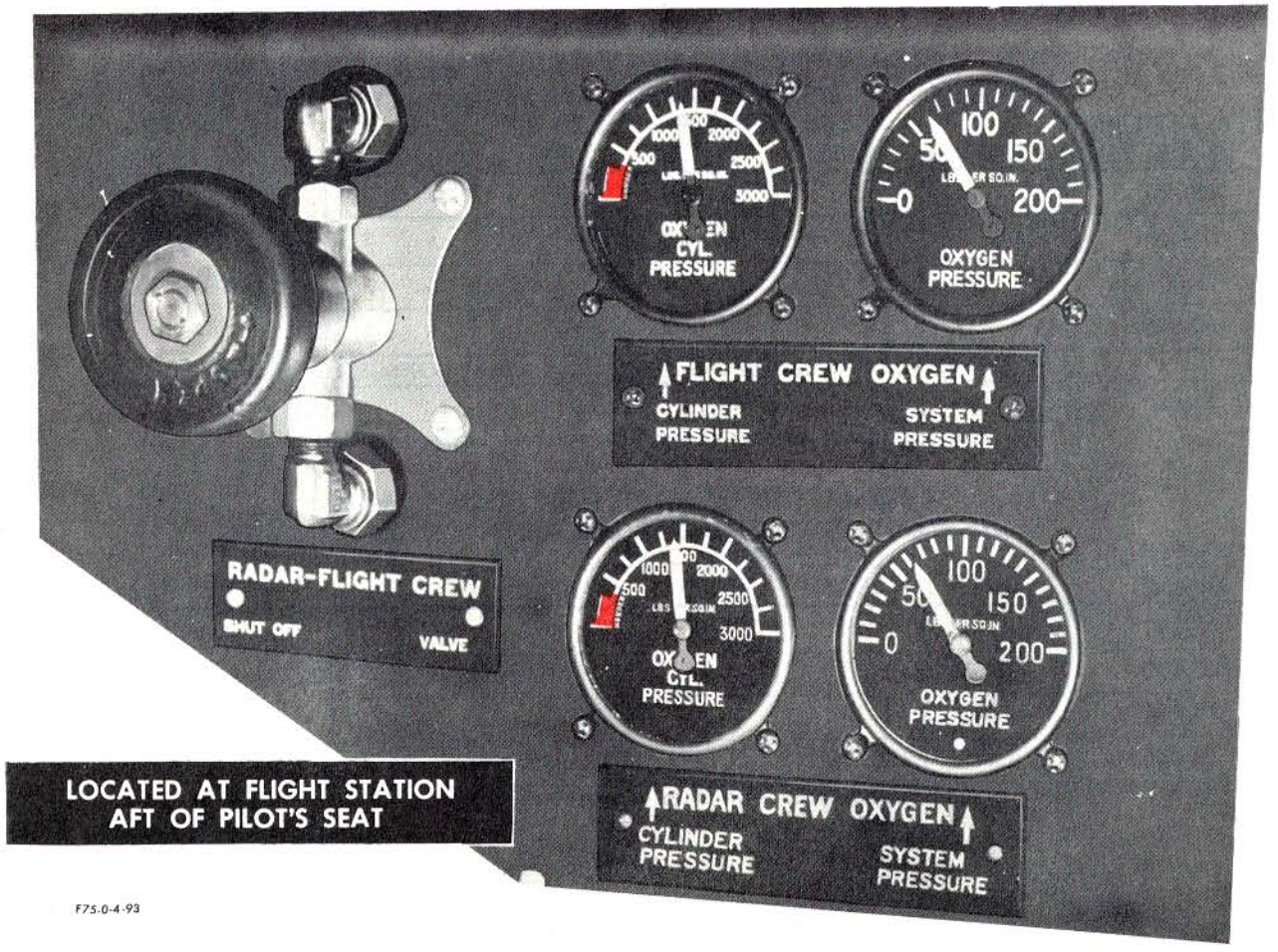


Figure 4-38. Oxygen System Control Panel

NORMAL OPERATING PROCEDURES.

Note

Each crew member should check his oxygen regulator with the diluter valve first at the NORMAL OXYGEN position and then the 100% OXYGEN position. Remove mask and blow gently into end of the oxygen regulator hose as during normal exhalation. If there is a resistance to blowing the system is satisfactory. Little or no resistance will indicate a faulty demand diaphram or diluter air valve or a leaking mask to regulator tube.

1. Oxygen supply cylinder shut-off valves — open slowly.

2. Oxygen supply control lever—ON.

3. High and low pressure gages — check for proper pressures.

4. Air valve control lever—NORMAL OXYGEN.

5. Oxygen masks—connect and check for leakage.

6. Flow indicator—check.

7. Crew valve—off, unless it is desired to supply the flight station from the radar crew system, then—open.

EMERGENCY OPERATING PROCEDURES.

1. Should symptoms of hypoxia occur or the regulator fail, turn the safety pressure control lever clockwise to the ON position and descend to an altitude not requiring oxygen.

2. Whenever excessive carbon monoxide or other noxious or irritating gas is present or suspected, then,

regardless of altitude, put on oxygen mask and set the air valve control lever to the 100% OXYGEN position until danger is past.

AUTOMATIC PILOT.

The PB-10 automatic pilot installed in the aircraft is an electrically operated system that requires alternating current, which is supplied by the main instrument inverter and direct current, which is supplied by the main bus. The automatic pilot establishes references for automatic control of the aircraft. Whenever there are any deviations in the attitude of the aircraft from these flight references, the system senses these deviations electronically and operates the rudders, ailerons, and elevators through the normal flight control system, accordingly.

AUTO PILOT COMPONENTS.

Fundamentally, the automatic pilot is made up of nine components. Of these the gyro Flux Gate transmitter, the amplifier signal generator, the three main servos, and the elevator trim tab servo, comprise the working units of the system. The remaining three components, the master direction indicator, the three-axis trim indicator, and the controller provide indications and operating controls for the pilots. In addition, switches are provided to control the various functions of the equipment. An elevator trim tab servo eliminates the need for manual nose up or nose down trimming when the automatic pilot is being used because the elevator trim tab servo is controlled directly by the elevator servo signal. When the elevator servo is required to sustain a force for a period of time to hold an elevator position, the elevator trim tab servo will be automatically actuated and will position the trim tab to provide aero-dynamic balance. The manual trim tab wheel will move very slowly and the tab position indicator will show the position of the tab.

Safety Circuit.

A safety circuit in the amplifier causes disengagement of the automatic pilot servo clutches in case of a. c. power failure likely to affect the operation of the gyros. The automatic pilot clutches are also automatically disengaged in case of d.c. failure.

Circuit Breakers.

Three circuit breakers (fig. 1-27), two labeled PB-10 AUTO PILOT Aϕ and Cϕ, and one labeled D. C., are located on the MJB No. 3 panel. When these circuit breakers are pushed in, both alternating and direct current are directed to the system.

Servo Disconnect Levers.

These three levers (10, fig. 1-36), located on the lower aft side of the center control stand, operate mechanical clutches in each of the servos. Raising any one lever completely disengages the corresponding servo pulley from the servo drive shaft so that the pulley is free to turn with cable control movement. The servo disconnect levers also operate interlock switches at the beginning of their travel which interrupt the d. c. power to the clutch switch and prohibit its engagement before the actual mechanical engagement.

Flux Gate Caging Switch.

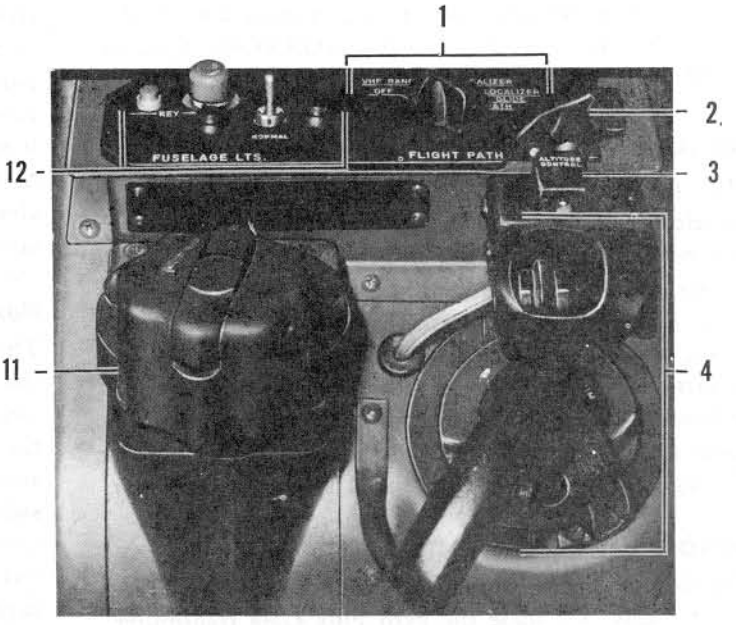
This momentary contact switch (6, fig. 4-39), located on the center control stand and to the left of the clutch switch, provides a means for expediting the erection of the gyro in the gyro Flux Gate transmitter and the automatic pilot vertical flight gyro. When the caging switch is placed in the CAGE (up) position and then released, the caging motors are energized to drive and lock the gimbal rings of the gyros so that the gyros are caged; then the gyros are automatically released (uncaged) and the caging motors are stopped. The caging circuit to the automatic pilot and Flux Gate compass also includes an interlock so that in case the caging switch is closed, while the automatic pilot is engaged, the clutch switch holding solenoid is de-energized. This releases the clutch switch, allowing it to pop out, disengaging the automatic pilot.

Clutch Switch.

This switch (5, fig. 4-39, is located on the center control stand, directly above the caging switch, and when pressed in, operates an electric clutch in each of the servos and the direction indicator to engage the automatic pilot, provided a. c. and d. c. power have been on approximately two minutes; servo disconnect levers are in the ON position; altitude control switch is OFF and gyros are uncaged. A clutch time delay relay prevents engagement of the clutch for approximately two minutes after the automatic pilot is turned on. The delay set in by the relay allows time for the amplifier tubes to warm up, the gyros to reach operating speed, and the servos to turn to cancel the net channel signal before the automatic pilot takes control of the aircraft. During this delay period, the clutch switch, when pressed, will not hold and will not operate the servo clutches. The trim tab functions with the automatic pilot clutch switch. With the clutch switch out and the automatic pilot not engaged, a clutch inside the trim tab servo disengages to free the servo. A pulley friction release, mounted on the servo shaft, permits overpowering the trim tab servo.

Altitude Control Switch.

This switch (3, fig. 4-39), which is mounted on top of the controller, energizes a clutch which connects the altitude control autosyn to its sensing aneroid. Any



1. FLIGHT PATH SELECTION SWITCH
2. FLIGHT PATH DIRECTION SELECTION SWITCH
3. ALTITUDE CONTROL SWITCH
4. AUTO-PILOT CONTROLS
5. AUTO-PILOT CLUTCH SWITCH
6. AUTO-PILOT FLUX-GATE CAGING SWITCH
7. LANDING GEAR LEVER RELEASE TRIGGER
8. LANDING GEAR LEVER
9. BRAKE SELECTOR LEVER
10. AUTO-PILOT SERVO DISCONNECT LEVERS
11. RUDDER TRIM TAB HANDCRANK
12. FUSELAGE LIGHT PANEL

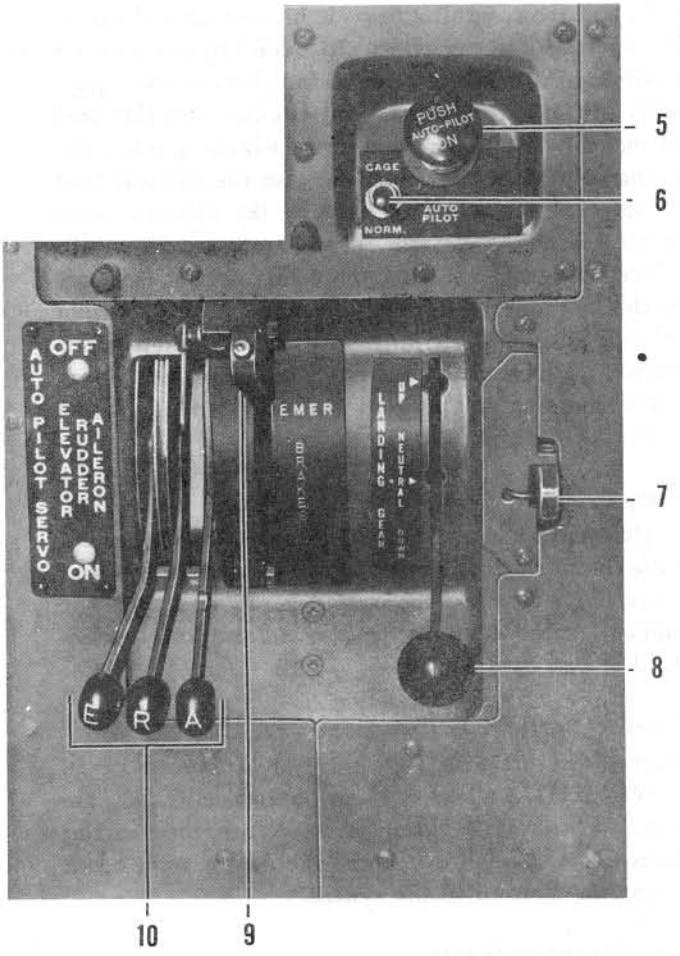


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Figure 4-39. Automatic Pilot Controls

deviation from the altitude at which this clutch is engaged will cause a signal to be generated for automatic control of the elevator, which will hold the aircraft at any pressure altitude up to 30,000 feet, provided airspeed and altitude are stabilized at the time it is turned on. Regardless of the amount the aircraft is displaced in altitude, the maximum pitch change that the unit can set in to return the aircraft to its original altitude is ±8°. The switch is electrically interlocked with the clutch switch to prevent engagement of the automatic pilot while the altitude control switch is ON. Also, when the altitude control switch is ON, a guard covers the pitch trim knob, making it inaccessible.

Controller.

The controller mounted on the center control stand is installed to permit maneuvering the aircraft through the automatic pilot to make coordinated turns, climbs, descents, climbing turns, or descending turns. The three controls and their functions are:

1. The pistol grip turn handle (4, fig. 4-39) incorporates two cut-out switches; one operated automatically whenever the handle is displaced 4 degrees maximum in either direction from the center position and the other operated manually by a trigger switch on the pistol grip. The switches are normally closed and are connected in series with the clutch solenoid in the master direction indicator. When either switch is opened, the course autosyn is disengaged, thus allowing the selection of a new heading by use of the turn handle. If neither of these switches is opened while maneuvering the aircraft with the controller, the aircraft will return to its original heading when the turn handle is returned to the detent.

2. The bank trim knob is d.c. operated and may be used to adjust bank attitude after squeezing the pistol grip trigger switch. (See paragraph on CRUISE procedure).

3. The pitch trim knob is d.c. operated and may be used to bias the elevator channel for any desired angle of climb or descent. This control is not accessible with the altitude control switch ON.

Pilot's Clutch Disconnect Switches.

These switches, mounted on the right hand grip of each pilot's control wheel, provide a means for disengaging the automatic pilot. When pressed, either of these switches will electrically disconnect the automatic pilot system and the clutch switch will pop out. When this occurs, the clutches in the servos and in the direction indicator are disengaged, preventing automatic control from being applied to the aircraft control surfaces.

Flux Gate Sensitivity Control.

This control, located on the lower right corner of the automatic pilot amplifier-signal generator, under a removeable cover, is used for adjusting Flux Gate compass sensitivity. For latitudes approximating that of the Continental United States, this adjustment can be full counterclockwise. For those latitudes nearer the poles where the horizontal component of the earth's flux is weaker, increased sensitivity will probably be preferred. A setting which is too high results in oscillation of the master direction indicator and of the aileron servo. Sluggish movement of the direction indicator occurs when the setting is too low.

Flux Gate Compass Master Direction Indicator.

The Flux Gate compass master direction indicator (15, fig. 1-7), located on the copilot's instrument panel, indicates the magnetic heading of the aircraft whether the automatic pilot is engaged or disengaged. The dial is directly connected through gears and linkages to an induction motor which operates both directionally and porportionally to changes of the magnetic heading of the aircraft. When the heading changes, the gyro Flux Gate transmitter, mounted in the wing, electrically senses this change due to its change of position in the earth's magnetic field, and transmits a signal to the Flux Gate direction indicator. This signal serves two purposes; it is used to drive the dial of the Flux Gate direction indicator, and to originate a course signal for automatic control. The course signal is then transmitted to the amplifier where it is amplified and modified to become a working signal with the characteristics necessary for application of power to the servo motor. When this working signal energizes the servo motor, which is tied to the aileron control system of the aircraft, it drives in the proper direction to apply corrective force for holding the aircraft on a desired magnetic heading.

Three-Axis Trim Indicator.

The three-axis trim indicator is d.c. operated and (34, fig. 1-7), mounted on the pilot's center instrument panel, is connected across all three amplifier channels and indicates trim condition in all three axes. A sustained displacement of the indicator hand indicates a servo is putting out torque and the direction indicated. This out-of-trim condition requires manual correction before engaging the auto-pilot by use of the trim tab control in the same direction.

NORMAL OPERATING PROCEDURES.

To engage the automatic pilot for ground check:

1. Circuit breakers—in.

2. Servo disconnect levers—ON.

3. Gyros—caged (after the inverter has been operating at least two minutes). Allow about 30 seconds for completion of the caging cycle.

4. Check 3 axis trim indicator.

5. Altitude control switch—OFF.

6. Clutch switch—PRESS.

Ground Check.

The forces tabulated below refer to: Elevator force applied on the center of the control wheel hub; aileron force applied at the rim of the control wheel; and rudder force applied on the rudder pedals.

	Stall
Elevator	33#±7
Rudder	65#±15
Aileron	16#±3

To determine that the values of the above stall forces are approximately correct:

1. With the engines running and with boost on, operate the surface controls several times.

2. Neutralize (center) surface controls.

3. Engage the automatic pilot.

4. By use of the pitch and turn controller, move the surface controls each way.

5. Operate the turn controller and determine that the rotation of the control wheel can be stopped with moderate effect of one hand.

6. Operate the pitch controller forward and aft and determine that the control column movement can be stopped with moderate effect of one hand.

7. Operate the turn controller and determine that the rudder motion can be stopped with moderate effort. (The rudder will move only a few inches).

To check the overpowering forces, proceed as follows:

1. With the turn and pitch controller in the neutral position, operate each of the surface controls against the power of the automatic pilot.

2. Using two hands on the wheel, the pilot should be able to turn or move it forward and aft.

3. By applying considerable effort on the rudders the pilot should be able to move the pedal each way.

Note

The above checks can be performed in flight as well as on the ground.

The above checks give the pilot an approximation of the forces that the automatic pilot can produce. If it requires maximum effort with two hands to stall the elevator, the pilot is sure that the automatic pilot is capable of producing excessive force. If the pilot can overpower the ailerons easily with one hand, he knows that the aileron servo is not putting out sufficient force.

Note

Wind blowing directly on the tail may affect the required force on the controls.

Before Take-off.

1. Pilot's clutch disconnect switch—press.

2. Servo disconnect levers—OFF.

Climb.

1. After climb power is set, the aircraft should be trimmed before the automatic pilot is used.

2. Altitude control—OFF.

CAUTION

Never turn the altitude control switch ON during a climb. If it is accidentally turned ON, trim the aircraft and disengage the automatic pilot before turning it OFF.

3. Servo disconnect levers—ON.

4. Center 3 axis trim.

5. Clutch switch—push.

Cruise.

When the desired cruising altitude has been attained, proceed as follows:

1. Disengage the automatic pilot.

2. Trim the aircraft manually for straight and level cruising flight at the desired altitude with desired cruising power.

3. Set the automatic pilot trim knobs to neutral.

4. Check that the altitude control is OFF.

5. Engage the automatic pilot.

6. Altitude control—ON if desired.

7. If the altitude control fails to hold a steady altitude, it is possible that the aircraft was slightly out of trim when the altitude control was turned ON. To correct this, repeat the steps in this paragraph.

Note

If a major change in trim occurs, such as a power change, while using the altitude control, it will be necessary to disengage the automatic

pilot, turn OFF the altitude control, and repeat the above steps. For minor changes in trim as noted on the three axis trim indicator, adjustments can be made to the aircraft trim tabs in the normal manner while on altitude control.

8. The automatic pilot now has control of all three axes of the aircraft. With the altitude control OFF, the aircraft can be maneuvered by moving various components of the controller. It is possible to adjust bank attitude by squeezing the trigger switch and using the bank trim knob, however, since the inclusion of the directional signal in the aileron channel the bank knob is of no practical use. The automatic pilot should be engaged with the aircraft trimmed for wing level flight. If changes in bank attitude become necessary, disengage the automatic pilot and re-trim the aircraft again for level flight. Rotating the pitch trim knob aft (toward the pistol grip) will move the elevator to raise the nose. Any desired angle of descent may be obtained by rotating the pitch trim knob forward. To make a coordinated turn, move the pistol grip in the direction it is desired to turn. This operation gives the proper amount of "up" elevator to maintain altitude and the correct amount of aileron and rudder for coordinated turn. When the turn control grip is rotated to make greater changes in heading, a switch is automatically tripped to disconnect the automatic pilot from the Flux Gate compass so that when the handle is returned to the central detent position, the aircraft will maintain the new heading. If very slight changes in heading are desired, squeeze the trigger switch under the pistol grip, which cuts out compass heading signals, and rotate the grip a small amount in the desired direction, and then return it to the detent. The aircraft will hold the new course.

Descent.

1. Automatic pilot—disengage.
2. Altitude control—OFF.

Note

The automatic pilot may be engaged and used for descents when the altitude control is turned OFF, by adjusting the pitch trim knob.

3. Pilot's (or copilot's) clutch switch—press.
4. Servo disconnect levers—OFF.

EMERGENCY OPERATING PROCEDURES.

When using the automatic pilot, the pilot or copilot must be in his seat, with his safety belt fastened so that if any malfunction of the automatic pilot should occur, he can recover immediately.

Automatic Pilot Failures.

Automatic pilot failures generally will fall into one of the following categories; continuous hard-over signals or oscillating signals. The continuous hard-over type of malfunction can result from shorting or grounding of certain circuits, and/or the failure of certain tubes. The result will be that the automatic pilot servo will develop full torque on one of the surfaces (not necessarily full deflection) and the maneuver that results will depend upon the speed, CG position, gross weight, and to a certain extent upon the type of failure that has occurred, as it is possible to get erroneous signals that do not develop full torque from the servo unit.

Elevator Hard Nose Down.

Should the automatic pilot malfunction give an elevator hard nose-down signal, the aircraft will pitch over quite rapidly to almost zero G, which is the critical condition. In combination with turbulence, this hard nose-down signal may produce an acceleration below zero G's which could unseat the pilot. Therefore, the pilot must have his safety belt fastened at all times.

Aileron Hard-over.

Another type of failure is an aileron hard-over signal which produces a smooth movement at the ailerons and the aircraft will roll at a maximum rate of about six degrees per second. This is so smooth that it is quite possible that the pilot will not detect the motion at night or when on instruments, unless he is actually observing the gyro horizon or the control wheel at the time. It is possible that the aircraft can reach a very steep angle of bank before the pilot detects the motion, particularly if the air is slightly tubulent, making the pilot relatively insensitive to the small acceleration produced by the aileron roll.

Oscillating Signals.

Oscillating signals can occur due to a failure in the automatic pilot follow-up circuit and will be evident by the oscillating movement of the controls. Should the automatic pilot malfunction, it should be disengaged immediately by one of the following methods:

1. Operate either the pilot's or copilot's clutch disconnect switch.

2. Pull out the clutch switch.

3. Move the servo disconnect levers to OFF (up) position.

4. Move the Flux Gate caging switch to the ON (up) position and then release.

If a malfunction occurs, the pilot must restrain the controls while disconnecting the automatic pilot to prevent

a sudden jerk when it disengages. The automatic pilot will be automatically disengaged by any momentary interruption of either a.c. or d.c. current.

Note

The automatic pilot may be over-powered; however, the control forces required will be higher than when the automatic pilot is disengaged.

FUSELAGE FURNISHINGS AND MISCELLANEOUS EQUIPMENT.

NAVIGATOR'S EQUIPMENT.

The navigator's station is located on the right forward side of the cabin and is equipped with a chair, table, instrument panel, fabric pocket for miscellaneous data, book locker, binoculars and case, periscopic sextant with case, sextant mount, and a driftmeter and tube.

Driftmeter.

A gyro-stabilized driftmeter is installed to aid the navigator in determining terrestrial bearings of objects relative to the heading of the aircraft, ground speed, and wind velocity. The driftmeter is mounted on the floor of the navigator's station. A switch mounted on the lower gyro housing controls the gyro erection system. A rheostat installed on top of the upper gyro housing controls illumination of the reticle optical system. A lever, mounted on the filter housing marked SHADE GLASS, controls a shade glass filter. By operation of the lever, the shade glass may be interposed in the optical system to reduce the intensity of light when the ground image is too bright. A one-power eyepiece and a three-power eyepiece are secured in an ocular housing. The eyepieces are equipped with rubber guard buffers and the unused eyepiece is stowed in a holder on the side of the driftmeter. The driftmeter telescope tube extends downward through the fuselage floor and projects through a hole in the lower fuselage skin.

WINDSHIELD WIPERS.

Electric windshield wipers are provided for the pilot's and copilot's forward windshield panels. Both wipers are driven through a flexible shaft by a d.c. electric motor mounted on the flight station canopy above the MJB switch panels.

CAUTION

Do not operate windshield wipers on dry glass.

Windshield Wiper Switch.

The windshield wipers are controlled by a rheostat located on the flight station ceiling to the right of the pilots' overhead panel. The rheostat is placarded START and TO SLOW, and PARK. On USAF Serials 55-118 and subsequent, these switches are located on the pilot's side panel (14, fig. 1-9). These switches are labeled PARK, OFF, HIGH, MED. and LOW. Clockwise movement starts the motor at high speed. Counterclockwise movement reduces speed as desired. The PARK position stops the wiper blades and positions them at the sides of the windshield panels so that they will not obstruct vision.

PERISCOPIC SEXTANT.

A periscopic sextant is provided which, through a periscopic optical system, enables the navigator to make observations from within the fuselage by projecting the periscope outside of the aircraft. To accommodate the sextant, a mount is installed at the navigators station. When the mount is installed, it is aligned with the aircraft longitudinal axis. The mount is sealed by a flap shutter which is flush with the aircraft skin. When the sextant is to be used the shutter is drawn aside by moving the adjacent lever and extending the sextant through the mount so that the tip of the tube is exposed 1½ inches above the aircraft. The sextant has a gimbal support whereby the navigator may compensate for variations up to 15 degrees from normal aircraft attitude, and is rotatable in azimuth through 360 degrees. An independently rotatable compass rose, engraved in increments of ½ degrees is provided. A fixed index which may be aligned with the aircraft's longitudinal axis to establish a lubber's line provides indications of azimuth on the scale. For manual setting of true azimuth to a tenth of a degree, a counter is synchronized with the lubber's line indication on the rotatable scale. The direction of numbering the graduations is so arranged that relative bearing is subtracted. Thus, when the azimuth of an observed body is set against the lubber's line and the sighting mechanism is aligned on that body, the true heading of the aircraft is indicated by the sextant vertical line of the article on the azimuth scale. The index prism in the top of the periscopic tube is rotatable about a horizontal axis to permit observations at any angle from $-10°$ to $+92°$ in elevation. The optical system of the sextant is a two-power telescope with a true field of 15 degrees. The eyepiece is adjustable from -2 to $+2$ diopters for focusing. Filters of varying densities are provided for selective use in the optical system so that the intensity of the sun's rays may be adequately reduced. The artificial horizon is an air bubble located at the top of the body of the sextant. The lens mounted above the bubble chamber may pre-

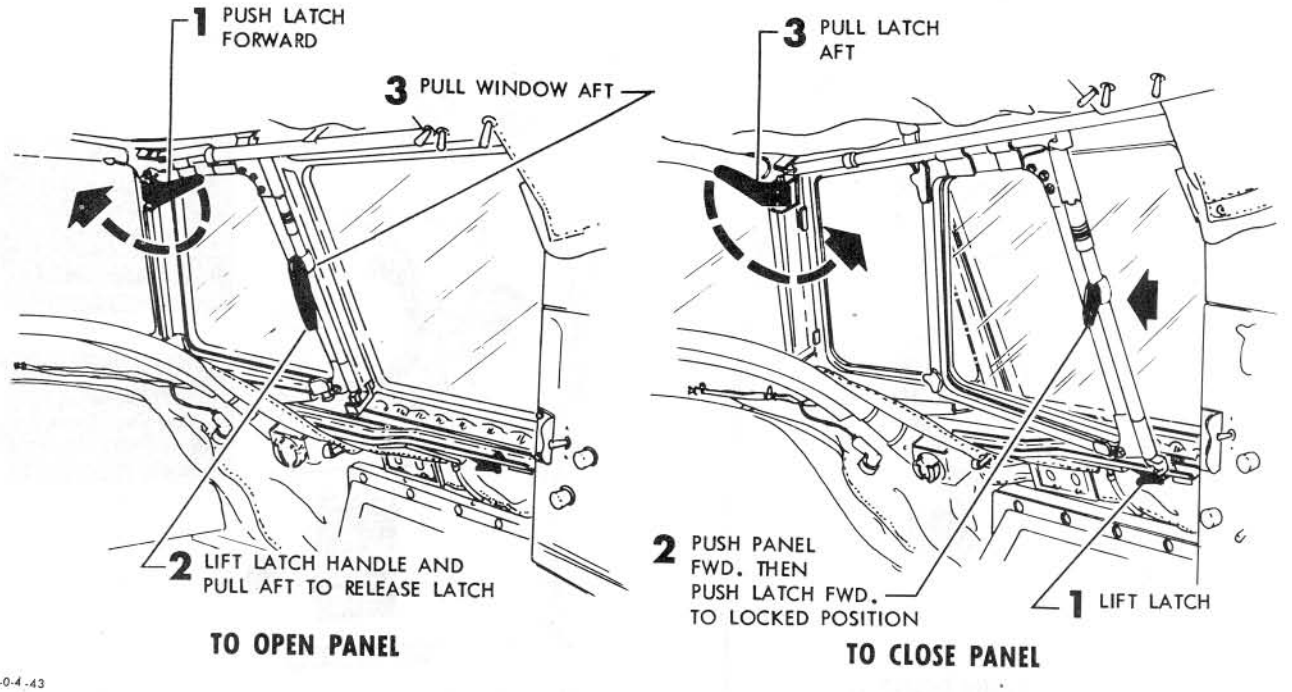

Figure 4-40. Pilot's Window Operation

vent the entrance of sufficient light for direct illumination, therefore artificial illumination, provided by a 28V lamp with controllable intensity, is usually required. The bubble may be formed and adjusted in size, while in the field of view, by means of the knob on the side of the chamber. Averaging is performed by a Deimel-Black ball integrator which effects a continuous moving average over any observation period up to two minutes. A single lever sets and winds it. Because it is continuously integrating altitude against elapsed time, after at least 30 seconds have gone by it may be stopped at any time up to two minutes as circumstances dictate. The average altitude angle is obtained at the end of an observation by recentering the average indices by means of the altitude knob. The average altitude may be read directly from the counter. A time dial graduated in seconds indicate the half time of the observation, which indication may be added directly to the time of start to give the mean time of the average altitude. At the end of two minutes of observation, the averager actuates a lever, which drops a shutter across the field of view, thus indicating that the observation period has been concluded. An on-off switch on the mount controls illumination. The illumination of the bubble and the azimuth scale of the mount is adjustable by a rheostat. No adjustment is provided to control the illumination of the mount counter, sextant counter, averager indices, or the navigator's watch. Electrical connection is made from the 28-volt power supply to a receptacle on the mount. A platform is provided for the use of the navigator while operating the sextant. It is stowed on the fuselage wall outboard of the driftmeter.

MISCELLANEOUS EQUIPMENT.

Cargo Door.

The aft cabin door in the left side of the fuselage (fig. 4-42) is hinged at the top and operated by a hydraulic mechanism consisting of a hydraulic fluid reservoir, hand pump bypass control valve, and door actuating cylinder. The cargo door is opened as follows:

1. Door latches—release.
2. Hydraulic bypass valve—close, by turning clockwise.
3. Pump hand pump until cylinder is fully extended.

The cargo door is closed as follows:

1. Hydraulic bypass valve—open slowly, by turning counterclockwise, to control rate of downward movement.
2. Cargo door latches—engage.

CAUTION

Leave the bypass valve open, except when the cargo door is being raised, to preclude pressure build-ups resulting from thermal expansion.

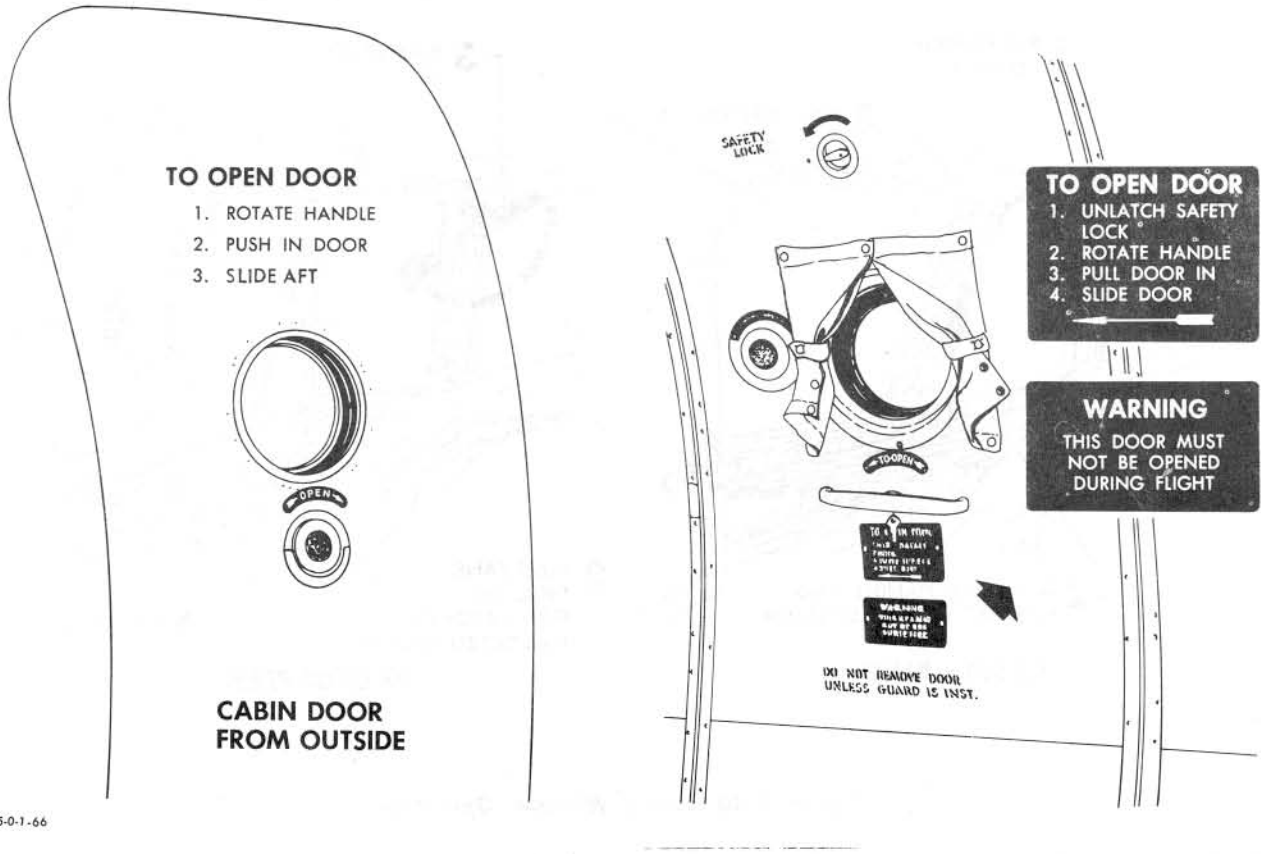

Figure 4-41. Cabin Door Operation

Upper Radome Access Door.

The upper radome access door is located on the centerline of the fuselage above the Height Finder's table. This door provides access for service and maintenance of the equipment installed in the upper radome and also forms a pressure seal between the main compartment and the radome chamber, which is not pressurized in flight. A warning light switch, installed in the door frame at the forward right latch, gives indication by a red warning light (3, fig. 1-15) located on the flight engineer's lower instrument panel when the door is not closed or latched. Some aircraft cannot be pressurized when these warning lights are on. A similar switch installation stops rotation of the height finder antenna when the access door is not closed and locked.

Lower Radome Access Door.

The lower fuselage-to-radome access door is located on the centerline below the upper radome door. This door provides limited access to the radome and forms a pressure seal between the aft lower compartment and the radome chamber, which is not pressurized during flight. In the event the access door is not closed and locked, vent holes in the radome assembly tend to provide pressure equalization. A warning light switch, installed in the door frame, actuates a red warning light (3, fig. 1-15) located on the flight engineer's lower instrument panel when the door is not closed and locked. A similar switch installation stops rotation of the antenna when the door is not closed and locked.

Table and Bench Installations.

Two tables and four benches are installed in the crew compartments. One table and bench assembly is installed in the forward crew compartment and the other table and bench assembly is located in the aft crew compartment. Each bench is provided with airfoam seat and back cushions. A technician's table and cabinet assembly, consisting of a work table and spare parts storage locker, is located aft of the cabin door. The cabinet contains 22 drawers and four enclosed compartments.

Navigator's Seat.

The navigator's seat is a tubular framed stool adjustable through a vertical range of approximately 11 inches and is provided with a padded back rest. The stool is secured to the floor with quick detachable latches.

AOC Crew Chairs.

The AOC crew (except SD, radar operator) and the radio operator's chairs are mounted on slide rails and are provided with adjustable and removable arm rests,

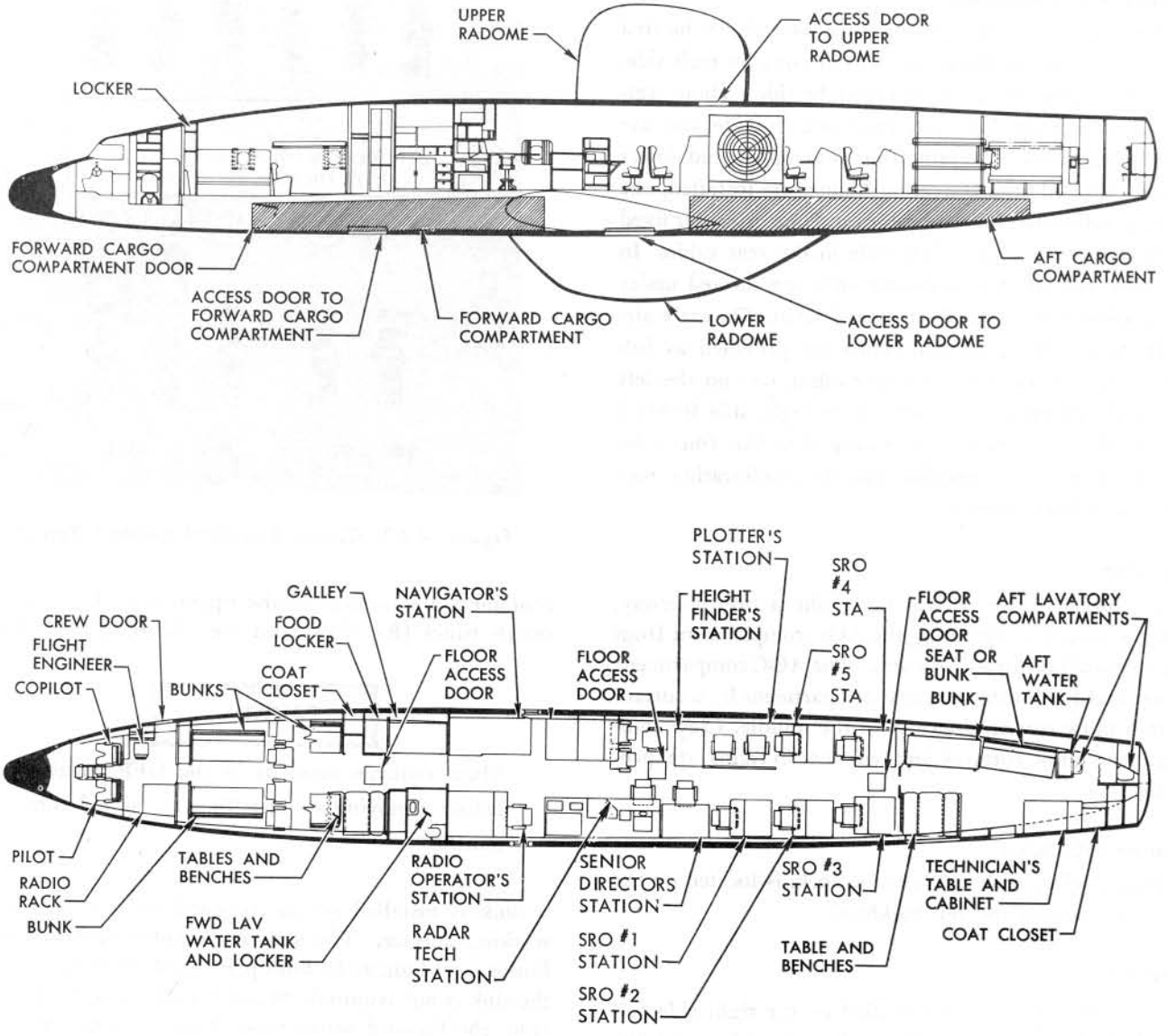

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Figure 4-42. Interior Arrangement

reclinable posture cushioned back, turnable throughout 360 degrees, and adjustable vertically. The chairs for SRO operators are mounted on slide rails and are arranged to swivel and lock in suitable positions. Each chair may be removed from its fixed supports.

Relief Crew Seat-Bunks.

Three relief crew seat-bunks on some aircraft, are located as follows: two in the forward cabin, one on each side, and one in the aft cabin on the right side. These seat-bunks are arranged to seat four side by side and are convertible without modification into upper and lower bunks. Two additional overhead bunks are installed, one on each side in the forward cabin, and one three-tier fixed bunk is located on the right side in the rear cabin. In addition, two aft facing double seats are located under the overhead bunks in the forward cabin. On early aircraft, four relief crew seat-bunks are provided as follows: one on the right side rear cabin, one on the left side forward cabin, and two on the right side forward cabin. These seat-bunks are arranged to seat four side-by-side and are convertible without modification into upper and lower bunks.

Curtains.

A drape-type curtain covers the flight station doorway, and the partition separating the AOC compartment from the forward lavatory-galley area. The AOC compartment is separated from the aft crew compartment by a curtain with a draw curtain doorway in the middle. Crew compartment bunk curtains and window curtains are provided.

Station 260 Locker.

A small locker, with combination lock, is located on the aft, right side of the 260 bulkhead.

GALLEY.

The galley (fig. 4-44) is installed on the right side forward of the AOC area. The galley provides complete facilities for the preparation of meals. Two storage compartments with double doors are installed in the upper part of the galley, on either side of the galley switch panel. Directly below the upper compartments six heated liquid containers are installed, each with a two gallon capacity. Each of these containers have provisions for installation of a dry ice cup. Each container is held in position by a individual locking device and to remove these containers, the handle directly in front of the desired container to be removed is turned in the down position, this releases the lock and the container then can be pulled out. The heater switches for the liquid

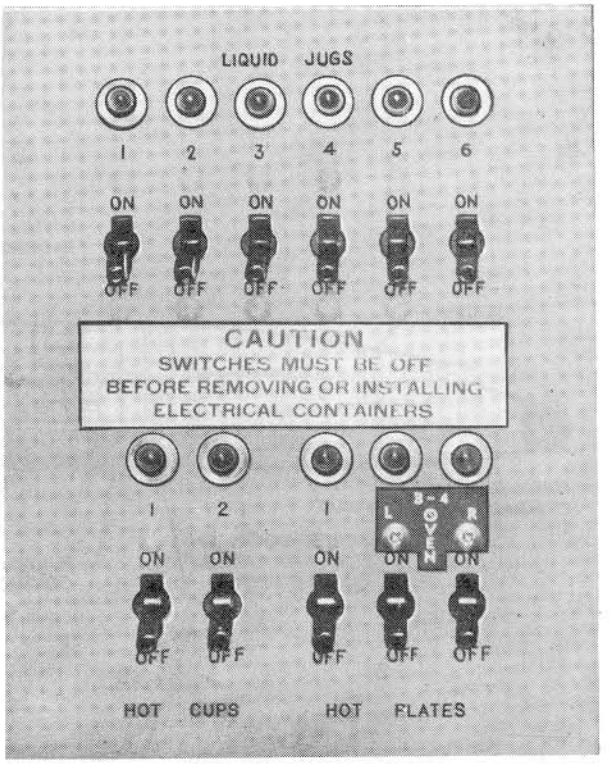


Figure 4-43. Galley Electrical Control Panel

containers are located on the upper row of the galley switch panel (fig. 4-43) and are placarded ON-OFF.

CAUTION

These switches must be in the OFF position before removing or installing the liquid containers.

A sink is installed on the forward end of the galley working surface. The sink is provided with a water faucet, overdrain and a flush perforated top for use when the sink is not required. Water for this sink is supplied from the forward water tank. Two one-quart hot cup receptacles are installed in the center, above the working surface. The switches (fig. 4-43) that control the hot cup are located on the forward end of the lower row of switches on the galley switch panel; they are placarded ON-OFF. Three hot plate assemblies are installed in the aft outboard corner of the galley. The master switch that controls the hot-plates is located in the middle of the lower row of switches on the galley switch panel and is placarded ON-OFF. Individual switches for the hot-plates are located on the hotplate assemblies and are placarded OFF-LOW-MED-HIGH. A waste container is mounted directly below the sink; it is readily removable for emptying and cleaning. Four storage drawers

FTS-3-4-69-128

Figure 4-44. Galley

are installed on the inboard face of the galley just aft of the waste container. Two heating ovens are installed aft of the storage drawers. The control switches (fig.4-43) for these ovens are located at the aft end of the lower row of switches on the galley switch panel; they are labeled OVEN LEFT and RIGHT and are placarded ON-OFF. Two pull out boards are located above the two ovens. Identical locks are provided on all compartment doors and drawers. Provisions are incorporated in all drawers and work boards to prevent their being accidentally pulled all of the way out. The galley is powered by 28 volt d.c. current.

Galley Exhaust.

The galley area may be vented through a sonic venturi which is installed in the upper aft corner. A manual control lever is located on the aft side of the venturi; to open the venturi, place the lever in the down position. The opening is protected by a metal slotted shroud.

Food Locker.

A refrigerator is installed immediately forward of the galley. A thermostat located inside the refrigerator, automatically controls the inside temperature while in use. The refrigerator is powered by a 28 volt d.c. bus.

FORWARD LAVATORY AND LOCKER.

The forward lavatory and locker compartment are located on the left side forward of the AOC area. Entrance to the lavatory is through a doorway opening into the center aisle of the aircraft; entrance into the locker is through the lavatory. The lavatory contains a urinal and toilet assembly located on the forward face of the AOC partition. A wash basin, soap dispenser, waste container, towel holder, mirror, paper cup holder, and an ash tray are included on the aft face of the forward partition of the lavatory. The door into the locker area is on the outboard side of this partition. The locker contains three shelves for storage of equipment and the water supply tank for the lavatory and the galley. The inboard partition of the locker may be removed for convenient access to the water plumbing system.

AFT LAVATORY.

The aft lavatory occupies the extreme aft end of the main fuselage compartment and is separated into three enclosures. The forward enclosure on the right contains a wash basin, mirror, towel holder, soap dispenser, ash tray, drinking cup dispenser and a waste container. A door is provided in the forward partition to allow access to the water supply tank and plumbing. The aft enclosure on the right is separated by a drape type curtain and from the enclosure on the left by a centerline partition. The aft right enclosure contains an ash tray, and toilet assembly. A removable door, which affords access to the aft pressure bulkhead is installed in the rear portion of the center line partition. This door is secured by two slide type latches and is accessible only from the right. The aft left enclosure is separated from the crew compartment by a drape type curtain and contains only a urinal assembly.

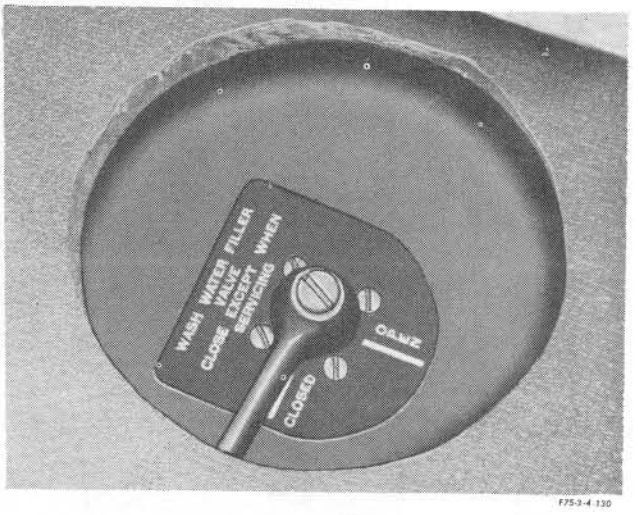
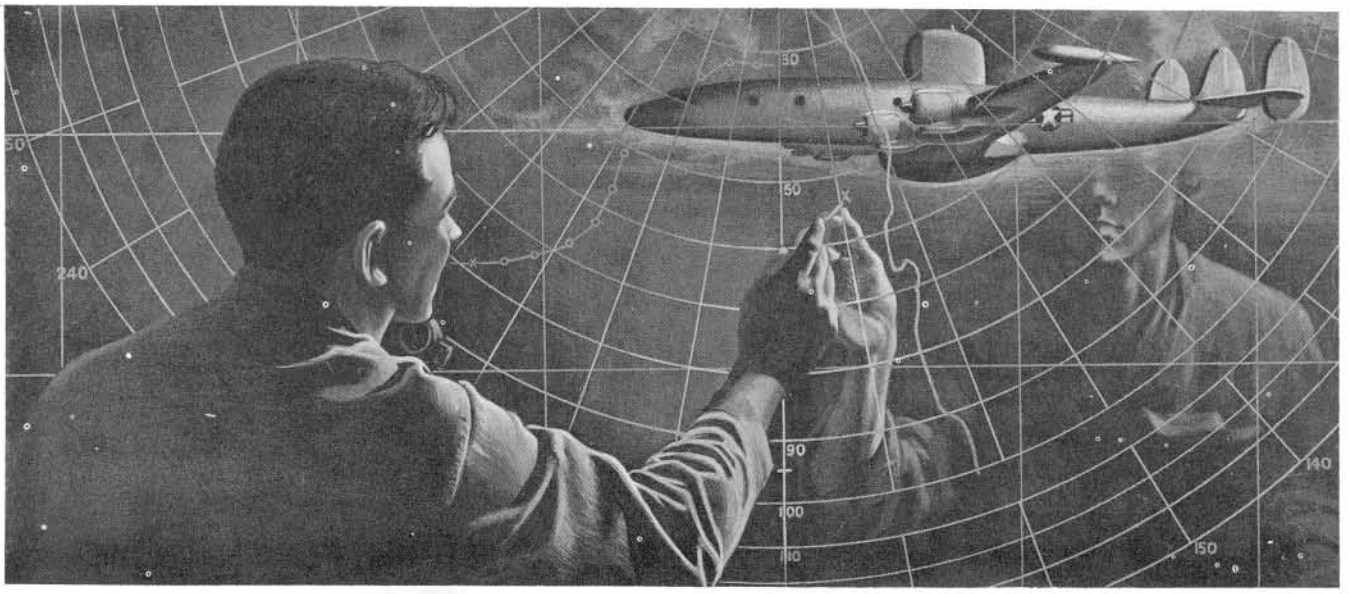


Figure 4-45. Water Filler Valve

WATER SYSTEMS.

The forward and aft water systems are separate gravity feed. Each system consists of a supply tank, a wash basin, a drain and filler valve (fig. 4-45), a tank shut-off valve, an external ground filler connection, a heated overboard drain, and the necessary piping to form an integral system. The galley supply and drain lines are plumbed into the forward system. The capacity of the forward tank is approximately 40 gallons and the aft tank is 15 gallons. The inboard partition of the water tank cabinet includes a sight gauge for determining the water level.

Last Page of Section IV.



SECTION V OPERATING LIMITATIONS.

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INTRODUCTION.

The limitations imposed on the aircraft must be observed during normal operation. Cognizance must be taken of the instrument markings since they represent limitations that are not necessarily repeated in the text. Further explanation of the instrument markings is covered in the text under pertinent headings.

MINIMUM CREW REQUIREMENTS.

The minimum crew requirements for this aircraft are the pilot, copilot, and flight engineer. Additional crew members may be added at the discretion of the pilot in command.

INSTRUMENT MARKINGS.

The limits and interpretation of the markings on the aircraft instruments are shown on (fig. 5-1).

ENGINE LIMITATIONS.

In addition to the instrument marking limitations indicated on figure 5-1 and the Engine Operating Limits curve, figure 5-2 the following limitations must be observed.

1. Do not make more than one engine supercharger shift to HIGH ratio more than once within a five minute interval.

BASED ON
MIL-F-5572
FUEL
GRADE 115/145

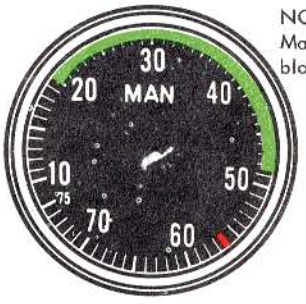
TACHOMETER

1400 – 2600 RPM . . . NORMAL
2900 RPM . . . . . MAXIMUM

CYLINDER HEAD

144 –246°C . . . NORMAL
260°C. . . . . MAXIMUM

MANIFOLD PRESSURE



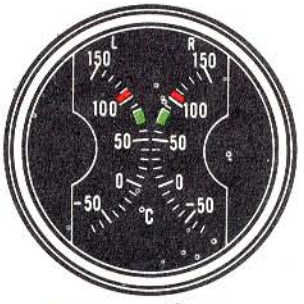
NOTE:
Maximum limit for sea level – low blower – auto rich is 47.5HG

20 – 48.5" Hg . . . NORMAL
56.5" Hg . . . . MAXIMUM

FUEL PRESSURE

23 – 27 PSI . . . . . NORMAL
19 PSI . . . . MINIMUM IN FLIGHT

OIL INLET



70 – 85°C . . . NORMAL
104°C . . . . MAXIMUM

ENGINE OIL PRESSURE
(REAR PUMPS)

65 – 90 PSI . . . . . NORMAL
65 PSI . . . . MINIMUM IN FLIGHT
90 PSI . . . . . MAXIMUM

F75-3-5-120 (1)

Figure 5-1. Instrument Markings (Sheet 1 of 2)

CABIN SUPERCHARGER DRIVE SHAFT

150°C . . . MAXIMUM

BASED ON MIL-F-5572 FUEL GRADE 115/145

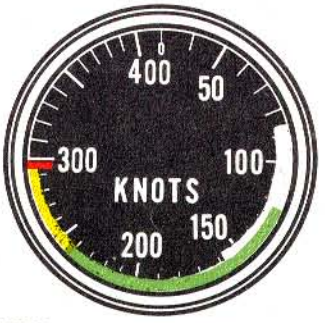
CARBURETOR AIR

30°C . . MAXIMUM WITH PRE-HEAT
15° TO 30°C . . . . . NORMAL
-10° TO +15°C. .ICING DANGERS

HYDRAULIC PRESSURE

1500 - 1700 PSI . . . NORMAL
1300 PSI . . . . . MINIMUM
1850 PSI . . . . . MAXIMUM

AIR SPEED

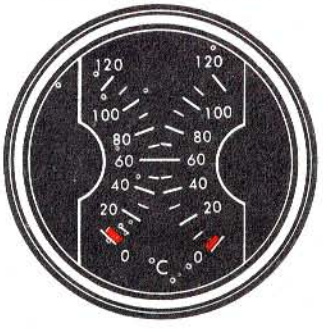


85 - 175 KNOTS . . . WING FLAP LANDING POSITION RANGE
120 - 240 KNOTS . . . NORMAL OPERATING RANGE
240 - 295 KNOTS . . . MAX DESIGN CRUISE SPEED TO MAX PERMISSABLE SPEED RANGE
295 KNOTS . . . . . .MAX PERMISSABLE SPEED

DE-ICER PRESSURE

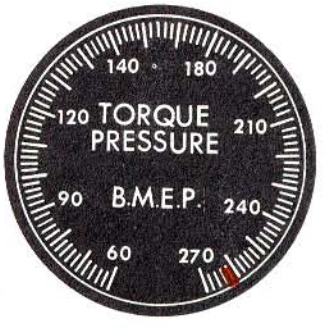
20 - 24 PSI . . . NORMAL
26 PSI . . . . MAXIMUM

REFRIGERATOR DISCHARGE DUCT TEMPERATURE



2° . . . MINIMUM

BMEP



265 BMEP..... MAXIMUM

F7S 3-5 120 (2)

Figure 5-1. Instrument Markings (Sheet 2 of 2)

2. Operation at speeds between 3050 and 3120 rpm represents limited overspeed which must be followed by inspection.

3. Operation at speeds greater than maximum permissible power-off diving speed of 3120 rpm must be followed by engine removal.

PROPELLER LIMITATIONS.

There are no restricted operating speeds within the normal operating region for aircraft equipped with the Hamilton Standard 43E60/6903-0 or 43H60/6959-0 propellers. However, the aircraft will be headed into the wind during static run-up tests when engine speeds exceed 2600 rpm. The propellers must not be unfeathered at flight speeds in excess of 155 knots. Do not reverse the propellers in flight.

CARBURETOR TEMPERATURE LIMITATIONS.

When the carburetor air temperature gage reads 30°C the air intake temperature at the carburetor deck may be 38°C. Therefore, it is recommended that the carburetor air temperature not exceed 30°C as read on the carburetor air temperature gage.

AIRSPEED LIMITATIONS.

The maximum permissible indicated airspeeds are as follows:

Maximum propeller unfeathering	155 knots
Maximum boost off	155 knots
In smooth air—	
at 15,000 feet or below	295 knots
at 20,000 feet	270 knots
at 25,000 feet	240 knots
With landing gear extended	165 knots
With flaps extended	
Take-off (60%)	190 knots
Approach (66%)	175 knots
(80%)	175 knots
Landing (100%)	155 knots
With landing light extended	175 knots
For fuel dumping (permitted only when landing gear and wing flaps are retracted).	190 knots

For turbulent air penetration speeds, refer to Section IX.

PROHIBITED MANEUVERS.

In-flight maneuvers are restricted as follows:

1. The angle of bank shall not exceed 60 degrees.
2. The flight controls shall not be moved abruptly.
3. Slipping or skidding shall be avoided at indicated airspeed in excess of 180 knots. At indicated airspeeds below 180 knots, slipping or skidding is permitted as required.

FLIGHT CONTROL PRECAUTIONS.

Although the control forces for patrol and transport aircraft are heavier than in some other types, it is still possible to apply severe structural loads by a rapid and violent application, sudden release or reversal of forces on any of the three control systems. It is within the pilot's physical power to cause failure of some components of the airframe structure, particularly when flying at high speeds. A rapid release or reversal of rudder force can result in heavy loads on the vertical fins and aft fuselage and should be avoided.

CENTER OF GRAVITY LIMITATIONS.

The forward center of gravity limit is variable depending upon the aircraft gross weight. The aft c.g. is constant 32% with gear down at all gross weights. Raising the landing gear, will move the c.g. forward approximately 1%. Refer to Handbook of Weight Limitations, AN 01-1B-40.

CABIN PRESSURIZATION LIMITATIONS.

Cabin pressurization is not permitted during take-off and landing. In the event of emergency during take-off and landing, cabin pressurization would interfere with opening of doors and emergency exits. Refer to figure 4-1.

FUEL LOADING AND USAGE LIMITATIONS.

Main tanks (1, 2, 3, and 4), tank-to-engine, with auxiliary fuel boost pumps for these tanks on HIGH, normally will be used for take-off. During flight, lateral balance must be maintained within limits set forth in this section. Minimum fuel quantity restrictions applicable because of structural limitations are shown on (fig. 5-3). Use of the normal fuel loading and fuel management procedures given in Section VII will result in compliance with the minimum fuel quantity restrictions. Under some circumstances, such as training operations, it may be desirable to deviate from normal fuel loadings. Optional fuel loading and usage procedures suited to the particular situation are permitted in such cases, provided structural minimum fuel restrictions for individual tanks shown in (fig. 5-3) are observed. In the event circumstances, such as training operations, require deviations from normal fuel loading, and tanks 2 and 3 do not contain the minimum of 150 gallons each, then tanks 2A and 3A may be used for take-off. In either event, tanks used for take-off must contain the minimum of 150 gallons each. Because

of structural wing strain, during landing, the maximum permissible fuel in the tip tanks (2B and 3B are as follows:

At landing gross weight of 122,000 lbs.—300 gals ea. (Reduced limit sinking speed—7 ft./sec.)

At landing gross weight of 110,000 lbs.—200 gals ea. (Design limit sinking speed—10 ft./sec.)

LATERAL UNBALANCE OF FUEL LOAD.

The following table presents the maximum safe fuel differential between opposite tanks. Lateral unbalance may cause abnormal control deflection therefore, producing asymmetrical airload conditions.

TANK	MAXIMUM DIFFERENTIAL	
	Flight or Landing	Take-off
2A & 3A or 1 & 4 or 2 & 3 or 2B & 3B	3,390# (565 gals)	1,200# (200 gals)
	5,400# (900 gals)	1,800# (300 gals)
	4,740# (790 gals)	4,740# (790 gals)
	2,700# (450 gals) (for flight only)	1,200# (200 gals)

WEIGHT LIMITATIONS.

Weight limits have been provided here to show operational capabilities and restrictions which must be observed due to structural and performance considerations. Their proper use will assure maximum utilization of the aircraft as well as extended life of its structural components. Over-loading or improper weight distribution results in penalties in performance and can result in structural damage or failure. Factors which govern weight limitations, as applied to this aircraft, are discussed in the succeeding paragraphs.

WEIGHTS AND LOADS.

The total weight an aircraft must sustain is composed of the basic operating weight of the aircraft plus the crew, fuel, oil, cargo and any additional equipment. Additional loads are frequently imposed on the structure during flight which result from operation in turbulent air or from maneuvering of the aircraft. These loads have been considered in the design of the aircraft and will not exceed the limit strength of the structure in normal operation. However, if these loads were imposed with the aircraft in an overweight condition, the limit strength of the supporting structure might be exceeded and damage or failure could result. The maximum weight which the aircraft can safely carry is dependent upon distribution of the weight throughout the aircraft, its capacity to sustain airloads in accelerated flight, and its available performance under the existing flight conditions. Fuel and cargo must be carried in accordance with recommended procedures if maximum structural capability is to be maintained.

LOAD FACTORS.

A load factor is the ratio of the load imposed on the aircraft (when accelerated in any direction) relative to the weight of the aircraft. The load factor is indicative of the magnitude of the forces acting on the aircraft due to such accelerations, and may occur because of sudden changes in air currents or by manipulation of the controls or due to loads imposed during ground handling. The load resulting from these forces is expressed in terms of "g's" and is the ratio of forces acting on the structure to the airplane weight. For example, if a 110,000 pound aircraft underwent an acceleration of 3.0 g's at some given moment, the wings would have to sustain approximately three times the load on the wings in 1 "g" level flight, or 330,000 pounds.

MARGIN OF SAFETY.

The margin of safety of an airplane part in a given design condition is defined as the amount by which its strength exceeds its design loading in that condition. In actual operation of the aircraft, the margin of safety becomes the difference between the load carried by the airplane structure at a particular instant and the load at which structural damage would occur.

EXPLANATION OF WEIGHT LIMITATIONS CHART.

The gross weight limitation chart, figure 5-4, is intended to represent graphically the weight carrying capabilities of all RC-121-D aircraft. Through the use of the chart, flight planning is aided by recognizing the weight limitations within which the airplane can conduct a specific mission.

Note

Although the chart indicates the limitations applicable to a specific loading of the aircraft, the authority for operating the aircraft at a given gross weight remains the responsibility of the commander.

GROSS WEIGHTS.

The data in this chart is referenced to a basic operating weight, exclusive of fuel and cargo, of 85,000

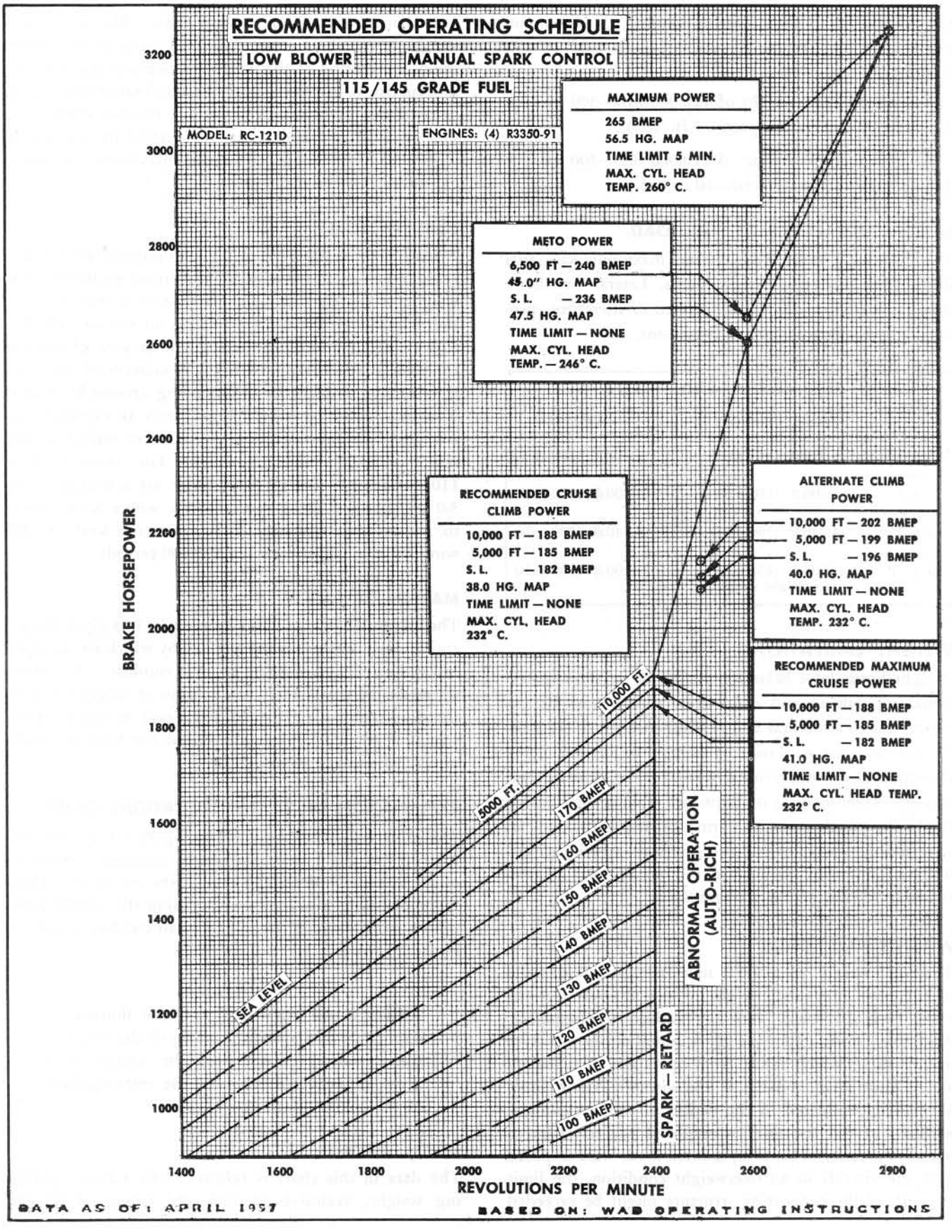


Figure 5-2. Recommended Operating Schedule — 115/145 Fuel — Low Blower (Sheet 1 of 3)

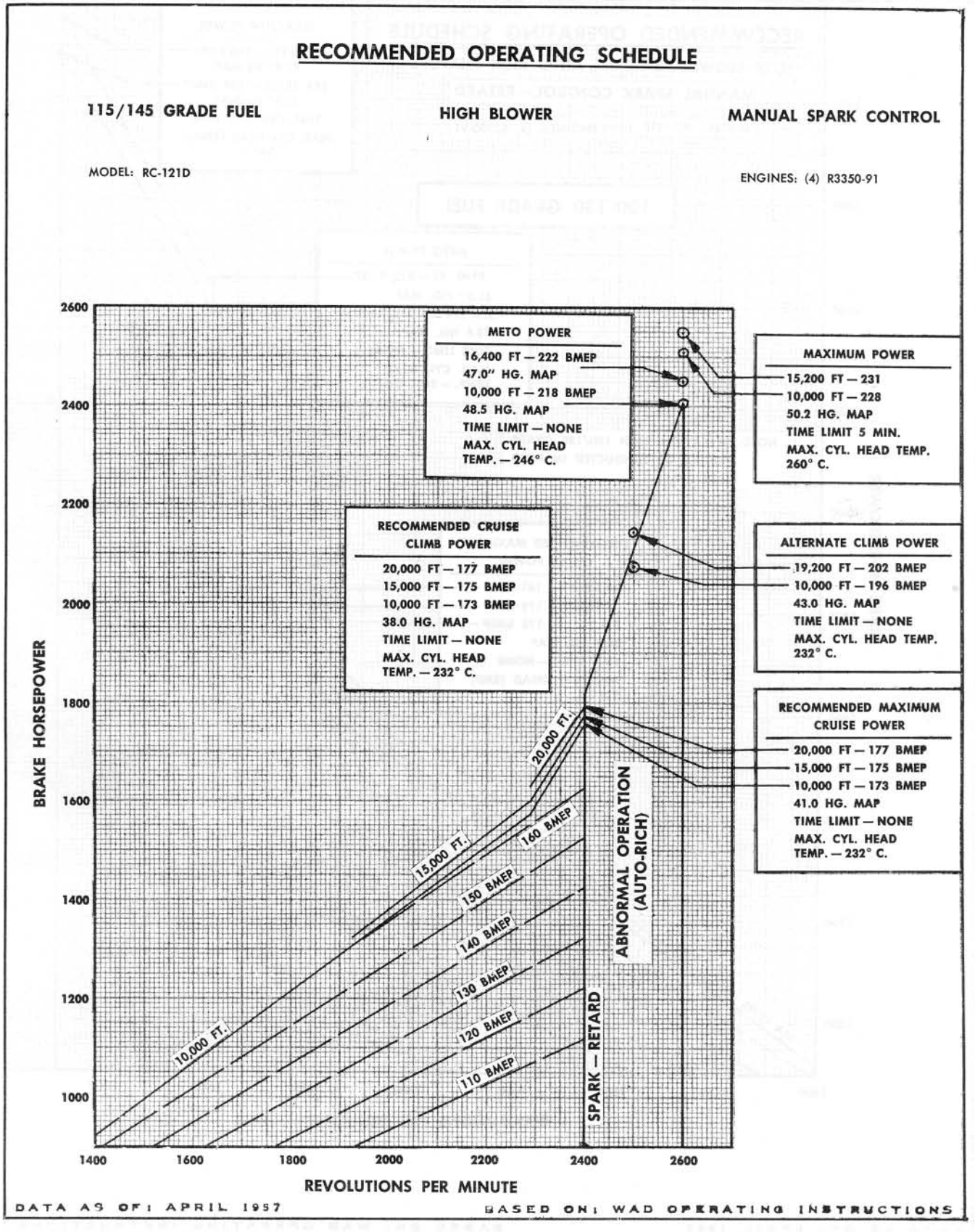


Figure 5-2. Recommended Operating Schedule — 100/145 Fuel — High Blower (Sheet 2 of 3)

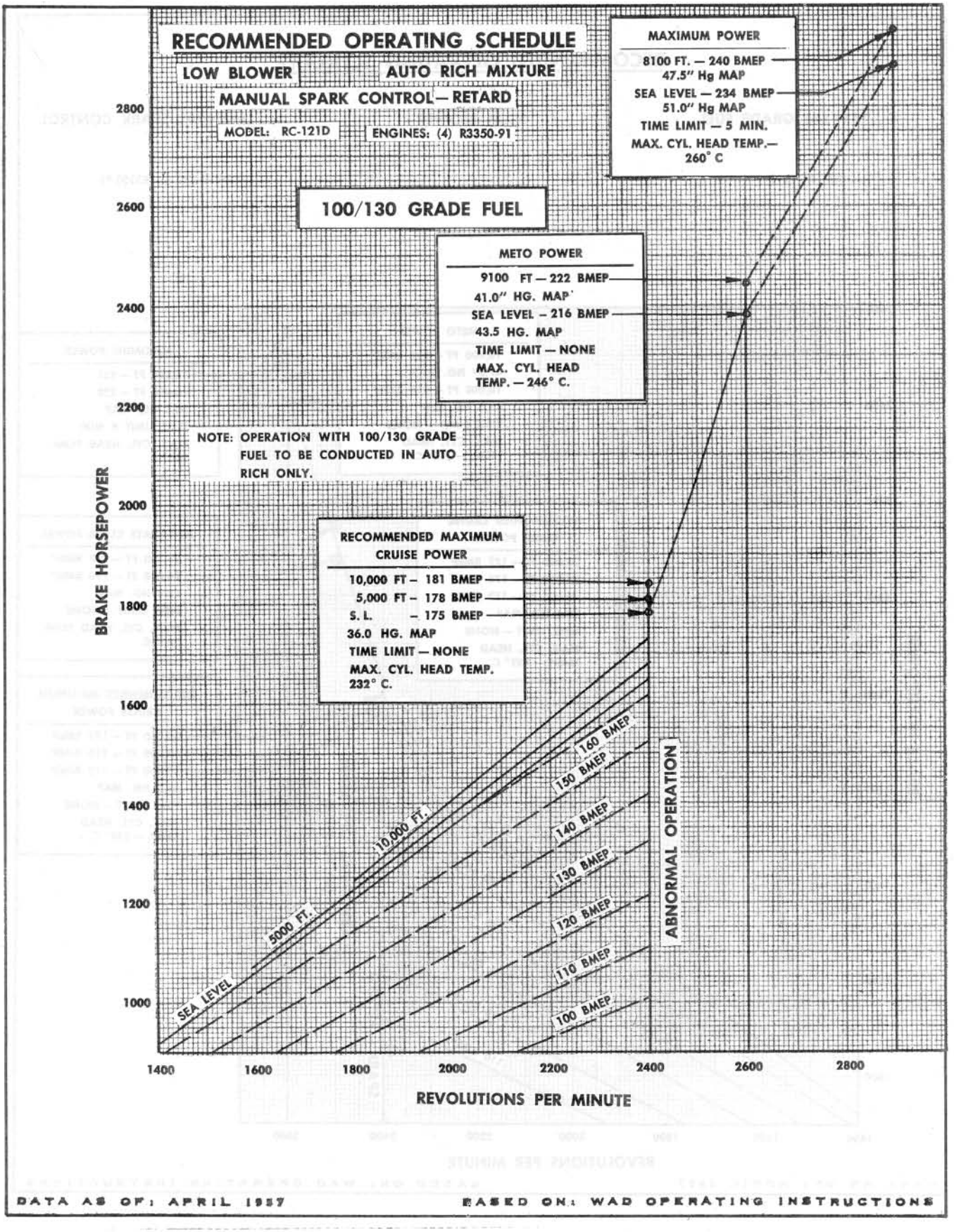


Figure 5-2. Recommended Operating Schedule — 100/130 Fuel — Low Blower (Sheet 3 of 3)

pounds. This value is an arbitrary weight which approximates the aircraft basic weight shown on Chart "C" of T.O. 1-1B-40, Handbook of Weight and Balance Data, plus standard crew and full oil capacities. Individual aircraft weights vary because of differences in equipment weights. Therefore, it may be necessary to adjust the chart for variations in basic operating weight before use for a specific aircraft.

The basic operating weight is represented on the chart by the intersection of the vertical and horizontal axes where the fuel load and cargo load are zero (the terms, cargo or payload, are used to indicate extra crew members, baggage, or other removable items). The diagonal Gross Weight lines show combinations of Fuel Load and Cargo Load that can be used to make up a given permissible gross weight. The allowable design load factor varies along these weight lines. Constant load factor lines appear as near horizontal lines in the chart. They are valid only when the FUEL AND CARGO ARE LOADED TO RECOMMENDED PROCEDURE. They separate the chart in three distinct areas as follows: Safe area (green), Cautious area (yellow) and Damage area (red). Listed, furthermore, are normal take-off, landing gross weights where performance or structural considerations may limit operations.

DESIGN LOAD FACTORS.

The design load factor is 2.5 g's for a design zero fuel weight of 92,000 pounds. The aircraft normally will be loaded and flown so that maneuvering loads, gust loads or a combination of both will not cause load factors in excess of 2.5 g's to be experienced in the green area. The aircraft has strength capabilities in flight such that it can support limit loads due to a 2.5 g maneuver without detrimental deformation, and such that any deformation which might occur will not interfere with safe operation of the airplane. The structure is also designed to ultimate loads obtained by applying a 1.5 factor of safety to limit loads, and is capable of supporting ultimate loads without failure of the primary structure.

WING FUEL LOAD.

The ability of the wing to safely withstand the imposed airloads is dependent on the weight of the fuel present in the wings, and with the distribution of the fuel in the wings along the span. Therefore, it is important to adhere to fuel loading and consumption schedules recommended in Section VII.

WING LIMITATIONS.

Lines showing wing strength in terms of aircraft flight load factors for combinations of fuel and payload are shown for 2.0, 2.25 and 2.5 g's. If the aircraft utilizes combinations of payload and fuel which reduce the allowable load factor to less than 2.5 g's, it should be flown with caution, especially when making turns and pull-outs and when operating in turbulent air. In addition to the instructions noted under the paragraph titled LOADING NOT RECOMMENDED, *the aircraft should never be loaded with any combination of payload and fuel which reduces the load factor below 2.0 g's as shown in figure 5-4 because of the probability of structural damage to the wing.*

LANDING GEAR AND BRAKING LIMITATIONS.

The aircraft design landing weight is 110,000 pounds for a sinking speed of 10 feet per second. The overload design landing weight is 122,000 pounds with a limit sinking speed of 7 feet per second at touchdown. The landing gear and associated structure are of required strength for normal taxiing and ground handling at take-off weights up to 130,000 pounds. Increased care should be exercised in taxiing, braking, turning and other ground handling operations at heavier weights. It should be possible to make at least 100 normal stops without reverse thrust from 110,000 pound landing weight without brake difficulty (provided brakes are cooled properly on the ground or in the air between landings). Brake wear at heavier landing weight will be increased unless the assistance of reverse thrust is used properly. The brakes are capable of bringing the aircraft to an emergency stop from normal take-off speed at a weight of 135,400 pounds without assistance of reverse propeller thrust. It should also be possible to make one emergency stop at overload operating weights up to 152,500 pounds. However, full reverse thrust should be used during such a stop, especially at altitudes above sea level, to reduce the energy which would otherwise be absorbed by the brakes. Full application of brakes should be delayed, if possible, until speed has been reduced to that for design take-off weight. The critical braking condition for take-off would be reached at about 155,000 lbs. using full reverse thrust on two engines or partial reverse thrust on three engines.

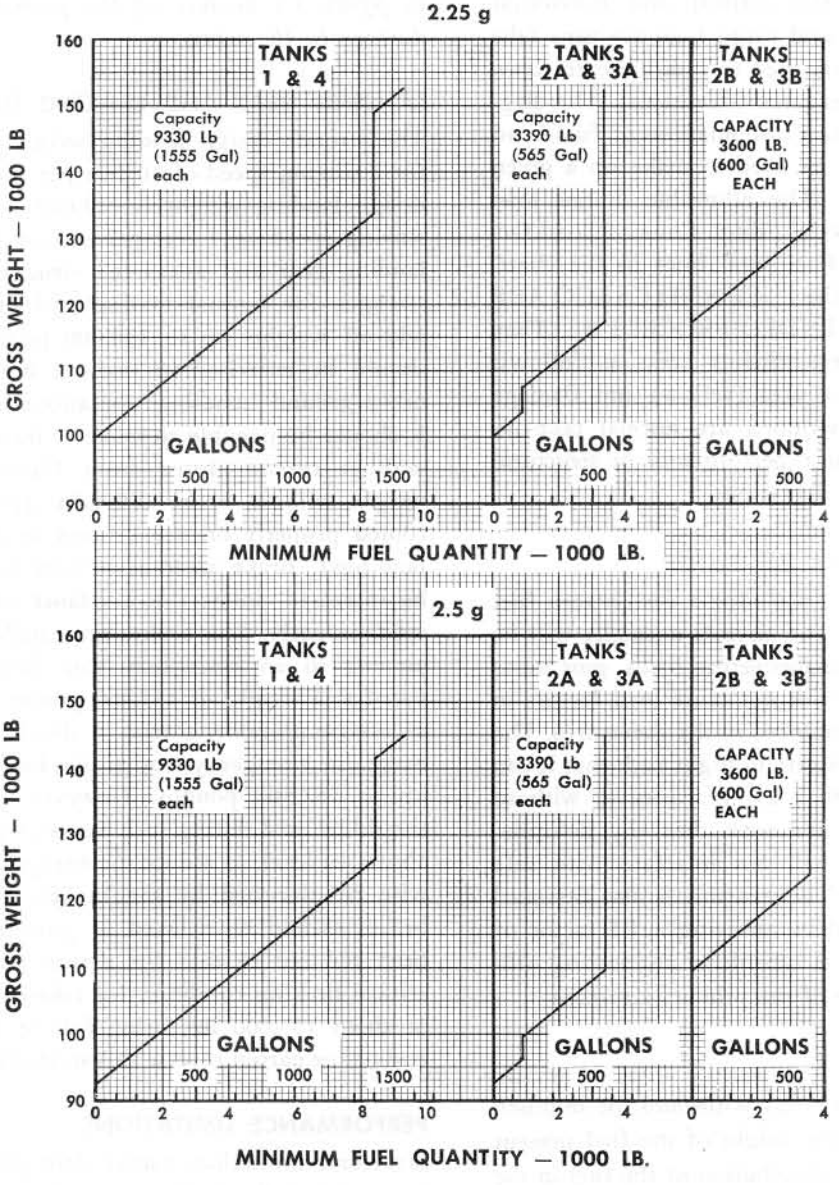
PERFORMANCE LIMITATIONS.

Structural limitations rather than performance requirements generally limit the weight carrying capabilities of a four-engine airplane. This is the case for the RC-121D. The most severe of the normal performance requirements is met at a weight of 150,200 lb. The airpane will take-off and climb fifty feet within a distance of 10,000 feet at sea level on a hot day at that weight. Higher weights are listed on the Weight Limitations

MINIMUM PERMISSIBLE FUEL RESTRICTIONS FOR INDIVIDUAL TANKS DURING FLIGHT WITH TIP TANKS INSTALLED

OBSERVANCE OF MINIMUM FUEL RESTRICTIONS SHOWN PERMITS WING STRUCTURE TO WITHSTAND NORMAL LOAD FACTORS NOTED. NO MINIMUM FUEL REQUIRED IN TANKS 2, 3, 5 OR 6.

A LESSER QUANTITY OF FUEL MAY BE CARRIED IN TANKS 1, 2A, 3A OR 4 IF THE MINIMUM FUEL REQUIRED IN TANKS 2B AND 3B IS INCREASED BY AN EQUAL AMOUNT.



NOTE: Use of the recommended fuel loading and fuel management procedures given in Sect. VII for normal operations will result in compliance with the above restrictions. Under circumstances where other procedures are more desirable, an amount of fuel equal to the difference between maximum allowable zero fuel weight and actual zero fuel weight may be distributed between tanks in any manner within limits required for lateral balance. However, an appropriate fuel management procedure must be used which results in compliance with the above restrictions.

DATA AS OF: 1 JUNE 1957

Figure 5-3. Minimum Permissable Fuel Restrictions

curve, figure 5-4, for less severe performance requirements. However, this chart is to be used only as a guide with respect to performance available. Refer to the appendix for detailed performance information. Local operating conditions may limit allowable weights more severely than is indicated by the weight limitations chart.

CONFIGURATION AND PERFORMANCE.

The configuration of the airplane may impose a penalty on performance. An increase in drag from that for the cruise configuration results in a decrease in the rate of climb available, increases power required and may require a readjustment of the permissible operating gross weight. As with power losses, increases in drag are most critical at take-off when the landing gear is extended, the cowl flaps are open and the wing flaps are 60% extended. The effect of the drag produced is indicated on the weight limitations chart by the gross weights at which minimum performance requirements are met with various airplane configurations.

RECOMMENDED LOADING AREA.

The green areas of the chart represent the loading conditions that present no particular problem in regard to strength or performance of the aircraft. Operation of the aircraft at weights outside of this recommended loading area should be avoided.

CAUTIONARY LOADING AREA.

The yellow area on the chart represents loading of progressively decreasing margin of safety as the red area is approached. An aircraft may reasonably be expected to encounter a load factor of 2.5 g's at times because of either maneuvering or turbulence. Also, performance may become critical in the upper region of this area depending upon airplane configuration and atmospheric condition. Careful adherence to rough air penetration speeds is recommended when operating at weights in the cautionary range. In a particular emergency, landing at weights in excess of normal landing weights are practicable on the condition that the pilot exercise ordinary care and precaution during the approach and landing. The glide path should be planned for decremental power changes from the start of the final approach to the landing. Rapid power changes should be held to a minimum during the approach and a small amount of engine power should be kept in reserve until after the landing flare. Every effort should be made to achieve minimum rate of descent on landing.

LOADING NOT RECOMMENDED.

Note

Whenever flights are conducted at weights shown on the red area of the chart, entry of this fact in AF Form DD 781 Part II is required.

The red area represents loadings which are not recommended because of the reduced margin of safety available from the standpoint of both performance and structural limitations. Under conditions of extreme emergency (when a reduction in normal requirements for safety of flight may be tolerable), the commander will determine if the degree of risk warrants operation of the aircraft at gross weights appearing in the red zone.

SAMPLE USE OF WEIGHT LIMITATIONS CHART.

Example 1.

Assume a mission requires a 4,000 pound payload and a 39,000 pound fuel load (including the reserve allowance). Calculate the gross weight to be:

Basic operating weight	85,760 lbs.
Payload	4,000 lbs.
Fuel load	39,000 lbs.
	128,760 lbs.

The Weight Limitations Curve can only be used directly for a basic operating weight of 85,000 pounds since its construction is based on this value. Any other value (as in this example) must be adjusted to 85,000 pounds before entering the curve. This step can be accomplished by subtracting 85,000 pounds from the basic operating weight for the problem and adding this difference to the problem payload value. The solution then would be as follows:

Example 1 Basic Operating Weight	85,760 lbs.
Curve Basic Operating Weight	85,000 lbs.
Difference	760 lbs.

The problem payload now becomes 4,000 plus 760 or 4760 pounds.

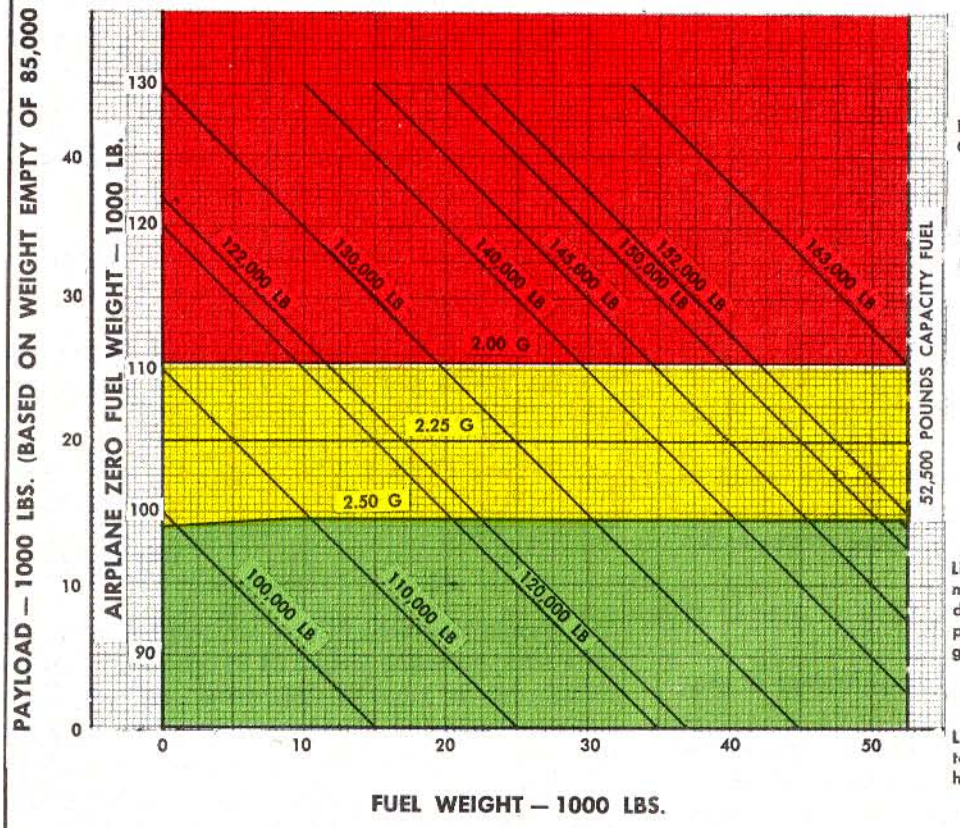
Recalculate the loaded gross weight:

Adjusted Operating Weight	85,000 lbs.
Payload & Weight Adjustment	4,760 lbs.
Fuel Load	39,000 lbs.
	128,760 lbs.

GROSS WEIGHT LIMITATIONS

TIP TANKS INSTALLED

MODEL: RC-121D **ENGINES:** (4) R3350-91 **PROPS:** Ham. Std. 43E60/6903-0



85,000 Pounds
Basic Operating Weight.

110,000 Pounds
Design Landing Weight for 10 F.P.S. Limit Contact Sinking Speed

122,000 Pounds
Overload Landing Weight with 7 feet per second limit contact sinking speed.

130,000 Pounds
Design Take-off Weight.

149,900 Pounds*
Limiting Gross Weight for 100 feet per minute rate of climb at sea level on a hot day with one engine inoperative and propeller feathered, take-off (60%) flaps and gear up.

150,200 Pounds
Limiting Gross Weight for 10,000 ft. distance to take-off and climb 50 ft. on a hot day.

152,500 Pounds
Overload Design Gross Weight.

* Maximum "Normal" Operating Weight on basis of minimum military performance requirements.

NOTES:
Adherence to rough air penetration speeds is recommended when operating at airplane weights in the cautionary range. Sinking speeds less than 7 feet per second are required when operating in the upper part of the cautionary range, where zero fuel weights shown will lead to landing weights in excess of 122,000 pounds. Refer to appendix for detailed performance information.

DATA AS OF: 1 JUNE 1957

Figure 5-4. Gross Weight Limitations

Enter the weight limitations curve at "0", which now represents the basic operating weight of 85,000 pounds, and proceed horizontally to the fuel load line 39,000 pounds. Move vertically along this line to 4,760 pounds payload. Find the loaded gross weight on the diagonal lines by interpolation to be 128,760 pounds; which checks the initial calculation. This initial operating point falls in the green area and the planned landing weight (with reserve fuel included) is less than 110,000 pounds.

Example 2.

Use a fuel load of 52,500 pounds, assume that the basic operating weight was found to be 90,500 pounds due to the addition of equipment. Also assume that mission requirements increase the payload to 9,000 pounds.

The following conditions are now present:

Basic Operating Weight	90,500 lbs.
Payload	9,000 lbs.
Fuel Load	52,500 lbs.
Total	152,000 lbs.

As in Example 1, the basic operating weight for the problem must be adjusted to 85,000 pounds before entering the weight limitations curve. This adjustment is made, as before, by adding the difference of the two basic operating weights to the payload value.

Example 2 Basic Operating Weight	90,500 lbs.
Adjusted Basic Operating Weight	85,000 lbs.
Difference	5,500 lbs.

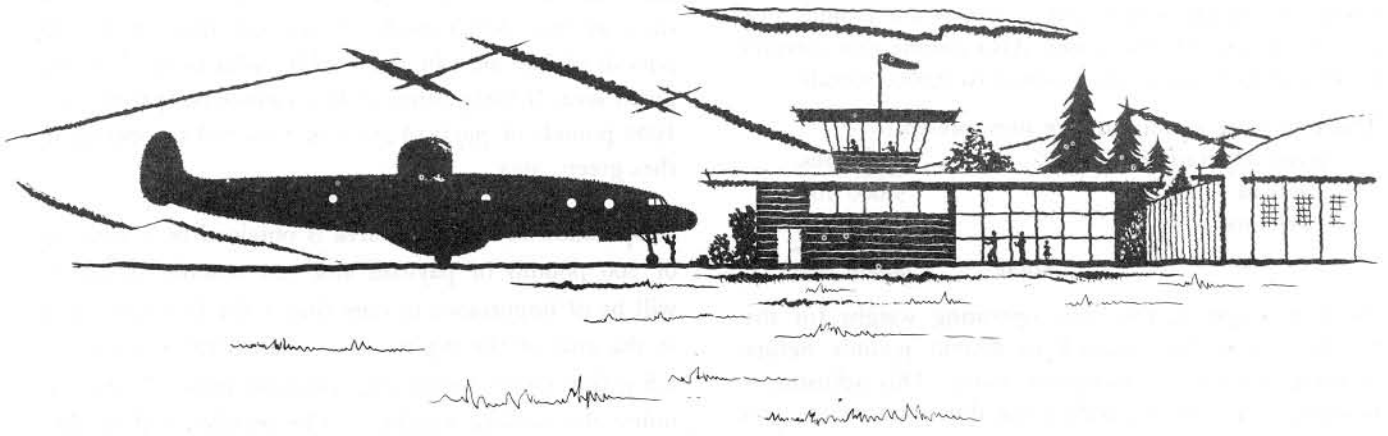
Actual Payload	9,000 lbs.
Difference between Basic Operating Weights	5,500 lbs.
New Payload Value	14,500 lbs.

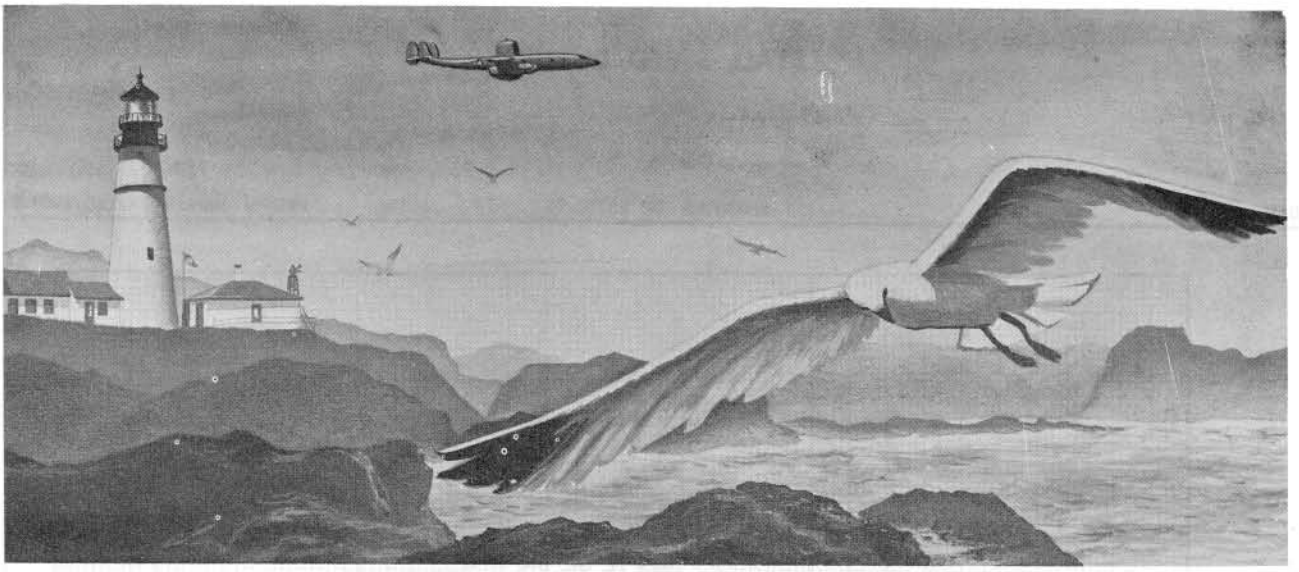
Enter the curve as in the previous example with the fuel load, 52,500 pounds, and the new payload value, 14,500 pounds. Read the loaded gross weight to be 152,000 pounds which checks the initial calculation. The point falls in the cautious area, 1000 pounds above the 2.5 g line. If overweight operations are not permissible then the mission requirements must be reexamined since at least 500 pounds of payload along with 500 pounds of fuel must be removed in order to move to the green area. If 500 pounds of fuel cannot be spared, then 1000 pounds of payload must be removed to operate in the green area.

If operation in the green area is obtained by a removal of 500 pounds of payload and 500 pounds of fuel it will be of importance to note that if the fuel remaining at the end of the flight is less than 8,500 pounds the 2.5 g line moves under the operating point. Therefore, unless the landing weight is to be between 108,000 lbs. and 110,000 lbs. the payload should be limited to 8,500 pounds (9000—5000) for this mission.

The appendix should be checked for detailed performance data to determine whether further limitations should be imposed.

Last Page of Section V.





SECTION VI FLIGHT CHARACTERISTICS.

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INTRODUCTION.

This aircraft exhibits no flight characteristics that would tend to place the pilot in a difficult situation. It has been flown during various weather conditions including severe icing. General performance and flight characteristics under such conditions have been described as good by operating personnel. Its handling qualities are normal in every respect. Control response under typical flight conditions and with asymmetrical power is considered excellent.

Note

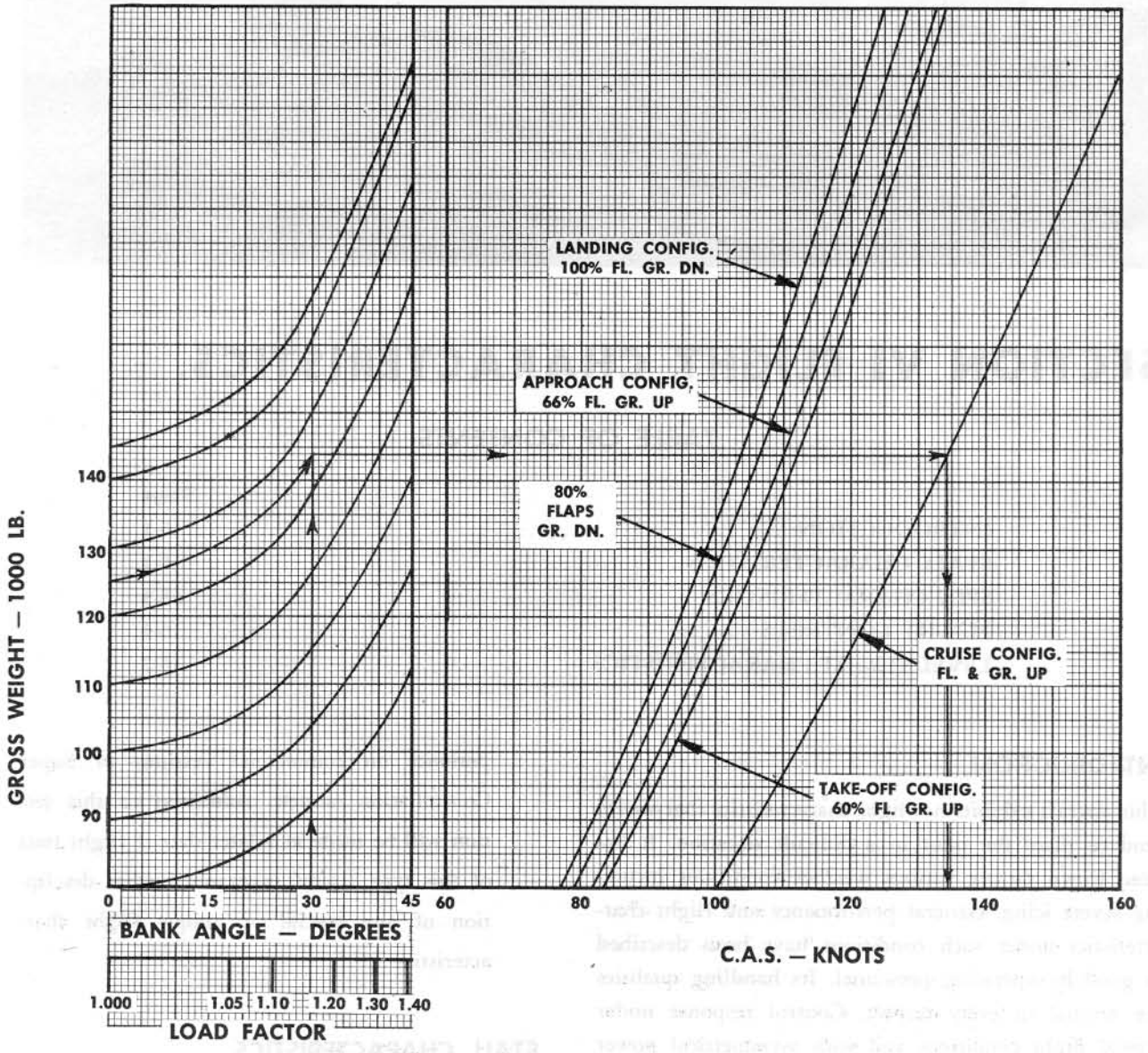
The information contained in this section is based on the experience gained from prototype flight tests of RC-121C and WV-2 aircraft and from tests and operating experience on commercial versions of Super Constellation models. Additions to this section will be made at a later date if flight tests of this type aircraft warrants further description of any special or unique flight characteristics.

STALL CHARACTERISTICS.

The stall characteristics of this aircraft, with any combination of wing flap or landing gear positions, are excellent and the stall is preceded by adequate warning in the form of mild buffeting. There is no abnormal tendency for a wing to drop and aileron and rudder controls are effective up to and into the actual stall

STALL SPEED CURVE

MODEL: RC-121D ENGINES: (4) R3350-91 PROPS: Ham. Std. 43E60/6903-0



NOTE:

Indicated airspeed may vary from equivalent airspeed values shown at the actual stall. Readings will depend on individual IAS instrument calibration system in use, rate of deceleration, power settings, and other factors which affect the indication or the stall speed. Therefore, this chart should be used primarily as a basis for establishing minimum desired flight speed margins above stall speed to be observed in normal operation.

1. **Load factors are for coordinated turns at constant altitudes with bank angles noted.**
2. **Stall speeds are those with props set at low pitch, engine power at zero thrust at 110% V_{stall}, deceleration = —1 knot/sec. From contractor's WV-2 flight tests.**

Figure 6-1. Stall Speed Curve

through both power-on and power-off stalls. With a forward center of gravity, the control forces that are necessary to slow the aircraft down to the stall speed will be fairly heavy and will increase as the speed is reduced. At the stall, a pronounced nose-down pitch will occur; however, if the center of gravity is moved near the aft limit, the forces that are necessary to accomplish the stall will be greatly reduced and this nose-down pitching tendency at the stall will also be reduced. With increased power, the stall occurs at a more pronounced nose-up attitude, at a lower speed, with a slight increase in rolling tendency and a reduction in stall warning. The stall speeds for three gross weights, and angles of bank with the airplane in three configurations are given on figure 6-1.

ACCELERATED STALLS.

Accelerated stalls are similar to the level flight unaccelerated stalls, except that the warning margin, normally 3 to 5 knots above the stall, is somewhat reduced. During progressive stalls (one stall immediately following another), no change occurs in the stall characteristics with each succeeding stall. However, if only a partial recovery is effected between stalls, a considerable increase in rolling tendency and buffeting will result.

The technique for recovering from stalls of any nature is to move the control column forward and apply whatever aileron and rudder control and power is necessary to keep the wings level.

SPIN CHARACTERISTICS.

WARNING

Intentional spins with this aircraft are prohibited.

No spin tests have been conducted with Constellation aircraft; however, in the event of an inadvertent spin, it is believed that a normal spin recovery method, consisting of the application of opposite rudder followed by the forward movement of the wheel, would accomplish recovery. However, it is recommended that the control column not be pushed forward of its neutral position, as excessive build-up in speed might result. Avoid excessive back pressure on the wheel during the pull-out after recovery.

FLIGHT CONTROLS.

In order to perform their primary mission efficiently, aircraft in the patrol and transport categories are designed to withstand lower load factors than some other types, such as attack bombers and fighters which require greater maneuverability. To reduce the possibility of inadvertently applying structural loads greater than those for which they are designed, transports have a very high degree of stability. Because of this stability, the control forces necessary to perform maneuvers are somewhat greater than those required on other types.

NORMAL OPERATION.

The aileron, elevator, and rudder control systems of the RC-121D are conventional in every respect except that they are partially powered by means of hydraulic booster units. Since these booster units do not completely accomplish the movement of the surfaces but merely assist in this movement, "feel" of the controls is retained by the pilot. To maintain this feel and to prevent overcontrolling, the booster units are designed to provide low boost ratios for small control force applications, and to increase boost ratios as the applied control force is increased.

BOOST-OUT OPERATION.

The possibility of the booster units becoming inoperative is rather remote since the boosters are operable with either the primary or secondary hydraulic system inoperative. If both of these systems fail, the auxiliary booster systems will still provide hydraulic pressure to the rudder and elevator booster units. In the event that a situation should arise which would result in all booster units being inoperative, the aircraft will still be adequately controllable, provided that the center of gravity is between 23-30% MAC. The control forces will, of course, be quite heavy, and the emergency elevator booster shift control should be pulled out to reduce the forces on the control wheel. This reduction in force is accomplished by a change in mechanical ratio and results in a corresponding reduction in the available elevator travel.

Flight Control Precautions.

Although the control forces for transport aircraft are, in general, heavier than in some other types, it is still possible to apply severe structural loads by a rapid and violent application, sudden release, or reversal of force on any of the three control systems. It is within the pilot's physical power to cause failure of some components of the airframe structure, particularly when flying at high speeds. A rapid release or reversal of rudder force can result in heavy loads on the vertical fins and aft fuselage, and should, therefore, be avoided.

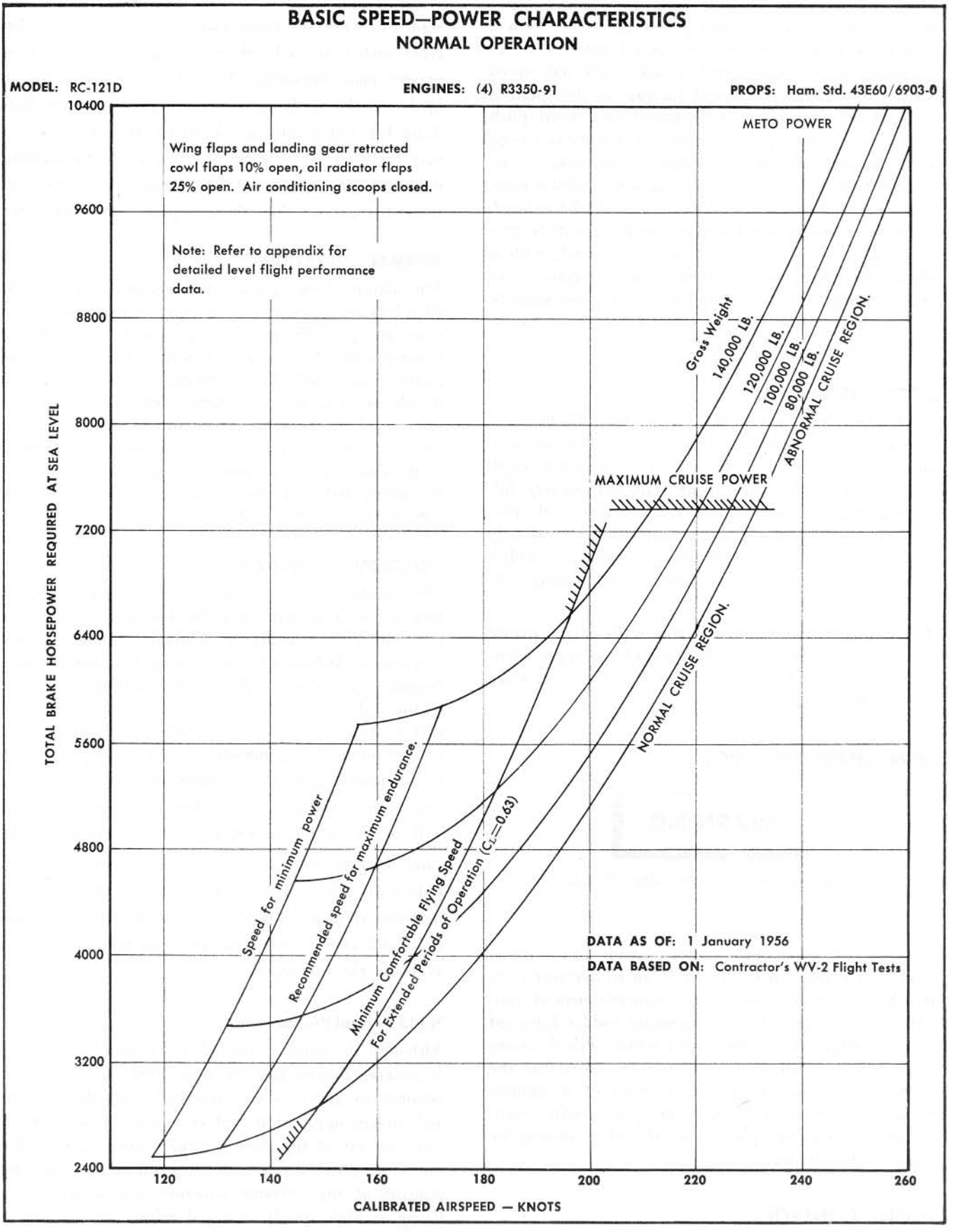


Figure 6-2. Basic Speed — Power Characteristics (Sheet 1 of 3)

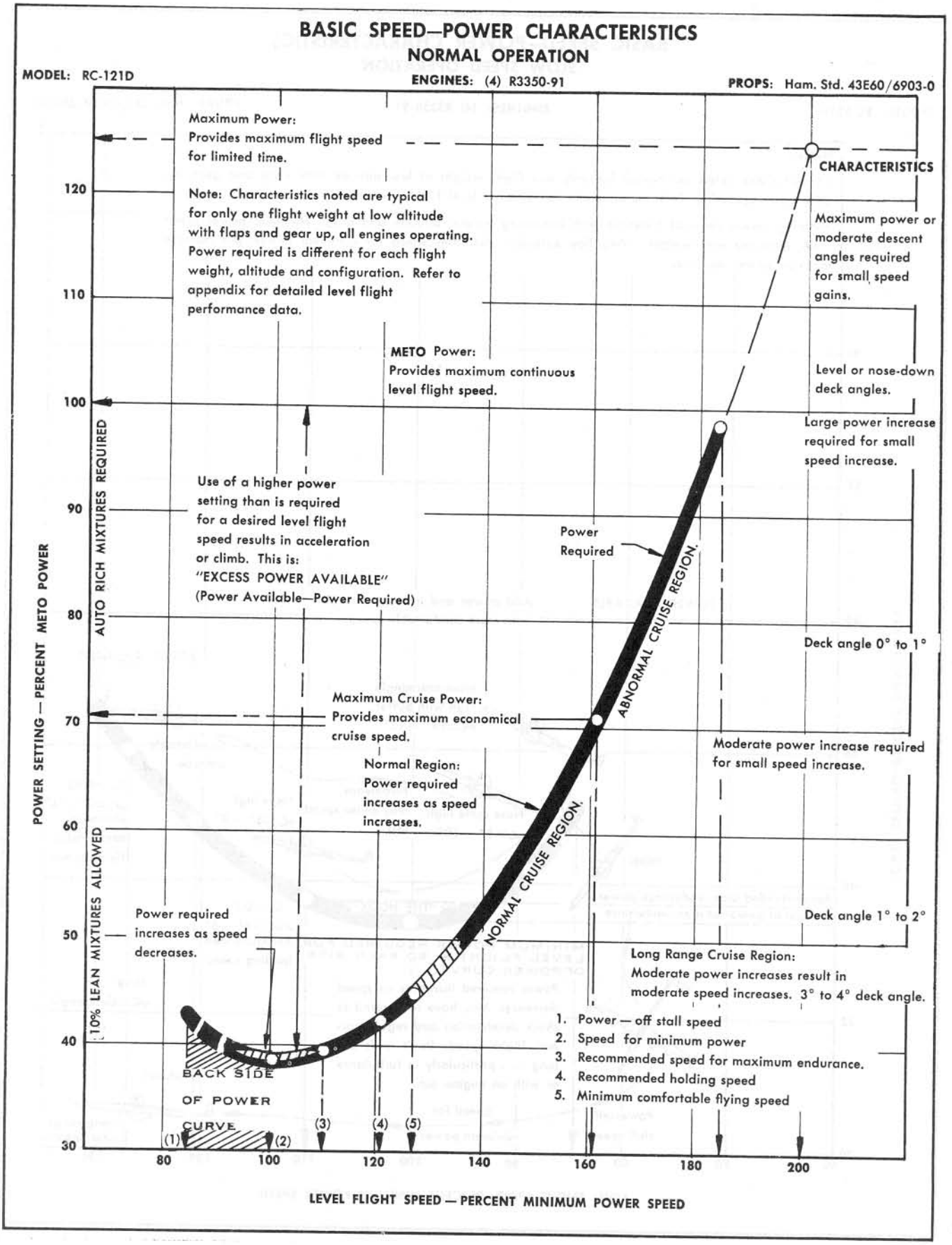


Figure 6-2. Basic Speed — Power Characteristics (Sheet 2 of 3)

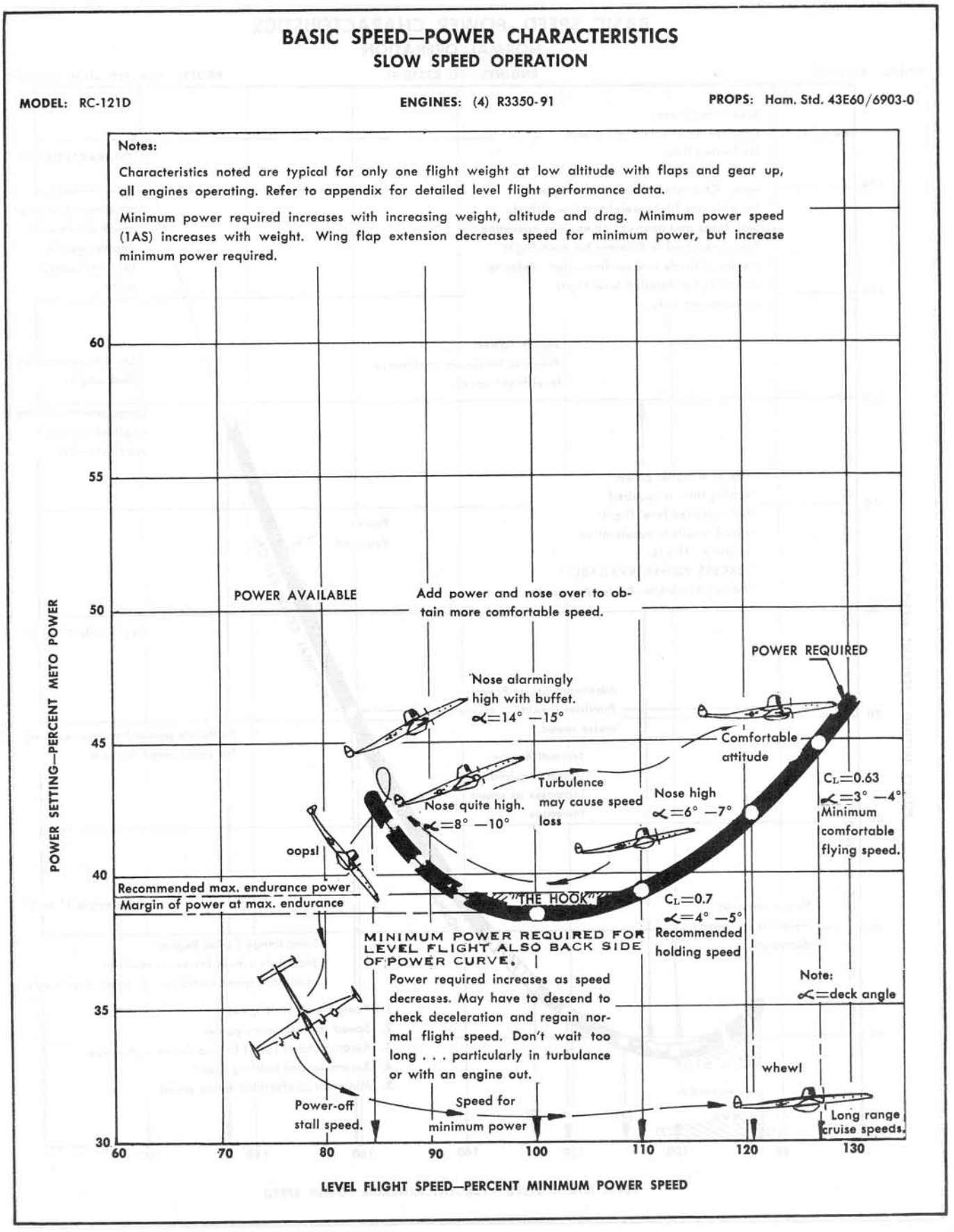


Figure 6-2. Basic Speed — Power Characteristics — Slow Speed (Sheet 3 of 3)

BOOST-ON OPERATION.

Boosters should never be turned on at high speeds, or at any speed, if the aircraft is out of trim. This will result in a rapid and severe application or release of forces on any system in which the boost is turned either off or on. In an emergency, the boost may be turned off at any airspeed. If conditions permit, however, the speed should be maintained between 130 and 155 knots during the change-over. Normal cruising speed schedules may be re-established with boost off; however, an increase in control forces required may be expected. If the auto-pilot is engaged during boost-off operation the flight crew should monitor airplane attitude continually and more carefully than during normal operation, particularly during flight through turbulent areas. If gusts cause deviation from the trimmed attitude, the auto-pilot might become stalled due to increased air loads on the controls, so that action by the crew may be required to effect recovery.

Cross Wind Effect

Cross wind landing characteristics are excellent; however, airspeeds above 115 knots may be desirable in the approach if gusty conditions exist in order to maintain desired margins of aileron control response rate.

LEVEL FLIGHT CHARACTERISTICS.

Extensive flight tests of civilian and military versions of Super Constellation aircraft similar to the RC-121D indicate that it will be stable throughout its speed range. It can be flown from its maximum placard speed to the stall speeds without reversals or abnormal variations of control force. However, as is true of most aircraft, excellent piloting technique and smooth air are required in order to maintain steady flight speeds when power is reduced to settings recommended for holding and maximum endurance.

Figure 6-2 illustrates some typical speed-power characteristics at normal and slow flight speeds discussed in the following paragraphs.

SLOW FLYING.

There are two major differences between operating at slow and normal flight speeds. The most noticeable is the different ratio of speed change to power change. The aircraft becomes much more sensitive to small power changes as speed is reduced. A power adjustment which might normally result in a two or three knot speed change at high speed cruise conditions can result in a ten to fifteen knot speed change in calm air at endurance speeds. The effects of turbulence are also much greater, and the speed change takes place over a longer period of time. Successive gusts, encountered before intermediate recovery is affected, might result in excessive slowing of the airplane. Therefore, the pilot should exercise a more positive degree of control than would be considered normal for higher speed operation.

MINIMUM SPEED OPERATION.

This leads to the second difference between normal and slow speed operation. There is a possibility of the airplane flying on the back side of the power curve. An airplane may be longitudinally stable throughout its speed range, as the RC-121D is, and still experience what might seem to be airspeed instability in the slow speed area of operation. This is a situation which can occur at low flight speeds with any airplane having a favorable lift, drag ratio and reasonable stall speeds. It is referred to either as flying on the back side of the power curve or "operating in the reverse command region." It happens when airspeed is reduced to less than the speed for minimum power required for level flight, most often when power settings in use are just sufficient to maintain holding or endurance speeds.

POWER REQUIREMENTS.

The power required for flight increases with decreasing speed after the minimum power point has been passed. The airplane can then accelerate to a greater speed without loss of altitude only if a positive margin of power exists; that is, if power required at reduced speed does not exceed the power setting in use. If a positive margin does not exist, the airplane will tend to recover trim speed by descending and accelerating unless adversely affected by turbulence. Recovery can also be affected by increasing power at constant altitude provided speed loss has not progressed to the point where insufficient power is available to check decelleration. The fastest recovery can be made, of course, by combined descent and addition of power. The only danger involved lies in not recognizing that the aircraft is flying "on the back side of the power curve" as it occurs, and attempting to maintain altitude without increasing power. Deceleration may then continue until the lowering airspeed and high deck angle are noticed, pre-stall buffet is felt, or the aircraft enters a stall.

SPEED REQUIREMENTS.

Recommended speeds for maximum endurance shown on the Appendix miles per pound curves are approximately 110% of the speeds for minimum power or absolute maximum endurance. This provides a margin of excess power for acceleration if speed reduction due to turbulence should occur, thus allowing normal op-

erations to be conducted at endurance cruising schedules. AEW aircraft might enter the reverse command region more frequently than transport type aircraft since holding or maximum endurance speed schedules are used more often. In addition, mission requirements might be such that operation at low speeds in a turbulent area may be required. Use of slightly higher than scheduled power settings should forestall large speed losses in mild or moderate turbulence, and ample power is available from the four engines to check large decelerations. The characteristic effects of "flying around the hook" should be known and recognizable however. Inadvertent entry into a "reverse command region" during an emergency might affect airplane performance so as to affect flight safety.

WEIGHT CONSIDERATIONS.

An example might be illustrated by considering an airplane operating at heavy weight with two engines inoperative, at an altitude just less than its rated power ceiling. It can maintain altitude and expect an increase in performance as fuel is consumed and weight decreased. If turbulence slows the airplane beyond the minimum power speed however, power required for flight might become more than available. The pilot must then sacrifice altitude by descending rapidly enough to increase speed to the original value, check the deceleration by use of maximum power, or both. Continued operation at the reduced speed might result in slower but continuous loss of much more altitude than would be required to accelerate to the original speed.

EFFECT OF WING FLAPS.

Operation with flaps extended decreases the speed for minimum power to some extent. However, the value of minimum power associated with the decreased speed is always greater than that for the clean configuration at its corresponding minimum power speed.

CRUISING FLIGHT.

The basic mission of this type aircraft involves long periods of operation at cruise power settings. It is for such conditions that the aircraft was designed and is most effective. Patience and skill on the part of the flight crews will result in optimum aircraft performance. Adequate data are presented in Appendix I to permit preparation of a wide variety of flight plans. It is suggested that the pilot consider use of the following techniques however, as a means to obtain maximum performance from the aircraft.

1. Maintain climb power after leveling off until the desired cruise speed is reached when entering a cruise condition from a climb speed which is less than that desired for level flight, and then reduce to the desired cruising power. Airspeed will tend to increase thereafter as fuel is consumed if cruising power is held constant. The increase in speed relative to the decrease in weight is lessened as light weights are approachd.

2. Flight characteristics in turbulent air are favorable although, as would be expected, the average airspeed will tend to be less than for the same power setting in calm air. Some loss of range results. If range is the primary consideration, the pilot will find that a slight increase in power will result in a more stable speed. The increase should be determined for the specific conditions existing by inspection of fuel economy data in Appendix I. No change of power setting should normally be necessary if maximum endurance is the primary consideration. Duration is a function of total fuel flow rather than average airspeed. However, power may have to be increased at the expense of fuel flow in turbulence if the average airspeed tends to become less than 90% of the value recommended for maximum endurance.

HIGH SPEED FLIGHT.

In general, high speed flight will be normal in all respects; that is, no compressibility effects will be noted at speeds up to the placarded dive speed.

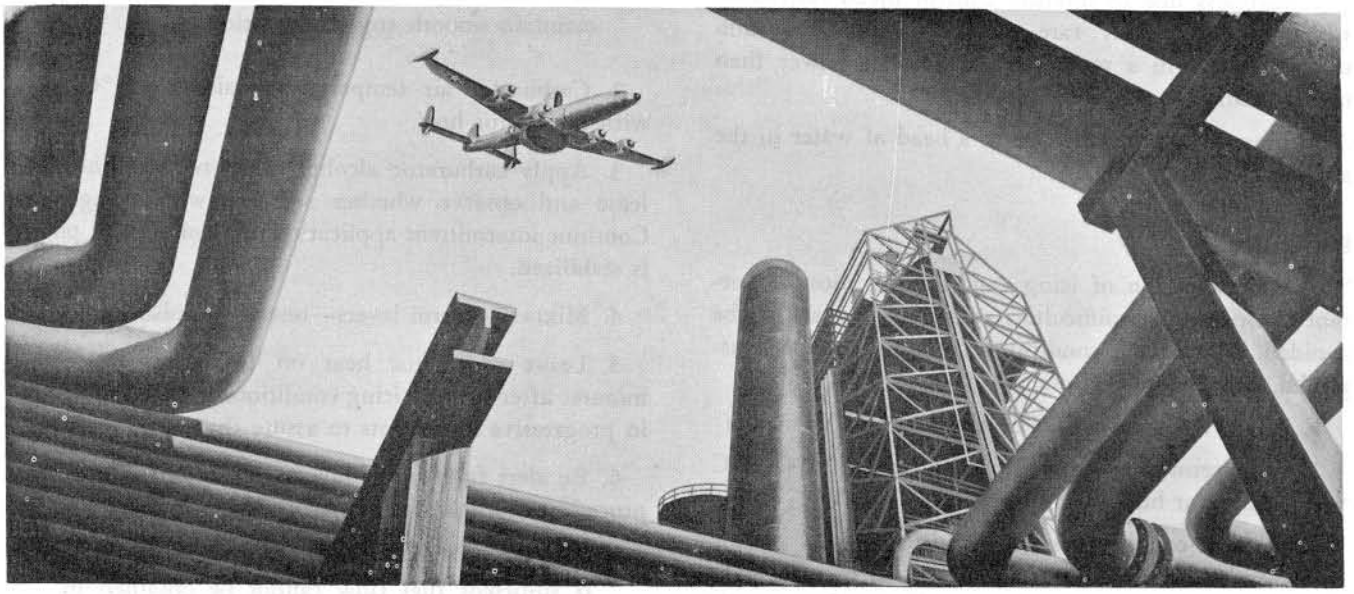
MANEUVERING FLIGHT.

The maneuvering flight characteristics are normal with the exception that it is necessary to maintain pressure on the bottom rudder to sustain a coordinated turn.

DIVING.

In general, it is not necessary to observe any special precautions when diving, other than to observe the limit speeds and structural load factors described in Section V of this handbook. Under these conditions, no high-speed compressibility affects will be encountered. The aircraft should be retrimmed manually with speed changes in the normal manner. When recovering from a dive attitude, the aircraft should be pulled out manually without changing trim. The pilot should not use excessive or rapid application of control forces in the recovery to avoid possible structural damage to the aircraft.

Last Page of Section VI.



SECTION VII SYSTEMS OPERATION

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ENGINE OPERATION.

CARBURETOR ICING.

(Aircraft not equipped with alternate fuel and ram air).

Whenever there is visible moisture in the air, such as rain, snow, sleet, clouds, super-cooled precipitation, etc., the flight crew should be alert for indications of carburetor icing which can be detected by close attention to fuel flow and BMEP. With the fuel injection engine, the occurence of throat ice or refrigeration ice is very rare. Furthermore, precipitation particles of large density are removed by inertia separation at the induction scoop entrance. Icing in this installation, therefore, is the result of very fine particles of ice in the impact tube system of the carburetor, and is most likely to occur when visible moisture is present and the free air temperature is below 10°C. The most likely causes of engine instability during precipitation conditions are:

1. Ice crystals or water droplets entering the impact tube system and physically restricting the passages. This results in excessive leanness and usually causes a sudden and radical power loss.

2. Ice crystals or fine snow becoming lodged in the automatic mixture control unit needle aperture. This also results in excessive leanness and usually causes a sudden and radical power loss. This particular condition is most critical at higher altitudes and at very low free air temperatures when carburetor heat is being used.

3. Accumulation of moisture in passage or bleeds (with heat on) and subsequent freezing and blocking of bleeds after removal of heat.

4. Accumulation of ice on various parts of the master control.

Power losses can also occur because of the following:

1. Richness due to mixture control bleed restriction which is a relatively rare occurence. This condition usually results in a more gradual loss of power than occurs with the above conditions.

2. Leanness or richness due to a head of water in the air passages.

Prevention.

Timely anticipation of icing conditions is most important if operational difficulties caused by ice are to be avoided. When icing conditions are anticipated, or suspected, proceed as follows:

1. Mixture control—AUTO RICH.

2. Carburetor air temperature—raise to 25°C-30°C with carburetor heat.

3. Mixture control—reset for cruising.

4. Monitor fuel flow and BMEP while in icing conditions in order to detect first evidence of any malfunctioning. Impending loss of power is usually indicated by intermittent fluctuations of fuel flow and BMEP, or gradual decrease or increase in fuel flow.

Note

Good results can often be obtained by intermittent use of alcohol as an anti-de-icer (with no carburetor heat) and by close observation of fuel flow and BMEP. When any instability of fuel flow or BMEP is noted, use intermittent application of carburetor alcohol until smooth operation is again obtained. It is recommended, however, that carburetor preheat be used as a preventative measure whenever engine critical altitude is not adversely affected, because the use of alcohol as an anti-icer requires considerable skill which is acquired only through experience. When alcohol is used it should be applied for a period of 3 to 5 seconds then released, and observation made as to whether or not stable power has been regained. An icing condition sometimes can be forestalled or prevented by periodic and intermittent application of alcohol prior to receiving the first indication described above when flying in questionable icing conditions.

When icing conditions are encountered suddenly and without warning, and there is a BMEP drop, fuel flow loss, or rpm surging, perform the following:

1. Mixture control levers—AUTO RICH.

Note

If fuel flow indicates that mixture is excessively rich, manually lean with mixture control to maintain smooth engine operation.

2. Carburetor air temperature—raise to 25°C–30°C with carburetor heat.

3. Apply carburetor alcohol for 3 to 5 seconds; release and observe whether stable power is regained. Continue intermittent application of alcohol until power is stabilized.

4. Mixture control levers—reset for cruising.

5. Leave carburetor heat on for approximately 5 minutes after leaving icing conditions. Then reduce heat in progressive increments to assure that ice is melted.

6. Be alert for further power loss and reapply above procedure if instability occurs.

Note

If sufficient fuel flow cannot be obtained in AUTO RICH after the above procedures have been applied, operate the primer for short periods until stable engine operation is resumed.

A power loss due to a mainfold pressure loss, which is usually gradual, is probably caused by a reduction of airflow because of screen and surface icing, either in the air scoop or carburetor. This condition may be encountered in freezing rain, heavy snow, ice, or when an extremely cold aircraft is exposed to moisture conditions during descent. The prevention and/or correction of this type of icing is the same as for the icing conditions previously described. Alcohol injection usually is very effective in removing the accumulation of ice if it is on the screen. The above procedures have been shown to be effective under all normal conditions where ice is likely to be encountered at altitudes below 20,000 feet and at temperatures between 10 and —25°C. At altitudes above 20,000 feet, extremely high carburetor air temperatures may cause excessive leaning of the mixture and result in engine instability. If such a condition occurs, the mixture should be enriched and/or carburetor heat reduced. It also may be necessary to use alcohol more frequently. At ambient temperatures below —25°C, the amount of visible moisture in the air is extremely small and is not likely to cause icing trouble; however, the temperature inside of clouds may be considerably different from the temperature outside the clouds. Therefore, it should be anticipated that icing conditions will be prevalent when entering a condition of visible moisture, and preventative measures should be taken.

CARBURETOR ICING.

Those aircraft incorporating alternate fuel and ram air provisions.

Air Side Icing.

The application of carburetor heat and alternate fuel source is not permissible during take-off. Carburetor heat may be used before take-off to insure that any ice accumulation has been dislodged, but the switch must be in the COLD position and the carburetor temperature normal before take-off. The alternate fuel source switch must also be in the NORMAL position before take-off. After the first power reduction is made, carburetor heat may be applied to maintain a minimum temperature indication of 20 to 30° C. Temperature stratification at the carburetor deck when using carburetor heat causes the carburetor air temperature gage to read 30°C when the actual average air intake temperature at the carburetor is 38°C. Therefore, it is recommended that the carburetor air temperature not exceed 30°C, as read on the carburetor air temperature gage. Anticipation of impending icing conditions is of primary importance in avoiding fuel metering disturbances. Visible moisture in the air with free air temperature below 10°C may be an indication of impending fuel flow disturbance. Intermittent fluctuations of fuel flow and BMEP, or gradual decrease or increase in fuel flow under these conditions, usually indicate a fuel metering disturbance which may be followed by a loss of power.

Note

If fuel flow indicates that the mixture is excessively rich, which has happened upon very rare occasions, manually lean with the mixture control to maintain smooth operation, then apply pre-heat to remedy.

The first step in preventing a fuel metering disturbance caused by carburetor ice is to use the alternate air source. The effectiveness of the under cowl air source in preventing moisture from entering the induction system may be increased by opening the cowl flaps from the normal cruise setting. A possible explanation for this is that by opening the cowl flaps the air flow velocity through the cowling is increased and, therefore, moisture particles are more likely to continue straight through the cowling instead of following the air into the undercowl opening. Cowl flap openings beyond faired (29%) position are not recommended because openings beyond this position may reduce the available carburetor heat. While it is recommended that the alternate air source be used to combat induction system ice, there are some conditions where it may be desirable to apply heat with the door in the ram position. If icing conditions are anticipated, or if any atmospheric condition is encountered which could cause a radical metering disturbance, the following procedures should be followed:

1. Mixture levers—AUTO RICH.
2. Alternate air switches—ALTERNATE.
3. Carburetor heat switches — raise temperature to 20°C.
4. Reset cruise power, and monitor fuel flow and BMEP for evidence of instability.
5. Continue to monitor all instruments to detect indications of icing.
6. Leave carburetor heat on for approximately five minutes after passing through icing conditions to insure that ice is melted, then remove heat slowly in small increments, one engine at a time.

When a metering disturbance (caused by atmospheric conditions) occurs suddenly and unexpectedly apply the same procedure as outlined above with special attention to "resetting power and fuel flows" plus:

1. Carburetor alcohol—as required to stabilize power.

In the event that the foregoing procedures are not effective in relieving the metering difficulties, the following procedures should be accomplished on one engine at a time:

1. Mixture levers—AUTO RICH.
2. Throttle—reduce manifold pressure to 25" Hg.
3. Alternate fuel switch—EMERGENCY.
4. Reset power—advance throttle to desired BMEP. Manually lean mixture to best power and readjust throttle to maintain desired BMEP.
5. Carburetor heat switch—adjust, on one engine at a time, to give temperature of 20 to 30° C and reset power, if required.
6. Return to normal metering and power adjustment as soon as deemed advisable, doing so on one engine at a time.

If it is absolutely necessary to continue operation in level flight with the alternate fuel source, lean mixture and simultaneously open throttle to maintain constant BMEP until manifold pressure is three inches Hg above value noted at best power. If aircraft altitude is changed, the mixture will have to be reset. When using the alternate fuel source, the following cautions should be observed:

CAUTION

- Monitor fuel flow and power indications closely to detect changing conditions. Power changes may require resetting the mixture control.
- The alternate fuel source does not depend upon airflow; therefore, fuel flow, BMEP, and manifold pressure should be monitored carefully. The alternate fuel source should not be used without the prescribed amount of pre-heat because a dangerous build-up of ice can occur without the usual fuel flow effects. Increasing throttle requirements to maintain manifold pressure usually indicates ice build-up, and increased pre-heat should always be used under these conditions to insure airflow to the engine.
- In the event of total loss of metering differential pressure, the alternate fuel source will supply sufficient fuel flow to allow power settings up to and including maximum cruise power, provided the mixture control is in the AUTO RICH position.

De-activating the Alternate Fuel Source.

1. Mixture lever—AUTO LEAN and simultaneously move alternate fuel source switch to NORMAL.

Note

Monitor fuel flow when deactivating the carburetor alternate fuel system.

2. Leave carburetor heat on for approximately five minutes after passing through icing conditions to insure that ice is melted, then remove heat slowly in small increments one engine at a time.

3. Reset cruise power and mixture.

During Descent.

It is possible that conditions conducive to carburetor icing will be aggravated by lower power, lean mixture, and part throttle operation, especially during long steep descents. If trouble is encountered under these circumstances, the icing condition should be controlled by use of alternate air and/or carburetor heat.

The use of carburetor heat has been effective under all normal conditions where ice is likely to be encountered at altitudes below 20,000 ft. and at temperatures between +10 and —25°C.

At ambient temperatures below —25°C the amount of visible moisture in the air is extremely small and is not likely to cause induction system icing trouble; however, the temperature inside of clouds may be considerably different from the temperature outside of clouds. Therefore, it should be anticipated that icing conditions will be prevalent when entering a condition of visible moisture, and preventative measures should be taken.

Generally speaking, it may be better not to change an established configuration while in icing conditions as long as no difficulties are encountered, whether or not any anti-icing technique is used. In any event, do not switch to RAM air until it is determined that ice has not accumulated on the scoop door while in ALTERNATE. Air supply may be restricted and result in a power loss.

Fuel Side Icing.

Because of the similarity of induction-side and fuel-side icing indications, and the possible damaging consequences of improper use of the fuel-side alcohol de-icing system, it is recommended that the following factors be evaluated before actuating this system:

1. Determine that extremely cold ambient temperatures are being encountered. (Tests and operational experience indicate that fuel-side icing difficulties should not be encountered at ambient temperatures above approximately —12°C.)

2. Take every precaution to ascertain that the metering disturbance is not of the induction-side type, i. e., by applying normal induction system de-icing measures attempt to alleviate disturbance before actuating the fuel-side alcohol de-icing system.

3. A 2 to 3 psi drop in engine fuel pressure is a definite and predictable characteristic of an iced bypass type master control inlet screen. Positive identification of this symptom, associated with persistent metering disturbances, is by far the most reliable indication of carburetor fuel-side icing.

It cannot be emphasized too strongly that improper, or untimely use of the fuel-side de-icing system can result in engine operational difficulties as severe as carburetor icing itself. Therefore, the following CAUTIONS should be observed and strictly adhered to:

CAUTION

- DO NOT actuate system until factors listed above have been analyzed.
- DO NOT actuate carburetor de-icing system

when engine is operating in lean mixture. Severe combustion instability may result.

- DO NOT actuate system with mixture control in Idle Cut-Off or with engine stopped, since this may cause damage to diaphragms in certain fuel system components.
- DO NOT inject fuel-side alcohol for periods in excess of 15 seconds. Tests have shown that longer bursts are no more effective, are wasteful of the alcohol supply, and are capable of imposing marginal fuel-air ratios.

If it is definitely ascertained that fuel-side icing is being encountered, the following de-icing procedure may be instituted, one engine at a time if more than one engine is affected.

1. Mixture lever—AUTO RICH.

2. Manual spark control—NORMAL (Retard Position).

3. Alcohol injection switch—hold to FUEL INLET SCREEN position for period of 10 seconds (do not exceed 15 seconds). Proper operation will be indicated by a drop in fuel flow of approximately 200 lbs/hr. A resumption of normal fuel flow is an indication that ice has been successfully removed.

If the above procedure does not remedy the suspected carburetor fuel-side icing problem, the mixture control lever may be moved back and forth several times between AUTO-RICH and AUTO-LEAN to impose maximum control pressures on the master control diaphragm. This will assist the alcohol in freeing an iced regulating poppet.

Note

The carburetor fuel-side alcohol injection system is designed to function as a restorative, rather than a preventative, device. By proper fuel system maintenance and operation, the likelihood of experiencing fuel-side icing is slight.

Although it has not been flight tested under actual icing conditions, the fuel-side de-icing system has been demonstrated on a full scale fuel system mockup to be capable of clearing the carburetor of major accumulations of ice under severe icing conditions for periods of one to two hours. Indiscriminate or excessive injection of alcohol through this system will deplete the available alcohol supply, which should be reserved for induction system and/or propeller de-icing. Engine damage is also possible.

MANUAL LEANING.
(When using maximum cruise BMEP or below).

The engine fuel metering is designed to give the best economy in the AUTO LEAN mixture position. However, variables such as atmospheric conditions, induction configuration (carburetor air source) or carburetor malfunctioning may exist for which automatic compensation cannot be provided. Manual leaning with the mixture control is to be used to obtain best economy fuel flows and cylinder cooling in accordance with the procedures outlined as follows:

1. Mixture lever — AUTO RICH
2. Propellers — Set desired cruise RPM
3. BMEP — As desired
4. Manual spark control switch — As desired
5. Lean manually with mixture lever until BMEP:
   a. Rises to the maximum.

Note

The rise normally is 1 to 5 BMEP. If the BMEP rise is more than 5 the master control is metering rich. Rich master control is not detrimental to engine operation. However, it can cause a power loss at the limiting MAP when operating at higher powers.

   b. Shows no rise and begins to drop.

Note

If the cruise altitude is above 5000′ and the carburetor air is direct, determine if the master control is metering lean by returning the mixture lever to the AUTO RICH position and operate the primer intermittently. If there is a BMEP increase the master control is metering lean. Subsequent operation should be in AUTO RICH until the discrepancy is corrected. Lean mixtures can be detrimental to engine life during high power operation.

6. Throttle levers—Reset to desired BMEP

7. Lean manually with the mixture lever for 10% BMEP drop.

Note

If the cruise power is above 1550 BHP in low ratio, or above 1450 BHP in high ratio, and the position of the mixture lever after manual leaning is richer than the AUTO LEAN detent, place the mixture lever in AUTO LEAN.

This condition should be investigated and action taken to correct the discrepancy. At powers below those stated above, the power enrichment valve is closed and the position of the mixture lever is of no consequence.

This procedure has the advantage of cooling the engine by means of lower combustion and exhaust temperature due to the excess air which absorbs some of the heat of combustion, resulting in optimum cylinder, tubing, nozzle box, and exhaust system durability.

An occasional need to maintain cruise power at altitudes above the 10% BMEP drop is recognized. On such occasions it is permissible to use the same procedure leaning to 7% BMEP drop. The critical altitude increase is approximately 700 feet.

The use of mixtures richer than 7% BMEP drop at cruise power in level flight should be avoided since this results in temperatures which have an adverse effect on the engine durability. The use of mixtures leaner than 10% BMEP drop should be avoided also since any abnormal distribution of fuel or air to the cylinders can result in serious cylinder to cylinder power differences which are aggrevated by extremely lean operation.

If engine condition does not permit stable operation when leaned to 10% BMEP drop, it is recommended that AUTO RICH be used until the engine condition can be corrected.

Under normal conditions when operating with either an AUTO RICH or a 10% BMEP drop mixture, it is recommended that all engines be operated within a maximum of 2 inches of MAP of each other. Appropriate compensation should be made.

8. Recheck manual lean mixture setting following any change in cruise altitude greater than 2000 feet.

MANUAL SPARK CONTROL OPERATION.

The manual spark control provides the flight engineer with a positive control of engine ignition timing. The spark control switch shall be placed in the RETARD position for all starting, for ground operation, for take-off, for climb, for approach, for landing, and whenever the engines are operating above 2400 rpm. The switch may be placed in the ADVANCE position only for level cruising and descent when the engines are operating at 2400 rpm or below.

WARNING

The manual spark control must be in the RETARD position for take-off and for all engine operation above 2400 rpm. Operation above 2400 rpm with advanced spark may result in engine damage, particularly with auto-lean mixture.

SPARK ADVANCE WITH ENGINE ANALYZER OPERATIVE.

1. Establish stabilized cruise power with mixture in AUTO RICH.

2. Select BOTH position for No. 1 engine on engine analyzer selector switch.

3. Place spark control master switch in ADVANCE and the spark control switch for the No. 1 engine in RETARD.

4. Move No. 1 engine spark control switch to NORMAL and note that analyzer pattern shifts to the left.

5. Repeat on other engines.

Note

If one pattern fails to shift to the left, that spark advance relay is inoperative. Select LEFT on analyzer selector switch and check. If pattern shifts, the right relay is inoperative.

Proper operation of the manual spark advance relays may be checked as follows:

1. Establish a cruising power (lean mixture) in stabilized flight and clear air.

2. Move the spark control master switch to the ADVANCE position.

Note

There should be a definite increase in BMEP when the spark is advanced. If no increase occurs, the spark advance relays are not operating.

ENGINE SUPERCHARGER SHIFT.

If a climb to high cruising altitudes is made and an engine supercharger shift is required to maintain adequate climb power, shift to HIGH ratio position in the following manner:

1. Reduce manifold pressure to 20″ Hg, or less.

2. Reduce engine speed to 1600 rpm.

3. Shift supercharger lever to HIGH position. (Make all shifts as smoothly and as rapidly as possible.)

4. After manifold pressure increases, indicating shift has been made, reset throttles to obtain the required climb power.

Note

Shift to HIGH position during normal climb-power at the altitude at which the BMEP drops to approximately 200.

TORQUEMETER MALFUNCTION.

If the overhaul modifications to the torque cell support brackets have been made, the possibility of a propeller decoupling in the event of a torque cell failure is greatly reduced. However, these modifications do not relieve the flight crew of their responsibility to trouble shoot and evaluate a malfunctioning or abnormal BMEP indication.

1. In the event of a complete loss of BMEP, the pilot should use his own good judgement prior to making the decision to feather.

2. Sudden changes in BMEP from normal indication to zero, either clockwise or counter-clockwise is not cause for immediate feathering. Stand by to retard throttle quickly; turn on auto feather test switch of affected engine; turn on master auto-feather switch and stand by for automatic feathering of the affected engine. If the feathering button is energized, retard throttle quickly and continue feathering procedure. If feathering button is not energized within two to three seconds, turn auto-feather switches off. Observe closely for any other malfunction and continue the mission. A run-up will be made after next landing for analysis of trouble. Record all engine instrument indications for the benefit of maintenance personnel.

3. A BMEP drop to zero, preceded by an unaccountable, progressive BMEP spread, will justify immediate feathering. Attempt to account for the BMEP spread by setting the affected engine and its symmetrical engine at identical rpm, MAP, and best power mixture. Note BMEP spread. Check analyzer patterns for indication of a non-productive cylinder. Check for power recovery turbine failure as follows: During daytime flight, visually inspect turbines for unusual discharge of smoke from or around exhaust flight hood. During night flight, visually inspect turbines for heavy discharge of orange sparks. If BMEP spread cannot be accounted for, feather engine when BMEP spread exceeds 20 BMEP. An engine that operates to 20 BMEP below the other engines at the same throttle setting, should be watched carefully for any signs of increase in torque deviation, or other indications of engine malfunction. An engine that apparently malfunctions in this manner should be submitted to maintenance for inspection and correction. In all instances of low BMEP indications, possible instrument error should also be investigated prior to any extensive torquemeter system malfunction investigation.

4. An indicated BMEP rise to off-scale is an occasional flight occurence. This is not to be considered as a cause for feathering. Continue mission, maintaining identical rpm, MAP and fuel flow with its symmetrical engine. Monitor cylinder head temperatures closely and adjust mixture accordingly.

5. In all instances, suitable correction should be allowed for instrument calibration correction and cabin supercharger and alternator power demands.

SPARK PLUG CLEAN OUT PROCEDURE.

Low Power Operation.

1. Throttles—1000 RPM

2. Mixtures—lean to 25 rpm below the idle best power position. Maintain this power setting for a period of five minutes, then recheck for plug fouling.

140 BMEP OPERATION.

In order to prevent excessive build-up of carbon deposits on the spark plugs during prolonged ground operation, the following procedure is recommended as a supplement to the procedure outlined above:

1. Cowl flaps—	OPEN
2. Mixtures—	AUTO RICH
3. Propellers—	full INC. RPM
4. Throttles—	As required for 140 BMEP

Operate the engines at this power setting for one minute after each fifteen minutes of ground operation. Cylinder head temperatures should be maintained below 200°C, if possible, so as not to exceed take-off temperature. In the event the spark clean out procedure as outlined above fails to satisfactorily clean the affected spark plugs, the flight engineer will proceed as follows:

1. Mixture controls—	AUTO RICH
2. Propellers—	full INC. RPM
3. Throttles—	1600 rpm

From the 1600 rpm position, gradually increase power in 200 rpm increments. At each 200 rpm increment, allow power instruments to stabilize. Check for fouled

plugs with ignition analyzer. When fouled plugs are detected, power should be reduced to the point where the plug commences firing (determined by the analyzer pattern). Allow the plug to fire for fifteen seconds then increase power to the next 200 rpm increment.

Note

This progressive power clean-out procedure is based on the fact that a plug must be firing in order to clean lead and carbon deposits. Spark plugs will often fire properly at low power settings, yet will break down at higher settings. A decrease in power, slightly below the breakdown point, will allow the plug to fire and clear deposits. During all spark plug clean out procedures the cylinder head temperatures should be maintained below 200°C.

Excessive RPM Spread.

When a spread of over 100 RPM is encountered during engine run-up, the following procedure will be initiated to determine malfunctions on symmetrical engines:

a. Determine that all engines are fully warmed up, and all pressures and temperatures normal.

b. Park aircraft facing into the wind.

Note

If the aircraft is not headed directly into the wind, unstable readings and possible rpm spread may be encountered.

c. Proceed with propeller check, comparing RPM and MAP.

Note

Use corrected MAP, as obtained from static readings on MAP gages before starting engines.

d. Perform standard magneto check at field barometric pressure, with MAP corrected, noting rpm, BMEP, and fuel flow. A drop of 75 rpm while operating on one magneto is permissible, provided no engine roughness is encountered. If magneto check is unsatisfactory, a cross reference with the pilot's tachometer and the ignition analyzer will be made. A cruise power performance check will be made as follows:

1. Mixtures	AUTO RICH
2. Throttles	set to 2050 RPM
3. Check MAP	As required
4. Mixtures	Manual lean to best power setting.

Note

If the BMEP increase between auto rich and best power is more than 3 BMEP, the master control is metering too rich. If no increase occurs place the mixture lever in AUTO RICH, engage the engine primer intermittently and if any increase of BMEP occurs the master control is metering too lean.

5. Propellers	SET 2000 rpm
6. Throttle	SET 120 BMEP

Note

Under normal conditions, with either AUTO RICH or 10% bmep drop leaning mixture, all engines should be within 2 in Hg MAP. and 5 BMEP. With large variations of accesory power requirements exist suitable allowance should be made during the above check.

If the above checks reveal no engine malfunction, but indicate a probable incorrect propeller blade pitch setting, make a full power check with brakes set. If correct rpm, MAP, and fuel flow is obtained the engine may be considered acceptable for flight.

Note

Once the propeller is off the LOW pitch stop, the propeller governor will maintain proper blade pitch.

IGNITION ANALYZER NORMAL OPERATING PROCEDURES.

Note

It is recommended that an ignition analysis be made during taxiing and during ground run-up magneto check. A trouble shooting check with the ignition analyzer should be made during the climb to cruising altitude, and at least once an hour during cruising flight.

1. Turn on the amplifier power supply and allow it and the cathode-ray tube to warm up.

2. Set the index on the inner dial of the condition switch to the L index (near the number 1) beneath the general caption IGNITION on the fixed ring.

3. Set the index labeled IGN on the inner dial of the cycle switch against the number 1 on the fixed ring. This setting, supplementing that of the condition switch, will present the pattern of No. 1 cylinder, left magneto,

of No. 1 engine on the indicator, followed by the pattern of No. 12 cylinder, which is next in firing order.

Note

With the push-pull knob in the "pulled-out" position, in the above condition, the indicator will portray all the ignition patterns associated with the left magneto beginning with No. 1 cylinder. When the spark plug is fired on the negative pulse of the magneto, the major portion of the pattern will appear below the zero line, and when fired on the positive pulse, the major portion will appear above the zero line. This condition is apparent at low rpm only.

4. Push the push-pull knob in and set the dial index of the condition switch to B, near the numeral 1 beneath the general caption IGNITION. Maintain IGN against 1 on the cycle switch. The pattern on the indicator will portray the functioning of both magnetos and both spark plugs for cylinders 1 and 12. This setting is used for checking magneto synchronization.

5. For study of the individual ignition patterns or all of the ignition patterns of engines No. 2, 3, or 4, the same settings of the cycle switch as for engine No. 1 are used, but the condition switch must be switched to L, B, and R adjacent to the numerals 2, 3, and 4 respectively.

6. For an engine speed synchronization check, set the dial index of the condition switch against the index 2 under the caption SYN on the fixed ring. This setting establishes the electrical connection for the comparison of speed of engine No. 2 to that of engine No. 1. The push-pull knob should be in the "pushed-in" position. To compare the speeds of engines No. 3 and 4 to engine No. 1, set the dial index on the condition switch to 3 and 4 within the captioned SYN segment of the outer ring.

Note

When making the engine synchronization check, the position of the cycle switch is of no importance.

ENGINE OIL TANK REPLENISHING.

NORMAL IN-FLIGHT ENGINE OIL TANK REPLENISHING PROCEDURE.

Operational procedures for adding oil to the engine oil tanks are as follows:

Note

During interior flight station check, the reserve oil transfer circuit breaker should be pushed in and the reserve oil tank heater switches turned ON.

1. Reserve oil tank selector switch—RIGHT or LEFT, as desired.

2. Rotate engine tank selector switch to tank requiring replenishing.

Note

In the event of hydraulic transfer pump failure, place pump selector switch to AUX. (ELECT.) position.

3. Place pump selector switch to NORMAL (HYD.) position.

4. Press the start transfer button and check pump transferring light.

Note

When the engine tank maximum quantity limit has been reached, the transferring operation will automatically stop, the pump transferring light will go out, and the pump evacuating light will glow for 60 seconds, indicating that the pump has reversed to evacuate the lines. In the event that the engine tank is to be replenished but not filled to the maximum limit, press the stop transfer button when the fluid quantity reaches the desired amount.

EMERGENCY ENGINE OIL TANK REPLENISHING PROCEDURE.

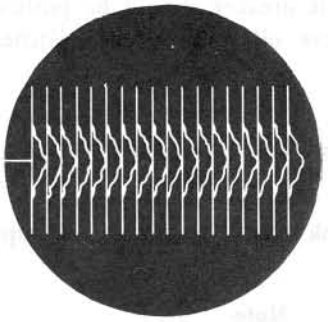
A manual reserve oil transfer procedure is provided for operation of the system in the event of electrical power failure. The sequence of steps is as follows:

CAUTION

Open the reserve oil system circuit breaker on the station 260 upper switch panel before operating the manual controls.

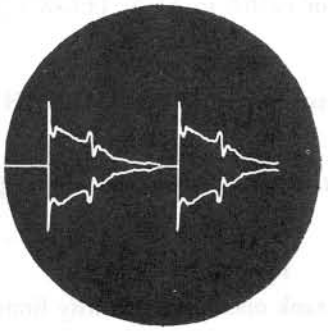
1. Rotate engine oil tank selector to END position, then return to OFF position.

2. Select engine oil tank by rotating the handle from OFF to the desired engine tank position. Do not rotate handle backward while selecting engine tank.



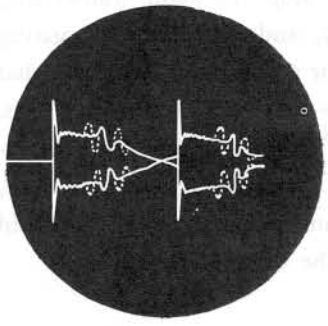
NORMAL PATTERNS — SLOW SWEEP

THE PICTURE OBSERVED PRESENTS THE PATTERNS OF 18 SPARK PLUGS FIRED BY TWO MAGNETOS IN ONE COMPLETE ENGINE CYCLE, OR 720 CRANKSHAFT DEGREES. THE NORMAL POLARITY REVERSAL OF CONSECUTIVE FIRINGS OF ONE MAGNETO IS INDICATED BY PATTERNS APPEARING ALTERNATELY ABOVE AND BELOW THE TRACE LINE. BECAUSE OF THE MAGNETO ARRANGEMENT OF THIS ENGINE, SUCCESSIVE FIRINGS OF THE SAME PLUG ARE ALTERNATELY POSITIVE AND NEGATIVE. THE FIRST PATTERN APPEARING FROM THE LEFT EDGE OF THE TUBE IS IDENTIFIED AS TO CYLINDER BY THE SELECTED CYLINDER ON THE CYCLE SWITCH. THE REMAINING PATTERNS ARE FOR THE REMAINING 17 CYLINDERS FIRED BY THE SELECTED MAGNETO IN FIRING ORDER.



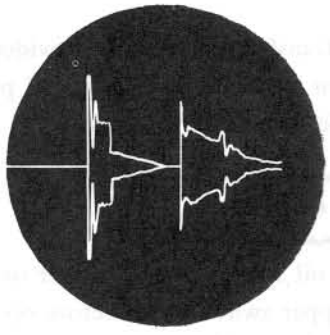
NORMAL PATTERN — FAST SWEEP

THE TWO PATTERNS THAT APPEAR IN THE FAST SWEEP ARE FOR THE CYLINDER SELECTED BY THE CYCLE SWITCH AND FOR THE NEXT CYLINDER FIRED BY THE SELECTED MAGNETO. BOTH PATTERNS ARE NORMAL AND APPEAR ABOVE AND BELOW THE TRACE LINE AS SUCCESSIVE FIRINGS OF THE SAME SPARK PLUG ALTERNATELY POSITIVE AND NEGATIVE.



NORMAL PATTERN — FAST SWEEP
LEAN MIXTURE

HOOK "DANCES" BACK AND FORTH BECAUSE OF NORMAL INSTABILITY OF COMBUSTION WHEN OPERATING WITH EXTREMELY LEAN MIXTURES.



HIGH RESISTANCE
SECONDARY CIRCUIT

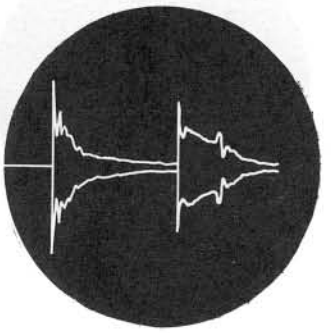
PROBABLE CAUSES: MISSING CIGARETTE SPRING, HIGH RESISTANCE WITHIN THE PLUG, DIRTY SPARK PLUG CONTACT BUTTON, OR ANY ABNORMAL GAP IN THIS SECONDARY CIRCUIT.

F75-0-4-97 (1)

Figure 7-1. Ignition Analyzer Patterns (Sheet 1 of 5)

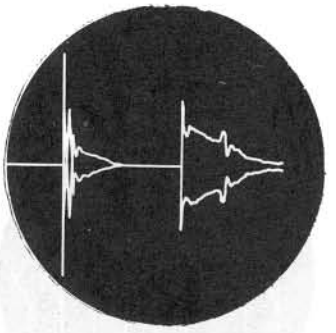
ADVANCED HIGH RESISTANCE SECONDARY CIRCUIT
FAST SWEEP

PROBABLE CAUSES: MISSING CIGARETTE SPRING, HIGH RESISTANCE WITHIN THE PLUG, LARGE PLUG GAP, DIRTY SPARK PLUG CONTACT BUTTON OR CYLINDER MOUNTED COIL CONTACT BUTTON, OR ANY ABNORMAL GAP IN THE SECONDARY CIRCUIT.



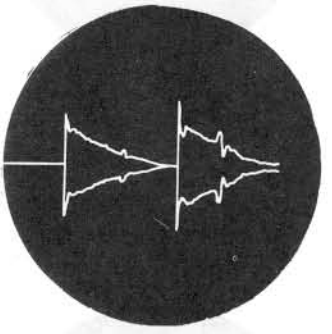
OPEN HIGH TENSION CIRCUIT
SECONDARY CIRCUIT

PROBABLE CAUSES: AN ABNORMALLY LARGE PLUG GAP, DISCONNECTED HIGH TENSION LEAD AT PLUG OR CYLINDER MOUNTED COIL OR ANY OPEN IN THE HIGH TENSION CIRCUIT.



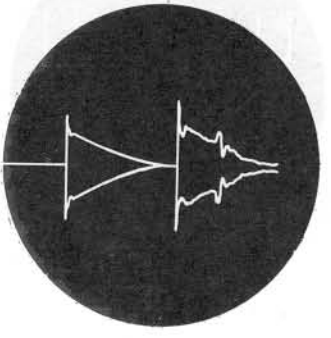
LOW RESISTANCE SHORTED SECONDARY

PROBABLE CAUSES: LOW RESISTANCE CONDITION DUE TO A NARROW PLUG GAP, SPARK PLUG FOULING (LEAD FOUL) (A SHORT IN THE HIGH TENSION LEAD OR PLUG LEAD OFF AND SHORTED TO GROUND) OR A LOSS OF COMPRESSION. IF PATTERN APPEARS ON BOTH PLUGS OF ONE CYLINDER IT MAY MEAN A MECHANICAL FAILURE.



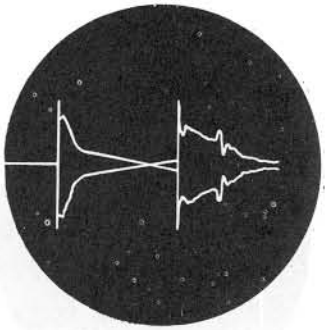
SHORTED HIGH TENSION CIRCUIT
SHORTED SECONDARY

PROBABLE CAUSES: A SHORT IN THE SECONDARY CIRCUIT. THE ABSENCE OF OSCILLATION INDICATES THAT THE PLUG IS NOT FIRING. A DEAD SHORT TO THE GROUND. IF THIS PATTERN APPEARS ON BOTH SPARK PLUGS OF ONE CYLINDER IT GENERALLY INDICATES CYLINDER FAILURE WHERE METAL PARTICLES HAVE PEENED OVER THE SPARK PLUG ELECTRODES.



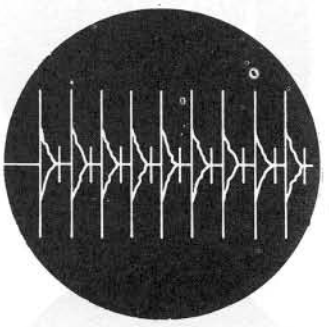
F75-0-4 97(2)

Figure 7-1. Ignition Analyzer Patterns (Sheet 2 of 5)



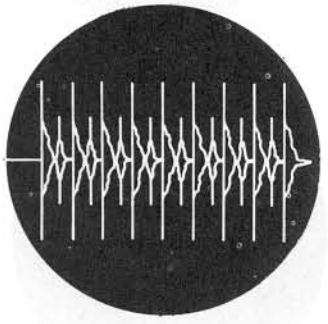
SHORTED SECONDARY FOULED PLUG

PROBABLE CAUSES: BADLY FOULED PLUGS, A SHORT CIRCUIT WITHIN THE PLUGS, SUCH AS A CRACKED CERAMIC OR CARBON TRACKED CIGARETTE WELL, A SHORT IN THE HIGH TENSION LEAD OR A SPARK PLUG LEAD OFF AND SHORTED TO THE GROUND. (MOST FREQUENTLY SEEN AT HIGH POWER SETTINGS WHEN BREAKDOWN IS MORE LIKELY TO OCCUR.)



SHORTED PRIMARY CIRCUIT (MAGNETO TO DISTRIBUTOR)

PROBABLE CAUSES: FAULTY MAGNETO GROUNDING SWITCH OR SYSTEM, THE BREAKER POINTS NOT OPENING, A GROUNDED PRIMARY COIL OR CONDENSER, OR A GROUND BETWEEN THE MAGNETO AND THE DISTRIBUTOR.

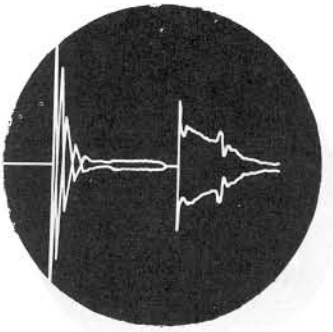


BREAKER POINTS NOT CLOSING

PROBABLE CAUSES: THE BREAKER POINTS ARE NOT CLOSING EITHER MECHANICALLY OR ELECTRICALLY. THIS CAN BE CAUSED BY EXCESSIVE POINT CLEARANCE, POINT BREAKAGE, TOO MUCH OIL ON FELT CAUSING IT TO SWELL, OR FOREIGN SUBSTANCE INSULATING ELETRICAL CONTACTS.

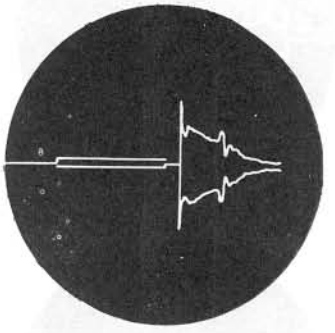
F75-0-4 /97(3)

Figure 7-1. Ignition Analyzer Patterns (Sheet 3 of 5)



OPEN PRIMARY CIRCUIT (DISTRIBUTOR TO COIL)

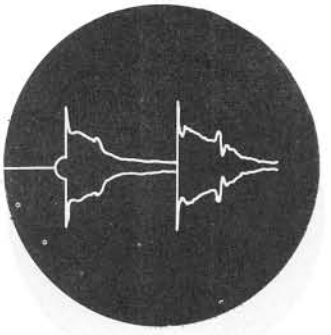
PROBABLE CAUSES: AN OPENING IN THE LEAD FROM THE DISTRIBUTOR TO THE CYLINDER MOUNTED COIL OR IN THE PRIMARY WINDING OF THIS COIL.



SHORTED PRIMARY CIRCUIT PATTERN (DISTRIBUTOR TO COIL) — FAST SWEEP

A SHORTED PRIMARY CIRCUIT BETWEEN THE DISTRIBUTOR AND CYLINDER MOUNTED COIL PRODUCES NO PATTERN FOR THE CYCLE SWITCH SELECTED SPARK PLUG POSITION; ONLY THE HORIZONTAL TRACE LINE WILL BE SEEN. THE PATTERN WILL APPEAR ON ONLY THE SELECTED CLYINDER POSITION, BUT THE PATTERN FOR THE NEXT CYLINDER TO BE FIRED BY THE SELECTED MAGNETO WILL GENERALLY BE DISTORTED BECAUSE OF THE REACTION OF THIS MALFUNCTION ON THE SYSTEM.

PROBABLE CAUSES: A GROUND IN THE PRIMARY LEAP FROM THE DISTRIBUTOR TO THE CYLINDER MOUNTED COIL OR A SHORT IN THE PRIMARY WINDING OF THIS COIL.

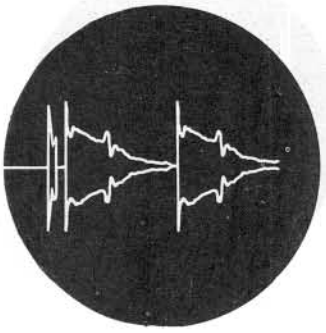


ARCING BREAKER POINTS

PROBABLE CAUSES: OIL ON THE BREAKER POINTS, DEFECTIVE PRIMARY CONDENSER OR FORFIGN MATTER.

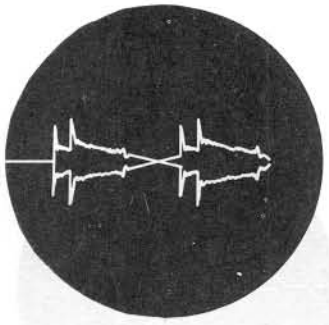
F75-0-4 97-(4)

Figure 7-1. Ignition Analyzer Patterns (Sheet 4 of 5)



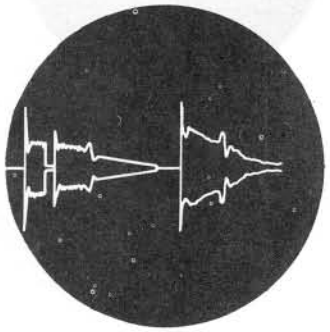
BREAKER POINT BOUNCE PATTERN

PROBABLE CAUSES: A WEAK BREAKER POINT SPRING OR DAMAGED CAM WITH ROUGH SPOTS ON IT. A WEAK SPRING SHOULD CAUSE BOUNCE ON ALL SPARK PLUG POSITIONS OF THE AFFECTED MAGNETO WHILE FOR A DAMAGED CAM THE BOUNCE SHOULD OCCUR AT RANDOM, DEPENDING ON THE POSITION OR POSITIONS OF THE SPOT OR SPOTS.



BREAKER POINT NON-SYNCHRONIZATION — FAST SWEEP

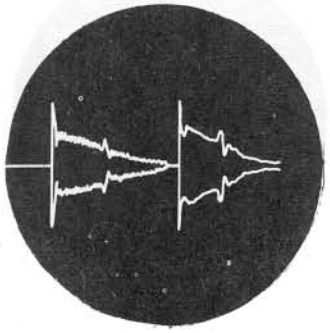
THE DISTRIBUTOR BREAKER POINT SYNCHRONIZATION CHECK IS MADE TO DETERMINE THAT BOTH SPARK PLUGS IN EACH CYLINDER ARE FIRED SIMULTANEOUSLY. THE CONDITION SWITCH IS SET TO DISPLAY THE PATTERNS OF BOTH THE LEFT AND RIGHT MAGNETOS SUPERIMPOSED UPON EACH OTHER. IF THE BREAKER POINTS ARE NOT SYNCHRONIZED, THE PATTERN TO THE LEFT WILL SHOW AN OPENING PERIOD BEFORE THE PATTERN TO THE RIGHT. BY MEASURING THE DISTANCE ON THE SCREEN BETWEEN THE LIMITS OF THE BREAKER POINT OPENING AND ALLOWING 1/32 IN. TO EQUAL ONE DEGREE OF CHANKSHAFT ROTATION, THE AMOUNT OF SYNCHRONIZATION ERROR MAY BE DETERMINED.



ADVANCE RELAY CHATTERING — FAST SWEEP

PROBABLE CAUSE: POINTS OF THE ADVANCE RELAY CHATTERING AND MAKING INTERMITTENT CONTACT.

NOTE: EASILY MISTAKEN FOR BREAKER POINT BOUNCE.



ARCING DISTRIBUTOR BRUSH — FAST SWEEP

PROBABLE CAUSES: BURNED OR DIRTY DISTRIBUTOR SEGMENTS; CONCAVE SEGMENT SURFACE CAUSING BRUSH TO HOP; WEAK BRUSH SPRING; FEATHERED SEGMENT EDGE, OR EXCESSIVE DISTRIBUTOR VIBRATION MAY CAUSE THE BRUSHES TO ARC.

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Figure 7-1. Ignition Analyzer Patterns (Sheet 5 of 5)

3. Rotate either right or left auxiliary oil tank handle to OPEN position.

4. Set hyd. pump transfer handle to PUMP position. Time pump operation to determine quantity of oil to be transferred. Transfer rate is approximately 3 gallons per minute.

5. After the desired quantity of oil has been transferred, set pump transfer handle to EVACUATE position and allow pump to operate for approximately 60 seconds.

6. Return hyd. pump transfer handle to OFF position.

7. Rotate auxiliary oil tank handle to CLOSED position, then return to NEUTRAL position.

8. Rotate engine oil tank selector handle to END position, then return to OFF.

Note

For each engine oil tank replenished, the above procedure is to be followed.

9. When not in use, the handles must be in the following positions:

a. Engine oil tank selector—OFF.

b. Hydraulic pump transfer—OFF.

c. Auxiliary oil tank shut-off—NEUTRAL.

FUEL SYSTEM.

FUEL SYSTEM MANAGEMENT.

For normal long range operation, all take-offs are to be made with tanks 1, 2, 3 and 4 supplying fuel to respective engines. All landings are to be made on tanks 1, 2A, 3A and 4. Use of the recommended fuel loading chart for normal operation, (fig. 7-2) results in optimum fuel distribution. Minimum wing stresses will result when this loading schedule is used in conjunction with the recommended fuel usage procedure. Minimum fuel load restrictions shown in Section V should be observed if deviations from the normal loading usage procedure are necessary. Improper fuel distribution due to unusual loading or usage procedures can, under some circumstances, result in the inability of the wing to withstand design load factors. Refer to the following tables, (fig. 7-2) for the proper fuel consumption sequence for various fuel quantities when the recommended operational fuel loading is followed. Use the tables by entering the column corresponding to the weight of fuel on board the aircraft at take-off and completing the fuel usage procedures in numerical sequence as shown on the left side of the table. The various routes of fuel flow from the fuel tanks to the engines are also shown on the samples (fig. 7-4).

Refueling.

During refueling operations, the following precautionary measures must be taken:

1. A crew member must be assigned who will prevent smoking in the aircraft or in the vicinity until refueling is completed.

2. Loading ramps or stairways must be in position at the entrances and the doors must be kept open.

3. During daytime refueling, the cart battery and the ship battery switches must be turned OFF.

4. During night refueling, the ship battery switch may be left on to provide cabin lighting. The exterior lights switch may either be turned OFF or left at the STEADY position, if required by the airport. All radio equipment, inverters, motors, and similar electrical equipment must be off. No switches are to be operated after refueling is started.

5. The auxiliary ground power source must be shut down and moved clear of the aircraft unless it is explosion-proof.

Fuel Stabilizing Time.

A fuel stabilizing time is required before accurate fuel quantity indications can be obtained for tanks 2 and 3. During that time, dip stick and fuel quantity indicator readings will be high. The following chart shows the approximate time required for fuel to stabilize between the two sections of the tank:

FUEL LOAD (Gallons)	TIME (Minutes)
100	27
200	27
300	27
350	4
400	2½
450	1½
full	1½

Below the 350-gallon level, fuel must stabilize through a ⅝-inch diameter tube. Above the 350-gallon level it stabilizes through a 3-inch diameter tube.

RECOMMENDED FUEL LOADING
WING TIP TANKS ON

TOTAL FUEL GALLONS	QUANTITY PER TANK — GALLONS					
	2B & 3B	2A & 3A	1 & 4	2 & 3	5	6
2000	0	350	500	150	0	0
2200	0	400	550	150	0	0
2400	0	450	600	150	0	0
2600	0	500	650	150	0	0
2800	0	550	700	150	0	0
2860	0	565*	715	150	0	0
3000	35	565*	750	150	0	0
3200	85	565*	800	150	0	0
3400	135	565*	850	150	0	0
3600	185	565*	900	150	0	0
3800	235	565*	950	150	0	0
4000	285	565*	1000	150	0	0
4200	335	565*	1050	150	0	0
4400	385	565*	1100	150	0	0
4600	435	565*	1150	150	0	0
4800	485	565*	1200	150	0	0
5000	535	565*	1250	150	0	0
5200	585	565*	1300	150	0	0
5260	600*	565*	1315	150	0	0
5400	600*	565*	1350	185	0	0
5600	600*	565*	1400	235	0	0
5800	600*	565*	1450	285	0	0
6000	600*	565*	1500	335	0	0
6200	600*	565*	1550	385	0	0
6220	600*	565*	1555*	390	0	0
6400	600*	565*	1555*	480	0	0
6600	600*	565*	1555*	580	0	0
6800	600*	565*	1555*	680	0	0
7000	600*	565*	1555*	780	0	0
7020	600*	565*	1555*	790*	0	0
7200	600*	565*	1555*	790*	180	0
7400	600*	565*	1555*	790*	380	0
7600	600*	565*	1555*	790*	580	0
7750	600*	565*	1555*	790*	730*	0
7800	600*	565*	1555*	790*	730*	50
8000	600*	565*	1555*	790*	730*	250
8200	600*	565*	1555*	790*	730*	450
8400	600*	565*	1555*	790*	730*	650
8600	600*	565*	1555*	790*	730*	850
8750	600*	565*	1555*	790*	730*	1000*

NOTE: Tanks full at quantities noted (*).

Figure 7-2. Recommended Fuel Loading Table — Tip Tanks On

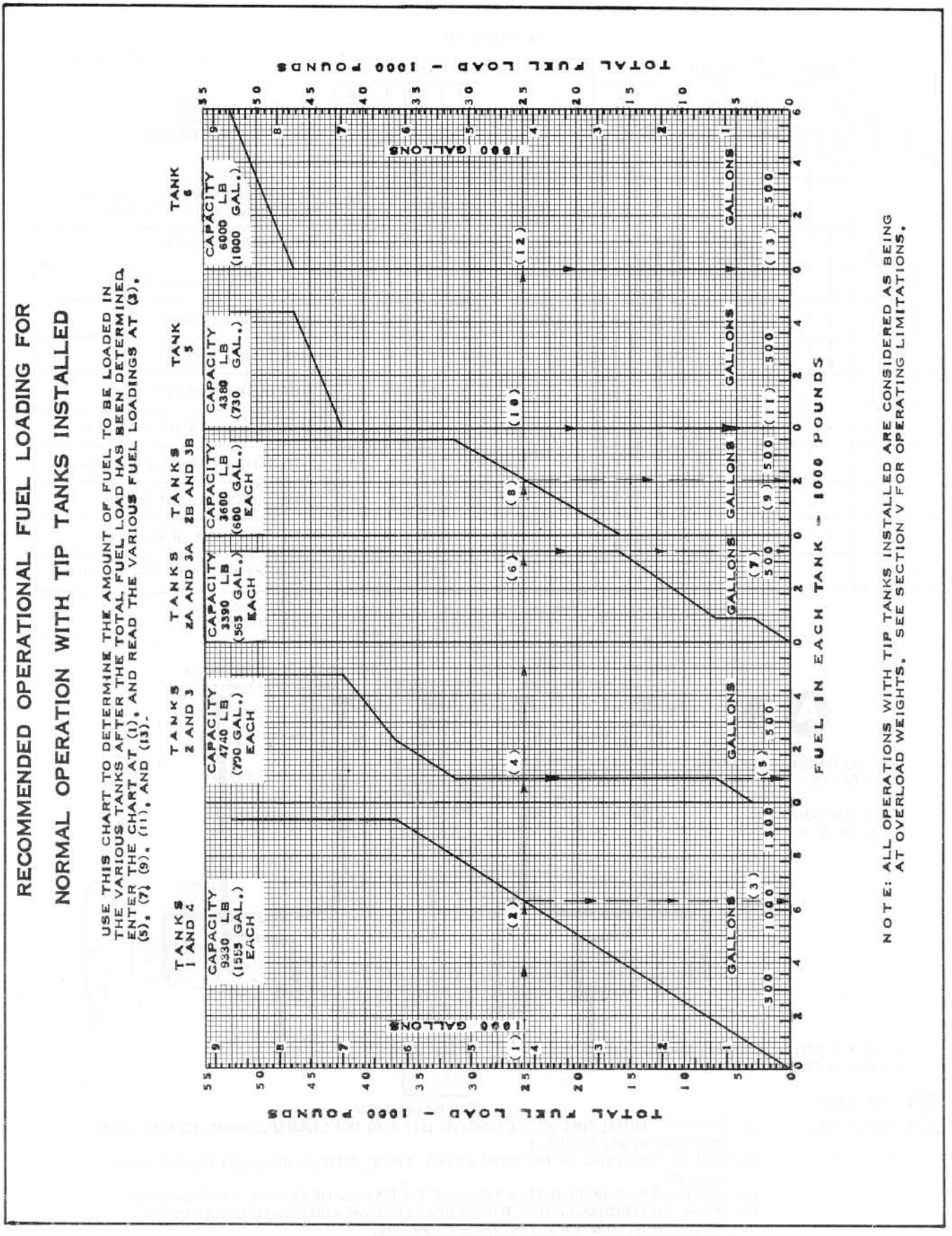
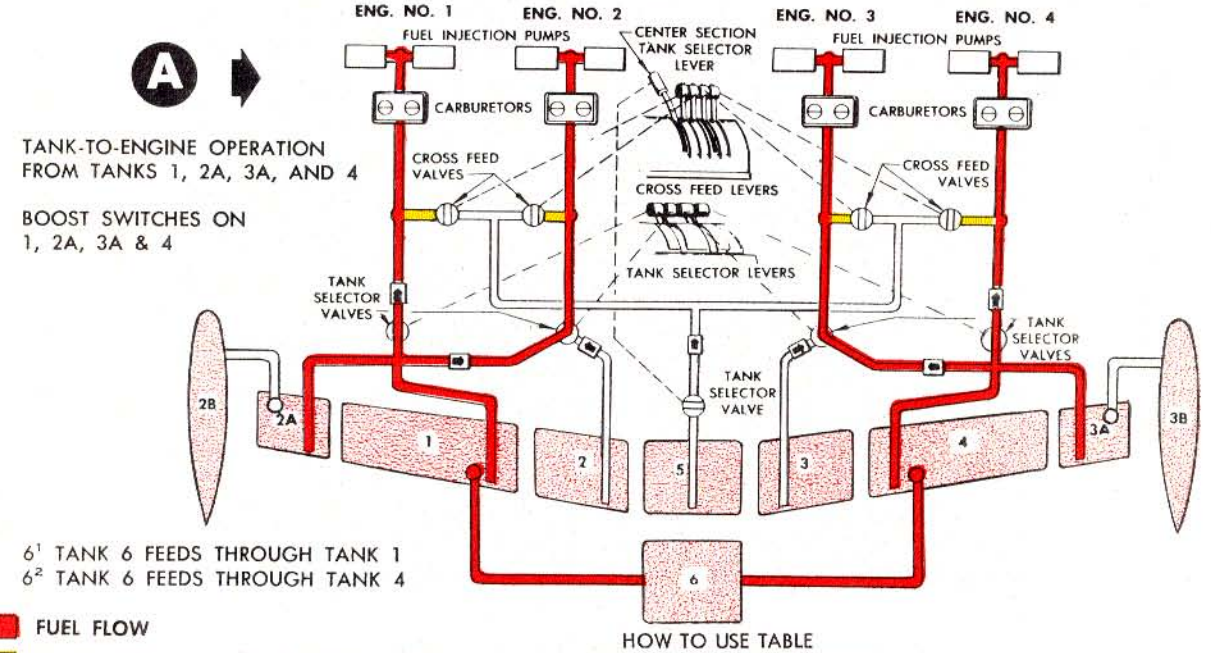


Figure 7-3. Recommended Operational Fuel Loading Graph — Normal Operation

TIP TANKS ON

INITIAL FUEL WEIGHT									ENGINE				FUEL USAGE PROCEDURES
52500 TO 50880	50880	50880 TO 46500	46500 TO 42120	42120 TO 37320	37320 TO 31560	31560 TO 17160	17160 TO 7200		1	2	3	4	
									FUEL TANK				
1	1	1	1	1	1	1	1	TAKE-OFF AND CLIMB	1	2	3	4	TAKE-OFF AND CLIMB, USING NOT MORE THAN 150 GALS./1 TANK
2	↓	↓	↓	↓	↓	↓	↓	EMPTY FUSELAGE TANKS	6[1]	5	5	6[2]	UNTIL TANK 5 IS EMPTY
↓	2	↓	↓	↓	↓	↓	↓		6	5	5	6	UNTIL TANKS 5 & 6 ARE EMPTY
↓	↓	2	↓	↓	↓	↓	↓		6	5	5	6	UNTIL TANK 6 IS EMPTY
3	↓	↓	↓	↓	↓	↓	↓		6	2	3	6	UNTIL TANK 6 IS EMPTY
↓	↓	3	2	↓	↓	↓	↓		5	2	3	5	UNTIL TANK 5 IS EMPTY
4	3	4	3	2	↓	↓	↓	CROSS FEED	2	2	3	4	UNTIL TANK 1 = TANKS 2 + 2A + 2B
5	4	5	4	3	↓	↓	↓		1	2	3	3	UNTIL TANK 4 = TANKS 3 + 3A + 3B
6	5	6	5	4	2	↓	↓	CRUISE	1	2	3	4	UNTIL TANKS 2 & 3 ARE EMPTY
7	6	7	6	5	3	2	↓		1	2B	3B	4	UNTIL TANKS 2B & 3B ARE EMPTY
8	7	8	7	6	4	3	2	END FLIGHT AND LAND	1	2A	3A	4	REMAINDER OF FLIGHT AND LANDING

The cross-feed operation is shown immediately after fuel in tank 5 is exhausted, which is the most critical time from structural considerations. However, it may be done at any operationally desirable time after the fuel in tank 5 has been used, provided it is complete by the time that tanks 2 and 3 become empty.
This fuel management procedure affords optimum utilization of wing strength.



HOW TO USE TABLE

(a) ENTER THE INITIAL FUEL WT. COLUMN AT LEFT AND TOP CORRESPONDING TO FUEL LOAD AND READ DOWN TO NO. 1.
(b) READ THE PROCEDURE AT THE RIGHT OF NO. 1 (FUEL TANK) AND ADJUST THE FUEL FEED AS SHOWN.
(c) CONTINUE FEED UNTIL INSTRUCTIONS OF THE FUEL USAGE COLUMN ARE COMPLETED.
(d) RETURN TO ORIGINALLY SELECTED VERTICAL COLUMN AND COMPLETE FUEL USAGE PROCEDURE IN NUMERICAL SEQUENCE AS SHOWN.

Figure 7-4. Fuel System Management

Auxiliary Fuel Pumps.

Each fuel tank contains an electrically-operated, submerged fuel booster pump. These pumps supply relatively vapor-free fuel under pressure to the engine-driven fuel pumps so that engine operation is not affected by vapor and entrained air. The HIGH positions are used during take-off and landing, and to supply fuel under pressure in the event of engine-driven fuel pump failures; or where the LOW position cannot maintain sufficient pressure. The LOW positions are used during climb, cruise, and descent.

Cross Feed Operation.

When going to cross-feed operation, it is recommended that the fuel booster pump of the tank to supply the fuel be turned to HIGH. After cross-feed operation has been established, the fuel booster pump of this tank may be returned to the LOW position provided fuel pressure is maintained within limits.

CAUTION

Do not place the switches for tanks 6R and 6L in HIGH position except during fuel dumping. In the event of a float valve malfunction in tanks 1 and 4, the HIGH position will deliver pressure to tanks 1 and 4 in excess of their design limitations.

FUEL LEAKS.

Inspecting and Recording Leaks:

Careful inspection in a well-lighted area is of prime importance. It is particularly important to inspect carefully for seeps and leaks in confined areas such as forward of the front spar, aft of the rear spar, and in the nacelles. Care and judgment will ensure that old stains, and leaks that have been fixed, are not recorded. If there is doubt as to whether a stain actually indicates the presence of a leak, the stain should be wiped off and the area observed for a time to see if fuel reappears.

Types of Leaks:

1. Stain: The mildest kind of leak is the stain. This is a discoloration around fasteners or seams caused by very slow fuel seepage which dries as it meets the open air. A stain should be wiped off, and if it does not reappear within one hour, it should merely be recorded and periodically inspected.

2. Seep: A seep is a heavy stain which, when wiped off with a rag, reappears within one hour. This type of leak should be inspected frequently for increased activity.

3. Heavy Seep: Seepage that increases to the point where it reappears immediately after being wiped off is defined as a heavy seep and should be repaired if maintenance is available.

4. Dripping Leak: This is a continuous fuel leak which wets a limited area and then drips off the aircraft. Repair is recommended before flight.

5. Running Leak: This is a continuous running of fuel caused by a definite break in the sealant and the source is usually easy to locate. A running leak should be repaired before the aircraft is released for flight.

Types of Leaks and Recommended Action:

The following table may be used as a guide to determine the action required when any type of leak occurs in various locations in the wing.

FUEL LEAK LOCATION	*ACTION REQUIRED*				
	Stain	*Seep*	*Heavy Seep*	*Dripping Leak*	*Running Leak*
Open areas on upper or lower skin surface	A	A	A	C	C
Between WS 450 and 480	A	A	B	C	C
Areas forward of front spar and aft of rear spar and areas on either side of the engine nacelles	A	B	C	C	C
From corrugations at WS 80	A	B	C	C	C
In wheel well	A	C	C	C	C
Under de-icer boot on outer wing	A	C	C	C	C
Under de-icer boot on outer wing	A	C	C	C	C
At cap strip, lower skin of inner wing at WS 80	A	C	C	C	C

A. Clean surface and inspect frequently.

B. Make temporary or external repairs if aircraft is not at a maintenance base.

C. Make internal repair immediately.

FILLING MAIN OR EMERGENCY HYDRAULIC RESERVOIR IN FLIGHT.

Emergency hydraulic fluid may be used to replenish either the main hydraulic reservoir or the emergency extension and brake reservoir by the following method.

1. Attach the emergency fluid hose to the capped line.

2. Set hydraulic reservoir selector to reservoir to be replenished.

3. Operate hydraulic reservoir filler wobble pump handle.

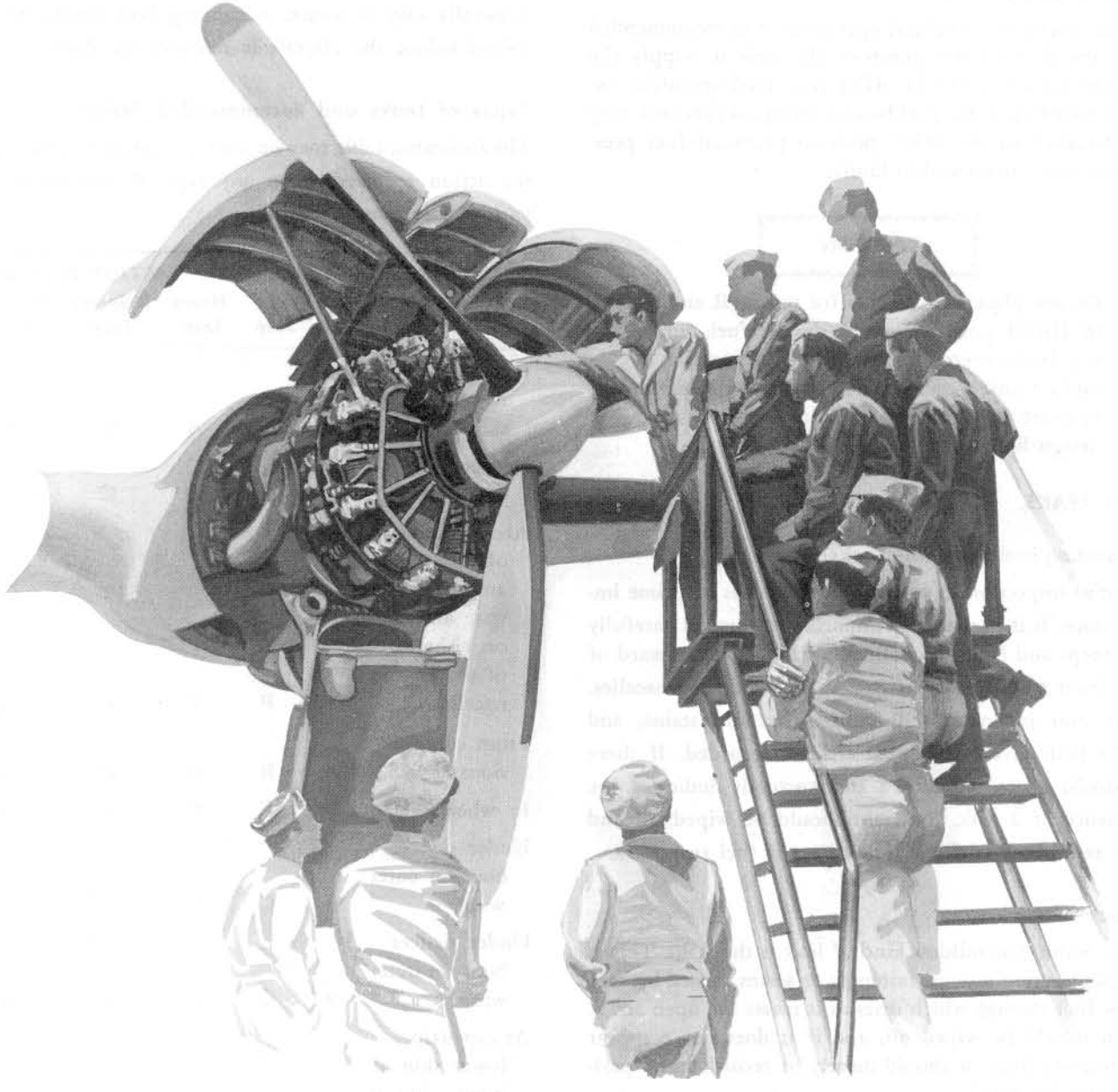
Note

If fluid fails to flow, the pump requires bleeding. Proceed as follows:

a. Pump bleed valve—OPEN.

b. Disperse air in the pump, by operating handle until fluid flows from the bleed port.

c. Pump bleed valve—CLOSED.



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SECTION VIII CREW DUTIES

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INTRODUCTION.

The successful completion of a mission assigned, is dependent upon crew coordination as well as the proficiency and training of each crew member. The duties are divided among the crew members on the premise that high speed AEW and patrol aircraft function with maximum efficiency as a result of flight crew cooperation. It is believed that adherence to the following items will establish the basic requirements of crew coordination, and aid in blending the skill and abilities of the individual crew members into an efficient team. Standard phraseology should be used during all flight operations and that those terms selected, are clear and familiar to the majority of flight crew members. Unnecessary conversations between crew members should be avoided during certain phases of the flight such as take-off, approaches, landings, and EMERGENCIES. Communications at these times should be limited to pertinent orders and responses. The tone of voice used by flight crew members must be of such clarity as to preclude the necessity of repeating a command or an acknowledgment. Misunderstanding a command may result in confusion and could induce a hazard to safe flight.

PILOT.

The pilot is responsible for the progress and completion of a successful flight. He is vested with the authority

to carry out this responsibility, and is in command of assigned crew members from the time they report for duty until termination of such assignment. The pilot's orders should receive prompt compliance; however, other crew members shall bring to his attention such information and factors of importance which could have a direct bearing on his ultimate decision in instances which involve safety of flight.

COPILOT.

The copilot is second in command and shall assist the pilot at such times the pilot in command deems necessary.

FLIGHT ENGINEER.

The flight engineer is directly responsible to the pilot in command. The check list for the flight engineer is covered in detail in Section II. Duties further include the following:

1. Maintain all necessary data and an accurate flight log.

2. Keeping ground stations informed of mechanical discrepancies that will facilitate repairs upon arrival.

3. Maintaining proficiency in handling emergency procedures.

RADIO OPERATOR.

The primary duty of the radio operator is to operate and check the radio equipment to assure the maintenance of communications throughout the mission. The following is a checklist for this position. Although these duties are the primary responsibility of the first radio operator, he may delegate any of these duties to the second radio operator.

MISSION PLANNING.

1. Tool kit — checked
2. Radio operator's kit — checked
3. Classified publications — checked
4. Briefing — as required

VISUAL PREFLIGHT.

1. Exterior of aircraft — checked
   a. Nose radome
   b. Liaison, Loran, L/F, Marker beacon, IFF, Radar altimeters, and all UHF antennas, insulators, mounts, for cleanliness and security.
   c. External ICS boxes — checked
   d. Static dischargers — checked
2. Form 781 and G file — checked

PREFLIGHT.

1. ICS dynamotors, Emergency ICS relay circuit breakers and fuses — ON
2. APU power — ON
3. No. 6 UHF control box dials locked and ON — REMOTE CHECKED
4. Radio operator's junction box circuit breakers — ON
5. Command equipment—Transmitter on REMOTE, Receiver on MCW/CAL, all dials locked — ON
6. Instrument inverter power — ON
7. Forward radio rack equipment plugs, fuses, security. — checked
8. Pilot's radio equipment — ALL ON
9. Flight deck headsets and mikes — checked
10. Pilots interphone system — checked
11. P. A. system (including emergency ICS) — checked
12. Radio compass, all bands, all functions, alignment, bearings and indicators — checked
13. ILS equipment, output, bearings, course selector, indicators and marker beacon lights — checked
14. Range filters, position 1 and 2 — checked
15. Radar altimeter — checked
16. UHF No. 6, two way communication, antenna relay, ADF operation and channelization card — checked
17. Command H/F remote operation — checked
18. Aldis lamp — checked
19. Mechanic's ICS switch — ON
20. Engineer's head set, mike and interphone — checked
21. Navigator's head set, mike, and interphone — checked
22. Navigator's ARN-6 control alignment and operation — checked
23. Navigator's range filter — checked
24. Radio operator's seat, track and lock — checked
25. Radio operator's headset mike and interphone — checked
26. Liaison equipment, two way communications, CFI, channelization card and security — checked

27. L/F receiver alignment, operation, and security — checked
28. IFF control box — checked
29. Emergency keyer light and safety ON-OFF switch — checked
30. Command liaison key transfer switch — checked
31. UHF sets No. 7 & 8, two way communications, relay operation and channelization — checked
32. Pilot relay UHF switch operation — checked
33. Hand key operation and adjustment — checked
34. Panel and flex light — checked
35. Obtain time clock and set all clocks — checked
36. All radio operator's equipment — OFF
37. Very pistol and flares — checked
38. CRT-3 radio — checked
39. Equipment in radio operator's equipment rack — checked
40. Equipment in forward baggage compartment — checked
41. ARN-6 receiver unit and equipment in DRT rack — checked
42. Equipment in aft baggage compartment — checked
43. URC-4 operation — checked
44. UHF Number 1–5 operation — checked
45. Form 781 — complete
46. Advise pilot preflight complete — reported
47. All required personal equipment — fitted and checked
48. All personal equipment — stowed
49. Overwing hatches — closed
50. Interphone and alarm bell check — reported

INFLIGHT.

1. Radio log — maintained
2. Communications with tower — monitor
3. Overwing check after take-off and hourly during flight — reported
4. Safety belt — fasten

POSTFLIGHT.

1. All equipment — OFF
2. Logs and forms — signed and complete
3. Form 781 — complete

NAVIGATOR.

The navigator is responsible for all matters pertaining to flight planning and will perform any other assigned duties. He will also perform the following preflight inspection of navigational equipment and report the condition to the pilot.

MISSION PLANNING.

1. Mission requirements — understood
2. Weather — checked
3. Navigation kit — completed
4. Flight plan — completed

PREFLIGHT.

1. Driftmeter (glass condition) — checked
2. GND STAB switch — STANDBY
3. Circuit breakers (CGRS) — checked
4. Form 781 (form 1) — checked
5. Circuit breakers (radio station as required) — checked

PREFLIGHT STATION.

1. Lights — checked
2. Driftmeter (operation and alignment) — checked
3. Periscopic sextant — checked
4. Inertia switch (when applicable) — checked
5. CGRS (when applicable) — checked
6. Loran (AN/APN-70, AN/APN-9) — checked
7. AN/APA-57B — checked
8. CP-131 (when applicable) — checked
9. Compass, altimeter and airspeed calibration cards — checked
10. SCR/718 radio altimeter — checked
11. Time check — obtained
12. First aid kits — aboard
13. Chair and safety belt — checked
14. Stand — stowed
15. Personal equipment — checked and stowed

INFLIGHT.

1. Navigational procedures as prescribed by existing directives.

POSTFLIGHT.

1. Equipment and switches	OFF
2. Police station	complete
3. Chair	stowed
4. Record all write-ups in form 781 (form 1)	complete
5. Turn in all maps, charts, logs, and forms as required	complete

RADAR TECHNICIAN.

The primary duty of the radar technician is to maintain all electronic equipment used in the radar system in operating condition, throughout the mission. Duties further include performing the following checklist.

MISSION PLANNING.

1. Tools (including special tools)	checked
2. Technical orders	checked
3. Test equipment	checked
4. Tube caddy	checked

VISUAL PREFLIGHT.

1. Form 781	checked
2. Inflight maintenance report	checked
3. Inflight maintenance kit	checked
4. Inventory of radar 263 equip.	checked
5. APS-20 insulating oil reservoir level	checked
6. APS-20 HD-125 coolant level	checked
7. Lower dome and interior and exterior inspection	checked
8. Cable connections	checked
9. Air line connections	checked
10. Interlocks and cabling	checked

PREFLIGHT.

1. A.C. and D.C. power units	checked
2. Power selector switch external	checked
3. Main electronic inverter	ON
4. Circuit breakers at radar technician A. C. power panel	ON
5. CGRS system	ON
6. Voltage input at APS-20 set control	checked
7. Voltage input APS-45 control panel	checked
8. APS-20 selector switch to STANDBY ON RCS	
a. Heat light ON should go out in approximately 10 seconds.	
b. Air light ON should go out when air pressure reads 15 PSI.	
c. Overload light ON should go out in 15 minutes when the set has timed out.	
9. Auxiliary vent blowers	ON
10. Blower motors operating	checked
11. APS-20 receiver and low voltage power supply	checked
12. APX-7 power switch	ON
13. Voltage output PP-347/APS-20	checked
14. Monitor video signals from RSC	checked
15. APS-45 master and standby switch	ON
16. CN-212/APA-56 power switches	ON
a. IP–230	ON
b. CV–78	ON
c. APA–81	ON
d. J–294	ON
e. IP–229's	ON

Note

Allow 20 minutes to warm up before alignment checks.

17. APA-57 Power	ON
18. APS-20 antenna control switch	ON
a. Low C. W.	ON
b. High C. W.	ON
Smooth sweep on all PPI indicators	
19. Monitor IFF APX-7	checked
a. Test meter reading	checked
b. Target returns	checked
20. Antenna stabilization	checked
21. Heading markers on all PPI same as aircraft magnetic heading	checked
22. GPI dislacement on all IP-229/APA-56	checked
23. APS-45	ON
a. Antenna rotation	checked

b. Antenna scan checked
c. Transmitter ON
d. Automatic run-up checked
e. Manual raise to normal checked
f. AFC locks ON
g. MDS power checked
h. RHI and PPI presentation checked

24. APS-20 ON
    a. Crystal shutter action checked
    b. MDS power and spectrum checked
25. Turn all control power switches on all radar equipment OFF
26. Turn A.C. power selector switch OFF
27. Personal survival equipment fitted and stowed

ENGINE RUN-UP.

1. A. C. generators check
2. Power selector switch NORMAL
3. A. C. generators ON

INFLIGHT.

1. Perform fume checks when ordered by the senior director.
2. Monitor A. C. voltage and adjust carbon pile regulators if necessary.
3. Turn ON electronic equipment as outlined in Section 4.
4. During the mission the radar technician will monitor the operation of the electronic equipment to insure maximum operating performance.
5. One technician will man the radar technician's station at all times, other than periods which require the combined efforts of both technicians to correct an electronic difficulty. The technician will constantly monitor the radar performance utilizing the IP-203 PPI scope for normal video and sweep presentation.
6. A complete check of the radar system will be accomplished every hour or earlier if deemed necessary.
7. The amount of inflight maintenance performed will be determined by the nature of the failure, parts, test equipment available and the feasibility of the repair. In the event of a malfunction of the radar equipment an estimate of time for the repair will be given to the senior director.

AFTER LANDING.

1. A. C. generators OFF (after engines are shut down)
2. CGRS OFF (after engines are shut down)
3. Electronic inverter OFF

POSTFLIGHT.

1. Upon completion of the mission the senior director's permission will be obtained prior to turning the radar equipment off.
2. Secure all loose equipment and test set.

SENIOR DIRECTOR.

MISSION PLANNING.

1. Intercept controller's kit checked
2. Attend crew briefing and obtain latest tactical information pertinent.

PREFLIGHT.

1. Assure that all radar systems are in operating condition and are capable of completing the assigned tactical mission.
2. Report radar system mission status to the pilot.
3. Personal survival equipment fitted and stowed
4. Take position assigned.
5. Duty rest schedule posted

INFLIGHT.

1. Complete operations in accordance with existing directives.

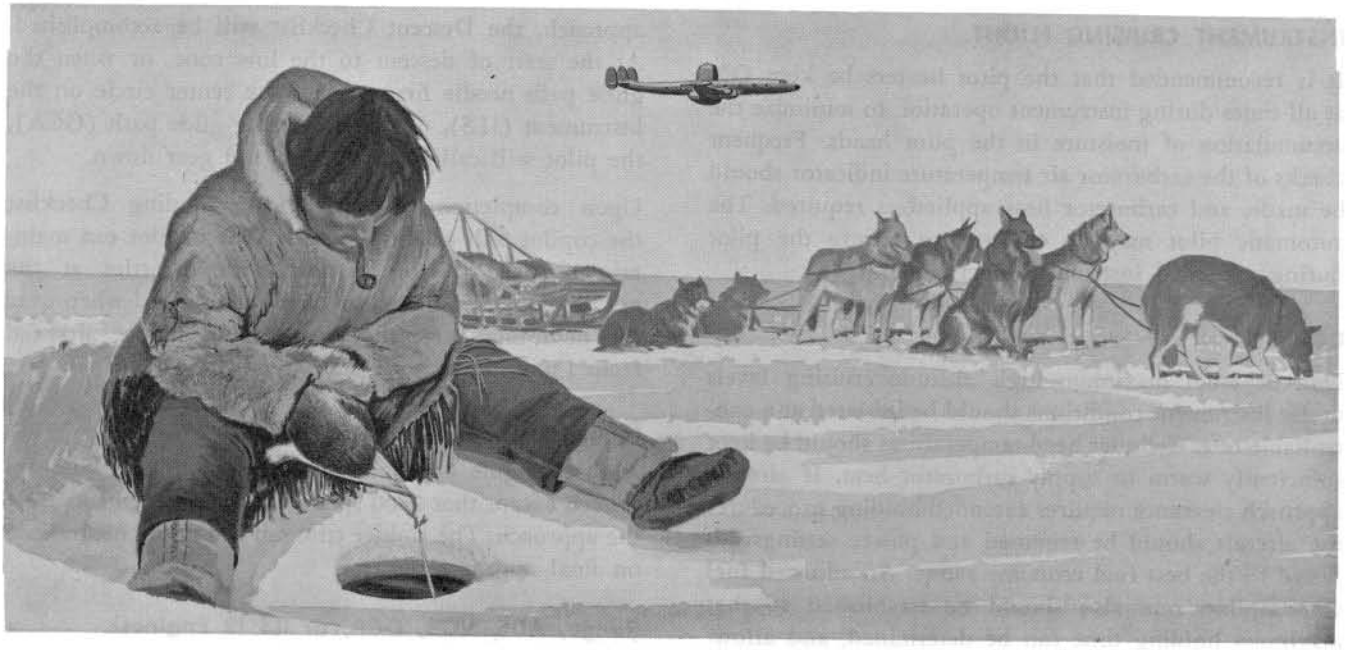
Note

The senior director is responsible for efficient operation of the airborne operation center during a specified tour of duty. He will brief AOC crew members and be responsible for their compliance with all instructions.

SEARCH RADAR OPERATOR

1. Individual emergency survival equipment checked, fitted and stowed.
2. Complete operations in accordance with existing directives.

Last Page of Section VIII.



SECTION IX ALL WEATHER OPERATION

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INTRODUCTION.

Except when repetition is necessary for emphasis, clarity, or continuity of thought, this section contains only those procedures that differ from normal operating instructions covered in Section II.

The aircraft has good stability and flight characteristics that make possible long range flights under sustained instrument operation with minimum pilot fatigue. Each pilot's instrument panel is arranged with a complete set of flight instruments, and an automatic pilot incorporated in the flight control system to relieve the pilot of manual control. Instrument lighting and radio remote controls are provided within easy reach of either pilot.

INSTRUMENT FLIGHT PROCEDURES.

INSTRUMENT TAKE-OFF.

1. Check directional flight instruments during taxiing turns.

2. Adjust instrument lighting as required.

3. Align aircraft with the center line of the runway, straighten nose wheel, and hold with toe brakes.

4. Turn on radio altimeter and set limit switch to 50 feet.

INSTRUMENT CRUISING FLIGHT.

It is recommended that the pitot heaters be kept ON at all times during instrument operation to minimize the accumulation of moisture in the pitot heads. Frequent checks of the carburetor air temperature indicator should be made, and carburetor heat applied as required. The automatic pilot may be engaged to relieve the pilot during extended instrument operation.

DESCENT.

Descent from maximum high altitude cruising levels under instrument conditions should be initiated at a controllable rate. Cylinder head temperatures should be kept sufficiently warm to supply carburetor heat. If airways approach clearance requires extended holding procedures the aircraft should be trimmed and power settings adjusted to the best fuel economy range. An adjusted fuel consumption rate also should be established so that maximum holding time can be determined, and allowances be made for proceeding to an alternate airport.

HOLDING PROCEDURE.

If it is necessary to hold, request an expected approach time and set up maximum endurance power. Extend flaps to TAKE-OFF position and maintain approximately 140 knots. If icing and turbulences are encountered during holding procedure, flaps should be retracted and airspeed increased.

INSTRUMENT APPROACHES.

The general qualities and capabilities of the aircraft during instrument approaches are considered to be excellent and no special technique is required. Instrument letdowns from holding patterns normally do not require extensive retrimming of the aircraft to establish the approach speeds. Letdown from cruising altitudes without holding procedures can be made in the clean configuration, or with the gear and flaps extended. Pilot's discretion is important in determining the particular choice of action when icing or turbulence is anticipated. If accurate ETA to the radio fix is known and no delay is expected, or approach clearance has already been granted, approximately 3 minutes prior to ETA the Descent Checklist should be accomplished. The aircraft should be slowed to 140 knots, take-off flaps extended, and rpm increased to 2400. If ETA is not known the Descent Checklist will not be accomplished until position is established, close in or over the cone. The radar altimeter will be set for minimum altitude for instrument approach. The pilot will maintain 140 knots during holding and procedure turns, and 130 knots will be maintained during final descent with gear and flaps extended. After holding, and when over high cone, outer marker (ILS), or radio fix (GCA) and starting approach, the Descent Checklist will be accomplished. At the start of descent to the low cone, or when the glide path needle first touches the center circle on the instrument (ILS), or when entering glide path (GCA), the pilot will call for 2600 rpm and gear down.

Upon completion of the Before Landing Checklist the copilot will advise the pilot. The copilot can maintain airspeed during descent with throttles at the pilot's request. When clear of all clouds and when over the field boundary, the pilot should reduce airspeed from 130 knots to 1.3 x stall speed.

Range, ADF, VOR, GCA, or ILS (3 Engines).

A three-engine approach is same as a four-engine approach except that 2600 rpm should be used throughout the approach. The rudder trim tab should be neutralized on final approach.

Range, ADF, VOR, GCA, or ILS (2 Engines).

A two-engine approach is same as a four-engine approach except that 2600 rpm (2900 if necessary) should be used throughout the approach. Delay putting gear down as long is possible, but allow adequate time for extension and locking. The rudder trim tab should be neutralized on final approach.

Insure against getting too low and slow at any point.

Pilots should acquaint themselves with all suitable alternate airfields within range of their usual landing field.

It is permissible to use the auto pilot during extended holding.

Careful study of the approach plate for each station is mandatory prior to the approach. Minimum altitudes, courses, times on various headings, and missed approach procedure should be fixed in the pilot's mind.

The copilot will advise the pilot if aircraft goes below a minimum altitude and/or airspeed deviates 10 knots or more from normal.

The Descent Checklist should be accomplished, and the aircraft set up for the instrument approach prior to crossing the high cone, or radio fix, when holding is required.

Turns during an instrument approach should be standard except when correcting for wind drift as in holding, or when making small corrections during final approach.

When the aircraft completes the turn onto final approach, it should be slowed to 130 knots. When the landing gear is lowered to start the descent, only a very small change in MAP will be necessary to establish a 500 fpm rate of descent.

To maintain a glide path, any adjustments to the rate of descent must be immediate and positive. When airspeed is off more than 5 knots and altitude is off more than 50 feet, a return to the glide path can best be accomplished by altering the attitude of the aircraft combined with a slight change in MAP. Normally, a 200 fpm variation from glide path rate of descent will bring the aircraft back to the glide path.

Heading corrections must be initiated promptly, but overcontrolling must be avoided. A good rule of thumb on final approach is not to exceed in angle of bank the number of degrees to be corrected in heading.

Although only one compass may be used as the primary indicator for directional control, (such as the CGRS on the pilot's side) the compass should be cross-checked. Thus malfunctioning of the primary compass can be detected immediately and primary shifted to another instrument.

Weather minimums for each station are contained in current publications. You must adhere to these minimums. Pilots are cautioned to allow for possible settling of the aircraft during pull up at minimums. Heavily loaded aircraft may settle as much as 100 feet before pull-up power takes affect. Both the pressure and the radio altimeters must be referred to constantly during the approach.

DO NOT DESCEND BELOW THE PRESCRIBED MINIMUMS.

During approaches with minimum weather conditions, it may be advisable not to change the wing flaps setting after breaking out.

The failure of two engines will affect the manner in which some aircraft systems function because of the way in which they are integrated with various engines. For this reason, effects of losing more than one engine must be understood and anticipated when executing a two-engine instrument approach.

Low Visibility Approaches.

If it becomes necessary to make a low visibility approach in order to align the aircraft with the landing runway, the following method may be used:

Fly downwind over the landing runway and as the aircraft passes over the end of the runway execute either a 40-second, or a 90-degree procedure turn. This turn may be started as early or as late as desired.

The maneuvering configuration for all four-engine, low visibility approaches will be 2600 RPM, gear down, 60% flaps, and 140 knots airspeed. Maintain a level altitude until turning on final with runway in sight. Landing gear will be lowered at a later point if an emergency exists.

During low visibility conditions at night, the tower should be requested to turn the runway lights to full brilliance until they see your lights on final, at which time they should dim the runway lights to about strength two.

The procedure turn may be made in either direction, keeping in mind obstructions near the end of the runway, and keeping the pilot on the inside of the final turn.

Radio Range Approach.

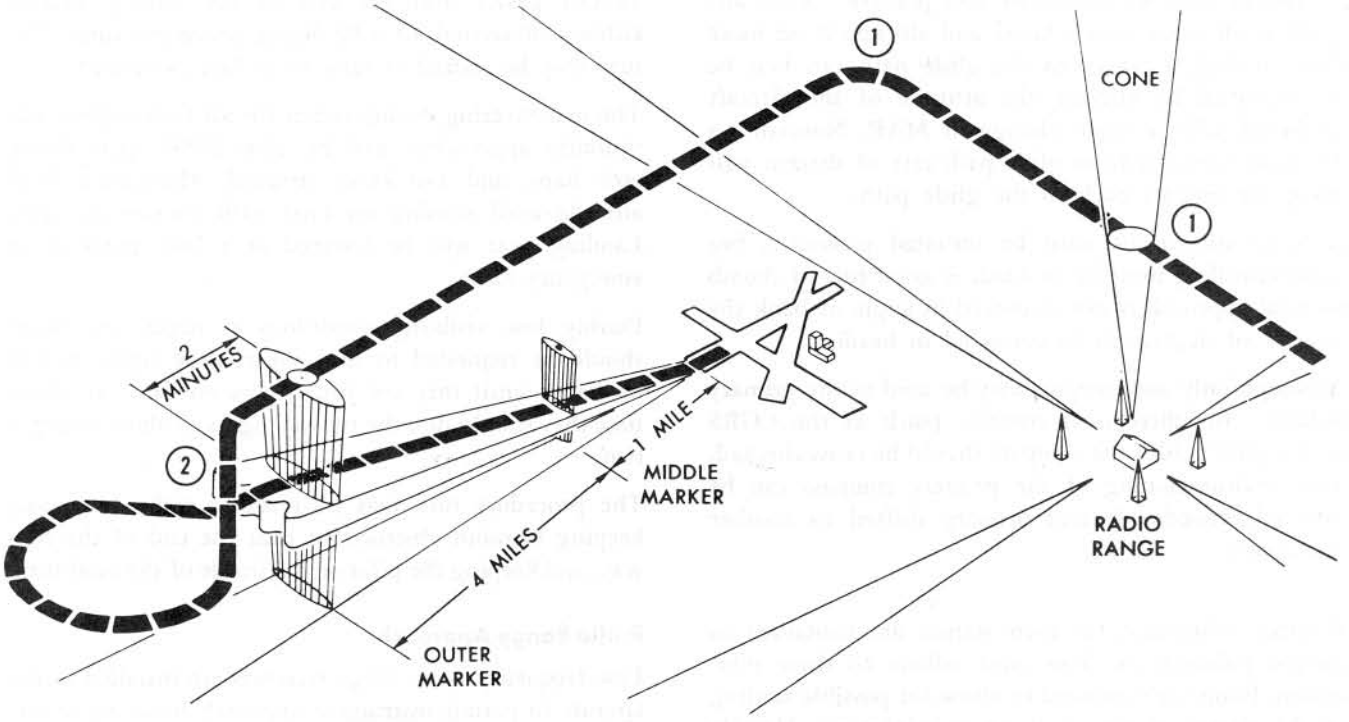
Low frequency radio range receivers are installed in the aircraft to permit instrument approach let-down at airfields that are equipped with only low frequency range facilities. During low frequency range operation, atmospheric conditions may cause excessive radio static which should be anticipated by the pilot when planning the approach.

Ground Controlled Approach.

The ground controlled approach (GCA) system consists of ground radar equipment that visually tracks the aircraft through an instrument let-down procedure. The GCA operators on the ground advise the pilot by voice communications of the headings and altitudes required to fly a transition pattern to the instrument landing runway.

Instrument Landing System.

The instrument landing system (ILS) provides the pilot with a means of completing precision instrument approaches. This system consists essentially of a localizer, a glide path, and outer and middle markers. When ILS and GCA facilities are available, one may be monitored against the other during the instrument approach.



4 ENGINE

(1) **TRANSITION FROM RANGE TO ILAS OR GCA:**
AIRSPEED - 140 KNOTS
RPM - 2400
FLAPS - T.O.
BEFORE LANDING CHECK LIST

AT GLIDE PATH: (2)
AIRSPEED - 130 KNOTS
RPM - 2600
GEAR DOWN
COMPLETE CHECK LIST

3 ENGINE

(1) **TRANSITION FROM RANGE TO ILAS OR GCA:**
AIRSPEED - 140 KNOTS
RPM - 2600
FLAPS - T.O.
BEFORE LANDING CHECK LIST

AT GLIDE PATH: (2)
AIRSPEED - 130 KNOTS
RPM - 2600
GEAR DOWN
COMPLETE CHECK LIST

2 ENGINE

(1) **TRANSITION FROM RANGE TO ILAS OR GCA:**
AIRSPEED - 140 KNOTS
RPM - 2600
FLAPS - T.O.
BEFORE LANDING CHECK LIST

AT GLIDE PATH: (2)
AIRSPEED - 130 KNOTS (MINIMUM)
RPM-2600
GEAR DOWN
COMPLETE CHECK LIST EXCEPT GEAR

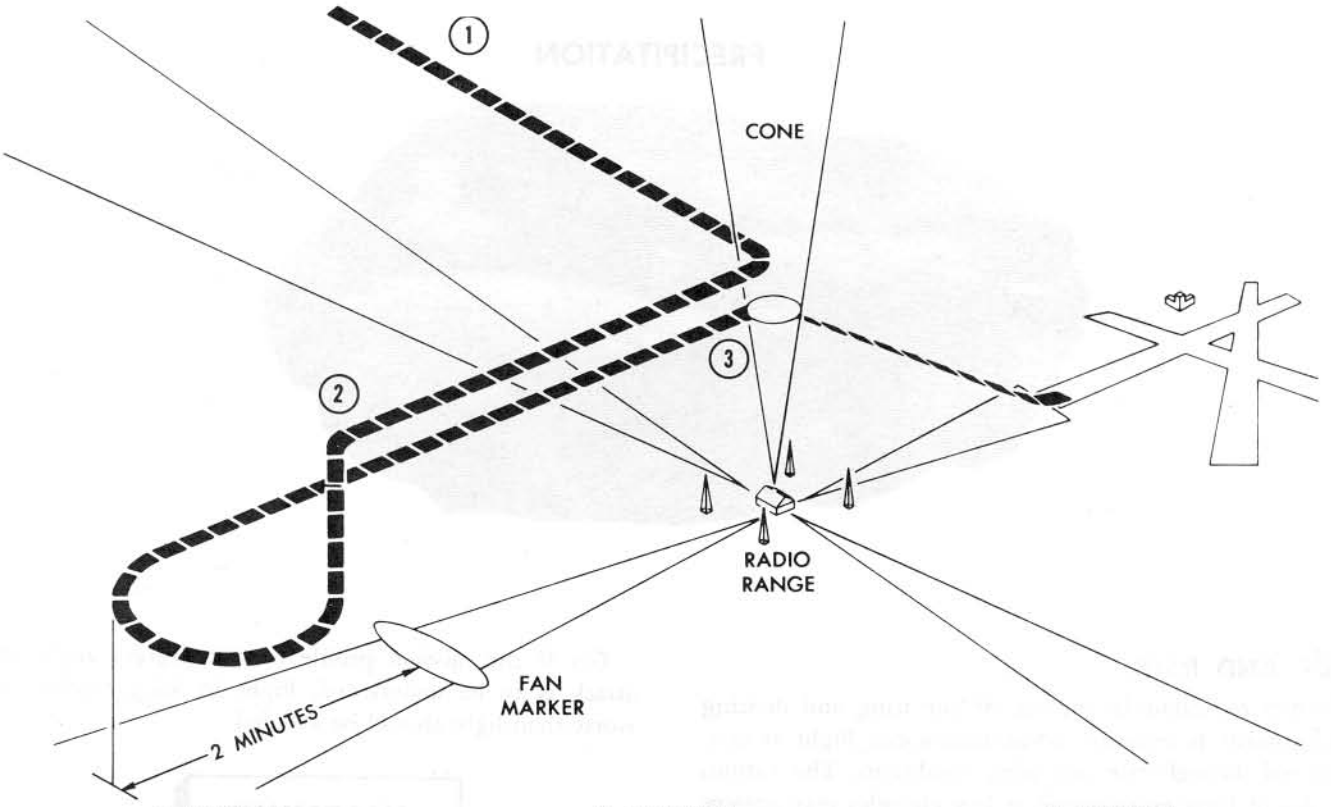
NOTE:
DELAY GEAR EXTENSION UNTIL LANDING IS REASONABLY ASSURED.

4 ENGINE POWER SETTINGS FOR FOLLOWING CONFIGURATIONS AT 110,000 LB. LANDING WEIGHT

FLIGHT	AIRSPEED	RPM	MAP	FLAPS	GEAR
LEVEL	140 KNOTS	2400	28″	T.O.	UP
LEVEL	140 KNOTS	2600	33″	T.O.	DOWN
DESCENT	130 KNOTS	2400	23″	T.O.	UP
DESCENT	130 KNOTS	2600	28″	T.O.	DOWN

F75-3-9-35 (1)

Figure 9-1. GCA or ILS Approach Procedures



4 ENGINE

BEFORE HIGH CONE:
AIRSPEED - 140 KNOTS
RPM - 2400
FLAPS - T.O.
BEFORE LANDING
CHECK LIST

PROCEDURE TURN:
140 KNOTS

LET DOWN:
AIRSPEED - 130 KNOTS
RPM - 2600
COMPLETE CHECK LIST

3 ENGINE

BEFORE HIGH CONE:
AIRSPEED - 140 KNOTS
RPM - 2600
FLAPS - T.O.
BEFORE LANDING
CHECK LIST

PROCEDURE TURN:
140 KNOTS

LET DOWN:
AIRSPEED - 130 KNOTS
RPM - 2600
COMPLETE CHECK LIST

2 ENGINE

BEFORE HIGH CONE:
AIRSPEED - 140 KNOTS
RPM - 2600
FLAPS - T.O.
BEFORE LANDING
CHECK LIST

PROCEDURE TURN:
140 KNOTS

LET DOWN:
AIRSPEED - 130 KNOTS (MINIMUM)
RPM - 2600
COMPLETE CHECK LIST
EXCEPT GEAR

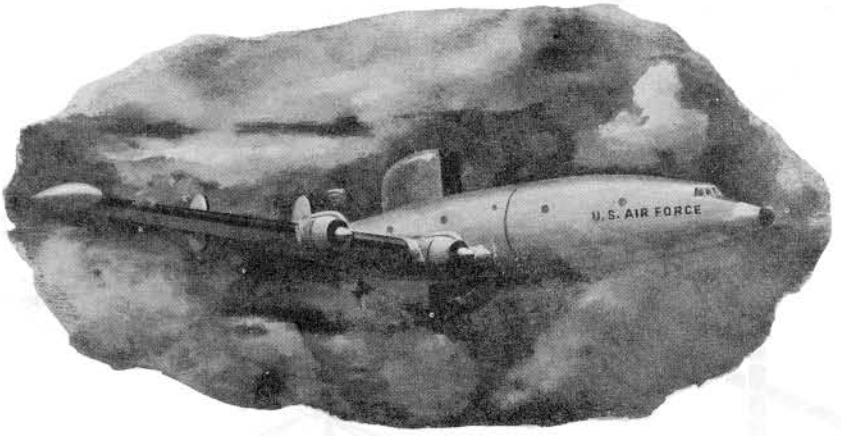
NOTE:
DELAY GEAR EXTENTION UNTIL
LANDING IS REASONABLY ASSURED.

4 ENGINE POWER SETTINGS FOR FOLLOWING CONFIGURATIONS AT 110,000 LB. LANDING WEIGHT

FLIGHT	AIRSPEED	RPM	MAP	FLAPS	GEAR
LEVEL	140 KNOTS	2400	28"	T.O.	UP
LEVEL	140 KNOTS	2600	33"	T.O.	DOWN
DESCENT	130 KNOTS	2400	23"	T.O.	UP
DESCENT	130 KNOTS	2600	28"	T.O.	DOWN

Figure 9-2. Radio Range Approach Procedure

PRECIPITATION



ICE AND RAIN.

Proper technique in the use of anti-icing and de-icing equipment is essential when instrument flight is conducted through rain and icing conditions. The various types of icing encountered at low altitudes may present greatest problems while instrument approaches are being made. When visible moisture is encountered it is better not to close the cowl flaps because closing them disturbs the flow of air past the engine and moisture will accumulate more rapidly in the engine section. It is better to keep the cowl flaps in the faired position. When icing conditions are encountered, no reduction in performance will be experienced when the de-icer boots are in operation. However, during flight through icing conditions the following conclusions should be understood.

(a) Flight in moderate icing conditions without the de-icer boots in operation can be accomplished for short periods at airspeeds of 180 knots or better. No significant losses in airspeed will result for approximately 15 minutes. Operating the de-icer boots and maintaining power settings will partially rectify speed losses, and an airspeed of approximately 155 knots can be maintained.

(b) If the de-icer boot system is inoperative, it is unsafe to enter icing conditions of intensities greater than light.

(c) The performance losses contributed by icing of the radomes are approximately two thirds of the total performance losses experienced by the aircraft in icing conditions.

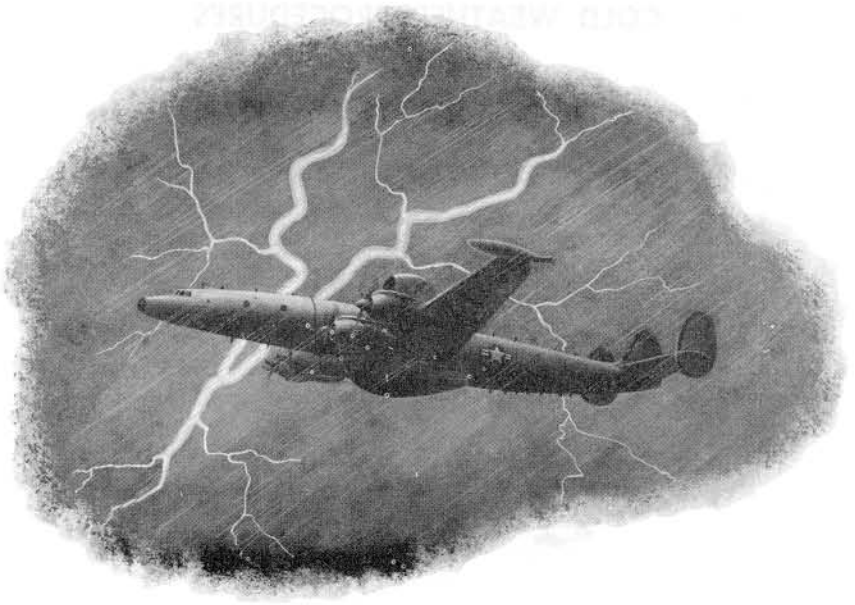
(d) If the mission profile of 4½ degrees angle of attack is to be maintained, flight in icing conditions worse than light should be avoided.

WARNING

Take-off should not be attempted with ice accumulations on the wing surfaces, nor during heavy freezing rain conditions.

(e) Apply propeller de-icing fluid and carburetor heat as required. Icing conditions and ice formation can vary in intensity. Ice can form during extensive cruising flight and have many different effects upon aircraft performance. Ice deposits increase the stall speed of the aircraft, which will occur at a smaller angle of attack. This means that increased dependence must be placed on the airspeed indicator, and landings must be at airspeeds made well above the normal landing speed. Efforts should be made to constantly maintain a smaller angle of attack during climb to minimize the development of ice deposits on the underside of the wing. During light icing, the aircraft can be flown for long periods, provided the anti-icing and de-icing equipment is handled properly. When icing reaches a moderate degree of intensity, the flight plan should be altered to avoid remaining in that condition. When icing is encountered, the wing and empennage de-icers should not be operated until ice has formed on the boots. If the de-icers are operated before entering the icing area, or if they are operated continuously, it is possible that a bridge of ice will form over the de-icer boots, thereby rendering the inflation cycle ineffective.

TURBULENCE AND THUNDERSTORMS



TURBULENCE AND THUNDERSTORMS.

Penetration of known thunderstorms should be avoided if possible; however, during instrument operation at night, such areas may be difficult to detect. Severe vertical air currents, heavy icing, and hail can be expected in thunderstorms, and all precautionary methods should be taken to prepare the aircraft prior to entering known thunderstorm areas. The automatic pilot may be engaged during light turbulence provided the altitude control is OFF. Maintain pitch attitude with the pitch control. A power setting should be made prior to entering a known thunderstorm area that will provide an airspeed of 60 knots above the stall speed for the weight, altitude, and configuration being flown. Refer to the stall speed chart, figure 6-1.

The aircraft should be maintained in the clean configuration (gear and flaps retracted) during turbulent air conditions. The aircraft should be prepared prior to entry as follows:

1. Turn pitot heaters ON.
2. Check gyro instruments for proper setting.
3. Tighten all seat belts.
4. Turn off all radio equipment that are affected by static.
5. Turn on cockpit lights to minimize blinding by lightning.

PENETRATING THE THUNDERSTORM.

1. Maintain power and propeller pitch settings established before entry. Hold these and the attitude constant, and airspeed will be constant regardless of erratic airspeed indicator readings.

CAUTION

If the reduction of airspeed is carried to an extreme the danger of stalling because of gusts is increased. It is necessary therefore, that the optimum penetration speed be maintained at 60 knots above stall speed.

2. Attention should be devoted to flying the aircraft by reference to the attitude indicator. Maintain a level attitude.

3. The altimeter is unreliable in severe turbulence because of differential barometric pressures.

4. Use as little elevator control as possible in maintaining attitude in order to minimize the stresses imposed on the aircraft.

CAUTION

Do not attempt to alter the aircraft attitude by reference to the airspeed indicator. Heavy rain may partially block the pitot heads and cause erratic readings.

COLD WEATHER PROCEDURES

COLD WEATHER PROCEDURES.

The following procedures supplement the NORMAL OPERATING PROCEDURES outlined in Section II and the SYSTEMS OPERATIONS procedures outlined in Section VII. These should be complied with when cold weather conditions are encountered. Procedures are covered in the preceding portion of this section under instrument flight. Procedures relative to carburetor icing are covered in Section VII.

The success of arctic operations depends greatly upon the preparations made during engine shutdown and postflight procedures, and upon the pre-flight procedures carried out prior to the next flight. Advance planning in the use of ground heating, wing and empennage covers, and other shelter facilities will help in assuring successful operations. If external heat will not be available for starting, or if oil dilution cannot be accomplished, the oil should be drained into clean containers and stored in a sheltered location where the temperature will not be lower than freezing. Where warm storage space is not available, the oil must be heated until it is free flowing and poured into the oil tanks immediately before starting engines.

BEFORE ENTERING THE AIRCRAFT.

1. Check that ice, snow, and frost have been removed from wing and tail surfaces. Check that the leading edges of control surfaces are clean. If hot air has been used, make certain that the areas are dry and free of ice.

2. Check all fuel, water, and oil vents and drain lines, and engine crankcase breathers to determine that they are free of frozen condensate.

3. Check landing gear struts for hydraulic leaks and proper inflation; micro-switches, uplocks and downlocks, wheels and brakes for freedom from ice, snow, slush, mud, etc.

4. Check that tires are not frozen to the ground or to the wheel chocks. Direct that ground heaters be used to thaw as necessary.

CAUTION

- Do not attempt to move the aircraft until the tires are free.
- Make certain that tire pressure is reduced to normal limits if over-inflation was used to help free tires that were frozen to the ground.
- Care must be taken when the aircraft is towed in snow or slush to avoid excessive strain on the nose wheel strut. Jerky and/or rocking starts should be avoided at all times.

5. Check that antennas and antenna masts have been cleared of ice and snow.

6. Check wing flap tracks thoroughly to determine that they are free of accumulations of ice and snow.

7. If no external power source is available for starting engines check battery fluid level and charge.

8. Check that engine preheating, if used, has been adequate. Preheating may be required if temperatures are below freezing even though oil dilution was accomplished at engine shut-down.

CAUTION

Never consider pre-heating adequate until fluid oil will flow from the "Y" drain. Do not attempt to start the engine if you cannot obtain oil flow from the "Y" drain.

ON ENTERING THE AIRCRAFT.

1. Direct that engine protective shields, nacelle covers, and propeller blade covers be removed. This should be the last operation before starting engines.

STARTING ENGINES.

Note

If a battery start must be made, keep the electrical load to a minimum until after the engines are started.

1. Follow normal engine starting procedures as outlined in Section II.

2. Prime the engine. In extremely cold weather, more priming may be necessary to assure successful engine starts. Avoid priming except while the engine is turning. If the engine is primed prematurely, the gasoline will not vaporize but will run down into the lower cylinders and will result in bent connecting rods and cracked cylinder heads when the piston contacts the cylinder full of fluid gasoline. Continue priming until engine is running smoothly.

CAUTION

- Start the engine by priming or by using auto-rich mixture, but not both.
- If there is no oil pressure after 20 seconds of operation, immediately stop the engine and investigate.
- If the oil pressure is abnormally high immediately after starting, observe it closely. However, as the oil temperature increases, the pressure should drop to within normal limits. Do not increase engine speed until oil temperatures and pressure are within normal limits.

ENGINE WARM UP.

1. Reserve oil system heater switch—ON.

2. Nesa power and pitot heater switches—ON.

3. Torquemeter line heater switches (if installed)—ON.

4. Use ice-free area or firmly anchored wheel chocks for all engine run-ups. Make sure no personnel, ground installations, or other aircraft are in the propeller wash.

5. Warm up engine. Do not make performance checks until oil temperature and pressure, and cylinder head temperatures are within desired limits.

Note

The following cold weather operational procedures prior to take-off are recommended to flush the propeller and the auxiliary pump line of oil that may have congealed while the airplane was idle. This action is necessary so that bleeds, which are provided to keep the oil in the propeller and auxiliary pump line warm, will function properly in flight. The following check prior to take-off should be conducted during engine run-up after engine oil has reached the recommended operating temperature of 40°C.

a. Set the master propeller pitch lever to full INC RPM position, and adjust throttles to obtain approximately 1700 rpm.

b. Move master propeller pitch lever toward DEC RPM until minimum rpm position is obtained. RPM should drop to minimum rpm setting.

c. Set the master propeller pitch lever toward INC RPM until engine speed increases to the value established in step "a".

d. Repeat steps "b" and "c" three or four times.

e. Readjust throttle setting if desired and conduct a feathering check. Push the feathering button for each engine individually and observe a drop of 200 to 300 rpm. Pull feathering button out to neutral. RPM should return to the initial setting.

f. Reverse and unreverse propellers.

g. Repeat step "e". If the rpm increases when the feathering button is depressed, the propeller is in reverse pitch. If this occurs, reduce power as necessary to prevent overspeeding and feather out to positive pitch range.

6. If external power source is available, turn on electronic and radar equipment and check for proper antenna operation.

7. Check wing flap operation.

TAXIING.

1. Avoid sharp turns during taxiing. Use asymmetrical power for steering in icy areas and avoid excessive use of brakes.

Note

Avoid deep snow, mud, and slush covered areas as much as possible. Do not stop in deep snow. Watch out for obstacles hidden by freshly fallen snow. Do not scrape lower radome on heavy crusted snow.

BEFORE TAKE-OFF.

1. Follow normal operating procedures as outlined in Section II.

Note

If flight is to be made during precipitation, removal of wing and empennage covers may be delayed until just prior to take-off.

2. Check all heating, anti-icing and de-icing systems for proper operation.

3. Carburetor heat—OFF.

4. Recheck trim tabs and controls for freedom of operation.

TAKE-OFF.

1. During cross-wind take-off on icy runways, use asymmetrical power for directional control until rudder control becomes effective. It may be necessary to lift the nose wheel earlier than normal during the take-off run to lessen the possibility of snow or icy slush being thrown into the nose wheel well.

WARNING

The use of asymmetrical power for directional control may appreciably lengthen the take-off run.

ICING DURING FLIGHT.

Wing ice during cruise can become critical if the proper procedure is not followed. Since long range cruise involves flying only slightly faster than the speed for maximum L/D, any loss of airspeed due to wing ice will mean flying in an unstable speed range on the nautical mile per pound fuel chart. (In other words, airspeed will vary over quite a range with changes in attitude caused by turbulence, crew movement, etc., even though a constant power setting is maintained). In this unstable speed range, the aircraft is quick to lose speed, but slow to recover it. The result is a further lowering of the average airspeed. This necessitates an increase in the angle of attack to maintain altitude. This increased angle of attack will allow ice to accumulate on the bottom of the leading edge where it can not be removed by the boots. This slows the aircraft still further and increases the stall speed considerably. If this cycle is allowed to continue, a very dangerous situation will quickly develop.

When encountering wing ice in cruise, watch the angle of attack as shown by the inclinometer. It should not be allowed to exceed 3°. If necessary, go to maximum cruise power for as long as is necessary to keep the angle of attack below the recommended maximum limit for operating in icing conditions. If unable to maintain an angle of attack of less than 3° with maximum cruise power, a change of altitude should be requested. Although it is usually impossible to see the empennage and radomes from the cockpit, it may be safely assumed that if ice is observed forming on the leading edge of the wing, a simultaneous action is taking place on the tail and radome surfaces. As ice forms on the vertical and horizontal stabilizers, an increased tendency to yaw will be noted.

Propeller icing may occur under the same conditions as surface icing. Propeller ice is especially dangerous because it decreases propeller efficiency by altering the blade profile and increasing the blade thickness. Refer to Section I for alcohol minimum and maximum flow.

Failure of the airspeed indicator may result from freezing of the pitot head or the static line. Use pitot heater and/or alternate static source as necessary.

Refer to CARBURETOR ICING in Section VII, and NORMAL OPERATING PROCEDURES FOR DE-ICER BOOTS in Section IV for information on these systems.

DESCENTS AND APPROACHES.

During descents and approaches, maintain power settings sufficient to prevent overcooling of the engines. Use carburetor heat and cowl flaps as necessary.

Note

It may be desirable to lower wheels and use partial flaps well in advance of the actual approach to check that they function correctly while sufficient altitude remains for emergency procedure.

LANDING.

When landing a heavily iced aircraft, approach and landing speeds should be considerably higher than normal depending upon the amount of icing.

Note

A slow touchdown speed is desirable, consistent with safe control. The brakes should be used as little as possible, and nose wheel steering used discriminately.

CAUTION

When landing on snow or slush covered runways, use of reverse thrust can cause serious impairment of pilots' visibility. Turn on windshield wipers prior to using reverse thrust. During the landing rollout, snow and slush may be carried into the wing flap well and on to the top surface of the wing flaps. Upon retraction of the wing flaps, the packed snow may cause damage to the wing trailing edge and the flap mechanism. Under these circumstances, the flaps should not be retracted beyond the 30% extended position until the flap area and mechanism can be inspected and cleaned if necessary.

STOPPING OF ENGINES.

When parking on ice, after having taxiied through slush, or when the temperature alternates between freezing and thawing, roll the aircraft onto a layer of some type of protective material to prevent the tires from freezing to the surface.

Note

Oil dilution is not recommended.

BEFORE LEAVING THE AIRCRAFT.

Install all necessary protective covers if shelter for the aircraft is not available.

CAUTION

The protective covers should not be installed until the engines have cooled sufficiently to preclude the possibility of condensation forming inside.

2. If a long layover is anticipated and if external heat will not be available for starting, or if oil dilution cannot be accomplished, the oil should be drained into clean containers and stored in a sheltered location where the temperature will not be lower than freezing.

3. If extremely low temperatures are expected, the aircraft batteries should be removed and stored in a warm location.

4. Release the brakes and chock the wheels. If the brakes are left on, the formation of ice may lock the wheels.

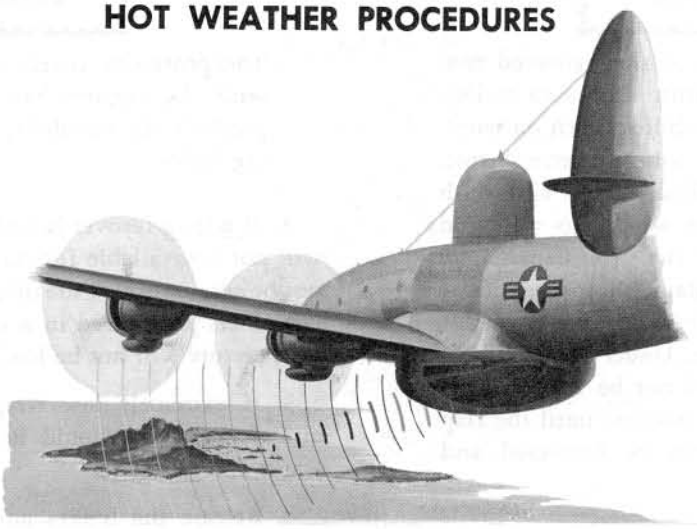
5. Drain water tanks if there is a possibility of freezing.

6. Drail oil tank sumps, "Y" drains, and fuel drains of condensate approximately 30 minutes after stopping engines.

7. Leave some aperture, such as a side window, partly open to help prevent the formation of frost on the inside of the windows.

8. Direct that any snow, slush, or mud picked up in nose wheel well or nacelles, or on landing gear mechanism be cleaned off before it freezes.

HOT WEATHER PROCEDURES



HOT WEATHER PROCEDURES.

TROPIC OR DESERT OPERATIONS.

Before Entering the Aircraft.

1. During exterior and interior inspections, be particularly observant for corrosion, growth of fungi, or excessive accumulations of sand and dust.

2. If sand or dust is blowing, do not direct the removal of covers from engines, nacelles, propellers, and pitot tubes until just prior to starting engines.

On Entering the Aircraft.

Note

The instruments should be pre-heated prior to flight to eliminate possible fungus growths.

Engine Warm-Up.

1. Conduct ground operations in a minimum amount of time, and be careful not to overheat engines.

CAUTION

Longer take-off runs are required than are necessary in ordinary temperatures.

2. Avoid taking off in the wake of another aircraft if ground is sandy or dusty.

Stopping Engines.

Follow normal operating procedures as outlined in Section II, except that cylinder head temperatures should be stabilized at the lowest temperature possible before shut-down.

Before Leaving Aircraft.

1. As soon as engines have cooled, install all protective covers.

2. If a sand or dust storm is anticipated, close all doors, windows, and hatches.

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PART 1 — INTRODUCTION

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SCOPE AND ARRANGEMENT.

This appendix contains information based on flight tested airplane performance which is needed for flight planning and in-flight cruise control. Worthwhile gains in operating efficiency and in maximum utilization of the airplane's performance capabilities will result from conscientious application of this material.

A "part type" arrangement groups the material as needed for planning general phases of each flight. Descriptive text in each part discusses and explains the use of the types of charts provided. The flight planning charts can be used to calculate performance for any specific type of operational or cruise control procedure desired. In addition, detailed information has been supplied for types of flight plans which are likely to be used most frequently in normal operation. Flight planning charts are also included for abnormal or emergency flight conditions where one or two engines are inoperative. A graphical type of presentation has been used in order to provide a greater degree of flexibility in their use than is possible with tabular forms.

The procedures to follow for accurate flight planning are presented by way of example problems throughout the text. The methods used for solutions of the examples apply to the actual performance charts discussed.

The performance data contained in this appendix are applicable to aircraft equipped with the standard (23 in. diameter) propeller afterbodies and to aircraft with afterbodies removed. No change in performance will be experienced with Hamilton Standard 43H60/6959B-0 propellers installed in lieu of 43E60/6903-0 propellers. All performance data shown reflect performance with Mark V-A ram scoops installed as indicated by the boxed configuration note on the applicable charts.

The data contained herein apply also to aircraft equipped with the Speed Kit. This includes:

1. Oil cooler scoop with inlet extended, boundary layer bypass, and thicker inlet lips.

2. Nacelle flame shields removed.

3. Refrigerator primary aftercooler door shape changed

and reduced maximum opening angle. The primary exit has the louvers removed and a variable exit door installed.

No arbitrary conservatism factors have been introduced in the airplane performance tables or charts which allow for less than optimum operating conditions. It is felt that operating personnel can establish suitable reserve allowances for factors which adversely affect performance, such as air turbulence, navigation error, etc., by drawing on specific local experience. This should result in a more realistic approach to the use of these data than if arbitrary conservatism allowances were included in the basic data shown.

FUEL AND FUEL DENSITY.

Aircraft and engine performance shown in this appendix are representative of normal operation with 115/145 grade fuel in all cases, except where specifically noted. A nominal value for fuel density of 6.0 pounds per gallon may be used to determine airplane gross weights or to convert fuel flow readings from pounds to gallons per hour; however, actual density of fuel loaded should be measured with a hydrometer whenever possible. Fuel flow data supplied are based on contractor's flight tests and flight service records supplied by operators of Super Constellation aircraft.

SYMBOLS AND DEFINITIONS.

Symbol	*Definition*
Basic Airspeed	The airspeed value read from the airspeed indicator.
IAS	Indicated Airspeed; the airspeed reading corrected for instrument mechanical errors.
CAS (V_C)	Calibrated Airspeed; Indicated Airspeed corrected for airspeed system position error. Obtained from IAS and Figures A1-1 and A1-3, or from Figure A1-5 if True Airspeed is known.
EAS (V_E)	Equivalent Airspeed; Calibrated Airspeed corrected for compressibility effect. Equals True Airspeed divided by $1/\sqrt{\sigma}$. The Standard Altitude Table, Figure A1-7 may be used to obtain $1/\sqrt{\sigma}$.
TAS (V_T)	True Airspeed; the speed of the airplane relative to the undisturbed air, may be obtained from Figure A1-5 if Calibrated Airspeed is known.
V_G	Ground Speed; the speed of the airplane relative to the ground.
OAT	Outside (ambient) Air Temperature; the temperature reading corrected for instrument error and corrected for compressibility temperature rise by use of Figure A1-6.
H_p	Pressure Altitude; the altitude corresponding to a certain pressure in the Standard Atmosphere.
H_d	Density Altitude; the altitude corresponding to a certain density in the Standard Atmosphere.

STANDARD CORRECTION CHARTS.

All airspeed and altimeter readings obtained directly from the flight instruments should be subjected to certain standard corrections prior to comparison with chart values. Obviously this also works the other way around: in order to translate standard performance data contained in this appendix into actual instrument readings, the corrections, as mentioned above, have to be applied in reverse. These corrections are a function of the static system in use and airplane configuration. The effect of gross weight was found to be small and has been neglected. Tables and graphs necessary for making the corrections are presented in this section on Figures A1-1 through A1-4.

For conversion of Indicated Airspeeds to Basic Airspeed and Pressure Altitude to Altimeter reading and vice-versa, use should be made of the Calibration Cards provided with the instruments. For pressure altitude measurements, the altimeter should also be set at 29.92″ Hg.

Note

The physical condition of the flush static and total head pressure openings is important since it affects the accuracy of these corrections. These openings should be inspected frequently and kept in alignment, free of dirt, leaks, metal burrs, etc., which might result in serious malfunction of the airspeed system.

DENSITY ALTITUDE CHART.

The Density Altitude Chart (Figure A1-8) and Standard Altitude Table (Figure A1-7) provide density altitudes for any combination of corrected pressure altitude and temperature.

PSYCHROMETRIC CHART.

A psychrometric chart is included as Figure A1-9. This will provide specific humidity and vapor pressure for any combination of wet and dry bulb temperatures or dew point temperature. The use of the chart is explained by means of the example provided.

EXAMPLES OF USE OF STANDARD CORRECTION CHARTS.

The example (A) given below illustrates the correct procedure to be followed in using the standard correction charts. From instrument readings of airspeed, altitude, and outside air temperature, determine CAS, TAS, H_p, H_d and OAT.

EXAMPLE A.

Illustration of Normal Use of Standard Correction Charts.

Airspeed Static System in Use	No. 1 Static	No. 2 Static
Instrument Panel	Pilot	Co-pilot
Airplane Configuration	Cruise	Cruise
Airspeed Indicator Reading	193 knots	185 knots
Instrument Correction (read on Calibration Card)	—2	+2
IAS	191	187
Position Error Correction	—1 (Fig. A1-1)	+3 (Fig. A1-3)
CAS	190	190
Altimeter Reading (set at 29.92" Hg)	20,250 ft.	19,700 ft.
Instrument Correction (read on Calibration Card)	—210 ft.	+210 ft.
Pressure Altitude (corrected for instrument error)	20,040	19,910
Position Error Correction	—40 (Fig. A1-2)	+90 (Fig. A1-4)
Hp	20,000	20,000
Air Temperature Reading	+29°F	
Instrument Correction (read on Calibration Card)	3°	
Air Temperature (corrected for instrument error)	+26°	
Compressibility Correction (Figure A1-6)	—16°	
OAT	+10°	
H_d (Figure A1-8)	22,250 ft.	
TAS (Figure A1-5)	266 knots	

The following example, using the same basic information as before, illustrates the discrepancies which can occur by neglecting the instrument calibration cards:

EXAMPLE B.

Airspeed Indicator Reading	193 knots	185 knots
Position Error Correction	—1	+3
CAS	192	188
Altimeter Reading	20,250 ft.	19,700 ft.
Position Error Correction	—40	+90
H_p	20,210	19,790
Air Temperature Reading	+29°F	
Compressibility Correction	—16°	
OAT	+13°	
H_d	21,800 ft.	21,200 ft.
TAS	272 knots	263 knots

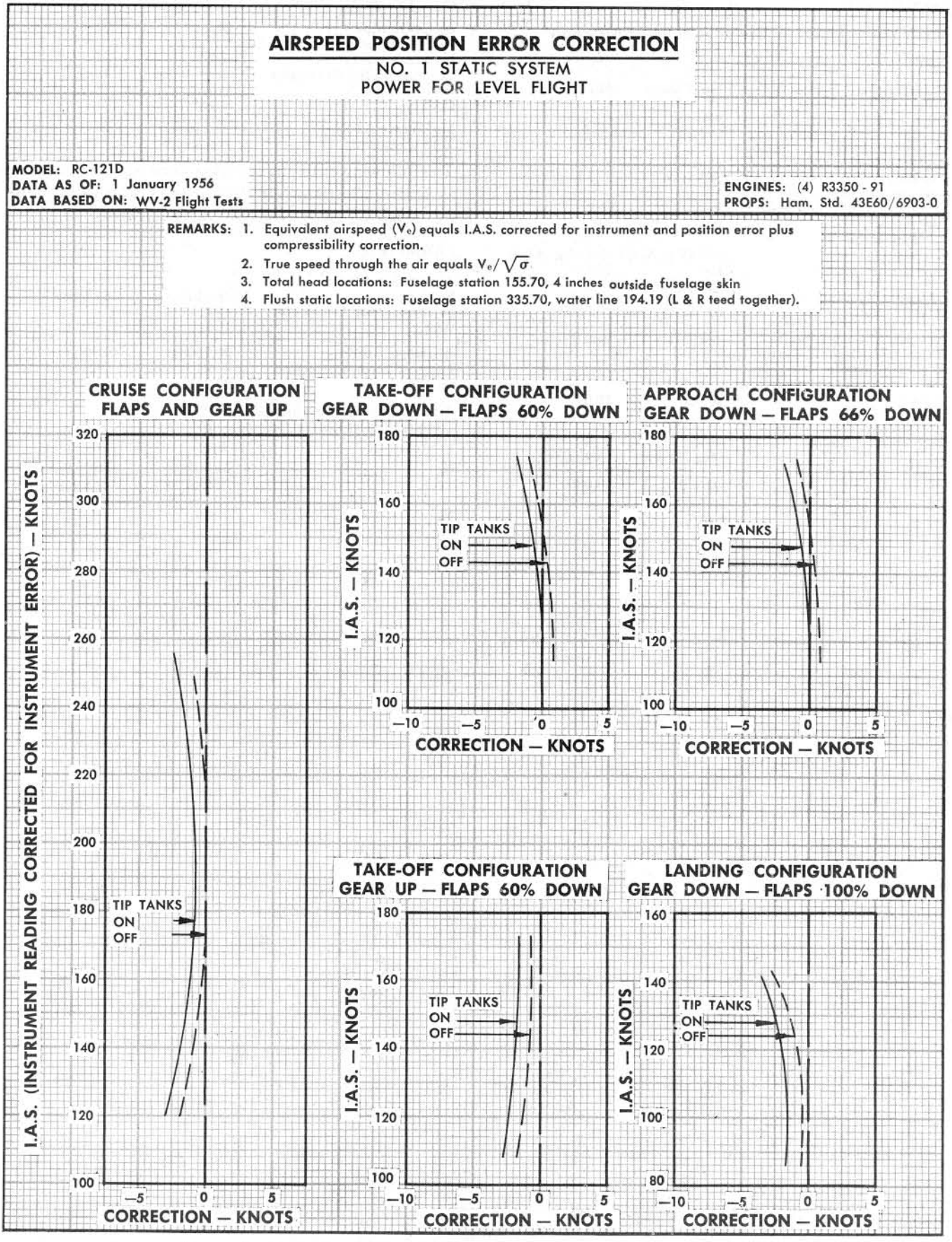


Figure A1-1. Airspeed Position Error Correction — No. 1 Static System

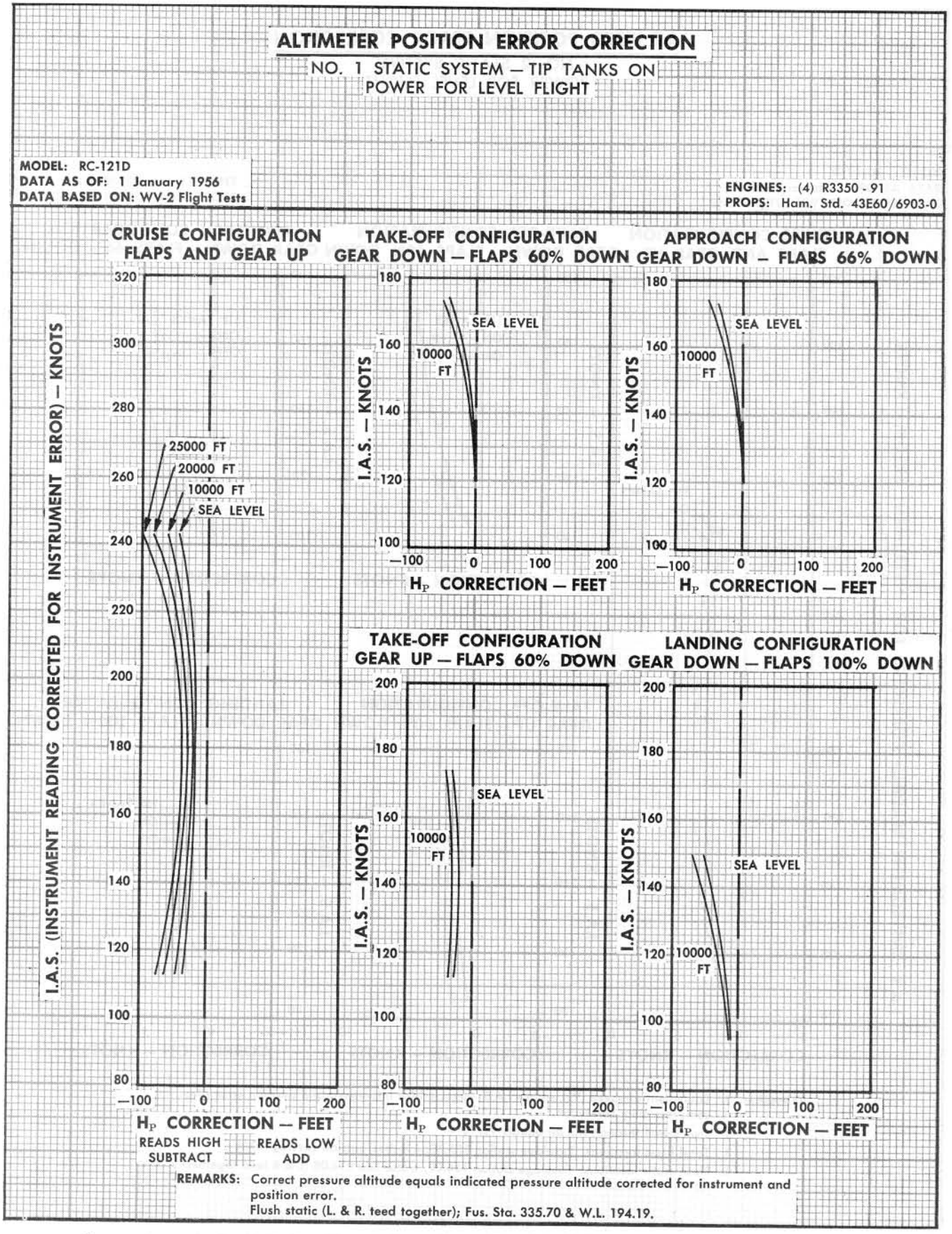


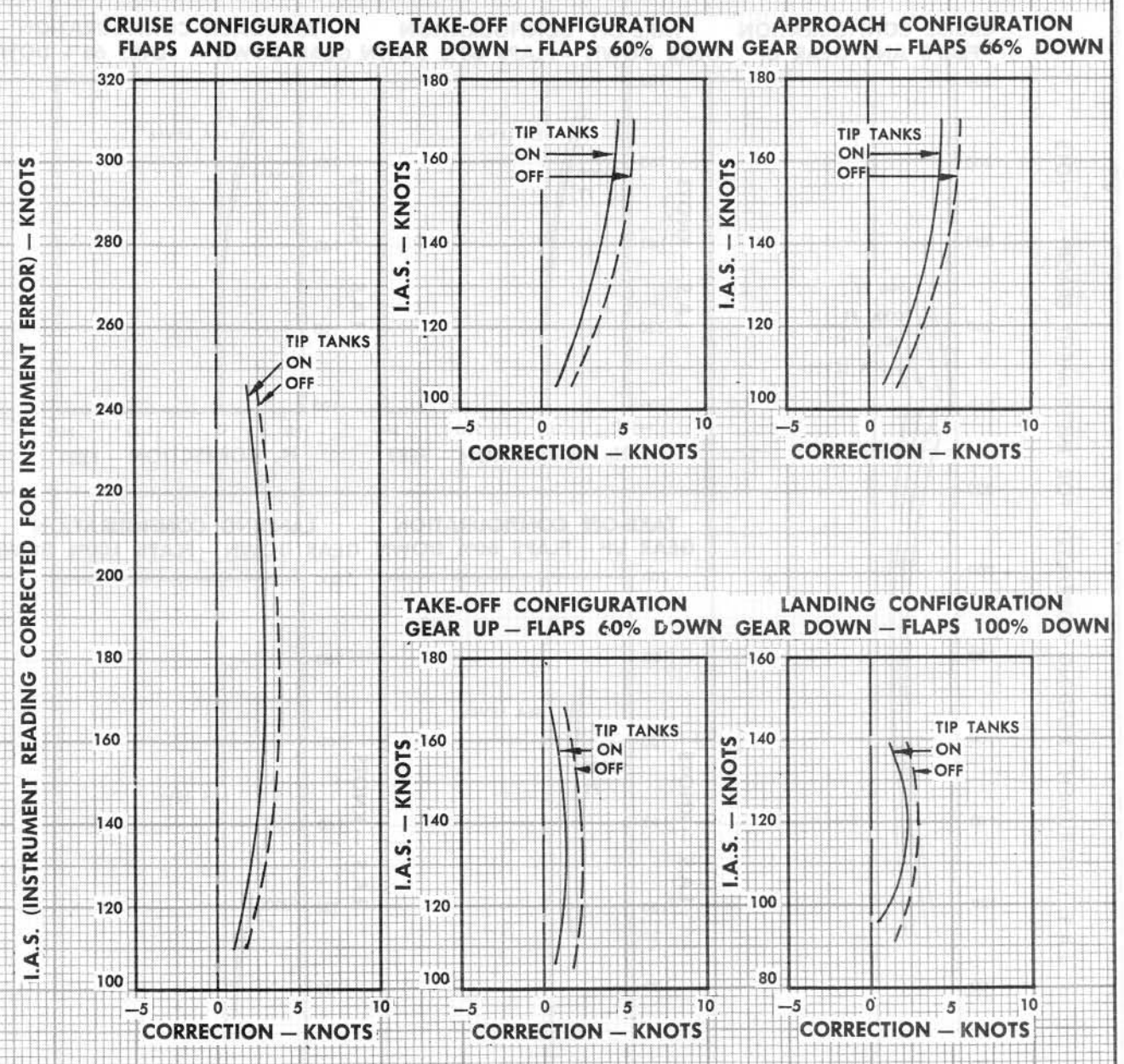
Figure A1-2. Altimeter Position Error Correction — No. 1 Static System — Tip Tanks ON

AIRSPEED POSITION ERROR CORRECTION

NO. 2 STATIC SYSTEM
POWER FOR LEVEL FLIGHT

MODEL: RC-121D
DATA AS OF: 1 January 1956
DATA BASED ON: WV-2 Flight Tests

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0



REMARKS:
1. Equivalent airspeed (V_e) equals I.A.S. corrected for instrument and position error plus compressibility correction.
2. True speed through the air equals $V_e/\sqrt{\sigma}$
3. Total head locations: Fuselage station 155.70, 4 inches outside fuselage skin
4. Flush static locations: Fuselage station 155.00, water line 214.08 (L & R teed together).

Figure A1-3. Airspeed Position Error Correction — No. 2 Static System

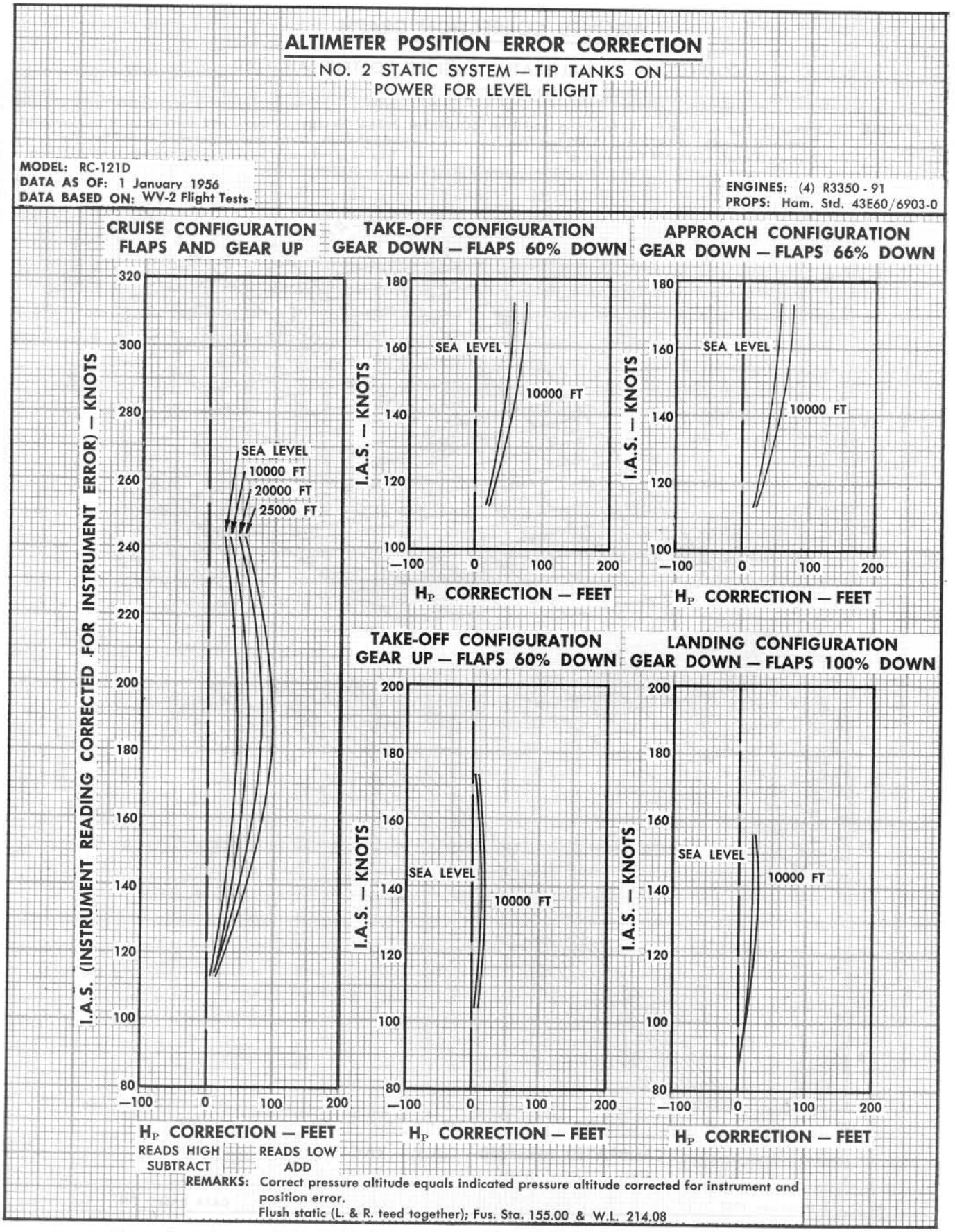


Figure A1-4. Altimeter Position Error Correction — No. 2 Static System — Tip Tanks ON

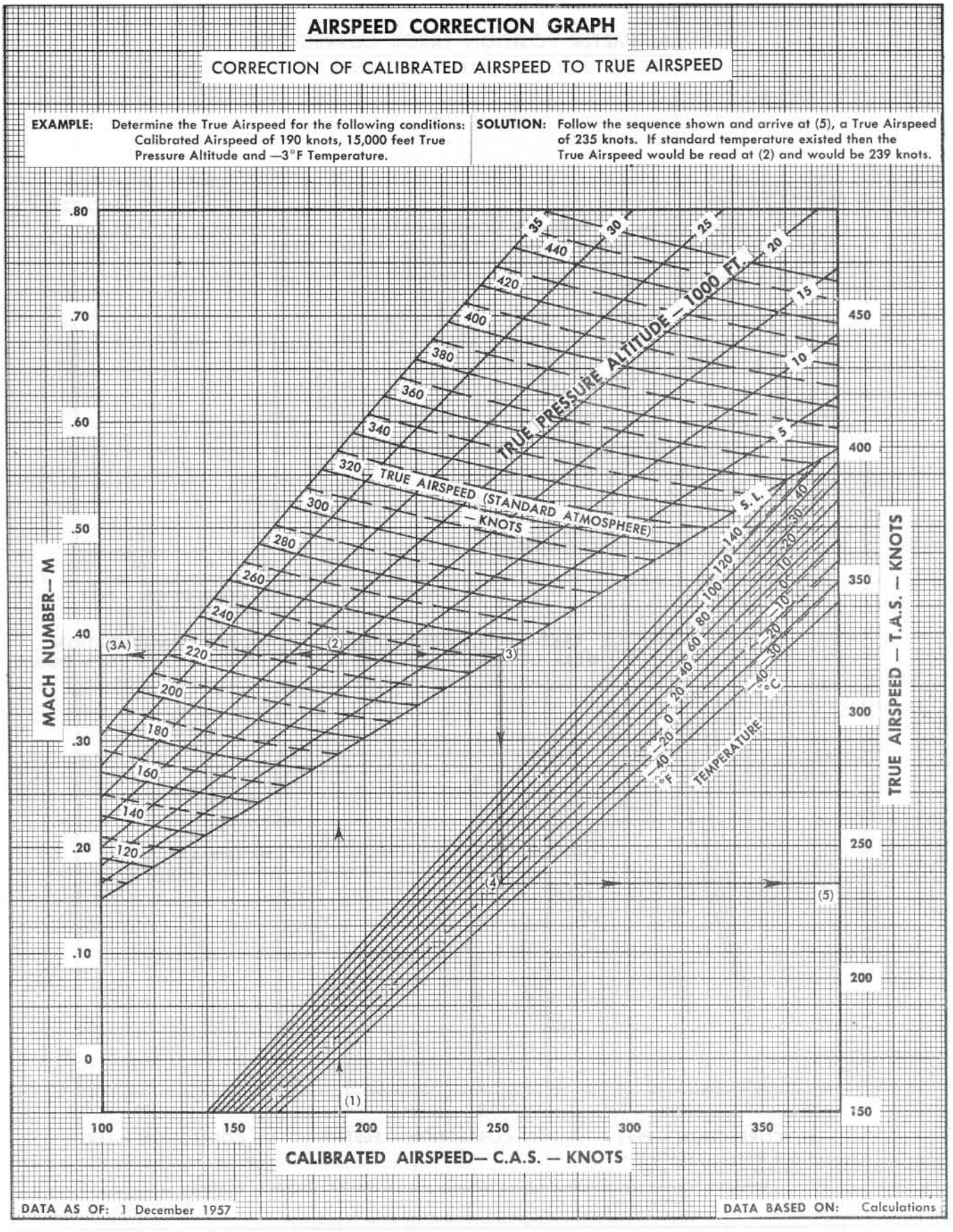


Figure A1-5. Airspeed Correction Graph — Correction of Calibrated Airspeed to True Airspeed

TEMPERATURE COMPRESSIBILITY CORRECTION GRAPH

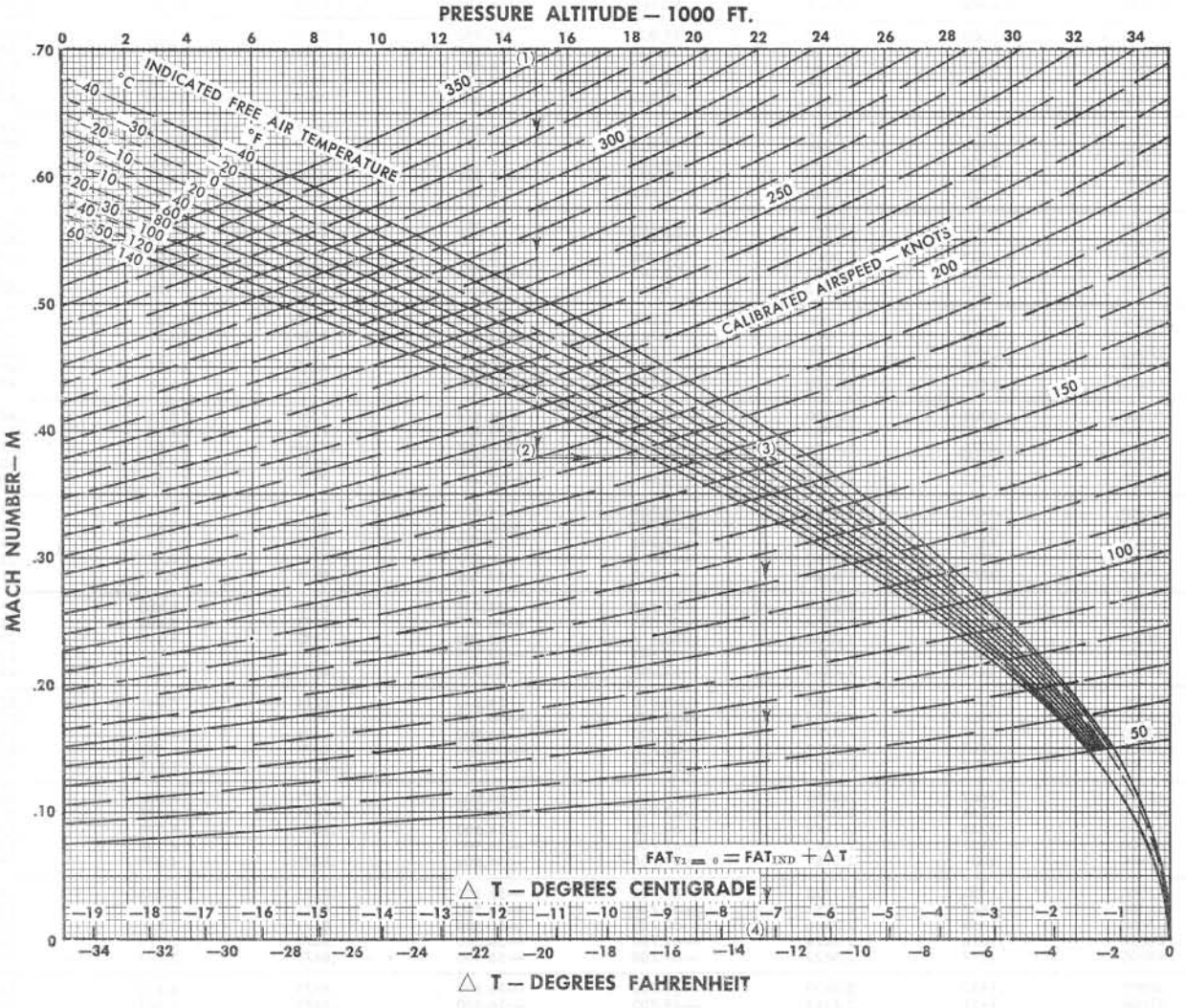
REMARKS:

1. 100% adiabatic temperature rise assumed.
2. Indicated temperatures read higher than free air temperatures.
3. The sensing element, a resistance bulb, is located in an externally ventilated box at Fuselage Station 220.65, Water Line 179.71.

EXAMPLE:

Find the corrected Free Air Temperature at 15,000 feet altitude, 190 knots Calibrated Airspeed and 10°F Indicated Free Air Temperature.

SOLUTION: Follow the sequence shown and arrive at (4), a ΔT of −12.8°F. The Free Air Temperature is then determined as follows: FAT = 10 + (−12.8) = −2.8°F.



(APPLY THIS CORRECTION TO INDICATED FREE AIR TEMPERATURE TO OBTAIN FREE AIR TEMPERATURE)

Figure A1-6. Temperature Compressibility Correction Graph

STANDARD ALTITUDE TABLE

STANDARD SEA LEVEL AIR:
T = 59°F
P = 29.921 IN. OF HG.

W = .076475 LB/CU. FT. ρ_o = .0023769 SLUGS/CU. FT.
1" OF HG. = 70.732 LB/SQ. FT. = 0.4912 LB/SQ. IN.
a_o = 1116.89 FT./SEC.

BASED ON INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO) STANDARD ATMOSPHERE
(NACA TECHNICAL REPORT NO. 1235)

ALTITUDE FEET	DENSITY RATIO ρ/ρ_o	$1/\sqrt{\sigma}$	TEMPERATURE DEG. F	TEMPERATURE DEG. C	SPEED OF SOUND RATIO a/a_o	PRESSURE IN. OF HG.	PRESSURE RATIO ρ/ρ_o
—2000	1.0598	0.9714	66.132	18.962	1.0064	32.15	1.0294
—1000	1.0296	0.9855	62.566	16.981	1.0030	31.02	1.0147
0	1.0000	1.0000	59.000	15.000	1.0000	29.92	1.0000
1000	.9711	1.0148	55.434	13.019	.9966	28.86	.9644
2000	.9428	1.0299	51.868	11.038	.9931	27.82	.9298
3000	.9151	1.0454	48.302	9.057	.9896	26.82	.8962
4000	.8881	1.0611	44.735	7.075	.9862	25.84	.8637
5000	.8617	1.0773	41.169	5.094	.9827	24.90	.8320
6000	.8359	1.0938	37.603	3.113	.9792	23.98	.8014
7000	.8106	1.1107	34.037	1.132	.9756	23.09	.7716
8000	.7860	1.1279	30.471	— 0.849	.9721	22.22	.7428
9000	.7620	1.1456	26.905	— 2.831	.9686	21.39	.7148
10000	.7385	1.1637	23.338	— 4.812	.9650	20.58	.6877
11000	.7156	1.1822	19.772	— 6.793	.9614	19.79	.6614
12000	.6932	1.2011	16.206	— 8.774	.9579	19.03	.6360
13000	.6713	1.2205	12.640	—10.756	.9543	18.29	.6113
14000	.6500	1.2403	9.074	—12.737	.9507	17.58	.5875
15000	.6292	1.2606	5.508	—14.718	.9470	16.89	.5643
16000	.6090	1.2815	1.941	—16.699	.9434	16.22	.5420
17000	.5892	1.3028	— 1.625	—18.681	.9397	15.57	.5203
18000	.5699	1.3246	— 5.191	—20.662	.9361	14.94	.4994
19000	.5511	1.3470	— 8.757	—22.643	.9324	14.34	.4791
20000	.5328	1.3700	—12.323	—24.624	.9287	13.75	.4595
21000	.5150	1.3935	—15.889	—26.605	.9250	13.18	.4406
22000	.4976	1.4176	—19.456	—28.587	.9213	12.64	.4223
23000	.4807	1.4424	—23.022	—30.568	.9175	12.11	.4046
24000	.4642	1.4678	—26.588	—32.549	.9138	11.60	.3876
25000	.4481	1.4938	—30.154	—34.530	.9100	11.10	.3711
26000	.4325	1.5206	—33.720	—36.511	.9062	10.63	.3552
27000	.4173	1.5480	—37.286	—38.492	.9024	10.17	.3398
28000	.4025	1.5762	—40.852	—40.473	.8986	9.725	.3250
29000	.3881	1.6052	—44.419	—42.455	.8948	9.297	.3107
30000	.3741	1.6349	—47.985	—44.436	.8909	8.885	.2970
31000	.3605	1.6654	—51.551	—46.417	.8871	8.488	.2837
32000	.3473	1.6968	—55.117	—48.398	.8832	8.106	.2709
33000	.3345	1.7291	—58.683	—50.379	.8793	7.737	.2586
34000	.3220	1.7623	—62.249	—52.361	.8754	7.382	.2467
35000	.3099	1.7964	—65.816	—54.342	.8714	7.041	.2353
36000	.2981	1.8315	—69.382	—56.323	.8675	6.712	.2243
37000	.2844	1.8753	—69.700	—56.500	.8671	6.397	.2138
38000	.2710	1.9209	—69.700	—56.500	.8671	6.097	.2038
39000	.2583	1.9677	—69.700	—56.500	.8671	5.811	.1942
40000	.2462	2.0155	—69.700	—56.500	.8671	5.538	.1851
41000	.2346	2.0645	—69.700	—56.500	.8671	5.278	.1764
42000	.2236	2.1148	—69.700	—56.500	.8671	5.030	.1681
43000	.2131	2.1662	—69.700	—56.500	.8671	4.794	.1602
44000	.2031	2.2189	—69.700	—56.500	.8671	4.569	.1527
45000	.1936	2.2728	—69.700	—56.500	.8671	4.355	.1455
46000	.1845	2.3281	—69.700	—56.500	.8671	4.151	.1387
47000	.1758	2.3848	—69.700	—56.500	.8671	3.956	.1322
48000	.1676	2.4428	—69.700	—56.500	.8671	3.770	.1260
49000	.1597	2.5022	—69.700	—56.500	.8671	3.593	.1201
50000	.1522	2.5630	—69.700	—56.500	.8671	3.425	.1145
51000	.1451	2.6254	—69.700	—56.500	.8671	3.264	.1091
52000	.1383	2.6892	—69.700	—56.500	.8671	3.111	.1040
53000	.1318	2.7546	—69.700	—56.500	.8671	2.965	.09909
54000	.1256	2.8216	—69.700	—56.500	.8671	2.826	.09444
55000	.1197	2.8903	—69.700	—56.500	.8671	2.693	.09001
56000	.1141	2.9606	—69.700	—56.500	.8671	2.567	.08578
57000	.1087	3.0326	—69.700	—56.500	.8671	2.446	.08176
58000	.1036	3.1063	—69.700	—56.500	.8671	2.331	.07792
59000	.09877	3.1819	—69.700	—56.500	.8671	2.222	.07426
60000	.09414	3.2593	—69.700	—56.500	.8671	2.118	.07078
61000	.08972	3.3386	—69.700	—56.500	.8671	2.018	.06746
62000	.08551	3.4198	—69.700	—56.500	.8671	1.924	.06429
63000	.08150	3.5029	—69.700	—56.500	.8671	1.833	.06127
64000	.07767	3.5881	—69.700	—56.500	.8671	1.747	.05840
65000	.07403	3.6754	—69.700	—56.500	.8671	1.665	.05566

Figure A1-7. Standard Altitude Table

DENSITY ALTITUDE CHART

BASED ON NACA TECHNICAL REPORT NO. 1235
(INTERNATIONAL CIVIL AVIATION ORGANIZATION–ICAO–STANDARD ATMOSPHERE)

NOTE:
SET ALTIMETER SETTING TO 29.92 IN. HG. BEFORE READING PRESSURE ALTITUDE AND TEMPERATURE IN ORDER TO DETERMINE THE DENSITY ALTITUDE.

STANDARD SEA LEVEL AIR CONDITIONS:
$T = 59°F$ $w = 0.076475$ Lbs/Cu. Ft.
$p = 29.92$ In. Hg.
$\rho_o = 0.0023769$ Slugs/Cu. Ft. $a_o = 1116.89$ Ft/Sec.
1 In. Hg. $= 70.732$ Lbs/Sq. Ft. $= 0.4912$ Lbs/Sq. In.

EXAMPLE:
IF THE AMBIENT TEMPERATURE IS 5°F, (−15°C), AND THE PRESSURE ALTITUDE IS 6000 FEET, THE DENSITY ALTITUDE IS FOUND TO BE 3700 FEET AND $1/\sqrt{\sigma}$ 1.056.

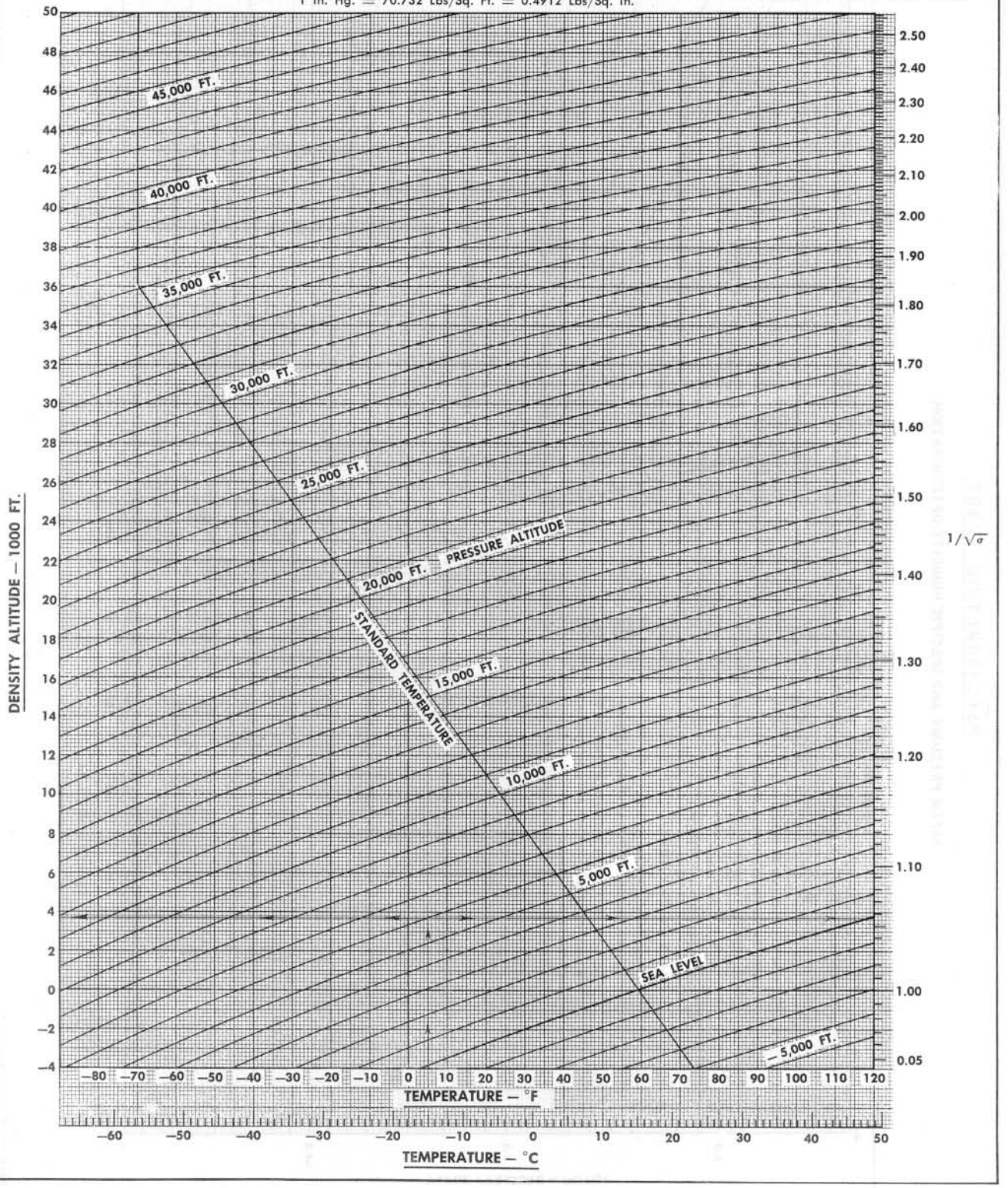


Figure A1-8. Density Altitude Chart

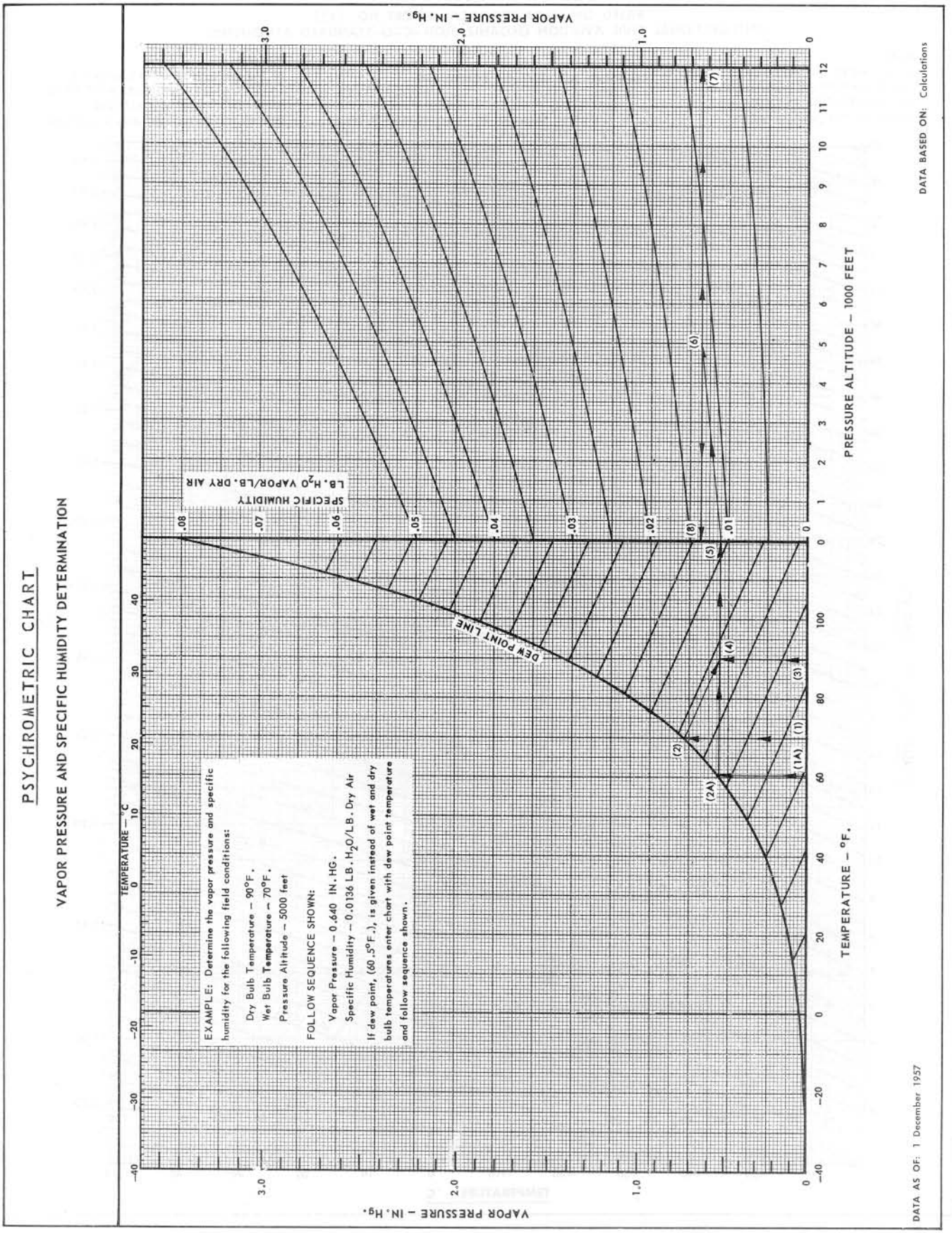


Figure A1-9. Psychrometric Chart

PART 2 — ENGINE OPERATING DATA

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* Indicates Illustration Pages

ENGINE OPERATING DATA.

Engine Operating Limits are provided for use with either 115/145 or 100/130 grade fuel. These curves (Figures A2-1, A2-2 and A2-3) are the engine manufacturer's calibrations of the WAD R3350-91 engine. As such, they are the basic curves from which approved limit settings of the engine controls may be determined for any operating condition. In addition, they form the basis for prediction of power output with any combination of control settings within allowable values. The curves are based on operation with 80% relative humidity and NACA Standard Day temperatures and pressure as defined by the Standard Altitude Table (Figure A1-7), and are directly applicable only with such conditions at the carburetor top deck. Corrections for other atmospheric conditions and for "ram" may be made, however, in such a manner as to make the basic data applicable to all types of operations.

Briefly described, each Operating Limits Graph is divided into four major parts: the Sea Level and 10,000 foot Calibrations, the Altiutde Calibration with low blower and the Altitude Calibration with high blower if applicable. Four sub-divisions of the Altitude Calibrations show the effects of part and full throttle conditions with Best Power and Auto Rich mixture control settings. It should be noted that operation with 100/130 grade fuel is limited to low blower and Auto Rich mixture settings only.

BMEP CONSIDERATIONS.

The near horizontal lines on the Altitude Calibration show the variation of limit brake horsepower with alti-

tude within the part throttle regions. Corresponding limit BMEP settings are found by the relationship:

$$BMEP = (BHP \times 236) / RPM$$

by definition from:

$$BHP = (RPM \times BMEP) / 236$$

Limit power values read from the curves at various engine speeds represent the maximum power which the engine may be allowed to develop. Indicated BMEP shows only that portion of total power developed which is delivered to the propeller shaft. The amount of power absorbed by the accessory drive section can limit the maximum BMEP which may be set. In addition, specific operating conditions may result in limit manifold pressure being reached first. This may also prevent use of maximum BMEP settings and use of limit power.

The following are examples that show the accounting which may be necessary to allow for that portion of total engine power delivered to drive accessory section equipment.

Power required to operate cabin pressurization equipment is obtained from the outboard engines. The amount varies with the operating altitude of the aircraft, pressurization desired, and engine speed. It is greatest at low altitude with full cabin differential and maximum engine speed, and least with no pressurization at lowest engine speeds. A nominal allowance of 5 BMEP has been established which is representative of normal operation. That is, with cabin pressurized and in normal cruising flight at altitude, a reduction in power setting of 5 BMEP on the outboard engines will account for cabin supercharger accessory section power requirements and result in the same total power being developed by all four engines at the same RPM.

The effect of generator loads on power settings is to reduce the limit BMEP values which would be determined from the power chart. Approximately 1½ BHP is required to generate 1000 volt-amperes (1 KVA) of electrical power. Therefore, if the outboard engine DC and AC generators are operated at capacity (39 KVA total), approximately 60 BHP of the total engine power being developed is delivered to the electrical system rather than to the propeller shaft. BMEP gages indicate only shaft horsepower. Therefore, a value of 6 BMEP must be subtracted from limit BMEP power settings in order not to exceed engine operating limits. If both DC generators on an inboard engine are operated at capacity (18 KVA total), an allowance for 27 BHP or 3 BMEP must be subtracted from limit power settings. If generator loads are less than the rated capacity, the BMEP allowance necessary is reduced proportionately.

MANIFOLD PRESSURE CONSIDERATIONS.

Values read along the broken slant lines shown on the Altitude Calibration (Figure A2-1) represent manifold pressure required to obtain limit brake horsepowers at the corresponding engine speeds with 80% relative humidity and standard day conditions. For convenience, interpolation is permitted between lines of constant engine speed and between lines of constant manifold pressure in both the part and full throttle portions of the curve. Interpolation is not permitted between areas of Auto Rich and Best Power operation, nor is extrapolation and use of Auto Rich manifold pressure with Best Power engine speeds and vice-versa.

Values of MAP read between the 2900 RPM and 2400 RPM lines (Auto Rich Section) in the part throttle sections of the Altitude Calibration are limits. Also values of 38″ Hg for Auto Rich recommended Maximum Cruise Power and 41″ Hg for Best Power or Manual Lean cruising at 2400 RPM or less are limits. MAP settings greater than these should not be made except at Maximum Power under unusually humid operating conditions, even if this results in inability to obtain limit BMEP settings.

Manifold pressures read below the 2400 RPM line (Best Power Section) are not to be considered as limits, since these are well within the 41″ Hg value given above. Hot day operation, engine condition, and manual leaning procedures affect the manifold pressures required to obtain cruising powers. This portion of the altitude calibration can be used very advantageously together with the Sea Level Calibration in determining constant MAP-RPM lines. These lines may be used to obtain values of part throttle power settings expected for power available with ram, or settings needed to obtain required powers at altitude.

For example, assume a problem is to find the line of standard day power vs. altitude which should be obtained at 2300 RPM and 33″ MAP in low blower with Best Power mixture. The first step is to locate the intersection of the 2300 RPM and 33″ MAP lines on Figure A2-1. The intersection occurs at 11,900 feet and 1800 BHP, and locates one point on the desired line. Next, on the left-hand or sea level calibration chart, find the intersection of the 2300 RPM line and the vertical 33″ MAP line at 1500 BHP. Project horizontally to the right and locate a point at 1500 BHP and sea level on the low blower altitude calibration chart. This establishes a second point on the constant RPM-MAP line and allows the line to be drawn through the two points. Any point on this line defines the altitude and power combination which will exist at 33″ MAP and 2300 RPM

on a standard day with Best Power mixture. Likewise, a line with this slope can be passed through any adjacent RPM-MAP point to determine low blower BHP at any altitude. A similar procedure can be followed using the 2400 RPM-2600 RPM sea level and altitude calibration lines for Auto Rich mixture operation.

It should be emphasized that MAP values less than 41" Hg which are read below the 2400 RPM line are not to be interpreted as limits. The near-horizontal RPM lines in this area limit the BHP and BMEP values allowable from engine design considerations. The sloping constant MAP-RPM lines merely show the standard day MAP values to be expected when given RPM and BMEP settings are established. For example, 36" MAP at 7700 feet represents the point at which limit BMEP for 2300 RPM should be obtained in low blower on a standard day with Best Power mixture setting. If carburetor air temperature is lower than standard, limit BMEP should be obtained at less than 36" Hg due to higher intake air density. If higher temperatures exist, BMEP and BHP will be less than the limit at 36"MAP. Variation of fuel-air ratio from normal may also result in a MAP deviation. However, since the cruising manifold pressure limit is 41" Hg. a sufficient margin is available to allow adjusting the manifold pressure slightly until limit power is obtained.

This does not mean to imply that the full margin can be or should be used to obtain limit BMEP. If full use of such a margin were necessary without some very apparent explanation, it should be assumed that an engine or BMEP gage malfunction exists and BMEP reduced. Observe the settings on the other engines as a check. No more than 2" Hg difference in manifold pressure is allowable between engines for a given power setting. If a greater spread is observed, after accounting for cabin supercharger power requirements, power on the engine(s) with the highest manifold pressure should be reduced until a difference of 2" Hg or less is obtained. An investigation should be made at the earliest opportunity to determine the cause of this discrepancy.

ENGINE INSTALLATION CONSIDERATION.

Each Operating Limits Graph is based on a zero ram calibration. That is, the calibration is made with ambient static pressure and temperature existing at the carburetor top deck, crankcase breather, and turbine exhaust hoods. Ducting necessary for installation of the engine on the aircraft alters these pressures and temperatures from the ambient condition when the engine is run, as does the operating flight condition.

This deviation from the standard calibration condition affects the altitude-power characteristics of the engine. The difference in performance is commonly referred to as "ram," since normal flight speed usually results in an increase in carburetor deck pressure over ambient static and thereby increases the altitude at which full throttle occurs for particular RPM settings.

Standard manifold pressure for this higher critical altitude may be obtained by the method described above. For example, if "ram" permitted 2300 RPM part throttle operation up to 15,000 feet altitude the maximum obtainable (and limit) power would be 1840 BHP. This 1840 BHP value is determined by extending the 2300 RPM part throttle line from the standard day full throttle limiting power line through the 15,000 foot altitude point. At the intersection of this point (15,000 feet and 2300 RPM) read the BHP on the vertical scale.

The standard day manifold pressure predicted for this power is found to be 32.6" Hg. This is determined by passing a slope line, parallel to the constant RPM-MAP line previously found, through the 15,000 foot 1840 BHP point and downward to the left to the 2300 RPM zero ram full throttle calibration line. The 32.6" Hg value is found by interpolation between 32.0" Hg and 33.0" Hg MAP along the 2300 RPM line.

OPERATING CONSIDERATIONS.

The operating Limits Graph can be modified to supply power settings for non-standard conditions very readily. General rules can be used to account for the effects of temperature and humidity. Settings thus obtained must be checked against special restrictions, however, to verify whether or not use of the values is permissible.

Non-standard carburetor air temperatures result in deviations from standard day manifold pressure required to obtain power settings shown on the chart. These deviations will amount to approximately ¼" Hg increase or decrease in manifold pressure required to obtain chart power values for each 6°C decrease or increase respectively of carburetor air temperature from standard for the flight altitude. The variation may be expected to occur with Auto Rich and Best Power or Manual Lean mixture settings and in high and low blower.

The above rule is particularly useful for predicting manifold pressure required to obtain limit cruising powers. There are definite restrictions to its application which must be observed, however, in order not to exceed engine operating limitations. It is not allowable in any case to increase manifold pressure above standard day limits in

order to compensate for power loss due to higher than standard carburetor air temperature, i.e., 41″ Hg for Manual Lean or Best Power cruising at 2400 RPM or less, 38″ Hg for Auto Rich Maximum Cruise Power. Manifold pressure limits are not reduced when higher than standard carburetor air temperatures (CAT) are experienced if direct ram air is being supplied to the engine, although CAT must be controlled to remain at or below 30°C when hot alternate air is being used. It is not permitted to set limit manifold pressure if limit BMEP is obtained first at less MAP.

Thus, for example, the MAP setting at take-off RPM is restricted to 56.5″ Hg at sea level for all direct ram carburetor air temperatures and for CAT values up to 30°C when using the alternate air supply. Similarly, if 37.6″ MAP and 2400 RPM are high blower power settings which should result in limit BMEP being obtained at 15,000 feet with —15°C CAT and Best Power mixture, the MAP required to set limit BMEP with 21°C CAT IS 37.6 + 1.5 or 39.1″ Hg. The limit MAP at this cruise condition is 41.0″ Hg with either —15°C or +21°C CAT. Obtain standard day temperature values from the Standard Altitude Table or from the Density Altitude Chart (Figures A1-7 or A1-8).

While it is not allowable to adjust limit manifold pressures because of unusual temperature conditions, it is allowable in the event that humidity is excessive. The engine operating limits curves are prepared for a condition of 80% relative humidity at standard temperatures. This tends to eliminate the need for making humidity adjustments under normal conditions, since, in temperate climates, this value is normally approached or surpassed only in the summer months. However, if conditions of extreme humidity do exist, the maximum power limit manifold pressure (56.5″ Hg) value may be increased by two times the difference between existing vapor pressure (P_v) and that which would exist as 80% relative humidity and standard temperature provided 265 BMEP or 57.5″ Hg MAP are not exceeded. The following tabulations are provided for reference.

ALTITUDE	STD. TEMP.	$*P_{v_{std}}$ @ 80% RELATIVE HUMIDITY
Sea Level	15°C	0.405″ Hg
2,500 ft.	10°C	0.288″ Hg
5,000 ft.	5°C	0.207″ Hg
7,500 ft.	0°C	0.144″ Hg
10,000 ft.	—5°C	0.097″ Hg

$*P_v$ = Vapor Pressure

TEMPERATURE	$*P_v$ @ 100% RELATIVE HUMIDITY
0°C	0.18″ Hg
10°C	0.36″ Hg
20°C	0.69″ Hg
30°C	1.26″ Hg
40°C	2.18″ Hg

$*P_v$ = Vapor Pressure

STANDARD DAY POWER AVAILABLE.

Figures A2-4 and A2-5 show the standard day variation of low and high blower power available with altitude for the complete engine installation with zero humidity, MK V-A scoops and the following flight conditions: in climb, with maximum, METO and alternate climb powers, and in level flight with normal cruising powers.

It will be noted that maximum power deviates somewhat from the limit values shown on the Operating Limits Graph. This is due to installation effects discussed in the previous section. Standard take-off and cruise performance shown in this appendix is based on the standard day powers shown to be available by this chart. If specific operating conditions or the conditions of individual engines permits more than standard power to be developed without exceeding BMEP or MAP limits, full advantage should be taken of such a situation in order to increase airplane performance.

Note

Take-off performance shown in this appendix is based on normal operating procedures, i.e., with carburetor airscoop open in the "Direct" position. Operation with these scoops in the "alternate" position is permissible provided carburetor air temperature does not exceed an indicated value of 30°C. The altitude at which full throttle will be obtained is reduced approximately 1000 feet at maximum and METO power settings. Take-off performance and METO power climb performance will be affected in the full operating region.

To predict take-off performance with airscoops in the "alternate" position, enter the maximum power prediction curve with a value 1000 feet higher than actual pressure altitude to predict actual power which will be available. Then, compare the power obtained with standard day power for the actual pressure altitude to determine per cent power deviation from standard. Use this power deviation value with actual winds and slopes to correct standard take-off performance for actual operating conditions.

Full throttle cruise powers available are based on fuel-air ratios obtained with 10% lean mixture settings (using the 10% manual leaning method as recommended by the engine manufacturer). Power values shown are directly applicable to the *inboard engines,* and to the outboard engines if the cabin supercharger and 30 KVA alternators are disconnected. The full throttle lines include the effect of level flight ram at four-engine flight speeds for average gross weights. Since the outboard engines normally operate with cabin superchargers and 30 KVA alternators connected, part and full throttle cruise powers shown on the chart are not representative of average performance available for four-engine operation. Values read must be reduced by a power increment equivalent to 5 BMEP to obtain *average* four-engine cruise power.

Note

10 BMEP is equivalent to the average power contribution of each outboard engine to cabin supercharger and 30 KVA alternator opeartion. This is a nominal value based on normal cabin differential pressures and electrical requirements at customary cruising powers and altitudes.

Four and three engine cruising performance is based on average power available with cabin superchargers connected. Two-engine performance is based on operation with cabin superchargers and alternators disconnected, the assumption being made that two-engine operating altitudes do not require cabin pressurization and that it is more desirable to make all of the engine power being developed available for propulsion.

ENGINE POWER SCHEDULE TABLE.

A tabulation of engine power settings likely to be used most frequently for operations from sea level to 25,000 feet density altitude is shown on Figures A2-6, 7, 8. Data are supplied for Auto Rich and for 10% Lean mixture settings which are applicable as marked to 115/145 or 100/130 grade fuel. Interpolation between altitudes and engine speeds is permitted within limits discussed under description of the Engine Operating Limits Curve.

Figure A2-6 provides RPM, BMEP, and limit MAP settings for maximum, METO, alternate climb, and maximum cruise powers with Auto Rich mixture. Stated values of average power and BMEP are maximum settings to be expected at standard temperatures with ram air when limited either by power or manifold pressure considerations.

The outboard engines should be set 10 BMEP less than values shown at all except maximum and METO powers to allow for cabin supercharger and alternator power requirements. This spread need not be set at MAXIMUM and METO powers if BMEP and MAP limits are carefully observed. Figure A2-7 lists recommended power settings for level flight cruise conditions. Low blower power settings reflect increased power limits in accordance with the engine manufacturer's operating instructions of April 1957. Cruising charts in this handbook have not yet been adjusted to reflect the increased operating limits referenced. Substitution of tabulated power settings for those shown on the cruising charts should result in fuel savings of up to five or ten pounds per hour per engine when operating in the affected region.

Figure A2-8 provides take-off, climb, and cruise power settings for use with 100/130 grade fuel.

FUEL FLOW CURVES.

The charts on Figures A2-9, A2-10, A2-11 and A2-12 show fuel flow in pounds per hour per engine versus inboard engine power for various engine speeds and density altitudes. Figures A2-9 and A2-10 are applicable to low blower operation with Auto Rich and 10% Lean mixture settings respectively; Figures A2-11 and A2-12 are similar charts for high blower operation. The fuel flow charts for 10% Lean mixture settings are based on results of Contractor's flight tests and operational cruise data. Auto Rich mixture charts are based on Contractor's climb and high speed flight tests. The fuel flow values shown are applicable to engines with 25° to 35° ignition timing. Installation of manual spark control equipment changes ignition timing to 25°-30° and may affect fuel flow characteristics. Unless service experience indicates otherwise, high blower fuel flows for power settings with spark advanced should be increased 1% (5 to 10 lbs/hr/eng.) when used to predict performance of aircraft equipped with manual spark control.

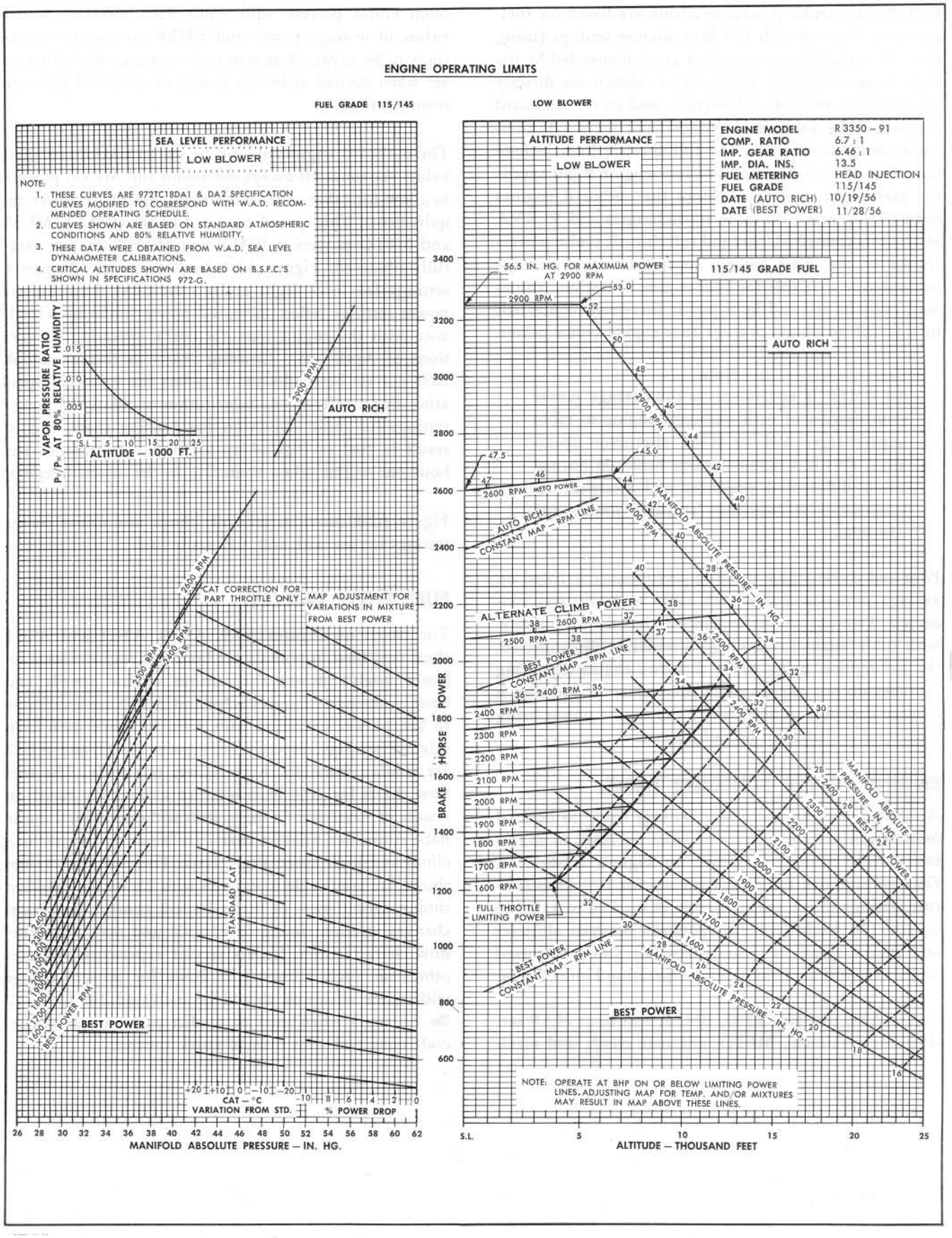

Figure A2-1. Engine Operating Limits — 115/145 Grade Fuel — Low Blower

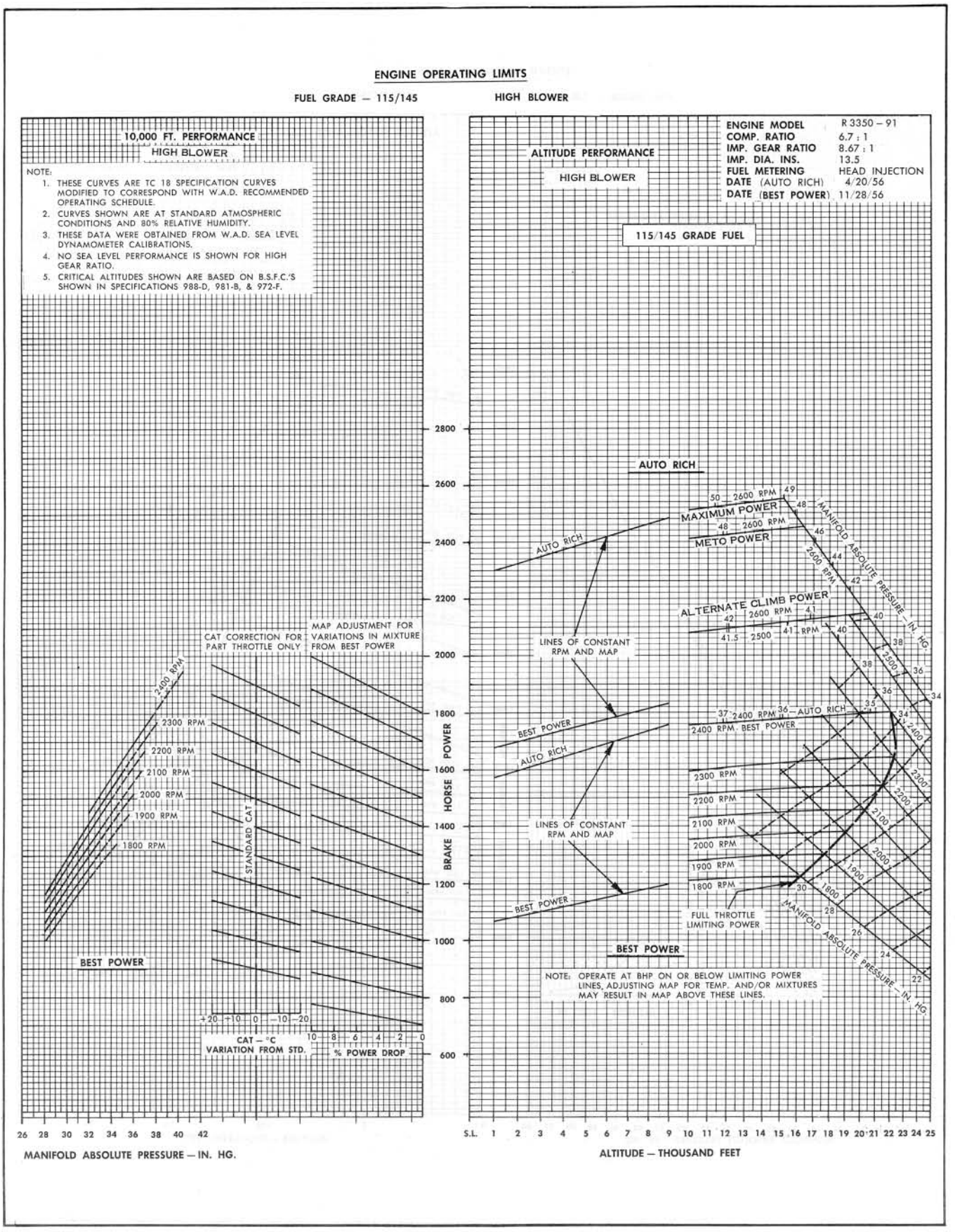

Figure A2-2. Engine Operating Limits — 115/145 Grade Fuel — High Blower

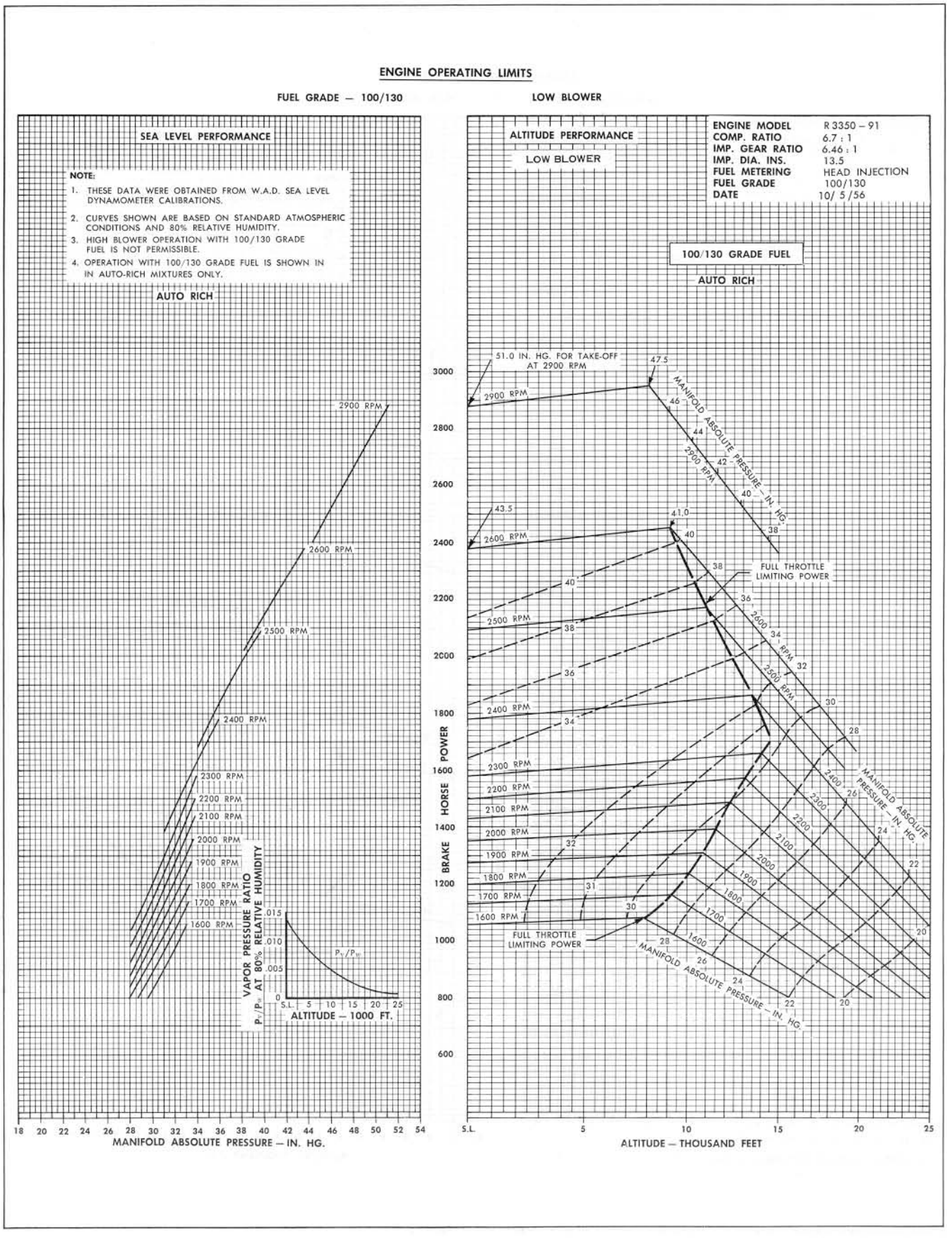

Figure A2-3. Engine Operating Limits — 100/130 Grade Fuel — Low Blower

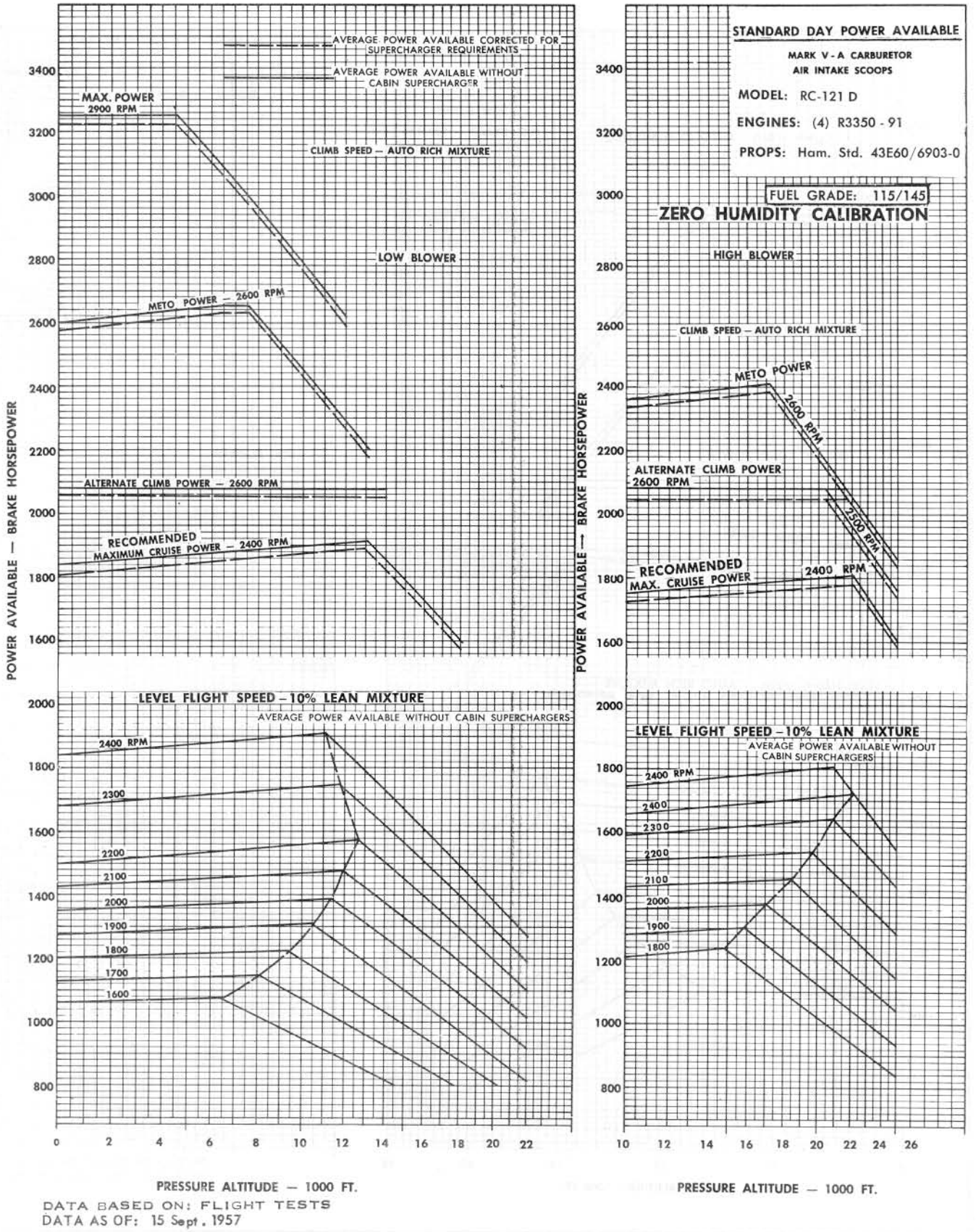

Figure A2-4. Standard Day Power Available — 115/145 Grade Fuel

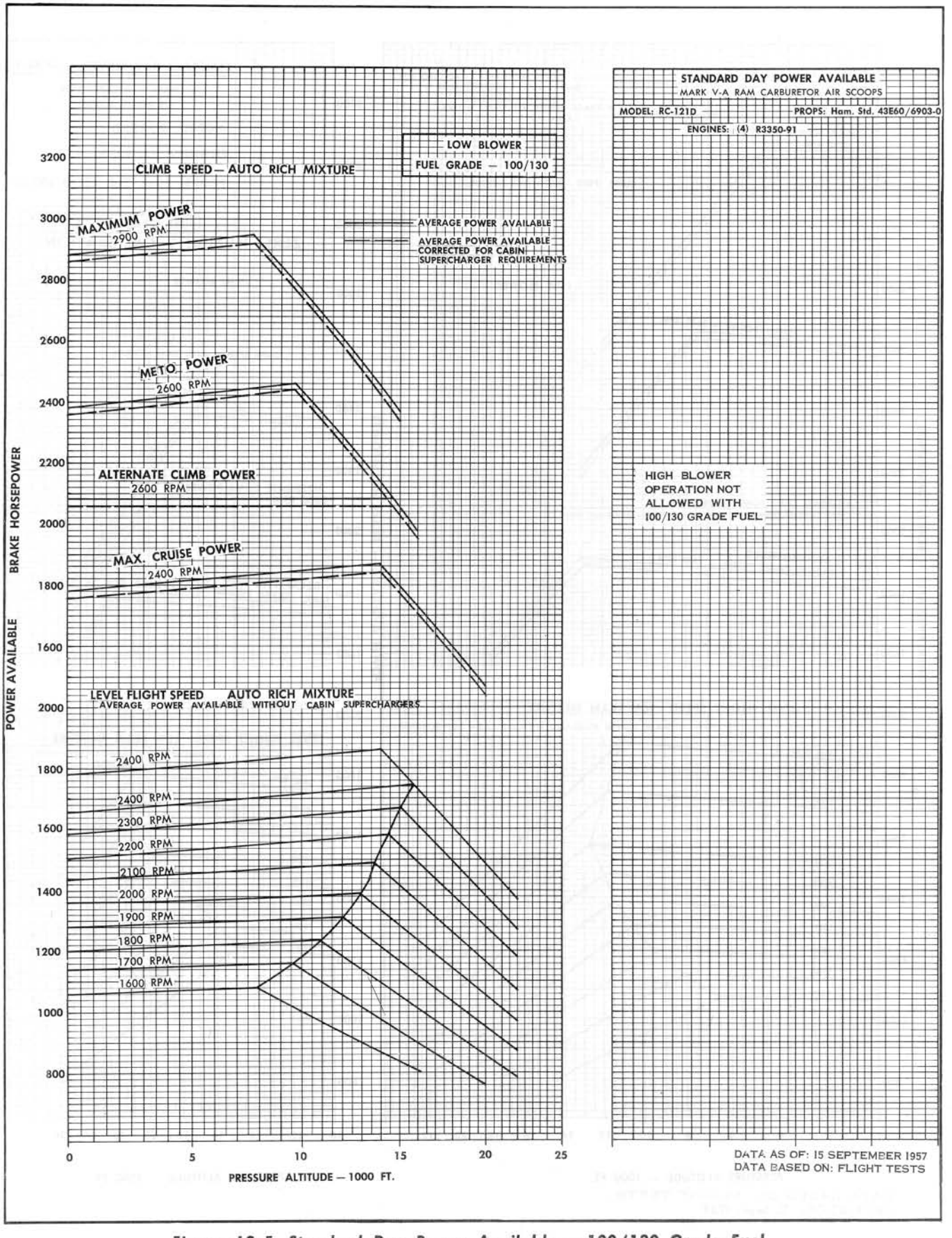

Figure A2-5. Standard Day Power Available — 100/130 Grade Fuel

ENGINE POWER SCHEDULE TABLE

MK V-A SCOOPS

AUTORICH MIXTURE

STANDARD DAY

115/145 GRADE FUEL

ZERO HUMIDITY AT STANDARD TEMP.

MODEL: RC-121D **ENGINES:** (4) R3350-91 **PROPS:** Ham. Std. 43E60/6903-0

AUTORICH MIXTURE

ENGINE SPEED RPM	POWER SETTINGS									
	ALTITUDE	S.L.	5,000	10,000	15,000	20,000	10,000	15,000	20,000	25,000
	BLOWER SETTING	LOW BLOWER					HIGH BLOWER			
2900	MAXIMUM POWER: MAX. ALLOW. C.H.T. 260°C: TIME LIMIT, 5 MIN: LIMIT BMEP 265									
	INB'D BHP	3250	3210F.T.	2785F.T			MAXIMUM POWER RESTRICTED TO LOW BLOWER AT THIS ENGINE SPEED.			
	INB'D BMEP	265	261	227						
	LIMIT MAP	56.5 In. Hg. PLUS HUMIDITY CORRECTION IF APPLICABLE								
2600	MAXIMUM POWER: MAX. ALLOW. C.H.T. 260°C: TIME LIMIT, 5 MIN: LIMIT BMEP, 227-231									
	INB'D BHP						2500	2540	2200F.T.	1860F.T.
	INB'D BMEP						227	231	200	169
	LIMIT MAP						49.1	47.9		
2600	METO POWER: MAX. ALLOW. C.H.T. 246°C. TIME LIMIT, NONE: LIMIT BMEP, 219 (HIBLO)									
	INB'D BHP	2600	2635	2450F.T	2050F.T.	1665F.T.	2360	2400	2200F.T.	1860F.T.
	INB'D BMEP	236	239	222	186	151	214	218	200	169
	LIMIT MAP	46.5	45.0				46.9	46.0		
2600	ALTERNATE CLIMB POWER: MAX. ALLOW. C.H.T. 232°C: TIME LIMIT, NONE									
	INB'D BHP	2080	2080	2080			2080	2080	2080	1860F.T.
	INB'D BMEP	189	189*	189*			189	189*	189*	169
	LIMIT MAP	40.0	40.0	40.0			43.0	43.0	43.0	
2500	ALTERNATE CLIMB POWER: MAX. ALLOW C.H.T. 232°C: TIME LIMIT, NONE									
	INB'D BHP	2080	2080	2080			2080	2080	2080	1760F.T.
	INB'D BMEP	196	196*	196*			196	196*	196*	166
	LIMIT MAP	40.0	40.0	40.0			43.0	43.0	43.0	
2400	MAXIMUM CRUISE POWER: MAX. ALLOW. C.H.T. 232°C. TIME LIMIT. NONE									
	INB'D BHP	1840	1870	1900	1795F.T.	1470F.T.	1750	1775	1800	1610F.T.
	INB'D BMEP	181	184	187	177	145	172	175	177	158
	LIMIT MAP	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0

NOTES:

1. SET POWER BY RPM AND BMEP UNLESS LIMIT MAP IS OBTAINED FIRST. SET OUTBOARD ENGINES 10 BMEP LESS THAN VALUES SHOWN AT ALL EXCEPT MAXIMUM AND METO POWER TO ALLOW FOR FOR CABIN SUPERCHARGER AND ALTERNATOR POWER REQUIREMENTS UNLESS CABIN SUPERCHARGERS ARE DISCONNECTED.
2. INBOARD ENGINE BMEP SETTINGS ARE THOSE EXPECTED TO BE AVAILABLE WITH STANDARD DAY TEMPERATURES AND RAM AIR. VALUES SHOWN ARE LIMITS UNLESS ESTIMATED FULL THROTTLE PERFORMANCE IS SHOWN, NOTED BY (F.T.).
3. THE MAXIMUM MAP SPREAD BETWEEN ENGINES MUST NOT EXCEED 1 IN. HG. DURING MANUAL LEANING TO ALTERNATE CLIMB POWER.

DATA AS OF: 15 SEPTEMBER 1957 FUEL GRADE: 115/145

DATA BASED ON: CONTRACTOR'S R7V-1 FLIGHT TESTS

Figure A2-6. Engine Power Schedule Table — 115/145 Grade Fuel — Auto Rich Mixture

ENGINE POWER SCHEDULE TABLE

10% LEAN MIXTURE

MK V-A SCOOPS

STANDARD DAY — 115/145 GRADE FUEL

ZERO HUMIDITY AT STANDARD TEMP.

MODEL: RC-121D **ENGINES:** (4) R3350-91 **PROPS:** Ham. Std. 43E60/6903-0

ENGINE SPEED RPM	POWER SETTINGS									
	ALTITUDE	S.L.	5,000	10,000	15,000	20,000	10,000	15,000	20,000	25,000
	Blower Setting	LOW BLOWER					HIGH BLOWER			
		MAXIMUM CRUISE POWER: MAX. ALLOW C.H.T. 232° C; LIMIT MAP. 41.0 HG; TIME LIMIT, NONE								
2400	INB'D BHP	1840	1870	1900	1670F.T.	1830F.T.	1750	1775	1800	1550F.T.
	INB'D BMEP	181	184	187	164	136	172	175	177	152
2350	INB'D BHP	1800	1830	1860	1620F.T.	1340F.T.	1670	1700	1720	1500F.T.
	INB'D BMEP	181	184	187	163	135	168	171	173	151
2300	INB'D BHP	1760	1790	1820	1570F.T.	1290F.T.	1595	1620	1640	1430F.T.
	INB'D BMEP	181	184	187	161	132	164	166	168	147
2250	INB'D BHP	1720	1750	1780	1510F.T.	1250F.T.	1555	1570	1590	1360F.T.
	INB'D BMEP	181	184	187	158	131	163	165	167	143
2200	INB'D BHP	1685	1720	1710F.T.	1450F.T.	1200F.T.	1510	1530	1520F.T.	1280F.T.
	INB'D BMEP	181	184	183	155	129	162	164	163	137
2100	INB'D BHP	1605	1640	1570F.T.	1330F.T.	1100F.T.	1430	1445	1380F.T.	1150F.T.
	INB'D BMEP	181	184	176	149	124	160	162	155	129
2000	INB'D BHP	1530	1555	1460F.T.	1220F.T.	1000F.T.	1360	1370	1250F.T.	1040F.T.
	INB'D BMEP	181	184	172	144	118	160	162	147	123
1900	INB'D BHP	1460	1480	1330F.T.	1100F.T.		1280	1300	1130F.T.	
	INB'D BMEP	181	184	165	137		159	161	140	
1800	INB'D BHP	1380	1400	1190F.T.	990F.T.		1210	1230 FT.	1020F.T.	
	INB'D BMEP	181	184	156	130		159	161	134	
1700	INB'D BHP	1300	1270F.T.	1070F.T.	890F.T.		1135	1070F.T.	930F.T.	
	INB'D BMEP	181	175	148	123		149*	140*	122*	
1600	INB'D BHP	1230	1130F.T.	950F.T.			1060	915F.T.	895F.T.	
	INB'D BMEP	181	166	140			139*	120*	117*	
1600	INB'D BHP	1020	1020	850F.T.						
	INB'D BMEP	151*	151*	126*						
1600	INB'D BHP	950	950	815F.T.						
	INB'D BMEP	140*	140*	121*						
1600	INB'D BHP	880	880	785F.T.						
	INB'D BMEP	130*	130*	116*						
1600	INB'D BHP	815	815							
	INB'D BMEP	120*	120*							
1600	INB'D BHP	745	745							
	INB'D BMEP	110*	110*							
1600	INB'D BHP	678								
	INB'D BMEP	100*								

10% LEAN MIXTURE

1800 RPM ONLY

NOTES:

1. THIS TABLE SUMMARIZES CRUISE POWER SETTINGS WHICH ARE LIKELY TO BE USED MOST FREQUENTLY. LOW BLOWER SETTINGS REFLECT INCREASED POWER LIMITS ALLOWABLE BETWEEN 1600 RPM AND 2400 RPM.
2. INBOARD ENGINE BMEP SETTINGS ARE THOSE EXPECTED TO BE AVAILABLE WITH STANDARD DAY TEMPERATURES AND RAM AIR. VALUES SHOWN ARE LIMITS UNLESS ESTIMATED FULL THROTTLE PERFORMANCE IS SHOWN, NOTED BY (F.T.), OR UNLESS BMEP SETTINGS LESS THAN LIMIT VALUES ARE RECOMMENDED, NOTED BY (*). SET POWER BY RPM AND BMEP UNLESS LIMIT MAP IS OBTAINED FIRST AND SET OUTBOARD ENGINES 10 BMEP LESS THAN VALUES SHOWN TO ALLOW FOR CABIN SUPERCHARGER AND ALTERNATOR POWER REQUIREMENTS. AN ARBITRARY "PAD" OF 50 RPM HAS BEEN INCLUDED IN THESE FULL THROTTLE POWER SETTINGS.
3. NO MORE THAN 2 IN. HG. DIFFERENCE IN MAP BETWEEN ENGINES IS ALLOWABLE FOR A GIVEN POWER SETTING AFTER ACCOUNTING FOR CABIN SUPERCHARGER AND ALTERNATOR POWER REQUIREMENTS. IF A GREATER DIFFERENCE IS OBSERVED, REDUCE POWER ON THE ENGINE WITH THE HIGHEST MAP UNTIL THE DIFFERENCE IS 2 IN. HG. OR LESS.

FUEL GRADE: 115/145

DATA AS OF: 15 SEPTEMBER 1957
DATA BASED ON: CONTRACTOR'S R7V-1 FLIGHT TESTS

Figure A2-7. Engine Power Schedule Table — 115/145 Grade Fuel — 10% Lean Mixture

ENGINE POWER SCHEDULE TABLE

MK V-A SCOOPS

AUTORICH MIXTURE SETTING

STANDARD DAY — 100/130 FUEL

ZERO HUMIDITY AT STANDARD TEMP.

MODEL: RC-121D — ENGINES: (4) R3350-91 — PROPS: Ham. Std. 43E60/6903-0

ENGINE SPEED RPM	POWER SETTINGS		S.L.	5,000	10,000	15,000	20,000	
	ALTITUDE							
	BLOWER SETTING		LOW BLOWER					HIGH BLOWER
2900	AUTORICH MIXTURE SETTING	INB'D BHP	2880	2920	2765F.T.	2365F.T.		MAXIMUM POWER: MAX. ALLOW C.H.T. 260°C TIME LIMIT, 5 MIN; LIMIT BMEP 234 TO 240
		INB'D ENG. BMEP	234	238	225	192		
		LIMIT MAP	51.0	49.0				
2600		INB'D BHP	2380	2420	2435F.T.	2055F.T.		METO POWER: MAX. ALLOW. C.H.T. 246°C; TIME LIMIT, NONE; LIMIT BMEP. 216 TO 223
		INB'D ENG. BMEP	216	219	221	187		
		LIMIT MAP	43.5	41.9				
2400		INB'D BHP	1780	1810	1840	1795F.T.	1465F.T.	MAXIMUM CRUISE POWER: MAX. ALLOW. C.H.T. 232°C; TIME LIMIT, NONE; LIMIT BMEP. 175 TO 183.
		INB'D ENG. BMEP	175	178	181	177	144	
		LIMIT MAP	36	36	36			
2300		INB'D BHP	1580	1615	1640	1670F.T.	1380F.T.	
		INB'D ENG. BMEP	162	166	168	171	142	
2200		INB'D BHP	1505	1530	1560	1550F.T.	1280F.T.	
		INB'D ENG. BMEP	162	164	167	166	137	
2100		INB'D BHP	1435	1455	1475	1415F.T.	1165F.T.	
		INB'D ENG. BMEP	161	163	166	159	131	
2000		INB'D BHP	1360	1375	1380	1290F.T.	1055F.T.	
		INB'D ENG. BMEP	161	162	163	152	125	
1900		INB'D BHP	1280	1290	1305	1170F.T.	950F.T.	
		INB'D ENG. BMEP	159	160	162	145	118	
1800		INB'D BHP	1200	1215	1230	1050F.T.	855F.T.	
		INB'D ENG. BMEP	157	159	161	138	112	
1700		INB'D BHP	1140	1150	1140F.T.	940F.T.	760F.T.	HIGH BLOWER OPERATION WITH 100/130 GRADE FUEL IS NOT PERMISSIBLE.
		INB'D ENG. BMEP	158	160	158	130	106	
1600		INB'D BHP	1060	1070	995F.T.	835F.T.		
		INB'D ENG. BMEP	156	158	147	123		
1600		INB'D BHP	1015	1030	995F.T.			
		INB'D ENG. BMEP	150*	152*	147			
1600		INB'D BHP	950	965	995F.T.			
		INB'D ENG. BMEP	140*	142*	147			
1600		INB'D BHP	880	895				
		INB'D ENG. BMEP	130*	132*				
1600		INB'D BHP	815	830				
		INB'D ENG. BMEP	120*	122*				
1600		INB'D BHP	745	760				
		INB'D ENG. BMEP	110*	112*				
1600		INB'D BHP						
		INB'D ENG. BMEP						

NOTES:

1. SET POWER BY RPM AND BMEP UNLESS LIMIT MAP IS OBTAINED FIRST. SET OUTBOARD ENGINES 10 BMEP LESS THAN VALUES SHOWN AT ALL EXCEPT MAXIMUM AND METO POWER TO ALLOW FOR CABIN SUPERCHARGERS AND ALTERNATOR POWER REQUIREMENTS UNLESS CABIN SUPERCHARGERS ARE DISCONNECTED.
2. INBOARD ENGINE BMEP SETTINGS ARE THOSE EXPECTED TO BE AVAILABLE WITH STANDARD DAY TEMPERATURES AND RAM AIR. VALUES SHOWN ARE LIMITS UNLESS ESTIMATED FULL THROTTLE PERFORMANCE IS SHOWN, NOTED BY (F.T.), OR UNLESS BMEP SETTINGS LESS THAN LIMIT VALUES ARE RECOMMENDED, NOTED BY (*). AN ARBITRARY PAD OF 50 RPM HAS BEEN INCLUDED IN THESE FULL THROTTLE POWER SETTINGS FOR CRUISE POWER.
3. NO MORE THAN 2 IN. HG DIFFERENCE IN MAP BETWEEN ENGINES IS ALLOWABLE FOR A GIVEN POWER SETTING AFTER ACCOUNTING FOR CABIN SUPERCHARGER AND ALTERNATOR POWER REQUIREMENTS. IF A GREATER DIFFERENCE IS OBSERVED, REDUCE POWER ON THE ENGINE WITH THE HIGHEST MAP UNTIL THE DIFFERENCE IS 2 IN. HG. OR LESS

DATA AS OF: 15 SEPTEMBER 1957 — FUEL GRADE: 100/130

DATA BASED ON: CONTRACTORS R7V-1 FLIGHT TESTS

Figure A2-8. Engine Power Schedule Table — 100/130 Grade Fuel — Auto-Rich Mixture

FUEL FLOW CURVE
LOW BLOWER — AUTO RICH MIXTURE

MODEL: RC-121D
DATA AS OF: 1 January 1956
DATA BASED ON: Contractor's WV-2 Flight Tests

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0

NOTE: Fuel flow values shown are based on inboard engine power. It is necessary to apply the following corrections to observed outboard engine BMEP in order to obtain correct fuel flow values.
Cabin Supercharger operating — add 5 BMEP to observed value.
30 KVA alternator operating — add 5 BMEP to observed value.
Cabin Supercharger and
30 KVA alternator operating — add 10 BMEP to observed value.

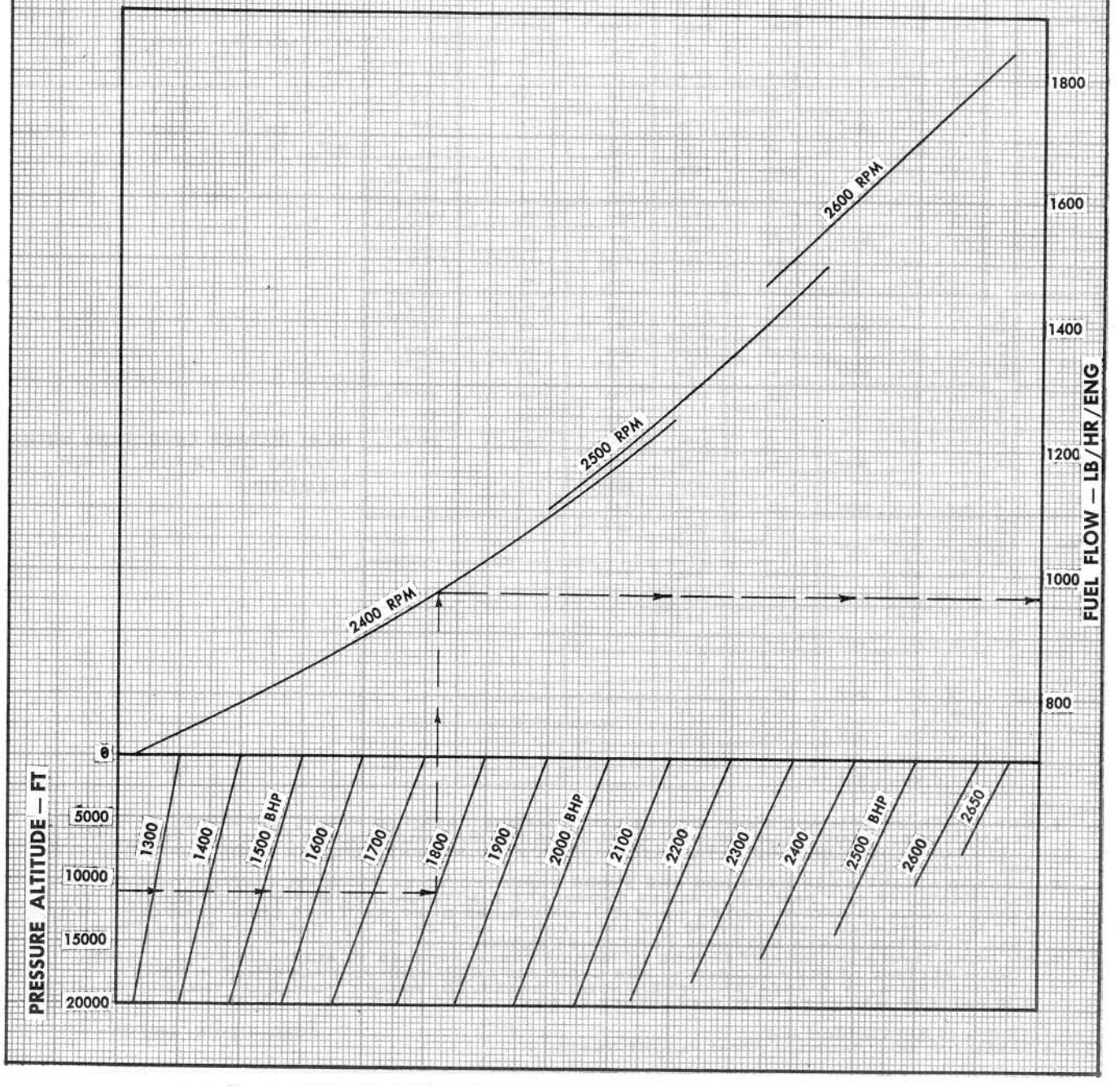

Figure A2-9. Fuel Flow Curve — Low Blower — Auto-Rich Mixture

FUEL FLOW CURVE

LOW BLOWER — *10% Lean Mixture*

MODEL: RC-121D
DATA AS OF: 1 January 1956
DATA BASED ON: Contractor's WV-2 Flight Tests

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0

NOTE: Fuel flow values shown are based on inboard engine power. It is necessary to apply the following corrections to observed outboard engine BMEP in order to obtain correct fuel flow values.
Cabin Supercharger operating — add 5 BMEP to observed value.
30 KVA alternator operating — add 5 BMEP to observed value.
Cabin Supercharger and
30 KVA alternator operating — add 10 BMEP to observed value.

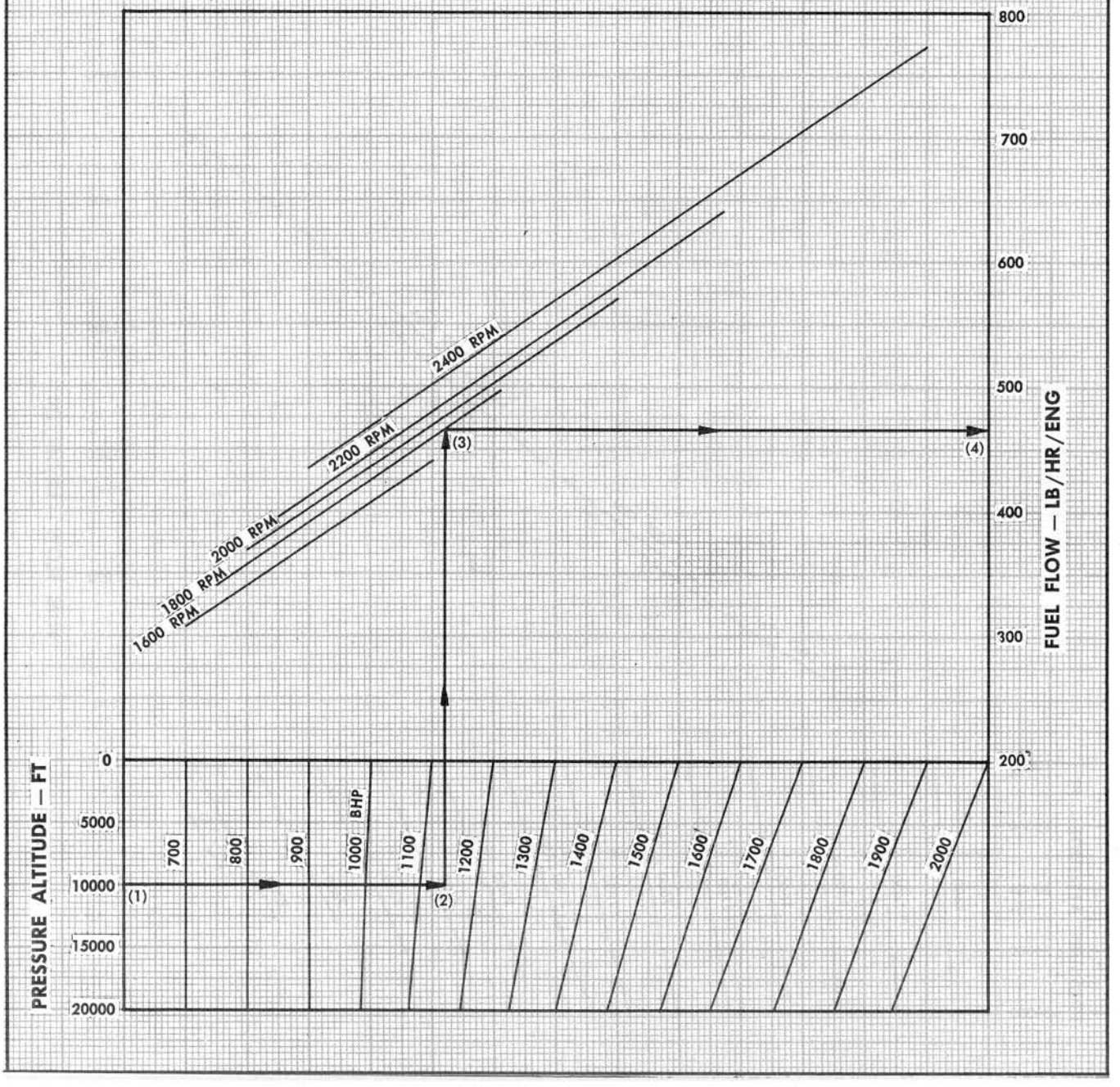

Figure A2-10. Fuel Flow Curve — Low Blower — 10% Lean Mixture

FUEL FLOW CURVE
HIGH BLOWER — AUTO RICH MIXTURE

MODEL: RC-121D
DATA AS OF: 1 January 1956
DATA BASED ON: Contractor's WV-2 Flight Tests

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0

NOTE: Fuel flow values shown are based on inboard engine power. It is necessary to apply the following corrections to observed outboard engine BMEP in order to obtain correct fuel flow values.
Cabin Supercharger operating — add 5 BMEP to observed value.
30 KVA alternator operating — add 5 BMEP to observed value.
Cabin Supercharger and
30 KVA alternator operating — add 10 BMEP to observed value.

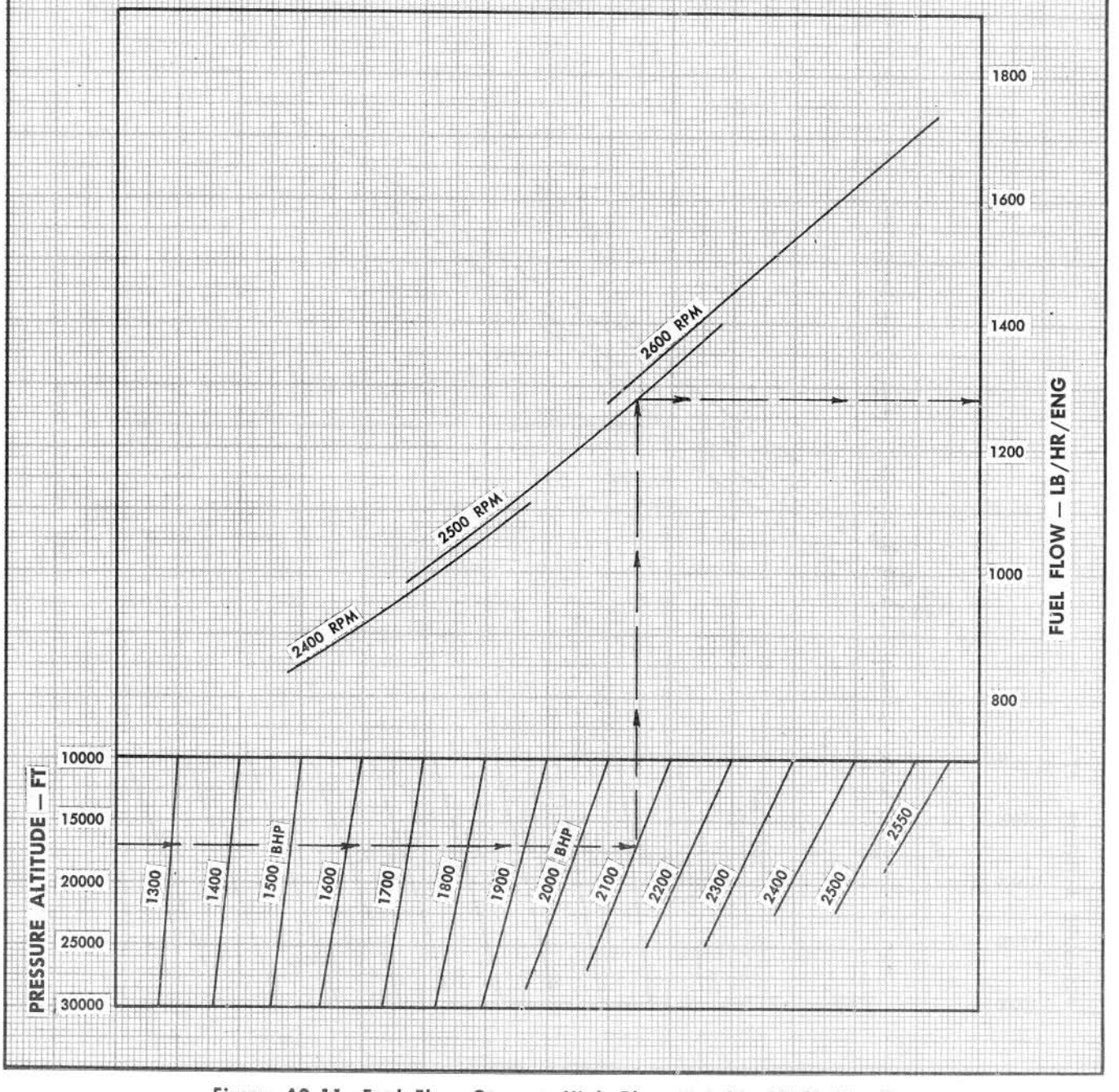

Figure A2-11. Fuel Flow Curve — High Blower — Auto-Rich Mixture

FUEL FLOW CURVE

HIGH BLOWER — *10% Lean Mixture*

MODEL: RC-121D
DATA AS OF: 1 January 1956
DATA BASED ON: Contractor's WV-2 Flight Tests

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0

NOTE: Fuel flow values shown are based on inboard engine power. It is necessary to apply the following corrections to observed outboard engine BMEP in order to obtain correct fuel flow values.
Cabin Supercharger operating — add 5 BMEP to observed value.
30 KVA alternator operating — add 5 BMEP to observed value.
Cabin Supercharger and
30 KVA alternator operating — add 10 BMEP to observed value.

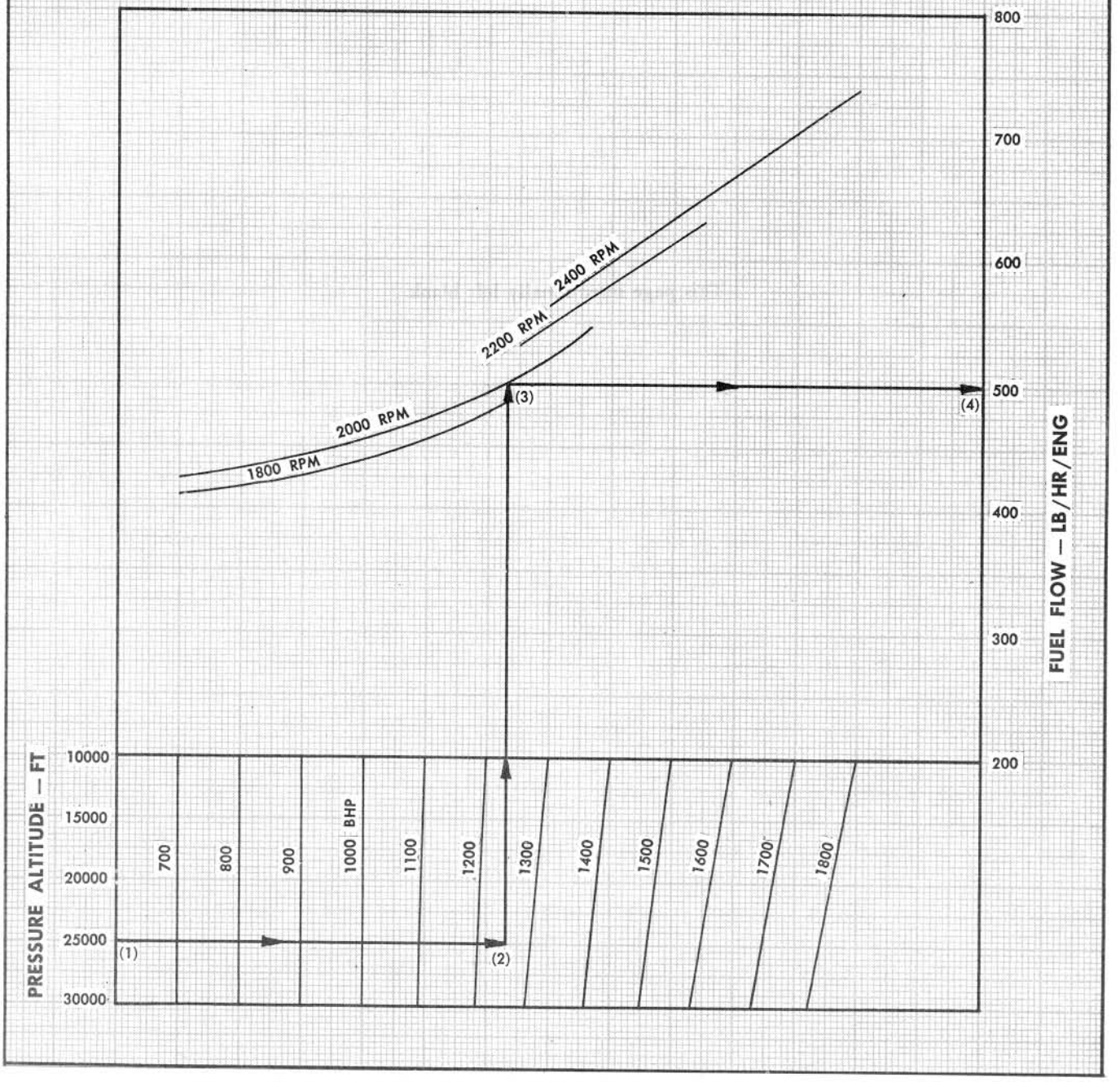

Figure A2-12. Fuel Flow Curve — High Blower — 10% Lean Mixture

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PART 3 — TAKE-OFF

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Performance With Take-off Emergency — Effect of Runway Slope on Critical Field Lengths and Critical Speeds for Engine Failure	A3-28*
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* Indicates Illustration Pages

SCOPE AND ARRANGEMENT.

Data included in this part of the appendix permit evaluation of field length requirements for various operating conditions.

The effects of temperature and humidity on power available and performance are discussed first. Normal take-off performance is shown next, which includes take-off ground run distances and take-off flight paths.

Performance with take-off emergency follows. Critical field lengths are presented, as are takeoff flight paths for 3 engine operation. Effects of slope on critical field lengths, limitations on weight by runway slope, refusal speeds and refusal distances, and the go-no-go concept are discussed and presented in graphs in some detail. Several sample problems explain the use of the charts.

BASIS FOR TAKE-OFF PERFORMANCE.

Take-off distances given in this Part are based on flight tests and reflect performance with power available under Standard (dry) Day conditions. Correction grids provide full accountability for the effects of winds and power deviation from standard.

TEMPERATURE ACCOUNTABILITY

Non-standard air temperatures have a decided effect on air density and power available, and a corresponding effect on take-off distances. Take-off performance can be expected to improve if air temperature is less than standard for a given field pressure altitude. Density altitude is decreased and the airplane can accelerate to take-off speed without having to reach so high a true airspeed. In addition, power available is increased if the field elevation is such that full throttle would be used at standard temperatures. Conversely, for temperatures higher than standard, an increase in take-off distances can be expected due to higher density altitudes. The airplane has to reach higher true airspeeds before the required indicated airspeeds for take-off will be attained. These temperatures may also prevent the use of standard day maximum power because of manifold pressure limitations. This reduces the acceleration and further increases the take-off run required. Use of density altitude as an entry value in determination of take-off performance accomplishes part of the correction necessary in accounting for non-standard temperature effects. Use of the power deviation correction grids completes the accounting required.

EFFECT OF HUMIDITY.

The existence of water vapor in the air and humidity, reduces the amount of power which can be developed with rich mixtures for a given manifold pressure and temperature. A portion of the oxygen which is required for combustion is replaced by water vapor, the fuel: oxygen ratio increases and combustion efficiency decreases. This will result in greater take-off distances unless manifold pressure can be increased sufficiently to counteract the power loss. Nothing can be done if full throttle is reached before limit MAP or limit power is obtained. If operation is at part throttle, MAP can be increased to 56.5 inches Hg to obtain the maximum power rating of 3250 BHP. Under conditions of excessive humidity, MAP can be increased further by twice the difference between actual vapor pressure and standard (0.4″ Hg at sea level) provided 3250 BHP or a value of 57.5 inches Hg is not exceeded.

PREDICTION OF MAXIMUM POWER AVAILABLE.

Figures A3-1 and A3-2 are provided to allow prediction of maximum power available at non-standard temperature and humidity conditions. Runway air temperature, field pressure altitude, and dew point or vapor pressure must be known. Maximum power, BMEP, and reject BMEP can be read from the curves. Percent power deviation from standard can be obtained by reference to figure A3-3. Figure A3-1 has been prepared specifically for low altitude operations and is applicable from sea level to 2000 ft. pressure altitude for airplanes using high grade (115/145) fuel. The second chart, figure A3-2, is more general, covering the altitude range to 10,000 ft. and supplying additional material for 100/130 grade fuel.

To predict maximum power for low altitude operations, obtain dew point or vapor pressure (P_v), runway air temperature, and field pressure altitude. These are normally supplied by the local field tower. If not available, airplane OAT and altimeter instrumentation may be used and wet bulb temperature or relative humidity obtained or estimated in the best way possible. Use figure A1-9 to obtain vapor pressure in this case. Then select either the upper or lower chart on figure A3-1, depending on whether field altitude is closer to sea level or 2000 ft. pressure altitude. Locate position (A), which is the dew point temperature, and note the corresponding limit

MAP. Keep this point in mind, but enter the chart at position (B) corresponding to runway air temperature. Proceed vertically to an intersection with either the limit MAP just determined or the full throttle line, whichever is reached first. Then proceed horizontally to the humidity base line located to the right. Follow parallel with the nearest guide line to a position above the humidity reference (A), and read predicted power, BMEP, and reject BMEP horizontally to the right from this point.

For example: with sea level pressure altitude, 90°F air temperature, dewpoint 70°F, limit MAP is 57.2" Hg. Dry day power would be 3268 BHP at this limit MAP. Predicted maximum power is actually 3088 BHP at 2900 rpm and 251 BMEP. With 2000 ft. pressure altitude instead of sea level, full throttle could be reached before limit MAP and predicted maximum power would be 2910 BHP.

Maximum power for higher altitudes can be predicted by use of Figure A3-2. The chart is more complex for this reason, but it is used in the same general way. Limit manifold pressure is determined first, then the left half of the figure is used to find power available under dry day conditions. The effects of humidity (vapor pressure) can be judged by use of the right hand half of the figure, the curved guide lines indicating the decrease in power available which can be expected. The sample problem illustrates the use of this curve.

Figure A3-3 relates predicted power available to standard power available for the field *density* altitude, and supplies the power deviation reference needed for take-off performance prediction. Enter at the left with field pressure altitude, and follow the altitude guide lines to an intersection with runway air temperature. Proceed horizontally from this point to an intersection with the predicted power available value obtained from Figure A3-1 or A3-2. Determine per cent power by referring to the superimposed grid.

Engine performance is sometimes affected by other factors, such as time since overhaul, spark plug condition, etc. For this reason, a pre-flight run-up should be conducted whenever possible. BMEP observed during the run-up should be compared with that calculated earlier. This will give an indication of any abnormal engine operation. Predicted take-off performance values should be revised if the power observed during the run-up check differs from that previously estimated.

The following examples explain the procedure to be followed in using figure A3-2.

Sample Problem A (115/145 Fuel).

Vapor Pressure $P_v = .65$ in Hg.

Field Outside Temperature

$OAT = 83°F$

Field Pressure Altitude

$H_p = 3000$ Ft.

1. Determine Limit MAP (= 57.3" Hg.)

2. Determine the critical altitude for 83°F and 57.3" Hg.

(= 850 Ft.)

3. Enter the left hand portion of the graph (Figure A3-2) at 3000 Ft. and determine the power at the intersection of this altitude line and the 83°F line. Project this point to the base line of the humidity correction grid.

4. Draw a curve parallel to the appropriate altitude guide line (3000 Ft.) down to the intersection with the vertical, representing $P_v = .65$. Project this point on the scale for predicted BHP and read:

Predicted Power = 2860 BHP

Predicted BMEP = 233

5. Enter the left-hand portion of Figure A3-3 with $H_p = 3000$ Ft. and 83°F and determine the density altitude, 5100 Ft.

6. Draw a horizontal line to the right and determine the intersection with the vertical line representing predicted power (2860 BHP).

7. Read power deviation from standard, —10%.

Sample Problem B (Low Grade Fuel)

Vapor Pressure $P_v = .65$ In. Hg.

Field Outside Temperature $OAT = 83°F$

Field Pressure Altitude $H_p = 500$ Ft

1. Determine limit MAP on the lower right hand part of the graph (Figure A3-2) with $P_v = .65$ and $H_p = 500$ Ft. Limit MAP = 51.3" Hg.

2. Determine the point on the 83°F constant temperature line where MAP = 51.3" Hg. (representing critical altitude). Proceed from there along the 100/130 constant MAP operating lines to the intersection with the vertical, representing the Field Pressure Altitude $H_p = 500$ Ft. This determines the dry power available.

3. Make the corrections for humidity as performed in the previous example.

Results: Predicted BHP = 2730
Predicted BMEP = 222

4. Enter the left hand portion of the graph (Figure A3-2) with 83°F and H_p = 500 Ft. and determine the density altitude, 500 Ft.

5. Draw a horizontal line to the right and determine the intersection with the vertical line representing predicted BHP.

6. Read power deviation from Standard for 115/145 fuel—15.2%.

FOUR ENGINE TAKE-OFF PERFORMANCE.

Four-engine ground roll distances to take-off and distances to take-off and climb fifty feet are shown in figures A3-4 and A3-6 for normal take-off procedures. Correction grids are supplied to account for the effects of true headwind existing at the runway and power deviation from standard. Figures A3-5 and A3-7 provide corrections to the distances for runway slope. The distances shown do not include any factor of conservatism, and apply to operation from hard-surface runways when 60% (Take-off) wing flap setting and 2900 RPM are used. The speed schedule recommended for normal take-offs is 1.15 times the zero thrust stall speed. Normal climb-out speeds recommended are five to seven knots faster. Their use places the airplane in an advantageous position for three-engine operation should an emergency arise.

In order to duplicate the performance shown, the engines should be run up to take-off power before the brakes are released and the take-off run started. It is most important that the nose wheel be kept on or close to the runway until within approximately 10 knots of the take-off speed. Start a smooth rotation to take-off attitude at this point so as to leave the ground at the illustrated take-off speed schedule. This results in maximum acceleration being achieved during the run and minimizes the possibility of overshooting the take-off speed prior to leaving the ground. Gear retraction should be initiated as soon as the aircraft is clear of the ground in order to decrease aerodynamic drag as quickly as possible. The climb-out should be made at the speeds noted on the charts until above the height of obstructions.

Figures A3-8 through A3-13 permit determination of the flight path followed during a normal four-engine take-off. Distances shown are referenced to the point of take-off, and are based on performance obtained when the recommended speeds are used. Add the distances shown on Figure A3-4 to obtain the distances required to attain a given height from the start of the take-off run.

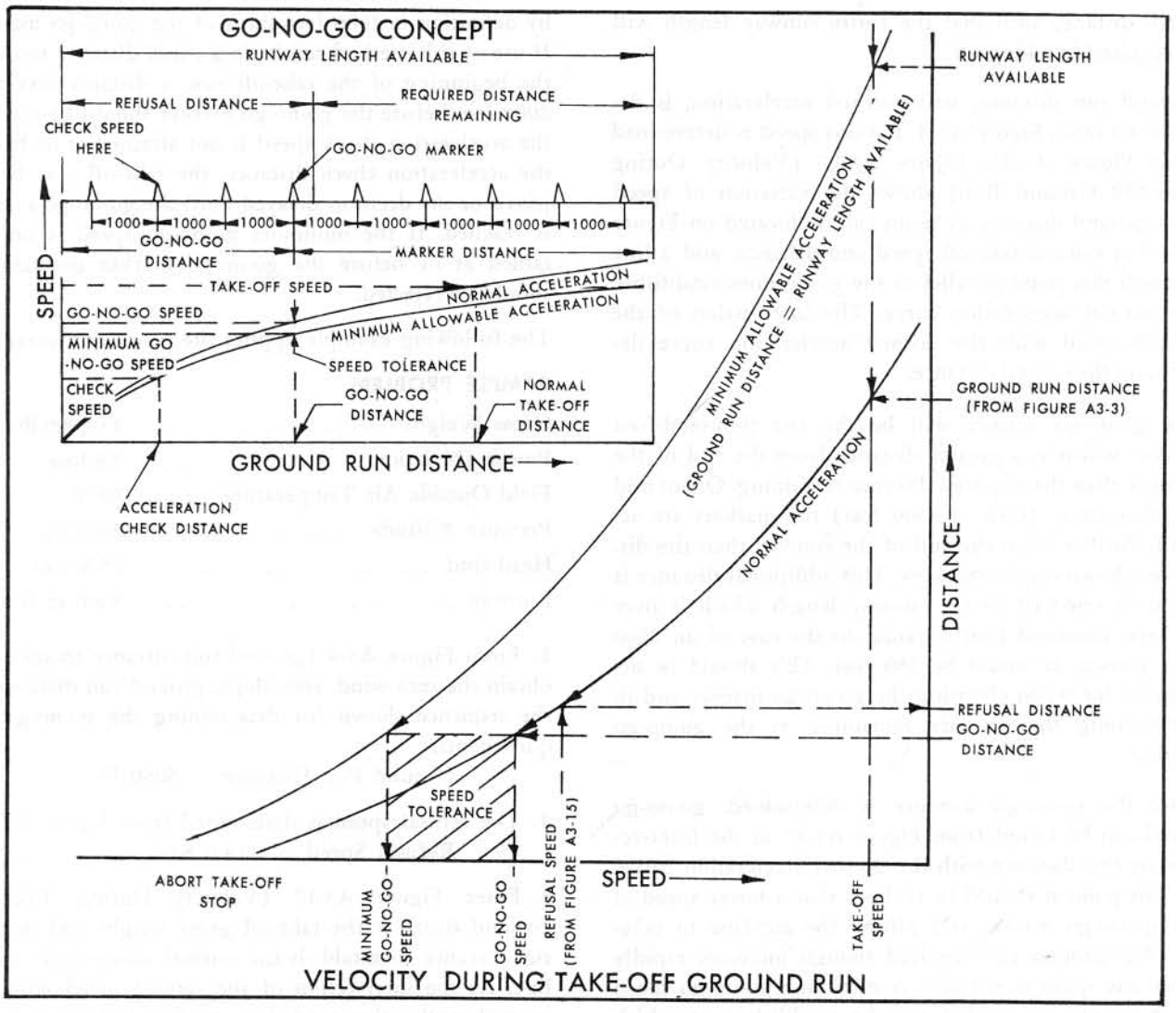
It should be realized that the performance shown on the normal distance take-off curves can not be realized in the event of an engine failure. For this reason, restriction of take-off weight by reason of runway availability is usually made on the basis of Critical Field Length curves which assume that engine failure takes place at the critical point during the run. However, the mission of the aircraft may be of such urgency that it is not feasible to limit the take-off weight to the safety level assumed in preparing the critical field length curves. The normal distance charts may be used in such a case to determine the maximum weight permitted by the operational conditions. However, it should be understood that if this basis for limitation of take-off weight is chosen, loss of an engine before clearance of whatever obstacles exist will preclude safe completion of the take-off.

Distances to stop are shown plotted on Figure A3-14 for operation in the take-off (60% wing flap position) configuration. Distances shown are based on the manufacturer's tests of the prototype Super Constellation on a hard surfaced, dry runway, using wheel brakes only. These data can be used to determine the stopping distances for normal take-offs up to speeds shown on the take-off charts. Stopping distances shown are based on zero runway slope. For slight runway slopes it can be assumed that the decrease in acceleration distance experienced during a slight downhill take-off will be equaled by the increase in stopping distance.

GO-NO-GO CONCEPT.

The purpose of the go-no-go concept is to supply data which permits the pilot to monitor airplane performance during the take-off run. It allows him to determine when progress is normal or if an abnormal condition exists. It also provides him with data allowing him to decide whether subnormal performance is acceptable or not from a safety standpoint. This is done by checking airplane acceleration during the ground run. If speeds at selected check points are below normal, a decision to continue or reject the take-off may be made before the refusal distance is reached.

Figures A3-15 and A3-17 are presented to provide speed check data. Figure A3-15 shows refusal speeds, the highest speeds at which the take-off can be rejected and a stop made within the available runway, for various combinations of runway lengths, weight, altitude and



other variables. Figure A3-17 permits a check on speed during ground-run, using the go-no-go concept. A sketch and the following definitions are given to illustrate the use of Figure A3-17 in the go-on-go concept:

Ground Run Distance—Required distance to take-off during normal service operation.

Refusal speed—Maximum speed developed during a 4 engine acceleration at which the take-off can be rejected and the airplane brought to a stop within the available runway length.

Refusal Distance—The distance required to accelerate the airplane to the refusal speed with four engines operating.

Required Distance Remaining—Runway length available minus refusal distance.

A go-no-go marker — last marker which provides a greater distance to the end of the runway than the required distance remaining.

Marker Distance—Remaining distance at the go-no-go marker.

Go-No-Go Distance—Distance covered by the airplane to the go-no-go marker.

Go-No-Go Speed—Speed at the go-no-go marker such that the normal Ground Run Distance will be covered in accelerating to take-off speed.

Minimum Go-No-Go Speed—Speed at the go-no-go marker such that the entire runway length available will be required to take-off.

Acceleration Check Distance—Distance 2000 ft. short of the go-no-go distance.

Acceleration Check Speed—Minimum speed at the acceleration check distance—the speed at the acceleration check distance such that the entire runway length will be required in taking-off.

Ground run distance, with normal acceleration, is determined from Figure A3-4. Refusal speed is determined from Figure A3-15. Figure A3-17 (Velocity During Take-Off Ground Run) shows the variation of speed with ground distance. A point can be located on Figure A3-17 at normal take-off speed and distance, and a line through this point parallel to the guide lines establishes the normal acceleration curve. The intersection of the refusal speed with the normal acceleration curve determines the refusal distance.

The go-no-go marker will be the last thousand-foot marker which is a greater distance from the end of the runway than the required distance remaining. On an odd length runway (such as 8500 feet) the markers are actually farther from the end of the runway than the distances shown on the markers. This additional distance is equal to one-half of the runway length which is over an even thousand foot distance. In the case of an 8500 foot runway it would be 250 feet. This should be accounted for when choosing the go-no-go marker and in determining the distance remaining at the go-no-go marker.

Once the go-no-go distance is determined, go-no-go speed can be found from Figure A3-17 at the intersection of this distance with the normal acceleration curve. At this point it should be realized that a lower speed at the go-no-go marker still allows the airplane to take-off. The ground run required though increases rapidly when the speed is reduced. A minimum go-no-go speed at the go-no-go marker can be established at which take-off is possible with a ground run equal to the runway length available. It should be clear that this speed is very marginal; if the speed is less than the minimum tolerance value, the take-off should be aborted and the airplane brought to a stop. The difference between the go-no-go speed (for normal acceleration) and the minimum go-no-go speed (for subnormal acceleration) is the speed tolerance and can be obtained from the auxiliary graph in Figure A3-17.

Though the minimum go-no-go speed permits reaching Take-Off Speed at the end of the runway it does not necessarily mean that the aircraft has three engine climb-out capability after leaving the runway. The emergency climb curves show whether a climb out can be made with one engine inoperative (see the Performance with Take-Off Emergency discussion).

The acceleration check speed is the minimum speed that must be attained at the acceleration check distance, which by definition is 2000 feet short of the go-no-go marker. If use of this method results in a check distance too near the beginning of the take-off run, a distance less than 2000 feet before the go-no-go marker should be used. If the acceleration check speed is not attained at or before the acceleration check distance, the take-off may be rejected or the decision delayed until the go-no-go marker is reached. If the minimum go-no-go speed is not attained at or before the go-no-go marker the take-off should be rejected.

The following example applies the go-no-go concept:

SAMPLE PROBLEM.

Gross Weight	140,000 lb.
Power Deviation	5% loss
Field Outside Air Temperature	80°F
Pressure Altitude	2000 Ft.
Headwind	15 Knots
Runway	8500 Ft. long

1. From Figure A3-4 (ground run distance to take-off) obtain the zero wind, zero slope, ground run distance by the sequence shown for determining the go-no-go requirements.

Ground Run Distance = 6050 Ft.

2. The refusal speed is determined from Figure A3-15.

Refusal Speed = 114.0 Kts.

3. Enter Figure A3-17 (Velocity During Take-Off Ground Run) at the take-off gross weight and ground run distance to establish the normal acceleration guide line. At the intersection of the refusal speed with the normal acceleration guide line, read the refusal distance.

Refusal Distance = 4200 Ft.

4. Determine the required distance remaining by subtracting the refusal distance from the runway length available.

Required Distance Remaining = 4300 Ft.

5. The last marker which provides at least 4300 feet to the end of the runway (the go-no-go marker) is the 5000 foot marker. Since an odd length runway exists, one-half the odd distance (250 ft.) must be added to the distance shown on the marker to obtain distance remaining at the go-no-go marker (5000 + 250) = 5250 Ft.

6. Determine the go-no-go distance by subtracting the distance remaining at the go-no-go marker from the runway length available.

Go-no-go Distance = 3250 Ft.

7. From Figure A3-17 and following the same normal acceleration guide line (step 3), the normal speed at the go-no-go distance is found to be

Go-no-go Speed = 105 Kts.

8. Entering Figure A3-17 at the take-off ground run and runway length, the allowable speed tolerance is found to be 10 knots. The zero wind, zero slope minimum go-no-go speed is (105 knots—10 knots).

Minimum go-no-go Speed = 95 Kts.

9. The go-no-go speed, corrected for headwind is (95 Kts. + 15 Kts.) = 110 Kts.

If the speed of the airplane is below 110 kts. at the go-no-go marker (5000 ft. marker) the take-off should be aborted.

10. By definition, the acceleration check distance is 2000 feet short of the go-no-go distance and is therefore (3250 — 2000 ft.)

Acceleration Check Distance = 1250 Ft.

11. From Figure A3-17, using the same normal acceleration guide line as used in the prediction of the speed at the go-no-go point, read the normal speed value at the intersection of the check distance with the guide line.

Normal Acceleration Check Speed = 71 Kts.

The normal speed is then corrected for speed tolerance and runway wind component and found to be

Minimum Acceleration Check Speed Corrected = 76 Kts.

This acceleration check speed may be determined for any arbitrary check distance.

12. From Figure A3-6, the total distance to take-off and clear a 50 foot obstacle, based on normal acceleration, 15 knot headwind, and 5% power loss will be

6850 Ft.

PERFORMANCE WITH TAKE-OFF EMERGENCY.

A take-off emergency occurs if an engine or propeller fails at some point along the runway during take-off. Although the probability of experiencing such a failure during take-off is small, the decrease in performance resulting from the drop in power available is sufficiently important to warrant consideration. Refusal speeds, critical speeds for engine failure, critical field lengths, and maximum power climb performance should be determined prior to each take-off as a standard practice. When these are known, two general rules can be applied which are summarized as follows:

1. The take-off should be rejected and the aircraft brought to a stop if a take-off emergency develops before or upon reaching the critical speed for engine failure.

2. The take-off should be continued and the airplane flown out on three engines if the emergency develops after the refusal speed is reached, unless the nature of the emergency or three engine performance is such that safe completion of the take-off is impossible.

The critical speed for engine failure will never be greater and may be less than the refusal speed, depending on the runway length and take-off conditions. The decision to reject or continue the take-off is optional when power failure occurs between the critical speed and refusal speeds, however, a stop is recommended.

The critical engine failure speeds for obstacle clearance may be determined from figure A3-19. These represent the speeds from which a take-off can either be continued and a fifty foot obstruction cleared at the critical field length distance or the take-off rejected and the airplane brought to a stop (without use of reverse thrust) within the same total runway length. Corresponding critical field lengths for obstacle clearance are provided by figure A3-18. Corrections to critical speeds and runway lengths for the effects of runway slopes are supplied by figure A3-20. FigureA3-21 shows limitations on take-off weight which apply to operation from operation from runways with appreciable runway slope when the runway slope equals the initial angle of climb on three engines. Figures A3-22 through A3-25 show three engine climb-out flight path profiles which may be used as a check on the ability to clear obstacles beyond the airport boundary.

SAMPLE PROBLEM.

The following problem shows the use of the critical field length curves. The conditions assumed are the same as were used to illustrate the go-no-go concept; 8500 ft. runway length available, 3800 ft. density altitude, 140,000 lb desired take-off weight, 5% predicted power loss, 15 knot headwind.

The first step is to determine the critical field length required for the desired take-off weight and the corresponding critical speed. Figure A3-18 shows that an 11,050 ft. distance would be required for obstacle clearance with standard conditions. This corrects to an 11,300 ft. distance with 5% power loss and 15 knot headwind.

However, the starting point (140,000 lb, 3800 ft H_a) is to the right of the zero rate of climb line for 95% power, indicating that the gear down rate of climb away from

ground effect would be negative. This is confirmed by the emergency rate of climb curves in Part 4. A downward runway slope equal to the initial angle of descent is required if performance data shown in this area of the curve is to be used. A lighter take-off weight is required for this problem if adequate performance in the event of take-off emergency is required.

Enter the critical field length curve, figure A3-18, with zero slope runway length available to determine maximum gross weight for obstacle clearance, after subtracting whatever allowance is desired for line-up distance and for conservatism. (If the runway has an appreciable slope, use the equivalent zero slope distance found by using figure A3-20.) Starting at the 8500 ft. distance for this problem, proceed vertically to the 15 knot headwind line, and then parallel the nearest guide lines to the zero wind base line. Account for power deviation next by proceeding vertically to the —5% power line, then parallel the guide lines again to the base reference at 0%. The standard distance at this point is read as 8800 ft. Next locate a point on the upper part of the chart at this distance and 3800 ft. density altitude (80° F. and 2000 ft. pressure altitude). The point falls at the position for a gross weight of 132,700 lb. and between the dashed lines for 50 fpm and zero rate of climb for 95% standard power. This means that the airplane is limited by critical field length available for obstacle clearance, if this criteria is chosen to determine allowable take-off weight, and that the initial angle of climb will be small but positive.

The corresponding critical speed for engine failure can be found from figure A3-19. Proceed horizontally along a line at 3800 ft H_d to a position corresponding to 132,700 lb. Note that the speed under standard conditions would be 118 knots CAS. Correct this value for power deviation and headwind effects by using the correction grids below and read a value of 124 knots CAS for zero slope. (Modify this value for effect of slope by use of figure A3-20 if necessary.) Read the three engine take-off speed for 132,700 lb at the bottom of the chart as 124 knots CAS, noting that the critical speed equals the take-off speed in this case. If the critical speed determind above were greater than the take-off speed, then the take-off speed would be used as the critical speed for engine failure.

The choice of take-off weights can be considered now. It is apparent that use of 140,000 lb at the stated take-off conditions involves some risk in the event of power failure during the initial take-off climb. Gear down rate of climb away from ground effect will be negative, and the flight path must be unobstructed until the gear up rate of climb is effective in allowing obstacle clearance. A reduction to the weight for zero initial rate of climb is desirable if consistent with ability to accomplish the mission. Figure A3-18 shows that zero initial rate of climb will be available at a weight of 134,000 lb for the problem conditions, but that a distance greater than 8500 ft is required for fifty foot obstacle clearance. An 8500 ft critical field length is obtained at 132,500 lb gross weight. The chart also shows that a weight reduction to 131,700 lb will permit an initial rate of climb of fifty feet per minute *away from ground effect,* and that the zero slope critical field length for obstacle clearance is then 7950 ft. This is less than the 8500 ft. actually available, allowing 550 ft. for lining up on the runway and for conservatism. No general conclusion can be made here since the importance of the flight and possibility of an alternate mission is subject to the commanding officers decision. However, the take-off weight which allows at least zero initial rate of climb shoud be duly considered.

THREE ENGINE TAKE-OFF FLIGHT PATHS.

Take-off flight path curves are provided to determine ability to clear obstacles beyond the runway. These profiles are based on distances from the point of take-off, and are directly applicable for various altitudes and weights. Wind and power correction grids are supplied, and interpolation between charts is permitted to account for intermediate weights.

AUTOMATIC PROPELLER FEATHERING.

The automatic propeller feathering system is assumed to be operative and armed for all take-off operations. Critical field length data provided here are applicable with the system operative or inoperative *provided* that manual feathering of the *proper* engine is accomplished *in the same time* normally required for the auto feathering system to feather the propeller of the failing engine. *If the auto feathering system is inoperative,* the crew must be alerted to shut down a failed engine immediately if an emergency occurs and power falls to zero thrust or less.

Note

The auto-feathering system is actuated when engine torque falls to between 90 and 104 BMEP and remains between or lower than these values for from 1½ to 2 seconds.

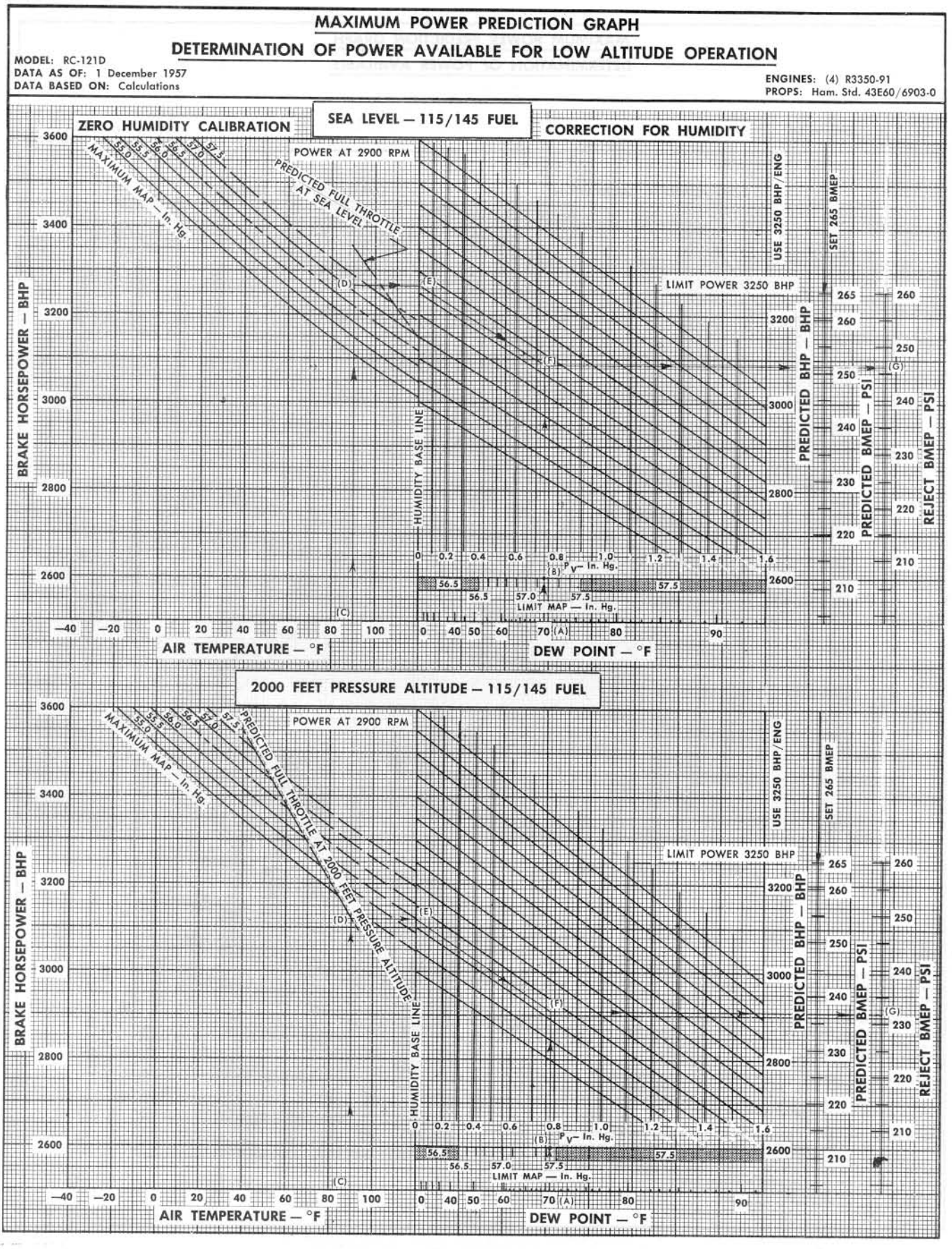
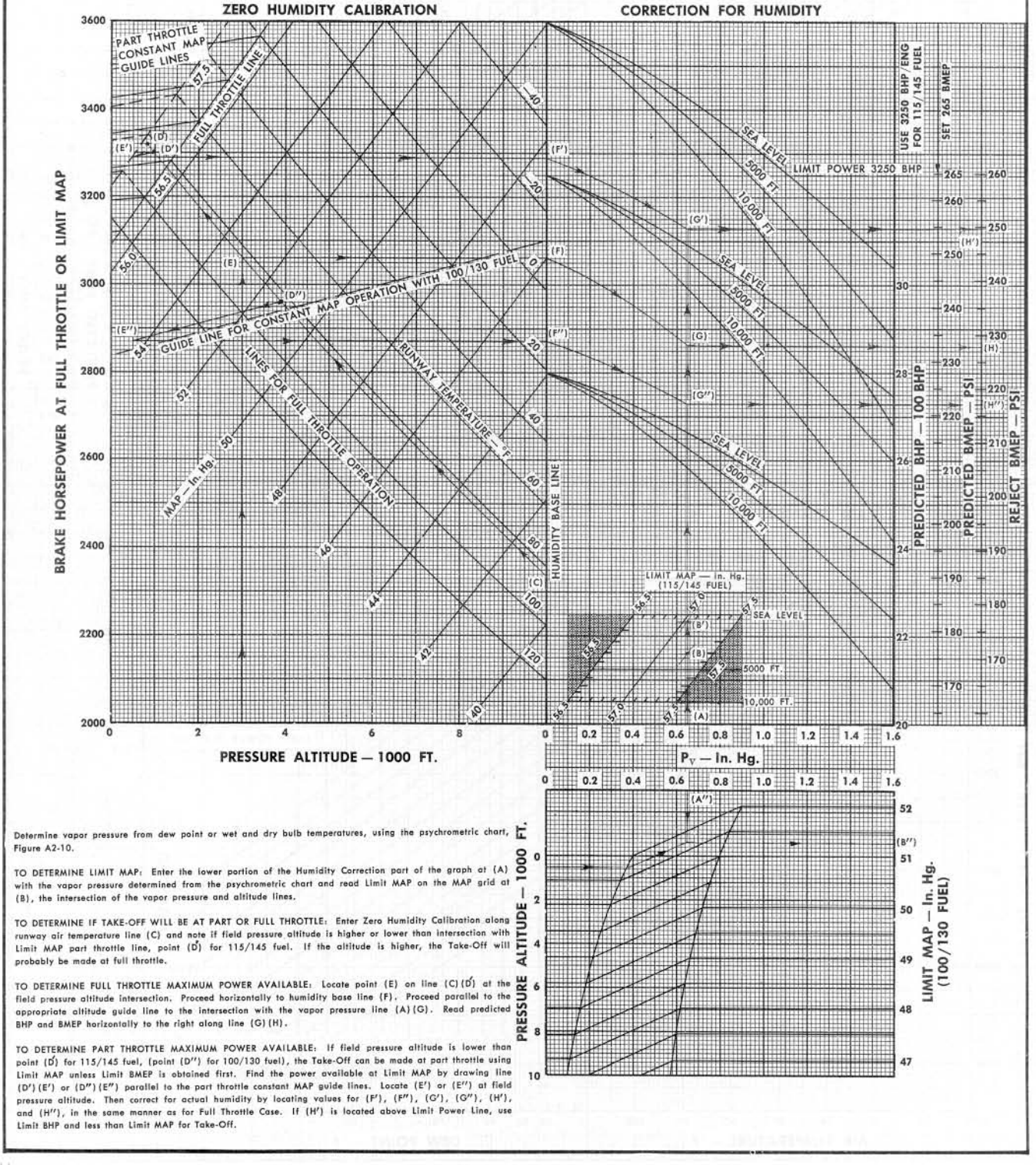


Figure A3-1. Maximum Power Prediction For Low Altitude Operation

MAXIMUM POWER PREDICTION GRAPH
DETERMINATION OF POWER AVAILABLE

MODEL: RC-121D
DATA AS OF: 1 December 1957
DATA BASED ON: Calculations

ENGINES: (4) R3350-91
PROPS: Ham. Std. 43E60/6903-0



Determine vapor pressure from dew point or wet and dry bulb temperatures, using the psychrometric chart, Figure A2-10.

TO DETERMINE LIMIT MAP: Enter the lower portion of the Humidity Correction part of the graph at (A) with the vapor pressure determined from the psychrometric chart and read Limit MAP on the MAP grid at (B), the intersection of the vapor pressure and altitude lines.

TO DETERMINE IF TAKE-OFF WILL BE AT PART OR FULL THROTTLE: Enter Zero Humidity Calibration along runway air temperature line (C) and note if field pressure altitude is higher or lower than intersection with Limit MAP part throttle line, point (D') for 115/145 fuel. If the altitude is higher, the Take-Off will probably be made at full throttle.

TO DETERMINE FULL THROTTLE MAXIMUM POWER AVAILABLE: Locate point (E) on line (C)(D') at the field pressure altitude intersection. Proceed horizontally to humidity base line (F). Proceed parallel to the appropriate altitude guide line to the intersection with the vapor pressure line (A)(G). Read predicted BHP and BMEP horizontally to the right along line (G)(H).

TO DETERMINE PART THROTTLE MAXIMUM POWER AVAILABLE: If field pressure altitude is lower than point (D') for 115/145 fuel, (point (D'') for 100/130 fuel), the Take-Off can be made at part throttle using Limit MAP unless Limit BMEP is obtained first. Find the power available at Limit MAP by drawing line (D')(E') or (D'')(E'') parallel to the part throttle constant MAP guide lines. Locate (E') or (E'') at field pressure altitude. Then correct for actual humidity by locating values for (F'), (F''), (G'), (G''), (H'), and (H''), in the same manner as for Full Throttle Case. If (H') is located above Limit Power Line, use Limit BHP and less than Limit MAP for Take-Off.

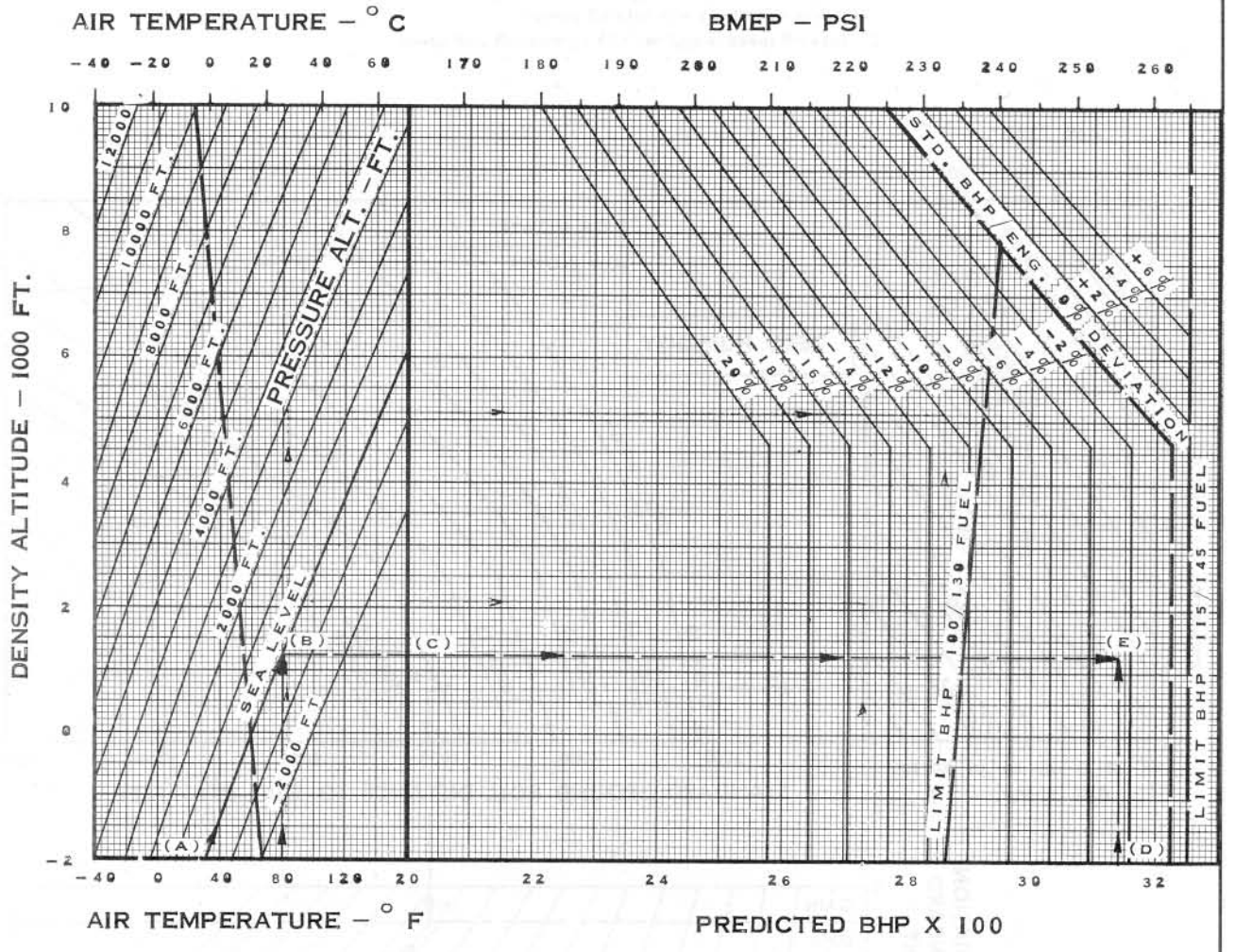
Figure A3-2. Maximum Power Prediction Graph — Determination of Power Available

MAXIMUM POWER PREDICTION GRAPH

PERCENT OF POWER DEVIATION FROM STANDARD

MODEL: RC-121 D
DATA AS OF: 1 December 1957
DATA BASED ON: Calculations

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0



TO FIND PERCENT POWER DEVIATION FROM STANDARD, ENTER ALONG PRESSURE ALTITUDE LINE (A) AND LOCATE POSITION (B) AT RUNWAY AIR TEMPERATURE. FIND INTERSECTION OF DENSITY ALTITUDE LINE (B)(C) WITH PREDICTED POWER(G), FROM FIG. A3-1, TO LOCATE POINT (E). READ POWER DEVIATION AT POINT (E) BY INTERPOLATION ON POWER DEVIATION GRID.

NOTE: STANDARD POWER BASED ON ZERO PERCENT RELATIVE HUMIDITY.

Figure A3-3. Maximum Power Prediction Graph — Determination of Per Cent Power

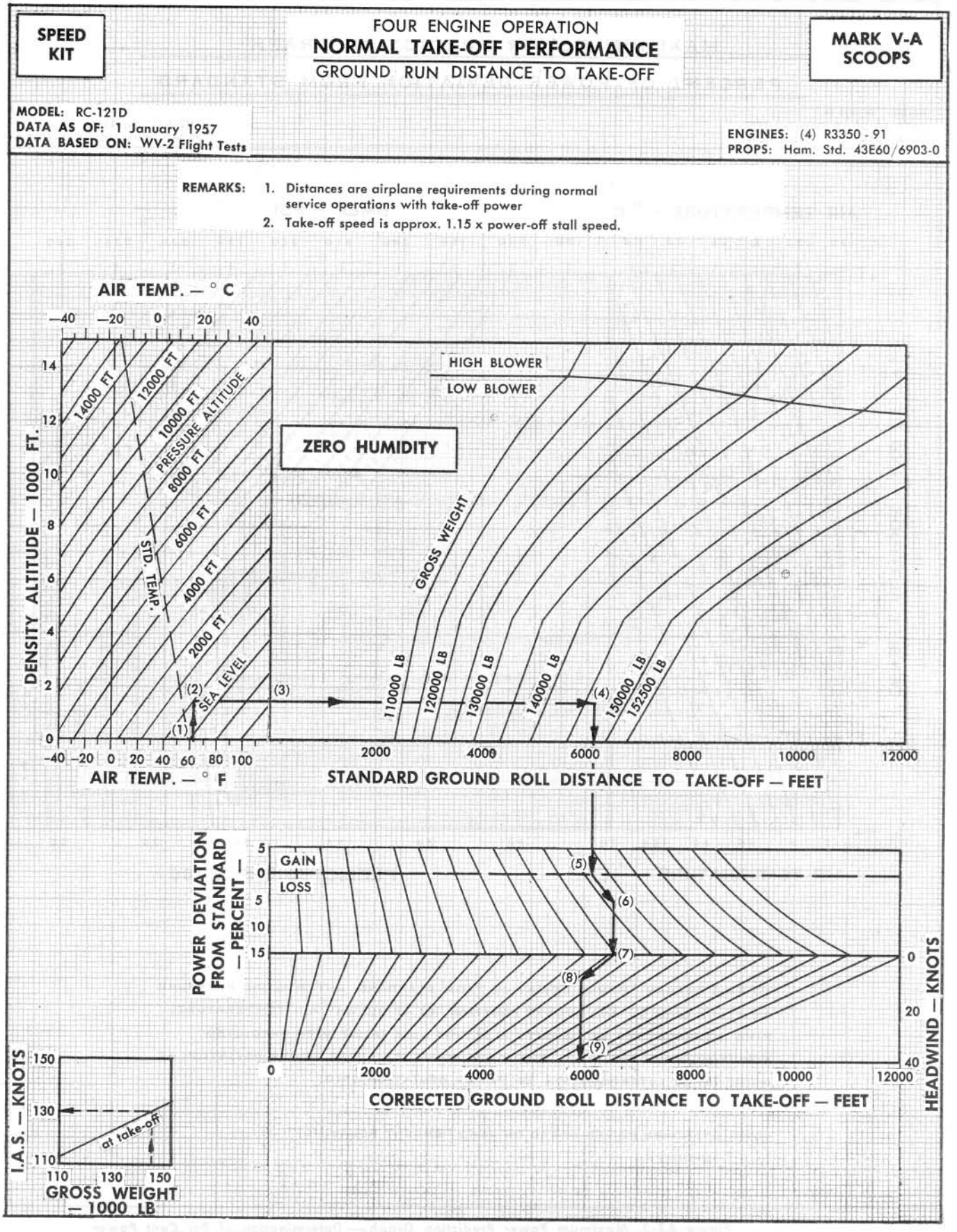


Figure A3-4. Normal Take-off Performance — Ground Run Distance to Take-off

SPEED KIT

FOUR ENGINE OPERATION

NORMAL TAKE-OFF PEFORMANCE

MARK V-A SCOOPS

EFFECT OF RUNWAY SLOPE ON GROUND RUN DISTANCE TO TAKE-OFF

MODEL: RC-121 D
DATA AS OF: 1 December 1957
DATA BASED ON: WV-2 Flight Tests

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0

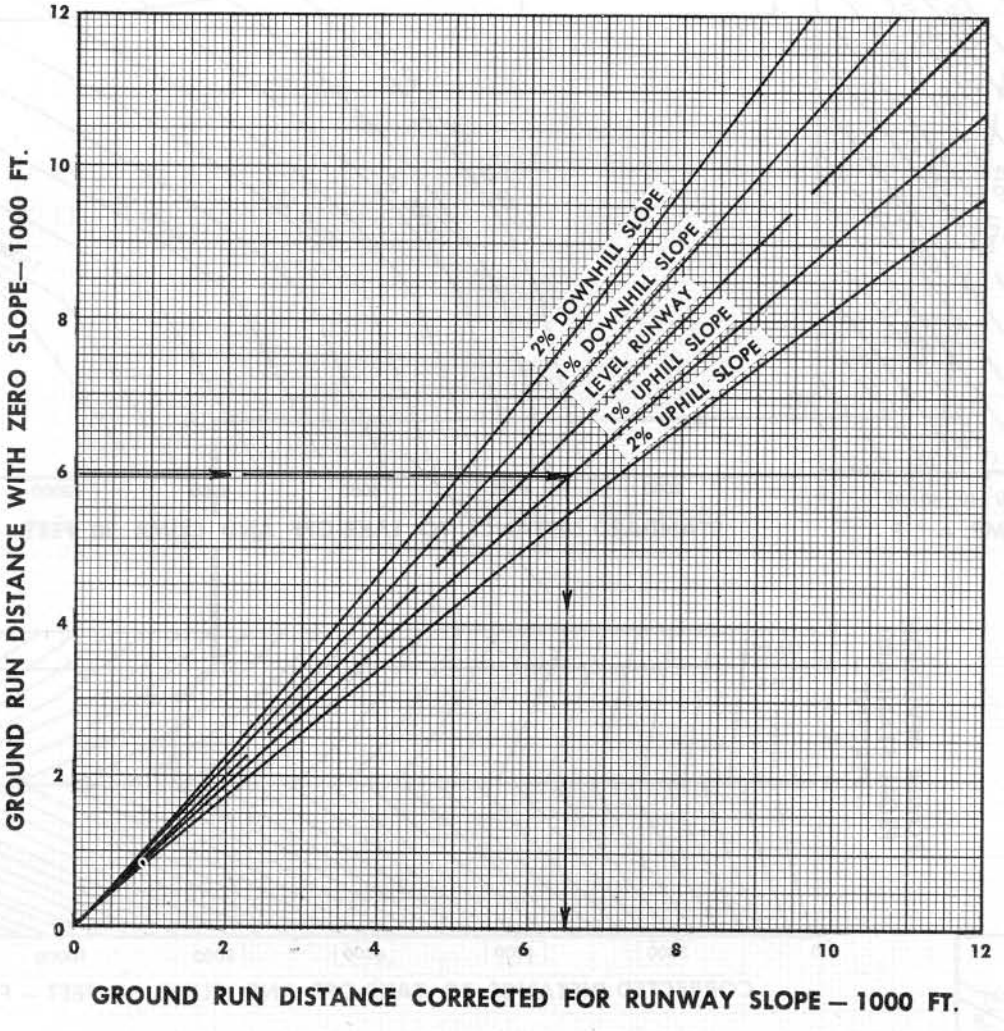


Figure A3-5. Normal Take-off Performance — Effect of Runway Slope on Ground Run

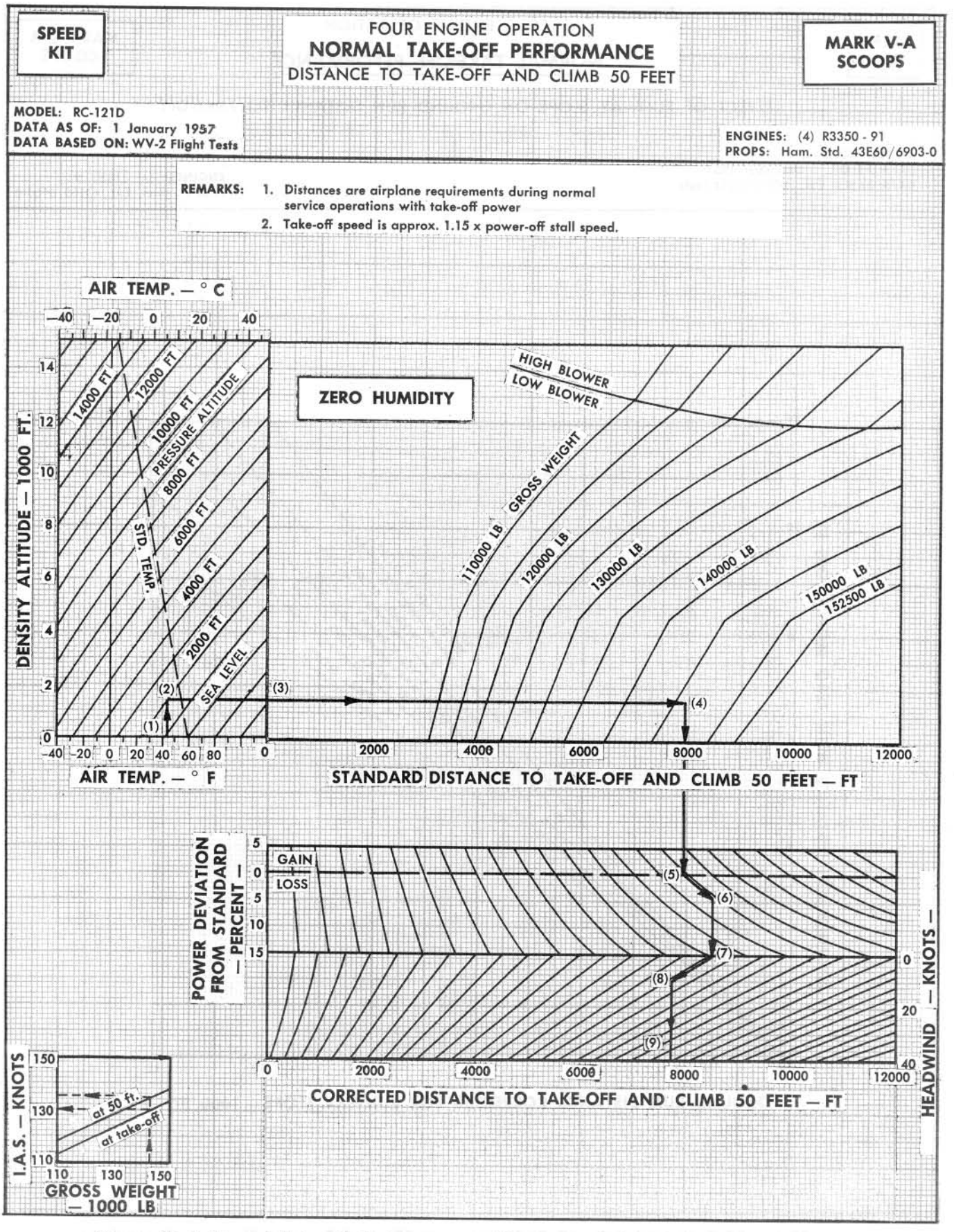


Figure A3-6. Normal Take-off Performance — Distance to Take-off and Climb Fifty Feet

SPEED KIT

FOUR ENGINE OPERATION

NORMAL TAKE-OFF PEFORMANCE

MARK V-A SCOOPS

EFFECT OF RUNWAY SLOPE ON GROUND RUN DISTANCE TO TAKE-OFF AND CLIMB 50 FT.

MODEL: RC-121 D
DATA AS OF: 1 December 1957
DATA BASED ON: WV-2 Flight Tests

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0

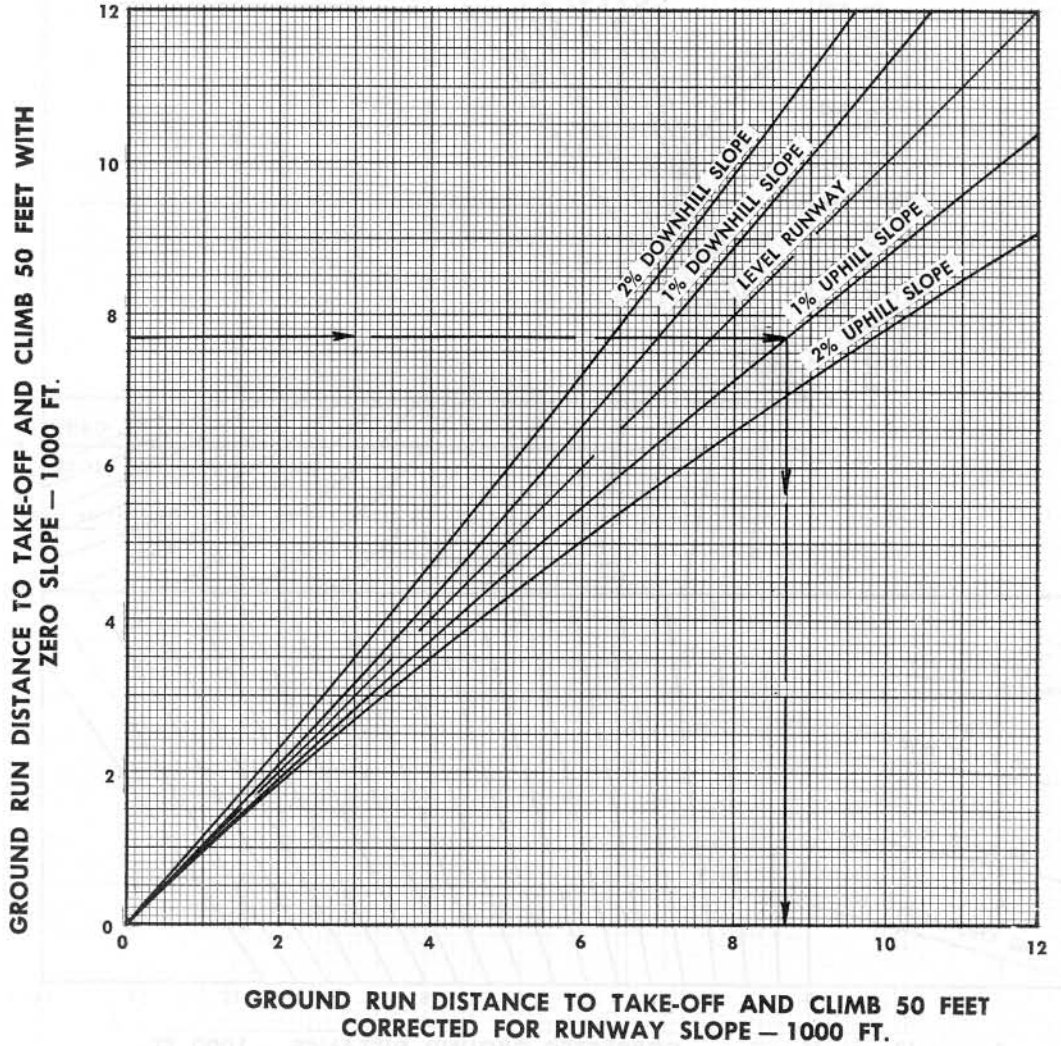


Figure A3-7. Normal Take-off Performance — Effect of Runway Slope on Distance to Take-off and Climb Fifty Feet

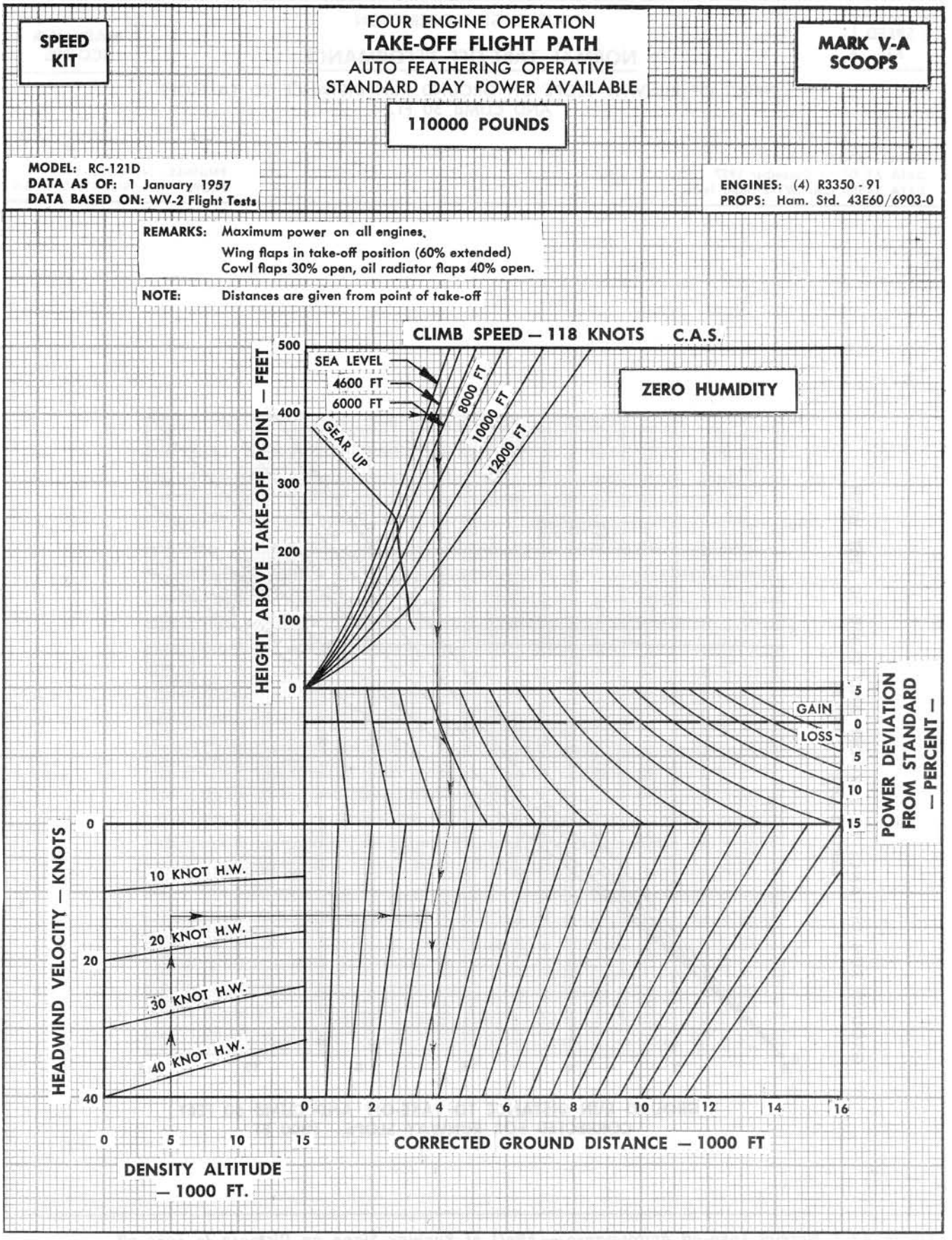


Figure A3-8. Take-off Flight Path — Four Engine Operation — 110,000 Pounds

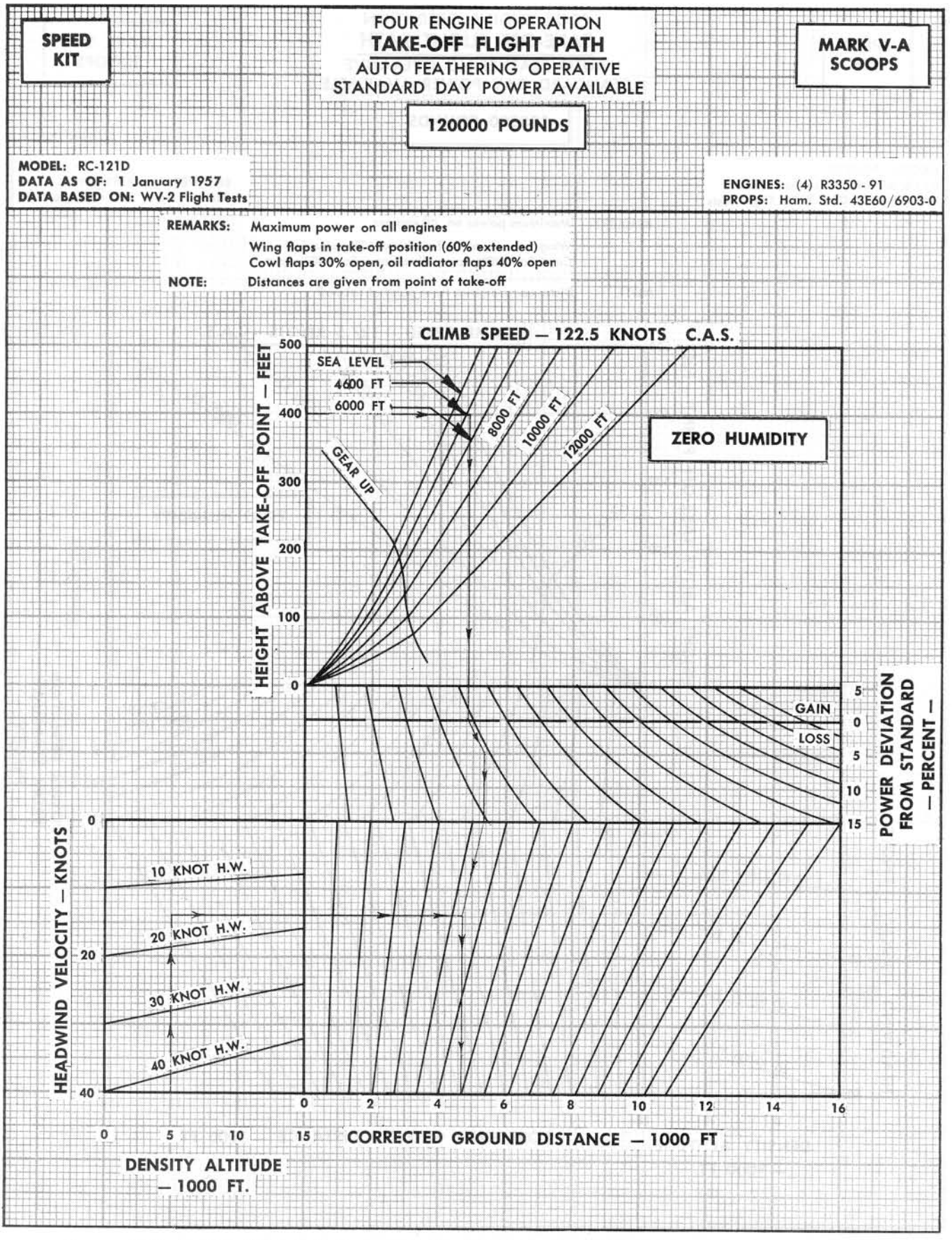


Figure A3-9. Take-off Flight Path — Four Engine Operation — 120,000 Pounds

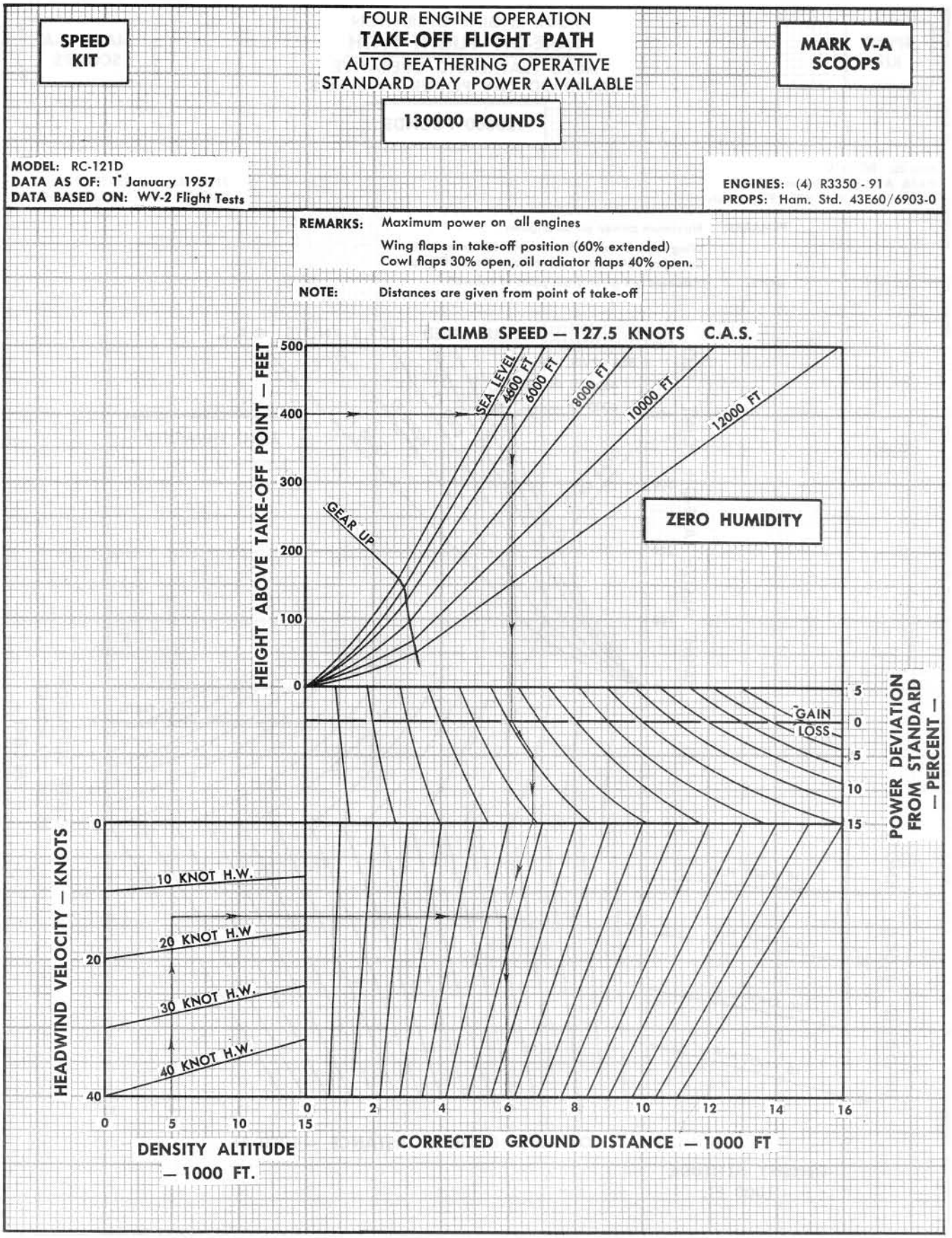


Figure A3-10. Take-off Flight Path — Four Engine Operation — 130,000 Pounds

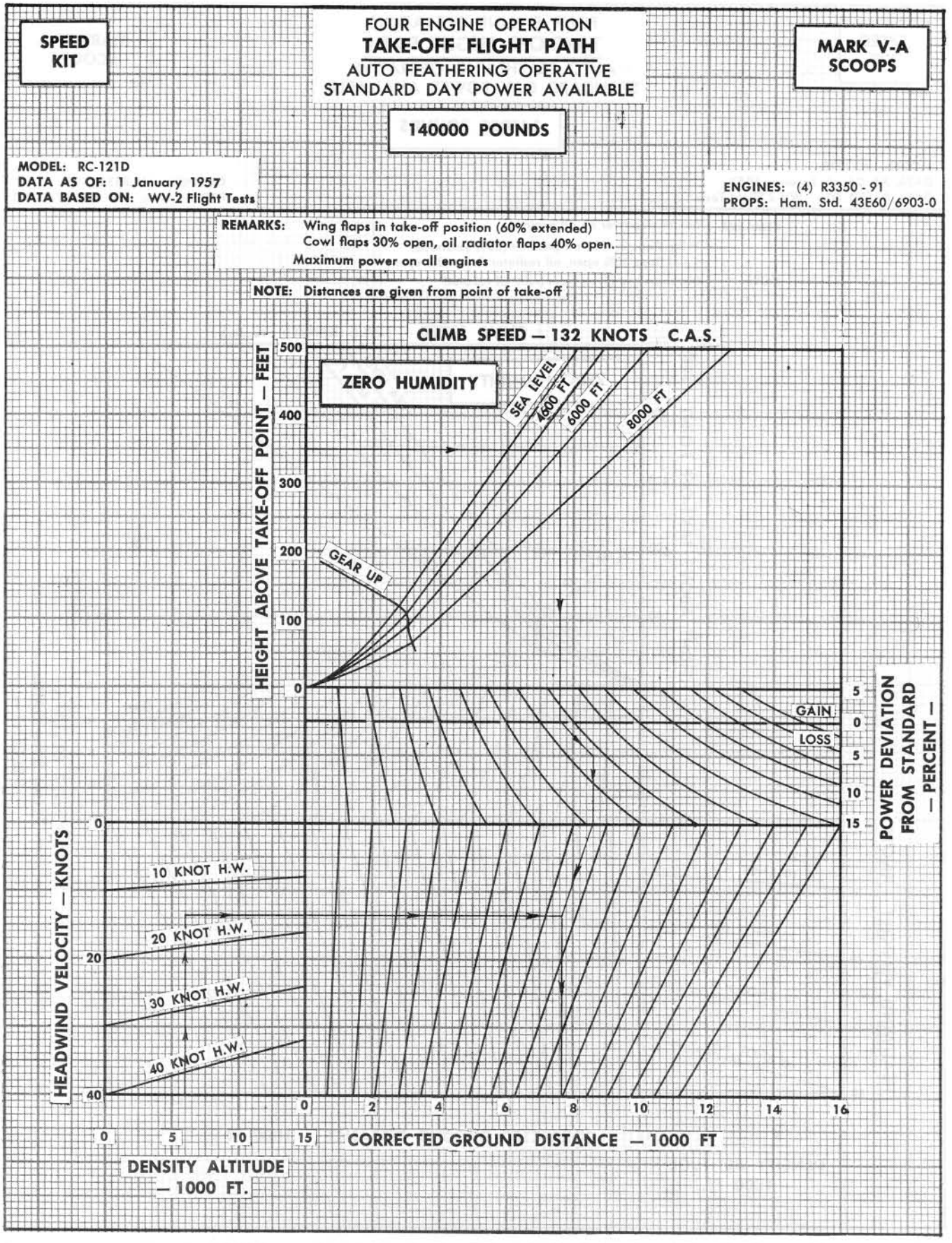


Figure A3-11. Take-off Flight Path — Four Engine Operation — 140,000 Pounds

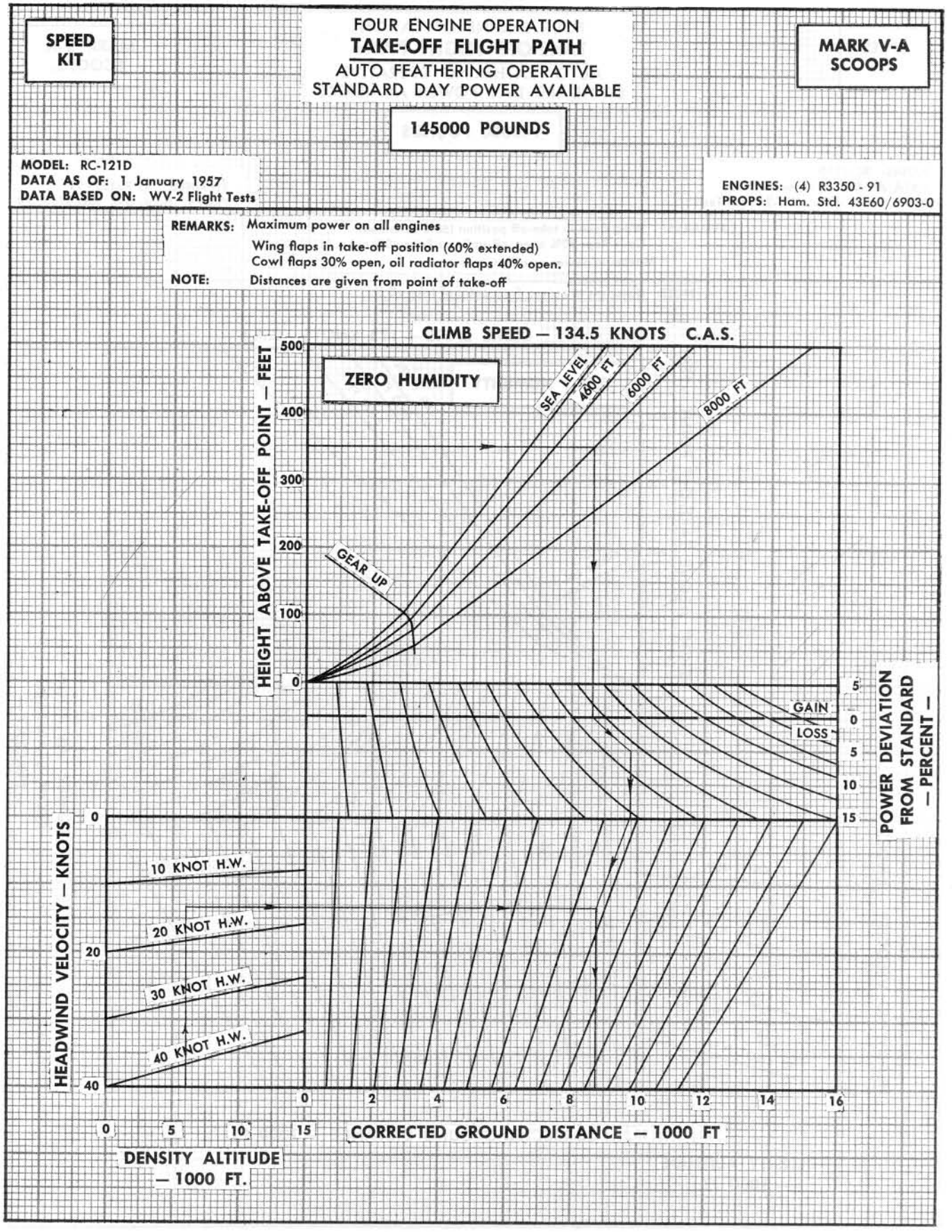


Figure A3-12. Take-off Flight Path — Four Engine Operation — 145,000 Pounds

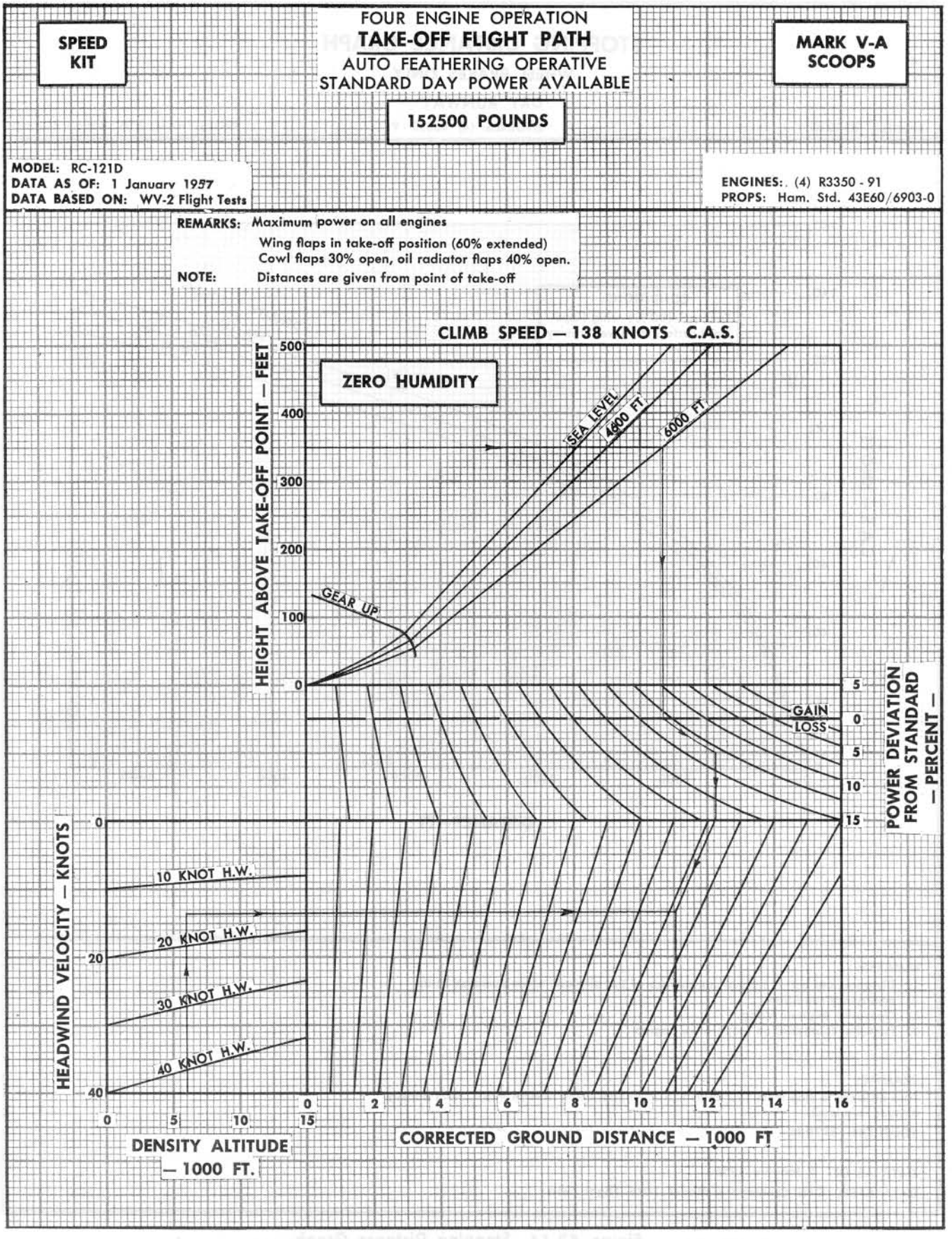


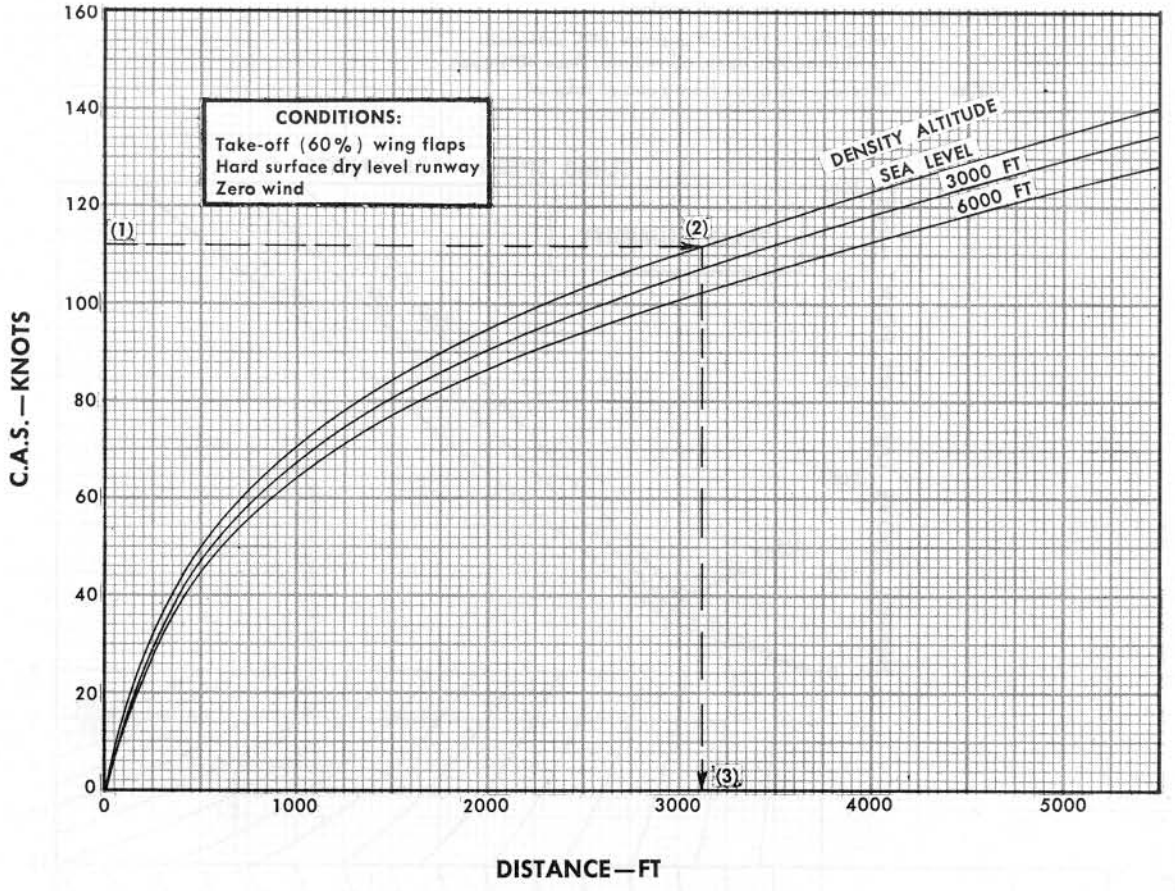
Figure A3-13. Take-off Flight Path — Four Engine Operation — 152,500 Pounds

STOPPING DISTANCE GRAPH

WHEEL BRAKES ONLY

DRY RUNWAY

MODEL: RC-121D ENGINES: (4) R3350 - 91 PROPS: HAM. STD. 43E60/6903-0



REMARKS:

1. Distances are within normal capabilities of the airplane when operated in an emergency condition.
2. Operative engines idling.
3. Propeller feathered on inoperative engine.

EXAMPLE:

Find distance to stop from 112 knots C.A.S. without using reverse thrust. Field density altitude, sea level.

SOLUTION: 3120 ft.

DATA AS OF: 1 January 1956

DATA BASED ON: Contractor's Model 1049 Flight Tests

Figure A3-14. Stopping Distance Graph

SPEED KIT

PERFORMANCE WITH TAKE-OFF EMERGENCY

REFUSAL SPEEDS FOR LONG RUNWAYS

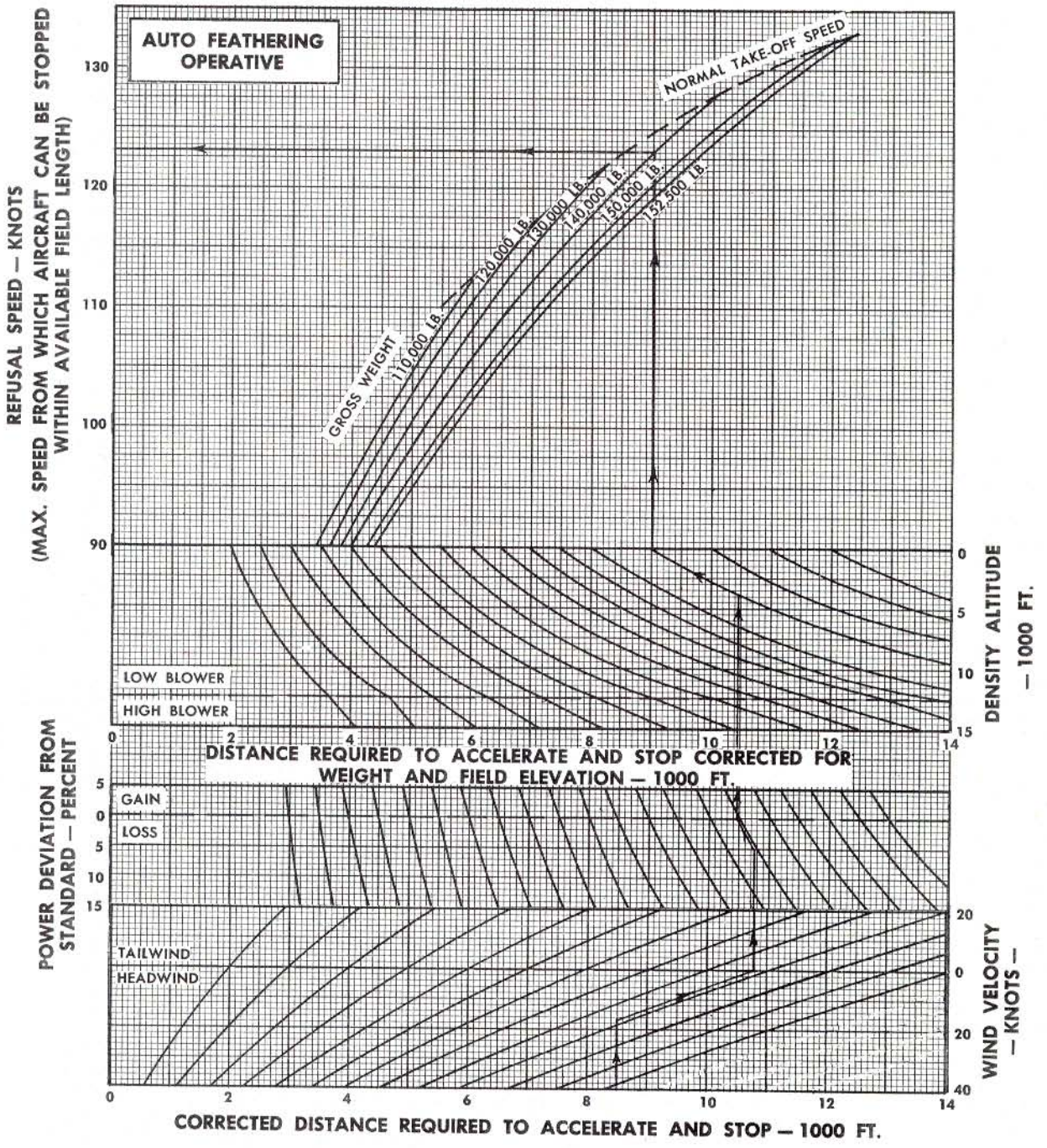
MARK V-A SCOOPS

MODEL: RC-121 D
DATA AS OF: 1 January 1957

ENGINES: (4) R3350 - 91

PROPS: Ham. Std. 43E60/6903-0
DATA BASED ON: WV-2 Flight Tests

REMARKS: Chart constructed for use when runway length exceeds minimum required for desired take-off gross weight. Take-offs can be rejected from Refusal speeds shown.



NOTE: Wing flaps in take-off position (60% extended). Propellers set at 2900 RPM in low blower position and at 2600 RPM in high blower position.

Figure A3-15. Performance With Take-off Emergency — Refusal Speeds for Long Runways

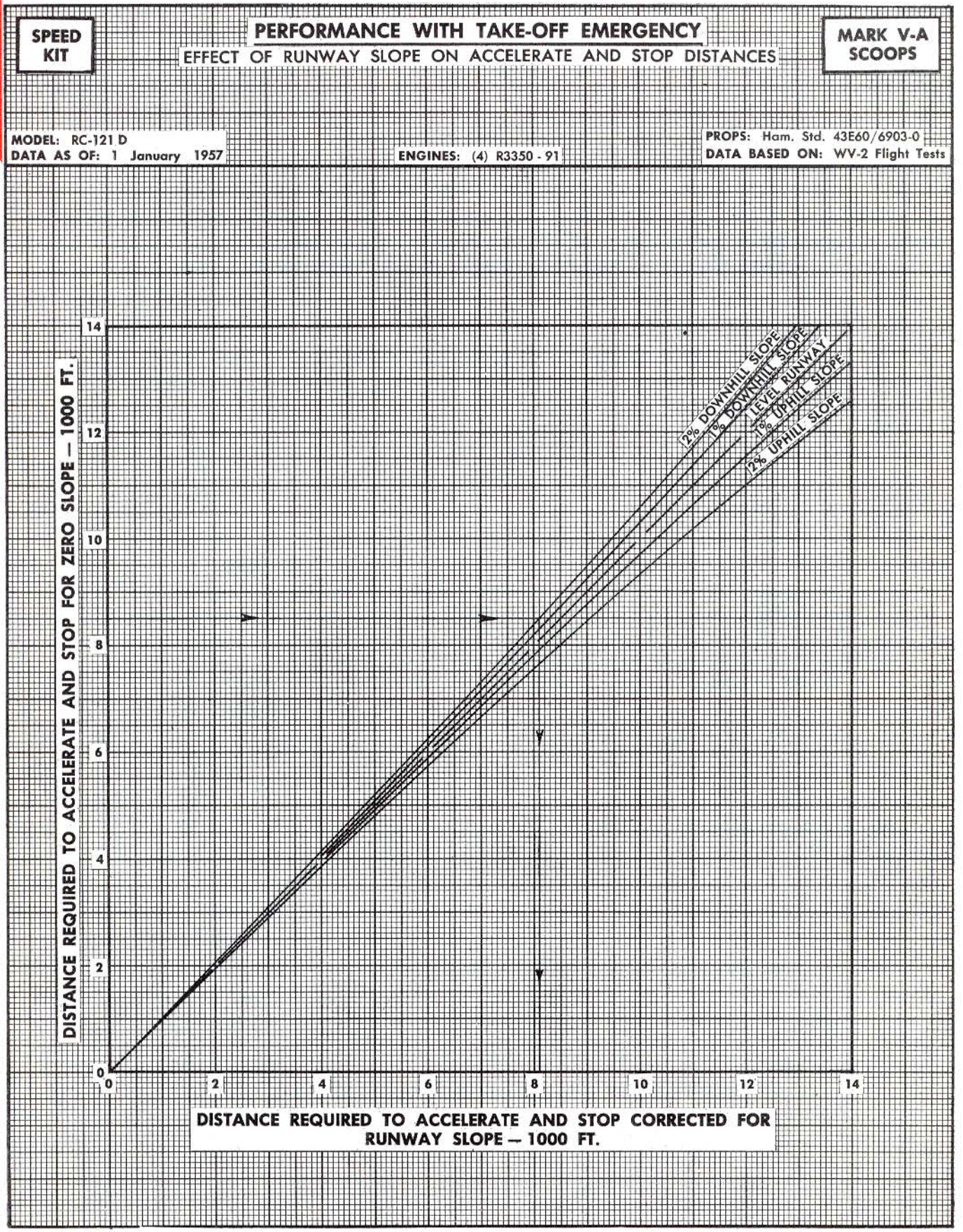


Figure A3-16. Performance With Take-off Emergency — Effect of Runway Slope on Accelerate and Stop Distances

SPEED KIT

FOUR ENGINE OPERATION

VELOCITY DURING TAKE-OFF GROUND RUN

MAXIMUM POWER

MARK V-A SCOOPS

MODEL: RC-121 D
DATA AS OF: 1 December 1957

ENGINES: (4) R3350 - 91

PROPS: Ham. Std. 43E60/6903-0
DATA BASED ON: WV-2 Flight Tests

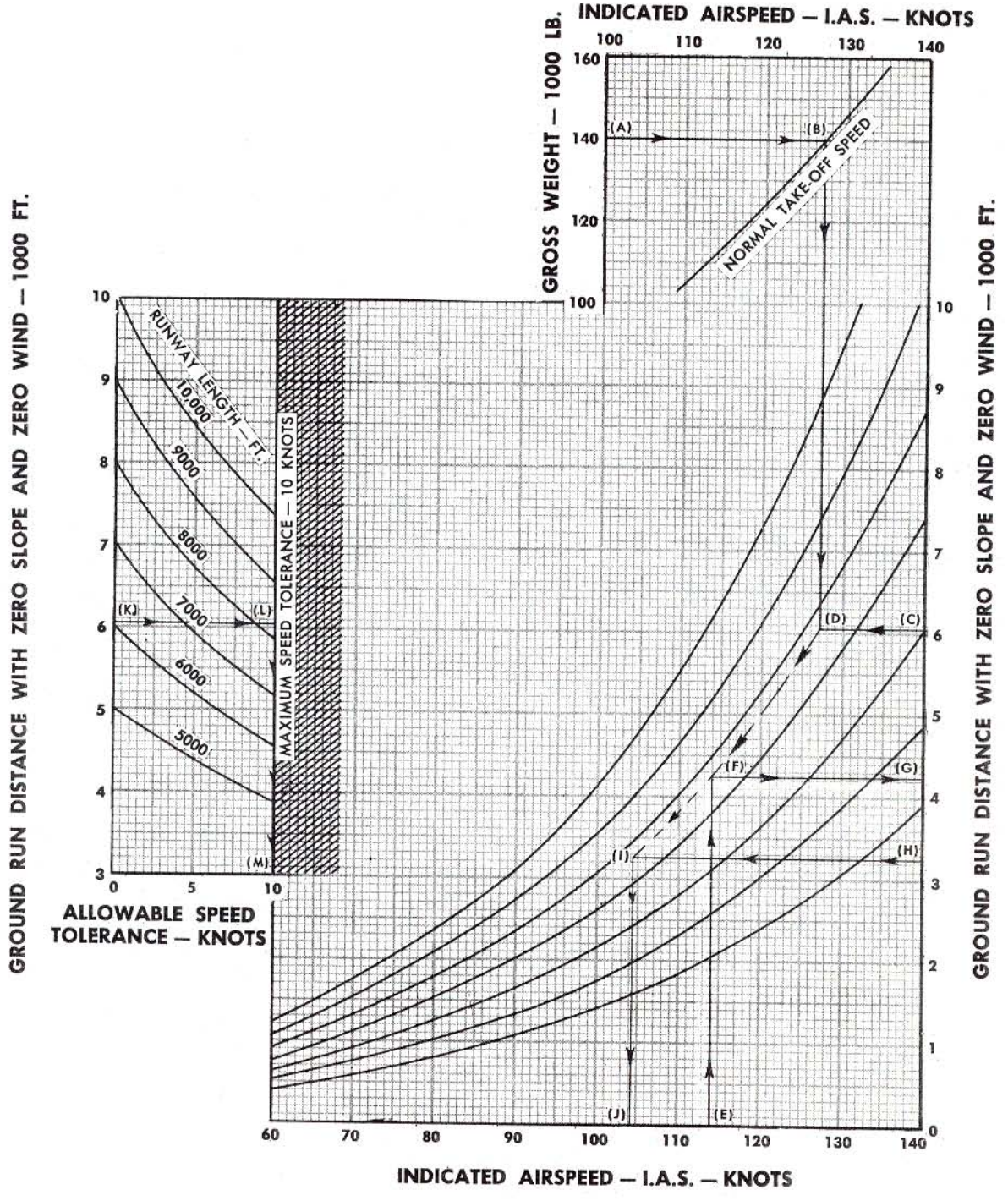


Figure A3-17. Performance With Take-off Emergency — Velocity During Take-off Ground Run

SPEED KIT

PERFORMANCE WITH TAKE-OFF EMERGENCY

CRITICAL FIELD LENGTHS FOR OBSTACLE CLEARANCE

MARK V-A SCOOPS

MODEL: RC-121 D
DATA AS OF: 1 December 1957
ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0
DATA BASED ON: WV-2 Flight Tests

REMARKS:

1. Use this chart to determine the Maximum Safe Take-off Weight for a given Runway Length, or the Maximum Safe Runway Length for a desired Take-off Gross Weight. Values given on this sheet are based on Critical Engine Failure and Take-off speeds given on Critical Engine Failure Speeds Chart.
2. If engine failure should occur after the critical speed has been reached, the Take-off may be continued. The total distance needed to reach Take-off Speed **and Climb 50 Feet** is less than the distance required to stop without reverse thrust. If failure should occur at the critical speed or less, the take-off should be rejected as the distance required to stop is equal to or less than that required to reach Take-off Speed **and Climb 50 Feet.**

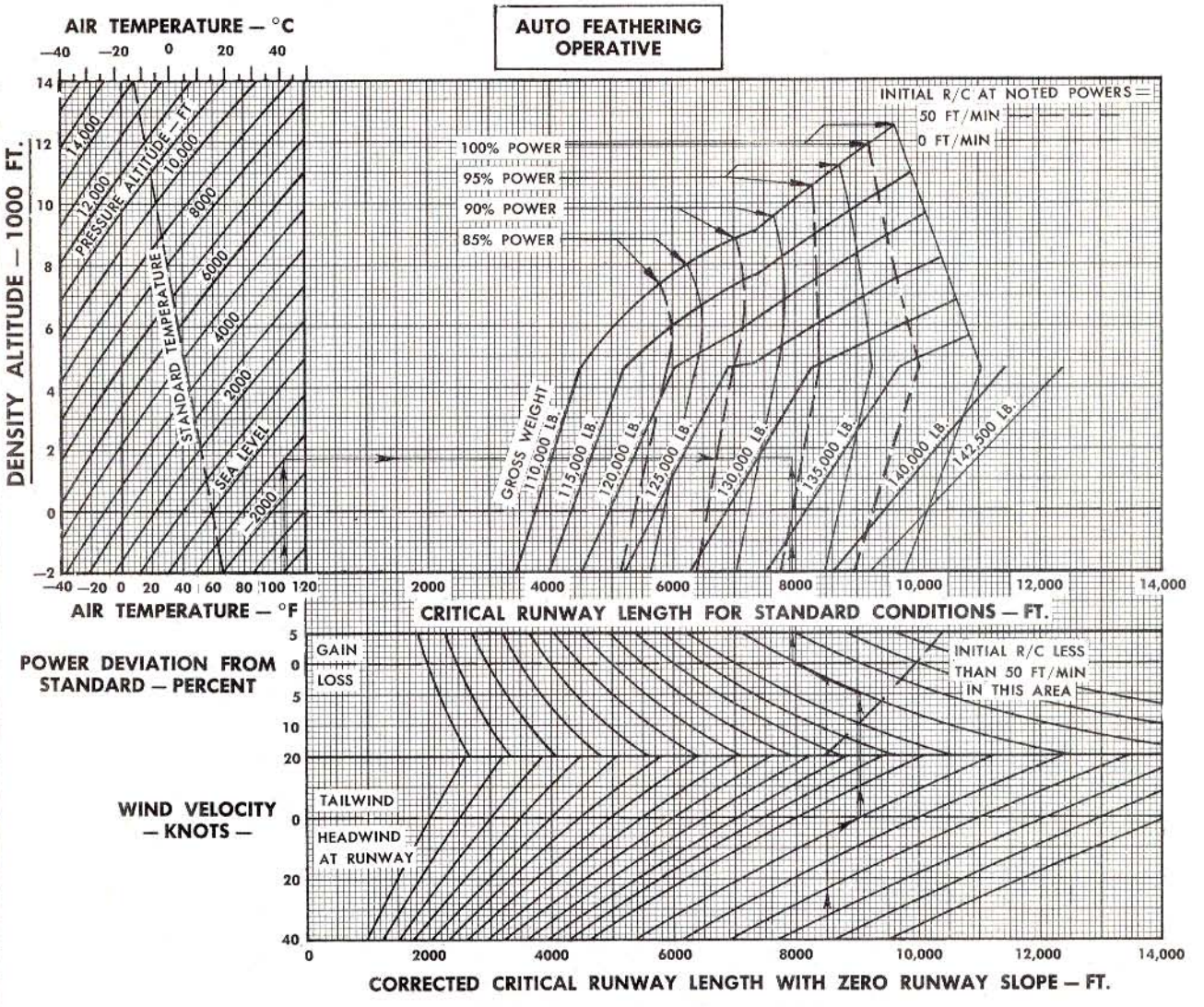


Figure A3-18. Performance With Take-off Emergency — Critical Field Lengths for Obstacle Clearance

SPEED KIT

PERFORMANCE WITH TAKE-OFF EMERGENCY

CRITICAL ENGINE FAILURE SPEEDS FOR OBSTACLE CLEARANCE

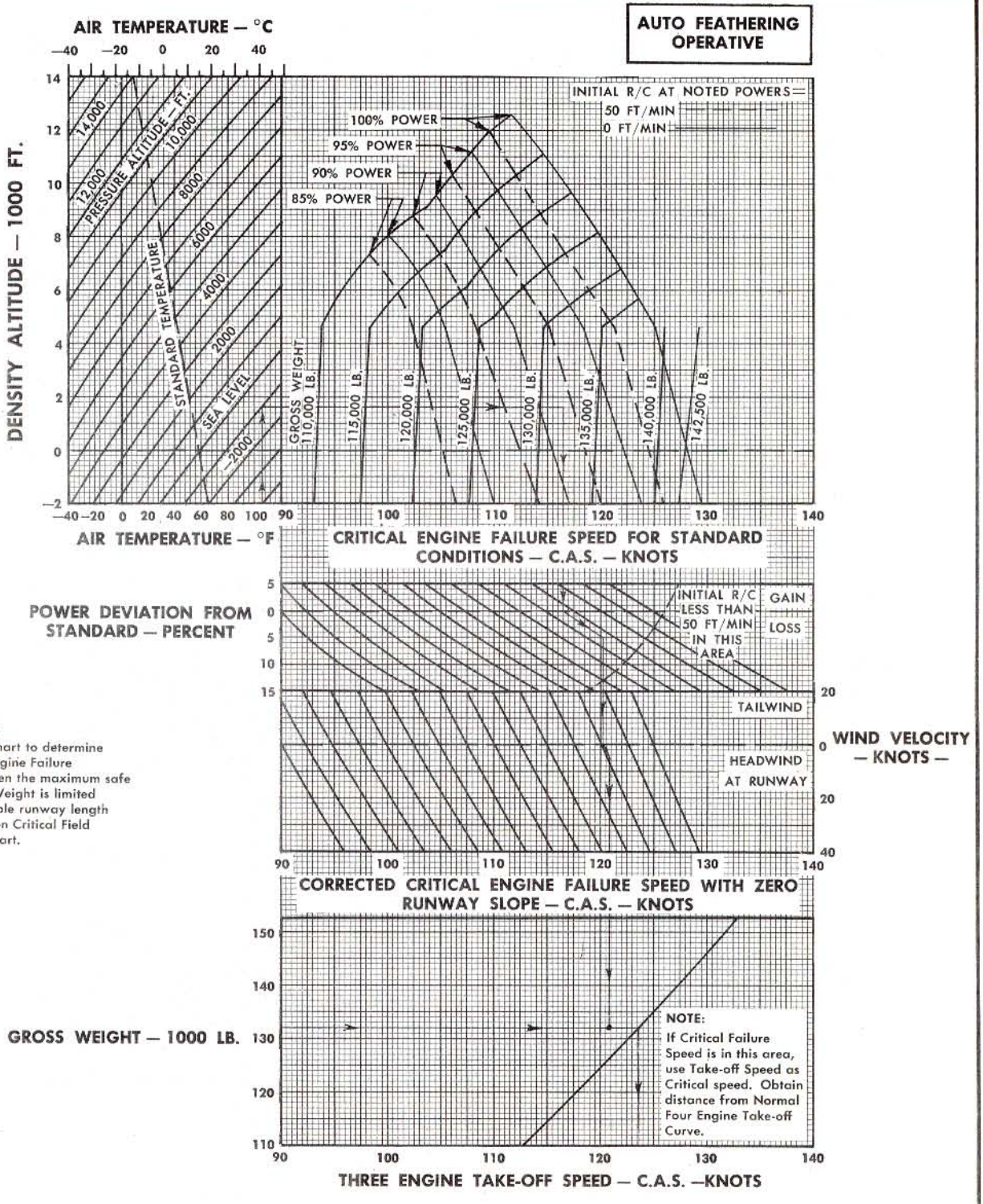
MARK V-A SCOOPS

MODEL: RC-121 D
DATA AS OF: 1 December 1957

ENGINES: (4) R3350 - 91

PROPS: Ham. Std. 43E60/6903-0
DATA BASED ON: WV-2 Flight Tests

AUTO FEATHERING OPERATIVE



REMARKS:

Use this chart to determine Critical Engine Failure Speed when the maximum safe Take-off Weight is limited by available runway length as given on Critical Field Length Chart.

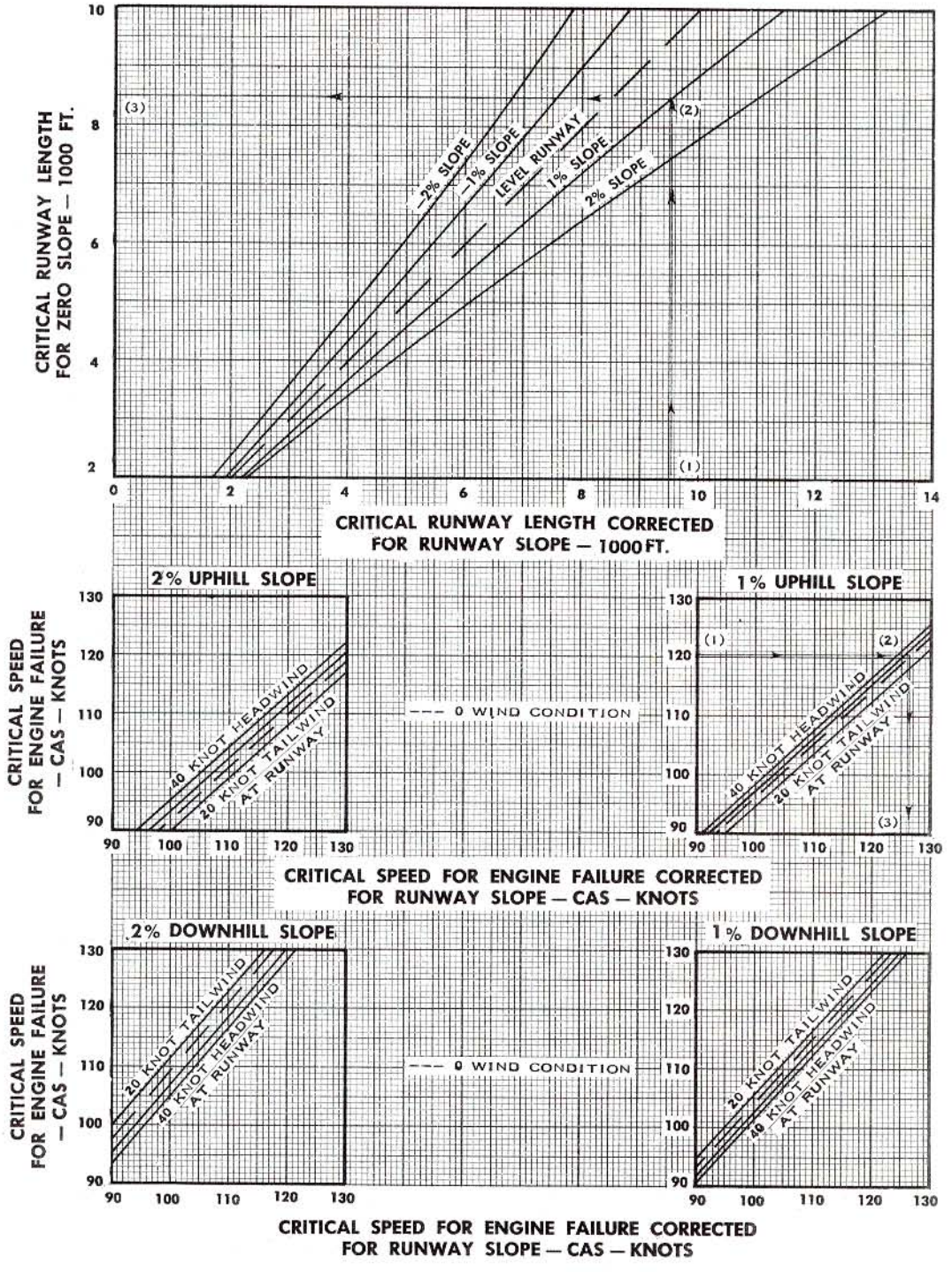
Figure A3-19. Performance With Take-off Emergency — Critical Speeds for Engine Failure

SPEED KIT

EFFECT OF RUNWAY SLOPE ON CRITICAL FIELD LENGTH AND CRITICAL SPEED FOR ENGINE FAILURE

MARK V-A SCOOPS

MODEL: RC-121 D ENGINES: (4) R3350 - 91 PROPS: HAM. STD. 43E60/6903-0



DATA AS OF: 1 JUNE 1957
DATA BASED ON: WV-2 Flight Tests

Figure A3-20. Performance With Take-off Emergency — Effect of Runway Slope on Critical Field Lengths and Critical Speeds for Engine Failure

SPEED KIT

TAKE-OFF WEIGHT AS LIMITED BY RUNWAY SLOPE

MARK V - A SCOOPS

MODEL: RC-121 D
DATA AS OF: 1 December 1957
DATA BASED ON: WV-2 Flight Tests

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0

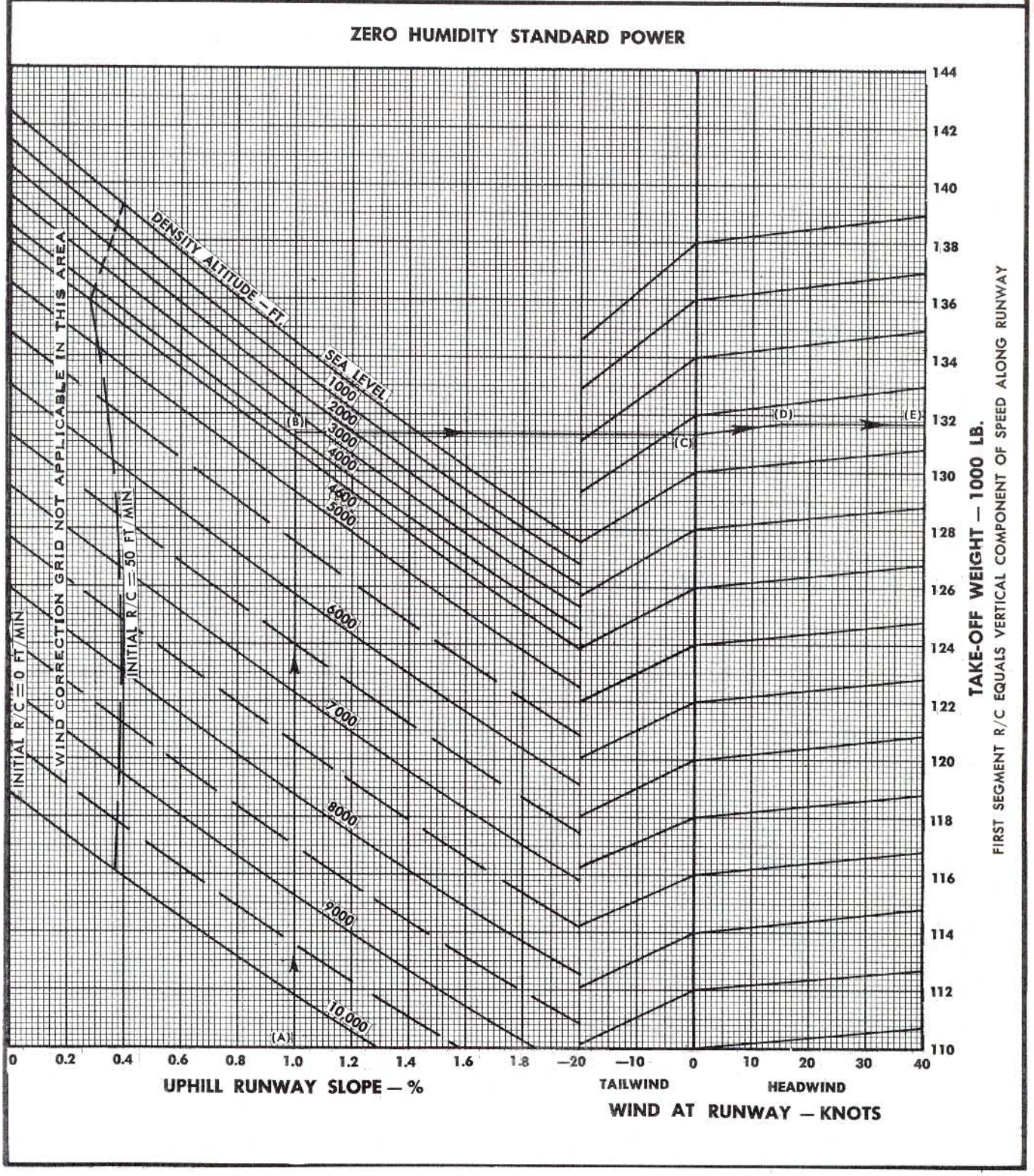


Figure A3-21. Performance With Take-off Emergency — Take-off Weight as Limited by Runway Slope

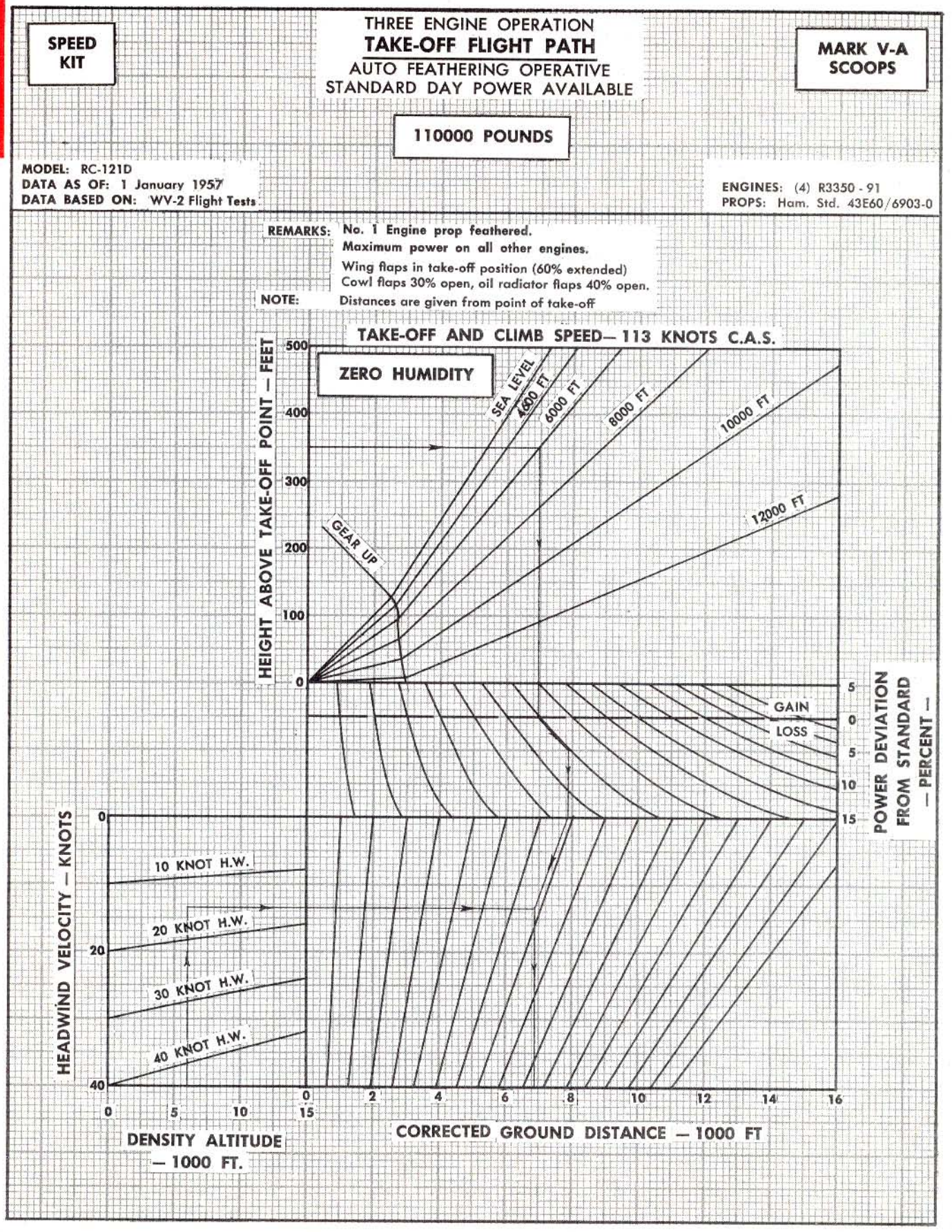


Figure A3-22. Take-off Flight Path — Three Engine Operation — 110,000 Pounds

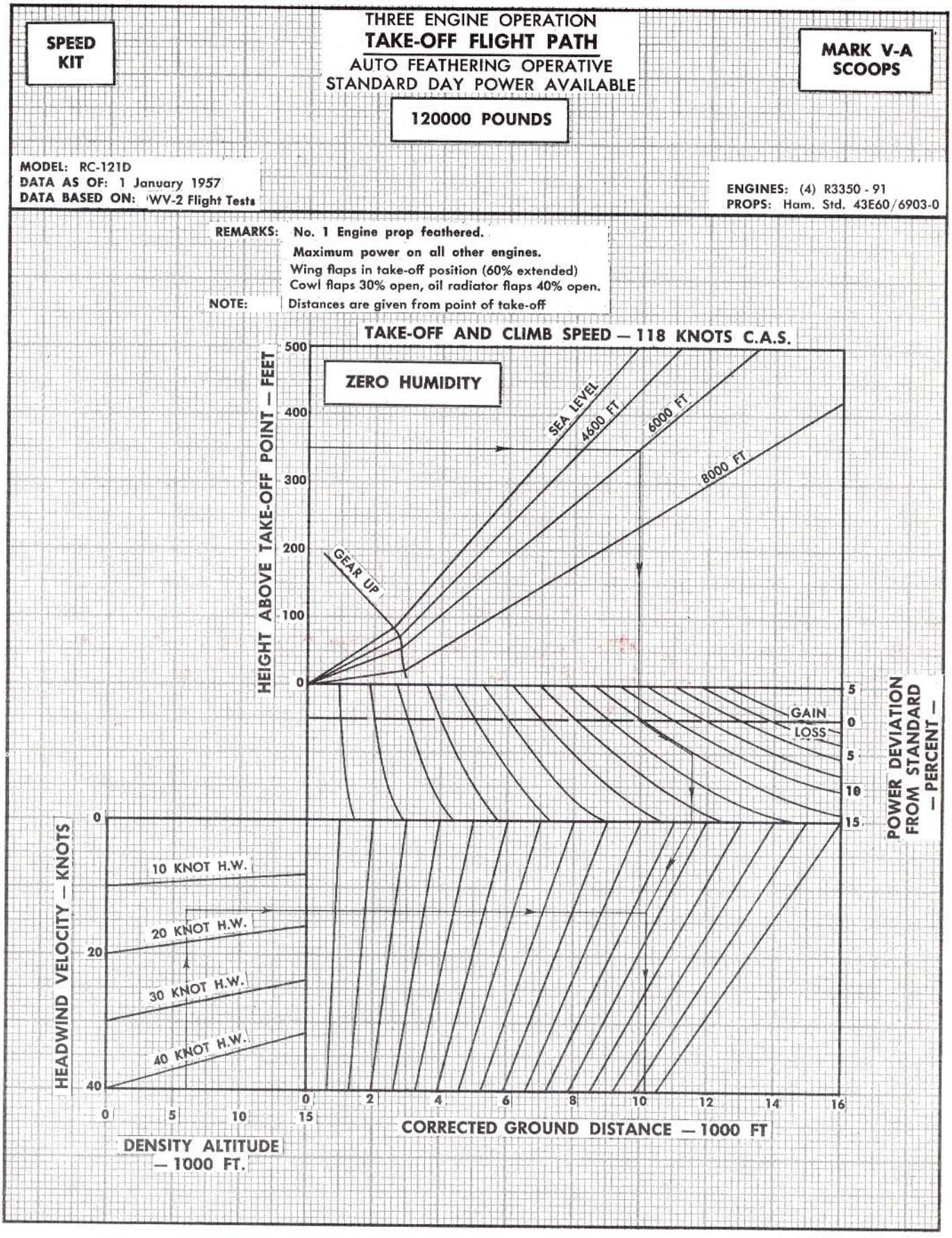


Figure A3-23. Take-off Flight Path — Three Engine Operation — 120,000 Pounds

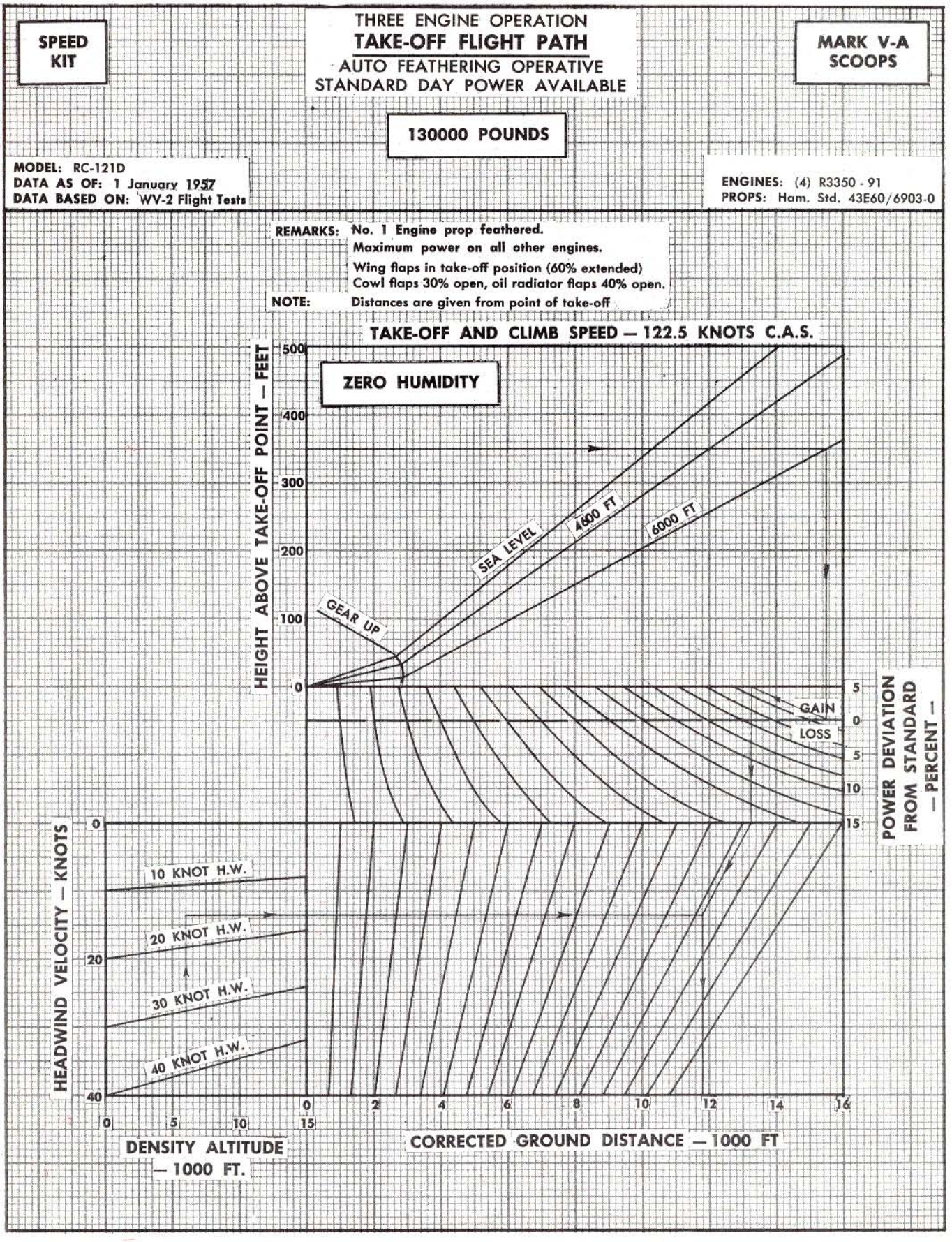


Figure A3-24. Take-off Flight Path — Three Engine Operation — 130,000 Pounds

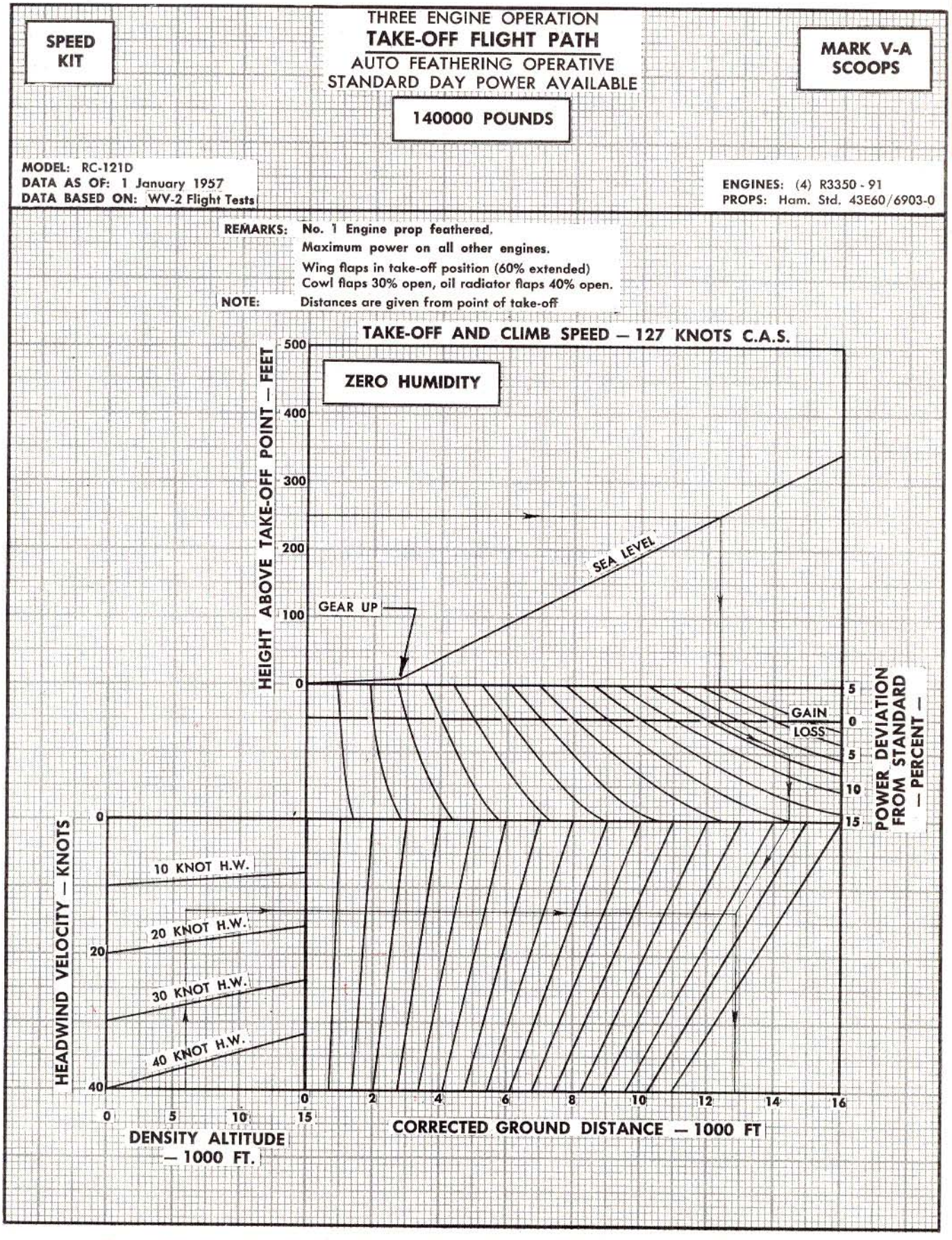


Figure A3-25. Take-off Flight Path — Three Engine Operation — 140,000 Pounds

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PART 4 — CLIMB

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* Indicates Illustration Pages

SCOPE AND ARRANGEMENT.

All climb performance data are included in this part of the Appendix. Normal climb performance is shown first with METO power and reduced Climb Power settings. Emergency Climb Performance is shown next with graphs for climb with all engines operating at maximum power and for climbs with one and two engines inoperative. This part concludes with a graph showing service ceilings for two, three or four engine operation with METRO power.

CLIMB PERFORMANCE FOR METO AND REDUCED POWER CLIMBS.

Climb performance is shown graphically on Figures A4-1 through A4-5. Data are included for METO power with four, three, and two engines operating, and for four-engine operation at Maximum Cruise Power and Alternate Climb Power Settings.

To find distance to climb, enter the graph with initial climb gross weight and proceed vertically and parallel to the guide lines until the desired altitude line is

intersected. Read distance horizontally to the left. On the Time to Climb graph, also proceed vertically parallel to the guide lines until the horizontal projection of the previously found distance is intersected. Interpolate between the time lines to find time to climb. The fuel used in climb may be read directly from the third graph on each figure.

The effect of non-standard temperatures on climb performance may be approximated by entering the charts at density altitude (as determined from the standard atmospheric chart) rather than pressure altitude.

Evaluation of climb power settings to be used is generally based on considerations of engine wear and reliability factors in addition to resultant performance. METO provides maximum performance with respect to rate of climb. Lower power settings result in less engine wear and less rate of climb, but better over-all performance may be obtained under some conditions due to reduced fuel flow during the climb. The point at which one setting becomes superior to another is generally a function of gross weight during climb, cruise altitude desired, and the cruise speed schedule to be used.

METO power requires the largest fuel flow during the climb, but allows the earliest reduction to cruise power settings. METO power is generally best when operating at high or overload weights, or when operating with one or more engines inoperative.

Alternate Climb Power settings result in less rate of climb, and, consequently, more time is required to attain a given cruise altitude. Engine wear is reduced, however, and lower fuel flows may result in better over-all performance. The constant power schedule of 2050 average BHP per engine up to the high blower critical altitude has the advantage of simplicity. Constant BMEP can be maintained by shifting blowers as the low blower critical altitude is reached. This climb power schedule is most frequently used at normal operating weights.

Limit alternate climb power may be used rather than constant 2050 BHP/Eng. This will result in slightly increased climb performance.

Maximum cruise power requires the least fuel flow, but results in the least rate of climb. This setting may be advantageous at light weights or where a change in cruising altitude is desired during a flight.

Climb performance shown is based on maximum rates of climb which can be obtained with standard power available and the configurations noted. While it is recommended that the prescribed airspeeds be maintained, speeds within five knots of the schedule noted are allowable and will not result in an appreciable decrease in rate of climb provided a steady speed is maintained. It is important to keep aircraft drag to a minimum by setting cowl, oil radiator, and cabin air conditioning scoops at the minimum position for adequate cooling.

No allowances have been made for time to reach climb speed after take-off, for time to shift blowers, or for time required to accelerate to cruise speed at the end of the climb. It is felt that operating personnel can determine allowances which should be made for these items with more accuracy than estimates which might be included in these basic data.

The blower shift should be made as quickly as possible and climb speed maintained during the shift if maximum performance is to be obtained. The optimum shift altitude is that at which the full throttle power available in low blower equals limit part throttle power to be expected in high blower. It will be noted that, with Alternate Climb Power, 2080 inboard BHP per engine is the high blower limit power at the recommended shift altitude. Therefore, the shift to high blower should be made on reaching critical altitude when using this climb power schedule.

AUTO RICH mixture settings are normally used for all climbs. Alternate and maximum cruise power climbs may be conducted with mixtures manually leaned to fuel flow values shown in Section VII if engine operating limits are not exceeded and if engine operation is normal. Manifold pressure spread between engines must not exceed 1" Hg. If any unusual engine operation is experienced AUTO RICH mixture settings must be used.

EMERGENCY CLIMB PERFORMANCE.

Emergency rates of climb are provided on figures A4-6 through A4-14 which show rates of climb vs airspeed at maximum power for various representative gross weights. Data are included for four, three, and two-engine operation with wing flaps retracted and for take-off and landing flap settings. The effect of landing gear position is shown for the take-off configuration, as well as effects of operation at higher altitudes or with less than standard power. These graphs show best climb speeds at the various weights and configurations, and performance that can be expected at standard conditions of temperature and power. They are arranged to allow rapid comparisons of the effects of varying airspeeds and flap and gear configurations. Note that rates of climb in the cruise configuration are always greater at the best flaps up climb speeds than the best rates of climb for any other configuration. However, best rates of climb at lower speeds may require use of flaps. This characteristic may be used to advantage under conditions where it is impractical to accelerate to the best clean configuration climb speed before trying to gain altitude.

The data represents rates of climb available in unaccelerated flight; that is, at stable climb speeds with bank angles less than 5°. Greater bank angles increase the apparent weight which must be supported by the wing and also decrease the excess power available for climb. The effect of accelerating is to reduce climb performance available due to the reduction in excess power available for climb purposes. Therefore, if obstacle clearance is required, it will generally be best to maintain constant flight speed until the height of immediate obstructions is reached. Subsequent acceleration to a more favorable speed will then result in best over-all climb performance. Correction curves are also supplied which show the effect of altitude on rate of climb at best climb speed, and the effects of power deviation on rate of climb at sea level with various configurations.

SERVICE CEILINGS.

The altitude at which a rate of climb of 100 ft./ min. can be obtained is plotted vs. gross weight on Figure A4-15. Curves are shown for two, three and four engine operation at METO power.

If engine failure should occur at an altitude greater than the three-engine emergency ceiling, a minimum rate of descent may be obtained by flying at climb speed with METO power set on the operative engines.

SPEED KIT

FOUR ENGINE OPERATION
METO CLIMB PERFORMANCE

MARK V-A SCOOPS

2600 RPM

STANDARD DAY

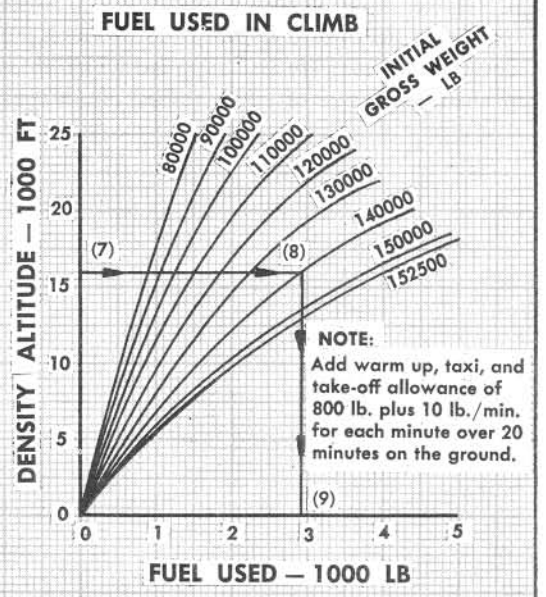
MODEL: RC-121D
DATA AS OF: 1 January 1956
DATA BASED ON: WV-2 Flight Tests

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0

NOTES:
1. Recommended Climb Speed — 155 Knots (V_e)
2. Engine Speed: 2600 RPM Spark: Retard
   Mixture Setting: Auto Rich
   BMEP Settings below critical altitudes:
   Inboard Engines: Limit values*
   Outboard Engines: 10 BMEP less than limit values*
   *(Unless limit MAP obtained at lower BMEP).
   Shift to High Blower at 11,2000 FT.
   Performance based on operation at Recommended Climb Speed.
   Cowl Flaps: 30% open (Low Blower)
   40% open (High Blower)
   Oil radiator Flaps: 35% open (Low Blower)
   40% open (High Blower)
   Cabin Superchargers: Connected; Alternators operating
   Aftercooler scoops closed.
3. Meto Power is that setting which gives maximum continuous climb performance.

EXAMPLE: Find distance, time, and fuel used in climb to 16,000 feet density altitude at an initial gross weight of 140,000 lb. Time on ground during warm-up and taxiing is 58 minutes.

SOLUTION: Follow sequence shown, Distance, (3), = 78 nautical air miles; Time, (6), = 26 minutes; Fuel used, (9), = 2925 lb. + 800 lb. + 10(38) = 4105 lb.



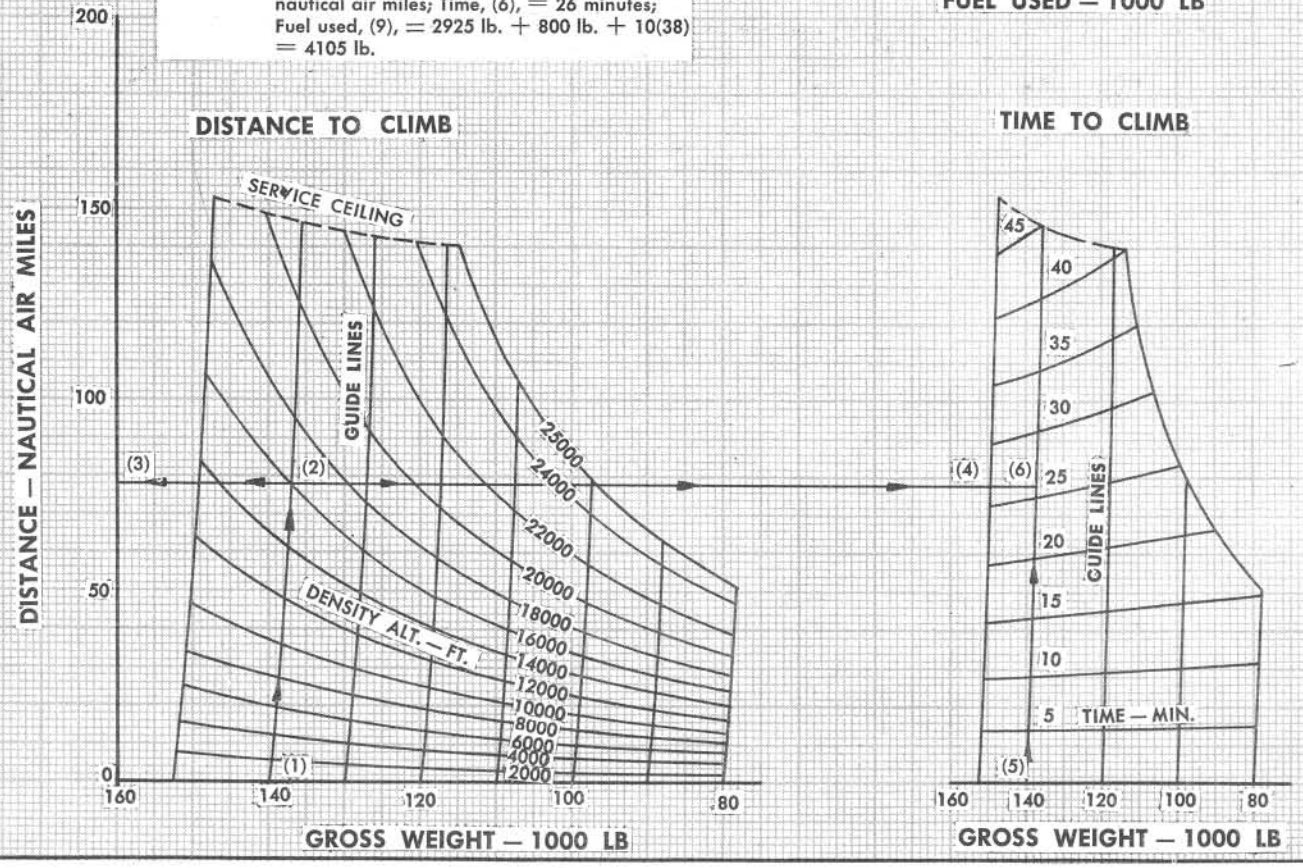


Figure A4-1. METO Power Climb Performance — Four Engine Operation — 2600 RPM

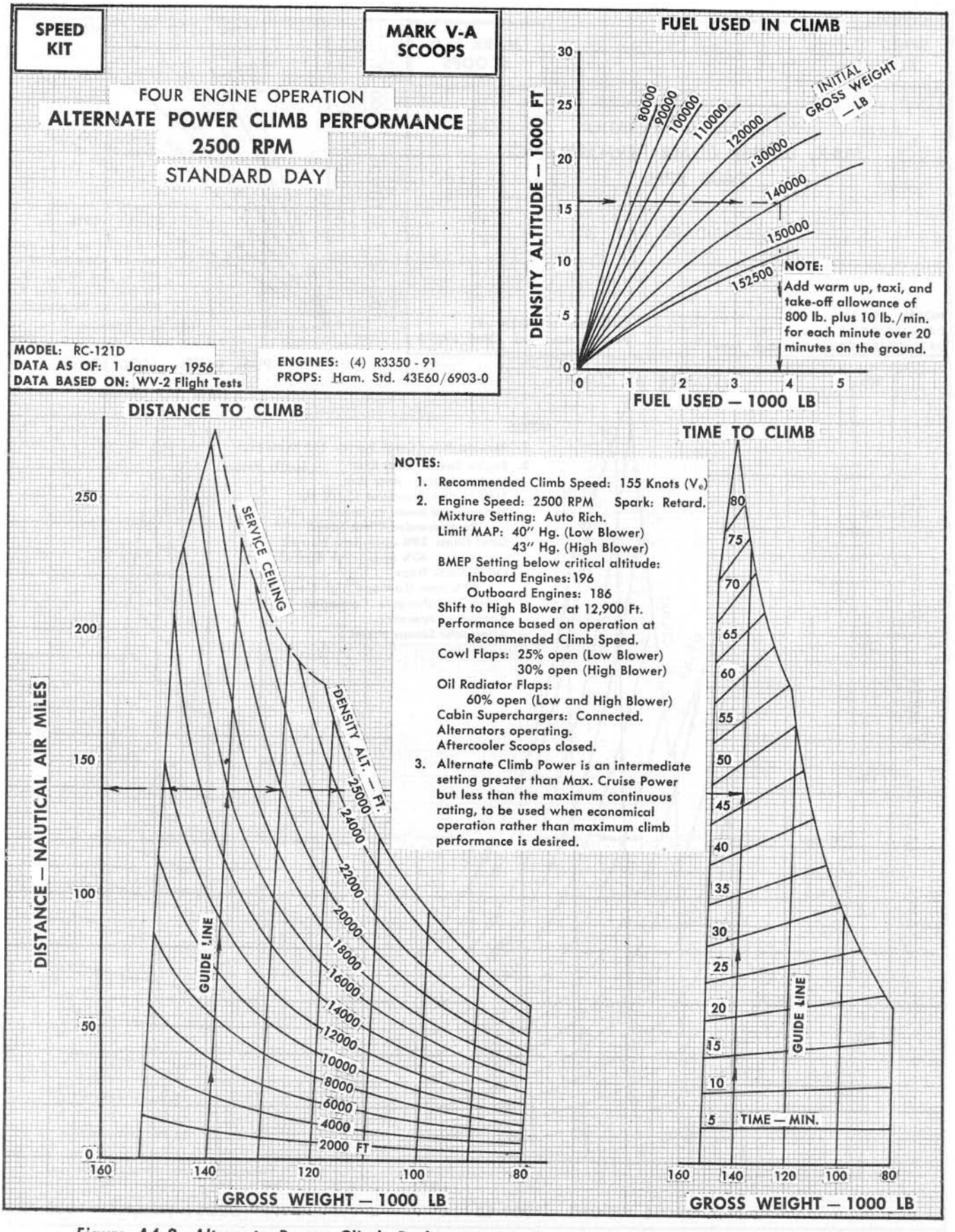


Figure A4-2. Alternate Power Climb Performance — Four Engine Operation — 2500 RPM

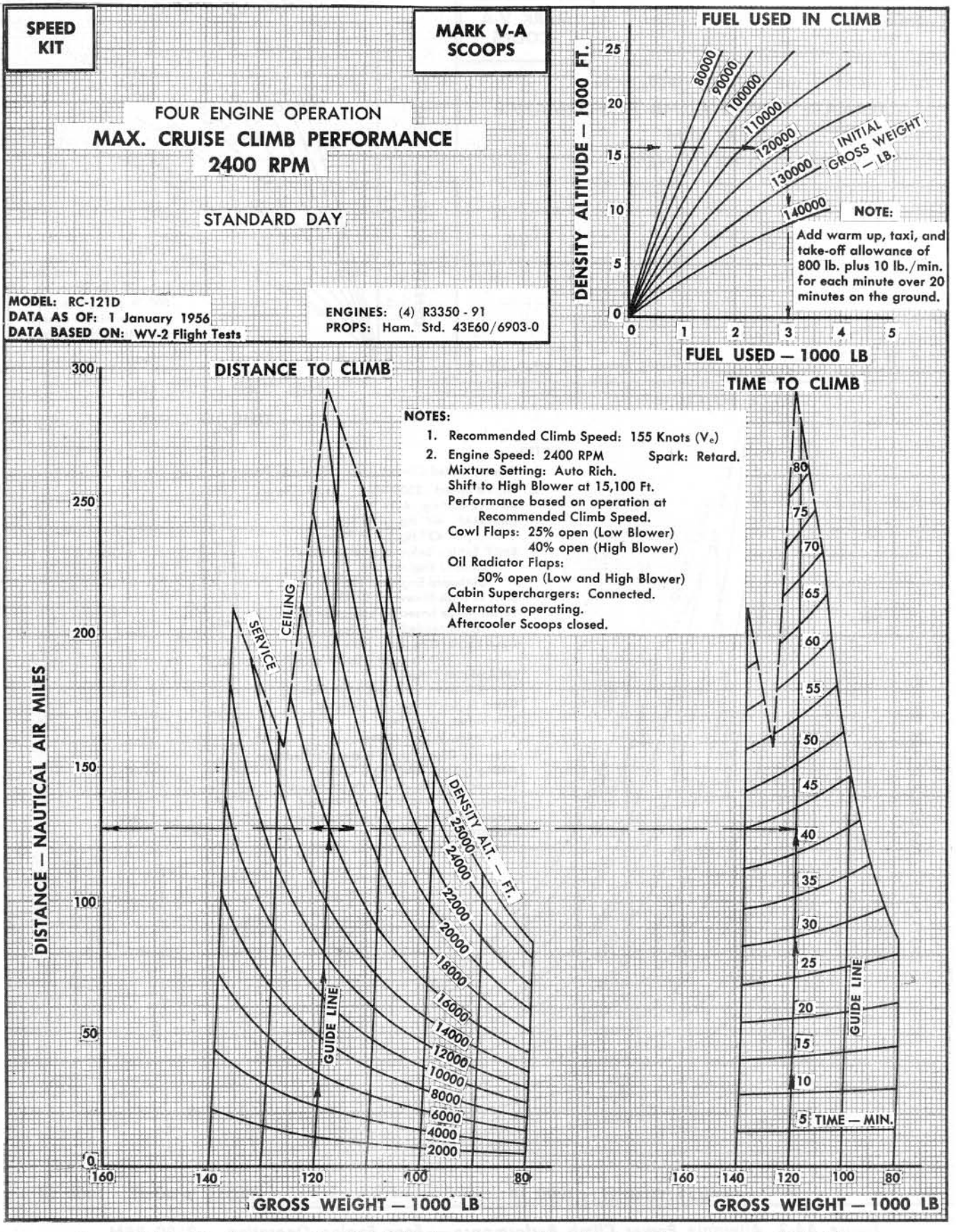


Figure A4-3. Maximum Cruise Climb Performance — Four Engine Operation — 2400 RPM

SPEED KIT

THREE ENGINE OPERATION
METO CLIMB PERFORMANCE

MARK V-A SCOOPS

2600 RPM

STANDARD DAY

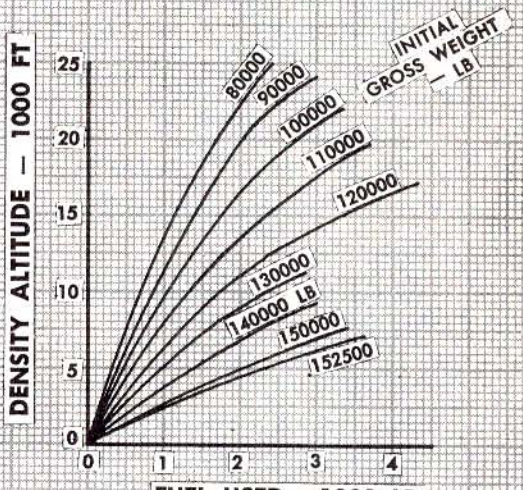
MODEL: RC-121D
DATA AS OF: 1 January 1956
DATA BASED ON: WV-2 Flight Tests

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0

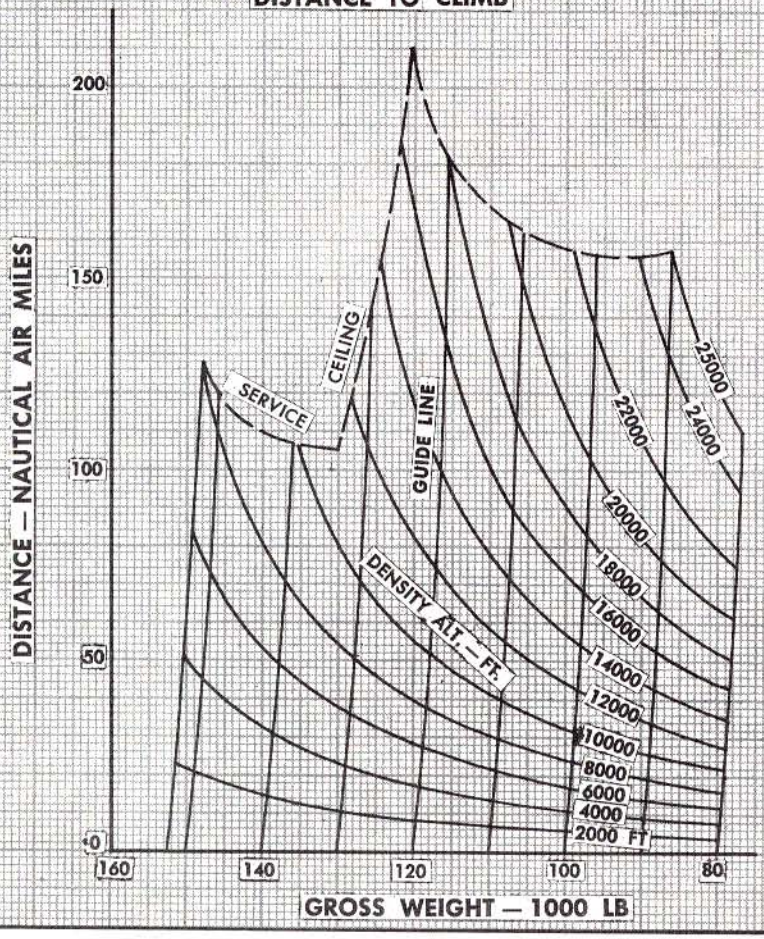
NOTES:

1. Recommended Climb Speed: 155 Knots (V_c)
2. Engine Speed: 2600 RPM Spark: Retard.
   Mixture Setting: Auto Rich.
   BMEP Setting: Inboard engines at Limit BMEP
   Outboard engines: 10 BMEP less, unless Limit MAP obtained first.
   Shift to High Blower at 11,200 Ft.
   Performance based on operation at Recommended Climb Speed.
   Cowl Flaps: 30% open on operative engines (Low Blower)
   40% open on operative engines (High Blower)
   Oil Radiator Flaps:
   35% open on operative engines (Low Blower)
   40% open on operative engines (High Blower)
   All Flaps closed and propeller feathered on inoperative engine
   Cabin Superchargers: Connected.
   Alternators operating.
   Aftercooler Scoops closed.

FUEL USED IN CLIMB — LB



DISTANCE TO CLIMB



TIME TO CLIMB

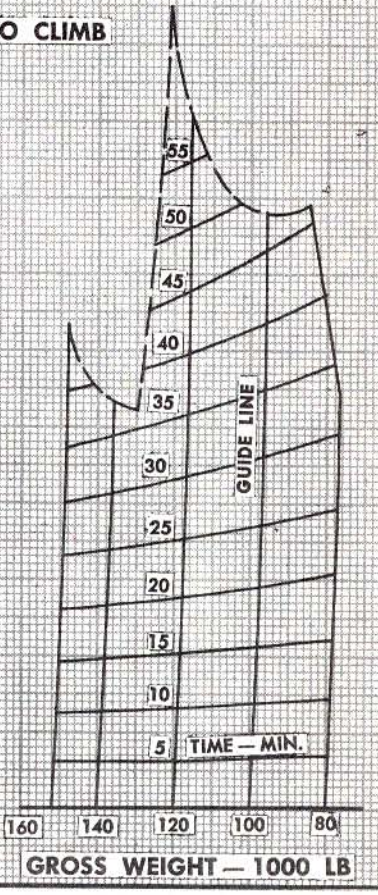


Figure A4-4. METO Power Climb Performance — Three Engine Operation — 2600 RPM

SPEED KIT

TWO ENGINE OPERATION
METO CLIMB PERFORMANCE

MARK V-A SCOOPS

2600 RPM | STANDARD DAY

MODEL: RC-121D
DATA AS OF: 1 January 1956
DATA BASED ON: WV-2 Flight Tests

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0

NOTES:

1. Recommended Climb Speed: 152 Knots (V_c)
2. Engine Speed: 2600 RPM Spark: Retard.
   Mixture Setting: Auto Rich.
   Set Limit BMEP unless Limit MAP obtained first.
   Shift to High Blower at 11,100 Ft.
   Performance based on operation at Recommended Climb Speed.
   Cowl Flaps: 30% open on operative engines (Low Blower)
   40% open on operative engines (High Blower)
   Oil Radiator Flaps:
   35% open on operative engines (Lo Blower)
   40% open on operative engines (Hi Blower)
   All Flaps closed and Propellers feathered on inoperative engines.
   Cabin Superchargers: Disconnected.
   Alternators not operating.
   Aftercooler Scoops closed.

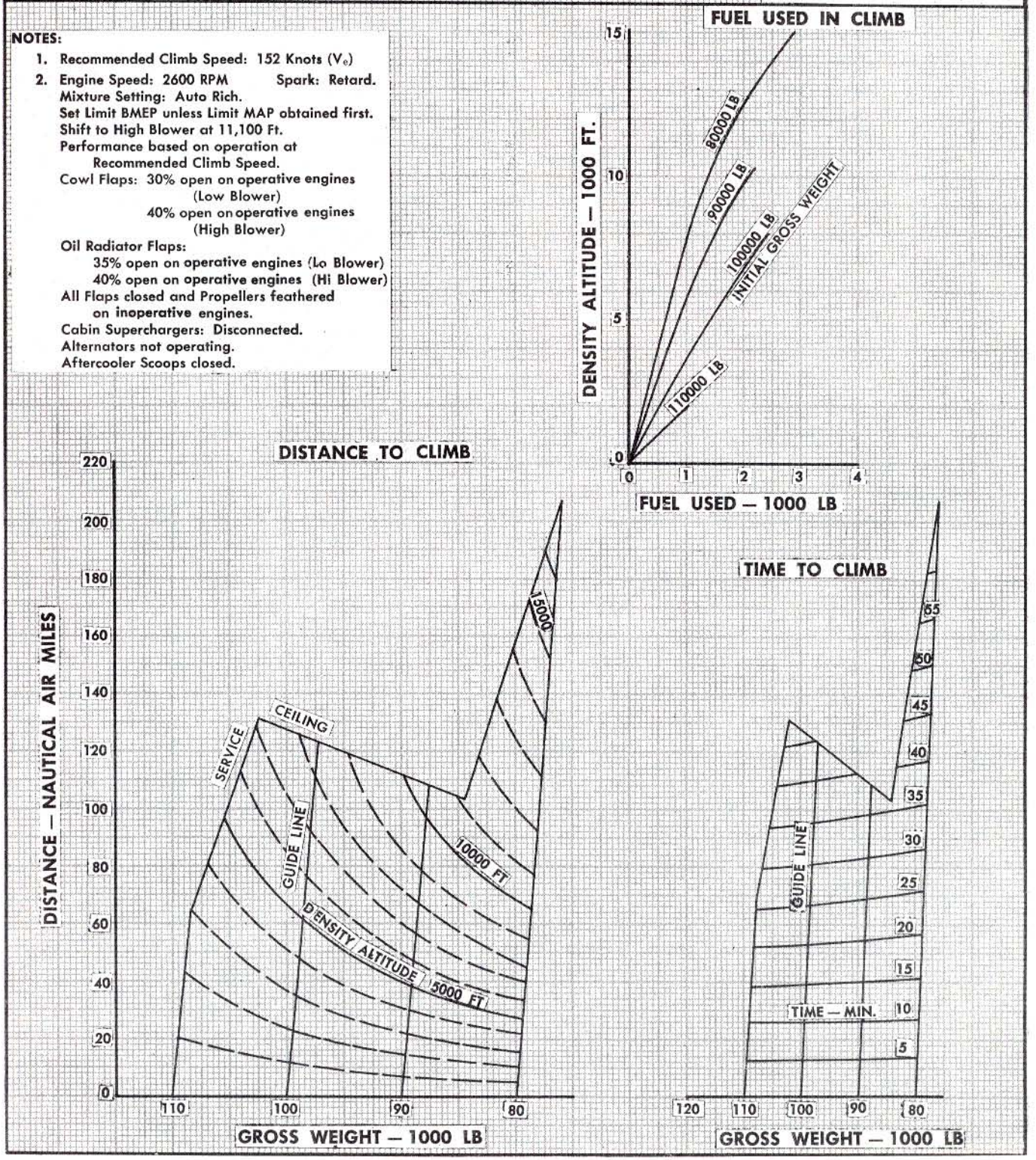


Figure A4-5. METO Power Climb Performance — Two Engine Operation — 2600 RPM

SPEED KIT

FOUR ENGINE OPERATION

EMERGENCY RATES OF CLIMB

EFFECT OF AIRSPEED AND VARIOUS CONFIGURATIONS

MARK V-A SCOOPS

SEA LEVEL | MAXIMUM POWER | STANDARD DAY

MODEL: RC-121D
DATA AS OF: 1 January 1956
DATA BASED ON: WV-2 Flight Tests

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0

2900 RPM — 3222 AVG. BHP/OPERATING ENGINE
CARBURETOR AIR — DIRECT POSITION
AMBIENT AIR TEMP. = 15° C

REMARKS: Climb performance based on operation with Cowl flaps 30% open and oil radiator flaps 40% open. Primary and secondary heat exchanger scoops closed.

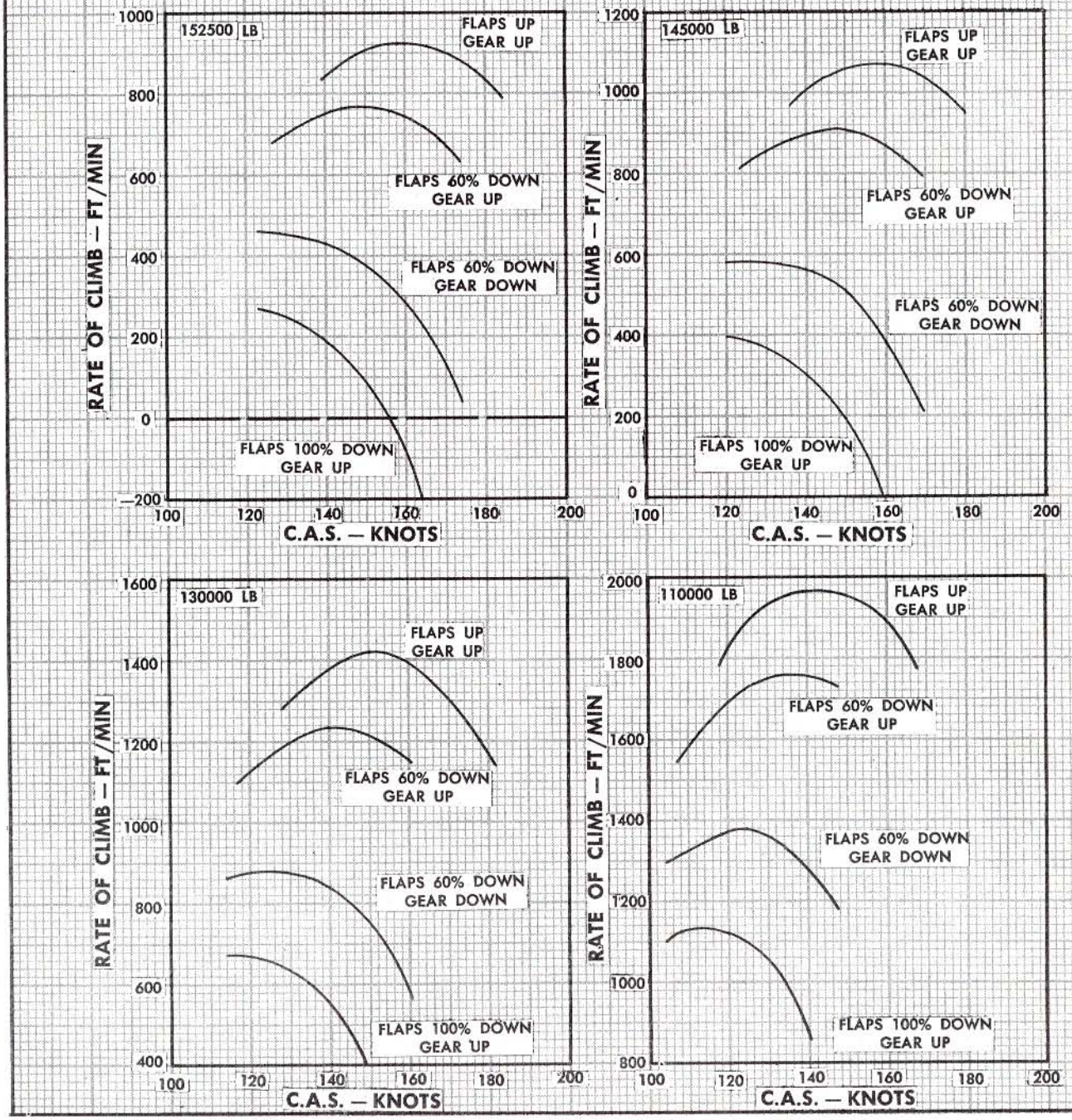


Figure A4-6. Emergency Rates of Climb — Four Engine Operation — Maximum Power — Effect of Airspeed and Various Configurations

SPEED KIT

FOUR ENGINE OPERATION

EMERGENCY RATES OF CLIMB

EFFECT OF ALTITUDE

MARK V-A SCOOPS

MAXIMUM POWER

STANDARD DAY

MODEL: RC-121D
DATA AS OF: 1 January 1957
DATA BASED ON: WV-2 Flight Tests

ZERO HUMIDITY

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0

2900 RPM — CARBURETOR AIR — DIRECT POSITION

REMARKS: Climb performance based on operation with Cowl flaps 30% open and oil radiator flaps 40% open. Primary and secondary heat exchanger scoops closed.

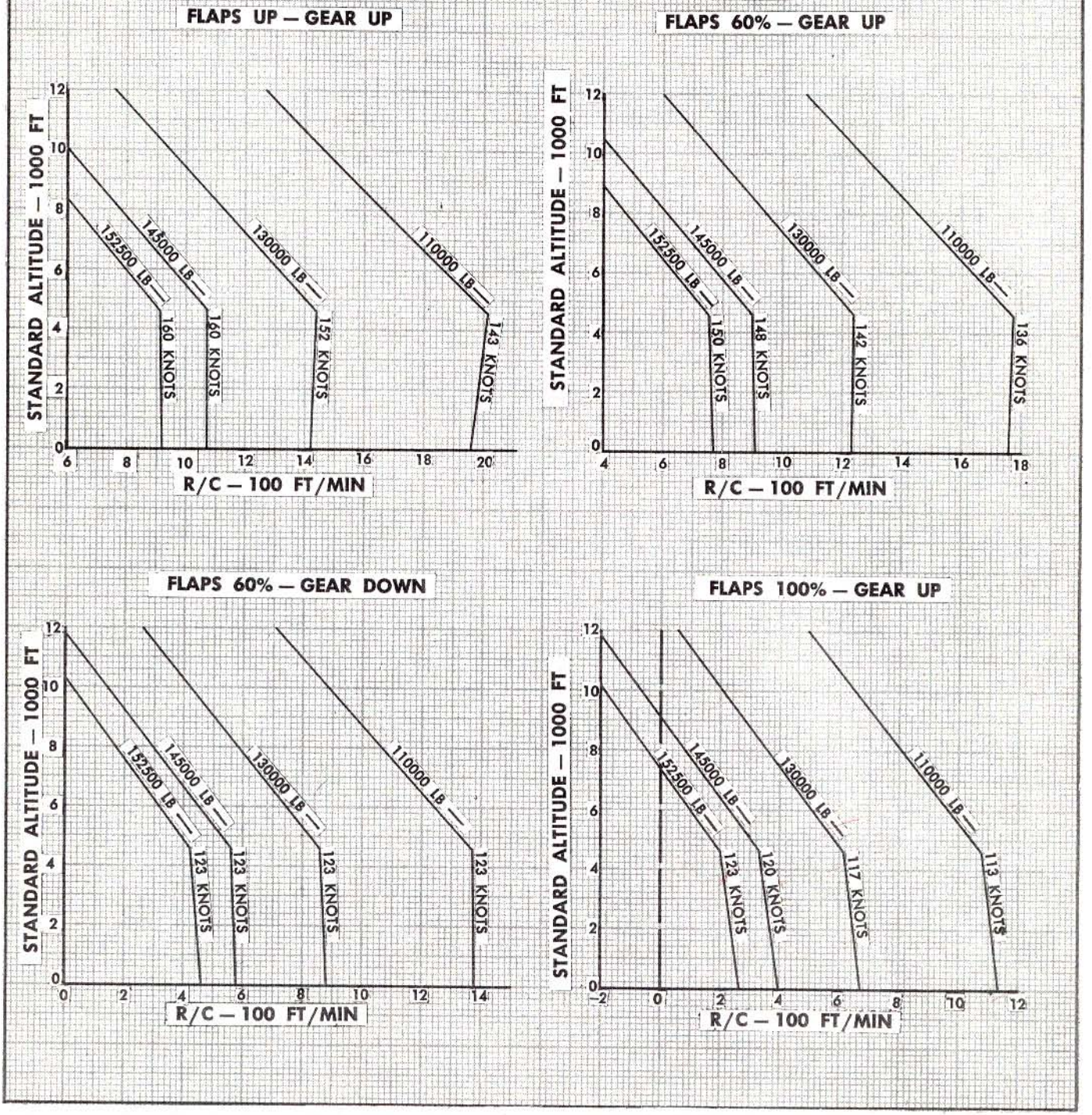


Figure A4-7. Emergency Rates of Climb — Four Engine Operation — Maximum Power — Effect of Altitude

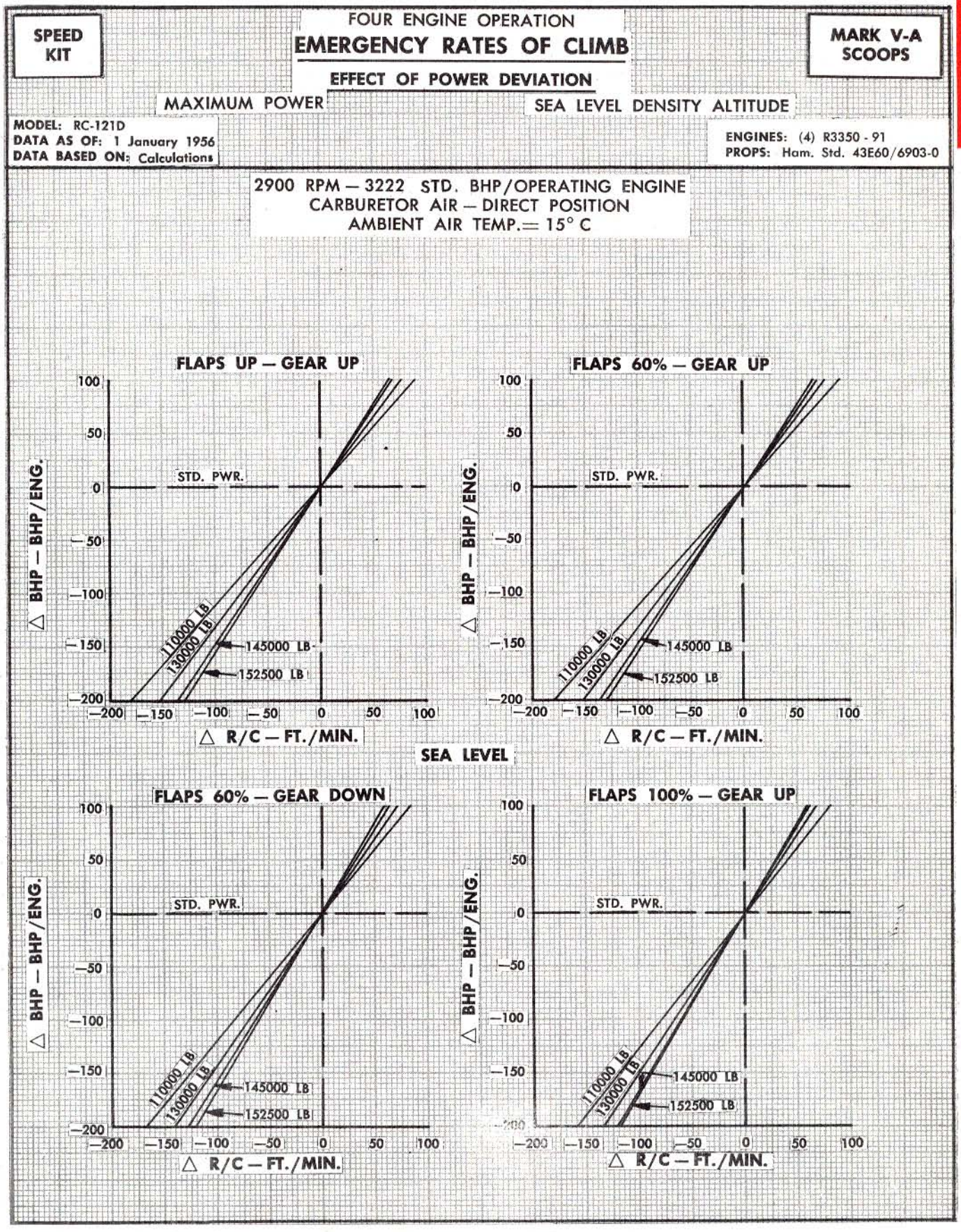


Figure A4-8. Emergency Rates of Climb — Four Engine Operation — Maximum Power — Effect of Power Deviation

SPEED KIT

THREE ENGINE OPERATION

EMERGENCY RATES OF CLIMB

EFFECT OF AIRSPEED AND VARIOUS CONFIGURATIONS

MARK V-A SCOOPS

SEA LEVEL | MAXIMUM POWER | STANDARD DAY

MODEL: RC-121D
DATA AS OF: 1 January 1956
DATA BASED ON: WV-2 Flight Tests

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0

2900 RPM — 3222 AVG. BHP/OPERATING ENGINE
CARBURETOR AIR — DIRECT POSITION
AMBIENT AIR TEMP.= 15° C
ONE ENGINE INOP. & PROP FEATHERED

REMARKS: Climb performance based on operation with Cowl flaps 30% open and oil radiator flaps 40% open. Primary and secondary heat exchanger scoops closed.

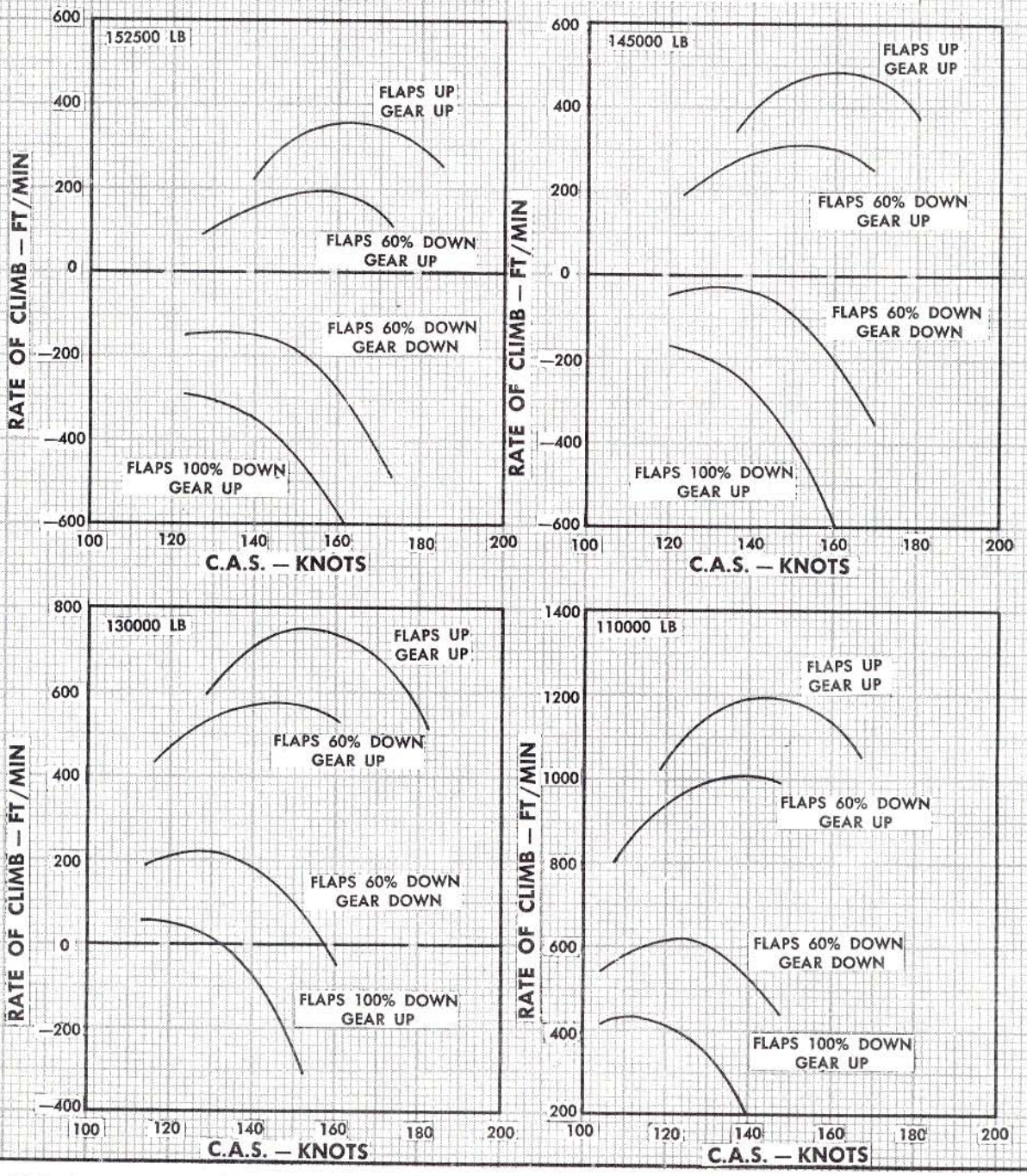


Figure A4-9. Emergency Rates of Climb — Three Engine Operation — Maximum Power — Effect of Air Speed and Various Configurations

SPEED KIT

THREE ENGINE OPERATION

EMERGENCY RATES OF CLIMB

EFFECT OF ALTITUDE

MARK V-A SCOOPS

MAXIMUM POWER

STANDARD DAY

MODEL: RC-121D
DATA AS OF: 1 January 1957
DATA BASED ON: WV-2 Flight Tests

ZERO HUMIDITY

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0

2900 RPM — CARBURETOR AIR — DIRECT POSITION
ONE ENGINE INOP. & PROP FEATHERED

REMARKS: Climb performance based on operation with Cowl flaps 30% open and oil radiator flaps 40% open. Primary and secondary heat exchanger scoops closed.

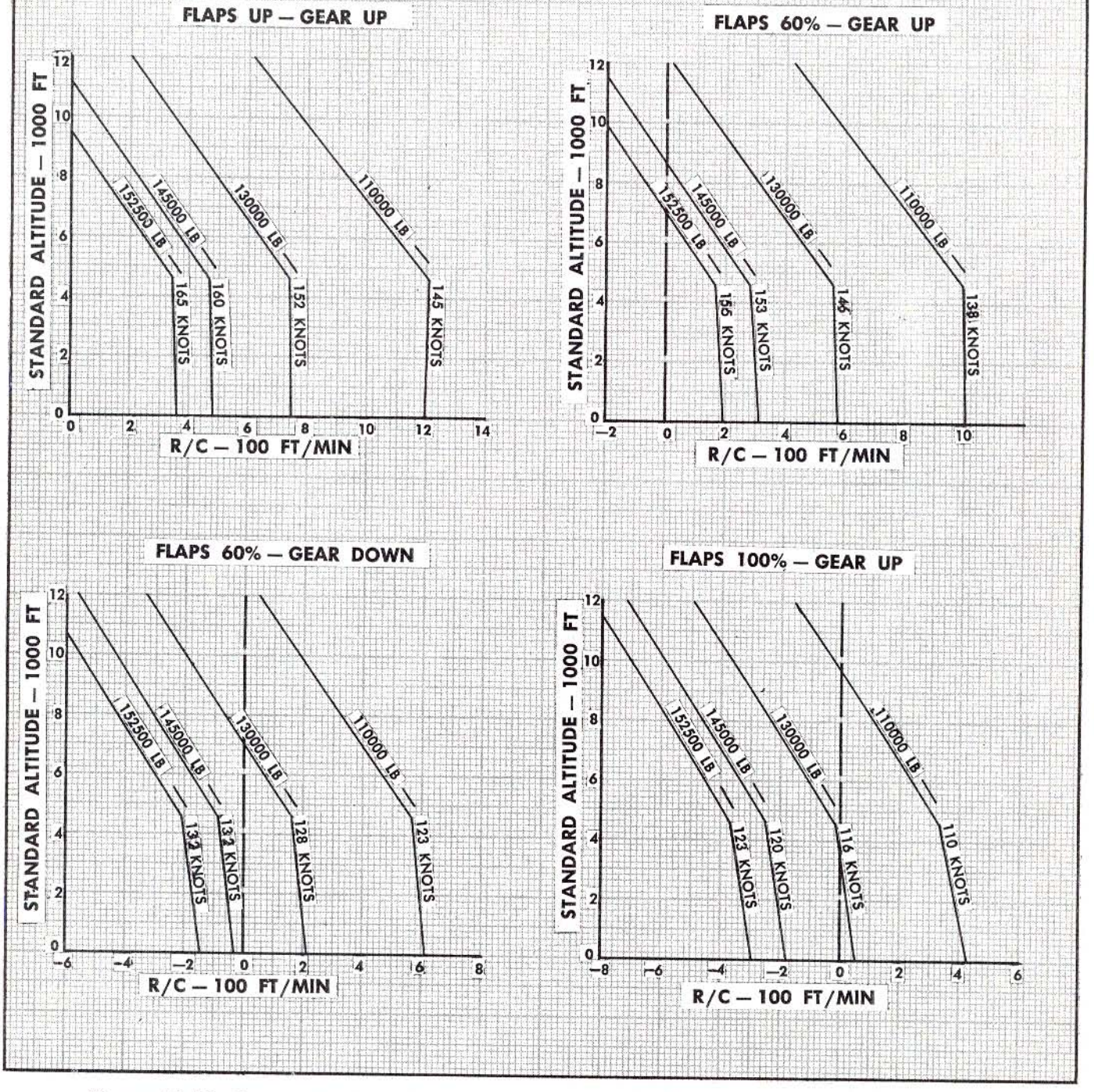


Figure A4-10. Emergency Rates of Climb — Three Engine Operation — Maximum Power — Effect of Altitude

SPEED KIT

THREE ENGINE OPERATION

EMERGENCY RATES OF CLIMB

EFFECT OF POWER DEVIATION

MARK V-A SCOOPS

MAXIMUM POWER

SEA LEVEL DENSITY ALTITUDE

MODEL: RC-121D
DATA AS OF: 1 January 1956
DATA BASED ON: Calculations

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0

2900 RPM — 3222 AVG. BHP/OPERATING ENGINE
CARBURETOR AIR — DIRECT POSITION
AMBIENT AIR TEMP.= 15° C
ONE ENGINE INOP. & PROP FEATHERED

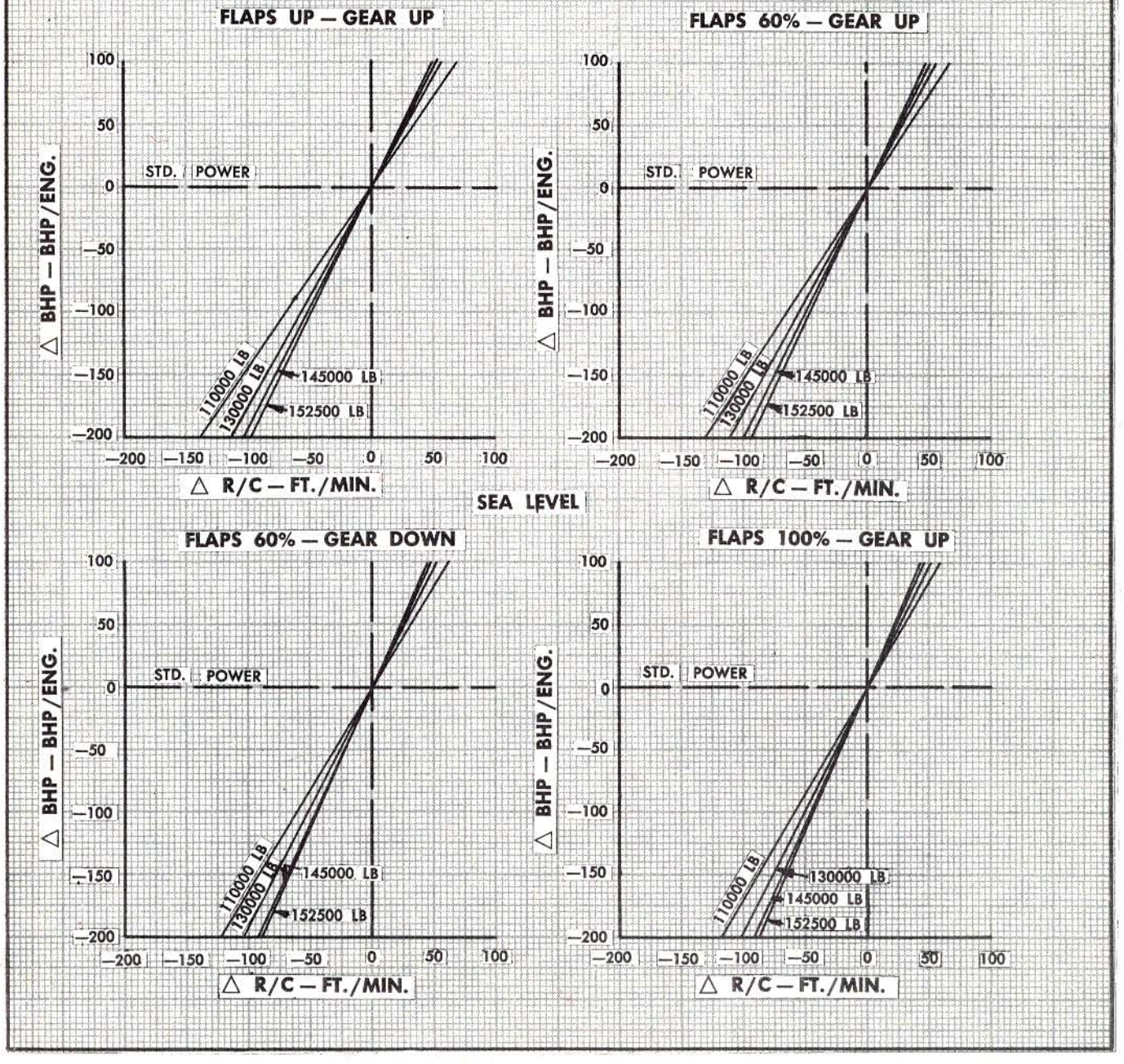


Figure A4-11. Emergency Rates of Climb — Three Engine Operation — Maximum Power — Effect of Power Deviation

SPEED KIT

TWO ENGINE OPERATION

EMERGENCY RATES OF CLIMB

EFFECT OF AIRSPEED AND VARIOUS CONFIGURATIONS

MARK V-A SCOOPS

SEA LEVEL | MAXIMUM POWER | STANDARD DAY

MODEL: RC-121D
DATA AS OF: 1 January 1956
DATA BASED ON: WV-2 Flight Tests

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0

2900 RPM — 3250 AVG. BHP/OPERATING ENGINE
CARBURETOR AIR — DIRECT POSITION
AMBIENT AIR TEMP.= 15° C
TWO ENGINES INOP. & PROP FEATHERED

REMARKS: Climb performance based on operation with Cowl flaps 30% open and oil radiator flaps 40% open. Primary and secondary heat exchanger scoops closed.

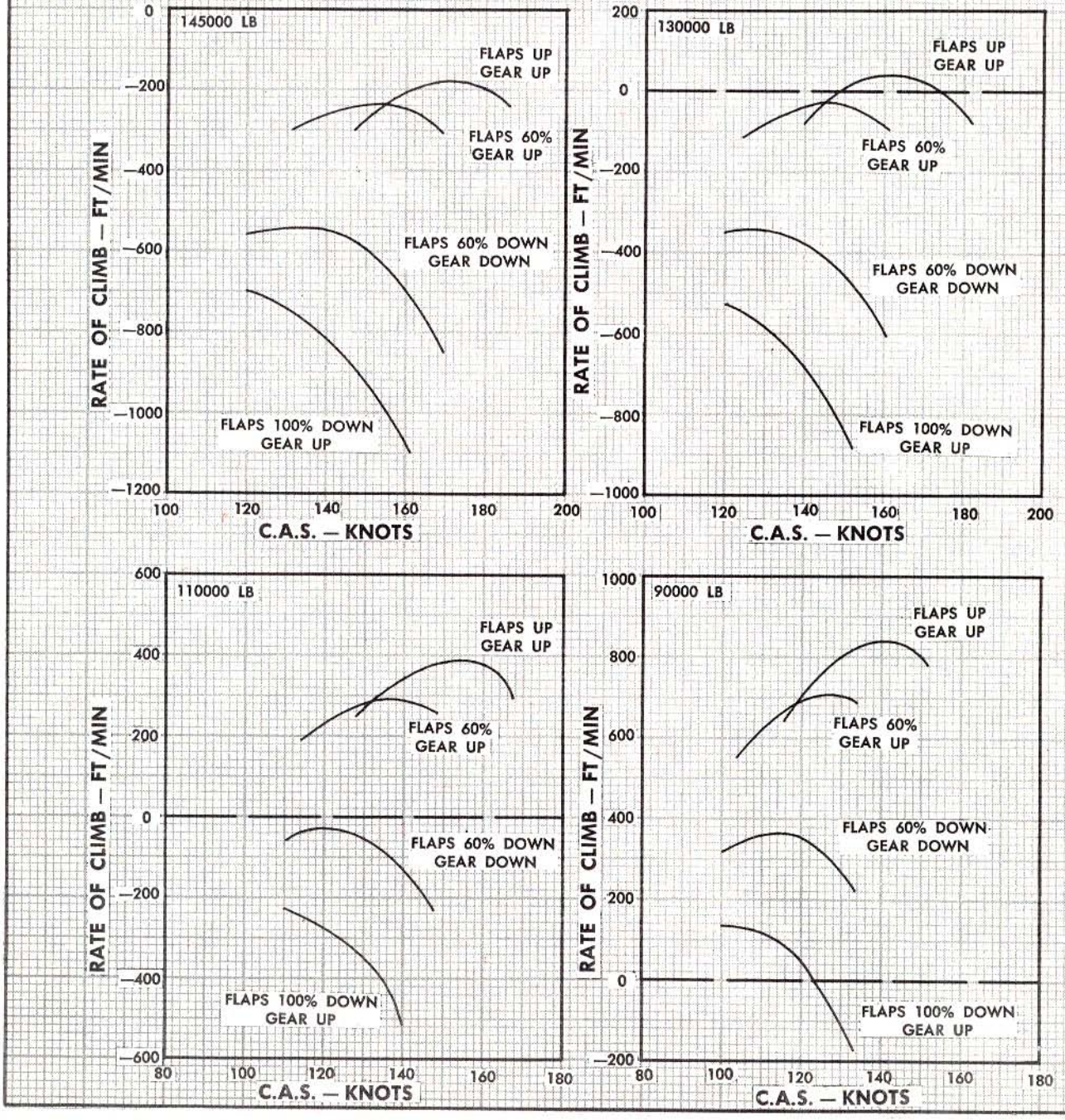


Figure A4-12. Emergency Rates of Climb — Two Engine Operation — Maximum Power — Effect of Airspeed and Various Configurations

SPEED KIT

TWO ENGINE OPERATION

EMERGENCY RATES OF CLIMB

EFFECT OF ALTITUDE

MARK V-A SCOOPS

MAXIMUM POWER

MODEL: RC-121D
DATA AS OF: 1 January 1957
DATA BASED ON: WV-2 Flight Tests

ZERO HUMIDITY

STANDARD DAY

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0

2900 RPM — CARBURETOR AIR — DIRECT POSITION
TWO ENGINES INOP. & PROPS FEATHERED

REMARKS: Climb performance based on operation with Cowl flaps 30% open and oil radiator flaps 40% open. Primary and secondary heat exchanger scoops closed.

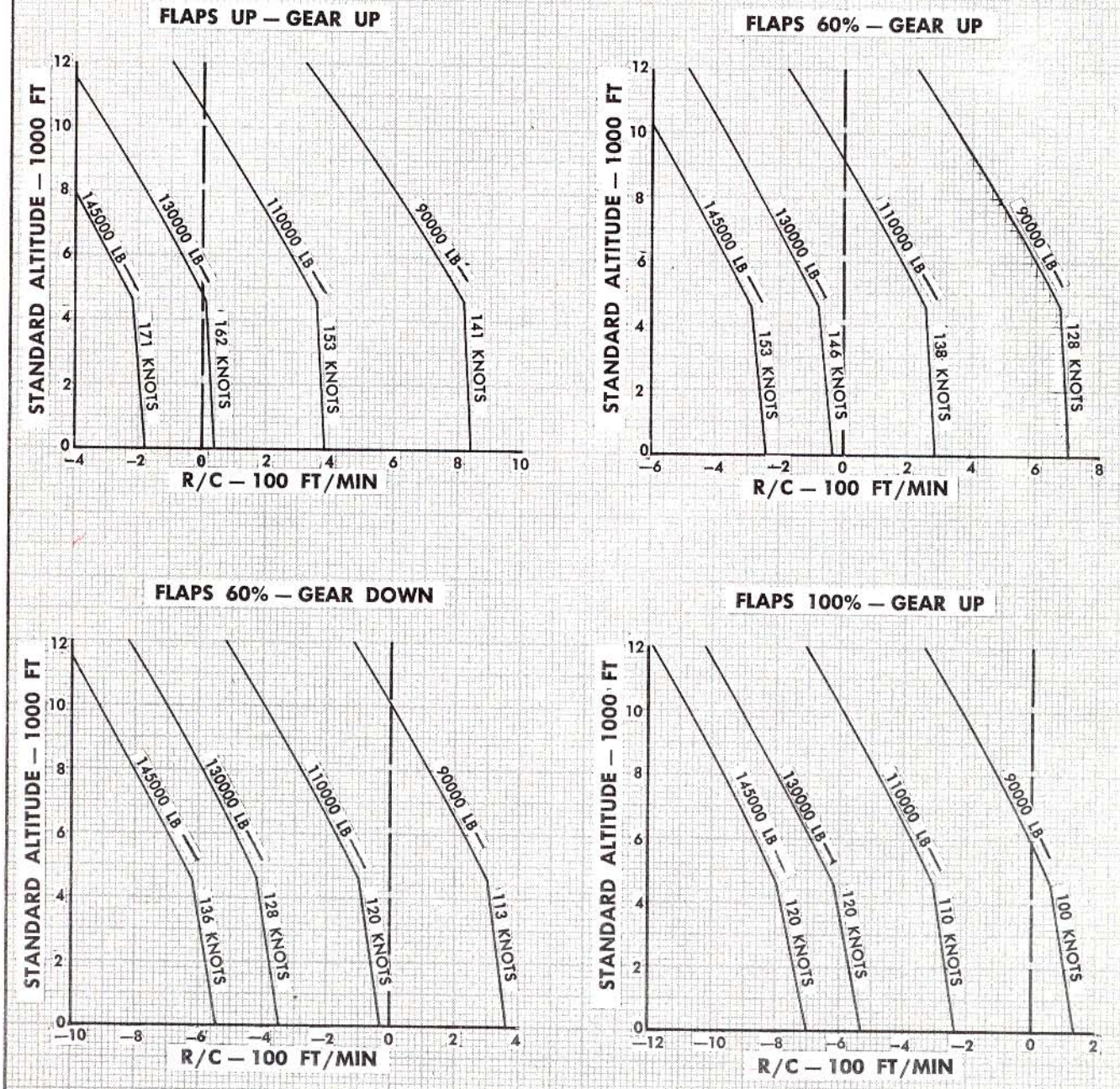


Figure A4-13. Emergency Rates of Climb — Two Engine Operation — Maximum Power — Effect of Altitude

SPEED KIT

TWO ENGINE OPERATION

EMERGENCY RATES OF CLIMB

EFFECT OF POWER DEVIATION

MARK V-A SCOOPS

MAXIMUM POWER | SEA LEVEL DENSITY ALTITUDE

MODEL: RC-121D
DATA AS OF: 1 January 1956
DATA BASED ON: Calculations

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0

2900 RPM — 3250 AVG. BHP/OPERATING ENGINE
CARBURETOR AIR — DIRECT POSITION
AMBIENT AIR TEMP.= 15° C
TWO ENGINES INOP. & PROP FEATHERED

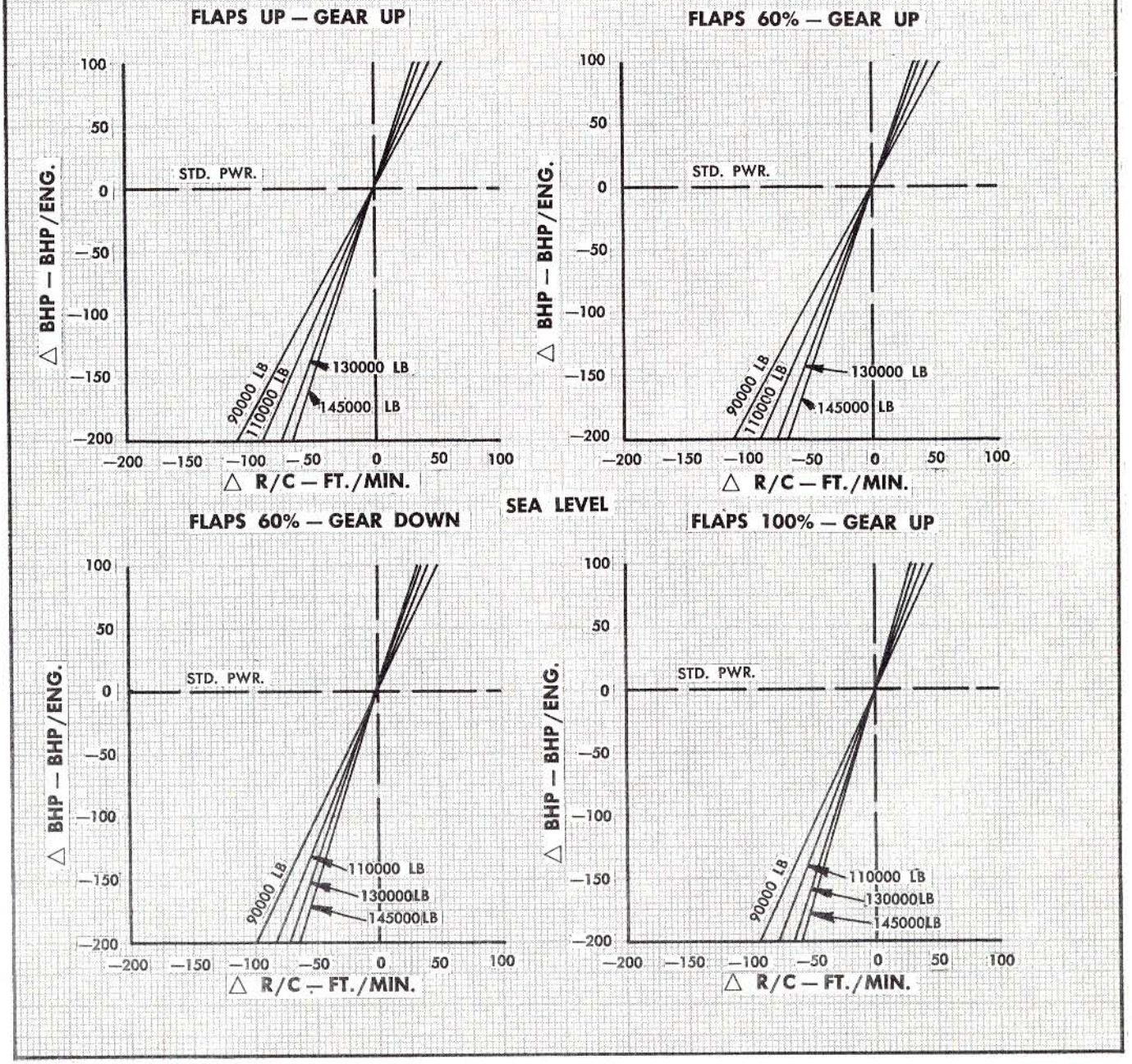


Figure A4-14. Emergency Rates of Climb — Two Engine Operation — Maximum Power — Effect of Power Deviation

SPEED KIT

SERVICE CEILING
STANDARD DAY

MARK V-A SCOOPS

MODEL: RC-121D
DATA AS OF: 1 January 1956
DATA BASED ON: WV-2 Flight Tests

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0

POWER SETTINGS		FLAPS SET. — % OPEN	
		COWL FLAPS	OIL RAD. FLAPS
4 ENG.	ALTER. POWER	25%* 30%△	60%*△
	METO	30%* 40%△	35%* 40%△
	MAX. CRUISE	25%* 40%△	50%*△
3 ENG. METO		30%* 40%△	35%* 40%△
2 ENG. METO		30%* 40%△	35%* 40%△
* LOW BLOW. △ HIGH BLOW.		CLOSED ON INOP. ENG.	

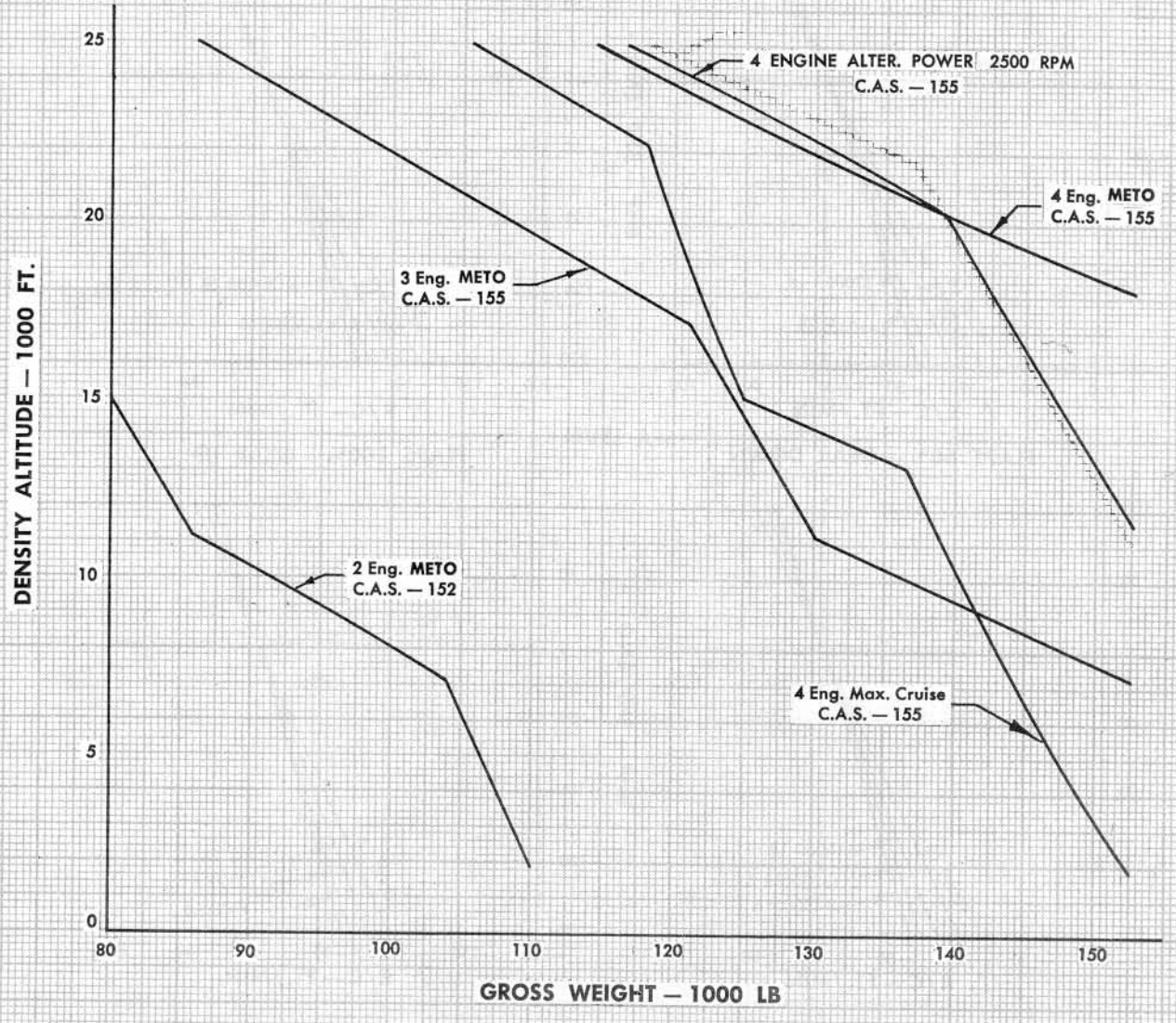


Figure A4-15. Service Ceilings — Standard Day

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* Indicates Illustration Pages

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* Indicates Illustration Pages

SCOPE AND ARRANGEMENT.

The purpose of this part is to provide charts whose primary function is to aid in efficient flight planning, and which permit selection of specific methods of operation most suited to assigned missions. However, operating weights determined as being suitable must be reviewed before use in light of operating field length requirements discussed in Part 3, Take-off. (Also see Example Problem in Part 8.)

The "philosophy of range prediction" (cruise control) is given in the introduction to this part. No reference to charts is made but all aspects of the art of cruise control are discussed thoroughly. The derivation of the chart data is explained under "Basis for Range Predictions".

Composite cruising charts are discussed and shown next. These make possible a rapid survey of the complete range of operating weights, speeds, and altitudes available in terms of engine power required and available. Fuel flow data are included which allow a quick evaluation to be made of the economy of any proposed type of operation. In addition, the composite charts can be used prior to or during flight as the basis for various types of cruise control schedules; that is, constant airspeed, constant power, modified long range cruise, etc.

The specific range curves can be used directly in the computation of all types of flight plans. Miles per pound data are included for altitudes from sea level to 25,000 feet in five thousand foot increments. These charts show fuel economy for weights from 80,000 pounds to 151,000 pounds. Power settings shown will result in maximum over-all operating economy from a standpoint of combined engine and propeller efficiencies.

The features of several basic types of cruise control are discussed next under Cruise Control Schedules. Maximum Endurance is discussed in Part 6.

Time and distance prediction charts are also included for Long Range Cruising with four, three or two engines operating.

A sample problem describing use of the charts and flight planning procedures is shown at the end of this appendix. (Part 8).

INTRODUCTION.

This discussion is an introduction to the art of cruise control. Proper cruise control is a measure of efficiency. It means more time on station, more payload carried farther, or faster, or more ton-miles per year per dollar. It doesn't mean maximum range, or long range necessarily, or any other specific type of crusing schedule. But it does mean planning.

Large modern airplanes, such as the Model RC-121D, are of such size and complexity as to demand the application of "Cruise Control" if maximum utility of the airplane is to be realized. The term "Cruise Control" means the intelligent flight planning and operation of an aircraft to accomplish most efficiently the mission assigned. These missions will be of such a variety that it is impractical to present detailed performance data for all types which might be anticipated. Basic information is provided which permits the evaluation of a wide selection of operational techniques. However, before discussing the various types in detail, an understanding of a few basic principles is necessary.

As stated, the purpose of cruise control is to accomplish a specific mission with maximum overall efficiency. Consideration should be given the performance of the airplane-engine-propeller combination, of course. These are primary items and determine the area of operation within which the airplane can accomplish the specific mission. If there is a choice of alternate methods of operation, there is a need to investigate other factors.

Since most missions can be accomplished in several ways, consideration should also be given to airplane utilization factors which may govern from an over-all point of view. These factors include, among others, total flight time per trip and number of trips possible per time period, weight of cargo and fuel expense per trip, crew relief requirements for long and short haul operations, and timing of maintenance and training operations. These all have a place in determining which type of cruise procedure is best suited for a particular mission or type of operation. In many cases, the final selection may be the best practical compromise based on these several requirements.

When considering performance only, maximum efficiency of propeller driven airplanes occurs when the maximum combined efficiencies of the propeller, engine, and wing are maintained. Few propeller, engine and airplane-wing combinations are so perfectly matched that all components maintain maximum efficiency at the same airspeed for each possible flight condition. Compromises were made in their selection and design. Therefore, these compromises must be reflected in the selection of cruise control procedures.

Wing efficiency is the primary factor affecting cruising characteristics, although engine performance may control under some conditions. Properly selected constant

speed propellers usually maintain near-maximum levels of efficiency if normal engine and airplane operating procedures are used.

Every airplane has an angle of attack of the wing at which the least amount of drag is created for the lift produced. This is usually expressed as the angle for maximum lift:drag or (L/D) ratio, and operation at this angle results in maximum efficiency as far as the wing alone is concerned. For gliders, the angle of attack for maximum (L/D) is the angle of attack for maximum range. In addition, as gliders operate at substantially constant weight, they achieve maximum range at constant airspeed.

Powered aircraft cannot cruise at a given altitude for long periods at both a constant value of (L/D) ratio and constant indicated airspeed. Gross weight changes in flight as fuel is consumed. Therefore, airspeed must be progressively reduced if it is desired to fly level at constant (L/D). The speed reduction schedule can be represented by the equation: $EAS_2 = EAS_1 \sqrt{(W_2/W_1)}$ where W_1 and W_2 refer to initial cruise and enroute weights respectively. This speed variation maintains wing lift equal to gross weight at constant angle of attack.

A maximum (L/D) ratio speed schedule seldom achieves maximum range for modern transport aircraft. From a practical point of view, effects of airspeed variations with turbulence, innacurate altitude control, etc., are greater and of longer duration at or below the speed for maximum (L/D) than they are for somewhat faster speeds. In addition, the combined efficiencies of the engine and propeller may not be such that maximum over-all efficiency is maintained.

Engine life and brake specific fuel consumption (BSFC) are the measures of engine operating efficiency to be considered. Engine reliability and time between overhauls is self explanatory. A power plant which continually needs attention and repair does not contribute its full share or serve its intended purpose. However, with proper use, a long and efficient time between removals for overhaul can be obtained.

Cruise power occupies the largest percentage of an engine's total operating time, and is the outstanding factor affecting the life, performance, and operating economy of modern aircraft reciprocating engines. This is substantiated by extended service history of identical engines in identical airplane installations over a period of years. Lower cruising powers extend engine life and result in better engine performance. Longer engine life is evidenced by comparison with actual experience. Some engines in military service, when cruised at approximately seventy percent of METO power lasted from 400 hours to 600 hours between failures or other abnormalities requiring overhaul. The same basic engines in commercial service operated reliably up to 1000 hours when cruised at sixty percent of METO power.

The brake horsepower taken from the engine is not the only operating factor which influences engine life. The manner in which this power is taken is of equal importance. It is readily apparent by reference to the engine calibration curves that a pilot or engineer can obtain a desired power output by an infinite number of RPM and BMEP settings. It has been shown conclusively by endurance tests, that, of two engines delivering equal powers, the engine which operates at the lower RPM will have the longer life if the allowable BMEP is not exceeded. The engine operating at lower speed will respond with better durability, as evidenced by having higher compression and lower oil consumption. The build-up of "piston ring miles" along the cylinder walls is a major factor in premature engine wear.

While engine wear is important from the over-all point of view, BSFC is the item of immediate concern to a crew in flight. This term is defined as the number of pounds of fuel consumed by the engine per hour divided by the brake horsepower delivered. Normal values to be expected vary from 0.4 to 0.5 pounds per BHP per hour, depending on power delivered, RPM, BMEP, altitude and blower setting. Minimum BSFC, and greatest efficiency is normally obtained in low blower, between 2000 RPM and 2400 RPM, with limit BMEP settings and 10% lean mixture strength. The BSFC increases rapidly if less than limit BMEP is used to obtain a given power, since this requires a higher RPM than necessary. Some other items which detract from engine efficiency are improper mixture, poor or incomplete combustion, friction of moving parts, and heat losses through exhaust and cooling systems.

The flight crew has some control over the losses which affect engine performance. Combustion efficiency can be changed with power settings and mixture control. Manually leaning to 10% lean mixture, using the 10% BMEP method, gives the best practical mixture for cruise. The largest engine losses controllable by the flight crew are those due to friction of the engine's moving parts. The simplest way to reduce friction is to reduce RPM. However, there is a limit to this reduction due to allowable cylinder BMEP, propeller design, possible vibration difficulties, and accessory minimum speeds.

There is one other factor which should be kept in mind—the portion of engine power developed which

is delivered to accessory equipment. It is not indicated by the BMEP gages, and includes the generators and cabin supercharger power requirements. While the loads imposed by the equipment are normally allowed for, they should not be allowed to become excessive without reason. For example, maintaining high cabin differential pressures when not needed can be wasteful of engine power. This is particularly true in hot weather when refrigerating the cabin air. Besides pumping more air into the cabin than is needed, cooling requirements are such that after cooler scoops must be set to wider openings. Extra fuel is required to pump more pressurized air, and more drag is created in cooling it for use.

The efficiency of the propellers is the last item to be discussed here as affecting performance. Operation outside the region for near maximum efficiency can penalize airplane performance severely. For example, if 85% efficiency is a normal value attainable in cruise and only 80% is realized because of an improper combination of airspeed and power setting, the power wasted is (85 —80)/85 or almost 6% of the engine power being delivered.

There is an optimum power setting for maximum propeller efficiency at each altitude and airspeed. The reactions on a propeller are much the same as the reactions on a wing. With a wing, power must be expended to overcome drag as well as to create lift or thrust. For a given propeller, the amount of power lost is largely a function of true airspeed and propeller RPM. Efficiency drops off rapidly as the tip speed approaches the speed of sound. Maximum efficiency occurs when the most engine torque is converted to propulsive thrust, or the most shaft horsepower is transmitted to the air as thrust horsepower. (This is something like operating at the point of maximum (L/D) for a wing.) Therefore, propeller efficiency must be taken into careful consideration and balanced with efficient engine power settings. This has been done in setting up the RC121-D cruise power schedules. Flight test data have been used wherever possible.

There are five general rules which should be followed in all types of planning. The first is concerned with gross weight. *Know it.* Know your empty weight, operational weight, loaded weight, take-off weight, in-flight weight, landing weight, and zero fuel weight. The performance of the airplane depends primarily on weight, power, and altitude.

The effect of excess weight on cruise performance must be stressed. It takes more power to fly at an efficient speed when your airplane is heavy than when it is light. The difference in fuel consumed per mile can amount to over thirty percent. Therefore it costs to carry an excessive fuel load above normal requirements.

Further, don't carry "pocket" fuel. The effects of this procedure are insidious. The airplane demonstrates this by its performance during take-off, climb and cruise. If you need the extra fuel, or think you may need it, load it, show it in your weight log, and plan your flight to allow for the additional weight. The cruise charts do not include any allowances for icing, turbulence, navigation tolerances, and items which detract from optimum performance. You are in the best position to judge what your needs might be. But unnecessary reserves increase operating costs due to higher fuel usage and reduced cargo loads.

In all cases, use actual gross weight as the basis for power settings. Keep a log of fuel used in order to determine gross weight variation in flight. The frequency with which power settings should be changed as weight decreases depends on the accuracy with which a cruise control procedure is to be followed. It is recommended that weight increments of no more than 4,000 pounds be used. Reduce power for every 3,000 pounds reduction in airplane gross weight whenever practical. When the weight increments have been selected for a particular operation, it is desirable to set powers within these weight brackets corresponding to those shown on the charts for the mid-points of the weight brackets. This insures that average airplane performance during these periods will closely correspond to predicted chart values for the weight increments chosen.

The second rule is to operate by *density altitude.* Proper altitude selection is very important in flight planning for best cruise performance. However, the geometric altitude is not the important thing except over mountains. The density of the air is the governing factor. That is what the engines, propellers, and wings are interested in. Density varies directly with pressure and inversely with temperature. Local barometric pressure and temperature are varying quantities, and the density of the air for a given geometric altitude at any one place will vary from day to day. Cruise control power settings have been established in terms of density altitudes rather than pressure altitudes and air temperatures. If flight plans are prepared in terms of density altitude, the effects of variation of air temperature from standard is minimized. Do not forget to use an altimeter set to 29.92" Hg reference pressure when reading pressure altitude to obtain density altitude.

The RC-121D operates most efficiently at density altitudes from 10,000 feet to 15,000 feet, depending on gross weight. As gross weights decrease, the best operating *density* altitude increases. High blower power settings may be used with good economy in some cases. However, if fuel consumption per nautical mile is of primary concern, operate at the altitude where the required power setting can be obtained with full throttle in low blower without increasing engine speed. The heavy lines on the long range cruising tables show where a blower shift will be necessary. A density altitude just under the altitude for blower shift will be the most efficient for that gross weight.

The effect of wind on cruise range and fuel required is very real and must be considered in flight planning. However, the effect of wind on cruise *procedure* is another problem. In theory you should speed up in a headwind, and slow down in a tailwind. A headwind decreases the ground speed and increases the time of flight or the time during which fuel will be consumed. Therefore, for slower type aircraft, it is generally profitable to increase speed and fuel flow in a headwind in order to achieve a saving in trip fuel by reducing flight time. For similar reasons it may be profitable to reduce speed and fuel flow in a tailwind and allow it to give you more help. The RC-121D, however, is a high speed aircraft and such winds are *normally* of little importance. In addition, the airspeed schedule recommended for long range cruise is already above the speed for theoretical maximum range. *Normal* headwinds of up to forty knots are automatically taken care of. However, an occasion may arise when the absolute maximum miles per pound is necessary. Refer to the miles per pound curves (figures A5-11 through A5-28). Note that an airspeed schedule is provided for "indicated" winds of 60 knots. If the "indicated" headwind (headwind component $\times$ $\sigma^{1/2}$) is between 40 and 60 knots, operate at a proportionate speed between the long range cruise speed and that recommended for flight with a 60 knot indicated headwind component. The following rule of thumb may be used if a greater wind exists:

a. Note the true airspeed for maximum air miles per pound of fuel shown on the miles per pound curves (figures A5-11 through A5-28) for the appropriate flight weight and altitude condiitons.

b. If a headwind exists, add twenty-five percent of the headwind to this true airspeed schedule, note power settings and calibrated airspeeds to be flown.

c. If a tailwind exists, *subtract* twenty-five percent of the reported tailwind from this true airspeed schcedule. Note power settings and calibrated airspeeds to be flown. However, do not schedule speeds slower than those recommended for holding.

d. Compute miles per pound at the modified cruising speed schedule. Miles per pound = (air miles per pound at modified flight speed) $\times$ (ground speed/modified true airspeed).

The third rule is not to climb higher than necessary. The fuel saved during a let-down is never equal to the additional fuel used for climb. It is, therefore, never worthwhile to climb in hopes of regaining extra fuel expenditure in a later descent. Of course, operation at higher levels may be desirable from a standpoint of decreased flight time or to decrease weather turbulence. It may also be desirable to use a step-climb procedure, particularly if operating at heavy initial weights. Start at a relatively low cruising altitude in order to avoid using high power settings. Then, as fuel is used and weight decreased, climb to a higher level where the initial power settings provide a considerably increased true airspeed.

The fourth rule is to maintain level flight at the selected cruising altitude. This is the only way in which stabilized speed performance shown in the cruising charts can be realized. The reason is quite simple. Aside from effects of drag items, which can be accounted for, turbulence and small rates of climb are the major factors causing speed loss. The speed loss in climb will be greater, and gain in descent decreased if scoops and flaps are not set to the minimum drag positions. The speed loss will be reduced when operating at higher than long range cruising speeds. However, speed increase may not be possible at heavy initial cruising weights if maximum cruise power schedules are required for long range speeds.

The fifth rule is fairly obvious. Use a minimum drag configuration whenever possible to maintain maximum speed. Set cowl and oil cooler flaps to the minimum drag positions noted on Figure A5-1 if engine operating temperatures permit it. Small deviations are not serious, but the effect of setting beyond faired positions is large.

Try to maintain comfortable cabin temperatures with the least opening of the air conditioning system heat exchanger scoops. In particular, avoid full opening of the secondary after cooler scoops whenever possible because of their effect on speed. Consider using a slightly higher cabin altitude, and check cabin temperature versus temperature at the flight engineer's station before using full refrigeration.

BASIS FOR RANGE PREDICTIONS.

The performance which can be obtained with any power schedule is a function of many variables. These include airspeed, gross weight, mixture setting, cowl flap position, power schedule, altitude, temperature, and number of engines operating. Each has an effect on over-all performance which can be expressed in terms of distance flown per unit of fuel used, or fuel economy, which is a direct measure of the efficiency with which the aircraft is being operated.

Power schedules presented in Part 2 are shown in terms of engine speed (RPM), inboard engine torque (BMEP), and inboard engine Brake Horse Power. Use of the tachometers and BMEP gages will allow a uniform type of cruise control to be used, based on density altitude. It will be independent of ambient air conditions and differences between individual engines as long as the engines are not operated at limit manifold pressure. The BMEP gages indicate engine torque supplied to the propeller, however, and are not indicative of total power developed by the engines unless no power is supplied to the accessory section. As cabin pressurization equipment is operated by accessory section drive shafts, it is customary to set the outboard engines 5 BMEP less than the inboard engines in part throttle conditions. A further reduction of up to 6 BMEP is required for outboard engines equipped with A. C. generators. At full throttle, of course, this adjustment is accomplished automatically.

Manifold pressure gage readings should be used as checks to insure that engine operating limits are not exceeded. Manifold pressure limits govern if they are reached before BMEP limits are reached. In addition, no more than two inchces of mercury difference in pressure is allowable between engines set at the same power. A greater difference is indicative of engine or BMEP gage malfunction, and power on the engine with the higher BMEP reading should be reduced until the variation between engines is 2″ Hg or less. An investigation to determine the cause should be made at the first opportunity.

The effect of using high blower when it is not required for a given power setting is to increase the amount of fuel consumed by the engines and decrease range. This is due to the higher internal horsepower required to drive the blowers at the greater speed. Miles per pound curves are shown for both high and low blower operation for some altitudes, and a rapid comparison can be made between the two operating conditions to determine the optimum blower setting.

Auto Rich and 10% Lean mixture cruise performance is given for a speed range from that recommended for holding to that for maximum continuous power operation. Power schedules are shown on the miles per pound curves in terms of inboard engine power and inboard RPM and BMEP. Limit manifold pressures are included.

Power available schedules were derived from the Standard Day Power Available curve and the Engine Power Schedule table; however, full throttle cruising power settings have been adjusted by a 50 RPM "pad" in order to allow for possible decrease in full throttle power available due to engine wear or operation with air temperature above standard. Fuel consumption values were obtained from the Fuel Flow Curves for operation with Auto Rich and 10% Lean mixture settings, see Part 2. If power required for full throttle cruise can be attained at less than charted values, a lower RPM should be used to conserve fuel.

The charts are based on power settings using Auto Rich and 10% Lean mixture settings and fuel flow values shown on figures A2-9 through A2-12. 10% Lean mixture settings should result in the most economical operation of the engines. Engine speeds for best economy are 2400 RPM and less. The procedure for manual leaning is given in the System Operation Section. Higher cruising powers should be avoided, but engine speeds greater than 2400 RPM may be utilized with Auto Rich mixture setting. 2600 RPM can be used for cruise, although engine durability may be affected. The manual spark control should be placed in the retard position for all operations at greater than 2400 RPM and for extended Auto Rich operation.

A Drag Conversion Chart is presented as Figure A5-1 which shows the effects of cooling flap and scoop positions on airspeed.

COMPOSITE CRUISING CHARTS.

Composite Cruising Charts are included as figures A5-2 thru A5-10, which cover four, three, and two engine operation respectively. Use of these charts permits rapid determination of level flight speeds, power settings, and fuel flows for any given weight and density altitude. Power settings required for various cruising speed schedules may be determined rapidly by superimposing the desired cruising speed schedule on the center portion of the chart. Required power schedules and resultant fuel flows may be read directly above and below the speed schedule line opposite the desired flight altitude. Examples illustrating the use of these charts are included.

Separate charts are furnished for use with either low or high blower and Auto-Rich or 10% lean mixtures. Power settings obtained from these charts apply directly to the inboard engines, and to the outboard engines when cabin superchargers and A-C. generators are disconnected. An allowance of 5 BMEP to 10 BMEP must be made between inboard and outboard engines to account for cabin supercharger power requirements with normal cabin pressurization and A.C. generator power requirements. The Fuel flow values shown on the lower portion of these charts are those which correspond to the power settings and altitudes as shown on the upper section of the charts.

Performance shown on these charts will be obtained if the aircraft is flown in the optimum cruising configuration; that is, with wing flaps and landing gear retracted, cowl and oil radiator flaps in the minimum drag position, and the cabin supercharger primary and secondary heat exchanger scoops closed.

The effect on performance of other than optimum openings of the flaps and scoops may be determined from figure A5-1.

It will be noted that the decrease in speed with change in flap position is dependent upon the speed at the minimum drag position. Approximately 7½ knots equivalent airspeed loss will be experienced by changing the oil flaps from the minimum drag position to the 50 percent open position. Approximately 9 knots equivalent airspeed are lost by varying cowl flap position from the minimum drag to 40 percent open position.

In cruising flight, adequate cooling is available to maintain engine temperatures within limits under standard atmospheric conditions with cowl and oil flaps at the minimum drag positions shown.

The lower curve shows the effect of cabin air conditioning primary and secondary heat exchanger scoops and exits on airspeed. Generally, it may be stated that speed loss due to operation of air conditioning equipment is a direct function of the scoop positions. These are in turn a function of position of the cabin air mixing and selector valves. The valves (one for each cabin supercharger) are controlled by paddle-type switches on the 260 panel. By toggling the paddle switches, scoop positions are adjusted so that comfortable cabin temperature levels can be obtained with a minimum increase in scoop openings and drag.

Complete and more detailed instructions outlining the proper use of cabin pressurization and cooling controls may be found in Section IV of this handbook.

SPECIFIC RANGE DATA.

Miles per pound curves are included in this section on Figures A5-11 through A5-28. Data are included for four, three, and two-engine operation. Performance is shown for weights from 80,000 pounds to 151,000 pounds except where limited by power available, and for altitudes from sea level to the operating ceiling for the figuration noted. These charts should be used to plan operations to which long range, search and endurance schedules do not apply. A supplemental schedule is shown on the four-engine miles per pound curves which provides maximum range speeds for indicated headwinds of 60 knots. (That is, true headwind component $\times \sqrt{\sigma} = 60$ knots).

CRUISE CONTROL SCHEDULES.

The introduction has covered the basic principles involved in cruise control and the general rules which are applicable. The main types of cruise control procedures in use can now be covered.

There are several basic types of cruise control procedures that can be used with considerable success. Some of the most common are listed below. Each has its advantages, and disadvantages, which depend on airpeed desired, distance to be flown, cargo required, and other considerations. The basic types are:

a. Maximum Range Cruise

b. Long Range Cruise

c. Modified Long Range Cruise

d. Constant Power Cruise

e. Constant Airspeed Cruise

f. High Speed Cruise

g. Maximum Endurance, or Holding Speed Cruise (discussed in Part 6)

Maximum Range Cruise Control should be considered first. It forms the general basis for all long distance types of operating schedules. But you should realize at once that it is very seldom used in actual practice, being one of the most difficult cruise procedures to apply successfully. Its use requires exact knowledge of airplane performance as related to wind and weather conditions, continuously precise piloting technique, and fine control of all engines in order to obtain the most miles per pound of fuel used. Maximum range speed and power schedules can be obtained from the peak values shown in the miles per pound curves. However, use of such a schedule may not be sufficiently rewarding to justify

its use. Effects of turbulence, inaccurate altitude control, etc., are greater and of longer duration at maximum range speeds than at higher speeds. The long range cruise schedule is approximately ten percent faster and only increases theoretical fuel requirements about one percent. This may be seen in the miles per pound curves by comparing maximum range values with the long range cruising speed lines.

Long Range Cruise is the most economical and practical type of cruising procedure for long flights. It requires less trip fuel than any faster schedule, and may be more economical in the long run than a maximum range schedule. Figures A5-29 and A5-30 provide time and distance prediction curves for long range operation. Data are included for overload weights and Auto Rich mixture power settings. It is suggested that this schedule be used whenever maximum loads are to be carried over long distances or where fuel consumption must be kept at a minimum.

While the indicated airspeeds for long range schedules are rather low, it will be found that operation at high altitudes will result in relatively high true airspeeds. Fuel economy is not unduly reduced unless Rich mixture power settings are used. Additional climb fuel allowances must be made, however.

Note

Refer to the Miles Per Pound Curves for a comparison of long range schedule specific range and true airspeed values with those for other speed schedules.

Long range cruise is actually a series of constant power cruising segments, or brackets. While it is true that always flying at the optimum IAS for long range would result in more range, it is impractical to do so. An infinite number of very small power reductions would be required. The recommended long range cruise procedure is a series of constant power cruises based on weight brackets. The average airspeed obtained will approximate the optimum IAS for the best practical combination of wing, engine, and propeller efficiencies.

Modified Long Range Cruise proceduce is a variation in long range procedure which may be made in flight. Plan the flight in accordance with long range cruise. Then, if the fuel remaining after the equi time point is reached is sufficient and if there will be no other need for reserve fuel, such as to reach an alternate destination, the cruise power being used at that time may be maintained for the remainder of the flight. This is somewhat similar to operating at an intermediate speed schedule and has many of the advantages of the maximum cruise power schedule. A constant power setting is used for most weight and altitude conditions to minimize cruise control management complexity. Airspeeds are not as high as for the maximum cruise power condition but are equal to or greater than those for the long range cruising condition in all cases. The favorable fuel economy makes the intermediate speed schedule particularly effective for middle distance operations where fuel load requirements must be considered in order not to reduce the cargo load.

Constant Power Cruise is probably the easiest and simplest method of cruise control. One power setting is used continously for cruise throughout the entire flight. The airspeed increases as the flight progresses, and the average airspeed is usually higher than that recommended for long range. No advantage is taken of the increased range or payload which could be obtained by reducing power as the weight of the aircraft decreases. It is less economical, fuel wise, than some other types of cruise control. However, for a short range operation, constant power is often desirable since the cruise power will be in the medium power range and the fuel requirements are not high enough to affect the maximum payload of the airplane. This method of operation is really worthwhile when the time saved can be used profitably, for example, to obtain extra flights between engine and/or airplane overhaul times.

Constant power cruise performance data can be obtained from the composite cruise charts. Select an altitude and power combination on the upper portion of the chart, and then note the corresponding fuel flow at the altitude on the lower plot. Read the predicted variation of equivalent airspeed with weight on the intermediate chart. Convert the average equivalent airspeed expected to true airspeed ($TAS = EAS/\sigma^{1/2}$). Divide this true airspeed into the distance to be flown to obtain flight time. The required fuel load for the cruising portion of the flight may now be computed by multiplying flight time by fuel flow. Fuel reserves and climb allowances must now be added to obtain total fuel load.

Constant Airspeed Cruise is a method whereby power is reduced as gross weight is reduced to maintain constant airspeed. This method simplifies flight planning and in-flight navigation. Power reductions are made at convenient intervals so that the airspeed will average a desired figure for a given distance. The composite cruise charts can be used to advantage in predicting necessary power settings. Although this type of cruising schedule can be more efficient and economical than constant power cruise, it will normally require more fuel per trip than long range cruise.

High Speed Cruise is a type of cruise control schedule which utilizes the maximum cruising power available in best economy mixture. It results in the shortest flight time per trip. It also decreases engine life somewhat due to the engine speeds used. This type of cruise control is usually used for missions where speed is vital, and for operations which require each aircraft to be available for a maximum number of flights within a limited time. Under these conditions this type of cruise can be economical to the operator.

Use of maximum cruise power allows the airplane to develop a higher continuous speed with reasonably economical fuel consumption and a minimum of cruise control management complexity. The schedule is particularly effective for operations at moderately short ranges when an increase in the fuel load does not require flight at overload weights or restriction of cargo loads.

The high speed cruise schedule requires expenditure of more fuel than would be necessary if long range or intermediate speed porcedures were followed. The difference in fuel required becomes greater at lower altitudes. Therefore, use of maximum cruise power may require a limitation of cargo to be carried if long distance flights are planned and if airplane loading is restricted to the normal operating weight.

Note

Refer to the Miles Per Pound Curves for a comparison of maximum cruise power specific range and true airspeed values with those for the long range schedule at various altitudes.

EMERGENCY LEVEL FLIGHT PERFORMANCE.

THREE ENGINE LONG RANGE SPEED SCHEDULE.

Time and distance prediction curves recommended for long range operation with three engines operative are given in Figures A5-31 and A5-32. While this type of operation represents an abnormal flight condition, ample performance is available so long as high altitude flight is not required. Auto Rich power settings are required at heavy gross weights. If prolonged flight is necessary, a cruising altitude should be selected which allows use of lean mixture power settings as soon as possible. It will be noted that three engine specific range values are 90% to 95% of four engine range values at lower altitudes and intermediate weights, and approach 100% of the four-engine values at light weights.

TWO ENGINE LONG RANGE SPEED SCHEDULE.

The time prediction curve for long range operation on two engines is shown in Figure A5-33. Only low blower performance is shown as two engine performance is limited to low altitudes. Cabin superchargers and alternators are assumed to have been disconnected in order to increase power available for propulsion. Most two engine operation, especially at heavier weights and higher altitudes, requires Auto Rich power settings. A study of the fuel economy curves, however, reveals that 10% Lean power settings may sometimes be used instead of Auto Rich if terrain clearance permits a low enough flight altitude.

SPEED KIT

Four Engine Operation

SPEED KIT

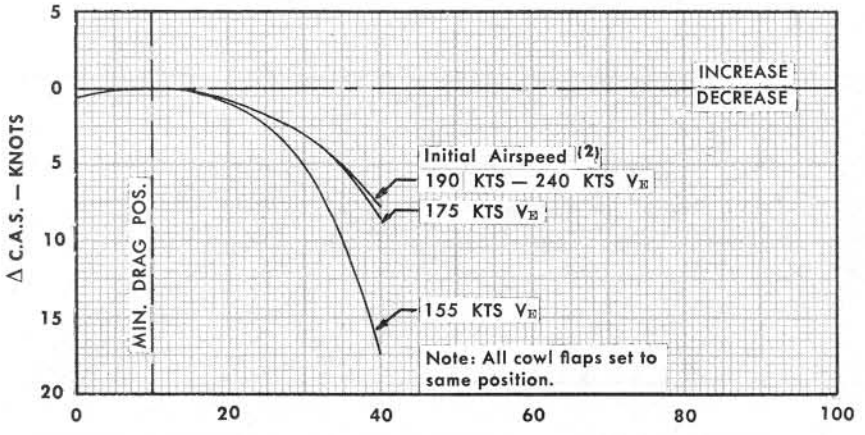
DRAG CONVERSION

EFFECTS OF COOLING FLAP AND SCOOP POSITIONS ON AIRSPEED

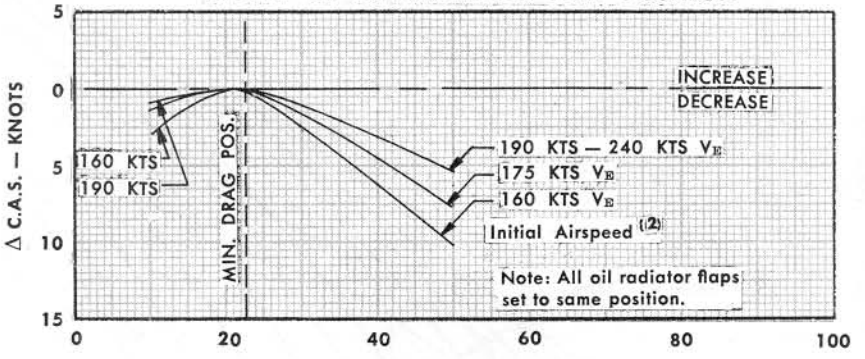
MODEL: RC-121 D
DATA AS OF: 1 January 1956
DATA BASED ON:. Contractor's R7V-1 Flight Tests

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0

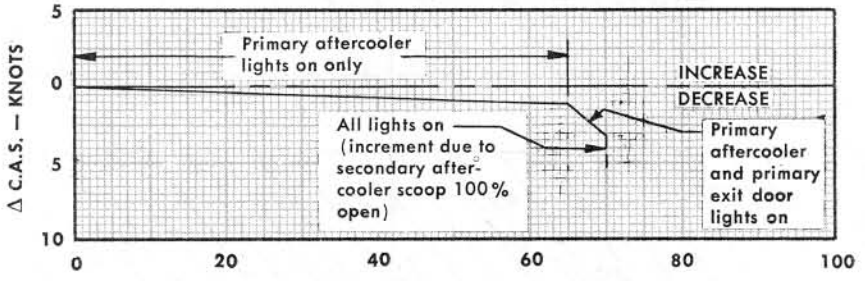
EFFECT OF COWL FLAP POSITION



EFFECT OF OIL RADIATOR FLAP POSITION



EFFECT OF AFTERCOOLER SCOOP POSITIONS



Note: Maximum primary aftercooler opening while in flight equals 70% of full travel.

REMARKS:

1. Closing of ram air door will cause a 3 to 4 knot decrease in C.A.S.
2. Change in velocity based on initial airspeed occurring at minimum drag position.
3. Cruise performance based on aftercooler scoops closed.

Figure A5-1. Drag Conversion — Four Engine Operation — Effects of Cooling Flap and Scoop Positions on Airspeed

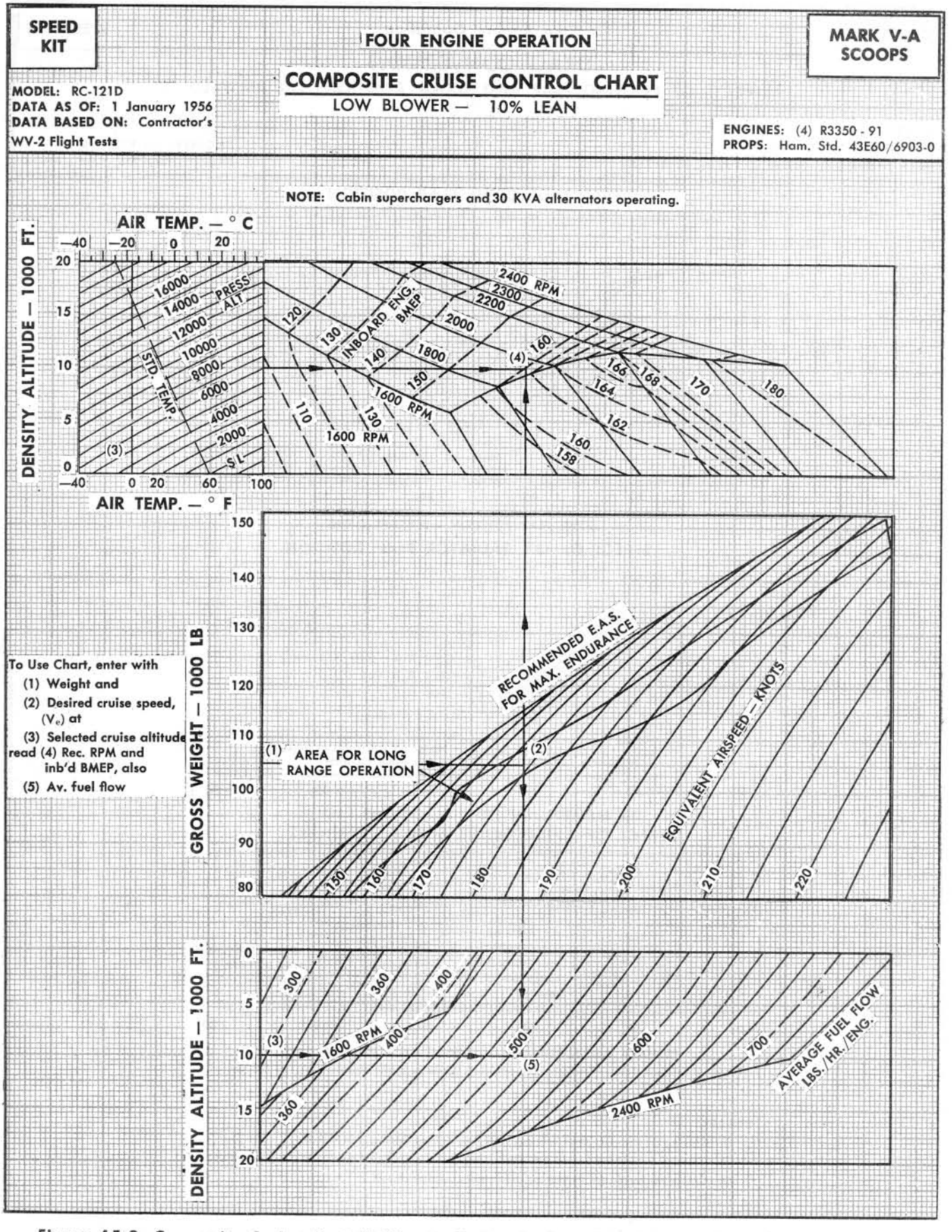


Figure A5-2. Composite Cruise Control Chart — Four Engine Operation — Low Blower — 10% Lean

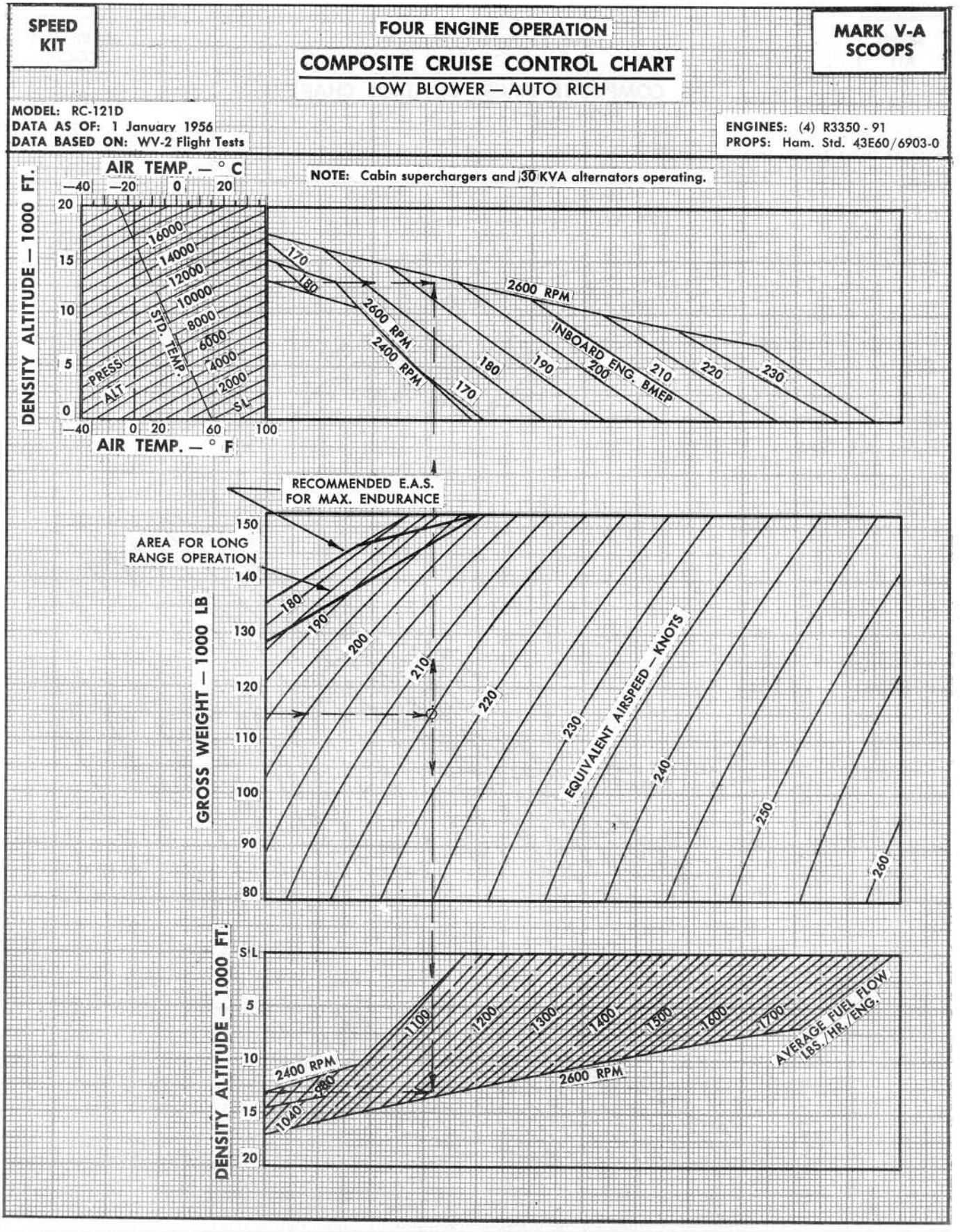


Figure A5-3. Composite Cruise Control Chart — Four Engine Operation — Low Blower — Auto Rich

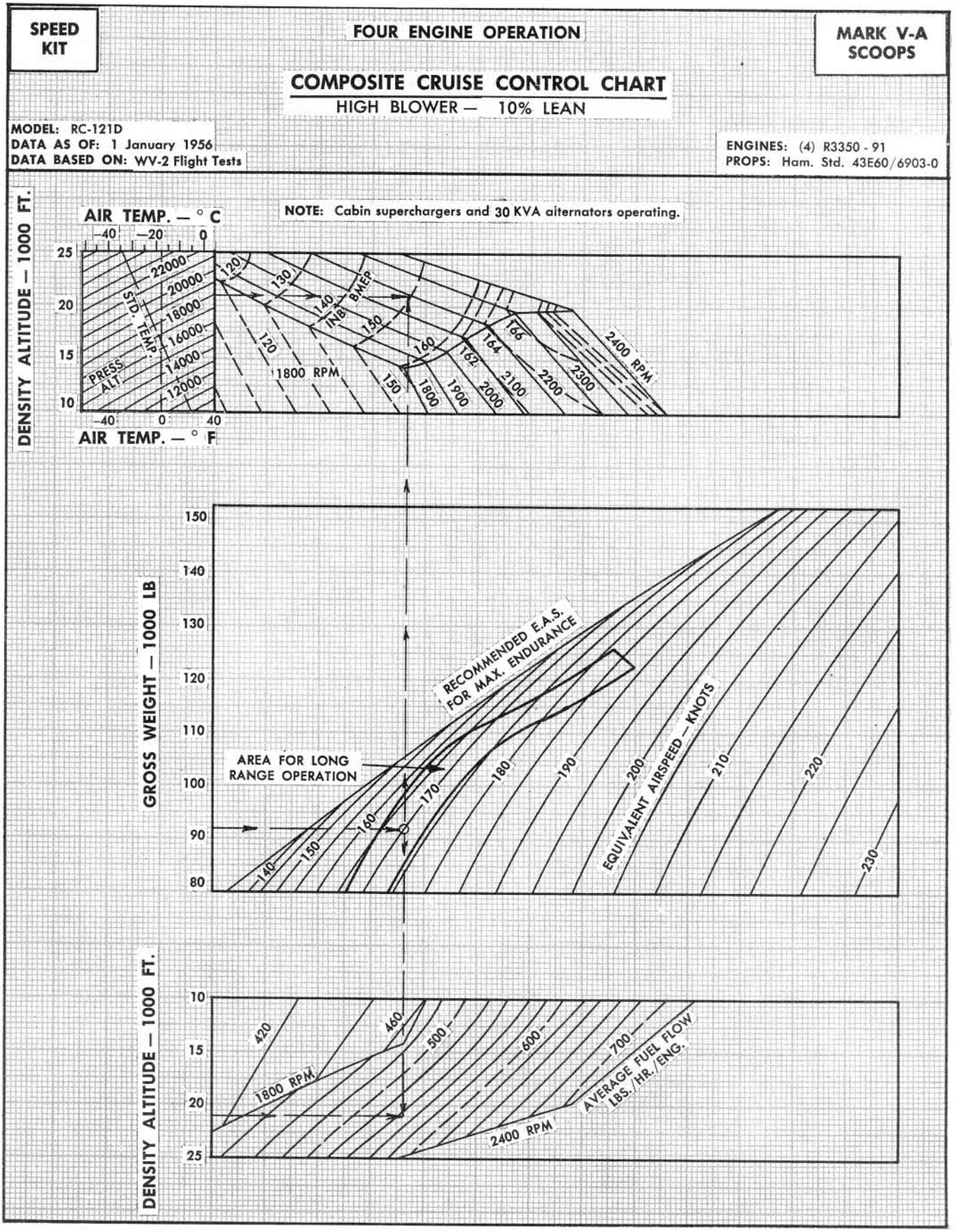


Figure A5-4. Composite Cruise Control Chart — Four Engine Operation — High Blower — 10% Lean

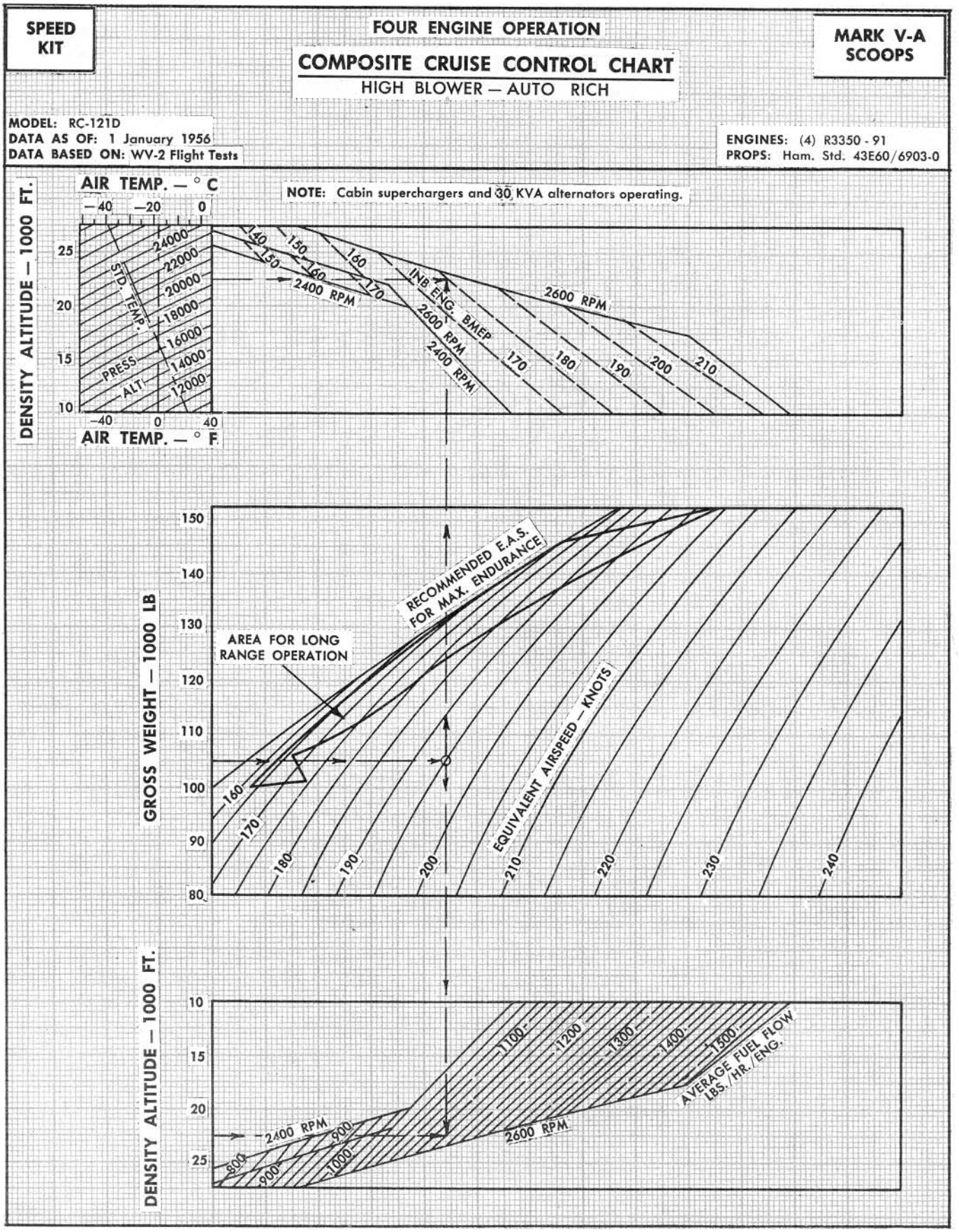


Figure A5-5. Composite Cruise Control Chart — Four Engine Operation — High Blower — Auto Rich

SPEED KIT

THREE ENGINE OPERATION
COMPOSITE CRUISE CONTROL CHART
LOW BLOWER — 10% LEAN

MARK V-A SCOOPS

MODEL: RC-121D
DATA AS OF: 1 January 1956
DATA BASED ON: WV-2 Flight Tests

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0

NOTE: Cabin superchargers and 30 KVA alternators operating.

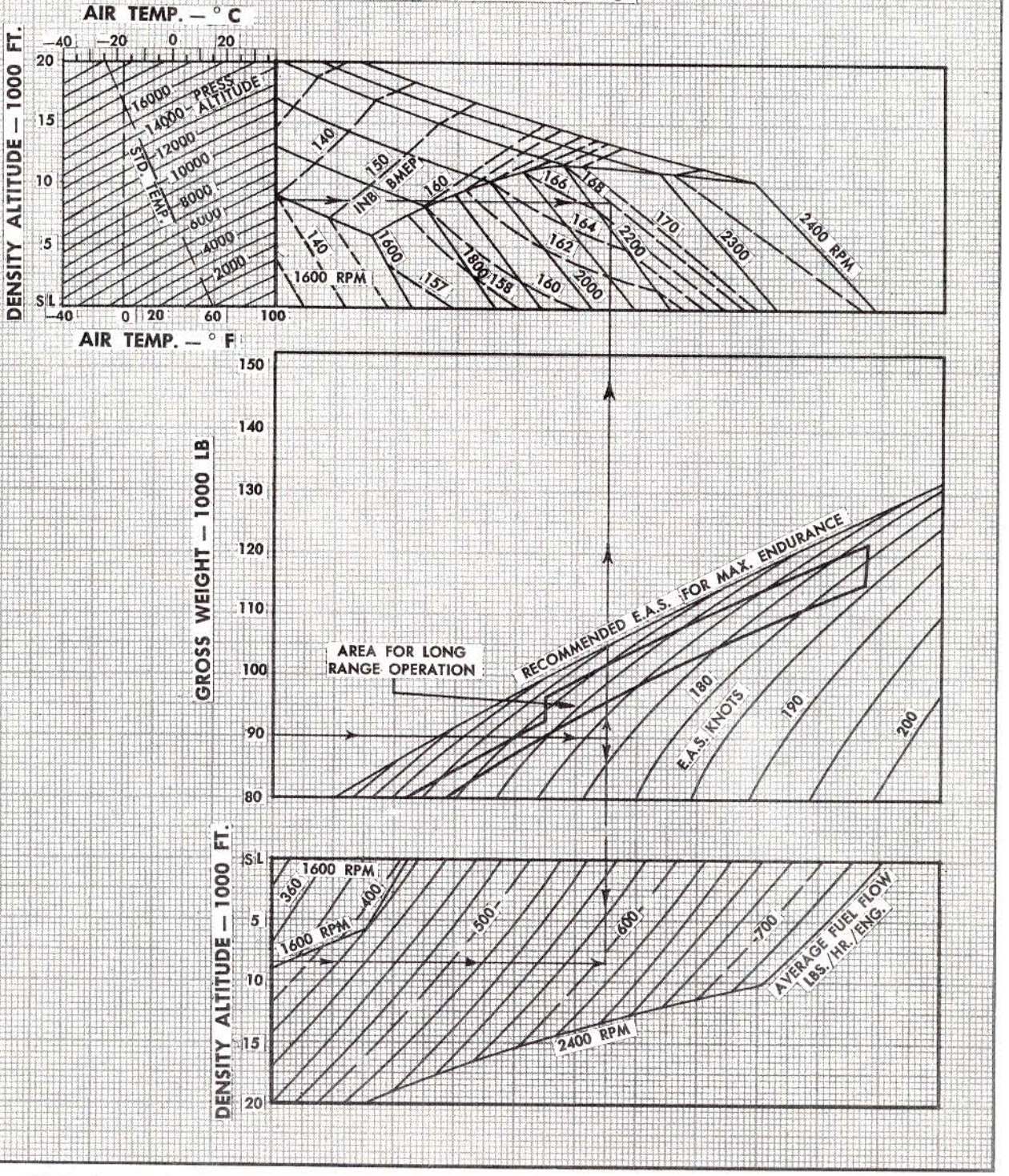


Figure A5-6. Composite Cruise Control Chart — Three Engine Operation — Low Blower — 10% Lean

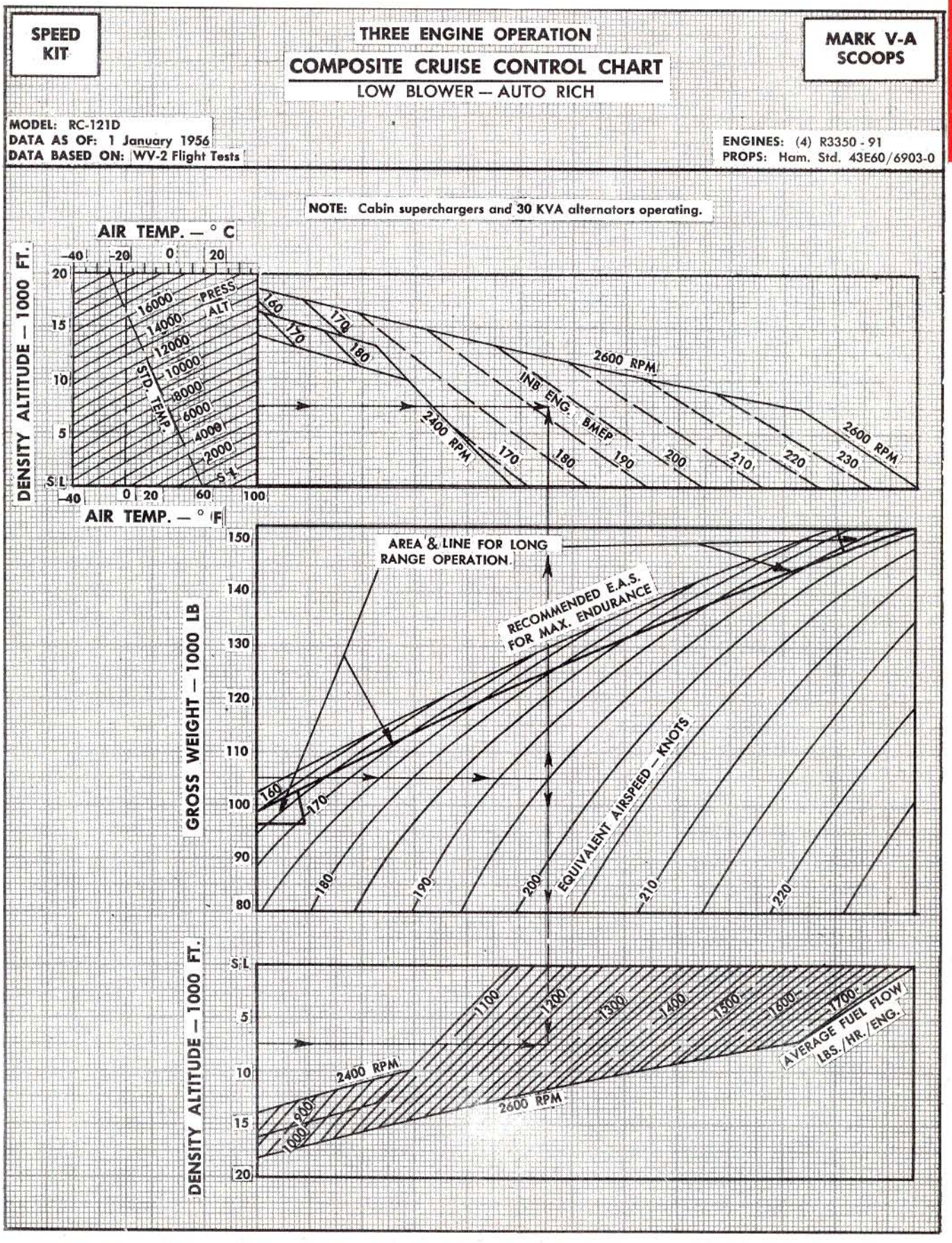


Figure A5-7. Composite Cruise Control Chart — Three Engine Operation — Low Blower — Auto Rich

SPEED KIT

THREE ENGINE OPERATION

MARK V-A SCOOPS

COMPOSITE CRUISE CONTROL CHART

HIGH BLOWER — 10% LEAN

MODEL: RC-121D
DATA AS OF: 1 January 1956
DATA BASED ON: WV-2 Flight Tests

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0

NOTE: Cabin superchargers and 30 KVA alternators operating.

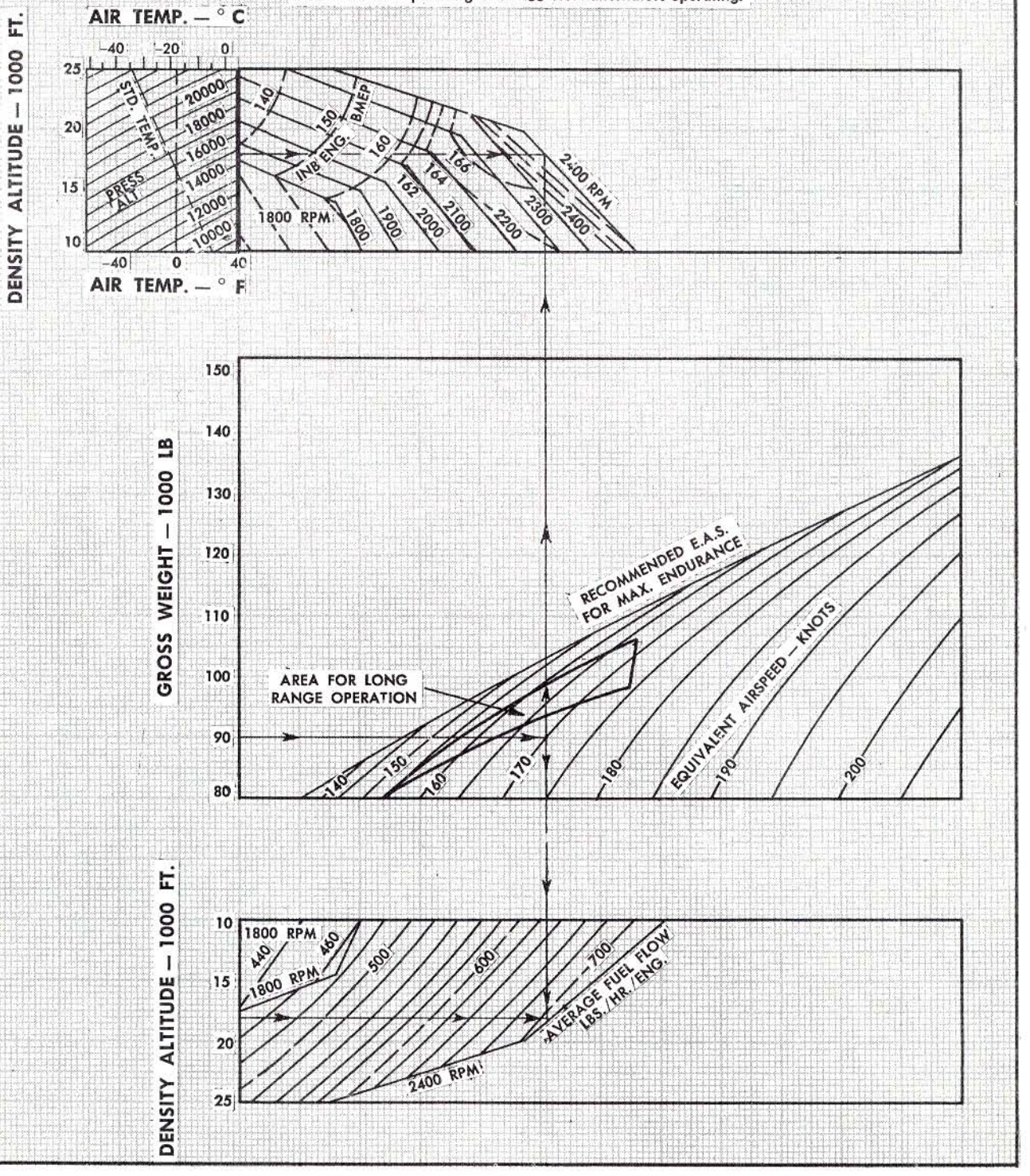


Figure A5-8. Composite Cruise Control Chart — Three Engine Operation — High Blower — 10% Lean

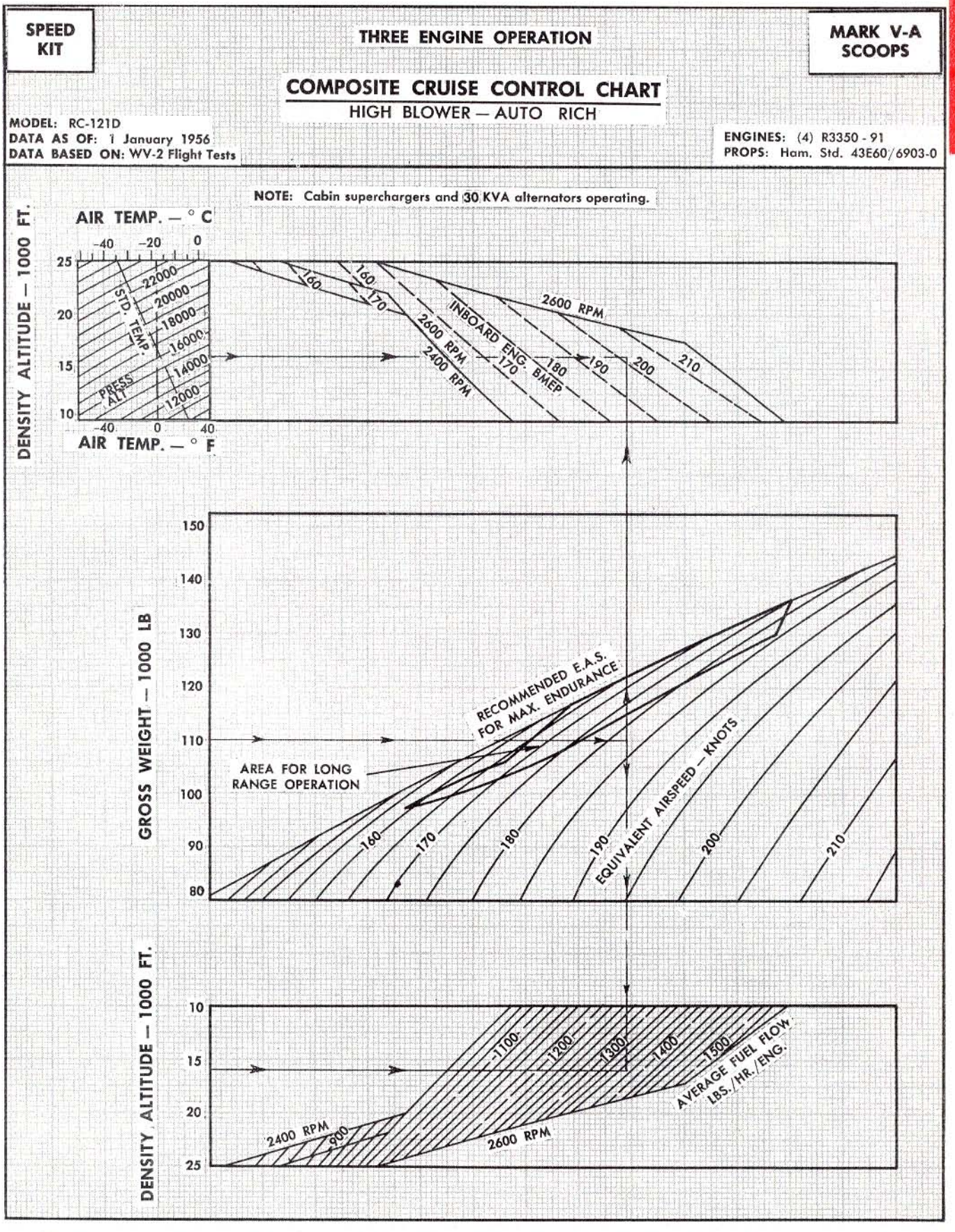


Figure A5-9. Composite Cruise Control Chart — Three Engine Operation — High Blower — Auto Rich

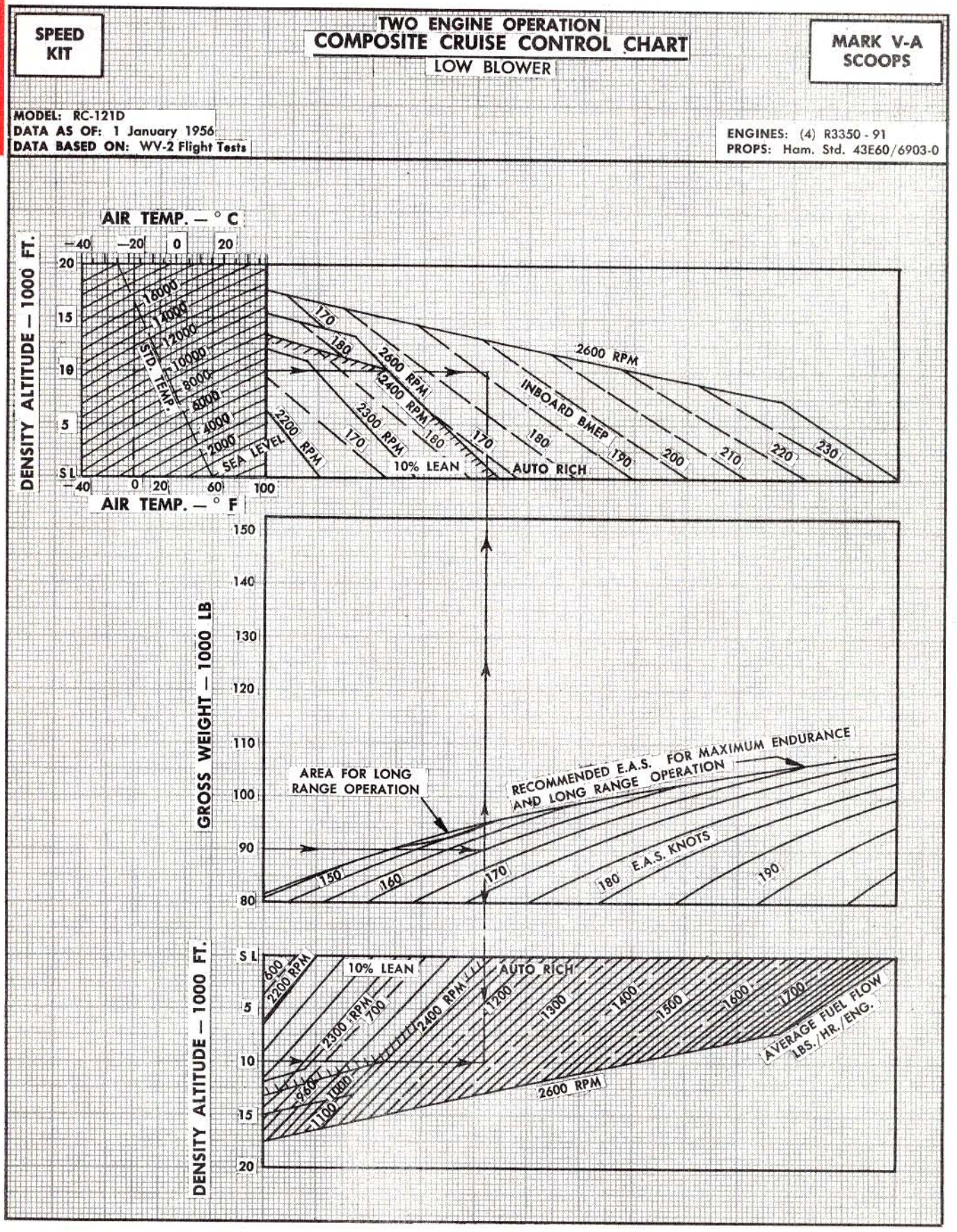


Figure A5-10. Composite Cruise Control Chart — Two Engine Operation — Low Blower

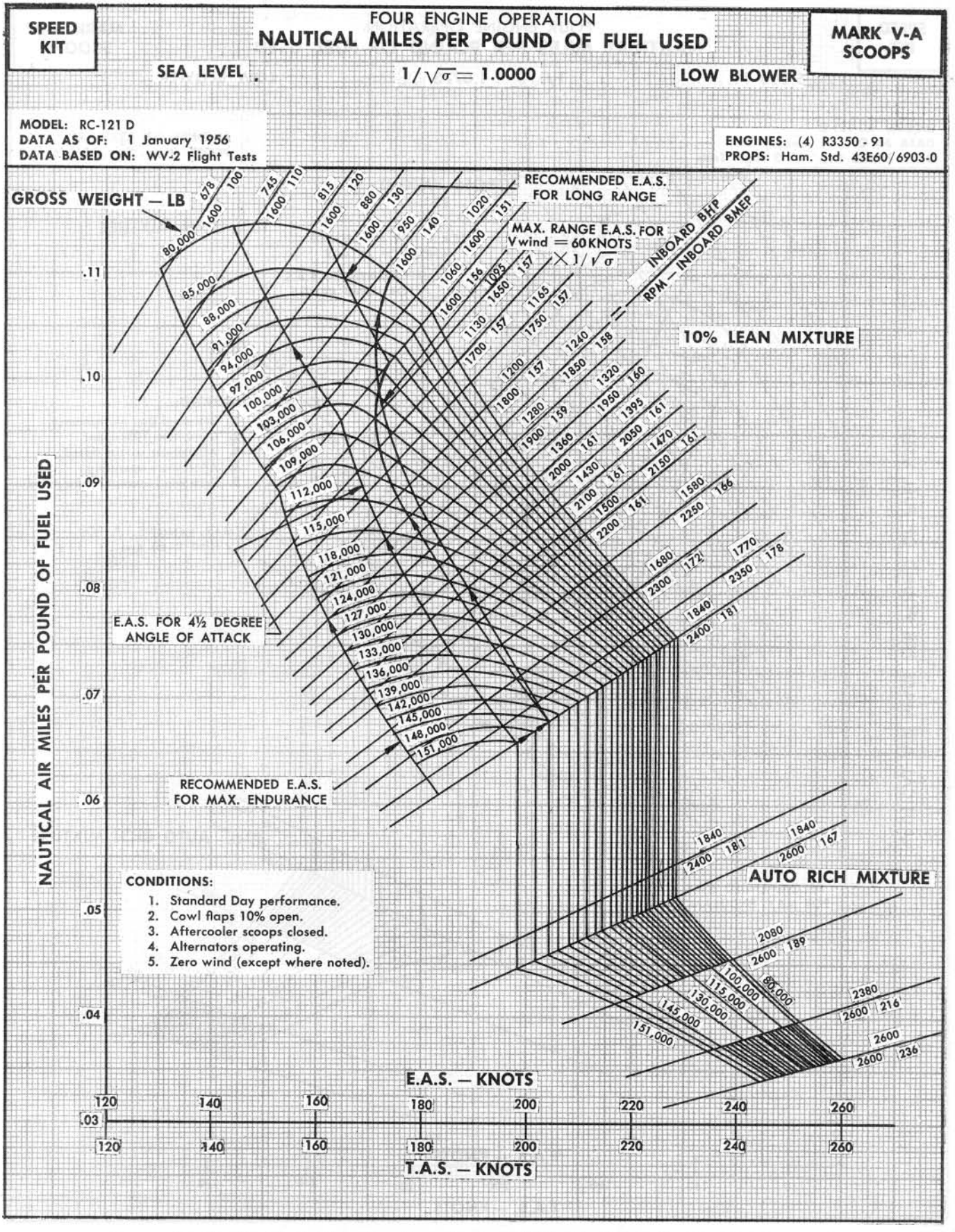


Figure A5-11. Nautical Miles Per Pound of Fuel Used — Four Engine Operation — Low Blower — Sea Level

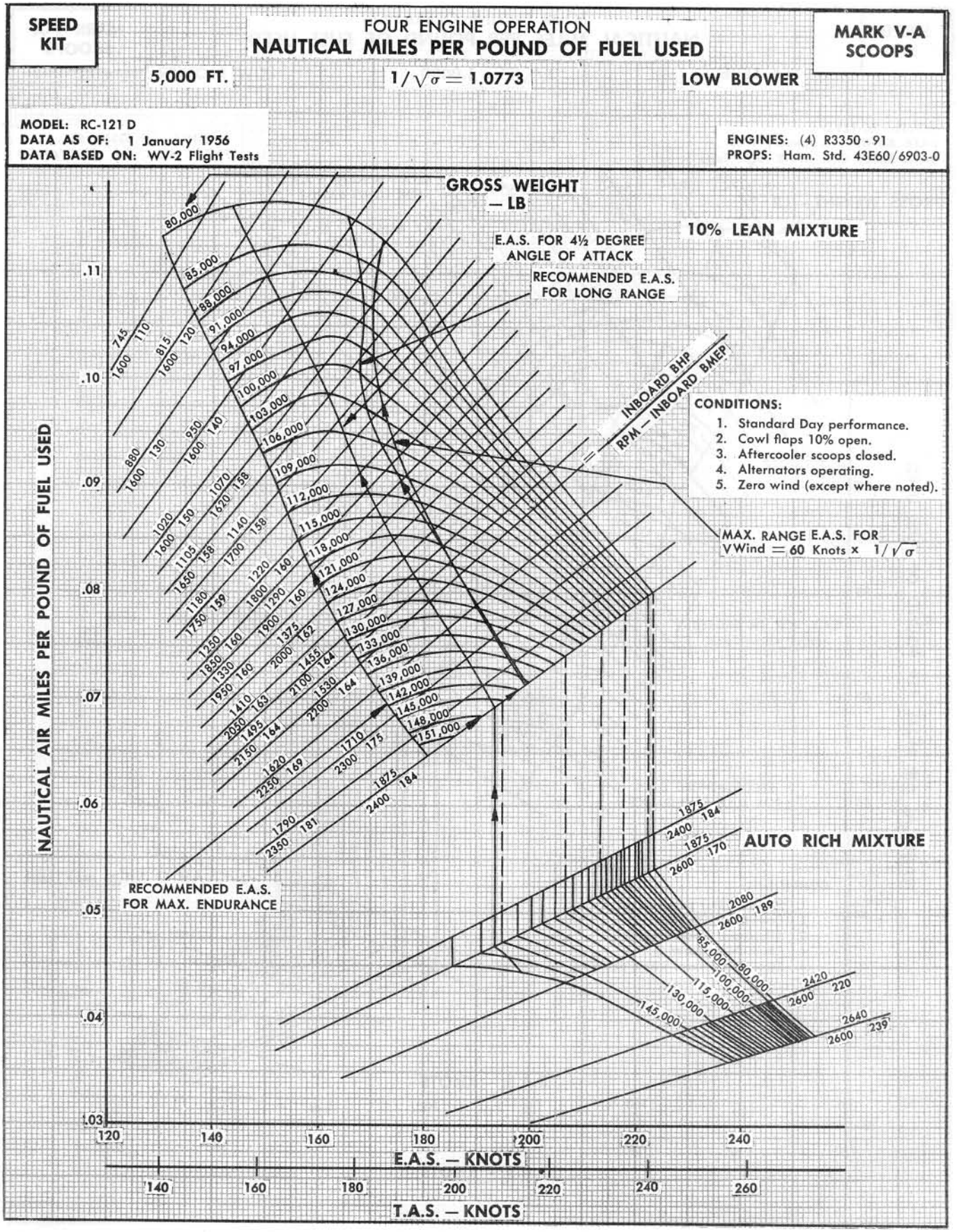


Figure A5-12. Nautical Miles Per Pound of Fuel Used — Four Engine Operation — Low Blower — 5000 Feet

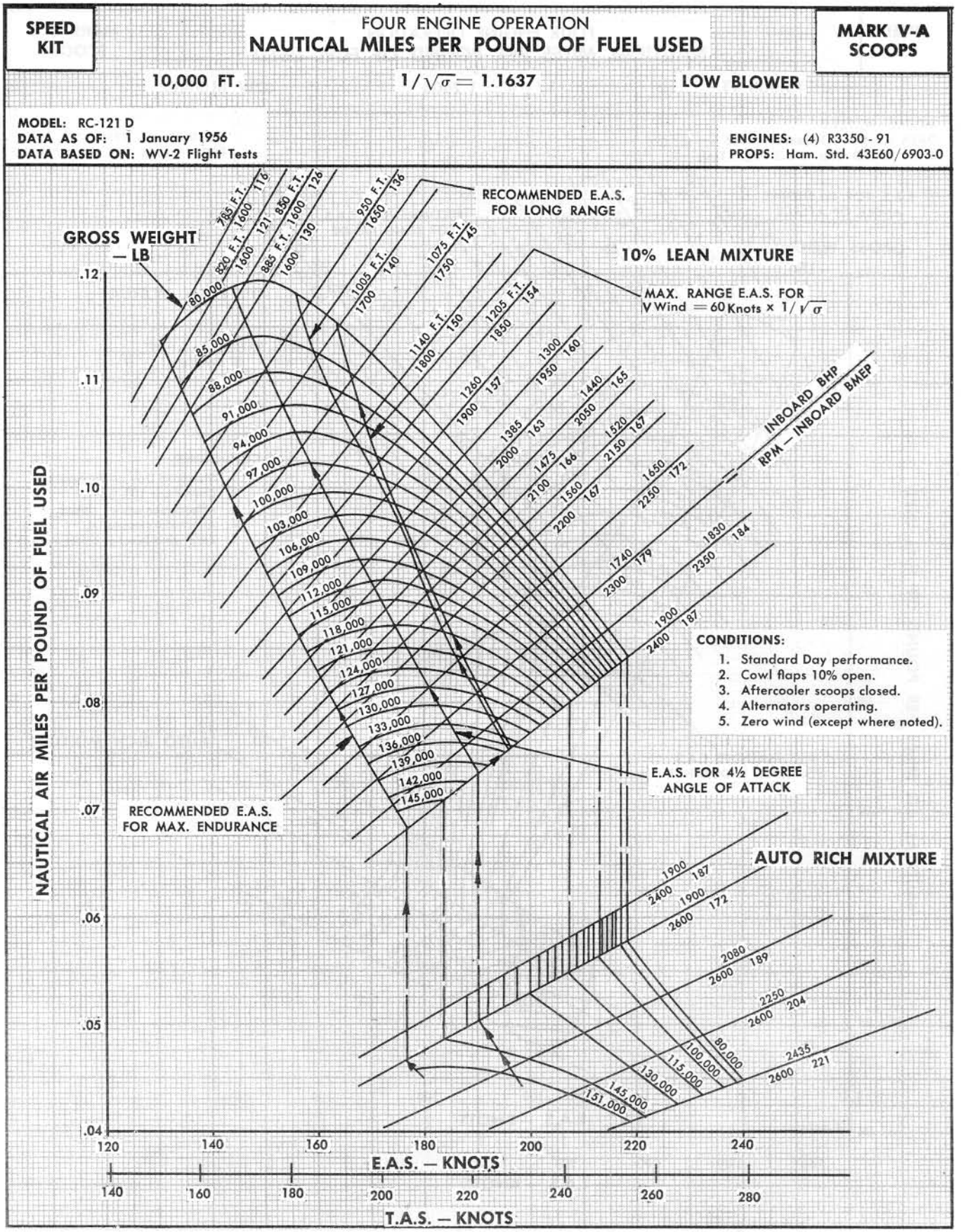


Figure A5-13. Nautical Miles Per Pound of Fuel Used — Four Engine Operation — Low Blower — 10,000 Feet

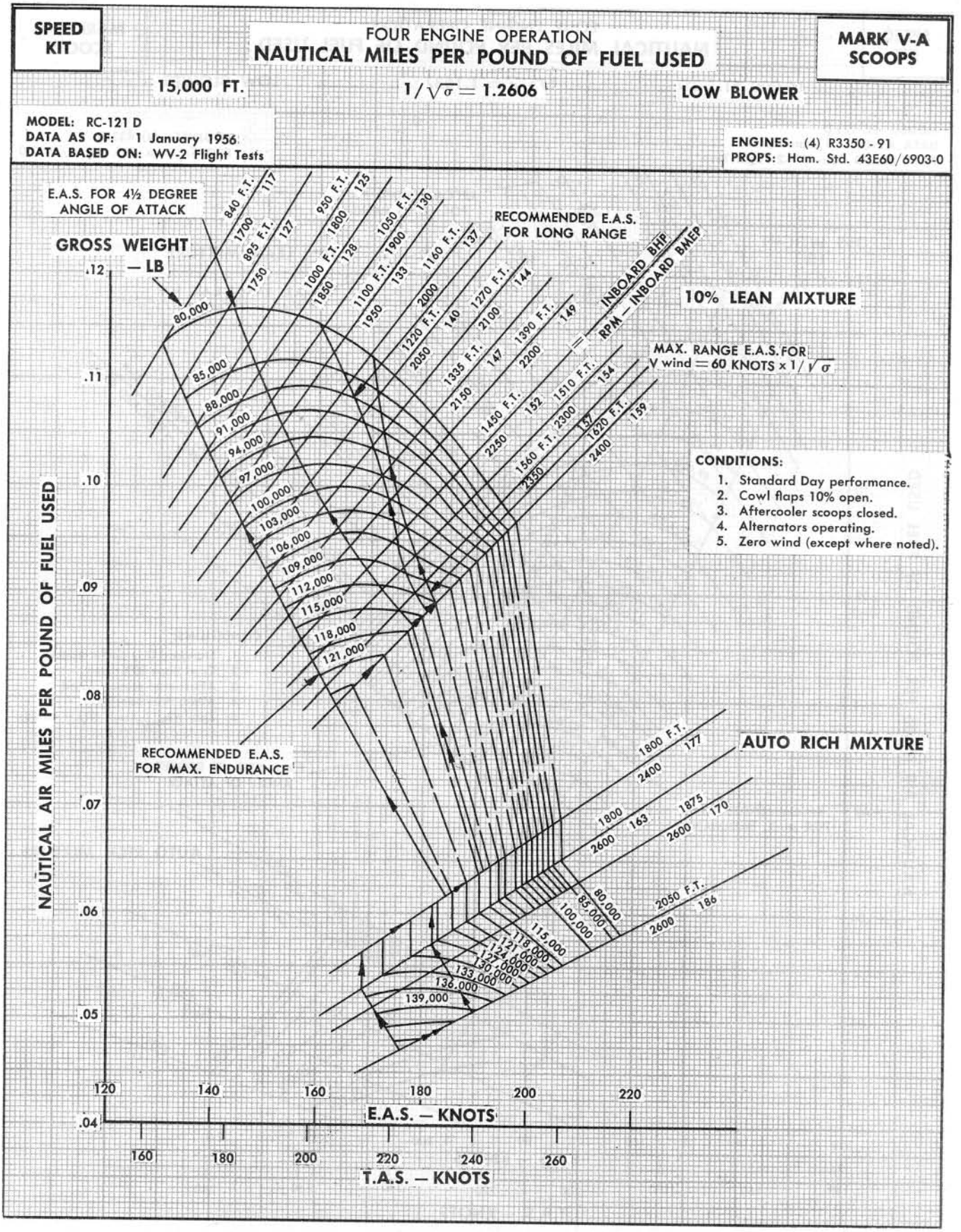


Figure A5-14. Nautical Miles Per Pound of Fuel Used — Four Engine Operation — Low Blower — 15,000 Feet

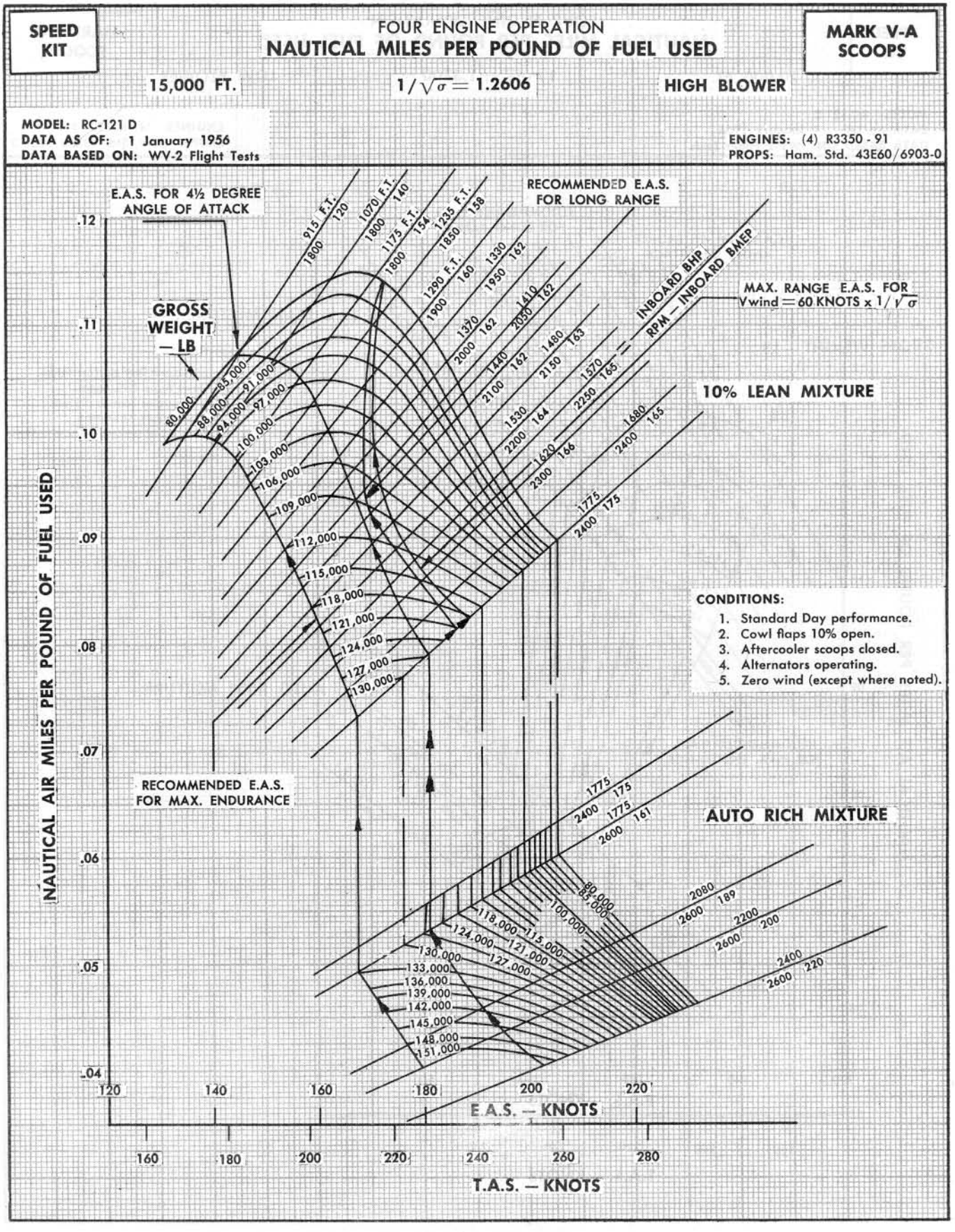


Figure A5-15. Nautical Miles Per Pound of Fuel Used — Four Engine Operation — High Blower — 15,000 Feet

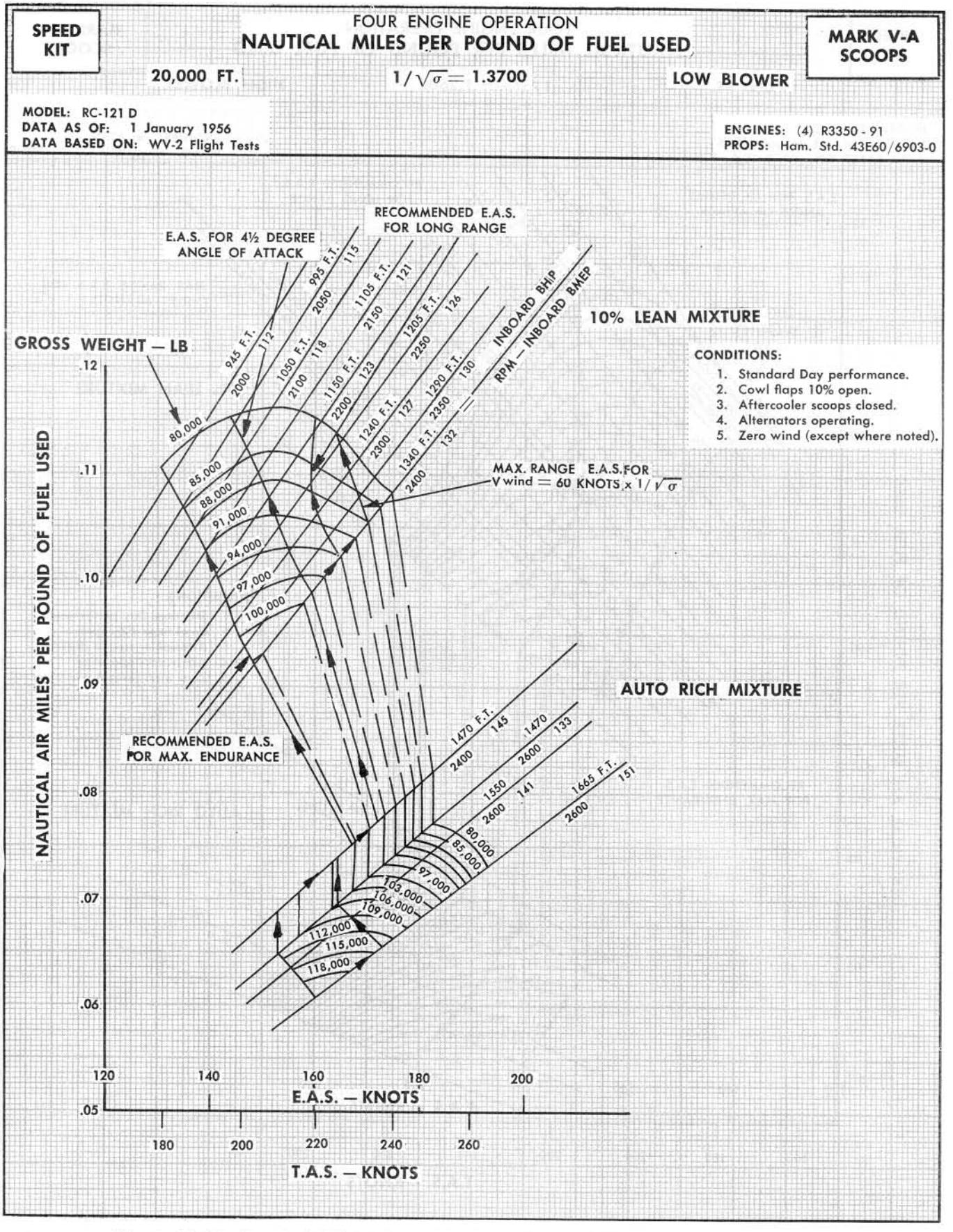


Figure A5-16. Nautical Miles Per Pound of Fuel Used — Four Engine Operation — Low Blower — 20,000 Feet

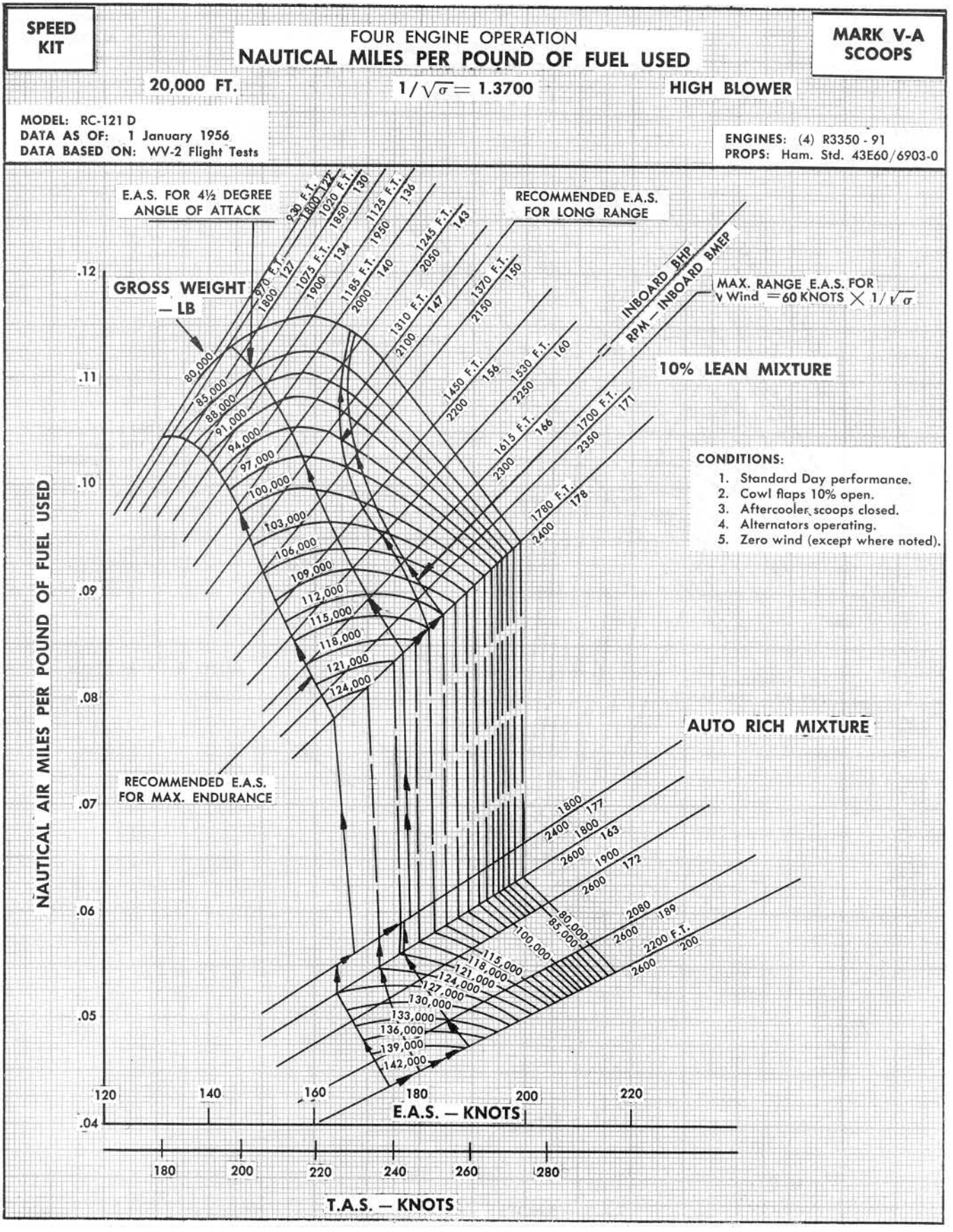


Figure A5-17. Nautical Miles Per Pound of Fuel Used — Four Engine Operation — High Blower — 20,000 Feet

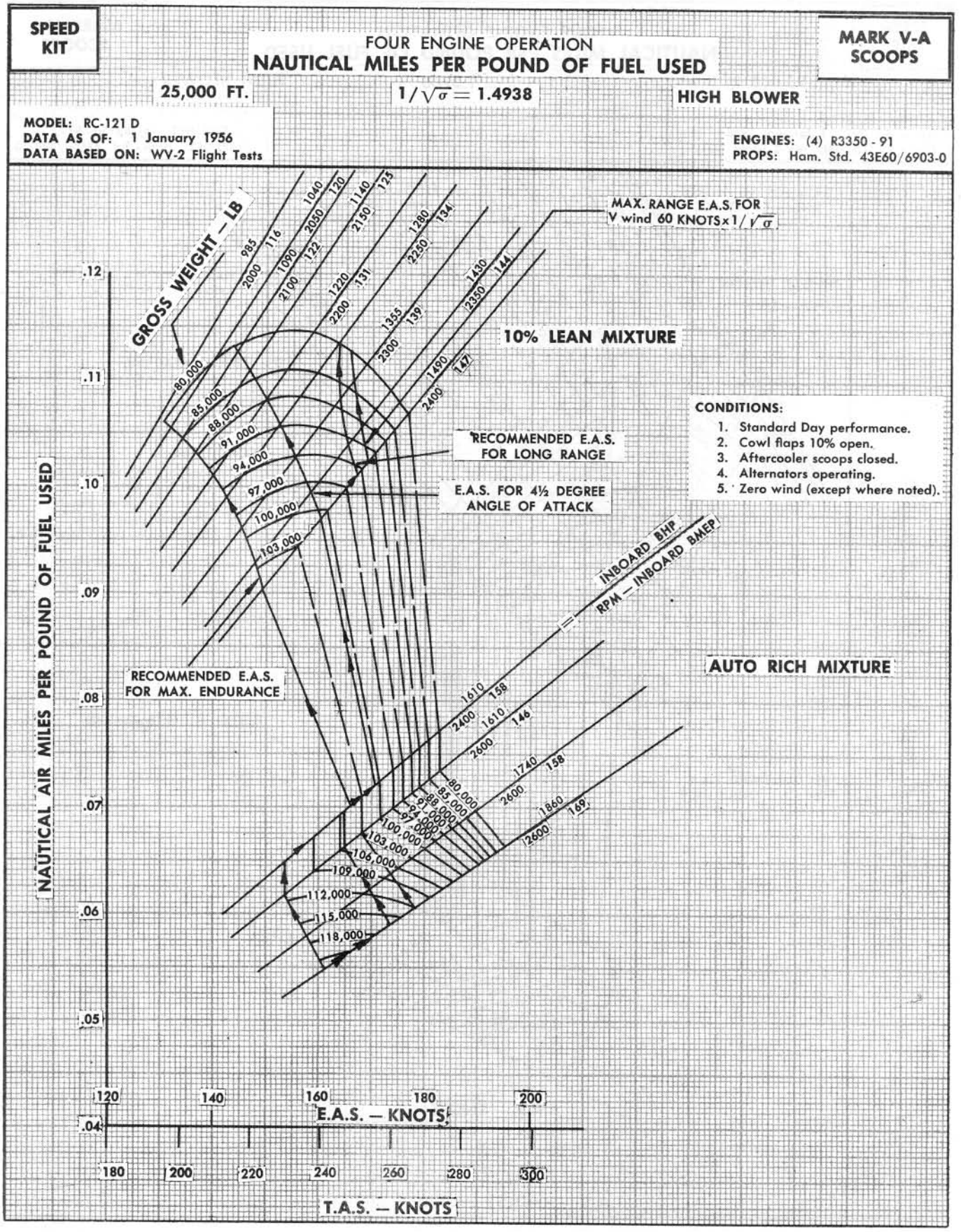


Figure A5-18. Nautical Miles Per Pound of Fuel Used — Four Engine Operation — High Blower — 25,000 Feet

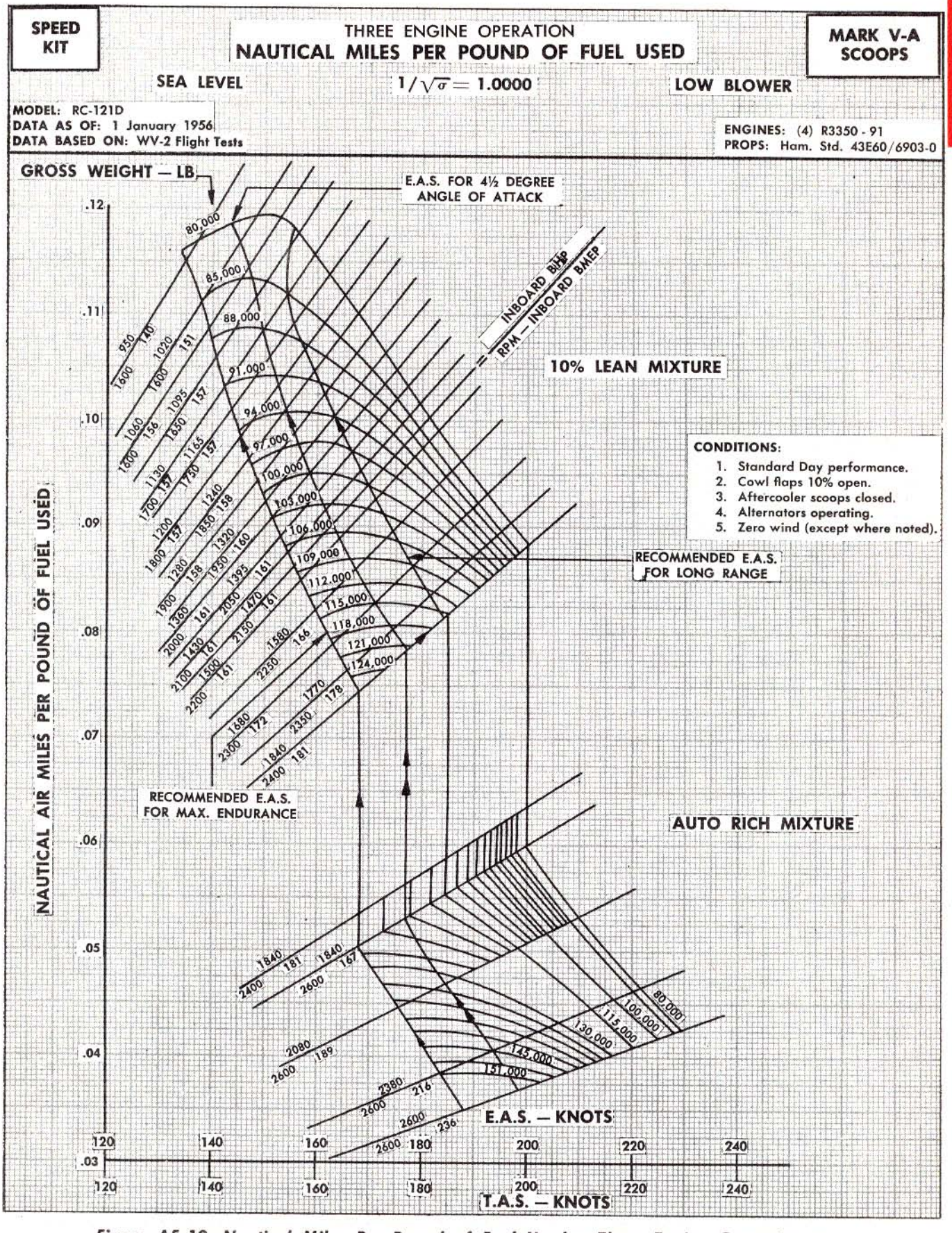


Figure A5-19. Nautical Miles Per Pound of Fuel Used — Three Engine Operation — Low Blower — Sea Level

SPEED KIT

THREE ENGINE OPERATION
NAUTICAL MILES PER POUND OF FUEL USED

MARK V-A SCOOPS

5,000 FT. | $1/\sqrt{\sigma} = 1.0773$ | LOW BLOWER

MODEL: RC-121D
DATA AS OF: 1 January 1956
DATA BASED ON: WV-2 Flight Tests

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0

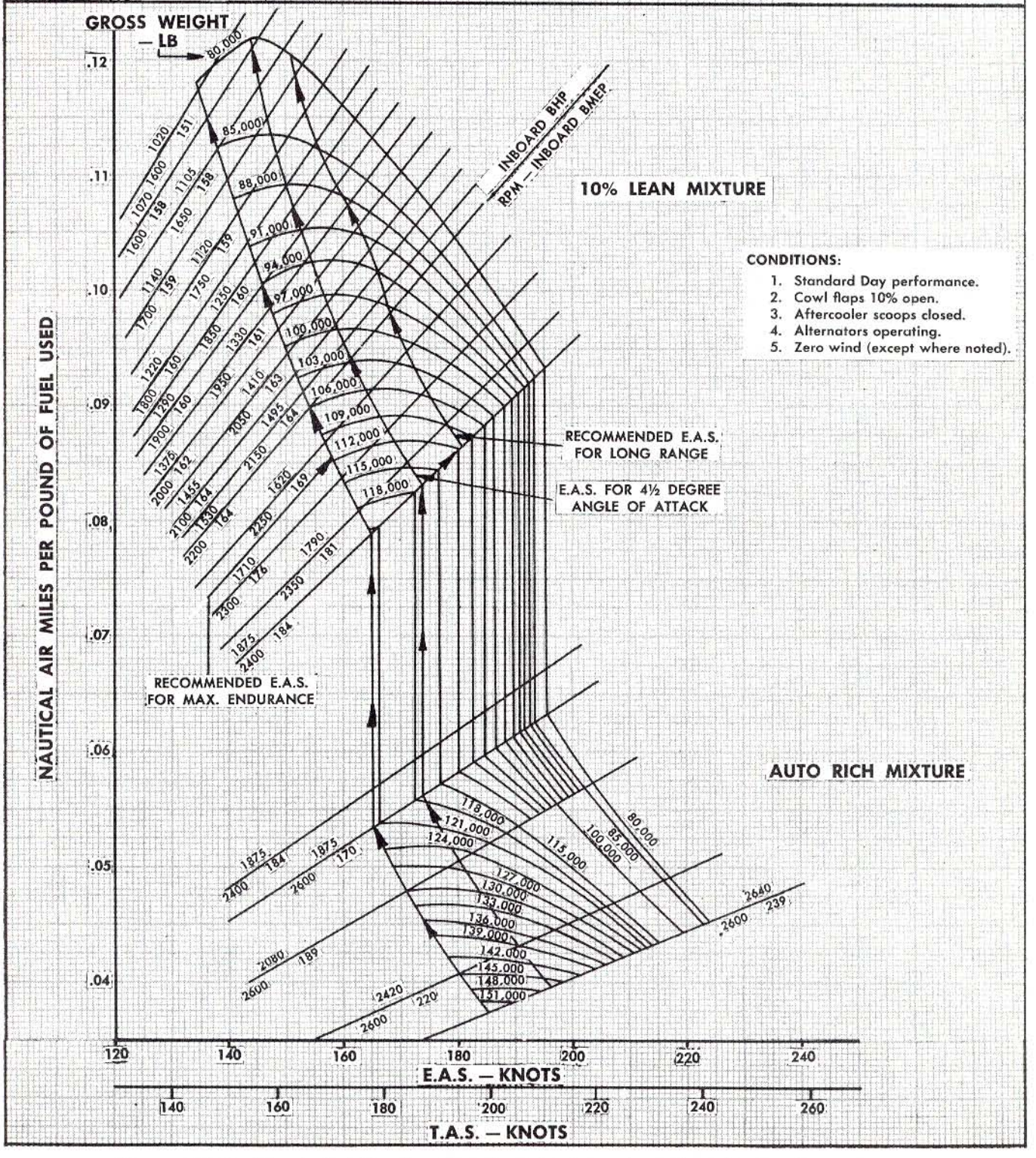


Figure A5-20. Nautical Miles Per Pound of Fuel Used — Three Engine Operation — Low Blower — 5000 Feet

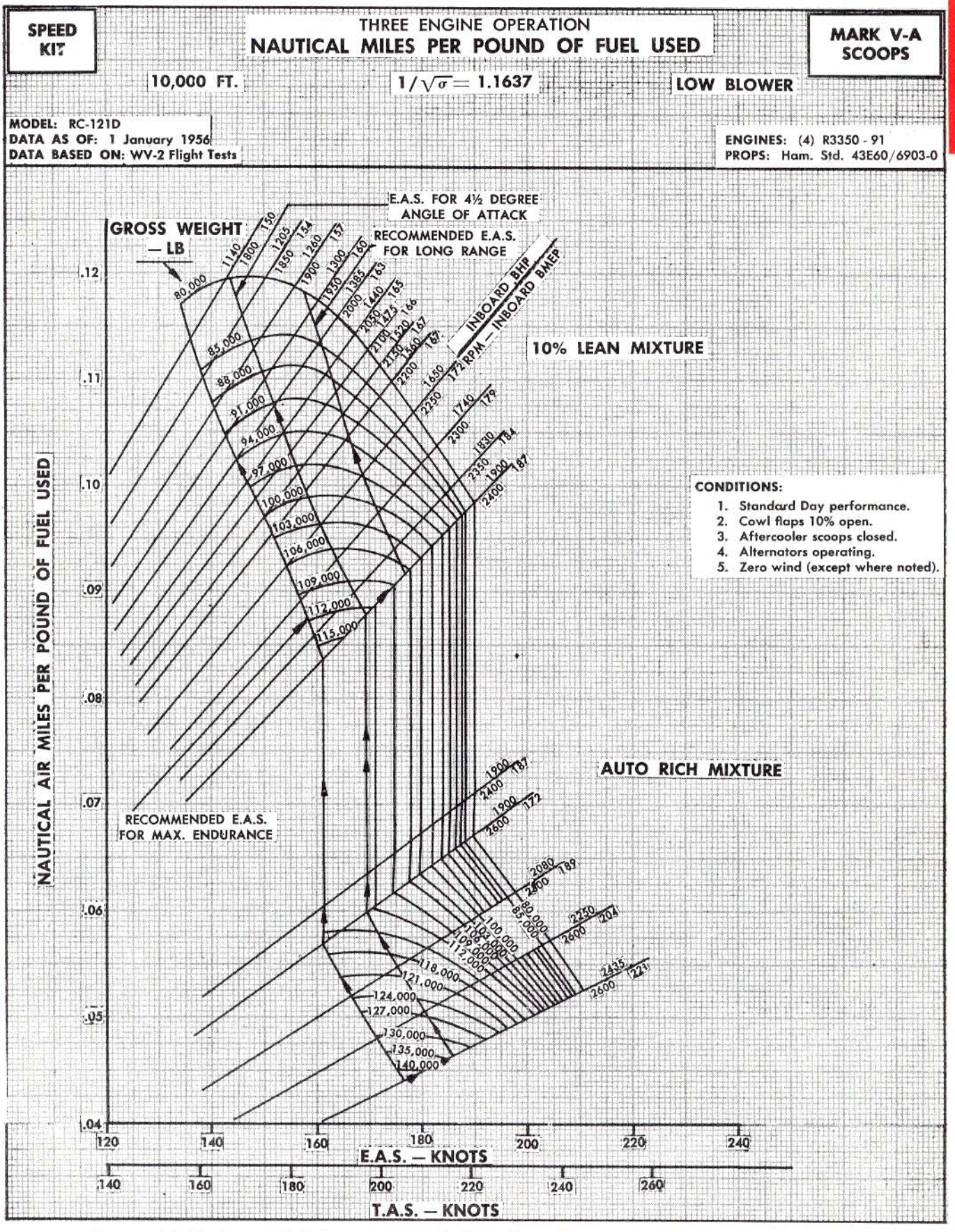


Figure A5-21. Nautical Miles Per Pound of Fuel Used — Three Engine Operation — Low Blower — 10,000 Feet

SPEED KIT

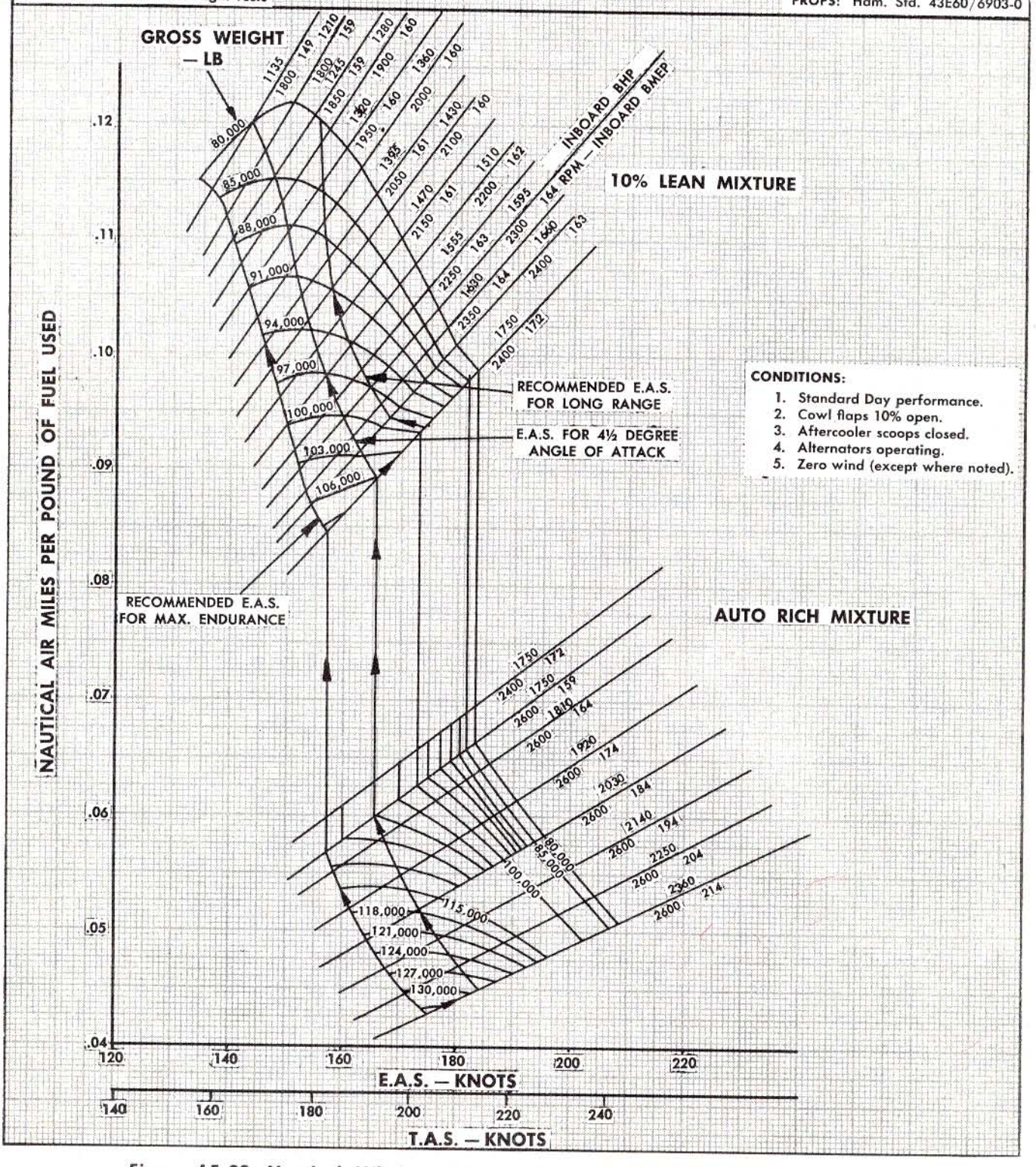
THREE ENGINE OPERATION
NAUTICAL MILES PER POUND OF FUEL USED

MARK V-A SCOOPS

10,000 FT. $1/\sqrt{\sigma} = 1.1637$ HIGH BLOWER

MODEL: RC-121D
DATA AS OF: 1 January 1956
DATA BASED ON: WV-2 Flight Tests

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0



CONDITIONS:

1. Standard Day performance.
2. Cowl flaps 10% open.
3. Aftercooler scoops closed.
4. Alternators operating.
5. Zero wind (except where noted).

Figure A5-22. Nautical Miles Per Pound of Fuel Used — Three Engine Operation — High Blower — 10,000 Feet

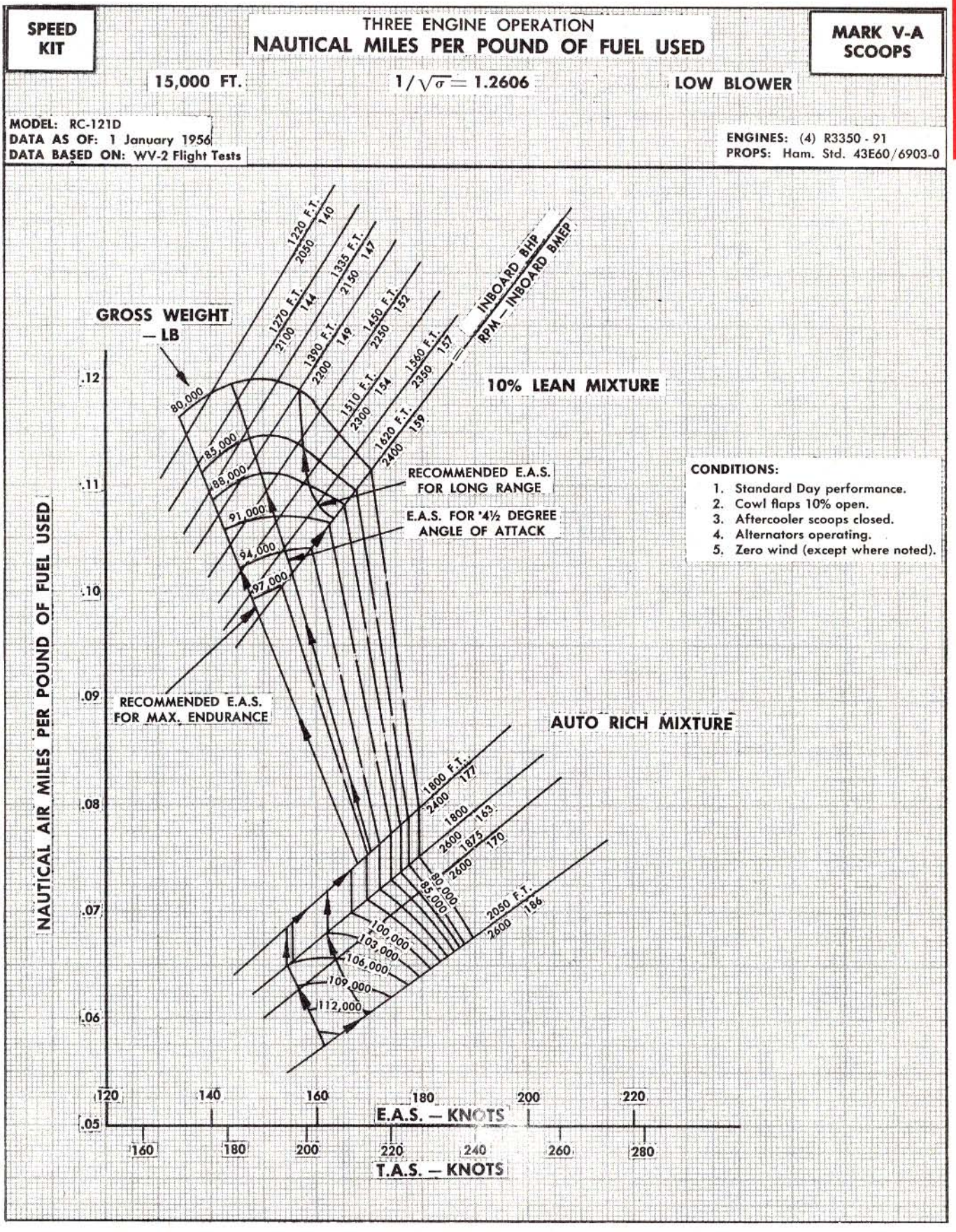


Figure A5-23. Nautical Miles Per Pound of Fuel Used — Three Engine Operation — Low Blower — 15,000 Feet

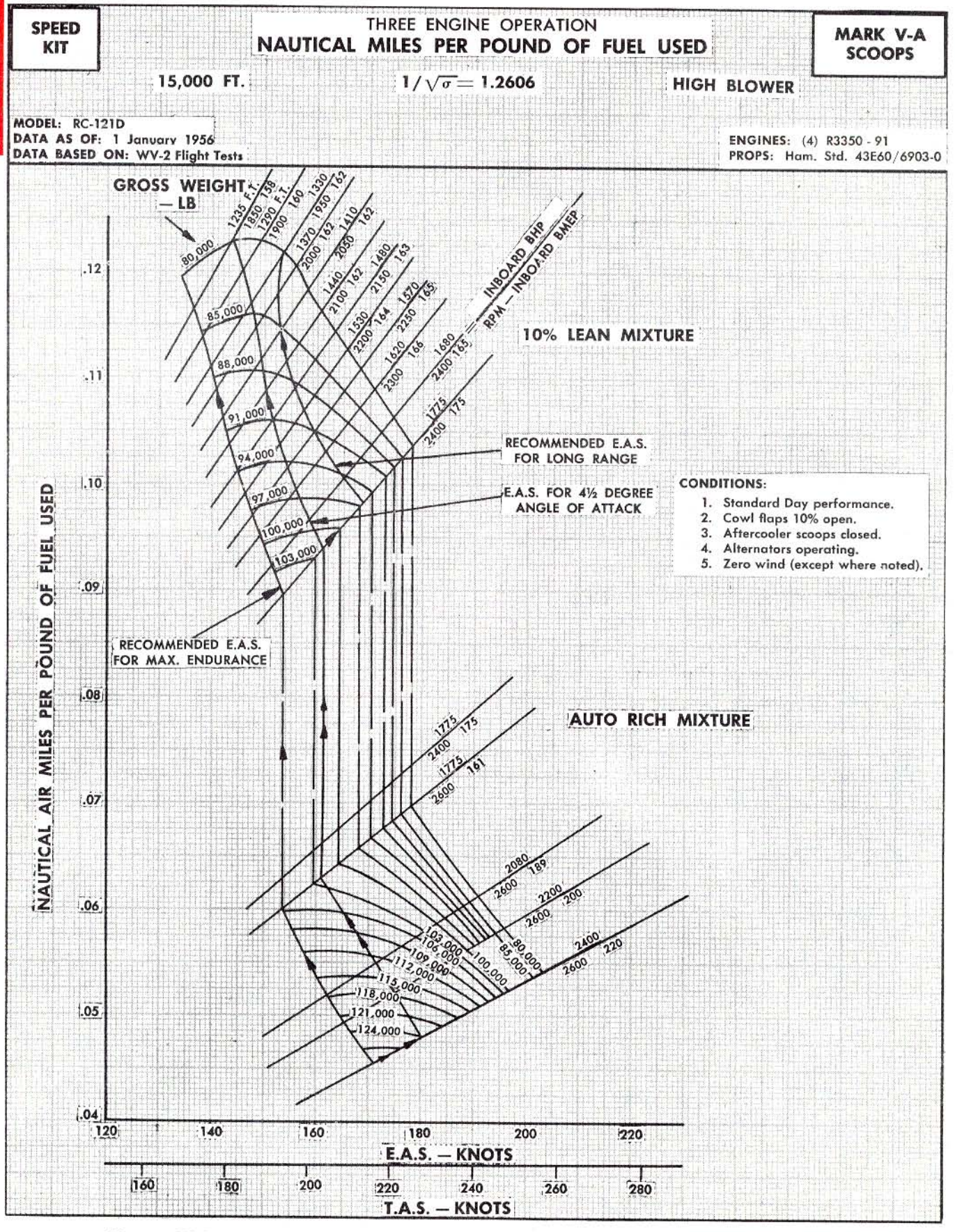


Figure A5-24. Nautical Miles Per Pound of Fuel Used — Three Engine Operation — High Blower — 15,000 Feet

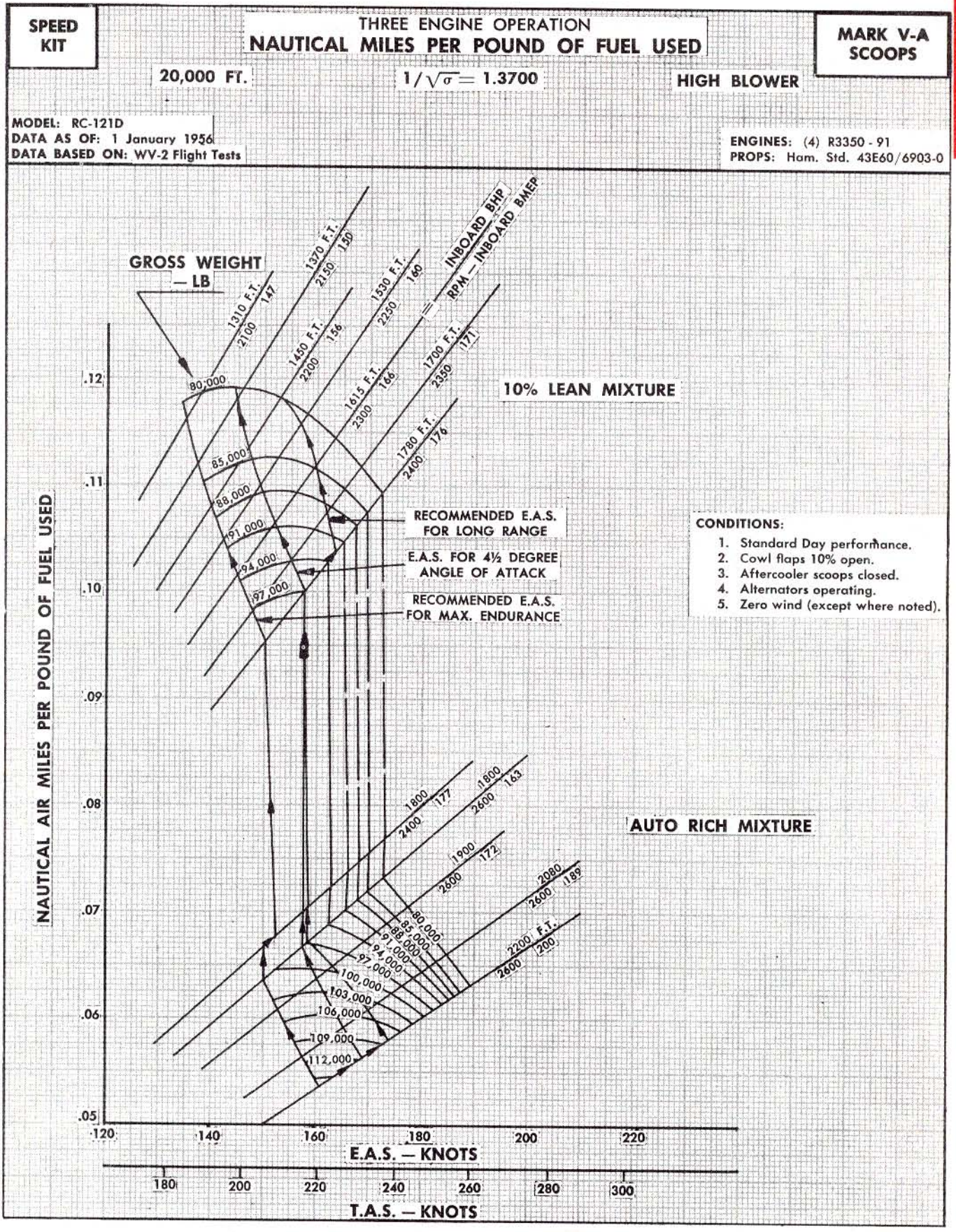


Figure A5-25. Nautical Miles Per Pound of Fuel Used — Three Engine Operation — High Blower — 20,000 Feet

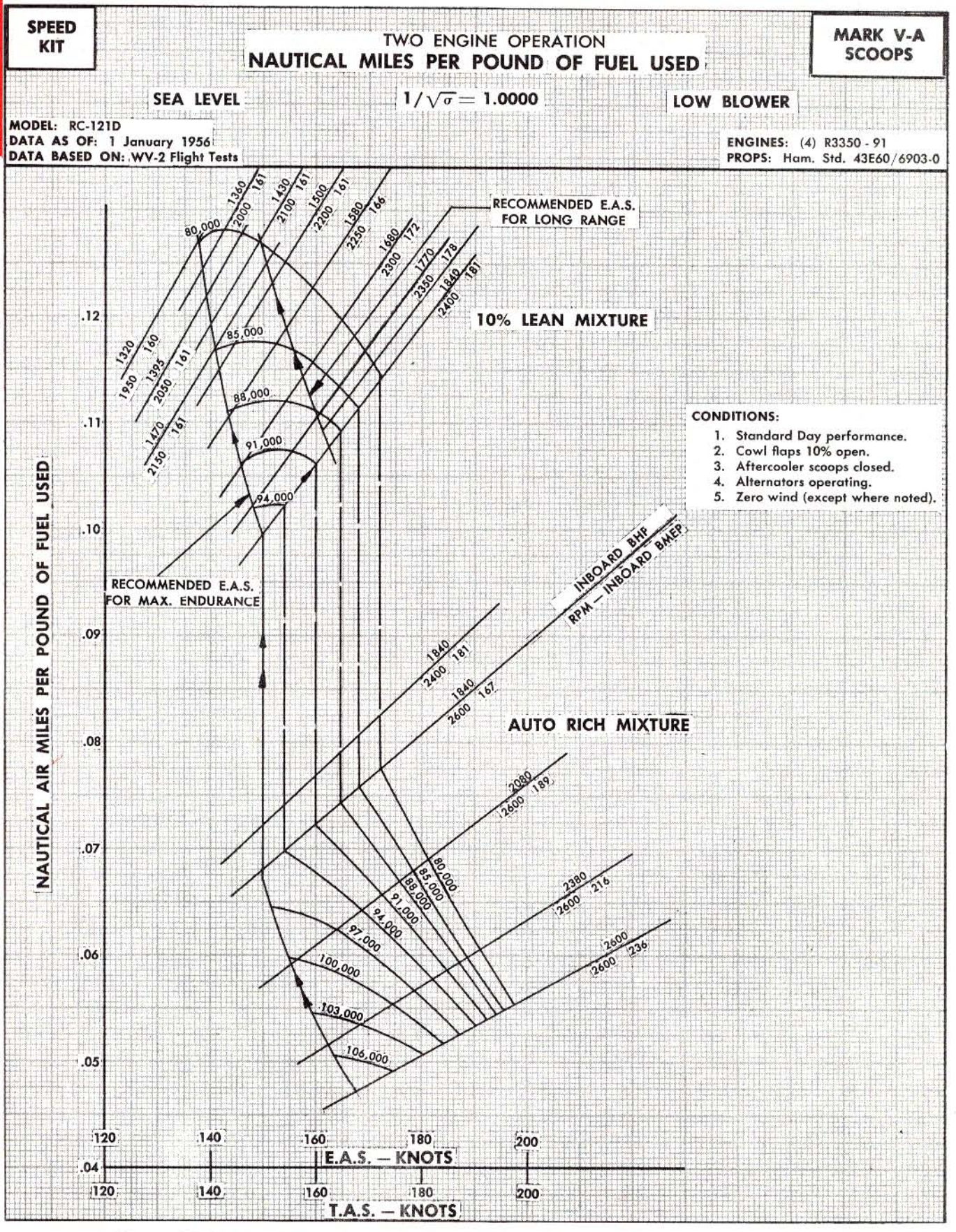


Figure A5-26. Nautical Miles Per Pound of Fuel Used — Two Engine Operation — Low Blower — Sea Level

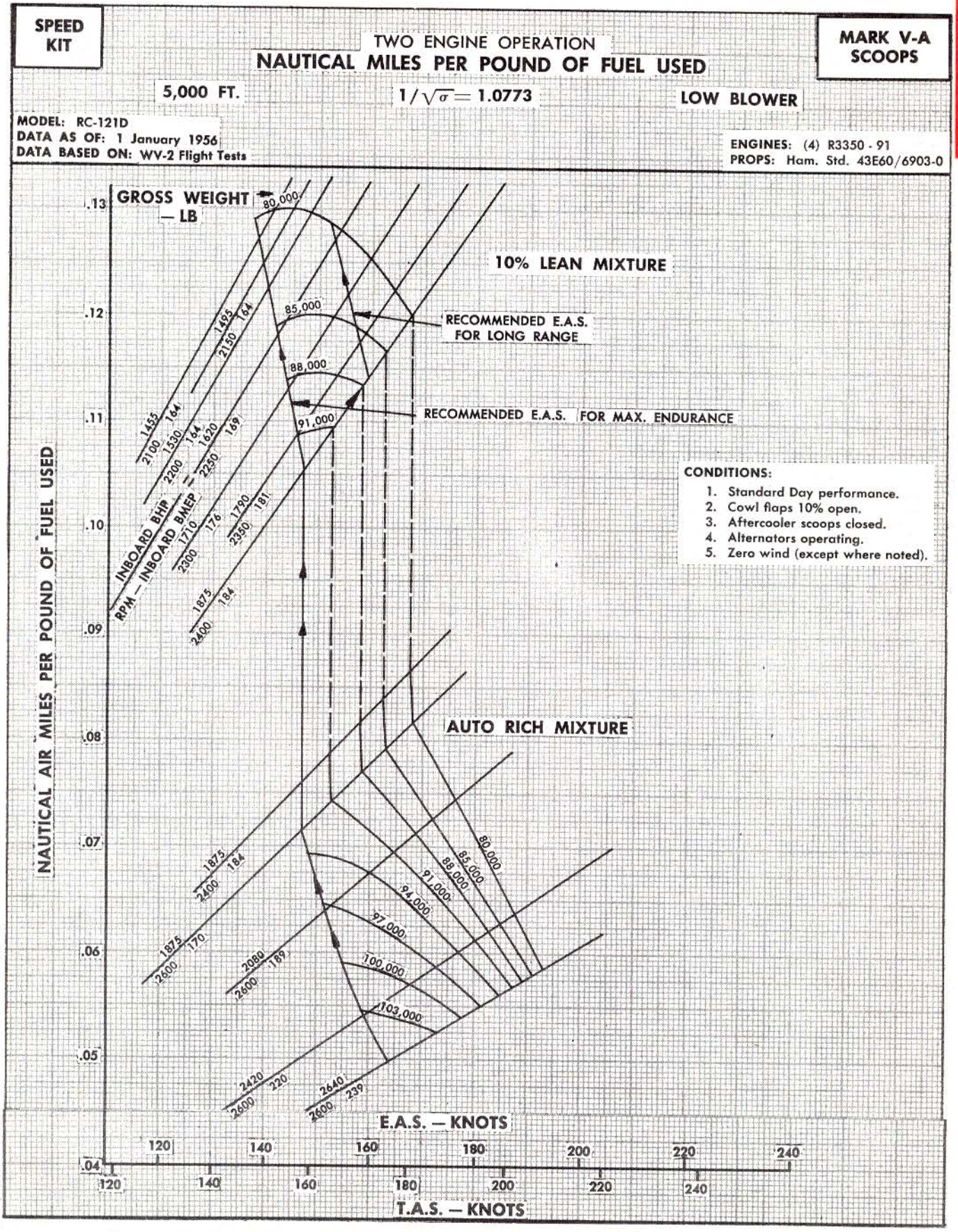


Figure A5-27. Nautical Miles Per Pound of Fuel Used — Two Engine Operation — Low Blower — 5,000 Feet

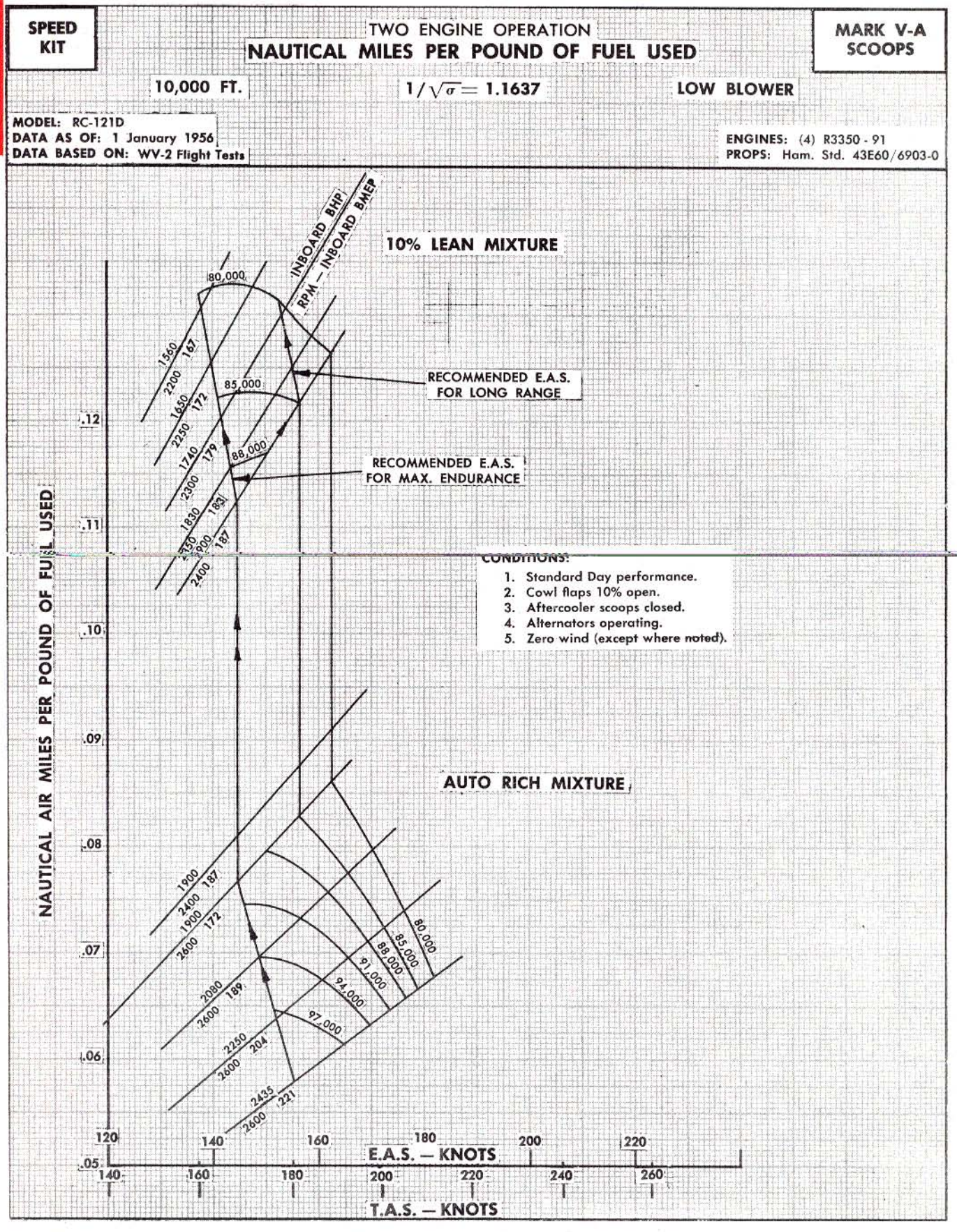


Figure A5-28. Nautical Miles Per Pound of Fuel Used — Two Engine Operation — Low Blower — 10,000 Feet

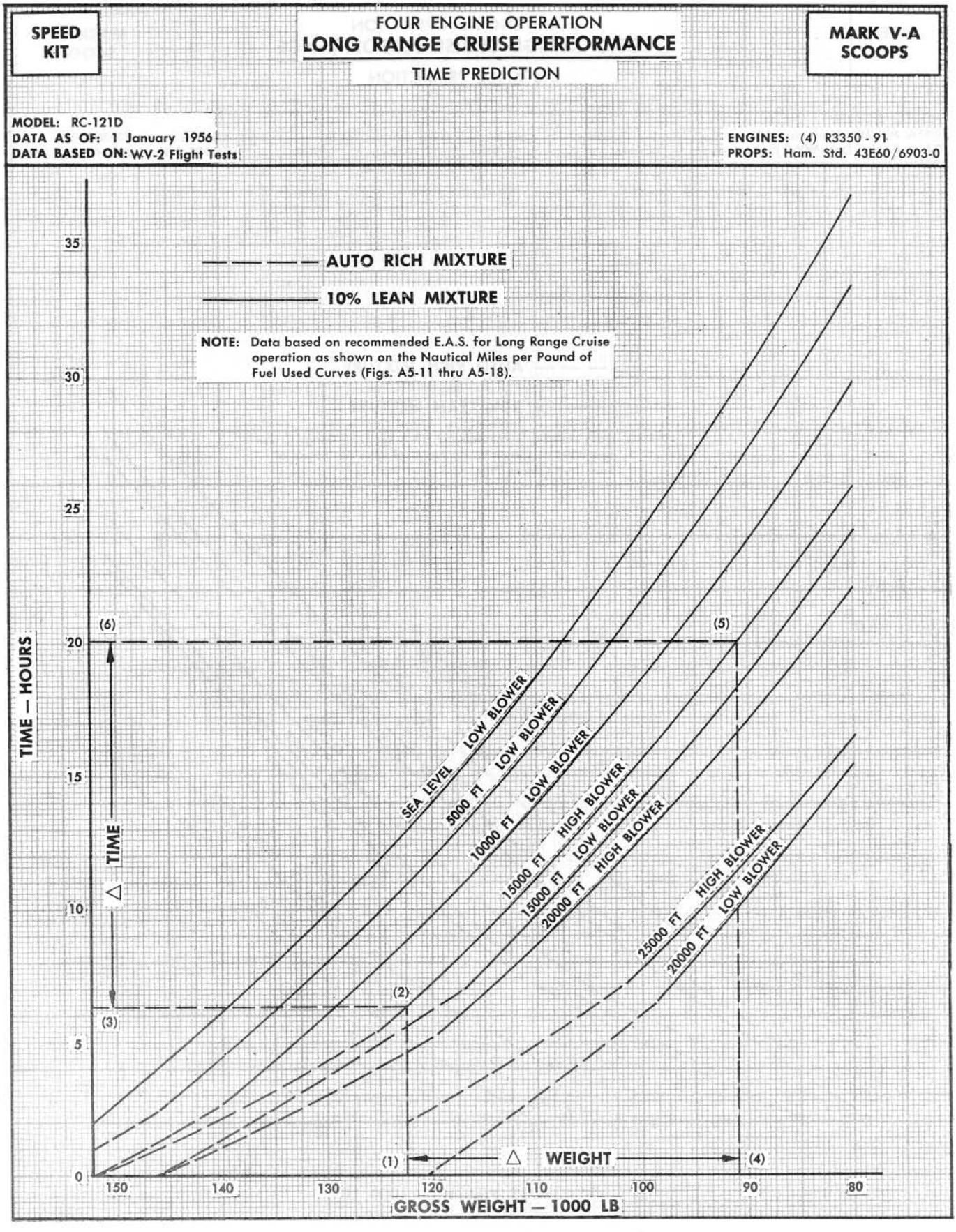


Figure A5-29. Long Range Cruise Performance — Four Engine Operation — Time Prediction

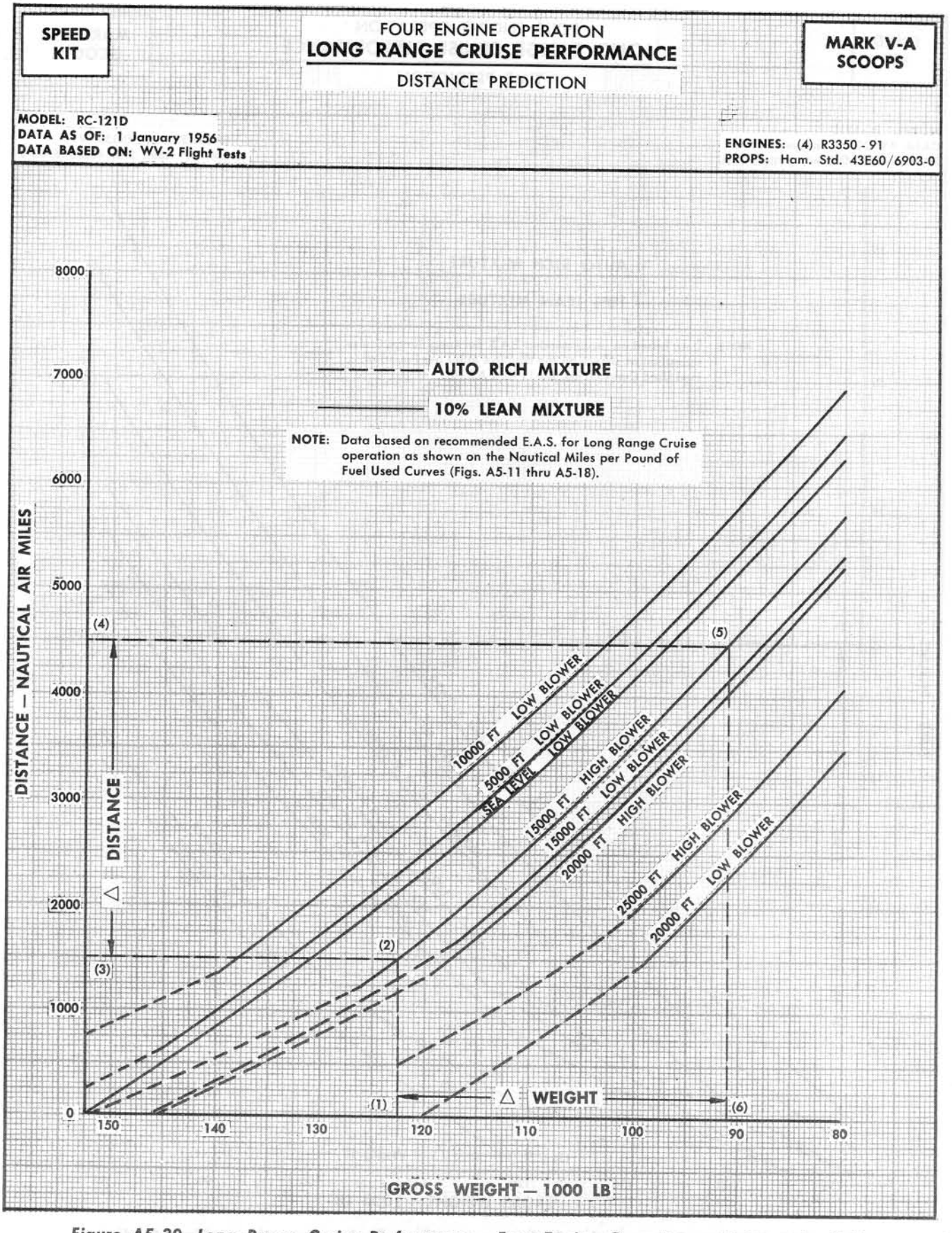


Figure A5-30. Long Range Cruise Performance —Four Engine Operation — Distance Prediction

SPEED KIT

THREE ENGINE OPERATION
LONG RANGE CRUISE PERFORMANCE
TIME PREDICTION

MARK V-A SCOOPS

MODEL: RC-121D
DATA AS OF: 1 January 1956
DATA BASED ON: WV-2 Flight Tests

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0

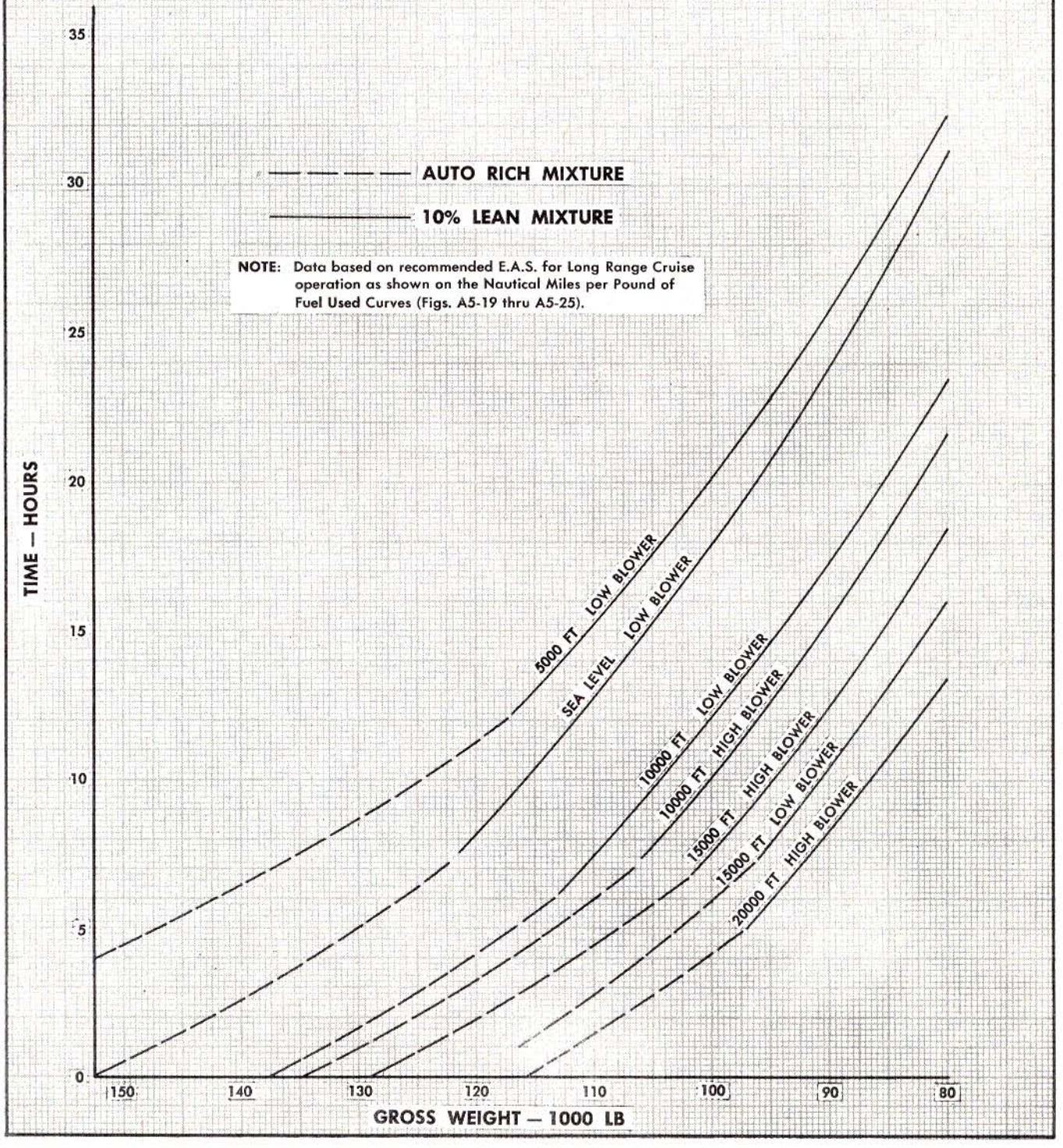


Figure A5-31. Long Range Cruise Performance — Three Engine Operation — Time Prediction

SPEED KIT

THREE ENGINE OPERATION
LONG RANGE CRUISE PERFORMANCE
DISTANCE PREDICTION

MARK V-A SCOOPS

MODEL: RC-121D
DATA AS OF: 1 January 1956
DATA BASED ON: WV-2 Flight Tests

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0

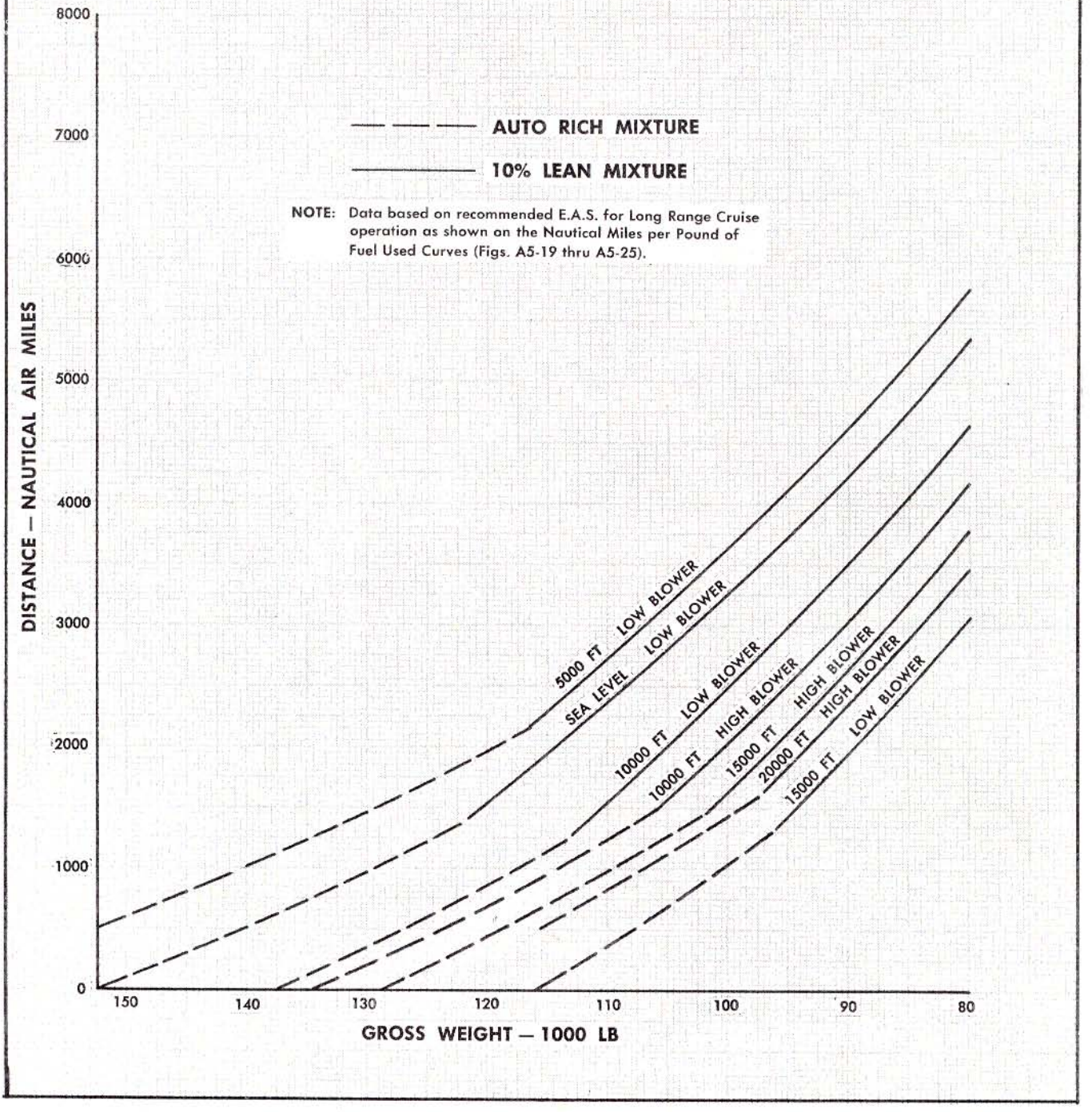


Figure A5-32. Long Range Cruise Performance — Three Engine Operation — Distance Prediction

SPEED KIT

TWO ENGINE OPERATION
LONG RANGE CRUISE PERFORMANCE
TIME PREDICTION

MARK V-A SCOOPS

MODEL: RC-121D
DATA AS OF: 1 January 1956
DATA BASED ON: WV-2 Flight Tests

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0

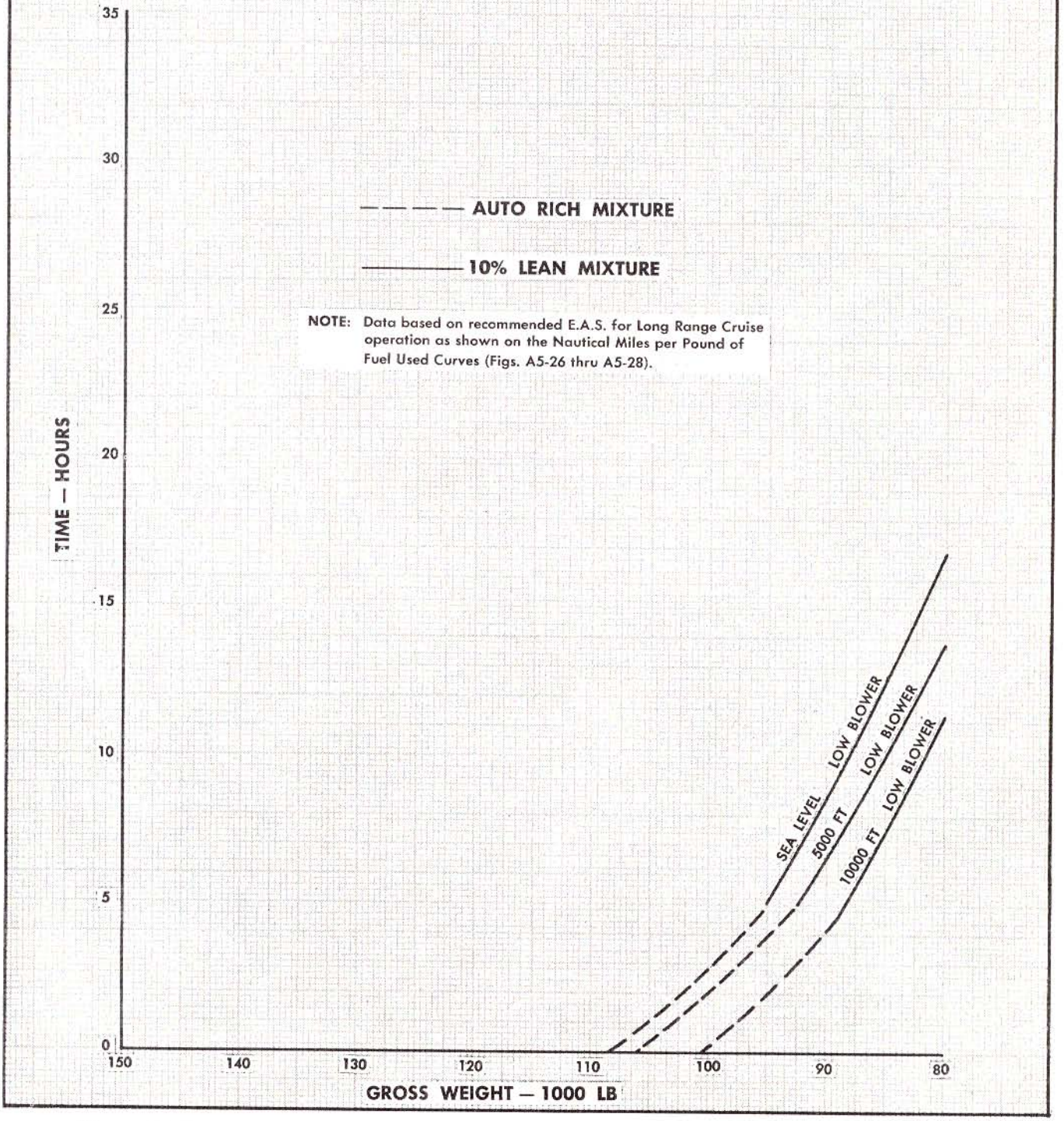


Figure A5-33. Long Range Cruise Performance — Two Engine Operation — Time Prediction

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PART 6 — ENDURANCE

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Recommended Search Endurance Performance — Four Engine Operation — Time Prediction	A6-2*
Maximum Endurance Performance — Four Engine Operation — Time Prediction	A6-3*
Maximum Endurance Performance — Three Engine Operation — Time Prediction	A6-4*

* Indicates Illustration Pages

INTRODUCTION.

Two cruising control procedures are presented in this part: the first is for use during search procedures and consists of flying at a constant deck angle; the second is used where maximum endurance is desired rather than maximum range. For the latter type of cruising, time prediction graphs are included for three as well as four engine operation.

SEARCH PERFORMANCE.

A speed schedule which will allow maintenance of a 4½ degree pitch angle is provided for search procedures. Performance is shown on Figure A6-1 and is also shown on the miles per pound curves. The endurance which will be obtained by following this airspeed schedule will be slightly less than that obtained from using the recommended maximum endurance speed schedule, but will be greater than if recommended maximum range speeds are used.

The main search equipment for the RC-121D is located of necessity, in such a manner that airplane attitude may affect searching efficiency. The normal deck angle limits which must be imposed during radar operations are considered to be + 2½ degrees to + 6½ degrees. It should be noted that at these limits the APS/45 radar set (located on top of the fuselage) stabilization is reduced to 3 degrees. The main search radar set (APS/20B) antenna is mounted below the fuselage in such a manner that the radar antenna is level when the aircraft's inclinometers read + 4½ degrees. The antenna itself is tiltable and gyro-stabilized. An angle of plus or minus 8 degrees above and below the horizontal is possible when the aricraft deck angle is 4½ degrees. The 8 degrees of scanning angle is reduced both above and below the horizontal as the limits noted above are approached. The search speed schedule (Figure A5-11) was therefore determined for the airplane angle of attach which results in a 4½ degree deck angle.

MAXIMUM ENDURANCE SPEED SCHEDULE.

Maximum Endurance Cruising time prediction graphs are shown in Figures A6-2 and A6-3. These charts may be used to compute fuel burned during holding.

In order to obtain maximum endurance, the slowest practicable airspeeds and the lowest practicable altitudes should be used so that engine power requirements and fuel flow may be reduced to a minimum. The recommended maximum endurance power settings are based on speeds 10% greater than that for absolute minimum power required. This speed schedule results in slightly higher than absolute minimum fuel flows, but it represents a practicable flight condition which permits operation in mild to moderate turbulence. (See Figure A5-11 through A5-28).

Extension of the wing flaps *decreases the speed* at which *minimum power* required for flight will be obtained. Deck angle is decreased for a given flight speed, and the ease with which a low airspeed can be maintained is increased. However, extension of the wing flaps increases the minimum power setting required for level flight and decreases the endurance time available. In addition, prolonged operation with wing flaps extended is not desirable from the point of view of flap structure durability.

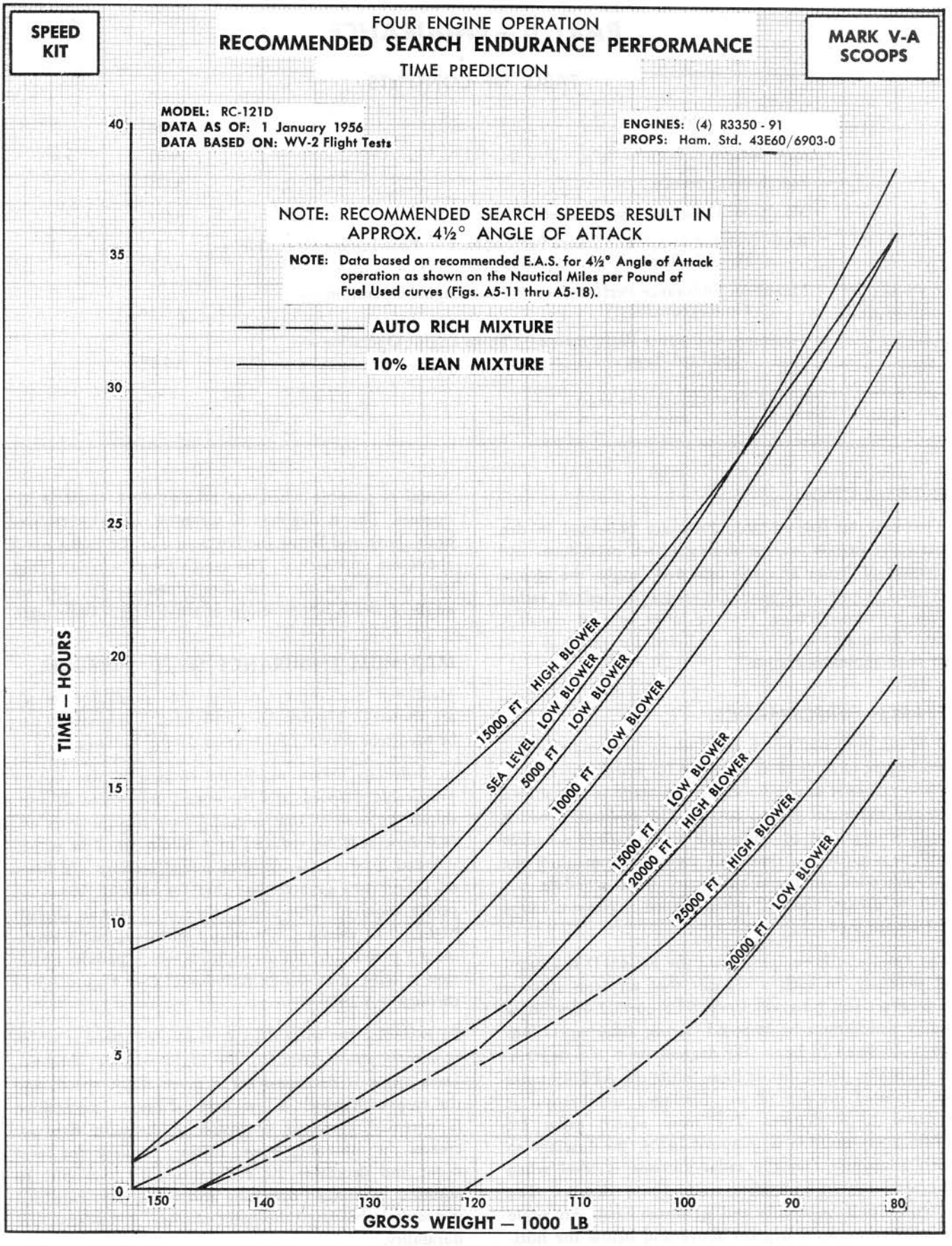

Figure A6-1. Recommended Search Endurance Performance — Four Engine Operation — Time Prediction

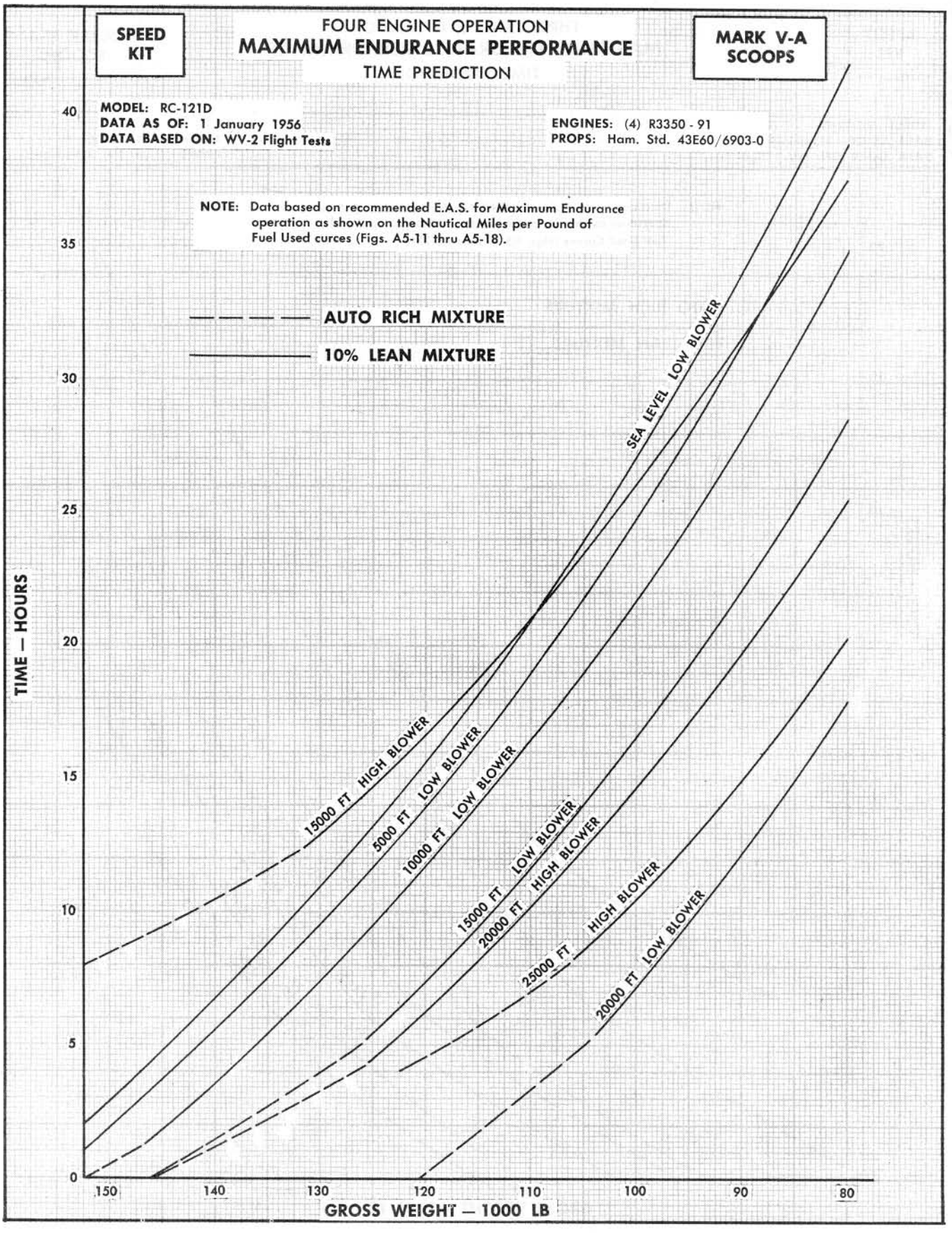

Figure A6-2. Maximum Endurance Performance — Four Engine Operation — Time Prediction

SPEED KIT

THREE ENGINE OPERATION
MAXIMUM ENDURANCE PERFORMANCE
TIME PREDICTION

MARK V-A SCOOPS

MODEL: RC-121D
DATA AS OF: 1 January 1956
DATA BASED ON: WV-2 Flight Tests

ENGINES: (4) R3350 - 91
PROPS: Ham. Std. 43E60/6903-0

NOTE: Data based on recommended E.A.S. for Maximum Endurance operation as shown on the Nautical Miles per Pound of Fuel Used Curves (Figs. A5-19 thru A5-25).

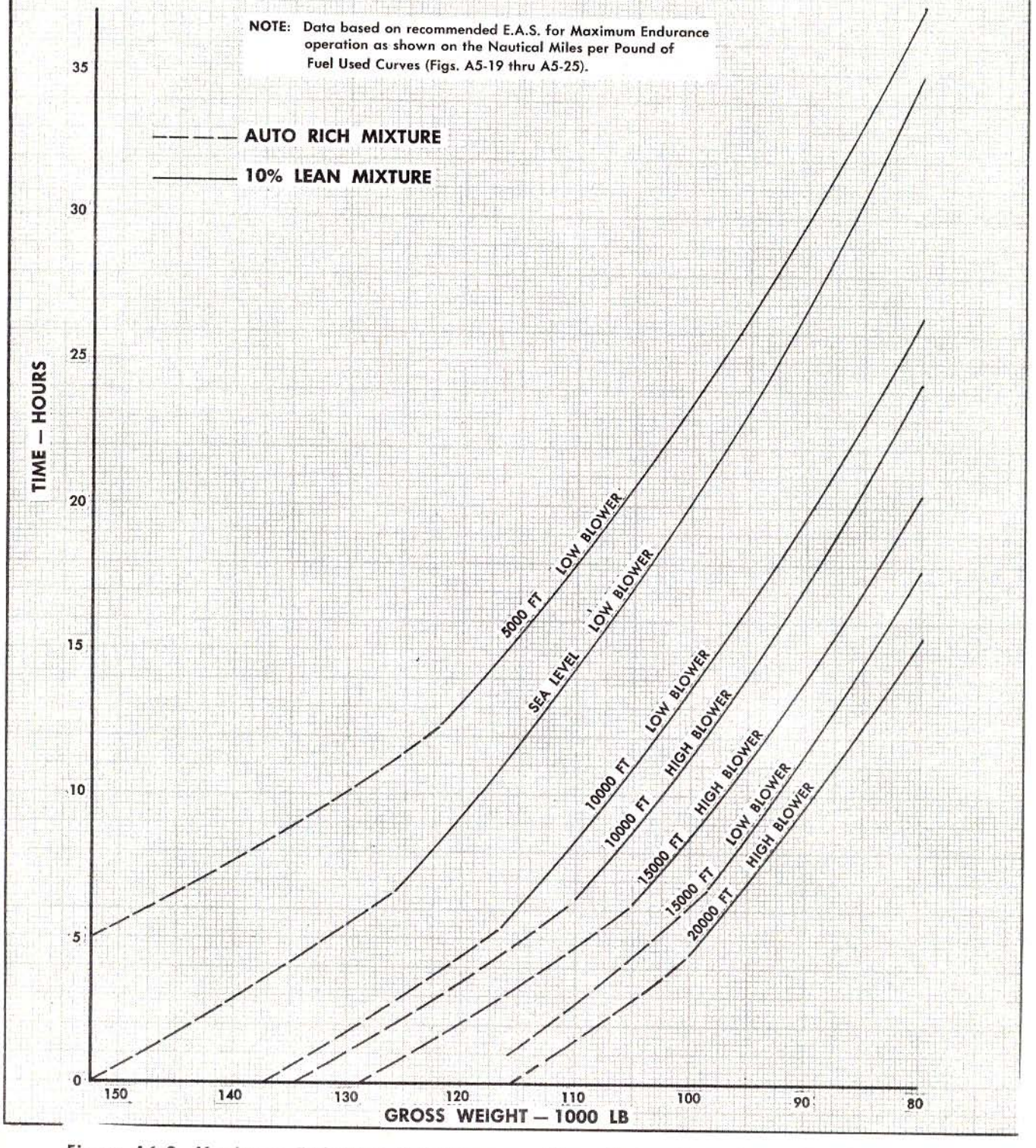

Figure A6-3. Maximum Endurance Performance — Three Engine Operation — Time Prediction

PART 7 – LANDING

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* Indicates Illustration Page

LANDING DISTANCE.

A graph showing landing ground roll distances for various gross weights, altitudes, and winds is shown on Figure A7-1 with an example showing the method for using the curve. Values given represent stopping distances obtainable if hard wheel braking is used without allowing the tires to slide, and provided schedules shown are observed. A note is included on the curve which permits estimation of the minimum distance to clear a 50 ft. obstacle and stop if power-off approach procedure is used; that is, if idle power is used from the 50 ft. obstacle clearance point to touchdown.

The use of reverse thrust in conjunction with wheel braking will reduce the landing ground roll shown considerably. If used, it should be applied as quickly as possible after touchdown since this type of braking is most effective at higher speed.

High power approach procedure may be used to reduce touchdown speeds and ground roll distances from those shown in Figure A7-1. Approach speeds at 50 ft. height can be reduced somewhat from power-off values, and touchdown speeds can be reduced to the power-off stall speed values shown in the following table. However, use of this procedure will not result in the shortest overall distance to clear a 50 ft. obstacle, land, and stop. The angle of the approach flight path is not as steep as that for normal procedure. High power approach procedure is not recommended unless waranted by an extremely short runway with a long, clear approach path.

LANDING SPEED TABLE
NORMAL PROCEDURE

Landing Gross Weight	*CAS at 50 Ft. Height Knots*	*CAS at Touchdown Knots*
80,000	96	85
85,000	99	88
90,000	102	90
95,000	104	93
100,000	107	95
105,000	111	98
110,000	113	100
115,000	115	102
120,000	118	104
122,000	119	105

MINIMUM GROUND ROLL PROCEDURE —
POWER APPROACH

Landing Gross Weight	*CAS at 50 Ft. Height Knots*	*Power Off Stall Speed CAS Knots*
80,000	84	77
85,000	87	80
90,000	89	82
95,000	91	84
100,000	93	86
105,000	96	89
110,000	98	91
115,000	100	93
120,000	102	95
122,000	103	96

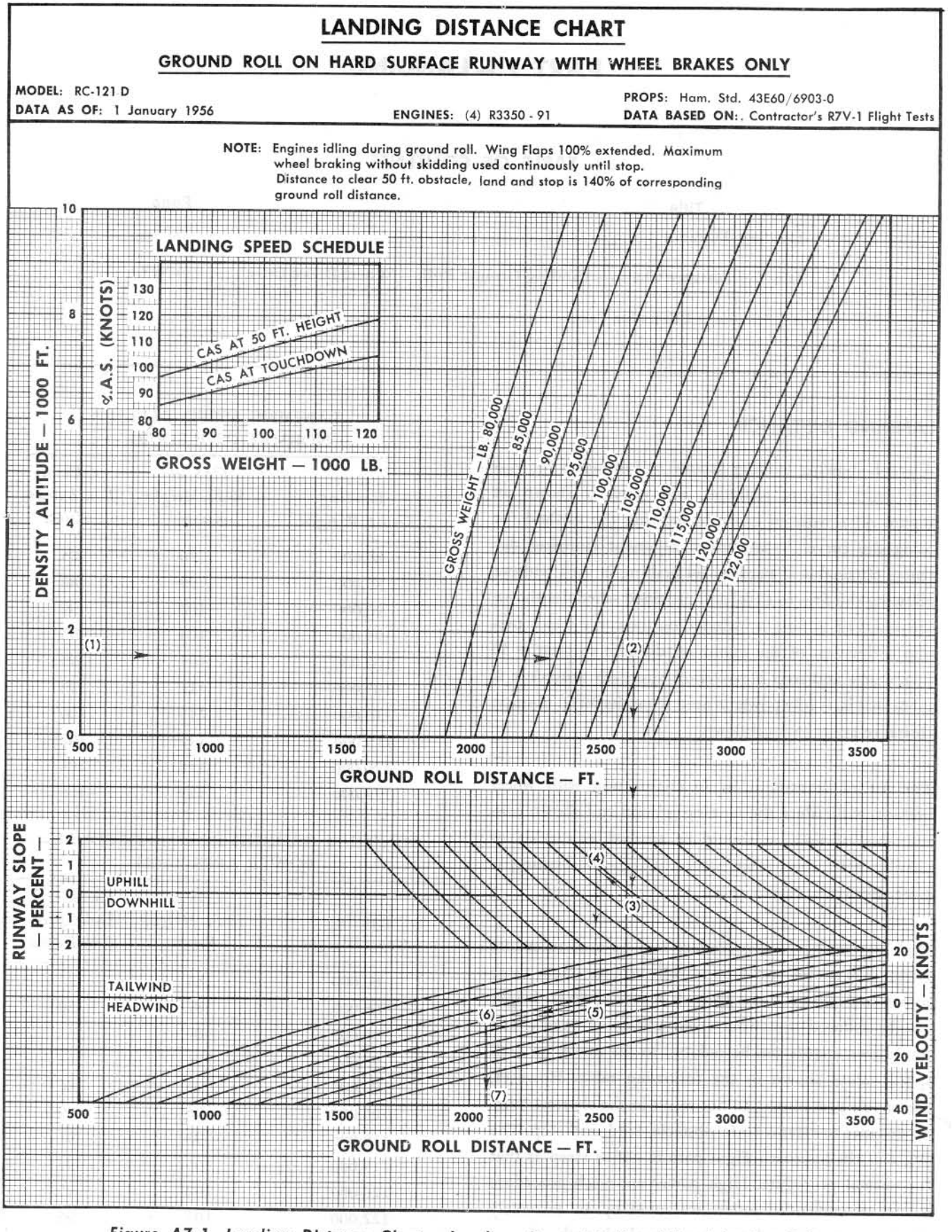

Figure A7-1. Landing Distance Chart —Landing Ground Roll — Wheel Brakes Only

PART 8 — USE OF CHARTS AND SAMPLE PROBLEM

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USE OF CHARTS AND SAMPLE PROBLEM.

The following general procedures and example problem are intended as an aid in gaining familiarity with the performance data presented and its application to practical operational problems.

PRE-FLIGHT PLANNING.

When the basic mission is known perform the following operations in advance of boarding the aircraft, to develop a flight plan which will make most effective use of the aircraft.

1. Determine what fuel reserves are to be carried, and what alternate bases are available for landing.

2. Determine the weight to which the aircraft must be loaded to accomplish the mission.

3. Prepare a flight plan which incorporates the information obtained.

4. Determine performance available and procedures to be followed in the event of an emergency during take-off or during flight.

5. Decide what procedures are to be followed in the event of an unexpected contingency, such as re-routing because of weather.

SAMPLE PROBLEM.

The following sample problem is presented to illustrate the use of the charts, and may or may not be typical of normal operation. Some flight plans will require a more detailed analysis if maximum efficiency is to be obtained. Others, such as local training flights, will require considerably less planning.

MISSION.

Make a long range flight from McClellan AFB, Sacramento, California to Hickam AFB, Honolulu, with Hilo as the alternate. The trip distance is 2180 nautical miles, the distance from the destination to the alternate is 190 nautical miles. Compute fuel reserves on the basis of 10% of trip fuel plus two hours holding at the alternate. Assume the aircraft's zero fuel weight to be 92,000 pounds.

Take-off Conditions.

a. Runway length—7000 feet

b. Pressure altitude—100 feet

c. Outside Air Temperature—80°F

d. Dew Point—60°F

e. Runway Slope—0%

f. Headwind—10 knots

Enroute Conditions.

a. Winds to Destination: 10 knot headwind at Sea Level
15 knot headwind at 10,000 ft.
20 knot headwind at 20,000 ft.

b. Wind—Destination to Alternate: 15 knot headwind at 10,000 ft.

DETERMINE THE FOLLOWING ITEMS.

Fuel Requirements.

a. Holding Fuel Requirements

b. Cruise fuel from destination to alternate

c. Level flight enroute fuel

d. Climb fuel using METO power to cruise altitude

e. Enroute reserve fuel

f. Warm-up, taxi, and take-off allowance

Power and Range Data.

a. Power settings

b. Flight progress graph

c. Three-engine cruising

Take-off and Landing Performance.

a. Take-off power available

b. Take-off and landing data cards

Determination of Fuel Requirements.

(a) Holding Reserve at the Alternate: This portion of the reserve is normally computed at 10,000 ft. density altitude using Maximum Endurance Cruising. Enter the maximum endurance time prediction graph (Fig. A6-2) with the zero fuel weight of 92,000 lbs. and read 26.55 hrs. at the 10,000 ft. density altitude line. The 2 hour holding time is subtracted from 26.55 hrs. to give 24.55 hrs. The graph is re-entered at 24.55 hrs., and a weight of 95,200 lbs is read. Holding reserve is then 95,200 —92,000 lbs. or 3200 lbs.

If desired, this portion of the reserve can be computed or checked using the miles per pound graphs at the holding speeds on Fig. A5-13. For computing, an average gross weight would have to be estimated; for checking, the average gross weight as determined from the above data would be 93,600 lbs. For the latter weight, the value of mi./lb. is 0.102, and the true airspeed is 164 knots. The total fuel flow for this specific range is (164 knots)/(0.102 mi./lb.) or 1608 lbs./hr. Round off to 1600 lbs./hr. The two hour holding reserve would then be 3200 lbs., and the initial weight is 92,000 + 3200 or 95,200 lbs.

(b) Cruise Fuel from Destination to Alternate. This portion of the reserve is normally computed at 10,000 ft. density altitude using Long Range Cruising. First of all, an estimate should be made of this portion of the reserve fuel. For this example, assume 2000 lbs. to obtain an average gross weight of 96,200 lbs. Entering the 10,000 ft. miles per pound graph (Fig. A5-13) using 96,200 lbs., read the true airspeed as 198 knots, and the mi./lb. as 0.1016. Fuel flow would then be (198 knots)/(0.1016 mi./lb.) or 1950 lbs./hr. Ground speed would then be 198-15 or 183 knots; and flight time (190/183) or 1.04 hrs. Fuel required would be 1950 x 1.04 or 2300 lbs. If this value differed greatly from the initially assumed value (2000 lbs.), the computation would have to be repeated with a different average gross weight. Landing at destination would then be 95,200 + 2030 or 97,230 lbs. provided the 10% enroute fuel reserve were utilized. The reserve can also be computed or checked by the use of the long range distance prediction graph (Fig. A5-30). The fuel required must be determined by using air miles rather than ground miles in the calculations. Air miles are ground miles multiplied by the ratio of true airspeed to ground speed. This speed ratio is 198/(198-15) or 1.081, and air distance is 190 x 1.081 or 205 nautical miles. Enter the graph at 95,200 lbs. and read the distance value of 5250 miles. Re-enter the graph at 5250-205 or 5045 miles and read a weight of 97,200 lbs. Reserve fuel would then be 97,200-95-200 or 2000 lbs. Note that because of the smaller scale of this graph, the accuracy is not quite as great as that obtained by use of the specific range graphs. However, reading fuel requirements to the nearest 100 pounds is considered to be sufficiently accurate for flight planning purposes.

(c) Level Flight Enroute Fuel. Since the zero fuel weight is low, for this example, a large variety of cruising procedures could be used for this flight, i.e. long range, maximum cruise power, constant intermediate power, etc. Assume, however, that low fuel consumption and low engine power requirements are the primary factors in this mission. An examination of the specific range curves indicates that Long Range Cruising at 10,000 ft. density altitude would be most advantageous for this problem.

The simplest procedure for obtaining cruise fuel would be to include the 10% reserve in the computation. To do this, add 10% to the cruise distance to obtain a total distance of 2398 nautical miles. A tabular method of computation is recommended, with gross weight brackets of 3000 pounds. The tabular method also permits using zonal winds, if desired, rather than an average wind component for the flight. Using Fig. A5-13 proceed as follows:

(1) Gross Weight Bracket	(2) TAS-Knots	(3) Mi./Lb.	(4) Lbs./Hr. (2)/(3)	(5) G.S. Knots	(6) Time (1)/(4)	(7) Dist. N.M. (5)/(6)	(8) Total Dist. N.M.
97,200 - 98,500	200	.1005	1990	185	0.65	121	121
98,500-101,500	202	.0985	2050	187	1.46	274	395
101,500-104,500	204	.0965	2120	189	1.41	268	663
104,500-107,500	206	.0945	2180	191	1.38	263	926
107,500-110,500	208	.0925	2250	193	1.33	258	1184
110,500-113,500	210	.0905	2320	195	1.29	252	1436
113,500-116,500	212	.0890	2380	197	1.26	248	1684
116-500-119,500	214	.0865	2470	199	1.21	242	1926
119,500-122,500	216	.0845	2560	201	1.17	235	2161
122,500-125,600	219	.0823	2660	204	1.16	237	2398

Note that the first weight bracket is determined by the gross weight at destination. The last bracket is found by working backwards from the distance remaining to the start of the flight. The value of 125,600 lbs. represents the gross weight at the beginning of the flight *plus a climb allowance.*

(d) Climb allowance for METO Power. The foregoing computation did not allow for the rich mixtures and low airspeeds used during climb. To determine this allowance, assume a take-off gross weight; for this example, 126,000 pounds. From Fig. A4-1, time to climb is 9.5 minutes and fuel used is 1200 lbs. EAS is 155 knots, and using the value of 1/½ at 5000 ft., average TAS is 167 knots. Using an average wind component between sea level and 10,000 feet of 12.5 knots, climb distance would be 9.5/60 (167-12.5) or 25 miles.

From the data on the last line of the level flight tabulation, the level flight fuel required to fly 25 miles would be (25/204) x 2660 or 300 lbs. (rounded off). Thus, the climb allowance would be 1200—300 or 900 lbs., and the weight at take-off would be 125,600 + 900 or 126,500 lbs.

(e) Enroute Reserve Fuel. As determined by the preceding paragraphs, total enroute fuel including reserve would be 126,500 —97,200 or 29,300 lbs. Of this the enroute reserve fuel would be 10% or 2930 lbs. (Round off to 2900 lbs).

(f) Warm-up, Taxi and Take-off Allowance. To allow for the fuel used from the time the engines are started until the aircraft becomes airborne, a fixed quantity of fuel is added to all other fuel requirements. For this example a value of 800 lbs. is used, which brings the total gross weight at the blocks up to 127,300 lbs., and the total fuel on board equal to 127,300—92,000 or 35,300 lbs.

The data determined in the preceding paragraphs can be summarized as follows:

	Fuel Required Lbs.	*Airplane Weight Lbs.*
Zero Fuel Weight		92,000
Holding reserve	3200	
Cruise—destination to alternate	2000	
Cruise to destination	25,200	
Climb to altitude	1200	
Warm-up, taxi and take-off	800	
10% of trip fuel	2900	
Total fuel on board	35,300	
Gross weight at blocks		127,300

Weight at start of cruise = (127,300—800—1200) = 125,300 lbs.

Weight at destination = (125,300—25,200) = 100,100 lbs. provided the trip reserve is not used.

Power and Range Data.

(a) Power Settings. The power settings required to realize the long range performance determined in the flight plan can be obtained from the specific range graph (Fig. A5-13). For these settings, it is convenient to use 3000 lb. weight brackets since the miles per pound data are shown for that increment. For the sample problem, select 125,300 lbs. to 122,500 lbs. for the first weight bracket, where 125,300 lbs. is the weight at the start of cruise. On Fig. A5-13 for the average long range cruising airspeed approximating that used in the flight plan, select the corresponding power settings by inter-

polation: 1695 BHP, 2275 RPM, and 176 BMEP. Total fuel flow, in pounds per hour, may be found by dividing miles per pound into true airspeed. However, a more accurate check of engine performance will be obtained by using the engine fuel flow curves for each power setting. Enter these curves with the actual pressure altitudes encountered during the flight.

By selecting the remaining weight brackets and by starting at 122,500 lbs. and subtracting 3000 lbs. each time, the average weights will coincide with the weight lines plotted on the graph, thereby facilitating selection of power settings. Normally, it will be satisfactory to select the closest plotted power setting corresponding to the intersection of weight and airspeed.

(b) Flight Progress Graph. From the tables in part A of this section, time and distance values together with the climb data and fuel reserves may be used to plot a "Flight Progress Chart." On this graph, time and distance are usually plotted versus pounds of fuel. Three engine return and three engine ahead predictions should also be made and plotted to determine the "point of no return" and the "equi-time point." This graph provides a constant check of the progress being made during the flight by showing a comparison of actual with predicted performance.

(c) Three Engine Cruising. The effect on range of losing an engine during the flight normally should be considered. From the weight determined at the equi-time point, the three engine range can be computed by use of the three engine specific range graphs and by tabulating the data in a manner similar to that illustrated for four engines in part A of this section. Whenever possible, a low enough altitude should be selected so as to avoid the necessity of using "Auto Rich" mixtures. For this sample problem, the weights encountered during the latter portion of the trip are so low that the decrease in specific range for three engine operation is negligible. This can be readily checked by comparing the three and four engine specific ranges at these weights at 10,000 feet density altitude and the long range cruising airspeeds corresponding to each type of operation.

Take-off Performance.

Although the example field length available is ample, take-off performance should be checked and the take-off and landing data cards filled out. This will include the determination of a check distance and speed using the go-no-go concept as discussed in Part 3.

(a) Determination of Power Available. Determine power available for take-off from Figure A3-1. In order to use the graph in accounting for humidity effect, vapor pressure must be known. This may be obtained from Fig. A2-9 as discussed in Part 3. Enter Figure A2-9 with the dewpoint value of 60°F, proceed with the sequence shown, and read a vapor pressure value of 0.52 inches Hg. Enter Fig. A3-1 with this vapor pressure and read 56.75 inches Hg. as the manifold pressure limit. Now, using this manifold pressure limit and the air temperature of 80°F, proceed through the graph with the sequence shown to read a dry day power of 3270 BHP. To correct this dry day power for humidity, project horizontally to the zero P_v base line, then parallel to the altitude guide line (100 ft. H_p) to a position above the original P_v value of 0.52 inches Hg. Horizontally from this position read a maximum power of 3150 BHP, maximum BMEP of 256, and reject BMEP of 251.

Next, determine precent power deviation from standard using Figure A3-3. Enter at 100 ft. pressure altitude and follow the guide lines to a runway air temperature of 80°F. Proceed horizontally from this point to the predicted power available of 3150 BHP just determined from Figure A3-1. Read percent loss as 2%.

(b) Take-off and Landing Data Cards. Take-off and landing data are obtained from Parts 3 and 7 and recorded as follows on that data card. For conservatism, the landing weight should be based on not utilizing the 10% enroute reserve fuel. Landing distance and speed are obtained from Figure A7-1, and, for this example, assume a sea level pressure altitude, zero wind, zero slope, and a temperature of 80°F.

TAKE-OFF DATA

Conditions

Gross Weight @ Take-Off ..... 127,300 lb.
C.G. Location — % MAC _____
Runway Length Available ..... 7000 ft.
Runway Wind ..... 10 Knot Headwind
Runway Air Temperature ..... 80°F
Field Pressure Altitude ..... 100 ft.
Dew Point ..... 60°F
Runway Slope 0

Data Resulting from Conditions

BMEP — Expected: 256 Minimum: 251
Normal 4 Engine Take-Off Distance: 3500 ft. Speed: 122 kkts.
Refusal Distance: 4000 ft. Refusal Speed: 122 Kts.
Acceleration Check Point Distance: 2000 ft. Speed @ Check Point: 95 kts.
Critical Field Length: 6100 Critical Speed for Engine Failure: 113 kts.
Three Engine Climb Speed ..... 122 kts.

LANDING DATA

Gross Weight @ Landing ..... 100,100 lbs.
Normal Landing Distance ..... 2300 ft.
Landing Speed — @ 50 Foot Height ..... 107 kts; @ Touchdown ..... 95 kts.

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