T.O. 1B-36H (III)-1

FLIGHT HANDBOOK

USAF SERIES B-36H-III AIRCRAFT

This publication was complete at the time of issue since there were no outstanding Safety of Flight Supplements.

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

PUBLISHED UNDER THE AUTHORITY OF THE SECRETARY OF THE AIR FORCE AND CHIEF OF THE BUREAU OF AERONAUTICS

69-115-A

26 NOVEMBER 1954

AFPS—SA—12-54-1000

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IMPORTANT

To Gain The Maximum Benefits From This Handbook, Read The Personal Message On This Page Carefully.

69-162-A

This handbook contains all the information necessary for safe and efficient operation of the B-36 airplanes. The instructions do not teach basic flight principles but 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 are avoided.

The only source of current, technically accurate operating instructions is your Flight Handbook. Instructions in the handbook are based on the technical knowledge of the aircraft manufacturer and the Air Force, as well as on the experience of the using commands. This handbook has no similarity to your old -1 Technical Order. Here your specific problems have been considered - - - - - current and accurate information is presented to you in an attractive and usable form. Not all Flight Handbooks have been prepared in accordance with the new requirements, but you can easily tell the new from the old. New type handbooks have a full page cover illustration; old type books have only a small "spot" illustration.

Each flight crew member *except those attached to an administrative base* is entitled to a personal copy of the flight handbook while he is stationed at a given base. Do not let any one tell you differently! *Air Force Regulation 5-13,* issued in 1953, specifically makes this provision.

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

The Technical Order system is very easy to cope with. *Technical Order 00-5-2* explains in a very few pages the easy means by which you can set the automatic machinery in motion. Actually, all you have to do is register your required quantities on the *Publications Requirements Table, T.O. 0-3-1;* then all revisions, reissues, and supplements will be automatically forwarded to you in the same quantities. Talk to your base supply officer—he should know all about the system since it is his job to fulfill your technical order requests. Each base must develop a system of feeding the handbooks and related data to their flight crew members so that no one will be using an obsolete book.

One more thing - - - we admit it takes a long time to revise the Flight Handbook. And, since the time lag is excessive for safety of flight information, a new program has been put into effect to get such information to you in a hurry. This is done by means of Safety of Flight Supplements which use the same number as your flight handbook except for the addition of a suffix letter. Supplements covering loss of life will get to you in 48 hours; those concerning serious damage to equipment will make it in six days. And what do you have to do to get these supplements? Absolutely nothing! If you have ordered your Flight Handbook on the Publications Requirements Table, you will automatically receive all supplements pertaining to your aircraft. (Additional information regarding these supplements can be obtained from T.O. 00-5-1E.)

Just as it is necessary to have a thorough knowledge of the airplane in order to operate it efficiently, so must you understand the arrangement of this handbook in order to benefit from it fully. A list of the sections and the type of information contained in each is given here to aid you in using your handbook.

Your comments and questions regarding any phase of the Flight Handbook program are invited. They should be directed to the Wright Air Development Center, Attn: WCSOH.

The handbook is divided into nine sections and an appendix as follows:

SECTION I, DESCRIPTION—A detailed description of the airplane and all its systems and controls which contribute to the physical act of flying the airplane. Also, this section includes all the emergency equipment that is not part of an auxiliary system. This section is reserved solely for descriptive material and, therefore, does not contain any operating procedures.

SECTION II, NORMAL PROCEDURES—A section containing the procedures to be accomplished from the time the airplane is approached by the flight crew until it is left parked on the ramp after accomplishing one complete flight under normal conditions.

SECTION III, EMERGENCY PROCEDURES—Specific instructions to be followed by the crew under all emergency conditions (except those connected with the auxiliary equipment) that could reasonably be expected to be encountered.

SECTION IV, DESCRIPTION AND OPERATION OF AUXILIARY EQUIPMENT—A section including the description, normal operation, and emergency operation of all equipment not directly contributing to flight, such as armament, radio, oxygen, etc.

SECTION V, OPERATING LIMITATIONS—A section covering all important limitations that must be observed during normal operation.

SECTION VI, FLIGHT CHARACTERISTICS—A section describing the unique flight characteristics of the airplane.

SECTION VII, SYSTEMS OPERATION—A discussion of the operation of the various airplane systems under all conditions of airplane operation.

SECTION VIII, CREW DUTIES—An amplified check list covering a discussion of the primary and alternate functions of each crew member.

SECTION IX, ALL WEATHER OPERATION—A supplement to Section II providing additional instructions for turbulent air and instrument flying and for cold weather, desert, and tropical operation.

APPENDIX I, OPERATING DATA CHARTS—A section containing operating data essential to flight planning.

AIRPLANE GROUP NUMBER CODE.

Airplanes having a particular control or system in common have been assigned group numbers to avoid breaking the continuity of the text with the listings of airplane serial numbers. The groups with the airplanes they include and the items that are peculiar to each group are listed as follows:

GROUP 1 — Deleted.

GROUP 2 — Deleted.

GROUP 3 — Three-position windshield wiper control switch; relocation of blood plasma kit to forward bulkhead of aft cabin—Airplane USAF Serial No. 51-5724 and subsequent.

GROUP 4 — Deleted.

GROUP 5 — Instrument approach equipment AN/-ARN-5B replaced by AN/ARN-18 — Airplane USAF Serial No. 52-1343 and subsequent.

GROUP 6 — Deleted.

GROUP 7 — Liaison radio set AN/ARC-21X replaces AN/ARC-8. Interphone set AN/AIC-10 replaces USAF combat interphone equipment—Airplane USAF Serial No. 52-1354 and subsequent.

GROUP 8 — Navigator's directional gyro and two-position on-off switch installed — Airplanes USAF Serial No. 50-1083 through 51-5742.

Table of Contents

THE B-36H-III AIRPLANE

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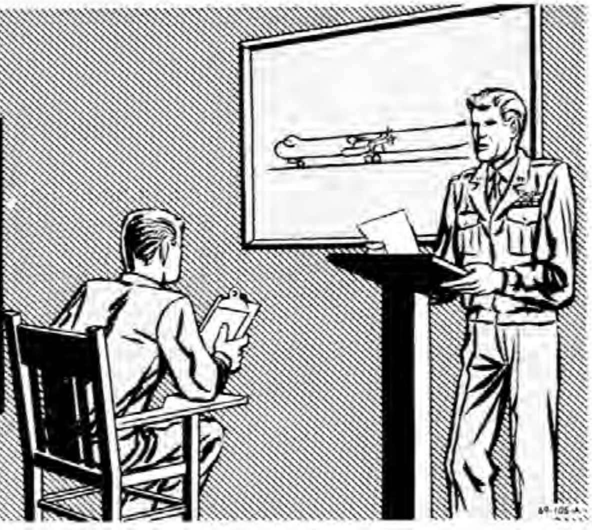
SECTION I
Description



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THE AIRPLANE.

The B-36H, built by Consolidated Vultee Aircraft Corporation, is a long-range, high altitude, heavy, bombardment airplane. Its tactical mission is the destruction of land and naval objectives by bombing. Six Pratt and Whitney R4360-53 reciprocating engines drive pusher-type Curtiss propellers which can be synchronized in normal or reverse pitch. Additional power is provided by four General Electric J47-19 jet engines. The control surfaces consist of servo-tab-operated ailerons, elevators, and rudder. The flap system consists of three pairs of flaps. Four a-c alternators, driven by four of the reciprocating engines through constant-speed drives, furnish the power to operate the airplane's electrical equipment. A portion of the a-c power is rectified to provide d-c power and electrical control. The landing gear, the brakes, the bomb bay doors, and the nose wheel steering system are hydraulically operated. The crew compartments are pressurized, heated, and ventilated, and provided with an oxygen system for emergency use. Compartment heating; enclosure defrosting; and wing and tail anti-icing are accomplished by heated air. Heat for the air is obtained through the use of heat exchangers installed in the reciprocating engine exhaust systems. Offensive armament consists of four bomb bays which are designed to carry 500-, 1000-, 2000-, 4000-, 12,000-, 22,000-, and 43,000-pound bombs. In addition 100-, 115-, 125-, 250-, 325-, and 350-pound bombs can be carried at the 500-pound stations. Defensive armament consists of a non-retractable, radar-controlled tail turret containing two 20-millimeter guns.

DESIGN GROSS WEIGHT.

The design gross weight is 357,500 pounds.

FLIGHT CREW.

The normal flight crew consists of 13 men as follows:

FORWARD CABIN
- Aircraft Commander
- Pilot
- Copilot
- First Engineer
- Second Engineer
- Navigator
- Radar Observer
- Observer
- First Radio Operator (ECM Operator)
- Second Radio Operator

AFT CABIN
- Lower Aft Scanner (Right)
- Lower Aft Scanner (Left)
- Tail Gunner

Airplane Dimensions

Approximate overall dimensions are as follows:

- **Length . . . . 162 feet, 2 inches**
- **Wing Span . . . . 230 feet**
- **Height (to top of fin) . 46 feet, 10 inches**
- **Wing Area . . . . 4772 square feet**

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RECIPROCATING ENGINES.

The airplane is primarily powered by six pusher-type Pratt and Whitney R4360-53 Wasp Major engines. Each engine has 28 cylinders which are arranged helically in seven four-row banks around the crankshaft which rotates counterclockwise as viewed from aft of the wing. A direct fuel injection system supplies fuel to the 28 cylinders through individual lines. Each engine is equipped with a water injection system which permits the horsepower rating to increase from 3500 (dry) to 3800. A torquemeter system for each engine measures the torque transmitted by the crankshaft to the propeller. This measurement is used to determine the actual power output of the engine. Carburetor and engine cooling air enters each nacelle at the wing leading edge. The flow of engine cooling air is augmented by an engine-driven fan. Controls are provided for varying the temperature of carburetor air and two turbosuperchargers maintain the required carburetor inlet pressure for each engine during high altitude operation. The cylinders of each engine are fired by a four-magneto, low tension ignition system. A two-position controllable spark advance system permits efficient engine operation over a wide range of power settings.

THROTTLE CONTROLS.

A set of throttle levers (23, figure 1-9) on the pilots' pedestal is mechanically interconnected with a set of throttle levers (24, figure 1-16) at the engineers' table. A lock lever (21, figure 1-9) on the pilots' pedestal will lock the throttle levers in any desired position. This lock can be overridden by the engineer.

A warning horn provides an indication of an unsafe condition of the throttle levers with respect to the position of the flaps or landing gear. The horn will sound when all six reciprocating engine throttle levers are advanced for take-off and the flaps are not extended at least 20 degrees (±4 degrees). The horn will

Main Differences TABLE

75-102-A

MODEL	DESIGN G.W. (LBS)	PRESSURIZED CREW COMPARTMENTS	CREW	ENGINEER'S STATION	RECIP. ENGINES	WING FUEL TANKS	GUN TURRETS	BOMB BAYS	BOMBING SYSTEM
B-36D	357,500	2	15	SINGLE	R4360-41	8	8	4	K( ) & UNIVERSAL
B-36D-II	357,500	2	15	SINGLE	R4360-41	8	8	4	K( ) & UNIVERSAL
B-36D-III	357,500	2	13	SINGLE	R4360-41	8	1	4	K( ) & UNIVERSAL
B-36F	357,500	2	15	SINGLE	R4360-53	8	8	4	K( ) & UNIVERSAL
B-36F-II	357,500	2	15	SINGLE	R4360-53	8	8	4	K( ) & UNIVERSAL
B-36F-III	357,500	2	13	SINGLE	R4360-53	8	1	4	K( ) & UNIVERSAL
B-36H	357,500	2	15	DUAL	R4360-53	8	8	4	K( ) & UNIVERSAL
B-36H-II	357,500	2	15	DUAL	R4360-53	8	8	4	K( ) & UNIVERSAL
B-36H-III	357,500	2	13	DUAL	R4360-53	8	1	4	K( ) & UNIVERSAL
B-36J	410,000	2	13	DUAL	R4360-53	10	1	4	K( ) & UNIVERSAL
RB-36D & E	357,500	3	22	SINGLE	R4360-41	8	8	2	CONV. & UNIVERSAL
RB-36D & E-II	357,500	3	22	SINGLE	R4360-41	8	8	2	CONV. & UNIVERSAL
RB-36D & E-III	357,500	3	19	SINGLE	R4360-41	8	1	2	CONV. & UNIVERSAL
RB-36F	357,500	3	22	SINGLE	R4360-53	8	8	2	CONV. & UNIVERSAL
RB-36F-II	357,500	3	22	SINGLE	R4360-53	8	8	2	CONV. & UNIVERSAL
RB-36F-III	357,500	3	19	SINGLE	R4360-53	8	1	2	CONV. & UNIVERSAL
RB-36H	357,500	3	22	DUAL	R4360-53	8	8	2	CONV. & UNIVERSAL
RB-36H-II	357,500	3	22	DUAL	R4360-53	8	8	2	CONV. & UNIVERSAL
RB-36H-III	357,500	3	19	DUAL	R4360-53	8	1	2	CONV. & UNIVERSAL

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also sound when the landing gear is up and locked and any throttle lever is retarded below minimum cruise. See "Landing Gear Warning Horn" and "Flap Warning Horn" of this section.

MIXTURE CONTROLS.

Two methods are available for controlling the mixture. Normally, control is accomplished electronically through the use of a set of control levers (21, figure 1-16) located on the engineers' table. Each lever is geared to a potentiometer which is located beneath the lever. Movement of the lever will move the potentiometer to originate a signal which is sent through an amplifier to an a-c actuator in the nacelle. The actuator positions the mixture control valve of the carburetor in response to the signal. In the event this method becomes inoperative, the mixture can be controlled by a set of override switches (9, figure 1-16) located on the engineers' table. These switches are connected directly to the mixture control actuators in the nacelles through an electrical circuit and provide emergency means of positioning the control valves. Both the normal and the override method of mixture control use 115-volt a-c power. No mixture controls are provided for the pilots.

Mixture Control Selector Switches.

Six two-position switches (8, figure 1-16), one for each engine, are provided to select the method of controlling the mixture. When these switches are placed in the LEVER position, the mixture control levers are effective for mixture control. When the switches are placed in the SWITCH position, the mixture control override switches become the means of controlling the mixture.

Mixture Control Levers.

Six mixture control levers (21, figure 1-16) are located on the engineers' table for normal control of the mixture. The positions on the control quadrant are IDLE CUT-OFF, NORMAL, and RICH. On engines equipped with model 391260-8, 391420-1, and 391410-1 and -2 carburetors, the NORMAL position is the automatic carburetor setting for all normal operations, such as ground operation. The range between NORMAL and IDLE CUT-OFF provides manual lean settings. The range between NORMAL and RICH provides a mixture too rich for normal engine operation; however, settings in this range can be used effectively under certain operating conditions. (Refer to "Cooling," Section VII.) On engines equipped with model 391260-3, -4, -5, and -6 carburetors, the RICH position is the automatic carburetor setting for normal operations. The range between RICH and IDLE CUT-OFF provides manual lean settings.

CAUTION

The engineer must check the carburetor on each engine, as it is possible that one airplane may have both models and will have to be operated accordingly.

Six normal mixture indicator lamps (7, figure 1-16) are provided and will glow when the mixture controls are set for normal mixture. The control quadrant is graduated with index marks for reference in positioning the control levers.

CAUTION

Should an output tube of the electronic mixture control system fail while the selector switch is in the LEVER position, the mixture can be expected to go to the idle cut-off or rich position, depending on which tube fails.

Mixture Control Override Switches.

Six mixture control override switches (9, figure 1-16), located on the engineers' table, are provided for controlling the mixture in the event the normal mixture controls become inoperative. Each switch has a spring-loaded IDLE CUT-OFF position, a spring-loaded AUTO-RICH position, and a neutral center position. No NORMAL position is provided, but a normal setting can be obtained by jiggling the switches between IDLE CUT-OFF and AUTO-RICH until the normal mixture indicator lamps light.

CARBURETOR AIR TEMPERATURE CONTROL.

Temperature control of carburetor air is accomplished by varying the volume of cooling air passing through the intercooler. This operation is accomplished through the use of intercooler shutters, which are controlled electrically from the engineers' station. Induction air may be heated before it enters the carburetor by diverting heated engine cooling air through the turbosuperchargers (figure 1-5) by means of the carburetor preheat switches. A carburetor air temperature gage (14, figure 1-18) for each engine is located on the engineers' main instrument panel.

Intercooler Shutter Switches.

The six three-position intercooler shutter switches (6, figure 1-16) are on the engineers' table. Each switch has a spring-loaded OPEN position, a spring-loaded CLOSE position, and a neutral OFF position. When a switch is held in the OPEN or CLOSE position, a 28-volt d-c control circuit energizes relays to supply 115-volt alternating current to the intercooler shutter actuators to obtain the desired carburetor air temperature. The switches can be placed simultaneously in the OPEN position by means of a gang bar.

Note

The left intercooler shutter closes automatically when a shift from dual to single turbo is accomplished.

Carburetor Preheat Switches.

Three carburetor preheat switches (3, figure 1-16) are ganged together on the engineers' table. A 28-volt d-c control circuit supplies 115-volt alternating current to the carburetor preheat actuators. Placing the switches in the ON position closes valves in the turbo air inlet ducts and opens valves in the carburetor preheat ducts. This permits heated engine cooling air, which is obtained from the engine bay, to circulate through the turbos.

CAUTION

When the preheat valves open, the cabin pressure wing shutoff valves automatically close to prevent the possibility of carbon monoxide contamination of the cabin air.

Note

Additional control of carburetor air temperature is available when carburetor preheat is on, by use of the intercooler shutter control switches.

Carburetor Air Filter Switch.

Provisions have been made for the installation of carburetor air filters. When these filters are installed, they are controlled by an ON-OFF switch-type circuit breaker on the engineers' table. Placing the switch in the ON position closes off ram air to the turbosuperchargers and draws air from the underside of the nacelle through the carburetor air filter. In the ON position the switch closes a 28-volt d-c control circuit which in turn supplies 115-volt a-c power to the carburetor air filter actuators.

TURBO SYSTEM.

Each reciprocating engine has two exhaust-driven turbosuperchargers which are used to maintain a constant carburetor inlet pressure up to 35,000 feet. The right turbo for each engine also provides pressurized air for the cabins. (See figure 4-1.)

GENERAL ARRANGEMENT *Diagram*

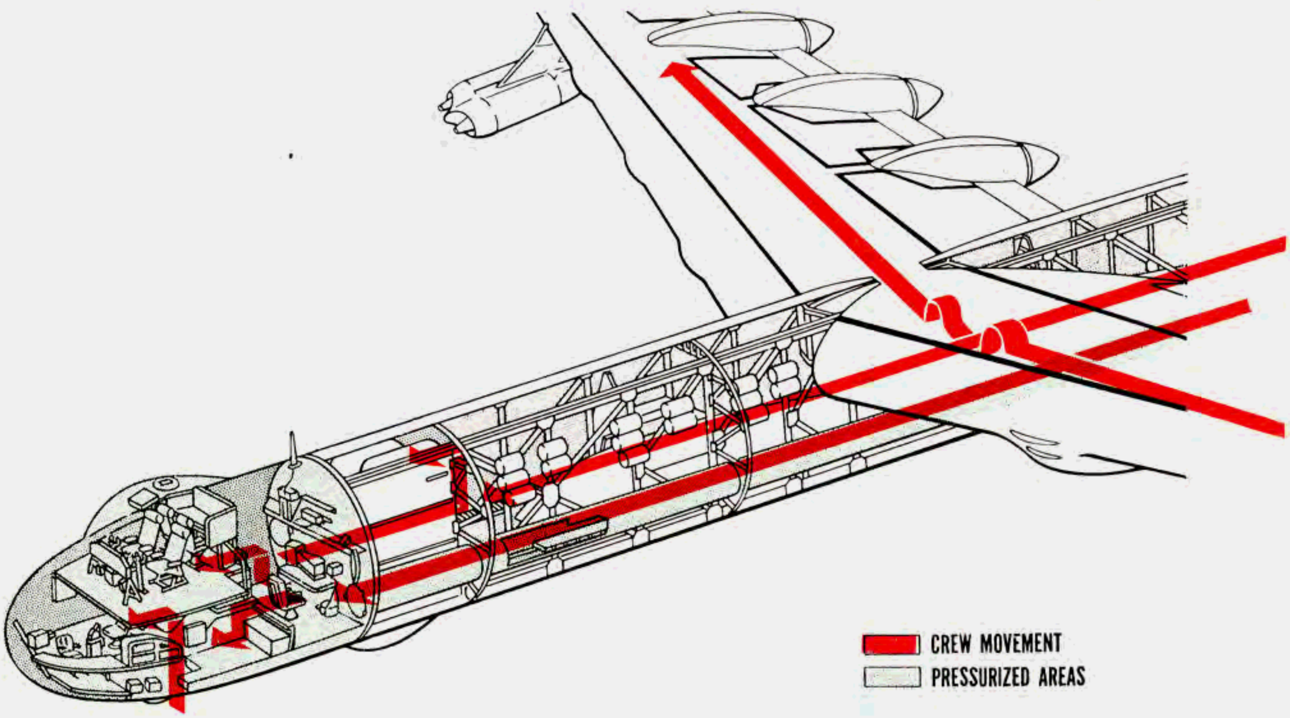

Figure 1-1. (Sheet 1)

Engine Supercharger Switches.

Six two-position switches (13, figure 1-16), located on the engineers' table are provided to select dual or single turbo operation. Switch positions are marked DUAL TURBO and SINGLE TURBO. Placing the switch in SINGLE TURBO will apply 115-volt a-c power to a turbo selector valve to divert all exhaust gases through the right turbo and will apply 115-volt a-c power to close the left intercooler shutter and the air intake for the left heat exchanger to reduce drag. Dual operation is provided when the switch is in the DUAL TURBO position.

Turbo Boost Selector.

An electronic turbo regulator system is used to control the boost of the turbos and is regulated from a master control panel on the engineers' table. This panel contains a turbo boost selector lever (19, figure 1-16) and six calibration potentiometer knobs (20, figure 1-16). The knobs are used to make small individual adjustments of manifold pressures during flight to compensate for small differences in engine or turbo performances. Moving the knobs counterclockwise reduces manifold pressure. Once the system is calibrated, the engineer can control the boost of all engines simul-

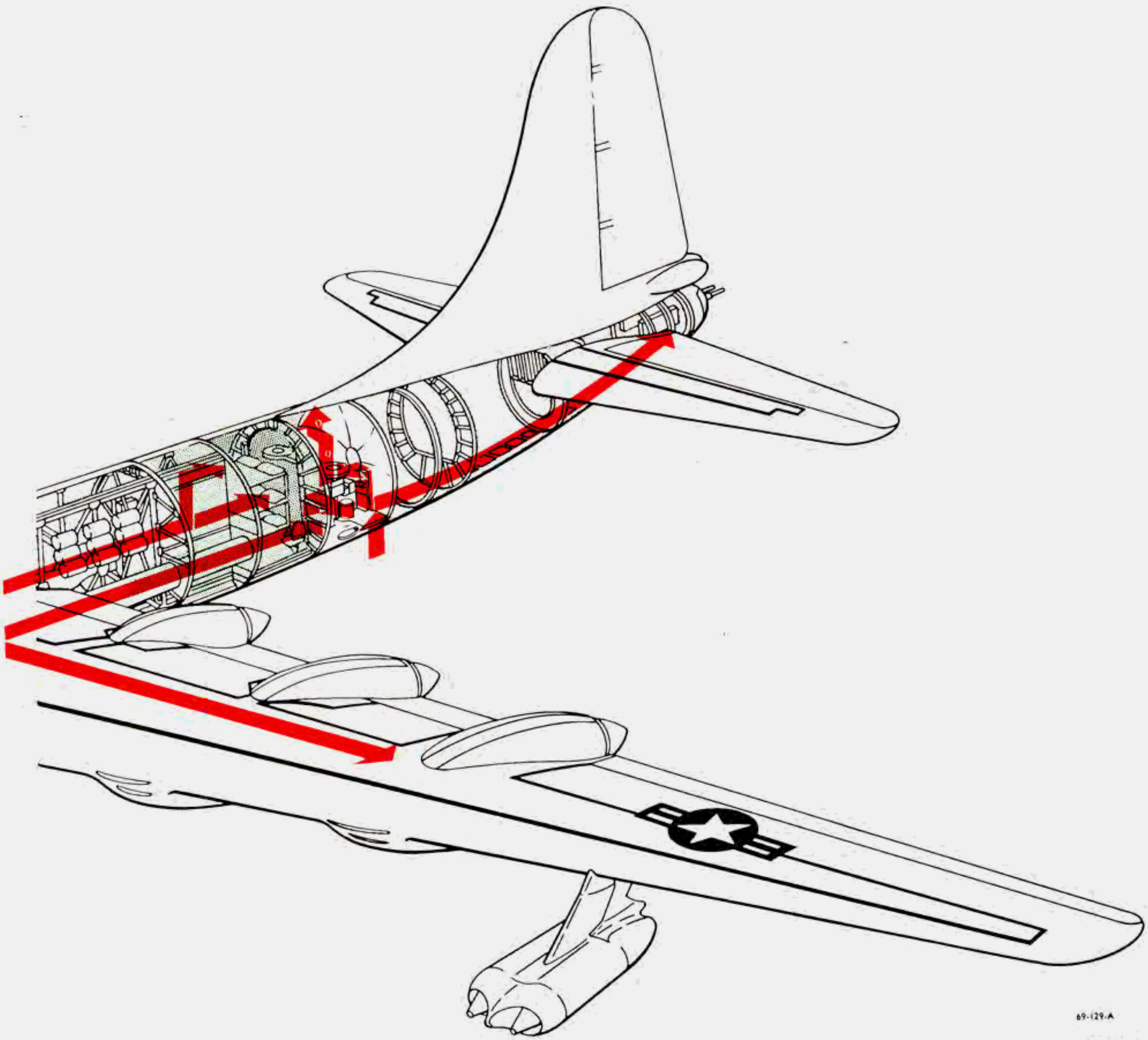

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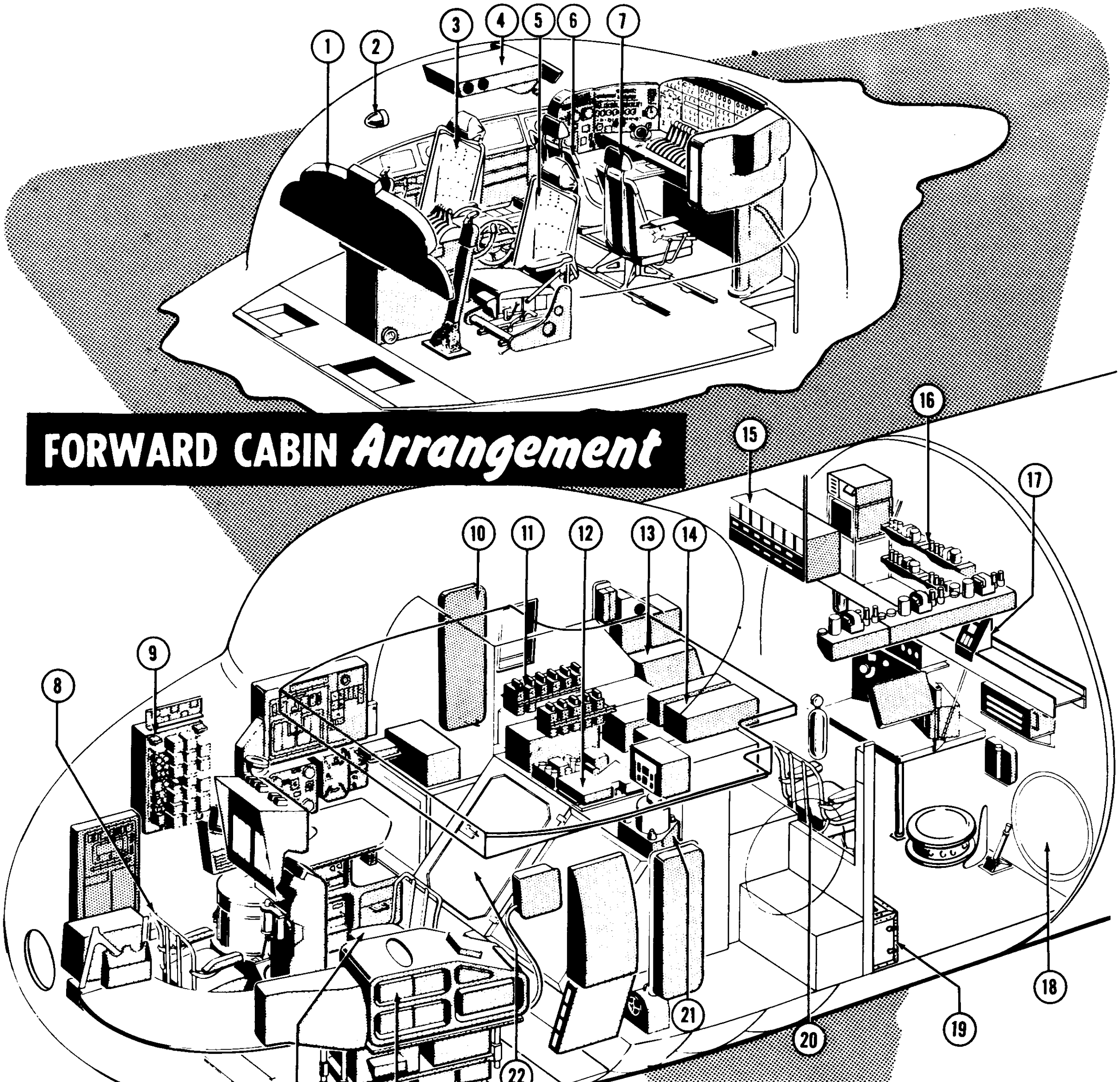
Figure 1-1. (Sheet 2)



1. PILOTS' INSTRUMENT PANEL
2. MAGNETIC COMPASS
3. PILOTS' STATION
4. JET ENGINE CONTROL PANEL
5. AIRCRAFT COMMANDER'S STATION
6. SECOND ENGINEER'S STATION
7. FIRST ENGINEER'S STATION
8. NAVIGATOR'S STATION
9. K SYSTEM AMPLIFIERS
10. RIGHT FWD POWER PANEL
11. FUEL QUANTITY AMPLIFIERS
12. AUTOPILOT CHASIS
13. STOWAGE RACKS
14. ECM EQUIPMENT RACKS
15. THROTTLE AND MIXTURE AMPLIFIERS
16. TURBOSUPERCHARGER AMPLIFIERS
17. TRANSFORMER RECTIFIER TEST UNIT
18. COMMUNICATION TUBE DOOR
19. SEXTANT STOWAGE CASE
20. RADIO OPERATOR'S SEAT
21. N-1 COMPASS GYRO
22. FORWARD ENTRANCE HATCH
23. K SYSTEM EQUIPMENT
24. RADAR OBSERVER'S STATION

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Figure 1-2.

taneously by operating the turbo boost selector lever. The lever has travel graduations from zero to ten. Normally, position 6 is used for take-off, even though the detent is at position 7. A turbo boost selector lever (27, figure 1-9) is also provided for the pilots and is mechanically interconnected to the engineers' lever. This lever is located on the pilots' pedestal. The regulator system operates on 115-volt alternating current.

Turbo Change-Over Switches.

Six two-position switches (17, figure 1-16), marked MANUAL and AUTOMATIC, are located on the engineers' table. When the switches are in AUTOMATIC the turbo electronic regulator systems control the waste gates. Placing the switches in MANUAL energizes one phase winding of the waste gate motor from a transformer which is energized by 115-volt alternating current. This sets up the motor for waste gate positioning through use of the override switches.

Turbo Override Switches.

Six of these switches (18, figure 1-16) are located on the engineers' table. Each switch has a spring-loaded OPEN position which opens the turbo waste gates, a spring-loaded CLOSE position which closes the turbo waste gates, and a neutral OFF position. With a turbo change-over switch in the MANUAL position, the respective turbo override switch can be used to open or close the turbo waste gates. When the override switch is placed in the OPEN or CLOSE position

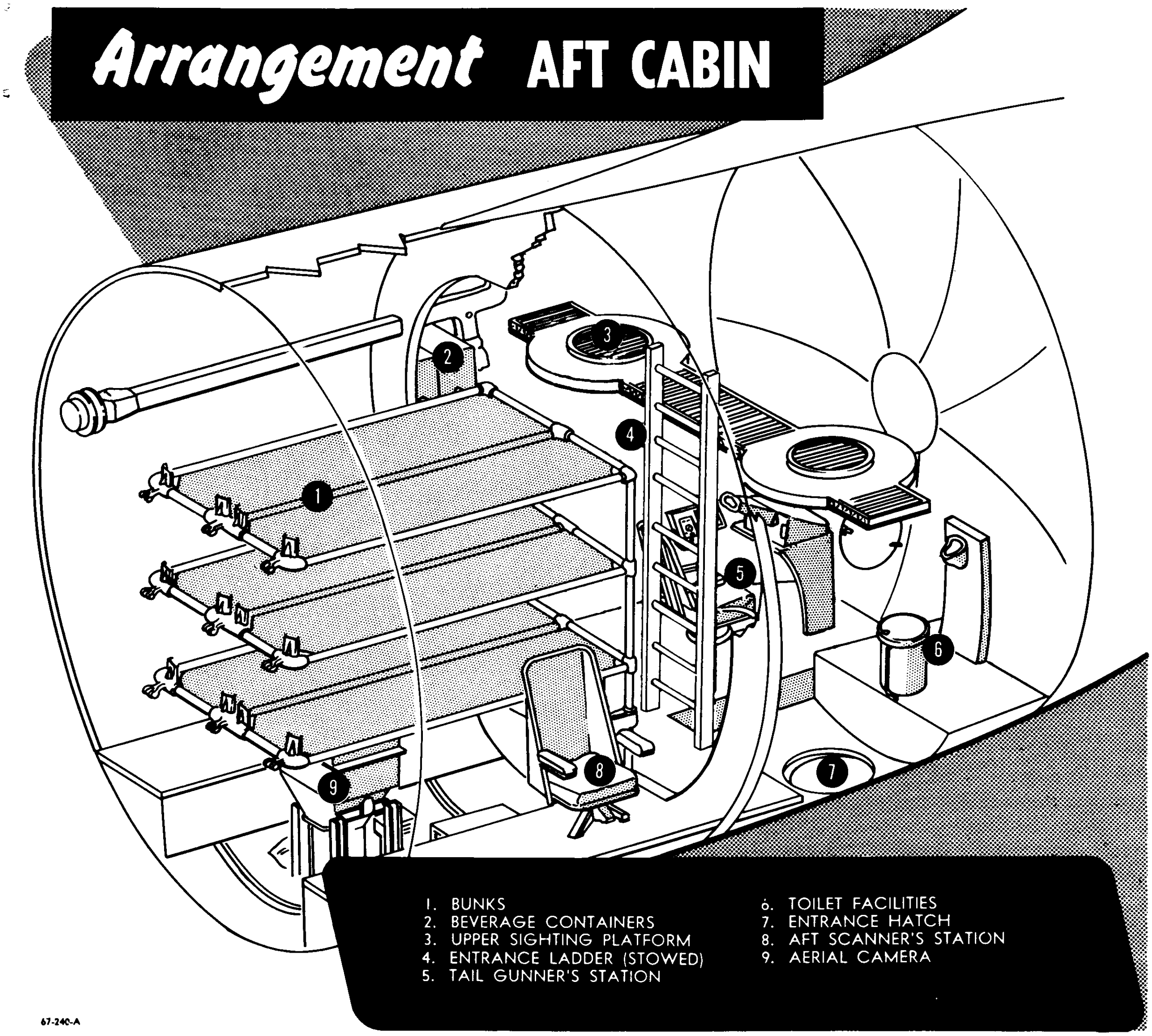

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Figure 1-3.

RECIPROCATING ENGINE NACELLE
General Arrangement

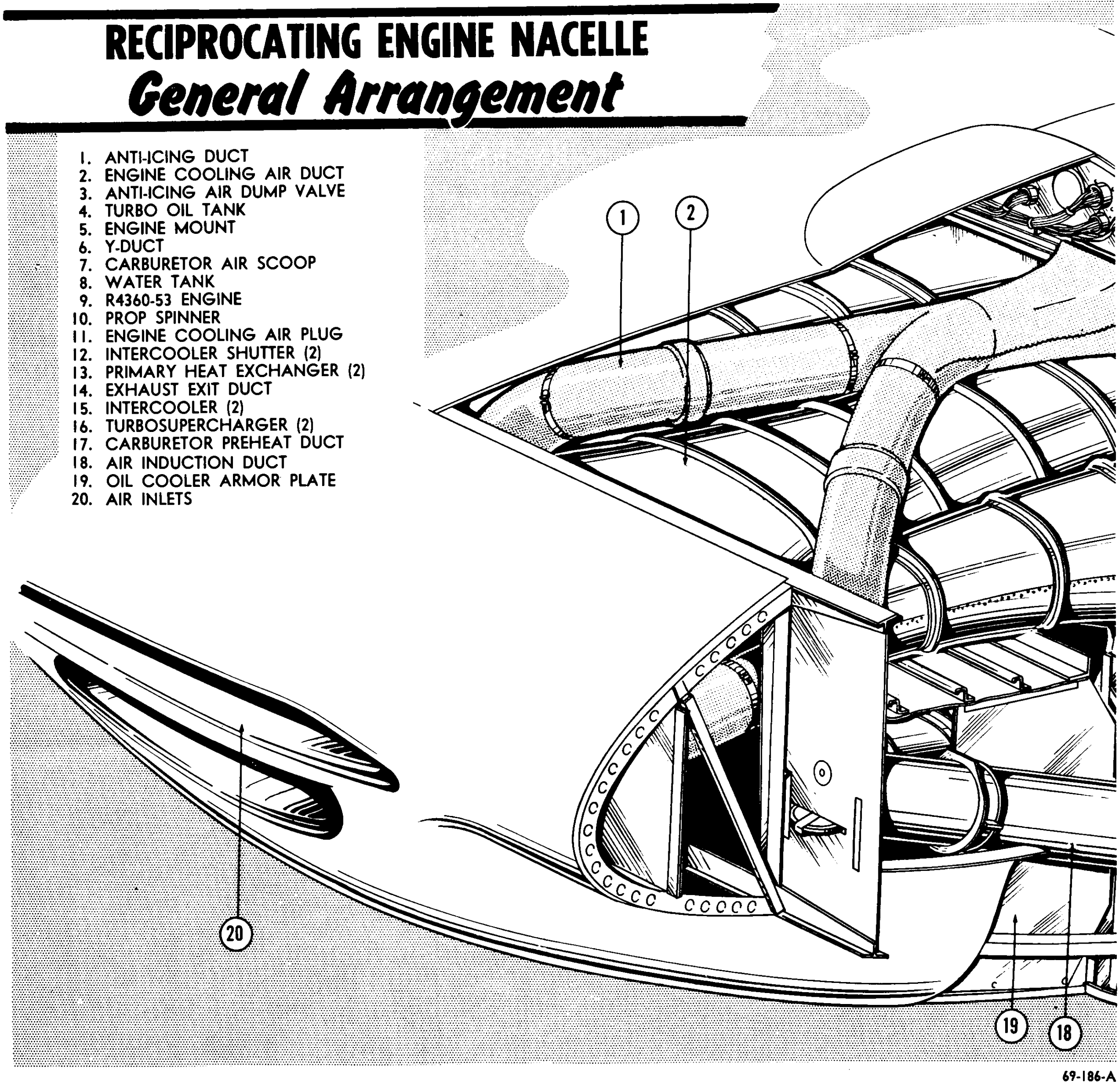

Figure 1-4. (Sheet 1)

230-volt current is taken from a transformer to energize the unenergized waste gate motor windings for actuating the waste gate to the desired position. The transformer has an input of 115-volt alternating current. The switches can also be utilized during emergency electrical operation. (See "Obtaining Emergency Electrical Power," Section III.)

Turbo Vernier Switch.

A switch-type circuit breaker (16, figure 1-16), located on the engineers' table, provides 28-volt d-c power to the turbo override relays for incremental operation of the waste gates when the turbo control override system is in use. When this switch is ON, each actuation of an override switch will operate the corresponding waste gate motor for approximately .05 second. With the vernier switch OFF and an override switch held in OPEN or CLOSE, the waste gate motor will operate until the override switch is released or until the waste gates reach their travel limit.

Turbo Tachometers.

Six turbo tachometers (21, figure 1-18) are provided on the engineers' main instrument panel. Each tachometer indicates the rpm of the right turbo for the respective engine.

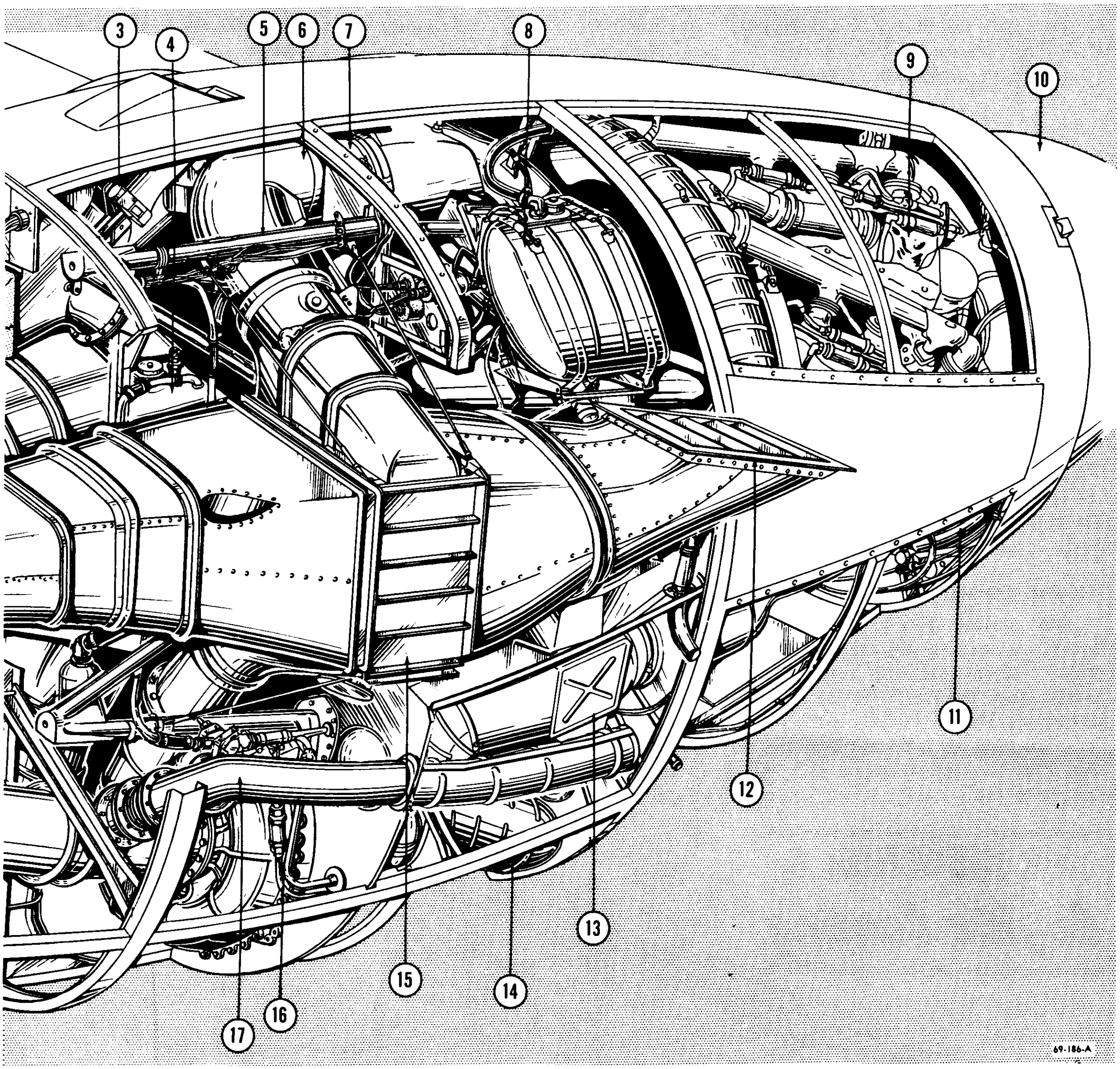

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Figure 1-4. (Sheet 2)

Note

The speed of the left turbo is normally equal to right turbo speed since a governor controls both turbos.

WATER INJECTION SYSTEM.

Each reciprocating engine is equipped with a non-hesitating type water injection system for obtaining additional power during take-off. The system for each engine includes a nine-gallon water tank, a water pressure pump, a water regulator, a water pressure gage, and a control switch. When the control switch is turned ON, water is pumped at a constant flow through the regulator to the engine blower case where it is mixed with carburetor air. This water-air mixture is routed through the intake manifolds to the cylinders where it is combined with fuel. The water supply is adequate for 5 minutes of continuous operation.

Water Injection Switches.

These six on-off switches (10, figure 1-17) are located on the engineers' main control panel and utilize 28-volt direct current to control 208-volt alternating current to the water injection pumps. When the switches are placed ON, the pumps are started and water is directly injected into the engine blower case. With the switches ON, the pumps will continue to operate even after the five-minute water supply has been depleted. They are stopped only by moving the switches to OFF.

CAUTION

> If the water pressure pump is operating and no water pressure is indicated on the gage, the water supply is depleted and the control switch should be turned OFF. The pump should never be allowed to operate for more than 2 minutes without water, since water is required to cool the pump motor.

All six switches are ganged together for simultaneous operation of the systems.

Water Pressure Gages.

Six single-indicating pressure gages (5, figure 1-18) are located on the engineers' main instrument panel. These gages indicate water pressure, in psi, when the water injection systems are in operation.

ENGINE COOLING SYSTEM.

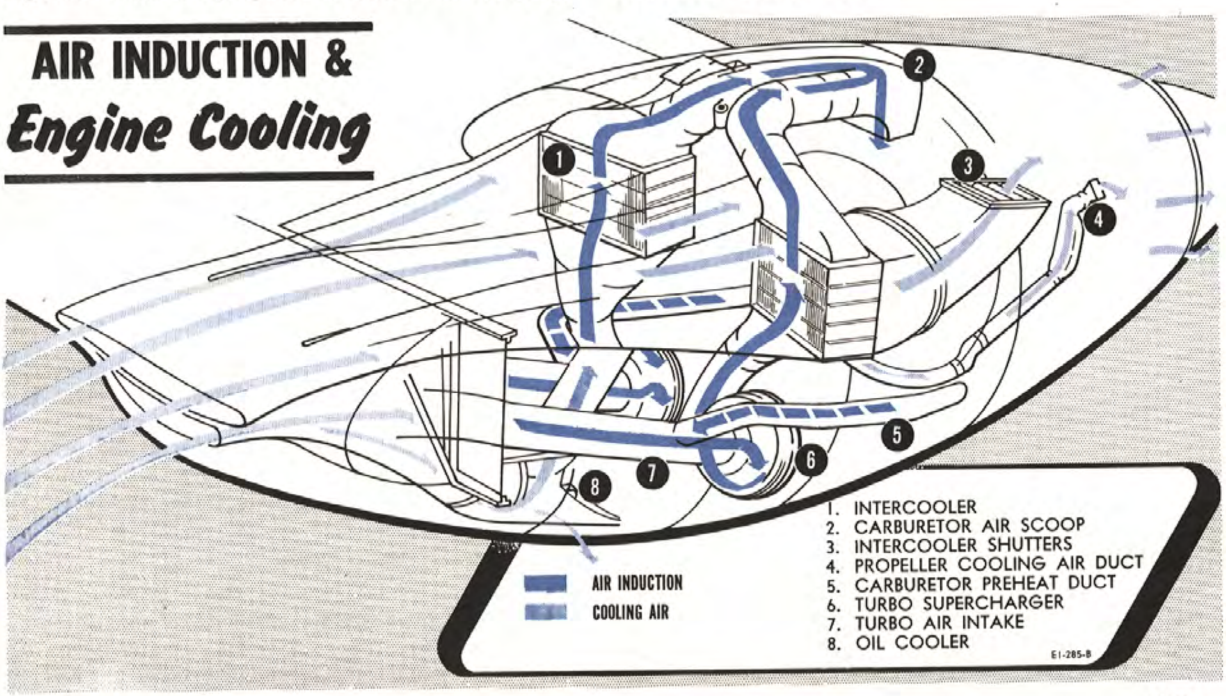
Engine cooling air is introduced into the nacelle through a cooling air tunnel. Air is taken from the tunnel for cooling the turbosuperchargers, the exhaust system, the propeller mechanism, and the various electrically driven actuators. The flow of the remainder of cooling air is routed over the engine and is controlled by a ring-shaped air plug. Six switches on the engineers' table are provided to control the air plugs in maintaining the proper cylinder head temperature. The position of the air plugs can be determined from the scanners' stations by observing the positions of the diamond-shaped markers painted on the air plugs. (See figure 1-7.) A two-speed engine-driven fan is installed in the air tunnel of each engine to increase the rate of cooling air flow.

Air Plug Switches.

Six three-position switches (4, figure 1-16), located on the engineers' table, control the engine air plugs. Each switch has a spring-loaded OPEN position, a spring-loaded CLOSE position, and a neutral center position marked OFF. The air plug is controlled by holding the switch in either the OPEN or CLOSE position to obtain the desired cylinder head temperature. The switches are provided with a gang bar for simultaneous operation in the OPEN position. A 28-volt d-c circuit controls 200-volt alternating current, which operates the air plug actuator motor.

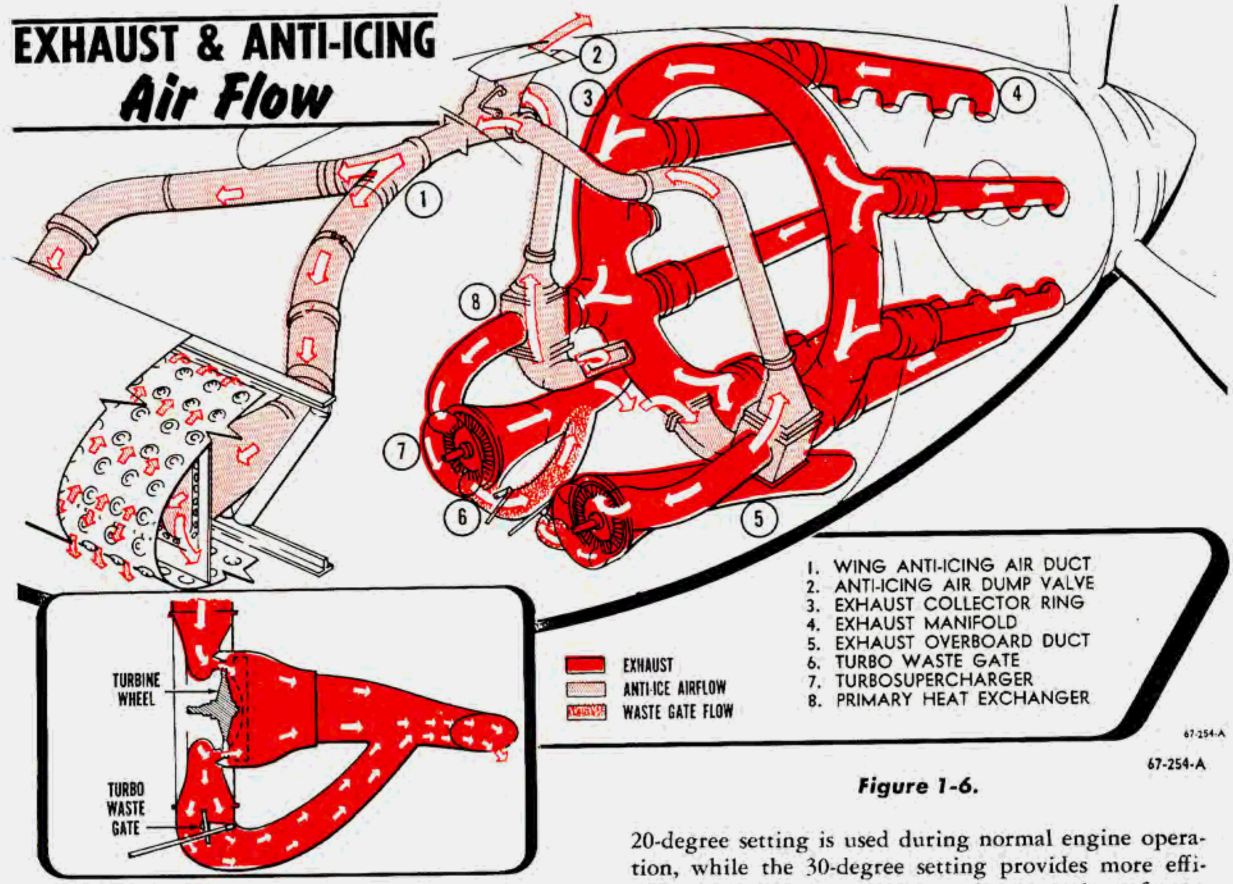
Fan Speed Switches.

On some airplanes, six two-position switches (12, figure 1-16) marked LOW RPM and HIGH RPM control the speed of the engine cooling fans. On some airplanes the switches have an additional NEUTRAL position. When the switches are in this position, the fan is disengaged from the engine, permitting engine operation without fan cooling. The fan speed control actuators use 115-volt alternating current. For additional information on fan speed control see "Cooling Fan Control," Section VII.



E1-285-B

Figure 1-5.



67-254-A

Figure 1-6.

IGNITION SYSTEM.

Four magnetos provide low tension ignition for each engine. The magnetos supply low voltage current through the primary ignition leads to transformer coils which are mounted near the spark plugs. This low voltage is converted to high voltage and is fed through short leads to the plugs.

The magnetos are designated L1, L2, R1, and R2 and each magneto furnishes ignition to the left or right spark plug in two rows of cylinders. For example, ignition is provided the left spark plugs in cylinder rows B and D by the L1 magneto and rows A and C by the L2 magneto.

Note

> The right spark plugs are on the intake side of the cylinders and the left spark plugs are on the exhaust side of the cylinders. Cylinder rows are designated A, B, C, and D from the accessory drive section of the engine.

The ignition controls for each engine consist of a grounding button for each of the four magnetos and one on-off ignition switch. In addition spark advance switches are provided to set the spark in each cylinder to occur at either 20 or 30 degrees before the piston reaches top dead center on its compression stroke. The 20-degree setting is used during normal engine operation, while the 30-degree setting provides more efficient operation for certain cruise control configurations during manual leaning.

Ignition Switches.

The six ignition switches (1, figure 1-7) are located on the engineers' main control panel.

Note

> There is no master ignition switch for either the engineers or the pilots.

The ignition switches have a two-position pointer which can be set in either the ON or OFF position. Each switch also has four grounding buttons marked L1, L2, R1, and R2. When a button is pulled the corresponding magneto is grounded and an indication of the operation of the other magnetos may be obtained. To check the ignition system the magnetos on one side of the engine are grounded by pulling either L1 and L2 or R1 and R2.

Note

> Button L1 grounds the exhaust side spark plugs in rows B and D. Button L2 grounds the exhaust side plugs in rows A and C. Button R1 grounds the intake side spark plugs in rows B and D and button R2 grounds the intake side spark plugs in rows A and C.

CAUTION

Buttons L1 and R1 or buttons L2 and R2 should never be pulled simultaneously. This would result in grounding the magnetos which fire two complete rows of cylinders. causing dangerous afterfiring.

Spark Advance Switches.

The six spark advance switches (10, figure 1-16) are located on the engineers' table and have positions marked ADVANCE and RETARD. When a switch is placed in the ADVANCE position, 28-volt d-c circuit is completed to a solenoid and the spark is advanced from the normal setting of 20 degrees to a setting of 30 degrees. Placing the switch in the RETARD position returns the spark to the normal 20-degree setting.

PRIMING SYSTEM.

Each reciprocating engine is equipped with a separate priming system to assist in starting whenever necessary. Priming is controlled by a solenoid-operated valve on the carburetor which allows fuel under booster pump pressure to pass into the engine blower case.

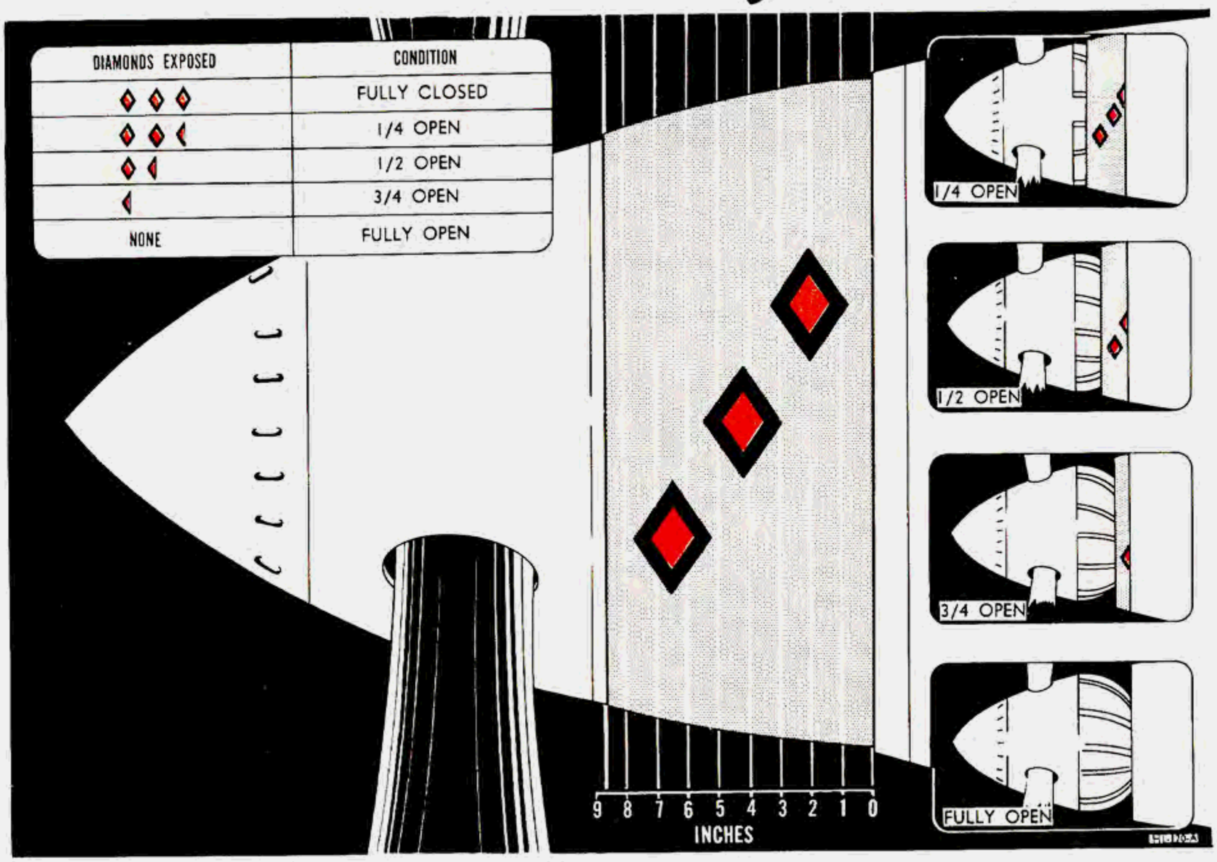
Engine Primer Switches.

The six priming systems are controlled by three three-position switches (3, figure 1-17) located on the engineers' main control panel. The switches are marked OFF in the center position with engine numbers above and below. When a primer switch is held in an engine position, a 28-volt d-c circuit is completed to a primer solenoid and fuel is injected directly into the blower case of the corresponding engine.

STARTING SYSTEM.

A heavy duty direct-cranking starter is mounted on the lower side of each reciprocating engine accessory case for cranking the engine. The starter cranks the engine through a planetary gear system, a dry-disc friction clutch, and a cranking jaw which engages the engine cranking jaw. The starter jaw automatically disengages when the engine starts. Engine damage due to

RECIPROCATING ENGINE *Air Plug Indications*



H1-170-A

Figure 1-7.

67-241-A

hydraulic lock is minimized by the friction clutch which is preset to slip at approximately 400-foot pounds of torque.

Engine Starter Switches.

The six direct-cranking starters are controlled by three three-position switches (2, figure 1-17). The switches are marked OFF in the center position with engine numbers above and below. Holding a starter switch in an engine position engages the starter and cranks the corresponding engine. A 28-volt d-c control circuit controls 200-volt alternating current which is applied to the engine starter.

PROPELLER SYSTEM.

The airplane is equipped with six Curtiss constant-speed, full-feathering, reversible propellers. The propellers are 19 feet in diameter and have three square-tipped hollow blades installed in a one-piece hub. The control system is similar to that used on previous models of synchronizer-equipped propellers except that synchronization is possible in the reverse range.

PITCH CHANGE SYSTEM.

Pitch change is accomplished mechanically by power taken directly from propeller shaft rotation. Clutch engagement for the operation of the pitch changing mechanism is accomplished hydraulically. The hydraulic power is controlled by small solenoid valves. A small electric motor drives the blades in the last of the feathering and the beginning of the unfeathering cycles when the engine is operating below 450 rpm and is unable to furnish sufficient power to operate the pitch changing mechanism.

Note

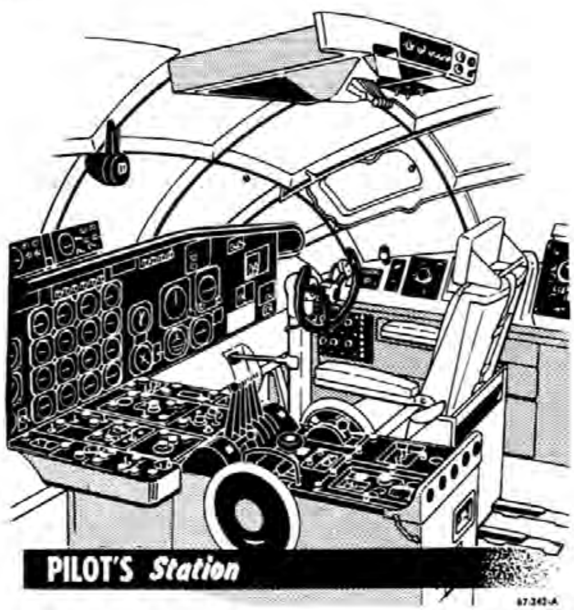
Pitch change during feathering and reversing is 45 degrees per second. Pitch change during normal operation is 2-1/2 degrees per second.

NORMAL PROPELLER CONTROLS AND INDICATORS.

Control of the propeller speed is conventional, but synchronization is accomplished by making the speed of all engines compare with the speed of an electrically driven master motor. A propeller alternator on each engine supplies an electrical indication of engine speed to a contactor assembly on the master motor. If the engine speed does not coincide with that of the master motor, corrective impulses are transmitted to the pitch changing mechanism until the engine is operating at master motor rpm. All engines operate at master motor rpm when their respective selector switches are placed in the AUTOMATIC OPERATION position and their throttles are advanced sufficiently for the engine to attain master motor rpm. Because of a protective relay in the master motor, if a master motor failure occurs the propeller will remain at the pitch in effect when the failure occurred. Pitch changes will then be accomplished by moving the selector switches to the INC. RPM or the DEC. RPM positions.

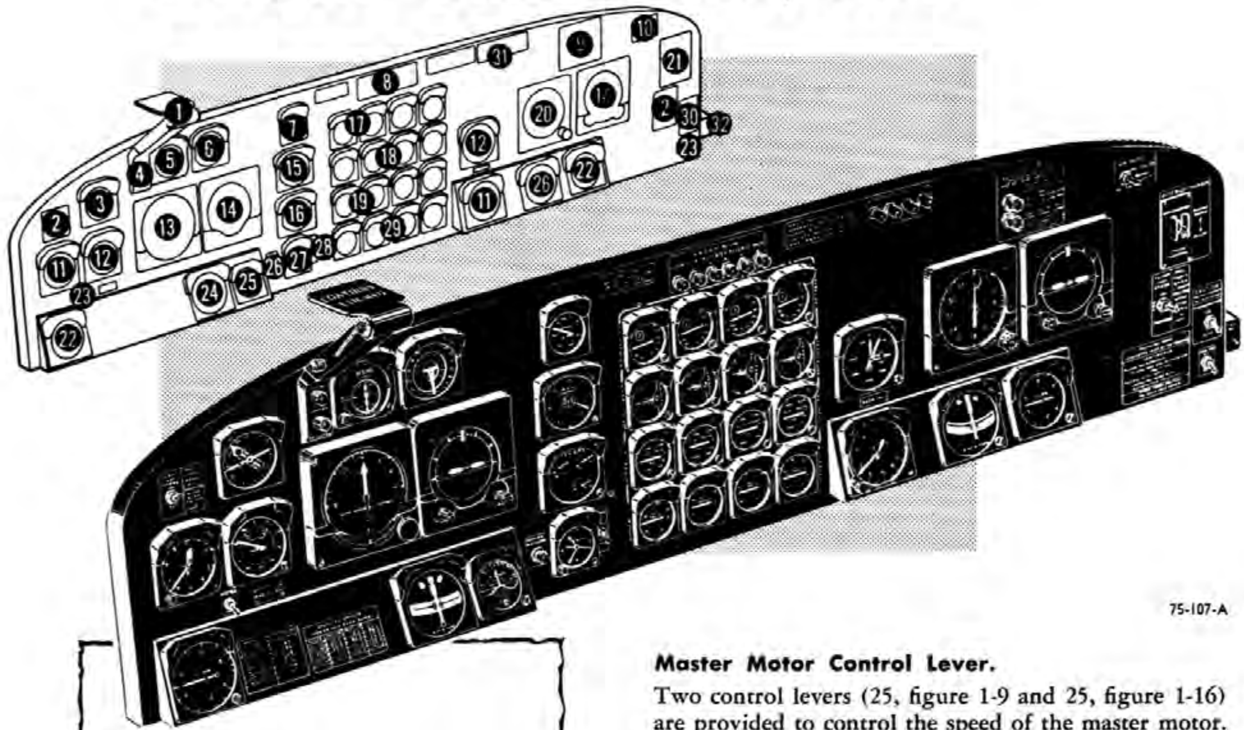
Propeller Selector Switches.

Six conventional propeller selector switches (28, figure 1-16) having four positions—AUTOMATIC OPERATION, DEC. RPM, INC. RPM, and FIXED PITCH—are provided on the engineers' table and control 28-volt d-c power to the pitch changing systems.



67-242-A

PILOTS' *Instrument Panel*



1. Flight Control Lock Switch
2. Flight Instrument Switch
3. Radio Magnetic Indicator
4. Flight Control Lock Indicator
5. ARN-14 Course Indicator
6. Pilot's Data Indicator
7. Manifold Pressure Gage
8. Propeller Reverse Warning Lamps
9. Landing Gear Indicator Lamps
10. Bomb Salvo Safety Switch
11. Altimeter
12. Air-Speed Indicator
13. High Latitude Compass Repeater Indicator
14. Attitude Gyro Indicator
15. Master Tachometer
16. Flap Position Indicator
17. Jet Engine Tachometer
18. Jet Tail Pipe Temperature Indicator
19. Jet Fuel Pressure Gage
20. Directional Gyro Indicator
21. Autopilot Transfer Switch
22. Rate of Climb Indicator
23. Pilots' Vent Fan Switches
24. Turn and Bank Indicator
25. Aileron Trim Tab Indicator
26. Bombs Released Indicator Lamp
27. Clock
28. Alarm Bell Switch
29. Jet Oil Pressure Gage
30. Windshield Wiper Switch
31. Jet Engine Fire Warning Lamps (Some Airplanes)
32. Taxi Lights Switch

Figure 1-8.

Master Motor Control Lever.

Two control levers (25, figure 1-9 and 25, figure 1-16) are provided to control the speed of the master motor. The lever located on the engineers' table is mechanically interconnected to the one on the pilots' pedestal. As well as controlling master motor rpm, these levers control the supply of 28-volt d-c power to operate the master motor through a micro switch which is set to cut out at 1250 rpm.

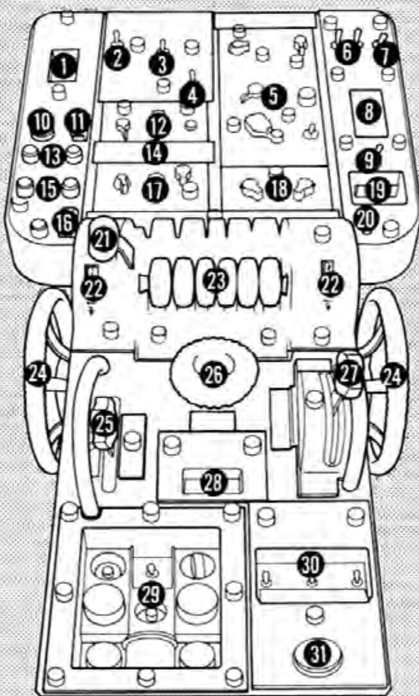
Master Tachometers.

The master tachometers, one for the pilots (11, figure 1-8) and one for the engineers (11, figure 1-18), indicate master motor rpm. It should be noted that master motor rpm will not always coincide with engine rpm, since the master motor may be operating at any selected rpm during ground operations, even when the engines are not running.

Propeller Tel-Lamps.

Six push-to-test tel-lamps (27, figure 1-16) are provided to indicate proper operation of the synchronization system. When the propeller selector switches are placed in the AUTOMATIC OPERATION position and the master motor is on-speed, the tel-lamps will light. If the master motor fails, all lamps will go out. Each lamp will go out when its corresponding selector switch is moved out of the AUTOMATIC OPERATION position.

• PILOTS' Pedestal •



1. Parking Brake Switch
2. Formation Lights Switch
3. Navigation Lights Dimming Switch
4. Navigation Lights Selector Switch
5. Radio Compass Control Panel
6. Landing Light Extend and Retract Switches
7. Landing Lights Filament Switch
8. Landing Gear and Brake Pump Switches
9. Nose Wheel Steering Switch
10. Bomb Salvo Indicator Lamp
11. Bomb Salvo Switch
12. AN/ARC-27 Command Radio Panel
13. Bomb Bay Door Indicator Lamps
14. Command Radio Selector Switch
15. Bomb Bay Door Switch
16. Bomb Bay Fuel Tank Release Switch and Indicator Lamp
17. AN/ARN/14 Receiver Control Panel
18. Liaison Radio Control Panel
19. Flap Switches
20. Warning Horn Shutoff Switch
21. Throttle Lock Lever
22. Elevator Trim Tab Indicator
23. Throttle Levers
24. Elevator Trim Tab Wheel
25. Master Motor Speed Control Lever
26. Rudder Trim Tab Knob and Indicator
27. Turbo Boost Selector Lever
28. Aileron Trim Tab Switch
29. Autopilot Control Panel
30. Propeller Reverse Selector Switches
31. Propeller Reverse Pitch Switch

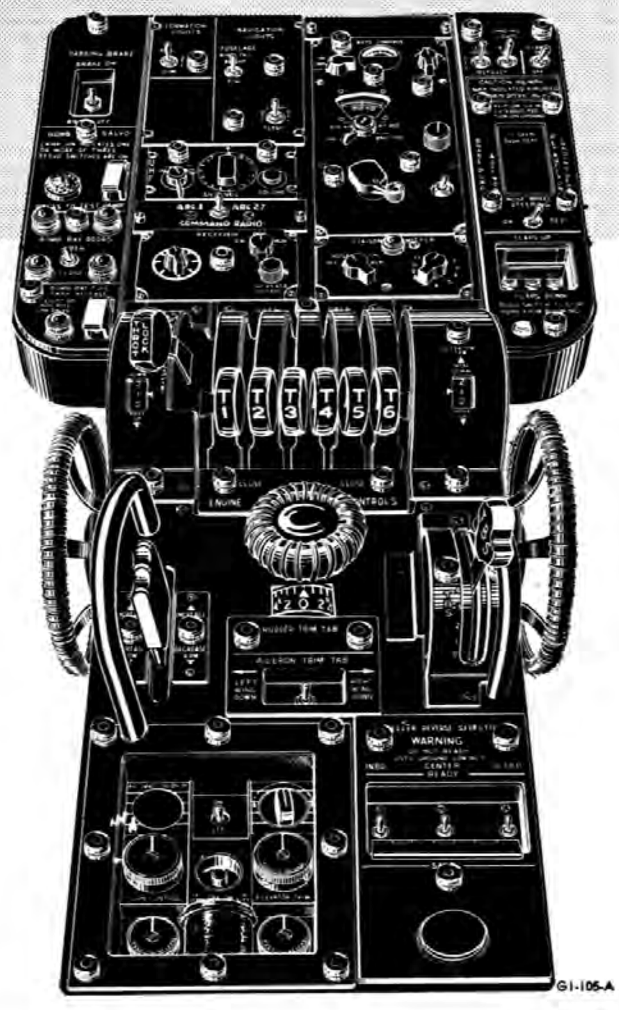


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Figure 1-9.

PROPELLER REVERSE PITCH CONTROLS AND INDICATORS.

Reverse Selector Switches.

Three propeller reverse selector switches (30, figure 1-9), marked READY and SAFE, are located on the pilots' pedestal. These switches are used to select symmetrical pairs of propellers to be reversed by setting up a 28-volt d-c circuit to the reverse pitch switch. The propellers are returned from reverse by placing the switches in the SAFE position.

CAUTION

Although it is possible to reverse the propellers in flight, this action is prohibited.

Reverse Pitch Switch.

A push-button type reverse pitch switch (31, figure 1-9), located on the pilots' pedestal, completes a 28-volt d-c circuit which reverses the symmetrical pairs of propellers selected by the reverse selector switches.

AIRCRAFT COMMANDERS' *Auxiliary Controls*

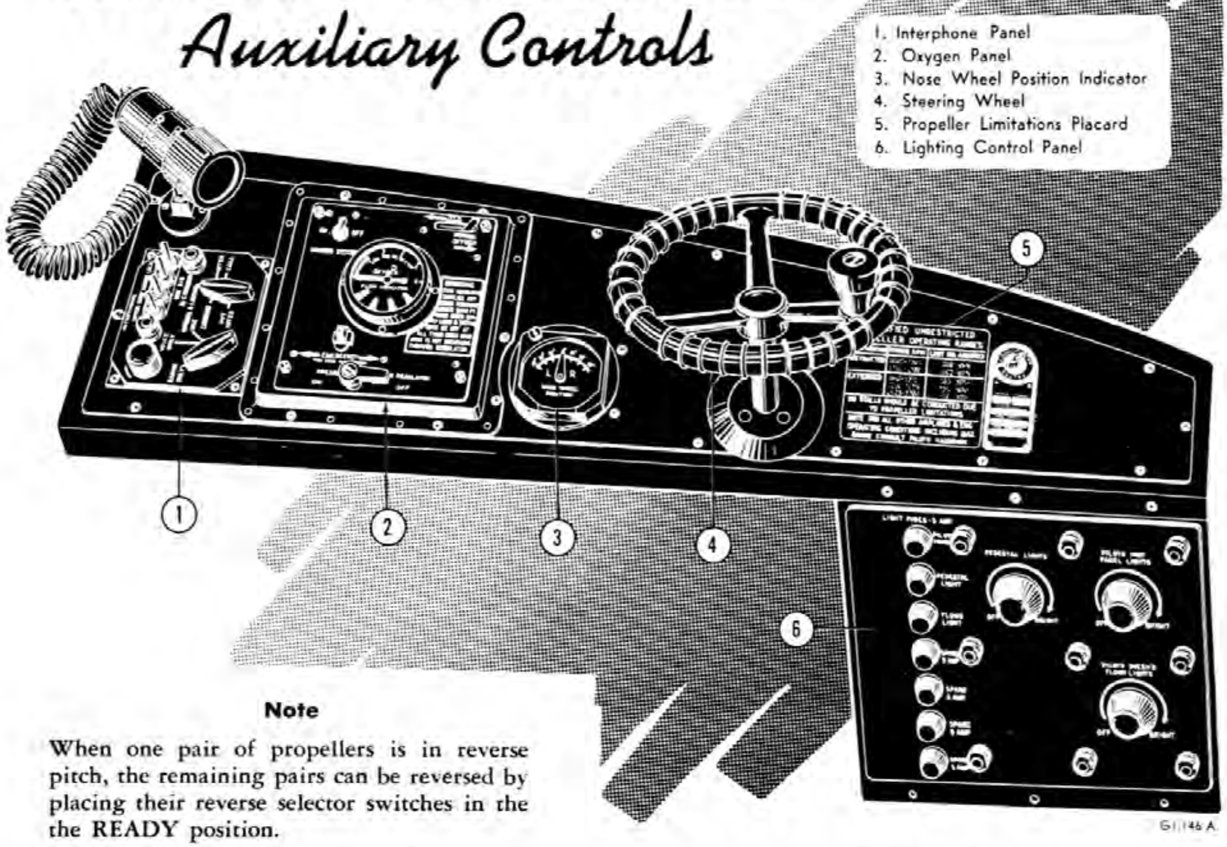


Figure 1-10.

Note

When one pair of propellers is in reverse pitch, the remaining pairs can be reversed by placing their reverse selector switches in the the READY position.

WARNING

If an engine is shut down (propeller feathered) the propeller of the symmetrically opposite engine cannot be reversed unless the feather switch of the inoperative engine is returned to NORMAL. However, this would create an unsafe condition during reversing after landing in that an unbalanced power condition would be present.

Propeller Reverse Warning Lamps.

Six red warning lamps (8, figure 1-8) are located on the pilots' instrument panel. When any propeller is in reverse pitch, the corresponding red lamp will be lighted. The lamp will go out when the propeller is returned to normal pitch.

Note

The lamps will light when the propeller blades reach a positive pitch angle of approximately 8.7 degrees going into reverse. Conversely, coming out of reverse, the lamps will go out at approximately an 8.7-degree positive pitch angle.

Propeller Normal Pitch Indicator Lamps.

Six green lamps (1, figure 1-19) are located on the engineers' auxiliary control and instrument panel. These lamps indicate when the propellers are in normal pitch. When any propeller is in reverse pitch, the respective lamp will not burn.

Note

The lamps will light when the propeller blades reach a positive pitch angle of approximately 8.7 degrees coming out of reverse. Going into reverse, the lamps will go out at approximately the 8.7-degree positive pitch angle.

PROPELLER FEATHER CONTROLS.

Six two-position switches (26, figure 1-16), marked FEATHER and NORMAL, are located on the engineers' table and route 28-volt direct current to the propeller system for feathering and unfeathering. The switches are guarded in the NORMAL position.

PILOTS' *Auxiliary Controls*

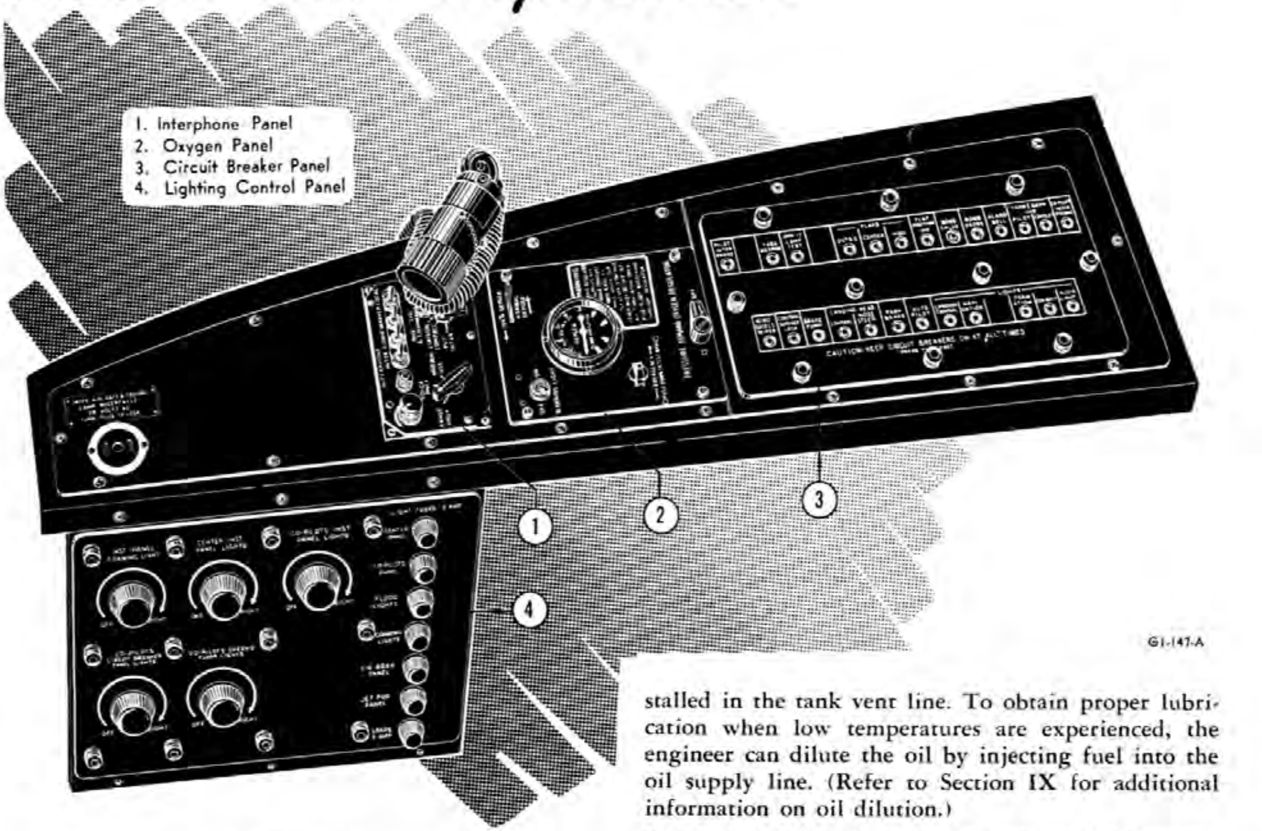


Figure 1-11.

WARNING

If the individual circuit breaker is out or defective the propeller cannot be feathered nor the blade angle changed.

RECIPROCATING ENGINE OIL SYSTEM.

Each reciprocating engine has an independent oil system which includes a tank, a shutoff valve, a drain valve, a vent system, provisions for oil dilution, and a cooling system. (See figure 1-13.) The capacity for each tank is given in figure 1-12. An oil shutoff valve is located in the oil supply line between each tank and engine. A set of six switches at the engineers' station provides 115-volt a-c power for operation of the valves. To reduce oil foaming and to insure a more positive oil flow to the engine pressure pump, each oil tank is pressurized through a line connected to the cabin pressurization system. The pressure is regulated by an aneroid valve which incorporates a relief valve installed in the tank vent line. To obtain proper lubrication when low temperatures are experienced, the engineer can dilute the oil by injecting fuel into the oil supply line. (Refer to Section IX for additional information on oil dilution.)

Electrical heating elements are provided for the tank vent lines and hoppers. For detailed information see "Oil System Heaters" in Section IV. Refer to figure 1-45 for servicing information.

OIL SYSTEM CONTROLS.

Oil Shutoff Valve Switches.

There are six two-position switches (16, figure 1-17) on the engineers' main control panel for operating the oil shutoff valves. The switches have positions marked OPEN and CLOSE and are guarded in the OPEN position. With the exception of the valve for engine No. 6, the shutoff valves are accessible from the wing crawlways and can be operated manually.

Oil Dilution Switches.

There are six oil dilution switches (8, figure 1-17) on the engineers' main control panel. Each switch has two spring-loaded ON positions and a neutral OFF. One ON position is provided for using the switches individually. The other ON position permits gang bar operation for simultaneous dilution of the oil for all engines. When a switch is placed ON, a 28-volt d-c circuit is completed to an oil dilution solenoid allowing fuel to be discharged into the engine oil inlet line.

Oil Tank Capacities
APPROXIMATE GALLONS

TANK	NO.	TOTAL VOLUME (NOTE 1)	EXPANSION SPACE (NOTE 2)	MAXIMUM CAPACITY (NOTE 3)	NORMAL LOADING (NOTE 4)
INBOARD	2	241	41	200	150
CENTER	2	248	48	200	150
OUTBOARD	2	262	62	200	150

NOTES:

1. Total volume is the total amount of internal space of each tank in gallons and is NOT to be interpreted as any oil loading capacity.
2. Expansion space cannot be used for additional oil because of the location of the filler neck.
3. 200 gallons is the maximum amount of oil that can be put into the tank.
4. The maximum normal loading is 150 gallons for each tank because of the following reasons:
   A. Oil in excess of 150 gallons will vent overboard.
   B. At high altitude, oil vented overboard will congeal, break loose, and damage the airplane.
   C. 150 gallons of oil per tank is all that is needed for normal engine operation.

67-184-A

Figure 1-12.

OIL SYSTEM INDICATORS.

Oil Temperature Gages.

Six oil temperature gages (4, figure 1-18) are located on the engineers' main instrument panel and indicate. in centigrade, reciprocating engine oil temperatures. The indicating system is energized by 28-volt d-c power.

Oil Pressure Gages.

Six oil pressure gages (7, figure 1-18), located on the engineers' main instrument panel, indicate the nose oil pressure of the reciprocating engines. The oil pressure indicating system is energized by 115-volt ac from the engineers' power panel.

Oil Quantity Gages.

There are six single-indicating oil quantity gages (16, figure 1-18) located on the engineers' main instrument panel. The gages indicate oil quantity in US gallons. Each oil quantity indicating system receives 28-volt dc through a circuit breaker on the engineers' table.

OIL COOLING.

Oil cooling is completely automatic for some aircraft. Thermostatically controlled valves regulate the flow of oil and cooling air through the oil cooler to keep the temperature within the desired operating range. Two methods of routing the cooling air through the cooler are provided to insure proper operating temperatures in both ground and flight operations. On the ground, air is drawn through the oil cooler by the engine-driven fan. During flight ram air independent of the fan passes through the oil cooler. Two doors in the air inlet ducts control the routing of the oil cooling air. The door actuators operate on 115-volt alternating current and are energized through a switch actuated by the movement of the left main gear oleo strut during take-off and landing. (See figure 1-14.) When an engine fuel valve is closed, 28-volt direct current closes a relay which routes 115-volt a-c power to the flight cooling door actuator of the related engine, moving the door to the closed position.. On some airplanes an oil cooler door override control system is installed to provide a means of overriding the automatic control when oil temperature drops below or exceeds the normal operating temperature.

Oil Cooler Door Mode Selector Switches (Some Airplanes).

Six switch-type circuit breakers (19, figure 1-17) marked AUTO and MANUAL are located on the engineers' main control panel. When the switches are in AUTO, the automatic control circuit operates the oil cooler doors. When the switches are in the MANUAL position, the automatic circuit is cut out and 28-volt direct current is fed to a manual control circuit. This sets up the manual control circuit for operation by means of the manual override switches.

Oil Cooler Door Override Switches (Some Airplanes).

Six three-position switches (20, figure 1-17) located on the engineers' main control panel are provided for direct control of the oil cooler doors. Each switch has spring-loaded OPEN and CLOSE positions and a neutral off position. When an oil cooler door mode selector switch is in MANUAL, the related oil cooler door is operated by holding the corresponding override switch in OPEN or CLOSE. Intermediate positions of the door can be obtained by jiggling the switch. The override circuit provides 115-volt a-c power to the flight cooling door actuator during flight or the ground cooling door actuator during ground operations.

Reciprocating Engine OIL SYSTEM SCHEMATIC

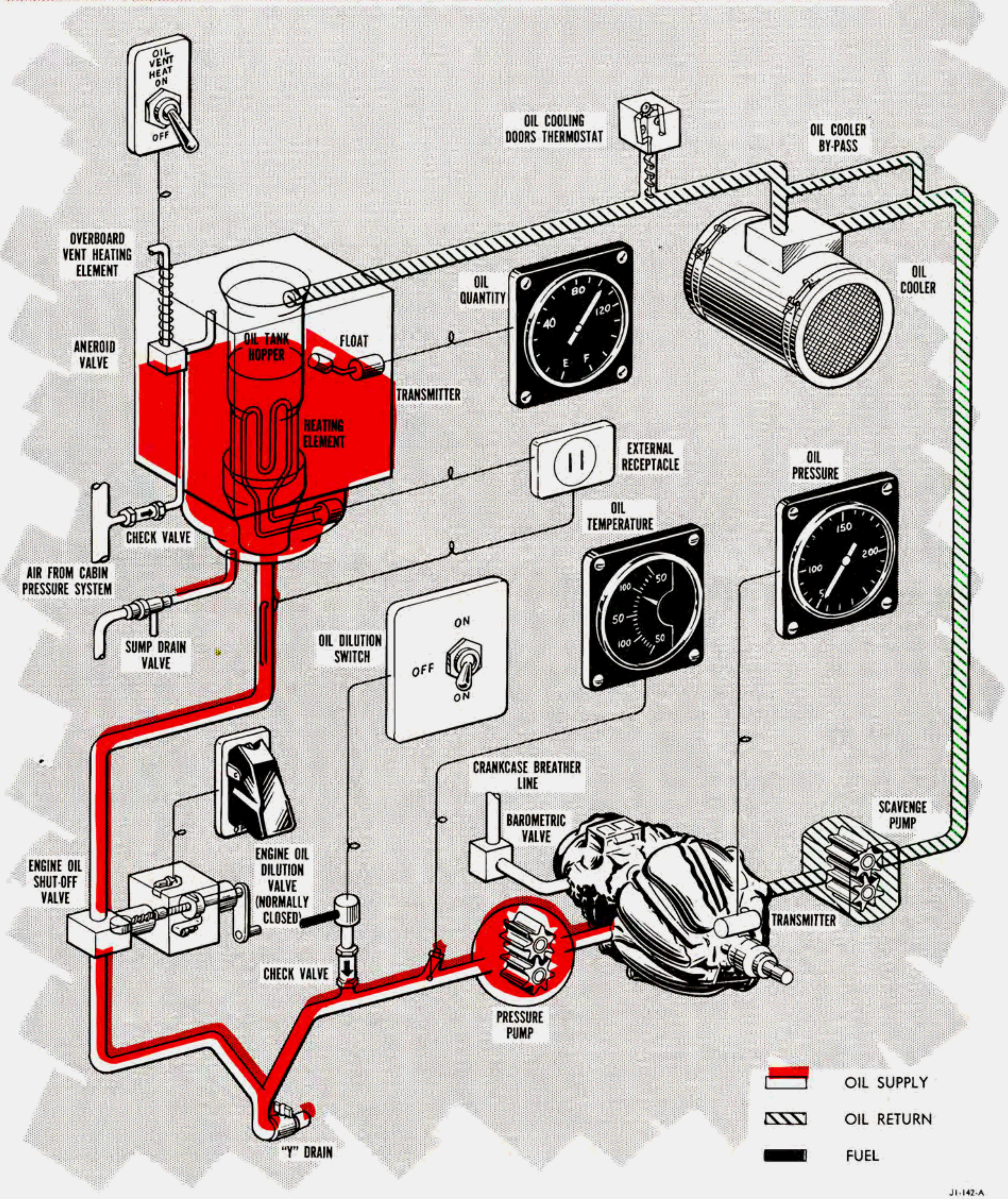


Figure 1-13.

JET ENGINES.

In addition to the six reciprocating engines, the airplane is equipped with four General Electric J47-19 jet engines to provide extra power for take-off, climb, target area operation, and other instances where extra power is required.

A pod nacelle containing two jet engines is suspended from each wing outer panel. Each engine is rated to deliver 5200 thrust pounds at sea level static conditions when operating at 100 per cent rpm with tail pipe temperature at 690° C.

The main components of the jet engine include an accessory section, a 12-stage axial flow compressor, eight can-type combustion chambers, and a single-stage turbine. A tail cone and tail pipe serve to conduct the hot exhaust gases away from the engines. Fuel used is the same grade as that used by the reciprocating engines and is taken from the same system. Oil for each jet is supplied from an individual oil tank. The oil is of a different specification than that used by the reciprocating engines. See figure 1-5 for servicing information on the oil system. A heating element is incorporated in each oil tank to heat the oil while the engines are not operating during flight. (For additional information see Section IV.)

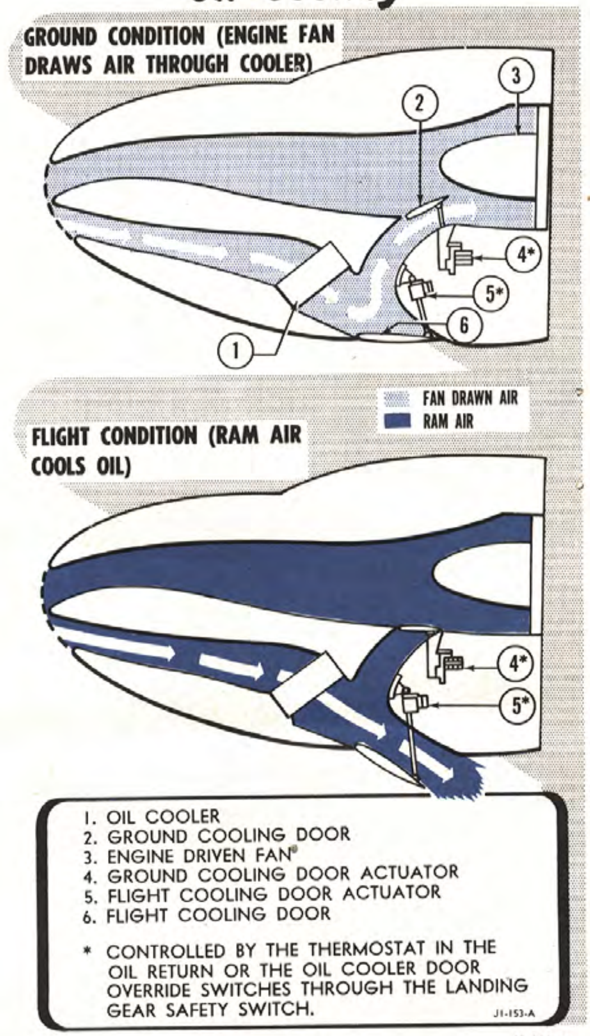
All jet engine controls are grouped on an overhead panel which is located directly above the pilots' pedestal.

All jet engine instruments, except the jet engine fuel flow indicators, are grouped in the center of the pilots' instrument panel. The fuel flow indicators are located on the engineers' main instrument panel. Each jet engine is controlled by a throttle lever which acts through a fuel regulator mounted on the engine accessory section. The regulator controls a fuel control valve to meter the amount of fuel to the engine called for by the throttle lever after automatically compensating for engine rpm and air density.

The airplane can fly with or without the jets in operation, according to the conditions of flight. Nose shutoff doors are used to shut off the engine air flow when the engines are inoperative. When the nose shutoff doors are fully closed, enough air will flow through to windmill the engines at approximately 5 per cent rpm. This low windmilling speed allows heated oil to circulate through the engines so the oil will not congeal at low temperatures. If additional heat is needed for the oil, heated anti-icing air can be taken from the wing anti-icing system and circulated around the oil lines and the oil cooler, and the oil tank heaters may be turned on. A special ignition circuit which by-passes the starters is provided to start the jet engines in flight.

An inlet air screen between the nose shutoff doors and the inlet guide vanes of each engine prevents engine damage from foreign objects which might otherwise enter the compressor.

RECIPROCATING ENGINE
Oil Cooling



J1-153-A

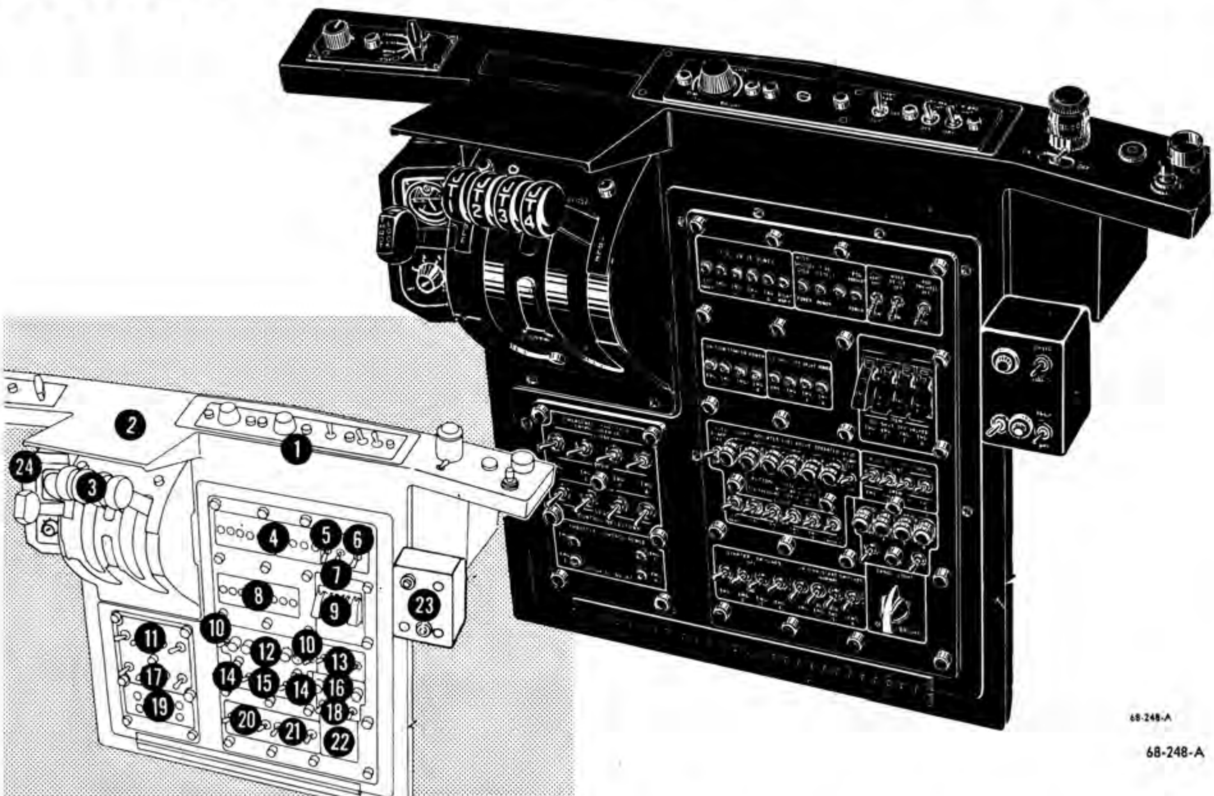
Figure 1-14.

FUEL REGULATOR CONTROLS.

Throttle Levers.

Four throttle levers (3, figure 1-15) and a friction lock lever (2, figure 1-15) are located on the jet engine control panel. The lock lever will lock the throttles in any desired position. The throttle lever positions are CLOSE, IDLE, and OPEN. Throttle control employs an electronic system similar to the reciprocating engine mixture control. Movement of a lever originates a 115-volt a-c signal which ultimately positions the fuel regulator and the stopcock of the corresponding engine. The stopcock acts as a fuel shutoff valve when the throttle is closed and functions as a fuel metering valve for engine starting before the fuel regulator becomes effective. The initial movement of a lever also completes the related ignition circuit for ground starting.

...PILOTS' *Overhead Jet Control Panel*



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1. Astrodome Control Panel
2. Throttle Lock Lever
3. Throttle Levers
4. Circuit Breaker Panel
5. Oil Heater Switch
6. Pod Preheat Switch
7. Nose De-Ice Switch
8. Circuit Breaker Panel
9. Oil Shutoff Valve Switches
10. Booster Pump Switches
11. Throttle Control Override Switches
12. Fuel Valve Indicator Lamps
13. Nose Shutoff Door Switches
14. Manifold Valve Switches
15. Engine Fuel Valve Switches
16. Fire Warning Lamps
17. Throttle Control Selector Switches
18. Fire Detector Test Switches
19. Circuit Breaker Panel
20. Engine Starter Switches
21. Egnition Start Switches
22. Panel Lights Switch
23. Automatic Approach And Altitude Control Panel
24. Jet Throttle Position Indicator and Selector Switch

Figure 1-15.

Throttle Control Selector Switches.

Four two-position switches (17, figure 1-15), located on the jet engine control panel, are used to select the type of throttle control desired. When the switches are in the LEVER position, the throttle levers provide throttle control. When the switches are placed in the SWITCH position, throttle control with a set of override switches is effective.

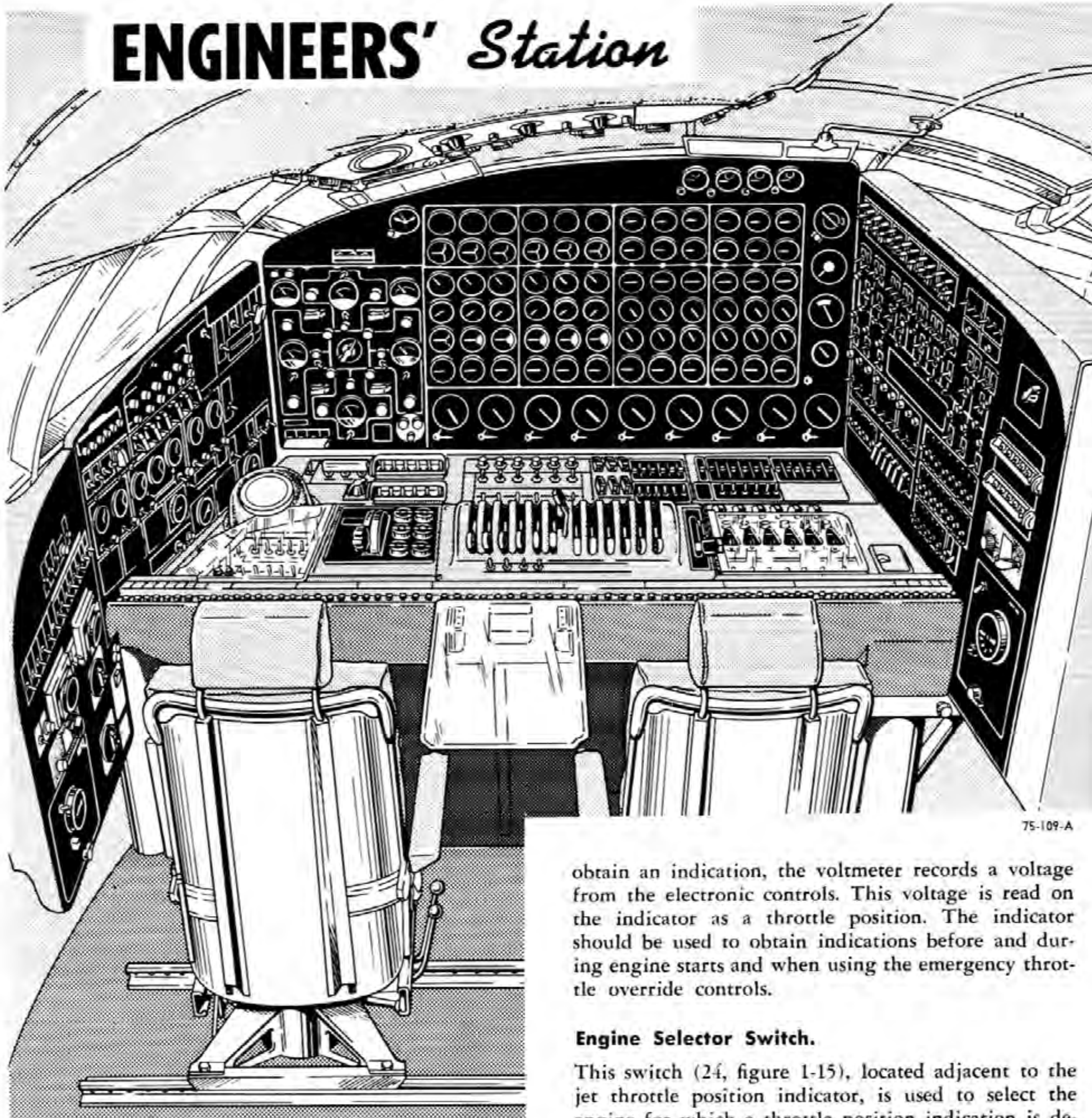
Emergency Throttle Control Override Switches.

Four three-position switches (11, figure 1-15), located on the jet engine control panel, are provided in the event the electronic throttle controls become inoperative. The switches are connected directly to actuators on the engines by electrical circuits and have spring-loaded OPEN and CLOSE positions and a neutral OFF position. Intermediate settings of the fuel regulator can be obtained by jiggling the override switches.

CAUTION

Throttle control is very sensitive when using the emergency throttle override switches.

ENGINEERS' *Station*



THROTTLE POSITION INDICATION (SOME AIRPLANES).

An indicator and a selector switch are provided to enable the pilots to determine the position of the jet engine electronic throttle controls. The indicator is a voltmeter which is scaled to indicate the degree of throttle opening. The indicator is connected through the selector switch to the electronic throttle controls for each jet engine. When the switch is positioned to obtain an indication, the voltmeter records a voltage from the electronic controls. This voltage is read on the indicator as a throttle position. The indicator should be used to obtain indications before and during engine starts and when using the emergency throttle override controls.

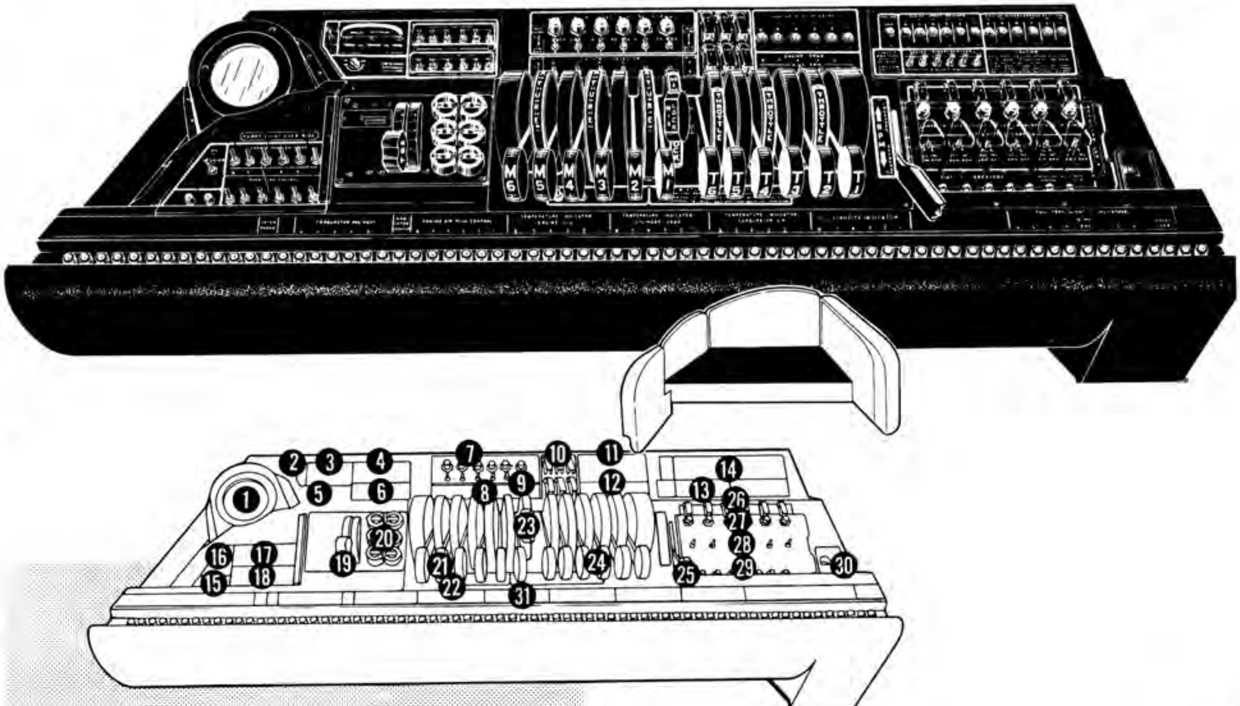
Engine Selector Switch.

This switch (24, figure 1-15), located adjacent to the jet throttle position indicator, is used to select the engine for which a throttle position indication is desired. The switch has intermediate positions marked 1, 2, 3, and 4 with OFF positions at either end.

Jet Throttle Position Indicator.

This voltmeter (24, figure 1-15), located on the jet control panel, is graduated to indicate jet throttle control positions. The extreme ends of the scale are marked CLOSED and OPEN and the intermediate positions are marked 1/4, 1/2, and 3/4. In addition, a position marked START is provided at one graduation less than the 1/4 position.

ENGINEERS' Table



GI-111-A

1. Engine Analyzer Indicator
2. Exciter Field Flashing Switch
3. Carburetor Preheat Switches
4. Air Plug Switches
5. Cylinder Head Temperature Selector Switch
6. Intercooler Shutter Switches
7. Normal Mixture Indicator Lamps
8. Mixture Control Selector Switches
9. Mixture Control Override Switches
10. Spark Advance Switches
11. Circuit Breaker Panel
12. Fan Speed Switches
13. Engine Supercharger Switches
14. Circuit Breaker Panel
15. Turbo Override Fuses
16. Turbo Vernier Switch
17. Turbo Change-Over Switches
18. Turbo Override Switches
19. Turbo Boost Selector Lever
20. Turbo Calibration Potentiometer Knobs
21. Mixture Levers
22. Alternator Breaker Hold-In Switches
23. Mixture Lock Lever
24. Throttle Levers
25. Master Motor Speed Control Lever
26. Propeller Feather Switches
27. Propeller Tel-Lamps
28. Propeller Selector Switches
29. Circuit Breaker Panel
30. Ash Receiver
31. Circuit Breaker Panel

Figure 1-16.

AIR INTAKE CONTROL.

The air intake of each jet engine is controlled by eight leaf-type doors which are operated by an actuator mounted in the nose cone. During jet engine operation the doors must always be open. When the jets are shut down, the doors should be closed to prevent excessive windmilling, minimize drag, and keep foreign objects from entering the air intake.

Note

When the doors are fully closed, the engine will windmill at approximately 5 per cent rpm to maintain oil circulation.

Nose Shutoff Door Switches.

Four three-position switches (13, figure 1-15), located on the jet engine control panel, provide control for the electrically operated engine nose shutoff doors. The switches have full-on positions marked OPEN and CLOSE and a neutral OFF position. The switches receive 28-volt direct current from a single circuit breaker to close relays which supply 115-volt a-c power to the nose shutoff door actuators. In the event of a short in one nose door control circuit, placing the switch of the defective circuit in the OFF position and

ENGINEERS' *Main Control Panel*

1. Ignition Switches
2. Engine Starter Switches
3. Engine Primer Switches
4. Fuel Valve Lights Dim-Bright Knob
5. Tank Valve Switch and Booster Pump Switch
6. Manifold Valve Switch and Indicator Lamps
7. Cross-Feed Valve Switch
8. Oil Dilution Switches
9. Engine Valve Switch and Indicator Lamps
10. Water Injection Switches
11. Pressure Refueling Valve Indicator Lamps
12. Pressure Refueling Valve Switches
13. Circuit Breaker Panel
14. Interphone Panel
15. Circuit Breaker Panel
16. Engine Oil Shutoff Valve Switches
17. Bomb Bay Fuel Tank Quantity Simulator Switch
18. Oxygen Panel
19. Oil Cooler Door Mode Selector Switches (Some Airplanes)
20. Oil Cooler Door Override Switches (Some Airplanes)

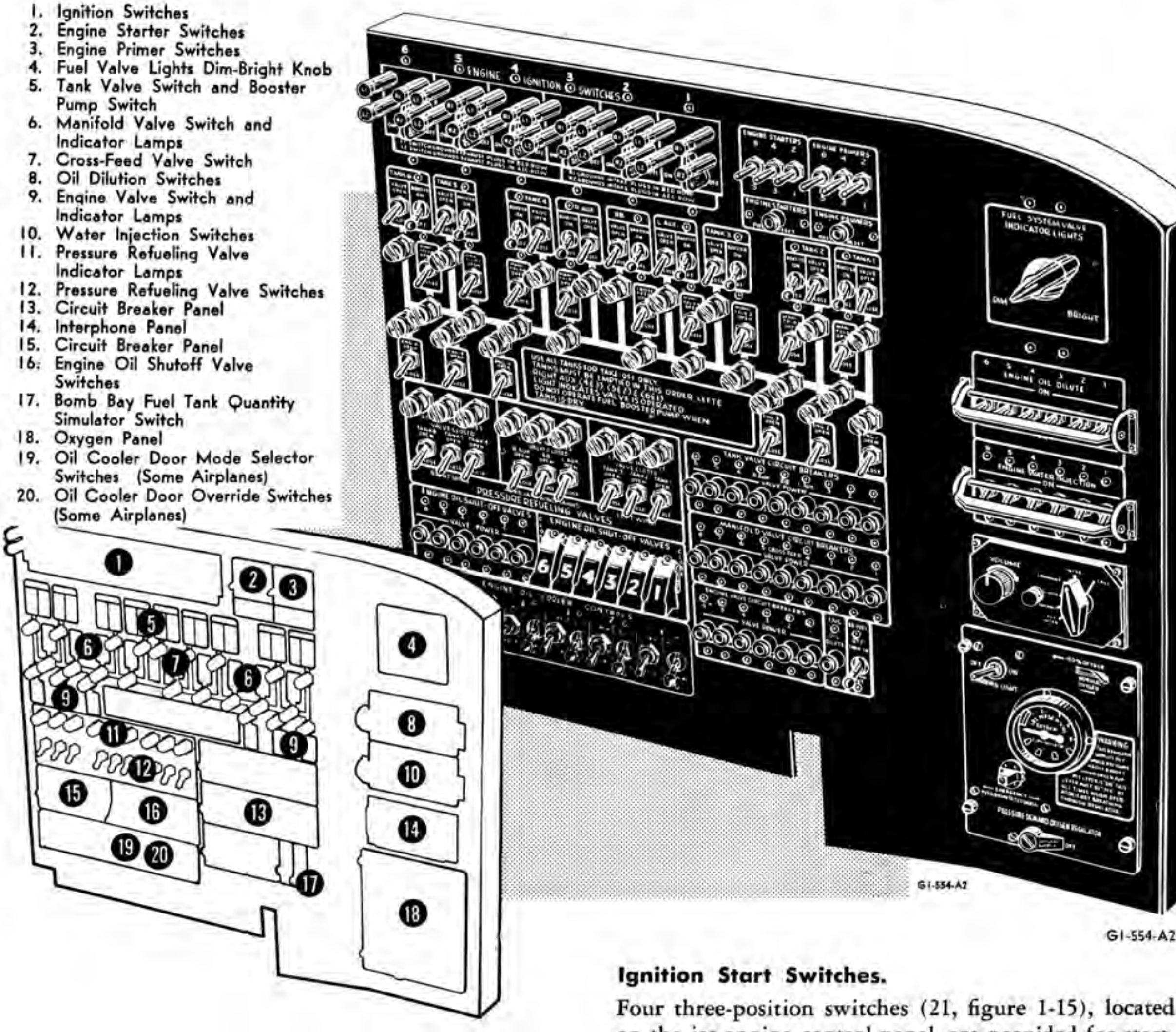


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Figure 1-17.

resetting the circuit breaker will allow operation of the other three circuits. The neutral OFF position can also be used for intermediate positioning of the nose doors.

IGNITION SYSTEM.

Ignition start switches supply electrical energy to ignition electrodes which are mounted in combustion chambers No. 3 and 7 of each jet engine. Complete combustion is carried out by flame propagation through the crossfire tubes. Ignition is used only for starting as combustion in the chambers is self-sustaining once it has been started, except when flame-out conditions occur.

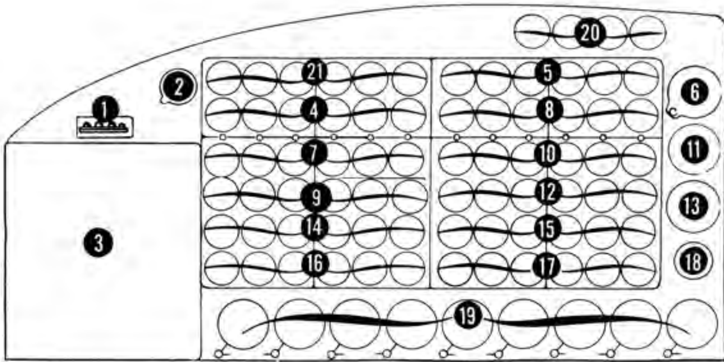
Ignition Start Switches.

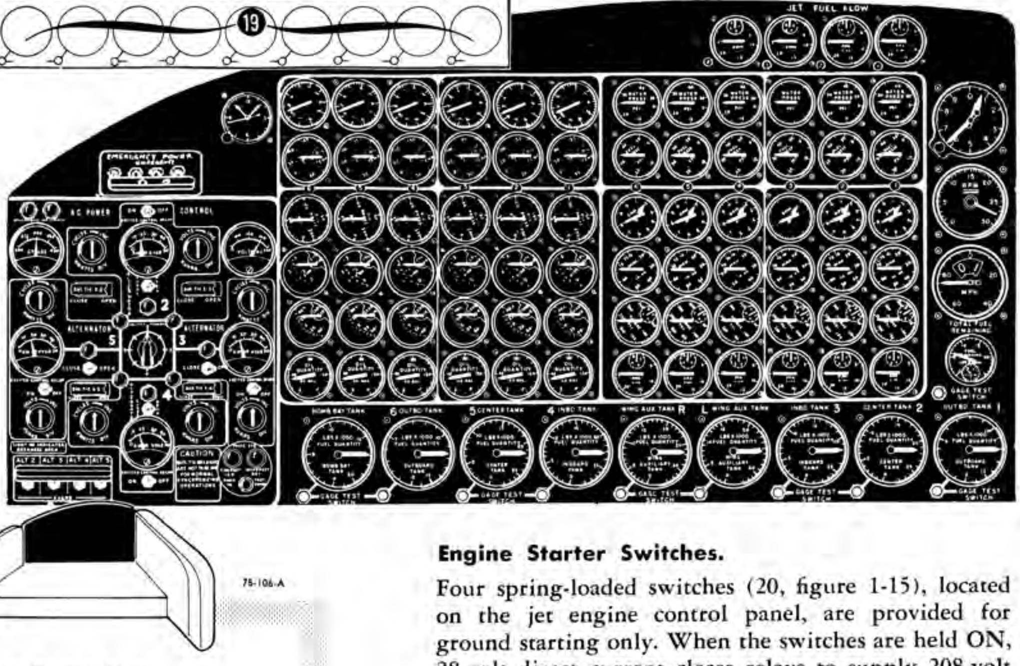
Four three-position switches (21, figure 1-15), located on the jet engine control panel, are provided for starting engines during flight. Each switch has a neutral OFF position, a NORMAL position, and a spring-loaded ALTITUDE position. With the switches in the NORMAL position, ignition occurs when the starter switches are held ON and the throttle levers are advanced from the CLOSE position. This prevents flooding the combustion chambers with raw fuel before ignition occurs which would result in a hot start. For aerial starts where the starter is not used because sufficient windmilling rpm is available, the switches are held in the ALTITUDE position and supply a-c current directly to the electrodes.

STARTING SYSTEM.

Each jet engine is equipped with an a-c starting system containing a starter switch and a starter. The starter is

ENGINEERS' *Main Instrument Panel*





1. Emergency Power Control
2. Clock
3. A-C Power Control Panel
4. Oil Temperature Indicator
5. Water Pressure Gage
6. Altimeter
7. Oil Pressure Gage
8. Fuel Pressure Gage
9. Cylinder Head Temperature Indicator
10. Engine Tachometer
11. Master Tachometer
12. Manifold Pressure Gage
13. Air-Speed Indicator
14. Carburetor Air Temperature Indicator
15. Torque Pressure Gage
16. Oil Quantity Gage
17. Reciprocating Engine Fuel Flow Indicator
18. Fuel Quantity Totalizer Gage
19. Fuel Quantity Gage and Test Switch
20. Jet Engine Fuel Flow Indicator
21. Turbo Tachometer

75-106-A

Figure 1-18.

used for ground starts only, as the jet engine is windmilled for aerial starts. After the engine fires during ground starts, the starter is used to aid engine acceleration up to 20 to 25 per cent rpm to prevent excessive tail pipe temperatures and possible compressor stall.

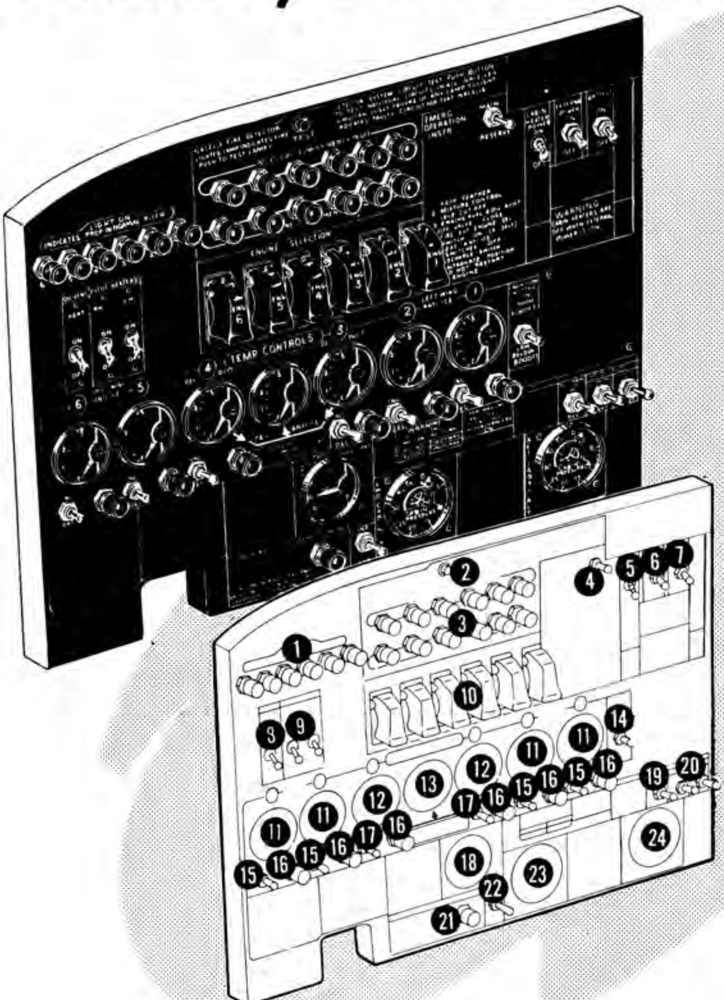
Engine Starter Switches.

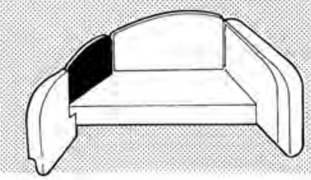
Four spring-loaded switches (20, figure 1-15), located on the jet engine control panel, are provided for ground starting only. When the switches are held ON, 28-volt direct current closes relays to supply 208-volt a-c power to the starters. Closing the switches also sets up the ignition circuits. When the switches are released, the starters are de-energized and the ignition is cut off.

JET ENGINE OIL SYSTEM.

Each jet engine has an independent oil system consisting principally of a 20-gallon supply tank, lines, pressure and scavenge pumps, a filter, an oil cooler, and an oil tank heater. The cylindrical metal tanks, installed in the wing above the jets, will hold 13 gallons of oil with the remaining 7-gallon space reserved for oil foaming. Refer to figure 1-45 for servicing information. The oil flows from the tank to a gear-driven combination pressure and scavenge pump mounted on the accessory section and is pumped to the lubrication points and to the fuel regulator. A filter mounted on the compressor case filters the oil passing through the line from the pressure pump to the aft bearings. A scavenge pump in the midframe returns the oil in the aft section through the cooler to the tank. The cooler is mounted on the compressor casing and uses fuel as a

ENGINEERS'
Auxiliary Control and Instrument Panel





1. Propeller Normal Pitch Indicator Lamps
2. Fire Detector Push-To-Test Switch
3. Fire Warning Lamps
4. Fire Extinguisher Discharge Selector Switch
5. Cabin Heater Power Switch
6. External Power Supply Switch
7. Battery Switch
8. Oil Vent Heater Switch
9. Pitot Heater Switches
10. Fire Extinguisher Engine Selector Switches
11. Wing Anti-Icing Temperature Indicator
12. Cabin Heat and Tail Anti-Icing Temperature Indicator
13. Tail Anti-Icing Temperature Indicator
14. Booster Fan Control Switch
15. Wing Anti-Icing Switches
16. Cabin Heating and Anti-Icing Warning Lamps
17. Cabin Heat and Tail Anti-Icing Switches
18. Duct Air Temperature Indicator (Fwd Cabin Pressure)
19. Aft Cabin Pressure Switch
20. Cabin Pressure Wing Shutoff Valve Switch
21. Cabin Temperature Control Valve Indicator Lamp
22. Cabin Air Supply Temperature Control Switch
23. Forward Cabin Altimeter
24. Aft Cabin Altimeter

69-135-A

69-135-A

Figure 1-19.

cooling medium. The oil cooling is fully automatic with a thermostatically controlled by-pass and relief valve regulating the flow of oil through the cooler. Lubricating oil pumped to the forward section of the engine is scavenged and returned to the supply tank by the scavenger side of the combination pressure and scavenge pump. This oil is not cooled, as temperatures are not high in the section it lubricates. Strainers within the accessory section gear case clean the oil of any large foreign particles. A combination filter and orifice filters and meters the oil supply to the fuel regulator.

CONTROLS AND INDICATORS.

Oil Shutoff Valve Switches.

Four on-off switches (9, figure 1-15), located on the jet engine control panel, are provided to control the oil shutoff valves. The valves operate on 115-volt a-c power.

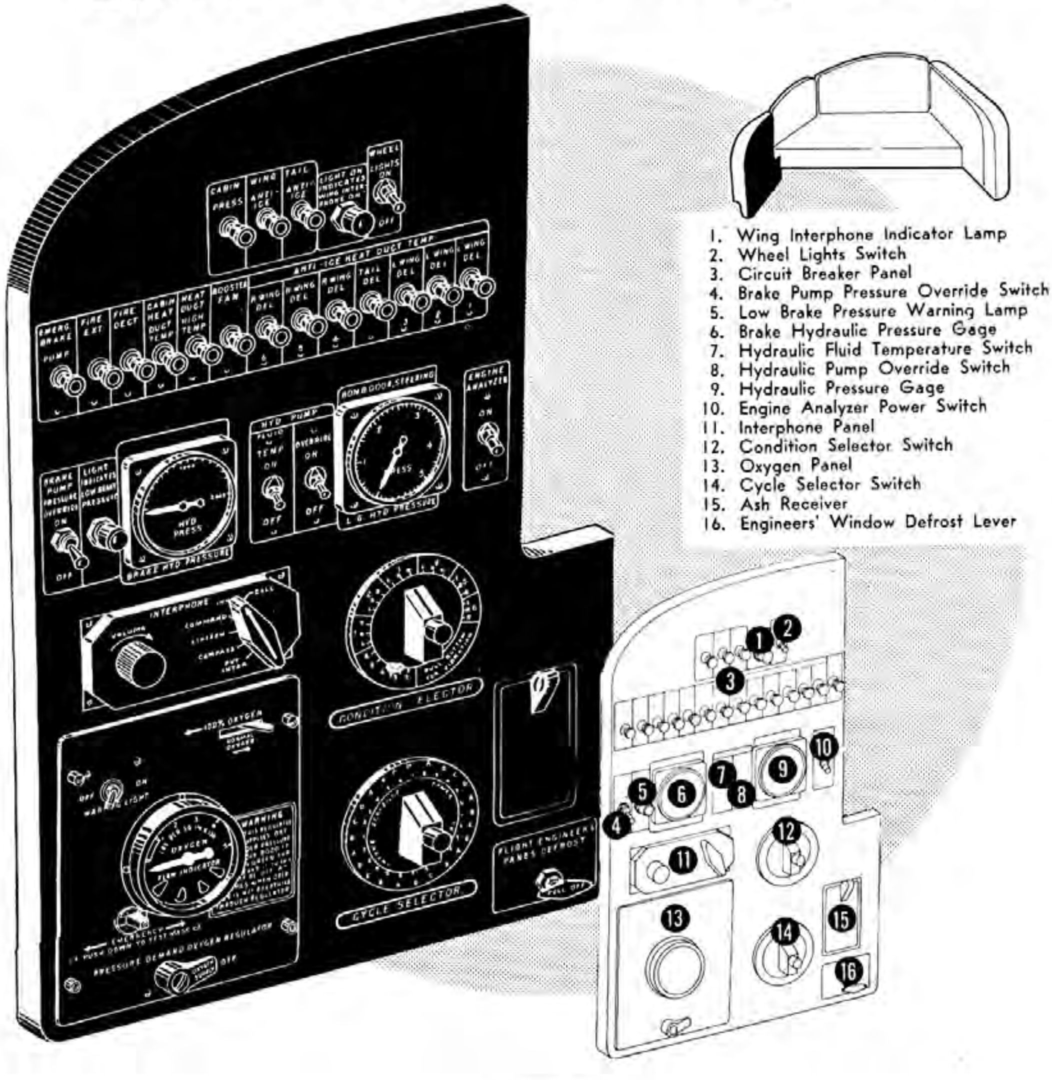
Oil Pressure Gages.

Four oil pressure gages (29, figure 1-8), one for each jet engine, are located on the pilots' instrument panel.

FUEL SYSTEM.

Fuel is supplied to the reciprocating and the jet engines from six main wing tanks and two auxiliary wing tanks. An additional tank can be installed in bomb

ENGINEERS' *Auxiliary Panel*



GI-107-A

Figure 1-20.

bay No. 3. The main wing tanks are formed by compartments between the front and rear spars inboard of each reciprocating engine nacelle. The auxiliary wing tanks are formed by a compartment on each side of the fuselage centerline between the front and rear spars. Each auxiliary wing tank compartment contains four interconnected bladder type cells which are non-self-sealing and are made of rubber impregnated nylon fabric. The bomb bay tank is of nonself-sealing metal construction and is equipped with quick disconnect fittings so it can be dropped in flight. It is supported within the bomb bay by bomb shackles. The capacity of each tank is given in figure 1-21.

Note

The capacity of each auxiliary wing tank varies from airplane to airplane because of small differences in the size of the bladder-type cells. For the sake of uniformity all auxiliary wing tanks are rated at 4788.5 gallons usable fuel.

All tanks are interconnected, making it possible to supply fuel from any combination of tanks to any combination of engines. Each fuel tank has an inlet and outlet line with a fuel valve in each. The inlet line is a provision for single-point pressure refueling which is accomplished from a special adapter valve in the left side of the fuselage between bomb bays 2 and 3. The outlet line connects the tanks to the main manifold fuel line which interconnects all of the wing fuel tanks. From this main manifold, fuel is supplied to the reciprocating and the jet engines. Fuel vapor which forms in the carburetor, the fuel injection pumps, the master control units, and the jet engine booster pump tanks is returned to the tanks through vapor return lines. The amount of fuel returned varies considerably and could possibly amount to 150 gallons for all six engines during a long flight. For fuel system arrangement, see figure 1-22. Fuel flow is controlled by tank, manifold, cross-feed, and engine fuel valves. Normally these valves are electrically operated by a 28-volt direct current. With the exception of the engine valves for the jet engines, the valves can be positioned manually during flight. Fuel pressure is provided by an engine-driven pump on each engine and a booster pump in each tank. An additional booster pump is installed in the fuel line leading to each pair of jet engines. The booster pumps operate on 208-volt alternating current. For fuel system management, refer to Section VII.

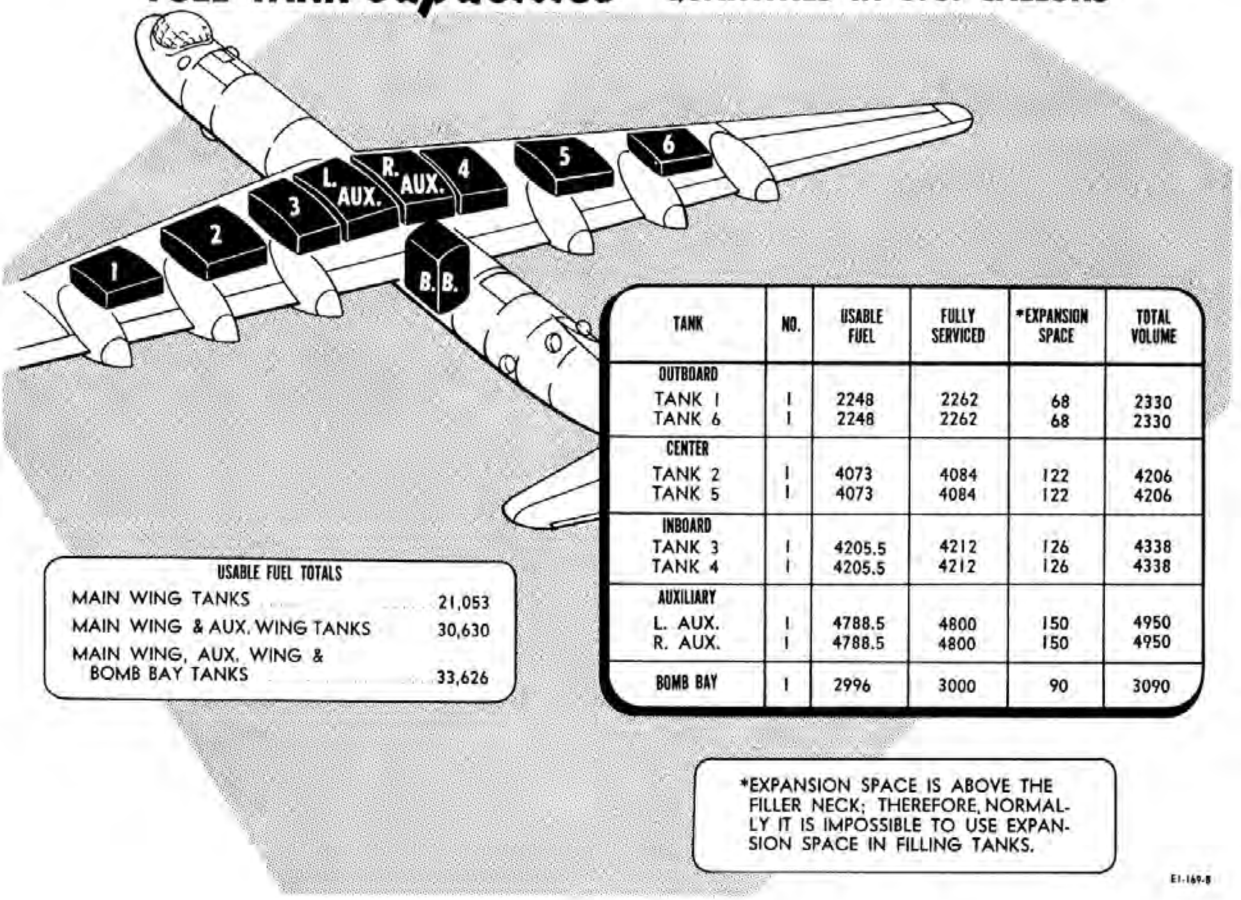
Fuel conforming to Specification No. MIL-F-5572 (AN-F-48), grade 115/145, is used. Grade 100/130 may be used as an alternate fuel.

CAUTION

When an alternate fuel is used, engine limitations differ from those established for the recommended fuel grade. Refer to Section V for all operating limits.

For additional fuel servicing information, see figure 1-45.

FUEL TANK *Capacities* QUANTITIES IN U. S. GALLONS



TANK	NO.	USABLE FUEL	FULLY SERVICED	*EXPANSION SPACE	TOTAL VOLUME
OUTBOARD					
TANK 1	1	2248	2262	68	2330
TANK 6	1	2248	2262	68	2330
CENTER					
TANK 2	1	4073	4084	122	4206
TANK 5	1	4073	4084	122	4206
INBOARD					
TANK 3	1	4205.5	4212	126	4338
TANK 4	1	4205.5	4212	126	4338
AUXILIARY					
L. AUX.	1	4788.5	4800	150	4950
R. AUX.	1	4788.5	4800	150	4950
BOMB BAY	1	2996	3000	90	3090

USABLE FUEL TOTALS

MAIN WING TANKS	21,053
MAIN WING & AUX. WING TANKS	30,630
MAIN WING, AUX. WING & BOMB BAY TANKS	33,626

*EXPANSION SPACE IS ABOVE THE FILLER NECK; THEREFORE, NORMALLY IT IS IMPOSSIBLE TO USE EXPANSION SPACE IN FILLING TANKS.

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E1-169-B

Figure 1-21.

FUEL SYSTEM CONTROLS.

Tank Valve Switches.

Each tank valve is provided with a control switch (5, figure 1-17) located on the main control panel at the engineers' station. The switches have positions marked OPEN and CLOSE, and are used to control fuel flow from the tanks.

Engine Valve Switches.

Six reciprocating engine valve switches (9, figure 1-17) are located on the engineers' main control panel. Four jet engine valve switches (15, figure 1-15) are located on the jet engine control panel. Each switch operates an engine valve to control the flow of fuel to its corresponding engine. Each of these switches has an OPEN and CLOSE position.

Manifold Valve Switches.

Eight manifold valve switches (6, figure 1-17) are located on the engineers' main control panel. Each switch controls a manifold valve. These manifold valves control fuel flow through the main manifold line. Two additional switches (14, figure 1-15) are located on the pilots' jet engine control panel. Each of these switches operates a valve which controls the flow to each pair of jet engines. All manifold valve switches are marked OPEN and CLOSE.

Cross-Feed Valve Switch.

One cross-feed valve switch (7, figure 1-17) is located on the engineers' main control panel. The switch is marked OPEN and CLOSE, and is used to operate the cross-feed valve which controls fuel flow from one wing system to the other.

Booster Pump Switches.

Nine switch-type circuit breakers (5, figure 1-17) are located on the engineers' main control panel. Each switch controls a fuel tank booster pump. Two switch type circuit breakers (10, figure 1-15), located on the jet engine control panel, operate the booster pumps for the jet engines. The booster pump switch positions are ON and OFF.

Fuel Indicator Lamps Dim-Bright Knob.

This rheostat knob (4, figure 1-17), located on the engineers' main control panel, controls the brilliance of the fuel valve indicator lamps on the fuel control panel except those for the pressure refueling valves.

FUEL INDICATORS.

Reciprocating Engine Fuel Flow Indicators.

Six fuel flow indicators (17, figure 1-18) for the reciprocating engines are located on the engineers' instrument panel. Each indicator is electrically connected to its respective flowmeter transmitter, which is located in the fuel line upstream from the engine-driven pump between the pump and the strainer on each reciprocating engine. The indicators register fuel flow in pounds per hour. The system is energized from a transformer which receives 115-volt alternating current from the engineers' power panel.

Jet Engine Fuel Flow Indicators.

Four fuel flow indicators (20, figure 1-18) are located on the engineers' main instrument panel. Each indicator is connected to its related flowmeter transmitter which is located in the fuel line between the filter and the engine shutoff valve. The indicators register flow in pounds per hour. The system uses power from transmitters which receive 115-volt alternating current from the jet pod power panels.

Fuel Pressure Gages.

Six fuel pressure gages (8, figure 1-18) for the reciprocating engines are located on the engineers' instrument panel. This autosyn system is energized from a transformer which has an input of 115-volt alternating current from the engineers' power panel. Four gages (19, figure 1-8) for the jet engines are mounted on the pilots' instrument panel. Power for the jet fuel pressure indicating system is received from a transformer which has an input of 115-volt alternating current from the jet pod power panel.

Fuel Valve Indicator Lamps.

Fuel valve indicator lamps (9, figure 1-17) are located on the engineers' main control panel and the pilots' jet engine control panel. The lamps represent fuel control valves, and they burn continuously when the power is on and the valve gates are in either of their extreme positions. At the beginning of valve gate travel, the corresponding lamp goes out; normally relighting of the lamp indicates successful operation of the valve.

CAUTION

The light indicates motor travel and will give an erroneous indication if the motor is disconnected from the valve.

The specific position of a control valve gate is indicated by the position of the corresponding switch only.

FUEL QUANTITY MEASURING SYSTEM.

Each fuel tank is equipped with a capacitor-type fuel indicating system which measures and indicates the weight of fuel in the tank. Nine gages, one for each tank, are located at the engineers' station and indicate fuel quantity in pounds. In addition a fuel totalizer system totals and indicates, on a totalizer gage, the number of pounds of fuel remaining in all tanks.

FUEL SYSTEM *Schematic*

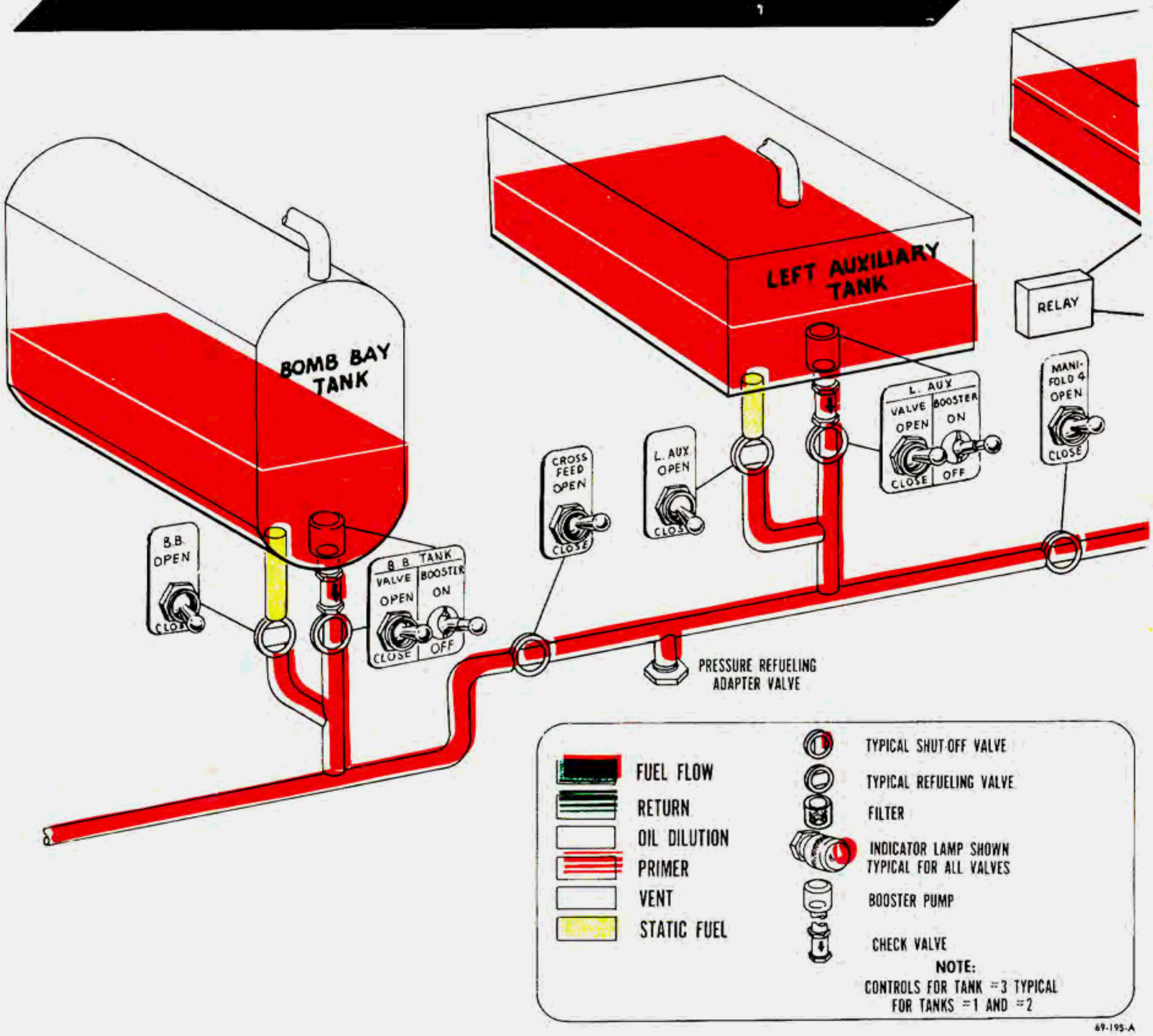


Figure 1-22. (Sheet 1)

Note

The totalizer totals only gage indications and not actual fuel quantity. Therefore if a quantity gage indicator spins and is stopped by pulling its related circuit breaker, the totalizer indication will be erroneous unless the spinning indicator happens to stop at an indication corresponding to the quantity of fuel in its related tank.

The fuel quantity measuring system consists of a tank capacitor unit, a bridge unit, an amplifier, an indicator, and the necessary electrical wiring. In addition to these units the bomb bay tank fuel quantity measuring system has a switch-controlled simulator which gives an empty tank reading whenever the bomb bay tank is not installed. The simulator prevents the bomb bay tank fuel quantity indicator pointer from "windmilling" counterclockwise which will cause an erroneous indication on the totalizer indicator. The totalizer

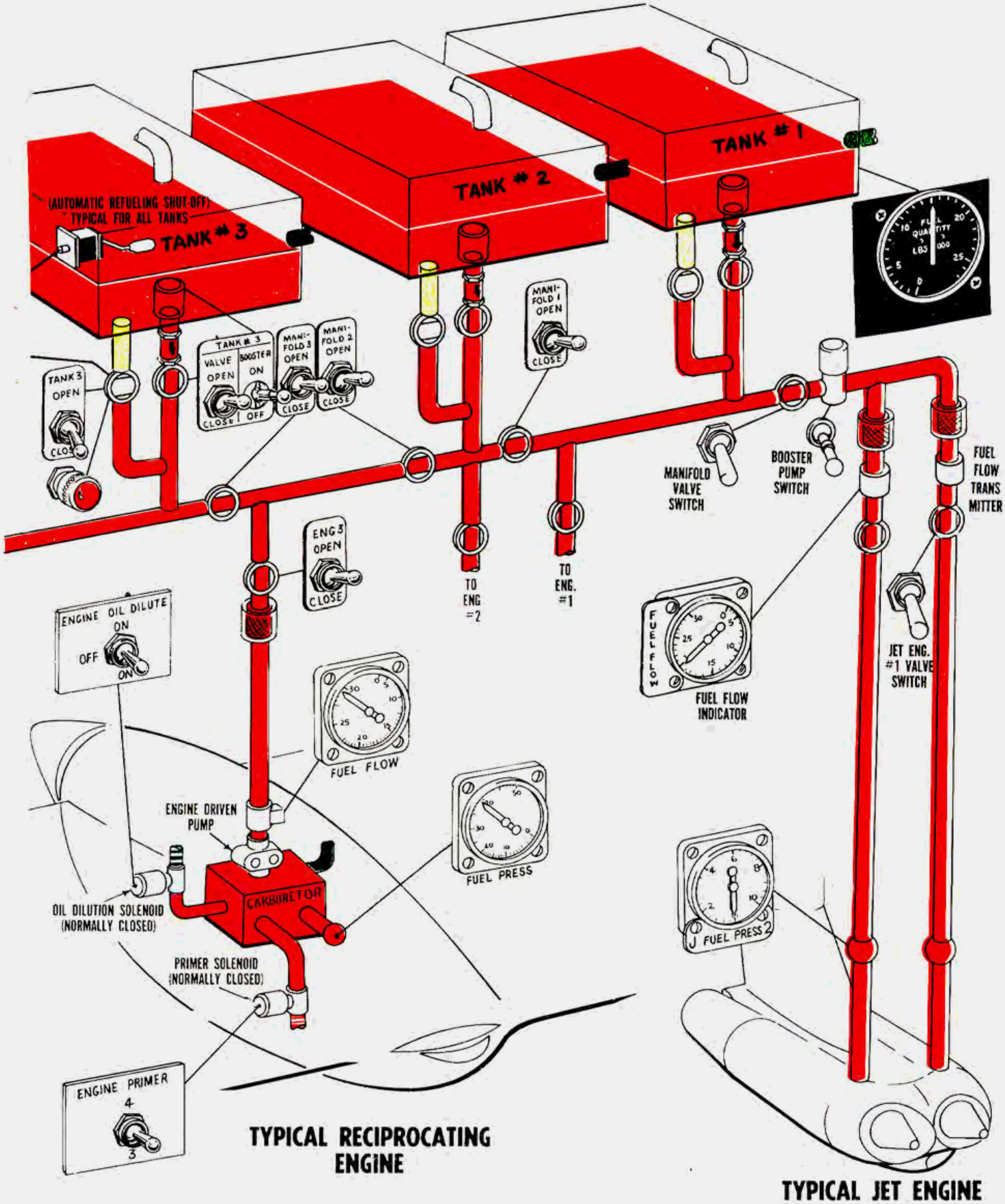


Figure 1-22. (Sheet 2)

systems consist of a totalizer bridge unit, an amplifier, a totalizer indicator, and the necessary electrical wiring.

Measurement of the fuel quantity is accomplished by having the fuel act as a dielectric between the conducting plates of the capacitor unit. (A dielectric is the insulating material which electrically separates the conducting plates of a capacitor or condenser. The capacitance of a capacitor varies directly with the dielectric constant of this insulating material.) A change in fuel level changes the amount of dielectric acting on the capacitor unit with a resulting change in its capacitance. A change in the capacitance of the capacitor unbalances the bridge unit which in turn energizes the fuel quantity indicator motor. The indicator motor drives a linear wire-wound potentiometer to rebalance the bridge unit and at the same time drives the indicator pointer to indicate the new fuel quantity.

Errors in readings caused by changes in temperature of the fuel are greatly reduced by this type of measuring system. When a fuel volume change occurs because of temperature variation, the tendency for the fuel weight indication to change is offset by a corresponding change in the dielectric constant of the fuel.

Push-To-Test Switch.

A push-to-test switch (19, figure 1-18) is provided for each fuel quantity indicator gage. When the switch is depressed and fuel is in the tank, moving of the indicator pointer toward zero is an indication that the gage is functioning properly.

Simulator Switch.

The simulator switch (17, figure 1-17) is a two-position switch-type circuit breaker on the engineers' main control panel with positions marked TANK IN and TANK OUT. With the switch in the TANK IN position and the bomb bay tank installed the bomb bay tank fuel quantity indicator will indicate the quantity of fuel in the tank. With the switch in the TANK OUT position, the indicator will read zero.

CAUTION

If the switch is in the TANK IN position and the bomb bay tank is not installed, the fuel quantity indicator will "windmill" counterclockwise, resulting in an erroneous reading on the totalizer indicator.

Fuel Quantity Gages.

Nine fuel quantity gages (19, figure 1-18) are mounted on the engineers' main instrument panel and indicate fuel quantity in pounds. There is a gage for each main wing tank, each auxiliary wing tank, and the bomb bay fuel tank. A push-to-test switch is provided near each indicator to test its operation. Depressing the switch while fuel is in the tank will cause the indicator pointer to move toward zero if the indicator is functioning properly. Each tank quantity indicating system obtains 115-volt a-c power through a circuit breaker on the engineers' table.

Note

When the electrical power to an indicator is interrupted for any reason, the pointer will remain in the position it was in before the power was interrupted.

The gages do not give a full-scale reading for a full tank. The full-tank reading can be calculated by multiplying the fully-serviced tank capacity (figure 1-21) and the fuel density as determined by the procedure in "Fuel Weighing Procedure," Section VII.

Totalizer Indicator.

A fuel totalizer indicator (18, figure 1-18) is located on the engineers' main instrument panel and indicates, in pounds, the total quantity of fuel indicated on the individual fuel quantity gages. A push-to-test switch is located near the indicator to test its operation. Depressing the switch while fuel is in the tanks will cause the indicator pointer to move toward zero if the indicator is functioning properly. The totalizer system obtains 115-volt a-c power through a circuit breaker on the engineer's table.

Note

When an indicator's electrical power is interrupted for any reason, the pointer will remain in the position it was in before the power was interrupted.

PRESSURE REFUELING CONTROLS.

Pressure Refueling Valve Switches.

Nine pressure refueling valve switches (12, figure 1-17), one for each wing tank and one for the bomb bay tank, are located on the engineers' main control panel. Each switch has OPEN and CLOSE positions and controls the fuel valve in the inlet line of each tank. During pressure refueling, the valves will automatically close when their tanks are within 25 to 75 gallons of being full; then, the valves cannot be opened electrically until 150 to 300 gallons of fuel have been used.

CAUTION

When pressure refueling is being carried out, someone should be stationed at the main control panel to observe the fuel level indicators and the refueling valve indicator lights. The refueling valves must be closed if they fail to operate automatically. Failure of a valve to operate is determined by the valve indicator light not coming on and the related fuel quantity gage pointer moving past the point at which the tank is full.

Note

Approximately one second is required for a refueling valve to travel from one extreme position to the other after the valve actuator has been energized.

Ground Refueling Safety Switch.

On some airplanes an on-off switch is located on the engineer's main control panel to eliminate the possibility of fire due to sparks caused by inadvertent equipment operation or equipment malfunction during single-point refueling operations. This switch, normally guarded in the OFF position, isolates all a-c and d-c power from the forward cabin external source except the power required to accomplish single-point refueling when placed in the ON position. Power is supplied only to the fuel quantity gage and tank refueling valve control circuits. Moving the switch to OFF returns all circuits to normal.

CAUTION

This switch isolates electrical equipment from electrical power applied to the forward cabin external power receptacle only.

Pressure Refueling Valve Indicator Lamps.

An indicator lamp (11, figure 1-17) for each pressure refueling valve will glow when its corresponding valve is fully closed. Each lamp will be dark when its valve is partly or fully open.

CAUTION

The light indicates motor travel and will give an erroneous indication if the motor is disconnected from the valve.

EMERGENCY FUEL CONTROLS.

The fuel valves can be operated manually in the event of electrical failure. (See figure 3-11.) The valves for the auxiliary wing tanks and the bomb bay tank are accessible from the bomb bay. The engine fuel valves for the jets are not accessible in flight.

BOMB BAY TANK RELEASE CONTROLS.

The bomb bay fuel tank can be jettisoned by use of a bomb bay tank release selector switch on the pilots' pedestal and the salvo switches located one each at the pilots' and the radar-bombardier's station. Refer to "Emergency Release Controls," Section IV, for information on the bomb salvo switches.

Bomb Bay Tank Release Selector Switch.

This two-position switch (16, figure 1-9), marked NO SALVO and CAN SALVO, is provided on the pilots' pedestal to either set up or de-energize a 28-volt d-c bomb bay tank salvo circuit. When the switch is in the NO SALVO position, the bomb bay fuel tank cannot be salvoed. When it is in the CAN SALVO position, the tank will release upon actuation of any one of the bomb salvo switches. Also, when the switch is in this position, a green indicator lamp (16, figure 1-9) adjacent to the switch will glow, indicating that the fuel tank can be salvoed. An indicator lamp is also provided on the bombing control panel.

ELECTRICAL SYSTEM.

A 3-phase, 400-cycle, a-c electrical system is employed because it permits a considerable weight saving in required wire gages, actuators, and generators. Alternating and direct current and supplied the airplane through a primary and secondary power distribution network. The primary network is a 208/115-volt, 3-phase, 400-cycle, alternating-current power system (figure 1-23) supplied by four engine-driven alternators. The secondary network is a direct-current power system (figure 1-26) supplied by transformer-rectifier units fed from the alternating-current system. The alternating-current system supplies 400-cycle, a-c power to the electronic-controlled turrets, heavy-duty motors, high speed actuators, lighting circuits, flight control equipment, and radio and radar equipment. The 28-volt direct-current system supplies power to such vital equipment as the bomb release system, radio and radar sets, propeller reverse and feathering control, fuel valves, and alarm bells.

The electrical system employs fuses and circuit breakers to clear faults automatically. Multicircuit feeders to three or four wires per phase are incorporated in the power distribution system. A multicircuit feeder will provide continued service after one of its conductors has been broken, causing an open circuit. To furnish the necessary protection against faults or shorts occurring on a feeder section, fuses are located on each end of the conductors. Should a conductor break and the two loose ends cause a short circuit, the fuses at each end will clear, isolating the fault and permitting continued operation of the feeder section through the remaining conductors. Any one of the four alternators can supply sufficient electrical power for emergency operations provided all unnecessary equipment is turned off.

EXTERNAL POWER SOURCE.

When the airplane is on the ground, electric power is obtained from a B-10 portable power cart on which is mounted an alternator driven by a gasoline engine.

During normal operation the cart is connected to the airplane through a six-prong external power receptacle located on the under side of the fuselage below the wing. The power cart supplies 208-volt, 3-phase, 400-cycle, alternating current, part of which energizes the airplane's transformer-rectifier units and furnishes

A-C POWER DISTRIBUTION

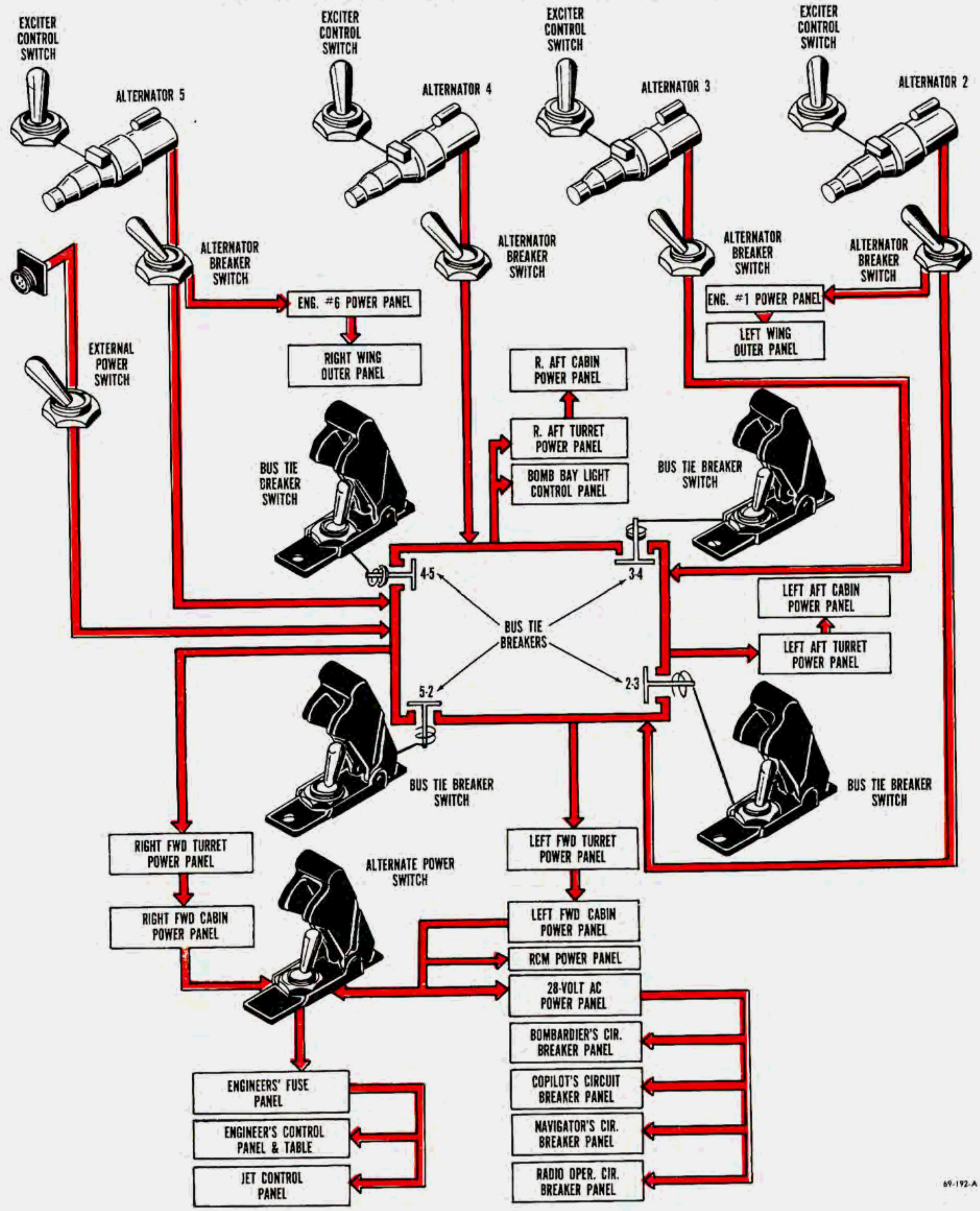


Figure 1-23.

28-volt direct current. When the portable power cart is connected to the airplane, it is imperative that the 3-phase power supplied has the same phase sequence as the alternators installed in the airplane. The direction of rotation of a 3-phase electric motor is entirely dependent on the phase sequence of its power supply. If two of the three power lines to a motor are interchanged, resulting in reversed phase sequence, the direction of motor rotation reverses. Therefore, if the power leads from the cart are interchanged so that the phase sequence of the power output is incorrect, motors on the airplane will run in the wrong direction when energized from the portable power cart. To prevent this error, indicator lamps for determining phase sequence are provided.

CAUTION

Serious damage will result to certain types of motors and equipment on the airplane if they are operated in the wrong direction.

On some airplanes a switch is located on the engineers' main control panel to isolate the power applied to the forward cabin external power receptacle from all electrical equipment except the fuel quantity gages and the refueling valves. Isolating the power from all but these two systems reduces the possibility of sparks which could cause a fire during single-point refueling.

External Power Supply Switch.

This two-position on-off switch (6, figure 1-19), when placed in the ON position, completes the circuit from the portable power cart of the airplane's electrical system. At the same time it breaks the circuits to all cabin heaters. The switch is located on the engineers' auxiliary control and instrument panel.

Phase Sequence Lamp Test Switch.

A push-to-test switch (15, figure 1-24) is located adjacent to the phase sequence lamps to test their operation.

Phase Sequence Lamps.

Two lamps (14, figure 1-24) are provided on the engineers' main instrument panel to indicate phase sequence. If the phase sequence of the cart is correct, the lamp marked CORRECT 1, 2, 3 will light. If the phase sequence is incorrect, the lamp marked INCORRECT 3, 2, 1 will light.

Note

If both lamps light, the indication of the brightest lamp should be followed.

ALTERNATING-CURRENT SYSTEM.

The a-c supply consists of four 40-kva, 208/115-volt, 3-phase, neutral grounded, 400-cycle alternators. One alternator each is installed on engines No. 2, 3, 4, and 5. Each alternator feeds into the main power panels in the fuselage, from where the power is distributed to the various electrical loads in the airplane.

Alternator Controls and Indicators.

Power output of any alternator is possible only when the alternator field is excited by d-c power supplied by a generator built into the alternator. This d-c flow is controlled by a three-position, spring-loaded, on-off exciter control relay switch (2, figure 1-24). Voltage output of the alternator is controlled by regulating the voltage of the exciter field. The real load output is measured in kilowatts. The real load output is accompanied by a reactive current during inductive load output; this reactive load is measured in kilovars.

One of the most important devices in the a-c power supply system is the unit used to drive the alternator at a constant speed throughout the range of various engine speeds. Alternator frequency varies with alternator speed; therefore, in order to generate a constant frequency, a reliable constant-speed source is required. The constant-speed drive used is a mechanical-hydro-electric governor and drive unit. The drive unit, a variable ratio hydraulic transmission, delivers power to the alternator at a speed which is held constant through controlling action applied to the drive by the governor equipment.

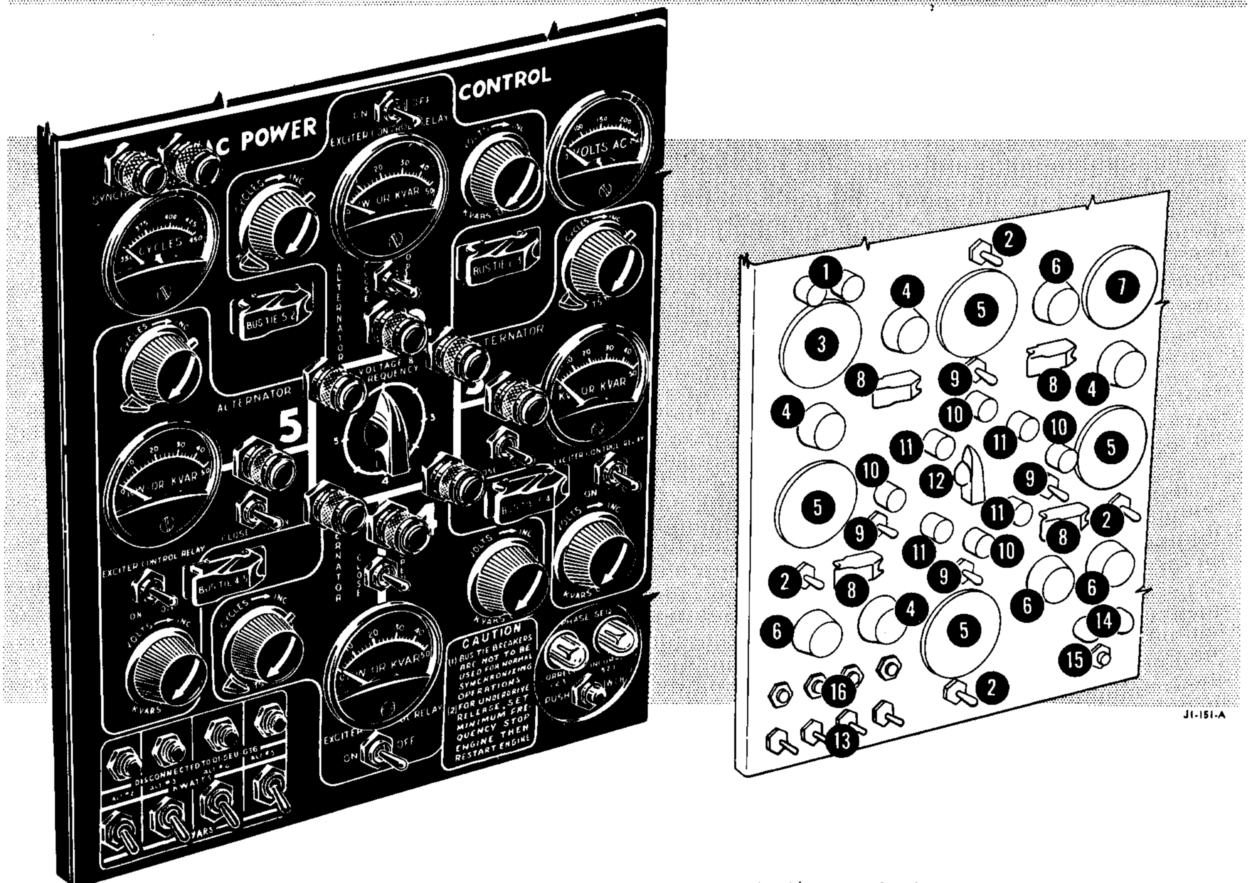
Parallel operation (more than one alternator supplying a common bus) is desirable, since it will give greater stability to the electrical system; and in the event one alternator is inoperative, the entire power supply will not be cut off. See "The Alternator" Section VII. One kilowatt-kilovar meter (5, figure 1-24) is supplied for each alternator to indicate its power output. Although it is desirable that the three alternators divide the load as much as possible, the free-wheeling feature of the constant-speed drive permits alternator motoring for periods up to 5 minutes without damage to the drive. (See "Alternator Motoring," Section III.)

Exciter Control Relay Switch. Holding this switch (2, figure 1-24) momentarily in the ON position excites the alternator. Holding the switch momentarily in the OFF position de-excites the alternator and discontinues its output. The OFF position is also used to flash the alternator field when the alternator field flashing switch is ON. (See "Alternator Field Flashing," Section III.)

Voltage Control Knob. Voltage control of each alternator is controlled by its associated voltage control knob (6, figure 1-24).

Frequency Control Knob. This knob (4, figure 1-24) connects to the governor control circuit to provide a means of controlling the speed of the constant-speed drive. Controlling the speed at which the alternator is driven directly controls the frequency of its output.

ENGINEERS' A-C Power Control Panel



J1-151-A

Figure 1-24.

1. Alternator Synchronizing Lamps
2. Exciter Control Relay Switch
3. Frequency Meter
4. Frequency Control Knob
5. Kilowatt-Kilovar Meter
6. Voltage Control Knob
7. Voltmeter
8. Bus Tie Breaker Control Switch
9. Alternator Breaker Switch
10. Alternator Breaker Indicator Lamp
11. Bus Tie Breaker Indicator Lamp
12. Voltage and Frequency Selector Switch
13. Kilowatt-Kilovar Selector Switches
14. Phase Sequence Lamps
15. Phase Sequence Lamps Push-To-Test Switch
16. Constant Speed Drive Underdrive Release Switches (Disconnected)

On some airplanes a mechanical stop has been added to the alternator frequency control knob to prevent a setting which might cause overspeeding of the alternator during ground operation. This mechanical stop can be overridden by depressing the lock until it clears the set screw.

CAUTION

Do not turn the frequency control knob past the mechanical stop during ground operation. If this mechanical limit is exceeded, overspeeding will occur with possible damage to the alternator.

Voltage and Frequency Selector Switch. An eight-position selector switch (12, figure 1-24) is located on the engineers' main instrument panel. Four of these positions are marked 2, 3, 4, and 5 with respect to the four alternators. With the switch in any of these positions, the voltmeter and frequency meter will indicate the voltage and frequency of the selected alternator. Also, the kilowatt-kilovar meter (5, figure 1-24) for each alternator will indicate the power output of the selected alternator when its alternator breaker is closed and electric power is being used. The four unmarked positions are connected to the four main bus bars. The position between 2 and 3 is connected to bus 201, the position between 3 and 4 to bus 301, the position between 4 and 5 to bus 401, and the position between 5 and 2 to bus 501. With the switch in any of these

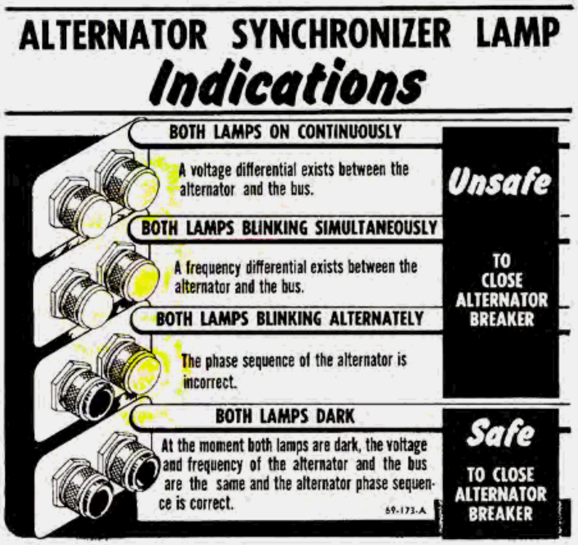


Figure 1-25.

positions, the voltmeter and frequency meter will indicate the voltage and frequency of the current of the selected bus, provided the bus tie breakers are open. If the bus tie-breakers are closed, any of these four positions will give the voltage and frequency of the current on the connected bus bars.

Alternator Breaker Switch. Each alternator is connected to the power distribution network by an alternator breaker. A three-position switch (9, figure 1-24), spring-loaded in the OPEN and CLOSE positions, controls the breaker which is a d-c operated solenoid. Individual alternator breaker indicator lamps (10, figure 1-24) are located adjacent to each alternator breaker switch. These red lamps glow when the breaker is in the OPEN position. In the event an alternator breaker of a particular alternator is closed and the mixture control lever of that engine is moved to the IDLE CUT-OFF position, the breaker will automatically be opened.

Alternator Breaker Hold-In Switches. A hold-in switch (22, figure 1-16) for each alternator is provided to prevent the alternator breaker from opening when the corresponding mixture control lever is moved to the IDLE CUT-OFF position. The switches are used during normal engine shutdown when it is necessary to keep the alternator breaker of the last engine being shut down closed so that electrical power will be available to properly position the mixture control. The switches each have a spring-loaded HOLD IN position and a full-on NORMAL position and are located on the engineers' table.

Kilowatt and Kilovar Selector Switches. A bank of four kilowatt-kilovar selector switches (13, figure 1-24) is used to determine the power output of the alternators. These switches, which are ganged together, are used to select the desired reading by placing them in either the KWATTS or KVARS position. Indicators (5, figure 1-24) are provided for use with the kilowatt-kilovar selector switches. During parallel operation the division of real load is indicated by these meters when the selector switches are in the KWATTS position. When the switches are in the KVARS position, the meters register the reactive current measured in vars being put out by each alternator.

Alternator Field Flashing Circuit Breaker. A circuit breaker is provided on the engineers' table to flash the alternator exciter field. When this circuit breaker is closed and the exciter control relay switch is held in the OFF position, a 28-volt d-c circuit, stepped down through a 50-ohm resistor, energizes the alternator exciter field circuit. This circuit breaker is to be used when alternator field reversal is encountered, as indicated by extreme fluctuation of the voltage, or when an alternator fails to excite.

Bus Controls and Indicators. When in parallel operation, the individual alternators are all interconnected to a common bus. This bus is divisible by means of tie breakers. The tie breakers are controlled by four three-position bus tie-breaker control switches (8, figure 1-24), which are spring-loaded in the OPEN and CLOSE positions. The switches have guards which identify the bus segments they interconnect. The arrangement of the main a-c power bus and the individual bus tie-breakers is illustrated in figure 1-23. A red indicator lamp (11, figure 1-24) is located adjacent to each bus tie-breaker switch and glows when the bus tie-breaker is open.

Synchronizer Lamps. The synchronization controls and indicators are provided to equalize the output and frequency of each alternator so that they may be put in parallel. Two lamps (1, figure 1-24) on the engineers' main instrument panel are used to synchronize alternators. These lamps are connected so that by means of the voltage and frequency selector switch each lamp is placed between one phase of the power bus and the corresponding phase of the alternator to be paralleled with the bus. Therefore, the lamps will light when a difference exists between the frequency of the power bus and the frequency of the alternator. If the alternator voltage does not have the same frequency as the power bus voltage, the lamps will flicker. During the period that both lamps are dark, there is no difference in the frequency between the power bus and the alternator, indicating that the polarities are the same and that it is safe to close the alternator breaker.

FUSE & CIRCUIT BREAKER *Location*

1. BOMBARDIER'S CIRCUIT BREAKER PANEL
2. COPILOT'S LIGHTING CONTROL PANEL
3. COPILOT'S CIRCUIT BREAKER PANEL
4. PILOTS' OVERHEAD JET CONTROL PANEL
5. ENGINEERS' AUXILIARY PANEL
6. ENGINEERS' LIGHTING CONTROL PANEL
7. ENGINEERS' TABLE
8. ENGINEERS' AUXILIARY CONTROL & INSTRUMENT PANEL
9. ENGINEERS' MAIN CONTROL PANEL
10. DECM EQUIPMENT 28-VOLT POWER PANEL
11. ENGINEERS' FUSE PANEL
12. ENGINE INSTRUMENTS FUSE PANEL
13. RIGHT FORWARD TURRET POWER PANEL
14. LEFT FORWARD TURRET POWER PANEL
15. BHD. 6.0 CIRCUIT BREAKER PANEL
16. RIGHT JET POD POWER PANEL
17. RECIP. ENGINE #6 POWER PANELS
18. RECIP. ENGINE #5 POWER PANEL
19. RECIP. ENGINE #4 POWER PANEL
20. RIGHT MAIN A-C POWER PANEL
21. BHD. 8.0 D-C POWER PANEL
22. RIGHT AFT TURRET POWER PANEL

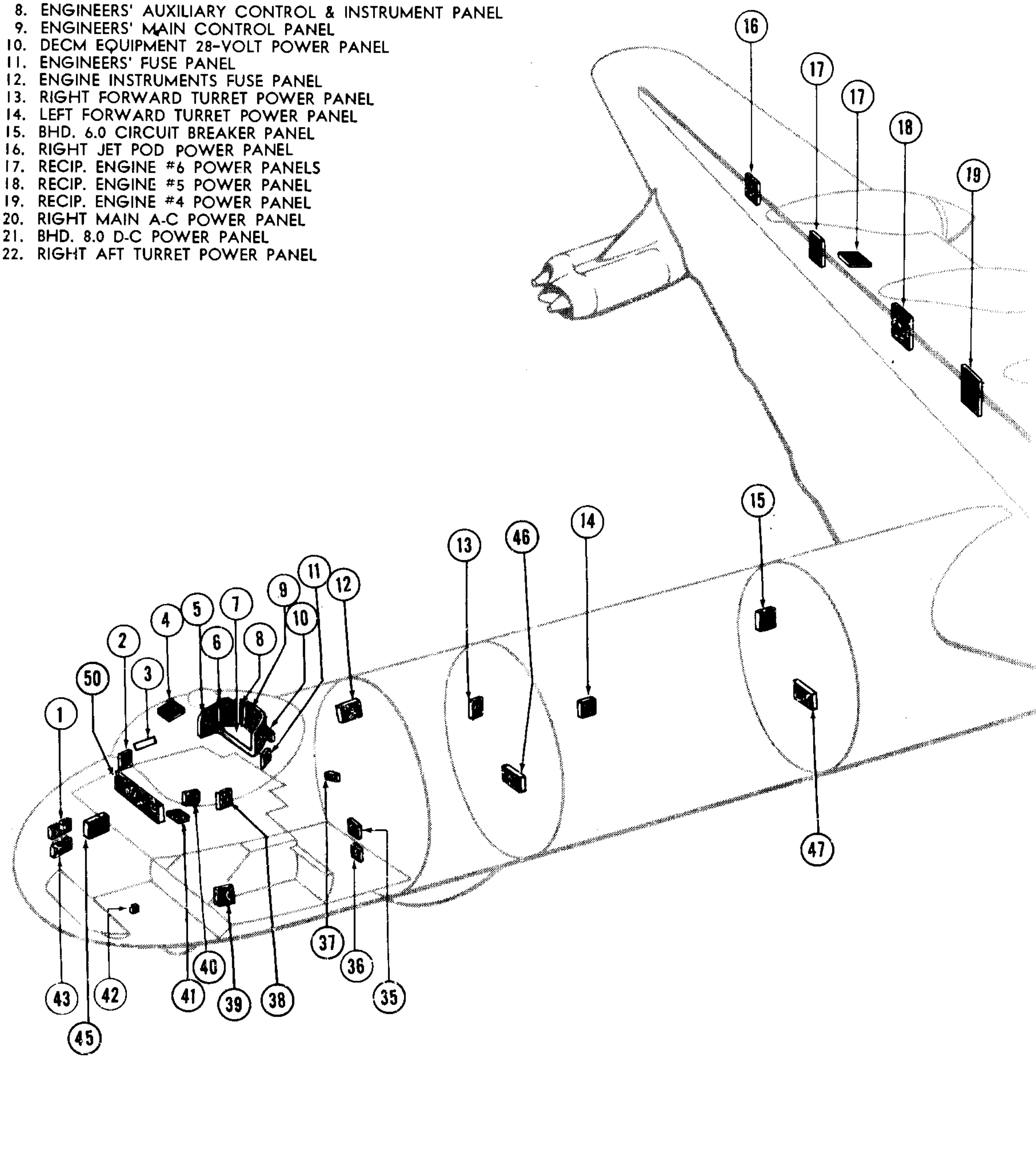


Figure 1-26. (Sheet 1)

23. AFT CABIN T-R FUSE BLOCK
24. RIGHT AFT CABIN POWER PANEL
25. LEFT AFT CABIN POWER PANEL
26. TAIL CONE LIGHTS CONTROL PANEL
27. LEFT AFT TURRET POWER PANEL
28. LEFT JET POD POWER PANEL
29. RECIP. ENGINE #1 POWER PANELS
30. RECIP. ENGINE #2 POWER PANEL
31. RECIP. ENGINE #3 POWER PANEL
32. LEFT MAIN A-C POWER PANEL
33. EXTERNAL POWER CONTROL BOX
34. BOMB BAY LIGHTS CONTROL PANEL
35. RADIO OPERATOR'S D-C POWER PANEL
36. BATTERY FUSE BOX
37. RADIO OPERATOR'S CIRCUIT BREAKER PANEL
38. RIGHT FORWARD CABIN POWER PANEL
39. LEFT FORWARD CABIN POWER PANEL
40. PILOTS' LIGHTING CONTROL PANEL
41. 28-VOLT A-C POWER PANEL
42. NAVIGATOR'S CIRCUIT BREAKER PANEL
43. BOMBARDIER'S CONTROL PANEL
44. SINGLE POINT REFUELING FUSE BOX
45. FCT JUNCTION BOX (4)
46. H-1 ACCESSORY EQUIPMENT PANEL (BB1)
47. H-1 ACCESSORY EQUIPMENT PANEL (BB2)
48. H-1 ACCESSORY EQUIPMENT PANEL (BB3)
49. H-1 ACCESSORY EQUIPMENT PANEL (BB4)
50. PILOT'S AND COPILOT'S INSTRUMENT PANEL

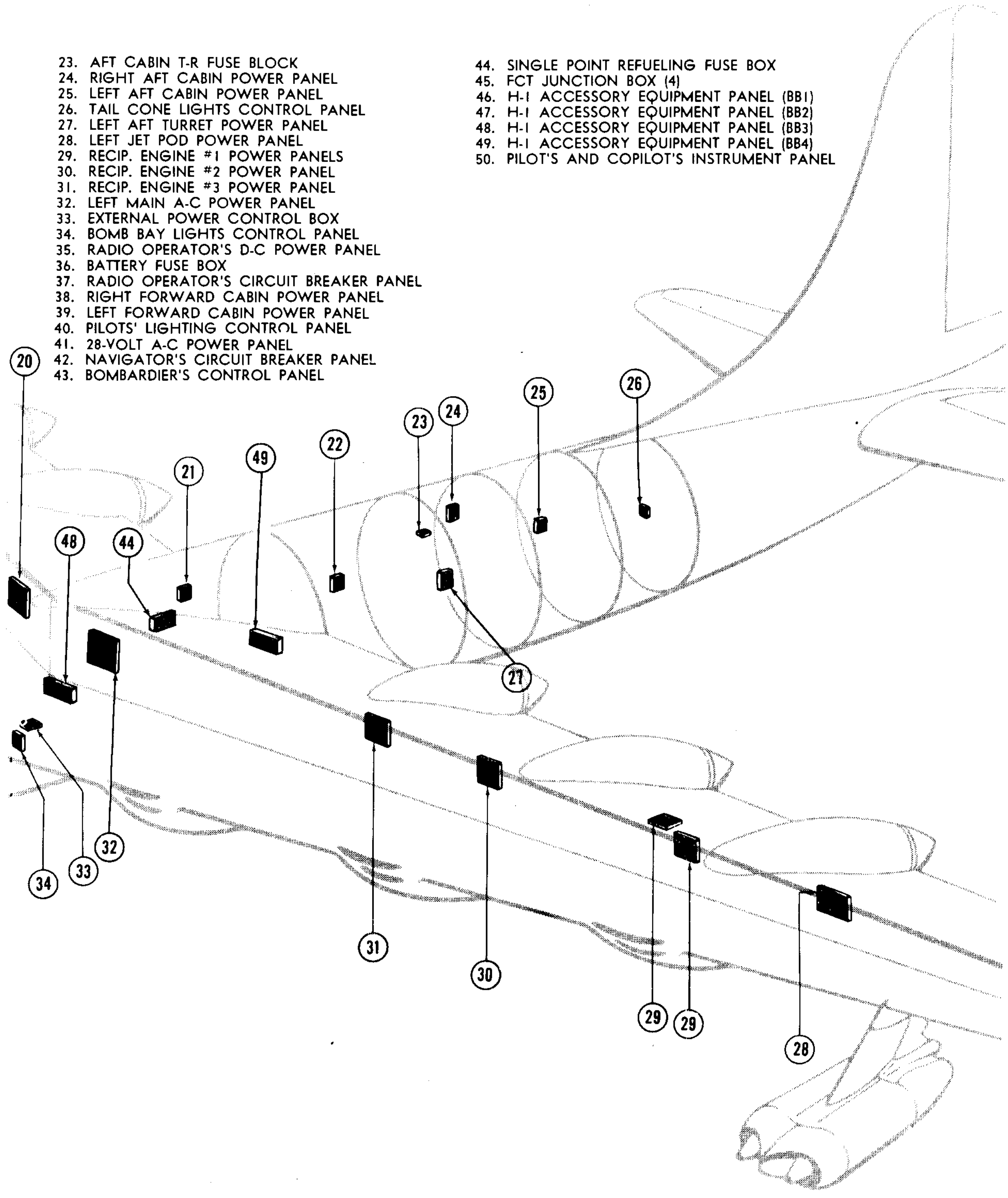


Figure 1-26. (Sheet 2)

Fuses & CIRCUIT BREAKERS

A-C SYSTEM FEEDER FUSES

QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE	CONNECTED TO
ENGINEERS' FUSE PANEL			
6	30	A-C POWER INPUT	Engineers' Fuse Panel A-C Power Switch
2	30	ENG'S TABLE AND PAN FEED	Engineers' Table and Main Control Panel
1	10	CYL HD TEMP IND	Engine Instrument Fuse Panel
1	10	INST PWR NORMAL	Engine Instrument Fuse Panel
1	10	INST PWR ALT	Engine Instrument Fuse Panel
1	10	INTERPHONE EMER. REL	AN/AIC-10 Interphone Sensing Relay (Group 7 Airplanes)
2	30	JET CONT PANEL	Pilots' Jet Control Panel
1	20	MASTER TURBO	Turbosupercharger Regulator Controls
K-( ) EXTERNAL POWER J BOX			
1	10	AC	Engineers' Tank Power Control Relay
LEFT AFT CABIN POWER PANEL			
9	30	WIRE SERIES 450-451-452	Left Aft Turret Power Panel
3	20	AFT CABIN T-R UNIT	Aft Cabin Transformer-Rectifier
LEFT AFT TURRET POWER PANEL			
12	40	WIRE SERIES 400-401-402-403	Left Main A-C Power Panel
9	30	WIRE SERIES 450-451-452-453	Left Aft Cabin Power Panel
LEFT FORWARD CABIN POWER PANEL			
3	30	ENGR'S ALT POWER	Engineer's Fuse Panel A-C Power Switch
3	20	LH TRANS RECT UNIT	Navigator's Transformer-Rectifier
2	40	RCM POWER PANEL	DECM Equipment 28-Volt Power Panel
12	40	WIRE SERIES 307-308-309-329	Left Forward Turret Power Panel
1	20	28 V TRANS	28-Volt A-C Power Panel
LEFT FORWARD TURRET POWER PANEL			
12	40	WIRE SERIES 300-301-302-303	Left Main A-C Power Panel
12	40	WIRE SERIES 307-308-309-329	Left Forward Cabin Power Panel
LEFT JET POD POWER PANEL			
9	60	WIRE SERIES 124-125-126	Recip. Engine #2 Power Panel
LEFT MAIN A-C POWER PANEL			
3	20	BOMB BAY TRANSF RECT UNIT	Transformer-Rectifier #1
12	60	WIRE SERIES 110-111-112-113	Recip. Engine #2 Power Panel
12	60	WIRE SERIES 140-141-142-143	Recip. Engine #3 Power Panel
LEFT MAIN A-C POWER PANEL (Continued)			
12	40	WIRE SERIES 300-301-302-303	Left Forward Turret Power Panel
12	40	WIRE SERIES 400-401-402-403	Left Aft Turret Power Panel
12	40	WIRE SERIES 420-421-422-423	Right Main A-C Power Panel
12	40	WIRE SERIES 430-431-432-433	Right Main A-C Power Panel
RECIP. ENGINE #1 POWER PANEL			
12	30	WIRE SERIES 116-117-118-119	Recip. Engine #2 Power Panel
RECIP. ENGINE #2 POWER PANEL			
12	60	WIRE SERIES 110-111-112-113	Left Main A-C Power Panel
12	30	WIRE SERIES 116-117-118-119	Recip. Engine #1 Power Panel
9	60	WIRE SERIES 124-125-126	Left Jet Pod Power Panel
RECIP. ENGINE #3 POWER PANEL			
12	60	WIRE SERIES 140-141-142-143	Left Main A-C Power Panel
RECIP. ENGINE #4 POWER PANEL			
12	60	WIRE SERIES 240-241-242-243	Right Main A-C Power Panel
RECIP. ENGINE #5 POWER PANEL			
12	60	WIRE SERIES 210-211-212-213	Right Main A-C Power Panel
12	30	WIRE SERIES 216-217-218-219	Recip. Engine #6 Power Panel
9	60	WIRE SERIES 224-225-226	Right Jet Pod Power Panel
RECIP. ENGINE #6 POWER PANEL			
12	30	WIRE SERIES 216-217-218-219	Recip. Engine #5 Power Panel
RIGHT AFT CABIN POWER PANEL			
9	30	WIRE SERIES 440-441-442	Right Aft Turret Power Panel
1	10	LIGHTING TRANSFORMER	Aft Cabin 28-Volt A-C Lighting Transformer
RIGHT AFT TURRET POWER PANEL			
12	40	WIRE SERIES 410-411-412-413	Right Main A-C Power Panel
9	30	WIRE SERIES 440-441-442	Right Aft Cabin Power Panel
RIGHT FORWARD CABIN POWER PANEL			
3	20	BLKHD 4.0 TRANS RECT UNIT	Radio Operator's Transformer-Rectifier
3	30	ENGR'S FUSE PANEL	Engineer's Fuse Panel A-C Power Switch
3	20	RH TRANS RECT UNIT	Copilot's Transformer-Rectifier
12	40	WIRE SERIES 317-318-319-339	Right Forward Turret Power Panel

Figure 1-27. (Sheet 1)

Fuses & CIRCUIT BREAKERS (Continued)

QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE	CONNECTED TO
RIGHT FORWARD TURRET POWER PANEL			
12	40	WIRE SERIES 310-311-312-313	Right Main A-C Power Panel
12	40	WIRE SERIES 317-318-319-339	Right Forward Cabin Power Panel
RIGHT JET POD POWER PANEL			
9	60	WIRE SERIES 224-225-226	Recip. Engine #5 Power Panel
RIGHT MAIN A-C POWER PANEL			
3	20	BOMB BAY TRANS RECT CENTER	Transformer-Rectifier #2
3	20	BOMB BAY TRANSF RECT AFT	Transformer-Rectifier #3
12	60	WIRE SERIES 210-211-212-223	Recip. Engine #5 Power Panel
12	60	WIRE SERIES 240-241-242-243	Recip. Engine #4 Power Panel
12	40	WIRE SERIES 310-311-312-313	Right Forward Turret Power Panel

QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE	CONNECTED TO
RIGHT MAIN A-C POWER PANEL (Continued)			
12	40	WIRE SERIES 410-411-412-413	Right Aft Turret Power Panel
12	40	WIRE SERIES 420-421-422-423	Left Main A-C Power Panel
12	40	WIRE SERIES 430-431-432-433	Left Main A-C Power Panel
12	40	WIRE SERIES 475-476-477-478	External Power Control Box
1	20	28V TRANSF	Bomb Bay Lights Control Panel
28-VOLT A-C POWER PANEL			
1	30	BOMBARDIER'S PANEL	Bombardier's Circuit Breaker Panel
3	20	COPILOT'S PANEL	Copilot's Circuit Breaker Panel
1	30	NAVIG'S PANEL	Navigator's Circuit Breaker Panel
1	30	RADIO OPER'S PANEL	Radio Operator's Circuit Breaker Panel

D-C SYSTEM FEEDER FUSES

QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE	CONNECTED TO
AFT CABIN T-R FUSE BLOCK			
3	40		Right Aft Cabin Power Panel
BATTERY FUSE BOX			
1	30	ALARM BELL	Copilot's Circuit Breaker Panel
3	40	ENGINEER'S PANEL	Engineers' Fuse Panel
2	30	SCR 695 DETONATOR	Radio Operator's Circuit Breaker Panel
BHD. 6.0 D-C POWER PANEL			
3	50	50 AMP FUSE	Bhd. 8.0 D-C Power Panel
BHD. 8.0 D-C POWER PANEL			
3	50	AFT CABIN	Right Aft Cabin Power Panel
3	40	AFT TRANSF RECT	Transformer-Rectifier #3
3	50	BLKHD 6.0 CIRCUIT BREAKER PANEL	Bhd. 6.0 D-C Power Panel
3	40	CENTER TRANSF RECT	Transformer-Rectifier #2
3	30	FWD CABIN	Engineer's Fuse Panel
3	40	FWD TRANSF RECT	Transformer-Rectifier #1
3	20	LEFT WING	Recip. Engines #1, 2, & 3 and Left Jet Pod Power Panels
3	20	RIGHT WING	Recip. Engines #4, 5, & 6, and Right Jet Pod Power Panels
ENGINEERS' FUSE PANEL			
3	40	BATTERY	Battery Fuse Box
3	30	BLKHD 8.0 POWER PANEL	Bhd. 8.0 D-C Power Panel

QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE	CONNECTED TO
ENGINEER'S FUSE PANEL (Continued)			
2	30	ENGRS' PANEL FEED	Engineers' Main Control Panel
2	30	ENGRS' TABLE FEED	Engineers' Table
2	30	JET CONTROL PANEL FEED	Pilots' Jet Control Panel
3	30	LH FWD PANEL	Left Forward Cabin Power Panel
3	30	RADIO OPER'S PANEL	Radio Operator's D-C Power Panel
3	30	RH FWD PANEL	Right Forward Cabin Power Panel
K-( ) EXTERNAL POWER J BOX			
1	10	DC	Engineers' Tank Power Control Relay
LEFT FORWARD CABIN POWER PANEL			
3	30	ENGR'S PANEL	Engineers' Fuse Panel
3	40	LH TRANSF RECT UNIT	Navigator's Transformer-rectifier
3	30	NAVIG. PANEL	Navigator's Circuit Breaker Panel
3	30	RH POWER PANEL	Right Forward Cabin Power Panel
LEFT JET POD POWER PANEL			
3	10	28V DC POWER	Bhd. 8.0 D-C Power Panel
RADIO OPERATOR'S D-C POWER PANEL			
3	40	BLKD. 4.0 CONVR'T	Radio Operator's Transformer-Rectifier
3	30	ENGR'S PANEL	Engineer's Fuse Panel
3	30	RADIO OPER'S PANEL	Radio Operator's Circuit Breaker Panel

Figure 1-27. (Sheet 2)

Fuses & CIRCUIT BREAKERS (Continued)

QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE	CONNECTED TO
RECIP. ENGINE #1 POWER PANEL			
3	10	28V DC POWER	Bhd. 8.0 D-C Power Panel
RECIP. ENGINE #2 POWER PANEL			
3	10	28V DC POWER	Bhd. 8.0 D-C Power Panel
RECIP. ENGINE #3 POWER PANEL			
3	10	28V DC POWER	Bhd. 8.0 D-C Power Panel
RECIP. ENGINE #4 POWER PANEL			
3	10	28V DC POWER	Bhd. 8.0 D-C Power Panel
RECIP. ENGINE #5 POWER PANEL			
3	10	28V DC POWER	Bhd. 8.0 D-C Power Panel
RECIP. ENGINE #6 POWER PANEL			
3	10	28V DC POWER	Bhd. 8.0 D-C Power Panel

QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE	CONNECTED TO
RIGHT AFT CABIN POWER PANEL			
3	50	BHD 8.0 DC POWER PANEL	Bhd. 8.0 D-C Power Panel
3	40	AFT CABIN T-R UNIT	Aft Cabin T-R Fuse Block
RIGHT FORWARD CABIN POWER PANEL			
3	30	BOMB'S CIRCUIT BREAKER PANEL	Bombardier's Circuit Breaker Panel
3	30	COPILOT'S CIRCUIT BREAKER PANEL	Copilot's Circuit Breaker Panel
3	30	ENGR'S PANEL	Engineer's Fuse Panel
3	30	LH POWER PANEL	Left Forward Cabin Power Panel
3	40	RH TRANS RECT UNIT	Copilot's Transformer-Rectifier
RIGHT JET POD POWER PANEL			
3	10	28V DC POWER	Bhd. 8.0 D-C Power Panel

A-C EQUIPMENT FUSES AND CIRCUIT BREAKERS

The words "Power" and "Control," in parenthesis, are in conjunction with certain "Equipment of Circuit" designations in both the A-C and D-C Equipment Fuse and Circuit Breaker lists. The word "Power" is used to indicate an electrical circuit which is completed through a relay. "Control" indicates an energizing circuit for a relay. For each power circuit, or groups of similar power circuits, there is a corresponding control circuit. For example, in the a-c system you will find:

AILERON TRIM TAB (POWER)

Left
Right

The corresponding control circuit appears in the d-c system as:

AILERON TRIM TAB (CONTROL), LEFT AND RIGHT

Normally, a-c power has d-c control. However, some equipment has d-c power with d-c control. Any equipment or circuit designation which does not contain either of the specified words, indicates a power circuit without a controlling relay.

EQUIPMENT OR CIRCUIT	LOCATION (Panel No.)	QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE
AILERON TRIM TAB (POWER)				
Left	29	3	10	AILERON TRIM TAB
Right	17	3	10	AILERON TRIM TAB

EQUIPMENT OR CIRCUIT	LOCATION (Panel No.)	QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE
AIR PLUG (POWER)				
Jet Engine 1	28	1	10	#1 AIR SHUT-OFF DOORS
Jet Engine 2	28	1	10	#2 AIR SHUT-OFF DOORS
Jet Engine 3	16	1	10	#3 AIR SHUT-OFF DOORS
Jet Engine 4	16	1	10	#4 AIR SHUT-OFF DOORS
Recip. Engine 1	29	3	10	ENGINE AIR PLUG
Recip. Engine 2	30	3	10	ENGINE AIR PLUG
Recip. Engine 3	31	3	10	ENGINE AIR PLUG
Recip. Engine 4	19	3	10	ENGINE AIR PLUG
Recip. Engine 5	18	3	10	ENGINE AIR PLUG
Recip. Engine 6	17	3	10	ENGINE AIR PLUG
A-C PHASE SEQUENCE INDICATOR LAMPS				
	33	3	10	EXTERNAL POWER PHASE SEQUENCE INDICATOR FUSE
ANTI-ICING				
Jet Pod Heaters (Power)				
Left	28	3	30	NOSE DOOR DE-ICE
Right	16	3	30	NOSE DOOR DE-ICE
Tail and Cabin Air Temperature Control Valve	5	1	* 5	TAIL ANTI-ICE
Wing Anti-Icing Control Valve	5	1	* 5	WING ANTI-ICE
AUTOPILOT AMPLIFIER				
	39	1	10	AUTOPILOT AMP

Figure 1-27. (Sheet 3)

Fuses & CIRCUIT BREAKERS (Continued) (AC)

EQUIPMENT OR CIRCUIT	LOCATION (Panel No.)	QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE
AUTOPILOT (POWER)				
	38	1	20	AUTOPILOT
BOMB STATION INDICATOR LIGHTS				
	38	1	10	BOMB ST. IND LTS.
BRAKE PUMP				
See: Hydraulic Pump (Power), Brake				
CABIN AIR TEMPERATURE CONTROL VALVE				
See: Anti-Icing, Tail, and Cabin Air Temperature Control Valve				
CABIN PRESSURIZATION				
See: Pressure Shutoff Valves, Aft Cabin and Wing				
CAMERA DOOR (POWER)				
	25	1	10	CAM. DR. MOTOR
CARBURETOR AIR FILTERS (POWER)				
Recip. Engines 1, 2, & 3	31	1	10	CARB. AIR FLTR.
Recip. Engines 4, 5, & 6	19	1	10	CARB. AIR FLTR.
CARBURETOR AIR PREHEAT (POWER)				
Recip. Engine 1	29	1	10	CARB. PREHEAT
Recip. Engine 2	30	1	10	CARB. PREHEAT
Recip. Engine 3	31	1	10	CARB. PREHEAT
Recip. Engine 4	19	1	10	CARB. PREHEAT
Recip. Engine 5	18	1	10	CARB. PREHEAT
Recip. Engine 6	17	1	10	CARB. PREHEAT
COMPASS, N-1 GYRO MAGNETIC				
	39	3	10	GYROSYN COMPASS
CONTROL SURFACE LOCKS (POWER)				
	20	3	10	CONT. SURF. LOCK R.H. AIL. L.H. AIL. TAIL

ELECTRONIC COUNTERMEASURES EQUIPMENT

NOTE

Any of the following groups of DECM equipment may be installed in the aircraft.

EQUIPMENT OR CIRCUIT	LOCATION (Panel No.)	QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE
Group I:				
AN/ALA-2	10	1	10	RACK POS 5A
AN/APR-4	10	1	10	RACK POS 2
AN/APT-4 (LH)	10	1	20	RACK POS 1 & 5
AN/APT-4 (RH)	10	1	20	RACK POS 4
Group II:				
AN/ALA-2	10	1	10	RACK POS 5A
AN/APR-4	10	1	10	RACK POS 2
AN/APT-4 (LH)	10	1	20	RACK POS 1 & 5
AN/APT-4 (RH)	10	1	20	RACK POS 4
AN/APT-6	10	1	20	RACK POS 1 & 5

*Push-Pull Type Circuit Breaker
†Switch-Type Circuit Breaker

EQUIPMENT OR CIRCUIT	LOCATION (Panel No.)	QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE
ELECTRONIC COUNTERMEASURES EQUIPMENT (Continued)				
Group III:				
AN/ALA-2	10	1	10	RACK POS 5A
AN/APR-4	10	1	10	RACK POS 2
AN/APR-9	10	1	10	AN/APR-9
AN/APT-4 (LH)	10	1	20	RACK POS 1 & 5
AN/APT-4 (RH)	10	1	20	RACK POS 4
AN/APT-9	10	1	20	RACK POS 1 & 5
ENGINE ANALYZER				
	5	1	† 5	ENGINE ANALYZER
FAN				
CABIN Air Booster (Power)	20	6	40	CABIN PRES. BOOST. FAN
FANS, ENGINE COOLING—RECIP. ENGINES 1, 2, 3, 4, 5, & 6 (Some Airplanes)				
	7	1	* 5	ENGINE FAN
FLAP (POWER)				
Center, Left	30	3	20	CENTER FLAPS
Center, Right	18	3	20	CENTER FLAPS
Inboard, Left	31	3	20	INBOARD FLAPS
Inboard, Right	19	3	20	INBOARD FLAPS
Outboard, Left	29	3	20	OUTBOARD FLAPS
Outboard, Right	17	3	20	OUTBOARD FLAPS
FUEL				
Indicator, Quantity Wing Tanks 1, 2, 3, Auxiliary Left, Bomb Bay, Auxiliary Right, and Wing Tanks 4, 5, & 6	7	9	* 5	FUEL TANK QUANTITY INDICATOR 1, 2, 3, L, BOMB BAY, R, 4, 5, & 6
Totalizer	7	1	* 5	TOTALIZER
Pressure Refueling (Control) Some Airplanes Wing Tanks 1 & 2	31	1	10	GRAV HI-LEVEL AMPLIFIER
Auxiliary Tank Left, Bomb Bay, AND Wing Tank 3	32	1	10	GRAV HI-LEVEL AMPLIFIER
Auxiliary Tank Right AND Wing Tank 4	20	1	10	GRAV HI-LEVEL AMPLIFIER
Wing Tanks 5 & 6	19	1	10	GRAV HI-LEVEL AMPLIFIER
Pressure Refueling (Control) (Some Airplanes) Amplifier Control Relay	44	11	5	SINGLE POINT REFUELING 1, 2, 3, 4, 5, 6, L AUX, R AUX, BOMB BAY

Figure 1-27. (Sheet 4)

Fuses & CIRCUIT BREAKERS (Continued) (AC)

EQUIPMENT OR CIRCUIT	LOCATION (Panel No.)	QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE
FUEL (Continued)				
Fuel High Level	7	1	* 5	FUEL HIGH LEVEL
Pump (Power), Booster				
Auxiliary Tank, Left	32	3	10	LEFT WING AUX. BOOST PUMP
Auxiliary Tank, Right	20	3	10	RIGHT WING AUXIL. BOOST PUMP
Bomb Bay Tank	27	3	10	BB #3 FUEL BOOST PUMP
Jet Engines 1 & 2	28	3	10	FUEL PUMP
Jet Engines 3 & 4	16	3	10	FUEL PUMP
Wing Tank 1	30	3	10	FUEL BOOSTER PUMP
Wing Tank 2	31	3	10	FUEL BOOSTER PUMP
Wing Tank 3	31	3	10	FUEL BOOSTER PUMP
Wing Tank 4	19	3	10	FUEL BOOSTER PUMP
Wing Tank 5	19	3	10	FUEL BOOSTER PUMP
Wing Tank 6	18	3	10	FUEL BOOSTER PUMP
Mixture—Recip. Engines 1 & 2, 3, 4, 5, & 6	6	6	* 5	ENGINE FUEL MIXTURE 1, 2, 3, 4, 5, & 6
GYRO INDICATOR				
Copilot's	38	3	10	PILOTS GYRO HORIZON
Pilot's	39	3	10	PILOTS GYRO HORIZON
HEATER, PITOT TUBE (Some Airplanes)				
Left	8	1	† 5	PITOT TUBE HEATER L.H.
Right	8	1	† 5	PITOT TUBE HEATER R.H.
HEATER (POWER), AUXILIARY CABIN				
Aft Cabin, Left	25	3	30	CABIN HEAT
Aft Cabin, Right	24	3	30	COMPT HEATER
Bombardier's	39	3	30	CABIN HEAT
Radio Operator's	38	3	30	RADIO OPERATOR'S COMPT. HEATER
HEATER (POWER), OIL				
Jet Engine 1	28	1	10	OIL CELL HEATER #1
Jet Engine 2	28	1	10	OIL CELL HEATER #2
Jet Engine 3	16	1	10	OIL CELL HEATER #3
Jet Engine 4	16	1	10	OIL CELL HEATER #4

*Push-Pull Type Circuit Breaker
†Switch-Type Circuit Breaker

EQUIPMENT OR CIRCUIT	LOCATION (Panel No.)	QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE
HEATER (POWER), OIL VENT LINE				
Recip. Engine 1	29	1	10	OIL VENT HEAT
Recip. Engine 2	30	1	10	OIL VENT HEAT
Recip. Engine 3	31	1	10	OIL VENT HEAT
Recip. Engine 4	19	1	10	OIL VENT HEAT
Recip. Engine 5	18	1	10	OIL VENT HEAT
Recip. Engine 6	17	1	10	OIL VENT HEAT
HOT CUPS, BEVERAGE TANK, OVEN AND VENT FANS				
Aft Cabin	24	3	20	HOT CUP & OVEN BEV TANK & OVEN
Forward Cabin, Left	39	1	20	VENT FAN
Forward Cabin, Right	38	1	10	HOT CUP & VENT FAN
Beverage Tank	38	1	10	BEV TANK
HYDRAULIC PUMP (POWER)				
Brake	32	6	60	BRAKE PUMP
#1	20	6	60	HYDRO PUMP MOTOR
#2	32	6	60	HYDRO PUMP MOTOR #2
IGNITION (POWER)				
Jet Engine 1	28	1	10	#1 IGN.
Jet Engine 2	28	1	10	#2 IGN.
Jet Engine 3	16	1	10	#3 IGN.
Jet Engine 4	16	1	10	#4 IGN.
INSTRUMENT, HYDRAULIC PRESSURE INDICATOR				
	20	1	10	HYD PRESS
INSTRUMENTS, RECIPROCATING ENGINE				
Cylinder Head Temperature Amplifiers	12	6	1	ENGINE CHT AMPLIFIERS 1, 2, 3, 4, 5 & 6
Selsyn	12	6	5	ENGINE SELYN INSTRUMENT 1, 2, 3, 4, 5, & 6
INSTRUMENTS, TURBO JET ENGINE				
	28	2	1	FUEL PRESS TRANS No. 1 & No. 2 JET
	28	2	1	OIL PRESS TRANS No. 1 & No. 2 JET
	28	2	1	FUEL PRESS & OIL PRESS IND No. 1 & No. 2 JET
	28	2	1	JET FUEL FLOW ENG 1 & 2
	16	2	1	FUEL PRESS TRANS No. 3 & No. 4 JET
	16	2	1	OIL PRESS TRANS No. 3 & No. 4 JET
	16	2	1	FUEL PRESS & OIL PRESS IND No. 3 & No. 4 JET
	16	2	1	JET FUEL FLOW ENG 3 & 4

Figure 1-27. (Sheet 5)

Fuses & CIRCUIT BREAKERS (Continued) (AC)

EQUIPMENT OR CIRCUIT	LOCATION (Panel No.)	QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE
INTERCOOLER (POWER)				
Close				
Recip. Engine 1	29	1	10	INTR COOL CLOSE
Recip. Engine 2	30	1	10	INTR COOL CLOSE
Recip. Engine 3	31	1	10	INTR COOL CLOSE
Recip. Engine 4	19	1	10	INTR COOL CLOSE
Recip. Engine 5	18	1	10	INTR COOL CLOSE
Recip. Engine 6	17	1	10	INTR COOL CLOSE
Open				
Recip. Engine 1	29	1	10	INTER COOL OPEN
Recip. Engine 2	30	1	10	INTER COOL OPEN
Recip. Engine 3	31	1	10	INTER COOL OPEN
Recip. Engine 4	19	1	10	INTER COOL OPEN
Recip. Engine 5	18	1	10	INTER COOL OPEN
Recip. Engine 6	17	1	10	INTER COOL OPEN
AN/AIC-10 INTERPHONE (GROUP 7 AIRPLANES)				
	7	2	* 5	INTERPHONE A-C POWER CHANNEL 3 INTERPHONE A-C POWER CHANNEL 4
	24	2	* 5	INTERPHONE CHANNEL 1 INTERPHONE CHANNEL 2
K-( ) BOMBING SYSTEM				
Amplifier—Computer, Type A-2	39	1	10	K-( ) SYS. REG.
Amplifier—Computer, Type A-2	39	1	20	K-( ) SYS. UNREG.
Filter, F-67/APS-23	39	1	20	BOMB'G RADAR
Relay "B" Heater Junction Box	38	3	20	K-( ) SYS. HEATERS
Relay "A" Heater Junction Box	39	3	20	K-( ) SYS. HEATERS
Transformer, Heater Junction Box	39	3	10	K-( ) SYS. GYROS
LIGHTS, PILOT'S				
Dome	40	1	5	FLOOD LIGHT
Pilot's Pedestal Interphone Panel Lighting Control Panel	40	1	5	PEDESTAL LIGHT
Instrument Panel	40	1	5	PILOT'S PANEL
LIGHTS, COPILOT'S				
Instrument Panel	2	1	5	COPILOT'S PANEL
Instrument Panel Coaming				
Red & White	2	2	5	COAMING LIGHTS RED & WHITE
Dome	2	1	5	FLOOD LIGHTS
Circuit Breaker Panel Lighting Control Panel	2	1	5	CIR BRKR PANEL
Jet Instrument Panel	2	1	5	CENTER PANEL
LIGHTS, ENGINEERS'				
Dome (Red & White)	6	1	5	FLOOD LIGHT
Rheostat Panel				
Free Air Temp Ind.				
Red	6	1	5	RED LIGHTS
White	6	1	5	WHITE LIGHTS
Dome	41	1	10	ENGR'S DOME LIGHT
LIGHTS, NAVIGATOR'S				
Fluorescent				
Cockpit	42	1	* 5	FLUOR. LIGHT
Table	42	1	* 5	TABLE LIGHT
LIGHTS, RADIO OPERATOR'S				
Cockpit	37	1	* 5	COCKPIT LIGHT
Dome	37	1	† 5	DOME LIGHT
LIGHTS, JET SWITCH & CONTROL PANEL				
Astrodome Lighting Panel Periscope Sextant Mount Jet Switch Panel Jet Throttle Nav's Clip Board Nav's Oxygen Panel	2	1	5	JET POD PANEL
LIGHTS, GUNNERS'				
Cockpit				
Aft lower (L & R)	24	1	* 5	COCKPIT LIGHTS
Nose gunner	1	1	* 5	TABLE LIGHT
Tail	24	1	* 5	COCKPIT LIGHTS
Dome				
Aft cabin (L & R) Platform Bunk (L & R)	24	1	* 5	DOME LIGHTS
Tail Cone Tail Turret	24	1	† 5	TAIL CONE
LIGHTS, COMMUNICATION TUBE				
Aft.	24	1	* 5	DOME LIGHTS
Fwd.	37	1	* 5	TUBE LIGHT
LIGHTS, BOMBARDIER'S				
Cockpit				
Dome (Red & White)				
Fluorescent	1	1	* 5	FLUOR. LIGHTS
Table	1	1	* 5	TABLE LIGHTS
LIGHTS, FORMATION				
	3	1	* 5	FORM. LIGHTS
LIGHTS, NAVIGATION (POWER)				
Wing Tip Rudder (White)	41	1	10	WING TIP LIGHTS
LIGHTS, LANDING				
Filament (Power)				
Left	41	1	30	LH LANDING LIGHT
Right	41	1	30	RH LANDING LIGHT

*Push-Pull Type Circuit Breaker
†Switch-Type Circuit Breaker

Figure 1-27. (Sheet 6)

Fuses & CIRCUIT BREAKERS (Continued) (AC)

EQUIPMENT OR CIRCUIT	LOCATION (Panel No.)	QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE
LIGHTS, MISCELLANEOUS				
Nose Steering Ind.	40	1	5	PEDESTAL LIGHTS
Free Airtemp Ind.	40	1	5	PILOTS PANEL
Pilots Lighting Trans	39	1	10	PILOTS LIGHTING TRANS
Copilots Lighting Trans	38	1	10	COPILOTS LIGHTING TRANS
Pilots C4 Copilots C4 Hatch Dome	3	1	* 5	LIGHTS COCKPIT
Sub Flight Deck	37	1	† 5	SUB FLT DECK LT.
LIGHTS (POWER)				
Dome				
Bomb Bay 1 & 2	34	1	†15	BOMB BAY LIGHTS 1 & 2
Bomb Bays 3 & 4	34	1	†15	BOMB BAY LIGHTS 3 & 4
Main A-C Power Panel	34	1	†15	BOMB BAY LIGHTS 3 & 4
Station 7.0	34	1	†15	BOMB BAY LIGHTS 1 & 2
Turret Bay				
Aft	34	1	†15	BOMB BAY LIGHTS 3 & 4
Forward	34	1	†15	BOMB BAY LIGHTS 1 & 2
Turret Passageway				
Aft	34	1	†15	BOMB BAY LIGHTS 3 & 4
Forward	34	1	†15	BOMB BAY LIGHTS 1 & 2
Instruments				
Flap Control Panel	34	1	†15	BOMB BAY LIGHTS 3 & 4
Turret Power Panels Forward (L&R)	34	1	†15	BOMB BAY LIGHTS 1 & 2
METERS, VOLTAGE AND FREQUENCY, WATT AND VAR, AND PHASE SEQUENCE LAMP, FROM:				
Alternator 2	30	3	10	AC INST
Alternator 3	31	3	10	AC INST
Alternator 4	19	3	10	AC INST
Alternator 5	18	3	10	AC INST

NOTE

The above fuses are in the circuits which lead from each alternator to the positions marked 2, 3, 4, and 5, of the Voltage and Frequency Selector Switch. THESE CIRCUITS ARE ALSO THE SOURCE OF EMERGENCY POWER, when the selector switch is positioned for any alternator which will excite, and when the Emergency Power Switch is in the EMERGENCY position.

*Push-Pull Type Circuit Breaker
†Switch-Type Circuit Breaker

EQUIPMENT OR CIRCUIT	LOCATION (Panel No.)	QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE
METERS, VOLTAGE AND FREQUENCY, FROM:				
Bus 201	32	2	10	AC INST
Bus 301	32	2	10	AC INST
Bus 401	20	2	10	AC INST
Bus 501	20	2	10	AC INST
OIL COOLER (POWER)				
Recip. Engine 1	29	1	10	ENG. OIL COOL
Recip. Engine 2	30	1	10	ENG. OIL COOL
Recip. Engine 3	31	1	10	ENG. OIL COOL
Recip. Engine 4	19	1	10	ENG. OIL COOL
Recip. Engine 5	18	1	10	ENG. OIL COOL
Recip. Engine 6	17	1	10	ENG. OIL COOL
Manual Override	7	1	* 5	OIL COOLER CONT.
OIL SHUTOFF VALVES—JET ENGINES 1, 2, 3, & 4				
	4	4	* 5	OIL SHUT-OFF VALVE POWER ENG. 1, 2, 3, & 4
(On Airplanes Equip. With A-C Actuators)				
OIL SHUTOFF VALVES—RECIP. ENGINES 1, 2, 3, 4, 5, & 6				
	9	6	* 5	ENGINE OIL SHUT-OFF VALVES 1, 2, 3, 4, 5, & 6
PREHEAT, JET POD				
	4	1	* 5	POD PREHEAT POWER
PRESSURE SHUTOFF VALVES				
Cabin, Right & Left Wing	5	1	* 5	CABIN PRESSURE
RADAR SET				
AN/APG-32 or 41A	24	1	20	TAIL RADAR SYNC
AN/APG-41A	24	1	10	TAIL RADAR SYNC
AN/APN-9A-Loran	39	1	10	LORAN RECVR
AN/APX-6	39	1	10	APX-6 I.F.F.
RADAR SET PRESSURIZATION				
AN/APG-32 or	24	1	10	RADAR PUMP
AN/APG-41	24	2	10	RADAR PUMP NO. 1 & 2
AN/APQ-31	38	1	10	RADAR PRESS PUMP
RADIO COMPASS AN/ARN-6				
	42	1	* 5	RADIO COMPASS
RADIO COMPASS AN/ARN-14				
	39	1	10	COMPASS C-1 AMPLIFIER
AN/ARN-18	1	1	* 5	GLIDE PATH RECVR (GROUP 5 AIRPLANES)
LIAISON RADIO SET AN/ARC-21X (GROUP 7 AIRPLANES)				
	24	1	* 5	FIL & LOW VOLT TRANSF
	24	1	*10	HIGH VOLT TRANSF

Figure 1-27. (Sheet 7)

Fuses & CIRCUIT BREAKERS (Continued) (AC)

EQUIPMENT OR CIRCUIT	LOCATION (Panel No.)	QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE
SPARK ADVANCE—RECIP. ENGINES 1, 2, 3, 4, 5, & 6 (SOME AIRPLANES)				
	7	6	* 5	ENGINE SPARK ADVANCE 1, 2, 3, 4, 5, & 6
SPECIAL BOMBING SYSTEM (AIRPLANES WITH SPECIAL BOMBING EQUIPMENT IN BB 1, 2, 3 & 4)				
Heater Trans (BB 1 & 2)	14	2	10	SPECIAL BOMBING BB 1 & 2
Heater Trans (BB 3 & 4)	27	2	10	SPECIAL BOMBING BB 3 & 4
Transf (Power) FCT Junction Box (BB 1, 2, 3, & 4)	38	2	10	SPECIAL BOMBING
Transformers (BB 1, 2, 3, & 4)	45	4	5	BB 1, 2, 3, & 4
(AIRPLANES WITH SPECIAL BOMBING EQUIPMENT in BB 1 & 4)				
Heater Trans (BB 1)	14	1	10	SPECIAL BOMBING BB-1
Heater Trans (BB 4)	27	1	10	SPECIAL BOMBING BB-4
Transformer (Power) FCT Junction Box (BB 1 & 4)	38	1	10	SPECIAL BOMBING
STARTER (POWER)—JET ENGINES 1, 2, 3, & 4				
(Connected Direct to Bus Bar—No Fuses)				
STARTER (POWER)				
Recip. Engine 1	29	3	60	STARTER
Recip. Engine 2	30	3	60	STARTER
Recip. Engine 3	31	3	60	STARTER
Recip. Engine 4	19	3	60	STARTER
Recip. Engine 5	18	3	60	STARTER
Recip. Engine 6	17	3	60	STARTER
THROTTLE—JET ENGINES 1, 2, 3, & 4				
	4	4	* 5	THROTTLE CONTROL POWER 1, 2, 3, & 4
TRANSFORMER, AUTOSYN				
Jet Engine 1	28	1	10	#1 AUT. TRANS.
Jet Engine 2	28	1	10	#2 AUT. TRANS.
Jet Engine 3	16	1	10	#3 AUT. TRANS.
Jet Engine 4	16	1	10	#4 AUT. TRANS.

EQUIPMENT OR CIRCUIT	LOCATION (Panel No.)	QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE
TURBO BOOST OVERRIDE				
	7	1	5	OVERRIDE
TURBOSUPERCHARGER REGULATOR—RECIP. ENGINES 1, 2, 3, 4, 5 & 6				
	11	1	20	MASTER TURBO
	11	6	10	ENGINE 1, 2, 3, 4, 5, & 6 TURBO
TUBOSUPERCHARGER SELECTION—RECIP. ENGINES 1, 2, 3, 4, 5 & 6				
	7	6	* 5	ENGINE SUPERCHARGER SELECTION 1, 2, 3, 4, 5, & 6
TURRET COMPUTER HEATER, AND THYRATRON ENERGIZING (CONTROL)				
Tail	Connected to Phase C of Turret Power—Tail			
TURRET DOOR (POWER)				
Aft Upper	29	3	10	UPPER TURRET DOOR MOTOR
Forward, Left	14	3	10	UPPER LH TURRET DOOR MOTOR
Forward, Right	13	3	10	UPPER RH TURRET DOOR MOTOR
Tail	24	3	40	TAIL TURRET POWER
VOLTAGE REGULATOR				
Alternator 2	30	3	10	AC PWR. EQUIP.
Alternator 3	31	3	10	AC PWR. EQUIP.
Alternator 4	19	3	10	AC PWR. EQUIP.
Alternator 5	18	3	10	AC PWR. EQUIP.
WATER INJECTION (POWER)				
Recip. Engine 1	29	3	10	WATER INJECTION PUMP
Recip. Engine 2	30	3	10	WATER INJECTION PUMP
Recip. Engine 3	31	3	10	WATER INJECTION PUMP
Recip. Engine 4	19	3	10	WATER INJECTION PUMP
Recip. Engine 5	18	3	10	WATER INJECTION PUMP
Recip. Engine 6	17	3	10	WATER INJECTION PUMP
WINDSHIELD WIPERS (POWER), PILOTS'				
	38	3	10	PILOTS WINDSHIELD WIPER

*Push-Pull Type Circuit Breaker
†Switch-Type Circuit Breaker

Figure 1-27. (Sheet 8)

Fuses & CIRCUIT BREAKERS (Continued)

D-C EQUIPMENT FUSES AND CIRCUIT BREAKERS

EQUIPMENT OR CIRCUIT	LOCATION (Panel No.)	QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE
AFT CABIN TEMPERATURE INDICATOR				
	5	1	* 5	AFT CABIN TEMP.
AILERON TRIM TAB (CONTROL), LEFT AND RIGHT				
	3	1	* 5	TABS AILERON
AILERON TRIM TAB POSITION INDICATOR				
Left	29	1	10	AIL. TAB
Right	17	1	10	AILERON TRIM TAB
AIR PLUG (CONTROL)				
Jet Engines 1, 2, 3, & 4	4	1	* 5	NOSE SHUTOFF DOOR POWER
Recip. Engines 1, 2, 3, 4, 5 & 6	7	6	* 5	ENGINES AIR PLUG CONTROLS 1, 2, 3, 4, 5, & 6
ALARM BELL				
	3	1	* 5	ALARM BELL
ALTERNATOR				
Exciter Ceiling and Differential Protection Relay 2	30	1	10	ALT. CONT.
Exciter Ceiling and Differential Protection Relay 3	31	1	10	ALT. CONT.
Exciter Ceiling and Differential Protection Relay 4	19	1	10	ALT. CONT.
Exciter Ceiling and Differential Protection Relay 5	18	1	10	ALT. CONT.
FIELD FLASHING CONTROL				
	7	1	† 5	ALT. FIELD FLASH CK. BRKR.
ANTI-ICING				
Air Temperature Warning Lamps	5	1	* 5	HEAT DUCT HIGH TEMP.
Heat Duct Temperature Indicators	5	7	* 5	ANTI-ICE HEAT DUCT TEMP.
Jet Pod Heaters (Controls), AND De-Ice Valves (Control)	4	1	† 5	NOSE DE-ICE
Jet Pod De-Ice Valve (Power), Left	28	1	10	POD DE-ICE
Right	16	1	10	POD DE-ICE
AUTOPILOT (CONTROL), E6				
	3	1	*10	AUTOPILOT

*Push-Pull Type Circuit Breaker
†Switch-Type Circuit Breaker

EQUIPMENT OR CIRCUIT	LOCATION (Panel No.)	QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE
BOMB BAY DOORS (CONTROL)				
Bombardier's	1	1	* 5	BOMB BAY DOOR
Pilots	3	1	* 5	BOMB DOORS
BOMB MASTER SWITCH				
	43	1	†25	MASTER POWER
BOMB NOSE ARMING (CONTROL)—BOMB BAYS 1, 2, 3 & 4				
	1	1	* 5	NOSE FUSING
BOMB NOSE ARMING (POWER)				
Bomb Bay 1	15	1	†25	BOMB NOSE FUSING B.B.1
Bomb Bay 2	15	1	†20	BOMB NOSE FUSING B.B.2
Bomb Bay 3	21	1	†20	BOMB NOSE FUSING B.B.3
Bomb Bay 4	21	1	†25	BOMB NOSE FUSING B.B.4
BOMB RACK COMPRESSORS, PNEUMATIC (SOME AIRPLANES)				
Aft	21	1	†25	U-1 RACK COMP.
Forward	15	1	†25	PNEUMATIC BOMB RACK COMP.
BOMB RACK JUNCTION BOX, PNEUMATIC (BB 2 & 3 SOME AIRPLANES)				
B.B. #1 & 2 Junction Box	15	2	†25	PNEUMATIC BOMB RACK JUNCT. BOX B.B. 1 & 2
B.B. #3 & 4 Junction Box	21	2	†25	SPECIAL SYSTEM B. B. 3 & 4 SALVO
BOMB RACK SELECTOR				
Bomb Bay 2	15	1	† 5	B.B.2 RACK SELECTOR
Bomb Bay 3	21	1	† 5	RACK SELECTOR B.B.3
Bomb Bays 1 & 4	21	1	† 5	RACK SELECTOR B.B.1 & 4
BOMB RELEASE SWITCH				
	1	1	*10	BOMB RELEASE
BOMB RELEASE INTERVALOMETER				
	1	1	* 5	INTER HEATER
BOMB SALVO (CONTROL)—BOMB BAYS 1, 2, 3 & 4				
Bombardier's	1	1	*10	BOMB SALVO
Pilots'	3	1	*10	BOMB SALVO
BOMB SALVO (POWER)				
Bomb Bay 1	15	1	†25	BOMB SALVO B.B.1
Bomb Bay 2	15	1	†25	BOMB SALVO B.B.2
Bomb Bay 3	21	1	†25	BOMB SALVO B.B.3
Bomb Bay 4	21	1	†25	BOMB SALVO B.B.4

Figure 1-27. (Sheet 9)

Fuses & CIRCUIT BREAKERS (Continued) (DC)

EQUIPMENT OR CIRCUIT	LOCATION (Panel No.)	QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE
BOMB SCORING TONE RELAY	1	1	* 5	BOMB SCORING TONE
BRAKE PUMP See: Hydraulic Pump (Controls), Brake				
BUS TIE BREAKERS	7	1	* 5	BUS TIE BAR
CABIN AIR DUCT TEMPERATURE INDICATOR	5	1	* 5	CABIN HEAT DUCT TEMP.
CAMERA BOMB IMPULSE	1	2	* 5	CAMERA BOMB IMPULSE SALVO, NORMAL
CAMERA DOOR (CONTROL)	43	1	* 5	DOOR
CAMERA INITIATION, C-1	43	1	* 5	CAMERA INITIATION
CAMERA INTERVALOMETER	43	1	5	INTERVALOMETER
CAMERA POWER	43	1	*10	CAMERA POWER
CAMERA RADAR SCOPE	1	1	*10	RADAR CAMERA
CAMERA VACUUM SYSTEM	43	1	*10	VACUUM SYSTEM
CARBURETOR AIR FILTER (CONTROL)	7	1	† 5	CARB. AIR FILTER
CARBURETOR AIR PREHEAT (CONTROL)—RECIP. ENGINES 1, 2, 3, 4, 5 & 6	7	6	* 5	CARBURETOR PRE-HEAT 1, 2, 3, 4, 5, & 6
CARBURETOR AIR TEMPERATURE INDICATORS—RECIP. ENGINES 1, 2, 3, 4, 5, & 6	7	6	* 5	TEMPERATURE INDICATORS CARBURETOR AIR 1, 2, 3, 4, 5, & 6
CHAFF DISPENSER				
Left	24	1	*15	CHAFF DISPENSER LH & RH
Right	24	1	*15	
COMPASS, HIGH LATITUDE	42	1	* 5	HIGH LATITUDE-COMPASS
COMPASS, RADIO—AN/ARN-6	24	1	*10	RADIO COMP
CONTROL SURFACE LOCKS (CONTROL)	3	1	* 5	CONTROL SURFACE LOCKS
ENGINE TEMPERATURE INDICATORS (SOME AIRPLANES)	12	6	* 5	TEMPERATURE INDICATORS—CYLINDER HEAD
FAN, AIR CIRCULATING				
Copilot's / Pilot's — See: Hot Cups, Beverage Tanks, Oven and Vent Fans.				
FAN (CONTROL), CABIN AIR BOOSTER	5	1	* 5	BOOSTER FAN
FANS, ENGINE COOLING—RECIP. 1, 2, 3, 4, 5, & 6 (SOME AIRPLANES)	9	6	* 5	ENGINE FAN
FIRE DETECTION				
Recip. Engine 1	29	1	10	FIRE DETECT
Recip. Engine 2	30	1	10	FIRE DETECT
Recip. Engine 3	31	1	10	FIRE DETECT
Recip. Engine 4	19	1	10	FIRE DETECT
Recip. Engine 5	18	1	10	FIRE DETECT
Recip. Engine 6	17	1	10	FIRE DETECT
FIRE DETECTION AND TEST—JET ENGINES 1, 2, 3 & 4	4	1	* 5	FIRE DETECT POWER
FIRE DETECTION TEST—RECIP. ENGINES 1, 2, 3, 4, 5 & 6	5	1	*10	FIRE DETECT
FIRE EXTINGUISHER	5	1	*15	FIRE EXT.
FLAPS (CONTROL), ALTERNATE	21	1	† 5	ALTER. FLAP CONTROL
FLAPS (CONTROL), NORMAL				
Center	3	1	* 5	FLAPS CENTER
Inboard	3	1	* 5	FLAPS INB'D
Outboard	3	1	* 5	FLAPS OUTB'D.
FLAPS POSITION INDICATOR	3	1	* 5	FLAP POSITION IND.
FLAPS POSITION TRANSMITTERS, CENTER, INBOARD AND OUTBOARD	21	1	† 5	FLAP TRANS

*Push-Pull Type Circuit Breaker
†Switch-Type Circuit Breaker

Figure 1-27. (Sheet 10)

Fuses & CIRCUIT BREAKERS (Continued) (DC)

EQUIPMENT OR CIRCUIT	LOCATION (Panel No.)	QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE
FUEL				
Pumps (Control), Booster				
Auxiliary Tanks Left & Right	9	2	† 5	TANKS L&R AUX. BOOSTER
Bomb Bay Tank	9	I	† 5	BB TANK BOOSTER
Jet Engines I & 2	4	I	† 5	L. FUEL PUMP
Jet Engines 3 & 4	4	I	† 5	R. FUEL PUMP
Wing Tanks I, 2, 3, 4, 5 & 6	9	6	† 5	TANKS L&R AUX. BOOSTER
Tank, Bomb Bay: Tank Valve Valve Pressure Refueling	9	I	* 5	BB TANK VALVE POWER
Simulator	9	I	† 5	BB FUEL QTY.
Tanks, Auxiliary—Left AND Right: Valves (2) Valves, Pressure Refueling (2)	9	2	* 5	L&R AUX. TANK VALVE POWER
Tanks, Wing—I, 2, 3, 4, 5 & 6 Valve (6) Valves, Pressure Refueling (6)	9	6	* 5	I, 2, 3, 4, 5, & 6 TANK VALVE POWER
Valves				
Cross Feed	9	I	* 5	CROSS FEED MANIFOLD VALVE POWER
Manifold—Jet Pod, Left	4	I	* 5	FUEL VALVE POWER LEFT MANIFOLD
Manifold—Jet Pod, Right	4	I	* 5	FUEL VALVE POWER RIGHT MANIFOLD
Jet Engines I, 2, 3 & 4	4	4	* 5	FUEL VALVE POWER ENG. I, 2, 3 & 4
Manifold—I, 2, 3, 4, 5, 6, 7 & 8	9	8	* 5	FUEL MANIFOLD VALVE POWER I, 2, 3, 4, 5, 6, 7 & 8
Recip. Engines I, 2, 3, 4, 5, 6 AND Oil Cooler (Control)—Flight Cooling—Recip. Engines I, 2, 3, 4, 5 & 6	9	6	* 5	ENGINE VALVE POWER I, 2, 3, 4, 5 & 6
GYRO INDICATOR, PILOTS'	39	I	10	PILOT'S GYRO HORIZON
HEATERS (CONTROL), AUXILIARY CABIN	8	I	† 5	CABIN HEATER POWER

*Push-Pull Type Circuit Breaker
†Switch-Type Circuit Breaker

EQUIPMENT OR CIRCUIT	LOCATION (Panel No.)	QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE
HEATERS (CONTROL), OIL—JET ENGINES 1, 2, 3, & 4	4	I	† 5	OIL HEAT
HEATERS (CONTROL), OIL VENT LINE—RECIP. ENGINES 1, 2, 3, 4, 5, & 6	8	I	† 5	OIL VENT HEAT
HEATER, PITOT TUBE (Some Airplanes)				
Left	8	I	† 5	PITOT TUBE HEATER L.H.
Right	8	I	† 5	PITOT TUBE HEATER R. H.
HYDRAULIC FLUID TEMPERATURE (CONTROL)	5	I	† 5	HYD. PUMP FLUID TEMP.
HYDRAULIC PUMP (CONTROL)				
Brake	3	I	* 5	BRAKE PUMP
Brake—Emergency	5	I	* 5	EMERG. BRAKE PUMP
#2—Emergency	5	I	† 5	HYD. PUMP OVER-RIDE
HYDRAULIC PARKING BRAKE	3	I	* 5	PARK BRAKE

HYDRAULIC PUMP (CONTROLS)

Brake — See: I. Hydraulic Pump (Control), Brake
2. Hydraulic Pump (Control), Brake—Emergency

#I — See: I. Bomb Bay Doors (Control), Bombardier's
2. Bomb Bay Doors (Control), Pilots'
3. Hydraulic Fluid Temperature (Control)
4. Landing Gear Etxension and Retraction (Control)
5. Landing Gear Steering (Control), Nose

#2 — See: I. Hydraulic Pump (Control), #2—Emergency
2. Landing Gear Extension and Retraction (Control)

EQUIPMENT OR CIRCUIT	LOCATION (Panel No.)	QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE
IFI ACCESSORY EQUIPMENT (AIRPLANES WITH SPECIAL BOMBING EQUIPMENT IN BB 1 & 4) (Some Airplanes)				
Air Pump				
Aft	21	I	†25	H-I EQUIP AIR PUMPS
Forward	15	I	†25	H-I EQUIP AIR PUMPS
Suit Heater Receptacle AND Test Receptacle	21	I	†25	BB-4 HEAT SUIT
Suit Heater Receptacle AND Test Receptacle	15	I	†25	H-I EQUIPMENT TEST REC HEAT SUIT
Test Receptacle				
BBI	46	I	†25	TEST RECEPTACLE
BB4	49	I	†25	TEST RECEPTACLE
Panel Lights				
BBI	46	I	† 5	WORK LIGHT
BB4	49	I	† 5	WORK LIGHT

Figure 1-27. (Sheet 11)

Fuses & CIRCUIT BREAKERS (Continued) (DC)

EQUIPMENT OR CIRCUIT	LOCATION (Panel No.)	QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE
IFI ACCESSORY EQUIPMENT (Continued) (AIRPLANES WITH SPECIAL BOMBING EQUIPMENT IN BB1, 2, 3, & 4)				
Suit Heater Receptacle & Test Receptacle (BB3 & 4)	21	2	†25	BB-4 HEAT SUIT & IFI EQUIPMENT TEST REC. HEAT SUIT
Suit Heater Receptacle and Test Receptacle (BB1 & 2)	15	2	†25	H-1 & IFI EQUIPMENT TEST REC HEAT SUIT
Test Receptacles				
BB1	46	1	†25	TEST RECEPTACLE
BB2	47	1	†25	TEST RECEPTACLE
BB3	48	1	†25	TEST RECEPTACLE
BB4	49	1	†25	TEST RECEPTACLE
Panel Lights				
BB1	46	1	† 5	WORK LIGHT
BB2	47	1	† 5	WORK LIGHT
BB3	48	1	† 5	WORK LIGHT
BB4	49	1	† 5	WORK LIGHT
IGNITION BOOSTER				
Recip. Engine 1	29	1	10	IGN. BOOST
Recip. Engine 2	30	1	10	IGN. BOOST
Recip. Engine 3	31	1	10	IGN. BOOST
Recip. Engine 4	19	1	10	IGN. BOOST
Recip. Engine 5	18	1	10	IGN. BOOST
Recip. Engine 6	17	1	10	IGN. BOOST
IGNITION (CONTROL), AND STARTER (CONTROL), AND STARTER ENGAGING (CONTROL)—JET ENGINES 1, 2, 3 & 4	4	4	* 5	IGNITION STARTER POWER ENG. 1, 2, 3 & 4
INSTRUMENT APPROACH SYSTEM—GLIDE PATH AND LOCALIZER RECEIVERS	1	1	* 5	GLIDE PATH RECVR
INTERCOOLERS CLOSE AND OPEN (CONTROL)—RECIP. ENGINES 1, 2, 3, 4, 5 & 6	7	1	* 5	ENG. INTER-COOLER
INTERPHONE COMBAT				
Amplifier, Mixer: Copilot's	3	1	* 5	COPILOT INTER-PHONE
Pilot's	3	1	* 5	PILOT INTER-PHONE
Radio Operator	37	1	* 5	MIXER AMP
Amplifier—Normal Channel	37	1	* 5	INTERPHONE
Amplifier—Private Channel (Through Audio Input Relays A&C)	7	1	* 5	INTERPHONE

EQUIPMENT OR CIRCUIT	LOCATION (Panel No.)	QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE
INTERPHONE AN/AIC-10 (GROUP 7 AIRPLANES)	7	3	* 5	INTERPHONE EMERGENCY INTERPHONE D-C POWER CHANNEL 3 INTERPHONE D-C POWER CHANNEL 4
	24	2	* 5	INTERPHONE CHANNEL 1 INTERPHONE CHANNEL 2
K-( ) BOMBING SYSTEM				
Amplifier—Computer Type A-2	39	1	30	K-( ) SYSTEM
Filter, F-67/APS-23 & Heater Relay Control	39	1	30	BOMB'G RADAR
LANDING GEAR EXTENSION AND RETRACTION (CONTROL), AND OIL COOLER (CONTROL)—GROUND COOLING—RECIP. ENGINES 1, 2, 3, 4, 5, & 6	3	1	* 5	LANDING GEAR CONTROL
LANDING GEAR STEERING (CONTROL), NOSE	3	1	* 5	LANDING GEAR NOSE STEER
INTER-AIRCRAFT SIGNAL LIGHTS & FACE PLATE HEATERS				
Aircraft Commanders & Pilots	39	1	10	AIRCRAFT COMMANDERS PILOTS FACE HTR
BHD. 30, Engineers Sta. & Radio Operators	35	1	10	BHD. 3.0 ENGRS. STA. RADIO OPERS. FACE HTRS. ALDIS RECP.
Copilots	3	1	*10	ALDIS LIGHT COPILOTS FACE HTR.
Engineers	5	1	† 5	ENGRS. FACE HEATER
Gunners Tail	24	1	*10	UPPER ALDIS LIGHT FACE HTR.
Aft (L&R)	24	1	*10	LOWER ALDIS LIGHT FACE HTR.
K-( ) Operator Htr. Nose Gunners Lamp Wheel Well Htr.	38	1	10	ALDIS LTS."K" OPER. NOSE WH. WELL HTR. ALDIS RECP.
Navigator K Maintenance Man	39	1	10	NAV. & K-MAINT. FACE HTR. ALDIS RECP.

*Push-Pull Type Circuit Breaker
†Switch-Type Circuit Breaker

Figure 1-27. (Sheet 12)

Fuses & CIRCUIT BREAKERS (Continued) (DC)

EQUIPMENT OR CIRCUIT	LOCATION (Panel No.)	QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE
LIGHTS				
Landing Gear				
Nose Wheel Well				
Left MLG Wheel Well				
Right MLG Wheel Well				
Left MLG Emer. Release				
Right MLG Emer. Release	5	1	† 5	WHEEL LIGHTS
Landing Lights				
Filament (Control) Extension & Retraction	3	1	* 5	LANDING LIGHT CONTROL
Navigation Lights				
Rudder (White) & Wing Tip, Lt. (Control)				
Rudder (Yellow)				
Fuselage (Upper & Lower)	3	1	* 5	NAVIGATION LIGHTS
Trailing Edge Lts.	21	1	†10	WING T.E. LIGHTS
Taxi Lights (Some Airplanes)				
Left (Power)	28	1	30	TAXI LIGHTS
Right (Power)	16	1	30	TAXI LIGHTS
L&R (Control)	50	1	† 5	TAXI LIGHTS
LIGHTS (CONTROL)				
Dome				
Bomb Bay 1&2	37	1	* 5	LIGHTS TURRET BB 1&2
Bomb Bay 3&4	24	1	* 5	TURRET & BB LIGHTS
Main A-C Power Panels	24	1	* 5	TURRET & BB LIGHTS
Station 7.0	37	1	* 5	LIGHTS TURRET BB 1 & 2
Turret Bay				
Aft	24	1	* 5	TURRET & BB LIGHTS
Forward	37	1	* 5	LIGHTS TURRET BB 1&2
Turret Passageway				
Aft	24	1	* 5	TURRET & BB LIGHTS
Forward	37	1	* 5	LIGHTS TURRET BB 1&2
Instruments				
Flap Control Panels	24	1	* 5	TURRET & BB LIGHTS
Turret Power Panels				
Forward (L&R)	37	1	* 5	LIGHTS TURRET BB 1&2
MARKER BEACON SET, AN/ARN-12	37	1	* 5	MARKER BEACON
MARKER BEACON TEST LAMP	3	1	* 5	ARN-12 TEST LAMP
OIL COOLER (CONTROL)—FLIGHT COOLING—RECIP. ENGINES 1, 2, 3, 4, 5 & 6				
See: Fuel Valves—Recip. Engines 1, 2, 3, 4, 5 & 6, AND Oil Cooler (Control)—Flight Cooling—Recip. Engines 1, 2, 3, 4, 5 & 6				
OIL COOLER (CONTROL)—GROUND COOLING—RECIP. ENGINES 1, 2, 3, 4, 5 & 6				
See: Landing Gear Extension AND Retraction (Control), AND Oil Cooler (Control)—Ground cooling—Recip. Engines 1, 2, 3, 4, 5 & 6				
OIL COOLER DOOR MANUAL OVERRIDE CONTROL—GROUND AND FLIGHT COOLING—RECIP. ENGINES 1, 2, 3, 4, 5 & 6 (GROUP 9 AIRPLANES)	9	6	† 5	ENGINE OIL COOLER CONTROLS
OIL DILUTION—RECIP. ENGINES 1, 2, 3, 4, 5 & 6	9	1	*15	ENGINE OIL DILUTE
OIL QUANTITY INDICATORS—RECIP. ENGINES 1, 2, 3, 4, 5 & 6	7	6	* 5	OIL QUANTITY INDICATORS 1, 2, 3, 4, 5 & 6
OIL SHUTOFF VALVE, JET ENGINES 1, 2, 3 & 4 (On Airplanes Equipped With DC Actuators)	4	4	* 5	OIL SHUTOFF VALVE POWER ENG. 1, 2, 3 & 4
OIL TEMPERATURE INDICATORS—RECIP. ENGINES 1, 2, 3, 4, 5 & 6	7	6	* 5	TEMPERATURE INDICATORS ENGINE OIL 1, 2, 3, 4, 5 & 6
PRIMERS—RECIP. ENGINES 1, 2, 3, 4, 5 & 6	9	1	* 5	ENGINE PRIMER
PROPELLERS FEATHERING, REVERSING, AND PITCH CHANGING—RECIP. ENGINES 1, 2, 3, 4, 5 & 6	7	6	*15	PROPELLER CONTROL 1, 2, 3, 4, 5 & 6
PROPELLER MASTER MOTOR	7	1	*10	PROPELLER CONTROL MASTER MOTOR
PROPELLER PITCH INDICATOR LAMPS, ENGINEER'S AND PILOT'S	7	1	* 5	PROPELLER CONTROL REVERSE LIGHTS

*Push-Pull Type Circuit Breaker
†Switch-Type Circuit Breaker

Figure 1-27. (Sheet 13)

Fuses & CIRCUIT BREAKERS (Continued) (DC)

EQUIPMENT OR CIRCUIT	LOCATION (Panel No.)	QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE
RADAR COUNTERMEASURE EQUIPMENT				

NOTE

Any one of the following groups of DECM equipment may be installed.

EQUIPMENT OR CIRCUIT	LOCATION (Panel No.)	QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE
Group I:				
AN/APT-4—Rack #1	10	1	*10	RACK POS. 1
AN/APR-4	10	1	* 5	RACK POS. 2
AN/APT-4—Rack #4	10	1	*10	RACK POS. 4
AN/APT-4—Rack #5	10	1	*10	RACK POS. 5
Group II:				
AN/APR-4	10	1	* 5	RACK POS. 2
AN/APT-4	10	1	*10	RACK POS. 4
AN/APT-6—Rack #1	10	1	*10	RACK POS. 1
AN/APT-6—Rack #5	10	1	*10	RACK POS. 5
Group III:				
AN/APT-9—Rack #1	10	1	*10	RACK POS. 1
AN/APR-9—Rack #5	10	1	* 5	APR-9
AN/APR-4—Rack #2	10	1	* 5	RACK POS. 2
AN/APT-4—Rack #4	10	1	*10	RACK POS. 4
Radar Set:				
AN/APG-32	24	1	*15	TAIL RADAR POWER
AN/APG-41	24	1	* 5	TAIL RADAR POWER
or	24	1	*25	TAIL RADARA POWER
AN/APG-41A	24	1	* 5	MASTER CONTROL
	24	1	*15	CONTROL POWER
	24	2	*25	ANTENNA 1, 2
AN/APN-9	42	1	* 5	LORAN
AN/APX-6	37	1	* 5	IDENT. REC'R
AN/APX-6 Detonator	37	10	*10	IDENT. DETONT'R
Radio Set:				
AN/ARC-3—Command	35	1	30	COMMAND AN/ARC-3
AN/ARC-8—Liaison (Dynamotor)	35	3	20	LIAISON RADIO DYN
AN/ARC-8—Liaison Receiver	37	1	* 5	LIAISON REC'R
AN/ARC-21X—	24	2	*20	BLOWER & HTR
Liaison Set (Group 7 Airplanes)	24	1	* 5	RATCHET & RELAY XMTR ANTENNA
AN/ARC-27	37	1	*10	COMMAND RADIO
AN/ARC-27	24	1	*25	ARC-27 RECVR
AN/ARN-14, Navigation Receiver	24	1	*10	ARN-14 NAV. RECVR.

EQUIPMENT OR CIRCUIT	LOCATION (Panel No.)	QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE
RADAR COUNTERMEASURE EQUIPMENT (Continued)				
AN/ARN-14, Test Receptacle	24	1	*10	ARN-14 TEST RECEP.
AN/ARN-14	1	1	* 5	GLIDE PATH
(Group 5 Airplanes) Compass Rec.	24	1	*10	RADIO COMPASS
SPECIAL BOMBING SYSTEM (AIRPLANES WITH SPECIAL BOMBING EQUIPMENT IN BB 1 & 4)				
Power Arming & Release	43	1	*25	
Release & Heater Control	43	2	* 5	
T-35	45	2	*35	
T-19	45	2	*35	
T-18	45	2	*25	
Test	45	2	*20	
FCT Junction Box (DC Feeder)	11	3	60	AUX. BOMB RACK TEST EQUIPMENT
(AIRPLANES WITH SPECIAL BOMBING EQUIPMENT IN BB 1, 2, 3 & 4)				
Power Arming & Release	43	1	*25	
Release & Heater Control	43	4	* 5	
T-35	45	4	*35	
T-19	45	4	*35	
T-18	45	4	*25	
Test	45	4	*20	
FCT Junction Box (DC Feeder)	11	3	60	AUX. BOMB RACK TEST EQUIPMENT
SPARK ADVANCE—RECIP. ENGINES 1, 2, 3, 4, 5 & 6 (Some Airplanes)	7	6	* 5	ENGINE SPARK ADVANCE
STARTERS (CONTROL)—JET ENGINES 1, 2, 3 & 4				
See: Ignition (Control), AND Starter (Control), AND Starter Engaging (Control)—Jet Engines 1, 2, 3, & 4				
STARTERS (CONTROL)—RECIP. ENGINES 1, 2, 3, 4, 5 & 6	9	1	* 5	ENGINE STARTER
STARTER ENGAGING (CONTROL)—JET ENGINES 1, 2, 3 & 4				
See: Ignition (Control), AND Starter (Control), AND Starter Engaging (Control)—Jet Engines 1, 2, 3 & 4				
STARTER ENGAGING (POWER)				
Jet Engine 1	28	1	10	#1 STARTER ENGAGING
Jet Engine 2	28	1	10	#2 STARTER ENGAGING
Jet Engine 3	16	1	10	#3 STARTER ENGAGING
Jet Engine 4	16	1	10	#4 STARTER ENGAGING

*Push-Pull Type Circuit Breaker
†Switch-Type Circuit Breaker

Figure 1-27. (Sheet 14)

Fuses & CIRCUIT BREAKERS (Continued) (DC)

EQUIPMENT OR CIRCUIT	LOCATION (Panel No.)	QUANTITY	SIZE (Amperes)	DECAL NOMENCLATURE
TEST POWER TERMINAL				
Recip. Engine 1	29	1	10	TEST POWER
Recip. Engine 2	30	1	10	TEST POWER
Recip. Engine 3	31	1	10	TEST POWER
Recip. Engine 4	19	1	10	TEST POWER
Recip. Engine 5	18	1	10	TEST POWER
Recip. Engine 6	17	1	10	TEST POWER
TRANSFORMER RECTIFIER FILTER				
Aft Cabin		1	10	
Copilots		1	10	
Navigator's		1	10	
Radio Operator's		1	10	
Bomb Bay #1, 2 & 3		3	10	
TURBO BOOST REGULATOR CONTROL	7	1	† 5	VERNIER
TURN AND BANK INDICATOR				
Copilot's	3	1	* 5	TURN & BANK IND. COPILOT
Pilot's	3	1	* 5	TURN & BANK IND. PILOT
TURRET DOOR CONTROL (FWD)	35	1	20	TURRET CONTROL
TURRET INTERLOCKING RELAY	21	1	† 5	TURRET DOOR INLOCK
TURRET SIGHT TEST RECEPTACLE				
Aft	24	1	*10	28V DC RECP.
Forward	35	1	20	GUNSIGHT CHECKER
WATER INJECTION (CONTROL) RECIP. ENGINES 1, 2, 3, 4, 5 & 6	9	6	† 5	ENGINE WATER INJECTION 1, 2, 3, 4, 5 & 6
WINDSHIELD WIPERS (CONTROL) PILOTS'	3	1	* 5	WINDSHIELD WIPER

*Push-Pull Type Circuit Breaker
†Switch-Type Circuit Breaker

Figure 1-27. (Sheet 15)

DIRECT-CURRENT SYSTEM.

The d-c power system consists of a 24-volt, 17 ampere-hour storage battery, and seven transformer-rectifier units. The t-r units convert 3-phase, 208-volt, alternating current into 28-volt direct current. Each unit is rated for a continuous output of 50 amperes. The units are located as follows: one under the floor of the forward cabin left passageway, one behind the radar observer's control panel, one under the radio operator's table, three in No. 3 bomb bay, and one on the forward bulkhead of the aft cabin. (See figure 1-30.)

The units are connected through fuses to the a-c system and operate in parallel to deliver direct current when power is on the a-c bus. The total load of the system is automatically shared by the units.

The battery is located in the aft end of the nose wheel well. The battery is connected to the d-c system through a relay which is controlled by a switch (7, figure 1-19) on the engineers' auxiliary control and instrument panel. Power for the relay is taken from the battery. During normal operation of the bus the relay is closed, permitting the battery to be charged by the transformer-rectifier units. The battery supplies a continuous source of d-c power to the alarm bell control switch on the pilots' instrument panel, to the destructor unit of

T-R TEST UNIT

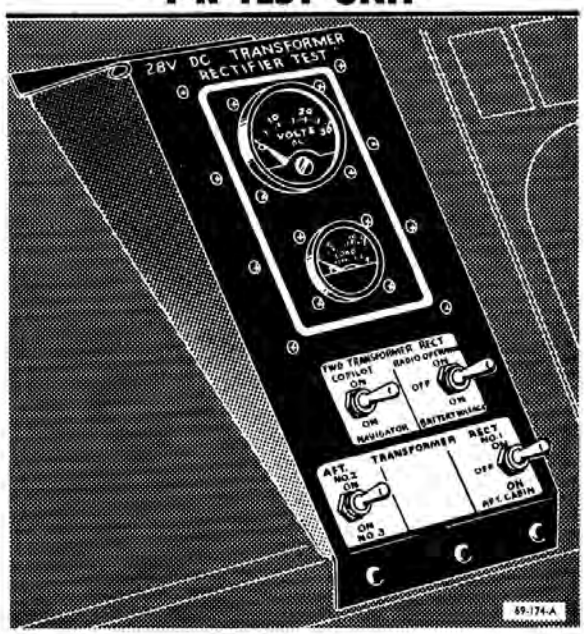


Figure 1-28.

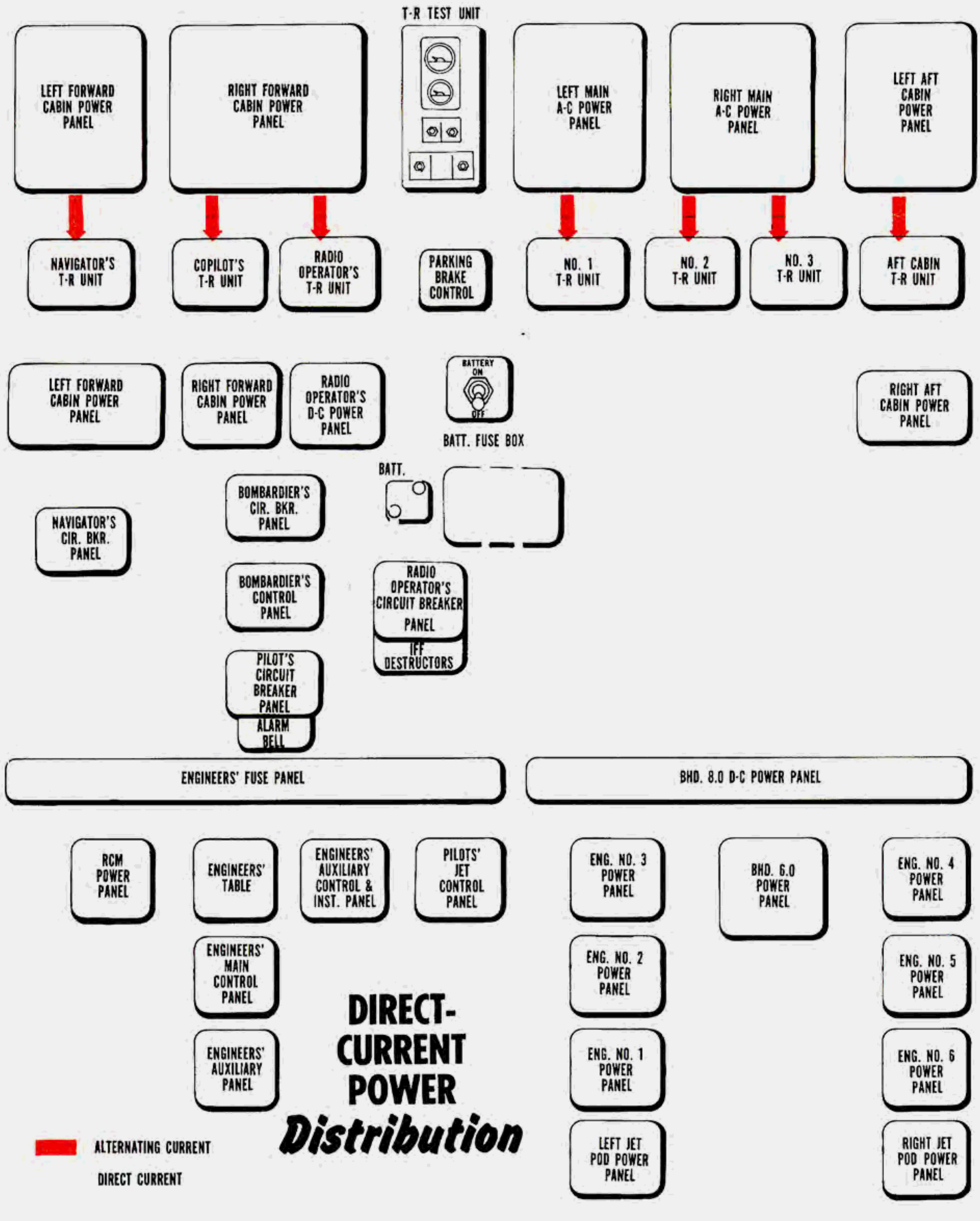

T-R TEST UNIT
LEFT FORWARD CABIN POWER PANEL
RIGHT FORWARD CABIN POWER PANEL
LEFT MAIN A-C POWER PANEL
RIGHT MAIN A-C POWER PANEL
LEFT AFT CABIN POWER PANEL
NAVIGATOR'S T-R UNIT
COPILOT'S T-R UNIT
RADIO OPERATOR'S T-R UNIT
PARKING BRAKE CONTROL
NO. 1 T-R UNIT
NO. 2 T-R UNIT
NO. 3 T-R UNIT
AFT CABIN T-R UNIT
LEFT FORWARD CABIN POWER PANEL
RIGHT FORWARD CABIN POWER PANEL
RADIO OPERATOR'S D-C POWER PANEL
BATTERY ON
OFF
BATT. FUSE BOX
RIGHT AFT CABIN POWER PANEL
BATT.
BOMBARDIER'S CIR. BKR. PANEL
NAVIGATOR'S CIR. BKR. PANEL
BOMBARDIER'S CONTROL PANEL
RADIO OPERATOR'S CIRCUIT BREAKER PANEL
IFF DESTRUCTORS
PILOT'S CIRCUIT BREAKER PANEL
ALARM BELL
ENGINEERS' FUSE PANEL
BHD. 8.0 D-C POWER PANEL
RCM POWER PANEL
ENGINEERS' TABLE
ENGINEERS' AUXILIARY CONTROL & INST. PANEL
PILOTS' JET CONTROL PANEL
ENG. NO. 3 POWER PANEL
BHD. 6.0 POWER PANEL
ENG. NO. 4 POWER PANEL
ENGINEERS' MAIN CONTROL PANEL
ENG. NO. 2 POWER PANEL
ENG. NO. 5 POWER PANEL
ENGINEERS' AUXILIARY PANEL
ENG. NO. 1 POWER PANEL
ENG. NO. 6 POWER PANEL
DIRECT-CURRENT POWER Distribution
ALTERNATING CURRENT
DIRECT CURRENT
LEFT JET POD POWER PANEL
RIGHT JET POD POWER PANEL
J1144-A

Figure 1-29.

the AN/APX-6 identification set at the radio operator's station, and to the parking brake switch. This feature permits direct operation of these units, regardless of the position of the battery switch.

Battery Switch.

This two-position on-off switch (7, figure 1-19) controls the battery relay which connects the battery to the d-c power distribution system.

Transformer-Rectifier Test Unit Panel.

A transformer-rectifier test unit panel (figure 1-29), installed on the radio operator's equipment shelf, is provided to check the voltage and amperage output of the seven transformer-rectifier units. It is also used to check the voltage of the battery. The unit consists of selector switches, a voltmeter, and an ammeter.

Transformer-Rectifier Test Unit Selector Switches.

Four three-position switches are provided to select the t-r unit to be tested. Each switch has two spring-loaded ON positions and a neutral OFF position. The switches marked COPILOT—NAVIGATOR and RADIO OPERATOR—BATTERY VOLTAGE select the t-r units in the forward cabin or the battery. The switches marked No. 2—No. 3 and No. 1—AFT CABIN select the t-r units in the bomb bay and the aft cabin. Placing a switch ON tests the voltage and the load output of the t-r unit selected or the battery voltage as indicated by the switch position.

Transformer-Rectifier Test Unit Voltmeter. Voltage output of the unit being tested is indicated by the voltmeter.

Transformer-Rectifier Test Unit Ammeter. This meter is provided to indicate the amperage output load of the unit being tested. A reading of 1.0 on the meter indicates 100 per cent (50 amperes) output.

EMERGENCY ELECTRICAL SYSTEM.

In the event all alternators "jump" off the line, an emergency circuit (figure 1-31) is provided to restore

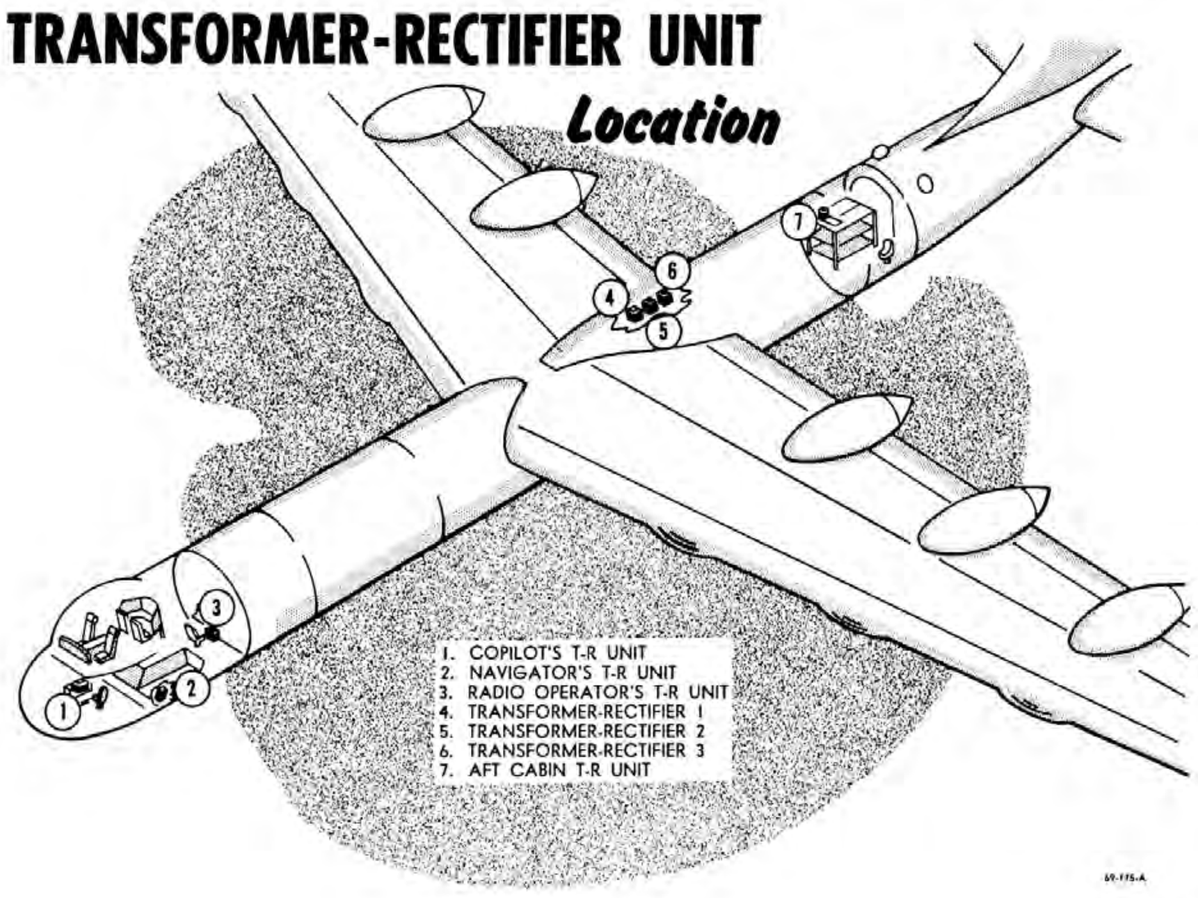


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Figure 1-30.

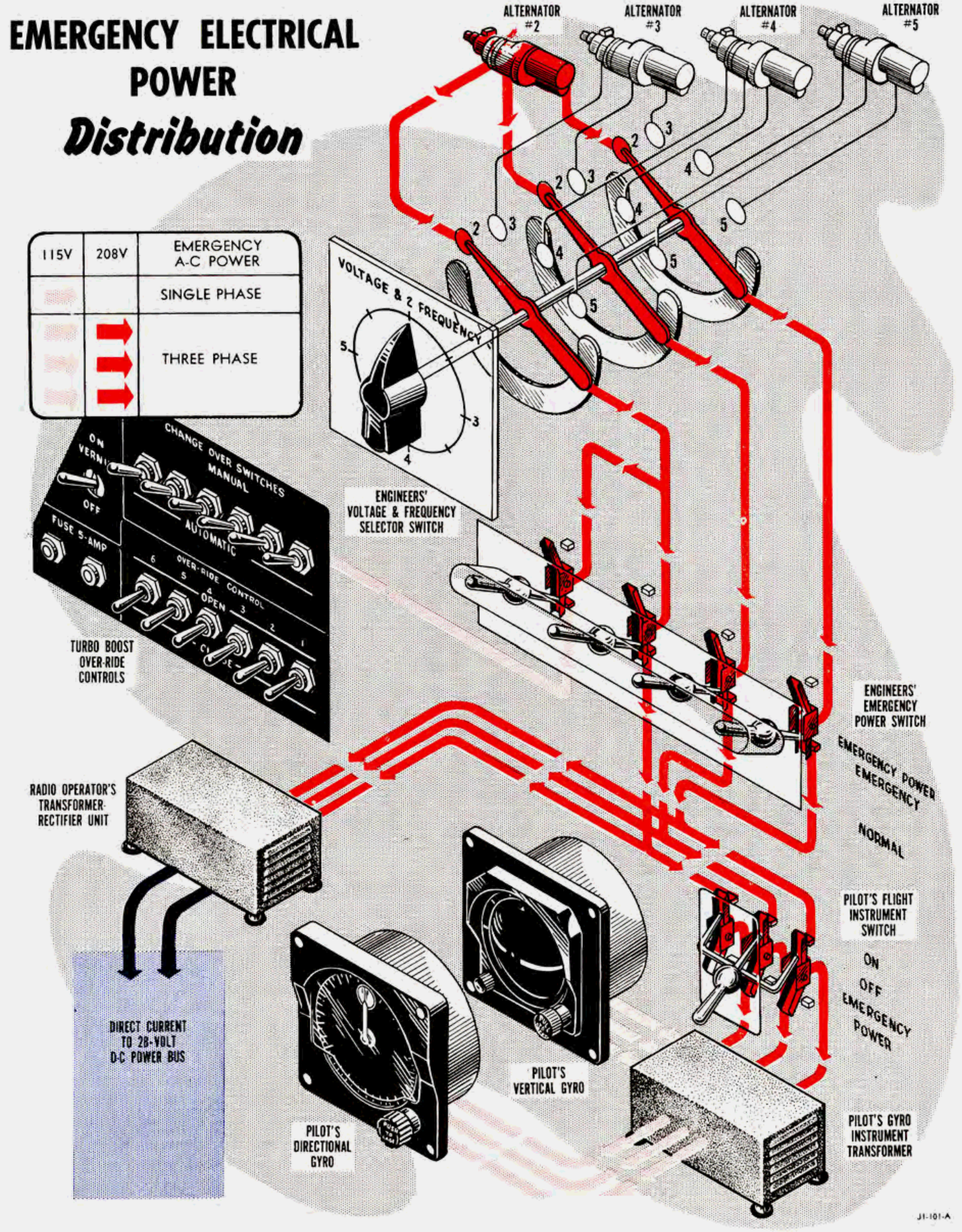
EMERGENCY ELECTRICAL POWER
Distribution
115V
208V
EMERGENCY A-C POWER
SINGLE PHASE
THREE PHASE
ALTERNATOR #2
ALTERNATOR #3
ALTERNATOR #4
ALTERNATOR #5
VOLTAGE & 2 FREQUENCY
ENGINEERS' VOLTAGE & FREQUENCY SELECTOR SWITCH
ON
VERNIER
OFF
CHANGE OVER SWITCHES
MANUAL
AUTOMATIC
FUSE 5-AMP
OVER-RIDE CONTROL
OPEN
TURBO BOOST OVER-RIDE CONTROLS
ENGINEERS' EMERGENCY POWER SWITCH
EMERGENCY POWER
EMERGENCY
NORMAL
RADIO OPERATOR'S TRANSFORMER-RECTIFIER UNIT
PILOT'S FLIGHT INSTRUMENT SWITCH
ON
OFF
EMERGENCY POWER
DIRECT CURRENT TO 28-VOLT D-C POWER BUS
PILOT'S VERTICAL GYRO
PILOT'S DIRECTIONAL GYRO
PILOT'S GYRO INSTRUMENT TRANSFORMER
J1-101-A

Figure 1-31.

ALTERNATE POWER *Switch*

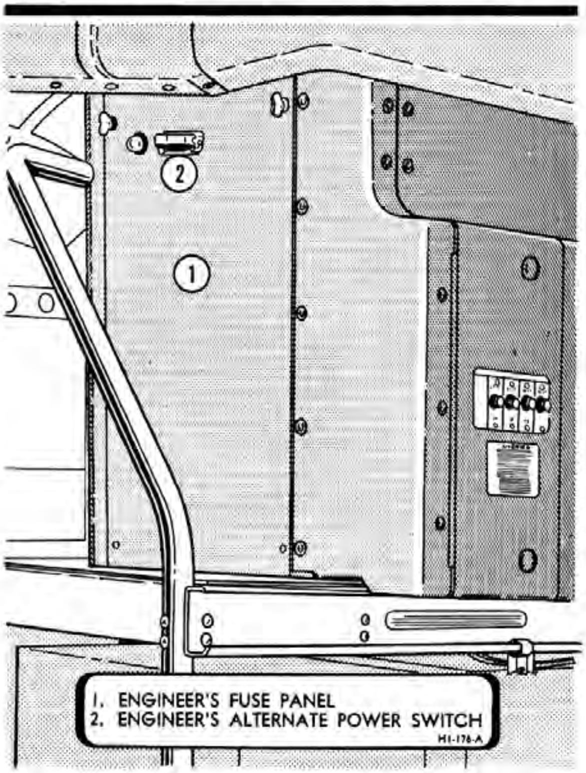

Figure 1-32.

enough power to operate essential electrical equipment. The emergency circuit begins at the terminals of each alternator and goes through the voltage and frequency selector switch to an emergency power switch. By use of the emergency switch, a-c power is fed to the pilot's flight instrument switch, the turbo boost override controls, and the radio operator's transformer-rectifier. The d-c output of the t-r unit can be used to close the alternator breaker when attempting to get an alternator back on the line or, if such attempts fail, to operate essential d-c equipment.

WARNING

Do not permit the d-c load to exceed 1.0 (50 amperes) as indicated on the load meter of the transformer-rectifier test unit, when selected to the RADIO OPERATOR position. An overload can damage the t-r unit with a resulting loss of all emergency power. An overload can damage the t-r unit or blow out the a-c fuses at the respective engine distribution panels with a resulting loss of all emergency power.

Emergency Power Control.

The emergency power control (1, figure 1-18) consists of four two-position switches ganged together on the engineers' main instrument panel. Placing the switches in EMERGENCY completes the emergency power circuit; moving the switches to NORMAL breaks the circuit. During normal operation the switches should always be in the NORMAL position.

ALTERNATE SOURCE OF A-C POWER TO ENGINEERS' FUSE PANEL.

A two-position switch (2, figure 1-32) is located on the engineers' fuse panel. This switch has positions marked NORM and ALT and is used to select one of two sources of a-c power for the engineers' fuse panel. This switch is wired in the NORM position, and power is supplied from the right forward cabin panel. The ALT position provides power from the left forward cabin power panel. Adjacent to this switch is a lamp which indicates when power from either source is being supplied to the engineers' fuse panel.

HYDRAULIC SYSTEM.

The hydraulic system is composed of four independent systems: a main system, a brake system, and two emergency systems. Each system has its own reservoir and selector valve. Main system pressure is supplied by two electrically-driven pumps. Hand pumps provide pressure for the emergency systems. The main system operates the landing gear, bomb bay doors, and nose wheel steering. Pressure from one emergency system can be used to extend the landing gear or to charge the brake system accumulators.

Note

Normally, brake pressure is supplied by an independent hydraulic system. For detailed information refer to "Brake System" of this section.

The other emergency system can be used to open or close the bomb bay doors.

MAIN HYDRAULIC SYSTEM.

The main hydraulic system (figure 1-33) supplies fluid pressure for landing gear, nose wheel steering, and bomb bay door operation. The system consists of a reservoir, two electrically-driven hydraulic pumps, and a main selector valve.

The main system reservoir, located on the wing front spar inside the fuselage, is provided with a sight level gage and filler neck. Fluid can be added during flight provided the main reservoir pressurization line is disconnected. For servicing information, refer to figure 1-45.

The main hydraulic system pumps operate whenever the associated control switch for landing gear operation, nose wheel steering, or bomb bay door operation is actuated.

MAIN HYDRAULIC *System*

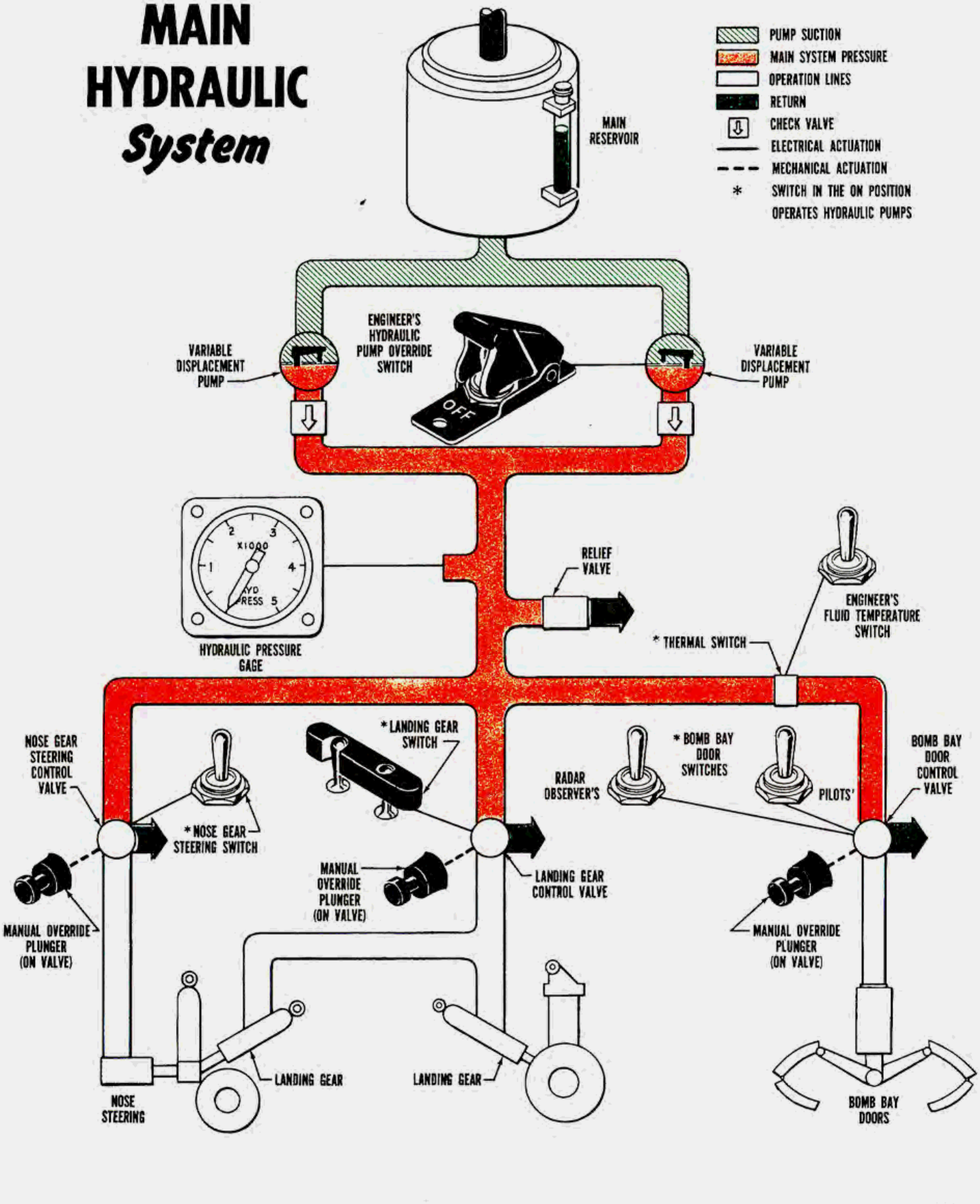

Figure 1-33.

Note

For information concerning these switches refer to "Landing Gear Switch" and "Steering Switch" of this section and "Bomb Bay Door Switch" of Section IV.

Both pumps operate for landing gear retraction and bomb bay door operation. Only one pump operates during landing gear extension and nose wheel steering. The pumps operate on 208-volt a-c power received through relays which are controlled by 28-volt direct current and deliver approximately 3100 psi fluid pressure to the system. The pumps stop operation through the action of limit switches after the bomb bay doors open or close or after the closing of the canoe doors upon completion of a landing gear operation cycle.

CAUTION

To prevent overheating of the hydraulic pump motor, limit pump operation to one retract or extend cycle in each 5-minute period.

The main system selector valve, located on the wing front spar inside the fuselage below the main system reservoir, is controlled by 28-volt direct current. The valve controls fluid pressure from the main pumps to the landing gear, nose wheel steering, and bomb bay door mechanisms. In the event of an electrical failure, the valve for the selected system can be operated manually as directed in "Manual Operation of Main Selector Valve," Section III.

Hydraulic Pump Override Switch.

This on-off switch (8, figure 1-20), located on the engineers' auxiliary panel, is used to control one pump motor during emergency manual operation of the main system selector valve. Placing the switch in the ON position closes a relay with 28-volt d-c power and routes 208 volt ac to energize the No. 2 main hydraulic pump motor.

Hydraulic Fluid Temperature Switch.

This switch (7, figure 1-20), located on the engineers' auxiliary panel, is used to set up a temperature control circuit for bomb bay door system hydraulic fluid. (Refer to "Hydraulic Fluid Temperature Control," Section IV.)

Hydraulic Pressure Gage.

A pressure gage (9, figure 1-20), located on the engineers' auxiliary panel, indicates the hydraulic pressure for the landing gear, bomb bay door, and nose wheel steering operation.

LANDING GEAR AND BRAKE EMERGENCY HYDRAULIC SYSTEM.

The main components of this system are a reservoir, a hand pump, and a selector valve (figure 1-41). Since the system serves for emergency operation of both landing gear and brakes, the selector valve is provided so that fluid pressure can be directed to the proper system. The emergency system hydraulic lines are separate from the main system. Shuttle valves are installed between the normal and emergency hydraulic lines so that pressure from either side can close the other line, directing fluid pressure into the actuating units. With the selector valve in EXTEND LG position, hand pump operation extends and locks the landing gear. Hand pump operation with the selector valve in CHARGE BRAKES position will supply fluid pressure to charge the brake accumulator. A fully charged accumulator will provide three full brake applications. Refer to "Emergency Hydraulic Landing Gear Extension" and "Emergency Brake Pressure," Section III, for operating instructions.

Note

When the emergency hydraulic system is used for landing gear extension, the main landing gear wheel well doors will not retract after the landing gear is lowered.

Emergency Selector Valve Control.

With the emergency selector valve in the CHARGE BRAKES or the EXTEND LG position, operation of the hand pump produces the selected action. Normally the valve should be left in the CHARGE BRAKES position. This permits any pressures caused by thermal expansion to be relieved in the accumulators.

BOMB BAY DOOR EMERGENCY HYDRAULIC SYSTEM.

The bomb bay door emergency hydraulic system has a separate reservoir, hand pump, selector valve, and hydraulic lines. The emergency lines are connected to the bomb bay door main actuating units through shuttle valves in an arrangement similar to that in the landing gear emergency system. For operation of this system, refer to "Operation of Bomb Bay Door Emergency Hydraulic System," Section IV.

FLIGHT CONTROL SYSTEM.

The movement of the ailerons, elevators, and rudder in response to their controls is conventional; however, the method of moving the main surfaces is unique. The controls are mechanically linked to flying servo tabs. When a control is moved to deflect a tab in one direction, the air load on the displaced tab causes the main surface to be deflected in the opposite direction. Even though an extra stage of action is involved between the control movement and the main surface movement in this method, response time is less than one-tenth of a second.

To provide control feel to the pilot, a spring-loaded piston in each main surface compresses whenever the related tab is deflected. In addition, the piston spring operates the tab to produce a dampening effect when the main surface is deflected by turbulence. The tab counteracts the movement of the main surface and restores the surface to its original position.

Note

> These pistons also provide for movement of the main surfaces when the airplane is on the ground and there are no air loads on the surfaces. When a tab is moved, the piston spring compresses until the spring load is sufficient to overcome the friction at the main surface pivot points; then the main surface will move.

All control surfaces can be locked simultaneously by means of hydraulic locks. The locks are electrically controlled and lock the surfaces at whatever position they are in. A bleed orifice will allow any surface to travel to either full position while locked.

Six flaps are installed on the wing trailing edge. The flaps are electrically controlled and actuated and are synchronized in symmetrical pairs by an electro-mechanical system.

The table in figure 1-34 shows the maximum deflection of all control surfaces. The reference point for these deflections is the chord plane of the surface.

SURFACE CONTROLS.

Control Columns and Rudder Pedals.

The aircraft commander's and pilot's stations are each

CONTROL SURFACE *Deflections*

Aileron	Up 20°	Down 20°
Aileron Servo Tabs	Up 25°	Down 25°
Elevator	Up 25°	Down 20°
Elevator Servo Tabs	Up 20°	Down 20°
Elevator Trim Tabs	Up 24°	Down 12°
Flaps	Up -- °	Down 30°
Rudder	Left 16°	Right 16°
Rudder Servo Tabs	Left 14°	Right 14°
Rudder Trim Tab	Left 20°	Right 20°

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Figure 1-34.

FLIGHT CONTROL *Lock Operation*

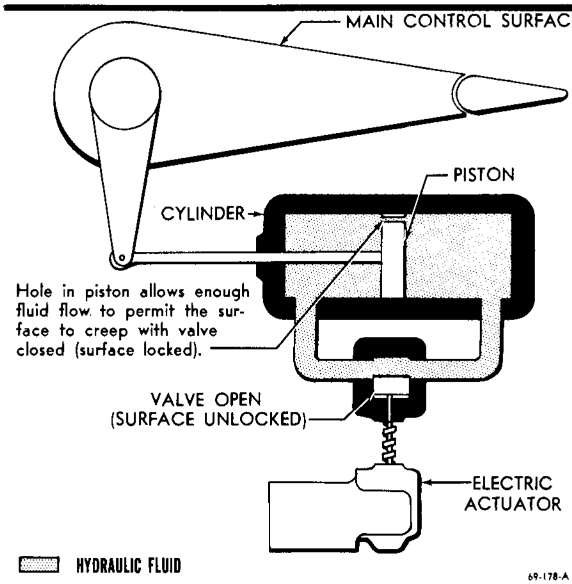

Figure 1-35.

provided with a control column and a set of rudder pedals. Operation of the columns and pedals is conventional.

Aileron Trim Tab Switch.

The aileron trim tab acts as a trim tab as well as a servo tab. A spring-loaded switch (28, figure 1-9), located on the pilots' pedestal, supplies 28-volt direct current to relays which supply 208-volt a-c power to the trim tab actuators. The switch positions are LEFT WING DOWN, RIGHT WING DOWN, and neutral OFF.

Aileron Trim Indicator.

An indicator (25, figure 1-8) on the pilots' instrument panel shows the degree of aileron trim. The indicator operates on 28-volt direct current in response to a signal from potentiometers on the trim tab actuators.

Elevator Trim Tab Control Wheels and Indicators.

The elevator trim tabs, which are independent of the flying servo tabs, are set by a pair of dual-operating control wheels (24, figure 1-9) on the pilots' pedestal. Rotable dials (22, figure 1-9) on each side of the pilots' throttles indicate the trim condition of the tabs.

Rudder Trim Tab Control Knob and Indicator.

The rudder trim tab, which is independent of the flying servo tab, is set by a control knob (26, figure 1-9) located on the pilots' pedestal. A dial aft of the knob indicates the trim setting of the rudder trim tab.

FLIGHT CONTROL Lock Switch

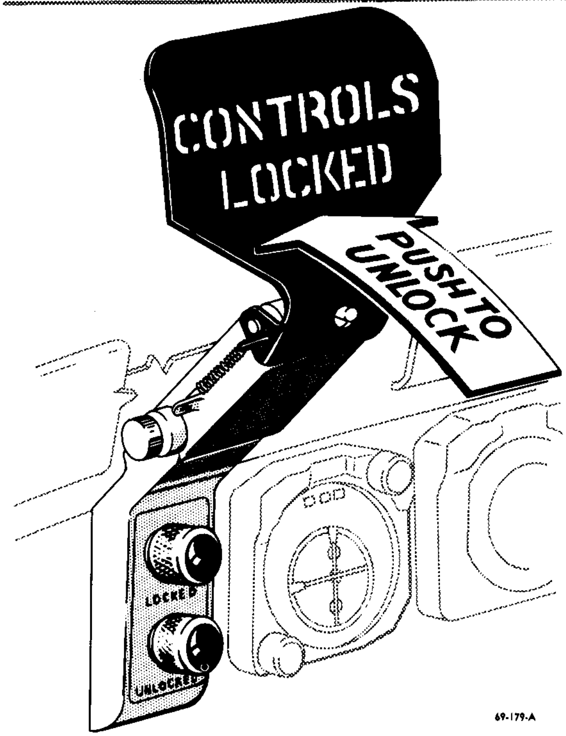

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Figure 1-36.

CONTROL SURFACE LOCKS.

The flight control surfaces are hydraulically locked in the position they are in when the locks are engaged. The locks prevent any sudden movement of the surfaces, but allow the surfaces to creep under load; therefore, locked controls will not restrict small movements of the control columns or rudder pedals. A safety switch, actuated by the movement of the right main oleo strut, automatically unlocks the controls as soon as the weight of the airplane is removed from the gear. Indicator lamps show when the surfaces are locked or unlocked.

Control Lock Switch.

The flight control lock switch (1, figure 1-8) is actuated by a red flag on the pilot's coaming. Raising the flag to its vertical CONTROLS LOCKED position locks all control surfaces. The switch supplies 28-volt direct current to relays which permit the flow of 115-volt a-c power to the control lock actuators.

Control Lock Indicators.

A red indicator lamp (4, figure 1-8) burns continuously when any one of the controls is locked. The red indicator light will go out the instant all lock actuators *start* their unlocking movement. With all controls unlocked on the ground, a green indicator lamp (4, figure 1-8) burns continuously. When the main gear is unlocked for retraction, the green lamp will go out.

WING FLAP SYSTEM.

The wing flap system consists of six slotted flaps which are mechanically and electrically synchronized in symmetrical pairs. Normally, all flaps are controlled by three ganged switches. These switches supply 28-volt direct current to close relays which provide 208-volt a-c power to the speed control relays. A synchronizer is connected to each pair of flaps by cables and keeps these flaps within 2 degrees of each other by operating the speed control relay. Whenever a flap gets more than 2 degrees ahead of its symmetrical flap, the speed control relay will place the lead flap motor in low speed until the lagging flap is again in synchronization at which time they will both operate at high speed. If the flaps become misaligned by 3 degrees, the normal flap control for the unsynchronized pair becomes inoperative. Emergency controls are provided for adjusting each flap individually if the normal control system fails.

Note

When one pair of flaps is inoperative because of misalignment, normal operation of the remaining pairs is unaffected.

Normal Controls.

Flap Switch. This switch (19, figure 1-9) is actually three switches ganged together and is located on the pilots' pedestal. The switch has spring-loaded FLAPS UP and FLAPS DOWN positions and a center OFF position.

CAUTION

If it is necessary to operate the flap actuators for more than two cycles on the ground, allow the actuators to cool for approximately 15 minutes between cycles.

Indicators.

Flap Position Indicator. This indicator (16, figure 1-8) is located on the pilots' instrument panel and consists of three separate indicators. Each individual indicator reflects the position of one pair of flaps as transmitted from the associated flap synchronizer.

Warning Horn. A warning horn, which is also used for landing gear warning, is provided for the flap system. The horn is electrically connected to the synchronizers and the throttles and indicates an unsafe condition of the flaps with respect to throttle position. If all throttles are advanced to take-off power and the flaps are not extended at least 20 degrees (±4 degrees), the horn will sound. No silencing button is provided for this circuit; therefore, the throttles must be retarded or the flaps extended to shut off the horn.

Emergency Controls.

An emergency flap control panel is located on the right side of the fuselage near the wing crawlway hatch. A separate 28-volt d-c source (bulkhead 8.0 power panel) is provided for this emergency panel. Three master selector switches are mounted at the top of the emergency panel, and six individual flap switches are grouped by pairs below the master switches. The individual switches supply 28-volt direct current to close the relays for the flap actuator motors.

Emergency Flap Switches. Each of these six switches has spring-loaded UP and DOWN positions and a center OFF position. Holding either of the switches in the UP or DOWN position and then holding the corresponding flap master selector switch in the ALTERNATE position will move the flap in the desired direction.

Flap Master Selector Switches. These switches are used to complete the emergency circuit for the system that has been "set up" by the individual emergency flap switches. Each master switch is marked NORMAL and ALTERNATE, and is spring-loaded to return to NORMAL when released. These switches operate the slow speed relays.

Note

When a flap is adjusted to the same position as its symmetrical flap, the synchronizing system (if operative) will maintain synchronization; therefore, any further actuation of any individual selector switch and the master selector switch for that pair will result in movement of both flaps. However, the flap which is individually selected will be operated at slow speed while the flap which is not selected by the individual switch will follow with jerky motion at fast travel.

LANDING GEAR SYSTEM.

The airplane has a tricycle landing gear consisting of two four-wheel main gears and a two-wheel nose gear. The nose and main gear and the main gear wheel well doors are hydraulically operated. The other fairings are mechanically operated by the movement of the gear.

The main landing gear is designed so a single oleo strut on each main gear cushions the taxiing, take-off, and landing shocks. Each set of dual wheels in the tandem arrangement is attached to the bottom of the main column by a separate axle beam which permits it to pivot up and down independent of the other set. These separate axles will permit one set of duals to pass over an obstacle approximately 16 inches high while the other set remains in contact with the runway. To permit even distribution of loads, the sets of duals in tandem are linked together through an equalizer which pivots on the main column; the aft set of duals is linked to the aft end of the equalizer by the oleo strut and the forward set is linked to the forward end by a fixed link. This system transfers the shocks taken by either set of duals to the oleo strut.

Hydraulic pressure for landing gear operation is furnished by the main hydraulic system pumps. The pumps supply fluid under pressure to the main selector valve where the fluid is directed to either the extension or retraction mechanism. The landing gear is normally operated by a single switch located on the pilots' pedestal. In the event the normal system fails, emergency controls are provided for gear operation. These include a means of manually positioning the main selector valve for retraction or extension of the gear, an emergency hydraulic landing gear extension system, and a method of releasing the gear manually for a free fall extension.

A safety switch, actuated by the oleo strut on the left main gear, prevents gear retraction while the airplane is on the ground. Ground safety locks (figure 2) are provided in the flyaway tool kit. When installed they prevent unlatching of the gear.

NORMAL CONTROLS.

Landing Gear Switch.

The landing gear switch (8, figure 1-9) is located on the pilots' pedestal and has positions marked EXTEND and RETRACT on either side of a center OFF position. When the switch is moved from OFF to RETRACT, both main system hydraulic pumps are started and the main selector valve is positioned to retract the landing gear. When moved from OFF to EXTEND, the switch starts one hydraulic pump and positions the selector valve for landing gear extension.

Note

When the landing gear control switch is moved to EXTEND, a gang bar automatically turns on a brake pump control switch to prevent landing with low brake pressure. Refer to "Brake Pump Switch" of this section.

The pumps stop operating after completion of the extend and retract cycles upon closing of the canoe doors through action of the door limit switches. When the switch is placed in the OFF position, the electrical circuit to the pumps is disconnected and the solenoid valves in the selector valve assume their neutral position.

Note

No override switch is provided for the landing gear.

MAIN LANDING GEAR *Arrangement*

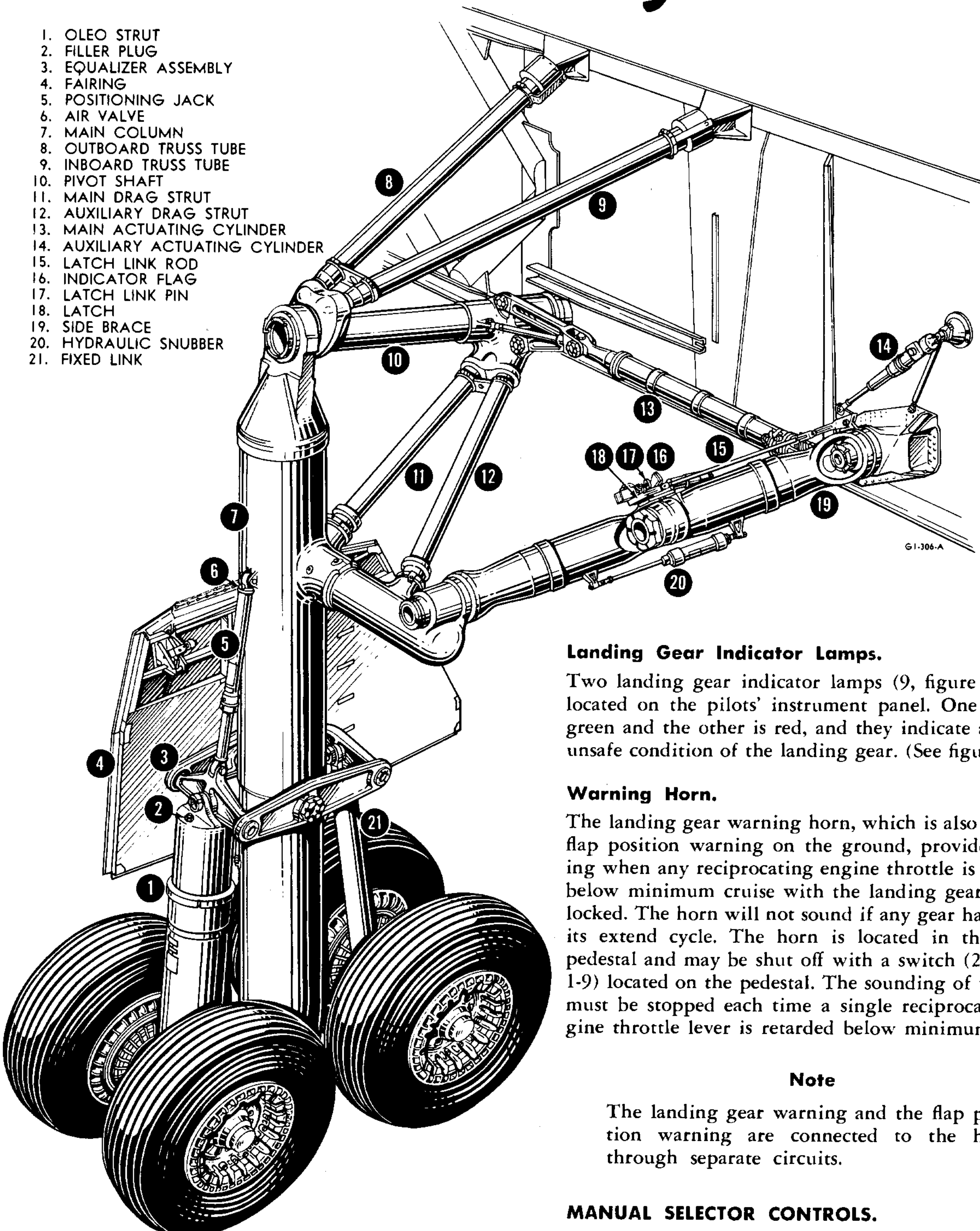

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Figure 1-37.

Landing Gear Indicator Lamps.

Two landing gear indicator lamps (9, figure 1-8) are located on the pilots' instrument panel. One lamp is green and the other is red, and they indicate a safe or unsafe condition of the landing gear. (See figure 1-38.)

Warning Horn.

The landing gear warning horn, which is also used for flap position warning on the ground, provides warning when any reciprocating engine throttle is retarded below minimum cruise with the landing gear up and locked. The horn will not sound if any gear has started its extend cycle. The horn is located in the pilots' pedestal and may be shut off with a switch (20, figure 1-9) located on the pedestal. The sounding of the horn must be stopped each time a single reciprocating engine throttle lever is retarded below minimum cruise.

Note

The landing gear warning and the flap position warning are connected to the horn through separate circuits.

MANUAL SELECTOR CONTROLS.

The main selector valve (figure 3-13) can be operated manually in conjunction with the hydraulic pump override switch to extend or retract the landing gear. A DOWN plunger and an UP plunger are provided on the valve body. When a plunger is depressed, hydraulic pressure is directed to accomplish the selected action. Plungers are also provided to direct hydraulic pressure for operating the bomb bay doors and nose wheel steering.

MAIN GEAR MANUAL EXTENSION CONTROL.

The main gear may be released manually for a free fall extension through the use of manual controls (figure 3-16) located in each main gear wheel well.

The main gear is locked in both the UP and DOWN positions by a side brace. The side brace pivots on each end, and has a latch-secured breaking point in the center. The breaking point is slightly off-center from the ends making it possible for the weight of the landing gear to hold the side brace in its locked position. During normal extension the side brace is unlatched and pulled off center by linkage connected to the side brace unlatching jack. During manual extension the hoist accomplishes the same actuation. (Refer to "Manual Extension of Main Landing Gear," Section III.)

Main Gear Door Release Handle.

One of these T-handles is located at the outboard edge of each main gear wheel well door. When rotated sufficiently, the handle will unlatch the door for a free fall extension.

WARNING

The handle is attached to the door and will fall when the door is unlatched.

Latch Link Pin.

This pin is painted red and is in the side brace unlatching linkage. Normally this linkage is operated by a hydraulic unlatching jack; however, during manual extension the unlatching linkage is disconnected by pulling out the latch link pin. This prevents the possibility of pressure in the hydraulic system interfering with manual unlatching.

Manual Hoist.

A manual hoist is located above the side brace of each main landing gear. The hoist is operated by a ratchet

LANDING GEAR POSITION *Indications*

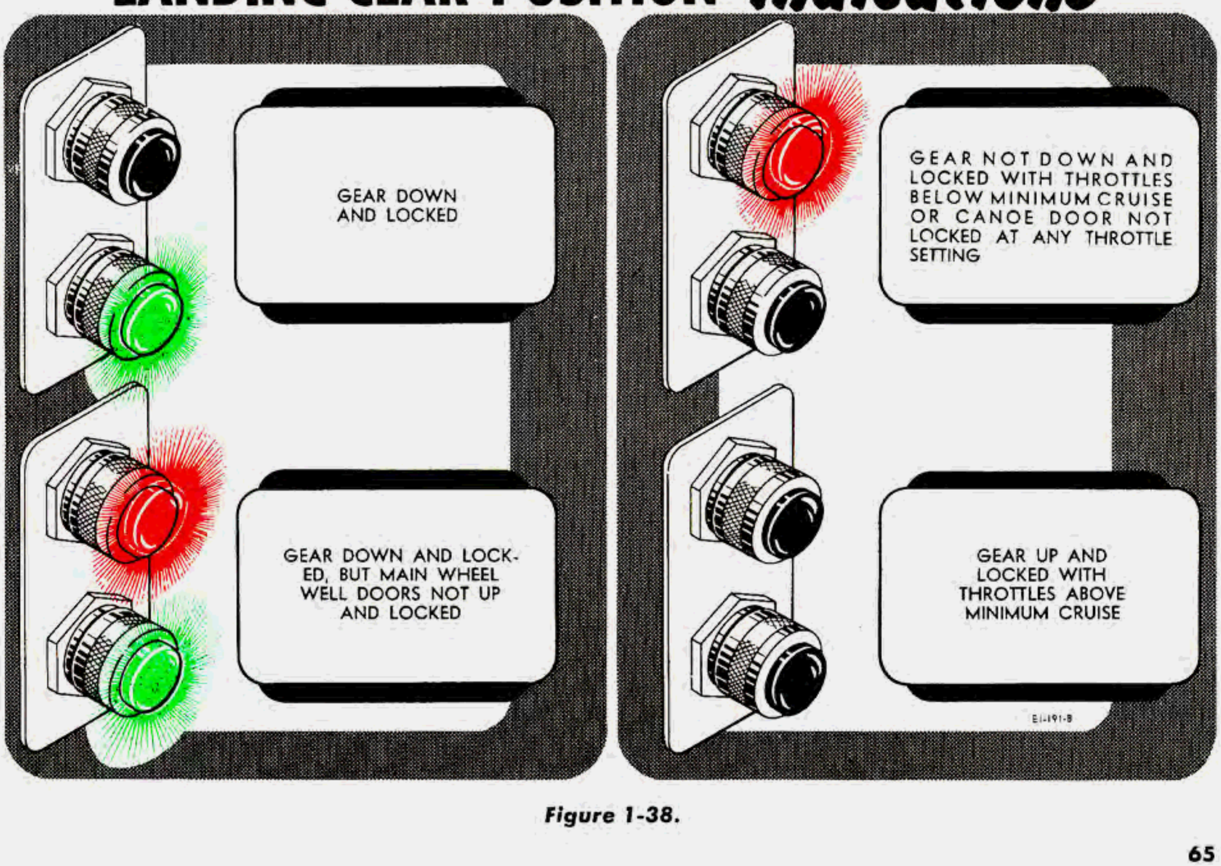

Figure 1-38.

handle and is rigged with a cable which is attached to a hoist hook. To unlatch and raise the side brace the hoist hook is engaged with a latch release lever and the hoist is operated until the side brace is unlocked.

Latch Release Lever.

A latch release lever is located on the side brace latching mechanism of each main gear. The lever has a fitting to which the manual hoist hook is engaged for unlocking the side brace.

NOSE GEAR MANUAL EXTENSION CONTROLS.

Nose Gear Release Handle.

This release handle (figure 3-18) is located on the floor near the radio operator's station, and when pulled will unlock and allow a free fall extension of the nose gear. (Refer to "Manual Extension of Nose Landing Gear," Section III.)

Nose Landing Gear Emergency Latch Hook.

This latch hook (figure 3-18), is stowed on the aft side of the beverage rack in the radio operator's compartment. The hook is used to latch the nose gear after an emergency manual extension.

NOSE WHEEL STEERING SYSTEM.

Nose steering is accomplished by a cable-controlled hydraulic system. (See figure 1-40.) The main components of the system are a steering switch, a 28-volt d-c control circuit, a steering wheel, a directional valve, an actuating cylinder, and control cables. Hydraulic fluid for steering operation is supplied by the main hydraulic system, and pressure is provided by one of the main system pumps. Movement of the steering wheel directs the pressure into the geared actuator which turns the nose wheel. Nose steering hydraulic pressure is indicated on the main hydraulic system pressure gage. A safety switch installed on the nose gear scissors renders the steering system inoperative when the nose gear is off the ground.

Note

> A safety switch on the left main landing gear also prevents steering when the main gear is off the ground.

When the nose gear leaves the ground and the nose gear strut extends, centering cams are engaged to keep the nose wheel straight during retraction. Upon landing, the cams disengage when the weight of the airplane compresses the strut three inches or more. If the nose gear strut has been heavily charged with air to support a high gross weight at take-off, the weight of the airplane at landing may not be sufficient to compress the strut the required three inches for disengaging the cams. In this condition, the nose gear will remain locked in its center position. Before landing, the strut must be depressurized by the nose gear strut pressure release valve located in the forward turret bay.

NOSE GEAR STRUT PRESSURE RELEASE VALVE

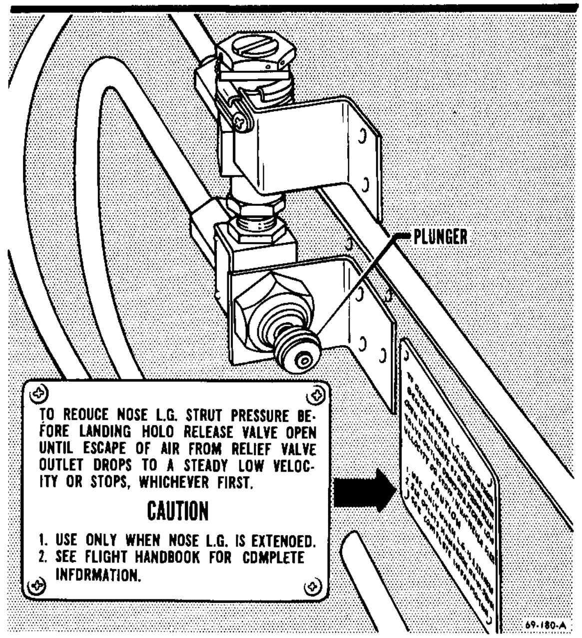

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Figure 1-39.

CONTROLS AND INDICATORS.

Steering Wheel.

This wheel (4, figure 1-10) is located on the aircraft commander's fairing to the left of the aircraft commander's control column and directs the action of the nose gear.

Steering Switch.

This on-off switch (9, figure 1-9) is located on the pilots' pedestal. This switch energizes one of the main hydraulic system pump motors and actuates the main hydraulic system selector valve to provide the pressure required for nose gear steering.

Nose Strut Pressure Release Valve.

The manually operated pressure release valve is provided to reduce the pressure in the nose gear strut in flight. (Refer to "Nose Gear Strut Depressurization," Section II.) The valve is located just aft and to the right of the forward catwalk entrance hatch and is operated by means of a spring-loaded plunger on the valve body. (See figure 1-39.) When the plunger is held in, pressure will be bled from the strut. When strut pressure has dropped to a value which will permit steering, a relief valve automatically closes. This prevents depressurization below the amount necessary to sustain the weight of the airplane.

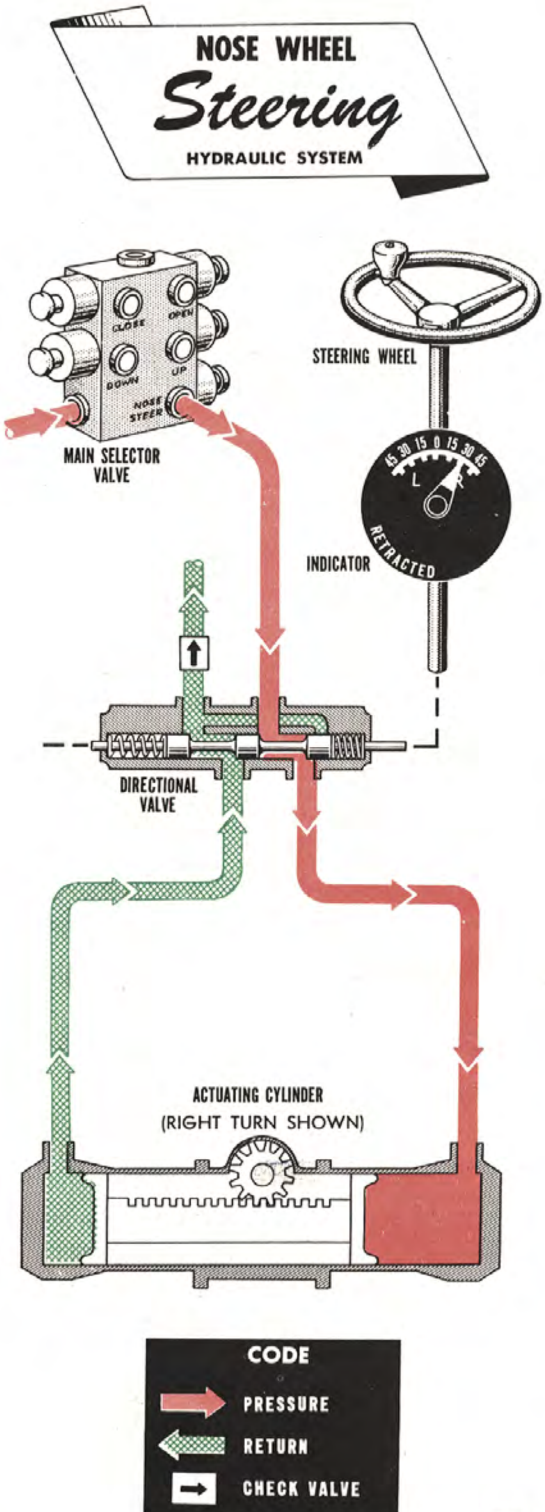

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Figure 1-40.

CAUTION

The relief valve is set to shut off the escape of air at a pressure occurring when the weight of the airplane is NOT on the nose gear. Therefore, to prevent damage to the strut, the nose gear pressure release valve must not be used for depressurizing when the airplane is on the ground. Also, to prevent the loss of hydraulic fluid, do not depressurize while the nose gear is retracted.

Note

Depressurization should be accomplished during approach after the landing gear is extended.

Nose Wheel Steering Indicator.

An indicator (3, figure 1-10) is provided adjacent to the nose steering wheel to indicate the direction and degree of deflection of the nose wheel from its center position.

BRAKE SYSTEM.

Each wheel of the main gear on this airplane is equipped with a hydraulically operated expander tube brake. The normal brake system is an independent hydraulic system. (See figure 1-41.)

Note

Emergency brake pressure is provided by an emergency system which is also used for emergency hydraulic landing gear extension. See "Landing Gear and Brake Emergency Hydraulic System" of this section.

The brake hydraulic system consists of the main brake system and the slave brake system. The main system is the power source for the brakes, and the slave system controls the power source through a brake control valve. The slave brake system extends from the flight deck controls to the main brake system which is located in the bomb bay directly between the two main landing gears. Since the slave system operates on low pressure as compared with the high pressure main system, considerable weight saving is realized and the possibilities of leakage in the main system lines are reduced by the use of long low-pressure lines and comparatively short high-pressure lines.

The slave brake system consists of two pressure reservoirs, a master cylinder mechanically connected to each brake pedal, and a slave cylinder which is located in the control valve. When a brake pedal is depressed, the pressure is transmitted from the master slave cylinder to the brake control valve. The valve is positioned by this pressure, allowing main system pressure to pass through the control valve to the brake.

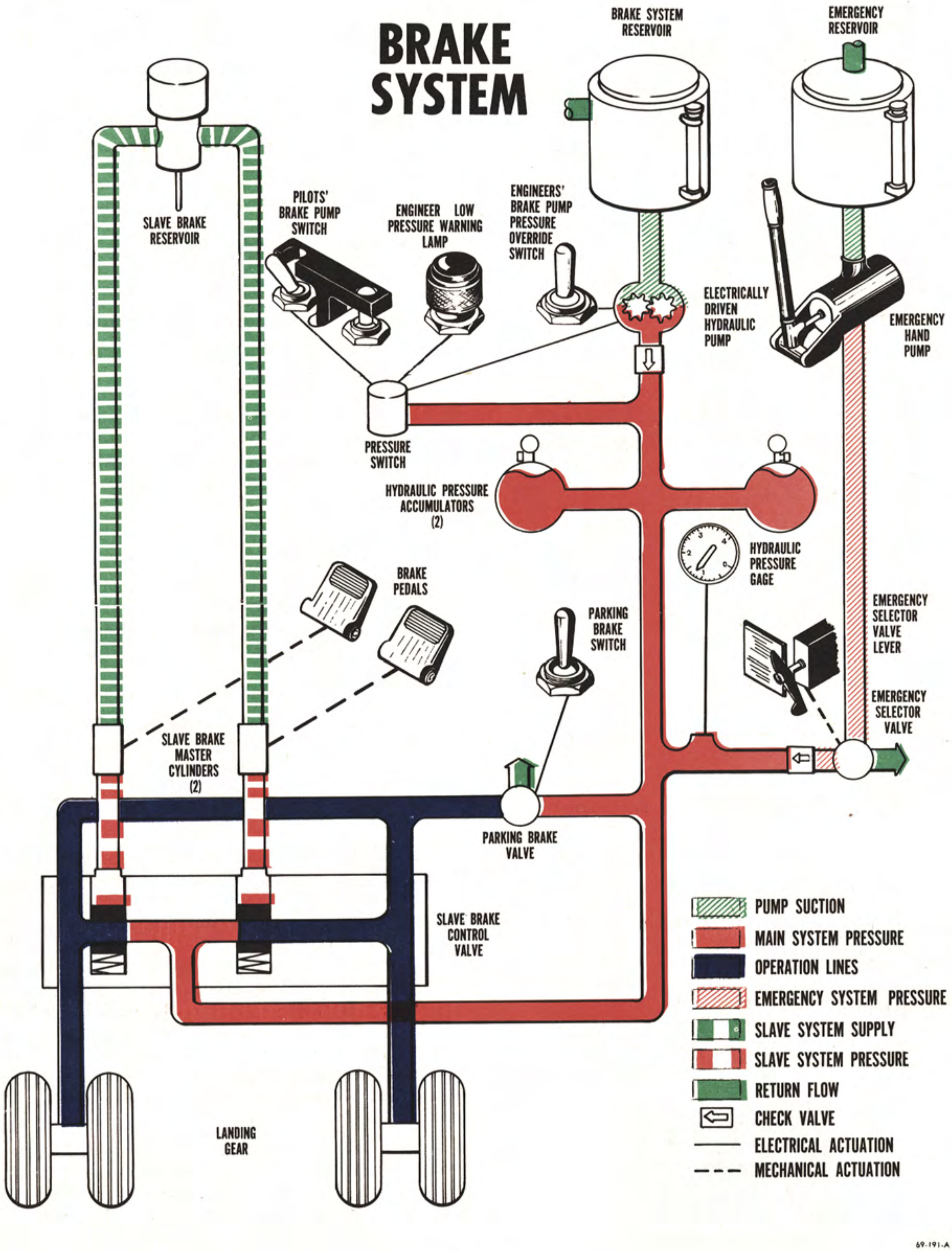

BRAKE SYSTEM
BRAKE SYSTEM RESERVOIR
EMERGENCY RESERVOIR
SLAVE BRAKE RESERVOIR
PILOTS' BRAKE PUMP SWITCH
ENGINEER LOW PRESSURE WARNING LAMP
ENGINEERS' BRAKE PUMP PRESSURE OVERRIDE SWITCH
ELECTRICALLY DRIVEN HYDRAULIC PUMP
EMERGENCY HAND PUMP
PRESSURE SWITCH
HYDRAULIC PRESSURE ACCUMULATORS (2)
HYDRAULIC PRESSURE GAGE
BRAKE PEDALS
PARKING BRAKE SWITCH
EMERGENCY SELECTOR VALVE LEVER
EMERGENCY SELECTOR VALVE
SLAVE BRAKE MASTER CYLINDERS (2)
PARKING BRAKE VALVE
SLAVE BRAKE CONTROL VALVE
LANDING GEAR
PUMP SUCTION
MAIN SYSTEM PRESSURE
OPERATION LINES
EMERGENCY SYSTEM PRESSURE
SLAVE SYSTEM SUPPLY
SLAVE SYSTEM PRESSURE
RETURN FLOW
CHECK VALVE
ELECTRICAL ACTUATION
MECHANICAL ACTUATION
69-191-A

Figure 1-41.

The main brake system consists of a reservoir, a pump, two accumulators, and a brake control valve. The accumulators store pressure for the main system, and accumulator pressure is maintained by the 208-volt, a-c, motor-driven pump. Normal system pressure is from 1125 to 1500 psi. Pump motor power is controlled by a 28-volt d-c circuit through the brake pump switch on the pilots' pedestal. A pressure switch installed in the control circuit holds the circuit open when accumulator pressure is from 1450 to 1500 psi. The pressure switch will close the circuit to start pump operation when the accumulator pressure drops to 1125 to 1225 psi. In the event of a malfunction in the control circuit, the pump can be operated by the pump pressure override switch located on the engineer's auxiliary panel. The pressure switch also has a set of contacts which control power to the low brake pressure warning light. These contacts close when the pressure decreases from 25 to 100 psi below the pressure where the pump power contacts close. The light contacts will open, turning off the light, when the pressure increases to within ±100 psi of the pressure where the pump power contact opens.

BRAKE CONTROLS AND INDICATORS.

Brake Pump Switch.

This switch (8, figure 1-9) controls the normal operation of the brake pump motor. To prevent landing with low brake pressure, a gang bar will move the brake pump switch to the ON position when the landing gear control switch is placed in the EXTEND position. In flight, however, the switch must be moved to the OFF position to minimize pump wear, as the gang bar control is not effective when the landing gear control switch is moved to RETRACT.

Parking Brake Switch.

The parking brake switch (1, figure 1-9), with positions BRAKE ON and BRAKE OFF, is located on the pilots' pedestal and controls the parking brake valve for applying accumulator pressure to the brakes.

Brake Pump Pressure Override Switch.

This spring-loaded switch (4, figure 1-20) is provided to energize the brake pump motor in the event the normal brake pump control circuit fails. If the brake pressure gage or warning lamp indicates low brake pressure when the brake pump switch is ON, system pressure can be brought within operating range by holding the override switch in the ON position.

CAUTION

Since the brake pump will operate continuously when the override switch is held ON, the switch must be released when the pressure is within operating range.

Pressure Gages.

Hydraulic pressure for the brake system is indicated on three gages. A hydraulic pressure gage (6, figure 1-20) is located on the engineers' auxiliary panel and indicates the pressure in the brake system. A pressure gage is located beneath each accumulator to indicate the pressure in each.

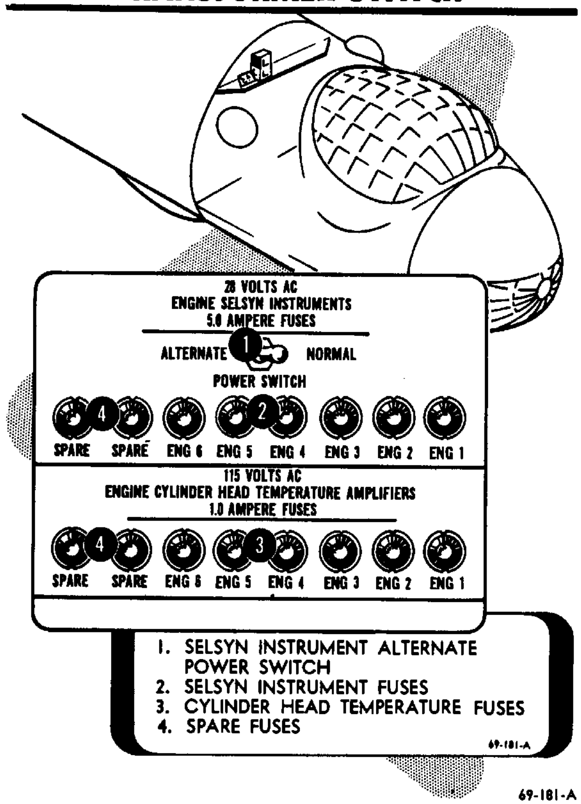
Low Pressure Warning Lamp.

A low pressure warning lamp (5, figure 1-20) is located adjacent to the brake hydraulic pressure gage and gives a warning when brake pressure falls below normal. (See figure 1-41.)

INSTRUMENTS.

Fuel pressure, water pressure, oil pressure, cylinder head temperature, torquemeter, manifold pressure, and fuel flow indications are supplied by autosyn transmitters. The transmitters and indicators operate on either 26- or 28-volt alternating current fed from transformers which step down 115-volt alternating current. On some airplanes torque pressure, manifold pressure, and fuel flow indications are supplied by sensitive-type instruments. The reciprocating engine instruments are

ENGINE INSTRUMENTS TRANSFORMER SWITCH



69-181-A

Figure 1-42.

located at the engineers' station. In addition, a master tachometer and manifold pressure gage are provided for the pilots. The pilots' manifold pressure gage is for No. 4 engine only. All gyroscopic instruments are electrically powered. Control switches are provided for turning off the pilots' flight gyros and the navigator's directional gyro when these instruments are not in use. A pair of ganged switches on the navigator's instrument panel are provided for turning off the N-1 high latitude compass. All other gyro instruments operate automatically when electrical power is on the airplane.

RECIPROCATING ENGINE INSTRUMENTS.

Two arrangements of the electrical power source for the autosyn instruments will be found on B-36H airplanes. The indicators and transmitters on some airplanes operate on 26-volt alternating current fed from a transformer in each nacelle. The indicators and transmitters on airplanes having sensitive-type instruments operate on 28-volt alternating current supplied by a single transformer at the radio operator's station. On airplanes with a cylinder head temperature selector switch, the cylinder head temperature indicating system operates on 115-volt a-c power.

Engine Instrument Transformer Switch.

On airplanes having sensitive-type instruments a two-position switch (1, figure 1-42), marked NORMAL and ALTERNATE, is located on the instrument fuse panel. This switch permits transferring to an alternate transformer in case the one being used fails. The fuse panel is located on the upper right side of the radio operator's station.

Torquemeter Indicators.

Six single indicating torquemeters (15, figure 1-18) are located on the engineers' main instrument panel. These torquemeters provide a convenient bhp determination based on easily measured quantities. For further information refer to "Torquemeter," Section VII.

Cylinder Head Temperature Indicators.

Six cylinder head temperature indicators (9, figure 1-18), one for each reciprocating engine, are located on the engineers main instrument panel. On some airplanes these gages indicate, in degrees centigrade, the head temperature of cylinders A-6, C-5, D-2, or D-5 of their corresponding engine, depending on the position of the cylinder head temperature selector switch. On some airplanes the gages indicate, in degrees centigrade, the head temperature of cylinder D-5 of the corresponding engine.

Cylinder Head Temperature Selector Switch. On some airplanes a cylinder head temperature selector switch (5, figure 1-16) is located on the engineers' table. This four-position switch enables the engineer to select cylinder A-6, C-5, D-2, or D-5 of the reciprocating engines for temperature readings on the cylinder head temperature indicators. Normally the switch is left in the D-5 position.

ENGINE ANALYZER.

Ignition Analysis.

The engine analyzer is designed to detect, locate, and identify abnormalities in the operation of the reciprocating engines. It performs these functions by presenting patterns on the screen of a cathode-ray tube of voltages across the primary circuits of the magneto. By use of the analyzer, the engineers can keep the reciprocating engines under constant surveillance during flight and thereby determine the severity of any engine malfunctions and make the required adjustments. They can also detect and analyze troubles peculiar to high altitudes which could not be normally discovered during ground checks. Any decision on the feathering of an engine as a result of analyzer observations should include consideration of normal engine instrument indications. The engine analyzer checks the performance of the magneto coils, condensers, and breaker points; it checks magneto timing, breaker point synchronization, and spark advance; it checks the operation of the spark plugs and distributors; and it checks the condition of the spark plug leads and ignition harnesses. During normal operation, an ignition system establishes a characteristic pattern and any malfunction in the system will alter this pattern. Since malfunction patterns are also characteristic of the malfunction, they serve to identify the specific nature of the trouble.

The basic components of the engine analyzer consist of a synchronizing generator for each engine, a condition selector switch, a cycle switch, a power supply-amplifier, and an indicator. The analyzer controls are on the engineers' auxiliary panel and the indicator is flush mounted on the engineers' table.

Note

Resistors are provided in analyzer electrical circuits to automatically isolate the analyzer system from the engine, so that a malfunction in the analyzer will not interfere with engine operation.

Controls.

Condition Selector Switch. A condition selector switch (12, figure 1-20), located on the engineers' auxiliary panel, is used to select the particular engine to be analyzed and the type of analysis: ignition (left, right, or both magnetos) or engine rpm synchronization. It is also used to select the engine to be analyzed. The condition selector switch consists of a fixed index ring surrounding a rotable switch dial. The index ring is divided into three general sectors which are engraved as follows:

1. The first sector is marked SYN, 2, 3, 4, 5, and 6 for selecting any of these engines to check their rpm synchronization with the rpm of engine No. 1.

2. The second sector, marked 1, 2, 3, 4, 5, and 6, is used for selecting an engine. The inner radius of this sector has designations L, B, and R opposite each engine number for selecting left, both, or right magnetos when making an ignition analysis.

3. The third sector, marked PULL BUTTON FOR VIBRATION, is not used except for this notation which refers to the push-pull knob centrally located on the switch dial. This knob must be pushed IN to select ignition analysis. The pull out position is inoperative.

Cycle Selector Switch. The cycle selector switch (14, figure 1-20) located on the engineers' auxiliary panel is marked as follows:

1. A fixed index ring is inscribed with symbols corresponding to cylinder designations of an engine.

2. A rotable switch dial has an index line labeled IGN.

3. A push-pull knob, located in the center of the rotable switch dial, selects a fast sweep when pushed IN, and a slow sweep when pulled OUT. To select a cylinder for ignition analysis, place the IGN index line opposite the cylinder desgination. If the push-pull knob is OUT for a slow sweep, all fourteen ignition patterns for one magneto will appear. The pattern of the selected cylinder will appear first in the series followed by the others in the order of firing of that magneto. If the knob is pushed IN for a fast sweep, only the significant oscillatory portion of a single ignition pattern will appear.

Engine Analyzer Power Switch. This on-off switch-type circuit breaker (10, figure 1-20), located on the engineers' auxiliary panel, is used to turn the system ON and OFF.

Signal Attenuating Switch (Some Airplanes). This spring-loaded, push-button type switch, located on the engineer's table, is provided to establish a more definite interpretation of engine ignition signals on the analyzer indicator. Engaging the switch attenuates the ignition signals thereby providing more distinction between primary patterns and open secondary patterns.

Indicators.

Engine Analyzer Indicator. The engine analyzer indicator (1, figure 1-20) consists of a three-inch cathode-ray tube mounted in the engineers' table.

JET ENGINE INSTRUMENTS.

Tail Pipe Temperature Indicators.

Four tail pipe temperature indicators (18, figure 1-8), one for each jet engine, are located on the pilots' instrument panel.

Engine Tachometers.

Four engine tachometers (17, figure 1-8), one for each jet engine, are located on the pilots' instrument panel.

FLIGHT INSTRUMENTS.

Flight Instrument Switches.

An on-off switch (2, figure 1-8) is located on the left side of the pilots' instrument panel, and a three-position switch (2, figure 1-8) is on the right side. The switch on the left side of the panel can be used to disconnect the aircraft commander's gyro horizon from 115-volt 3-phase alternating current while airplane is not being flown.

Note

> Both turn and bank indicator needles operate automatically on 28-volt direct current through the pilot's circuit breaker panel. Fundamental flight instruments (needle, ball, and air-speed) should therefore be available during emergency power operation as long as battery power exists.

The switch on the right side of the panel connects the directional gyro and the pilot's gyro horizon with 115-volt 3-phase alternating current. When this switch is ON, the power comes through the right forward cabin power panel; when the EMERGENCY position is used, power comes through the engineers' auxiliary instrument panel. Both instruments can be disconnected by the OFF position when they are not in use.

Navigator's Directional Gyro Control Switch.

On group 8 airplanes, the directional gyro which is mounted on the navigator's instrument panel is controlled by a two-position on-off switch (12, figure 4-31). Airplanes not in this group are not equipped with this directional gyro.

Attitude Gyro Indicator.

A type J-3 (or J-4) attitude gyro indicator is installed in some airplanes; the others are equipped with a type A-1 (or A-2) indicator. These instruments (14, figure 1-8) operate on 115-volt, 3-phase, a-c power and provide visual indication of the roll and pitch attitude of the airplane. The gyro of these instruments is enclosed in a sphere, a portion of which is visible through the opening on the face of the instrument. A blinker, appearing in a small opening in the sphere, flashes approximately 66 times per minute to indicate that power is being supplied to the unit and that the gyro is up to speed.

The indications of these two types of instruments may be confusing since the presentation of pitch differs. (See figure 1-43.)

1. On the A-1 and A-2 instruments, a horizon bar presents a conventional pitch indication—the miniature airplane appearing above the horizon bar in a climb and below the horizon bar in a dive. However,

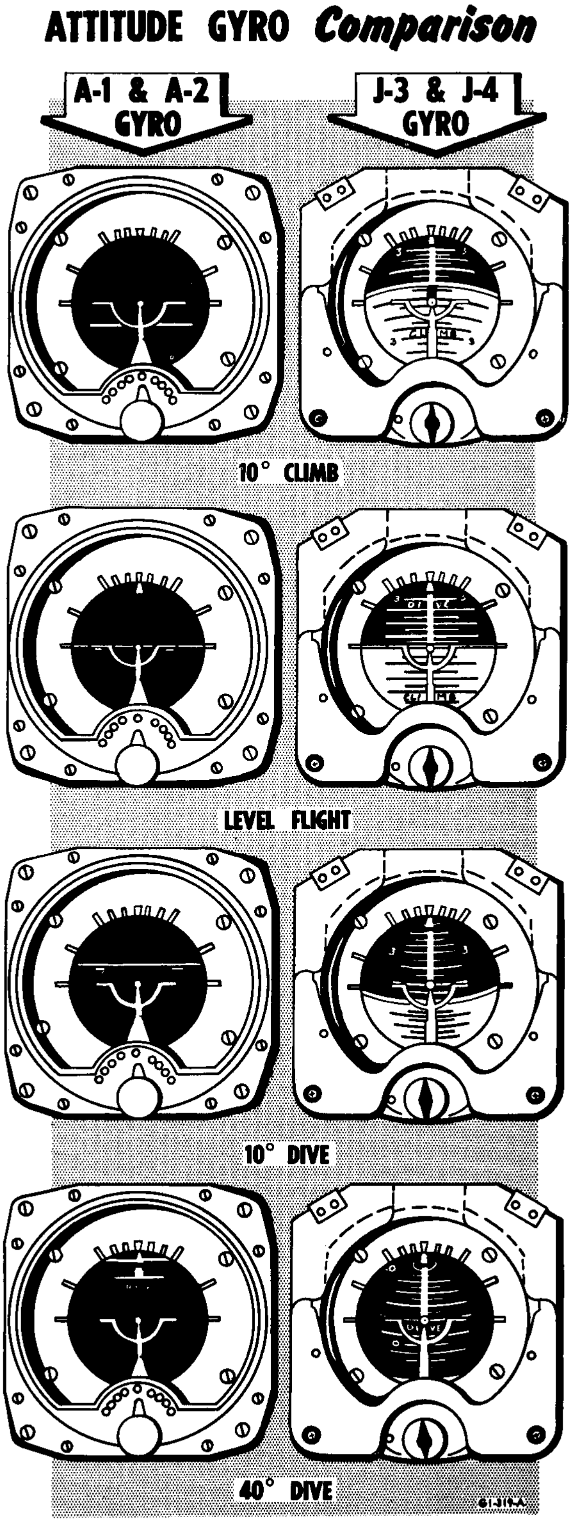


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Figure 1-43.

in a climb or dive exceeding 27 degrees of pitch, the horizon bar stops at the bottom or top of the instrument case and the sphere then becomes the reference.

2. The J-3 and J-4 indicators differ from conventional indicators in that climb and dive are not shown in relation to a horizon bar but are read directly on a sphere. The upper hemisphere, which is dark in color, indicates a dive; the lower (light) hemisphere indicates a climb. Lines similar to latitude markers are painted on the sphere and indicate in degrees the amount of pitch. In addition, a sensitive pitch indicator furnishes readings of climb or dive up to 10 degrees in one-degree increments. *It is of utmost importance, in interpreting the presentations of this instrument, to realize that:*

a. The sphere is stabilized, maintaining its equator parallel to the earth's surface.

b. The aircraft (and the miniature airplane) maneuvers around the stabilized sphere.

Therefore, when the aircraft is in a nose-high attitude, the miniature airplane will be displaced downward on the light portion of the sphere; and in a dive the miniature airplane will be displaced upwards into the dark portion of the sphere.

Whenever the aircraft approaches a vertical climb or dive attitude, the gyro is processed a controlled 180 degrees. This action is momentary and does not interfere with the indications. Thus, the pilot is reading the same face of the sphere regardless of attitude.

CAUTION

Allow 8 to 13 minutes for the gyros to come up to speed and erect before depending upon the indications of these instruments. A temporary displacement of the gyro from its normal position, up to a maximum of 10 degrees, will occur during a turn. This error will be corrected automatically by an erection mechanism at the rate of approximately 3 degrees per minute.

Pitot Static System.

The airplane contains two pitot static systems. Each system consists of a pitot head, two static ports, pitot static instruments, and necessary drains. Pitot heads are located on each lower side of the forward position of the fuselage, and static pressure ports are located just forward of bomb bay No. 1 on each side of the airplane for each system. One system, with the pitot head on the right side of the airplane, contains the engineer's altimeter and airspeed indicator, and the pilot's rate-of-climb indicator, altimeter, and air-speed indicator. The other system, with pitot head on the left side of the airplane, contains the aircraft commander's rate-of-climb, altimeter, and air-speed indicators, the navigator's true air-speed indicator and altimeter, the radar observer's true airspeed indicator, and the altitude control unit.

RECIPROCATING ENGINE *Fire Extinguishing System*

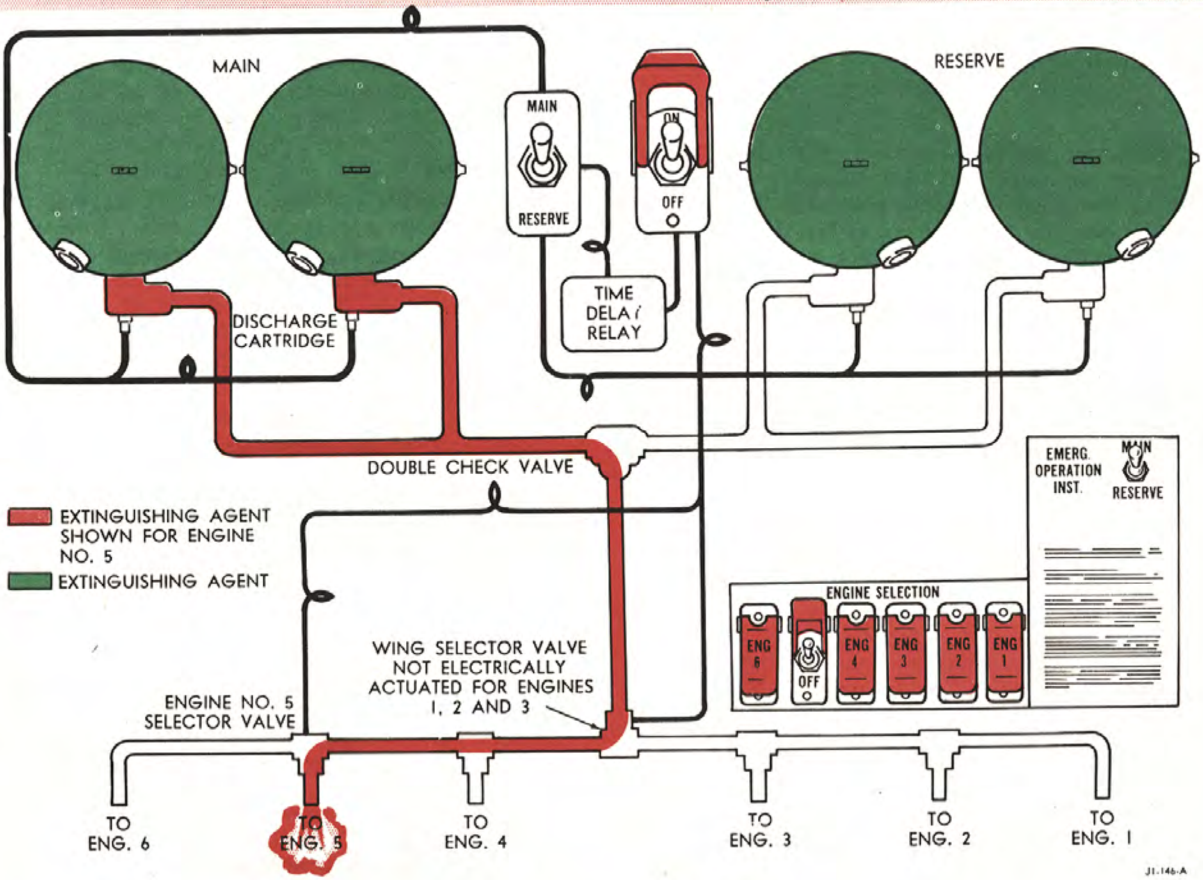


Figure 1-44.

Air-Speed Indicators.

Conventional air-speed indicators are provided for the aircraft commander and the engineers. True air-speed indicators are located at the navigator's and radar observer's stations. The pilot is provided with a maximum allowable air-speed indicator which has two pointers. The red pointer indicates the limit dive speed in mph or the limit Mach number, whichever is lower. These limiting air speeds are indicated by the red line in figure 6-4. The other pointer is a conventional air-speed indicator and a window in the instrument shows the Mach setting. The pointers should not be permitted to cross each other, as it would be an indication of operation in excess of safe speeds.

OUTSIDE AIR THERMOMETERS.

Three type C13B direct-reading outside air thermometers are mounted in the airplane. One is located on the flight deck above the engineers' station, one is located above the aircraft commander's station, and the other is located on the left side of the bombardier's enclosure. These instruments give direct readings of the outside air temperature.

EMERGENCY EQUIPMENT.

RECIPROCATING ENGINE FIRE EXTINGUISHER SYSTEM.

An electrically-operated, two-shot fire extinguisher system (figure 1-44) is provided for combating reciprocating engine fires. The system is controlled by 28-volt direct current and uses either methyl bromide or bromochloromethane as the extinguishing agent. The extinguishing agent is stored in four metal containers, two in each main gear wheel well, and each pair or bank of containers constitutes a discharge.

All of the controls for the system are located at the engineers' station. The bank of containers to be discharged is determined by the position of a discharge selector switch. Six engine selector switches are provided to discharge the containers and direct the discharge to the proper engine. Since the supply lines extend to engines No. 1 and 6, directional valves are provided for diverting the discharge to engines No. 2, 3, 4, and 5. Normally, the supply line to the left wing is open; therefore, when engine No. 4, 5, or 6 is selected, a directional valve opens the line to the right wing and closes the line to the left wing.

Note

The four engine directional valves and the wing directional valve are spring-loaded and are first positioned electrically then held in that position by the force of the discharge. For this reason, an engine selector switch should be held for approximately 5 seconds to assure pressure at the valves.

A relay is provided to delay the discharge of extinguishing agent for approximately one-tenth of a second to give the directional valves sufficient time to complete their operation.

Note

The jet engines are not equipped with an extinguisher system.

Discharge Selector Switch.

The discharge selector switch (4, figure 1-19), marked MAIN and RESERVE, permits the selection of either of the two banks of extinguishing agent containers for discharge.

Reciprocating Engine Selector Switches.

Six reciprocating engine selector switches (10, figure 1-19) are located on the engineers' auxiliary control and instrument panel. The switches are used to discharge the selected containers and, at the same time, to position the directional valves to direct the flow of extinguishing agent to the proper reciprocating engine.

RECIPROCATING ENGINE FIRE DETECTOR SYSTEM.

Each reciprocating engine nacelle is furnished with equipment for detecting the presence of fire. On some airplanes thermocouples, located in potential fire areas of the nacelle, are the fire-sensitive units of the system. If a thermocouple is subjected to an abnormally rapid rise in temperature, it generates a very low voltage. This voltage energizes a relay which connects 28-volt direct current to an indicator lamp on the engineer's auxiliary control and instrument panel, lighting the lamp. Since the thermocouples are sensitive only to rapid rates of change in temperature, gradual temperature increases resulting from engine warm-up or power runs will not cause a warning indication.

Some airplanes are equipped with a continuous cable-type detector system. A continuous cable is routed in loops through the engine, exhaust, and accessory areas of each reciprocating engine nacelle. The cable serves as the sensing element and it reacts to temperature changes of a critical value anywhere along its route. Whenever a temperature change of this type occurs, the compound in the cable at the affected point decreases in resistance allowing single-phase, 115-volt a-c power to flow from the cable core to the cable casing which is grounded. This flow of current closes a relay to light the corresponding fire warning lamp.

Reciprocating Engine Fire Warning Lamps.

On airplanes with a thermocouple-type fire detector system, twelve fire warning lamps (3, figure 1-19), two for each nacelle, are located on the engineers' auxiliary control and instrument panel to give a visual indication of a nacelle fire. A push-to-test switch (2, figure 1-19) is provided to test simultaneously the continuity of the detector circuit in each nacelle to the fire warning lamps.

WARNING

Never ignore an alarm indication. Inability to obtain a warning during test proves only that the system is not in perfect condition, but not necessarily that it is completely inoperative.

Airplanes with a cable-type detector system have six warning lamps, one for each nacelle, located on the engineer's main instrument panel. A push-to-test switch, provided adjacent to the lamps, is used to check the continuity of all six detector circuits simultaneously.

JET ENGINE FIRE DETECTOR SYSTEM.

The fire detector system on each jet engine consists of ten cartridge-type detector units strategically located in potential fire zones. The units are calibrated to close electrical contacts when subjected to a predetermined temperature. In event of a fire, when this temperature is reached, the 28-volt d-c circuit to a warning lamp on the jet control panel will be completed and the lamp will light.

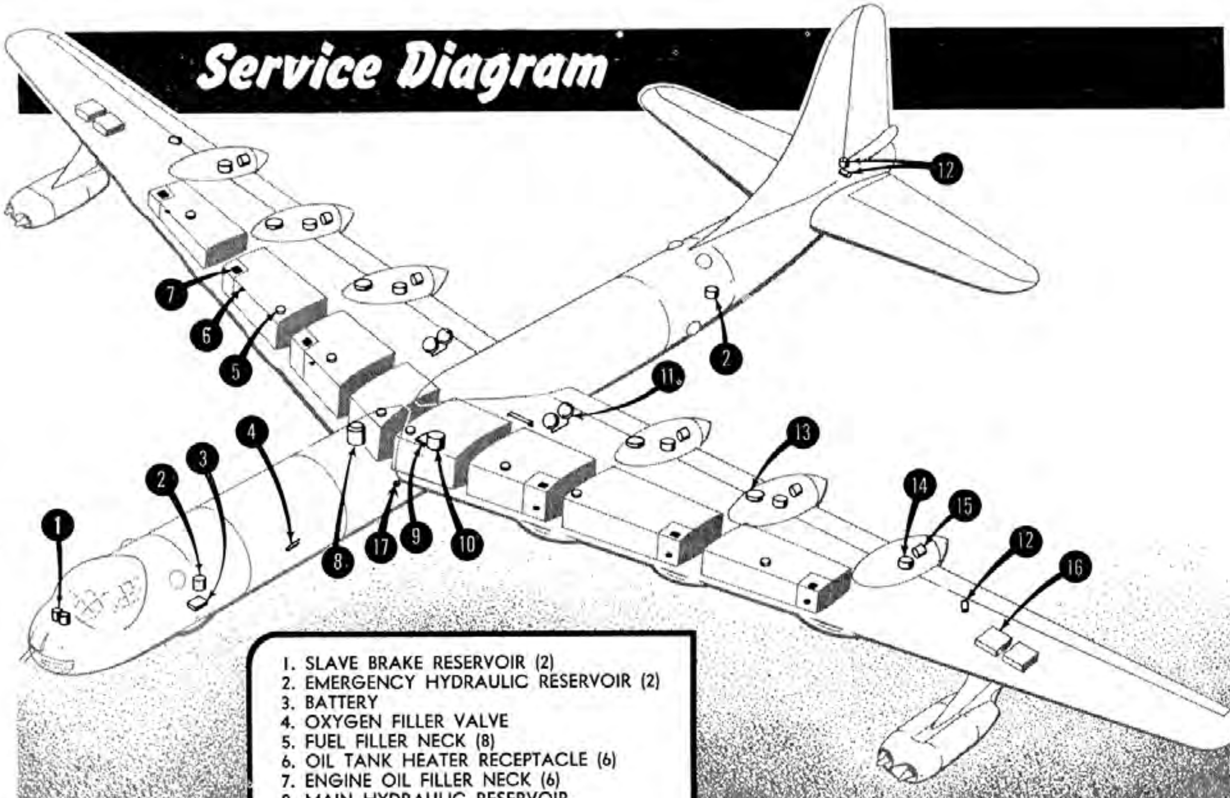
Jet Engine Fire Detection Switches.

Two two-position switches (18, figure 1-15), one for each pair of jet engines, are located on the pilots' jet engine control panel. When the switches are in the ON position, the fire detector circuits to the jet nacelles are set up. Placing the switches in the TEST position checks the continuity of the circuits from the nacelles to the warning lamps.

Jet Engine Fire Warning Lamps.

Four jet engine fire warning lamps (16, figure 1-15) are located on the pilots' jet engine control panel. These lamps, for each jet engine, give a visual indication of jet engine-nacelle fires. On some airplanes, an additional set of jet engine fire warning lamps are located on the pilots' instrument panel.

Service Diagram



1. SLAVE BRAKE RESERVOIR (2)
2. EMERGENCY HYDRAULIC RESERVOIR (2)
3. BATTERY
4. OXYGEN FILLER VALVE
5. FUEL FILLER NECK (8)
6. OIL TANK HEATER RECEPTACLE (6)
7. ENGINE OIL FILLER NECK (6)
8. MAIN HYDRAULIC RESERVOIR
9. EXTERNAL POWER RECEPTACLE
10. BRAKE SYSTEM RESERVOIR
11. FIRE EXTINGUISHING CONTAINER (4)
12. LOCK CYLINDER RESERVOIR (4)
13. CONSTANT SPEED DRIVE OIL RESERVOIR (4)
14. TURBO OIL RESERVOIR (6)
15. WATER INJECTION WATER TANK (6)
16. JET ENGINE OIL TANK (4)
17. PRESSURE REFUELING VALVE

FLUID	SPEC. NO	GRADE
FUEL		
RECIPROCATING AND JET ENGINES	MIL-F-5572	115/145
OIL		
RECIPROCATING ENGINES	MIL-L-6082	*1100 OR 1120
JET ENGINES & TURBOSUPERCHARGERS		
FOR OAT ABOVE -20°F	MIL-O-6081	1010 OR 1005
FOR OAT BELOW -20°F	MIL-O-6081	1005
CONSTANT SPEED DRIVE	MIL-L-6387	
* USE 1120 ONLY WHEN 1100 IS NOT AVAILABLE.		
HYDRAULIC FLUID		
ALL HYDRAULIC SYSTEMS	MIL-O-5606	—
WATER INJECTION		
OAT ABOVE -40°F: 50% ALCOHOL, 50% DISTILLED WATER	MIL-A-6091	—
OAT BELOW -40°F: 60% ALCOHOL, 40% DISTILLED WATER	MIL-A-6091	—
FIRE EXTINGUISHING AGENT		
METHYL BROMIDE	O-M-261	—
BROMOCHLOROMETHANE	MIL-B-4394	—

FLUID CAPACITIES (GALS.)

SYSTEMS	RESERVOIR	TOTAL SYSTEM
BOMB DOOR, LANDING GEAR & NOSE STEERING	6.70	20.28
BOMB DOOR EMERGENCY	.87	1.93
BRAKE (MAIN)	4.00	8.66
BRAKE (SLAVE)	.03	1.36
BRAKE & LANDING GEAR EMERGENCY	2.30	2.86
CONSTANT SPEED DRIVE	—	3.75
CONTROL LOCKS	.33	.37
TURBO	—	3.00

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Figure 1-45.

ALARM BELLS.

An alarm bell is located in each crew compartment and in bomb bays 1 and 4. The bells are controlled by an on-off switch (28, figure 1-8) on the pilots' instrument panel and use 28-volt d-c power from the airplane's battery.

PARACHUTE STATIC LINES.

Parachute static lines are located forward of the left lower emergency hatch in the forward cabin and forward of the entrance hatch in the aft cabin.

EMERGENCY HATCHES.

Ten emergency escape hatches are provided in the airplane—six in the forward cabin and four in the aft cabin. Refer to "Forced Landings," Section III, for their location and method of removal. Also see "Bail-Out," Section III, for recommended bail-out exits. In addition to the escape hatches, provisions are made for opening the forward turret bay doors for use as an emergency exit.

Forward Turret Bay Door Switch.

This switch is provided to operate the forward turret bay doors and is located on the equipment shelf adjacent to the catwalk entrance hatch in the radio operator's compartment. The switch has an OPEN position, an OFF position, and a spring-loaded CLOSE position. Placing the switch in the OPEN position or holding it in the CLOSE position supplies 28-volt direct current to the turret door motor reversing relays. These relays supply 208-volt a-c power to the turret door motors which move the doors to the position selected.

Forward Turret Bay Door Close Indicator Lamps.

Two turret bay door close indicator lamps, one for each door, are located adjacent to the turret door switch. The lamps will light when the doors reach their full-closed position and will go out when the turret door switch is released. The lamp will glow any time the doors are fully closed and the switch is held in the CLOSE position.

EMERGENCY ESCAPE ROPES.

Emergency escape ropes are located in the crew compartments to provide a means for emergency escape of personnel to the ground after crash landings. One rope is stowed at each of the following locations: The left forward escape hatch, the lower aft escape hatches, and above the aft cabin entrance beneath the sighting platform.

SURVIVAL SUITS.

Hooks are provided at each crew station for the stowage of survival suits.

LIFE RAFTS.

No emergency sea equipment is provided. When the mission requires such equipment, life rafts will be issued to the crew.

HAND FIRE EXTINGUISHERS.

The airplane is equipped with two type A-20 fire extinguishers. In the forward cabin, the extinguisher is located on the left side of the aircraft, just aft of the forward escape hatch. On some airplanes the extinguisher is located on the right side of the passage between the radio operator's compartment and the nose compartment. In the aft cabin, the extinguisher is on the left side in the center of the compartment.

The A-20 extinguishers are charged with bromochloromethane and can be used on any type fires.

WARNING

Bromochloromethane is toxic, particularly when used to fight a fire in a closed area where various kinds of materials are burning. It is important to use as little CB as possible and to wear an oxygen mask with the regulator diluter lever set at 100% OXYGEN as long as CB fumes are present in the airplane. Dizziness and nausea are symptoms of CB poisoning sufficient to require medical treatment.

HAND AXES AND KNIVES.

A panel containing a hand axe and a knife (6, figure 3-12) is installed in each crew compartment. One panel is near the left forward sighting station in the forward cabin, and one is in the forward bulkhead of the aft cabin.

FIRST AID KITS.

The airplane is equipped with seven first aid kits (4, figure 3-12). In the forward cabin the kits are located as follows: one on the left forward cabin power panel, one near the left escape hatch, one near the left forward sighting station, one under the bunk in the radio operator's compartment, and one near the forward cabin toilet facilities. The aft cabin contains two kits: one on the forward bulkhead and one on the aft side of the sighting platform.

BLOOD PLASMA KITS.

A blood plasma kit (1, figure 3-12) is located under the Loran set at the navigator's station, and one is located under the sighting platform in the aft cabin.

Note

On airplanes in group 3, the aft cabin blood plasma kit (1, figure 3-12) is located at the lower pressure beam on the forward bulkhead.

BATTLE DRESSING KITS.

A battle dressing kit (8, figure 3-12) is located under

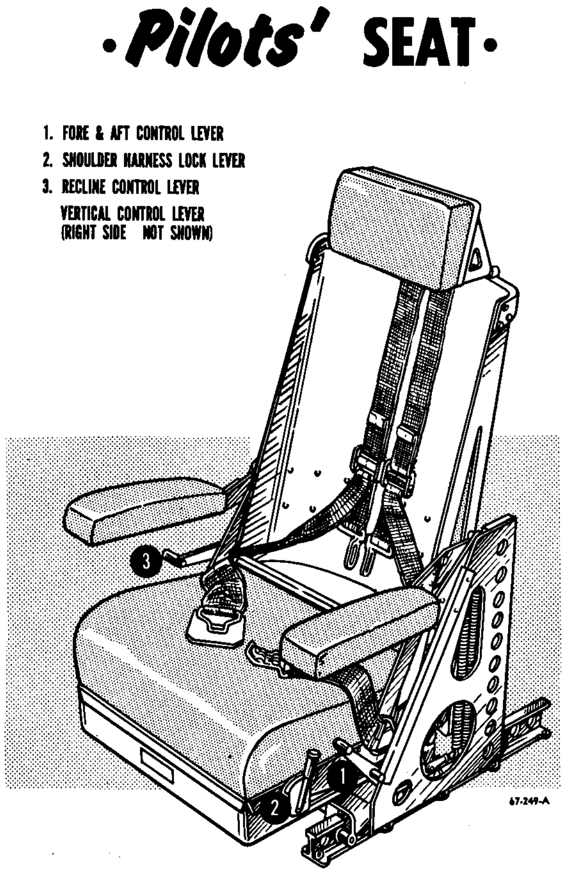

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Figure 1-46.

the navigator's table in the forward cabin, and one is located under the sighting platform in the aft cabin.

Note

> On airplanes in group 3, the aft cabin battle dressing kit (8, figure 3-12) is located at the lower pressure beam on the forward bulkhead.

PILOTS' SEATS.

The pilots' seats (figure 1-46) are provided with fore-and-aft, vertical, and angular adjustments, and have arm rests which retract to permit easy movement into and out of the seats. In addition each seat is equipped with an inertia reel lock-type shoulder harness for the protection of the occupant.

Shoulder Harness Control.

A two-position shoulder harness inertia reel lock control, with positions marked LOCKED and UNLOCKED, is located on the left side of the pilots' seats. A latch is provided for positively retaining the control handle at either position of the quadrant. By pressing down on the top of the control handle, the latch is released and the control handle may then be moved freely from one position to another. When the control is in the UNLOCKED position, the reel harness cable will extend to allow the pilot to lean forward; however, the reel harness cable will automatically lock when an impact force of 2 to 3 g's is encountered. When the reel is locked in this manner, it will remain locked until the control handle is moved to the LOCKED and then returned to the UNLOCKED position. When the control is in the LOCKED position, the reel harness cable is manually locked so that the pilot is prevented from bending forward. The LOCKED position is used only when a crash landing is anticipated. This position provides an added safety precaution over and above that of the automatic safety lock.

ENGINEERS' SEATS.

Two swivel-type adjustable seats (figure 1-47) are located at the engineers' station. The seats can be adjusted laterally, vertically, and fore and aft. The controls for the adjustments are located on the lower right side of the seats. Since the engineers face aft, no shoulder harness is provided at their seats.

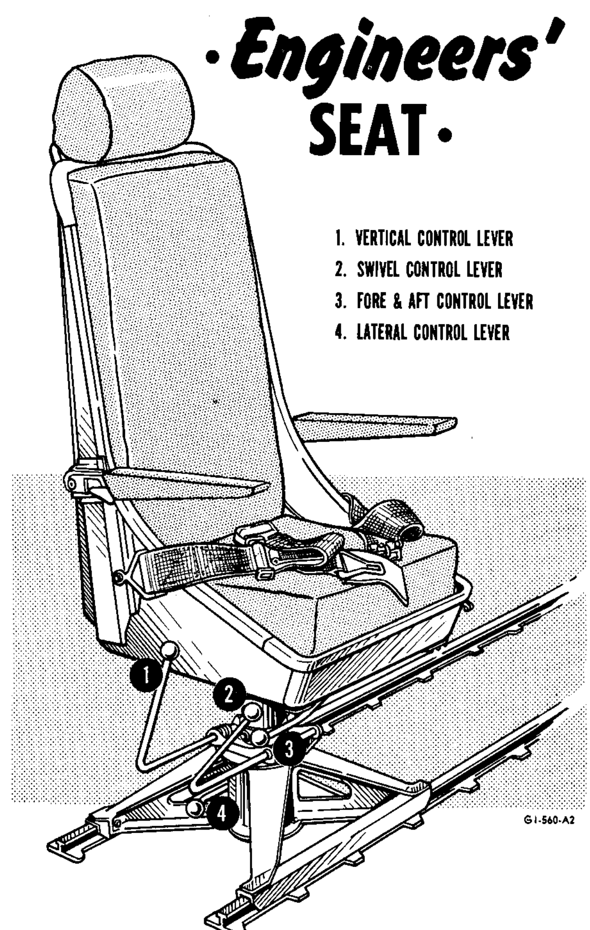

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Figure 1-47.

AUXILIARY EQUIPMENT.

Information concerning the following equipment and systems is given in Section IV.

1. Heating and Anti-Icing System.
2. Pressurization System.
3. Cabin Ventilating Equipment.
4. Auxiliary Cabin Heaters.
5. Jet Pod Heating and Anti-Icing System.
6. Pitot Tube Heaters.
7. Oil System Heaters.
8. Hand-Operated Heater.
9. Communication and Associated Electronic Equipment.
10. Lighting System.
11. Oxygen System.
12. Autopilot.
13. Navigation Equipment.
14. Portable D-C Power Unit.
15. Gunnery Equipment.
16. Bombing Equipment.
17. Photographic Equipment.
18. Miscellaneous Equipment.

SECTION II
Normal Procedures

69-106-A

INTRODUCTION.

In general, the purpose of this section is to establish a proper sequence of events and to set forth those procedures and techniques which must be performed in a prescribed manner during a complete flight under normal conditions. The scope has been expanded to include as much training information and normal operating procedures as practical. The sequence begins when the flight is conceived and does not end until the crew has completed their postflight duties. This provides a comprehensive picture of the requirements of a typical mission.

The arrangement of the data presented in this section has been devised by experienced personnel. It reflects the best information obtainable from all available sources including the using tactical organizations. It is only natural to expect that, from time to time, new and revised procedures will be necessary due to modifications of the systems and the development of new techniques. Revisions will be published from time to time to cover these changes.

To prevent undue complication of this section it will only include normal operating procedures applicable to the aircraft commander, pilot, copilot, first engineer, and second engineer. Procedures for other crew members will be dealt with only so far as co-ordination requires to properly execute a patricular function. For the specific duties of other crew members, see Section VIII, "Crew Duties." For emergency procedures, refer to Section III, "Emergency Procedures." Other sections in this publication will deal with various aspects of the aircraft and equipment from the standpoint of basic operation, and peculiarities characteristic of the equipment under various conditions. If information is desired on any particular phase of operation not covered in this section, reference to the other sections should provide the answer. If any question should arise that is not covered in this handbook, check with the standardization board. They will help you evaluate the situation and submit recommended changes to this publication through the proper channels.

The phases of operation covered in this section will follow a normal sequence as though you were actually planning and flying the mission. The sequence recommended is based upon the experience of tactical organizations in actual operation and constitutes the best compromise to reduce mission failures, crew fatigue, and maintenance to an acceptable minimum. Certain local considerations may require that the exact sequence be varied to meet the situation. However, the amplified procedures and techniques described herein are mandatory to provide a complete check and must be performed in the prescribed manner.

A unique innovation in normal operating procedures of the complex B-36 might be called a dual preflight run-up system. The first preflight run-up is called a "Preflight Operational Equipment Check" and is designed to check every piece of equipment aboard the aircraft from the safety standpoint as well as reasonably assuring its successful operation during any phase of the mission. This is a complete check of all operational equipment and normally is accomplished as early as possible within a 24-hour period; however, it may be accomplished up to and including 72-hours prior to estimated take-off time. The second preflight run-up occurs just prior to the actual take-off and is known as a minimum safety check. Experienced B-36 units have found that this system, coupled with good maintenance, has reduced their mission failure rate from very excessive to almost negligible. It has also reduced the ground time required on the reciprocating engines, although an unqualified inspection of the dual run-up system would not make this fact apparent. The times shown in figure 2-1 represent the amount of time that is generally required to perform each phase or event.

GENERAL MISSION PLANNING.

The mission may be conceived at any level of command. Each lower level of command must do a certain amount of planning upon receipt of the operations order. However, the final details of any mission plan and the execution of the individual mission is always up to the individual crew. The exact requirements for mission planning are set forth in Air Force, major command, and local directives with which the crew should be familiar. Receipt of an operations order dictates a multitude of tasks that must be performed by the combat crew as a team with time being a limiting factor. The crew should be assembled by the aircraft commander and notified of the impending flight. At this time the crew learns which aircraft is to be flown and approximately what is to be accomplished on the mission. Since time is a limiting factor and crew fatigue must be held to a minimum prior to a lengthy mission, a logical sequence of events must take place to make sure that everything required is accomplished with absolute efficiency. The responsibility for insuring efficient teamwork is the aircraft commander's. Through co-ordination with the engineering section, it should be determined when the assigned aircraft will be ready for preflight. If there is to be some delay, notify the crew so that they may continue with the next phase, "Detailed Mission Planning" while standing by for the

Typical TIME SCHEDULE

PHASE OR EVENT	AVERAGE ELAPSED TIME
GENERAL MISSION PLANNING	2:00
PREFLIGHT OPERATIONAL EQUIPMENT CHECK	5:00
DETAILED MISSION PLANNING	3:00
FORMAL BRIEFING	0:45
CREW INSPECTION	0:25
VISUAL PREFLIGHT INSPECTION	1:00
FINAL CREW BRIEFING	0:10
BOARDING AIRCRAFT	0:05
STATION TIME	0:10
STARTING RECIPROCATING ENGINES	0:05
COMPLETE ENGINE RUN-UP	0:25
TAXI	0:10
STARTING JET ENGINES	0:00 (INCLUDED IN OVER-ALL TIME)
CLEARANCE, LINE-UP, TAKE-OFF CONFIGURATION, SET POWER	0:05

69-141-A

69-141-A

Figure 2-1.

"Preflight Operational Equipment Check." As soon as each component system is declared ready, see that those crew members concerned proceed directly to the aircraft to perform their portion of the "Preflight Operational Equipment Check." This will allow maintenance maximum time to correct any discrepancies noted during this check and assures the crew that their aircraft is prepared to perform the anticipated mission before they proceed with other time-consuming requirements.

PREFLIGHT OPERATIONAL EQUIPMENT CHECK.

This preflight check is designed to be a thorough, comprehensive, and complete check of each crew member's operational equipment. This check constitutes the first of two preflight run-ups for all crew members. Many items not directly affecting safety of flight, but promoting successful accomplishment of the mission, need not be rechecked during the second preflight run-up just prior to take-off, unless a recheck is dictated by inclement weather conditions, additional repairs after the preflight operational check, or an unusual delay before take-off. This operational equipment check is amplified and aligned in such a manner that all crew members except the engineers can use their standard preflight check list to accomplish this complete check. A "Standard Check List" for the engineer is provided to insure that a complete, comprehensive preflight is accomplished as required for an "Operational Preflight Equipment Check." It can also be used to replace both run-ups and still provide a complete check in event only one run-up is desired due to the nature of the mission such as aircraft ferry flights, maintenance test flights, or due to the time factor. The pilots will accomplish a visual inspection in accordance with the visual preflight as outlined in this section.

The aircraft commander should co-ordinate his mission planning with all sections concerned and order the necessary equipment for accomplishment of the mission. It is impractical for other crew members to safely accomplish their respective preflights during the reciprocating engine preflight. This will necessitate the aircraft commander's scheduling crew members to accomplish their individual preflights as soon as their respective component systems are declared in commission. The following time allocations are recommended; however, they may be modified as required by experience and local conditions:

1. Observers, photographers, and radio-ECM operators (simultaneously) 2 hrs.
2. Pilots and engineers (simultaneously) 2 hrs.
3. Tail gunner (actual gunnery) 1 day.

Each crew member will accomplish his respective preflight as outlined in this handbook and/or other handbooks governing the operation of this aircraft. A preflight check list will be utilized at all times to insure the accomplishment of every item.

On completion of his preflight the crew member should immediately notify his aircraft commander and record any discrepancy in the AF Form 1. Auxiliary equipment to be checked includes all operational systems that are to be utilized during the forthcoming mission and items pertaining to safety of flight. *Wing flaps, hydraulic system, jet engine starter operation, and any other equipment demanding high electrical loads will not be operated during the radar preflight operational equipment check.*

In addition to an operational check of normal and special equipment, this preflight includes a complete reciprocating engine run-up. The jet engines should only be run to make sure that known deficiencies have been cleared since the preceding flight. All newly installed jet equipment must be thoroughly checked. Since this preflight is an operational check of all equipment, it should be accomplished as soon as possible. The necessity of the aircraft commander and pilots to accomplish the "Visual Preflight Inspection" twice is to insure that the aircraft is ready for engine run-up (cowling, stands, etc.) and also to check all systems for operation. There will of necessity be some duplication of effort with this system; however, those preflight procedures which are duplicated are necessary to insure the best interests of flying safety.

Before deciding where the aircraft is to be parked for run-up, check the wind direction and velocity. If practical the aircraft should be headed directly into the wind for several reasons. Considerable difficulty may be experienced in moving the rudder in strong cross winds. Tail winds can cause excessive or erratic tail pipe temperatures during jet engine starting and operation. A direct head wind provides maximum ground cooling and even propeller loading during engine run-up and single magneto check. Wind velocity affects the idle speed setting of the reciprocating engines. Other considerations also affect the choice of a proper parking spot for run-up. Park the aircraft on a clean, hard surface to prevent pick-up and throwing of gravel and debris by the jet intakes or propeller blast. Avoid tailing the aircraft toward other aircraft, buildings, close taxi strips, or runways to prevent damage from propeller or jet engine blast and to allow the run-up to progress as rapidly as possible without interruptions. If possible maintain a minimum of 250 feet frontal clearance during the run-up.

Note

Before boarding the aircraft, the engineers will check the following:

1. Contact the crew chief and determine what maintenance has been performed, and that the bomb bay and wing crawlway inspection has been completed (fuse panels, fuel leaks, etc.) as outlined in present maintenance regulations.

2. Proper status of the aircraft as reflected in Parts II and III of AF Form 1.

3. Bomb bay doors open and safety locks installed. If the bomb bay doors are closed, they will be pumped open and safety locks will be installed prior to starting the auxiliary power unit.

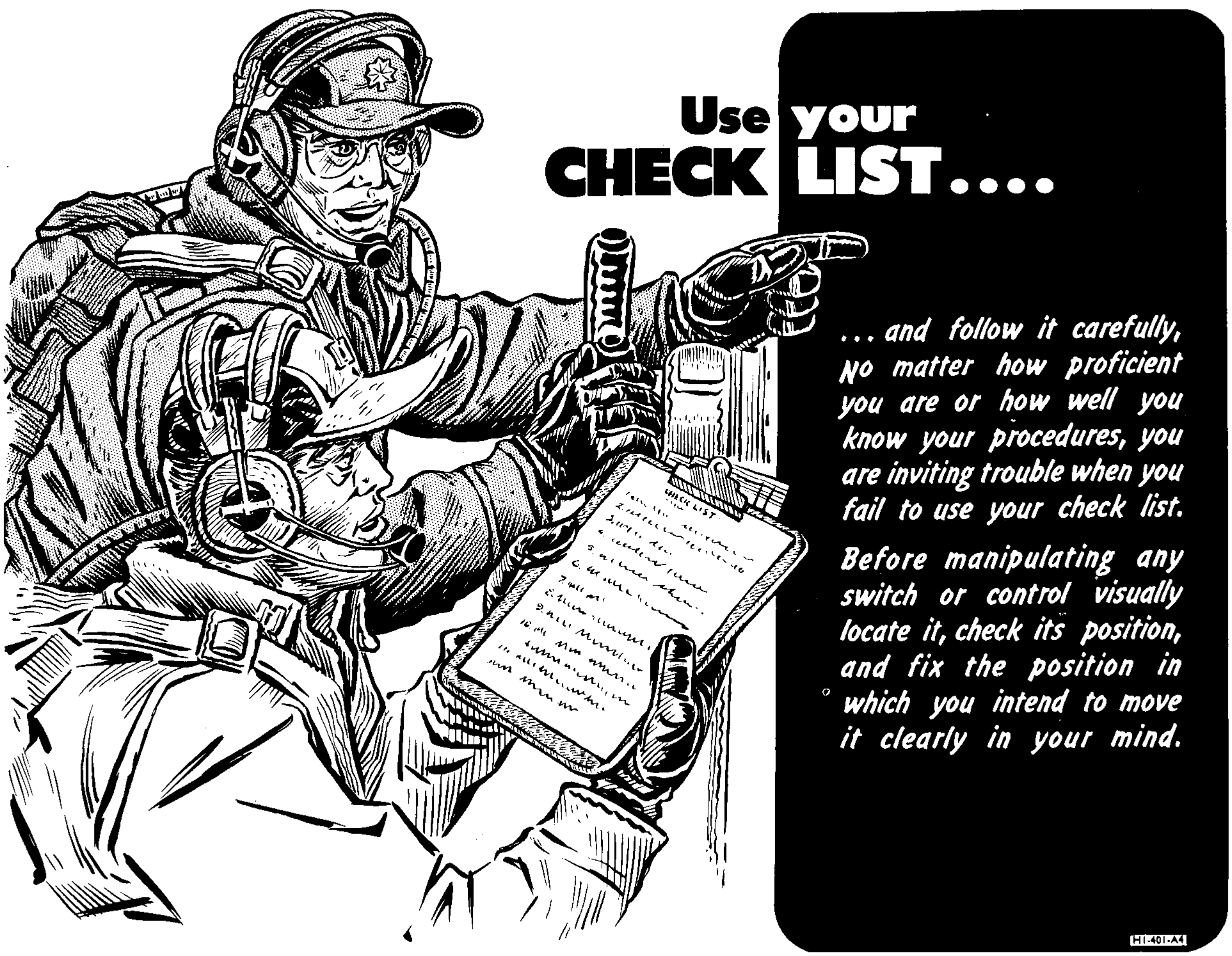
4. Make certain that the ground observer who will operate the ground interphone understands proper ground reporting procedures on engine starts, control checks, propeller checks, etc.

5. Insure that the auxiliary power unit is as far upwind from the aircraft as the electrical cord will permit.

CAUTION

Before the APU is plugged in, make certain that the external power switch is OFF.

The aircraft commander, pilot, and engineers proceed to their stations with their headsets and microphones and the pilot will read the "Before Starting Engines" check list to the aircraft commander, who will complete the checks. In the same manner, the second engineer may assist the first engineer. Co-ordination items between the aircraft commander and the first engineer are indicated on the check list and must be checked as indicated in the amplified check list.



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B-36H PILOTS' STANDARD CHECK LIST

BEFORE STARTING ENGINES

1. Landing Gear Control Switch .... EXTEND
2. Visual Inspection—Forms I, F, and Loading List .. COMPLETED
3. Pitot Covers and Ground Locks .... REMOVED
4. Nose Wheel Scissors .... CONNECTED
5. Personal Equipment .... CHECK IN PLACE
6. Seats and Pedals .... ADJUSTED
7. All Circuit Breakers .... IN
8. All Indicator Lamps .... PUSH TO TEST
*9. Radio Checks .... COMPLETED
10. Propeller Reverse Selector Switches .... SAFE, LIGHTS OUT
11. Flight Instrument Switches .... ON
*12. Nose Steering and Brakes .... CHECKED AND SET
13. Autopilot .... CHECKED AND OFF
14. Bomb Bay Door Locks .... REMOVED
15. Fire Equipment .... IN PLACE
*16. Receive Engineer's Report and Notify Engineer, "BRAKES SET, FIRE GUARD STANDING BY, START ENGINES"

DURING ENGINE WARM-UP

1. Bomb Bay and Camera Doors .... CLOSED

TAXIING

1. Nose Wheel Steering Switch .... ON
2. Engineer's Taxi Configuration .... CHECKED
3. Check Ground Man .... "ALL CLEAR" SIGNAL
4. Interphone, Alarm Bell Check .... COMPLETED
5. Call Control Tower .... TAXI INSTRUCTIONS
6. Inboard Propeller Reverse Selector Switch .... READY
7. Taxiing ...... ANNOUNCE "TAXIING" OVER INTERPHONE

ENGINE RUN-UP

1. Parking Brake Switch .... BRAKE ON
2. Nose Wheel Steering Switch .... OFF
3. Propeller Reverse Selector Switches .... SAFE (LIGHTS OUT)
4. Pilot's Manifold Pressure Gage .... CHECKED
5. Master Tachometer .... CHECKED
*6. Propeller Reverse Check .... COMPLETED

STARTING JET ENGINES (GROUND-AIR)

1. All Circuit Breakers .... IN
2. Fire Detection Test Switches .... TEST AND RELEASE
3. Throttle Selector Switches .... LEVER
4. Throttles .... CLOSED
5. Pod Preheat Switch .... AS REQUIRED
6. Nose De-Ice Switch .... AS REQUIRED
7. Oil Heater Switch .... AS REQUIRED
8. Oil Shutoff Valve Switches .... OPEN
*9. Notify Engineer ..... SET UP JET START CONFIGURATION
10. (Ground Start) Danger Area Clear and Fire Equipment Standing By
11. Nose Shutoff Door Switches .... OPEN
12. Jet Manifold Valve Switches (L and R) .... OPEN
13. Booster Pump Switches (L and R) .... ON
14. (Ground Start) Ignition Start Switches .... NORMAL
15. Throttle Position Indicator Selector Switch (Some Airplanes) .... SELECT J-1 ENGINE
16. J-1 Engine Fuel Valve .... OPEN
17. J-1 Fuel and Oil Pressure Gages .... NOTE READING
18. Notify Ground Observer or Aft Scanner .... STARTING J-1
19. (Ground Start) J-1 Starter Switch .... HOLD ON
19A. (Air Start) J-1 Ignition Start Switch . HOLD IN ALTITUDE
20. (Ground Start) J-1 Throttle ...... OPEN AT 6 PER CENT RPM TO OBTAIN 25 to 30 PSI FUEL PRESSURE
20A. (Air Start) J-1 Throttle ... OPEN TO OBTAIN 16 TO 20 PSI FUEL PRESSURE (10 TO 15 PSI ABOVE 40,000 FT)

CAUTION: WHEN IGNITION OCCURS ADJUST THROTTLE TO MAINTAIN A CONSTANT TAIL PIPE TEMPERATURE. DO NOT EXCEED 690°C TPT.

21. J-1 Oil Pressure ... REPORT INDICATION ON INTERPHONE

NOTE

Prior to starting J-2, run J-1 to 70 per cent rpm and check for approx. 5 psi indicated oil pressure.

22. (Ground Start) J-1 Starter Switch ...... RELEASE AT 20 PER CENT RPM
22A. (Air Start) J-1 Ignition Start Switch .... RELEASE AT IDLE
23. J-1 Throttle .... ADJUST TO MAINTAIN IDLE RPM
24. J-2, J-3, J-4—Repeat Steps 14 thru 23
25. (Ground Start) All Ignition Start Switches .... OFF

BEFORE TAKE-OFF

1. Parking Brake Switch .... BRAKE ON
2. Propeller Reverse Selector Switches . SAFE AND LIGHTS OUT
3. Flight Instrument Switches .... ON
4. Gyros .... SET AND UNCAGED
4A. Landing Lights .... AS REQUIRED
5. Nose Wheel Steering Switch .... ON
6. Landing Gear Control Switch .... EXTEND
7. Autopilot .... OFF
8. Flaps and Indicator .... SET AT 20° AND CHECKED
9. Trim Tabs .... SET
10. All Compartments ...... ENTRANCE LADDERS, WINDOWS, AND HATCHES, READY FOR TAKE-OFF
11. Engineer's Take-Off Configuration .... ENGINEER READS—"Take-Off Configuration Completed; Standing by for Propeller Reverse Safety Check and Take-Off Power."
12. Abort Procedure and Take-off and Landing Data .... BRIEFED & REVIEWED
13. Surface Controls .... UNLOCKED AND CHECKED
14. Salvo Circuits .... AS REQUIRED
15. Safety Belts and Safety Harnesses .... FASTENED
16. Read Pilot's Take-Off Configuration Over Interphone: "CONTROLS—UNLOCKED; FLIGHT INSTRUMENT SWITCHES—ON; FLAPS—20 DEGREES; TRIM TAB—......... DEGREES (UP OR DOWN); AUTOPILOT—OFF; NOSE STEERING—ON; PROPELLERS—SAFE, LIGHTS OUT; JET PANEL—CHECKED; PITOT HEAT—AS REQUIRED."

*PILOT-ENGINEER CO-ORDINATION ITEM

Figure 2-2. (Sheet 1)

B-36H PILOTS' STANDARD CHECK LIST

TAKE-OFF

1. Parking Brakes .... RELEASED
*2. Set Take-Off Power .... JETS TAKE-OFF RPM
3. Foot Brakes .... RELEASED

AFTER TAKE-OFF

1. Foot Brakes .... APPLY TO STOP WHEEL ROTATION
2. Nose Steering Switch .... OFF
*3. Landing Gear Control Switch .... RETRACT
4. Flap Switch .... UP
5. Landing Lights .... RETRACTED & OFF

INITIAL CLIMB

*1. Power Condition No. 2 .... JETS 96 PER CENT RPM
2. Landing Gear and Brake Pump Switch .... OFF WHEN PRESSURE IS RELIEVED
3. Hold Best Climb IAS .... SEE APPENDIX
4. Bomb Bay Area .... CHECKED

STOPPING JET ENGINES (GROUND-AIR)

1. (Ground) Throttles .... IDLE THREE MINUTES, THEN CLOSE
1A. (Air) Throttle .... FLIGHT IDLE THREE MINUTES, THEN CLOSE
2. Booster Pumps .... OFF
2A. (Air) Nose Shutoff Doors .... CLOSED AT OR BELOW 100°C TPT AND 30 PER CENT RPM
3. Jet Manifold Valve Switches (L and R) ... CLOSED BELOW 20 PER CENT RPM
4. Engine Fuel Valves .. CLOSED BELOW 10 PER CENT RPM
5. Nose De-Ice .... AS REQUIRED
6. Pod Preheat .... AS REQUIRED
7. Oil Heater Switch .... AS REQUIRED
8. Oil Shutoff Valves ...... ALWAYS OPEN DURING FLIGHT
9. Throttle Circuit Breakers .... OUT
10. (Ground) Jet Nose Shutoff Door Switches .... CLOSE AFTER 30 MINUTES

BEFORE LANDING

1. Notify Crew .... "PREPARE TO LAND"
2. Bomb Bay Area .... CHECKED
3. Autopilot .... OFF
4. Nose Shutoff Door Switches .... OPEN
5. Jet Engines .... AS REQUIRED
6. Engineer's Landing Configuration ...... ENGINEER READS—"Before Landing Check List Complete, Standing by for rpm, landing gear, and brake check."
7. Stalling Speeds and Take-off and Landing Data .... CHECKED & REVIEWED
8. Master Tachometer .... 2600 RPM
9. Landing Gear Control Switch .... EXTEND
   a. Receive Aft Scanners' Visual Report, "Gear Down and Locked."
   b. Hydraulic Pressure .... RELIEVED
   c. Receive Radio Operator's Visual Report, "Nose Gear Down and Locked"
   d. Landing Gear Lights .... CHECKED GREEN
   e. Nose Wheel Steering Indicator .... ZERO
10. Parking Brake Switch .... BRAKE OFF
*11. Left and Right Brakes .... CHECKED
12. Nose Gear Strut .... BLED IF REQUIRED
13. Bomb Bay Doors .... CHECKED CLOSED VISUALLY
14. Nose Steering Switch .... ON
15. Read Pilot's Landing Configuration Over Interphone:
    "GEAR DOWN AND LOCKED, AUTOPILOT—OFF, NOSE WHEEL STEERING SWITCH — ON, STANDING BY ON FLAPS."
16. Flaps .... 10 DEGREES

BASE LEG

1. Flaps .... 20 DEGREES
2. Jet Nose Shutoff Door Switches .... CLOSE
3. Landing Lights (If Required) ... EXTENDED AND CHECKED

FINAL APPROACH

At High Gross Weights High Field Elevation, And In Emergencies 2800 RPM and No. 6 TBS Setting May Be Used.

1. Flaps .... 30 DEGREES

LANDING

1. Propeller Reverse Selector Switches .... READY ON MAIN GEAR CONTACT
2. Propeller Reverse Pitch Switch .... DEPRESS ON A/C's COMMAND
3. Control Surfaces .... LOCKED AT APPROXIMATELY 50 MPH
4. Propeller Reverse Selector Switches .... SAFE
5. Flaps .... RETRACTED
6. Jet Oil Shutoff Valve Switches .... CLOSED AT ZERO PER CENT RPM

POSTFLIGHT ENGINE RUN-UP

1. Propeller Reverse Selector Switches .... SAFE (LIGHTS OUT)
2. Parking Brake Switch .... BRAKE ON
3. Nose Wheel Steering Switch .... OFF

STOPPING RECIPROCATING ENGINES

1. Parking Brake Switch .... BRAKE ON
2. Propeller Reverse Selector Switches .... SAFE (LIGHTS OUT)
3. Nose Wheel Steering Switch .... OFF
4. Flight Instrument Switches .... OFF
5. Contact Engineer .... "READY TO STOP ENGINES"
6. Radio Equipment .... OFF

BEFORE LEAVING AIRCRAFT

1. All Control Switches .... PROPERLY POSITIONED
2. Wheel Chocks and Ground Locks .... IN PLACE
3. Parking Brake Switch .... BRAKE OFF AFTER WHEELS ARE CHOCKED
4. Postflight Visual Inspection .... COMPLETED

*PILOT-ENGINEER CO-ORDINATION ITEM

Figure 2-2. (Sheet 2)

B-36H ENGINEERS' STANDARD CHECK LIST

BEFORE STARTING ENGINES

1. Required Forms .... ABOARD AND CHECKED
2. All Circuit Breakers and Control Switches .... PROPERLY POSITIONED
3. Ground Refueling Safety Switch (Some Airplanes) .... OFF
4. Emergency Power Switch .... NORMAL
5. Cabin Heater Power Switch .... OFF
6. External Power Supply Switch .... OFF
7. Battery Switch .... ON
8. Alternator Panel Configuration .... CHECKED
9. External Power .... PLUGGED IN
10. Correct A-C Phase Sequence Lamp .... LIGHTED
*11. External Power Supply Switch .... ON
12. Engine Ignition Switches .... OFF
13. Mixture Control Check .... COMPLETED
14. Throttle Lever and Flap Warning Horn Check .... COMPLETED
15. Fuel Panel Configuration .... CHECKED
16. Liquid Lock Check (With Ignition Switches OFF) .... COMPLETED
17. Intercoolers and Air Plugs .... AS REQUIRED
18. Oil Cooler Door Manual Operation (Some Airplanes) .... CHECKED
19. Oil Shutoff Valve Switch Guards .... DOWN
20. Bomb Bay Fuel Tank Quantity Simulator Switch .... AS REQUIRED
21. Water Injection Switches .... OFF
22. Propeller Control Panel .... CHECKED
23. Engine Supercharger Switches .... DUAL TURBO
24. Fan Speed Switches .... LOW RPM
25. Spark Advance Switches .... RETARD (GUARDS DOWN)
26. Carburetor Preheat Switches .... OFF
27. Panel Lights .... AS REQUIRED
28. Carburetor Air Filter Switch .... AS REQUIRED
29. TBS .... ZERO
30. Turbo Calibration Knobs .... FULL COUNTERCLOCKWISE
31. Turbo Override Control Panel .... CHECKED
32. Wheel Well Lights Switch .... AS REQUIRED
*33. Hydraulic Control Panel .... CHECKED
34. Engine Analyzer Power Switch .... OFF
35. Oil Vent Heater Switch .... AS REQUIRED
36. Pitot Heat Switches .... OFF
37. Nacelle Fire Detector and Extinguisher .... CHECKED
38. Wing, Cabin Heat and Tail Anti-Ice Switches .... DEC
39. Booster Fan Switch .... OFF
40. Aft Cabin Pressure Switch .... INC
41. Cabin Pressure Wing Shutoff Valve Switches .... DEC
42. Cabin Temperature Control Switch .... DEC UNTIL LAMP LIGHTS
43. Instrument Check .... NORMAL
44. All Indicator Lamps .... PUSH TO TEST
*45. Report to A/C, "Check List Completed, Ready to Start Engines."

STARTING RECIPROCATING ENGINES

1. Fuel Tank Valve Switches .... OPEN
2. Booster Pumps of Tanks Being Used .... ON
3. Inform Ground Observer, "Ready to Start Engines, Clear No. 4."
4. Voltage and Frequency Selector Switch .... NO. 4 POSITION
5. Throttle Levers .... CLOSED
6. Engine Fuel Valves .... OPEN
7. Fuel Pressure .... 10-14 PSI
8. Engine No. 4 Starter Switch .... ON
9. Engine No. 4 Ignition Switch .... ON
10. Prime .... AS REQUIRED
11. No. 4 Mixture Control Levers .... NORMAL OR RICH
12. Report "Alternator Normal, Oil and Fuel Pressure Normal"
13. Repeat Steps 8 thru 12 for Starting Engines 5, 6 3, 2 and 1.
14. Engine Analyzer Power Switch .... ON

DURING ENGINE WARM-UP

(PREFLIGHT OPERATIONAL EQUIPMENT CHECK)

1. Ignition Switch Check .... IDLE RPM
2. Engine-Driven Fuel Pumps .... CHECK
3. Heat and Anti-Icing Check .... COMPLETED
4. Alternator Checks .... COMPLETED
5. Engine Oil-In Temperature .... MINIMUM 40°C

TAXIING

1. Taxi Configuration, "Alternators on the line and Paralleled, Brake and Nose Steering Pressure Normal, Ready to Taxi."

ENGINE RUN-UP

(PREFLIGHT OPERATIONAL EQUIPMENT CHECK)

1. Inflight Oil Cooling Doors .... CHECKED
*2. Propeller Control System .... CHECKED
3. Cabin Pressure Wing Shutoff Valve and Carburetor Preheat Checks .... COMPLETED
4. Barometric Pressure Checks .... COMPLETED
5. Ignition System Check .... COMPLETED
6. Full Power No Boost Checks .... COMPLETED
7. Turbo Override and Single Turbo Check .... COMPLETED
8. Full Power With Boost Checks .... COMPLETED

DURING ENGINE WARM-UP

(DAY OF FLIGHT)

2. Engine-Driven Fuel Pumps .... CHECK
4d. Alternators on Line .... MINIMUM OF TWO
5. Engine Oil-In Temperature .... MINIMUM 40°C

ENGINE RUN-UP

(DAY OF FLIGHT)

*2. Propeller Control System .... CHECKED
5. Ignition System Check .... COMPLETED
6. Full Power No Boost Checks .... COMPLETED
8. Full Power With Boost Checks .... COMPLETED

STARTING JET ENGINES (GROUND-AIR)

*1. Jet Start Configuration .... CHECKED AND REPORT, "STANDING BY FOR JET ENGINE START."

BEFORE TAKE-OFF

1. Fuel Panel Checked .... BOOSTER PUMPS ON
2. Propeller Selector Switches .... AUTOMATIC OPERATION (TEL-LAMPS LIGHTED)
3. Engine Supercharger Switches .... DUAL TURBO
4. Engine Fan Speed Switches .... LOW RPM
5. Spark Advance Switches .... RETARD (GUARDS DOWN)
6. Mixture Control Selector Switches .... LEVER
7. Mixture Control Levers .... RICH

NOTE

All mixture control levers will be in the RICH position for take-off regardless of the type of carburetor installed.

*PILOT-ENGINEER CO-ORDINATION ITEM

Figure 2-3. (Sheet 1)

B-36H ENGINEERS' STANDARD CHECK LIST

8. Air Plugs and Intercoolers .... AS REQUIRED
9. Temperatures .... CHECKED AND WITHIN LIMITS
10. Carburetor Preheat Switches .... OFF
11. Turbo Control Change-Over Switches .... AUTOMATIC
12. Turbo Control Vernier Switch .... OFF
13. Alternators Paralleled on the Line one Bus Isolated (Bus 301 or 401 Preferred).
14. Cabin Heater Power Switch .... OFF
15. Cabin Booster Fan Switch .... AS REQUIRED
16. Cabin Pressure Wing Shutoff Valve Switches .... DEC
17. Wing, Cabin Heat and Tail Anti-Ice Switches .... DEC
18. Pitot Heater Switches .... AS REQUIRED
19. Propeller Normal Pitch Indicated Lamps .... LIGHTED
20. Brake and Nose Steering Pressure .... NORMAL

*21. Engineer's Take-Off Configuration .... ENGINEER READS: "Take-Off Configuration Completed, Standing by for Propeller Reverse Safety Check and Take-off Power."

TAKE-OFF

*1. Propeller Reverse Safety Check and Set Take-Off Power Corrected for Humidity.
2. Report, "Power Stabilized," Prior to Nose-Up Speed.

AFTER TAKE-OFF

*1. Report, "Main Hydraulic Pressure Normal."
2. Report, "Main Hydraulic Pressure Relieved," After Gear Retraction is Completed.

INITIAL CLIMB

1. Power Condition No. 2 .... UPON PILOT'S REQUEST
2. Turbo Boost Selector .... REDUCE M.P. TO 55 INCHES
3. Water Injection Switches .... OFF
4. Reduce Power to Predicted Climb Schedule.
5. Torque Fuel Flow, CHT, CAT and M.P. .... WITHIN LIMITS

CRUISE

For Specific Cruise Data See Appendix I and Amplified Check List.

BEFORE CLIMB (HIGH POWER OPERATION AFTER A MANUAL LEAN SPARK ADVANCE CRUISE)

1. Air Plugs and Intercoolers .... OPEN
2. Spark Advance Switches .... RETARD
3. Mixture Controls .... NORMAL (LIGHTS ON) OR RICH
4. Engine Supercharger Switches .... DUAL TURBO
5. Desired Power .... SET

BEFORE LANDING

1. Fuel Panel Checked .... BOOSTER PUMPS ON
2. Propeller Selector Switches .... AUTOMATIC OPERATION (TEL-LAMPS LIGHTED)
3. Engine Supercharger Switches .... DUAL TURBO
4. Engine Fan Speed Switches .... LOW RPM
5. Spark Advance Switches .... RETARD (GUARDS DOWN)
6. Mixture Control Selector Switches .... LEVER
7. Mixture Control Levers .... RICH

NOTE

All mixture control levers will be in the RICH position for landing regardless of the type of carburetors installed in the engines.

8. Air Plugs and Intercooler Shutters .... AS REQUIRED
9. Turbo Booster Selector .... ZERO
10. Temperature .... CHECKED AND WITHIN LIMITS
11. Carburetor Preheat Switches .... AS REQUIRED
12. Turbo Control Change-Over Switches .... AUTOMATIC
13. Turbo Control Vernier Switch .... OFF
14. Alternator Panel .... CHECKED
15. Cabin Heater Power Switch .... OFF
16. Booster Fan Switch .... AS REQUIRED
17. Cabin Pressure Wing Shutoff Valve Switches .... DEC
18. Wing, Cabin Heat and Tail Anti-Ice Switches .... AS REQUIRED
19. Pitot Heater Switches .... AS REQUIRED
20. Propeller Normal Pitch Indicator Lamps .... LIGHTED
21. Brake Pressure .... NORMAL

*22. Engineer's Landing Configuration .... ENGINEER READS: "Before Landing Check List Complete, Standing by for RPM, Landing Gear, and Brake Check, Gross Weight .... lbs."
23. Master Tachometer .... 2600 RPM
24. Hydraulic Pressure Normal, Pressure Relieved.

*25. Brakes Checked .... PRESSURE NORMAL

LANDING

1. Brake and Nose Steering Pressure .... NORMAL AFTER NOSE WHEEL CONTACTS GROUND
2. RPM and M.P. Checked .... AFTER PROPS REVERSE DO NOT EXCEED 30 INCHES OF M.P. EXCEPT IN EMERGENCY

TAXIING

1. Alternators (Minimum of Two on the Line) .... PARALLELED
2. Brake and Nose Steering Pressure .... NORMAL

POSTFLIGHT ENGINE RUN-UP

1. All Propeller Normal Pitch Indicator Lights .... ON
2. Master Tachometer .... 2800 RPM
3. Parking Brakes .... SET, PRESSURE NORMAL
4. Nose Steering Pressure .... ZERO
5. Announce over Interphone, "Ready for Postflight"
6. Engine Run-Up .... COMPLETED
7. Repeat Step 6 for Remaining Symmetrical Engines.
8. Shut down engine 1 & 6 after checking that CHTs are 170°C or as low as possible if unable to attain 170°C.
9. Report to A/C, "Ready to taxi to Line."

STOPPING RECIPROCATING ENGINES

1. Air Plug Switches .... OPEN
2. Master Motor Speed Control Lever .... FULL DECREASE
3. Propeller Selector Switches .... FIXED PITCH
4. Booster Pump Switches .... OFF
5. Alternator Control Checks .... COMPLETED
6. Idle Speed and Mixture Checks .... COMPLETED
7. Fuel Tank Valve Switches .... CLOSE
8. Cross-Feed, Manifold, and Engine Valve Switches .... OPEN
9. Ignition Switches .... OFF
10. Intercooler Shutter Switches .... CLOSE
11. Static Propeller Feather Check .... COMPLETED
12. Battery Switch .... OFF

BEFORE LEAVING AIRCRAFT

1. Fuel Dip Stick Readings .... AS REQUIRED
2. Forms and Reports .... COMPLETED

*PILOT-ENGINEER CO-ORDINATION ITEM

Figure 2-3. (Sheet 2)

Proceed with the applicable entries of the pilots' and engineers' check lists as amplified below:

BEFORE STARTING ENGINES.

PILOTS

1. Landing Gear Control Switch—EXTEND. The landing gear control switch should be in the EXTEND position for all ground operations. With the switch in this position, a gang bar arrangement holds the brake pump switch ON.

2. Visual inspection; Forms 1, F, and Loading List—Completed.

Before flight the visual inspections, loading lists, and Forms 1 and F must be complete. Visual inspection should be completed to the aircraft commander's satisfaction. Discrepancies noted in the Form 1 which have been corrected should be particularly checked to insure that those items of equipment are in proper working order.

The Form F which was filled out by the engineer must be thoroughly checked for accuracy and signed by the aircraft commander. Take-off and landing data will be computed by the engineer and reviewed by the aircraft commander and the pilot prior to take-off. This information will be given to the pilot by the engineer on a take-off and landing data card. The original copy Form F must be filed with Operations. Loading list must be checked to insure that the name, rank, serial number, and organization of every person on the flight is on the loading list. One copy of the loading list must be filed with the aircraft clearance at base operations.

3. Pitot Covers and Ground Locks—Removed. (Not to be accomplished during "Preflight Operational Equipment Check.")

The aircraft commander will personally check just before he enters the aircraft to see that all locks (main landing gear, nose gear, and control locks) have been removed and that the pitot covers have been removed.

4. Nose Wheel Scissors—Connected. The aircraft commander will also check just before he enters the aircraft to insure that the nose wheel scissors have been connected. The nose wheel scissors will only be disconnected when it is necessary to move the aircraft by use of a tug or towing equipment.

The aircraft should be in proper taxi position when the crew boards the aircraft so that it is unnecessary to have the nose wheel scissors disconnected for any further towing operations.

ENGINEERS

1. Required Forms—Aboard and Checked. Check the AF Form 1 before any preflight or flight operations. Before flight, complete the Form F, and check the Flight Log initiated with proper headings, correct gross weight and fuel load in pounds, and predicted take-off and climb power settings indicated. Check other required forms aboard such as engineers' reports, prediction forms, or test flight reports as required by local directives.

2. All Circuit Breakers and Control Switches—Properly positioned. To make certain control circuits are connected to their respective power source and to prevent inadvertent operation of systems when power is applied to the aircraft.

3. Ground Refueling Safety Switch (some airplanes) —OFF. (Guard Down.) To insure that power will be available to the forward cabin when the external power supply is connected to the aircraft.

4. Emergency Power Switch—NORMAL. To insure that the normal power distribution system is not partially blocked out; for example, the radio operator's t-r unit would be blocked out except when fed by an excited alternator which has been selected by the engineer's voltage and frequency selector switch.

5. Cabin Heater Power Switch—OFF. The circuit is automatically de-energized when the external power is ON. However, the switch will be OFF before engine starting to prevent overload of the a-c system after external power is turned off and the engine alternator is placed on the line.

6. External Power Supply Switch—OFF. To prevent inadvertent connection of the external power supply to the bus before correct phase sequence has been established and the alternator breakers checked open.

7. Battery Switch—ON. To energize the d-c bus system, providing power for the interphone indicator lamp and control circuits.

8. Alternator Panel Configuration—Checked.

Note

Any discrepancies during this check must be corrected.

a. Frequency Control Knobs—Full Decrease. This is the normal position for these controls when the alternators are not operating. It provides a safety precaution against constant-speed drive surging and overspeeding during engine start.

BEFORE STARTING ENGINES (Cont'd)

5. Personal Equipment—Checked in place. (Not to be accomplished during "Preflight Operational Equipment Check.")

Oxygen equipment, headset, and mike should be in place and plugged in. Other equipment necessary for the immediate flight should be readily available at each station. All other personal equipment should be in the A-3 bag and properly stowed.

6. Seats and Pedals—Adjusted. Make certain that the seat and rudder pedals are in proper positions for the most efficient use of brakes and rudder.

7. All Circuit Breakers—In. To make sure that various indicator lamps, instruments, and control circuits are connected to the electrical power distribution systems, including the jet panel.

8. All Indicator Lamps—Push to test. To see that the indicator lamps are not burned out.

b. Bus Tie-Breaker Switches—CLOSED. Check the action of these breakers by raising the switch guards and open each breaker-lamp. ON indicates breaker is open. Close each breaker and place switch guards down. Lamp out indicates breaker closed. All breakers closed insures that a-c power is feeding all four bus systems. Push-to-test any lamps that do not appear to be operating to make sure lamp is not burned out.

c. Mixture Control Levers—Move out of IDLE CUT-OFF position. It will be necessary to move the mixture control levers from the IDLE CUT-OFF position on the alternator-equipped engines, because a microswitch behind each mixture control lever of these engines keeps the exciter relay control circuit broken.

d. Exciter Control Relay Switches—ON. Exciting the alternators prior to engine start allows the operator to see that the alternator control circuits are functioning normally as each engine is started by watching the voltage and frequency indications.

e. Alternator Breaker Switches—OPEN (lamps lighted). To insure that alternator breakers are open prior to placing the external power switch ON, thus placing a-c power on the bus system. The open position prevents motorizing of the engine-driven alternators and subsequent excessive loads on the auxiliary power unit.

CAUTION

Never close the alternator breakers while external power is ON.

f. All Alternator Breaker Switches—CLOSE (lamps out).

g. All Alternator Exciter Control Relay Switches—Momentarily OFF. Observe that the alternator breaker lamps are lighted. If an alternator breaker lamp does not light, check alternator d-c fuse at the respective engine power distribution panel.

CAUTION

Do not attempt to start alternator-equipped engines until this condition is corrected.

h. All Alternator Exciter Control Relay Switches—ON.

i. All Alternator Breaker Switches—Close (lamps out).

j. All Alternator Breaker Hold-In Switches—Hold in. Return each mixture control lever of the alternator-equipped engine to IDLE CUT-OFF. See that the al-

PILOTS | ENGINEERS

BEFORE STARTING ENGINES (Cont'd)

9. Radio Checks—Completed.

Contact the control tower and request fire equipment. Receive OAT. and dew point and inform engineer. If instrument conditions are to be encountered immediately after take-off, have radio compass tuned to local range station and on compass position for take-off. Either the aircraft commander or pilot will monitor interphone at all times.

10. Propeller Reverse Selector Switches—SAFE. Lights out. This will prevent inadvertent operation in reverse pitch. The red propeller reverse warning lamps indicate when the propellers are in reverse pitch. The lamps should go out when the propeller reverse selector switches are in the SAFE position.

11. Flight Instrument Switches—ON. These switches are provided so that the flight instruments may be spared hours of ground operation during maintenance of the airplane. These switches must be ON approximately fifteen minutes before take-off so that the gyros can stabilize and so that flight instrument operation

ternator breaker lamps are still out. Then move the mixture control lever for alternator-equipped engines out of IDLE CUT-OFF and release the hold-in switches. See that the alternator breaker lamps are still out. Move each mixture control lever slowly towards IDLE CUT-OFF and observe the position of the mixture control lever when the respective alternator breaker lamp lights.

Note

> Maladjustment of the microswitch and the travel of the mixture control lever towards the manual lean range will open the alternator breaker.

9. External power—Plugged In.

The ground observer can either close the APU circuit breaker or plug in the external power, depending upon type of power unit involved. You also know he is standing by on interphone to make any adjustments to power found neecssary by aircraft instrumentation.

10. Correct A-C Phase Sequence Lamp—Lighted. To insure that external power is in correct phase (1, 2, 3) with the aircraft wiring system. If *incorrect phase* external power were placed on the aircraft a-c power distribution system, it would cause all three phase motors to operate in reverse, nullifying limit switches on electrical actuators and resulting in immediate damage to aircraft structure and equipment.

11. External Power Supply Switch—ON. Check bus voltage (208V) and frequency 405 ($\pm$5) cycles. Have the ground observer adjust if necessary.

12. Engine Ignition Switches—OFF.

Note

> Individual ignition buttons may be left pushed in.

13. Mixture Control Check—Completed.

a. Mixture Control Levers—Move from IDLE CUT-OFF to RICH and note that the indicator lamps light and go out as the mixture control travels through NORMAL.

b. Move mixture control levers back to NORMAL —Lights on.

c. Selector Switches—SWITCH.

d. Override Switches—Hold to RICH and note that the indicator lamps go dark as mixture control travels toward RICH.

BEFORE STARTING ENGINES (Cont'd)

can be checked. During the preflight operational equipment check, place the pilot's flight instrument switch to EMERGENCY until the emergency electrical power system check has been completed. While the switch is in this position, check for proper operation of instruments.

e. Override Switches—Hold to IDLE CUT-OFF and note that the indicator lamps light and go out as mixture control travels through NORMAL.

f. Selector Switches—LEVER, and note that the indicator lamps light as mixture control travels to NORMAL.

g. Mixture Control Levers—IDLE CUT-OFF and note that indicator lamps go dark as mixture control moves to IDLE CUT-OFF.

14. Throttle Lever and Flap Warning Horn Check—Completed. Move the throttle levers, one at a time, to the full open position. Observe closely for binding to insure freedom of movement through entire range of travel. When all six levers are full open, check sounding of flap warning horn. Return the throttle levers, one at a time, to the fully closed position and check cutting out of warning horn after first throttle is retarded. Check for proper cushioning at extreme limits of throttle lever movement.

15. Fuel Panel Configuration—Checked.

a. Pressure Refueling Valve Switches—CLOSE. These valves should always be closed except when fuel is being transferred. Normally closed these valves prevent inadvertent fuel transfer.

CAUTION

Inadvertent transfer of fuel may result in fuel tank overflow if pressure refueling valve switches are left OPEN and a malfunction exists which would prevent automatic closing of the valve. Open valves would also cause abnormally low fuel pressures during checks and operation.

b. Fuel Booster Pumps—OFF. Always OFF except when fuel is to be used from tank and respective tank valve is open.

c. Fuel Tank Valves—CLOSE. Normal position when fuel is not being used or transferred and engines are not running.

d. Manifold, Cross-Feed and Engine Fuel Valves—OPEN. These valves are open at all times except when checking valve operation or during fuel system emergencies. In the OPEN position these valves permit any fuel tank to feed any engine plus allowing for temperature expansion of fuel in the long manifold system.

Note

Steps a, b, c, and d above constitute the normal fuel panel configuration any time the

PILOTS ENGINEERS

BEFORE STARTING ENGINES (Cont'd)

engines are not operating, refueling or fuel transfer is not being accomplished, or operation of the fuel system is not being checked. Set up this configuration before and after conducting any of these operations to establish a known condition from which to start or end any operation.

e. Fuel System Operational Check.

Note

The following check should be made during the "Preflight Operational Equipment Check" to assure that all valves and booster pumps in the fuel system perform their designated functions. It should only be necessary to perform one complete check prior to any flight to prevent wear from added operation of these components, but additional checks may be made any time it is deemed advisable and in every case where a recheck is dictated by repair or replacement of equipment.

(1) No. 1 Tank Valve—OPEN (all others closed).

(2) No. 1 Booster Pump—ON (all others OFF).

(3) No. 6 Engine Valve—OPEN (all others OFF). No. 6 engine fuel pressure gage should register 10 to 14 psi.

(4) No. 1 Manifold Valve—CLOSED (all others OPEN).

(5) Right Auxiliary Pressure Refueling Valve momentarily OPEN then CLOSED to drop No. 6 engine fuel pressure to zero.

Note

After the valve is closed, no fuel pressure should register after 10 seconds on No. 6 engine fuel pressure gage.

(6) Close No. 2 Manifold Valve and open No. 1 Manifold Valve. No fuel pressure on No. 6 engine.

(7) Close No. 3 Manifold Valve and open No. 2 Manifold Valve. No fuel pressure should register on No. 6 engine.

(8) Continue above procedure on remaining manifold and cross-feed valves until all have been checked.

Note

At any time a pressure is indicated on No. 6 engine, the valve that was last operated to the closed position is leaking or inoperative. When No. 8 manifold valve is opened, a fuel pressure of 10 to 14 psi should be registered

BEFORE STARTING ENGINES (Cont'd)

again. If a pressure is not indicated, one of the cross-feed or manifold valves is stuck in the closed position. Detection of the one that is not operating can be narrowed down by opening engine fuel valves 5 and 4, etc., across the panel until a fuel pressure is finally obtained.

(9) No. 1 Booster Pump OFF and left auxiliary pressure refueling valve open momentarily to kill fuel pressure on No. 6 engine as before.

(10) Close pressure refueling and engine valves.

(11) No. 1 Tank Valve OPEN and Booster Pump ON. (No pressure should register.)

(12) No. 1 Engine Valve OPEN (pressure should register on No. 1 Engine and fuel flow should show fluctuation).

(13) No. 1 Tank Booster Pump OFF. Leave tank valve OPEN.

Note

The booster pump pressure (10 to 14 psi) should remain up for at least 10 seconds. If the pressure drops immediately, there is a possibility that the check valve is leaking or the mixture control is not in IDLE CUT-OFF.

(14) No. 1 Tank Valve—CLOSE.

(15) No. 1 Pressure Refueling Valve—OPEN. Note that refueling lamp goes out and fuel pressure drops on No. 1 engine.

Note

If pressure does not drop, check refueling lamp lighted and tank quantity since refueling valve will not open if the tank is within 350 gallons of being full.

(16) Repeat steps (11) through (15) for remaining tanks.

Note

Use No. 3 or 4 fuel pressure for checking auxiliary tanks.

(17) All Engine and Tank Valves—CLOSE.

16. Liquid Lock Check (with ignition switches OFF)—Completed. Perform a liquid lock check at this time with the ignition switches OFF. Pull propellers through 15 blades with starters. Sequence 4, 5, 6, 3, 2, 1.

CAUTION

Energize starter continuously for 15 blades. Maintain contact with observer for reports

PILOTS ENGINEERS

BEFORE STARTING ENGINES (Cont'd)

of propeller movement. This procedure must be followed to minimize the possibility of damage in the event of a liquid (hydraulic) lock.

17. Intercoolers and Air Plugs—As Required. Normal position for all ground and high power operation is full open. However, the desired position should be dictated by good reasoning after due consideration of such factors as weather, accelerated warm-up, etc. A complete cycle of operation of these controls may be performed at this time or during the engineers' preflight inspection. A check of the left intercooler shutters may also be made at this time. This check is made by placing the turbo selector switches in SINGLE TURBO and noting that the left intercooler shutters close and then by returning the turbo selector switches to DUAL TURBO and noting that the left intercooler shutters open. It should not be necessary to check cycle of operation more than once prior to any flight. This will prevent undue wear on actuators and linkage.

18. Oil Cooler Door Manual Operation (some airplanes)—Checked. Check manual operation as follows:

a. Engine Fuel Valves—OPEN.

b. Request the pilot, "Pull landing gear control circuit breaker." Ask the ground observer to inform you of inflight oil cooler door operation.

c. Oil Cooler Door Mode Selector Switches—MANUAL. This sets up manual override operation.

d. Oil Cooler Door Override Switches—OPEN. Fully open all inflight cooling doors to check the control circuits and door actuators.

e. Oil Cooler Door Override Switches—CLOSE. Close all inflight cooling doors, check the control circuits and door actuators. Close doors approximately half way.

f. Oil Cooler Door Mode Selector Switches—AUTO. Inflight oil cooler doors should close. AUTO is the normal position for these switches and provides automatic oil cooling.

g. Request the pilot "Close the landing gear control circuit breaker." This provides normal ground cooling for the oil system.

h. Engine Fuel Valves—CLOSE.

19. Oil Shutoff Valve Switch Guards—Down. This is the normal position for these controls to prevent starvation of oil to engine when started.

PILOTS ENGINEERS

BEFORE STARTING ENGINES (Cont'd)

20. Bomb Bay Fuel Tank Quantity Simulator Switch—As Required. If a bomb bay fuel tank is installed, place this switch in the TANK IN position. If a bomb bay tank is not installed, this switch must be in the TANK OUT position.

21. Water Injection Switches—OFF. To prevent water injection pumps from operating.

22. Propeller Control Panel—Checked.

a. Propeller Feather Switch—NORMAL (guards down). To prevent accidental feathering of propeller. All normal circuits pass through each propeller feather switch.

b. Propeller Circuit Breakers—In. Connects all propeller controls to d-c power distribution.

c. Propeller Selector Switches—AUTOMATIC OPERATION. Sets up system for eventual run-up and for a check on the protective relay tel-lamps as master motor speed is increased.

d. Master Motor Speed Control Lever—2800 rpm full INCREASE rpm position. This step checks automatic increase rpm controls and the master motor protective relay circuit as indicated by the tel-lamps. The tel-lamps should go out during any rapid change of the master motor speed control lever and come on again as the master motor begins governing at this new setting. This indicates that the master motor protective relay is breaking the ground for each contactor, thus preventing undesired rpm changes in event of a master motor failure. Any time the tel-lamps are out (provided the bulbs are good), the automatic control circuit is disrupted and the propellers assume a fixed pitch position until the system is again in balance and the tel-lamps come back on.

e. Propeller Tel-Lamps—Lighted. Tel-lamps indicate that contactors are properly grounded through the master motor protective relay and that control panel is set up for automatic operation.

23. Engine Supercharger Switches—DUAL TURBO. Normal position for all ground operation to prevent abnormal manifold pressures during run-up.

24. Fan Speed Switches—LOW RPM. Normal position for all ground operation except when checking engine cooling fan for shift from low rpm to NEUTRAL to high rpm and then back to low rpm through NEUTRAL. The LOW RPM position, being normal, prevents low torque readings during run-up and prevents damage to fan, cooling tunnel, accessory case, and shear couplings during full power checks.

PILOTS

ENGINEERS

BEFORE STARTING ENGINES (Cont'd)

12. Nose Steering and Brakes—Checked and set. This check must be made in co-ordination with the engineer. It includes a check of the nose steering system, a complete brake check, and setting of the parking brake prior to engine start.

25. Spark Advance Switches—RETARD (guards down). This places engine ignition timing in retard position (20 degrees BTC), which is normal for all ground and high power operation except when checking the ADVANCE position during engine run-up for proper operation.

26. Carburetor Preheat Switches—OFF. These switches should be OFF at all times except when checking system or when icing is anticipated. If left ON, excessive carburetor temperatures will be experienced during run-up and control of cabin pressure wing shutoff valves will be lost, since these valves automatically close when carburetor preheat is ON.

27. Panel Lights—As Required. Check the operation of panel and overhead lights.

28. Carburetor Air Filter Switch—As required. Used only under extreme dust conditions. The switch is inoperative and filters are not installed on most airplanes under normal conditions.

29. Turbo Boost Selector—ZERO. Waste gates full open to prevent damage from backfire during starting and excessive back pressures and overheating during run-up.

30. Turbo Calibration Knobs—Fully counterclockwise. This prevents staggered indications and probable excessive manifold pressures when setting TBS for full take-off power.

31. Turbo Override Control Panel—Checked.

a. Turbo Change-Over Switches—AUTOMATIC. In this position, the TBS is effective for controlling the turbo waste gates.

b. Turbo Control Vernier Switch—OFF.

32. Wheel Well Lights Switch—As required. This switch should be OFF except during gear operation at night, when a crew member is in the wing, or when a crew member is checking the nose gear latch. It controls lamps that shine upon the landing gear release mechanism.

33. Hydraulic Control Panel—Checked.

a. Hydraulic Fluid Temperature Control Switch—As required. Use to keep bomb bay door fluid temperature between —18°C (0°F) and 38°C (100°F) to insure proper operation of the bomb bay door system. Turn ON when ambient air temperature is below 0°F (—18°C) if bomb bay door operation is anticipated.

b. Hydraulic Pump Override Switch—OFF. Turn ON momentarily (approximately 1/4 second) and then OFF. Observe surge of main system hydraulic pressure and electrical load. Main system hydraulic pressure

PILOTS

ENGINEERS

BEFORE STARTING ENGINES (Cont'd)

a. Steering Control Switch—ON, and check for normal pressure.

CAUTION

> Do not apply steering pressure to the nose wheel while the aircraft is static. This would cause undue stress and strain on nose gear components and scrubbing abrasions of the tires.

b. Steering Control Switch—OFF.

c. Landing Gear and Brake Pump Switch—Neutral and OFF. The brake check will be made with the brake pump switch OFF and the parking brake switch OFF.

d. Announce, "Left Brake," and firmly depress left brake pedal and release. Then announce, "Right brake," and firmly depress right brake pedal and release. The engineer will check for pressure drop.

e. Depress and release both brake pedals until brake pressure drops to air charge in accumulator.

f. Landing Gear and Brake Pump Switch—EXTEND and ON.

g. Parking Brake Switch—BRAKE ON. Announce, "Parking brake set."

CAUTION

> Do not have brake pedal depressed when parking brakes are applied.

Brake pedals should be fully extended. Normal pressure on the brake pedals should not cause any depression.

If the brake pedals move spongily, the slave brake system must be bled and rechecked.

The aircraft must be completely stopped for normal parking brake setting because of the instantaneous locking action of the system. The foot brakes will be used to hold the airplane when releasing the parking brakes.

13. Autopilot—Checked and OFF.

a. Turn autopilot on.

b. Pilot's turn control in detent.

should return to zero with override switch OFF. The above check with the override switch assures that the override circuit and relay and No. 2 hydro pump and motor are operative.

c. Report nose steering pressure on pilot's request.

d. Brake System Check—Completed. Contact pilot and announce "Ready for brake check." Report pressures during check.

e. As pilot depresses and releases brake pedals, report remaining pressure, "........ psi."

f. Note and report, "Accumulator preload pressure .... psi." Accumulator pressure should be approximately 450 psi.

g. Brake Pump Pressure Override Switch—Hold ON until pressure is 500 to 600 psi; then release and announce, "........ psi with override."

h. Observe low brake pressure warning lamp lighted and then pressure build-up until lamp goes out. Observe continued build-up of pressure to normal. Report, "Brake pressure normal."

i. Observe and announce, "Pressure down, building up, normal."

34. Engine Analyzer Power Switch—OFF.

35. Oil Vent Heater Switch—As Required. To prevent vapors from congealing, freezing, and consequently plugging the engine oil tank vent lines. This switch should be placed in the ON position for ground and flight operations when the ambient air temperature is at 32°F (0°C) and below.

36. Pitot Heat Switches—OFF. This is the normal position for these switches except during operational checks or when icing is anticipated during flight. Leaving pitot heat switches ON on the ground will burn out the heater elements.

37. Nacelle Fire Detector and Extinguisher—Checked.

a. Fire Extinguisher Engine Selector Switches—OFF (guards down). To prevent accidental discharge of the fire extinguisher system.

PILOTS ENGINEERS

BEFORE STARTING ENGINES (Cont'd)

c. Engage the autopilot when the green lamps come on. If only one green lamp burns, the other lamp is merely burned out and will not hinder operation of the autopilot.

CAUTION

Do not engage the autopilot with a heavy preload on the controls due to high winds. This will result in clutch slippage with consequent overheating and burning out.

d. Turn each trim knob (aileron, rudder, and elevator) and check control movement for proper direction.

e. Turn pilot's turn control and check control movement for proper direction.

f. In turn, disengage the aileron, the rudder, and the elevator trim knobs. The green lamps should blink when any one surface is disengaged, and normal manual control should be obtained in that axis.

g. Re-engage the autopilot and depress each autopilot release switch to ascertain proper operation. Then check for freedom of movement of the controls.

h. Turn the autopilot off.

14. Bomb Bay Door Locks—Removed. Bomb bay door locks should be removed at this point so that the doors can be closed after engine start. The locks have been left on up to this point so ground crew personnel could safely observe any fuel leaks in the bomb bays and to make the interior of the bomb bays readily accessible to fire fighting equipment in the event of a fire in the bomb bays.

15. Fire Equipment—In Place. A fire truck or an officially authorized equivalent will be in place accessible to the engine being started before attempting to start engines.

16. Receive engineer's report and notify engineer, "Brakes set, fire guard standing by, start engines."

b. Fire Detector Push-to-Test Switch—Push to test circuit. This tests the complete warning circuit for continuity and normal operation from a rapid rate heat rise. If any one lamp does not light within 10 seconds, the circuit is defective and must be checked.

38. Wing, Cabin Heat and Tail Anti-Ice Switches—DEC. The cabin heat and tail anti-ice switches must be held in the DEC position for approximately 8 seconds. This opens the engine dump valves and prevents heating the leading edges of wings and empennage during engine run-up. If leading edges are heated over 50°C above OAT. during ground operation, damage such as permanent wrinkling of the leading edges (oilcanning) will probably result.

39. Booster Fan Switch—OFF.

40. Aft Cabin Pressure Switch—INC. Sets up aft cabin for pressurization. There is no reason for this valve to be closed except when it is desired to depressurize the aft cabin during flight or to check cabin air flow.

41. Cabin Pressure Wing Shutoff Valve Switches—DEC. This closes the wing shutoff valves and is the normal position for these valves prior to engine start. Prevents drainage of manifold pressure during full power checks.

42. Cabin Temperature Control Switch—DEC. until lamp lights.

43. Instrument Check—Normal. This can be accomplished while manipulating air plugs and intercoolers. See that all temperature indicators check against ambient air. Check all positions on the cylinder head temperature selector switch. Check rpm, torque, and fuel flow indicators for zero reading. Fuel, oil, and water pressures normal. Have second engineer observer static M. P. for future use during check at field barometric pressure.

44. All Indicator Lamps—Push to test.

45. Report to aircraft commander, "Check list completed, ready to start engines."

STARTING RECIPROCATING ENGINES.

When starting engines, a ground observer (a qualified engineer or crew chief) must be in constant communication with the engineer. A qualified pilot will be in his seat and a qualified crew member standing by on interphone at the emergency brake pump. The engineer should announce what he is doing at all times during ground operation so that the aircraft commander, ground observer, and scanners will be able to anticipate their activities where co-ordination is required. Ground fire equipment of adequate capacity to combat any anticipated fire should be properly manned and standing by. See "Reciprocating Engine Fire on the Ground," Section III, for instructions on combating engine fires. As each of the engines is turned over, any observation of abnormal operation must be reported to the engineer immediately. The engine starting sequence is 4, 5, 6, 3, 2, 1.

PILOTS

ENGINEERS

1. Fuel Tank Valve Switches—OPEN. Use a minimum of two tanks containing fuel.

2. Booster Pumps of Tanks Being Used—ON. To provide positive fuel pressure to engine-driven fuel pump and fuel under pressure to primer. The primer is effectively inoperative without pressure.

3. Inform ground observer, "Ready to start engines, clear No. 4."

4. Voltage and Frequency Selector Switch—No. 4 position. See that bus voltage provided by external power source is within limits by moving the selector switch to the bus position. Then move it to the No. 4 position. This will allow you to observe voltage and frequency of engine being started.

5. Throttle Levers—CLOSED. If it becomes necessary to restart a relatively "hot" engine, a more open throttle setting may be required.

6. Engine Fuel Valves—OPEN. Opens fuel supply to engine carburetors, fuel pressure gages, and primers.

7. Fuel pressure 10 to 14 psi. This is normal booster pump pressure. Pressure varies with altitude, cycles, fuel density, and condition of booster pump.

Note

Locate No. 4 starter, primer, and ignition switches. Operate starter and primer switches with right hand and ignition switch with left hand. Starter and primer switches are spring-loaded OFF.

PILOTS ENGINEERS

STARTING RECIPROCATING ENGINES (Cont'd)

8. Engine No. 4 Starter Switch—ON. Energize starter continuously for six blades. Maintain contact with observer for reports of propeller movement. This procedure is followed to minimize the possibility of damage in the event of a liquid (hydraulic) lock.

9. No. 4 Engines Ignition Switch—ON after six blades of propeller rotation.

Note

If the engine is relatively "hot" when the ignition is turned ON, the engine will probably start firing even though the mixture is in IDLE CUT-OFF. In any event, there should be a time lapse from the time the ignition is turned ON and the mixture control lever is moved out of the IDLE CUT-OFF position.

10. Prime as required.

11. No. 4 Mixture Control Lever—RICH.

Note

For engines equipped with 391260-8, 391420-1 and 391410-1 and -2 carburetors, move the mixture control lever to NORMAL from the RICH position.

CAUTION

Maximum continuous cranking time is *one minute*—then allow the starter to cool a minimum of *three minutes.*

12. Report, "Alternator normal, oil and fuel pressure normal."

CAUTION

If oil pressure does not register 50 psi within 30 seconds, the engine will be shut down and the cause investigated.

Adjust voltage to 208 volts and frequency to 375 cycles to allow control circuits to stabilize. Move the voltage and frequency selector switch to the number of the next alternator-equipped engine to be started.

Note

The frequency will increase with the temperature of the control circuit resistor.

Do not move the frequency control knob beyond the

PILOTS ENGINEERS

STARTING RECIPROCATING ENGINES (Cont'd)

mechanical stop during ground operation. If the mechanical limit is exceeded overspeeding may occur.

CAUTION

a. If excitation of the alternator is not immediately apparent, the field will be flashed. If flashing the field fails to excite the alternator, shut down the engine. With no meter indication, malfunctions which might cause alternator damage would not be evident.

b. Alternators must be excited and properly governed before advancing the throttles above 1400 rpm. This is necessary so that the alternators can be checked when the engines are run up. If the frequency of any alternator increases with an increase in engine rpm and cannot be adjusted, then the affected engine must be shut down and the constant-speed drive unit checked. Otherwise an overspeed condition may be reached, causing the units to disintegrate and cause a serious fire.

13. Repeat steps 8 through 12 for starting engines 5, 6, 3, 2 and 1. Since No. 1 and No. 6 engines are not alternator-equipped, references to alternators in the starting procedure should be disregarded.

Note

If the engine stops running with the mixture control in NORMAL or RICH, the lever should be returned to the IDLE CUT-OFF position. After the starter has been allowed to cool, the starting procedure may be repeated.

14. Engine Analyzer Power Switch—ON.

RECIPROCATING ENGINE GROUND OPERATION.

During darkness and under conditions of poor visibility, a designated crew member, equipped with headset, microphone, and Aldis lamp, will be stationed inside the aircraft in direct communication with the aircraft commander and engineer and will observe through the nose wheel entrance hatch for any movement of the aircraft prior to and during engine run-up. At any time that communication is broken or aircraft movement reported, engine run-up will cease. The aft scanners, by illumination from the wheel well lights, will maintain visual contact with a reference point immediately adjacent to the aircraft, and notify the aircraft commander of any movement of the aircraft. The pilot, using a landing light if necessary, will maintain visual contact with a reference point immediately adjacent to the aircraft, and will notify the aircraft commander of any movement of the aircraft.

The ground operation of each engine must be held to an absolute minimum. During idling, an attempt should be made to maintain cylinder head temperatures between 170° to 220°C by use of the air plugs. This will minimize the possibility of spark plug fouling. Normally, high idle speed will not be used to keep cylinder head temperature high. However, if these temperatures cannot be maintained with the air plugs, it may be necessary to use higher idle speeds provided oil temperatures are within limits. Engines shall be run only when it is necessary to perform the required checks. An engine should be shut down, when possible, if running unnecessarily during a prolonged check of another engine. Spark plug fouling occurs very rapidly during ground idling, particularly if the idle mixture setting is too rich. This type fouling can be minimized by using the following procedures:

When it is necessary to run an engine on the ground for an extended time and lead fouling is suspected, it shall be run up to 2200 rpm, 37 inches manifold pressure, for a 1-minute period every 15 minutes. This procedure will act to clear away the fouling deposits in their early stages.

If the above procedure does not clear the fouling, the following procedure may be used as an alternate method.

1. Operate the engine at 2000 rpm and bring the cylinder head temperatures to 200° to 220°C.

2. Increase to take-off power with water on and hold for 30 seconds.

3. At the end of 30 seconds operate for 1 minute at dry take-off power and then repeat wet take-off power for 30 seconds.

4. Reduce manifold pressure to 55 inches, turn water injection switches OFF, and reduce rpm to idle.

Note

If the above procedure does not clear the fouling, the spark plugs must be changed.

The normal operating range of the turbosupercharger tachometers is above the range obtainable during engine ground operation. Therefore, no ground checks of the turbo tachometers are recommended. However, a low rpm indication will occur during power checks with boost and water. Failure to obtain such an indication may be indicative of a malfunction and should be investigated before flight.

CAUTION

If the fuel pressure drops below the operating limits during ground operation but the engine continues to operate normally, shut down *immediately*, investigate the cause, and take corrective action.

DURING ENGINE WARM-UP.

All reciprocating engines have now been started and are operating at idle speed. Do not exceed 1400 rpm until the engine oil-in temperature reaches 40°C. Make all ground operations with the mixture controls in the RICH position on engines that have 391260-3, -4, -5 and -6 carburetors and in the NORMAL position on those engines that have 391260-8, 391420-1 and 391410-1 and -2 carburetors. The engine analyzer may be used to perform the following checks:

1. Slow sweep check of all magnetos and spark plugs.
2. Ignition grounding system.
3. Breaker point synchronizer.
4. Fast sweep of ignition check pattern at magneto check power.

The following procedures call for an ignition switch check, engine-driven fuel pump check, heat and anti-icing check, and alternator checks. To reduce engine ground test time, these checks can be made on all six engines at once.

Normally, it should be necessary to perform the ignition switch check once prior to any flight provided the engine anlyzer is used to determine condition of ignition system prior to the ignition system checks. Normally it will be made after engine start of the initial complete reciprocating engine run-up during the "Preflight Operational Equipment Check." *If the engine analyzer is inoperative, it is imperative that an ignition switch check be made after each engine start.* Proceed with the checks as follows:

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1. Ignition Switch Check—Idle RPM.

a. Pull the No. 1 R1 and R2 ignition buttons out, check for a slight drop in rpm and torque pressure, then push them in; then pull the L1 and L2 ignition buttons out and push them in. Repeat this check on engines 2, 3, 4, 5, and 6.

Note

The L1 and L2 buttons when pulled out ground the two left magnetos and check the

PILOTS ENGINEERS

DURING ENGINE WARM-UP (Cont'd)

right ignition system; the opposite is true with the R1 and R2 buttons pulled out. If a cutout occurs when the L1 and L2 or the R1 and R2 buttons are pulled out, check ignition system before further operation.

CAUTION

Never pull the L1 and R1 buttons together; the same applies to the L2 and R2 buttons. To do so may cause serious afterfiring. Also, in the event of defective magnetos, which could cause the engine to cut out completely when grounding the magnetos on one side, do not push the buttons to the in position in an effort to "catch" the engine. This, too, may cause afterfiring and probable damage to the exhaust system. It is recommended that the mixture control first be placed in IDLE CUT-OFF and the exhaust system be purged of combustible mixture by the windmilling action. If time permits, push in the buttons and return the mixture control to the NORMAL or RICH position.

2. Engine-Driven Fuel Pumps—Check. Turn all booster pumps OFF and check fuel pressures to see that they remain within limits. Erratic fuel pressure readings indicate a faulty engine-driven fuel pump or other defects which must be investigated before flight. When this check has been completed turn booster pumps of tanks being used ON.

3. Heat and Anti-Icing Check—Completed.
Turn all cabin heat and tail and wing anti-ice switches to INC. until a temperature rise occurs, then turn to DEC.

CAUTION

Do not allow temperatures to exceed 50°C above ambient air temperature.

Check a little later to see that temperatures have receded to normal, indicating that the engine dump valves have operated through one complete cycle and are in the open position.

4. Alternator Checks—Completed. No constant-speed drive oil warm-up is required. Proceed with the following checks.

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DURING ENGINE WARM-UP (Cont'd)

a. Voltage and Frequency Range—Checked.

Note

Alternator control circuits will normally take approximately 5 minutes to warm up in normal ambient temperature ranges.

(1) Voltage and frequency selector switch to desired alternator.

(2) Voltage Control Knob—Check voltage range. The voltage range should be at least 195 to 215 volts by adjustment of the engineer's voltage control knob. Reset voltage to 208 volts.

(3) Frequency Control Knob—Check frequency range. The maximum frequency should be 440 ($\pm$5) cycles. DO NOT go above 445 cycles. If the limit 440 ($\pm$5) cycles is not obtained, adjustment should be made to the frequency control rheostat located in the governor control "J" box on the respective engine distribution panel. On some airplanes, the frequency control rheostats are located in the lower left side of the forward cabin between the radio and observer's compartment. While adjustments are being made, the engineer's frequency control knob will be turned to full decrease to preclude the possibility of the constant-speed drive going into underdrive. After the adjustment is made, the minimum indication with the engineer's knob in the FULL DECREASE position will be approximately 370 cycles, depending upon the constant-speed drive and control circuit temperatures. Reset frequency to 405 cycles.

(4) Repeat the above steps on alternator-equipped engines.

b. Emergency Power—Checked. The alternator will be checked by using the emergency method of restoring normal electric power. The inflight procedure is given in Section III, "Emergency Procedures." This ground check will vary slightly. Proceed as follows:

(1) Reduce a-c and d-c electrical loads to a minimum and request all crew members to turn off all unnecessary electrical loads.

(2) De-excite all alternators.

(3) External Power Switch—OFF.

(4) Battery Switch—OFF.

(5) Turn the voltage and frequency selector switch to No. 2 alternator.

(6) Move the emergency power switch to EMERGENCY and momentarily hold the respective exciter control relay switch ON.

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DURING ENGINE WARM-UP (Cont'd)

Pilot's Flight Instrument Switch—EMERGENCY and check instruments for proper operation. When check is completed, place switch in the ON position.

(7) Request the pilot to move his flight instrument switch to EMERGENCY and to check that his flight instruments are functioning properly.

CAUTION

With the t-r test unit selector switch in RADIO OPERATOR position, a crew member on interphone should observe the load on the unit during the check of the first alternator. Do not permit the d-c load to exceed 1.0 (50 amperes) as indicated on the test unit. An overload can damage the t-r unit, or blow out the a-c instrument fuses at the engine distribution panel with a resulting loss of all emergency power. The voltage output of the transformer-rectifier should be 24 to 28 volts. It is the characteristic of the t-r unit that as the load is increased its output voltage decreases. A d-c overload on the radio operator's t-r unit may occur when power is suddenly applied through the emergency circuit, causing the voltage to be low for a short time.

(8) Repeat steps 4b (5) thru 4b (6) for 3, 4, and 5 alternator-equipped engines.

(9) Close the alternator breaker switch of No. 5 alternator.

Note

If you find that the alternator functions normally on the line, return the emergency power switch to NORMAL and readjust voltage and frequency.

(10) Request pilot to place his flight instrument switch back to ON.

(11) Battery Switch—ON.

c. Alternator Power Check—Checked. With No. 2 and No. 5 alternators on the line, split the bus by opening BUS TIE 5-2 and BUS TIE 3-4. See step 4d (6) below for paralleling. Remove No. 5 alternator from the line. The normal mixture indicator lamps will go out. Place the alternate power switch in the ALTERNATE position. The mixture lamps should light. Close BUS TIE 5-2 and BUS TIE 3-4. Place the alternate power switch in NORMAL. Parallel remaining alternators in the normal manner, starting with step 4d (6) below.

d. Alternators On Line—Minimum of two. If the above "Special Check" was satisfactory, then the electrical panel will be set up using the normal method during the preflight prior to take-off.

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DURING ENGINE WARM-UP (Cont'd)

(1) Voltage and Frequency Selector Switch—No. 4 position.

(2) No. 4 Voltage and Frequency—Adjust to 208 volts and 405 cycles.

(3) Voltage and Frequency Selector Switch—Bus Position (Detent between 4 and 5).

(4) External Power Supply Switch—OFF. Watch bus voltage and frequency drop-off.

(5) No. 4 Alternator Breaker Switch—CLOSE. Watch bus voltage and frequency build-up. Adjust frequency if necessary.

(6) Voltage and Frequency Selector Switch—No. 5 position.

(7) No. 5 Voltage and Frequency—Adjust to 208 volts and 405 cycles. Make fine adjustment on frequency until alternator synchronizing lamps blink at slowest rate possible.

(8) No. 5 Alternator Breaker Switch—CLOSE. (When alternator synchronizing lamps are out.) The synchronizing lamps indicate three things. First, when both lamps are blinking simultaneously, they indicate correct phase sequence. Second, alternately blinking lamps indicate a crossed phase sequence; very serious damage will result if two alternators with opposing phase sequences are paralleled. It would amount to a direct short of the total output of both units. Third, the lamps indicate when two alternators of correct phase sequence are in or out of step. Lamps out indicate "in step" and lamps on indicate "out of step."

(9) Adjust the kilowatt and kilovar load division as indicated on the kilowatt-kilovar meters. These meters read kilowatts when the kilowatt-kilovar selector switches are in the KWATTS position. Use the frequency control knobs to divide the kilowatt load. Move the kilowatt-kilovar selector switches to the KVAR position and use the voltage control knobs to divide the kilovar load.

(10) Repeat steps (6) thru (9) to parallel No. 3 and No. 2 alternators.

(11) Voltage and Frequency Selector Switch—Detent position between any two alternator positions. This will allow you to read bus voltage on the voltmeter. Selection of any alternate position enables you to read individual frequency and voltage of alternators on stand-by.

(12) Instruct ground crew to unplug the external power supply if the aircraft is to be taxied. When it is unplugged, the Correct-Incorrect phase sequence lamps will go out.

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DURING ENGINE WARM-UP (Cont'd)

1. Bomb Bay and Camera Doors—Closed. Closing the camera doors as soon as possible will eliminate the possibility of the window being splattered with mud, snow, or slush during taxi and engine run-up. Bomb bay doors will be closed before taxiing to prevent anything from being blown into the bomb bays by the propeller blast.

5. Engine Oil-In Temperature—Minimum 40°C. Check all engine temperatures in limits, paying particular attention to oil-in temperatures prior to advancing throttles for engine run-up. CHT must be above 120°C before exceeding idle rpm.

TAXIING.

If it is necessary to move the aircraft to a run-up area, taxiing will be accomplished in accordance with the instructions given in "Taxiing" of this section.

Note

> It is important that a propeller reverse check be made before taxiing to assure a means of stopping the aircraft in the event of brake failure. This check may be made at idle rpm.

ENGINE RUN-UP.

The operational preflight procedures call for inflight oil cooling door check, propeller checks, cabin pressure wing shut-off valve and carburetor preheat checks, barometric pressure checks, ignition system checks, and power checks. Power checks include full power with no boost checks, turbo override and single turbo checks, and full power with boost checks. After power checks are completed on any engine it should be shut down as soon as its cylinder head temperature cools to 170°C or as low as possible if unable to attain 170°C, provided take-off is not to follow and provided it is not needed for taxiing or for jet engine starting or operation. Run-up procedures are as follows:

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1. Parking Brake Switch—BRAKE ON. The aircraft commander will set the parking brakes and both he and the pilot will stand by on the foot brakes in case the aircraft creeps forward during engine run-up or in case of parking brake failure.

2. Nose Wheel Steering Switch—OFF. This switch must be in the OFF position during all ground operation—except when you are taxiing—to eliminate unnecessary hydraulic pump operation.

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ENGINE RUN-UP (Cont'd)

3. Propeller Reverse Selector Switches—SAFE (lights out). When the aircraft commander has the aircraft in position for engine run-up he should announce over interphone, "Nose steering switch off, all propeller reverse selector switches safe, parking brakes set, ready for engine run-up." As each item is announced, the aircraft commander should check each one by putting his hand on the item being checked. The propeller reverse selector switches have a gang bar to move all three switches to the READY position, but in order to place them in the SAFE position, each of the three switches must be moved individually.

Note

Pull the pilot's landing gear control circuit breaker upon the engineer's request. Close the circuit breaker as soon as the engineer requests it.

4. Pilots' Manifold Pressure Gage—Checked. This is a check to insure that the instrument is functioning normally by cross checking the indication on the engineers' No. 4 engine manifold pressure gage with the pilots' manifold pressure gage. The pilots' manifold pressure gage gives an indication of No. 4 engine only and is used as master indicator for the pilots' observation.

5. Master Tachometer—Checked. Cross check the pilots' master tachometer setting with the setting on the engineers' master tachometer during all propeller automatic checks. This check should be made when the engineer sets 1700 rpm with the propeller master motor. When this check is complete, stand by for a propeller reverse check.

6. Propeller Reverse Check—Completed, lights out. The propeller reverse check will be made at the same time as the engineer's propeller control system check. The engineer will notify the aircraft commander when he has 1700 rpm set and is ready to check propeller reversing.

Propellers will be checked in symmetrical pairs (inboards, centers, outboards) in that order. This will minimize flutter of the aileron tabs.

a. After the engineer reports that engines are ready for propeller reverse check, place the inboard reverse selector switch in READY.

b. Announce over the interphone, "Reversing inboards." This alerts the engineer. Then depress the propeller reverse pitch switch, thereby energizing the circuit and reversing the selected pair of propellers. After the circuit has been energized, it is not necessary to depress the reverse pitch switch again as long as one pair of propellers remain reversed. As each pair of

1. Inflight Oil Cooling Doors—Checked. Request the pilot, "Pull landing gear control circuit breaker." Ask the ground observer to let you know when all inflight oil cooling doors are open. Keep a close watch on oil temperatures during this check. While the oil temperature is increasing you can continue with your other checks. The doors will be visibly open at approximately 86°C oil-in temperature. Ask the pilot, "Close the landing gear circuit breakers," as soon as the ground observer reports or as soon as the oil-in temperature reaches 98°C.

2. Propeller Control System—Checked. This is to provide a complete operational check of the automatic, reversing, manual increase and decrease, and feather control circuits.

a. Throttle Levers—Set to obtain approximately 1900 rpm.

b. Master Motor Speed Control Lever—1700 rpm. Decrease until master tachometer indicates 1700 rpm. The rpm of all engines should decrease until engine tachometers indicate 1700 (± 50) rpm. This step checks automatic decrease rpm controls and resets propeller low limit blade angle limit switches.

c. Advise aircraft commander, "Ready for propeller reverse check."

d. Observe propeller reversing in symmetrical pairs. Note for definite increase in engine rpm and then the decrease back to the original rpm. This is a definite indication that the propellers are governing in reverse. Also note that normal pitch lamps go dark.

ENGINE RUN-UP (Cont'd)

PILOTS

propellers is reversed, check to see that the corresponding red propeller reverse warning lamps light.

c. Announce, "Reversing centers," and place the center reverse selector switch in READY. Check corresponding red propeller reverse warning lamps.

d. Announce, "Reversing outboards," and place the outboard reverse selector switch in READY. Check corresponding red propeller reverse warning lamps.

CAUTION

Do not allow outboard propellers to remain in reverse pitch longer than 5 seconds because of possible aileron damage due to aileron flutter.

e. The propellers will be brought out of reverse in symmetrical pairs (outboards, centers, and inboards) in that order. Move outboard reverse selector switch to SAFE and announce, "Outboards safe, lights out."

f. Move center reverse selector switch to SAFE and announce, "Centers safe, lights out."

g. Move inboard reverse selector switch to SAFE and announce, "Inboards safe, lights out."

h. Receive engineer's report, "Propellers normal, lights on," after reverse check.

ENGINEERS

e. After propellers are reversed, report to aircraft commander, "Propellers reversed, lights out."

f. As propellers return from reverse, obtain definite increase in engine rpm and then decrease back to the original rpm. Also note that normal pitch lamps light.

g. After propellers return to normal pitch report to aircraft commander, "Propellers normal, lights on."

h. No. 1 and 6 Propeller Selector Switches—DEC. RPM until engine speed drops to 1400 rpm, then INC. RPM until engine speed reaches 1500 rpm. Finally, place selector switches in AUTOMATIC OPERATION. Engine speed should return to 1700 rpm. Repeat this procedure on remaining engines, working inboard on symmetrical pairs—ie., 2 and 5, 3 and 4, RPM's quoted are approximate. You are looking for direction of control primarily and not for specific rpm. However, when switches are released, pitch change must stop and rpm should not overshoot over 100 rpm unless the propeller selector switches are sticking. Anticipate instrument lag, power build-up, and power drop; release the switches about 50 to 100 rpm shy of the value you are shooting for. All engine rpm's should return to 1700 rpm after this check.

i. Momentary Feather Check—Completed. Perform check in this order: Engines 1, 2, 3, 4, 5, and 6. All engines should return to 1700 rpm after this check. Raise the propeller feather switch guard. Place your fingers behind the switch guard, actuate the switch with your thumb, and immediately slap the guard down with your fingers. Shoot for a 100-rpm drop-off

ENGINE RUN-UP (Cont'd)

and automatic return to 1700 rpm. This checks the fast rate feather operation.

CAUTION

Do not leave the propeller feather switch in FEATHER longer than 1/4 of a second, or the propellers will go into full feather. Stand by on the mixture control levers and, in the event of a malfunction, move to IDLE CUT-OFF immediately to lessen the possibility of an induction fire.

j. Master Motor—2800 rpm.

Note

If you are proceeding with the cabin pressure wing shutoff valve and carburetor preheat checks, the master motor should remain at 1700 rpm.

3. Cabin Pressure Wing Shutoff Valve and Carburetor Preheat Checks (all six engines at one time)—Completed.

a. Aft cabin pressure shutoff valve switch—DEC.

b. Turbo boost selector lever—10 position.

c. Throttle levers—Adjust to obtain 35 inches M. P.

d. Cabin pressure wing shutoff valve switches—L. WING INC and R. WING INC.

e. Carburetor preheat switches—ON and check the following:

(1) Ceasing of cabin pressure air flow into the cabin.

(2) M. P. drop of 2 to 4 inches.

(3) Rapid increase in carburetor air temperature.

CAUTION

Do not allow CAT. to exceed 43°C.

f. Carburetor preheat switches—OFF and check the following:

(1) Resumption of cabin pressure air flow into the cabin.

(2) Rise in M. P.

(3) Decrease in carburetor air temperature.

g. Aft cabin pressure shutoff valve switch—INC.

h. Cabin pressure wing shutoff switches—L. WING DEC and note decrease in air flow; then R. WING DEC and note further decrease in air flow.

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ENGINE RUN-UP (Cont'd)

i. Turbo booster selector lever—ZERO.

j. Throttles—Idle.

k. Master motor—2800 rpm.

4. Barometric Pressure Checks—Completed. Set throttles to manifold pressure values observed by second engineer prior to engine start. Observe the rpm, torque, and fuel flow of all engines while you are making this check in order to insure a positive check of return from high fan drive and spark advance checks before proceeding to higher powers. Proceed with the following checks:

a. Engine Cooling Fan Speed Check.

Fan Speed Control Switches—HIGH RPM and check torque pressure and rpm drop (approximately 75 to 175 rpm). Initial torque pressure drop should not exceed 30 psi. Stabilized pressure drop should be 7 to 20 psi. Fan Speed Control Switches—LOW RPM and check torque pressure and rpm return to normal. After return to normal, check the anti-icing temperature again to see that the dump valves are open and temperatures have receded. Torque pressure and rpm should now be stabilized, so proceed with the next check.

b. Spark Advance Check.

Spark Advance Switches—ADVANCE and check for a definite rise in torque pressure up to 6 psi and an rpm increase of 25 to 50.

Note

If a definite rise in torque pressure is not noted, either a malfunction of the spark advance system or improper spark timing exists. A torque pressure rise in excess of 6 psi may be indicative of an engine out of time. Although an engine slightly out of time will operate satisfactorily, engine efficiency (maximum economy) will be affected.

Spark Advance Switches—RETARD and check for a drop in torque pressure to normal.

Note

In the event that the torque indicating system does not determine proper spark advance operation, use the engine analyzer as follows:

(1) Index the cycle selector switch to D1 cylinder and select the desired engine on the condition selector switch.

(2) Mark the scope at the normal firing event with a soft pencil.

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ENGINE RUN-UP (Cont'd)

(3) Move the spark advance switch to ADVANCE. The scope pattern will shift to the left approximately 5/16 inch in a proper spark advance operation.

(4) Return the spark advance switch to RETARD. If proper operation occurs, the pattern will shift back to its original position.

CAUTION

Spark must be retarded before going to higher power. If in doubt of spark position, make a single ignition check. If the spark is still advanced, the rpm drop will be negligible.

Note

Note oil, carburetor air, and cylinder head temperatures before proceeding with the next check.

5. Ignition System Check—Completed. This check may be performed on one engine at a time or in symmetrical pairs, as conditions, time, and engine temperatures permit. Record required readings then retard throttles to idle. Use the following procedure to check engines:

a. Master motor speed control lever—Set to govern all engines at 2200 rpm.

b. Throttle lever (or levers)—Adjust to obtain a torque pressure of 140 psi.

Note

Manifold pressure should not exceed 40 inches.

c. Ignition button—Pull R1, allow torque to stabilize, record torque drop, and push back in.

d. Ignition button—Pull R2, allow torque to stabilize, record torque, and push back in.

Note

The maximum torque drop for one magneto is 8 psi, minimum 3 psi.

e. Repeat steps c and d for L1 and L2 individually.

f. Ignition buttons—Pull R1 and R2, allow torque to stabilize, record torque drop, and push back in.

Note

The maximum permissible torque drop for both right or left magnetos is 13 psi and minimum drop is 7 psi.

ENGINE RUN-UP (Cont'd)

g. Repeat step f for L1 and L2 magnetos.

Note

If torque pressure drops of less than 3 psi are experienced during the single magneto check or less than 7 psi during the dual magneto check, the engine should be given a thorough engine conditioning check. If after conducting this check the engines are found to be in satisfactory operating condition, despite the fact that the torque pressure drops are below the prescribed limits, the aircraft may be cleared for flight.

h. Repeat steps b thru g on remaining engines. When the above procedure is completed on the last engine, the first engine that was checked will be cool enough to continue with the next check.

i. Master motor speed control lever—INCREASE until master tachometer indicates 2800 rpm.

6. Full Power No Boost Checks—Completed. These checks may be performed on one engine at a time or in symmetrical pairs as conditions, time, or engine temperatures permit. Use the following procedure to check engines:

a. Intercooler Shutter Switches—OPEN.

b. Advance throttle lever (or levers) of coolest engine to full open and check for proper acceleration. Allow this full throttle no boost power to stabilize for approximately 30 seconds. Observe rpm, M. P., torque, and fuel flow. If manifold pressure varies more than 3 inches between engines with a corresponding variation in torque reading (approximately 11 psi) the engine is not operating correctly or the propeller low pitch stop setting is incorrect.

7. Turbo Override and Single Turbo Check—Completed.

Note

Do not operate the turbo override system on more than two engines at a time. The turbo waste gate has a fast rate of travel when the vernier switch is OFF.

a. Turbo Control Change-Over Switches—MANUAL on the engines being checked.

b. Turbo Control Vernier Switch—ON.

c. Turbo Control Override Switches—Jiggle in the CLOSE position until a rise of 3 to 5 inches M. P. is obtained.

ENGINE RUN-UP (Cont'd)

d. Turbo Vernier Switch—OFF.

e. Turbo Control Override Switches—Momentarily hold in the OPEN position until a drop of 1 to 2 inches M. P. is obtained.

f. Turbo Control Change-Over Switches—AUTOMATIC and check that M. P. returns to the original value.

g. Engine Supercharger Switches—SINGLE TURBO. Check manifold pressure rise (approximately 6 inches).

h. Engine Supercharger Switches—DUAL TURBO and check M. P. drop to original value.

i. Intercooler Shutter Switches—OPEN.

Note

If engine temperatures permit, continue on to next check. If not, retard throttles to allow engines to cool and repeat steps 6a thru 7i on remaining engines.

8. Full Power With Boost Checks—Completed.

a. Turbo Boost Selector—Advance smoothly to position 6. To avoid sudden overboost of engines, always exercise due caution when moving turbosupercharger controls or when moving throttles of an engine if turbosupercharger controls are set.

b. Turbo Calibration Knobs—Trim M. P. to 57 inches.

c. Water Injection Switches—ON and note decrease in fuel flow and an increase in water pressure to 23 to 27 psi on aircraft with electrical derichment and 30 to 36 psi on aircraft with hydraulic derichment.

Note

Manifold pressure will rise 2 to 3 inches with water injection ON. If there is not a proper rise in water pressure, the water injection switches must be turned OFF immediately.

d. Turbo Calibration Knobs—Indexed at 60 inches M. P. and note rpm, M. P., torque, and fuel flow. Check turbo calibration knob indexing after manifold pressure is set up. If index marks do not line up, hold the center screw in place with a screw driver and move outer plastic knob until index marks are lined up.

CAUTION

Do not exceed 246 torque pressure.

e. Water Injection Switches—OFF and note rise in fuel flow. To prevent flooding the engine when reducing power, water injection must be turned OFF before reaching 55 inches M. P.

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ENGINE RUN-UP (Cont'd)

f. Turbo Boost Selector—Zero and not M. P. drop.

g. Throttle Levers—Retard to Idle.

h. Repeat steps 6a thru 8g on remaining engines.

Note

After all reciprocating engines have been checked and indexed at 60 inches M. P. with water injection ON, move the calibration knob in full decrease. Then, *without changing the screw driver adjustment,* check that the index marks on the knobs are relatively in the same position. If the index mark of an individual calibration knob is not in the relative position of the index marks of the other knobs, that engine must be checked for turbo system malfunction or induction system leaks. Upon completion of the check, realign the index mark on each knob with the index mark on its housing without disturbing the screw driver adjustment.

STARTING JET ENGINES.

Jet engines are considered to be supplementary power for the B-36. They provide an ease of operation never before experienced in heavy gross weight take-offs and high altitude performance of a basically reciprocating-engine powered aircraft. Due to their relatively high specific fuel consumption, the jet engines should not be used unwisely.

Unlike the complex reciprocating engines, your jet engines are mechanically simple. Although a preflight run-up of the jets cannot be omitted, they need not be run during the "Preflight Operational Equipment Check" except to ground-check a new installation or to clear previous discrepancies. Ordinarily, if your jet engines were satisfactory on the last flight and the required visual inspections reveal nothing of any consequence, they may be started immediately prior to take-off with a power check constituting the preflight run-up.

Consult the maintenance records and the crew chief to find out which jet engines, if any, must be checked. Let your engineer know before engine start whether or not any jet engines are to be run so that he may arrange his run-up accordingly.

Once the engineer starts his reciprocating engine run-up, it will be necessary for him to utilize the interphone and the ground observer if ground time is to be held to a minimum. Therefore, the best time to start the jet engines is probably after the engineer has finished his power checks and has shut down No. 1 and No. 6 engines. After the jets are started and are idling satisfactorily, all but two alternator-equipped engines which have their alternators on the line may be shut down.

Record the starting times, temperature of each hot start, and the number of minutes at each power setting. The "Time Today" and "Hot Starts" are recorded in the Part II, AF Form 1, along with other noted discrepancies. The number of minutes at each power setting affects fuel consumption should be given to your engineer.

By the time you have taxied into position for reciprocating engine run-up, the control tower should have dispatched a fire truck to the area so that you can start your jet engines.

Before starting jet engines, make certain that the danger areas, as shown in figure 2-4, are clear of personnel and ground equipment. When a jet engine instrument is read during starting or during changes of power and rpm, the instrument panel may be vibrated to get accurate readings from the instrument.

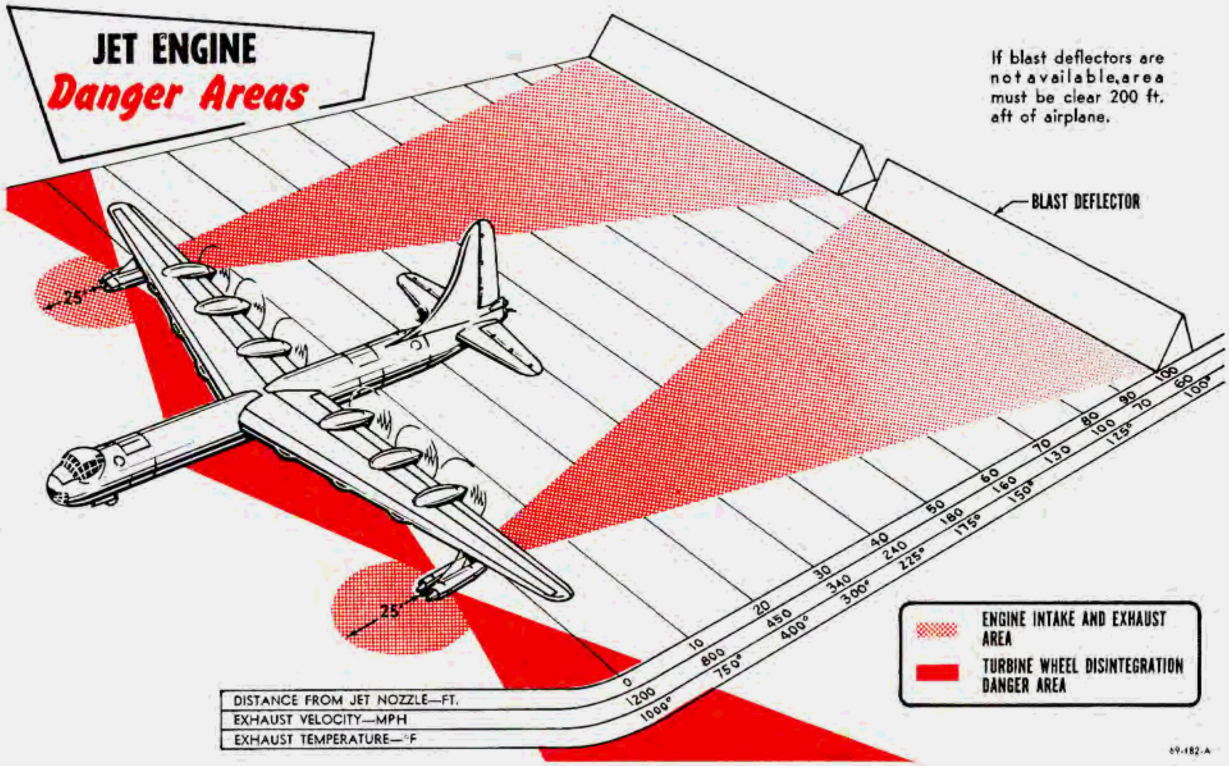


Figure 2-4.

Cautions To Observe During Jet Engine Starting.

Throttle Sensitivity. The throttles are very sensitive to throttle lever movement; therefore, extreme care must be used when operating the throttle levers.

Hot Starts. For information on hot starts, refer to "Jet Engines," Section V.

Failure to Start. If the engine fails to start before 11 per cent rpm is reached, close the throttle, close the engine fuel valve, and release the starter switch. Allow 3 minutes for fuel to drain from the combustion chambers before attempting another start.

Engine Starter Limitations. Operation of the engine starter is limited to three starting attempts of 45 seconds duration each. If more than three attempts are required, allow the starter to cool one hour. Do not attempt a start until the engine has come to a complete stop.

In the event false starts are experienced, operation of the starter is limited to two false starts of 20 seconds duration each and one actual start during a 30-minute period. If necessary, this cycle may be repeated immediately; however, after the second cycle a one-hour cooling period will be required before any further attempt is made to start the engine.

Accelerations and Decelerations. The engine should accelerate from 50 to 100 per cent rpm in approximately 12 seconds. When 100 per cent rpm is obtained, the high rpm stop should prevent overspeeding. If time permits, accelerations and decelerations should be slow in order to prevent unnecessary wear and tear on the engine. If time does not permit, then rapid throttle movements can be accomplished and the fuel regulator will control the acceleration rate. The exhaust temperature during rapid acceleration may climb momentarily to a value over 690°C but not over maximum allowable for take-off and acceleration.

Starting Procedure.

The jet engines are simple to start and easy to operate, but always use your check list and complete it in the following sequence:

PILOTS

1. All Circuit Breakers—IN. Push in all circuit breakers on the pilots' jet control panel. Don't forget the throttle circuit breakers.

2. Fire Detection Test Switches—TEST and Release. This will test the continuity of the fire detection circuits from the jet pods to the lamps.

3. Throttle Selector Switches—LEVER.

4. Throttles—Closed.

Note

On airplanes equipped with a jet throttle position indicator, make a sweep of the engines with the selector switch to ascertain that the throttles are closed. If the indicator shows that a throttle is not closed, a start of that engine must not be attempted until the source of difficulty has been corrected.

5. Pod Preheat Switch—OFF.

6. Nose De-Ice Switch—OFF.

7. Oil Heater Switch—As Required. Turn this switch ON to heat the jet engine oil if the ambient air temperature is below 41° F (5°C).

8. Oil Shutoff Valve Switches—OPEN.

9. Notify engineer, "Set up jet start configuration."

10. Danger area clear and fire equipment standing by. Clear the starting area of personnel and equipment. If the jet engines cannot be started in the parking position, have the aft gunners clear the danger area and have a fire truck proceed to the starting position.

11. Nose Shutoff Door Switches—OPEN. Check doors visually. The aircraft commander will make a visual check of J-1 and J-2 while the pilot is visually checking J-3 and J-4 to see if the doors are open.

12. Manifold Valve Switches (L and R)—OPEN.

13. Booster Pump Switches (L and R)—ON. No pressure will be indicated on the fuel pressure gage until the throttles are advanced to open the stopcock.

14. Ignition Start Switches—NORMAL.

15. Throttle Position Indicator Selector Switch (some airplanes)—Select J-1 engine.

ENGINEERS

1. Jet Start Configuration — Checked and report, "Standing by for jet engine start."

a. At least two alternators paralleled on the line (three on the line and one standing by recommended).

b. Engines with alternators, which are on the line, operating above 1200 rpm for heavy electrical loads to minimize wear on the constant-speed drives.

c. Two tank valve switches OPEN and two booster pump switches ON in each wing.

PILOTS ENGINEERS

STARTING JET ENGINES (Cont'd)

16. J-1 Engine Fuel Valve—OPEN.

17. J-1 Fuel and Oil Pressure Gages—Note reading.

18. Notify ground observers or aft scanner—"Starting J-1." If a ground observer is present he will move to a position where he can see when the engine is being started and observe the exhaust heat waves and report when combustion occurs.

19. J-1 Starter Switch—Hold ON until the engine attains 20 per rpm.

20. J-1 Throttle—OPEN at 6 per cent rpm to obtain 25 to 30 psi fuel pressure. Move the throttles slowly to prevent overshooting due to the lag in the pressure indication. On airplanes equipped with a throttle position indicator, observe the throttle opening during this phase of the starting. Maintain 25 to 30 psi during initial acceleration to avoid excessive temperatures in the tail pipe and around the shroud ring and shroud ring binding which are caused by higher fuel pressures. Although the engines will probably start at 6 to 11 per cent rpm, the starter switch should be held ON to aid engine acceleration until 20 per cent rpm has been reached. This reduces the possibility of excessive tail pipe temperatures during the initial acceleration period. During a normal start, combustion will occur immediately after fuel pressure is indicated.

21. J-1 Oil Pressure—Report indication on interphone. This precludes the possibility of operating an engine with no oil pressure and also permits the crew member keeping the jet engine log to maintain an accurate record of operating time.

Note

Prior to starting J-2, run J-1 to 70 per cent rpm and check for approximately 5 psi indicated oil pressure.

22. J-1 Starter Switch—Release at 20 per cent rpm.

23. J-1 Throttle—Adjust to maintain idle rpm (25 to 30 per cent), keeping the tail pipe temperature below maximum allowable used for normal flight operation.

24. J-2, J-3, and J-4—Repeat steps 14 thru 23.

25. All Ignition Start Switches—OFF.

STOPPING JET ENGINES (GROUND).

The pilots will stop the jet engines as follows:

PILOTS

Note

Jet engines must be stopped prior to shutting down the last two alternator-equipped reciprocating engines.

1. Throttles—Idle for 3 minutes; then CLOSE. The 3-minute idle period will stabilize temperatures throughout the engines, preventing malfunctions due to differential expansion and contraction of engine parts. Remember that the tail pipe temperature indicator takes the temperature at the tail pipe only.

2. Jet Booster Pump Switches—OFF.

3. Manifold Valve Switches—CLOSE below 20 per cent rpm.

4. Engine Fuel Valves—CLOSE below 10 per cent rpm.

5. Nose De-Ice Switch—OFF.

6. Pod Preheat Switch—OFF.

7. Oil Heater Switch—OFF.

8. Oil Shutoff Valve Switches—CLOSE after engines stop rotating.

9. Throttle Circuit Breakers—Out.

10. Jet Nose Shutoff Door Switches—CLOSE, after thirty minutes. Jet nose shutoff doors should remain open for approximately thirty minutes after stopping jet engines to allow sufficient circulation of air through the engine to dissipate the residual heat. It will be necessary to vary this procedure as weather conditions dictate. The advisability of leaving the nose shutoff doors open during blowing snow, sand, etc. must be carefully considered by the aircraft commander. If these conditions exist, nose doors will not be closed above 100°C tail pipe temperature and zero per cent rpm.

Note

Aft scanners will observe jet engines for residual fire during all jet engine shutdowns and immediately report any fire.

DURING RECIPROCATING ENGINE SHUTDOWN.

The aircraft commander will accomplish the following during reciprocating engine shutdown:

1. Parking Brake Switch—BRAKE ON.

STOPPING RECIPROCATING ENGINES.

The engineer will stop the reciprocating engines as follows:

ENGINEERS

1. Air Plug Switches—OPEN until air plugs are fully open. This will allow the engines to cool to 170°C (or as low as possible if unable to attain 170°C) before shutdown and will allow heat to dissipate after shutdown.

2. Master Motor Speed Control Lever — Full DECREASE.

3. Propeller Selector Switches—FIXED PITCH.

4. Booster Pump Switches—OFF.

5. Alternator Controls Positioned.

a. Voltage and Frequency Selector Switch—to position of alternator-equipped engine to be shut down.

b. Alternator Breaker—OPEN. Observe that the alternator breaker lamp lights.

c. Frequency Control Knob—Full Decrease.

d. Repeat the above steps on alternator-equipped engines, one at a time, until only one alternator is left. After completing the above steps on the last alternator, re-establish electrical power by reclosing the alternator breaker or by placing the external power switch ON if an auxiliary power unit is available. If the correct phase sequence lamp is on, the APU is plugged in and standing by.

6. Perform idle speed and mixture check as engines are shut down as follows:

a. Check to see that cylinder head temperature is at 170°C or as low as possible if unable to attain 170°C.

b. Throttle Lever—Advance to 1700 to 1800 rpm and allow engine to operate at this rpm for approximately 10 seconds for scavenging purposes. Then return to idle and allow rpm to stabilize.

c. Idle Speed—Checked. Should be set for 1100 rpm with throttles fully retarded, approximately 160°C

PILOTS

ENGINEERS

STOPPING ENGINES (Cont'd)

2. Propeller Reverse Selector Switches—SAFE (lights out.)

3. Nose Wheel Steering Switch—OFF.

4. Flight Instrument Switches—OFF.

5. Contact engineer, "Ready to stop engines."

CAUTION

Aircraft commander, engineer, and aft scanner will remain on interphone. The pilot will have radio tuned to tower frequency until the last propeller has stopped turning.

6. Radio Equipment—OFF.

($\pm 10°$) CHT, no wind condition, and average barometric pressure for seasonal conditions at the base at which your aircraft is primarily stationed. Allow a 30-rpm variation for each 10 mph effective head wind.

d. Mixture Control Lever—IDLE CUT-OFF. When the mixture control is moved *SLOWLY* to IDLE CUT-OFF, check the idle mixture setting for a minimum 5-rpm rise and a maximum 10-rpm rise as indicated on the respective engine tachometer. Record the readings that do not fall within these limits so proper settings may be made at the earliest possible convenience. A minimum 5-rpm rise when leaning the mixture assures that the idle mixture is not too lean while the 10-rpm maximum rise prevents idling in the "too rich" range.

Note

When making the idle speed and mixture check on the last alternator-equipped engine, the hold-in switch must be actuated until the engine drops to 1000 rpm. Release the hold-in switch as soon as the engine drops below 1000 rpm and observe that the alternator breaker lamp comes on, indicating that the alternator breaker has opened.

CAUTION

DO NOT hold the alternator on the line until the engine stops. This will reduce the stress imposed on the constant speed drive input shaft since the peak load on the shaft occurs as the engine speed drops below 1000 rpm.

7. Fuel Tank Valve Switches—CLOSE.

8. Cross-Feed, Manifold, and Engine Valve Switches—OPEN.

Note

Allowing these valves to remain open will prevent fuel expansion damage to the main manifold line.

9. Ignition Switches—OFF after propellers have stopped.

10. Intercooler Shutter Switches—CLOSE until intercooler shutters are fully closed.

11. Static Propeller Feather Check—Completed.

Note

The static feather check is required only after engine shutdown following completion of the "Preflight Operational Equipment Check."

PILOTS ENGINEERS

STOPPING ENGINES (Cont'd)

a. Contact ground observer on interphone—"Ready for static feather check."

b. Propeller Selector Switches—FIXED PITCH.

c. All propeller feather switches FEATHER position for 30 seconds then return to NORMAL position (feather switch guards down).

Note

If longer than 30 seconds is required to feather any propeller (i.e., cold weather operation), wait at least two minutes before attempting to complete the feather operation. Allow feather motors to cool a minimum of two minutes between feather and unfeather operation. Allow a minimum of five minutes before attempting to complete another cycle if a recheck is required.

d. The second engineer or a qualified observer will report all blade angles in the approximate feather position. Any propeller that will not reach the feather position on this check will not feather in the air and must be repaired or changed prior to flight.

e. Propeller Selector Switch—INC RPM. Hold in INC RPM until normal low pitch position is reached.

f. The second engineer or a qualified observer will report all blade angles returning to normal low pitch position.

12. Battery Switch—OFF.

Note

Thirty minutes after engine shutdown, have the propellers pulled through 10 blades with the starters. Energize the starter continuously for 10 blades.

DETAILED MISSION PLANNING.

Mandatory requirements for detailed mission planning set forth in Air Force, major command, and local directives. The purpose here is to maintain a proper sequence of events and to remind the aircraft commander that a study of the proper directives and a common sense application of the principles involved will promote better teamwork in developing good flight planning techniques.

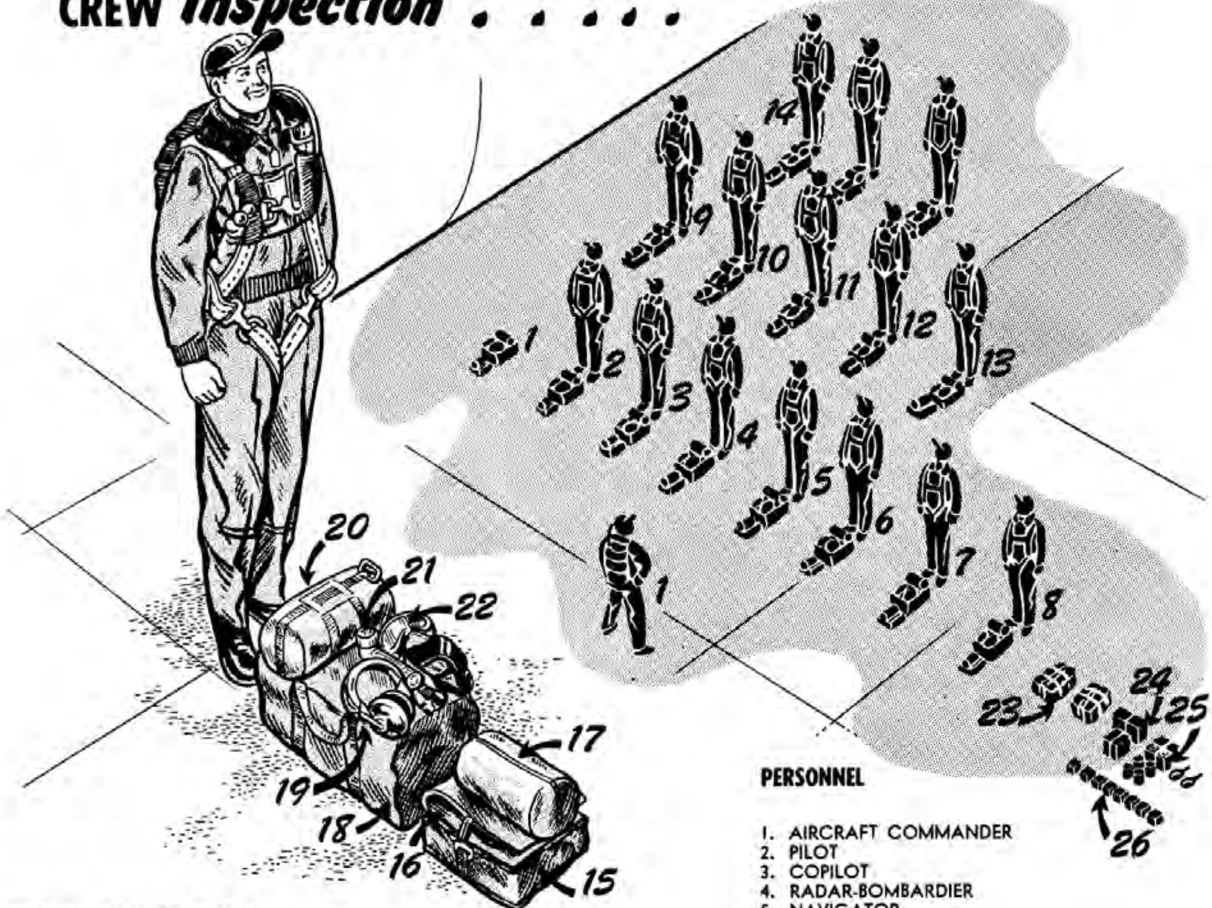
Note

Normally the basic Form F is completed during this planning phase; however, alterations will probably have to be made after the visual preflight inspection.

FORMAL BRIEFING.

As in "Detailed Mission Planning," the requirements for a formal briefing are set forth in other directives with which you must be familiar. Again, it is mentioned here to maintain proper sequence of events, to provide ready information as to the aircraft commander's responsibilities pertaining specifically to the B-36 aircraft, and to provide helpful suggestions or hints based on principles derived from experience gained in managing the B-36 combat crew. For aircraft commander's responsibilities see "Crew Duties." Section VIII.

CREW *Inspection* . . . . .



CREW INSPECTION.

The time for crew inspection shall be established during the formal briefing. Normally, the crew will report to the airplane for this inspection.

Note

> During inclement weather, the inspection may be accomplished under any available shelter. After such an inspection, all equipment should be packed in A-3 bags, transported to the airplane, and loaded aboard before "Final Crew Briefing."

In addition to the personal equipment required, each crew member will wear dog tags on each flight. The information on these tags must be kept current. All crew members will wear tags on a chain around their necks. Crew formation for crew inspection should be standardized so that all crew members know exactly what is expected of them. The crew will form on the left side of the aircraft and will lay out their personal equipment as shown in figure 2-5. Then the aircraft commander will accomplish the inspection as follows:

1. Give command, "Attention," and call the roll.

PERSONNEL

1. AIRCRAFT COMMANDER
2. PILOT
3. COPILOT
4. RADAR-BOMBARDIER
5. NAVIGATOR
6. OBSERVER
7. FIRST ENGINEER
8. SECOND ENGINEER
9. FIRST RADIO OPERATOR
10. SECOND RADIO OPERATOR
11. AFT SCANNER (RIGHT)
12. AFT SCANNER (LEFT)
13. TAIL GUNNER
14. PASSENGERS

PERSONNEL EQUIPMENT

15. ONE-MAN LIFE RAFT
16. MAE WEST
17. ANTI-EXPOSURE SUIT
18. A-3 BAG
19. HEADSET AND MICROPHONE
20. CHEST-TYPE PARACHUTE
21. FLASHLIGHT
22. OXYGEN MASK AND HELMET
    NOTE: BAIL-OUT BOTTLE ATTACHED TO PARACHUTE HARNESS

MISCELLANEOUS EQUIPMENT

23. EXTRA PARACHUTES, OXYGEN MASKS, AND BAIL-OUT BOTTLES
24. FOOD AND BEVERAGE CONTAINERS
25. ALDIS LAMPS
26. FIRST AID KITS

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Figure 2-5.

2. Give commands, "Right face," "At ease," and "Inspect parachutes." Each crew member shall check the parachute of the man in front of him. The aircraft commander's parachute shall be checked by the pilot. After checking the parachutes of the men in front of them, the crew members standing next to last in each line shall turn around and check the parachute of the man on the end of each line. As each crew member completes his part of the parachute check, he shall assume the "at ease" position.

Note

If both chest-type and back-type parachutes are used, each crew member must check his own chest pack in addition to checking the back pack as indicated in the preceding paragraph.

3. Give commands, "Attention," "Left face," and "At ease." Check each crew member's displayed equipment for completeness and condition. Spot check any crew member's equipment as desired. Each crew member will come to attention as the aircraft commander approaches to inspect his equipment.

4. Read discrepancies which are pertinent to your mission as noted in Parts II and III of Form 1.

5. Have the navigator give the crew a time "hack."

6. Designate specific crew members for command of the nose, radio, and aft compartments. Each of these men will command his compartment under all conditions. He will be responsible for the execution of all normal and emergency instructions affecting his compartment, and will subsequently notify the aircraft commander.

7. Give the crew any special instructions not previously covered and order any special checks necessary on preflight. Also, answer any questions the crew may have.

8. Announce the time for the final crew briefing.

9. Give commands, "Attention" and "Dismissed."

BOARDING AIRCRAFT.

All equipment will be loaded and stowed before "Final Crew Briefing" time. Each crew member will make a preflight check of his oxygen station and mask in accordance with the procedure described in "Oxygen System," Section IV. In checking his interphone, each crew member will use his oxygen mask mike and helmet, and check the normal interphone for side tone. He will then plug in his normal headset and switch to PVT INTER, checking this interphone channel in the same manner as the normal interphone check.

Note

On aircraft that have the ground man connected to the normal interphone system, all crew members will be on normal interphone at start engine time.

Compartment commanders will insure that all regulators in the compartment have been checked and that a uniform, full oxygen supply is provided. In addition each will check that all A-14 oxygen regulators are in NORMAL NORMAL or that the D-1 or D-2 regulators are in OFF, NORMAL.

Note

Before boarding the aircraft, the second engineer will check that the bomb bay doors are open with safety locks installed and that the auxiliary power unit has been started and is operating properly. If the bomb bay doors are closed, they will be pumped open and safety locks will be installed prior to starting the auxiliary power unit.

AIRCRAFT COMMANDER'S VISUAL PREFLIGHT INSPECTION.

HOW TO MAKE A GOOD PREFLIGHT.

The aircraft commander is responsible for performance of preflight inspections; however, the complexity of the aircraft and the detailed check lists make it necessary for the aircraft commander to delegate some of these preflight duties to the pilot and copilot as well as to other crew members. Being a teamwork airplane, close co-ordination and wise planning are required to effect a good preflight in a minimum amount of time. A good aircraft commander guards against fatiguing himself or his crew before starting on the mission. At the same time, he does not make a sketchy preflight inspection and risk an aircraft accident. Plan wisely and delegate responsibility.

A good aircraft commander will make the checks listed in figure 2-6 carefully and completely. Omit nothing. Follow the route shown in this figure. As your training and familiarization with the airplane progress, you will be able to speed up this inspection so that it does not hold up your preparation for flight, but still accomplishes its purpose. It is the aircraft commander's responsibility to see that the inspection is actually made and not just signed off on the AF Form 1.

Normally about two hours before take-off, it is necessary to complete all phases of the aircraft preflight and final crew briefing. This time will vary with the crew experience. In order to accomplish the preflight inspection in minimum time, it is well to delegate certain duties to the pilot and copilot. As aircraft commander you are personally responsible for the entire preflight inspection, but that does not mean you will accomplish the entire inspection yourself. Delegate the responsibility of certain portions of the aircraft preflight inspection to each pilot.

Have your pilots accompany you on preflight inspections until they become throughly familiar with inspection procedures and can be relied upon to make an inspection by themselves. Then you will be able to divide the aircraft up in sections, having one pilot inspect the top of the wings and the other pilot inspect one side of the aircraft while you inspect the other side. This will expedite the inspection and reduce the individual time and effort expended to accomplish a full preflight.

The aircraft commander, pilot, and copilot will inspect and check the aircraft as outlined in the following preflight check lists.

Aircraft Commander.

1. Oxygen supply and equipment checked in accordance with existing oxygen preflight procedure. Check normal interphone using helmet and oxygen mask, verifying side tone.
2. Check private interphone with regular headset, verifying side tone.
3. Assist pilot in checking control surfaces.
4. Check all lights at aircraft commander's station.
5. Visual preflight of aircraft as shown in figure 2-6.
6. Stow personal equipment.
7. Conduct fiinal crew briefing and receive preflight report.
8. Final check of aircraft (down locks, pitot covers, control locks, wing access panels, and nose scissors).

Pilot.

1. Oxygen supply and equipment checked in accordance with existing oxygen preflight. Check normal interphone using helmet and oxygen mask, verifying side tone.
2. Check private interphone with regular headset, verifying side tone.
3. All circuit breakers in.
4. Check parking brake pressure on engineers' auxiliary panel and set parking brakes.
5. Surface Controls and Trim Tabs—Checked. Before unlocking the controls, check for wind velocity and

Aircraft Commander's *Visual Preflight* Inspection

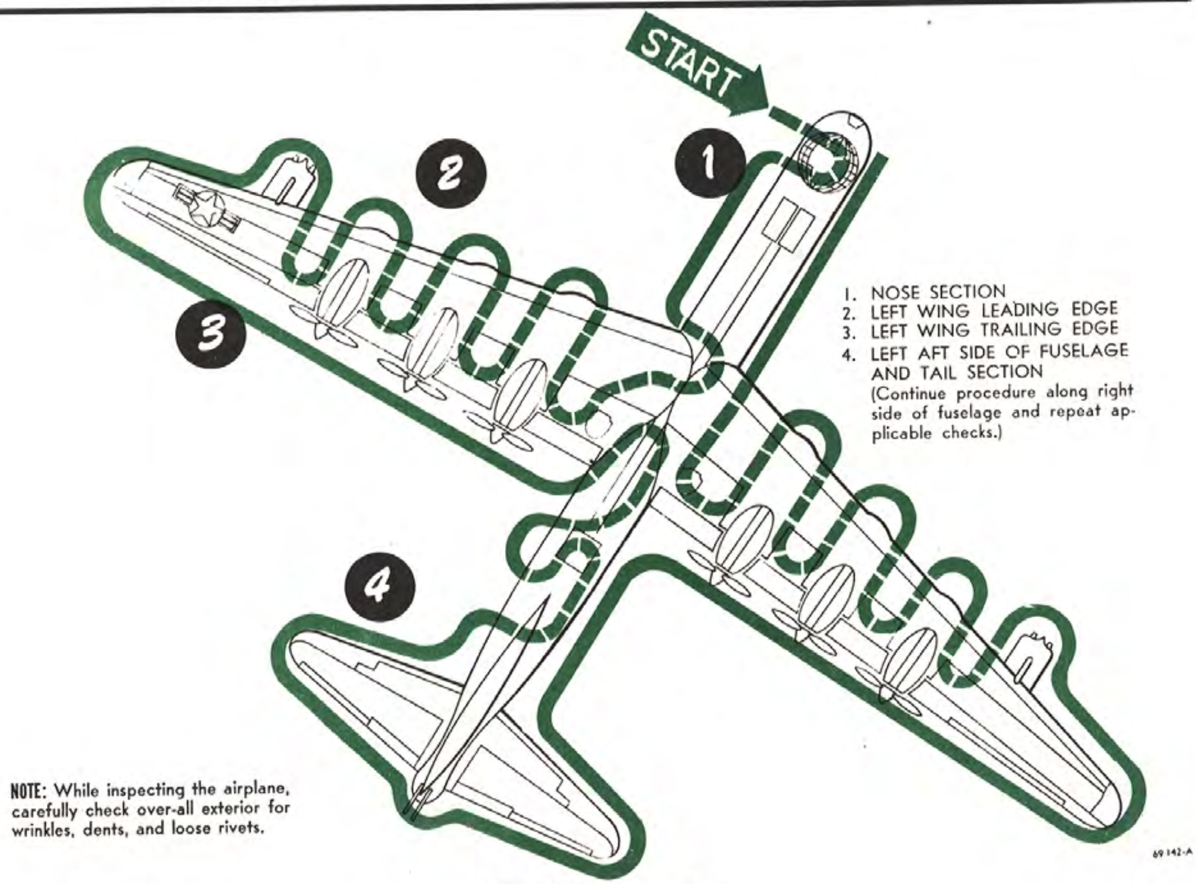
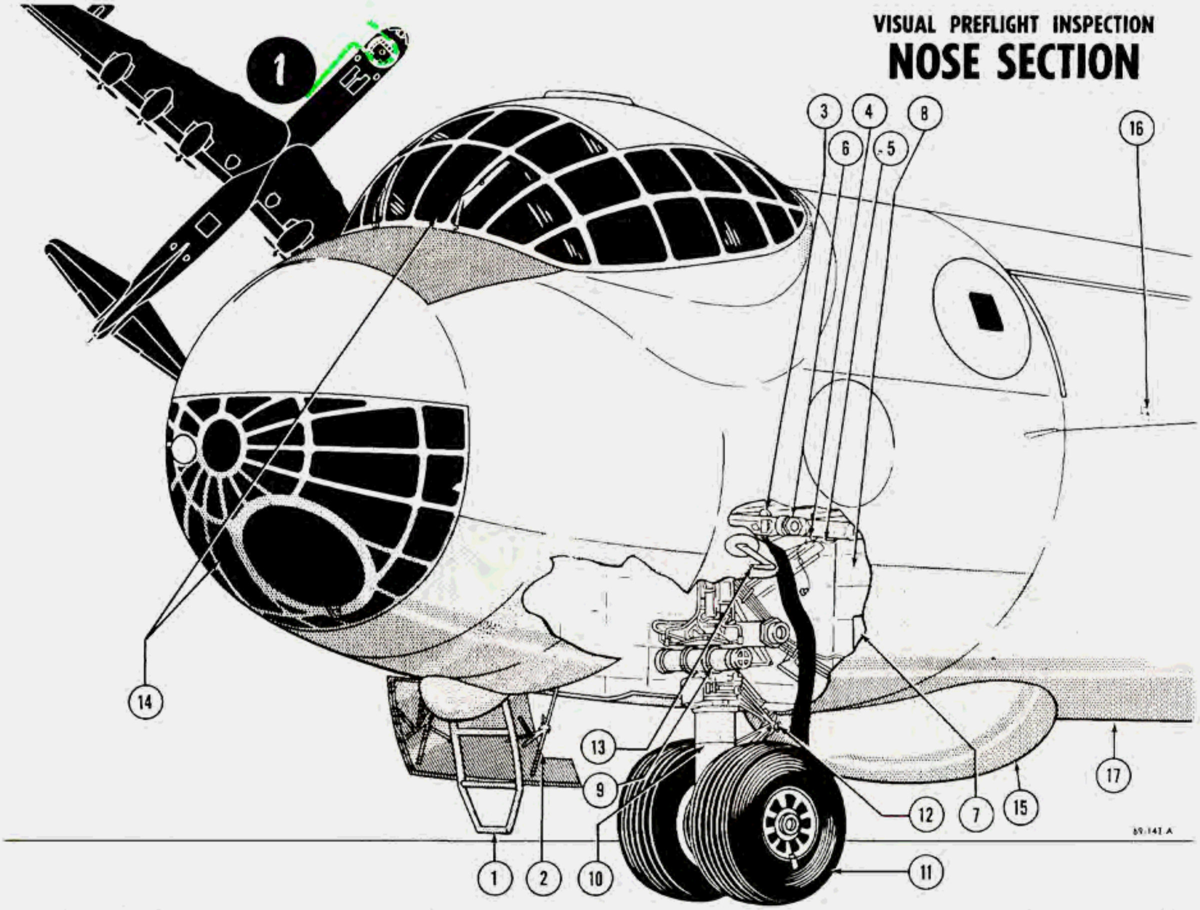


Figure 2-6. (Sheet 1)



1. Condition of nose entrance ladder, linkage, and stowage provisions.
2. Condition of nose wheel well doors, linkage, and pick-up arm.
3. Nose gear ground safety lock in place.
4. Nose gear latch mechanism and latch release link and pin in place.
5. Emergency release cables and pulleys for proper rigging.
6. Nose gear latch spot light for proper operation and security at mounting.
7. Battery for mounting, connections, and signs of corrosion in general area of battery.
8. Nose wheel area for hydraulic leaks.
9. Nose steering unit and equipment, including cable system and nose steering safety switch.
10. Oleo strut for cleanliness, proper inflation (3 inches plus or minus 1/4 inch), and general condition.
11. Tires and wheels for general condition, cuts, blisters, proper inflation, slippage, and wear (roll radius 20 inches). Security of co-axial retaining plate and pick-up arm roller.
12. Nose gear scissors for condition (up and connected).
13. Pitot mast covers removed and tube clear.
14. Nose glass and pilots' windshield for cracks and cleanliness.
15. Radar dome for cracks.
16. Static port clear.
17. Fuselage for cracks.

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Figure 2-6. (Sheet 2)

direction, and if possible, head the aircraft into the wind. Considerable difficulty may be experienced in moving the rudder and elevator in strong cross winds. Under these conditions it will be necessary to head the airplane into the wind before a rudder movement check can be made.

In the event ramp congestion prevents moving the aircraft into the wind, this check will be made when the aircraft is lined up into the wind prior to take-off.

Note

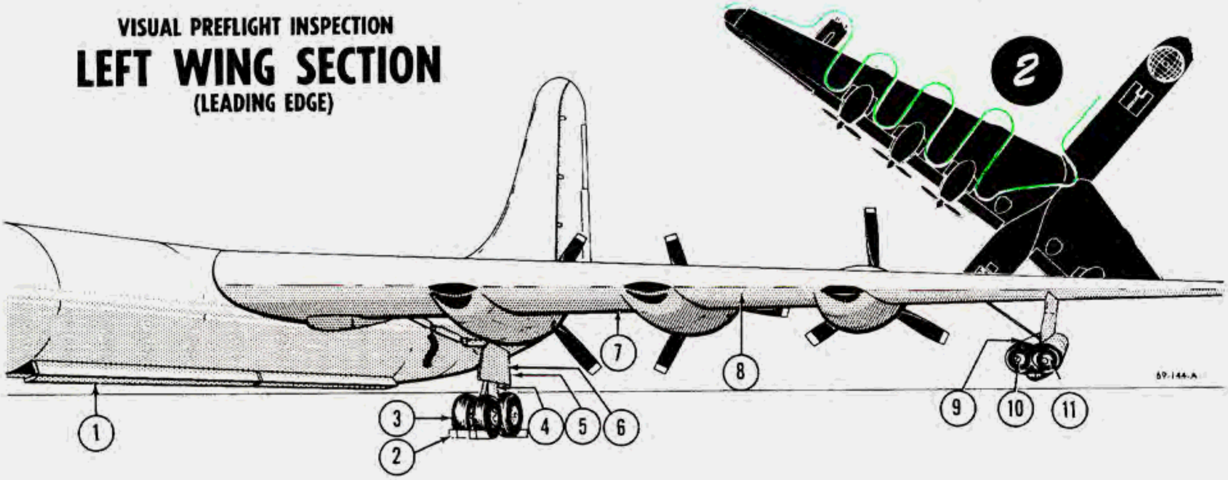
When the control lock switch is placed in the unlocked position, the red indicator lamp will go out the instant all lock actuators start their unlocking movement. If the green light does not come on after a slight delay, one or more control lock actuators are probably inoperative in the intermediate position. Even though the green light indicates the controls unlocked, a complete freedom of movement check must be accomplished. When controls fail to unlock, check the appropriate control lock fuse in the right main power panel.

A ground observer will check proper movement of the control surfaces and tab. The controls should be

VISUAL PREFLIGHT INSPECTION

LEFT WING SECTION

(LEADING EDGE)



1. Forward bomb bay and wing center section area for hydraulic and fuel leaks and for general condition.
2. M.L.G. safety lock and wheel chocks in place.
3. Inspect tires and wheels for general condition, cuts, blisters, proper inflation, slippage and wear. (Roll radius 24.3 inches plus or minus 1/8 inch.)
4. Left main wheels hydraulic brake lines, gear struts, and positioning jacks for leaks and safety switch for condition and mounting.
5. Oleo struts for cleanliness and proper inflation (3 1/2 inches plus or minus 1/4 inch.)
6. Condition of equalizer assembly, wheel fairing, and main column.
7. Underside of wing for loose rivets, cowling, inspection plates, open vents, fuel leaks, oil leaks, and cracks.
8. Leading edge for excessive dents and warping.
9. Jet engines 1 and 2 for loose cowling and general condition.
10. Jet engines starter cooling inlet plugs removed.
11. Jet air plugs open. Intakes for foreign material.

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Figure 2-6. (Sheet 3)

checked in the following order: elevators, rudder, and ailerons. To expedite this check it is recommended that the trim control be moved in the same direction as the control surface and that the surfaces, servo tabs, and trim tabs be checked simultaneously. For example, elevator trim full nose-up and control column full back gives elevator surface up with servo and trim tab down. Aileron trim tabs are checked by operating trim tab control switch in each direction and observing proper movement of control wheel and correct indication on the indicator. It should be remembered that aileron trim tabs are electrically operated and that a few minutes cooling period should be allowed to cool the electric motor.

Set trim tabs for take-off, using 30 per cent MAC as neutral elevators; set 1 degree elevator trim for each 1 per cent variation from 30 per cent MAC. If nose is heavy (30 per cent minus), trim nose up; if tail is heavy (30 per cent plus), trim nose down.

6. Surface Controls—Locked. After the surface control check is completed, the lock will be engaged. A red lamp will burn for controls in the locked position and a green lamp will burn for controls in the unlocked position. If neither green nor red lamp burns, the condition can be caused from the lamps being burned out.

7. Flaps and Indicators—Checked. Fully extend the flaps and have the ground observer report their position. Check the flap indicators for 30-degrees. Fully raise the flaps and check observer's report with indicators. If it is necessary to operate flap actuators for more than two cycles on the ground, allow the actuators to cool for approximately ten minutes between cycles.

8. Throttle Levers and Flap Warning Horn Check—Completed. Move the throttle levers, one at a time, to the full open position. Observe closely for binding to insure freedom of movement through entire range of travel. When all six levers are full open, check sounding of flap warning horn. Return the throttle levers, one at a time, to the fully closed position and check cutting out of warning horn after first throttle is retarded. Check for proper cushioning at extreme limits of throttle lever movement.

9. Turn autopilot ON.

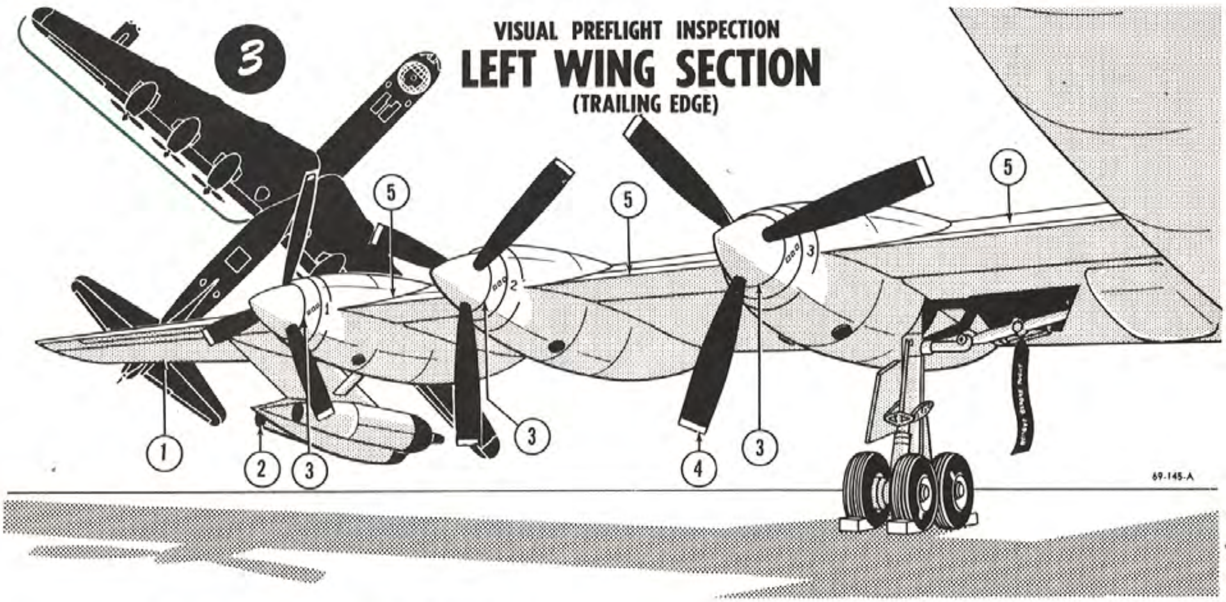
10. Check instrument panel and flight deck lights and see that spare bulbs are available.

11. Check autopilot and then turn OFF.

12. Turn on landing, formation, and position lights.

a. Landing lights OFF after ground check.

b. Formation and fuselage lights will be checked by the copilot while he is inspecting the top of the wing.



1. Wing tips, ailerons, and trim tabs for general condition. Aileron ground locks removed.
2. Jet tail section for general condition.
3. Air plugs and propeller after bodies for general condition.
4. Propeller blades and spinners for general condition and oil leaks.
5. Flaps for general condition.

Figure 2-6. (Sheet 4)

c. Position lights will be visually checked in FLASH and STEADY position. (This can be accomplished during jet engine pressure check.)

13. Check pitot covers removed by ground observer and turn pitot heater switch ON.

a. Turn pitot heater switch OFF after being checked by ground observer.

14. Jet Engine Fuel System Pressure Check.

a. Jet Nose Shutoff Door Switches—OPEN.
b. Throttle Selector Switches—LEVER.
c. Throttle Levers—Closed.
d. All Circuit Breakers—In.
e. Jet Manifold Valve Switches (L and R)—OPEN.
f. All Jet Engine Fuel Valve Switches—OPEN.
g. Fuel Booster Pump Switches—ON.

Note

This jet panel configuration will be maintained for no more than 5 minutes. This procedure allows an adequate fuel pressure check of the entire jet engine fuel system down to the jet engine fuel stopcock. On engines equipped with a check valve in the by-pass line between the fuel pump and the flow divider, leakage from the aft drain system is not normal and an engine start must not be attempted until the source of difficulty is located and corrected. On engines not equipped with a check valve in the by-pass line, slow dripping from the aft drain system is normal because of the bleed by-pass. However, if the dripping appears to be excessive, disconnect the line between the aft drain and the combustion chamber drain manifold. If it is determined that fuel is leaking from the combustion chamber, an engine start must not be attempted until the source of difficulty is located and corrected. If fuel is leaking from the forward drain and it is determined to be from the flow divider, an engine start may safely be attempted provided the leak is not in excess of approximately 90cc per minute (steady flow).

h. Obtain ground observer's report—Fuel Pressure Check—Normal.

i. Jet Fuel Booster Pump Switches (L and R)—OFF.
j. All Jet Engine Fuel Valve Switches—CLOSE.
k. Jet Manifold Valve Switches (L and R)—CLOSE.
l. Jet Throttle Circuit Breakers—Out.
m. Jet Nose Shutoff Door Switches—CLOSE.

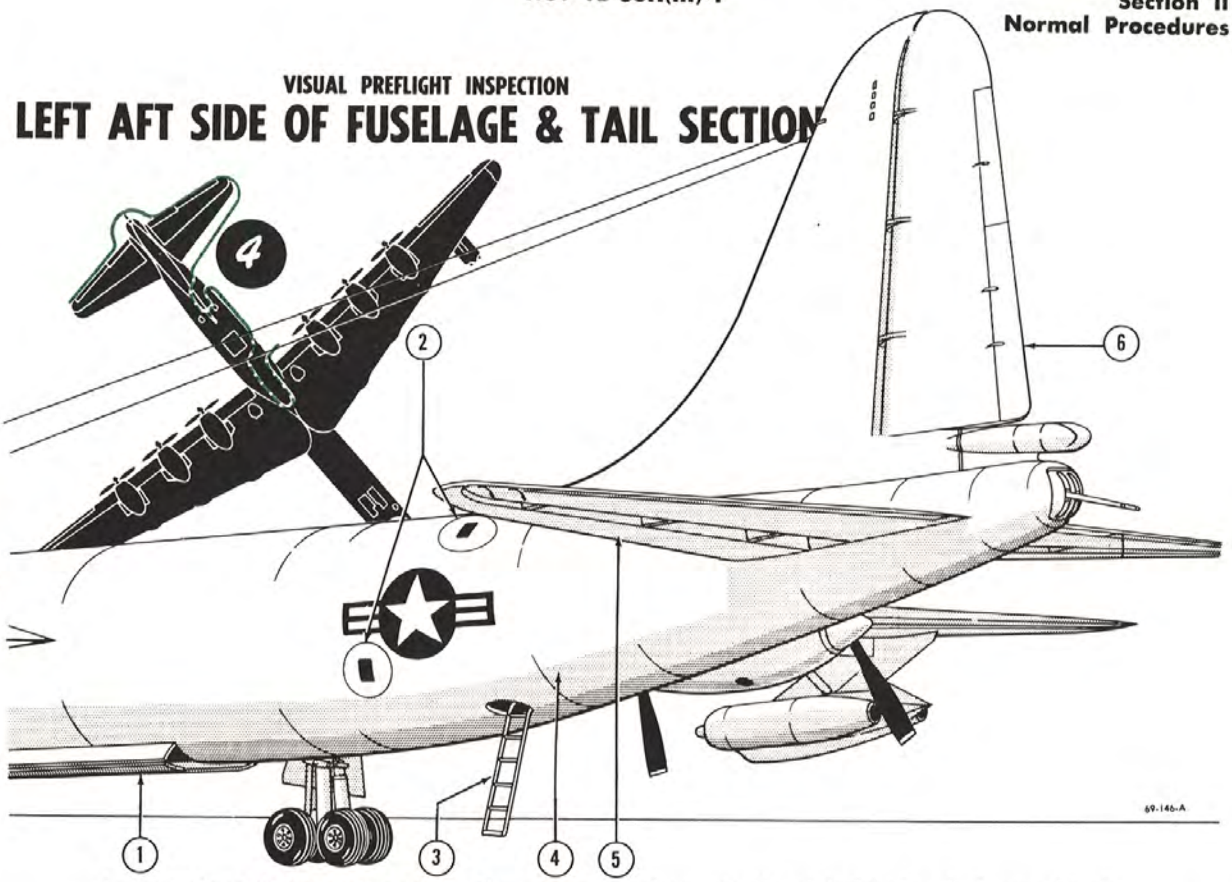
15. Check pilots' night flying curtain stowage in the forward cabin.

16. Notify aircraft commander of aircraft discrepancies.

17. Stow personal equipment.

VISUAL PREFLIGHT INSPECTION

LEFT AFT SIDE OF FUSELAGE & TAIL SECTION



1. Proceed to check aft bomb bay, repeating the procedure followed for forward bomb bays. If a bomb bay tank is installed, check for leaks and general condition.
2. Scanning windows for cleanliness and cracks.
3. Enter the aft cabin through the aft entrance hatch and check for cleanliness, stowage of equipment, and general condition.
4. Leave aft cabin and check fuselage skin for general condition.
5. Horizontal and vertical stabilizers for general condition. Rudder ground locks removed.
6. Rudder, elevator and tabs for general condition.

Figure 2-6. (Sheet 5)

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Copilot.

1. Oxygen supply and equipment check in accordance with existing oxygen preflight procedure.

2. Proceed to top of wing and check for condition of the following:

   a. Loose rivets and fasteners.

   b. Control surfaces and aileron curtains.

   c. Fairings and cowlings.

   d. Propellers, spinners and intercooler shutters.

   e. All anti-icing ducts and accessible valves.

   f. Turret doors.

   g. Hatches and general condition of fuselage.

   h. Formation and fuselage lights.

   i. Tail surfaces.

3. Notify aircraft commander of aircraft discrepancies.

4. Stow personal equipment.

ENGINEERS' VISUAL PREFLIGHT INSPECTION.

This inspection will be accomplished on the day of flight with a minimum of two engineers. Although the first engineer will be assisted in the inspection, this in no way relieves him of the responsibility of insuring that every step is properly completed. He is expected to know the B-36 and to determine its condition before flight.

The procedure contained herein comprises an inspection route (figure 2-7) arranged in a sequence which will allow greatest efficiency. The procedure results in a thorough inspection. Various factors may force it to be modified slightly. Additional items may be inspected as warranted by local conditions and requirements; but all items must be performed.

Actually your preflight inspection begins as you and the second engineer approach the aircraft. You should

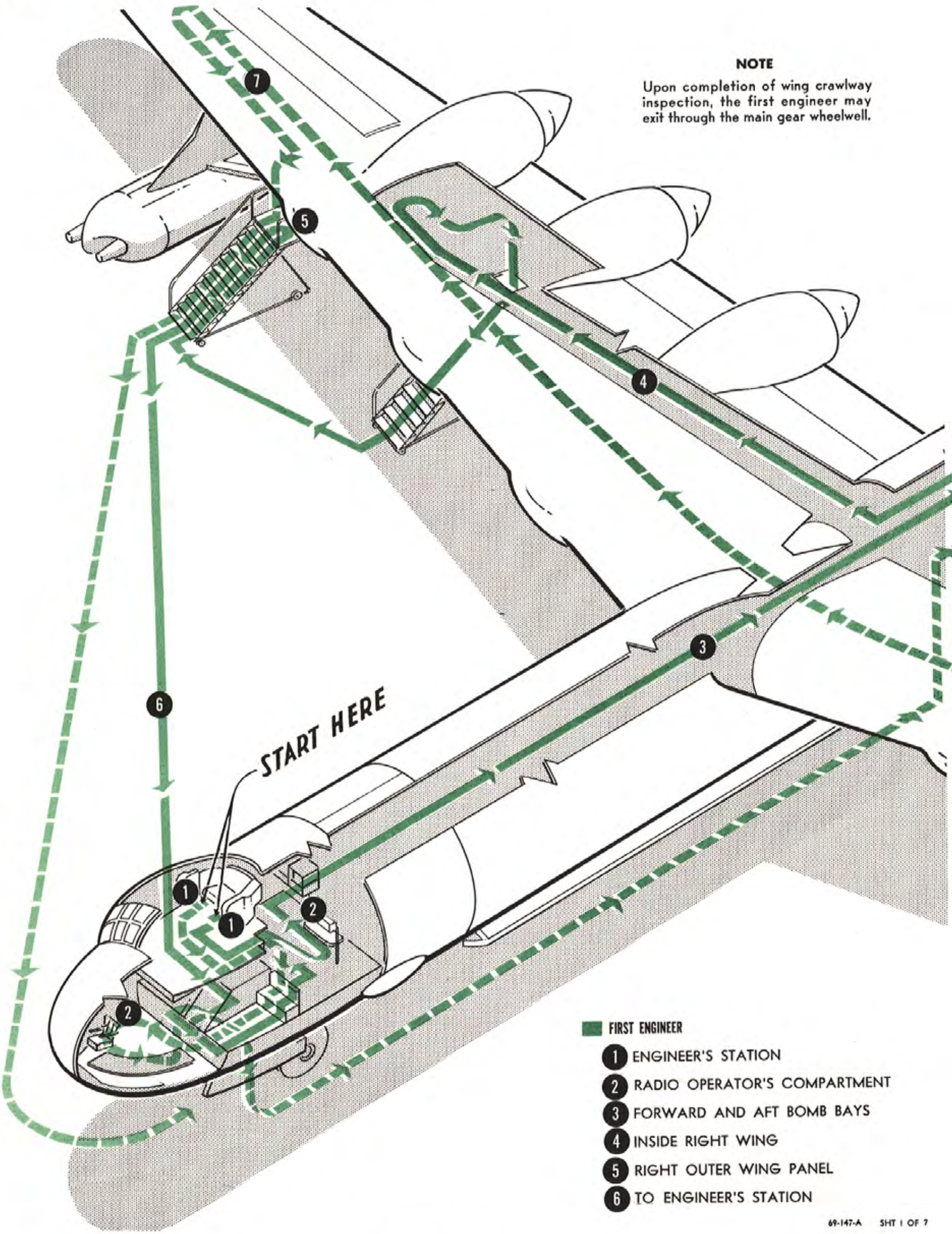

Figure 2-7. (Sheet 1)

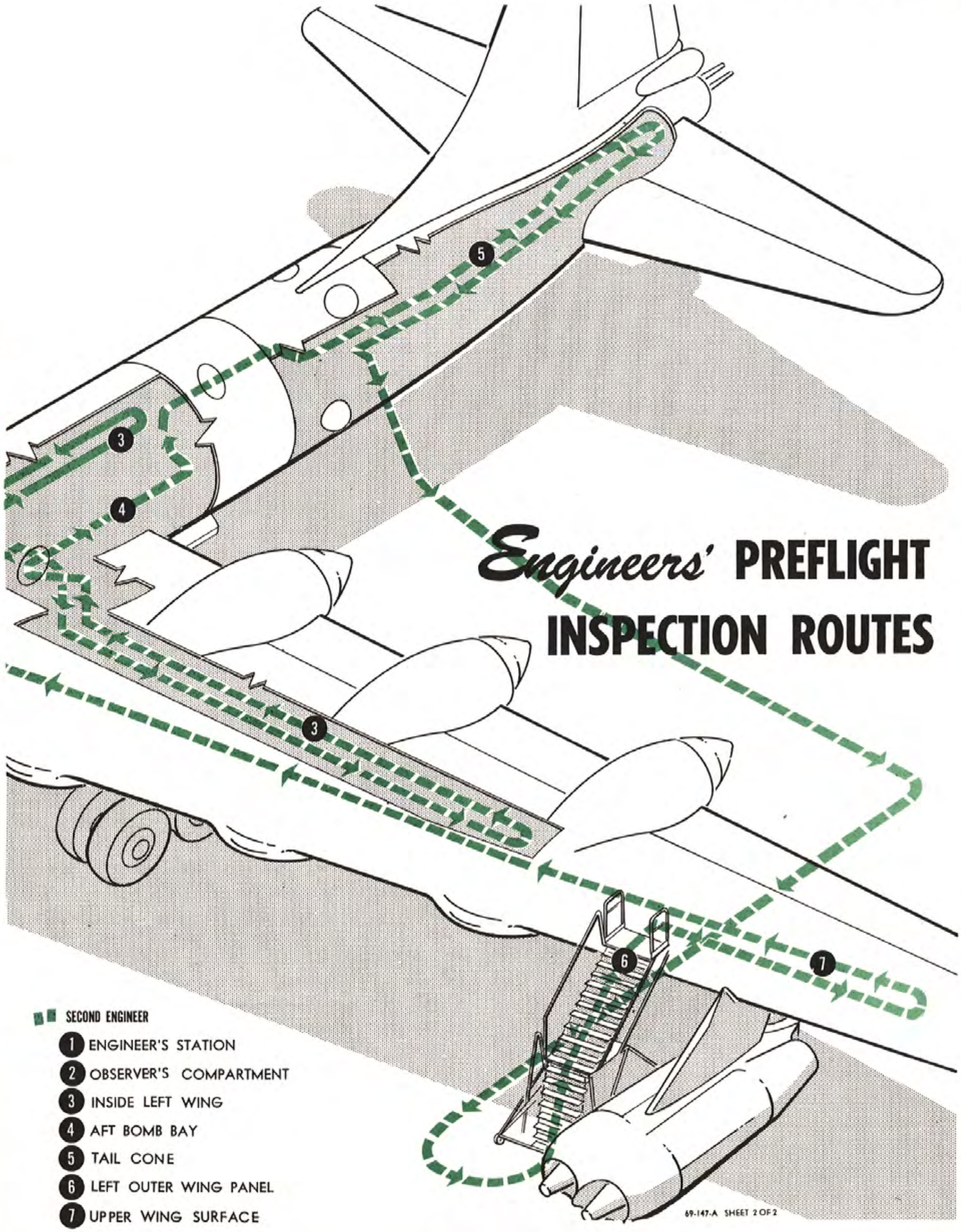

Figure 2-7. (Sheet 2)

have immediately noticed if any obvious maintenance was still in progress and if adequate stands, auxiliary power units, lighting, towing equipment, fire equipment, etc., are standing by for use.

Note

Insure that the wing access panels between the outboard and center engines on left and right wings have been removed in order to provide an escape route in the event of fires occurring during the wing crawlway inspection. Also check to see that the jet access panels are removed.

Recheck the status of the aircraft with the crew chief as reflected by Parts II and III of the AF Form 1. Pay particular attention to the corrective action taken on all discrepancies noted by the crew during the preflight operational equipment check.

The Part II of the AF Form 1 should indicate that the daily inspection has been completed, the amount of fuel, oil, and water injection fluid serviced, and the totals of fuel and oil by location.

Standby for crew inspection. Upon completion of this crew inspection both engineers will proceed with their preflight inspection.

Note

In order to prevent an abort or late take-off, any discrepancies discovered during the preflight inspection will be reported to the crew chief immediately so that corrective action may be started as soon as possible.

FIRST ENGINEER.

Engineer's Station.

1. Required Forms—Aboard and Checked.
2. All Circuit Breakers and Control Switches—Properly positioned.
3. Ground Refueling Safety Switch (Some airplanes)—OFF (Guard Down).
4. Emergency Power Switch—NORMAL.
5. Cabin Heater Power Switch—OFF.
6. External Power Supply Switch—OFF.
7. Battery Switch—ON.
8. Alternator Panel Configuration—Checked.
9. Call ground observer for external power.
10. Correct A-C Phase Sequence Lamp—Lighted.
11. External Power Supply Switch—ON.
12. Engine Ignition Switches—OFF.
13. Mixture Control Check—Completed.
14. Throttle Lever and Flap Warning Horn Check—Completed.
15. Fuel Panel Configuration—Checked.
16. Liquid Lock Check (with ignition switches OFF)—Completed.
17. Intercooler and Air Plugs—As required.

Note

If an operational preflight was not performed, a static propeller feather check will be performed at this time. See "Stopping Reciprocating Engines" for amplification.

18. Instrument Check—Normal.
19. Altimeter—Check and set at 29.92.
20. Panel Lights—Check.
21. Wheel Well Lights Switch—ON.
22. Nacelle Fire Detection Circuit—Push to test.
23. Wing, Cabin Heat and Tail Anti-Ice Switches—Full decrease.
24. Minimum of two tank valves OPEN and booster pumps ON (one in each wing to provide system pressure).
25. All Engine Fuel Valves—OPEN to allow pressure up to carburetors and to cause oil cooler control motors to operate.
26. Oxygen supply and equipment check in accordance with existing oxygen preflight procedure. Check normal interphone using helmet and oxygen mask, verifying side tone.
27. Engineer's Fuse Panel—Check for proper rating and security of fuses.
28. Alternate A-C Power Switch—NORMAL, lamp lighted.

Radio Operator's Compartment.

1. Emergency dump valve pedal reset in untripped position and valve closed (manual modulating knob full clockwise).
2. Visually inspect condition and rigging of normally accessible control cables and pulleys.
3. T-R Test Unit—Check voltage and load output of each t-r unit and the battery; return selector switch to RADIO OPERATOR.
4. Turbo, jet throttle, and mixture control amplifiers. Check wiring, mounting, and presence of two spares.
5. Inspect propeller filter junction box and master motor.
6. Inspect autosyn instrument amplifier, transformers, and fuse panel for condition, wiring, mounting, and presence of spare fuses. Switch in NORMAL.
7. Auxiliary Oxygen Pressure-Checked, supply valve closed.

Forward and Aft Bomb Bays.

1. Bomb bay lights switch ON.
2. Auxiliary Oxygen Bottles in Forward Turret Bay—Security and condition.

Left Main A-C POWER PANEL

3. Check general condition and security of the following:

a. A-C and D-C fuse panels.

b. Bomb bay for cracks, breaks, etc.

c. Heat and pressurization ducting.

d. Cables, pulleys, wiring, hydraulic lines, and oxygen bottles.

e. Loose equipment.

4. Disconnect interphone at station 6.1.

5. Inspect main hydraulic panel and electrical hydraulic relay panel.

6. Check aileron cross-over cables, pulleys, and autopilot servo for interference, condition, rigging, and proper alignment.

7. Inspect brake panel.

8. Inspect manifold fuel lines, fuel valves, and center wing section.

9. Inspect emergency flap switches, cables, wiring, and flap synchronizers.

10. Disconnect interphone at station 7.1.

11. Inspect bomb bay No. 3 fuel tank quick-disconnects.

12. Inspect auxiliary spar (station 8.0) for evidence of failure.

13. Inspect transformer-rectifier units (fans operating).

14. Wing crawlway and interphone switches—ON.

Inside Right Wing.

1. Inspect the following items for general condition, security connections, routing, etc.

a. Accessible portions of the fuel manifold lines, valves, and tanks.

b. Wheel well and wing crawlway lights.

c. Throttles and flap synchronizer cables for condition and rigging.

d. Fuel level transmitters for proper mounting and wiring.

e. Fuel tank vent lines and vapor return lines.

f. Pressurization ducting and flow limiters.

g. Wing flap relays and attachments.

1. BUS 301
2. BUS 201
3. LEADS TO BUS TIE BREAKER 5-2
4. LEADS TO BUS TIE BREAKER 4-5
5. SPARE FUSES
6. FUSES
7. LEADS TO LEFT FORWARD TURRET POWER PANEL
8. LEADS TO LEFT AFT TURRET POWER PANEL
9. BUS TIE BREAKER 2-3
10. BUS TIE BREAKER 3-4

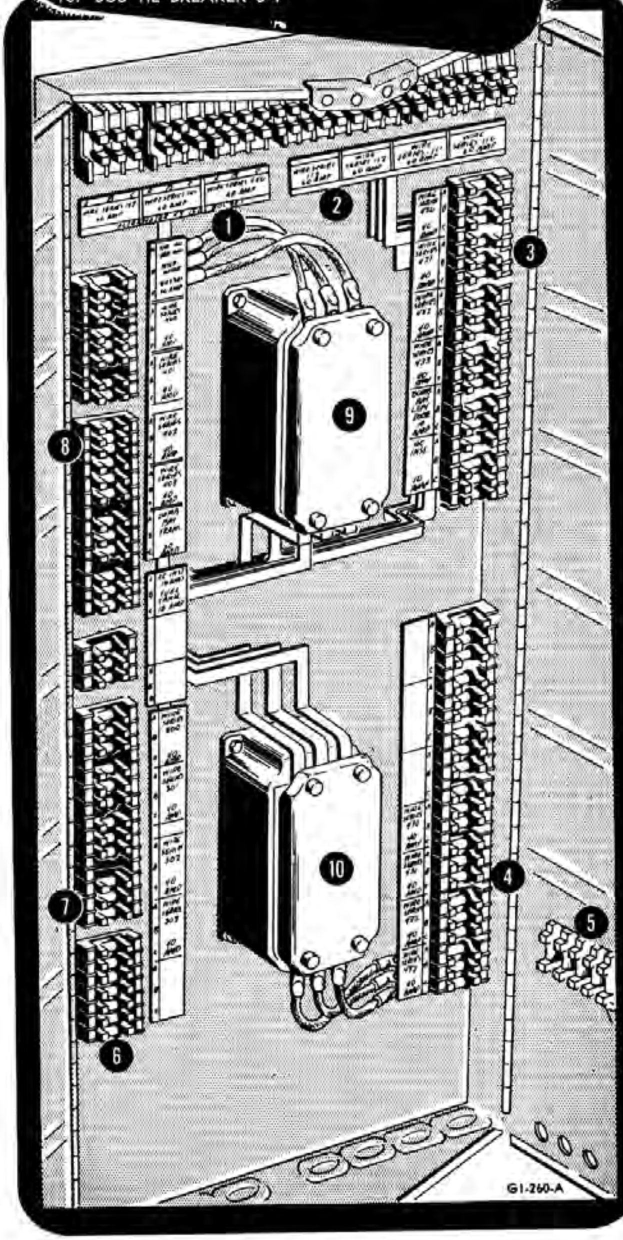

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Figure 2-8.

h. Accessible wing internal bracing.

i. Accessible internal wiring.

j. Condition of miscellaneous crawlway equipment.

2. Fire extinguisher agent cylinders, valves, and pressure. Auxiliary spar forging for cracks.

3. Inspect condition of all hinges, levers, and actuating linkages for landing gear fairings, doors, and sequence valves.

4. Inspect the latch mechanism and main gear wheel well door limit switches for proper condition, security of mounting, proper electrical connections, and corrosion or binding of the micro-switch actuating mechanism.

5. Make the following inspection of the main landing gear manual extension controls:

a. Cable wound correctly on large drum approximately 2 turns.

b. Hoist hook and spring properly stowed, ratchet handle for security.

6. Check the main landing gear hydraulic actuating mechanism, lines, and connections for security, condition, and evidence of leakage.

7. Check the main side brace for general condition of the latching mechanism, proper connecting and alignment of latch release arm at both ends, and security and condition of hydraulic snubber. See that the ground safety lock is in place.

8. Landing gear pivot shaft attachments for fuel leaks, security, and condition.

9. Inspect the following at each engine nacelle:

a. Alternator and turbo oil tanks for leaks.

b. K-truss cutout and accessible engine mounts for cracks.

c. Accessible ducting for alignment, cracks, breaks, connections, etc.

d. Check tank-to-engine oil lines and connections for leaks, oil thermostats for proper operation, and manual crank stowed on engine oil shutoff valves.

10. Inspect each engine power distribution panel for the following:

a. Check the A, B, C phase power-on indicator lamps and proper rating and installation of the active and spare fuses. Check bottom of the panel for cleanliness.

b. Check the 28-volt d-c power lamp and the alternator control fuses.

c. Check the relays for proper wiring and security of mounting.

d. Visually inspect the wiring and mounting of the alternator control units.

11. Return to crawlway entrances and turn off wing crawlway light and interphone switch.

Right Outer Wing Panel.

1. Distribution panel for wiring, security, fuse ratings and condition.

2. Fuel and oil lines for condition, installation, and leaks.

3. Fuel and oil valve for mechanical and electrical hook up and leaks.

4. Jet booster pump tank for installation and leaks.

5. Jet oil tanks for condition and leaks.

6. All structure for condition and security.

7. Aileron control linkage and aileron lock for security.

Engineer's Station.

1. Fuel Panel Configuration—Booster pumps OFF, close all tank and refueling valves—all other valves OPEN.

2. Note fuel quantity as indicated on tank gages and check this later with quantities dip sticked by second engineer.

3. If no one is using external power, turn OFF the external power and battery switches.

Miscellaneous.

1. Check status of all last minute repairs with the crew chief and insure that wing access panels have been replaced.

2. Complete or correct Form F and return to the aircraft commander, who will check it for accuracy and sign. It is your responsibility to see that the aircraft is properly loaded and balanced.

3. Complete the take-off and landing data card. Obtain the take-off and the anticipated landing gross weights and CG locations. Also check to ascertain that the required amounts of fuel, ammunition and bombs have been loaded. Loading information can be obtained from the "Handbook of Weights and Balance," T.O. 1-1B-40. Refer to "Operating Limitations," Section V for operational weight limitations. Check the basic weight of your aircraft carefully. Remember, it probably has undergone modification affecting its weight. Be absolutely sure that the basic weight you are using applies to the airplane you are going to fly.

4. Check the results of the preflight inspection with your second engineer. You and the second engineer will then meet with the aircraft commander and go over all discrepancies noted. Enter them in Form 1, Part II.

5. Stow personal equipment.

SECOND ENGINEER.

Engineer's Station.

1. Assist the first engineer as required to perform station check.

2. Oxygen supply and equipment check in accordance with existing oxygen preflight procedure. Check normal interphone using helmet and oxygen mask, verifying side tone.

3. Check private interphone with regular headset.

Observer's Compartment.

1. Remove sufficient overhead upholstery (under flight deck) to visually inspect control column and brake pedal rigging. Depress the plunger on the slave brake reservoirs. If these plungers can be pushed full in, the reservoirs are fully serviced. If the plungers extend over 3/4 inches when depressed, the slave brake system should be bled of all air and reservoirs re-serviced. Also check the master cylinders.

2. Check fuel quantity amplifiers for security and mounting.

Inside Left Wing.

1. The second engineer will perform the same check inside the left wing as the first engineer performs inside the right wing.

Aft Bomb Bay.

1. Wing crawlway lights OFF.
2. Inspect a-c power panels.
3. Check fuel manifold lines, fuel valves, and center wing section.
4. Inspect auxiliary spar (station 8.0) for evidence of failure.
5. Inspect the wing flap synchronizers.
6. Inspect heat and pressurization ducting, accessible cables, wiring, and general condition.
7. Check oxygen bottles for condition and security.

Tail Cone.

1. Tail cone lights ON to check operation and OFF when tail cone inspection is complete.
2. Inspect bulkhead 12.0 for cracks, breaks, and general condition.
3. Tail anti-icing ducts for condition and cracks.
4. Remove interphone jackbox plugs disconnected.
5. Visually inspect the condition and rigging of the elevator, rudder control system, and rudder casting.
6. Check the condition and servicing of the rudder and elevator control locks, making sure that cylinders have been properly filled.
7. Check the mounting, linkage, electrical connections, and rigging of the autopilot servos.
8. Security of loose equipment.
9. Tail cone section for breaks, cracks, and general condition.

Left Outer Wing Panel.

The second engineer will perform the same check of the left outer wing panel as the first engineer makes of the right outer wing panel.

Upper Wing Surface.

1. Proceed to the top of the wing and check the following:

a. Check fuel level, using the dip stick, and record the amount in each tank.

b. Check oil level, using dip stick, and record the amount in each tank.

Note

After the above checks, it is essential that all fuel and oil caps be checked for security.

Miscellaneous.

1. Report to the first engineer the results of your preflight inspection and submit to him the quantities of fuel and oil loaded.
2. Standby with the first engineer to assist in completing the Form F and to report the results of your preflight inspection to the aircraft commander.
3. Stow personal equipment.

FINAL CREW BRIEFING.

When all crew members have completed their preflight, and have stowed their equipment, and the aircraft commander is satisfied that a thorough preflight inspection has been completed, he will conduct an informal final crew briefing.

1. Call the roll, and have each crew member give preflight report. Any discrepancies will be reported.
2. Check Form 1 to see that specialized equipment has been signed off after preflight.
3. Brief crew on emergency signals and procedures, and oxygen, interphone, and parachute discipline. If passengers are aboard, make sure they know emergency signals, positions for take-off, landing, crash landing, oxygen outlets, primary and secondary exits for bail-out, and ditching; proper operation of their parachute, bail-out bottle, oxygen equipment, etc.
4. State time interval at which aft cabin scanners are to render visual engine check during the flight. During daylight, it will be every hour; during night, high altitude cruise, weather, and high power, it will be every 30 minutes. In addition, during the visual engine check, the right scanner will give the aft cabin altimeter reading to the engineer during pressure flight.

WARNING

The left and right scanning stations must be manned at all times during flight.

5. Designate an observer in the nose to aid in clearing the aircraft during flight at night, in periods of restricted visibility, and when flying through congested control areas.
6. The aircraft commander will check the N-1 compass heading with the magnetic heading every 30 minutes.
7. Cover route, altitudes to be flown, weather, and duration of flight. If information has not changed since formal briefing, it is unnecessary to cover it again at this point.

8. Answer any questions crew may have.

9. Have ground locks removed before boarding aircraft.

10. Crew members board the aircraft. All crew members will go on interphone and stand by as soon as they board the aircraft.

RULES TO BE ENFORCED ON EACH FLIGHT.

SMOKING.

1. No smoking during ground operation, take-off, and landing.
2. No smoking at any time gas fumes are detected.
3. No smoking except in crew compartments.
4. Make sure all cigarettes are completely out before throwing away.
5. Do not attempt to throw a lighted cigarette from the airplane.
6. No smoking while wearing helmet with oxygen mask attached.

WARNING

Keep lighted cigarettes away from oxygen masks at all times that masks are connected to the airplane's supply system.

PARACHUTES.

Parachute will be worn at all times by crew members while they are occupying the aircraft commander's, pilot's, engineer's, and gunners' positions. This is considered necessary so that these key crew members may devote complete attention to coping with an emergency situation that may arise without being distracted by the necessity of putting on parachutes prior to abandoning the aircraft.

1. All crew members will wear parachutes at all times under the following conditions:

a. When above 25,000 feet pressure altitude with the aircraft pressurized, with the exception that parachute may be removed temporarily when it is necessary for proper performance of duty.

b. During take-off, landing, formation flying, fighter passes, gunnery practice, when emergency conditions exist, when gas fumes are detected, or any time danger is imminent.

c. While occupying positions when the aircraft is pressurized and there is imminent danger of explosive decompression.

2. At all other times parachutes need not be worn, but will be kept close by at all times.

3. Stow an extra parachute with bail-out bottle attached in each pressurized compartment.

4. Make sure all parachutes have been properly inspected and packed before take-off.

SAFETY BELTS.

1. One pilot, the engineer, and blister gunners will have safety belts fastened at all times.
2. Above 25,000 feet altitude aircraft commander, pilot, engineer, and gunners at blister positions will have safety belts fastened when the cabins are pressurized.

STATION TIME.

Station time is designated by the aircraft commander to make sure that each crew member knows the exact time he should be at his assigned station aboard the aircraft ready for engine start, taxi, and take-off. The pilots and engineers have several duties to perform between "Station Time" and "Starting Engines" and should be allowed approximately 15 minutes between these times to make sure the remaining schedule is not interrupted. "Station Time" immediately follows "Final Crew Briefing." Since the pilot and first engineer have the most duties to perform before engine start, they should be first to enter the aircraft after dismissal from final briefing. The aircraft commander will want to be last for several reasons:

1. *To see that all personnel and equipment are aboard.*
2. To make a last visual check to see that the gear-down locks, pitot covers, and control locks are removed and that the wing access panels are secured and the nose gear scissors are connected.
3. To see that the area is clear of obstructions and adequate fire equipment is available preparatory to engine start.

The aircraft commander, pilot, and engineers will recheck and complete applicable items of the "Before Starting Engines" check list and stand by for starting engines.

STARTING RECIPROCATING ENGINES.

The reciprocating engines will be started in accordance with the instructions given under "Preflight Operational Equipment Check, Starting Reciprocating Engines" of this section. An effort should be made to start the engines as close to take-off time as the situation and the experience of the crew permits in order to conserve fuel and engine life.

DURING ENGINE WARM-UP.

If a complete "Preflight Operational Equipment Check" was accomplished, the only checks that must be made during this engine warm-up are listed below:

1. Engine-Driven Fuel Pumps.
2. Alternators Paralleled (three on the line, one standing by).
3. Engine Oil-In Temperatures — Minimum 40°C.

TAXIING.

PILOTS

CAUTION

When any malfunction of the hydraulic system or related electrical circuits is indicated during taxiing, e.g., if the canoe doors creep open during taxiing and do not return to and remain in the closed position with the landing gear control switch in EXTEND, the aircraft must be brought to a smooth stop as soon as possible. *Do not* stop the aircraft suddenly since doing so would cause the aircraft to rock and in the event that the nose gear is unlocked, this rocking action could cause the nose gear to retract. After the aircraft is stopped, install the landing gear down locks and investigate and correct the malfunction prior to further taxiing.

1. Nose Wheel Steering Switch—ON. This switch energizes the main hydraulic system pump motor and actuates the main hydraulic system selector valve to provide pressure for nose wheel steering. This pressure is indicated on the engineer's hydraulic pressure gage and is indicated only when the airplane is on the ground.

2. Engineer's Taxi Configuration—Checked. Check the pressure in the brake system and nose wheel steering hydraulic system. These readings are obtained from the engineer. Never release the parking brake before checking for normal brake pressure. Never start to taxi until the engineer tells you he is prepared. Request, "Engineer's taxi configuration," over interphone.

3. Check Ground Man—"All Clear" signal. After all checks are completed on the "During Engine Warm-up" check list and the engineer is ready to taxi, have the ground observer check to be certain that all obstructions have been removed and that the aircraft is clear. Before the aircraft commander clears the ground observer off interphone, the ground observer will check and report. "Nose wheel doors full open, all static wires removed, wheel chocks removed, external power unit cleared." The ground observer then passes the ground communications cord in the forward compartment, comes forward, and signals to the aircraft commander that he is clear to taxi.

4. Interphone and Alarm Bell Check—Completed. The aircraft commander will announced on private interphone, "Crew, this is Aircraft Commander. All crew members switch to normal interphone for interphone and alarm bell check." The aircraft commander will

ENGINEERS

1. Taxi configuration. "Alternators on the line and paralleled, brake and nose steering pressure normal, ready to taxi."

a. A minimum of two alternators must be on the line and in parallel.

b. Note and report brake and steering pressures at 30-second intervals during all taxi operations in congested areas and prior to turns.

PILOTS ENGINEERS

TAXIING (Cont'd)

then ring the alarm bell. All compartment commanders will report. "Normal interphone and alarm bell loud and clear, ready to taxi." This check will be made by compartments, progressing from tail to nose.

5. Call Control Tower—Taxi instructions. While the aircraft commander is clearing with the ground observer, the pilot will contact the control tower and receive taxi instructions and clearance to taxi.

6. Inboard Propeller Reverse Selector Switch—READY. Propeller reverse thrust will be used to aid in controlling taxi speed. This reduces the use of brakes and increases their usefulness. Continuous cycling of the propellers will not be used; slight adjustments of throttle to control the forward speed will be used instead. For normal taxi operation, No. 3 and 4 propellers will be used in reverse pitch. When taxiing with tail winds or when taxiing down slopes, it may be necessary to have two pairs of propellers in reverse. The aircraft commander will move the inboard propeller reverse selector switch to READY and stand by to reverse.

Note

Outboard propellers should not be reversed during normal taxiing except in an emergency. Reversing outboard propellers below 40 mph IAS results in sudden aileron movement which could cause aileron damage.

7. "Taxiing." Announce "Taxiing" over the interphone. Allow the aircraft to roll forward from its parked position before pushing the reverse pitch switch to reverse the inboard propellers. This will eliminate the necessity for additional power on the center and outboard engines in order to get the aircraft in motion.

Note

The aft cabin scanners will be on interphone during all taxi operations. At night they will be equipped with Aldis lamps.

The control surfaces must be locked at all times during taxiing. The B-36 has a normal nose-down attitude while on the ground. Don't let this attitude bother you, you'll become accustomed to it. Directional control while taxiing is accomplished hydraulically through the use of the steering wheel.

CAUTION

In order to minimize drag loads on the main gear, steer with the nose gear and avoid steer-

PILOTS ENGINEERS

TAXIING (Cont'd)

ing with the brakes; avoid braking over ice-spotted surfaces as much as possible; minimize the sudden application of brakes while taxiing, especially at low speeds and when the brakes are cold; and reduce taxiing as much as feasible.

Jet nose shutoff doors should be closed during taxi operations. This will expose the jet engines to a minimum amount of foreign material while propellers are in reverse.

CAUTION

If the jet engines had been running, the thirty minute cooling period with nose doors open will apply.

This airplane is the largest that you have yet encountered, and several new techniques must be learned before becoming adjusted to its size. One of these is the procedure used to make turns. Because of the make-up of the main gear "skate," the aircraft must be turned with caution to prevent skidding of tires. The airplane must be in motion before executing turns; use the largest turning radius possible and limit taxi speed to approximately 12 mph while turning in order to minimize tire wear and landing gear stress. Make alternate right and left turns, when practical, to equalize tire wear. Make a visual check of all gyros during taxiing. The minimum turning radius recommended for the nose gear is 119 feet for gross weights up to 357,500 pounds. The pivot point is about two-thirds from the outboard engine toward the wingtip. It must be remembered that you are about 50 feet in front of your main gear so that when lining up with the runway you must over turn and then bring the nose wheel back to the center line. A runway width of 300 feet is adequate for executing normal turns. After making a turn allow a short roll and stop with the nose wheel in line with the fuselage center line, thereby reducing nose wheel stresses at the start of take-off. Aircraft clearances are especially important during taxiing. The B-36's wing span of 230 feet will in many cases overlap on both sides of the taxi strip. Along taxi strips be careful to avoid damaging obstacles such as boundary lights, vehicles, etc. Use particular care at night; all crew members must be alert to avoid any obstructions. Use your taxi lights and have your observers in all compartments use Aldis lamps to observe obstructions while taxiing. When in doubt about aircraft clearance, send out crew members with flashlights to act as "wing walkers." A tip is to use shadows

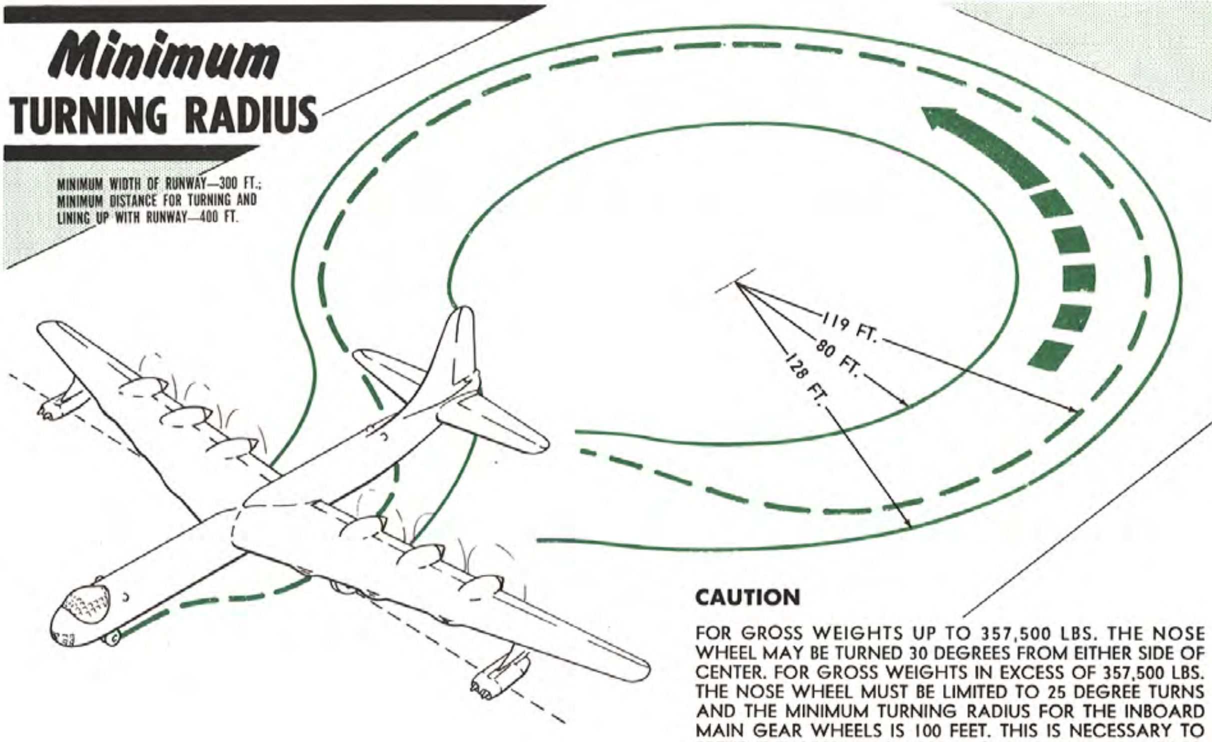

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Figure 2-9.

PILOTS ENGINEERS

TAXIING (Cont'd)

cast by the aircraft to judge aircraft clearance while taxiing. Remember, be safety-conscious while taxiing as well as when flying.

CAUTION

The aircraft should not be taxied without brakes except in an extreme emergency.

ENGINE RUN-UP.

If a complete "Preflight Operational Equipment Check" was accomplished, the only checks that must be made during this engine run-up are listed as follows:

1. Propeller Control System.
2. Ignition System Checks—R1 and R2 simultaneously, L1 and L2 simultaneously, on each engine.
3. Full Power No Boost Checks.
4. Full Power with Boost Checks.

STARTING JET ENGINES.

Start the jet engines in accordance with the instructions given under "Preflight Operational Equipment Check, Starting Jet Engines" of this section. The jets should be started as close to take-off as remaining time will allow to conserve fuel and engine life.

BEFORE TAKE-OFF.

Before and during take-off your perspective will differ from that experienced on other airplanes. Your flight deck is higher, the wing is approximately 40 feet aft, and the reciprocating engines are pusher type. Therefore, you will not have the customary reference to the wings and engines. However, with a few flights you will develop the proper perspective.

When the aircraft is taxied into position for take-off, the aircraft commander will align the nose wheel on the center marker for the runway and make certain the nose wheel indicator reads zero before setting the parking breaks.

The engineer will give basic take-off information to the aircraft commander on the take-off and landing data card. The aircraft commander will study this information and pass the card to the pilot. The pilot will then call off the pertinent data prior to and during take-off.

While the engineer is completing his final engine checks, the aircraft commander and the pilot will be going through the "Before Take-Off" check list.

CAUTION

Use your check list and follow it carefully. No matter how proficient you are or how well you know your procedures, you are inviting trouble when you fail to use your check list.

Note

Tests indicate that approximately 5 seconds less time is required to operate the elevator trim tab control wheel from one extreme position to the other when the operator's inboard arm rest is in the up position. At a speed of 135 mph this 5 seconds represents 990 feet of travel which could mean the difference between a successful maneuver and a crash during take-off or landing.

The aircraft commander will have the jet engines started at this point and will keep them in stand-by until the engineer is ready to set take-off power on the reciprocating engines. While the engineer sets take-off power, the pilot will advance all jet engines to take-off rpm.

1. Parking Brake Switch—BRAKE ON.

2. Propeller Reverse Selector Switches—SAFE (lights out). Observe that all propeller reverse warning lights are out, indicating all propellers are in normal pitch.

3. Flight Instrument Switches—ON. These switches should be turned ON while accomplishing "Before Starting Engines" check list. This is a double check to insure that it is done.

4. Gyros—Set and uncaged. Observe the indications of the directional gyro, vertical gyros, turn and bank indicators, and N-1 high latitude compass. Set the directional gyro with the magnetic compass. The accuracy of the turn and bank indicators should have been checked during taxiing.

4a. Landing Lights—As Required. If the landing lights are needed for take-off, extend them and turn them ON at this point.

5. Nose Wheel Steering Switch—ON. This will turn on one hydraulic pump and circulate fluid through the system at approximately 600 psi.

1. Fuel Panel Checked—Booster pumps ON.

2. Propeller Selector Switches—AUTOMATIC OPERATION, Tel-Lamps Lighted.

3. Engine Supercharger Switches—DUAL TURBO.

4. Engine Fan Speed Switches—LOW RPM.

5. Spark Advance Switches—RETARD (guards down).

6. Mixture Control Selector Switches—LEVER.

7. Mixture Control Levers—RICH.

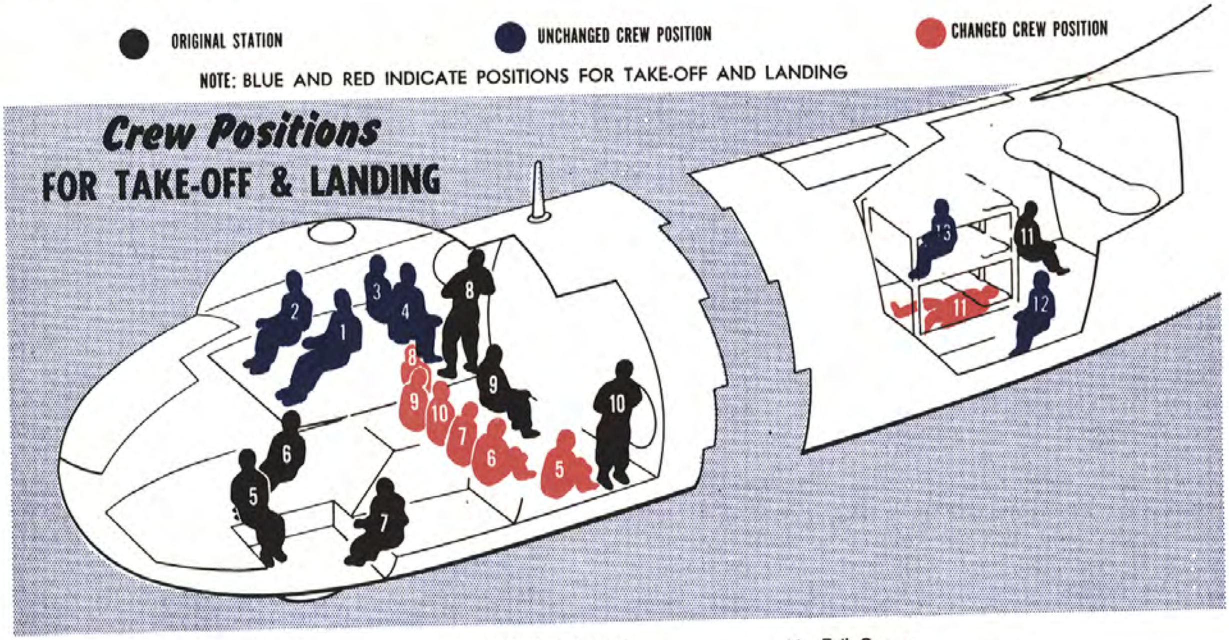
Note

All mixture control levers will be in the RICH position for take-off regardless of the type of carburetors installed on the engines.

8. Air Plugs and Intercoolers—As required.

9. Temperatures—Checked and within limits.

10. Carburetor Preheat Switches—OFF.



1. Aircraft Commander
2. Pilot
3. Second Engineer
4. First Engineer
5. Navigator
6. Radar Observer
7. Observer
8. Second Radio Operator
9. First Radio Operator
10. Copilot
11. Tail Gunner
12. Lower Aft Scanner (Left)
13. Lower Aft Scanner (Right)

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Figure 2-10.

BEFORE TAKE-OFF (Cont'd)

6. Landing Gear Control Switch—EXTEND. This action will position the brake pump switch ON.

7. Autopilot—OFF.

8. Flaps and Indicators—Set at 20 degrees and checked.

9. Trim Tabs—Set.

Note

To facilitate movement of the elevator trim tab control, the inboard arm rests on the pilots' seats should be in the up position for all take-offs and landings.

10. All Compartments—Entrance ladders, windows, and hatches, ready for take-off. The compartment commanders are responsible to check that all crew members have assumed their take off position (figure 2-10), and that all ladders are up, all windows and hatches are closed, all defroster nozzles are removed, and all equipment is properly stowed.

11. Turbo Control Change-Over Switches—AUTOMATIC.

12. Turbo Control Vernier Switch—OFF.

13. Alternators Paralleled on the Line. One Bus Isolated (Bus 301 or 401 Preferred).

14. Cabin Heater Power Switch—OFF.

15. Cabin Booster Fan Switch—As required.

16. Cabin Pressure Wing Shutoff Valves Switches—DEC.

17. Wing, Cabin Heat and Tail Anti-Ice Switches—DEC.

18. Pitot Heater Switches—As required.

19. Propeller Normal Pitch Indicator Lamps—Lighted.

20. Brake and Nose Steering Pressure—Normal.

PILOTS | ENGINEERS

BEFORE TAKE-OFF (Cont'd)

11. Engineer's Take-off Configuration — Engineer reads: "Take-Off Configuration Completed, Standing by for Propeller Reverse Safety Check and Take-Off Power."

12. Abort Procedure and Take-off and Landing Data—Briefed and Reviewed. The aircraft commander will review the abort procedure and take-off and landing data with the pilot and engineers.

13. Surface Controls—Unlocked and Checked. Check the control lock indicator lamps; the green lamp should be on and the red lamp out. If the green lamp is out and the red lamp is on, check the toggle switch which is actuated by the flag on the pilots' instrument panel. This switch may not have been actuated by the flag. Check controls for freedom of movement at full throw.

14. Salvo Circuits—As required. Have salvo circuits set for salvo if heavily loaded for take-off.

15. Safety Belts and Safety Harnesses—Fastened. Crew members will be in their take-off positions. Safety belts and shoulder harnesses will be fastened and inertia reel lock controls UNLOCKED.

16. Read pilot's take-off configuration over interphone. This will insure that all checks made by the aircraft commander before take-off are completed. The pilot should recheck each item when he calls it off as follows: "Controls—Unlocked; Flight Instrument Switches—ON; Flaps—20 degrees; Trim Tabs—____ degrees (up or down); Autopilot—OFF; Nose Steering—ON; Propellers—SAFE, Lights Out; Jet Panel—Checked; Pitot Heat—As Required."

The aircraft commander will be sure the jet booster pumps are on, all jet manifold and engine valves are open, pod pre-heat and nose de-ice switches are off, and the jet engine oil tank heater switch is as required. It will take about 30 seconds to read and visually check the entire take-off configuration.

21. Engineer's Take-Off Configuration — Engineer reads: "Take-Off Configuration Completed. Standing by for Propeller Reverse Safety Check and Take-Off Power."

TAKE-OFF.

PILOTS | ENGINEERS

Note

If high carburetor air temperatures were encountered during ground run-up, use the procedures outlined in "Take-Off, Hot Weather Procedures," Section IX.

TAKE-OFF (Cont'd)

PILOTS

1. Parking Brakes—Released. The aircraft commander and pilot will hold the aircraft with foot brakes while setting take-off power.

2. Set take-off power—Jets take-off rpm. When the aircraft commander has completed his take-off configuration (including take-off clearance from tower) he will instruct the pilot to advance the jets to take-off rpm and the engineer to advance his throttles at the same time to make propeller reverse check and set take-off power.

CAUTION

> In order to minimize drag loads on the main landing gear, the time interval for the full power checks prior to releasing the brakes should be held to a minimum.

3. Foot Brakes—Released. When the brakes are released, directional control will be maintained by use of nose steering until the rudder becomes effective at 50 to 60 mph. As soon as power has been stabilized during take-off roll, the engineer will report this fact to the aircraft commander.

The pilot should keep his hand on the jet throttles during the take-off run in order to handle immediately any jet emergency on take-off. Start applying elevator pressure at approximately 10 mph below nose-up speed. When an air speed of approximately 5 mph below nose-up speed has been attained, apply and maintain 50 to 75 pounds pull on the elevator control wheel. If control wheel pull is maintained until nose-up speed is attained, the airplane will begin to move to the take-off attitude.

As take-off air speed is approached, the 50 to 75 pound pull requirement of the control wheel will subside and, at the instant of take-off "get-away," the force required will be reduced to approximately zero.

As the airplane emerges from ground effect to climb, a normal tendency of the airplane to nose up will be experienced. This tendency must be countered by elevator "push force" and retrimming of the elevator trim tabs. Initiate landing gear retraction as soon as the airplane is positively air-borne.

Retraction and extension of the landing gear induces a mild change in longitudinal trim of the airplane. The sweepback of the wing causes flap movement to exercise a great effect on longitudinal stability. The resultant effect of flap movement can be reduced by operating the flaps in increments of 5 degrees.

ENGINEERS

1. Propeller reverse safety check and set take-off power. Advance throttles to 35 inches M. P. on all engines, decrease master motor to 2000 rpm to insure prop limit switches are against low blade stops, increase master motor to 2800 rpm, check that engine tachometers are within 100 rpm of each other, TBS 6, advance throttles to 55 inches M. P., water injection on, set take-off power corrected for humidity. Report to aircraft commander, "Power set, propellers normal, ready for take-off."

2. Report, "Power stabilized," prior to nose-up speed.

AFTER TAKE-OFF.

PILOTS

1. Foot Brakes—Apply to stop wheel rotation. If the wheels are allowed to spin during gear retraction, unnecessary loads will be imposed on the retraction mechanism because of the gyro effect of the spinning wheels. The tires could also be damaged if the wheels were allowed to rotate in the wheel wells.

2. Nose Steering Switch—OFF.

3. Landing Gear Control Switch—RETRACT. The aircraft commander will give the order, "Gear up," over the interphone in addition to a visual order for gear up to the pilot. During retraction the scanners will report, "Left door coming open, right door coming open"; and after gear retraction, "Left door closed, right door closed." If the gear retraction sequence is not normal, or if the gear positioning jacks are not functioning properly, the scanners will report the discrepancy to the aircraft commanders. It will take approximately 50 seconds to retract the gear.

4. Flap Switch—UP. At the verbal order from the aircraft commander on interphone, the pilot will begin to retract the flaps. Retraction should be accomplished in 5-degree increments to allow the pilot to trim the airplane as the flaps are raised.

Flap retraction should not begin until 130 mph IAS or 125 per cent of stalling speed, whichever is higher, has been obtained. (See "Flap Retraction Speeds," figure 6-6.) Since drag with the gear and flaps down is excessive, if it is practical the landing gear should be retracted immediately and retraction of the flaps begun at 130 mph, even though the wear is not completely retracted. At least two alternators on the line is a requirement for simultaneous operation of the gear and flaps. Do not fully retract the flaps until 140 mph IAS or 125 per cent of stalling speed, whichever is higher, has been reached.

The aft scanners should report the action of the flaps as they are raised to be sure that all flaps operate in unison. If either the inboard or outboard flaps fail to rise, the attitude of the airplane will be affected. If the inboard flaps fail, the aircraft will have a tendency to nose up; if the outboard flaps fail, the tendency will be to nose down. With any pair of flaps fully extended, the stalling speed is reduced approximately 6 mph. To operate one pair of flaps, open the circuit breakers for the other two pairs and operate the flap control switch.

ENGINEERS

1. Report, "Main hydraulic pressure normal."

2. Report, "Main hydraulic pressure relieved," after gear retraction is completed.

PILOTS — ENGINEERS

AFTER TAKE-OFF (Cont'd)

In the event the normal flap controls fail, use the alternate flap controls as described in "Wing Flaps," Section III.

CAUTION

Flaps must not be extended during flight except for take-off, landing, and emergencies. Propeller vibratory stresses encountered are increased with flaps extended.

5. Landing Lights—Retracted and OFF.

INITIAL CLIMB.

PILOTS — ENGINEERS

1. Power Condition No. 2—Jets 96 per cent rpm. After gear and flaps are up and a minimum of 500 feet above terrain has been reached. Unless some abnormality arises this should serve as a notification to the pilot and engineer that you consider the aircraft safely air-borne and that power may be reduced as predicted for the flight. At the aircraft commander's discretion, each take-off is usually predicted to last from 3 to 5 minutes. At the end of the predicted period the pilot will reduce power on the jet engine to planned climb schedule.

2. Landing Gear and Brake Pump Switch—OFF when pressure is relieved. This is an added precaution against inadvertent operation of hydraulic motors and subsequent loss of system operation.

3. Hold Best Climb IAS—(See Appendix 1). Climb performance has been tested and charted for all normal operation. Request the climb speed for your configuration from the engineer. Climb speed varies with power and altitude for long range climb. It also varies with gross weight for normal rated climb when maximum rate of climb is desired. The initial indicated air speed will drop off approximately 3 mph for each 5000 feet of altitude up to 35,000 feet and slightly more thereafter. Hold the correct air speed during climb—then performances should equal the engineer's and navigator's prediction. Charted climb air speed values result in stable operation under all weather conditions and the best compromise between power available from jet and reciprocating engines. This results in the

1. Power Condition No. 2—Upon pilot's request.

2. Turbo Boost Selector—Reduce M. P. to 55 inches.

3. Water Injection Switches—OFF. Use individual switches to cut off one water injection pump at a time. Note fuel flow increase, water pressure decrease to static value, and slight torque pressure drop-off.

4. Reduce power to predicted climb schedule.

WARNING

During flight, do not move more than one mixture control lever at a time. This precludes the possibility of inadvertently moving all mixture levers to IDLE CUT-OFF and consequently, losing power on all reciprocating engines.

5. Torque, Fuel Flow, CHT, CAT. and M. P.—Within limits. Manually adjust controls to obtain specifications desired. Specified fuel flow for climb is indicated in the "Fuel Consumption Curve." (See Appendix 1.)

Note

Engine fuel flow meters should be calibrated.

Torque varies with altitude due to engine cooling fans absorption of bhp. Once set, torque will increase approximately 0.3 psi for each 1000 feet of altitude. CHT

PILOTS ENGINEERS

INITIAL CLIMB (Cont'd)

best rate of climb consistent with efficient operation. If the jet engines are not to be used after level off, they should be reduced to idle speed, preparatory to shutdown, the instant the planned altitude is reached.

As the planned level-off altitude is attained, the aircraft may be climbed 200 to 500 feet above cruising altitude prior to reducing power unless instrument flight rules dictate leveling off at the exact altitude. This small amount of altitude will allow a cushion for the pilot to trim the aircraft while the engineer is stabilizing reciprocating power. Regardless of level-off technique, the engineer has sufficient power available from the reciprocating engines, at less cost in fuel consumption to complete this maneuver.

4. Bomb Bay Area—Checked. A designated crew member will inspect the bomb bay area for fuel fumes and fuel and hydraulic leaks. Upon completion of the check, the crew member will report to the aircraft commander.

and CAT. should be held constant throughout the climb at near maximum allowable to decrease cooling drag. To hold the above values constant, it will be necessary to vary manifold pressure. During any climb power setting, engine overheating can be combatted by opening intercoolers and air plugs to lower CAT. and CHT; by enriching fuel flow; by reducing bmep; and by increasing air speed.

Note

Normally the alternator frequency will decrease during an extended climb and increase during descent because OAT. affects the resistance of the control circuit. So you must remember to adjust alternator frequency to compensate for these variations.

STOPPING JET ENGINES (AIR).

After climb when the flight plan calls for shutting down the jet engines; the pilot will shut down jet engines as follows:

1A. Throttles—Flight-idle three minutes and then close. This procedure is followed in order to let temperatures throughout the jet engine stabilize. Because of the close tolerances involved and the fact that metals with different expansion and contraction factors were used in manufacturing the various parts of the engines and shroud ring, binding can result unless temperatures are stabilized. Remember that the tail pipe temperature indicator shows the temperature of the tail pipe only.

2. Booster Pumps—OFF.

2A. Nose Shutoff Doors—Closed at or below 100°C tail pipe temperature and 30 per cent rpm. Check the fuel pressure and see that it reads zero before closing the nose shutoff doors. Watch tail pipe temperatures as the nose shutoff doors are closing; if temperatures rise sharply, open the nose shutoff doors on the affected jet immediately. Tail pipe temperature rise is an indication that the jet is still running. Attempt to shut off the affected jet by using the switch position of the throttle. If the jet still continues to run, close the engine fuel valve.

3. Manifold Valve Switches—CLOSE below 20 per cent rpm.

4. Engine Fuel Valves—Closed below 10 per cent rpm.

Note

Immediately after shutdown, position the nose shutoff door to allow the engine to windmill at 10 to 12 per cent rpm for a period of 10 minutes. After the 10-minute period, adjust the nose shutoff door to maintain a windmilling rpm of 5 per cent.

5. Nose De-Ice—As required.

6. Pod Preheat—As required. Since pod preheat must be off when wing anti-icing is being used, in order to give adequate heat for wing anti-icing, preheating the jet pod must be handled with care when flying in icing conditions. Keep wing anti-icing heat on until the wings are free of ice, turn on pod preheat, start the jets, and then turn pod preheat off and route the heat back to the wing.

7. Oil Heater Switch—As required. Leave on at 15,000 feet and above or when OAT. is 41°F (5°C) or below.

8. Oil Shutoff Valves—Always open during flight.

9. Throttle Circuit Breakers—Out. To prevent unnecessary operation of jet throttle amplifiers and inadvertent opening of the throttles.

CRUISE NO. 1 (LOW ALTITUDE-HEAVY GROSS WEIGHT).

Cruising at any altitude calls for real cruise control. The responsibility for cruise control rests heavily on the engineer. By working closely with his aircraft commander and navigator, the engineer must base his operations on calculations derived from a series of performance charts and curves. In addition he must develop operational techniques such as *manual adjustment and manual leaning*, and *dual* and *single* turbo operation. While maintaining a reasonable balance of the many operational variables and techniques involved, he must develop, in co-ordination with his aircraft commander and the navigation team, definite procedures in conjunction with the *Long Range Cruise* problem to compromise with other problems such as navigation, bombing, etc.

Cruise No. 1 is the initial leg of the normal mission after take-off at maximum gross weight. At this time the long range air speed is, of necessity, relatively fast. The combination of gross weight, air speed, and altitude demands power settings which are above the manual leaning range. With perfect carburetion, operation would simply be in NORMAL or RICH mixture setting, but reasonable manufacturing tolerances do not allow such simplicity. To correct for this variable it is necessary to manually adjust the mixture controls until a specified fuel flow is obtained. These specified fuel flows are furnished the aircraft manufacturer by the engine manufacturer and in turn are plotted on fuel consumption curves, which are found in the appendix along with other operational data. For further information on manual adjustment refer to "Mixture Control," Section VII.

Proper manual adjusting calls for accurate instrumentation; however, it must be noted by the operator that when operating below rated power, manually adjusted power settings are just slightly richer than best power. Investigate and observe the fuel flow at which best power is obtained. Common sense application of these observations will serve as a check of instrument calibration when compared with the average engine and will prevent marginal operation which might be detrimental to engine life.

After two or three cruises at this altitude, your gross weight and airspeed requirement will decrease to such a point that subsequent operation will phase into the manual leaning power range. Manual leaning procedures are given in Section VII, "Manual Leaning." Study these procedures carefully, for manual leaning is the "heart" of the overall operation of the B-36. It is one procedure that must be precise. Study the entire Section VII, "Reciprocating Engines" carefully, for it contains valuable information which will assist you in understanding various operational techniques and procedures.

BEFORE CLIMB OR HIGH POWER OPERATION.

Normally the first leg of the mission is accomplished with the jet engines off. The initial high reciprocating engine powers have phased into lean operation. On some long initial cruises it may become necessary to resort to single turbo operation if low rpm's in manual lean are attempted. You must anticipate the end of this leg, for several important steps must be taken before establishing a climb to a higher altitude. The engineer should know whether jet engines will be required for additional power, and will inform the aircraft commander of the required power configuration including the indicated air speeds to be maintained during the climb. In addition, the engineer and aircraft commander should allow themselves sufficient time to perform the items included in the following check lists when co-ordinating with the other crew members and establishing a time at which the climb should start.

STARTING JET ENGINES (AIR).

PILOTS ENGINEERS

Note

> Prior to starting jet engines, nose and cowl lips must be free of ice accumulation.

1. All Circuit Breakers—In. To connect control and actuator circuits to their respective power sources.

2. Fire Detector Test Switches—TEST and release. This action checks the continuity of the detector system. Failure of any lamp to light within a reasonable

PILOTS

ENGINEERS

STARTING JET ENGINES (AIR) (Cont'd)

length of time, or any light that flickers indicates a detector system malfunction and any later indications may not be reliable.

3. Throttle Selector Switches—LEVER.

4. Throttles—CLOSED.

Note

> On airplanes equipped with a jet throttle position indicator, make a sweep of the engines with the selector switch to ascertain that the throttles are closed. If the indicator shows that a throttle is not in this position, close the throttle with the throttle override control switch.

5. Pod Preheat Switch—As required. ON when icing is anticipated or 10 minutes prior to jet engine start when OAT. is—22°F (—30°C) or colder. When jets are inoperative, pod preheat will not be effective unless the engineer's wing anti-icing switches are ON. Pod preheat should be turned off any time there is suspicion of fire so that fire may not enter the wing area.

6. Nose De-Ice Switch—As required. ON only to prevent ice forming on the nose shutoff doors.

7. Oil Heater Switch—As required. To maintain jet engine oil temperature when the ambient air temperature is below 41°F (5°C).

8. Oil Shutoff Valve Switches—OPEN. Always open during normal flight.

9. Notify engineer, "Set up jet start configuration."

10. (Not applicable for air start.)

11. Nose Shutoff Doors—OPEN (check doors visually).

The aircraft commander and pilots will visually check their respective sides to see that nose shutoff doors are opening. The jet engines should start windmilling as the nose shutoff doors open. Approximately 185 mph IAS should result in a windmill speed of about 15 per cent rpm at any altitude. After nose shutoff doors have opened and the initial rpm build-up has stabilized, the desired starting speed may be controlled by varying the indicated air speed.

12. Manifold Valve Switches (L and R)—OPEN.

13. Booster Pump Switches (L and R)—ON.

14. (Not applicable for air start.)

15. Throttle Position Indicator Selector Switch (Some Airplanes)—Select J-1 Engine.

16. J-1 Engine Fuel Valve—OPEN.

1. Jet Start Configuration—Checked and, "Standing by for jet engine start."

The inflight jet start configuration requires a minimum of two tank valve switches OPEN and respective booster pumps ON in each wing.

BEFORE CLIMB (HIGH POWER OPERATION, AFTER A MANUAL LEAN SPARK ADVANCE CRUISE).

A tremendous amount of reciprocating engine damage can result if you fail to properly prepare the engine for high power operation. A good engineer should always remember the following items which must be checked, but even the best are prone to forget or overlook an item under certain conditions of stress or fatigue. By actually using the following check list, any oversight will be avoided and the transition from low to high power operational configurations will be successful.

PILOTS

ENGINEERS

STARTING JET ENGINES (AIR) (Cont'd)

17. J-1 Fuel and Oil Pressure Gages—Note Reading. Notice where these pressure instruments zero so that you can tell when a pressure indication is obtained as rpm increases and the throttles are opened for a start.

18. Notify Ground Observer and/or Aft Scanner—"Starting J-1." The scanners should be able to detect and report any unusual leaks or fire noted. With experience they will let you know when combustion occurs by observing the heat waves.

19. (Not applicable for air start.)

19a. (Air Start) J-1 Ignition Switch—Hold in ALTITUDE. This operation sets up the spark action which will ignite a combustible mixture as the proper fuel-air ratio is obtained when opening the throttle. Do not release the ignition switch until idle rpm for your specific altitude is stabilized.

20. (Not applicable for air start.)

20a. (Air Start) J-1 Throttle—Open throttle to obtain 16 to 20 psi fuel pressure for normal altitude starts and 10 to 15 psi fuel pressure for starts at 40,000 feet or above. Ignition is primarily indicated by a sharp increase in tail pipe temperature. A successful start at any altitude is dependent on the correct fuel-air-ratio, consequently at high altitudes less fuel must be used because of the rarified air. As fuel pressure indication is received, the throttle should be retarded to obtain the desired fuel pressure mentioned above. In some instances this will necessitate retarding the throttle almost to the CLOSE position. Since low fuel pressure of this kind cannot easily be read, the tail pipe temperature indicator and tachometer can be used as reliable references. The tail pipe temperature should be increased very gradually from 100°C as engine-speed increases toward idle rpm. For altitudes of 30,000 to 40,000 feet, the tail pipe temperature should not exceed 350°C. Throttle technique is very important and at high altitude the throttle must be advanced gradually and slowly allowing enough time for per cent rpm to increase to the corresponding throttle position. It may at times become necessary to retard the throttle slightly if it is noted that the tail pipe temperature is rapidly increasing, if the tail pipe temperature is above the aforementioned value, or if a false start condition is evident. Use of the starter is not required for an air start.

CAUTION

Do not exceed the maximum allowable tail pipe temperature limits for starting or for acceleration and operation.

1. Air Plugs and Intercoolers—OPEN. To prevent engine overheating during subsequent operation at higher bmep and increased fuel-air ratio.

2. Spark Advance Switches—RETARD.

Note

See Section VII, "Spark Selection" for the specific procedure for return from manual lean spark advance operation to retard spark.

3. Mixture Controls—NORMAL (lights on) or RICH. To provide an adequate fuel flow for any condition until the desired power is set.

4. Engine Supercharger Switches—DUAL TURBO. Dual turbo and high power operation go hand in hand. Use of single turbo in conjunction with a dual turbo power setting will result in overheating, turbo overspeeding, and, if allowed to continue at high bmep, severe engine damage. Abnormally high CAT., is a prime indication of an engine stuck in single turbo in flight when setting up a dual turbo power setting. See Section VII, "Supercharging" for further information on use of single and dual turbo and shifting procedures. If a malfunction of the system forces single turbo operation on one or more engines they may be safely operated at sufficiently reduced powers to prevent excessive CAT.

5. Desired Power—SET. Procedure for setting powers, after observing the above steps, is normal.

PILOTS ENGINEERS

STARTING JET ENGINES (AIR) (Cont'd)

Note

If combustion does not occur within 30 seconds after fuel pressure is available, discontinue this starting attempt and allow the excess fuel in the engine to drain. Close the throttle and place the ignition switch OFF. After allowing approximately one minute for draining, the starting attempt may be repeated.

21. J-1 Oil Pressure—Report indication on interphone. The oil pressure should increase with rpm. If a positive increase has not been observed by the time a start has been effected, the engine should be shut down to prevent damage from lack of lubrication.

Note

Prior to starting J-2, run J-1 to 70 per cent rpm and check for approximately 5 psi indicated oil pressure.

22. (Not applicable for air start.)

22A. (Air Start) J-1 Ignition Switch—Release at idle. When idle rpm for your specific altitude is stabilized. flame propagation should be complete and selfsustaining. Release the ignition switch, which is springloaded, to the OFF position.

23. J-1 Throttle—Adjust to maintain idle rpm. Allow the initial started engines to idle while starting subsequent engines. This aids in preventing a more asymmetrical power condition while starting the corresponding symmetrical jet engine.

24. J-2, J-3, J-4—Repeat steps 14 through 23. As for a ground start, begin the start procedure with the engines which have accumulated the least time. However subsequent starts will be from side to side in order to maintain the best balanced power condition. In order to even up the logged time when operating only two jets, you may operate any combination of jet engines provided one on each wing is used. One or two engines may be started at any time to offset loss of reciprocating engines if sufficient fuel remains or safety is a factor.

Simultaneous Starts.

The simultaneous air starting of two jet engines can be accomplished at altitudes of 30,000 feet and below. Jets should be started in symmetrical pairs. The normal starting procedure and check list will be used with the following:

PILOTS ENGINEERS

STARTING JET ENGINES (AIR) (Cont'd)

1. The aircraft commander will simultaneously place the appropriate ignition start switches in the ALT position with his right hand.

2. He will simultaneously open both throttles normally with his left hand. Individual adjustments to control tail pipe temperatures during combustion will be made.

3. After combustion both throttles will be cautiously advanced to idle rpm and the ignition switches will be released. Both throttles will continue to be advanced together until the desired jet power setting is reached before the remaining pair of jet engines is started.

The above procedure is useful during formation climbs and is also desirable from a standpoint of fuel economy.

CLIMB TO HIGH ALTITUDE.

Crew co-ordination is very important during climb to altitude, particularly co-ordination between the aircraft commander, the engineer, and the scanners. The scanners must keep check of reciprocating engine air plug settings, evidences of over-heating, oil leaking, or any other sign of malfunction of the airplane. The engineer must be aware of all malfunctions as indicated by the engine instruments and reported by the scanners so as to effectively control the engines at peak efficiency during the climb. The aircraft commander must fly the correct air speed, maintaining the rate of climb steady for the given air speed, and retrim the airplane frequently to obtain best climb performance. The engineer should also insure that the windows in the flight compartment are kept defrosted as much as possible by controlling the cabin air temperature and air flow.

The engineer will maintain a close surveillance on the engine instruments and keep the air plugs adjusted to maximum allowable cylinder head temperatures, thereby obtaining minimum drag. The air plug is a direct control over cooling air flow and can be considered a throttle to the cooling passages. When the combination of air speed and fan results in an excess of air being pumped over that required to maintain statisfactory temperatures, considerable drag is eliminated by restricting the passage and, consequently, the weight of air being pumped.

The entire crew must be well trained, properly disciplined, and prepared to operate as a co-ordinated team if safety and efficiency are to be obtained at high altitudes. The B-36 has been operated consistently at extreme altitudes where the greatest strain is place upon both the airplane and the individual. How well it will perform for you depends upon all the preparation, training, checking, and planning thus far—plus an alert ability to anticipate the requirements that will provide an ease of operation with a reasonable margin of safety. Any time operation is to be above 35,000 feet altitude, each crew member should have some specific task to perform that will aid the operation. All crew members should be notified and prepared for altitude operation before the climb begins until after the descent below critical altitude. The engineer's log should be up-to-date and the climb and initial cruise powers and air speeds should have already been entered in appropriate columns for ready reference and information to the aircraft commander and navigator when requested. Last minute preparations for pressurization, heating, and anti-icing should be considered. Any equipment needed must be accessible to your oxygen station.

The navigation team should be prepared to keep the pilot informed of correct headings to fly and to make frequent position reports.

You will normally use the jet engines for long range climb below 30,000 feet altitude. (See Appendix I for recommended climb power for various gross weights and altitudes.) The fuel consumed for a given climb increment for normal rated power is about equal to the fuel consumed using the recommended long range climb power, but a greater distance is covered since the time and average speed are greater.

CREW SAFETY AT ALTITUDE.

Crew safety at altitude is extremely important. The aircraft commander should be on guard at all times while flying at high altitude in seeing that his crew is doing the right thing at the right time. One of the most important aspects of altitude flying is oxygen discipline. Refer to "Oxygen System," Section IV.

HIGH ALTITUDE CRUISE.

Cruise at high altitude is normally defined in two categories: Cruise No. 2, which is cruising at high altitude with the jet engines operating, and Cruise No. 3, which is cruising at high altitude without the use of jet engines. Again the main factor is manual leaning, and the engineer must concern himself with the many problems that will confront him during these operations.

As cruise control extends the range of the airplane, so does it amplify the duties and responsibilities of the engineer. Complete proficiency in the use of the charts and curves will be attained only by understanding them and working with them. Conscientious study of the pages to follow and of Appendix I is essential.

Obviously. the term cruise control cannot be applied exclusively to any single operation. Actually, it consists of five interrelated operational steps as follows:

1. Preflight planning
2. Inflight operations
3. Inflight replanning
4. Operations after failure of one or more engines
5. Postflight analysis

These steps are founded on a series of performance curves and charts. Since these charts and the use of them are basic to the other operations, they will be discussed first. However, before considering the charts and curves at length, let's have a brief explanation of "Drag Factors," and "Air Speed Versus Gross Weight and Altitudes," since doing so will make certain features of the charts and curves more readily understandable.

DRAG FACTORS.

Unnecessary drag is a very detrimental factor in planning proper cruise control. It can be caused by improper trimming of the airplane or by improper settings of air plugs or cooling doors.

To combat improper trim of the aircraft, it is recommended that a definite schedule of trimming be set up. For instance, if the engineer is on a 2-hour power schedule, the aircraft should be retrimmed every 30 minutes on the elevator axis. In all cases of power changes the aircraft should be retrimmed to conform with the new air speed, and it should also be retrimmed after all fuel transfers and changes in cg of the aircraft.

A second cause of drag to be reckoned with is the settings of the air plugs and cooling doors. From their fully open to fully closed positions the air plugs on all six engines can vary the air speed as much as six mph EAS and the intercoolers as much as four mph EAS. Open doors and hatches also cause drag. Keep them closed. When an air speed is given, it should be maintained as closely as possible to get maximum cooling of the engine with air plugs and cooling doors shut down as far as possible so as to maintain the engine temperatures within limits. The opening of these doors and plugs will reduce air speed considerably by increasing the drag.

AIR SPEED VERSUS GROSS WEIGHT AND ALTITUDE.

Air speed versus gross weight and altitude is the basis for the development of the nautical mile per pound charts which determine long-range cruising plans. In the nautical mile per pound charts a recommended EAS is obtained for a given weight and altitude. Through proper power setting and proper trimming of the airplane the engineer and pilot maintain these recommended air speeds.

Since long-range flying is based on cruise control, it is necessary to see the effect of gross weight and altitude in air speed. Air speed is the starting point for the engineer in setting proper power, while the pilot must maintain level flight through correct trimming of the aircraft. The final goal, nautical miles per pound, can then be attained.

Level-off for cruising altitude may be made from an altitude of 200 to 500 feet above cruising altitude. The engineer should set up cruise power commensurate with aircraft weight and altitude, less the extra 200 to 500 feet, to help establish cruising air speed and trim the aircraft cruising straight and level. Efficient cruising requires maintaining a recommended air speed which can be obtained from the "Specific Range Curves." Maintain the desired air speed by use of the elevators and vary power settings slightly to maintain altitude. Do not allow air speed to drop, if it is impossible to maintain altitude with a given air speed, check trim and then add power as necessary.

SYSTEMS OPERATION.

Operation of the various systems during flight is given in Section VII, "Systems Operation."

FLIGHT CHARACTERISTICS.

Refer to Section VI, "Flight Characteristics," for the characteristics of the aircraft during flight.

DESCENT FROM HIGH ALTITUDE.

After cruising at high altitudes, the next phase will be to descend to a medium altitude. For information concerning descents, refer to "Normal Descent" of this section.

CRUISE NO. 4 (MEDIUM ALTITUDE-LOW GROSS WEIGHT).

Cruising at a medium altitude at low gross weight on the last leg of the journey home is known as Cruise No. 4. Again the engineer concerns himself with manual leaning.

DESCENT.

NORMAL DESCENT.

Descent in every case should be governed by the air speed and propeller limitations specified in "Operating Limitations," Section V. Air speed is the more critical limit because undetected flutter could cause structural failure. Propeller vibration, however, usually means a sharp reduction in blade life rather than an immediate failure.

Descents should always be made at long-range air speed. Most long-range flights are made with the airplane on automatic pilot, and the rate of descent will be approximately 300 feet per minute. When necessary, power reduction will be made in accordance with the bmep power schedule of the Appendix in order to maintain efficient and economical engine operation.

CAUTION

Do not collapse reciprocating engines except for emergency descent. This procedure is discussed in Section III.

Under no-wind conditions, approximately 2.2 nautical miles of range can be gained for every 1000 feet of altitude. For example, descent from 25,000 feet to sea level will add about 55 miles to the range. However, that is a small factor compared with the magnitude of winds at altitude. Consequently, wind conditions must be given primary consideration in making a descent. If there is a strong head wind at a high altitude and a tail wind is predicted for a lower altitude, obviously descent should be made to the lower altitude to take advantage of the tail wind. On the other hand, if the winds at all altitudes are the same but the nautical miles per gallon at the higher cruising altitude is greater than that which would be obtained at the lower altitude, the high altitude should be maintained since the airplane is already at altitude.

Another factor entering into the descent picture is crew fatigue. If there is only a slight difference in nautical miles per gallon obtainable at high and low altitude, the decision would probably be made to remain at the higher altitude so as to reduce the time required to complete the mission.

RAPID DESCENT.

When head winds are encountered, it is best to descend rapidly through the regions of the high adverse winds and cruise at altitudes where wind conditions are more favorable. Regardless of these factors, however, you should in no case descend below the altitude you will have to maintain for the remainder of the flight because of topographic conditions.

Rapid descent like normal descent should also be governed by the air speed and propeller limits specified in Section V. In this case, however, power settings are reduced to minimum values required to prevent excessive wear and stress from reverse bearing loads. The absolute minimum setting is 1400 rpm and 14.5 inches M. P. Settings above this minimum should be computed on the basis of 1 inch M. P. for each 100 rpm increase.

CAUTION

Manifold pressures below these minimum values will be limited to 30 seconds or less. Gas pressure is needed inside the cylinder to prevent stress and wear caused by windmilling.

NORMAL LANDING.

This airplane is not difficult to land after you've made a few landings to adjust yourself to its landing attitude. This adjustment is necessary because your station is so far forward of the wing; and, with the nose-up condition of a normal landing, you are about 40 to 50 feet in the air. Since the airplane has such a large wing span, you must realize that somewhat less control response can be expected at the slower air speeds encountered during final approach. However, if you use good judgment and apply the knowledge gained from landing other airplanes, you can land this airplane without difficulty.

Note

Tests indicate that approximately 5 seconds less time is required to operate the elevator trim tab control wheel from one extreme position to the other when the operator's inboard arm rest is in the up position. This time saving could mean the difference between a successful maneuver and a crash during landing.

NOSE GEAR STRUT DEPRESSURIZATION.

The requirements for depressurization of the nose strut are based on the relationship of nose strut loads at take-off and at landing. This relationship can be obtained from the charts in figure 2-11 to determine whether depressurization of the nose gear strut is necessary. The charts are used in the following manner:

1. Using Chart A, determine the strut load at take-off by finding the point of intersection of the lines representing take-off gross weight and cg location. From

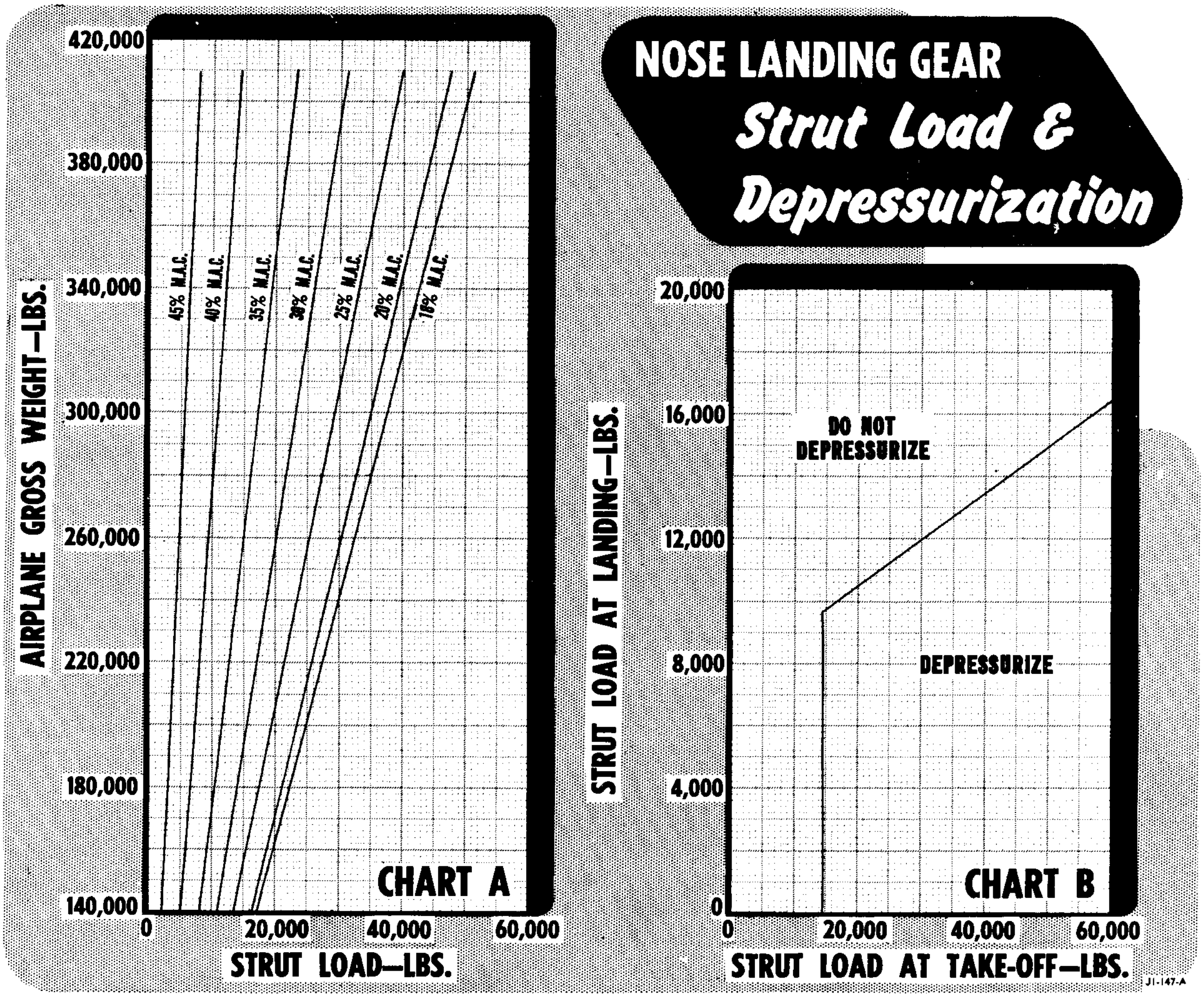


Figure 2-11.

this point, follow the vertical line to the bottom of the chart and read the strut load.

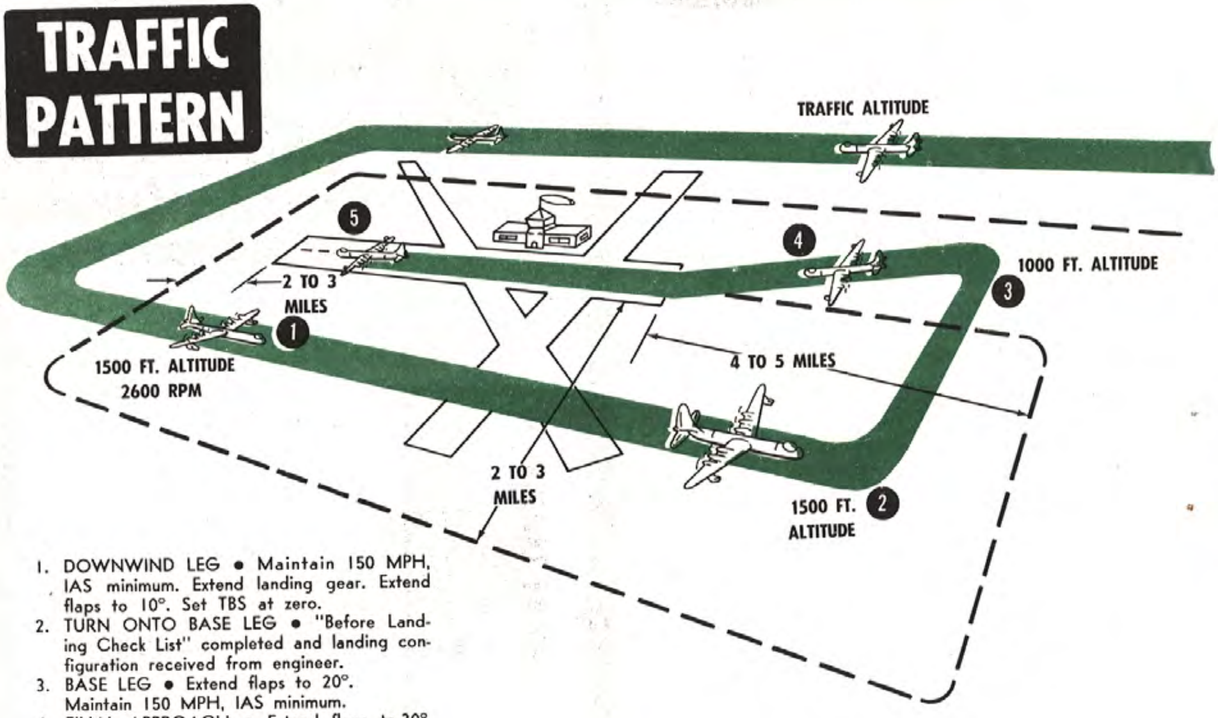
2. To determine the strut load at landing, repeat step 1, using landing gross weight and cg location.

3. Using Chart B, follow the lines representing the strut loads at landing and at take-off until they intersect. The area in which the lines intersect will indicate whether or not depressurization is required.

TRAFFIC PATTERN.

Because of the high stability of the airplane, considerable longitudinal retrimming will be necessary when executing steep turns. This trimming must be accomplished during the entry and exit periods of the turns to maintain constant air speed and nominal elevator control forces. For normal traffic patterns with those airplanes equipped with two-minute turn indicators, use one-half needle width turns; for airplanes equipped with a four-minute turn indicator use single needle width turns. These turns will be 2-minute turns at 90 degrees per minute. Because of the slower turning rate, the traffic pattern for this airplane will be somewhat larger than for other aircraft.

The traffic pattern should be entered by flying upwind parallel to the landing runway at traffic altitudes. This will give you an opportunity to observe airdrome traffic and space your aircraft in the traffic pattern accordingly. The down wind leg is approximately two or three miles out from the landing runway at 1500 feet above the terrain. A 500-foot descent should be made on the base leg so that the turn on the final approach is accomplished at 1000 feet. Before turning on the base leg, the "Before Landing" check list should be complete and the landing configuration should be received from the engineer. This will permit a correct approach speed with a 500-foot per minute descent on the final leg.



1. DOWNWIND LEG • Maintain 150 MPH, IAS minimum. Extend landing gear. Extend flaps to 10°. Set TBS at zero.
2. TURN ONTO BASE LEG • "Before Landing Check List" completed and landing configuration received from engineer.
3. BASE LEG • Extend flaps to 20°. Maintain 150 MPH, IAS minimum.
4. FINAL APPROACH • Extend flaps to 30°. Establish 500 FPM descent at minimum of 135% stalling speed, not to exceed 145%.
5. LANDING • Use rudder above 60 MPH and nose steering below 60 MPH for directional control. Reverse propellers. Lock controls at 50 MPH.

Figure 2-12.

A minimum air speed of 150 mph IAS should be maintained on the down wind leg during normal landings. The landing gear should not be extended until you are halfway through the down wind leg or when opposite the end of the landing runway. When the gear is extended and checked, the flaps should be lowered to 10 degrees. The minimum air speed for the down wind leg will be maintained for the base leg, and the flaps will be extended to 20 degrees. On the final approach, air speed should be maintained at a minimum of 135 per cent of stalling speed. Do not exceed 145 per cent of stalling speed. The flaps should also be lowered to 30 degrees.

When the flaps are lowered, the airplane tends to nose up and gain altitude. Therefore when the flaps are lowered, anticipate this change in attitude and roll in enough nose-down elevator trim to counteract this tendency. Each successive lowering of the flaps on the base and final legs will require further down-elevator trim.

When the aircraft is at an average landing weight of about 200,000 to 230,000 pounds, a power setting of about 30 inches M. P. should maintain sufficient air speed and altitude on the down wind leg. When the gear is lowered and flaps set at 10 degrees, an increase in power to about 37 inches M. P. is necessary to maintain correct air speed and altitude.

Control effectiveness versus air speed is very important during the final approach while trying to maintain a constant IAS. Excessive aileron movement, cross trim, improper throttle settings, or overcontrolling tend to increase stall characteristics and decrease control effectiveness, with a resultant loss of air speed. On the final approach, keep the wings as level as possible. For directional control, minimize the use of aileron control. During cross-wind landings, employ rudder control rather than aileron control to correct for drift. Aileron control sluggishness is evident at low approach speeds and can cause wing wallow if inadvertent aileron overcontrol is used. Because of this condition and the low clearance of pods and outboard propellers from the runway (5-foot clearance between outboard propeller tips and the ground and 5-foot, 8-inch clearance between the pods and the ground), *it is imperative to maintain wings level during flare-out and landing.*

The aircraft should be landed in a slightly nose-high attitude at as high a touchdown speed as practical. In no case should full stall landings be attempted. Flare-out should be started from an altitude of 60 to 70 feet. Keep air speed well above stalling speed during the round out. When landing with an aft cg location, it must be remembered that during the flare-out the tail will drop more rapidly than with forward cg location. When the main gear is on the runway, the pilot will ready the propellers on the order of the aircraft commander. The nose should be eased down on the runway and directional control maintained with the rudder. Rudder control is effective down to speeds of 60 mph. Propellers will be reversed on the command of the aircraft commander who will apply the necessary power with the throttles to slow down the airplane. This application of power should not exceed 30 inches M. P. unless there is an emergency. The pilot will hold forward pressure to keep the nose wheel firmly on the runway. After the air speed has dropped to 60 mph IAS, the aircraft commander should lock the controls with his right hand and use nose wheel steering with his left hand. If nose steering is inoperative, differential power with the propellers in reverse pitch can be used to maintain directional control. Caution should be taken not to use the nose steering to make any large corrections until the airplane has slowed considerably. Severe oscillations or buffeting of the nose section will occur if you use over-control of the nose wheel steering on fast ground rolls.

WARNING

Flight crew will not be stationed in the lower nose section during landing because of the likelihood of personnel being trapped in event of a crash landing.

The aircraft commander will stand by on the interphone and the pilot will be on command radio with the mixer selector switch at INTER.

BEFORE LANDING.

PILOTS

1. Notify crew—"Prepare to land." The safety belts and shoulder harness fastened and inertia reel lock controls UNLOCKED. The landing check should be started 8 to 10 minutes before landing.
2. Bomb Bay Area—Checked. A designated crew member will inspect the bomb bay area for fuel and hydraulic leaks.
3. Autopilot—Off.
4. Nose Shutoff Door Switches—OPEN. Although the 2 to 4 per cent windmilling rpm experienced in flight with the jet nose doors closed will scavenge most of the jet oil, a certain amount will tend to collect in the engine. To scavenge all of the oil, it is necessary to open the doors to increase windmilling rpm when entering the landing pattern.
5. Jet Engines—As required. If landing at heavy gross weights, start the required number of jet engines at this time.

ENGINEERS

1. Fuel Panel Checked—Booster pumps ON.
2. Propeller Selector Switches—AUTOMATIC OPERATION, Tel-Lamps Lighted.
3. Engine Supercharger Switches—DUAL TURBO.
4. Engine Fan Speed Switches—LOW RPM.
5. Spark Advance Switches—RETARD (guards down).
6. Mixture Control Selector Switches—LEVER.
7. Mixture Control Levers—RICH.

Note

All mixture control levers will be in the RICH position for landing regardless of the type of carburetors installed on the engines.

8. Air Plugs and Intercooler Shutters—As Required.
9. Turbo Booster Selector—ZERO, calibration knobs indexed.
10. Temperatures—Checked and within limits.
11. Carburetor Preheat Switches—As required. (See "Emergency Use of Carburetor Preheat," Section IX.)

PILOTS

ENGINEERS

BEFORE LANDING (Cont'd)

6. Engineers' Landing Configuration—Engineer reads: "Before Landing Check List Complete, standing by for rpm, landing gear, and brake check. Gross Weight ....lbs."

7. Stalling Speeds and Take-off and Landing Data—Check and Reviewed. A check of the placard on your instrument panel will give you the stalling speeds at various flap settings for the landing gross weight. Also, review the take-off and landing data with the pilot.

8. Master Tachometer—2600 rpm.

9. Landing Gear Control Switch—EXTEND. The gang bar arrangement will turn the brake pump switch ON. The pilot will report on the interphone, "Gear coming down," and will place the landing gear and brake pump switches in EXTEND and ON, respectively. The aft scanners will watch gear operation through the complete cycle and will report on interphone as follows: "Left door coming open, right door coming open. Left gear down and locked, right gear down and locked. Left door fully closed, right door fully closed." The pilot will observe the landing gear indicator lamps and note whether the warning horn is sounding; also he will receive the engineer's report that main hydraulic system pressure is relieved. The radio operator will check the nose gear through the inspection window and will report, "Nose gear down and locked." Complete extension of the gear normally takes approximately 50 seconds. After receiving the pilot's report that the gear is down and locked, the aircraft commander will check to see that the red landing gear indicator lamp is out and the green lamp is lighted.

12. Turbo Control Change-Over Switches—AUTOMATIC.

13. Turbo Control Vernier Switch—OFF.

14. Alternator Panel—Checked.

15. Cabin Heater Power Switch—OFF.

16. Booster Fan Switch—As required.

17. Cabin Pressure Wing Shutoff Valve Switches—DEC.

18. Wing, Cabin Heat and Tail Anti-Ice Switches—As required.

19. Pitot Heater Switches—As required.

20. Propeller Normal Pitch Indicator Lamps—Lighted.

21. Brake Pressure—Normal.

22. Engineer's Landing Configuration—Engineer reads: "Before Landing Check List Complete, standing by for rpm, landing gear, and brake check. Gross weight—lbs."

23. Master Tachometer—2600 rpm. At high gross weight, high field elevations, or in emergencies 2800 rpm and 6 TBS setting may be used.

24. Hydraulic pressure normal, pressure relieved.

PILOTS

ENGINEERS

BEFORE LANDING (Cont'd)

The indicated air speed must not exceed 188 mph during landing gear extension. A visual check of the landing gear by the aft scanners and radio operator is very important. The green indicator lamp is operated by the main and nose gear limit switches and is not a positive check. The aft scanners' check of the flags on the main gear side braces and the radio operator's check of the nose gear, together with the hydraulic pressure relief noted by the engineer, is a positive check. After receiving the radio operator's and scanners' reports that the landing gear is down and locked, check that the nose wheel steering indicator is at zero.

10. Parking Brake Switch—BRAKE OFF. The parking brakes can be set accidentally by personnel moving about on the flight deck.

11. Left and Right Brakes—Checked. After the gear is down and locked, check the brakes. The pilot should depress the foot pedals one at a time, and the engineer will report a drop in brake pressure as each pedal is operated. After both pedals are operated and the pressure has returned to normal, the engineer will report the fact on interphone.

12. Nose Gear Strut—Bled, if required. See figure 2-11 to determine whether depressurization is necessary.

13. Bomb Bay Doors—Checked closed visually. As the nose gear strut is being bled, the bomb bay doors will be checked closed visually and reported to the aircraft commander.

14. Nose Steering Switch—ON. No steering pressure will be indicated until the nose strut is compressed below 10 inches after landing.

15. Read pilots' landing configuration over interphone: "Gear down and locked, autopilot OFF, nose wheel steering switch ON, standing by on flaps."

16. Flaps—10 degrees.

WARNING

Do not extend flaps at indicated air speeds in excess of those shown for propeller and flap limitations in figure 5-2.

BASE LEG.

1. Flaps—20 degrees.
2. Jet Nose Shutoff Door Switches—CLOSE.
3. Landing Lights (if required)—Extended and check.

25. Brakes Checked—Pressure normal.

PILOTS ENGINEERS

BEFORE LANDING (Cont'd)

FINAL APPROACH.

1. Flaps—30 degrees.

Check propeller limitations against flap setting as shown in figure 5-2.

Maintain a minimum of 135 per cent of stalling speed or a minimum of 120 mph IAS, whichever is higher. Do not exceed 145 per cent of stalling speed. Lift with 30-degree flap setting is sufficient to allow a very steep landing approach with power off; however, normal approach is made with power on to prevent overcooling of the engines.

Note

The pilot will call out each 5 mph change in IAS and each 100 ft. change in altitude, except during GCA and instrument letdowns.

WARNING

Extreme caution must be observed when in close proximity to the ground as only a small angle of bank can be executed before propellers or pods contact the runway.

LANDING.

PILOTS

1. Propeller Reverse Selector Switches—READY, on main gear contact. The pilot will place these switches in READY at the order of the aircraft commander.

CAUTION

Do not ready the propellers until ground contact has been made.

2. Propeller Reverse Pitch Switch—Depressed on aircraft commander's command. The pilot will actuate this switch at the order of the aircraft commander after the nose wheel has contacted the runway. When the pilot actuates the switch, the aircraft commander will increase the throttles to the desired power. With the propellers in reverse during normal landings, 30

ENGINEERS

1. Brake and Nose Steering Pressure—Normal after nose wheel contacts ground.

2. Rpm and Manifold Pressure Checked—after propellers are reversed, do not exceed 30 inches M. P. except in an emergency.

PILOTS ENGINEERS

LANDING (Cont'd)

inch M. P. is maximum; however, in emergencies full power application is acceptable. The pilot will stand by on the control and will hold them in neutral while reversing. The effect of reverse thrust from the propellers is greater at high speeds; thus, it is desirable to use reverse thrust as soon as possible after landing.

3. Control Surfaces—Locked at approximately 50 mph. On normal landing the flight controls should not be locked until the forward speed reaches approximately 50 mph. This will permit the use of the rudder for directional control for as long as it is effective. Since gusty winds can cause serious rudder damage when the airplane's speed is less than 50 mph, the controls must be locked at approximately 50 mph on all landings. If more than 30 inches M. P. is needed after reverse pitch, controls must be locked at all speeds.

4. Propeller Reverse Selector Switches—SAFE. The aircraft commander will return the desired pairs of propellers to the normal position after the landing The engines should be reduced to idle before returning the reverse selector switches to SAFE.

CAUTION

If the outboard propellers are not needed for emergency stopping, they must be placed in normal pitch before reaching 40 mph to prevent aileron flutter and possible damage.

5. Flaps—Retracted. Flaps will be retracted after turning off the runway.

6. Jet Oil Shutoff Valve Switches—CLOSE, at zero per cent rpm. These valves should be closed at zero per cent rpm to trap all of the oil in the tanks. If this is not done and the oil tanks are filled before the next flight, the excess oil trapped in the engine will be forced out the vent lines on the next jet start. When closing the valves, be sure the associated circuit breakers are pushed in.

Note

One of the symmetrical pairs of reciprocating engines will be stopped on command of the aircraft commander after landing has been completed, after the airplane has been turned off the active runway, and after the engines have been checked for proper operation.

HEAVY GROSS WEIGHT LANDINGS.

With the forward cg location of the B-36 at high gross weights, very large up-elevator deflections are required when flying at low air speeds in the landing condition near the ground. This is caused by the great amount of static stability possessed by the aircraft when in a forward cg condition combined with the nullifying effect of the ground on the down wash air load over the tail. This requires additional up-elevator deflection to produce the total tail-down load needed to balance the pitching moments of the aircraft.

The following pilot techniques are recommended for landings with gross weights of approximately 283,000 pounds or more:

1. Start two jet engines on the downwind leg and have them operating at 90 per cent rpm.

2. Conduct the final approach portion of the landing as flat as practicable with power on, maintaining a minimum of 135 per cent stalling speed. Do not exceed 145 per cent stalling speed. Adjust reciprocating engine power to maintain these speeds.

3. As the aircraft approaches the ground in the transition to flare-out, be ready to apply up-elevator deflection rapidly. Use the elevator trim tab continuously to help trim out the elevator control column "pull" forces.

4. Allow the power to remain on until the aircraft actually touches the runway. As soon as the main gear wheels are on the runway, cut power and apply additional up-elevator control force to counter the rapidly increasing nose-down moment of the aircraft which occurs when power is cut. This will minimize the impact of the nose wheel when the aircraft pitches forward.

5. When the nose wheel contacts the runway, reverse the propellers immediately. In the event of a minimum run landing, keep power on and reverse the propeller as soon as the main gear wheels touch the runway. No difficulty will be experienced in getting the nose wheel down. In fact, the nose will still go down rapidly unless additional up-elevator is employed.

MINIMUM-RUN LANDINGS.

Use the same procedure as that used in normal landing with the following exceptions: Reverse the propellers after the main landing gear touches the ground and before the nose wheel touches the ground. When reversing the propellers with the nose still in the air, the nose must not be at too high a deck angle and must be held steady since there is a slight tendency to nose up. When a maximum of 30 inches M. P. is used, reduce master motor speed to 2000 rpm. This will give a more effective reverse thrust.

CAUTION

Since the airplane has a very responsive brake system and is equipped with four-wheel main gears, extra care must be used to avoid skidding the rear wheels. Scanners should be alert for such observations and should notify the aircraft commander.

CROSS-WIND LANDINGS.

Cross-wind landings will be avoided if at all possible. If, at any point during final approach, lateral corrections of an appreciable magnitude are required, an immediate go-around will be executed in order to avoid having a wing drop while near the ground. Avoid dropping one wing to correct for a cross wind. The recommended procedure for making a cross-wind approach and landing is to head into the wind (crab) just enough to keep a straight ground path and hold the wing level. It is recommended that the jet engine air plugs on the down wind side be opened as an aid in reducing the amount of crab necessary to maintain a straight flight path. Take out the crab with the rudder after flare-out and before touch-down, being careful not to inadvertently drop a wing. Put nose gear down as soon as possible after touch-down and apply forward pressure on the control column.

GO-AROUND.

The decision for go-around should be made before descending to 500 feet, if possible. The sooner the decision to go-around is made, the better the chances are for success. When weighing the possibilities for go-around in terms of altitude, air speed, gross weight, aircraft configuration, wind conditions, runway facilities, and visibility, the aircraft commander should always consider the advantages of a controlled crash landing over an unsuccessful go-around. This is especially true if aircraft performance is critical or altitude (500 feet or less) is marginal.

In the event a go-around becomes necessary, proceed as follows:

PILOTS

1. The aircraft commander will announce over interphone, "Go-around."

2. The pilot will raise the flaps from full down position to 20 degrees on aircraft commander's command.

CAUTION

Drag with full flaps is excessive. Raise the flaps to 20 degrees as quickly as possible when the decision to go around has been made. Do *not* raise flaps past 20 degrees until a safe IAS has been obtained. Flaps should not be completely retracted before 140 mph IAS or 125 per cent of stalling speed (whichever is greater).

WARNING

A safe IAS must be maintained in a go-around; therefore, continue on the same approach angle until safe flying speed has been reached.

3. The aircraft commander will adjust power as required, co-ordinating reciprocating engine and jet engine power with the pilot.

4. Landing Gear Switch—RETRACT. The aircraft commander will give the order, "Gear up."

Note

A landing gear check will be made in accordance with the procedure in "Take-Off" of this section.

WARNING

This landing gear will not be retracted until it is certain that the touch-down will not be made. Remember that the aircraft will continue to settle for a short period after full power has been applied.

TAXIING AFTER LANDING.

For taxiing instructions after landing, refer to "Taxiing" of this section. When taxiing after landing and after postflight engine checks, one symmetrical pair of engines may be shut down.

ENGINEERS

1. Smoothly increase M. P. to 55 inches. If additional power is required, increase master motor cautiously to 2800 rpm and manifold pressure as required.

CAUTION

To avoid overspeeding propellers when increasing power in a go-around, advance the throttles to full open before advancing the turbo boost selector to 6 position.

POSTFLIGHT ENGINE RUN-UP.

The postflight engine run-up will be performed by the pilots and engineer as follows:

CAUTION

Make sure wheels are chocked if engine run-up is performed in a congested area.

PILOTS

1. Propeller Reverse Selector Switches—SAFE (lights out).
2. Parking Brake Switch—BRAKE ON.
3. Nose Wheel Steering Switch—OFF.

ENGINEERS

1. All Propeller Normal Pitch Indicator Lights—ON.
2. Master Tachometer—2800 rpm.
3. Parking Brakes—Set, pressure normal.
4. Nose Steering Pressure—ZERO.
5. Announce over interphone, "Ready for postflight."
6. Engine Run-up—Completed.

a. Perform ignition switch check.

b. Idle speed and mixture—Check.

Note

Refer to "Stopping Reciprocating Engines, Preflight Operational Equipment Check."

c. Set master motor speed control lever at 2200 rpm and adjust throttle levers 1 and 6 to obtain 140 psi torque pressure.

Note

Manifold pressure should not exceed 40 inches.

d. Note and record rpm, M. P., torque, and fuel flow.

e. Perform single ignition check.

f. Check cruising fuel-air mixture.

Note

This information will be included when available.

g. Throttle lever—Full open.

h. Note and record rpm, M. P., torque, and fuel flow.

i. Throttle lever—Closed.

7. Repeat step 6 for remaining symmetrical engines.
8. Check that cylinder-head temperatures are 170°C or as low as possible if unable to obtain 170°. Shut down engines 1 and 6 in accordance with "Stopping Reciprocating Engines" of this section.

PILOTS ENGINEERS

POSTFLIGHT ENGINE RUN-UP (Cont'd)

9. Report to aircraft commander "Ready to taxi to line."

10. Repeat steps 1 through 4 and step 8 before shutting down remaining engines.

CAUTION

If an engine has been shut down in flight then unfeathered for emergency use, that engine should be carefully watched during engine shutdown on the ground. This is necessary because loss of ram air and an accumulation of oil or fuel around the engine and exhaust system creates a fire hazard. A check of that engine should be made before leaving the aircraft.

STOPPING RECIPROCATING ENGINES.

The engineer will stop engines in accordance with the instructions given in "Preflight Operational Equipment Check, Stopping Reciprocating Engines." The aircraft commander will accomplish the following during engine shutdown:

PILOTS ENGINEERS

1. Parking Brake Switch—BRAKE ON.
2. Propeller Reverse Selector Switches—SAFE (lights out).
3. Nose Wheel Steering Switch—OFF.
4. Flight Instrument Switches—OFF.
5. Contact engineer, "Ready to stop engines."

CAUTION

Aircraft commander, engineer, and aft scanners will remain on interphone. The pilot will have radio tuned to tower frequency until the last propeller has stopped turning.

6. Radio Equipment—OFF.

BEFORE LEAVING AIRCRAFT.

Check and accomplish the following before leaving the aircraft:

PILOTS

1. All Control Switches—Properly positioned. Check that the navigation, fuselage, cabin, compass, fluorescent, and all other miscellaneous lights are off. Pull the following circuit breakers on the pilot's circuit breaker panel; N-1 compass, bomb salvo, bomb bay doors, aircraft commander's and pilot's turn and bank indicators. Check that all oxygen regulators are off.

2. Wheel Chocks and Ground Locks—In place.

3. Parking Brake Switch—BRAKE OFF after wheels are chocked.

4. Postflight Visual Inspection—Completed.

a. Crew members will exit aircraft upon command of the aircraft commander.

b. Ground locks installed.

c. Crew will fall in at the left side of the nose in two ranks.

d. Roll call and aircraft discrepancies for entry in the Form I.

e. Assign crew duties for unloading the aircraft, emptying garbage cans, etc.

f. Collect all reports, logs, etc.

g. Dismiss crew.

h. A rapid visual inspection of the exterior should be made by the aircraft commander.

Note

The postflight visual inspection will normally be conducted after each flight; however, weather, crew fatigue, and other intangible factors may sometimes necessitate a modification of this inspection.

ENGINEERS

1. Fuel Dip Stick Readings—As required (or the best available method of determining fuel remaining).

2. Forms and Reports—Completed. Coordinate with maintenance and operations.

SECTION III
Emergency Procedures

69-107-A

Survival in an emergency requires the fully co-ordinated effort of each crew member. A well trained crew will know what to do and, if properly disciplined, will react with efficiency. Since procedure drills are the nearest approach to reality, they should be conducted at every opportunity so that the crew will be familiar with each procedure and will learn to accomplish it in a minimum of time. If time and circumstances permit, planning for an impending bail-out or forced landing will increase the chances for survival. The chances of survival depend critically on communication equipment; water, food, and medical supplies; and crew discipline.

Note

In case of emergency, the aircraft commander will be notified over interphone on the CALL channel.

Emergency signals are given on the alarm bells and are as follows:

1. Prepare to bail out—Three short rings.
2. Bail out—One long ring.
3. Prepare to ditch or crash land—Six short rings.
4. Ditching or crash landing—One long ring.

Note

If possible the crew should be warned and acknowledgement received by interphone.

ENGINE FAILURE.

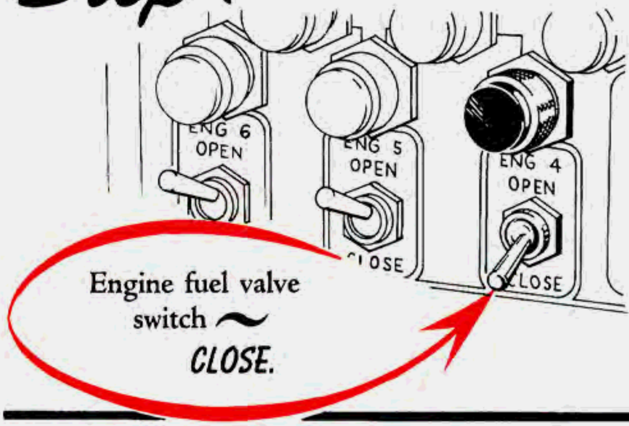
FLIGHT CHARACTERISTICS WITH PARTIAL POWER.

The airplane is not difficult to maneuver under conditions where some engines are inoperative. The ease of maneuverability results from the free-floating characteristic of the servo-operated control surfaces and the positive means of trimming the airplane. Do not be apprehensive about normal turns into dead engines. Remember, too, in case of critical power failure, the jet engines are there to supplement the remaining power.

It is important to be familiar with the appendix which gives rate of climb versus air speed for various flap and gear positions with engines inoperative. With asymmetrical power, the drag of the inoperative engine and the thrust of the opposite engine combine to form a powerful turning effect. Any resulting turn increases the lift of the faster moving wing, causing a roll into the dead engine. Normal aileron correction tends to bring up the low wing but at the same time adds adverse yaw into the inoperative engine. With speed reduction the drag of the inoperative engine decreases, but the thrust of the opposite engine (at constant power setting) increases. As speed is decreased, both ailerons and rudder become less effective. Above the safety speeds listed in figure 3-2, full control of the airplane can be maintained with high asymmetrical power. When cruising on four or five engines, all engines should be kept operating at the same power setting. At low speeds, however, it is necessary to throttle back to more symmetrical power conditions to maintain control. The charts shown in figure 3-2 represent the best available information until such time as the stall and lateral control tests are completed.

• *Reciprocating Engine* SHUTDOWN IN FLIGHT

Step 1



WARNING

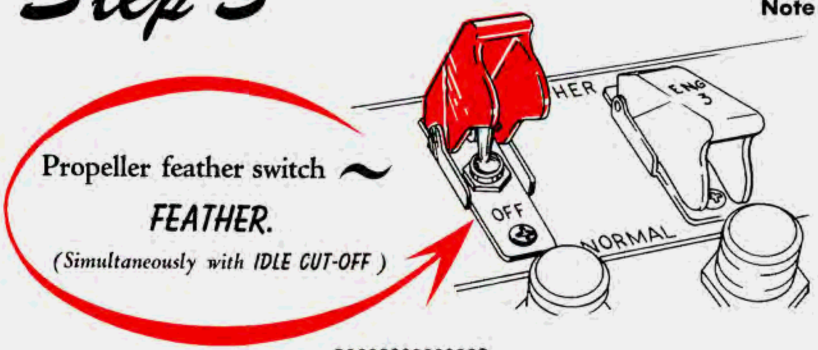
Do not, without forethought, close other fuel valves or shut off fuel booster pumps, since other engines may be dependent on their position or operation.

CAUTION

Do not close oil shutoff valves unless engine is being feathered because of fire.

Step 2

Step 3



CAUTION

Do not allow a propeller to windmill in reverse, because the engine may be damaged because of inadequate lubrication. If an engine windmills in reverse for an appreciable length of time, have it thoroughly checked after the flight.

Note Because of an aerodynamic characteristic, slight windmilling in reverse will occur on completion of the feathering cycle of propeller No. 1, 2, or 3. To remedy this condition, place the propeller selector switch of the affected propeller in FIXED PITCH, return the feather switch to NORMAL, and then jiggle the selector switch in the INC. RPM position until the windmilling stops. Leave the selector switch in FIXED PITCH position. If the propeller is inadvertently moved through the feather position and begins to windmill in the normal direction, actuate the feather switch and repeat the above procedure. When a propeller is feathered, the lower aft scanners will report to the engineer, "Propeller Feathered and Stopped." Report any rotation of the propeller after it is feathered.

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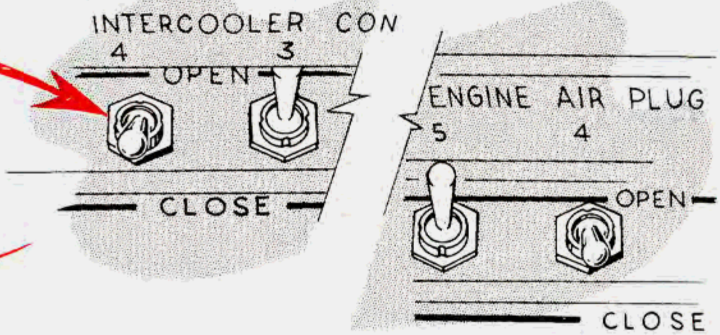
Figure 3-1. (Sheet 1)

Step 4

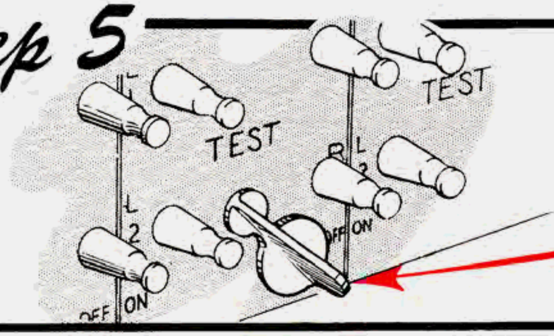
Intercooler and air plug control switches ~

Hold in **CLOSE**

position until intercoolers and air plug are fully closed.



Step 5



Ignition switch ~ **OFF.**

after emergency is over.

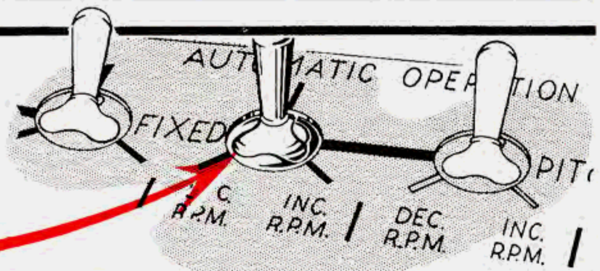
Note

The following steps may be accomplished at any time after emergency.

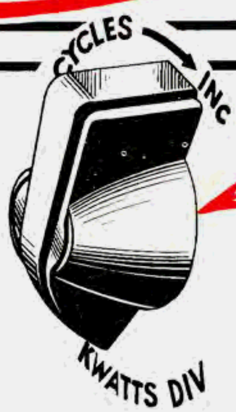
Step 6

Propeller selector switch ~

FIXED PITCH.



Step 7



Frequency control knob ~

full DECREASE.

Note

Turn the voltage and frequency selector switch to the number of the feathered engine if it is alternator-equipped. Check for zero readings on the frequency meter and the voltmeter.

69-184-A

Figure 3-1. (Sheet 2)

MINIMUM IAS (MPH) FOR ZERO YAW

FULL RUDDER DEFLECTION

RED FIGURES ARE INDICATED AIR SPEEDS (MPH).
(ALL ENGINES AT TAKE-OFF POWER)

CONFIGURATION	77°F (OAT.)		104°F (OAT.)		NACA DAY							
	SEA LEVEL		SEA LEVEL		SEA LEVEL		3000'		6000'		9000'	
	300,000 LBS.	400,000 LBS.	300,000 LBS.	400,000 LBS.	300,000 LBS.	400,000 LBS.	300,000 LBS.	400,000 LBS.	300,000 LBS.	400,000 LBS.	300,000 LBS.	400.000 LBS.
6 RECIP ENG + 3 JETS + 2 JETS	100* 145	100* 149	98* 146	97* 150	101* 146	101* 150	97* 140	97* 144	93* 135	93* 137	90* 131	90* 131
5 RECIP ENG + 4 JETS + 3 JETS + 2 JETS	124 152 180	124 155 182	125 153 180	114* 156 182	124 152 180	124 155 181	122 148 174	115* 152 177	119 145 169	113* 149 172	117 141 164	111* 145 166
4 RECIP ENG + 4 JETS + 3 JETS + 2 JETS	147 173 196	151 175 197	148 173 197	151 175 199	147 173 195	151 175 197	146 168 191	150 171 192	143 165 185	148 168 186	141 162 181	145 164 183
3 RECIP ENG + 4 JETS	159	162	159	162	158	161	156	159	155	157	152	155

Speeds quoted are for the most asymmetric configuration, i.e. inoperative engines are those most outboard on one side.

Airplane in ground attitude when CG is approximately 22% MAC at 300,000 lbs or 25% MAC at 400,000 lbs.

Take-off configuration.

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Figure 3-2.

OIL DILUTION AFTER ENGINE SHUTDOWN.

After engine shutdown, if the engine is operable, use the following procedures:

1. Oil shutoff valve—Check OPEN.
2. Immediately after feathering windmill the engine 50 to 100 rpm and allow the engine to cool to an oil temperature of 30° to 40°C.
3. Windmill engine to 800 rpm.
4. Engine fuel valve—Check OPEN.
5. Use normal oil dilution procedure. Refer to the oil dilution table, "Oil Dilution," Section IX.

FUEL PRESSURE DROP—ENGINE OPERATING NORMALLY.

If an engine's fuel pressure drops below the operating limits but the engine continues to operate normally, proceed as follows:

1. During ground operation:

a. Stop the airplane.

b. Shut down the engine immediately.

c. Investigate the cause and correct the trouble before flight.

2. During flight—Attempt to determine the source of trouble, such as primer leakage, oil dilution solenoid valve leakage, clogged pressure line, instrument failure, or fuel line leakage. After determining the source of trouble, proceed with one of the following courses of action:

a. Shut down the affected engine immediately if it is not needed to sustain flight.

b. If the fuel pressure drop was not caused by a fuel leak, continue normal operation of the engine.

c. If the exact source of trouble cannot be established and the engine is required to sustain flight, keep the affected engine in operation at or above cruising speed. Maintain a close watch for indications of fire. Prior to reducing power for entrance into the landing pattern, shut down the affected engine.

WARNING

Unless the added power is essential to effect a safe landing, do not reduce airspeed until the affected engine is shut down. Engine shutdown is necessary since a fuel leak may exist. Such a leak may not be evident during cruise due to the cooling and dispersing effect of the airflow over the engine. However, when power is reduced, the reduced cooling and dispersing effect may cause the fuel leak to ignite.

PROPELLER UNFEATHERING DURING FLIGHT.

CAUTION

If a propeller has been feathered for 5 minutes or more in low temperatures requiring oil dilution as given in figure 9-6 and the oil was not diluted at engine shutdown, do NOT unfeather. Also, due to the existence of a potential fire hazard, no attempt will be made to restart a reciprocating engine that has been feathered due to a malfunction, unless the aircraft commander deems it necessary to use that engine because of power loss of other engines.

1. Mixture control lever—IDLE CUT-OFF.
2. Throttle lever—Approximately 1/4 open.

Note

Above 30,000 feet a more open throttle will be required to initiate an engine start.

3. Engine oil shutoff valve switch—OPEN.
4. Engine fuel valve switch—OPEN.
5. Fuel pressure—10 to 14 psi.
6. Propeller selector switch—FIXED PITCH.
7. Propeller feather switch — NORMAL (guard down).
8. Propeller selector switch—INC. RPM until engine rpm is from 10 to 50.

CAUTION

If rpm does not increase when propeller selector switch is engaged, hydraulic lock is indicated; therefore, discontinue starting procedure and refeather.

9. Propeller selector switch—Hold in INC. RPM until engine turns over 600 to 800 rpm; then return to FIXED PITCH.

CAUTION

Check for an indication of oil pressure or alternator excitation. If there is no oil pressure indication within 30 seconds, refeather the engine.

10. Ignition switch—ON.
11. Mixture control—NORMAL, models 391260-8, 391420-1, and 391410-1 and -2 carburetors; RICH, model 391260-3, -4, -5, and -6 carburetors.

Note

The torquemeter will indicate a successful engine start. If the torque oil has congealed in the line to the autosyn transmitter, a power surge and a normal rise in CHT indicate a successful start. To accomplish a successful engine start at altitude, it may be necessary to increase rpm.

12. Propeller selector switch—INC. RPM until 1400 rpm is attained; then return to FIXED PITCH.
13. Throttle lever—Advance until M.P. is approximately 25 inches.
14. Propeller selector switch—As required to maintain 1400 rpm during throttle advance.

CAUTION

Warm up the engine at 1400 rpm and 25 inches M.P. until engine oil temperature is within minimum limits.

15. Propeller selector switch—INC. RPM until rpm nears that of other engines.
16. Propeller selector switch—AUTOMATIC OPERATION.
17. Throttle lever—Advance to required power setting.
18. Alternator—Parallel on bus. (Engines No. 2, 3, 4, or 5.)

ABORTING TAKE-OFF.

The aircraft commander is charged with the responsibility of making the decision on whether to abort a take-off. There will not be time to make a delayed decision. No one can tell you what to do in these situations; however, you can equip yourself with knowledge on which to base your decision by knowing your REFUSAL SPEED, your STOPPING DISTANCE WITH BRAKES ONLY, and your STOPPING DISTANCE WITH BRAKES AND REVERSE PROPS. Then if you have sufficient runway left when the decision is made to abort the take-off, you will know what to do. If the aircraft commander should decide to abort a take-off after take-off power has been established, he should notify the crew by announcing over the interphone, "Aborting take-off." Immediately following this announcement, the crew members concerned will comply with the following procedure:

1. Engineer — Stand by to turn water injection switches OFF if manifold pressure on any engine is reduced below 55 inches.
2. Pilot—Propeller reverse selector switches READY and shut down jet engines.
3. Aircraft Commander—Power as required.

Note

Propellers may be reversed at full take-off power; however, slight overspeeding of engines will occur.

4. Pilot—Depress reverse pitch switch upon command of aircraft commander.

5. Aircraft Commander—Use maximum brakes but avoid skidding.

6. Pilot—Assist aircraft commander in holding controls to prevent buffeting.

7. Aircraft Commander—Lock controls, if possible, below 50 mph.

Note

Prior to each take-off the aircraft commander will personally brief the pilot and engineers on the above "Aborting Take-Off" procedure.

ENGINE FAILURE DURING TAKE-OFF.

In the event of engine failure on take-off, accomplish these steps:

1. Obtain directional control by using rudder with a minimum of aileron.

2. Pick up at least minimum control air speed before attempting to climb. (See figure 3-2.)

3. Raise the landing gear immediately, if practical, and start retracting the flaps at 125 per cent of stalling speed even though the gear is not completely up. (See figure 6-6.)

4. If emergency power is being used, reduce this power as soon as possible.

5. Determine which engine or engines have failed and whether or not they are delivering enough power to carry themselves; if not, feather their propellers and make a normal landing approach.

CAUTION

Failure of an output tube of the electronic mixture control system may cause the mixture control to be driven to the IDLE CUT-OFF position. If there is evidence of such a failure as shown by complete loss of power with a sharp decrease in fuel flow and torque, with fuel pressure normal, retard throttle to prevent power surge and backfiring and use the mixture control override switch to reset the mixture. If power is not restored, feather the propeller.

Note

If sufficient power is not available to execute the landing pattern, prepare to crash land straight ahead. Refer to "Crash Landings" of this section.

WARNING

Never attempt a turn before directional control is obtained and a safe flying speed is reached.

PARTIAL POWER TAKE-OFF.

CAUTION

In order to avoid failure of the vertical stabilizer closure skin, do not operate the airplane in an asymmetric power condition of two or more engines out on one side unless in an emergency. If operation in this power configuration is necessary, an inspection of the stabilizer closure skin will be made immediately after landing.

This procedure should be used when some engines are inoperative and the airplane must be flown from a base where repair facilities are inadequate.

Note

If symmetrical engines are inoperative, use the normal take-off procedure. See Appendix I for take-off performance.

CAUTION

This procedure does not apply in the event of engine failure on take-off or reduced power take-off.

Study the applicable portion of the "Take-Off and Distance Curve" in the appendix. Prepare the airplane by closing the air plug doors of the inoperative jets and sealing the air intakes of the inoperative reciprocating engines, but do not seal any exhaust or air outlets. One point to consider in this type of take-off is the unbalanced thrust created by asymmetrical power. With full take-off power, full opposite rudder will not be sufficient to counteract the yaw at low speeds. Therefore, with all operative engines idling and the airplane restrained with the footbrakes, the take-off should be accomplished as follows:

1. Apply full take-off power to the symmetrical engines.

2. Release the foot brakes, but hold the rudder at full deflection.

Note

If an outboard engine is inoperative, it is recommended that approximately 16 degrees of rudder trim be set in to aid in holding full rudder deflection.

3. As the airplane accelerates and the rudder becomes more effective, apply full power to the remaining engines.

CAUTION

At no time should full power be applied to a strong side engine until all engines inboard from it are operating at full power.

4. When all operative engines are at full power, reduce rudder deflection to maintain zero yaw.

5. Use rudder trim and hold the nose wheel on the ground as long as possible to aid in maintaining directional control.

6. As soon as take-off air speed is reached, make a rapid pull-off followed by level flight to accelerate to a safe climbing speed; retract the landing gear as soon as the airplane is positively airborne.

WARNING

Remember that minimum safe climb speed is 120 per cent of stalling speed. See figure 3-2 for minimum yaw.

TURBO BOOST CONTROL.

When the normal turbo controls fail, proceed as follows:

1. Control manifold pressure within limits by use of the throttles.

2. Turbo vernier control switch—OFF.

3. Turbo control change-over switch—MANUAL.

4. Turbo override control switch—Move toward OPEN or CLOSE to trim to the desired manifold pressure.

5. Turbo vernier control switch—ON.

6. Turbo override control switch—Jiggle OPEN or CLOSE to trim to the desired manifold pressure.

Note

With the vernier switch ON, each actuation of the override switch will operate the waste gate for approximately 0.05 of a second. Therefore, when adjusting the manifold pressure, the override switch must be jiggled.

The turbo override system can be operated during emergency power operation to open the waste gates. (See "Obtaining Emergency Electrical Power" of this section.) However, there will be no indication from critical engine instruments such as manifold pressure, CHT, CAT., torque pressure, or fuel flow gages.

Jet Engine REQUIREMENTS

(PARTIAL POWER LANDING)

5 RECIPROCATING ENGINES

GROSS WEIGHT – POUNDS		JET POWER REQUIREMENTS	
FROM	TO	JETS	% RPM
———	236,000	None	———
236,000	288,000	2	90
288,000	303,000	2	96
303,000	313,000	2	100
313,000	331,000	4	90
331,000	362,000	4	96

4 RECIPROCATING ENGINES

GROSS WEIGHT – POUNDS		JET POWER REQUIREMENTS	
FROM	TO	JETS	% RPM
———	187,000	None	———
187,000	240,000	2	90
240,000	253,000	2	96
253,000	262,000	2	100
262,000	294,000	4	90
294,000	322,000	4	96
322,000	340,000	4	100

3 RECIPROCATING ENGINES

GROSS WEIGHT – POUNDS		JET POWER REQUIREMENTS	
FROM	TO	JETS	%RPM
———	192,000	2	90
192,000	208,000	2	100
208,000	236,000	4	90
236,000	264,000	4	96
264,000	275,000	4	100

NOTE

When landing gross weight is 283,000 pounds or over and all six reciprocating engines are operative, two jet engines will be run at 90% rpm to insure sufficient power in the event of reciprocating engine failure during landing.

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69-168-A

Figure 3-3.

Therefore, there can be no assurance of obtaining the proper power setting.

Note

If overboost occurs during take-off and the take-off manifold pressure is exceeded by more than 10 inches for a period of 15 seconds, the engine must be changed before the next flight. If the take-off manifold pressure is exceeded by not more than 10 inches for a period of 15 seconds, the engine must be inspected prior to the next flight.

PARTIAL POWER LANDING.

It may sometimes be necessary to land with two or more engines inoperative; however, with careful planning there is seldom cause for alarm. When operating with asymmetric reciprocating engines inoperative, the resulting conditions of unbalanced thrust and lift greatly affect directional control at low air speeds with high powers on the remaining engines. For the critical air speeds below which effective control cannot be maintained with a given asymmetrical power configuration, refer to figure 3-2. There are many factors that must be considered in attempting a partial power landing. The aircraft commander should weigh these factors and determine the subsequent action. After alerting the crew to prepare for a possible crash landing, proceed as follows:

1. Make sure that the cg location is within proper limits for landing.

2. Based on expected landing gross weight, determine whether jet engine thrust is required to replace the loss of the reciprocating engines.

3. If the jet engines are to be used, they should be operated at the required per cent rpm (figure 3-3), maintaining pattern speeds and final approach glide angle by retarding the reciprocating engine throttle.

4. The jets should be started as early as practical prior to entering the traffic pattern, based on estimated power requirements, fuel reserve, etc. (For starting procedure see "Starting Jet Engines in Flight," Section II.)

5. During the landing approach, maintain a safe air speed of 135 per cent of stalling speed. Do not exceed 145 per cent of stalling speed.

6. Leave the gear up as long as practical before entering the final approach, thereby eliminating the need for high engine power to overcome landing gear drag. Care must be used to insure that gear is fully down and locked prior to turning on final approach. Normal gear extension requires approximately 45 seconds.

7. Adjust power on operating engines to maintain the desired approach speed.

8. Adjust directional trim with the rudder trim tabs during final approach.

9. Position flaps at 20 degrees until there is no possibility of undershooting; then extend full flaps.

10. Just prior to touch-down, if conditions permit, fully retard throttles on live reciprocating engines and simultaneously neutralize the rudder trim controls. Do not reduce jet power until a safe landing is assured; however, slight reductions may be necessary to maintain correct final approach air speeds even after reciprocating engines have been fully retarded.

CAUTION

Jet engines do not provide as rapid acceleration of the aircraft as do reciprocating engines; therefore, required jet engine power changes must be anticipated earlier.

11. After the airplane contacts the runway, place the propeller reverse selector switches in the READY position in preparation for thrust reversal.

12. Shut down the jet engines and reverse the propellers simultaneously.

PROPELLER FAILURE.

RUNAWAY PROPELLER (OVERSPEEDING ENGINE).

Failure of the propeller synchronizing system may result in a runaway propeller. When such a failure occurs, the engine may exceed allowable limits. Attempt to reduce rpm as follows:

1. Engineer—Hold the propeller selector switch in the DEC. RPM position.

2. Engineer—Maintain M.P. within limits.

3. If the above procedure does not reduce rpm, use momentary feather to control rpm.

CAUTION

When using momentary feather, remember that pitch change is 45 degrees per second.

4. Engineer—If this procedure does not reduce rpm, feather propeller on order from aircraft commander.

Note

If the propeller will not feather, engine overspeeding can be reduced by decreasing air speed and/or altitude.

CAUTION

All conditions of overspeeding should be noted on Form 1. If engine rpm was between 3100 and 3300 rpm, the engine must be inspected before the next flight. If the engine speed exceeded 3300 rpm, the engine must be changed.

EMERGENCY PITCH SETTING BEFORE LANDING.

When a landing is to be made in fixed pitch because of synchronizer failure, set the propeller blades and turbos to insure full power in the event of a go-around. This is done at traffic altitude before entering the final approach by using the following procedure:

1. Aircraft Commander—Maintain 135 per cent of stalling speed or 145 mph IAS whichever is greater, based on gear down and flaps 20 degrees while the engineer performs the following steps:

2. Engineer—Propeller Selector Switches—Increase all engines to approximately 2200 rpm then return to fixed pitch. This will provide the aircraft commander with sufficient power to maintain IAS and altitude.

3. Engineer—Turbo Calibration Trim Knobs—Full Decrease.

4. Engineer—TBS-6.

Note

Accomplish the remaining steps, one engine at a time on symmetrical engines No. 1 and 6, 2 and 5, 3 and 4, respectively. The aircraft commander can use remaining throttles to maintain the required airspeed. It is important that a constant airspeed and altitude be maintained while the engineer is setting this power to assure adequate and balanced power for go-around.

5. Engineer—Throttle Lever—Full Open.

6. Engineer—Turbo Calibrator Knob—Increase to 55 inches M.P. maintaining 2600 rpm with propeller selector switch.

Note

The values desired are 2600 rpm and 55 inches M.P. which is adequate power for normal landing weights. At any rate, more power should be used only in an emergency since maximum dry engine power would be exceeded. When stabilized at 2600 rpm and 55 inches M.P., retard the throttle to the average power of the other engines and proceed with the next engine.

7. Aircraft Commander—Gear and flaps will be lowered at same time as in normal landing procedure.

CAUTION

In the event a go-around is necessary, advance throttle levers to full open *slowly* and *smoothly* to avoid overspeeding the propellers.

FIRE.

JET ENGINE FIRE ON THE GROUND.

In the event of a jet engine ground fire, the pilot must call the tower and position his controls as follows:

1. All throttles—CLOSE.
2. Both manifold fuel switches—CLOSE.
3. All engine fuel valve switches—CLOSE.
4. All fuel booster pump switches—OFF.
5. All oil shutoff valve switches—CLOSE.
6. Pod preheat switch—OFF.

CAUTION

In the event fuel is burning on the ground, move the airplane upwind.

RECIPROCATING ENGINE FIRE ON THE GROUND.

If your aft scanners report a flaming exhaust stack, the fire is probably a torching turbo and may be put out by increasing the throttle momentarily. For other fires on the ground immediately warn the crew, signal to fire truck and the ground crew for portable equipment, and notify the control tower. Meanwhile the engineer should carry out this procedure:

Note

If the jet engines are operating, shut them down.

1. All engine fuel and oil shutoff valve switches—CLOSE.
2. All alternator breaker hold-in switches—Hold in.

Note

This step is applicable only when the alternators are furnishing electrical power to the airplane.

3. All mixture control levers—IDLE CUT-OFF.

Note

There are instances where the fire will burn itself out after the fuel has been shut off; therefore, before proceeding to the next step check to see whether the fire is out.

4. Proper engine fire extinguisher selector switch—Hold ON for at least five seconds as soon as the engine stops.
5. Fire extinguisher discharge selector switch—Place in the reverse position—Discharge if fire is still burning.
6. All ignition switches—OFF.
7. External power and battery switches—OFF.

Note

Prolonged exposure to methyl bromide may prove toxic; bromochloromethane is less toxic. Since exposure to either is usually for short periods of time, little ill effects are possible.

DIAGNOSING *Smoke & Fire* . . . .

• • RECIPROCATING ENGINE FIRE IN FLIGHT

Engine abnormalities are often difficult to diagnose either rapidly or accurately while in flight; however, from indications of the engine instruments coupled with information from the scanners in the aft cabin, fairly effective action can be taken in a minimum time. Engine malfunctions are often indicated by smoke or fire. Torching exhaust stacks are observed sometimes when the engine is operating on excessively rich mixtures. In some instances flame may extend through the air plug opening and the propeller. Effective leaning of the mixture will stop this condition almost immediately.

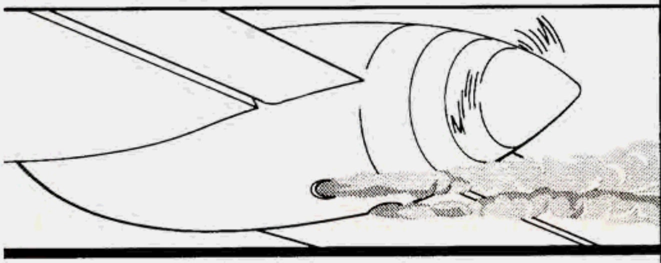
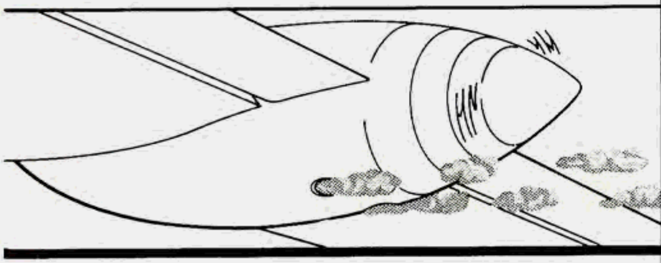
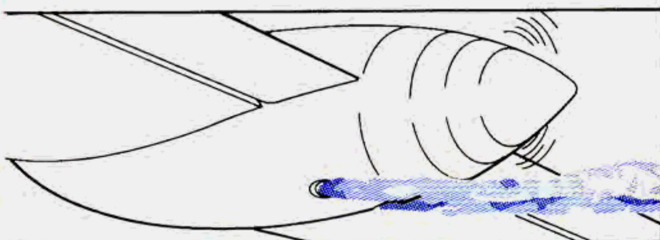
	PROBABLE CAUSE	CORRECTIVE ACTION
THIN BLACK SMOKE FROM EXHAUST 	RICH MIXTURE AT HIGH POWER	NONE
	RICH MIXTURES AT HIGH RPM AND LOW MANIFOLD PRESSURE	ADJUST POWER SETTING
	LEAKY PRIMER	NONE
PUFFS OF BLACK SMOKE FROM EXHAUST 	DETONATION	CHECK FUEL PRESSURE. CHECK MIXTURE CONTROL SETTING RICHEN MIXTURE. REDUCE MANIFOLD PRESSURE. REDUCE CYLINDER HEAD TEMPERATURE.
	CYLINDER MALFUNCTION	REDUCE POWER. WATCH FOR FIRE.
	FOULED SPARK PLUGS	INCREASE CYLINDER HEAD TEMPERATURE TO LIMIT.
THIN BLUISH WHITE SMOKE FROM EXHAUST 	INTERNAL FAILURE—RINGS	CHECK OIL PRESSURE. CHECK OIL QUANTITY.
	IMPELLER SEAL OR TURBO SEAL OIL LEAKAGE	

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Figure 3-4. (Sheet 1)

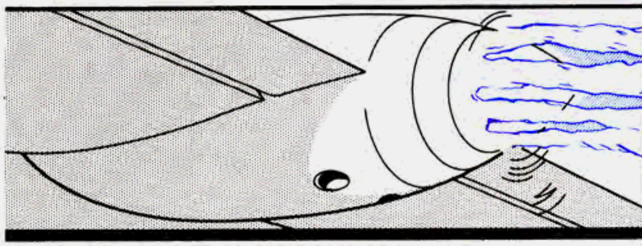
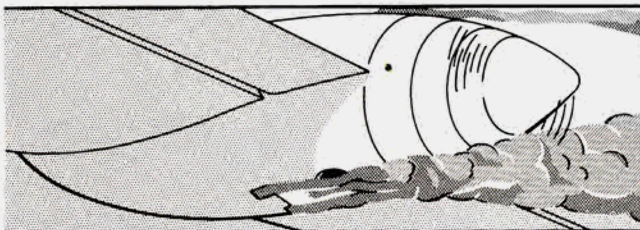
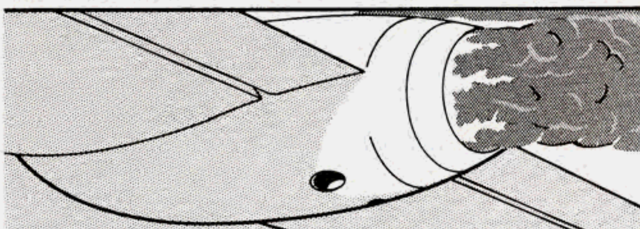
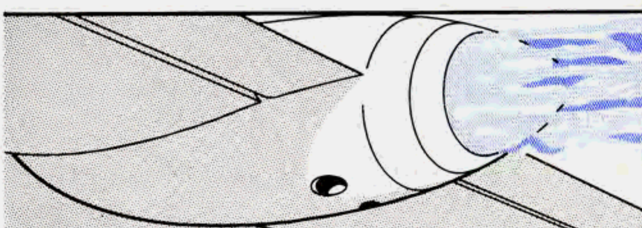
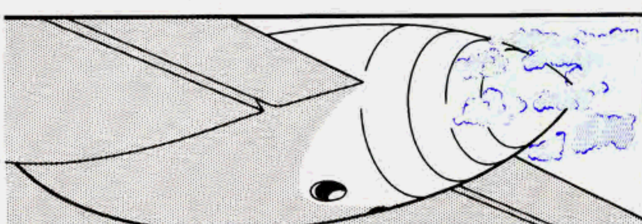
	PROBABLE CAUSE	CORRECTIVE ACTION
WHITE SMOKE FROM AIR PLUG OPENING 	EXHAUST SYSTEM FAILURE	CUT OFF FUEL. FEATHER PROPELLER. WATCH FOR FIRE.
BLACK SMOKE FROM LOUVERS, BLUISH WHITE SMOKE FROM LOUVERS OR OIL COOLER DOOR. 	FUEL LINE AFIRE	CUT OFF FUEL. FEATHER PROPELLER. USE FIRE PROCEDURE.
	OIL LEAK	CHECK OIL PRESSURE. CHECK OIL QUANTITY. WATCH FOR FIRE.
DENSE BLACK SMOKE AND FLAME FROM AIR PLUG OPENING. FIRE MAY IMMEDIATELY BURN THROUGH UPPER COWLING OF NACELLE. 	BROKEN FUEL LINE OR ACCESSORY SECTION FIRE	CUT OFF FUEL. FEATHER PROPELLER. USE FIRE PROCEDURE.
THIN BLUISH WHITE SMOKE FROM AIR PLUG OPENING 	OIL LEAK	CHECK OIL PRESSURE. CHECK OIL QUANTITY. WATCH FOR FIRE.
PUFFS OF BLUISH WHITE SMOKE FROM AIR PLUG OPENING 	OIL LEAK	CHECK OIL PRESSURE. CHECK OIL QUANTITY. WATCH FOR INTERNAL ENGINE FAILURE. WATCH FOR FIRE.

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Figure 3-4. (Sheet 2)

INFLIGHT FIRE FIGHTING PROCEDURES.

Reciprocating Engines.

When a crew member spots a fire, he will place his interphone selector switch in the CALL position and report, "Flame" or "Smoke" whichever is applicable "From No. ____ engine." The crew member will further identify the location of the flame or the type and location of the smoke. The engineer will use this information in conjunction with his fire warning lamp indicators to determine the exact location of the fire and he will immediately inform the aircraft commander of the extent of the emergency condition.

Note

> It is possible to isolate engine or wing fires through the use of fuel shutoff valves. To accomplish this the engineer must take into consideration his fuel configuration—then determine the valves that can be shut off without jeopardizing the operation of other engines.

1. Affected engine's fuel shutoff valve switch—CLOSE.
2. Mixture control lever—IDLE CUT-OFF.
3. Propeller feather switch—FEATHER, simultaneously with idle cut-off.
4. Affected engine's oil shutoff valve switch—CLOSE.

Note

> There are cases when the fire will burn itself out after the engine is feathered and the fuel is cut off. Therefore, before continuing with the fire fighting procedure, check to see whether the fire is extinguished.

5. Proper fire extinguisher engine selector switch—Hold ON for at least five seconds as soon as engine stops.
6. Air plug and intercooler switches—OPEN.
7. Proper cabin pressure wing shutoff valve switch—DEC. Use pressure from unaffected wing.
8. Proper cabin heat and tail anti-ice control switch—DEC., if fire is in engine No. 3 or No. 4.
9. Proper wing anti-ice control switch—DEC., if fire is in engine No. 1, 2, 5, or 6.
10. Fire extinguisher discharge selector switch—Place in reserve position and repeat step 5 if necessary.
11. After the emergency is over, the proper ignition switch may be turned OFF.
12. Do not restart engine.

Analysis of Fire Warning Lamp Indication. When a reciprocating engine fire warning lamp lights, the engineer will take action to determine the cause of the indication. This action is necessary to prevent inadvertent shutdown of a good engine due to a false indication.

If a fire warning lamp lights during flight, the engineer will hold his interphone selector switch in CALL and request the applicable aft cabin scanner to check for flame, smoke or any other abnormality. If flame or smoke is reported, follow the instructions described under "Inflight Fire Fighting Procedures" of this section. If the scanner reports "No smoke or flame," position the controls of the affected engine as follows to determine the cause of the warning indication.

1. Position the air plug fully OPEN to dissipate nacelle heat and check the resultant drop in CHT.

Note

> If the warning lamp goes out, normal operation of the engine can be continued. If the lamp remains lighted, proceed with step 2.

2. Temporarily reduce power on the affected engine to check for an exhaust system failure.
3. If the lamp remains lighted after power is reduced, shut down the engine.

Note

> If the lamp remains lighted after the engine is shut down, the fire detector system is probably faulty. In this case, unfeather the engine and resume normal operation.

4. If the lamp goes out after power is reduced, shut down the engine unless it is needed to maintain safety of flight in which case it may be operated at reduced power.

Jet Engines.

In the event of a jet engine fire in flight, the pilot will position his controls as follows:

1. Throttle—CLOSE.
2. Proper engine fuel valve switch—CLOSE.
3. Proper oil shutoff valve switch—CLOSE (OPEN, after fire is extinguished).
4. Pod preheat switch—OFF.
5. Nose de-ice switch—OFF.

Note

> If fire is not extinguished, repeat steps 1 through 3 on remaining jet engine in affected pod and proceed with steps 6 and 7.

6. Proper fuel manifold valve switch—CLOSE.
7. Proper fuel booster pump switch—OFF.

Wing Fire.

A wing fire involving fuel and oil tanks may be difficult to identify, because the smoke and flames usually emerge from the engine nacelle. A wing fire will, therefore, probably be reported as an engine fire by the aft cabin scanners and should be fought as such until all the extinguishing agent is exhausted. The engineer will turn off the anti-icing system and stop the flow of cabin pressurizing air from the wing on fire. Check that the other wing is furnishing pressurization. After the fire is out, a reasonable length of time must be allowed for the fumes to dissipate before investigating the damage via the wing crawlway.

Fuselage Fire.

Reduce the draft by shutting off pressurized or ventilating air. Isolate the fire by use of valves and doors. Know the locations and limitations of the hand fire extinguishers.

1. Crew—Don oxygen masks and goggles and set diluter lever of oxygen regulator to 100% OXYGEN. Push emergency toggle lever to left or right.
2. Crew—Locate cause of fire.
3. Crew—If it is an electrical fire, isolate the circuit.
4. Crew—If the fire is caused by fluid leak, stop the fluid flow.
5. Engineer—Affected cabin pressure switch—DEC, if necessary.
6. Engineer—Cabin pressure wing shutoff valve switches—DEC, if necessary.
7. Crew—Affected cabin manual pressure shutoff valve—CLOSED, if necessary.
8. Crew—Use hand fire extinguishers.

WARNING

> Do not increase ventilation until the flames are extinguished. Use oxygen masks for protection against fumes.

9. Crew—Open dump valves, doors, or hatches as required *after* the fire is out.

Electrical Fire.

Fuses and circuit breakers protect most of the electrical circuits and tend to isolate an electrical fire. However, there are cases where fuses of high capacity will permit a short sufficient to cause a fire. In such instances use A-20 fire extinguisher and attempt to isolate the circuit containing the short.

WARNING

> Bromochloromethane is toxic, particularly when used to fight a fire in a closed area where various kinds of materials are burning. It is important to use as little CB as possible and to wear an oxygen mask with the regulator diluter lever set at 100% OXYGEN as long as CB fumes are present in the airplane. Dizziness and nausea are symptoms of CB poisoning sufficient to require medical treatment.

SMOKE ELIMINATION.

To eliminate smoke and toxic fumes from the cabins, use the procedures in the following paragraphs:

UNPRESSURIZED FLIGHT.

Forward Cabin.

1. Open the nose turret disposal door.
2. Open the left forward escape hatch.
3. Partially open the aircraft commander's and pilot's clear vision panels.
4. Partially remove the right upper forward escape hatch.

Note

> The smoke and fumes should be completely eliminated in approximately 1 minute and 15 seconds after the fire is extinguished. Most of the smoke will dissipate through the clear vision panel openings.

CAUTION

> If the clear vision panels are opened while a fire is still burning in the observer's compartment, flames may be drawn up to the flight deck.

Aft Cabin.

1. Open the catwalk entrance hatch.
2. Open the tail cone access door.
3. Open the cabin entrance hatch.

Note

> The aft cabin should be entirely clear of smoke and fumes in approximately 3 minutes. Most of the smoke will dissipate through the cabin entrance hatch.

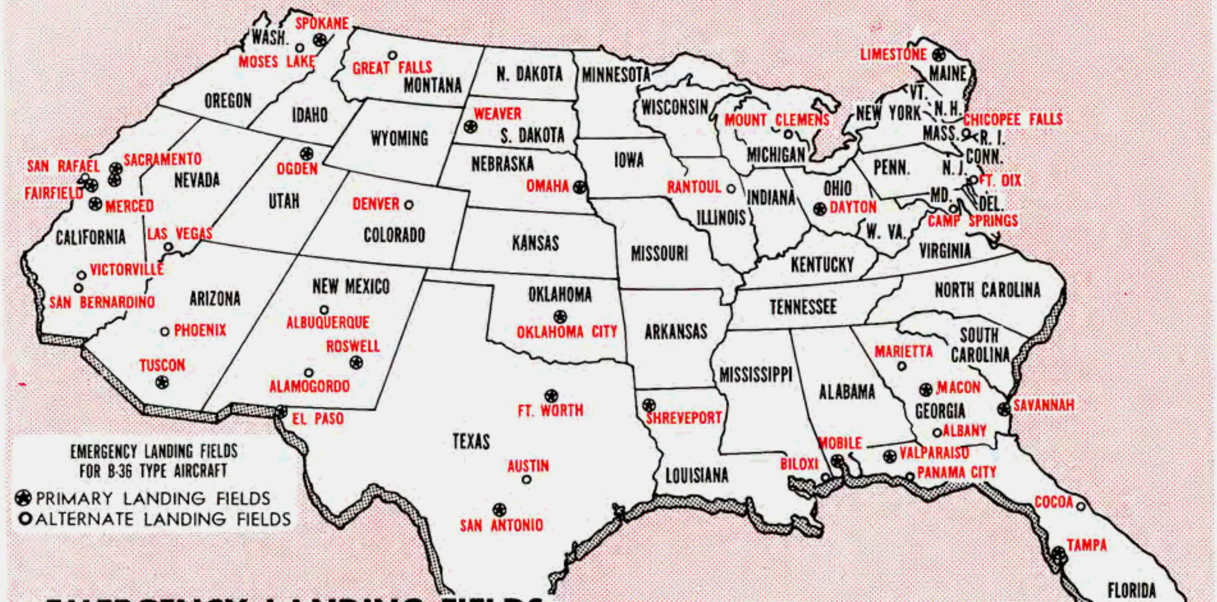
PRESSURIZED FLIGHT.

If a fire occurs during pressurized flight, the airplane must first be depressurized; then the cabins can be cleared of smoke as indicated in the preceding paragraph. During depressurization approximately 50 per cent of the smoke and fumes will be eliminated before the exit and hatches are opened.

EMERGENCY DESCENT.

Emergency descent should be used only when circumstances call for maximum rate of let down. Engine wear and propeller vibration must be tolerated under these conditions, but air-speed limits should be observed to avoid immediate structural failure.

Throttles on six engines should be fully retarded, cabin heater switch OFF, engine speed 2300 rpm above 40,000 feet (2600 rpm below 40,000 feet), and maximum allowables IAS (figure 5-3) maintained for maximum drag. The degree of emergency will be the governing factor, but engines 3 and 4 can be maintained at sufficient power to provide pressure and heat.



• EMERGENCY LANDING FIELDS.

In the event of an emergency where a landing at other than the home base is necessary, the aircraft commander will make every attempt, consistent with safety, to land at a *Primary Field*. If it is not possible, he should try to land on an *Alternate Field*. All *Primary Fields* have fuel, adequate maintenance, and the proper type of runway for B-36 operation. All *Alternate Fields* are adequate for limited B-36 operation only. They cannot refuel or perform major maintenance on B-36 type aircraft, and the runways are not stressed for continuous B-36 operation.

WARNING

Runway lengths are approximate. Consult the latest revision of "Radio Facility Charts" for correct runway lengths of fields listed below.

PRIMARY FIELDS

Location	*Base*	*Longest Runway*
Alabama, Mobile	Brookley AFB	8800
Arizona, Tucson	Davis Monthan AFB	7900
California, Fairfield	Travis AFB	8100
California, Merced	Castle AFB	7000
California, Sacramento	Mather AFB	7500
California, Sacramento	McClellan AFB	7000
Florida, Tampa	MacDill AFB	10,000
Florida, Valparaiso	Eglin AFB	8000
Georgia, Macon	Robins AFB	7000
Georgia, Savannah	Hunter AFB	10,500
Louisiana, Shreveport	Barksdale AFB	10,000
Maine, Limestone	Limestone AFB	10,000
Nebraska, Omaha	Offutt AFB	6100
New Mexico, Roswell	Walker AFB	8500
Ohio, Dayton	Wright-Patterson AFB/Patterson	8000
Oklahoma, Oklahoma City	Tinker AFB	7800
South Dakota, Weaver	Ellsworth AFB	10,500
Texas, Fort Worth	Carswell AFB	8200
Texas, El Paso	Biggs AFB	9500
Texas, San Antonio	Kelly AFB	6700
Utah, Ogden	Hill AFB	7500
Washington, Spokane	Fairchild AFB	10,500

ALTERNATE FIELDS

Location	*Base*	*Longest Runway*
Arizona, Chandler	Williams AFB	6100
California, San Bernardino	Norton AFB	7600
California, San Rafael	Hamilton AFB	6200
California, Victorville	George AFB	9500
Colorado, Denver	Lowry AFB	8300
Florida, Cocoa	Patrick AFB	10,000
Florida, Miami	Miami International	9400
Florida, Panama City	Tyndall AFB	8000
Georgia, Albany	Turner AFB	9200
Georgia, Marietta	Dobbins AFB	7500
Illinois, Rantoul	Chanute AFB	6300
Maryland, Camp Springs	Andrews AFB	5500
Massachusetts, Chicopee Falls	Westover AFB	7300
Michigan, Mt. Clemens	Selfridge AFB	8200
Mississippi, Biloxi	Keesler AFB	6500
Montana, Great Falls	Great Falls AFB	9500
Nevada, Las Vegas	Nellis AFB	6800
New Jersey, Fort Dix	McGuire AFB	8200
New Mexico, Alamogordo	Holloman AFB	8400
New Mexico, Albuquerque	Kirtland AFB	10,200
Texas, Austin	Bergstrom AFB	8000
Washington, Moses Lake	Larson AFB	10,000

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Figure 3-5.

●FORCED LANDINGS

Successful forced landings depend on the crews' familiarity with the proper procedures. One crew member will be designated for the command of each compartment during emergencies and will be responsible for reporting the compartment clear of personnel before leaving. Frequent dry-run drills should be conducted so that the crew will be prepared for this emergency. The instructions contained in the following paragraphs deal with crash landing and ditching.

● ●CRASH LANDINGS.

● ● ●Crash Landing On Take-Off.

In case of an impending crash landing immediately after take-off, proceed as follows:

1. Pilot–Warn crew to brace for the impact and land straight ahead.
2. Crew–Remain in crash landing positions.
3. After the impact and deceleration, the aft scanners will proceed as follows:

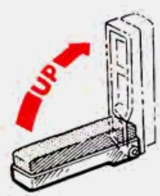
WARNING

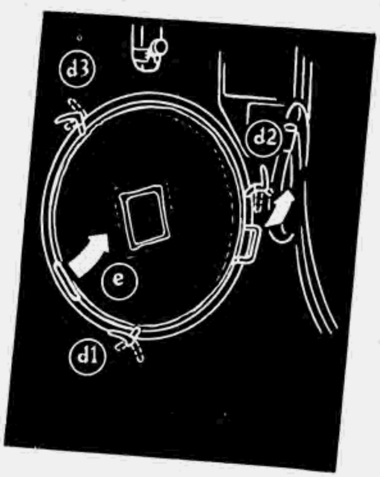
It is the aircraft commander's responsibility to see that the following escape procedures are regularly rehearsed. The importance of regular escape drills cannot be over-emphasized.

a. Undo safety belt.

b. Stand up.

c. Swing outboard arm rest into an upward position.





d. Release hatch latches.

WARNING

The upper latch *must* be the last latch released. Failure to observe this caution may result in a delayed exit, for there is danger that the latch may fall back into place or that the hatch may fall out and strike the crewmen.

e. Grasp the hatch and pull hatch inboard and upward. (Pivot hatch about the aft edge to clear the scanner's oxygen panel.)

f. Stow hatch, release escape rope, and make exit.

WARNING

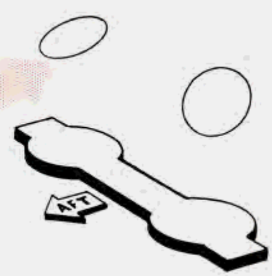
When the hatch is removed, be sure that it is stowed clear of the exit so as not to hamper exit of those who must follow you.

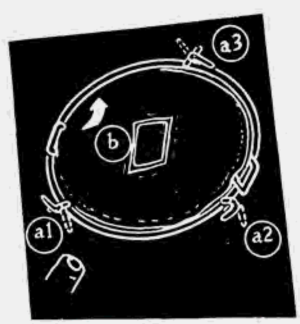
4. The tail gunner and crew members on the right bunk exit through the right escape hatch; those on the left bunk exit through the left escape hatch.

NOTE

If escape through the two lower aft escape hatches is impossible, follow procedure in step 5 and exit through the upper aft escape hatches.

5. The upper aft escape hatches are alternate escape exits To escape through these ports proceed as follows:





a. Release hatch latches.

Figure 3-6. (Sheet 1)

WARNING

The upper latch *must* be the last latch released. Failure to observe this caution may result in a delayed exit for there is danger that the latch may fall back into place or that the hatch may fall out and strike the crewman.

b. Grasp the hatch and remove it.

WARNING

When the hatch is removed be sure that it is stowed clear of the exit and that it is not dropped on crewmen behind you.

c. Stow the hatch, release escape rope if provided, and make exit.

6. The pilots and engineers exit through their hatches in the canopy.

7. All personnel in the radio operator's compartment must use the left escape hatch if possible; however, if jamming prevents removal of this hatch, use the upper right and left forward escape hatches.

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Figure 3-6. (Sheet 2)

Controlled Crash Landing.

When it is possible, the decision to crash land should be made early enough to allow the crew time for adequate preparation. These general instructions must be remembered in case of a crash landing:

1. If control of the landing gear position is retained by the aircraft commander and an airfield is not available for landing, land the aircraft with the gear retracted on the smoothest possible terrain. If an airfield is available, a normal wheels down landing should be accomplished. If the gear cannot be extended, make the landing on terrain as smooth and hard as possible, preferably an airfield runway if available.

2. If it is possible, crash land near a road, a telephone line, or a small settlement to assure quick communication and immediate medical aid.

3. Crew—Assume crash landing positions.

4. The crew will take the positions used for ditching (figure 3-9). They must brace for the impact and remain braced until the airplane comes to rest. The forces generated during deceleration are enough to cause serious injury to any unprepared crew member.

Before Approach. When the decision to crash land is made, warn the crew by interphone and by six short rings on the alarm bells. The crew must immediately make the following preparations:

1. Pilot—Salvo all bombs and bomb bay tanks over an unpopulated area if possible.

2. Pilot—Bomb bay door switches—CLOSE.

3. Radio Operator—Transmit course, altitude, ground speed, and position, and turn IFF to EMERGENCY.

4. Navigator—Remove left forward escape hatch and stow in nose of airplane.

5. Crew—Jettison all loose equipment and items which might fly loose on impact.

WARNING

Do not jettison the hand axes, because they may be needed to cut through the fuselage.

6. Prevent jamming, leave all emergency hatches open, but leave bomb bay doors closed.

7. Crew—Forward turret door control switch—OPEN.

Note

This will interfere with the source of airspeed indication.

8. Crew—Release the three locking clamps on respective hatches and pull hatches inside the fuselage. Hatches in the forward cabin must be placed in the nose of the airplane.

9. All crew members will remove parachutes and flak suits and use for padding. Don flak helmets and loosen neckties.

10. Compartment Commander—Report to aircraft commander when his compartment is ready for crash landing.

Crash Landing EXITS & ENTRANCES

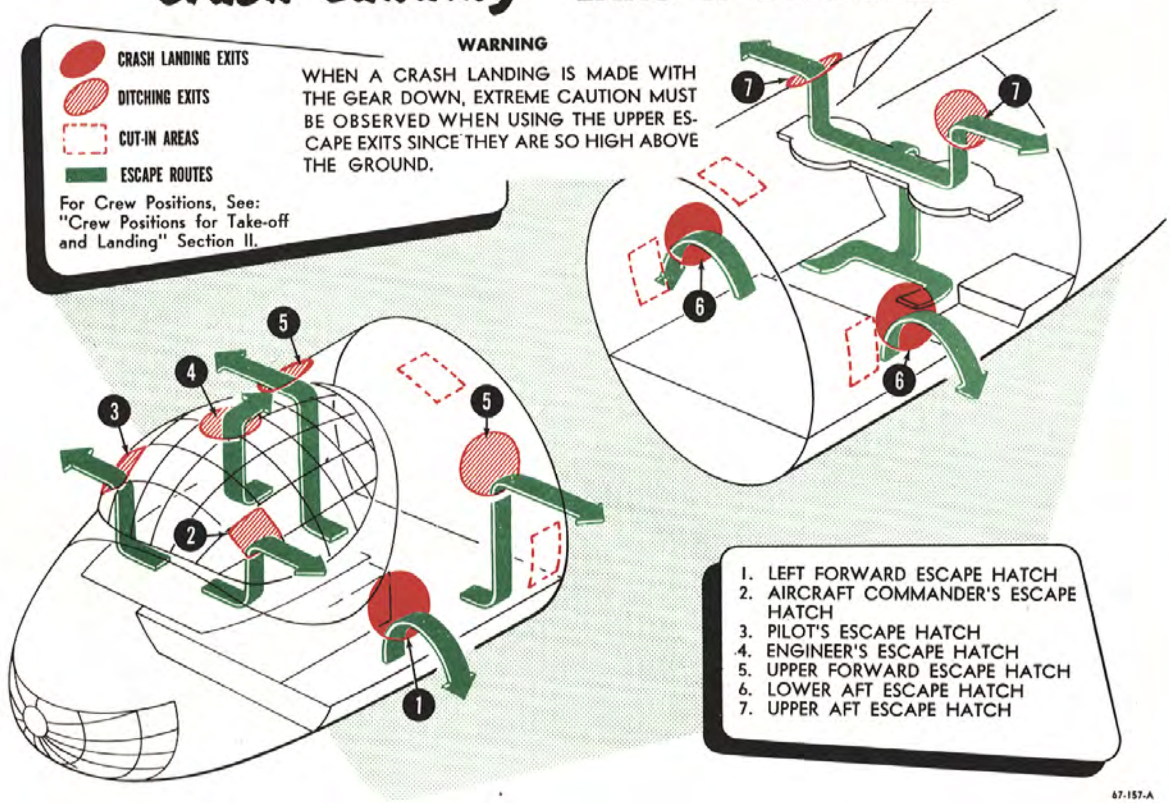

Figure 3-7.

11. Aircraft Commander—Give crew members not essential to crash landing permission to bail out.

12. Aircraft Commander—If practical, circle the landing area until the remaining fuel supply is 500 gallons in each wing.

13. Aircraft Commander—If the landing is to be made on a known airfield, notify the tower to clear traffic and have crash equipment standing by.

Approach and Contact. Begin the approach far enough from the landing area to allow the remaining crew members time to make last minute preparations. The pilot and the engineer must accomplish the following:

1. Engineer—Obtain a fuel configuration in each wing of the most outboard tank feeding three engines; then close the fuel cross-feed valve and the necessary manifold valves.

2. Aircraft Commander—Fully extend the flaps and maintain a very flat approach.

3. Aircraft Commander—By one long ring to the alarm bell and by interphone warn the crew to prepare for the impact.

4. Pilots—Tighten safety belts and shoulder harnesses and lock inertia reel lock controls.

CAUTION

The pilots are prevented from bending forward when the inertia reel is locked; therefore, all switches not readily accessible must be "cut" before moving the control to the LOCKED position.

5. Engineer—All alternator breaker hold-in switches—Hold in; mixture control lever—IDLE CUT-OFF on aircraft commander's request.

6. Engineer—All fuel valve switches—CLOSE.

7. Engineer—Engine ignition and battery switches—OFF.

Emergency Entrance.

If it becomes necessary to enter the airplane the rescue trapped crew members, use the emergency entrances as shown in figure 3-7. The left escape hatch in the forward cabin can be released from the outside if it is not jammed. Otherwise, it is necessary to chop through the fuselage at one of the marked cut-in areas.

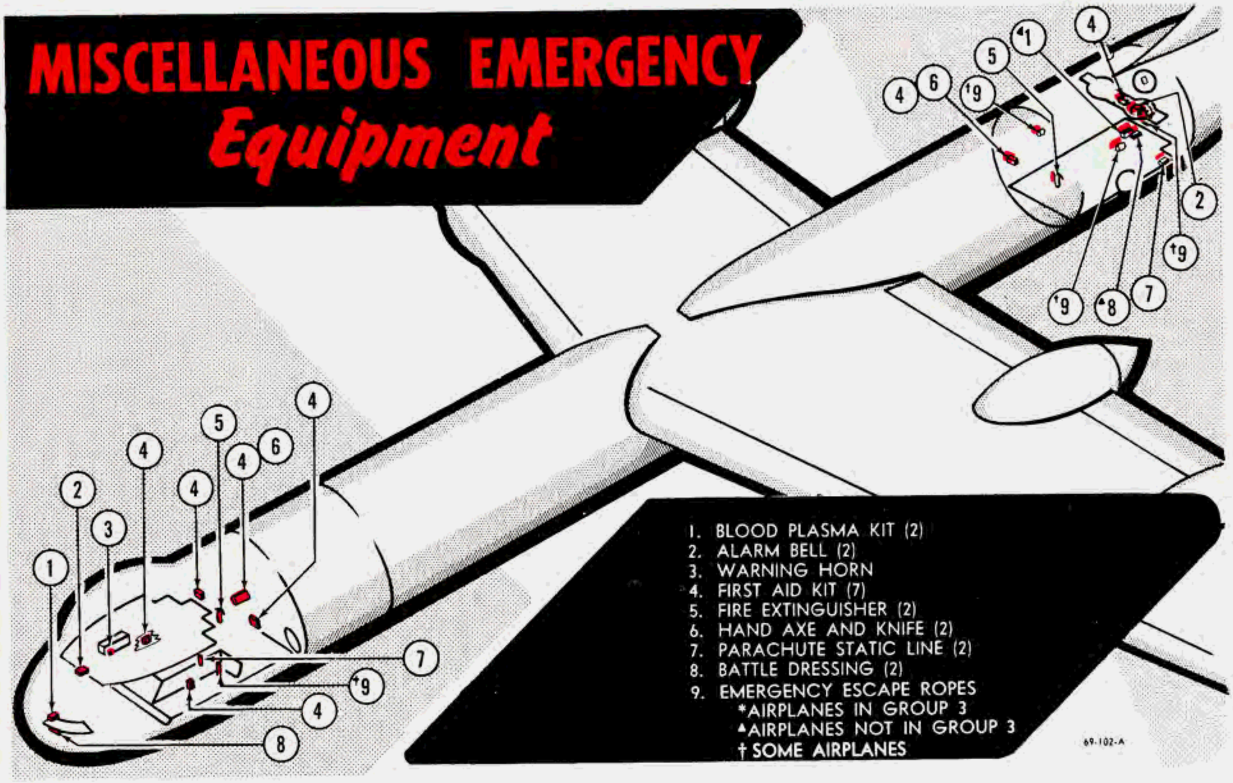

Figure 3-8.

DITCHING.

At the present time B-36 type aircraft do not carry permanently installed ditching equipment; however, ditching is considered preferable to over water bail-out when water temperatures and availability of surface vessel would indicate that mass survival of the crew members would be improbable. Final decision to bail out or ditch the aircraft shall be the responsibility of the aircraft commander, dependent on the nature of the emergency.

Note

The following ditching procedure is for a 13-man crew and is intended for use as a guide only until adequate provisions are made for ditching the aircraft.

Ditching drills should be performed until each crew member is thoroughly familiar with the procedure and the specific duties for which he is responsible. Make an equipment check before each overwater flight. Kits should be complete and crew life vests, survival suits, and life rafts should be in good condition.

Preparation For Overwater Flight.

One type F-2A 20-man life raft should be stowed in the radio compartment just aft of bulkhead 3.0.

A static line 30 feet in length should be provided for the raft to prevent its drifting free from the airplane after ditching. The static line must be attached to the raft in a manner that will cause the discharge of the inflating bottle when the line is pulled.

WARNING

The 30-foot static line must be cut after the life raft is loaded and the crew members are aboard to prevent the sinking airplane from pulling the raft under.

CAUTION

Be careful to prevent entanglement of the static line which might result in inflation of the life raft before its ejection.

A Gibson Girl radio should be stowed on the floor of the radio operator's compartment. Two static lines and a G-8 aerial delivery-type parachute shall be provided for the radio. The static lines serve the same purpose as the one provided for the life raft.

Before Approach.

When ditching becomes imperative, give the crew warning over the interphone and also by six short rings of the alarm bells. Crew members not actively engaged in controlling the airplane should jettison loose equipment and any objects which might fly loose on impact. When jettisoning is completed, crew members must assume the positions shown in figure 3-9 for ditching.

All crew members should remove their flak suits and parachutes. The one-man rafts should be removed from the parachutes and stowed for later use. The crew must don R-1 anti-exposure suits, flag helmets, emergency kits, life vests, and gloves. Neckties should be loosened. The life raft in the radio operator's compartment should be place against bulkhead 3.0 to serve as padding for the ditching stations.

All crew members except the aircraft commander and the pilot shall sit facing aft with their hands clasped behind their heads to prevent snapping their necks on impact. They should use their parachutes and all available padding for their backs. All upper escape hatches, pilots' windows, and the engineer's escape hatch must be removed and the hatches stowed prior to impact. After the impact each man must take his one-man life raft when he leaves the airplane.

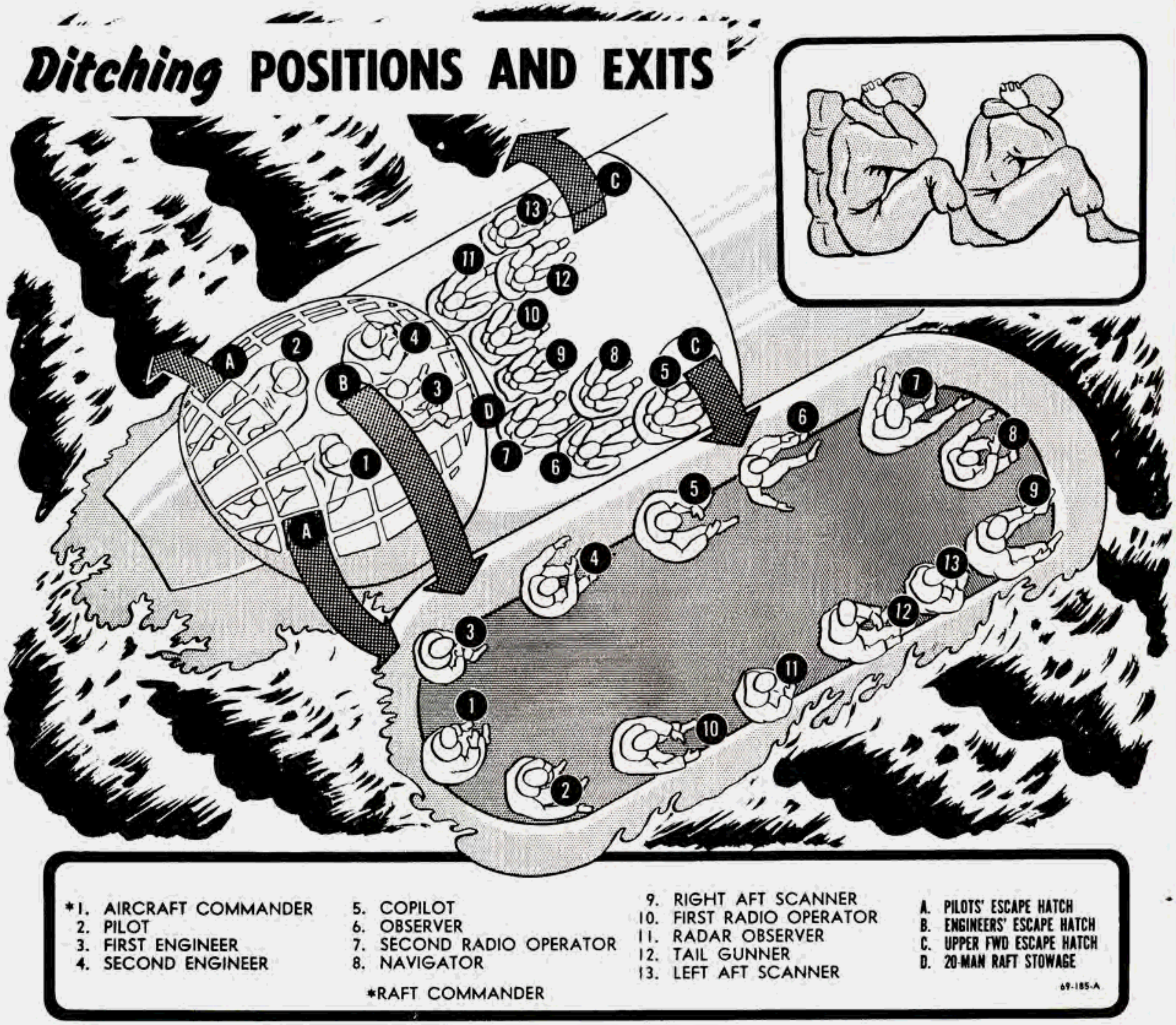

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Figure 3-9.

Crew Responsibilities.

When a decision is made to ditch the airplane, each crew member must follow the procedures as outlined in the following paragraphs:

Aircraft Commander.

1. Duties before impact:

a. Warn pilot—"Prepare for ditching in — minutes."

b. Give 6 short rings on the alarm bells.

c. Order pilot—"Open emergency exits and jettison loose equipment." Open canopy window and jettison if possible.

d. Fasten safety belt and shoulder harness.

e. Radio other craft of your distress, giving position and time of ditching. Have the radio operator broadcast a position report and turn the IFF switch to EMERGENCY.

f. Order pilot—"Stations for ditching. Impact in minutes." Have pilot obtain weight from engineer and figure stalling speed.

g. About five second before impact, give order: "Brace for impact." Have the pilot give one long ring on the alarm bell.

h. Instruct engineer to complete ditching configuration.

2. Ditching Position:

a. Lower seat and push rearward. Brace feet on rudder pedals with knees flexed and hands on control wheel after locking inertia reel.

CAUTION

The pilots are prevented from bending forward when the inertia reel is locked; therefore, all switches not readily accessible must be "cut" before moving the control to the LOCKED position.

3. Duties after impact:

a. Check to see that the crew is clear, throw out one-man life raft, and exit through the left canopy window.

b. Take command of the 20-man raft. Supervise removal of injured crew members and the securing of emergency equipment aboard the raft. Guide the raft a safe distance from the airplane.

Pilot.

1. Duties before impact:

a. Relay the aircraft commander's instructions to the crew. Receive acknowledgements and notify the aircraft commander, "Crew notified."

b. Open the window; jettison, if possible.

c. Fasten shoulder harness and safety belt.

d. Stand by on interphone to relay aircraft commander's orders to crew. Check progress of crew in jettisoning equipment. A minimum of one minute before impact, order radio operator to clamp down key and assume ditching position. Relay command, "Brace for impact." Send one long ring on the alarm bell.

2. Ditching position:

a. Lower seat and push rearward. Brace feet on rudder pedal stand with knees flexed, left hand on left knee, and right hand braced against the right window frame after locking inertia reel.

CAUTION

The pilots are prevented from bending forward when the inertia reel is locked; there fore, all switches not readily accessible must be "cut" before moving the control to the LOCKED position.

3. Duties after impact:

a. Throw out one-man life raft, exit through the right window and proceed to 20-man raft.

b. Assist aircraft commander in supervising removal of injured crew members and emergency equipment.

First Engineer.

1. Duties before impact:

a. Acknowledge ditching order.

b. If ditching is necessary because of insufficient fuel, estimate the remaining time aloft and inform aircraft commander and navigator.

c. Fasten safety belt.

d. Obtain a fuel configuration of the most outboard tank in each wing feeding the three engines in that wing, then close the cross-feed valve and the necessary manifold valves.

e. On aircraft commander's command, "Complete ditching configuration": CLOSE the tank valves; all hold-in switches—IN; mixture control levers—IDLE CUT-OFF; ignition switches—OFF; battery switch—OFF.

2. Ditching position:

a. In the first engineer's seat facing aft with hands clasped behind head to prevent snapping the neck on impact.

3. Duties after impact:

a. Take all necessary equipment and exit through the engineer's escape hatch to the 20-man raft.

b. Assist injured crew members and aid in stowing equipment aboard raft.

Second Engineer.

1. Duties before impact:

a. Acknowledge ditching order.

b. Assist first engineer.

c. Assist in jettisoning loose equipment.

d. On command, remove the engineer's escape hatch and pass it to the nose compartment.

2. Ditching position:

a. In the second engineer's seat facing aft with hands clasped behind head to prevent snapping neck on impact.

3. Duties after impact:

a. Obtain necessary emergency equipment.

b. Exit through engineer's escape hatch to the 20-man raft.

Navigator.

1. Duties before impact:

a. Acknowledge ditching order.

b. Through coordination with the aircraft commander and the engineer calculate the course, altitude, ground speed, and probable position of ditching. Give this information and an accurate loran line to the radio operator so that he may broadcast a position report.

c. Inform aircraft commander of surface wind speed and direction.

d. Destroy classified documents and material and aid in jettisoning all loose equipment. Gather essential maps and navigation equipment, including the octant if possible, into water-tight bags or tuck into clothing.

e. Take first aid kit from table.

2. Ditching position:

a. Seated on left side of radio compartment floor, facing aft with back to second radio operator's knees. Use all available padding.

3. Duties after impact:

a. Assist in ejecting life raft and emergency equipment through left upper escape hatch.

b. Take necessary equipment and exit from escape hatch to the 20-man raft.

c. Assist injured crew members and aid in stowing equipment aboard the raft.

Second Radio Operator.

1. Duties before impact:

a. Acknowledge ditching order.

b. Assist radio operator in jettisoning all unnecessary equipment.

c. Secure first aid kit to arm.

d. Destroy all classified documents.

e. Remove right upper escape hatch and pass to the nose section.

2. Ditching position:

a. Seated on left side of radio compartment facing aft, between the observer and the right aft scanner.

3. Duties after impact:

a. Assist in ejecting life raft and emergency equipment through left upper escape hatch.

b. Take CRC-7 VHF transmitter-receiver and water jug into the life raft.

Tail Gunner.

1. Duties before impact:

a. Acknowledge ditching order.

b. Destroy all secret equipment.

c. Remove all food and liquid containers and put in A-3 bag.

d. Proceed through the communication tube to forward ditching position with first aid kit secured to arm.

2. Ditching position:

a. Seated on floor in radio compartment facing aft, with back to radar observer's knees.

3. Duties after impact:

a. Throw out one-man raft, take A-3 bag containing food, and exit through right upper escape hatch.

b. Proceed to the 20-man raft.

First Radio Operator.

1. Duties before impact:

a. Acknowledge ditching order.

b. Check IFF emergency switch ON, if installed.

c. Transmit position, course, altitude, and ground speed as received from navigator. Relay fix or bearings and estimated time and position of ditching.

d. Jettison radio operator's chair.

e. Remain on interphone.

f. On command of pilot, screw down transmitter key.

2. Ditching position:

a. Seated on floor in radio compartment between the right aft scanner and the radar observer, facing aft.

3. Duties after impact:

a. Throw out one-man raft, take Gibson Girl radio, and exit through right upper escape hatch.

b. Proceed to 20-man raft.

Radar Observer.

1. Duties before impact:

a. Acknowledge ditching order.

b. Salvo bombs on command of aircraft commander.

Do not salvo bomb bay fuel tank if empty. Close the bomb bay doors.

c. Take first aid kit from nose compartment and secure it to arm.

d. Take navigation equipment to ditching position.

2. Ditching Position:

a. Seated on right side of radio compartment next to first radio operator, facing aft.

3. Duties after impact:

a. Throw out one-man raft, take water jug and exit through right upper escape hatch.

b. Proceed to 20-man raft.

Copilot.

1. Duties before impact:

a. Acknowledge ditching order on interphone. If not on interphone, relay acknowledgement through someone else.

b. Remove upper left escape hatch and pass it to the nose section.

2. Ditching Position:

a. Seated on left side of radio compartment floor with back to observer's knees.

3. Duties after impact:

a. Assist in lowering the life raft into the water. Exit through the left upper escape hatch.

b. Assist injured crew members and aid in stowing equipment in raft.

Observer.

1. Duties before impact:

a. Acknowledge ditching order.

2. Ditching Position:

a. Sitting on left side of radio compartment, facing aft, to right of second radio operator.

3. Duties after impact:

a. Assist in lowering the life raft into the water and exit through the left upper escape hatch.

b. Assist injured crew members and aid in stowing equipment in raft.

Left Aft Scanner.

1. Duties before impact:

a. Acknowledge ditching order.

b. Secure first aid kit to arm.

c. Take water jug to ditching position.

d. Proceed through the tunnel to the radio compartment.

2. Ditching position:

a. Sitting on right side of radio compartment floor facing aft, to left of tail gunner.

3. Duties after impact:

a. Throw out one-man life raft.

b. Take water jug and exit through right upper escape hatch.

c. Proceed to 20-man raft.

Right Aft Scanner.

1. Duties before impact:

a. Acknowledge ditching order.

b. Secure first aid kit to arm.

c. Take water jug to ditching position.

d. Proceed through tunnel to the radio compartment.

2. Ditching position:

a. Sitting on radio compartment floor between second and first radio operators, facing aft.

3. Duties after impact:

a. Assist in ejecting 20-man life raft through left upper escape hatch.

b. Take water jug and proceed to life raft.

Approach and Contact. It is believed that ditching the airplane with 30-degree flaps while maintaining a 9-degree nose-high attitude at a low air speed will result in the most satisfactory procedure. This must be accomplished while power is still available in order to maintain the lowest possible rate of descent. The landing gear should be up and the bomb bay doors closed. Head the airplane parallel to uniform waves or swells. If the sea is irregular and confused, make the ditching into the wind. Aim for contact along the swell crest or just after the crest has passed.

BAIL-OUT.

If over uninhabited territory, all bail-outs should be made so that the crew will land in the same vicinity. If over water and surface vessels are below, the airplane should be headed so that crew members will drift on to the course of the vessel. A slow turn may be executed or two bail-out runs made, if necessary, to place the men close together. See figure 3-10 for emergency exits. Procedure will vary according to conditions. If circumstances requiring bail-out permit, descend to at least 10,000 feet and minimize forward speed. Over-water or polar bail-outs should be made with as much of the survival equipment as possible.

When alerting the crew, it is advisable to remind them of their survival equipment. How to attach all survival equipment to the parachute should be stressed at practice drills. Successful bail-outs result chiefly from the intuitive action taken by the crew members under circumstances frequently unfavorable for clear thinking and logic. It is strongly recommended that frequent and thorough drills be performed at the aircraft to instill conditioned habits and to insure smoothness of performance of each man's duties.

When bailing out, it is essential to remember a few elementary points concerning the parachute.

Bail-Out ROUTES & EXITS

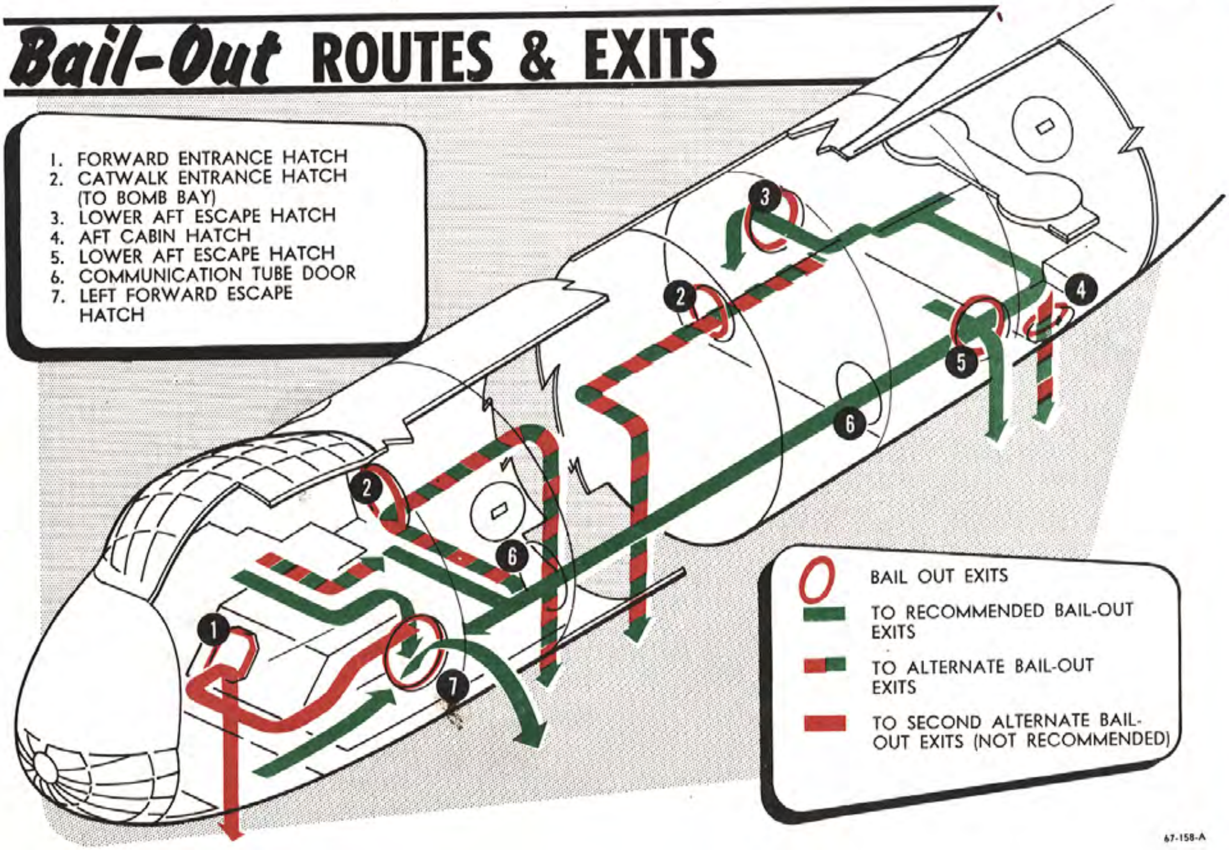


Figure 3-10.

1. If the bail-out is made at night, it is advisable to place your right hand very close to the ripcord since you must rely on feel alone.

2. If the bail-out is during daylight hours, place your right hand near the ripcord. When you are ready to open your chute, look to see where the handle is rather than depending upon feel.

3. Keep your legs together and your body straight with the elbows close in and the left hand holding the oxygen mask tight to the face.

4. If feasible, the best body position for you to attain at the time of opening is feet toward the ground with the back and chest style parachutes.

5. During an emergency jump, do not waste too much time attaining a particular body position. Delay long enough to be certain you have cleared the aircraft, then pull the ripcord.

Steps given below apply to standard unpressurized bail-out procedure.

1. Aircraft Commander—Perform the following:

a. Direct pilot to give "prepare to bail out" emergency signal; three short rings on the alarm bells, amplified by interphone warning.

b. Ascertain that crew members have completed special and general duties as outlined below.

c. Check parachute, bail-out bottle, goggles, gloves, and helmet with mask. Secure E-1 kit or dinghy to the parachute harness after leaving the seat. If over water, wear a Mae West under the chute.

2. Pilot—Actuate salvo switch to open bomb bay doors and salvo if not over populated area.

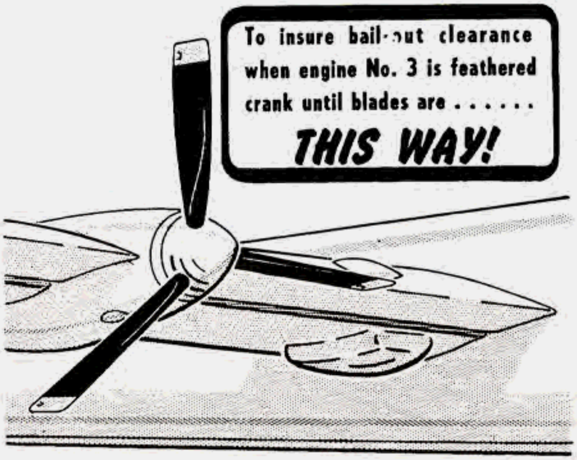
3. Radio Operator—Transmit course, altitude, ground speed, and estimated position of bail-out as received from the navigator, turn IFF emergency switch ON.

4. Observer—Remove left escape hatch and place it in the nose compartment.

5. Navigator—Compute position report for radio operator.

6. If time permits, destroy classified equipment.

7. Aft Cabin Scanners—Remove lower raft aft escape hatches. (See figure 3-6.)



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8. Pilot—Give bail-out emergency signal on aircraft commander's direction: one long sustained ring on the alarm bells, amplified by interphone warning.

CAUTION

The No. 3 engine should not be feathered to position the propeller for bail out, unless sufficient altitude and power to other engines remain to enable successful abandonment of the aircraft.

All compartment commanders report to aircraft commander "Compartment clear." After determining that all crew members have bailed out, the aircraft commander will be free to abandon the aircraft after putting it on autopilot with a heading that will avoid populated areas.

To bail out of the recommended exit in the forward or aft cabin, the crew members sit at the escape hatch in a tight ball and roll out of the exit. This procedure will eliminate the possibility of being caught on the edge of the hatch.

Note

If time and conditions permit, as many crew members as possible should bail out of the aft cabin since it is considered the safest.

When using the forward bomb bay for bail-out, crew members should sit at the forward right side of the bay and roll out head first. Interphone contact between the bomb bay and the aircraft commander must be established before the bomb bay is used for bail-out.

Personnel using the wheei well for bail-out should climb down the entrance ladder and jump from there.

HIGH ALTITUDE BAIL-OUT.

During high altitude bail-out the jumper is faced with three major problems.

1. Lack of oxygen.
2. Low temperatures.
3. High shock during opening of parachute.

If it becomes necessary to bail out at high altitude, every attempt should be made to ride the airplane down to at least 30,000 feet before bail-out is attempted. If bail-out is necessary at extreme altitudes, refer to "Emergency Depressurization," Section IV. During descent, the following steps should be taken:

1. If possible, while the airplane is being depressurized, each crew member should remain at his station and breathe 100 per cent oxygen.
2. Helmet chin straps should be cinched, mask straps tightened, flying clothes and gloves secured, goggles put in place, and oxygen mask disconnect secured to parachute harness.
3. Bail-out bottles should be fastened to parachutes just above the accessory ring on right side and connected to oxygen masks with oxygen hose under parachute harnesses.
4. Portable oxygen bottles should be used by crew members opening the emergency exits.

WARNING

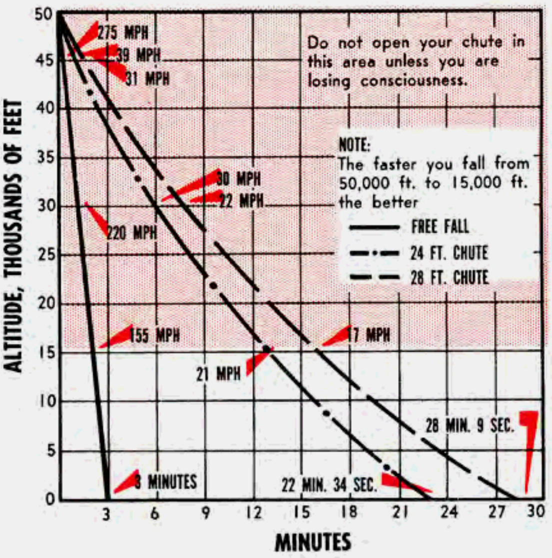
Each crew member using a portable oxygen bottle will be closely watched by another crew member. At the first sign of anoxia, he will be returned to the ship's system and replaced by another man.

When the alarm bell rings and the interphone command is received for bail-out, each crew member should proceed as follows:

1. Take several deep breaths from the airplane's oxygen system.
2. Pull out the safety pin, actuate the bail-out bottles, and disconnect from the aircraft's oxygen system.
3. Go quickly to the designated escape hatch.
4. Place right hand near rip cord but not on it.
5. With the left hand holding mask to the face and with chin on chest, bail out.

VELOCITY OF DESCENT FROM 50,000 FT.

FREE FALL AND WITH PARACHUTE



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Free Fall.

Remember, the average useful consciousness is about 15 seconds at 40,000 feet without oxygen. After clearing the airplane, straighten the body and keep the knees flexed and the elbows at the sides. The right hand should remain near the ripcord and the left hand on the mask during bail-out. If the ground is visible, pull the rip cord to open the chute between 10,000 and 5,000 feet (approximately two minutes after bail-out from 40,000 feet). At night or in weather conditions where the terrain is not visible, attempt to free fall for one minute before pulling the rip cord if bail-out is made from above 35,000 feet. When the parachute has opened, readjust and tighten the oxygen mask.

Note

> Some parachute assemblies are equipped with an automatic ripcord release. The release is preset by the parachute rigger for a time delay of 5 to 7 seconds and an altitude of 5,000 feet above the highest terrain on the projected flight path. If you have a parachute with an automatic release, pull the arming knob (red ball on the left side of the harness just above the leg strap fastener) at the instant of bail-out. The automatic release will then release the parachute at the present altitude. The automatic release does not interfere with the manual operation of the ripcord.

OVER-WATER BAIL-OUT.

Normally, on over-water flights a Mae West will be worn under the parachute harness. If time permits (no fire aboard or other emergency demanding immediate bail-out) put on all of your over-water survival equipment. Over your regular flying clothes put on the following items in the following order:

1. Emergency survival vest buttoned tight. (Either C-1 vest or E-1 kit, not both.)

2. Rubberized anti-exposure suit, with air squeezed out of lower extremities and fitted snugly around face.

Note

> Do not put suit on unless water temperature is approximately 52°F or below.

3. Mae West.

4. Parachute. Attach your one-man dinghy to the parachute harness making sure that the dinghy lanyard is under the harness and attached to the "D" ring of the Mae West.

POLAR BAIL-OUT.

Since most of the polar flights are over desolate, frozen country, the E-1 kit has been designed to fasten to your parachute harness in the same manner as the dinghy. For bail-out over remote areas, and when time permits, the following items should be put on over your regular flying clothes in the order listed:

1. Emergency survival vest buttoned tight. (Either C-1 vest or E-1 kit, not both.)

2. Rubberized anti-exposure suit fitted snugly around the face, if there is the slightest chance of landing in water.

3. Parachute. Fasten the E-1 kit to your parachute harness. Because of the weight and bulk of the kit, it can be attached most easily by sitting on it and then snapping to the harness.

FUEL AND OIL SYSTEMS.

ENGINE-DRIVEN FUEL PUMP FAILURE.

The loss of an engine-driven fuel pump will result in a sharp decrease in fuel pressure and a loss in torque pressure. If this occurs, determine whether or not the engine is delivering enough power to carry itself; if not, feather the propeller. Additional power may be obtained by use of the engine primer in an emergency.

MANUAL OPERATION OF FUEL AND OIL VALVES.

If electrical failure or unit malfunction prevents normal operation of the fuel and oil shutoff valves, they can be operated manually. (See figure 3-11.) The jet engine fuel and oil shutoff valves and the oil shutoff valve for reciprocating engine No. 6 are inaccessible during flight. The cross-feed valve and the bomb bay tank valves are accessible from the catwalk. The other valves are accessible from the wing crawlway.

ELECTRICAL SYSTEM.

EXCESSIVE ELECTRICAL LOADS.

At the first indication of an unusual or excessive electrical load for which no correction is immediately evident, perform the following steps as rapidly as possible:

1. All four bus tie breaker switches—OPEN

Note

To allow more rapid diagnosis, completely isolate the four buses. Bus isolation will in-

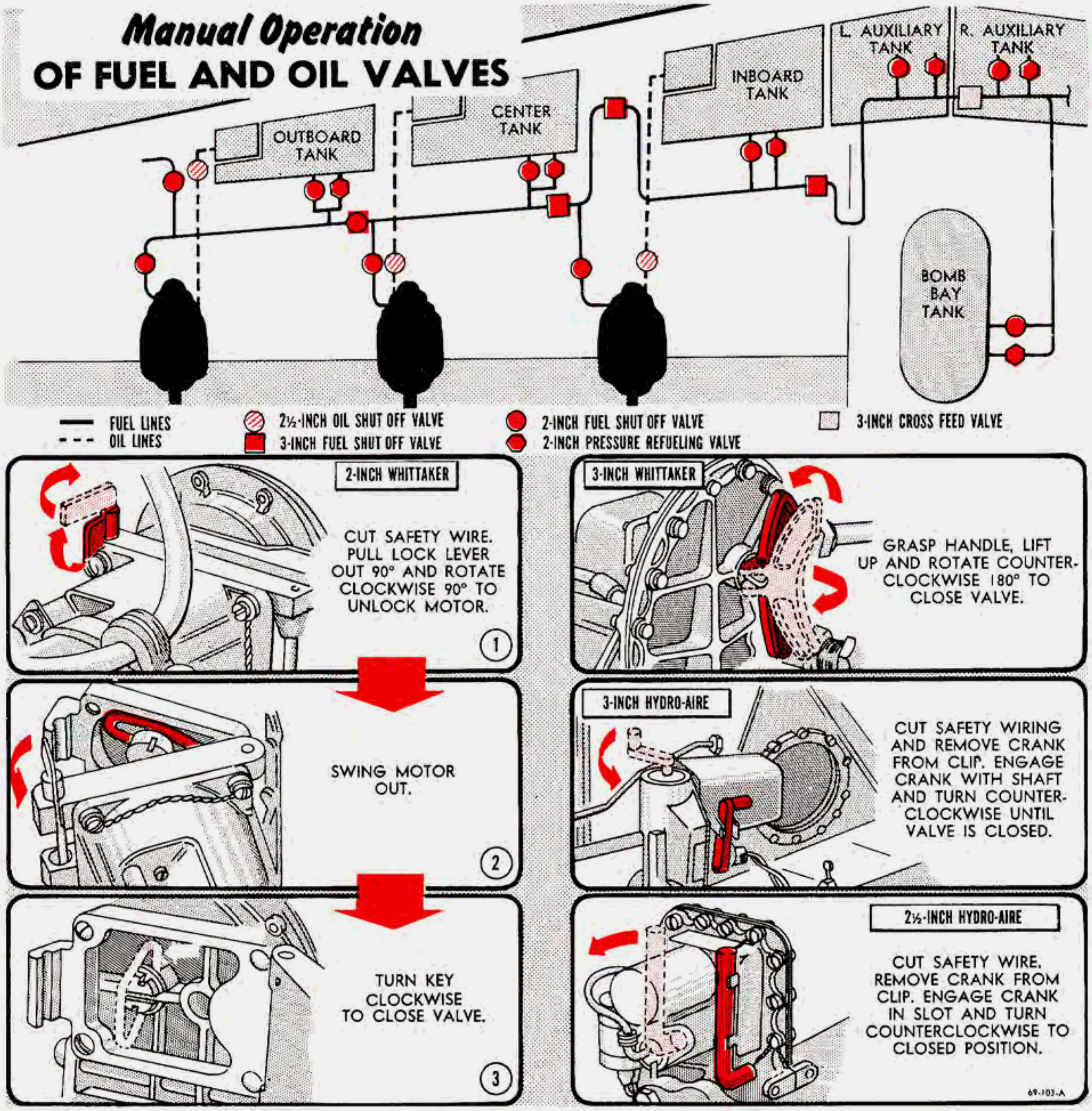


Figure 3-11.

sure that power is still available on normal buses. A faulted bus will be indicated by a high kilowatt reading. Any load division malfunction will be eliminated by bus isolation. See Section VII, "Chart For Electrical System Trouble Shooting," for probable cause and remedies.

2. Immediately de-excite any alternator that is carrying too much load (KWATT or KVAR) or that is fluctuating over 10 cycles or volts.

CAUTION

If it becomes necessary to de-excite No. 5 alternator (which feeds 501), the engineer's fuse panel a-c power switch must be placed in the ALT position. (Check indicator light.)

3. Check the frequency and voltage control and stability of remaining isolated buses.
4. Reduce electrical loads to a practical minimum until diagnosis is complete.
5. Connect adjacent operative bus to the dead bus and note for excessive loads or fluctuations. If the dead bus is clear of fault, allow the bus to remain energized. If excessive loads or fluctuations are noted, isolate immediately and do not restore power to the affected bus.
6. Place the selector switch between the two buses to be connected. When the synchronizing lamps are dark, close the bus tie breakers.

CAUTION

Restore only essential electrical loads to prevent overloading remaining alternators.

7. If check as stated in step 5 reveals a faulted bus, that bus and its alternator must be left isolated and must not be used until the fault is cleared.

ALTERNATE SOURCE OF A-C POWER.

Should it be determined that a-c power for the engineers' fuse panel has been disrupted, as indicated by the lack of power for such critical items as mixture controls, spark advance, turbosuperchargers, anti-icing, cabin pressure, etc., check the indicator lamp on the engineers' fuse panel to see whether power is being supplied to that panel. If the lamp is not burning, place the fuse panel a-c power switch in the ALT position. If there is still no indication of power, check the feeder fuses in the left and right cabin power panels.

EMERGENCY ELECTRICAL POWER OPERATION.

Restoring Normal Electrical Power.

If a complete loss of normal alternator power occurs, the following operating procedure will be followed:

1. All bus tie-breakers OPEN.
2. De-excite only the alternators indicating abnormal readings.
3. Recheck to insure that the alternator breaker indicating lamps of all previously parallel alternators are lighted.
4. Reduce a-c and d-c electrical loads to a minimum. Notify all crew members that the battery switch is going to be turned OFF rendering the interphone inoperative; then turn the battery switch OFF.

CAUTION

If the battery switch is left ON, the d-c load requirements will drain battery power which should be conserved for operation of essential equipment.

5. Turn the voltage and frequency selector switch to any alternator which is excited or which will excite.
6. Re-excite this alternator as follows:

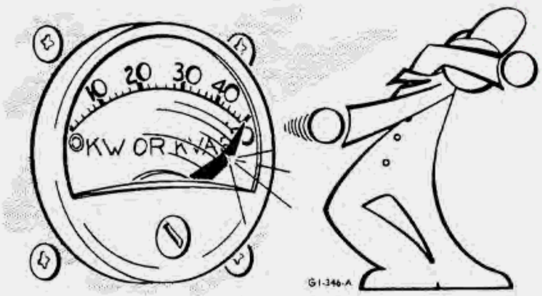
a. Place the emergency power control in the EMERGENCY position.

b. Momentarily hold the exciter control switch ON.

c. Adjust voltage and frequency to normal.

d. If voltage and frequency cannot be adjusted, momentarily hold the exciter control switch in the OFF position and proceed to another alternator.

7. If voltage and frequency can be adjusted to normal, connect the alternator to its respective bus by holding the alternator breaker switch in the CLOSE position until the indicator lamp goes out.



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CAUTION

The kilowatt-kilovar meter should be observed closely while connecting the alternator to the respective bus to assure that an overload condition does not exist. If the kilowatt-kilovar meter indicates that the overload condition exists, the bus is faulted and cannot be used until the fault is cleared. In this case, the alternator should be removed from the line immediately and care exercised to keep the faulted bus disconnected from the rest of the electrical system.

8. Return the emergency power control to NORMAL.

CAUTION

Do not leave alternator selector switch in any bus position with an alternator on the line while switches are in EMERGENCY.

9. After the above procedure is accomplished for each alternator, parallel all working alternators using the bus tie-breakers. Use normal paralleling procedures except connect the voltage and frequency selector switch between the two buses to be paralleled. When the alternator synchronizing lamps are dark, close the bus tie-breaker switch connecting these two buses.

10. Battery switch ON.

Obtaining Emergency Electrical Power.

If attempts to get an alternator back on the line fail and there is an alternator capable of being excited, enough a-c and d-c power can be obtained to operate all d-c units, the pilot's attitude and directional gyros, and the turbo override controls. Proceed as follows:

1. Position the voltage and frequency selector switch to any alternator which will excite or which appears to be in underdrive.

Note

An underdrive condition may be verified by increasing or decreasing engine speed and noting that the frequency is proportional to engine rpm.

2. Place the emergency power control in the EMERGENCY position.

3. Momentarily hold the exciter control relay switch ON.

4. Place the pilot's flight instrument switch in the EMERGENCY position.

5. Restore only essential d-c loads.

WARNING

Do not permit the d-c load to exceed 1.0 (50 amperes) as indicated on the load meter of the transformer-rectifier test unit, when selected to the RADIO OPERATOR position. An overload can damage the t-r unit with a resulting loss of emergency power. In this event, the radio operator's t-r unit can be replaced with another t-r unit even while pressurized.

RELEASING THE CONSTANT-SPEED DRIVE FROM UNDERDRIVE.

If the constant-speed drive goes into underdrive, proceed as follows:

CAUTION

If the alternator overspeeds and does not go into underdrive, feather the engine immediately to avoid alternator disintegration.

1. Open the alternator breaker.

CAUTION

Prolonged motoring of the alternator may damage the override clutch in the drive.

2. Shut down the engine.

Note

When the engine is feathered, the overspeed control will automatically reset itself.

3. Turn the frequency control knob fully counterclockwise to avoid overspeeding of the drive when the engine is restarted.

4. Start the engine and advance the throttle to obtain 1150 to 1200 rpm. This will hold alternator speed within safe limits in the event the cause of overspeeding still exists.

5. If frequency control is normal and the cause of overspeed no longer exists or if the overspeed control puts the alternator in underdrive again, resume normal operation of the engine.

Note

If the alternator stays in underdrive, full rated alternator power may be obtained by increasing engine rpm to approximately 2800 to obtain a minimum of 360 cycles.

ALTERNATOR MOTORING.

The free-wheeling element in the constant-speed drive permits motoring of the alternators, for short periods of time, as indicated by high kilovar loads and low or negative kilowatt loads; however, if the alternator has motored continuously for approximately 5 minutes and attempts at adjusting the alternator have failed, OPEN the affected alternator breaker.

CAUTION

Do not feather the affected engine. This action is not necessary since opening the alternator breaker protects the electrical system and the shear section of the constant-speed drive protects the engine in the event that the motoring was caused by internal drive failure.

ALTERNATOR FIELD FLASHING.

Extreme fluctuations of voltage during alternator excitation may be the result of improper voltage regulation caused by reversed alternator exciter field polarity. If this condition exists, flash the alternator field in the following manner:

1. Isolate the affected alternator by placing the alternator breaker switch in the OPEN position. Check to see that the alternator breaker indicator lamp is lighted.

2. Check that the alternator field flashing circuit breaker is engaged.

3. De-excite the alternator and flash the field by holding the exciter control relay switch in the OFF position from 1 to 2 seconds.

4. The alternator field is now flashed, and the alternator is ready for excitation.

5. If the extreme fluctuations continue when the alternator is excited, flash the field again.

6. If the malfunction persists, repeated use of the flashing circuit is not recommended.

EMERGENCY FLIGHT PROCEDURES IN THE EVENT OF COMPLETE FAILURE OF A-C POWER.

A complete failure of all four alternators to the extent that none can be excited by the emergency electrical system or by use of the battery constitutes an extreme emergency. The battery switch must be placed in the OFF position immediately and turned ON only when the engine rpm change is desired. All electrical switches in the aircraft must be placed to the OFF or neutral position to conserve the battery.

This type of electrical failure will most likely occur during a cruise condition. But regardless of when it occurs, every precaution must be taken by the aircraft commander and the engineer to control the engines so as not to cause engine failure before a successful landing is accomplished.

If cruise is required before reaching a landing field, and the electrical failure occurred at a cruise power setting, leave the engine controls as they were when the failure occurred. The engineer will have no indication of engine power since all autosyn instruments (torque pressure, manifold pressure, CHT, CAT., and fuel flow) will be inoperative.

Note

For airplane USAF Serial No. 51-5699 and subsequent, refer to "Engine Instrument Trouble Shooting" of this section.

Air speed is the best indication of engine power settings. If the air speed is excessive, retard the throttles. If the air speed gets too low increase the engine rpm gradually by intermittent use of the battery and propeller selector switches. Because the waste gates should remain where they were at the time of the electrical failure, engine power should be varied by gradual changes in engine rpm and throttle settings.

If a descent of several thousand feet is necessary and a relatively low engine rpm was set at the time of electrical failure, the rpm must be increased occasionally by intermittent use of the battery and the propeller selector switches in the descent. This is due to denser air at lower altitudes which tends to automatically decrease the engine rpm (approximately 50 rpm decrease for each 1000-foot descent). Continue to hold the desired rpm throughout the descent by intermittent use of the battery and propeller selector switches at 5000-foot increments and control air speed by use of the throttles. As the aircraft approaches the landing pattern altitude, *gradually increase* the rpm to 2600 and continue to adjust the throttles to maintain the desired air speed. This procedure will prevent exceeding the engine limitations toward destructive values even if the waste gates are closed more than they normally would be. Extreme care must be exercised when increasing the engine rpm since the manifold pressure is dependent upon the waste gate position. As the rpm is increased, retard the throttle. A safe landing can be accomplished even if the engines were in advanced spark and manual lean at the time of the complete electrical failure. By constant surveillance of air speed and adjustment of the throttles, the engines will be operating at a reasonably low bmep which will "cushion" the manual lean and spark advance settings.

Note

On airplanes equipped with fail-safe spark advance, the spark will automatically return to 20 degrees in the event of complete loss of a-c power. (Refer to "Electrical System," Section VII.)

The aircraft commander will order the landing gear extended by use of the emergency hand pump and selector valve in the radio compartment.

CAUTION

The emergency reservoir must be reserviced after the landing gear is extended. If this method of extension is unsuccessful, the aircraft commander will order a mechanical drop of the landing gear. The aircraft commander will accomplish the landing without the aid of the wing flaps and a "go-around" should not be attempted due to the high engine power requirements under these adverse conditions.

Reverse propellers may be used after touch-down by use of the battery and reverse pitch switches. A crew member will stand by at the emergency hand pump in the radio compartment with the selector to the CHARGE BRAKES position. The aircraft commander must use steady pressure on the brake pedals to conserve brake accumulator pressure. After the aircraft has stopped the engineer will shut down all engines by closing all engine fuel valves and turning the battery switch OFF. The aircraft commander will then set the parking brakes.

Note

> The parking brakes can be set after the battery is turned OFF.

ENGINE INSTRUMENT TROUBLE SHOOTING.

On airplane USAF Serial No. 51-5699 and subsequent, these procedures should be used when it is determined that any of the following equipment is malfunctioning:

Torquemeter indicating system.
Manifold pressure indicating system.
Fuel flow indicating system.
Fuel pressure indicating system.
Oil pressure indicating system.
Water pressure indicating system.

A power failure to the above named instruments will be indicated when the indicator arms do not vibrate and remain motionless when a change in power setting is accomplished.

1. If all previously mentioned instruments for one engine cease operation, check the corresponding ENGINE SELSYN INSTRUMENTS FUSE at the instrument fuse panel.

2. If the torquemeter, fuel flow indicator, or the manifold pressure gage for one engine ceases operation, check the corresponding instrument amplifier by replacing it with the spare amplifier.

Note

> The engine instrument amplifiers are located in a rack adjacent to the instrument fuse panel.

3. If all of the previously listed instruments for all engines cease operation, place the ALTERNATE-NORMAL switch on the instruments fuse panel in the ALTERNATE position. If the instruments resume operation the normal transformer is inoperative.

a. If some, but not all, of the instruments resume operation, check the fuses in the instrument fuse panel.

b. If all instruments remain inoperative, check the INST PWR-NORMAL and INST PWR-ALT fuses in the engineers' fuse panel. If these fuses are blown and continue to blow when replaced, the power transformers in the instrument fuse panel may be shorted. When this occurs or when power is not obtained after a fuse is replaced without it being blown, both the normal and alternate transformers are probably inoperative. In such an emergency, power can be restored to the related instruments by jumping 28-volt alternating current to the instrument fuse panel as follows:

(1) Remove the INST PWR-NORMAL and INST PWR-ALT fuses.

(2) Detach the instrument fuse panel to gain access to the alternate-normal switch terminals.

(3) Remove the transformer leads, and connect a 14-gauge jumper wire to the terminals on either side of the switch.

(4) Connect the jumper wire to a clip in the 28-volt a-c power panel. Insert a 20-amp fuse to complete the circuit.

CAUTION

> Do not use the landing lights while this power is jumped from the 28-volt a-c power panel; otherwise the lighting transformer will burn out.

Note

> Any lighting transformer in the lighting system may be used for 28-volt ac when all of the lighting requirements are removed.

(5) If the alternate-normal switch is inoperative in both positions, connect 26- or 28-volt a-c power from any source to terminals 1, 3, 5, 7, 9, and 11 of the B terminal strip in the instrument fuse panel. This procedure should be used only in an emergency which justifies the risk of wiring burnouts, since wiring will not be properly fused with this circuit.

Shorted wiring, faulty indicators, or bad transmitters will be indicated by pointers which are motionless or oscillate or rotate rapidly. If changing amplifiers and replacing fuses do not remedy the malfunction, use other instruments to judge engine operation.

Cylinder Head Temperature Instruments.

A power failure to the cylinder head temperature instruments is indicated when the indicator pointer remains motionless when a change in air plug opening is accomplished or a change in cooling requirements occurs.

1. If the cylinder head temperature indicator ceases operation for one engine, check the cylinder head temperature amplifier fuse for that engine at the instrument fuse panel.

2. If the cylinder head temperature indicator remains inoperative, check the corresponding cylinder head temperature amplifier by replacing it with the spare amplifier.

3. If the cylinder head temperature indicators for all engines cease operation, check the CYL HD TEMP IND fuse at the engineer's fuse panel.

4. If some, but not all, cylinder head temperature indicators resume operation, check the fuses and amplifiers at the instrument fuse panel.

5. If the power line from the engineers' fuse panel is broken, 115-volt alternating current may be jumped to the instrument fuse panel for emergency operation of all the cylinder head temperature indicators. To jump 115-volt alternating current, proceed as follows:

a. Remove the CYL HD TEMP IND fuse.

b. Detach the instrument fuse panel to gain access to terminal strip A.

c. Disconnect the lead from terminal 7 and connect 115-volt alternating current to the terminal from any source such as the right forward cabin power panel.

Note

> Do not use the original fuse clip in the engineers' panel because the power may be shorted and will blow the fuses when the circuit is completed.

A short circuit in the wiring of the cylinder head temperature indicator will probably cause the indicator pointer to read extremely low. Change the setting of the cylinder head temperature selector switch to check for a short.

1. If new setting results in a reasonable reading, a short exists between the temperature bulk and the selector switch.

2. If the low reading remains unchanged, amplifier or indicator failure or wiring fault is indicated.

An open circuit will cause the indicator pointer to rotate rapidly. Change the setting of the cylinder head temperature selector switch to check for an open circuit.

1. If rotation stops when switch is changed, an open circuit exists between the bulb and the selector switch.

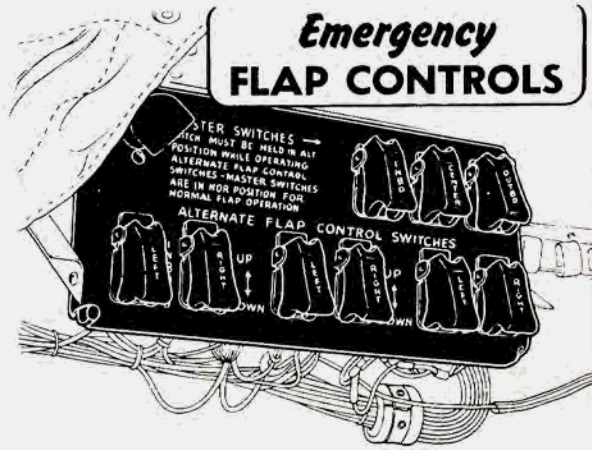
2. If the rotation continues, an amplifier or indicator is faulty or the return ground connections or selector switch circuits are open.

WING FLAPS.

When a pair of flaps does not extend or retract normally it is necessary to operate the emergency switches on the alternate flap control panel near the right wing crawlway entrance. The following emergency steps will be accomplished to raise or lower the flaps:

1. Plug in a headset at the alternate flap control panel to establish interphone contact with the pilots and scanners.

2. Hold the proper alternate flap control selector switch in the UP or DOWN position, depending on the flap movement desired.



DI-243-C

Figure 3-12.

3. With the aft cabin scanners checking flap position, hold the proper master flap control selector switch in the spring-loaded ALTERNATE position.

4. If the synchronizing system is completely inoperative, proper flap positioning will depend on the judgment of the scanners.

5. For landing, set flaps at 20 degrees and land in this configuration.

WARNING

> Do not lower flaps to 30 degrees since flaps cannot be raised quickly in the event of go-around.

If the synchronizing system is operative and you move the lagging flap approximately two and one-half degrees past the position of the symmetrical good flap, the scanner will notice that the good flap will follow with a jumping motion. To keep the flap settings at the required deflection, the scanner must inform you to release the switch at the first movement of the good flap. At this point, both flaps will be equal in deflection.

Note

> If the emergency flap control system is inoperative, check alternate flap panel circuit breaker switch at bulkhead 8.0 d-c power panel; then check the fuses at the respective engine power panel of each flap. If the fuses are blown, replace them and try the emergency switches again before trying the normal system. If the emergency system works, do not use the normal system until maintenance is accomplished. For further information, refer to "Emergency Operation of Electrical Equipment," Section VII.

EMERGENCY LANDING GEAR OPERATION.

If the landing gear fails to respond to the positioning of the landing gear control switch, three emergency methods are provided to effect landing gear operation. Emergency gear extension procedures should be attempted in the order listed, except when the main hydraulic reservoir is empty; in this case, the first procedure should be omitted. These methods are as follows:

1. Manual Operation of Main Selector Valve.
2. Emergency Hydraulic Landing Gear Extension.
3. Manual Extension of Main and Nose Landing Gear.

Note

Gear retraction can be accomplished by the first method only. Extension can be accomplished by any of the three methods.

To determine the probable cause of normal control failure, proceed as follows:

1. Place the landing gear control switch in EXTEND or RETRACT position, as required.

Note

If no hydraulic pressure is indicated, the landing gear extend or retract relays may be inoperative.

2. Hold the hydraulic pump override switch ON.

Note

a. If there is no hydraulic pressure, check the main hydraulic reservoir fluid level and the main hydro pump fuses in the main a-c power panel.
b. If pressure is indicated, but the gear does not operate, a faulty electrical circuit to the selector valve may be the source of trouble.

3. Turn the landing gear control switch to OFF and release the hydraulic pump override switch to OFF.

CAUTION

Do not operate the main hydraulic pumps more than two out of every ten minutes at maximum pressure since sustained operation will damage the pump motors.

Note

For further information, refer to "Emergency Operation of Electrical Equipment," Section VII.

MANUAL OPERATION OF MAIN SELECTOR VALVE.

1. Landing gear control switch—OFF.
2. Landing gear control circuit breaker—Pull out.

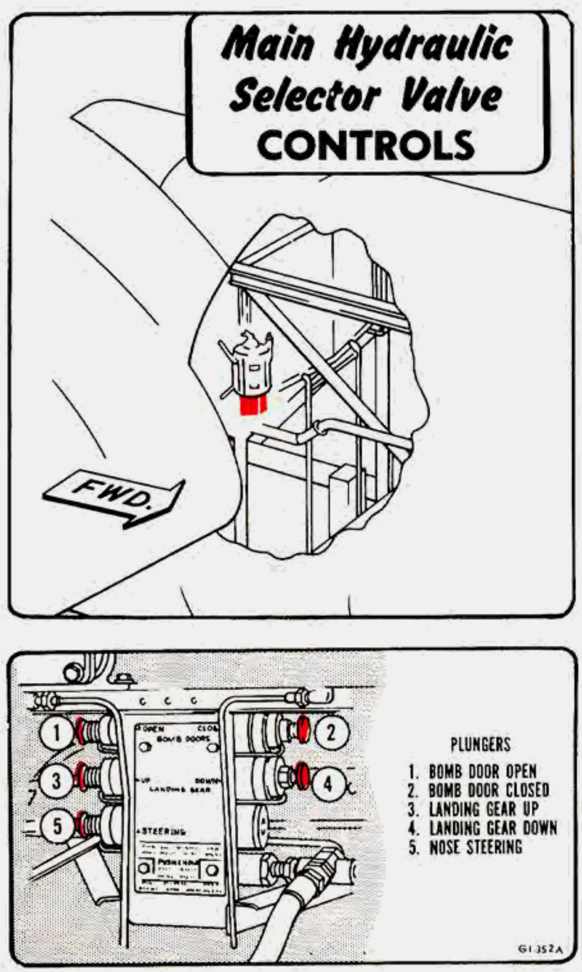
CAUTION

The preceding steps should be accomplished to prevent inadvertent operation of the gear.

3. Main selector valve—Push in and hold the UP or DOWN landing gear plunger, as desired.

CAUTION

The crew member operating the selector valve must be in interphone contact with the aircraft commander, engineer, and scanners and must notify the engineer when he has positioned the valve plunger.



G1-352-A

Figure 3-13.

4. Hydraulic pump override switch—Hold On until aft cabin scanners report "Door open, gear coming down, door closed"; then turn to OFF.

CAUTION

To prevent pump motor damage, limit the operation of the main hydraulic pumps to two minutes out of every ten at miximum pressure.

Note

At any time normal gear sequence stops, the scanners will immediately report this condition over interphone.

5. Main selector valve—Release plunger when notified that gear action has been completed.

WARNiNG

To be certain that the gear is down and locked, the aft scanners will visually check the position of the pink fluorescent flag on each main gear side brace. The flags will not be visible when the gear is down and locked. Scanners will also notice a snapping motion of the latch link rod as it goes into the locked position.

6. Landing gear control circuit breakers—In and check gear position indicator lights.

7. Nose gear—Checked visually down and locked by the radio operator.

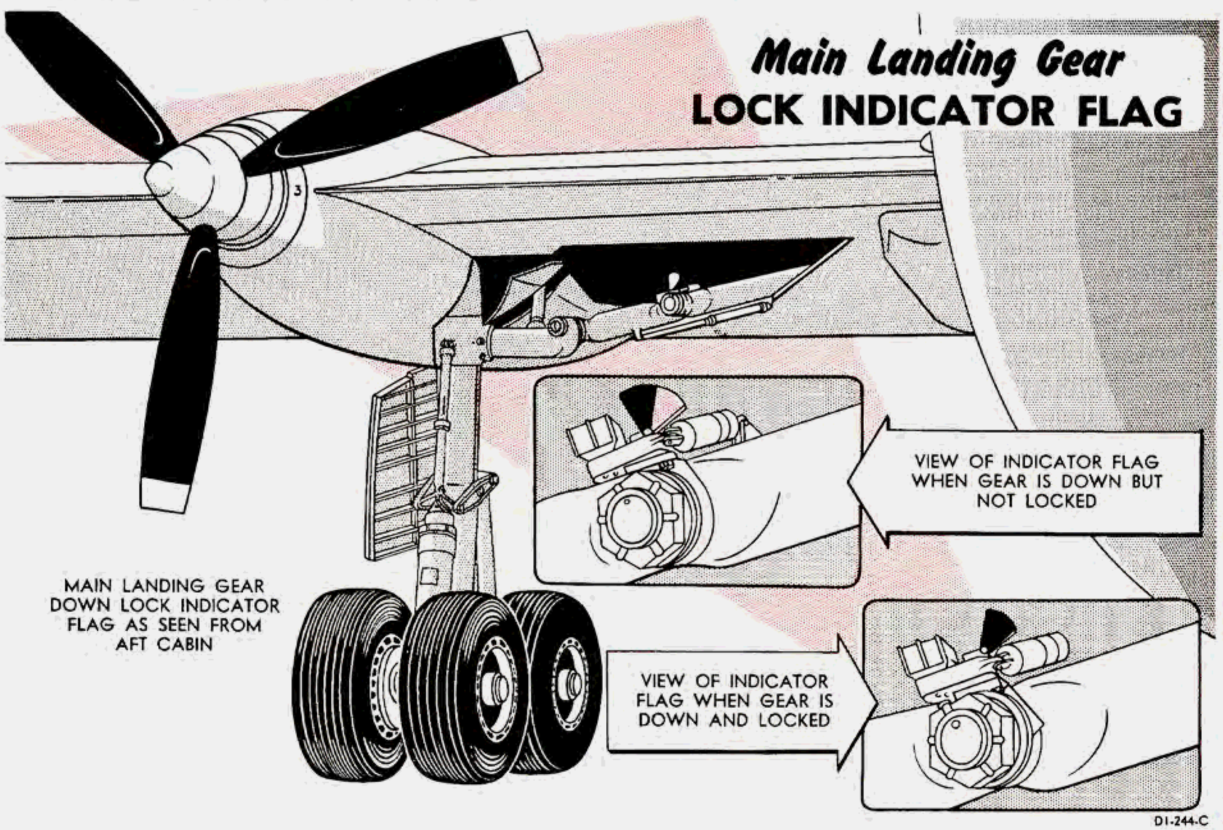
EMERGENCY HYDRAULIC EXTENSION.

If the main hydraulic pumps fail to operate in response to the landing gear control switch or the pump override switch, use the following procedure to extend the landing gear:

1. Landing gear control switch—OFF.
2. Landing gear control circuit breaker—Pull out.

CAUTION

The preceding steps will prevent inadvertent operation of the gear. The crew member pumping the gear down must establish interphone contact with the aircraft commander and the scanners.



D1-244-C

Figure 3-14.

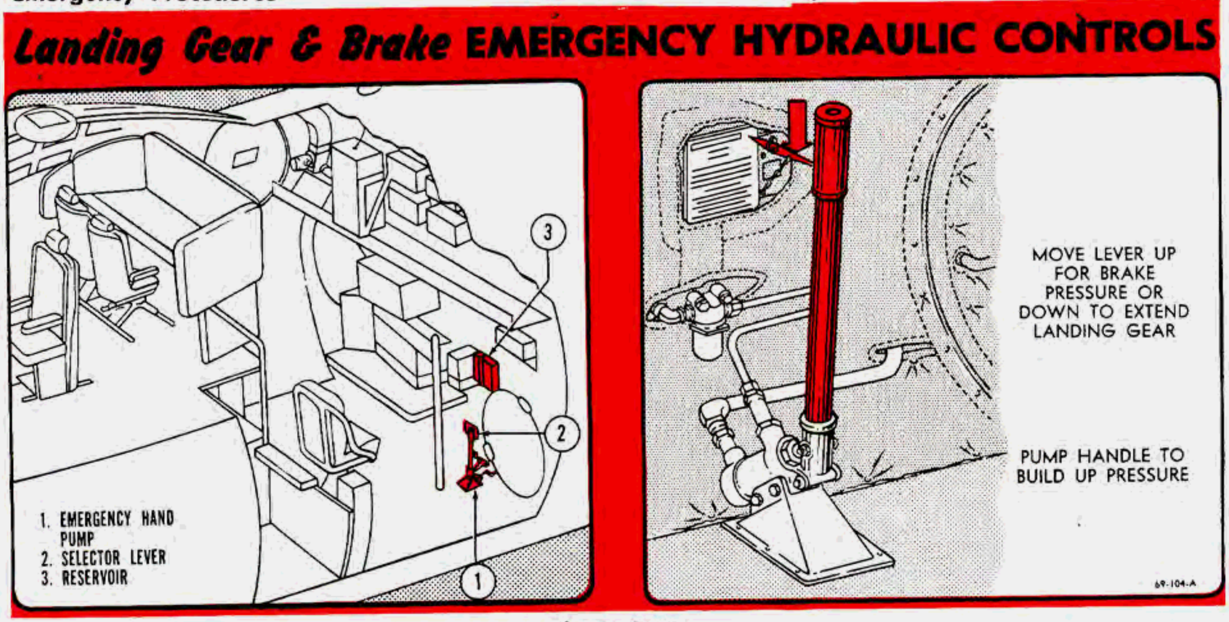


Figure 3-15.

3. Emergency selector valve—Position at EXTEND LG.

WARNING

Make sure that the emergency selector valve is held in the detent position during landing gear extension or the hydraulic lines may rupture.

4. Hand pump—Operate until the gear is down and locked. The nose gear usually extends first, the main gear doors open, and then the main gear extends.

Note

The main gear doors will remain down since they cannot be retracted by hand pump operation.

WARNING

If the green landing gear indicator light does not come ON when the landing gear control circuit breaker is pushed in, make a visual check at the wing crawlway entrances to be sure the gear is down and locked.

5. Emergency selector valve lever—Return to the CHARGE BRAKES position.

CAUTION

The emergency selector valve must be placed in the CHARGE BRAKES position before operating the normal brake hydraulic system. Otherwise, fluid will be transferred into the emergency reservoir if the check valve between the main brake system and the emergency brake system is leaking. If fluid begins to overflow in the emergency reservoir during gear extension, the emergency selector valve must be placed in EXTEND LG to prevent further loss of fluid.

WARNING

If the normal gear system is operated after an emergency extension of the gear, the landing gear control switch must first be moved to EXTEND to properly position shuttle valves and close canoe doors. Because the landing gear doors remain down after a hand-pump extension, the gear and the doors might retract simultaneously if the landing gear control switch was moved to RETRACT first.

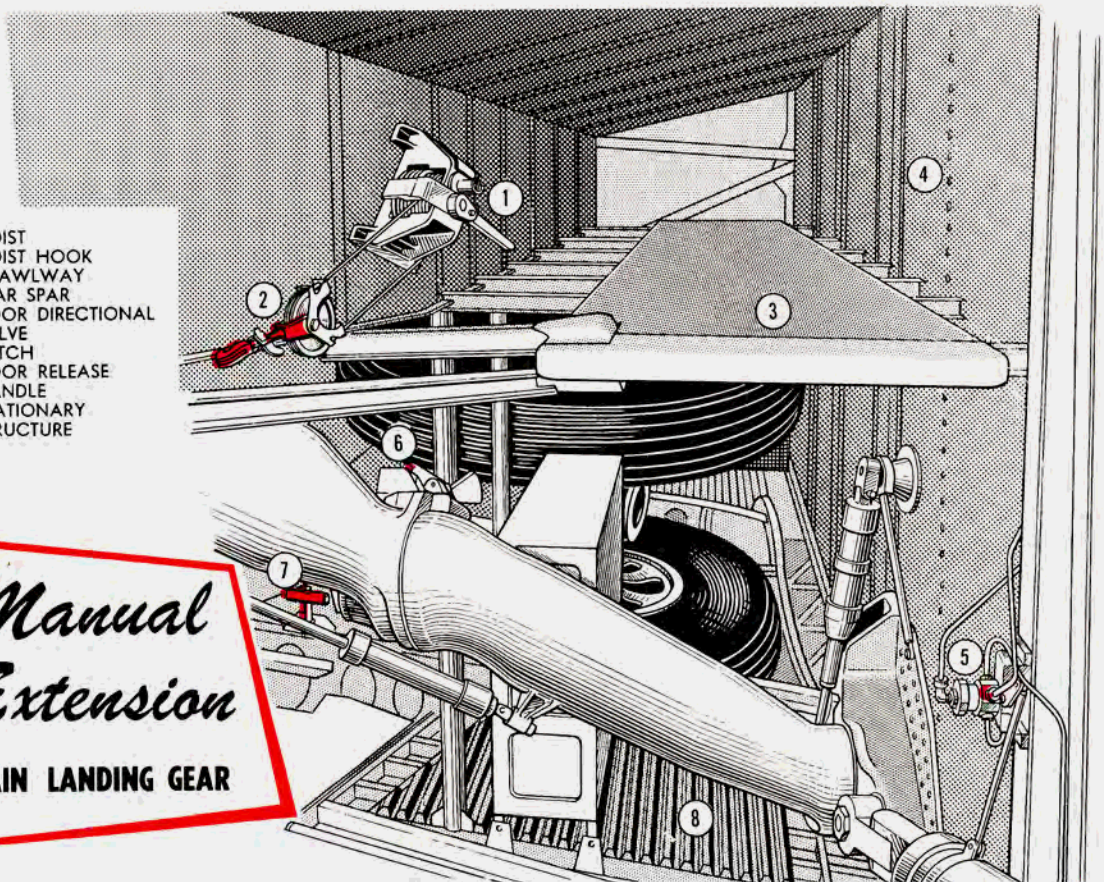
CAUTION

If during hand pump extension of the gear, the landing gear control switch is inadvertently moved to RETRACT, a hydraulic lock will be created between the nose gear emergency extension line and the emergency hand pump. To overcome this condition, momentarily place the landing gear control switch in EXTEND. This action will reposition a shuttle valve in the nose gear emergency line and remove the hydraulic lock. There will be no loss of hydraulic fluid and the resulting pressure will be normal.

6. Reservice emergency hydraulic reservoir prior to landing, if necessary.

Manual Extension

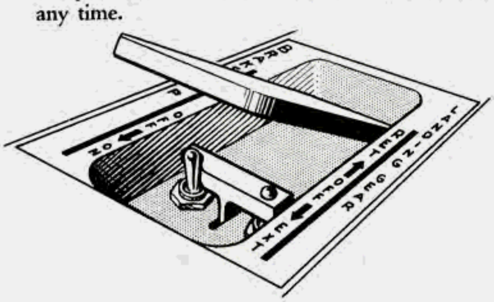
MAIN LANDING GEAR



Before attempting a manual extension of the main gear, the landing gear control switch must be OFF and its circuit breaker pulled. Two crew members will proceed to the wing crawlway entrance hatch. One will plug into the interphone system at the hatch. The other will gain access to the manual extension controls shown above via the wing crawlway and extend the gear as follows:

WARNING

No parachute will be worn in the wing crawlway at any time.



Step 1

Assume a position on the wing crawlway from where it will be possible to reach the red latch link pin. Remove this pin and allow the latch link rod to drop free of the latch. This prevents the possibility of pressure in the hydraulic system interfering with manual unlatching and also eliminates the hazard of someone operating the gear while you are working in the wheel well.

Note

A complete inspection of manual extension equipment will be made before extending the gear.

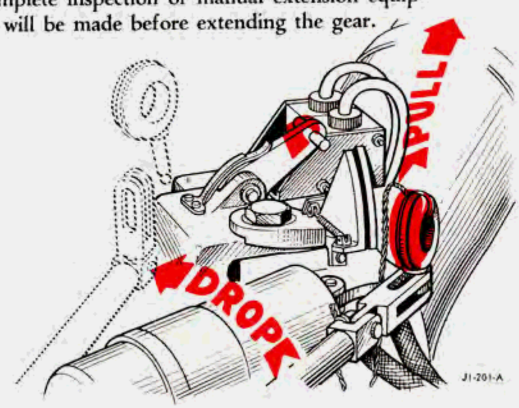
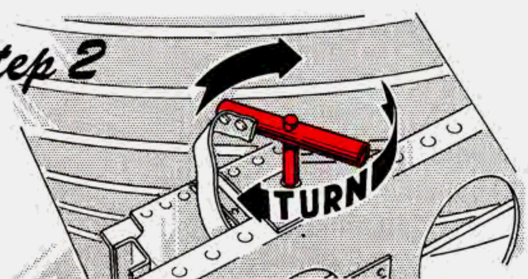
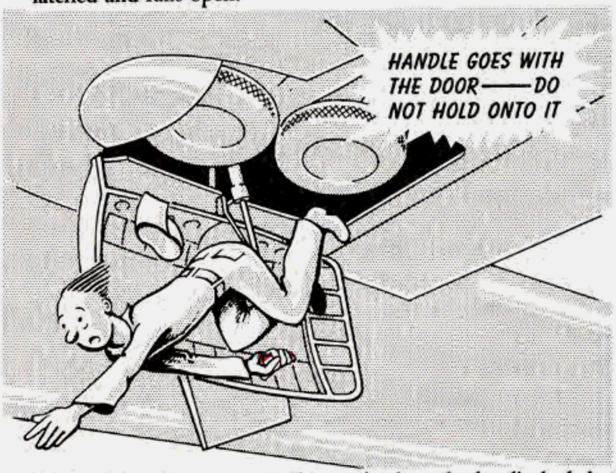


Figure 3-16. (Sheet 1)

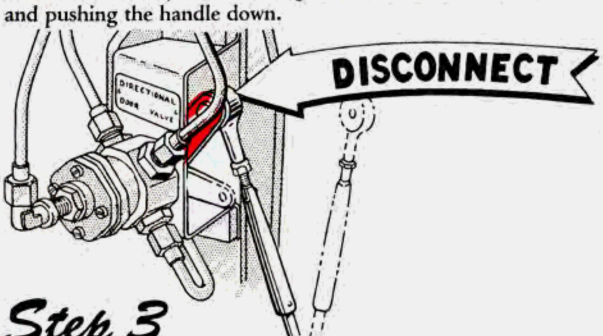
Step 2



Assume a position on the wheel well stationary structure and remove the safety wire or strap from the main wheel well door release handle. Turn the handle clockwise until the door is unlatched and falls open.

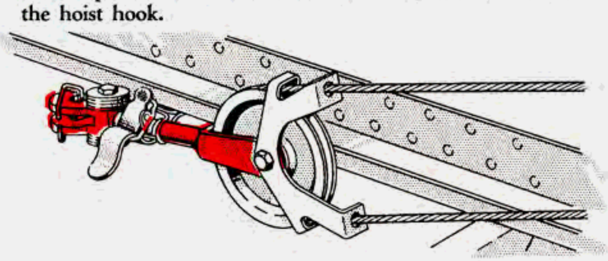


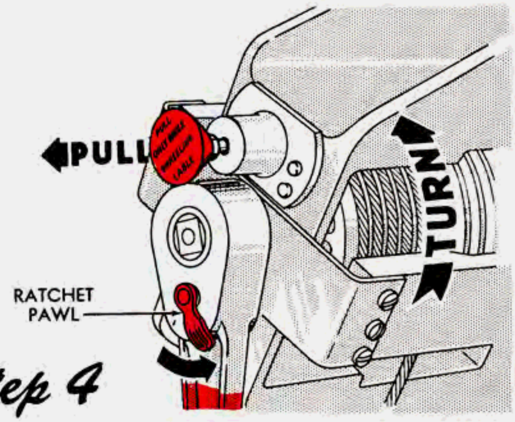
If the door does not extend completely, a hydraulic lock is indicated between the main selector valve and the door jack. Relieve this lock by disconnecting the rod from the valve handle and pushing the handle down.



Step 3

From a position on the wheel well stationary structure, unstow the hoist hook.





Step 4

If the hoist hook does not reach the latch release lever, the hoist lock pin located above the ratchet handle on the cable drum must be disengaged from the drum to extend the cable. The hoist lock pin is disengaged by pulling out and holding its spring loaded button. The ratchet handle pawl must then be set to allow unreeling of the cable (counterclockwise turning of the drum). The cable extends by unwinding from the large drum and winding onto the small drum. Releasing the button will re-engage the hoist lock pin with the cable drum.

Step 5

Engage the hoist hook with the pins on the latch release lever and hold it there making sure that the spring release on the hoist hook is behind the pins. This will insure positive release of the hook when cable tension is relieved after the side brace is raised. Also, when engaging the hoist hook, make sure that the cables are not crossed.

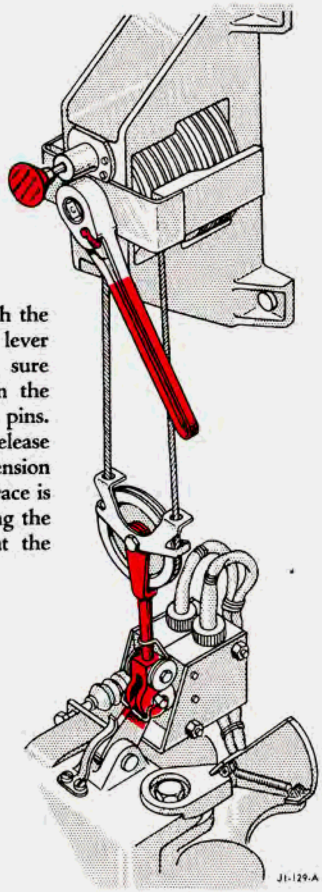
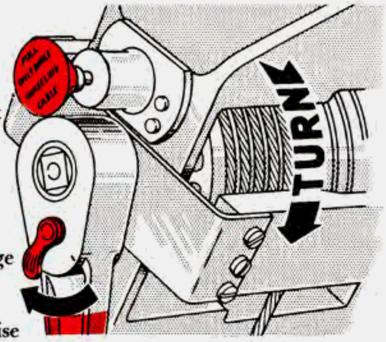


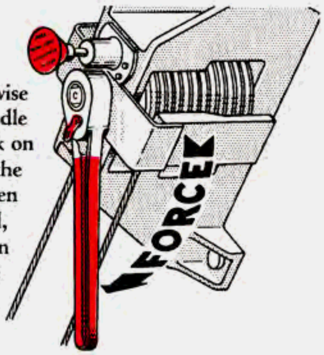
Figure 3-16. (Sheet 2)

Step 6



Engage the hoist lock pin by releasing the button. Reverse the ratchet handle pawl so that operation of the ratchet will wind the cable onto the large drum (force being applied to the ratchet handle in the clockwise direction).

Step 7

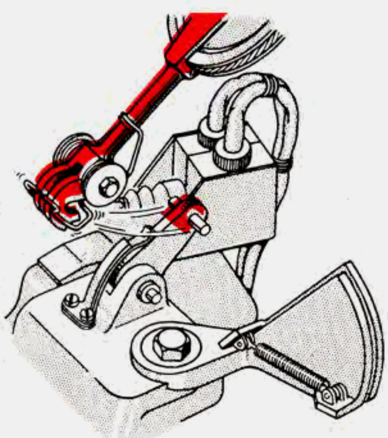


Tighten the cable by a clockwise movement of the ratchet handle while holding the hoist hook on the latch release lever until the cable slack is taken up. When the hoist lock pin is engaged, the only movement that can be made is in the clockwise direction (cable unwinding onto the large drum).

Step 8

For the right main gear, lying on the catwalk facing aft, *push* the ratchet handle for clockwise movement of the drum. For the left main gear, lying on the catwalk facing aft, *pull* the ratchet handle for clockwise movement of the drum. Continue applying force to the ratchet handle in the clockwise direction to apply tension to the cable, and turning the handle in the counterclockwise direction to obtain a new "bite" on the drum. This racheting is necessary because of the limited space and leverage when in a prone position.

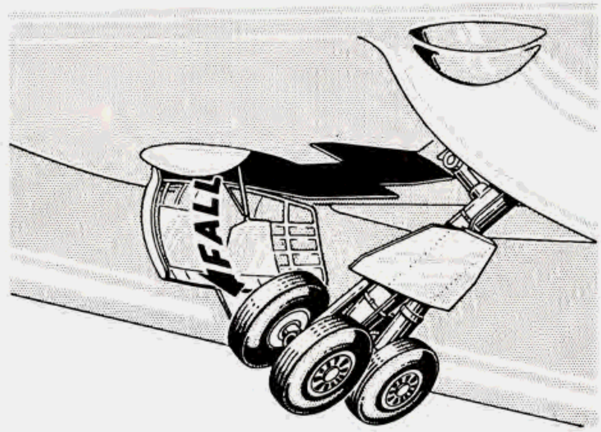
Step 9



When the latch release lever unlatches the side brace, and the side brace begins to rise, cable tension will be relieved and the hook should spring free. If the hook remains engaged, disengage it by hand.

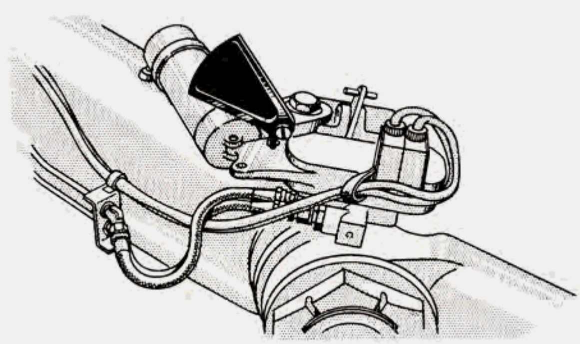
Step 10

The gear will fall away under its own weight and should lock after extension. If it does not lock in the down position a slight kicking of the latch link bracket should engage the lock.
Note: If the latch cannot be engaged install the ground safety lock.



Step 11

Check the position of the pink flag on the landing gear side brace. If the gear is down and locked, the flag will not be visible.



Step 12

Push in pilot's landing gear circuit breaker and check landing gear indicator lamps.

Step 13

Leave the landing gear switch OFF and place the brake pump switch ON.

J1-130-A

Figure 3-16. (Sheet 3)

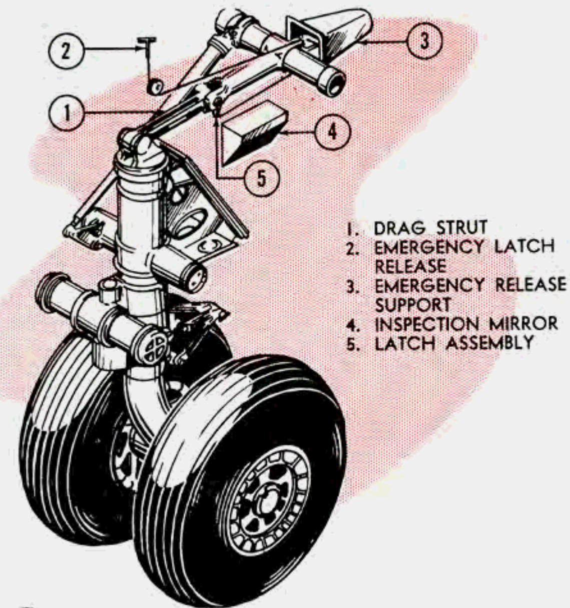
• EMERGENCY RETRACTION OF NOSE LANDING GEAR.

In the event the nose gear fails to retract with the main landing gear, determine whether the emergency release pin is in place by looking through the inspection window in the floor of the radio operator's compartment. If the pin is not in place, the nose gear latch will not unlock. When this occurs, the nose gear can be retracted by either of two methods.

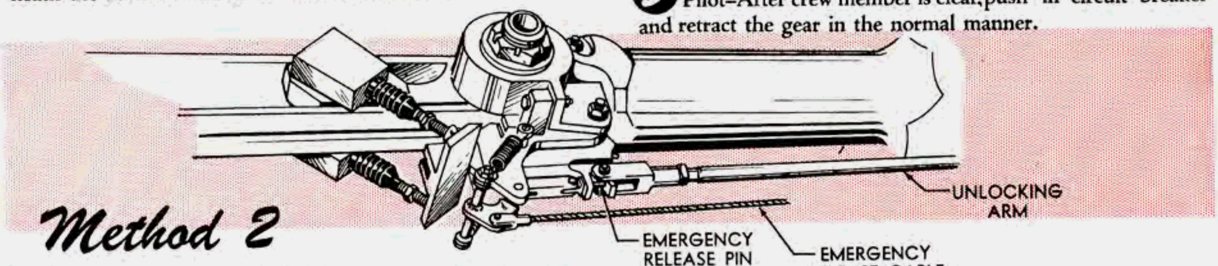
Method 1

If the emergency release pin is still available but not in place, use the following procedure:

1. Aircraft Commander – Instruct that all radar equipment be turned OFF.
2. Pilot– Extend the landing gear; then place the landing gear control switch off, check for zero hydraulic pressure, and pull the landing gear circuit breaker.
3. Crew member–Enter the radar equipment bay beneath the forward turrets and, using the access hole in the forward bulkhead, insert the release pin through the latch assembly beneath the forward end of the latch release rod.



4. Crew member-To connect the unlocking arm it may be necessary to rotate the unlocking arm collar slightly. *Do not attempt to adjust the rod length.*
5. Pilot–After crew member is clear, push in circuit breaker and retract the gear in the normal manner.



Method 2

If the emergency release pin is missing completely, the gear can be retracted as follows:

1. Pilot–Place the landing gear control switch OFF, check for zero hydraulic pressure, and pull the landing gear circuit breaker.
2. Crew member–Apply a steady pull of approximately 150 pounds on the nose gear release handle. The latch will open and the cable will pull through the floor another two or three inches. Check the position of the latch by looking through the inspection window.
3. Crew member–While holding the cable tight, inform pilot to push in circuit breaker and place the landing gear control switch in RETRACT. When the gear begins to retract, release the handle; the gear should then lock in the retracted position.
4. Crew member–Make sure that the release cable is properly seated over the pulleys; this is essential because the nose gear must be extended manually when the above method is used for retraction.

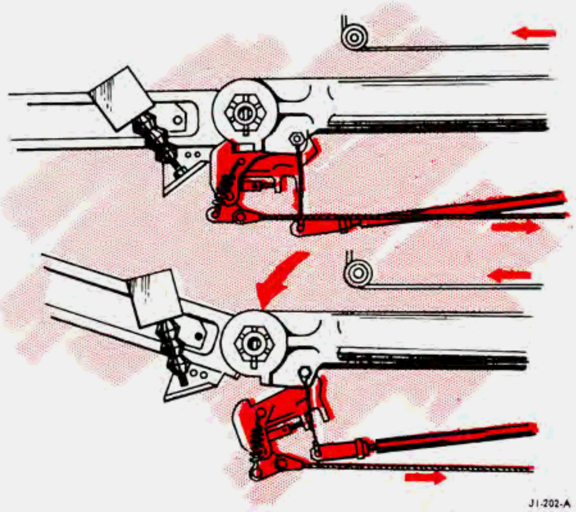


Figure 3-17.

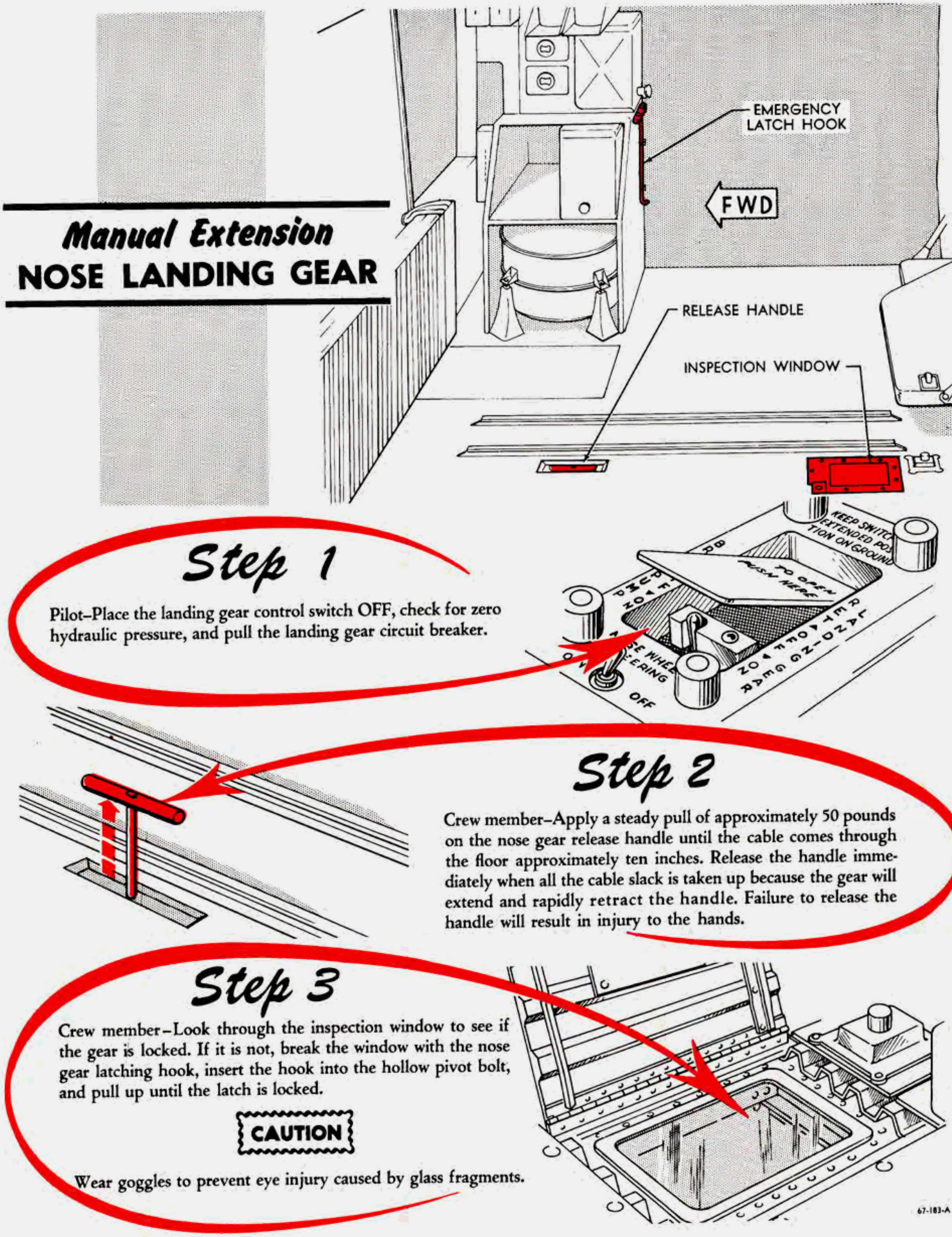

Manual Extension
NOSE LANDING GEAR
EMERGENCY LATCH HOOK
FWD
RELEASE HANDLE
INSPECTION WINDOW
Step 1
Pilot–Place the landing gear control switch OFF, check for zero hydraulic pressure, and pull the landing gear circuit breaker.
TO OPEN PUSH HERE
OFF
Step 2
Crew member–Apply a steady pull of approximately 50 pounds on the nose gear release handle until the cable comes through the floor approximately ten inches. Release the handle immediately when all the cable slack is taken up because the gear will extend and rapidly retract the handle. Failure to release the handle will result in injury to the hands.
Step 3
Crew member–Look through the inspection window to see if the gear is locked. If it is not, break the window with the nose gear latching hook, insert the hook into the hollow pivot bolt, and pull up until the latch is locked.
CAUTION
Wear goggles to prevent eye injury caused by glass fragments.
67-183-A

Figure 3-18.

EMERGENCY STOPPING.

USE OF BRAKES AND PROPELLERS.

For normal stopping of the aircraft, reverse pitch of the six reciprocating engine propellers is sufficient to slow or stop the aircraft with little or no brake action. However, emergency stopping concerns stopping the aircraft in as short a space as possible without going off the runway. Therefore, all normal restrictions on use of brakes and propellers do not apply. To increase the effect of reverse thrust, reduce rpm to 2000 with the master motor as power is applied.

You are not concerned with burning out a set of brakes or exceeding prop restrictions in reverse. The main concern is to save the crew and aircraft. The brakes have an independent hydraulic system which keeps pressure available in two accumulators. The accumulators are automatically charged by an a-c motor-driven pump; however, if the automatic operation fails the engineer has an override switch to maintain the necessary pressure in the accumulators. If neither system is operating, an emergency hand pump method is available.

CAUTION

> With the brake system off, a fully charged accumulator will furnish enough pressure for three brake applications. In order to obtain the most effective braking action with a minimum of three applications available, keep the brake pedals depressed as long as the action is required.

The normal operating limits of 30 inches M.P. for use in reverse pitch may be exceeded if necessary for emergency stopping. When this limitation is exceeded, the controls must be LOCKED to prevent damage to the control surfaces.

CAUTION

> If the brakes are not available during landing, landing roll, or while taxiing, the aircraft will be stopped on the runway or taxi strip by using reverse pitch for breaking action. Hold the aircraft stationary by using either reverse or forward action of the propellers. If the cause is from a broken hydraulic line, the brake pump circuit breaker will be pulled to prevent fluid from being pumped overboard. *Do not* shut down engines until chocks or other object have been placed under the main gear to prevent the aircraft from rolling after the engines have been stopped. Stop engines at low rpm regardless of propeller pitch position. The aircraft will be towed to the parking apron. If the active runway has to be cleared, the aircraft may be taxied off the runway with extreme caution and stopped not less than 100 feet from the active runway and then towed to the parking apron.

EMERGENCY BRAKE PRESSURE.

If the pilots' brake pump switch is on, the brake low pressure warning lamp is lighted, and a pressure gage check indicates low brake pressure, proceed as follows:

1. Pilot—Brake pump switch—ON.
2. Engineer—Brake pump pressure override switch—ON; hold until pressure is within range.

Note

> Should step 2 fail to produce pressure, perform the following steps:

3. Crew—Emergency selector valve—CHARGE BRAKES.

CAUTION

> Be sure that the emergency selector valve is held in the detent during charging or the hydraulic lines may rupture.

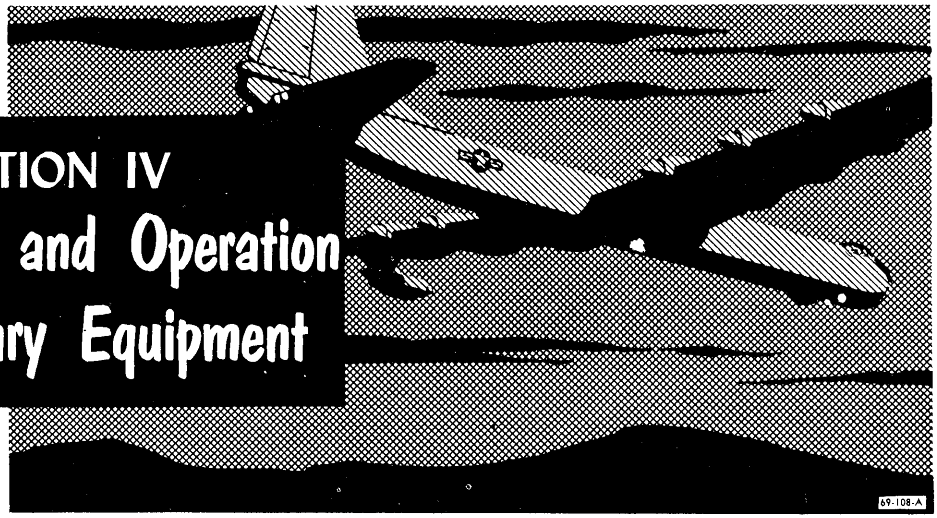
4. Crew—Operate hand pump until pressure is within normal range.

Note

> Fully charged accumulators will supply brake pressure for three full brake applications. To obtain maximum efficiency from fully charged accumulator, apply the brakes moderately and hold them using differential braking as required.

CAUTION

> Don't fully release the brake pedals. If you do, the efficiency of the brake system will be decreased.



SECTION IV
Description and Operation of Auxiliary Equipment

69-108-A

HEAT AND ANTI-ICING SYSTEM.

Heated air for wing and tail anti-icing and for heating pressurized air is obtained by ducting ram air from the nacelle cooling air tunnel through the two primary exhaust gas heat exchangers in each nacelle. The heated air from engines 1, 2, 5, and 6 is used for wing anti-icing. Engines 3 and 4 provide the air which is used as required in the secondary heat exchanger to heat the pressurized air for cabin heating. The air from engines 3 and 4 is also used to provide tail anti-icing. A duct system routes the air from the nacelles to the leading edges of the wing and tail. Flow is controlled by electrically operated valves located in the duct system. These valves are controlled from the engineer's station and operate on 115-volt a-c power. See figure 4-1 for system arrangement.

Note

> During operation of the anti-icing system, the leading edge of the wing and tail surfaces may "oilcan." The "oilcanning" is a normal occurrence and will not have any damaging effects.

HEAT AND ANTI-ICING CONTROLS.

Cabin Heat and Tail Anti-Icing Control Switches.

There are two three-position switches (17, figure 1-19) on the engineers' auxiliary control and instrument panel for operating the modulating dump valves in the inboard nacelles. These switches are spring-loaded to the neutral position and enable you to regulate the amount of heated air going to the tail for anti-icing or to supply the secondary heat exchanger for cabin heat. When the switches are held in the INC position, the valves are positioned for full cabin heat and tail anti-icing; when they are held in the DEC position, the valves are positioned for full dump.

Cabin Air Supply Temperature Control Switch.

This three-position switch (22, figure 1-19) controls a modulating valve which regulates the amount of heated air passing through the secondary heat exchanger on its way to the tail for anti-icing. When the switch is held in the INC position, the tail anti-icing air is routed through the secondary heat exchanger to heat the cabin air. In the DEC position, the tail anti-icing air by-passes the secondary heat exchanger and no heat is supplied to the cabins other than that provided by the heat of compression of the pressurized air from the turbos. An indicator lamp (21, figure 1-19) glows when the valve has reached either of its extreme travel limits.

Wing Anti-Icing Switches.

Four three-position switches (15, figure 1-19) are located on the engineers' auxiliary control and instrument panel to control the dump valves for engines 1, 2, 5, and 6. These switches have operating positions marked INC and DEC and a neutral center position which is not marked.

Placing the switches in the INC position actuates the valves in a direction which permits heated air to enter the anti-icing ducts. With the switches in the DEC position, the valves are actuated in the opposite direction to route the heated air overboard. The valves may be stopped at any intermediate position by returning the switches to the neutral center position. In this manner the anti-icing air temperature is controlled by regulating the volume of heated air which enters the system.

HEATING, ANTI-ICING AND PRESSURIZATION SYSTEMS

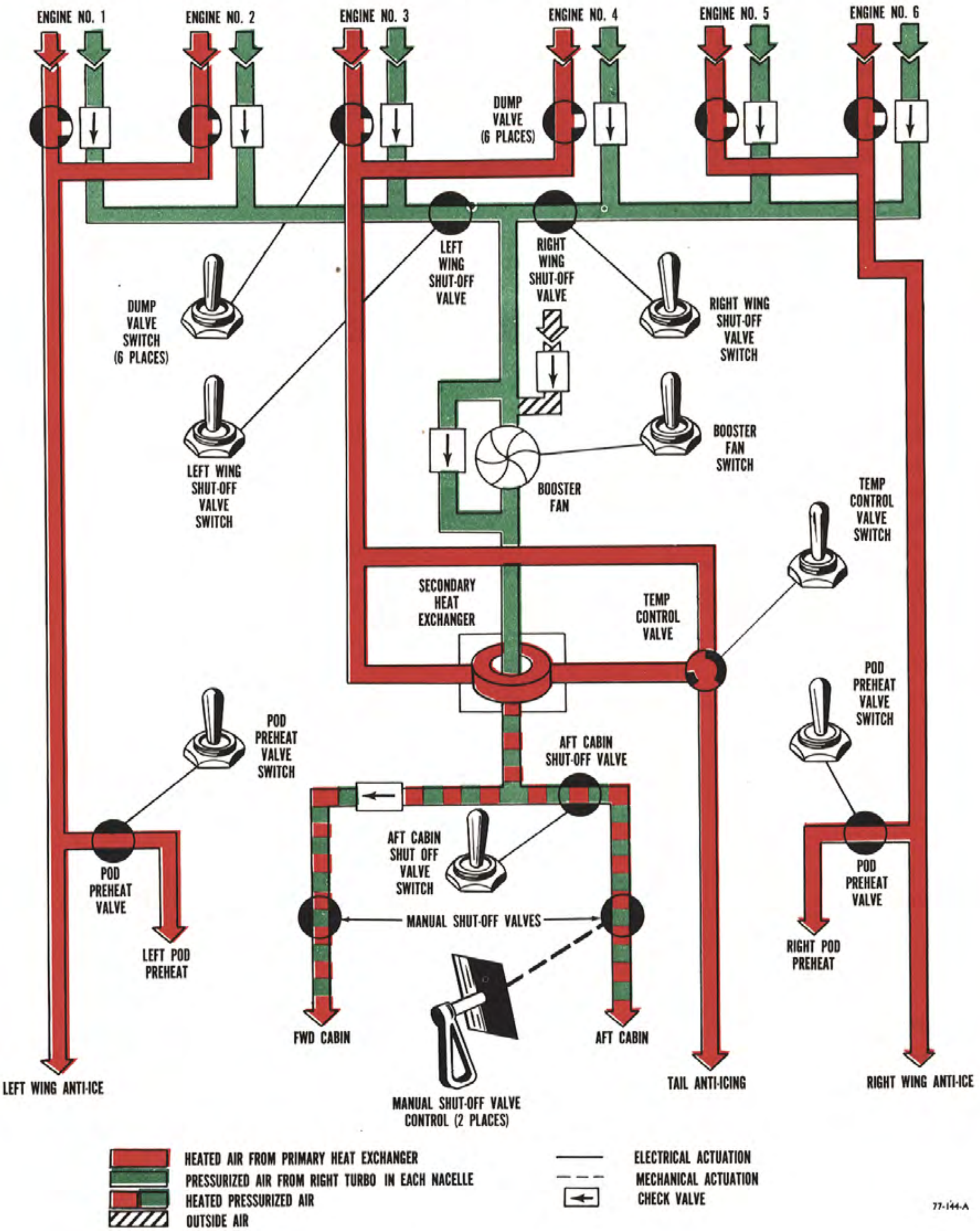


Figure 4-1.

INDICATORS.

Wing Anti-Icing Temperature Indicators.

Four wing anti-icing temperature indicators (11, figure 1-19) are located on the engineers' auxiliary control and instrument panel. An indicator is provided for the anti-icing air delivered by engines 1, 2, 5, and 6. The indicators give the temperature of the wing anti-icing air in degrees centigrate as the air passes through the delivery duct to the wing leading edge.

Cabin Heat and Tail Anti-Icing Temperature Indicators.

Two temperature indicators (12, figure 1-19) are provided on the engineers' auxiliary control and instrument panel for indicating the temperature of the cabin heat and tail anti-icing air. An indicator is provided for the heated air delivered by engines 3 and 4. The indicators give the temperature of the cabin heat and tail anti-icing air in degrees centigrade as the air passes through the delivery duct on the way to the secondary heat exchanger and the tail.

Tail Anti-Icing Temperature Indicator.

A temperature indicator (13, figure 1-19) located on the engineers' auxiliary control and instrument panel, indicates the tail anti-icing air temperature in degrees centigrade as the air enters the leading edge of the tail.

Cabin Heat and Anti-Icing Air Temperature Warning Lamps.

Six temperature warning lamps (16, figure 1-19) are provided on the engineers' auxiliary control and instrument panel. The lamps are connected to fire detector thermal switches located in the anti-icing air ducts between the dump valve and primary heat exchanger of each nacelle. The lamps will light when the corresponding fire detector thermal switches are subjected to temperatures in excess of 425°C.

CAUTION

For two or three minutes after placing the system in operation, you may get erroneous indications from the temperature warning lamps. This condition is caused by the time lapse required for the internal temperature of the thermal switches to stabilize.

Duct Air Temperature Indicator.

A temperature bulb, located in the air duct leading to the forward cabin, is connected to a temperature indicator (18, figure 1-19) on the engineers' auxiliary control and instrument panel. This gage indicates the temperature of the air entering the cabin through the duct.

CAUTION

This air should not exceed a temperature of 105°C.

PRESSURIZATION SYSTEM.

The forward and aft cabins and the interconnecting communication tube are pressurized by a controllable system which utilizes air from the right turbosupercharger in each nacelle. Pressure regulators are located in each cabin to maintain cabin pressure automatically. The pressure regulators are set to allow an unpressurized condition from sea level to 8000 feet, to permit a constant pressure altitude of 8000 feet, from 8000 to 35,000 feet, and to hold a constant differential pressure of 7.45 psi above 35,000 feet. (See figure 4-2.) In pressurized flight either cabin can be depressurized while maintaining pressure in the other cabin. A booster fan is provided to draw ambient air into the duct system when an auxiliary source of ventilating and pressurizing air is required. See figure 4-1 for system arrangement.

CAUTION

Cabin pressurization is not available when carburetor preheat is used. Some pressurization and cabin heat can be made available at low altitudes by turning on the cabin booster fan. However, as altitude is increased the efficiency of the booster fan will be reduced at an increased rate. Above 12,000 feet the booster fan operates at such low efficiency that cabin pressure can decrease to the extent that some airplane equipment becomes inoperative. Normal cabin pressurization will

Cabin Pressure VS. ATMOSPHERIC PRESSURE

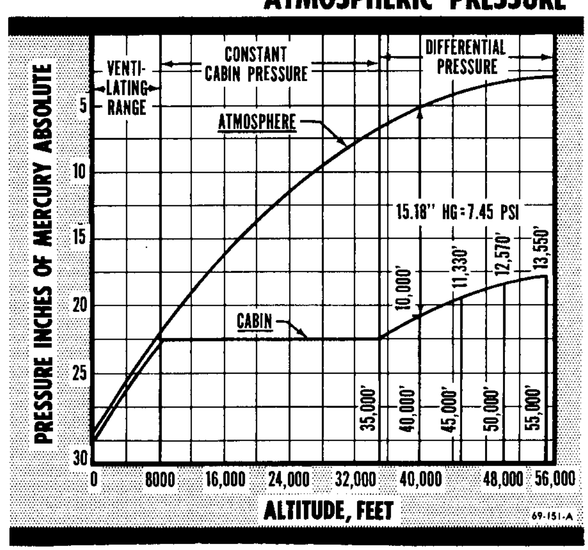


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Figure 4-2.

be available above 12,000 feet in most cases however, since carburetor preheat is seldom required above this altitude because of the heat provided by turbo boost. Above 12,000 feet altitude carburetor preheat should be used only as an emergency measure.

NORMAL CONTROLS.

Wing Pressure Shutoff Valve Switches (Cabin Supply From Turbos).

There are two three-position switches (20, figure 1-19) located on the engineers' auxiliary control and instrument panel. They are marked CABIN SUPPLY FROM TURBOS. These switches have positions marked INC and DEC, and have a neutral off position. When either switch is placed in the INC position, a control arm in the respective valve is actuated by 115-volt alternating current in a direction which allows the valve to open when pressurized air is flowing to the cabins. However, the valve will close automatically during any air flow reversal. The DEC position actuates the arm in the opposite direction and forces the valve against its seat, shutting off the flow of pressurized air from that wing. The control arm can be stopped at any intermediate position by moving the switch to the neutral center position during either cycle of operation, thus restricting the flow of pressurized air to the cabin air system.

Aft Cabin Pressure Switch (Aft Cabin Flow).

The flow of pressurized air to the aft cabin is controlled by a three-position switch (19, figure 1-19) located on the engineers' auxiliary control and instrument panel. This switch completes a 115-volt a-c circuit to the aft cabin pressure shutoff valve. The switch is labeled AFT CABIN FLOW and has positions marked INC and DEC with a neutral off position.

CABIN BOOSTER FAN.

A two-speed booster fan is located in the ventilating air duct and supplies air independent of the turbos to the cabins. The fan is operated on LOW when it is used to ventilate the cabins during ground operation and flight altitudes up to 8000 feet. For pressurized flight above 8000 feet it is operated in the HIGH position to furnish additional boost to the cabins for more positive pressurization and heating. The fan can also be used in conjunction with the secondary heat exchanger to supply heated air to the cabins independent of the cabin pressure system in unpressurized flight.

Cabin Air Booster Fan Control Switch.

A three-position switch (14, figure 1-19) located on the engineers' auxiliary control and instrument panel, controls the action of the booster fan. This switch has positions marked HIGH ABOVE 8000 FEET, BELOW 8000 FEET LOW, and OFF. The low speed position is used for ventilating the cabins during ground operation and at altitudes up to 8000 feet. This position can also be used in conjunction with the secondary heat exchanger for cabin heat during unpressurized flight. The high speed position can be used at altitudes above 8000 feet to create additional boost for more positive heating and pressurization. Each switch position completes a 28-volt d-c circuit to the respective fan speed control relay which connects 208-volt three-phase alternating current to the fan motor.

CAUTION

Never run the fan at high speed at altitudes below 8000 feet except for a few seconds to check its operation. The greater air resistance to the fan blades at altitudes below 8000 feet will cause the motor to burn out.

INDICATORS.

Cabin Altimeters.

Two altimeters located on the engineers' auxiliary control and instrument panel, one for the forward cabin (23, figure 1-19) and for the aft cabin (24, figure 1-19), indicate the pressure altitude for each cabin. An additional cabin altimeter is located at the tail gunner's station for the convenience of the aft cabin personnel.

Note

The engineers' aft cabin altimeter static port is located in the forward end of the communication tube. Any condition causing loss of pressurization in the communication tube will cause the aft cabin altimeter to read incorrectly.

EMERGENCY CONTROLS.

Manual Shutoff Valves.

In the event of failure of the electrical pressurization shutoff valves, which are controlled by the cabin pressure shutoff valve switches, manual shutoff valves are provided in each cabin. The extreme positions of the valve handles are OPEN and CLOSED. The forward shutoff valve (3, figure 4-3) is located in the pressure duct inlet just forward of the aft bulkhead in the forward cabin. The valve (4, figure 4-4) in the aft cabin is located in the pressure duct inlet near the forward bulkhead.

Forward Cabin Dump Valve.

The forward cabin dump valve (2, figure 4-3) located under the flight deck step, has a foot-operated dump pedal provided on the valve body. This valve can be used to decrease the pressure in all cabins simultaneously, provided the communication tube doors are open. Release of the pressurized air is obtained by depressing the quick-release pedal on the valve body. The dump valve hand knob (1, figure 4-3) located on the floor near the engineers' station can be used to control the pressure in the forward cabin manually.

Fwd Cabin MANUAL PRESSURE CONTROLS

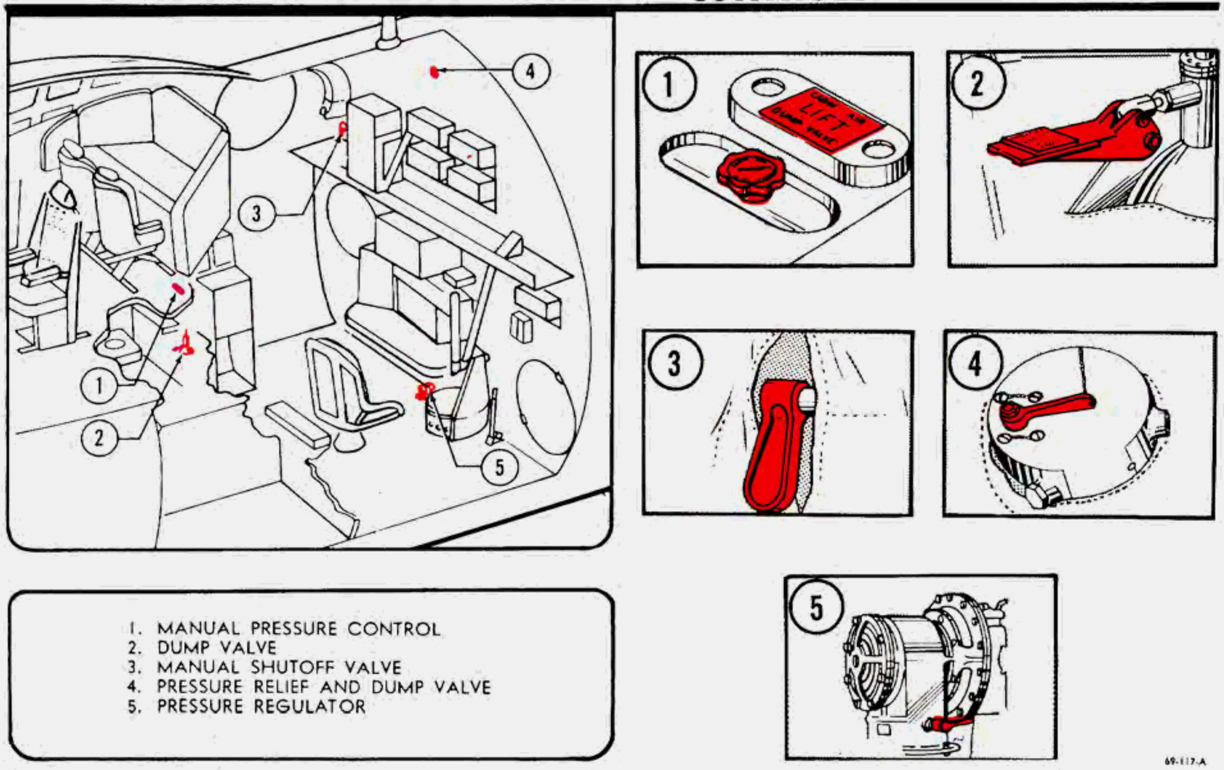

Figure 4-3.

Note

To reset the valve after using the pedal for depressurizing, the knob must be rotated counterclockwise several times and pulled up until the release pedal locks in its untripped position. Then the knob must be turned clockwise until the valve is closed.

Pressure Relief and Dump Valves.

To supplement the forward cabin dump valve in cabin depressurization, the forward and aft cabins are equipped with pressure relief and dump valves (4, figure 4-3 and 2, 4-4). The normal function of these valves is to automatically relieve excess cabin pressure; however, each valve is equipped with a handle for emergency depressurization. By cutting the safety wire and moving the handle from NORMAL to DUMP, the valve is opened to release cabin pressure.

Vacuum Relief Valves.

A vacuum relief valve is provided in each crew compartment; however, only the valve (3, figure 4-4) in the aft cabin is used for emergency depressurization since the forward cabin valve has no strap attached. The strap on the aft cabin valve is pulled for emergency depressurization.

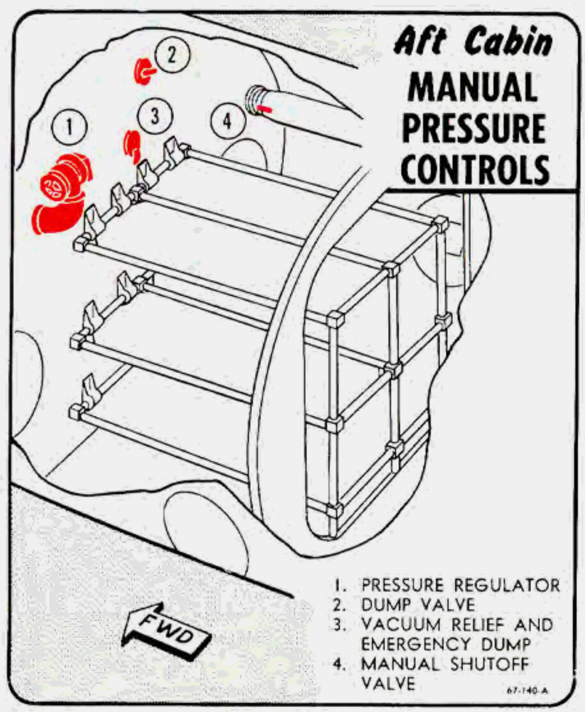

Figure 4-4.

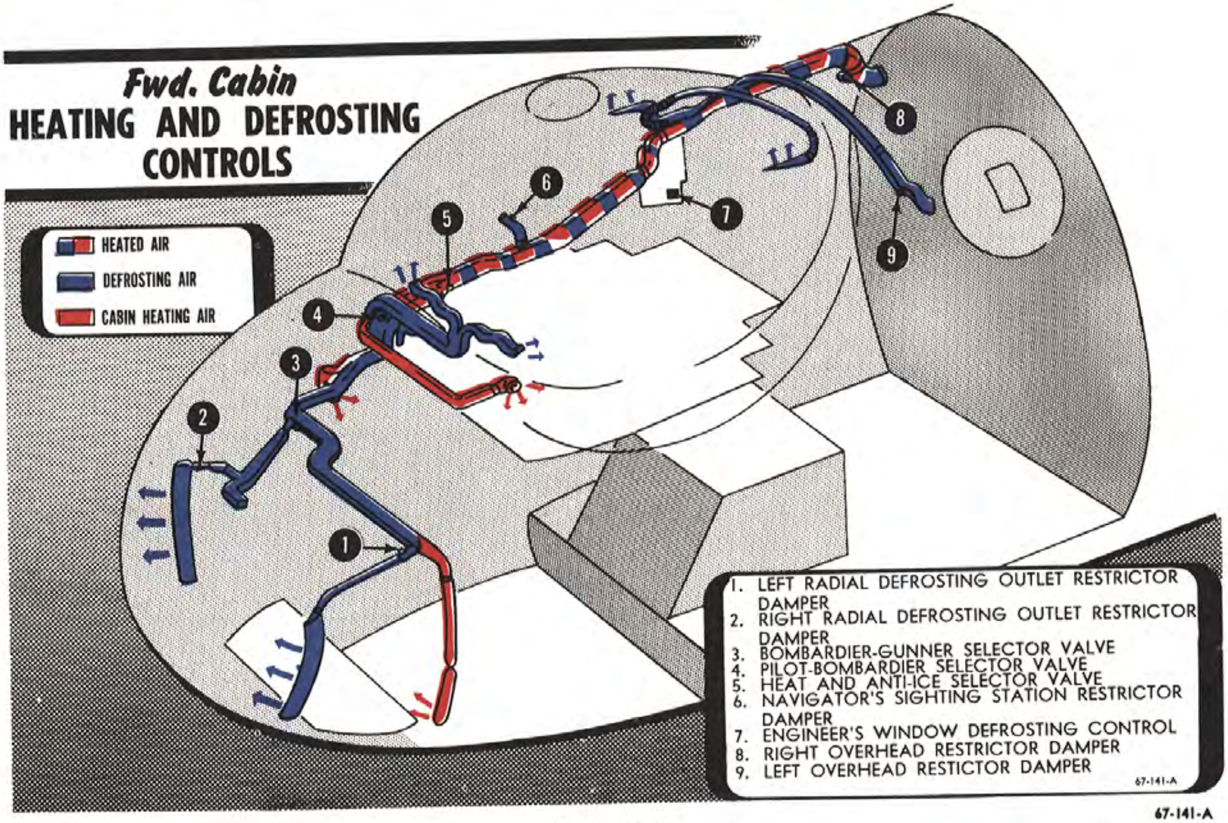

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Figure 4-5.

Pressure Regulator Control.

In the event of a pressure regulator failure which would allow the escape of pressurized air, a manual shutoff valve on the side of the regulator (5, figure 4-3 and 1, figure 4-4) can be used to close off its air exit provisions; the forward cabin dump valve hand knob can be used to modulate air pressure.

CABIN HEATING, DEFROSTING, AND ENCLOSURE ANTI-ICING.

After heated air is ducted into the cabins, it can be regulated by manual controls. These controls consist of selector valves, restrictor dampers, and various types of outlets. (See figures 4-5 and 4-6.) The defroster outlets, which are nonadjustable, provide heating as well as defrosting. Adjustable heating outlets provide heated air when defrosting is not required.

CONTROLS.

Heat and Anti-Ice Selector Valve.

This valve (5, figure 4-5) is located in the heating duct at the pilot's station. The control knob has positions marked CABIN HEAT and ANTI-ICE AND DEFROST. Intermediate settings can be obtained between these two positions.

Pilot-Bombardier Selector Valve.

This valve (4, figure 4-5) is located forward and to the right of the pilot's rudder pedals. The control knob, located adjacent to the pilot's right rudder pedal, has positions marked PILOT and BOMB'R. The PILOT position is used to route the flow of heated air for the pilots' enclosure defrosting outlets. The BOMB'R position directs the heated air to the bombardier-gunner selector valve.

Bombardier-Gunner Selector Valve.

This valve (3, figure 4-5) is located over the radar observer's station in the observer's compartment. The control knob has positions marked BOMB, BOTH, and GUNR. The BOMB position is used to route heated air to the heating outlet and the defrosting duct on the left side of the enclosure. The GUNR position is used to route the air to the defrosting duct on the right side of the nose enclosure. The BOTH position allows heated air to flow to both locations simultaneously.

Restrictor Dampers.

Restrictor dampers (figure 4-5) are located in the ducts which lead to the following locations in the forward cabin: the engineers' clear vision side windows, the pilot's heating outlet, and the nose enclosure. The restrictor damper for the engineers' windows is remotely controlled from the engineers' auxiliary panel. In the aft cabin there is a restrictor damper (figure 4-6) for each heating and defroster outlet. These restrictor dampers are used to restrict or shut off the flow of heated air to a particular location.

Heating Outlets.

There are four heating outlets (figure 4-5) installed in the air ducts in the forward cabin. One each is located at the aircraft commander's station, the pilot's station, the nose compartment, and the navigator's station. In the aft cabin, heating outlets (4, figure 4-6) are located aft of each low scanning station, and on the right forward side of the cabin near the catwalk entrance. With the exception of the non-adjustable outlet at the navigator's station, each outlet has five manually controlled positions which provide five flow patterns.

Defrosting Nozzles.

Defrosting nozzles (figure 4-5) are located at the engineers' clear vision window and on each side of the nose enclosure. These units are not adjustable but provide heating as well as defrosting.

OPERATION OF CABIN HEATING, ANTI-ICING, AND PRESSURIZATION SYSTEM.

CREW RESPONSIBILITY.

Obtaining optimum cabin heating and defrosting requires the cooperative effort of every crew member. When heating and defrosting are required, the crew members are responsible for the duties listed in the following paragraphs.

Aircraft Commander and Pilot.

Before flight the aircraft commander will assure himself that a periodic check of the cabin pressure duct system has been made with the cabin pressure test machine. From the results of the test he will determine what the capabilities of his system will be. The pilot will control the pilot-bombardier valve.

Engineers.

The engineers are responsible for the control of their valves and will maintain optimum duct temperatures and air flow. To achieve this they will receive reports from other crew members as to the results of their configuration. If a crew member becomes uncomfortable because of the temperature, it is the engineers' responsibility to correct the condition as nearly as possible.

Radar Observer.

The radar observer will control the bombardier-gunner valve, heating outlet, and the restrictor dampers in the observer's compartment.

Observer.

The observer will operate the auxiliary cabin heater in the observer's compartment.

Radio Operator.

The radio operator will adjust the overhead restrictor dampers and will also operate the auxiliary cabin heater in his compartment.

Aft Cabin.

The compartment commander in the aft cabin will have the duty of obtaining optimum valve settings, through cooperation with other crew members, for defrosting and for the operation of the auxiliary cabin heaters. He will also keep the engineers informed as to the cabin temperature and the condition of the camera and photocell windows.

Note

If defrosting becomes critical, completely shut off the heating outlets, allowing all air to flow to the defroster outlets.

NORMAL OPERATION.

Cabin Heating and Defrosting.

To obtain heat for the forward and aft cabins use the following procedure:

1. Place the aft cabin pressure switch in the INC position.
2. Check to determine that the forward and aft cabin manual shutoff valves are OPEN.
3. Place the left and right cabin pressure wing shutoff valve switches in the INC position.

CAUTION

If the carburetor preheat is being used, the wing shutoff valves cannot be opened. In this condition the cabin booster fan should be turned on to supply some heat. However, heat will be reduced as altitude is increased.

4. Hold the cabin air supply temperature control switch in the DEC position until the lamp lights.
5. Place the cabin heat and tail anti-ice control switches in the INC position.

Note

These dump valves may be modulated if necessary to prevent the tail anti-icing air duct temperature from exceeding its maximum temperature of 180°C.

6. Jiggle the cabin air supply temperature control switch in the INC position until the temperature of the air is suitable for cabin heating.

CAUTION

Do not exceed 105°C as read on the engineers' duct air temperature indicator.

Note

As an alternate method for controlling the cabin air temperature, hold the cabin temperature control switch in the INC position until the lamp lights. Then jiggle the cabin heat and tail anti-ice switches in the DEC position until the desired cabin air temperature is obtained. During icing conditions the procedure as outlined in steps 4, 5, and 6 should be used to insure maximum air flow for anti-icing the tail.

7. In the forward cabin perform the following:

a. Restrict the flow of heated air to the engineers' clear vision panes to that required for defrosting.

b. Place the heat anti-ice selector valve in the ANTI-ICE AND DEFROST position. This diverts all of the air from the heating outlets to the pilots' and observers' enclosure for defrosting purposes.

c. Place the pilot-bombardier enclosure defrosting control located near the pilot's rudder pedals 3/4 from PILOT toward BOMB.

d. In the observers' compartment place the bombardier-gunner selector valve on BOTH.

e. Adjust the restrictor dampers for the observers enclosure to obtain optimum defrosting.

f. As a refinement to the above system, provided acceptable defrosting is obtained, the valve listed under step b above may be moved slightly off the ANTI-ICE AND DEFROST position toward CABIN HEAT. After this has been done, the restrictor valves in the ducts to the radio operator's compartment, the observers' compartment, and the aircraft commander's station should be adjusted, as well as the heating outlets to these stations and to the pilot's station.

8. In the aft cabin the restrictor and selector valves should be adjusted so that optimum camera and photocell defrosting and cabin heating are obtained. Generally this will require restricting or closing the heating outlets to obtain acceptable defrosting.

Aft Cabin HEATING AND DEFROSTING CONTROLS

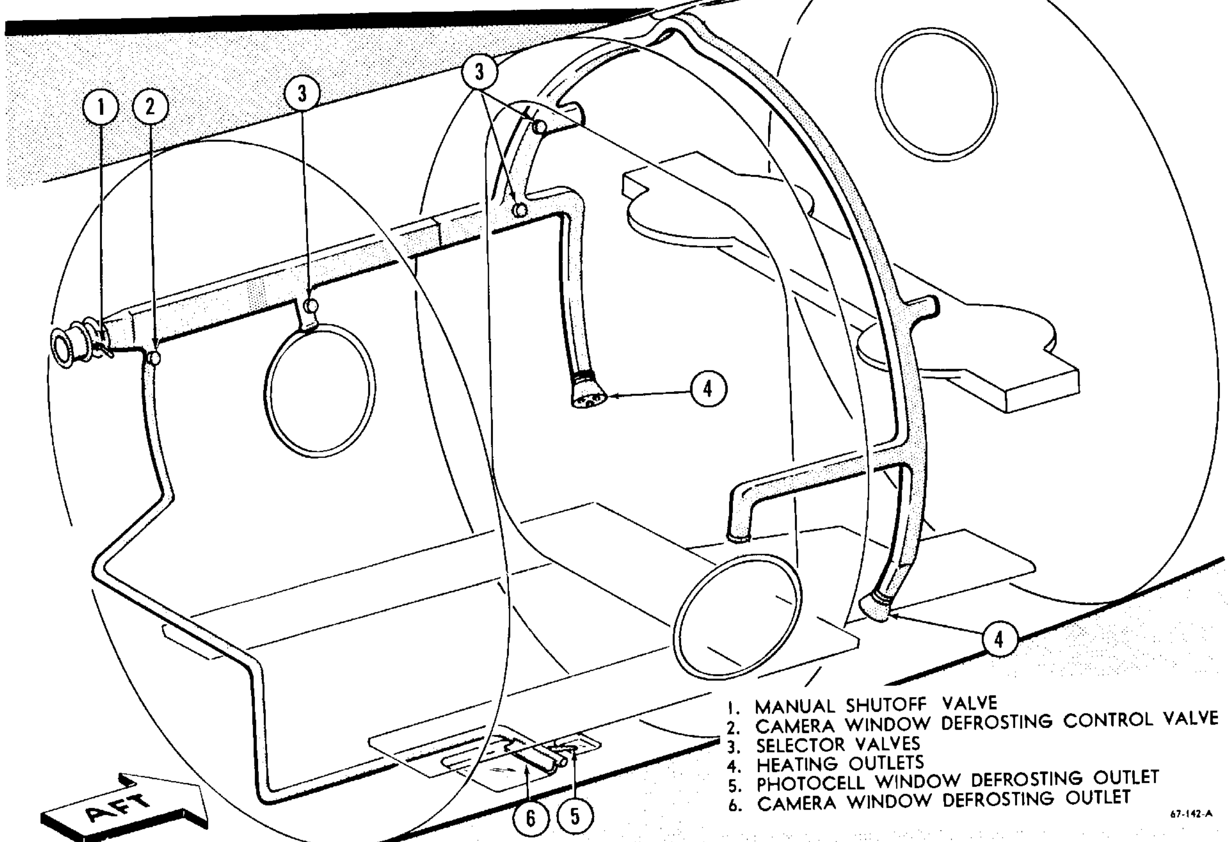

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Figure 4-6.

9. Turn the auxiliary cabin heater switches to LOW or HIGH as required.

CAUTION

Do not turn the heaters on if the pressure altitude of the cabin exceeds 12,000 feet, because the cooling air supplied by the heater fan would be insufficient to cool the fan motor, causing rotor seizure.

10. Turn on cabin booster fan.

Enclosure Anti-Icing.

For optimum enclosure anti-icing under severe icing conditions, it will be necessary to obtain maximum flow of heated air to the pilots' and observers' enclosures. Maximum flow is accomplished as follows:

1. Place the heat anti-ice selector control knob in the ANTI-ICE AND DEFROST position.
2. Place both cabin pressure wing shutoff valve switches in the INC position.
3. Restrict flow to the aft cabin to the amount required for pressurization.
4. Obtain high manifold pressure by placing the engine supercharger switches in DUAL TURBO. (See "Shifting Turbos," Section VII.) Also advance the turbo boost selector lever as near to position 10 as conditions permit.
5. Hold the cabin heat and tail anti-icing control switches in the INC position.

Note

If tail anti-icing temperatures are too high, jiggle the cabin heat and tail anti-ice control switches to obtain proper temperatures.

6. Hold the cabin temperature control switch in the INC position until the indicator lamp lights.

CAUTION

To forestall damage to the enclosure panes, the duct temperature must not be allowed to exceed 105°C.

7. Turn on the cabin booster fan.
8. Adjust the flow between the observers' and pilots' enclosures as required.

When frosting or icing of a certain enclosure becomes critical, such as the pilots' enclosure during landing, it may be necessary to direct the entire flow of heated air to that area by adjusting the selector provided in the heating ducts for these stations. When the entire supply of heating air is being used for defrosting purposes, the auxiliary cabin heaters can be used for cabin heating if required.

Under certain atmospheric conditions, moisture will form between the inner and outer panes of the enclosures. This condition can be alleviated by obtaining a maximum flow of heating air to the enclosure as described in the preceding paragraphs. The pilots' fans can be used to obtain a more uniform and lower temperature on the flight deck, since they tend to replace the hot air with cooler air from the lower portion of the cabin.

Cabin Pressurization.

The pressurization system is put in operation by placing the cabin pressure shutoff valve switches in the INC position. The aft pressure switch must be in the INC position for aft cabin pressurization.

EMERGENCY OPERATION.

Anti-Icing System Overheating.

When any of the warning lamps indicate an excessive temperature, check this temperature immediately and govern any subsequent action on the basis of temperature indicator rather than the warning lamps. If an excessive temperature is indicated, proceed as follows:

1. Engineer—Proper wing or cabin heat and tail anti-ice switch—Momentarily DEC, routing some of the heated air overboard, until the temperature is within limits.
2. Engineer—Reduce power of the engine in the nacelle indicated. Opening the air plugs will also aid in diminishing heat.
3. Pilot—If climbing, increase the air speed without increasing power.

WARNING

If none of the above efforts reduces the excessive temperature satisfactorily, position the proper wing or cabin heat and tail anti-ice switch to DEC for full dump. Observe the warning lamp; if it still burns, a temperature in excess of 425°C between one of the heat exchangers and the dump valve in the affected nacelle is indicated. The only known cause of this condition is a ruptured heat exchanger which permits exhaust gases to enter the anti-icing duct. If this condition exists, alert the gunners because a fire may be imminent and engine shut down necessary.

Cabin Pressure Control.

If a pressure regulator fails, shut off the unit and let the other regulator control the pressure air exit for both compartments. If a single regulator proves insufficient, the engineers must assist the single regulator by manual operation of the pressure dump valve (manual pressure control). In case of aft cabin shutoff valve failure, shut off the pressure by closing the manual shutoff valve in the compartment.

EMERGENCY DEPRESSURIZATION.

If it becomes necessary to depressurize the cabins so that escape hatches can be opened in an emergency, all crew members must be on 100 per cent oxygen and the airplane must be depressurized as soon as possible. The engineers must cut off cabin air flow, and the compartment commander of each cabin must see that all dump valves are opened. In the aft cabin the strap on the vacuum relief valve should be pulled and held open to speed depressurization. If the dump valves do not do the job, use the hand axes and cut through the fuselage along the stringers. The stringers will act as barriers to any objects being sucked out of the airplane.

WARNING

Do not attempt to break the scanning windows to depressurize the cabins.

VENTILATION EQUIPMENT.

The cabin air can be circulated for ventilation by means of seven electrically operated fans. The main source of ventilation is provided by the cabin air booster fan, which can be used to pull outside air through the pressurizing ducts into the forward and aft cabins. (Refer to "Cabin Air Booster Fan" of this section.) Two circulating fans are located at the pilots' station to aid in ventilating the flight compartment. The fans of the four auxiliary cabin heaters can be used independently of the heating elements to provide additional air circulation in the cabins. (Refer to "Auxiliary Cabin Heaters" of this section.)

PILOTS' VENT FANS.

There are two fans on the flight deck to provide air circulation for the aircraft commander and pilot. The fans, mounted in the floor adjacent to the rudder pedals, pull cabin air from the observers' compartment, through ducts, to a vane-type vent on each side of the pilots' instrument panel. The flow of air can be controlled by manually positioning the vanes in the vent. The fans also provide an air flow to the windshield for defrosting purposes.

Pilots' Vent Fan Switches.

These two-position switches (23, figure 1-8) are located on the pilots' instrument panel. When these switches are placed ON, a 115-volt a-c circuit is completed to the respective fan motor.

OBTAINING CABIN VENTILATION ON GROUND.

For ventilation during ground operations, accomplish the following:

1. Open the communication tube doors.
2. Turn the cabin heat and tail anti-icing control switches to DEC.
3. Place the cabin air booster fan switch in the low speed position and control the air flow with the selector valves and restrictor dampers.
4. Utilize the pilots' vent fans and the auxiliary cabin heater fans for ventilating local areas.

OBTAINING CABIN VENTILATION IN FLIGHT.

For ventilation during flight, perform the following steps:

1. Turn the cabin pressure shutoff valve switches to DEC.
2. Turn the cabin heat and tail anti-icing switches to DEC.
3. Turn the aft cabin pressure switch to INC.
4. Place the cabin air booster fan switch in the low speed position and control the air flow with the selector valves and restrictor dampers.
5. Utilize the pilots' vent fans and the auxiliary cabin heater fans for ventilating local areas.
6. Open the communication tube doors.

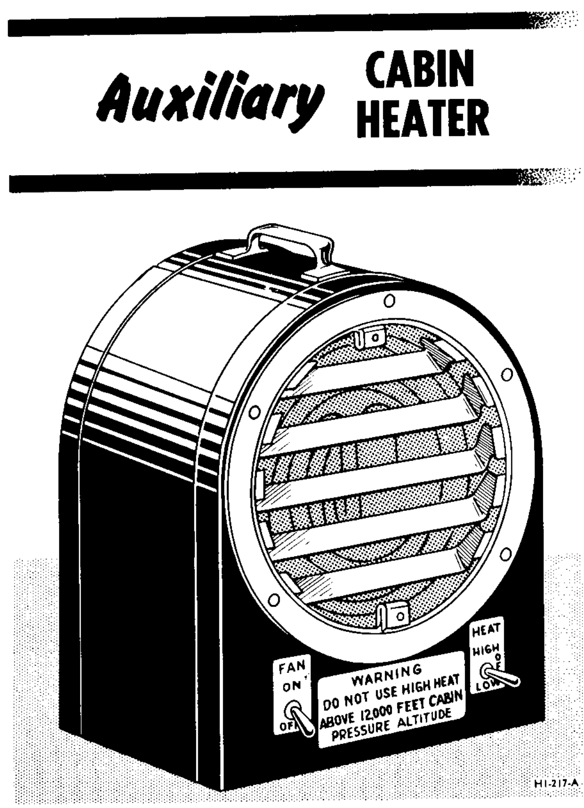

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Figure 4-7.

7. If a small quantity of heat is desired, perform the preceding steps, with one exception: place the cabin pressure shutoff valve switches in the INC position. In this manner the heat of compression can be utilized, eliminating use of the tail anti-icing system to obtain cabin heat.

AUXILIARY CABIN HEATERS.

In addition to the regular cabin heating system, four portable cabin heaters are stowed in the airplane. (See figure 4-7.) In the forward compartment, one heater is stowed on the floor of the walkway to the observers' compartment and one on the radio operators' floor below the catwalk entrance hatch. An alternate location for the heater is provided on the top surface of the step at the forward end of the nose wheel well. In the aft cabin, one is stowed beneath the bunks aft of the right scanning station and the other is adjacent to the food locker on the right side of the compartment. Each heater is comprised of a heating element and a motor-driven fan which operates on 208-volt, 3-phase alternating current. Each heater is equipped with an electric cord of sufficient length to allow the heater to be moved about the cabin.

CONTROLS.

Heater Control Switch.

Each heater is controlled by a three-position switch marked HIGH, LOW, and OFF. The HIGH and LOW positions are provided to control the output of the heating element. The heater power circuit is provided with power from the fan control circuit; therefore, the fan switch must be ON before the heater will operate.

Fan Control Switch.

When cabin heating is not required, the fan of each heater may be operated independently to provide additional air circulation. Independent operation is made possible by a fan control switch located on each unit. This on-off switch controls the fan motor and applies power to the heater control switch.

Cabin Heater Power Switch.

This two-position switch (5, figure 1-19) located on the engineers' auxiliary control and instrument panel is used to shut off all auxiliary cabin heaters. During engine starting or when a partial loss of alternator power occurs, this switch should be placed in the OFF position. With either of these conditions existent there is a possibility of overloading the a-c system because of the high power requirements of the heaters.

Note

When external power is on the airplane, the heater power circuit is automatically de-energized, regardless of the position of heater power switch.

CAUTION

Crew members must be sure that the heaters are free of obstruction at all times in order to avoid inadvertent operation of the heaters.

JET POD HEATING AND ANTI-ICING SYSTEM.

The jet pod heating and anti-icing system employs three independent sources of heat and is designed to perform the following functions: to prevent icing of the nacelle and the strut leading edges, to prevent the formation of ice on the nose cones and nose shutoff doors, and to provide heat for the jet oil system prior to starting the engines during flight.

CAUTION

There are no provisions for internal anti-icing of the jet engine. Internal icing is indicated by an increase in tail pipe temperature which can be alleviated by reducing the rpm.

JET NACELLE AND STRUT ANTI-ICING.

For nacelle and strut anti-icing when the jet engines are operating, hot air is bled through a port at the 12th stage of each compressor and is controlled by a valve, which operates in conjunction with the nose cone and air plug anti-icing facilities. A portion of the heated air is ducted to the nacelle leading edge where it flows aft between the inner and outer skins and exits from the nacelle through louvers in the cowling forward of the fire wall. The remainder of the air is used for anti-icing of the strut leading edge and is ducted through the double skin passages of the leading edge to the top of the strut. The air then flows aft to the strut trailing edge where it exits through louvers.

NOSE CONE AND NOSE SHUTOFF DOOR ANTI-ICING.

The nose shutoff door and nose cone of each engine are provided with electrical heating elements to prevent the formation of ice on these sections. The system should be turned on in icing conditions, whether the engines are in operation or not.

PREHEATING.

Wing anti-icing air is used to provide heat for the jet engine oil system prior to starting the engines during flight. The flow of this air is controlled by a valve located in the duct which conveys the air from the wing leading edge to each jet pod. A portion of this air is used for heating the oil cooler and oil lines in each nacelle. The remainder of the air is ducted into the strut to heat the lines which lead from the oil tank to the engines.

Note

The wing anti-icing system must be in operation before jet pod preheating can be accomplished.

CONTROLS.

Nose De-Ice Control Switch.

This on-off switch-type circuit breaker (7, figure 1-15), located on the jet control panel, controls the nose cone and nose shutoff door heating elements and the internal anti-icing valve for nacelle and strut anit-icing. When this switch is placed ON, 28-volt direct current energizes a relay which connects 200-volt a-c power to electrical heating elements of the nose cone and air plug doors. Also, 28-volt direct current opens a valve which permits heated air from the engine compressor to be routed into the pod nacelle and strut for anti-icing.

Pod Preheat Control Switch.

This on-off switch (6, figure 1-15) operates a valve in the duct leading from each wing leading edge to the jet nacelles and their struts. When the switch is placed ON, 115-volt alternating current is routed to the pod preheat valve actuators which opens the valves. Wing anti-icing air is then routed to the nacelles and struts for pod preheating, provided the wing anti-icing system is in operation.

WARNING

In the event of a jet engine fire, this switch must be placed in the OFF position to prevent fire from passing through the duct to the interior of strut and wing.

Note

When the wing anti-icing system is being used during severe icing conditions, the pod preheat control switch must be in the OFF position to obtain maximum heat for wing anti-icing.

PITOT TUBE HEATERS.

Pitot tube heat is controlled by two on-off switches (9, figure 1-19) located on the engineers' auxiliary control and instrument panel. When the switches are in the ON position 115-volt a-c power is routed to the heaters.

OIL HEATERS.

OIL TANK VENT LINE HEATERS.

Each reciprocating engine oil tank vent line is equipped with a heating element to prevent vapors from congealing, freezing, and consequently plugging the vent lines. The heaters are controlled by a single switch (8, figure 1-19) located on the engineers' auxiliary control and instrument panel. The switch positions are ON and OFF. When the switch is in the ON position, 28-volt direct current is routed to a relay which in turn energizes the heater element circuit with 115-volt alternating current. This switch should be placed in the ON position for ground and flight operations when the ambient air temperature is at 32°F (0°C) and below.

OIL TANK HOPPER HEATERS.

Electrical heating elements for each oil hopper and outlet line are provided for preheating the reciprocating engine oil prior to starting. The heating elements require a power output of 5250 watts and operate on 115-volt—either alternating or direct current. Because the portable power cart of the airplane does not have sufficient output, the power must be supplied by ground facilities. An oil tank heater receptacle (figure 1-45) for plugging in the external power source is located beneath each oil tank. Access to the receptacles is gained through panels on the lower surface of the wing. Time required for the oil to become properly heated is approximately one minute for each degree below 0°F. For further information see "Cold Weather Procedures" of Section IX.

JET ENGINE OIL HEATERS.

The jet engine oil tanks are equipped with 28-volt d-c controlled, 115-volt a-c actuated heating elements for maintaining the oil temperature above an operating minimum. A thermal switch located in each tank closes when the oil temperature drops to approximately 40°F (±5°) and reopens at approximately 2 degrees above its closing temperature. If the jet engine oil heater switch is turned ON, the oil is heated automatically when the thermal switch closes. For additional information regarding the heating of jet engine oil, refer to "Jet Pod Heating and Anti-Icing System," of this section.

Jet Engine Oil Heater Switch.

A two-position switch-type circuit breaker (5, figure 1-15), located on the pilots' overhead jet control panel, controls the action of both oil heaters. When it is in the ON position, 115-volt a-c power is supplied to each heating element.

HAND-OPERATED HEATER.

Provisions are made in the aft turret bay for the stowage of a type F-2 hand-operated heater for use in preheating the cylinder of the portable d-c power unit. (Refer to "Portable D-C Power Unit" of this section.) A duct used in connecting the heater to the cylinder is stowed adjacent to the heater. The heater has a two-hour gasoline supply tank, is ignited manually, and has an output of 20,000 BTU per hour at 60 rpm. A blower is incorporated in the heater for forcing the heated air through the duct to the power unit. The blower is manually rotated by a hand crank located on the side of the heater. At —29°C (—20°F) or below, the heater will not burn any fuel other than 100-octane aviation gasoline.

WARNING

Under no conditions should the hand-operated heater be used to heat shelters or occupied enclosures, because air delivered by this heater is NOT free from carbon monoxide.

CAUTION

The exhaust gases discharged from the type F-2 heater reach temperatures as high as 583°C (1000°F). Therefore it should not be used to heat any equipment which will be damaged at this temperature.

COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT.

The communication and associated electronic equipment consists of radio and interphone equipment to provide airplane-to-airplane communication, airplane-to-ground communication and intraplane communication between crew members; navigation sets for guidance and blind landing; and radar sets for identification, long range navigation, radar defense, radar bombing, and tail turret control. Equipment is provided on each wing and on the rudder and elevators to discharge static electricity. For antenna arrangement see figure 4-9. A functional breakdown of the installed equipment of the airplane is listed in figure 4-10.

COMBAT INTERPHONE SYSTEM (Airplanes not in Group 7).

The interphone system provides interphone communication between all crew stations. In addition, remote audio outlet connector receptacles and their attaching combined headset and microphone cords are located in the wing crawlways between the nacelles, in the tail section, and in the bomb bays. An outside receptacle is also provided under the fuselage between bomb bays No. 2 and No. 3. The cordage for this outside receptacle is normally stowed at the radio operator's station.

The basic interphone system is conventional. The system, however, has been modified to include a private interphone channel; a call circuit; and provisions for either the aircraft commander or pilot, or both, to mix command radio, radio compass, interphone, marker beacon, and localizer audio signals into one output. To start the interphone amplifier, turn on the airplane's main power supply. Make sure the on-off switch on the amplifier is in the ON position.

Note

Normally this switch is safety-wired in the ON position.

Private Interphone Channel.

The private interphone channel employs a private interphone amplifier and can be used in the event of normal interphone channel failure. In addition, interphone contact with the wing, fuselage, and external audio outlets must be made by using the private interphone channel.

When use of the private interphone channel is desired, the following steps must be performed:

1. Hold the selector switch on the interphone control panel in the spring-loaded CALL position and speak into the microphone, directing the crew members with whom communication is desired to place their selector switches in the PVT. INTER position.

Note

This also places all panels in direct communication with all audio outlet stations.

2. Release the selector switch, place it in the PVT. INTER position, and continue the conversation on the private interphone channel.

Emergency Interphone Operation.

When it is apparent that the normal interphone system has become inoperative, the crew member first noticing the deficiency will alert the other crew members to switch to PVT. INTER.

Note

The call circuit operates through the normal interphone amplifier only.

Wing Interphone Control Switch.

An on-off wing interphone control switch is provided at each wing crawlway entrance hatch. This switch is used to isolate the wing interphone channel from the basic interphone channel so that, in the event a nacelle fire short-circuits the wing interphone channel, the basic interphone channel will remain operative. Each switch is mechanically ganged to a wing crawlway light switch.

CAUTION

When the wing interphone channel is not in use, the wing interphone control switch must

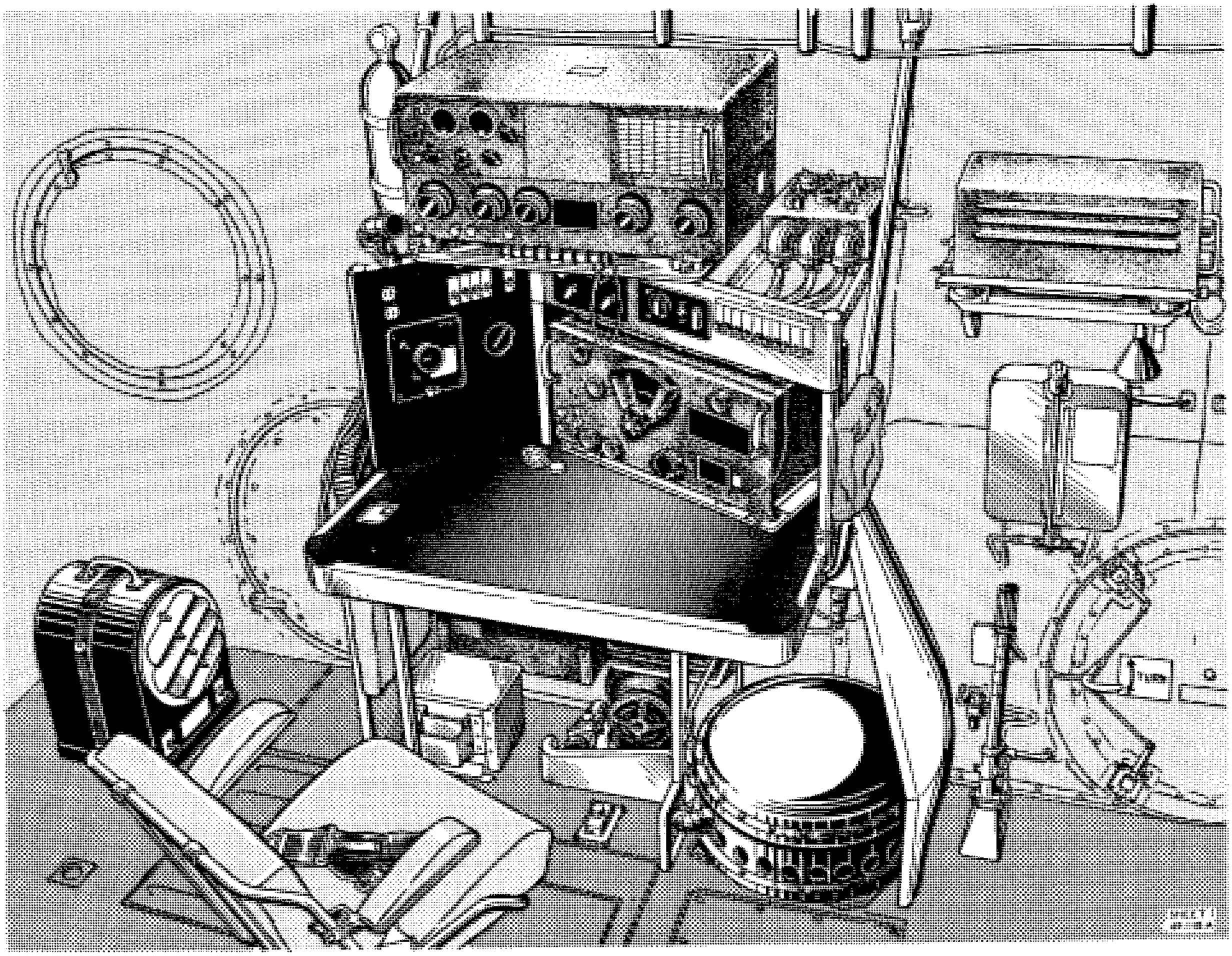

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Figure 4-8. (Sheet 1)

always be in the OFF position to prevent failure of the private interphone channel in the event of a short circuit in the wing interphone wiring.

An indicator lamp (1, figure 1-20) located on the engineers' auxiliary panel, lights when one or both of the wing interphone control switches are ON.

Call Circuit.

A call circuit is provided to enable a crew member at any crew station to interrupt the reception of the other stations provided the normal interphone channel is operative. When the call circuit is selected by holding a selector switch in the spring-loaded CALL position, all other interphone controls are switched from any facility being used to the output of the normal interphone amplifier.

Mixed Signals and Command.

This feature of the interphone system is provided for the aircraft commander and pilot only. (See figure 4-11.) It allows either or both of them to mix any combination of radio compass, interphone, marker beacon, and localizer audio signals with command radio signals, affording close co-ordination for take-off or landing operation. To use the mixed signals and command feature, proceed as follows:

1. Place the selector switch on the interphone control panel in the MIXED SIGNALS & COMMAND position. The command radio signals will be received in the headset, provided either set is in operation and its volume is properly adjusted.

2. Adjust the volume control on the interphone control panel for the desired output level.

3. To transmit on either command radio set, close the microphone switch and speak into the microphone.

Radio OPERATOR'S STATION

1. LIAISON TRANSMITTER
2. INTERPHONE CONTROL PANEL
3. AN/APX-6 CONTROL PANEL
4. AN/ARC-27 RADIO CONTROL PANEL
5. CIRCUIT BREAKERS
6. AN/APT-5 RECTIFIER POWER UNIT
7. BRAKE & LANDING GEAR EMERGENCY HYDRAULIC RESERVOIR
8. EMERGENCY HYDRAULIC HAND PUMP
9. RT-124/APS-23 RECEIVER-TRANSMITTER
10. LIAISON RECEIVER
11. PRESSURE REGULATOR
12. MICROPHONE SWITCH
13. TRANSFORMER-RECTIFIER UNIT
14. TRANSFORMER-RECTIFIER FILTER
15. AUXILIARY HEATER
16. OXYGEN CONTROL PANEL
17. CLOCK
18. LIAISON MONITOR SWITCH
19. COMMUNICATION TUBE LIGHT SWITCH
20. DOME LIGHT SWITCH
21. SUB FLIGHT DECK LIGHT SWITCH
22. TURRET BAY & BOMB BAY LIGHTS SWITCH
23. 115 VOLT A-C RECEPTACLE

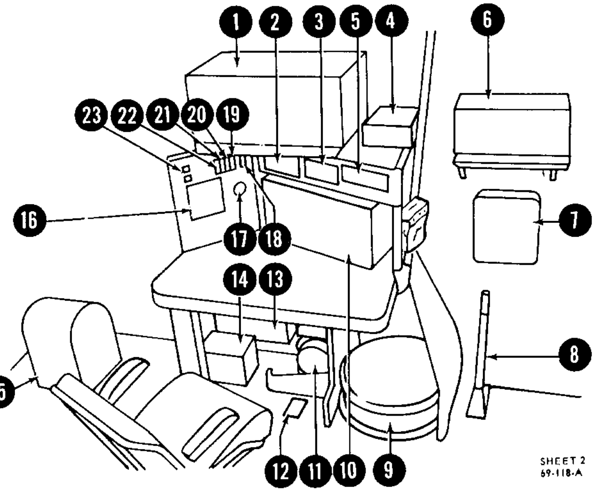

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Figure 4-8. (Sheet 2)

4. To receive signals from other sets in conjunction with command radio signals, place any combination of the toggle switches marked INTER, COMP, MARKER, LOCALIZER in the ON position. The INTER switch is for the interphone channel, and the COMP switch is for the radio compass channel. The MARKER switch is for the marker beacon channel and the LOCALIZER switch is for the localizer channel.

Note

These four channels are operative only when their switches are on and the interphone selector switch is set at MIXED SIGNALS & COMMAND.

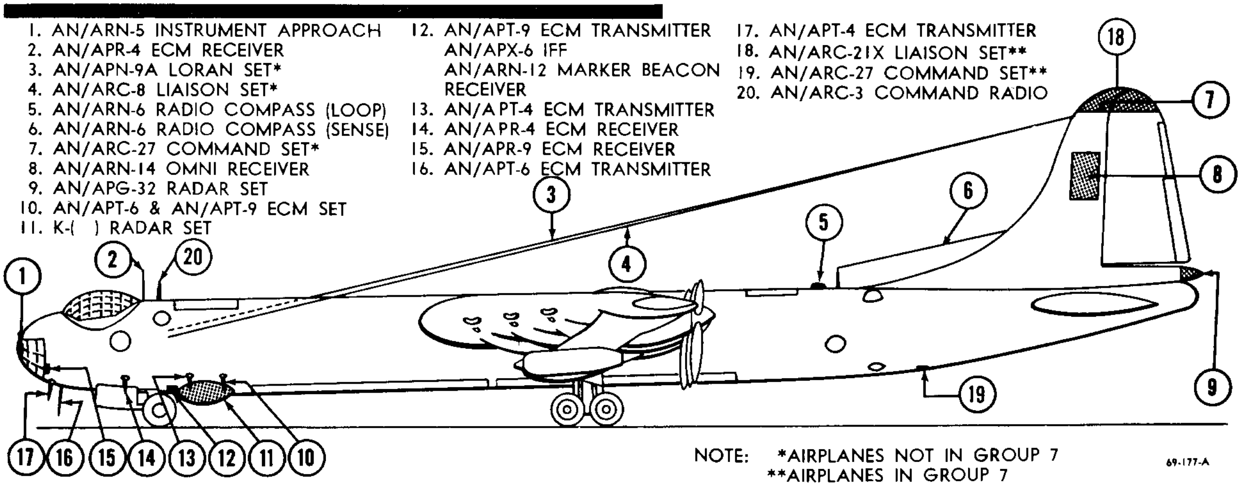
Mixed Signals and Liaison.

This facility is provided for the radio operator only and is utilized as follows:

1. Place the selector switch on the interphone control panel in the MIXED SIGNALS & LIAISON position. The liaison radio signals will be received in the headset, provided the set is in operation and its volume is properly adjusted.

• *Antenna* LOCATIONS

1. AN/ARN-5 INSTRUMENT APPROACH
2. AN/APR-4 ECM RECEIVER
3. AN/APN-9A LORAN SET*
4. AN/ARC-8 LIAISON SET*
5. AN/ARN-6 RADIO COMPASS (LOOP)
6. AN/ARN-6 RADIO COMPASS (SENSE)
7. AN/ARC-27 COMMAND SET*
8. AN/ARN-14 OMNI RECEIVER
9. AN/APG-32 RADAR SET
10. AN/APT-6 & AN/APT-9 ECM SET
11. K-( ) RADAR SET
12. AN/APT-9 ECM TRANSMITTER
AN/APX-6 IFF
AN/ARN-12 MARKER BEACON RECEIVER
13. AN/APT-4 ECM TRANSMITTER
14. AN/APR-4 ECM RECEIVER
15. AN/APR-9 ECM RECEIVER
16. AN/APT-6 ECM TRANSMITTER
17. AN/APT-4 ECM TRANSMITTER
18. AN/ARC-21X LIAISON SET**
19. AN/ARC-27 COMMAND SET**
20. AN/ARC-3 COMMAND RADIO



NOTE: *AIRPLANES NOT IN GROUP 7
**AIRPLANES IN GROUP 7

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69-177-A

Figure 4-9.

COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT

	TYPE	DESIGNATION	USE	PRIMARY OPERATOR	RANGE	LOCATION
COMMUNICATION EQUIPMENT	INTERPHONE	USAF COMBAT OR AN/AIC-10	CREW COMMUNICATION	CREW		ALL CREW STATIONS
	COMMAND RADIO (VHF)	AN/ARC-3	PLANE TO PLANE OR PLANE TO GROUND COMMUNICATION	AIRCRAFT COMMANDER & PILOT	30 MILES AT 1000 FEET	PILOTS' PEDESTAL
	COMMAND RADIO (UHF)	AN/ARC-27	PLANE TO PLANE OR PLANE TO GROUND COMMUNICATION	AIRCRAFT COMMANDER & PILOT	30 MILES AT 1000 FEET	PILOTS' PEDESTAL
	LIAISON RADIO	AN/ARC-8 OR AN/ARC-21X	CODE OR VOICE TRANSMISSION & RECEPTION	RADIO OPERATOR	5000 MILES	RADIO OPERATOR'S STATION
	RADIO SET WALKIE-TALKIE	AN/CRC-7	EMERGENCY TRANSMITTER AND RECEIVER	CREW	15 MILES AT 2000 FEET	
NAVIGATION EQUIPMENT	INSTRUMENT APPROACH (GLIDE PATH)	AN/ARN-5( ) OR AN/ARN-18	VISUAL INDICATION FOR VERTICAL GUIDANCE DURING INSTRUMENT APPROACH	AIRCRAFT COMMANDER & PILOT	LOCAL	PILOTS' PEDESTAL
	RADIO COMPASS	AN/ARN-6	RECEPTION OF CODE OR VOICE SIGNALS, DIRECTIONAL BEARING & HOMING	AIRCRAFT COMMANDER PILOT & NAVIGATOR	200 MILES	PILOTS' PEDESTAL AND NAVIGATOR'S STATION
	MARKER BEACON	AN/ARN-12	TO OBTAIN FIX ON NAVIGATION BEAM	AIRCRAFT COMMANDER & PILOT	LOCAL	
	OMNI-DIRECTIONAL NAVIGATION RECEIVER	AN/ARN-14	POSITION FINDING HOMING & INDICATION OF LATERAL ALIGNMENT FOR INSTRUMENT APPROACH	AIRCRAFT COMMANDER & PILOT	200 MILES AT 40,000 FEET	PILOTS' PEDESTAL
	LORAN SET	AN/APN-9	LONG RANGE NAVIGATION	NAVIGATOR	750 MILES	NAVIGATOR'S STATION
RADAR EQUIPMENT	IDENTIFICATION	AN/APX-6	IDENTIFICATION	RADIO OPERATOR		RADIO OPERATOR'S STATION
	RADAR SET	AN/APQ-31	HIGH ALTITUDE BOMBING AND NAVIGATION AID	RADAR OBSERVER	200 MILES	RADAR OBSERVER'S STATION
	AUTOMATIC GUN LAYING	AN/APG-32 OR AN/APG-41( )	TO CONTROL THE TAIL TURRET	TAIL GUNNER		TAIL GUNNER'S STATION

69-150-A

Figure 4-10. (Sheet 1)

dows, the pilot's heating outlet, and the nose enclosure. The restrictor damper for the engineers' windows is remotely controlled from the engineers' auxiliary panel. In the aft cabin there is a restrictor damper (figure 4-6) for each heating and defroster outlet. These restrictor dampers are used to restrict or shut off the flow of heated air to a particular location.

Heating Outlets.

There are four heating outlets (figure 4-5) installed in the air ducts in the forward cabin. One each is located at the aircraft commander's station, the pilot's station, the nose compartment, and the navigator's station. In the aft cabin, heating outlets (4, figure 4-6) are located aft of each low scanning station, and on the right forward side of the cabin near the catwalk entrance. With the exception of the non-adjustable outlet at the navigator's station, each outlet has five manually controlled positions which provide five flow patterns.

Defrosting Nozzles.

Defrosting nozzles (figure 4-5) are located at the engineers' clear vision window and on each side of the nose enclosure. These units are not adjustable but provide heating as well as defrosting.

OPERATION OF CABIN HEATING, ANTI-ICING, AND PRESSURIZATION SYSTEM.

CREW RESPONSIBILITY.

Obtaining optimum cabin heating and defrosting requires the cooperative effort of every crew member. When heating and defrosting are required, the crew members are responsible for the duties listed in the following paragraphs.

Aircraft Commander and Pilot.

Before flight the aircraft commander will assure himself that a periodic check of the cabin pressure duct system has been made with the cabin pressure test machine. From the results of the test he will determine what the capabilities of his system will be. The pilot will control the pilot-bombardier valve.

Engineers.

The engineers are responsible for the control of their valves and will maintain optimum duct temperatures and air flow. To achieve this they will receive reports from other crew members as to the results of their configuration. If a crew member becomes uncomfortable because of the temperature, it is the engineers' responsibility to correct the condition as nearly as possible.

Radar Observer.

The radar observer will control the bombardier-gunner valve, heating outlet, and the restrictor dampers in the observer's compartment.

Observer.

The observer will operate the auxiliary cabin heater in the observer's compartment.

Radio Operator.

The radio operator will adjust the overhead restrictor dampers and will also operate the auxiliary cabin heater in his compartment.

Aft Cabin.

The compartment commander in the aft cabin will have the duty of obtaining optimum valve settings, through cooperation with other crew members, for defrosting and for the operation of the auxiliary cabin heaters. He will also keep the engineers informed as to the cabin temperature and the condition of the camera and photocell windows.

Note

If defrosting becomes critical, completely shut off the heating outlets, allowing all air to flow to the defroster outlets.

NORMAL OPERATION.

Cabin Heating and Defrosting.

To obtain heat for the forward and aft cabins use the following procedure:

1. Place the aft cabin pressure switch in the INC position.
2. Check to determine that the forward and aft cabin manual shutoff valves are OPEN.
3. Place the left and right cabin pressure wing shutoff valve switches in the INC position.

CAUTION

If the carburetor preheat is being used, the wing shutoff valves cannot be opened. In this condition the cabin booster fan should be turned on to supply some heat. However, heat will be reduced as altitude is increased.

4. Hold the cabin air supply temperature control switch in the DEC position until the lamp lights.
5. Place the cabin heat and tail anti-ice control switches in the INC position.

Note

These dump valves may be modulated if necessary to prevent the tail anti-icing air duct temperature from exceeding its maximum temperature of 180°C.

6. Jiggle the cabin air supply temperature control switch in the INC position until the temperature of the air is suitable for cabin heating.

CAUTION

Do not exceed 105°C as read on the engineers' duct air temperature indicator.

Note

As an alternate method for controlling the cabin air temperature, hold the cabin temperature control switch in the INC position until the lamp lights. Then jiggle the cabin heat and tail anti-ice switches in the DEC position until the desired cabin air temperature is obtained. During icing conditions the procedure as outlined in steps 4, 5, and 6 should be used to insure maximum air flow for anti-icing the tail.

7. In the forward cabin perform the following:

a. Restrict the flow of heated air to the engineers' clear vision panes to that required for defrosting.

b. Place the heat anti-ice selector valve in the ANTI-ICE AND DEFROST position. This diverts all of the air from the heating outlets to the pilots' and observers' enclosure for defrosting purposes.

c. Place the pilot-bombardier enclosure defrosting control located near the pilot's rudder pedals 3/4 from PILOT toward BOMB.

d. In the observers' compartment place the bombardier-gunner selector valve on BOTH.

e. Adjust the restrictor dampers for the observers enclosure to obtain optimum defrosting.

f. As a refinement to the above system, provided acceptable defrosting is obtained, the valve listed under step b above may be moved slightly off the ANTI-ICE AND DEFROST position toward CABIN HEAT. After this has been done, the restrictor valves in the ducts to the radio operator's compartment, the observers' compartment, and the aircraft commander's station should be adjusted, as well as the heating outlets to these stations and to the pilot's station.

8. In the aft cabin the restrictor and selector valves should be adjusted so that optimum camera and photocell defrosting and cabin heating are obtained. Generally this will require restricting or closing the heating outlets to obtain acceptable defrosting.

Aft Cabin HEATING AND DEFROSTING CONTROLS

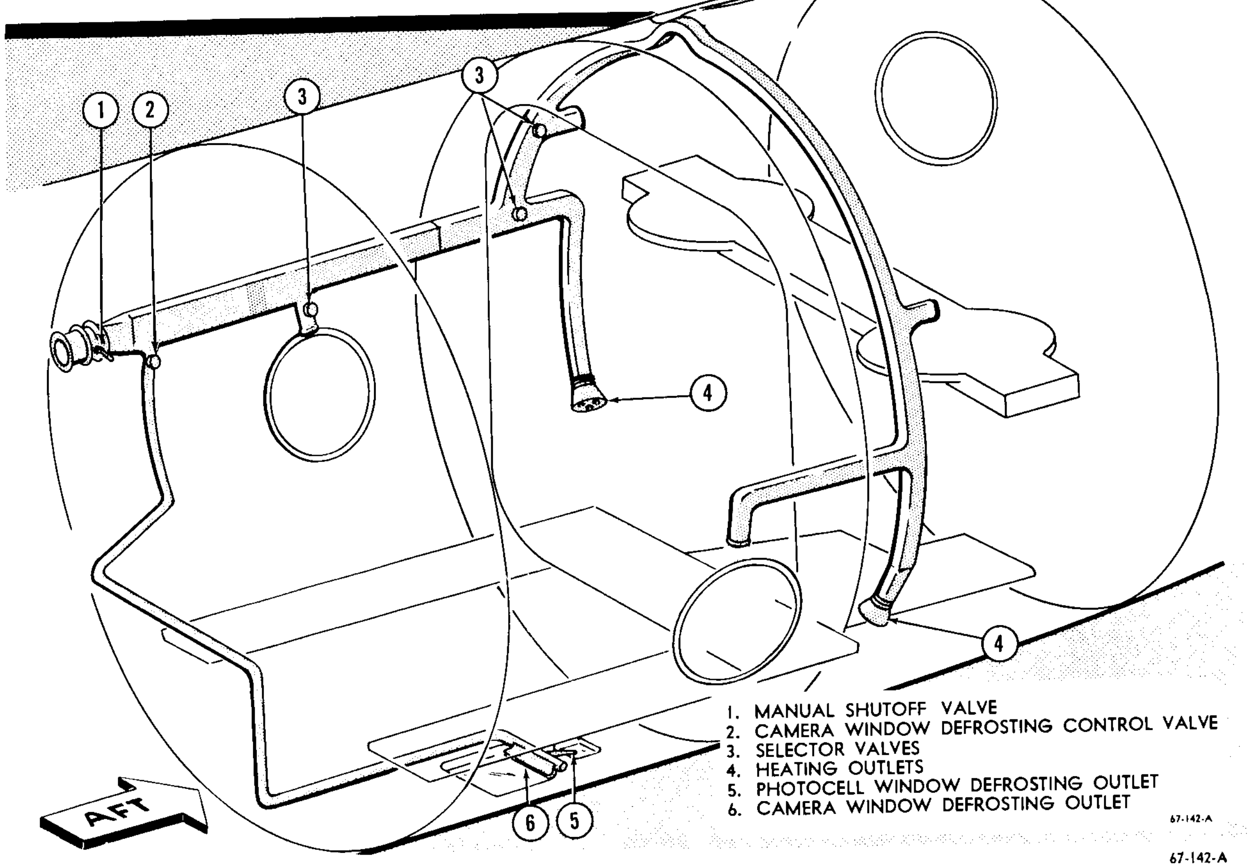

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Figure 4-6.

2. Release the CALL button and continue the conversation on the PRIVATE interphone channel.

CAUTION

If the volume control on an auxiliary control panel is turned counterclockwise, CALL signals will not be heard at that station.

Note

The bomb bay No. 1, wing crawlway, and external auxiliary control panels have the CALL button disconnected since operation from these boxes is accomplished by means of a long extension cord from areas too far from the control panel to afford the operator access to the CALL button.

Emergency Interphone Operation.

The interphone system employs an emergency power circuit that will furnish power to six key stations in the event of total a-c power failure. The circuit is automatically controlled by a sensing relay that connects the airplane's battery to an emergency dynamotor, provided the battery switch is on. The six key stations served by this circuit are the aircraft commander, pilot, first and second engineers, and the scanners.

Emergency Reception.

If any crew member's station amplifier becomes inoperative, as indicated by failure to receive any signal on the headset, turn the NORMAL/AUX LISTEN switch on the affected control panel to AUX LISTEN. On the affected panel, talk on the interphone line will be heard at line level only. On the pilot's and radio operator's control panels, turn ON the mixing switch for the single channel on which listening is desired and turn all other mixing switches OFF. If listening is desired on a channel available only on the channel selector switch, set the selector switch to the desired channel and *turn all mixing switches OFF.* Talk will be heard at line level only. On the crew member's panel turn the channel selector switch to the desired channel. Talk will be heard at line level.

Pilot's INTERPHONE PANEL

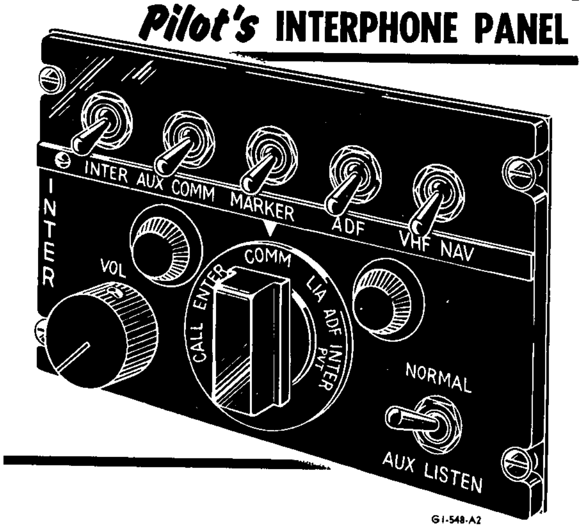

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Figure 4-13. (Group 7 Airplanes)

Crew Members' INTERPHONE CONTROL PANEL

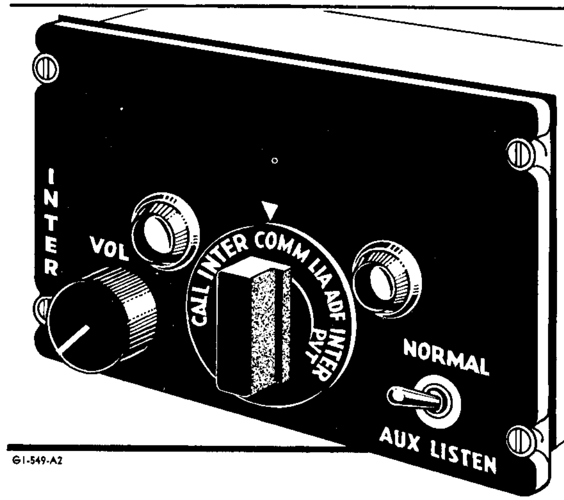

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Figure 4-14. (Group 7 Airplanes)

Wing Interphone Control Switch.

The wing interphone control switch and wing indicator warning light system is identical to the one used with the combat interphone system.

Mixed Signals.

This feature of the interphone system provides the aircraft commander and pilot mixing of INTER, AUX COMM, MARKER, ADF, and VHF NAV signals and provides the radio operator mixing of INTER, COMM, LIA, ECM—1 and ECM—2 signals. To use the mixed signals feature, proceed as follows:

1. Set the desired mixing switches ON.

2. Mixed signals are now available for listening *regardless of the setting of the channel selector switch,* except CALL position.

Note

When the AUX COMM switch is in the OFF position, it isolates the command set not in

Auxiliary INTERPHONE PANEL

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Figure 4-15. (Group 7 Airplanes)

use. When this switch is ON, signals from both command sets are received at the control panel simultaneously provided the channel selector switch is on COMM.

To utilize the filter assembly F-90/AIC in conjunction with the control panel at the pilots' position, proceed as follows:

1. Set the ADF mixing switch on the interphone control panel to ON.

2. Set the F-90/AIC filter switch located on the pilots' auxiliary control panels to ADF-1 RANGE or ADF-1 VOICE as desired.

COMMAND RADIO SETS.

The airplane is equipped with two command radios for plane-to-plane or plane-to-ground communication. The two sets are the AN/ARC-3 which operates in the VHF range and the AN/ARC-27 which operates in the UHF range. The receivers of both sets may be operated at the same time to permit reception on all channels. Transmission on a desired set is controlled by the pilots' command radio selector switch. If both sets are operating when a signal is received which does not disclose its type of command set or frequency range, the pilots must determine which set is receiving the signal before they can transmit on the correct command set. To determine which operating set is receiving an undisclosed signal:

1. Vary the volume on one set. If the audio level remains unchanged, the set with the original volume setting is receiving the signal and must be used for transmission.

2. If the receiving set can not be determined by varying the volume, transmit on first one set and then the other until contact is made.

Pilots' Command Radio Selector Switch.

This switch (2, figure 4-15), marked ARC-3 and ARC-27, permits the pilots to transmit on either the AN/ARC-3 or AN/ARC-27 command radios, depending on the switch position. The pilots may receive radio signals on either set, regardless of the selector switch position, providing their interphone selector switches are placed in the MIXED SIGNALS & COMMAND or the COMMAND (group 7 airplanes) position, the mixed signals AUX COMM switches are turned on (group 7 airplanes), and the sets are turned on.

Note

On airplanes in group 7, the pilots can isolate the receiver of the command set not in use by turning the AUX COMM mixing switch on their interphone panels to OFF. When the AUX COMM mixing switch is turned to ON, both command receiver signals will be received at the pilots' interphone panels, provided the channel selector switch on the interphone panel is set to COMM.

Note

Other crew members will hear the command set indicated by the command radio selector switch position when their interphone selector switches are placed in the COMMAND position.

Radio Operator's CONTROL PANEL

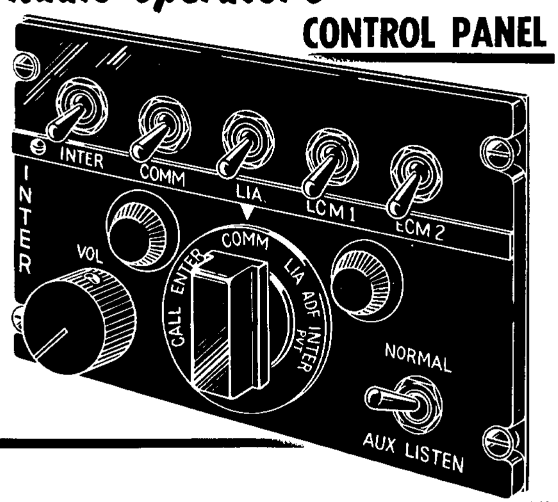

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Figure 4-16. (Group 7 Airplanes)

Command Radio Set AN/ARC-3.

For operation of this equipment from the control panel (figure 4-17) on the pilots' pedestal, proceed as follows:

1. Place the selector switch on the aircraft commander's or pilot's interphone control panel to the MIXED SIGNALS & COMMAND or COMMAND (group 7 airplanes) position.

2. Place the pilots' command radio selector switch in the ARC-3 position.

3. Place the on-off switch on the command set control panel in the ON position and turn the channel selector switch to any one of the positions designated A through H on the control panel. This action applies power to the unit, which then automatically tunes itself to the channel selected.

4. To stop the equipment place the on-off switch in the OFF position.

Command Radio Set AN/ARC-27.

The AN/ARC-27 command radio has provisions for operation on any one of eighteen preset frequencies and a guard frequency with provisions for monitoring of guard channel reception during operation on any of the eighteen preset channels. There is also a provision for tone or modulated continuous wave operation for emergency use or aid to direction finding equipment.

Operation of this equipment can be accomplished from either of two positions depending on the setting of the control panel (4, figure 4-8) at the radio operator's station.

For operation from the control (1, figure 4-19) on the pilots' pedestal, the radio operator's control panel is adjusted as follows:

1. Place the LOCAL-REMOTE switch in REMOTE position.

2. Place the TONE-VOICE switch in VOICE position.

With these adjustments operate from the control panel on the pilots' pedestal as follows:

1. Place the selector switch on either the aircraft commander's or pilot's interphone control panel in the MIXED SIGNALS & COMMAND or COMMAND (group 7 airplanes) position.

2. Place the command radio selector switches in the ARC-27 position.

3. Turn on the command radio set by placing the function switch (marked OFF, T/R, T/R+G REC, ADF) in the T/R position.

Note

Allow at least one minute warm-up time before transmission.

Radio Operator's ARC-27 CONTROL UNIT

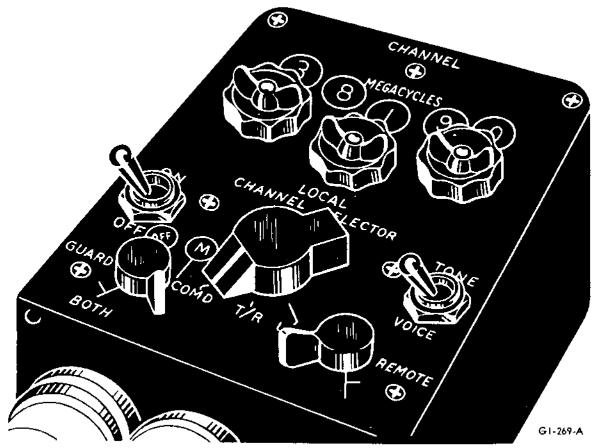

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Figure 4-18.

Pilots' AN/ARC-3 RADIO CONTROL PANEL

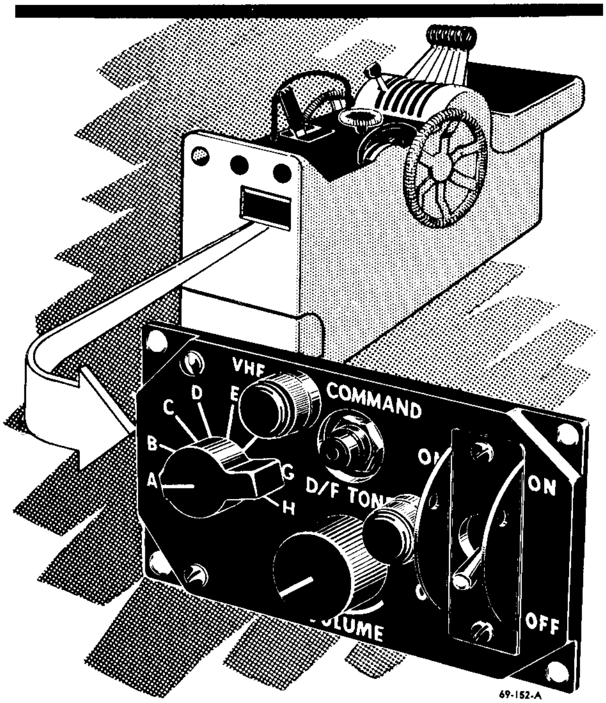

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Figure 4-17.

Note

The ADF position on the function switch is inoperative.

4. With the function switch in the T/R position, the equipment is ready for transmission and reception on any of eighteen preset frequencies and the guard frequency, depending on the setting of the channel selector switch. Operate the channel selector to the desired preset channel.

5. For reception on both the main and the guard channel frequencies, place the function switch in the T/R+G REC position.

6. For transmission on the guard channel frequency, place the function switch in either the T/R or the T/R+G REC position and the channel selector switch in the G position.

7. To turn the equipment off from the pilot's pedestal, place the function switch in the OFF position.

8. Tone or modulated continuous wave operation for an emergency signal or to aid direction finding equipment is accomplished from the radio operator's control panel. For modulated continuous wave operation from the radio operator's control panel, proceed as follows:

a. Place the TONE-VOICE switch in the TONE position.

b. Place the power switch in the ON position.

c. Place the LOCAL-REMOTE switch in the LOCAL position.

d. Place the radio operator's function switch (marked GUARD, BOTH, COMD T/R in the BOTH or COMD T/R position.

e. Adjust the local channel selector switch as needed.

f. To turn the equipment off from the radio operator's control panel, place the LOCAL-REMOTE switch in LOCAL and the power switch in the OFF position.

LIAISON RADIO.

Airplanes not in group 7 are equipped with liaison radio set AN/ARC-8.

Control of transmitting equipment is accomplished from the radio operator's table. (See figure 4-8.) The equipment is started by placing the LOCAL-REMOTE switch to the LOCAL position and setting the emission switch to VOICE. A remote control panel (5, figure 4-19) is located on the pilots' pedestal for use by the aircraft commander or pilot. Control of this panel is attained when the radio operator places the LOCAL-REMOTE switch to REMOTE. A green light on the pilots' remote control panel will indicate that the transmitter is ready for remote control. To stop the transmitter, place the emission switch in the OFF position.

On airplanes in group 7, liaison radio set AN/ARC-21X replaces the AN/ARC-8 equipment. Radio set AN/ARC-21X consists of a remote controlled receiver and transmitter designed to operate in the 2.0 to 24 megacycle band. Twenty frequencies are preset at the radio operator's control panel. To operate the equipment set the on-off control switch in the radio operator's panel to the ON position and allow the set about 40 seconds to warm up. Set the channel selector to the desired channel. To stop the equipment, set the on-off control switch on the control panel to OFF.

Provisions are made for the installation and use of a TT-301AGA-1 teletypewriter in conjunction with liaison set.

RADIO SET AN/CRC-7 (WALKIE-TALKIE).

This set is stowed on the left side of the radio operator's compartment adjacent to the stowage rack and is provided for emergency use. To start this unit, remove the lock pin from the three switch keys marked TONE, TRAN, and REC and press the desired key. To stop the set, release the keys.

INSTRUMENT APPROACH EQUIPMENT.

On airplanes not in group 5, the instrument approach equipment consists of the AN/ARN-5B and the AN/ARN-14 sets (3, figure 4-19). On airplanes in group 5, the instrument approach equipment consists of the AN/ARN-18 and the AN/ARN-14. About 20 minutes before approaching the runway, turn the selector switch on the AN/ARN-14 control panel to the desired channel and allow the receivers time to warm up. The receiver signals provide visual reference on the course indicator (5, figure 1-8) located on the pilots' instrument panel. For instrument approach operation, set the ARN-14 control panel switch to the TONE position (3, figure 4-19). To stop the equipment, place the switch on OFF.

RADIO COMPASS AN/ARN-6.

This equipment is used by the pilot and navigator; each has a control panel and an indicator. The pilots' control panel(4, figure 4-19) is located on the pilots' pedestal, and the navigator's control panel (14, figure 4-31) is located above the navigator's instrument panel. The radio compass indication is read on the number 1 pointer of the radio magnetic indicators for the AN/ARN-14 receiver. One radio magnetic indicator (3, figure 1-8) is located on the pilots' instrument panel and one (10, figure 4-31) is located on the navigator's instrument panel. To start the radio compass equipment, place the function switch in the COMP, ANT, or LOOP position. If set operation is not evidenced by the tuning meter, momentarily hold the function switch in the spring-loaded CONT position and reselect the desired position. To stop the equipment, turn the function switch to OFF.

Note

On some airplanes the N-1 high latitude compass or the AN/ARN-14 receiver must be operating before the AN/ARN-6 radio compass will give a visual indication.

Pilots' RADIO CONTROLS

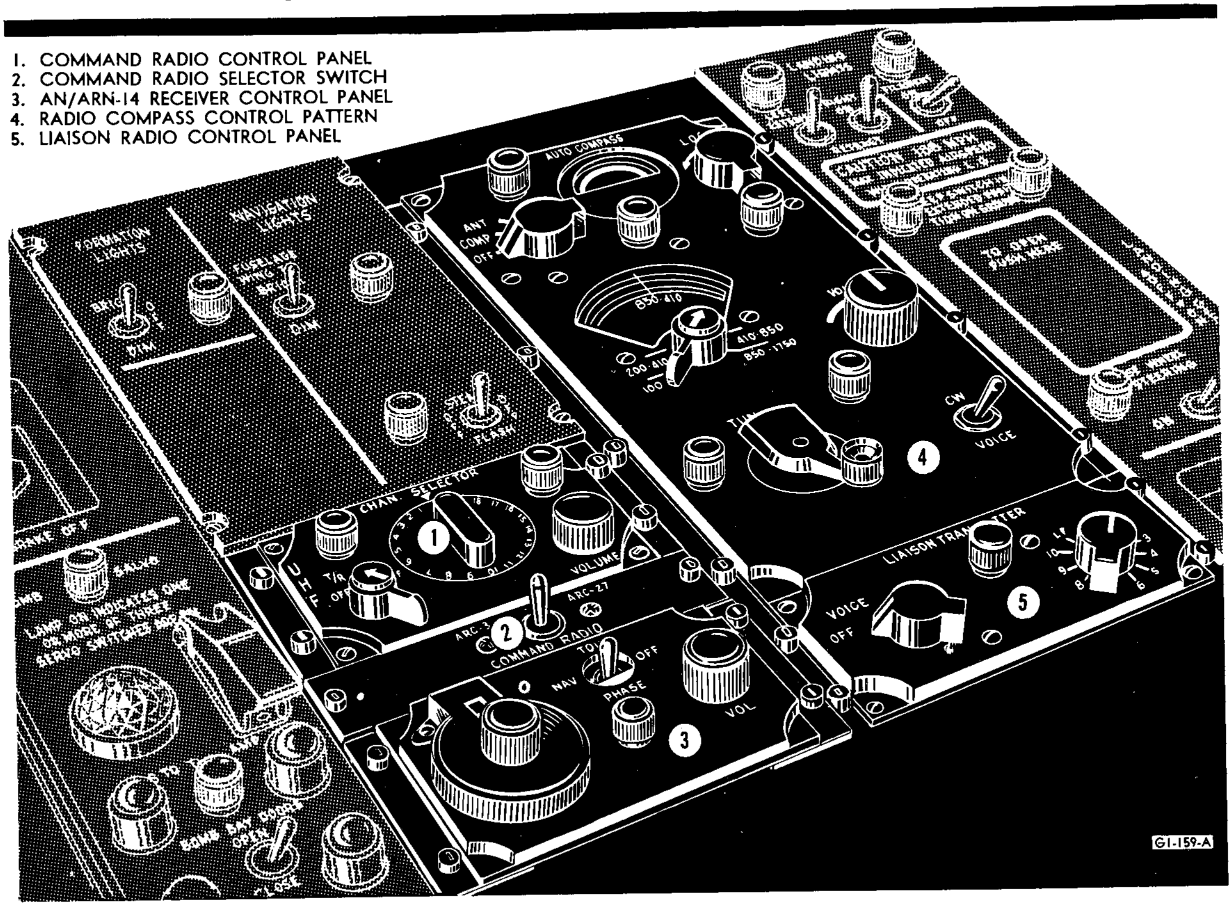

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Figure 4-19.

MARKER BEACON SET AN/ARN-12.

The operation of this equipment is automatic when the airplane's d-c power is on and its circuit breaker is closed. Marker beacon signals are indicated by a lamp on the corner of the course indicator (5, figure 1-8) on the pilots' instrument panel. To receive signals aurally, the interphone control panel marker mixing switch must be on MARKER and the selector switch must be on MIXED SIGNALS & COMMAND or COMMAND (group 7 airplanes).

RADIO RECEIVER AN/ARN-14.

This radio navigational aid consists of a receiver, a course indicator, two radio magnetic indicators, and a bearing converter indicator.

Note

The bearing converter indicator is located in the aft cabin and is for test and adjustment purposes only.

The course indicator (5, figure 1-8) and one magnetic indicator (3, figure 1-8) are located on the pilots' instrument panel. The other magnetic indicator (10, figure 4-31) is located on the navigator's instrument panel. The course indicator provides the facilities of an instrument approach indicator, a magnetic heading indicator, a course selector, and a marker beacon indicator. The radio magnetic indicators consist of a rotating compass card that indicates the magnetic heading as detected by the N-1 high latitude compass, a number 1 pointer actuated by the radio compass, and a number 2 pointer actuated by the AN/ARN-14 receiver. To turn on the AN/ARN-14 receiver place the switch on the AN/ARN-14 control panel in the TONE position.

To stop the operation, place the switch in the OFF position.

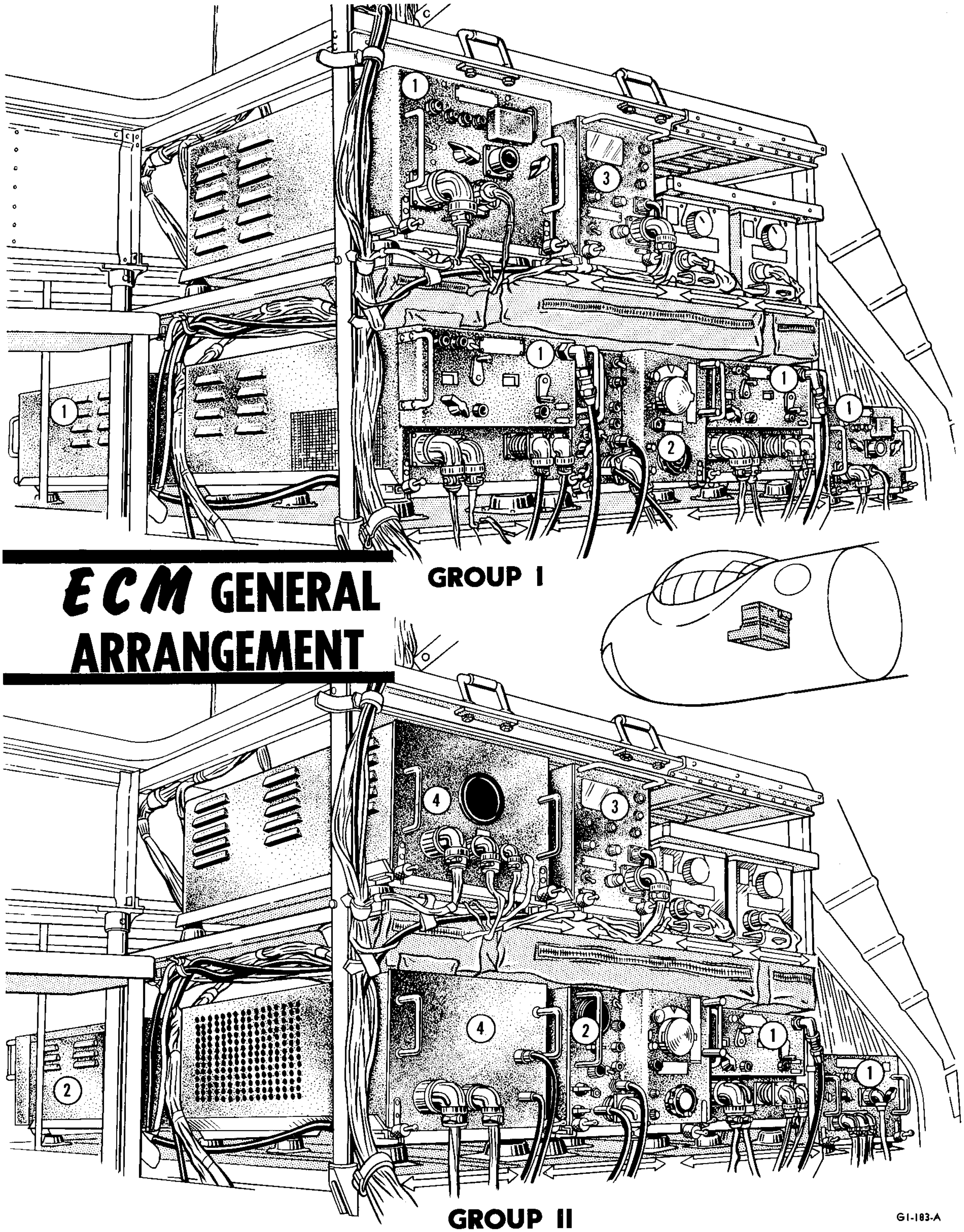

Figure 4-20. (Sheet 1)

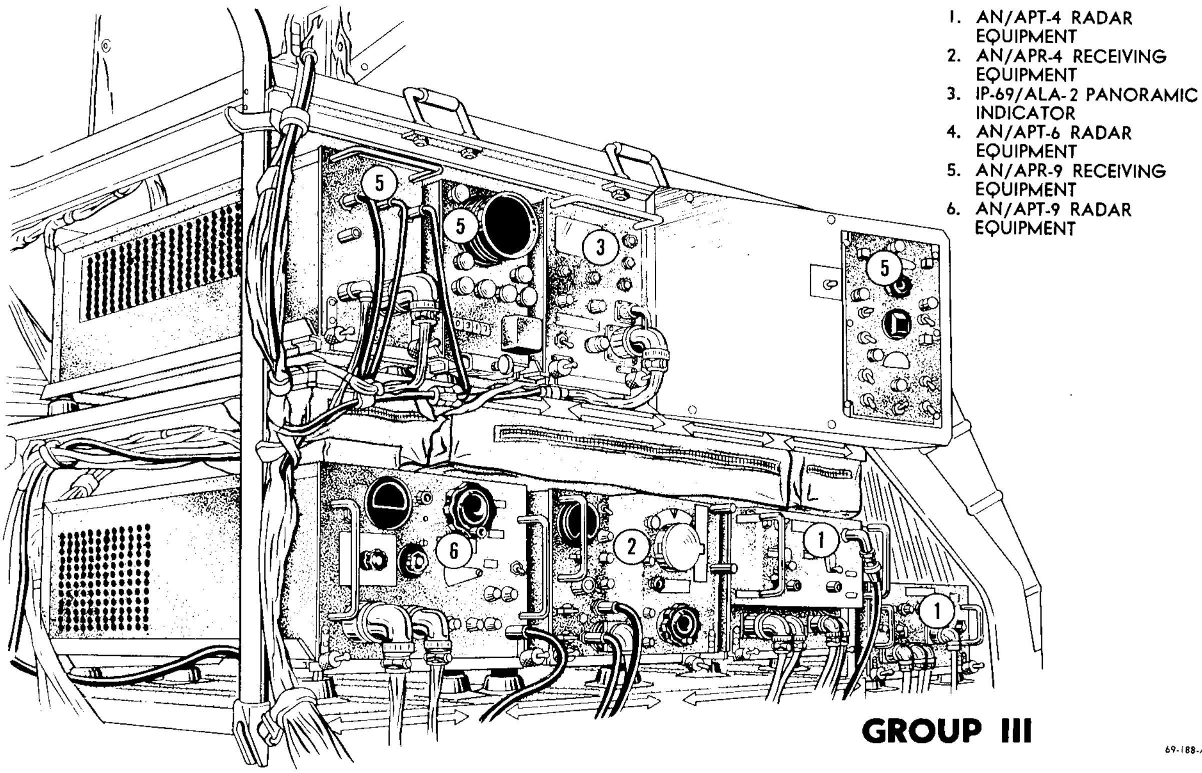

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Figure 4-20. (Sheet 2)

LORAN SET AN/APN-9.

The receiver-indicator (12, figure 4-31) of this set is installed on the navigator's table. A control panel incorporated on the front of the receiver-indicator in conjunction with a detachable visor provides all of the manual controls.

To start the set, proceed as follows:

1. Set the AMPLITUDE BALANCE control at its center position.

2. Turn the FINE DELAY control to its center position of rotation.

3. Set the DRIFT control at its center position of rotation.

4. Turn the RECEIVER GAIN control clockwise until the STATION rate identification (pilot light) illuminates. Wait at least five minutes to allow the equipment to warm up. The set is now ready for operation. (See figure 4-21 for calibration information.)

5. To stop the equipment, turn the RECEIVER GAIN control to POWER OFF and check to see that the pilot light is not illuminated. Also check to see that the pattern on the indicator screen has disappeared.

IDENTIFICATION SET AN/APX-6.

Provisions have been made for the installation of an AN/APX-6 identification set at the radio operator's station.

Operation.

To operate the identification set AN/APX-6, proceed as follows:

CAUTION

Before take-off, insert three destructors in the face of AN/APX-6 IFF transpondor located beneath the step under the left escape hatch. Remove all three destructors immediately after landing, and insert dummy plugs.

1. Master control in OFF position.

2. Set receiver frequency counter to correct frequency channel.

3. Turn low frequency counter to same channel.

4. Set transmitter frequency counter to transmitting channel.

AN/APN-9 LORAN CALIBRATION Chart

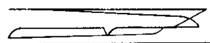
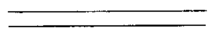
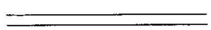
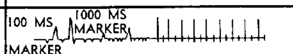
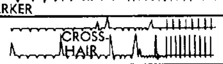
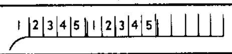
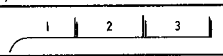
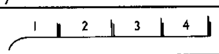
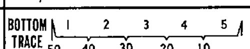
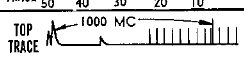
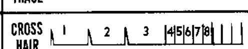
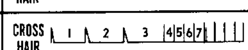
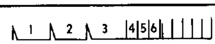
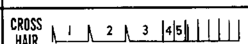
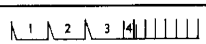
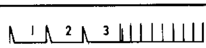
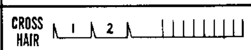
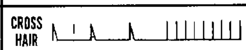
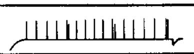
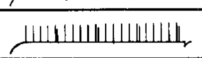
FUNCT	STN	PRR	SCOPE PATTERN	REMARKS	ADJ	CRSE	FINE
5	0	L OR H		ADJUST FOR DISTINCT PICTURE	FOCUS		
5	0	L OR H		ADJUST TO OPERATORS DESIRE	BRILL		
1	0	L OR H		ADJUST ALTERNATELY FOR LENGTH & POSITION	SL. SWP. H. CENT. & AMPL.		
2	0	L OR H		ADJUST ALTERNATELY FOR LENGTH & POSITION	FA. SWP. H. CENT. & AMPL.		
2	0	L OR H		ADJUST TO CENTER VERTICALLY	VERTICAL CENTER		
5	0	L OR H		ADJUST 1000 MS MKRS 1/8"-1/4" ABOVE 100 MS MKRS	MARKER AMPL.		
5	0	L OR H		ADJUST UNTIL CROSS HAIR BARELY TOUCHES 10 MS MARKERS ON UPPER TRACE	CROSS HAIR		
4	0	H		5 (1000 SPACES) BETWEEN (5000 MKRS)	C		
4	0	H		3 (5000 MS MARKERS)	0		
4	0	L		4 (5000 MS MARKERS)	E		
5	0	H		4 (10 MS MKRS) BETWEEN (50 MS MKRS)	A		
5	0	H		9 (100 MS MKRS) BETWEEN (1000 MS MKRS)	B		
5	0	H		COUNT 8 SPACES FROM CROSS HAIR ON LEFT TO FIRST STN RATE ON RIGHT (BTM TRACE)	B		
5	1	H		COUNT 7 SPACES FROM CROSS HAIR TO STN RATE MARKER	B		
5	2	H		COUNT 6	2		
5	3	H		COUNT 5	2		
5	4	H		COUNT 4	4		
5	5	H		COUNT 3	4		
5	6	H		COUNT 2	F 6		
5	7	H		COUNT 1	F 6		
5	4	H	MOVE L-R SWITCH TO RIGHT, STN RATE MARKER SHOULD JUMP TWO SPACES LEFT.		B R-L		
4	0	H		MARKER READS BETWEEN 11,000 & 11,500	5 HOLE RIGHT SIDE	C.C.W.	C.W.
4	0	H		MARKER JUST OFF SCREEN. RECHECK PREVIOUS STEP	2 HOLE RIGHT SIDE	C.W.	C.W.
4	0	L		MARKER READS BETWEEN 13,500 & 14,000	4 HOLE RIGHT SIDE	C.C.W.	C.W.
4	0	L		MARKER JUST OFF SCREEN. RECHECK PREVIOUS STEP	3 HOLE RIGHT SIDE	C.W.	C.C.W.
5	0	H	ROTATE FINE DELAY C.W. TO C.C.W. & COUNT HUNDREDS; READ NO LESS THAN 700 NOR MORE THAN 1500		1 HOLE RIGHT SIDE	SET ON 5000	C.W. & C.C.W.

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Figure 4-21.

5. Rotate master control to NORM position (full sensitivity and maximum performance) or to STDY or LOW as required.

6. Set the mode 2 switch to 1/P or required position.

7. Set the mode 3 switch to OUT or required position.

8. For emergency operation, press the dial stop, and rotate master control to EMERGENCY position.

9. An impact switch to fire the detonators and destroy the IFF system is incorporated in the system as a security measure. However, the detonators may be fired manually by a destructor switch on the IFF control panel. To fire the destructors manually, lift destructor guard by breaking safety wire and place toggle switch in the ON position.

CAUTION

The destructor switch should be operated only when AN/APX-6 equipment is in danger of falling into enemy hands.

10. To turn off equipment, rotate master switch to the OFF position.

RADAR SET AN/APQ-31.

For information on the AN/APQ-31 radar set refer to "K-( ) Bombing-Navigation System" of this section.

RADAR PRESSURIZATION.

A 115-volt a-c motor-driven pressure pump, located in the lower section of the forward cabin, provides pressurized air for the radio frequency unit, the radio frequency line (wave guide), and the modulating unit of the AN/APQ-31 radar set. The pressure pump draws cabin air through a dehydrator to remove all moisture and then pressurizes it before it is routed to the units. The system incorporates a pressure pump switch, a pressure gage, an indicator lamp, and a pressure drain valve located at the radar-bombardier's station. The system is controlled by the pressure pump switch which has three positions—AUTOMATIC ON, OFF, and MANUAL ON. When the switch is in the AUTOMATIC ON position, operation of the pump is controlled automatically by the action of a pressure switch. The indicator lamp lights when the pump is in operation. In the event the pressure begins to exceed its specified limits, as indicated on the pressure gage, and the indicator lamp indicates that the pump is still operating, the pump should be stopped by placing the switch in the OFF position. If the pressure begins to drop to a critically low point and the indicator lamp indicates that the pump is not in operation, hold the switch in the spring-loaded MANUAL ON position until the pressure is back to normal.

CAUTION

Do not operate the radar set until the radar t-r unit air pressure is above minimum limits.

LIGHTING SYSTEM.

The lighting system is composed of two groups of lights, exterior and interior. These lights operate on both 28-volt alternating and direct current, as well as 115-volt alternating current. The exterior group includes landing lights, taxi lights, formation lights, navigation lights, and code-signalling lights. Interior lighting is accomplished by means of dome, cockpit, and other miscellaneous lights. Receptacles for operating Aldis signal lights are located at the navigator's station, on the pilot's fairing, and at each sighting station.

EXTERIOR LIGHTS.

Landing Lights.

Two retractable landing lights are mounted flush with the fuselage, one on each side of the nose just above the lower flight deck floor. Each light has a switch for extension and retraction, and one additional switch is provided for illumination control of both lights.

Landing Lights Extend and Retract Switches. Two three-position switches (6, figure 1-9), located on the pilots' pedestal, are provided for extending and retracting the landing lights. These switches, one for each light, have positions marked EXTEND, OFF, and RETRACT, and function accordingly.

Landing Lights Filament Switch. One on-off switch (7, figure 1-9), located on the pilots' pedestal, controls the illumination of both landing lights. Placing this switch in the ON position connects 28-volt alternating current to the filaments of the landing lights.

CAUTION

When operating in extremely cold temperatures, or when icing conditions prevail, the illumination control switch should be turned on a few moments before extending the landing lights. This will preheat the light assembly and insure proper operation.

Taxi Lights (Some Airplanes).

Some airplanes are equipped with two taxi lights located on the jet pods. The lights, located one between the engine housing of each pod, are controlled by a single switch at the pilot's station.

Taxi Lights Switch. The taxi lights are controlled by an ON-OFF switch (32, figure 1-8) located on the bottom right corner of the pilot's instrument panel.

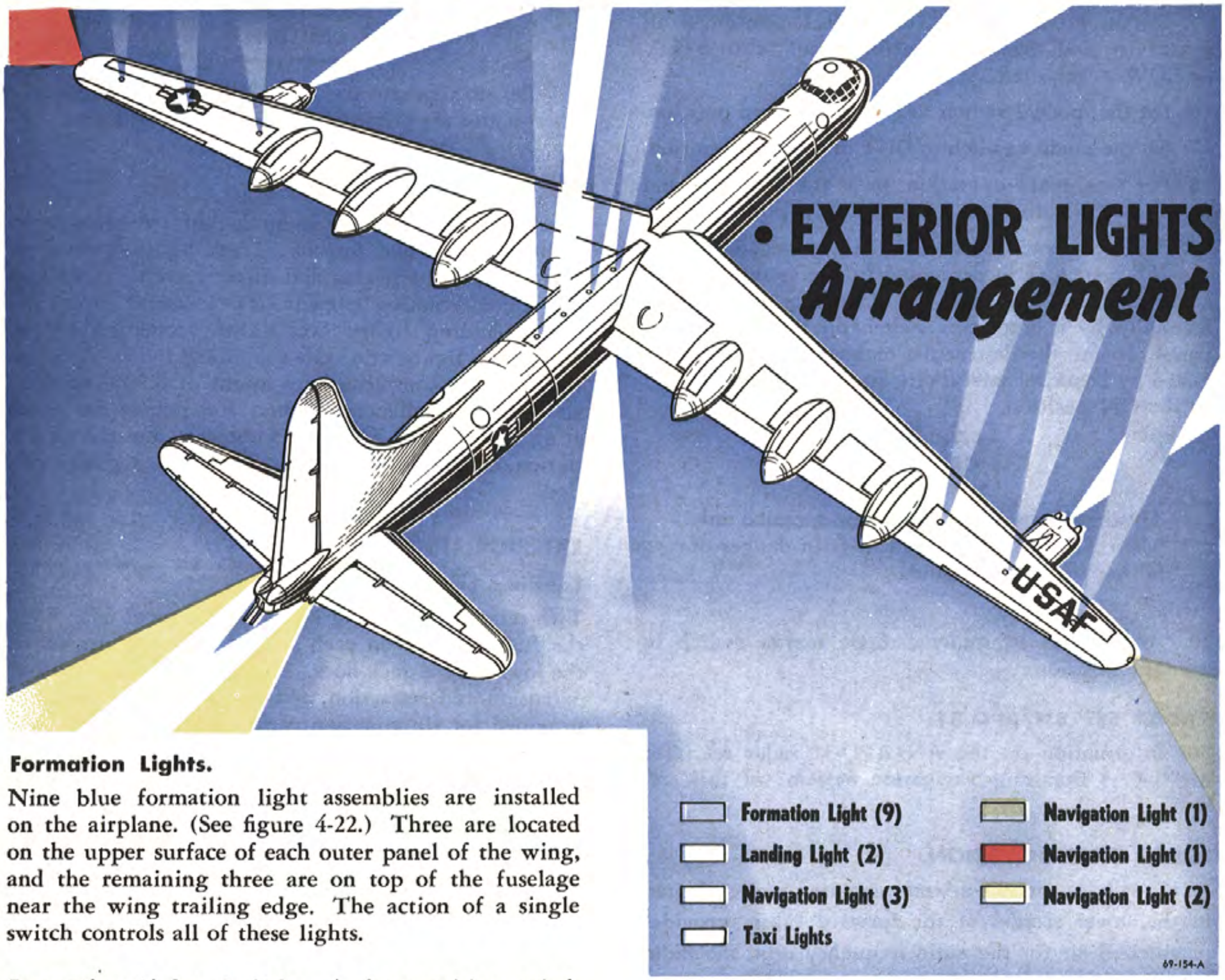

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Figure 4-22.

Formation Lights.

Nine blue formation light assemblies are installed on the airplane. (See figure 4-22.) Three are located on the upper surface of each outer panel of the wing, and the remaining three are on top of the fuselage near the wing trailing edge. The action of a single switch controls all of these lights.

Formation Lights Switch. A three-position switch (2, figure 1-9), located on the pilots' pedestal, has positions marked BRIGHT, OFF, and DIM, and is used for controlling the formation lights.

Navigation Lights.

The navigation lighting system consists of a red light on the left wing tip, a green light on the right wing tip, two white and two yellow lights on the trailing edge of the stabilizer near the fuselage, a white light on top of the fuselage approximately in line with the trailing edge of the wing, and a white light on the lower surface of the fuselage, forward of the wing leading edge. This system is used to show the position and indicate the direction of the airplane. The wing tip lights and the white tail lights operate on an a-c circuit, while the yellow tail lights are illuminated by a d-c circuit. The wing tip lights and the white and yellow tail lights will burn continuously or can be made to flash alternately through the use of a flashing mechanism. When flashing, one circuit closes for approximately one-half second; then both circuits are open; the other circuit closes for approximately one-half second; then both are open, etc. While either burning continuously or flashing, these lights can be made bright or dim. The small white lights, which are located on the top and bottom of the fuselage, are on an independent d-c circuit. They can be made to burn either bright or dim, but will not flash. Operation of the navigation lights system is controlled by a navigation lights selector switch and a navigation lights dimming switch.

Navigation Lights Selector Switch. A three-position switch (4, figure 1-9), located on the pilots' pedestal, controls the fuselage, wing, and tail navigation lights. This switch has positions marked STEADY, OFF, and FLASH. When it is in the STEADY position, the two white fuselage lights, the wing tip lights, and both the white and yellow lights on the tail will burn continuously. The FLASH position causes the wing tip lights and white tail lights to flash alternately with the yellow tail lights, as explained in the preceding paragraph.

Navigation Lights Dimming Switch. A two-position switch (3, figure 1-9), located on the pilots' pedestal, controls the intensity of the fuselage, wing tip, and both the white and yellow tail lights. This switch has positions marked BRIGHT and DIM, and functions accordingly.

INTERIOR LIGHTS.

Dome, instrument, control panel, cockpit, table, and crew station lights are located throughout the forward cabin to provide the crew with adequate illumination. The lights are controlled by built-in dimmer and switch units, panel switches, and rheostats. Lights in the forward turret bay and the dome and passage lights in the forward bomb bays are controlled by either of two switches, one on the radio operator's control panel and the other on the bomb bay lights control panel. The aft turret bay and aft bomb bay dome and passage lights are controlled by either of two switches, one on the bunk equipment panel in the aft cabin and the other on the bomb bay lights control panel.

The aft cabin dome light is controlled by two switches, one on the left side of the cabin near the communication tube and the other at the entrance hatch. The scanners' cockpit lights are controlled by built-in dimmer and switch units. The switch for the tail cone and tail turret dome lights is a switch-type circuit breaker located above the tail cone entrance hatch. A switch at each wing crawlway entrance controls the wing crawlway lights. Mounted on the engineer's circuit breaker panel is one switch-type circuit breaker for control of the nose and main landing gear wheel well lights. Receptacles for operating the Aldis lamps are located at the navigator's station, the pilot's station, and at each scanning station.

Indirect Panel Lighting.

Indirect lighting is provided for the pilots' instrument panel, the pilots' pedestal, and the pilot's circuit breaker panel. Rheostat switches are located on the aircraft commander's and pilot's lighting control panels (6, figure 1-10 and 4, figure 1-11) to control the brilliancy of the lights from OFF to BRIGHT. In addition, the engineers have rheostat switches overhead to regulate the indicator lamps and the flood lights at their station.

Flight Deck Flood Lights.

The flight deck is provided with three flood lights installed around the navigator's sighting station in the pilots' enclosure. The lights are arranged to shine on the aircraft commander's, pilot's, and engineers' station. At each of the lights is a three-position switch with RED, WHITE, and neutral off positions. With the white lights on, the blinding effect of lightning is minimized. The red lights are used when night vision must be preserved.

Navigator's Utility Light.

A utility light (5, figure 4-32), located on the navigator's sighting station control panel, is equipped with an adjustable head to provide red or white pencil beam or flood light illumination. An on-off switch is located adjacent to the light, and a six-foot cord reeled in the light receptacle permits the light to be moved about.

Aldis Lamp Receptacles.

Receptacles for operating the Aldis lamps are located at the navigator's station, the pilot's station, and at each scanning station.

LIGHTING SYSTEM EMERGENCY OPERATION.

In the event of failure of all alternators, the only electric power available will be from the airplane battery. To conserve the strength of the battery it is necessary that all nonessential lights be turned off.

OXYGEN SYSTEM.

The airplane is equipped with a low pressure oxygen system which consists of the following components: 24 type G-1 oxygen cylinders, five type J-1 cylinders which compose an auxiliary supply, three portable diluter oxygen units, eight recharger hoses, and oxygen controls at each crew station. The type G-1 cylinders are located on the left side of the bomb bay area, and the auxiliary system cylinders are in the forward turret bay. An oxygen supply valve and a pressure gage at the radio operator's station provide for replenishing the main system from the auxiliary system.

The oxygen system is serviced through a single filler valve located on the lower left side of the fuselage near the radar dome. (See figure 1-45.) For combat safety each crew oxygen station is supplied from two distribution lines through automatic check valves. The approximate duration of the oxygen system is given in figure 4-23. Only a pressure-breathing demand oxygen mask will be used above 34,000 feet pressure altitude.

Note

As an airplane ascends to high altitudes where the temperature is normally quite low, the oxygen cylinders become chilled. As the cylinders grow colder, the oxygen gage pressure is reduced, sometimes rather rapidly. With a 100°F decrease in temperature in the cylinders the gage pressure can be expected to drop 20 per cent. This rapid fall in pressure

Figure 4-23. Man-Hour Oxygen Consumption Table Will Be Furnished When Available.

is occasionally a cause for unnecessary alarm. All the oxygen is still there, and as the airplane descends to warmer altitudes, the pressure will tend to rise again, so that the rate of oxygen usage may appear to be slower than normal. A rapid fall in oxygen pressure while the airplane is in level flight, or while it is descending, is not ordinarily due to falling temperature. When this happens, leakage or loss of oxygen must be suspected.

REGULATOR CONTROLS AND INDICATORS.

A D-1 or D-2 automatic pressure-breathing, diluter demand oxygen regulator (figure 4-24) is installed at each crew station. Additional regulators are provided at the nose wheel well entrance hatch, on bulkhead 3.0 in the radio operator's compartment, and on the forward bulkhead in bomb bay No. 1. An oxygen flow indicator and a pressure gage are incorporated in the regulator. The function of the regulator is to simulate sea level oxygen pressure conditions in high altitude flight. The regulator accomplishes this by means of an aneroid assembly which progressively delivers a richer oxygen-air mixture to the oxygen mask at correspondingly greater pressures until at high altitude (generally beginning in the vicinity of 34,000 feet) 100 per cent oxygen is being delivered at a pressure verying from 2 to 17 inches of water.

Regulator Diluter Control.

A diluter lever is provided on each oxygen regulator. At NORMAL OXYGEN the lever opens the air inlet valve so that the regulator automatically supplies a proper mixture of air and oxygen to the mask at all altitudes, provided the regulator supply valve lever is ON. The lever at 100% OXYGEN closes the air inlet valve so that 100 per cent oxygen is supplied to the mask for emergency use.

Regulator Supply Valve Lever.

An oxygen supply valve lever is located at the bottom of each regulator panel. The lever, when turned to the ON position, opens the oxygen supply to the regulator. The lever, when turned to the OFF position, cuts off the oxygen supply. A force of approximately 20 inch-pounds should be used in turning the valve.

WARNING

If the supply valve is left ON at an unused station, the oxygen supply will be depleted.

Regulator Emergency Toggle Lever.

The emergency toggle lever provides a means of manually supplying positive pressure to the mask for emergency purposes. Pushing the lever in gives a positive pressure to the mask. This pressure is automatically stopped when the lever is released. This feature of the lever is to be used when testing the fit of the oxygen mask. The lever can also be pushed to either side (right or left.) This action locks the lever to give a continuous positive pressure to the mask.

WARNING

Except for testing oxygen mask fit, the emergency toggle lever is not to be used except in an emergency, because the duration of the oxygen supply will be seriously affected.

Regulator Warning System Switch.

This switch is inoperative because the oxygen system warning signals are not incorporated in this airplane.

Pressure Gage and Flow Indicator.

A combination pressure gage and flow indicator is mounted on the face of each regulator. The pressure gage shows oxygen cylinder pressure and is calibrated from 0 to 500 psi. The range from 400 to 450 psi is marked FULL. The flow indicator consists of a blinker plate which indicates the flow of oxygen by exposing four fluorescent painted segments with each inhalation.

RADIO OPERATORS AUXILIARY OXYGEN SYSTEM CONTROLS.

Auxiliary Oxygen System Supply Valve.

The supply valve for the auxiliary oxygen system is located on bulkhead No. 4 at the left of the radio operator's station. It has two positions, OPEN and CLOSE. By placing the valve in the OPEN position, the radio operator can replenish the main oxygen system supply from the auxiliary supply. At all other times the valve should remain in the CLOSE position.

Auxiliary Oxygen System Pressure Gage.

A gage to register pressure in the auxiliary oxygen system is installed on bulkhead 4.0 at the left of the radio operator's station.

PORTABLE OXYGEN EQUIPMENT.

Three portable oxygen units are provided to furnish the crew with oxygen when entering the unpressurized areas in the airplane while at high altitude and to serve as an emergency system in case of failure of an oxygen panel. Two of these units are in the forward cabin and one is in the aft cabin. The units consist of an A-6 walk-around oxygen cylinder and an A-15 regulator.

Eight portable recharger assemblies are in the airplane; four are in the forward cabin, two above the catwalk in the bomb bay, and two in the aft cabin. Any of the eight recharger hoses may be used to fill the portable cylinders.

Note

> The A-15 regulator is not a pressure demand regulator and therefore cannot be used above 34,000 feet in an unpressurized cabin. Type A-21 regulators must be used above 34,000 feet up to 45,000 feet.

OPERATIONAL USE OF OXYGEN EQUIPMENT.

The D-1 or D-2 pressure demand regulator provides adequate protection below approximately 43,000 feet. Protection becomes marginal between 43.000 and 45.000 feet because of the likelihood of mask leakage and the fatigue of breathing against higher pressure settings. The regulator serves only as an emergency device above 45,000 feet, useful for preserving consciousness long enough to descend to a safe altitude after rapid decompression. As an example, at 50.000 feet two minutes of consciousness might be anticipated. These limitations of the oxygen equipment impose the following restrictions on crew and aircraft operation.

1. The number of crew members and passengers will not be greater than the number of installed oxygen outlets and walk-around bottles on any flight above 14.000 feet if the aircraft is not pressurized; 20,000 feet if pressurized; or 34,000 feet if walk-around bottles do not have pressure demand regulators.

Note

> If passengers are being carried and walk-around bottles are used as the primary source of oxygen, the altitude will be limited to 30 000 feet.

2. Aircraft not equipped with the D-1 or D-2 regulator will normally be restricted by operation clearance authorities to pressure altitudes not to exceed 43,000 feet. If an aircraft so equipped is to exceed 43,000 feet, the following special precautions will apply.

a. Clearance authorities and the aircraft commander will insure that all personnel aboard are properly fitted to either A-13 or A-13A pressure masks which have been inspected and refitted immediately prior to the flight.

b. Clearance authorities and the aircraft commander will insure that all personnel have received recent altitude indoctrination and are thoroughly familiar with the use of assigned oxygen equipment.

c. Individuals not proficient in the use of oxygen equipment will be referred to the unit flight surgeon or physiological training officer for a course in altitude indoctrination. Certification that the individual has qualified for high altitude flight will be reported to the aircraft commander and clearing authorities.

Preflight Check of Oxygen Equipment.

Each crew member will preflight his oxygen equipment as follows:

1. Regulator and Hose Connections.

a. Alligator clip (clothing clamp) in proper working condition.

b. Clamps secure at each end of a regulator.

c. Regulator elbow nut tight.

2. D-1 or D-2 Regulator Check.

a. With the regulator supply valve lever OFF, set the diluter lever at NORMAL OXYGEN. Cabin air only should be delivered by the regulator. Place the diluter lever in the 100% OXYGEN position. Neither cabin air nor oxygen should be delivered by the regulator.

b. With the oxygen supply lever ON, accomplish the following:

(1) Check gage for proper pressure (400 to 450 psi or FULL).

(2) Check flow indicator for blinking when inhaling.

Typical OXYGEN PANEL

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Figure 4-24.

(3) Place the diluter lever in 100% OXYGEN and check for continuous flow.

(4) Return diluter lever to NORMAL OXYGEN.

(5) Move emergency toggle lever to either right or left and check for continuous positive pressure.

(6) Depress emergency toggle lever and check for greater positive pressure.

Note

With the emergency toggle lever depressed, check the mask for proper fit.

c. Return the oxygen supply lever to OFF, using approximately 20 inch-pounds of torque to insure that the supply valve is completely closed. Then push the emergency toggle lever in momentarily to reset the gage to a zero reading.

Note

If pressure builds up after several minutes, the oxygen supply valve is not fully closed. This condition will cause oxygen to flow from the regulator any time the cabin altitude reaches the altitude at which the regulator begins to meter oxygen.

d. Check the regulator for outward leakage by using the following blow-back test: Blow gently into the end of the oxygen regulator hose as during normal exhalation. (Blowing hard may tend to seal a leaky diluter air valve.) Resistance to blowing indicates that the demand diaphragm and diluter air valve are satisfactory; little or no resistance to blowing indicates that they are faulty.

Note

Conduct the blow-back test on all demand regulators twice, once with the diluter valve at the NORMAL OXYGEN position and again at the 100% OXYGEN position.

3. Portable Walk-Around Bottle—Type A-6.

a. Attach recharger hose and fill bottle to at least 400 psi.

b. Detach and listen for leaks in the recharger hose.

c. Check pressure gage. Should be at least 400 psi.

d. Plug mask into regulator and check pull to disconnect. It should be from 10 to 20 pounds.

e. Blow gently into regulator to detect leaks in diaphragm or check valve.

CAUTION

Excessive blowing may rupture diaphragm.

4. Emergency Bail-Out Bottle—Type H-2.

Note

A fully charged H-2 cylinder will last approximately 10 minutes, depending on altitude and temperatures.

a. Check pressure gage. Pressure should be 1800 psi.

b. Check adequate fit of all connections.

c. Secure bottle to parachute harness below the D-ring.

Normal Oxygen Procedures.

The following rules will be followed on every altitude flight.

1. Mask will be worn at all times when *cabin* altitude is 10,000 feet and above.

2. *Pressure altitude 10,000 to 28,000 feet and cabin altitude below 10,000 feet.*

Mask and helmet need not be worn. Mask will be plugged into an oxygen regulator or a walk-around bottle and kept accessible near person.

WARNING

When the aircraft is pressurized and the pressure altitude is above 25,000 feet, crew members stationed near blowable structures, such as blisters or large plexiglas panels, will keep their seat belts or safety straps fastened.

3. *Pressure altitude 28,000 to 35,000 feet and cabin altitude below 10,000 feet.*

At least one crew member in each compartment will remain on oxygen.

The mask will be attached to helmet and plugged into regulator. The helmet will be worn but the mask need not be applied to the face.

Pressure altitude above 35,000 feet and cabin altitude below 10,000 feet.

All crew members will have the mask loosely fitted to face; however, the aircraft commander may, at his discretion, authorize certain crew members to remove their masks. Permission will apply to specific instances *only*.

4. *Pressure altitude above 35,000 feet and cabin altitude above 10,000 feet.*

All crew members will have the mask snugly fitted to face with the oxygen supply lever ON.

5. Oxygen mask and helmet will not be stowed in or near blisters or plexiglas panels.

6. H-2 bail-out bottle will be attached to the parachute and connected to the oxygen hose adapter at 28,000 feet.

7. *Regulator Settings.*

D-1 or D-2 REGULATOR

Cabin Altitude	*Regular Setting*
0 to 10,000 feet	Oxygen Supply Lever OFF
10,000 feet and above	Oxygen Supply Lever ON

Note

The diluter lever will be in the NORMAL OXYGEN position at all times. However, in case of an emergency under 30,000 feet, the 100% OXYGEN position will be used.

Crew Interphone Oxygen Checks. The pilot will initiate an interphone check at frequent intervals as stated below. The check will be made from tail to nose as outlined under the interphone and alarm bell check in "Taxiing," Section II. The check is as follows:

1. Oxygen gage pressure reading in pounds.
2. Position of controls.
3. The compartment commanders will check crew members for unusual behavior symptomatic of hypoxia.
4. Frequency of checks will conform to periods of useful consciousness at various altitudes.

a. Hourly check by compartments when cabin altitude is under 15,000 feet.

b. At cabin altitudes of 15,000 to 25,000 feet, check will made every 15 minutes.

c. At cabin altitudes above 25,000 feet, compartment checks will be made every 5 minutes and individual checks will be made every 15 minutes.

Oxygen System Emergency Operation.

With symptoms of the onset of hypoxia, or if smoke or fuel fumes should enter the cabin, set the diluter lever of the oxygen regulator to the 100% OXYGEN position. In the event of accidental loss of cabin pressure, immediately set the diluter lever of the regulator to 100% OXYGEN and push the emergency toggle lever to the right or left.

CAUTION

When use of 100% OXYGEN or EMERGENCY becomes necessary, the aircraft commander will be informed of this action. Use of 100% OXYGEN or EMERGENCY will reduce oxygen duration of the airplane. After the emergency is over, set the diluter lever to NORMAL OXYGEN and push the emergency toggle lever to the center position.

If the regulator should become inoperative, disconnect the mask from the airplane oxygen system and connect it to a portable oxygen unit. If an adequately filled portable unit is not available, pull the cord of the H-2 emergency oxygen cylinder.

WARNING

When use of the H-2 emergency oxygen cylinder becomes necessary, the aircraft commander will be informed of this action so that he can immediately descend to an altitude at which oxygen is not required.

OXYGEN DISCIPLINE.

Oxygen discipline is extremely important at high altitude because of the very short period of useful consciousness in the event of an oxygen system malfunction, improperly used oxygen equipment, or an explosive decompression. Training in the altitude chamber should be taken very seriously and practiced religiously during all high altitude flights. In fact the aircraft commander must enforce good oxygen discipline. This discipline should not begin in the air, but on the ground during personal equipment inspection. See to it that every crew member has properly fitted equipment, knows how to use his oxygen equipment, and knows how to handle any emergency situation. Lack of oxygen discipline in a crew could destroy it as surely as an anti-aircraft shell.

Rapid Decompression.

Explosive decompression or sudden loss of cabin pressurization results in an equalization of cabin altitude and airplane altitude within a few seconds time. In aircraft hulls with large cabin volumes, this explosive type of decompression occurs only with the sudden and complete blowout of a large blister or panel. Since time is all-important in preventing hypoxia after explosive decompression crew members will immediately report hull defects which could possibly cause loss of pressure. If decompression occurs without warning, the following will be accomplished.

1. Notice of the emergency will be immediately transmitted over interphone to provide all crew members time to carry out necessary oxygen procedures.
2. Immediately following this notice, the engineer will announce over interphone the pressure altitude and final cabin altitude in each compartment.

The crew members in the damaged compartment will recognize explosive decompression by the following events: dull booming sound with forceful out-rush of air and usually a formation of fog; forceful expiration of breath with mask chattering back and forth on face; passage of gas and belching; rapid popping of ears or plugging of ears; rasping or screeching in interphone.

Crew members in remote areas of hull may not hear or feel anything except a rapid popping and plugging of ears, which of itself alone should be sufficient warning to crewmen that cabin pressure has been lost.

Mechanical effects of the explosive decompression result in considerable suction being exerted toward the blown hull area. Therefore crew members at duty stations near structures which might blow out must keep their seat belts or safety straps fastened when the cabin is pressurized. The communication tube should not be used except in cases of emergency at altitudes above 30,000 feet when cabin pressurization is being used.

The extent and severity of physical effects on personnel following explosive decompression depend on the following factors:

1. Rapidity of decompression.
2. Final cabin altitude resulting from decompression.
3. Range of altitude differential or pressure gradient through which cabin decompression has occured.
4. Duration of time spent without oxygen at resultant altitude.
5. Individual physical condition.

The important physical effects of explosive decompression on personnel are hypoxia and decompression sickness such as bends or chokes (altitude dysbarism). Hypoxia is the most immediate, potentially dangerous, and disabling threat to the air crew. The average useful conscious time is indicated in the following table:

AVERAGE USEFUL CONSCIOUS *Time*

ALTITUDE	Time
20,000 Feet	15 Minutes
25,000 Feet	3-4 Minutes
30,000 Feet	1 Minutes
35,000 Feet	45 Seconds
40,000 Feet	15-20 Seconds
45,000 Feet	10 Seconds
50,000 Feet	10 Seconds

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When explosive decompression occurs, perform the following steps as rapidly as possible:

1. If mask is not on face, turn the oxygen supply valve on, apply mask to face, and tighten face straps to hold pressure.
2. If mask is being worn, turn the oxygen supply valve ON and then tighten face straps on mask. The D-1 or D-2 regulator operates automatically if the oxygen supply valve lever is turned ON.
3. Check oxygen hose connections and blinker activity at regulator.
4. All crew members will be accounted for over the interphone as soon as possible, particular attention being given those not at their stations at the time of decompression.
5. If the aircraft is above 40,000 feet and all occupants are not provided with automatic or manual pressure demand oxygen equipment, the aircraft commander will rapidly descend to 40,000 feet and, as soon as the operational situation permits, descend to 34,000 feet or below for additional safety.
6. If the aircraft is above 45,000 feet, the aircraft commander will rapidly descend to 45,000 feet and, as soon as the operational situation permits, descend to 43,000 feet or below for additional safety.
7. All crew members will observe other occupants for symptoms of hypoxia, and if any occupant appears to be in difficulty or has lost consciousness, notify the aircraft commander.

Treatment of Hypoxia Victims.

A crewman evidencing hypoxia symptoms will be assisted by the nearest crew member, if the latter can go to the aid of the victim without detaching himself from his own regulator hose. If this is impossible, he will report intended rescue action over the interphone to the aircraft commander who will approve the action or designate another rescuer if it is essential that the reporting crew member remain at his station.

The designated rescuer will act as follows:

1. Connect his mask to a walk-around bottle if one is available, or pull his bail-out bottle valve cable if a walk-around bottle is not available.
2. Turn the hypoxia individual's emergency toggle lever to either side and hold his mask in place forcibly until he regains consciousness and appears rational and able to take care of himself. If the victim's oxygen equipment appears not to be functioning properly and other regulator outlets or walk-around bottles are not available, fasten his mask tightly to his face and pull his bail-out bottle valve cable. Since hypoxia victims may struggle violently and aggressively when regaining consciousness, they must be restrained to prevent dislodging their own or rescuer's mask. If using a walk-around bottle, the rescuer will not allow the pressure to drop below 100 psi without refilling; if using a bail-out bottle, he will not remain disconnected from an oxygen regulator for more than five minutes. An individual should not be disconnected from his walk-around bottle more than half the average useful conscious time.
3. Whether the victim is immediately revived or not, the rescuer will return to his own station at once, reconnect his oxygen regulator, and report to the aircraft commander the status of the emergency.
4. If the victim has not recovered, the rescuer will return to him and continue revival efforts. If there is doubt that he is breathing, artificial respiration will be employed.
5. If informed that the victim has not recovered, the aircraft commander will determine whether the operational situation will permit immediate descent to an

ambient pressure altitude of 15,000 feet or below, at which 100 per cent oxygen and artificial respiration will be adequate to revive the victim.

6. Administration of oxygen and, if necessary, artificial respiration will be continued until the victim has recovered or it is positively determined that he is dead.

Use of Pressure Oxygen Breathing Following Cabin Decompression.

The pressure oxygen system is designed primarily for emergency use and will provide adequate oxygen to the crew during descent of the airplane from an altitude of 50,000 feet down to 35,000 feet or below, where normal diluter-demand oxygen can be used from the regulator. Pressure breathing requires a forceful expiration against an oxygen pressure resistance which increases with altitude. At the higher pressures the individual not conditioned to and practiced in pressure breathing will become fatigued, but there is no discomfort or injury inflicted on him as the result of pressure breathing during the time of descent after cabin decompression. Likewise, no damage to the lungs will occur as a result of having the mask on the face and breathing normal or 100 per cent oxygen at the time of descent after cabin decompression or at the time explosive decompression occurs.

Bends, chokes, creeps, decompression sickness, and altitude dysbarism are synonymous terms and indicate a condition of the body in which nitrogen bubbles are released into the tissue spaces and blood stream as a result of the sudden loss of pressure surrounding the body. This physical effect seldom occurs except after prolonged exposure at cabin altitudes in excess of 35,000 to 40,000 feet or after explosive decompression through large pressure differentials to resultant cabin altitudes above 40,000 feet.

The condition is relieved upon descent of the airplane to 30,000 feet or below, or upon repressurization of the cabin. When decompression sickness occurs after decompression, it is seldom disabling and has no permanent after-effects on the body. The incidence and severity of decompression sickness at any given altitude can be markedly reduced by preliminary denitrogenization or by wearing a pressure suit.

Denitrogenization Procedure For Prevention of Decompression Sickness.

Tactical considerations may require that the aircraft complete a specific portion of the mission at an altitude of 40,000 feet without descending to a lower altitude, even though complete pressurization is lost. This requires that the crew receive maximum possible protection against potential decompression sickness. To accomplish this protection the following procedure is outlined:

1. One hour prior to reaching the critical point in the flight the aircraft commander will order all crew members to put on oxygen masks, if not already being worn, and to turn regulator to 100% OXYGEN.

2. Cabin pressure will be maintained at or below 10,000 feet for 30 minutes, during which time the crew will be breathing 100 per cent oxygen.

3. Cabin pressure will then be gradually decreased during the next 30 minutes until a cabin altitude of 30,000 feet is reached. At this point cabin altitude is leveled off and maintained there with crew on 100 per cent oxygen through the critical period of the flight.

4. If cabin pressure is completely lost during the critical period, maximum protection against disabling hypoxia symptoms will be afforded crew members by setting the D-1 or D-2 regulator at 100% OXYGEN.

Use of Walk-Around Bottles.

Walk-around bottles will be used under the following condtions:

1. In an unpressurized aircraft when crew members will be absent from their stations:

   a. Over *ten* minutes between 14,000 and 16,000 feet.

   b. Over *five* minutes between 16,000 and 18,000 feet.

   c. Over *two* minutes between 18,000 and 20,000 feet.

2. In communication tubes in pressurized aircraft at 25,000 feet or above.

3. In a pressurized cabin above 30,000 feet, with mask plugged in to bottle if crew member is not close to regular station. Mask will be worn and plugged in above 35,000 feet unless permission to the contrary has been granted, in which case the crew member not on oxygen will be under the constant observation of one who is.

Precautions in Using Walk-Around Bottles.

1. Keep charged to at least 400 psi when not in use.

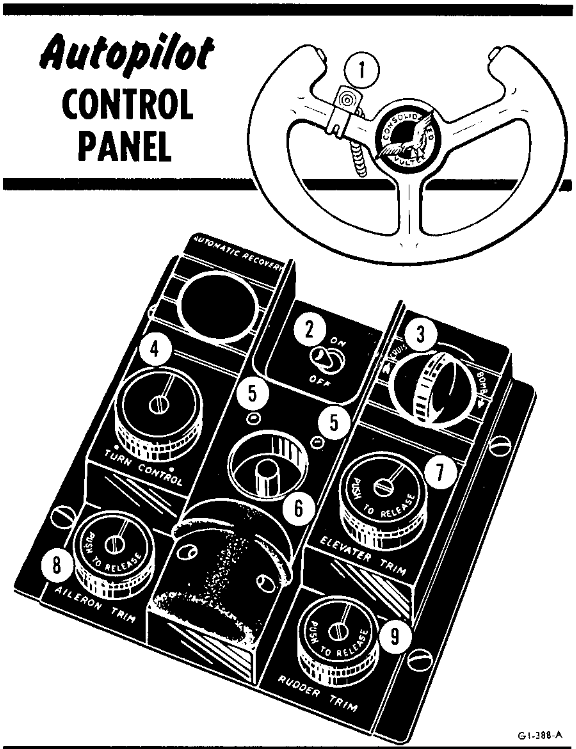
2. If recharger hose leaks, keep it attached to a walk-around bottle to conserve oxygen.

3. When using a walk-around bottle, check the pressure gage regularly and recharge when gage reads 100 psi.

AUTOPILOT.

The airplane is equipped with a type E-6 autopilot. This electro-mechanical device automatically positions the control surfaces for level flight, coordinated turns, or flight paths based on information provided by other equipment.

Primary control of the system is accomplished from the autopilot control panel (29, figure 1-9) located on the pilots' pedestal. "Second station" turn control operation can be transferred to the radar observer at the discretion of the aircraft commander.



1. AUTOPILOT RELEASE SWITCH
2. AUTOPILOT ON-OFF SWITCH
3. CRUISE-BOMB KNOB
4. TURN CONTROL KNOB
5. INDICATOR LIGHTS
6. ENGAGE SWITCH
7. ELEVATOR TRIM KNOB
8. AILERON TRIM KNOB
9. RUDDER TRIM KNOB

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Figure 4-25.

Calibration controls are also provided for the adjustment of autopilot response through the wide variations in gross weight, cg, air speed, and altitude. These calibration controls are located in the observers' compartment.

PRIMARY CONTROLS.

The primary controls of the autopilot are located on the autopilot control panel (figure 4-25). Individual controls on the autopilot control panel are discussed in the following paragraphs.

Autopilot On-Off Switch.

This switch (2, figure 4-25) controls 115-volt alternating current from the right forward power panel and 28-volt direct current from the pilot's circuit breaker panel. The autopilot is normally ready for operation 3 minutes after this switch is placed in the ON position.

Elevator, Rudder and Aileron Trim Knobs.

These knobs (7, 9, and 8, figure 4-25) are used to apply electrical trim to the autopilot while it is engaged. If the autopilot in ON but not engaged, these knobs will normally oscillate in order to maintain a neutral position with respect to the movement of the control surfaces. Each knob has a push-button type switch located in its center. These push-button switches can be used to disengage the three axes individually. If an axis is disengaged by one of these switches, the autopilot engage switch must be pressed to re-engage the axis.

Autopilot Engage Switch.

A push-button type switch (6, figure 4-25) is provided to engage the autopilot after the green lights on the autopilot control panel begin to flicker. After the autopilot is engaged, the green lamps will burn steadily.

Turn Control Knob.

The turn control knob (4, figure 4-25) is used to establish a coordinated automatic turn in the direction of knob rotation. Maximum bank obtainable is 32 degrees.

Cruise-Bomb Knob.

This knob is not used as a functional control.

Automatic Recovery Switch.

The automatic recovery switch should not be used because airplane response is too violent. This control is covered by a plate on the pilots' pedestal.

Autopilot Release Switches.

Both control wheels are equipped with an autopilot release switch (1, figure 4-25). Either switch will release all three control axes simultaneously.

TRANSFER CONTROLS.

The following controls are used during remote or "second station" turn control operation by the radar observer.

N-2 Transfer Switch.

This switch (21, figure 1-8) located on the pilots' instrument panel, is provided to enable the radar observer to utilize the turn control feature of the autopilot. The switch has two positions, RADAR BOMB and PILOT. Normally it is left in the PILOT position and the turn control is operated from the autopilot control panel on the pilots' pedestal. When the switch is placed in the RADAR BOMB position, the autopilot turn control is made available to the radar observer as well as the pilots.

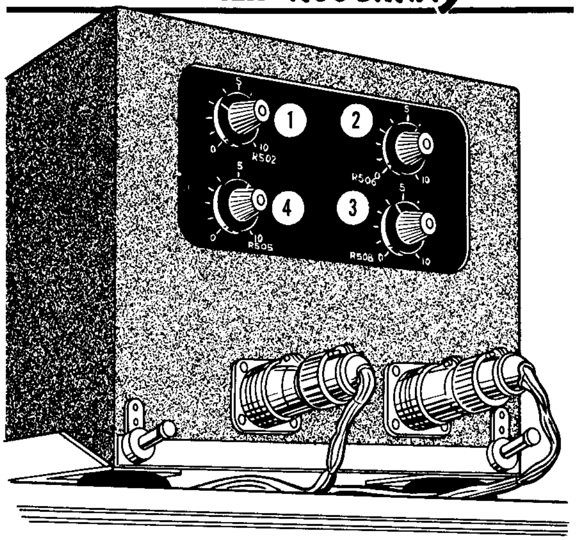
E-2 Turn Control Unit.

The E-2 turn control unit (2, figure 4-36), located at the radar observer's station, consists of a turn control knob, a two-position mode selector switch, and an indicator light. When the aircraft commander transfers control to the radar observer, the indicator light will glow. If the mode selector is in MANUAL, the radar observer can maneuver the aircraft with his turn control knob. If the mode selector is in AUTOMATIC, the radar observer can maneuver the aircraft with the tracking handle of the K-( ) system.

CALIBRATION CONTROLS.

All calibration controls are located in the observers' compartment. The directional coupler amplifier assembly (figure 4-26) is located behind the radar observer's control panel. Four calibration control knobs are located under the cover plate of this unit. The remaining calibration controls are located on the main chassis (figure 4-27) above the nose wheel well. The sensitivity and throttling control knobs are located on the amplifier. Access to the control knobs is gained by removing the covers on the face of the units. The ratio, auto recovery, coordination, and E-FS control knobs are located on the calibrator unit. The control knobs for rudder gain, rudder roll rate, and aileron roll rate are located under the cover of the auxiliary calibrator unit.

DIRECTIONAL COUPLER AMPLIFIER *Assembly*



1. COMPASS MAXIMUM BANK
2. COMPUTER MAXIMUM BANK
3. PROPORTIONAL RANGE
4. CURVATURE

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Figure 4-26.

***Autopilot* MAIN CHASSIS**

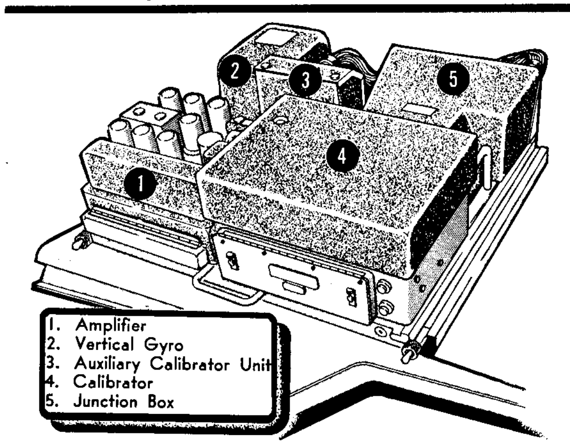

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Figure 4-27.

Compass Maximum Bank Knob.

This control determines the directional stiffness of the system or the amount of corrective bank angle applied per degree of heading error.

Computer Maximum Bank Knob.

This control sets the maximum bank angle the airplane can reach in correcting for a large steering signal from the ground position computer.

Curvature Knob.

The effect of this control is similar to the throttling control on the E-6 amplifier. This knob setting should be carried as high as possible to keep course corrections proportional to the amount of remaining error.

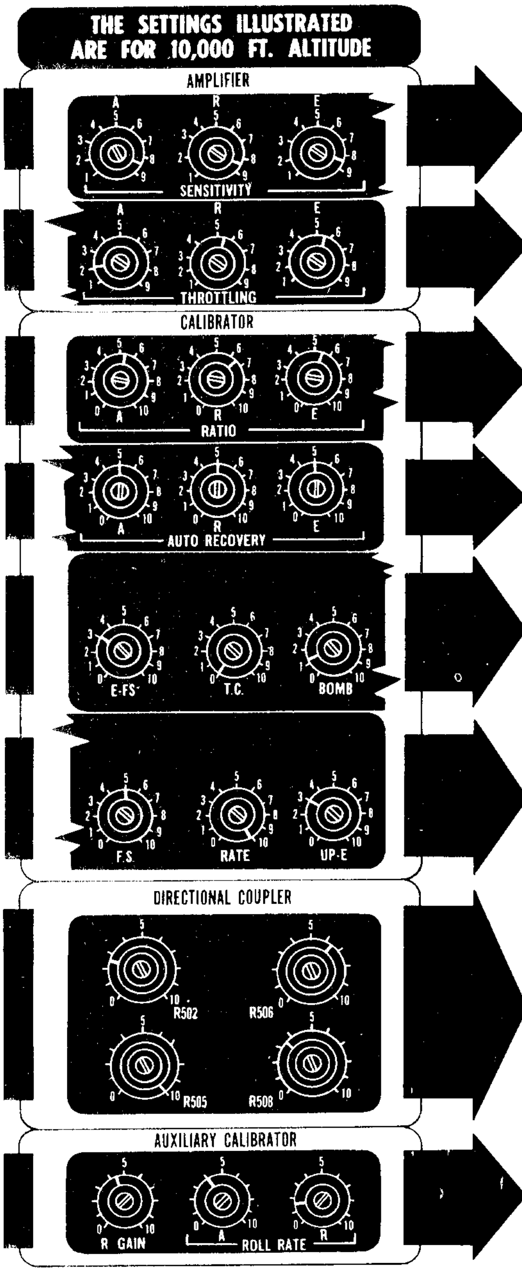
Proportional Range Knob.

This control sets the heading correctional signal required for the airplane to reach the maximum bank angle established by compass maximum bank or computer maximum bank. This could also be considered as the rate of amplifier response to the input signal.

Sensitivity Knobs.

The sensitivity knobs establish the minimum signal level for which the amplifier will call for correction. In most cases, input signals come from the reference gyros which detect deviations in the attitude of the aircraft. They may, however, come from the autopilot control panel or from "second station" corrections. Under these conditions the induced signal is "nulled" by the gyros whenever the aircraft reaches the steady

RECOMMENDED AUTOPILOT CALIBRATION CONTROL *Settings*



CONTROL	SETTINGS 10,000 FT.	SETTINGS 25,000 FT.	SETTINGS 40,000 FT.
AILERON SENSITIVITY	8 to MAX.	8 to MAX.	8 to MAX.
RUDDER SENSITIVITY	8 to MAX.	8 to MAX.	8 to MAX.
ELEVATOR SENSITIVITY	8 to MAX.	8 to MAX.	8 to MAX.
AILERON THROTTLING	2.0	2.0	2.0
RUDDER THROTTLING	5.5	5.5	5.5
ELEVATOR THROTTLING	5.5	5.5	5.5
AILERON RATIO	5.5	4.0	1.0
RUDDER RATIO	6.5	6.5	6.5
ELEVATOR RATIO	5.5	5.5	5.5
AILERON RECOVERY	5.0	5.0	5.0
RUDDER RECOVERY	5.0	5.0	5.0
ELEVATOR RECOVERY	5.0	5.0	5.0
E. F. S.	3.0	3.0	3.0
TURN COORDINATION	0	0	0
BOMB COORDINATION	1.8	1.8	1.8
F. S. COORDINATION	5.0	5.0	5.0
YAW RATE COORDINATION	10.0	10.0	10.0
UP ELEVATOR COORDINATION	3.0	3.0	3.0
COMPASS MAXIMUM BANK	2.5	2.5	2.5
COMPUTER MAXIMUM BANK	6.5	6.5	6.5
PROPORTIONAL RANGE	3.5	4.0	6.0
CURVATURE	10.0	10.0	10.0
RUDDER GAIN	4.5	3.0	2.0
AILERON ROLL RATE	4.0	4.0	4.0
RUDDER ROLL RATE	1.5	1.5	1.5

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Figure 4-28.

state of the maneuver. The sensitivity setting of the amplifier determines the amount the aircraft can deviate from a steady attitude before a corrective maneuver is applied. The range of this adjustment is very small, and it should be carried as high as possible on each axis.

Throttling Knobs.

The settings on these knobs determine the speed at which the servos drive and consequently the speed with which the control surfaces move. They are in effect electronic brakes. The higher the setting, the greater the braking action, and the slower the movement of control surfaces.

Ratio Knobs.

The settings on these knobs determine the amount of control surface deflection applied for each unit signal that goes into the amplifier or the dynamic response of the aircraft. The range of adjustment on these knobs is great and their settings are quite delicate under most conditions.

Automatic Recovery Knobs.

The auto-recovery switch is covered and taken out of the control circuit. However, the knobs are still carried at five to maintain bridge balance in the circuit.

E-FS and FS Knobs.

These knobs were used to coordinate formation stick turns. They are still in the circuit. Moving E-FS will change the pitch attitude of the aircraft.

TC Coordination Knob.

This knob is carried at zero. Turns are coordinated with rudder gain in the auxiliary calibrator.

Bomb Coordination Knob.

This knob was used to coordinate turns made from the Norden bombsight. It is still in the circuit but has little or no dynamic effect.

Rate Coordination Knob.

This knob is used to "damp" the action of the rudder It is the electrical equivalent of a mechanical "dashpot." Rudder ratio must be kept high enough to insure flying a good heading. It is a characteristic of most aircraft that rudder ratio must be so high that the aircraft is on the verge of overcorrecting. For this reason the rudder needs "damping."

Up-Elevator Coordination Knob.

This knob is used to control the pitch attitude of the aircraft while it is in a bank.

Rudder Gain Knob.

This knob is used to coordinate turns made either by the pilots' turn control knob or "second station." Its setting determines the amount and direction of rudder applied per degree of bank. With the knob at ten, the autopilot puts in its maximum value of bottom rudder; with the knob at zero, the autopilot puts in its maximum value of top rudder.

Aileron Roll Rate Knob.

This control acts the same way in the aileron axis as the rate coordination control acts in the rudder axis. It damps the action of the ailerons while the aircraft is rolling in or out of turns. It also helps to keep the ailerons from overcorrecting when in straight and level flight. Its action puts in opposite aileron for any roll.

Rudder Roll Rate Knob.

This control attempts to coordinate the rudder while rolling in and out of turns. While the effect of this control is not too obvious, it aids in smoothing out turns, particularly at higher air speeds.

RECOMMENDED CALIBRATION CONTROL SETTINGS.

The control settings shown in figure 4-28 are recommended for satisfactory autopilot performance. All settings, except those which vary with altitude, should remain constant throughout the flight range.

Note

Slight deviations from the settings shown may be necessary for individual airplanes.

OPERATION.

Before Engaging the Autopilot.

1. Attain a safe altitude and manually trim the airplane for straight and level flight. Check with flight instruments.
2. Autopilot on-off switch—OFF.
3. Turn control knob—In detent.
4. Rudder, elevator, and aileron trim knobs—Center.

Engaging the Autopilot.

1. Place the autopilot on-off switch in the ON position; then wait until the two green indicator lamps begin to flicker before performing step 2 below.

Note

The autopilot will be ready for operation approximately one minute after it is turned on.

2. Autopilot engage switch—Press firmly.

CAUTION

Do not engage the autopilot while the airplane is turning.

Note

Center the annunciator pointer of the N-1 compass before engaging the autopilot. Also, do not adjust the synchronizer knob of the compass while the autopilot is engaged, because it will affect the directional stability of the airplane.

3. After the autopilot is engaged, check the flight instruments. Carefully readjust the autopilot trim knobs on the control panel until the airplane is flying straight and level.

WARNING

Never adjust the manual trim tab on any axis while that axis is engaged.

4. To make coordinated automatic turns, rotate the turn control knob in the desired direction.

Note

If the airplane turns in the opposite direction when the turn control knob is moved out of detent, check manual trim. If it is found to be satisfactory, remove the undesired trim with the autopilot trim knobs.

Disengaging the Autopilot.

1. To disengage the autopilot, press the release button on either the aircraft commander's or the pilot's control column. This action will release all servo motors simultaneously, but the autopilot will remain on.

2. To disengage the servo motors individually, press the center of the autopilot trim knob for the axis to be disengaged.

3. To stop autopilot operation, place the autopilot on-off switch in the OFF position.

Retrimming.

1. If extensive retrimming of the airplane is required, push the center of the electrical trim knob on the axis to be retrimmed. This will release the servo motor.

2. Trim the surface manually.

3. Re-engage the servo motor by pressing the engage switch.

Operation From Radar Observer's Station.

1. Wait for the indicator light to glow indicating that aircraft commander's transfer switch is in the RADAR BOMB position.

CAUTION

Do not attempt to move mode selector switch to AUTOMATIC until light comes on indicating that the aircraft commander has transferred control.

2. Leave mode selector switch in MANUAL to maneuver aircraft with the turn control knob.

3. Move the mode selector switch to AUTOMATIC to maneuver aircraft with the K-( ) tracking handle.

Regaining Control From Radar Observer's Station.

To regain control, the aircraft commander must do one of the following:

1. Move the N-2 transfer switch back to PILOT.
2. Disengage the autopilot.
3. Disengage the aileron axis.
4. Shut the autopilot off.

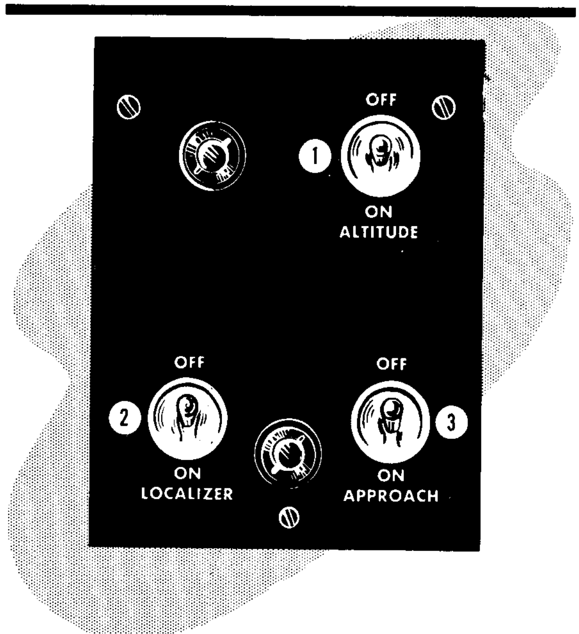
Note

The N-2 transfer switch will automatically move back to PILOT when either step 2, 3, or 4 is accomplished, and the autopilot must be re-engaged before the N-2 transfer switch can again be placed on RADAR BOMB.

ALTITUDE CONTROL UNIT.

On some airplanes an altitude control unit is provided for use in conjunction with the autopilot in maintaining the aircraft at any desired pressure altitude. The unit is essentially a sensitive barometric pressure sensor

AUTOMATIC APPROACH AND ALTITUDE CONTROL PANEL



1. Altitude Control Switch
2. Localizer Switch
3. Approach Switch

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H1-452-A5

Figure 4-29.

that supplies control signals to the autopilot system. When engaged, it provides automatic elevator control for changes in angle of attack resulting from power changes or gross weight variations. The altitude at the time of engagement is the reference altitude. A slip clutch maintains reference altitude even if the control range (approximately ± 145 feet) is exceeded. The unit is controlled by an on-off switch (1, figure 4-29) located on the automatic approach and altitude control panel. This panel is mounted on the right side of the pilots' jet control panel. Placing the control switch in the ON position engages the unit.

Note

Before the altitude control unit will engage, the autopilot elevator axis must be operating (engaged).

The unit can also be used in conjunction with the autopilot to provide altitude control during the localizer phase of the ILAS approach. It allows smooth transition into the glide path phase.

Note

If the altitude control unit is used in conjunction with the automatic approach coupler during the localizer phase of the approach, it will automatically disengage when the approach function of the coupler is placed ON.

AUTOMATIC APPROACH COUPLER UNIT.

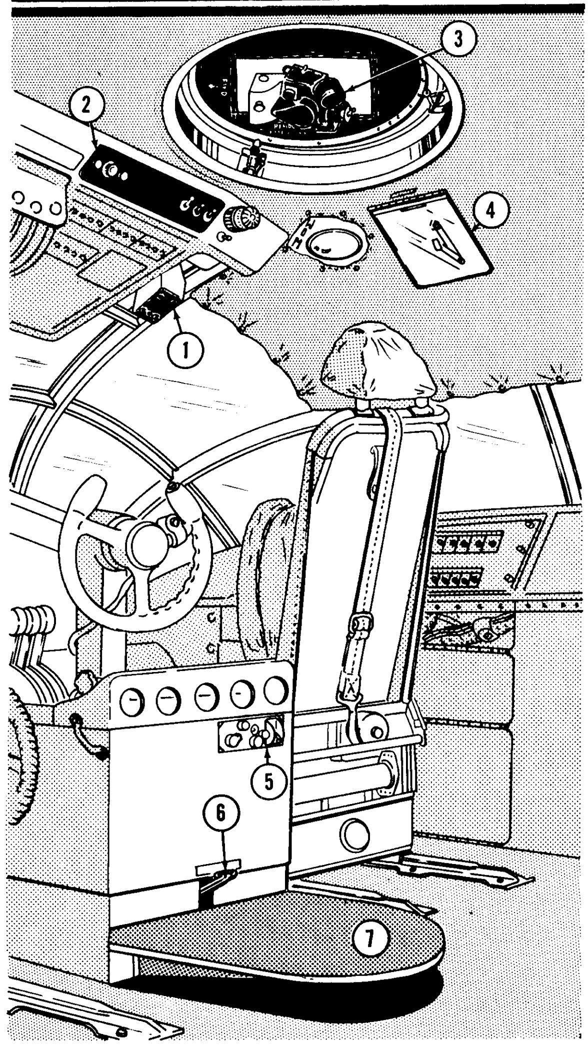
Some airplanes are equipped with an automatic approach coupler unit which provides a means of making an automatic ILAS approach. The unit consists of a localizer coupler, a glide path coupler, and two control switches. The coupler unit receives information from the glide path (AN/ARN-5B or AN/ARN-18) and the AN/ARN-14 sets. By modifying this information, the coupler provides signals to the autopilot to furnish directional guidance along the runway heading and vertical guidance down the correct descent angle to the runway.

Controls.

The coupler unit is controlled by two spring-loaded on-off switches which are located on the automatic approach and altitude control panel. This panel is mounted on the right side of the pilot's jet control panel. The switches are spring-loaded in the ON position. When the instrument approach equipment is on and the autopilot is engaged, placing a function switch in the ON position engages its function and the switch is locked in the ON position by a solenoid. Disengaging the autopilot or turning the instrument approach equipment off will disengage the coupler unit and the switch (or switches) will automatically return to OFF.

Localizer Switch. When this switch (2, figure 4-29) is locked in the ON position, the localizer function is engaged. This function supplies signals to the autopilot to hold the aircraft on the beam heading during the localizer and glide slope portions of the landing.

NAVIGATOR'S SIGHTING *Station*



1. AUTOMATIC APPROACH AND ALTITUDE CONTROL PANEL
2. NAVIGATOR'S SIGHTING STATION CONTROL PANEL
3. PERISCOPIC SEXTANT MOUNT
4. CLIP BOARD
5. PILOT'S AN/ARC-3 CONTROL PANEL
6. SIGHTING PLATFORM CONTROL LEVER
7. SIGHTING PLATFORM

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69-119-A

Figure 4-30.

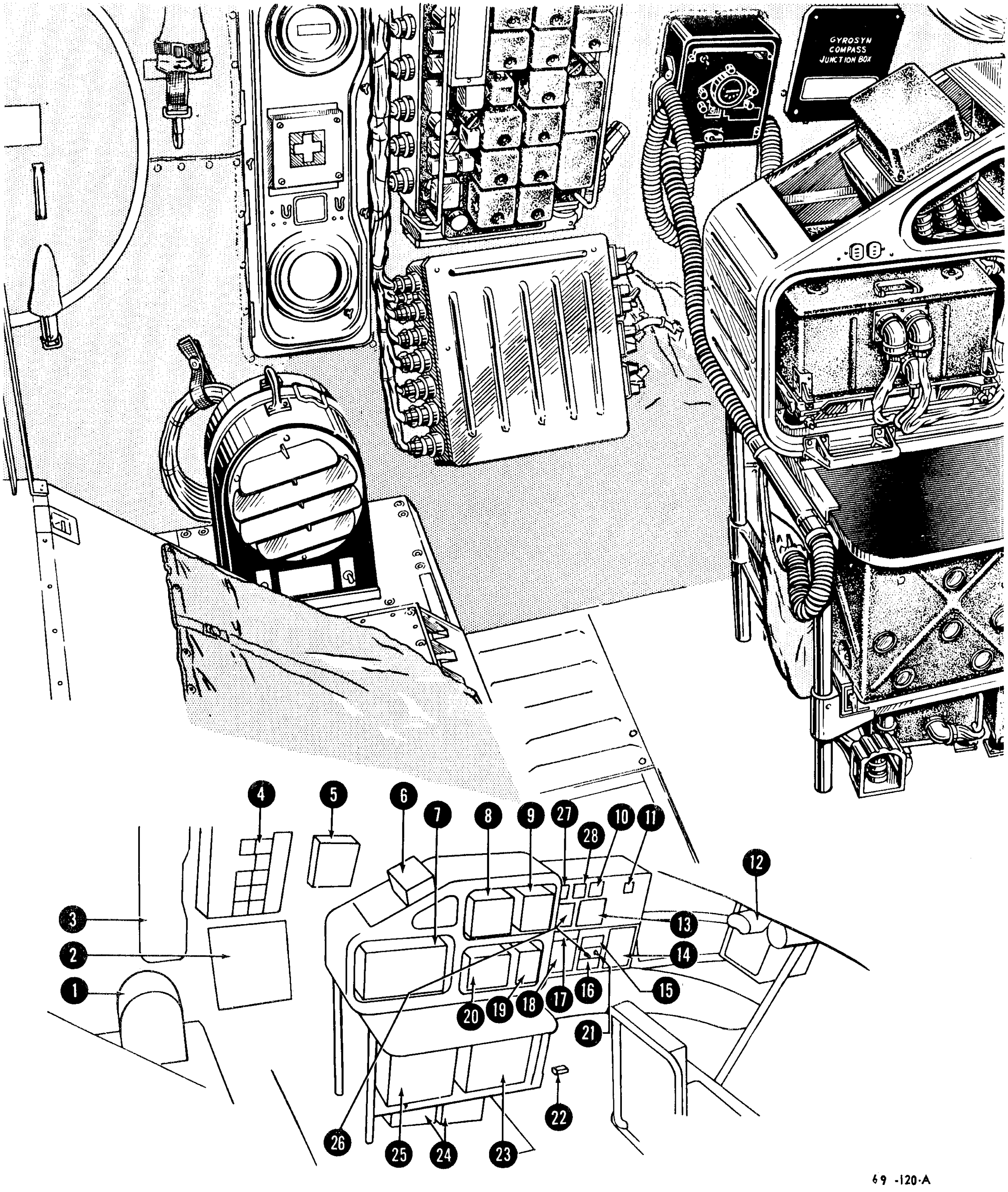
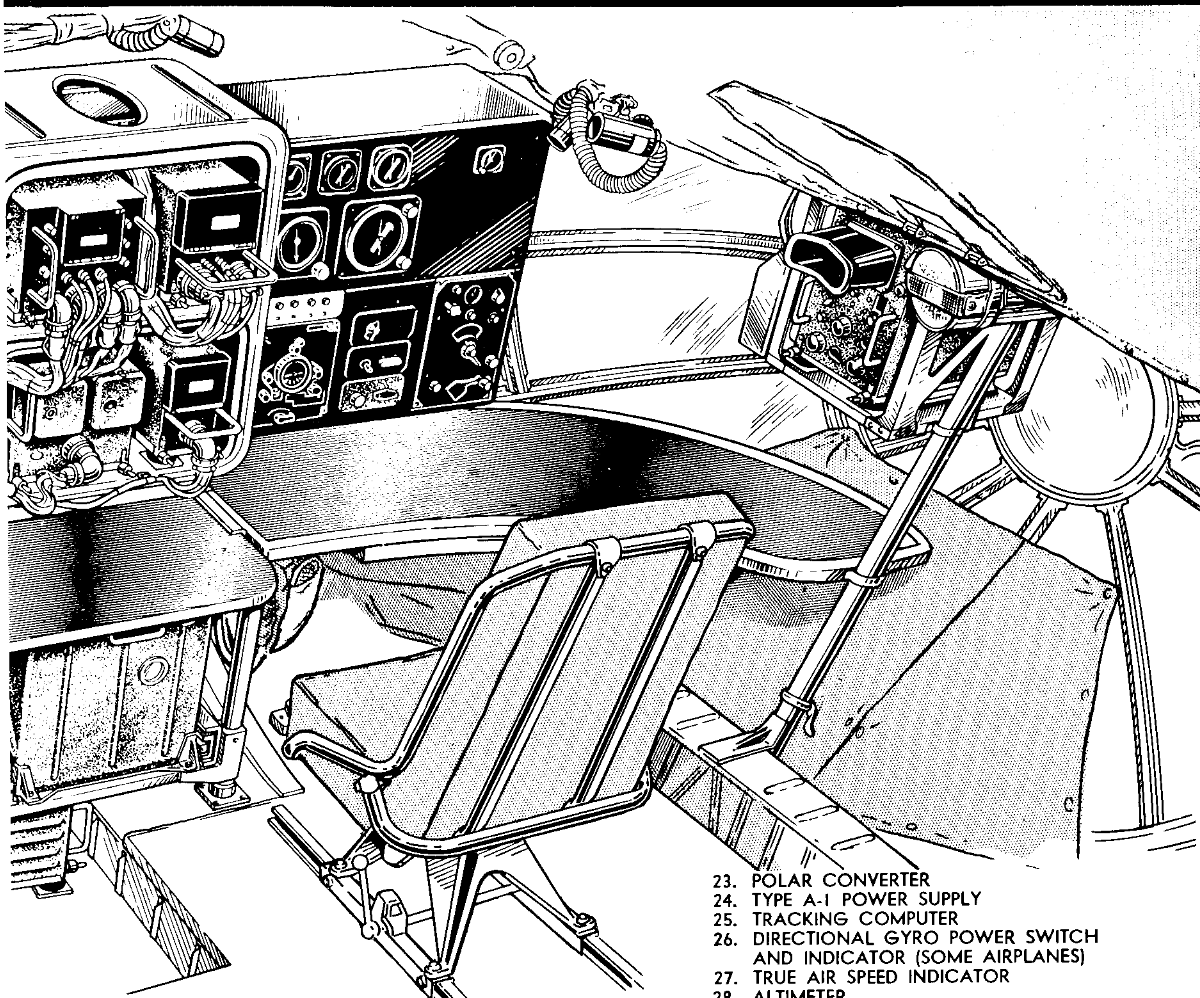


Figure 4-31. (Sheet 1)

Navigator's STATION



1. AUXILIARY CABIN HEATER
2. JUNCTION BOX
3. LEFT FWD CABIN PANEL
4. COMPUTER AMPLIFIER
5. OXYGEN REGULATOR
6. TRUE HEADING TRANSMITTER
7. BOMB RELEASE COMPUTER
8. SN-57/APQ-31 RADAR SYNCHRONIZER
9. PP-353/APQ-31 POWER SUPPLY
10. ARN-14 MAGNETIC INDICATOR
11. CLOCK
12. AN/APN-9 LORAN RECEIVER INDICATOR
13. N-1 COMPASS MASTER INDICATOR
14. RADIO COMPASS CONTROL PANEL
15. NAVIGATOR'S LIGHT SWITCH
16. INTERPHONE CONTROL PANEL
17. CIRCUIT BREAKERS
18. OXYGEN REGULATOR
19. PP-352/APQ-31 POWER SUPPLY
20. CP-53/APQ-31 AZIMUTH COMPUTER
21. N-1 COMPASS POWER SWITCH
22. NAVIGATOR'S MICROPHONE SWITCH
23. POLAR CONVERTER
24. TYPE A-1 POWER SUPPLY
25. TRACKING COMPUTER
26. DIRECTIONAL GYRO POWER SWITCH AND INDICATOR (SOME AIRPLANES)
27. TRUE AIR SPEED INDICATOR
28. ALTIMETER

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Figure 4-31. (Sheet 2)

Approach Switch. When this switch (3, figure 4-29) is locked in the ON position, the approach function of the coupler is engaged. This function provides elevation control to center the aircraft on the glide slope beam to give the correct descent angle required to land on the runway.

Operation.

1. Turn the instrument approach equipment on and engage all three axes of the autopilot.

2. When the localizer beam is intersected and the vertical needle of the course indicator leaves its full scale stop, place the localizer switch in the ON position.

Note

The altitude control unit can be used during this phase of the approach.

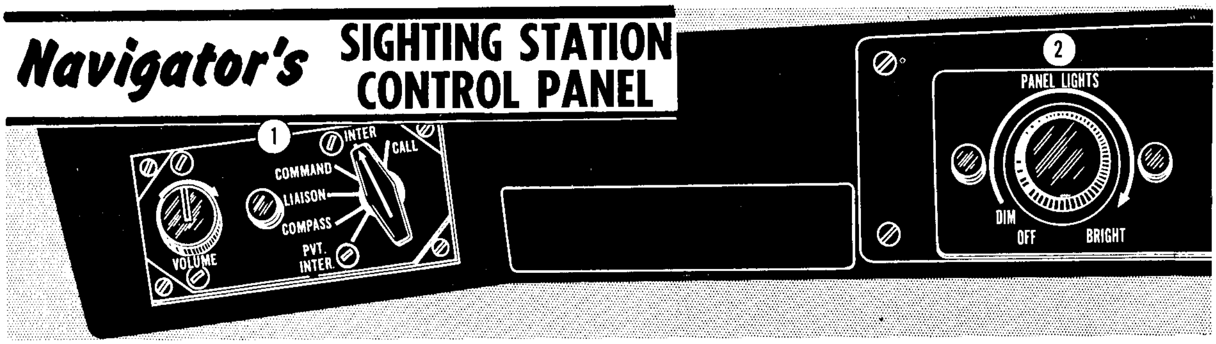

Figure 4-32. (Sheet 1)

3. When the center of the glide slope beam is intersected, place the approach switch in the ON position.

4. Maintain normal approach speeds and normal rate of descent.

5. When it is desired to control the aircraft manually, disengage the autopilot.

Note

For automatic approach procedure refer to figure 9-4.

NAVIGATION EQUIPMENT.

MAGNETIC COMPASS.

A magnetic compass is located directly above the pilots' instrument panel.

N-1 HIGH LATITUDE COMPASS.

The N-1 high latitude compass system is designed to alleviate the problems of polar navigation and to provide a source of directional reference with the degree of accuracy required by a dependent navigational system. It provides two methods of operation. When flying through the high latitudes where a magnetic compass becomes unreliable, the N-1 system operates as a directional gyro that is constantly being corrected for the effects of the rotation of the earth by a latitude correction device. On flights in the lower latitudes, the system serves as a gyro stabilized magnetic compass. The high latitude compass system includes a master indicator (13, figure 4-31) at the navigator's station, a repeater indicator (13, figure 1-8) on the pilots' instrument panel, and a flux valve located in the left wing tip. In addition the system actuates the rotating compass cards on the radio magnetic indicators at the pilots' and navigator's stations. (Refer to "Radio Receiver AN/ARN-14" in this section.)

When operating as a magnetic compass, the system is "slaved" (electrically connected) to the flux valve. The flux valve senses its position with respect to the earth's magnetic meridian, and transmits a heading signal to the master indicator. A synchronizer knob on the master indicator is used to quickly synchronize the indicator with the flux valve when the system is initially put into operation. An annunciator pointer on the master indicator shows which direction the SYNCHRONIZER knob must be turned to align the indicator with the flux valve. Movement within the small window on the master indicator shows that a misalignment is being corrected. When this movement ceases, the indicator and flux valve are synchronized.

The N-1 high latitude compass system receives electrical power through two on-off switches (21, figure 4-31) which are ganged together on the navigator's instrument panel.

Operation as a Slaved Magnetic Compass.

1. N-1 high latitude compass power switch—ON.

Note

From 10 to 15 minutes are required for the gyro to reach a synchronous speed and erect.

2. Turn the LATITUDE CORRECTION knob on the master indicator counterclockwise as far as possible.

Note

The small latitude pointer will move to the OFF position rendering the latitude correcttion device inoperative and slaving the compass to the flux valve.

Note

During flight, the compass will be temporarily deslaved by a slaving control gyro when the airplane is turning at a rate in excess of approximately 25 degrees per minute.

3. Center the annunciator pointer, using the SYNCHONIZER knob. Lack of movement in the annunciator window indicates that the flux valve and indicator are synchronized.

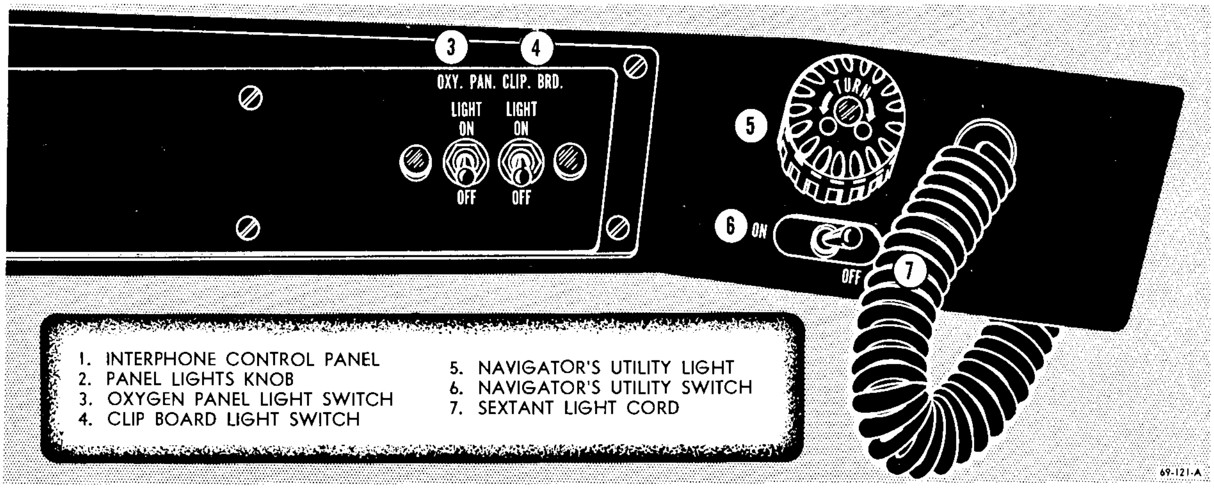

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Figure 4-32. (Sheet 2)

CAUTION

Be sure to turn the SYNCHRONIZER knob to the left or right as indicated by the annunciator pointer, since it is possible to center the pointer with the compass 180 degrees off the magnetic heading. A check with the pilots' standby compass will verify the accuracy of the adjustment.

Before flying into the regions where magnetic references become unreliable, turn the LATITUDE CORRECTION knob until the latitude pointer indicates the actual latitude. This deslaves the flux valve and starts the operation of the latitude correction device. Continual movement in the annunciator window indicates that latitude correction is being made. Except for a random wander of 1 degree or less per hour, the indicator will continue to indicate the correct magnetic heading.

CAUTION

The basic magnetic reference will be lost if the SYNCHRONIZER knob is moved.

Operation as a Directional Gyro.

1. Compass Power Switch—ON.
2. Latitude Correction Knob—Clockwise until pointer indicates latitude of aircraft position.
3. As the airplane changes latitude in flight, reset the latitude pointer to the new latitude.

Note

Setting of the mid-latitude every two degrees is sufficient for proper operation.

4. Engage and rotate the synchronizer knob to the gyro heading reference desired.

Note

Check rotation of the small white dot. The indicator rotates clockwise in northern latitudes and counterclockwise in southern latitudes.

CELESTIAL NAVIGATION PROVISIONS.

A sighting station is provided for the navigator on the flight deck between the pilots' and engineers' stations. Provisions include control panel, sighting platform, and clip board. (See figure 4-30.)

Navigator's Sighting Platform.

The sighting platform enables the navigator to position himself at a convenient height for using the periscopic sextant when it is installed at the navigator's sighting station. The platform is adjusted by a control lever (5, figure 4-30) located just above the platform floor. Raising the lever disengages lock pins from the platform track and permits the platform to be moved to the desired position. Releasing the lever locks the platform in place.

Sextant.

Stowage provisions for a periscopic sextant and support have been installed on the left side of the airplane on the floor just aft of the forward wall of the radio operator's compartment. Provisions have been made for the installation of the sextant at the navigator's sighting station (figure 4-30).

PORTABLE D-C POWER UNIT.

Provisions have been made in the aft turret bay for the stowage of a 28-volt d-c power unit consisting of a generator driven by a one-cylinder gasoline engine. The function of the unit is to furnish electric power to the airplane's d-c system for the purpose of operating the communications equipment in the event of a crash landing in a remote region. During operation the unit is connected to the airplane through a power receptacle located at the radio operator's station. The unit is started through the use of a starter plate and a rope. The output of the generator is controlled automatically.

GUNNERY EQUIPMENT.

The airplane is equipped with one nonretractable, radar-controlled, gun turret located in the tail of the airplane. The turret is controlled by an APG-32 or APG-41 radar set and is operated through controls in the aft cabin. It is equipped with two 20-mm cannon. Provisions are made in the turret for 600 rounds of ammunition per cannon. The tail gunner's station is furnished with a turret control panel and oxygen and interphone controls. The equipment is started by turning the selector switch on the control panel from OFF or WARM UP to STAND BY. The switch is then turned from STAND BY to RADAR for operation. The equipment will begin to operate after a 3-1/2 minute warm up period and can be completely stopped by turning the switch to the OFF position.

CAUTION

Before turning the selector switch to OFF, place the altitude knob in the maximum altitude position. This applies to B-2 armament equipment.

NORMAL CONTROLS.

Turret Safety Switch.

This two-position switch is located on the turret junction box. When it is ON, the 28-volt d-c circuit from the thyratron controller to the turret power switch is closed.

Turret Power Switch.

This two-position d-c switch-type circuit breaker on the turret control panel is in series with a turret safety switch in the system junction box; this switch controls all d-c power to the turret system.

Tail Turret System Selector Switch.

This four-position switch is on the tail gunner's control panel (figure 4-33) to control the turret and radar circuits. The four positions are OFF, WARM UP, STAND BY, and RADAR. All circuits are de-energized when the switch is in the OFF position. In the WARM UP position the switch supplies 120-volt single-phase a-c power to the gun and feeder heaters, the computer and resolver input unit heaters, and the heaters in the azimuth and elevation gyro.

In the STANDBY position the switch supplies power to the computer, antenna selsyns, the gyro drive selsyns, the thyratron controller, the control indicator, the frequency converter, the stow transformer, turret drive motor fields, and gyros.

The RADAR position supplies d-c power to the radar control indicator and the antenna drive motors.

A-C and D-C Power Switches (Safe-Fire).

These switches, ganged together on the control panel, have positions marked SAFE and FIRE. When the a-c switch is placed in the FIRE position, it allows a-c power to be supplied to the free fire control box circuits. When the d-c power switch is placed in the FIRE position, it turns on the gun firing circuit.

Tail Gunner's
CONTROL PANEL

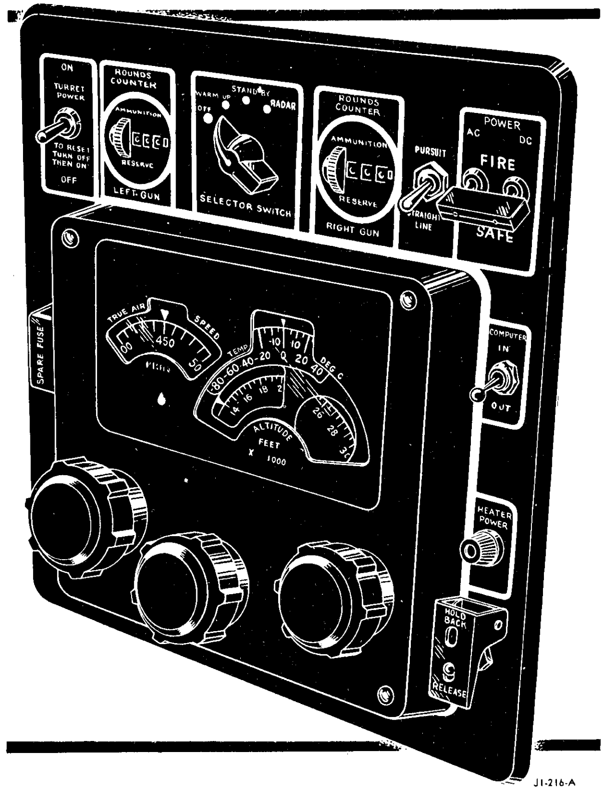

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Figure 4-33.

Placing this switch in SAFE turns off the gun firing circuit.

Note

On some airplanes the gang bar simultaneously places both switches in the SAFE position only.

Altitude-Airspeed Handset Unit.

This unit (figure 4-33) is located on the control panel. It incorporates three knobs and three dials to be used in setting up data for the computer. The dials consist of true air speed in mph, temperature in degrees centigrade, and altitude in thousands of feet. Proper setting of knobs and dials will furnish the computer with true air speed of the aircraft and air density to aid in properly computing lead prediction and ballistics corrections during turret operation.

Action Switch.

This switch is located on the antenna hand control. Actuating this switch controls the movement of the turret to follow the antenna in manually tracking a target. When the switch is released, the turret will automatically return to the stowing position.

Computer Switch.

The computer switch is a two-position switch with positions marked IN and OUT. When this switch, located on the gunner's control panel, is in the IN position, ballistic, parallax, and lead prediction are automatically computed and fed into the turret control circuit for corrected gun fire.

Attack Factor Switch.

This two-position switch, marked STRAIGHT LINE and PURSUIT, is located on the control panel. The position in which this switch is placed is determined by the type of approach being made by an attacking aircraft. The STRAIGHT LINE position provides signals to the computer to correct for a straight-line approach. The PURSUIT position provides additional signals to the computer to correct for a pursuit-curve approach.

Gun Charging Switch.

A guarded two-position switch, marked HOLD BACK and RELEASE, is located on the lower right corner of the gunner's control panel. When the switch is in the HOLD BACK position, the bolts of both guns of the turret are held back, leaving the breech empty. In the event of a gun jam, placing the switch to HOLD BACK may clear the jam. Placing the switch in RELEASE position allows normal operation of the guns.

Heater Power Fuse.

This fuse is located on the control panel. In addition, a spare fuse holder is located on the opposite side of the control panel. Insertion or removal of this fuse controls heater power to the gun and feeder heaters when required to do so.

INDICATORS.

Ammunition Counter Dials.

Two dials on the turret control panel will indicate reserve ammunition for each gun.

RADAR PRESSURIZATION.

Either one or two 115-volt, a-c motor-driven pressure pumps are located to the left and aft of the tail radar station on the right wall of the aft cabin. The pump provides pressurized air for the radio frequency unit, the modulating unit, and the radio frequency line (wave guide) of the gun laying radar set. The system is controlled by a pressure pump switch located on the pressure system indicator control. Operation of the system is identical to that of the AN/APQ-31 radar set. (Refer to "K-( ) Bombing Navigation System" of this section.)

AMPLIFIED CHECK LIST.

Tail Gunner's APG-32 Equipment Amplified Check List.

The check list which follows in an amplification of the abbreviated check list presented in "Crew Duties," Section VIII.

Visual Inspection.

1. Check with senior gunner on status of turret and gunnery equipment before commencing preflight.
2. All switches OFF or SAFE and heater fuse REMOVED.
   a. Turret power switch OFF.
   b. Selector switch OFF.
   c. Safe-fire switches SAFE.
   d. All indicator controls fully CCW.
   e. Heater power fuse REMOVED. Check for continuity.
   f. External-normal to NORMAL.
   g. Turret safety switch SAFE.
   h. Pressure system switch OFF.
   i. Computer switch OUT.
   j. Charger switch RELEASE.
3. Spare bulbs. Check spare bulbs on indicator.
4. Check desiccant. Check desiccant blue down to change line.
5. Fuses and circuit breakers.
   a. Check indicator circuit breakers IN.
   b. Right aft cabin power panel circuit breaker IN.
   c. Check fuses in right aft cabin power panel for proper rating and spares.
      (1) RCT 3 fuses - 40 amps.
      (2) Pressure pump fuse - 10 amps.
      (3) Tail radar fuse - one 10 amp, one 20 amp.

6. All units in pressurized compartment. Check electrical cables for damage and connectors for tightness. Check units for proper installation, damage and loose or missing parts.

a. Antenna hand control.

b. Range, azimuth indicator.

c. Voltage regulator.

d. Pressure pump system connections.

e. Computer, resolver input unit, and gyro drive unit.

f. System junction box and fire control box.

g. Control panel.

h. Thyratron controller.

7. Remove thyratron and radar central covers.

a. Thyratron.

(1) Check all fuses for proper installation and continuity.

(2) Check power thyratron tubes for proper installation and that tube plates are not damaged.

b. Radar central.

(1) Check all electrical cables for damage and connectors for tightness.

(2) Check that all sub-units are tight and all tube shields are in place.

(3) Check CAL-NORMAL switch to NORMAL.

(4) Check antenna control switch (S901) to ON.

(5) AFC/MANUAL switch to AFC.

(6) SCAN/CONTROL switch (S-902) for clockwise position.

8. External turret safety switch OFF.

CAUTION

This switch must always be placed to the OFF position when personnel are on or at the turret. The only exceptions to this rule are indicated on the check list (OPERATIONAL).

9. Remove gun enclosure assembly.

a. Check for dents, fasteners, clearance, and security.

b. Place the enclosure in a safe place where it will not be damaged.

10. All radar units in unpressurized compartment.

a. All cable connections at bulkhead 12 for damage.

CAUTION

At bulkhead 12, be careful not to step on cables near tail cone entrance door. These are coaxial, IFF, etc., cables which are very delicate.

b. Check pressure system lines for damage in tail cone.

c. Check wiring along fuselage to tail unit.

d. Radar modulator and RF head.

(1) Check electrical cables for damage, connectors for tightness, and units for bonding straps.

(2) Inspect hat, ring, and clamp for damage.

(3) Check for paint peeling on units.

(4) Check blowers for freedom of rotation.

e. Wave guide assembly.

(1) Check that caps on bi-directional coupler are tight.

(2) Check rubber on flexible wave guide for damage.

f. Check that antenna screen door is closed and S-1709 is in the ON position.

11. Boosters and ammo cans.

a. Check for proper rotation.

b. Check ammunition cans for cleanliness, dry condition, and damage.

12. Remove the feeder and check that the gun is cleared of the round in the chamber. Inspect that the chamber is CLEARED. If there is a round in the chamber, use the following procedure: Remove the driving spring; unlock the breechblock with the unlocking tool and extract the round.

13. Remove breechblocks and inspect guns and chargers.

a. After the gun has been cleared, remove the rear buffer assembly and breechblock group. Check gun tube for obstructions.

b. Check guns for the following:

(1) Receiver and tube clean and excess oil removed.

(a) Receiver interior for burrs, deformation, and general condition.

(b) Presence of lug on carrier slide (Rhode-Lewis or Johnson Farebox Chargers).

(2) Round sensing switch and plunger for proper spring tension.

(3) Breechblock contact properly installed and safety wired.

(4) Disassemble the breechblock and inspect for the following:

(a) Broken, loose, or worn parts.

(b) Burrs and deformation.

(c) Insulation worn or missing.

(d) All parts wiped dry and re-assembled.

(e) Reinstall the breechblock in the receiver.

(f) Replace the rear buffer and driving spring assemblies.

(5) Security of mount and attachment.

(6) Scribe marks are aligned on the magazine slide and receiver.

(7) Magazine slide anchor secured and anchor nuts tight.

(8) Firing leads moving freely for gun recoil (no clamps).

(9) Presence of cotter keys, lock washers, and safety wire.

c. Check gun chargers for the following:

(1) Security of mount and attachment.

(2) Charging stud installed and charging stud retainer in place (GE charger only).

(3) Charger switch in NEUTRAL position.

d. Check cables and AN connectors for good condition on guns and chargers.

14. Inspect feeders and link chutes. Check for the following:

a. Links or ammo in the feeder.

b. Feeder mouth for burrs and deformation.

c. Operating lever locks in down position.

d. Feeder for excess oil or grease.

e. Feeder cover or adapter of proper series.

f. Link deflectors and link chutes for obstruction or damage.

g. Link chute installed with wide side away from the feeder.

h. Cartridge guides, control pawl, and holding dog for freedom of movement.

i. Star wheels and link strippers for damage.

j. Connectors for damage.

k. Presence of cotter keys and safety wire.

15. Feeders installed and operating levers connected.

a. Install the feeder and make sure that the magazine latch locks it to the gun.

b. Connect the operating lever to the bracket on the gun and lock it.

16. Brass and ammo feed chutes.

a. Check the ammo chutes for proper mount, bent or damaged links, proper configuration, and cleanliness.

b. Check brass chutes for obstruction, damaged areas, and security of mount; check that sliding deflectors are secured; check deflector springs.

17. Limit switches, actuators, and mechanical stops. Check azimuth and elevation limit switches for security of mount, damage, and proper spring operation when actuated manually. Check actuators and mechanical stops for proper installation.

18. Selsyns and drive motors.

a. Check selsyns and selsyn caps for tightness, contactor plugs for proper installation and security, and selsyn covers for proper installation.

b. Check drive motors. Check brush holders for security of mount, electrical cables for damage, and connectors for tightness. Check security of mount.

19. Complete brass chute inspection (OUTSIDE). See paragraph 16 to complete the remainder of brass chute inspection which could not be accomplished from inside of aircraft.

20. Inspect and engage feeder winders. Inspect for the following:

a. Damaged electrical cables and tightness of connectors.

b. Security of mount and attachment.

c. Free wheeling.

d. Proper operation of locking device.

21. Complete gun and turret inspection (OUTSIDE). See paragraph 13 to complete gun inspection which could not be accomplished from inside the aircraft.

22. Turret Movement (MANUAL). Disengage turret drive motor brakes and check that turret moves smoothly and freely in azimuth and elevation.

23. Brakes locked; re-engage drive motor brakes.

Operational Check.

1. Turret clear for operation. Check that personnel and stands are cleared of turrets before operating. Be sure that turret is cleared of ammunition and that power is available. Do not load guns until operational check has been completed and units do not require maintenance.

2. Selector switch WARMUP, heater fuse IN; check heaters. When the feeder and gun heater become warm, remove the heater fuse.

CAUTION

Heaters should be left on just long enough to check operation.

External turret safety switch ON; turret power and turret safety switches ON.

3. Wave guide shutter action. Check operation of the wave guide shutter by switching from WARMUP to STANDBY to WARMUP. Have an observer check for clicking action of wave guide shutter at the transmission line.

CAUTION

Always make sure the wave guide shutter is operational before checking pressure.

4. Selector switch STANDBY. Check thyratron and all radar blowers.

a. Check the thyratron blower for operation.

b. Check radar central, RF head, and modulator external blowers for operation. Check internal blower by placing hand on unit.

CAUTION

If thyratron or any radar blowers are not operating, turn system OFF. Do not let fingers come in contact with rotary fans.

5. Thyratron timed out. After 100 ($\pm$30) seconds, check to see whether thyratron controller times out.

6. Radar central timed out. After 3 minutes and 45 (±10) seconds, check that radar central times out. Observe that the AFC XTAL current oscillates, indicating that the radar central has timed out.

7. 28.5-volt d-c check. Check line 143 at turret junction box for 28.5-volt d-c output; if necessary, adjust R-43 in thyratron controller to get desired voltage.

CAUTION

Use extreme caution to avoid shorting out other wires in turret junction box. While assistant is checking 28.5-volt d-c output at turret junction box do not close action switch.

Note

If turret junction box does not have a test jack for checking d-c voltage, use the external turret safety switch as a checking point. Voltage should read 28.5-volt dc. If no external turret safety switch is installed on the aircraft, then check test jack J-66 at the thyratron controller for 31.5-volt d-c voltage reading.

8. Selector Switch RADAR. Adjust intensity.

CAUTION

An intense spot may burn the screen of the cathode ray tube.

9. Scope Presentation.

a. Check the search pattern by observing the azimuth motion of sweep and elevation UP and DOWN lights.

b. Check jizzle width is 30 degrees.

c. Check azimuth deflection amplitude.

d. Check range sweep amplitude.

e. Check vertical and horizontal centering.

f. Check for normal ground presentation.

g. Check that the alarm lamp is lit when the sweep passes over a target or ground return.

Note

If many targets are present, the ALARM lamp may be lit continuously.

10. Indicator unit controls.

Note

Two man team needed for the following checks.

a. Check L.O. - MANUAL control. Tune manually for best targets. Maximum current and best targets should occur together, and current should be approximately .7 to .9 MA. Switch to L.O. Targets and current should be approximately the same as in MANUAL. AFC light should then be OUT.

b. Check operation of range search limit control.

(1) Turn IF gain fully clockwise.

(2) Turn range search limit fully clockwise.

(3) Depress action switch. The jizzle width should now be approximately 7 degrees and the range gate should now sweep from zero to 8000 yards repeatedly.

(4) Turn range search limit fully counterclockwise, but do not actuate the switch. The range gate should now sweep from zero to 2000 yards repeatedly.

(5) Turn range search limit fully counterclockwise, actuating the switch. The Range Gate should now disappear.

c. IF gain, alarm, AGC and lock on check.

(1) Turn IF gain control counterclockwise until targets begin to appear. Alarm light will light as targets appear.

(2) Check that the range gate locks on weak targets.

(3) Turn IF gain fully CCW, actuating the switch. Lock on strong target; observe weak targets disappear. Lock on distant target; observe that guns do not spiral or hunt.

d. Check range IN-OUT switch for proper operation.

e. Depress the search button. Check that the turret returns to stow position and the antenna goes into automatic search.

f. Check operation of long range-short range switch.

11. 1 and 31 speed operation and thyratron tubes firing.

a. Press action switch.

b. 31 speed check. Slowly move hand control; the antenna, indicator sweep, and turret should follow the hand control smoothly. Check both directions, in azimuth and elevation.

c. 1 speed check. Slew hand control; turret should follow rapidly. Check both directions in azimuth and elevation.

d. While turret is being operated, check to see that all azimuth, elevation and d-c power thyratron tubes are firing properly. No excessive overheating and no cross-firing should occur. Check for a bluish purple color while firing. No firing should occur above the plate or at the base of the tube.

Note

A pinkish orange or whitish color indicates a bad tube which should be replaced.

12. Check wave guide and RF head for RF leakage.

13. Safe-fire switches FIRE.

14. Gun charger, booster, and feeder winder operation.

a. At the turret, place charger switch to HOLD-BACK position; charger should charge and hold the breechblock to the rear position. Place switch to NEUTRAL position; the charger should release breechblock. Place the charger switch to CHARGE position; the charger should automatically charge and release breechblock.

b. At control panel, place charger switch to HOLD-BACK position. Charger should charge and hold breechblock to the rear position. Place charger switch to RELEASE position. Charger should release breechblock.

c. Press firing button. Chargers and boosters should operate and feeder winders rotate in proper direction.

15. Antenna and turret limit switches; backout and stowing circuits.

a. Press the action switch and move the antenna and turret into a limit. The turret should stop and then the antenna. Press the firing button; the boosters, chargers, and feeder winders should not operate. Check that the turret does not drift at extreme antenna position.

b. Move hand control in the opposite direction, keeping the firing button actuated. Antenna and turret should move off the limits smoothly; boosters and chargers should operate. Release the firing button and action switch; the turret should stow and the antenna should go into automatic search.

c. Repeat this procedure right and left in azimuth, up and down in elevation.

Note

Elevation turret limits may not always be actuated by use of hand control movement because of positioning of antenna limits.

16. OOSFI.

a. Depress action switch; move guns into azimuth limit.

b. Slew the guns toward opposite azimuth limit and depress firing button. Do not go into the limit.

c. Chargers and boosters should not operate until guns are within 3 degrees of alignment with antenna.

d. Repeat the above for elevation.

17. Pressure System Check.

a. Place system in SEARCH.

b. Press manual switch ON and build pressure up to "40" as indicated by tail radar pressure gage.

c. Check for leakage by observing the pressure gage. The gage reading should not drop lower than "39" within a period of 15 minutes.

d. While pressure is built up to "40," check for ballooning of flexible wave guide.

e. If leakage is within tolerance, push the DRAIN pressure button and drain pressure until gage again reads "30."

Note

The pressure will increase slightly due to heating of units, this increase in pressure will vary in different geographical locations.

18. Disconnect chargers at guns.

CAUTION

When disconnecting or reconnecting gun charger cables be sure that turret safety switch or external turret safety switch is in OFF position.

19. Firing Circuit Check.

a. Close action switch; point guns to an unrestricted area.

CAUTION

Be sure that breechblock is in battery position before inserting magic wand. Use extreme caution in placing any part of the body in front of gun muzzles.

CAUTION

Do not release action switch any time during this check.

b. Have an assistant insert firing circuit tester in tube of gun and push it against firing pin. (This will prevent firing pin from grounding out on the firing pin port.)

c. Depress firing button and have assistant check that gun fires. Check other gun by same method.

WARNING

While checking firing circuit insure that when triggers are released the firing circuit is OUT. If there is an indication that the firing circuit is still functioning after the firing button is released, get it repaired *immediately* and *do not load* the guns until it has been repaired.

d. After firing circuit check, release action switch and put system in SEARCH.

20. Reconnect chargers; safe-fire switches SAFE and safety wired in SAFE position before continuing with other checks.

21. Computer Check.

a. Range check.

(1) Computer switch IN and attack factor switch PURSUIT.

(2) Set range beyond 1000 yards. Jog RANGE IN-OUT switch downward until range gate locks on the 1000 yard marker. The computer range dial should read 1000 (± 20) yards.

(3) LOCK on the 500 yard marker. Computer range dial should read 500 (± 10) yards.

(4) With the attack factor in STRAIGHT-LINE position, the readings for 500 yard marker should

read 477 (± 10) yards. 1000 yard marker should read 982 (± 20) yards.

(5) Check ballistic dial changes with range movement.

b. Set altitude MINIMUM, air speed MAXIMUM at handset unit and lock range 1000 yard marker.

(1) Lead check. Close action switch and track steadily for some distance. Stop the hand control abruptly and observe the movement of the turret. The turret should stop when the hand control is stopped and then creep in the opposite direction. Check both directions in azimuth and elevation.

(2) Windage check. Close action switch. Move antenna as close to broadside as possible without getting turret on a limit. Place computer switch to OUT. Guns should swing slightly to the rear, place computer switch to IN. The windage correction should come back IN and move the guns slightly forward.

(3) Gravity check. Move the antenna and turret straight aft and zero degrees elevation. Move computer switch to OUT; guns should move down slightly. When the computer switch is moved IN, the guns should jump up slightly.

c. Check resolver input unit dials correspond to movements of antenna.

d. Check elevation and azimuth correction dials follow antenna movement.

e. Computer switch OUT.

f. CAL-NORMAL switch to NORMAL.

CAUTION

Do not turn selector switch to off position when action switch is actuated, as it may cause a computer malfunction.

22. All switches OFF or SAFE.

a. Turn intensity control fully counterclockwise.

b. Turret power switch OFF.

c. Selector switch OFF.

d. Turn external turret safety switch OFF.

23. Replace thyratron and radar central covers.

24. External-normal switch to EXTERNAL.

Tail Gunner's APG-41 Equipment Amplified Check List.

The check list which follows is an amplification of the check list given in "Crew Duties," Section VIII.

Visual Inspection.

1. Check turret status. Check with senior gunner on status of turret and gunnery equipment before commencing preflight.

2. All switches off or safe and heater fuse removed.

a. Selector switch OFF, turrret power switch OFF, turret safety switch OFF, safe-fire switches SAFE, computer switch OUT, external-normal switch to NORMAL, charger switch RELEASE, and heater power fuse removed (check fuse for continuity).

b. All intensity control knobs on B and C scopes, turned fully CCW.

c. All knobs on radar set control turned fully CCW.

d. Turn C-INTERVAL fully CCW.

e. ALO-MANUAL switch to MANUAL position.

f. STANDBY 1 & 2, Radar 1 & 2 to the OFF position.

g. Pressure system OFF.

3. Check desiccant (both). Check desiccant blue down to change line.

4. Fuses and circuit breakers.

a. All circuit breakers IN on the radar set control.

b. Circuit breakers IN at aft cabin power panel.

c. Check fuses at aft cabin power panel for proper rating and spares.

(1) Tail radar fuses—synchronous 10 amps, non-synchronous 20 amps.

(2) Pressure pump 2 fuses—10 amps.

(3) RCT 3 fuses—40 amps.

5. All units in pressurized compartment. Check electrical cables for damage and connectors for tightness; units for proper installation, damage, loose or missing parts.

a. Antenna hand control.

b. Azimuth elevation and range indicator.

c. Radar set control.

d. Control panel.

e. Voltage regulator tightness.

f. Pressure pump system connections.

g. Computer, resolver input unit, and gyro drive unit.

h. System junction box and fire control box.

i. Thyratron controller.

6. Remove thyratron cover; check thyratron fuses and tubes.

a. Check all fuses for proper installation and continuity.

b. Check power thyratron tubes for proper installation and tube plates are not damaged.

7. External turret safety switch OFF.

CAUTION

This switch must always be placed to the OFF position when personnel are on or at the turret. The only exceptions to this rule are indicated on the check list (OPERATIONAL).

8. Remove gun enclosure assembly.

a. Check for dents, fasteners, clearance, and security.

b. Place enclosure in a safe place where it will not be damaged.

9. Remove interconnecting group covers. Check all radar units in unpressurized compartment.

a. All cable connections at bulkhead 12 for damage.

CAUTION

At bulkhead 12, be careful not to step on cables underneath radar table near tail cone entrance door. These are coaxial, IFF, etc., cables which are very delicate.

b. Pressure system lines for damage in tail cone.

c. Wiring along fuselage to tail units.

d. Interconnecting group, 2 voltage regulators, and electrical synchronizer.

(1) Check electrical cables for damage and connectors for tightness and presence of bonding straps.

(2) Check that all subunits are tight and all tube shields are in place (radar centrals).

(3) CAL-NORMAL switch to NORMAL, antenna control switch ON, antenna scan to CW position, modulator disable switch ON, rotary wave guide switch ON, and AFC switch to AFC.

e. Radar modulators (two). Frequency converter transmitters (two).

(1) Check electrical cables for damage and connectors for tightness.

(2) Inspect hat, ring, and clamp for damage.

(3) Check for paint peeling on unit.

(4) Check blowers for freedom of rotation.

f. Wave guide assembly (two).

(1) Check caps on uni-directional coupler for tightness.

(2) Check rubber on flexible wave guides for damage.

g. Check antenna screen doors closed and S-1709 is in the ON position (two located behind antennas).

h. Switch box. Check electrical cables for damage; connectors for tightness and presence of bonding straps.

10. Boosters and ammo cans.

a. Check boosters for proper rotation.

b. Check ammunition cans for cleanliness, dry condition, and damage.

11. Remove feeders and check that guns are cleared of rounds in the chamber. Inspect that chamber is *cleared*. If there is a round in the chamber, use the following procedure: Remove driving spring, unlock the breechblock with unlocking tool, and extract the round.

12. Remove breechblocks; inspect guns and chargers.

a. After gun has been *cleared*, remove the rear buffer assembly and breechblock group. Check gun tube for obstructions.

b. Check guns for the following:

(1) Receiver and tube clean and excess oil removed.

(a) Receiver interior for burrs, deformations, and general condition.

(b) Presence of lug on carrier slide (Rhode-Lewis or Johnson Farebox Chargers).

(2) Round sensing switch and plunger for proper spring tension.

(3) Breechblock contact properly installed and safety wired.

(4) Disassemble breechblock and inspect for the following:

(a) Broken, loose, or worn parts.

(b) Burrs and deformation.

(c) Insulation worn or missing.

(d) All parts wiped dry and reassembled.

(e) Reinstall breechblock in receiver. Replace rear buffer and driving spring assemblies.

(5) Security of mount and attachment.

(6) Scribe marks are aligned on magazine slide and receiver.

(7) Magazine slide anchor is secured and anchor nuts tight.

(8) Firing leads moving freely for gun recoil (no clamps).

(9) Presence of cotter keys, lock washers, and safety wire.

c. Check gun chargers for the following:

(1) Security of mount and attachment.

(2) Charging stud is installed and charging stud retainer in place (GE charger only).

(3) Charger switch in NEUTRAL position.

d. Check cables and AN connectors for damage and proper installation on all above units.

13. Inspect feeders and link chutes.

a. Check for links or ammo in the feeder.

b. Check feeder mechanism feed mouth for burrs and deformation.

c. Check operating lever, locks in down position.

d. Check feeder for excess oil or grease.

e. Check feeder cover on adapter is of proper series.

f. Check link deflector and link chute for obstruction or damage.

g. Check link chute is installed with wide side away from the feeder.

h. Check cartridge guides, control pawl, and holding dog for freedom of movement.

i. Check connectors for damage.

j. Check star wheels and link strippers for damage.

14. Install feeder; operating levers connected.

a. Install the feeder and make sure the magazine latch locks it to the gun.

b. Connect the operating lever to the bracket on the gun and lock it.

15. Brass and ammo chutes.

a. Check ammo chutes for proper mount, bent or damaged links, configuration, and cleanliness.

b. Check brass chutes for obstructions, damaged areas and security of mount; check sliding deflectors are secured; check deflector springs.

16. Limit switches, actuators, and mechanical stops. Check azimuth and elevation switches for security of mount, damage, and proper spring operation when actuated manually. Check actuators and mechanical stops for proper installation.

17. Selsyns and drive motors.

a. Check selsyns and selsyn caps for tightness. Contactor plugs for proper installation and security. Selsyn covers for proper installation.

b. Check drive motors. Check brush holders for security of mount, electrical cables for damage, and connectors for tightness. Check security of mount.

18. Complete brass chute inspection (OUTSIDE). See paragraph 15 to complete remainder of brass chute inspection which was not accomplished from inside the aircraft.

19. Inspect and engage feeder winders. Inspect for the following:

a. Electrical cables for damage and connectors for tightness.

b. Security of mount and attachment.

c. Free wheeling.

d. Locking device proper operation.

20. Complete gun and turret inspection (OUTSIDE). See paragraphs 12, 16, and 17 to complete gun inspection which could not be accomplished from inside the aircraft.

21. Turret movement (MANUAL). Disengage turret drive motor brakes and check that turret moves smoothly and freely in azimuth and elevation.

22. Brakes locked. Re-engage turret drive motor brakes.

Operational Check.

1. Turret clear for operation. Check that personnel and stands are clear of turrets before operating. Be sure that turret is cleared of ammunition and that power is available. *Do not load guns* until operational check has been completed and units do not require maintenance.

Note

Complete operational check on RADAR 1; upon completion, check RADAR 2 and then make a dual track system check.

2. Selector switch WARMUP and heater fuse IN; check the heaters. When the feeder and gun heaters become warm, remove the heater fuse. External turret safety switch ON.

CAUTION

Heaters should be left ON just long enough to check operation.

3. Turn standby 1 and 2 switches ON; turret power and turret safety switches ON.

4. Selector switch to STANDBY. Check thyratron and all radar blowers.

a. Check thyratron blower for operation.

b. Check interconnecting group (two radar centrals) blowers. Check by placing hand near blowers.

c. Check frequency converter (RF head) (two) blowers for operation. Check to see if internal blowers are operating by placing hand on unit and check external blower by placing hand near external blower.

d. Check both modulator blowers for operation. Check to see if internal blower is operating by placing hand on unit; check external blower by placing hand near external blower.

CAUTION

If thyratron or any radar blowers are not operating, turn system off. Do not let fingers come in contact with rotary fans.

5. Rotary wave guide switch action.

a. Check radar 1 wave guide switch action by operating standby 1 switch OFF and ON.

b. Accomplish same check for radar 2 rotary wave guide switch by use of standby 2 switch.

c. Standby 1 and 2 switches must be left in ON position after checks.

d. Have assistant check for wave guide switch action at each transmission line.

CAUTION

Always make sure rotary wave guide switches are operational before checking pressure.

6. Thyratron controller timed out. After 100 (± 30) seconds, check to see if thyratron controller times out.

7. Interconnecting (two radar centrals) group times out. After approximately four minutes, observe that the AFC XTAL current oscillates, indicating that the interconnecting group has timed out.

Note

Do not turn selector switch to RADAR without the prescribed four minute warmup period.

8. 28.5-volt dc check. Check line 143 at turret junction box for 28.5-volt d-c output. If necessary adjust R-43 in thyratron controller to get desired voltage.

CAUTION

Use extreme caution to avoid shorting out other wires in turret junction box. While assistant is checking 28.5-volt d-c output at turret junction box, *do not close action switch.*

Note

If turret junction box does not have a test jack for checking d-c voltage, use the external turret safety switch as a checking point; voltage should read 28.5-volt dc. If no external turret safety switch is installed on the aircraft, then check test jack J-66 at thyratron controller for 31.5-volt d-c voltage reading.

9. Selector switch RADAR. Adjust intensity.

WARNING

If jizzle does not appear on the "B" and "C" scopes, turn the selector switch to STANDBY immediately. Notify gun laying maintenance personnel at once that equipment is inoperative. Prompt action in turning the equipment OFF when jizzle is absent may save radar set from serious damage.

10. Radar 1 switch ON and track select to LEFT position.

11. Scope presentation, radar set control, and indicator controls. Check for the following:

a. Search pattern. Observe jizzle on the "B" scope. The azimuth coverage on Radar 1 will extend from 60 degrees right to 80 degrees left. Radar 2 will extend from 60 degrees left to 80 degrees right (60 degrees left to 60 degrees right on unmodified APG-41 sets on both radars 1 and 2). The "C" scope jizzle will move on a rectangular path corresponding to the motion of the antenna.

b. Jizzle width is 45 degrees on both scopes insearch.

c. Range sweep amplitude.

d. Vertical-centering on both scopes.

e. Normal ground returns.

f. Alarm lamp is lighted. The alarm lamp should light when the sweep passes over a target or ground return.

Note

If many targets are present, the alarm light may be lighted continuously.

g. Focus.

h. Video gain controls (unnecessary on APG-41A).

i. If jizzle is present, check that jizzle is centered on scope and check MAN-TUNING and IF GAIN lamps on the radar control set are not lighted.

j. OVERLAY INTENSITY—Observe scopes to check scale brilliance. If necessary, adjust the OVERLAY INTENSITY until brilliance is satisfactory.

k. Automatic search—Put system in automatic search by pushing the SEARCH button on the control unit.

l. Check that the indicator sweep moves in synchronism with the antenna.

m. Depress action switch; the antenna dish should tilt about 1.5° as indicated by jizzle narrowing to 7°.

n. Lock radar set on a target using hand control.

Note

If necessary, jog the RANGE IN-OUT switch to lock on a target.

o. Check that the antenna does not spiral around the target. This can be checked by observing the turret is not hunting.

p. Check for AGC by noting if other target returns become dim when radar set is locked on a brilliant target.

q. Range gate check. Turn IF gain fully clockwise and RANGE SEARCH LIMIT fully counterclockwise until range gate disappears beyond 10,000 yards.

Note

Check brilliance of targets.

Now turn the RANGE SEARCH LIMIT clockwise to barely actuate the switch; the range gate should now sweep to 2000 yards. Return system to automatic search.

r. Turn the IF GAIN control clockwise and check that the targets begin to disappear until no targets are present and the ALARM light remains OFF. Check that the IF GAIN lamp is lighted at the instant the IF GAIN control is turned clockwise and its internal switch is actuated. Restore the IF GAIN control to its counterclockwise position, actuating its internal switch; the lamp should go out.

s. The AFC crystal current meter should read approximately .7 to .9 milliamps with the manual turned to OFF or AFC position.

t. Actuate the LONG-RANGE switch; observe the movement of targets indicating range increase.

12. 1 and 31 Speed Operation and Thyratron Tubes Firing.

a. Press action switch.

b. 31 speed check. Slowly move hand control, the antenna, indicator sweep and turret should follow hand control smoothly. Check both directions in azimuth and elevation.

c. 1 speed check. Slew hand control, turret should follow rapidly. Check both directions in azimuth and elevation.

d. While turret is being operated, check to see that all azimuth, elevation and d-c power thyratron tubes are firing properly. No excessive overheating and no cross-firing should occur. Check for a bluish purple color while firing. No firing above the plate or at base of tube should occur.

Note

A pinkish orange or whitish color indicates a bad tube which should be replaced.

13. Turn Radar 1 switch OFF.

14. Turn Radar 2 switch to the ON position and track select to the RIGHT position. Accomplish radar operational check of Radar 2, steps 11 through 12.

15. Dual Track System.

a. Radar 1 and 2 and standby 1 and 2 switches ON.

b. Track select in DUAL position.

c. Place both radars in SEARCH.

d. Check that both antennas rotate in synchronism; both antennas should adjust their relative position periodically.

e. Use hand control and place radar 1 in TRACK and lock on a target.

f. Depress action switch on hand control again. Radar 2 should stop searching.

g. With radar 1 in TRACK, place radar 2 in TRACK and lock on a target.

h. Check that the larger amplitude range gate is on the radar 1B scope sweep, indicating that computer is still connected to radar 1.

i. Depress SEARCH button on control unit and see that radar 1 goes into search and the range gate amplitude increases on the radar 2 sweep.

j. Lock radar 1 on a target again and see that the larger range gate is on the radar 2 sweep.

k. Depress SEARCH button once and see that radar 2 goes into SEARCH. Depress the SEARCH button again; radar 1 should go into search.

16. Pressure system check (Both).

a. Place system in SEARCH.

b. Press MANUAL switch ON and build pressure up to "40" as indicated by tail radar pressure gage.

c. Check for leakage by observing the pressure gage. The gage reading should not drop lower than "39" within a period of 15 minutes.

d. While pressure is built up to "40," check for ballooning of flexible wave guides.

e. If leakage is within tolerance, push the DRAIN pressure button and drain pressure until gauge again reads "30."

Note

The pressure will increase slightly because of heating of units; this increase in pressure will vary in different geographical locations.

17. Check wave guides, modulator, and FCT for RF leakage as indicated by hot spots or singing.

18. Safe-fire switches to FIRE.

19. Boosters and Chargers.

a. At the turret, place charger switch to HOLDBACK position; the charger should charge and hold the breechblock to the rear position. Place switch to NEUTRAL position; the charger should release breechblock. Place the charger switch to CHARGE position; the charger should automatically charge and release breechblock.

b. At the control panel, place charger switch to HOLDBACK position. Charger should charge and hold breechblock to the rear position. Place charger switch RELEASE position. Charger should release breechblock.

c. Press firing button-chargers; boosters should operate and feeder winders rotate in proper direction.

20. Turret and antenna limit switches; backout and stowing circuit.

a. Press action switch and move the antenna and turret into a limit. Turret should stop and then antenna should stop. Press the firing button; the booster and chargers should not operate. Check the turret does not drift at extreme antenna position.

b. Move hand control in the opposite direction, keeping the firing button actuated. Antenna and turret should move off the limits smoothly; booster and chargers should operate. Release the firing button and action switch; the turret should stow and antenna should go into automatic search.

c. Repeat this procedure right and left in azimuth, up and down in elevation.

Note

Elevation turret limit switches may not always be actuated by use of hand control movement due to positioning of antenna limits.

21. OOSFI.

a. Depress action switch; move guns into azimuth limit.

b. Slew the guns toward opposite azimuth limit and depress firing button. Do not go into the limit.

c. Chargers and boosters should not operate until guns are within 3 degrees of alignment with antenna.

d. Repeat same check for elevation.

22. Disconnect Chargers at Guns.

CAUTION

When disconnecting or reconnecting gun charger cables, *be sure* that turret safety switch or external turret safety switch is in OFF position.

23. Firing Circuit Check.

a. Close action switch; point guns to an unrestricted firing area.

CAUTION

Do not release action switch any time during this check.

CAUTION

Be sure that breechblock is in battery position before inserting magic wand. Use caution in placing any part of the body in front of gun muzzles.

b. Have an assistant insert firing circuit tester in tube of gun and push it against firing pin. (This will prevent firing pin from grounding out on the firing pin port.)

c. Depress firing button and have assistant check that gun fires. Check other gun by same method.

WARNING

While checking firing circuit, insure that when firing button is released that the firing circuit is OUT. If there is an indication that the firing circuit is still functioning after the firing button is released, get it repaired *immediately* and *do not load* the guns until it has been repaired.

d. After firing circuit check, release action switch and put system in SEARCH.

24. Reconnect chargers and safe-fire switches SAFE and safety wired in SAFE position before continuing with other checks.

25. Computer check.

a. Range Check.

(1) Computer switch IN and attack factor switch PURSUIT.

(2) Set the range beyond 1000 yards. Jog RANGE IN-OUT switch downward until range gate LOCKS on the 1000 yard marker. The computer range dial should read 1000 (±20) yards.

(3) Set the range beyond 500 yards; repeat the preceding step so that the range gate LOCKS on the 500 yard marker. Computer range dial should read 500 (±10) yards.

(4) With attack factor in STRAIGHT-LINE position, the readings for 500 yard marker should read 477 (±10) yards. 1000 yard marker should read 982 (±20) yards.

(5) Check ballistic dial changes with range movement.

b. Set altitude MINIMUM and air speed MAXIMUM at handset unit and lock range on 1000 yard marker.

(1) Lead check. Close action switch and track steadily for some distance. Stop the hand control abruptly and observe the movement of the turret. The turret should stop when the hand control is stopped and then creep in the opposite direction.

(2) Windage check. Close action switch. Move antenna as close to broadside as possible without getting turret on a limit. Place computer switch to OUT. Guns should swing slightly to the rear. Place computer switch to IN. The windage correction should come back IN and move the guns slightly forward.

(3) Gravity check. Stow the antenna and turret straight aft and zero degrees elevation. Move computer switch to OUT; guns should move down slightly. When the computer switch is moved to IN, the guns should jump up slightly.

c. Check resolver input unit dials correspond to movement of antenna.

d. Check elevation and azimuth correction dials follow antenna movement.

e. Computer switch OUT.

f. Cal-Normal switch to NORMAL.

CAUTION

Do not turn selector switch to OFF position when action switch is actuated as it may cause a computer malfunction.

26. All switches OFF or SAFE.

a. Turn intensity controls fully counterclockwise.

b. Turret power switch OFF.

c. Turn standby 1 and 2, radar 1 and 2 switches OFF.

d. Turn selector switch OFF.

e. Turret safety switch OFF.

f. Turn external turret safety switch OFF.

27. Replace thyratron and interconnecting group covers.

28. External-Normal switch to EXTERNAL.

LOADING AMMUNITION AND ARMING GUNS.

1. External turret safety switch OFF.

2. Inspect ammunition.

a. Check rounds and links for cleanliness, corrosion, scratches, loose primers, loose projectiles, bent or major dented cases; inspect links for broken stripping ears or bent areas.

b. Check linkage set at 2 9/32 (±1/16) inches.

c. Check that the belt is flexible and all rounds are held securely in position.

3. Load ammunition.

a. Disconnect the ammunition feed chutes from the booster assembly.

b. Remove the ammunition can covers.

c. Place the proper link end of the belt in the can first. (Make sure a round is in the double link end of the belt or a single link is bent or secured in a manner to prevent the link from catching on the ammunition feed chute.) This depends on the type of belt used.

Note

Ammunition cans will be loaded as shown by decals on the cans.

d. Lay the ammunition in the can as evenly as possible.

Note

Never fill the ammunition can so full that the can cover must be forced in place. The ammunition will be jammed.

e. When the cans are filled, thread the belt through the booster and replace the ammunition can cover; reconnect the ammunition chute.

4. Arm feeders.

a. Before loading the feeder mechanism, check that the operating lever is inserted in the operating lever bracket and the magazine latch is locking the feeder to the gun.

b. Place the proper link end of the belt into the feed mechanism. Place the rounds over the star wheel so that the link stripping ears are riding over the link strippers.

c. Wind the feeder mechanism until the clutch slips. Three links should be stripped in the process of winding the feeder mechanism.

Note

If the double link is fed into the feeder, only two links will be stripped.

5. Final turret checks. Make the final check of the drive motor brakes engaged, operating levers engaged, and driving spring retainers locked. Firing and charging leads connected. Feeder winders should be locked.

6. Replace gun enclosures and access panels.

7. Set round counters. Set at number of rounds loaded per gun.

8. External turret safety switch ON.

9. Place warning signs on control panels and forward and aft hatches. WARNING: HOT GUNS

10. Proper entry Form 1 and Form F. The senior gunner will insure that the total number of rounds loaded on the aircraft are entered on Form 1. The senior gunner will advise the flight engineer of the ammunition load so that it will be entered on Form F.

WARNING

Do not load the guns HOT.

Note

In the event circumstances necessitate postponement of the mission for more than 48 hours after the turret system preflight has been completed, the guns will be unloaded and ammunition withdrawn to the ammunition cans. The turrets will be extended, the firing circuits will be checked, and the ammunition will be reloaded into the guns within 24 hours of the rescheduled take-off time.

GUNNERY OPERATION.

In Flight Gunnery Procedures.

Prior to Take-Off. Check that all switches on the control panel are at OFF, SAFE, RELEASE, and OUT.

Gunnery Equipment Operation and Aerial Firing. Do not operate the turret or turn the firing switches ON until directed by the aircraft commander after the airplane is on the firing range. On training missions where the turret is not loaded with ammunition practice turret operation, search and fire area techniques, and target reporting.

1. Turn the external-normal switch to NORMAL and the pressure system to AUTOMATIC as soon as practical after take-off.

2. Switching procedure. Before entering a zone in which turret use is anticipated, request permission from the aircraft commander prior to energizing the RCT systems. Turn on the system and confirm by interphone. Before reaching the firing range establish the following conditions:

a. Safe-fire switches to SAFE.

b. Heater power.

(1) Turn on guns and feeder heaters no longer than 30 minutes prior to firing. Leave heaters on during firing.

(2) If condition exists where firing of guns is delayed, operate gun and feeder heaters in cycles of no longer than 30 minutes OFF and 30 minutes ON until firing is resumed. When firing is resumed, turn on heaters immediately and leave on during firing.

(3) Turn heaters off when gunnery portion of missions is completed.

c. Turret power switch to ON.

d. Round counters set at number of rounds loaded.

e. Handset unit. Adjusted in accordance with information received from the navigator. These settings will be true air speed, corrected outside air temperature, and pressure altitude.

Note

Some handset units require true air speed in KNOTS and others in MPH. Be sure to check handset unit for required type air speed before requesting air speed from navigator. If there is a change of ± 5 MPH or KNOTS, ± 500 feet of altitude or ± 5 degrees of temperature deviation from the setting on the handset unit, a new setting must be established.

f. Computer switch IN as required.

g. Attack factor switch set as required. Normally this position is PURSUIT.

h. Selector switch to STANDBY.

CAUTION

Allow four minutes for necessary warm up time delay before turning selector switch to RADAR.

i. Selector switch to RADAR.

j. Indicator unit, radar set, antenna, and turret operation checked.

k. Safe-fire switch to FIRE. Only when permission has been granted by aircraft commander and aircraft is over firing range.

CAUTION

Whether in combat or training, the following will be accomplished prior to firing. The safe-fire a-c warm-up switch requires a 3-minute warm-up period prior to firing. This applies every time the switch is turned on. (Not applicable to systems utilizing the free fire box.)

Cooling Guns and Burst Control. Conservation of equipment and other conditions require that restrictions be placed on missions conducted for training.

1. Aim guns away from own aircraft and other friendly aircraft.

2. Fire in 2- to 3- second bursts with a cooling period of 45 to 60 seconds between bursts.

Note

The purpose of the firing burst and cooling in paragraph 2 above is to conserve the life of gun tubes during training flights.

3. Aim guns to a clear area while cooling between bursts.

WARNING

Never allow guns to point to exposed parts of the aircraft at any time.

4. Aim guns to a clear area when ordered to cease firing or when gun firing has been completed.

a. Turret power switch OFF.

b. Safe-fire switch SAFE.

5. Safety precautions to avoid self-inflicted damage by runaway guns.

a. Aim guns away from own aircraft and other friendly aircraft.

b. Set safe-fire switch to SAFE and gun charger switch to HOLDBACK.

c. If above procedure does not stop runaway gun, let it fire and keep the other gun ready for action.

CAUTION

Do not release action switch or turn turret power switch off during this condition.

Gunnery Portion of Mission Completed.

1. Safe-fire switch SAFE.

2. Cool guns 20 minutes prior to stowing.

3. Turret moved to stow position and stowed.

4. All switches OFF or SAFE.

Note

Place pressure system in NEUTRAL prior to landing.

After Landing Procedures.

Before Leaving Aircraft.

1. Gun clearance procedure.

a. Check that gunnery control panel switches are OFF and turret safety switch is SAFE.

b. Place red flag with white lettered words HOT GUNS on control panel selector switch.

c. Place a larger red flag with white lettered words HOT GUNS at the forward and aft hatches.

d. Clearance of live ammunition from the guns will be accomplished by an armament analysis team only.

2. Report RCT discrepancies. Enter equipment discrepancies in Part II of Form 1. Report other discrepancies to the flight engineer.

3. Complete gunnery report forms.

Combat Operations.

The principles outlined below must be followed under combat conditions.

Approaching the Combat Area. Enroute to the target gunnery equipment will be tested and guns fired at low altitude only. You will be briefed or the aircraft commander will direct when to accomplish this operation. The tail gunner will perform the switching procedure. The guns will be positioned in an unrestricted area and test fired a short burst. So far as possible, any malfunctions indicated will be corrected. After the operation is completed, switches will be turned OFF or SAFE.

Reaching the Combat Area. When enemy fighters appear, the following conditions should prevail:

1. Gunners hand set preset in accordance with information received from the navigator. These settings will be true air speed, corrected outside air temperature, and pressure altitude.

Note

In combat, this information should be checked every 10 minutes.

2. Turret in stow position.

3. System energized.

4. Gun and feeder heaters warm; heater fuse IN as far as possible. The cycle of heater use IN for 30 minutes and OUT for 30 minutes will be followed. The fuse should be left in during firing.

5. Computer switch IN.

6. Attack factor switch set at PURSUIT.

How to Report. Target reporting will be by the clock system. Report both enemy and friendly aircraft. Talk clearly; don't shout. Use only the following standard words and phrases — no other — and make a definite pause between each phrase as indicated. Repeat each message once. "NUMBER AND TYPE, pause, CLOCK AND ELEVATION POSITION, pause, WHAT THEY ARE DOING." Never fail to report when fighters appear.

How to Fire From Radar Tail Position. Whenever an attack develops from this sector, opening fire must be performed at the maximum range of just short of 1500 yards. Firing will be in bursts of 2 to 3 seconds. A mandatory cooling period between bursts is not required. Efficient operation of the gun laying radar system requires emphasis on the following:

1. APG-32 operator must remain in search until the last possible moment. Then he must switch to hand control and lock on the target in such a manner that he can and will open fire at maximum range.

a. The APG-32 operator must be adept at interpreting the scope presentation. He must recognize the time when a fighter abandons the attack or the fighter has been hit.

b. As soon as this condition happens the operator must switch to search and be ready to immediately lock on any other target that may have appeared.

2. The manipulating of the APG-41 is slightly different from that of the APG-32.

a. Assume that both radars are in search. The operator must have one set locked on the target and open fire on this target at the maximum range. The range at which this lock-on is accomplished is not critical to the operation of this set.

b. If the search radar indicates a more dangerous target, the operator must have the ability to lock on this new target in the shortest possible time. The other set must be released to search.

Cooling Guns. During lulls in firing, sufficient control of the guns and turret must be maintained to insure that they always point at an unrestricted area (in formation). Keep guns in designated cooling position a minimum of 20 minutes prior to stowing.

After the Mission. After landing, guns must be cleared of ammunition. This requirement does not necessarily mean gunners will clear the guns of ammunition. Duration of flight and locally established policies will determine responsible personnel.

BOMBING EQUIPMENT.

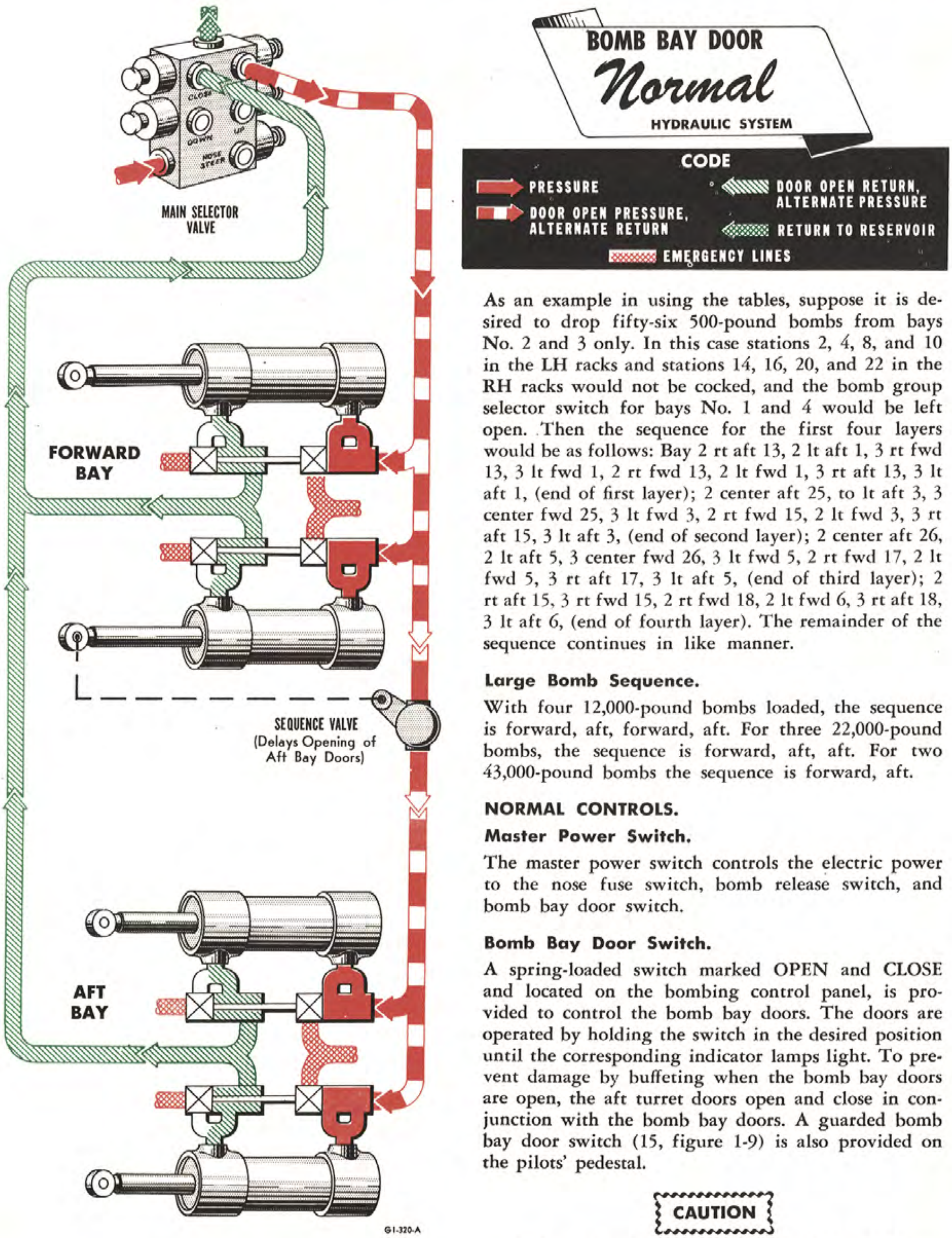
The airplane incorporates four bomb bays designed to carry varied bomb loads and various sized bombs. Provisions are made for carrying a fuel tank in bomb bay No. 3. The double-folding, gate-action bomb bay doors are hydraulically operated. (See figure 4-34.)

Thirty-six removable bomb racks of 15 different types are furnished with each airplane, allowing a number of bomb loading conditions. Design of the bombing equipment is based on 500-, 1000-, 2000-, 4000-, 12,-000-, 22,000-, and 43,000-pound bombs. However, 100-, 115-, 125-, 220-, 250-, 325-, and 350-pound bombs can be carried at the 500-pound stations. The forward section, comprising bomb bays No. 1 and No. 2, and the aft section, comprising bomb bays No. 3 and No. 4, are fitted for carrying the various 12,000-, 22,-000-, and 43,000-pound bomb loads.

The all-electric bomb release system, based on the type A-5 and S-4 bomb rack releases with controls at the radar observer's station (figure 4-36), consists of five individual circuits: a 28-volt d-c nose fuse arming circuit, a 115-volt a-c bomb indicator lamp circuit, a 28-volt d-c circuit for normal release with tail fuse automatically armed, a 28-volt d-c circuit for salvo release with tail fuse automatically safe, and a 28-volt d-c bomb bay door opening circuit. A K-( ) system consisting of a vertical periscopic bomb sight and the AN/APQ-31 radar-computer equipment is installed in the airplane. Most of the K-( ) bombing equipment is located in pressurized compartments to facilitate emergency maintenance in flight by the observer. Seven inspection windows are provided in the communication tube for checking to see if any bombs have hung or jammed in the bomb bay during a bomb drop. An aerial camera is provided in the airplane which can be used for bomb spotting. For additional information regarding the camera, refer to "Photographic Equipment" of this section.

BOMB RELEASE SEQUENCE.

The tables in figure 4-35 give the general release sequences for dropping bombs from all four bays with all releases installed and cocked. Beginning at the top of the first column, as shown, the sequence passes from rack to rack, firing the lowest release in each rack. When the first layer has been fired in this manner, the rack sequence is repeated again, firing the second release in each rack and so on until all releases have been operated. The sequence is always from rack to rack; two releases on the same rack are never fired in succession, and a rack is not by-passed in the sequence until all releases on that rack have been fired. Although all the releases installed in the airplane are not cocked simultaneously in any normal loading condition, the sequence is given in this manner to cover all conditions. For any particular loading configuration, only the releases to be used will be cocked. In using the tables when an uncocked release is encountered, pass on to the next release in that rack. If any of the four bays are not used, the racks in the unused bays will be by-passed in the sequence. For a mixed load, the sequence can be determined by combining information from the two tables.



G1-320-A

Figure 4-34.

As an example in using the tables, suppose it is desired to drop fifty-six 500-pound bombs from bays No. 2 and 3 only. In this case stations 2, 4, 8, and 10 in the LH racks and stations 14, 16, 20, and 22 in the RH racks would not be cocked, and the bomb group selector switch for bays No. 1 and 4 would be left open. Then the sequence for the first four layers would be as follows: Bay 2 rt aft 13, 2 lt aft 1, 3 rt fwd 13, 3 lt fwd 1, 2 rt fwd 13, 2 lt fwd 1, 3 rt aft 13, 3 lt aft 1, (end of first layer); 2 center aft 25, to lt aft 3, 3 center fwd 25, 3 lt fwd 3, 2 rt fwd 15, 2 lt fwd 3, 3 rt aft 15, 3 lt aft 3, (end of second layer); 2 center aft 26, 2 lt aft 5, 3 center fwd 26, 3 lt fwd 5, 2 rt fwd 17, 2 lt fwd 5, 3 rt aft 17, 3 lt aft 5, (end of third layer); 2 rt aft 15, 3 rt fwd 15, 2 rt fwd 18, 2 lt fwd 6, 3 rt aft 18, 3 lt aft 6, (end of fourth layer). The remainder of the sequence continues in like manner.

Large Bomb Sequence.

With four 12,000-pound bombs loaded, the sequence is forward, aft, forward, aft. For three 22,000-pound bombs, the sequence is forward, aft, aft. For two 43,000-pound bombs the sequence is forward, aft.

NORMAL CONTROLS.

Master Power Switch.

The master power switch controls the electric power to the nose fuse switch, bomb release switch, and bomb bay door switch.

Bomb Bay Door Switch.

A spring-loaded switch marked OPEN and CLOSE and located on the bombing control panel, is provided to control the bomb bay doors. The doors are operated by holding the switch in the desired position until the corresponding indicator lamps light. To prevent damage by buffeting when the bomb bay doors are open, the aft turret doors open and close in conjunction with the bomb bay doors. A guarded bomb bay door switch (15, figure 1-9) is also provided on the pilots' pedestal.

CAUTION

The turret door interlocking switch, which is located on bulkhead 8.0 d-c power panel,

500 AND 1000 POUND BOMB RACK INSTALLATION

START DOWN THIS COLUMN

SEQUENCE OF RELEASES ON EACH RACK

RACK TO RACK SEQUENCE

BAY	LOC. OF RACK IN BAY	RELEASE STATION NUMBERS														
4	RT. AFT	13	14	15	16	17	18	19	20	21	22	*28	23	*29	24	*30
1	RT. FWD.	13	14	15	16	17	18	19	20	21	22	*28	23	*29	24	*30
4	LT. AFT.	1	2	3	4	5	6	7	8	9	10	11	12			
1	LT. FWD.	1	2	3	4	5	6	7	8	9	10	11	12			
4	RT. FWD.	13	14	15	16	17	18	19	20	21	22	*28	23	*29	24	*30
1	RT. AFT	13	14	15	16	17	18	19	20	21	22	*28	23	*29	24	*30
4	LT. FWD.	1	2	3	4	5	6	7	8	9	10	11	12			
1	LT. AFT	1	2	3	4	5	6	7	8	9	10	11	12			
2	RT. AFT	13	14	*25	*26	15	16	17	*27							
2	LT. AFT	1	2	3	4	5										
3	RT. FWD.	13	14	*25	*26	15	16	17	*27							
3	LT. FWD.	1	2	3	4	5										
2	RT. FWD.	13	14	15	16	17	18	19	20	21	22	*28	23	*29	24	*30
2	LT. FWD.	1	2	3	4	5	6	7	8	9	10	11	12			
3	RT. AFT	13	14	15	16	17	18	19	20	21	22	*28	23	*29	24	*30
3	LT. AFT	1	2	3	4	5	6	7	8	9	10	11	12			END

*RELEASE IN ADJACENT CENTER RACK

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Figure 4-35. (Sheet 1) Bomb Sequence Tables

must be ON during flight for simultaneous operation of the aft turret doors and the bomb bay doors.

Bomb Bay Selector Switches.

Three on-off switches, one each for bomb bays No. 2 and 3 and a single switch for bomb bays No. 1 and 4, are provided on the bombing control panel to set up the release circuit to the bomb racks when a normal bomb load is being carried. When large bombs are being carried, the No. 2 switch is used for the forward section, which includes bomb bays No. 1 and 2; and the No. 3 switch is used for the aft section, which includes bomb bays No. 3 and 4.

Nose Fuse Switch.

This switch, marked SAFE and ARM, is provided to arm the nose fuses from the bombing control panel. All bombs can be armed simultaneously with this switch. When the switch is in the SAFE position during normal release, only the tail fuses will be armed. During salvo the tail fuse will be automatically safe and the nose fuse will either be armed or safe, depending on the position in which the nose fuse switch is placed.

Bomb Interval Control Panel.

A type B-3A bomb release interval control (13, figure 4-36) is located adjacent to the bombing control panel.

Bomb Release Switch.

A type D-2 switch is provided for releasing the bombs. The switch, stowed forward of the radar observer's table, is equipped with a long cord so that it can be removed and held in the hand for operational purposes. The bombs are released when the switch is depressed.

Bomb Bay Door Safety Switch.

A two-position on-off safety switch (26, figure 4-36) is provided at the radar observer's station to prevent injury to personnel by the inadvertent closing or opening of the bomb bay doors during ground checking of the K-( ) system. The guarded safety position is marked DOORS SAFE. When the switch is in this position, the K-( ) bombing system will not operate the bomb bay doors. When the switch is placed in the DOORS OPERABLE position, operation of the bomb bay doors is automatically controlled by the K-( ) system.

2000 AND 4000 POUND BOMB RACK INSTALLATION

START DOWN THIS COLUMN

SEQUENCE OF RELEASES ON EACH RACK

RACK TO RACK SEQUENCE

BAY	LOC. OF RACK IN BAY	RELEASE STATION NUMBERS					
4	RIGHT	35	36	37	38	39	40
1	RIGHT	35	36	37	38	39	40
4	LEFT	31	32	33	34		
1	LEFT	31	32	33	34		
2	RIGHT	35	36	37	38	39	40
2	LEFT	31	32	33	34		
3	RIGHT	35	36	37	38	39	40
3	LEFT	31	32	33	34		END

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Figure 4-35. (Sheet 2) Bomb Sequence Tables

CAUTION

Except during a radar bombing run, the switch must always be in the guarded DOORS SAFE position. If left in the DOORS OPERABLE position and an attempt is made to open the bomb bay doors with the bomb bay door switch, the doors will go to an intermediate position. If this condition occurs and is not immediately recognized, the hydraulic pumps will burn out, because the pump motors will continue to operate even after the bomb bay door switch is released. To correct this condition, place the safety switch in the DOORS SAFE position.

Note

The above condition is caused by the following electrical configuration. When in the DOORS OPERABLE position, the bomb bay door safety switch produces a continuous door-closed signal unless broken by the door-closed limit switches. If the bomb bay door switch is actuated, the doors will start to open and will make contact with the closed limit switches. This causes a door-closed and a door-open signal to be sent simultaneously, resulting in the doors' stopping at an intermediate position. In this condition, the pumps will operate continuously.

Bomb Station Indicator Lights Switch.

This switch is located on the bombing control panel. When this switch is placed ON, each indicator light will burn as long as its bomb rack release unit is cocked.

Bomb Station Indicator Light Test Switch.

This switch is provided on the bombing control panel to test all bomb station indicator lights.

INDICATORS.

Bomb Bay Door Lamps.

Five bomb bay door lamps, three for OPEN and two for CLOSE, give visual indication of bomb bay door position. The three OPEN lamps are wired through the rack selector switch-type circuit breakers in the bomb bays.

The OPEN lamps glow continuously when the doors are fully open. The CLOSE lamps glow when the doors reach their full-closed position but go out when the bomb bay door switch is released. The light will glow at any time the doors are fully closed and the switch is held in the CLOSE position.

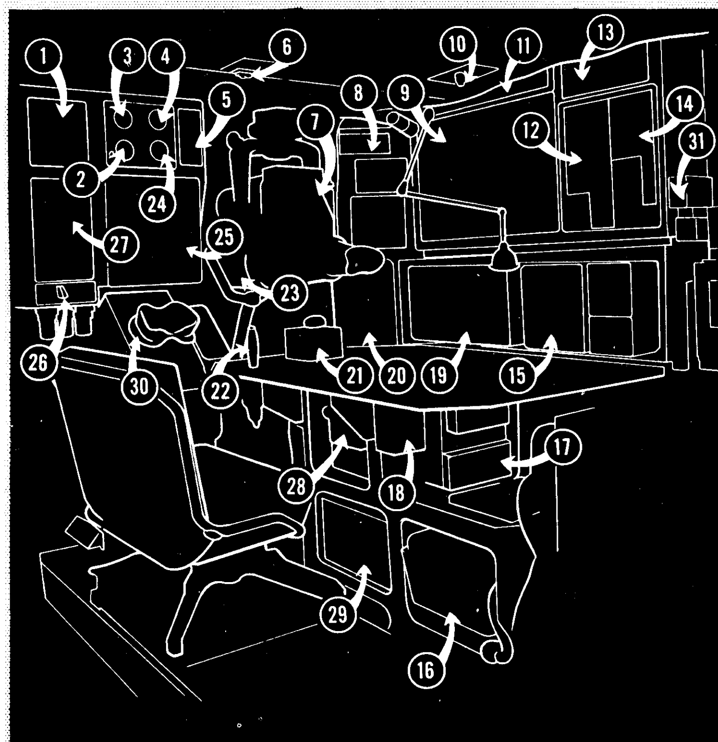
Note

If the closed indicator lamps continue to burn after the bomb bay door switch has been released, check the position of the bomb bay door safety switch at the radar observer's station.

Bomb Bay Door Ready Lamp.

This lamp, located adjacent to the bomb bay door safety switch (26, figure 4-36), lights when the bomb bay doors can be operated by the K-( ) system.

RADAR OBSERVER'S *Station*



1. H-1 LINE OF SIGHT CONTROL
2. TIME-TO-GO INDICATOR
3. GYRO COMPASS
4. TRUE AIRSPEED INDICATOR
5. RADAR PRESSURIZATION CONTROLS
6. P-8 RADAR CAMERA CONTROL
7. RADAR SCOPE CAMERA
8. OXYGEN AND INTERPHONE CONTROLS
9. BOMBING CONTROL PANEL
10. C-412/APS-23 CONTROL UNIT
11. CIRCUIT BREAKER PANEL
12. AUXILIARY BOMBING CONTROLS
13. BOMB INTERVAL RELEASE CONTROL
14. CAMERA CONTROLS
15. POLAR NAVIGATION CONTROL
16. SN-47( )/APS-23 SYNCHRONIZER
17. J-218A/APS-23 JUNCTION BOX
18. VARIABLE AUTO TRANSFORMER
19. NAVIGATION CONTROL
20. C-1 BALLISTICS CONTROL
21. E-2 TURN CONTROLLER
22. TRACKING CONTROL
23. ID-218/APS-23 INDICATOR
24. RADAR PRESSURE GAGE
25. C-413/APS-23 INDICATOR
26. BOMB BAY DOORS SAFETY SWITCH
27. B-1 PRIMARY CONTROL
28. AM-193A/APS-23 SERVO AMPLIFIER
29. PP-259( )/APS-23 RECTIFIER POWER UNIT
30. K-( ) BOMBSIGHT
31. BOMB SCORING TONE CONTROL BOX

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Figure 4-36. (Sheet 1)

Nose Fuse Lights.

This light, when on, indicates that the bomb nose fuses are armed.

Bomb Station Indicator Lights.

One hundred and thirty-two bomb station indicator lights, one for each station, are located on the bombing control panel. Each light will burn as long as its bomb rack release unit is cocked. Each light will go out as the bomb at its station is released.

Bomb-Size Indicators.

Four bomb-size indicators, one for each bomb bay, can be set manually to show the size of bombs loaded in each bay.

HYDRAULIC FLUID TEMPERATURE CONTROL.

Provisions for maintaining proper hydraulic fluid temperatures for operation of the bomb bay doors are incorporated in the main hydraulic system.

Operation of the system is fully automatic, provided the switch-type circuit breaker (7, figure 1-20) on the engineers' auxiliary panel is in the ON position. In this condition a circuit is set up to a thermal switch located in the system. The switch then reacts to hydraulic fluid temperatures as follows: When the fluid temperature drops to approximately —18°C (0°F), the thermal switch engages. This in turn starts one of the main hydraulic pump motors and energizes the door-close solenoid of the main selector valve. Fluid is then circulated through the system until it

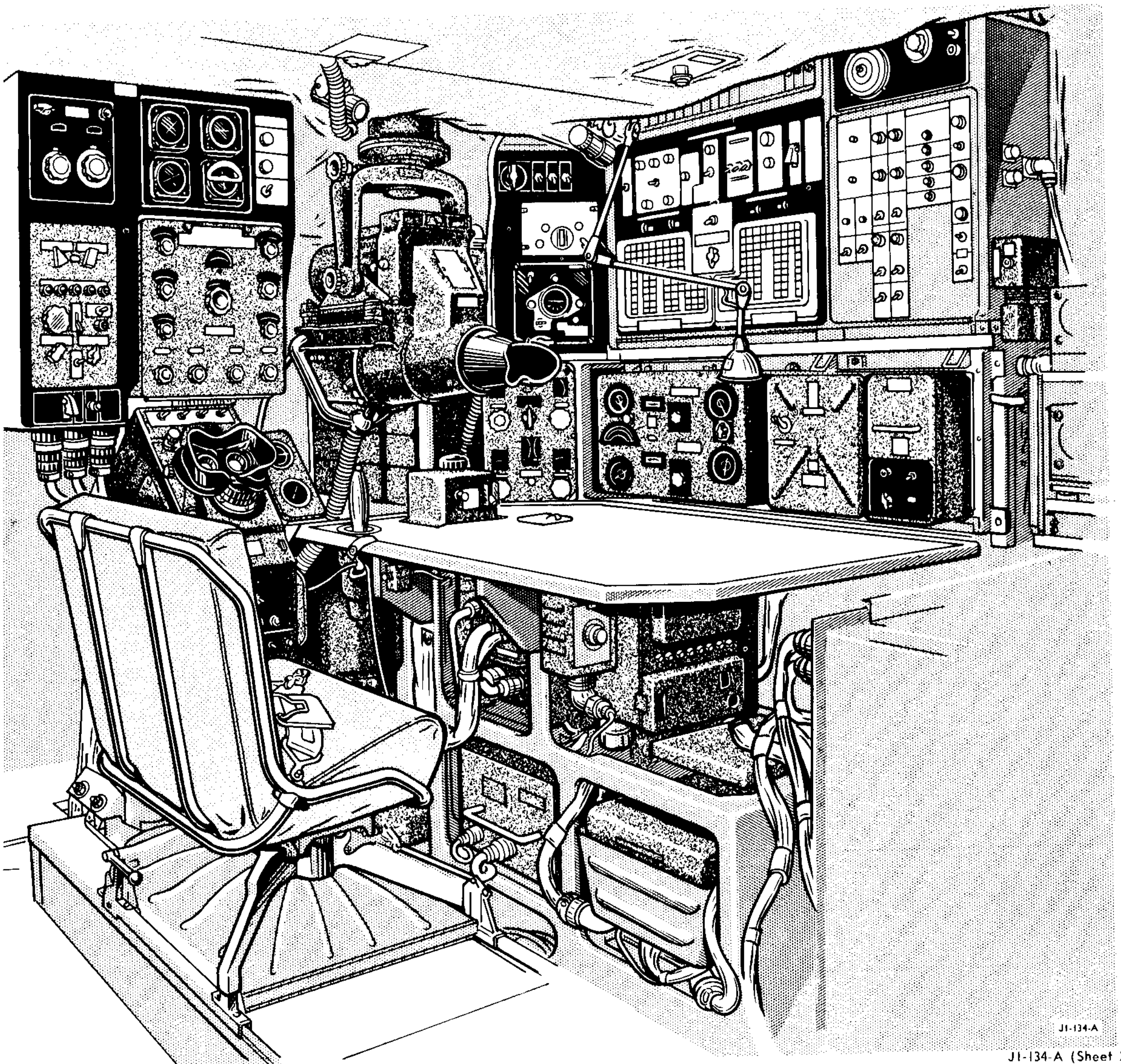

J1-134-A (Sheet 2)

Figure 4-36. (Sheet 2)

reaches a temperature of approximately 38°C (100°F) at which time the thermal switch opens, the pump stops, and the door-close solenoid is de-energized.

Note

Actuation of a bomb bay door switch will render the hydraulic fluid temperature control inoperative.

EMERGENCY RELEASE CONTROLS.

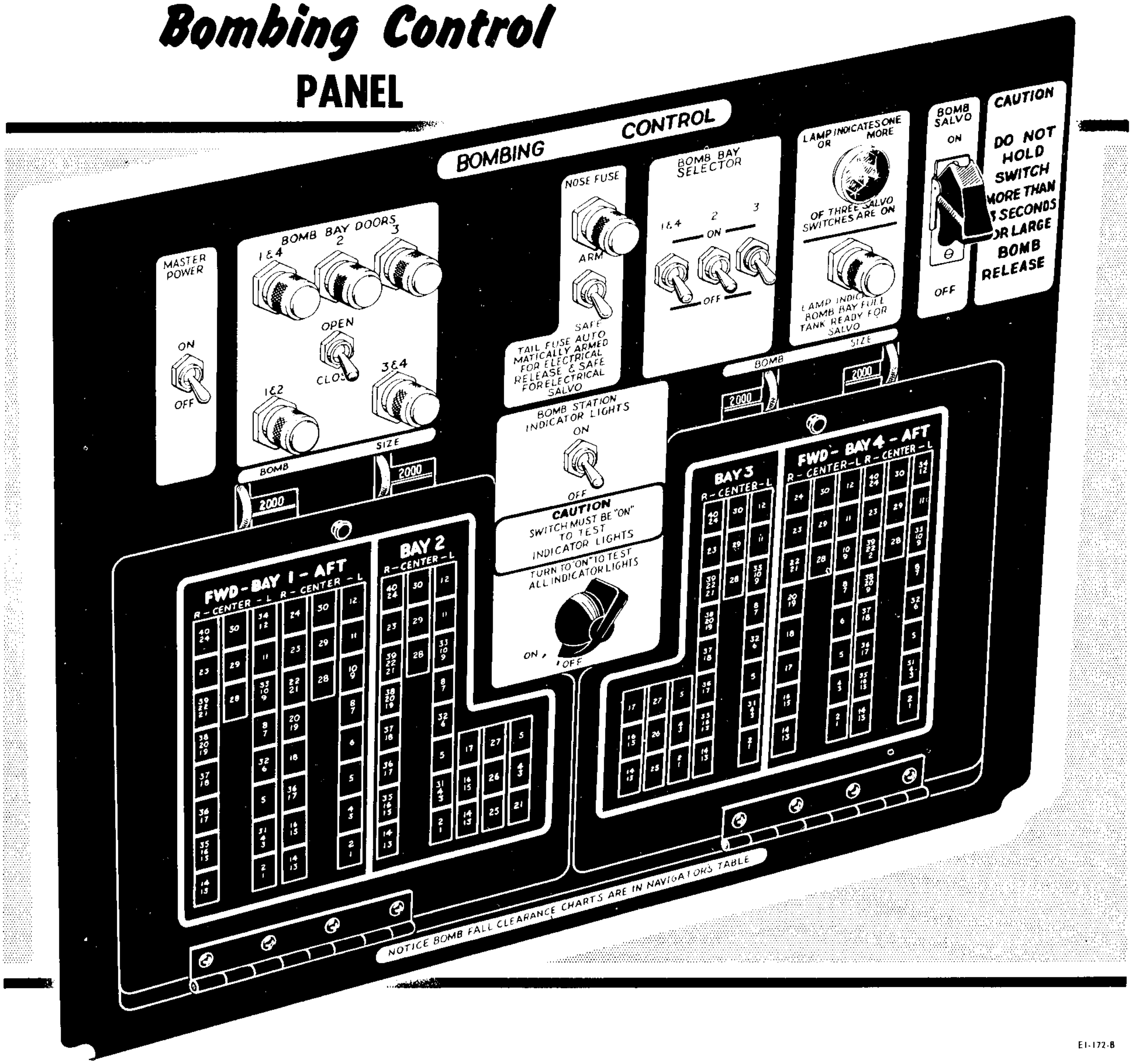
Bomb Salvo Switches.

Two bomb salvo switches are provided: one each at the pilot's and the radar observer's stations. Each switch has a spring-loaded ON position and OFF position. Holding either switch in the ON position de-energizes the K-system bomb bay door safety circuit, opens the bomb bay doors, and releases the bombs with the tail fuses safe.

Note

If the radar observer's bomb salvo circuit breaker is pulled and the bomb bay doors are closed, the bombs cannot be salvoed by the pilot's salvo switch. If, however, the bomb bay doors are open and the radar observer's circuit breaker is pulled, the bombs can be salvoed by holding the pilots' salvo switch in the ON position.

Bombing Control PANEL



EI-172-B

Figure 4-37.

If a bomb bay fuel tank is being carried, it can be salvoed with the bombs, provided the bomb bay tank release selector switch (16, figure 1-9) is in the CAN SALVO position. A lamp adjacent to each salvo switch will light when the salvo cycle begins and will go out when the bombs are salvoed and the bomb bay doors are closed.

Note

The bomb bay doors must be closed with the bomb bay door switches after salvo.

BOMB RELEASE.

The bombs can be released individually, in train, in salvo, by radar, and pneumatically. To maintain airplane trim during bomb release, the release circuits in bays 1 and 4 are set up so that if bombs are released from either bay, an equivalent is released from the other. Because of this arrangement it is necessary to select either bay 2 or 3 when single release is desired. For train release any of the four bays can be used.

The bombs can be salvoed from either the pilots' or the radar observer's station. If desired, the bomb bay fuel tank can be salvoed in conjunction with the bombs.

Single Release.

To set up the radar observer's station for single release, proceed as follows:

1. Master power switch—ON.
2. Bomb bay selector switch (No. 2 and 3)—ON.
3. Release transfer switch (located on the auxiliary bomb control panel)—BOMB RACK RELEASE.
4. Interval control switch—SEL.
5. Nose fuse switch—ARM.
6. Bomb bay door safety switch—DOORS SAFE.
7. Bomb bay door switch—OPEN.
8. D-2 release switch—Depress to release bombs.

Train Release.

To release the bombs in train, proceed as follows:

1. Master power switch—ON.
2. Bomb bay selector switch—ON for desired bays.
3. Release transfer switch (located on the auxiliary control panel)—BOMB RACK RELEASE.
4. Interval control switch—TRAIN, and set in desired spacing and number of bombs.
5. Nose fuse switch—ARM.
6. Bomb bay door safety switch—DOORS SAFE.
7. Bomb bay door switch—OPEN.
8. D-2 bomb release switch — Depress to release bombs.

Salvo Release.

To salvo the bombs, proceed as follows:

1. Pilots' and radar observer's salvo circuit breakers —Pushed in.
2. Bomb bay fuel tank release switch—NO SALVO.
3. Bomb salvo switch—Momentarily ON.

Note

Once the salvo circuit is completed, it takes approximately 3 seconds to salvo the bombs. To stop the salvo cycle, reactuate either of the salvo switches.

WARNING

If two salvo switches are actuated at approximately the same time, the salvo either will not occur or will be incomplete; therefore, only one salvo switch must be actuated when it is necessary to salvo bombs.

4. Bomb bay door switch—CLOSE.

WARNING

The bomb salvo switch-type circuit breakers located at 6.0 and 8.0 in the bomb bay must be ON because all electrical impulses to the racks go through these switches.

Note

In the event of electrical power failure the bombs may be salvoed by first pumping the bomb bay doors open manually and then actuating the salvo switch by use of battery power. After the salvo has been completed the bomb bay doors should be pumped closed.

Radar Release.

For information on radar release of bombs, refer to "Radar Observer," Section VIII. For preflight checks of the system refer to "K-( ) Bombing-Navigation System" of this section.

Pneumatic Release.

For information on pneumatic release, refer to "Special Bombing System" of this section.

BOMB BAY FUEL TANK SALVO RELEASE.

To salvo the bomb bay fuel tank, proceed as follows:

1. Bomb Bay Fuel Tank Booster Pump Switch—OFF.
2. Bomb Bay Fuel Tank Valve—CLOSE.
3. Pilots' and Radar Observer's Salvo Circuit Breakers—Pushed in.
4. Bomb Bay Fuel Tank Release Selector Switch—CAN SALVO.
5. Bomb Salvo Switch—Momentarily ON.
6. Bomb Bay Door Switch—CLOSE.

WARNING

The bomb salvo switch-type circuit breakers in the bomb bay must be ON because all electrical impulses to the racks go through these switches.

RADAR BOMB SCORING TONE DEVICE.

The radar bomb scoring tone device eliminates the possibility of human error in radar bomb scoring for training crews. The bomb scoring tone control box has a spring-loaded on-off toggle switch, two connector mounting type sealed relays, and an indicator light. It is located adjacent to the radar observer's auxiliary control panel.

To operate the bomb scoring tone device, proceed as follows: Press the spring-loaded toggle switch to the ON position momentarily. This action starts a 1000-cycle tone from either command set transmitter and lights the tone control box indicator lamp. The tone will remain on until a bomb release signal is received at the tone control box. This signal stops the tone and turns off the indicator lamp. The tone may also be stopped by momentarily pressing the spring-loaded switch to the OFF position.

CAUTION

If bombs are aboard the aircraft the RBS safety check list under "Radar Observer," Section VIII, will be accomplished prior to the tone check.

K-( ) BOMBING-NAVIGATION SYSTEM.

The K-( ) system functions either optically or by radar to locate and bomb targets. It also records the position of the aircraft in flight. The system incorporates a polar navigation attachment which enables the radar observer to assist the navigator during polar flights.

Radar Observer's Preflight Check.

The following list is an abbreviated preflight check list. For a comprehensive preflight of the K-( ) system, refer to the observer's manual.

1. Preliminary Inspection:
   a. External and safety check—Complete.
   b. Bomb bay and radome check—Complete.
   c. Forward cabin—Check.
2. Preoperational Check Control Knob Setting Check:
   a. Control unit—Checked.
   b. Indicator—Checked.
   c. Variac—Checked.
   d. Primary control—Checked.
   e. Line of sight—Checked.
   f. Ballistics control—Checked.
   g. Navigation control—Checked.
   h. Polar navigation unit—Checked.
   i. Periscope—Checked.
3. Turn-On:
   a. One to five minute check—Completed.
   b. Auxiliary equipment check—Completed.
   c. Radar voltage check—Completed.
4. Radar Operation Check—Completed.
5. Computer Operation:
   a. Polar navigation control check—Completed.
   b. Computer voltage and TAS—Completed.
   c. Optics, LOS, and forward sighting check—Completed.
   d. Optics tracking and memory point check—Completed.
   e. PPI tracking, memory point, and 0-15 camera check—Completed.
   f. RAI tracking, memory point, and Y-3 camera check—Completed.
   g. Tracking control, fix dials, and offset sector check—Completed.
   h. Offset sighting check—Completed.
   i. Radar altitude and emergency bombing check—Completed.
   j. Navigation unit and pressure check—Completed.
   k. APS/23—Off.
6. Ballistics and Bomb Release Check:
   a. Tone check—Completed.
   b. Ballistics and bomb release check—Completed.
   c. Vertical camera check—Complete
   d. Release angle and bomb rack check—Completed.
   e. Autopilot second station check—Completed.
   f. Bombing problem check—Completed.
7. Function Switch and K-3 Preheat—Off.
8. Bomb Bay and Camera Doors—Closed.
9. Bombing Switches and Circuit Breakers—Off.
10. Periscope Dome Cover—Replaced.
11. Form 1 and Radar Maintenance Form—Completed.

Radar Observer's Day-of-Flight Check.

Abbreviated Day-of-Flight Check List.

1. Preoperational Check—Completed.
2. Turn-On and Voltage Check—Completed.
3. Radar Operation Check—Completed.
4. Computer Operation Check—Completed.
5. Ballistics, Bomb Release, and Vertical Camera Check—Completed.
6. Bomb Rack Check—Completed (optional).
7. Bombing Problem Check—Completed (optional).
8. Turn-Off—Completed.

Expanded Day-of-Flight Check List.

1. Preoperational Check:
   a. APS/23 Switches OFF or properly positioned.
   b. Computer switches OFF or properly positioned.
2. Turn-On and Voltage Check:
   a. One to five minute check:
      (1) Stabilization power supply voltage check (STAB position).
      (2) Initial radar voltage check.
      (3) Heading and mag var check.

(4) Auxiliary equipment check. (Pressure pump, RT unit and modulator blowers, spare amplifiers, and desiccant.)

b. Radar voltage check.

3. Radar Operation Check:

a. Check for picture, range marks, etc.

4. Computer Operation Check:

a. Turn function switch to NAV and check voltages and TAS.

b. Optics, LOS, and forward sighting checks.

c. Lat-Long counter drive check.

d. Offset sighting check.

e. Radar altitude check. (Set on 5000 feet.)

f. Pressure check (optional).

g. Memory point and optical tracking check. (Set ramp in counters; turn constant-speed motor on.)

h. PPI, memory point, and 0-15 camera check.

i. RAI and Y-3 camera check.

j. Radar tracking control check:

(1) NAV and PPI position; check fix dial and cross hair movement.

(2) NAV and OB position; check cross hair movement.

(3) TRACK and PPI position; check sector orientation and fix dial movement.

k. Nav unit check.

(1) Check that LAT and LONG counters read ramp co-ordinates.

(2) Set in mag var.

(3) Set in first metro wind.

5. Ballistics, Bomb Release, and Vertical Camera Checks.

a. Tone check (VHF on other than tower frequency).

b. Ballistics control check.

c. Bomb release check.

d. Vertical camera check.

e. Bomb rack check (optional).

f. Bombing problem (optional).

g. Turn-off: APSI/23 and computer.

K-( ) Bombing-Navigation System Altitude Determination.

Primary Method.

1. Power Switch—SCAN FAST.
2. Function Switch—TRACK.
3. Radar Altitude Switch—ON.
4. Receiver Gain and Tilt-Adjust for sharp first ground return.
5. B-Scope Focus and Intensity-Adjust for well defined cross hairs and target.
6. Altitude Control—Bring first ground return down to range mark.
7. Radar Altitude Switch—OFF.

Secondary Method (PPI only).

1. Aircraft in level flight over reasonably flat terrain of known elevation.
2. Adjust for good scope presentation.
3. Range Control—Shortest usable range (must be greater than altitude).
4. Cross Hairs-Range Marks Switch—CROSS-HAIRS.
5. Master Function Switch—NAV.
6. Power Switch—SCAN OFF.
7. Altitude Switch—ON.
8. Antenna Tilt—Down for best definition of first ground return.
9. Receiver Gain—Adjust to give first ground return appearance of faint range mark.
10. Altitude Control Knob—Depress and turn until range marks and first ground return merge and bloom.
11. Altitude Switch—OFF.

Elevation of Terrain Unknown.

1. Adjust Radar for Normal Presentation.
2. Master Function Switch—Track.
3. PPI-OB Switch—OB.
4. Cross Hairs-Range Marks Switch—CROSS-HAIRS.

Note

Aiming point must be positively identified in both the optics and B-scope.

5. Tracking Control—Place B-scope cross hairs on selected point.
6. Altitude Control—Place optics cross hairs on same selected point.
7. Read Altitude.

K-( ) Bombing System Wind Determination Check.

1. Check Radar Altitude.
2. Master Function Switch—TRACK.
3. Cross Hairs-Range Marks Switch—CROSS-HAIRS.
4. Place optics or B-scope cross hairs on target with tracking handle.
5. Memory Point-Displacement Switch—MEMORY POINT.

CAUTION

Cross hairs *must* be on a recoverable target at this instant.

Note

Minimum 15-seconds delay.

6. Return cross hairs to target with tracking handle. (Do not slew.)

Note

Maximum memory point operation 5 minutes.

7. Memory Point-Displacement Switch—DISPLACEMENT.

8. Read wind components from navigation unit dials.

Navigation Departure and Fixing.

1. Measure altitude.
2. Check variation.
3. Place cross hairs on departure point or reference point and make wind run. Leave function switch in TRACK.
4. With cross hairs synchronized on departure point, or reference point hold Plane's Position-Reference Point switch in REFERENCE POINT.
5. Using latitude and longitude set knobs, set departure point or reference point coordinates and release Plane's Position-Reference Point switch.
6. Function Switch—NAV.
7. Take fixes at regular intervals to correct Plane's Position Counter.

Beacon Navigation.

1. Master Function Switch—NAV.
2. Cross Hairs-Range Marks Switch — RANGE MARKS.
3. Power Switch—SCAN FAST.
4. Variac—FULL CCW.
5. Tuning Function Control—BEA AFC.
6. Range Control Knob—Desired range.
7. Variac Control—Clockwise until signal is received.

Note

If AFC does not operate properly, use manual tuning.

8. Take range and bearing fix on center of leading signal and subtract 1 n. m.

SPECIAL BOMBING SYSTEM.

The U-2 universal bombing equipment rack is the chief component of the special bombing system. It is a single-hook, electrically heated, pnuematically operated bomb rack.

Controls.

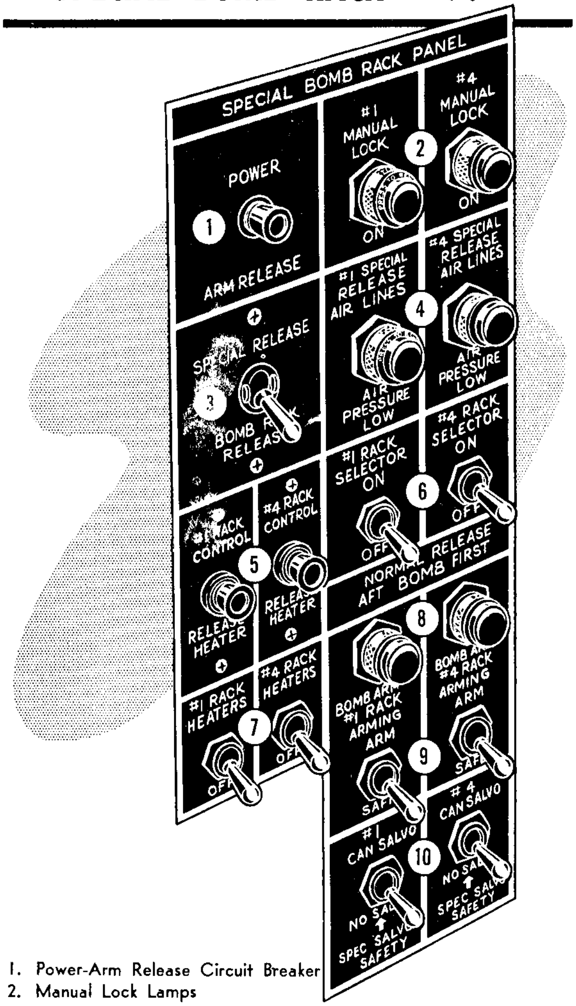
The special bomb rack panel for the special bombing system is located at the radar observer's station (12, figure 4-36 and figure 4-38.)

Special Release Switch. The special release switch (3, figure 4-38) has two positions, SPECIAL RELEASE and BOMB RACK RELEASES. When placed in the SPECIAL RELEASE position the switch transfers power from the normal bomb racks to the U-2 pneumatic release system.

Rack Heater Switches. The two-position heater switches, one for No. 1 and one for No. 4 rack (7, figure 4-38) receive 28-volt power through the CONTROL-RELEASE HEATER circuit breakers (5, figure 4-38). When the switches are placed in the HEATER position, they supply power to the U-2 rack and arming control heaters.

Rack Selector Switches. Two ON-OFF rack selector switches (6, figure 4-38), one for No. 1 rack and

SPECIAL BOMB RACK *Panel*



1. Power-Arm Release Circuit Breaker
2. Manual Lock Lamps
3. Special Release Switch
4. Pressure Warning Lamps
5. Control-Release Heater Circuit Breakers
6. Rack Selector Switches
7. Rack Heater Switches
8. Bomb Armed Indicator Lamps
9. Arm-Safe Switches
10. Salvo Safety Switches

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GI-731-A5

Figure 4-38.

one for No. 4 rack, provide a means of selecting the racks desired for bombing operation.

Arm-Safe Switches. These spring-loaded three-position ARM-SAFE switches, one for No. 1 and one for No. 4 rack (9, figure 4-38), receive power through the POWER-ARM RELEASE circuit breakers (1, figure 4-38). When the switches are in the ARM position they supply power to the arming control solenoids. The switches return to the neutral off position when not in use.

Salvo Safety Switches. Two switches marked CAN SALVO and NO SALVO (10, figure 4-38) control salvo operation of the special bombing system. Placing the switches in the CAN SALVO position permits salvo from the U-2 racks by means of the normal salvo system in the airplane.

Indicator Lamps.

Manual Lock Lamps. A MANUAL LOCK ON warning lamp for each U-2 rack is provided on the special bomb rack panel (2, figure 4-38). The lamp glows when the manual lock pin is inserted in the respective rack.

Pressure Warning Lamps. A low air pressure warning lamp (4, figure 4-38) is provided for each rack. The lamp glows when the pressure in the respective system drops below 625 (±40) psi.

Bomb Armed Indicator Lamps. An indicator lamp (8, figure 4-38) for each ARM-SAFE switch glows when the respective switch is in the ARM position.

Preflight Check of Special Bombing System.

The following check of the special bombing system should be performed 24 to 48 hours prior to loading:

1. Check that the armament section has installed a new drier cartridge. On airplanes equipped with compressor units, check to see that a new moisture separator diaphragm has been installed.
2. Check Form 1.
3. Bomb bay doors open; ground locked installed.
4. On airplanes equipped with compressors, turn off the compressor circuit breakers when pressure has reached 1200 psi.
5. Loosen plugs from air bottles; bleed pressure to zero.

Note

If moisture is evident during drainage, report the condition to the armament section.

6. Low Pressure Warning Light—ON.
7. Function Switch—STAB.
8. Compressor Circuit Breakers—ON.
9. All Other Circuit Breakers on Bulkheads No. 6 and No. 8—OFF.
10. U-2 Release Hooks—Latched.
11. Manual Locks—Installed (Lock lights on).
12. Door Safety Switch—OFF.
13. Bomb Panel Master Switch—ON.
14. Intervalometer—ON and SELECT.
15. Radar Observer Circuit Breaker Panel—BOMB RELEASE, INTER-HEATER and table light on; all others off.
16. Special Bomb Rack Panel:
    a. Power-Arm Release Circuit Breaker—ON.
    b. Special-Bomb Rack Release—BOMB RACK RELEASES.
    c. Rack Control and Heater Circuit Breakers—ON.
    d. Heater Switches—Heater.
    e. No. 1 Rack Selector Switch—ON.
    f. No. 4 Rack Selector Switch—OFF.
    g. No. 1 and No. 4 Arming Switches—Momentarily SAFE.
    h. No. 1 and No. 4 Salvo Safety Switches—NO SALVO.
17. Pull Manual Release Handles—Neither rack should release.
18. Manual Locks Removed—Light Out.
19. Manual Release Handles Pulled—Racks should release.
20. Relatch No. 1 and No. 4 Hooks, Press D-2 Switch —Neither rack should release.
21. Special Bomb Rack Switch—SPECIAL RELEASE.
22. Depress D-2 Switch—No. 1 rack should release.
23. Relatch No. 1 Hook; No. 1 Rack Selector Switch —OFF; No. 4 Rack Selector Switch—ON.
24. Depress D-2 Switch—No. 4 rack should release.
25. Relatch No. 4 hook.
26. Bomb Bay Doors—Ground locks removed, doors cleared.
27. Bomb Door Circuit Breaker—In, doors closed.
28. Depress D-2 Switch—Neither rack will release.
29. Bomb Door and Bomb Release Circuit Breakers—OFF.
30. Master Switch—OFF.
31. Pull Manual Release Handle—Neither rack should release.
32. Rack Selector Switch—ON for rack desired; other switch OFF.
33. Bomb Bay Doors—Cleared.
34. Bomb Door Safety Switch—ON.
35. Release through K System—Doors should open and then close after rack releases.
36. Relatch Hook; Check Air Pressure.
37. Bulkhead No. 6 BOMB SALVO NO. 1—ON. Pneumatic Rack Junction Box Circuit Breakers—On.

Note

If pressure is above 1200 psi, the compressor circuit breaker should be turned off.

38. Bulkhead No. 8 BOMB SALVO NO. 1—ON; Pneumatic Rack Junction Box Circuit Breakers—On.
39. Function Switch, Bomb Door Safety Switch, and Rack Selector Switch—OFF.
40. Arming Switches—ON (One at a time, lights on, arming shafts go to ARMED position).
41. Pull Arming Shafts—Lights go out.
42. Arming Switch—ARM.
43. Manual Safe—Pull; arming shafts should go to SAFE position; lights should go out.
44. Arming Switch—ARM; lights on.
45. Arming Control Heaters—Checked.
46. Heater Switch—OFF; circuit breaker pulled.
47. Camera Master Switch—Circuit breaker in.
48. Radar Observer's Circuit Breaker Panel—Bomb impluse switch ON; all others OFF.
49. Pilot's Salvo Safety Switch No. 4—CAN SALVO.
50. Pilot's Salvo Safety Switch No. 1—NO SALVO.
51. No. 2 and No. 3 bomb bay contents checked impossible to salvo.
52. Bomb Doors—Cleared.
53. Pilot's Bomb Salvo Circuit Breakers—In.
54. Salvo Switch ON—No salvo should occur.
55. Radar Observer's Salvo Circuit Breaker—In.
56. Pilot's Salvo Switch—Actuate; after light has been on three seconds, rack should release.
57. Repeat steps 49 through 56—No. 1 rack should release (pilot's salvo safety switch No. 1 CAN SALVO).
58. Relatch both hooks.
59. Camera doors should be open; camera should have actuated on salvo.
60. Camera Circuit Breakers—Off.
61. Pilot's Salvo Safety Switch—NO SALVO; circuit breaker pulled.
62. Special Bomb Rack Panel Salvo Safety Switches —NO SALVO.
63. Actuate SALVO Switch—No salvo should occur.
64. Special Bomb Rack Panel Salvo Safety Switches —CAN SALVO.
65. Actuate SALVO Switch—Both racks should release.
66. Bomb Bay Door Ground Locks—Installed.
67. Bulkhead No. 6 and No. 8 Circuit Breakers—OFF.
68. Record discrepancies in Form 1.

Switch Positions For Special Bomb Release.

1. Manual Lock—Removed.
2. Bulkhead No. 6 and No. 8 Circuit Breakers—ON.
3. Master Power Switch—ON.
4. Bomb Door Circuit Breaker—In.
5. Bomb Release Circuit Breakers—In.
6. Inter-Heater Circuit Breakers—In.
7. Intervalometer—SELECT.
8. Special Bomb Panel Circuit Breakers—In.
   a. Special Release Switch—SPECIAL RELEASE.
   b. Rack Heater Switch—HEATER.
   c. Radar Observer's and Pilot's Salvo Safety Switches—NO SALVO.
   d. Rack Selector Switch—As desired.

BOMB BAY DOOR EMERGENCY CONTROLS.

Manual Selector Controls.

The hydraulic system main selector valve is provided with an OPEN and CLOSE plunger for operation of the bomb bay doors. The plungers are used in conjunction with the hydraulic pump override switch.

Manual Operation of Main Selector Valve. (See figure 3-13.)

CAUTION

Do not open the bomb bay doors until the aft turret doors are open.

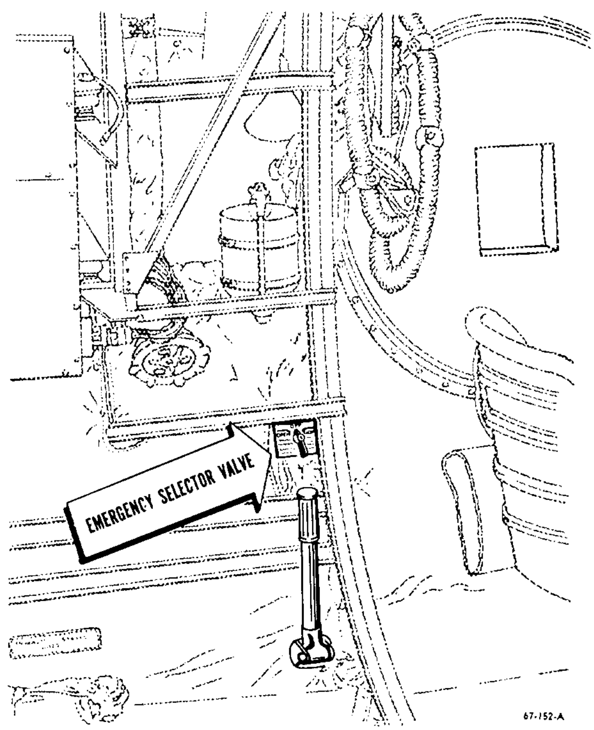

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Figure 4-39. Bomb Bay Door Emergency Hydraulic Controls

BOMB BAY DOOR *Emergency* HYDRAULIC SYSTEM

CODE

- SUPPLY
- PRESSURE
- DOOR OPEN PRESSURE, ALTERNATE RETURN
- DOOR OPEN RETURN, ALTERNATE PRESSURE
- RETURN TO RESERVOIR
- NORMAL LINES

1. Pilot—Bomb Bay Door Circuit Breaker—Pull out.
2. Radar Observer—Bomb Bay Door Safety Switch—DOORS SAFE; Bomb Bay Door Circuit Breaker—Pull Out.
3. Engineer—Hydraulic Fluid Temperature Control Switch—OFF.
4. Crew Member—Main Selector Valve OPEN or CLOSE Plunger—Hold in until desired action is completed.
5. Engineer—Hydraulic Pump Override Switch—ON.
6. Engineer—Hydraulic Pump Override Switch—OFF, after desired action is completed.

Bomb Bay Door Emergency Hydraulic System.
A fluid supply, a hand pump, and a bomb bay door emergency selector valve (figure 4-39) are the main components of the emergency bomb bay door system. With the selector valve in the OPEN or CLOSE position, operation of the hand pump produces the selected action.

WARNING

When not in use, the emergency selector valve lever will be left in the OFF position. Operation of the normal bomb bay door system with the lever in any position other than OFF will result in flooding the emergency system reservoir and consequent loss of fluid.

Operation of Bomb Bay Door Emergency Hydraulic System. (See figure 4-40.)

CAUTION

Do not open the bomb bay doors until the aft turret doors are open.

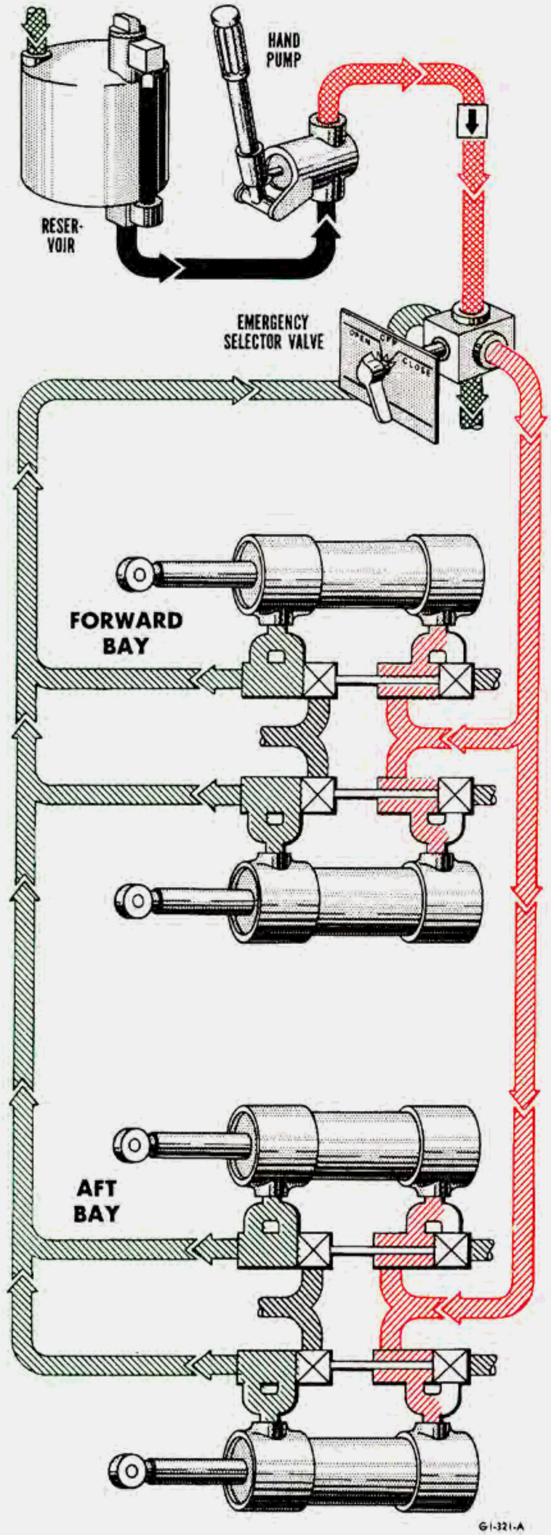

Figure 4-40.

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1. Pilot—Bomb Bay Door Circuit Breaker—Pull out.

2. Radar Observer—Bomb Bay Door Safety Switch—OFF; Bomb Bay Door Circuit Breaker—Pull out.

3. Engineer—Hydraulic Fluid Temperature Control Switch—OFF.

4. Crew Member—Emergency Selector Valve—OPEN or CLOSE as desired.

5. Crew Member—Hand Pump—Operate until the doors are in the desired position.

6. Crew Member—Emergency Selector Valve—OFF.

PHOTOGRAPHIC EQUIPMENT.

The camera station is located below the bunks in the aft cabin. The camera can be operated from either the radar observer's station or the camera control box in the aft cabin. Any one of the cameras listed below can be installed at this station, depending on the type of photographic coverage desired.

TYPE	FOCAL LENGTH —INCHES	USE
K-22A	6, 12 or 24	Bomb Spotting & Reconnaissance
K-17C	6, 12 or 24	Bomb Spotting & Reconnaissance
K-37	12	Night Photography
K-38	24 or 36	Bomb Spotting

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With the exception of the K-37 camera, the cameras can be controlled by the intervalometer at the radar observer's station. They can also be operated by the mode selector switch at the radar observer's station or by the initiation switch in the aft cabin. The K-37 camera is controlled by a photocell unit located adjacent to the camera door. The camera door is controlled by the camera door switches. Also, the door will open when the bomb bay doors open. A vacuum system is provided to insure that the film is flat against the magazine platen. The vacuum system operates automatically when the camera door is open. Vacuum is created either by utilizing the differential between the ambient pressure and the cabin pressure or, if this pressure differential is insufficient, by the action of a pressure switch which will start the operation of a motor-driven vacuum pump. Defrosting of the camera window is accomplished by ducting cabin heating air from the duct on the right side of the cabin. A restrictor damper valve (2, figure 4-6) is provided to regulate the amount of defrosting air.

A radar recording camera is mounted on the radar scope at the radar observer's station. For further information refer to "Radar Camera" of this section.

CAMERA CONTROLS.

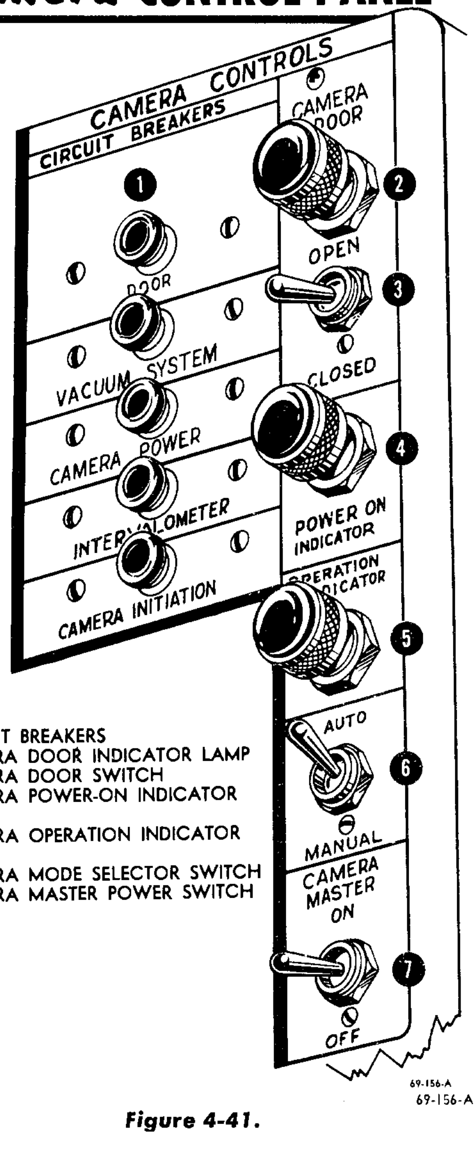
Camera Master Power Switches.

An on-off camera master power switch (7, figure 4-41) is located on the radar observer's auxiliary control panel. Placing this switch ON supplies electrical power to the control circuits of the camera system. An additional master power switch (6, figure 4-42) is located on the camera control panel in the aft cabin. When ON, this switch supplies power to the entire camera system with the exception of the camera intervalometer.

Intervalometer.

A type B-7 or B-8A camera intervalometer is located on the radar observer's control panel. The intervalometer

Camera CONTROL PANEL



1. CIRCUIT BREAKERS
2. CAMERA DOOR INDICATOR LAMP
3. CAMERA DOOR SWITCH
4. CAMERA POWER-ON INDICATOR LAMP
5. CAMERA OPERATION INDICATOR LAMP
6. CAMERA MODE SELECTOR SWITCH
7. CAMERA MASTER POWER SWITCH

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Figure 4-41.

controls the automatic operation of the camera and the interval between exposures.

Controls of the intervalometer include a single-exposure switch, a start-stop switch, a recycle switch, an exposure counter dial, an interval selector, and a mode selector switch for setting up the electrical circuit for the type of camera operation to be used. The positions of the mode selector switch are NT. RECON., BOMB SPT., NT. ORIEN., DAY ORIEN., DAY RECON., and OFF.

Camera Mode Selector Switch.

A camera mode selector switch (6, figure 4-41), having an AUTO position and a spring-loaded MANUAL position, is provided on the auxiliary bombing control panel. When the switch is in the AUTO position, the operation of the camera is controlled by the intervalometer and camera operation is initiated when the bomb release switch is actuated. When the switch is held in the MANUAL position, camera operation will be iniated and the rate of exposure will be determined by the cycling speed of the camera.

Camera Door Switches.

A three-position switch (3, figure 4-41) is provided on the radar observer's camera control panel for operating the camera doors. The switch has a spring-loaded OPEN position, a spring-loaded CLOSE position, and a neutral center position. When the switch is in the neutral position and the camera power switch is on, the camera doors will open when the bomb bay doors open.

Note

The camera doors can be closed only by means of a camera door switch.

An additional camera door switch (5, figure 4-42) is located on the camera control box in the aft cabin. This switch is identical in operation to the one provided for the radar observer.

Camera Initiation Switch.

A camera initiation switch (1, figure 4-42) is located on the camera control box in the aft cabin. This on-off switch is spring-loaded in the ON position and is provided for operating the camera from the aft cabin.

INDICATORS.

Camera Operation Indicator Lamp.

A green indicator lamp (5, figure 4-41) is located on the auxiliary bombing control panel. When the camera is operating, the lamp will blink at the rate of exposure.

Camera Door Indicator Lamps.

An amber lamp (2, figure 4-41 and 3, figure 4-42) located adjacent to each camera door switch, lights when the camera door is open.

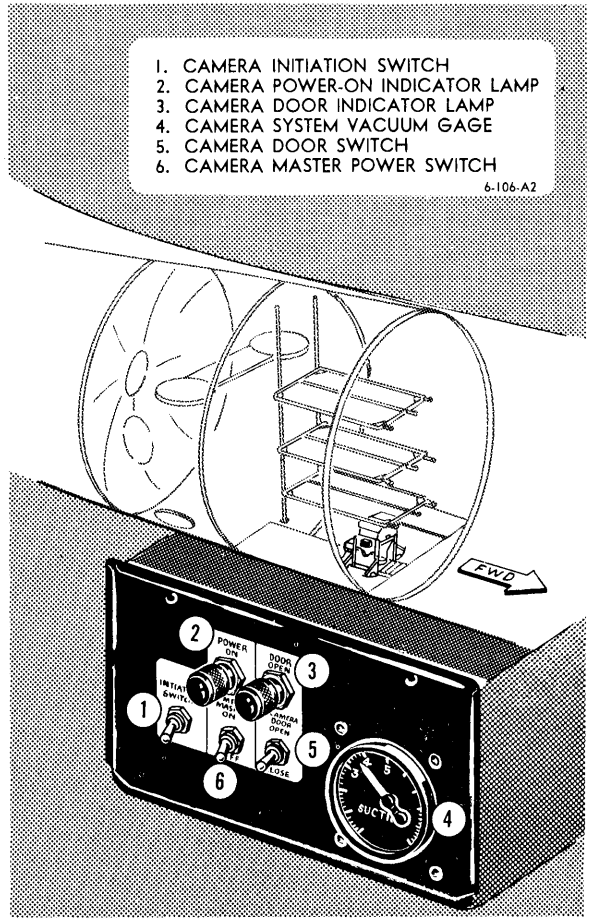

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Figure 4-42. Aft Camera Station

Camera Power-On Indicator Lamps.

A camera power-on indicator lamp (4, figure 4-41 and 2, figure 4-42) is located adjacent to each camera master power switch. Both white lamps will light when either camera master power switch is ON.

Camera System Vacuum Gage.

A vacuum gage (4, figure 4-42) is located on the camera control panel in the aft cabin. The gage indicates the amount of vacuum in inches of mercury.

OPERATION.

Operation of the aerial camera for day reconnaissance is accomplished as follows:

1. Camera master power switch—ON.
2. Camera door switch—OPEN.
3. Check door open indicator lamp lighted.
4. Intervalometer mode selector switch—DAY RECON.

5. Set desired exposure interval on the intervalometer selector dial.
6. Intervalometer START button—Push.

Note

The warning light on the intervalometer will light 2 seconds prior to each exposure.

7. Intervalometer STOP button—Push after the desired number of exposures have been made.
8. Camera door switch—CLOSE.
9. Intervalometer mode selector switch—OFF.
10. Camera master power switch—OFF.

For day orientation operation, proceed as follows:

1. Camera master power switch—ON.
2. Camera door switch—OPEN.
3. Check door open indicator lamp lighted.
4. Intervalometer mode selector switch — DAY ORIEN.
5. Intervalometer selector dial—Set desired length of time for camera operation.
6. Intervalometer START Switch—Push.

Note

The camera will operate at its cycling speed for the preset period and then stop. The intervalometer warning lamp will light after the cycle is completed and remain on until the start switch is again actuated. It denotes that the instrument is ready for the next cycle of operation.

7. Camera Door Switch—CLOSE.
8. Intervalometer Mode Selector Switch—OFF.
9. Camera Master Power Switch—OFF.

To operate the camera for night reconnaissance and bomb spotting, proceed as follows:

1. Camera Master Power Switch—ON.

Note

The camera doors open automatically when the bomb bay doors open.

2. Intervalometer Mode Selector — NT. RECON., BOMB. SPT.
3. Intervalometer Selector Dial—Set in bomb fall time.
4. Intervalometer operation is initiated at the instant of bomb release and will actuate the camera at and following bomb strike time. An exposure is also made at the time of bomb release.
5. For night photography, it is necessary only to have the camera master switch ON and the camera doors open, as the camera is tripped automatically when the flash from the bomb strikes the photocell.

To operate the camera from the aft cabin, proceed as follows:

1. Camera Master Power Switch—ON.
2. Camera Door Switch—OPEN.
3. Camera Initiation Switch—ON. The camera will operate at its cycling speed as long as the switch is held ON.
4. Camera Door Switch—Hold in CLOSE position upon completion of photography.
5. Camera Master Power Switch—OFF.

RADAR CAMERA.

The O-15 radar camera (recording) system is composed of a type C-1 radar recording camera (7, figure 4-36) and a C-1A magazine mounted on the radar scope at the radar observer's station and a camera control box (6, figure 4-36). The camera records radar screen images at these positions. With each exposure of the scope camera film, a photograph of a clock is made to establish the time of exposure.

Radar Camera Controls.

Radar Camera Power Switch. The radar camera power switch is an on-off switch located on the camera control box. Placing the switch in the ON position initiates radar camera operation.

Frequency Selector Switch. The frequency selector switch located on the camera control box has four positions marked EVERY SCAN, EVERY OTHER, 1 EVERY 4 SCANS, and 1 EVERY 12 SCANS. The frequency of camera exposure is obtained by placing the switch in the desired position.

O-15 Camera Preflight.

1. Load the camera magazine in subdued light. Be sure that the take-up spool flanges will not bind the film. (Not applicable if the photo lab loads all magazines.)

Magazine data card should show:

a. Date of loading.
b. Class of film.
c. Film loader's name.

2. Check the magazine footage dial for sufficient film.
3. Make sure the film emulsion is visible in the slot before attaching the magazine to the camera.
4. Attach the magazine to the camera and check for correct seating. (Hook right side first.)
5. Check the camera diaphragm setting. Usual settings for Class L film are f/4 or f/5.6.
6. Check the inside camera counter against the outside counter and reset if necessary.
7. Wind and synchronize the camera hack watch with the navigator's watch (GCT).
8. Check that the range indicator holes in the data card are not obstructed.
9. Fill out the data card, printing with a soft lead pencil. Do not show security classification.

a. General area of photography (or photo project number).

b. True altitude (feet).

c. Date (GCT).

d. A/C Type and last 4 digits of serial number.

e. Type radar.

f. Last name of radar observer.

Camera Operation.

1. Take 20 frames of blank photos before starting radar photography in order to alleviate any fogging of good photos.

2. Check the rotation of tell-tale indicators on magazine (large red and silver knob is on take-up shaft, small knob is on feed shaft). The check on the take-up spool is the most important, since counter operation and feed shaft rotation can be misleading.

3. Keep camera viewing door closed when photographing, except when viewing the scope, as long as the effectiveness of the bomb run is not impaired.

4. Change data card as GENERAL AREA or FLIGHT ALTITUDE changes.

5. Take five blank exposures at the end of each series of photos (target runs, radar photo lines).

6. Check film footage frequently on long flights.

Camera Postflight.

1. Take 30 exposures at the end of radar scope photography to eliminate the possibility of fogged photos.

2. Deliver the exposed film to the persons designated to receive it. The Radar Scope Photo Log must be complete and must accompany the film.

3. Make an immediate report to the appropriate radar maintenance or camera maintenance shop if there were camera malfunctions during flight.

MISCELLANEOUS EQUIPMENT.

COMMUNICATION TUBE CART.

The communication tube cart provides transportation through the communication tube which connects the pressurized compartments. Rollers on the cart are mounted on a track laid in the tube. The user lies face-up on the cart and pulls himself along by means of an overhanging rope. The cart is automatically locked in place when it reaches its end of travel.

It can be unlocked by pulling the ring on the top surface of the cart. It can be unlocked and brought from the opposite end of the communication tube by turning the handle on the cart return carriage pulley between the tracks. The cart is equipped with brakes for controlling its speed during changes in airplane attitude.

CAUTION

Keep the communication tube door closed at all times when the cabins are pressurized except when crewmen are entering or leaving the tunnel. This is necessary to preclude the possibility of having the door torn out in event of sudden decompression. In addition, because of the possibility of entangling the harness straps in the tube cart, do not use the tube when wearing a parachute.

ENTRANCE LADDERS.

Two ladders are provided for access to the crew compartments. The forward cabin entrance ladder is permanently attached to the forward bulkhead of the nose wheel well and swings up into the well to its stowed position. The aft cabin entrance ladder is stowed in the tail compartment.

PILOTS' NIGHT-FLYING CURTAIN.

When in use, the night-flying curtain is snapped into position between the pilots' and the engineers' stations. The curtain is stowed in the pilot's fairing.

PRESSURIZED SUITS.

Crew members will be provided with pressurized suits for use during high altitude flights. Information concerning the use of the suits will be furnished when available.

PRESSURIZED SUIT RECEPTACLES.

Fourteen electrical receptacles in the crew compartments furnish current for the heating elements of pressurized suits. The receptacles and control rheostats for each are located as follows: aircraft commander's station, pilot's station, frame aft of the pilot's seats, first engineer's station, second engineer's station, radio operator's station, left forward wall of the radio operator's compartment, radar observer's station, training station aft of the radar observer, observer's station, navigator's station, tail gunner's station, each scanner's station.

SPARE LAMP BULB STOWAGE.

Three panels are provided for the stowage of spare electric light bulbs. One panel is located in each pilot's fairing, and one panel is provided near the left escape hatch.

NAVIGATOR'S SEAT.

The navigator's seat rotates 360 degrees and slides on tracks between the nose sighting station and the navigator's station. The seat is provided with a safety belt and control locks for vertical and horizonal movements.

RADAR OBSERVER'S SEAT.

The radar observer's seat is mounted on tracks which permit the seat to be adjusted fore and aft. It rotates sufficiently on its base to allow access to the bombsight and control panel. The seat is equipped with a control knob lock and safety belt.

RADIO OPERATOR'S SEAT.

The radio operator's seat rotates approximately 360 degrees in each direction. It moves fore and aft on a fixed track and is equipped with a control knob lock and safety belt. Both arm rests fold up, giving ample freedom of movement in and out of the seat.

SCANNERS' SEATS.

The scanners' seats are designed so that they can be used during take-off and landing. For this reason the seats are equipped with inertia reel lock-type shoulder harnesses identical to those provided for the pilots. For further information on this type shoulder harness, refer to "Shoulder Harness Control" in Section I.

WINDSHIELD WIPERS.

The pilots are provided with two windshield wipers which are controlled by a single switch.

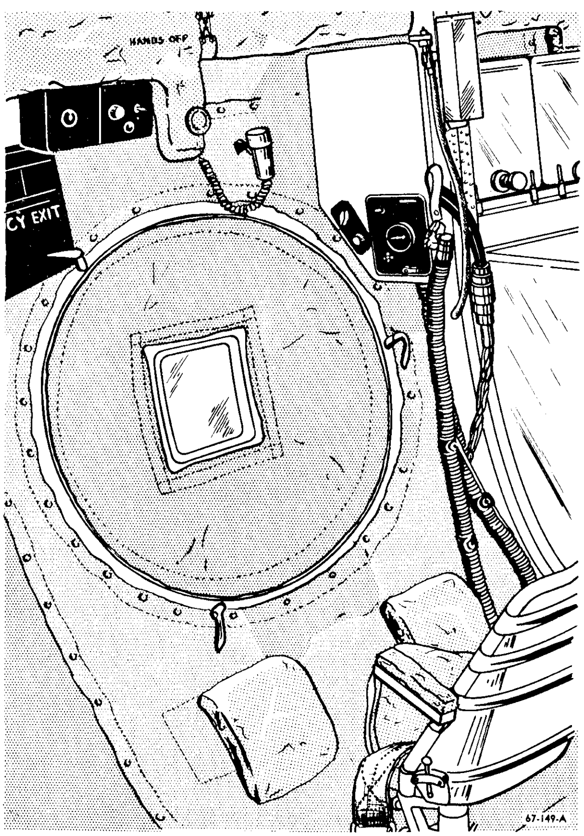

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Figure 4-43. Typical Scanner's Station

On airplanes not in group 3, the switch has two positions, ON and OFF. When the switch is placed in the ON position, 28-volt direct current actuates a relay which completes a 200-volt a-c circuit to the windshield wiper motors.

On airplanes in group 3, a switch marked RUN, OFF, and PARK controls the wipers. Placing the switch in the RUN position energizes a 28-volt, d-c controlled relay which completes a 200-volt a-c circuit to the wiper motors. When the switch is placed in the OFF position, windshield wiper operation halts regardless of blade position. If the blades stop at some intermediate position on the pilots' windows, holding the switch in the spring-loaded PARK position will energize the wiper motor and move the blades to an outboard position where they will not obstruct the pilots' forward view.

CREW COMFORT PROVISIONS.

Bunks.

Six bunks, complete with mattresses, pillows, and blankets are provided in the aft cabin of the airplane. The bunks are equipped with foot braces, safety harnesses, and safety belts, and are to be used for crew positions during take-off and landing.

Auxiliary Bunks. Provisions are made for the installation of an auxiliary bunk in the forward cabin. When installed it is located aft of the engineers' station in the radio operator's compartment. The bunk has no stowed position but can be readily installed or removed.

Miscellaneous Personal Gear Stowage.

Small hammock-type mesh bags for the stowage of personal gear are located adjacent to each bunk. Small racks are provided on each side of the bunks in the aft cabin for parachute stowage.

Kit Bag Stowage.

Provisions are made to stow parachute bags in the following locations: two in a folding rack on the nose wheel well in the navigator's compartment, and one under the step in the left walkway of the forward cabin.

Hot Cups.

Three hot cups (figure 4-44) are provided for crew use. Two are located adjacent to the liquid containers on the right side of the radio operator's compartment. The other one is located adjacent to the liquid containers on the right side of the aft cabin.

Liquid Containers.

A four-gallon electrically heated liquid container (figure 4-44) is located on the right side of the radio

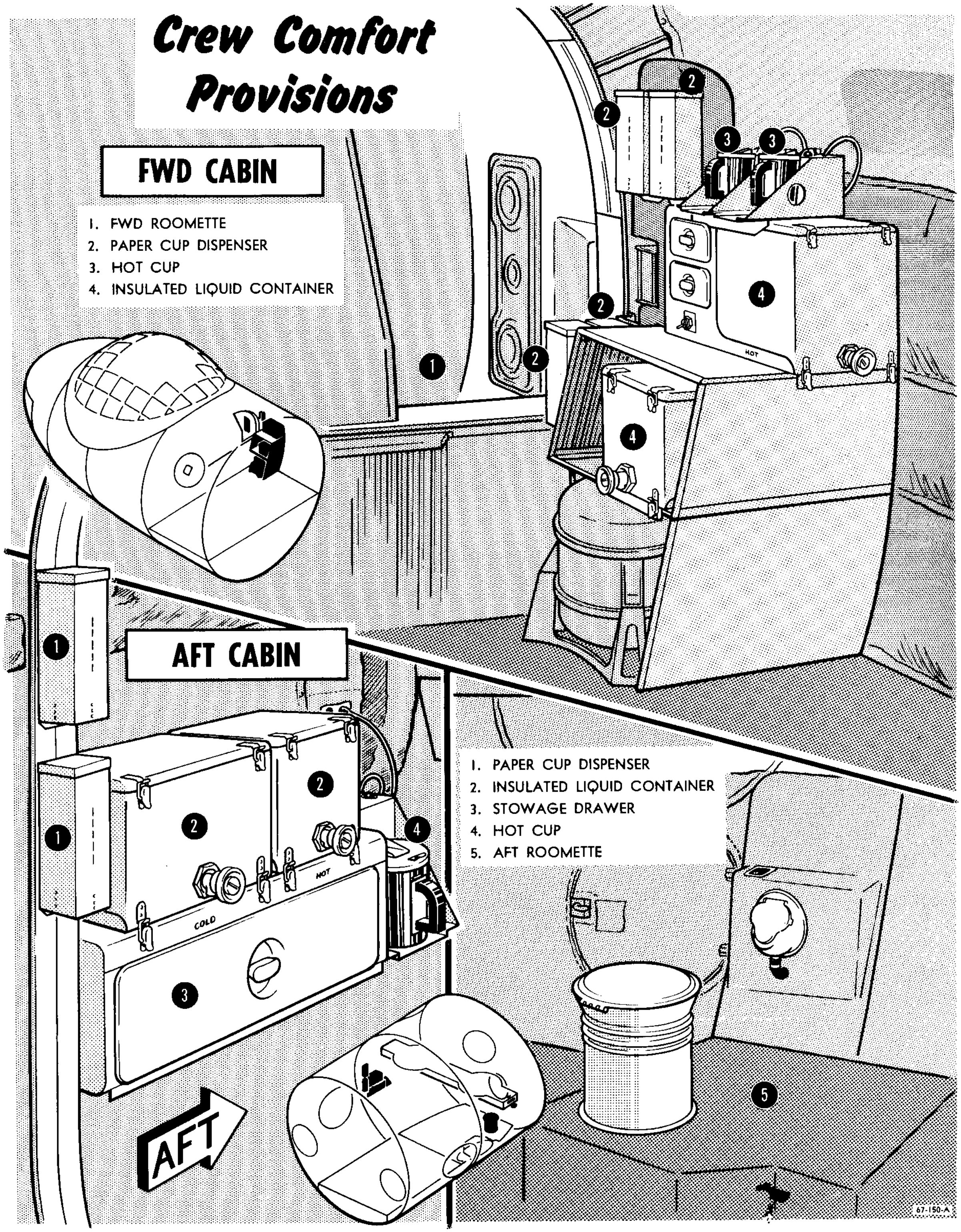

Crew Comfort Provisions
FWD CABIN
1. FWD ROOMETTE
2. PAPER CUP DISPENSER
3. HOT CUP
4. INSULATED LIQUID CONTAINER
HOT
AFT CABIN
1. PAPER CUP DISPENSER
2. INSULATED LIQUID CONTAINER
3. STOWAGE DRAWER
4. HOT CUP
5. AFT ROOMETTE
COLD
HOT
AFT
67-150-A

Figure 4-44.

operator's compartment. An insulated drinking water container of the same capacity is mounted adjacent to the heated container. In the aft cabin a four-gallon and a two-gallon insulated drinking water container (figure 4-44) are mounted on the right wall.

Cup Dispensers.

Paper cup dispensers (figure 4-47) are located adjacent to the liquid containers in each compartment.

Frozen Food Oven.

Provisions for an electric oven are located under the scanning platform on the right side of the aft cabin. When installed the oven provides for heating prepared frozen meals or canned rations. It is thermostatically controlled and contains six removable shelves, each with detachable heating elements. Electric power to the oven is controlled by an on-off switch on the utility switch panel. Two push-to-reset buttons above the oven door are used to turn the oven on, and the thermostatic controls automatically break the circuit when the proper temperature is reached. The thermostats may be reset after the oven partially cools by pushing the push-to-reset buttons. A pilot light located below the door lights when the oven is heating.

Operation. To warm frozen foods, proceed as follows:

1. Remove the cellophane wrappers from the packages, but do not remove the metal foil.
2. Place one meal on each shelf.

CAUTION

The oven accommodates six meals; however, if less than six are to be heated, remove the unused shelves from the oven.

3. Push in both reset buttons.
4. Wait 10 minutes after the pilot light goes out; then remove the meals.

Note

The oven must partially cool before the reset buttons are effective again. If the oven is to be reused immediately, place cold meals on the shelves and leave the door open. If the pilot light comes on when the push-to-reset buttons are pushed, the oven is ready for use.

Canned rations can be heated as follows:

1. Remove shelves 1, 3, and 5 (counting from the top) from the oven.
2. Place 4 to 5 cans on each remaining shelf.
3. Push in the reset buttons.
4. If small cans of food are being heated, remove them when the pilot light goes out. Large cans should be left in the oven a little longer.

CAUTION

Do not push the reset buttons unless cold (room temperature) cans are placed on the shelves.

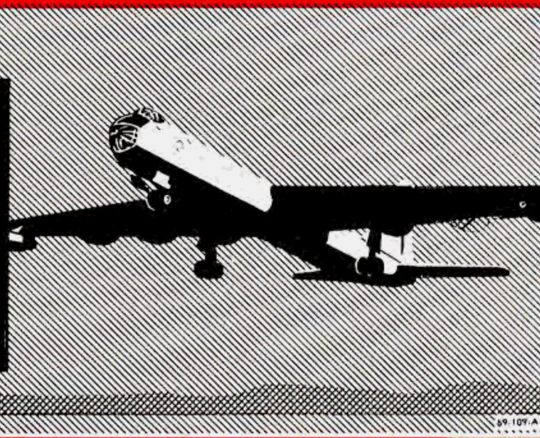
CAUTION

Always remove the heating elements before cleaning the shelves in water.

Toilet Facilities.

Toilet facilities are provided both in the forward and the aft cabins of the airplane. In the forward cabin the facilities consist of a toilet and a relief tube located forward and to the right of the radio operator's compartment. The relief tube drains into a tank built around the toilet. In the aft cabin the facilities include a toilet and a urinal installed just aft of the entrance hatch. The urinal drains overboard when the button on the floor is depressed.

SECTION V
Operating Limitations



The purpose of this section is to cover all important limitations that must be observed during normal operation. Special attention should be given to the instrument markings (figure 5-1) since these limitations are not necessarily repeated in the text. When necessary, an additional explanation of instrument markings is covered in the text under appropriate headings.

MINIMUM CREW REQUIREMENTS.

The minimum crew requirements for this airplane are the aircraft commander, pilot, two engineers, and two scanners. Additional crew members will be added at the discretion of the Wing Commander.

INSTRUMENT LIMITATIONS.

The limits marked on the airplane instruments are shown in figure 5-1 except for cylinder head temperatures for engines equipped with a single thermocouple. Limits for these indicators are given below.

Cylinder Head Temperature (Single Thermocouple).

Minimum Permissible—170°C.

Above 2600 bhp—Optimum 225°C; not to exceed 260°C with fully opened air plug.

2600 bhp and below, Retard Spark, Rich, Normal, or Manual Adjust—240°C.

2030 bhp and below, Retard Spark, Manual Lean Mixture—250°C.

1760 bhp and below, Advance Spark, Manual Lean Mixture—250°C.

Maximum Permissible—260°C.

ENGINE LIMITATIONS.

RECIPROCATING ENGINES.

In addition to the limitations indicated in figure 5-1, the limits discussed in the following paragraphs are imposed on reciprocating engine operation.

Maximum Overspeed.

Maximum overspeed is 3300 rpm. However, if engine speed has reached between 3100 and 3300 rpm, the engine must be inspected before the next flight. If the engine speed exceeded 3300 rpm, the engine must be changed. All conditions of overspeeding are to be noted on the Form 1.

Minimum Idle Speed.

Minimum idling speed at sea level is 1100 rpm.

Note

During ground operation of the flaps or jet engine starting, the alternator-equipped engines (2, 3, 4, and 5) must be idled at 1200 rpm.

Fan Speed Limitations.

Because of structural limitations of the fan, the use of high ratio fan is restricted. High ratio fan is limited to the following conditions:

Maximum Engine RPM	*Density Altitude*
2200	Sea Level
2400	5000 feet
2600	10,000 feet
2800	15,000 feet

INSTRUMENT MARKINGS

• *Flight* INSTRUMENTS . . . .

F-1A AIRSPEED INDICATOR

- (white) *160 Maximum Speed Flaps Down (Landing Gear 188)
- (red) 286 Maximum Diving

F-5 AIRSPEED INDICATOR

- (white) *160 Maximum Speed Flaps Down (Landing Gear 188)

The instrument setting is such that the red pointer will move to indicate the limiting structural air speed of 286 mph or the air speed representing the limiting Mach. No. of .66, whichever it is.

*The airspeed limit of 160 is imposed because of propeller vibrations.

• *Reciprocating* ENGINE INSTRUMENTS . .

CARBURETOR AIR TEMP

- −20 to −5°C Continuous Operation
- +5°C and Below, Danger of Icing
- +5°C to 20°C Advanced Spark Between 1815 and 2000 RPM Desired 15°C to 20°C
- 20°C to 38°C Retard Spark, Any Mixture.
- 38°C Maximum Except Take-Off, See Appendix I. Danger of Detonation Above 38°C.

MANIFOLD PRESSURE

- 23.4 to 44 Manual Lean Permissible (With Either Spark Position)
- 44 to 55 Normal or Rich Required
- 66 Take-Off (With 0% Humidity Correction) or Military Dry) Limited to 5 Minutes Take-Off Power or to 30 Minutes Military.

OIL TEMPERATURE

- 40 Minimum
- 60 to 85 Desired Operating Range
- 100 Maximum Permissible Below 40,000 feet.
- 110 Maximum Permissible Above 40,000 Feet.

WATER PRESSURE

Airplanes with electric derichment valve

- 23 Minimum
- 23 to 27 Desired Operating Range
- 27 Maximum

Airplanes with hydraulic derichment valve

- 30 Minimum
- 30 to 36 Desired Operating Range
- 36 Maximum

MIXTURE CONTROL QUADRANT

- Idle Cut-Off
- Manual Lean
- Normal and Rich

MASTER TACHOMETER

- 1400 Minimum Cruise
- 1400 to 2000 Manual Lean Permissible (With Either Spark Position)
- 2000 to 2300 Manual Lean Permissible (With Retarded Spark Only.)
- 2300 to 2600 Normal or Rich Required.
- 2800 Maximum Permissible, Limited to 5 Minutes Take-Off Power or to 30 Minutes Military

NOTE:

LIMITATIONS ARE BASED ON 115/145 GRADE FUEL

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Figure 5-1. (Sheet 1)

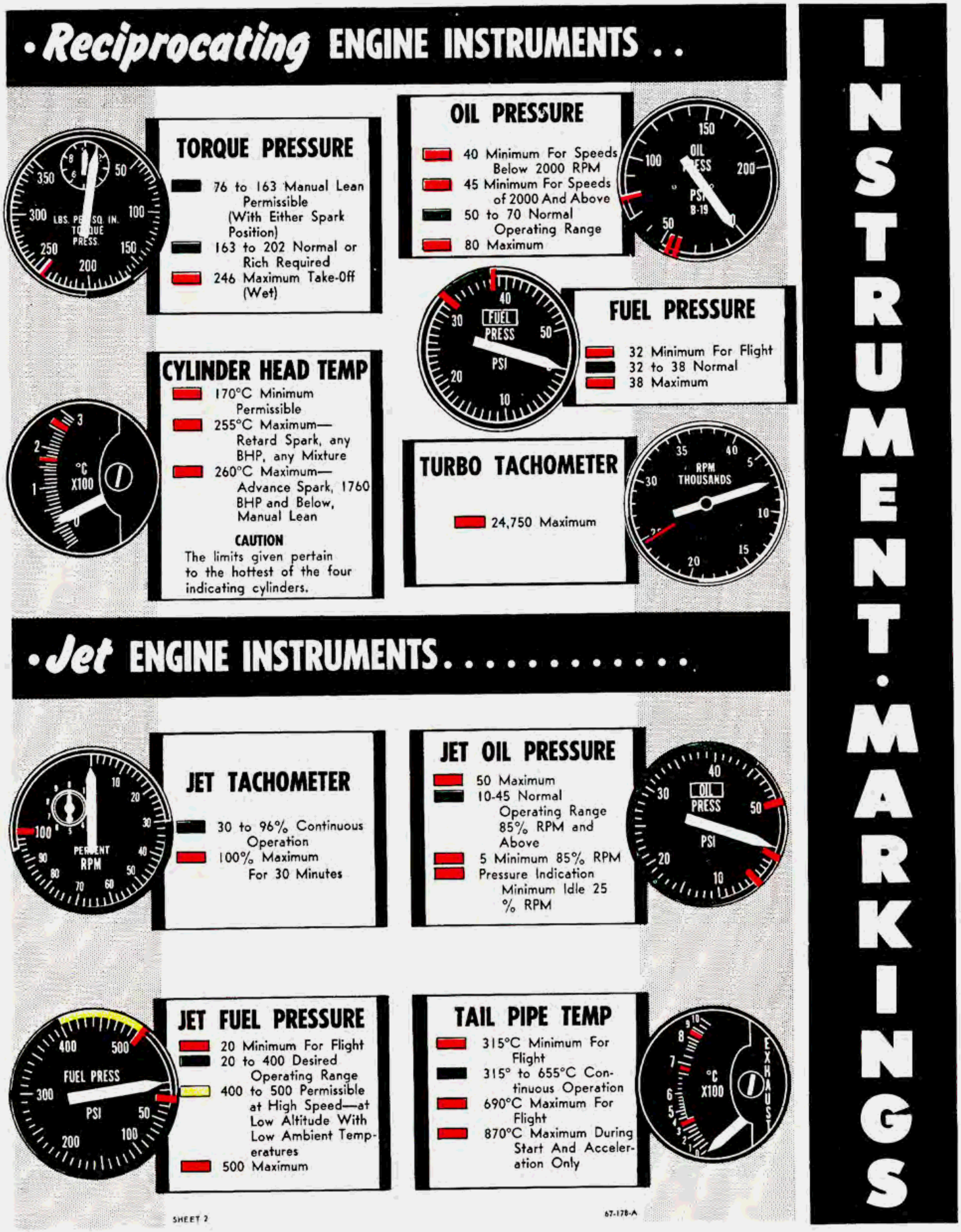

Figure 5-1. (Sheet 2)

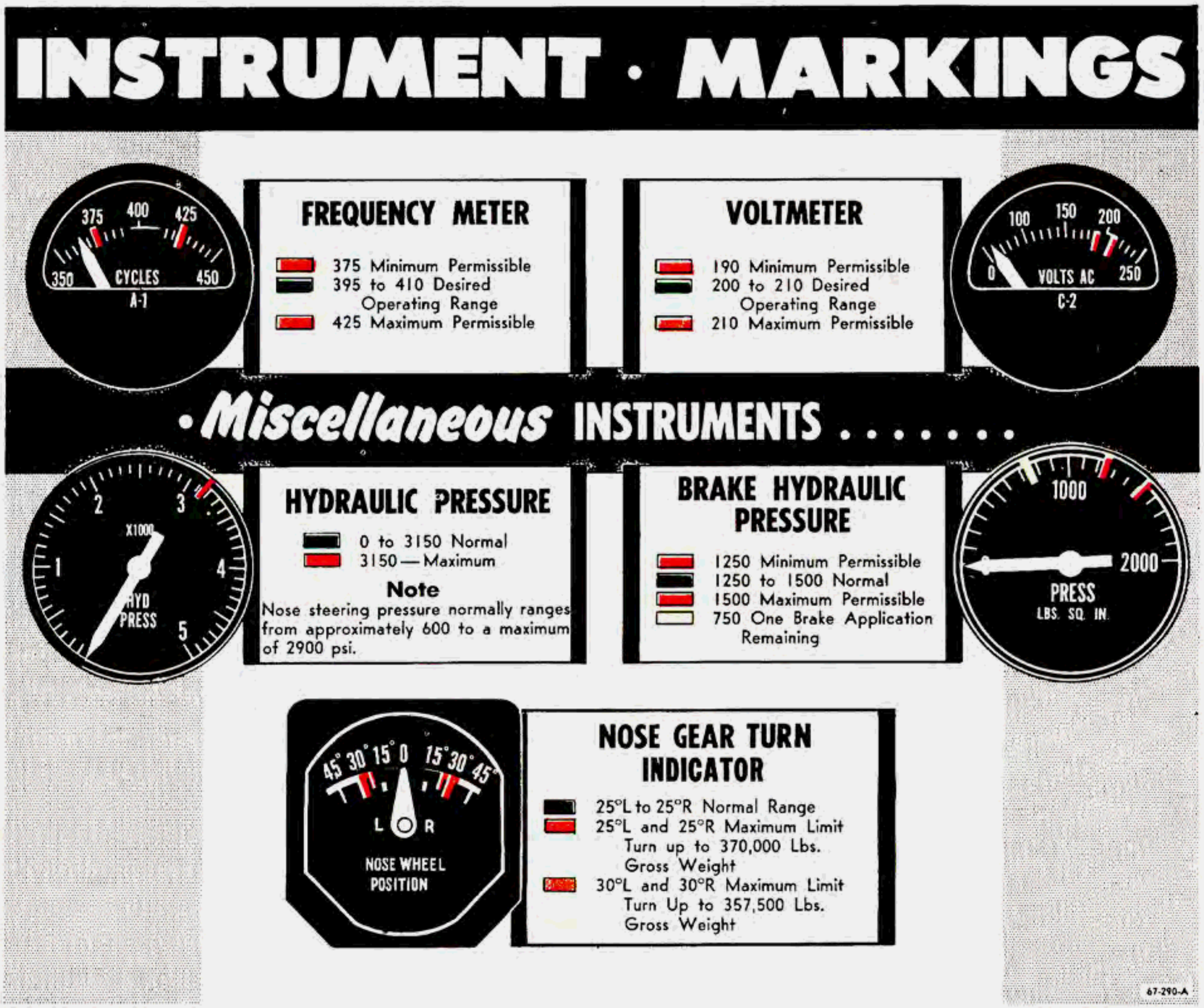

Figure 5-1. (Sheet 3)

Note

RPM limits are specified for limit CHT or closed air plugs, whichever occurs first. Large increases in cooling air flow obtained by abnormally wide air plug openings will cause fan horsepower to exceed structural limits of the engine fan drive.

The use of neutral fan in flight is prohibited except as follows:

In the event that CHT cannot be maintained high enough for proper engine operation and if carburetor heat, almost closed air plugs, single turbo, etc., operation (observing allowable limits) does not bring CHT up sufficiently to maintain normal engine operation; then, as a last resort neutral fan operation may be used. When using neutral fan, however, the hottest of the four indicating cylinders should not be allowed to exceed 224°C CHT inasmuch as the A-1 cylinder may exceed 274°C CHT. Also, when operating in neutral fan, engine speed will be limited to 2300 rpm maximum.

Operating Limits with Alternate Fuel.

This information will be included when available.

JET ENGINES.

The limits for jet engine operation which are not shown in figure 5-1 are given in the following paragraphs.

Maximum Overspeed.

Maximum overspeed is 104 per cent rpm. Engine overspeed operation reaching 104 per cent rpm requires

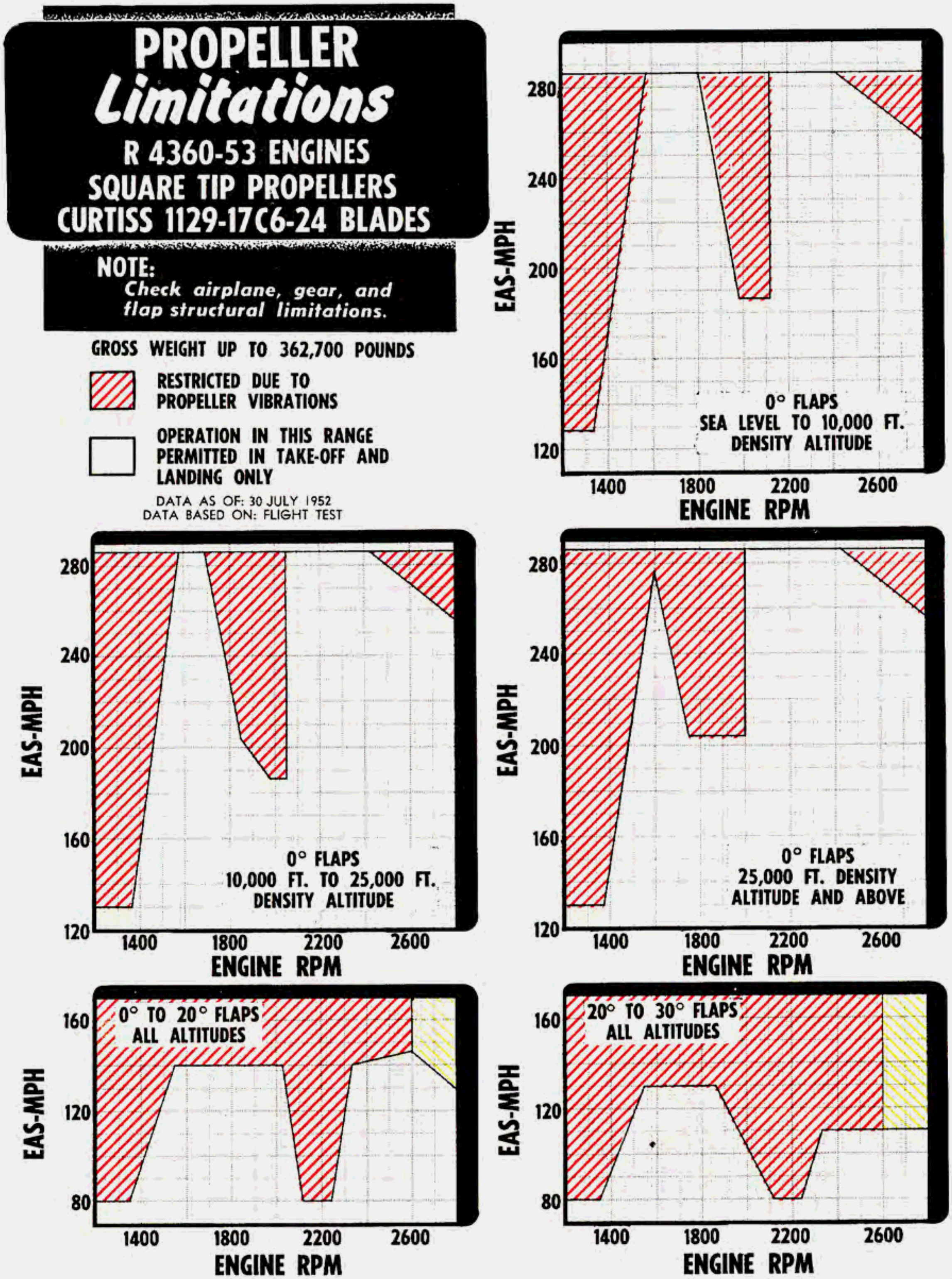

Figure 5-2. (Sheet 1)

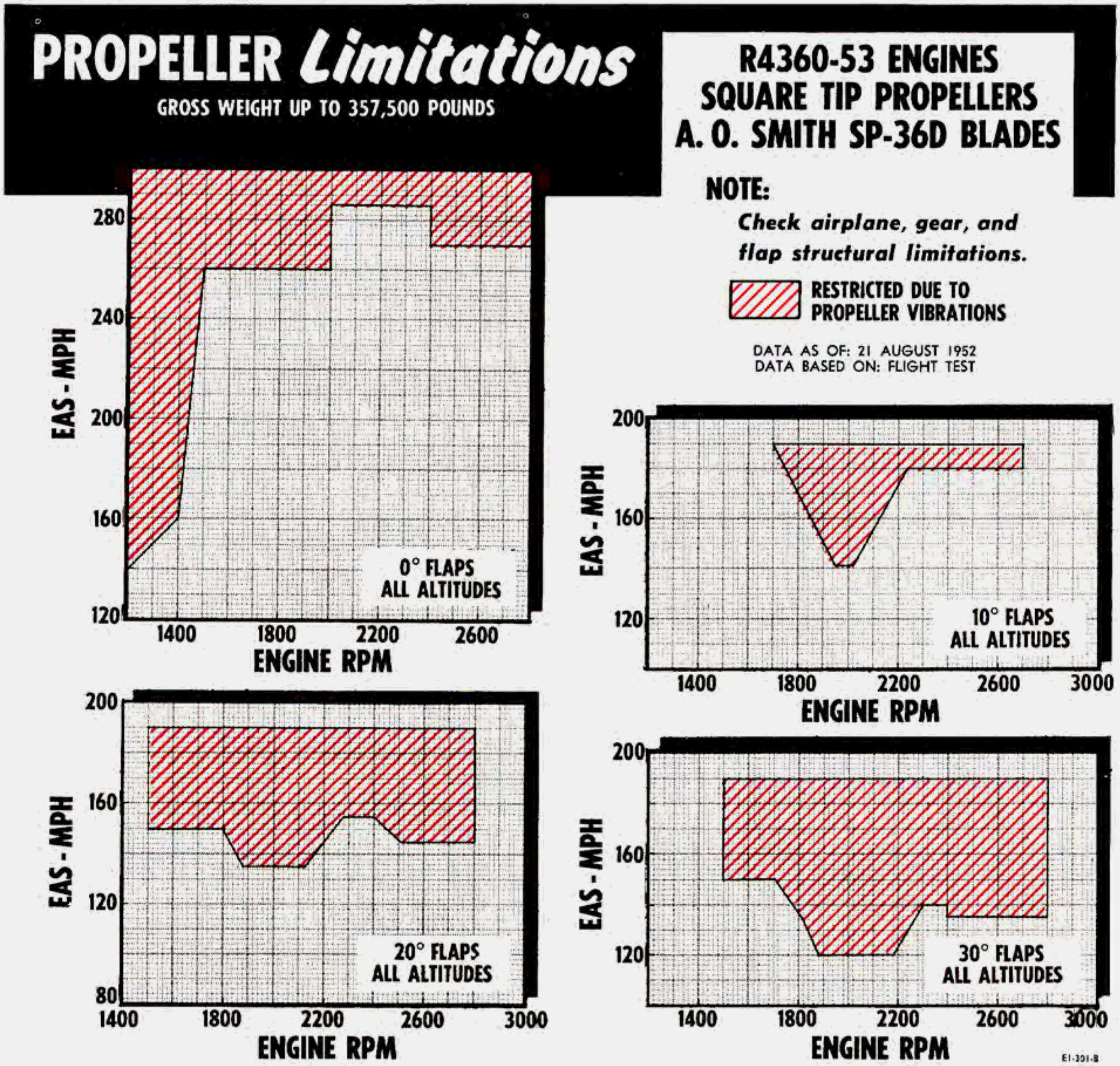

Figure 5-2. (Sheet 2)

that the engine be changed even though over-temperature limits were not encountered.

Minimum Idle Speed.

Minimum idling speed is 25 per cent rpm.

Note

Rapid advancement of the throttle on an engine idling below 25 per cent rpm will probably cause a flame-out. For minimum flight idle speeds refer to figure A-55.

Over-Temperature Operation.

Any start or acceleration during which the tail pipe temperature exceeds 1000°C or any ten starts or accelerations during which the tail pipe temperature exceeds 870°C constitutes over-temperature operation and requires that the engine be removed from the airplane and returned to overhaul.

Note

This is required in case of ten hot starts regardless of time lapse between starts.

Maximum INDICATED AIR SPEEDS

WITH PODS

ALTITUDE FEET	MAX. CONTINUOUS INDICATED AIR SPEED—MPH			LIMIT DIVE SPEEDS—MPH
	TWO 43,000 LB. BOMBS	ALL BOMB LOADS EXCEPT TWO 43,000 LB. BOMBS		ALL BOMB LOADS
	357,500 LBS. G.W. OR LESS	370,000 LBS. GROSS WEIGHT	280,000 LBS. G.W. OR LESS	ALL G.W.
SEA LEVEL	251	251	267	287
10,000	248	248	270	291
20,000	242	242	272	293
27,500	234	234	276	296
30,000	232	232	277	282
35,000	229	229	255	256
40,000	222	222	227	228
45,000	193	193	198	199
50,000	167	167	173	180

WITHOUT PODS

ALTITUDE FEET	MAX. CONTINUOUS INDICATED AIR SPEED—MPH			LIMIT DIVE SPEEDS—MPH
	TWO 43,000 LB. BOMBS	ALL BOMB LOADS EXCEPT TWO 43,000 LB. BOMBS		ALL BOMB LOADS
	357,500 LBS. G.W. OR LESS	357,500 LBS. GROSS WEIGHT	280,000 LBS. G.W. OR LESS	ALL G.W.
SEA LEVEL	230	250	250	250
10,000	227	235	235	235
20,000	220	221	221	221
25,000	214	214	214	214
30,000	207	207	207	207
35,000	200	200	200	200
40,000	182	182	182	182
45,000	164	164	164	164
INTERPOLATE FOR INTERMEDIATE GROSS WEIGHTS				

- Maximum continuous air speeds are based on structural ability to withstand an indicated gust of 50k feet per second velocity.
- Limit dive indicated air speeds are based on flutter and dynamic pressure restrictions. Gusts are not considered; but in general, indicated gusts of 30k feet per second or better can be withstood at these speeds.

- The limit dive indicated air speeds shown in this chart are based on structural limitations of the air frame. Normal dive indicated air speeds must be based on propeller limitations.

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69-137-A

Figure 5-3.

The temperature and duration of all over-temperature operation (870°C) shall be entered on Form 1.

Five starts or accelerations during which the tail pipe temperature exceeds 870°C requires that the engine be carefully inspected prior to flight for possible damage.

PROPELLER LIMITATIONS.

The operating limits for propellers are reflected in figure 5-2.

Note

For aircraft equipped with both Curtiss and A. O. Smith propeller blades, the particular blade which imposes the most severe limitation will establish the propeller limitation for any given flight condition.

AIR-SPEED LIMITATIONS.

The maximum continuous indicated speeds and limit dive speeds are shown in figure 5-3. Other limiting air speeds are as follows:

1. Bomb bay door operation is permitted up to the maximum dive speed.

2. The maximum IAS for the following operations is 188 mph because of structural limitations.

   a. Landing gear extension and retraction.

CAUTION

To prevent exceeding the structural limitations of the canoe doors, the 188 mph IAS limit will be observed any time a landing gear canoe door is open or closed and not locked.

   b. Landing light extension.

   c. Full aileron deflection.

   d. Flap extension.

PROHIBITED MANEUVERS.

All acrobatics including spins and stalls are prohibited. The maximum permissible bank while turning is 60 degrees at a gross weight of 357,500 pounds.

ACCELERATION LIMITATIONS.

The diagrams in figure 5-4 show the airplane acceleration limits versus air speed for altitudes from 10,000 to 45,000 feet for two gross weight conditions. The accelerations shown represent the limit design factors for the aircraft structure. The airplane must operate within the boundaries of the appropriate curve corresponding to its weight and altitude at all times.

Each curve envelops several limiting curves and is the maximum allowable acceleration for a given speed. These limiting curves include maximum wing lift,

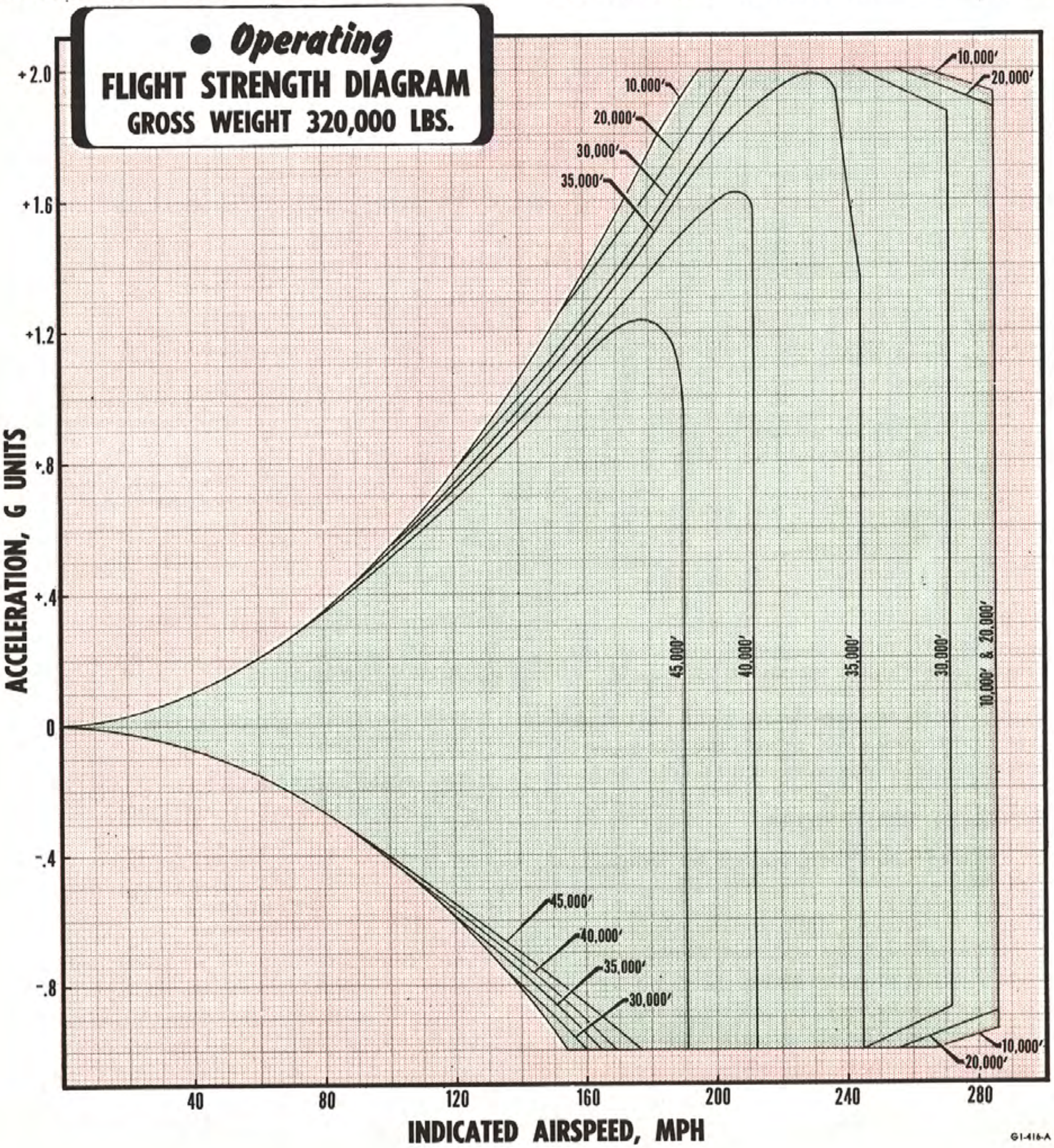


Figure 5-4. (Sheet 1)

specified maneuver factors, positive and negative gust factors, buffet boundaries (characterized at low speeds by small buffeting and at high speeds by lift divergence), and the airplane limit diving speeds.

CENTER OF GRAVITY LIMITATIONS.

The cg limits are from 17 to 45 percent MAC.

HEAT AND ANTI-ICING TEMPERATURE LIMITATIONS.

These temperatures are as follows:

1. Cabin Heat and Tail Anti-Icing Air—180°C.
2. Forward Cabin Duct Air—105°C.
3. Wing Anti-Icing Air—180°C.

The minimum speeds necessary to prevent exceeding these temperatures are given in figure 5-5.

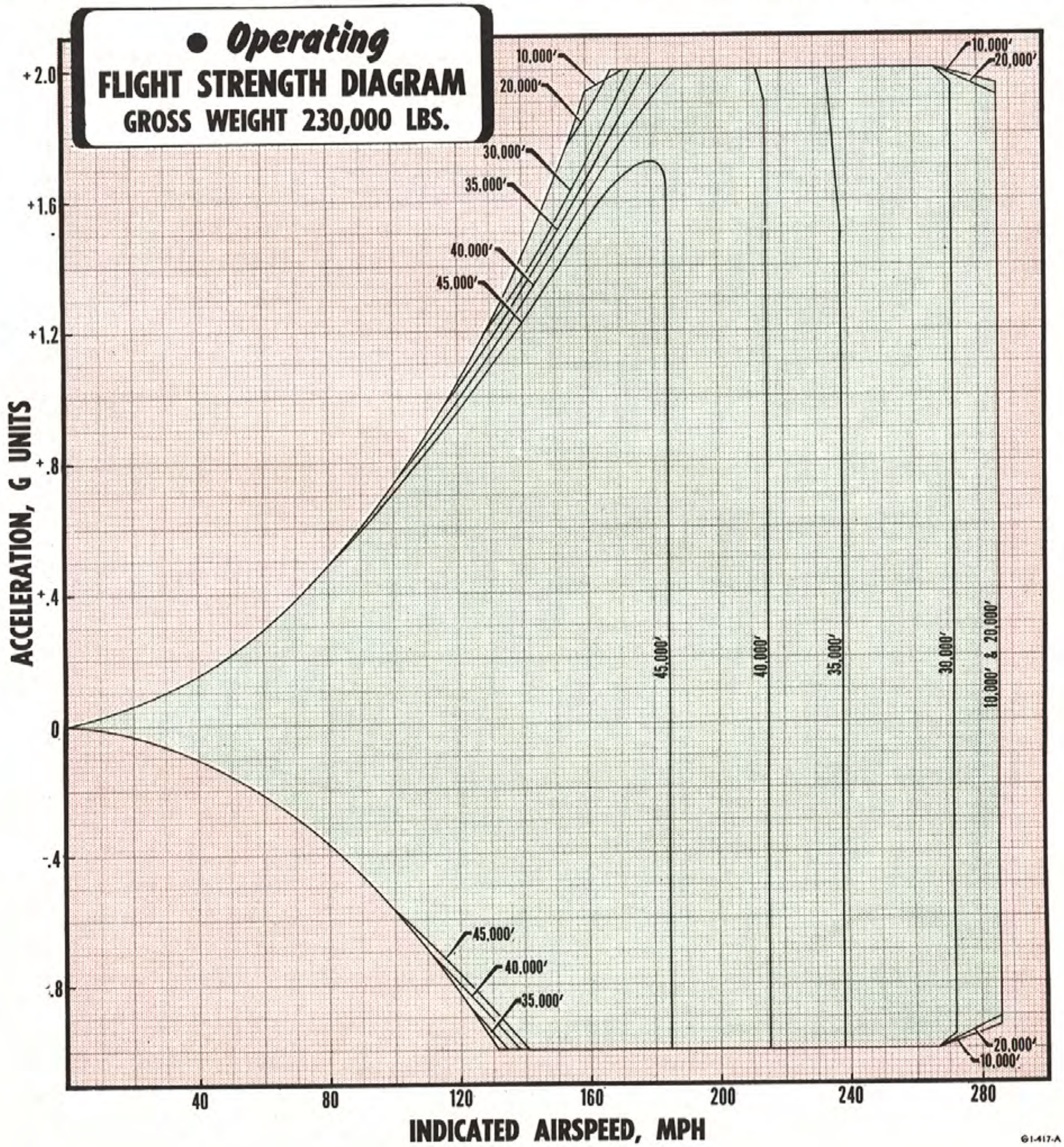
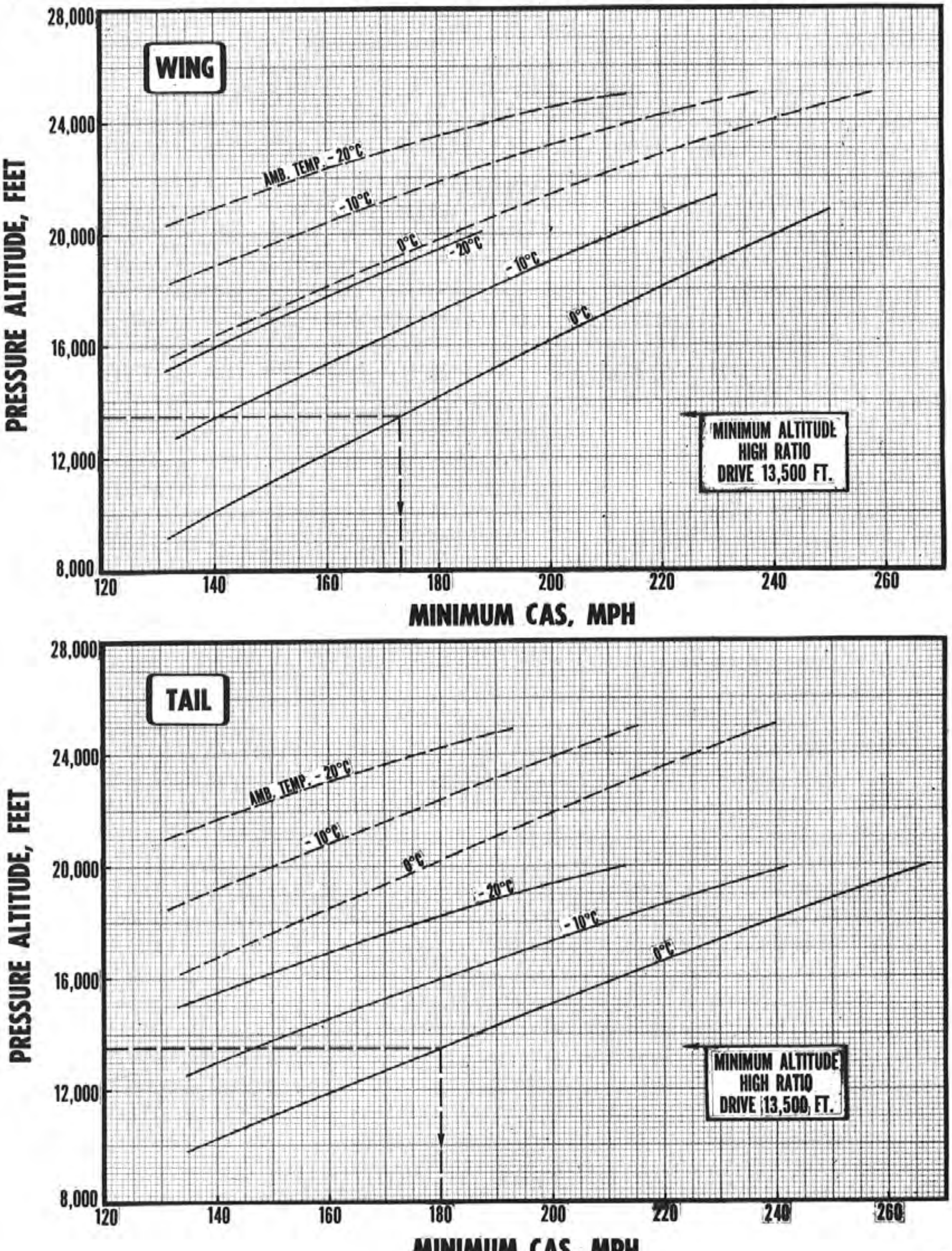


Figure 5-4. (Sheet 2)

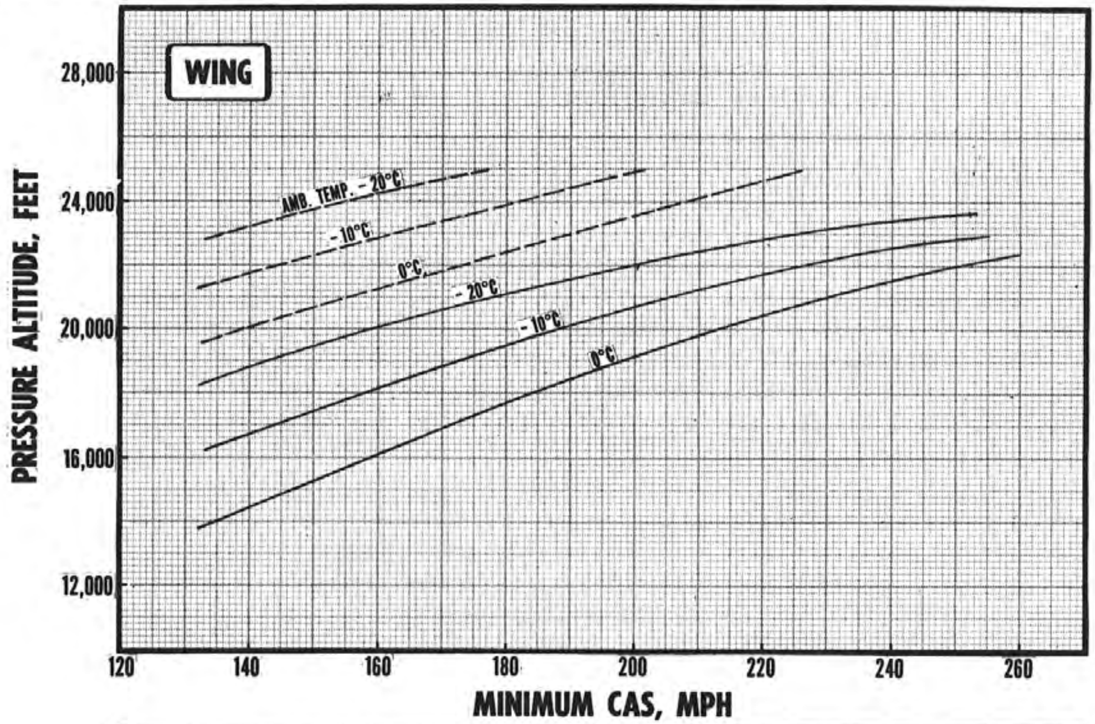
HEAT AND ANTI-ICING LIMITATIONS AT NORMAL RATED POWER

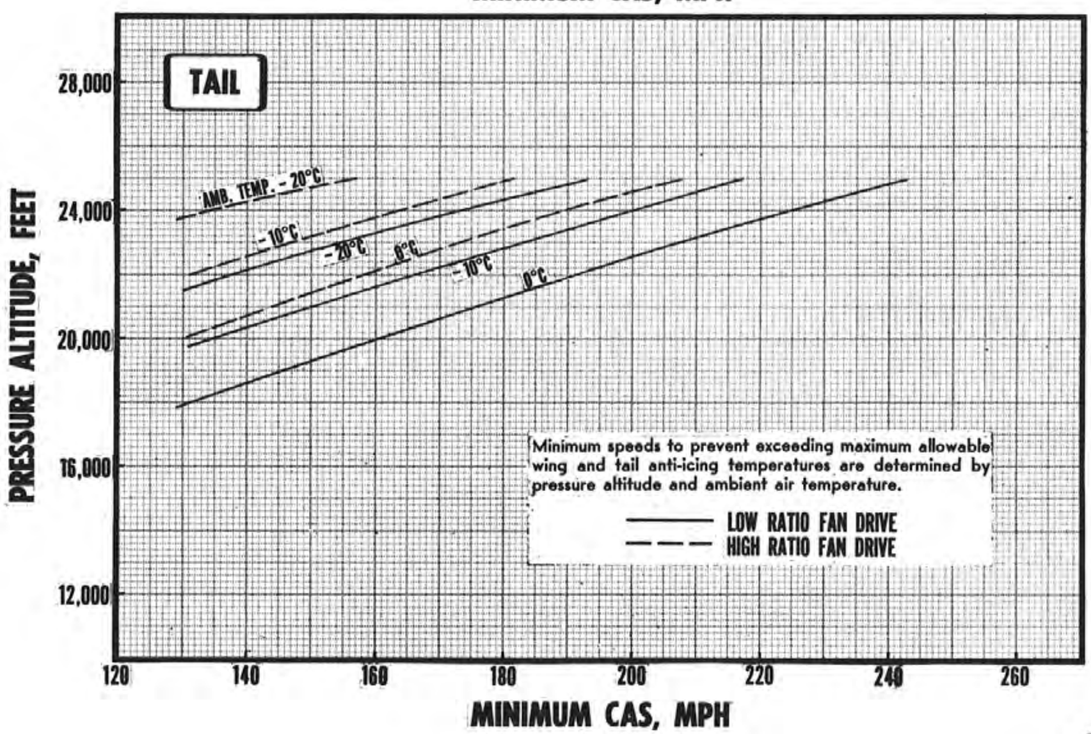


SHEET 1
C1-232-C

Figure 5-5. (Sheet 1)

HEAT AND ANTI-ICING LIMITATIONS AT 1500 HORSEPOWER





SHEET 2
CI-232-C

Figure 5-5. (Sheet 2)

WEIGHT LIMITATIONS.

The airplane is designed to provide optimum performance at high altitudes, an excess of power being available at take-off and low altitudes. Maximum gross weight for operation is therefore established primarily by structural considerations. These considerations are explained in the following paragraphs.

LOAD FACTORS.

It is readily understandable that as a structure is loaded to higher weights, its ability to withstand gust shocks or additional maneuver loads becomes increasingly less. The minimum flight factor generally considered acceptable is 2.0. Should a mission involve excessive maneuvering or flight under very turbulent conditions early in the flight, higher factors might be advisable. It should be noted, however, that with the high percentage of expandable load carried by the airplane, the allowable load factor continually increases as the flight progresses.

DISTRIBUTION OF LOAD.

The maximum load that the airplane can carry is dependent on the way that load is distributed. The weight in flight is carried by the wings and, therefore, the more load carried in the fuselage, the greater the bending moment on the wings. This means that the airplane might safely carry 175,000 pounds if 55,000 pounds were carried in the fuselage and 120,000 pounds in the wings. But the same 175,000 pounds would be an unsafe load if 120,000 were carried in the fuselage and 55,000 pounds in the wings.

OPERATIONAL WEIGHT LIMITATIONS CHART.

The purpose of the "Operational Weight Limitations Chart" (figures 5-6 and 5-7) is to illustrate the weight carrying capabilities of the airplane in relation to the various criteria that limit safe operation. In this fashion, the flight planner can visualize the type of limitation that is restricting maximum permissible weight and judge for himself, based on the urgency of the mission, as to how near any limitation shall be approached. In other words, the chart serves as a warning of the specific dangers involved in loading the airplane, but leaves the matter of selecting maximum weight in the hands of the flight planner.

Operating Weight.

As shown in the upper right corner of the charts, the data is for airplanes which weigh 173,300 pounds before any fuel or alernate load is added. The alternate load shown includes only bombs carried in the bomb bay. Alternate load could also include any additional load, such as extra fuel tanks carried in the fuselage. The weight of the standard crew, oil, ammunition, standard equipment, etc., is included in the 173,300 pounds.

Gross Weight.

The gross weights of the loaded airplane are shown by the lines which slope at a 45-degree angle at the axes of the chart. Note that the zero point of the charts (intersection of the vertical and horizontal axes) represents a gross weight of 173,300 pounds.

Fuel Versus Alternate Load Capacity.

In order to provide maximum wing bending relief in flight, fuel should be maintained as far outboard as possible. To accomplish this, when the airplane is fueled the outer tanks should be filled first, then the center, then the inboard, and last the auxiliary wing tanks. In flight the fuel should be used in the reverse order. The load factors shown on this chart are based on this fuel sequence. The two 43,000-pound bomb load imposes an airplane gross weight limitation of 357,500 pounds. The maximum bomb load for the various size bombs are tabulated below:

Size	*Quantity*	*Bomb Wt.-Lbs.*	*Rack & Equip-Wt.-Lbs.*	*Total Wt.-Lbs.*
500 lbs. (AN-M64A1)	132	68,904	2732	71,636
1000 lbs. (AN-M65A1)	72	71,784	1937	73,721
2000 lbs. (AN-M66-A2)	28	57,736	1552	59,288
4000 lbs. (AN-M56A1)	12	50,412	900	51,312
12,000 lbs. (M-109)	4	50,488	2004	52,492
22,000 lbs. (M-110)	3	69,411	1839	71,250
43,000 lbs. (T-12)	2	87,200	1894	89,094

Note

The design limit factor for the supporting structure for any of the above loads is 2.67.

Wing Flight Load Factors.

Wing flight load factors of 2.00, 2.25, and 2.50 are represented. The load factor 2.00 line represents the minimum normally considered acceptable; the 2.25 and 2.50 load factor lines are included for comparative purposes.

A load factor of 2.00 will result in each of the following instances:

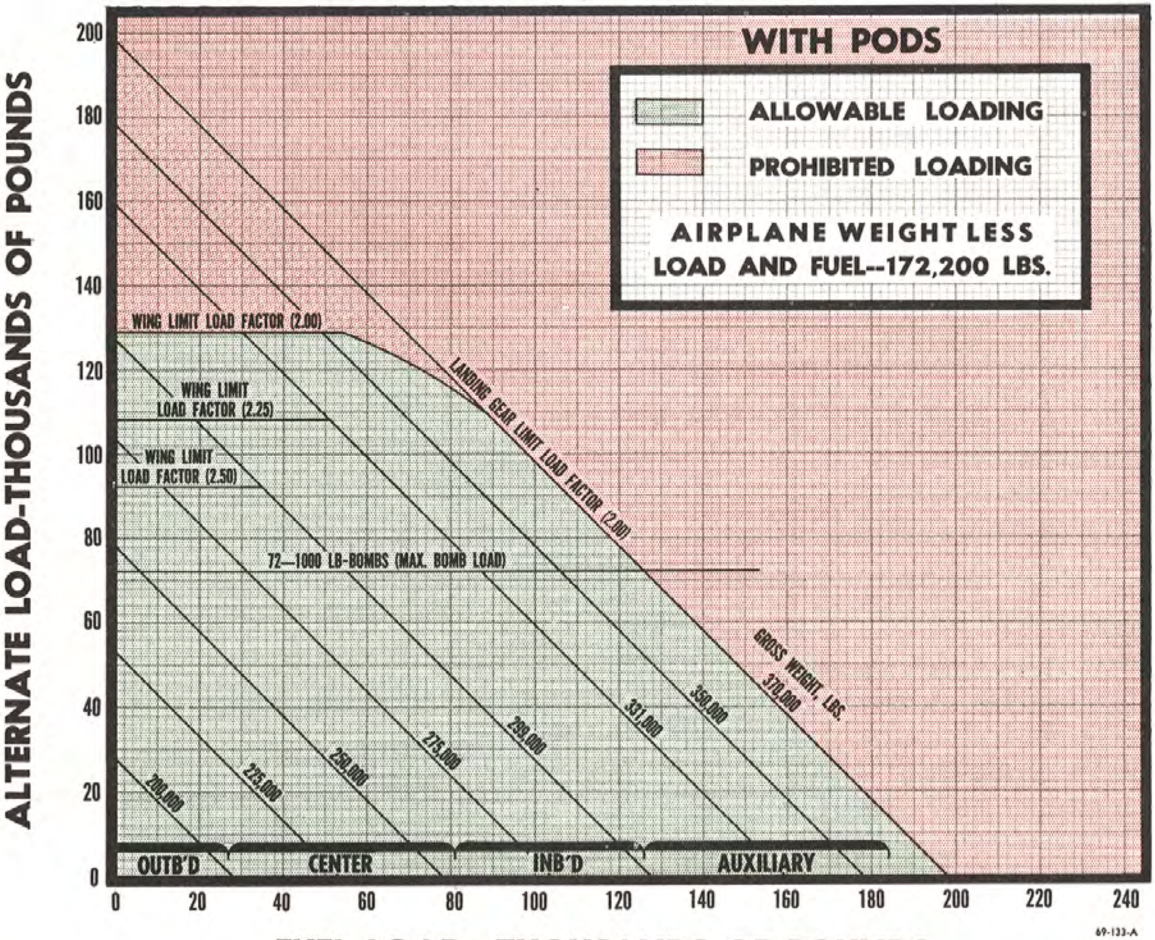
1. At a gross weight of 301,300 pounds with no fuel in the wings.
2. At a gross weight of 351,300 pounds with 50,000 pounds of fuel in the wings.
3. At a gross weight of 370,000 pounds with 86,500 pounds of fuel in the wings.

Landing Gear Load Factor.

In figure 5-6, the gross weight at which the landing gear is 2.0 is shown by the gross weight line representing 370,000 pounds. The landing gear is satisfactory

OPERATIONAL WEIGHT
Limitations

370,000 POUNDS MAXIMUM GROSS WEIGHT



69-133-A

Figure 5-6.

for this factor and gross weight for taxiing and take-off.

CAUTION

The maximum gross weight for landing is 357,500 pounds.

In figure 5-7, the gross weight at which the landing gear factor is 2.0 is shown by the gross weight line representing 357,500 pounds. The landing gear is satisfactory for this factor and gross weight for landing as well as taxiing and take-off.

Using the Charts.

Two operational weight limitations charts are provided. The chart in figure 5-6 is to be used for airplanes with a maximum gross weight of 370,000 pounds; the chart in figure 5-7 is for airplanes with a maximum gross weight of 357,500 pounds. When two 43,000-pound bombs are to be carried, the chart in figure 5-7 is to be used regardless of the airplane's maximum gross weight.

The charts can be used for any B-36H airplane provided jet pods are installed and no external loads

OPERATIONAL WEIGHT *Limitations*

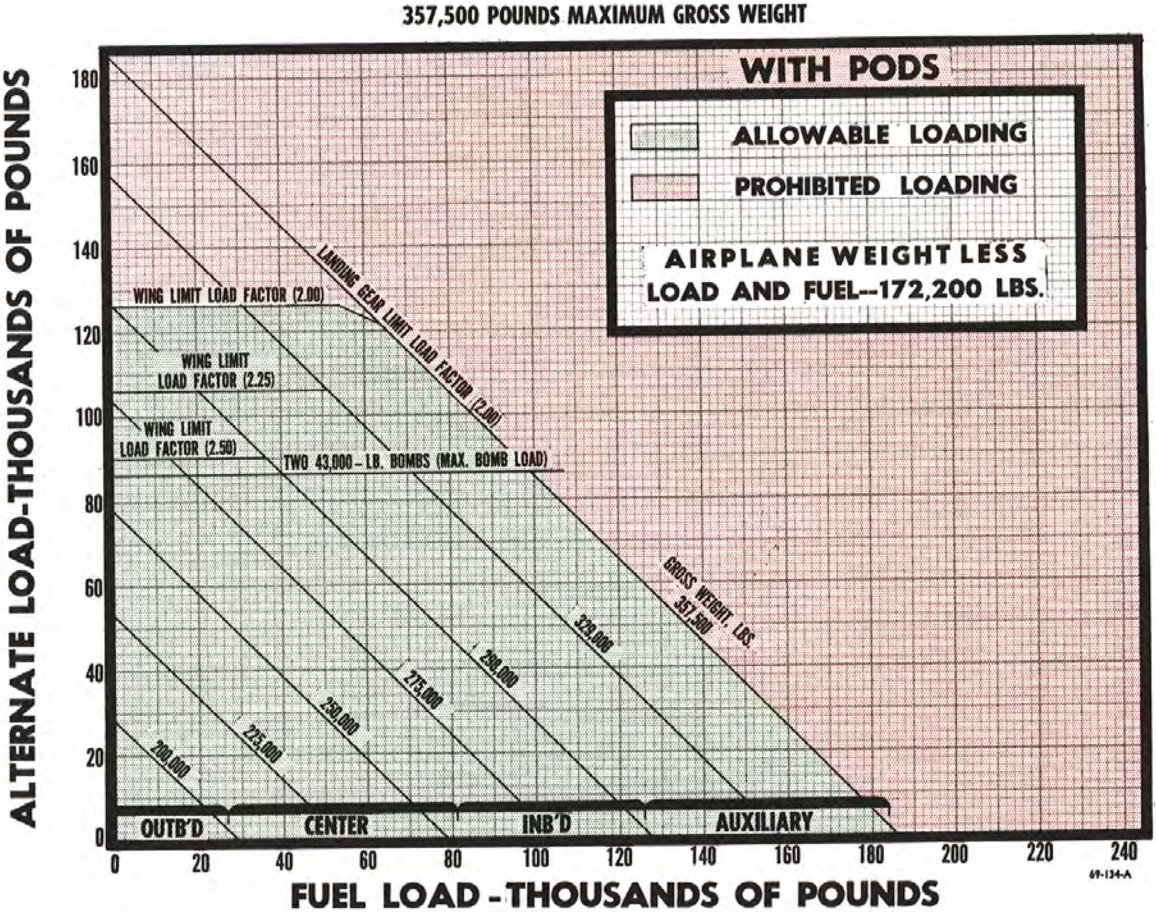


Figure 5-7.

are supported by the wing. Any wing loading other than internal fuel, as shown on the chart, would invalidate the wing flight load factor curves. Two examples are given to illustrate the use of the charts.

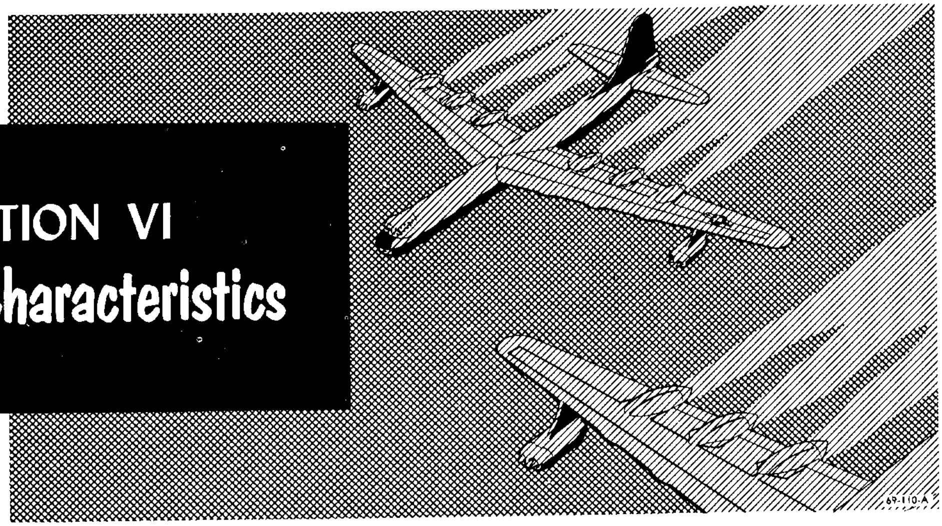
PROBLEM 1—Twenty thousand gallons of fuel are required to attack a given target. What is the maximum bomb load that can be carried?

SOLUTION—Having established from Form F that the airplane weighs 172,200 pounds before the fuel and bombs have been added, enter figure 5-6 at a fuel weight of 120,000 pounds (20,000 x 6 pounds per gallon). Moving vertically to the line representing a wing limit factor of 2.0, it is determined that a maximum bomb load of 77,000 pounds can be carried. Should it be established from Form F that the airplane weighs say for example, 175,000 pounds before the fuel and bombs have been added, subtract the difference between 175,000 and 172,000 from the allowable alternate load. That is, a maximum bomb load of 77,000 minus (175,000 minus 172,200) or 74,200 pounds can be carried.

PROBLEM 2—Determine if two 43,000-pound bombs can be dropped on a target requiring 20,000 gallons of fuel to accomplish the mission.

SOLUTION—Enter figure 5-7 at a fuel weight of 120,000 pounds (20,000 x 6 pounds per gallon). Move vertically up the line representing this weight until the line representing the maximum bomb load for two 43,000-pound bombs is reached. The chart indicates that this loading condition is not possible since the lines intersect in the red area representing prohibited loads.

SECTION VI
Flight Characteristics



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Even though this airplane is the largest tactical type, its pusher design offers some advantages over comparable tractor designs. This is particularly true of flight characteristics and performance.

Uniform weight distribution and servo-tab controls account for the conventional response with normal stick forces. However, more weight is located at correspondingly greater distances from any given control axis.

This increased inertia effect reduces the rate of control response. Maneuvers must therefore be planned further ahead.

Along with this maneuver anticipation, you will need increased clearance perception or dimensional awareness. Roll and pitch limits on take-offs and landings are narrowed by the physical dimensions of the airplane.

STALLS.

A study of stall characteristics is primarily a study of those factors which influence the flow of air over the top of the wing. When flow is smooth, lift exists; when flow separates or burbles, lift is largely destroyed.

NON-ACCELERATED POWER-OFF STALLS.

Power-off stall characteristics are conventional with unusually distinct warnings. During the entry you will notice tail buffeting, aileron shake, and increased stick resistance. There is a slight tendency to roll as the full stall is approached, but this is controllable.

At full stall, you will notice both roll and pitch down. There is no predominant direction of roll, and with normal recovery technique the amount of roll will be restricted by the inertia effect of the wing.

Recovery is orthodox, and with proper technique you can hold the altitude loss to less than 1500 feet. Flaps may intensify tail buffeting and pitch down, but the position of the landing gear exerts no noticeable effect.

NON-ACCELERATED POWER-ON STALLS.

Full stalls have been accomplished with a power setting of 20 inches M. P. The usual power-off warnings are still present. Tail buffeting is reduced, but aileron shake is more noticeable. In addition, you will notice an unusually high deck angle during the approach. Propeller induced air flow, as shown in figure 6-1, maintains smooth flow over the center section of the wing well beyond the angle at which a stall would normally occur. This extreme nose-high attitude combined with very low air speed is another stall warning. Since the wing tips extend beyond the propeller air flow effect, separation of flow occurs when the critical angle is reached. This increases the rolling tendency, but roll is controllable up to complete stall. Conventional recovery technique is effective.

ACCELERATED STALLS.

No accelerated stalls have been accomplished, but entry, stall, and recovery should be normal.

PRACTICE STALLS.

Practice stalls are not permitted.

STALLING SPEEDS.

Calculated stalling speeds for various gross weights, flap settings, and angles of bank are given in figure 6-5. The chart in figure 6-2 presents a quick reference for stalling and approach speeds at different gross weights and flap settings.

Note

In figure 6-2, it should be noted that the 135 and 145 per cent of stall speed curves for 30-degree flaps are not 135 and 145 per cent

PROPELLER INDUCED AIRFLOW EFFECT

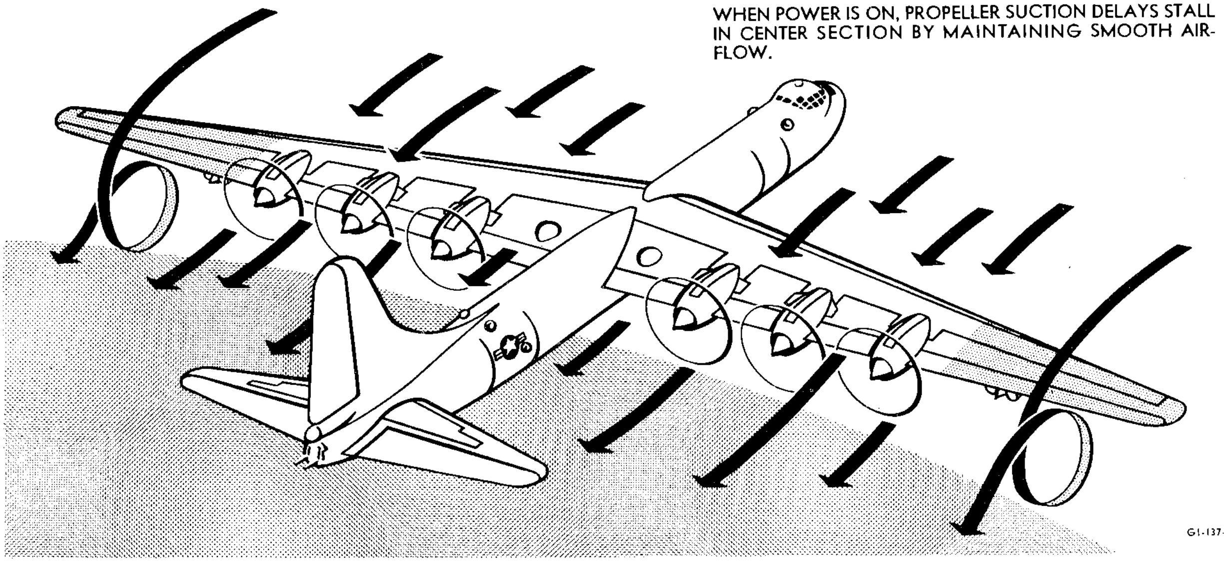

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Figure 6-1.

of the 30-degree flap stalling speed curve as it might appear. To obtain a per cent of an air speed, the percentage must be applied to EAS rather than IAS because the compressibility and position errors do not vary with air speed in a straight line.

The relationship of stalling speeds with wings level to stalling speeds at certain angles of bank are given in figure 6-3.

SPINS.

Since spins are absolutely prohibited, no experimental recovery data is available.

ACROBATICS.

All acrobatics are prohibited.

FLIGHT CONTROLS.

TRIM TABS.

Control forces should be trimmed out to maintain normal control response. You should reset the elevator tab just before take-off using 30 per cent MAC as a cg reference point. Allow 1 degree nose-up trim for each 1 per cent cg forward of 30 per cent MAC, or 1 degree nose-down trim for each 1 per cent cg aft of 30 per cent MAC. Actuating either flaps or landing gear will change longitudinal trim. You can minimize the effect of flaps on trim by operating them in increments of 5 degrees, and retrimming the airplane between each operation.

ELEVATORS.

Elevator control is excellent within allowable cg limits (17 per cent to 45 per cent MAC). At minimum speed

STALLING SPEED *Chart*

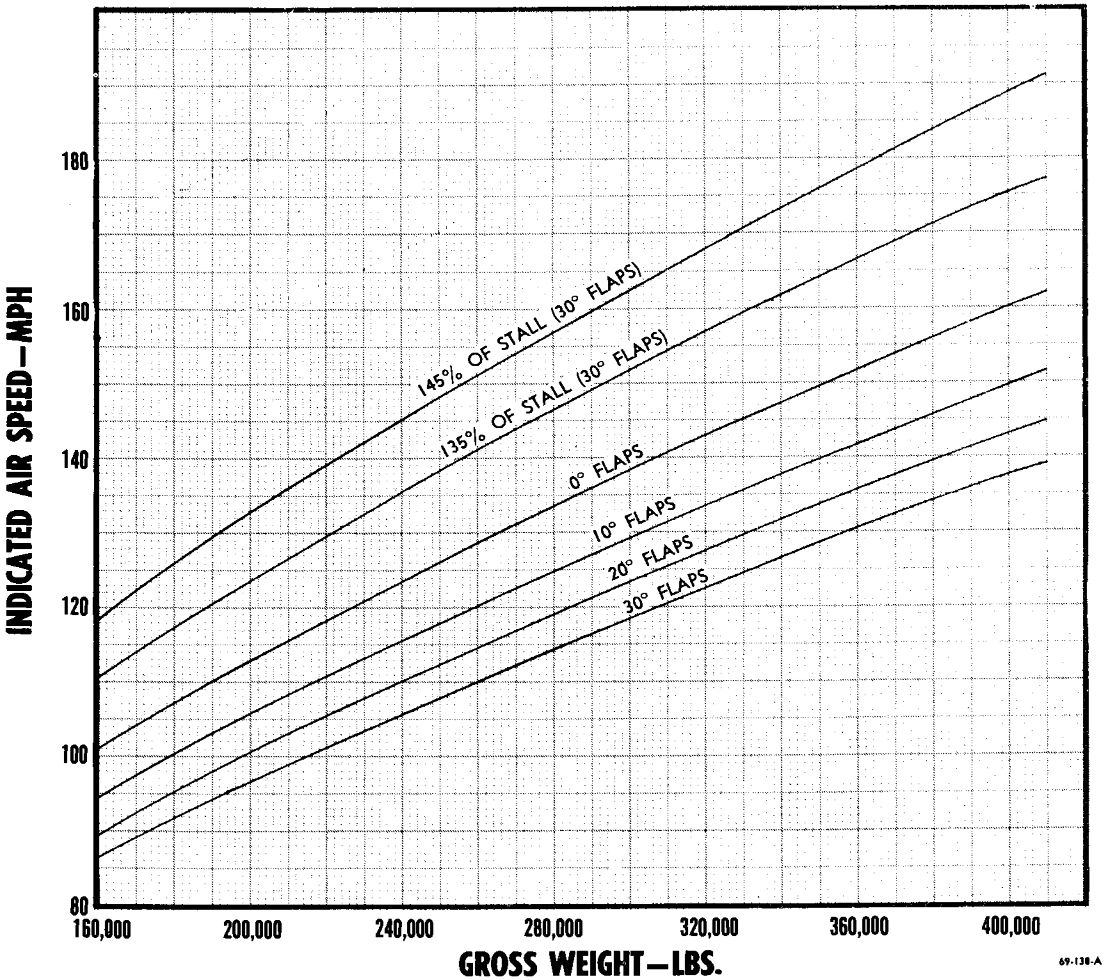

Figure 6-2.

during the take-off run, you will have to apply 50 to 75 pounds of back pressure to establish the proper nose-high take-off attitude. When airborne this pressure can be relaxed, and nose-down trim will be required as the airplane leaves "ground effect."

AILERONS.

Aileron control response equals or exceeds that of the nearest comparable bombardment type. More wheel movement is required at high altitude to obtain the same low altitude effect, but control is still positive.

At low air speed, the control force that ailerons can exert on the airplane is reduced. The resistance or inertia of the wing, however, remains constant. This means that you must allow more time to start and stop lateral movements.

ANGLE OF BANK	CORRECTION FACTOR
15°	1.016
30°	1.075
45°	1.186
60°	1.410
70°	1.813

CORRECTION FACTOR (ANGLE OF BANK) x STALLING SPEED (LEVEL FLIGHT) = STALLING SPEED (ANGLE OF BANK)

Example:

If the stalling speed in level flight is 114 mph IAS, determine the corrected stalling speed for a 30-degree angle of bank.

From the table find that the correction factor for a 30-degree angle is 1.075. Then substituting in the above formula,

1.075 x 114 = 123 mph IAS,

determine that the corrected stalling speed is 123 mph IAS in this instance.

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Figure 6-3.

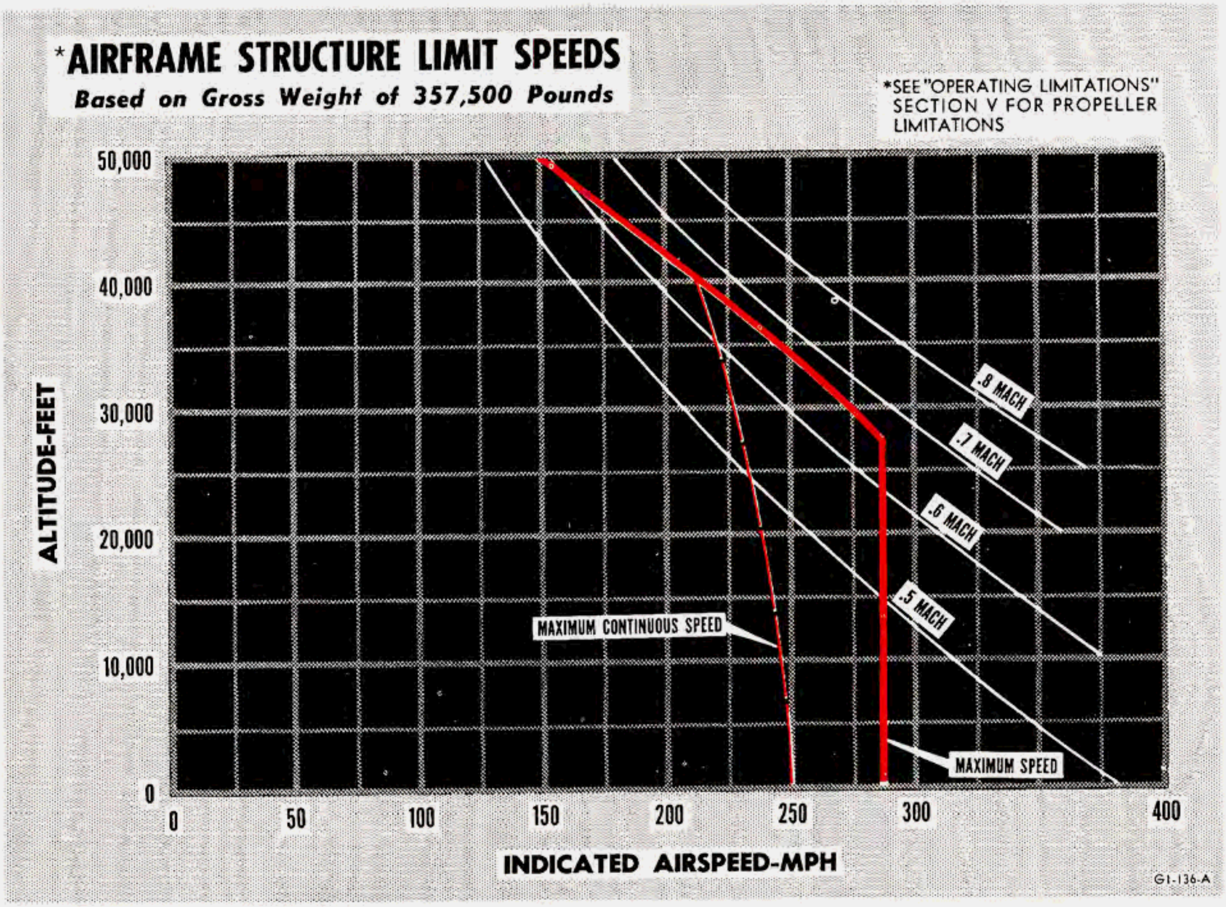

Figure 6-4.

RUDDER.

Rudder control is effective at very low air speeds with gear and flaps down. Under asymmetrical power conditions, air speed must be held above a critical value to maintain rudder effectiveness. These critical control speeds for various power combinations are shown in figure 3-1.

ASYMMETRICAL POWER CONDITIONS.

Operation with one or more engines inoperative is usually no problem since excess power is available at low altitude. If you are above the control air speed minimum for your power condition, normal turns can be made into the inoperative engines. However, because of possible structure damage to the vertical stabilizer closure skin, the airplane should not be operated in an asymmetric power condition of two or more engines out on one side unless in an emergency.

AFTER TAKE-OFF.

If you are below critical control air speed after take-off power failure, drop the nose and permit air speed to build up to the required minimum. Consider reducing gross weight if you cannot climb or maintain minimum terrain clearance.

CRUISE.

Power failure during cruising flight should not cause undue concern. Use jet engines to supplement your remaining reciprocating engines if required. Proper flying technique and pilot-engineer coordination will greatly increase the potential range under asymmetrical power conditions.

LANDING.

Partial power landings procedure is discussed in Section III. The power required to maintain level flight for your landing gross weight with gear and flaps down is shown by tables in the appendix.

LEVEL FLIGHT CHARACTERISTICS.

The range between slow and high speed flight is unusually large, but the upper air-speed limit is below the Mach number region where compressibility effect begins. Control and stability will be normal for any trimmed condition during slow, cruising, and high speed flight.

Air-speed limits for high speed level flight and high speed descent are shown in figure 6-4. Propeller vibratory stress limits are given in "Operating Limitations," Section V.

MANEUVERING FLIGHT.

A structural maneuver factor of 2 has been imposed as a limit for full gross weight. This limit restricts banks to 60 degrees or less, and pull-ups to 2 g's or less. As weight decreases, the maneuver factor increases slightly. See figure 6-5 for calculated stalling speeds and induced maneuver factors at various angles of bank. Stick forces will increase in steep turns and dives, and trim may be required. Response for any trimmed condition, however, will be normal within allowable load, cg, and maneuver limits.

DIVES.

Dives are permissible within the air-speed and propeller limits discussed under high speed level flight. Propeller restrictions can be ignored under stress of military necessity, but limit dive speeds should be observed under all conditions. Undetected flutter could cause structural failure.

CALCULATED *Stalling Speeds*

• POWER ON • GEAR DOWN • SEA LEVEL •

ANGLE OF BANK	0°			10°			20°			30°			40°			60°		
MANEUVER FACTOR	1.0			1.0			1.1			1.2			1.3			2.0		
GROSS WEIGHT LBS. / FLAP ANGLES	0°	20°	30°	0°	20°	30°	0°	20°	30°	0°	20°	30°	0°	20°	30°	0°	20°	30°
200,000	114	101	97	114	102	98	116	103	99	121	107	102	128	112	107	153	135	130
240,000	124	111	107	125	111	107	128	113	109	132	117	109	139	123	118	168	148	143
280,000	134	120	115	135	120	116	137	122	118	143	126	121	150	133	127	182	160	154
320,000	144	128	123	145	128	124	147	131	126	152	135	130	160	142	136	193	170	165
360,000	152	136	131	153	136	131	156	139	133	162	143	138	170	150	144	206	181	175
400,000	161	143	138	162	144	138	165	146	141	171	151	145	179	158	152	217	*	184
410,000	163	145	139	164	146	140	167	148	142	173	153	147	182	160	154	219	*	187

NOTE: RED FIGURES ARE STALLING SPEEDS IN MPH — INDICATED AIR SPEED
*STALLING SPEED EXCEEDS STRUCTURAL LIMITATIONS INDICATED

69-139-A

Figure 6-5.

Flap Retraction Speeds

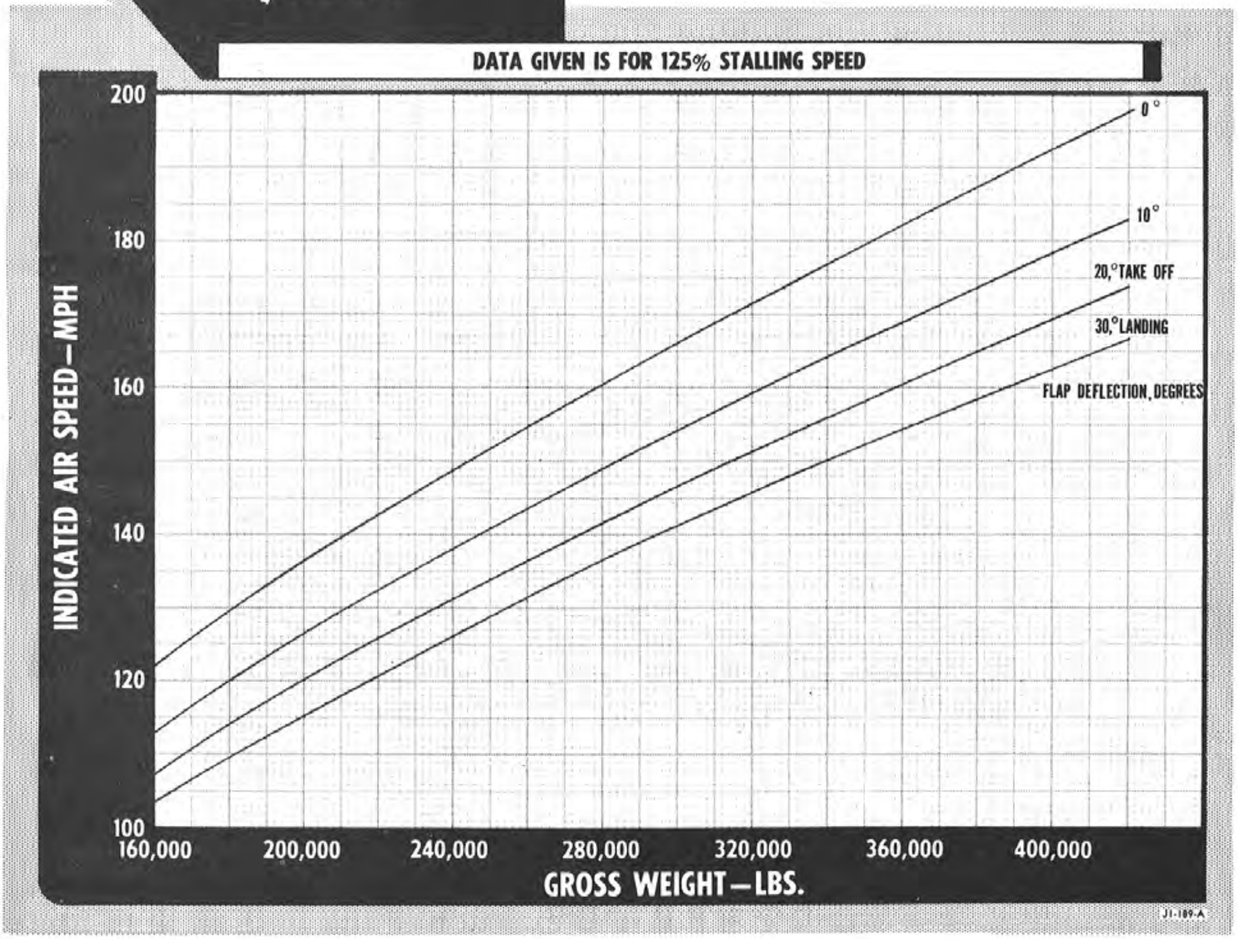

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Figure 6-6.

Stick forces in dives should be continually trimmed out particularly when inadvertent relaxation would sharply increase the "g" load.

FLIGHT WITHOUT JET PODS.

Maximum range missions may require removal of jet pods. However, this does not noticeably change flight characteristics. Take-off and climb performance will be correspondingly reduced by the loss of jet power.

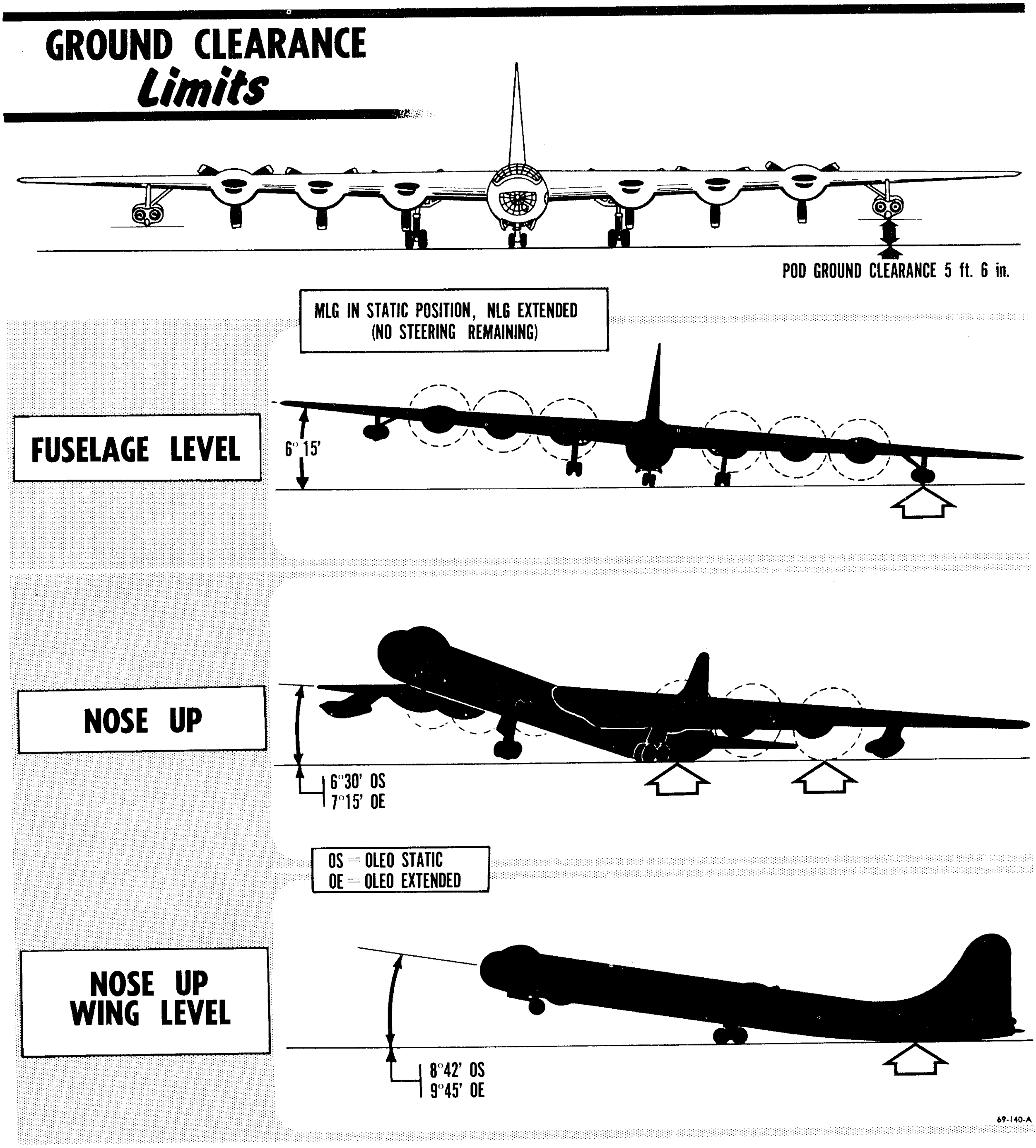
DIMENSIONAL AWARENESS.

As mentioned in the general discussion, this airplane requires that you be more careful of clearances. See figure 6-7.

FLAP RETRACTION TECHNIQUE.

When take-off gross weight exceeds 300,000 pounds, you must use proper flap retraction technique to maintain the necessary lift with a safe margin above wing-tip stall.

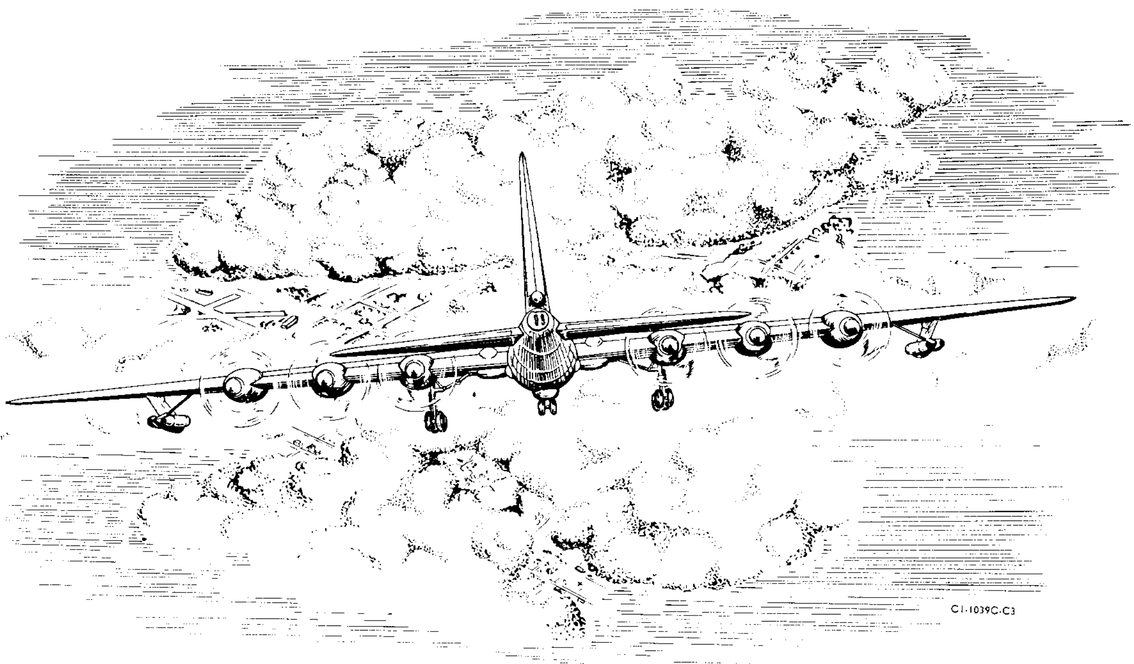
You will recall from the stall discussion that the wing tips extend beyond the influence of propeller induced air flow as shown in figure 6-1. They will stall when their critical angle is reached regardless of power setting. The recommended air speeds for flap retraction are shown graphically in figure 6-6. You should select the ordinate corresponding to your take-off gross weight and record air speeds for each flap setting during the retraction from 20 degrees to 5 degrees. Interpolation will be required for 5-degree increments.



69-140-A

Figure 6-7.

After take-off, allow the airplane to accelerate to the air speed recorded for the 20-degree setting; repeat this procedure for each succeeding flap increment until flaps are fully retracted. This technique will carry you through the transition zone with a margin of 25 per cent above stall. If chart air speed exceeds the placard air speed limit for any flap extension, the chart should be given preference. Placard limits on flap extension were imposed by propeller restrictions—not flap structure. Maintaining lift at a safe margin above stall is considered to be more important than briefly extending operation in a propeller vibration zone.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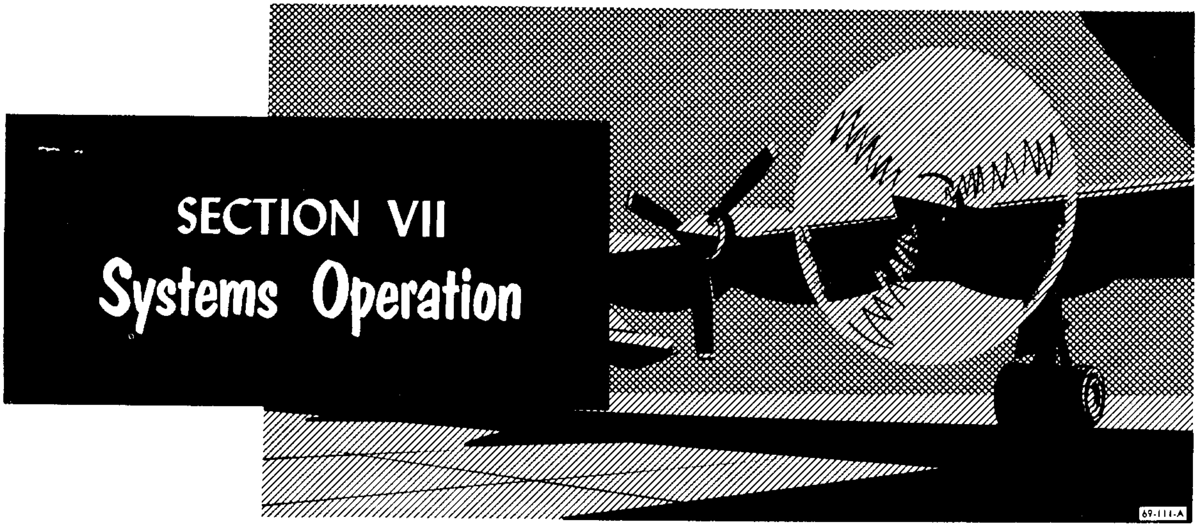

SECTION VII Systems Operation

69-111-A

RECIPROCATING ENGINES.

THE ENGINEER AND HIS ENGINES.

The engineer of the B-36 is provided with a formidable array of levers and switches to control the output and condition of his engines. Instruments enable him to interpret the results of these manipulations. Because the engines cannot be seen from his station, engine abnormalities are often difficult to diagnose either rapidly or accurately, while in flight. However, with proper interpretation of the instruments coupled with correct and clear information from the aft cabin scanners, fairly effective action can be taken in a minimum of time. Even though the levers and their corresponding instruments are very close together there is a long path between them. The levers and switches by themselves do not produce the instrument reaction. The engine is the necessary link that joins the control to the affected instrument.

The main concern of the engineer is not the portion of the engine to which the control or instrument is attached but rather the power section. It is in the power section that the impact of the power producing temperatures, pressures, and forces is applied and it is there that the results of improper control adjustment or the imposition of unsuitable conditions are felt. Excessive manifold pressure will not blow up the supercharger manifold, but it may blow off a cylinder head. Improper use of the mixture or spark advance controls does not directly harm the carburetor or magnetos, but may cause combustion chamber difficulties.

In spite of this consideration for the power section it appears to be treated with indifference. None of the controls and only one instrument, the cylinder head temperature gage, are connected to this portion of the engine. The control of power section conditions is affected indirectly through other sections. The interpretation of the results of this control is through instruments which indicate the conditions of other sections. Engine operation is not a matter of memorizing arbitrarily selected numbers. It is knowing what each control ultimately does to the power section and the meaning of the corresponding instrument indications in terms of power section temperatures, pressures, and forces.

ENGINE RPM.

The adjustment of engine rpm is used to establish engine power output according to the operating requirements such as take-off, climb, or level flight. The engineer must consult operating charts in the appendix to determine the correct rpm for use under the various flight conditions. However, he should be acquainted with the basis for specifying the different rpm settings. Cruise defines the operating limits which apply in sustained level flight when less than normal rated power is used. On the B-36 this must be described in three steps as follows:

Step One — This step (figure 7-1) considers only powers slightly less than normal rated, such as are used in the early stages of a mission. The maximum permissible bmep for this step is that for normal rated power. As power requirements decrease, the rpm is lowered but the normal rated bmep is maintained. If a propeller restriction is imposed, however, it will be necessary to adjust the power-rpm relationship to avoid the restricted range. In the example shown, when power is reduced to reach the restricted rpm range at point A, further power reduction is accomplished by reduction of torque alone. This continues until point B is reached. The power schedules do not allow operation at normal rated bmep below the propeller vibration restricted range.

Step Two—This step (figure 7-2) is reached when level flight power is lowered to the maximum permitted for manual leaning, but is still above the maximum for using advanced spark. The limits under these conditions can be described as in step one except that maximum bmep and rpm, hence maximum power, are lower.

Step Three — This step (figure 7-2) applies when power is reduced to the point where the spark can be advanced. In this condition the same bmep limit applying to the higher power manual lean range continues but the maximum rpm and power are reduced.

POWER SCHEDULE OPERATION AT NORMAL RATED BMEP

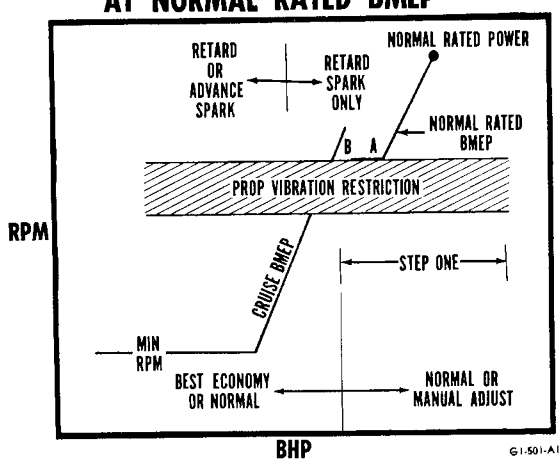

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Figure 7-1.

In the above cases, the maximum rpm limit is imposed to control the temperature rise through the internal supercharger. However, for time-limited powers the maximum permitted rpm is usually selected because maximum power is the goal. Then it becomes essential to maintain maximum air pumping action of the cylinders in order to keep bmep within limits. A minimum rpm is specified to avoid undesirable structural vibration in flight.

Descent.

During a long range descent, thrust power is reduced so that the airplane will maintain an optimum attitude along the flight path. As the engine output is reduced the rpm is reduced to lower the true air speed of the propeller blades proportionally. Significant gains in range are realized during long descents by utilizing the minimum practical rpm, provided that bmep limits are not exceeded and cabin pressure can be maintained. A propeller in low rpm produces much less drag than one in higher rpm because it is approaching high blade angle.

POWER SCHEDULE—OPERATION CRUISE BMEP

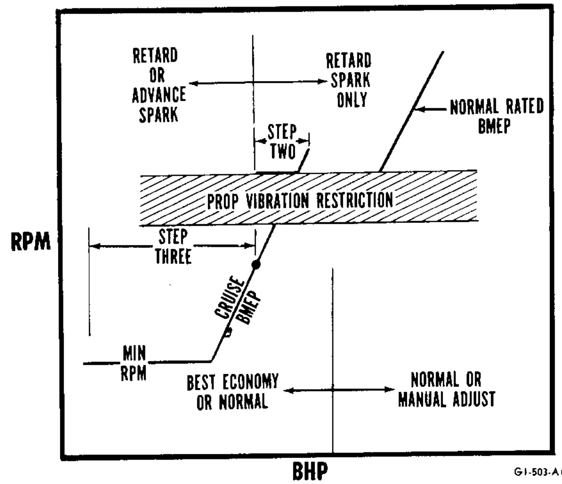

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Figure 7-2.

Overspeed.

There are two main forces exerted on the master rod bearings, the resultant of which makes the act of overspeeding critical. The main factor (figure 7-4) is the centrifugal force caused by the inertia of the connecting rod and piston assembly. This force is partially opposed by the cylinder gas pressures, leaving a mean resultant of about 80 per cent of the centrifugal force. Therefore, the resultant must be absorbed by the master rod bearing. The master rod bearing, crankpin, and their lubrication are designed for a 50 per cent overload factor. The centrifugal forces vary as the square of the rpm; therefore, at 120 per cent of normal rated rpm (100 per cent) the centrifugal load is 144 per cent, approaching the critical overload factor of 150 per cent. Under these conditions M. P. must be used to furnish gas pressures which reduces the resultant force on the master rod bearing.

PERMISSIBLE RPM VARIATION

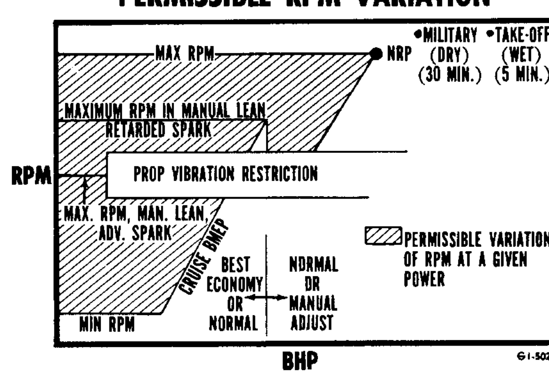

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Figure 7-3.

It should be noted that gas forces (figure 7-5) at high M. P. and bmep, and not centrifugal force, determine the strength of materials used in cylinder hold-down studs and piston pin.

Ground Operation.

The ignition system is checked with the propeller at 2200 rpm and with a torque pressure of 140 psi. Combustion flame speed characteristics are used to provide a standard for comparison. The use of this engine speed results in an airflow that causes the carburetor, in NORMAL, to meter approximately "best power" mixture. This minimizes the influences of fuel-air ratio variables. Using one spark plug results in a single

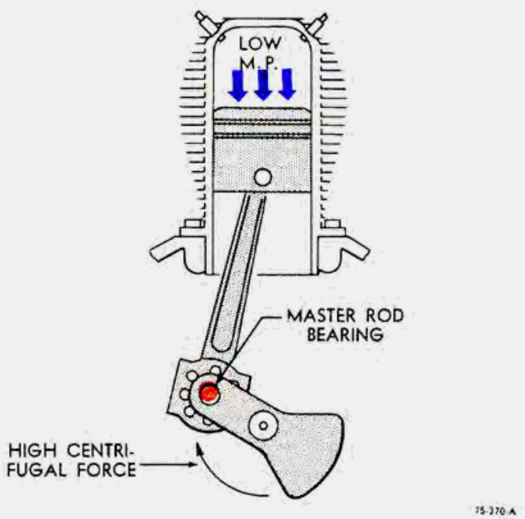

Figure 7-4.

flame front requiring a longer time for the completion of the burning process. With the spark in RETARD, this is equivalent to retarding the spark timing about 10 degrees more. The resulting loss of power is indicated by a reduction in torque pressure (figure 7-6)

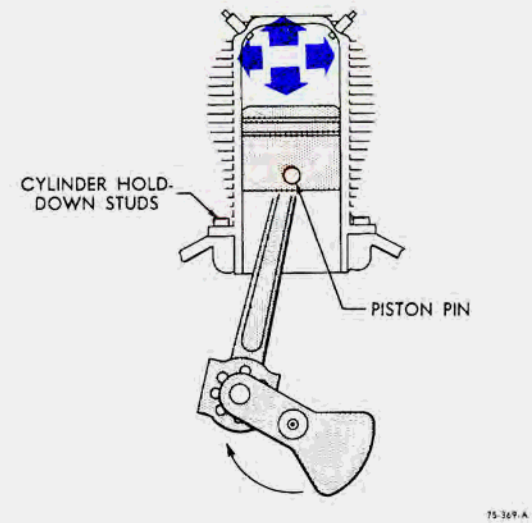

Figure 7-5.

and is a normal reaction. Failure to register a specified drop is evidence of improper timing, improper switch action, or other malfunctions. The lean slow burning mixtures used in flight with advanced spark require earlier ignition by two plugs for best combustion. Only one plug firing in each cylinder with the lean cruise mixtures will cause rough operation or after-firing.

Rpm variations are also used for ground checks of fan operation. When the fan drive is changed from low to high ratio, more power is diverted from the propeller and the engine rpm decreases accordingly. In the air, with constant speed propeller operation, this change is reflected only on the torquemeter reading. The fan ground check is made at the rpm obtained at field barometric manifold pressure because higher rpms would impose excessive fan loads on the fan drive in high ratio.

EFFECTS OF VARIOUS IGNITION & MIXTURE COMBINATIONS ON TORQUE

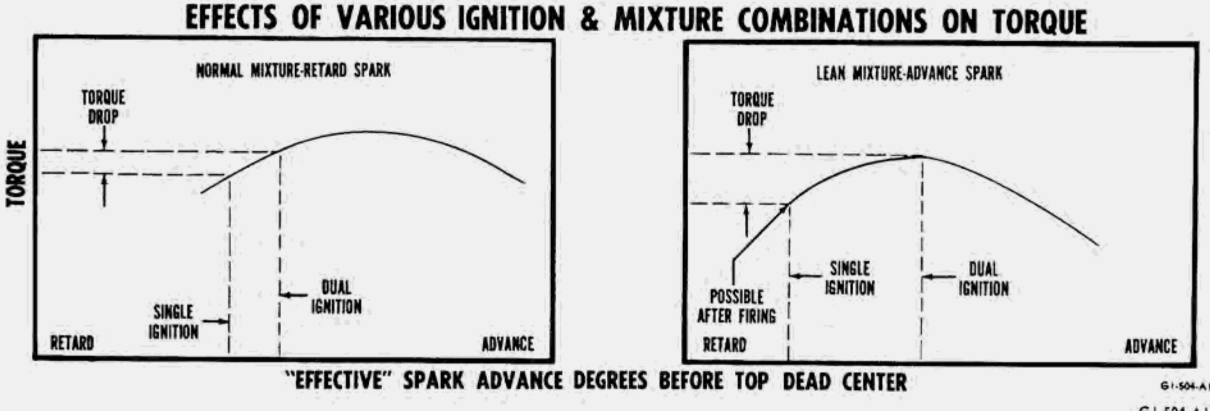

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Figure 7-6.

The tachometer is the basic instrument for checking proper position selection and functioning of various electrical circuits which control the propellers, master motor speed, the propeller circuit breakers, and the selector and feathering switches. Propeller and control system response is judged by rpm indication. The engine tachometer is also consulted with regard to alternator operation, oil pressure, fuel pressure, oil spewing, and other malfunctions.

MANIFOLD PRESSURE.

For practical purposes manifold pressure is a good tool for engine power setting, and when used with rpm in an unmodified form, a degree of accuracy sufficient for many types of operation is realized. B-36 missions cannot be accomplished with such "rule of thumb" methods. However, the engineer must have a complete concept of the nature of manifold pressure, and the steps that must be taken after rpm and boost adjustment before he can be sure that the engine power output is as specified. Variations in manifold pressure required for take-off power under different atmospheric conditions are the best illustrations of the necessary correction of manifold pressure for B-36 operating accuracy.

Test stand calibration of the R4360-53 with water injection shows that 3800 bhp is obtained at 2800 rpm and 64 inches manifold pressure when 31 inches Hg exhaust back pressure is imposed, the carburetor air temperature is 38°C, and all other factors are standard, including dry air. However, the engine installation on the B-36 results in an exhaust back pressure greater than 31 inches Hg at take-off power, and 66 inches or more manifold pressure would be needed to obtain 3800 bhp. This increase is required to overcome the additional exhaust pressure.

Dry air is included in the list of "all other factors" but isn't always present for maximum gross weight take-off. The engine produces power in proportion to the amount of dry air consumed and as water vapor displaces dry air its presence constitutes a loss of power producing potential in the charge being pumped into the cylinders. The total pressure of the charge air is the total of the pressures of its component parts (nitrogen, oxygen, water vapor, etc.). Sensing total pressure only, the manifold pressure gage is unable to reject water vapor pressure and concentrate only on pressure supplied by air.

Starting with atmospheric pressure, if the barometer reads 29.5 inches Hg and .5 inch Hg vapor pressure is present, the dry air is responsible for 29.0 inches Hg of the barometer reading. By the time the charge has passed through the induction system, the .5 inch of vapor pressure is multiplied by the superchargers to about 1.08 inches Hg. Therefore, 66 inches of manifold pressure represents 66—1.08 or 64.92 inches of power producing charge—a loss of about 75 bhp per engine.

The carburetor cannot distinguish between water vapor and dry air, so it sends in fuel for the water vapor thus furnishing too much fuel for the dry air actually taken in. This results in an additional loss of power for the observed manifold pressure. Humidity often accompanies high outside air temperatures and the combination of the above factors detract from the airplane take-off performance. Humidity corrections outlined in the appendix are for correcting the take-off manifold pressure setting so the air portion of the charge pressure is equal to the maximum allowable charge pressure if dry air were used. This correction assures maximum safe power delivery.

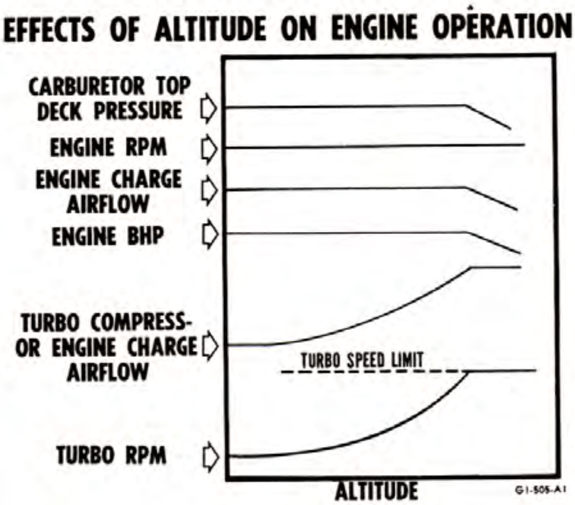
The humidity correction factor is used only during take-off since moisture at operating levels is negligible. This correction should not be neglected by the engineer when he calculates beforehand the take-off manifold pressure he will use.

The large variations in exhaust back pressure resulting from the turbosupercharging system cause discrepancies between the engine manufacturer's calibration and the power obtained in the airplane. The manifold pressure settings specified in the appendix are results of flight testing and with proper corrections of carburetor air temperature variations and humidity to take-off the required accuracy will be obtained.

SUPERCHARGING.

Two conditions of operation govern the procedure of manifold pressure control. If the turbo boost selector (TBS) is at zero, primary regulation is by the throttle and the manifold pressure obtained varies as with more elementary installations. However, because of the drag of the idling superchargers and ducting loss at full throttle and full low pitch, the pressure at the carburetor entrance is only about 24 inches at sea level resulting in a manifold pressure of approximately 48 inches. RPM lower than that for take-off causes reduced internal supercharger compression and accounts for further lowering of the available manifold pressure on the ground. In flight with TBS at zero, variations of indicated air speed influence manifold pressure as the ram pressure changes. As long as performance needs are satisfied, the TBS should be kept at zero due to better fuel economy without the back pressure and increased induction air temperature resulting from turbo use.

With full throttle and constant rpm, the manifold pressure varies directly with carburetor entrance pressure. The job of the turbosupercharger is to keep this pressure constant at a value that permits the internal supercharger to deliver the required manifold pressure for a selected rpm. Setting the TBS directs the pressuretrol to maintain necessary entrance pressure. The pressuretrol proceeds to do this by regulating the waste gate position.



GI-505-AI

Figure 7-7.

During a climb with normal rated power, with the TBS set and individual turbo-calibration knobs trimmed for the required manifold pressure, the pressuretrol actually works to maintain approximately 27 inches Hg carburetor entrance pressure. If the rpm is reduced with the TBS fixed, the manifold pressure lowers. This occurs because the internal supercharger compression ratio falls with the drop in crankshaft speed, and the pressuretrol is unconcerned with this variation. However, if the indicated air speed were to be lowered, the manifold pressure would be unaffected as the pressuretrol would act on the waste gates and compensate for the reduction of ram pressure.

As the climb progresses at normal rated rpm and the turbosupercharger entrance pressure falls off, the pressuretrol continues to maintain the carburetor entrance pressure demanded by the TBS. The limit is reached when the turbo overspeed control takes over to prevent excessive turbine speed. At this point each supercharger is operating at maximum rpm and engine charge air flow falls off with altitude (figure 7-7) similar to a simple fixed speed supercharger. There is a mild hunting of the turbo overspeed control and the waste gate. This hunting results in a wavering of 2 or 3 inches in manifold pressure. Air speed again exerts a direct influence on the manifold pressure indication.

The control sequence is as follows: First, with zero TBS, advance the throttle. Second, when full throttle will not give the needed manifold pressure, advance the TBS as required. Do not obtain manifold pressure with the TBS when the throttle is only partially open except for unusual situations. Damming the induction system (figure 7-8) between the throttle and the turbos can result in stalling of the turbo-compressors and cause severe cyclic pulsations accompanied by afterfiring. Also, using turbos in this manner is inefficient since exhaust back pressure and carburetor air temperature are higher than necessary.

Obtaining Maximum Turbo Speed.

It is difficult to operate at a turbo speed near the rpm at which the turbo governors are set to cut in. This is due to the fact that when the turbo rpm reaches the governor setting, the governor will open the waste gate until the turbo rpm is reduced sufficiently to remove the governor's control. At this point the waste gate starts closing and the cycle is repeated, resulting in unstable engine operation. The following procedure is recommended when it is necessary to operate at or near the limiting turbo speed:

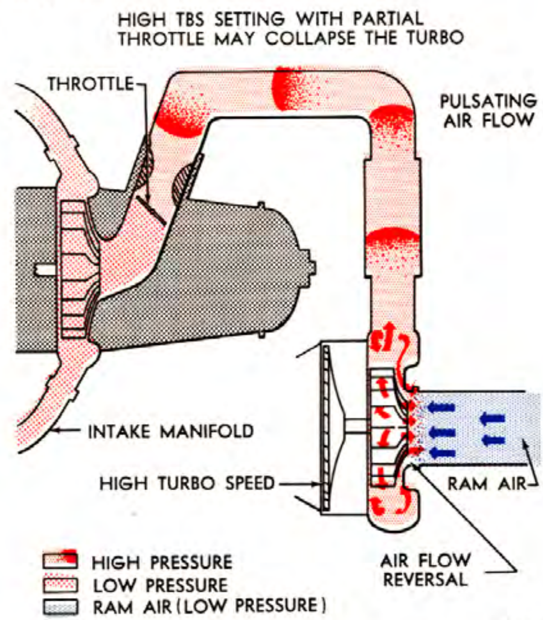
1. Shift to manual override.

2. Advance power until the desired engine setting is attained, not to exceed 24,750 turbo rpm.

3. Do not exceed 24,750 rpm on the turbos at any time.

4. Periodically check this reading, particularly with any change in altitude, air speed, or CAT.

The turbo speed limit of 24,750 rpm is the maximum speed recommended for satisfactory turbo life. Short tests have been conducted at higher speeds to determine what gains in power could be made by exceeding this limit, but the attendant increase of CAT. necessitates further opening the intercooler shutters, thereby increasing drag, reducing air speed, and resulting in no worthwhile increase in performance.



CI-195-C

Figure 7-8. Power Collapse with Closed Throttle

Turbosupercharger Operation.

The use of single turbo in place of dual is necessary if the waste gates close fully. Its use may be dictated by power collapse of pulsation possibilities at low air flow, low rpm, and high manifold pressure. By using one unit, the quantity of the charge air through the turbosupercharger is increased and stable operation can be maintained. It must be realized that during single turbo operation, there is a difference in the temperature rise from dual operation. Only one intercooler is removing the compression heat; therefore, the carburetor air temperature rises accordingly unless the intercooler shutters are opened. When shifting from dual to single turbo, and when returning from single turbo to dual, the engineer can help the power plant make the change smoothly by following steps favorable to conditions present during the transition.

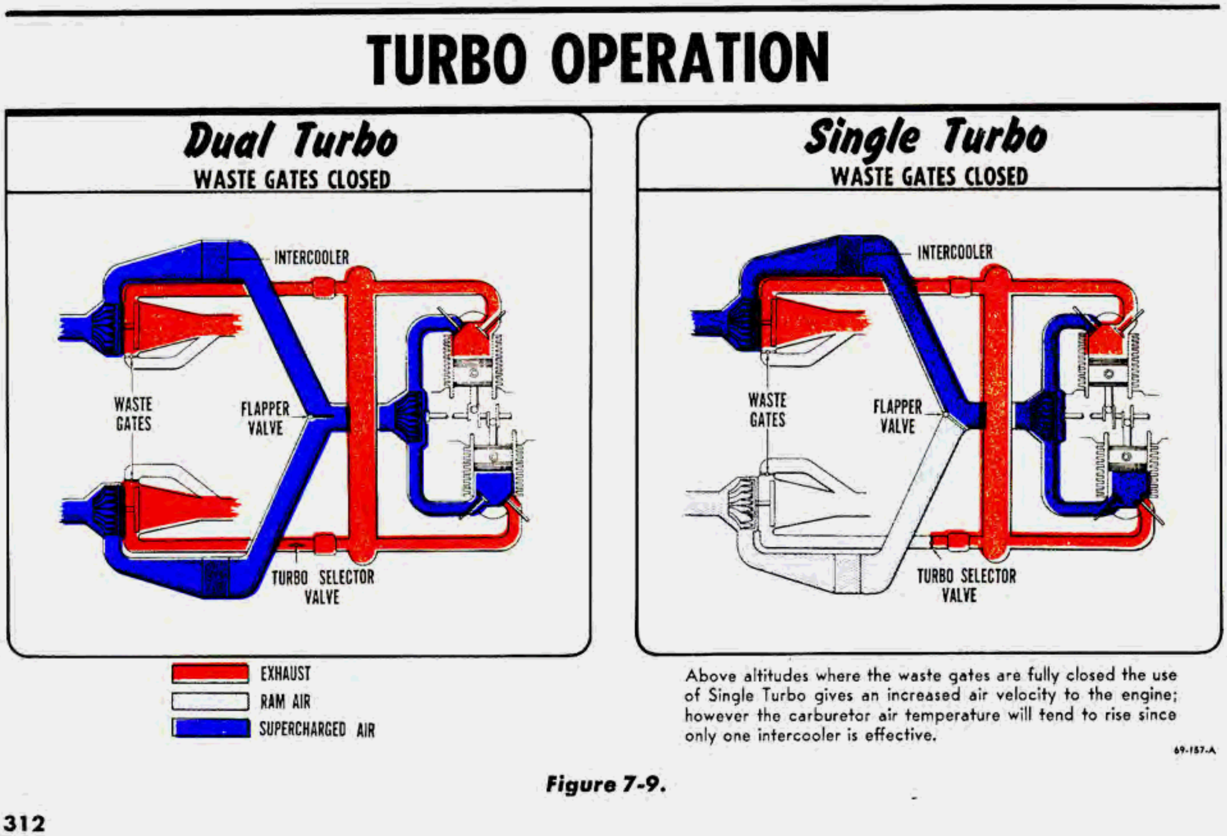
When shifting from dual to single, one turbo slows down and the other, influenced by the pressuretrol, speeds up to take over the entire pumping load. At first, the unit that is cut out loses speed faster than the active unit speeds up and a momentary drop of 2 to 5 inches manifold pressure results.

If shift does not occur within a reasonable length of time, pull the throttle back sufficiently to allow the turbo to shift. Pulling back the throttle reduces the exhaust gas loading on the selector valve to the left turbo and permits the actuator to break loose the valve gate in the exhaust duct and move it. If the shift is not completed in about one minute, the actuator motor is likely to overheat and burn out. Close observation of the alternator instruments just as switches are thrown often will give clues as to whether circuits and motors are acting properly.

When the shift is from single to dual turbo the selector valve quickly divides the exhaust flow, suddenly denying the active turbo a portion of its energy source, slowing it down. The previously inactive unit speeds up, however, and for a moment the combined output of both is low and a drop in manifold pressure is noticed.

In either case the pressuretrol acts to increase the carburetor deck pressure to that of the TBS setting. There will be a small amount of overshooting, however, before it stabilizes. These momentary changes in air flow should not be allowed to occur with the carburetor mixture leaned to cruising because afterfiring can occur. Therefore, the mixture control lever must be in NORMAL or RICH before making the shift. Also, the spark advance switch must be in RETARD because early ignition with the faster burning mixture can cause heat to build up in the combustion chamber materials faster than it can be transferred away.

This explains that the spark must be retarded before placing the mixture in NORMAL or RICH. However, the spark should not be retarded while operating with



Above altitudes where the waste gates are fully closed the use of Single Turbo gives an increased air velocity to the engine; however the carburetor air temperature will tend to rise since only one intercooler is effective.

Figure 7-9.

a fully leaned cruise mixture because retarded spark with the slow burning fuel-air ratio will cause afterfiring. Therefore, the mixture must be partially richened before retarding the spark. This can not be done if the CHT is at its limit, for the increased mixture strength causes an increase of CHT that must be anticipated before starting the shift. Also, when shifting from DUAL TURBO to SINGLE TURBO a carburetor air temperature rise occurs due to the greater heat rise through the use of single turbo.

Again this temperature rise should be anticipated and the intercooler shutters must be adjusted accordingly preparatory to shifting to single turbo.

During single turbo operation, icing of the left exhaust tail pipe can occur. Apparently exhaust gases condense and freeze on the tail pipe outlet. There should be no concern on the part of the flight crew relative to any hazard being present from these ice formations. It is possible, however, for enough ice to form, break loose, and strike the fuselage, causing some damage. Icing of this nature can be removed by shifting to dual turbo for a few minutes. However, this decision should be left to the discretion of the aircraft commander since a shift to dual turbo could not be made unless power was advanced with a resultant loss in range.

Shifting Turbos—Dual to Single. Use the following procedure for shifting to single turbo operation. It is very desirable to remain in dual turbo as long as power can be maintained. At such time when power can no longer be maintained in dual turbo, proceed as follows:

1. Intercooler shutters—Full open.

CAUTION

It is very important to open the intercooler shutters because the CAT. increases very rapidly in single turbo operation. In addition, turbo selection must never be made while in manual lean or advanced spark.

2. Air plugs—As required.
3. Work on two symmetrical engines at a time.
4. Spark advance switches—RETARD.

Note

In the event of fully leaned mixture, enrichen the mixture before placing the spark advance switches in RETARD.

5. Mixture control levers—NORMAL or RICH.
6. Reduce manifold pressure to 30 inches or below.
7. Shift from dual to single turbo.

Note

Manifold pressure will drop approximately 2 to 5 inches and then tend to surge upward.

8. After the shift has been completed, increase M. P. to approximately 35 inches while the other turbos are being shifted.

Note

If a shift does not occur within a reasonable length of time, pull throttle back sufficiently to allow the turbo to shift.

9. After all turbos are shifted to single, set desired power.
10. Readjust air plugs and intercooler shutters.

CAUTION

The alertness of the engineer is the only safety factor for maintaining CHT and CAT. below maximum limits.

Shifting Turbos—Single to Dual. The following procedure is for shifting to dual turbo at a constant altitude when additional power is required:

1. Intercooler shutters—As required.
2. Air Plugs—As required.
3. Spark advance switches—RETARD.
4. Mixture control levers — NORMAL, model 391260-8, 391420-1, and 391410-1 and -2 carburetors; RICH, model 391260-3, -4, -5, and -6 carburetors.
5. Reduce manifold pressure to 35 inches or below.
6. Increase engine speed to at least 2000 rpm.

Note

This is a step in the direction to keep the power up without exceeding temperature limits during the shifting procedure.

7. Maintain manifold pressure at 35 inches or below.
8. Shift to dual turbo.
9. Open intercooler shutters as required.
10. Retrim engines to power required and readjust air plugs and intercooler shutters.
11. Repeat steps on other engines.

Power Collapse.

Satisfactory operation of the supercharging system requires that a balanced loading of all units be maintained. The pressure rise load of each compressor can be compared to the wing loading of an airplane. Similarly, the charge air velocity through the compressor closely follows the engine rpm and is comparable to the air velocity over a wing. If the load (pressure) is too high for the charge air velocity (rpm), the diffuser and compressor blades stall and collapse, possibly ac-

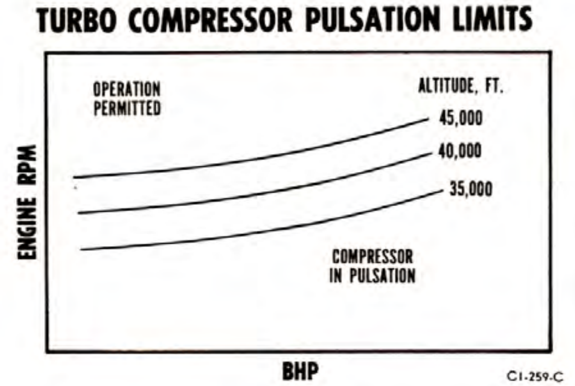


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Figure 7-10.

companied by afterfiring. This condition can occur at moderate to high altitudes (figure 7-10) by attempting to maintain a high manifold pressure at a low engine rpm. When this is done, the low internal supercharger pressure rise must be made up by driving the turbo faster and the system approaches instability. The turbo pulsation limits are defined in the appendix. These turbo characteristics cause difficulties during that portion of the flight when the airplane is very light and low power is being established with high bmep. The low engine rpm shifts the manifold pressure load to the turbos and as the rate of air flow diminishes, the velocity through the turbo-compressors is critically slow and blade stalling is approached. When the critical point is reached, stalling occurs and power collapse takes place. There is seldom any instrument warning of this event from the manifold pressure gage, the torquemeter, the tachometer or other instruments, but there is plenty of unmistakable evidence afterward. There is a sudden and complete loss of power. It is so abrupt that the propeller automatic pitch control cannot compensate rapidly enough to maintain engine speed, with the result that rpm drops momentarily and then overshoots the initial setting slightly. When this happens, DON'T CLOSE THE THROTTLE. This would be comparable to pulling back the stick of a stalled airplane. Placing a dam in the induction system only accentuates the difficulty and will bring on pulsations with attendant afterfire.

The solution of this problem is to increase airspeed over the stalled surfaces of the turbosuperchargers, which is comparable to increasing the airspeed of a stalled airplane. The most effective means is to immediately increase the engine rpm which results in an increased velocity through the turbo compressors for the same carburetor deck pressure. In case of a marginally unstable power setting, increasing speed 25 to 50 rpm and lowering the TBS setting slightly to retain the bhp are sufficient to restore harmony by developing balanced loads among the various pumping elements.

Other factors may be adjusted to alleviate the condition and permit maintenance of the established power and bmep. A reduction of charge air temperature permits obtaining the required brake horsepower with less manifold pressure and reduces the pressure loading on the turbos. To accomplish this, lower the carburetor air temperature by opening the intercooler shutters. Other corrective actions that can be taken from the engineer's station are: reduction of turbo boost, mixture enrichment, use of advanced spark (if within the permissible range), and increase of cabin air flow. Using any of these steps aids the turbo function, either by increase of air flow and air velocity through the internal supercharger, or by reducing the pressure load on the turbo system.

It is apparent from the above considerations that increasing engine speed is the most effective means of recovering from power collapse. If the initial rpm is just marginally unstable, the slight overshooting of rpm after the momentary drop will frequently be enough to unload the turbo and permit self-recovery with no adjustment of controls. An increase of 25 to 50 rpm is then sufficient to prevent recurrence of the trouble.

Seasonable changes in outside air temperature affect the stable rpm-manifold pressure combination by a range of 75 rpm even with the same carburetor air temperature. This is due to the effect on efficiencies of the turbo-compressor and intercooler.

Leakage or restriction in the induction or exhaust systems may contribute to instability. Nicked or damaged turbo or engine compressors are inefficient and cause too high a temperature rise. These conditions reduce the weight of charge air that passes through the system.

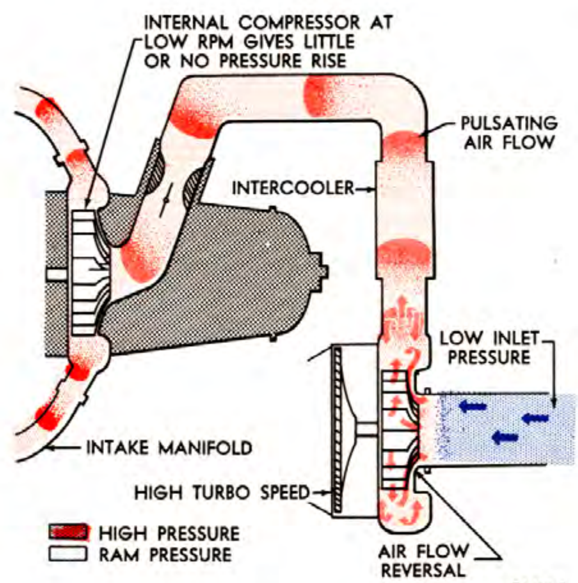

Figure 7-11. Power Collapse

Power Collapse Recovery. This procedure is designed to get the power plant into the stable operating range quickly and safely.

CAUTION

Do NOT retard the throttle because this results in an even worse condition of power collapse.

1. Master motor speed control lever—Increase until engine speed increases 25 to 50 rpm.

Note

This step will remove all engines from a marginal surge condition.

2. Turbo calibration knob of affected engine—Fully counterclockwise.
3. Spark advance switch of affected engine—RETARD.
4. Mixture control lever of affected engine—NORMAL or RICH.
5. Turbo calibration knob of affected engine—Turn clockwise *slowly* to regain power and observe engine rpm.

CAUTION

Don't regain power too rapidly as rpm surges may result.

6. Re-establish proper setting of mixture and spark on affected engine.

CARBURETION.

Carburetor Air Temperature.

Carburetor air temperature is regarded by many as the indication of the possibility of induction system ice formation. It still serves this purpose on the B-36 but also provides other important items of information. As previously shown CAT. must be combined with manifold pressure and rpm to measure air flow. It is also a major factor affecting maintenance of satisfactory operating conditions.

The maximum CAT. is specified to prevent detonation. At engine speeds greater than 1815 rpm with advanced spark, this limit is not ideal but marginal. Occasionally, outside air temperature is 38°C and above, and since there is no refrigeration in the induction system, the heat rise through the turbosuperchargers results in a CAT. above the limit. *A reduction of 1 inch manifold pressure for each 5.5°C above 38°C CAT. is then mandatory to insure safety during take-off.* This correction is automatically obtained when the M. P. is corrected for humidity during take-off. As engine speed is reduced from 2800 rpm and the heat rise through the internal superchargers is lowered, the margin increases. When this exists it is possible to consider CAT. with relations to engine efficiency as well as safety.

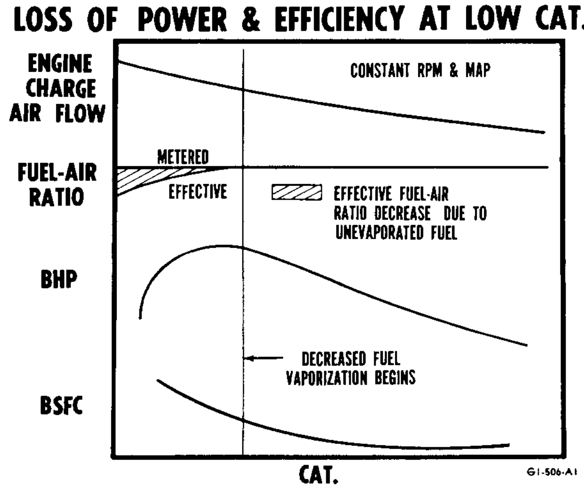

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Figure 7-12.

The power plant is a heat machine and the temperature of component parts or fluids flowing through it affects the combustion process, either directly or indirectly. The temperature level of induction air upon leaving the carburetor not only affects the charge density but also fuel vaporization. When considering rate of air flow at constant manifold pressure, the colder the CAT. the greater the weight packed into the charge air volume. By this measure alone, power should continue to increase as colder air enters, provided other factors are held constant.

However, this increase in power may not be directly proportional to air flow in which case the brake specific fuel consumption will start to increase. This trend (figure 7-12) is below a certain CAT. and is dependent on variables such as rpm, mixture strength, fuel temperature, and the temperature of engine parts which the fuel contacts. Thus, at extremely low temperatures, it is possible for a critical condition to occur which results in power loss and consequently irregular operation.

These phenomena are brought about by failure of the fuel to vaporize in the cold induction air. Obtaining the maximum potential power from a given rate of charge air flow requires complete vaporization of all fuel supplied by the carburetor. Unevaporated fuel, even though finally divided into a spray or mist, does not burn and does not contribute to power. The carburetor does its job by providing fuel according to air flow requirements as previously discussed. It meters, or measures, liquid fuel and is unaware of occurences downstream. The "measured" fuel-air ratio is based

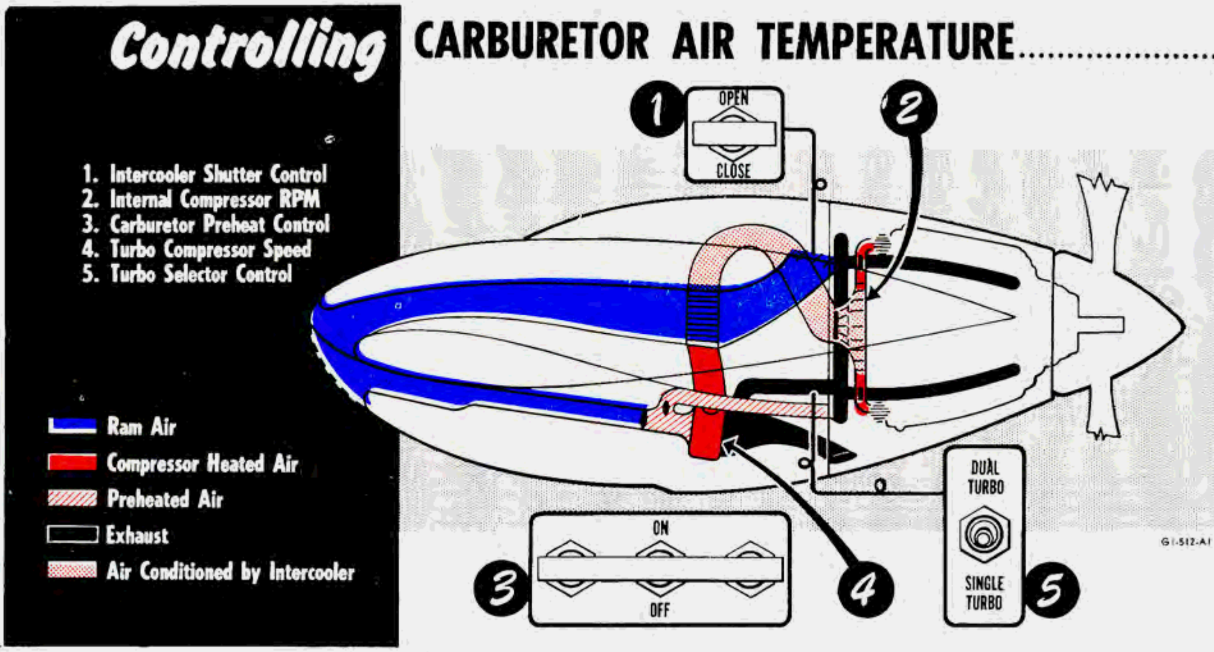

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Figure 7-13.

on the proportion of this liquid fuel to air. The "effective" fuel-air ratio is the proportion of vaporized fuel to air and if all the fuel is not vaporized the "effective" fuel-air ratio, which does the work, is lowered.

At high power with a high charge air flow and a rich mixture, this effect can be favorable for a range of temperature reduction as the "effective mixture" is approaching "best power." However, if continued to a frigid extreme, "effective" mixtures leaner than "best power" may result even though the "measured" fuel-air ratio is adequately rich. The unburned fuel often causes "torching" at the exhaust pipe. With cruise powers and lean "measured" mixtures, lack of vaporization results in overly lean "effective" fuel-air ratios and power loss. Because of charge distribution irregularities, some cylinders receive leaner mixture than others and they cease to fire since the mixture supplied to them will not support combustion. The lead in the fuel tends to stay with the unevaporated liquid which hastens its deposit on the combustion chamber surfaces and spark plugs.

Under the conditions described, more power for a given rpm, manifold pressure, and fuel flow is obtained by increasing the CAT. Even though air flow is decreased, the improved combustion resulting from better vaporization gives optimum performance and fuel economy.

Gasoline is a chemical mixture. Some of its components are highly volatile and evaporate easily under any operating condition. But the heavier components must be heated to over 100 C before rapid vaporization is possible. These heavier components finally leave the liquid state from 130 C. Obviously, air at carburetor air temperature cannot perform this function and large quantities of heat must be added as the charge air flows from the carburetor to the cylinder. The greatest amount comes from the internal supercharger, but its contribution varies with its speed of rotation. At high powers, with high rpm, its heat producing capacity is adequate and excess fuel can be absorbed by the engine without hesitation. As rpm is reduced, the heat rise through the impeller is less and its vaporizing capacity is lowered. At low cruise rpm the small heat rise, combined with low entering air temperature and lean mixture, can cause operating difficulties.

Besides heat from the internal supercharger, further heat exchange occurs through contact with the supercharger housing, intake pipes, and combustion chamber surfaces. The last increment of temperature before combustion is supplied by compression in the cylinder. Elevated charge temperatures also retard the rate of spark plug fouling. If the temperatures are not elevated sufficiently through the internal supercharger, the desired rise can be obtained by use of CAT. control. A reduction in CAT. is necessary at the highest rpm permitted with advanced spark, since the engine can not tolerate the extra carburetor heat added to the supercharger temperature rise. When the rpm is reduced so that the supercharger rise is sufficiently low, it is permissible to return to the maximum limit.

The simplest application is to use 20°C as the maximum CAT. with manual leaning above 1815 rpm. The low fuel-air ratio lacks the ability to absorb the heat rise of the impeller at the higher rpm. Compensation for this is made by reducing the CAT. In controlling the CAT. by means of the intercooler shutters, set them at minimum opening to obtain maximum limiting temperatures. This reduces the drag of forcing air through the intercoolers, and the disturbance of air flow over the wing. However, under maximum range conditions, with high bmep, this may lead to marginal operation, producing power instability. The high CAT. calls for more manifold pressure which, in turn increases the turbine load. A greater turbine load increases the exhaust back pressure, which in turn augments the original manifold pressure demand. At the same time, the elevated CAT. and additional back pressure start the CHT in the upward direction.

Besides the primary carburetor air temperature control and the intercooler shutters, three other means of regulation are provided. The preheat system heats induction air by bleeding heated engine cooling air from the engine bay into the intake of the turbo-compressors. This system is used when power and altitude are insufficient to require a heat producing output of the turbosuperchargers. The use of single turbo is accompanied by an increase of CAT. since removal of induction air heat is through one intercooler instead of the usual two.

During icing conditions with low cruise power at low altitude there may not be sufficient heat avai' ıble from the above means, to maintain ice free operation. Under these conditions another means of quickly raising the CAT. is to advance the TBS to a fairly high setting while controlling manifold pressure with the throttle. This action forces the turbo to higher speed with an increased temperature rise; however, caution should be observed to avoid stalling the turbo compressor and possibly causing backfiring.

In addition to its normal uses, CAT. is useful in checking the induction system condition. Excessive duct leaks on one power plant will cause its turbosuperchargers to increase their speed to maintain the carburetor entrance pressure called for by the TBS. This elevates the CAT. on that engine above the other five, thus giving a positive indication of the trouble.

If an induction fire occurs during starting with prime a continuous elevation of CAT. will show.

During flight, power adjustments approaching instability or power collapse may cause a rise of CAT. As the turbocompressor becomes less efficient, more of its energy is dissipated in heat, increasing the induction air temperature.

Carburetor air temperature should be noted on the ground before starting and just after shutdown. It is the best indication of fuel temperature in the carburetor body and indicates whether vaporization will be sufficient for the initial firing. Otherwise the mixture may need to be augmented by prime. If an engine is shut down for a short period of time, the residual heat in the carburetor and the power plant makes it possible to rely on this heat for vaporizing the fuel in the engine. Then priming is unnecessary. After shutdown, a high CAT. means that fuel trapped in the carburetor will expand producing high internal pressures. This force, if great enough, ruptures diaphragms and damages vent valve seats. The fuel lines and manifold valves should be open when the above conditions exist to allow fuel passage back to the tanks.

Carburetor Impact Icing.

Carburetor icing occurs on the airplane, but is not generally the screen type or throttle body type usually experienced on other aircraft. Impact ice can form on the carburetor screens and, in special instances, on the throttles. This is possible when the CAT. is near 0°C and there is high moisture content in the atmosphere as this ice builds up, it restricts the air flow just as if the throttle were being closed. Any attempt to increase rpm merely aggravates this condition, resulting in an additional loss of power. The expected drop of manifold pressure is accompanied by reduction of torque and fuel flow readings.

This type of icing is prevented by maintaining the CAT. above 5°C. While greater than 0°C is sufficient to keep ice off the screen, there is a slight temperature drop through the throttle body and the extra 5°C takes this into account.

When anticipating icing conditions, the CAT. should be maintained as close to maximum as possible for the power being used. This is accomplished by closing the intercooler shutters. If this is not adequate, additional carburetor heat is obtained by turning on the carburetor preheat and varying the temperature with intercooler adjustments. If more heat is required, raise CHT if possible and increase the speed of the external superchargers. This is accomplished by retarding the throttle to reduce M. P. approximately 6 inches, and increase the TBS setting to restore the original M. P. In addition, raising the CHT will be of some aid. If this does not provide sufficient heat, switch to single turbo and repeat the preceding step, providing power conditions permit.

If carburetor heat is still insufficient, continue to decrease M. P. in 5-inch decrements and increase TBS to restore M. P. until the desired CAT. is obtained.

It is also possible for ice to form on the throttle and mixture control linkage. This is detected only by attempting to move the controls. In event this type of icing occurs, an altitude should be found where icing conditions do not prevail. Icing conditions are seldom encountered above 25,000 feet; at lower altitudes a change in altitude, either up or down, often removes the airplane from the icing zone.

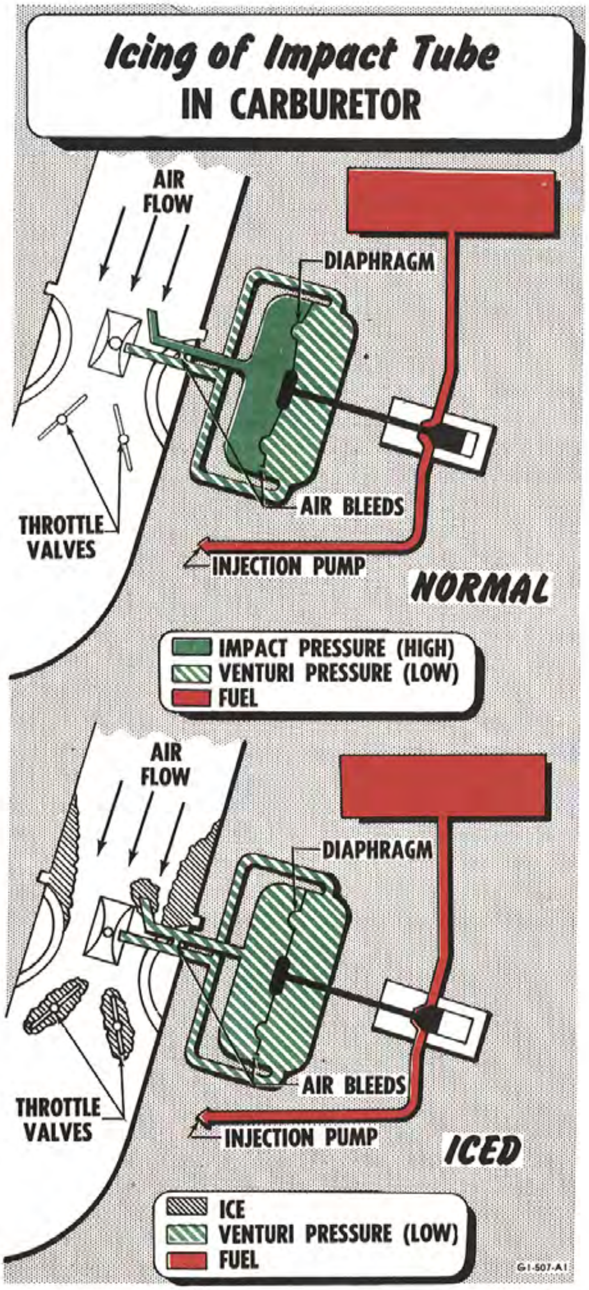

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Figure 7-14. Icing of Impact Tube in Carburetor

Carburetor Internal Icing.

The foregoing describes carburetor icing that affects the induction air passages by choking the engine. Another type of icing occurs within the carburetor and restricts the air flow between the A and B chambers, upsetting fuel metering. This flow is restricted by ice forming in the bleeds which connect the passages joining chambers A and B. One of the bleeds is located in the regulator section of the carburetors and the other is located in the automatic mixture control unit of the carburetor. With this type icing the manifold pressure does not decrease since the main air ducts are unaffected but the upset metering causes a fuel flow change. In this case power, as measured on the torquemeter will rise or fall, depending on the initial fuel-air ratio and the effect of changing fuel-air ratio on power.

This type icing comes in two packages, rich and lean. If fuel flow increases under normal operation, it is probable that atmospheric moisture has found its way to one or both of the bleeds connecting the passages to chamber A and B and froze. The tendency to freeze is augmented by the temperature reduction that accompanies the drop in pressure of the air flowing between the passages connecting the two chambers. However, the principle cause of freezing of the bleed in the regulator is from cold fuel which flows through nearby chamber D and takes heat from B chamber faster than it is brought in by the small airflow through the bleeds. The principle cause of icing of the bleed in the automatic mixture control unit is low CAT. If both bleeds freeze, the unrelieved A chamber pressure builds up, while that in B chamber decreases, increasing the metering differential to discharge more fuel. In this condition the fuel-air mixture can enrichen 56 per cent more than the normal automatic setting, and if nature takes its course large power losses result. Depending on the mixture setting, and fuel-air ratio, the torque pressure may first increase or decrease. In severe cases, a large loss of torque pressure results, accompanied by torching at the exhaust pipe and, where small leaks occur, in the exhaust system.

Control of the fuel flow by manual leaning when both bleeds are iced is extremely difficult and it may be necessary to approach IDLE CUT-OFF in some cases. Since icing of the bleed in the regulator cannot be readily controlled, the bleed in the automatic mixture control unit which is located in the carburetor inlet section, must be anti-iced by use of higher CAT. After the bleed is anti-iced the CAT. should be maintained above freezing, preferably between 20°C and the maximum limit, to prevent re-icing of the bleed. Adequate CAT. will not only prevent icing of the bleed, it will also prevent icing of the impact tubes or passages, the entire induction system, and the boost back vent bleed in the automatic mixture control unit. With only the bleed in the regulator iced the mixture can easily be controlled by manual adjustment of the mixture control level. When a restoration of normal conditions is indicated, a decrease in fuel flow, return the mixture level to its proper position. The fuel flow must be watched if icing continues during the landing approach since changing conditions can quickly thaw the bleeds, resulting in extremely lean mixtures.

A leaning process results when moisture collects in the impact tubes and freezes in the passage to the A chamber. (See figure 7-14.) The pressure and temperature drop at the automatic mixture control unit can cause condensation and freezing, thereby blocking air flow to A chamber. This permits its pressure to approach the B chamber pressure. The reduction of pressure difference between A and B chambers is not representative of air flow and causes the carburetor to lessen the fuel supply and "starve" the engine. Again the torque and fuel flow tell the story. In this situation, carburetor preheat is necessary. Enriching the mixture, by using prime together with mixture control adjustment, maintains fuel flow until the heat becomes effective.

Heat application to eliminate icing of the impact tube should be performed in the same order and to the same degree. However, the cure is more difficult. It is necessary for the metal supporting the carburetor, the automatic mixture control unit, and impact tubes to be warmed sufficiently to melt ice formed internally. Experience shows that manual mixture adjustment gives adequate control until a change of external conditions bring permanent relief. The basic causes for this condition are the effect on the carburetor body temperature of the induction air temperature, the engine cooling air flow temperature, the power plant operating temperature, and the fuel temperature. The rich or bleed type icing is encountered with cold fuel only; in fact, fuel temperatures above 7°C (45°F) thawed out frozen bleeds in laborary tests.

Other icing effects in the induction system are indicated by unusual turbosupercharger control, peculiar readings of instruments vented to carburetor deck pressure, and undue surging or collapse after shifting to single turbo. Apparently, the carburetor flange and fittings for carburetor deck pressure sampling run cold enough in pusher type installations to cause ice formation over the openings under certain icing conditions even though the CAT. is just above freezing.

When the pressuretrol fitting is affected, it is unable to sense change in carburetor deck pressure and relays signals for small changes in the waste gate setting to increase or decrease M. P. The TBS trim may be approximately set to balance the pressure locked in the sensing line by ice and thus maintain approximate power for several minutes. Eventually, a large loss or gain in M. P. may occur, control of which is regained by playing the trim against the locked pressure. Higher CAT. or warmer atmosphere clears the trouble. If the fitting that senses carburetor deck pressure for the fuel pump, its pressure gage, the water pump and its pressure gage, becomes iced there are various indications. The degree of indication depends upon the effect of locked pressure on pressure regulating valves, gages, fuel flow, water flow, and whether or not the pressuretrol is iced. Since the fuel pump and gage are balanced to the same ice-locked pressure, the fuel pressure will read the proper value even though the true pressure relative to actual carburetor deck pressure is off. The fuel flow and fuel-air ratio varies under this situation.

CAUTION

In the event of water balance line icing, the manifold pressure should not be varied in an attempt to correct water pressure indication.

The intercoolers may partially ice internally when CAT. is below freezing, when air flow is low, and weather is conducive to external icing. When shifting to single turbo there will be an undue surge and power collapse, accompanied by a high CAT. rise before collapse. Returning to a warmer or ice-free atmosphere clears the difficulty after a reasonable length of time and single turbo operation becomes normal. It is not known whether operation with high CAT. and a surge-free power will slowly thaw out the partially iced R. H. intercooler and eventually permit full single turbo operation or not. Also, it might be troublesome to resume climb power if the intercoolers were partially iced internally during extended cruise operation with CAT. below freezing.

Another type of internal icing which may occur is the freezing of water trapped in the fuel side of the regulator. This condition can be prevented by draining the fuel sumps during preflight inspection.

Good tightly sealed balance line fittings go a long way towards eliminating internal icing since without flow in the lines there is little tendency for moisture to enter and freeze. The balance line should be strictly a static pressure line.

Still another cause of internal icing is the use of fuel which is contaminated with water. Freezing water in contaminated fuel can cause a gradual loss of fuel pressure or high fuel pressure, resulting in loss of reciprocating engine power. Such a condition can be caused by any of the following:

a. Collection and freezing of contaminated fuel in injection and carburetor units.

b. Freezing of water in engine fuel pump pressure regulator cover diaphragm.

c. Condensation in empty or partially empty tanks.

d. Deposits of water collected in natural traps within the fuel tanks and fed into the fuel system during turbulent flight conditions. This condition is particularly true in No. 3 and No. 4 tanks.

e. Freezing of water trapped in the engine fuel transfer pump pressure relief valve diaphragm cover. Abnormally high fuel pressure results from this condition.

The following emergency procedure will be followed in the event a gradual loss of fuel pressure is encountered:

a. Isolate the fuel tanks being used; select and use the remaining tanks.

b. Turn on the booster pumps in the tanks being selected.

c. Start the jet engines as required. Anticipate reciprocating engine power loss.

d. Operate the affected engine or engines on constant prime. Reduce M. P. with the TBS as fuel pressure drops below 26 psi because the mixture will become too lean, resulting in engine backfire or afterfire. Power should stabilize at approximately 2000 rpm, 32 inches M. P., at least 100 psi torque pressure, and from 500 to 700 lb/hr fuel flow. Attempt to maintain maximum CHT and CAT. limits.

Note

If no fuel flow is indicated with the use of the primer, icing has progressed too far and the only alternative is feathering the engine.

e. Begin a gradual descent to a warmer atmosphere. Normally this condition will correct itself around -20°C OAT. if the above procedure is used.

f. When normal fuel pressure is restored, release the primer and return to normal operation.

g. Use fuel from the tanks that were isolated when a lower and warmer altitude is reached.

The following emergency procedure is recommended in the event high fuel pressure is encountered:

a. Retard throttle. If fuel pressure indication follows the throttle, prevent fuel pressure from going overboard and rupturing parts of the fuel injection system by proceeding as follows as quickly as possible.

b. Reduce rpm.

c. Open the tank valves and turn on the booster pumps in the remaining tanks on the affected side.

d. Isolate the affected engine fuel system by use of the manifold valves.

Note

Normally the condition will correct itself when lower and warmer altitudes are reached.

TORQUEMETER.

There are two methods frequently used to estimate reciprocating engine power in airplanes. One utilizes measurement of manifold pressure and engine speed. The other depends on measurement of torque pressure and engine speed. The primary difference between the two is that the manifold pressure method measures, in effect, power put into the engine, while the torque pressure method measures power output of the engine. Manifold pressure and rpm, at best, are a crude indication of engine power, because they are only a rough measure of charge air flow into the engine. The charge air flow for a particular M. P. and rpm combination varies with CAT., exhaust back pressure, and CHT.

Furthermore, power which is developed for a particular charge air flow varies with mixture conditions. Besides the variables within the individual engine, additional variables result from slight differences among engines in valve timing, ignition timing, etc.

Since there is no simple equation relating bhp, M. P., and rpm, this type of schedule must be presented in chart form, such as the M-1 tables or curves found in the appendix. An attempt is made to achieve better accuracy by providing a correction for CAT. and by providing M. P. values for a series of altitudes so the effects of varying back pressure can be approximated. Spark advance and mixture strength are considered with the assumption that definite values of the two factors will be used for each combination of bhp and rpm. However, it is either impossible or impractical to include in charts the other variables mentioned above. Therefore, M-1 charts much to be desired when accurate cruise control is the objective.

The torquemeter provides a direct measurement of the torque transmitted by the crankshaft to the propeller. In most airplanes, practically all torque developed is applied to the propeller, so that engine power may be determined from the following simple equation:

$$\text{Bhp} = \text{constant} \times \text{torque pressure} \times \text{rpm}.$$

This equation is independent of the many variables that affect the M. P. method of estimating power.

In this airplane an engine cooling fan is driven by a power take-off in the accessory section of the engine. Under some conditions, the fan absorbs a large amount of power. Fan power is not sensed by the torquemeter, which measures only the part of engine bhp transmitted through the propeller reduction gear. Therefore, the equation for bhp is as follows:

$$\begin{aligned}\text{Bhp} &= \text{propeller shaft hp} + \text{fan hp}\\ &= \text{constant} \times \text{torque pressure} \times \text{rpm}\\ &\quad + \text{fan hp (Constant for R4360-53} = 0.00524)\end{aligned}$$

Fan power is easily obtained from M-4 curves, so that only torque pressure, rpm, and altitude need be known for the rapid and accurate determination of bhp developed by the engine. To simplify the engineer's work, the above equation was solved for a large number of points along the recommended power schedules, and resultant values of torque pressure were summarized in the M-3 tables. Although torquemeter use is recommended in setting power for accurate cruise control, it must be remembered that the torquemeter senses only the total power output to the propeller shaft, regardless of how the individual cylinders are operating. Thus, if any cylinders are not operating properly due to faulty ignition or other malfunction, the remaining cylinders would have to develop more than their share of power to produce the desired torque. To avoid damage under such conditions, M. P. should be used as a check against torque pressure. The simplest and most useful check is to ascertain that all engines which are set at the same torque, rpm, and fuel flow have manifold pressures with 3 inches of each other but not to exceed 2 inches above the corrected manifold pressure. If any engine requires manifold pressure in excess of the allowable 2 inches required to produce the desired torque, its torque should be reduced until the manifold pressure is within the allowable 3-inch spread.

SPARK SELECTION.

Spark selection is provided on the R4360 engines to obtain the maximum range advantage when using manually leaned mixtures. With retarded spark, cruise power fuel economy improves with decreasing mixture strength to approximately .060 fuel-air ratio. Further manual leaning will not increase fuel economy unless the spark is advanced. With a leaner ratio, flame propagation becomes so slow that combustion energy from the charge is released too late in the power cycle, making the cycle less efficient. When this condition is approached, use of advanced spark improves fuel economy in two ways. First, earlier ignition of the slow-burning mixture results in better timing of the energy release and, consequently, better cycle efficiency. Second, it permits use of leaner mixtures to approximately .055 fuel-air ratio before flame speeds again become too low for efficient operation. Thus, advanced spark provides a 4 to 6 per cent decrease in brake specific fuel consumption for manual lean cruise power operation.

Advancing the spark results in a rise in CHT and increases the cylinder cooling requirements. Because of the additional cooling requirement, it is essential to lean all the way to "best economy" mixture, in order to take full advantage of the cooling effect of lean mixtures. It is desirable to lean through the intermediate mixture range (.067-.070) as rapidly as possible, since the most severe cooling requirements generally occur somewhere between normal and "best economy" mixture strengths. Advanced spark benefits fuel economy most at lean mixtures. Because of the effects on cooling requirements and detonation margin, advanced spark should not be used for operation with normal or rich mixtures.

The engineer must check the spark advance control for proper operation each time it is used. Failure of the actuator to change the spark timing calls for corrective action. Correct operation may be checked by noting the effect on engine power. Advancing the spark normally causes an increase of torque pressure. However, mixture strength may obscure this check on the ground. At 2000 rpm with the mixture in NORMAL, the fuel-air ratio can be near "best power" if the carburetor is set on the rich side. In this case, advancing the spark will show very little torque increase and the operator might conclude that the spark mechanism is stuck in retard. This can be confirmed by switching the ignition to the right or left position which is equivalent to retarding the spark 10 degrees. If the timing is advanced and the mixture is near "best power" little or no change of power will occur. The torque pressure and rpm will remain practically constant because the mixture burns too fast to require advanced spark. If the timing is stuck in retard, the use of single ignition will cause a definite and recognizable power loss. In this event a recheck with the mixture lever in the manual lean range will give a more positive indication whether or not the spark has advanced properly. Lean mixture on single ignition gives large drops in rpm and torque.

In flight the spark is not advanced until the mixture has its first dose of leaning from normal. In this condition single ignition can cause afterfiring. The interpretation of the torque pressure reading is evidence that the timing has changed from retard to advance, or vice versa. With lean mixtures this is quite positive. The cylinder head temperature rise is a further check that operation is satisfactory, but it is somewhat slow in response. Higher temperatures occur with the use of advanced timing than with retarded, if the mixture strength and other cooling factors are unchanged. While the direction of temperature change shows up in a short time, it takes about 5 minutes for the reading to stabilize after the shift of spark advance.

Spark advance is similiar in detonation effect to high carburetor air and cylinder temperatures, high M. P. and high rpm (impeller speed). The combinations of these factors must be taken into consideration when arriving at the limits for the use of advanced spark.

The use of advanced timing may be beneficial if ignition irregularities are present—magneto or plug malfunctioning. If an individual cylinder is operating on one plug, even with the switch in BOTH the effect in that cylinder is the same as though the timing had been retarded 10 degrees. This explains why afterfiring can sometimes be eliminated by shifting from RETARD to ADVANCE. With one plug out, the combustion process lasts too long and in some cases burning is still going on when the exhaust valve opens. By advancing the spark, timing in the offending cylinder is brought more nearly in to line. However, this procedure is used only at powers where advanced spark is permitted. Richer or leaner mixtures may help the situation, depending upon how close the basic carburetor setting is to "best power" at the air flow being used. The use of prime helps the carburetor through a lean range when one or more cylinders are firing on one plug.

If the spark advancing equipment malfunctions, leaving the timing at advance, the engine should not be operated at higher powers than those permitted with advanced spark. In a emergency, when higher power is needed, alleviate the situation by operating that power plant on single magneto rather than dual. This will, in effect, retard the spark.

Procedure For Advancing Spark.

The procedure for advancing spark is included in "Manual Leaning" of this section.

Procedure For Retarding Spark.

The following procedure is used to retard the spark from advanced spark operation.

a. Reduce M. P. approximately 2 inches with turbo calibration knob.

b. Restore torque pressure by enriching the mixture.

c. Spark advance switch—RETARD and note torque pressure drop. Monitor this procedure with engine analyzer.

d. Gradually increase mixture and lower M. P. to maintain the desired torque pressure.

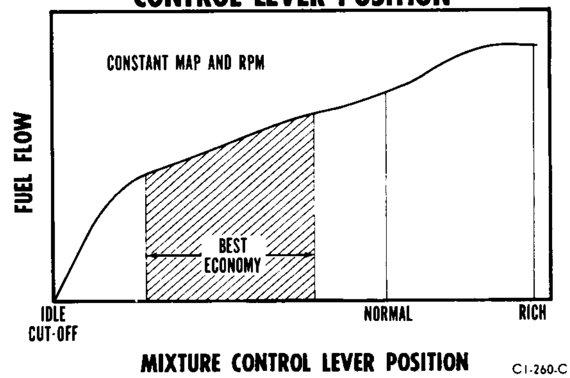
e. Mixture control lever — NORMAL, model 391260-8, 391420-1, and 391410-1 and -2 carburetors; RICH, model 391260-3, -4, -5, and -6 carburetors.

MIXTURE CONTROL.

It was shown previously that mixture strength of the charge can be varied and that this variation produces changes in the engine operating condition affecting power, temperature, and spark timing requirements. "Best-power" fuel-air ratio (.074-.080 F/A) is desirable when the greatest power from a given charge air flow is required. "Best economy" mixture results in obtaining the given power output with the least fuel flow and is close to .060 with RETARD spark advance and about .055 with ADVANCE. The need for automatic enrichment above "best power" for detonation control was discussed.

The carburetor controls fuel flow by varying two basic factors. First, the fuel control unit, acting as a pressure reducing valve, determines the metering pressure in response to the metering forces. Then the metering unit, in effect, varies the size of the orifice through which the metering pressure forces the fluid. It is a law of hydraulics that the amount of fluid passing through an orifice varies with the pressure drop across the orifice and with the size of the orifice. The internal automatic devices and the mixture control act to determine the effective size of the fuel metering passage. The internal devices—fixed jets and variable power enrichment valve—are not subject to direct external control and by themselves determine the basic shape of the metering curve as the power changes from low cruise to take-off. The mixture control, adjustable from the cockpit, permits a modification of this basic curve by directly changing the size of the effective orifice. The RICH position provides the maximum orifice opening possible for any given air flow. The fuel flow characteristics with this mixture determines the basic shape of the metering curve. If the control lever is fixed in intermediate position, a new metering curve is established at leaner fuel-air ratios but with essentially the same shape as with RICH.

FUEL FLOW VERSUS MIXTURE CONTROL LEVER POSITION



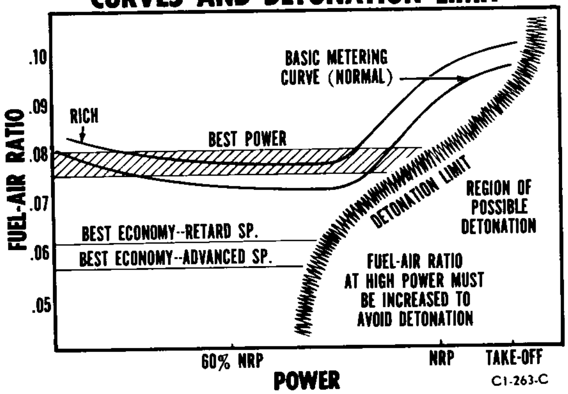
CI-260-C

Figure 7-15.

Fuel flow variations as a result of mixture control lever movement at fixed rpm and manifold pressure are shown in figure 7-15.

Between 20 and NORMAL a gradual fuel flow increase provides the useful range for manual leaning. A more rapid rise above NORMAL furnishes a comparatively coarse range for manual adjustment. RICH gives the maximum fuel flow for a given air flow and is used most often to assist in cooling the engine under usually hot conditions or raising effective fuel-air ratio when charge air and fuel are abnormally cold. The detented position marked NORMAL is one of an infinite number of fixed positions between IDLE CUT-OFF and RICH. It was selected because metering characteristics accompanying its use provide desirable operation throughout the power range. When operating in NORMAL, the carburetor meters approximately "best power" mixture (.078) in the cruising range. The NORMAL setting meets engine requirements, with respect to usual operating temperatures and powers; and, its lowest fuel-air ratio (in the cruise power range) accomodates accelerations over a moderate range of cool operating temperatures. The mixture strengths at the high power end are limited by detonation with a suitable safety factor. The basic metering curve with RICH added is shown in figure 7-16. The shape and position of the enriched portion of the curve at the high power end is determined by detonation. The limiting point of detonation at any power is not a fixed value but a variable, determined primarily by the final temperature of the charge as it is compressed and ignited. Adding the detonation limit line to this basic curve reflects the influence of other factors on opening safety. The detonation limits are not sharply defined, but will bounce back and forth even when an engine is tested under controlled conditions in the laboratory. A 10 to 15 per cent margin seems necessary to be safe.

TYPICAL CARBURETOR METERING CURVES AND DETONATION LIMIT



C1-263-C

Figure 7-16.

Anything tending to keep the temperature down pushes the detonation limit away from the point of operation and permits higher powers for a given fuel-air ratio. Anything that elevates the charge temperature lowers the detonation limited power. Below about 60 per cent of normal rated power (including fan horsepower) the engine is virtually free of these detonation limits and with reasonable operating temperatures, engine conditioning, and the use of specified fuel, manual leaning can be used.

In the range of power between approximately 60 and 70 per cent normal rated power (including fan hp) manual leaning can be very marginal and the combination of unfavorable factors present must be considered. If the engine is in good condition, manual leaning in this range is accomplished satisfactorily and safely, provided the temperature and spark advance limits are observed. If the combustion chambers are allowed to load up with lead and other deposits, the stage is set for detonation and probable preignition unless compensating reductions of carburetor air and cylinder temperature are used.

Mixture strength affects the power available from a given charge air flow, the temperature of the cylinders, and other temperatures. These effects are shown by curves in figure 7-17. The maximum values of torque pressure occur at "best power" fuel-air ratios and fall off as the mixture is enriched or leaned. The fact that loss of power is greater on the lean side explains the need for seemingly large increases of manifold pressure to maintain constant bhp while leaning. For example, during take-off or rated power climb it would be physically possible to lean manually to "best power" mixture. However, the temperature increase shown in the above curve would show its effects on CHT. This would encourage detonation or preignition, afterfiring, and burned pistons.

In this situation there would be noticeable loss of power output which could be measured by torque pressure, indicated air speed, and rate of climb.

Manual leaning is not only possible and permissible below approximately 75 per cent normal rated power (including fan hp) but is necessary when maximum range is desired. As the fuel-air ratio is reduced below .067, temperatures are reduced (figure 7-17) and cumulative gains are possible by adding the lowered cooling drag to the fuel saving. It is also possible that mixtures leaner than "best economy" are efficient. However, they would be impractical when the mixture distribution to the individual cylinders is such that power becomes unstable. While the bhp per pound cannot be increased, and may even decrease, the miles per pound may be favored by further permissible reduction of the cooling air flow. It is possible, and often desirable, to lean to such an extent with advanced spark that if the timing were retarded the engine would be rough due to poor combustion.

When establishing these super-lean mixtures, consider the temperature factors. Usually the cruise power setting is made following a rated power climb with all operating temperatures near the maximum. The passage from normal to cruising lean mixtures is safely accomplished if the power plant is well cooled. Do not set up limiting cylinder head and carburetor air temperatures and then lean. First, for a minute or so, hold the temperatures well below the limits to allow piston heads, exhaust valves, spark plugs, and the superchargers to cool. Then adjust the mixture and, finally, establish the operating temperatures.

EFFECT OF FUEL-AIR RATIO UPON BHP & CHT

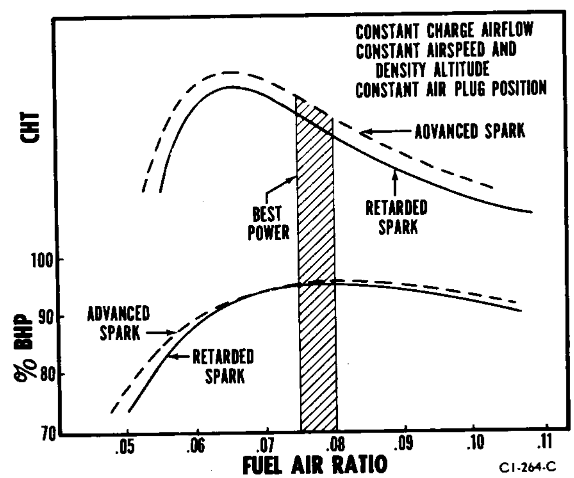


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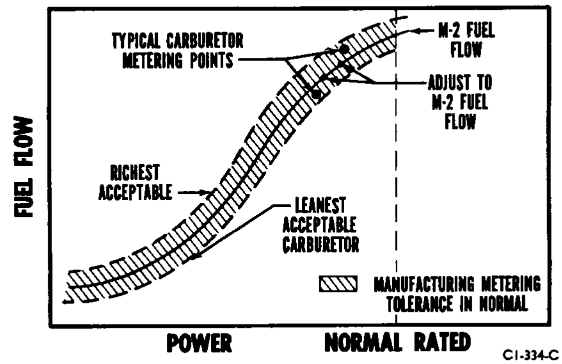
Figure 7-17.

MANUAL ADJUSTMENT OF NORMAL MIXTURE



C1-334-C

Figure 7-18.

The idle mixture strength is of great importance. A mixture too lean results in poor acceleration, misfiring with possible plug fouling, and poor flight operation with nearly closed throttle. If the mixture is too rich, extended ground operation causes plug fouling due to carbon.

Manual Adjustment.

Because of manufacturing tolerances of the carburetors, it is possible for fuel flow variations to exist between the six engines, even when they are operating at the same rpm and M. P. (air flow) in NORMAL mixture. (See figure 7-18.) The M-2 (fuel flow) curves call for a definite fuel flow to each engine when set for climb power or in the high power range. The manipulation of the mixture control lever out of the NORMAL position on either side to attain the proper fuel flow is called manual adjustment.

Manual adjustment is authorized under all flight conditions, except take-off, provided the airplane is equipped with calibrated engine instruments and the engines are operating properly. Other than insuring that minimum specified fuel flow is provided to each engine, this procedure calls for no unusual attention on the part of the engineer.

Procedure for Manual Adjustment During High Power Operation.

1. Establish power, rpm, and M. P. corrected for CAT. in RICH or NORMAL mixture.

2. Manually adjust the fuel flow (using calibration corrections) to the specified value consistent with the bhp. Refer to "Manual Adjust—20° Spark Advance Fuel Comsumption" Curve, Appendix I.

Note

With good conditioned engines the bhp (torque) may be obtained with less corrected M. P. than the M-1 table indicates. With poorly conditioned engines, the bhp (torque) may not be obtained even with maximum allowable corrected M. P. and corrected fuel flow. If this condition exists, accept the low bhp (torque) and in no case allow the corrected M. P. to exceed 3 inches above the charted value. Also, the spread in M. P. between the six engines must not exceed 3 inches.

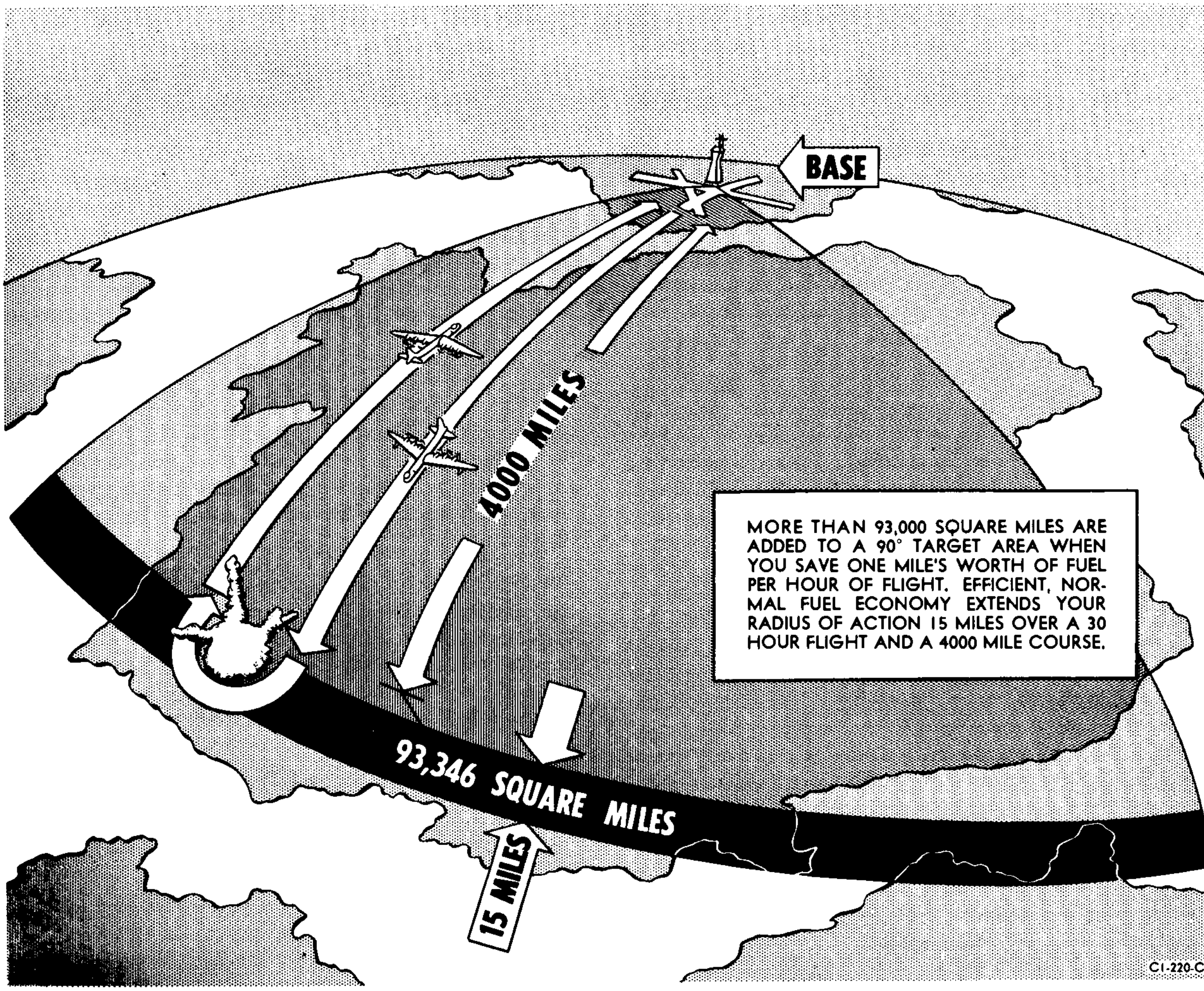
Manual Leaning.

The B-36 engine handling practices are conceived primarily to attain long range and to promote engine life compatible with the tactical mission of the airplane. The conventional engine setting practices used on other aircraft will not accomplish these ends. Former limits of bmep, cruise power, and fuel-air ratio arbitrarily set higher than "best economy" result in an operating range considerably below that required. On the B-36, every limit that hinders obtaining maximum miles per pound of fuel is being raised as high as possible as experience progresses. The change from previous practices to B-36 operation has not been without difficulty and, in too many instances, all the apparent differences in engine handling are blamed. It would be more sound to examine each factor separately and see which particular one contributes most to the reduction of engine service life.

The same basic engine, without external supercharging using lower continuous cruise power and with atmospheric exhaust back pressure, achieves a normal service life with no more difficulty than that involving the maintenance of sufficient overall warmth to insure stable running.

The B-36, with its turbosuperchargers, can sustain high power to higher altitudes than have been flown regularly on service aircraft. This type of operation, requiring the higher sustained powers, results in higher cylinder and carburetor temperatures and more exhaust back pressure than would be encountered at lower levels. These general factors alone are unfavorable to long service life. When the long range cruise techniques are added, a real operating problem is given to the engineer.

Not every factor of combat cruise is unfavorable. The increase of bmep from 150 to 160 for a given power is accompanied by a reduction of the internal supercharger rpm and attendant lower charge-air heat rise which permits a higher bmep detonation limit at the lower rpm. The maximum limit of cruise bmep is often a structural fatigue limit concerned with the loads and deflections on the power transmitting system —rods, crankshaft, reduction gear, and propeller. Low rpm means a less frequent rate of power impulses to these parts and, consequently, is a favorable condition



C1-220-C

Figure 7-19. Range Extension

with respect to fatigue failure provided resonant vibration is not encountered. The absolute limit is reached when distress results from a further increase of bmep, even with these favorable low rpms. All previous experience, has been at a maximum of 150 bmep but there is no reason to expect that 160 bmep has exceeded a critical value in view of the experience accumulated so far.

The other operating factors are largely unfavorable. The increase of maximum power for use of lean mixture with both retard and advance spark bring the operation much nearer to the detonation limit line and fatigue limits.

With conventional operation, cruising at 1750 maximum bhp and normal mixture still left a good margin of safety commonly called a cushion. This came in handy when substandard ignition, valve operation, or combustion chamber conditions appeared. But with higher power operation and the manual leaning practiced on the B-36, the margin is greatly reduced. When substandard conditions show up, detonation and preignition are more likely.

Other attendant problems can show up with long range cruise. The higher bmep requires that the turbosupercharger assume a greater share of the charge compression load and power collapse can result. Power instability and ignition difficulties are accentuated by the extreme high altitude of operation. The correction for these malfunctionings can be described with fair accuracy and is covered in other portions of this section. However, exact steps to avoid detonation and preignition cannot be as accurately described and no "pat" answer can be given for eliminating their occurence if long range cruise procedures are followed. When the decision is made to leave the comparative safety of the conventional power settings and apply relatively high cruise power with manually leaned mixture, the operation is getting closer to the area where trouble has been known to exist. If detonation and preignition can be avoided, the mission will probably be successful. The consecutive steps in manual leaning and in returning to a rich mixture must follow a prescribed procedure which results in approaching the final setting without going into the known danger area at any time. This requires considering the effect of each change on the conditions inside the combustion chamber after the change is made.

The first manual lean power setting may follow an extended climb during which the cylinder heads may have gone to the maximum limit. Immediate leaning with this temperature present is a bad procedure and possible engine damage may result. Some engineers have been pleased to find that the head temperature was reduced by leaning and have used it as the primary means of temperature control at this time. While the indicated temperature came down, there could be no assurance that the other 27 cylinders behaved as well and it can be certain that the temperature of the piston did not lower to the same degree. Therefore, do not start the manual leaning until the engine is well cooled and do not use mixture for cooling at this time. Cylinder head temperature is the only direct means of judging the engine temperature and the most successful engineers leave the mixture control alone until the heads are down to 210 to 220°C. The time taken to bring about this cooling also allows the turbosupercharger to drop in temperature even though it has no direct means of advising the engineer.

The detonation limit line is further pushed aside and out of the way if carburetor air temperature is brought down to 10 degrees or more below the final value.

Procedure for Manual Leaning. To conserve fuel as much as possible during a long range flight, the following procedures are used to obtain best economy mixture at a certain power setting.

Note

It is very important to have the engine instruments calibrated to effect the procedures contained herein. The use of uncalibrated instruments could easily result in establishing dangerous conditions without the engineer being aware of the situation.

After reaching cruise altitude, proceed as follows:

CAUTION

Start manual leaning procedure with mixture control lever in the RICH position on those engines that have 391260-3, -4, -5 and -6 carburetors and in NORMAL position on those engines that have 391260-8, 391420-1, and 391410-1 and -2 carburetors.

1. Spark advance switches — RETARD. The shift from retarded to advanced spark must be delayed until the mixture strength is sufficiently low to permit firing the charge further in advance of top center. Shifting to advanced spark while the mixture is still in the rich, hot burning area can result in immediate detonation possibly followed by preignition and cylinder damage.

2. Air plugs and intercooler shutters—As required.

3. Insure that CHT and CAT. are below limiting cruise values. The desired CHT range is 240-250°C. By reducing these temperatures to the lowest practicable value, the engineer is insuring that the engine is in a condition to receive the lean mixtures with advanced spark.

4. Find "best power" at the desired torque pressure and observe readings. These readings determine relative engine condition and are used as a reference during the manual leaning procedure. Proceed with the following steps on one engine at a time. "Best power" is found by holding torque pressure constant with the turbo calibration knob while at the same time the mixture control from NORMAL, either richer or leaner, and noting manifold pressure. "Best power" is the range in fuel flow in which the desired torque pressure is obtained with the least manifold pressure (or for a given M. P. the power is greatest). Those engines requiring the greatest manifold pressure (more than an inch above average or two inches above the lowest) should be watched carefully during the ensuing steps as deficiencies may be present in these units.

5. Move the mixture control lever toward lean until a 15 psi torque drop is obtained. This reduces the mixture strength to a value that is safe to take advanced spark and about as lean as will remain stable in retarded spark.

6. Place the spark advance switch in ADVANCE and note that the torque pressure rises. It is important that the engineer be certain that the spark has advanced. Torque pressure rise is evidence that the change has taken place. Monitoring of each engine by means of the engine analyzer during this operation will provide a further indication that the spark has been advanced.

7. Re-establish desired torque pressure by increasing manifold pressure with the turbo calibration knob.

Note

Normally an increase of approximately 4-1/2 (±1/2) inches manifold pressure above best power manifold pressure will produce best economy mixture ratio for constant CAT., torque pressure, and rpm conditions.

8. Maintain CHT and CAT. within desired limits.

9. Search for best economy for each engine by movement of the mixture control lever to obtain minimum fuel flow and holding the correct torque for the desired power by adjustment of manifold pressure with the turbo calibration knob.

Note

It is usually desirable to first search for best economy on the rich side of the setting obtained in the previous steps to avoid engine instability.

10. Adjust air plugs and intercooler shutters to desired setting.

Note

Past experience with the R4360-53 has shown that more stable operation and a minimum of afterfiring will be realized if the CHT and CAT. are maintained near the upper limits.

11. If the fuel flow is high and the engine is apparently normal, a slightly higher fuel-air ratio will have to be accepted since the corrected charted M. P. plus 3 inches must not be exceeded. If, however, the engine is apparently malfunctioning (one or more cylinders out) the recommended M-1 manifold pressure (corrected for CAT.) should be set up and the desired fuel-air ratio obtained by use of the mixture control, accepting the torque obtained.

Good engine handling procedures at this time can go far toward gaining the ultimate economy possible. It is generally recognized that it is better to decelerate to cruising air speed rather than allowing the airplane to fall below this air speed in the transition from climb to level flight and then requiring it to accelerate to this stabilized velocity. Many engineers have found it desirable to hold the climb power after leveling off so that the airplane accelerates rapidly to a figure well above the final anticipated value. Some cooling benefits are derived during this period with increasing air speeds. Then power is reduced on all engines to a point which is slightly above the final amount so that while the manual leaning procedure is followed, the necessary power reductions on individual engines do not result in allowing the airplane to decelerate below the recommended air speed.

ENGINE COOLING.

It should be remembered that the R4360 engine is an air-cooled engine and its requirements for cooling air should be met if long life is to be attained. When the cylinder head temperature has stabilized, it is known that equalibrium is being maintained between the heat absorbed by the cylinder head material from combustion and the extraction of this heat by the cooling air flow that is passing through the fin and deflector passages. The rate at which heat is forced into the head from the inside depends upon the amount of heat generated in the combustion chamber to produce indicated horsepower which in turn varies with rpm, manifold pressure, carburetor air temperature, mixture strength, spark advance, and other items affected by the general condition of the engine. The rate at which the heat is removed from the head is dependent upon the weight of the cooling air flow and the temperature difference between the head material and the cooling air. The quantity factor governs the number of air particles participating in the activity. The temperature difference factor is a measure of the heat absorbing capacity of each particle.

These two factors work in opposing directions as the altitude of operation is increased. The decreasing temperature is favorable as it widens the temperature difference of the heat exchange. Unfortunately the decreasing air density, which is unfavorable, reduces the weight of cooling air flow at a rate that overcomes the beneficial temperature factor. If constant power is maintained at high altitude, the cylinder cooling problem becomes increasingly difficult.

The principal factors that control engine cooling are those which regulate the rate of cooling air flow.

Air Speed Versus Cooling.

The air speed indicator reading is a measure of the effects of density and altitude, plus the forward speed of the airplane. Air speed variation generally is only to be used as direct means of cooling control during climbs. At this time a small increase in indicated air speed above that for best rate of climb may materially assist in maintaining satisfactory temperature without appreciable loss of performance. At very low indicated air speeds requiring a high angle of attack, a peculiarity of the aircraft causes a change in the relationship between plug opening and cylinder cooling. In this attitude, there is a tendency for the air under the wing to flow around the trailing edge to the upper side. This results in a forward flow through the bottom of the air plug opening which interferes with cooling air flow through a portion of the engine. This may be a limiting factor in attaining a minimum indicated air speed in climb and cruise at high altitude. If cylinder head temperature cannot be controlled by direct means, increased air speed may bring the required relief even though additional power is required.

Engine Fan Operation.

The engine fan is installed to aid in engine cooling. At low air speeds or during ground operation, the fan contributes its greatest share of the cooling load. As air speed increases, the fan becomes increasingly less essential, until at high air speeds, the naturally induced air flow provides most of the cooling air. The fan is driven by the crankshaft through hydraulic couplings.

The low speed drive should be used as long as adequate cooling is possible because of the high power requirements of the high speed drive.

WARNING

The use of high ratio fan operation is restricted because of structural limitation of the fan. (Refer to "Operating Limitations," Section V.)

When engine overheating is experienced, shifting to high fan drive should be accomplished if within structural limitations of the fan. It should be noted that the net loss in thrust caused by shifting from low to high fan is less than indicated by the torque drop because the higher fan power is partially compensated by added jet thrust of the cooling air.

In using the fan speed selection for cylinder head temperature control, the engineer must observe the torque pressure reactions as a check that the fan drive couplings are in satisfactory condition. The shift is performed by changing the flow of oil from the low speed coupling to the high speed coupling. As the low speed coupling drains, the high speed unit is filling and when the process is complete the fan is turning at the higher ratio. For a short interval, during which a quantity of oil still remains in the low speed coupling and the high speed coupling has received a sufficient amount to start transmitting power, the two couplings are bucking each other and more power is being absorbed from the crankshaft than when either coupling is functioning independently. This shows up in a momentary reduction of torque pressure, followed by an increase to a new reading that is below that when the fan was driven at low speed.

The torque oil pressure reaction furnishes a check as to the amount of sludge in the couplings. The maximum drop is 30 psi with a stabilized drop of 7 to 20 psi below the original torque pressure. Upon returning to LOW RPM, the torque should return to the original value.

Air Plug Operation.

The air plug is the remaining direct control over cooling air flow and can be considered as a throttle for the cooling air passage. When the combination of air speed and fan speed results in an excess of air being

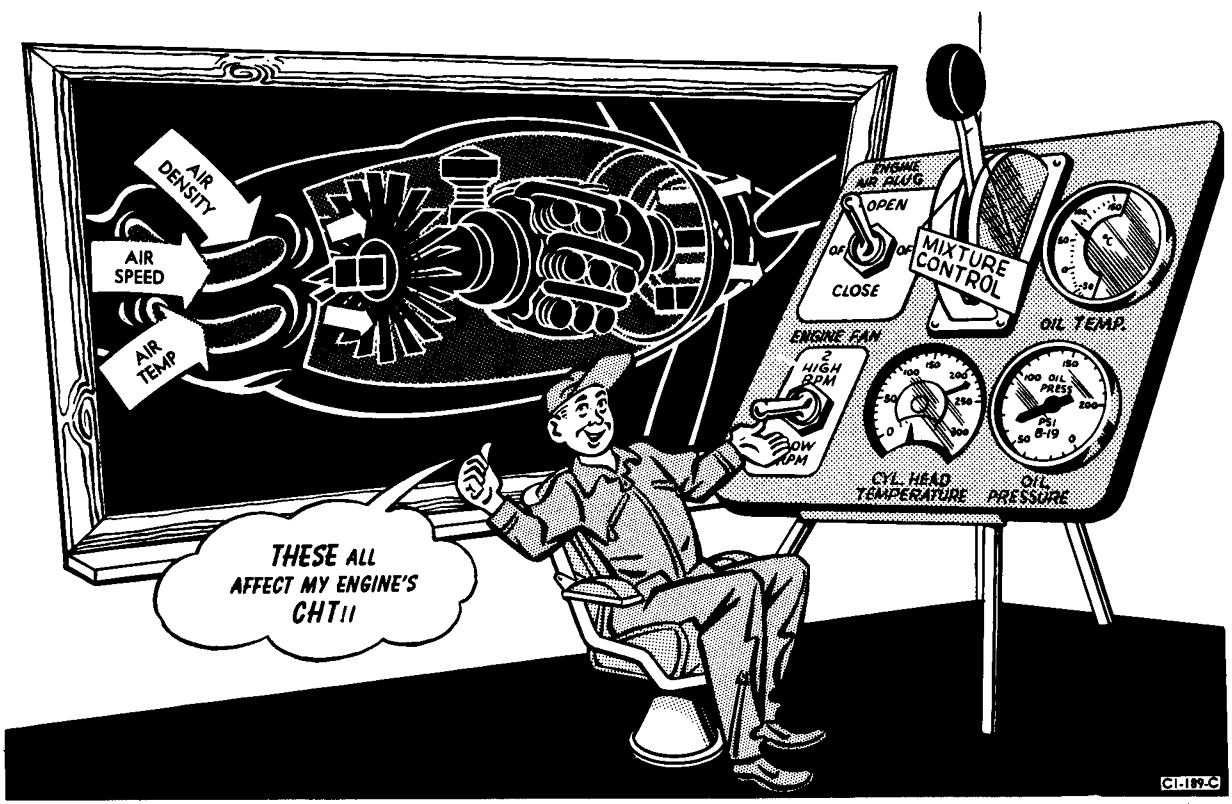


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Figure 7-20. Principal Factors Affecting Engine Cooling

ENGINE COOLING THROUGH USE OF MIXTURE CONTROL

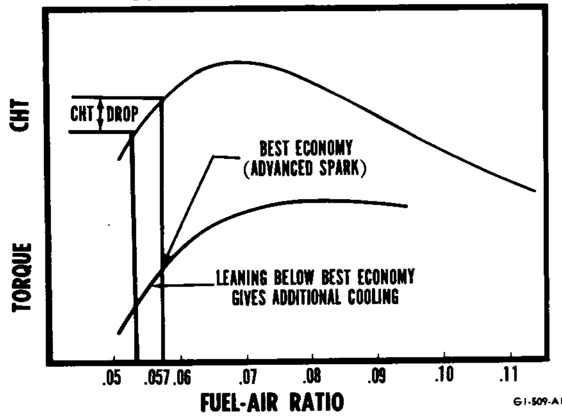

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Figure 7-21.

pumped, over that required to maintain satisfactory temperatures, considerable drag is eliminated by restricting the passage and the weight of air being pumped.

Cooling by Mixture Control.

If, after shifting to high fan drive, additional cooling is required during climb up to 40,000 feet, it can be obtained by increasing air speed or shifting to RICH mixture.

If the cylinder head temperatures exceed the limit with NORMAL mixture and high fan drive in level flight at powers above the limit for manual leaning, shifting to RICH will improve cooling. For powers below this range, the use of RICH mixture provides little improvement, but manual leaning to "best economy" is very effective in reducing temperatures. Over 20°C CHT reductions can be realized by leaning out from NORMAL to "best economy." Since initial leaning results in cylinder head temperatures higher than the temperature at "best economy," it is advisable to get into the air cooling range of mixtures in one step, rather than several small steps. This is accomplished by leaning out in the first step until the torque drops an amount which requires 4 inches M. P. increase to re-establish torque. A torque drop of 15 psi is generally about right.

To obtain the full benefit of the leaning effect on cylinder head temperatures, it is important to lean out all the way to "best economy," because most of the temperature reduction results from the last portion of the mixture control adjustment. Following the initial leaning of 4 inches M. P., a range of 1 or 2 inches M. P. in either direction should be investigated (maintaining constant torque) to establish the minimum fuel flow accurately.

Cylinder Head Temperature.

On airplanes USAF No. 50-1083 through 50-1097 the thermocouple for measuring cylinder head temperature is attached to only one of the twenty-eight cylinders of each reciprocating engine. On airplane USAF No. 51-5699 and subsequent, the thermocouples for measuring cylinder head temperature are attached to cylinders A-6, C-5, D-2, and D-5 of each reciprocating engine. Being able to read the temperature of four cylinders on each engine allows a more comprehensive "picture" of over-all head conditions and permits more accurate interpretation than could be made by reading the cylinder head temperature of only one cylinder of each engine. This is especially true since tests have shown that at low fuel-air ratios and lower powers the "hot" cylinder location shifts from cylinder to cylinder and may run as much as 30°C hotter than the other cylinders.

Shifting of the "hot" cylinder location was observed on engines with ignition and carburetion in good condition. At the same time all limits of temperature, power, and other items were being observed. Therefore, the cylinder head temperature reading is representative of the general engine heat condition rather than evidence of an individual cylinder malfunctioning. The chance of finding trouble on any one cylinder where there is only one themocouple per engine is only one in twenty-eight, whereas, when there are four themocouples per engine the chances are one in seven that the trouble will be on a cylinder to which a thermocouple is attached.

Also a thermocouple is located in a cylinder head at an arbitrarily selected spot which is neither the hottest nor the coldest part of the head. The temperature measured at this point is merely a reference to temperatures at other critical points, especially the piston head, exhaust valve and seat, exhaust valve guide, and spark plug. The relationship between the temperatures at the critical points and the cylinder head temperature demands that limits be established. Experience shows that these limits are necessary, not only to prevent detonation and its destructive results, but also to prevent the formation of sludge and carbon. Failure to observe the CHT limits may also result in lead fouling and spark plug malfunctioning.

In deciding on the cylinder head temperature for operation, a compromise between performance and durability must be made. If the demands for maximum range are foremost, head temperature will be held at the upper limit to reduce the drag of excess cooling air flow. Tactical necessity will dictate this "all-out" operation on occasions. It must be realized that exceeding the limit can lead to difficulty. Since the carburetor air temperature is also held to its limit during maximum cruise, the combination can bring about detonation or preignition if any engine item is in substandard condition.

EFFECT OF FUEL-AIR RATIO ON CHT

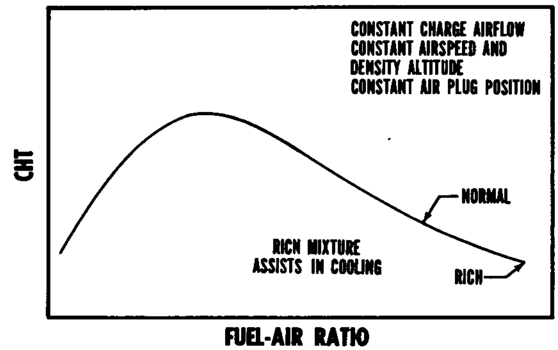

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Figure 7-22.

When tactical demands are not pressing, it is sound judgment to hold more conservative temperatures. Engine operation and life through the years have been best with cylinder head temperatures 25 to 40°C lower than the maximum limits and there has been no recent change of material which would give the same durability with higher operating temperatures. Operation in this manner serves to keep the engine in a condition permitting sustained "all-out" performance when needed. Habitual use of limiting temperatures reduces the margin of safety and keeps the engine vulnerable to the unknown little things that go wrong or accumulate between inspections, little things that would not be destructive at lower temperatures and powers.

Most of the temperature concern of design, development, and testing has been of the troubles caused by high temperature. Cold temperatures can be equally troublesome with almost the same list of difficulties. Good operation should point to a middle range, where the greatest amount of satisfactory experience has been accumulated.

On the ground, experience has indicated that temperatures lower than 170°C are apt to cause lead fouling troubles. With temperatures above approximately 220°C, the tendency is toward sludging, rocker box coking, and a hardening of rubber seals and insulation resulting in oil leaks and ignition troubles. For these reasons the cylinder head temperatures on the ground are recommended to be between 200 and 220°C; in emergencies, however, a maximum of 250°C is permissible. For idling conditions the air plug is partially closed; for high power operation the plug is open in order to anticipate the need that will accompany the high power operation. At idling speeds the direction of the wind may offset the ability of the fan to circulate air through the engine and cause some of the cylinders to run excessively hot, even though the cylinders under observation are within limits.

For take-off it is realized that the power is going to be at the highest value of any time during the operation of the engine. The air speed will be the lowest, at the start, and gradually build up to the speed of the climb after take-off. The usual procedure is to set the air plugs full open, then adjust thereafter to maintain a minimum CHT of 225°C. This procedure will aid in preventing the CHT from exceeding the maximum limits during take-off and initial climb. The required air plug setting to maintain 225°C CHT will vary some with the weight of the airplane as the gross weight affects the acceleration and length of time to attain final speed. The plug setting is also affected by the outside air temperature and can be partially closed for cold weather take-off; however, wide open plugs will usually be required during hot weather.

When the power is reduced from the take-off values to the normal rated power used in climb, there will be a reduction in the fuel-air ratio as delivered by the carburetor. This reduction tends to keep the cylinder head temperatures up and thus requires a fairly wide open setting of the air plug, particularly at low indicated air speed. If the mixture is manually adjusted to something less than the carburetor normal mixture strength, the air plug may have to be opened somewhat to accommodate the CHT rise.

If any thing is done during level cruising flight to change the drag of the airplane, such as opening the bomb bay doors, camera doors, or extending the gun turrets, the effect upon the indicated air speed and cooling air should be anticipated and the air plug reset to suit the new condition. If the indicated air speed of the airplane is maintained to carry on the cruise flight control at the weight of the airplane, there will be required an increase in power to offset the drag of the new condition. It is obvious that increased horsepower will require a readjustment of the air plug. Temperature readings will start to rise very shortly after the increase in horsepower, but it will take three to five minutes for the temperatures to stabilize. This stabilization period is the time in which the air plug must be adjusted to prevent the cylinders from exceeding the limits.

During letdown, with reduced power and the air flow maintained as shown by the indicated air speed, it may not be possible to maintain the cylinder head temperature up to the desired minimum even with the air plugs in a closed position. This should not cause any undue concern unless the engine begins to run rough or afterfire. In this case the mixture may be enriched somewhat, if the powers are quite low, in order to approach the .067 fuel-air ratio which is the hottest mixture strength. Also periodic power bursts are helpful in clearing combustion chambers and keeping oil temperature up. Oil temperatures should be maintained above 75°C at all times, if possible, to provide good lubrication and supply heat to the fuel injection pump.

While preparing for a landing, each time that the drag of the airplane is increased the power requirements are increased, and the cooling must be adjusted to keep the cylinder temperatures within limits. Again, power versus indicated air speed tell of the heat being forced into the cylinder heads and the ability of the air to remove it. The air plug must be opened to enable the engine to use the available air flow provided by the indicated air speed.

During all ground operation, including taxiing, the tendency will be to have the air plug open fairly well. However, it is necessary to adjust the plug opening to keep the cylinder head at a temperature that will not encourage plug fouling. Just prior to shutting down the engine, the cylinder head temperatures should be lowered as much as conveniently possible. Tests of rubber items around the engines, such as the pushrod housing seals and ignition harness installations, show that their temperatures rise considerably after engine shut down as they absorb heat from the cylinders while the cylinders cool. On days when there is no wind to bring cool air into the engine compartment the rubber temperatures can exceed their limiting values five to seven minutes after the engine has been shut down.

The effect on the rubber parts is cumulative. After a number of times of overheating they become hard and brittle. The oil seals lose their resiliency so that they are not able to seal the oil, and leaks ensue. The ignition harness will break down and more than likely cause trouble at altitude. Prolonged running of the engine at cylinder head temperatures below 170°C brings on lead fouling troubles and it does not pay to try to get the cylinder temperatures below 170°C. If the airplane is headed into a stiff breeze, there is less need of getting the cylinder head temperatures down to a low value. Carburetor air temperature after shut down is indicative of the flow of heat from cylinders to other parts of the engine.

PREVENTION AND ELIMINATION OF SPARK PLUG FOULING.

Spark plug fouling is considered to be undesirable deposits that accumulate on or near the spark plug electrodes and cause misfiring. Fouling may result from carbon, lead, ice, thread lubricant, metal particles, or preservative compounds. The regular ignition system checks will give indications of malfunctions somewhere in the ignition system. Fouling, however, is concerned only with the combustion end of the spark plug and standard checks will not always point directly to the source of trouble. Regular monitoring with the engine analyzer provides a valuable means for determining the operating efficiency of individual spark plugs.

Ground Run-Up.

The tetra-ethyl lead used in the fuel contains certain scavenging agents. These agents unite with the lead and at low cylinder temperatures condense out on the inside of the cylinder. At idling speeds, low cylinder temperatures are especially conducive to lead fouling. However, during ground operation there must be a compromise between high temperatures to prevent fouling, and cold temperatures to prevent overheating of rubber seals, ignition harnesses, and magnetos. Therefore, the CHT must be kept within the established limits by means of air plug adjustment. For the procedures on prevention and elimination of spark plug fouling during ground operation, refer to "Reciprocating Engine Ground Operation," Section II.

Inflight Prevention.

Inflight symptoms and procedures are basically the same as those on the ground except that governing propeller is used rather than fixed pitch; powers are at cruising or climb rather than idling, and very lean mixtures and advance spark may be in use while cruising. The M. P., rpm, and CHT are higher than at idling. The carburetor air temperature varies with weather conditions. These factors are practically all favorable to lead fouling prevention except the very lean mixtures. Periodic changes from rich to lean mixtures and inflight prevention. Other mild or severe thermal shocks help. During cruise conditions cylinder heads should not operate for long periods at temperatures lower than 220°C.

EFFECT OF SPARK ADVANCE AND F/A ON SPARK PLUG CORE NOSE TEMP.

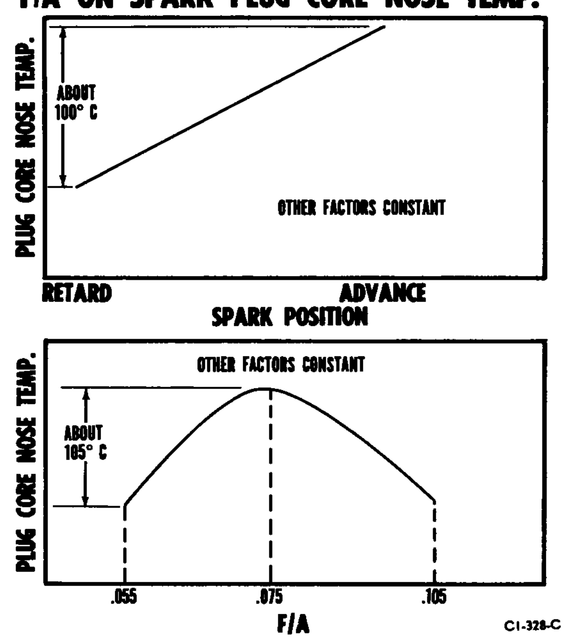

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Figure 7-23.

Spark Advance. Tests made under laboratory conditions show that the temperature of the spark plug core nose increases about 100°C (180°F) when shifting from retarded to advanced spark (figure 7-23). These tests were made at power settings between cruise and normal rated. It can be seen that use of advanced spark may have considerable effect upon the accumulation of deposits or upon purging of the deposits after they have accumulated. The above example shows only one method of increasing the core nose temperature to prevent fouled spark plugs. The core nose temperature is also affected by many other factors such as: imep, exhaust back pressure, fuel-air ratio, CHT, rpm, and CAT.

Fuel-Air Ratio. The study of the effects of fuel-air ratio on spark plug core nose temperatures show about the same range of temperature change as for spark advance. The hottest temperature of the core nose did not come with the mixture strength for hottest gas temperature (.067) but at .075. This apparent discrepancy is associated with the compression effects on the first gases to burn after the flame is farther along and pressures are still increasing. The result is that the first gases to burn, near the spark plug under low pressure, rise to a certain temperature at the time of burning and the temperature increases greatly with further compression. Since the highest power at a given air flow or manifold pressure is found with "best power" mixtures, it may be surmised that the hottest temperature would come with lean "best power" mixtures. The temperatures, found in the test, lowered with fuel-air ratios leaner or richer than .075 (figure 7-23). At .055 and at .105 fuel-air ratio, the temperature of the spark plug core nose was about 105°C (190°F) lower than at .075.

RPM. An occasional increase of rpm may be used beneficially in clearing the combustion chambers. To do this, increase rpm for one or two minutes using cruise M. P., hot mixture strength (.067 to .075), and retarded spark. This purging procedure must be used carefully as operation will be approaching the detonation and preignition limits. The combustion chamber is being subjected to high temperatures, made even higher by the internal supercharger (at moderately high rpm), without the benefit of the rich mixtures ordinarily used with these engine speeds. The high temperatures tend to loosen lead deposits and allow them to be carried out the exhaust.

After this purging, the spark plugs, exhaust valves, and piston heads may have approached dangerous temperatures. It will be beneficial to operate for a minute or so at low rpm and power to allow the heat to dissipate and the temperatures to become lower than cruise power temperatures. When cruise power is resumed the engine temperatures will rise but will take a long time to stabilize completely. If the cruise power is established with internal parts hotter than stabilized values, the temperatures will fall rapidly at first. The remaining degrees take longer, never lowering fully, during which time engine distress may occur. To prevent such trouble, approach limiting temperatures from below rather than above.

Manifold Pressure, BMEP, And Exhaust Back Pressure. These items are discussed together in that they are difficult to separate when an engine is equipped with turbosuperchargers. Laboratory tests show that an imep increase of approximately 60 psi causes the spark plug core nose temperature to rise about 80°C (142°F). This imep change increases the bmep about the same amount because, at a fixed rpm, the change in friction horsepower is small. The same series of tests showed a core nose temperature rise of about 65°C (118°F) when exhaust back pressure is increased from 31 inches Hg. to 41 inches Hg. On the aircraft these two effects would be added together in suitable proportions for dual or single turbo operation and other actual operating conditions.

Cylinder Head Temperature. A cylinder head temperature rise can sometimes be used to aid in clearing fouled plugs. As might be expected, a change in cylinder head temperature produces a change in spark plug core nose temperature practically a degree for a degree. The spark plug core nose in the test for this effect runs about 300°C (710°F) hotter than the cylinder head bayonet thermocuple.

Carburetor Air Temperature. In the single cylinder tests being quoted there was no change in the temperature of the spark plug core nose when inlet air temperature was changed 28°C (50°F). The effect of inlet air temperature on imep and cylinder head temperature was compensated for by changes in manifold pressure and cooling air flow. This was necessary to hold other readings constant. In fact the whole series of tests were run in this manner. These tests show only the effects on the spark plugs core nose temperature.

Power Change Rate Effect. Sudden applications of power cause an abrupt change in spark plug insulator temperature with a resultant change in deposit resistance. This change in resistance can cause the plugs to misfire. It is therefore desirable to make major changes in power as gradual as is practical. This causes the plug temperature to rise slowly and gradually rather than in one abrupt change. After extended periods of manual lean operation it would be desirable to extend the change in power over a period of two or three minutes whenever possible. Sudden reductions in power do not create any adverse effects on plug fouling.

High Power Before Landing. Some operators have derived benefit from use of normal rated power for a minute or two, five or ten minutes before entering the landing pattern. This gives a purging effect after descent and, if ineffectual, a chance to size up the engines so that discrepancies can be reported and cleared up. To determine engine condition at a high power it is recommended that a survey of all engines through ignition analysis be made after descent and prior to landing. In flight checks of this nature are useful in reducing the running time on the ground after flight.

CONTROL OF DETONATION AND PREIGNITION.

Detonation limits almost all phases of B-36 engine operation. Its sustained occurrence in moderate form causes inefficient combustion and deterioration of combustion chamber parts. Short intervals of severe detonation cause inflight failure necessitating shutdown.

When the mixture control is in NORMAL on engines that have 391410-1 and -2, 391420-1, and 391260-8 carburetors and in RICH on engines that have 391260-3, -4, -5, and -6 carburetors, detonation protection (figure 7-24) is provided by the "buil' in" carburetor settings if other limits are observed. When mixture is leaned from NORMAL, the "built-in" margin is eliminated and the maintenance of detonation-free operation requires the greatest judgment of the engineer. He must rely on experience, either his own or someone else's. Remember, it is not the engine that detonates, but the charge air mixture and this is basically a condition brought about by temperature.

CARBURETOR METERING IN MANUAL LEAN CAUSES DETONATION AT HIGHER POWERS

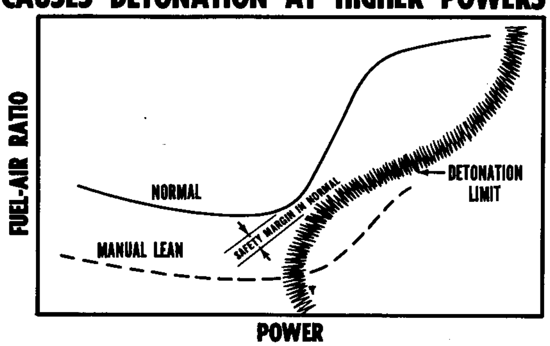

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Figure 7-24.

At high power all the high temperature factors are unfavorable. The high rpm means the fast turning internal supercharger is giving its highest heat rise. The large amount of charge air being consumed produces large quantities of heat. Therefore, the greatest mixture enrichment is required with maximum engine output. As power *and rpm* are reduced, the temperature factors become more favorable and it is possible to reduce mixture strength with safety. Eventually, power and rpm reduction reach a point below which it is possible to use "best power" fuel-air ratio without detonation. Finally, at still lower power rpm, "best economy" fuel-air ratio is entirely safe. The carburetor was originally set for normal mixture use during all operation above 70 per cent normal rated (including fan) horsepower. The fan power is included to relate mixture strength to indicated horsepower, which described the actual situation inside the cylinder. However, the B-36 range requirements are important enough to use manual adjustment up to normal rated power to compensate for difference in carburetor; however, care must be exercised in making these adjustments because of the possibility of erroneous instrument readings.

During manual leaning, engine operation is approaching the area of possible detonation. However, the lower fuel-air ratio is only one of the factors that makes this procedure marginal. To determine the effect of the many variables on the detonation limit, it is necessary to run the engine on a test stand. This must be done so that one factor can be checked while all others are held constant.

For instance, the test engine may be run with all known variables, except M. P., held constant. Readings taken at various increments of M. P. show that for most of the way horsepower and CHT increase in a straight line relationship with increasing M. P. (See figure 7-25.)

The situation changes, however, if the M. P. is pushed far enough; the power line sags and the cylinder temperature line begins an upward swing. In a change from straight lines to curves, points A and A' are definite indications that detonation is present. By the time it progresses to a degree of evidence, it is mildly destructive. The operational interest is to the left of A and A' where detonation is present but not noticeable. To find these incipient stage limits, special analyzers are necessary that detect the slightest traces by the vibration effect on cylinder structure. This instrumentation indicates the immediate limit of safe operation to be left of B-B.

EFFECTS OF DETONATION ON CHT AND BHP

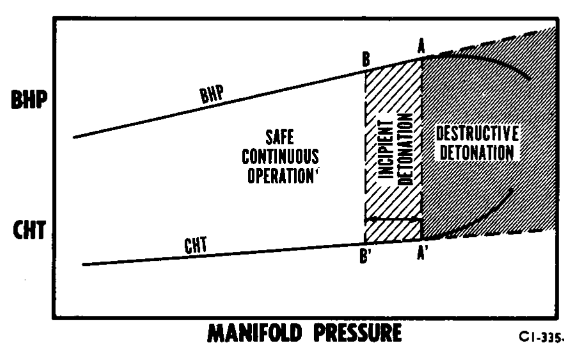

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Figure 7-25.

EFFECTS OF OPERATING VARIABLES ON DETONATION LIMITS

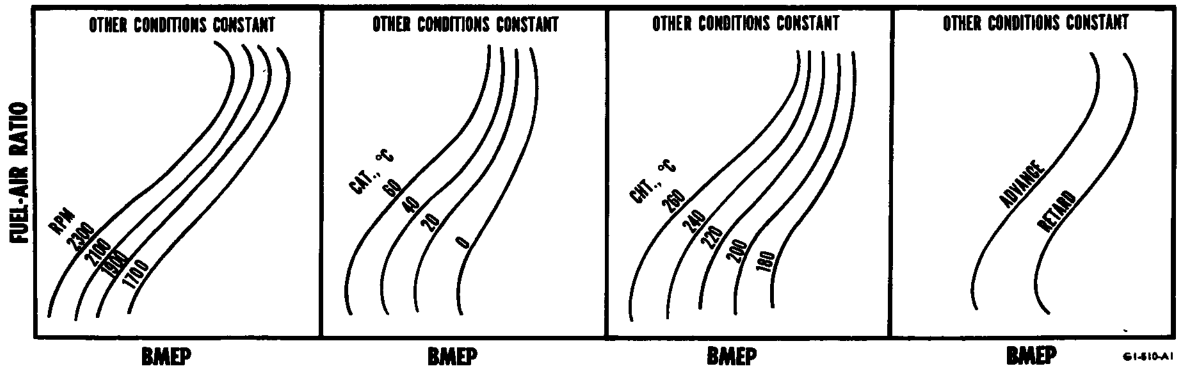

Figure 7-26.

Additional information is obtained in the same manner with different fuel-air ratios. Another series is run at different rpm using the previous series of constant fuel-air ratios. This is continued until every conceivable combination of rpm, fuel-air ratio, cylinder head temperature, carburetor air temperature, spark advance, and fuel grade has been tested. In addition to operating variables, design factors such as compression ratio, valve timing, cam profile, combustion chamber configuration, and spark plug type can be "cranked in." Also, conditions not within operation control such as humidity and exhaust back pressure are held constant or accounted for by accepted corrections. The result of the study is data plotted in an orderly manner. Distinguishing the variations of rpm from the rest of the data shows the effect of engine speed on the detonation limit to power (figure 7-26). Rpm exerts influence principally through its relation to the internal supercharger temperature rise. With high rpm, the charge entering the cylinder is hottest and most likely to detonate. As engine speed reduces, the charge cools and is less likely to kindle ahead of the normal flame front. Do not confuse this with data based on unsupercharged engines, where heat does not rise ahead of the normal flame front and the main detonation influence of rpm has a favorable turbulence effect as rpm increases. This occurs in supercharged engines but is outweighed by the heat rise factor.

Carburetor air temperature influence (figure 7-26) is similar to that of rpm because of its effect on the temperature of the unburned charge before and during combustion.

The cylinder head temperature (figure 7-26) also influences the heat condition of the charge.

Spark advance, another variable subject to the engineer's control, also has a definite effect on the detonation limit as shown in figure 7-26.

Humidity or water vapor in the atmosphere has a strong effect upon detonation, possibly because the water molecules disassociate into hydrogen and oxygen atoms as the temperature rises during combustion. Tests show that there is a greater tendency toward detonation with dry air than with humid air. Lubricating oil has a very low octane or performance number and severely lowers the rating of a fuel when mixed with it, as it might if an oil tank leaks into the fuel tank. Leaking impeller shaft oil seal rings are not likely to give this type of trouble because of the reversal of flow past the seals between low manifold pressure, when oil is drawn into the induction system, and high manifold pressure, when charge air leaks into the crankcase.

Afterfiring.

The most frequent causes of afterfiring are the use of excessively lean mixtures, which burn too slowly, and failure of the ignition system to provide a satisfactory spark. The two main classes of ignition malfunctions are energy losses in the system external to the cylinder and plug fouling from lead or other materials. The former results in insufficient voltage across plug electrodes and the latter in a short circuit instead of a spark. The external system performance depends on magneto pressurization and ventilation, clean connection throughout the system, and good insulation.

Mild afterfiring due to lead fouling may be encountered during sustained flight at lean mixture settings. If it occurs, increase power *slowly,* keeping just within the range of mild afterfiring until the afterfiring ceases.

CAUTION

Sudden acceleration of power must be avoided as it may produce severe afterfiring.

If operating with retarded spark and afterfiring persists, it is sometimes stopped by shifting to spark advance, reducing power if necessary.

TRIM OF ENGINES VERSUS TRIM OF AIRCRAFT CONTROL.

When, for any reason, the power of one or more engines is low, or the propeller is feathered, some consideration must be given to the effects on the aircraft trim and miles per pound of fuel. Except for wing or fuselage warpage, the rudder and aileron trims will be in neutral positions when the engines are all evenly balanced on power, and the aircraft loads and drag items are balanced. If an outboard engine is low on power or its cooling drag is high compared to the other engines there is a yawing effect (a torque), the opposite good engine tending to turn the airplane toward the side with low power. An equal and opposing torque must be generated by the rudder which is offset at first by the pilot pushing on the rudder pedal, then he transfers this load to the trim tab by an appropriate setting of the trim tab control. The offset rudder generates some drag that slows the aircraft or requires a little more power from all the engines to maintain speed. The offset rudder causes the aircraft to crab very slightly to follow the desired track, causing the air to flow over the wing with a cross component. The cross component works on the dihedral of the wing, setting up a slight rolling tendency that the pilot holds off for a little while with the wheel and soon transfers to the aileron trim tabs. The asymmetrical ailerons cause additional drag, slowing the airplane further and requiring additional rudder trim at the slower speed to trim the airplane, or additional power to maintain speed.

Under circumstances of this nature, it may be well to consider balancing up the engines by reducing power on the opposite outboard good engine, approximately equal to an outboard engine, about two-thirds of the loss in power of a center engine, and about one-third of the loss of an inboard engine. The proportionate reductions are due to the distances of the respective engines from the airplane center line. The total power required is attained by increasing the rpm of all engines to divide the loss of power of one engine among the others. Variations of this scheme can be applied by dividing the unequal power among two or three engines. It does not pay to shut down one good engine to balance another that is shut down. Here engine trim must be compromised with control trim. If the control trims get cockeyed, it is well to check engine trim. The engineer and the pilot must cooperate closely at all times to obtain best range results. Precision piloting can be nullified by inaccurate power plant handling and it is equally true that top quality engineering can be cancelled by indifferent airplane handling. Five to ten miles an hour indicated air speed can be lost by sloppy airwork which can use up all the fuel that a good engineer can save.

ENGINE ANALYZER.

The engine analyzer, when installed as an airborne unit, provides a means of accurately and quickly evaluating the ignition system while in flight or during ground operation. By use of the anaylzer during flight the engineer can evaluate the seriousness of a trouble and adjust his engines properly for optimum performance.

Through regular use of ignition analysis, it is possible to determine the firing characteristics of all spark plugs and detect the various degrees of malfunctions in the rest of the ignition system. Weak and mistimed magnetos, open, shorted, or disconnected ignition leads, arcing or out of synchronization breaker points, as well as various distributor malfunctions can all be detected. As combustion within the cylinder has a definite effect on the characteristics of the ignition pattern, intake manifold failures and valve malfunctions may often be detected. Individual defective spark plugs or other defective ignition units can, in this manner, be detected and replaced prior to severe malfunctioning of the engine. Considerable time and replacement part saving is thereby accomplished by replacing only those components of the ignition system known to be causing trouble. Also, in the case of malfunctioning engines due to causes other than ignition, it is possible to establish the serviceability of the ignition system and look further for possible carburetion or valve system malfunction.

Ignition analysis is particularly valuable in determining those components of the ignition system breaking down only at altitude. Very often engine malfunction is experienced at altitude operation, but returns to normal when trouble shooting procedures are applied on the ground. Through application of ignition analysis at altitude such items as weak condensers, ignition harness failures, and misfiring spark plugs may be detected.

When regularly applied in flight, the engine analyzer has been particularly valuable in detecting lead fouling of spark plugs in their early stages. The application of prime in purging procedures is far more effective when applied prior to complete shorting of the spark plug. In addition it is possible to determine the effect the application of prime has had, and whether additional applications are required to complete the desired procedure.

The engine analyzer may be employed whenever a magneto check is made in judging ignition system performance. It must be remembered that "no excessive drop-off" on either the left or right circuits is not necessarily an indication of "no trouble," since the system being checked might have equal dead components in both halves of the system and selecting either half of the dual ignition system will make no difference in output. In performing ground checks

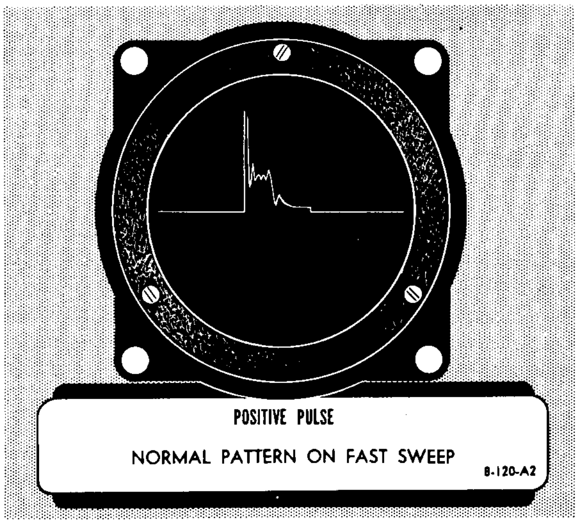

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Figure 7-27. Typical Ignition Pattern

of suspected engines, magneto checks at higher power settings are not advisable. The engine analyzer can be safely utilized in detecting those spark plugs whose operation is satisfactory at normal magneto check engine powers but cut out at higher power.

It should be realized that the engine analyzer does not replace the present methods of trouble shooting or malfunction correction, but rather is a valuable aid or tool in supplementing these checks. The secret of successful analyzer utilization is that of a competent operator who can accurately interpret the patterns and who will use good, sound, logical reasoning in arriving at his decision for corrective action.

Ignition System Analysis.

For ignition analysis the engine analyzer is operated as follows.

1. Engine analyzer power switch—ON.

Note

Allow approximately one minute for the power supply-amplifier and the indicator tube to warm up.

2. Condition selector switch knob — Push in to obtain ignition patterns.
3. Condition selector switch—Place index line on L, R, or B within the sector for the engine to be checked. Indexing the dial to L, R, or B determines whether the pattern will be for the left, right, or both magnetos of the particular row of cylinders to be checked.
4. Cycle switch—Align the IGN index line with the number of the cylinder to be shown first in the series of patterns for one magneto.
5. Cycle switch knob—Pull out to obtain a slow sweep covering the ignition patterns for all of the cylinders fired by the magneto. The cylinder selected by the cycle switch will appear to the left on the indicator followed by the other thirteen in the order of firing of that magneto.
6. If all of the patterns are abnormal during the slow sweep, the malfunction is associated with that portion of the magneto circuit that is common to all cylinders fired by that magneto. This would indicate magneto or distributor difficulty.
7. If a partial quality of the series is abnormal, position the cycle switch to bring one of the abnormal patterns to the left side of the screen.
8. Cycle switch knob—Push in for a more thorough examination of the expanded pattern of any abnormal cylinder.
9. Repeat the above steps for all magnetos. It is suggested that at slack work periods all ignition patterns be investigated on the fast sweep for malfunctions that may not be observed on the slow sweep.

Magneto Synchronization Check.

The magneto synchronization check is made to determine that both magnetos simultaneously fire the two plugs in a cylinder. Magnetos L1 and R1 are timed on cylinder D1, and magnetos L2 and R2 are timed on cylinder C4. To check breaker point synchronization, the cycle switch should be indexed only to these two cylinders. For this check proceed as follows:

1. Engine analyzer power switch—ON.

Note

Allow approximately one minute for the power supply-amplifier and the indicator tube to warm up.

2. Condition selector switch knob—Push in.
3. Condition selector switch—Index line on B under the engine number to be checked.
4. Cycle switch knob—Push in for fast sweep.
5. Cycle switch—Align the IGN index line with D1. If L1 and R1 magneto pulses are of the same polarity, the two patterns will be superimposed. If L1 and R1 magneto pulses are opposite polarity, one pattern will be above the other. If the breaker points are synchronized, the initial traces occurring at breaker point opening will coincide; otherwise, the breaker points associated with the pattern appearing to the left are opening before those associated with the pattern on the the right. By measuring the distance on the scope between the points of breaker point opening and allowing 1/32 inch to equal 1 degree of crankshaft travel, the amount of synchronization error may be determined.

6. Repeat the preceding step with the cycle switch indexed to C4 for checking magnetos L2 and R2.

Two methods are available for determining which magneto, right or left, is out of synchronization. The first is as follows:

1. Engine analyzer power switch—ON.

Note

> Allow approximately one minute for the power supply-amplifier and the indicator tube to warm up.

2. Condition selector switch knob—Push in.
3. Condition selector switch—Set to R under the engine number to be checked.
4. Measure the exact distance between the start of the horizontal trace at the left edge of the indicator screen and the point at which the breaker points open.
5. Condition selector switch—Set to L.
6. Repeat the measurement.
7. The pattern with the shorter horizontal trace is advanced with respect to the other.
8. Compare the length of the traces to that obtained when the synchronizing generator was installed to determine which magneto is advanced or retarded with respect to the crankshaft position.

The second method is as follows:

1. Engine analyzer power switch—ON.

Note

> Allow approximately one minute for the power supply-amplifier and the indicator tube to warm up.

2. Push in the knob on condition selector switch to obtain ignition patterns.
3. Set the condition selector switch to L. If activity of small magnitude is observed ahead of the breaker point opening, that activity is caused by the right magneto because of inductive pickup, indicating that the right magneto is opening early.
4. Switch the condition selector switch to R and this should eliminate the activity.

Perform the synchronization check for each magneto on the engine and repeat on the remaining engines.

RPM Synchronization Analysis.

In comparing engine rpm of the different engines, engine number one is used as a reference and the other engine speeds are compared to its speed. This check should be made at any time that engine rpm synchronization system malfunction is suspected.
To make this check proceed as follows:

1. Engine analyzer power switch—ON.

Note

> Allow approximately one minute for the power supply-amplifier and the indicator tube to warm up.

2. Cycle switch—Any position with knob in for fast sweep.
3. Condition selector switch knob — In to obtain ignition patterns.
4. Condition selector switch—Align the index line in the SYN sector with the number of the engine to be compared to engine number one.
5. Indicator—The ignition pattern will be stationary on the screen if the engines are synchronized, and moving if they are not synchronized. A progressive horizontal shift to the right indicates that the selected engine is under speed with respect to engine number one; a shift to the left indicates that the selected engine is over speed with respect to number one.
6. Condition selector switch—Index to each of the remaining SYN positions.

PROPELLERS.

If an engine is operating at less than master motor rpm and the propeller pitch changing system is actuated to move the blades from positive to reverse pitch or from reverse to positive pitch, the blades will stop before entering the normal operating range of either positive or reverse pitch. This stoppage is due to the necessary tolerance within the propeller limit switch system which prevents energizing two pitch changing systems simultaneously. If at this time the throttle is advanced past the point at which it is necessary to bring the engine up to master motor rpm and the master motor is set below 2800 rpm, the engine speed will exceed the rpm set on the master motor because of the low propeller blade angle. This excessive rpm condition will last for only a short time until the constant speed feature of the propeller system increases the propeller blade angles to give the desired rpm; however, this excess rpm condition reduces propeller efficiency and should be avoided. To eliminate overspeeding above master motor rpm (below 2800 rpm), a decrease rpm signal must be sent to the propeller pitch changing mechanism before the throttle is advanced. The decrease rpm signal is sent by reducing master motor rpm two or three hundred rpm below the rpm indicated on the engine tachometer.

This signal causes the pitch changing mechanism to increase the propeller blade angles, moving them into the normal operating range. The master motor can then be set to the desired rpm and the throttle can be advanced without engine overspeeding.

The manual pitch change system can also be utilized to transmit the increase blade angle signal to the pitch changes mechanism. Transmission of the signals can be accomplished by moving the propeller selector switch to the DEC RPM position and holding it there until a two or three hundred engine rpm drop occurs. The selector switch can then be moved to the AUTOMATIC OPERATION position and the throttle advanced without an overspeed condition occurring.

Propeller limitation charts in Section V must be observed closely. The limitations are based on propeller vibrations, which can be of such a nature that they will weaken the propeller shaft. The vibrations result from combinations of rpm, density altitude, and EAS. The vibratory forces are caused by power impluses imposed as each cylinder fires; by the aerodynamic disturbances created as a blade or blades pass through a region of turbulent air behind the wing or adjacent to the fuselage; and by other causes such as misfiring cylinders, malfunctioning vibration dampers, and extended flaps. By avoiding these vibration limitations areas you will prevent undue strain and fatigue of the metallic components of which your aircraft is constructed.

It must be understood that operation of the propeller in a restricted range will shorten its life and that the vibration stresses mentioned are present in the blades, hub, and shaft, even though no vibration of the aircraft is noticeable to the crew. However, if emergencies dictate that the propeller be operated in a restricted range for a limited period of time, there should be no hesitancy and no cause for alarm. Except in emergencies affecting safety of flight or during very brief periods of time required to go through a restricted region to reach a higher or lower rpm, propellers shall not be operated in a restricted range. An accurate log should be kept of all operation within a restricted range and will include length of time, horsepower, altitude, EAS, and rpm.

FEATHERING.

On this airplane the engine nacelles are not parallel with the fuselage center line in the horizontal plane. The nacelles are "toed in" at the propeller end, resulting in the propellers on one wing having a slightly different relative wind than those on the other wing. This condition may lead to propellers on engines No. 1, 2, and 3 windmilling in a direction opposite to normal operation when they are feathered. This rotation can be stopped by utilizing the manual pitch changing system to make a slight blade angle change. Refer to "Reciprocating Engine Shutdown," in Section III.

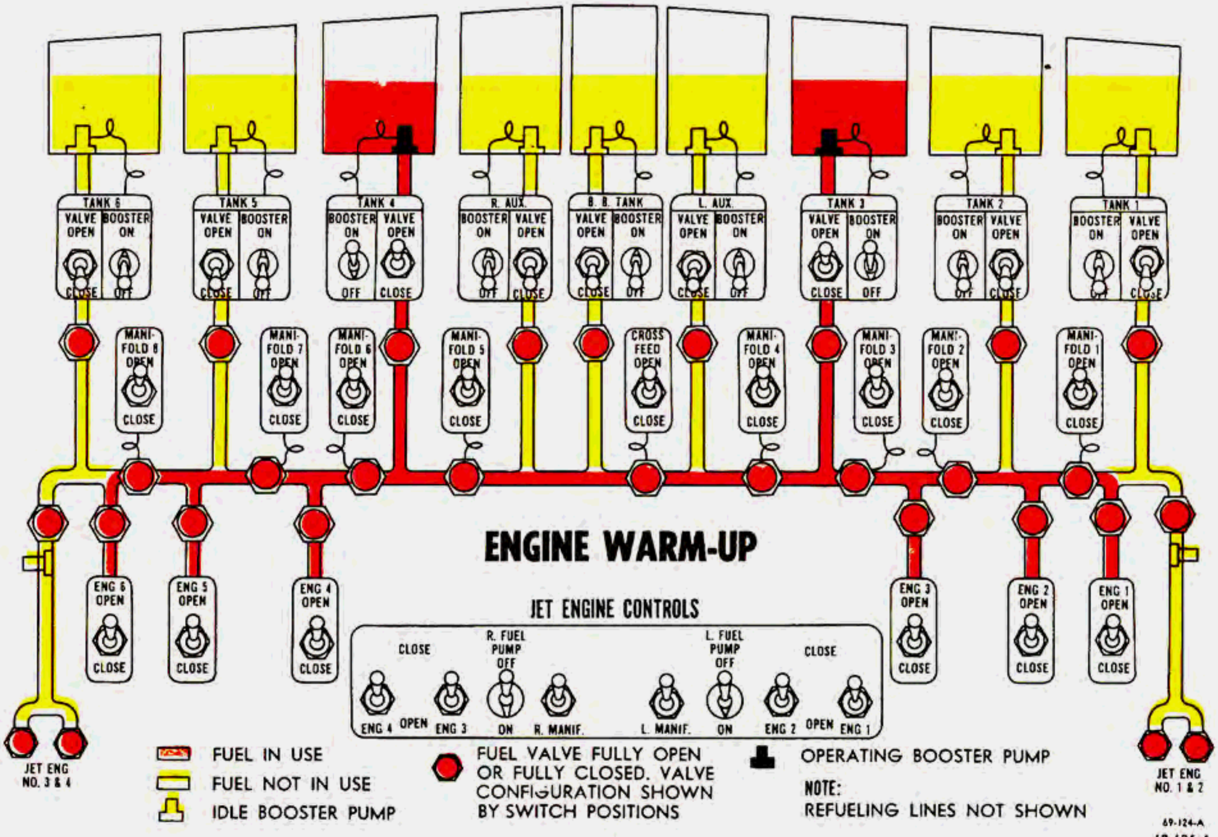

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Figure 7-28. (Sheet 1) Fuel Management

REVERSE PITCH.

The jet engines should be inoperative during reverse pitch operation to avoid the necessity of counteracting their forward thrust and to prevent debris lifted from the ground by propellers being drawn into the jet intakes.

JET ENGINES.

The primary purpose of the jet engines on the airplane is to provide additional power for take-off, climb, and operation in the target vicinity. High altitude cruise at high gross weights also requires operation of the jets. When performing high gross weight landings, the jets should be operated in accordance with the instructions given in "Partial Power Landing," Section III, to provide additional power in the event a go-around is necessary. Operational requirements of the jets at various configurations and powers may be determined from the charts in Appendix I.

The jets are operated on the ground by the flight crew for only a short time, normally being started after the airplane is aligned with the runway just prior to take-off.

WINDMILLING.

Windmilling of the jets in flight with the nose shutoff doors open causes an increased drag; consequently, the doors should be closed when the engines are not operating. Some air leakage through the doors is provided intentionally so that the engine will rotate to circulate oil and to prevent freezing of the rotors at low temperatures. If the jets will not windmill at sufficient rpm to circulate oil and to prevent freezing of the rotors with the doors closed, the nose shutoff doors should be opened enough to maintain sufficient windmilling rpm.

FUEL SYSTEM.

FUEL DENSITY VARIATION.

Because of the wide range of climatic conditions under which this airplane operates, it is not feasible to assume that the fuel weight per gallon is always the same. With full wing tanks, it is possible to have an error of 4500 pounds if the actual density is 15/100 of a pound per gallon different from an assumed weight. To prevent such errors, the weight of the fuel can be more closely computed by use of a fuel hydrometer.

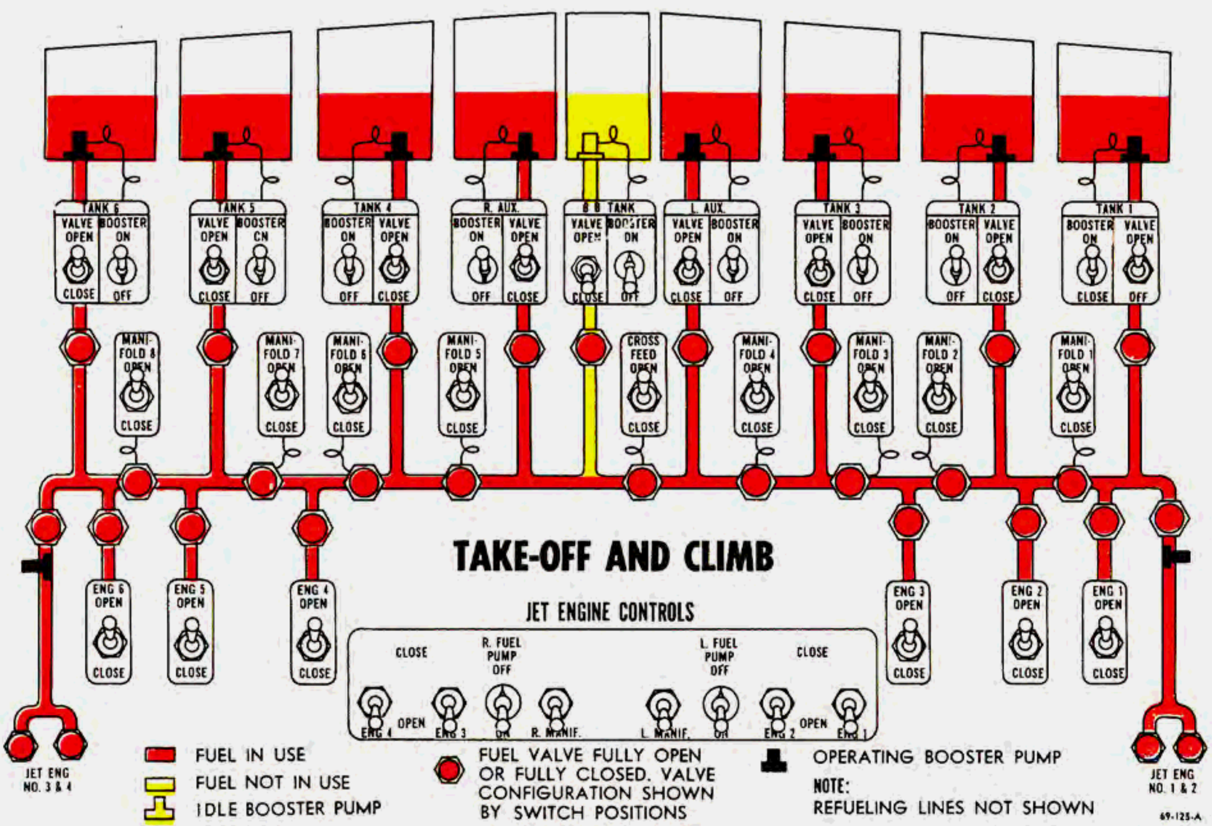

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Figure 7-28. (Sheet 2) Fuel Management

Fuel Weighing Procedure.

This information will be included when available.

NORMAL CRUISE.

During normal cruise, use all fuel in the bomb bay tank first, auxiliary wing tanks second, inboard tanks third, center tanks fourth, and outboard tanks last. This is necessary to maintain the wing bending moments at a minimum. (Refer to "Distribution of Load," in Section V.)

Note

Whenever both the jet and the reciprocating engines are being used, it is essential that fuel be supplied from two tanks in each wing.

Because residual fuel of the empty tank will collect at the booster pump, it is usually advantageous to open the tank valve and turn on the booster pump approximately one hour after the tank was originally turned off. The booster pump should be allowed to operate five minutes to assure complete drainage of the tank.

Note

It is not recommended to CLOSE any fuel tank valve after take-off until the tank has been emptied. If any check valve malfunctions, allowing a reversal of fuel flow, the fuel usage of any tank may be controlled by the correct operation of the booster pump; therefore, any chances of having an inoperative tank valve in the CLOSE position, which would be difficult to operate manually at altitude, would be eliminated.

ELECTRICAL SYSTEM.

TRANSFORMER-RECTIFIER UNIT.

The transformer-rectifier unit is used to convert a-c power to d-c power. Each unit consists of a transformer, a rectifier, and a cooling fan. The transformer reduces the normal a-c voltage and the rectifier converts the alternating current into direct current. The rectifier is a stack of selenium-coated plates through which the alternating current must pass. Metallic selenium on the rectifier plates permits the alternating current to pass through the plates in one direction only; hence, the alternating current becomes "direct" current. The fan is used to cool the rectifier stack. The d-c output of a t-r unit is automatically maintained as the load of the t-r units demand, but the input of 3-phase alternating current is the controlling factor.

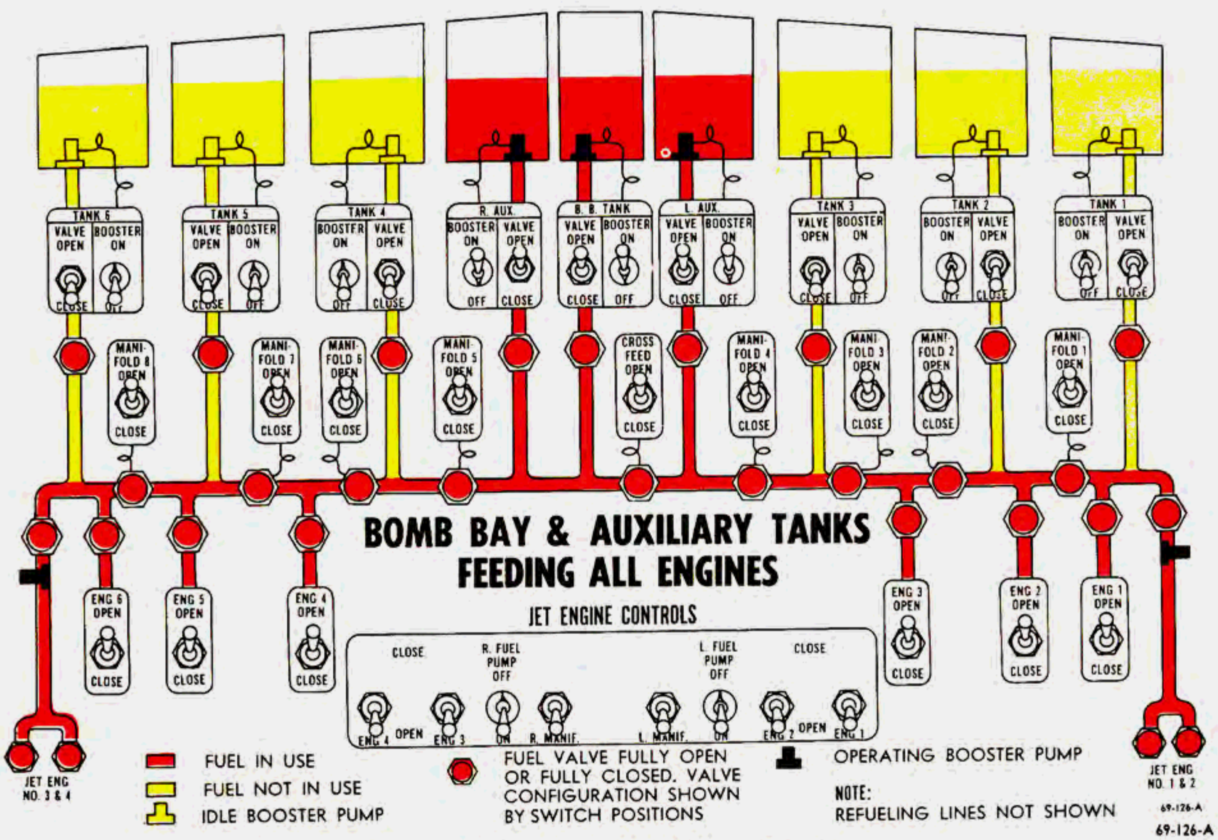

Figure 7-28. (Sheet 3) Fuel Management

THE ALTERNATOR.

The alternator converts mechanical energy into electrical energy. The alternator consists of a stator assembly within which a rotor assembly is driven by the constant-speed drive unit. Windings around the four sets of field poles on the rotor are energized by an exciter generator when the engine is operating and the exciter control relay is closed. When the alternator field poles are energized, magnetic fields are created and the alternating current is produced in the stator coils. The stator assembly consists of three sets of coils, one for each of the alternating current phases. When the rotating field poles are energized, the coils in the stator will supply three-phase alternating current at a frequency determined by the speed of rotation and at a voltage fixed by the strength of the alternator magnetic field.

Exciter Generator.

The exciter generator which supplies voltage to the alternator field poles is integral with the alternator. The exciter is a self-excited, shunt-wound, direct-current generator. A carbon stack voltage regulator is connected in series with the shunt circuit. Because the generator is self-excited and shunt-wound, it energizes its own magnetic field through the shunt circuit. The exciter armature is on the same shaft as the alternator rotor and current is directed from one to the other by means of slip rings.

When the exciter armature rotates at a constant speed, its electrical output depends on the amount of resistance in the shunt field circuit. This resistance is controlled directly by the voltage regulator and indirectly by means of the voltage control knob. The amount of exciter output to the alernator controls the alternator output voltage. Since the carbon stack controls the exciter shunt field strength and the exciter output, it regulates the voltage of the alternator.

Constant-Speed Drive Unit.

The constant-speed drive unit drives the alternator at a constant speed with the mechanical input it receives from the reciprocating engine. The unit consists of a variable angle wobble plate, a fixed angle wobble plate, and a cylinder block assembly which contains motor pistons at one end and pump pistons at the other. The cylinder block assembly is rotated between the wobble plates by gears on an input shaft which is attached to the universal connection from the engine. The pump pistons rotate against the variable angle

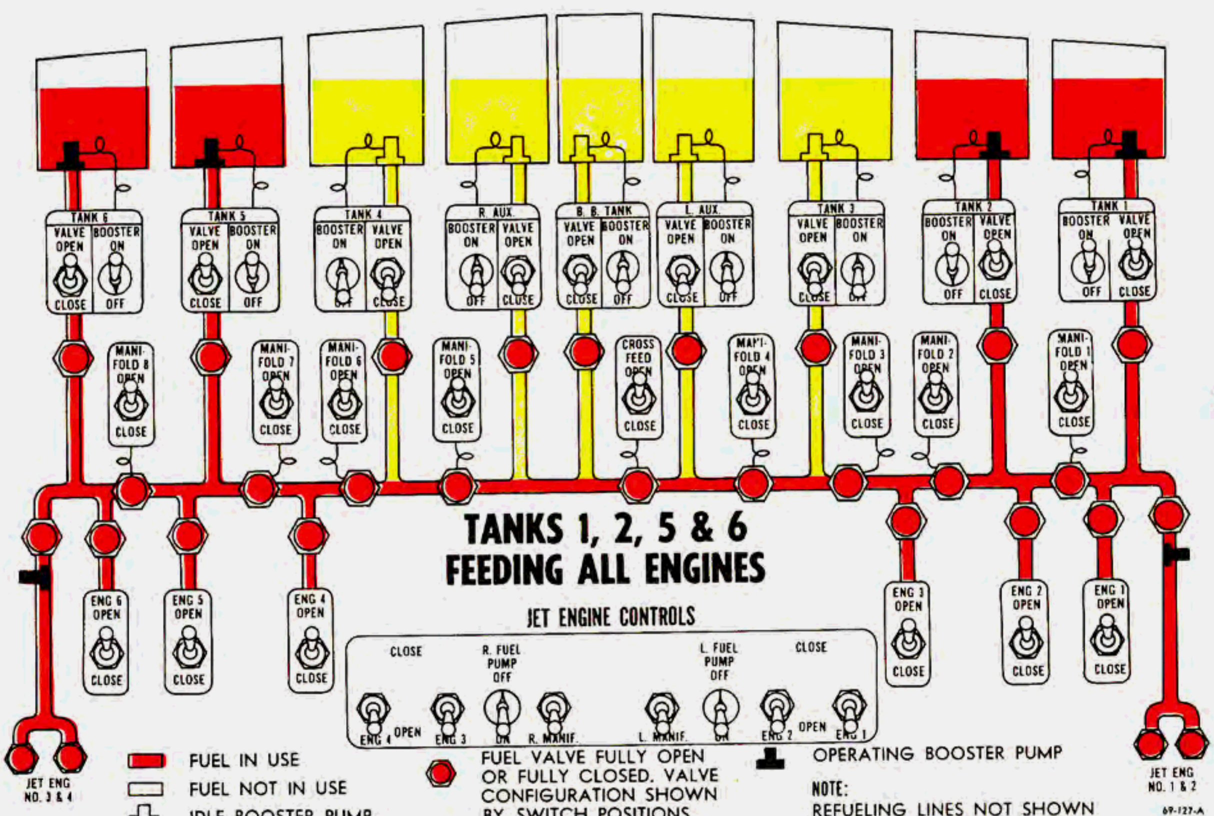

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Figure 7-28. (Sheet 4) Fuel Management

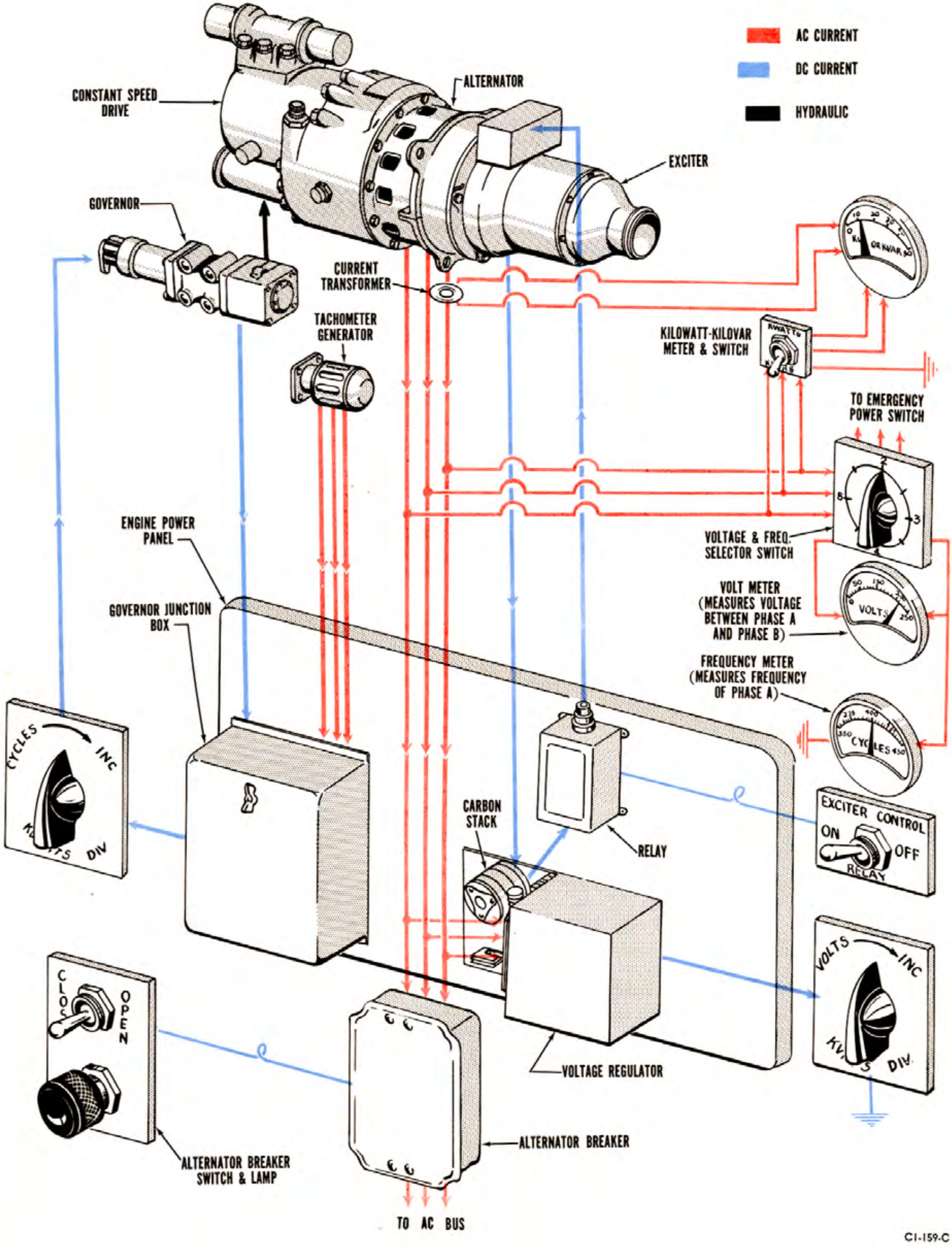

Figure 7-29. Alternating-Current Control Schematic

wobble plate and pump hydraulic fluid to the motor pistons, which turn the fixed angle wobble plate. When rotated, the fixed angle wobble plate turns the output shaft, which is connected to the alternator.

The speed of the output shaft is equal to the input shaft speed plus the speed change caused by the action of the motor pistons on the fixed angle wobble plate. The cylinder block assembly is connected to the fixed angle wobble plate so that the motor pistons can either increase or decrease the speed of the output shaft with respect to the input shaft. The increase or decrease in output shaft speed depends on the direction of the oil flow from the pump pistons to the motor pistons, and the amount of speed change depends on the rate of oil flow. The displacement of the pump pistons and the direction of the oil flow are controlled by the position of the variable angle wobble plate. The position of the variable angle wobble plate thus controls the increase or decrease in the output shaft speed of the constant-speed drive unit. A constant output speed is maintained by controlling the position of the variable angle wobble plate.

CONTROLLING THE A-C SYSTEM.

The a-c system is controlled by regulating the output of the alternators. There are three types of alternator controls: frequency controls, voltage controls, and load division controls. In addition, protective devices are provided to protect the alternator from overloads, short circuits, and overspeeding. The frequency controls regulate the action of the constant-speed drive unit, and the voltage controls regulate the strength of the alternator magnetic field. The load division controls affect these other controls to assure equal real and reactive load division among the alternators. Both real and reactive loads should be equally shared by the parallel alternators to prevent either mechanical overload or excessive current drain through the windings of any one alternator. The reactive load does not impose a mechanical load, but is a part of the current drain through the alternator windings.

Frequency Controls.

The alternator frequency controls consists of a tachometer generator on the output shaft of the constant-speed drive unit, a rectifier in the governor junction box, the engineer's frequency control knob, a spring-biased governor pilot valve and solenoid assembly, and a servo unit which positions the variable angle wobble plate on the constant-speed drive unit. A frequency adjustment rheostat in the governor junction box adjusts the frequency control limits.

The tachometer generator produces 3-phase alternating current which is directly proportional to the speed of the drive unit output shaft. This current is rectified and applied to the control coil in the governor solenoid assembly. The engineer's frequency control knob regulates the amount of the resistance in the circuit between the rectifier and the control coil. The magnetic pull of the control coil acts against the spring-bias and positions the pilot valve in the assembly. When the output speed of the drive unit is correct, the tachometer generator current is sufficient to center the pilot valve, preventing a flow of oil to the control piston in the servo unit. However, any change in the output speed affects the tachometer voltage, causing the control coil to reposition the pilot valve. Depending on the position of the pilot valve, oil will flow to either side of the control piston in the servo unit, which is attached to the variable angle wobble plate on the constant-speed drive unit. The flow of oil will change the position of the control piston and cause the wobble plate to move in the direction which will restore the original speed required for the drive unit. The flow of oil ceases when the output speed is corrected and the tachometer current in the control coil repositions the pilot valve. The frequency controls are automatic and should not require manual adjustment except for temperature changes which affect the frequency.

Note

> The frequency will drop with a decrease in ambient temperature or a considerable increase in load. By the same token, frequency will increase as the temperature of the alternator conductors increase, as in the case of an alternator being initially placed on the line, or a rise in the ambient temperature.

Voltage Controls.

The alternator voltage is adjusted by the engineer's voltage control knob and automatically controlled by the voltage regulator unit. The voltage regulator unit consists of two line transformers, a rectifier, a regulator coil, and a carbon stack resistor. A voltage adjusting rheostat adjusts the voltage control limits. Compensating resistors are also provided for temperature changes and a damping transformer is provided to reduce hunting or prolonged oscillation of voltage changes. A mutual reactor located in the voltage regulator senses unbalanced reactive loads between alternators.

Three-phase voltage from the alternator is rectified, and the d-c current flows through the regulator coil in direct proportion to the alternator voltage except as modified by the mutual reactors. The carbon stack is composed of a number of carbon discs kept under compression by a spring. Current in the regulator coil creates a magnetic force which opposes the spring force and tends to decrease the compression on the stack when the current flow is increased. When the stack compression decreases, its electrical resistance increases. The carbon stack is in series with the exciter shunt field circuit and when the stack resistance increases, the exciter shunt field decreases, causing reduced alternator voltage output. Since the current in the regulator voil directly influences the alternator voltage, any change in alternator voltage affects the carbon stack resistance which acts to restore the voltage to its previous level.

Real Load Division.

The ability of an alternator to assume real load in kilowatts depends on the mechanical torque applied to it by the constant-speed drive unit. After the alternators have been paralleled, they normally will not change their frequency output. However, the torque applied to each alternator may be changed by its drive unit. The torque may be increased by causing the drive unit to attempt to speed up the alternator. This can be done with the engineer's frequency control knob or by the load equalization circuit. When the drive unit attempts to speed up, the alternator rotor will not revolve faster, because it is electrically locked in parallel; but the added torque from the drive will permit it to assume more real load.

Automatic division of the real load is accomplished by a load equalization circuit after the engineer's controls have been set. Basically the circuit consists of four droop coils, one in each governor solenoid assembly. Each droop coil has the same effect as the control coil on the pilot valve and the action of the constant-speed drive unit. When the alternators are unequally sharing real load, each droop coil receives rectified current from load measuring transformers in each governor junction box. A droop control rheostat in each governor junction box adjusts the sensitivity of each droop coil.

The four droop coils are parallel-connected in a circuit so that when the alternators are equally sharing real load, no current flows through the droop coils. When an alternator assumes unequal load, current flows through the droop coils in proportion to the unbalance in load division. This unbalance in current results in the pilot valves being repositioned to cause the overloaded alternators to reduce torque and the others to increase torque until the load is equally divided again. The action of the droop circuit ceases when the load is equally divided.

Reactive Load Division.

The ability of an alternator to assume reactive load in kilovars depends on its magnetic field strength. After the alternators have been paralleled, they normally will not change their voltage output. However, the output of the exciter to the alternator field may be changed with the engineer's voltage control knob or by the reactive load division circuit. When the exciter output is increased to a paralleled alternator, it increases the ability of that alternator to assume more reactive load.

The reactive load division circuit consists of the mutual reactor in each voltage regulator and a current transformer for each mutual reactor. The transformers supply the reactors with current when the alternators are unequally sharing reactive load. The four mutual reactors are in series. Therefore, when the alternators are sharing equal reactive load, only an insignificant amount of current passes through the mutual reactors and the regulator coils in the voltage regulators are not affected. However, when the alternators assume unequal reactive loads, current proportional to the unequal load on each alternator flows through its mutual reactor. The effect on the regulator coils is the same as if the alternators were producing different voltages. The regulator coils change the resistances in the carbon stacks so that the overloaded alternators will receive less excitation and the others more excitation until the loads are equally divided again. The action of the reactive load division circuit ceases when the reactive loads are equally shared.

Load Variations.

A load variation of 4 kw or less on an alternator in a paralleled a-c system is not abnormal and does not require any action. If the variation is in excess of 4 kw, however, close all bus tie-breakers and remove the alternator with the largest load variation from the line. This action should alleviate the excessive load condition. If it does not, return the alternator to the line and remove each of the other alternators one at a time until the one causing the load variation is located. Flash the field of this alternator and return it to the line. If the load variation persists, remove the bad alternator from the line and operate the good alternators.

If it later becomes necessary to return the defective alternator to the line, connect it to an isolated bus and operate the other alternators on the remaining buses, making certain that the load limitations are not exceeded.

ALTERNATOR PROTECTIVE DEVICES.

Exciter Ceiling Relay.

An exciter ceiling relay protects the alternator from overloads. It consists of a thermal switch connected to the alternator breaker and the exciter control relay. When the alternator is overloaded, the thermal switch closes and completes a 28-volt d-c circuit to open the alternator breaker and de-excite the alternator.

Differential Protection Relay.

A differential protection relay protects the alternator from short circuits in the alternator windings. It consists of a transformer installed around the power and ground return leads for each phase and a switch connected to the alternator breaker and the exciter control relay. When the power and ground return leads have unequal current passing through them, the transformers are energized by the difference in current and close the switch, completing a 28-volt circuit to open the alternator breaker and de-excite the alternator.

Alternator Overspeed Control.

A constant-speed drive overspeed control protects the alternator from excessive speeding. It consists of a centrifugal switch in the tachometer generator and a coil in the governor pilot valve and solenoid assembly. When the output shaft speed is excessive, the centrifugal switch closes and completes a 28-volt d-c circuit to the coil in the governor solenoid. The energized coil pulls the pilot valve to an extreme position which causes the drive unit to go into full underdrive and reduce the output speed to a minimum. The pilot valve is latched into position, and the drive unit maintains lowered speeds to the alternator until the latch is released.

When the drive unit is locked in underdrive, the alternator frequency closely follows engine rpm.

NORMAL OPERATING PROCEDURES.

Four Good Alternators.

When four good alternators are available, isolate one bus, preferrably No. 3 or 4, and tie the other three buses together. Operation with 20 kw per alternator as a maximum is not essential but allows greater flexibility of operation, since it will permit intermittent equipment operation within the normal alternator rating and will provide for adequate fault clearing capacity.

Three Good Alternators.

If only three good alternators are available, operate the alternators in parallel with all bus tie-breakers closed. It is desirable to reduce all alternator loads to a maximum of 20 kw per alternator, if practicable, by removing nonessential loads.

Note

If three or more good alternators are available, use standard manual leaning procedure for 30-degree spark advance, best economy operation, if maximum range is desired. If less than three good alternators are available but maximum range engine performance is imperative for safe return of the aircraft, continue to use standard manual leaning procedure for 30-degree spark advance, best economy operation.

Two Good Alternators.

If only two good alternators are available, operate them in parallel with all bus tie-breakers closed. It is desirable to reduce all electrical loads to a maximum of 20 kw per alternator, if practicable, by removing non-essential electrical loads.

One or Less Than Three Good Alternators (Sacrifice in Maximum Range).

When less than three good alternators are available and the airplane is equipped with d-c solenoid type spark advance actuators, use the following alternate procedure if conditions permit a sacrifice in maximum range performance:

a. When best economy fuel-air ratio has been established at 30 degrees spark advance, select retard spark, 20 degrees BTC, one engine at a time and observe stability of the engine as indicated by the torquemeter and fuel flow. A slight loss of torque is normal. If engine is unstable, enrichen mixture gradually until a stable condition is reached. This will insure that if a complete loss of electrical power occurs and the spark automatically returns to the retard position, the engine will operate reasonably stable.

b. Reselect advance spark and observe torque rise. Control any excessive torque rise with a reduction in manifold pressure.

c. Make these adjustments to obtain a desirable fuel flow, fuel-air ratio, and brake horsepower without undue sacrifice in engine stability in the event of loss of electrical power to the spark advance actuator.

Note

The engine analyzer should be monitored for determining position of spark timing if a decrease in torque is observed. In the event of an electrical power failure to the spark advance actuator, the ignition pattern in fast sweep will move five-sixteenth of an inch to the right on the scope when moving from the spark advance to the spark retard position. The exhaust back pressure will tend to increase due to after-firing caused by lean mixture-retard spark and thereby result in increased boost and CAT. in the event of an electrical failure during manual lean spark advance operation. When in single turbo this could result in excessive carburetor air temperature; therefore, the CAT. should be maintained at such a value that in the event of electrical power failure, the CAT. will not exceed the maximum limit providing weather and engine stability permit.

Less Than Three Good Alternators (Range Unimportant).

If range is unimportant and less than three good alternators are available, set up required power with 20 degrees spark advance, normal mixture and dual turbo. The operating procedure with one good alternator is the same as outlined above.

Electrical Loads.

The following is a list of significant electrical loads which can be removed at the discretion of the crew, depending on tactical requirements.

a. *AC Electrical Loads* — *Approximate Average KW*

Cabin Heaters	34
Turret	3
Jet Anti-Icing	10
Cabin Air Booster Fan	9 (high speed)
Oil Vent Line Heaters	1.5
Hydraulic pump Temperature Cycling	11
Oven, Hot Cups	5
K-( ) Equipment	13 (intermittent max.)
Jet Oil Tank Heaters	2

b. *DC Electrical Loads* — *Approximate Average Amps*

Tail Radar	15
Chaff Dispensers	30
RCM Equipment	14.4
Radio Equipment	74 (maximum)
Special Bombing Equipment	102 (maximum)
K-( ) Equipment	41
Autopilot	15

CHART FOR ELECTRICAL SYSTEM TROUBLE SHOOTING.

Directions for using the trouble shooting chart: The "Parallel Condition" column indicates the initial abnormal condition which would be noted while a malfunctioning alternator is operating in parallel with other alternators. After the breaker of the affected alternator is opened, the no-load operation should be observed and compared with the conditions shown in the "Isolated Condition" column. Directly opposite the isolated condition is shown the trouble shooting procedure which should be followed.

Note

The malfunctioning alternator may be determined by splitting the bus four ways. Isolate the affected alternator by opening its alternator breaker. If necessary, the bus tie-breakers may be closed after the affected alternator is isolated.

Note

When operating under reduced electrical power, the cabin heaters should be turned off to conserve power.

PARALLEL CONDITION	ISOLATED CONDITION	PROCEDURE
Frequency oscillations (Isolate alternator with largest variation in KVAR or KWATT load.)	Voltage oscillation (± 10 volts)	1. Polarity of exciter field may be reversed—Flash the field. If the field is not flashed, leave unexcited.
	Frequency oscillations.	1. Rotate frequency control knob rapidly back and forth to free sticky governor. Isolate alternator if fault cannot be corrected.
No KWATT or KVAR indications.	No frequency — No voltage — one or both synchronization lights out.	1. Alternator failure is indicated. 2. Be sure alternator breaker is opened. 3. Check AC INST fuses at engine power panel.
Alternator will not stay on line.	All readings normal when alternator breaker is opened and alternator re-excited.	1. De-excite alternator. 2. May be caused by the protective devices. In emergency, disconnect cannon plugs from exciter ceiling relay and differential protection relay at engine power panel.
Negative KVAR and KWATT load. (Alternator motoring)	Erratic or no frequency or voltage.	1. Slipping clutch or broken drive shaft—Open alternator breaker. 2. In emergency, replace carbon stack with stack from non-operative unit.
	Low frequency—Low voltage—Alternator frequency varies with engine speed.	1. Unit is in underdrive—Isolate alternator and manually reset. 2. If underdrive condition persists, use alternator at 2800 rpm engine speed.
No d-c power to alternator control panel.		1. Reset bus tie control circuit breaker on engineer's table.

PARALLEL CONDITION	ISOLATED CONDITION	PROCEDURE
No KVAR or KWATT indication on one alternator, but power is apparently being supplied by the alternator.	No frequency, voltage low or zero, synchronization lights dim or out.	1. CHECK AC INST fuses at engine power panel. 2. Remove alternator from line and use only in emergency on isolated bus.
Low or negative KVAR load.	Low voltage with little or no control.	1. Check AC INST fuses at engine power panel. 2. Check adjustment of voltage regulator rheostat at the engine power panel. 3. Remove either wire from terminal D-9 at the engine distribution panel and adjust voltage regulator rheostat at engine power panel. 4. In emergency only, replace carbon stack with stack from a non-operative unit (excitation must be off to remove stack).
Low KWATT load—Some control. KVAR'S normal.	Frequency low—Some control.	1. Readjust frequency control rheostat on governor control junction box at the alternator control panel.
	No frequency, low voltage.	1. Check AC INST fuses at engine power panel.
High KVAR load—No control.	High voltage—No control.	1. Check AC PWR EQUIP. fuse at engine power panel. 2. Replace carbon stack when excitation is OFF. 3. De-excite alternator.
High KVAR load — or KVAR division wandering over wide range.	Frequency and voltage readings normal.	1. Isolate alternator and split bus.
High KWATT load—or KW division wanders over wide range.	Abnormal frequency control.	1. Readjust frequency rheostat in the governor control junction box at engine power panel. 2. May be sticky governor—Rotate frequency control knob rapidly back and forth to free.
	Normal control.	1. Isolate alternator and split bus if trouble persists.
Complete loss of power.		See "Emergency Electrical Operation" of Section III.

EMERGENCY OPERATION OF ELECTRICAL EQUIPMENT.

When a unit fails to operate because of a faulty electrical circuit, power can be applied to the unit by the use of wire jumpers. It is suggested that two jumpers be prepared for this purpose. One jumper should be made of heavy wire capable of carrying the largest 3-phase power load which may be encountered; the other jumper can be made of relatively thin wire for use on low current circuits. Each jumper should incorporate a switch. The three-phase jumper should incorporate a three-pole switch. These switches are important for the following reasons:

a. When the jumper is connected from the unit to the power line, the circuit will remain open until the switch is closed. This eliminates the possibility of dangerous sparking.

b. If the limit switch of a unit is inoperative, the circuit will be kept open until the second crew member is prepared to observe movement of the unit.

c. If the circuit carries three-phase power, the three-gang switch will permit all phases to be connected simultaneously.

CAUTION

Application of three-phase power to a motor when all three phases aren't connected may cause motor damage.

Connect the jumper to the unit first, and then to the power line with insulated metal clips having a maximum of contact surface and a minimum of exposed outer surface.

WARNING

Because dangerous voltages will be encountered in various parts of the airplane, always open the circuit breakers or remove the fuses which will de-energize the circuit before attaching a jumper.

The procedures given in the following tables are to be used when a unit fails to operate because of a faulty electrical circuit.

UNIT	TERMINAL LOCATION	OPERATION	
		TO CLOSE VALVE	TO OPEN VALVE
Aft Cabin Pressure Shutoff Valve	Just forward of aft cabin	1. Apply 115-volt AC to pigtail B.	1. Apply 115-volt AC to pigtail A.
		TO CLOSE BREAKER	TO OPEN BREAKER
Alternator Breaker	On aft side of Alternator Control Panel 2, 3, 4, or 5.	1. Open bus tie-breakers to isolate alternator: Then momentarily apply 28-volt DC to terminal A6. (28-volt DC power available at terminals B2 and B3). 2. Connect jumper from terminal B4 to A6.	1. Momentarily apply 28-volt DC to terminal A8 (28-volt DC available at terminals B2 and B3.) 2. Connect jumper from terminal B4 to A8.
		TO CLOSE RELAY	TO OPEN RELAY
Alternator Exciter Control Relay	On aft side of Alternator Control Panel 2, 3, 4, or 5.	1. Apply 28-volt DC to terminal B11 of alternator terminal strips (28-volt DC available at terminals B2 and B3).	1. Apply 28-volt DC to terminal B10 of alternator terminal strips (28-volt DC available at terminals B2 and B3).
		TO CLOSE DOORS	TO OPEN DOORS
Bomb Bay Doors	Landing gear control relay panel	1. Apply 28-volt DC to terminal B2 of hydraulic fluid temperature control relay. Also apply 28-volt DC to terminal X1 and ground terminal X2 of the No. 1 hydraulic pump relay. 2. If the main selector valve fails to operate, depress the CLOSE plunger on the valve. If pump No. 1 fails to operate, No. 2 may still be operative; however, if No. 2 pump is also inoperative, apply 28- volt DC to terminal X1 and ground X2 of No. 2 pump relay.	1. Apply 28-volt DC to terminal C1 on the bomb bay door open relay. Also apply 28-volt DC to terminal X1 and X2 of the No. 1 hydraulic pump relay. 2. If the main selector valve fails to operate, depress the OPEN plunger on the valve. If pump No. 1 fails to operate, No. 2 may still be operative; however, if No. 2 pump is also inoperative, apply 28-volt DC to terminal X1 and ground X2 of No. 2 pump relay.
		TO CLOSE BREAKER	TO OPEN BREAKER
Bus Tie Breaker	At A-C Power Panel (LH 2-3 and 3-4; RH 4-5 and 5-2)	1. Apply 28-volt dc to terminal CL.	1. Apply 28-volt dc to terminal TR.
		TO CLOSE VALVE	TO OPEN VALVE
Cabin Pressure Wing Shutoff Valve	Overhead in bomb bay No. 3.	1. Apply 115-volt AC to pigtail B.	1. Apply 115-volt AC to pigtail A.

UNIT	TERMINAL LOCATION	OPERATION	
		TO CLOSE AIR PLUG	TO OPEN AIR PLUG
Engine Air Plug	At Engine Distribution Panels	1. Apply 28-volt DC to terminal A9 of engine distribution panel. 2. If motor fails to operate, connect jumpers between the following air plug motor relay terminals: T1 to L1; T2 to L3; T3 to L2.	1. Apply 28-volt DC to terminal A10 of engine distribution panel. 2. If motor fails to operate, connect jumpers between the following air plug motor relay terminals: T1 to L1; T2 to L2; T3 to L3.
		FOR LOW RPM	FOR HIGH RPM
Engine Fan	At Engine Distribution Panels	1. Apply 115-volt AC to terminal A1. NOTE: Circuit breaker on engineer's panel must be open.	1. Apply 115-volt AC to terminal A2. NOTE: Circuit breaker on engineer's panel must be open.
		TO CLOSE DOOR	TO OPEN DOOR
Engine Oil Flight Cooling Door	At Engine Distribution Panels	1. Apply 115-volt AC to terminal N5. NOTE: Fuse must be removed from engine power panel.	1. Apply 115-volt AC to terminal N4. NOTE: Fuse must be removed from engine power panel.
		TO CLOSE DOOR	TO OPEN DOOR
Engine Oil Ground Cooling Door	At Engine Distribution Panels	1. Apply 115-volt AC to terminal N7. NOTE: Fuse must be removed from engine power panel.	1. Apply 115-volt AC to terminal N6. NOTE: Fuse must be removed from engine power panel.
		TO RETRACT	TO EXTEND
Flaps (Inboard)	At L.H. Wing-Fuselage Splice (L.H. Flap) or R.H. Wing-Fuselage Splice (R.H. Flap.)	1. Apply 28-volt DC to terminals A1 and A4.	1. Apply 28-volt DC to terminals A2 and A4.
	At Speed Control and Motor Reversing Relay.	1. If motor still fails to operate, check fuses, and if blown, replace. Apply 28-volt dc to motor reversing relay terminal X1 and speed relay terminal X1. Ground speed relay terminal X2.	1. If motor still fails to operate, check fuses, and if blown, replace. Apply 28-volt dc to motor reversing relay terminals Y2 and speed relay terminal X1. Ground speed relay terminal Y1.
		TO RETRACT	TO EXTEND
Flaps (Center)	At L.H. WING-Fuselage Splice (L.H. Flap) or R.H. Wing-Fuselage Splice (R.H. Flap.)	1. Apply 28-volt DC on terminals A5 and A8.	1. Apply 28-volt DC on terminals A6 and A8.
	At Speed Control and Motor Reversing Relays.	1. If motor still fails to operate, check fuses, and if blown, replace. Apply 28-volt DC to	1. If motor still fails to operate, check fuses and if blown, replace. Apply 28-volt DC to

UNIT	TERMINAL LOCATION	OPERATION	
		motor reversing relay terminal X1 and speed control relay terminal X1. Ground speed relay terminal X2.	motor reversing relay terminal Y2 and speed relay terminal X1. Ground speed relay terminal Y1.
		2. If fuses not blown, or fuses continue to blow and motor fails to operate, connect jumpers between the following terminals: T1 on reversing relay to L13 on speed relay, T2 to L11, T3 to L12.	2. If fuses not blown, or continue to blow and motor does not operate, connect jumpers between the following terminals: T1 on reversing relay to L13 on speed relay, T2 to L12, T3 to L11.
		3. If motor does not run, remove the jumpers and connect them as follows: T1 on reversing relay to L3 on speed relay, T2 to L1, T3 to L2.	3. If motor does not run, remove the jumpers and connect them as follows: T1 on reversing relay to L3 on speed relay, T2 to L2, T3 to L1.
		TO RETRACT	TO EXTEND
Flaps (Outboard)	At L.H. Wing-Fuselage Splice (L.H. Flap)	1. Apply 28-volt DC to terminals A10 and A12.	1. Apply 28-volt DC to terminals A9 and A12.
	At R.H. Wing-Fuselage Splice (R.H. Flap)	1. Apply 28-volt DC to terminals A9 and A12.	1. Apply 28-volt DC to terminals A10 and A12.
	At Speed Control and Motor Reversing Relay	1. If motor still fails to operate, check fuses, and if blown, replace. Apply 28-volt DC to motor reversing relay terminal X1 and speed control relay terminal X1. Ground speed relay terminal X2.	1. If motor still fails to operate, check fuses, and if blown, replace. Apply 28-volt DC to motor reversing relay terminal Y2 and speed control relay terminal X1. Ground speed relay terminal Y1.
		2. If fuses not blown, or fuses continue to blow and motor fails to operate, connect jumpers between the following terminals: T1 on reversing relay to L13 on speed relay, T2 to L11, T3 to L12.	2. If fuses not blown, or continue to blow and motor does not operate, connect jumpers between the following terminals: T1 on reversing relay to L13 on speed relay, T2 to L12, T3 to L11.
		3. If the motor does not run, remove jumpers and connect them as follows: T1 on reversing relay, to L3 on speed relay, T2 to L1, T3 to L2.	3. If the motor does not run, remove jumpers and connect as follows: T1 on reversing relay to L3 on speed relay, T2 to L2, T3 to L1.
		TO OPERATE	
Fuel Booster Pump	At Engine Distribution Panels	1 Apply 28-volt DC to pump relay terminal X1. Ground terminal X2.	
		2. If jump fails to operate, add jumpers between the following relay terminals: L1 to T1; L2 to T2; L3 to T3.	

UNIT	TERMINAL LOCATION	OPERATION		
		TO OPERATE		
Hydraulic Pump	At Landing Gear Control Panel	1. Apply 28-volt DC to pump motor relay terminal X1. Ground terminal X2. 2. If pump fails to operate, apply 28-volt DC to No. 2 pump relay terminal X1 and ground terminal X2.		
		TO OPEN SHUTTERS	TO CLOSE SHUTTERS	
Intercooler Controls	At Engine Distribution Panels	1. Apply 115-volt AC to terminal B12 for LH shutter and C12 for RH shutter. NOTE: Fuses must be removed at engine power panel.	1. Apply 115-volt AC to terminal B13 for LH shutter and C9 for RH shutter. NOTE: Fuses must be removed at engine power panel.	
		TO RETRACT	TO EXTEND	
Landing Gear	At Landing Gear Control Panel	1. Apply 28-volt DC to terminal X2 of retract relay and ground terminal X1. Also, apply 28-volt DC to terminal X1 and ground terminal X2 of the No. 1 hydraulic pump relay. 2. If the main selector valve fails to operate, depress the UP plunger on the valve. If No. 1 pump fails to operate, No. 2 may still be operative; however, if No. 2 is also inoperative, apply 28-volt DC to terminal X1 and ground X2 of No. 2 pump relay.	1. Apply 28-volt DC to terminal X2 of the extend relay and ground terminal X1. Also apply 28-volt DC to terminal X2 of the No. 1 hydraulic pump relay. 2. If the main selector valve fails to operate, depress the DOWN plunger on the valve. If No. 1 pump fails to operate, No. 2 may still be operative; however, if No. 2 is inoperative also, apply 28-volt DC to terminal X1 and ground X2 of No. 2 pump relay.	
		TO EXTEND	TO ILLUMINATE	
Landing Light	Landing Light Pressure Disconnect	Apply 28-volt DC to pin B of landing light pressure disconnect.	Apply 28-volt AC to pin C of landing light pressure disconnect.	
		TO CLOSE DUMP VALVE	TO OPEN DUMP VALVE	
Nacelle Dump Valves	At RH Fuselage Wing Splice At Engine Distribution Panels 3 and 4	1. Apply 115-volt AC to terminals A16 and A18. 2. If motor fails to operate apply 115-volt AC to terminal M16. NOTE: Circuit breakers on engineer's table must be open.	1. Apply 115-volt AC to terminals C12 and C9. 2. If motor fails to operate, apply 115-volt AC to terminal M15. NOTE: Circuit breakers on engineer's table must be open.	
		TO INCREASE RPM	TO DECREASE RPM	TO FEATHER
Propeller	At Engine Distribution Panels	Apply 28-volt DC to terminal A3.	Apply 28-volt DC to terminal A4.	Apply 28-volt DC to terminal B7.

UNIT	TERMINAL LOCATION	OPERATION	
		TO ADVANCE	TO RETARD
Spark Advance	At Engine Distribution Panels	1. Apply 115-volt AC to terminal A13. NOTE: Circuit breakers on engineer's panel must be open.	1. Apply 115-volt AC to terminal A14. NOTE: Circuit breakers on engineer's panel must be open.
		FOR SINGLE TURBO	FOR DUAL TURBO
Turbo Selector Valve	At Engine Distribution Panels	Apply 115-volt AC to terminal B5. NOTE: Circuit breaker on engineer's panel must be open.	Apply 115-volt AC to terminal B6. NOTE: Circuit breaker on engineer's panel must be open.
		TO CLOSE VALVE	TO OPEN VALVE
Wing Anti-Icing Control	At Engine Distribution Panels 1, 2, 5, and 6	1. Apply 28-volt DC to terminal X1 of anti-icing dump valve relay. Ground terminal X2. 2. If motor fails to operate, apply 115-volt AC to terminal M16. NOTE: Fuses must be removed from power panel.	1. Apply 28-volt DC to terminal X1 of anti-icing dump valve relay. Ground terminal X2. 2. If motor fails to operate, apply 115-volt AC to terminal M15. NOTE: Fuses must be removed from power panel.

LANDING GEAR SYSTEM.

LANDING GEAR RETRACTION.

When the landing gear control switch is moved to the RETRACT position and the airplane is airborne, both main system hydraulic pumps are energized and the main selector valve is actuated to direct hydraulic fluid, under pressure, into the gear-up lines. The pressure is routed to the door directional valve from where it is routed to the sequence shutoff valve which is open when the main gear is locked in the up or down position. At the same time, pressure is routed to and stops at the up sequence valve which is closed. Pressure is also routed to the up end of the nose gear actuating cylinder to retract the nose gear. After passing through the door directional valve and the sequence shutoff valve, the flow divides with part of it going to the door unlatching cylinder and the remainder to the up side of the door actuating cylinder. The fluid going to the up side of the door actuating cylinder preloads the actuator in the up position. This preloading is necessary to prevent airloads from pulling the door open suddenly and cavitating the actuating cylinder when the door latches are released. Preloading also permits easier opening of the door latches. When the fluid passes through the door unlatching cylinder, opening the latches, it enters the down side of the door actuating cylinder to extend the door to the full down position. As the door becomes fully extended, the mechanical linkage between the door actuating cylinder and the sequence valves opens the up sequence valve and the down sequence valve. When the up sequence valve is opened, fluid is routed to the main gear unlatching cylinder and through the cushion valve. The unlatching cylinder unlatches the main gear and breaks the side brace. The fluid which passes through the cushion valve is routed to the main gear actuating cylinder and the gear begins retraction. While the gear is retracting, the mechanical linkage between the actuating cylinder and the door directional valve positions the directional valve actuating cylinder. However, the door cannot close because the sequence shutoff valve is closed preventing the flow of return fluid from the down port of the door actuator. When the gear is full up the side brace falls in to place and automatically locks. As the main gear latch falls into place, the sequence shutoff valve is actuated to the open position. The opening of this valve allows return fluid to escape from the down side of the door actuator. This permits fluid to enter the up side of the actuator, raising the door. As the door rises, fluid is forced from the down port of the door actuator through the door unlatching cylinder. This holds the door latches open until the door is completely closed, at which time the flow through the unlatching cylinder ceases and the door latches fall into place, locking the door in the up position. As the latches fall into place, the door limit switches are actuated, shutting off the hydraulic pumps.

LANDING GEAR EXTENSION.

When the landing gear control switch is moved to the EXTEND position, the No. 1 hydraulic pump is energized and the main selector valve is actuated to direct hydraulic fluid under pressure into the gear-down lines. The pressure is routed to the door directional valves from where it is routed to the sequence

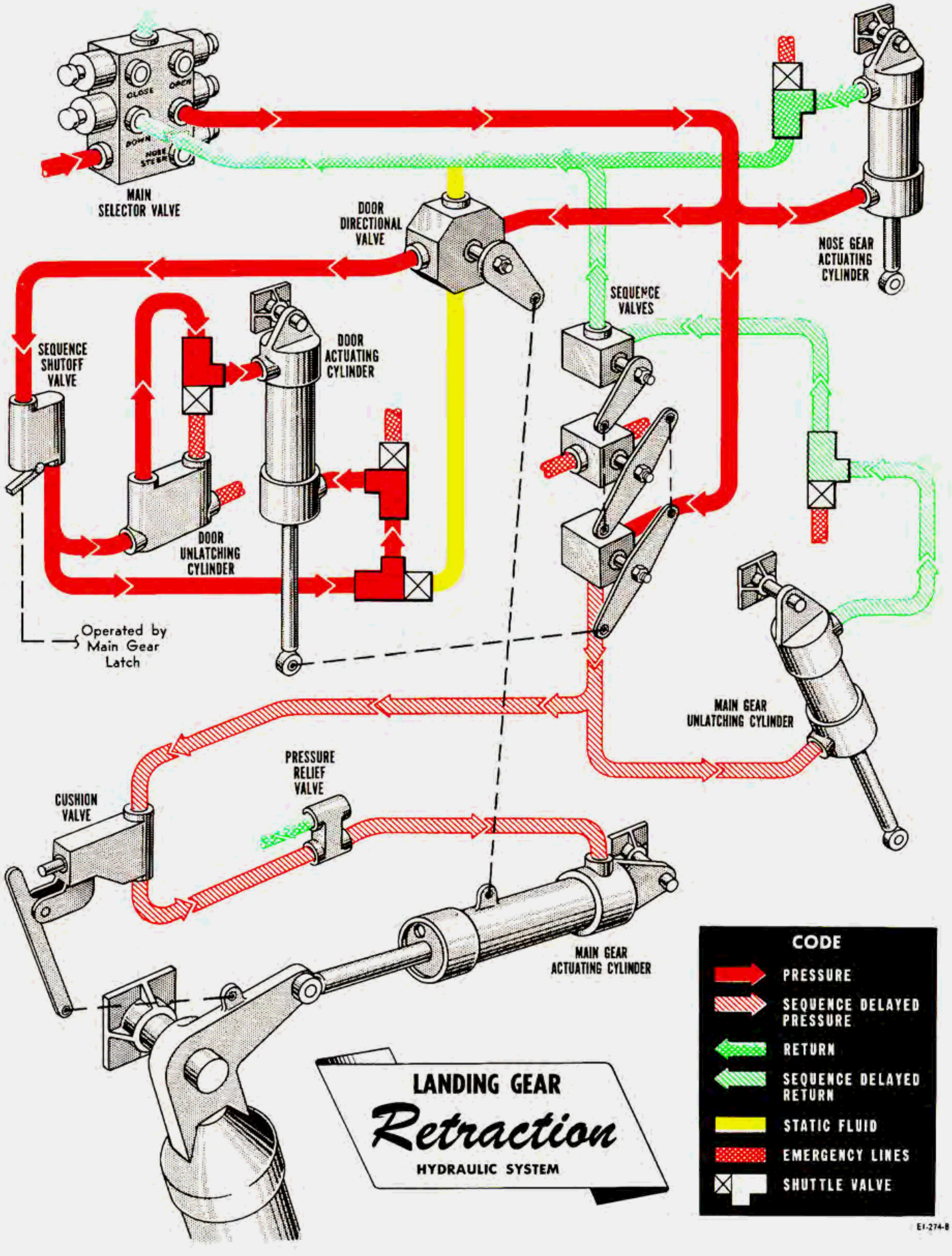

Figure 7-30. (Sheet 1)

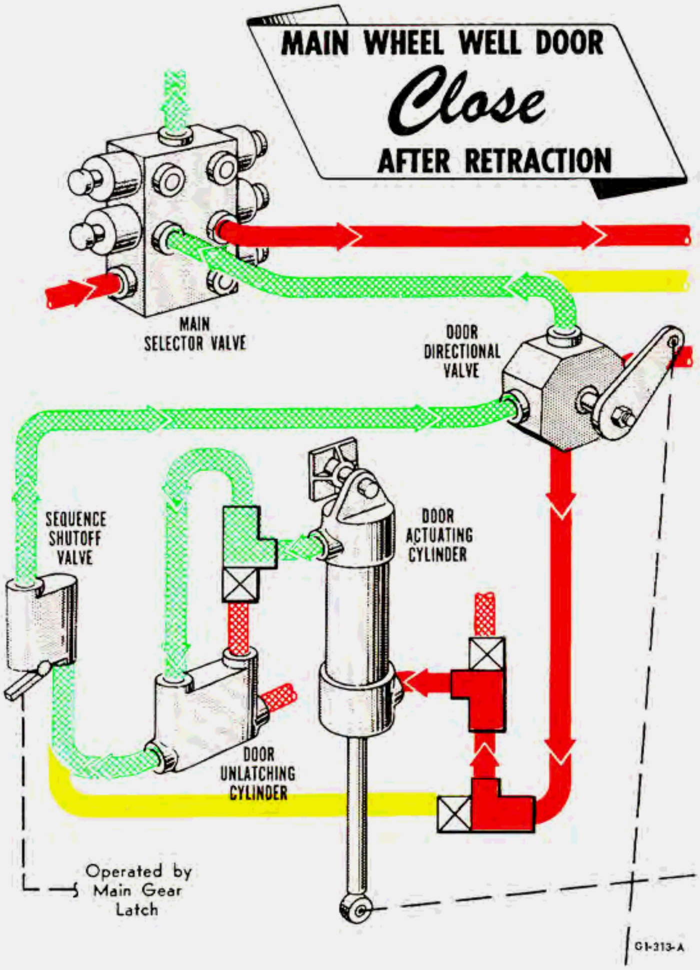

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Figure 7-30. (Sheet 2)

shutoff valve. At the same time, pressure is routed to and stops at the down sequence valve, which is closed, and to the nose actuating cylinder to extend the nose gear. After passing through the door directional valve and the sequence shutoff valve, the flow divides with part of it going to the door unlatching cylinder and the remainder to the upside of the door actuating cylinder. From the door unlatching cylinder the flow enters the down side of the door actuating cylinder. This divided flow combines action to unlock and actuate the main gear door to the down position in the same manner as in gear retraction. As the door becomes fully extended, the mechanical linkage between the door actuating cylinder and the sequence valves opens the up sequence valve and the down sequence valve. When the down sequence valve is opened, fluid is routed to the top of the main gear unlatching cylinder and to a port in the cushion valve for preloading the main gear actuating cylinder and raising the gear slightly. The pressure at the top of the unlatching cylinder unlocks the gear and breaks the side brace, allowing the gear to fall of its own weight. The preloading reduces the initial shock of the fall and a restrictor built into the main gear actuating cylinder controls the speed of extension. After the first 10 degrees of extension the passage in the cushion valve, used to preload the actuator, is closed and the passage to the gear up line is open. This allows the fluid to return from the actuating cylinder to the reservoir through the cushion valve, the up sequence valve, and the up port of the main selector valve. When the gear is fully extended the side brace straightens and the pressure in the unlatching cylinder allows the gear to lock in the down position. While the gear is extended, the mechanical linkage between the actuating cylinder and the door directional valve positions the directional valve to direct fluid to the door actuating cylinder, raising and locking the doors in the up position as in the gear retraction sequence. The hydraulic pump is shut off when the door latches fall into place, actuating the door limit switches.

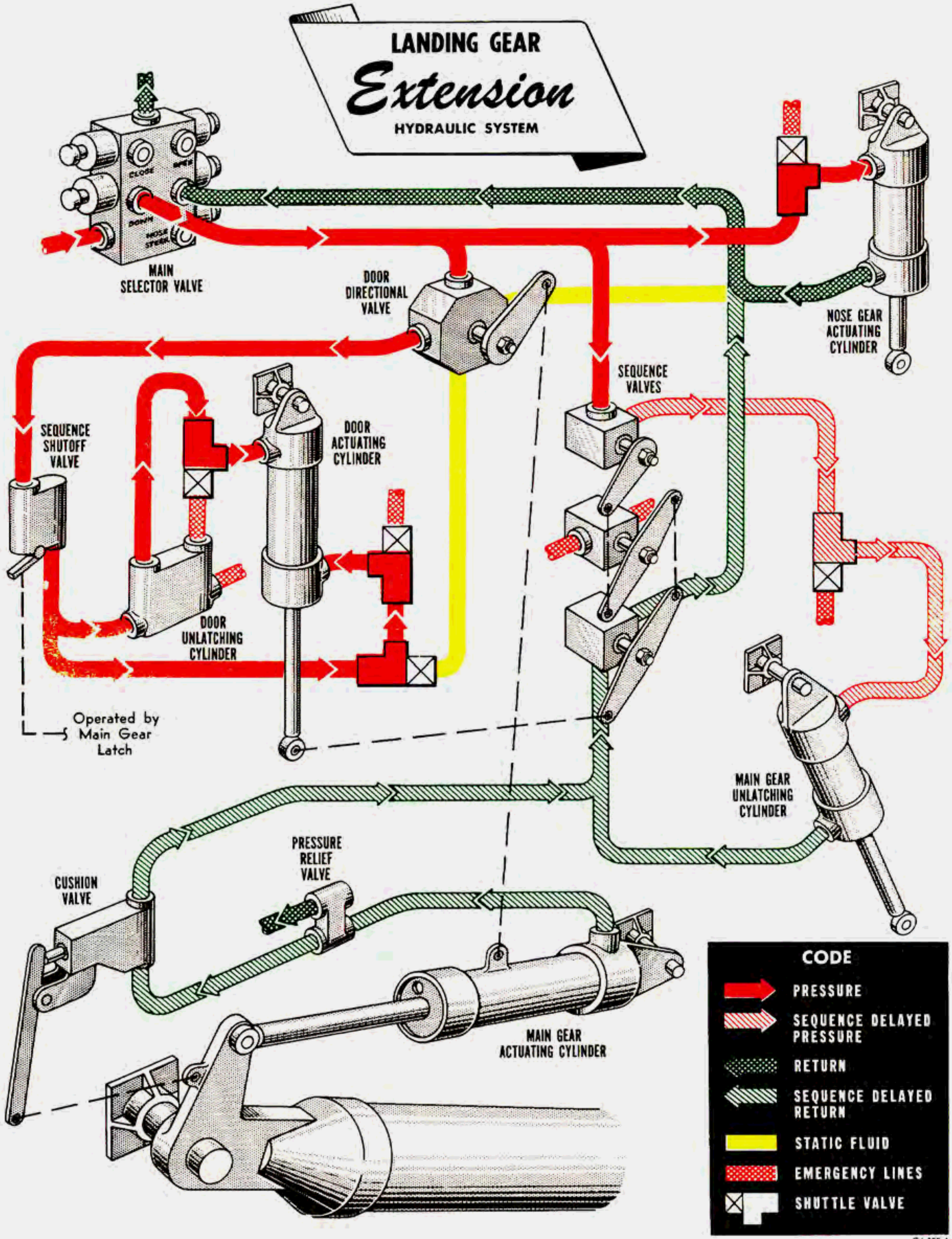

Figure 7-31. (Sheet 1)

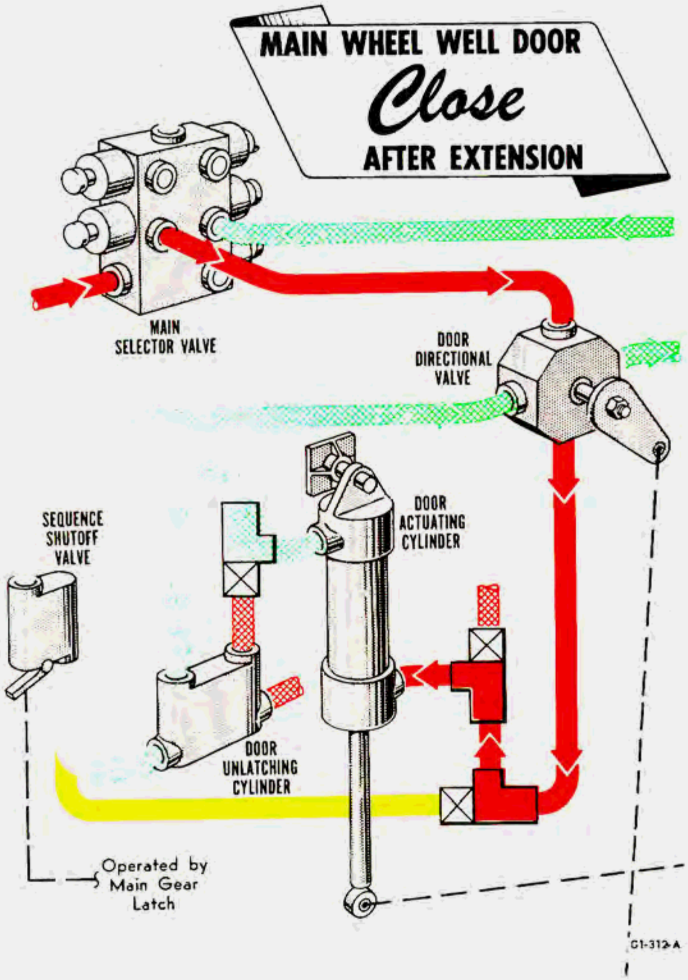

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Figure 7-31. (Sheet 2)

LANDING GEAR EMERGENCY EXTENSION.

When the emergency selector valve is placed in the EXTEND LG postion and the hand pump is operated, hydraulic fluid under pressure is directed into the emergency gear down lines. The pressure is routed to the up side of the door actuating cylinder, to the door unlatching cylinder, and to the nose gear actuating cylinder to extend the nose gear. At the same time, pressure is routed to and stops at the emergency down sequence valve, which is closed. Pressure to the up side of the door actuating cylinder preloads the cylinder in the up position to prevent rapid opening of the door. This also permits easier opening of the door latches. When the fluid passes through the door unlatching cylinder, opening the latches, it enters the down side of the door actuating cylinder to extend the door to the full down position. As the door becomes fully extended, the mechanical linkage between the door actuating cylinder and the sequence valves opens the up sequence valve and the emergency down sequence valve. When the emergency down sequence valve is opened, fluid is routed to the top of the main gear unlatching cylinder and to a port in the cushion valve for preloading the main gear actuating cylinder. The pressure at the top of the unlatching cylinder unlocks the gear and breaks the side brace, allowing the gear to fall of its own weight. The preloading reduces the initial shock of the fall and a restrictor built into the main gear actuating cylinder controls the speed of extension. After the first 10 degrees of extension the passage in the cushion valve, used to preload the actuator, is closed. This allows fluid to return from the actuating cylinder to the main system reservoir through the cushion valve, the up sequence valve, and the up port of the main selector valve. When the gear is fully extended, the side brace straightens and the pressure in the unlatching cylinder allows the gear to lock in the down position. After an emergency hydraulic extension, the main gear doors will remain open.

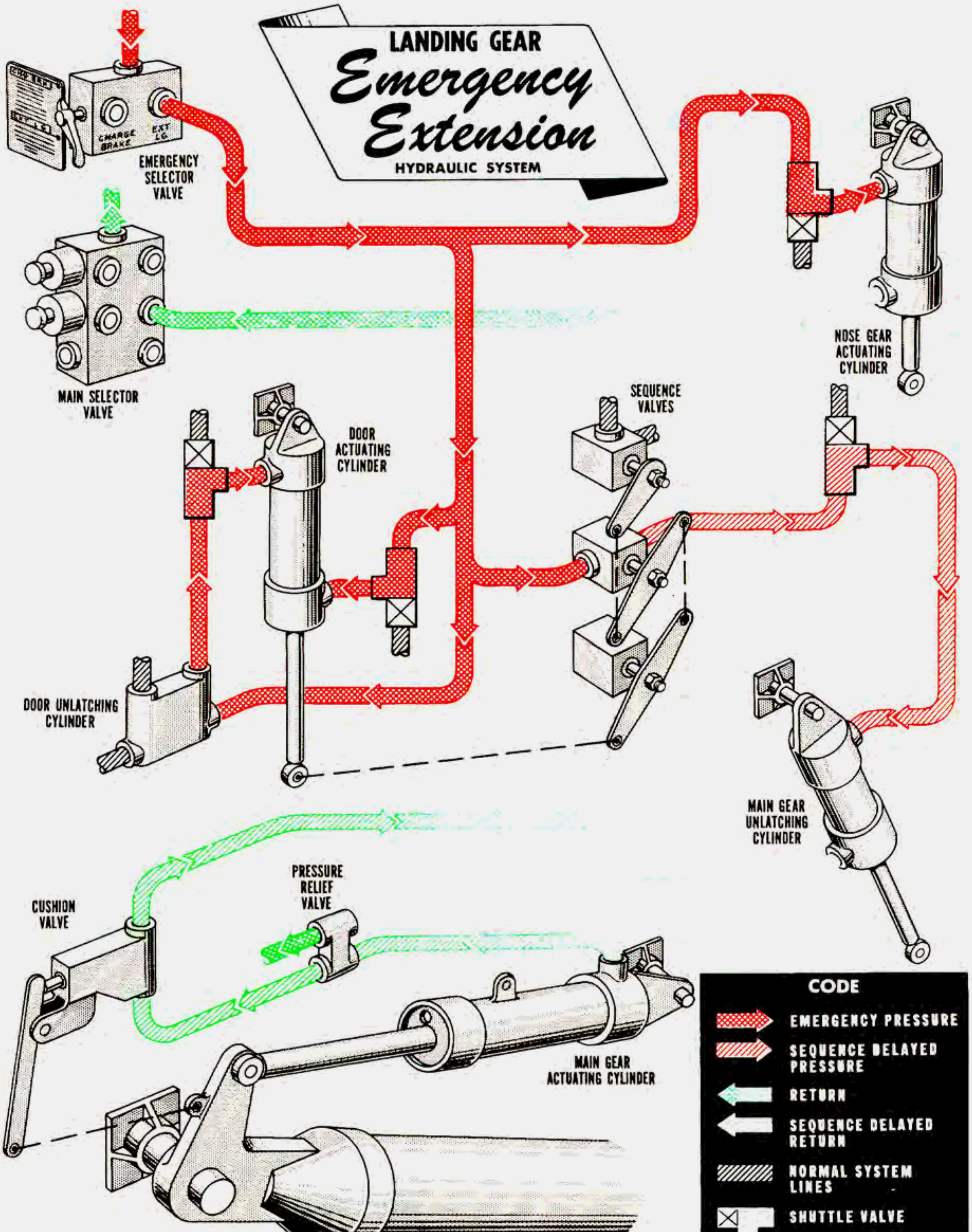

LANDING GEAR
Emergency
Extension
HYDRAULIC SYSTEM
CHARGE BRAKE
EXT L.G.
EMERGENCY SELECTOR VALVE
MAIN SELECTOR VALVE
NOSE GEAR ACTUATING CYLINDER
SEQUENCE VALVES
DOOR ACTUATING CYLINDER
DOOR UNLATCHING CYLINDER
MAIN GEAR UNLATCHING CYLINDER
PRESSURE RELIEF VALVE
CUSHION VALVE
MAIN GEAR ACTUATING CYLINDER
CODE
EMERGENCY PRESSURE
SEQUENCE DELAYED PRESSURE
RETURN
SEQUENCE DELAYED RETURN
NORMAL SYSTEM LINES
SHUTTLE VALVE
G1-205-A

Figure 7-32.

LANDING GEAR SYSTEM TROUBLE SHOOTING.

Listed below are troubles which may be encountered and remedied in flight.

Trouble	*Probable Cause*	*Remedy*
All gears fail to retract.	Hydraulic system malfunction.	Refer to "Emergency Landing Gear Operation," Section III.
	Failure of d-c control power.	Check all d-c fuses. Check output to pilot's circuit breaker panel.
	Selector valve not operating.	Check fuses in d-c control system; operate selector valve manually.
	Low fluid supply.	Fill main reservoir to proper level.
	Safety switch malfunction.	Refer to "Emergency Landing Gear Operation," Section III.
Nose gear retracts, canoe doors open, but neither main gear moves.	Main gear latch link rods disconnected.	Connect latch link rods.
	Low fluid supply.	Add fluid to main reservoir.
	Relief valve malfunction.	Retract doors; then extend for a short distance. Repeat 2 or 3 times; then retract gear.
	Side brace too tight.	Remove two one-quarter inch bolts from nut on side brace. Loosen nut until side brace clearance is not less than 0.030 inch or not more than 0.100 inch. Retract gear and replace bolts in nut.
Canoe doors open, nose gear retracts, pressure falls from approximately 2800 to 500 psi and neither main gear moves.	Relief valve cracks open and bypasses fluid.	Reset relief valve by moving landing gear switch to neutral and allowing pressure to fall to zero. Then place switch in RETRACT. If relief valve does not reset, enter the bomb bay and tap on relief valve located beneath main hydraulic reservoir.
Left main gear does not retract.	Latch link rod disconnected.	Connect latch link rods.
	Relief valve malfunction.	Extend gear and make several attempts to retract. If gear does not retract, enter wing crawlway and tap on relief valve. Repeat retraction attempt.
Nose gear retracts, canoe doors open, but main gears do not move (pressure remains at 2800 to 2900 psi).	Main selector valve malfunction.	Move landing gear switch to OFF, to EXTEND, and then to RETRACT.
Nose gear retracts, canoe doors open, both main gears retract half-way and stop. Pressure remains at 2700 to 2900 psi.	Low fluid supply.	With landing gear switch OFF add fluid to main reservoir.
A canoe door does not close after a retraction sequence.	Restrictor in shuttle valve on door actuating jack is jammed.	Loosen nut on restrictor valve and let fluid escape. When the door is up and locked, remove the restrictor and clean.

Trouble	Probable Cause	Remedy
Both canoe doors open 6 to 8 inches and stop during retraction. None of the gears move and gage pressure is approximately 2800 psi.	Emergency selector valve in GEAR RETRACT position.	Place landing gear switch in EXTEND and allow doors to lock closed. Place emergency selector valve in CHARGE BRAKE and then place landing gear switch in RETRACT.
A canoe door starts to close before the gear is fully retracted.	Sequence shutoff valve malfunction.	Place landing gear switch in EXTEND with gunners observing door action. Retract gear one third up and then extend. Repeat three or four times and then retract. **CAUTION** Let pump cool 2 minutes out of every 10.
Canoe door does not open; gear cannot extend.	Jammed restrictor valve on gear door actuator causing hydraulic lock.	Drain fluid from actuator by loosening nut on T-fitting on lower end of actuator and push in on plunger protruding from nut.
Main gear and doors operate normally, nose gear extends 10 to 20 degrees and stops.	Jammed restrictor valve causing hydraulic lock.	Place landing gear switch in neutral, place emergency selector valve in GEAR EXTEND, and pump gear down with emergency hand pump—or loosen line from forward side of nose gear relief valve and allow fluid to escape.
Main gear and doors retract normally, pressure 2800 psi but nose gear will not lock into place. When pressure is relieved nose gear falls freely down.	Striker plate too tight.	Enter radar dome, remove inspection plate, and use emergency latching hook or screw driver to push latch into place. **CAUTION** Turn all radar off and leave the landing gear control switch in RETRACT.
Emergency hydraulic reservoir overflows with landing gear switch in RETRACT.	Shuttle valve malfunctions.	Reposition shuttle valves by moving landing gear switch to EXTEND then to RETRACT.
	Bomb bay door switch in OPEN or CLOSE position.	Return bomb bay door switch to neutral position.
No pressure indication.	Pumps not operating.	Check fuses in d-c control system and a-c power to pump.
	Low fluid supply.	Fill main reservoir to proper fluid level.
Main gear retracts; nose gear does not.	Emergency release pin pulled.	Replace pin. Refer to "Emergency Retraction of Nose Landing Gear," Section III.
Pumps do not stop at end of cycle.	One or more limit switches not actuating.	Pull circuit breakers.
	Faulty relay.	Remove pump fuses to pervent overheating.
All gears fail to extend.	Hydraulic system malfunction.	Refer to "Emergency Landing Gear Operation," Section III.

Trouble	Probable Cause	Remedy
	Failure of d-c control power.	Check fuses in d-c control system and a-c power to pump.
Retraction exceeds time limits.	One pump inoperative.	Check a-c fuses in pump power circuit. Check fuses in a-c power to pumps.
Hydraulic fluid lost during gear operation.	Leaky connections.	Tighten connections, disconnect reservoir pressure line and refill reservoir.
Main gear door fails to retract and lock.	Air speed too high.	Reduce air speed.

NOSE WHEEL STEERING SYSTEM.

Listed below are troubles that may be encountered and remedied in flight.

Trouble	Probable Cause	Remedy
No pressure indication.	Blown fuse.	Check all nose steering fuses. Check circuit breaker on pilot's panel.
No pump action.	Blown fuse.	Check all nose steering fuses. Check circuit breaker on pilot's panel.
No actuation.	Selector valve malfunction.	Manually position selector valve.
	Relief valve stuck in open position.	Lightly tap relief valve.
	Nose gear extension too high.	Bleed nose strut.

BOMB BAY DOOR SYSTEM.

In the event of improper bomb bay door operation the emergency system should be employed as directed in "Bomb Bay Door Emergency Hydraulic System," Section IV. However, listed below are troubles that may be encountered and remedied in flight.

Trouble	Probable Cause	Remedy
Doors do not open, pumps operating.	Hydraulic malfunction.	Refer to "Bomb Bay Door Emergency Hydraulic System," Section IV.
	Solenoid on selector valve not operating.	Depress plunger on selector valve.
Doors do not open, no pump operation.	Control circuit malfunction.	Check circuit breakers and 28-volt d-c fuses.
	Pump power failure.	Check a-c fuses to pump.
Doors open, then close part way.	Door open pump limit switches out of adjustment.	Hold bomb bay door switch in OPEN position until doors lock open.
Lamp does not light, bomb bay doors open.	Rack selector circuit breaker open.	Close circuit breaker at d-c power panel.
Door operation exceeds time limits.	One pump inoperative.	Check fuses in a-c power to pumps.
Doors open part way and pumps continue to operate.	Bomb bay door switch actuated when bomb bay door safety switch is ON.	Place bomb bay door safety switch OFF.
Doors open part way and fluid pressure ruptures emergency reservoir in aft cabin.	Emergency selector valve at reservoir is not in OFF position.	Place valve in OFF position. Check fluid level in reservoir.

WING AND TAIL ANTI-ICING.

Wing and tail anti-icing is accomplished by passing heated air through the leading edges of the wing and tail surfaces. The heat for this air is obtained from the engine exhaust gases as it flows through the primary heat exchangers. (See figure 4-1.) As the temperature and rate of flow of the anti-icing air depend on such engine operating conditions as the use of dual or single turbo, high or low turbo boost, and high or low engine fan drive, the effectiveness of the anti-icing system is directly influenced by engine operation. Therefore, it may be necessary, in some instances, to operate "off schedule" of the engine power configurations given in Appendix 1 to obtain adequate anti-icing throughout the wide range of icing conditions which may be encountered. Information in the following paragraph describes methods in which the effectiveness of the anti-icing system can be increased by operating the engines "off schedule." For a description of the anti-icing system, refer to "Heat and Anti-Icing System," Section IV.

OFF SCHEDULE OPERATION.

Dual turbo operation increases the anti-icing system air flow over that obtained in single turbo. Closed waste gate limitations with dual turbo require operation at higher rpm with a resulting lower bmep and higher fuel flow than single turbo in the low power range. The charts in figure 7-33 show power plant operating limits from sea level to 25,000 feet with dual turbo throughout the operating range. Additional anti-icing air flow can be obtained by operating the engine fan at high rpm when only low rpm is required for cooling. As shown in figure 5-5, high fan drive is required to prevent the anti-icing air temperature from exceeding the limits at altitude approaching 25,000 feet.

Above 25,000 feet, if icing is encountered, modulating the dump valve by means of the anti-icing switches is required in addition to high fan drive to prevent the anti-icing air temperature from exceeding the limits. This is accomplished by jiggling the anti-icing switches from the full INC. position toward DEC. until the air temperatures are within limits. This reduces the effectiveness of the system, but icing encountered above 25,000 feet is normally light. The use of high fan drive may result in over-cooling the engine. If the CHT cannot be maintained above 170°C when the mixture setting is in manual lean, an increase in CHT may be obtained by first returning to the 20-degree spark advance position and then increasing the fuel-air ratio slightly.

This, however, will increase fuel consumption somewhat. If the CHT still remains appreciably lower than 170°C, it will be necessary to revert to low fan drive. If the carburetor preheat system is in use and the use of high fan drive reduces the CAT. below 0°C with closed intercooler shutters, an indication of carburetor icing will dictate reverting to low fan drive.

SPECIFIC OPERATING INSTRUCTIONS.

The wing and tail anti-icing systems must be placed in operation as soon as ice formation is observed on either the wing or tail surfaces. Icing conditions can be detected by observing other airplane surfaces for ice formation or by observation of water droplets or ice on the outside of the pilots' enclosure windows when the ambient air temperature is 32°F (0°C) or below. At night, frequent checks of the wing and tail surfaces should be made for indications of ice formation. When operation of the anti-icing systems is required, an attempt should be made to hold the flight path and brake horsepower constant, changing other operating conditions if necessary. As the severity of icing conditions will vary over a wide range, the necessary steps to obtain adequate anti-icing will also vary. The following procedure indicates steps to be taken progressively to obtain satisfactory anti-icing. When this procedure is used, the propeller and engine normal operating limitations given in Section V and the dual turbo waste gate limits shown in figure 7-33 must be observed.

1. Wing anti-icing and cabin heat and tail anti-icing control switches—INC.

Note

> To insure full closure of the dump valves, begin this operation with the valves in the full open position and then hold the switches in the INC. position for a minimum of 25 seconds. This will prevent the actuators from "torquing-out" before the valves have completely closed.

2. If operating in single turbo, increase engine rpm above the dual turbo closed waste gate limit shown in figure 7-33.

Note

> To maintain an approximately constant thrust horsepower, decrease torque pressure 7 psi for each 100 rpm increase in engine speed. If applicable, retard the spark and increase the mixture setting to NORMAL before performing the above step.

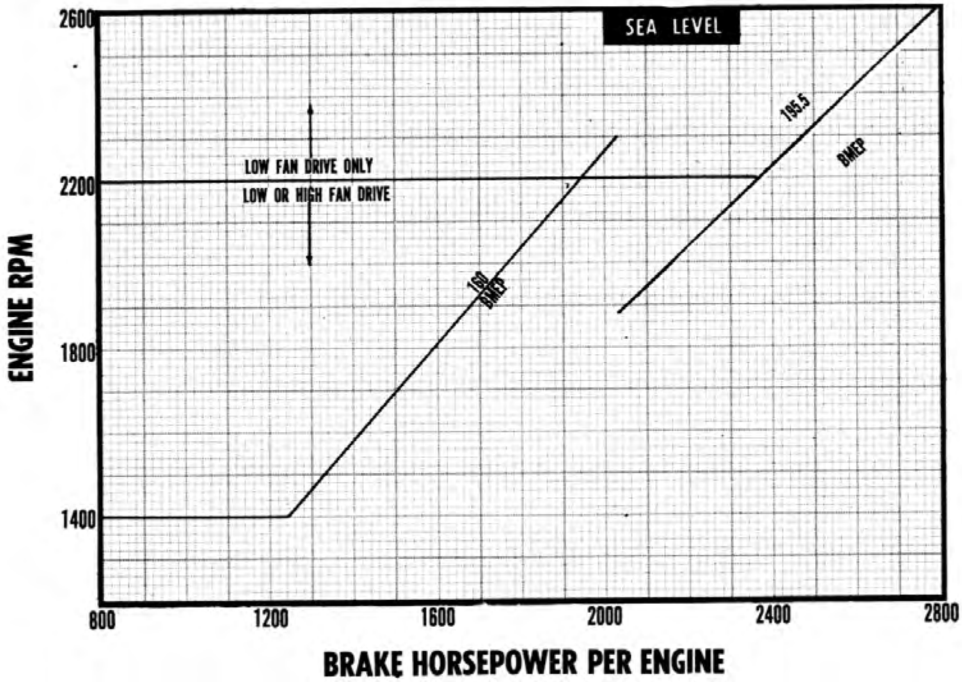
3. Engine supercharger switches—DUAL TURBO.
4. Cabin temperature control switch—As required but not to exceed 105°C duct temperature for the enclosure defrosting air.
5. All fan speed control switches—HIGH RPM.

CAUTION

> To prevent exceeding the structural limitations of the fan, refer to "Fan Speed Limitations," Section V.

Wing and Tail ANTI-ICING

DUAL TURBO POWER SCHEDULE



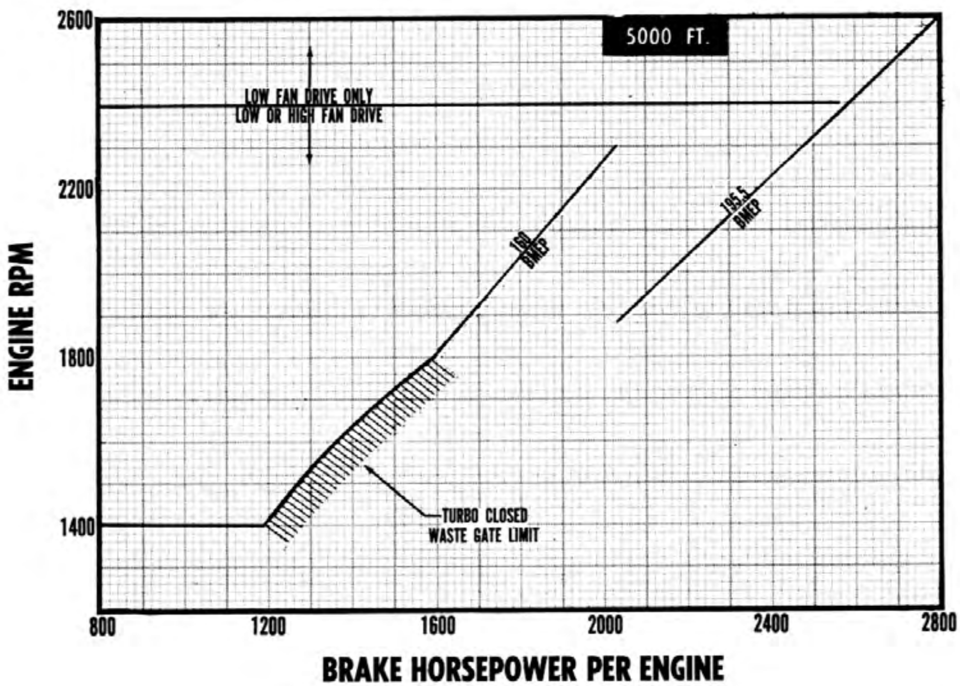
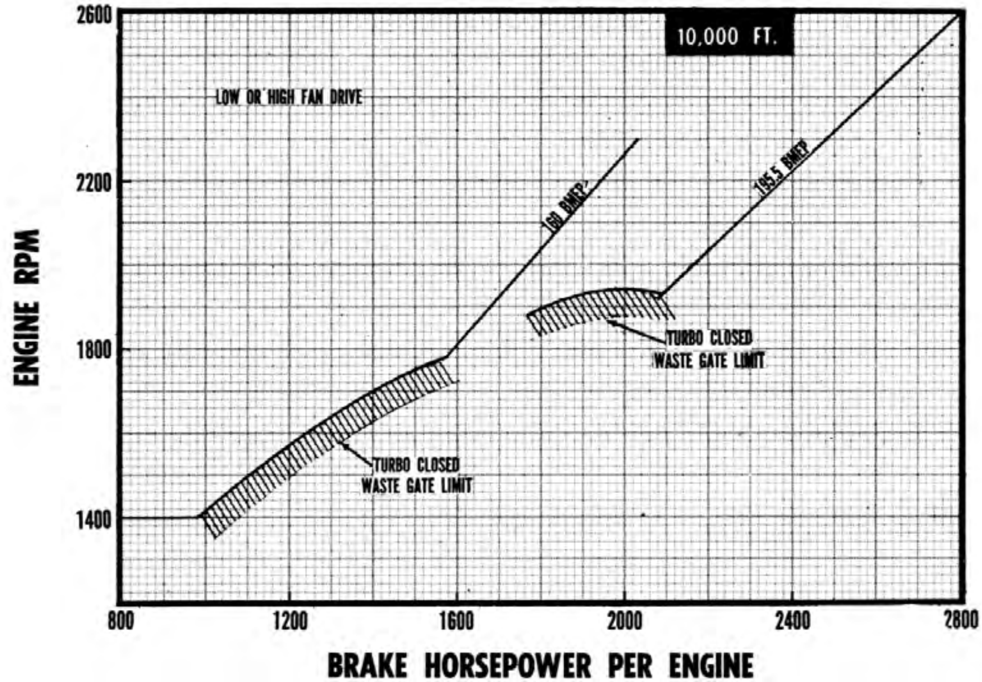


Figure 7-33. (Sheet 1)

Wing and Tail ANTI-ICING

DUAL TURBO POWER SCHEDULE



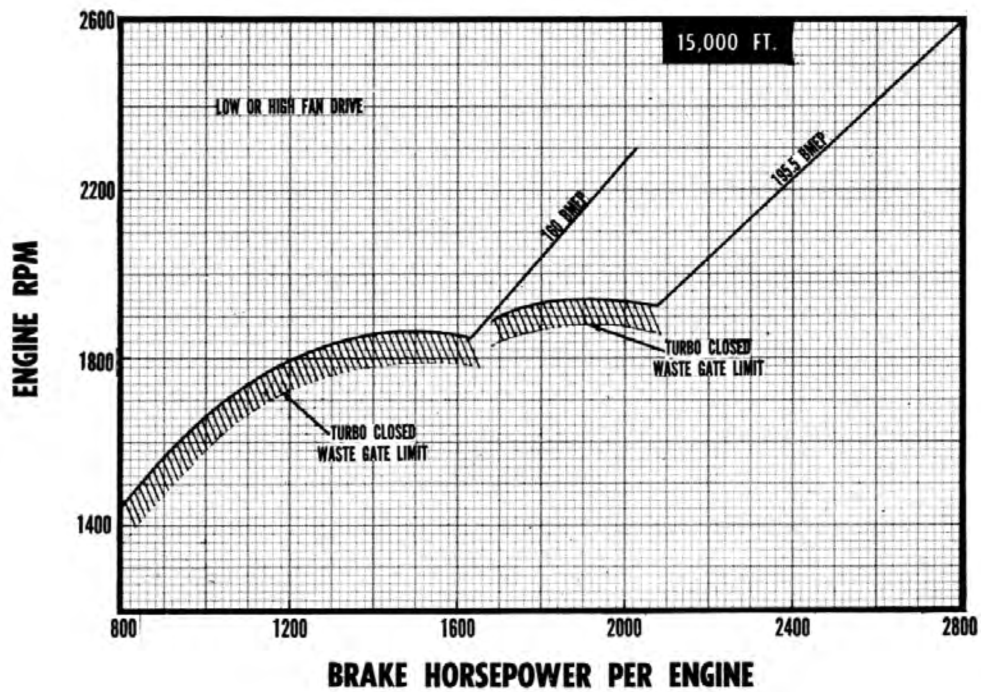
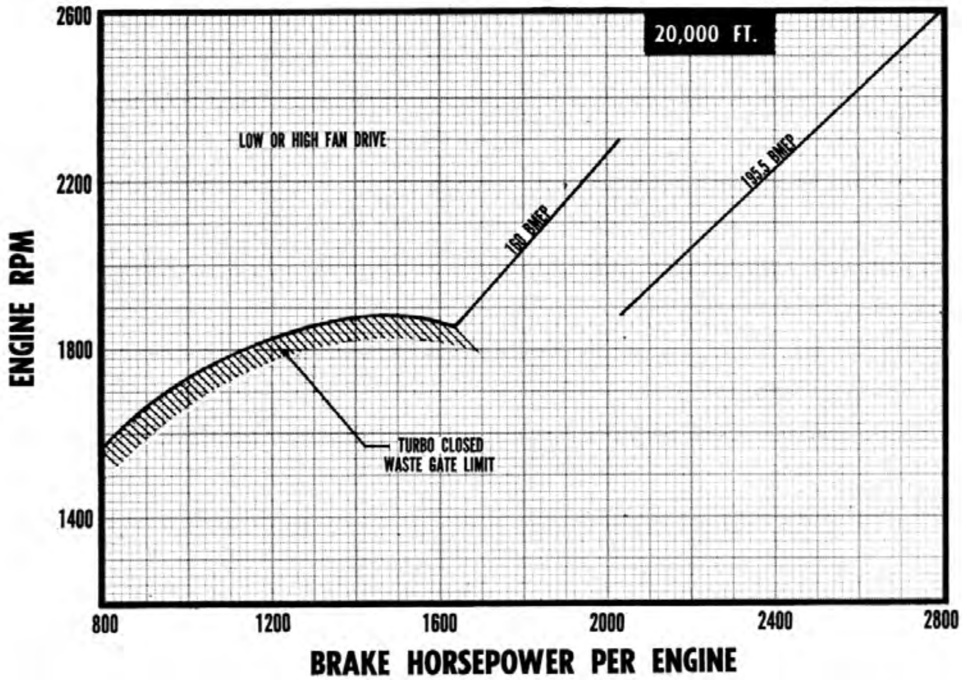


Figure 7-33. (Sheet 2)

Wing and Tail ANTI-ICING

DUAL TURBO POWER SCHEDULE



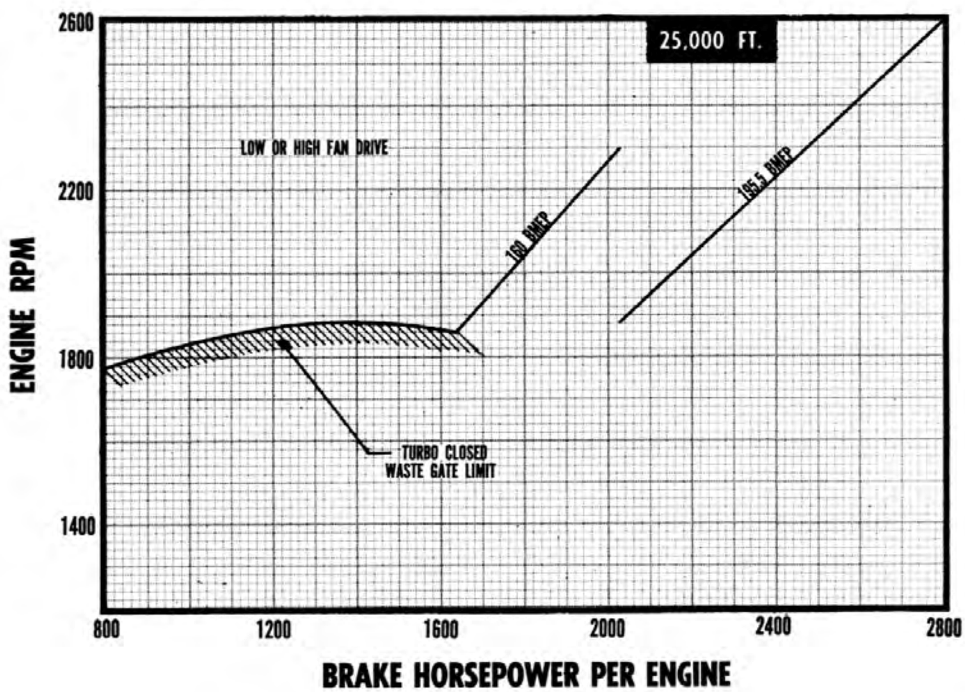


Figure 7-33. (Sheet 3)

6. Increase engine rpm.

7. If icing of the tail becomes critical, the temperature of the tail anti-icing air can be increased by jiggling the cabin temperature control switch toward the DECREASE position.

8. Change altitude to reduce the severity of the icing conditions.

Note

During all operation do not allow the wing anti-icing temperature to exceed 180°C or the tail anti-icing temperature to exceed 180°C.

Ice Runback and Afterfreezing.

Since the antic-icing system extends to only 12 per cent of the wing chord, in particularly severe conditions, formation of ice aft of the front spar may occur due to "runback" and "afterfreezing." De-icing of this portion of the wing can be accomplished only by changing altitude until an ambient temperature above 32°F (0°C) is reached.

AUTOPILOT SYSTEM.

A fundamental autopilot design assumption is that the airplane to be controlled is rigid. This assumption applies to small airplanes with negligible error. Large airplanes, however, must either be more flexible or must sacrifice useful load for additional weight of structure. Flight tests with the unmodified E-6 autopilot show that the control frequency and the natural tail-fuselage frequency can sometimes interact to produce a pronounced tail shake or divergent rudder oscillation. Several changes have been made to improve autopilot adaptation to the airplane and reduce tail shake.

E-6 MODIFICATIONS.

The following modifications have been made on the E-6 autopilot:

1. Relocation of the yaw rate gyro from the autopilot main chassis to a position near the airplane's center of gravity.

2. Addition of a roll rate gyro, also at a position near the center of gravity of the airplane.

3. Addition of the auxiliary calibrator unit mounted on the autopilot main chassis is the place of the yaw rate gyro.

4. Addition of noise filters in each of the control circuits.

5. Modification of the autopilot control panel so that a smaller displacement of the pilots' turn control knob is required to establish a turn of a given bank angle.

6. Replacement of the A-8 directional coupler amplifier with the A-11 directional coupler amplifier. The A-11 amplifier is capable of introducing 5.5 degrees of bank angle per degree of heading correction required, as compared to three degrees of bank angle for the same heading correction with the A-8. Also, the A-11 amplifier has maximum output signal from the computer output potentiometer 1-1/2 seconds after the initiation of automatic controls as compared to 6 seconds for the A-8 amplifier.

CHARACTERISTIC RESPONSE CURVE.

The characteristic E-6 response curve is shown in figure 7-34. Note that servo correction signals at any given time are proportional to the remaining error. Normal corrections should be smooth with no overshoot or undershoot. The shaded electrical deadspot area is a graphical representation of the effect of the sensitivity controls.

FAMILIARIZATION WITH CALIBRATION CONTROLS.

Before you attempt to set the autopilot calibration controls for optimum performance, study the effect of each control by operating it through its range of adjustment while all other settings are constant. Use the basic settings tabulated in figure 4-28 for the initial calibration control configuration. Turn on the autopilot, trim the airplane, and engage autopilot. Go down to the chassis and manipulate each of the following controls.

Sensitivity.

Turn all three sensitivity knobs down near zero and notice that the aircraft becomes sluggish but still flies a good heading straight and level. Turn them all up to 10 and notice that the controls become a little jittery but the aircraft itself is not affected and still flies straight and level. Turn them back to zero again and notice that you can still make a normal maximum bank turn with the turn control knob. Carry sensitivity as high as possible—further adjustment here is somewhat futile.

Ratio.

Turn all three ratio knobs to zero and notice that the aircraft gets "sloppy" in all three axes. Notice the altimeter and compass. The aircraft will hold neither altitude nor heading. Try a maximum bank turn with the turn control knob. Notice how long it takes to get into the bank and establish any degree of coordination. Set the knobs back to the basic setting and increase them (one axis at a time) toward 10. In aileron, notice that a wing tip "hunt" occurs near a knob setting of 7.5 to 8. In rudder (use caution) notice that the tail begins to "hunt" and shake near a knob setting of 8. In elevator, notice that the aircraft begins to "porpoise" near 8.5 to 9. At these increased settings the aircraft is overcorrecting for small gyro displacements, therefore overshooting gyro null points. The aircraft reacts this way because too much control movement is being used to correct for these small displacements. Once this overshoot is started, it easily becomes divergent. Ratio settings are the most important ones on the autopilot. They should be your first adjustment in correcting for an abnormal flight condition.

Throttling.

Turn aileron ratio up just to the point where a wing tip "hunt" appear. Then turn aileron throttling to zero and notice that the "hunt" increases in frequency and amplitude. Now turn aileron throttling up to 10 and notice that the "hunt" has practically disappeared or at least has been reduced to a very low frequency and amplitude. Try the same procedure with the elevator axis. Be very careful if you try it with the rudder—this is one of the best ways to develop a divergent tail shake (empennage oscillating about yaw axis with increasing amplitude). Throttling is second only to ratio in importance. These knobs are particularly handy in getting rid of bumps, shakes, and shudders during high speed turns.

Automatic Recovery.

The automatic recovery switch is obstructed on most aircraft, but the knobs on the calibrator are still active. Moving them with the autopilot engaged will change the attitude of the aircraft—leave them alone. These knobs may have been set from their basic setting to reduce the "hash level" in the autopilot.

E-FS and FS.

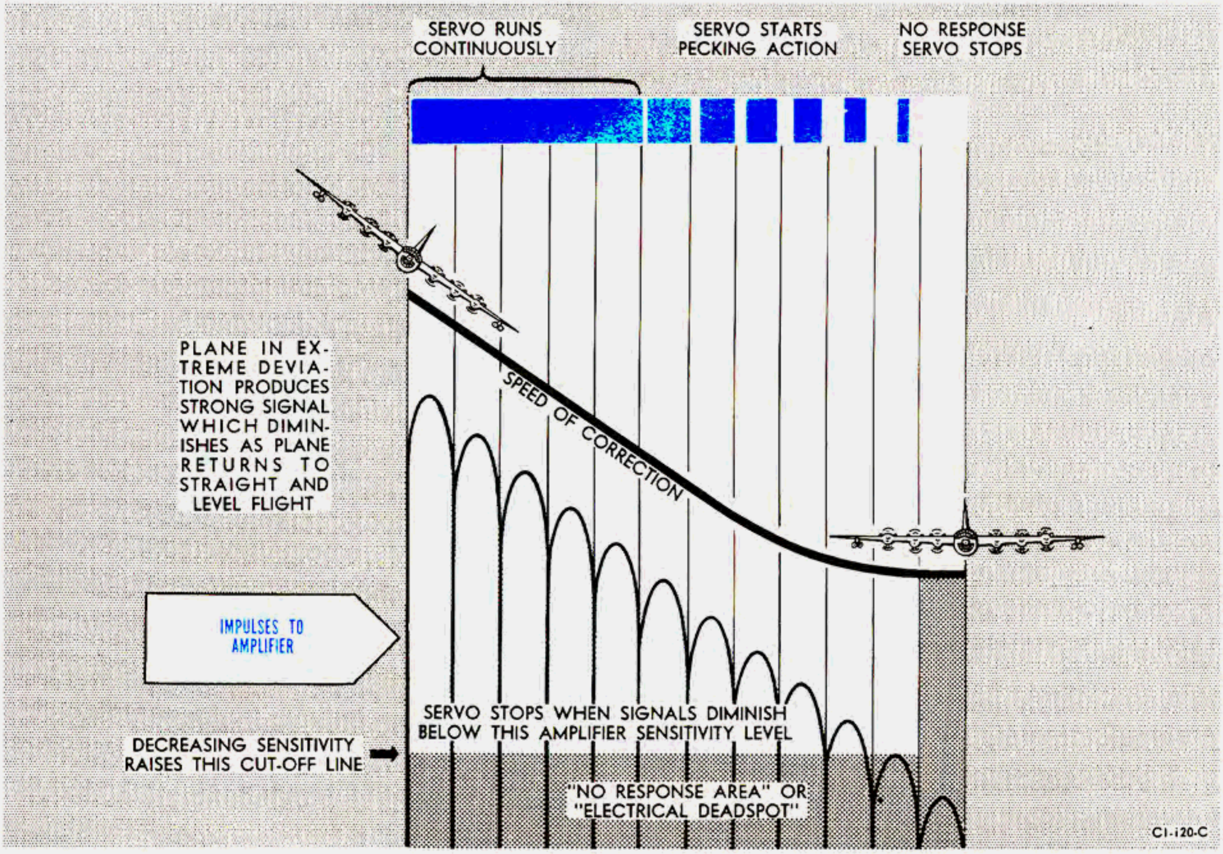
These knobs were used to coordinate formation stick turns. They are still in the circuit but they should not be changed. Moving E-FS will change the pitch attitude of the aircraft.

TC Coordination.

Leave this knob at zero. Turns are coordinated with the rudder gain knob on the auxiliary calibrator.

Bomb Coordination.

This knob has little or no dynamic effect on any axis. Set it at 1.8.



CI-120-C

Figure 7-34. Autopilot Response Curve

Rate Coordination.

Turn this knob to zero and notice that the tail begins to "hunt." Make a small turn and notice that the aircraft "fish-tails" (mild oscillating about the yaw axis) around the turn. Place this knob at 10 and leave it there. This circuit still does not provide enough damping for this aircraft.

Up-Elevator Coordination.

Go into a 20-degree bank turn and turn this knob up to 6. Notice that the aircraft is climbing in the turn. Reduce the setting to zero. Notice that the aircraft is diving in the turn. Adjust this knob so that altitude is held constant during turns in both directions. This knob may require frequent adjustment on long flights. It should be readjusted every time a large change in manual elevator trim is required. A compromise setting may be required to equalize performance in right and left turns. This is caused by the exceedingly long length of elevator rigging in the aircraft.

Rudder Gain.

Set this knob at 10, and notice that the aircraft makes a skidding turn. Set it at zero and notice that the aircraft makes a slipping turn. Adjust for a coordinated turn and leave it alone except for altitude corrections.

Aileron Roll Rate.

Turn this knob to zero and go into a turn. Notice that the aircraft is on the verge of a wing tip "hunt." It will probably overshoot the roll-in and roll-out of the turn and wind up with a wing tip "hunt." Turn the knob up to 10 and notice how sluggish the response is during the roll-in and roll-out of a turn. This knob is very sensitive—adjust it to the point just below which the aircraft begins to "hunt" and overshoot in turns.

Rudder Roll Rate.

First try the zero setting and then go into a 20-degree bank turn. Notice that the aircraft tends to have a rudder "bump" (transient instability about the yaw axis) when rolling in and out of the turn. Now turn the knob up to 10 and notice that the aircraft actually "skids" when rolling in and out of the turn. This circuit puts in bottom rudder for any roll. The amount depends on the knob setting. Adjust for the type roll-in and roll-out turns that you prefer. Once set, this knob rarely needs readjustment.

Compass Maximum Bank.

Note

Of the four knobs on the directional coupler amplifier (type A-11), this is the only one of interest to the pilot. The other three knobs concern the operation of the autopilot in "second station."

Turn the compass maximum bank knob to zero, displace the directional gyro about 2 degrees in the shock mount, and hold it there. Notice that the airplane takes up a 2.5-degree bank (1.25 degrees per degree of heading displacement). Recover, turn the knob to 10, and repeat the procedure. Notice that the airplane takes up a 6.0-degree bank (3.00 degrees bank per degree of heading displacement). In turbulence or at low air speeds (150 IAS), reduction to zero is recommended. Normally, however, 2.5 is the optimum setting.

INFLIGHT ADJUSTMENT OF AUTOPILOT.

Now that you are familiar with the individual calibration controls, you must learn to refine the basic settings for top performance under all conditions. All adjustments herein pertain to *minor* variations from the recommended nominal settings given in figure 4-28. No attempt should be made to adjust the autopilot without using the nominal settings as a starting point. The following procedure is recommended for inflight adjustment.

1. Upon reaching a safe altitude, turn the autopilot ON.

2. Trim the aircraft very delicately for "hands off" straight and level flight.

Note

Do this very meticulously because you are setting up the attitude the autopilot will interpret from the reference gyros and maintain electronically.

3. When the green lights begin to flicker, engage the autopilot. In the event that one of the electrical trim knobs is oscillating when the engage switch is pressed, the autopilot will be out of "electrical trim" and the knob will have to be adjusted. If one knob is moving rapidly, hold it at its point of least resistance while you press the engage switch. Another method involves the use of the calibration unit. Turn throttling on the oscillating axis up to 10. If the knob still oscillates, reduce sensitivity on the same axis until oscillation stops. Engage autopilot and set calibration knobs back to their normal settings.

4. Crack the turn control out of its detent in either direction. If the aircraft banks momentarily in the wrong direction then goes into the correct turn, the autopilot needs trimming. Repeat the check in the other direction before making any adjustments. Find out which surface is the biggest offender. Use only the autopilot trim knobs.

a. Lift up the wing that is dropping in the wrong direction.

b. Try the turn control again. If the bank in the wrong direction persists, the ailerons are not out of trim. Trim the wing tip back where it was.

c. Trim in a reasonable amount of bottom rudder for a turn in the desired direction. Try the turn control knob again. Most of the maladjusted trim should be gone. Both surfaces could have been out of adjustment.

d. If the condition persists, disengage the autopilot, retrim manually, and repeat this procedure. You should now be set up for a good straight and level flight.

5. Try a few 20-degree bank turns and see if the aircraft holds altitude in both directions. If not, adjust the UP-E coordination knob toward 10 for "nose up" and toward zero for "nose down."

6. Check the needle and ball for coordination and adjust the rudder gain knob for slip or skid.

7. Check the roll-in and roll-out. If it "bumps" or "hunts" (transient instability in the yaw axis), turn rudder throttling up and rudder ratio down.

CAUTION

Do not use ratio unless necessary. Turn rudder throttling up before turning the rudder roll rate up, then turn the rudder ratio down if necessary. Use these knobs in the above order and use only as much as required to eliminate the oscillation.

8. Check the recovery of the aircraft when in the "second station" automatic recovery.

Note

Establish optimum performance with the autopilot control panel before attempting to adjust "second station" automatic flight controls.

a. Displace the pilot's data indicator to obtain the maximum bank angle; then go into "second station" automatic.

Note

The K-( ) system configuration must be in BOMB and SYNC before placing the E-2 switch in automatic.

b. Observe the PDI for undershoot or overshoot of the zero point when the aircraft automatically centers it.

c. If the aircraft undershoots, correct by increasing proportional range.

d. If the aircraft overshoots, correct by decreasing proportional range.

MALFUNCTION AND CORRECTIONS.

If the autopilot appears to be maladjusted and abnormal flight response appears, there are two questions you should ask yourself.

a. What has changed?

b. What would I be doing to the controls to make the aircraft fly like this?

Divergent Tail Fuselage Shake.

If the aircraft shakes violently in the yaw axis with increasing amplitude either in turns or straight and level flight, use the following procedure:

1. Disengage autopilot and go into a sharp bank turn. Level out when shake disappears.
2. Set rudder ratio at 4 or below.
3. Set rudder throttling at 10.
4. If rudder shake is only in "second station" automatic operation, request radar observer to reduce directional stiffness (proportional range).
5. Re-engage autopilot and try it again.

Rudder Hunt.

If the aircraft oscillates constantly at a regular frequency in the yaw axis either in turns or in straight and level flight, use the following procedure:

1. Reduce rudder ratio.
2. Set rate coordination up to 10.

Sluggish Rudder.

If the aircraft is sluggish in yaw and will not hold heading, use the following corrective measure:

1. Increase rudder ratio.
2. Set rate coordination at 10.
3. Increase directional stiffness (compass maximum bank or, if in second station, proportional range).

Nose Hunt in Turns.

If the aircraft oscillates in the yaw axis in turns or appears to make turns in steps, use the following corrective measures:

1. Increase rudder throttling.
2. Set rate coordination to 10.
3. Decrease rudder ratio.
4. Decrease rudder roll rate.

Wing Tip Hunt.

If the aircraft oscillates constantly at small but regular frequency in the roll axis and has no noticeable yaw, use the following procedure:

1. Reduce aileron ratio.
2. Increase aileron throttling.
3. Increase aileron roll rate.

Loose rigging is very capable of causing a wing tip "hunt," but it is usually accompanied by a yaw "hunt."

The combination produces a "dutch roll" (wing tip describing an ellipse). Loose rigging should be spotted by the general feel of the controls at the higher altitudes. If loose rigging is suspected the following procedure will confirm your suspicion and alleviate the problem to some extent.

1. Rudder ratio at 1 or 2.

2. Rudder throttling at 10.

3. Increase aileron ratio until the "hunt" stops.

4. Write up "Loose Rigging" in the Form 1.

5. If just one wing or the cross rigging is loose, adjustment will not help.

Sluggish Roll Axis.

(Do not confuse this condition with wing tip"hunt.") If the aircraft is "sloppy" in heading, occasionally drops a wing, and "wallows" erratically in straight and level flight, use the following procedures:

1. Increase aileron ratio.

2. Increase directional stiffness (compass maximum bank toward 10).

Aircraft Dips Wing in Opposite Direction When Starting Turn.

If the aircraft dodges in the wrong direction before going into a turn, the following corrective action should be used:

1. Go through electrical trim procedure discussed under "Inflight Adjustment of Autopilot," of this section.

2. If this does not help, the vertical flight gyro is faulty.

Note

If this condition occurs in both directions, the equipment is faulty or the rigging is exceptionally bad.

Aircraft Overshoots Roll Out Of Turn Made With Turn Control Knob.

If the aircraft has a slight roll overshoot followed by a slow yaw overshoot recovery, try the following remedy:

1. Move the turn control back into detent very slowly.

2. Turn aileron ratio down.

3. Turn aileron throttling up.

4. Turn aileron roll rate toward 10.

PDI Goes Off Center During Bomb Run.

If the pilot's data indicator (PDI) goes off center when control is transferred into "second station" automatic and stays off for the entire run, the aircraft-bombing computer-autopilot combination may be out of trim. If the PDI jumps off center quickly when control is transferred, the trim of the aircraft may not be aligned with the PDI. For corrective action:

1. Center the PDI with the autopilot rudder trim knob.

2. Use the aileron trim knob to keep the wings level and the elevator trim knob to control the pitch attitude.

Note

Do not use the turn control to center the PDI.

If the PDI drifts slowly off center, and the above corrective measures do not keep it centered, the PDI synchro, the bombing computer-autopilot synchro, or both, may be misaligned. If a misalignment is indicated, write it up for ground maintenance.

Green Lights Will Not Come On.

If the green lights fail to come on, try the following procedures:

1. Check that all circuit breakers are in. There are two on the autopilot calibrator chassis, and one on the pilot's auxiliary panel.

2. See if the trim knobs are effective. Turn the knobs both ways and see if they drive back. If one is inoperative, turn it by hand until the green lights come on; then engage the autopilot. If is seems to erratic in one axis, pull out the tubes located in the amplifier on the main autopilot chassis for that axis, and drive the trim knobs by hand until the lights come on.

3. If one of the tubes is burned out, there are some spares in the spare turbo amplifier. The TE-5 is interchangeable with the 1274.

4. Work the autopilot release switches on the control wheels a few times. If the green lights remain out when the autopilot tubes are lighted and the trim knobs are responding properly, it is a good indication that the autopilot release switches are open. If the switches cannot be closed, they can be by-passed with a jumper to engage the autopilot. Momentarily short terminals 1 and 2 on the "Autopilot Terminal Strip" to see if the lights come on. If the lamps light, place a jumper between the terminals, engage the autopilot, and use it as normal.

WARNING

The release switches are now by-passed and cannot be used for disengaging. To disengage the autopilot, place the autopilot power switch in the OFF position or disengage each axis individually from the pedestal.

Elevator Trim Knob Malfunction.

If the first few trim knob adjustments do nothing and the last one produces a violent change, the following procedures will apply:

1. Increase elevator ratio until a "hunt" appears.
2. Remove the "hunt" with elevator throttling.
3. Shake the control column when you put in a correction.

Autopilot Becomes Sluggish.

If the aircraft "wallows" after 10 to 15 hours, the following corrective procedure should be used. The aircraft is much lighter now and is probably overcorrecting rather than "wallowing."

1. Reduce ratio in the oscillating axis.
2. Reduce directional stiffness.

Aircraft Precesses.

If the aircraft precesses, it is probably caused by the N-1 high latitude compass.

1. Make sure the navigator has the power switch ON.
2. Have the compass checked.

SECTION VIII
Crew Duties

69-112-A

69-112-A

Each crew member of the airplane has primary and alternate duties. Generally, the primary duties of the crew member are explained by his station title. Each crew member has additional duties which must be performed to insure proper flight of the airplane and to support crew safety and comfort during ground operation and flight.

The aircraft commander's, the pilots', and the first and second engineers' preflight inspections and duties are covered in "Normal Procedures," Section II. Additional duties and responsibilities of other crew members, including the aircraft commander, are assigned in the following text. It is your individual responsibility to be familiar with each item of equipment and to be able to inspect it thoroughly for any irregularities. Don't let this inspection become so routine that you check it off as completed without doing a thorough job. Remember, it is not just your life at stake but also the lives of your fellow crew members.

AIRCRAFT COMMANDER.

The aircraft commander is responsible for the issuance of instructions governing all phases of flight operation. His duties and preflight inspection are given in "Normal Procedures," Section II. His responsibilities with regard to formal crew briefing are discussed in the following paragraphs.

RESPONSIBILITIES.

A formal crew briefing should be conducted by the aircraft commander as soon as possible after detained mission planning. The first item that the aircraft commander should cover in his crew briefing is a recapitulation of the mission plan to insure that all crew members are completely familiar with the requirements to be accomplished. In case of doubt in any crew member's mind, the aircraft commander should completely review that phase of the mission. He should discuss personal equipment to be carried and assign additional duties such as compartment commanders, and the drawing of extra parachutes, water jugs, and lunches to the various crew members. Before dismissing the crew, he should again check to make certain that each member is aware of the schedule for reporting to the aircraft, of station time, and of take-off time. If the aircraft commander has paid close attention to the premission planning and has conducted his briefing well, one of the most difficult phases of flying a mission will have been accomplished successfully.

Personal Equipment Requirements.

Personal equipment plays such an important part in the safety and comfort of the crew during a flight that the aircraft commander must never assume that all crew members are adequately equipped. It is his responsibility to make certain prior to flight that all crew members know what equipment they must carry. He will perform a formal crew inspection before boarding the aircraft. Personal equipment used in the B-36 is similar to that used in several other aircraft. In the briefing that you will attend prior to flight, either the operations officer or the aircraft commander will specify the equipment needed on the specific flight for which you have been briefed. Common sense will tell you that if you are scheduled for any altitude work you will need heavy clothing, oxygen equipment, and bail-out bottles plus your normal gear. Keep the cabin heat at a minimum when flying over cold regions so that your crew may wear their heavy clothing with comfort. In this manner, if an emergency occurs, the crew will be properly clothed for survival. Oxygen masks will be carried on all flights by all crew members regardless of altitudes to be flown. The following minimum clothing and equipment will be carried by each crew member on all flights above 28,000 feet:

1. Oxygen mask, pressure demand (type A-13, A-13A, or A-15) with adapter for use with H-2 emergency cylinder (bail-out bottle). Demand oxygen mask, type A-14, may be substituted when foregoing types are not available, but only for flights up to 34,000 feet. No attempt will be made to use the type A-14, as a pressure breathing mask.

2. Emergency oxygen cylinder, type H-2, attached to parachute.

3. Helmet, flying, intermediate, type A-11, standard.

4. Goggles, type B-8, for eye and face protection in case of a high altitude bail-out.

5. Jacket, flying, winter, type B-11, standard, or M-1.

6. Trousers, flying, winter, type A-10, standard.

7. Gloves, flying, winter type A-9A, or gloves, flying intermediate type A-11A, and insert glove, rayon.

8. Shoes, flying, intermediate, type A-6A.

9. Flashlight.

For overwater flights the following minimum personal equipment will be carried in addition to the above:

1. Mae West for each crew member.

2. Gibson Girl radio.

3. One-man life raft for each crew member.

4. One 20-man life raft for crew.

5. Anti-exposure suit for each crew member.

6. Applicable survival kits.

Time Schedule.

It is very important that all crew members know station time, when to complete their preflights, crew inspection time, etc. The aircraft commander, assisted by the pilot and copilot, should see that all crew members meet these schedules; nothing makes a crew more slovenly than stragglers. Insist on promptness!

RADAR OBSERVER.

The radar observer operates the radar set and the K-( ) bombing system. Following is an abbreviated check list for this position:

Note

All pertinent information, check and cross-checks will be made over interphone.

WARNING

This aircraft has snap action bomb bay doors.

PREFLIGHT

1. Mission Planning
   - a. Preflight Time .... RADAR SHOP NOTIFIED
   - b. Mission Orders .... CHECKED
   - c. Target Data .... CHECKED
   - d. Blank Forms .... CHECKED
   - e. Target Study .... COMPLETED
   - f. Ultrasonic Requirements .... IF APPLICABLE
   - g. Flight Plan and Weather ... CHECKED WITH NAVIGATOR
   - h. Form 1 and Maintenance Log .... CHECKED
2. Preflight (Arrival at Aircraft)
   - a. Periscope Sight Cover .... REMOVED
   - b. Bomb Door Ground Locks .... INSTALLED
   - c. Bomb Door Limit Switches .... INSPECTED
   - d. Racks and Bombs .... CHECKED
   - e. K-38 Camera .... MANUALLY OPERATE
   - f. IFI Station Bomb Bay #4 .... OXYGEN REGULATOR CHECKED
   - g. Circuit Breakers Bulkhead 8.0 .... ON
   - h. Circuit Breakers Bulkhead 7.0 .... ON
   - i. Circuit Breakers Bulkhead 6.0 .... ON
   - j. IFI Station Bomb Bay #1 .... OXYGEN REGULATOR CHECKED
   - k. Equipment in Radome .... CHECKED
   - l. K-System Gyro Fuses in Left Fwd Power Panel ... CHECKED
   - m. Spare Amplifier and Tube Kit .... CHECKED
   - n. Radar External Power Switch (If Applicable) .... ON
   - o. Constant Speed Motor Switch .... ON
   - p. AM-193 .... STAB
   - q. Computer Amplifier Rack and Fuses .... CHECKED
   - r. K-System Component Cabling .... CHECKED
   - s. Stab Amplifier Rack and Fuses .... CHECKED
   - t. Directional Amplifier (Coupler) .... CHECKED
   - u. Radar Junction Box and Fuses .... CHECKED
3. Preflight (Station)
   - a. Bomb Door Safety Switch .... OFF
   - b. Bomb Bay Selector Switch .... OFF
   - c. Intervalometer .... TRAIN & ZERO
   - d. Bomb Panel Circuit Breakers .... OFF
   - e. Special Bomb Panel Circuit Breakers .... OFF
   - f. Camera Circuit Breakers .... OFF
   - g. Tone Switch .... OFF
   - h. Bomb Master Switch .... OFF
   - i. Special Bomb Panel Rack Release .... AS DESIRED
   - j. Bomb Arming Switch .... OFF
   - k. Salvo Switch & Light .... SAFETIED & OFF
   - l. O-15 Camera Switch .... OFF
   - m. Pressure Pump Switch .... ON
   - n. Preheat and Cooling Switch .... AS DESIRED
   - o. Normal & Private Interphone .... CHECKED
   - p. Oxygen .... CHECKED
   - q. Table and Instrument Lights .... CHECKED
   - r. Preflight Radar In Accordance With SOP
   - s. Preflight O-15 and K-38 Camera ....
   - t. Turn Radar Off
4. Duties at Station Time
   - a. Personal Equipment .... STOWED
   - b. Survival and Combat Equipment .... STOWED
   - c. Safety Belt .... CHECKED
5. Pre-Taxi Duties
   - a. Aircraft Power .... CHECKED WITH F/E
   - b. Function Switch .... STAB
   - c. Fwd Entrance Ladder .... STOWED
   - d. Ground Cord & Nose Wheel Down Lock .... STOWED
   - e. Forward Entrance Hatch .... CLOSED
   - f. All Circuit Breakers & Switches .... AS BRIEFED
   - g. Camera Doors .... CLOSED
   - h. APS-23 Power Switch ..... STAND BY AFTER JET START, IF DESIRED

INFLIGHT

1. Turn On and Operate K-System
2. Pre-Bombing Check (Actual Drop)
   - a. Ballistic Data .... CHECKED
   - b. Bomb Panel Circuit Breakers .... ON

c. Special Bombing Panel Circuit Breakers .... AS BRIEFED
d. Master Switch .... ON
e. Bomb Arming Switch .... AS BRIEFED
f. Bomb Station Indicator Light Switch .... ON
g. Special Normal Rack Switch .... AS BRIEFED
h. Vertical Camera Circuit Breakers .... ON
i. Intervalometer .... AS BRIEFED
j. E-6 Autopilot Ratio ..... SET FOR AUTOMATIC RUN AT BOMBING ALTITUDE
k.. Bomb Bay Selector Switches ...... ON JUST PRIOR TO RELEASE AND OFF IMMEDIATELY AFTER DOORS CLOSE
l. Special Bombing Rack Selector Switches ON JUST PRIOR TO RELEASE AND OFF IMMEDIATELY AFTER DOORS CLOSE
m. Bomb Bay Door Safety Switch .... ON JUST PRIOR TO RELEASE AND OFF IMMEDIATELY AFTER DOORS CLOSE

3. Pre-Bombing Check (RBS)
   a. Ballistic Data .... CHECKED
   b. Bomb Bay Doors .... CLOSED & CIRCUIT BREAKER OUT
   c. Bomb Bay Tank Safety Switch .... NO SALVO
   d. Bomb Bay Selector Switches .... OFF
   e. Salvo Circuit Breakers .... PULLED
   f. Pilot's & Bombardier's Salvo Switches .... OFF
   g. Notify A/C that RBS Safety Check List is Complete
   h. All Other Bomb Panel Circuit Breakers .... ON
   i. Master Switch .... ON
   j. Vertical Camera Intervalometer .... ON
   k. Vertical Camera Door .... OPEN
   l. Intervalometer .... AS DESIRED
   m. Vertical Camera Intervalometer .... AS BRIEFED
   n. Tone .... CHECKED WITH RBS

4. RBS and Camera Safety Check List
   a. Bomb Bay Doors .... CLOSED
   b. All Salvo Switches .... OFF
   c. Tank Salvo Switches .... NO SALVO POSITION
   d. Bomb Bay Selector Switches .... OFF
   e. Special Release-Bomb Rack Release Switch In Special Release Position
   f. Bomb Bay Safety Switch .... OFF

5. Bomb Run Check List
   a. Prior to Pre-IP
      (1) Perform Safety Check List .... COMPLETED
      (2) TAS Computed and Checked .... COMPLETED
      (3) Precomputed Ballistics .... SET
      (4) Offset Information Set & Checked ...... COMPLETED
      (5) Simulated Bomb Run .... COMPLETED
   b. Prior to IP
      (1) Altitude Measurement .... COMPLETED
      (2) Adjusted Bombing Altitude & Ballistics ... SET
      (3) Label Camera Data Plate .... CHECKED
      (4) True Heading Checked With Navigator .. CHECKED
      (5) Set Up D-2 Nav Unit & Complete Bomb Run On IP .... COMPLETED
   c. Bomb Run
      (1) Proper Positioning of Switches for Bomb Run .... CHECKED
      (2) Call A/C 30 N.M. From Target .... COMPLETED
      (3) Complete Bomb Run .... COMPLETED
      (4) After Bombs Away Call Necessary Information to Pilot .... COMPLETED

PRIOR TO LANDING

1. Pre-Landing Duties
   a. Monitor GCA or Instrument Let-Down Until Cleared by A/C
   b. Turn Off APS-23
   c. Sighting Angle Dial .... 45°
   d. Bombing Mode Switch .... LOS
   e. Function Switch .... STAB

POSTFLIGHT

1. Complete the Following:
   a. Function Switch ...... OFF WHEN AIRCRAFT IS PARKED
   b. Station .... POLICED
   c. K-System Maintenance Form .... COMPLETED
   d. All Malfunctions .... NOTED ON AIRCRAFT FORM 1
   e. All Logs and Forms .... FILLED OUT

NAVIGATOR.

The navigator operates the installed navigational equipment. Following is an abbreviated check list for this position:

PREFLIGHT

1. Mission Planning
   a. Mission Requirements .... UNDERSTOOD
   b. Weather .... CHECKED
   c. No Wind Flight Plan .... COMPLETED
   d. Maps and Charts .... CHECKED AND ANNOTATED
   e. Target Study .... COMPLETED
   f. Navigation Kit & Aux Equipment .... CHECKED

2. Preflight (Day Preceding Flight)
   a. Form 1 .... CHECKED
   b. Circuit Breakers (As Desired) .... IN
   c. Oxygen Equipment & Pressure .... CHECKED
   d. Interphone (Normal & Private) .... CHECKED
   e. Lights (Table, Dome & Fluorescent) .... CHECKED
   f. Compass, Altimeter, and Airspeed Calibration Cards (When Applicable) .... CHECKED
   g. Compasses .... CHECKED
   h. Loran .... CHECKED
   i. Standby Gyro .... CHECKED
   j. Radio Compass .... CHECKED
   k. Accessible T-R Unit (When Applicable) .... CHECK WIRING, SECURITY, FOREIGN MATERIAL AND FAN OPERATION
   l. Aircraft Clocks (When Applicable) .... CHECKED
   m. Pilot's Magnetic Compass .... CHECKED
   n. Astro Position Interphone .... CHECKED
   o. Astro Position Oxygen Equipment .... CHECKED
   p. Astro Panel (Applicable Aircraft) .... CHECKED
   r. Periscopic Sextant .... CHECKED AND STOWED
   s. Loran Antenna .... CHECKED
   t. Static Ports (Open and Clean) .... CHECKED

3. Preflight Station (Day of Mission)
   a. Form 1 .... CHECKED
   b. Equipment (Personal & Navigational) .... STOWED
   c. Circuit Breakers (As Required) .... IN
   d. Oxygen Equipment & Pressure .... CHECKED
   e. Oxygen Report (To Radio Operator) .... COMPLETE
   f. Interphone (Normal & Private) .... CHECKED
   g. Lights (Table, Dome & Fluorescent) .... CHECKED
   h. Safety Belts .... CHECKED
   i. Compasses (See N-1 Compass Preflight) .... CHECKED
   j. Loran .... CHECKED
   k. Standby Gyro (Caged & Off) .... CHECKED
   l. Aircraft Clocks (If Applicable) .... CHECKED
   m. Astro Position Interphone .... CHECKED
   n. Astro Position Oxygen Equipment .... CHECKED
   o. Astro Position Panel (Applicable Aircraft) .... CHECKED
   p. Periscopic Sextant Mount .... CHECKED
   q. Periscopic Sextant .... CHECKED & STOWED
   r. Time Hack (Obtained at Navigator's Convenience) .... OBTAINED
   s. Static Ports (Open and Clean) .... CHECKED

4. Crew Inspection .... COMPLETED

INFLIGHT

1. Initial Heading .... TO A/C
2. Navigational Methods As Described In SAC Manuals
3. RCT Information to Crew (When Applicable)

BOMB RUN CHECK

1. Prior to Pre-IP
   a. Direct Aircraft to Pre-IP .... AS BRIEFED

b. Compute TAS .... CHECKED WITH VO AND FE
c. At Pre-IP Direct Aircraft to IP .... AS BRIEFED

2. Prior to IP
a. Check True Heading .... CHECKED
b. Using VO Latest Wind, Compute Mag Heading From IP to Target, Notify Pilot .... COMPLETED

3. Bomb Run
a. At Bombs Away Record Time and True Heading .... COMPLETED
b. Compute Bombs Away Wind and Inform VO COMPLETED

POSTFLIGHT

1. Turn Off All Switches and Equipment .... COMPLETE
2. Police Station .... COMPLETE
3. Record All Nav. Write Ups in Form I .... COMPLETE
4. Turn In All Maps, Charts, Logs and Forms Required .... COMPLETE

OBSERVER.

The Observer assists the Radar Observer and Navigator when required. Following is the abbreviated check list for this position.

PREFLIGHT

1. Mission Planning
a. Mission Orders .... CHECKED
b. Mission Folder & Observer's Kit .... COMPLETE
c. Target Study .... COMPLETE
d. Flight Plan and Weather .... CHECKED

2. Preflight (Arrival at Aircraft)
a. Nose Turret Access Door .... SECURE
b. Personal Equipment .... CHECKED & STOWED
c. Parachute Static Line .... CHECKED
d. Cabin First Aid Kit .... CHECKED
e. Cabin Heater .... OFF
f. Spare Bulb Box .... FILLED
g. Portable Oxygen Bottle .... FILLED
h. Oxygen Pressure .... CHECKED
i. Normal & Private Interphone .... CHECKED
j. Dome Lights .... CHECKED
k. Spare Sextant .... CHECKED & STOWED
l. 28V DC and Right Forward Power Panels .... CHECKED
m. Assist Navigator & Radar Operator .... AS REQUIRED

INFLIGHT

1. After Take-Off
a. Assist Navigator & Radar Observer .... AS REQUIRED

2. Prepare for Landing
a. Auxiliary & Misc Equipment .... SECURED

POSTFLIGHT

1. Nose Turret Sighting Station
a. Oxygen Panel .... OFF
b. Malfunctions .... REPORTED IN FORM I

BOMB RUN CHECK

1. Prior to Pre-IP
a. O-15 Camera Checked For Proper Operation .... COMPLETED
b. Offset Data .... CHECKED
c. Safety Check List .... CHECKED

2. Prior to IP
a. Max Range From IP O-15 Camera .... 1 EVERY 12 SCANS
b. Altitude Measurement & Adjustment .... CHECKED
c. Cross Check Computations & Ballistic Data Settings .... COMPLETED
d. Read True Heading In Heading Unit As Nav Obtains True Heading Check .... COMPLETED

3. Bomb Run
a. Cross Check Following Switches For Actual Drop:
(1) Bombing & Camera Panel Circuit Breakers .... IN
(2) Auxiliary Panel Circuit Breakers .... IN
(3) Bomb Master Switch .... ON
(4) Bomb Station Indicator Light Switch .... ON
(5) Bomb Arming Switch .... AS BRIEFED
(6) Intervalometer .... AS DESIRED
(7) Camera Intervalometer .... AS BRIEFED
(8) Special Rel Bomb Rack Release Switch .... AS DESIRED
(9) Bomb Bay Door Safety Switch .... ON
(10) Bomb Bay & Special Rack Selector Switch .... ON JUST PRIOR TO RELEASE AND OFF IMMEDIATELY AFTER RELEASE

b. Cross Check Following Switches for RBS Run
(1) Intervalometer .... AS DESIRED
(2) Bomb Bay Selector Switch .... OFF
(3) Bomb Bay Door Safety Switch .... OFF
(4) Bomb Bay Doors .... CLOSED, CB PULLED
(5) Salvo Circuit Breakers .... PULLED
(6) Camera Circuit Breakers .... ON
(7) RBS Tone & Intervalometer Heater Circuit Breakers .... IN
(8) All Other Bomb Panel Circuit Breakers .... PULLED
(9) Master Switch .... ON
(10) K-38 Camera Doors .... OPEN
(11) Camera Intervalometer .... AS BRIEFED

c. O-15 Camera on At 30 Mile Call .... 1 EVERY 2 SCANS
d. Inform VO Position of Offset Switch .... COMPLETED
e. Function Switch Bomb Position .... CHECKED
f. N-2 Transfer Switch (Autopilot) .... RADAR BOMB
g. E-2 Turn Control (Autopilot) .... AUTOMATIC
h. Inform VO When ECO Light On .... CHECKED
i. Inform VO When Memory Point Light On .... CHECKED
j. Inform Pilot When 15 N.M. From Target .... CHECKED
k. Tone "On" 20 Seconds To Go .... COMPLETED
l. Tone "Off" at "Bombs Away" .... COMPLETED
m. Maintain Camera Log & Record Necessary Flight Information .... COMPLETED
n. When 30 N.M. Past Target .... 1 EVERY 12 SCANS
o. Camera Off .... AS BRIEFED

FIRST RADIO OPERATOR (ECM OPERATOR).

The first radio operator operates the high frequency communications equipment, the defensive ECM equipment and the IFF. The following is a check list for this position.

Although these duties are primarily the responsibility of the first radio-ECM operator, he may delegate any of these duties to the second radio operator as required.

VISUAL PREFLIGHT

1. EXTERIOR OF PLANE
a. Location and Type of ECM Antenna .... CHECKED
b. Liaison, Compass, ILS, Loran, Marker Beacon, VHF, UHF, IFF and ARN-14 Antennas, Insulators and Mounts .... CHECKED
c. Static Dischargers .... CHECKED

2. Form I and "G" File .... CHECKED

PREFLIGHT OPERATIONAL EQUIPMENT CHECK

1. Hydraulic Selector Valve .... CHARGE BRAKES
2. Hydraulic Tank Level (and Spare Fluid) .... CHECKED
3. Compartment and Tunnel Lights .... CHECKED
4. Communication Tube Cart .... CHECKED
5. Facility Charts (VOR and IF/MF), Radio Data and Pilot's ILS, EAST-WEST Handbooks Up-to-Date .... CHECKED

6. Cabin Pressure Regulator .... ON
7. Cabin Pressure Relief Valve .... CLOSED
8. Cabin Pressure Air Manual Shutoff Valve .... OPEN
9. All Plugs, Cables and Connections .... CHECKED
10. All Fuses, Spare Fuses and Circuit Breakers (Including Aft Compartment As Required) .... CHECKED
11. Spare Bulbs .... CHECKED
12. Nose Latching Hook .... STOWED
13. Cabin Heater .... STOWED
14. Fire Axe, First Aid Kits and Fire Extinguishers .... ABOARD
15. Walk-Around Bottle and Filler Hose .... CHECKED
16. All Defensive ECM Equipment Installed .... CHECKED
17. Complete Interphone System and All Sections .... CHECKED
18. AN/ARC-8 or ARC-21X and Antenna Connections CHECKED
19. IFF (Including Detonator Circuit and Inertia Switch) .... CHECKED
20. Recorders (If installed) .... CHECKED
21. ARC-3 and ARC-27 (If Applicable) .... CHECKED
22. ILS (To Include ARN-14, If Applicable) .... CHECKED
23. BC-453 (If Applicable) .... CHECKED
24. ARN-6 or ARN-7 (Both Stations) .... CHECKED
25. Relief Container Valves .... CLOSED
26. Radio Operator's T-R Unit .... CHECKED
27. Chaff Dispensers Checked and Loaded .... AS REQUIRED

CREW INSPECTION

1. As Outlined in Section II, Normal Procedures .... COMPLIED
2. All Required Personal Equipment .... CHECKED
3. Radio-ECM Operator's Kit, Including Current Coding and Identification System .... CHECKED
4. Tool Kit and VHF Crystals Necessary for Flight .... CHECKED
5. Load Aircraft and Stow Equipment .... CHECKED
6. Check Private and Normal Interphone Using Oxygen Mask and Helmet, Verifying Side-Tone .... CHECKED

PREFLIGHT (DAY OF FLIGHT)

1. OPERATIONAL CHECK (Radio Operator's Compartment)
   a. Liaison Equipment, ARC-8 or ARC-21X .... CHECKED
   b. Mixer Amplifier, All Switches .... CHECKED
   c. ECM Defensive Equipment .... CHECKED
   d. IFF (APX-6) .... CHECKED
   e. Recorders (If Installed) .... CHECKED
   f. ARC-3 Crystals .... INSTALLED
   g. Hydraulic Selector Valve .... CHARGE BRAKES
   h. Hydraulic Tank Level (And Spare Fluid) .... CHECKED
   i. Compartment and Tunnel Lights .... CHECKED
   j. Communication Tube Cart .... CHECKED
   k. Facility Charts (VOR and LF/MF), Radio Data and Pilots ILS, EAST-WEST Handbooks Up-To-Date .... CHECKED
   l. Cabin Pressure Regulator .... ON
   m. Cabin Pressure Relief Valve .... CLOSED
   n. Cabin Pressure Air Manual Shutoff Valve .... OPEN
   o. All Plugs, Cables and Connections .... CHECKED
   p. All Fuses, Spare Fuses and Circuit Breakers .... CHECKED
   q. Spare Bulbs .... CHECKED
   r. Nose Latching Hook .... STOWED
   s. Cabin Heater .... STOWED
   t. Fire Axe, First Aid Kits and Fire Extinguishers .... ABOARD
2. OPERATIONAL CHECK (Flight Deck)
   a. Circuit Breakers on Pilots' Panel .... IN
   b. VHF, All Channels .... CHECKED
   c. UHF .... CHECKED
   d. Radio Compass .... CHECKED
   e. ILS (ARN-14 and ARN-5) .... CHECKED
   f. Marker Beacon Lamp .... CHECKED
   g. Mixer Amplifier Switches (Left and Right Seat) CHECKED
   h. BC-453 and Range Filter Box (If Applicable) .... CHECKED
   i. Engineer's Interphone Circuit Breaker and Wing Crawlway Interphone Lamp CHECKED IN AND OFF
3. OPERATIONAL CHECK (Nose Compartment)
   a. Radio Compass .... CHECKED
   b. Circuit Breakers and Fuses .... IN

FINAL CREW BRIEFING

1. As Outlined In Section II, Normal Procedures .... CHECKED
2. A/C Informed of Discrepancies .... CHECKED

STATIONS (START ENGINES)

1. On Private Interphone .... STANDBY

NOTE

ON AIRCRAFT IN WHICH THE GROUND MAN IS ON NORMAL INTERPHONE ALL CREW MEMBERS WILL ALSO BE ON NORMAL AT ENGINE START.

2. Liaison Set Tuned to Tower Frequency .... CHECKED
3. Alarm Bell, Oxygen-Interphone .... REPORTED

TAXI

1. Interphone Compartment Report (Normal) .... READY
2. Nose Compartment Clear, Hatch Closed and All Personnel In Take-Off Position .... REPORTED

TAKE-OFF

1. Safety Belt .... FASTENED
2. Parachute .... ON
3. Nose Gear and Doors .... REPORTED UP

CRUISE

1. Mission .... AS BRIEFED
2. Parachute and Oxygen Equipment as Regulation Requires .... COMPLIED

LANDING

1. On Normal Interphone .... STANDBY
2. Emergency Hydraulic Selector Valve .... BRAKE
3. Nose Gear Down and Locked After Engineer Reports, "Pressure Relieved" .... REPORTED
4. Nose Strut (As Required) .... BLED
5. Liaison Set Tuned to Tower Frequency .... CHECKED
6. Nose Compartment Clear and Personnel In Landing Position .... REPORTED
7. Parachute .... ON

POSTFLIGHT

1. All Equipment .... OFF
2. Radio-ECM Logs .... COMPLETED AND SIGNED
3. Form I .... COMPLETED
4. Relief Containers .... EMPTIED
5. Radio Compartment .... CLEANED

LEFT SCANNER.

This crew member is the secondary tail radar gunner and is held responsible for assisting the primary tail radar gunner with the preflight of the tail radar equipment. The left scanner's technical requirements are the same as the requirements for the primary tail radar gunner.

PREFLIGHT

1. Gunnery Equipment Preflight and Loading .... ASSIST TAIL GUNNER AS REQUIRED
2. Crew Inspection
   a. Spare parachute (bail-out bottle attached) ... CHECKED
   b. First aid kits (aft cabin) .... CHECKED
   c. Battle splints and blood plasma .... AS REQUIRED
3. Combat Station
   a. Oxygen and interphone .... CHECKED
   b. Personal equipment .... CHECKED
   c. Trouble light .... CHECKED
   d. Hatches for proper installation, cracks and cleanliness .... CHECKED
   e. Safety straps floor attachments .... SECURED
   f. Safety belt and shoulder harness .... SECURED
   g. Aldis lamp .... CHECKED
4. Crew Duties
   a. Emergency escape rope .... CHECKED
   b. Fire extinguisher .... GAUGE PRESSURE 150-175 LBS.
   c. Emergency hydraulic reservoir ... OIL LEVEL & LEVER OFF CHECKED
   d. Parachute static line .... CHECKED
   e. Left aft cabin power panel .. FUSES, CIRCUIT BREAKERS 3-PHASE LIGHTS—SECURED
   f. Aft cabin dome lights .... CHECKED
   g. Aft cabin pressure regulator .... SAFETY WIRED IN OPEN POSITION
   h. TR Unit .... SECURITY OF MOUNT, DAMAGE AND BLOWER ACTION
   i. Tunnel door and flange valve .... PROPER FIT
   j. Tunnel cart (trial run) CHECK FOR PROPER OPERATION
   k. Left wall heat & pressurization duct .... SECURITY AND CONDITION CHECKED
   l. Upper panels (right and left)—proper installation .... CHECKED
   m. Check removal of rudder locks .... AS REQUIRED

NOTE

IF REQUIRED TO REMOVE RUDDER LOCKS, USE AVAILABLE CREW MEMBERS TO ASSIST IN REMOVAL.

   n. Final crew briefing .... REPORT DISCREPANCIES IN FORM I PART II AND A/C
   o. Left gear safety lock .... REMOVED
5. Prior to take-off
   a. Flap report .... AS REQUIRED
   b. Safety belt and shoulder harness .... FASTENED

INFLIGHT

1. After take-off
   a. Flap and landing gear report .... AS REQUIRED
   b. Engine and intercooler checks .... AS REQUIRED
2. Engine check intervals
   a. Daylight engine checks .... EVERY HOUR
   b. Night, high power, high altitude cruise, weather engine checks .... EVERY 30 MINUTES
   c. Engineering malfunctions .... REPORTED
3. Prepare for landing
   a. Landing Gear and flap report .... AS REQUIRED
   b. Engine report .... AS REQUIRED
   c. Safety belt and shoulder harness .... FASTENED

POSTFLIGHT

1. After landing
   a. Station area .... CLEANED
   b. Interphone cords .... SECURED
   c. Oxygen panel settings and oxygen hose ..... SECURED
   d. Left gear safety lock .... REPLACED

RIGHT SCANNER.

This crew member is the aircraft electrician and is responsible for aircraft electrical maintenance and trouble shooting. He must also know how to operate the tail radar equipment as may be required.

1. Gunnery equipment preflight and loading ..... ASSIST TAIL GUNNER AS REQUIRED
2. Crew inspection
   a. Spare oxygen equipment .... AS REQUIRED
   b. Heated and insulated liquid containers (aft cabin) .... FILLED
   c. Mattresses, pillow and blankets (aft cabin) AS REQUIRED
3. Combat Station
   a. Oxygen and interphone .... CHECKED
   b. Personal equipment .... CHECKED
   c. Trouble light .... CHECKED
   d. Hatches for proper installation, cracks and cleanliness .... CHECKED
   e. Safety straps floor attachments .... SECURED
   f. Safety belt and shoulder harness .... SECURED
   g. Aldis lamp .... CHECKED
4. Crew Duties
   a. Emergency escape rope .... CHECKED
   b. Auxiliary cabin heaters (2)—Switches OFF .... CHECKED AND SECURED
   c. Right wall heat & pressurization duct (security and condition) .... CHECKED
   d. Right aft cabin power panel—Fuses, circuit breakers, 3-phase lights .... SECURED
   e. Cabin pressure manual shut-off valve .... SAFETY WIRED OPEN
   f. Cabin pressure relief and dump valve .... SAFETY WIRED NORMAL
   g. Vacuum relief valve and strap .... CHECKED
   h. Hand axe .... CHECKED
   i. Aft bomb bay lights .... CHECKED
   j. Bomb bay entrance door .... PROPER FIT
   k. Door interlock switch (ON) .... CHECKED
   l. Final crew briefing .... REPORT DISCREPANCIES IN FORM I PART II AND TO A/C
   m. Right gear safety lock .... REMOVED
5. Prior to take-off
   a. Flap report .... AS REQUIRED
   b. Safety belt and shoulder harness .... FASTENED

INFLIGHT

1. After take-off
   a. Flap and landing gear report .... AS REQUIRED
   b. Engine and intercooler checks .... AS REQUIRED
2. Engine check intervals
   a. Daylight engine checks .... EVERY HOUR
   b. Night, high power, high altitude cruise, weather engine checks .... EVERY 30 MINUTES
   c. Engineering malfunctions .... REPORTED
3. Prepare for landing
   a. Landing gear and flap report .... AS REQUIRED
   b. Engine report .... AS REQUIRED
   c. Safety belt and shoulder harness .... FASTENED

POSTFLIGHT

1. After landing
   a. Station area .... CLEANED
   b. Interphone cords .... SECURED
   c. Oxygen panel settings and oxygen hose .... SECURED
   d. Right gear saftey lock .... REPLACED

TAIL GUNNER.

This gunner is responsible for preflight and use of the AN/APG-41A gunlaying radar equipment. This gunner accomplishes the following duties:

1. Gunnery Equipment Preflight and Loading
   a. VISUAL INSPECTION
      (1) Check turret status.
      (2) All Switches OFF and SAFE. Heater fuse removed.
      (3) Check desiccant (both).
      (4) Fuses and circuit breakers.
      (5) All units in pressurized compartment.
      (6) Remove thyratron and interconnecting group covers. Check thyratron fuses and tubes.
      (7) All radar units in unpressurized compartment.
      (8) Boosters and ammo cans.
      (9) External turret safety switch OFF.
      (10) Remove feeder and check gun is cleared of round in the chamber.
      (11) Inspect guns, chargers and feeder winders.
      (12) Inspect feeders and link chutes.
      (13) Install feeders, connect operating lever and feeder winders.
      (14) Brass and ammo chutes.
      (15) Remove enclosure assembly.
      (16) Complete brass chute inspection. (Outside)
      (17) Complete gun inspection. (Outside)
      (18) Limit switches and mechanical steps.
      (19) Selsyns and drive motors.
      (20) Turret movement. (Manual)
      (21) Brakes locked.
      (22) External turret safety switch "ON."
   b. OPERATIONAL
      (1) Turret clear for operation.
      (2) Selector switch "WARMUP" and heater fuse "IN." Check heaters.
         (a) After heater check remove fuse.
      (3) Standby 1 and 2 switches "ON." Turret power and safety switches "ON."
      (4) Wave guide switch action.
      (5) Selector switch "STANDBY." Check thyratron and all radar blowers.
      (6) Thyratron timed out.
      (7) Interconnecting group timed out.
      (8) Radar 1 switch "ON" and track select to "LEFT" position.
      (9) Selector switch "RADAR."
      (10) Adjust intensity.
      (11) Check wave guides, modulators and RF head for RF leakage.
      (12) Antenna, indicator and radar set check.
      (13) 1 and 31 speed operation and thyratron tubes firing.
      (14) Radar 1 switch "OFF."
      (15) Radar 2 switch "ON" and track select to the "RIGHT" position.
         (a) Check radar 2 in steps (10) thru (13).
      (16) Radar 1 switch "ON" and track select "DUAL" position. Check dual track system.
      (17) Pressure system check. (Both) Complete during dual track system check. Dump pressure after check.
      (18) Safe-fire switches "FIRE."
      (19) Gun charger, boosters and feeder winder operation.
      (20) Turret and antenna limit switches, backout and stowing circuit.
      (21) OOSFI.
      (22) Disconnect chargers at guns.
      (23) Firing circuit check. Reconnect chargers after check.
      (24) Safe-fire switches "SAFE." (Safety Wired)
      (25) Computer check.
         (a) Computer switch "OUT" after check.
      (26) All switches "OFF" and "SAFE."
      (27) Replace thyratron and interconnecting group covers.
   c. LOADING
      (1) External turret safety switch "SAFE."
      (2) Inspect ammo.
      (3) Load ammo.
      (4) Arm feeders.
      (5) Replace enclosure assembly.
      (6) External turret safety switch "ON."
      (7) Set round counters.
      (8) Place warning signs on control panel.
      (9) Proper entry Form 1 and Form F.

2. Crew Inspection
   a. Hot cups .... CHECKED
   b. Toilet paper .... CHECKED
   c. Paper cups .... CHECKED

3. Combat Station
   a. Oxygen and interphone .... CHECKED
   b. Personal equipment .... STOWED
   c. Trouble light .... CHECKED
   d. Indicator unit, radar set and control panel switches .... OFF
   e. Aft cabin altimeter (if installed) .... SET AT 29.92 INCHES HG
   f. Safety belt .... SECURED

4. Crew Duties
   a. Emergency escape rope (under catwalk) .... CHECKED
   b. Walk around bottle .... FILLED & IN PLACE
   c. Aft cabin entrance door .... CHECKED
   d. Relief can clean (valve closed) and relief tube .... CHECKED
   e. Tail cone entrance door .... PROPER FIT
   f. Visual inspection of tail turret .... CHECKED
   g. External turret safety switch .... ON
   h. Turret safety switch .... ON
   i. Final crew briefing .... REPORT DISCREPANCIES IN FORM 1 PART II AND TO A/C
   j. Nose gear safety lock .... REMOVED

5. Prior to take-off
   a. Ladder .... REMOVED & STOWED
   b. Aft cabin entrance door .... CLOSED
   c. Safety belt .... FASTENED

INFLIGHT

1. Gunnery equipment operation and aerial firing
   a. Safe-Fire switches .... SAFE
   b. Heater power .... ON & OFF AS REQUIRED UNTIL GUNNERY PORTION OF MISSION IS COMPLETED
   c. Turret power switch .... ON
   d. Round counters .... SET
   e. Handset unit .... SET
   f. Computer .... IN
   g. Attack factor switch .... SET AS REQUIRED
   h. Selector switch .... STANDBY

CAUTION

ALLOW FOUR MINUTES FOR NECESSARY WARMUP TIME DELAY BEFORE TURNING SELECTOR SWITCH TO RADAR POSITION.

   i. Selector switch .... RADAR
   j. Indicator unit, radar set, antenna and turret operation .... CHECKED
   k. Safe-fire switches .... FIRE
   l. Burst control .... AS REQUIRED

2. Gunnery portion of mission completed
   a. Safe-Fire switches .... SAFE
   b. Guns cooled .... 20 MINUTES
   c. Turret stowed .... COMPLETED
   d. All switches .... OFF

3. Prepare for Landing
   a. Auxiliary and miscellaneous equipment .... SECURED
   b. Safety belt .... FASTENED

POSTFLIGHT

1. After Landing
   a. Sighting station and area .... CLEANED
   b. Interphone cords .... SECURED
   c. Oxygen panel settings and oxygen hose .... SECURED
   d. Guns and gunnery equipment secured .... TURRET SAFETY SW—SAFE AND WARNING SIGNS POSTED
   e. Malfunctions .... REPORTED FORM 1 PART II
   f. Gunnery forms and radar report .... COMPLETED

SECOND RADIO OPERATOR.

The second radio operator assists the first radio operator. The following are his duties.

CREW INSPECTION

1. As Outlined In Section II, Normal Procedures .... CHECKED
2. All Required Personal Equipment .... CHECKED
3. Load Aircraft and Stow Equipment .... CHECKED
4. Check Private and Normal Interphone Using Oxygen Mask and Helmet, Verifying Side-Tone .... CHECKED

PREFLIGHT (DAY OF FLIGHT)

1. Hatch For Proper Installation, Cracks and Cleanliness .... CHECKED
2. Aldis Lamp For Operation .... CHECKED
3. Night Flying Curtain .... CHECKED
4. Visual Inspection of Turret and Turret Bay Doors .. CHECKED
5. All Loose Equipment in R/O Compartment, Radome and Right Catwalk .... SECURED
6. Gibson Girl Radio .... STOWED
7. URC-4 (If Applicable) .... STOWED
8. Spare Parachute and Oxygen Equipment .... STOWED
9. Toilet Paper .... STOWED
10. Two Hot Cups .... STOWED
11. Walk-Around Bottles .... FILLED
12. Roomette Oxygen Station (If Applicable) .... CHECKED
13. Escape Ropes .... STOWED

FINAL CREW BRIEFING

1. According to Section II, Normal Procedures .... CHECKED
2. A/C Informed of Discrepancies .... CHECKED

TAXI

1. On Normal Interphone .... STANDBY

TAKE-OFF

1. In Take-Out Position .... READY
2. Parachute .... ON

CRUISE

1. Parachute and Oxygen Equipment As Regulations Require .... COMPLIED

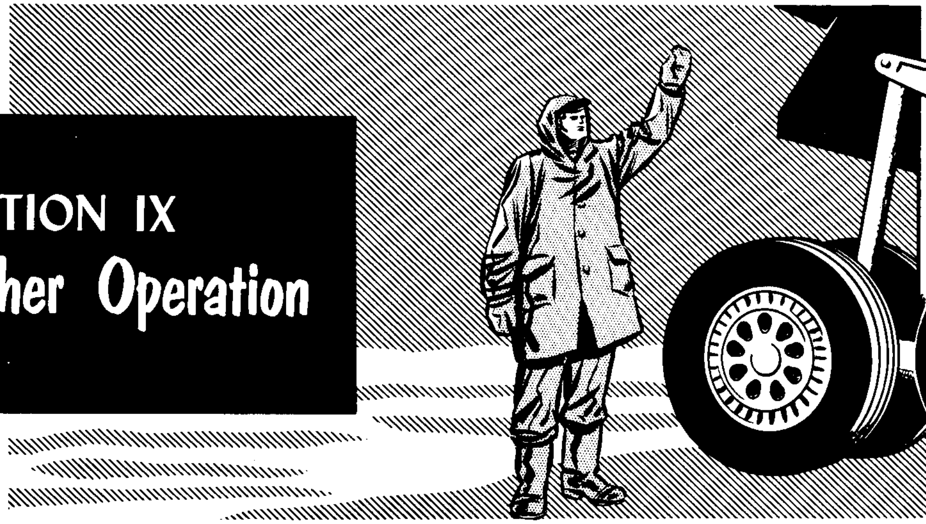
LANDING

1. Upper Forward Turret Doors .... OPEN
2. In Landing Position, Parachute On .... READY

POSTFLIGHT

1. Interphone Cords .... SECURED
2. Oxygen Panel Settings and Oxygen Hose .... SECURED
3. Malfunctions .... REPORTED

SECTION IX
All Weather Operation



69-113-A

69-113-A

This section contains discussions and specific procedures pertaining to operation of the airplane at night, under instrument conditions, in thunderstorms, in cold weather, in hot weather, and in the desert. The normal operating instructions of Section II are repeated only when the unity of this section requires this duplication. Operation of the various systems and equipment is discussed in Section VII.

• Night Flying Procedures •

69-161-A

Night flying and instrument flying are identical in many points of technique. Take-off, climb, and landing will require instrument reference when visual orientation becomes uncertain. Since most missions involve night flying, the following items should be checked prior to each flight.

1. Taxi lights.
2. Landing lights.
3. Position lights.
4. Formation lights.
5. Wing crawlway lights.
6. Instrument panel lights.
7. Flight deck flood lights.
8. Aldis lamps (1 in forward compartment—2 for aft scanners).
9. Spare bulbs.
10. Flashlights.
11. Night-flying curtains.
12. Flight instrument switches ON.
13. Flight indicators and instruments operating.
14. VHF, UHF, low frequency, ILAS, radio compass and VOR.
15. N-1 compass uncaged and erecting.

NIGHT TAKE-OFF.

1. Keep cockpit lights dim to protect your night vision.
2. Use night-flying curtain to permit engineer to illuminate his panel.
3. Check flight instruments during taxi turns.
4. Be particularly alert for taxi strip obstructions. Use Aldis lamp or dispatch wing walkers to check clearances with flashlights.
5. Line up with runway; have nose wheel straight.
6. Landing lights extended and on.
7. Set gyro to zero or to 5-degree mark nearest runway heading.
8. Perform usual checks.
9. During the ground run, the aircraft commander should maintain visual contact, and the pilot should watch instruments.

10. After the "getaway," aircraft commander should go on instruments, and pilot should maintain visual contact to prevent airplane from settling back onto the runway.

NIGHT CLIMB.

1. Use nose down trim after leaving ground effect if climb becomes too steep.
2. Retract flaps in the usual 5-degree increments, retrimming between retractions.

Note

Flap retraction technique for take-off gross weight in excess of 300,000 pounds is discussed in Section VI, "Flight Characteristics."

3. Landing lights retracted and OFF.
4. Maintain take-off power until airplane is "clean" and altitude is between 500 and 1000 feet above the terrain.
5. Maintain optimum climb speed.

NIGHT LANDING.

1. Make normal checks. Scanners should use Aldis lamps for visual inspections.
2. Use landing lights for last part of final approach.
3. Use caution in judging height over the end of the runway.

• Instrument Flying Procedures •

69-163-A

The instrument flight characteristics of this airplane are conventional. Operation of flaps and landing gear does not cause pitch changes that would be dangerous at any stage of instrument flight.

Duplicate flight instrumentation is provided along with all standard electronic aids to instrument navigation and approach. The limiting factor will usually be availability of ground facilities. You will have to consult applicable radio and navigational charts for specific local equipment and procedures.

BEFORE STARTING ENGINES.

Prior to starting the engines and with the portable power cart operating; check the following:

1. Windshield wiper operation and blade contact.
2. Pitot heater operation.
3. Navigation lights.
4. Flight instrument switches—ON.
5. Flight indicators operating and instruments erecting.
6. Cockpit lights and flashlights.
7. VHF, UHF, low frequency, ILAS, radio compass, and VOR.
8. N-1 high latitude compass uncaged and operating.
9. Position cockpit heat and anti-icing valves for maximum windshield defrost.
10. Pilot's ventilating fans on to aid windshield defrost.

AFTER STARTING ENGINES.

Check the anti-icing equipment for proper operation and then turn OFF.

DURING TAXI.

During taxi, check:

1. Landing lights.
2. Turn needles.
3. Gyros and compass (for proper swing and operation).

BEFORE TAKE-OFF.

Check the following items before take-off.

1. Radio receivers turned to proper stations.
2. Altimeter and gyros set.
3. Pitot heater ON (if icing conditions exist).

CAUTION

Flight instruments require a maximum of 15 minutes for warmup.

TAKE-OFF.

The aircraft should be flown off the ground as during a visual take-off; however, instrument take-off should not be attempted unless there is sufficient visibility to aid in steering the aircraft during the initial take-off roll.

In aircraft equipped with J-8 attitude indicator, because of the high angle of pitch on take-off, the horizon bar will ride near the bottom of the indicator, and only limited pitch and roll information will be displayed. Therefore, during the instrument take-off, the air-speed indicator will have to be used to provide additional pitch information. Since the aircraft accelerates rapidly after becoming air-borne, use caution to prevent exceeding the maximum flap speed.

The following instrument take-off procedure is recommended:

1. Visually align the aircraft on the center line of the runway with nose wheel straight.
2. Use normal elevator tab and flap settings.
3. Set miniature aircraft reference on attitude indicator as desired.
4. Set gyro to zero or to 5-degree mark nearest runway heading.
5. Position cockpit heat and anti-icing valves for maximum flow to pilots' enclosure in the event icing conditions are encountered on take-off.
6. Advance power and make normal VFR take-off.
7. Retract landing gear after becoming definitely air-borne.
8. Retract flaps in accordance with the procedure in Section VI, if your take-off gross weight exceeds 300,000 pounds.
9. Apply nose down trim as required between flap retractions.
10. Establish climb configuration.

CAUTION

Limit turns to a maximum bank angle of 15 degrees.

11. Anti-icing equipment ON (if required).

INSTRUMENT CLIMB.

1. Maintain optimum climb speed.
2. Keep turns under one-needle width.

INSTRUMENT CRUISING FLIGHT.

Extended operation on instruments can usually be avoided by cruising at high altitude. As you increase your flight level, the number of cloud types that can exist is substantially reduced. While you are cruising on instruments, the following points are significant:

CAUTION

At no time should the aircraft be permitted to enter an unusual altitude which might result in exceeding the critical Mach number and entering the buffet or compressibility range.

1. Trim airplane "hands off" before engaging autopilot.
2. Repeat "hands off" trimming operation every half hour to compensate for cg changes.
3. Avoid extreme turbulence if possible.
4. If you cannot avoid turbulence, disengage autopilot and fly "attitude" rather than "altitude."
5. Cross check all instruments and electronic aids.

SPEED RANGE.

The rapidity with which you must scan all flight instruments varies with the speed of flight. While this airplane has a very wide speed range for a bomber, normal operating speeds are not high enough to make instrument flight more difficult. Ordinarily, the speeds established by cruise control requirements will be the desirable instrument speeds.

RADIO AND NAVIGATION EQUIPMENT.

The dependability of electronic aids to instrument flight and navigation is closely related to the influence of the various types of static. Man-made static, precipitation static, and dust static can be controlled or suppressed. Crash static from active storm areas, however, cannot be controlled. This accounts for the increased dependence on very high frequencies which are comparatively immune to this type of interference. Electrical disturbances will affect equipment with frequencies below 75 mc within a radius of several thousand miles. Therefore, under severe instrument conditions, VHF equipment will offer greater dependability.

TABLE OF ELECTRONIC *Aids*

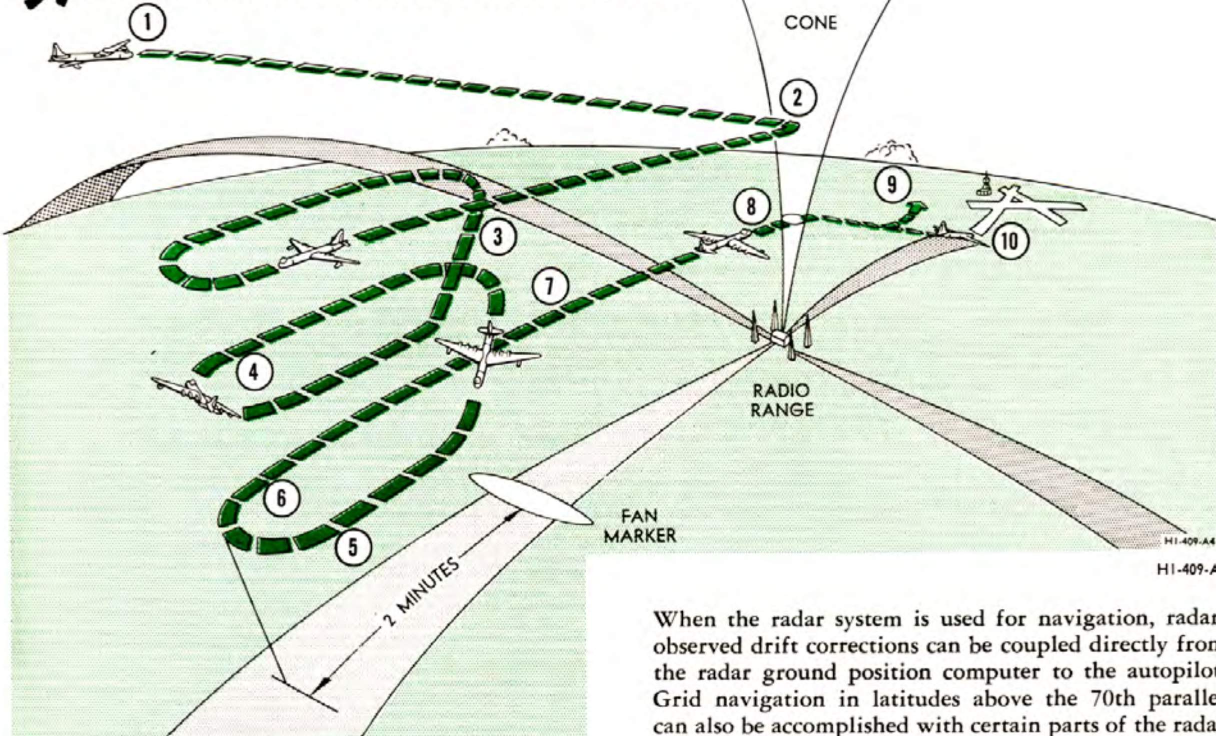
Low to High Frequency	Very High Frequency or Above
Liaison Radio	Instrument Approach Indicator
Radio Range Receiver	Command Sets
Radio Compass	Marker Beacon Receiver
Loran Set	Radar Equipment

H1-287-A

AIR-BORNE RADAR.

This equipment permits visual or contact flight precision under instrument conditions. The amount and accuracy of information obtained through radar scope interpretation depend largely on the skill of the operator. Distinctive terrain features can be used for navigation regardless of prevailing visibility. Relative bearings and distances can be read directly from the scopes; relative altitudes can be determined by comparing flight altitude with map elevation lines or color codes.

Typical RADIO RANGE PROCEDURE



Range procedures will remain fundamental until new techniques are developed. More precision is offered by GCA and ILAS for low approaches, but preliminary orientation and holding on the radio range are usually required.

1. Obtain approach clearance upon entering control area.
2. Hold as directed-Monitor all conversations.
3. Report leaving each assigned altitude promptly.
4. Report reaching and leaving each assigned holding fix.
5. Time your holding pattern to put you over the holding fix at expected approach time.
6. Complete check list prior to this point except:
   a. Flaps-extend 10°.
   b. IAS-150 or 135% stall-whichever is greater.
7. Extend flaps 20°-stabilize IAS at final approach speed.
8. Establish proper rate of let down by reducing MP (on 6 engines) 1" for each 100 ft./min. rate of descent desired.
9. If you are not contact at specified minimum, use "missed approach" procedure.
10. Flaps-extend 30° after reaching visual flight conditions.
11. Report "below all clouds" as soon as possible.

Figure 9-1.

When the radar system is used for navigation, radar-observed drift corrections can be coupled directly from the radar ground position computer to the autopilot. Grid navigation in latitudes above the 70th parallel can also be accomplished with certain parts of the radar system. A great circle path between the high latitude entry and exit points can be followed by reference to a free gyro rather than magnetic field of the earth in the polar regions.

At low altitude, the strong ground echo and the greater apparent speed of the airplane relative to the ground make accurate scope interpretation almost impossible. For this reason, instrument low approaches accomplished exclusively by air-borne radar are not recommended.

Turbulence does not provide a discontinuity that would show up on the radar scope. Thunderstorm research, however, shows that rain and turbulence are related. Consequently, you can pick the smoothest path through a thunderstorm area by avoiding strong rain echoes. This path should be selected before entering the storm area. Heavy local rain will temporarily block the radar scope with strong echoes.

Absolute altitude can be read from the radar scope with a degree of accuracy that depends on the terrain. When the ground is smooth, accuracy is best; when the ground is rough or hilly, the scope shows altitude above an "average" ground level. The radial distance on the scope to the first ground echo is the altitude index.

DESCENT.

Descent under instrument conditions will be in accordance with normal procedures discussed in Section II unless atmospheric conditions dictate changes in power settings. Rapid drops in CHT should be avoided. Prolonged operation with CHT below 170°C can cause spark plug fouling. If icing conditions exist, it will be necessary to change power settings to provide sufficient heat for carburetor, wing, and tail de-icing.

HOLDING.

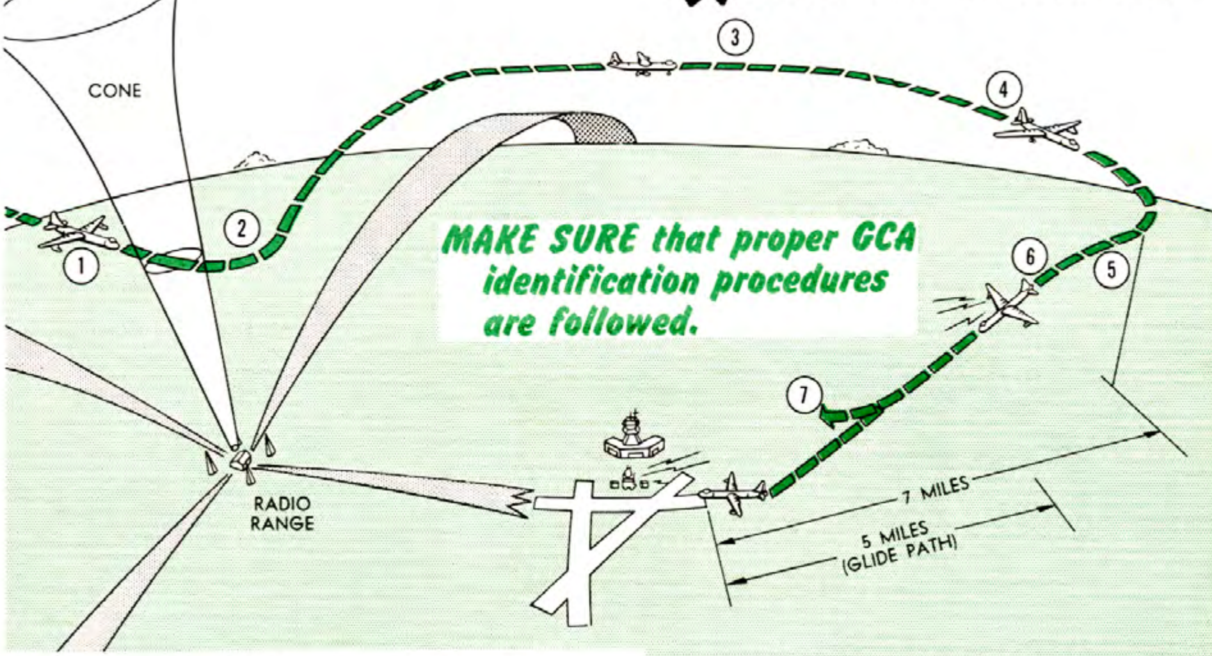
Endurance ordinarily is not critical. If you are required to hold while waiting for airways or approach clearance, use maximum endurance power settings for your gross weight and altitude. A typical holding procedure is shown in figure 9-1 in conjunction with the radio range procedure.

INSTRUMENT APPROACHES.

Equipment is provided for the reception of radio range, ILAS, and GCA signals. ILAS and omnidirectional range signals are interpreted by visual indicators. Approaches based on any combination of equipment are recommended for additional safety. See figures 9-1, 9-2, 9-3, and 9-4 for instrument approach procedures.

Some aircraft are equipped with an automatic approach system which provides a means of making an automatic ILAS approach. For information concerning the description and operation of this equipment, see "Automatic Approach Coupler Unit," Section IV.

Typical GCA PROCEDURE



This system is usually referred to as GCA. The instrument publications should be consulted for procedure in obtaining a GCA channel. Low frequencies are usually available if VHF equipment is inoperative.

1. Turn as directed by GCA. Report leaving cone.

2. Descend as directed to GCA traffic altitude.

3. Complete check list prior to this point except:
   a. Flaps – extend 10°.
   b. IAS–150 or 135% stalling speed, whichever is greater.

4. Extend flaps 20° – stabilize IAS at 150 mph or 135% stall, whichever is greater – descend as directed to final approach altitude.

5. Level off at final approach altitude, stabilize IAS at final approach speed.

6. When you intercept glide path, reduce power on 6 engines approximately 1" MP for each 100 ft./min. rate of descent required. After airspeed and descent rate stabilize, adjust power as required.

7. Flaps–Extend 30° after reaching visual flight conditions.

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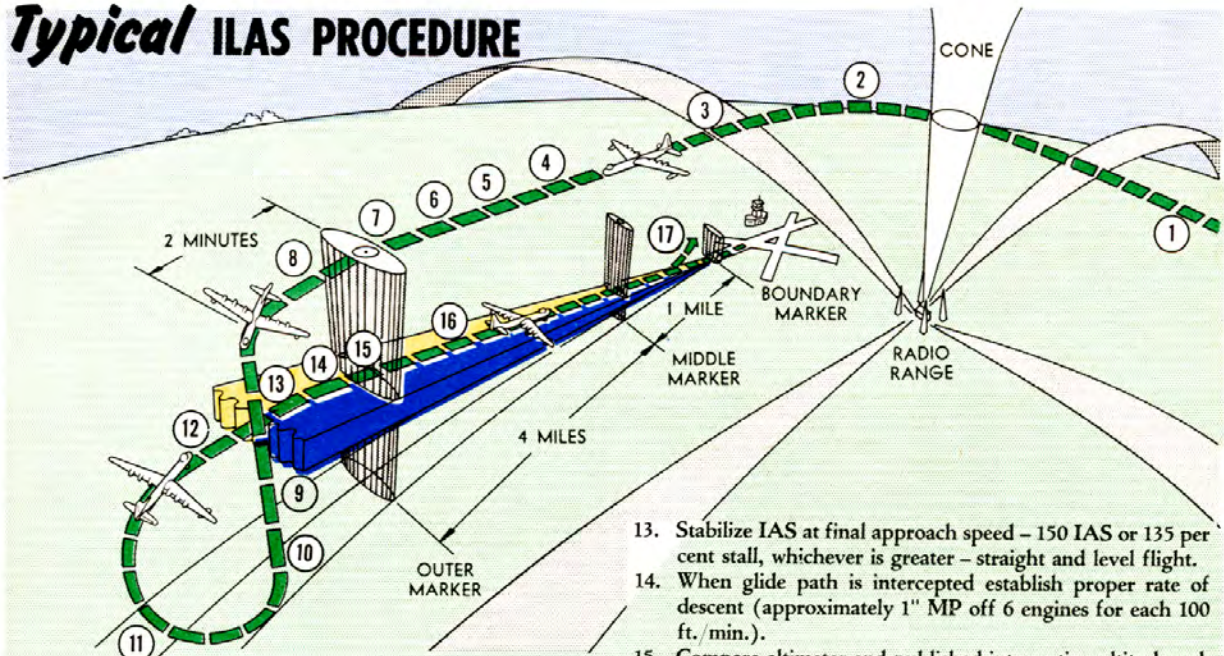
HI-410-A4

Figure 9-2.

Typical ILAS PROCEDURE



ILAS is the standard designation for this low approach system. Procedures and minimums are also defined in applicable radio and navigational charts. When both ILAS and GCA facilities are available, an ILAS with GCA monitor is desirable from the standpoint of safety. If signal strength is too low to give accurate needle deflections, red warning flags appear in the indicator.

1. After clearance has been received, descend to initial approach altitude.
2. Perform final landing check; set propellers, extend gear, and set flaps to 20°.
3. Use low frequency homing facility to aid interception of localizer beam outbound at an angle of less than 30°.
4. Bring ILAS cross pointer into normal sequence of cross-check (outbound deflections are reversed).
5. If interception is made close to localizer, turn to corrected published heading (use metro winds or drift calculated during holding procedure) until localizer needle settles to a steady indication.
6. Center the localizer needle (outbound).
7. Course should be established within 1 or 2 degrees. (Degrees of bank should not exceed degrees of correction indicated).
8. Note outbound drift correction.
9. Complete check list prior to this point except:
   a. Flaps – extend to 30°
   b. IAS – 150 or 135% stall – whichever is greater.
10. Standard turn procedure.
11. Cross check needle frequently during last 90° of turn toward inbound heading – adjust turn to give "on course" indication when turn is complete.
12. Descend to final approach altitude.
13. Stabilize IAS at final approach speed – 150 IAS or 135 per cent stall, whichever is greater – straight and level flight.
14. When glide path is intercepted establish proper rate of descent (approximately 1" MP off 6 engines for each 100 ft./min.).
15. Compare altimeter and published intersection altitude – allowable error is 50 feet. If error is excessive and ground is not visible, go around.
16. Increase speed of cross check and make smooth coordinated corrections as soon as pointers deviate – avoid over controlling.
17. Flaps–Extend 30° after reaching visual flight conditions.

H1-411-A4

Figure 9-3.

The following points of technique will apply to all instrument approaches:

1. Consult applicable radio and navigational charts for specific local procedure.

2. Limit flaps to 20 degrees until landing is assured.

3. Pilot should double check aircraft commander's procedure.

4. Pilot should check for runway or high intensity approach light as aircraft commander reaches final stage of approach.

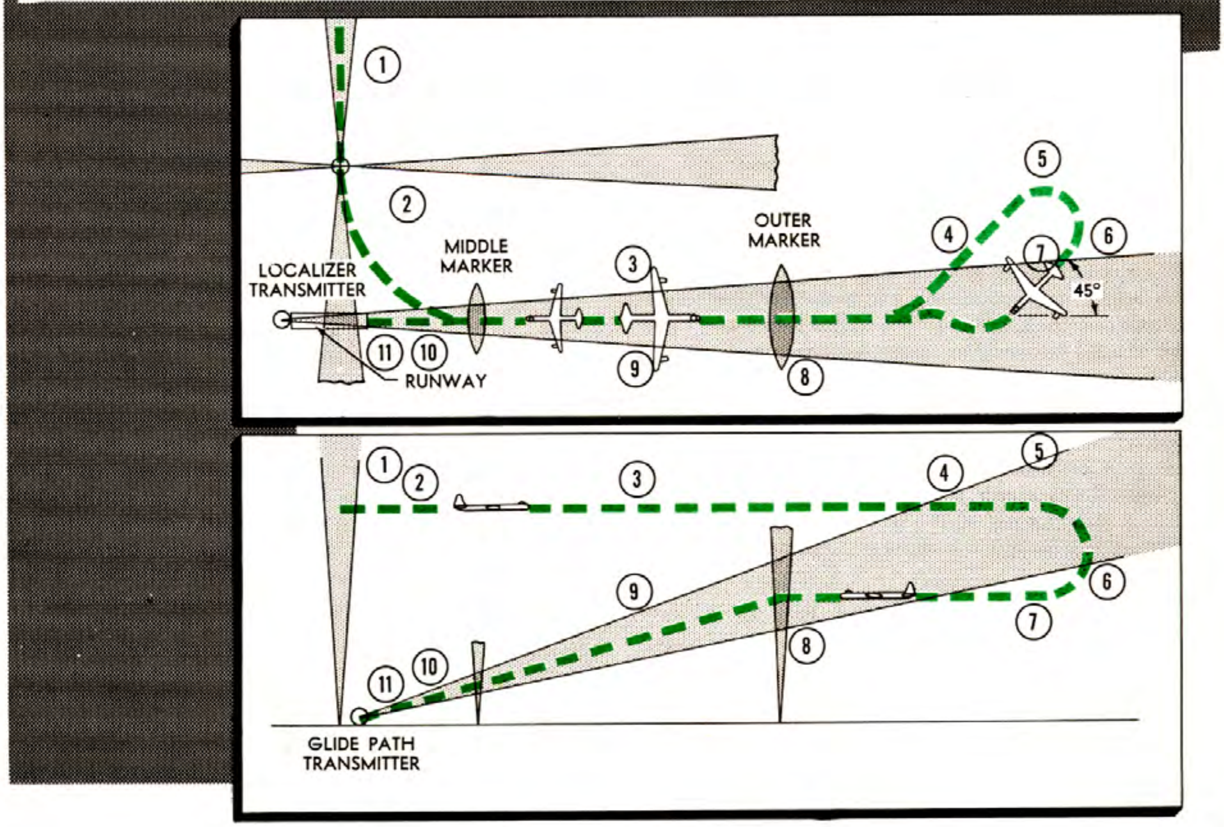
CAUTION

Do not change from your approach system until you are in the clear. Partial visibility can introduce serious errors in depth perception.

ICE, SNOW, AND RAIN.

Proper technique is essential when flying in ice, snow, or rain. The various types of icing are probably the greatest hazard, but rain and snow can impair forward

Automatic APPROACH PROCEDURE



The procedure for making an automatic approach is essentially the same as the ILAS procedure described in figure 9-4. Since the autopilot controls the flight attitude of the aircraft during the automatic portion of this procedure, its three axes must be engaged before this portion of the approach pattern is reached. The approach pattern is devised to allow the aircraft to approach the beam at a sufficient angle and a sufficient distance from the station to have the aircraft lined up on the localizer beam before the outer marker is passed. The altitude, which is automatically maintained if the altitude control unit is engaged, should be approximately 1500 feet if possible. This altitude permits interception of the localizer well below the glide path and allows sufficient time for the aircraft to align itself on the localizer course before the glide path is intercepted.

1. After clearance has been received, descend to initial approach altitude.
2. Perform final landing check–set propellers, extend gear, and set flaps to 20 degrees.
3. Use normal ILAS procedure in flying the outbound leg.
4. Use standard turn procedure.
5. Descend to final approach altitude and turn the altitude control switch on.
6. Approach the beam at approximately 45 degrees.
7. As soon as the localizer needle leaves its stop, place the localizer switch in the ON position.
8. When the glide path needle reaches its approximate center position, place the approach switch in the ON position.
9. Use throttles to maintain normal approach speeds.
10. After reaching visual flight conditions, disengage the autopilot and extend flaps to 30 degrees.
11. Complete the landing manually.

75-120-A

75-120-A

Figure 9-4.

visibility to the extent that instrument technique will be required. If propeller icing is experienced, intermittent rapid increases in rpm should be made in an effort to rid the propeller of ice.

ICE.

It is desirable to establish optimum anti-ice configuration prior to operation in an icing zone. Maximum heat will then be available for wing, windshield, and tail anti-icing. Optimum anti-ice configuration is listed as follows:

1. Dual turbo.
2. High rpm.
3. High engine fan speed.
4. Low air speeds.
5. Maintain maximum allowable CHT and CAT.
6. Maintain maximum allowable anti-icing temperature.

When the anti-icing system is operated correctly during a severe icing condition and flow-back freezing is encountered, the anti-icing system has failed and every effort should be made to leave the icing area.

The anti-icing system should be turned on before entering icing conditions. In severe icing conditions, flow-back freezing may be encountered, and this will result in a loss of air speed. Under these conditions, ice may also form along the bomb bay doors. Periodic opening and closing of the doors will break up this accretion. If windshield is icing or frosting, accomplish the following:

1. Position valves for maximum heat in forward compartment. (Refer to "Heat and Anti-Ice Systems," Section IV.)
2. Direct air flow to pilots' enclosure, and position pilots' air circulating fans for windshield defrosting.
3. Turn on booster fan to increase flow of air in pressure duct.

During flight in heavy icing conditions, especially in freezing precipitation and thunderstorms, icing of the induction system may be encountered. (Refer to "Carburetion," Section VII.)

Emergency Use of Carburetor Preheat.

The temperature range that is most critical for induction system icing is from —50°C to +15°C. In event it becomes necessary to maintain the CAT. above the icing range throughout a descent to touch-down, the following procedure will apply. Use single turbo and a high turbo setting with part throttle down to the traffic pattern altitude, with carburetor preheat off. At traffic pattern altitude, with the carburetor preheat circuit breakers pulled, place the carburetor preheat switch to the ON position. Advance the throttle on one engine at a time to 37 inches M.P. and shift to dual turbo. As the shift occurs, push the carburetor preheat circuit breaker in for that engine. This procedure will maintain the CAT. at approximately 30°C during and after shifting from single to dual turbo.

CAUTION

In icing conditions it is imperative to maintain the CAT. well above the icing range during the transition of the turbo shift. Repeat these steps for the other five engines.

CAUTION

If the landing is rejected, turn the carburetor preheat switch OFF as go-around power is applied.

Jet Engine Icing.

The jet engines can be seriously affected by icing. Ice forms on the fixed inlet screens and compressor inlet guide vanes and restricts the flow of inlet air. The reduced air flow causes a loss in thrust and a richer fuel-air mixture. As thrust decreases the rpm decreases and as the fuel-air mixture becomes richer the tail pipe temperature increases. In an attempt to maintain rpm the automatic fuel control routes a greater amount of fuel to the combustion chambers which further increases the tail pipe temperature. Once the ice begins to restrict the air flow and the tail pipe temperature starts to rise it may be only a matter of seconds until turbine failure occurs if corrective action is not taken. Critical ice build-up on inlet screens can occur in less than one minute, and if the inlet screens are not installed, critical ice build-up on the inlet guide vanes can occur in four minutes or less.

The rate of engine icing for a given atmospheric icing intensity with outside air temperature below freezing is relatively constant at the speeds this airplane flies. Ram pressure heating of air at high speeds does not offset the icing conditions.

Icing of external surfaces cannot be regarded as an indication of jet engine icing because the engines can ice to a serious extent before external icing is evident. When flying at relatively low air speed and with a high power setting, as in a climb, the intake air is sucked instead of rammed into the compressor inlet. This suction causes a decrease in air temperature, and air at ambient temperature above freezing may be reduced to sub-freezing temperature as it enters the compressor inlet. Free moisture in this air may become super cooled and cause engine icing while no external icing is evident. The maximum temperature drop which can occur is approximately 9°F (5°C). This maximum drop occurs at high rpm on the ground. The drop will become less as rpm decreases or as air speed increases.

The initial indication of engine icing is an increase in tail pipe temperature and usually this is the only indication before complete engine failure. Since icing and failure can occur very rapidly, the tail pipe temperature indicator must be watched closely when possible icing conditions are present.

Icing Prevention. To prevent jet engine icing the following should be observed:

1. Avoid atmospheric icing conditions whenever feasible.

2. If possible, avoid take-offs with jet engines operating when temperature is between 14°F (—10°C) and 41°F (5°C) if fog is present or the dew point is within 7°F (4°C) of the ambient temperature. These are conditions under which jet engine icing can occur without external icing.

3. If the ambient temperature is in the range of 32°F (0°C) to 41°F (5°C) and the dew point is within 7°F (4°C) of ambient temperature, the jet engines should be shut down and the nose doors closed.

Note

The above procedure should be used only to avoid icing when the temperature and dew point are conducive to the formation of ice caused by a drop of air temperature as it is sucked into the jet engine air intake. Do not follow this procedure if icing conditions already exist.

4. If icing conditions are encountered at freezing atmospheric temperatures, immediate action should be taken as follows:

Note

The rate of engine icing for a given atmospheric icing intensity with outside air temperature below freezing is relatively constant at the speeds this airplane flies. Ram pressure heating of air at high speeds does not offset the icing conditions.

a. If practical, change altitude rapidly by climb or descent in layer clouds or vary course as appropriate to avoid cloud formations.

b. If the jets are operating, shut them down.

CAUTION

It is permissible to use the jet engines while encountering ice if threatened with loss of aircraft due to loss of jet engine thrust. A continuous surveillance of jet tail pipe temperature and such power reduction of the jet engines as may be required to hold these temperatures within the allowable limit is necessary to prevent the possibility of major damage to the aircraft. The rise in tail pipe temperature due to ice blockage can be very rapid and the consequences of not shutting down the jets are turbine buckets erupting through the jet pod nacelle.

c. Close the nose doors.

d. Apply pod preheat, depending upon requirement for wing anti-icing.

Note

Do not apply heat to nose doors.

Starting Engine After Leaving Icing Conditions.

To start engines after leaving icing conditions proceed as follows:

1. Apply pod preheat if not already on.

2. Determine whether the rotor is free as follows (without cracking throttle):

a. Crack nose doors.

Note

Tap tachometers for early rpm indication.

b. If rotor does not turn, open air plugs fully.

CAUTION

Do not attempt to open doors with ice visible on jet pod lips and doors. If ice is visible and ambient temperature is below 41°F (5°C) do not apply heat to nose doors. This temperature restriction is necessary to prevent ice melted at the nose doors refreezing in the compressor section and stopping engine rotation causing possible damage to the engine.

c. If rotor does not turn with doors fully open, apply starter for a maximum of 5 seconds.

CAUTION

Starter will burn out if operated over 5 seconds or if reapplied over three times in rapid succession with rotor locked.

d. With nose doors fully open and with the correct windmilling rpm, attempt a normal air start.

CAUTION

The pilot should be alert for excessive tail pipe temperature due to intake air blockage or any indication that pieces of ice have damaged the compressor.

SNOW.

Impaired forward visibility is the main problem when flying in a snowstorm. Windshield wipers and maximum windshield defrost will improve forward visibility under this condition. Side visibility will not be greatly reduced. Optimum anti-ice configuration should be maintained.

RAIN.

Forward visibility in rain is also a serious problem. Side visibility will not be seriously impaired, but final approaches in heavy rain will be rather difficult. Proper windshield wiper blade contact will reduce the hazard considerably.

TURBULENT AIR PENETRATION *Speeds*
ALL LOADS EXCEPT TWO 43,000 LB. BOMBS

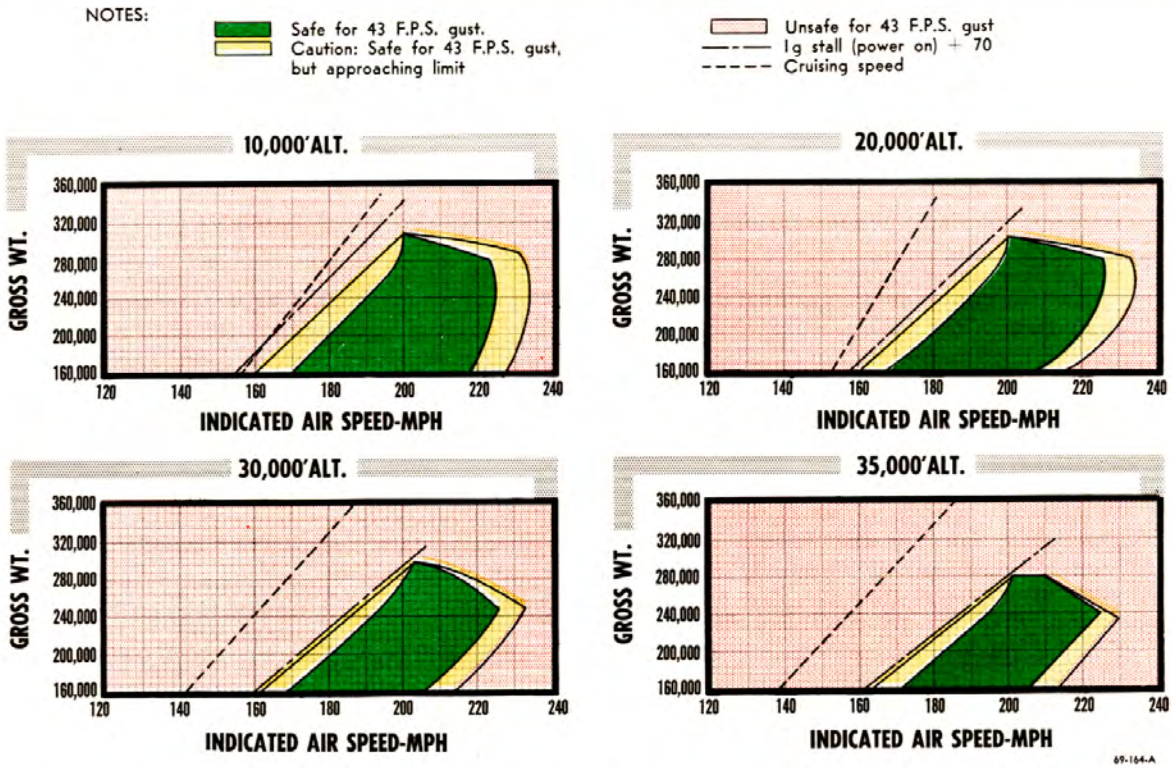


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Figure 9-5.

TURBULENT AIR AND THUNDERSTORM FLYING.

Flight through a thunderstorm should be avoided. However, since circumstances may force you to fly into a zone of severe turbulence, you should be familiar with piloting techniques recommended for these conditions. Power setting and pitch attitude are the keys to proper piloting technique when flying in turbulent air. The power setting and pitch attitude required for the proper penetration air speed are established before entering the storm. This attitude, if maintained throughout the storm, will result in a constant air speed regardless of any false readings of the air-speed indicator. Specific instructions for preparing to enter a storm and flying in it are given in the following paragraphs.

CAUTION

On entering thunderstorms and areas of excessive precipitation close surveillance of alternators must be maintained because it is possible for the d-c exciter generator commutator to collect enough moisture to drown out completely. The volts and cycles will go to maximum negative readings and the alternator will not automatically come off the line. Re-excitation is possible and normal power can be restored after the airplane has emerged from the precipitation area and the d-c exciter generator has had time to dry.

APPROACHING THE STORM.

It is imperative that you prepare the airplane prior to entering a zone of turbulent air. If the storm cannot be seen, its proximity can be detected by radio crash static and strong rain echoes picked up by the airborne radar. Prepare the airplane as follows:

1. Disengage the autopilot.

2. Maintain sufficient CHT and CAT. to preclude the possibility of engine or carburetor icing.

3. Mixture controls — NORMAL, model 391260-8, 391420-1, and 391410-1 and -2 carburetors; RICH, model 391260-3, -4, -5, and -6 carburetors.

4. Pitot heater switches—ON.

5. Carburetor preheat—As required.

6. Throttle—Adjust as necessary to obtain recommended penetration speeds shown in figure 9-5. These speeds provide the maximum margin under turbulent air conditions between stall possibilities at slower speeds and structural limits and compressibility buffeting at higher speeds.

7. Check gyroscopic instruments for proper settings.

8. Safety belts—Tightened. (Check with crew members.)

9. Turn off radio equipment rendered useless by static.

10. At night, turn on the white flight deck flood lights to minimize the blinding effect of lightning.

WARNING

Do not lower the landing gear or the flaps because they merely decrease the aerodynamic efficiency of the airplane.

IN THE STORM.

1. Maintain power setting and pitch attitude (established before entering the storm) throughout the storm. Hold these constant and your air speed will be constant—regardless of what the air-speed indicator reads.

2. Devote all of your attention to flying the airplane.

3. Expect turbulence, precipitation, and lightning, but do not allow them to cause you undue concern.

4. Maintain attitude. Concentrate principally on holding a level attitude by reference to the artificial horizon.

5. Do not "chase" the air-speed indicator, since doing so will result in extreme airplane attitudes. If a sudden gust should be encountered while the airplane is in a nose-high attitude, a stall might easily result. A heavy rain may partially block the pitot tube pressure head, causing the reading on the air-speed indicator to decrease by as much as 70 mph.

6. Use as little elevator control as possible to maintain your attitude in order to minimize the stresses imposed on the airplane.

7. The altimeter is unreliable in thunderstorm flying because of differential barometric pressures within the turbulent area. A gain or loss of several thousand feet may be expected. Make allowances for this error in determining minimum safe altitude.

Note

Normally, the least turbulent area in a thunderstorm will be at an altitude of 6000 feet above the terrain. Altitudes between 10,000 feet and 20,000 feet are usually the most turbulent.

• Cold Weather Procedures •

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The following procedures are written as a supplement to the instructions in Section II, "Normal Procedures," and should be complied with when cold weather conditions are encountered. The success of the next day's operation depends greatly on advanced planning and the preparations made during engine shutdown and postflight procedures. Because of their importance, these procedures will be treated first and at the same time a logical sequence of events will be maintained. Because of the mission of the B-36, which is long range, it would be normal for a flight to start in a warm climate and end up in a cold climate. *Therefore, cold weather procedures start with engine shutdown and postflight procedures.*

ADVANCED PLANNING.

Proper advanced planning can mean success or failure of an entire cold weather operation. When planning, bear one thing in mind—"an ounce of prevention is worth a pound of cure."

1. The first part to consider is proper ground heating equipment. Each crew compartment should be heated, as well as the reciprocating engines and jet pods. Make sure there are the proper number of heaters, heater ducts, and electrical power plants for each aircraft. (Sixteen heaters per aircraft desired.)

2. Make sure there are ample fueling facilities for the power plants and heaters.

3. If night work is anticipated, have ample supply of stand lights and drop lights.

4. All flight engineers and crew chiefs should be properly briefed on oil dilution during engine shutdown and engine starting in cold weather. This will be explained later in this section.

5. Snow and ice removal equipment should accompany each aircraft.

6. Two B-2 stands and two B-1 stands per aircraft are a minimum to be able to maintain an aircraft. More

OIL DILUTION *Tables*

Table I

EXPECTED OUTSIDE AIR TEMPERATURE	PER CENT DILUTION REQUIRED	DILUTION TIME REQUIRED (MINUTES)
40°F	0	0
40° to 25°F	10	2
25° to 10°F	15	3
10° to —5°F	20	4
—5° to —20°F	25	6
—20° to —35°F	30	8
—35° to —65°F	35*	12

*MAXIMUM AVAILABLE

Table II

ENGINE RUN TIME (MINUTES)	PER CENT DILUENT REMAINING			ENGINE CONDITION
	35% DILUTION	25% DILUTION	15% DILUTION	
0	35	25	15	IDLE
1	32.5	23	14	IDLE
3	25	20	12	IDLE
5	19	18	10	IDLE
10	16	15	8	IDLE
15	15	11	7	MAG. CHECK
20	11	8	6	MAG. CHECK
25	9	6	5	OTHER CHECKS
30	7	5	5	OTHER CHECKS
35	6	5	4	OTHER CHECKS
40	5	4	3	OTHER CHECKS
45	4	3	3	OTHER CHECKS

For a full dilution use Table I. For a partial dilution obtain the per cent diluent remaining from Table II and apply this value and the total per cent dilution required to Table I to obtain the dilution times for these percentages. The difference in the times required, as indicated by Table I, will be the dilution time required to obtain the desired final dilution.

Example: If the expected OAT. is -20°F the dilution required will be 25 per cent, as indicated on Table I. Then say the engine had been run at idle for 10 minutes and shut down. The diluent would be 15 per cent as indicated in the "Diluent Remaining, 25 Per Cent Dilution" column in Table II. Table I indicates that 6 minutes is required for 25 per cent dilution and 3 minutes is required for 15 per cent dilution. Therefore 3 minutes (6 minutes minus 3 minutes) is the dilution time required to replace the diluent lost during the previous engine operation.

NOTE

The required dilution for -65°F, which is 40 per cent, cannot be obtained on this aircraft but satisfactory operation can be obtained with the maximum dilution now obtainable, which is 35 to 37 per cent.

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Figure 9-6.

stands should be used if available. All stand steps and platforms should be coated with sheets of No. 3 grit sand paper. This is to prevent slipping when feet are wet.

7. Safety straps and ropes should be used while walking on slick wings.

8. A fuel tank repair crew should be set up to take care of existing leaks.

9. Aircraft servicing equipment should be checked and sumps drained before use.

10. A kit of cold weather handling equipment should be made up for each aircraft. This section relates the proper handling of this equipment.

POSTFLIGHT PROCEDURES.

OIL DILUTION.

To accomplish satisfactory starting of engines in cold weather, it is imperative that each engine oil system be diluted in accordance with the following procedure:

1. Stop engines, check oil level, and service if necessary. Allow engines to cool until oil temperatures are 10°C to 50°C. While waiting for oil temperature to reduce to that required for dilution, service oil tanks and drain condensate from the oil tank sumps, oil cooler drains, and Y-drains. Experience has shown that in order to prevent accumulation of ice in the tank oil-out line, oil tank sumps must be drained from 15 to 45 minutes after shutdown.

Note

The sumps should not be drained after dilution. Draining the sumps after dilution would permit undiluted oil to enter the tank hopper and sump.

2. Restart the engines and idle at 1200 rpm.

3. Hold the oil dilution switches ON as long as required for proper oil dilution. The per cent dilution required will vary according to the lowest expected OAT. The dilution time required will vary according

to whether diluent remains in the system from a previous dilution. If the engines have been operated for less than one hour following a full dilution it will be necessary to accomplish only a partial dilution when the engines are shut down to replace the diluent which has boiled off. Experience has shown that boil-off is influenced by CHT, oil temperature, bhp, and other factors and for this reason an exact determination for redilution following short engine runs is not practical. The two tables shown in figure 9-6 will give the required dilution at various OAT.'s and an approximation of the diluent remaining after certain periods of engine run.

The operation of the dilution system is indicated by a fuel pressure drop to approximately 20 psi which will be approximately a 15-psi drop. If this pressure drop is not obtained, investigate the cause. Pay particular attention to dilution solenoids which may be stuck, dilution lines which may be plugged, and restrictor fittings which may be reversed.

CAUTION

Do not allow the engine oil pressure to fall below 15 psi during dilution. If necessary, stop the engine until oil temperature drops to 10° to 50°C. If the oil temperature rises above 60°C during dilution, the engine must be shut down until the oil temperature drops sufficiently to allow completion of dilution on the next attempt.

4. Release the dilution switch at 500 rpm as the engine is being shut down and check for an increase in fuel pressure. This is important because only diluted oil must be circulated through the engine oil system

5. Insure that the oil dilution valves are fully closed by performing the following check:

a. With fuel booster pumps ON, note fuel pressure and fuel flow indications.

b. Hold the oil dilution switch ON long enough to note fuel pressure drop and fuel flow increase.

EXTERNAL DRAIN AND VENT *Locations*

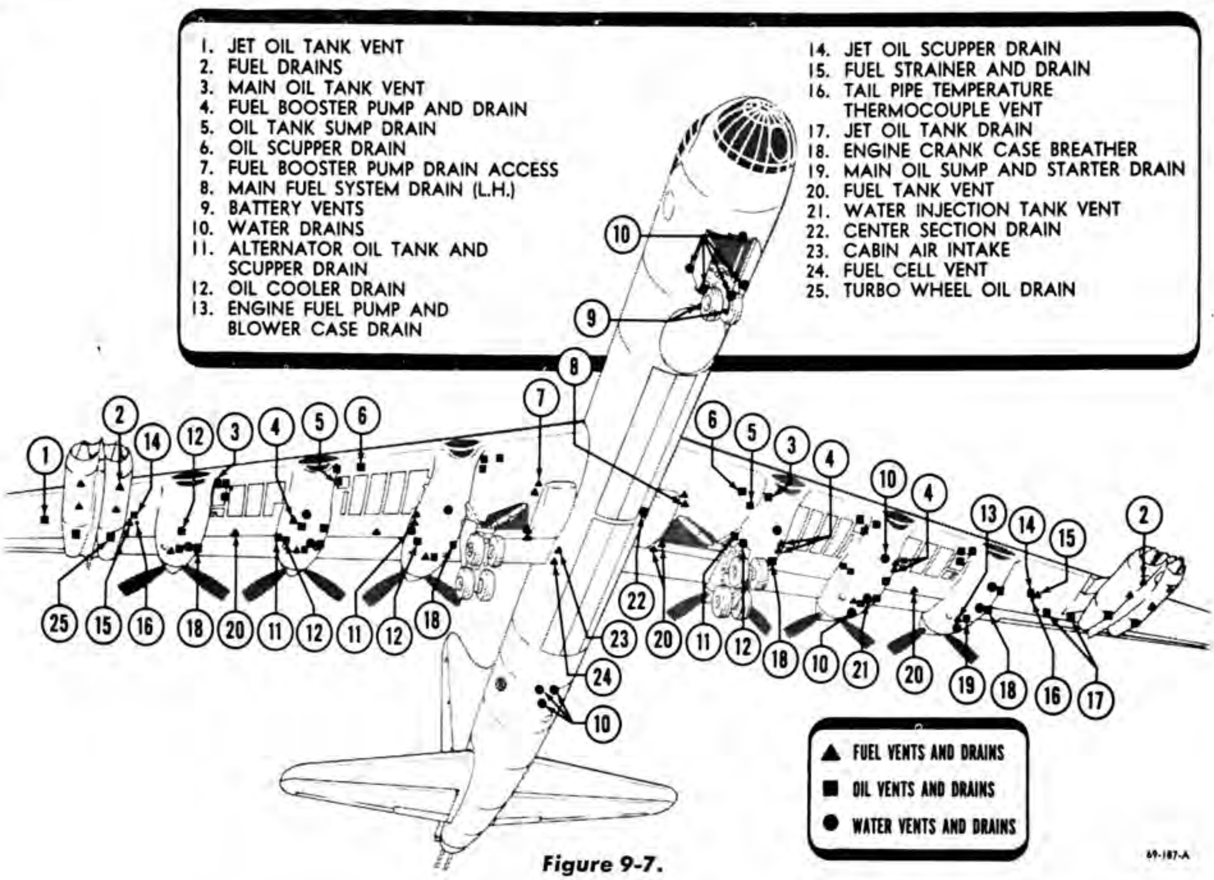

Figure 9-7.

c. Oil dilution switch OFF and observe fuel pressure rise to original value and fuel flow drop to original value. If either fails to return to the original value, the dilution valve did not close. In either case, corrective action must be taken.

Note

Under no circumstances will the oil dilution valves be used as a means of relieving trapped pressure in the fuel lines.

ENGINE SHUTDOWN.

Use the normal engine shutdown procedure with the following exceptions:

1. Dilute the engine for anticipated temperatures in accordance with figure 9-6.
2. During the last minute of the dilution period specified above, operate the engine at 1600 to 1700 rpm, in order to clean the spark plugs, and manually adjust to the best power, provided oil temperature does not exceed 50°C and the CHT is limited to a maximum of 150°C. This clearing procedure will be abandoned if oil temperature reaches 50°C or the cylinder head temperature rises above 150°C; however, the dilution period will be completed.
3. Close the throttle.
4. Open the air plug to prevent post shutdown increase of engine temperature, which is conducive to subsequent condensation within the cylinder.
5. Move the mixture control to IDLE CUT-OFF *very slowly,* thus allowing the chamber to be completely scavenged of moisture and carbon.
6. Never open the throttle after shutdown.

AFTER ENGINE SHUTDOWN.

After engine shutdown, the following procedure should be followed:

1. Drain fuel tank and booster pump drains before moisture freezes. If fuel tanks are kept filled, condensation in fuel lines and drains will be minimized.
2. Inspect turbo oil system vents and drains. Drain condensation.
3. Approximately 30 minutes after stopping engines, turn each propeller through 10 blades by energizing the starter continuously.
4. Install air intake ducts, engine, turret, nose compartment, blister, pilots' enclosure, and pitot mast covers. Install tape over static ports.
5. If wings are dry and no wind condition prevails, wing and elevator covers may be used. Wing covers should not be used if wings are wet because of the possibility of freezing the covers to the wings. If wing covers are available but surfaces are wet, coat surfaces with defrosting fliud and install covers. If wing covers are not available, section covers should be made locally.
6. Position the propeller blades so that two blades are down and one is up. Cover the tip of the blade that is up to prevent ice and snow from entering the anti-icing air exit opening.
7. Drain the overflow and filler lines for the roomette waste tanks. Drain all liquid containers.

ENGINE AND POWER PLANT SERVICING.

The following is a list of oils that must be used in the engines and auxiliary power units during cold weather operations.

• SERVICE INFORMATION *Table* •

1. Reciprocating Engines • Specification MIL-L-6082, grade 1100 lubricating oil.

2. Jet Engines and Turbosuperchargers • Specification MIL-L-6081 grade 1010 or 1005 above −20°F, grade 1005 below −20°F.

3. Propellers
   Hub • MIL-0-6086 Grade M.
   Power Section • MIL-L-7870

4. Engine Instruments • Service the oil pressure lines of engine instruments with hydraulic oil, Specification MIL-0-5606 in accordance with instructions contained in T.O. 05-70-6.

5. Water Injection • 60 percent methyl alcohol and 40 percent distilled water, thoroughly mixed.

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SNOW AND ICE REMOVAL.

The removal of ice and snow can present quite a problem if preparations have not been made prior to its arrival. The following is a list of do's and don'ts and the equipment needed in the combating and removal of ice and snow.

1. It is necessary that all frost, snow, and ice be removed from the wings, tail surfaces, and propellers prior to flight. Even a slight amount of frost will disturb air flow over the air foil and reduce lift. Loose snow can be removed with a long-handled broom. Melt ed and refrozen snow is extremely difficult to remove.

2. Removal of frost and any light coating of ice may be accomplished by the use of defrosting fluid in accordance with Specification 3609. If snow or freezing rain is anticipated, the wing and control surfaces should be coated with defrosting fluid prior to arrival.

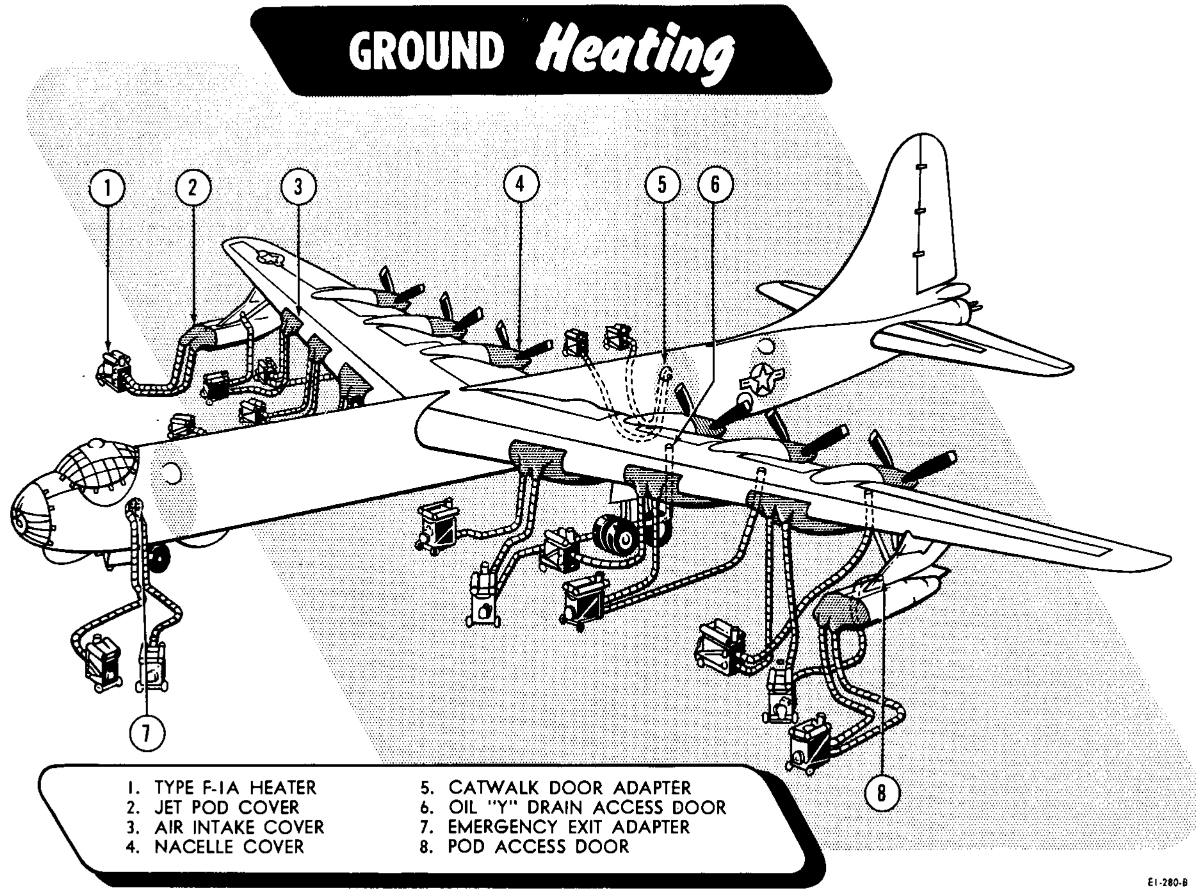

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Figure 9-8. Ground Heating

Surfaces coated with de-icing fluid should be inspected every 4 hours and resprayed if necessary.

CAUTION

a. Due to the rapid evaporation characteristic of defrosting fluid, contact with the skin at low temperatures may cause serious frost bite.

b. Do not use picks, knives, or other sharp pointed objects to break ice as damage to the aircraft structure will result.

c. Use extreme caution when walking on surfaces after application of defrosting fluid.

d. The fluid should not be sprayed on engine surfaces or into engine air ducts leading to the carburetor or oil coolers.

e. After use of defrosting fluid, inspect surface hinge areas and remove deposits of slush; use heat if necessary.

f. Do not use defrosting fluid on sighting blisters or any other panes used for gun sighting.

PREHEAT OF ENGINES AND AIRCRAFT.

1. Check the Y-drains and oil tank sumps for oil flow. If oil does not flow, apply external heat to Y-drain.

CAUTION

Do not drain more than one half pint in order to prevent undiluted oil from entering the oil line.

2. Oil screens should be checked before each flight during the early part of the cold weather period to remove engine sludge which has been washed down by oil dilution. After the first five or six oil dilutions, oil screens will be checked according to existing regulations.

3. Check turbo oil system drains for free flow and the turbo oil tank vents for freedom from frozen condensate. Insert a heavy wire in the vent line to check the first right angle bend in the line for freedom from ice.

4. Check all fuel, water, and oil tank vent lines and crankcase breathers for freedom from frozen condensate.

5. Apply external heat to the oil tank vent line aneroid valve for 30 minutes prior to starting. It has been found that during ground operation under cold weather conditions, ice forms in the aneroid valve, blocking the oil tank vent line. This results in excessive pressures being built up in the tank which will cause structural damage to the oil tank.

CAUTION

After engine start, observe the oil tank vents for fifteen minutes for signs of escaping vapors which indicate that the aneroid valve is thawed and the line is open. If vapors are not observed, shut down the engine immediately and apply more heat to the aneroid valve.

It appears that the most critical period of operation is immediately after starting—probably the valve is warmed later on by hot gases from the engine being pumped back to the tank by the scavenge pumps.

6. Always preheat the engines any time oil dilution was not accomplished and OAT. is less than 32°F (0°C) or any time engines were diluted and OAT. is less than 16°F (—9°C). Preheat as follows:

a. Connect two heater ducts to the air intake cover at the leading edge of the wings.

b. Install the engine cover (if not previously installed).

c. Connect one heater duct at the oil Y-drain access cover if temperature is below—40°F (—40°C).

d. Heat until cylinder head temperature indicates at least 0°C; oil will flow from the Y-drain and propellers can be pulled through. Always leave the air plug and intercooler shutters closed for all preheating.

CAUTION

In the event the air plugs were inadvertently left open, do not attempt to close them until the engines are started and sufficient heat from the engine has warmed the air plug actuator and jackscrews.

Note

Normal starts can be made when the cylinder head temperature reaches 0°C. No damage can result from prolonged heating, whereas considerable difficulties may result from insufficient heat.

7. Warm the oil supply by plugging in the external power source to the heating receptacle on the wing lower surface near each oil tank. The heaters heat the oil tank hopper and tank oil-out line. Use of heat is necessary when the OAT. is below the pour point of the oil which will vary from +20° to 0°F.

HEATING TIME *Requirements*

Outside Air Temperature	Time
+20°F to -10°F	10 minutes
-10°F to -20°F	20 minutes
-20°F to -30°F	30 minutes
-30°F to -40°F	40 minutes

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The heaters must be completely covered with oil before using them to prevent coking of the oil and overheating of the heating elements. Therefore, do not operate the heaters if the oil level is below 145 gallons.

Note

To check for proper heater operation, see that the power consumption is 45 to 50 amperes for each heater installation; otherwise, because of their locations, it will be impossible to tell whether or not the heaters are functioning.

CAUTION

The hopper heaters heat only the oil in the hopper and tank oil-out line. The warm return oil from the engine will melt oil in the tank and if a serious oil leak develops the melting rate may not be of sufficient speed to replenish the oil in the hopper. This would result in an insufficient oil flow to the engine. Watch oil pressures closely since the oil level liquidometer may be in congealed oil and may not show a change in oil level.

8. Turn on oil tank vent electric heaters 30 minutes prior to engine start. Operation of the heaters should be checked by inserting finger in the vent outlet 20 minutes after turning switch ON.

9. If low or no oil pressure is indicated after engine start, heat the oil-in line from the tank bulkhead to the oil shutoff valve. An effective method of heating

the line is to cover the line with a piece of canvas and direct hot air under it.

10. Preheat the crew compartments to heat flight instruments, radios, dynamotors, recitifiers, radar, and other equipment within the airplane, and to retard the formation of frost on transparent areas when the crew enters the airplane.

CAUTION

Do not operate electrical cabin heaters unless two or more alternators are paralleled on the line.

11. Check the fuel system for leaks and check all fuel drains for free flow. Apply heat where necessary to obtain flow.

12. Install warm battery or heat cold battery if it has not been removed after preceding flight.

13. Check the tires and shock struts for proper inflation.

CAUTION

Checking and servicing of tires and shock struts may result in valve leakage. Usually this can be corrected by applying external heat.

If the aircraft has been parked more than 48 hours in temperatures of —40°F (—40°C) or below, the tires must be heated and rotated. Heat should be left on the tires for at least 15 minutes after rotation to eliminate the flat spot.

14. Remove the covers of the engines, wing, tail, guns, pilots' enclosure, nose compartments, and pitot masts. Also, remove tape from static ports.

15. Remove ice, snow, and frost from the fuselage, wings, and horizontal stabilizer. Inspect the turret bay door tracks and remove ice and snow. Snow can be removed by brushing with brooms, use of portable heaters and alcohol, or by vibrating a rope across the wing surface. Ice must be removed carefully to prevent scatching or marring the wing surfaces.

16. Remove ice, frost, snow, and dirt from the landing gear shock struts, actuating cylinders, wheels, and brakes. After shock struts and actuating cylinders are clean, wipe with a hydraulic-fluid-soaked cloth.

STARTING RECIPROCATING ENGINES.

1. Start with closed air plugs and intercoolers. Do not open the air plugs until the engine CHT is 170°C. On airplanes in group 3, if the CHT cannot be raised to 170°C with the air plug closed, place the engine fan speed switch in the NEUTRAL position. In the event the air plugs were inadvertently left open, do not attempt to close them until the engines have been started and sufficient heat from the engine has warmed the air plug actuator and jackscrews.

2. A normal start should be made by following the procedure outlined in Section II, "Normal Procedures," except that prime may be required to help the start and except for the following:

a. Position the ignition switch at OFF.
b. Place the mixture control in IDLE CUT-OFF.
c. Close the throttle.
d. Turn on the booster pump.
e. Crank continuously.
f. Turn the propeller through 12 blades while observing for hydraulic lock.
g. Place the mixture control in NORMAL position and turn the propeller through six additional blades.
h. Position the ignition switch at ON and prime as necessary.
i. Adjust the throttle to maintain stable operation.

3. Listed below are possible starting troubles and the proper corrective action:

Trouble	*Probable Cause*	*Corrective Action*
Failure to start	Frosted spark plugs	Additional preheat
Low fuel pressure	Faulty oil dilution valve	Check for stuck valve
Low oil pressure	Congealed oil in lines	Apply heat to lines
	Faulty instrument pressure for lack of fluid in lines or congealed oil	Check instrument Check instrument system and bleed lines with hydraulic fluid
High oil pressure which falls off or fluctuates when rpm is increased	Heavy viscous oil	Additional preheat to tank and lines if pressure is below limits
Props not controllable	Stuck solenoids	Apply heat
Oil leakage from turbos into shroud	Turbo oil tank vent obstructed with ice	Clear vent
	Faulty anti leak valve	Replace valve

4. If the oil pressure is too high after starting or if it fluctuates and drops back with an increase of engine rpm, do not exceed idle rpm until the oil temperature reaches the minimum allowable. Erratic or high oil pressures may be caused by the high viscosity of the oil due either to applications of insufficient preheat or to insufficient dilution after the last flight.

CAUTION

If fuel pressure is lower than normal, check for a stuck oil dilution valve.

5. If no indication of oil pressure is obtained within 50 seconds after starting, shut down. After approximately 5 minutes, make a restart and run an additional 50-second period. If pressure is still not obtained, shut down and check for oil flow at Y-drain. If no flow is obtained at the Y-drain apply heat in this area for 30 minutes. If flow is satisfactory from Y-drain, apply heat to oil lines between tank and oil shutoff valve for 30 minutes. The primary and most common causes for lack of oil pressure indications are:

a. Congealed oil in the engine oil-in line, usually near the tank.

b. Failure of oil pressure gage to indicate properly because of congealed oil in the pressure lines or transmitter.

Note

To mimimize this type of trouble, purge the pressure lines with hydraulic fluid after every fifth start.

6. If oil pressure drops after a few minutes of ground operation, shut down the engine and check the following:

a. Y-drain for congealed oil or ice.

b. Blown lines or oil coolers.

c. Failure of pressure gage.

d. Oil strainers for foreign materials which might indicate that engine failure is the cause of low oil pressure.

e. Insufficient hopper heat.

Note

Oil dilution may be used to reduce viscosity of the oil if time does not permit normal engine warm-up or if the oil pressure is too high for a prolonged period.

CAUTION

Dilute oil with care because engine failure can result from over-dilution.

ENGINE WARM-UP.

After engine start, with air plug and intercooler shutters closed, if the OAT. is 0°F (—18°C) or below, or if 170°C CHT cannot be obtained, the following engine warm-up procedure should be used:

1. Idle the engines at 1000-1200 rpm with carburetor preheat ON until oil-in temperature reaches the minimum allowable limits.

2. With the propeller master motor set at 2800 rpm, increase engine rpm to 1550 rpm.

3. After power has stabilized, reset master motor to 1550 rpm and increase M. P. to 30 inches.

4. When oil-in temperature reaches 60°C or above, increase rpm to 2000 maintaining 30 inches M. P.

Note

While waiting for the engines to warm up, make all field barometric pressure checks except high fan and magneto checks.

5. When oil-in temperature reaches 70°C, turn preheat OFF and make high power checks.

CAUTION

Do not go above 2200 rpm until oil-in temperature reaches 70°C or above.

6. Attempt to maintain CHT from 210° to 225°C during all ground operation. This may require keeping the air plugs fully closed.

Note

It would require from 45 minutes to one hour of engine operation at normal temperatures to evaporate all the fuel in the diluted oil. Even though high oil inlet temperatures of 70°C (158°F) and above would shorten the period, this procedure is not recommended. Normal warm-up procedure will evaporate sufficient fuel to assure normal scavening.

7. After several days layover, during which time the engine has been started and diluted several times, it is advisable to ground run the engine for at least 30 minutes at normal cylinder head and oil inlet temperatures prior to take-off. It is also recommended that the oil level be checked; it may have fallen considerably due to evaporation of gasoline. The ground run will tend to eliminate any excess dilution which might otherwise cause oil discharge through the breathers or loss in oil pressure during high power take-off or operation.

DURING ENGINE WARM-UP.

1. Check all instruments for proper operation.

2. To prevent the flight instruments from cooling and to aid in windshield defrosting, operate the cabin heating system as follows:

a. Increase the manifold pressure on the inboard engines until a good cabin heat air flow is obtained. If the air thus supplied is insufficiently warm for defrosting, turn on the tail anti-icing system and place the cabin booster fan switch in the LOW RPM position to raise the temperature of the cabin heating air at the secondary heat exchanger.

CAUTION

Do not operate booster fan in HIGH RPM position below 8000 feet.

b. To prevent overheating of the tail structure do not allow the temperature of the tail anti-icing air to exceed 105°C (221°F) during ground operations. Use the cabin heat and tail anti-icing control switches to reduce the temperatures of the tail anti-icing air.

c. Increase cabin temperature and aid defrosting by utilizing the auxiliary cabin heaters.

CAUTION

To avoid overloading the a-c system due to the high power requirements of the auxiliary cabin heaters, do not operate these heaters unless two or more alternators are on the line.

3. Operate the windshield wipers.

4. Operate the wing flaps and bomb bay doors through at least one cycle.

5. Check wing and empennage anti-icing.

CAUTION

Be careful not to exceed anti-icing air temperature of 105°C (221°F).

STARTING JET ENGINES.

Use the normal starting procedure.

Note

A slightly longer cranking period will probably be required to bring the jets up to starting rpm than is required in warmer weather.

TAXIING AND PARKING.

1. Avoid use of brakes as much as possible during last part of taxiing and parking. This prevents the brakes from getting hot and then freezing. If brakes are frozen, heat can be used, but the aircraft should be moved as soon as brakes are thawed to prevent refreezing.

CAUTION

Under certain snow and ice conditions the use of differential power and braking may result in a skipping or lateral skidding action of the nose wheel. This skipping action can best be overcome by stopping the airplane, changing the nose wheel angle, and resuming taxiing. Light braking may be erratic and lack proper brake "feel"; therefore, control ground speed with one pair of propellers in reverse. Use propeller reversing with caution as the resulting snow cloud may blind the pilot.

2. Wheel covers should be installed when the airplane is parked and snow and ice are present.

BEFORE TAKE-OFF.

1. Keep CHT as high as possible within allowable limits using the air plugs to control temperatures.

CAUTION

Flight indicators are not very reliable at temperatures below —45°F (—43°C). For this reason cabin heating is very necessary during warm-up and take-off, and all flight instruments must be cross checked.

2. Frequent exercising of the brakes during power stabilization and prior to take-off may prevent brakes from freezing.

CAUTION

Brakes will not hold the aircraft during high power runs on ice and snow.

TAKE-OFF.

1. Turn on the pitot heaters and the wing and tail anti-icing systems if precipitation is encountered or if icing conditions are anticipated at the beginning of the take-off roll. Icing conditions may exist where there is visible moisture in the air at outside air temperatures of 45°F (7°C) and below. Most severe icing conditions usually occur in the range from 32°F (0°C) to 5°F (—15°C).

2. If oil dilution was used on previous engine shutdown, take-off can be made as soon as oil pressure is normal, engine operation is smooth, and CHT is up to 180°C. Precaution must be taken to insure that the oil pressure is normal. Oil pressure below normal may be due to over-diluted oil. Cold oil properly diluted has the same viscosity as warm undiluted oil and

therefore the same ability to circulate and properly lubricate the engines. The term "over-dilution" has been used to indicate any amount of dilution which causes the engine scavenging system to break down and discharge diluted oil through the engine breather.

3. In order to avoid overtaxing the engine on take-off or to avoid standing short on take-off horsepower available, it is essential to make the proper humidity and CAT. correction to manifold pressure. These corrections modify the value of M. P. necessary to develop the torque corresponding to 3800 bhp. This is especially true in cold weather operation where it is quite easy to take more than 3800 bhp out of the engine if normal day M. P. is used. In this case a 3800 bhp torque may be obtained at manifold pressures as low as 52 inches.

CAUTION

Do not pull more than 3800 bhp torque regardless of the M. P. attained. Also, do not exceed the corrected M. P. while trying to attain 3800 bhp, since an engine malfunction may exist.

4. Under certain cold weather conditions, water injection may cause drowning of cylinders and loss of power due to improper vaporization of the water mixture. Since limiting operating temperatures (CAT., CHT, water temperature, etc.) have not been established, *it is urgent that a test on at least one engine be performed prior to take-off to determine whether operation at wet take-off power is satisfactory.* This test period should be of at least one minute duration. The results of this check will determine whether water injection should be used for take-off. Loss of torque and rough running are indications of improper engine operation with water injection.

5. It is advisable to maintain CAT. above freezing, if possible to do so without exceeding the maximum CAT. limit. The desired temperature range is from +20° to +35°C to avoid carburetor icing as well as to aid in vaporizing the fuel and water.

Note

The CHT measured on D-5 cylinders should be at least 225°C to also aid in vaporizing the fuel and water.

It is recognized that use of the carburetor preheat system may result in excessive CAT. at take-off power if used at ambient temperatures in excess of 10°F (—12°C). At ambient temperatures higher than this, the preheat system is not needed due to adequate temperature rise from turbo compression. It is suggested that under these conditions, CAT. be controlled by intercooler shutters.

For ambient temperatures of 10°F (—12°C) or less, use of the preheat system should be attempted. The exact upper limit of outside air temperature at which preheat should be used has not definitely been established, but tests have been proposed to evaluate the preheat system at or near the previously defined upper limit of OAT. at which carburetor preheat could be used.

Although the CAT. may be within limits with carburetor preheat ON at the beginning of the take-off run, the application of full power may cause the CAT. to increase rapidly and exceed the safe range resulting in loss of manifold pressure and power. In view of this, *any aircraft operating in cold weather with an OAT., of 10°F (—12°C) or lower should make a preliminary preheat evaluation by performing a simulated take-off and trying the system on one engine.* To do this the intercooler shutters should be OPEN, the CHT should be at the low limit, and the preheat system should be operated with the circuit breaker at the start of the take-off roll. *The results of this test will determine whether it is safe to use preheat on all six engines for take-off.*

If CAT. is maintained in the range specified, the worst icing that could be encountered would be in the small mixture control bleed at the bottom of the regulator resulting in an enrichment that could be easily controlled with the mixture control lever. *If CAT. is not kept above freezing there is danger of icing the entire induction system and metering elements of the carburetor. Icing of the impact tubes and/or passages can result in dangerous leaning which cannot be controlled.* Icing of the split mixture control bleed in the boost hanger will result in a very high enrichment that is difficult to control with the mixture control lever.

Note

The engineer should watch the carburetor air temperature indicator and be ready to reduce CAT. by opening the intercooler shutters or by turning off the carburetor preheat system.

6. Turn off all auxiliary cabin heaters until after the landing gear and flaps are up.

7. Instruct the scanners to watch for locked wheels during take-off. Don't be alarmed if the brakes should lock temporarily while on snow and ice, because you will be able to retain control of the airplane. Ordinarily the brakes will not hold the airplane on ice and snow above normal rated power.

8. If discharge through the oil breather is noted at take-off, reduce rpm as quickly as practicable and operate engines at moderate powers for 10 to 15 minutes before increasing rpm. Oil discharge should cease soon after the reduction in rpm. When most of the diluted

oil has been expelled as indicated by normal oil pressure and temperature, normal engine operation can be resumed. If the oil discharge does not cease after reducing rpm, land and investigate the cause. Should the persistent discharge of oil be caused by high dilution of oil throughout the tank, drain the oil from the tank and refill with undiluted oil.

DURING FLIGHT.

For *all* operation, maintain the recommended range of CAT. to (1) aid in fuel vaporization, (2) reduce tendency to lead-foul spark plugs, and (3) improve fuel economy to extend range.

APPROACH.

1. Follow the normal procedure except use carburetor preheat as required and, if possible, employ a long, low approach to aid in keeping cylinder heads above critically low temperatures of 170°C.

2. Apply carburetor preheat as required during the entire landing operation. If a sudden acceleration is necessary, heat will be available for fuel vaporization regardless of how low cylinder head temperatures have dropped. However, should full power be required for a take-off or a go-around, keep carburetor air temperature below maximum allowable limit and be ready to reduce or shut off carburetor preheat. (See "Emergency Use of Carburetor Preheat" of this section.)

3. The air plugs should be closed during prolonged glides or approaches.

4. Temperature inversions are common in winter in arctic regions. Thus, the air may be from 27° to 54°F (15° to 30°C) colder on the ground than at altitude. Therefore, care must be taken to avoid rapid cooling when letting down. Extend the landing gear and use partial flaps to reduce air speed. Also, regulate the intercooler shutters to eliminate excessive engine cooling. Maintain cylinder head temperatures above 170°C minimum.

LANDING.

When landing on slick or icy runways and traction is poor, nose wheel steering may have little effect on directional control of the airplane, even though it is operating properly. When landing on a dry runway spotted with ice, it is possible to skid the nose gear on the ice and damage it by a full deflection. Directional control should be maintained with the throttles until the airplane is almost completely stopped. Practice this procedure on dry runways so as to become accustomed to the reverse action of the throttles when the propellers are in reverse thrust position. When landing in loose snow, exercise caution during reverse thrust application to prevent obscuring the runway with flying snow particles. Obscuring the runway with flying snow is especially possible below 50 mph.

The following precautions should be observed:

1. Use the brakes with caution when landing on snow or ice.

2. When reversing propellers, apply only enough power to decelerate airplane without obstructing vision by blowing snow.

3. Toward the end of the landing roll turn off the wing and empennage anti-icing.

4. Approaching the end of the runway very slowly to prevent skidding when turn is started.

KITS AND LOOSE EQUIPMENT.

The following is a list of kits and their components needed for smooth operation during arctic conditions:

1. Snow and ice removal kit for each aircraft.

a. Two brooms.
b. Two squeegees with 6-inch handles.
c. Two safety harnesses with 150 feet of rope for each harness. (For walking on slick wings.)
d. One hundred and fifty yards of cheese cloth.
e. Wing and elevator covers if available.
f. Two barrels of de-icing fluid, Specification 3609.

2. Engine and Aircraft Duct Cover Kit.

a. Six air intake covers.
b. Six engine covers.
c. Six propeller tip covers.
d. Two main landing gear strut covers.
e. Eight main gear tire covers and two nose wheel tire covers.
f. Six oil-in line covers. (These will have to be locally manufactured.)
g. Electrical harnesses for oil tank hopper heaters.
h. Four jet engine covers.

3. Miscellaneous Equipment.

a. One rubber hose 1-1/2 inches by 10 feet (for servicing auxiliary power units and heaters from bomb bay manifold stopcock).
b. One large funnel, 6 inches by 1 inch.
c. One five-gallon bucket.
d. Three drop lights with 100-foot cord for each.
e. One complete copy of cold weather operating instructions.

CHECK LIST—COLD WEATHER.

PREHEATING.

1. Engine—Supply external heat through engine tunnel until D-5 cylinder reaches at least 0°C. Remove just before engine start.

2. Hopper Sump and Line—Use electrical heat one minute for each degree below 0°F, prior to engine start. Cut circuit just prior to engine start.

3. Oil Tank Vent Line—Use electrical heat at least 30 minutes prior to engine start and continue heat after start.

4. Flight Deck Instruments—Supply external heat to flight-deck for at least 30 minutes prior to engine start to warm instruments.

5. Oil Tank Vent Aneroid Valve—If the OAT. is below 32°F (0°C), apply external heat to valve for at least 30 minutes prior to engine start.

6. Oil Line—If the OAT. is below —40°F (—40°C) (1) supply external heat to the oil-in line from the shutoff valve to the oil tank. The most effective method for doing this is to cover the line with canvas and direct hot air under it for at least 30 minutes. (2) supply external heat through the Y-drain access for at least 30 minutes. Leave heat on until oil pressure is satisfactory on starting.

Note

It is assumed that the oil was properly diluted prior to cold soak; if not, a longer period will be required.

BEFORE STARTING ENGINES.

1. Check turbo oil system drains for free flow and turbo oil tank vents for frozen condensate.

2. Check all fuel, water, oil tank, and crankcase breather vents for frozen condensate.

3. Check all fuel and oil line hose clamps for tightness.

STARTING ENGINES.

1. Engage starter intermittently for 3 blades (60-degree increments), then continuously for 3 blades with ignition switch off and mixture lever in IDLE CUT-OFF. (If liquid lock is encountered, eliminate lock and repeat.)

2. Turn ignition on with starter still engaged.

3. *After* the ignition is turned on, move mixture lever from IDLE CUT-OFF to NORMAL or RICH mixture.

4. Use prime intermittently at the discretion of the engineer to bring engine up to idle rpm.

OIL PRESSURES.

1. If oil pressure does not reach 25 psi in 50 seconds after engine start, shut down.

2. Wait five minutes.

3. Start engine again and repeat step I. If satisfactory oil pressure is not indicated after this second attempt, shut down the engine and proceed as follows:

a. Reinstall the engine tunnel heat ducts to continue engine preheat.

b. Check for oil flow at the Y-drain. If no flow is obtained, apply heat in this area. If flow is satisfactory from the Y-drain, apply heat to the oil lines between the tank and oil shutoff valve. Apply the heat as recommended under "Preheating," steps 6 and 9 of this section.

c. Supply hopper sump and line heat for at least an additional 30 minutes.

d. Continue heat to flight deck.

e. Purge the oil pressure indicating line with hydraulic oil (Specification MIL-0-5606) per instructions in T.O. 05-70-6 even if it has been previously purged.

f. Supply external heat directly to oil pressure transmitter for at least 20 minutes.

g. Check the oil shutoff valve manually to make certain it is open.

h. Prevent oil tank pressurization by method recommended under "Preheating," step 5.

4. Repeat engine starting procedure outlined under "Starting Engines." If oil pressure does not reach 25 psi in 50 seconds on this third attempt, shut down and check for bad instrument or transmitter, or for obstruction in the oil-in line.

• Hot Weather Procedures •

GI-450-A

BEFORE ENTERING AIRPLANE.

1. Cool the crew compartments by the use of type A-1 portable coolers. The 15-foot refrigerant lines can be routed into the cabins through the entrance hatches.

2. Check all fabric surfaces and control surface hinge points for freedom from fungus. If fungus is evident, remove it from all surfaces, except the fabric surfaces, with a stiff brush or compressed air. Use a clean soft cloth for the fabric surfaces.

3. Inspect the oleo struts and tires for cleanliness and proper inflation.

4. Inspect all limit switches for moisture.

5. Remove the engine and air duct covers and other protective covers.

ON ENTERING AIRPLANE.

1. Operate all movable surfaces.

2. If necessary, warm electrical instruments with an external source of heat until all moisture is eliminated.

3. Start the cabin ventilating fans as soon as the external power supply is connected.

4. Check the wing and fuselage drainage and ventilating holes.

STARTING RECIPROCATING ENGINES.

Use the normal starting procedure except a more open throttle may be required.

1. Operate the engine-driven fans only in low ratio.
2. Do not overprime the engines.
3. Do not exceed cylinder head and carburetor air temperature limits during engine warm-up.

STARTING JET ENGINES.

Use the normal starting procedure.

TAKE-OFF AND LANDING.

Extremely warm weather necessitates a longer take-off and landing run, and increases the sinking speed of the airplane. Maximum cylinder head and carburetor air temperature for take-off must be kept within limits. If high carburetor air temperatures are being encountered during ground run-up use the following procedure:

1. Engineer—Make the propeller reverse safety check immediately after completion of the final engine check.

Note

The aircraft will be taxied into take-off position WITHOUT the use of propeller reversing.

2. Pilot—Set full take-off power on jet engines.
3. Engineers—Set "no boost" power on reciprocating engines. Report to aircraft commander, "Power is set."
4. Aircraft Commander—Release brakes.
5. Engineer—Immediately advance TBS to full take-off power, water injection on.
6. Engineer—Report to aircraft commander prior to nose-up speed, "Power stabilized, propeller governing."

STOPPING ENGINES.

Stop the engines as soon as possible. Use normal procedure.

BEFORE LEAVING AIRPLANE.

1. Install covers for the nose compartment, pilots' enclosure, gun turret, and pitot mast.
2. As soon as the engines have cooled, install the engine and the air duct covers. The covers will keep out moisture, thus preventing corrosion and growth of fungi.
3. If possible, keep delicate instruments such as communication equipment warmer than ambient temperature by approximately 10°F (6°C). If heating cannot be accomplished, circulation of air over this equipment will be helpful.
4. Leave all windows and hatches slightly open to aid in air circulation. Close above openings during rains.

• Desert Procedures •

GI-451-A

BEFORE ENTERING AIRPLANE.

1. Cool the crew compartments by the use of two type A-1 portable coolers.
2. Make sure the carburetor air filters are installed and connected.
3. Check the operation of the filter doors.
4. Operate all movable surfaces.
5. Use a cloth moistened with hydraulic fluid to wipe the nose, both main gear shock struts, and exposed portions of acuating cylinders free of dust and sand.
6. Check tires and shock struts for proper inflation.
7. Remove ground cooling ducts, engine and airplane covers.

ON ENTERING AIRPLANE.

1. Start the cabin ventilating fans as soon as the external power supply is connected.
2. Clean the instrument panels with a lint-free cloth to remove any dust or sand.
3. Operate all instruments that can be checked without engine operation by using an external source of power.

STARTING RECIPROCATING ENGINES.

Use the normal starting procedure, except a more open throttle may be required.

1. Operate engine-driven fans in low ratio only.
2. Do not overprime the engines.

ENGINE WARM-UP.

1. Conduct ground operation in a minimum amount of time.

CAUTION

Do not operate the engine-driven fans in high ratio during ground operation or take-off.

2. Do not exceed cylinder head and carburetor air temperature limits.

STARTING JET ENGINES.

Use the normal starting procedure.

TAKE-OFF AND LANDING.

See "Take-off and Landing" under "HOT WEATHER PROCEDURES" of this section.

STOPPING ENGINES.

1. Park the airplane into the wind.
2. Stop the engines as soon as possible.

BEFORE LEAVING AIRPLANE.

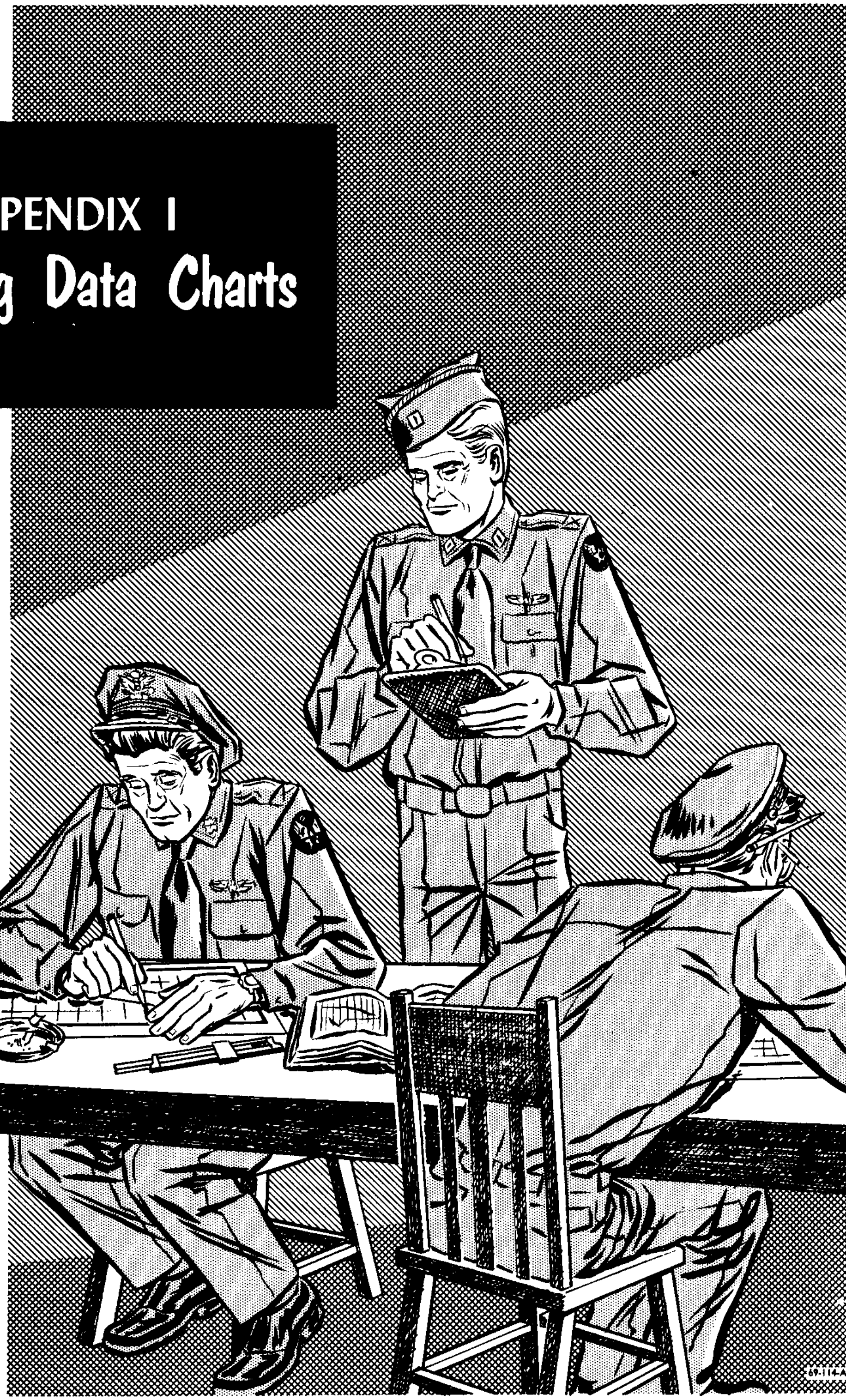
1. Install the covers for the pitot mast, pilots' enclosure, nose compartment, and gun turret.
2. After the engines have cooled, close the air plugs and install the engine air intake covers.

WARNING

Handle high octane fuel with care. Make sure all fueling equipment and airplane is well grounded.

3. Exercise care to avoid letting sand or dust enter the engine fuel and oil tank and turbo oil tanks while servicing.
4. Clean the instrument filters. Replace any that are in questionable condition.
5. Leave windows and hatches slightly open to aid air circulation. Close during sand and dust storms.

APPENDIX I
Operating Data Charts



CONTENTS

INTRODUCTION.

Performance data presented in this section is based on flight tests of standard B-36F airplanes conducted by the USAF and the Consolidated Vultee Aircraft Corporation.

The charts and tables in this section enable the flight planner to determine take-off, climb, level flight, descent, and landing performance for normal or emergency flight conditions.

Note

The take-off, landing, and partial engine data of this section was prepared for the former external configuration of this model. This configuration included six gun sighting blisters, a nose turret, an astrodome, fuel tank external sealing pads, and a chute for the manual chaff dispenser. Since the difference in drag between the two external configurations has a negligible effect on take-off and landing performance, these curves can be used without correction. However, prior to using the partial reciprocating engine specific range or long range operating data, an equivalent weight correction must be applied to the airplane gross weight as noted on each chart.

This section also contains supplementary data furnishing performance and operating conditions for the airplane with jet pods removed and for an alternate power schedule in the event reduced bmep operation is desired for a short training test. Atmospheric data, conversion charts, and calibration curves are included for accurate determination of flight operating conditions. Basic data are presented for NACA Standard Day atmospheric conditions. In addition to this basic data, certain curves contain corrections for wind and nonstandard temperatures. Charts for emergency operating conditions have red borders for rapid identification. Examples are provided to further clarify use of each type of chart.

The charts portray expected performance of the airplane when recommended operating procedures are followed and *include no arbitrary* conservatism or "padding." If unusual conditions exist, additional safety factors must be introduced by operating personnel as deemed consistent with the particular situation.

Rigid cruise control is absolutely necessary for efficient operation of heavy bombardment aircraft and cannot be over-emphasized. This efficient operation can be realized only through careful maintenance, conscientious training, and exact adherence to recommended operating procedures. The results of this preparation will be the extra 1500 feet of altitude over the target or the additional 50 miles of range necessary to make the mission successful.

GENERAL DATA.

SYMBOLS AND ABBREVIATIONS.

Symbols and abbreviations which appear in this section are defined in the table of figure A-1.

AIR-SPEED DEFINITIONS.

Throughout this appendix reference is made to four types of air speeds. These air speeds are defined as follows:

1. Indicated Air Speed—The reading of the air-speed indicator corrected for instrument error.

2. Calibrated Air Speed—IAS corrected for the error resulting from the location of the static pressure port.

3. Equivalent Air Speed—CAS corrected for the effects of compressibility.

4. True Air Speed—EAS corrected for atmospheric density (altitude and temperature).

The air speeds expressed in equation form are:

IAS = Air-speed indicator reading—Instrument error.

CAS = IAS—Position error.

EAS = CAS—Compressibility error.

TAS = EAS x $1/\sqrt{\sigma}$

These equations are incorporated in figures A-11, A-12, and A-13 for ease of converting IAS to EAS or TAS, and vice versa.

DENSITY ALTITUDE CHART.

The relationship of atmospheric density, pressure, and temperature is presented in figure A-2 (where density and pressure are expressed in terms of altitude).

Symbols & Definitions

ρ_0	STANDARD SEA LEVEL ATMOSPHERIC DENSITY— .002378 SLUGS/CU. FT.
σ	ATMOSPHERIC DENSITY RATIO — ρ/ρ_0
IAS	INDICATED AIR SPEED— AIR SPEED INDICATOR READING CORRECTED FOR INSTRUMENT ERROR
CAS	CALIBRATED AIR SPEED— INDICATED AIR SPEED CORRECTED FOR INSTALLATION
EAS	EQUIVALENT AIR SPEED— CALIBRATED AIR SPEED CORRECTED FOR COMPRESSIBILITY
TAS	TRUE AIR SPEED— EQUIVALENT AIR SPEED CORRECTED FOR ATMOSPHERIC DENSITY
KTS	KNOTS— NAUTICAL MILES PER HOUR
V STALL	STALLING SPEED
6+4	SIX RECIPROCATING & FOUR JET ENGINES OPERATING (THIS IS A TYPICAL SYMBOL INDICATING THE NUMBER OF RECIPROCATING AND JET ENGINES OPERATING)
ADI	ANTI-DETONATION INJECTION (WATER INJECTION)
BHP	BRAKE HORSEPOWER
RPM	REVOLUTIONS PER MINUTE
BMEP	BRAKE MEAN EFFECTIVE PRESSURE—PSI
FHP	FAN HORSEPOWER
FF	FUEL FLOW
ML	MANUAL LEAN
MA	MANUAL ADJUST
SA	SPARK ADVANCE
MAP	MANIFOLD ABSOLUTE PRESSURE
IN Hg	INCHES OF MERCURY
TP	TORQUE PRESSURE
PSI	POUNDS PER SQUARE INCH
MRPM	MILITARY RPM
NRP	NORMAL RATED POWER
CHT	CYLINDER HEAD TEMPERATURE
CAT.	CARBURATOR AIR TEMPERATURE
N. MI/LB	NAUTICAL MILES PER POUND
OAT.	OUTSIDE AIR TEMPERATURE
°F	DEGREES FAHRENHEIT
°C	DEGREES CENTIGRADE
GW	GROSS WEIGHT
FPM	FEET PER MINUTE
HW	HEAD WIND
TW	TAIL WIND

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Figure A-1.

The "NACA Standard Day Curve" (pressure altitude equals density altitude) has been superimposed on the basic pressure-density-temperature variation. Temperature lapse rates for an Army Hot Day and for an Alaska Cold Day have also been included for reference purposes. Temperature lapse rates may vary from day to day, and for the same time and day they may vary with geographical location. Prior to planning a mission it is recommended that a temperature lapse rate be obtained for the regions through which the mission is to be flown. By using reported temperature lapse rates the resulting mission predictions will be realistic.

EXAMPLE.

Determine the density altitude under the following conditions:

29,928 feet corrected pressure altitude
—26.5°C actual ambient air temperature

Enter the "Density Altitude Chart" at —26.5°C on the outside air temperature scale, move vertically to 29,928 feet pressure altitude (interpolated), and read 31,800 feet on the density altitude scale.

STANDARD ALTITUDE TABLE.

The most commonly used physical properties of the NACA Standard Atmosphere are presented in tabular form in figure A-3.

DENSITY CHART.

Two density charts have been presented for convenience in determining the "smoe" factor, $1/\sqrt{\sigma}$, for any pressure altitude and ambient air temperature. Figure A-4 covers the low altitude region and figure A-5 covers the high altitude region.

EXAMPLE.

Determine the true air speed when the following conditions exist:

29,928 feet corrected pressure altitude
—26.5°C OAT.
165.2 mph equivalent air speed

Enter figure A-4 at —26.5°C outside air temperature, move vertically to 29,928 feet pressure altitude and read a value of 1.695 for $1/\sqrt{\sigma}$. The true air speed is 165.2 mph x 1.695 or 279.7 mph. To convert true air speed, mph, into true air speed, knots, divide 279.7 by 1.152 which gives 242.5 knots.

TEMPERATURE CONVERSION CHART.

The temperature conversion chart (figure A-6) is presented for convenience in converting temperatures from the Fahrenheit scale to the centigrade scale and vice versa. The chart covers all expected free air temperatures for both arctic and tropical operations.

EXAMPLE.

Determine the temperature in °C for a reading of 84°F.

Enter figure A-6 at 84°F. Move horizontally to the conversion line and then vertically to the centigrade scale. The temperature is 29°C.

CONVERSION FACTORS.

A few useful conversions are:

Nautical Miles = .8684 x Statute Miles
Statute Miles = 1.152 x Nautical Miles
TAS (mph) = 1.152 x TAS (kts)
TAS (kts) = .8684 x TAS (mph)
TAS (mph) = $1/\sqrt{\sigma}$ x EAS (mph)
TAS (kts) = .8684 x $1/\sqrt{\sigma}$ x EAS (mph)

$$\text{EAS (mph)} = \frac{1.152 \times \text{TAS (kts)}}{1/\sqrt{\sigma}}$$

$$\text{EAS (mph)} = \frac{\text{TAS (mph)}}{1/\sqrt{\sigma}}$$

DENSITY ALTITUDE CHART

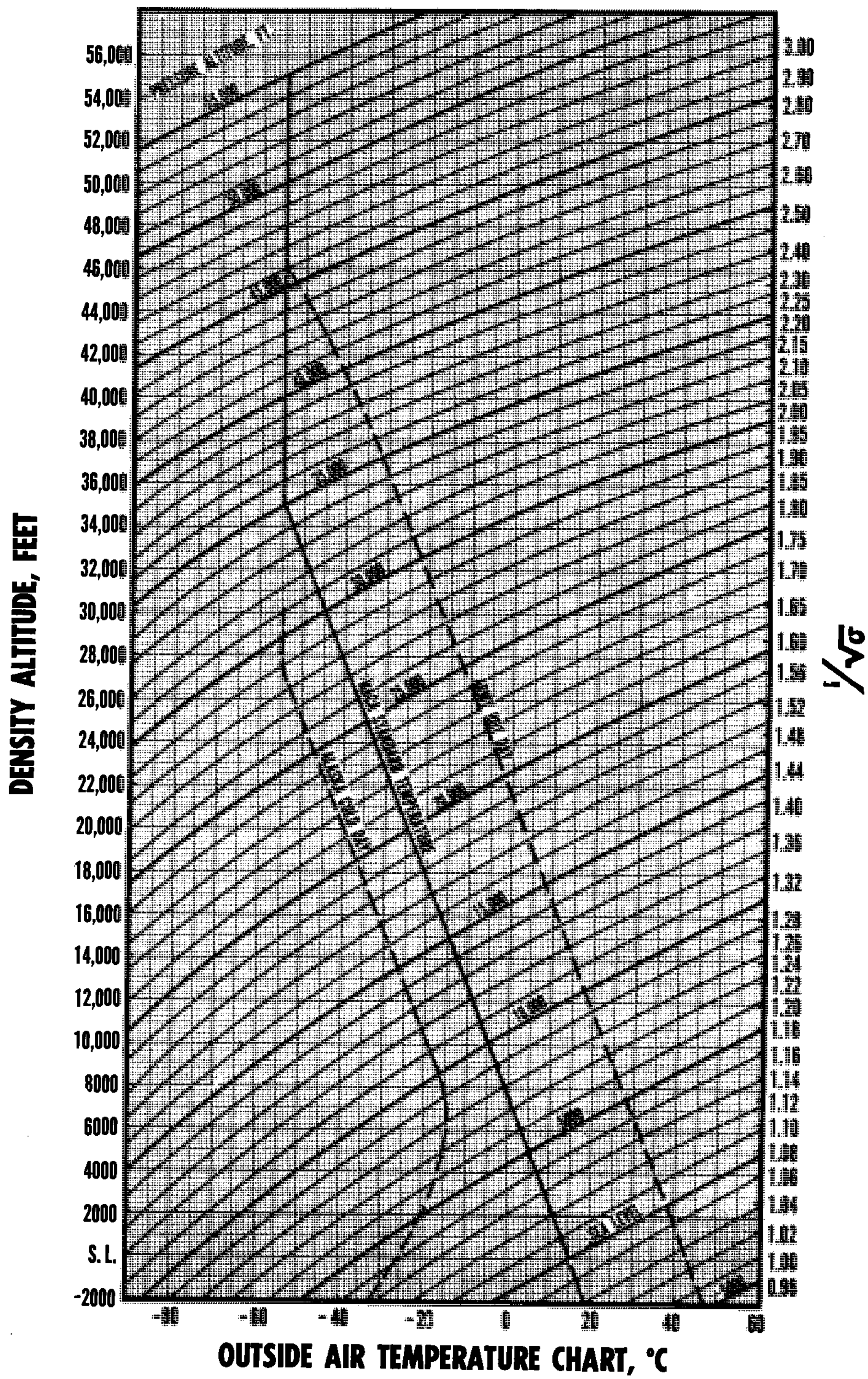

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Figure A-2.

STANDARD ALTITUDE TABLE

NACA STANDARD SEA LEVEL AIR: $T_o = 15°C$, $P_o = 29.92$ in. of Hg, $W_o = .07651$ lb/cu ft, $\rho_o = .002378$ slugs/cu ft, $a_o = 1116$ fps

ALTITUDE (feet)	DENSITY RATIO $\sigma = \rho/\rho_o$	$\frac{1}{\sqrt{\sigma}}$	C.F.†	TEMPERATURE		SPEED OF SOUND RATIO a/a_o	PRESSURE *In. of Hg.	PRESSURE RATIO p/p_o
				Deg. C	Deg. F			
−2000	1.0599	0.9713	0.8435	18.96	66.13	1.007	32.15	1.0745
−1000	1.0296	0.9855	0.8558	16.99	62.57	1.003	31.02	1.0367
0	1.0000	1.0000	0.8684	15.00	59.00	1.000	29.92	1.0000
1000	.9710	1.0148	0.8812	13.02	55.43	.997	28.86	.9644
2000	.9428	1.0299	0.8944	11.04	51.87	.993	27.82	.9298
3000	.9151	1.0454	0.9078	9.06	48.30	.990	26.81	.8962
4000	.8881	1.0611	0.9215	7.08	44.74	.986	25.84	.8636
5000	.8616	1.0773	0.9355	5.09	41.17	.983	24.89	.8320
6000	.8358	1.0938	0.9498	3.11	37.60	.979	23.98	.8013
7000	.8106	1.1107	0.9645	1.13	34.04	.976	23.09	.7716
8000	.7859	1.1280	0.9795	−0.85	30.47	.972	22.22	.7426
9000	.7619	1.1456	0.9948	−2.83	26.90	.968	21.38	.7147
10000	.7384	1.1637	1.0106	−4.81	23.34	.965	20.58	.6876
11000	.7154	1.1822	1.0266	−6.79	19.77	.962	19.79	.6614
12000	.6931	1.2012	1.0431	−8.77	16.21	.958	19.03	.6359
13000	.6712	1.2206	1.0600	−10.76	12.64	.954	18.29	.6112
14000	.6499	1.2404	1.0772	−12.74	9.07	.950	17.57	.5873
15000	.6291	1.2608	1.0949	−14.72	5.51	.947	16.88	.5642
16000	.6088	1.2816	1.1129	−16.70	1.94	.943	16.21	.5418
17000	.5891	1.3029	1.1314	−18.68	−1.63	.940	15.56	.5202
18000	.5698	1.3247	1.1504	−20.66	−5.19	.936	14.94	.4992
19000	.5509	1.3473	1.1700	−22.64	−8.76	.932	14.33	.4790
20000	.5327	1.3701	1.1898	−24.62	−12.32	.929	13.75	.4594
21000	.5148	1.3937	1.2103	−26.61	−15.89	.925	13.18	.4405
22000	.4974	1.4179	1.2313	−28.59	−19.46	.922	12.63	.4222
23000	.4805	1.4426	1.2527	−30.57	−23.02	.917	12.10	.4045
24000	.4640	1.4681	1.2749	−32.55	−26.59	.914	11.59	.3874
25000	.4480	1.4940	1.2974	−34.53	−30.15	.910	11.10	.3709
26000	.4323	1.5209	1.3207	−36.51	−33.72	.906	10.62	.3550
27000	.4171	1.5484	1.3446	−38.49	−37.29	.903	10.16	.3397
28000	.4023	1.5768	1.3693	−40.47	−40.85	.899	9.72	.3248
29000	.3879	1.6056	1.3943	−42.46	−44.42	.895	9.29	.3106
30000	.3740	1.6352	1.4199	−44.44	−47.99	.891	8.88	.2968
31000	.3603	1.6659	1.4467	−46.42	−51.55	.887	8.48	.2834
32000	.3472	1.6971	1.4737	−48.40	−55.12	.883	8.10	.2707
33000	.3343	1.7295	1.5019	−50.38	−58.68	.879	7.73	.2583
34000	.3218	1.7628	1.5308	−52.36	−62.25	.875	7.38	.2465
35000	.3098	1.7966	1.5601	−54.34	−65.82	.871	7.04	.2352
36000	.2962	1.8374	1.5956	−55.00	−67.00	.870	6.71	.2242
37000	.2824	1.8818	1.6341	−55.00	−67.00	.870	6.40	.2137
38000	.2692	1.9273	1.6736	−55.00	−67.00	.870	6.10	.2037
39000	.2566	1.9738	1.7140	−55.00	−67.00	.870	5.81	.1943
40000	.2447	2.0215	1.7555	−55.00	−67.00	.870	5.54	.1852
41000	.2332	2.0707	1.7982	−55.00	−67.00	.870	5.28	.1765
42000	.2224	2.1207	1.8416	−55.00	−67.00	.870	5.04	.1683
43000	.2120	2.1719	1.8861	−55.00	−67.00	.870	4.80	.1605
44000	.2021	2.2244	1.9316	−55.00	−67.00	.870	4.58	.1530
45000	.1926	2.2785	1.9786	−55.00	−67.00	.870	4.36	.1458
46000	.1837	2.3332	2.0261	−55.00	−67.00	.870	4.16	.1391
47000	.1751	2.3893	2.0748	−55.00	−67.00	.870	3.97	.1325
48000	.1669	2.4478	2.1256	−55.00	−67.00	.870	3.78	.1264
49000	.1551	2.5071	2.1771	−55.00	−67.00	.870	3.60	.1205
50000	.1517	2.5675	2.2296	−55.00	−67.00	.870	3.44	.1149
51000	.1447	2.6289	2.2829	−55.00	−67.00	.870	3.28	.1095
52000	.1380	2.6919	2.3376	−55.00	−67.00	.870	3.12	.1044
53000	.1319	2.7587	2.3957	−55.00	−67.00	.870	2.98	.0996
54000	.1253	2.8250	2.4532	−55.00	−67.00	.870	2.84	.0949
55000	.1195	2.8928	2.5121	−55.00	−67.00	.870	2.71	.0905

†Airspeed Conversion Factor = $\frac{1/\sqrt{\sigma}}{1.152}$
TAS (kts) = C.F. x EAS (mph)

*1 in. Hg = 70.732 psf = 0.4912 psi

67-292-A

Figure A-3.

DENSITY CHART

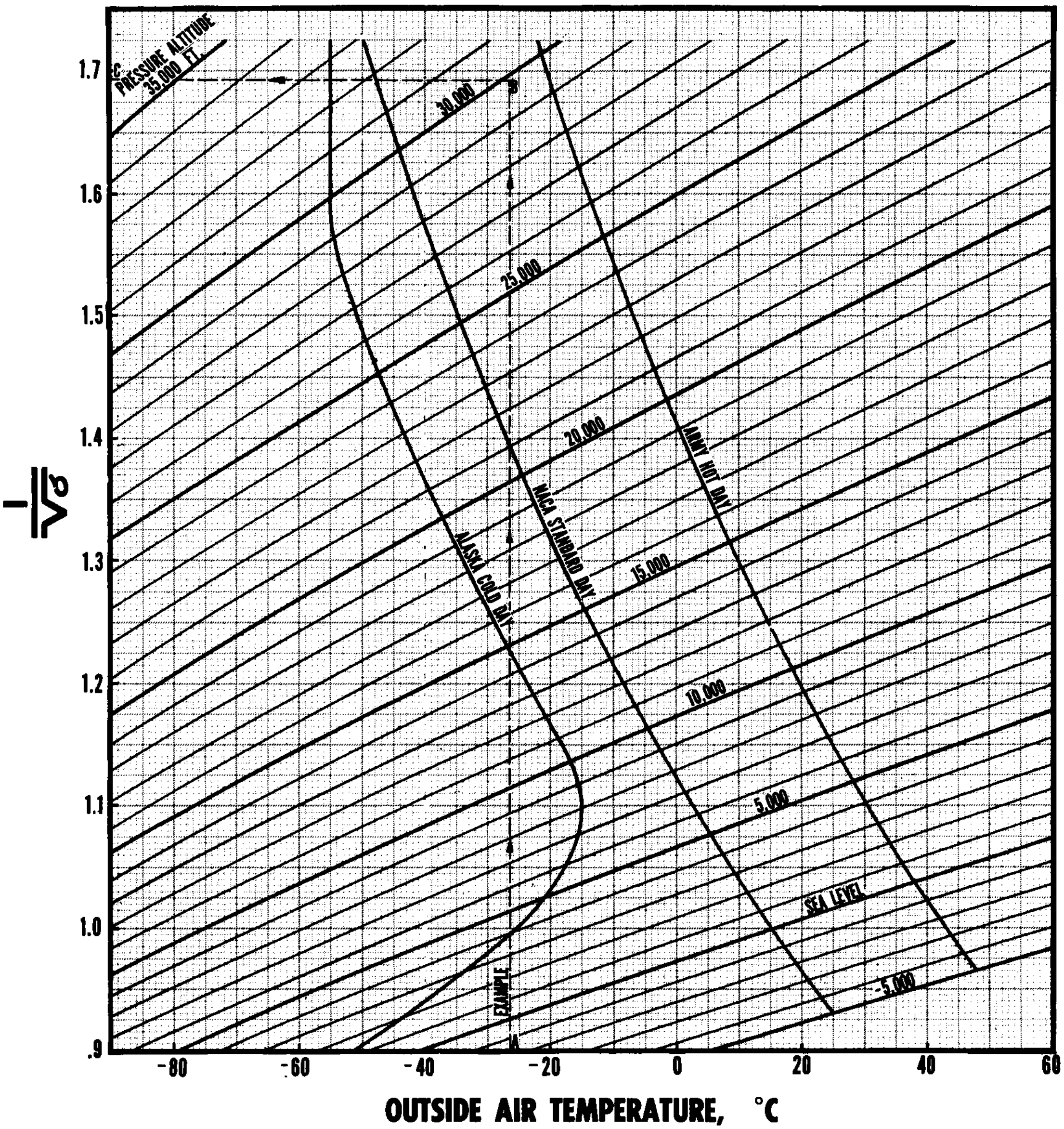


Figure A-4.

DENSITY CHART

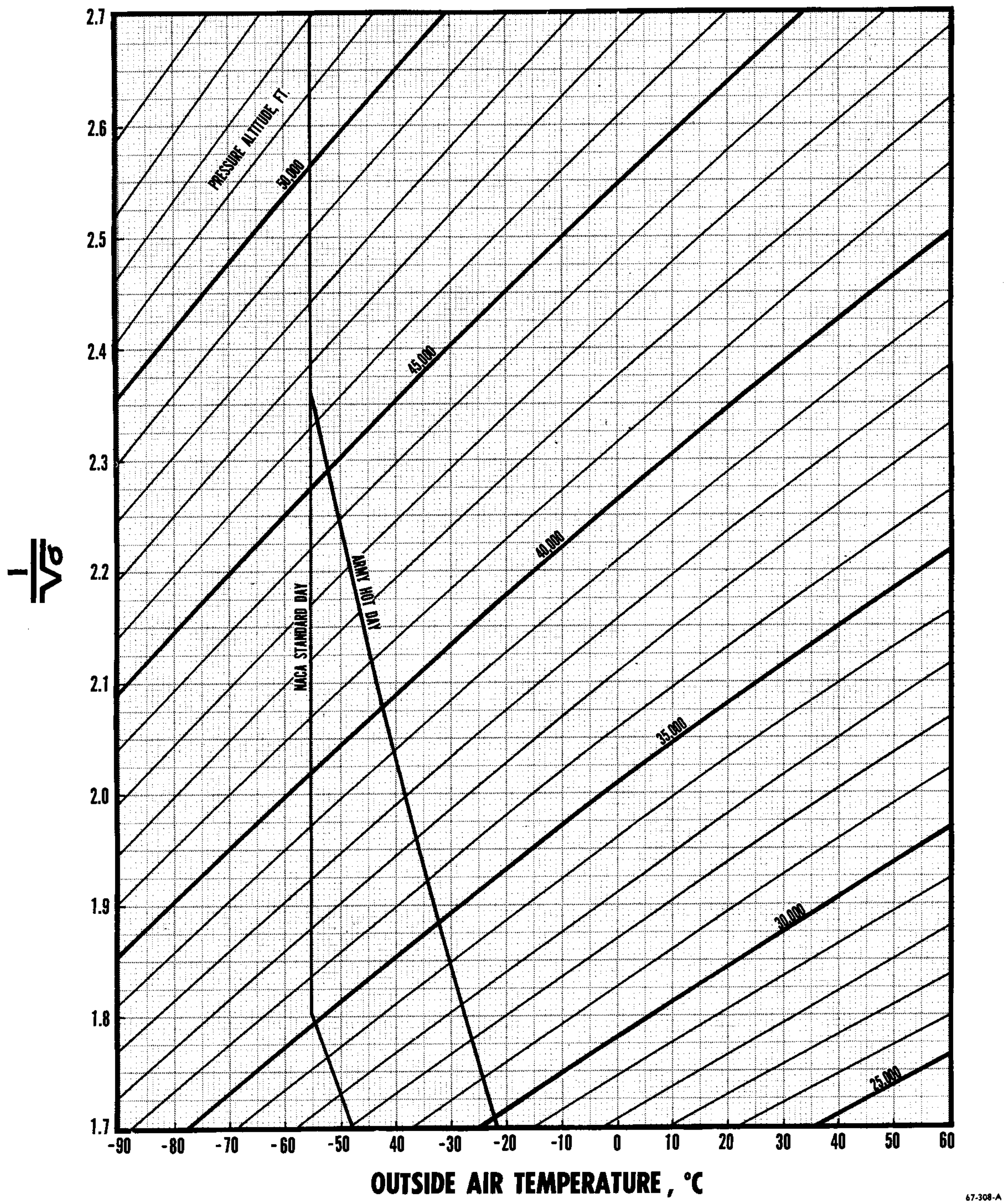


Figure A-5.

TEMPERATURE CONVERSION CHART

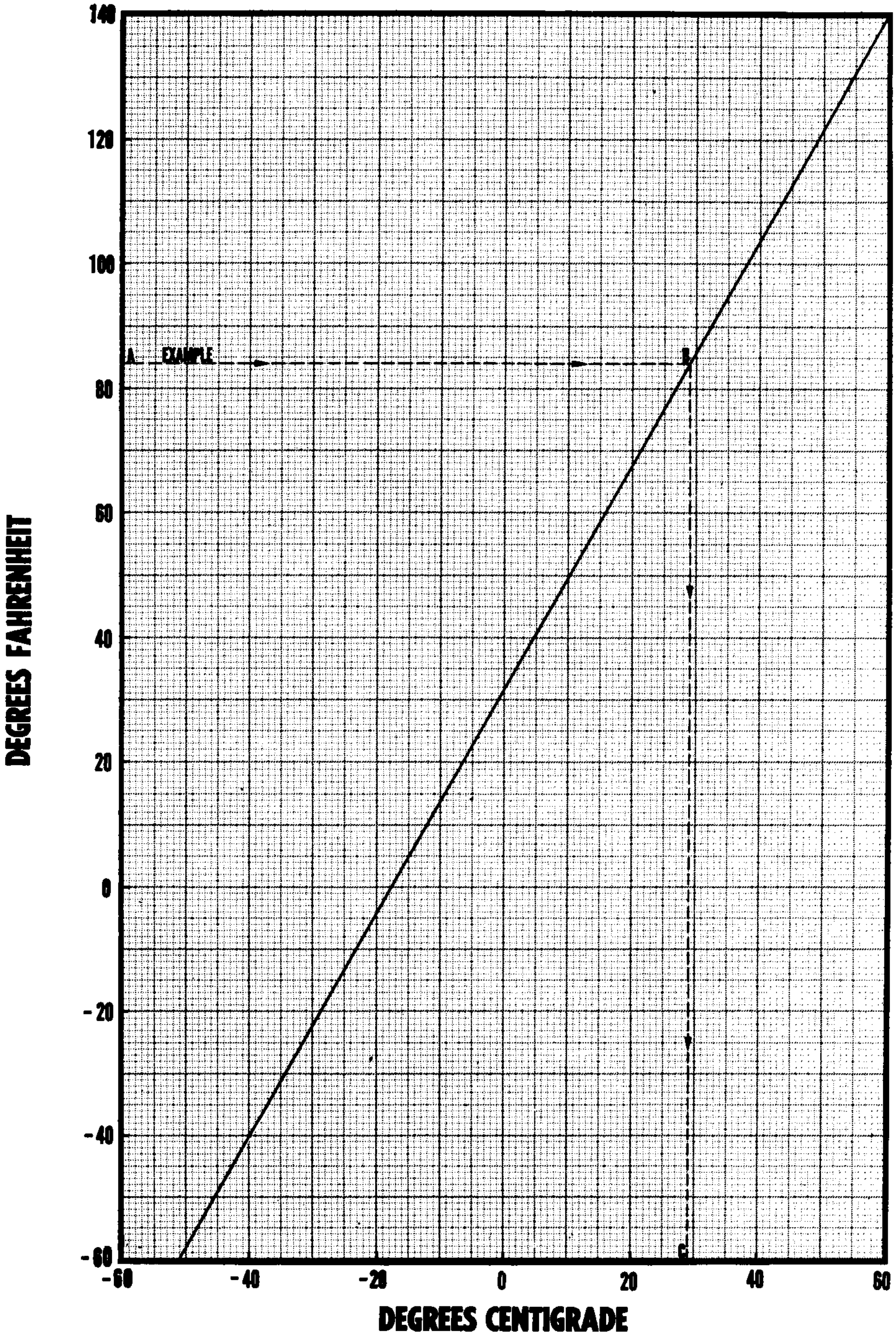


Figure A-6.

INSTRUMENT ERRORS.

Efficient cruise control is dependent upon accurate flight and power instrumentation.

All instruments have inherent errors of some degree and should be calibrated so that appropriate compensations can be made. Though calibrations vary for each instrument and cannot be presented here, it is nevertheless quite important that they be considered in flight. Special attention should be given to the air-speed and outside air temperature indicators, altimeter, reciprocating and jet engine tachometers, torquemeters, fuel flow, manifold pressure, cylinder head temperature, carburetor air temperature, and tail pipe temperature indicators. Calibrations for these instruments should be checked periodically for accuracy.

Power instruments will have instrument calibrations only, while multiple calibrations must be considered for flight instruments. The indicated air speed must be corrected for instrument, installation (static pressure port position), and compressibility errors; the indicated pressure altitude must be corrected for instrument and position errors; and the indicated outside air temperature must be corrected for instrument and compressibility errors to obtain actual values. If flight at a certain equivalent air speed or pressure altitude is desired, the reverse calibration prodecure must be accomplished to determine the corresponding instrument settings.

Air-Speed and Altimeter Installation Error.

The pilot's air-speed system is a standard differential-pressure type, with pitot (total pressure) and static pressure pickups as discussed in "Instruments," Section I. The pilot's altimeter is also connected to the air-speed static line. Because air pressure at the static pressure port is less than free atmospheric stream pressure, the air-speed and pressure altitude instruments will read too high.

Air-speed and altimeter errors due to the static port installation location are presented in figure A-8 for the clean airplane configuration. Any change in the external configuration of the airplane will change the air pressure at the static port and thus necessitate different installation calibrations.

Air-speed system position error calibration are presented in figure A-8 for the take-off configuration and for the landing configuration.

Periodic pressure checks should be made to determine if the lines have developed leaks; regular visual examinations should be made to determine if the installation has become damaged.

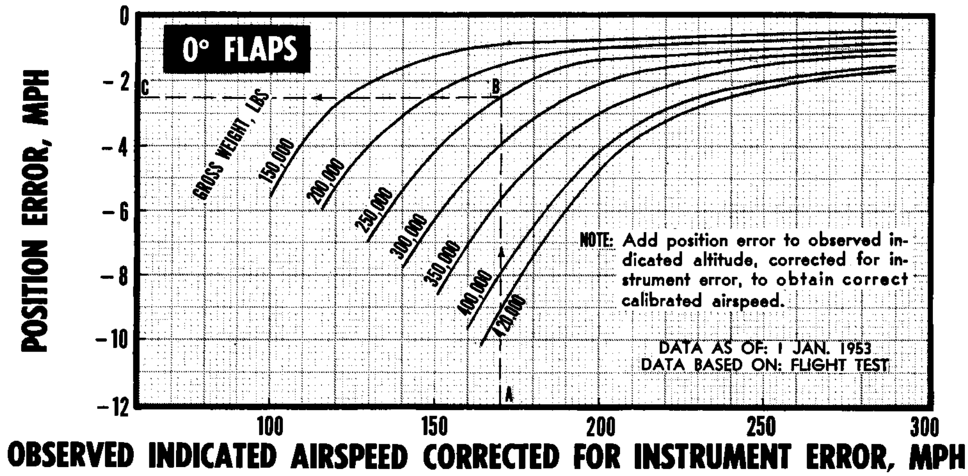
EXAMPLE.

Determine the position errors for the following conditions:

250,000 pounds gross weight
170 mph observed IAS corrected for instrument error
30,000 feet pressure altitude

Enter the position error correction chart of figure A-7 at 170 mph (A). Move vertically to the 250,000-pound line (B) and read a position error correction of —2.5 mph on the scale to the left (C). The calibrated air speed is then 170 —2.5 = 167.5 mph. Next enter the chart for altimeter error correction at 170 mph (A) and move vertically to 250,000 pounds (B); then proceed horizontally to the base line (C). Now follow the direction of the guide lines to the observed pressure altitude of 30,000 feet and from (D) read a position error correction of —72 feet (E) on the left scale. The corrected pressure altitude is 29,928 feet.

AIRSPEED POSITION ERROR CORRECTION



ALTIMETER POSITION ERROR CORRECTION

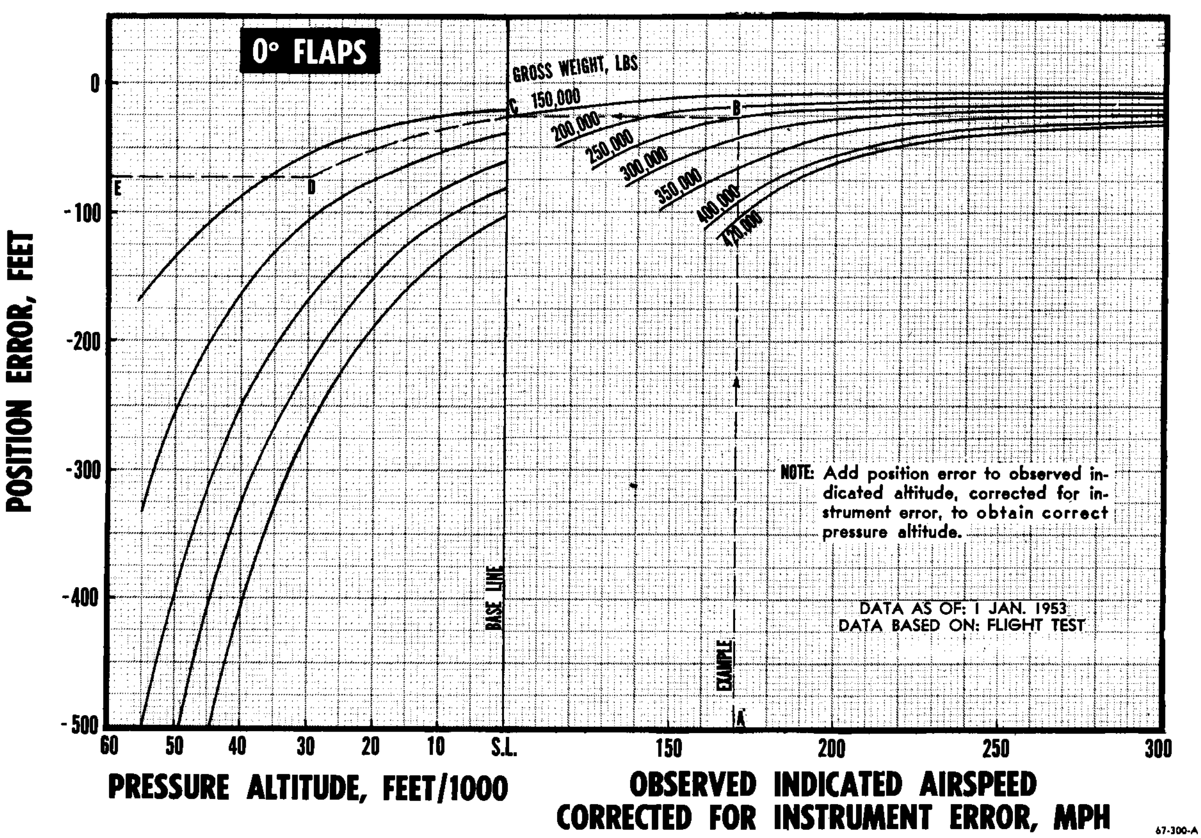
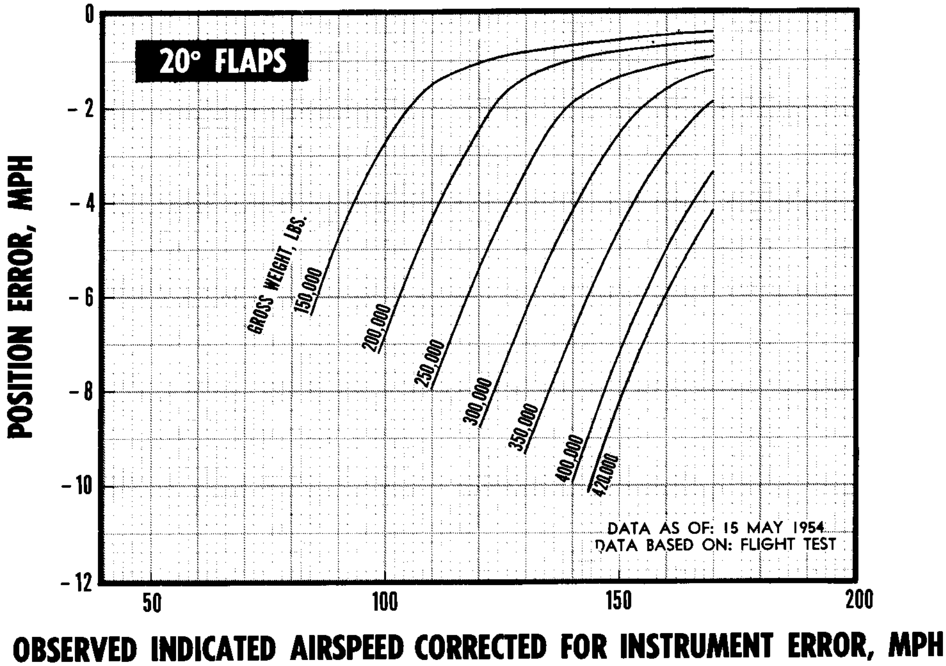
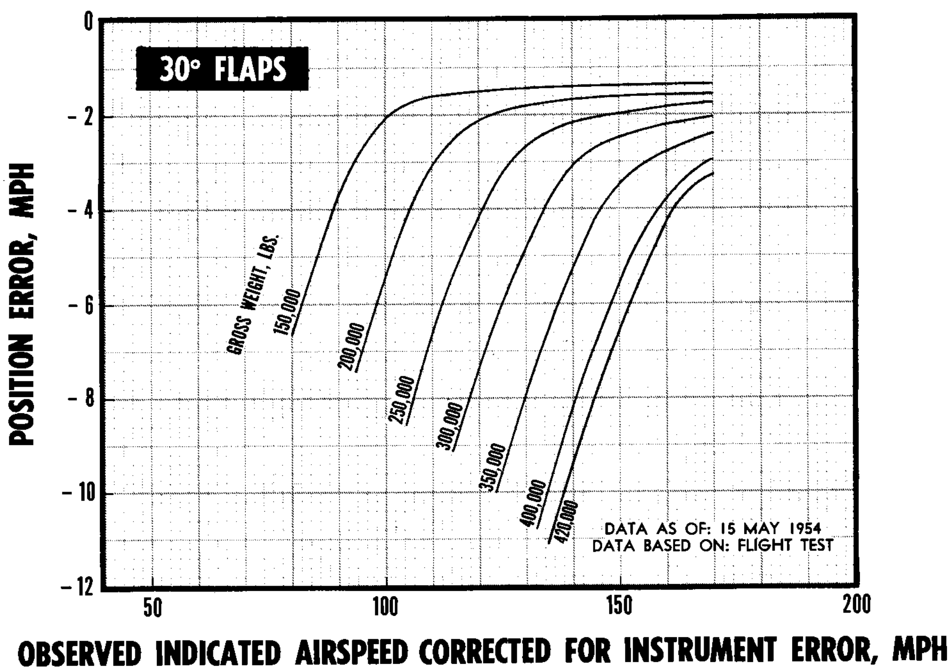


Figure A-7.

AIRSPEED POSITION ERROR CORRECTION

NOTE:
Add position error to observed indicated airspeed, corrected for instrument error, to obtain calibrated airspeed.





67-303-A

Figure A-8.

Air-Speed Correction for Compressibility.

An error in indicated air speed is introduced at the total pressure (pitot) port because of pressure rise due to air compressibility. This results in too high an indicated air-speed reading. The air-speed indicator is calibrated to include this error for sea level operation. For operation at all altitudes above sea level, air speed must be corrected by the compressibility calibrations presented in figure A-9.

EXAMPLE.

Determine the air-speed compressibility error for:

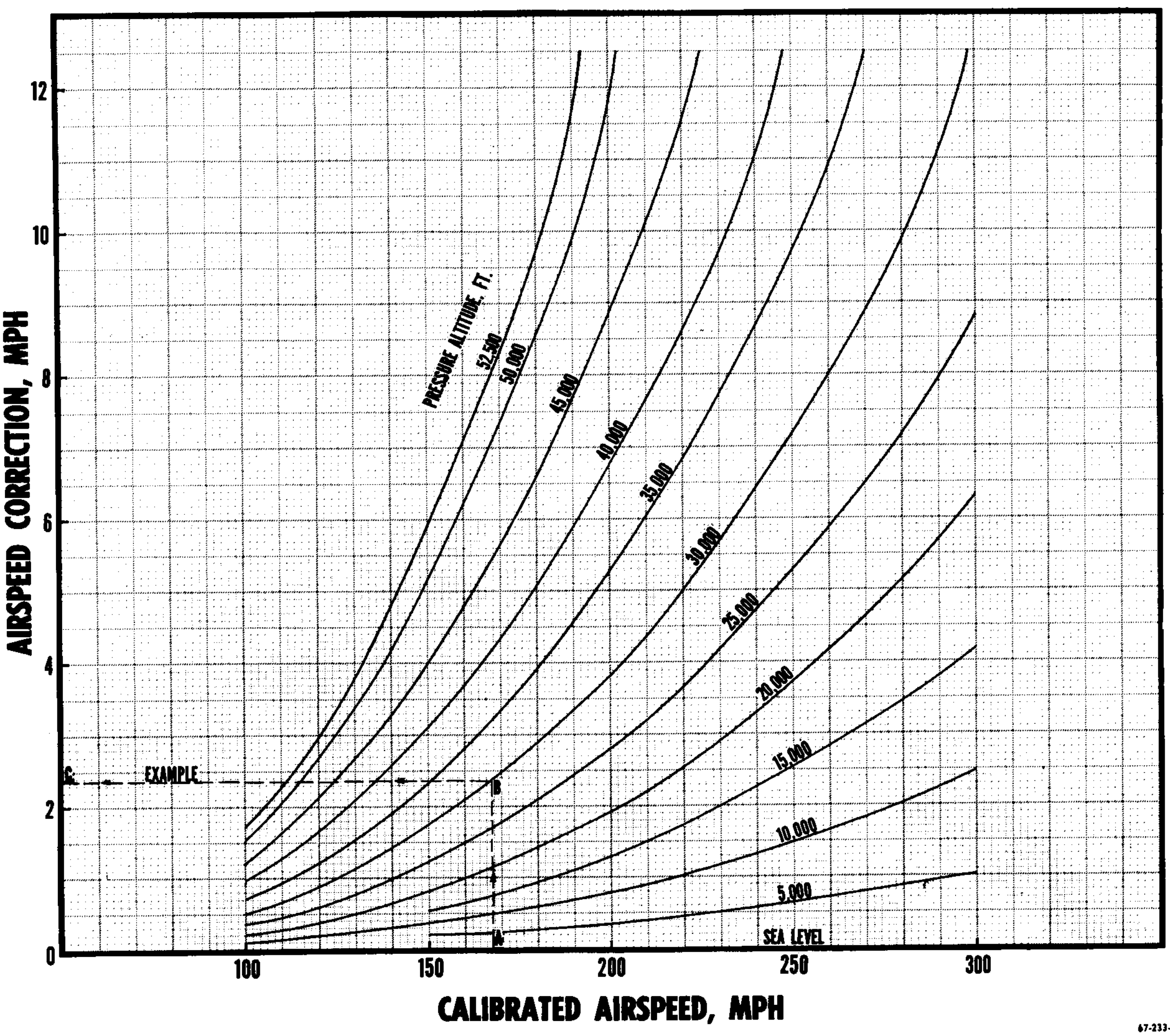
29,928 feet pressure altitude
167.5 mph indicated air speed corrected for instrument and position error

Enter the air-speed compressibility correction chart at 167.5 mph on the horizontal scale, move vertically to 29,928 feet pressure altitude (interpolated) and read an air-speed error of 2.3 mph from the vertical scale. The equivalent air speed is 167.5 —2.3 or 165.2 mph.

AIRSPEED CORRECTION FOR COMPRESSIBILITY

NOTES:

1. Correct instrument reading for instrument and position error prior to use of this chart.
2. Subtract correction from calibrated airspeed (CAS) to obtain equivalent airspeed (EAS).



67-233-A

Figure A-9.

Temperature Correction for Compressibility.

In addition to the inherent mechanical instrument error present in an ambient air temperature indicator, there also exists an error due to air compressibility. The indicated temperature reads higher than actual because of the temperature rise caused by friction attendant with bringing a certain amount of the measured air to rest. Corrections for this error may be obtained from figure A-10.

EXAMPLE.

Find the ambient air temperature where the following conditions exist:

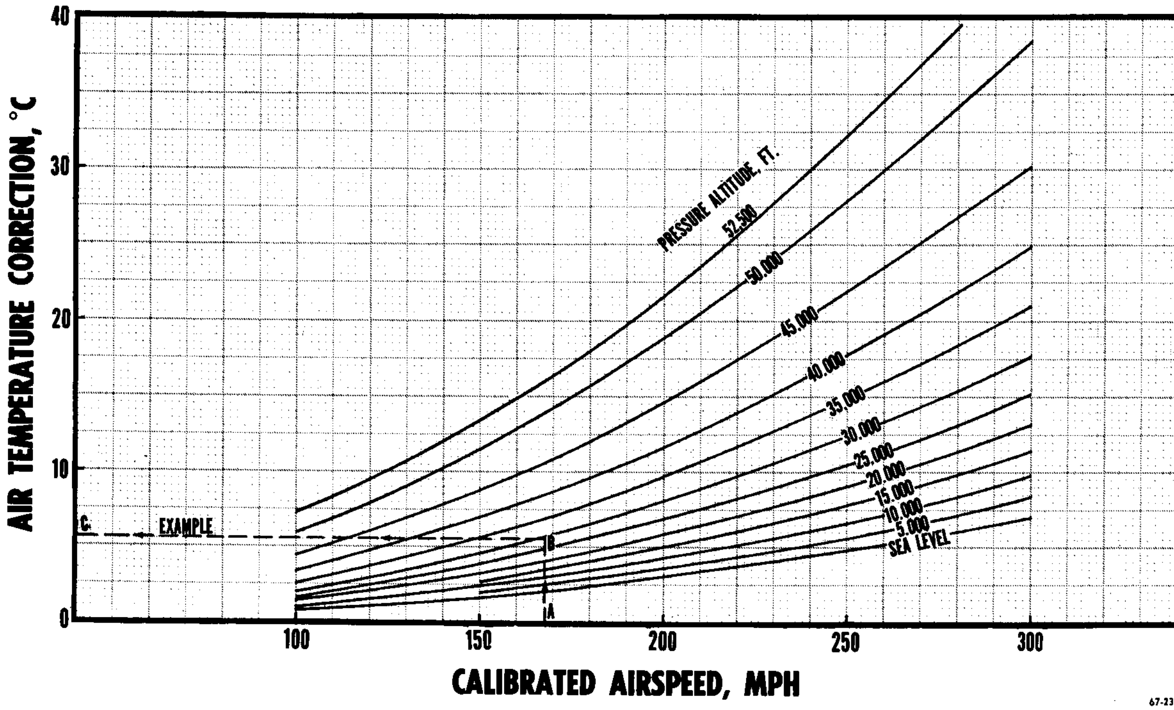
29,928 feet pressure altitude
167.5 mph calibrated air speed
21°C indicated outside air temperature corrected for instrument error

Enter the temperature compressibility correction chart at 167.5 mph on the horizontal scale, move vertically to 29,928 feet pressure altitude and read an error of 5.5°C on the vertical scale. The actual OAT. would be (—21.0°) + (—5.5°), or —26.5°C.

TEMPERATURE CORRECTION FOR COMPRESSIBILITY

NOTES:

1. Correct airspeed instrument reading for instrument and position error prior to use of this chart.
2. Subtract temperature correction from indicated air temperature to obtain free air temperature.



67-232-A

Figure A-10.

AIR-SPEED CONVERSION CHARTS.

The charts presented in figures A-11, A-12, and A-13 enable direct conversion from indicated air speed to equivalent or true air speed, and vice versa.

Figure A-11 incorporates the air-speed errors which result from static position and compressibility. Before using this curve, however, the observed indicated air speed must be corrected for instrument error. From this figure the true air speed, Mach number, temperature rise, and OAT. can be determined for any IAS.

EXAMPLE 1.

Find the TAS (knots) for the following conditions:

175 mph IAS
300,000 pounds gross weight
35,000 feet pressure altitude
—47°C OAT.

Enter figure A-11 at an IAS of 175.0 mph. Parallel the guide lines to a gross weight of 300,000 pounds. Move horizontally to the right to a pressure altitude of 35,000 feet and then vertically downward to an interpolated OAT. of —47°C.

Proceed horizontally to the right and read a TAS of 262 knots and a temperature rise to 7.3°C. Subtract the temperature rise from the OAT. (—47.0 —7.3) and obtain the true OAT. of —54.3°C. Now move horizontally to the left until the intersection 35,000 feet pressure altitude and —54.3°C. From this point, move vertically downward and reach a Mach number of 0.457.

Figure A-12 provides for the conversion from IAS to EAS, or vice versa, for a clean airplane configuration.

EXAMPLE 2.

Find the equivalent air speed for the following conditions:

165.0 mph IAS
320,000 pounds gross weight
35,000 feet pressure altitude

Enter figure A-12 at an IAS of 165.0 mph (A). Parallel the guide lines to a gross weight of 320,000 pounds (B). Proceed horizontally to the right to the base line (C). Parallel the guide lines to 35,000 feet pressure altitude (D); then move horizontally to the right to the EAS scale and read an EAS of 157.1 mph (E).

Figure A-13 provides for the conversion from IAS to EAS, or vice versa, for the 20- and 30-degree flap deflection configurations. The procedure for the use of this curve is identical to that of figure A-12.

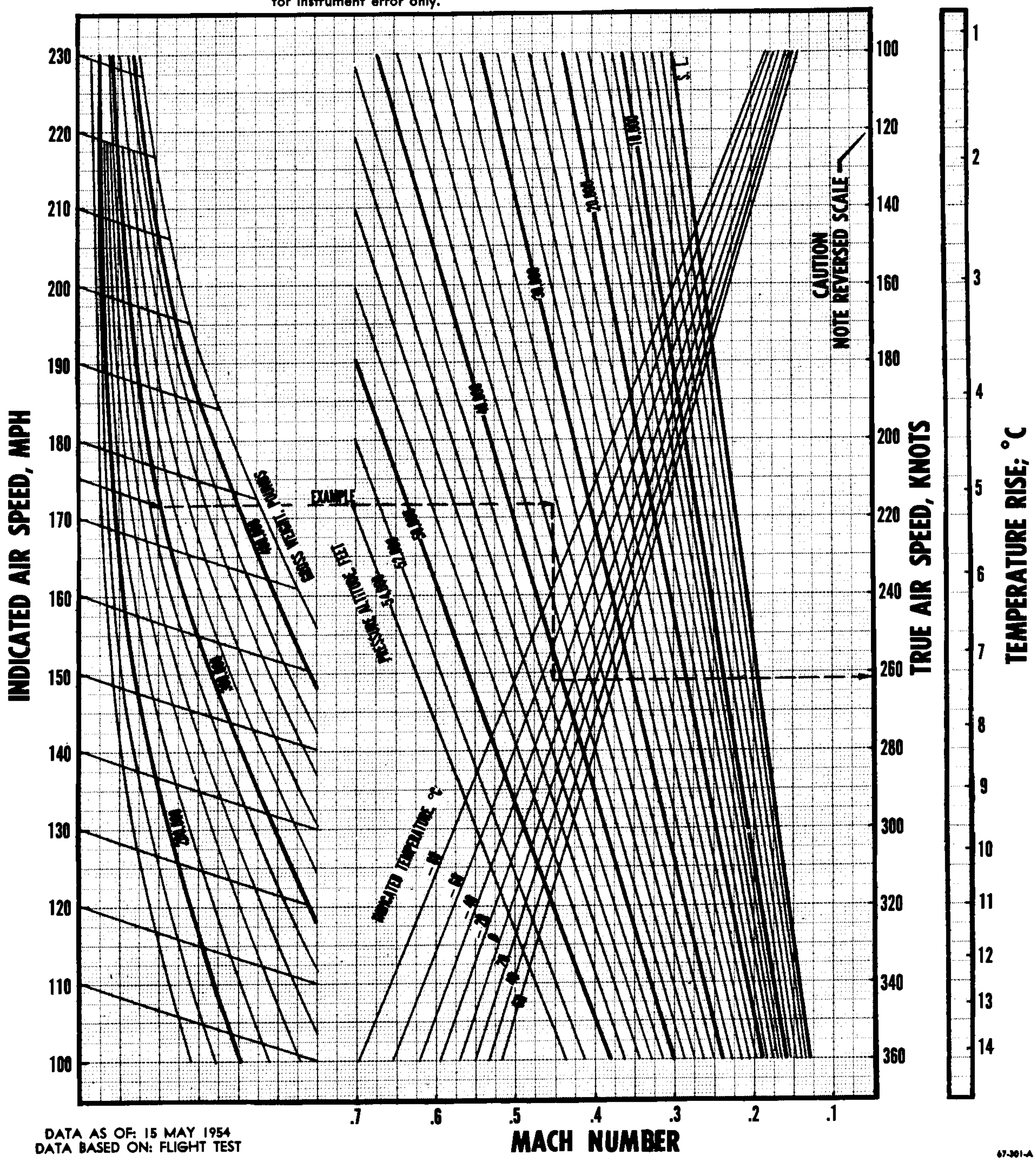
Note

Figures A-11, A-12, and A-13 are valid only when observed indicated air speed has been corrected for instrument error.

TRUE AIRSPEED CONVERSION

CLEAN CONFIGURATION

NOTES:
1. Indicated air speed, corrected for instrument error only.
2. Indicated temperature corrected for instrument error only.
3. Subtract temperature rise from indicated temperature to obtain true temperature.



DATA AS OF: 15 MAY 1954
DATA BASED ON: FLIGHT TEST

67-301-A

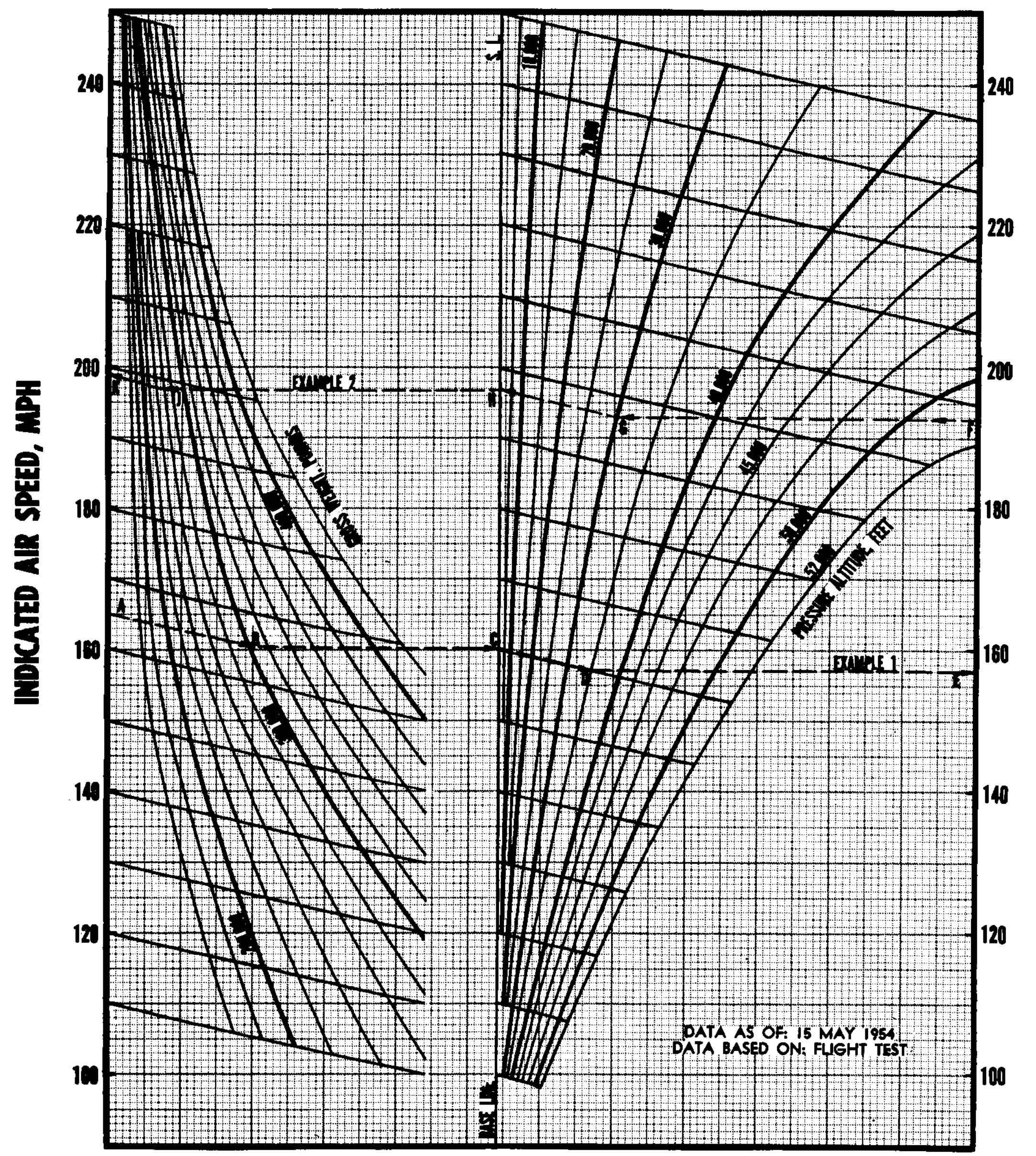
Figure A-11.

EQUIVALENT AIRSPEED CONVERSION

CLEAN CONFIGURATION

NOTES:

1. Indicated airspeed, corrected for instrument error only.



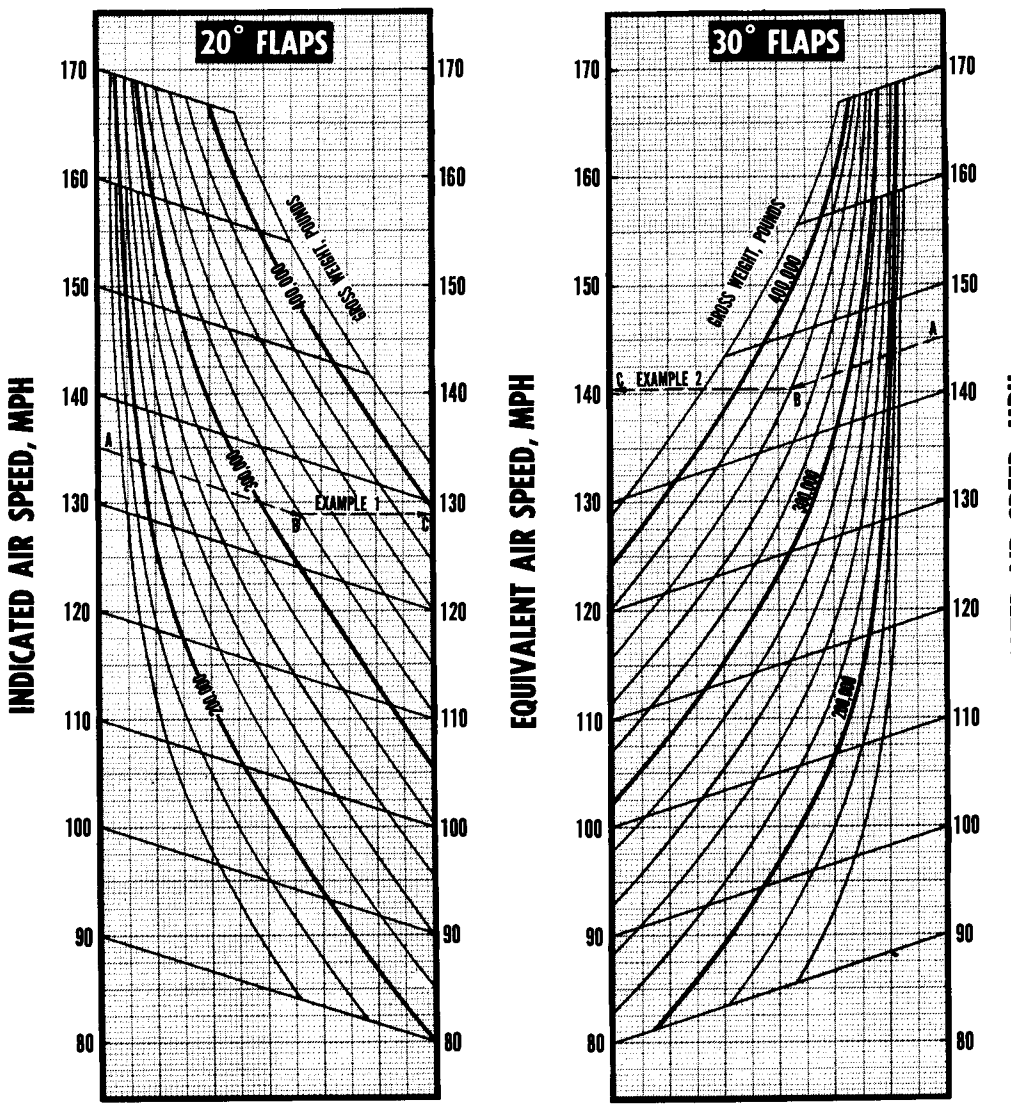
67-302-A

Figure A-12.

EQUIVALENT AIRSPEED CONVERSION

TAKE-OFF & LANDING CONFIGURATION

NOTES:
1. Indicated air speed corrected for instrument error only.
2. Compressibility effect is considered negligible below 10,000 feet for this range of air speeds.



DATA AS OF: 1 JAN. 1953
DATA BASED ON: FLIGHT TEST

FI-496-81

Figure A-13.

SPECIFIC HUMIDITY DETERMINATION.

Two methods are presented to enable determination of specific humidity. One is a conversion scale to determine specific humidity when the dew point is known; the other is a nomogram to be used when the wet bulb and dry bulb temperatures are known.

EXAMPLE 1.

Find the specific humidity of the atmosphere when

Dew point = 66°F.

Locate a dew point of 66°F (A) on the conversion scale of figure A-14. Opposite this point read (by interpolation) a value of .0135 lb water vapor/lb dry air (C).

EXAMPLE 2.

Find the specific humidity of the atmosphere when

Dry bulb temperature = 72°F.
Wet bulb temperature = 67°F.

Enter the nomogram in figure A-14 at 72°F (point A) on the dry bulb temperature scale. Locate 67°F (point B) on the wet bulb temperature scale. Project a straight line from point A through point B to the specific humidity scale and read .013 lb water vapor per lb dry air (point C).

WIND COMPONENTS CHART.

Figure A-15 presents a quick method of determining head-wind and cross-wind components from a known wind velocity and heading. The angular guide lines of the chart represent the angle between the wind direction and the heading of the airplane. The magnitude circles denote the wind speed in mph or knots.

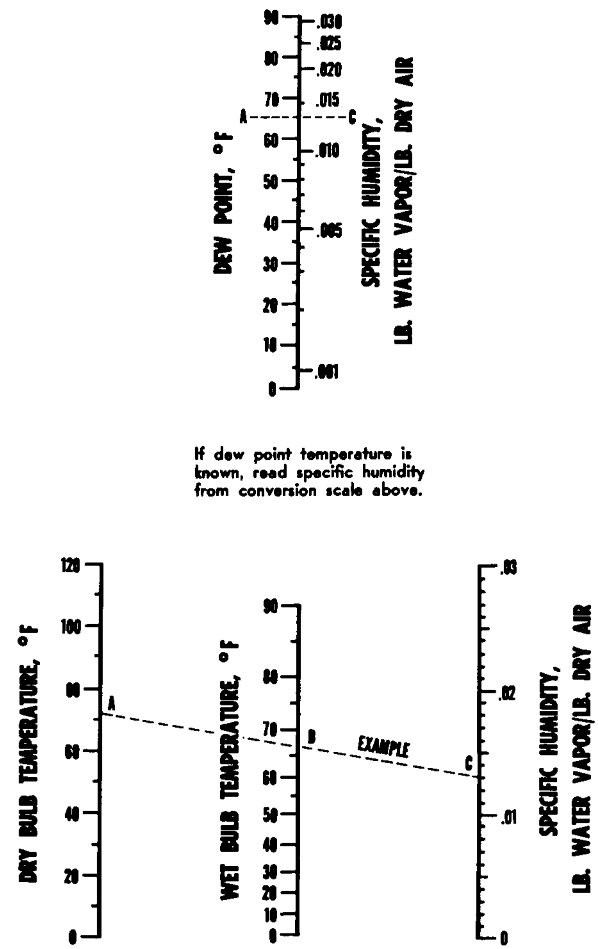
EXAMPLE.

Determine the head-wind (runway) and cross-wind components for take-off under the following conditions:

30-degree runway heading
33-knot wind from an 85-degree heading

First, determine the angle of the wind relative to the runway. This is 85 —30 = 55 degrees. Enter the "Wind Components Chart" at an angle of 55 degrees and a velocity of 33 knots. Move horizontally and vertically to the runway and cross-wind scales and read values of 19 and 27, respectively. Since the wind velocity was originally stated in knots, the recorded head-wind and cross-wind components will also be in knots.

SPECIFIC HUMIDITY DETERMINATION



If only wet and dry temperatures are known, determine specific humidity from nomogram above.

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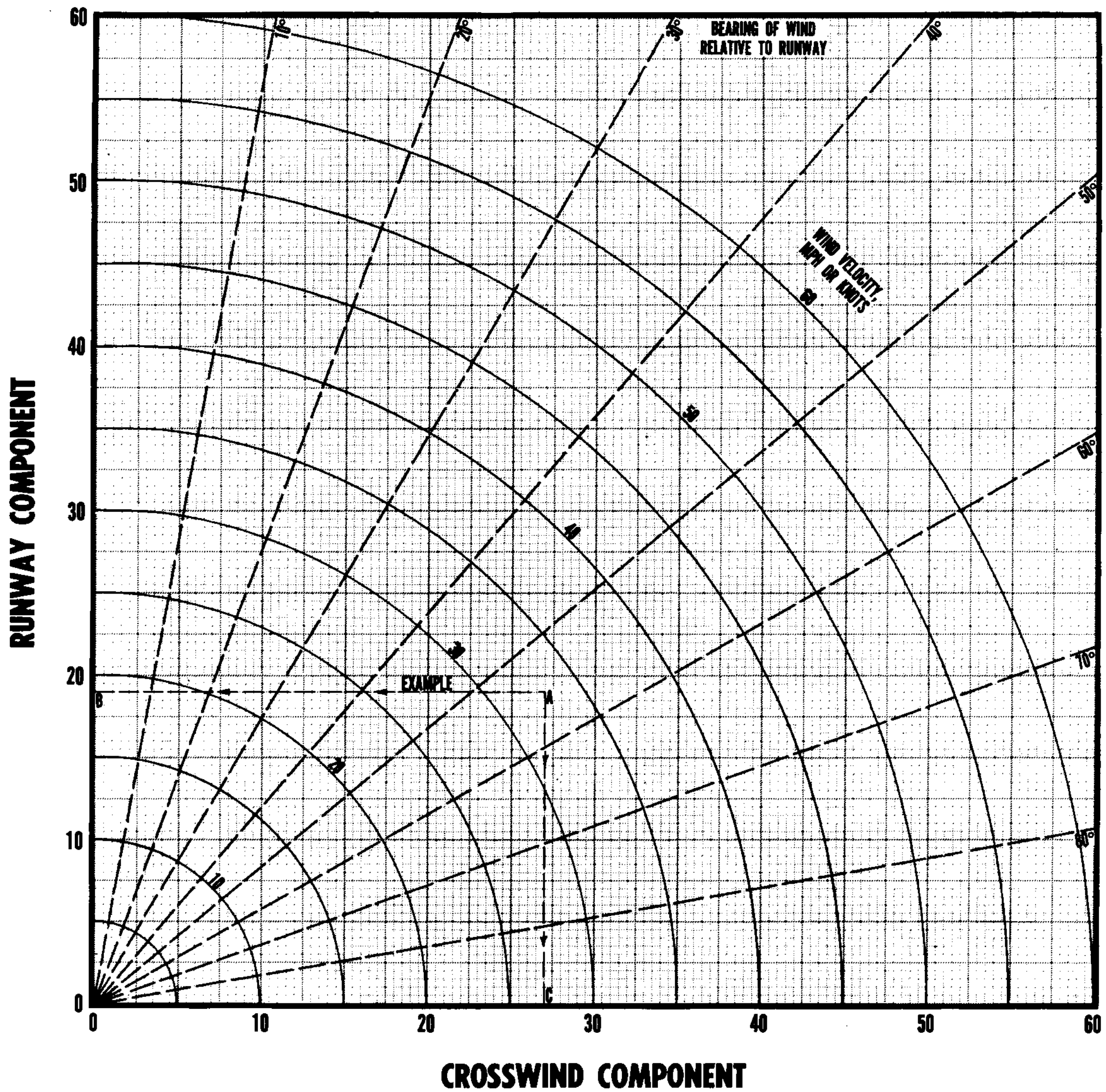
Fi-630-BI

Figure A-14.

WIND COMPONENTS CHART

DETERMINATION OF COMPONENT OF WIND PARALLEL TO AND ACROSS RUNWAY



E1-636-B1

Figure A-15.

POWER PLANT DATA.

TAKE-OFF MANIFOLD PRESSURE.

Curves are presented for two nominal take-off powers, 3800 and 3500 bhp at 2800 rpm. The 3800 bhp setting requires the use of water injection and is recommended for high performance take-offs. The 3500 bhp setting is the maximum dry rating and is to be used when maximum power is necessary and water injection is either not available or not desirable. Although maximum power may not be attainable because of installation and atmospheric conditions as discussed in Section VII, figures A-16 and A-17 allow preflight determination of the maximum permitted manifold pressure which will yield the maximum allowable power during take-off.

For dry air, the maximum allowable take-off MAP varies with carburetor air temperature. Average take-off CAT. can be determined from the lower part of the chart for any atmospheric temperature and pressure and for any intercooler setting with carburetor preheat OFF. It may be noted that this imposes an upper limit on CAT. for safe operation.

Note

At the present time test data for the preheat ON condition is not available; therefore, no lower safe operating limits have been established.

After determining the take-off CAT., the maximum allowable manifold pressure can be determined from the upper part of the chart. When water vapor is present in the atmosphere, a greater total volume of air is required to obtain an equivalent charge of "dry" air. Increases in maximum allowable manifold pressure for specific humidity, as shown in the upper part of the chart, have been authorized to recover the power which will be lost due to the presence of water vapor in the air.

Note

All military power data in this appendix are based on 3800 bhp/2800 rpm (wet).

EXAMPLE.

Determine the manifold pressure to be held during take-off and climb-out with intercoolers full open and water injection ON under the following conditions:

9°C OAT.
2000 feet pressure altitude
.0075 lb water vapor/lb dry air specific humidity

Enter figure A-16 for 3800 bhp at 9°C on the OAT. scale on the lower plot. Move horizontally to the right to the 2000-foot pressure altitude line (interpolated) on the full-open intercooler curves and read an average take-off CAT. of 28°C from the lower scale. Move vertically along this CAT. value into the upper plot to a specific humidity of .0075 lbs water vapor/lb dry air proceed horizontally to the left to read a corrected maximum manifold pressure of 66.9 in. Hg.

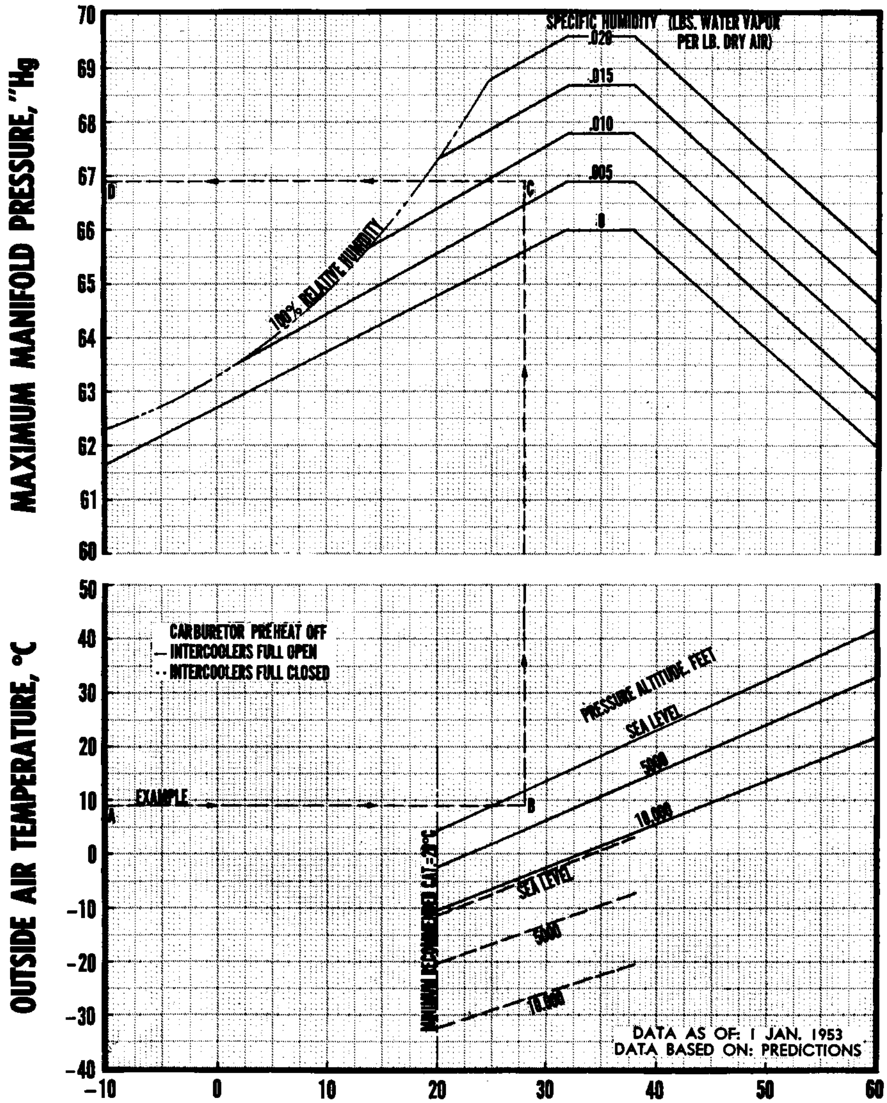
MAXIMUM ALLOWABLE TAKE-OFF MANIFOLD PRESSURE

3800 BHP

R4360-53 ENGINE

NOTES:
1. 2800 RPM.
2. Rich mixture setting. ADI on.
3. Full throttle
4. Dual (BH-1) turbo.
5. 115/145 grade fuel.

LIMITATIONS:
1. Minimum CAT. = 20°C.
*2. Maximum CHT = 255°C.
3. Minimum CHT = 225°C.
* For hottest of A-6, C-5, D-2 and D-5 cylinders.



F1-702-81

Figure A-16.

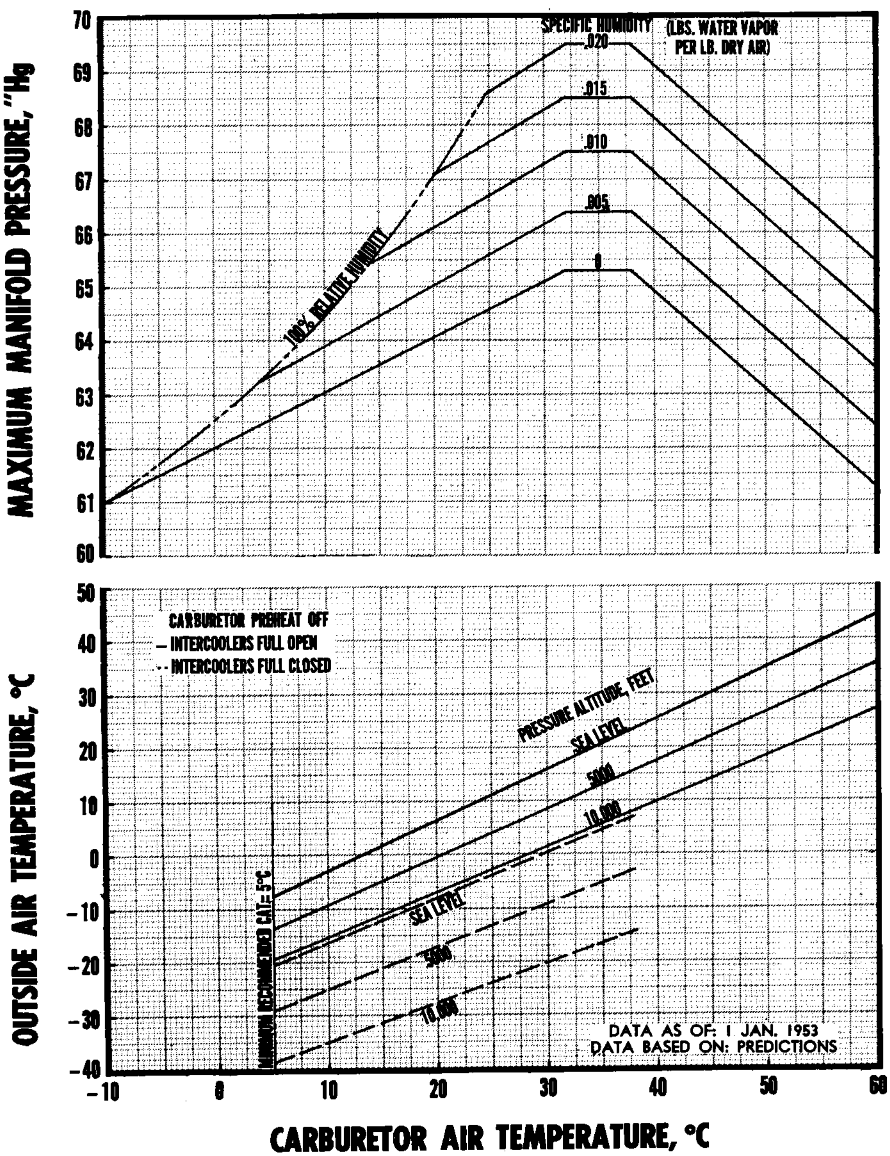
MAXIMUM ALLOWABLE TAKE-OFF MANIFOLD PRESSURE

3500 BHP

R4360-53 ENGINE

NOTES:
1. 2800 RPM.
2. Rich mixture setting. ADI off.
3. Full throttle
4. Dual (BH-1) turbo.
5. 115/145 grade fuel.

LIMITATIONS:
1. Minimum CAT. = 5°C.
*2. Maximum CHT = 255°C.
3. Minimum CHT = 225°C.
* For hottest of A-6, C-5, D-2 and D-5 cylinders.



F1-703-81

Figure A-17.

R4360-53 ENGINE POWER SCHEDULES.

Recommended power schedules for the reciprocating engines are presented in curve and tabular form. All cruise performance shown in this section is based on operation according to these schedules.

Individual charts and tables are presented for altitudes from sea level to 40,000 feet in increments of 5000 feet and from 40,000 feet to 50,000 feet in increements of 2500 feet. A chart and table are also presented for 51,000 feet. The basic schedule consists of operation at a bmep of 195.5 psi, maximum for continuous operation, with fuel flows manually adjusted to specification normal setting, and at a bmep of 160 psi, maximum for continuous operation is best economy mixture setting. Engine speeds of 2300 rpm for manual lean operation and 2600 rpm for continuous operation in manual adjust mixture should not be exceeded. Deviations from the basic power schedule are caused by propeller vibration restrictions and turbosupercharger limitations. A minimum rpm of 1880 is imposed on manual adjust mixture operation at bmeps in excess of 160 psi. Manual lean operation is limited to 1400 rpm to avoid airplane vibration. A detailed discussion of engine operation and power schedule limitations is presented in "Engine Failure" and "Propeller Failure," Section III, "Engine Limitations," Section V, and "Reciprocating Engines," Section VII. Complete propeller vibration restrictions are presented in "Propeller Limitations," Section V.

Cooling limits and turbo switch points are indicated on each chart. Carburetor air temperature and cylinder head temperatures should be maintained as near limits as possible to effect minimum fuel consumption and minimum drag.

Charted manifold pressures are based on a CAT. of 38°C except from 1600 to 1760 bhp in 30-degree spark advance where the base is 20°C. A correction scale is provided for adjusting MAP. for variations in carburetor air temperature.

Note

> Manifold pressures shown on these curves are not intended for accurate settings of power or mixture. They are average values determined from tests on several engines and are furnished as a guide only. The procedures outlined in "Mixture Control," Section VII, should be followed for accurately setting power in manual lean and manual adjust mixtures.

Because of production tolerances and power plant conditions, the manifold pressure required to develop a given power will vary slightly between engines. It is permissible to have an over-all spread in MAP. between the six engines not to exceed 3 in. Hg. In no case, however, will the corrected MAP. be greater than the charted value plus 3 inches of mercury.

Torque pressures are presented for both high and low cooling fan settings at altitudes where high fan might be required. Operating conditions (altitude, bhp, EAS) requiring HIGH RPM cooling fan setting can be determined from the "Flight Operating Data Charts" (climb control, specific range, etc.).

Charted fuel flow rates are the average expected. If fuel flow is above charted values in normal mixture setting, the manual adjust procedure outlined in "Mixture Control," Section VII, should be used provided the instruments are calibrated.

Power relationship for the R4360-53 engine can be determined from

$$BMEP = 181.5\frac{BHP}{RPM}$$

$$RPM = BHP\frac{181.5}{BMEP}$$

$$BHP = RPM\frac{BMEP}{181.5}$$

EXAMPLE.

Find the operating conditions under the following requirements:

2440 bhp and
10°C CAT. at
sea level

Enter the chart for sea level (figure A-19) at 2440 bhp. Move vertically to the power schedule line (manual adjust-normal mixture, 20-degree spark advance, 195.5 bmep) and read an rpm of 2265 from the scale on the left. At 2440 bhp, move vertically to the manifold pressure line, horizontally to the MAP. scale base line on the right, then parallel to the guide lines to a CAT. of 10°C and read a predicted average manifold pressure of 47.3 in Hg. At 2440 bhp move vertically to the torque pressure curve. Low cooling fan only is presented at this altitude, and the corresponding torque pressure is 196 psi. Again at 2440 bhp move vertically to the fuel flow curve and read an average expected engine fuel consumption rate of 1535 pounds per hour per engine.

R4360-53 ENGINE POWER SCHEDULE AT SEA LEVEL

BHP	RPM	BMEP (psi)	MIXTURE	SPARK ADVANCE	MAP In. of Hg	TURBO SETTING	LOW FAN T. P. (psi)	F. F. (lb/hr)	REMARKS
2800	2600	195.5	MA	20°	55.0	DUAL	193.5	2040	
2700	2510	195.5	MA	20°	53.5	DUAL	194.0	1905	
2600	2415	195.5	MA	20°	52.0	DUAL	194.5	1770	
2500	2320	195.5	MA	20°	50.6	DUAL	196.0	1630	
2400	2225	195.5	MA	20°	49.2	DUAL	196.5	1470	
2300	2135	195.5	MA	20°	47.9	DUAL	197.0	1290	
2290	2125	195.5	MA	20°	47.8	DUAL	197.0	1270	
2200	2125	188.0	MA	20°	45.6	DUAL	189.0	1140	Min. EAS = 187†
2100	2125	179.4	MA	20°	42.9	DUAL	180.0	1025	Min. EAS = 187†
2070	2125	176.8	MA	20°	42.0	DUAL	177.0	1005	Min. EAS = 222†
2200	2040	195.5	MA	20°	46.6	DUAL	197.5	1110	Max. EAS = 187*
2100	1950	195.5	MA	20°	45.3	DUAL	198.0	970	Max. EAS = 204*
2025	1880	195.5	MA	20°	44.4	DUAL	198.0	905	
2000	1880	193.1	MA	20°	43.8	DUAL	196.0	890	
1900	1880	183.5	MA	20°	41.5	DUAL	186.0	830	
1800	1880	173.8	MA	20°	39.4	DUAL	176.0	790	
1700	1880	164.1	MA	20°	37.2	DUAL	166.0	745	
1600	1880	154.6	MA	20°	35.2	DUAL	155.1	710	
2030	2300	160.0	ML	20°	44.1	DUAL	158.5	965	
2000	2270	160.0	ML	20°	43.8	DUAL	159.0	950	
1900	2155	160.0	ML	20°	42.6	DUAL	160.0	885	
1875	2125	160.0	ML	20°	42.4	DUAL	160.0	870	
1800	2125	153.8	ML	20°	41.0	DUAL	152.5	835	Min. EAS = 187†
1720	2125	146.9	ML	20°	39.8	DUAL	146.0	800	Min. EAS = 187†
1800	2040	160.0	ML	20°	41.7	DUAL	160.0	825	Max. EAS = 187*
1760	2000	160.0	ML	20°	41.4	DUAL	160.0	800	Max. EAS = 187*
1760	2000	160.0	ML	30°	42.0	DUAL	160.0	775	Max. EAS = 195*
1700	1930	160.0	ML	30°	41.5	DUAL	160.5	745	20°C CAT.
1600	1815	160.0	ML	30°	40.6	DUAL	161.0	700	20°C CAT.
1600	1815	160.0	ML	30°	43.0	SINGLE	161.0	700	38°C CAT.
1500	1700	160.0	ML	30°	41.9	SINGLE	162.0	650	
1400	1590	160.0	ML	30°	40.7	SINGLE	162.0	605	
1300	1475	160.0	ML	30°	39.5	SINGLE	162.5	565	
1235	1400	160.0	ML	30°	38.8	SINGLE	163.0	540	
1200	1400	155.6	ML	30°	37.9	SINGLE	158.0	525	
1100	1400	142.6	ML	30°	35.4	SINGLE	144.5	485	
1000	1400	129.6	ML	30°	32.9	SINGLE	132.0	445	
900	1400	116.7	ML	30°	30.4	SINGLE	118.0	410	
800	1400	103.7	ML	30°	28.0	SINGLE	105.0	375	

COOLING LIMITS:

1. CHT = 255°C in 20° spark advance
   CHT = 260°C in 30° spark advance
   for hottest of A-6, C-5, D-2 and D-5 cylinders.
2. Oil-in temp. = 93°C in level flight and 100°C in climb.
3. CAT. = 20°C between 1600 and 1760 BHP in 30° spark advance. CAT. = 38°C FOR ALL OTHER OPERATION.

NOTES:

1. 115/145 grade fuel
2. MAP based on limit CAT.

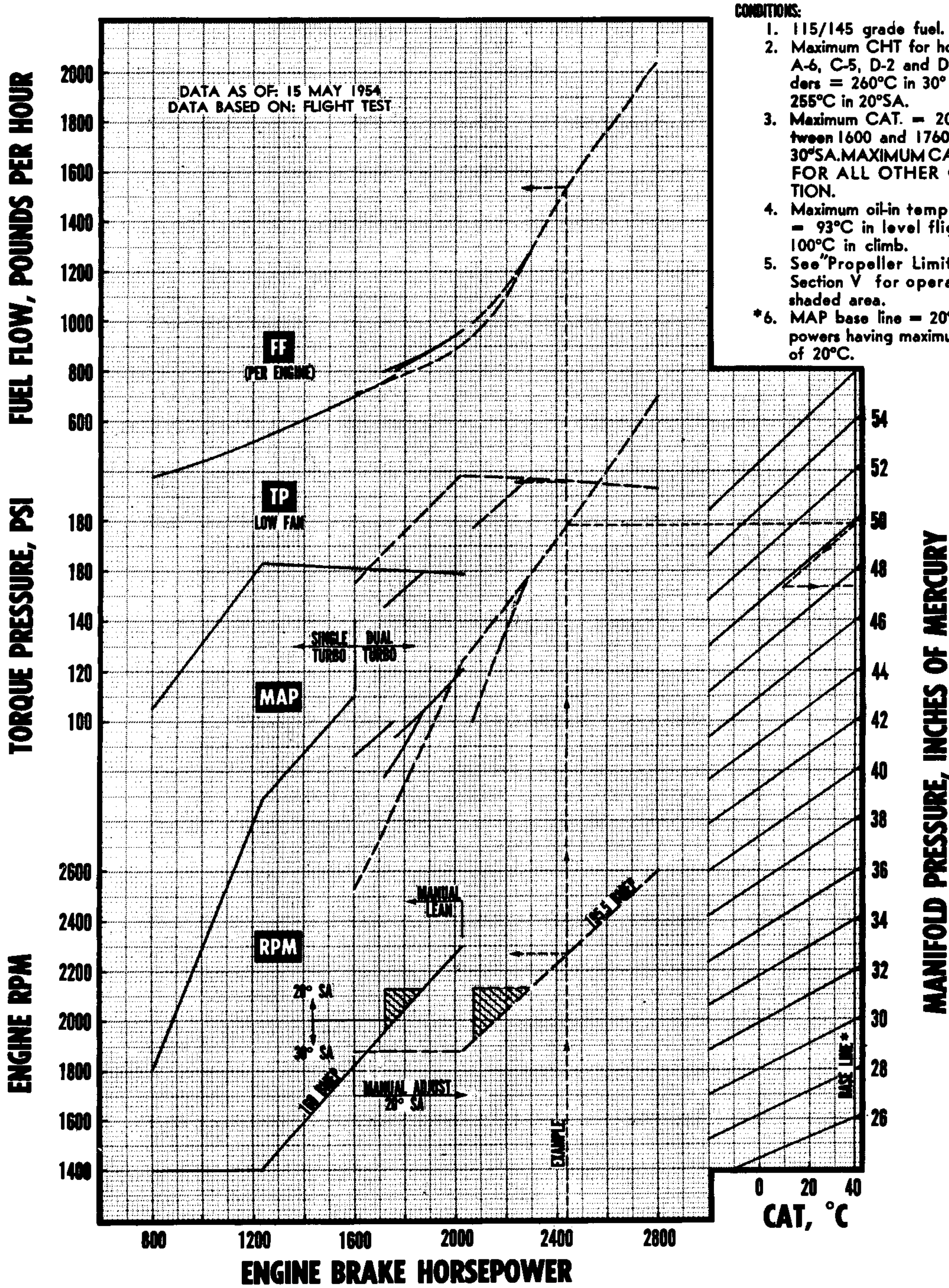
†This air speed is the minimum for best n. mi/lb when operating within the propeller restriction region and using the specified bhp.

*To avoid propeller vibration do not exceed this air speed at the noted bhp/rpm combination. Refer to Specific Range Curves for operation at higher air speeds.

67-164-?

Figure A-18.

R4360-53 ENGINE POWER SCHEDULE AT SEA LEVEL



CONDITIONS:

1. 115/145 grade fuel.
2. Maximum CHT for hottest of A-6, C-5, D-2 and D-5 cylinders = 260°C in 30° SA and 255°C in 20°SA.
3. Maximum CAT. = 20°C between 1600 and 1760 BHP in 30°SA.MAXIMUM CAT.=38°C FOR ALL OTHER OPERATION.
4. Maximum oil-in temperature = 93°C in level flight and 100°C in climb.
5. See "Propeller Limitations," Section V for operation in shaded area.

*6. MAP base line = 20° C for powers having maximum CAT. of 20°C.

Figure A-19.

R4360-53 ENGINE POWER SCHEDULE AT 5,000 FEET

BHP	RPM	BMEP (psi)	MIXTURE	SPARK ADVANCE	MAP In. of Hg.	TURBO SETTING	LOW FAN T. P. (psi)	F. F. (lb/hr)	REMARKS
2800	2600	195.5	MA	20°	54.0	DUAL	194.5	2040	
2700	2510	195.5	MA	20°	52.4	DUAL	196.0	1905	
2600	2415	195.5	MA	20°	50.9	DUAL	196.5	1770	
2500	2320	195.5	MA	20°	49.4	DUAL	197.0	1630	
2400	2225	195.5	MA	20°	47.9	DUAL	198.0	1470	
2300	2135	195.5	MA	20°	46.5	DUAL	198.0	1290	
2290	2125	195.5	MA	20°	46.4	DUAL	198.0	1270	
2200	2125	188.0	MA	20°	44.1	DUAL	190.0	1140	Min. EAS = 187†
2100	2125	179.4	MA	20°	41.6	DUAL	181.0	1025	Min. EAS = 187†
2080	2125	177.7	MA	20°	41.1	DUAL	179.5	1005	Min. EAS = 187†
2200	2040	195.5	MA	20°	45.1	DUAL	199.0	1110	Max. EAS = 187*
2100	1950	195.5	MA	20°	43.7	DUAL	199.5	970	Max. EAS = 204*
2025	1880	195.5	MA	20°	42.7	DUAL	200.0	905	
2000	1880	193.1	MA	20°	42.1	DUAL	197.0	890	
1900	1880	183.5	MA	20°	40.2	DUAL	186.5	830	
1800	1880	173.8	MA	20°	38.2	DUAL	176.0	790	
1700	1880	164.1	MA	20°	36.3	DUAL	166.0	745	
1600	1880	154.3	MA	20°	34.3	DUAL	156.0	710	
2030	2300	160.0	ML	20°	43.1	DUAL	159.5	965	
2000	2270	160.0	ML	20°	42.7	DUAL	160.0	950	
1900	2155	160.0	ML	20°	41.6	DUAL	160.0	885	
1875	2125	160.0	ML	20°	41.3	DUAL	160.5	870	
1800	2125	153.8	ML	20°	40.0	DUAL	153.5	835	Min. EAS = 187†
1725	2125	147.5	ML	20°	38.5	DUAL	147.0	805	Min. EAS = 187†
1800	2040	160.0	ML	20°	40.5	DUAL	161.0	825	Max. EAS = 187*
1760	2000	160.0	ML	20°	40.0	DUAL	161.5	800	Max. EAS = 187*
1760	2000	160.0	ML	30°	41.4	DUAL	161.5	775	Max. EAS = 195*
1700	1930	160.0	ML	30°	40.9	DUAL	162.0	745	20°C CAT.
1600	1815	160.0	ML	30°	39.6	DUAL	162.0	700	20°C CAT.
1600	1815	160.0	ML	30°	42.8	SINGLE	162.0	700	38°C CAT.
1500	1700	160.0	ML	30°	41.4	SINGLE	162.5	650	
1400	1590	160.0	ML	30°	39.9	SINGLE	163.5	605	
1300	1475	160.0	ML	30°	38.4	SINGLE	164.0	565	
1235	1400	160.0	ML	30°	37.6	SINGLE	164.0	540	
1200	1400	155.6	ML	30°	36.7	SINGLE	160.0	525	
1100	1400	142.6	ML	30°	34.5	SINGLE	146.0	485	
1000	1400	129.6	ML	30°	32.1	SINGLE	132.5	445	
900	1400	116.7	ML	30°	29.8	SINGLE	119.0	410	
800	1400	103.7	ML	30°	27.6	SINGLE	106.0	375	

COOLING LIMITS:

1. CHT = 255°C in 20° spark advance
   CHT = 260°C in 30° spark advance
   for hottest of A-6, C-5, D-2 and D-5 cylinders.
2. Oil-in temp. = 93°C in level flight and 100°C in climb.
3. CAT. = 20°C between 1600 and 1760 BHP in 30° spark advance. CAT. = 38°C FOR ALL OTHER OPERATION.

NOTES:

1. 115/145 grade fuel
2. MAP based on limit CAT.

†This air speed is the minimum for best n. mi/lb when operating within the propeller restriction region and using the specified bhp.

*To avoid propeller vibration do not exceed this air speed at the noted bhp/rpm combination. Refer to Specific Range Curves for operation at higher air speeds.

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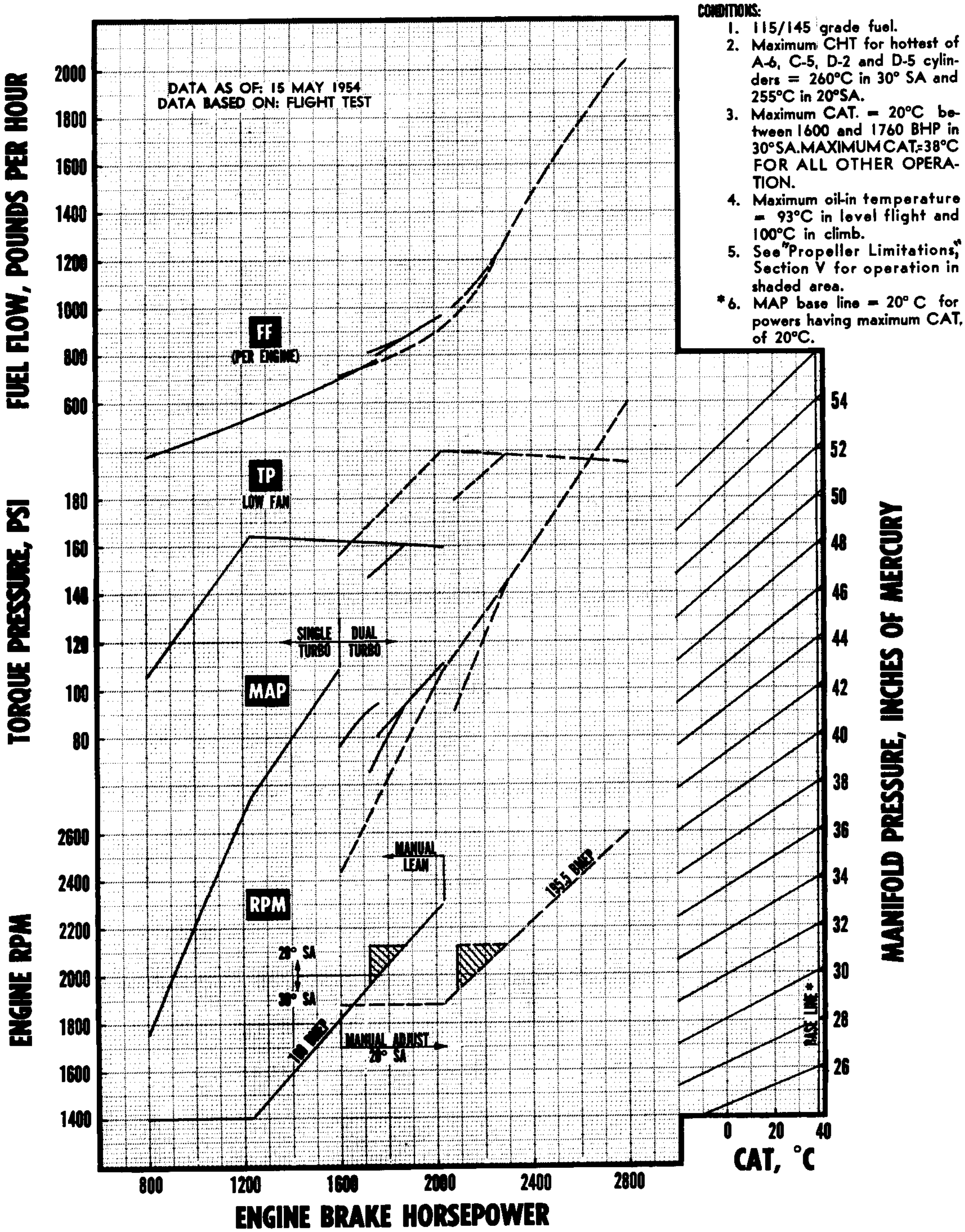
Figure A-20.

R4360-53 ENGINE POWER SCHEDULE AT 5,000 FEET



CONDITIONS:

1. 115/145 grade fuel.
2. Maximum CHT for hottest of A-6, C-5, D-2 and D-5 cylinders = 260°C in 30° SA and 255°C in 20°SA.
3. Maximum CAT. = 20°C between 1600 and 1760 BHP in 30°SA. MAXIMUM CAT.=38°C FOR ALL OTHER OPERATION.
4. Maximum oil-in temperature = 93°C in level flight and 100°C in climb.
5. See "Propeller Limitations," Section V for operation in shaded area.

*6. MAP base line = 20° C for powers having maximum CAT. of 20°C.

Figure A-21.

R4360-53 ENGINE POWER SCHEDULE AT 10,000 FEET

BHP	RPM	BMEP (psi)	MIXTURE	SPARK ADVANCE	MAP In. of Hg.	TURBO SETTING	LOW FAN T. P. (psi)	F. F. (lb/hr)	REMARKS
2800	2600	195.5	MA	20°	53.0	DUAL	195.5	2040	
2700	2510	195.5	MA	20°	51.4	DUAL	196.0	1905	
2600	2415	195.5	MA	20°	49.9	DUAL	196.5	1770	
2500	2320	195.5	MA	20°	48.5	DUAL	197.5	1630	
2400	2225	195.5	MA	20°	47.0	DUAL	198.0	1470	
2300	2135	195.5	MA	20°	45.6	DUAL	198.0	1290	
2210	2050	195.5	MA	20°	44.5	DUAL	199.0	1125	
2200	2050	194.8	MA	20°	44.3	DUAL	198.0	1110	Min. EAS = 187†
2100	2050	186.0	MA	20°	41.9	DUAL	188.0	1005	Min. EAS = 188†
2000	2050	177.1	MA	20°	39.5	DUAL	179.0	925	Min. EAS = 198†
2200	2040	195.5	MA	20°	44.2	DUAL	199.0	1110	Max. EAS = 187*
2100	1950	195.5	MA	20°	43.0	DUAL	199.5	970	Max. EAS = 191*
2100	1950	195.5	MA	20°	47.6	SINGLE	199.5	970	Max. EAS = 191*
2025	1880	195.5	MA	20°	46.3	SINGLE	199.5	905	Max. EAS = 201*
2000	1880	193.1	MA	20°	45.7	SINGLE	197.0	890	Max. EAS = 201*
1900	1880	183.5	MA	20°	43.1	SINGLE	187.0	830	Max. EAS = 201*
1800	1880	173.8	MA	20°	40.5	SINGLE	177.0	790	Max. EAS = 201*
1700	1880	164.1	MA	20°	37.8	SINGLE	167.5	745	Max. EAS = 201*
1600	1880	154.3	MA	20°	35.4	SINGLE	156.8	710	Max. EAS = 201*
2030	2300	160.0	ML	20°	41.5	DUAL	160.0	965	
2000	2270	160.0	ML	20°	41.1	DUAL	160.0	950	
1900	2155	160.0	ML	20°	40.3	DUAL	161.0	885	
1810	2050	160.0	ML	20°	39.6	DUAL	161.5	835	
1800	2050	159.4	ML	20°	39.5	DUAL	160.5	825	Min. EAS = 187†
1700	2050	150.5	ML	20°	37.3	DUAL	151.0	790	Min. EAS = 187†
1800	2040	160.0	ML	20°	39.5	DUAL	162.0	825	Max. EAS = 187*
1760	2000	160.0	ML	20°	39.4	DUAL	162.0	800	Max. EAS = 187*
1760	2000	160.0	ML	30°	40.5	DUAL	162.0	775	Max. EAS = 187*
1700	1930	160.0	ML	30°	39.8	DUAL	162.5	745	Max. EAS = 193*
1600	1815	160.0	ML	30°	38.7	DUAL	162.5	700	20°C CAT.
1600	1815	160.0	ML	30°	42.1	SINGLE	162.5	700	38°C CAT.
1500	1700	160.0	ML	30°	40.8	SINGLE	163.5	650	
1400	1590	160.0	ML	30°	39.6	SINGLE	164.0	605	
1300	1475	160.0	ML	30°	38.1	SINGLE	164.5	565	
1235	1400	160.0	ML	30°	37.2	SINGLE	165.0	540	
1200	1400	155.6	ML	30°	36.2	SINGLE	160.0	525	
1100	1400	142.6	ML	30°	33.8	SINGLE	147.0	485	
1000	1400	129.6	ML	30°	31.4	SINGLE	134.0	445	
900	1400	116.7	ML	30°	29.0	SINGLE	120.5	410	
800	1400	103.7	ML	30°	26.5	SINGLE	107.0	375	

COOLING LIMITS:

1. CHT = 255°C in 20° spark advance
   CHT = 260°C in 30° spark advance
   for hottest of A-6, C-5, D-2 and D-5 cylinders.
2. Oil-in temp. = 93°C in level flight and 100°C in climb.
3. CAT. = 20°C between 1600 and 1760 BHP in 30° spark advance. CAT. = 38°C FOR ALL OTHER OPERATION.

NOTES:

1. 115/145 grade fuel
2. MAP based on limit CAT.

†This air speed is the minimum for best n. mi/lb when operating within the propeller restriction region and using the specified bhp.

*To avoid propeller vibration do not exceed this air speed at the noted bhp/rpm combination. Refer to Specific Range Curves for operation at higher air speeds.

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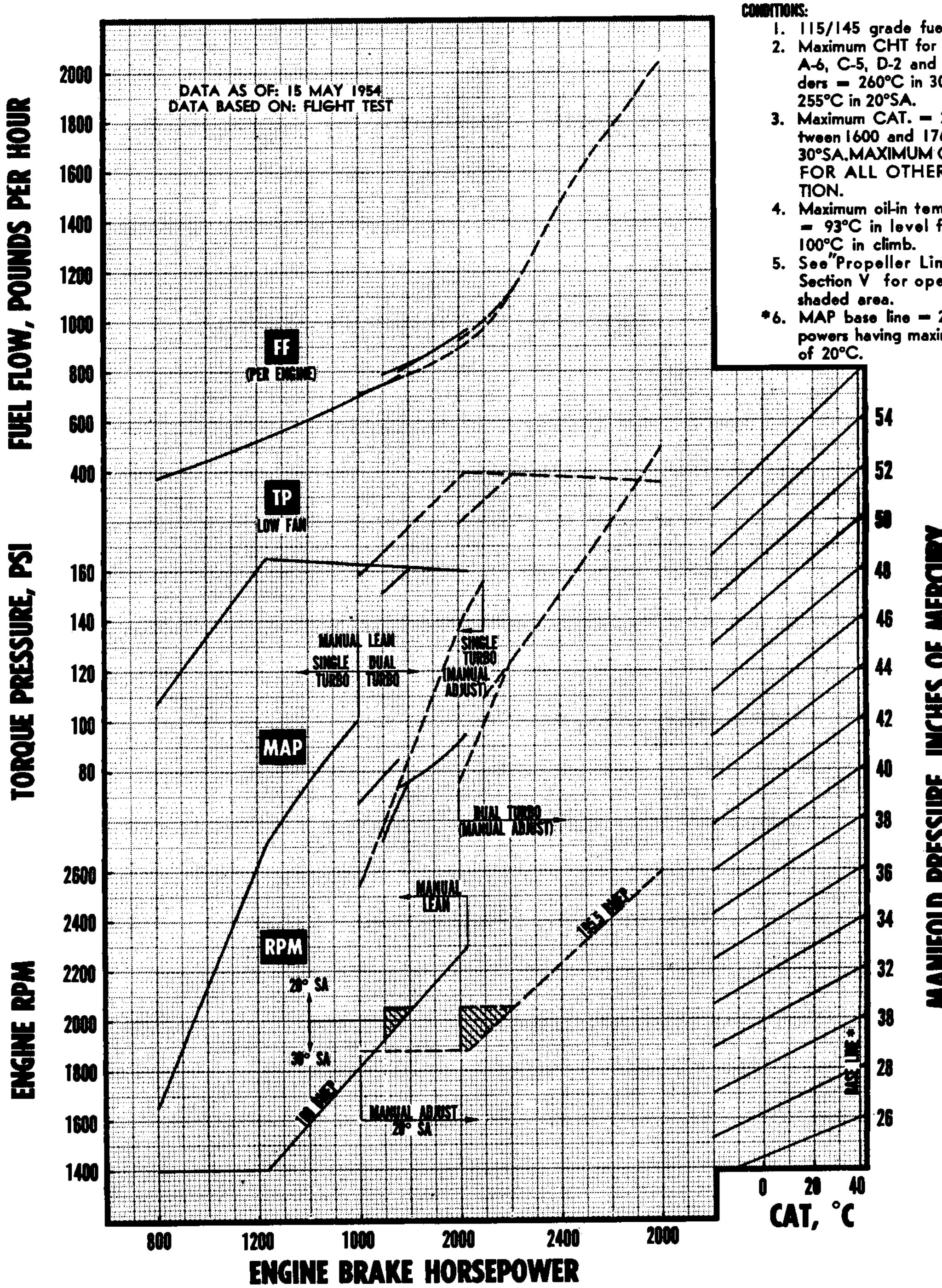
Figure A-22.

R4360-53 ENGINE POWER SCHEDULE AT 10,000 FEET

CONDITIONS:

1. 115/145 grade fuel.
2. Maximum CHT for hottest of A-6, C-5, D-2 and D-5 cylinders = 260°C in 30° SA and 255°C in 20°SA.
3. Maximum CAT. = 20°C between 1600 and 1760 BHP in 30°SA. MAXIMUM CAT.=38°C FOR ALL OTHER OPERATION.
4. Maximum oil-in temperature = 93°C in level flight and 100°C in climb.
5. See "Propeller Limitations," Section V for operation in shaded area.
*6. MAP base line = 20° C for powers having maximum CAT. of 20°C.



67-167-A

Figure A-23.

R4360-53 ENGINE POWER SCHEDULE AT 15,000 FEET

BHP	RPM	BMEP (psi)	MIXTURE	SPARK ADVANCE	MAP In. of Hg.	TURBO SETTING	LOW FAN T. P. (psi)	F. F. (lb/hr)	REMARKS
2800	2600	195.5	MA	20°	53.1	DUAL	197.0	2040	
2700	2510	195.5	MA	20°	51.8	DUAL	197.5	1905	
2600	2415	195.5	MA	20°	50.5	DUAL	198.0	1770	
2500	2320	195.5	MA	20°	49.0	DUAL	199.0	1630	
2400	2225	195.5	MA	20°	47.6	DUAL	199.5	1470	
2300	2135	195.5	MA	20°	46.1	DUAL	200.0	1290	
2210	2050	195.5	MA	20°	44.7	DUAL	200.0	1125	
2200	2050	194.8	MA	20°	44.2	DUAL	199.0	1110	Min. EAS = 187†
2100	2050	186.0	MA	20°	41.5	DUAL	189.5	1005	Min. EAS = 187†
2025	2050	177.1	MA	20°	39.5	DUAL	182.0	940	Min EAS = 195†
2200	2040	195.5	MA	20°	44.5	DUAL	200.0	1110	Max. EAS = 187*
2100	1950	195.5	MA	20°	42.6	DUAL	200.5	970	Max. EAS = 191*
2100	1950	195.5	MA	20°	48.2	SINGLE	200.5	970	Max. EAS = 191*
2025	1880	195.5	MA	20°	46.9	SINGLE	200.5	905	Max. EAS = 201*
2000	1880	193.1	MA	20°	46.1	SINGLE	198.0	890	Max. EAS = 201*
1900	1880	183.5	MA	20°	43.5	SINGLE	188.0	830	Max. EAS = 201*
1800	1880	173.8	MA	20°	40.9	SINGLE	178.0	790	Max. EAS = 201*
1700	1880	164.1	MA	20°	38.2	SINGLE	167.5	745	Max. EAS = 201*
1600	1880	154.3	MA	20°	35.6	SINGLE	157.3	710	Max. EAS = 201*
2030	2300	160.0	ML	20°	41.0	DUAL	160.5	965	
2000	2270	160.0	ML	20°	40.7	DUAL	161.0	950	
1900	2155	160.0	ML	20°	39.9	DUAL	161.5	885	
1810	2050	160.0	ML	20°	39.3	DUAL	162.0	835	
1800	2050	159.4	ML	20°	39.1	DUAL	161.0	825	Min. EAS = 187†
1725	2050	152.8	ML	20°	37.5	DUAL	154.0	795	Min. EAS = 190†
1800	2040	160.0	ML	20°	39.3	DUAL	162.0	825	Max. EAS = 187*
1760	2000	160.0	ML	20°	39.1	DUAL	162.5	800	Max. EAS = 187*
1760	2000	160.0	ML	30°	40.4	DUAL	162.5	775	Max. EAS = 187*
1700	1930	160.0	ML	30°	39.5	DUAL	163.0	745	20°C CAT.
1600	1815	160.0	ML	30°	38.0	DUAL	163.5	700	20°C CAT.
1600	1815	160.0	ML	30°	42.3	SINGLE	163.5	700	38°C CAT.
1500	1700	160.0	ML	30°	40.7	SINGLE	164.0	650	
1400	1590	160.0	ML	30°	38.9	SINGLE	164.5	605	
1300	1475	160.0	ML	30°	36.9	SINGLE	165.0	565	
1235	1400	160.0	ML	30°	35.7	SINGLE	165.5	540	
1200	1400	155.6	ML	30°	34.9	SINGLE	160.0	525	
1100	1400	142.6	ML	30°	32.9	SINGLE	146.0	485	
1000	1400	129.6	ML	30°	30.9	SINGLE	133.0	445	
900	1400	116.7	ML	30°	28.9	SINGLE	119.0	410	
800	1400	103.7	ML	30°	26.9	SINGLE	105.0	375	

COOLING LIMITS:

1. CHT = 255°C in 20° spark advance
   CHT = 260°C in 30° spark advance
   for hottest of A-6, C-5, D-2 and D-5 cylinders.
2. Oil-in temp. = 93°C in level flight and 100°C in climb.
3. CAT. =20°C between 1600 and 1760 BHP in 30° spark advance. CAT. = 38°C FOR ALL OTHER OPERATION.

NOTES:

1. 115/145 grade fuel
2. MAP based on limit CAT.

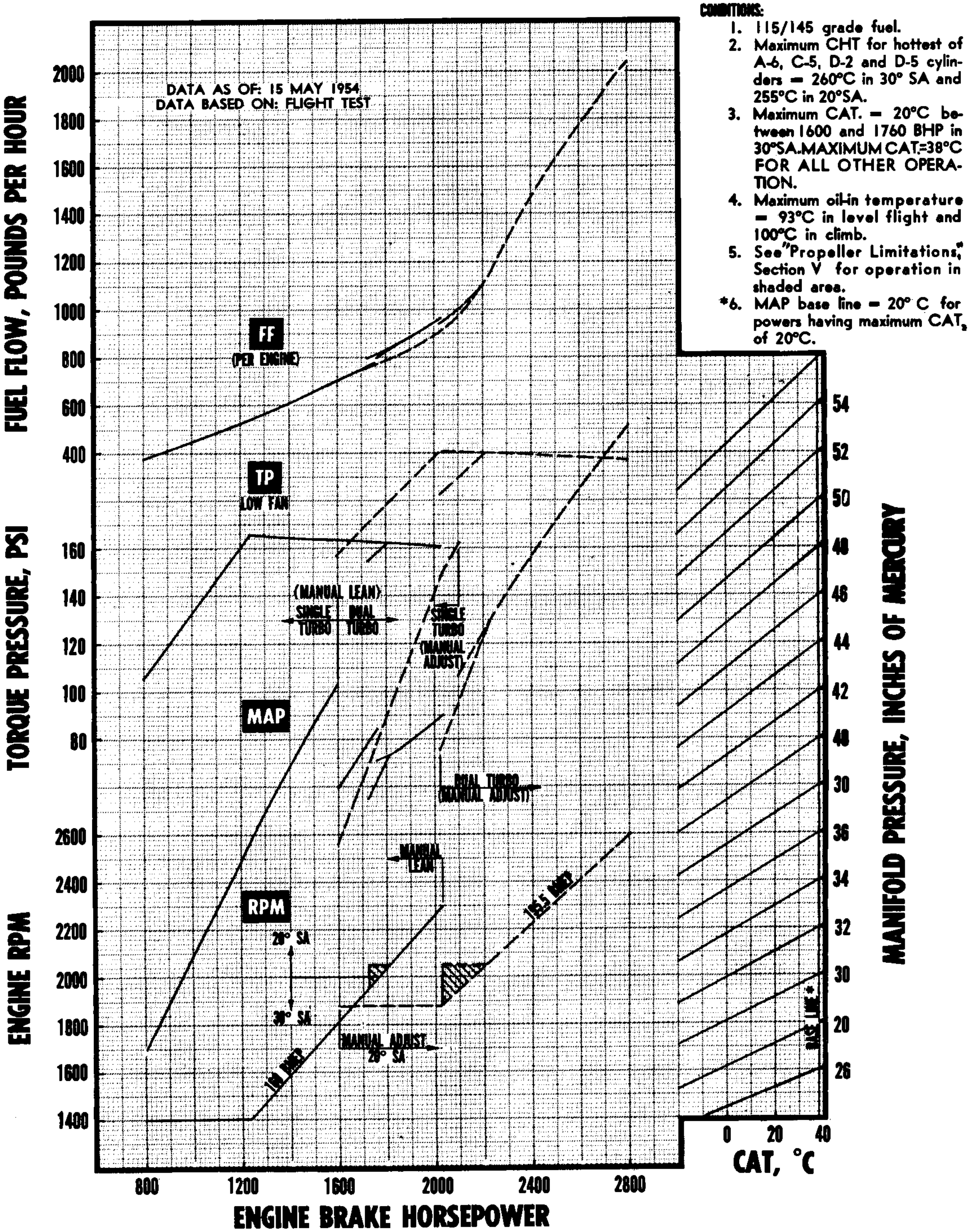
†This air speed is the minimum for best n. mi/lb when operating within the propeller restriction region and using the specified bhp.

*To avoid propeller vibration do not exceed this air speed at the noted bhp/rpm combination. Refer to Specific Range Curves for operation at higher air speeds.

67-172-A

Figure A-24.

R4360-53 ENGINE POWER SCHEDULE AT 15,000 FEET



CONDITIONS:
1. 115/145 grade fuel.
2. Maximum CHT for hottest of A-6, C-5, D-2 and D-5 cylinders = 260°C in 30° SA and 255°C in 20°SA.
3. Maximum CAT. = 20°C between 1600 and 1760 BHP in 30°SA.MAXIMUM CAT.=38°C FOR ALL OTHER OPERATION.
4. Maximum oil-in temperature = 93°C in level flight and 100°C in climb.
5. See "Propeller Limitations," Section V for operation in shaded area.
*6. MAP base line = 20° C for powers having maximum CAT, of 20°C.

Figure A-25.

R4360-53 ENGINE POWER SCHEDULE AT 20,000 FEET

BHP	RPM	BMEP (psi)	MIXTURE	SPARK ADVANCE	MAP In. of Hg.	TURBO SETTING	LOW FAN T. P. (psi)	HIGH FAN T. P. (psi)	F. F. (lb/hr)	REMARKS
2800	2600	195.5	MA	20°	54.0	DUAL	197.5	182.0	2040	
2700	2510	195.5	MA	20°	52.2	DUAL	198.0	183.5	1905	
2600	2415	195.5	MA	20°	50.4	DUAL	199.0	185.0	1770	
2500	2320	195.5	MA	20°	48.7	DUAL	199.5	186.0	1630	
2400	2225	195.5	MA	20°	47.1	DUAL	200.0	187.5	1470	
2300	2135	195.5	MA	20°	45.5	DUAL	200.5	188.5	1290	
2210	2050	195.5	MA	20°	44.1	DUAL	201.0	189.5	1125	
2200	2050	194.8	MA	20°	43.9	DUAL	199.0	189.0	1110	Min. EAS = 187†
2100	2050	186.0	MA	20°	41.4	DUAL	190.5	179.0	1005	Min. EAS = 187†
2060	2050	182.4	MA	20°	40.4	DUAL	186.0	175.0	965	Min. EAS = 191†
2200	2040	195.5	MA	20°	44.0	DUAL	201.0	190.0	1110	Max. EAS = 187*
2100	1950	195.5	MA	20°	42.6	DUAL	201.5	191.0	970	Max. EAS = 191*
2025	1880	195.5	MA	20°	41.5	DUAL	201.5	191.5	905	Max. EAS = 201*
2000	1880	193.1	MA	20°	40.9	DUAL	199.0	189.0	890	Max. EAS = 201*
1900	1880	183.5	MA	20°	38.8	DUAL	189.0	179.0	830	Max. EAS = 201*
1800	1880	173.8	MA	20°	36.6	DUAL	179.0	169.0	790	Max. EAS = 201*
1700	1880	164.1	MA	20°	34.4	DUAL	169.0	159.0	745	Max. EAS = 201*
2030	2300	160.0	ML	20°	41.4	DUAL	162.0	149.5	965	
2000	2270	160.0	ML	20°	41.1	DUAL	162.0	150.0	950	
1900	2155	160.0	ML	20°	40.1	DUAL	162.5	151.5	885	
1800	2040	160.0	ML	20°	39.0	DUAL	163.0	152.5	825	
1760	2000	160.0	ML	20°	38.6	DUAL	163.5	153.5	800	38°C CAT.
1760	2000	160.0	ML	30°	41.3	DUAL	163.5	153.5	775	20°C CAT.
1700	1930	160.0	ML	30°	39.8	DUAL	164.0	154.0	745	20°C CAT.
1600	1815	160.0	ML	30°	38.3	DUAL	164.0	155.5	700	20°C CAT.
1600	1815	160.0	ML	30°	42.9	SINGLE	164.0	155.5	700	38°C CAT.
1500	1700	160.0	ML	30°	41.8	SINGLE	164.5	156.5	650	
1400	1590	160.0	ML	30°	40.5	SINGLE	165.0	158.0	605	
1300	1475	160.0	ML	30°	38.9	SINGLE	165.5	158.5	565	
1235	1400	160.0	ML	30°	37.9	SINGLE	165.5	159.5	540	
1200	1400	155.6	ML	30°	37.0	SINGLE	161.0	155.0	525	
1100	1400	142.6	ML	30°	34.1	SINGLE	147.0	141.0	485	
1000	1400	129.6	ML	30°	31.3	SINGLE	134.0	128.0	445	
900	1400	116.7	ML	30°	28.5	SINGLE	120.5	115.0	410	
800	1400	103.7	ML	30°	25.7	SINGLE	108.0	101.0	375	

COOLING LIMITS:

1. CHT = 255°C in 20° spark advance
   CHT = 260°C in 30° spark advance
   for hottest of A-6, C-5, D-2 and D-5 cylinders.
2. Oil-in temp. = 93°C in level flight and 100°C in climb.
3. CAT. =20°C between 1600 and 1760 BHP in 30° spark advance. CAT. = 38°C FOR ALL OTHER OPERATION.

NOTES:

1. 115/145 grade fuel
2. MAP based on limit CAT.

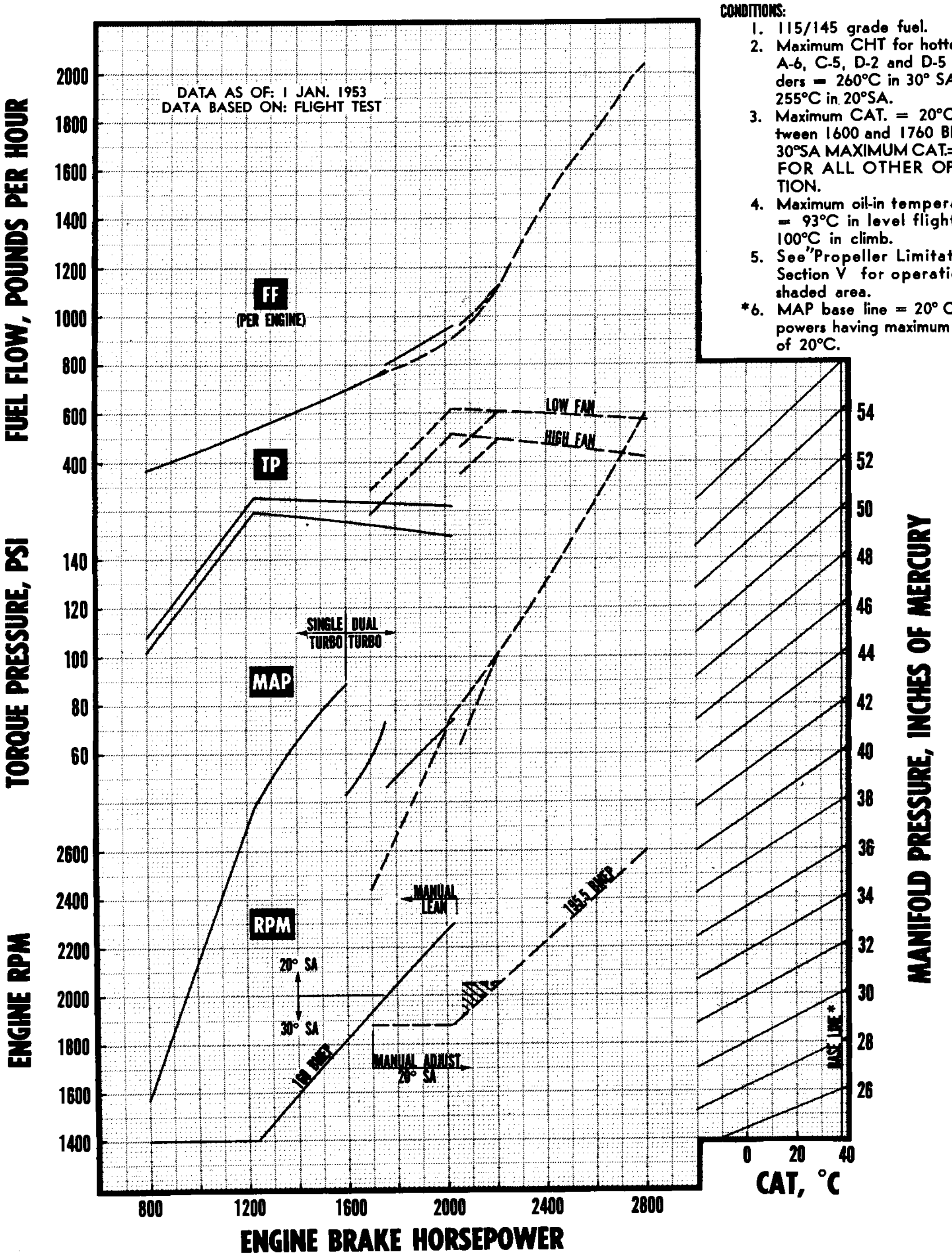
†This air speed is the minimum for best n. mi/lb when operating within the propeller restriction region and using the specified bhp.

*To avoid propeller vibration do not exceed this air speed at the noted bhp/rpm combination. Refer to Specific Range Curves for operation at higher air speeds.

FI-717-81

Figure A-26

R4360-53 ENGINE POWER SCHEDULE AT 20,000 FEET



CONDITIONS:

1. 115/145 grade fuel.
2. Maximum CHT for hottest of A-6, C-5, D-2 and D-5 cylinders = 260°C in 30° SA and 255°C in 20°SA.
3. Maximum CAT. = 20°C between 1600 and 1760 BHP in 30°SA MAXIMUM CAT.=38°C FOR ALL OTHER OPERATION.
4. Maximum oil-in temperature = 93°C in level flight and 100°C in climb.
5. See "Propeller Limitations," Section V for operation in shaded area.

*6. MAP base line = 20° C for powers having maximum CAT. of 20°C.

E1-505-81

Figure A-27.

R4360-53 ENGINE POWER SCHEDULE AT 25,000 FEET

BHP	RPM	BMEP (psi)	MIXTURE	SPARK ADVANCE	MAP In. of Hg.	TURBO SETTING	LOW FAN T. P. (psi)	HIGH FAN T. P. (psi)	F. F. (lb/hr)	REMARKS
2800	2600	195.5	MA	20°	54.5	DUAL	199.0	184.0	2040	
2700	2510	195.5	MA	20°	52.7	DUAL	199.0	185.5	1905	
2600	2415	195.5	MA	20°	50.9	DUAL	199.5	186.5	1770	
2500	2320	195.5	MA	20°	49.2	DUAL	200.0	188.0	1630	
2400	2225	195.5	MA	20°	47.5	DUAL	200.5	189.5	1470	
2300	2135	195.5	MA	20°	46.0	DUAL	200.5	190.5	1290	
2200	2040	195.5	MA	20°	44.5	DUAL	201.0	192.0	1110	
2100	1950	195.5	MA	20°	43.1	DUAL	201.5	192.5	970	
2025	1880	195.5	MA	20°	42.0	DUAL	201.5	193.5	905	
2000	1880	193.1	MA	20°	41.4	DUAL	199.0	190.5	890	
1900	1880	183.5	MA	20°	38.4	DUAL	189.0	180.5	830	
1800	1880	173.8	MA	20°	35.7	DUAL	179.0	171.0	790	
1700	1880	164.1	MA	20°	33.0	DUAL	169.5	160.0	745	
2030	2300	160.0	ML	20°	41.2	DUAL	163.0	151.5	965	
2000	2270	160.0	ML	20°	41.0	DUAL	163.0	152.0	950	
1900	2155	160.0	ML	20°	40.1	DUAL	164.0	153.5	885	
1800	2040	160.0	ML	20°	39.0	DUAL	164.0	154.5	825	
1760	2000	160.0	ML	20°	38.5	DUAL	164.0	155.0	800	38°C CAT.
1760	2000	160.0	ML	30°	40.2	DUAL	164.0	155.0	775	20°C CAT.
1700	1930	160.0	ML	30°	39.7	DUAL	164.0	156.0	745	20°C CAT.
1600	1815	160.0	ML	30°	38.3	DUAL	164.5	157.0	700	20°C CAT.
1600	1815	160.0	ML	30°	43.1	SINGLE	164.5	157.0	700	38°C CAT.
1500	1700	160.0	ML	30°	42.1	SINGLE	165.0	158.0	650	
1400	1590	160.0	ML	30°	40.9	SINGLE	165.5	159.0	605	
1300	1475	160.0	ML	30°	39.4	SINGLE	166.0	160.0	565	
1235	1400	160.0	ML	30°	38.5	SINGLE	166.0	160.5	540	
1200	1400	155.6	ML	30°	37.4	SINGLE	161.0	155.0	525	
1100	1400	142.6	ML	30°	34.7	SINGLE	148.0	142.0	485	
1000	1400	129.6	ML	30°	31.8	SINGLE	134.0	128.0	445	
900	1400	116.7	ML	30°	29.0	SINGLE	120.5	115.0	410	
800	1400	103.7	ML	30°	26.0	SINGLE	108.0	101.0	375	

COOLING LIMITS:

1. CHT = 255°C in 20° spark advance
   CHT = 260°C in 30° spark advance
   for hottest of A-6, C-5, D-2 and D-5 cylinders.
2. Oil-in temp. = 93°C in level flight and 100°C in climb.
3. CAT. =20°C between 1600 and 1760 BHP in 30° spark advance. CAT. = 38°C FOR ALL OTHER OPERATION.

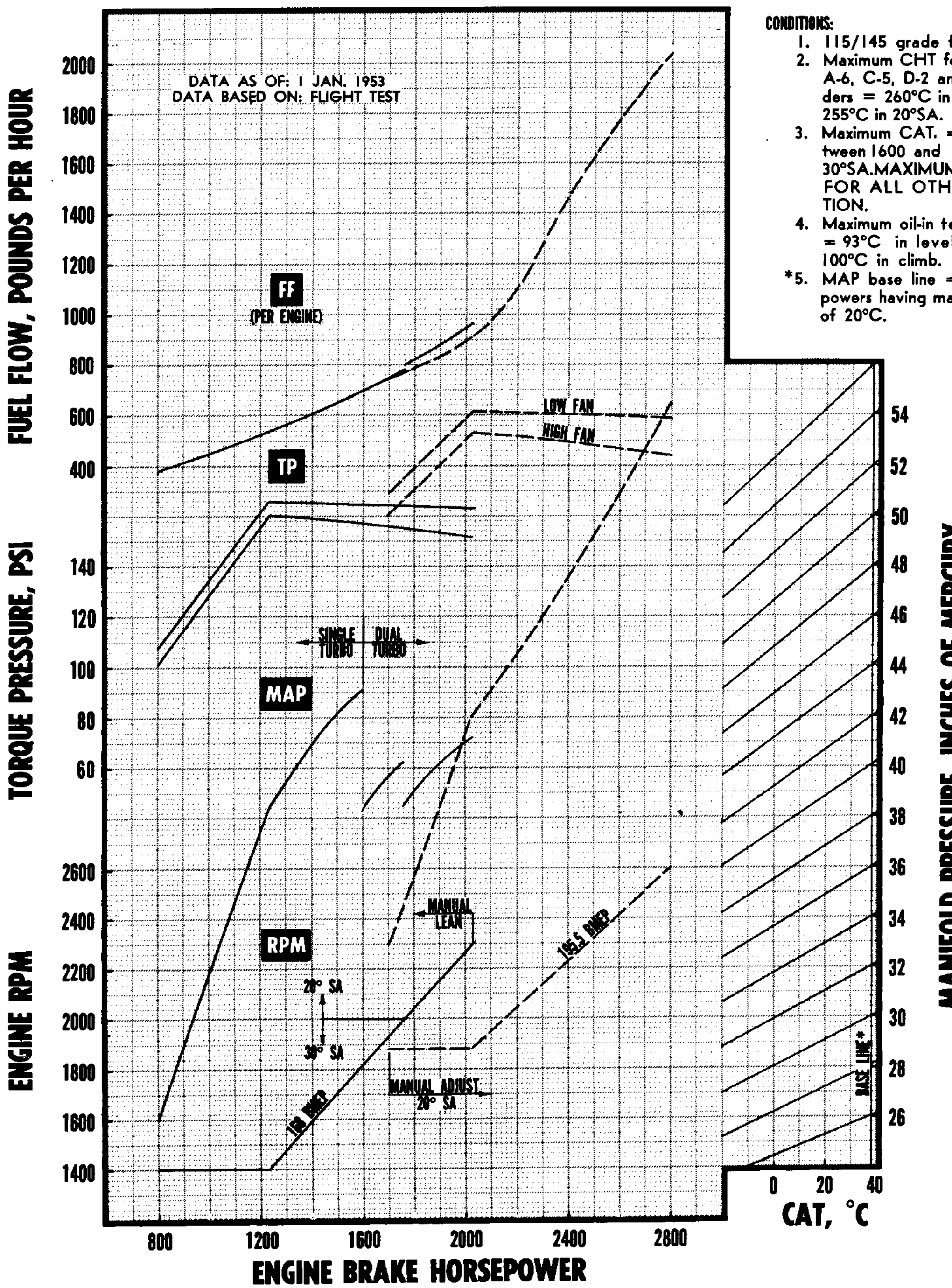
NOTES:

1. 115/145 grade fuel
2. MAP based on limit CAT.

E1-517-81

Figure A-28.

R4360-53 ENGINE POWER SCHEDULE AT 25,000 FEET



CONDITIONS:

1. 115/145 grade fuel.
2. Maximum CHT for hottest of A-6, C-5, D-2 and D-5 cylinders = 260°C in 30° SA and 255°C in 20°SA.
3. Maximum CAT. = 20°C between 1600 and 1760 BHP in 30°SA. MAXIMUM CAT.=38°C FOR ALL OTHER OPERATION.
4. Maximum oil-in temperature = 93°C in level flight and 100°C in climb.

*5. MAP base line = 20° C for powers having maximum CAT. of 20°C.

E1-506-81

Figure A-29.

R4360-53 ENGINE POWER SCHEDULE AT 30,000 FEET

BHP	RPM	BMEP (psi)	MIXTURE	SPARK ADVANCE	MAP In. of Hg.	TURBO SETTING	LOW FAN T. P. (psi)	HIGH FAN T. P. (psi)	F. F. lb/hr)	REMARKS
2800	2600	195.5	MA	20°	55.0	DUAL	199.0	186.0	2040	
2700	2510	195.5	MA	20°	53.3	DUAL	199.5	187.5	1905	
2600	2415	195.5	MA	20°	51.6	DUAL	200.0	188.5	1770	
2500	2320	195.5	MA	20°	50.1	DUAL	200.5	190.0	1630	
2400	2225	195.5	MA	20°	48.6	DUAL	201.0	191.0	1470	
2300	2135	195.5	MA	20°	47.1	DUAL	201.5	192.0	1290	
2200	2040	195.5	MA	20°	45.6	DUAL	202.0	193.0	1110	
2100	1950	195.5	MA	20°	44.1	DUAL	202.0	194.5	970	
2025	1880	195.5	MA	20°	43.1	DUAL	202.0	195.0	905	
2000	1880	193.1	MA	20°	42.5	DUAL	199.0	192.0	890	
1900	1880	183.5	MA	20°	40.6	DUAL	189.0	182.0	830	
1800	1880	173.8	MA	20°	38.7	DUAL	179.0	172.0	790	
1700	1880	164.1	MA	20°	36.9	DUAL	169.0	162.0	745	
2030	2300	160.0	ML	20°	42.3	DUAL	163.5	153.0	965	
2000	2270	160.0	ML	20°	42.0	DUAL	163.5	153.5	950	
1900	2155	160.0	ML	20°	41.0	DUAL	164.0	154.5	885	
1800	2040	160.0	ML	20°	39.8	DUAL	164.5	156.0	825	
1760	2000	160.0	ML	20°	39.2	DUAL	164.5	156.5	800	38°C CAT.
1760	2000	160.0	ML	30°	40.8	DUAL	164.5	156.5	775	20°C CAT.
1700	1930	160.0	ML	30°	39.9	DUAL	165.0	157.0	745	20°C CAT.
1600	1815	160.0	ML	30°	38.8	DUAL	165.0	158.5	700	20°C CAT.
1600	1815	160.0	ML	30°	45.2	SINGLE	165.5	158.5	700	38°C CAT.
1500	1700	160.0	ML	30°	43.2	SINGLE	165.5	160.0	650	
1400	1590	160.0	ML	30°	40.9	SINGLE	166.0	160.5	605	
1325	1500	160.0	ML	30°	38.9	SINGLE	166.0	162.0	580	
1300	1500	157.3	ML	30°	38.2	SINGLE	162.5	159.0	565	
1200	1500	145.2	ML	30°	35.4	SINGLE	150.0	146.0	525	
1100	1500	133.1	ML	30°	32.7	SINGLE	138.0	133.0	485	
1000	1500	121.0	ML	30°	30.2	SINGLE	125.0	120.0	450	
900	1500	108.9	ML	30°	27.8	SINGLE	112.5	108.0	415	
800	1500	96.8	ML	30°	25.5	SINGLE	100.0	95.0	380	

COOLING LIMITS:

1. CHT = 255°C in 20° spark advance
   CHT = 260°C in 30° spark advance for hottest of A-6, C-5, D-2 and D-5 cylinders.
2. Oil-in temp. = 93°C in level flight and 100°C in climb.
3. CAT. =20°C between 1600 and 1760 BHP in 30° spark advance. CAT. = 38°C FOR ALL OTHER OPERATION.

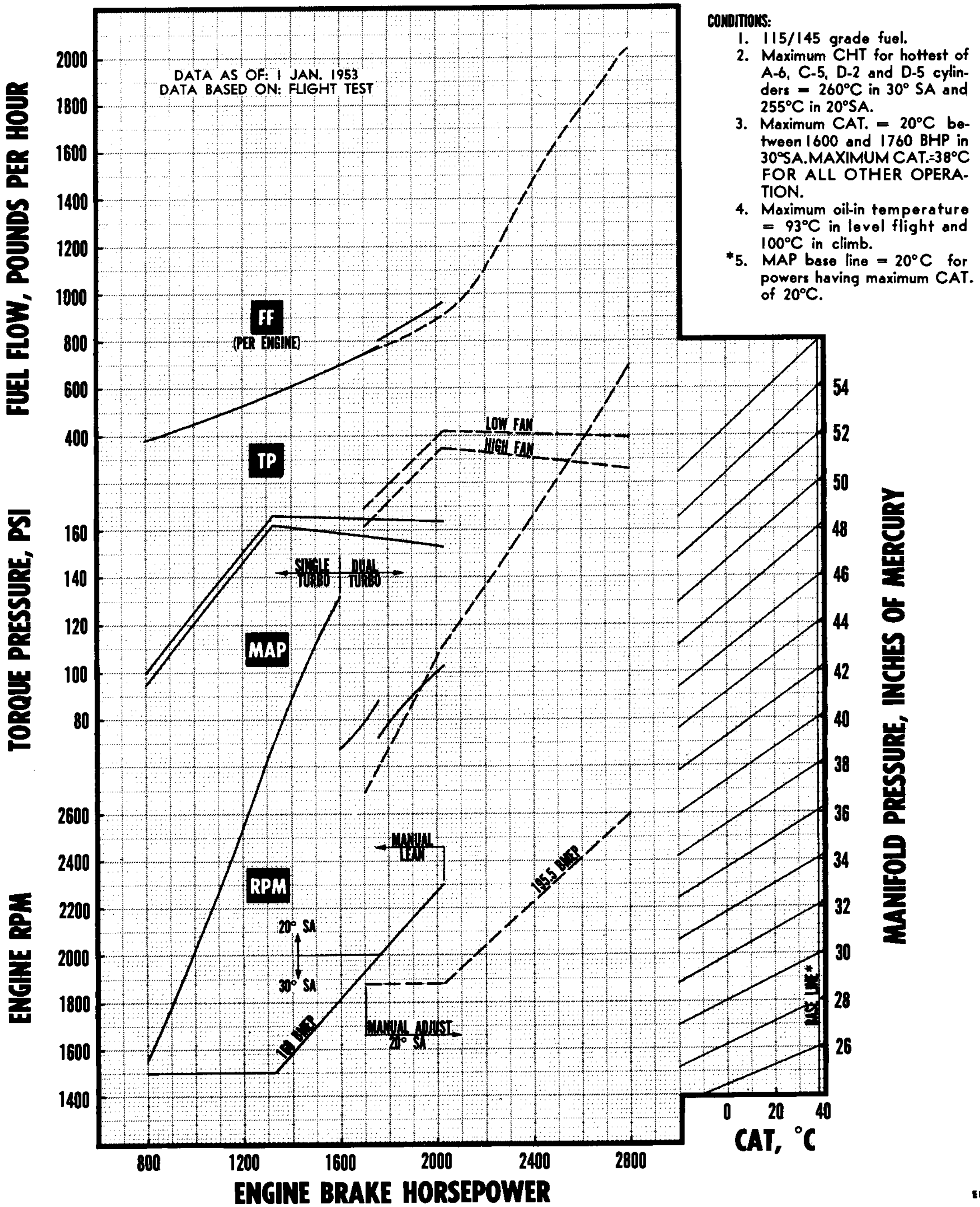
NOTES:

1. 115/145 grade fuel
2. MAP based on limit CAT.

E1-518-81

Figure A-30.

R4360-53 ENGINE POWER SCHEDULE AT 30,000 FEET



CONDITIONS:

1. 115/145 grade fuel.
2. Maximum CHT for hottest of A-6, C-5, D-2 and D-5 cylinders = 260°C in 30° SA and 255°C in 20°SA.
3. Maximum CAT. = 20°C between 1600 and 1760 BHP in 30°SA. MAXIMUM CAT.=38°C FOR ALL OTHER OPERATION.
4. Maximum oil-in temperature = 93°C in level flight and 100°C in climb.

*5. MAP base line = 20°C for powers having maximum CAT. of 20°C.

E1-607-91

Figure A-31.

R4360-53 ENGINE POWER SCHEDULE AT 35,000 FEET

BHP	RPM	BMEP (psi)	MIXTURE	SPARK ADVANCE	MAP In. of Hg.	TURBO SETTING	LOW FAN T. P. (psi)	HIGH FAN T. P. (psi)	F. F. (lb/hr)	REMARKS
2800	2600	195.5	MA	20°	55.0	DUAL	200.0	188.0	2040	
2700	2510	195.5	MA	20°	53.1	DUAL	200.5	189.5	1905	
2600	2415	195.5	MA	20°	51.4	DUAL	201.0	190.0	1770	
2500	2320	195.5	MA	20°	49.9	DUAL	201.5	191.5	1630	
2400	2225	195.5	MA	20°	48.5	DUAL	202.0	192.0	1470	
2300	2135	195.5	MA	20°	47.1	DUAL	202.0	193.0	1290	
2200	2040	195.5	MA	20°	45.9	DUAL	202.0	194.0	1110	
2100	1950	195.5	MA	20°	44.7	DUAL	202.0	195.0	970	
2090	1940	195.5	MA	20°	44.6	DUAL	202.5	195.5	960	
2000	1910	190.1	MA	20°	42.6	DUAL	196.0	189.0	895	
1900	1880	183.5	MA	20°	40.3	DUAL	189.5	183.0	830	
1800	1880	173.8	MA	20°	38.1	DUAL	179.5	173.0	790	
1700	1880	164.1	MA	20°	35.9	DUAL	170.0	163.0	745	
2030	2300	160.0	ML	20°	43.0	DUAL	164.0	154.5	965	
2000	2270	160.0	ML	20°	42.8	DUAL	164.0	155.0	950	
1900	2155	160.0	ML	20°	42.0	DUAL	164.5	156.0	885	
1800	2040	160.0	ML	20°	40.9	DUAL	165.0	157.0	825	
1760	2000	160.0	ML	20°	40.4	DUAL	165.0	157.5	800	38°C CAT.
1760	2000	160.0	ML	30°	41.2	DUAL	165.0	157.5	775	20°C CAT.
1700	1930	160.0	ML	30°	40.2	DUAL	165.0	158.0	745	20°C CAT.
1650	1870	160.0	ML	30°	39.4	DUAL	165.0	158.5	720	20°C CAT.
1600	1860	156.1	ML	30°	38.5	DUAL	161.0	155.0	700	20°C CAT.
1600	1860	156.1	ML	30°	39.8	DUAL	161.0	155.0	700	38°C CAT.
1500	1835	148.4	ML	30°	38.0	DUAL	153.5	147.5	660	
1410	1815	141.0	ML	30°	36.2	DUAL	145.7	140.0	630	
1500	1700	160.0	ML	30°	43.4	SINGLE	166.0	160.5	650	
1410	1600	160.0	ML	30°	42.1	SINGLE	166.0	161.0	615	
1400	1600	158.8	ML	30°	41.7	SINGLE	166.0	159.5	610	
1300	1600	147.5	ML	30°	38.8	SINGLE	152.5	147.0	570	
1200	1600	136.1	ML	30°	36.0	SINGLE	141.0	136.0	530	
1100	1600	124.8	ML	30°	33.1	SINGLE	129.0	123.5	495	
1000	1600	113.4	ML	30°	30.1	SINGLE	117.0	111.5	460	
900	1600	102.1	ML	30°	27.4	SINGLE	105.0	99.5	420	
800	1600	90.8	ML	30°	24.5	SINGLE	940	88.5	385	

COOLING LIMITS:

1. CHT = 255°C in 20° spark advance
   CHT = 260°C in 30° spark advance
   for hottest of A-6, C-5, D-2 and D-5 cylinders.
2. Oil-in temp. = 93° C.
3. CAT. =20°C between 1600 and 1760 BHP in 30° spark advance. CAT. = 38°C FOR ALL OTHER OPERATION.

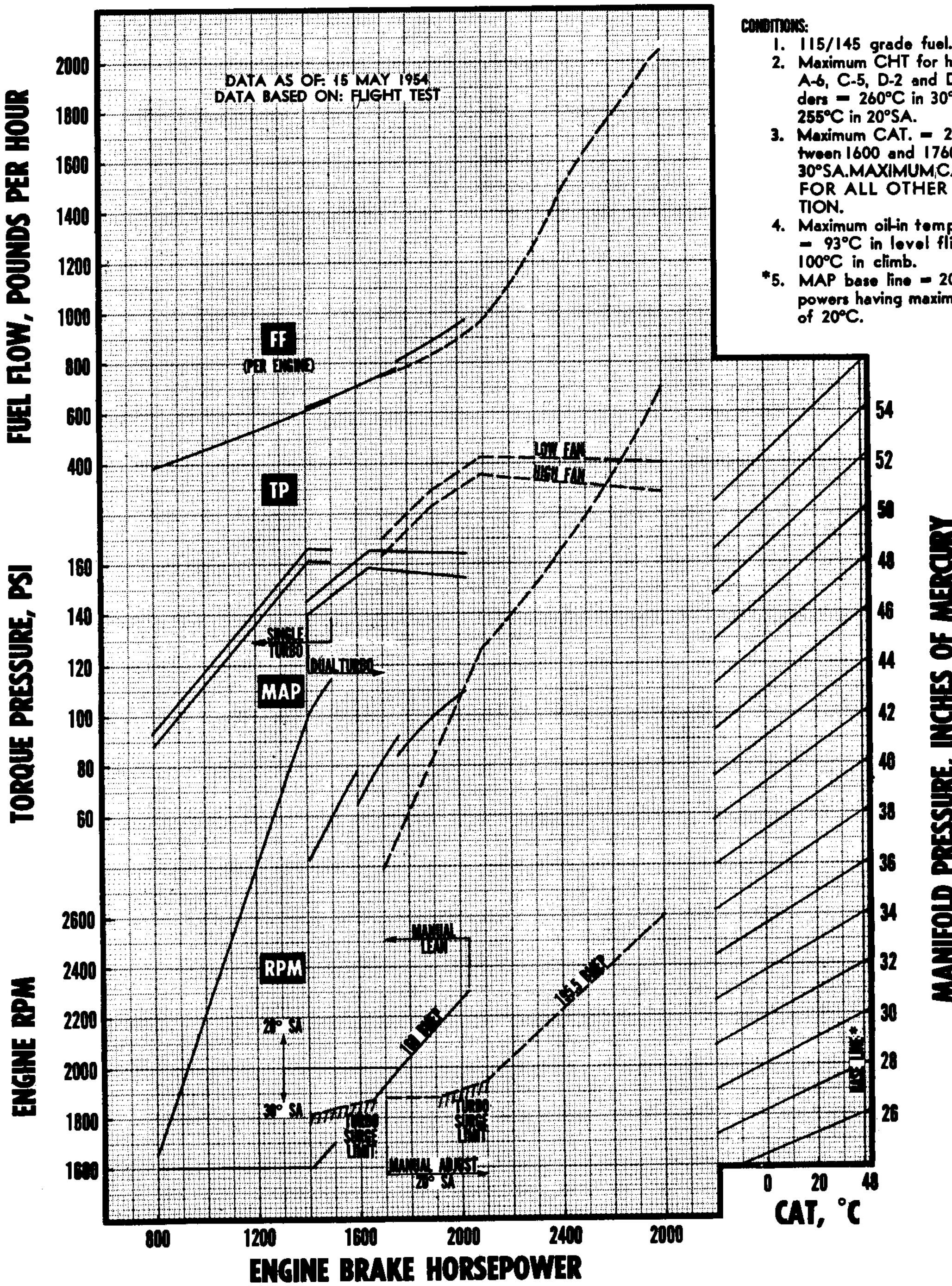
NOTES:

1. 115/145 grade fuel
2. MAP based on limit CAT.

69-189-A

Figure A-32.

R4360-53 ENGINE POWER SCHEDULE AT 35,000 FEET



CONDITIONS:

1. 115/145 grade fuel.
2. Maximum CHT for hottest of A-6, C-5, D-2 and D-5 cylinders = 260°C in 30° SA and 255°C in 20°SA.
3. Maximum CAT. = 20°C between 1600 and 1760 BHP in 30°SA. MAXIMUM CAT.=38°C FOR ALL OTHER OPERATION.
4. Maximum oil-in temperature = 93°C in level flight and 100°C in climb.

*5. MAP base line = 20°C for powers having maximum CAT. of 20°C.

67-173-A

Figure A-33.

R4360-53 ENGINE POWER SCHEDULE AT 40,000 FEET

BHP	RPM	BMEP (psi)	MIXTURE	SPARK ADVANCE	MAP In. of Hg.	TURBO SETTING	LOW FAN T. P. (psi)	HIGH FAN T. P. (psi)	F. F. (lb/hr)	REMARKS
2640	2600	184.3	MA	20°	51.1	DUAL	189.0	178.0	1870	
2645	2550	188.3	MA	20°	51.9	DUAL	196.0	184.0	1850	
2650	2460	195.5	MA	20°	52.4	DUAL	201.5	192.0	1840	
2600	2415	195.5	MA	20°	51.5	DUAL	201.5	192.0	1770	
2500	2320	195.5	MA	20°	49.8	DUAL	202.0	193.0	1630	
2400	2225	195.5	MA	20°	48.4	DUAL	202.0	194.0	1470	
2300	2135	195.5	MA	20°	47.1	DUAL	202.5	195.0	1290	
2240	2080	195.5	MA	20°	46.4	DUAL	202.5	195.5	1180	
2200	2060	193.9	MA	20°	45.7	DUAL	200.0	193.5	1120	
2100	2030	187.8	MA	20°	43.5	DUAL	193.5	187.5	990	
2000	2000	181.6	MA	20°	41.3	DUAL	188.0	181.5	910	
1900	1970	175.1	MA	20°	39.0	DUAL	182.0	175.5	845	
1800	1940	168.5	MA	20°	36.8	DUAL	175.5	170.0	800	
2030	2300	160.0	ML	20°	43.4	DUAL	165.0	156.5	965	
2000	2270	160.0	ML	20°	43.0	DUAL	165.0	157.0	950	
1900	2155	160.0	ML	20°	41.9	DAUL	165.0	158.0	885	
1800	2040	160.0	ML	20°	40.8	DUAL	165.5	159.0	825	
1760	2000	160.0	ML	20°	40.3	DUAL	166.0	159.0	800	38°C CAT.
1760	2000	160.0	ML	30°	40.9	DUAL	166.0	159.0	775	20°C CAT.
1730	1965	160.0	ML	30°	40.4	DUAL	166.0	159.5	765	20°C CAT.
1700	1955	157.9	ML	30°	39.7	DUAL	164.0	157.0	750	20°C CAT.
1600	1930	150.5	ML	30°	37.7	DUAL	156.0	149.5	710	20°C CAT.
1600	1930	150.5	ML	30°	39.2	DUAL	156.0	149.5	710	38°C CAT.
1500	1905	142.9	ML	30°	37.2	DUAL	148.0	142.0	670	
1400	1880	135.1	ML	30°	35.2	DUAL	140.0	134.0	630	
1300	1860	126.9	ML	30°	33.3	DUAL	131.0	125.0	590	
1200	1840	118.4	ML	30°	31.2	DUAL	122.5	117.0	550	
1200	1700	128.1	ML	30°	34.0	SINGLE	133.0	128.0	540	
1100	1700	117.5	ML	30°	31.3	SINGLE	122.0	117.0	500	
1000	1700	106.8	ML	30°	28.6	SINGLE	111.0	106.0	465	
900	1700	96.1	ML	30°	26.1	SINGLE	99.5	94.5	425	
800	1700	85.4	ML	30°	23.4	SINGLE	88.5	83.5	390	

COOLING LIMITS:

1. CHT = 255°C in 20° spark advance
   CHT = 260°C in 30° spark advance
   for hottest of A-6, C-5, D-2 and D-5 cylinders.
2. Oil-in temp. = 110°C.
3. CAT. =20°C between 1600 and 1760 BHP in 30° spark advance. CAT. = 38°C FOR ALL OTHER OPERATION.

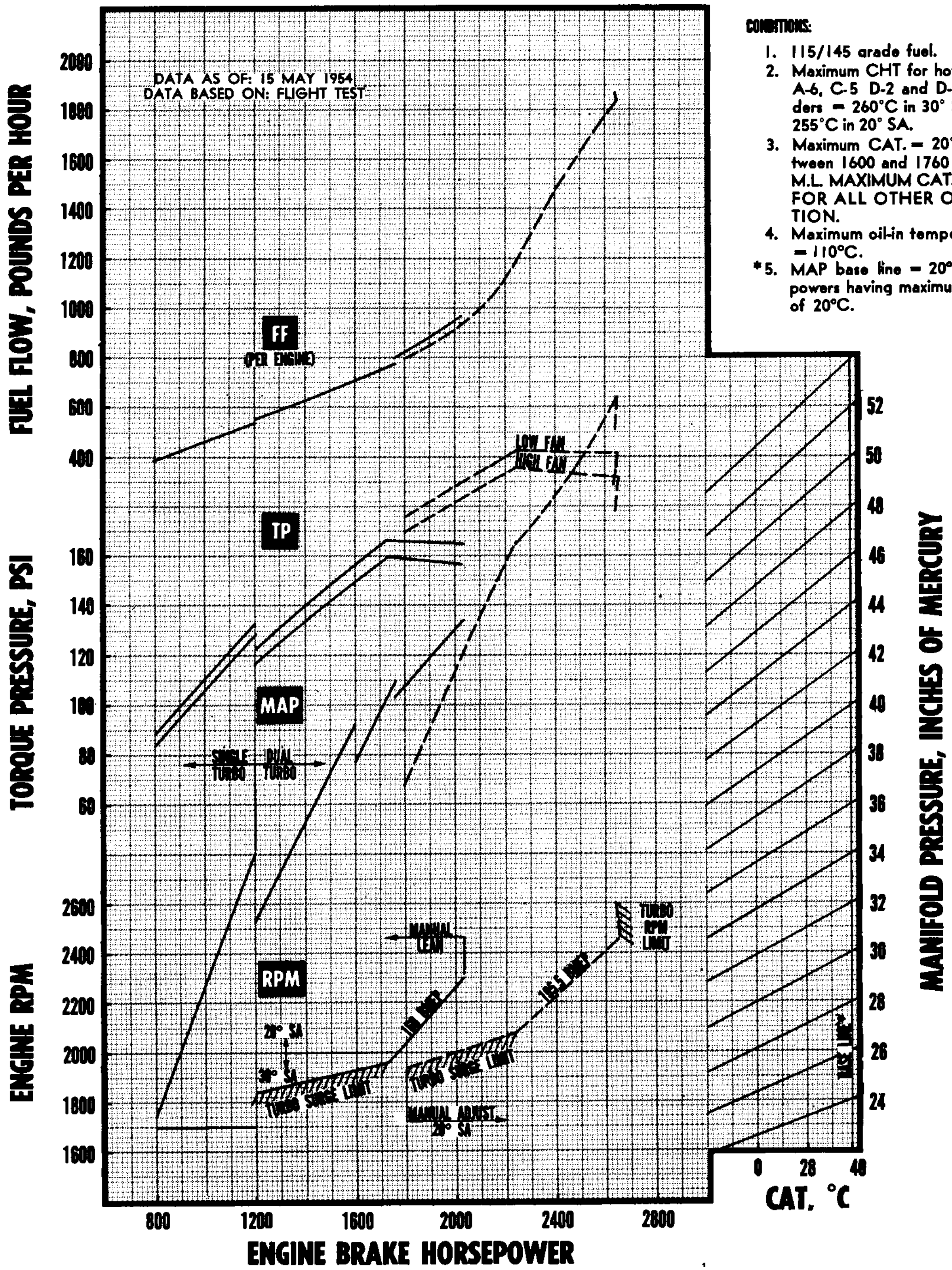
NOTES:

1. 115/145 grade fuel
2. MAP based on limit CAT.

67-213-A

Figure A-34.

R4360-53 ENGINE POWER SCHEDULE AT 40,000 FEET



CONDITIONS:

1. 115/145 grade fuel.
2. Maximum CHT for hottest of A-6, C-5 D-2 and D-5 cylinders = 260°C in 30° SA and 255°C in 20° SA.
3. Maximum CAT. = 20°C between 1600 and 1760 BHP in M.L. MAXIMUM CAT.=38°C FOR ALL OTHER OPERATION.
4. Maximum oil-in temperature = 110°C.

*5. MAP base line = 20° C for powers having maximum CAT. of 20°C.

67-314-A

Figure A-35.

R4360-53 ENGINE POWER SCHEDULE AT 42,500 FEET

BHP	RPM	BMEP (psi)	MIXTURE	SPARK ADVANCE	MAP In. of Hg.	TURBO SETTING	LOW FAN T. P. (psi)	HIGH FAN T. P. (psi)	F. F. (lb/hr)	REMARKS
2390	2600	166.9	MA	20°	45.0	DUAL	171.0	161.0	1620	
2390	2500	173.6	MA	20°	47.0	DUAL	179.0	169.5	1600	
2380	2400	180.0	MA	20°	47.0	DUAL	187.0	170.0	1540	
2300	2190	190.6	MA	20°	46.1	DUAL	197.5	190.0	1320	
2230	2100	192.7	MA	20°	45.0	DUAL	200.5	194.0	1170	
2200	2090	191.1	MA	20°	44.5	DUAL	199.0	192.5	1120	
2100	2060	185.0	MA	20°	42.9	DUAL	192.5	186.0	1005	
2000	2030	176.7	MA	20°	41.2	DUAL	186.0	179.5	920	
1900	2000	173.4	MA	20°	39.6	DUAL	179.0	174.0	850	
1800	1970	165.9	MA	20°	37.9	DUAL	172.5	167.0	800	
1700	1945	158.8	MA	20°	36.3	DUAL	164.5	159.5	755	
2030	2300	160.2	ML	20°	43.6	DUAL	165.5	157.5	965	
2000	2265	160.3	ML	20°	43.1	DUAL	166.0	158.0	950	
1900	2155	160.0	ML	20°	41.7	DUAL	166.0	158.5	885	
1800	2050	157.1	ML	20°	40.4	DUAL	166.0	159.5	820	
1760	2000	159.8	ML	20°	40.0	DUAL	166.0	160.0	800	38°C CAT.
1760	2000	159.8	ML	30°	41.0	DUAL	166.0	160.0	775	20°C CAT.
1700	1985	155.5	ML	30°	40.2	DUAL	161.5	155.0	750	20°C CAT.
1600	1960	148.2	ML	30°	38.9	DUAL	154.0	147.0	710	20°C CAT.
1600	1960	148.2	ML	30°	37.2	DUAL	154.0	147.0	710	38°C CAT.
1500	1940	140.4	ML	30°	35.9	DUAL	145.5	139.0	670	
1400	1920	132.3	ML	30°	34.5	DUAL	137.0	131.0	635	
1300	1900	124.2	ML	30°	33.0	DUAL	129.0	122.5	595	
1200	1880	115.9	ML	30°	31.3	DUAL	120.0	114.0	555	
1100	1865	107.1	ML	30°	29.4	DUAL	111.0	105.0	510	
1000	1845	98.4	ML	30°	27.6	DUAL	102.0	96.0	470	
900	1830	89.2	ML	30°	25.7	DUAL	92.0	86.5	430	
800	1820	79.7	ML	30°	23.5	DUAL	82.0	77.0	400	

COOLING LIMITS:

1. CHT = 255°C in 20° spark advance
   CHT = 260°C in 30° spark advance
   for hottest of A-6, C-5, D-2 and D-5 cylinders.
2. Oil-in temp. = 110°C.
3. CAT. =20°C between 1600 and 1760 BHP in 30° spark advance. CAT. = 38°C FOR ALL OTHER OPERATION.

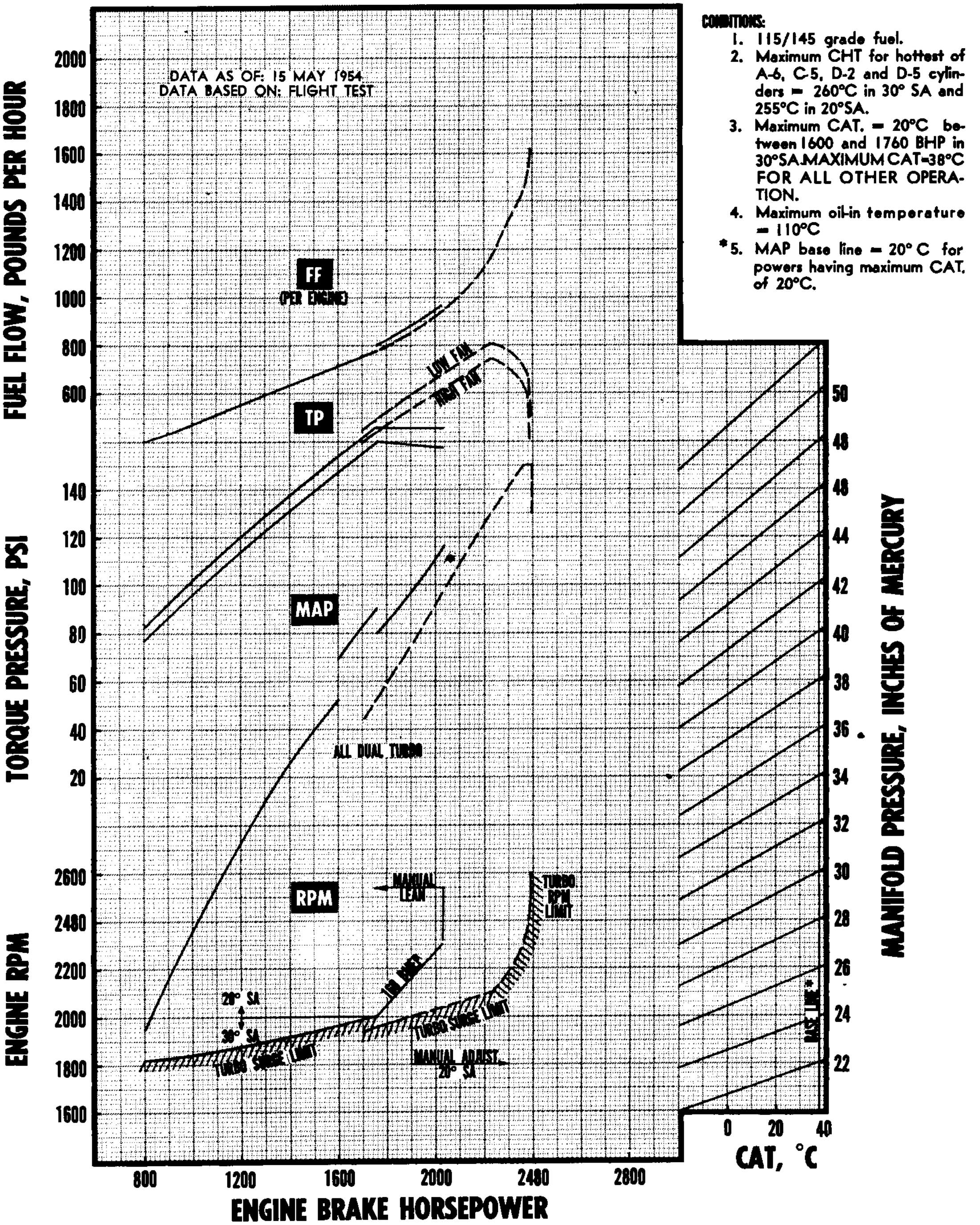
NOTES:

1. 115/145 grade fuel
2. MAP based on limit CAT.

67-218-A

Figure A-36.

R4360-53 ENGINE POWER SCHEDULE AT 42,500 FEET



CONDITIONS:

1. 115/145 grade fuel.
2. Maximum CHT for hottest of A-6, C-5, D-2 and D-5 cylinders = 260°C in 30° SA and 255°C in 20°SA.
3. Maximum CAT. = 20°C between 1600 and 1760 BHP in 30°SA.MAXIMUM CAT=38°C FOR ALL OTHER OPERATION.
4. Maximum oil-in temperature = 110°C
*5. MAP base line = 20° C for powers having maximum CAT. of 20°C.

67-216-A

Figure A-37.

R4360-53 ENGINE POWER SCHEDULE AT 45,000 FEET

BHP	RPM	BMEP (psi)	MIXTURE	SPARK ADVANCE	MAP In. of Hg	TURBO SETTING	LOW FAN T. P. (psi)	HIGH FAN T. P. (psi)	F. F. (lb/hr)
2100	2600	146.6	MA	20°	39.0	DUAL	150.0	140.5	1230
2110	2500	153.2	MA	20°	39.3	DUAL	157.0	147.0	1205
2115	2400	159.9	MA	20°	40.3	DUAL	164.0	155.0	1140
2110	2300	166.5	MA	20°	41.2	DUAL	169.0	165.0	1060
2095	2200	172.9	MA	20°	41.4	DUAL	180.0	173.0	1020
2085	2150	176.0	MA	20°	41.6	DUAL	182.0	176.0	1010
2000	2115	171.7	MA	20°	40.2	DUAL	178.0	172.5	930
1900	2075	166.2	MA	20°	38.7	DUAL	172.0	166.5	865
1800	2040	160.2	MA	20°	37.2	DUAL	166.0	161.0	810
1700	2000	154.3	MA	20°	35.6	DUAL	159.5	155.0	765
1600	1970	147.4	MA	20°	33.9	DUAL	152.0	148.0	720
1500	1940	140.4	MA	20°	32.0	DUAL	145.0	140.5	675
1400	1915	132.7	MA	20°	30.1	DUAL	137.0	132.0	630
1300	1890	124.9	MA	20°	28.2	DUAL	128.5	123.5	585
1200	1875	116.2	MA	20°	26.2	DUAL	119.5	115.0	545
1100	1860	107.4	MA	20°	24.2	DUAL	110.5	106.0	505
1000	1850	98.1	MA	20°	22.2	DUAL	100.5	96.5	465
900	1850	88.3	MA	20°	20.2	DUAL	91.0	86.0	425
800	1850	78.5	MA	20°	18.1	DUAL	81.0	76.0	385
1945	2400	147.1	ML	20°	40.9	DUAL	152.0	143.0	940
1930	2300	152.0	ML	20°	41.5	DUAL	157.5	151.0	920
1865	2125	159.3	ML	20°	40.6	DUAL	165.0	158.5	875
1800	2100	155.6	ML	20°	39.6	DUAL	161.0	155.0	830
1700	2060	149.8	ML	20°	38.0	DUAL	154.5	149.0	780
1600	2025	143.4	ML	20°	36.4	DUAL	148.0	142.5	740
1525	2000	138.4	ML	20°	35.2	DUAL	142.0	137.5	710
1525	2000	138.4	ML	30°	37.0	DUAL	142.0	137.5	690
1500	1990	136.8	ML	30°	36.7	DUAL	140.5	135.5	675
1400	1965	129.3	ML	30°	35.0	DUAL	133.0	128.5	640
1300	1940	121.6	ML	30°	33.3	DUAL	125.0	120.0	600
1200	1915	113.7	ML	30°	31.5	DUAL	116.5	112.0	560
1100	1895	105.4	ML	30°	29.6	DUAL	108.0	103.0	520
1000	1875	96.8	ML	30°	27.7	DUAL	99.0	94.5	480
900	1865	87.6	ML	30°	25.8	DUAL	90.0	85.0	445
800	1855	78.2	ML	30°	23.7	DUAL	81.0	76.0	405

COOLING LIMITS:

1. CHT = 255°C in 20° spark advance
   CHT = 260°C in 30° spark advance
   for hottest of A-6, C-5, D-2 and D-5 cylinders.
2. Oil-in temp = 110°C.
3. CAT. = 38°C.

NOTES:

1. 115/145 grade fuel
2. MAP based on limit CAT.

67-217-A

Figure A-38.

R4360-53 ENGINE POWER SCHEDULE AT 45,000 FEET

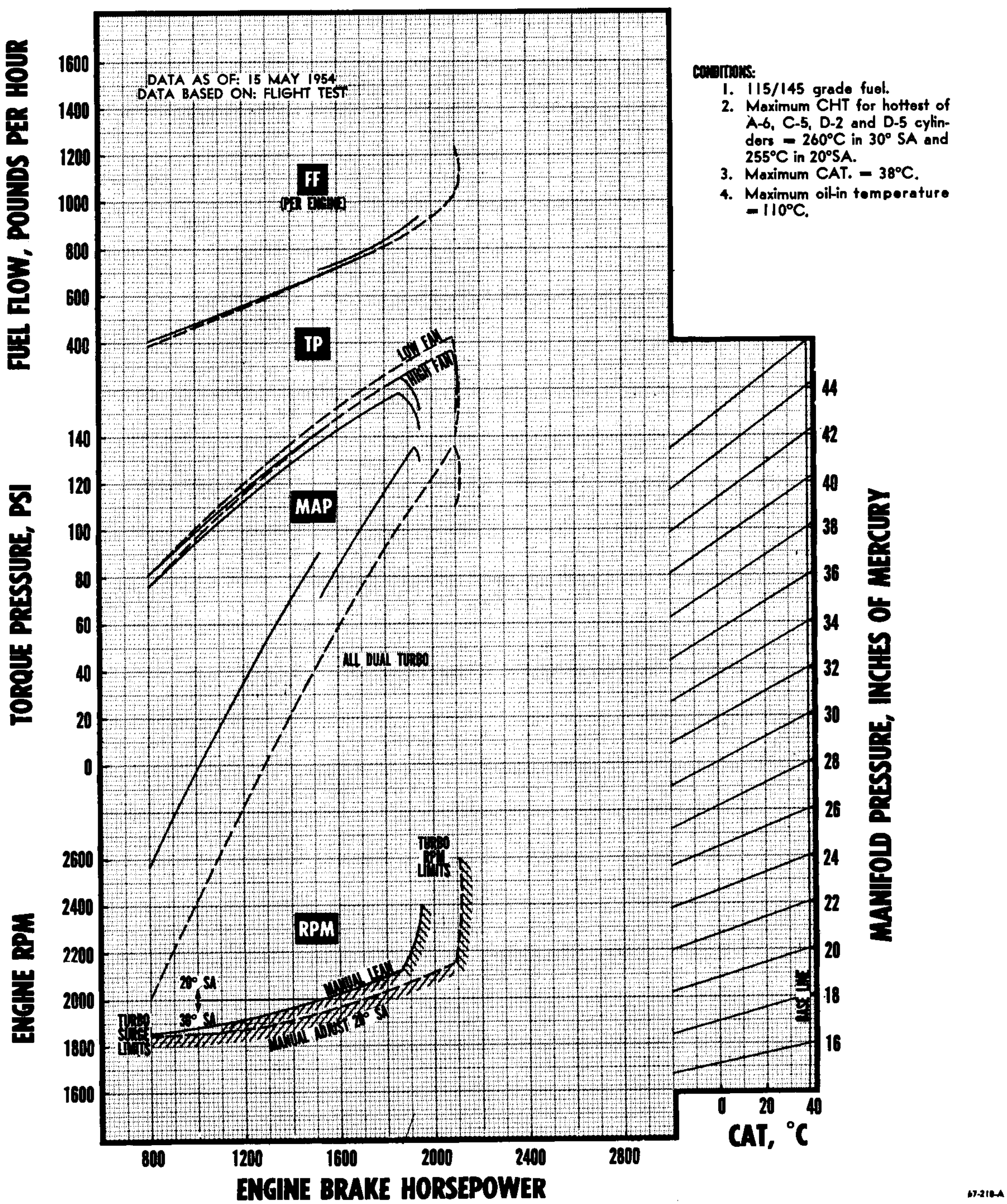


Figure A-39.

R4360-53 ENGINE POWER SCHEDULE AT 45,000 FEET

RICH MIXTURE

NOTES: 1. 115/145 grade fuel.
2. MAP. based on limit CAT.
3. All dual turbo operation.

BHP	RPM	BMEP (psi)	MIXTURE	SPARK ADVANCE	MAP In. of Hg.	TURBO SETTING	LOW FAN T. P. (psi)	HIGH FAN T. P. (psi)	F. F. (lb/hr)
2130	2600	148.7	RICH	20°	41.0	DUAL	153.0	143.0	1340
2150	2500	156.1	RICH	20°	41.5	DUAL	164.0	156.0	1360
2150	2400	162.7	RICH	20°	42.4	DUAL	170.0	164.0	1340
2140	2300	168.9	RICH	20°	42.5	DUAL	175.0	168.0	1325
2120	2200	174.9	RICH	20°	42.5	DUAL	181.5	175.5	1285
2100	2130	179.0	RICH	20°	42.4	DUAL	186.0	180.0	1250
2000	2095	173.3	RICH	20°	41.0	DUAL	180.5	175.0	1130
1900	2060	167.3	RICH	20°	39.5	DUAL	174.5	169.0	1035
1800	2025	161.2	RICH	20°	37.8	DUAL	168.5	162.5	960
1700	1995	154.7	RICH	20°	36.1	DUAL	161.5	156.0	905
1600	1960	148.1	RICH	20°	34.3	DUAL	155.0	149.0	850
1500	1925	141.4	RICH	20°	32.5	DUAL	147.0	141.5	800
1400	1900	133.8	RICH	20°	30.5	DUAL	139.0	134.0	745
1300	1875	125.9	RICH	20°	28.6	DUAL	130.5	126.0	700
1200	1855	117.4	RICH	20°	26.6	DUAL	122.0	117.5	650
1100	1835	108.8	RICH	20°	24.6	DUAL	112.5	108.0	600
1000	1825	99.5	RICH	20°	22.6	DUAL	102.5	98.5	550
900	1820	90.0	RICH	20°	20.5	DUAL	92.0	88.0	505
800	1825	79.5	RICH	20°	18.5	DUAL	81.5	77.5	460

COOLING LIMITS: 1. CHT = 255°C in 20° spark advance for hottest of A-6, C-5, D-2 and D-5 cylinders.
2. Oil-in temperature = 110°C.
3. CAT. = 38°C.

67-205-A

Figure A-40.

R4360-53 ENGINE POWER SCHEDULE AT 45,000 FEET

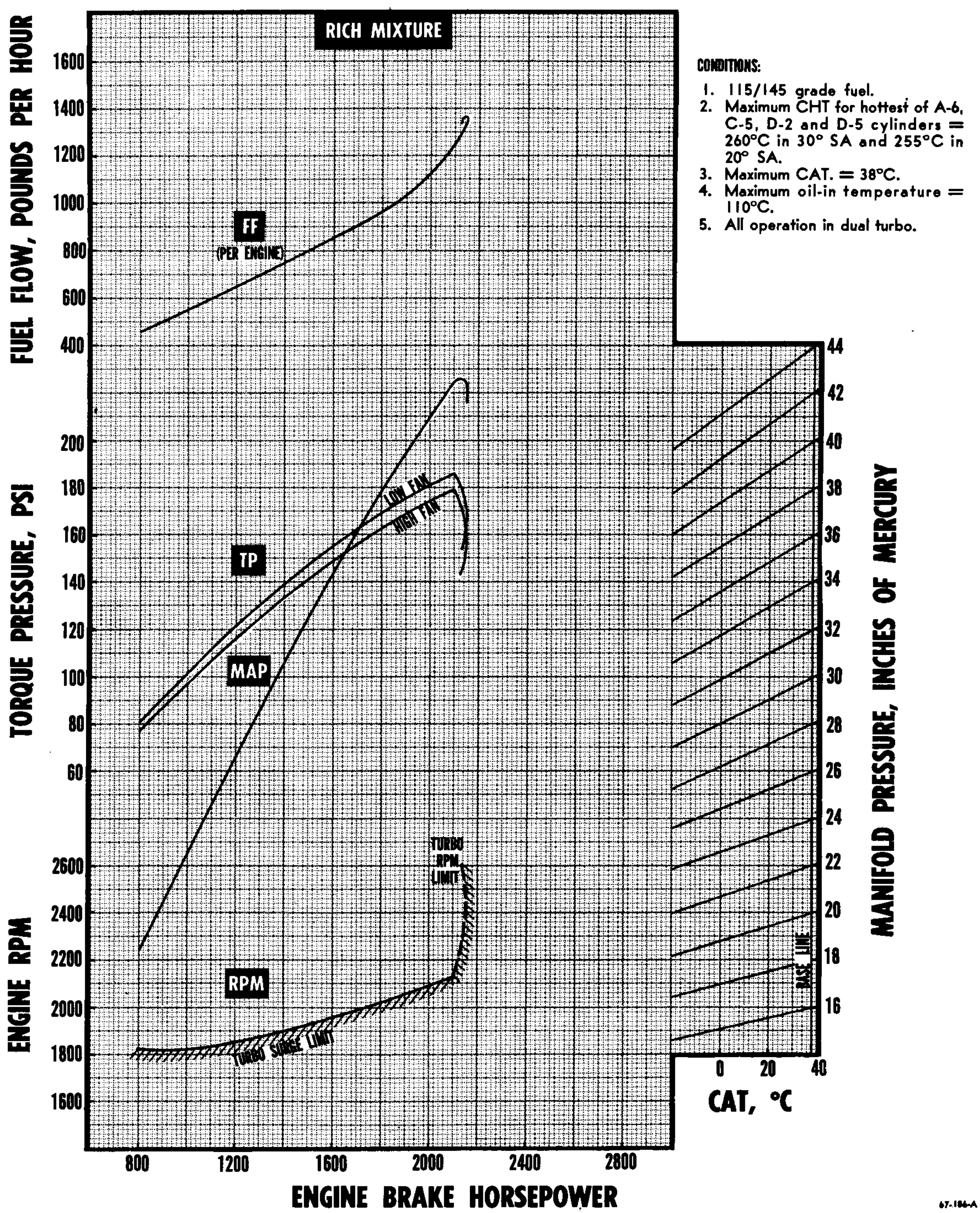


Figure A-41.

R4360-53 ENGINE POWER SCHEDULE AT 47,500 FEET

BHP	RPM	BMEP (psi)	MIXTURE	SPARK ADVANCE	MAP In. of Hg.	TURBO SETTING	LOW FAN T. P. (psi)	HIGH FAN T. P. (psi)	F. F. (lb/hr)
1885	2600	131.6	RICH	20°	34.0	DUAL	135.0	126.0	1080
1910	2500	138.7	RICH	20°	35.2	DUAL	142.0	133.0	1090
1925	2400	145.6	RICH	20°	36.0	DUAL	148.0	140.0	1080
1920	2300	151.6	RICH	20°	35.8	DUAL	150.0	144.0	1060
1900	2200	156.8	RICH	20°	37.1	DUAL	163.0	156.0	1045
1880	2145	159.1	RICH	20°	37.1	DUAL	165.0	159.0	1030
1800	2110	154.9	RICH	20°	36.0	DUAL	160.0	154.5	975
1700	2075	148.7	RICH	20°	34.5	DUAL	155.0	149.0	910
1600	2040	142.4	RICH	20°	32.9	DUAL	147.5	142.5	860
1500	2005	135.8	RICH	20°	31.3	DUAL	141.0	135.5	810
1400	1975	128.7	RICH	20°	29.7	DUAL	133.0	129.0	755
1300	1945	121.3	RICH	20°	28.0	DUAL	125.0	121.0	705
1200	1920	113.4	RICH	20°	26.3	DUAL	117.5	114.0	655
1100	1895	105.5	RICH	20°	24.5	DUAL	109.0	105.0	605
1000	1880	96.5	RICH	20°	22.7	DUAL	100.5	97.0	560
900	1860	87.8	RICH	20°	20.8	DUAL	91.5	87.0	510
800	1850	78.5	RICH	20°	19.0	DUAL	81.0	77.0	460

R4360-53 ENGINE POWER SCHEDULE AT 50,000 FEET

1620	2600	113.1	RICH	20°	29.7	DUAL	116.0	108.0	910
1660	2500	120.6	RICH	20°	30.5	DUAL	122.5	116.0	930
1685	2400	127.5	RICH	20°	31.4	DUAL	131.0	124.0	935
1690	2300	133.5	RICH	20°	32.0	DUAL	137.0	128.0	925
1660	2140	139.8	RICH	20°	32.7	DUAL	145.0	140.0	900
1600	2120	137.1	RICH	20°	31.8	DUAL	142.0	136.5	865
1500	2070	131.7	RICH	20°	30.5	DUAL	136.0	131.0	815
1400	2035	124.9	RICH	20°	29.2	DUAL	130.0	125.0	765
1300	2005	117.7	RICH	20°	27.6	DUAL	121.5	115.5	715
1200	1980	110.0	RICH	20°	26.2	DUAL	114.5	109.5	665
1100	1960	101.9	RICH	20°	24.5	DUAL	105.5	101.0	610
1000	1945	93.3	RICH	20°	23.0	DUAL	96.5	92.5	560
900	1935	84.4	RICH	20°	21.3	DUAL	87.5	83.0	515
800	1925	75.5	RICH	20°	19.7	DUAL	78.0	73.5	470

COOLING LIMITS:

1. CHT — 255°C in 20° spark advance
   CHT — 260°C in 30° spark advance
   for hottest of A-6, C-5, D-2 and D-5 cylinders.
2. Oil-in temp. — 110°C.
3. CAT. — 38°C.

NOTES:

1. 115/145 grade fuel
2. MAP based on limit CAT.

67-219-A

Figure A-42.

R4360-53 ENGINE POWER SCHEDULE AT 47,500 FEET

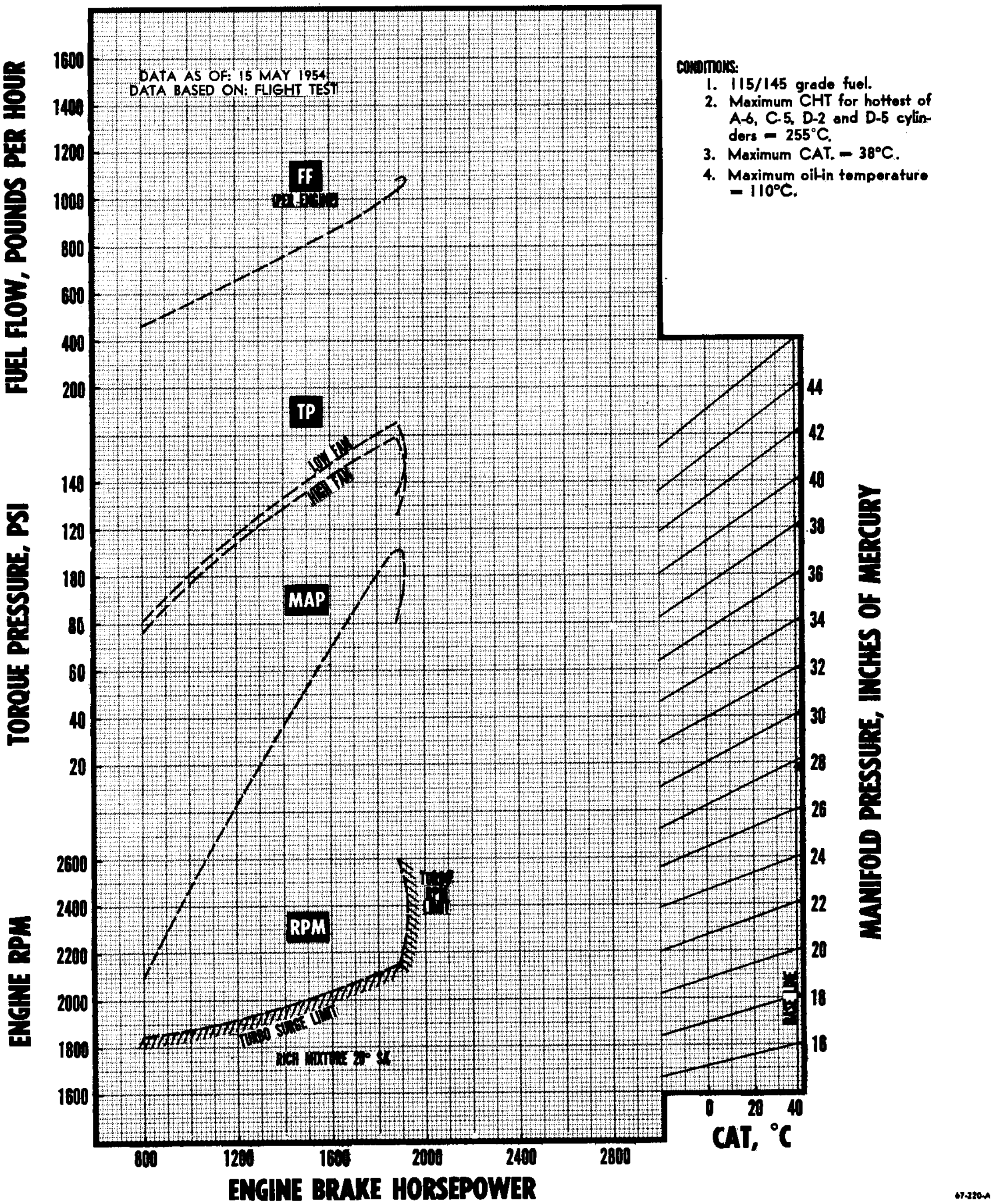
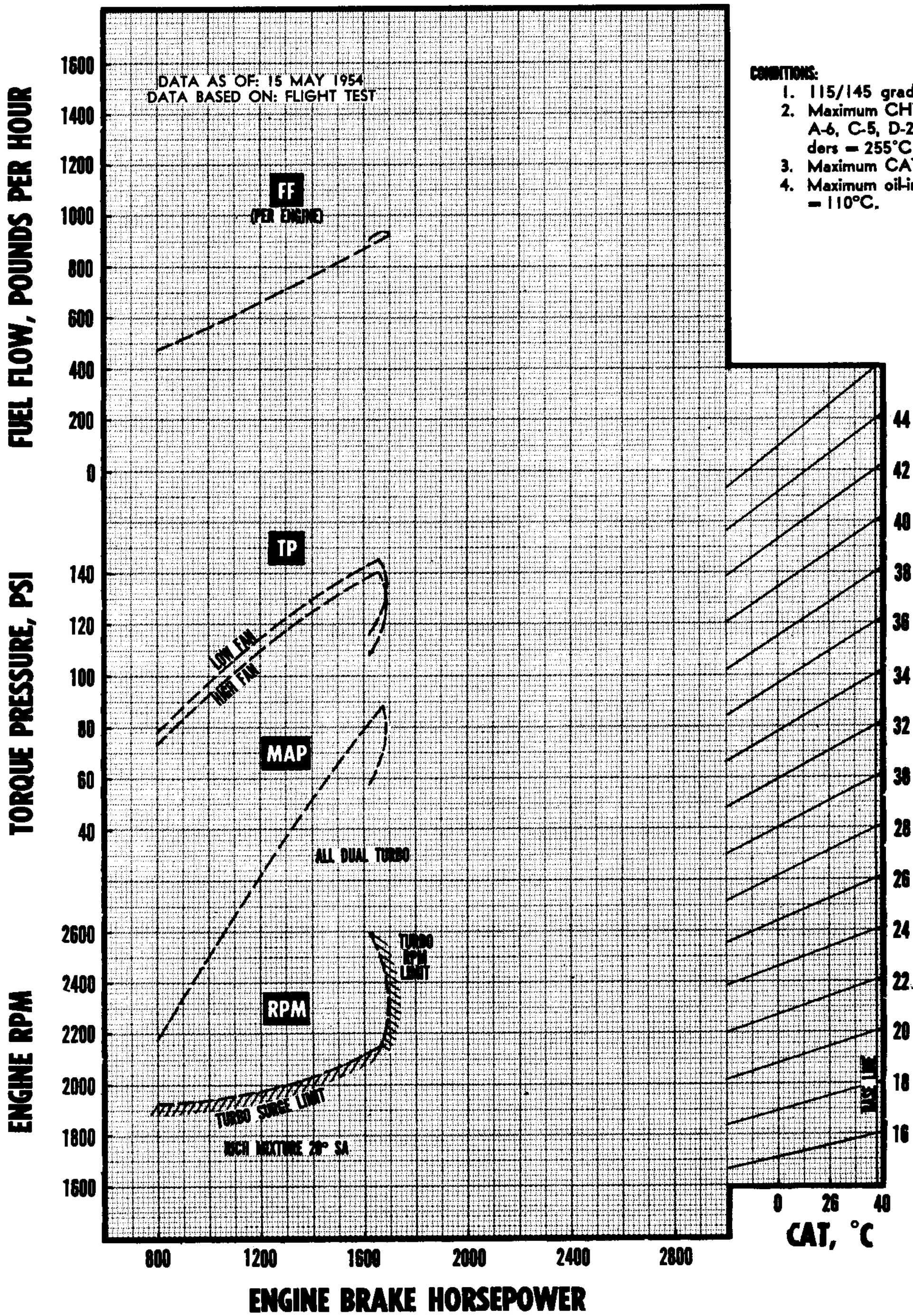


Figure A-43.

R4360-53 ENGINE POWER SCHEDULE AT 50,000 FEET



CONDITIONS:

1. 115/145 grade fuel.
2. Maximum CHT for hottest of A-6, C-5, D-2 and D-5 cylinders = 255°C
3. Maximum CAT. = 38°C.
4. Maximum oil-in temperature = 110°C.

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Figure A-44.

R4360-53 ENGINE POWER SCHEDULE AT 51,000 FEET

NOTES: 1. 115/145 grade fuel.
2. MAP based on limit CAT.
3. All dual turbo operation.

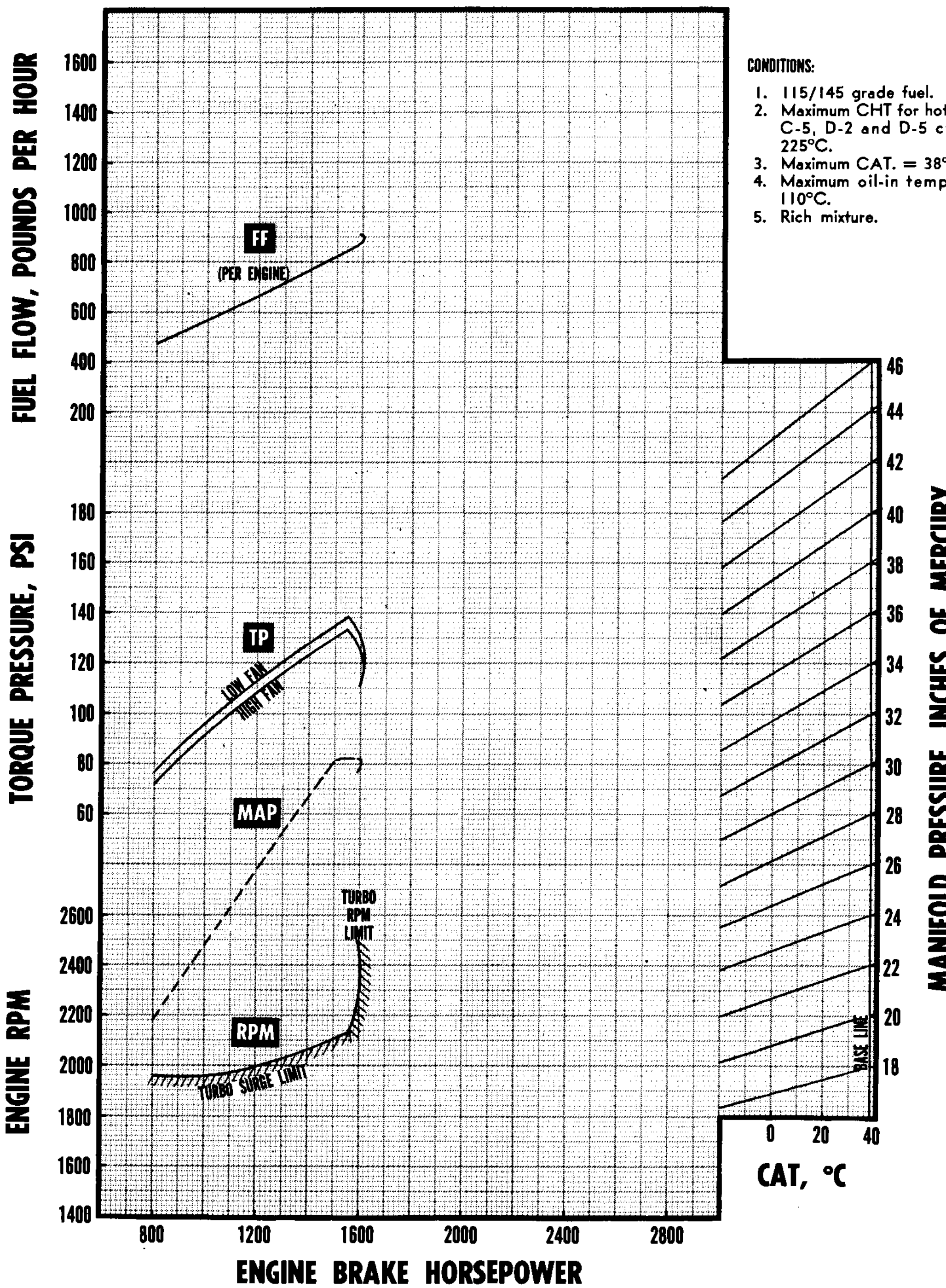
BHP	RPM	BMEP (psi)	MIXTURE	SPARK ADVANCE	MAP In. of Hg.	TURBO SETTING	LOW FAN T. P. (psi)	HIGH FAN T. P. (psi)	F. F. (lb/hr)
1590	2520	114.5	RICH	20°	29.6	DUAL	118.0	110.0	905
1610	2400	121.8	RICH	20°	30.1	DUAL	125.5	117.5	895
1600	2300	126.2	RICH	20°	30.3	DUAL	130.5	123.5	885
1580	2200	130.3	RICH	20°	30.3	DUAL	134.5	128.5	865
1550	2120	132.8	RICH	20°	30.3	DUAL	137.5	132.5	845
1500	2100	129.7	RICH	20°	30.1	DUAL	135.0	129.5	820
1400	2060	123.3	RICH	20°	28.7	DUAL	128.0	123.5	765
1300	2020	116.8	RICH	20°	27.2	DUAL	121.0	116.5	715
1200	1995	109.1	RICH	20°	25.7	DUAL	112.5	109.0	660
1100	1970	101.3	RICH	20°	24.2	DUAL	104.5	100.5	615
1000	1960	92.6	RICH	20°	22.7	DUAL	95.5	91.5	565
900	1950	83.8	RICH	20°	21.2	DUAL	86.0	82.0	520
800	1960	74.1	RICH	20°	19.7	DUAL	76.5	72.0	470

COOLING LIMITS: 1. CHT = 255°C in 20° spark advance for hottest of A-6, C-5, D-2 and D-5 cylinders.
2. Oil-in temperature = 110°C.
3. CAT. = 38°C.

67-206-A

Figure A-45.

R4360-53 ENGINE POWER SCHEDULE AT 51,000 FEET



CONDITIONS:

1. 115/145 grade fuel.
2. Maximum CHT for hottest of A-6, C-5, D-2 and D-5 cylinders = 225°C.
3. Maximum CAT. = 38°C.
4. Maximum oil-in temperature = 110°C.
5. Rich mixture.

67-187-A

Figure A-46.

R4360-53 ENGINE COOLING FAN HORSEPOWER.

Figures A-47 and A-48 present the horsepower required to drive the engine cooling fans. Charts are presented for operation in low fan drive ratio (1.07:1) and high fan drive ratio (1.7:1). Horsepower delivered to the propeller (shaft horsepower) is the engine brake horsepower less fan horsepower.

Fan horsepower may be determined from these curves for any atmospheric condition, provided density altitude is used.

CAUTION

Structural limits of the fan drive restrict the engine speeds, as noted, at which HIGH RPM fan drive may be used.

Since LOW RPM fan drive generally results in higher air speeds, it is desirable to use this setting whenever possible. However, at high altitude, under many conditions, it is impossible to operate within cylinder head temperature limits in low fan and it is necessary to operate in high fan to improve cooling.

CAUTION

Refer to the "Power Schedule Curves," of this section and to "Propeller Limitations," Section V, to avoid operation under restricted conditions.

EXAMPLE.

Find engine shaft horsepower under the following conditions:

2300 rpm
2370 bhp
22,000 feet density altitude
LOW RPM fan drive ratio

Enter the LOW RPM engine cooling fan horsepower chart at 2300 rpm. Move vertically to 22,000 feet (interpolated) density altitude and read 74 fan horsepower required to drive the engine cooling fan. The shaft horsepower is 2370—74=2296; hence, the torque pressure for this setting will be 2296/.00524 x 2300 or 190.5 psi.

R4360-53 ENGINE COOLING FAN HORSEPOWER

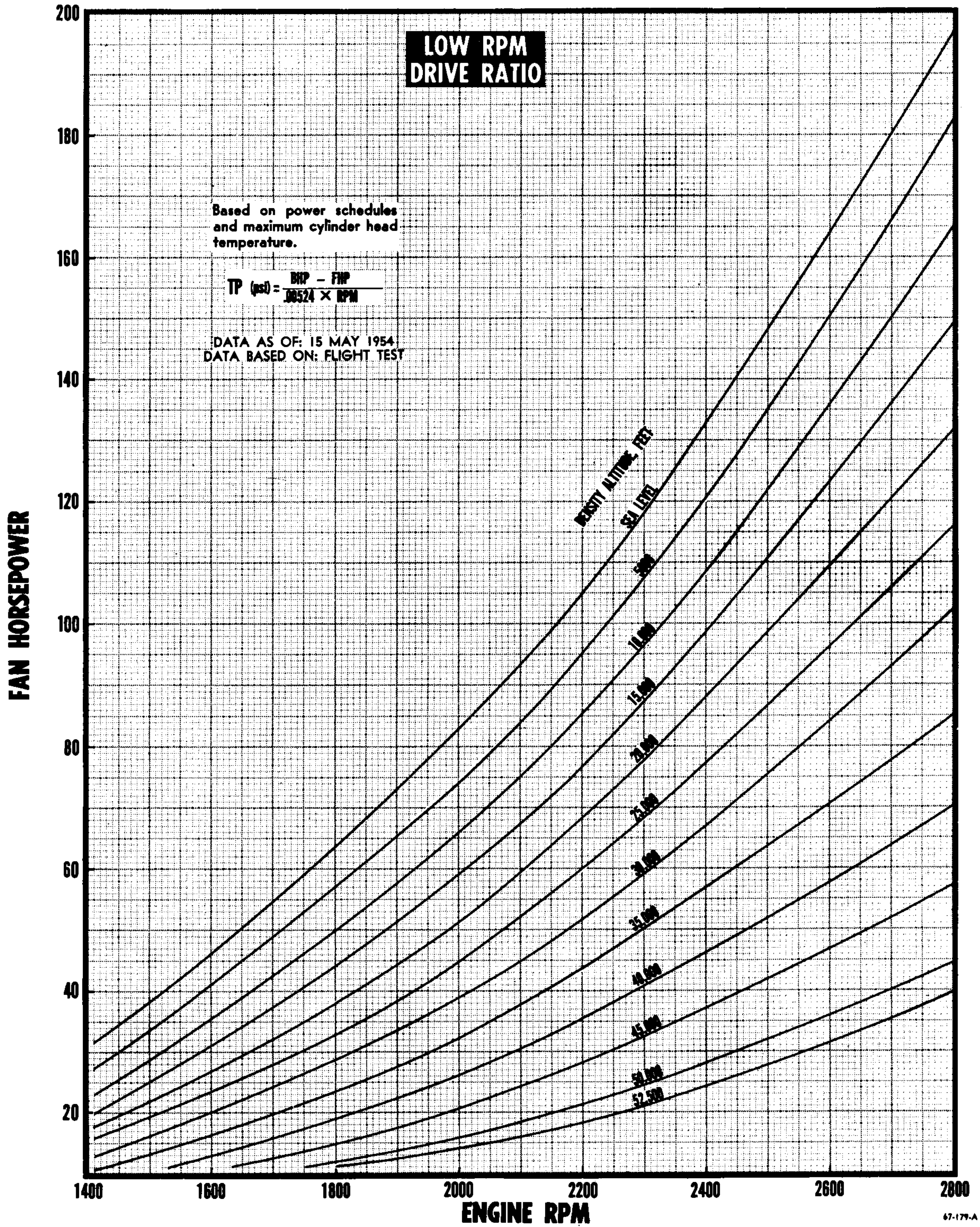


Figure A-47.

R4360-53 ENGINE COOLING FAN HORSEPOWER

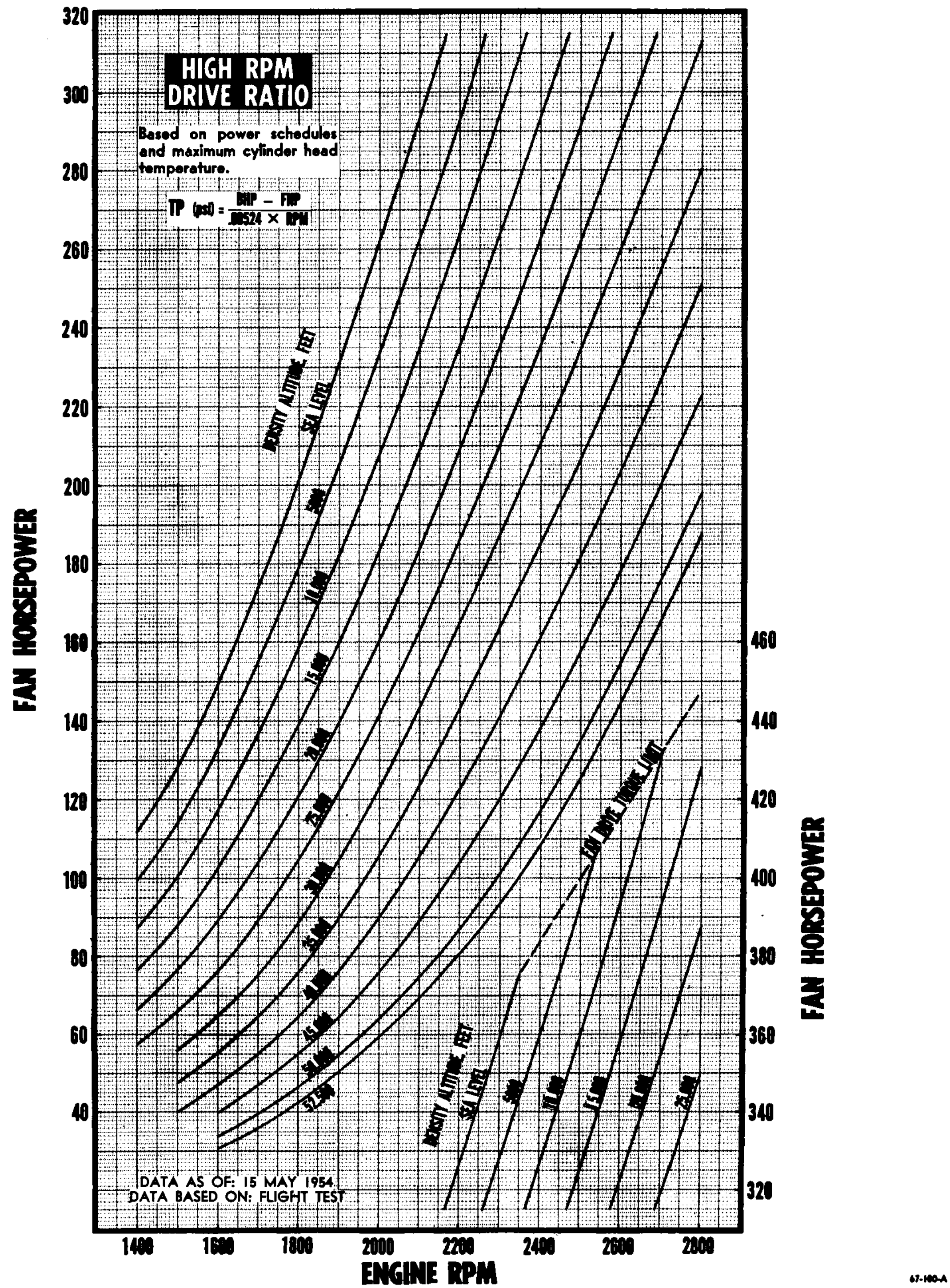


Figure A-48.

R4360-53 ENGINE TORQUEMETER PRESSURE.

The R4360-53 engine torquemeter pressure chart (figure A-49) is presented for convenience in determining torquemeter pressure for any power setting not presented elsewhere. This chart incorporates engine cooling fan horsepower, shown in the "Fan Horsepower Curves," in the form of fan torque pressure. Fan torque pressure may be subtracted from engine brake torque pressure to determine the indicator torque pressure for any particular power setting and altitude, and for LOW or HIGH RPM fan drive.

CAUTION

Refer to the "Power Schedule Curves" of this section and to "Propeller Limitations," Section V, to avoid operation under restricted conditions.

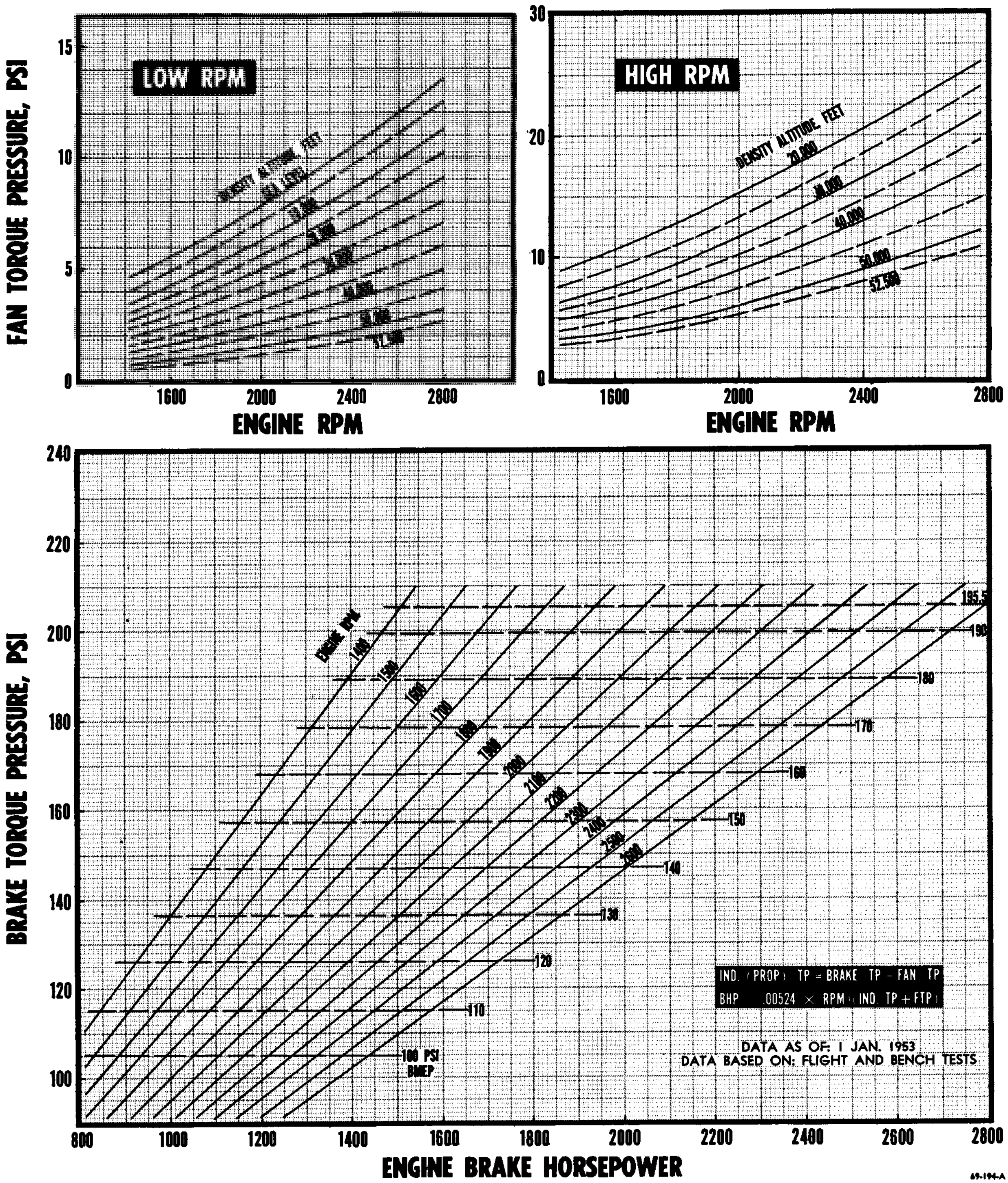
EXAMPLE.

Find the torquemeter pressure to be set for the following conditions:

2450 bhp
2275 rpm
20,000 feet density altitude
LOW RPM fan drive ratio

In figure A-49 locate 2450 bhp on the lower horizontal scale and proceed vertically to 2275 rpm (interpolated). Move horizontally to the left and read 205.2 psi brake torque pressure on the vertical scale. (This value corresponds to a bmep of 195.5 psi.) On the upper left chart, designated LOW RPM, enter the horizontal scale at 2275 engine rpm. Move to 20,000 feet density altitude and read fan torque pressure of 6.2 psi from the left hand scale. Subtract fan torque pressure from the brake torque pressure to obtain the indicator torque pressure, 205.2—6.2=199 psi, to be maintained in obtaining the power setting.

R4360-53 ENGINE TORQUEMETER PRESSURE



69-194-A

Figure A-49.

R4360-53 ENGINE FUEL FLOW.

Reciprocating engine fuel consumption rates are presented for best economy, normal, and rich mixture operation. The manual lean and manual adjust charts cover all operation from sea level through 45,000 feet. At altitudes above 45,000 feet, rich mixture must be used to provide stable engine operation and to supplement engine cooling.

Refer to the "Power Schedules" of this section and to "Propeller Limitations," Section V, to avoid operation under restricted conditions.

Note

Recent fuel consumption trends indicate that, through minor changes and improved operating techniques and maintenance, small reductions in fuel flow have been effected over the original early flight test results. Charted fuel flow rates, therefore, may be slightly conservative in certain operating regions.

EXAMPLE.

Find expected fuel consumption under the following conditions:

Manual lean mixture setting
30-degree spark advance setting
1400 bhp
1590 rpm

Enter the 30-degree spark advance section of figure A-50 at 1590 rpm. Move vertically to 1400 bhp and read a fuel flow of 605 lbs per hour per engine.

FUEL-AIR RATIO DETERMINATION.

The manual leaning technique discussed under "Mixture Control, Manual Leaning Operation," Section VII, requires a check on fuel-air ratio in the region of best economy. Figures A-53 and A-54 enable the determination of fuel-air ratios for this check.

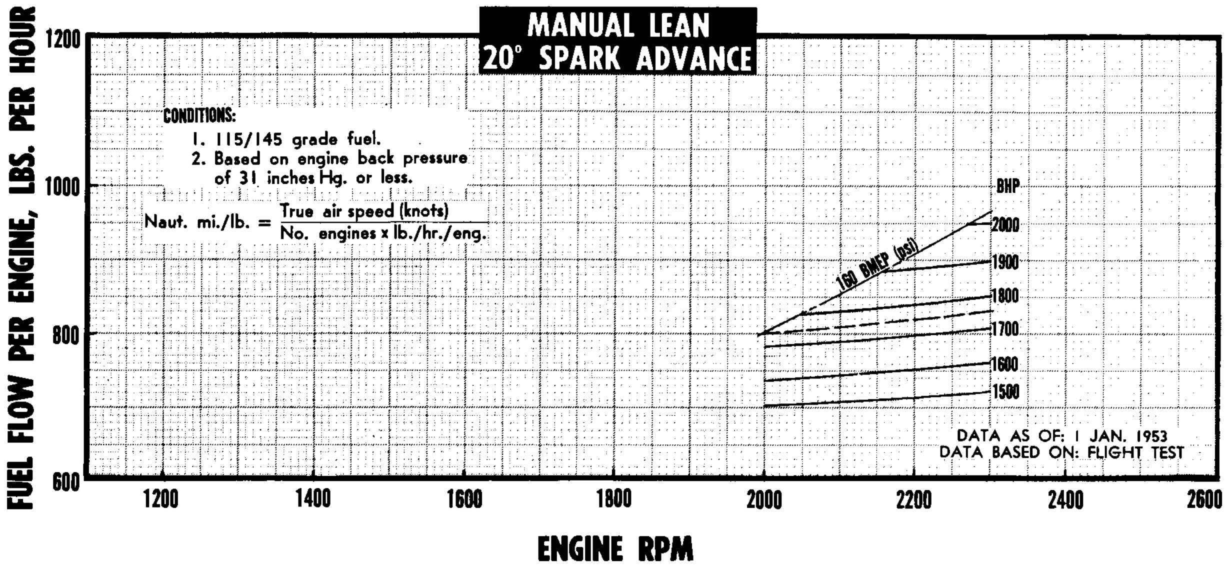
EXAMPLE.

Determine the fuel-air ratio for operation under the following conditions:

Single turbo operation
20,000 feet pressure altitude
18°C CAT.
1500 rpm
Fuel Flow = 580 lbs/hr
MAP. = 39 in. Hg.

Enter figure A-53 at 20,000 feet pressure altitude (A). Move vertically to 39 in. Hg. MAP. (interpolated), (B), then horizontally to the CAT. base line. Now parallel the CAT. guide lines to 18°C CAT. (C). From here move horizontally to 1500 rpm (D), then vertically to a fuel flow of 580 lbs/hr (E). From this point read, on the scale to the right, the fuel-air ratio of .0576 (F).

R4360-53 ENGINE FUEL CONSUMPTION



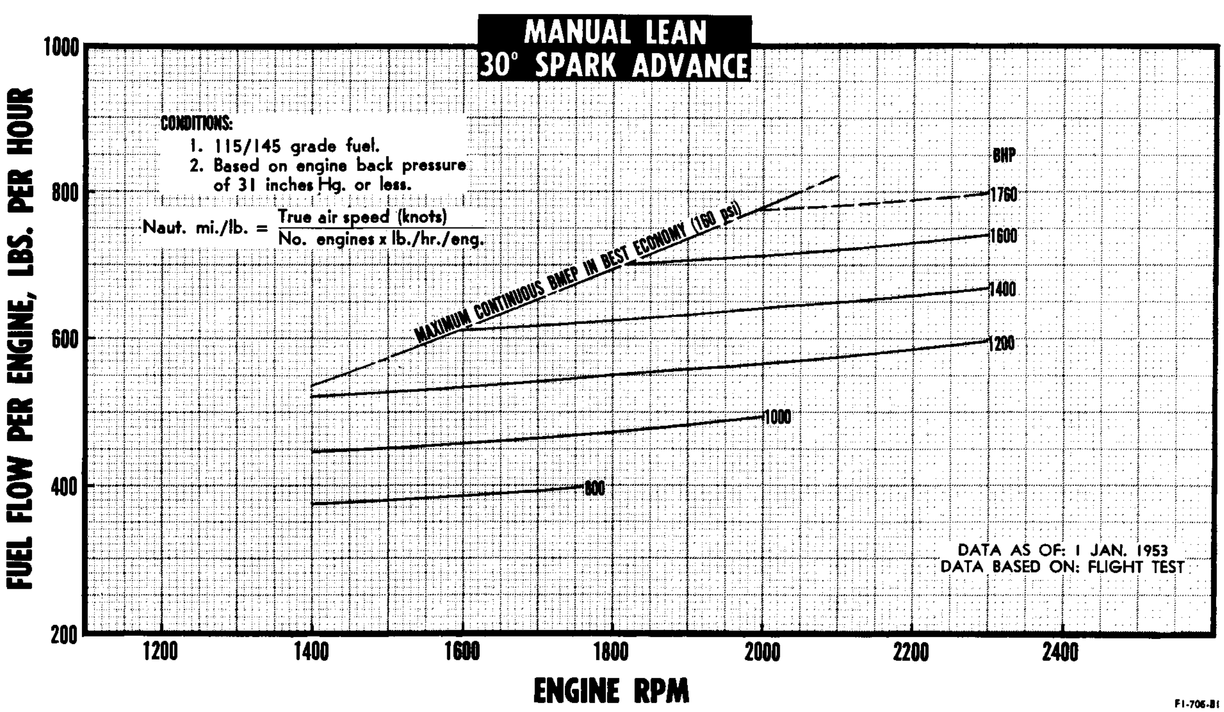
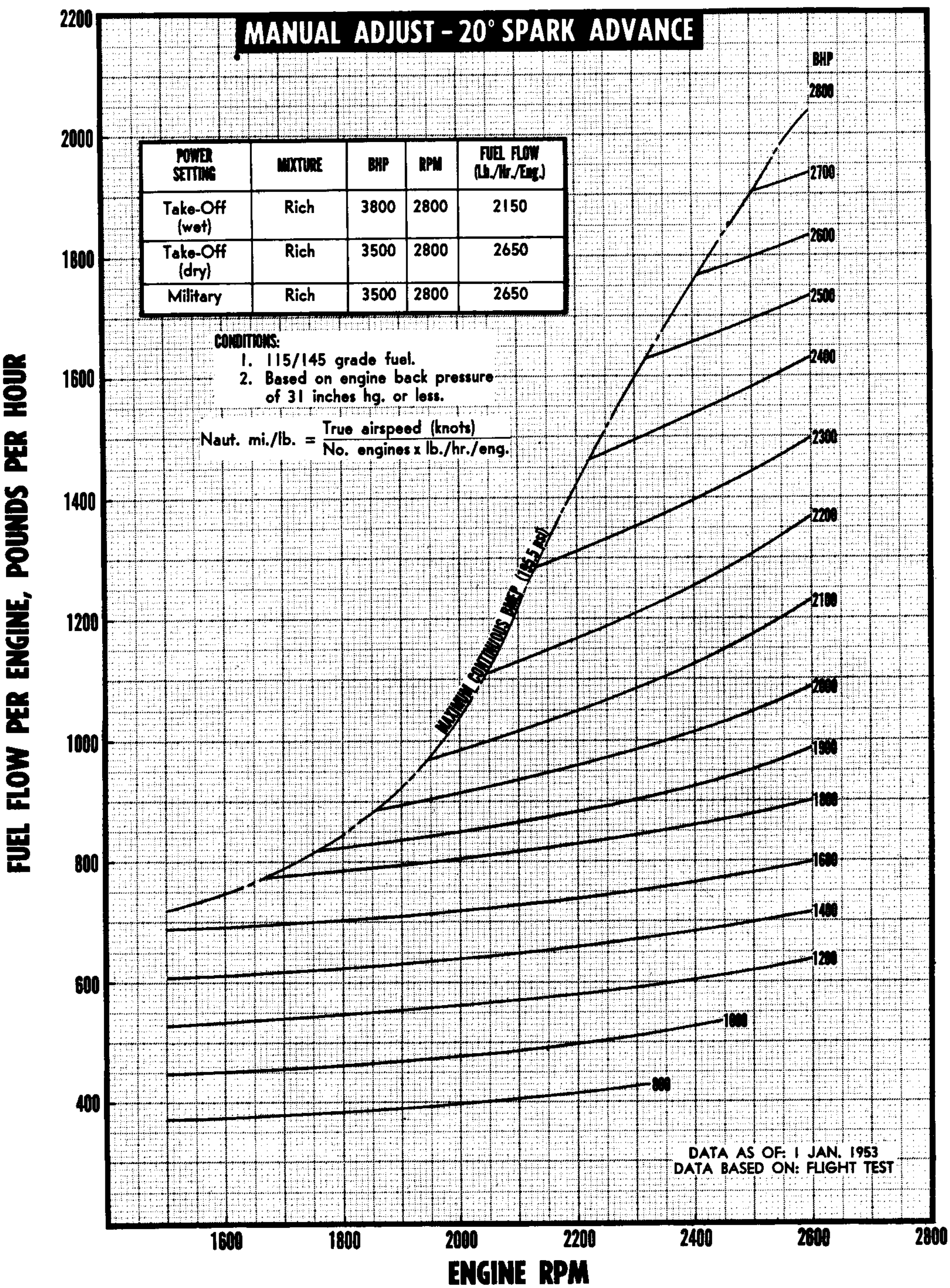


Figure A-50.

R4360-53 ENGINE FUEL CONSUMPTION



POWER SETTING	MIXTURE	BHP	RPM	FUEL FLOW (Lb./Hr./Eng.)
Take-Off (wet)	Rich	3800	2800	2150
Take-Off (dry)	Rich	3500	2800	2650
Military	Rich	3500	2800	2650

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Figure A-51.

R4360-53 ENGINE FUEL CONSUMPTION

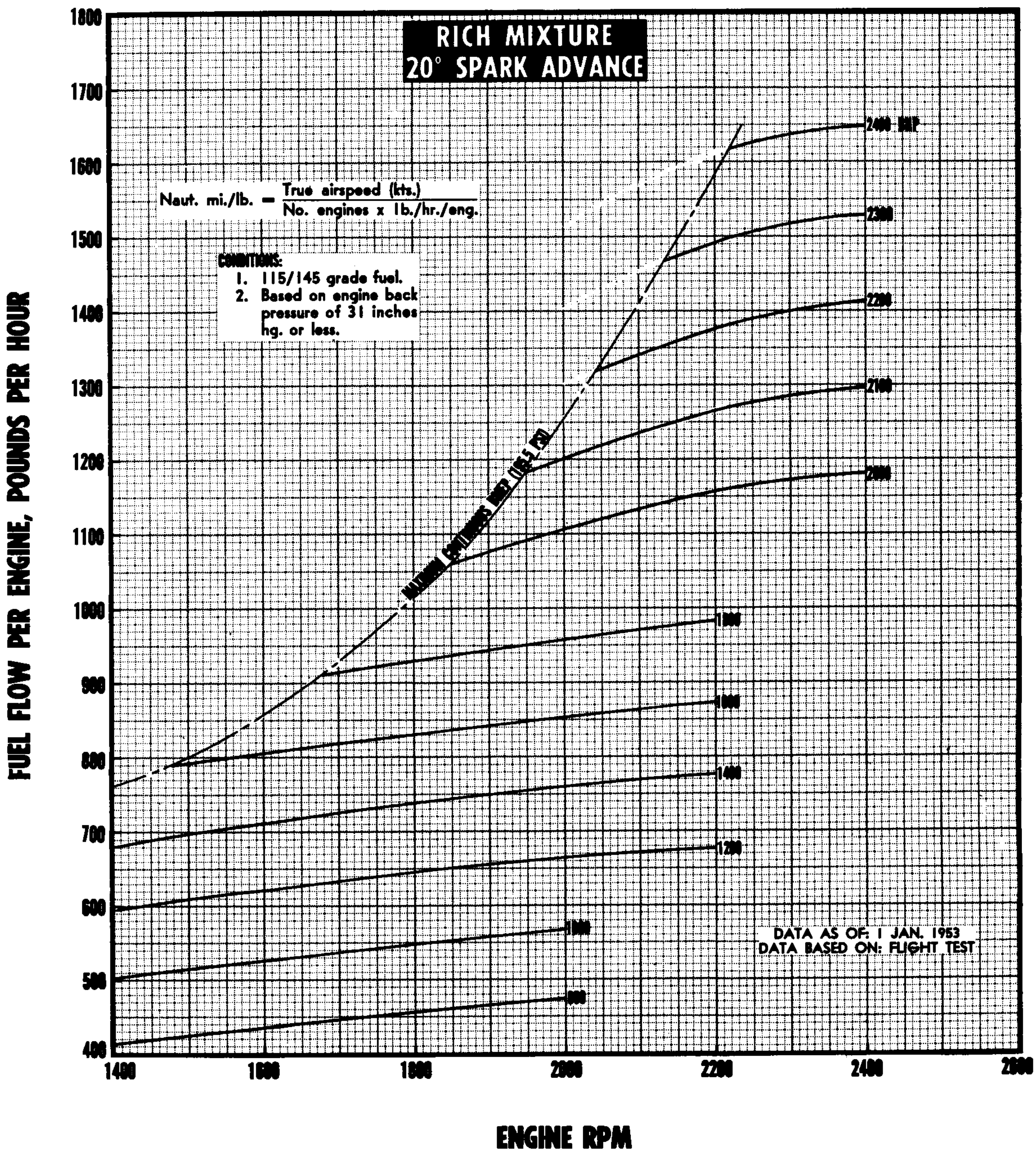


Figure A-52.

R4360-53 ENGINE
FUEL AIR RATIO-MANUAL LEAN MIXTURE
SINGLE TURBO

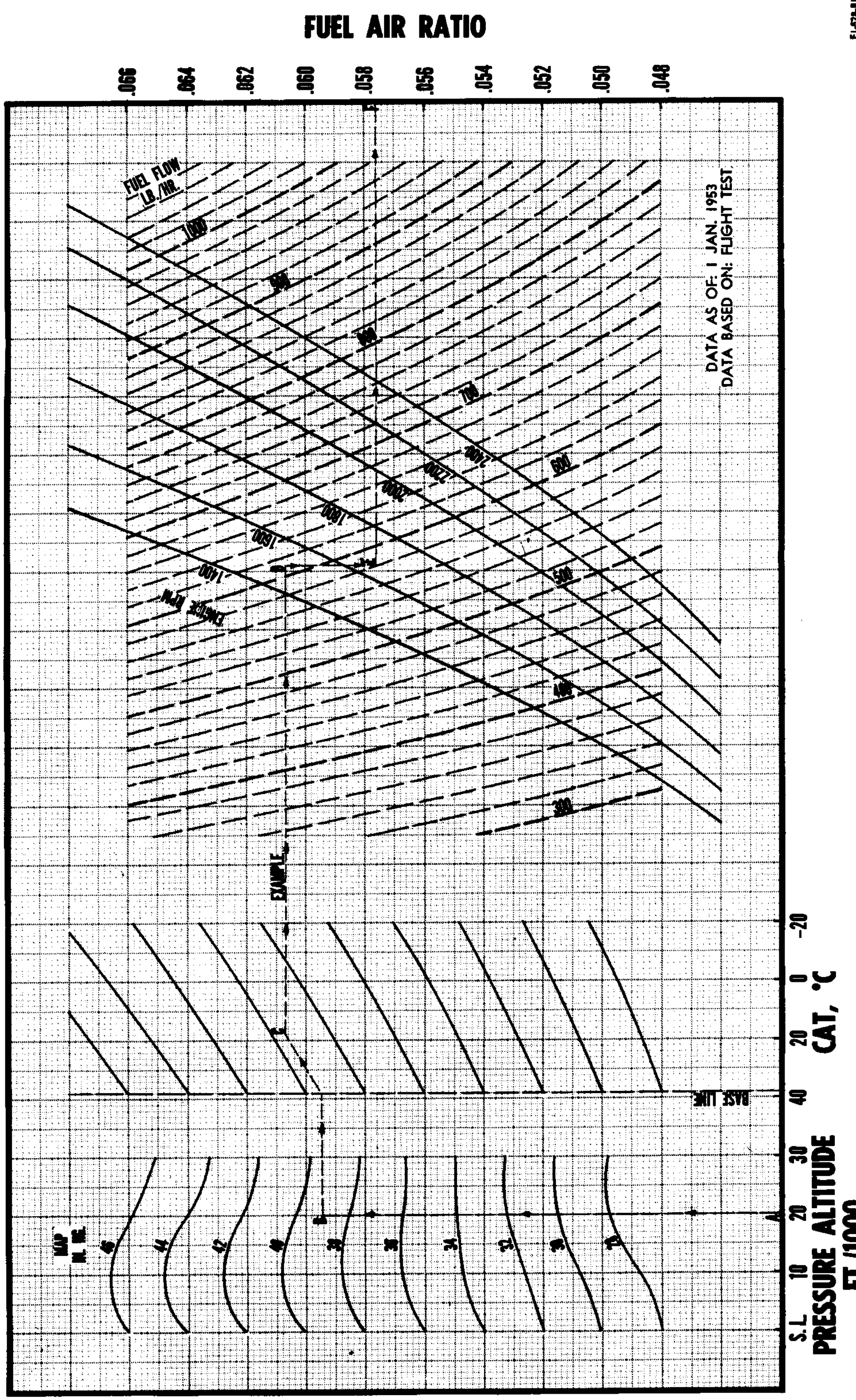


Figure A-53.

R4360-53 ENGINE

FUEL AIR RATIO—MANUAL LEAN MIXTURE

DUAL TURBO

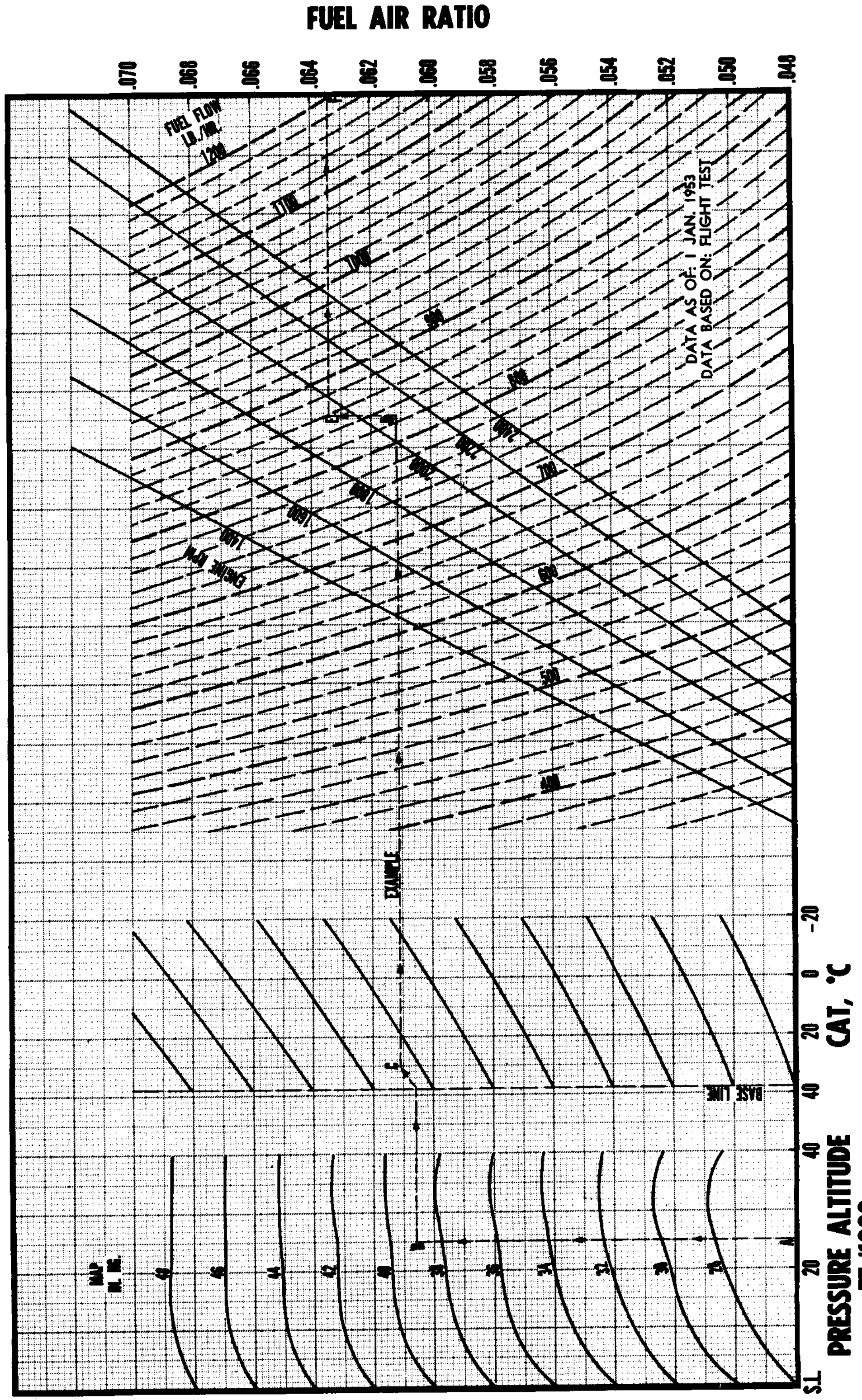
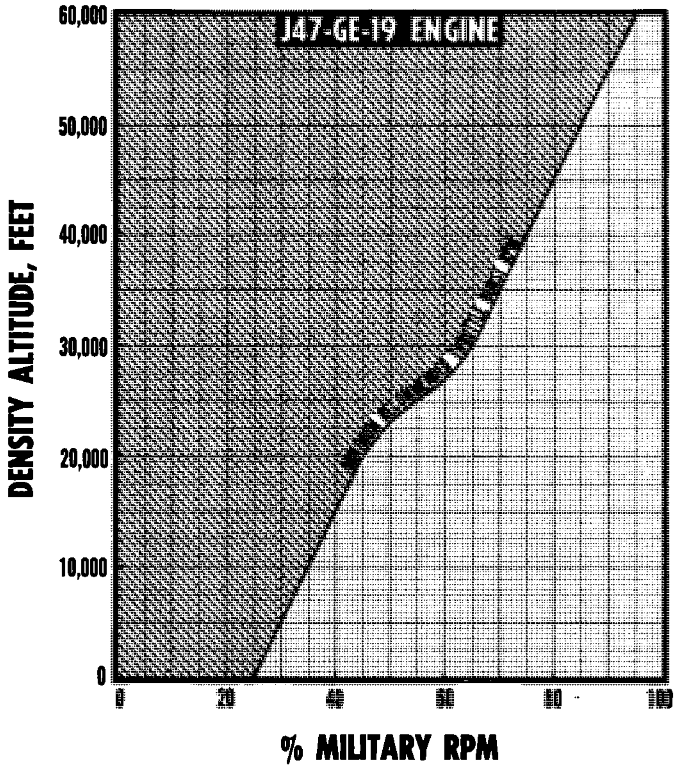


Figure A-54.

RECOMMENDED MINIMUM THROTTLE BURST RPM



67-223-A

67-223-A

Figure A-55.

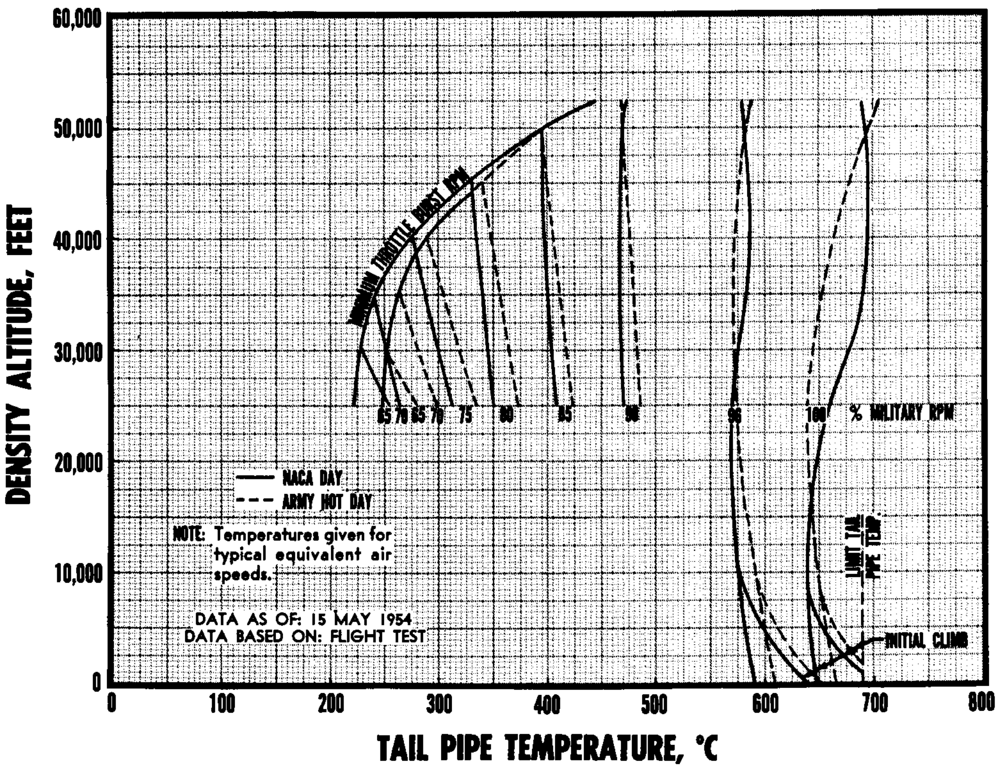
RECOMMENDED MINIMUM THROTTLE BURST RPM FOR J47-19 ENGINE.

Certain conditions require that full rated turbojet thrust be immediately available if needed. The minimum throttle burst rpm curve (figure A-55) presents the lowest recommended operating rpm from which throttles could be instantaneously moved to full-open without danger of blow-out. This rpm is not to be confused with minimum idling rpm which occurs at a somewhat lower engine speed and affords lower fuel consumption. However, minimum idling rpm requires careful handling of throttle opening for power build-up. Air speed has a negligible effect on minimum throttle burst rpm variation.

EXAMPLE.

If throttle burst may be necessary, the minimum recommended J47-19 operating rpm at 40,000 feet density altitude is 75 per cent military rpm.

J47-GE-19 ENGINE TAIL PIPE TEMPERATURE



67-224-A
67-224-A

Figure A-56.

J47-19 ENGINE TAIL PIPE TEMPERATURE.

Normal anticipated turbojet tail pipe temperatures may be determined from figure A-56. Extreme variations from this chart will immediately indicate symptoms of engine malfunction. Tail pipe temperature operating limitations, imposed to avoid engine structural damage, are presented in "Over-Temperature Operation," Section V.

The chart presents average tail pipe temperatures, at typical air speeds, for the complete range of engine speeds and altitudes. Extreme air-speed variations will have little effect upon the accuracy of the data. Temperatures may be determined by interpolation for atmospheric variations between standard and hot day temperatures.

Take-off and initial climb at 96 per cent and 100 per cent military rpm produce temperatures in excess of normal operation by approximately 50°C. This is probably due to the fact that during take-off and initial climb the turbine wheel has had insufficient time to expand to its normal size for continuous operation, thus allowing an excess of high energy hot gases to escape through the turbine to the tail pipe. Under these conditions, retard throttle to comply with limit tail pipe temperature of 690°C.

It may be further noted that the inherent characteristics of the jet engine under certain atmospheric conditions and engine speeds will give lower tail pipe temperature for a hot day than for a standard day.

EXAMPLE.

Determine expected J47-19 tail pipe temperature for the following operating conditions:

33,000 feet pressure altitude
—34°C OAT.
91 per cent military rpm

These atmospheric conditions correspond to a density altitude of 34,800 feet and a temperature approximately 2/3 of the difference between standard day and hot day temperature at that density altitude. Enter figure A-56 at an altitude of 34,800 feet, move to the right to 90 per cent rpm and record a reference temperature of 475°C (corresponding to the interpolated atmospheric condition). In a similar manner, read a reference tail pipe temperature for 96 per cent military rpm of 575°C. The average tail pipe temperature for 91 per cent military rpm will be

$$475 + \frac{91-90}{96-90}(575-475) = 492°C.$$

J47-19 THRUST HORSEPOWER.

Figures A-57B through A-60 show the values of true thrust horsepower plotted versus $1/\sqrt{\sigma}$ for various jet engine powers (per cent military rpm). Charts are presented for EAS values of 140, 160, 180, and 200 mph. These charts are particularly useful in determining the allowable decrease in reciprocating engine bhp for a certain increase in jet engine rpm.

EXAMPLE.

An airplane weighing 333,000 pounds if flying at 35,000 feet according to long range operating conditions with 6 R4360-53 and 4 J47-19 engines operating. It is desired to decrease the reciprocating engine power as much as possible and maintain the same thrust horsepower by increasing the jet engine rpm to maximum continuous power.

From figure A-128 the following values are read:

180 mph EAS
2230 BHP
87 per cent MRPM

From figure A-59 the jet engine thrust horsepower for 87 per cent rpm is 960 and for 96 per cent rpm is 1242. Subtracting gives a difference of 282.

The allowable decrease in reciprocating engine bhp, assuming a propeller efficiency of 80 per cent is then calculated as follows:

$$\text{BHP decrease} = \frac{282 \text{x} 4}{6 \text{x.} 8} = 235$$

Therefore, a bhp per engine setting of 2230-235, or 1995 is permitted with the increase in jet rpm.
When a thrust horsepower for an EAS other than those presented is desired it is necessary to interpolate between the charts.

J47-19 THRUST HORSEPOWER

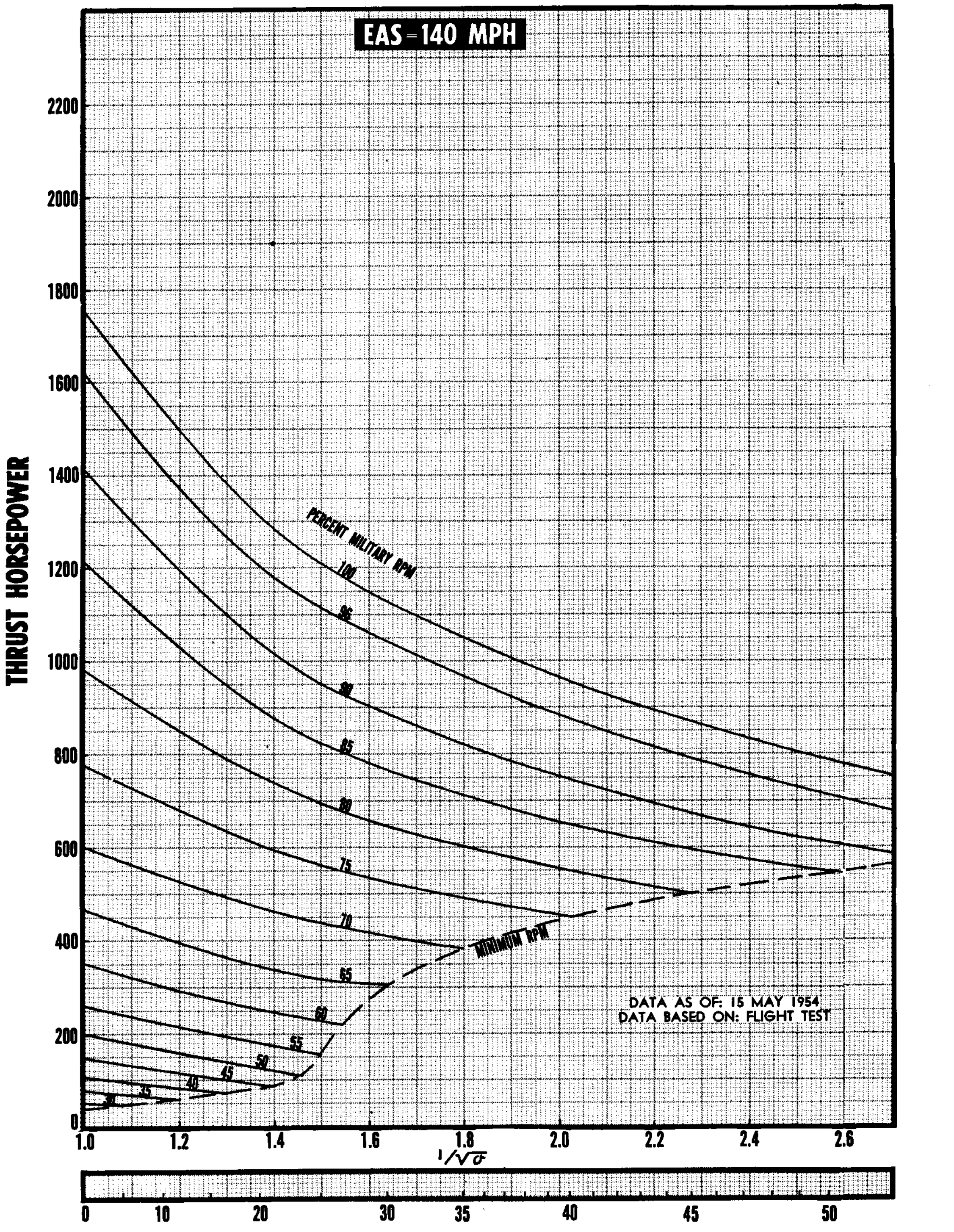


Figure A-57.

J47-19 THRUST HORSEPOWER

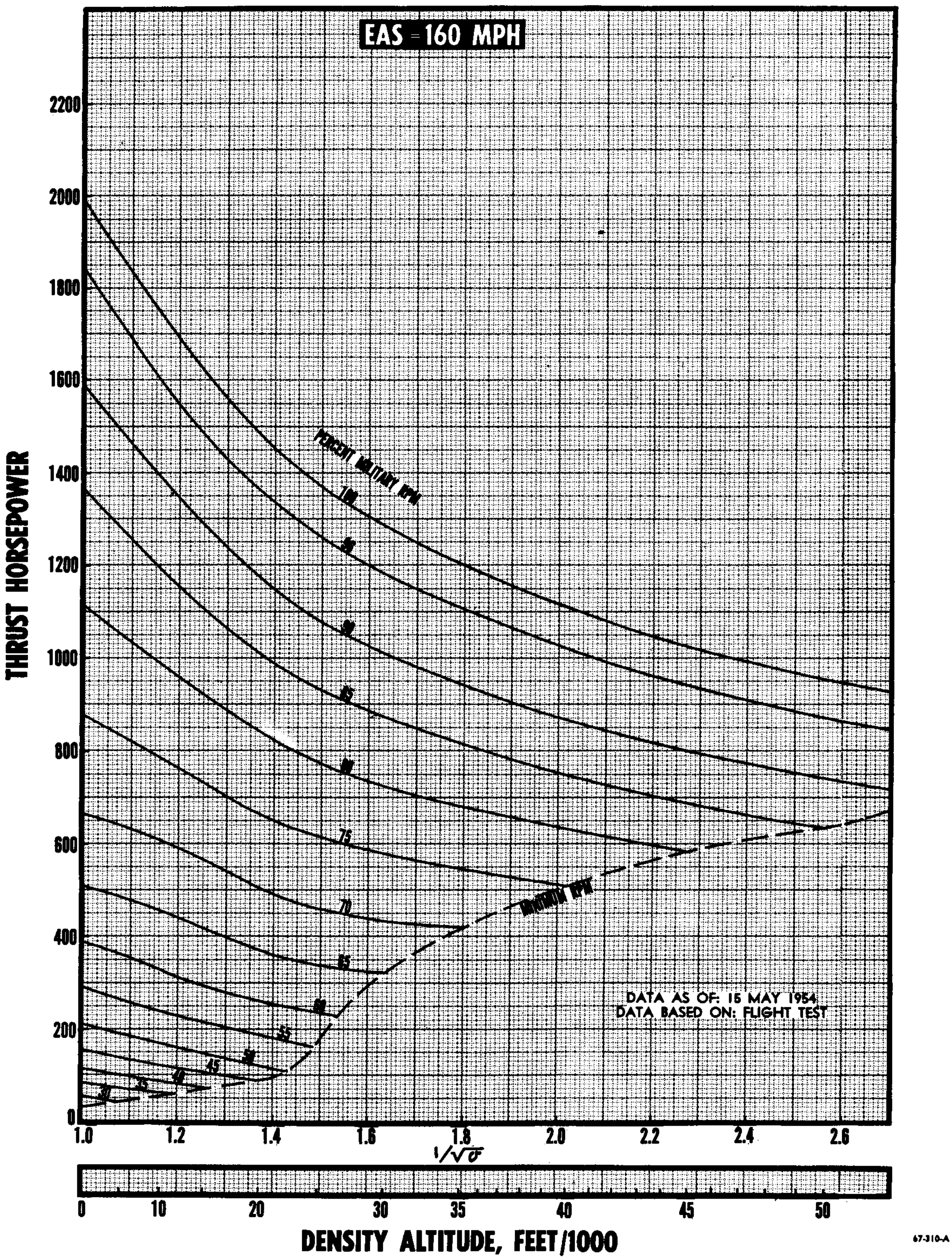


Figure A-58.

J47-19 THRUST HORSEPOWER

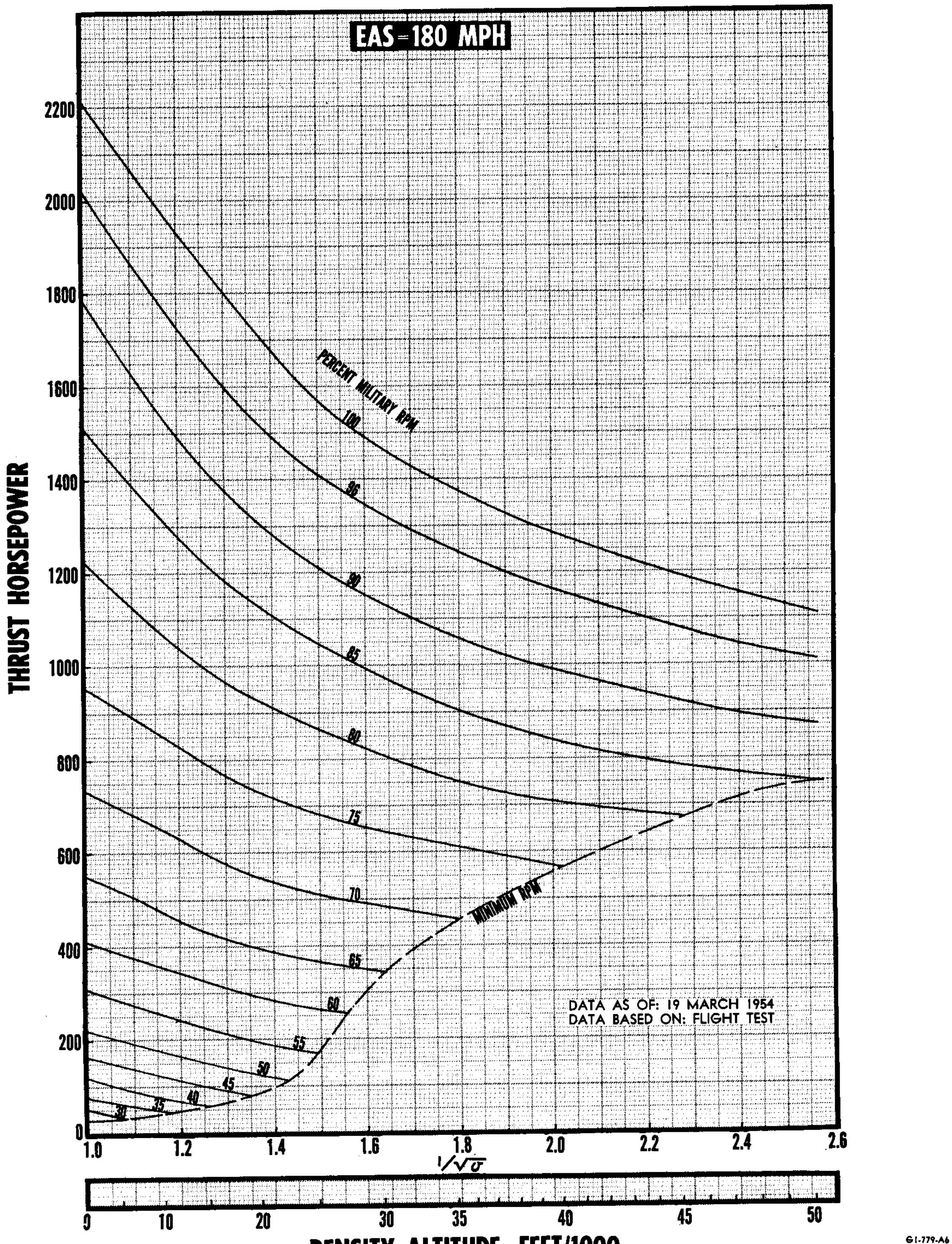


Figure A-59.

J47-19 THRUST HORSEPOWER

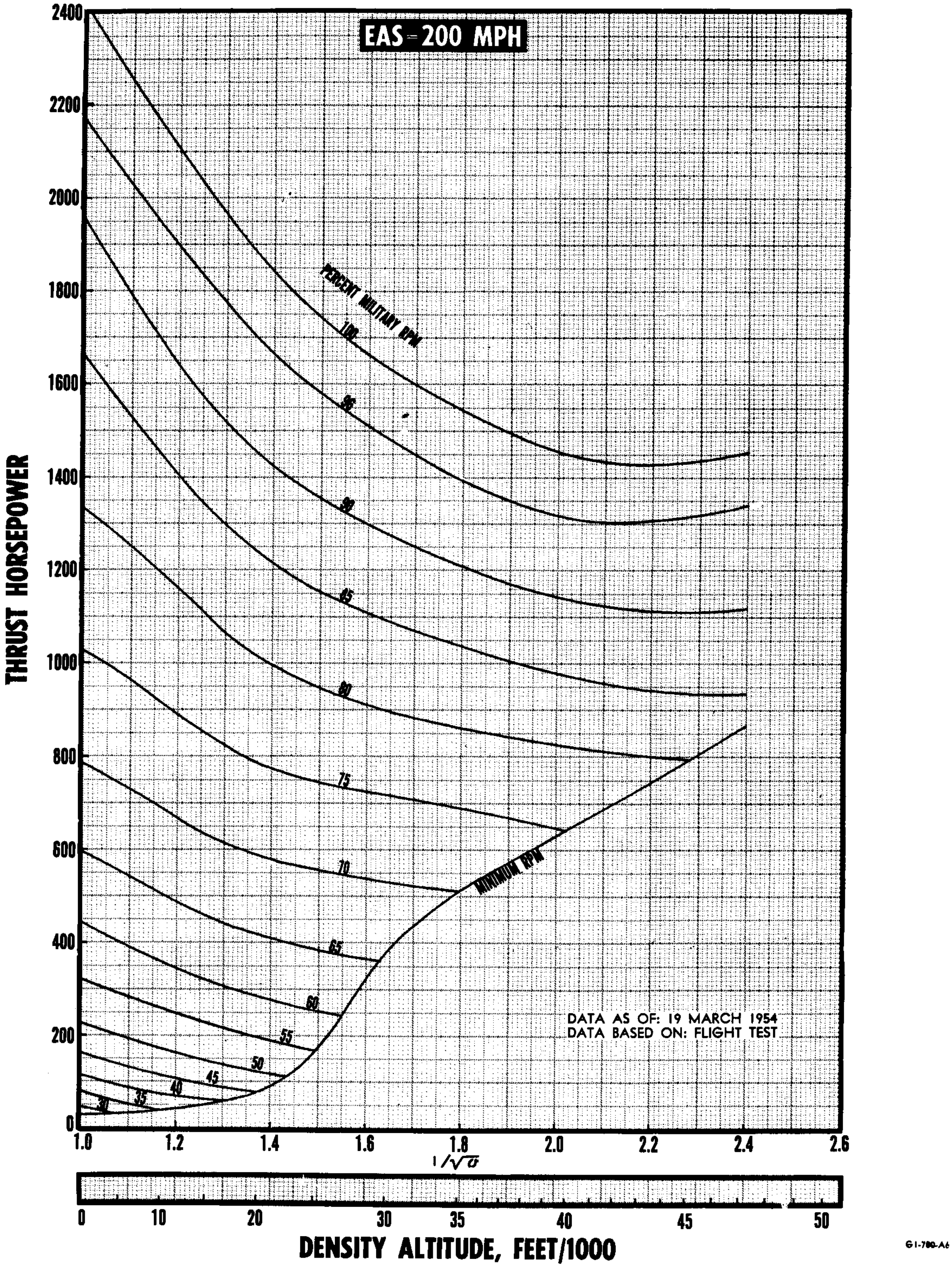


Figure A-60.

J47-19 ENGINE FUEL FLOW.

Fuel flow charts presented here furnish a means of predicting the average amount of fuel consumed by jet operation. Figures A-61 through A-65 present average jet fuel flow for 5 equivalent air speeds from 100 to 300 mph and figure A-66 presents fuel flow data for low jet power at three air speeds. Each chart furnishes average fuel flow rates for any atmospheric condition and engine speed. When the fuel flow for an air speed other than those presented is desired, an interpolation between values obtained for the two bracketing air speeds is necessary.

During jet operation the fuel flow values read from the calibrated jet fuel flow indicators should be used for all engineers' log entries.

EXAMPLE.

Find the fuel consumption for four J47-19 engines under the following conditions:

35,000 feet pressure altitude
—38°C OAT.
90 per cent military rpm
140 mph EAS

Enter the chart for 100 mph at an OAT. of —38°C, move vertically to a pressure altitude of 35,000 feet to establish the density altitude and note the position of this point relative to the "Hot" and "Cold" day lines. At this density altitude move horizontally to the right to the 90 per cent military rpm line corresponding to the atmospheric conditions determined above, interpolating between "Hot" and "Cold" days if necessary, and read a fuel flow of 1300 pounds per hour per engine.

Note

It should be noted that an rpm interpolation is necessary at this point if the J47 setting is not one of the "even fives" plotted.

Next enter the chart for 150 mph EAS and follow through exactly as above, reading a fuel flow of 1290 pounds per hour per engine. The fuel flow at 140 mph is

$$1300 - \frac{140-100}{150-100}(1300-1290) = 1292 \text{ lbs/hr/eng.}$$

Fuel consumption for 4-jet operation is 5168 lbs/hr.

J47-GE-19 ENGINE FUEL CONSUMPTION

EAS = 100 MPH

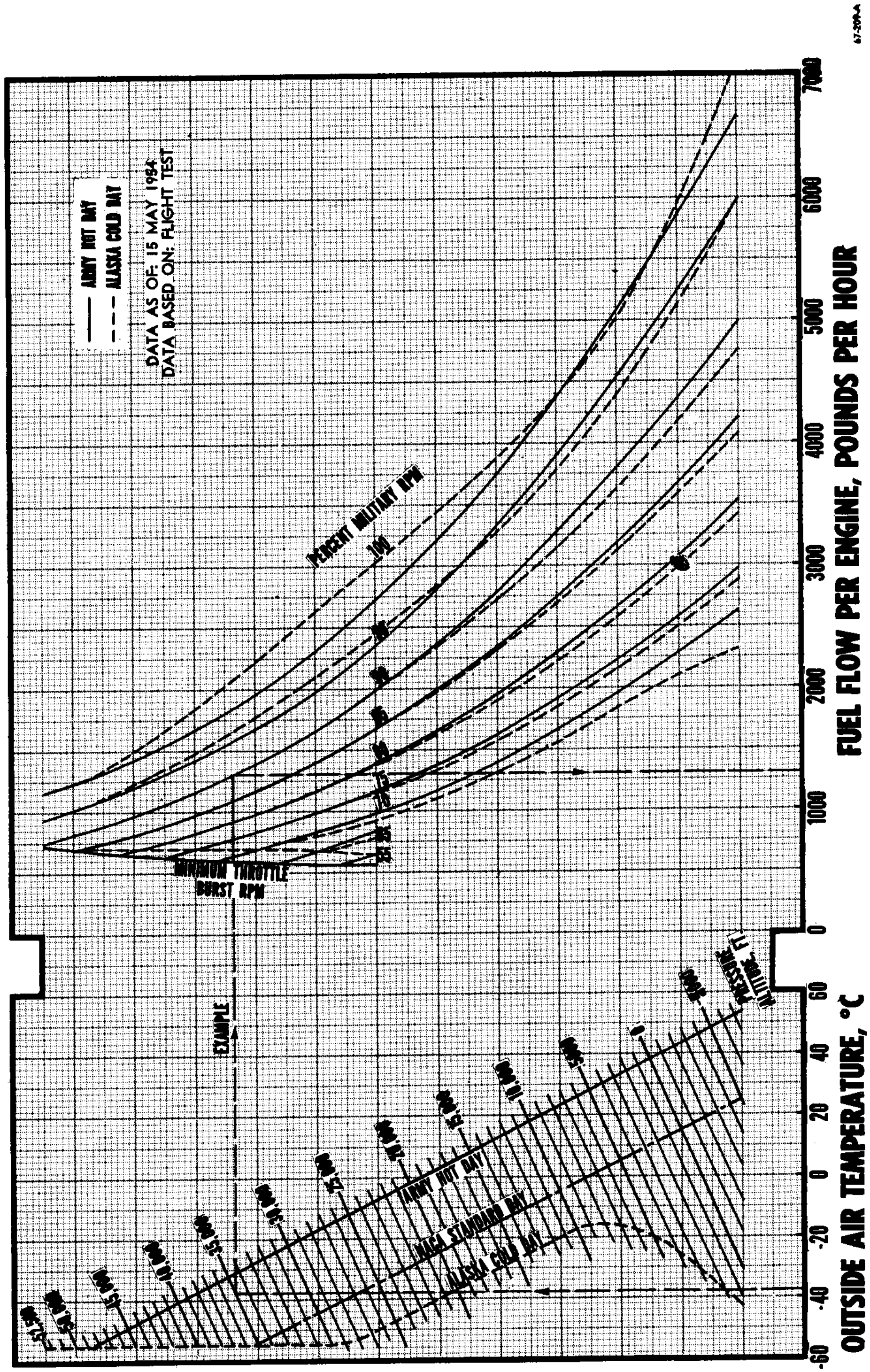


Figure A-61.

J47-GE-19 ENGINE FUEL CONSUMPTION

EAS= 150 MPH

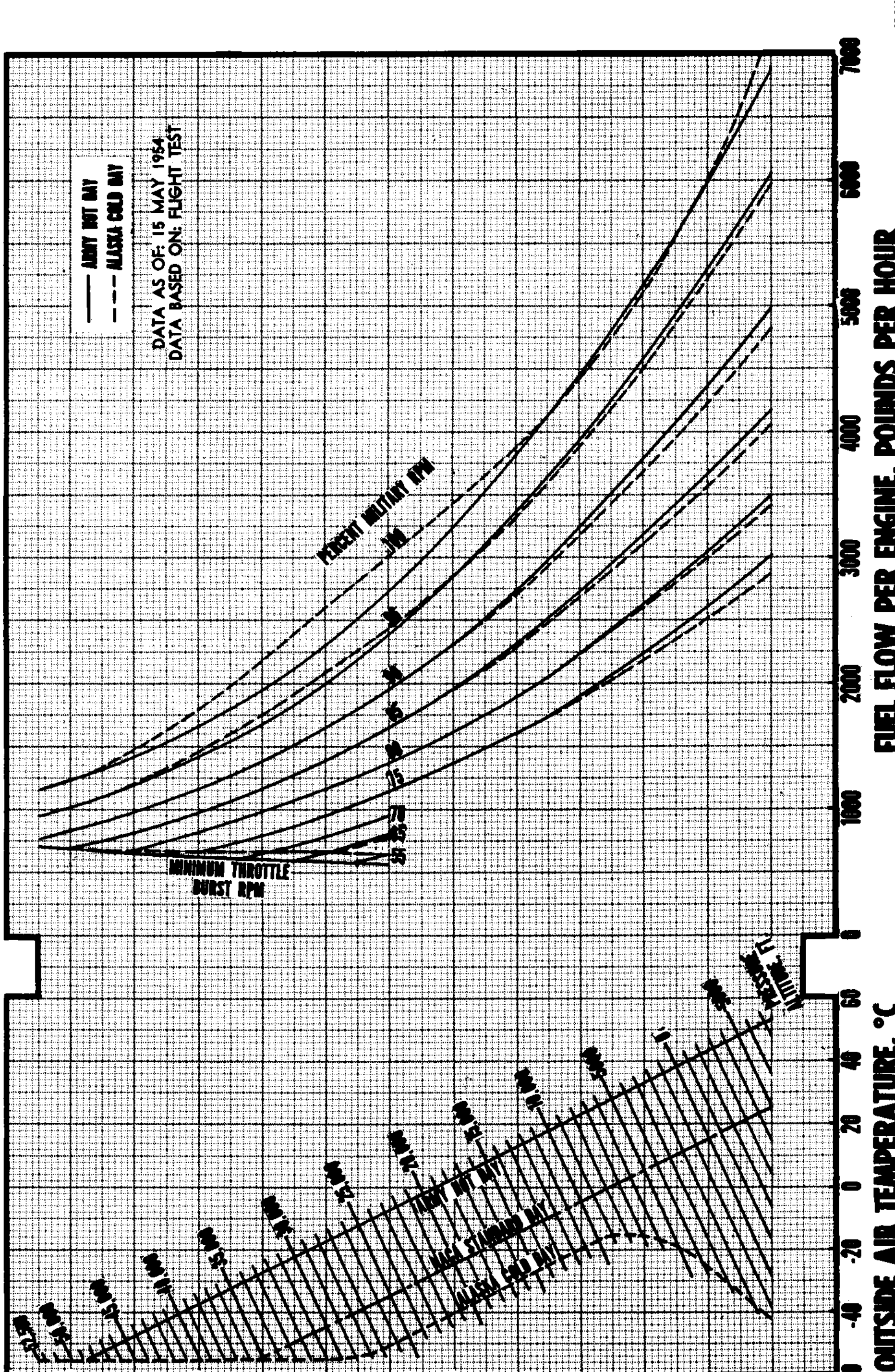


Figure A-62.

J47-GE-19 ENGINE FUEL CONSUMPTION
EAS = 200 MPH

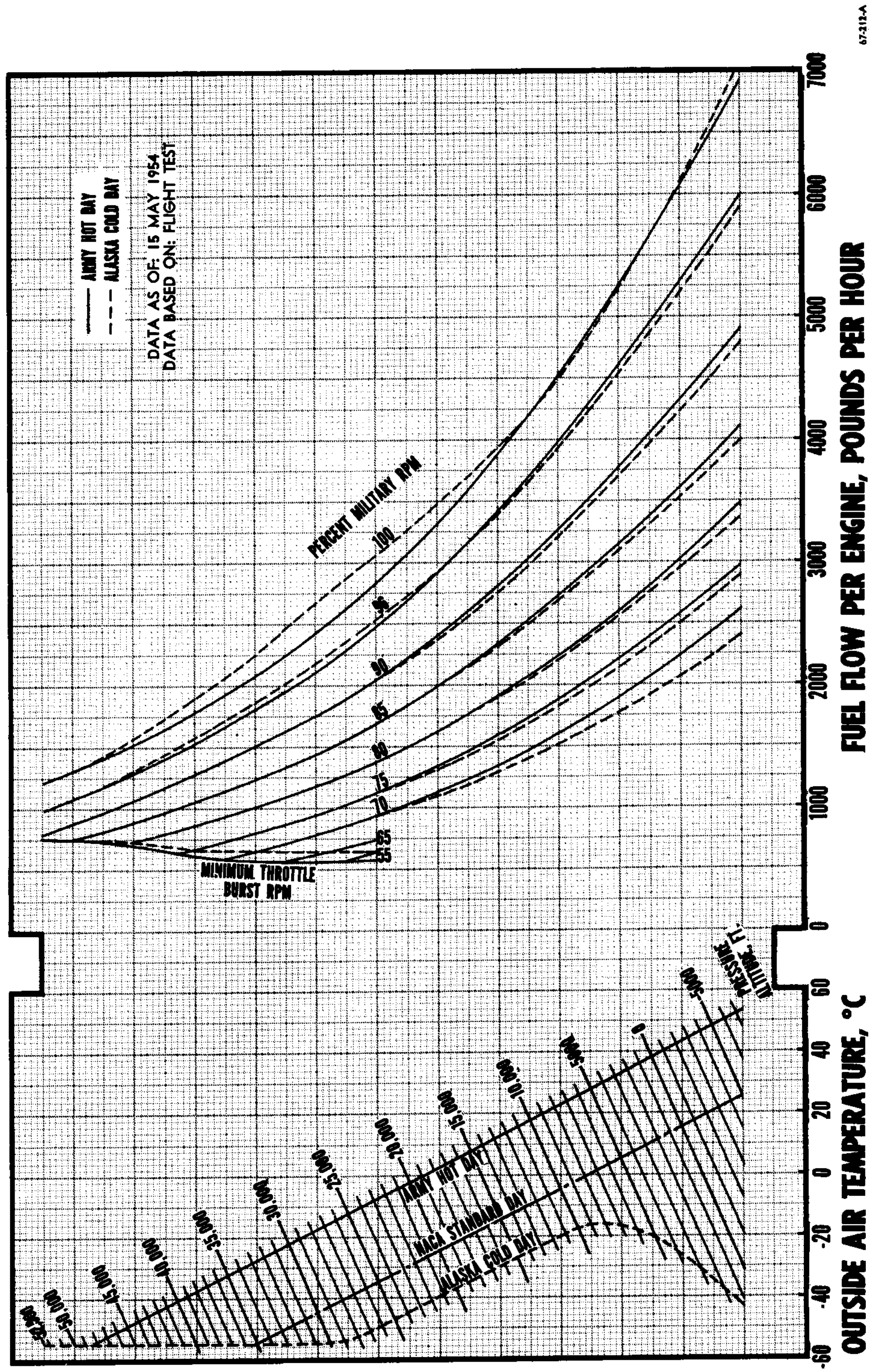


Figure A-63.

J47-GE-19 ENGINE FUEL CONSUMPTION

EAS = 250 MPH

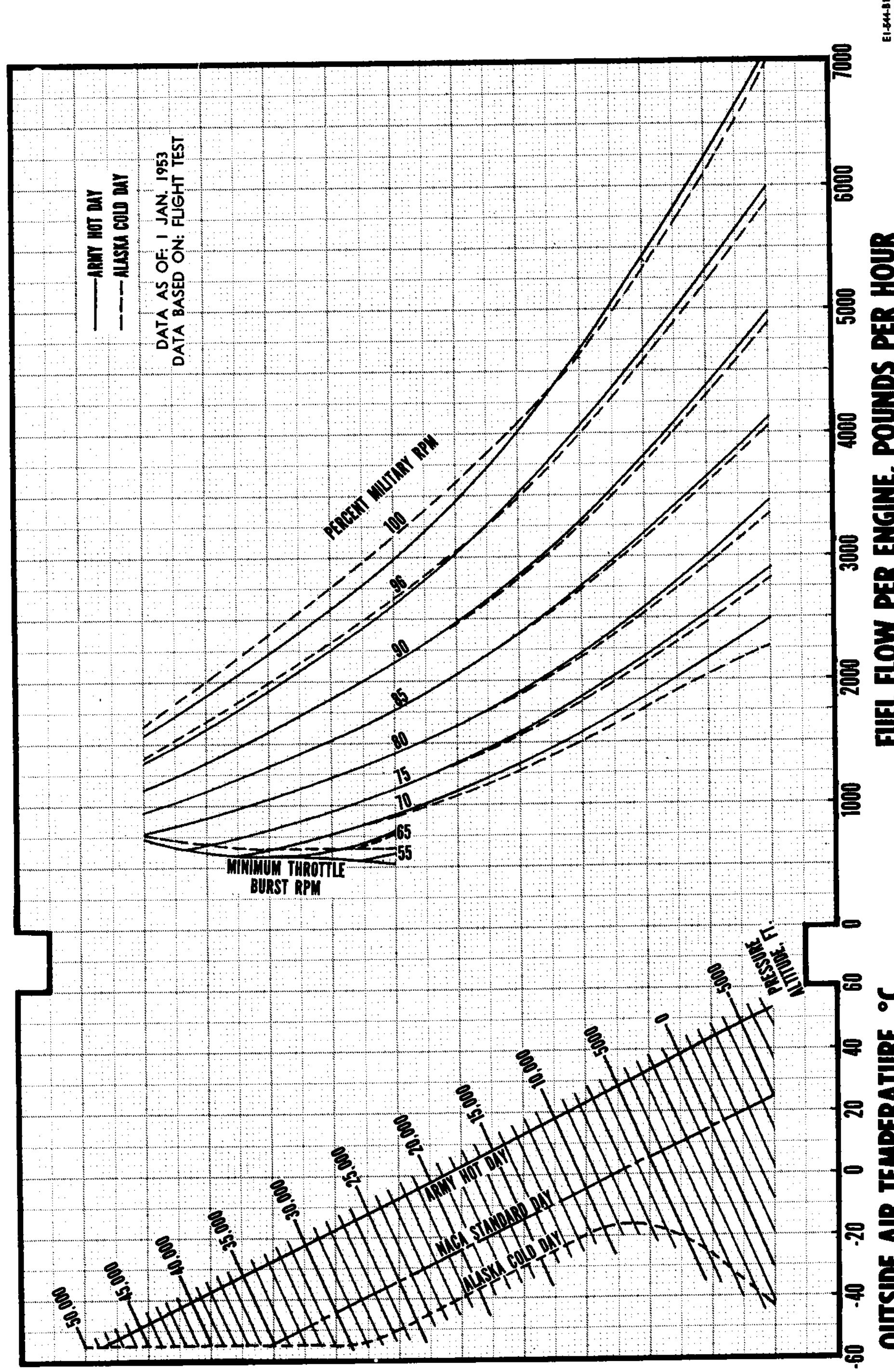


Figure A-64.

J47-GE-19 ENGINE FUEL CONSUMPTION

EAS=300 MPH

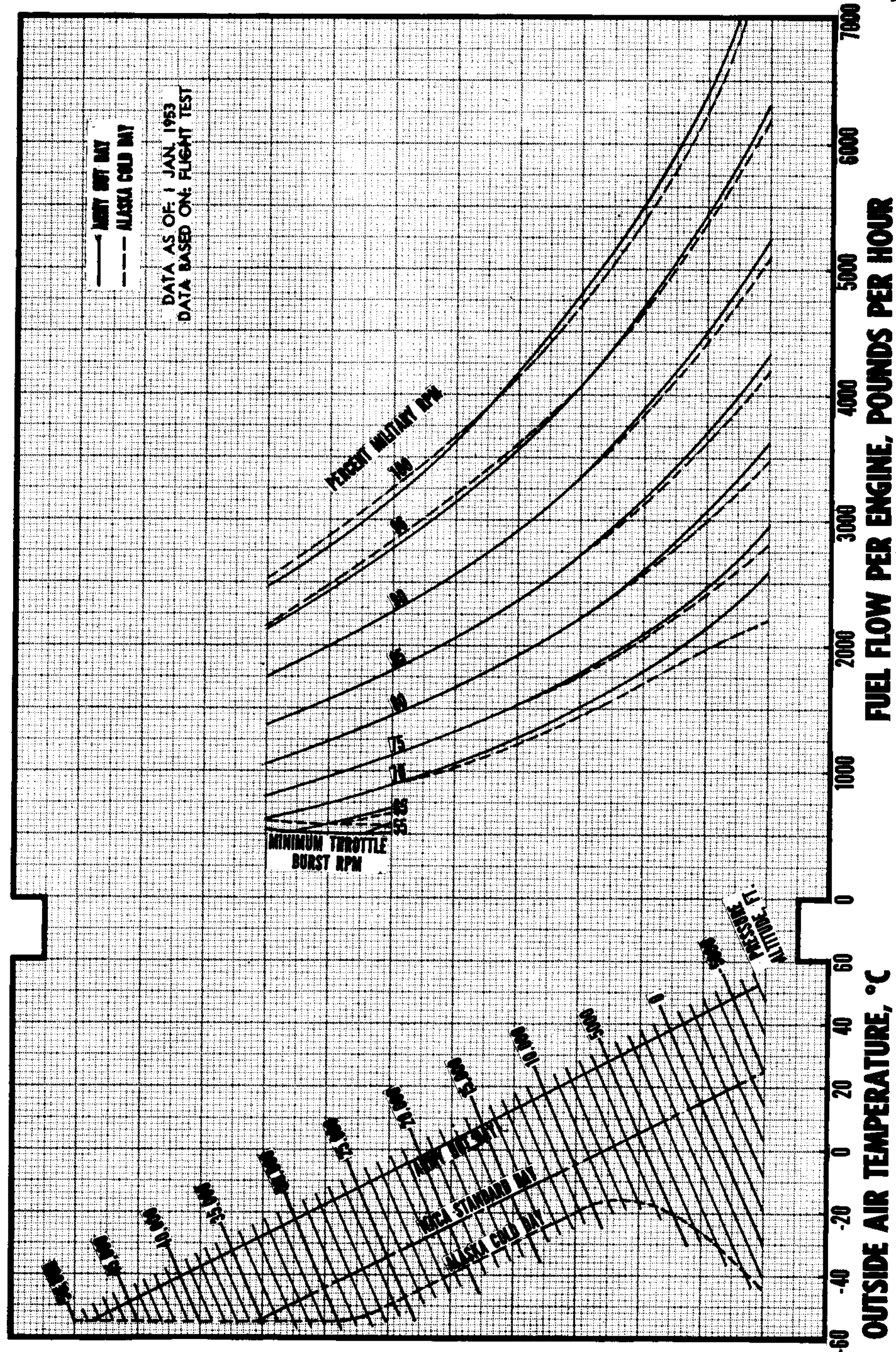
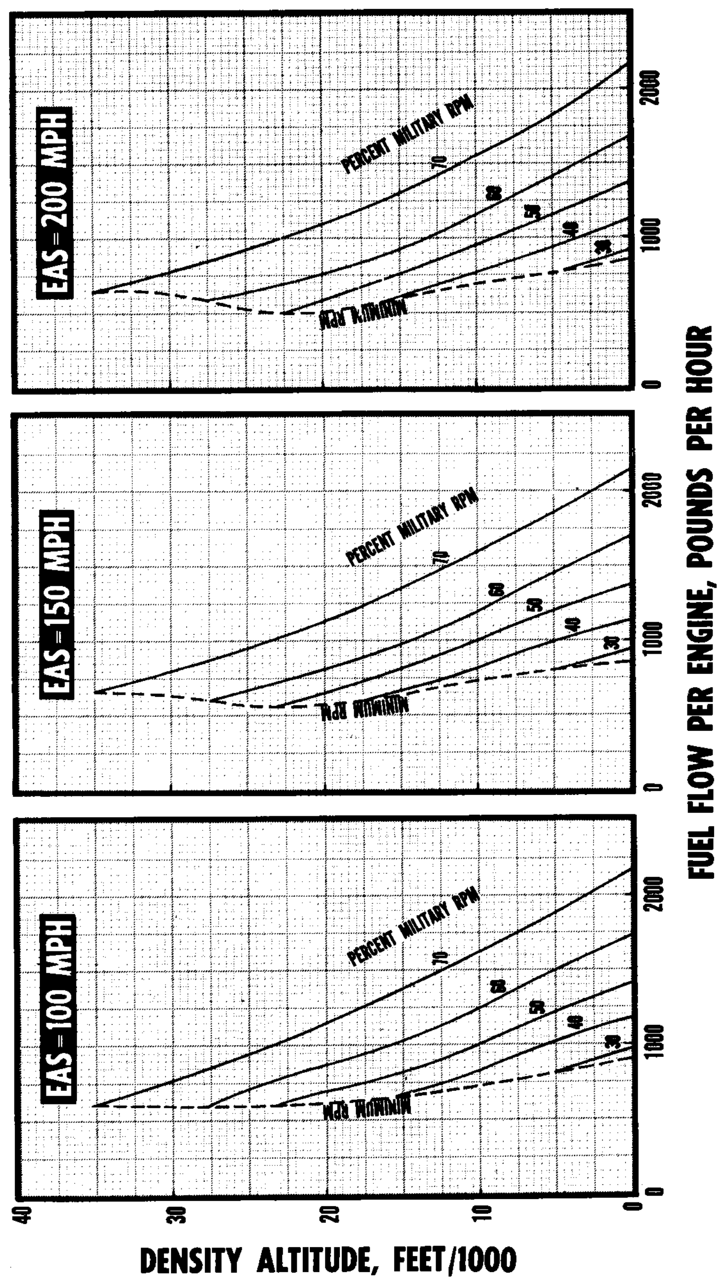


Figure A-65.

J47-19 ENGINE FUEL CONSUMPTION

(FOR POWERS BELOW 70% MRPM)



DATA AS OF: 19 MARCH 1954
DATA BASED ON: FLIGHT TEST

GI-781-A6

Figure A-66.

R4360-53 ENGINE ALTERNATE POWER SCHEDULE.

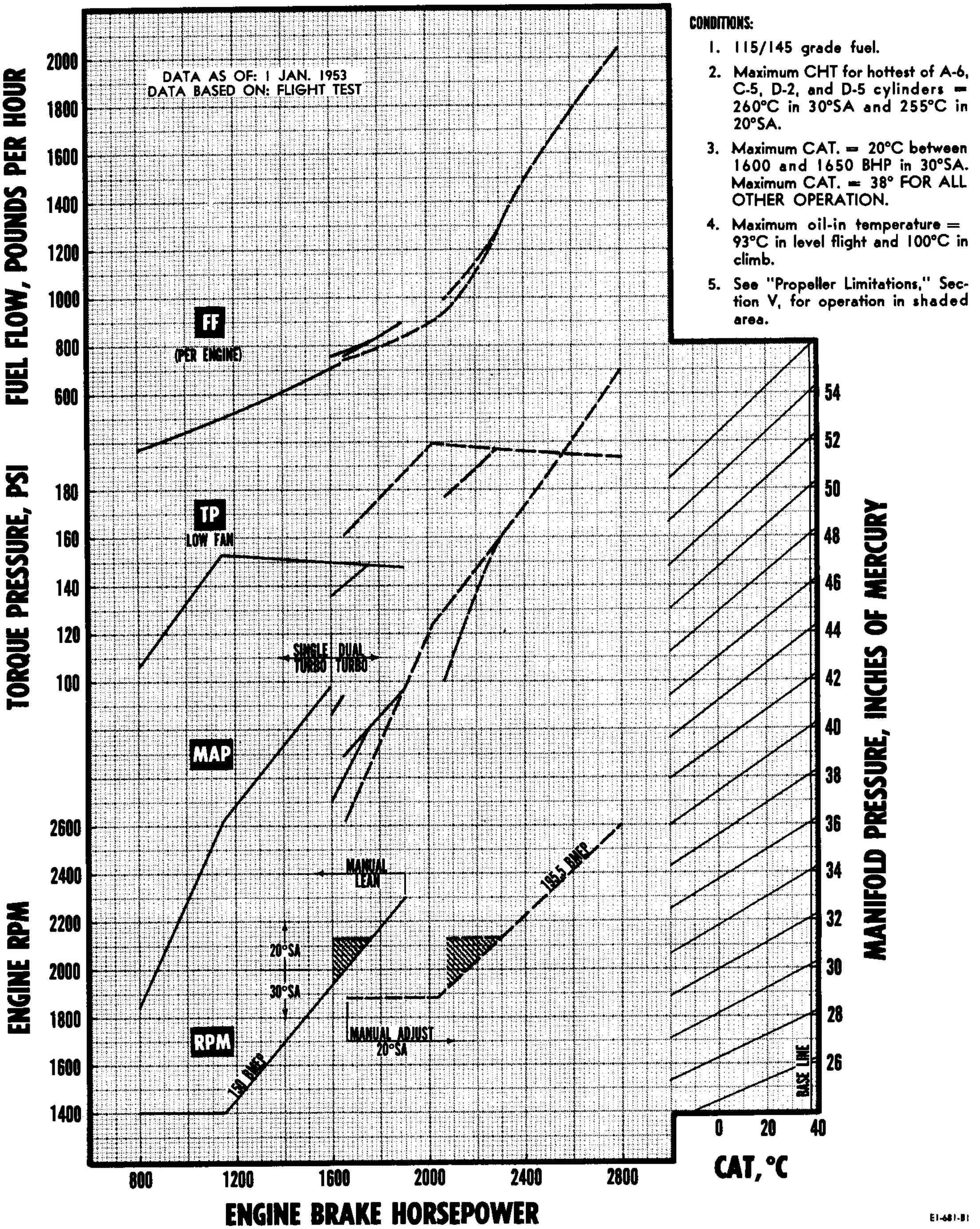
Alternate R4360-53 engine power schedules are presented in figures A-67 to A-75 for operation from sea level to an altitude of 40,000 feet. The major difference between the normal and alternate power schedule is the use of 150 psi bmep in manual lean mixture setting on the alternate schedule.

These alternate schedules are intended for use on short tests where maximum efficiency and high performance are not required.

ALTERNATE FUEL GRADE OPERATION.

Engine power schedules and performance data using an alternate grade fuel are not presented because current operation of the R4360-53 engines is restricted to the use of 115/145 grade fuel.

R4360-53 ENGINE ALTERNATE POWER SCHEDULE AT SEA LEVEL



CONDITIONS:

1. 115/145 grade fuel.
2. Maximum CHT for hottest of A-6, C-5, D-2, and D-5 cylinders = 260°C in 30°SA and 255°C in 20°SA.
3. Maximum CAT. = 20°C between 1600 and 1650 BHP in 30°SA. Maximum CAT. = 38° FOR ALL OTHER OPERATION.
4. Maximum oil-in temperature = 93°C in level flight and 100°C in climb.
5. See "Propeller Limitations," Section V, for operation in shaded area.

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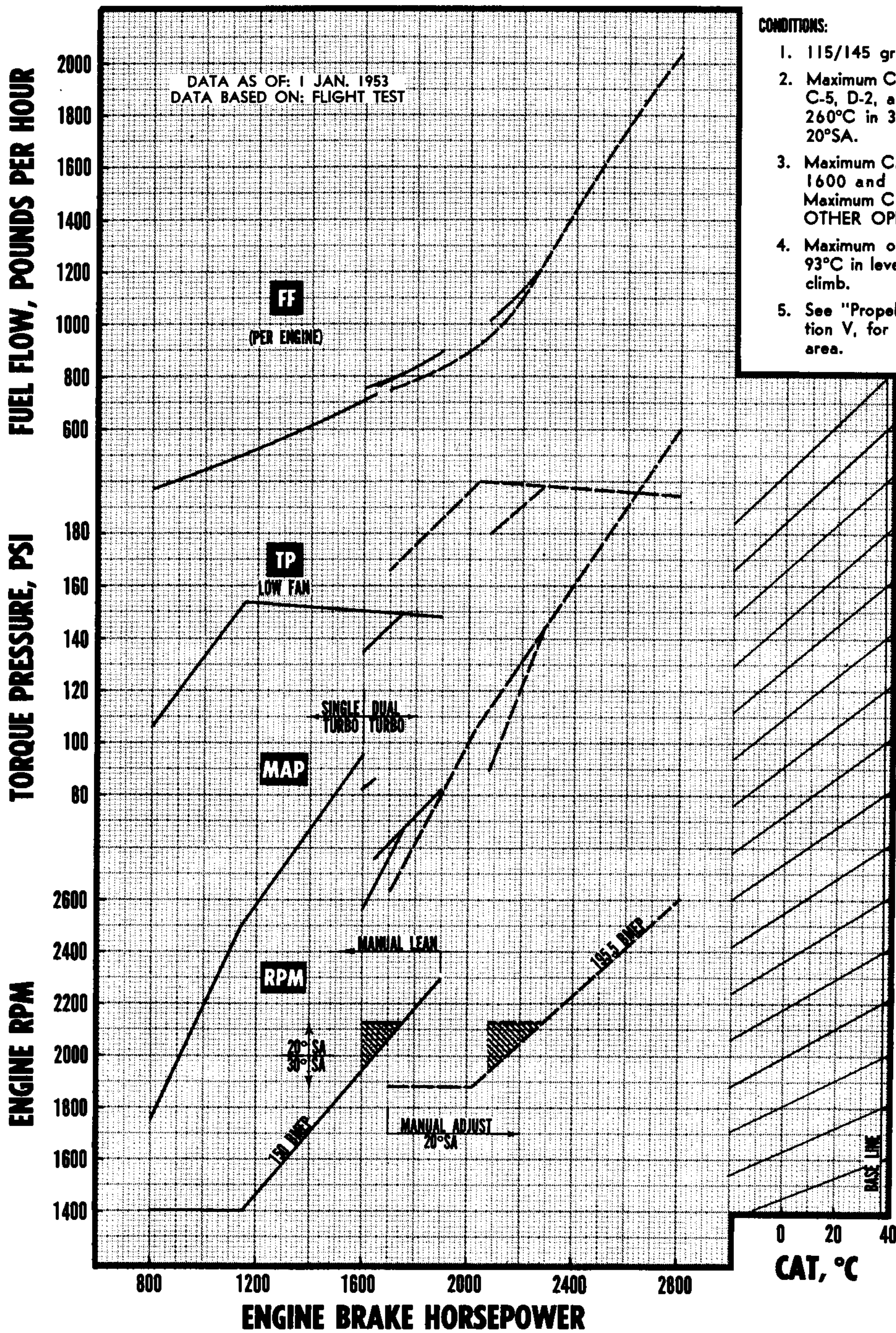
Figure A-67.

R4360-53 ENGINE ALTERNATE POWER SCHEDULE AT 5,000 FEET

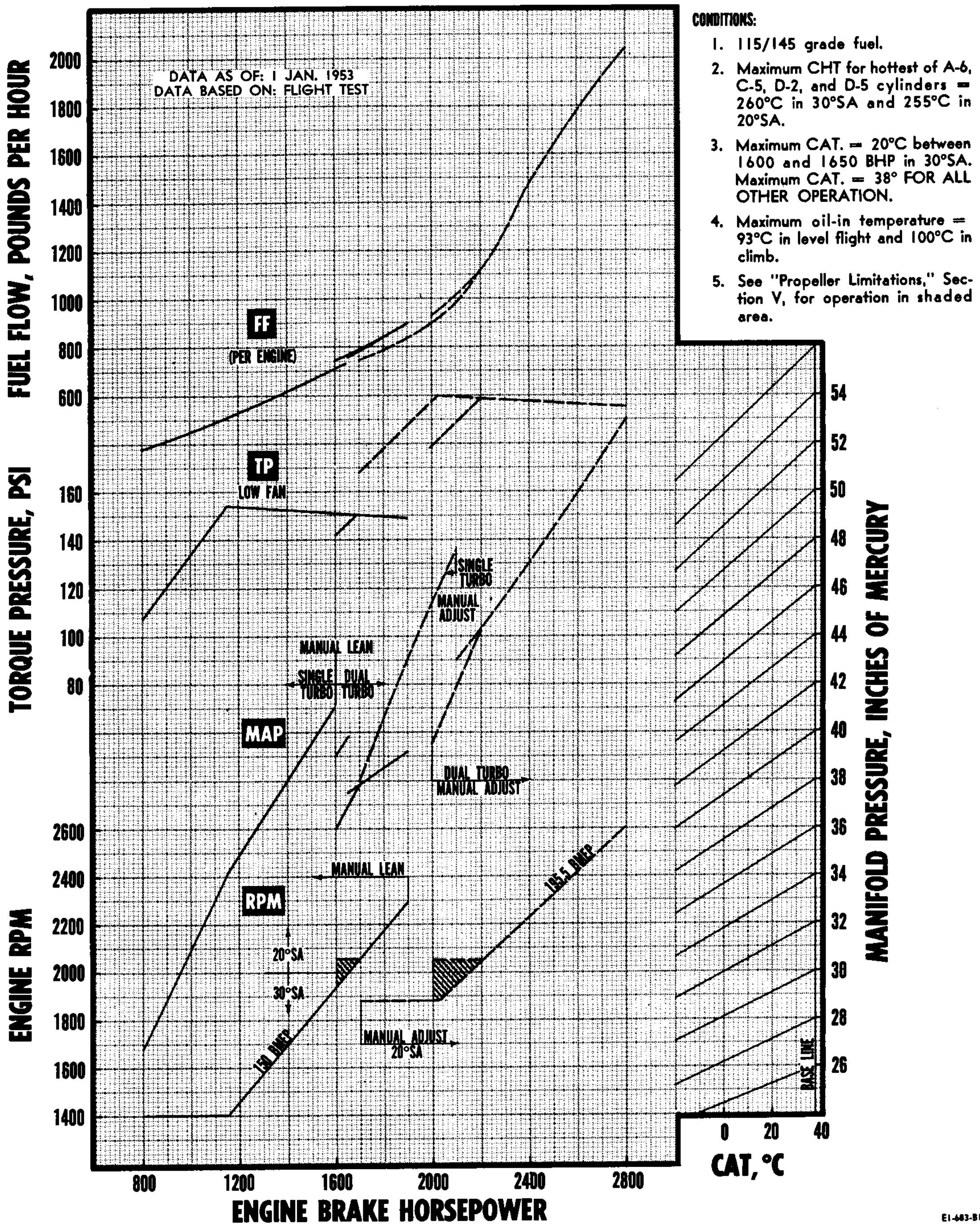


CONDITIONS:

1. 115/145 grade fuel.
2. Maximum CHT for hottest of A-6, C-5, D-2, and D-5 cylinders = 260°C in 30°SA and 255°C in 20°SA.
3. Maximum CAT. = 20°C between 1600 and 1650 BHP in 30°SA. Maximum CAT. = 38° FOR ALL OTHER OPERATION.
4. Maximum oil-in temperature = 93°C in level flight and 100°C in climb.
5. See "Propeller Limitations," Section V, for operation in shaded area.

Figure A-68.

R4360-53 ENGINE ALTERNATE POWER SCHEDULE AT 10,000 FEET

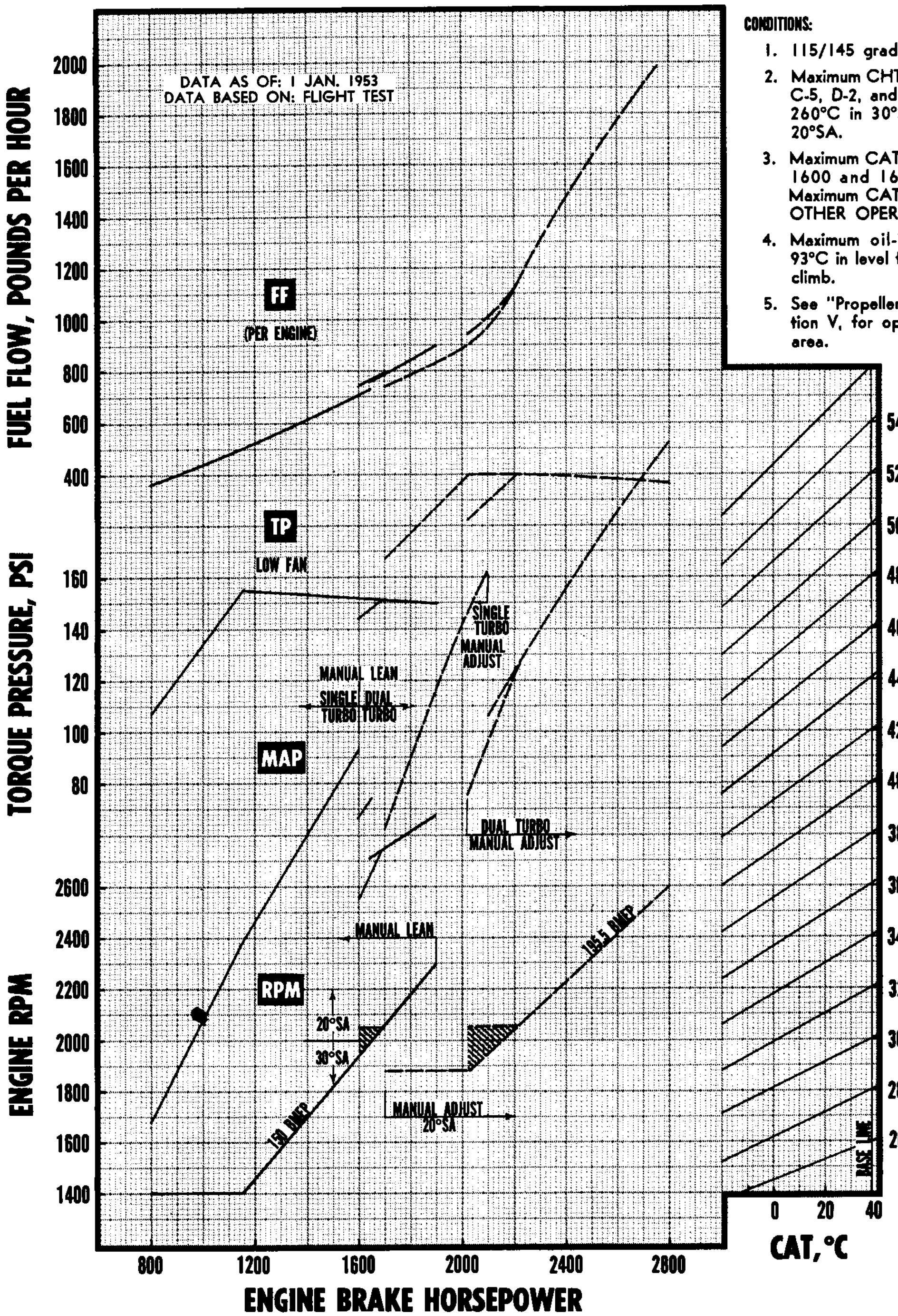


CONDITIONS:

1. 115/145 grade fuel.
2. Maximum CHT for hottest of A-6, C-5, D-2, and D-5 cylinders = 260°C in 30°SA and 255°C in 20°SA.
3. Maximum CAT. = 20°C between 1600 and 1650 BHP in 30°SA. Maximum CAT. = 38° FOR ALL OTHER OPERATION.
4. Maximum oil-in temperature = 93°C in level flight and 100°C in climb.
5. See "Propeller Limitations," Section V, for operation in shaded area.

Figure A-69.

R4360-53 ENGINE ALTERNATE POWER SCHEDULE AT 15,000 FEET



CONDITIONS:

1. 115/145 grade fuel.
2. Maximum CHT for hottest of A-6, C-5, D-2, and D-5 cylinders = 260°C in 30°SA and 255°C in 20°SA.
3. Maximum CAT. = 20°C between 1600 and 1650 BHP in 30°SA. Maximum CAT. = 38° FOR ALL OTHER OPERATION.
4. Maximum oil-in temperature = 93°C in level flight and 100°C in climb.
5. See "Propeller Limitations," Section V, for operation in shaded area.

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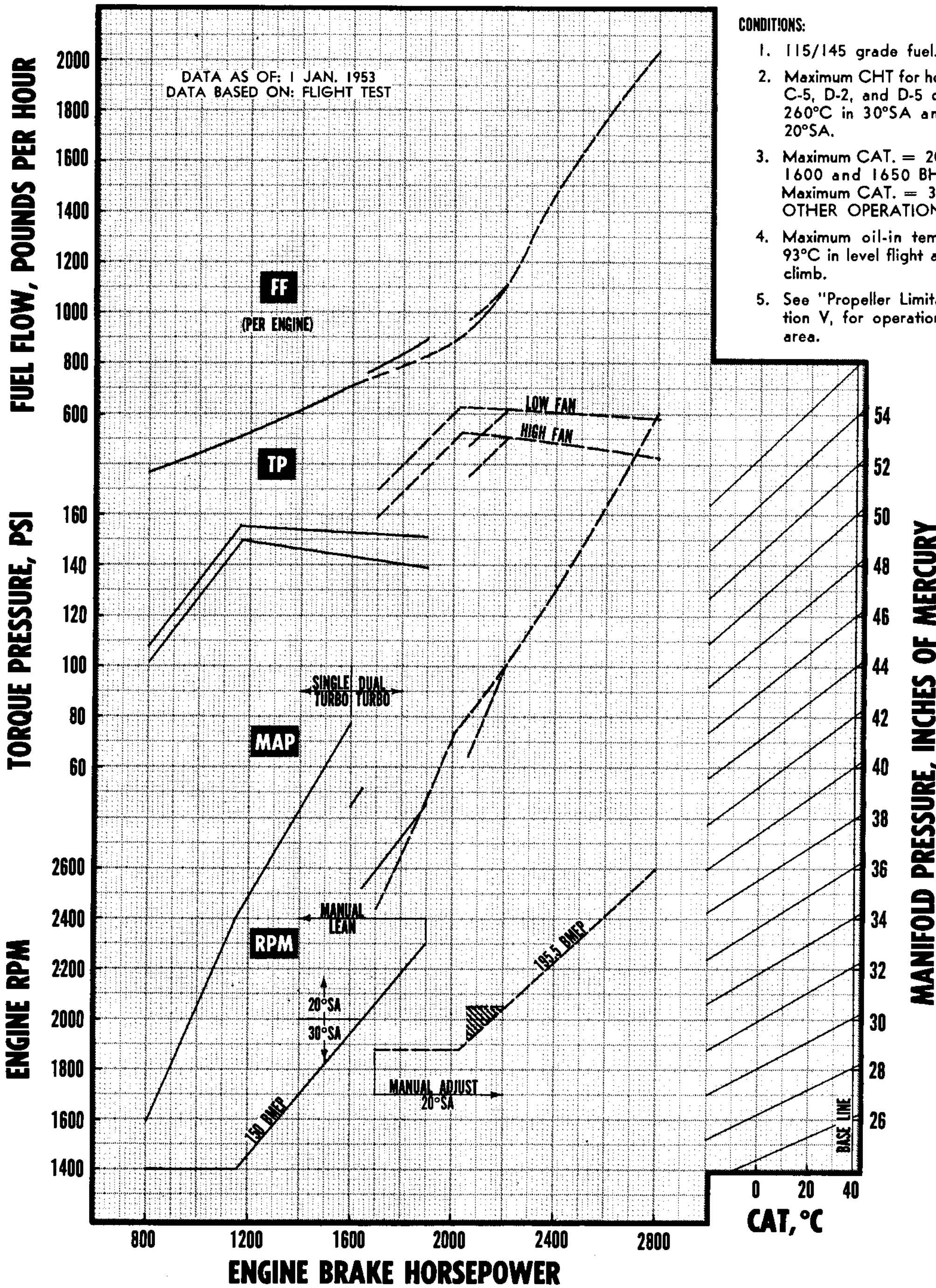
Figure A-70.

R4360-53 ENGINE ALTERNATE POWER SCHEDULE AT 20,000 FEET

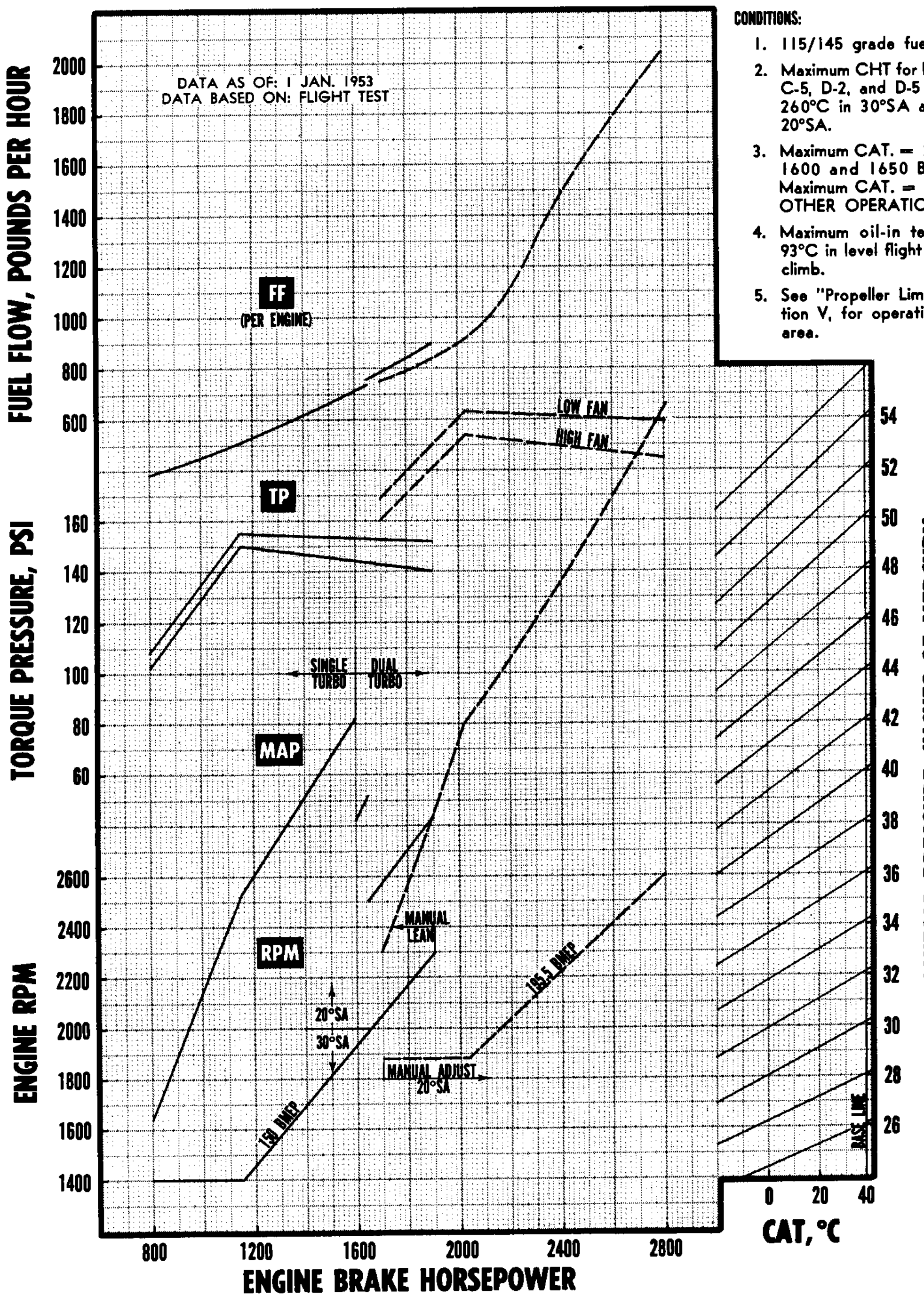


CONDITIONS:

1. 115/145 grade fuel.
2. Maximum CHT for hottest of A-6, C-5, D-2, and D-5 cylinders = 260°C in 30°SA and 255°C in 20°SA.
3. Maximum CAT. = 20°C between 1600 and 1650 BHP in 30°SA. Maximum CAT. = 38° FOR ALL OTHER OPERATION.
4. Maximum oil-in temperature = 93°C in level flight and 100°C in climb.
5. See "Propeller Limitations," Section V, for operation in shaded area.

Figure A-71.

R4360-53 ENGINE ALTERNATE POWER SCHEDULE AT 25,000 FEET



CONDITIONS:

1. 115/145 grade fuel.
2. Maximum CHT for hottest of A-6, C-5, D-2, and D-5 cylinders = 260°C in 30°SA and 255°C in 20°SA.
3. Maximum CAT. = 20°C between 1600 and 1650 BHP in 30°SA. Maximum CAT. = 38° FOR ALL OTHER OPERATION.
4. Maximum oil-in temperature = 93°C in level flight and 100°C in climb.
5. See "Propeller Limitations," Section V, for operation in shaded area.

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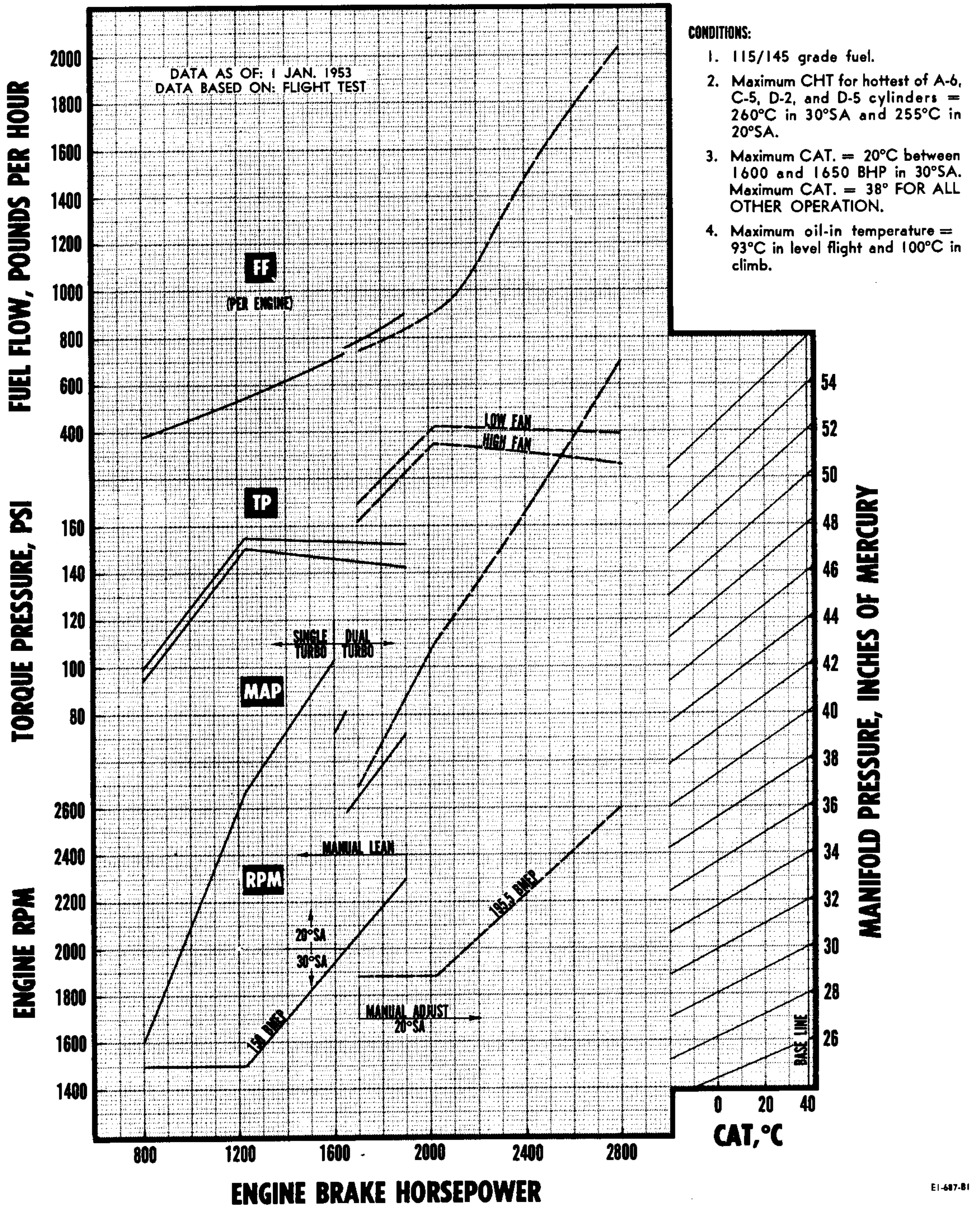
Figure A-72.

R4360-53 ENGINE ALTERNATE POWER SCHEDULE AT 30,000 FEET

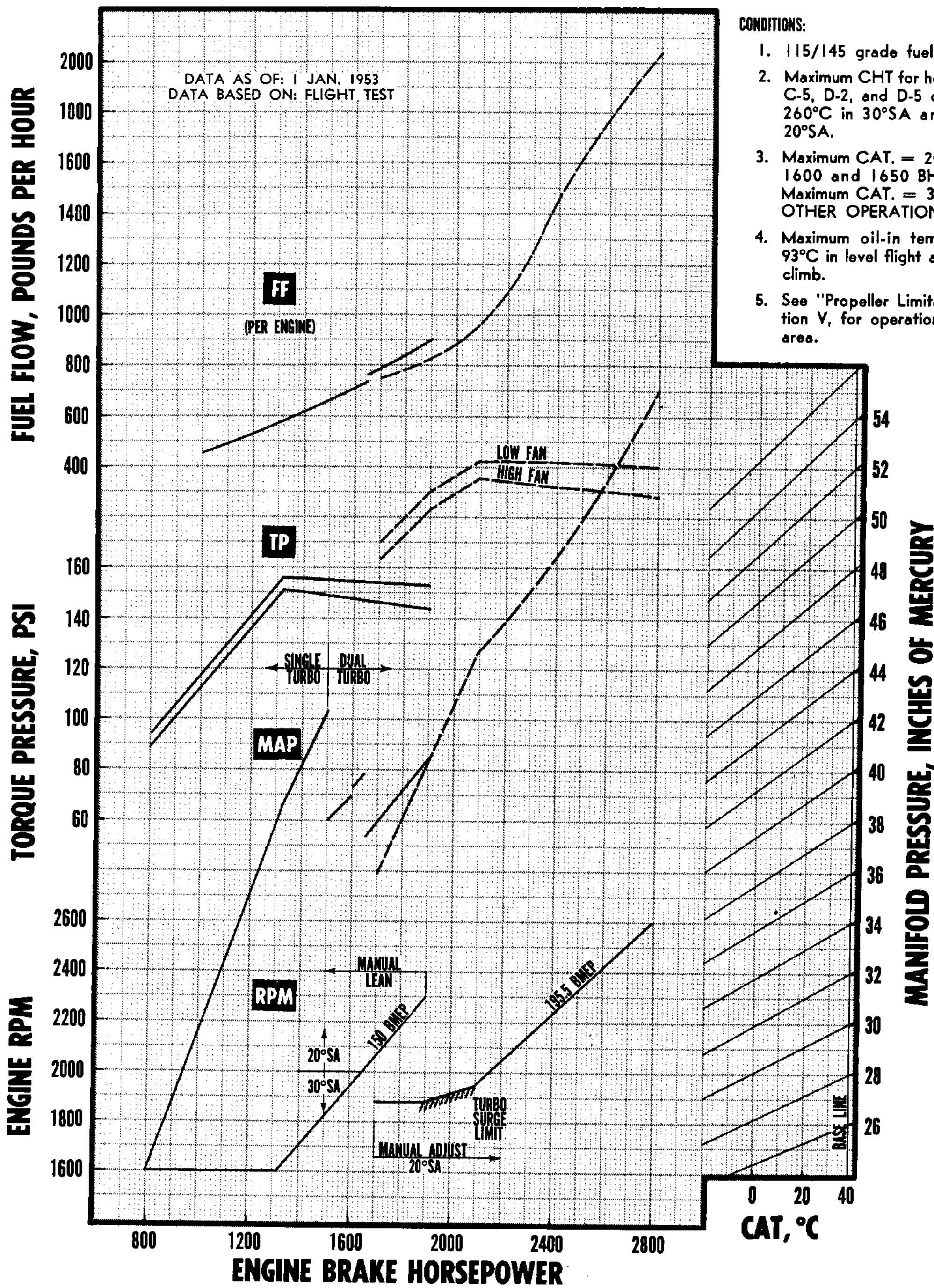


CONDITIONS:

1. 115/145 grade fuel.
2. Maximum CHT for hottest of A-6, C-5, D-2, and D-5 cylinders = 260°C in 30°SA and 255°C in 20°SA.
3. Maximum CAT. = 20°C between 1600 and 1650 BHP in 30°SA. Maximum CAT. = 38° FOR ALL OTHER OPERATION.
4. Maximum oil-in temperature = 93°C in level flight and 100°C in climb.

Figure A-73.

R4360-53 ENGINE ALTERNATE POWER SCHEDULE AT 35,000 FEET



CONDITIONS:

1. 115/145 grade fuel.
2. Maximum CHT for hottest of A-6, C-5, D-2, and D-5 cylinders = 260°C in 30°SA and 255°C in 20°SA.
3. Maximum CAT. = 20°C between 1600 and 1650 BHP in 30°SA. Maximum CAT. = 38° FOR ALL OTHER OPERATION.
4. Maximum oil-in temperature = 93°C in level flight and 100°C in climb.
5. See "Propeller Limitations," Section V, for operation in shaded area.

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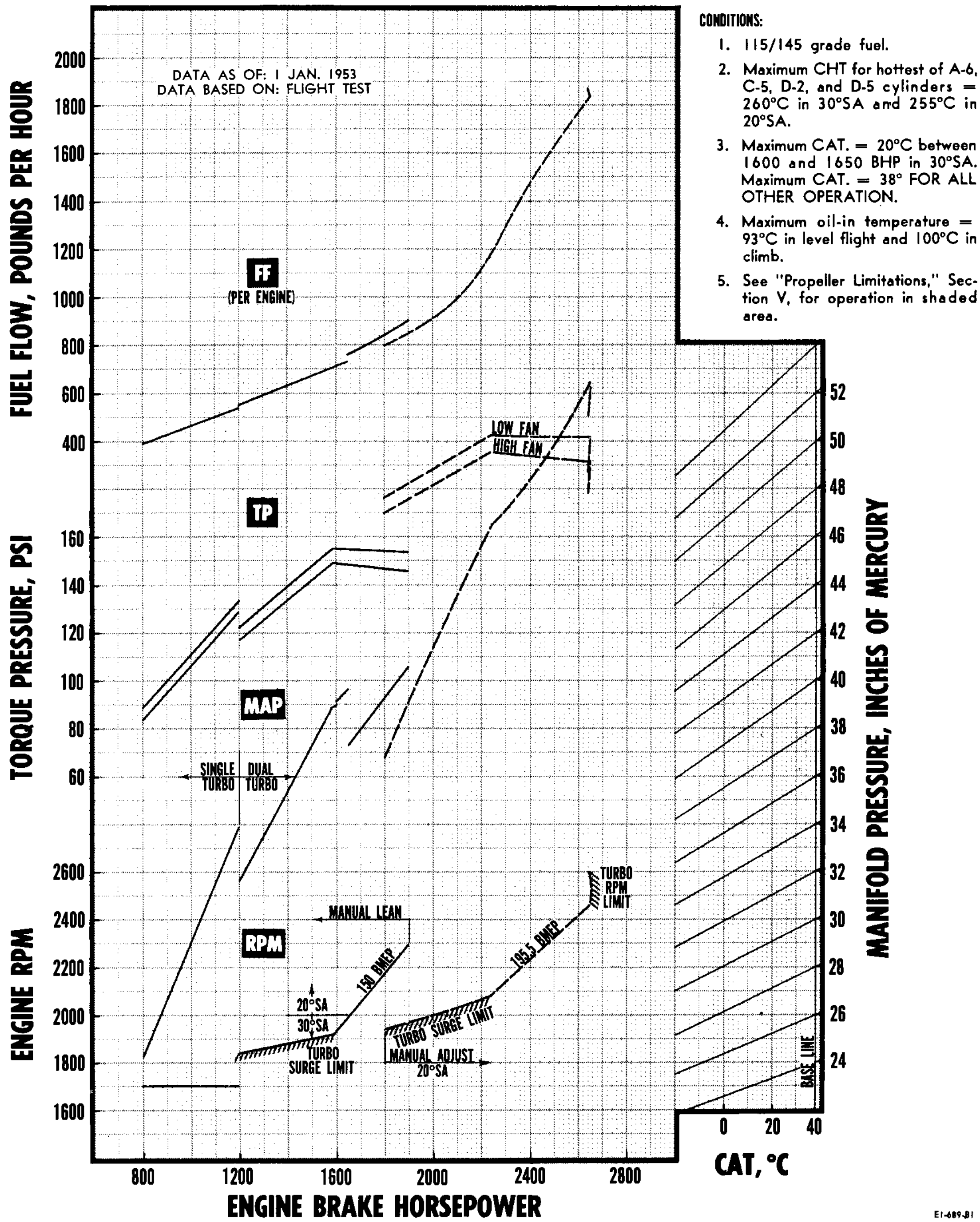
Figure A-74.

R4360-53 ENGINE ALTERNATE POWER SCHEDULE AT 40,000 FEET



CONDITIONS:

1. 115/145 grade fuel.
2. Maximum CHT for hottest of A-6, C-5, D-2, and D-5 cylinders = 260°C in 30°SA and 255°C in 20°SA.
3. Maximum CAT. = 20°C between 1600 and 1650 BHP in 30°SA. Maximum CAT. = 38° FOR ALL OTHER OPERATION.
4. Maximum oil-in temperature = 93°C in level flight and 100°C in climb.
5. See "Propeller Limitations," Section V, for operation in shaded area.

E1-689-B1

Figure A-75.

FLIGHT OPERATION DATA.

TAKE-OFF DISTANCE.

Take-off distance requirements are presented in figures A-76 through A-89. This performance is based on the standard take-off flap configuration (20 degrees), with jets at 100 per cent rpm and reciprocating engine power set as shown in figure A-16.

These curves furnish ground run and total distance to clear a 50-foot obstacle for any gross weight and any atmospheric condition for the specified (operative) engine power configurations. (Charted performance compensates for changes in aerodynamic forces and power resulting from atmospheric variations.) The charted partial engines data is conservative unless inoperative engines are in the most asymmetric power configuration.

The take-off charts are based on optimum take-off per formance at the speeds noted, with climb out at 110 per cent stall speed. A five per cent increase in take-off (unstick) and climb-out speeds will result in a 10 per cent increase in ground run and a 15 per cent increase in total distance to clear a 50-foot obstacle.

EXAMPLE.

Determine ground run and total distance to clear a 50-foot obstacle for a high-performance ten-engine take-off under the following conditions:

330,400 pounds gross weight
4800 feet pressure altitude
25°C OAT.
20 mph headwind

Enter figure A-76 at a pressure altitude of 4800 feet and gross weight of 330,400 pounds (A). Proceed horizontally to the outside air temperature base line (B). Follow the guide lines to a temperature of 25°C (C), and then move horizontally to the base line of the headwind velocity curves (D). Follow the guide lines to a headwind of 20 mph (E) and read a total distance to clear 50 feet of 4450 feet.

Enter figure A-77 and follow the same procedure to determine a ground run distance of 3450 feet.

TAKE-OFF DISTANCE TO CLEAR 50 FT. OBSTACLE

115/145 GRADE FUEL

6 R4360-53 + 4 J47-GE-19 ENGINES AT TAKE-OFF POWER (WET)

NOTES:
1. Level concrete runway.
2. Flaps 20°.
3. Airplugs and intercoolers full open.

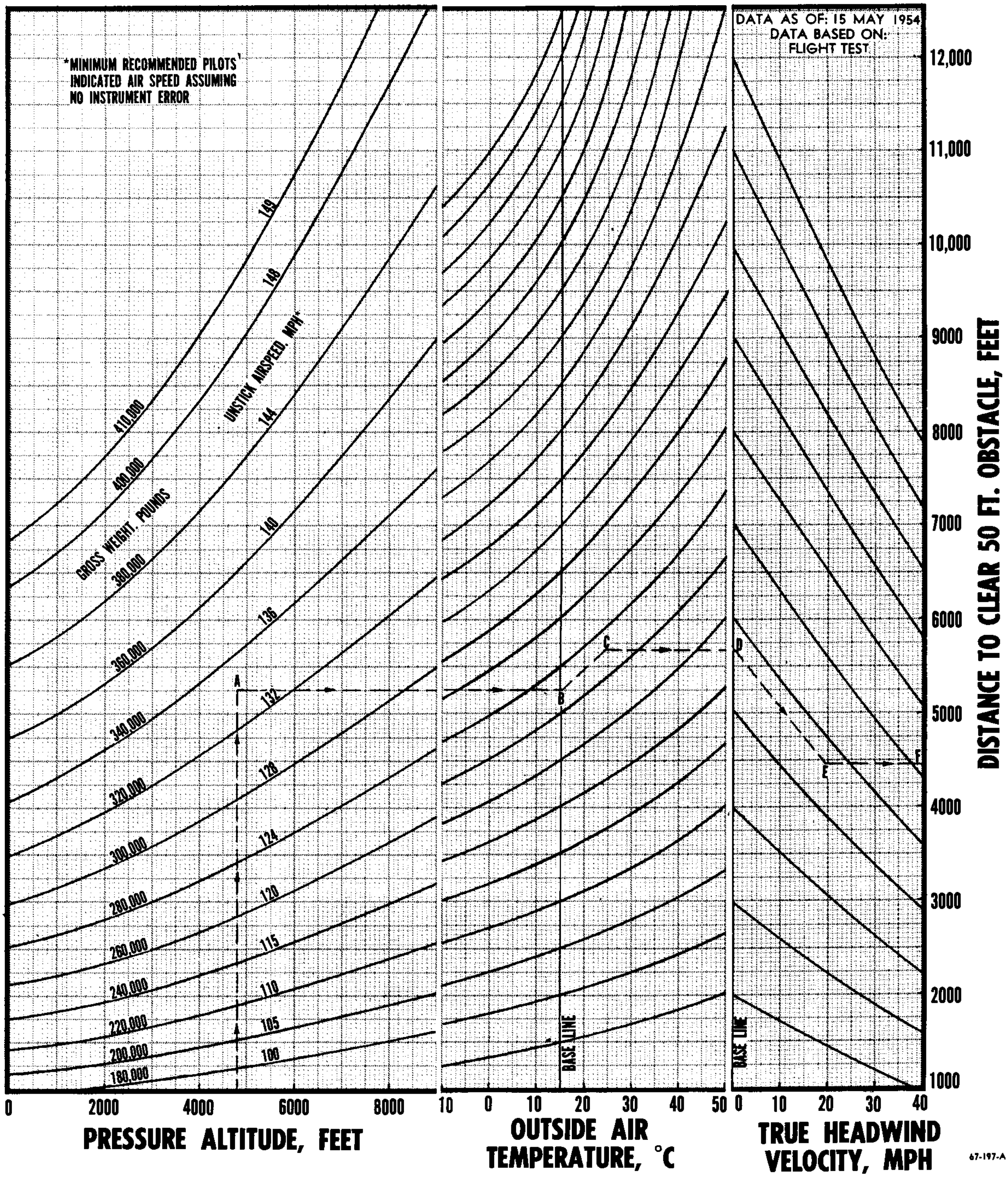


Figure A-76.

TAKE-OFF GROUND RUN

115/145 GRADE FUEL

6 R4360-53 + 4 J47-GE-19 ENGINES AT TAKE-OFF POWER (WET)

NOTES: 1. Level concrete runway.
2. Flaps 20°.
3. Airplugs and intercoolers full open.

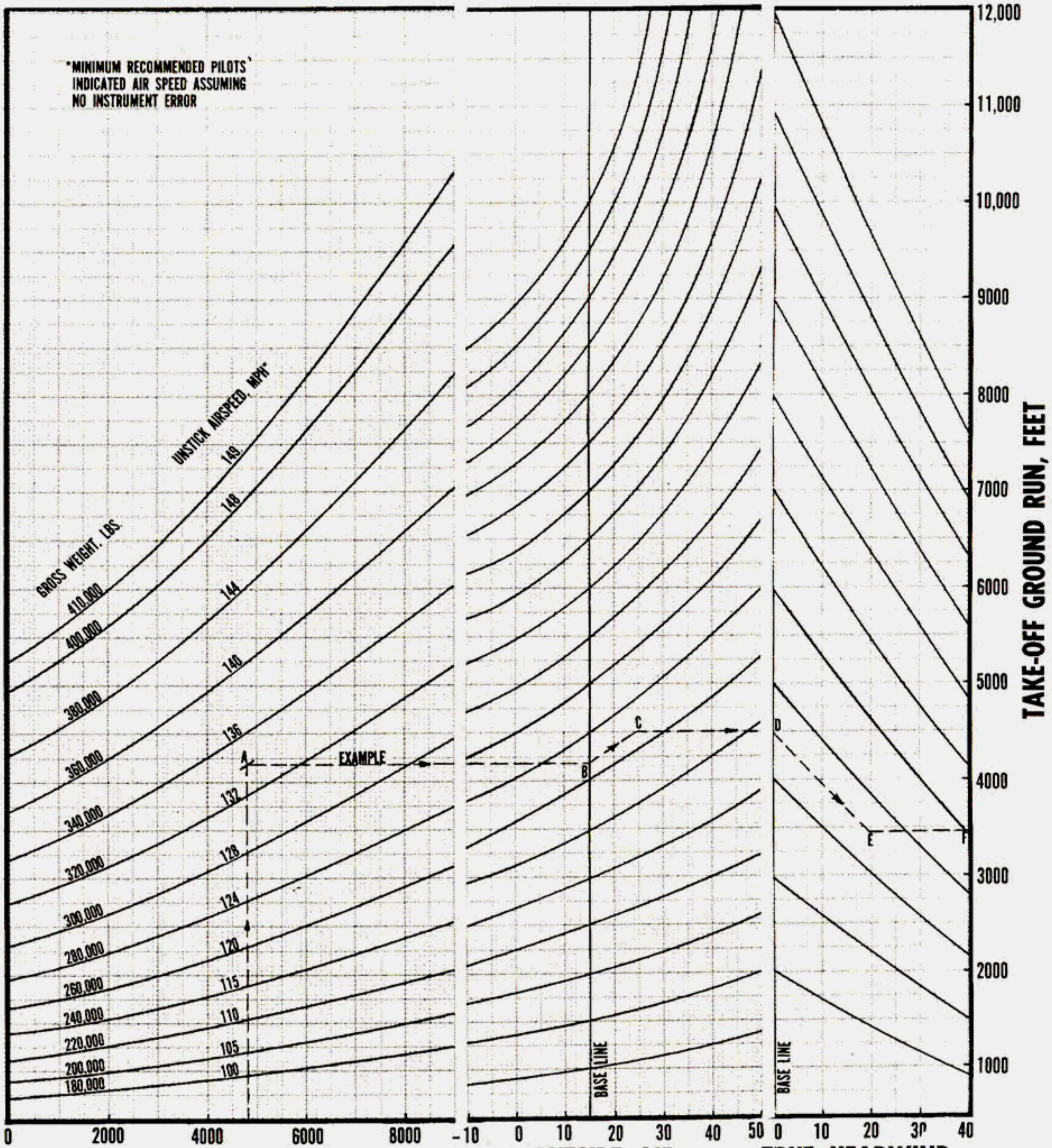


Figure A-77.

TAKE-OFF DISTANCE TO CLEAR 50 FT. OBSTACLE

115/145 GRADE FUEL

6 R4360-53+2 J47-GE-19 ENGINES AT TAKE-OFF POWER (WET)

NOTES:
1. Inoperative engines in most asymmetric condition.
2. Level concrete runway.
3. Flaps 20°
4. Airplugs and intercoolers full open.

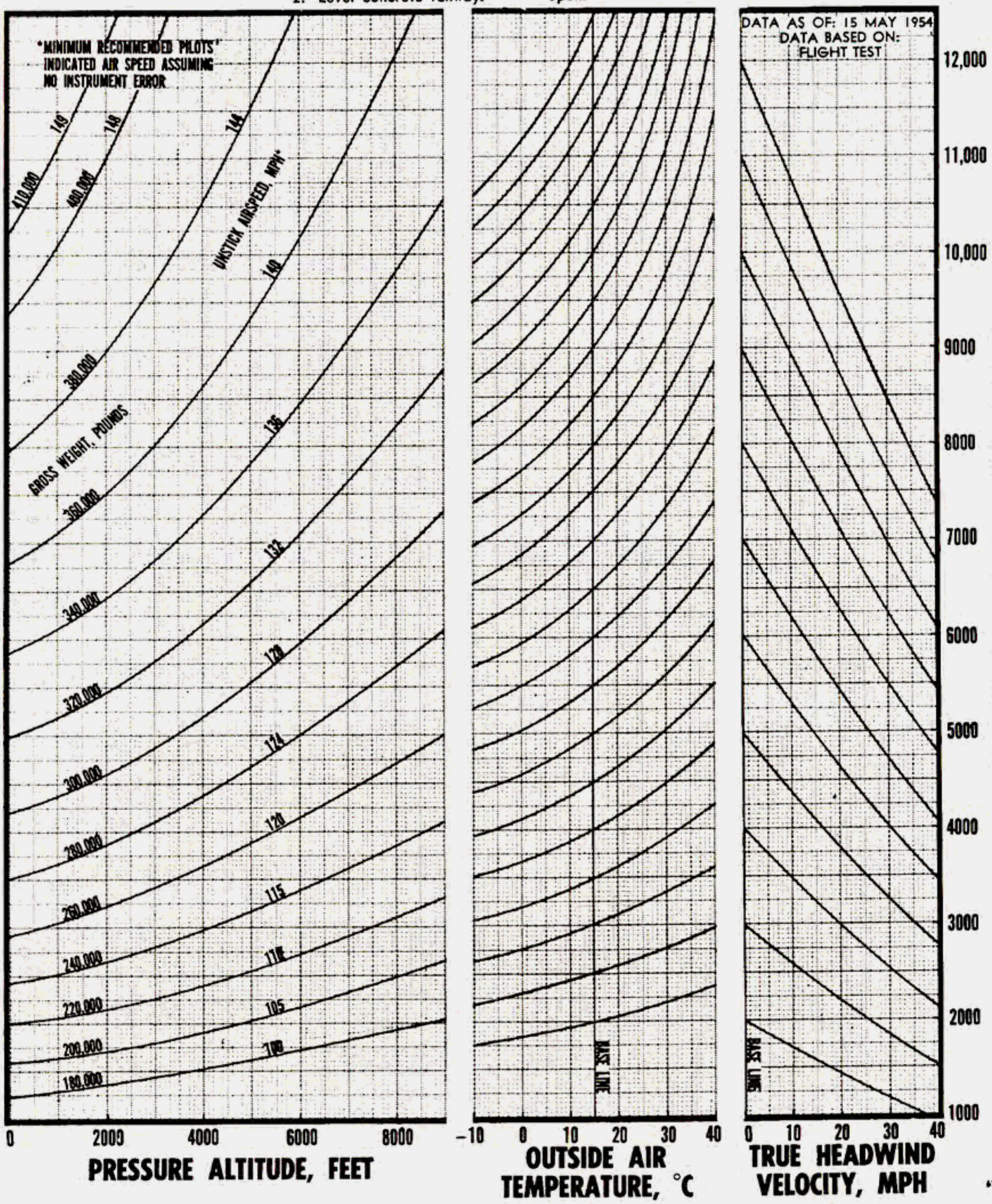


Figure A-78.

TAKE-OFF GROUND RUN

115/145 GRADE FUEL

6 R4360-53 + 2 J47-GE-19 ENGINES AT TAKE-OFF POWER (WET)

NOTES:
1. Inoperative engines in most asymmetric condition.
2. Level concrete runway.
3. Flaps 20°.
4. Airplugs and intercoolers full open.

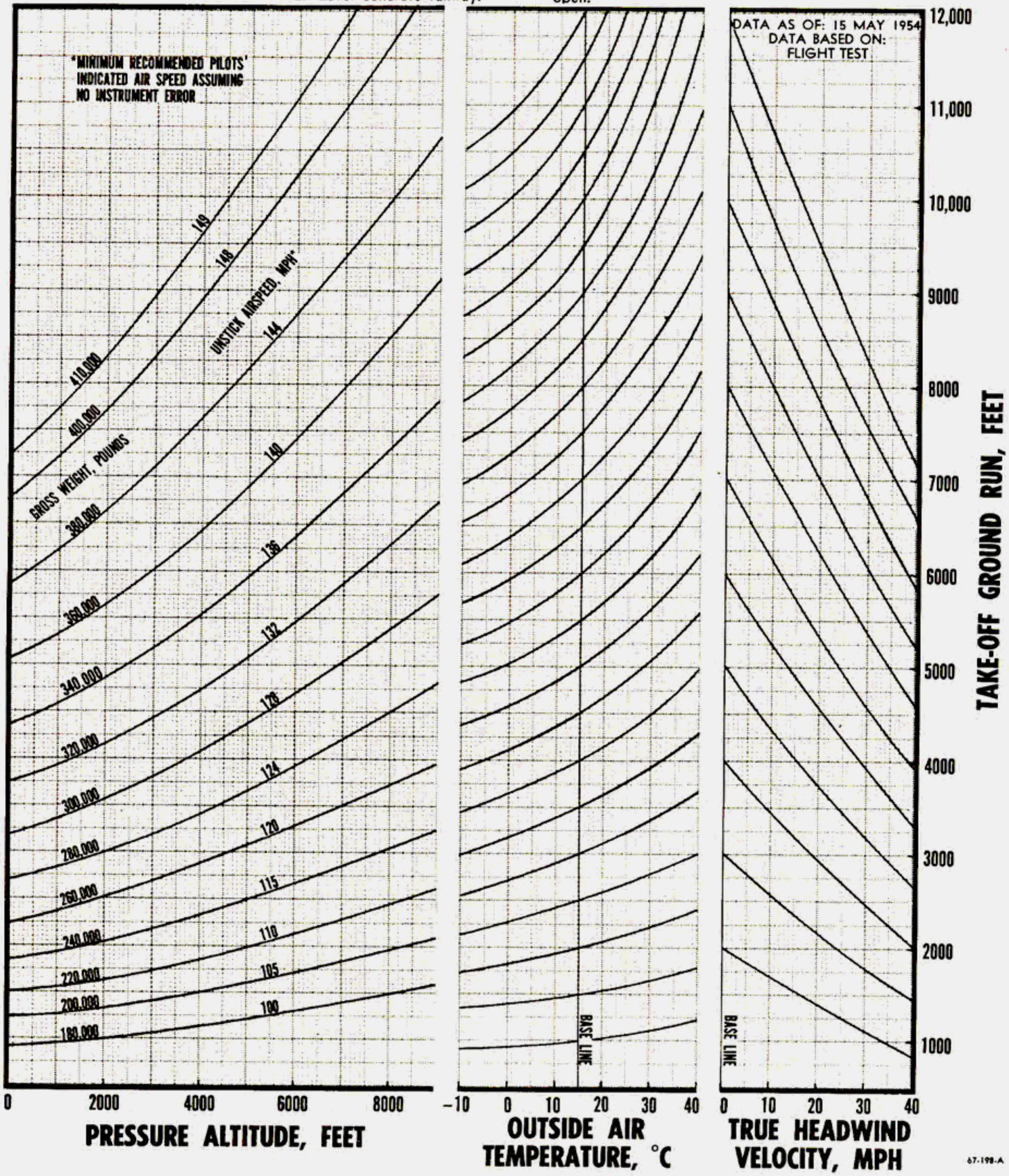


Figure A-79.

TAKE-OFF DISTANCE TO CLEAR 50 FT. OBSTACLE

115/145 GRADE FUEL

6 R4360-53 ENGINES AT TAKE-OFF POWER (WET)

NOTES: 1. Level concrete runway.
2. Flaps 20°.
3. Airplugs and intercoolers full open.

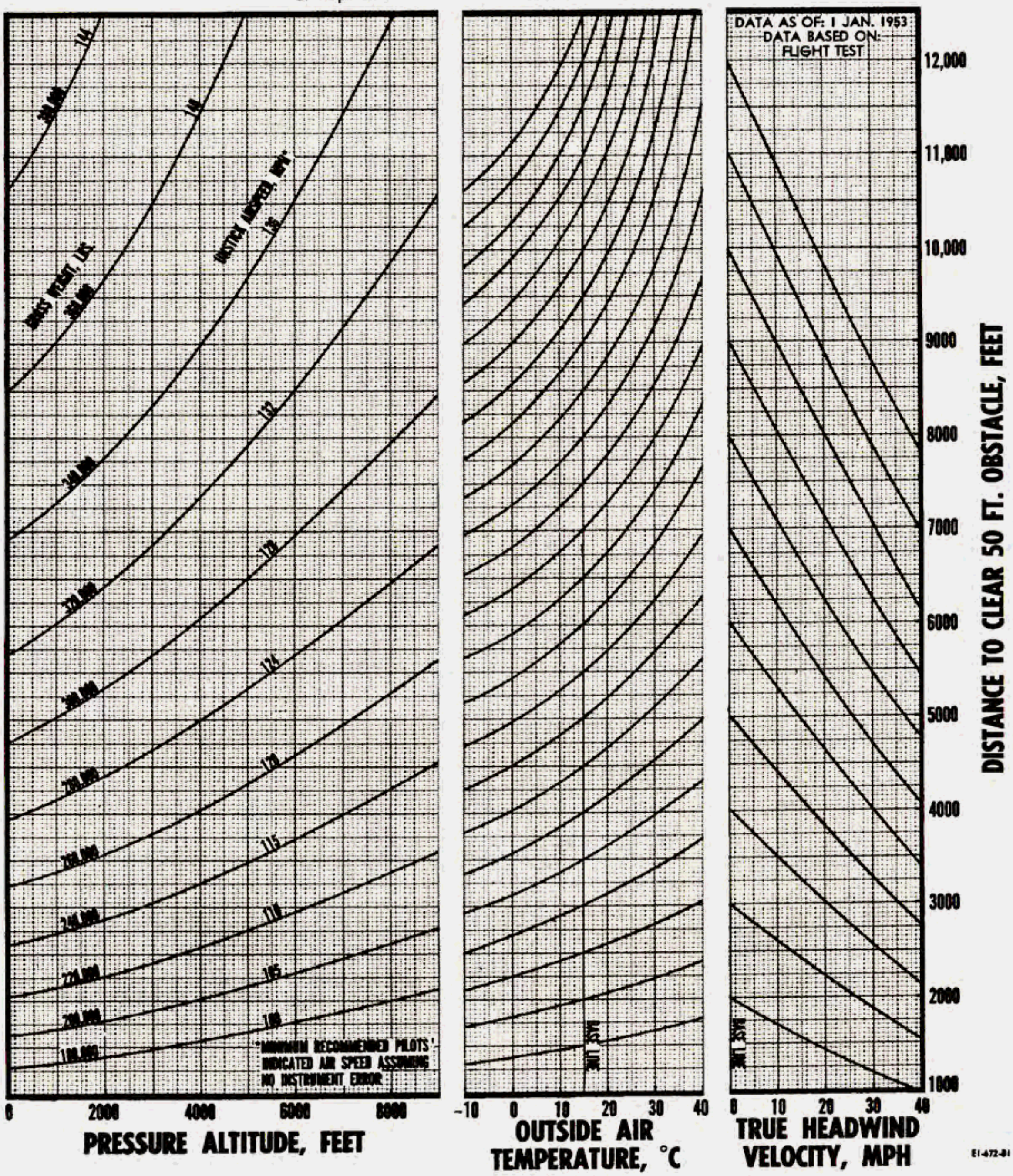


Figure A-80.

TAKE-OFF GROUND RUN

115/145 GRADE FUEL

6 R4360-53 ENGINES AT TAKE-OFF POWER (WET)

NOTES: 1. Level concrete runway.
2. Flaps 20°
3. Airplugs and intercoolers full open.

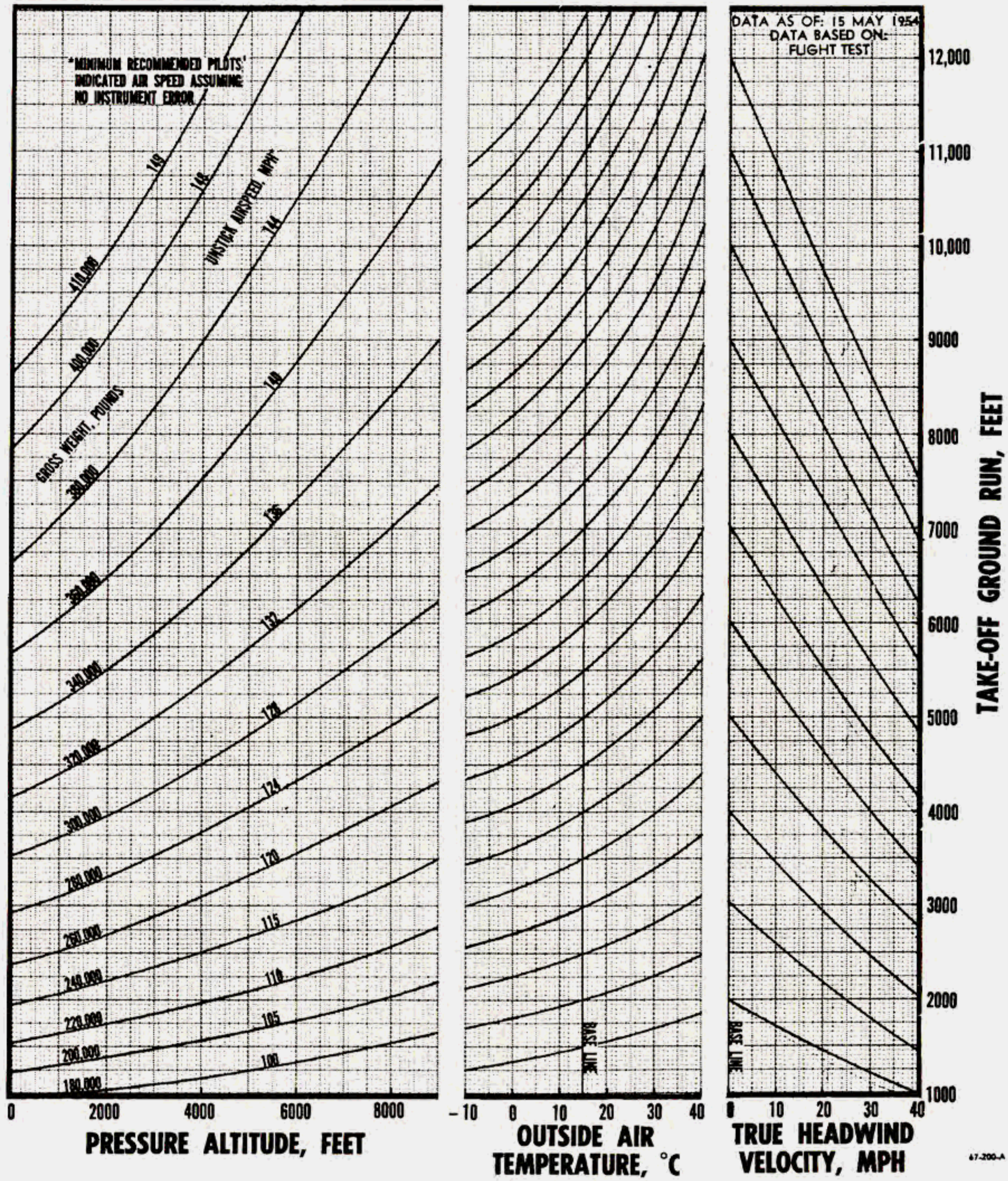


Figure A-81.

TAKE-OFF DISTANCE TO CLEAR 50 FT. OBSTACLE

115/145 GRADE FUEL

5 R4360-53 + 4 J47-GE-19 ENGINES AT TAKE-OFF POWER (WET)

NOTES:
1. Inoperative engine in most asymmetric condition.
2. Level concrete runway.
3. Flaps 20°.
4. Airplugs and intercoolers full open.

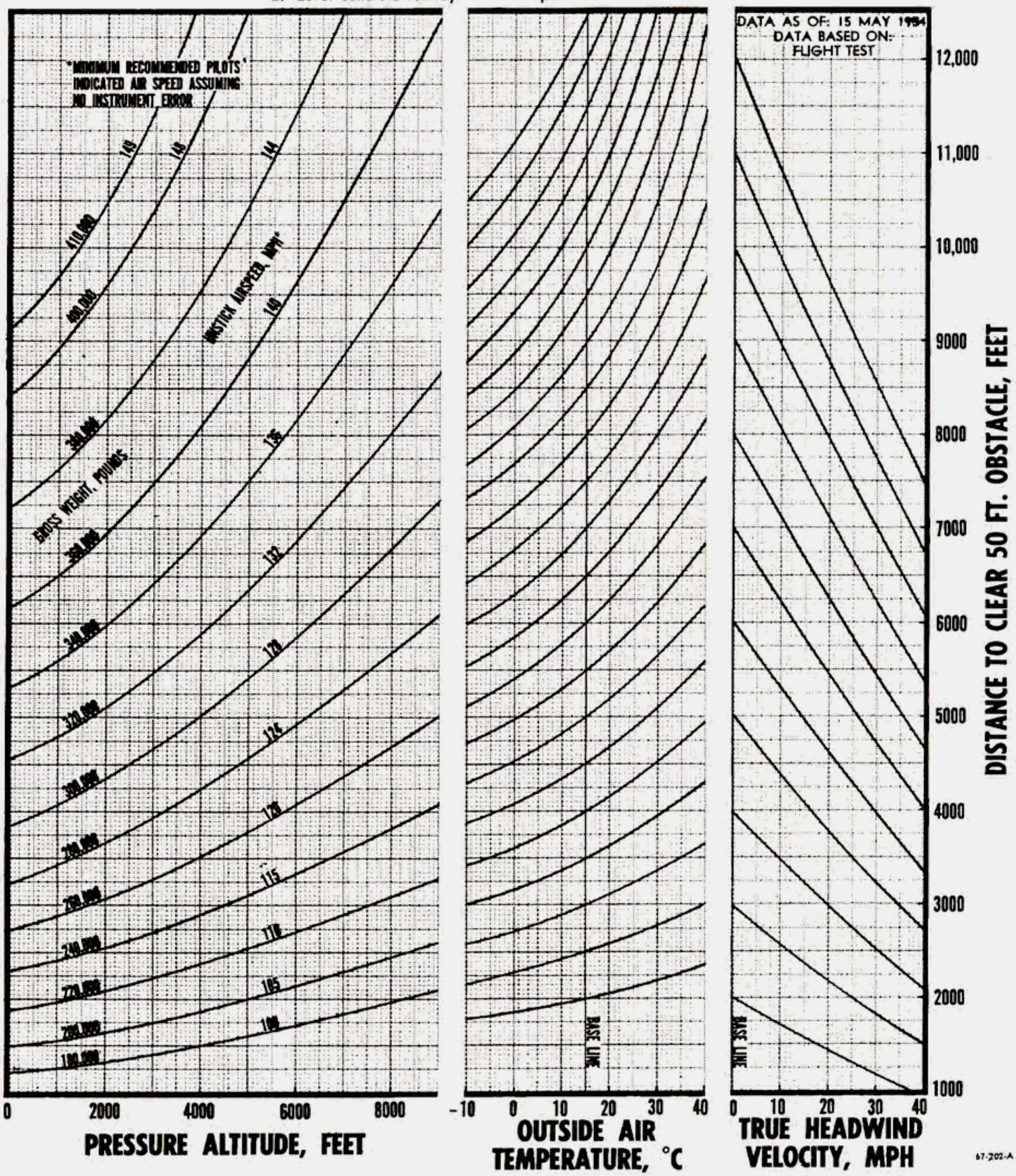


Figure A-82.

TAKE-OFF GROUND RUN

115/145 GRADE FUEL

5 R4360-53 + 4 J47-GE-19 ENGINES AT TAKE-OFF POWER (WET)

NOTES:
1. Inoperative engines in most asymmetric condition.
2. Level concrete runway.
3. Flaps 20°
4. Airplugs and intercoolers full open.

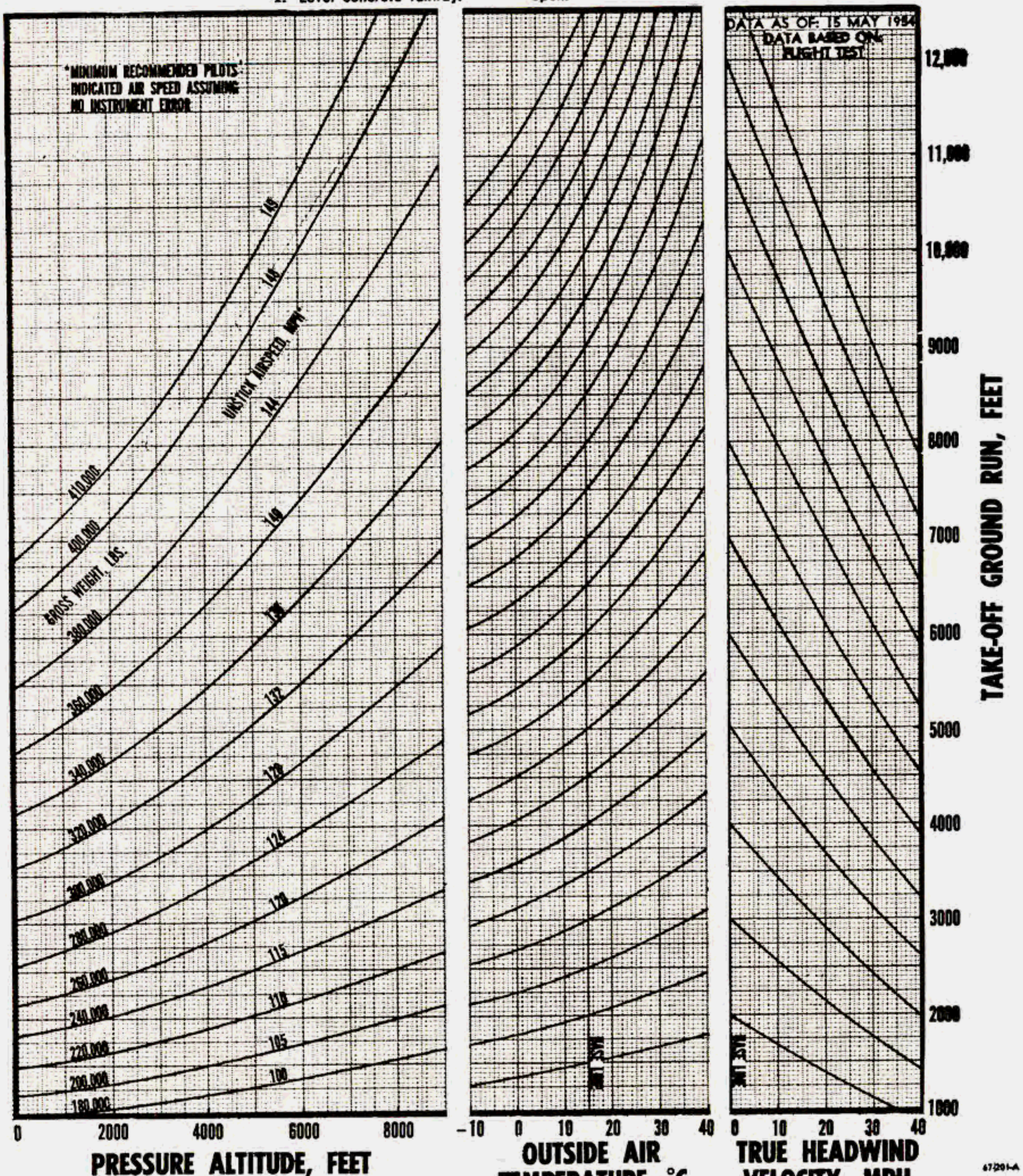


Figure A-83.

TAKE-OFF DISTANCE TO CLEAR 50 FT. OBSTACLE

115/145 GRADE FUEL

5 R4360-53 + 2 J47-GE-19 ENGINES AT TAKE-OFF POWER (WET)

NOTES: 1. Inoperative engines in most asymmetric condition.
2. Level concrete runway.
3. Flaps 20°.
4. Airplugs and intercoolers full open.

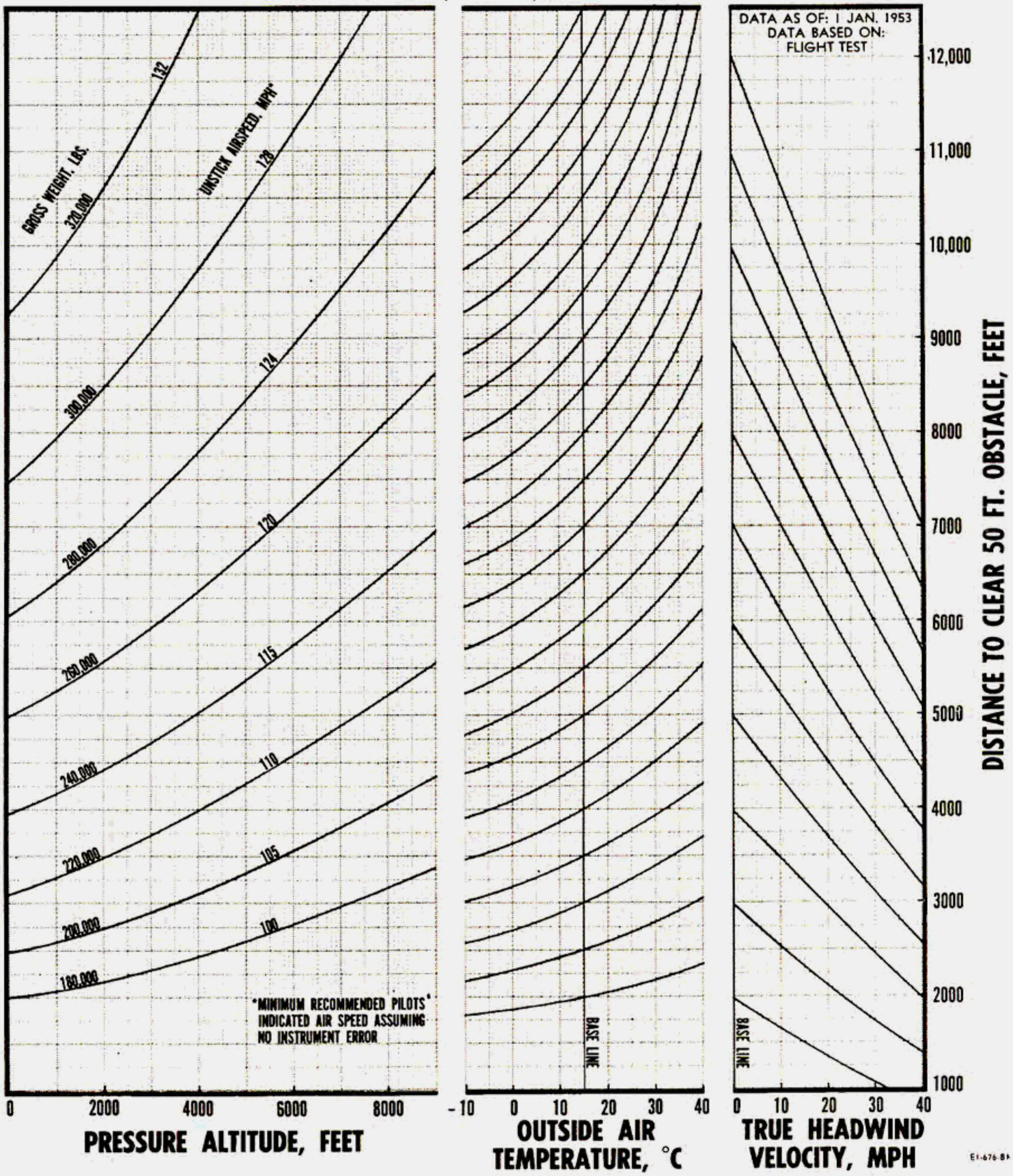


Figure A-84.

TAKE-OFF GROUND RUN

115/145 GRADE FUEL

5 R4360-53 + 2 J47-GE-19 ENGINES AT TAKE-OFF POWER (WET)

NOTES:
1. Inoperative engines in most asymmetric condition.
2. Level concrete runway.
3. Flaps 20°.
4. Airplugs and intercoolers full open.

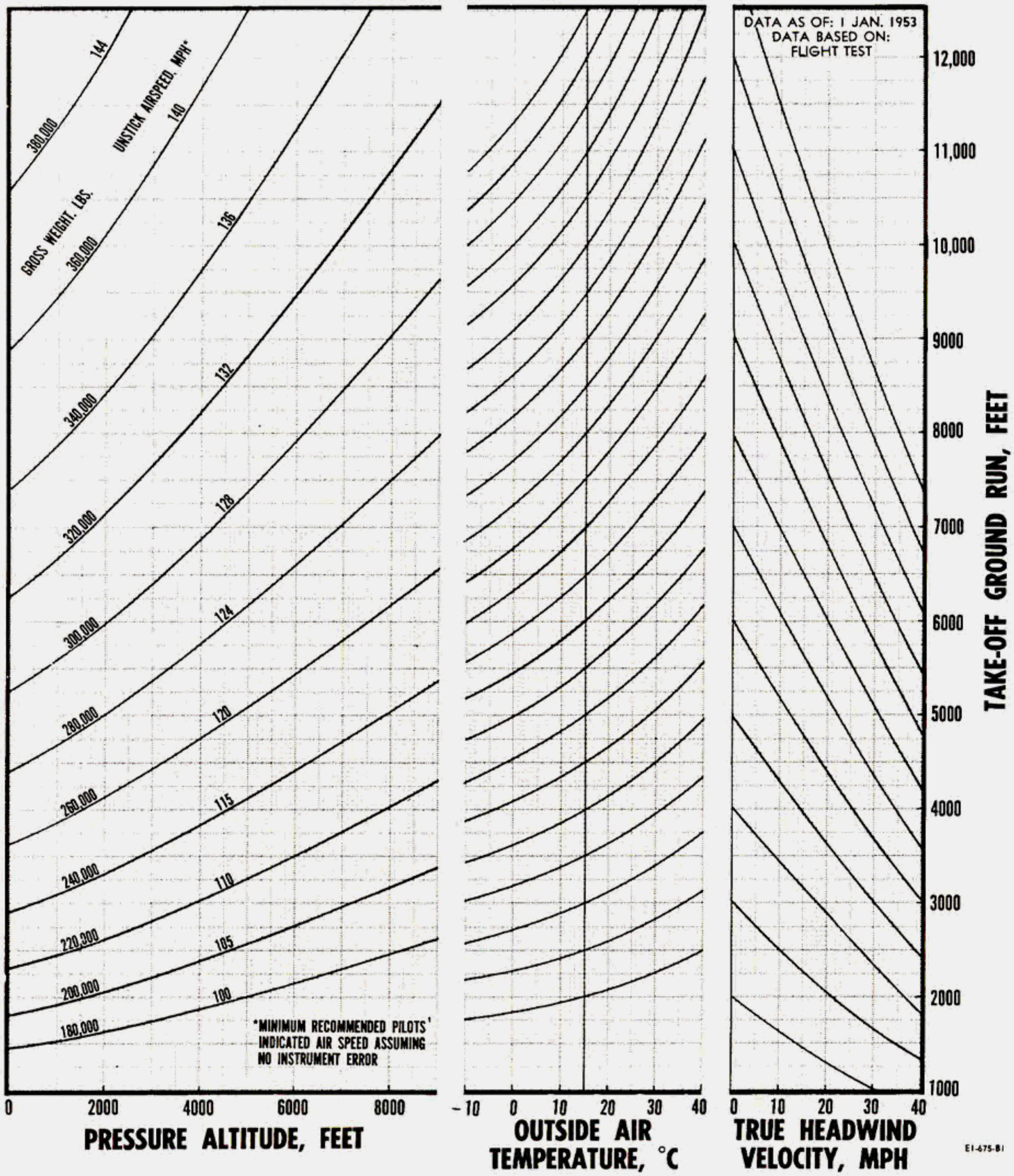


Figure A-85.

TAKE-OFF DISTANCE TO CLEAR 50 FT. OBSTACLE

115/145 GRADE FUEL

5 R4360-53 ENGINES AT TAKE-OFF POWER (WET)

NOTES:
1. Inoperative engines in most asymmetric condition.
2. Level concrete runway.
3. Flaps 20°.
4. Airplugs and intercoolers full open.

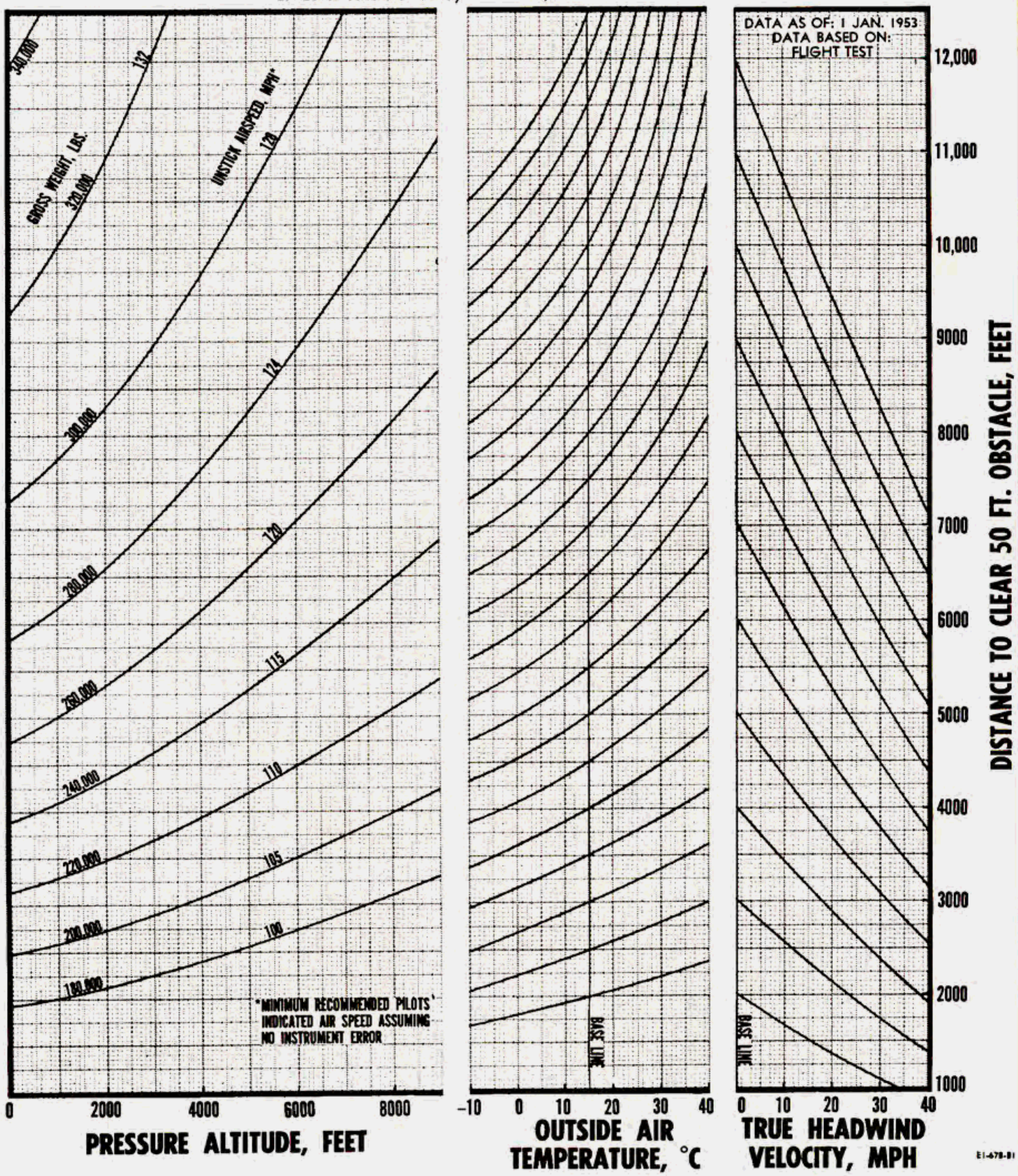


Figure A-86.

TAKE-OFF GROUND RUN

115/145 GRADE FUEL

5 R4360-53 ENGINES AT TAKE-OFF POWER (WET)

NOTES:
1. Inoperative engine in most asymmetric condition.
2. Level concrete runway.
3. Flaps 20°
4. Airplugs and intercoolers full open.

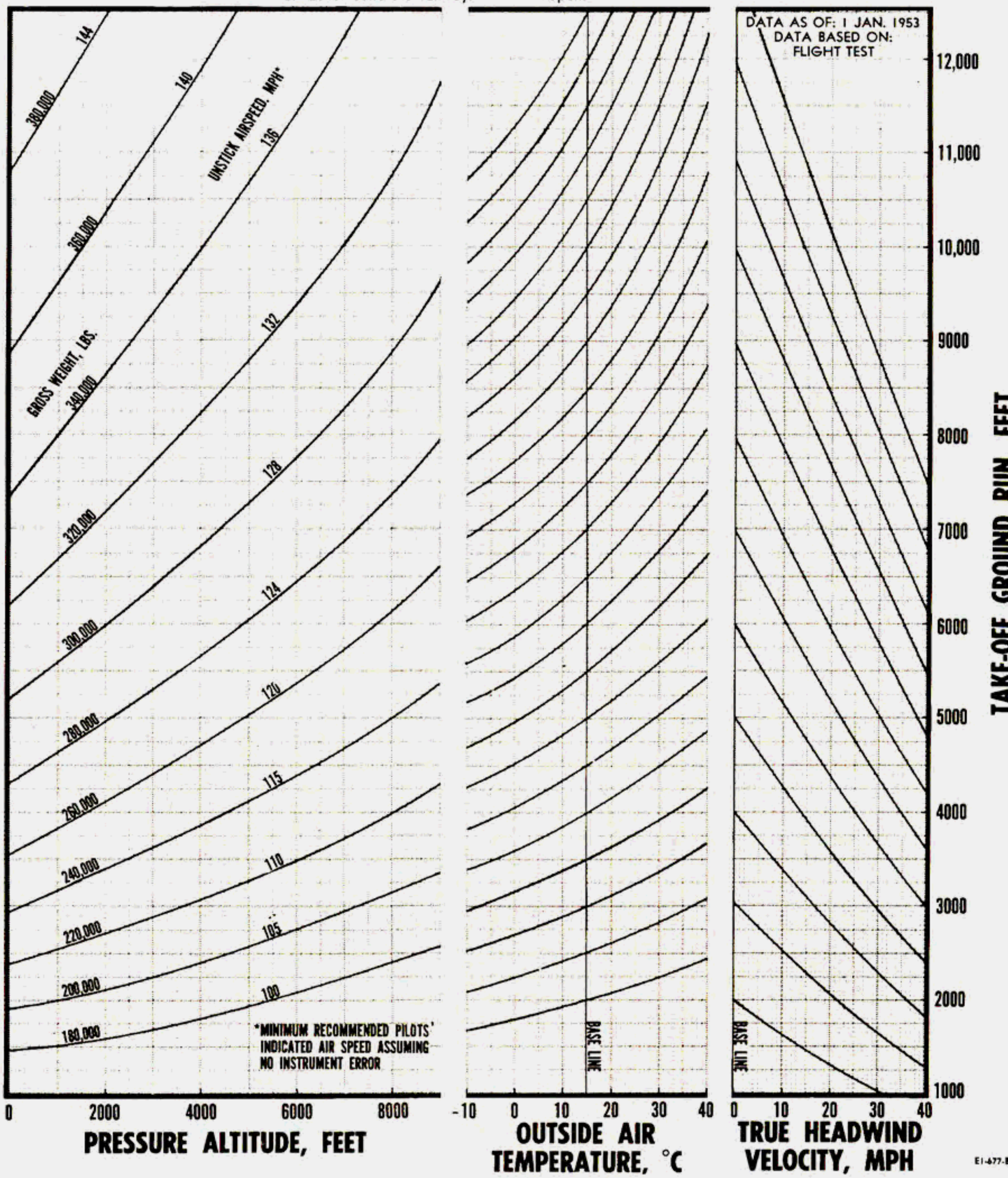


Figure A-87.

TAKE-OFF DISTANCE TO CLEAR 50 FT. OBSTACLE

115/145 GRADE FUEL

4 R4360-53 + 4 J47-GE-19 ENGINES AT TAKE-OFF POWER (WET)

NOTES:
1. Inoperative engines in most asymmetric condition.
2. Level concrete runway.
3. Flaps 20°
4. Airplugs and intercoolers full open.

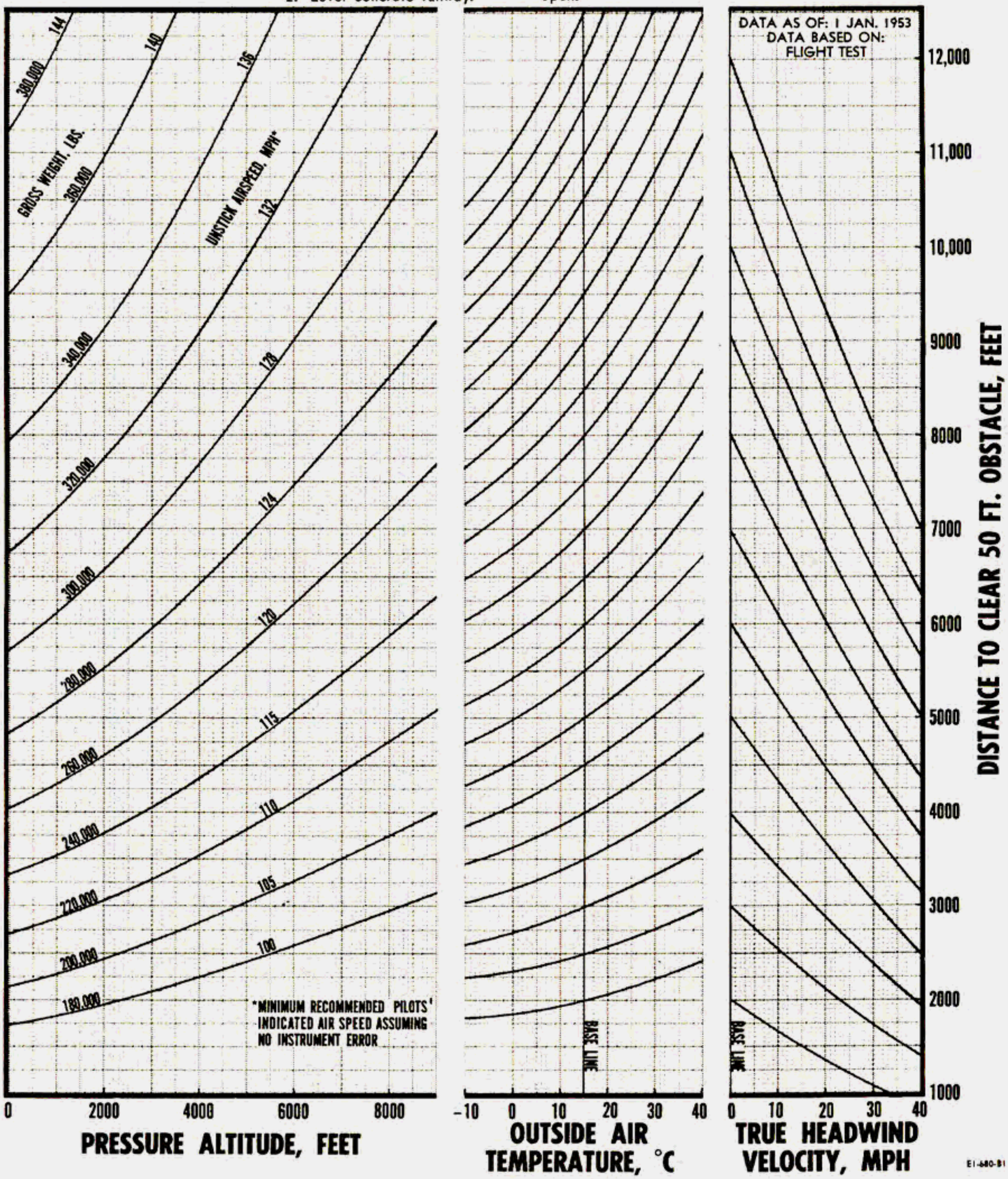


Figure A-88.

TAKE-OFF GROUND RUN

115/145 GRADE FUEL

4 R4360-53 + 4 J47-GE-19 ENGINES AT TAKE-OFF POWER (WET)

NOTES: 1. Inoperative engines in most asymmetric condition.
2. Level concrete runway.
3. Flaps 20°
4. Airplugs and intercoolers full open.

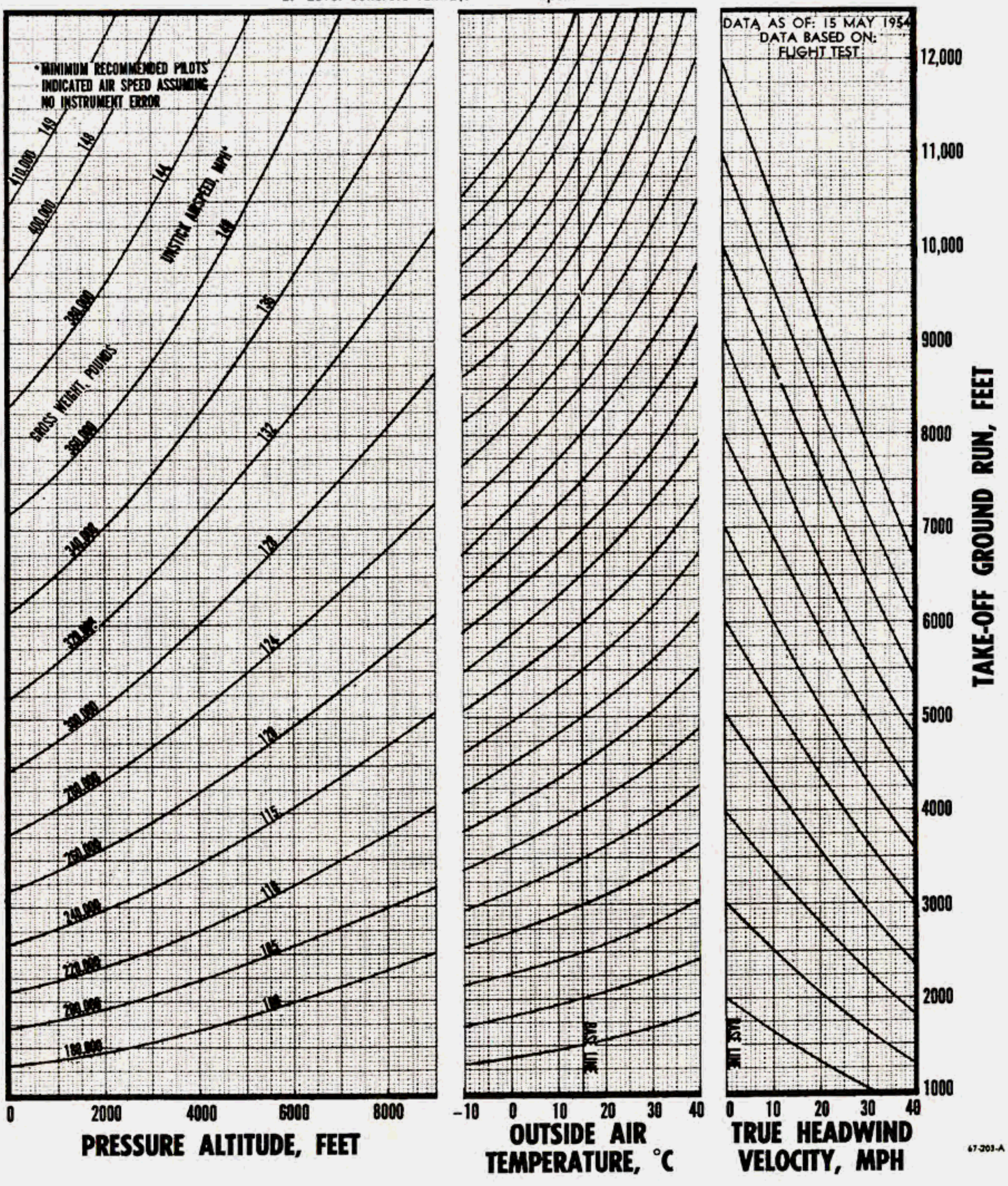


Figure A-89.

RUNWAY SLOPE CORRECTION

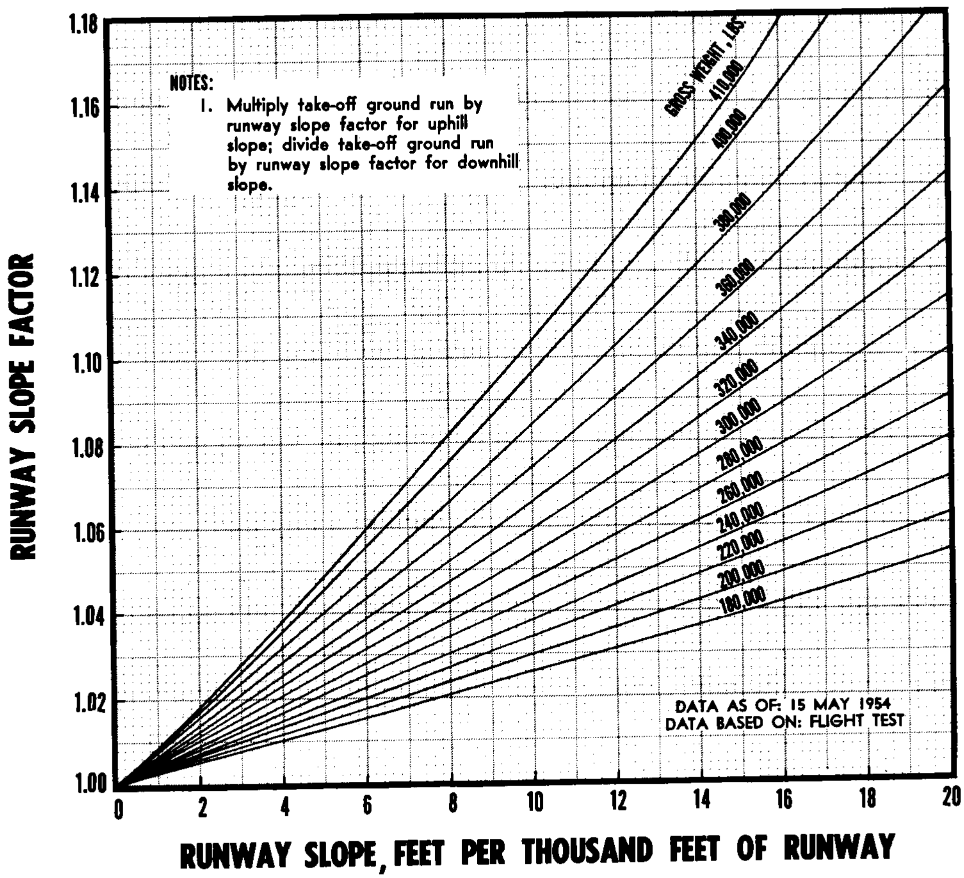


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Figure A-90.

TAKE-OFF CORRECTION FOR RUNWAY SLOPE.

Figure A-90 presents a factor for correcting take-off distance for runway slope. The corrected take-off distance is obtained by multiplying (or dividing if take-off is downhill) the level runway ground-run distance by the factor.

EXAMPLE.

Determine ten-engine take-off requirements for the following conditions:

350,000 pounds gross weight
3400 feet pressure altitude
10°C OAT.
20 mph true headwind velocity
5.2/1000 ft. runway slope—uphill in the direction of take-off

From figures A-76 and A-77 determine level runway take-off distances of 3240 and 4130 feet for ground run and total distance to clear a 50-foot obstacle, respectively.

Enter figure A-90 at a runway slope of 5.2. Move vertically to a gross weight of 350,000 pounds and read a runway slope factor of 1.035. The correct ground run distance is 1.035 x 3240 or 3350 feet and the corrected distance to clear 50 feet is 4130 + (3350-3240) or 4240 feet.

VELOCITY IN TAKE-OFF GROUND RUN.

Curves of velocity during take-off ground run are presented for the same engine operating configurations as shown for take-off. They enable the pilots to check ground run progress against known runway reference points and tell whether or not the airplane is accelerating properly.

EXAMPLE.

Find the expected EAS at the 3000-foot marker for a take-off under the following conditions:

357,500 pounds take-off gross weight
5500 feet pressure altitude
25°C OAT.
16 mph headwind velocity
6 R4360-53's + 4 J47-GE-19's operating at take-off power

Enter figure A-91 (for 10-engine take-off) at a pressure altitude of 5500 feet. Move horizontally to the right to a take-off weight of 357,500 pounds (A) (interpolated); then drop vertically to the OAT. base line (B). From this point parallel the OAT. guide lines to 25°C (C) before projecting vertically to the base line for ground run distance (D). Move parallel to the guide lines to a runway distance of 3000 feet (scale along bottom of page) (E); then move horizontally to the no-headwind line (F). From this point parallel the headwind guide lines to 16 mph (G), and read, on the scale to the left, an EAS of 114 mph (H), at the 3000-foot marker.

VELOCITY DURING TAKE-OFF GROUND RUN

6 R4360-53 + 4 J47-GE-19 ENGINES AT TAKE-OFF POWER (WET)

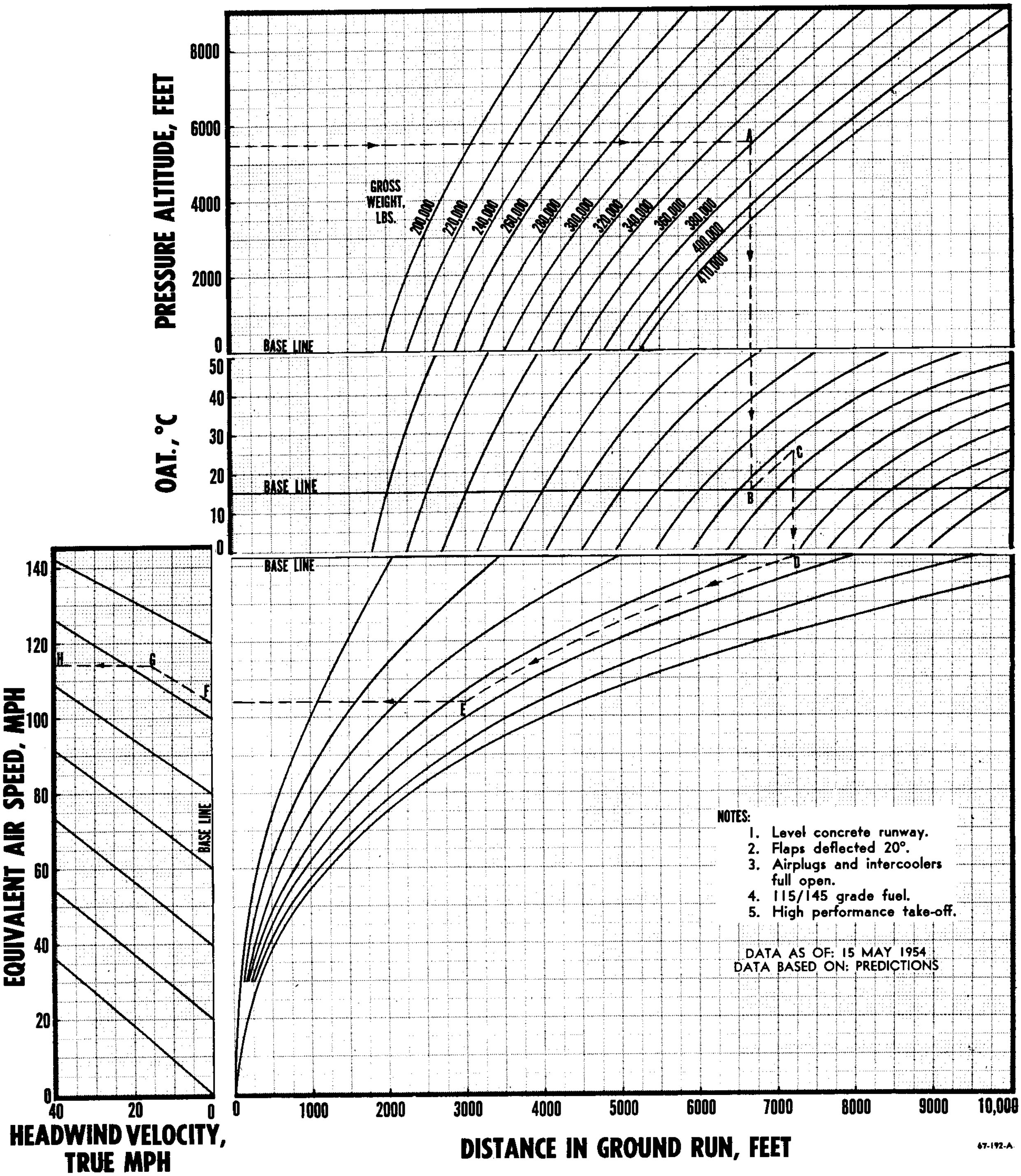

Figure A-91.

VELOCITY DURING TAKE-OFF GROUND RUN

6 R4360-53 + 2 J47-GE-19 ENGINES AT TAKE-OFF POWER (WET)*

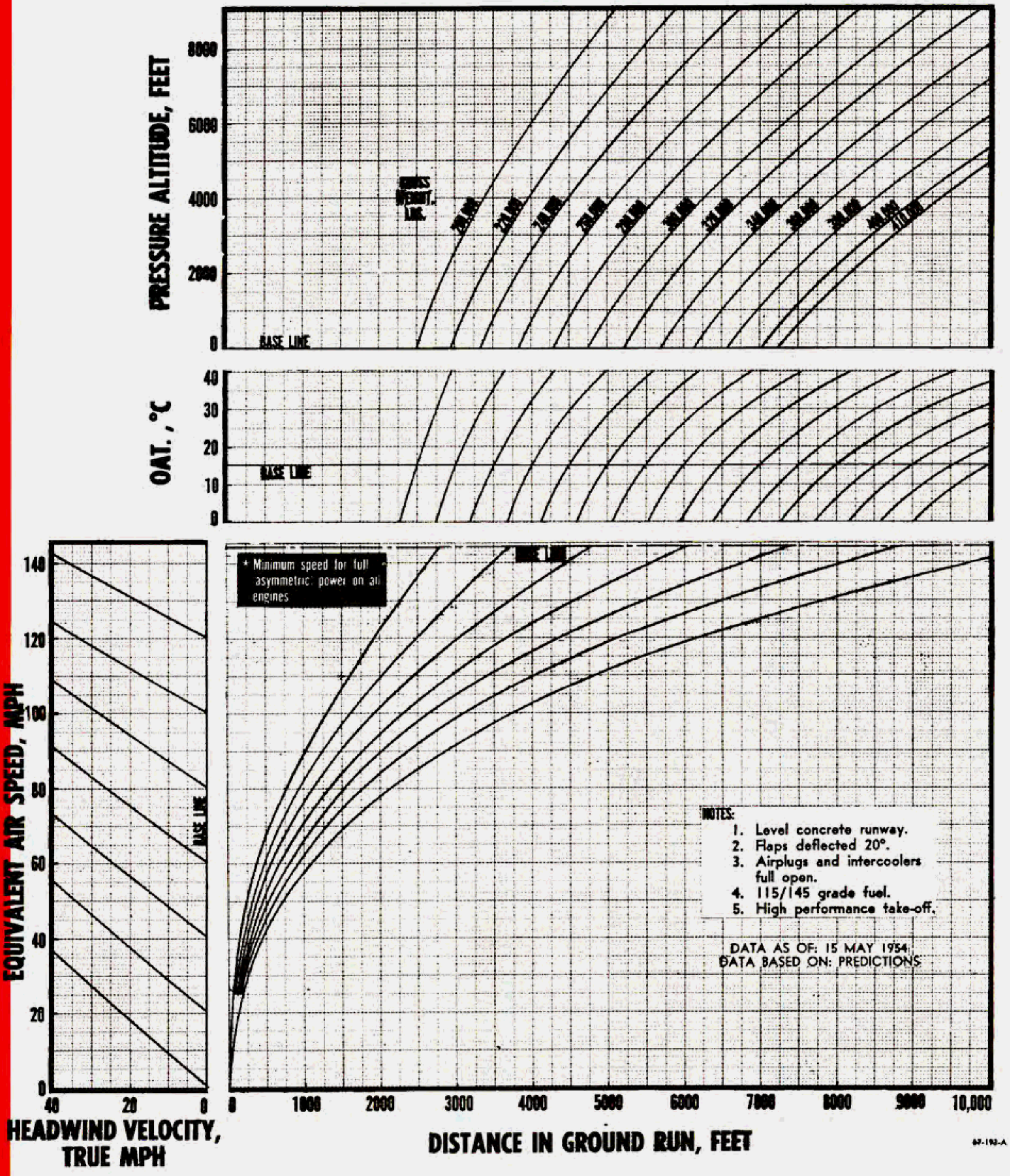

Figure A-92.

VELOCITY DURING TAKE-OFF GROUND RUN

6 R4360-53 ENGINES AT TAKE-OFF POWER (WET)

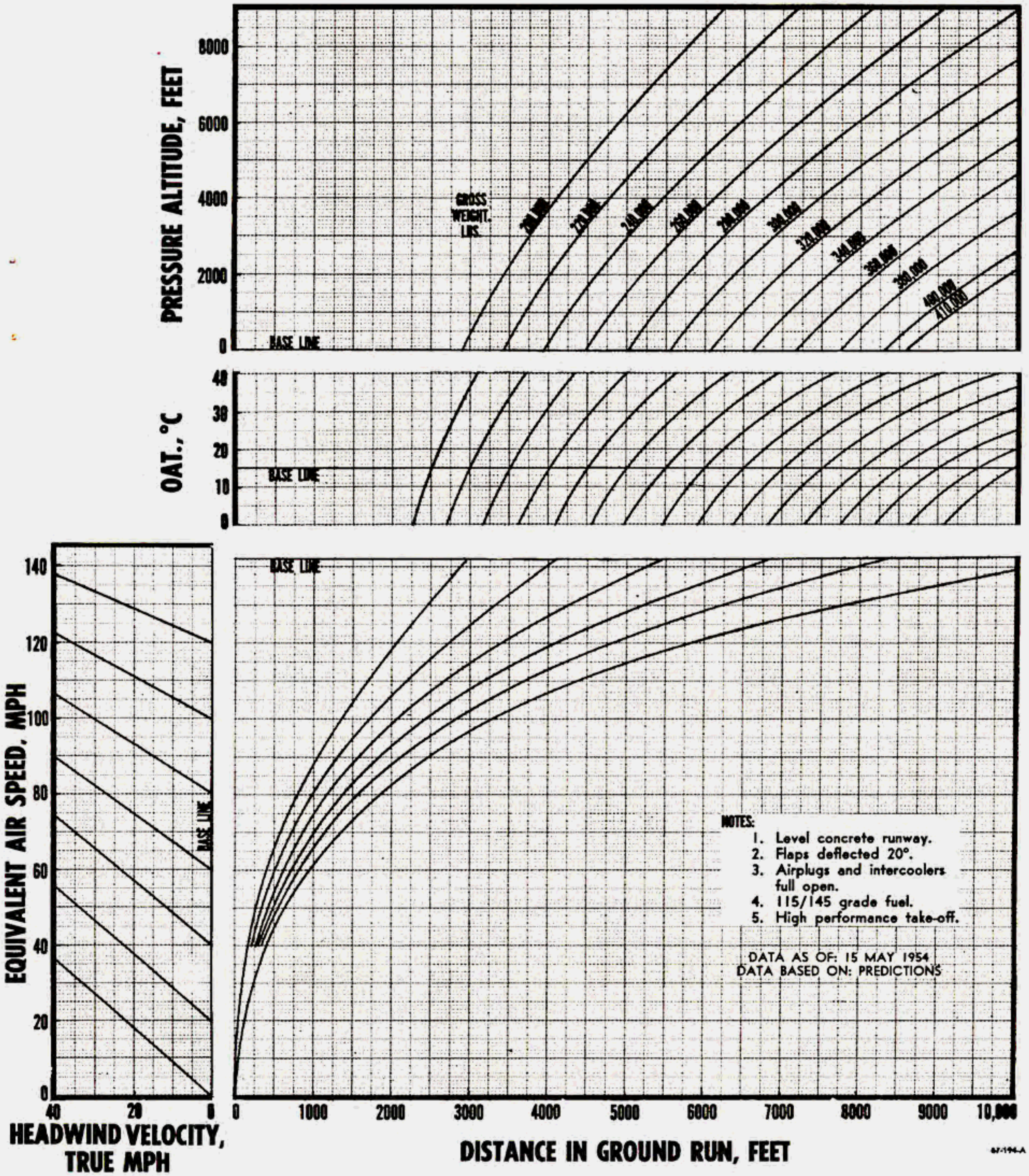

Figure A-93.

VELOCITY DURING TAKE-OFF GROUND RUN

5 R4360-53 + 4 J47-GE-19 ENGINES AT TAKE-OFF POWER (WET)*

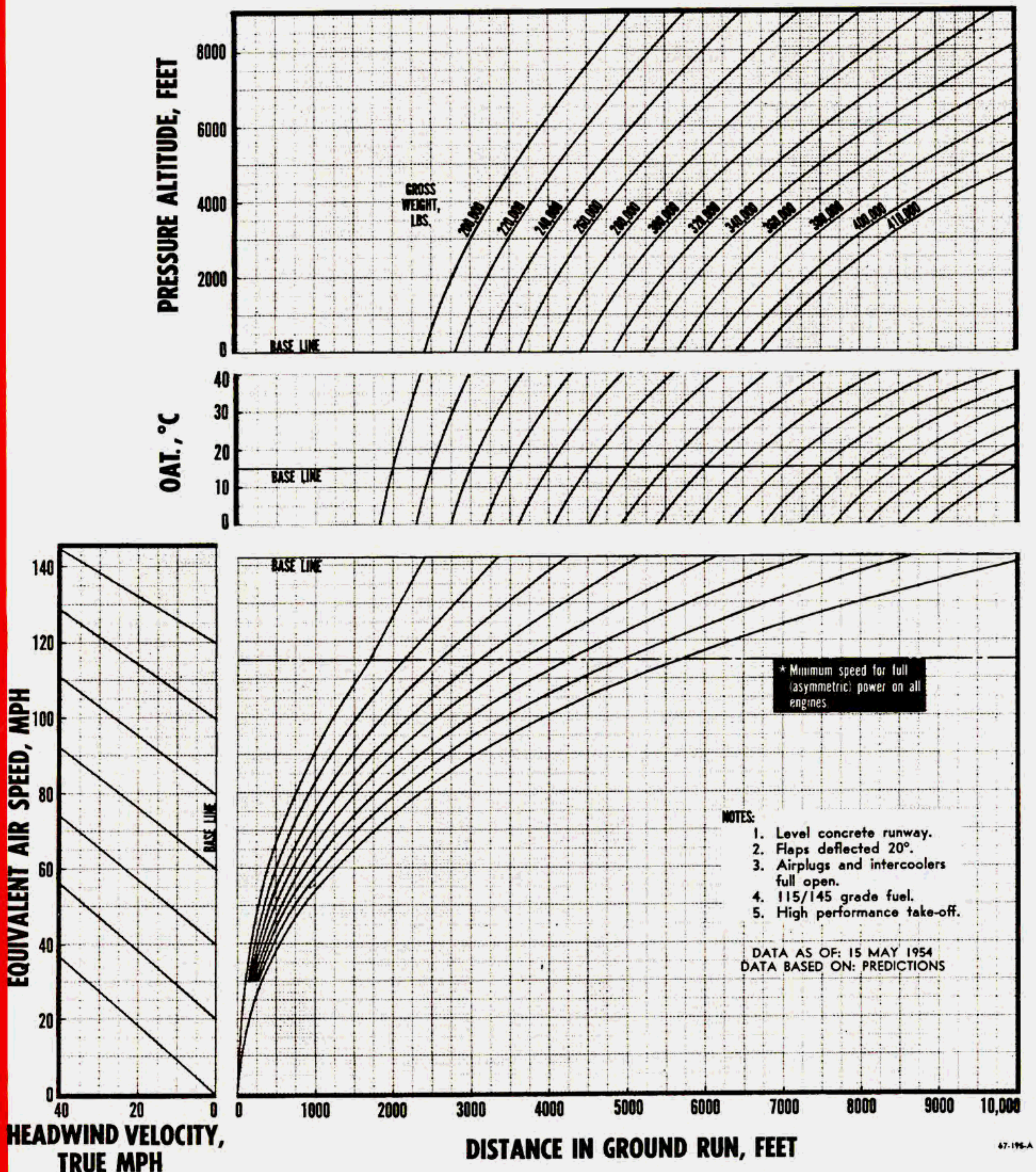

Figure A-94.

VELOCITY DURING TAKE-OFF GROUND RUN

5 R4360-53 + 2 J47-GE-19 ENGINES AT TAKE-OFF POWER (WET) *

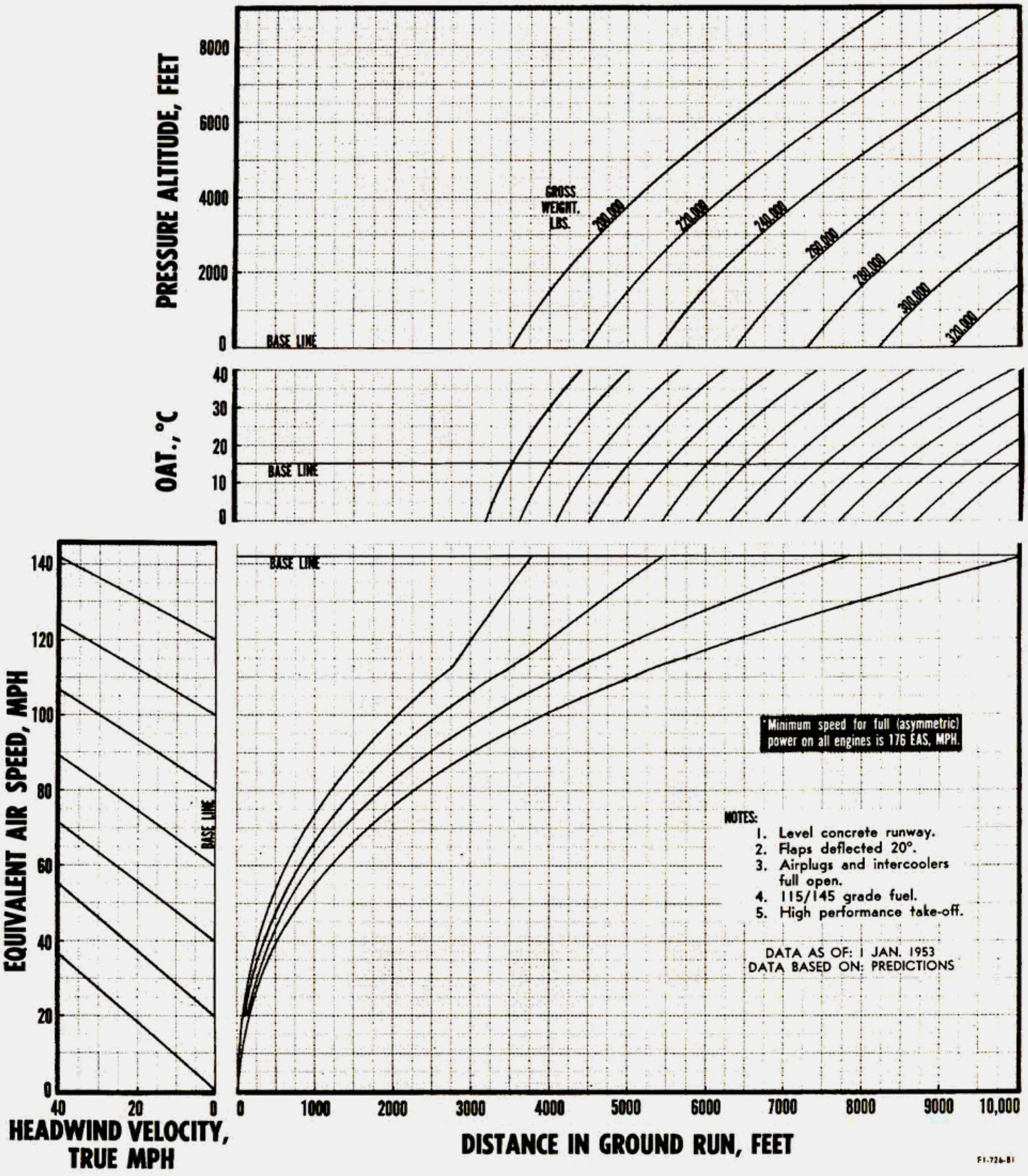

Figure A-95.

VELOCITY DURING TAKE-OFF GROUND RUN

5 R4360-53 ENGINES AT TAKE-OFF POWER (WET)*

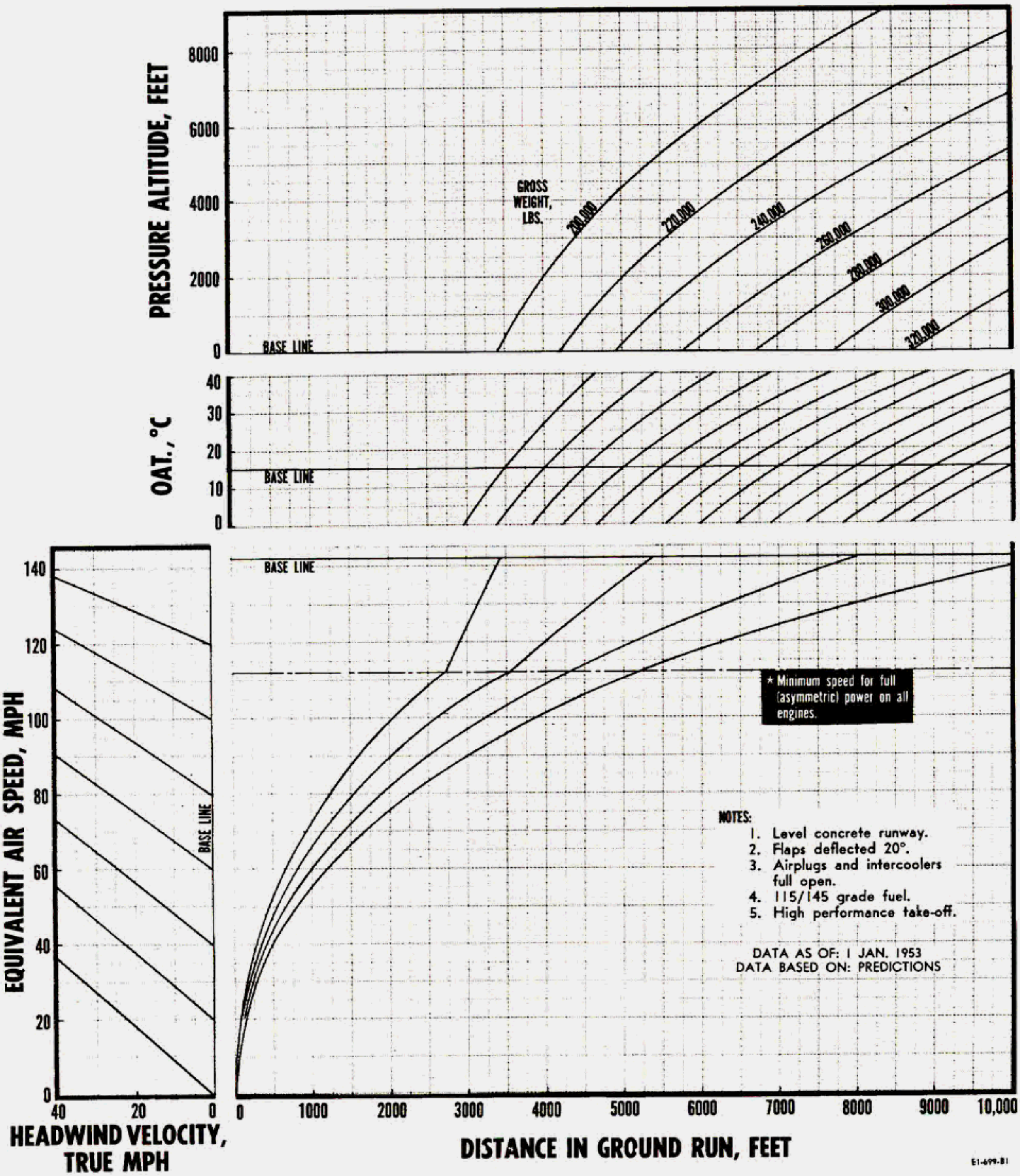

Figure A-96.

VELOCITY DURING TAKE-OFF GROUND RUN

4 R4360-53 + 4 J47-GE-19 ENGINES AT TAKE-OFF POWER (WET)*

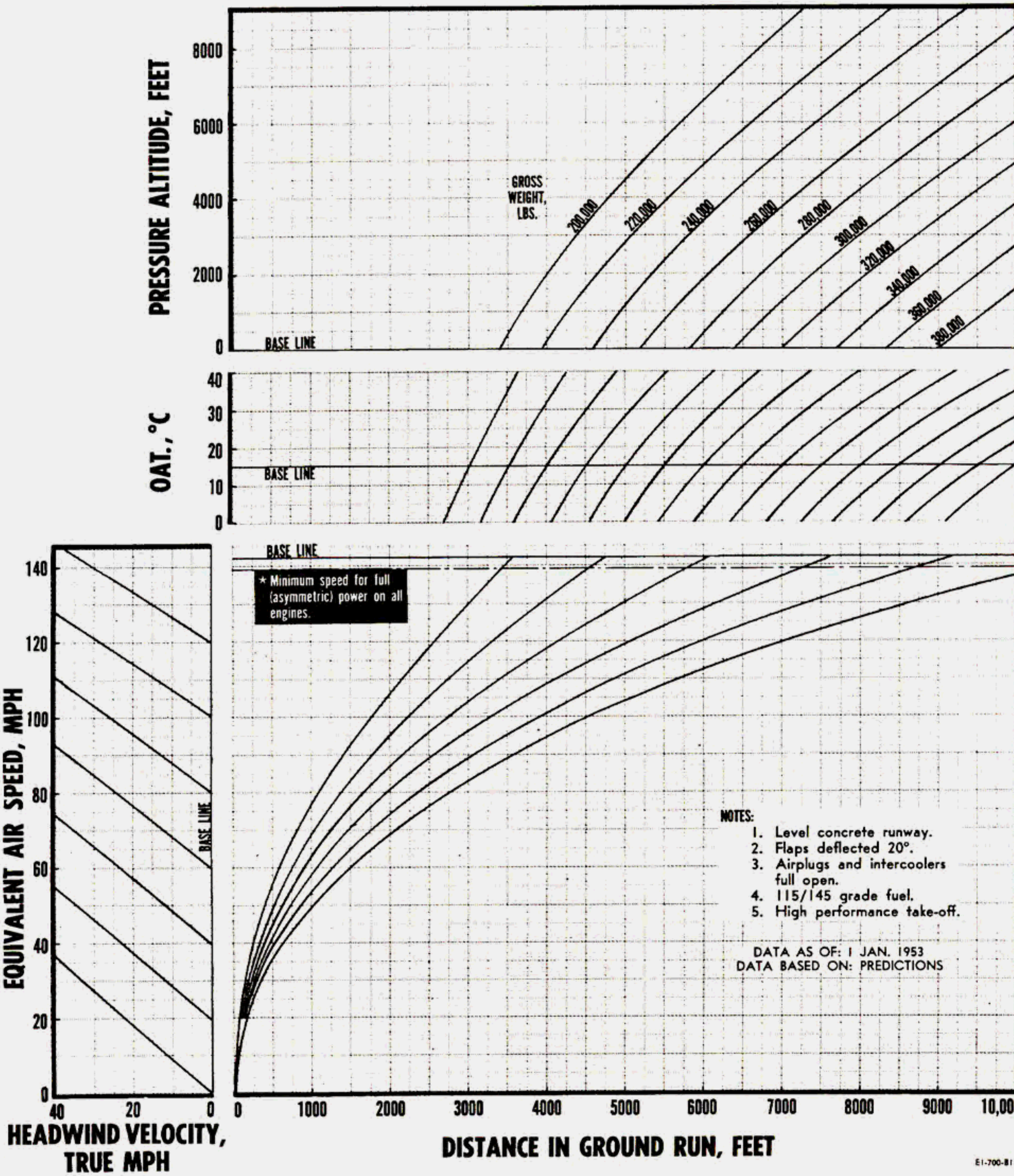

Figure A-97.

MINIMUM NOSE-UP AIR SPEED.

A nose-up air speed chart is presented to aid the pilots in determining the performance during take-off for any airplane CG location and gross weight.

It should be noted that the chart is for a 20-degree "up-elevator" deflection with the airplane in a ground attitude (nose wheel on ground). Although the speeds obtained from the chart are EAS, they may be used as IAS since the difference between the two air speeds is negligible when the airplane is in a ground attitude.

EXAMPLE.

Find the nose-up air speed for the following conditions:

360,000 pounds take-off gross weight
CG at 22% MAC

Enter figure A-98 at 360,000 pounds gross weight, project vertically to the 22 per cent MAC line and read 122.5 mph, EAS. This is the minimum air speed at which take-off attitude can be obtained.

Variations in the nose-up air speed at a particular gross weight and CG location can occur from any of several sources. Any condition which causes increased rolling friction on the tires such as low tire pressure, snow or sand on the runway, or higher true air speeds associated with the take-off from runways above sea level will all cause the minimum nose-up speed to increase. The same effect will result from a dragging brake or from binding in the wheel bearings. Variations in the vertical CG location resulting from different bomb and fuel loadings will also affect the nose-up air speed.

A particularly important factor affecting the nose-up air speed of the B-36 is the free-floating action of the elevator. Since aerodynamic forces position the elevator in response to the servo tab input, anything which restricts the elevator from rotating freely about its hinge line will reduce the elevator deflection available and raise the nose-up air speed. Such things as congealed oil in the hinge brackets, ice and snow accumulated between the stabilizer and elevator, and excessive friction in the hinge bearings are possible causes of this difficulty. The nose-up air speeds shown in figure A-98 are for average airplanes that are properly maintained. Some variations from these values will occur in service as a result of the causes described above.

Minimum Allowable Nose-Up Air Speed With a Cross Wind.

It is necessary when making a cross-wind take-off to utilize nose wheel steering in the early part of the ground roll in order to prevent the airplane from yawing into the wind. As air speed is increased, it will be possible to counteract some of the yawing tendency with the rudder control, until eventually nose wheel steering is no longer required and the rudder control alone is adequate to maintain the desired take-off direction. If the nose gear is raised while the cross-wind yawing moment is being counteracted by nose wheel steering, the airplane will swerve into the wind. It can thus be seen that the nose gear must remain on the runway until the rudder becomes fully effective.

In most cases for average cross winds, the speed at which nose gear steering is no longer required is below the minimum nose-up air speed given in figure A-98, in which case it is not possible to raise the nose gear before the rudder is fully effective. However, for strong cross winds, it may be necessary to keep the nose wheel on the ground above the minimum nose-up air speed in order to maintain directional control. Figure A-99 is presented to enable the pilot to determine for a particular cross-wind condition whether or not he will be required to exceed the normal minimum nose-up air speed before raising the nose gear.

EXAMPLE.

1. For the following conditions determine the speed at which nose wheel steering is no longer required.

320,000 pounds take-off gross weight
30 mph cross wind 40 degrees from airplane heading

Enter figure A-99 at the 30 mph wind velocity, project vertically to the 40-degree wind direction line and read 119.5 mph EAS. This is the minimum air speed at which zero yaw can be maintained by rudder alone.

2. With a 25 per cent MAC CG location, determine if the minimum allowable nose-up air speed due to cross wind exceeds the normal minimum nose-up air speed.

From figure A-98 the normal minimum nose-up air speed is 108.5 mph, which is 11 mph below that determined in part 1 of this example. Therefore, for the conditions given, the nose gear should not be raised at the normal minimum nose-up air speed, but should remain on the ground until nose wheel steering is no longer required (approximately 119.5 mph).

MINIMUM NOSE-UP AIR SPEED

STANDARD ATMOSPHERE

CONDITIONS: 1. 20° flap deflection.
2. 20° up elevator.
3. Take-off power.
4. Correction of EAS to pilots' IAS is negligible with the airplane in ground attitude.

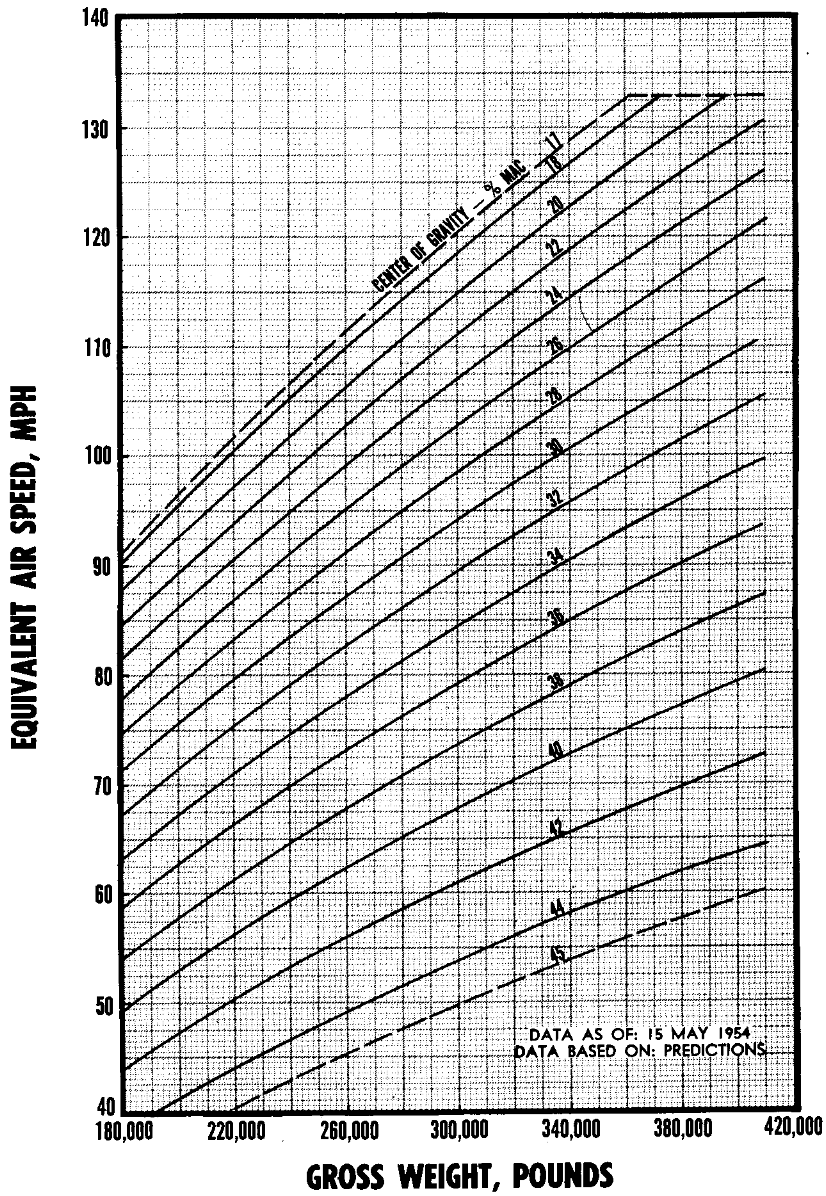

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Figure A-98.

MINIMUM ALLOWABLE NOSE-UP AIR SPEED WITH CROSS WIND

STANDARD ATMOSPHERE

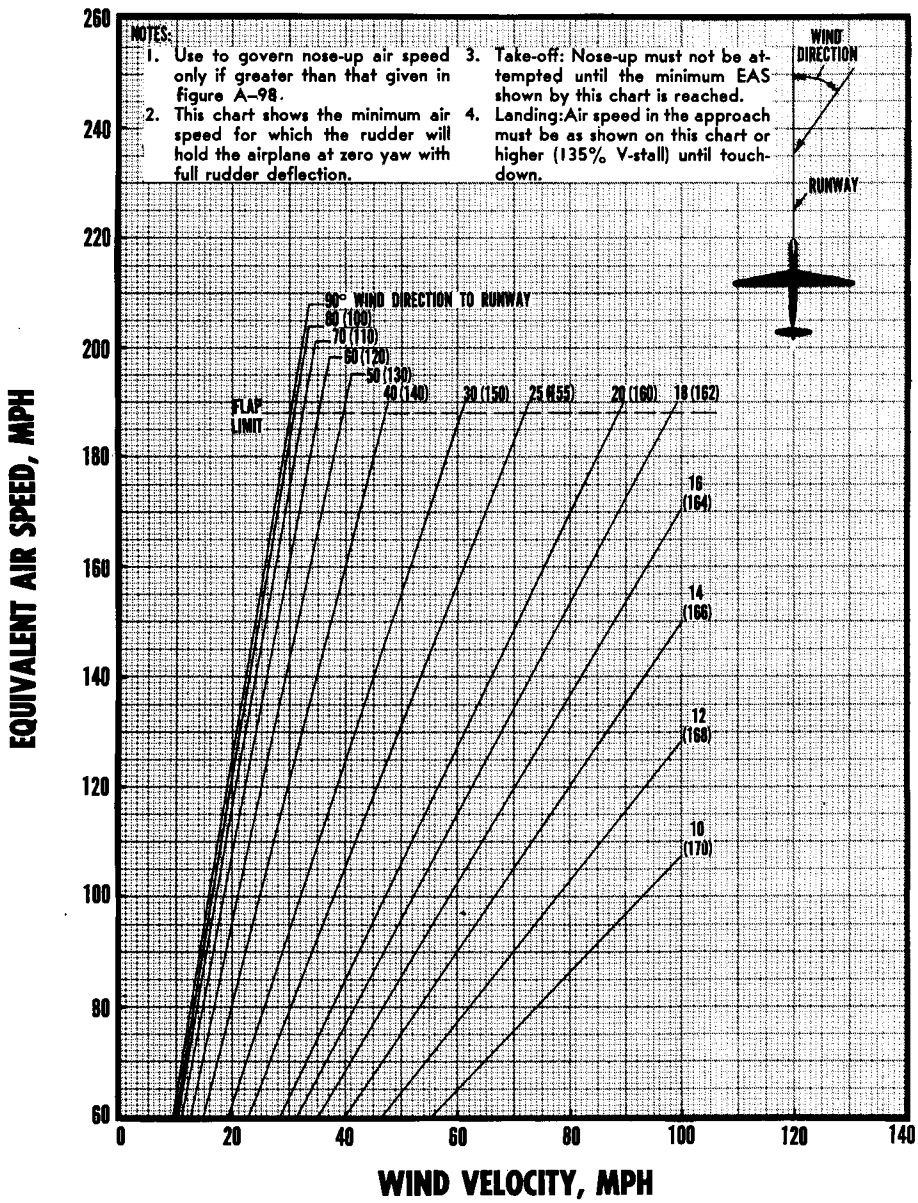

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Figure A-99.

TAKE-OFF REFUSAL SPEED AND ACCELERATE-STOP DISTANCE.

The following curves provide a basis for decision of whether to stop or continue take-off in event of an emergency. These curves present (1) total distance required to accelerate the airplane to any speed and then stop if a decision is made to discontinue take-off, and (2) an indication of the speed at which take-off may be aborted and the airplane stopped within the runway length.

Individual charts are presented for the following braking combinations: (1) brakes only; (2) brakes plus two propellers in reverse pitch; (3) brakes plus four propellers in reverse pitch; (4) brakes plus six propellers in reverse pitch; (5) six propellers in reverse pitch. The data are based on acceleration under high performance take-off procedure with ten engines operating, and include an allowance for pilot reaction time. Stopping distance requirements are available up to take-off speed for all gross weights and practical atmospheric conditions.

Refer to "Aborting Take-Off," Section III, for the procedure to follow when a decision is made to abort take-off.

EXAMPLE 1.

Find the total distance to accelerate and stop the airplane, with six propellers in reverse pitch plus brakes, when take-off is aborted at an EAS of 105 mph under the following conditions:

357,500 pounds take-off gross weight
12 mph headwind
27°C outside air temperature
3600 feet pressure altitude

Enter figure A-100 on the gross weight scale at 357,500 pounds (A) and proceed horizontally to the decision speed line of 105 mph (B). Move vertically to the pressure altitude base line (C) and follow the guide lines to 3600 feet (D). Proceed vertically to the OAT. base line (E) and parallel to the guide lines to 27°C (F). Next move vertically to the headwind velocity base line (G) and again parallel the guide lines to 12 mph (H). Read a total accelerate-stop distance of 4400 feet (J).

EXAMPLE 2.

Find the maximum speed to which the airplane may be accelerated and then stopped, using brakes plus six propellers in reverse pitch, within a runway length of 7000 feet under the following conditions:

320,000 pounds take-off gross weight
0 mph headwind
5°C outside air temperature
7000 feet pressure altitude

Enter figure A-100 at a runway length of 7000 feet (A) and move straight downward to 0 mph headwind. Proceed vertically to an OAT. of 5°C and follow the guide lines to the base line (D). Then move downward to a pressure altitude of 7000 feet (F) and parallel the guide lines to the base line. Proceed downward to the take-off gross weight and read (by interpolation) a refusal speed of 122 mph (J).

TOTAL STOPPING DISTANCE AND REFUSAL SPEED
6 ENGINES IN REVERSE PITCH AND BRAKES APPLIED

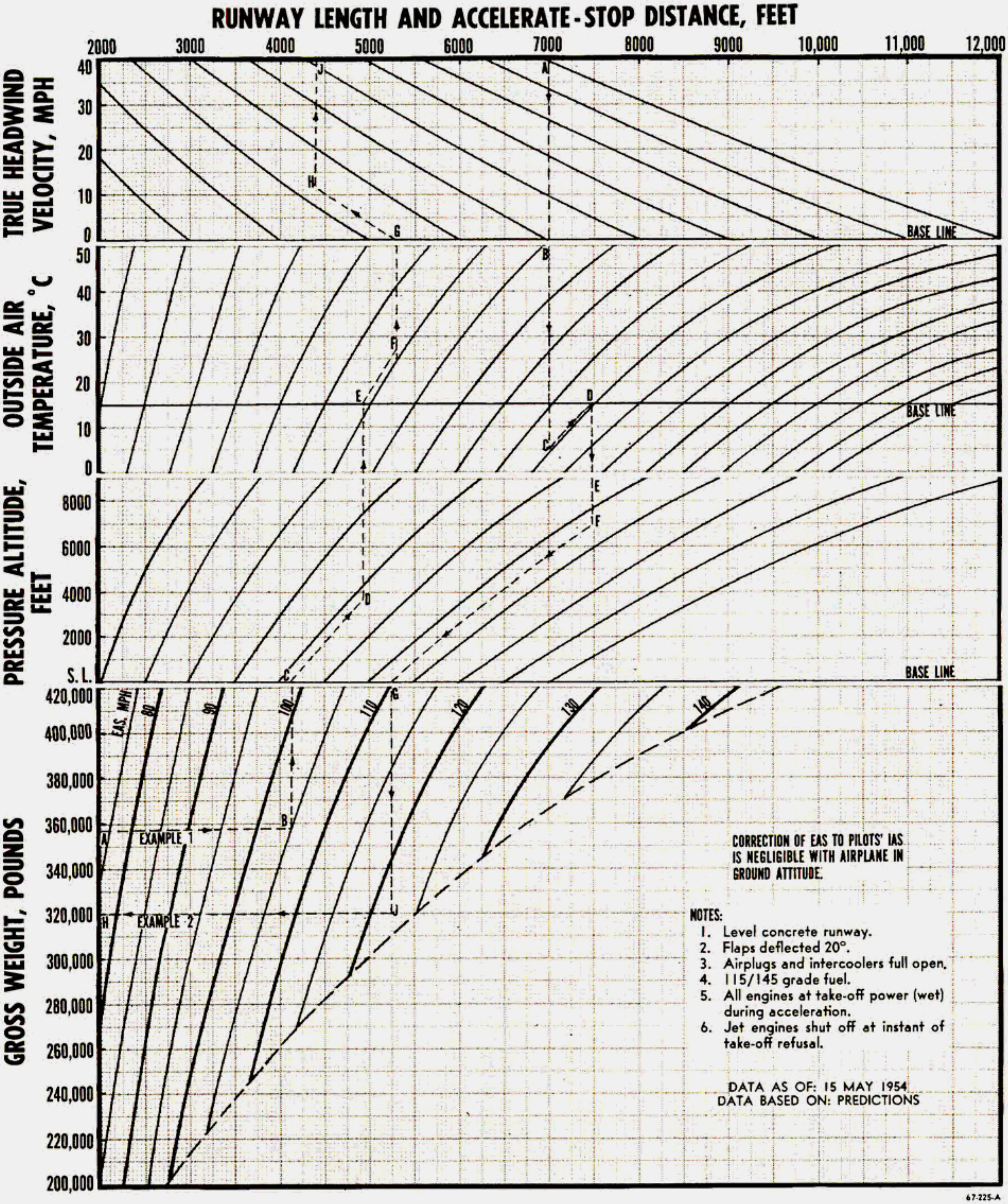

Figure A-100.

TOTAL STOPPING DISTANCE AND REFUSAL SPEED
4 ENGINES IN REVERSE PITCH AND BRAKES APPLIED

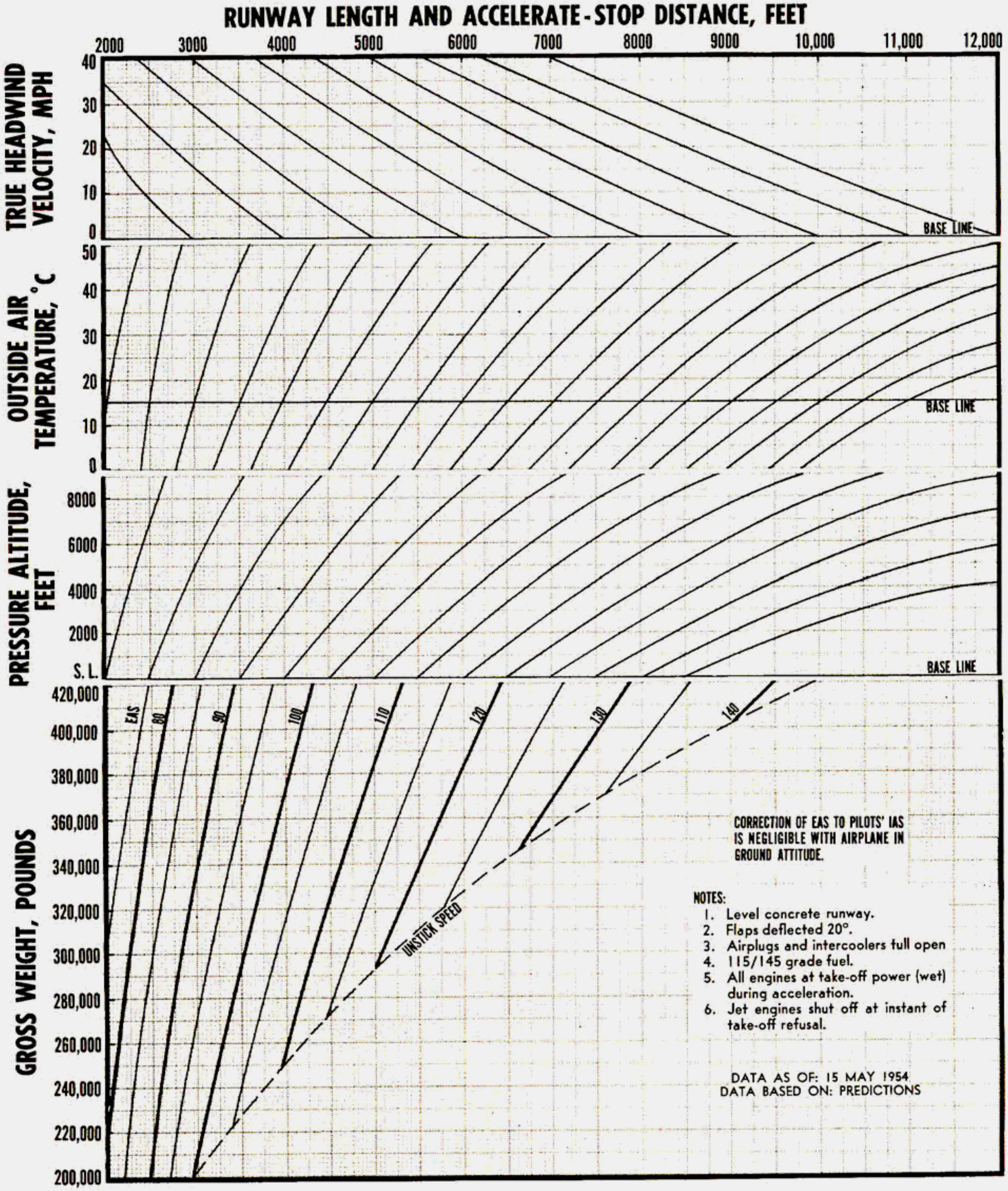

Figure A-101.

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TOTAL STOPPING DISTANCE AND REFUSAL SPEED
2 ENGINES IN REVERSE PITCH AND BRAKES APPLIED

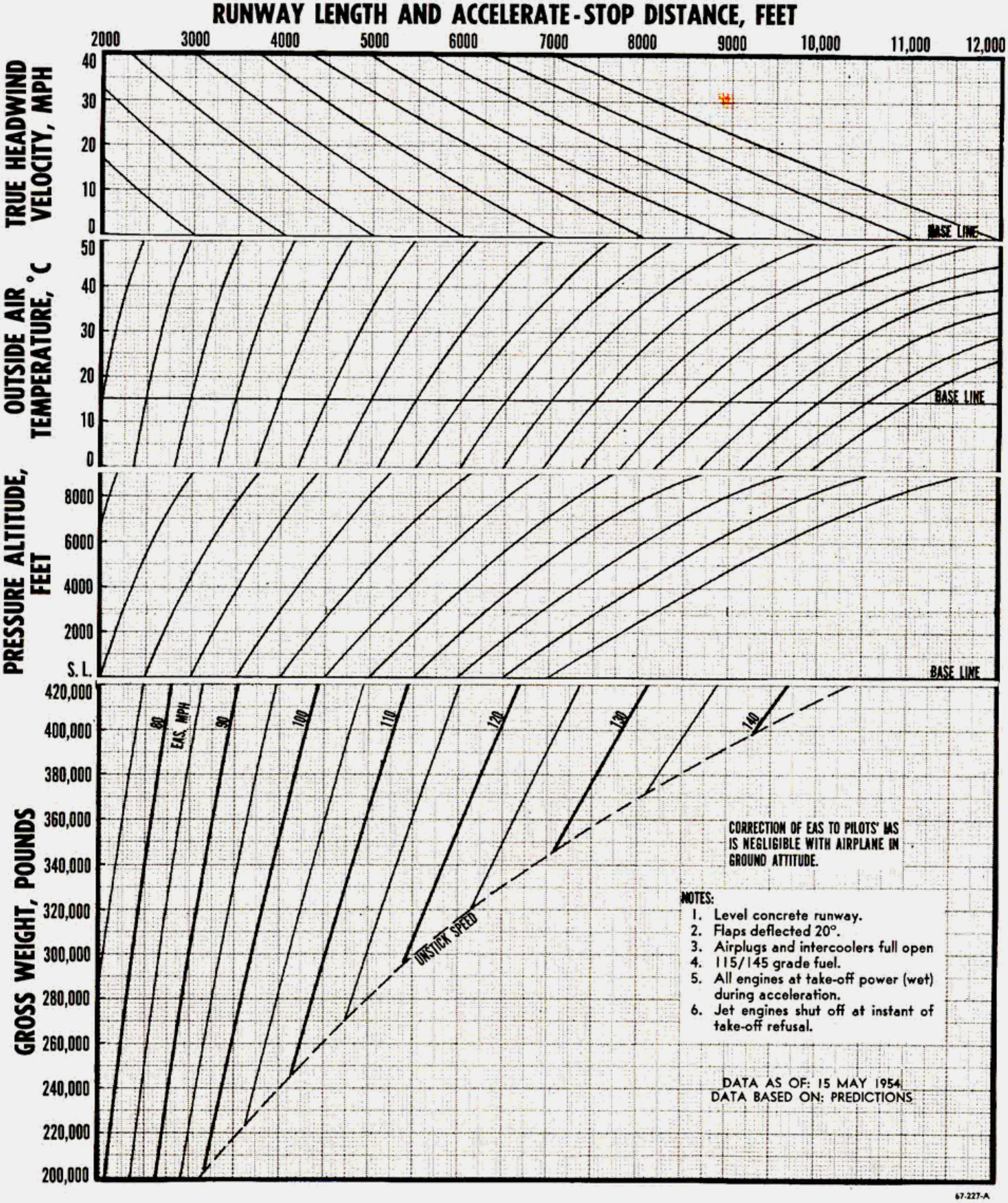


Figure A-102.

TOTAL STOPPING DISTANCE AND REFUSAL SPEED

BRAKES ONLY APPLIED

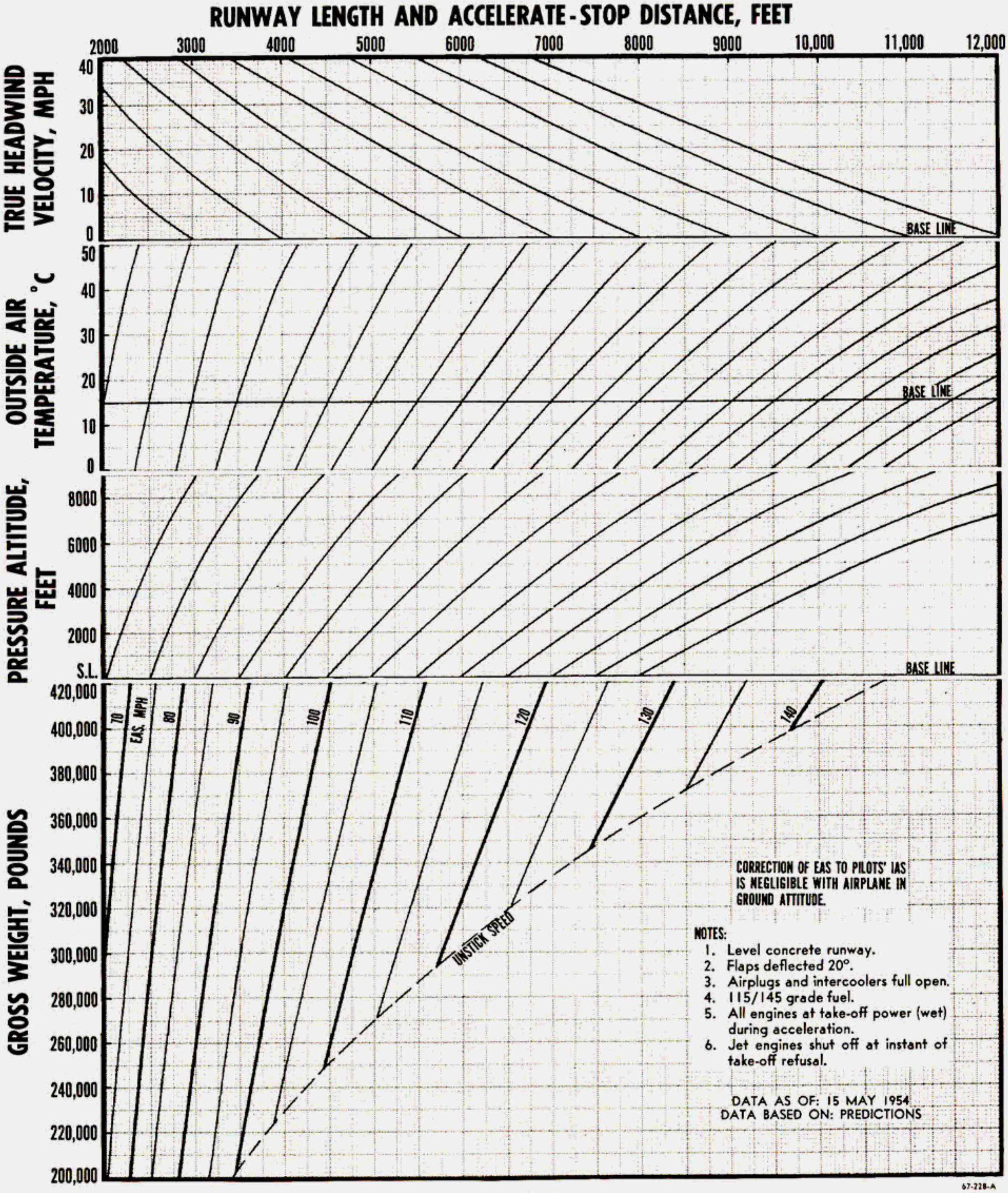


Figure A-103.

TOTAL STOPPING DISTANCE AND REFUSAL SPEED
6 ENGINES IN REVERSE (NO BRAKES APPLIED)

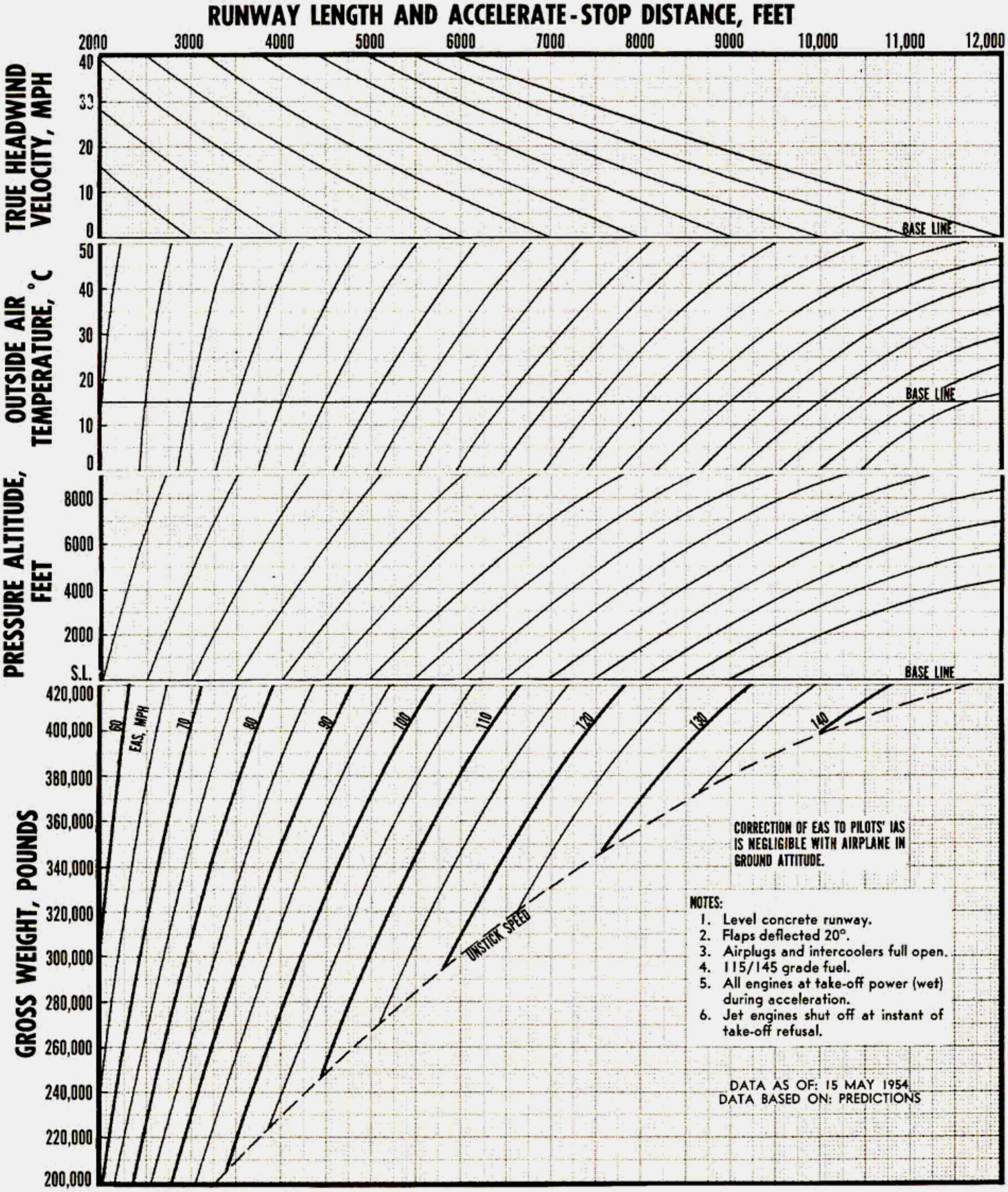


Figure A-104.

EMERGENCY CLIMB CURVES.

The emergency climb curves present the variation of rate of climb/descent with air speed for emergency operation at sea level and 5000 feet. At each altitude data is given for an NACA Standard Day and a Hot Day. These charts enable the determination of best climb speeds and provide a basis for determining safe operating conditions.

Charts are presented for seven different engine configurations, and the most asymmetric power conditions are assumed for inoperative engines. Reciprocating engine operation is at military power (3500 bhp/2800 rpm) at 5000 feet and 3300 bhp/2740 rpm at sea level. Jet operation is at 100 per cent military rpm for both altitudes. Hot Day correction values are given in tabular form on the Standard Day curves. In determining emergency climb performance for Hot Day conditions, these corrections must first be added algebraically to the Standard Day curves; then, if necessary, interpolate as illustrated in the example.

EXAMPLE.

Determine the emergency rate of climb at sea level for the following conditions:

Standard Day
355,000 pounds gross weight
20 degrees flap deflection
Gear down
9-engine operation—one reciprocating engine inoperative, propeller feathered

In figure A-111, using the curve for a gross weight of 400,000 pounds, determine the maximum rate of climb to be 350 fpm at 147 mph. In a similar manner, at 300,000 pounds, the rate of climb is found to be 950 fpm at 137 mph. The maximum rate of climb at 355,000 pounds by interpolation is

$$350 + \left[\frac{(400{,}000 - 355{,}000)}{(400{,}000 - 300{,}000)} (950-350)\right] = 620 \text{ fpm}$$

at an air speed of

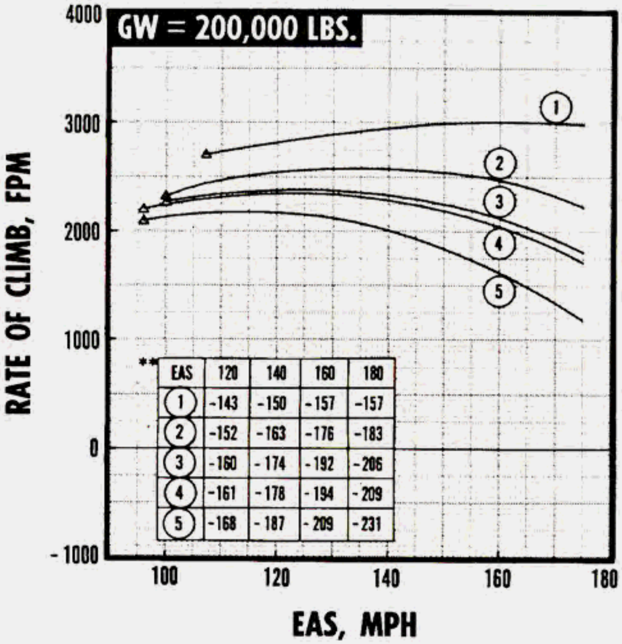
$$147 - \left[\frac{(400{,}000 - 355{,}000)}{(400{,}000 - 300{,}000)} (147-137)\right] = 143 \text{ mph,}$$

EAS.

EMERGENCY CLIMB AT SEA LEVEL

STANDARD ATMOSPHERE*

6 R4360-53 + 4 J47-GE-19 ENGINES OPERATING



EAS	120	140	160	180
(1)	-143	-150	-157	-157
(2)	-152	-163	-176	-183
(3)	-160	-174	-192	-206
(4)	-161	-178	-194	-209
(5)	-168	-187	-209	-231

NOTES: 1. AIRPLANE CONFIGURATIONS:

(1) Clean airplane.

(2) Wing flaps 20°, gear up.

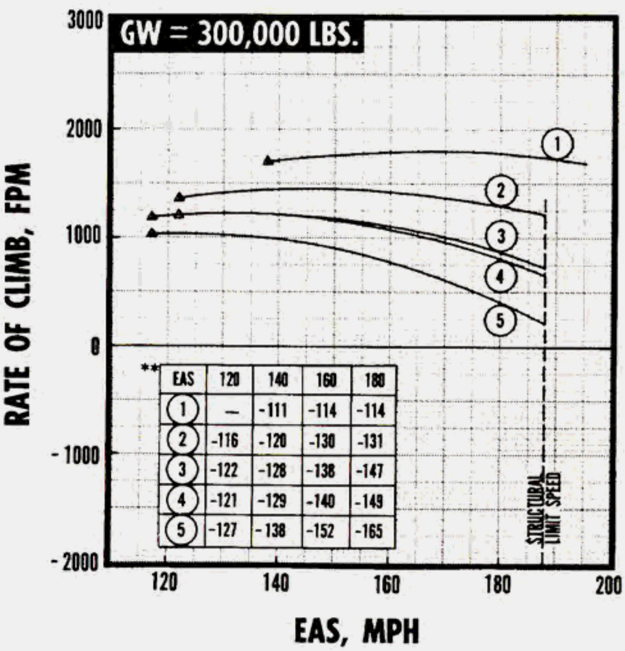
(3) Wing flaps 20°, gear down.

(4) Wing flaps 30°, gear up.

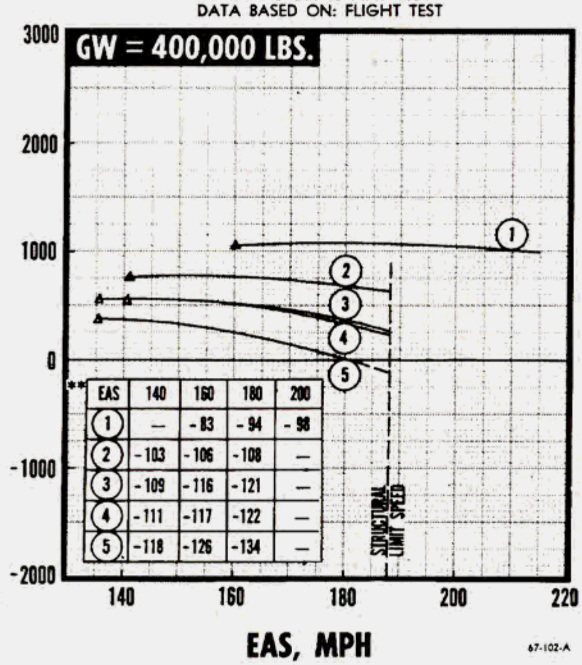
(5) Wing flaps 30°, gear down.

2. POWER CONDITIONS:
6 R4360-53 engines operating at 3300/2740 (BHP/RPM) per engine. 4 J47-GE-19 engines operating at 100% MRPM.
3. COOLING DEVICE SETTINGS:
Air plugs fully open.
Intercooler shutters fully open.
Oil cooler doors automatic.
4. △Denotes 1.06 x V stall.
5. Oil-in temperature limits will be exceeded at air speeds less than 185 mph. CAT. limits will be exceeded at air speeds less than 106 mph.
*6. Sea level pressure altitude (15°C).
**7. To obtain climb performance for Army Hot Day (38°C) condition, add algebraically the tabulated value corresponding to the particular combination of gross weight, airplane configuration and EAS to the value read from the curve.

DATA AS OF: 15 MAY 1954
DATA BASED ON: FLIGHT TEST



EAS	120	140	160	180
(1)	—	-111	-114	-114
(2)	-116	-120	-130	-131
(3)	-122	-128	-138	-147
(4)	-121	-129	-140	-149
(5)	-127	-138	-152	-165



EAS	140	160	180	200
(1)	—	-83	-94	-98
(2)	-103	-106	-108	—
(3)	-109	-116	-121	—
(4)	-111	-117	-122	—
(5)	-118	-126	-134	—

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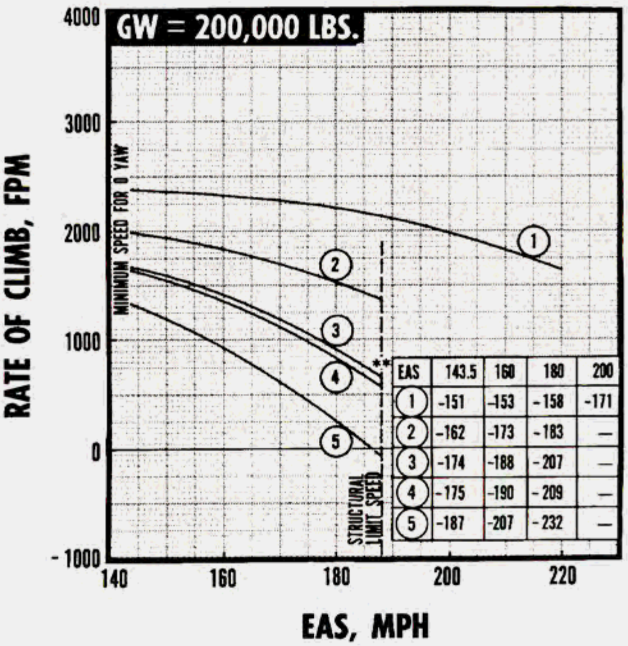
Figure A-105.

EMERGENCY CLIMB AT SEA LEVEL

STANDARD ATMOSPHERE *

6 R4360-53 + 2 J47-GE-19 ENGINES OPERATING



EAS**	143.5	160	180	200
(1)	-151	-153	-158	-171
(2)	-162	-173	-183	—
(3)	-174	-188	-207	—
(4)	-175	-190	-209	—
(5)	-187	-207	-232	—

NOTES: 1. AIRPLANE CONFIGURATIONS:

(1) Clean airplane.

(2) Wing flaps 20°, gear up.

(3) Wing flaps 20°, gear down.

(4) Wing flaps 30°, gear up.

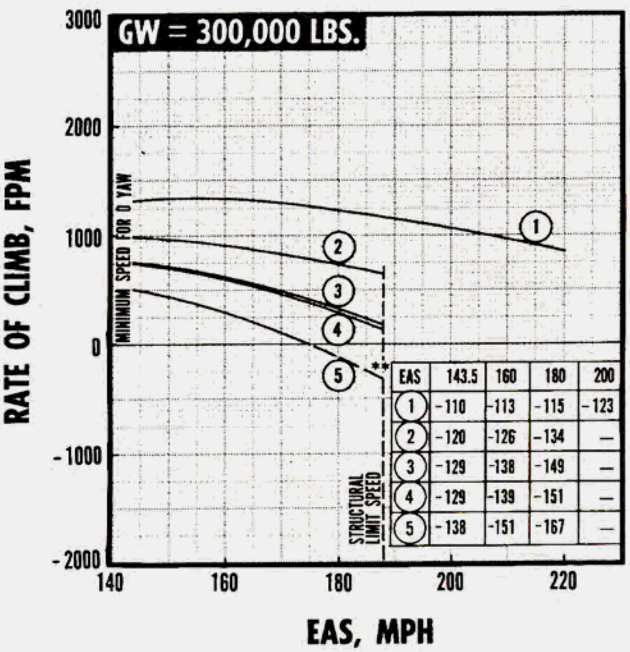
(5) Wing flaps 30°, gear down.

2. POWER CONDITIONS:
6 R4360-53 engines operating at 3300/2740 (BHP/RPM) per engine. 2 J47-GE-19 engines operating asymmetrically at 100% MRPM. Nose shutoff doors closed on inoperative jet engines.
3. COOLING DEVICE SETTINGS:
Air plugs fully open.
Intercooler shutters fully open.
Oil cooler doors automatic.
4. △ Denotes 1.06 x V stall.
5. Oil-in temperature limits will be exceeded at air speeds less than 185 mph. CAT. limits will be exceeded at air speeds less than 106 mph.

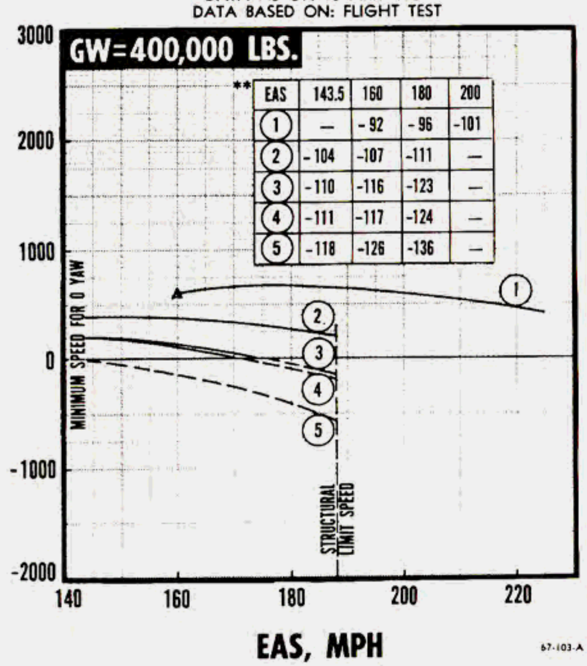
*6. Sea level pressure altitude (15°C).

**7. To obtain climb performance for Army Hot Day (38°C) condition, add algebraically the tabulated value corresponding to the particular combination of gross weight, airplane configuration and EAS to the value read from the curve.

DATA AS OF: 15 MAY 1954
DATA BASED ON: FLIGHT TEST



EAS**	143.5	160	180	200
(1)	-110	-113	-115	-123
(2)	-120	-126	-134	—
(3)	-129	-138	-149	—
(4)	-129	-139	-151	—
(5)	-138	-151	-167	—



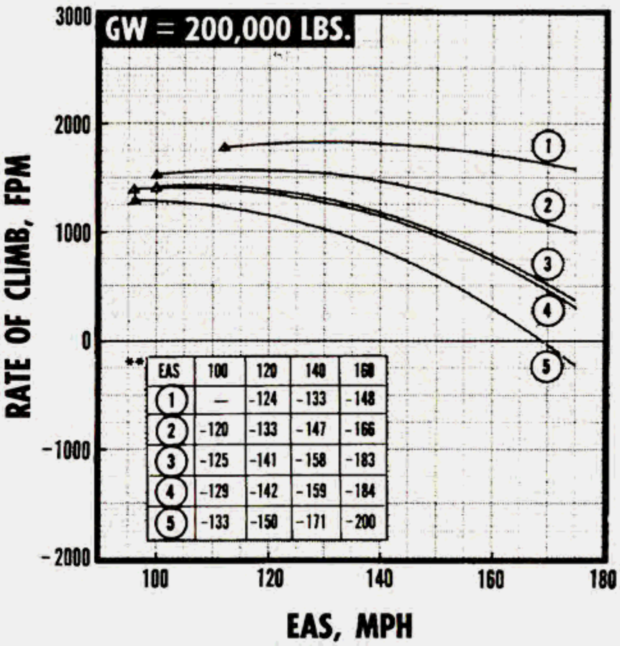
EAS**	143.5	160	180	200
(1)	—	-92	-96	-101
(2)	-104	-107	-111	—
(3)	-110	-116	-123	—
(4)	-111	-117	-124	—
(5)	-118	-126	-136	—

Figure A-106.

EMERGENCY CLIMB AT SEA LEVEL

STANDARD ATMOSPHERE *

6 R4360-53 ENGINES OPERATING



**

EAS	100	120	140	160
1	—	-124	-133	-148
2	-120	-133	-147	-166
3	-125	-141	-158	-183
4	-129	-142	-159	-184
5	-133	-150	-171	-200

NOTES: 1. AIRPLANE CONFIGURATIONS:

(1) Clean airplane.

(2) Wing flaps 20°, gear up.

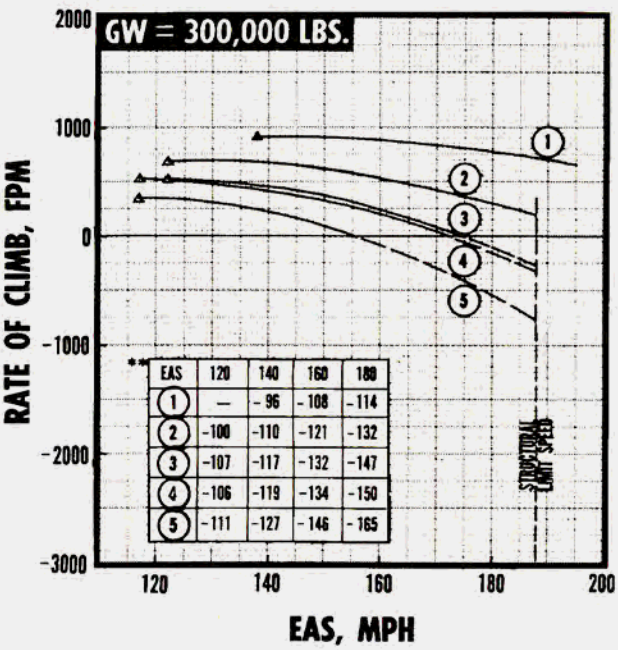
(3) Wing flaps 20°, gear down.

(4) Wing flaps 30°, gear up.

(5) Wing flaps 30°, gear down.

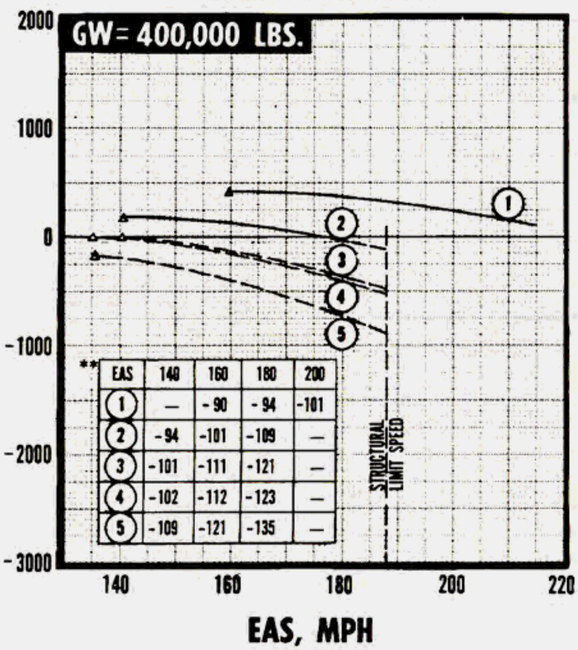
2. POWER CONDITIONS:
6 R4360-53 engines operating at 3300/2740 (BHP/RPM) per engine. Nose shutoff doors closed on inoperative jet engines.
3. COOLING DEVICE SETTINGS:
Air plugs fully open.
Intercooler shutters fully open.
Oil cooler doors automatic.
4. △ Denotes 1.06 x V stall.
5. Oil-in temperature limits will be exceeded at air speeds less than 185 mph. CAT. limits will be exceeded at air speeds less than 106 mph.
*6. Sea level pressure altitude (15°C).
**7. To obtain climb performance for Army Hot Day (38°C) condition, add algebraically the tabulated value corresponding to the particular combination of gross weight, airplane configuration and EAS to the value read from the curve.

DATA AS OF: 15 MAY 1954
DATA BASED ON: FLIGHT TEST



**

EAS	120	140	160	180
1	—	-96	-108	-114
2	-100	-110	-121	-132
3	-107	-117	-132	-147
4	-106	-119	-134	-150
5	-111	-127	-146	-165



**

EAS	140	160	180	200
1	—	-90	-94	-101
2	-94	-101	-109	—
3	-101	-111	-121	—
4	-102	-112	-123	—
5	-109	-121	-135	—

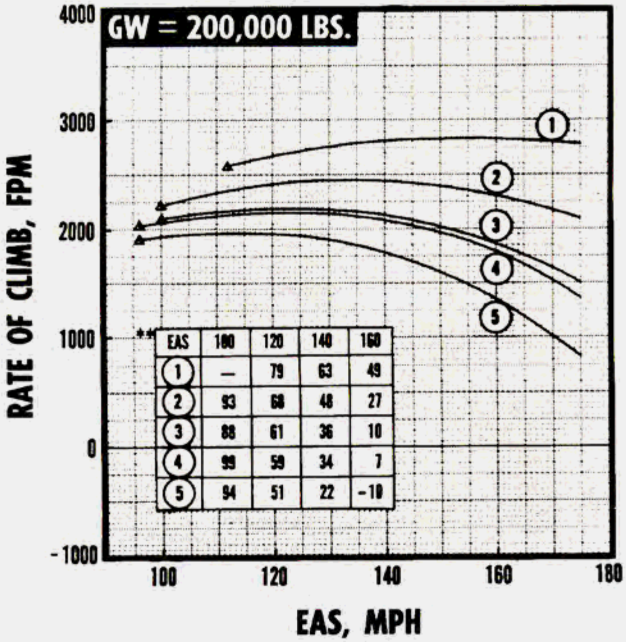
67-104-A

Figure A-107.

EMERGENCY CLIMB AT 5000 FEET

STANDARD ATMOSPHERE*

6 R4360-53 + 4 J47-GE-19 ENGINES OPERATING



**EAS	100	120	140	160
(1)	—	79	63	49
(2)	93	68	48	27
(3)	88	61	36	10
(4)	99	59	34	7
(5)	94	51	22	-10

NOTES: 1. AIRPLANE CONFIGURATIONS:

(1) Clean airplane.

(2) Wing flaps 20°, gear up.

(3) Wing flaps 20°, gear down.

(4) Wing flaps 30°, gear up.

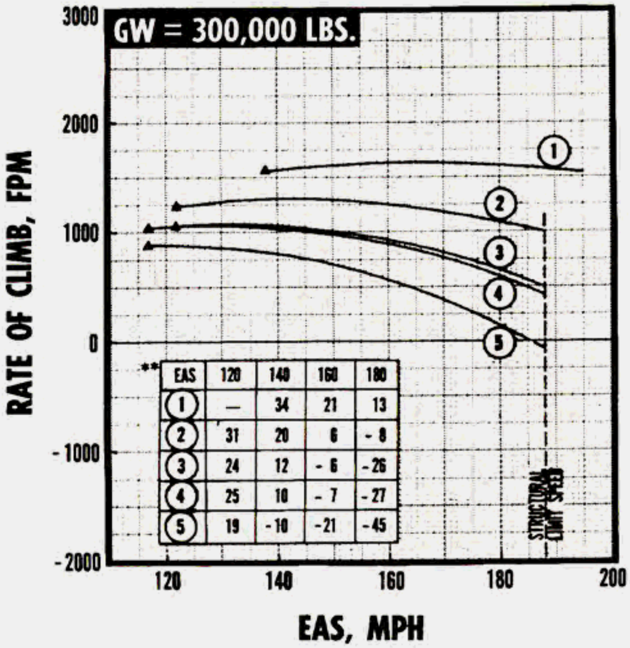
(5) Wing flaps 30°, gear down.

2. POWER CONDITIONS:
6 R4360-53 engines operating at 3500/2800 (BHP/RPM) per engine. 4 J47-GE-19 engines operating at 100% MRPM.
3. COOLING DEVICE SETTINGS:
Air plugs fully open.
Intercooler shutters fully open.
Oil cooler doors automatic.
4. △Denotes 1.06 x V stall.
5. Oil-in temperature limits will be exceeded at air speeds less than 175 mph.

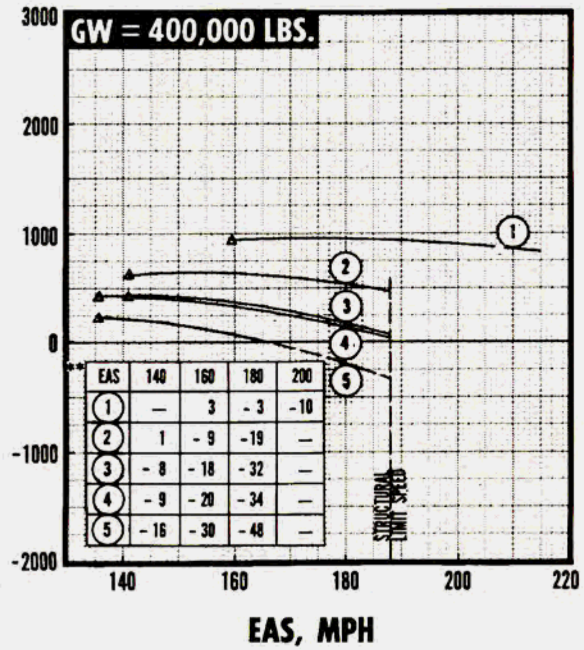
*6. 5000 feet pressure altitude (5.1°C)

**7. To obtain climb performance for Army Hot Day (28°C) condition, add algebraically the tabulated value corresponding to the particular combination of gross weight, airplane configuration and EAS to the value read from the curve.

DATA AS OF: 15 MAY 1954
DATA BASED ON: FLIGHT TEST



**EAS	120	140	160	180
(1)	—	34	21	13
(2)	31	20	6	- 8
(3)	24	12	- 6	-26
(4)	25	10	- 7	-27
(5)	19	-10	-21	-45



**EAS	140	160	180	200
(1)	—	3	- 3	-10
(2)	1	- 9	-19	—
(3)	- 8	- 18	- 32	—
(4)	- 9	- 20	- 34	—
(5)	- 16	- 30	- 48	—

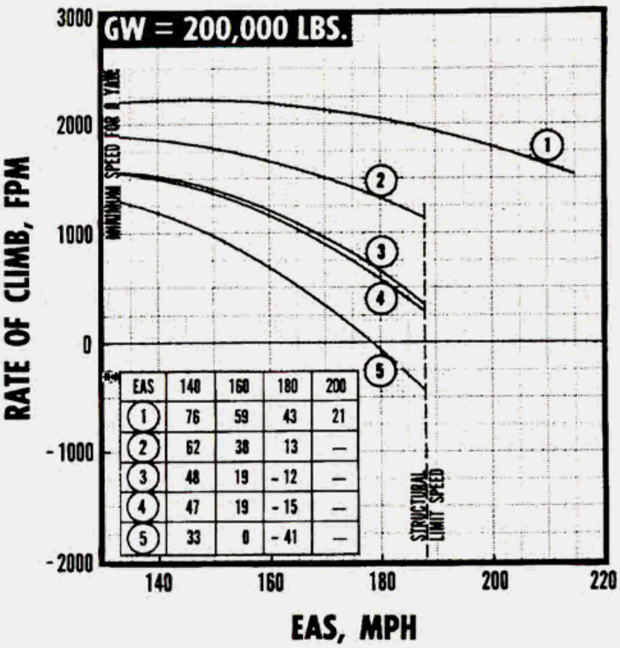
67-109-A

Figure A-108.

EMERGENCY CLIMB AT 5000 FEET

STANDARD ATMOSPHERE*

6 R4360-53 + 2 J47-GE-19 ENGINES OPERATING



** EAS	140	160	180	200
(1)	76	59	43	21
(2)	62	38	13	—
(3)	48	19	-12	—
(4)	47	19	-15	—
(5)	33	0	-41	—

NOTES: 1. AIRPLANE CONFIGURATIONS:

(1) Clean airplane.

(2) Wing flaps 20°, gear up.

(3) Wing flaps 20°, gear down.

(4) Wing flaps 30°, gear up.

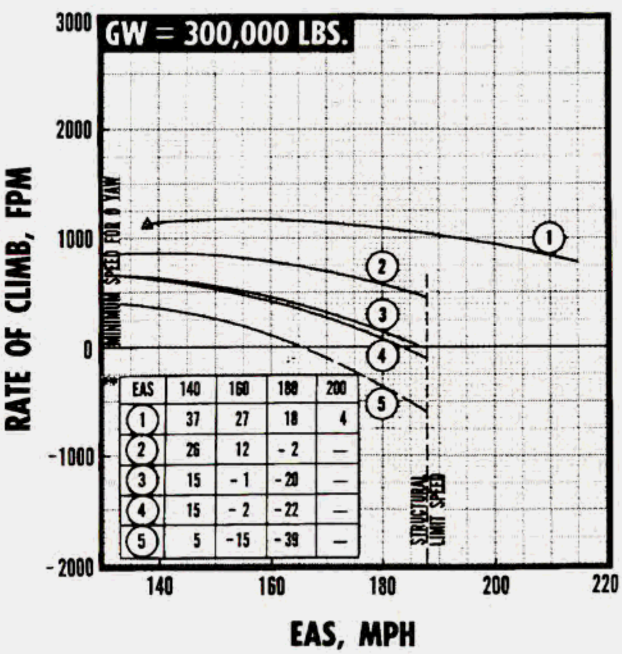
(5) Wing flaps 30°, gear down.

2. POWER CONDITIONS:
6 R4360-53 engines operating at 3500/2800 (BHP/RPM) per engine. 2 J47-GE-19 engines operating asymmetrically at 100% MRPM. Nose shutoff doors closed on inoperative jet engines.
3. COOLING DEVICE SETTINGS:
Air plugs fully open.
Intercooler shutters fully open.
Oil cooler doors automatic.
4. △Denotes 1.06 x V stall.
5. Oil-in temperature limits will be exceeded at air speeds less than 175 mph.

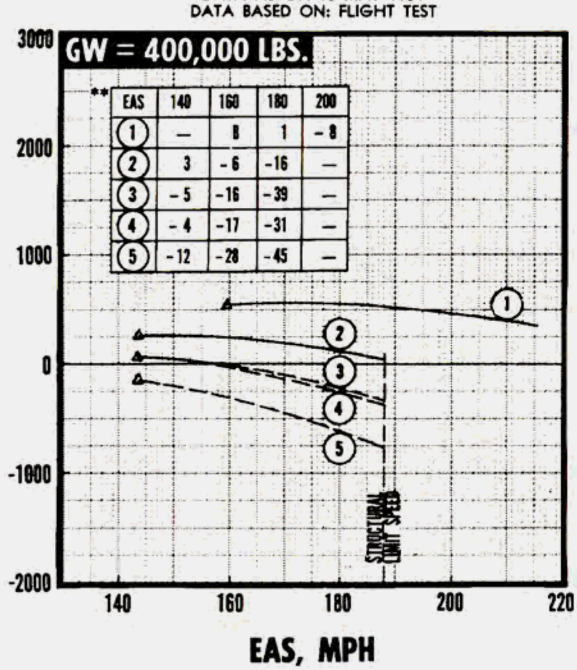
*6. 5000 feet pressure altitude (5.1°C)

**7. To obtain climb performance for Army Hot Day (28°C) condition, add algebraically the tabulated value corresponding to the particular combination of gross weight, airplane configuration and EAS to the value read from the curve.

DATA AS OF: 15 MAY 1954
DATA BASED ON: FLIGHT TEST



** EAS	140	160	180	200
(1)	37	27	18	4
(2)	26	12	-2	—
(3)	15	-1	-20	—
(4)	15	-2	-22	—
(5)	5	-15	-39	—



** EAS	140	160	180	200
(1)	—	8	1	-8
(2)	3	-6	-16	—
(3)	-5	-16	-39	—
(4)	-4	-17	-31	—
(5)	-12	-28	-45	—

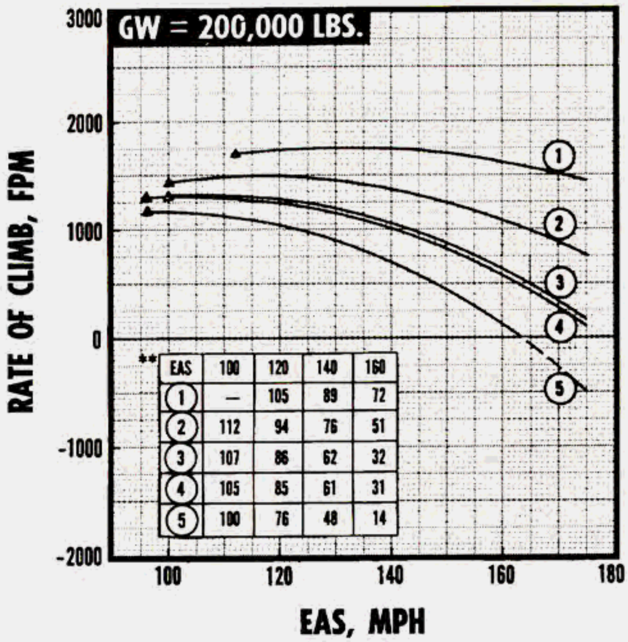
67-110-A

Figure A-109.

EMERGENCY CLIMB AT 5000 FEET

STANDARD ATMOSPHERE*

6 R4360-53 ENGINES OPERATING



** EAS	100	120	140	160
(1)	—	105	89	72
(2)	112	94	76	51
(3)	107	86	62	32
(4)	105	85	61	31
(5)	100	76	48	14

NOTES: 1. AIRPLANE CONFIGURATIONS:

(1) Clean airplane.

(2) Wing flaps 20°, gear up.

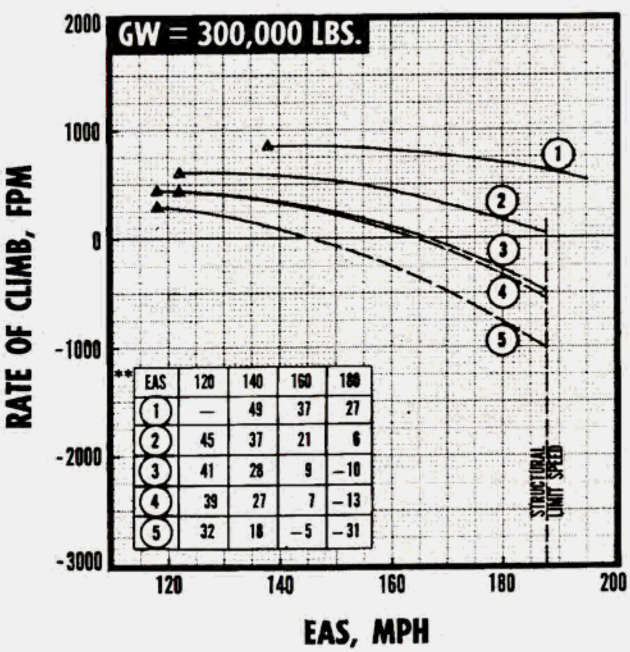
(3) Wing flaps 20°, gear down.

(4) Wing flaps 30°, gear up.

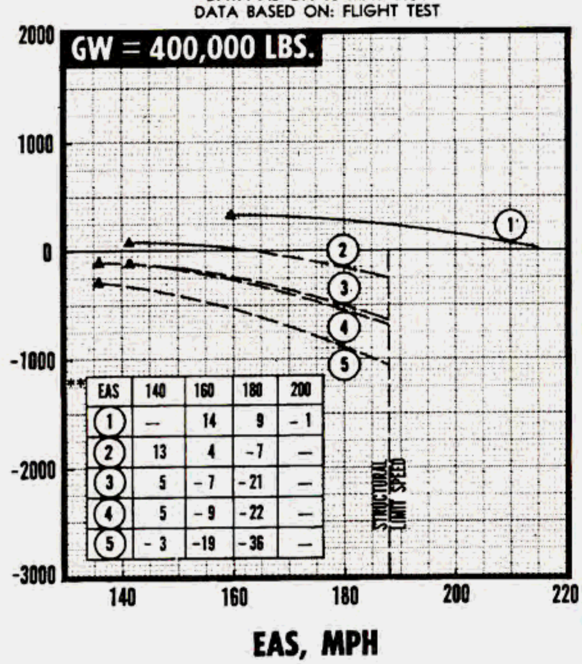
(5) Wing flaps 30°, gear down.

2. POWER CONDITIONS:
6 R4360-53 engines operating at 3500/2800 (BHP/RPM) per engine. Nose shutoff doors closed on inoperative jet engines.
3. COOLING DEVICE SETTINGS:
Air plugs fully open.
Intercooler shutters fully open.
Oil cooler doors automatic.
4. △ Denotes 1.06 x V stall.
5. Oil-in temperature limits will be exceeded at air speeds less than 175 mph.
*6. 5000 feet pressure altitude (5.1°C)
**7. To obtain climb performance for Army Hot Day (28°C) condition, add algebraically the tabulated value corresponding to the particular combination of gross weight, airplane configuration and EAS to the value read from the curve.

DATA AS OF: 15 MAY 1954
DATA BASED ON: FLIGHT TEST



** EAS	120	140	160	180
(1)	—	49	37	27
(2)	45	37	21	6
(3)	41	28	9	-10
(4)	39	27	7	-13
(5)	32	18	-5	-31



** EAS	140	160	180	200
(1)	—	14	9	-1
(2)	13	4	-7	—
(3)	5	-7	-21	—
(4)	5	-9	-22	—
(5)	-3	-19	-36	—

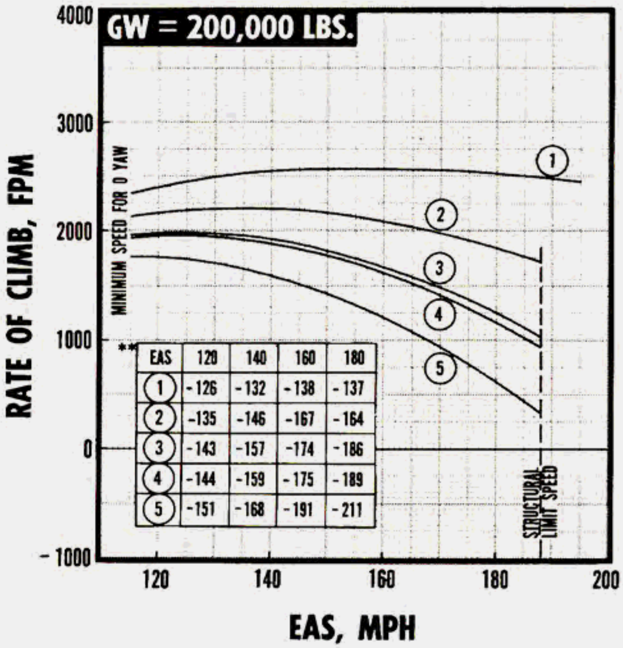
67-111-A

Figure A-110.

EMERGENCY CLIMB AT SEA LEVEL

STANDARD ATMOSPHERE *

5 R4360-53 + 4 J47-GE-19 ENGINES OPERATING



** EAS	120	140	160	180
(1)	-126	-132	-138	-137
(2)	-135	-146	-167	-164
(3)	-143	-157	-174	-186
(4)	-144	-159	-175	-189
(5)	-151	-168	-191	-211

NOTES: 1. AIRPLANE CONFIGURATIONS:

(1) Clean airplane.

(2) Wing flaps 20°, gear up.

(3) Wing flaps 20°, gear down.

(4) Wing flaps 30°, gear up.

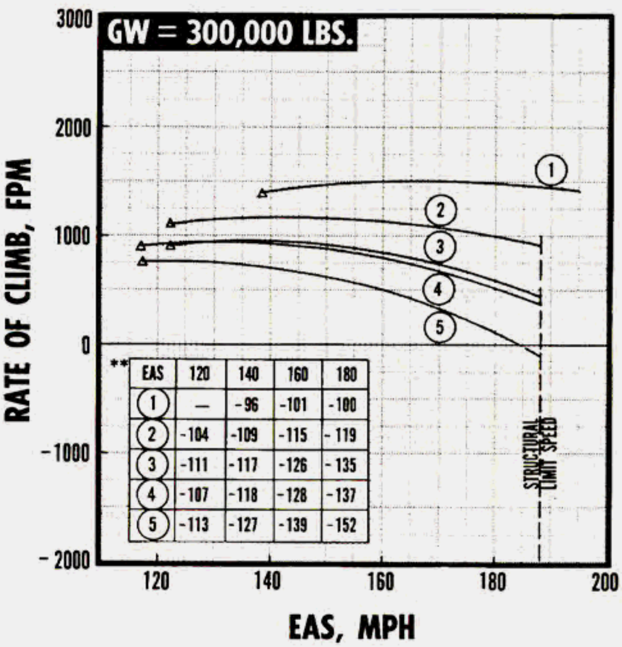
(5) Wing flaps 30°, gear down.

2. POWER CONDITIONS:
5 R4360-53 engines operating at 3300/2740 (BHP/RPM) per engine. Outboard propeller feathered. 4 J47-GE-19 engines operating at 100% MRPM.
3. COOLING DEVICE SETTINGS:
Air plugs fully open.
Intercooler shutters fully open.
Oil cooler doors automatic.
4. △ Denotes 1.06 x V stall.
5. Oil-in temperature limits will be exceeded at air speeds less than 185 mph. CAT. limits will be exceeded at air speeds less than 106 mph.

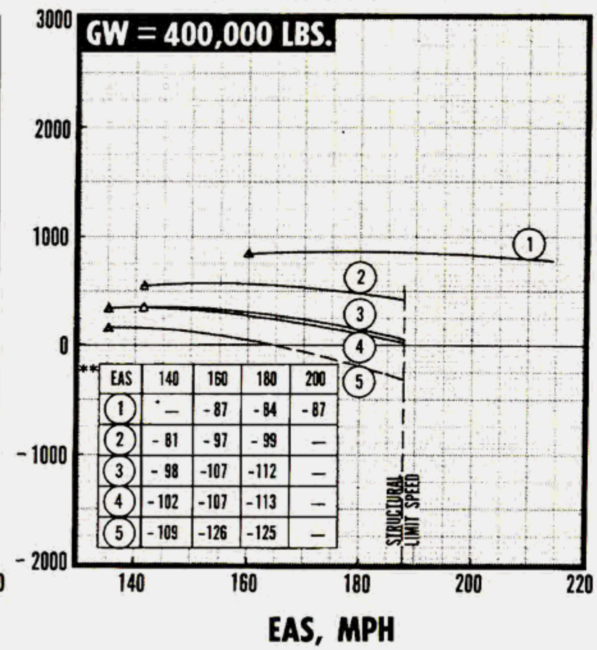
*6. Sea level pressure altitude (15°C).

**7. To obtain climb performance for Army Hot Day (38°C) condition, add algebraically the tabulated value corresponding to the particular combination of gross weight, airplane configuration and EAS to the value read from the curve.

DATA AS OF: 15 MAY 1954
DATA BASED ON: FLIGHT TEST



** EAS	120	140	160	180
(1)	—	-96	-101	-100
(2)	-104	-109	-115	-119
(3)	-111	-117	-126	-135
(4)	-107	-118	-128	-137
(5)	-113	-127	-139	-152



** EAS	140	160	180	200
(1)	—	- 87	- 84	- 87
(2)	- 81	- 97	- 99	—
(3)	- 98	-107	-112	—
(4)	- 102	-107	-113	—
(5)	- 109	-126	-125	—

67-105-A

Figure A-111.

EMERGENCY CLIMB AT SEA LEVEL

STANDARD ATMOSPHERE *

5 R4360-53 + 2 J47-GE-19 ENGINES OPERATING

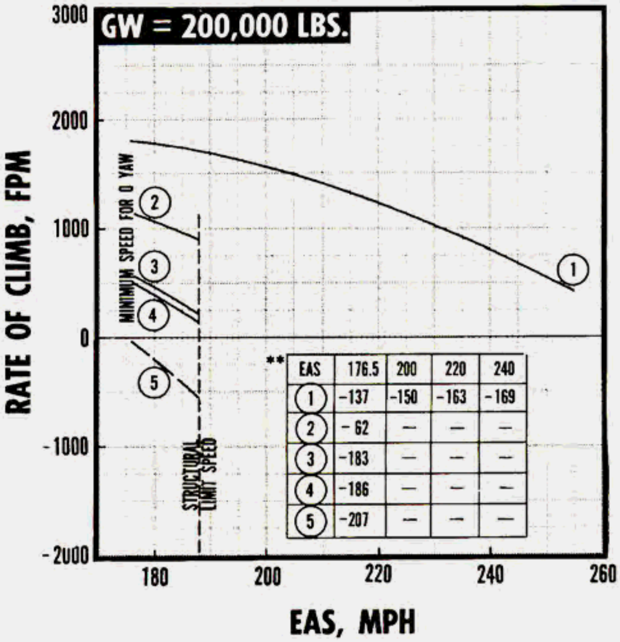
NOTES: 1. AIRPLANE CONFIGURATIONS
- (1) Clean airplane.
- (2) Wing flaps 20°, gear up.
- (3) Wing flaps 20°, gear down.
- (4) Wing flaps 30°, gear up.
- (5) Wing flaps 30°, gear down.

2. POWER CONDITIONS: 5 R4360-53 engines operating at 3300/2740 (BHP/RPM) per engine. Outboard propeller feathered. 2 J47-GE-19 engines operating asymmetrically at 100% MRPM. Nose shut-off doors closed on inoperative jet engines.
3. COOLING DEVICE SETTINGS: Air plugs fully open. Intercooler shutters fully open. Oil cooler doors automatic.
4. △ Denotes 1.06 x V stall.
5. Oil-in temperature limits will be exceeded at air speeds less than 185 mph. CAT. limits will be exceeded at air speeds less than 106 mph.

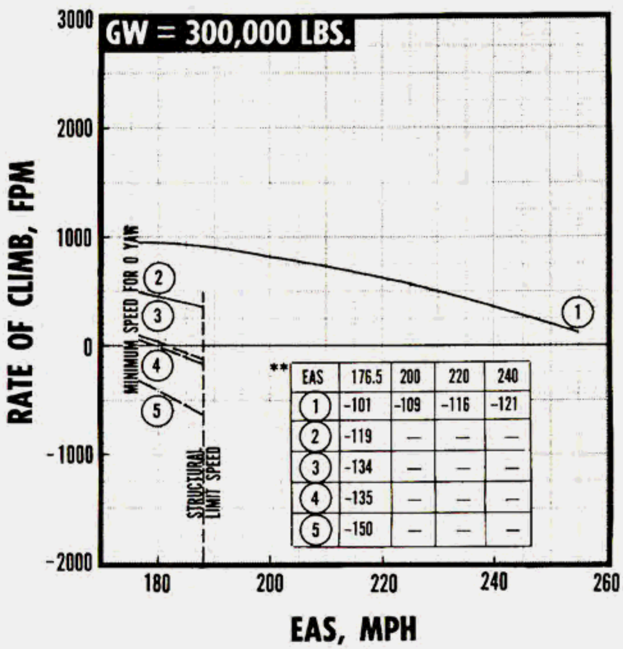
*6. Sea level pressure altitude (15°C).

**7. To obtain climb performance for Army Hot Day (38°C) condition, add algebraically the tabulated value corresponding to the particular combination of gross weight, airplane configuration and EAS to the value read from the curve.

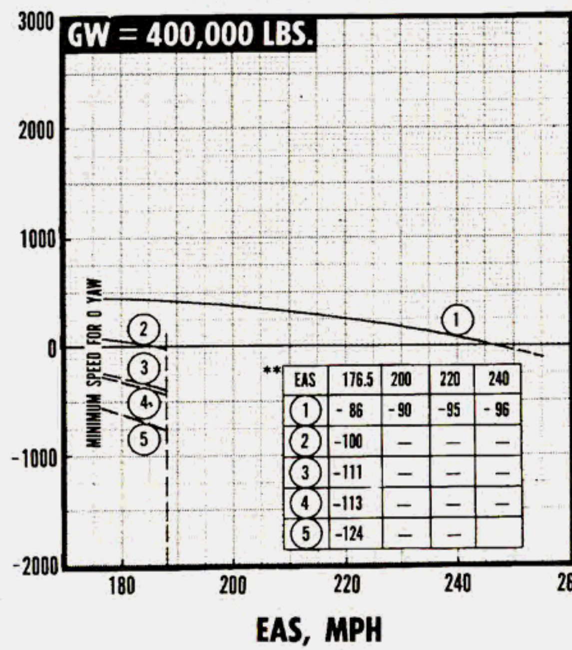
DATA AS OF: 15 MAY 1954
DATA BASED ON: FLIGHT TEST



** EAS	176.5	200	220	240
(1)	-137	-150	-163	-169
(2)	- 62	—	—	—
(3)	-183	—	—	—
(4)	-186	—	—	—
(5)	-207	—	—	—



** EAS	176.5	200	220	240
(1)	-101	-109	-116	-121
(2)	-119	—	—	—
(3)	-134	—	—	—
(4)	-135	—	—	—
(5)	-150	—	—	—



** EAS	176.5	200	220	240
(1)	- 86	- 90	-95	- 96
(2)	-100	—	—	—
(3)	-111	—	—	—
(4)	-113	—	—	—
(5)	-124	—	—	

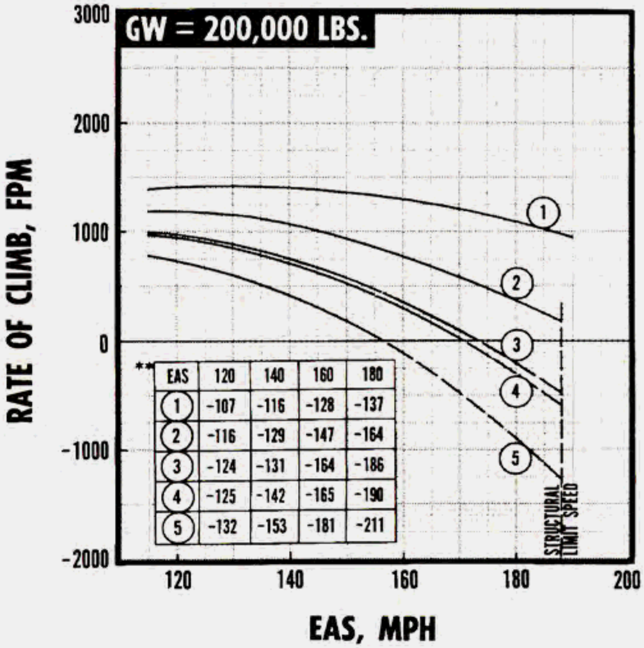
67-106-A

Figure A-112.

EMERGENCY CLIMB AT SEA LEVEL

STANDARD ATMOSPHERE*

5 R4360-53 ENGINES OPERATING



EAS	120	140	160	180
(1)	-107	-116	-128	-137
(2)	-116	-129	-147	-164
(3)	-124	-131	-164	-186
(4)	-125	-142	-165	-190
(5)	-132	-153	-181	-211

NOTES: 1. AIRPLANE CONFIGURATIONS:
(1) Clean airplane.
(2) Wing flaps 20°, gear up.
(3) Wing flaps 20°, gear down.
(4) Wing flaps 30°, gear up.
(5) Wing flaps 30°, gear down.

2. POWER CONDITIONS:
5 R4360-53 engines operating at 3300/2740 (BHP/RPM) per engine. Outboard propeller feathered. Nose shutoff doors closed on inoperative jet engines.

3. COOLING DEVICE SETTINGS:
Air plugs fully open.
Intercooler shutters fully open.
Oil cooler doors automatic.

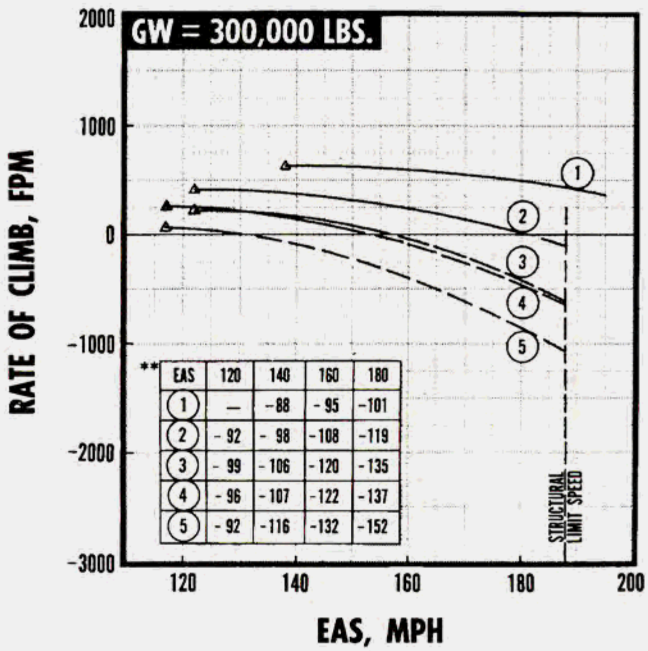
4. △ Denotes 1.06 x V stall.

5. Oil-in temperature limits will be exceeded at air speeds less than 185 mph. CAT. limits will be exceeded at air speeds less than 106 mph.

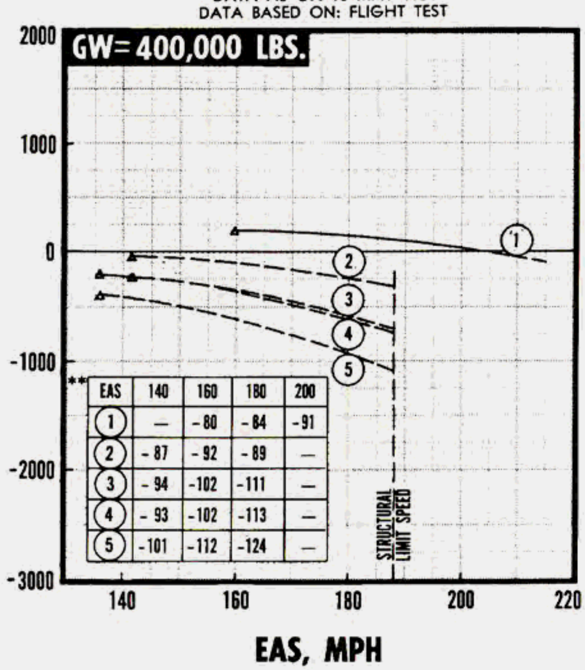
*6. Sea level pressure altitude (15°C).

**7. To obtain climb performance for Army Hot Day (38°C) condition, add algebraically the tabulated value corresponding to the particular combination of gross weight, airplane configuration and EAS to the value read from the curve.

DATA AS OF: 15 MAY 1954
DATA BASED ON: FLIGHT TEST



EAS	120	140	160	180
(1)	—	-88	-95	-101
(2)	-92	-98	-108	-119
(3)	-99	-106	-120	-135
(4)	-96	-107	-122	-137
(5)	-92	-116	-132	-152



EAS	140	160	180	200
(1)	—	-80	-84	-91
(2)	-87	-92	-89	—
(3)	-94	-102	-111	—
(4)	-93	-102	-113	—
(5)	-101	-112	-124	—

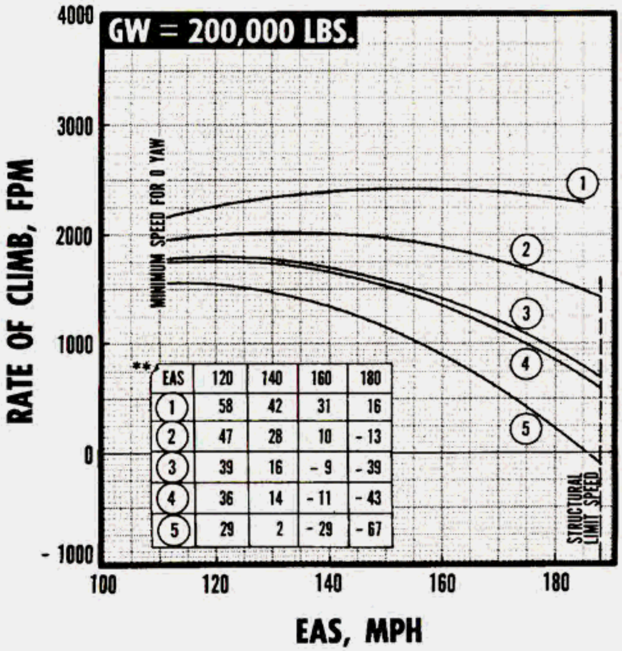
Figure A-113.

67-107-A

EMERGENCY CLIMB AT 5000 FEET

STANDARD ATMOSPHERE*

5 R4360-53 + 4 J47-GE-19 ENGINES OPERATING



** EAS	120	140	160	180
(1)	58	42	31	16
(2)	47	28	10	- 13
(3)	39	16	- 9	- 39
(4)	36	14	- 11	- 43
(5)	29	2	- 29	- 67

NOTES: 1. AIRPLANE CONFIGURATIONS:

(1) Clean airplane.

(2) Wing flaps 20°, gear up.

(3) Wing flaps 20°, gear down.

(4) Wing flaps 30°, gear up.

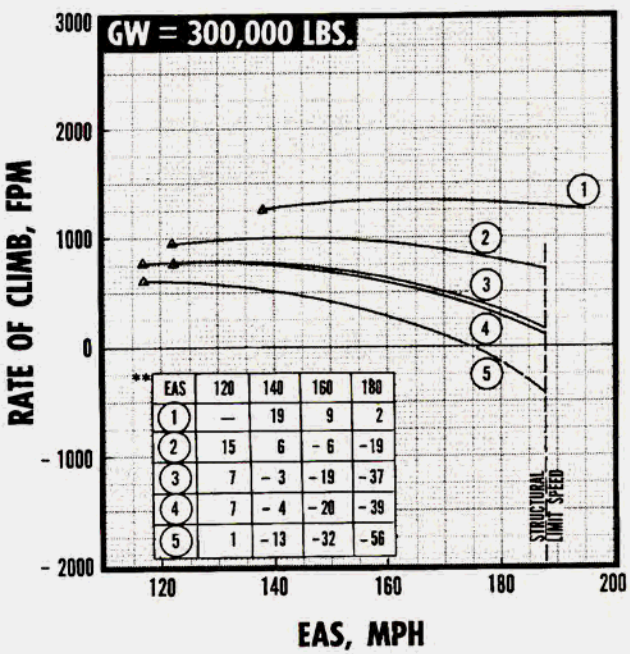
(5) Wing flaps 30°, gear down.

2. POWER CONDITIONS:
5 R4360-53 engines operating at 3500/2800 (BHP/RPM) per engine. Outboard propeller feathered. 4 J47-GE-19 engines operating at 100% MRPM.
3. COOLING DEVICE SETTINGS:
Air plugs fully open.
Intercooler shutters fully open.
Oil cooler doors automatic.
4. △ Denotes 1.06 x V stall.
5. Oil-in temperature limits will be exceeded at air speeds less than 175 mph.

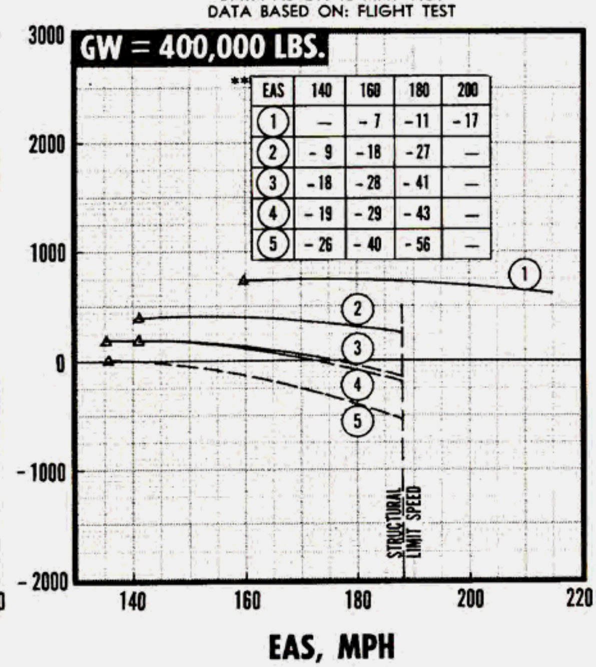
*6. 5000 feet pressure altitude (5.1°C)

**7. To obtain climb performance for Army Hot Day (28°C) condition, add algebraically the tabulated value corresponding to the particular combination of gross weight, airplane configuration and EAS to the value read from the curve.

DATA AS OF: 15 MAY 1954
DATA BASED ON: FLIGHT TEST



** EAS	120	140	160	180
(1)	—	19	9	2
(2)	15	6	- 6	- 19
(3)	7	- 3	- 19	- 37
(4)	7	- 4	- 20	- 39
(5)	1	- 13	- 32	- 56



** EAS	140	160	180	200
(1)	—	- 7	- 11	- 17
(2)	- 9	- 18	- 27	—
(3)	- 18	- 28	- 41	—
(4)	- 19	- 29	- 43	—
(5)	- 26	- 40	- 56	—

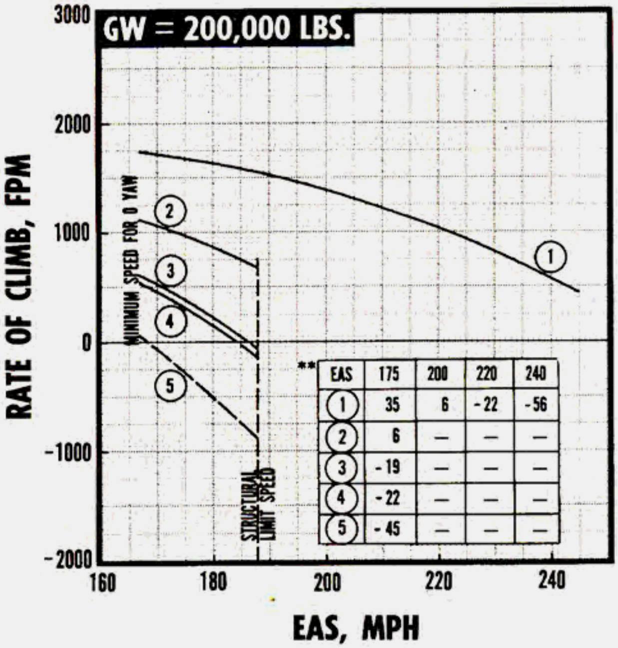
67-112-A

Figure A-114.

EMERGENCY CLIMB AT 5000 FEET

STANDARD ATMOSPHERE *

5 R4360-53 + 2 J47-GE-19 ENGINES OPERATING



** EAS	175	200	220	240
(1)	35	6	-22	-56
(2)	6	—	—	—
(3)	-19	—	—	—
(4)	-22	—	—	—
(5)	-45	—	—	—

NOTES: 1. AIRPLANE CONFIGURATIONS:

(1) Clean airplane.

(2) Wing flaps 20°, gear up.

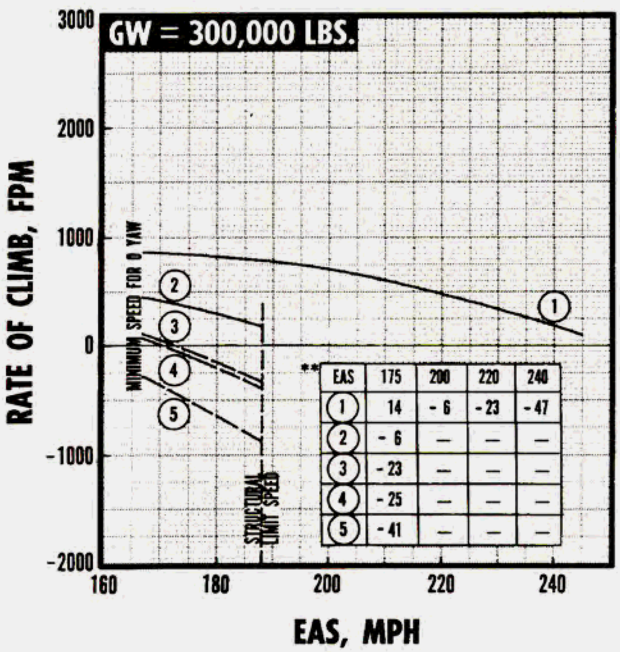
(3) Wing flaps 20°, gear down.

(4) Wing flaps 30°, gear up.

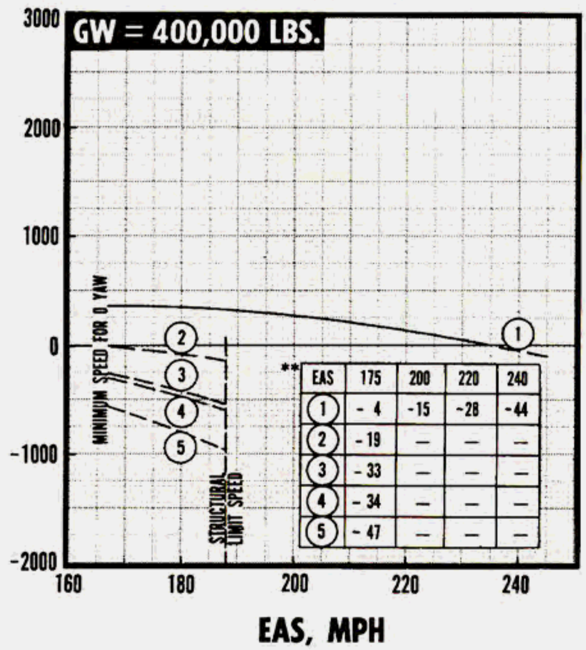
(5) Wing flaps 30°, gear down.

2. POWER CONDITIONS:
5 R4360-53 engines operating at 3500/2800 (BHP/RPM) per engine. Outboard propeller feathered. 2 J47-GE-19 engines operating asymmetrically at 100% MRPM. Nose shut-off doors closed on inoperative jet engines.
3. COOLING DEVICE SETTINGS:
Air plugs fully open.
Intercooler shutters fully open.
Oil cooler doors automatic.
4. △ Denotes 1.06 x V stall.
5. Oil-in temperature limits will be exceeded at air speeds less than 175 mph.
*6. 5000 feet pressure altitude (5.1°C)
**7. To obtain climb performance for Army Hot Day (28°C) condition, add algebraically the tabulated value corresponding to the particular combination of gross weight, airplane configuration and EAS to the value read from the curve.

DATA AS OF: 15 MAY 1954
DATA BASED ON: FLIGHT TEST



** EAS	175	200	220	240
(1)	14	-6	-23	-47
(2)	-6	—	—	—
(3)	-23	—	—	—
(4)	-25	—	—	—
(5)	-41	—	—	—



** EAS	175	200	220	240
(1)	-4	-15	-28	-44
(2)	-19	—	—	—
(3)	-33	—	—	—
(4)	-34	—	—	—
(5)	-47	—	—	—

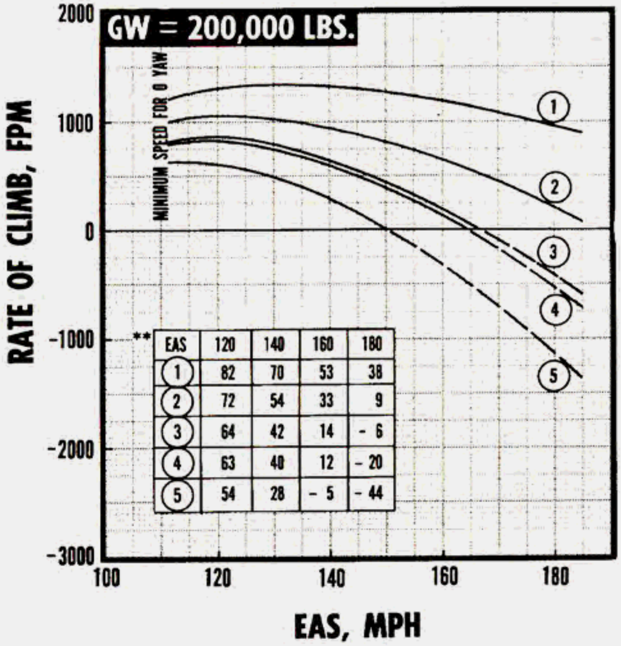
67-113-A

Figure A-115.

EMERGENCY CLIMB AT 5000 FEET

STANDARD ATMOSPHERE *

5 R4360-53 ENGINES OPERATING



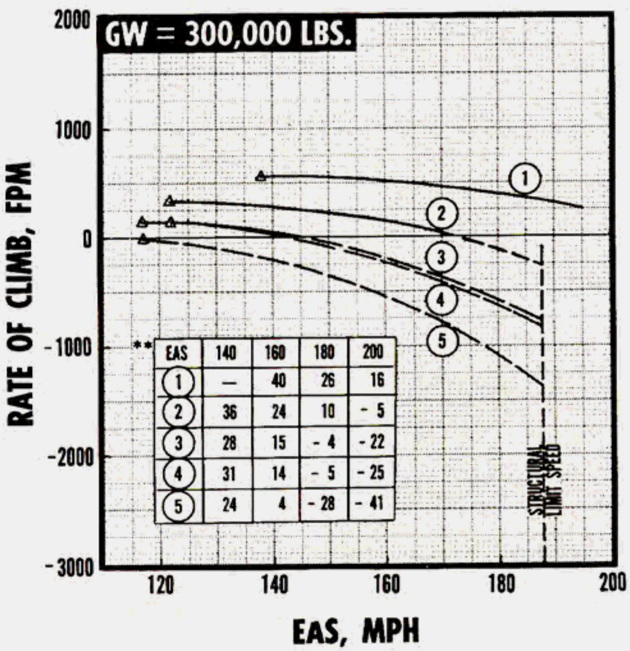
EAS	120	140	160	180
(1)	82	70	53	38
(2)	72	54	33	9
(3)	64	42	14	- 6
(4)	63	40	12	- 20
(5)	54	28	- 5	- 44

NOTES: 1. AIRPLANE CONFIGURATIONS:

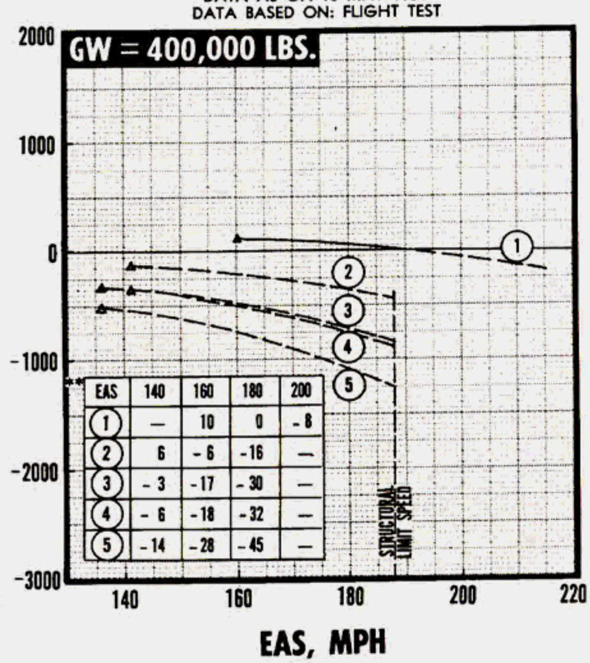
(1) Clean airplane.
(2) Wing flaps 20°, gear up.
(3) Wing flaps 20°, gear down.
(4) Wing flaps 30°, gear up.
(5) Wing flaps 30°, gear down.

2. POWER CONDITIONS:
5 R4360-53 engines operating at 3500/2800 (BHP/RPM) per engine. Outboard propeller feathered. Nose shutoff doors closed on inoperative jet engines.
3. COOLING DEVICE SETTINGS:
Air plugs fully open.
Intercooler shutters fully open.
Oil cooler doors automatic.
4. △ Denotes 1.06 x V stall.
5. Oil-in temperature limits will be exceeded at air speeds less than 175 mph.
*6. 5000 feet pressure altitude (5.1°C)
**7. To obtain climb performance for Army Hot Day (28°C) condition, add algebraically the tabulated value corresponding to the particular combination of gross weight, airplane configuration and EAS to the value read from the curve.

DATA AS OF: 15 MAY 1954
DATA BASED ON: FLIGHT TEST



EAS	140	160	180	200
(1)	—	40	26	16
(2)	36	24	10	- 5
(3)	28	15	- 4	- 22
(4)	31	14	- 5	- 25
(5)	24	4	- 28	- 41



EAS	140	160	180	200
(1)	—	10	0	- 8
(2)	6	- 6	- 16	—
(3)	- 3	- 17	- 30	—
(4)	- 6	- 18	- 32	—
(5)	- 14	- 28	- 45	—

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Figure A-116.

EMERGENCY CLIMB AT SEA LEVEL

STANDARD ATMOSPHERE *

4 R4360-53 + 4 J47-GE-19 ENGINES OPERATING

NOTES: 1. AIRPLANE CONFIGURATIONS:

(1) Clean airplane.

(2) Wing flaps 20°, gear up.

(3) Wing flaps 20°, gear down.

(4) Wing flaps 30°, gear up.

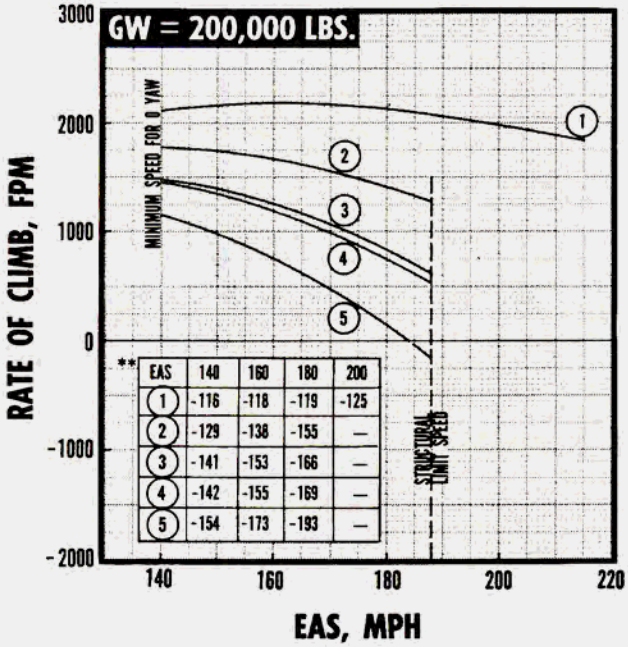
(5) Wing flaps 30°, gear down.

2. POWER CONDITIONS:
4 R4360-53 engines operating asymmetrically at 3300/2740 (BHP/RPM) per engine. Inoperative propellers feathered. 4 J47-GE-19 engines operating at 100% MRPM.
3. COOLING DEVICE SETTINGS:
Air plugs fully open.
Intercooler shutters fully open.
Oil cooler doors automatic.
4. △ Denotes 1.06 x V stall.
5. Oil-in temperature limits will be exceeded at air speeds less than 185 mph. CAT. limits will be exceeded at air speeds less than 106 mph.

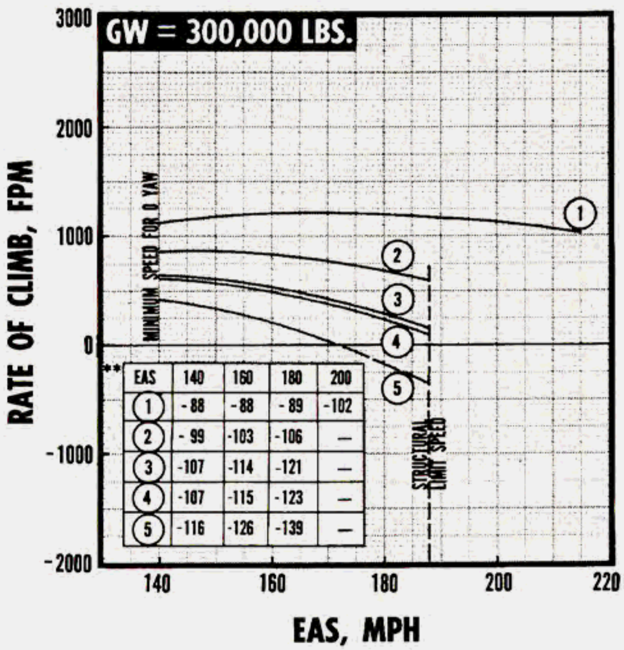
*6. Sea level pressure altitude (15°C).

**7. To obtain climb performance for Army Hot Day (38°C) condition, add algebraically the tabulated value corresponding to the particular combination of gross weight, airplane configuration and EAS to the value read from the curve.

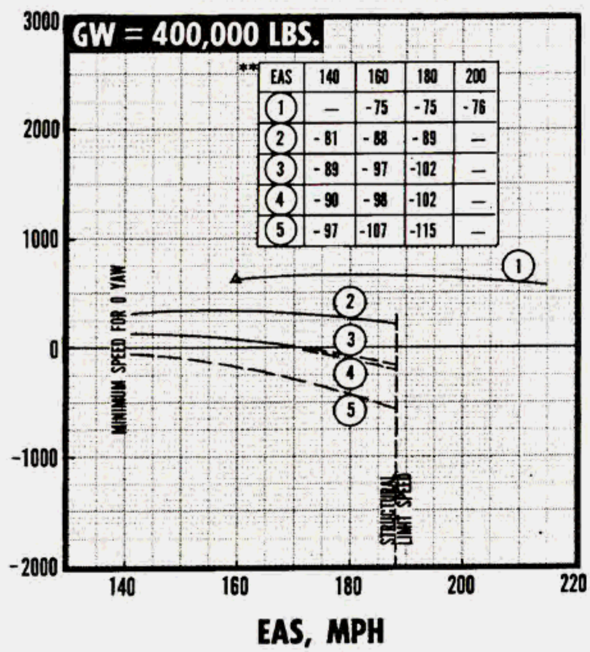
DATA AS OF: 15 MAY 1954
DATA BASED ON: FLIGHT TEST



EAS	140	160	180	200
①	-116	-118	-119	-125
②	-129	-138	-155	—
③	-141	-153	-166	—
④	-142	-155	-169	—
⑤	-154	-173	-193	—



EAS	140	160	180	200
①	-88	-88	-89	-102
②	-99	-103	-106	—
③	-107	-114	-121	—
④	-107	-115	-123	—
⑤	-116	-126	-139	—



EAS	140	160	180	200
①	—	-75	-75	-76
②	-81	-88	-89	—
③	-89	-97	-102	—
④	-90	-98	-102	—
⑤	-97	-107	-115	—

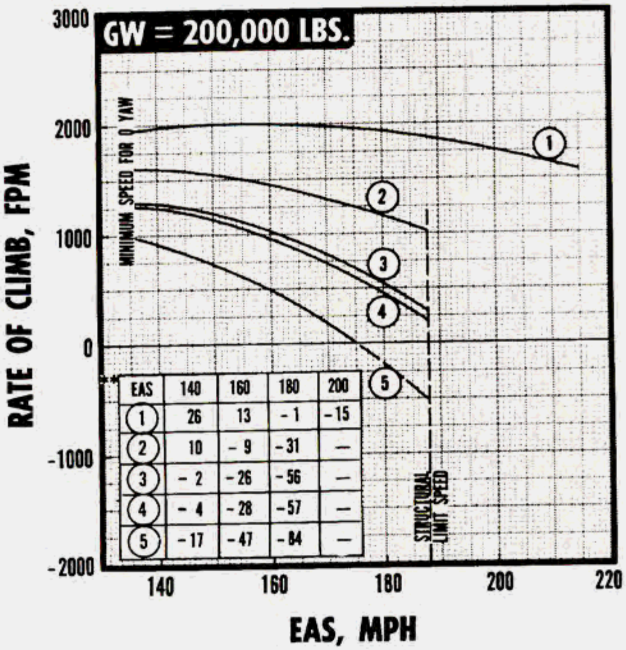
67-108-A

Figure A-117.

EMERGENCY CLIMB AT 5000 FEET

STANDARD ATMOSPHERE*

4 R4360-53 + 4 J47-GE-19 ENGINES OPERATING



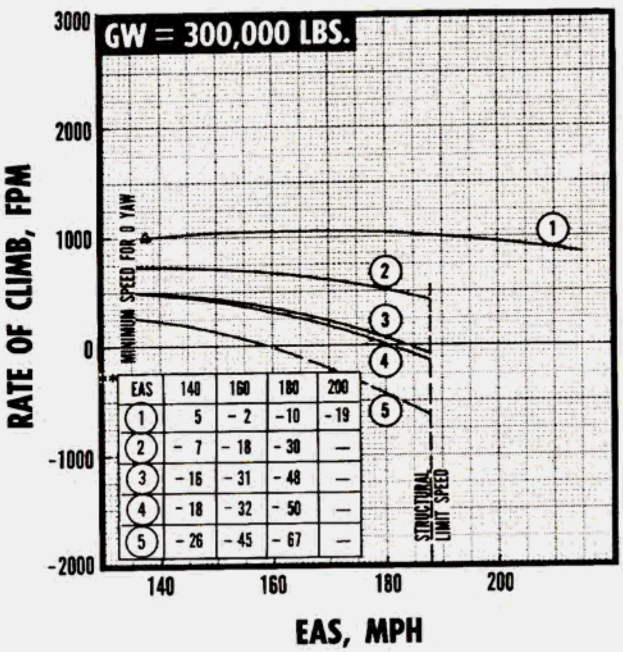
EAS	140	160	180	200
(1)	26	13	-1	-15
(2)	10	-9	-31	—
(3)	-2	-26	-56	—
(4)	-4	-28	-57	—
(5)	-17	-47	-84	—

NOTES: 1. AIRPLANE CONFIGURATIONS:

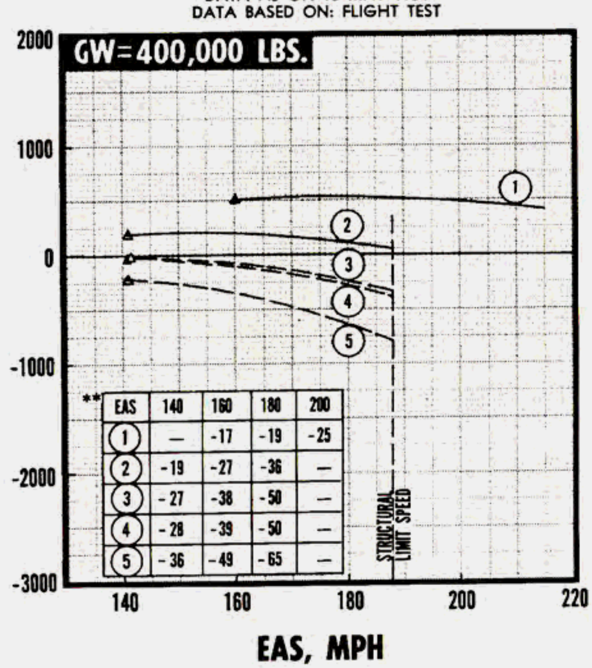
(1) Clean airplane.
(2) Wing flaps 20°, gear up.
(3) Wing flaps 20°, gear down.
(4) Wing flaps 30°, gear up.
(5) Wing flaps 30°, gear down.

2. POWER CONDITIONS:
4 R4360-53 engines operating asymmetrically at 3500/2800 (BHP/RPM) per engine. Inoperative propellers feathered. 4 J47-GE-19 engines operating at 100% MRPM.
3. COOLING DEVICE SETTINGS:
Air plugs fully open.
Intercooler shutters fully open.
Oil cooler doors automatic.
4. △Denotes 1.06 x V stall.
5. Oil-in temperature limits will be exceeded at air speeds less than 175 mph.
*6. 5000 feet pressure altitude (5.1°C)
**7. To obtain climb performance for Army Hot Day (28°C) condition, add algebraically the tabulated value corresponding to the particular combination of gross weight, airplane configuration and EAS to the value read from the curve.

DATA AS OF: 15 MAY 1954
DATA BASED ON: FLIGHT TEST



EAS	140	160	180	200
(1)	5	-2	-10	-19
(2)	-7	-18	-30	—
(3)	-16	-31	-48	—
(4)	-18	-32	-50	—
(5)	-26	-45	-67	—



EAS	140	160	180	200
(1)	—	-17	-19	-25
(2)	-19	-27	-36	—
(3)	-27	-38	-50	—
(4)	-28	-39	-50	—
(5)	-36	-49	-65	—

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Figure A-118.

CLIMB CONTROL.

The climb performance curves present time, range, and fuel consumed in climb to a selected altitude. The long range climb curves are presented in gross weight groups, each group having been developed for a constant speed. The engine power settings and cooling device openings for long range climb are given on each long range climb chart. A table accompanying the maximum continuous power curves gives engine power settings, cooling device openings, and climb speeds required to obtain this climb performance.

Power settings chosen for maximum continuous power climb represents a compromise designed to give the best possible climb performance commensurate with adequate cooling, high propulsive efficiency, and a minimum number of power changes. Long range climb power settings were selected to afford the greatest range upon arrival at any desired altitude with any desired weight after take-off or after a cruise at any lower altitude.

Note

> Long range climb control should be used whenever possible because it furnishes greater range and longer engine life.

Since it is necessary to make frequent power changes during the latter stages of a high altitude climb in order to approach the absolute ceiling capabilites of the airplane, an optimum climb power schedule (figure A-119) is included to show the maximum R4360-53 engine power obtainable at any altitude from 30,000 to 52,500 feet. This power schedule must be rigidly followed in lieu of the tabulated schedule for maximum continuous power climb in order to attain the maximum altitudes indicated by the shaded areas of figure A-125.

The optimum climb power schedule must likewise be followed above the altitudes indicated on the long range climb charts in order to attain maximum altitudes.

Air speeds shown in the table accompanying the maximum continuous power climb charts should be maintained during the climb to maximum altitudes. Constant climb speeds as given on each long range climb chart should be maintained during climb to the altitude indicated, at which time optimum climb speeds and powers are to be maintained in climb to maximum attainable altitude.

Engine power settings and climb speeds at maximum attainable altitudes are presented in "Operating Conditions for Maximum Attainable Altitude" of this section.

It should be noted in the maximum continuous power climb control schedule that the power setting given to arrive at 40,000 feet altitude must be reduced sufficiently at climb speeds below 158 mph EAS to maintain, but not exceed, the intercooler temperature limit. A decrease in power (while maintaining constant rpm) is also required in climbing from 40,000 to 42,500 feet altitude at speeds below 153 mph EAS in order to maintain, but not to exceed, engine cooling temperature limits.

Low engine cooling fan ratio produces a greater net power and consequently a higher rate of climb than high fan ratio. Therefore, low fan ratio should be used whenever possible. Because of cooling requirements, however, it is necessary to operate in high fan ratio at very high altitudes except under adverse atmospheric conditions. Climb schedules, therefore, include both high and low fan ratio operation for the critical altitudes region.

Note

> To obtain maximum continuous power climb performance with one reciprocating engine inoperative add the correction gross weight (given on the maximum continuous power climb performance charts) to the actual gross weight of the airplane and enter the appropriate climb chart. Remember, after the climb performance has been determined subtract the correction weight from the equivalent weight to get the actual weight of the airplane.

Note

> To obtain long range climb performance with one reciprocating engine inoperative, add the correction gross weight (given on the long range climb performance charts) to the actual gross weight of the airplane and enter the appropriate climb chart. In utilizing the correction weight for long range climb it is necessary to regain the thrust lost by the one inoperative engine by a 20 per cent increase in power on each of the remaining operative reciprocating engines. Remember after the climb performance has been determined subtract the correction weight from the equivalent weight to obtain the actual weight of the airplane.

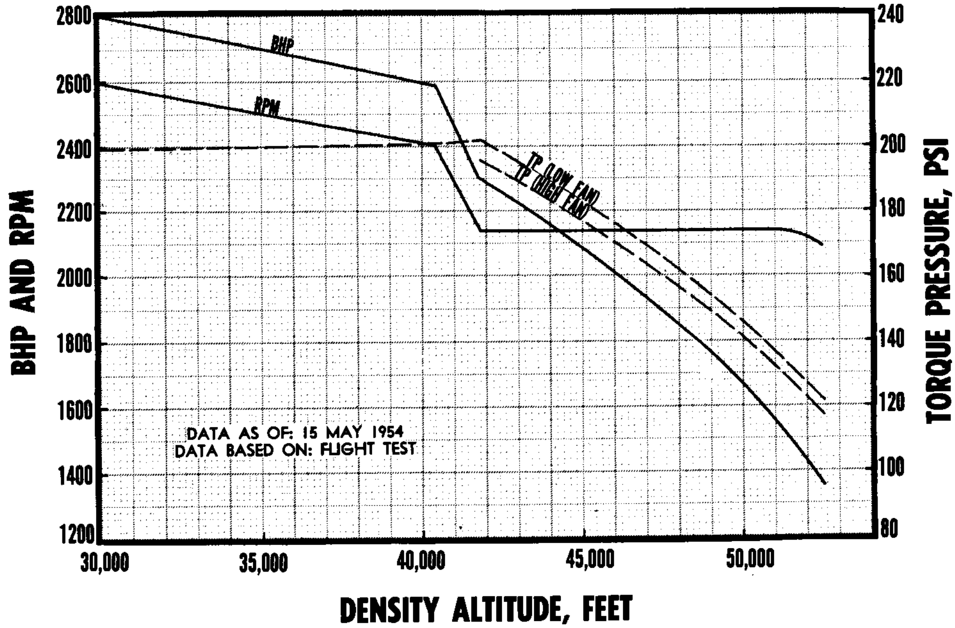
The following examples should clarify use of both maximum continuous power and long range climb charts.

LONG RANGE CLIMB EXAMPLE.

Assume a climb to 25,000 feet to begin at a sea level take-off gross weight of 342,500 pounds. Determine the time, range, and fuel consumed in the climb, using the long range climb power schedule.

Enter figure A-122 at a gross weight (at sea level) of 342,500 pounds (A). Moving parallel to the guide lines, read at the 25,000 foot altitude line (B) the time in climb of 51.5 minutes and the corresponding range in climb of 152 nautical miles (by interpolation). From the horizontal scale, read the gross weight at 25,000 feet of 328,800 pounds. The fuel consumed in climb is then 342,500 — 328,800 or 13,700 pounds.

OPTIMUM CLIMB POWER ABOVE 30,000 FEET



67-253-A

Figure A-119.

MAXIMUM CONTINUOUS POWER CLIMB.

EXAMPLE.

For an initial gross weight of 320,000 pounds, determine the time, range, and the fuel consumed in climbing from 25,000 feet to 35,000 feet, using six reciprocating and four jet engines at maximum continuous power.

Enter figure A-125 at a gross weight of 320,000 pounds (A) and move vertically to the 25,000-foot altitude line (B). Read a time (C) of 26.6 minutes and (by interpolation) a range of 80.2 nautical miles. Move parallel to the guide lines to the 35,000-foot altitude line (D) and read a time (E) of 46.1 minutes. Interpolation gives a range of 154 nautical miles and a gross weight (F) of 313,500 pounds. The range covered in climb is 154 — 80.2 = 73.8 nautical miles. Similarly, the time is 46.1 — 26.6 = 19.5 minutes and the fuel consumed is 320,000 — 313,500 or 6500 pounds. The specific range for this example is $\frac{73.8}{6500}$ = 0.01136 nautical miles per pound of fuel.

Had the above example been calculated using long range climb (at a constant EAS of 165 mph) instead of maximum continuous power climb, the time, range, and fuel consumed would have been 28.4 minutes, 111.2 nautical miles, and 7,700 pounds, respectively. The nautical miles per pound for this example would have been $\frac{111.2}{7700}$ = 0.01444. It is therefore obvious that long range climb affords greater economy and should be used whenever possible.

LONG RANGE CLIMB PERFORMANCE

STANDARD ATMOSPHERE

6 R4360-53 + 4 J47-GE-19 ENGINES OPERATING

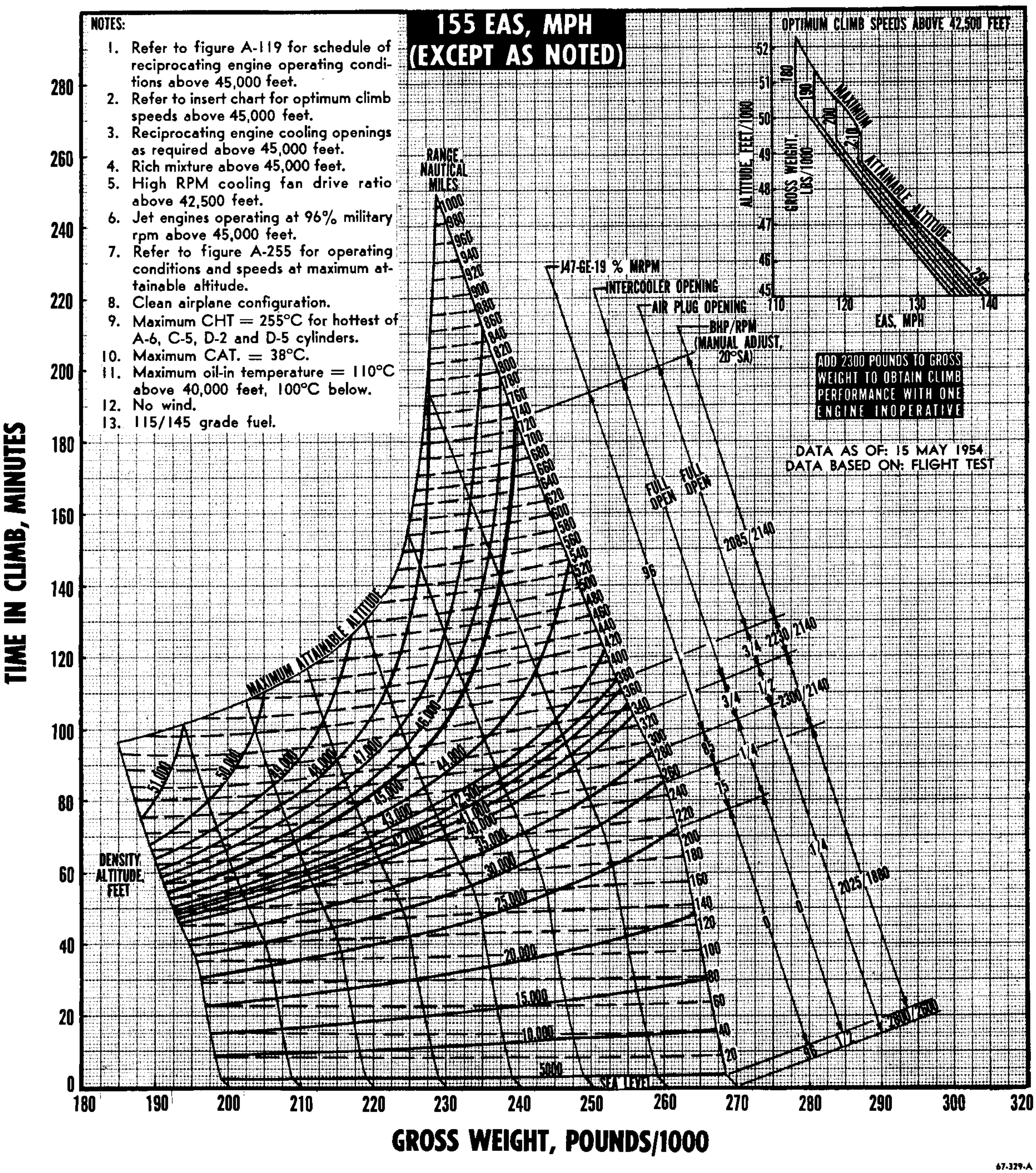


Figure A-120.

LONG RANGE CLIMB PERFORMANCE

STANDARD ATMOSPHERE

6 R4360-53 + 4 J47-GE-19 ENGINES OPERATING AS NOTED

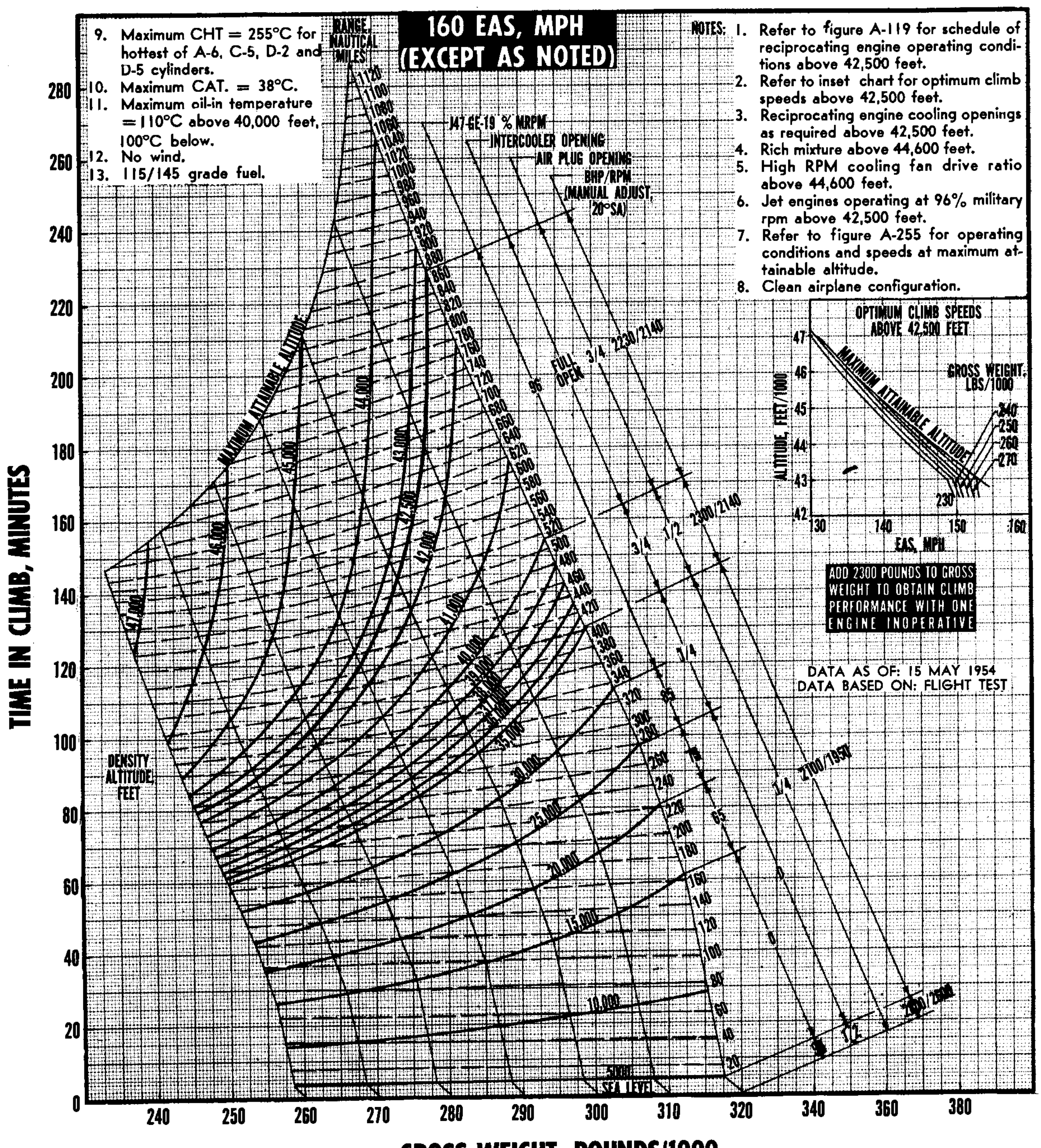


Figure A-121.

LONG RANGE CLIMB PERFORMANCE

STANDARD ATMOSPHERE

6 R4360-53 + 4 J47-GE-19 ENGINES OPERATING

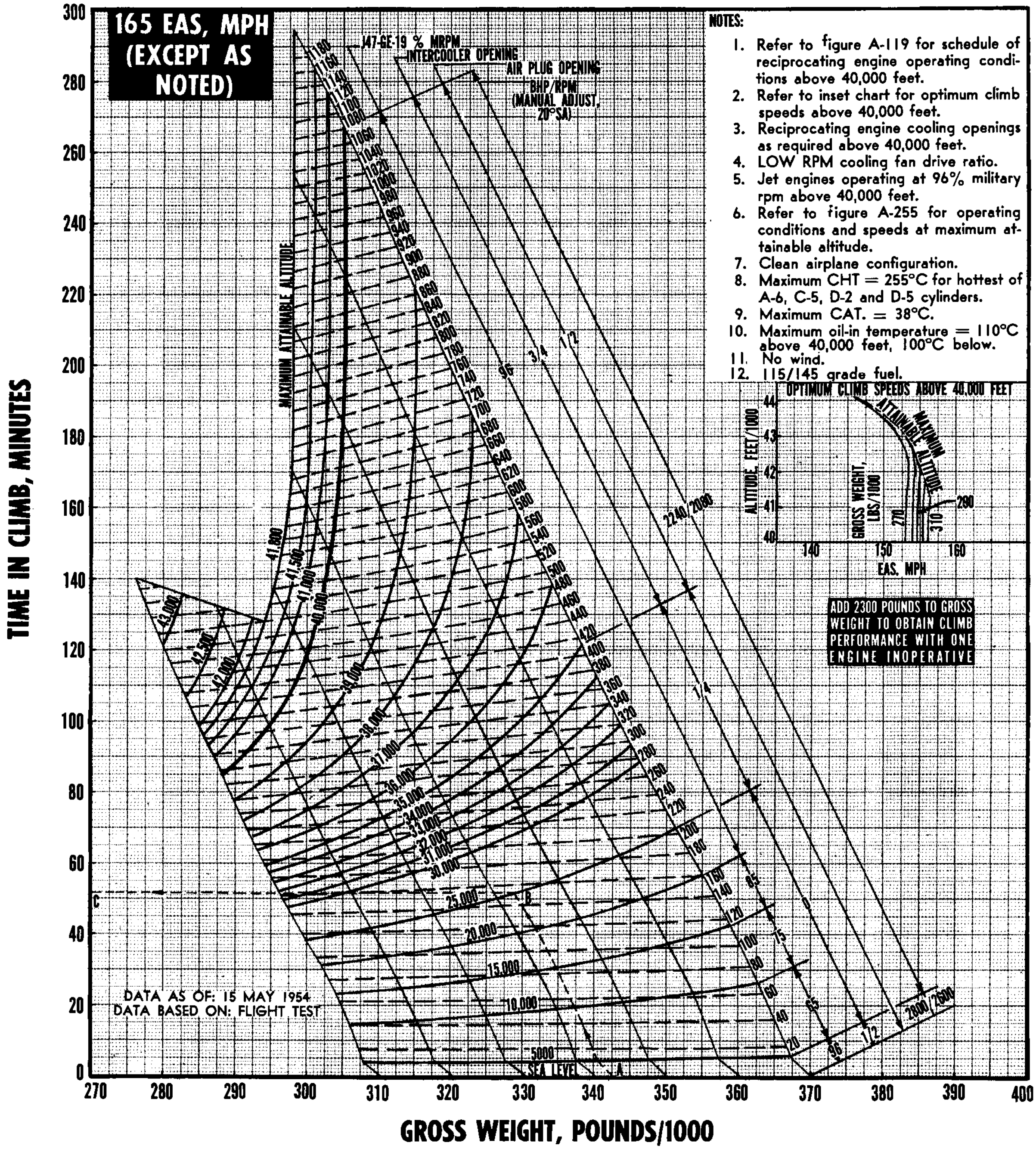


Figure A-122.

LONG RANGE CLIMB PERFORMANCE

STANDARD ATMOSPHERE

6 R4360-53 + 4 J47-GE-19 ENGINES OPERATING AS NOTED

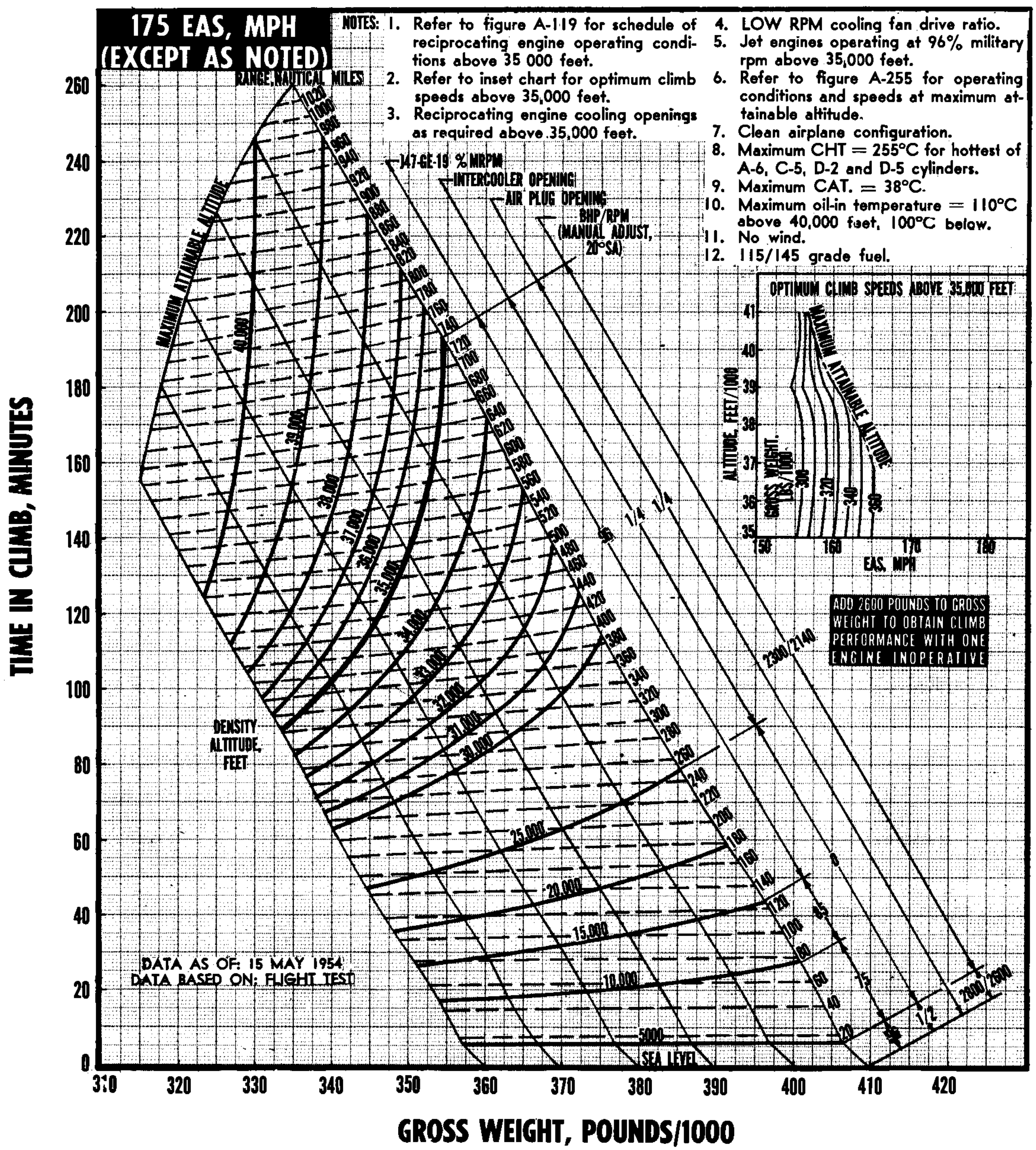


Figure A-123.

MAXIMUM CONTINUOUS POWER CLIMB CONTROL SCHEDULE

STANDARD ATMOSPHERE

6 R4360-53 + 4 J47-GE-19 ENGINES OPERATING

DENSITY ALTITUDE (FT.)	BHP	RPM	TORQUE PRESSURE (PSI)		APO†	ICO‡	BEST CLIMB EAS (mph)											
			LOW FAN	HIGH FAN			200,000 Lbs.	220,000 Lbs.	240,000 Lbs.	260,000 Lbs.	280,000 Lbs.	300,000 Lbs.	320,000 Lbs.	340,000 Lbs.	360,000 Lbs.	380,000 Lbs.	400,000 Lbs.	410,000 Lbs.
0	2800	2600	193.5		1/4	1/2	161	164	166	168	170	172	174	176	178	181	183	183
5,000	2800	2600	194.5		1/4	1/2	159	162	164	167	169	171	173	176	178	181	184	184
5,000	2800	2600	194.5		1/4	0	159	162	164	167	169	171	173	176	178	181	184	184
10,000	2800	2600	195.5		1/4	0	155	158	161	164	166	169	172	174	177	180	183	183
10,000	2800	2600	195.5		1/2	0	155	158	161	164	166	169	172	174	177	180	183	183
15,000	2800	2600	196.5		1/2	0	151	154	157	160	163	165	168	171	174	177	180	
20,000	2800	2600	197.5		1/2	0	146	149	152	155	158	161	164	167	171	176	180	
25,000	2800	2600	198.5		1/2	0	140	144	147	150	153	156	161	167	171	176	180	
25,000	2800	2600	198.5		3/4	1/2	140	144	147	150	153	156	161	167	171	176	180	
30,000	2800	2600	199.0		3/4	1/2	134	137	141	145	151	156	161	167	171	176		
30,000	2700	2510	199.5		3/4	1/2	134	137	141	145	151	156	161	167	171	176		
35,000	2700	2510	200.5		3/4	1/2	134	137	141	145	151	156	161	167	171			
35,000	2600	2415	201.0		3/4	Full Open	134	137	141	145	151	156	161	167	171			
40,000	2600*	2415*	202.0		3/4	Full Open	130	134	140	145	151	156	161					
40,000	2245	2140	197.2		Full Open	Full Open	130	134	140	145	151	156	161					
42,500	2245**	2140	197.5		Full Open	Full Open	127	134	140	145	151	156						
42,500	2085	2140	183.2	176.5	Full Open	Full Open	127	134	140	145	151	156						
45,000	2085	2140	183.6	177.3	Full Open	Full Open	127	134	140	145	151							
45,000	1885	2140	165.7	159.5	Full Open	Full Open	127	134	140	145	151							
47,500	1885	2140	166.0	160.2	Full Open	Full Open	127	134	140									
47,500	1660	2140	146.0	140.2	Full Open	3/4	127	134	140									
50,000	1660	2140	146.2	141.0	Full Open	3/4												

NOTES:
1. R4360-53 engines operating in manual adjust, 20° spark advance, from sea level to 45,000 ft., and in rich mixture above 45,000 ft.
2. J47-GE-19 engines operating at 96% military RPM.
3. Interpolate climb EAS for intermediate gross weights.
4. High fan operation within dashed line. Low fan operation permissible if engine cooling limits can be avoided.
5. Maximum CHT for hottest of A-6, C-5, D-2 and D-5 cylinders = 255°C.
6. Maximum CAT. = 38°C.
7. Maximum oil-in temperature = 110°C.
8. 115/145 grade fuel.

†Air plug opening—fraction of full open.
‡Intercooler opening—fraction of full open.
*Decrease power to avoid exceeding cooling limits at best climb speeds below 158 EAS (see text).
**Decrease power, maintain 2140 rpm to avoid exceeding cooling limits at best climb speeds below 153 EAS (see text).

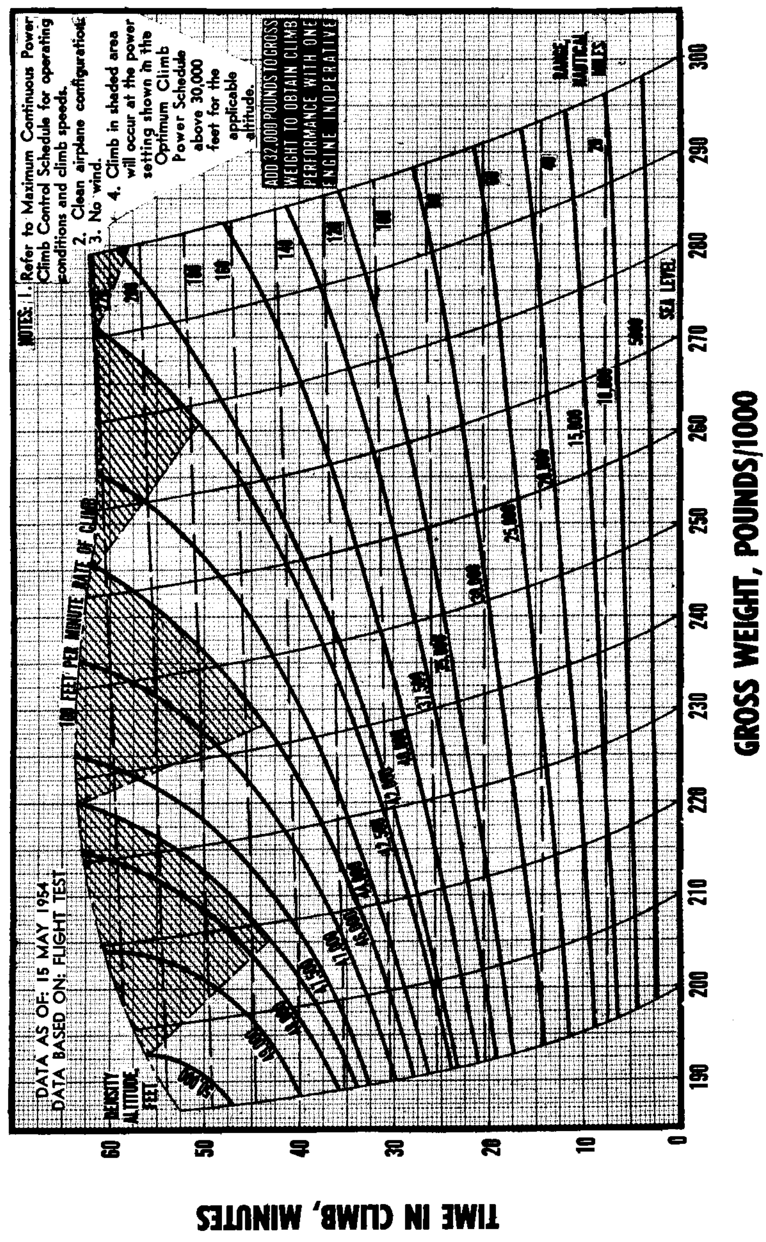
67-327-A

Figure A-124.

CLIMB PERFORMANCE

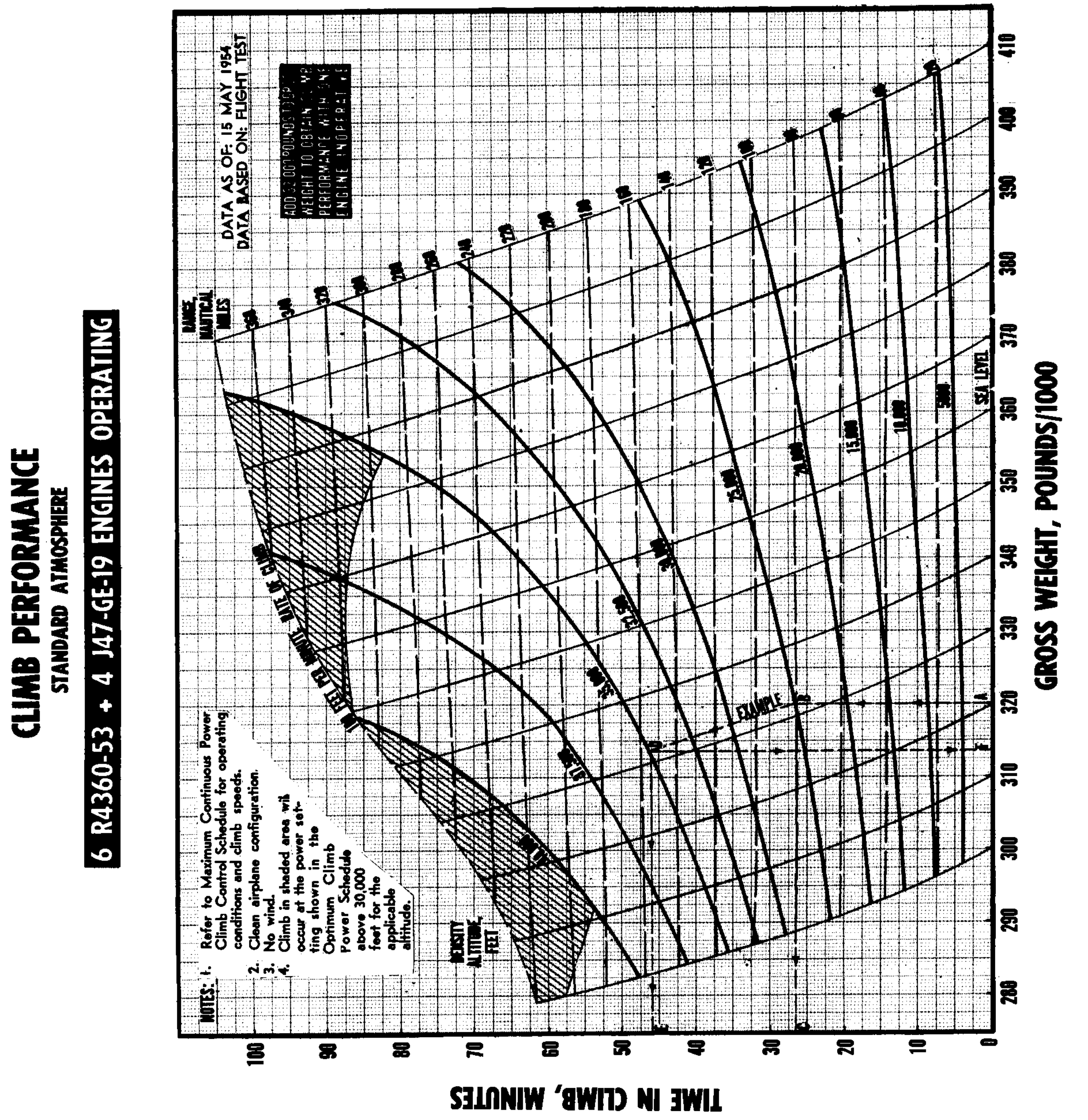
STANDARD ATMOSPHERE

6 R4360-53 + 4 J47-GE-19 ENGINES OPERATING



67-311-A

Figure A-125. (Sheet 1)



67-316-A

Figure A-125. (Sheet 2)

SPECIFIC RANGE CURVES.

These curves present composite performance at constant altitude. Charts are presented for altitudes from sea level to 51,000 feet in increments of 5000 feet up to 40,000 feet and increments of 2500 feet from 40,000 to 50,000 feet. The curves include normal and partial reciprocating engine operating configurations, and at 15,000 feet and above jet engine operation is presented in conjunction with reciprocating engine data.

Note

Prior to using any of the partial reciprocating engine specific range data, equivalent weight corrections from figure A-276 must be made.

As an added convenience composite charts of reciprocating engine performance plus optimum jet engine combinations are presented.

The specific range, or nautical miles per pound, type curves furnish cruise control data for constant altitude operation under any condition from high speed to maximum range. The recommended speeds for long range are for cruise at 99 per cent of maximum range, except that a maximum airplane cruise attitude corresponding to a lift coefficient of 0.85 has arbitrarily been imposed. These long range operating conditions have been presented in a more convenient form in subsequent charts (figures A-194 to A-247). Charted partial engine data are conservative except when the inoperative engine is in the most asymmetric position.

Note

Cruise with one or more reciprocating engines inoperative is not recommended for any type mission. Performance data for partial (reciprocating) engine operation is presented for planning and operation on alternate flight plans which are necessitated by such emergencies as propeller or engine failure resulting from fire, combat action, etc..

EXAMPLE 1.

It is desired after a climb to 10,000 feet to set up power for a long range cruise. Initial cruise gross weight is 300,000 pounds, and the distance for the first cruise is 200 nautical miles. Determine power setting, recommended EAS, amount of fuel used, and time in cruise. Enter figure A-128 and from the intersection of the recommended EAS line with the 300,000 pounds gross weight line, read 184 mph EAS, 1770 bhp (interpolated), and .0395 nautical miles per pound. Engine operation is in single turbo with 20-degree SA in manual adjust. The average fuel used in flying 200 nautical miles is 200 ÷ .0395 = 5064 pounds.

A closer approximation for the actual fuel used is obtained by reading .0397 nautical miles per pound at 300,000 — (5064 ÷ 2) = 297,468 pounds and calculating 200 ÷ .0397 = 5040 pounds. Time for the

Cruise is $200 \div \left(184 \times \frac{1/\sqrt{\sigma}}{1.152}\right) = 1.07$ hours.

It should be noted that the answers for the above example can be obtained more readily by using figures A-196, A-207, and A-208.

EXAMPLE 2.

It is desired to fly 300 nautical miles at an altitude of 35,000 feet (assuming no wind) at a speed of 320 knots TAS (205 mph, EAS) with an initial gross weight for cruise at 230,000 pounds. Determine the power combination for the best nautical miles per pound for these conditions.

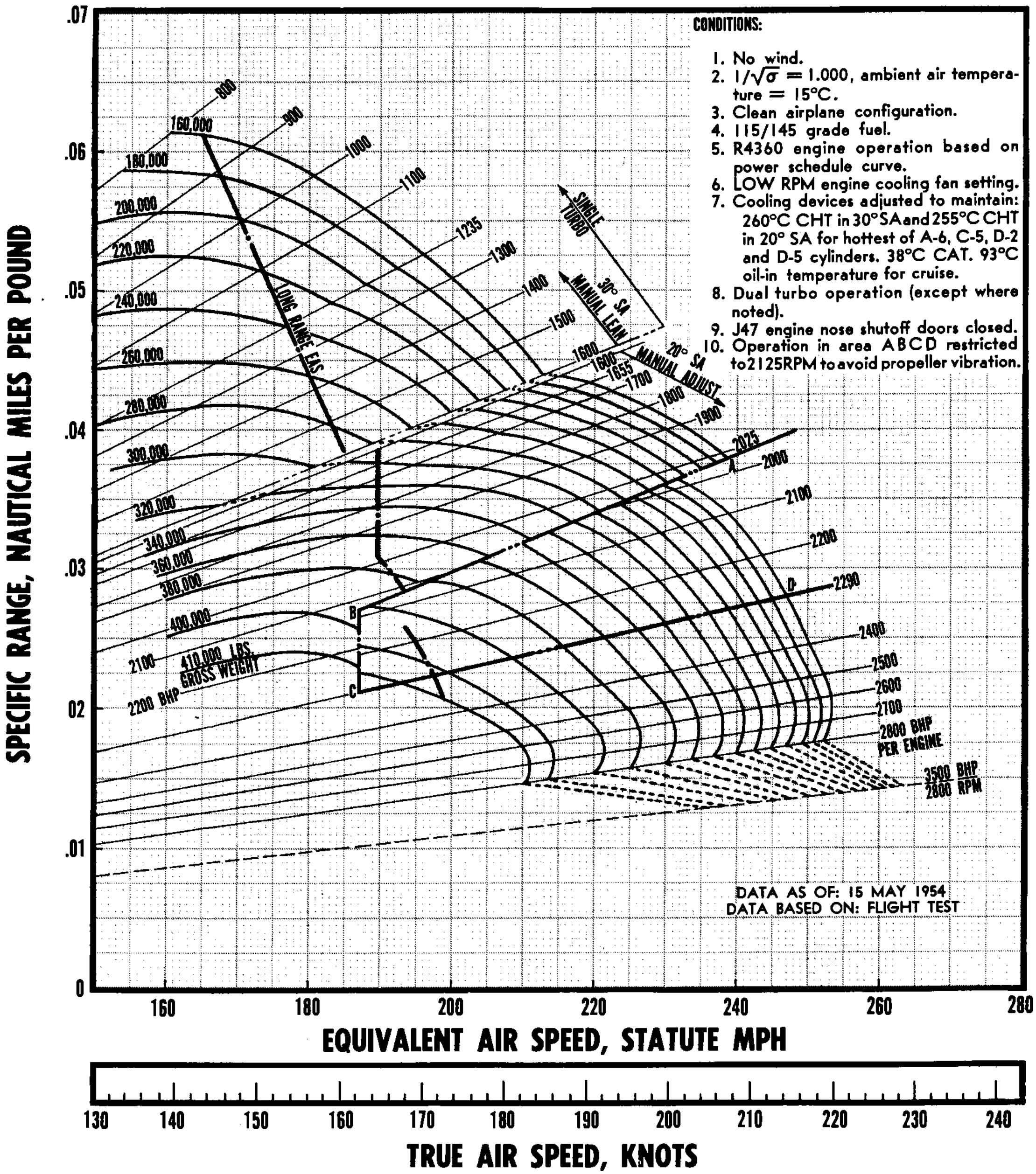
Enter the specific range curves for 6 + optimum jet engines operating at 35,000 feet at 205 mph on the EAS scale and move vertically to 230,000 pounds gross weight (interpolated). Read .0310 nautical miles per pound from the left scale. A first approximation of the fuel consumed during flight will be 300 nautical miles divided by .0310 = 9677 pounds. *Since it is recommended that engine power should be completely reset on all operable engines every time that approximately 5,000 pounds of fuel are consumed, it will be necessary to make two power setting changes for this example.*

Now read .0315 nautical miles per pound for a gross weight of 230,000 — 5,000 = 225,000 pounds. The average cruise nautical miles per pound for the first cruise is (.0310 + .0315 ÷ 2 = .0313. The first cruise distance is 5,000 pounds × .0313 = 157 nautical miles. The average power setting for the first cruise shall be 2165 bhp in N.S., 20 degrees S.A. on the six R4360-53's with four J47's operating at 78 per cent of military rpm. For the second cruise beginning at 225,000 pounds, read .0315 nautical miles per pound. An approximation of fuel consumed for the remaining portion of flight of 143 nautical miles will be 143 nautical miles ÷ .0315 = 4537 pounds fuel. Now read .0320 nautical miles per pound for a weight of 225,000 — 4537 = 220,463 pounds. The average cruise nautical miles per pound is (.0315 + .0320) ÷ 2 = .0318, which gives (143 ÷ .0318) 4500 pounds of fuel consumed for a second approximation. A third approximation is unnecessary in this case. The average power setting is seen to be 2160 bhp in N.S., 20 degrees. S.A. on the six R4360-53's with four J47's operating at 77 per cent of military rpm. Gross weight at the end of the 300-nautical mile cruise leg is 230,000 — (5000 + 4500) = 220,500 pounds and the cruise time at 300 ÷ 320, or .94 hours.

SPECIFIC RANGE AT SEA LEVEL

STANDARD ATMOSPHERE

6 R4360-53 ENGINES OPERATING



67-116-A

Figure A-126.

SPECIFIC RANGE AT 5000 FEET

STANDARD ATMOSPHERE

6 R4360-53 ENGINES OPERATING

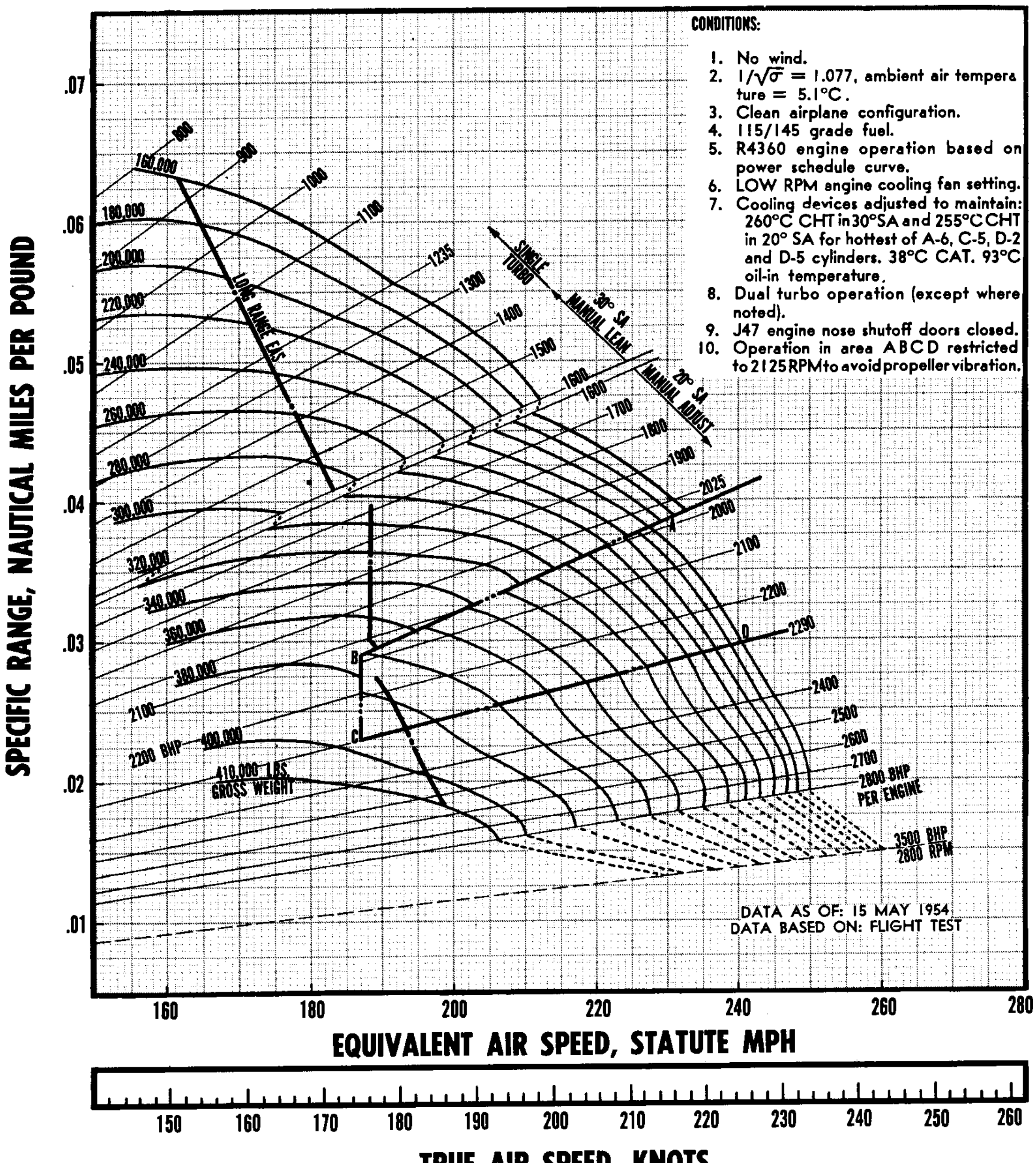
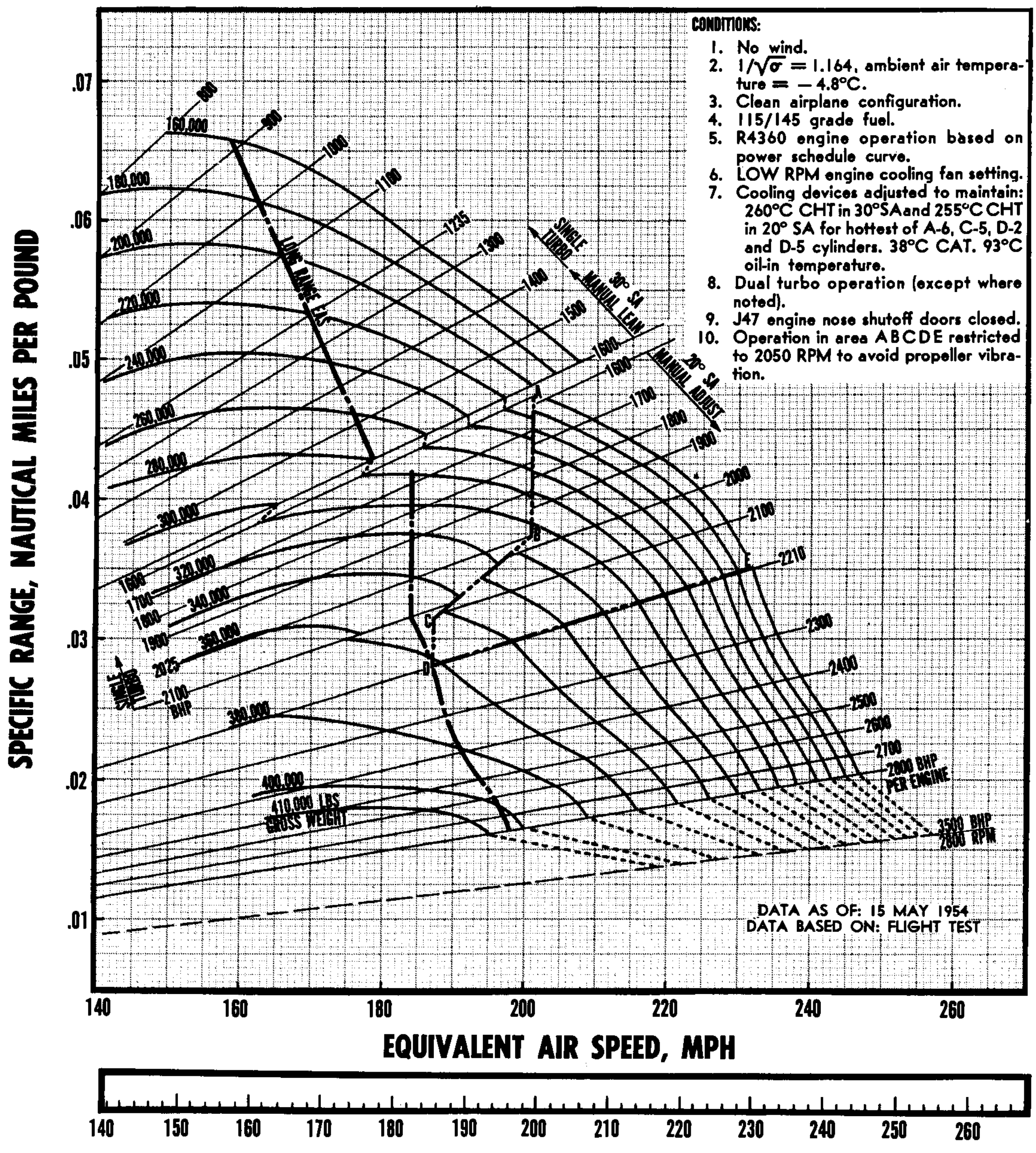


Figure A-127.

SPECIFIC RANGE AT 10,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 ENGINES OPERATING



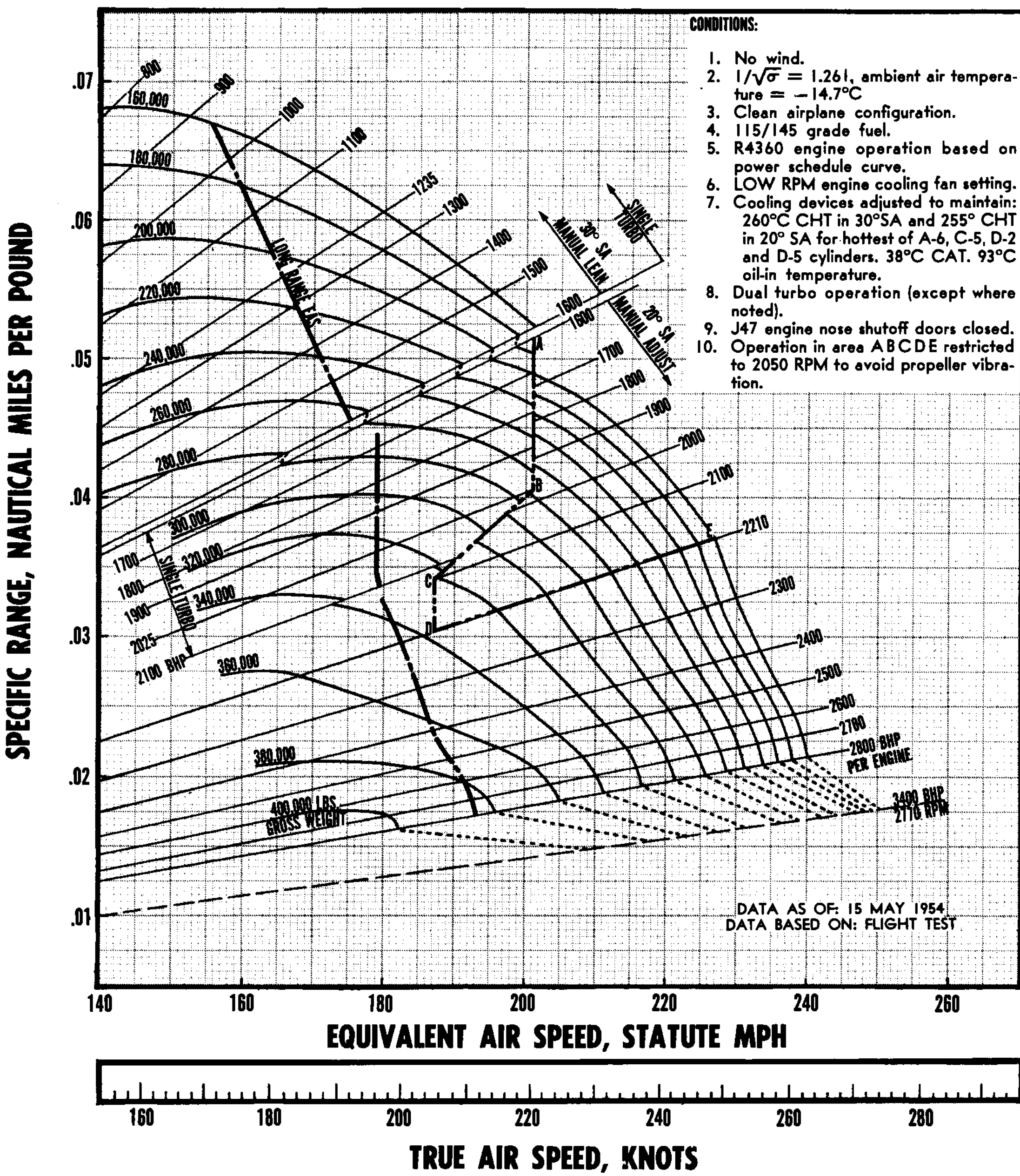
67-118-A

Figure A-128.

SPECIFIC RANGE AT 15,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 ENGINES OPERATING



67-119-A

Figure A-129.

SPECIFIC RANGE AT 15,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 + OPTIMUM J47-GE-19 ENGINES OPERATING

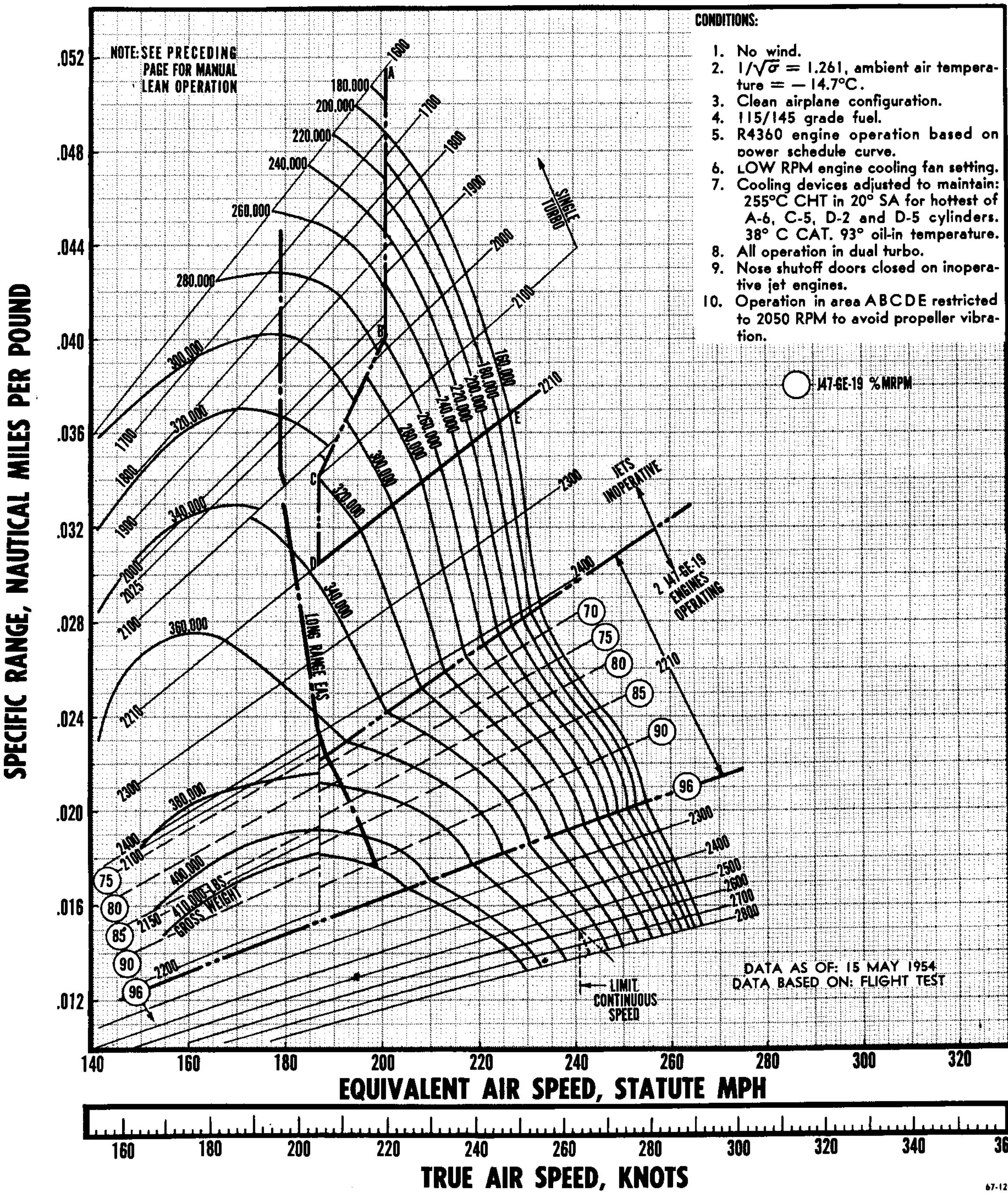


Figure A-130.

SPECIFIC RANGE AT 20,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 ENGINES OPERATING

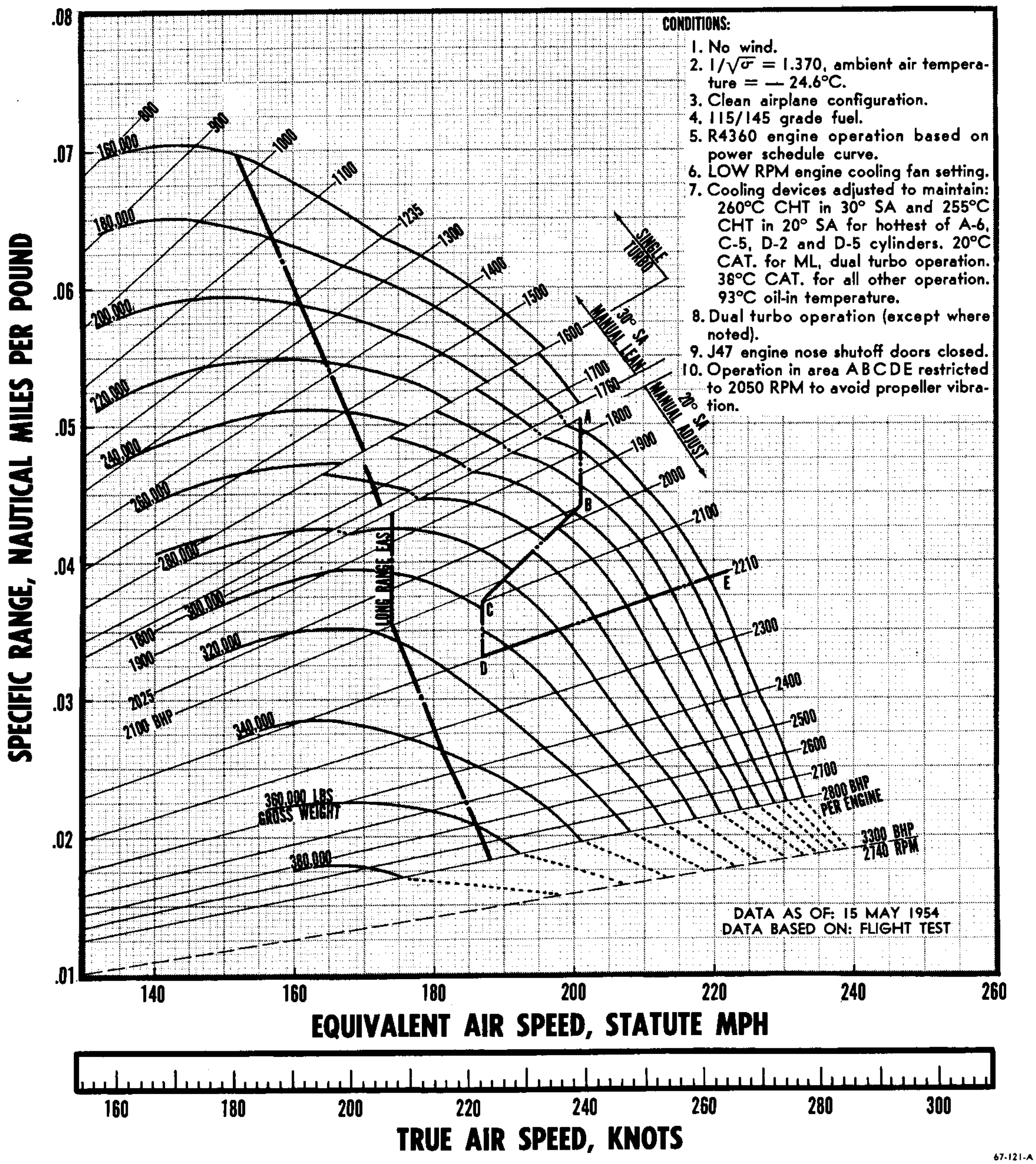


Figure A-131.

SPECIFIC RANGE AT 20,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 + OPTIMUM J47-GE-19 ENGINES OPERATING

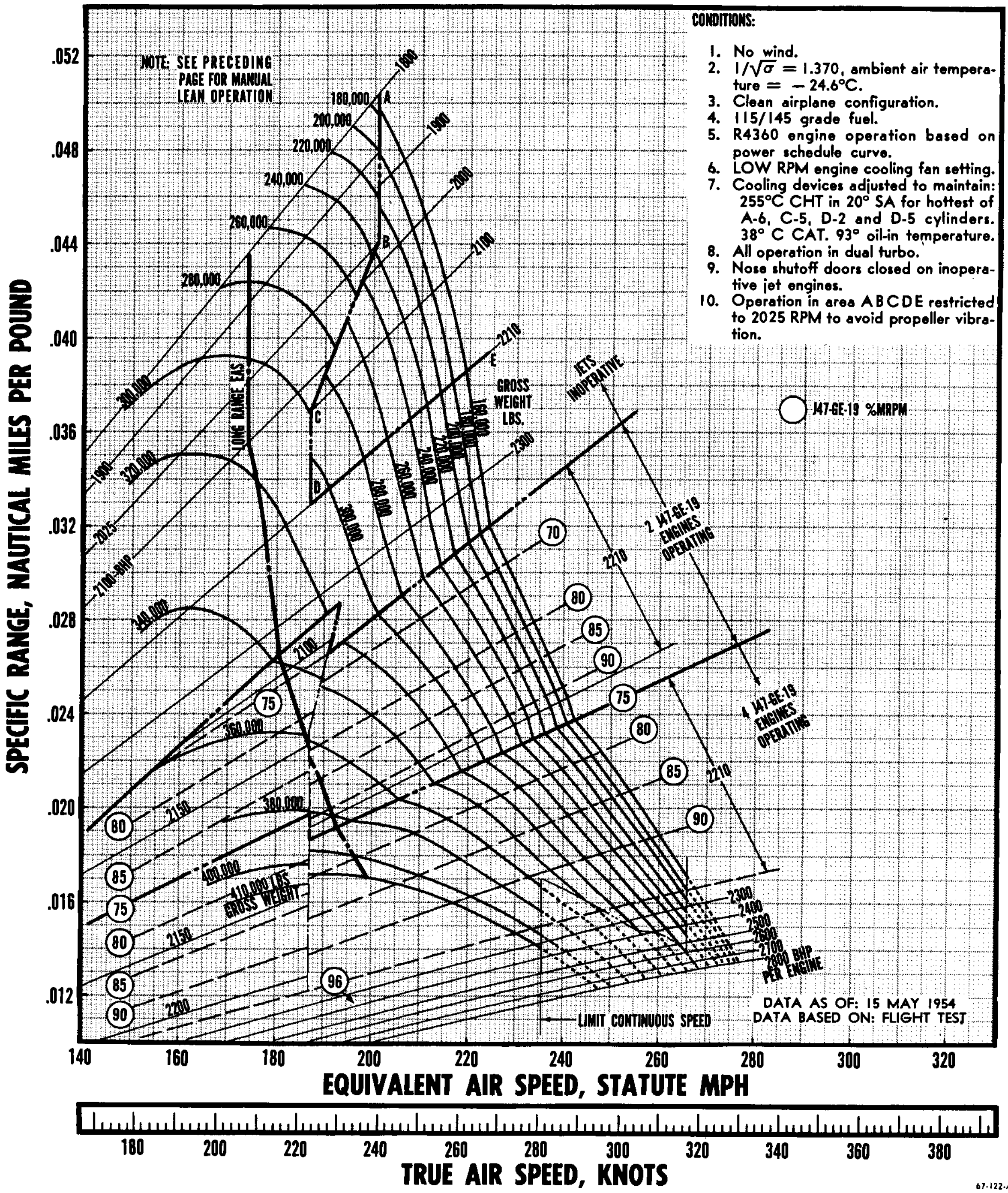


Figure A-132.

SPECIFIC RANGE AT 25,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 ENGINES OPERATING

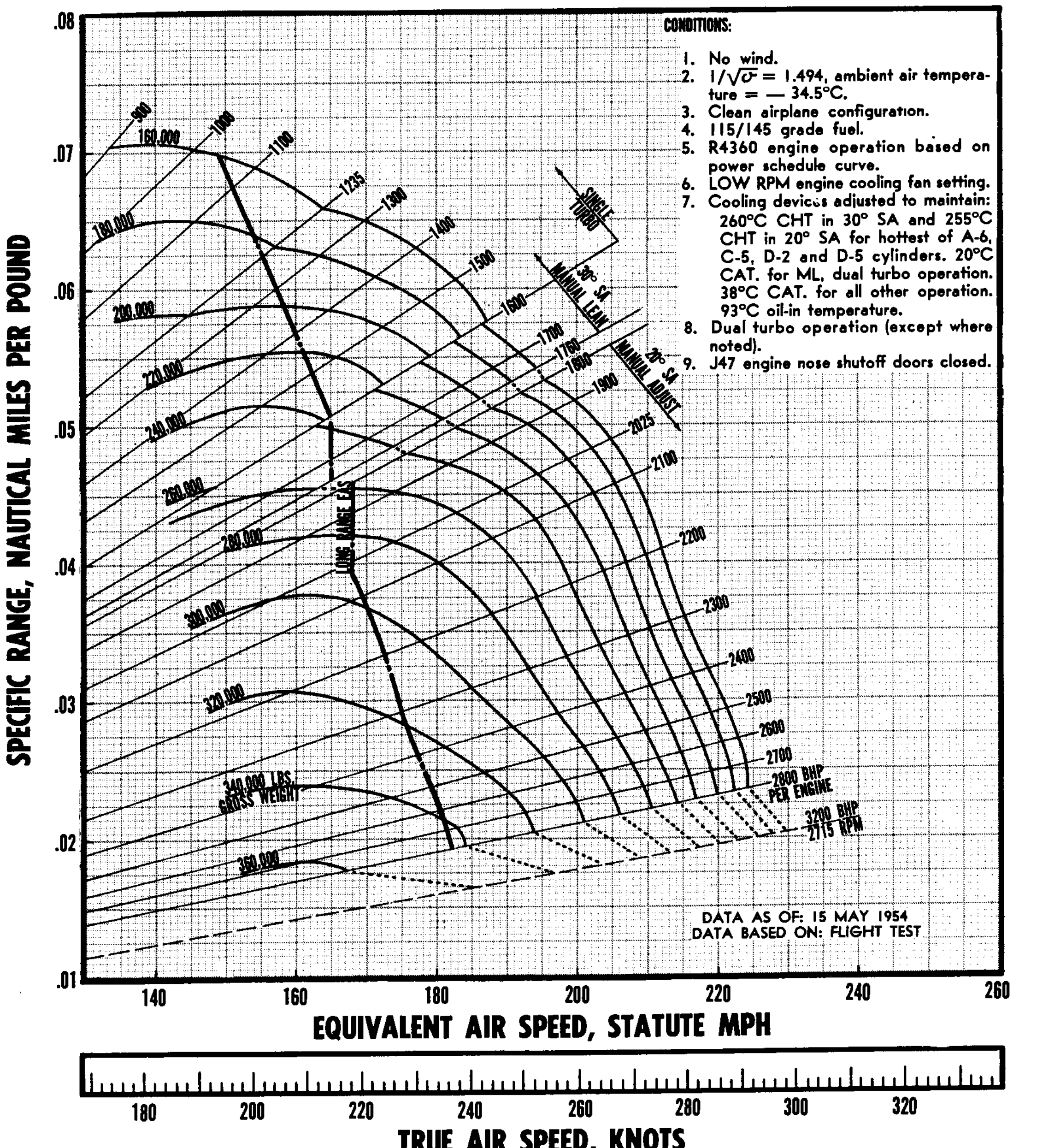


Figure A-133.

SPECIFIC RANGE AT 25,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 + OPTIMUM J47-GE-19 ENGINES OPERATING

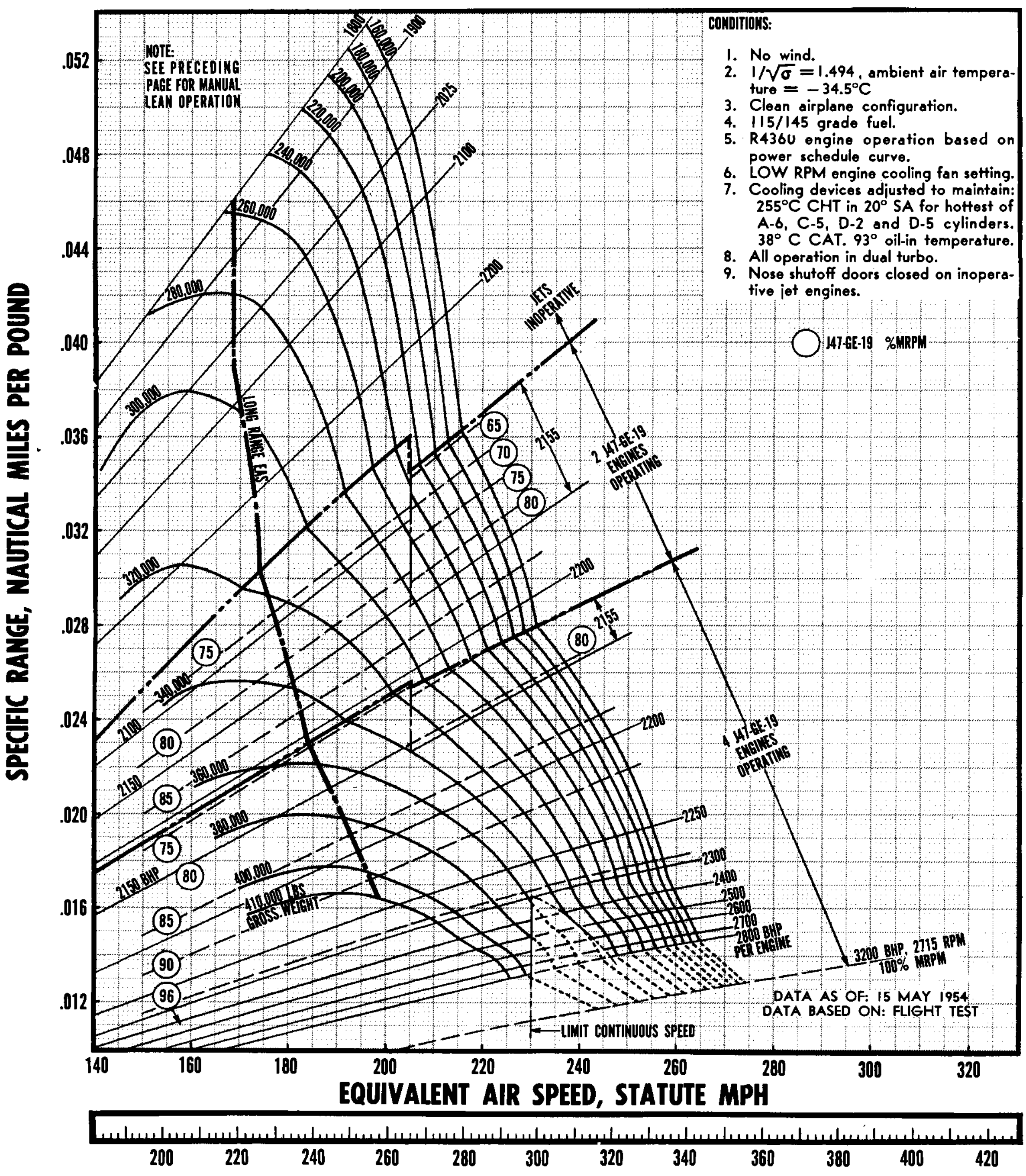


Figure A-134.

SPECIFIC RANGE AT 30,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 ENGINES OPERATING

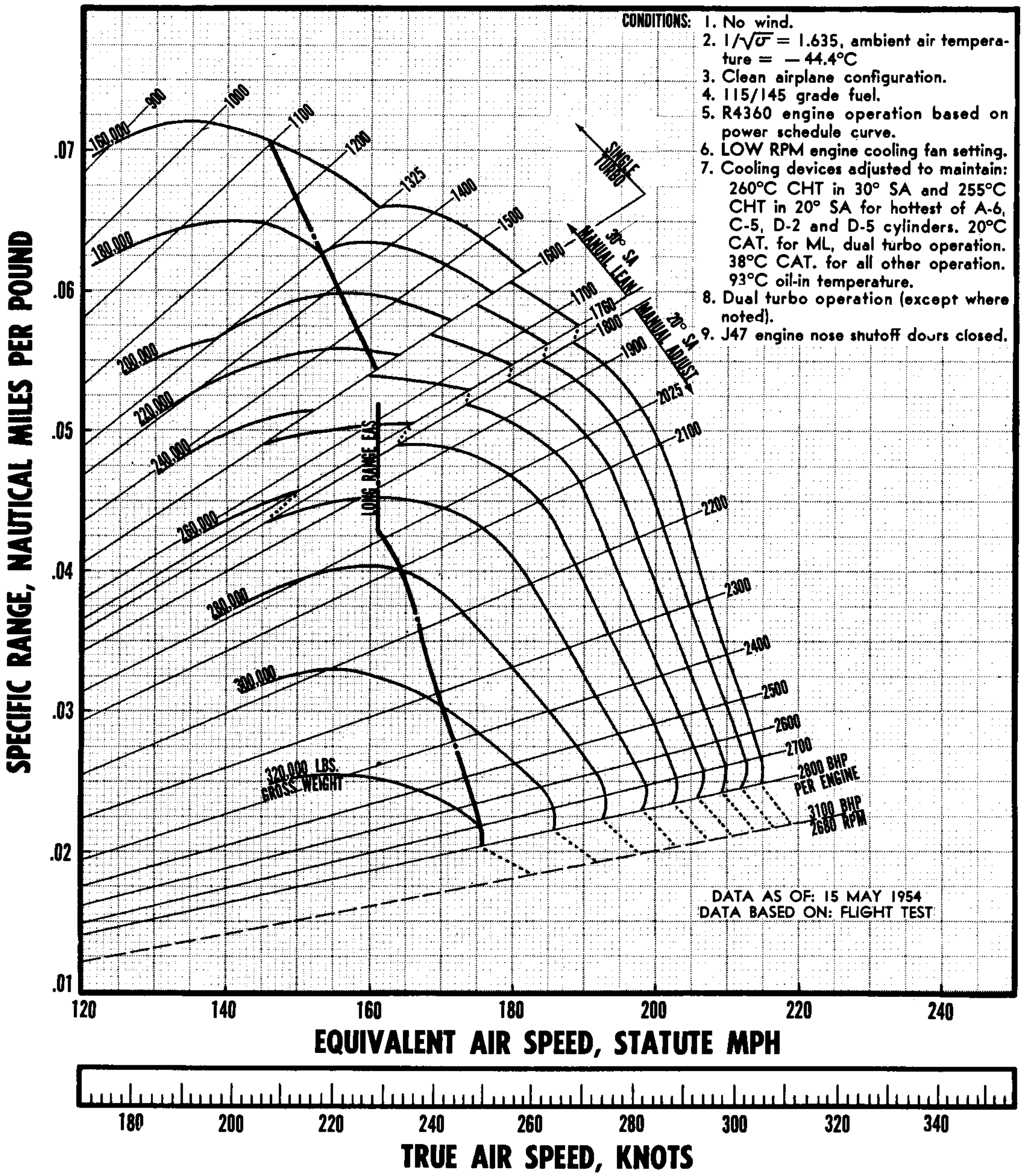


Figure A-135.

SPECIFIC RANGE AT 30,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 + 2 J47-GE-19 ENGINES OPERATING

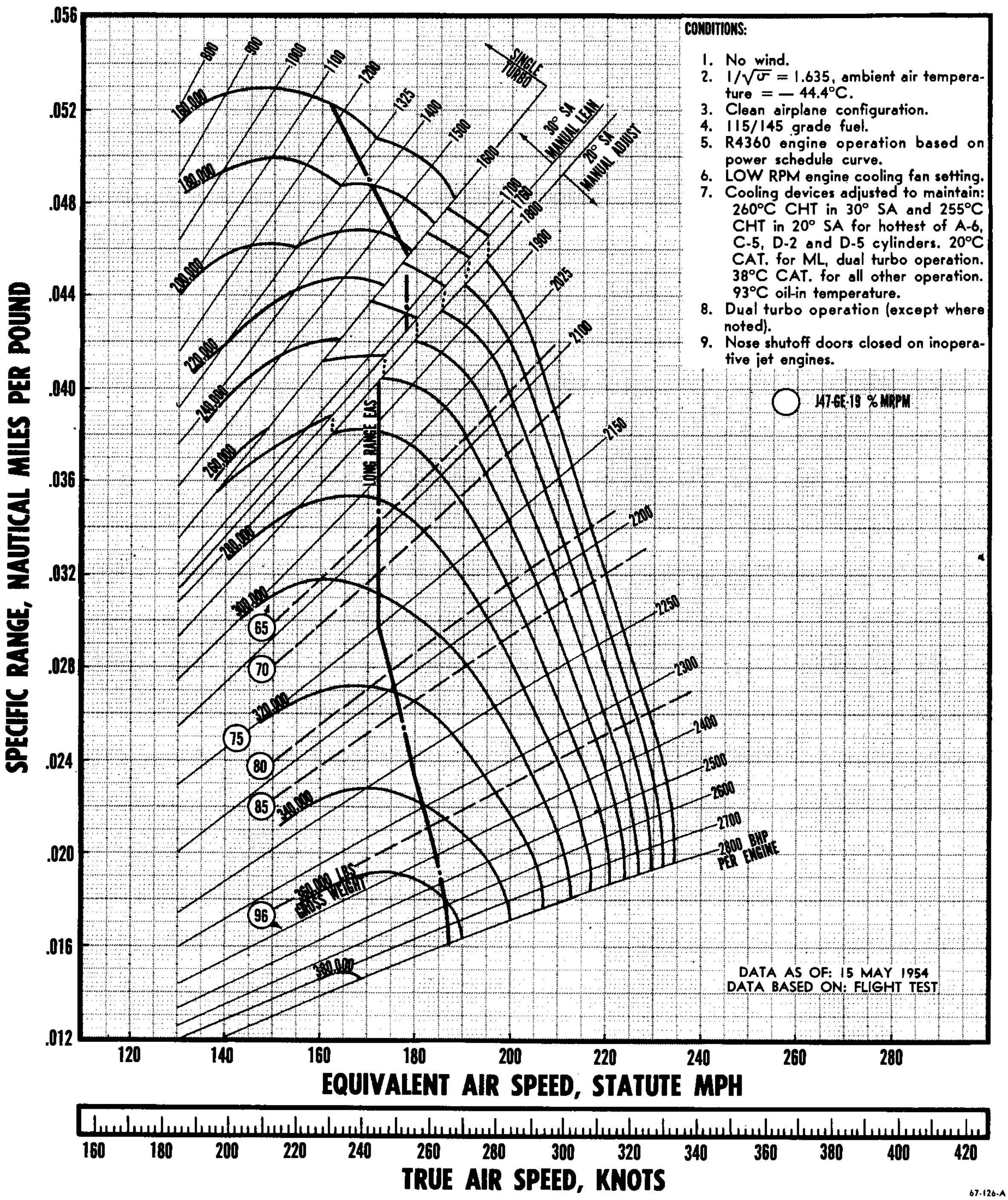


Figure A-136.

SPECIFIC RANGE AT 30,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 + 4 J47-GE-19 ENGINES OPERATING

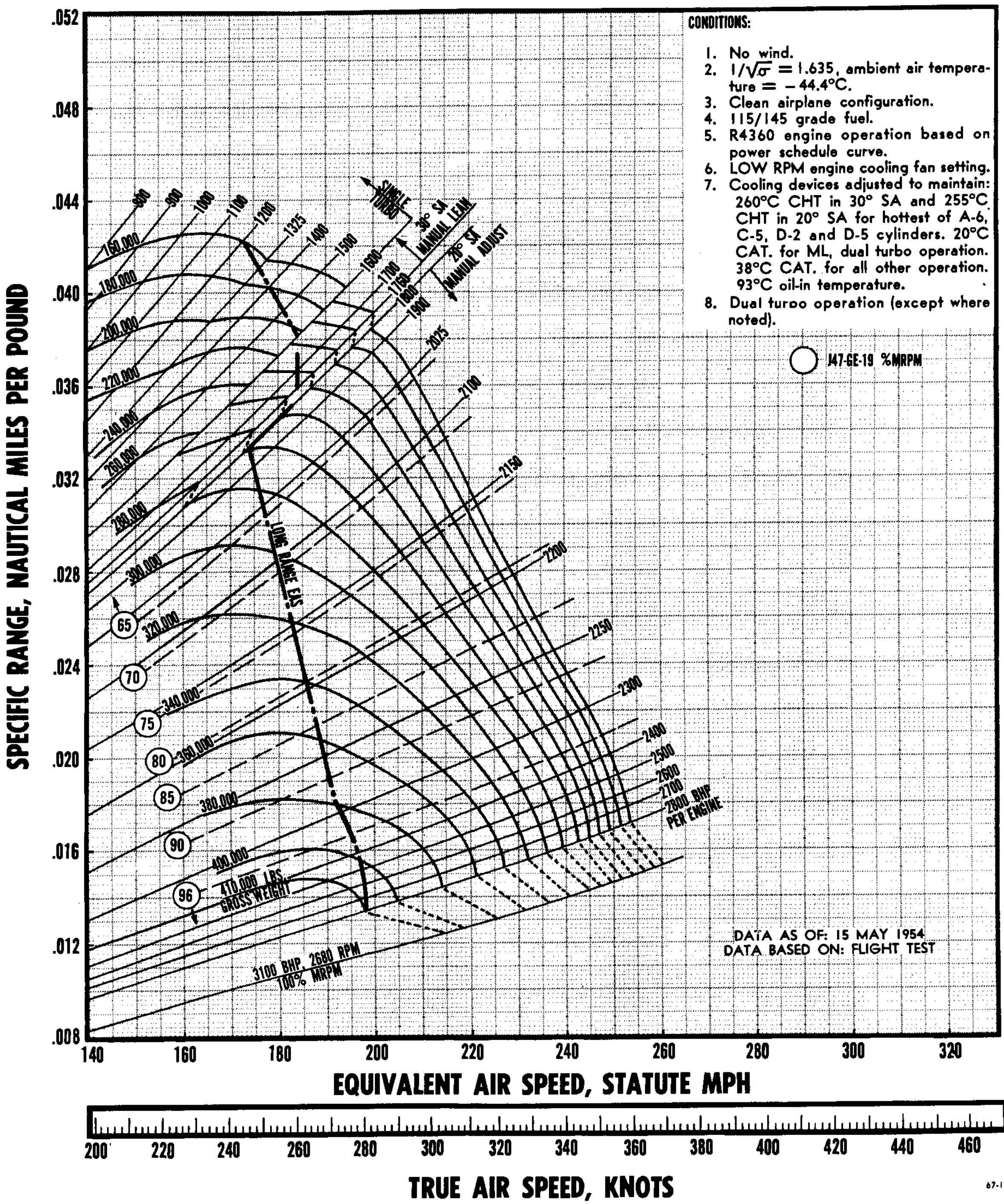


Figure A-137.

SPECIFIC RANGE AT 30,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 + OPTIMUM J47-GE-19 ENGINES OPERATING

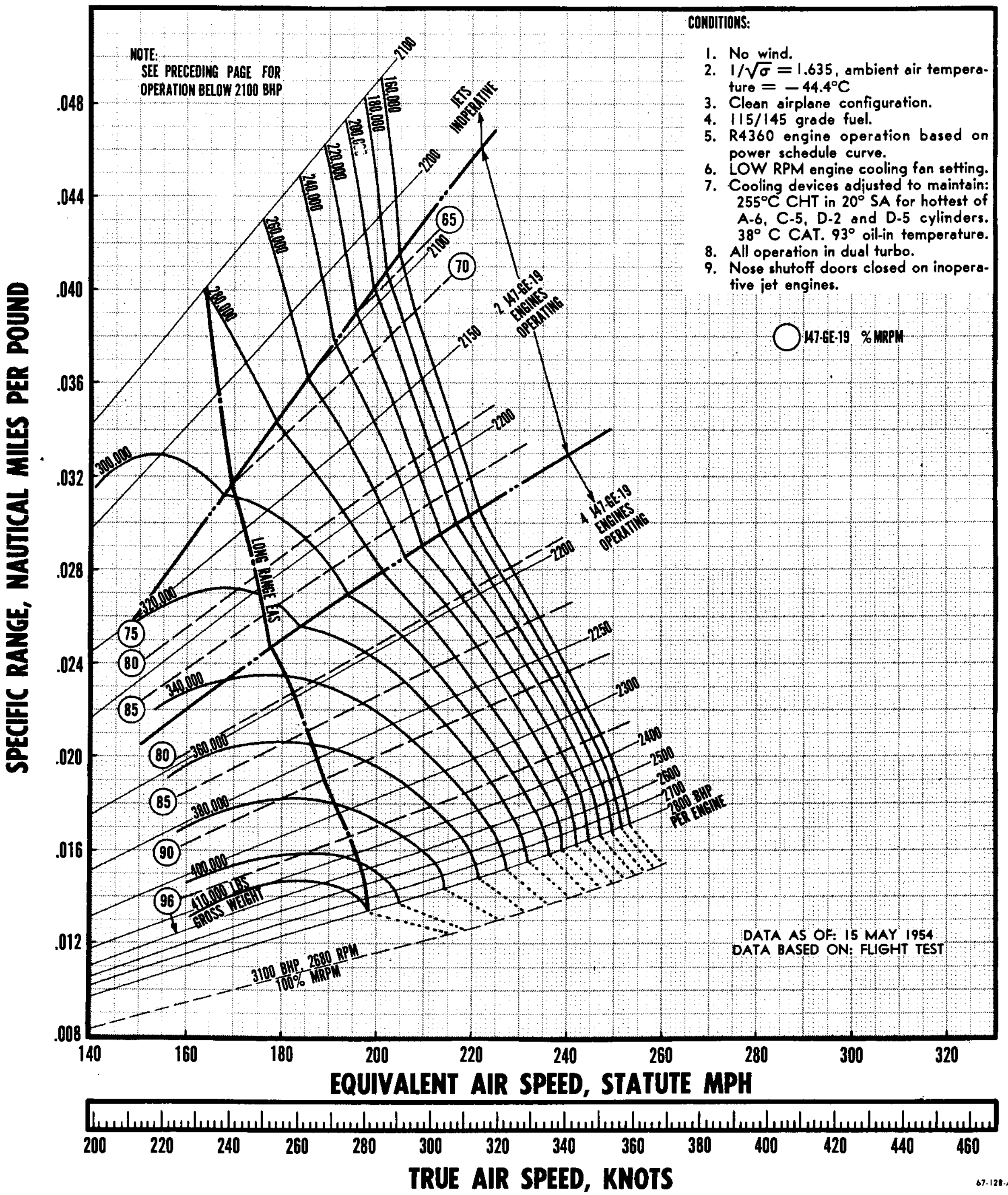


Figure A-138.

SPECIFIC RANGE AT 35,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 ENGINES OPERATING

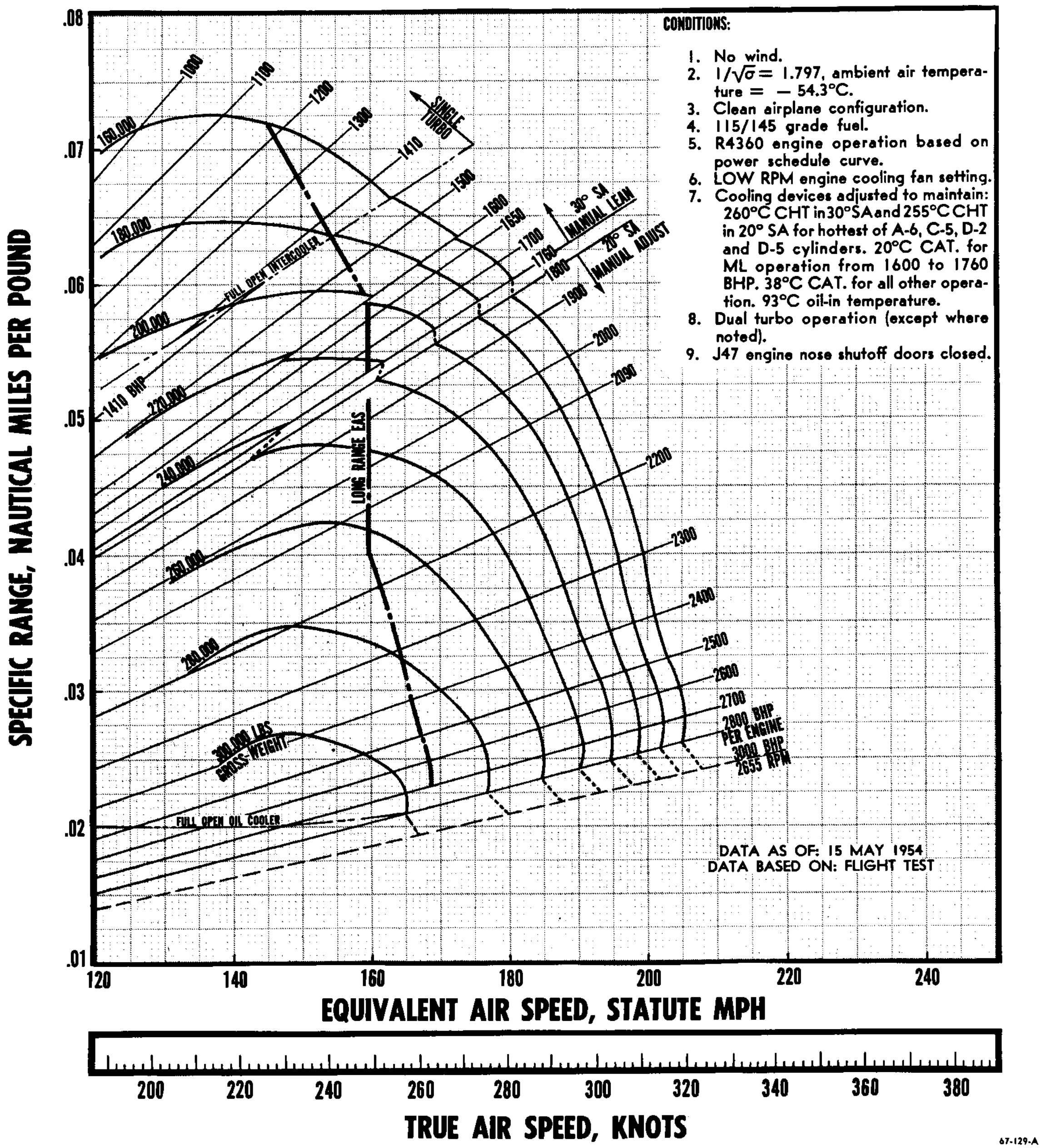


Figure A-139.

SPECIFIC RANGE AT 35,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 + 2 J47-GE-19 ENGINES OPERATING

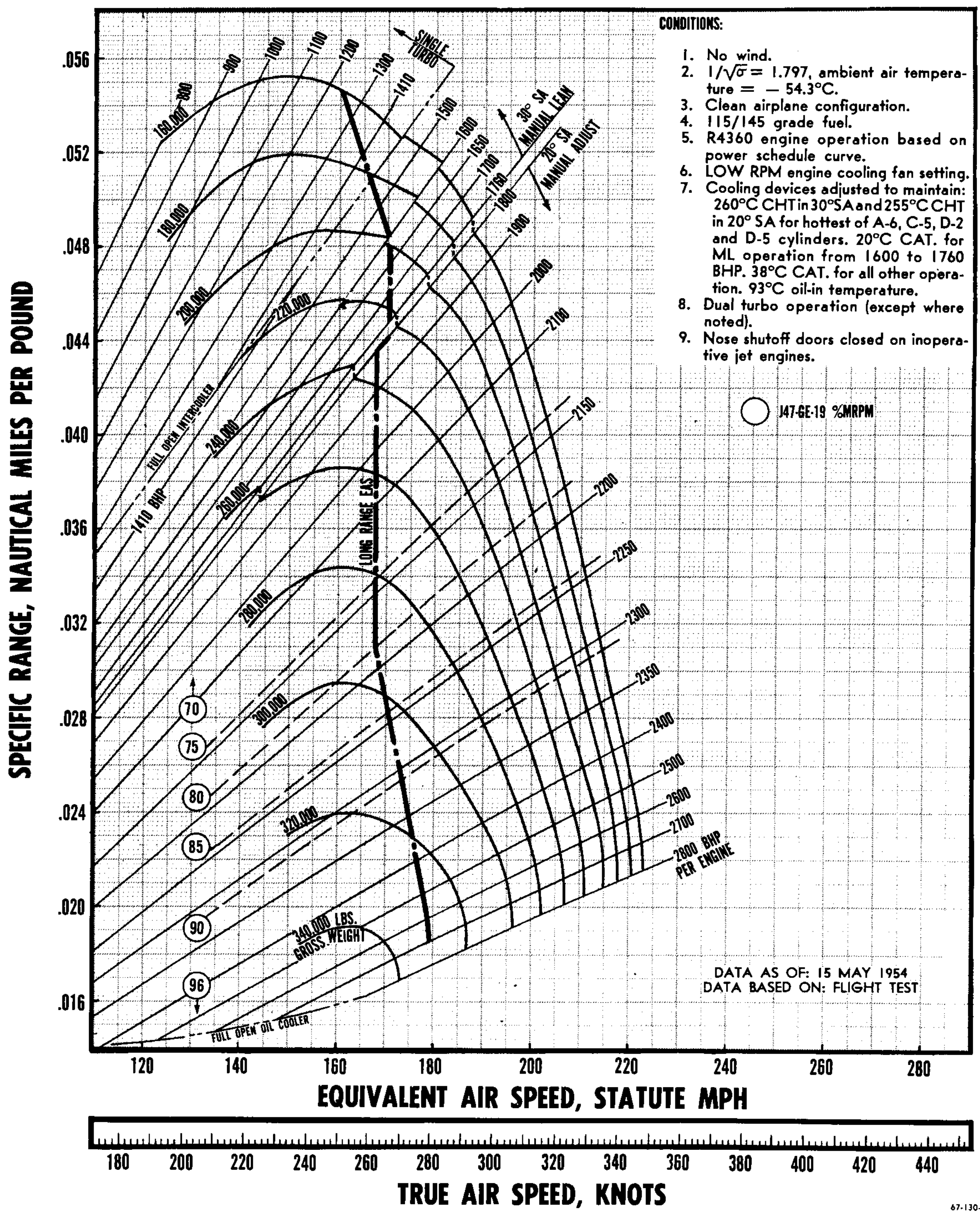


Figure A-140.

SPECIFIC RANGE AT 35,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 + 4 J47-GE-19 ENGINES OPERATING

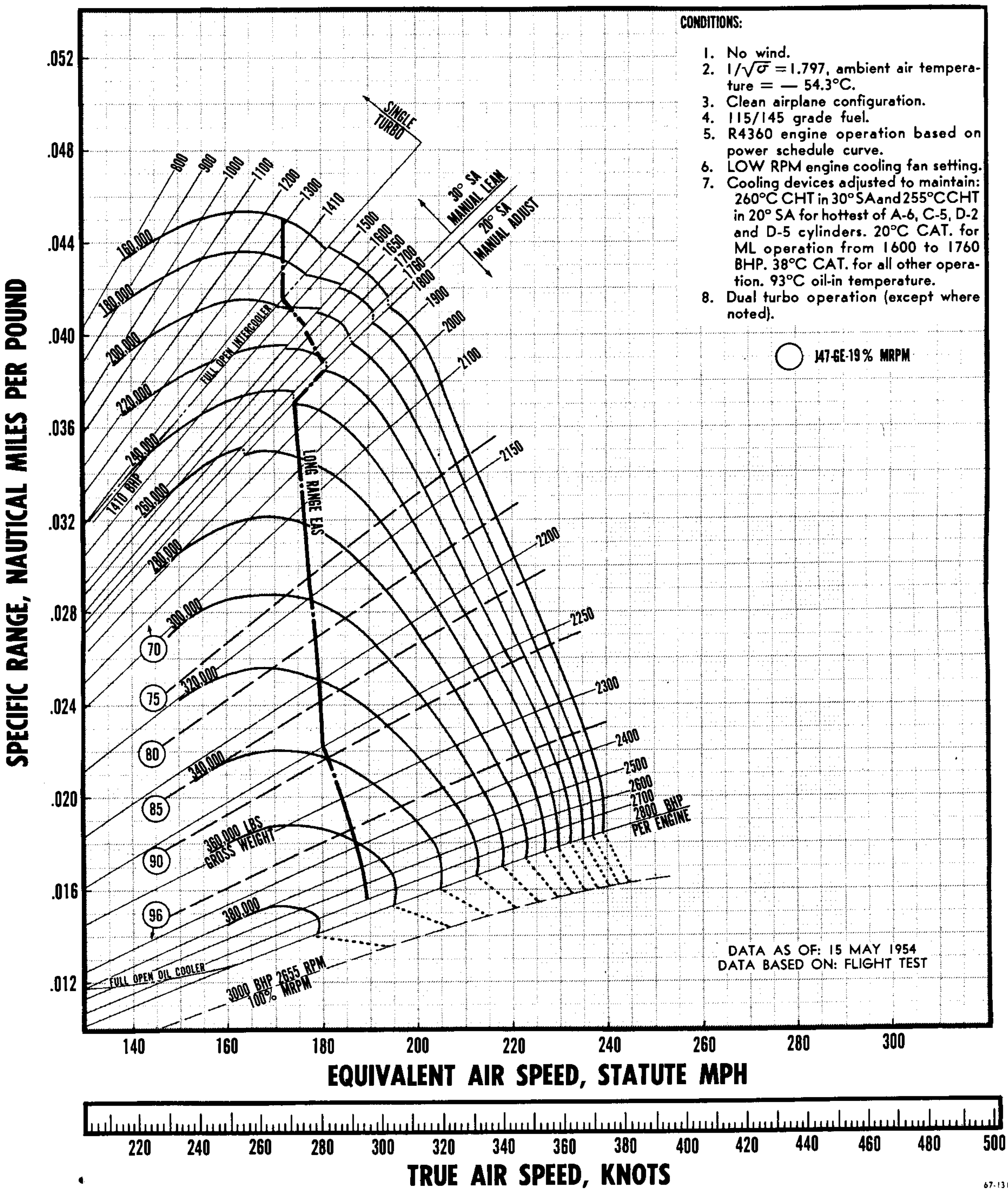


Figure A-141.

SPECIFIC RANGE AT 35,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 + OPTIMUM J47-GE-19 ENGINES OPERATING

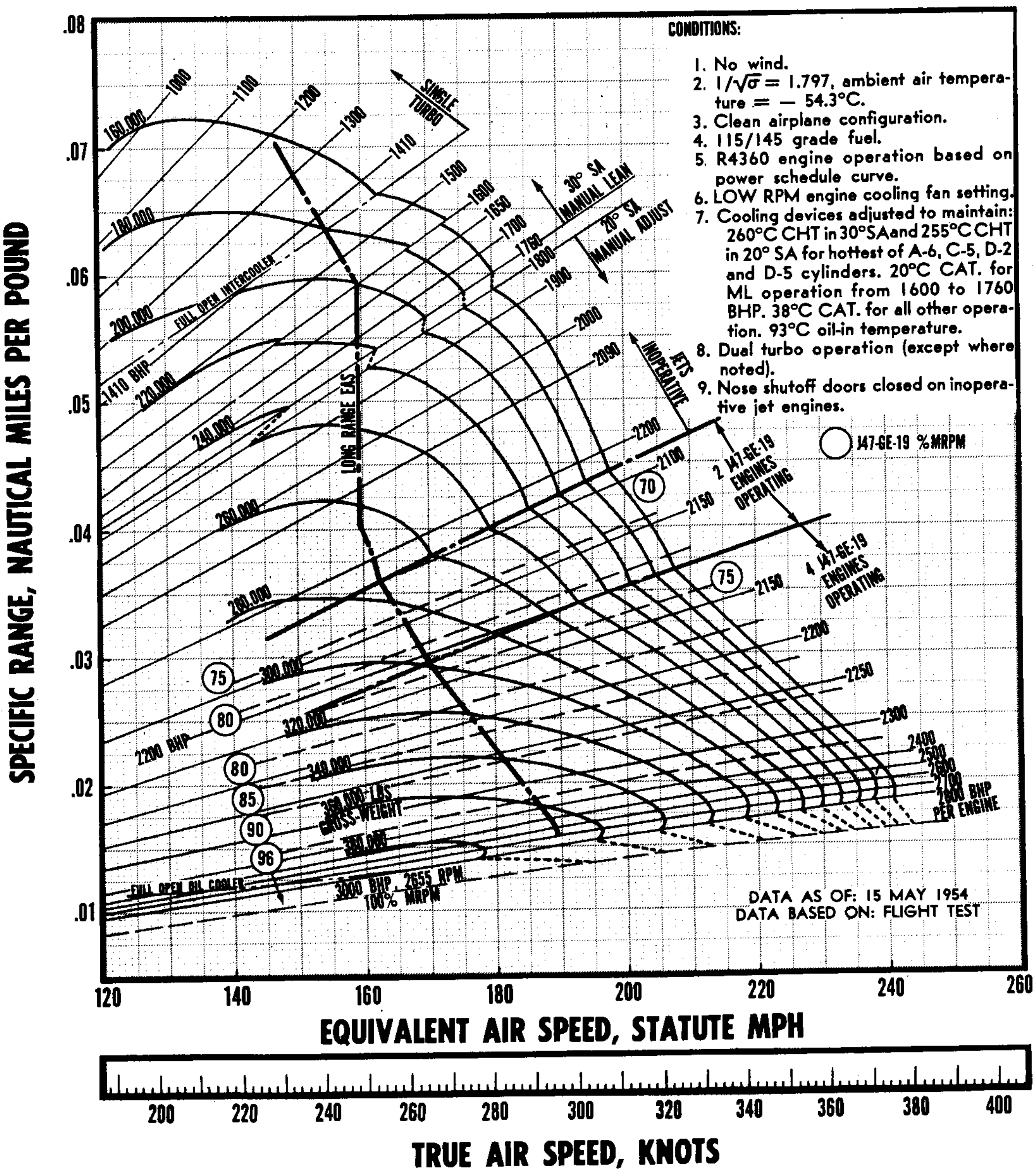


Figure A-142.

SPECIFIC RANGE AT 40,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 ENGINES OPERATING

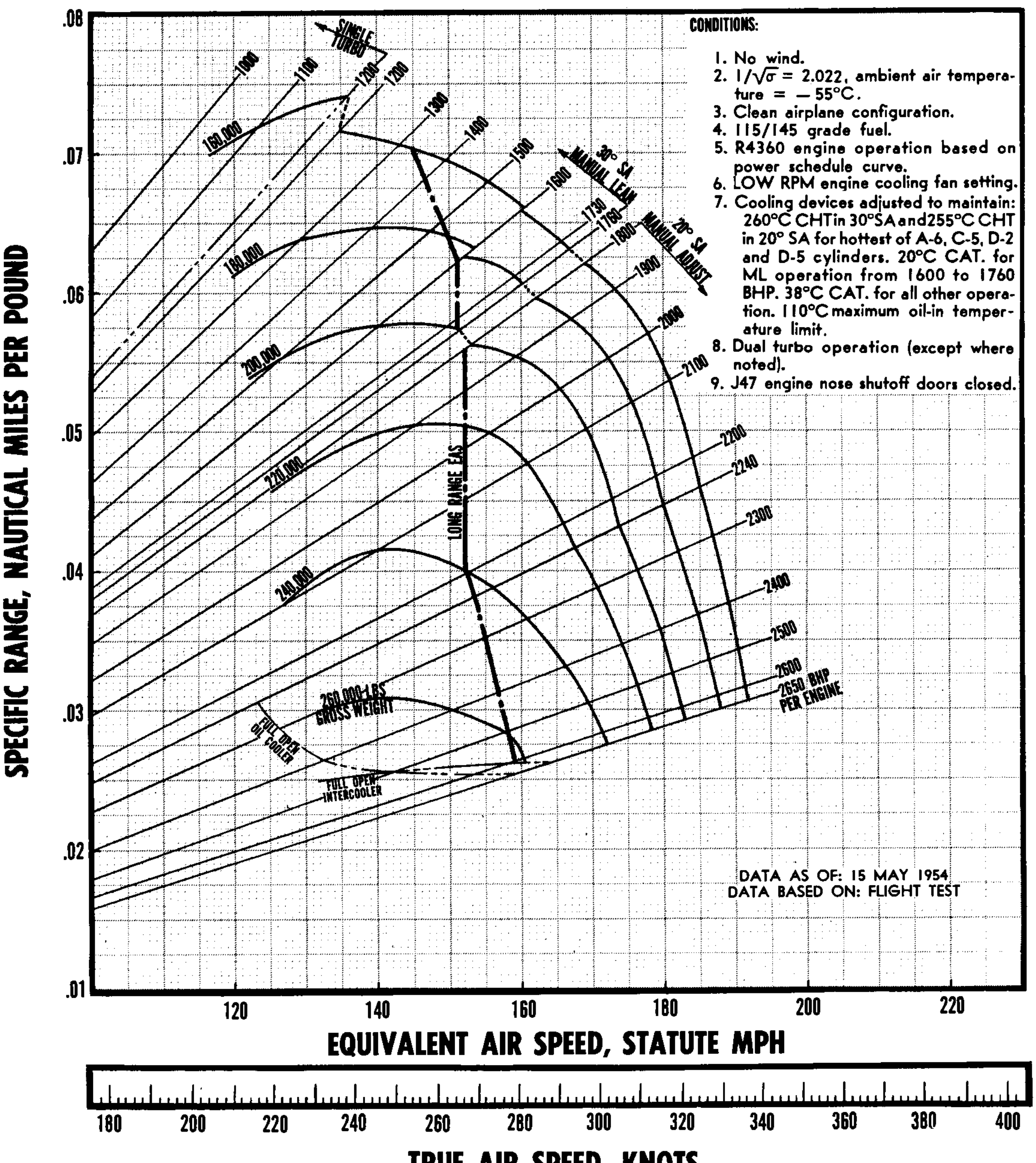


Figure A-143.

SPECIFIC RANGE AT 40,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 + 2 J47-GE-19 ENGINES OPERATING

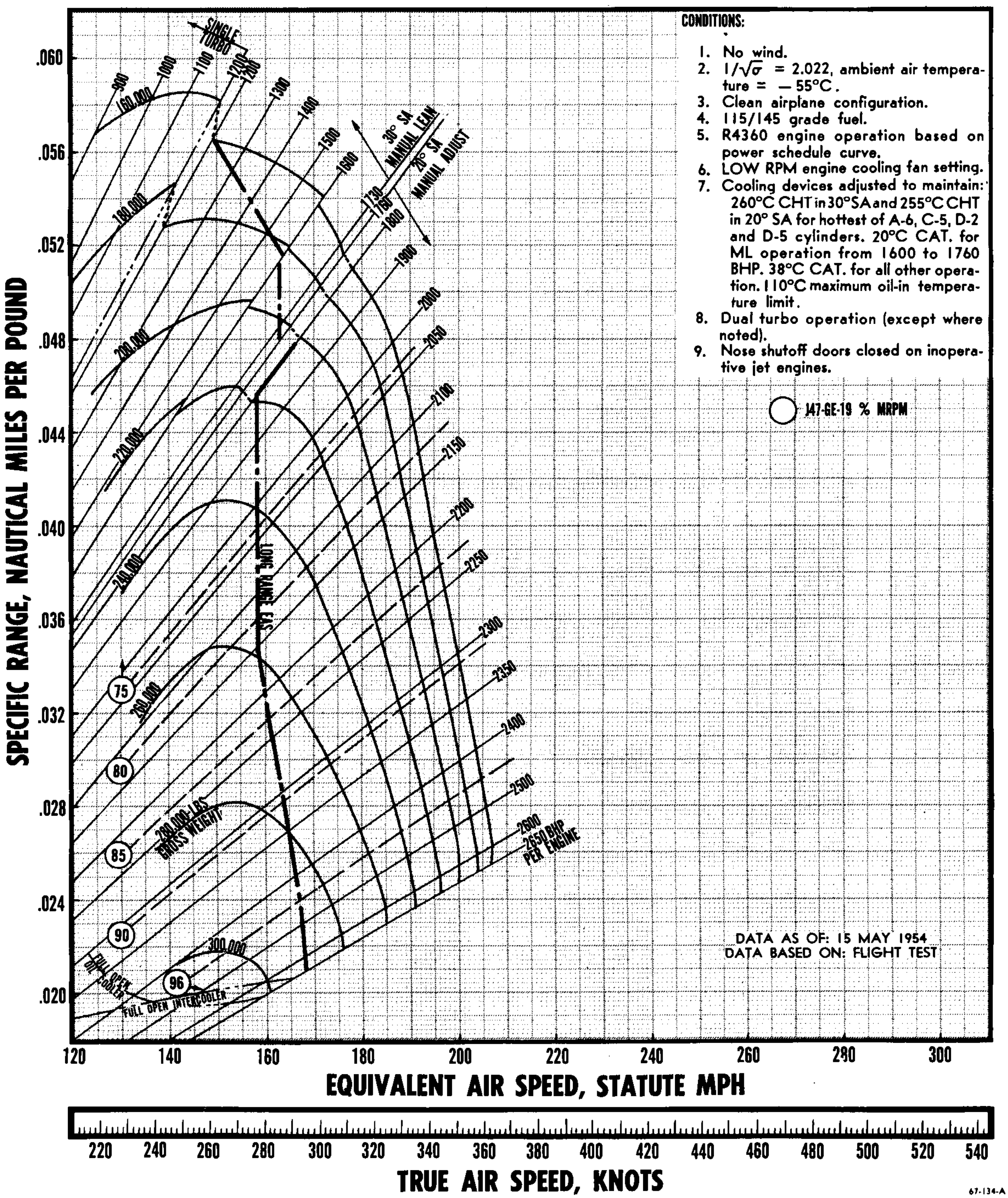


Figure A-144.

SPECIFIC RANGE AT 40,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 + 4 J47-GE-19 ENGINES

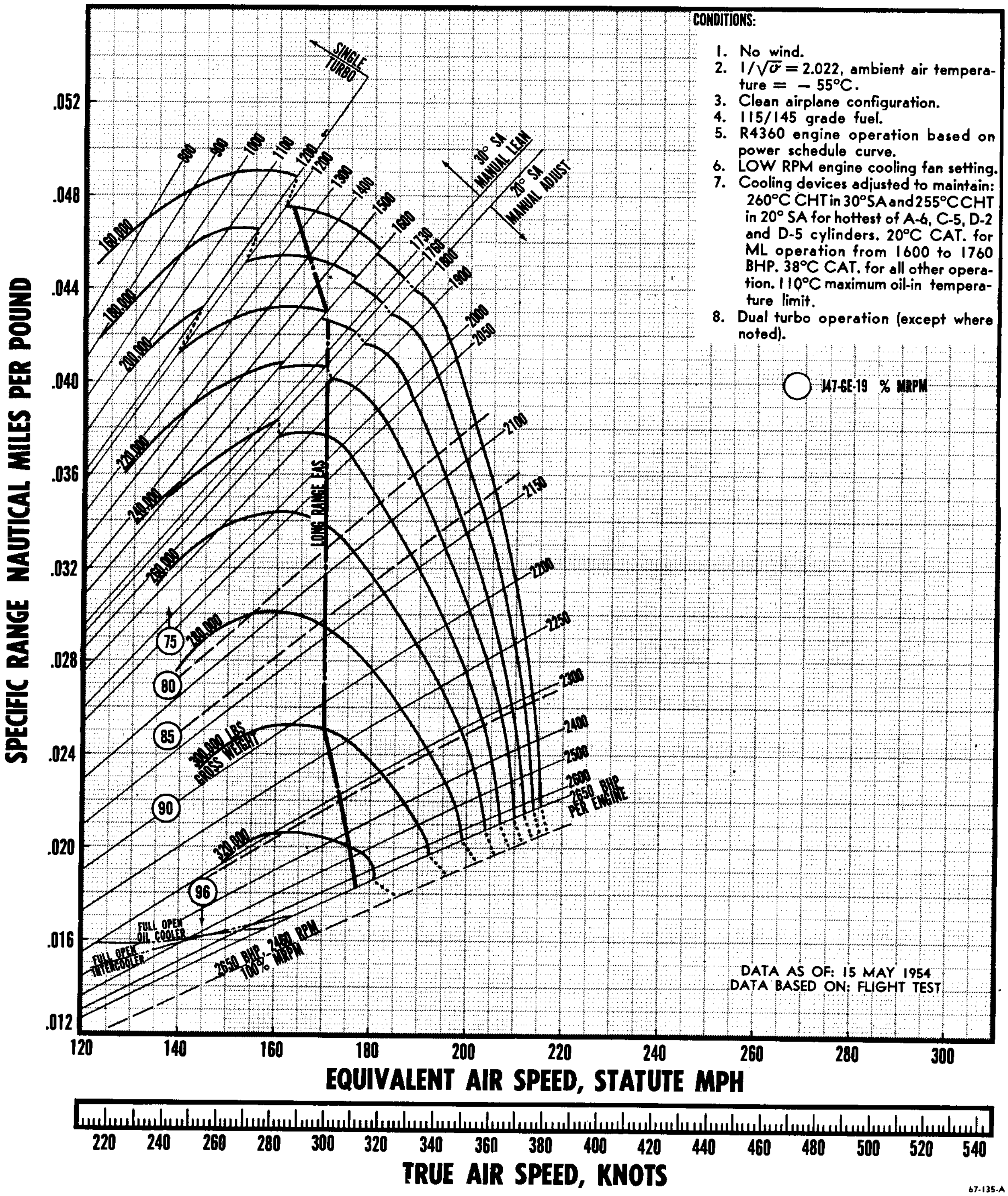
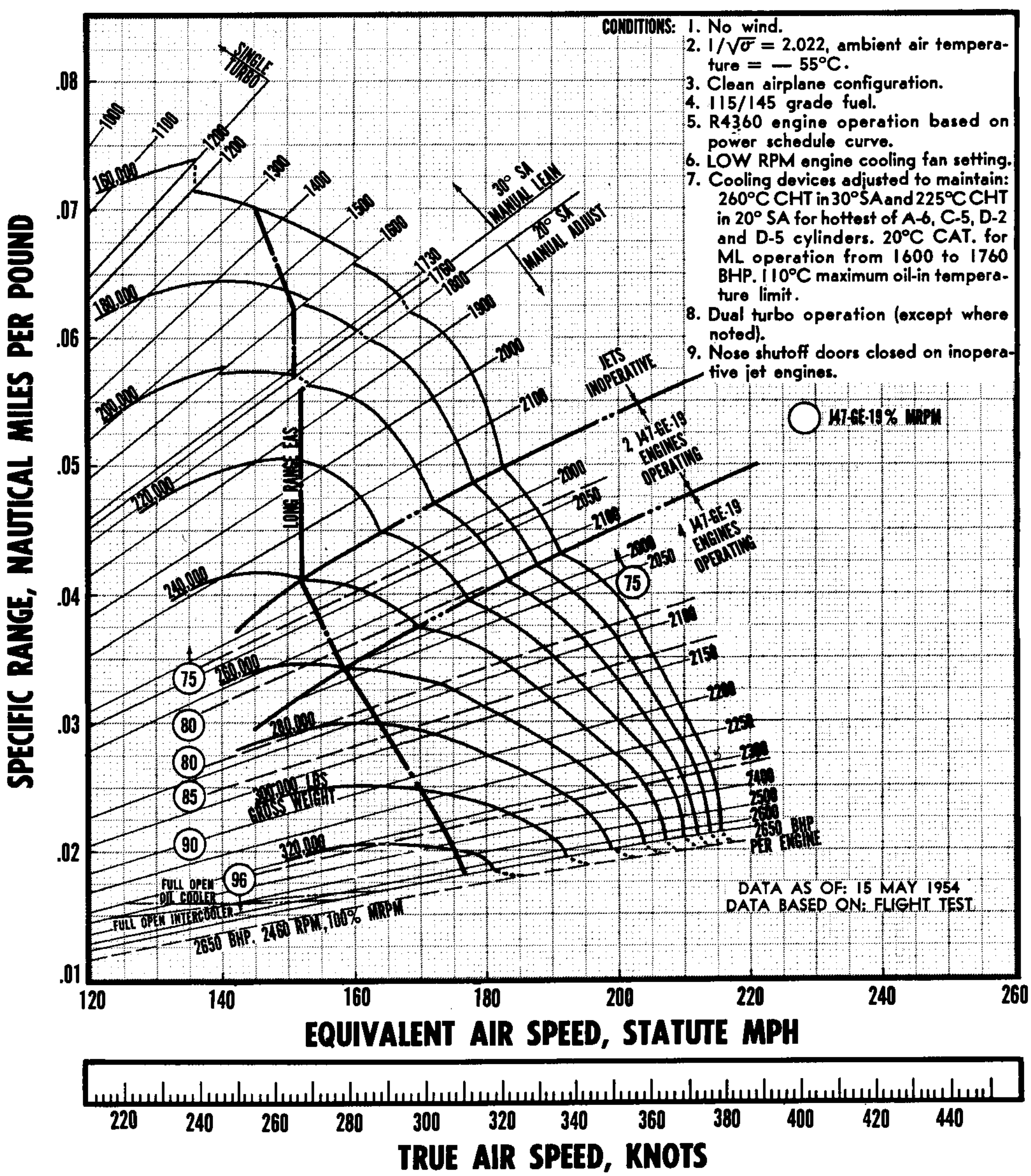


Figure A-145.

SPECIFIC RANGE AT 40,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 + OPTIMUM J47-GE-19 ENGINES OPERATING



67-136-A

Figure A-146.

SPECIFIC RANGE AT 42,500 FEET

STANDARD ATMOSPHERE

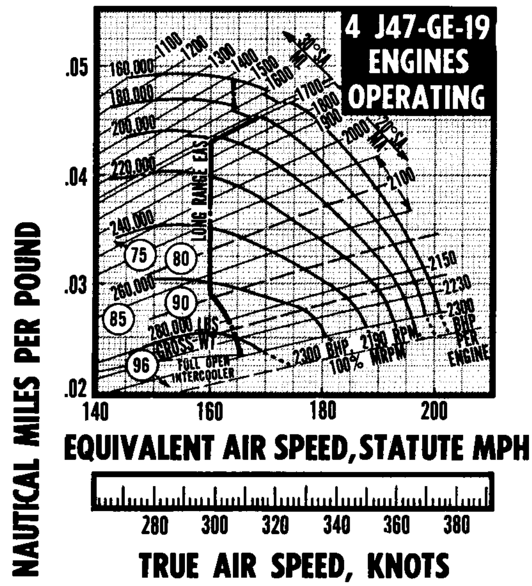
6 R4360-53 + J47-GE-19 ENGINES OPERATING AS NOTED

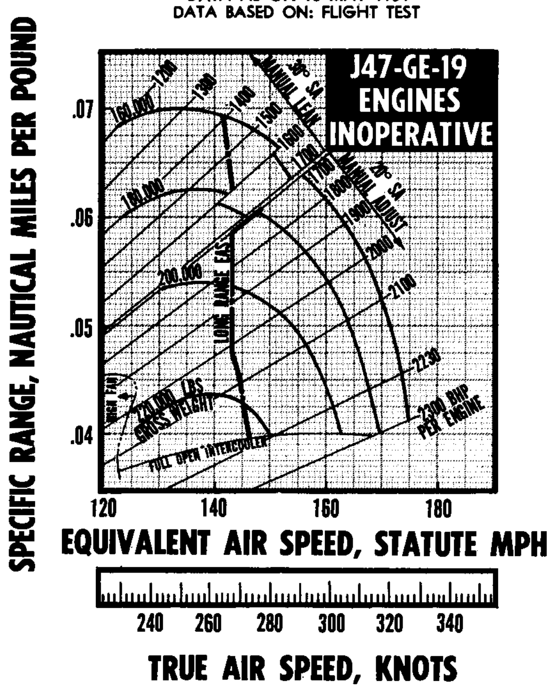
CONDITIONS:

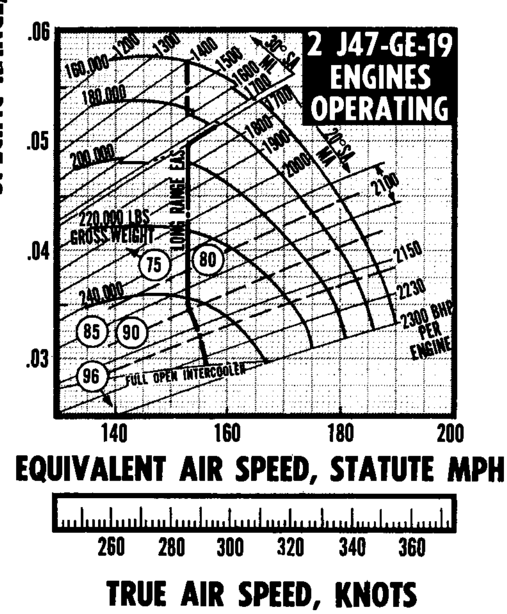
1. No wind.
2. $1/\sqrt{\sigma} = 2.146$. ambient air temperature = −55°C.
3. Clean airplane configuration.
4. 115/145 grade fuel.
5. R4360 engine operation based on power schedule curve.
6. LOW RPM engine cooling fan setting (except where noted).
7. Cooling devices adjusted to maintain: 260°C CHT in 30°SA and 255°C CHT in 20°SA for hottest of A-6, C-5, D-2 and D-5 cylinders. 20°C CAT. for ML operation from 1600 to 1700 BHP, 38°C CAT. for all other operation. 110°C maximum oil-in temperature limit.
8. All operation in dual turbo.
9. Nose shutoff doors closed on inoperative jet engines.

◯ J47-GE-19 %MRPM

DATA AS OF: 15 MAY 1954
DATA BASED ON: FLIGHT TEST







67-162-A

Figure A-147.

SPECIFIC RANGE AT 42,500 FEET

STANDARD ATMOSPHERE

6 R4360-53 + OPTIMUM J47-GE-19 ENGINES OPERATING

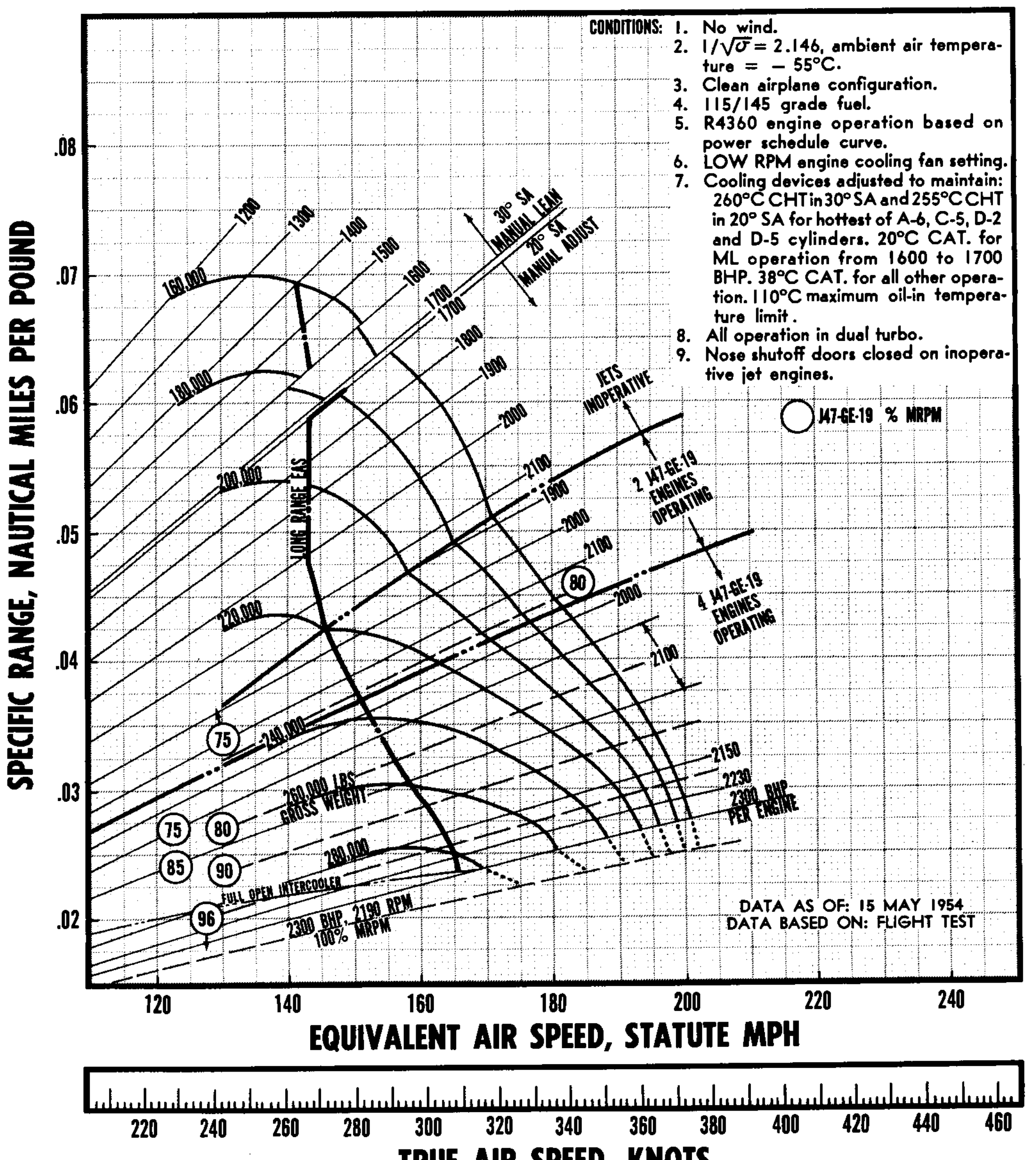


Figure A-148.

SPECIFIC RANGE AT 45,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 + J47-GE-19 ENGINES OPERATING AS NOTED

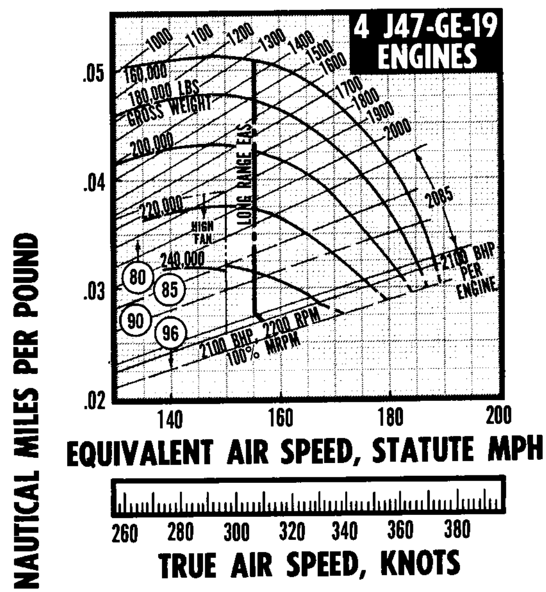
MANUAL ADJUST

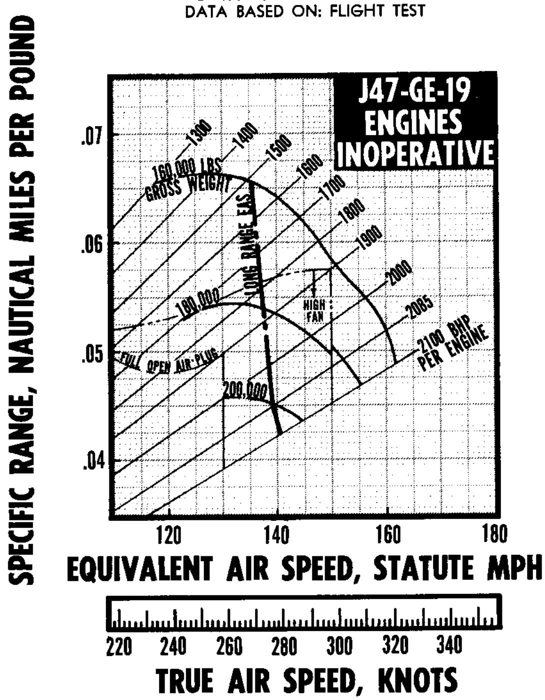
CONDITIONS:

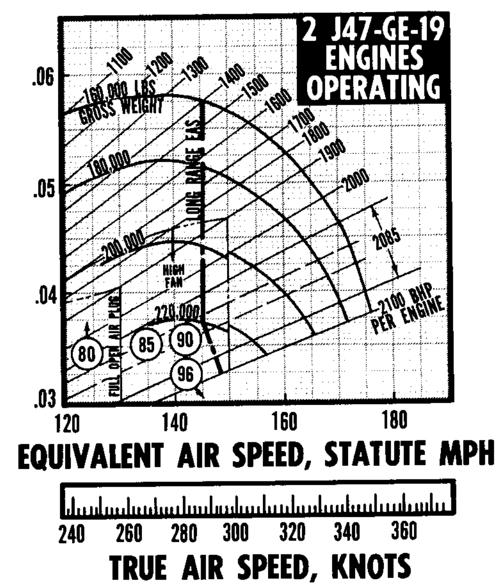
1. No wind.
2. $1/\sqrt{\sigma} = 2.146$, ambient air temperature = — 55°C.
3. Clean airplane configuration.
4. 115/145 grade fuel.
5. R4360 engine operation based on power schedule curve.
6. LOW RPM engine cooling fan setting (except where noted).
7. Cooling devices adjusted to maintain: 255°C CHT in 20°SA for hottest of A-6, C-5, D-2 and D-5 cylinders. 38°C CAT. 110°C maximum oil-in temperature limit.
8. All operation in dual turbo.
9. Nose shutoff doors closed on inoperative jet engines.
10. All operation in manual adjust and 20°SA.

○ J47-GE-19 % MRPM

DATA AS OF: 15 MAY 1954
DATA BASED ON: FLIGHT TEST







67-207-A

Figure A-149.

SPECIFIC RANGE AT 45,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 + OPTIMUM J47-GE-19 ENGINES OPERATING

MANUAL ADJUST

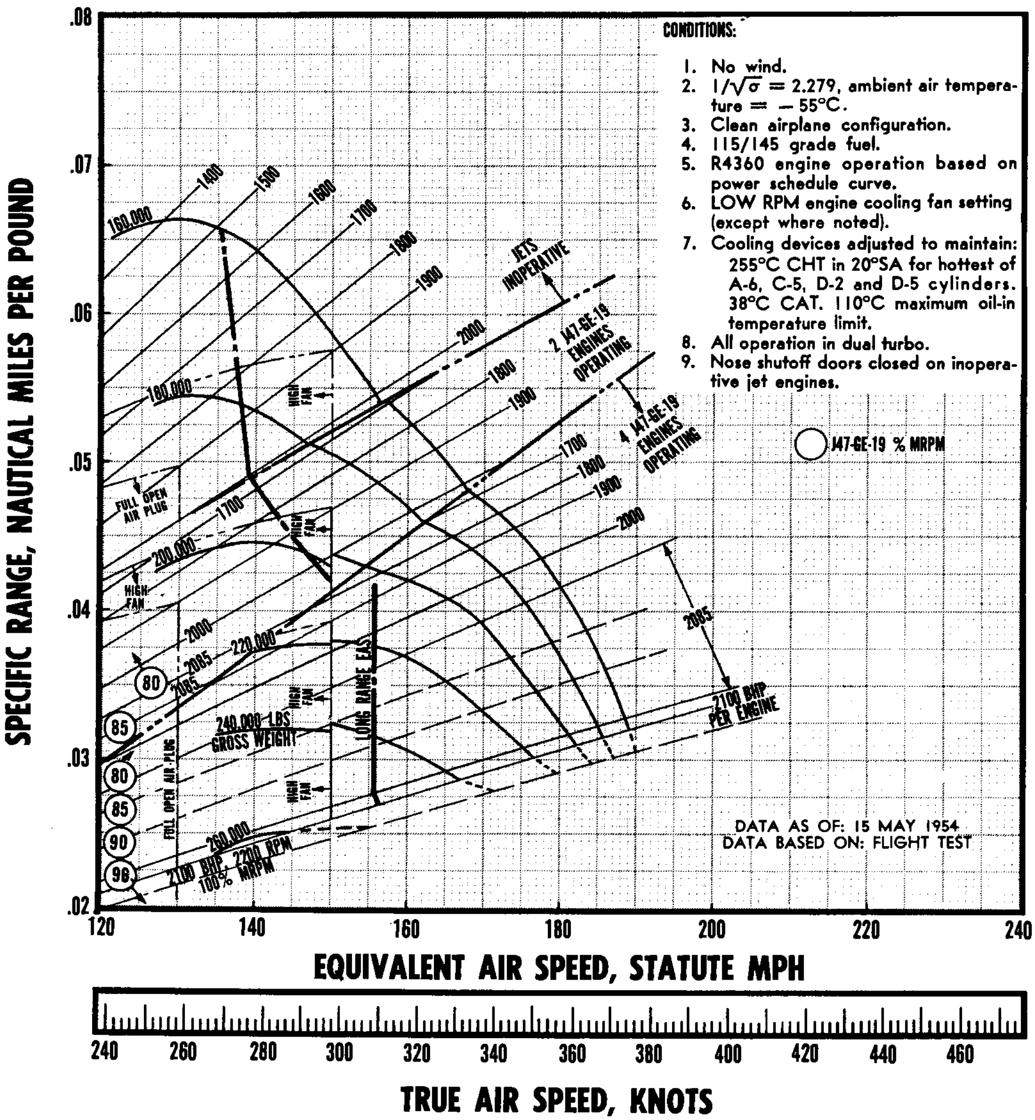


Figure A-150.

SPECIFIC RANGE AT 45,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 + J47-GE-19 ENGINES OPERATING AS NOTED

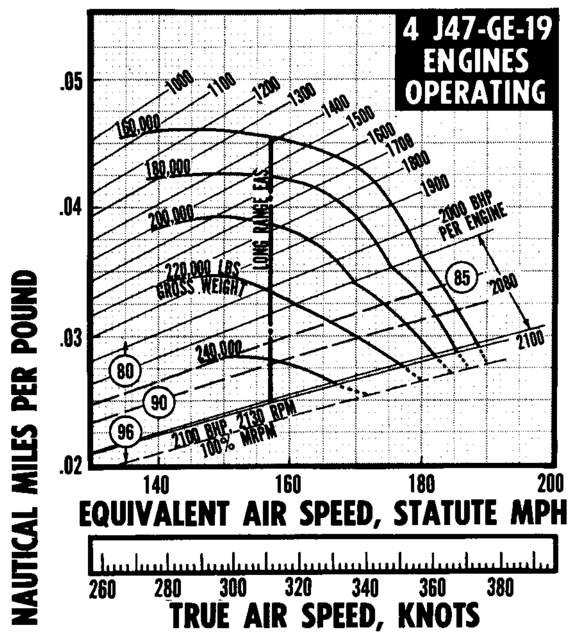
RICH MIXTURE

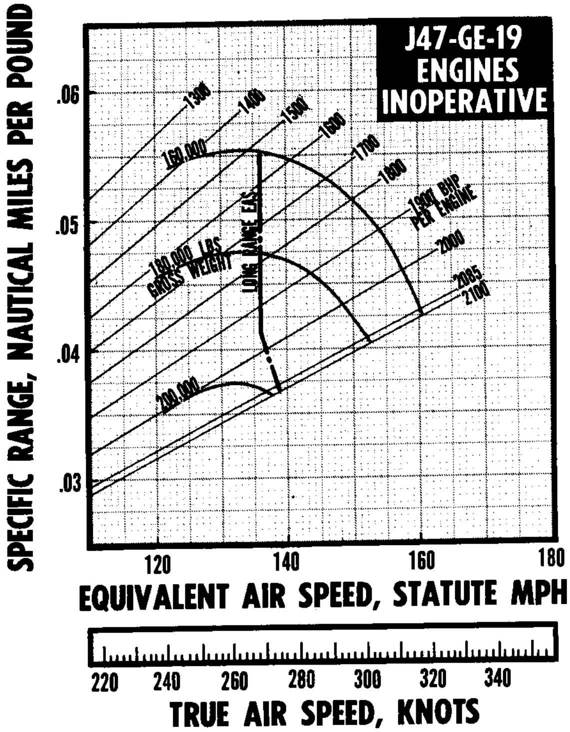
CONDITIONS:

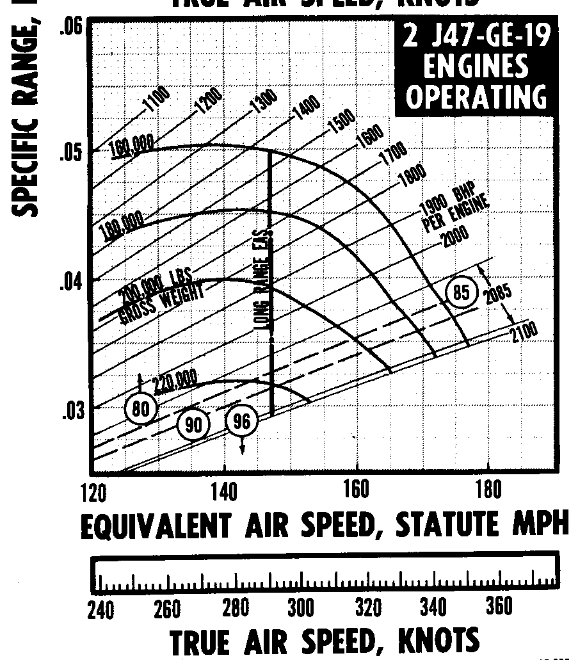
1. No wind.
2. $1/\sqrt{\sigma} = 2.279$, ambient air temperature = — 55°C.
3. Clean airplane configuration.
4. 115/145 grade fuel.
5. R4360 engine operation based on power schedule curve.
6. LOW RPM engine cooling fan setting.
7. Cooling devices adjusted to maintain: 255°C CHT in 20°SA for hottest of A-6, C-5, D-2 and D-5 cylinders. 38°C CAT. 110°C maximum oil-in temperature limit.
8. All operation in dual turbo.
9. Nose shutoff doors closed on inoperative jet engines.

○ J47-GE-19 % MRPM

DATA AS OF: 15 MAY 1954
DATA BASED ON: FLIGHT TEST







67-257-A

Figure A-151.

SPECIFIC RANGE AT 45,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 + OPTIMUM J47-GE-19 ENGINES OPERATING

RICH MIXTURE

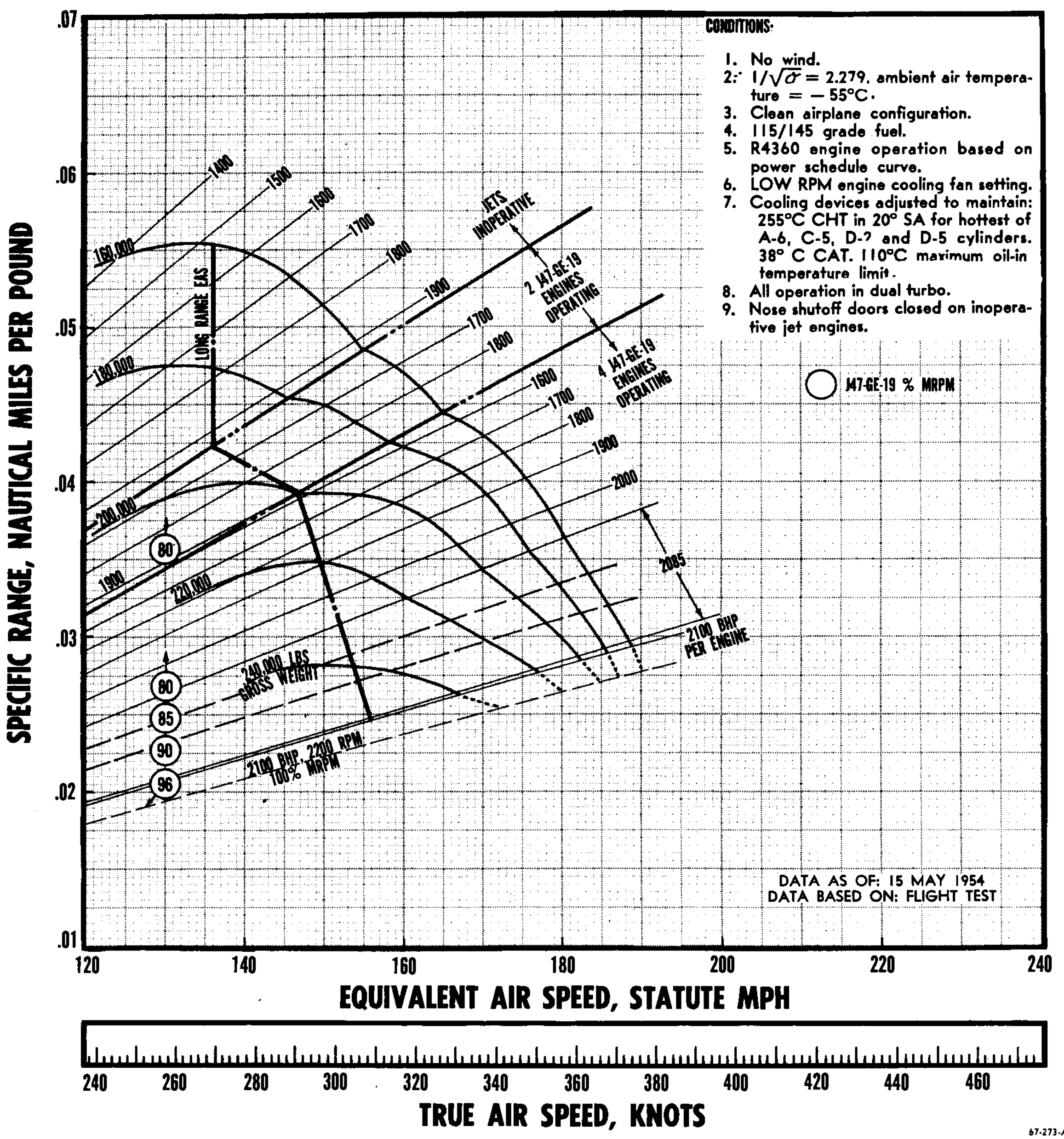


Figure A-152.

SPECIFIC RANGE AT 47,500 FEET

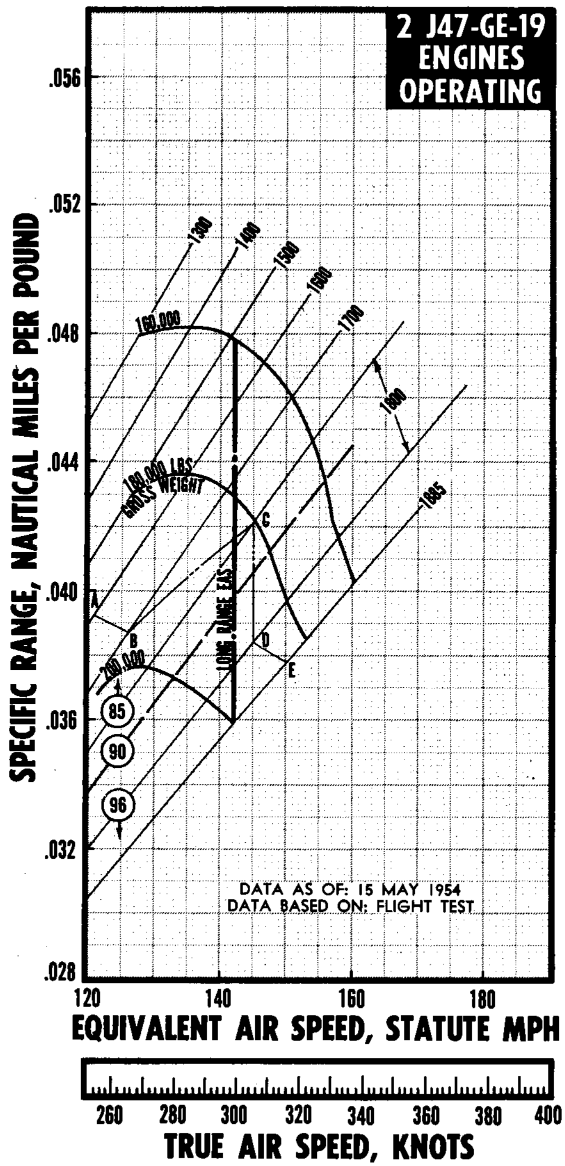
STANDARD ATMOSPHERE

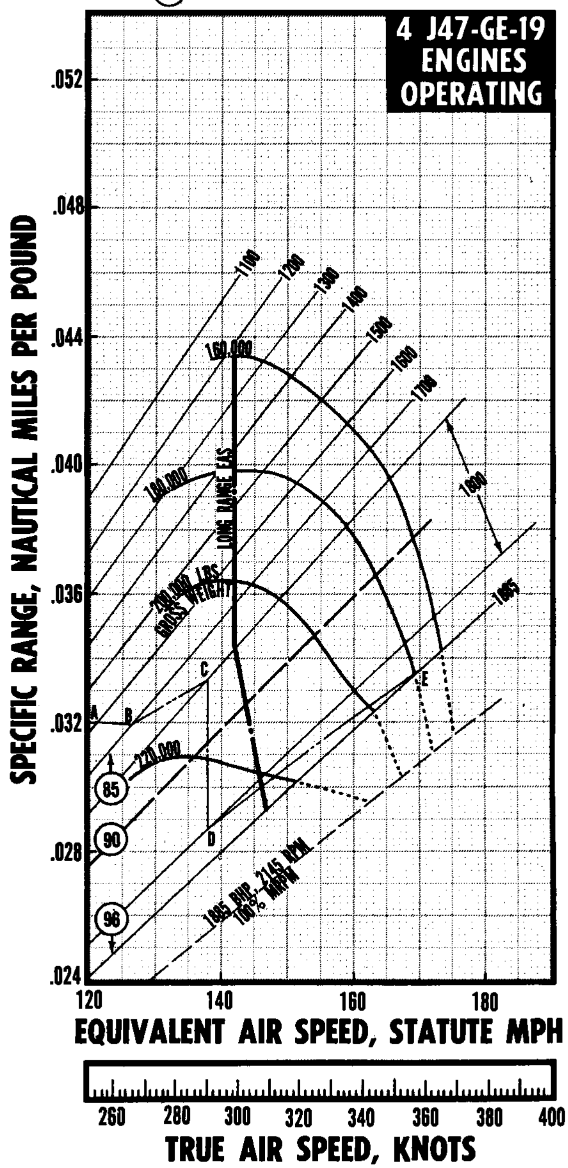
6 R4360-53 + J47-GE-19 ENGINES OPERATING AS NOTED

CONDITIONS:

1. No wind.
2. $1/\sqrt{\sigma} = 2.418$, ambient air temperature = — 55°C.
3. Clean airplane configuration.
4. 115/145 grade fuel.
5. R4360 engine operation based on power schedule curve.
6. LOW RPM engine cooling fan setting, (except where noted). HIGH RPM engine cooling fan setting below and to the left of line ABCDE.
7. Cooling devices adjusted to maintain: 255°C CHT in 20°SA for hottest of A-6, C-5, D-2 and D-5 cylinders. 38°C CAT. 110°C maximum oil-in temperature limit.
8. All operation in dual turbo.
9. Nose shutoff doors closed on inoperative jet engines.
10. All operation in rich mixture.

◯ J47-GE-19 % MRPM





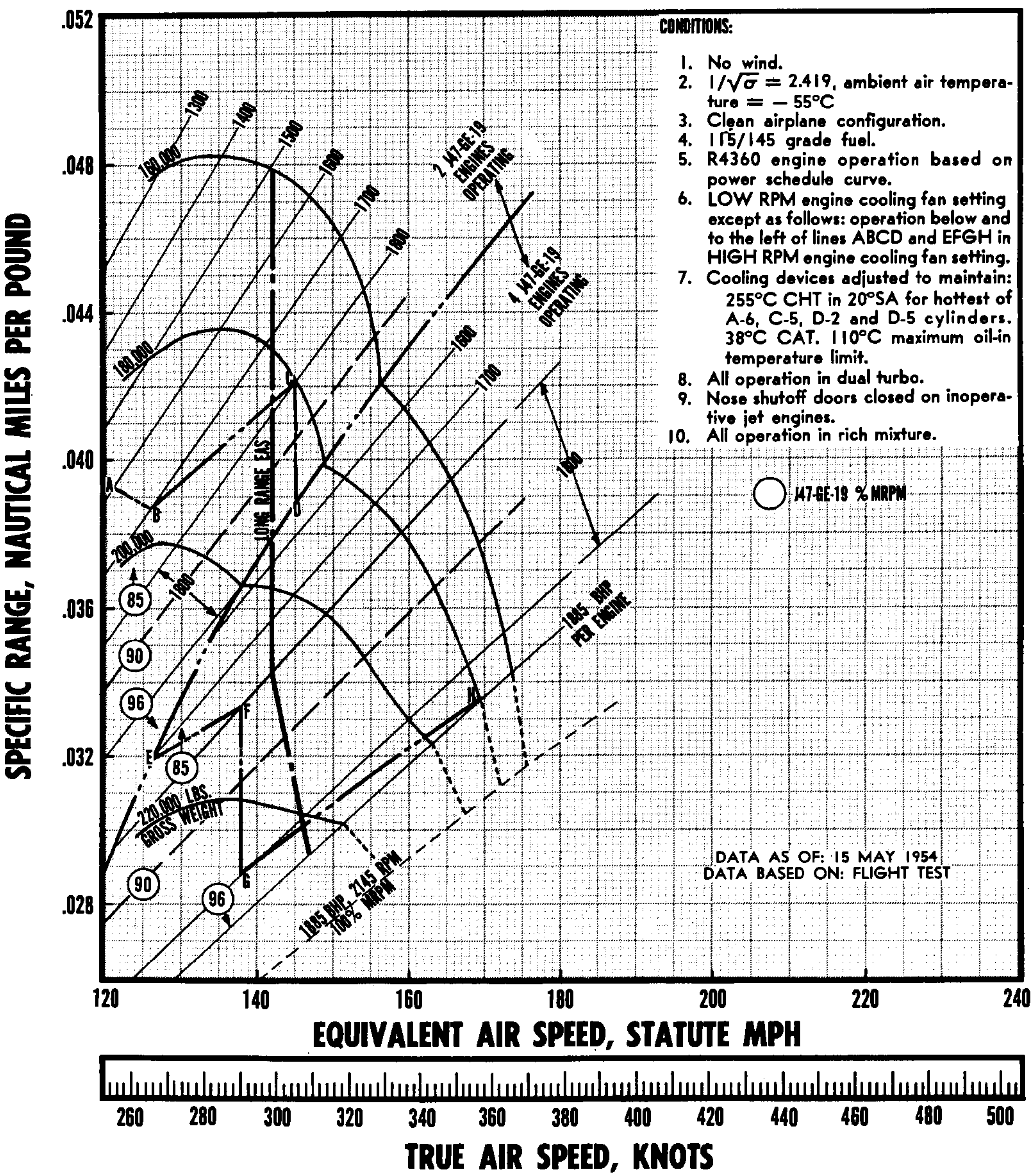
67-259-A

Figure A-153.

SPECIFIC RANGE AT 47,500 FEET

STANDARD ATMOSPHERE

6 R4360-53 + OPTIMUM J47-GE-19 ENGINES OPERATING



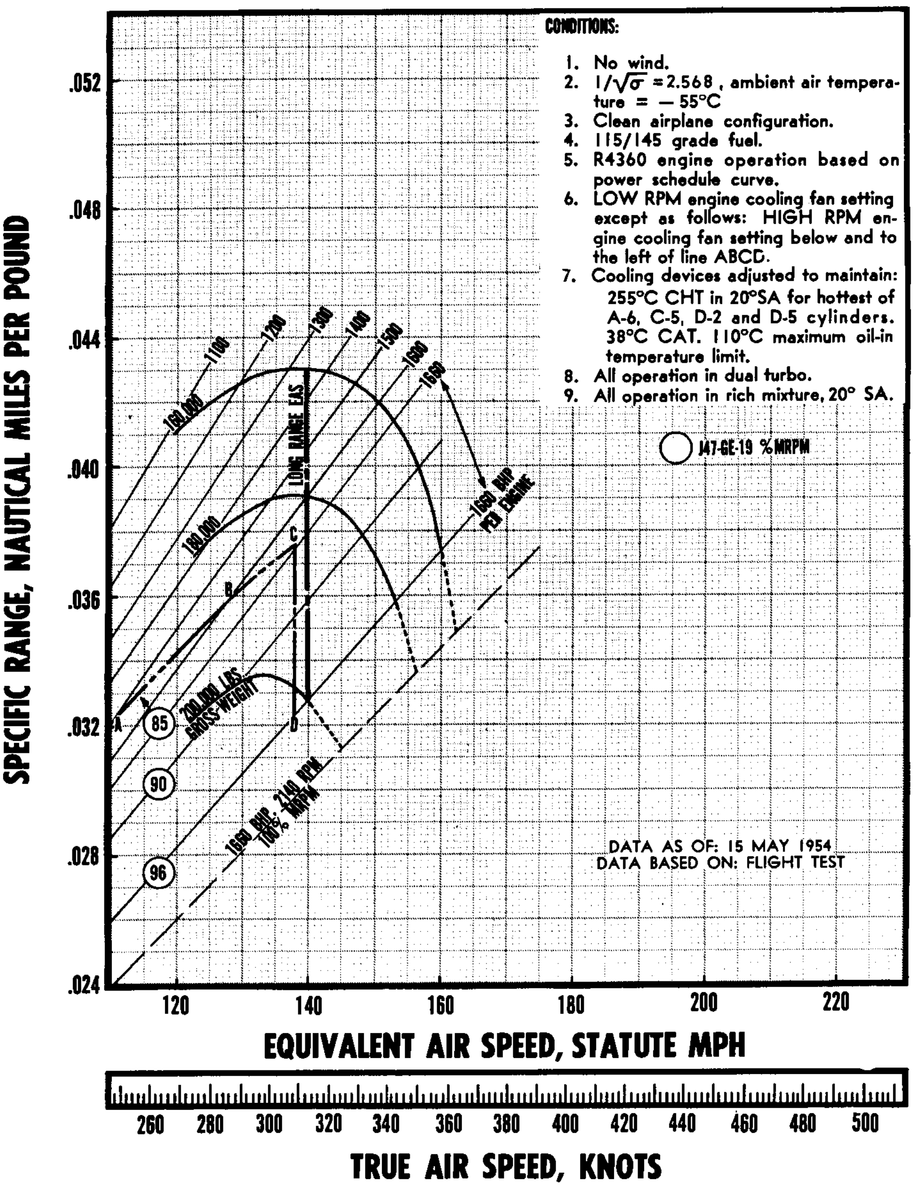
67-260-A

Figure A-154.

SPECIFIC RANGE AT 50,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 + 4 J47-GE-19 ENGINES OPERATING



67-258-A

Figure A-155.

SPECIFIC RANGE AT 51,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 + 4 J47-GE-19 ENGINES OPERATING

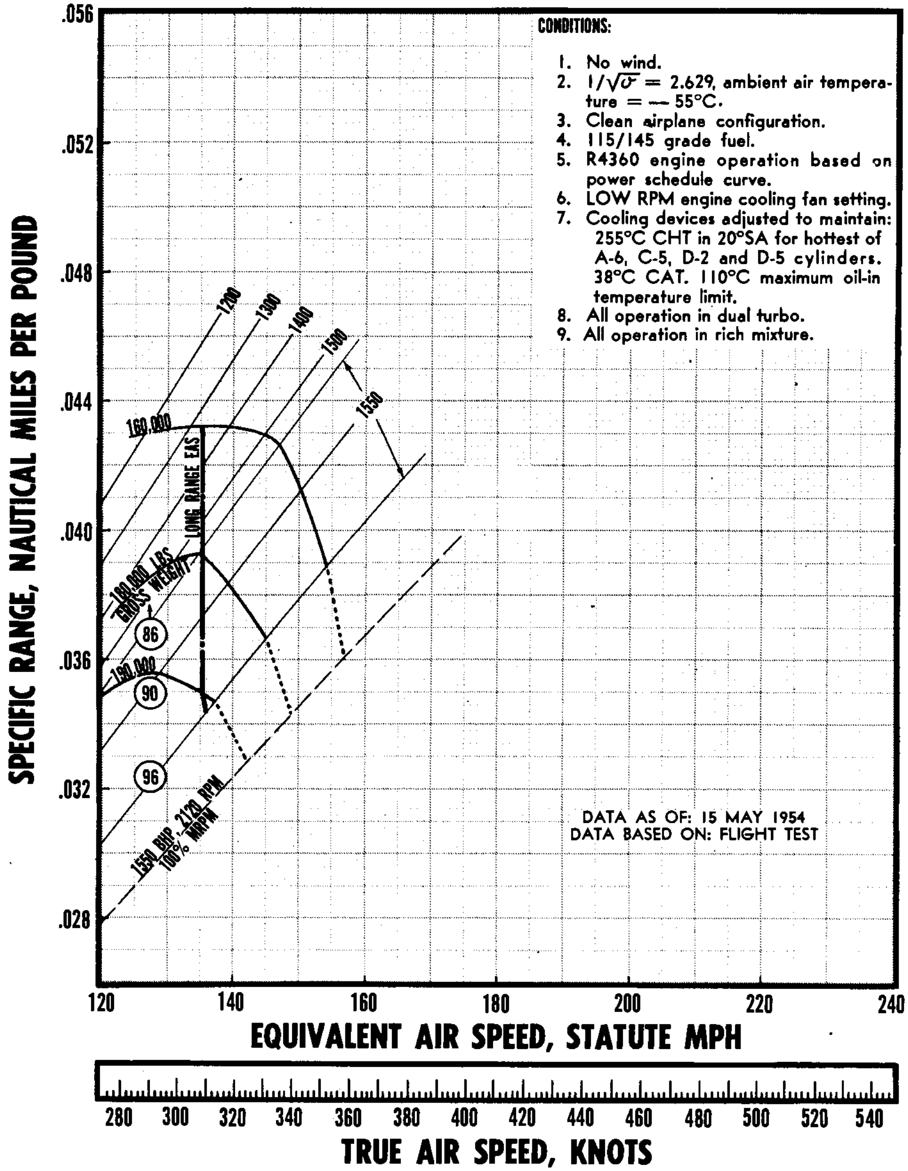


Figure A-156.

SPECIFIC RANGE AT SEA LEVEL

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING

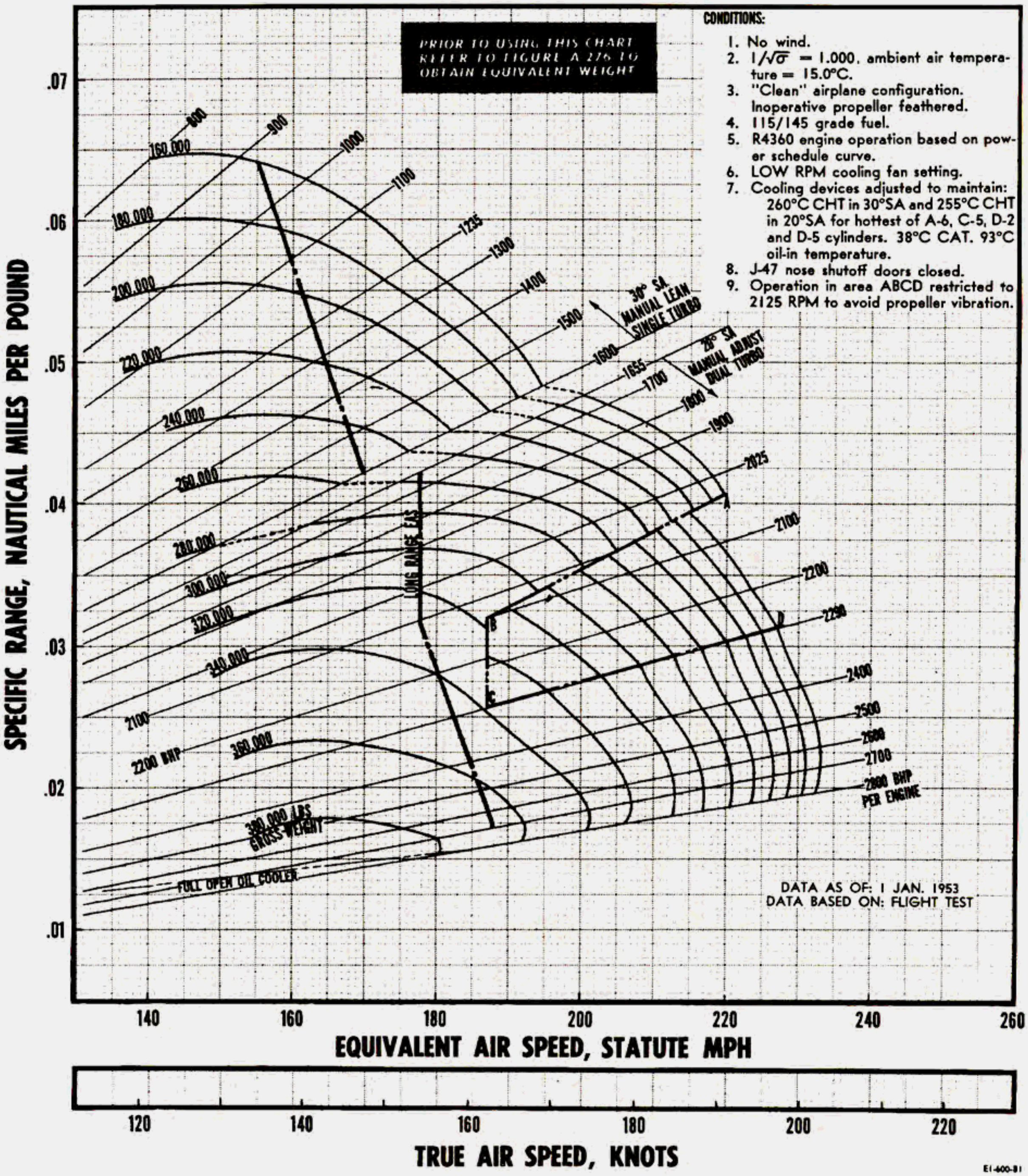


Figure A-157.

SPECIFIC RANGE AT 5000 FEET

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING

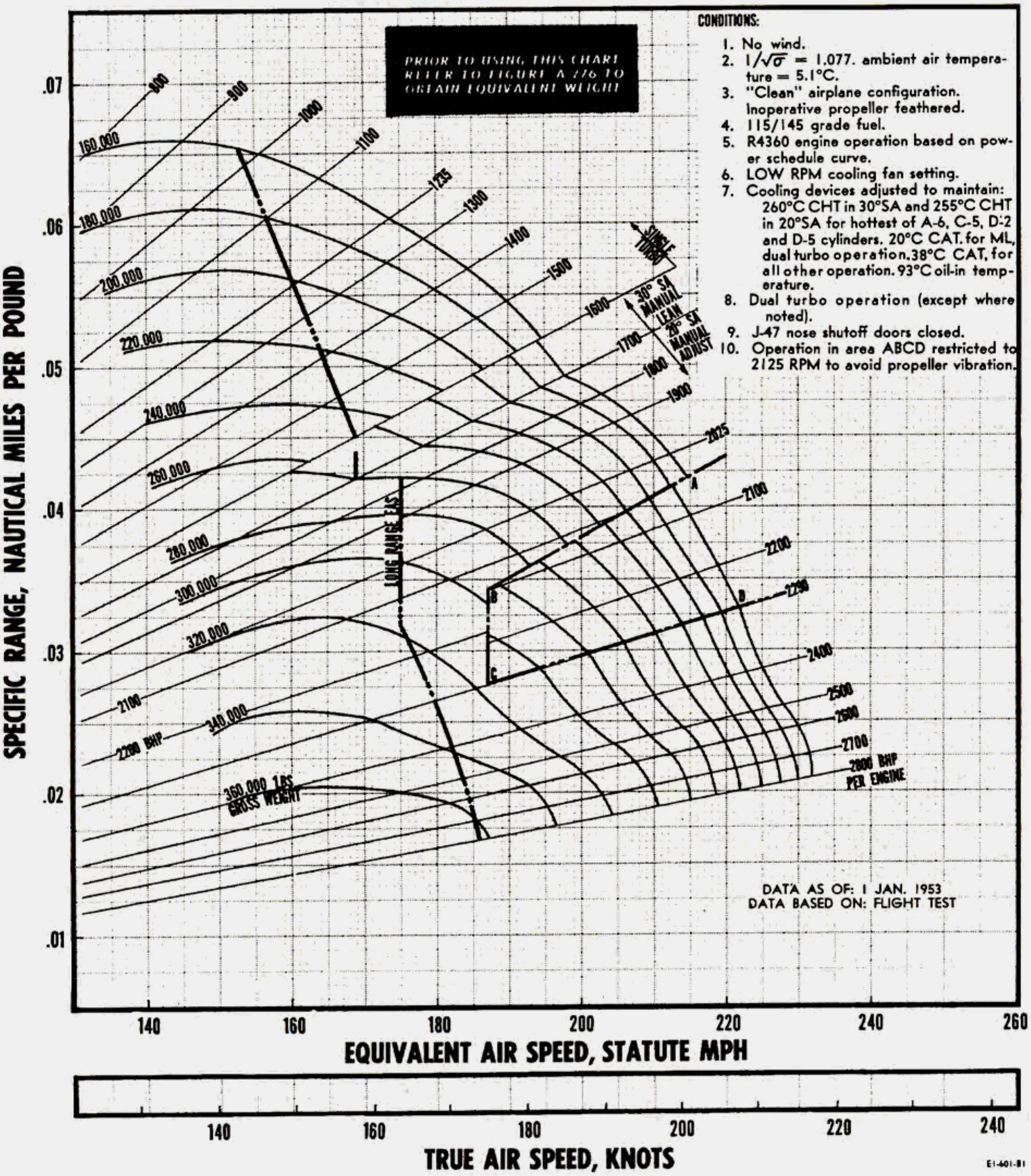


Figure A-158.

SPECIFIC RANGE AT 10,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING

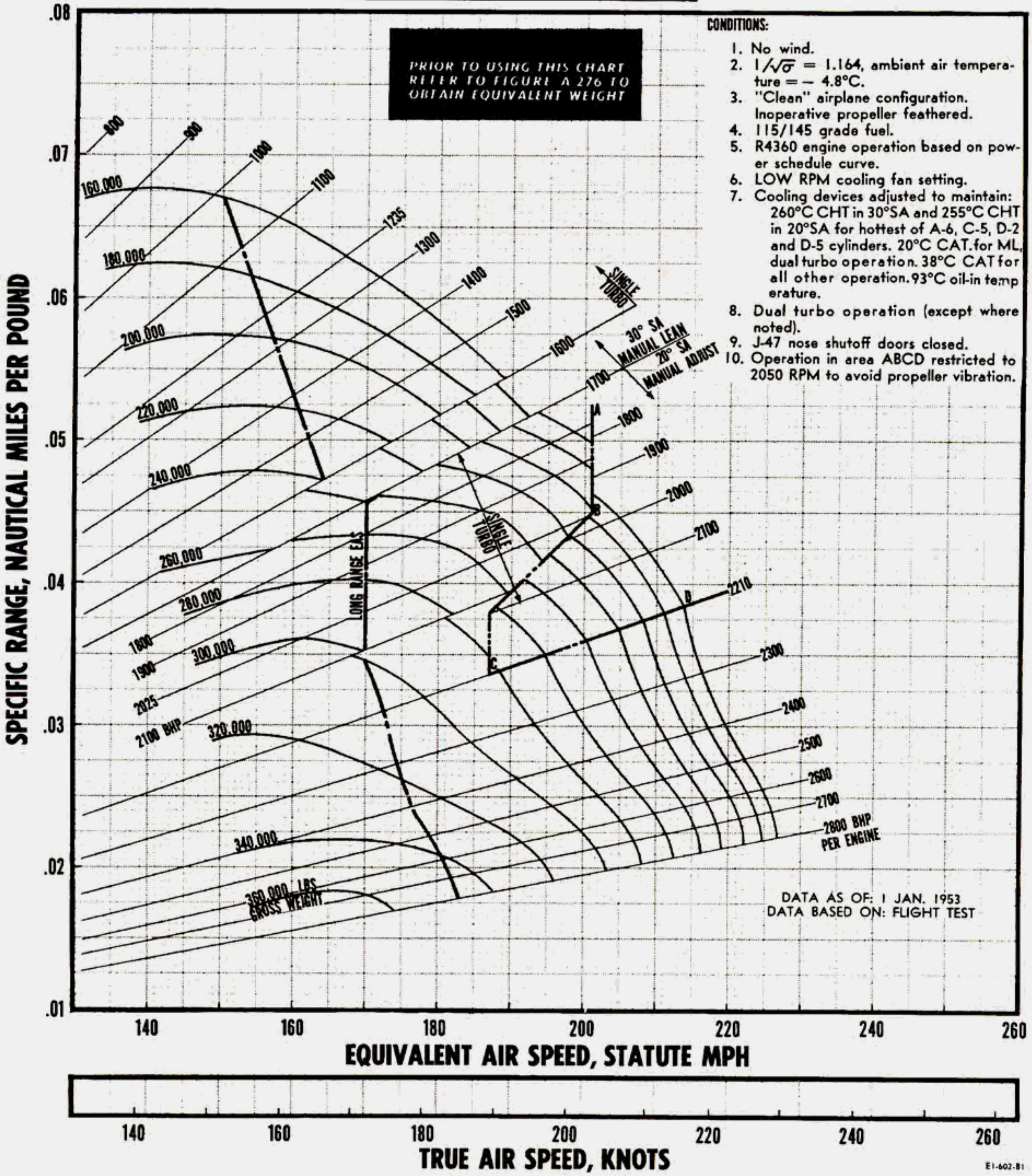


Figure A-159.

SPECIFIC RANGE AT 15,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING

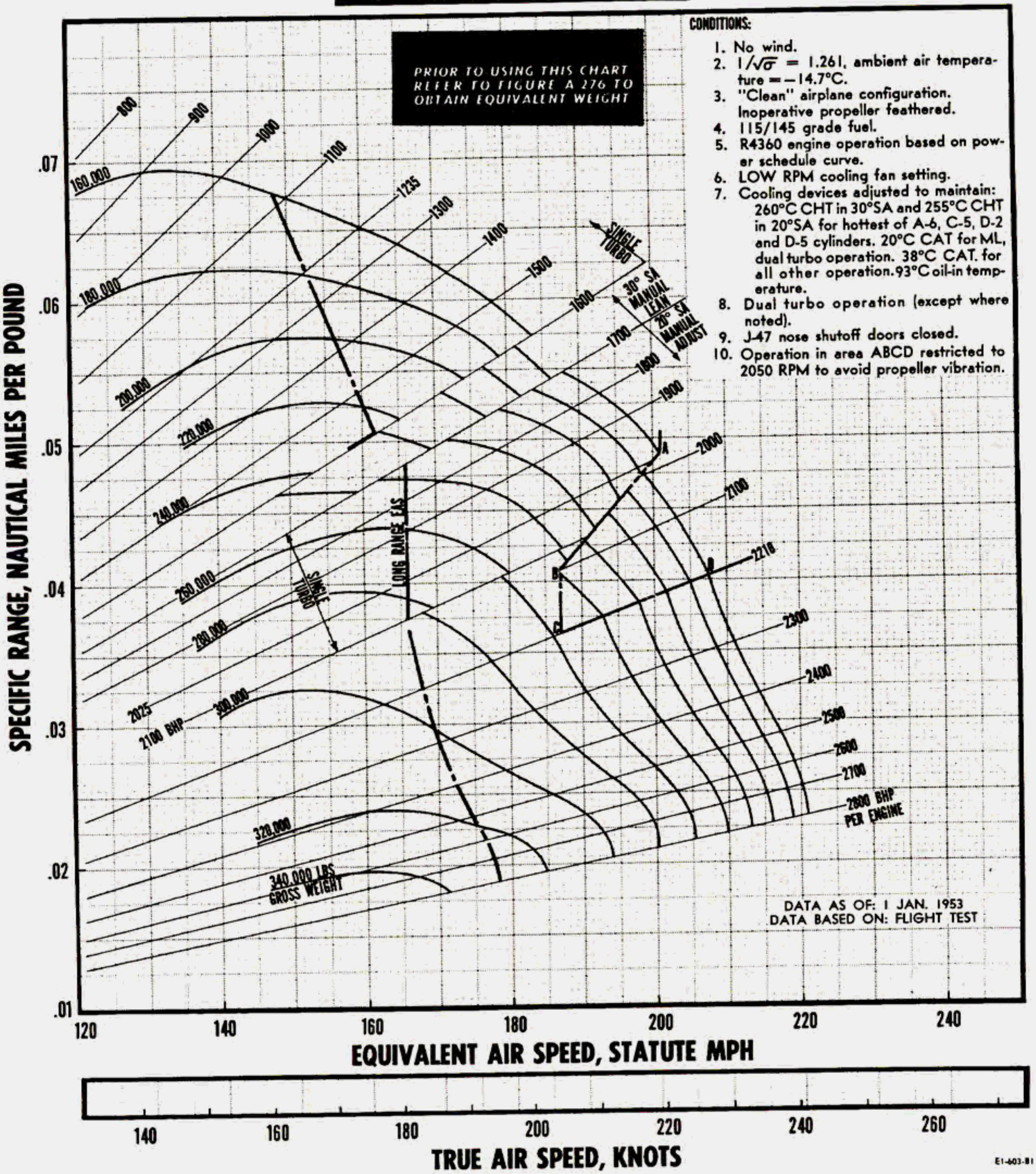


Figure A-160.

SPECIFIC RANGE AT 20,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING

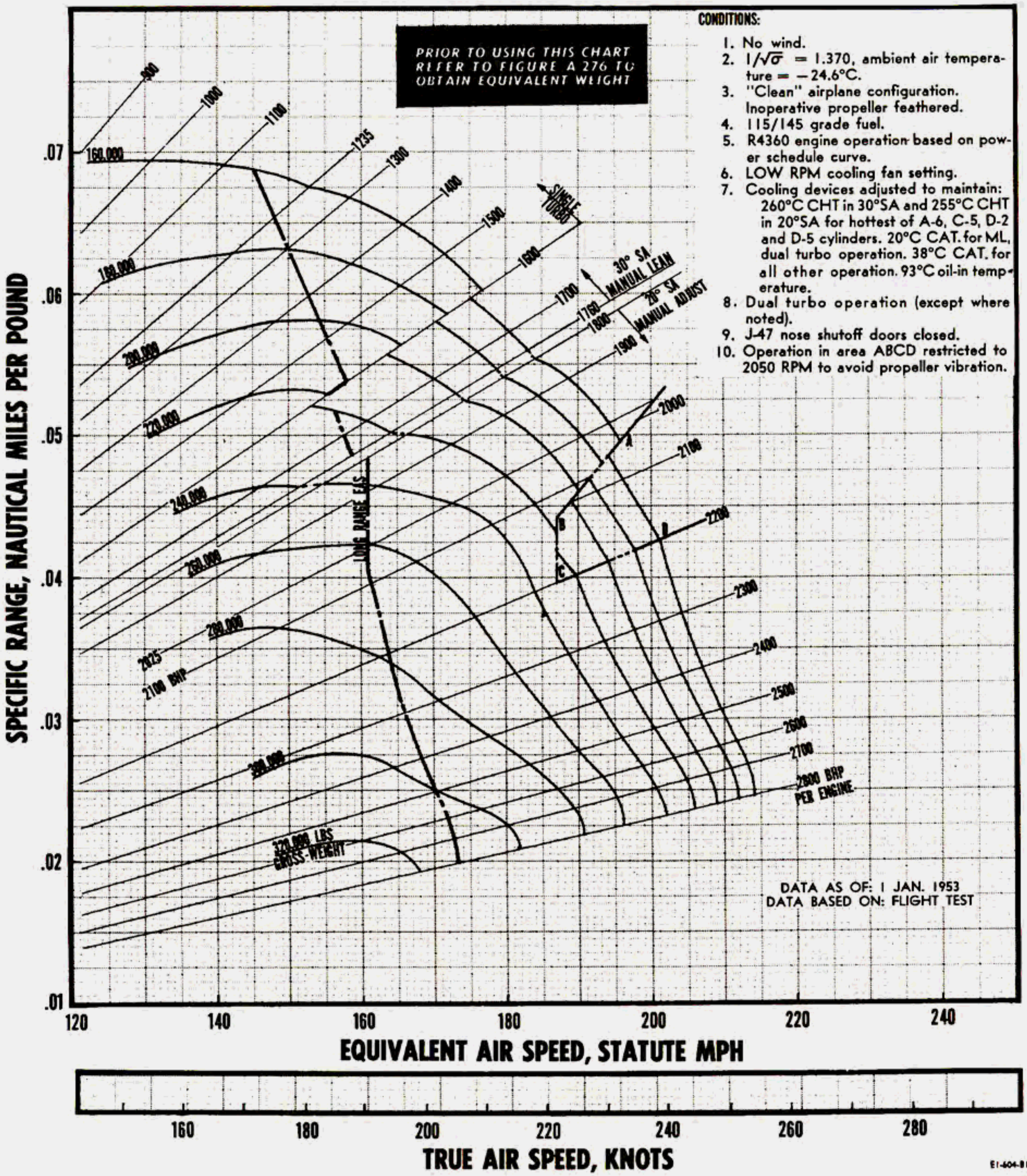


Figure A-161.

SPECIFIC RANGE AT 25,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING

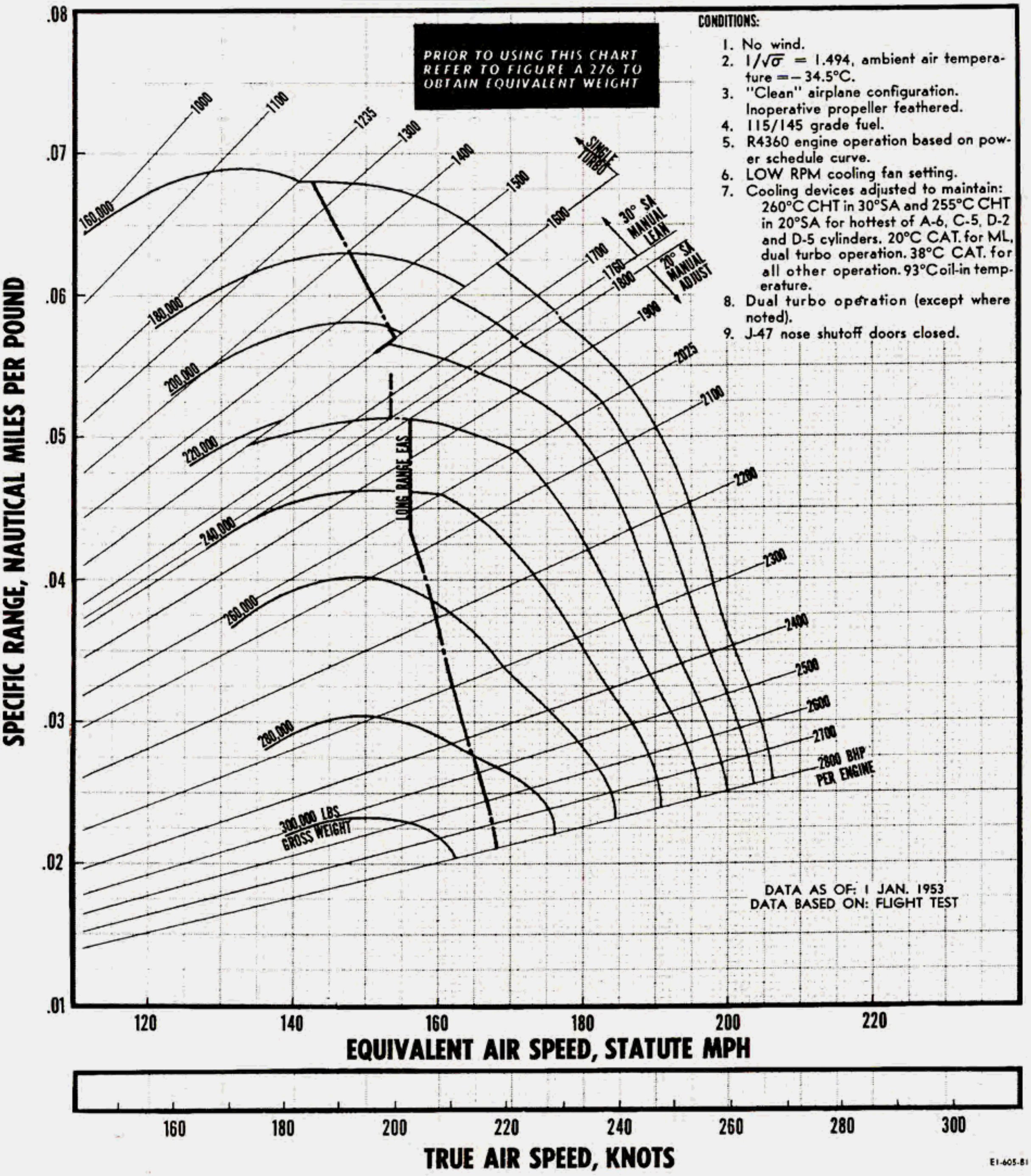


Figure A-162.

SPECIFIC RANGE AT 30,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING

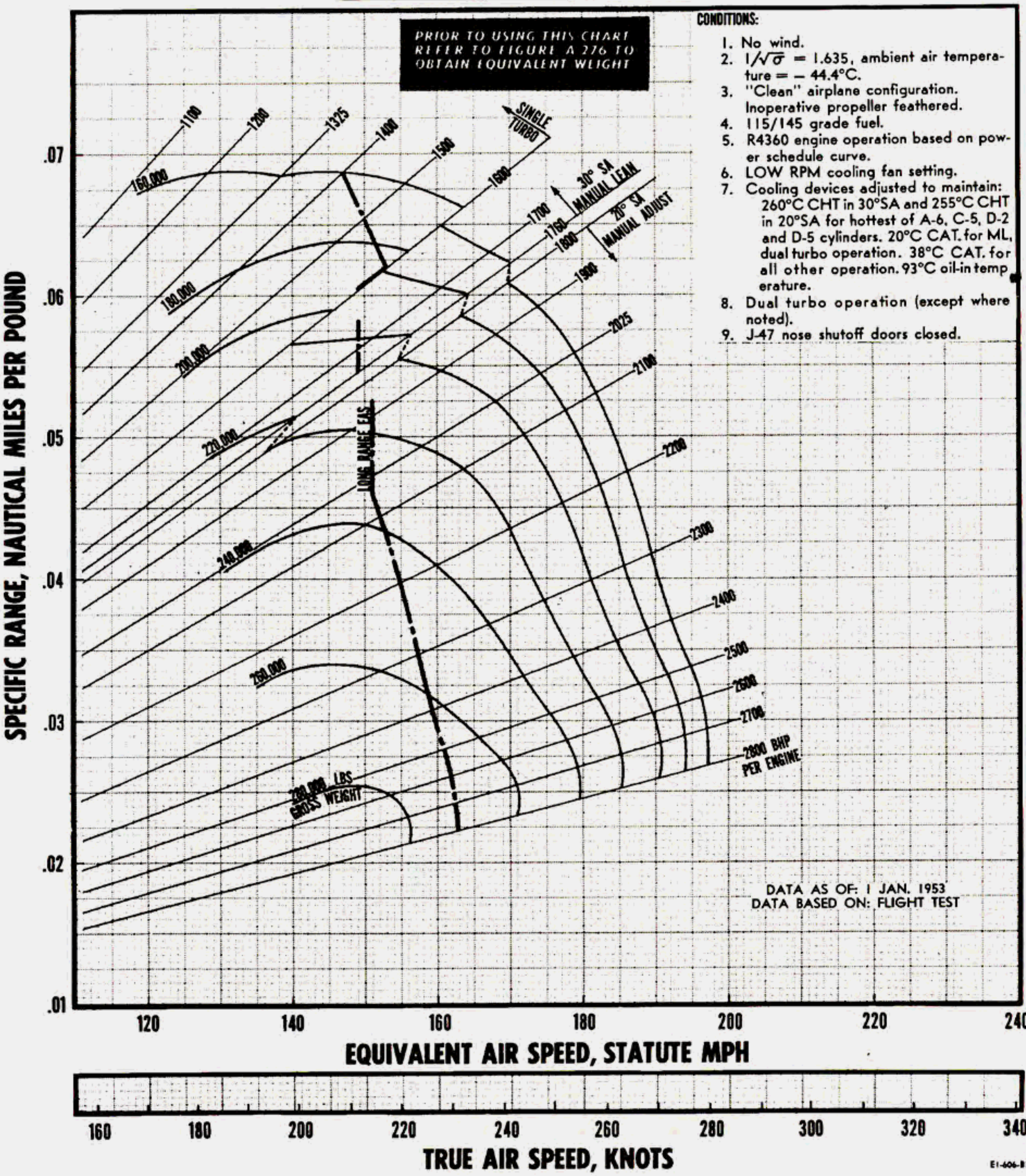


Figure A-163.

SPECIFIC RANGE AT 30,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 +2 J47-GE-19 ENGINES OPERATING

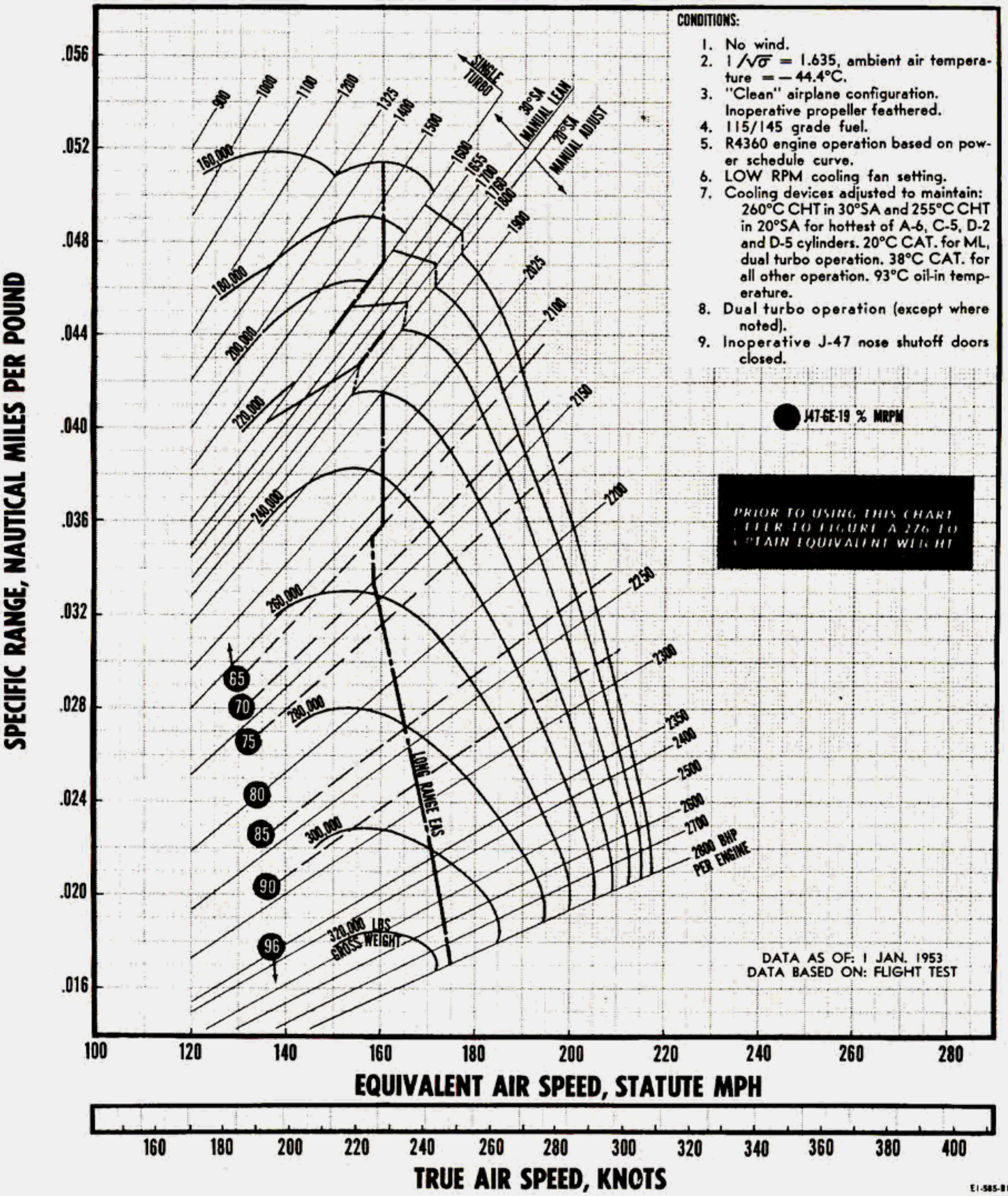


Figure A-164.

SPECIFIC RANGE AT 30,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 + 4 J47-GE-19 ENGINES OPERATING

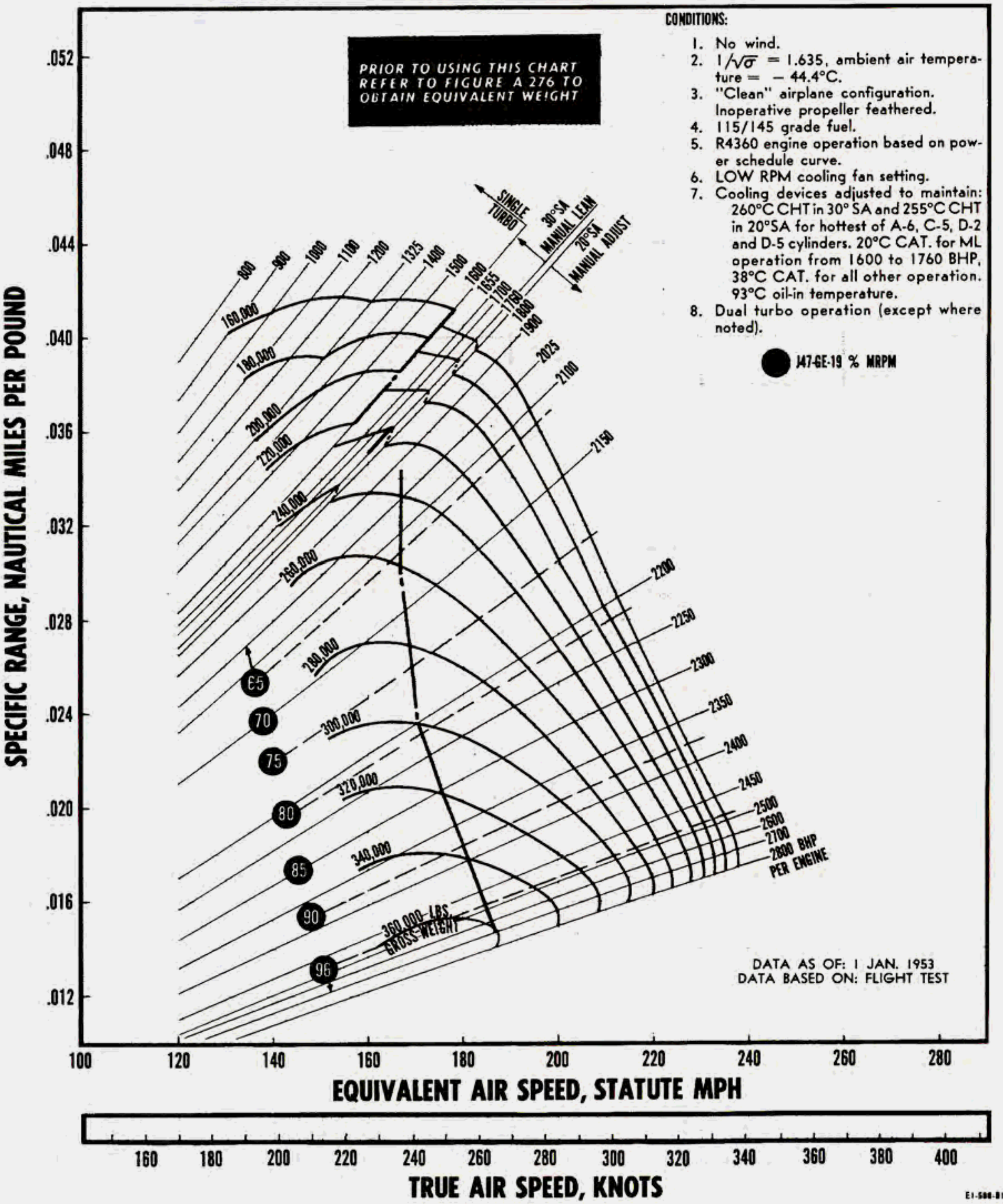


Figure A-165.

SPECIFIC RANGE AT 30,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING, OPTIMUM J47-GE-19 ENGINES OPERATING

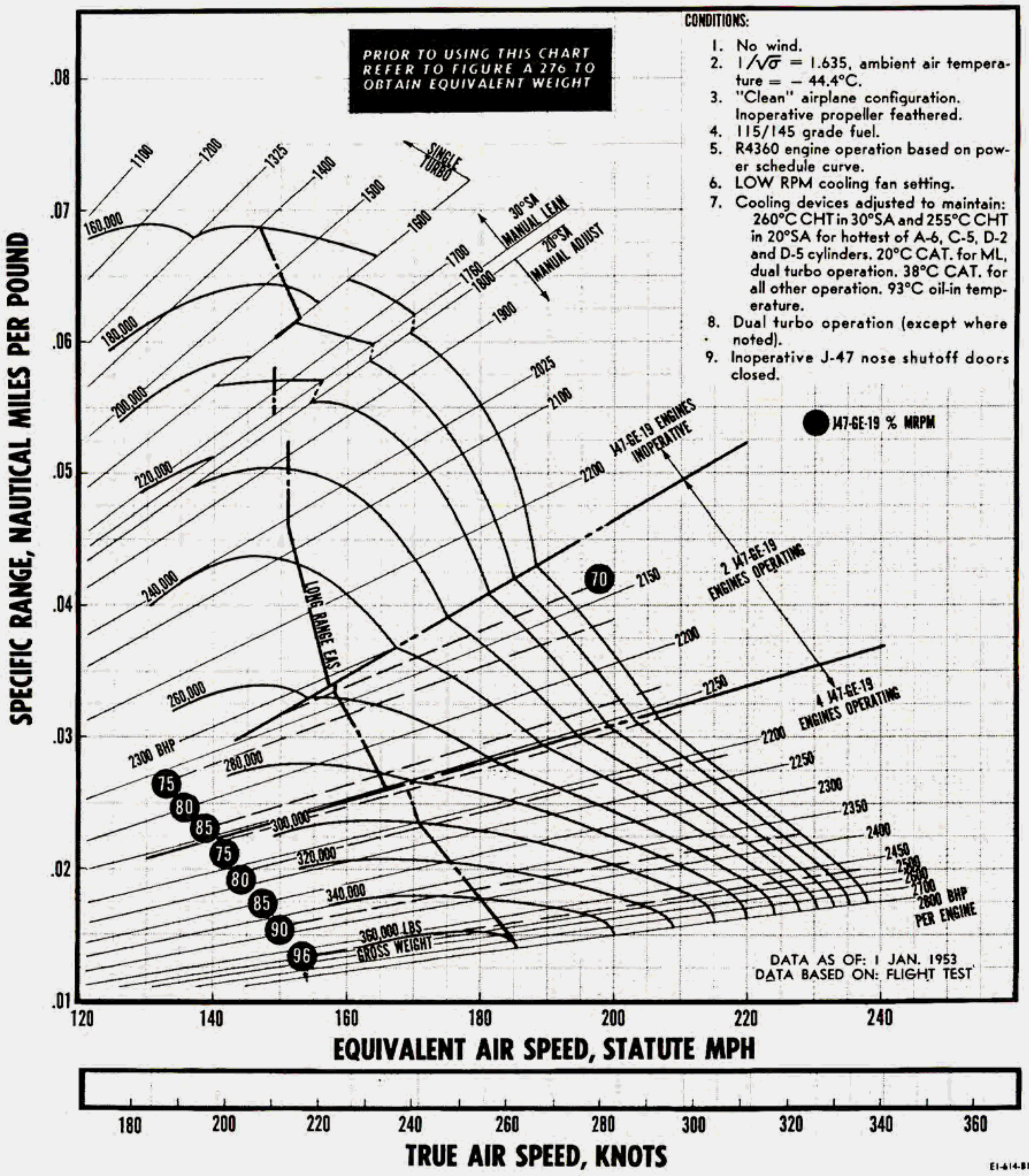


Figure A-166.

SPECIFIC RANGE AT 35,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING

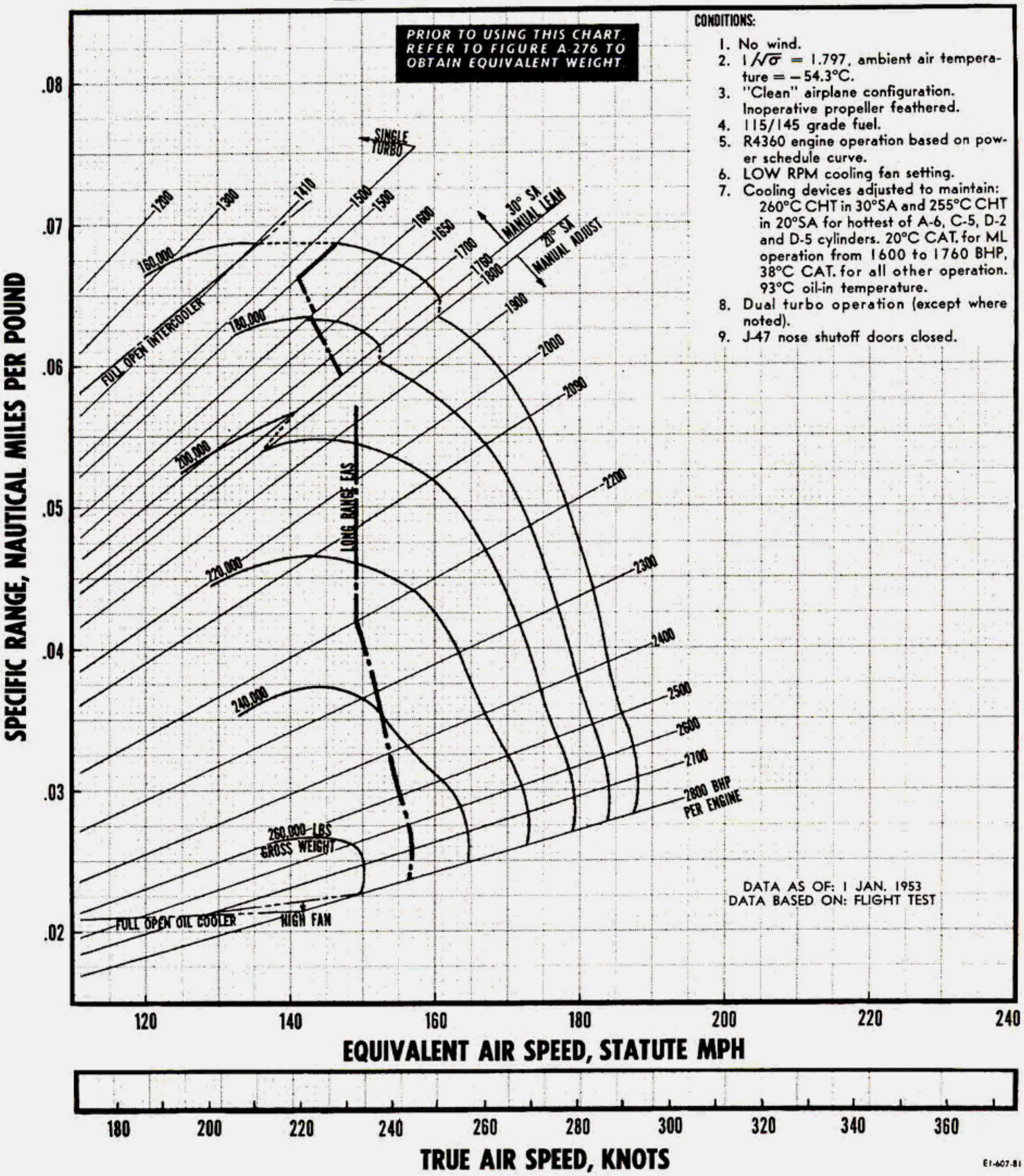


Figure A-167.

SPECIFIC RANGE AT 35,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 +2 J47-GE-19 ENGINES OPERATING

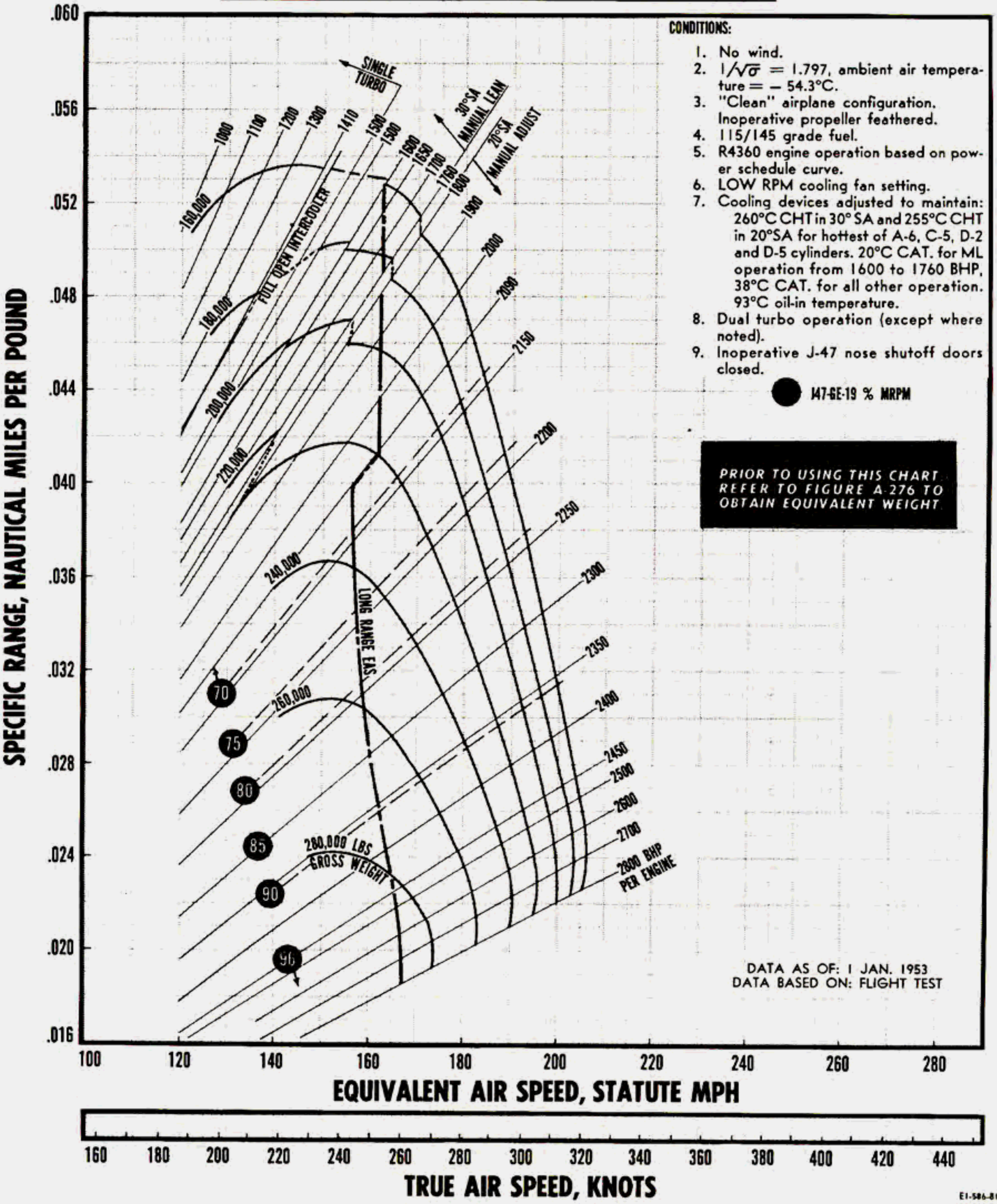


Figure A-168.

SPECIFIC RANGE AT 35,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 + 4 J47-GE-19 ENGINES OPERATING

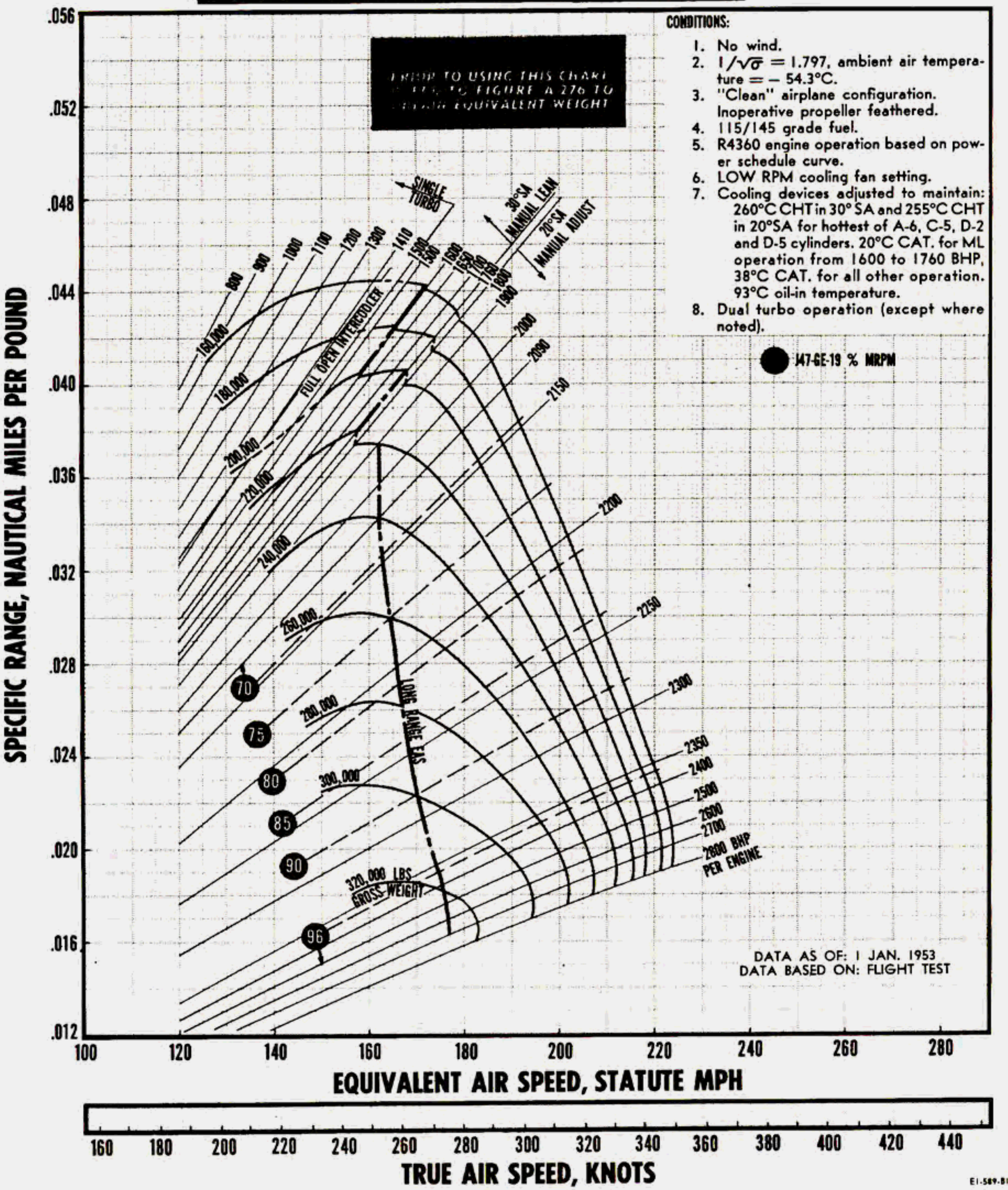


Figure A-169.

SPECIFIC RANGE AT 35,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING, OPTIMUM J47-GE-19 ENGINES OPERATING

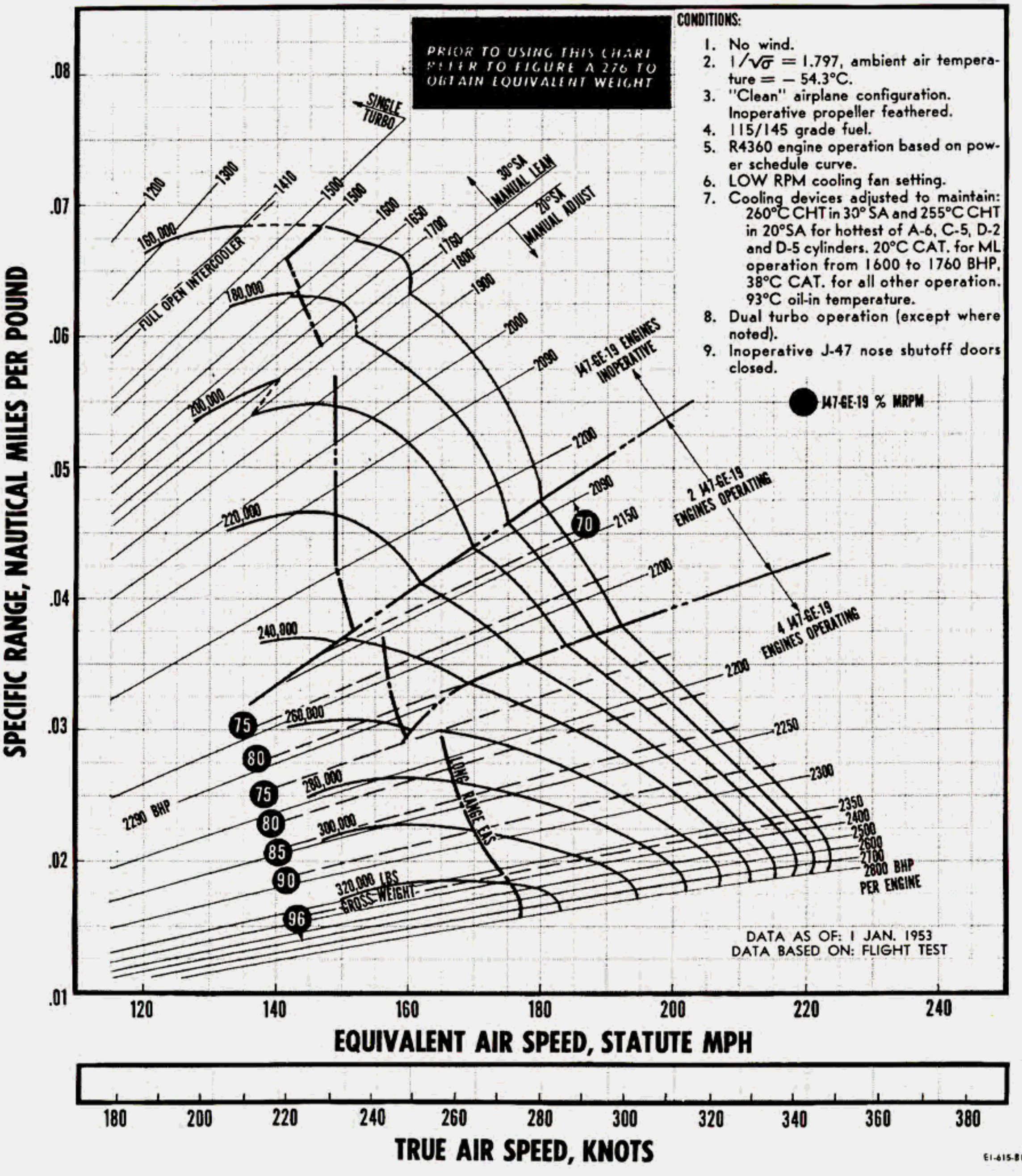


Figure A-170.

SPECIFIC RANGE AT 40,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING

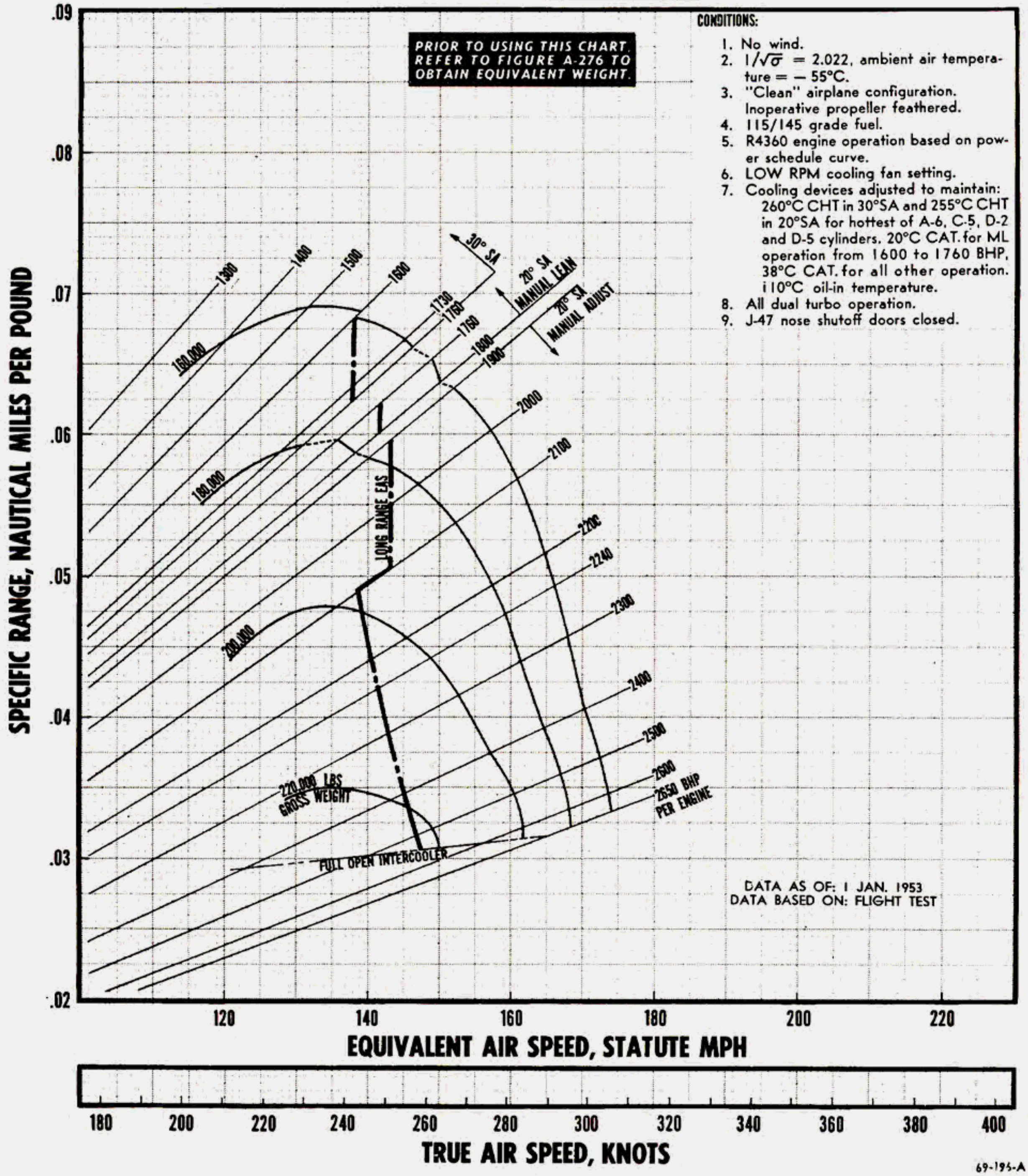


Figure A-171.

SPECIFIC RANGE AT 40,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 + 2 J47-GE-19 ENGINES OPERATING

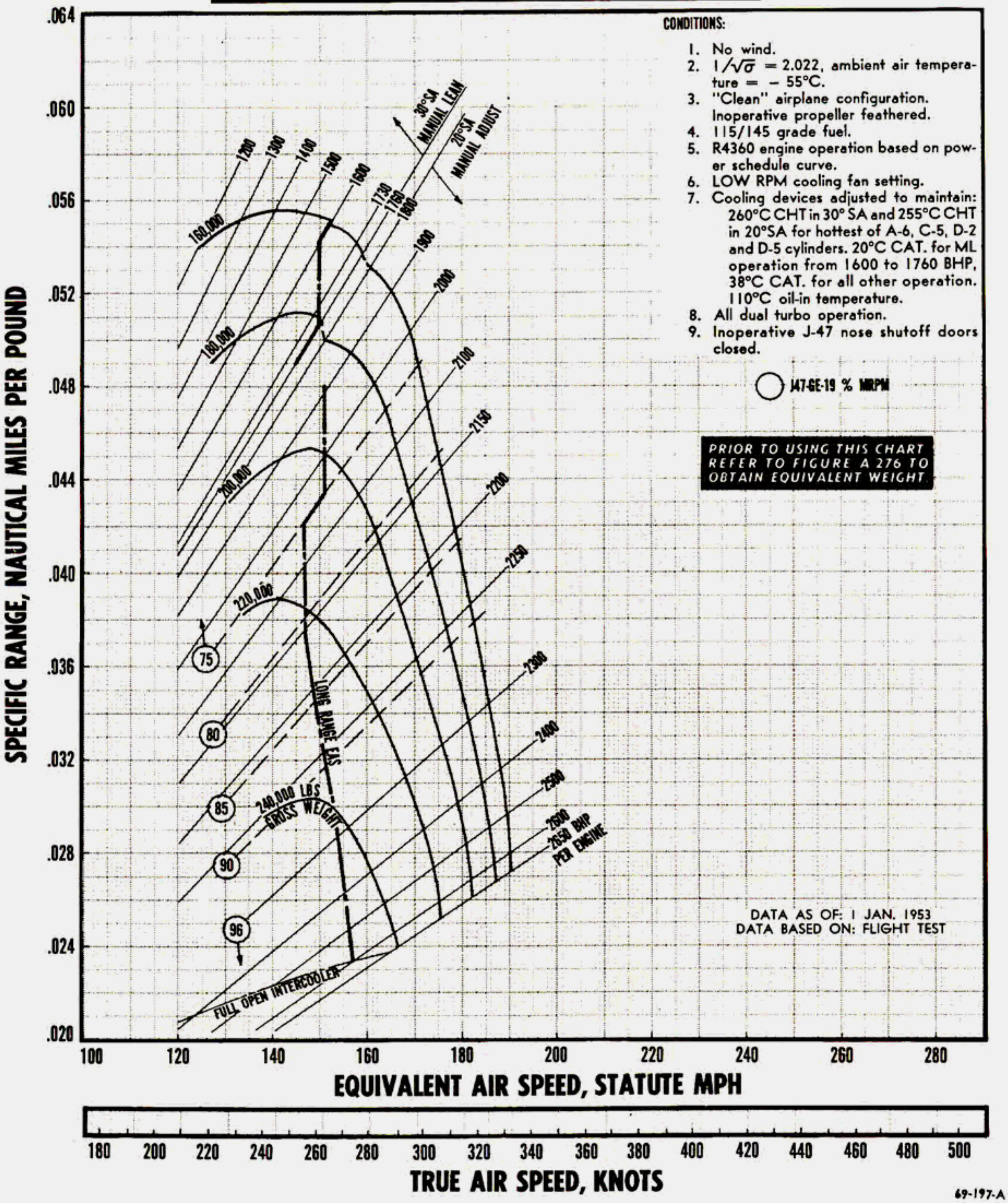


Figure A-172.

SPECIFIC RANGE AT 40,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 + 4 J47-GE-19 ENGINES OPERATING

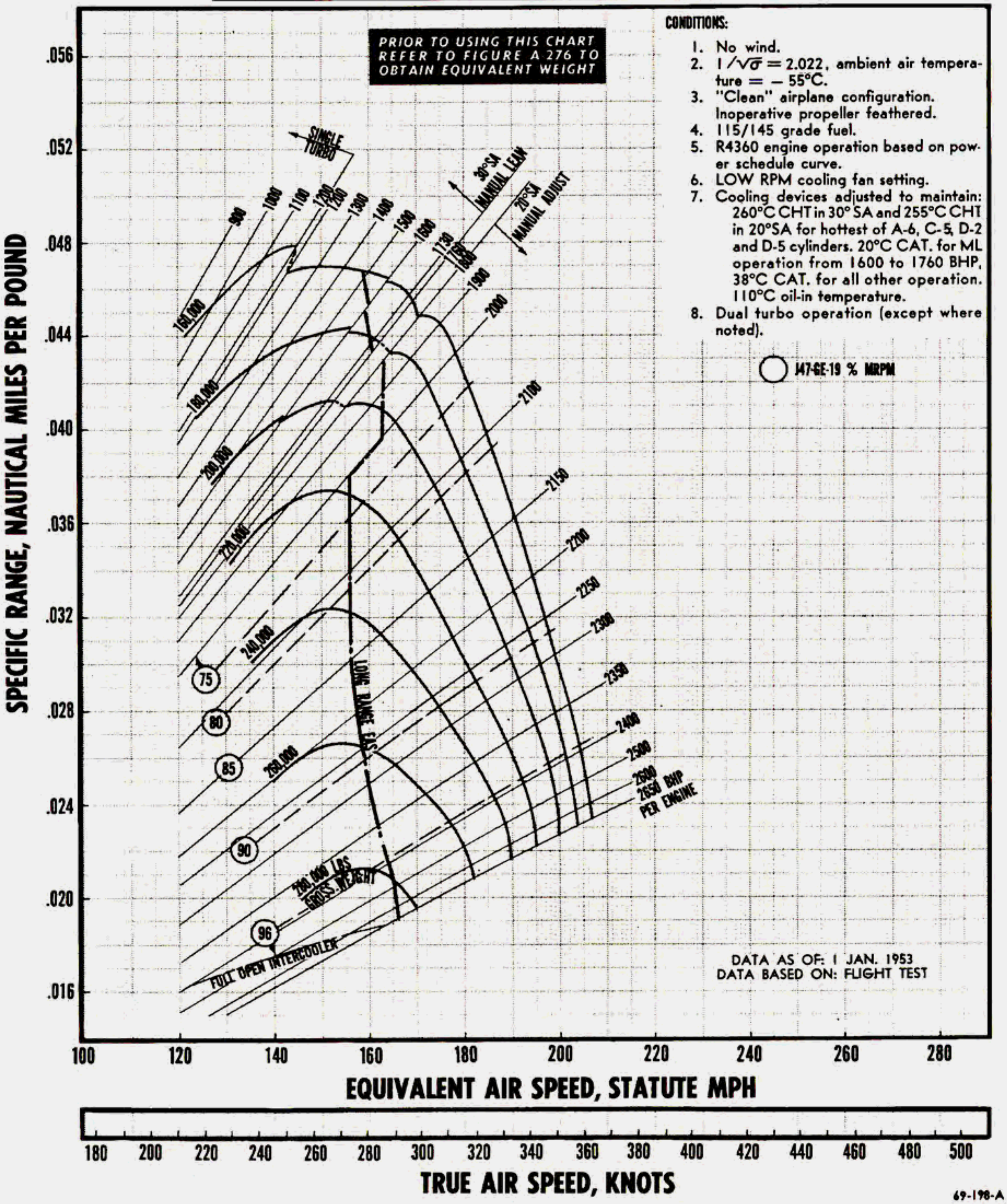


Figure A-173.

SPECIFIC RANGE AT 40,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING, OPTIMUM J47-GE-19 ENGINES OPERATING

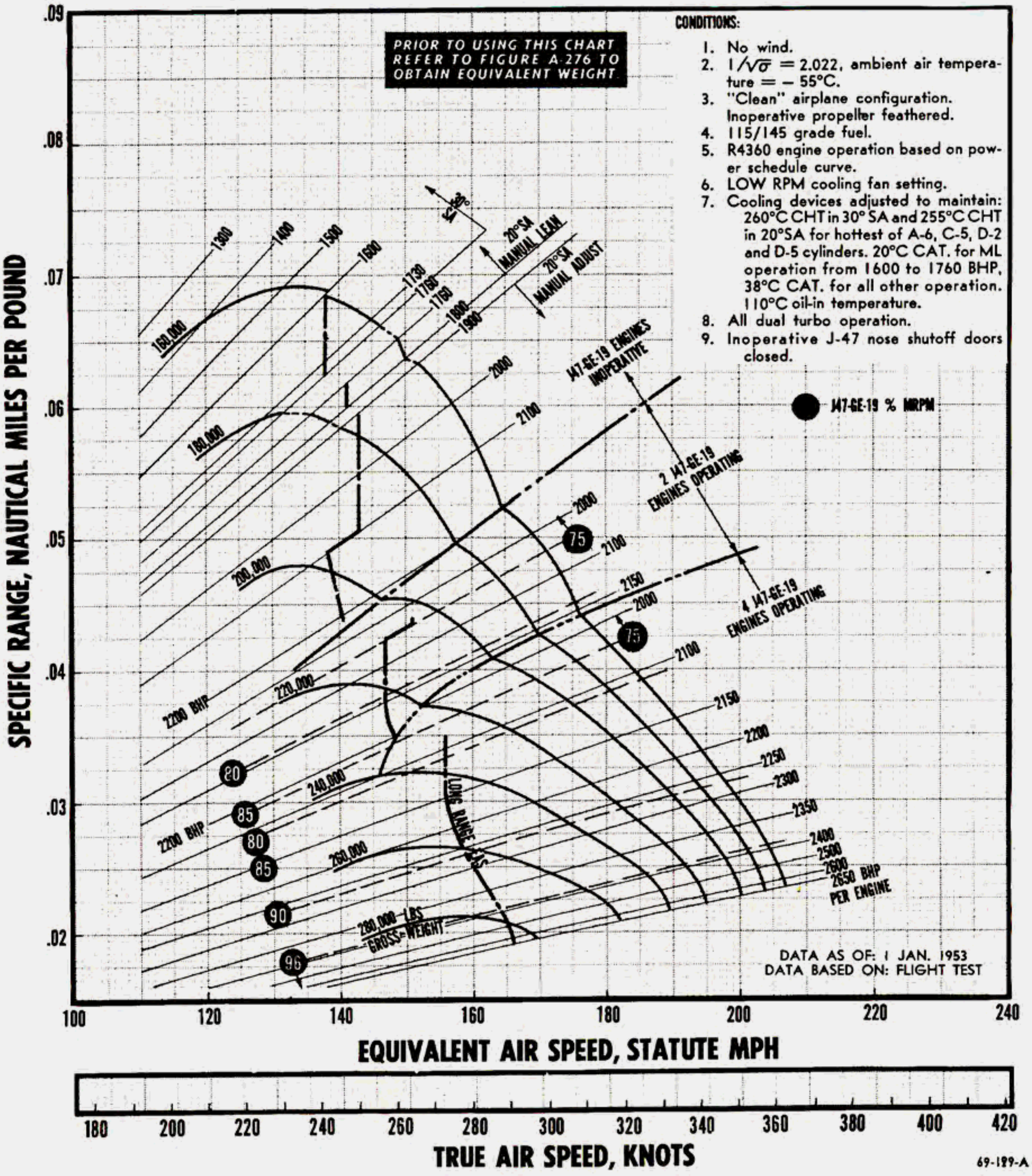


Figure A-174.

SPECIFIC RANGE AT 42,500 FEET

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING, J47-GE-19 ENGINES OPERATING AS NOTED

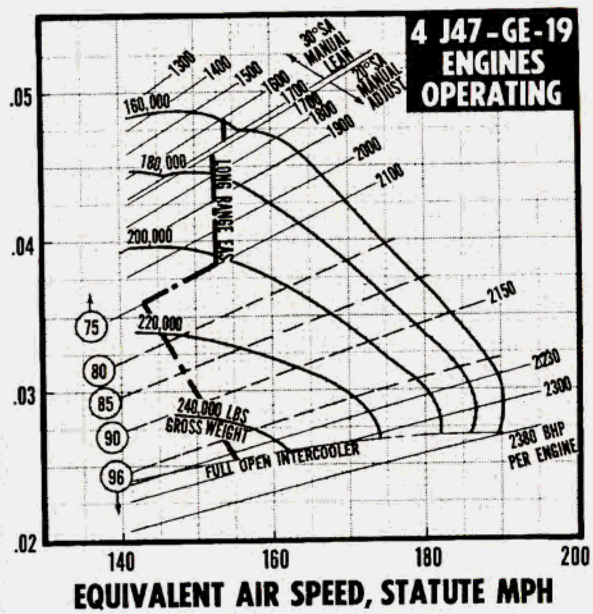
PRIOR TO USING THIS CHART REFER TO FIGURE A-276 TO OBTAIN EQUIVALENT WEIGHT.

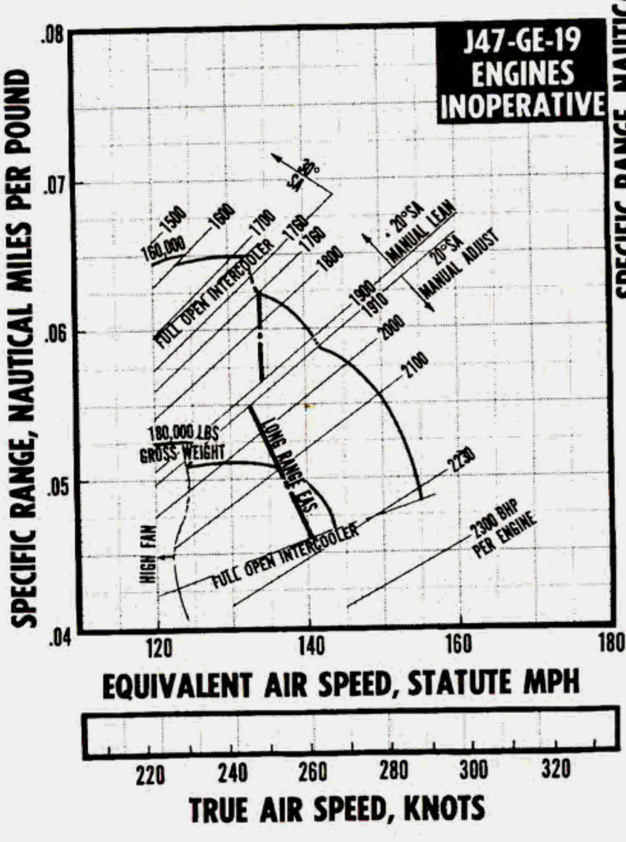
CONDITIONS:

1. No wind.
2. $1/\sqrt{\sigma}$ = 2.146, ambient air temperature = − 55°C.
3. "Clean" airplane configuration. Inoperative propeller feathered.
4. 115/145 grade fuel.
5. R4360 engine operation based on power schedule curve.
6. LOW RPM cooling fan setting(except where noted).
7. Cooling devices adjusted to maintain: 260°C CHT in 30°SA and 255°C CHT in 20°SA for hottest of A-6, C-5, D-2 and D-5 cylinders. 20°C CAT. for ML operation from 1600 to 1760 BHP, 38°C CAT. for all other operation. 110°C oil-in temperature.
8. All dual turbo operation.
9. Inoperative J-47 nose shutoff doors closed.

○ J47-GE-19 % MRPM

DATA AS OF: 1 JAN. 1953
DATA BASED ON: FLIGHT TEST





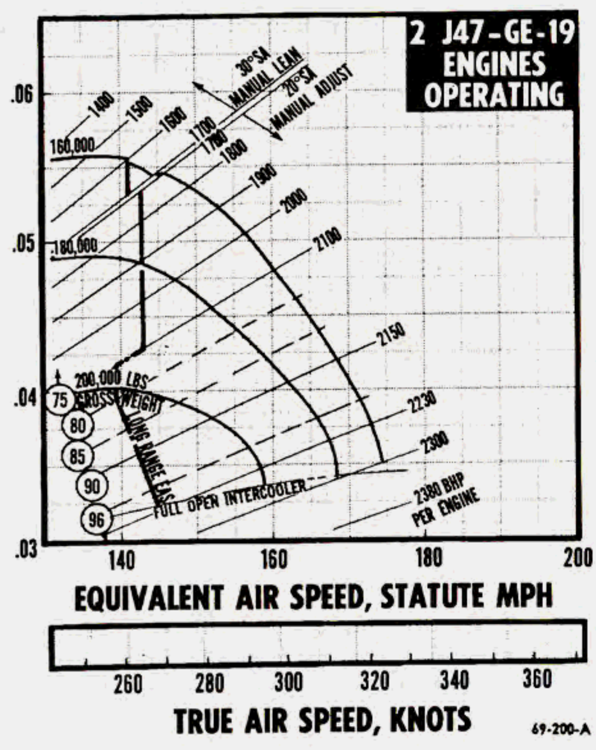


Figure A-175.

SPECIFIC RANGE AT 42,500 FEET

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING, OPTIMUM J47-GE-19 ENGINES OPERATING

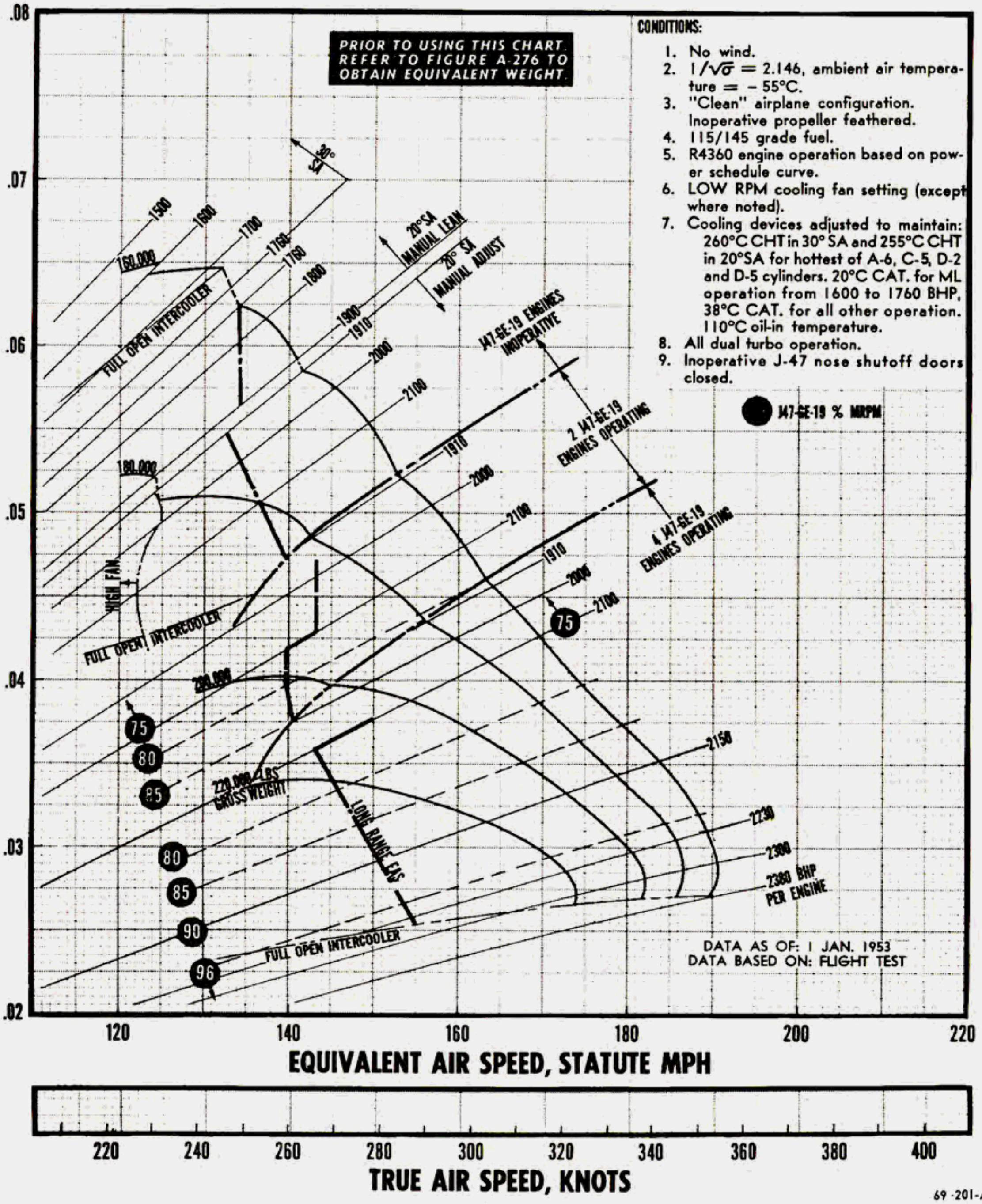


Figure A-176.

SPECIFIC RANGE AT 45,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING, J47-GE-19 ENGINES OPERATING AS NOTED

PRIOR TO USING THIS CHART, REFER TO FIGURE A-276 TO OBTAIN EQUIVALENT WEIGHT.

CONDITIONS:
1. No wind.
2. $1/\sqrt{\sigma}$ = 2.279, ambient air temperature = – 55°C.
3. "Clean" airplane configuration. Inoperative propeller feathered.
4. 115/145 grade fuel.
5. R4360 engine operation based on power schedule curve.
6. LOW RPM cooling fan setting (except where noted).
7. Cooling devices adjusted to maintain: 255°C CHT for hottest of A-6, C-5 D-2 and D-5 cylinders. 38°C CAT. 110°C oil-in temperature.
8. All dual turbo operation.
9. Inoperative J-47 nose shutoff doors closed.

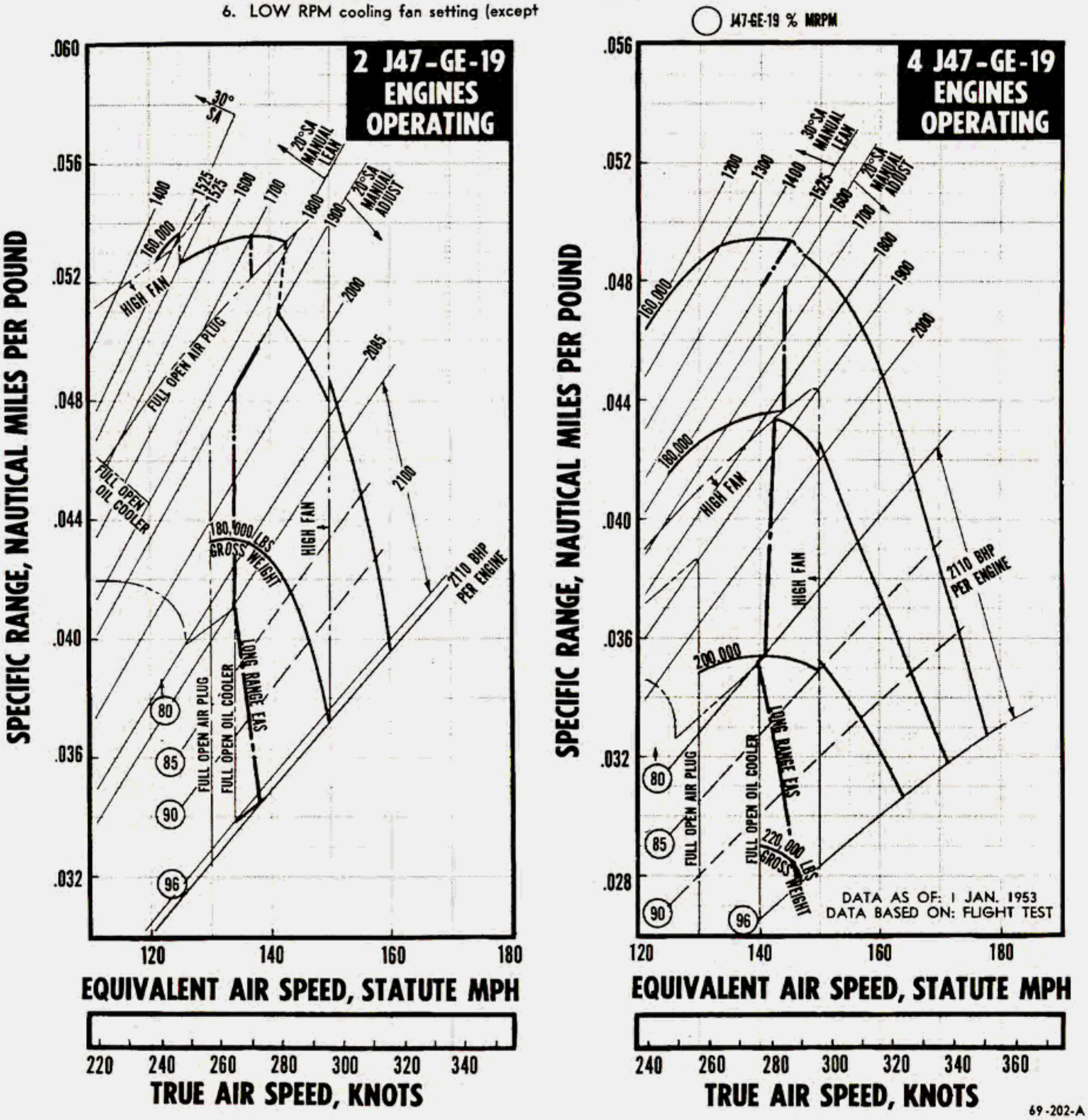


Figure A-177.

SPECIFIC RANGE AT 45,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING, OPTIMUM J47-GE-19 ENGINES OPERATING

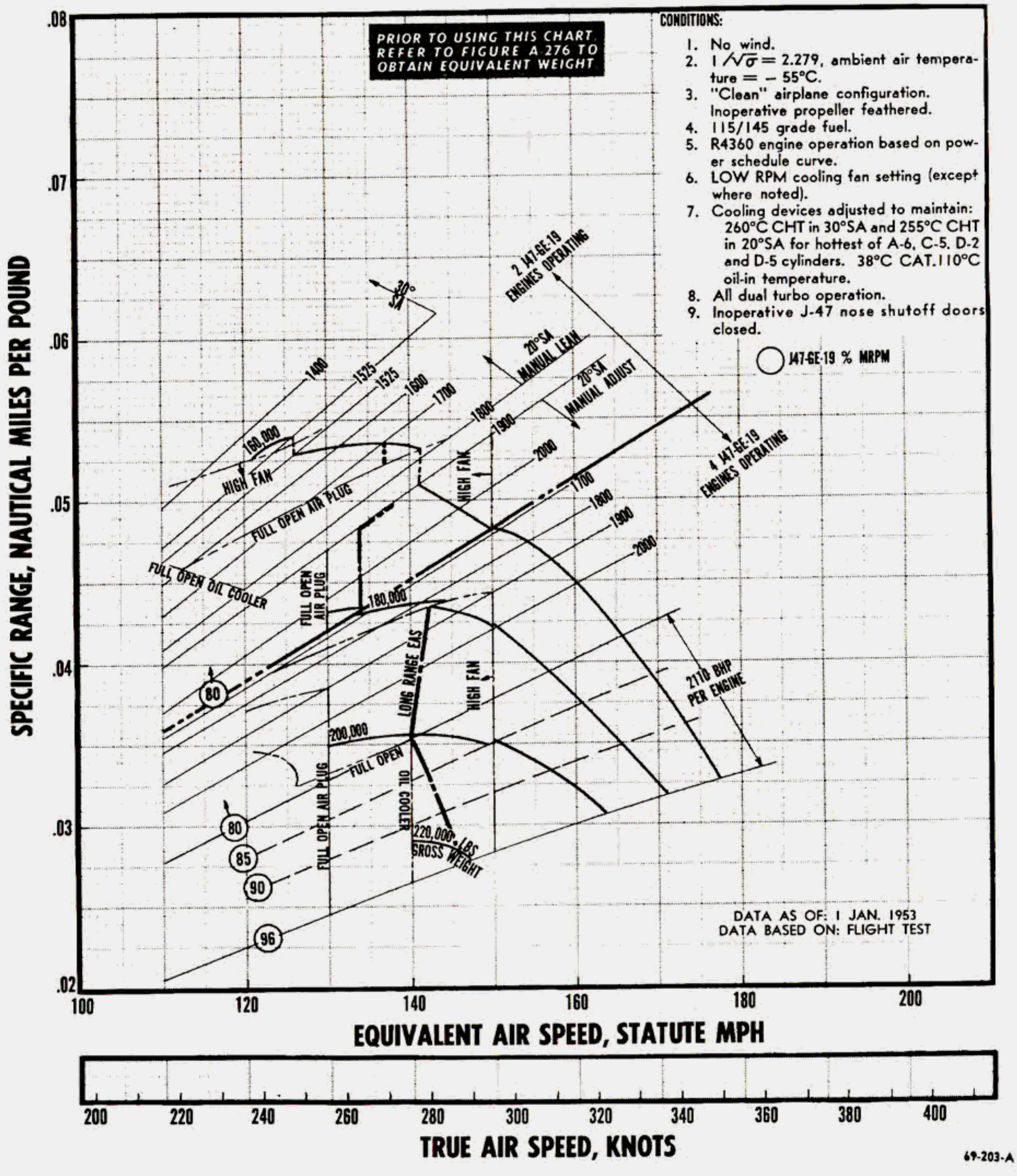


Figure A-178.

SPECIFIC RANGE AT SEA LEVEL

STANDARD ATMOSPHERE

4 R4360-53 ENGINES OPERATING

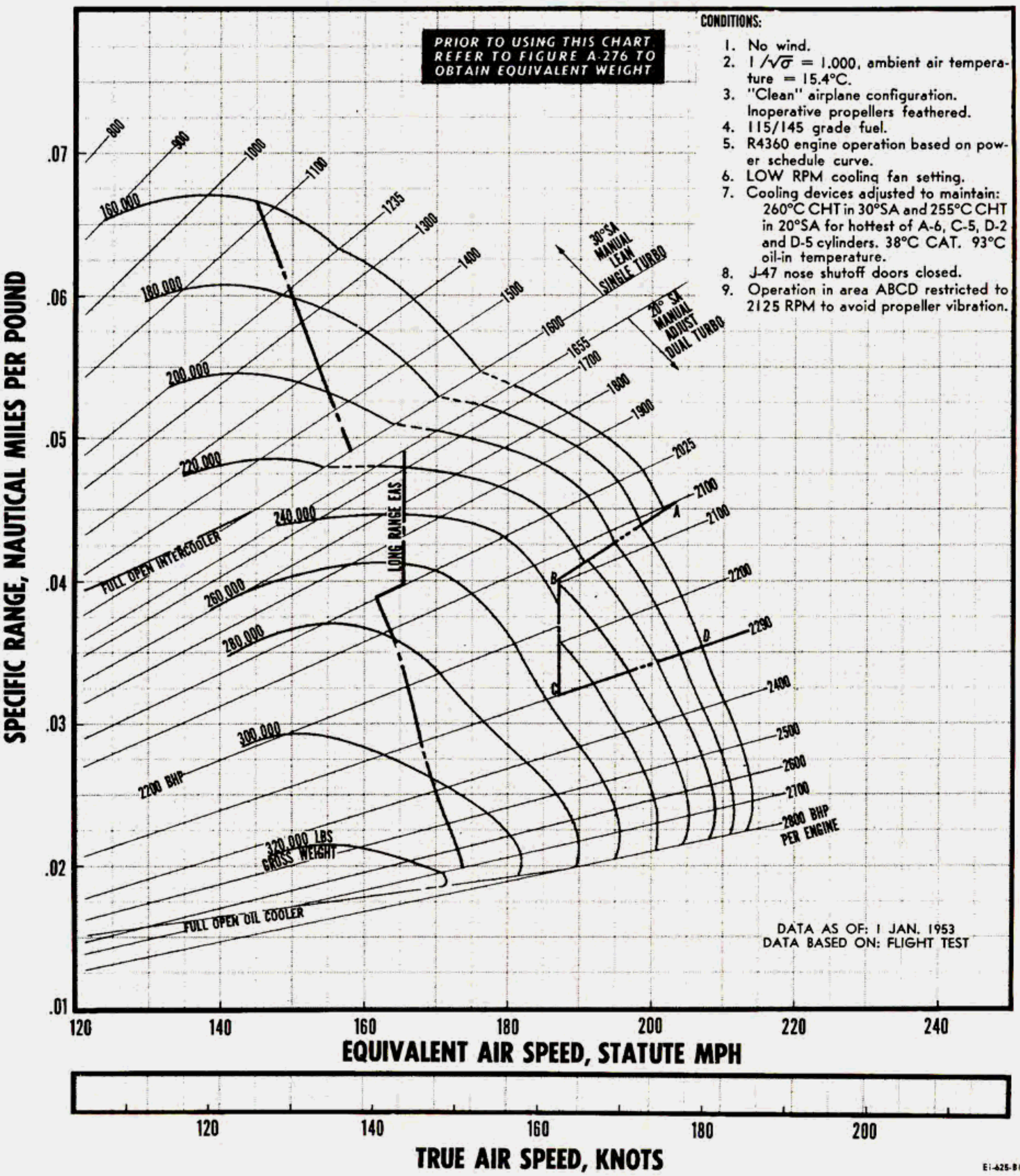


Figure A-179.

SPECIFIC RANGE AT 5,000 FEET

STANDARD ATMOSPHERE

4 R4360-53 ENGINES OPERATING

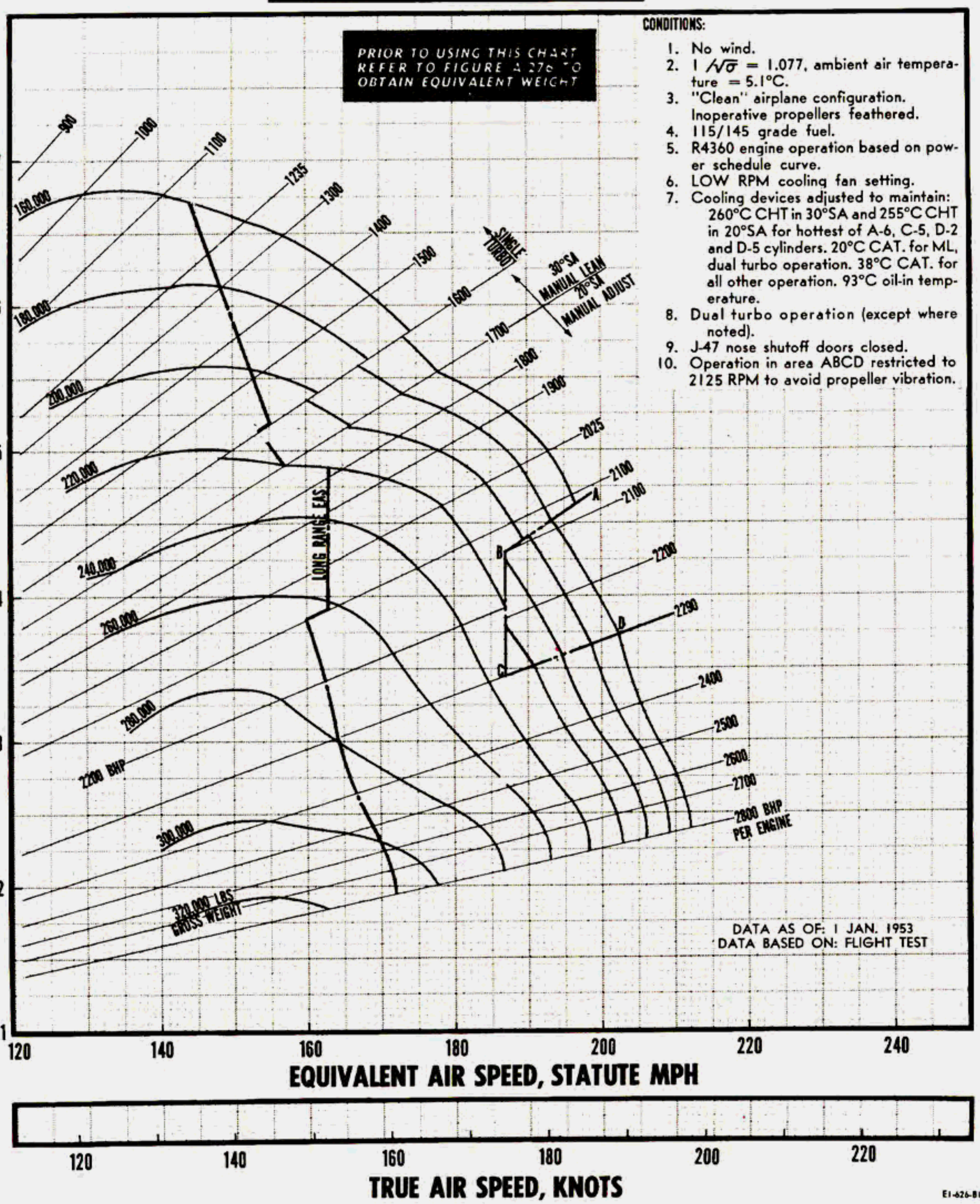


Figure A-180.

SPECIFIC RANGE AT 10,000 FEET

STANDARD ATMOSPHERE

4 R4360-53 ENGINES OPERATING

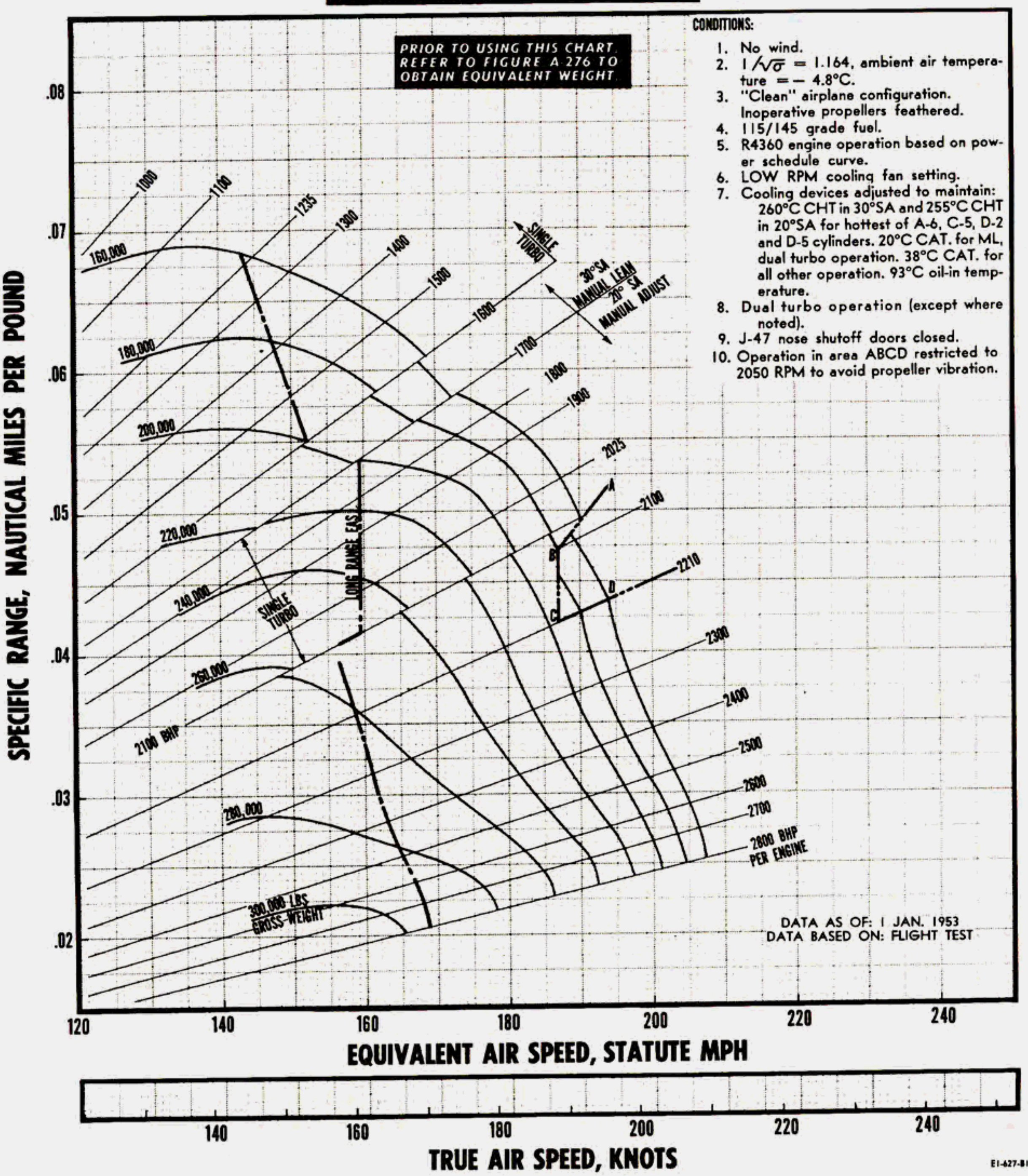


Figure A-181.

SPECIFIC RANGE AT 15,000 FEET

STANDARD ATMOSPHERE

4 R4360-53 ENGINES OPERATING

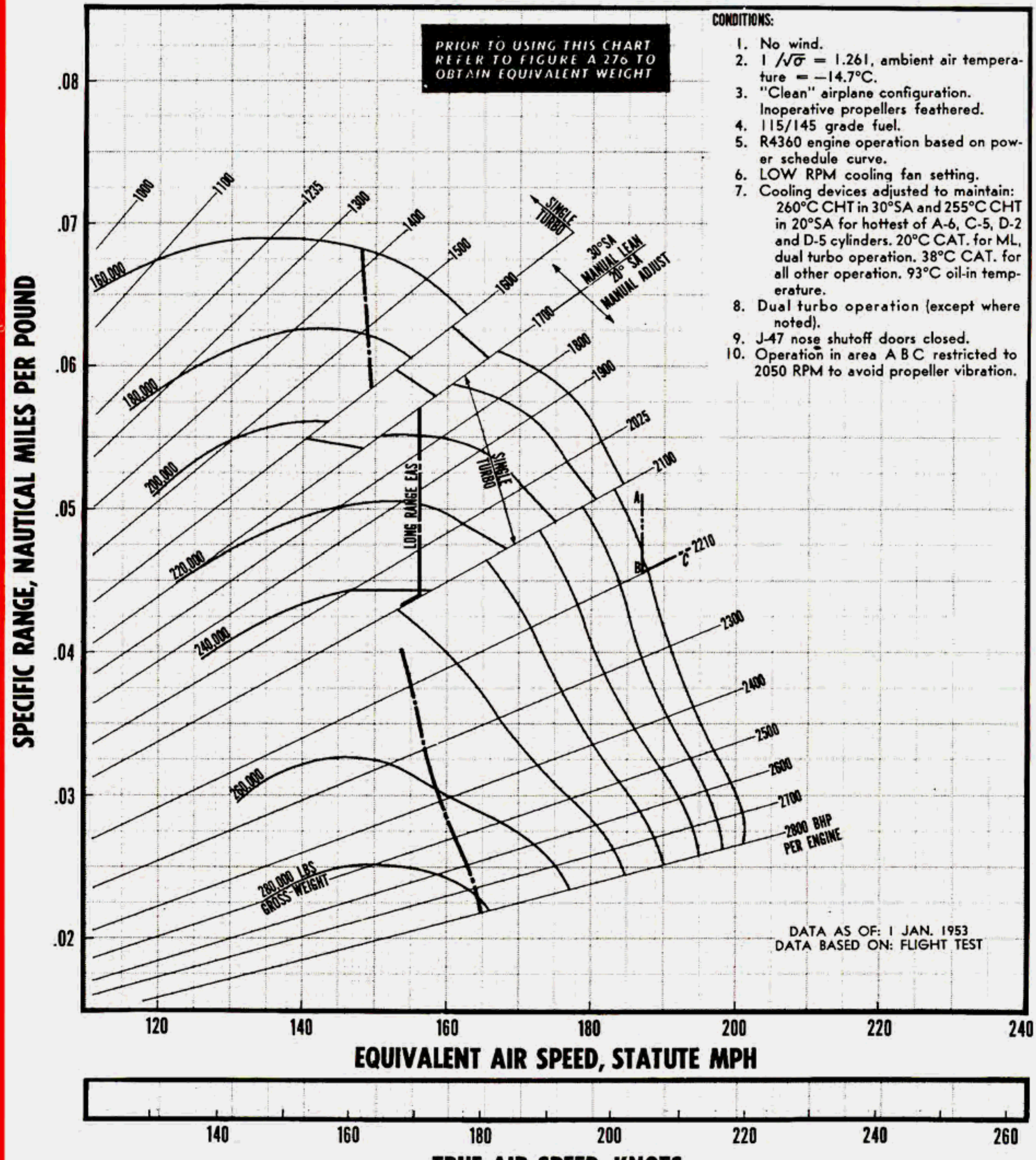
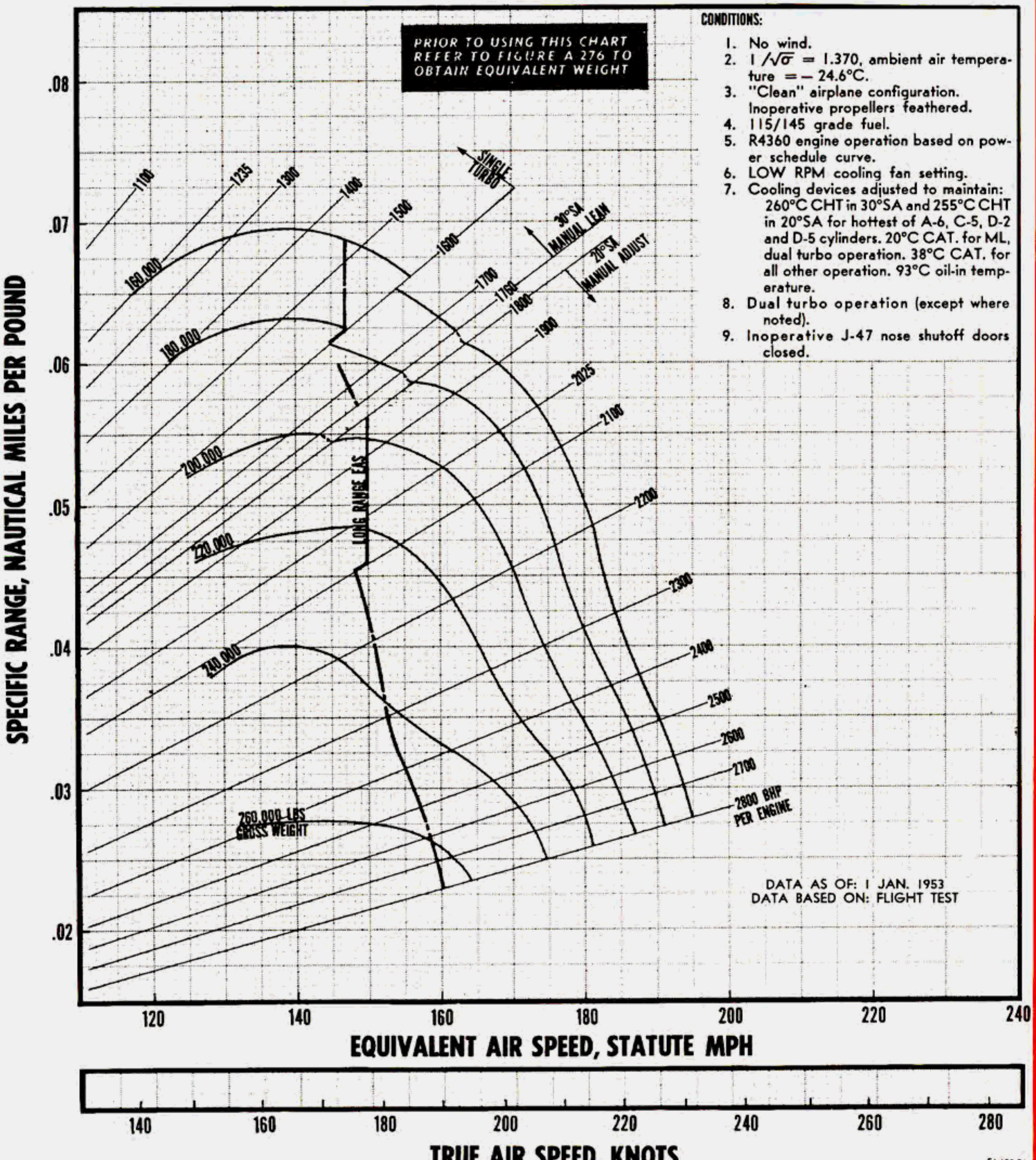


Figure A-182.

SPECIFIC RANGE AT 20,000 FEET

STANDARD ATMOSPHERE

4 R4360-53 ENGINES OPERATING



CONDITIONS:

1. No wind.
2. $1/\sqrt{\sigma}$ = 1.370, ambient air temperature = − 24.6°C.
3. "Clean" airplane configuration. Inoperative propellers feathered.
4. 115/145 grade fuel.
5. R4360 engine operation based on power schedule curve.
6. LOW RPM cooling fan setting.
7. Cooling devices adjusted to maintain: 260°C CHT in 30°SA and 255°C CHT in 20°SA for hottest of A-6, C-5, D-2 and D-5 cylinders. 20°C CAT. for ML, dual turbo operation. 38°C CAT. for all other operation. 93°C oil-in temperature.
8. Dual turbo operation (except where noted).
9. Inoperative J-47 nose shutoff doors closed.

DATA AS OF: 1 JAN. 1953
DATA BASED ON: FLIGHT TEST

Figure A-183.

SPECIFIC RANGE AT 25,000 FEET

STANDARD ATMOSPHERE

4 R4360-53 ENGINES OPERATING

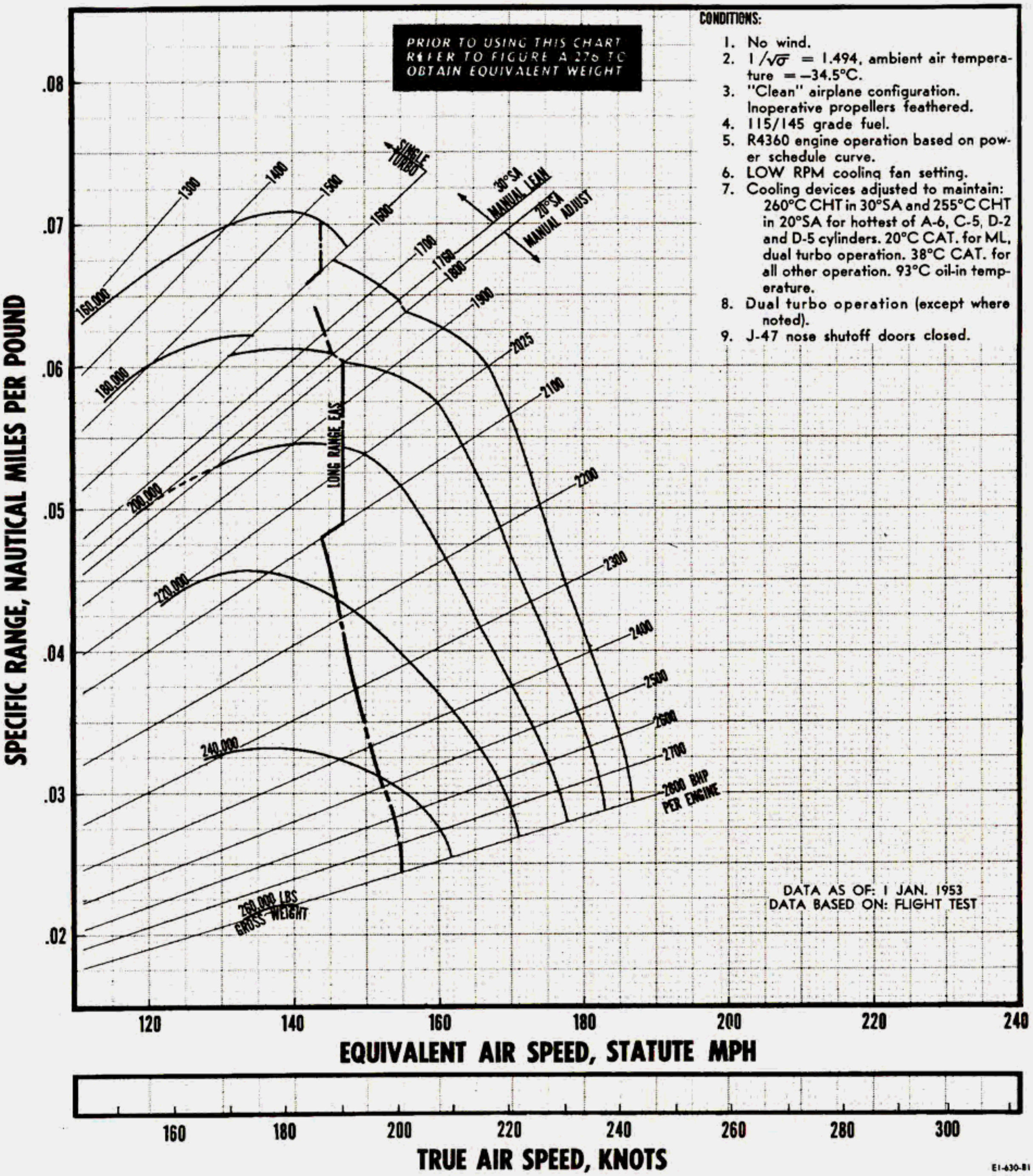
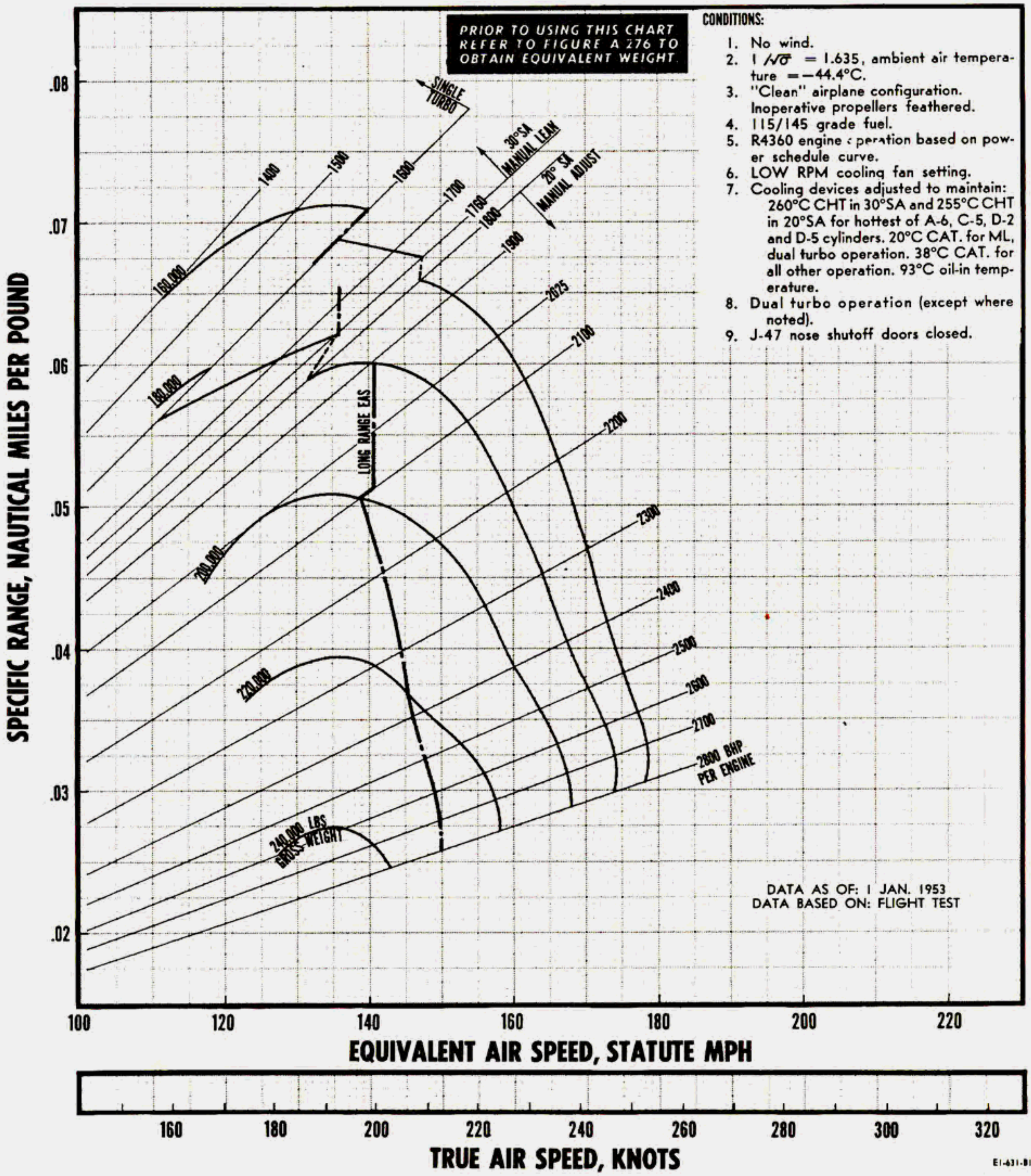


Figure A-184.

SPECIFIC RANGE AT 30,000 FEET

STANDARD ATMOSPHERE

4 R4360-53 ENGINES OPERATING



CONDITIONS:

1. No wind.
2. $1/\sqrt{\sigma}$ = 1.635, ambient air temperature = −44.4°C.
3. "Clean" airplane configuration. Inoperative propellers feathered.
4. 115/145 grade fuel.
5. R4360 engine operation based on power schedule curve.
6. LOW RPM cooling fan setting.
7. Cooling devices adjusted to maintain: 260°C CHT in 30°SA and 255°C CHT in 20°SA for hottest of A-6, C-5, D-2 and D-5 cylinders. 20°C CAT. for ML, dual turbo operation. 38°C CAT. for all other operation. 93°C oil-in temperature.
8. Dual turbo operation (except where noted).
9. J-47 nose shutoff doors closed.

DATA AS OF: 1 JAN. 1953
DATA BASED ON: FLIGHT TEST

Figure A-185.

SPECIFIC RANGE AT 30,000 FEET

STANDARD ATMOSPHERE

4 R4360-53 + 4 J47-GE-19 ENGINES OPERATING

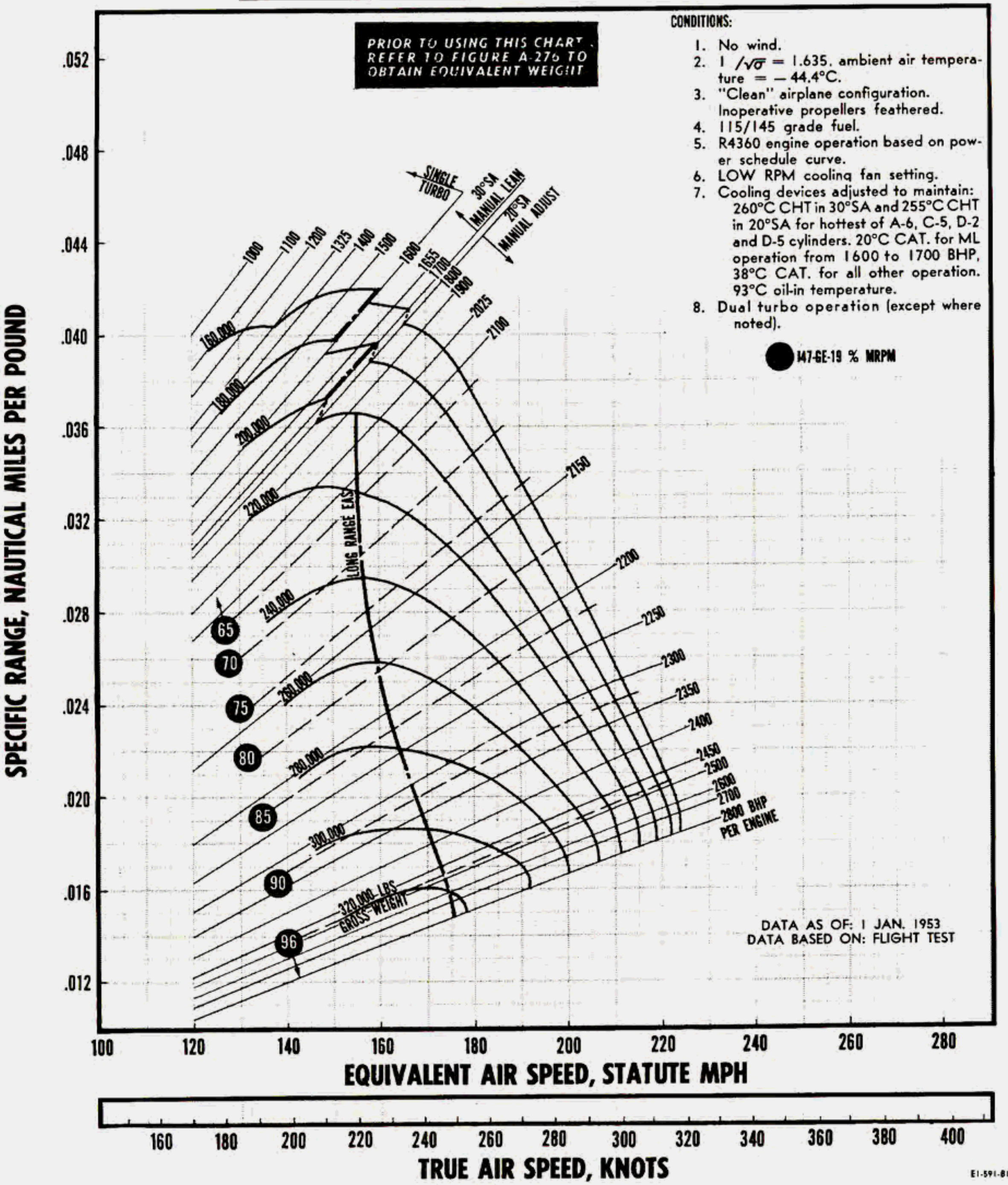
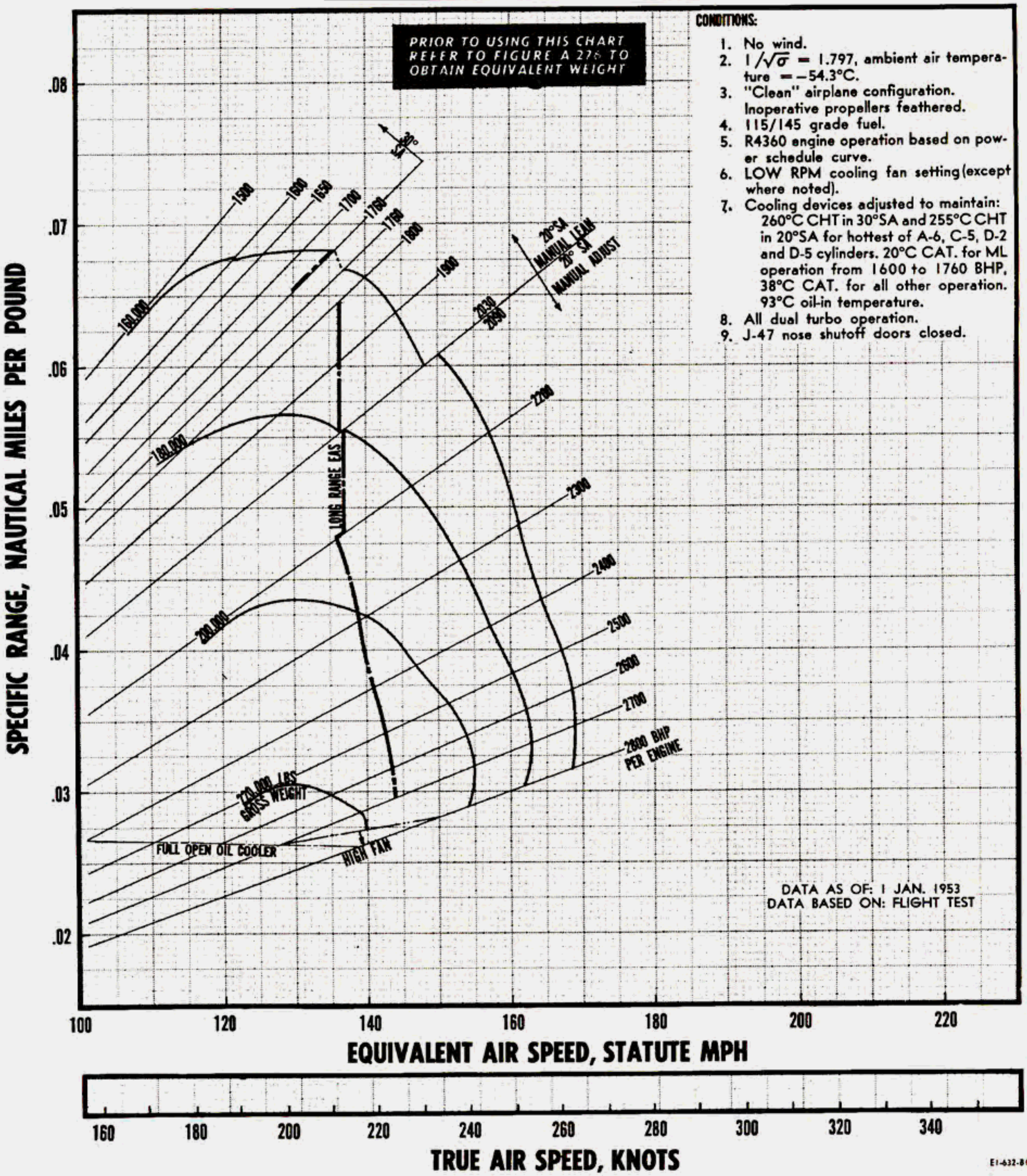


Figure A-186.

SPECIFIC RANGE AT 35,000 FEET

STANDARD ATMOSPHERE

4 R4360-53 ENGINES OPERATING



CONDITIONS:

1. No wind.
2. $1/\sqrt{\sigma} = 1.797$, ambient air temperature $= -54.3°C$.
3. "Clean" airplane configuration. Inoperative propellers feathered.
4. 115/145 grade fuel.
5. R4360 engine operation based on power schedule curve.
6. LOW RPM cooling fan setting (except where noted).
7. Cooling devices adjusted to maintain: 260°C CHT in 30°SA and 255°C CHT in 20°SA for hottest of A-6, C-5, D-2 and D-5 cylinders. 20°C CAT. for ML operation from 1600 to 1760 BHP, 38°C CAT. for all other operation. 93°C oil-in temperature.
8. All dual turbo operation.
9. J-47 nose shutoff doors closed.

DATA AS OF: 1 JAN. 1953
DATA BASED ON: FLIGHT TEST

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Figure A-187.

SPECIFIC RANGE AT 35,000 FEET

STANDARD ATMOSPHERE

4 R4360-53 + 4 J47-GE-19 ENGINES OPERATING

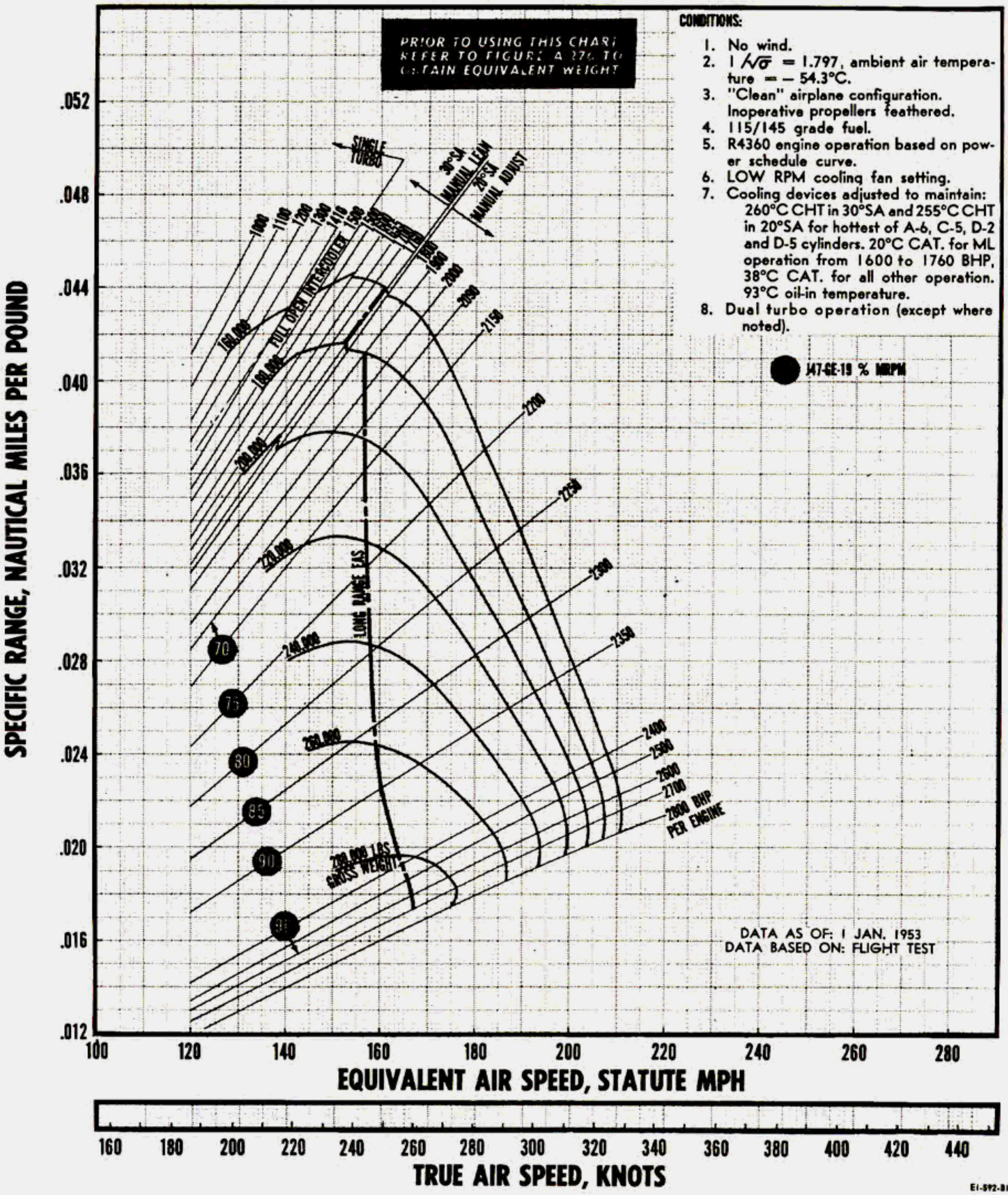
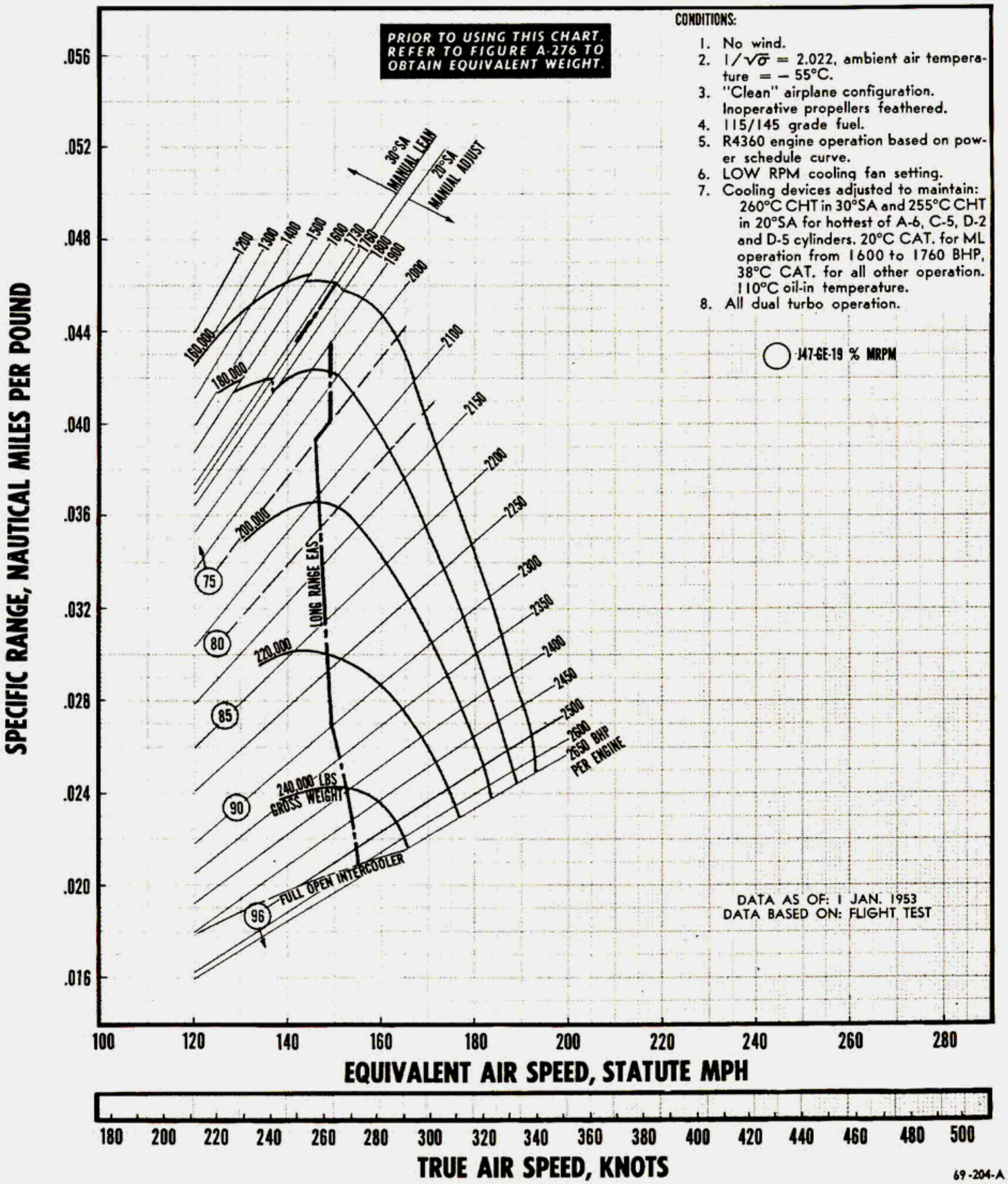


Figure A-188.

SPECIFIC RANGE AT 40,000 FEET

STANDARD ATMOSPHERE

4 R4360-53 + 4 J47-GE-19 ENGINES OPERATING



CONDITIONS:

1. No wind.
2. $1/\sqrt{\sigma}$ = 2.022, ambient air temperature = − 55°C.
3. "Clean" airplane configuration. Inoperative propellers feathered.
4. 115/145 grade fuel.
5. R4360 engine operation based on power schedule curve.
6. LOW RPM cooling fan setting.
7. Cooling devices adjusted to maintain: 260°C CHT in 30°SA and 255°C CHT in 20°SA for hottest of A-6, C-5, D-2 and D-5 cylinders. 20°C CAT. for ML operation from 1600 to 1760 BHP, 38°C CAT. for all other operation. 110°C oil-in temperature.
8. All dual turbo operation.

DATA AS OF: 1 JAN. 1953
DATA BASED ON: FLIGHT TEST

69-204-A

Figure A-189.

SPECIFIC RANGE AT 42.500 FEET

STANDARD ATMOSPHERE

4 R4360-53 + 4 J47-GE-19 ENGINES OPERATING

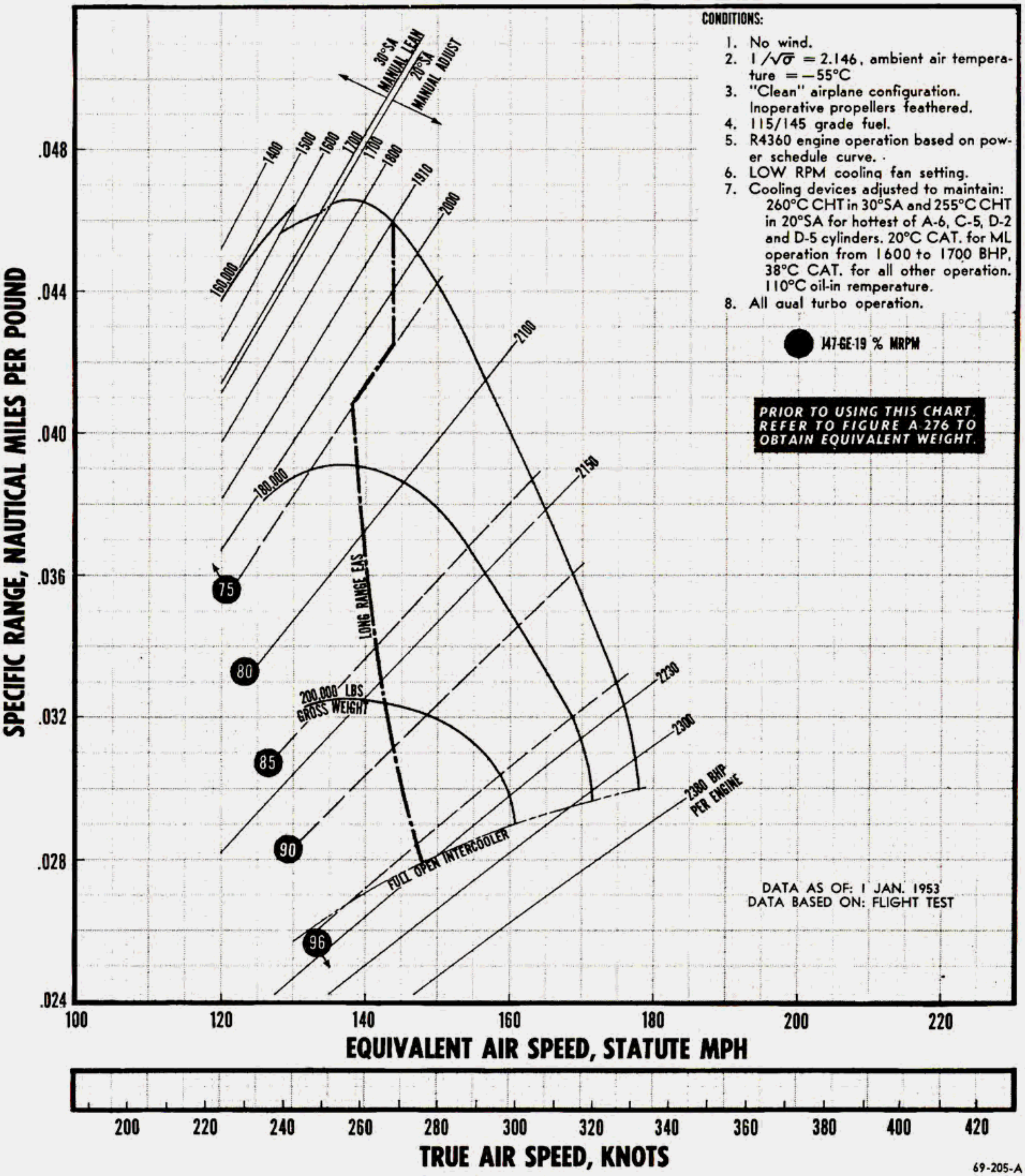


Figure A-190.

SPECIFIC RANGE AT 10,000 FEET

STANDARD ATMOSPHERE

3 R4360-53 + 2 J47-GE-19 ENGINES OPERATING AS NOTED

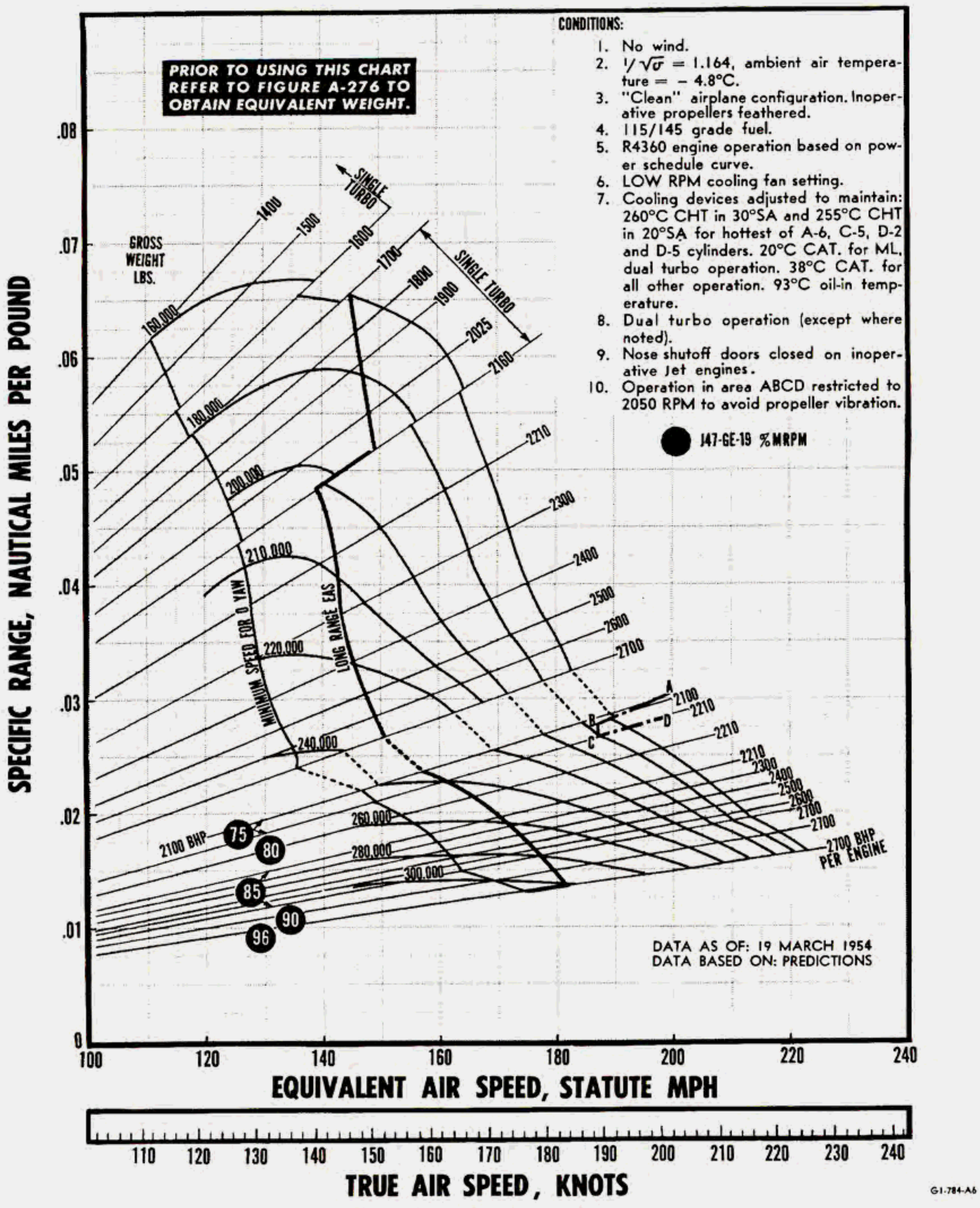


Figure A-191.

SPECIFIC RANGE AT 10,000 FEET

STANDARD ATMOSPHERE

2 R4360-53 + 4 J47-GE-19 ENGINES OPERATING

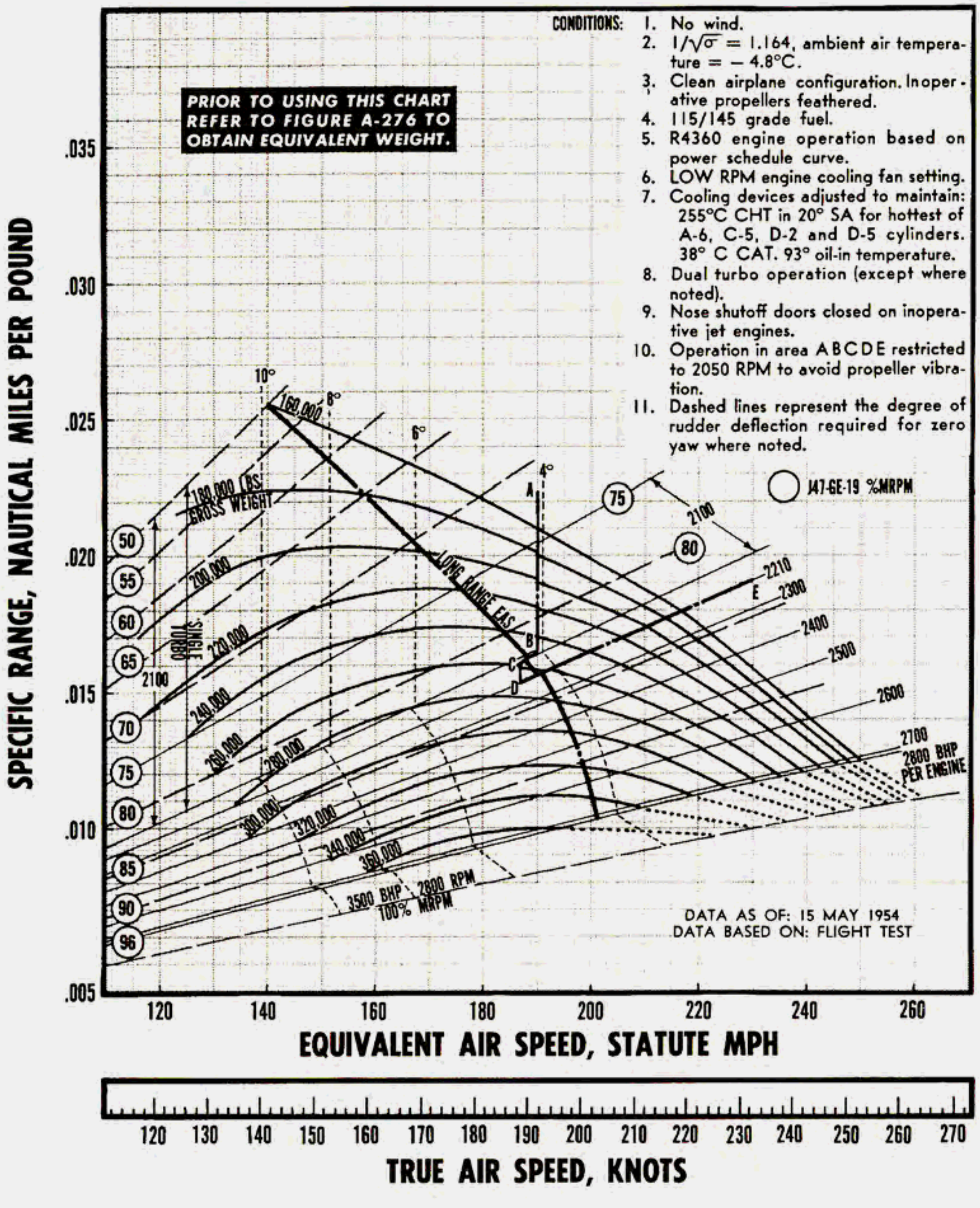


Figure A-192.

SPECIFIC RANGE AT 10,000 FEET

STANDARD ATMOSPHERE

2 R4360-53 + 2 J47-GE-19 ENGINES OPERATING

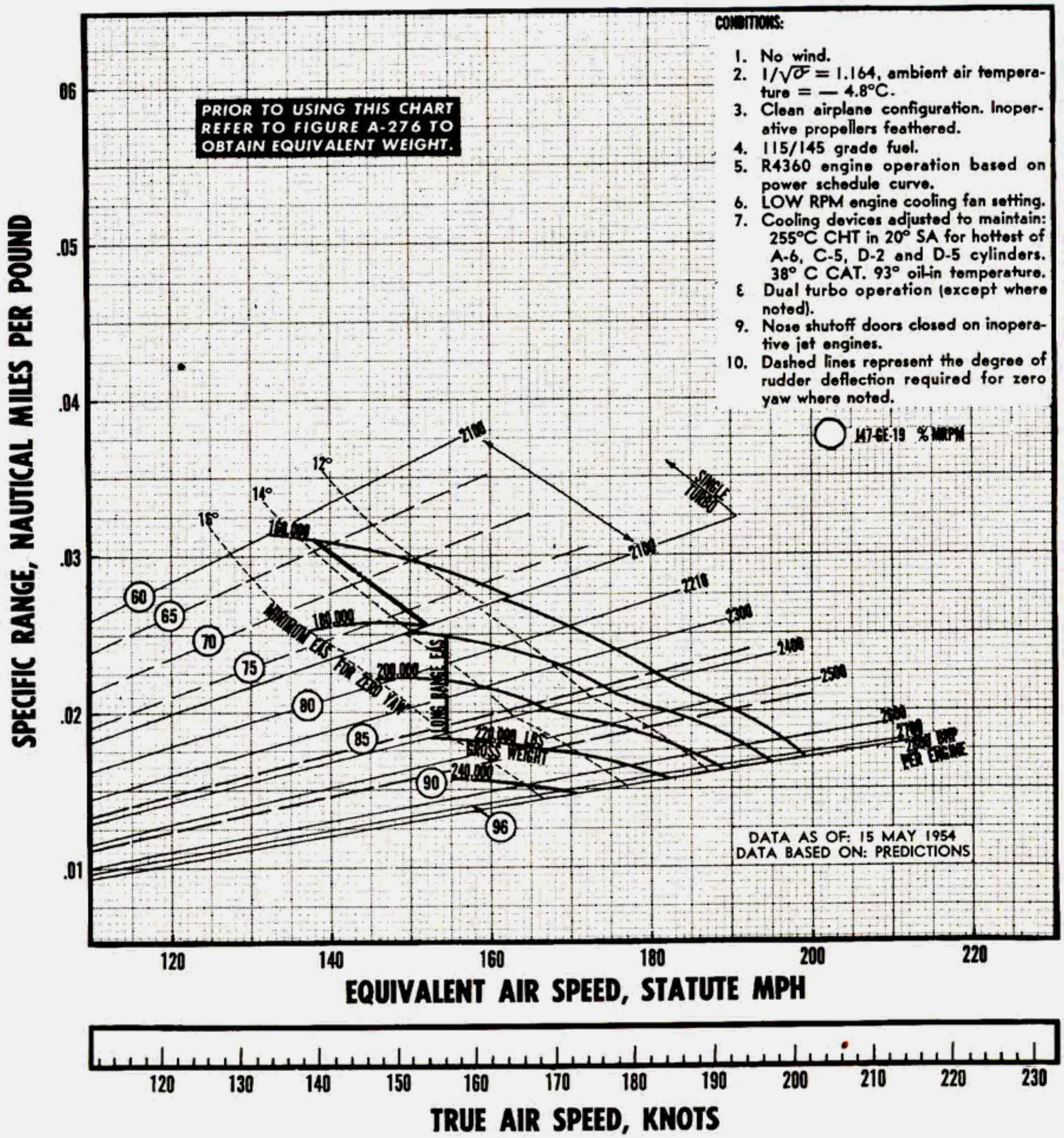


Figure A-193.

LONG RANGE OPERATION AT CONSTANT ALTITUDE.

These charts present data for long range flight at constant altitudes. Included in the long range operating charts are required power setting curves and the resulting specific range for the recommended EAS at any gross weight. Air speed is the most important factor in long range cruise control and should be maintained within close operating limits, while power may be varied from charted values if required to obtain the desired cruising EAS. Long range cruise speed, power, and specific range are also shown for operation in headwinds and tailwinds.

Note

It is emphasized that of maximum cruise efficiency a power change and an airplane retrim should be made at the end of each 5000 pounds of fuel consumed.

Constant altitude long range time and distance prediction curves are also presented. These curves are based on long range operating conditions for zero wind velocity.

Note

Prior to using any of the partial reciprocating engine long range operating data, equivalent weight corrections from figure A-276 must be made.

EXAMPLE.

Determine elapsed time and gross weight after cruise under the following conditions:

3000 nautical miles traveled
25,000 feet cruise altitude
6 R4360-53 engines operating
0 mph wind velocity

Enter figure A-207 at 245,000 pounds gross weight, move vertically to the 25,000-foot altitude line and read a reference range of 5520 nautical miles. Add 3000 nautical miles to this reading and obtain 8520 nautical miles. At a reference range of 8520 nautical miles on the 25,000-foot altitude curve, read a gross weight of 190,500 pounds. This is the true gross weight at the end of the 3000 mile cruise.

Enter figure A-208 at gross weights of 245,000 and 190,580 pounds and read reference times of 24.6 and 39 hours on the 39 — 24.6 = 14.4 hours. The schedule of cruising speeds and power settings should be obtained from figure A-133 or A-199.

To obtain the operating conditions for this example, enter figures A-199 and A-29 and obtain the following information. The pilots' IAS can be obtained from figure A-12.

GROSS WEIGHT	EAS	PILOTS' IAS	BHP	RPM	TP	APPROX. MAP	FF
245,000	165.0	170.0	1670	1900	164.0	39.3	735
238,000	165.0	169.5	1620	1840	164.5	38.6	705
238,000	165.0	169.5	1600	1815	164.5	43.1	700
235,000	164.6	169.0	1575	1790	164.5	42.9	685
230,000	163.7	168.4	1530	1740	165.0	42.5	665
225,000	163.0	167.4	1495	1600	165.0	42.1	645

67-333-A

67-333-A

LONG RANGE OPERATING CONDITIONS AT SEA LEVEL

STANDARD ATMOSPHERE

6 R4360-53 ENGINES OPERATING

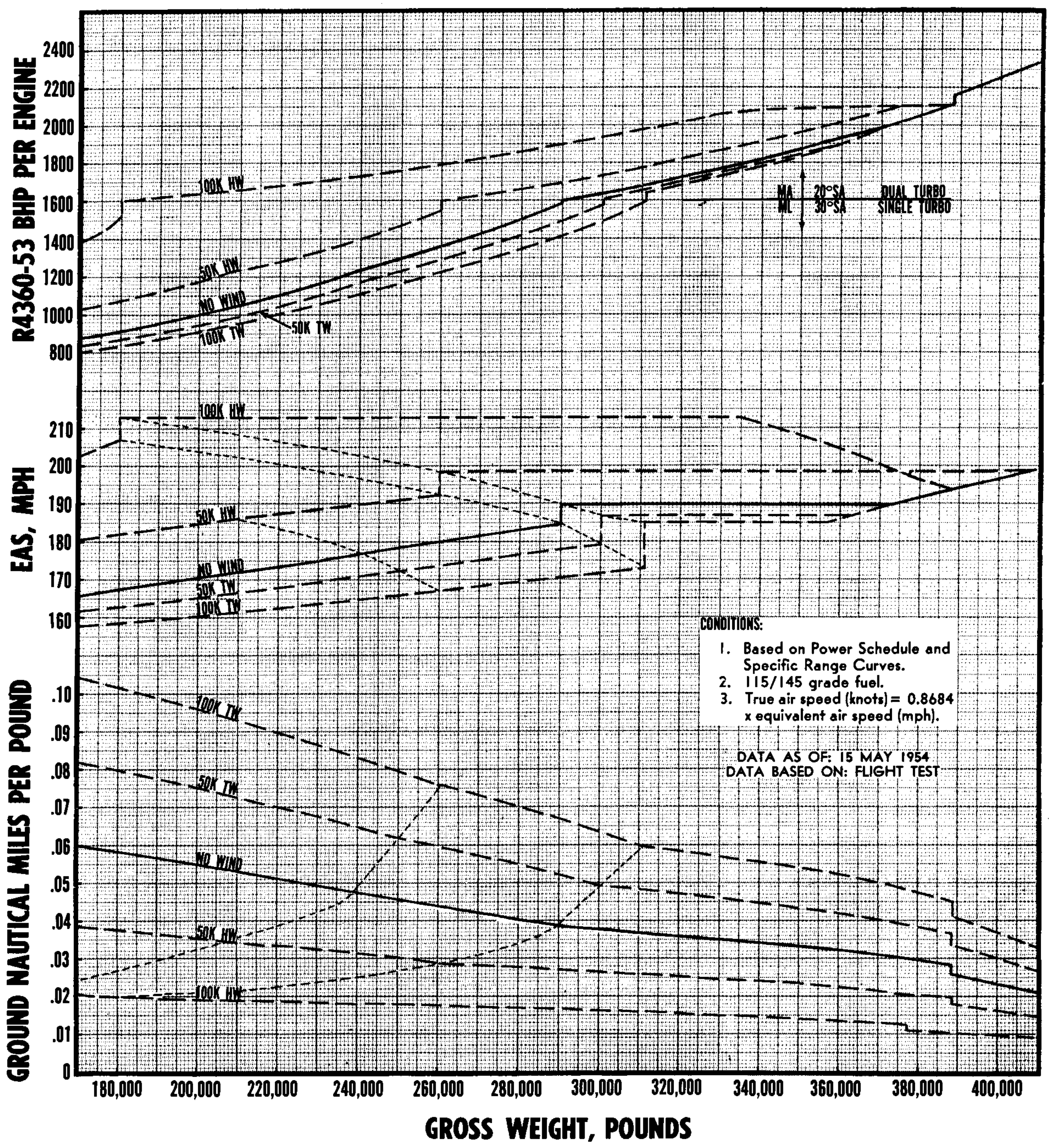


Figure A-194.

LONG RANGE OPERATING CONDITIONS AT 5000 FEET

STANDARD ATMOSPHERE

6 R4360-53 ENGINES OPERATING

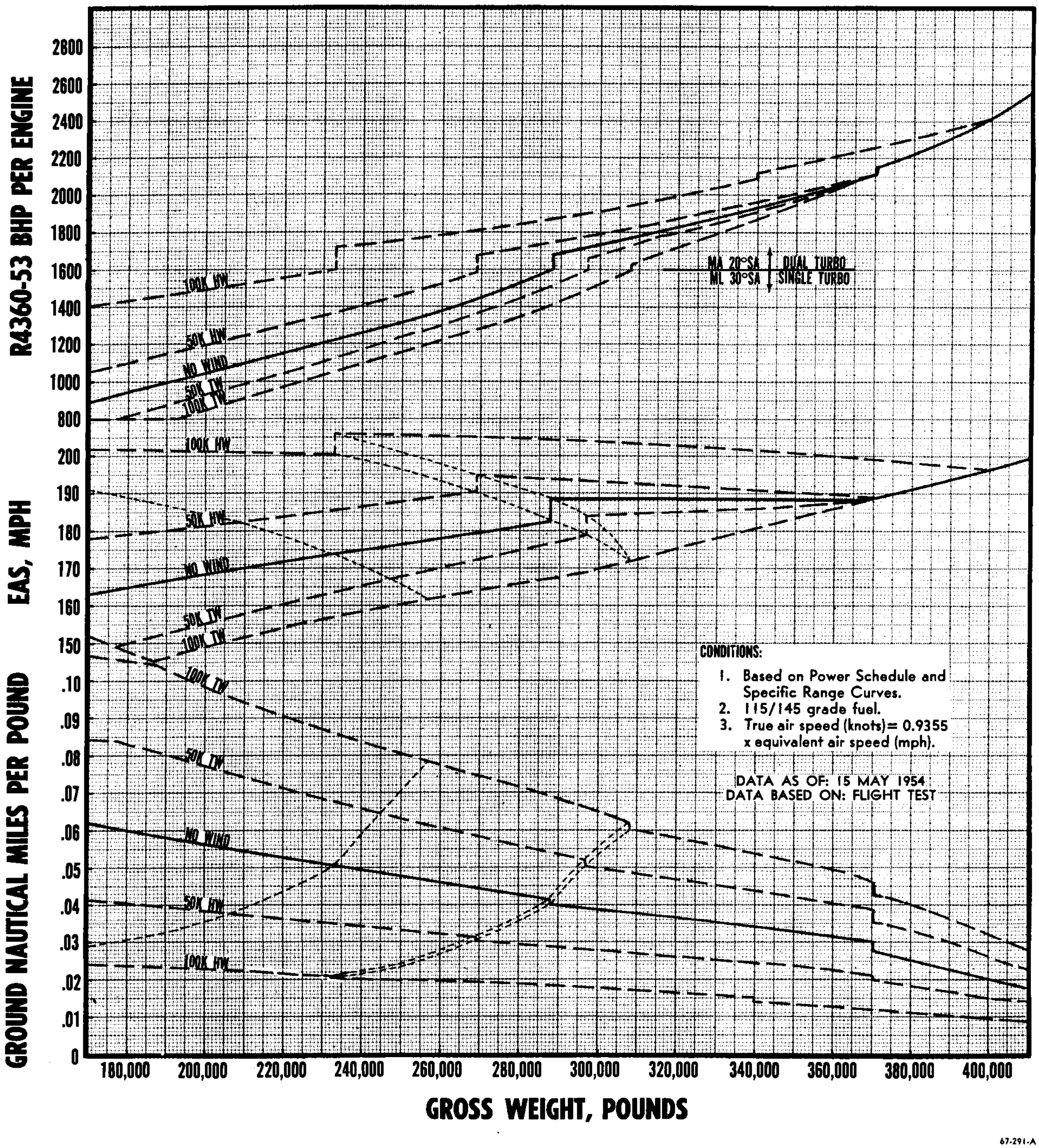


Figure A-195.

LONG RANGE OPERATING CONDITIONS AT 10,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 ENGINES OPERATING

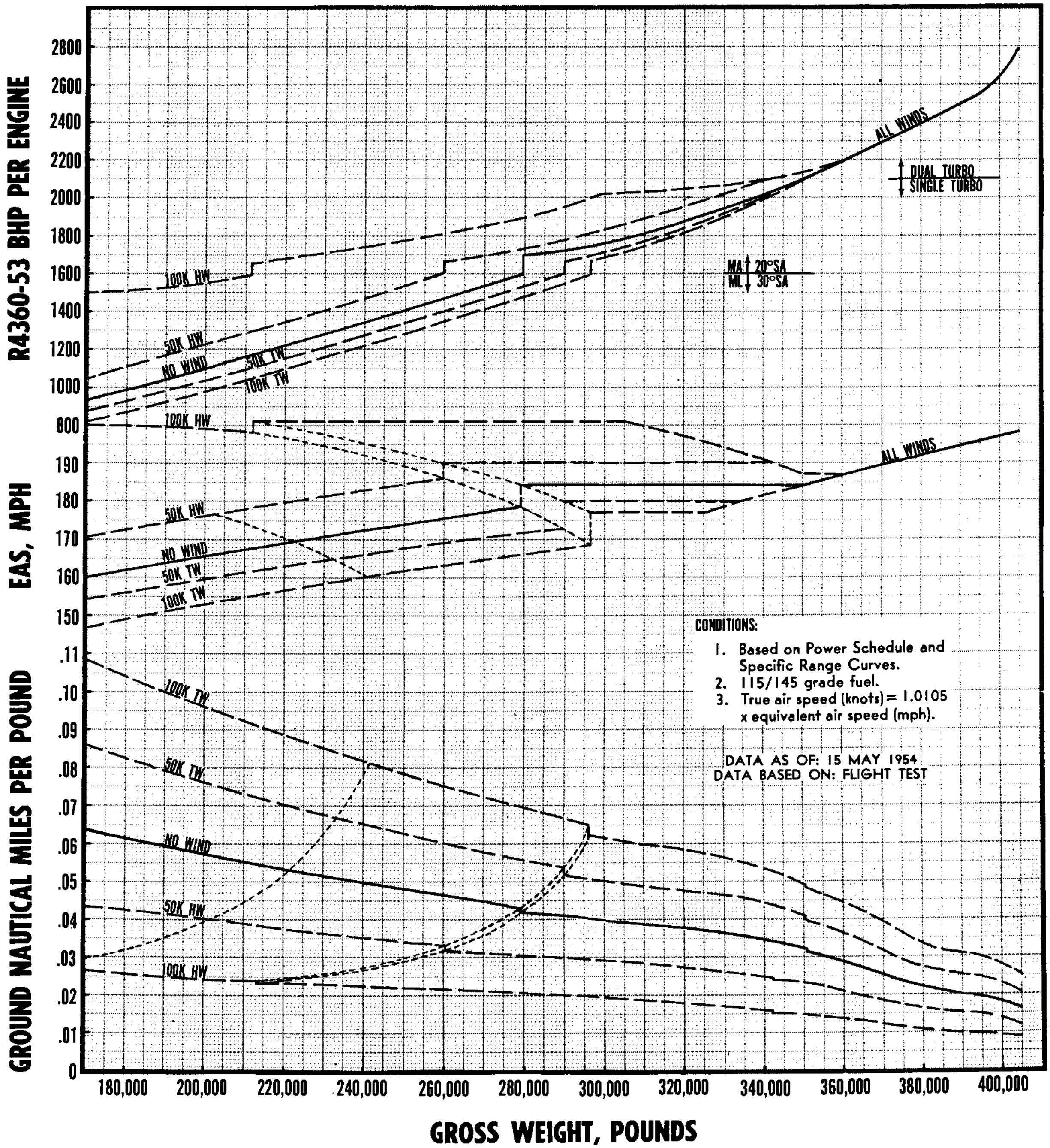


Figure A-196.

LONG RANGE OPERATING CONDITIONS AT 15,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 + OPTIMUM J47-GE-19 ENGINES OPERATING

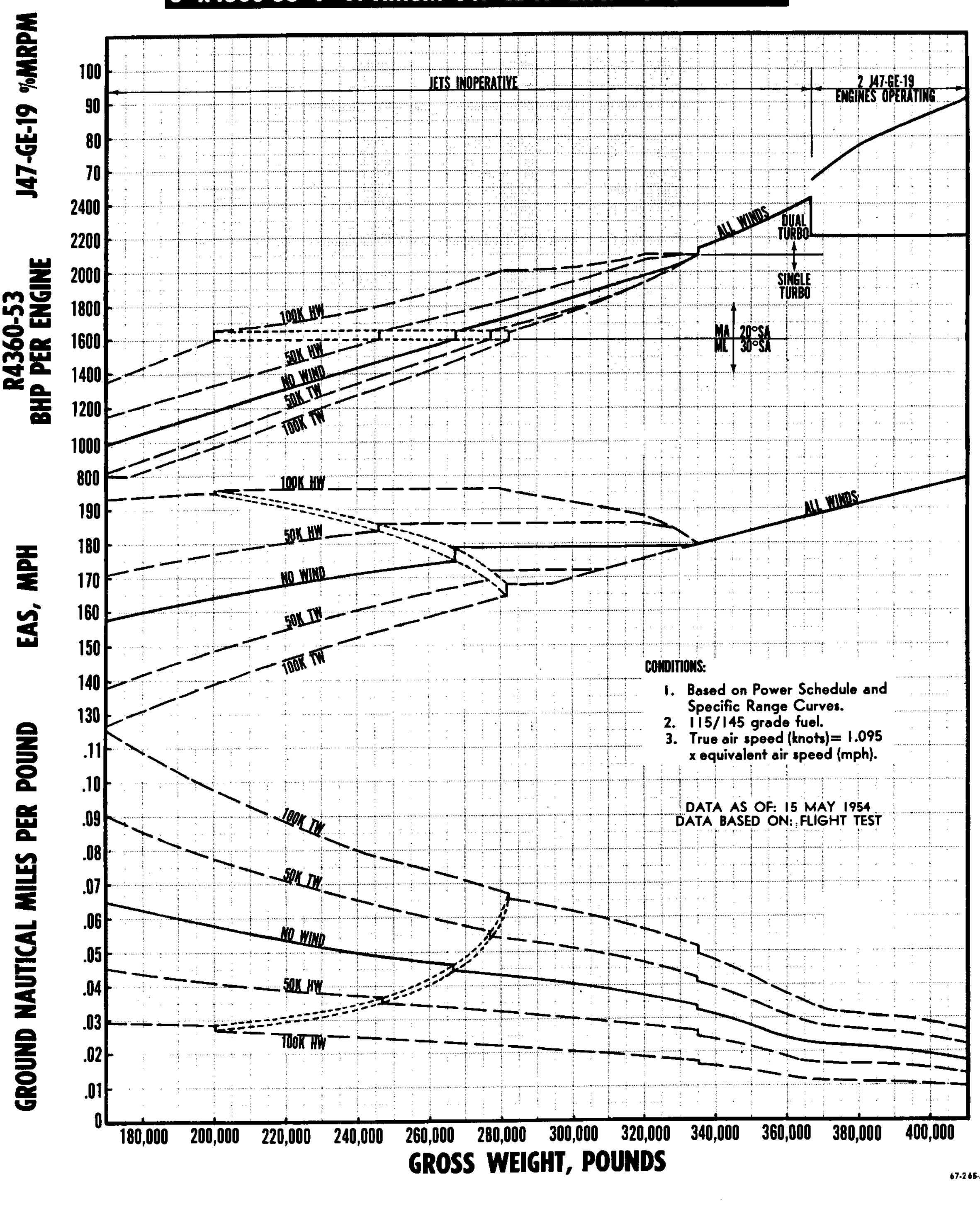


Figure A-197.

LONG RANGE OPERATING CONDITIONS AT 20,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 + OPTIMUM J47-GE-19 ENGINES OPERATING

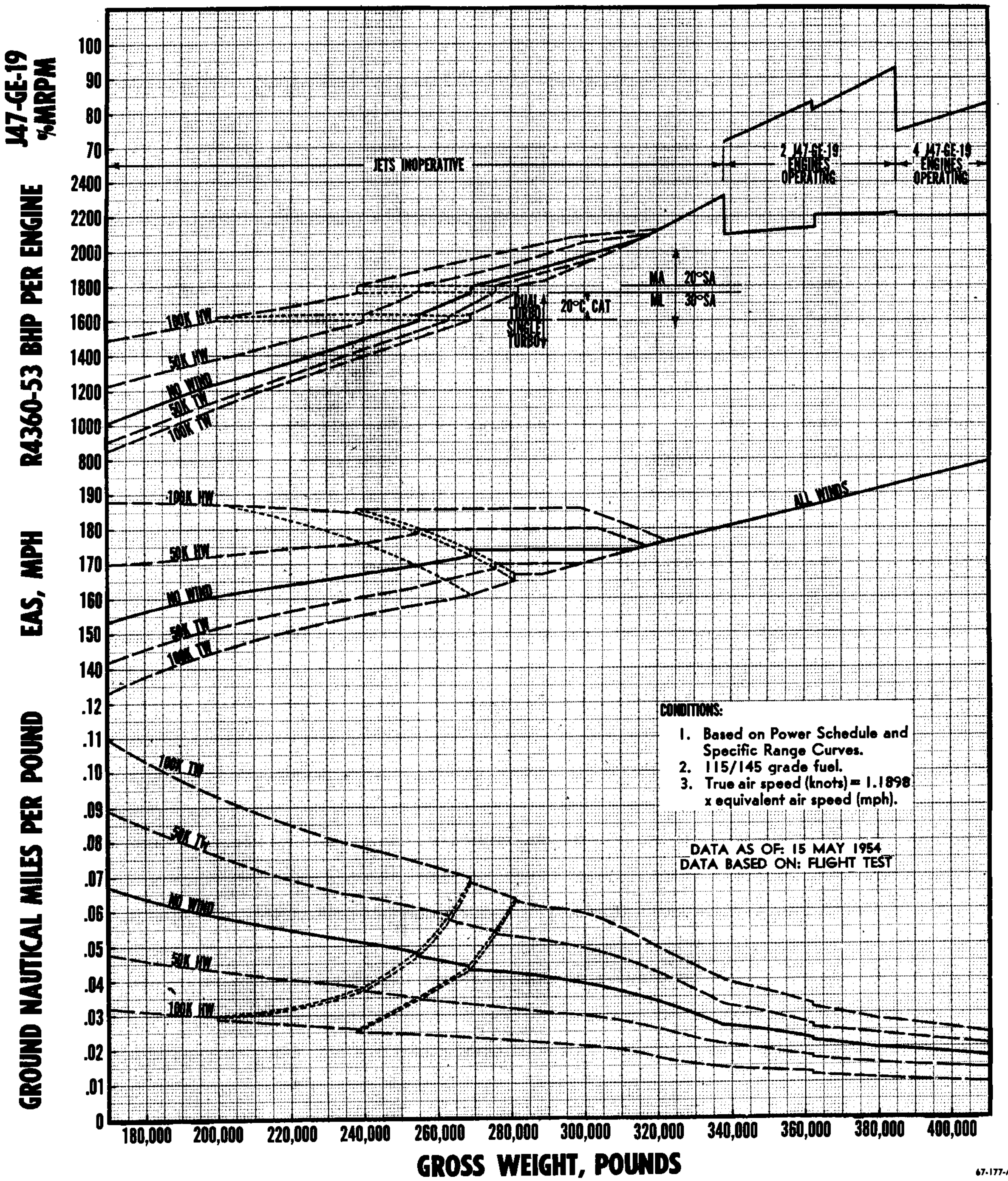


Figure A-198.

LONG RANGE OPERATING CONDITIONS AT 25,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 + OPTIMUM J47-GE-19 ENGINES OPERATING

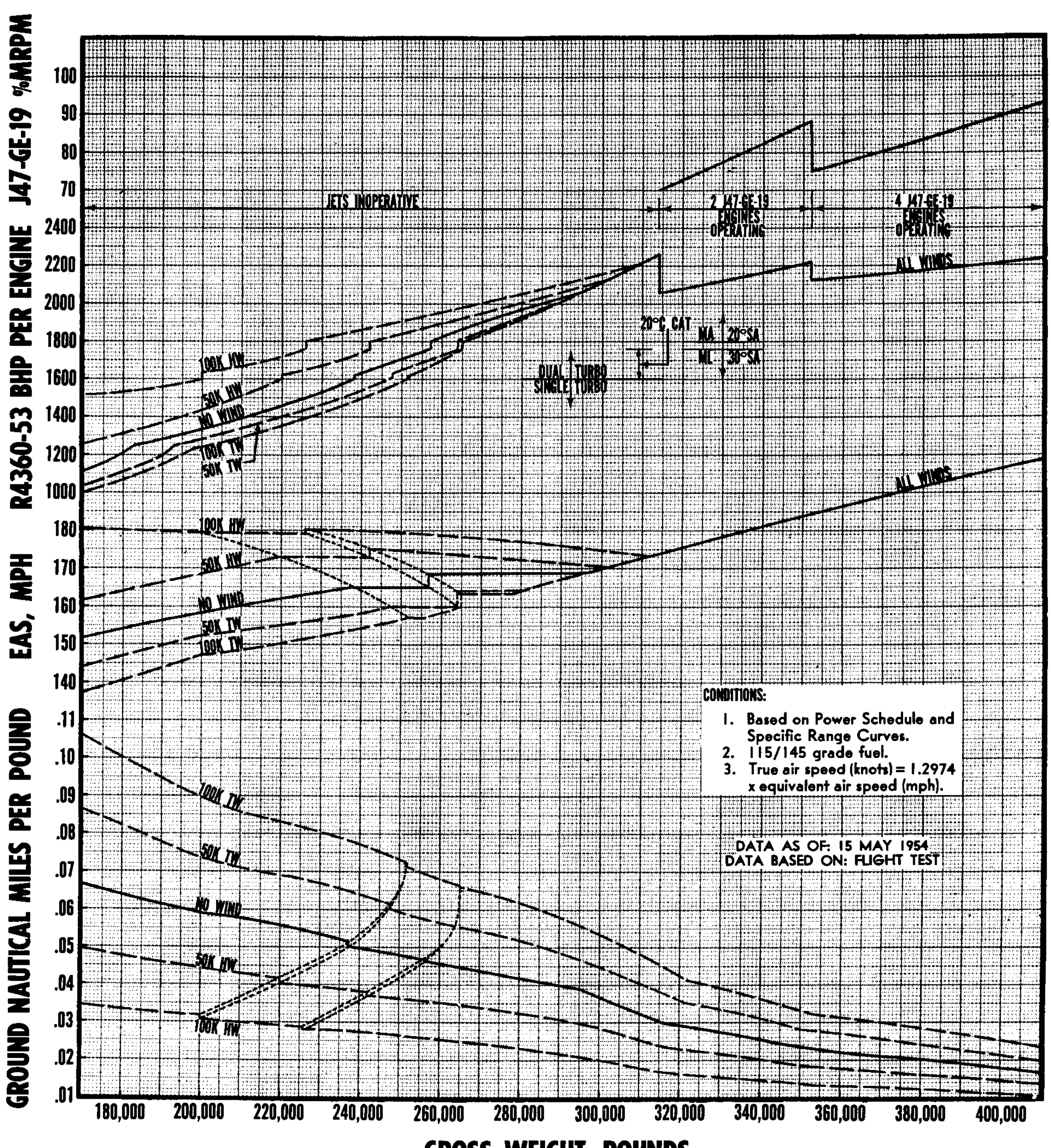


Figure A-199.

LONG RANGE OPERATING CONDITIONS AT 30,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 + OPTIMUM J47-GE-19 ENGINES OPERATING

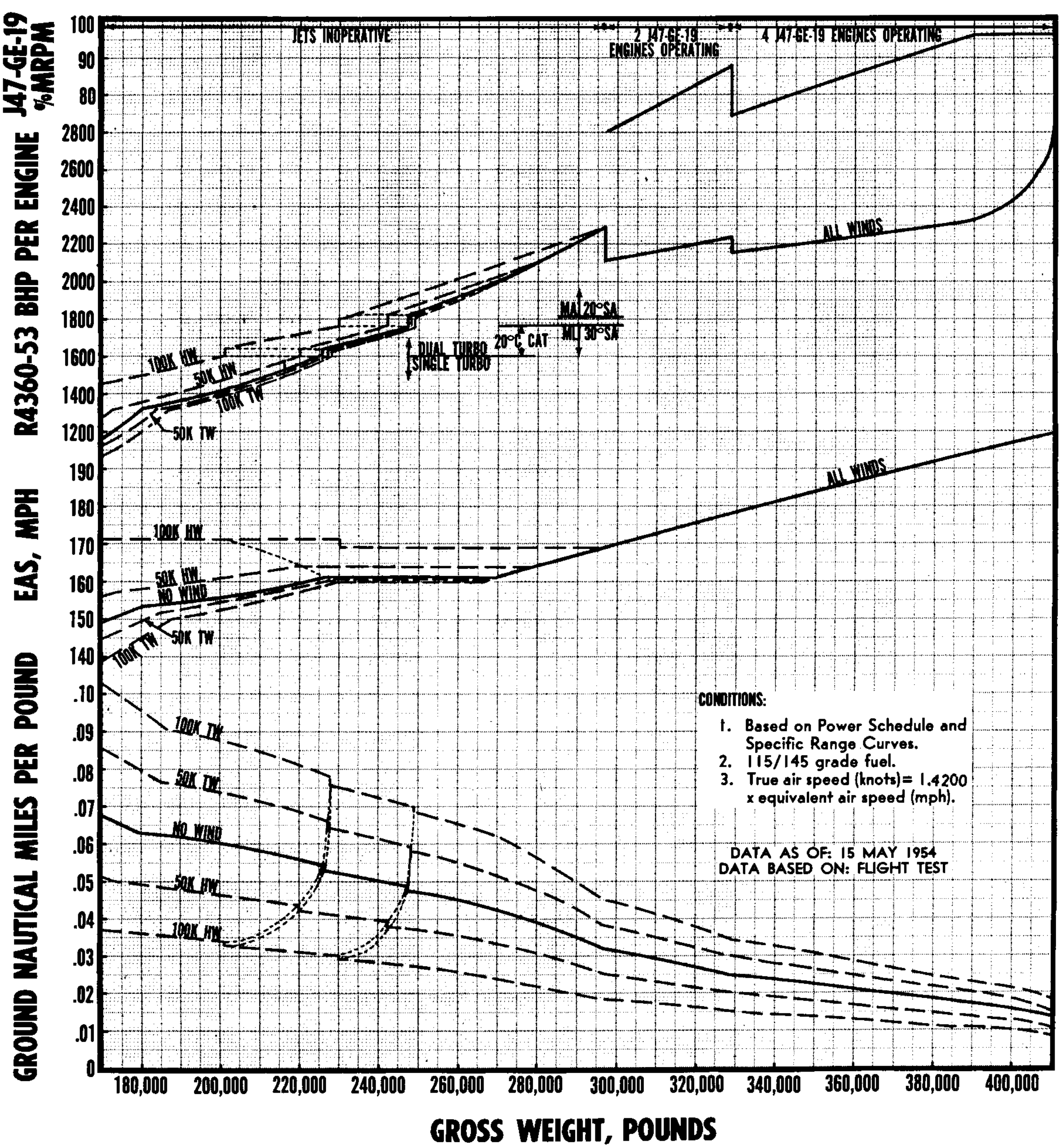


Figure A-200.

LONG RANGE OPERATING CONDITIONS AT 35,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 + OPTIMUM J47-GE-19 ENGINES OPERATING

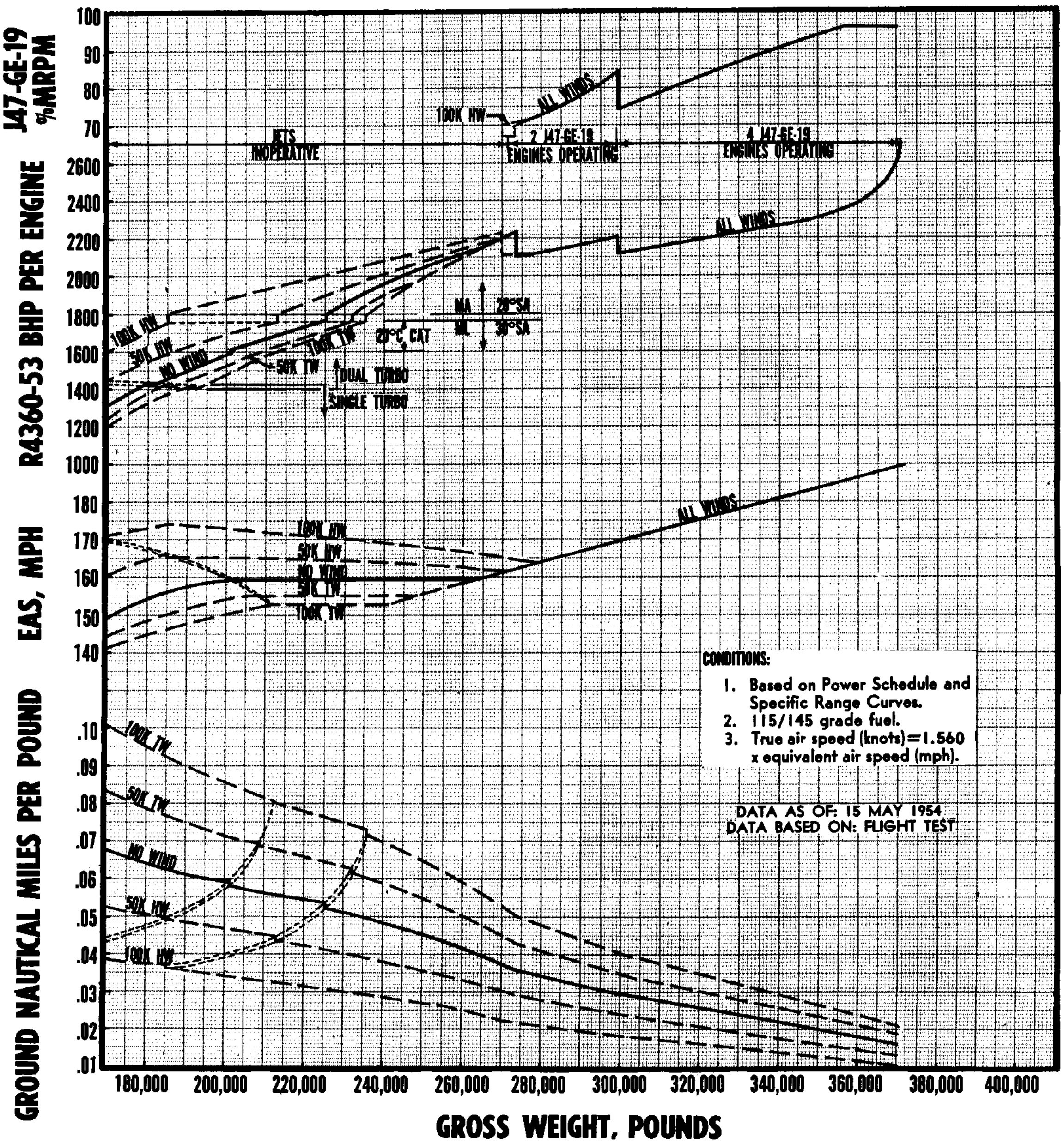


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Figure A-201.

LONG RANGE OPERATING CONDITIONS AT 40,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 + OPTIMUM J47-GE-19 ENGINES OPERATING

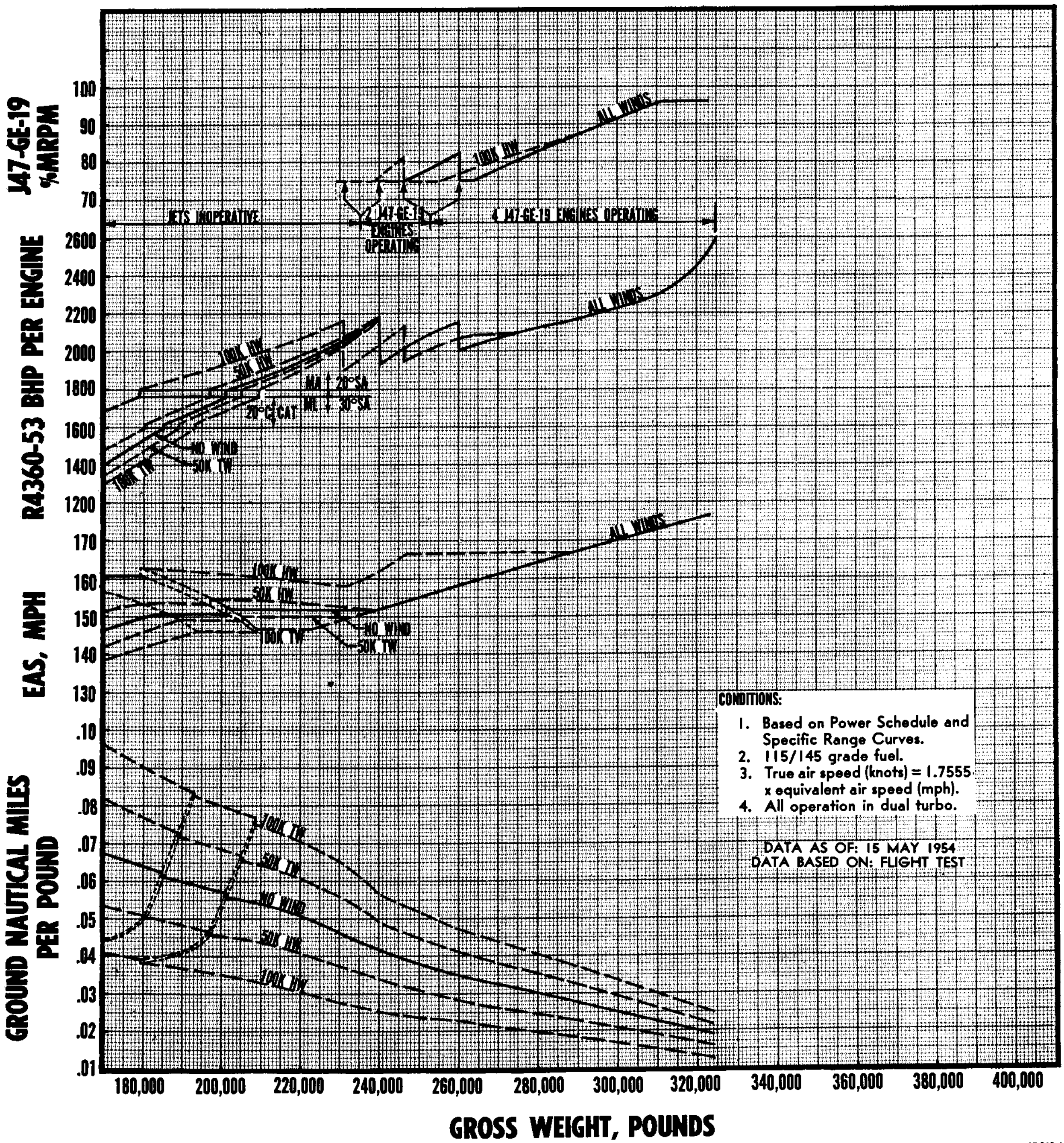


Figure A-202.

LONG RANGE OPERATING CONDITIONS AT 42,500 FEET

STANDARD ATMOSPHERE

6 R4360-53 + OPTIMUM J47-GE-19 ENGINES OPERATING

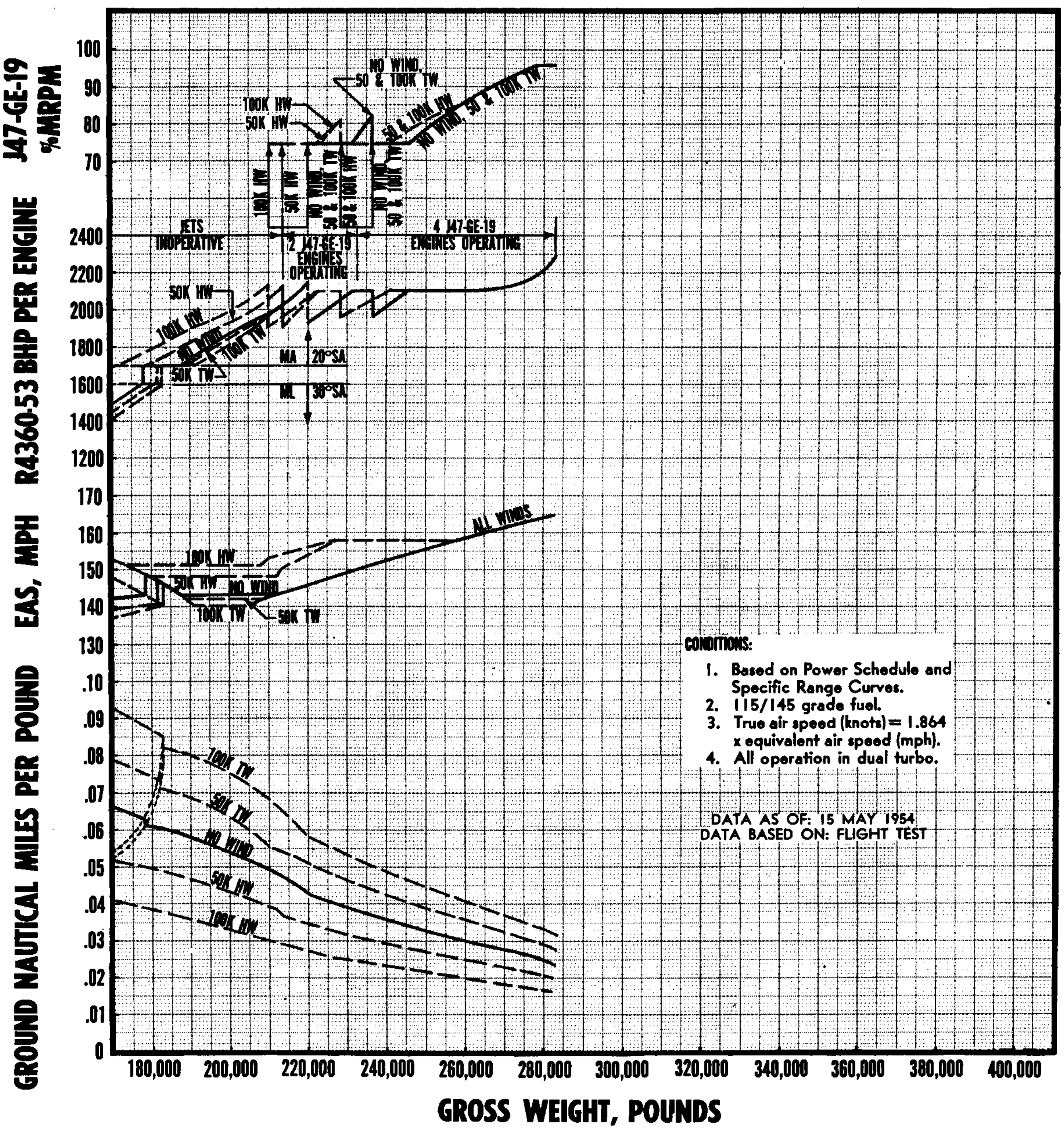


Figure A-203.

67-264-A

LONG RANGE OPERATING CONDITIONS AT 45,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 + OPTIMUM J47-GE-19 ENGINES OPERATING

CONDITIONS:
1. Based on Power Schedule and Specific Range Curves.
2. 115/145 grade fuel.
3. True air speed (knots)= 1.8638 x equivalent air speed (mph).
4. All operation in dual turbo.

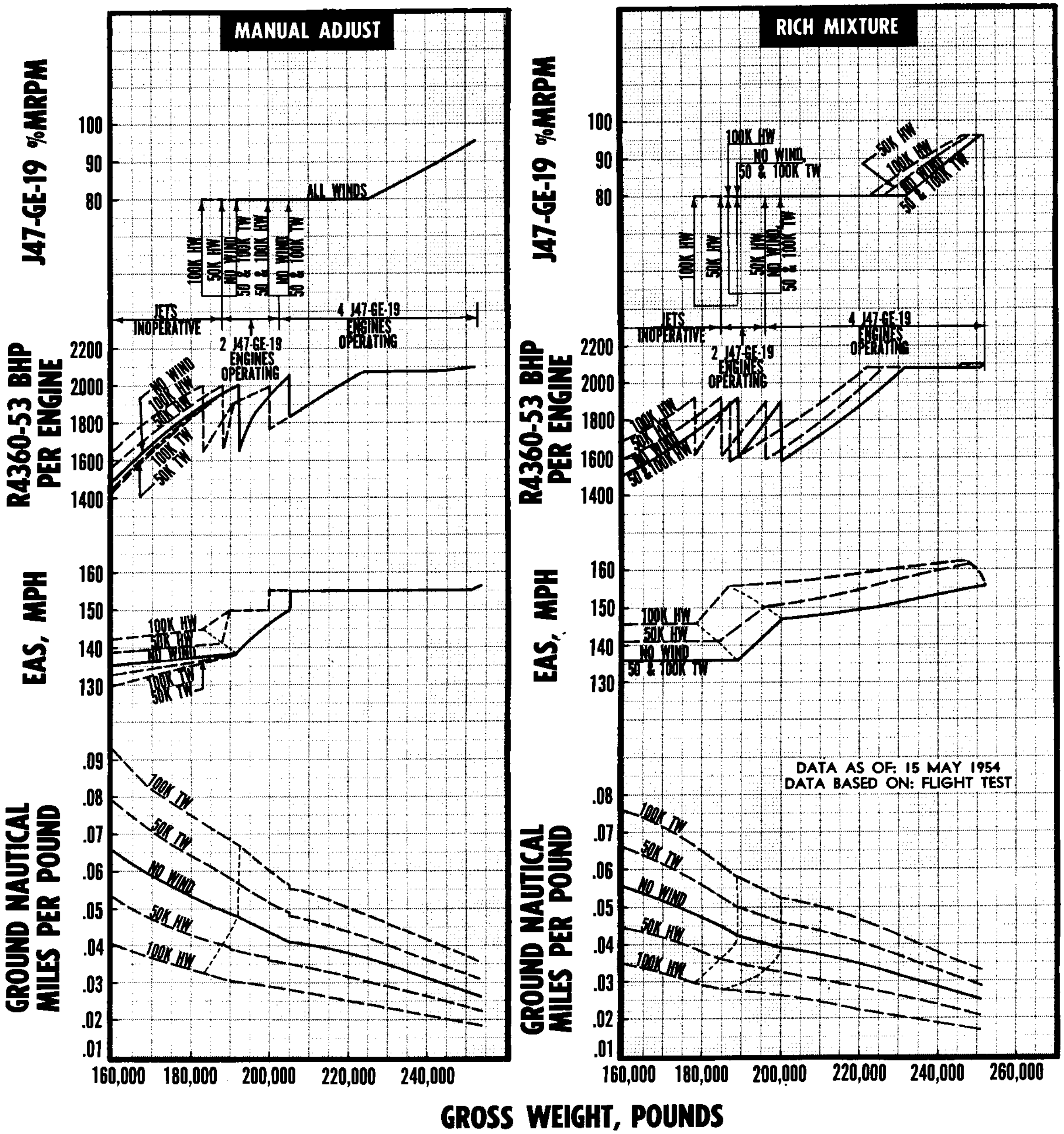


Figure A-204.

LONG RANGE OPERATING CONDITIONS AT 47,500 FEET

STANDARD ATMOSPHERE

6 R4360-53 + OPTIMUM J47-GE-19 ENGINES OPERATING

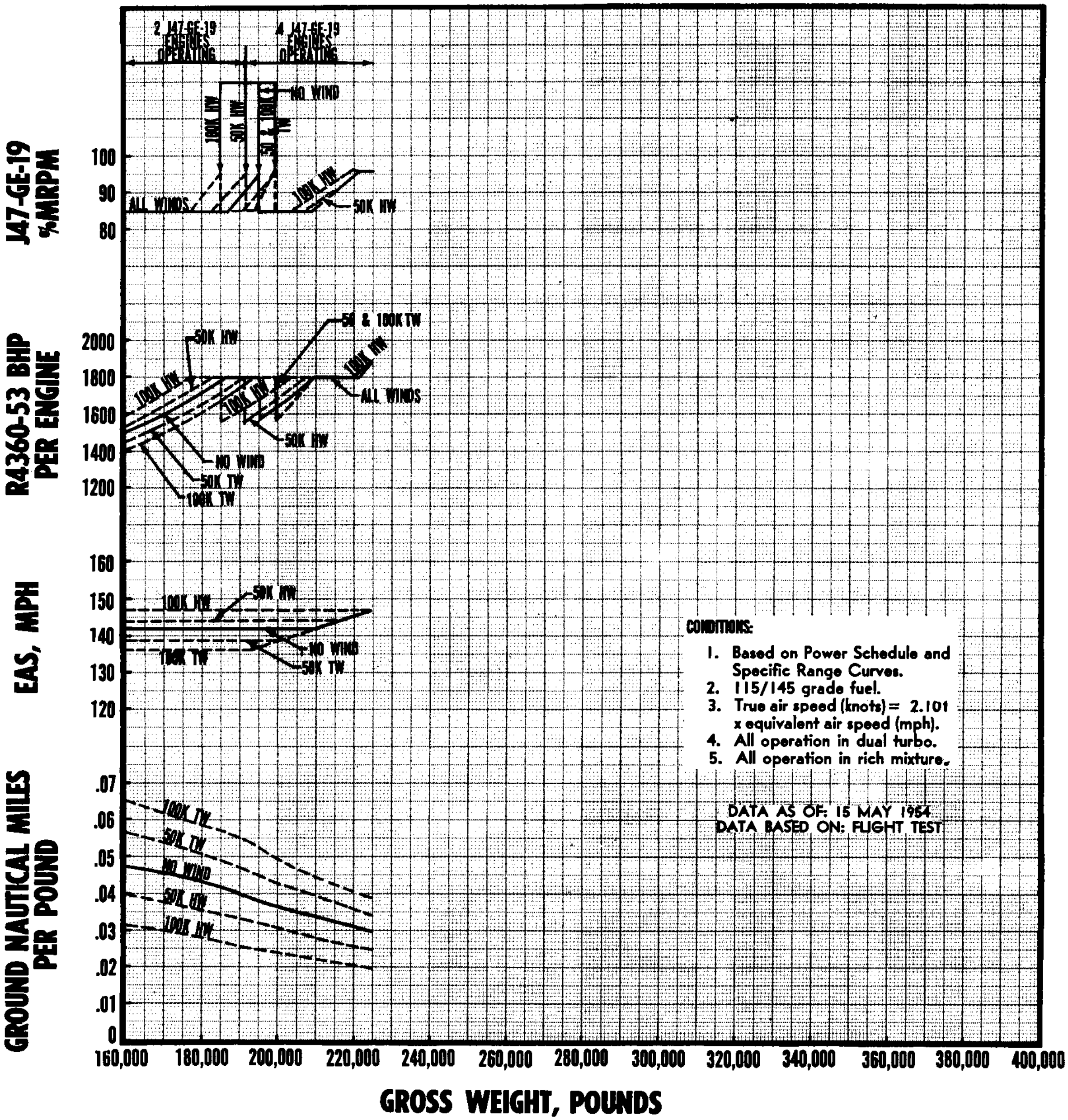


Figure A-205.

LONG RANGE OPERATING CONDITIONS AT 50,000 AND 51,000 FEET

STANDARD ATMOSPHERE

6 R4360-53 + 4 J47-GE-19 ENGINES OPERATING

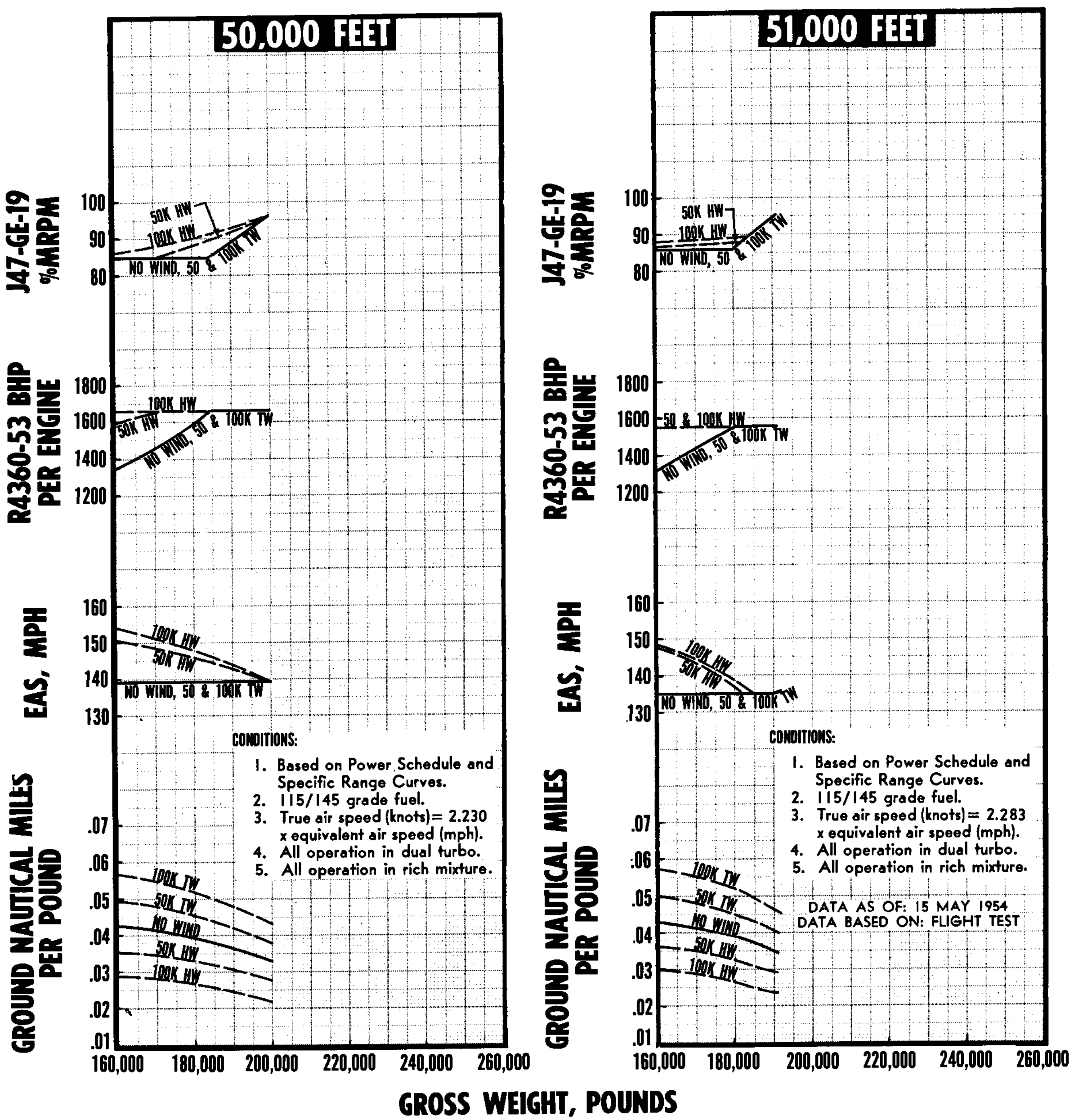


Figure A-206.

LONG RANGE DISTANCE PREDICTION

STANDARD ATMOSPHERE

6 R4360-53 + J47-GE-19 ENGINES OPERATING AS NOTED

CONDITIONS: 1. Based on Power Schedule and Specific Range Curves. 2. 115/145 grade fuel. 3. No wind.

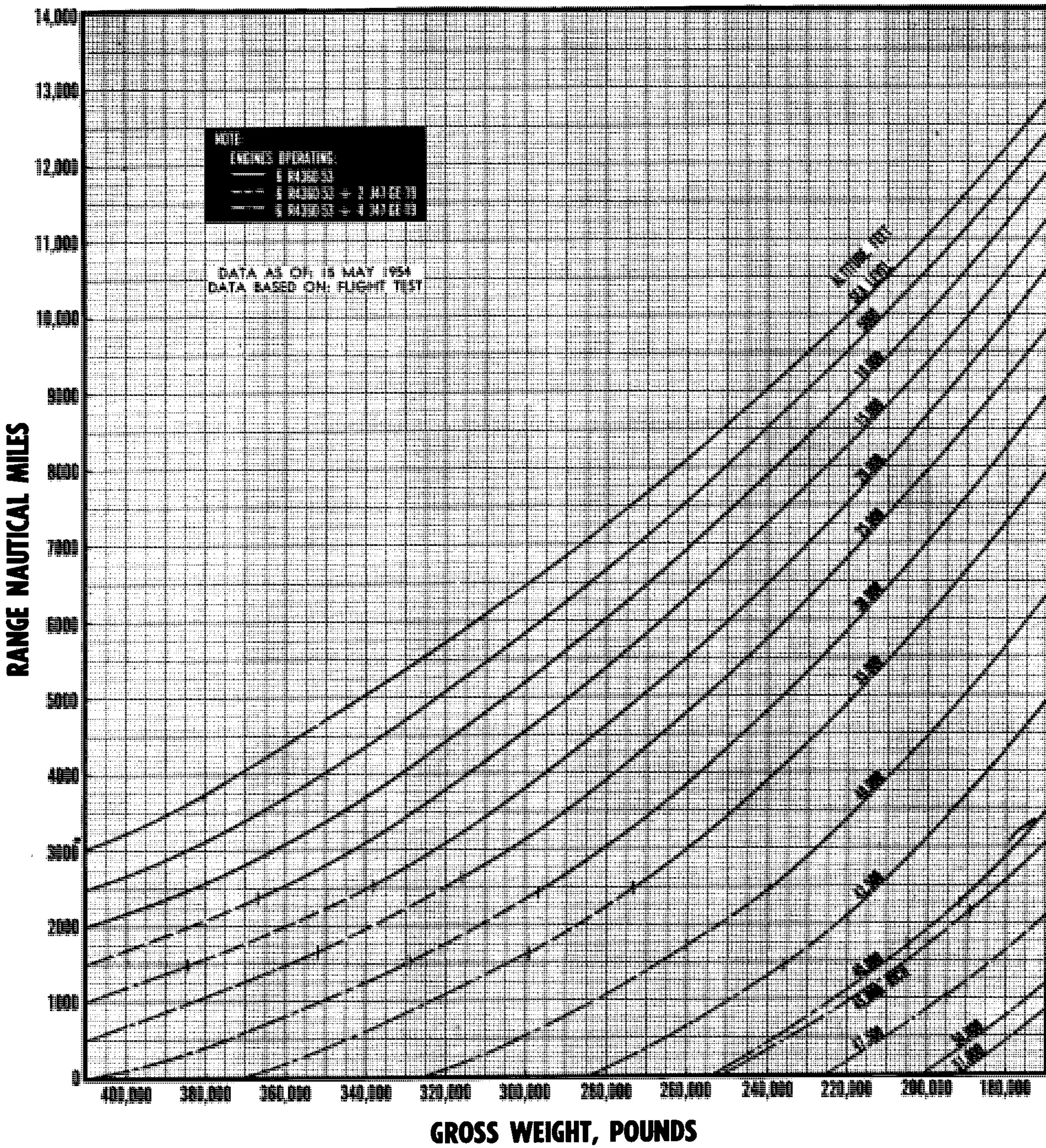
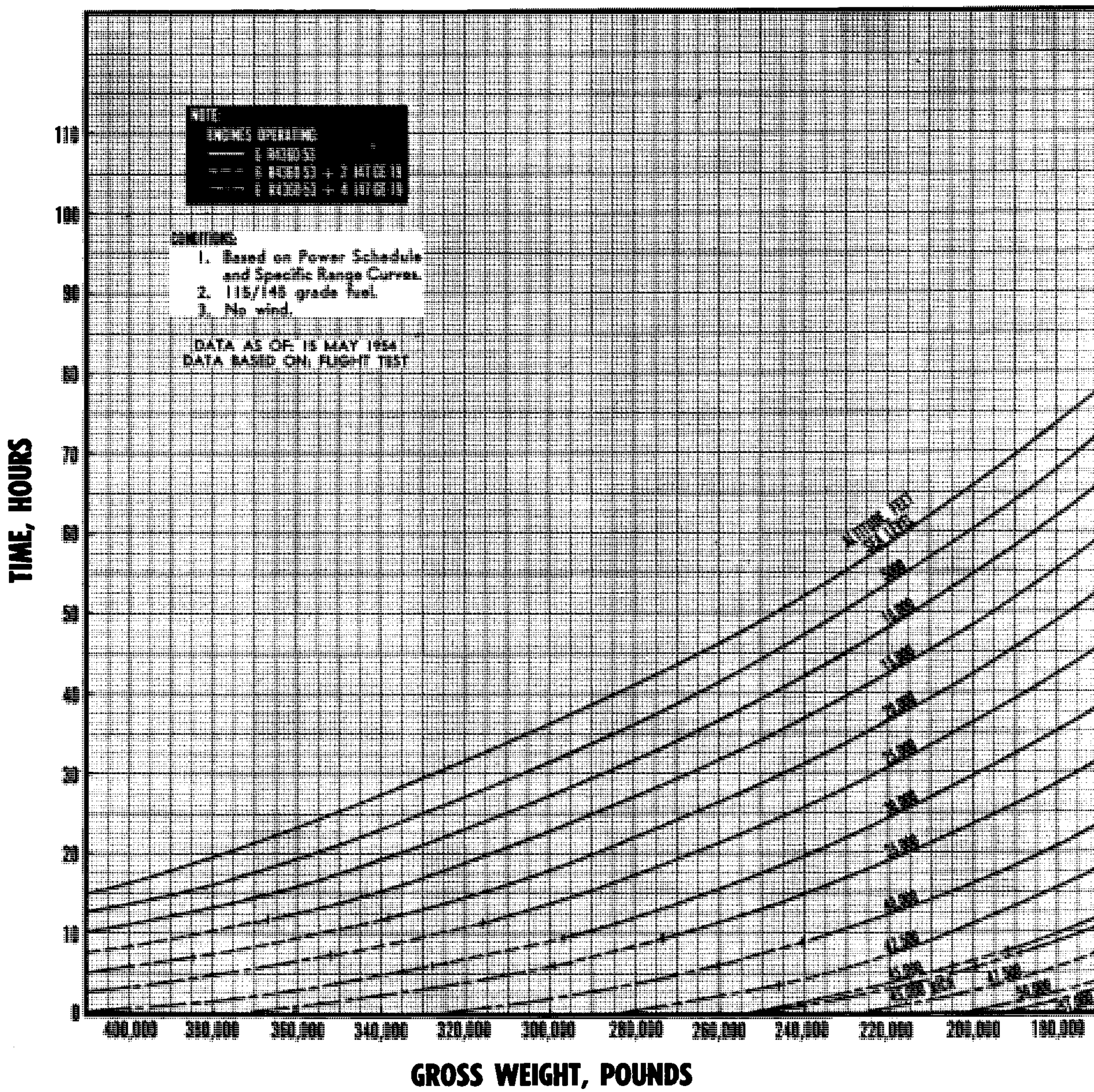


Figure A-207.

LONG RANGE TIME PREDICTION

STANDARD ATMOSPHERE

6 R4360-53 + J47-GE-19 ENGINES OPERATING AS NOTED



67-272-A

Figure A-208.

LONG RANGE OPERATING CONDITIONS AT SEA LEVEL

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING

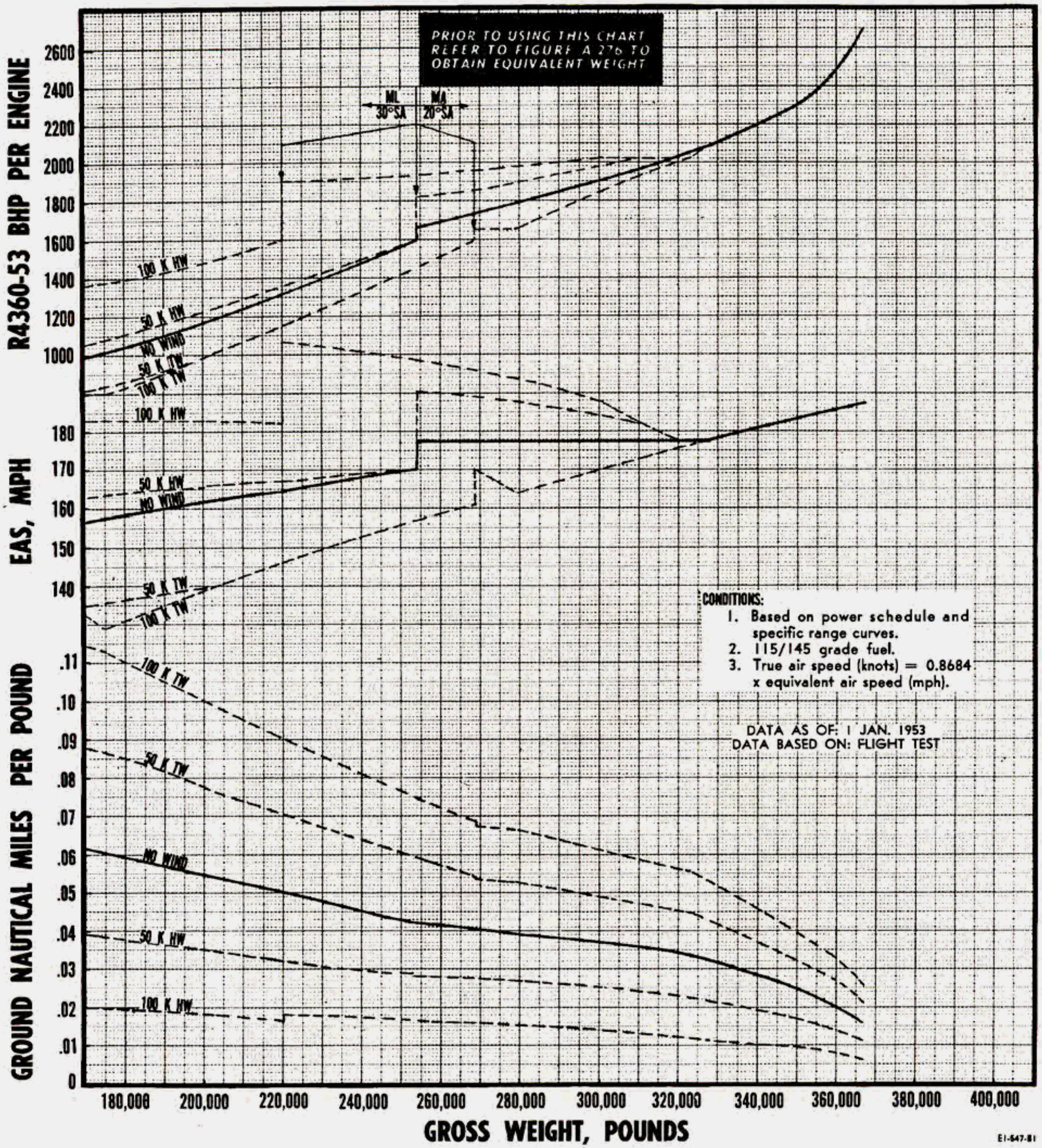


Figure A-209.

LONG RANGE OPERATING CONDITIONS AT 5,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING

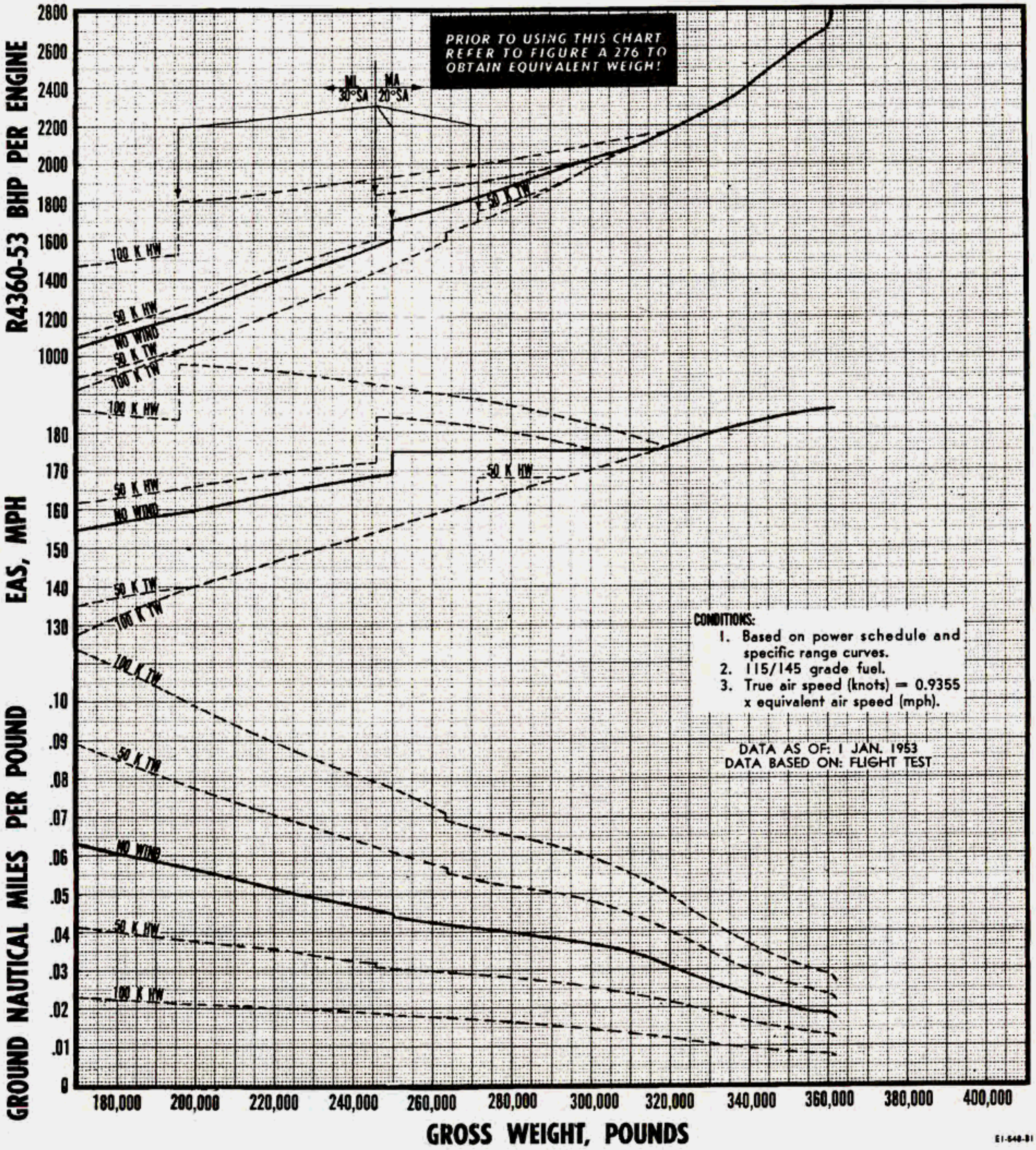


Figure A-210.

LONG RANGE OPERATING CONDITIONS AT 10,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING

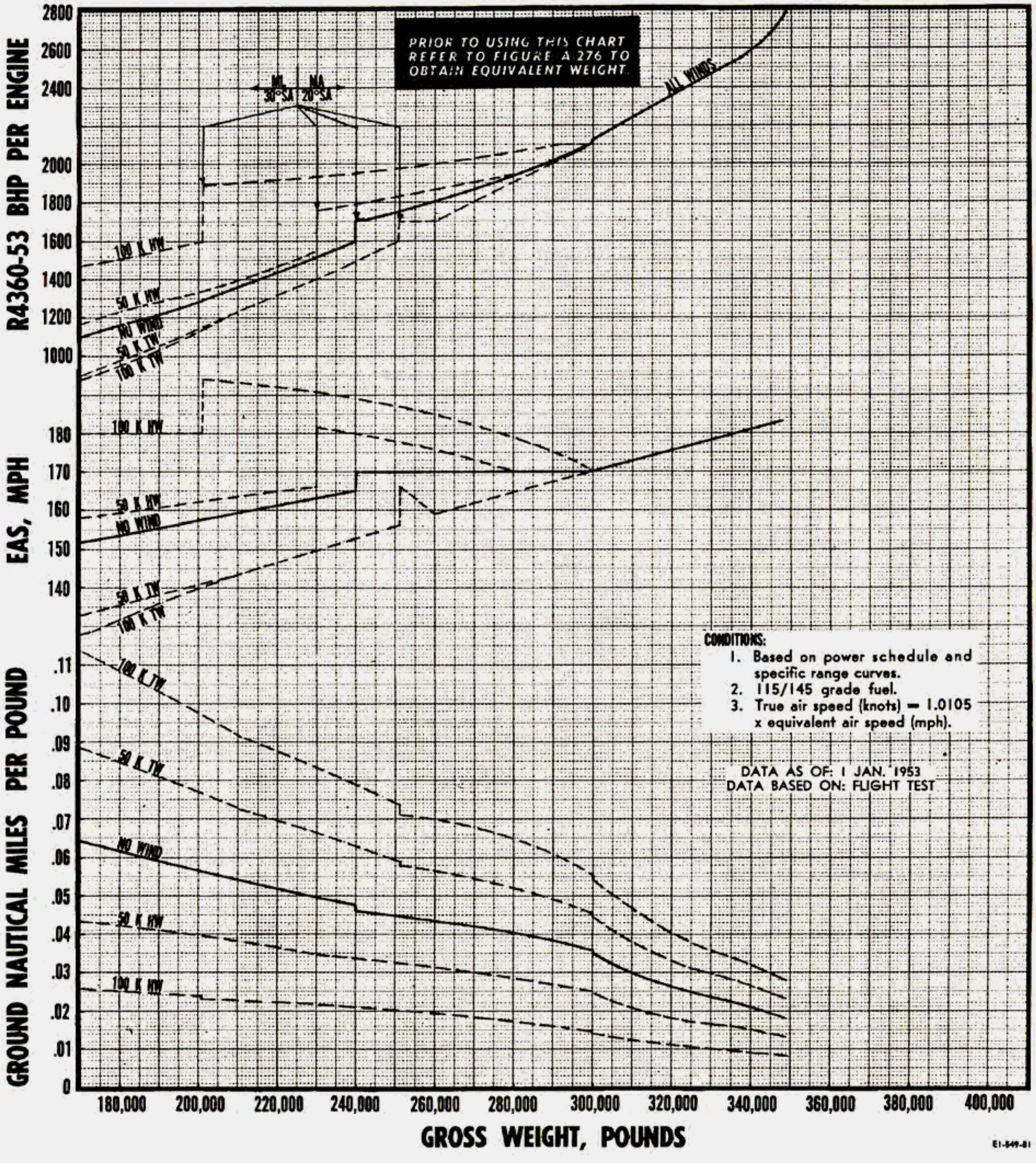


Figure A-211.

LONG RANGE OPERATING CONDITIONS AT 15,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING

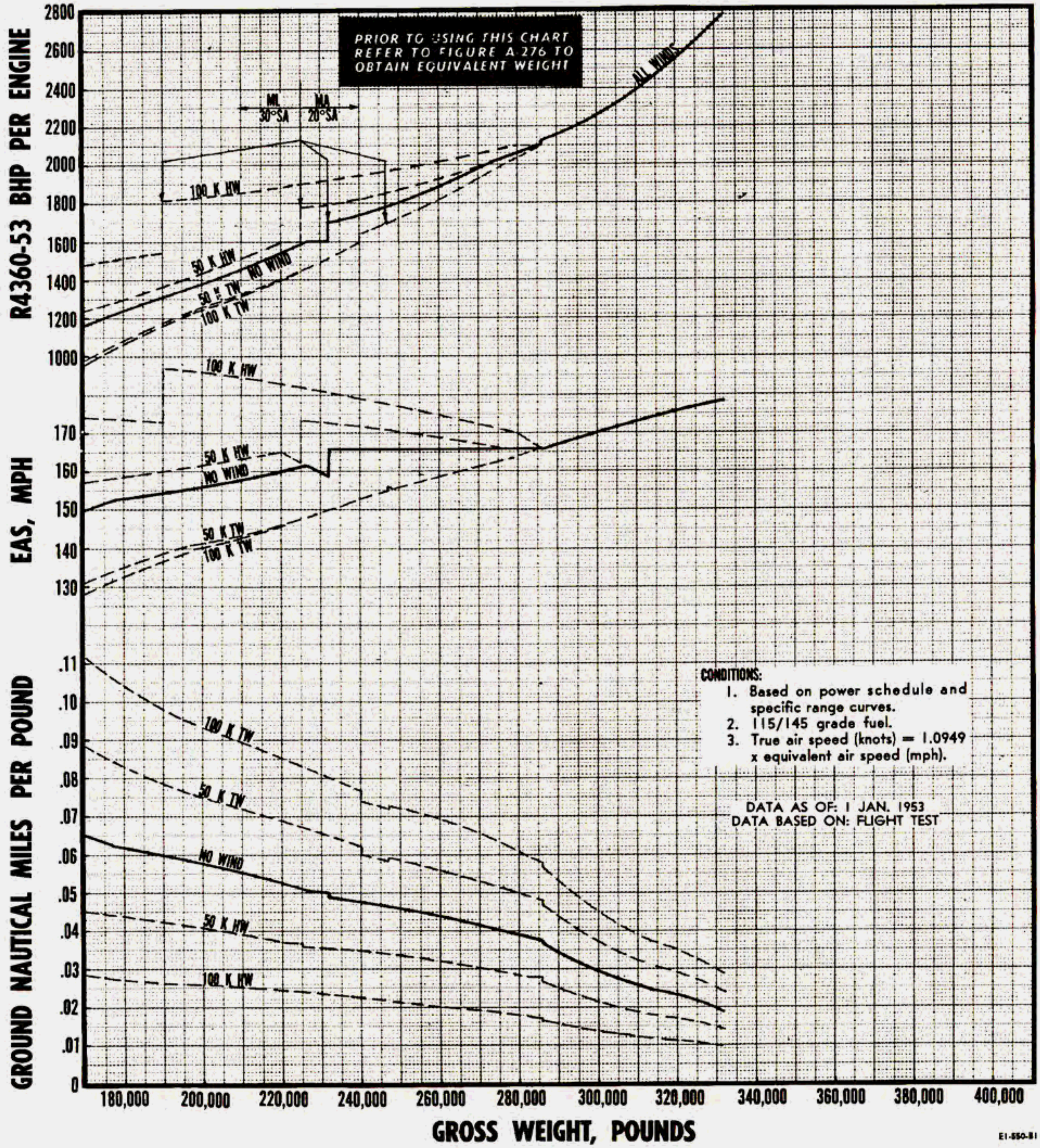


Figure A-212.

LONG RANGE OPERATING CONDITIONS AT 20,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING

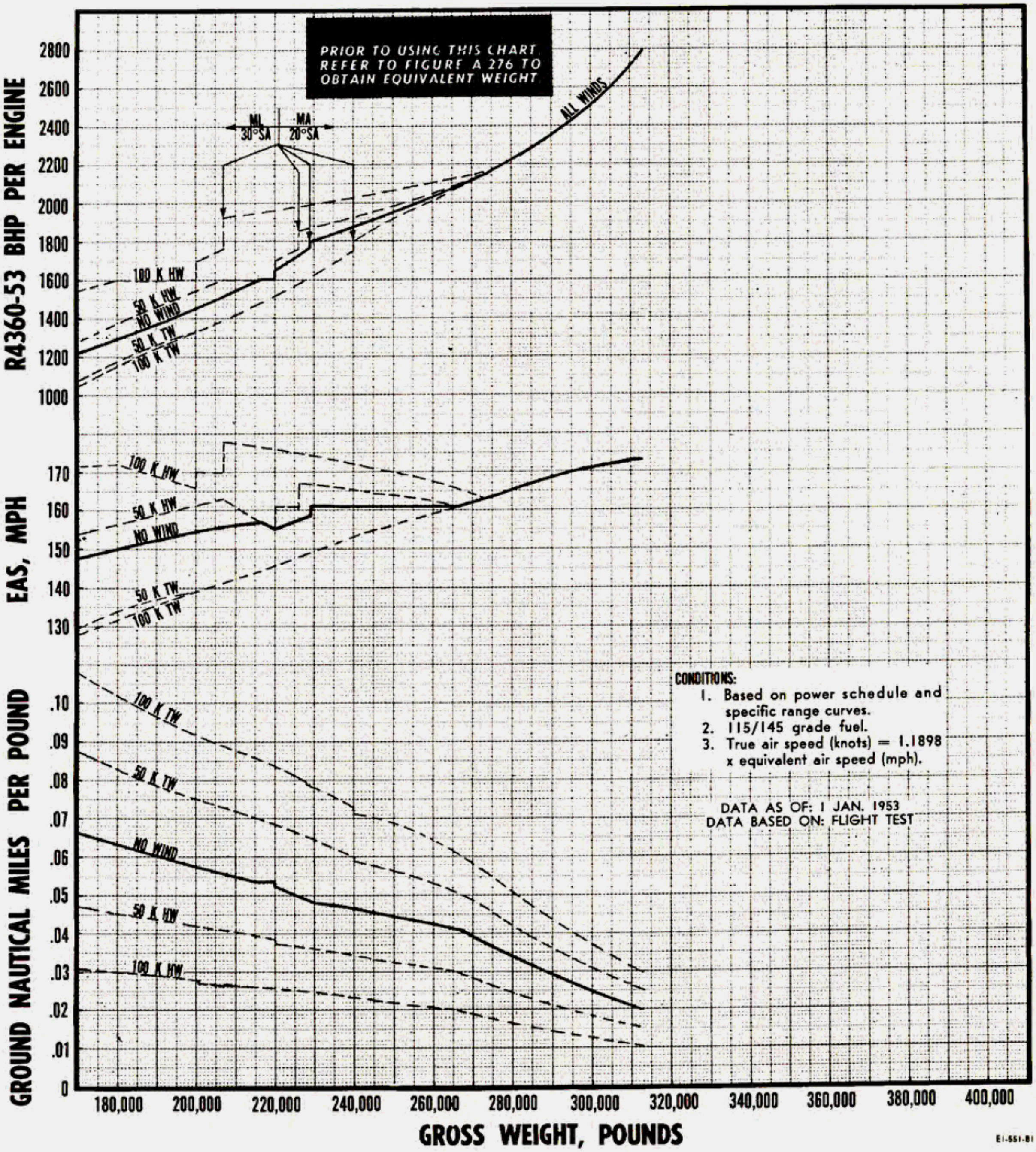


Figure A-213.

LONG RANGE OPERATING CONDITIONS AT 25,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING

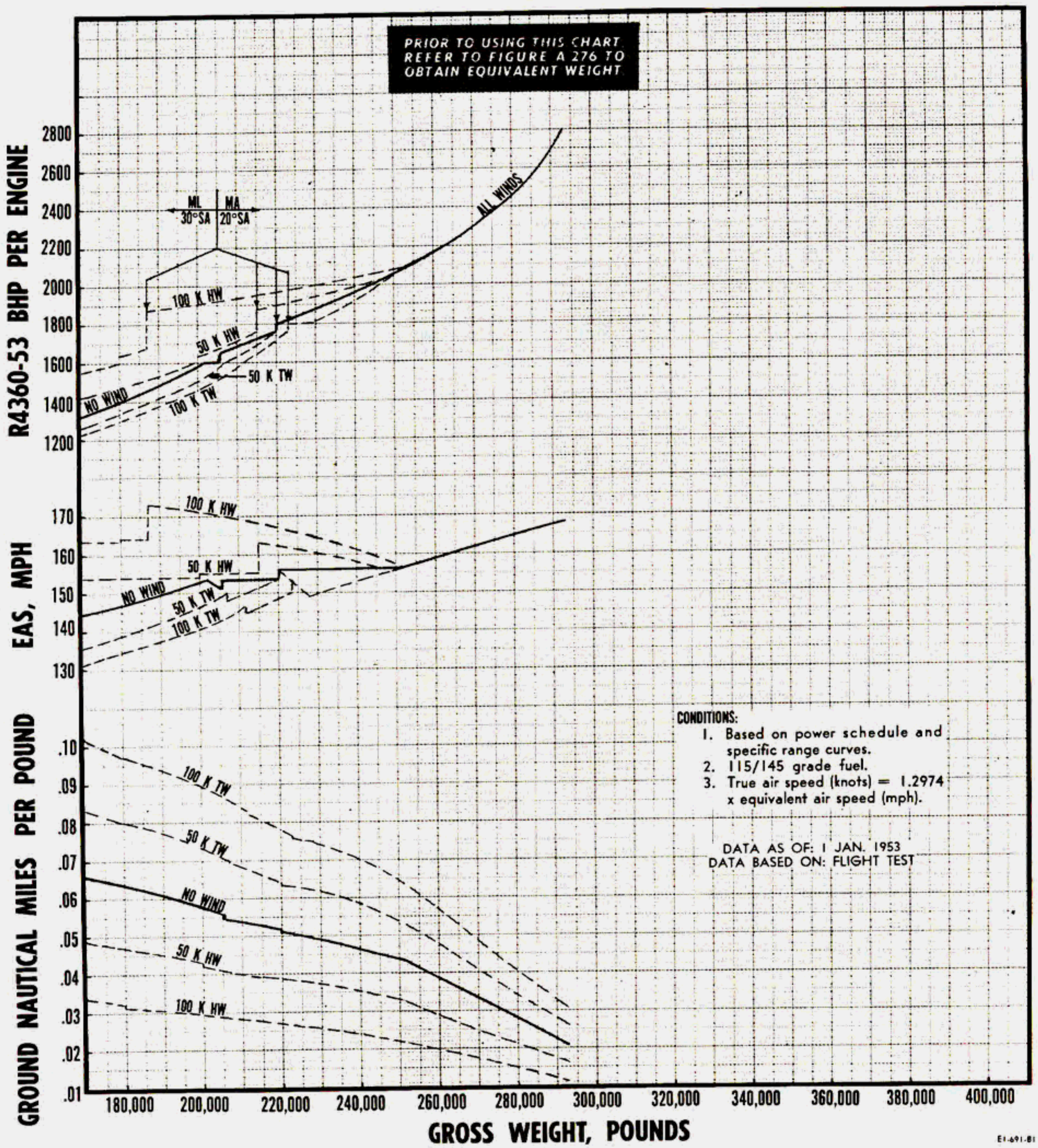
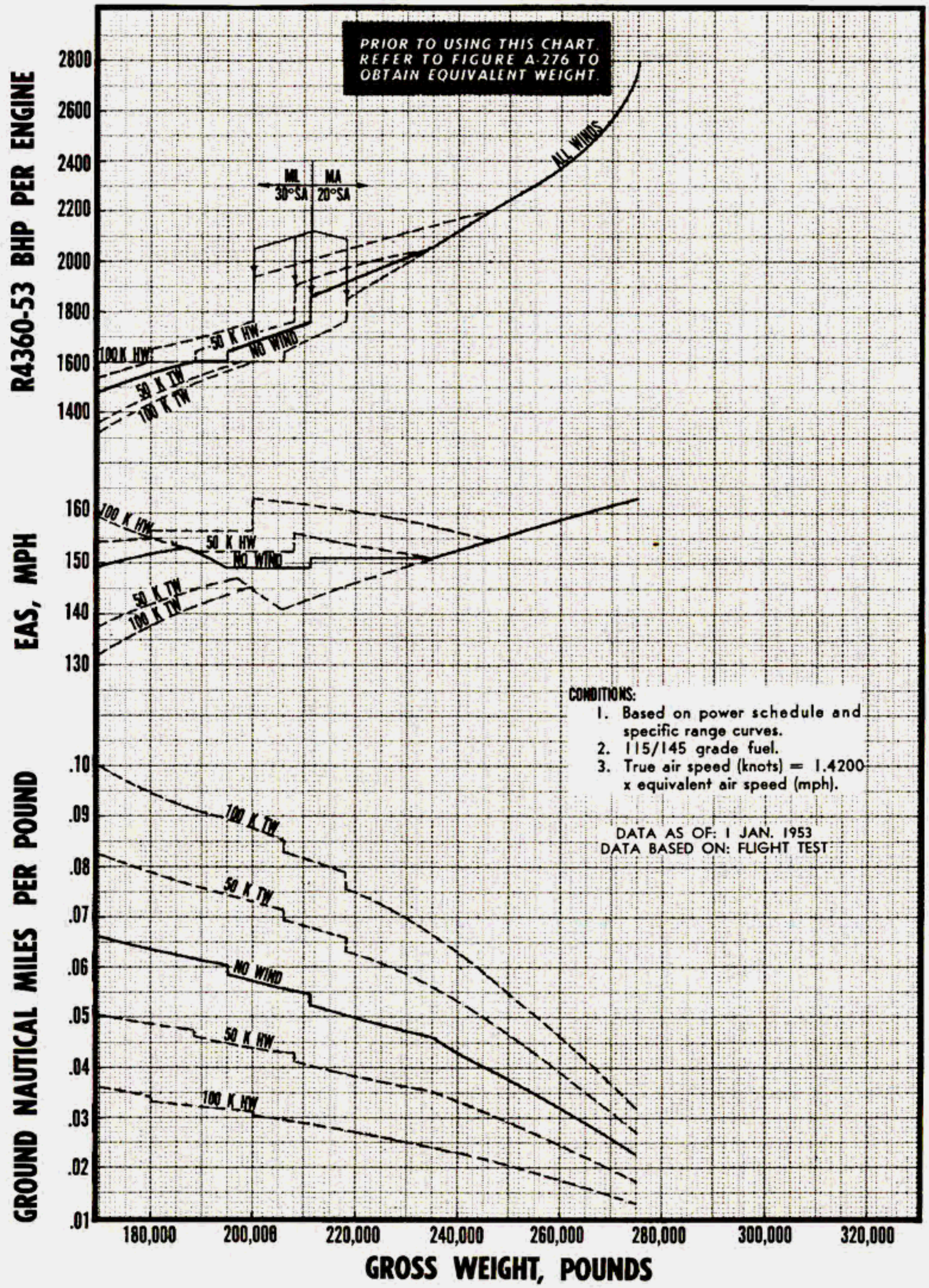


Figure A-214.

LONG RANGE OPERATING CONDITIONS AT 30,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING



CONDITIONS:

1. Based on power schedule and specific range curves.
2. 115/145 grade fuel.
3. True air speed (knots) = 1.4200 x equivalent air speed (mph).

DATA AS OF: 1 JAN. 1953
DATA BASED ON: FLIGHT TEST

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Figure A-215.

LONG RANGE OPERATING CONDITIONS AT 30,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 +2 J47-GE-19 ENGINES OPERATING

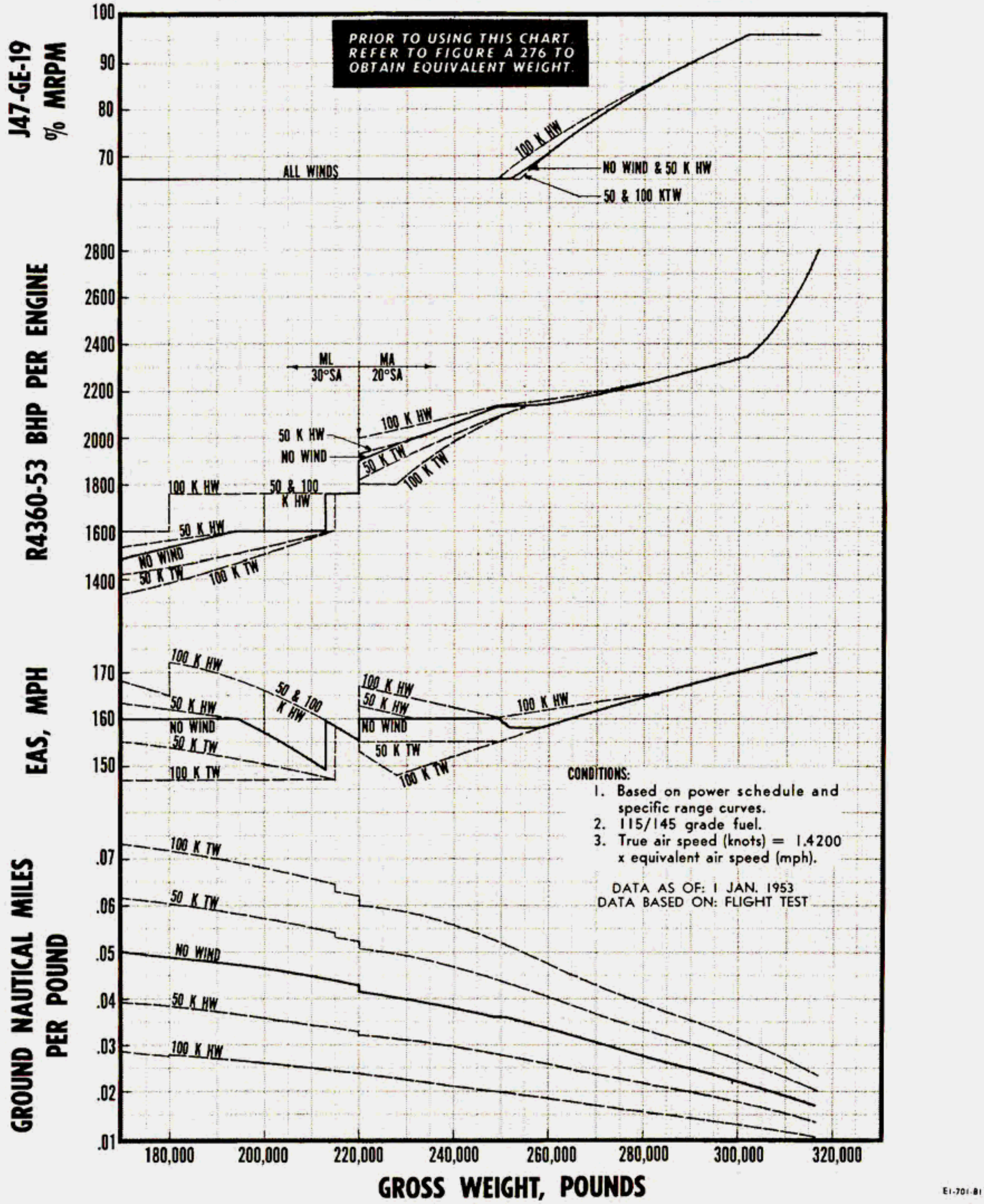
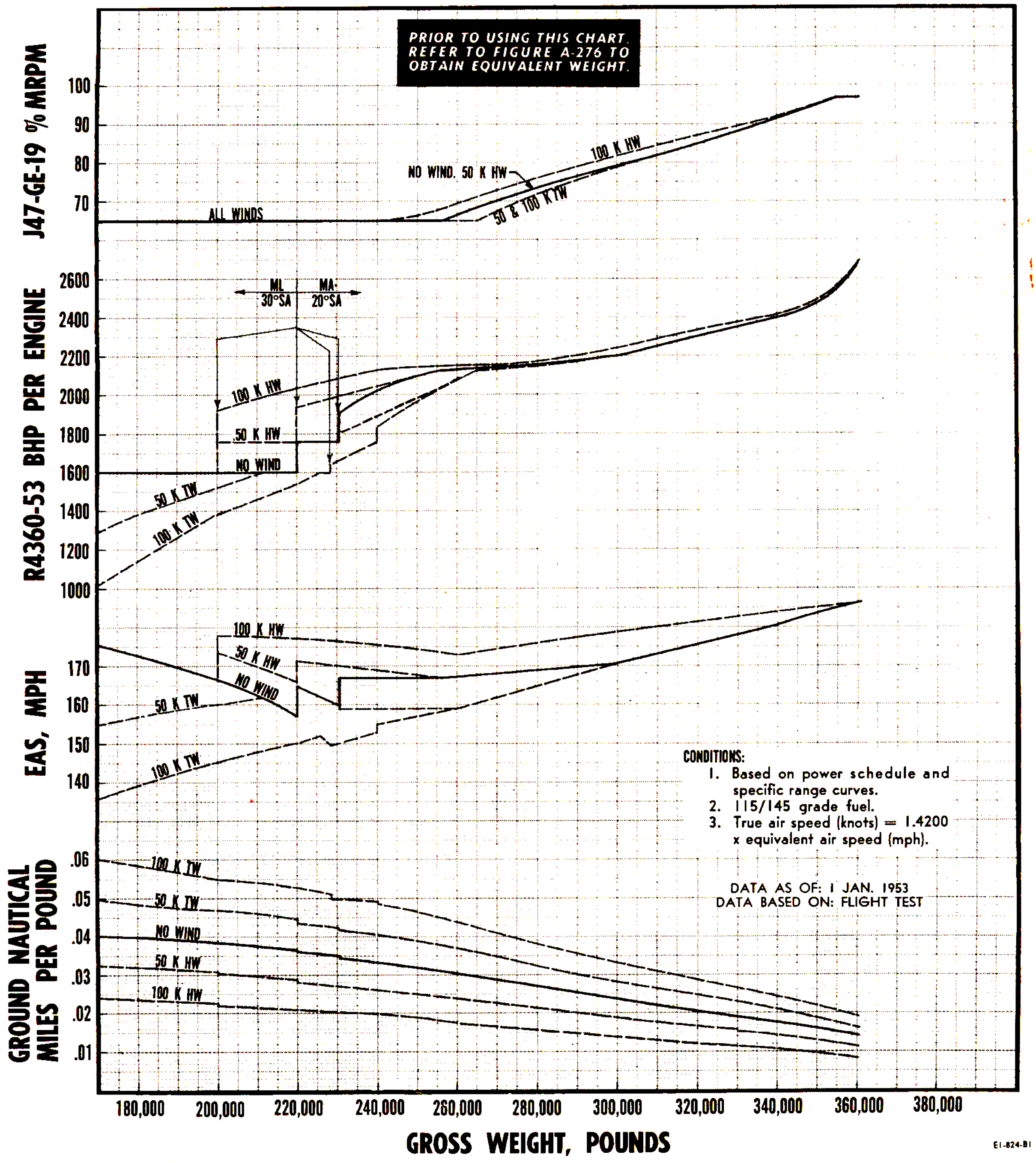


Figure A-216.

LONG RANGE OPERATING CONDITIONS AT 30,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 + 4 J47-GE-19 ENGINES OPERATING



CONDITIONS:

1. Based on power schedule and specific range curves.
2. 115/145 grade fuel.
3. True air speed (knots) = 1.4200 x equivalent air speed (mph).

DATA AS OF: 1 JAN. 1953
DATA BASED ON: FLIGHT TEST

Figure A-217.

LONG RANGE OPERATING CONDITIONS AT 30,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING, OPTIMUM J47-GE-19 ENGINES OPERATING

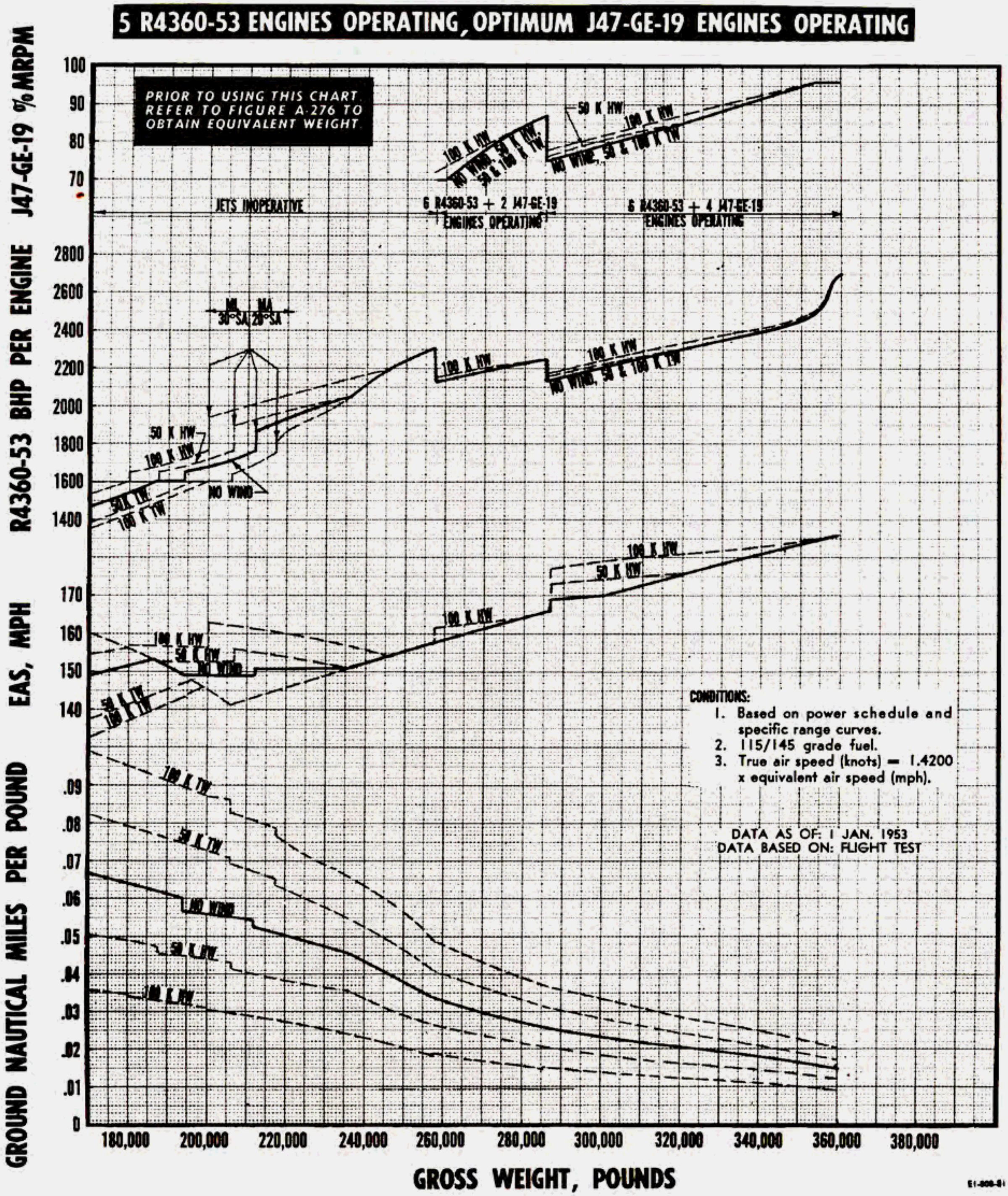


Figure A-218.

LONG RANGE OPERATING CONDITIONS AT 35,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING

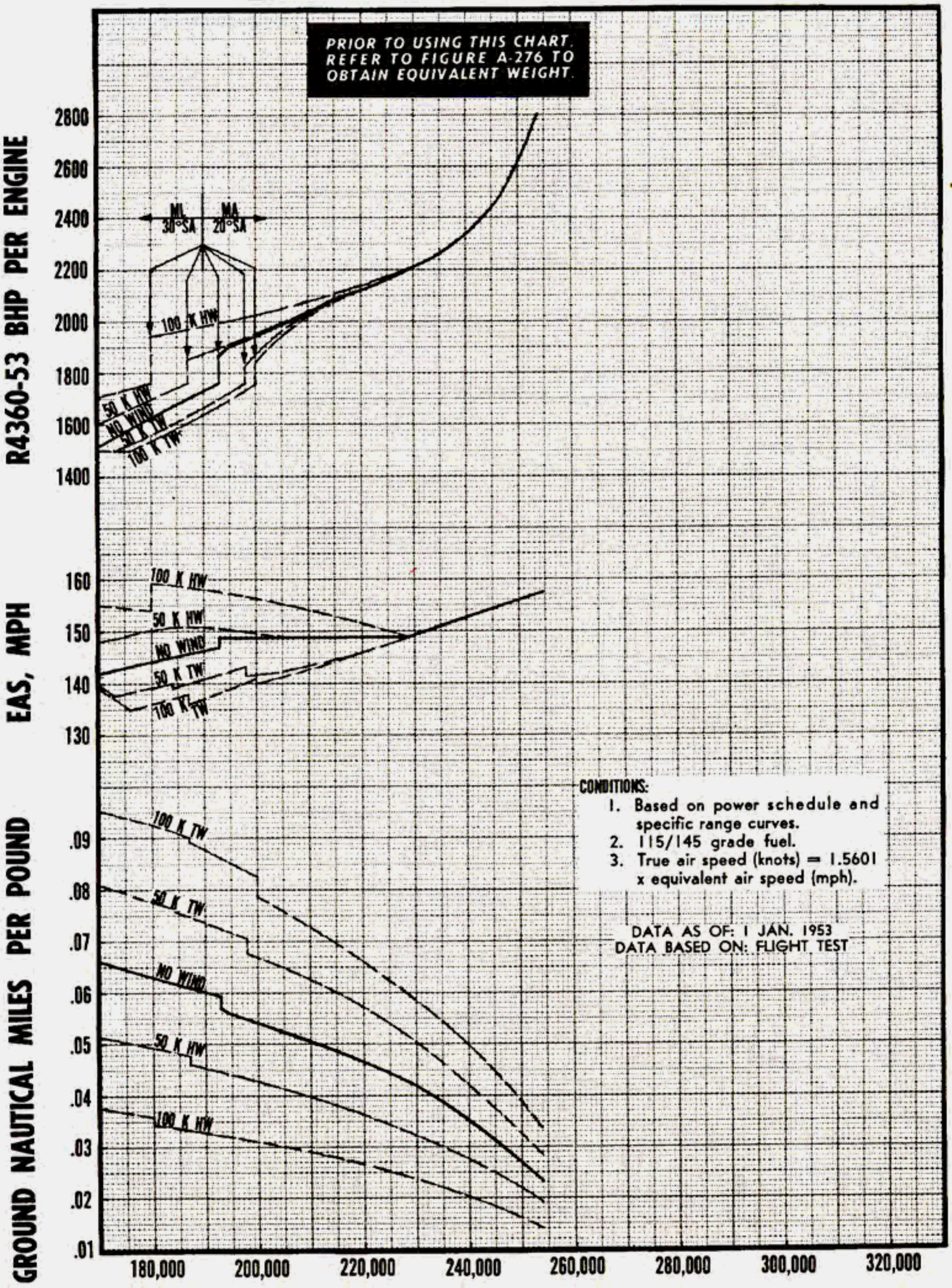


Figure A-219.

LONG RANGE OPERATING CONDITIONS AT 35,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 + 2 J47-GE-19 ENGINES OPERATING

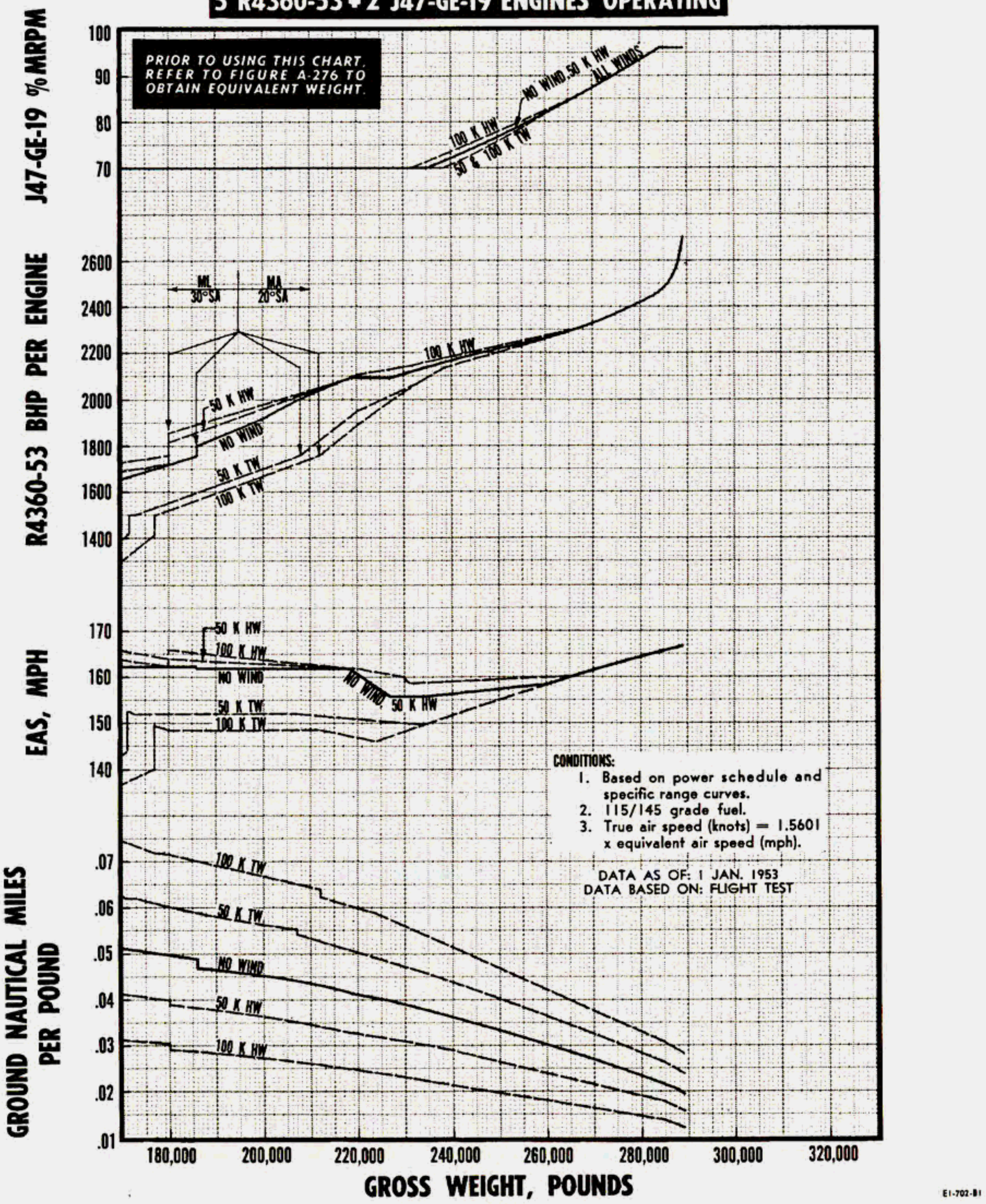
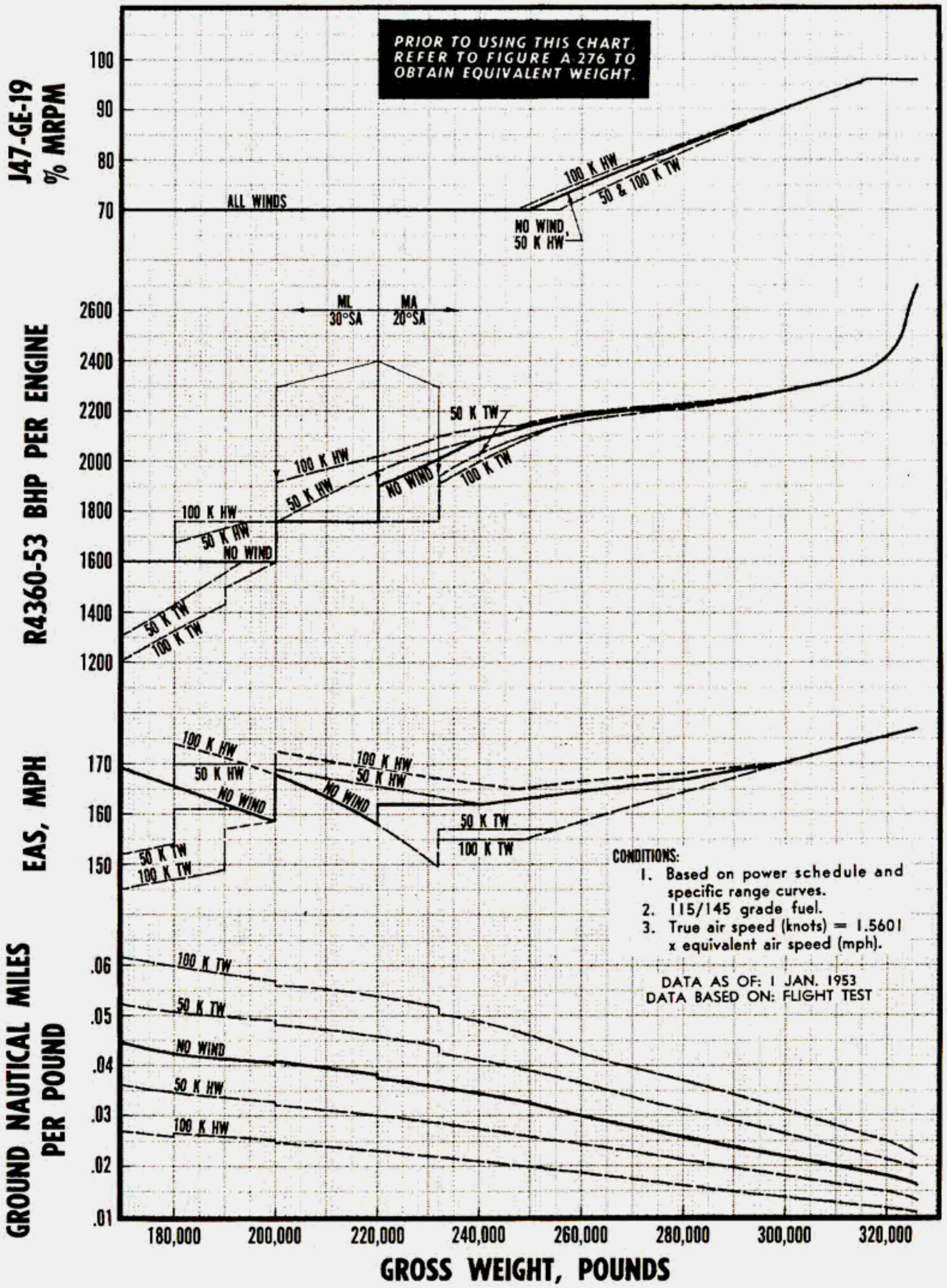


Figure A-220.

LONG RANGE OPERATING CONDITIONS AT 35,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 + 4 J47-GE-19 ENGINES OPERATING



CONDITIONS:

1. Based on power schedule and specific range curves.
2. 115/145 grade fuel.
3. True air speed (knots) = 1.5601 x equivalent air speed (mph).

DATA AS OF: 1 JAN. 1953
DATA BASED ON: FLIGHT TEST

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Figure A-221.

LONG RANGE OPERATING CONDITIONS AT 35,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 + OPTIMUM J47-GE-19 ENGINES OPERATING

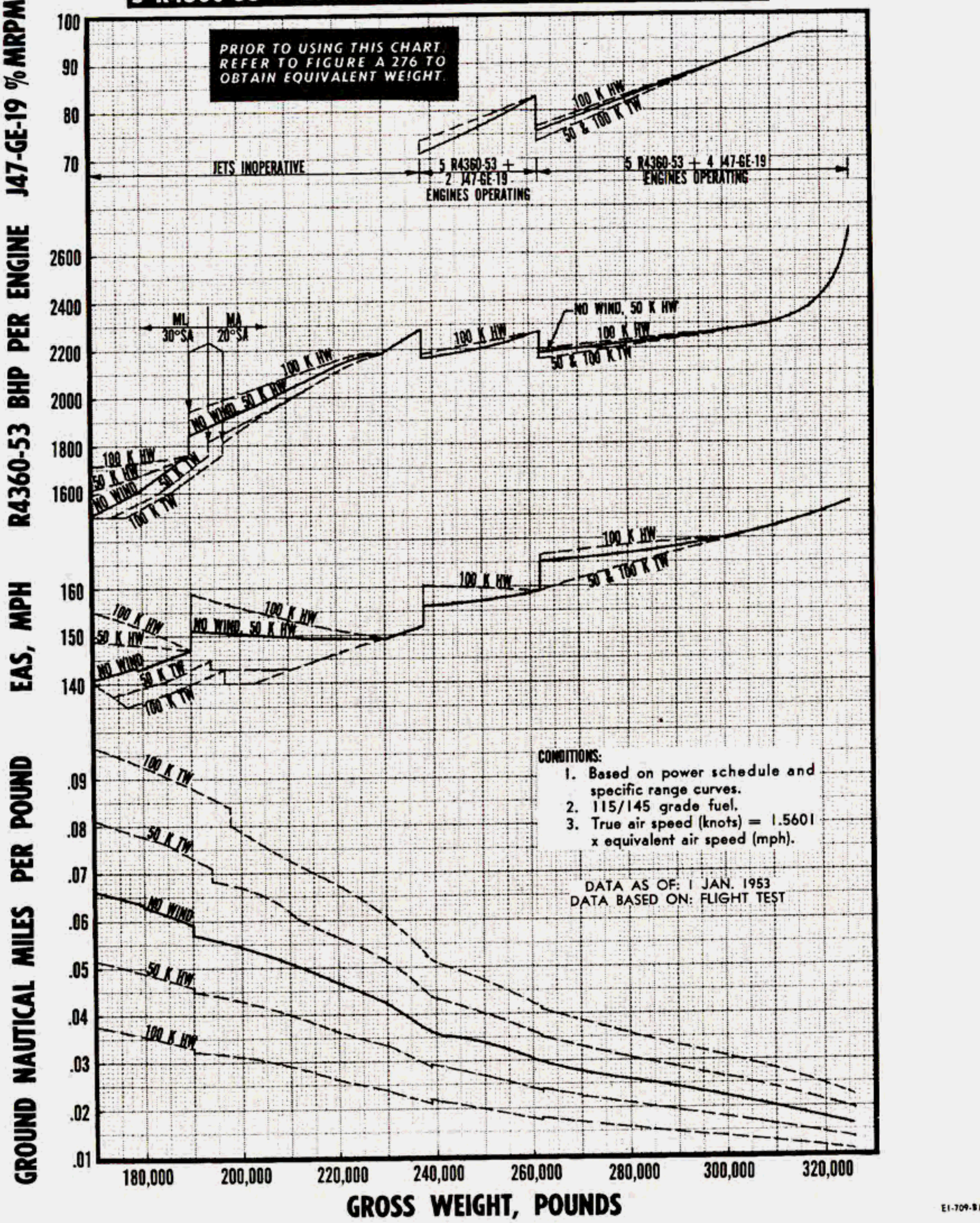

Figure A-222.

LONG RANGE OPERATING CONDITIONS AT 40,000 FEET

STANDARD ATMOSPHERE

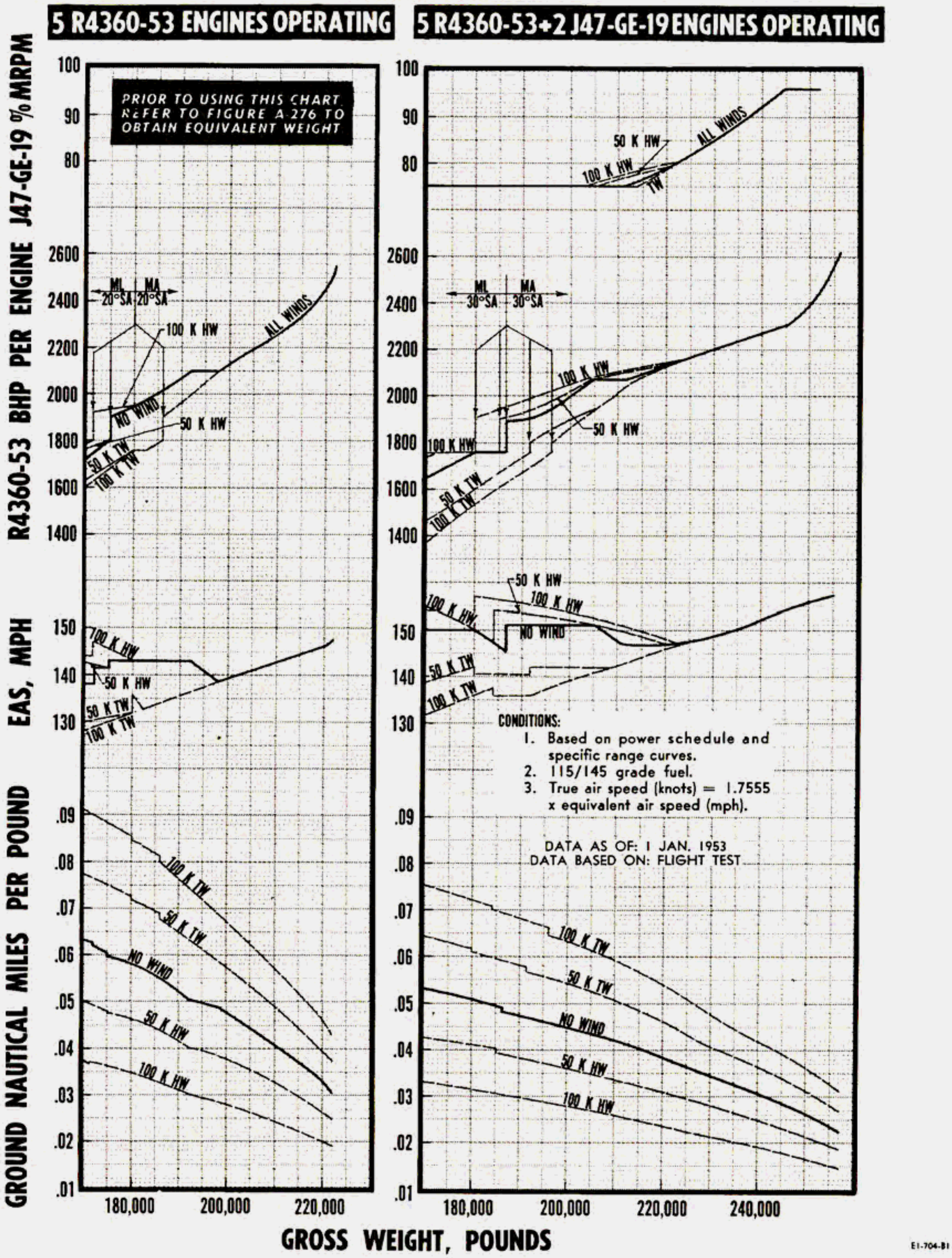

Figure A-223.

LONG RANGE OPERATING CONDITIONS AT 40,000 FEET

STANDARD ATMOSPHERE

5 R4360-53 + 4 J47-GE-19 ENGINES OPERATING

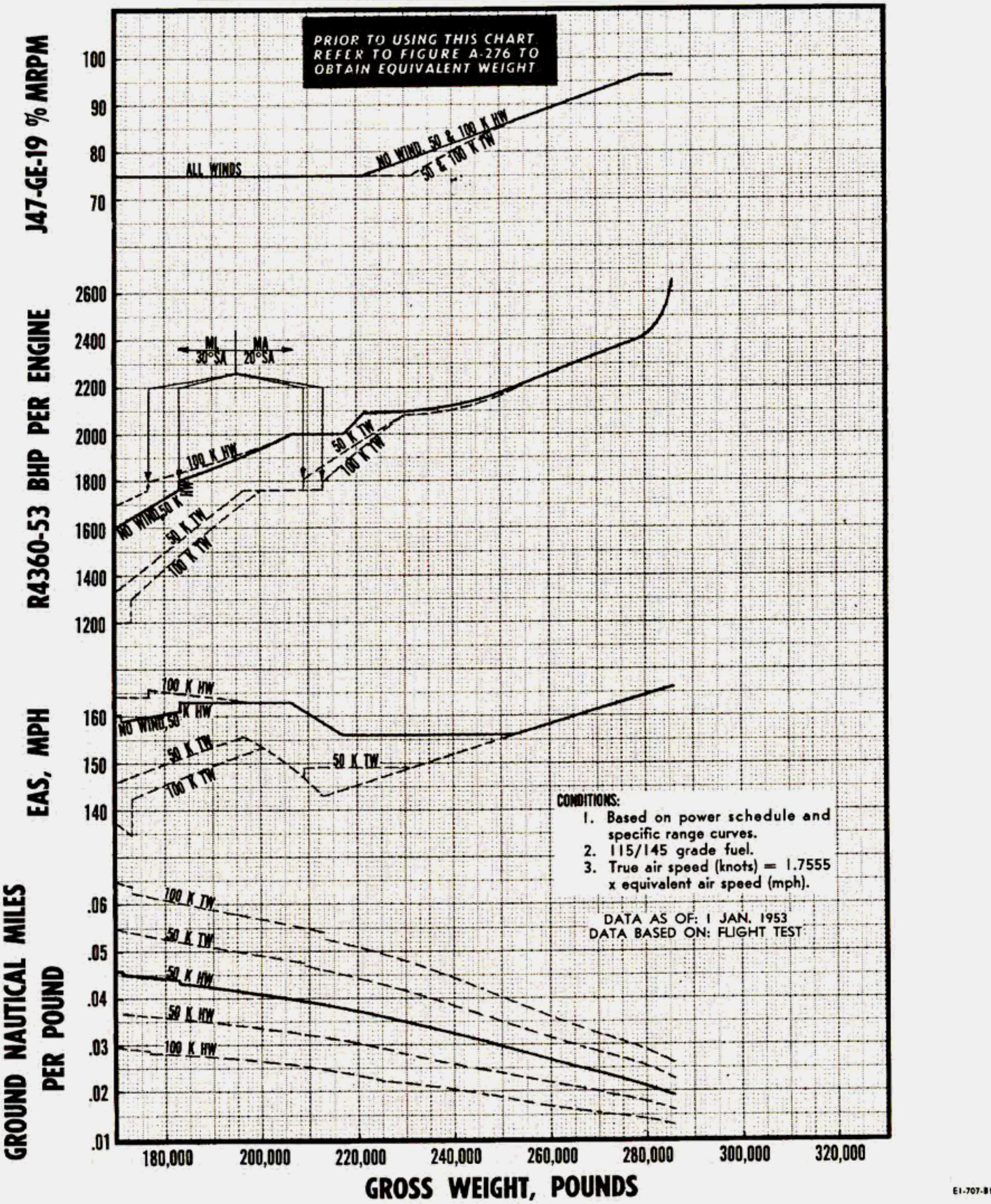

Figure A-224.

LONG RANGE OPERATING CONDITIONS AT 40,000 FEET

STANDARD ATMOSPHERE

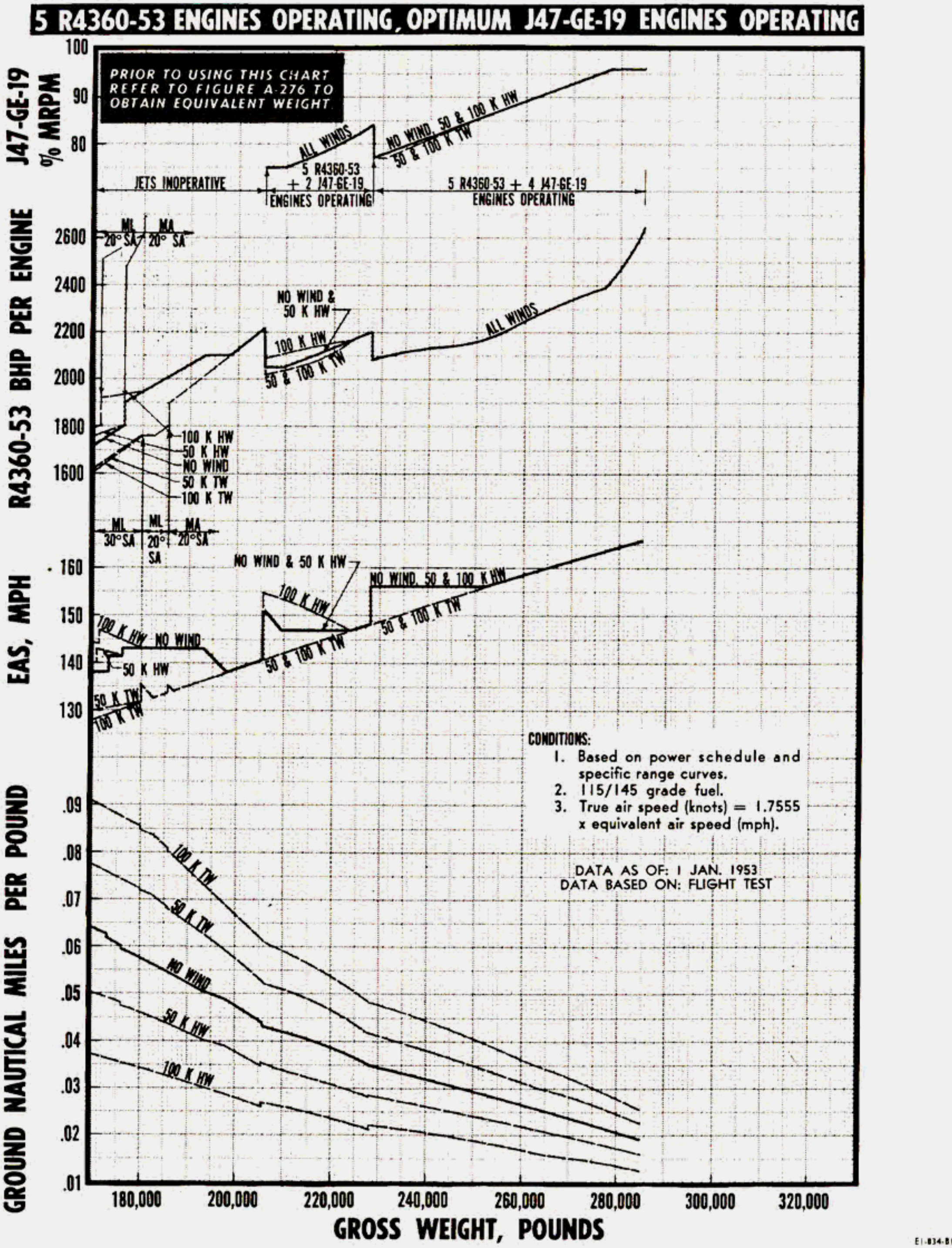

Figure A-225.

PRIOR TO USING THIS CHART, REFER TO FIGURE A-276 TO OBTAIN EQUIVALENT WEIGHT.

LONG RANGE OPERATING CONDITIONS AT 42,500 FEET

STANDARD ATMOSPHERE

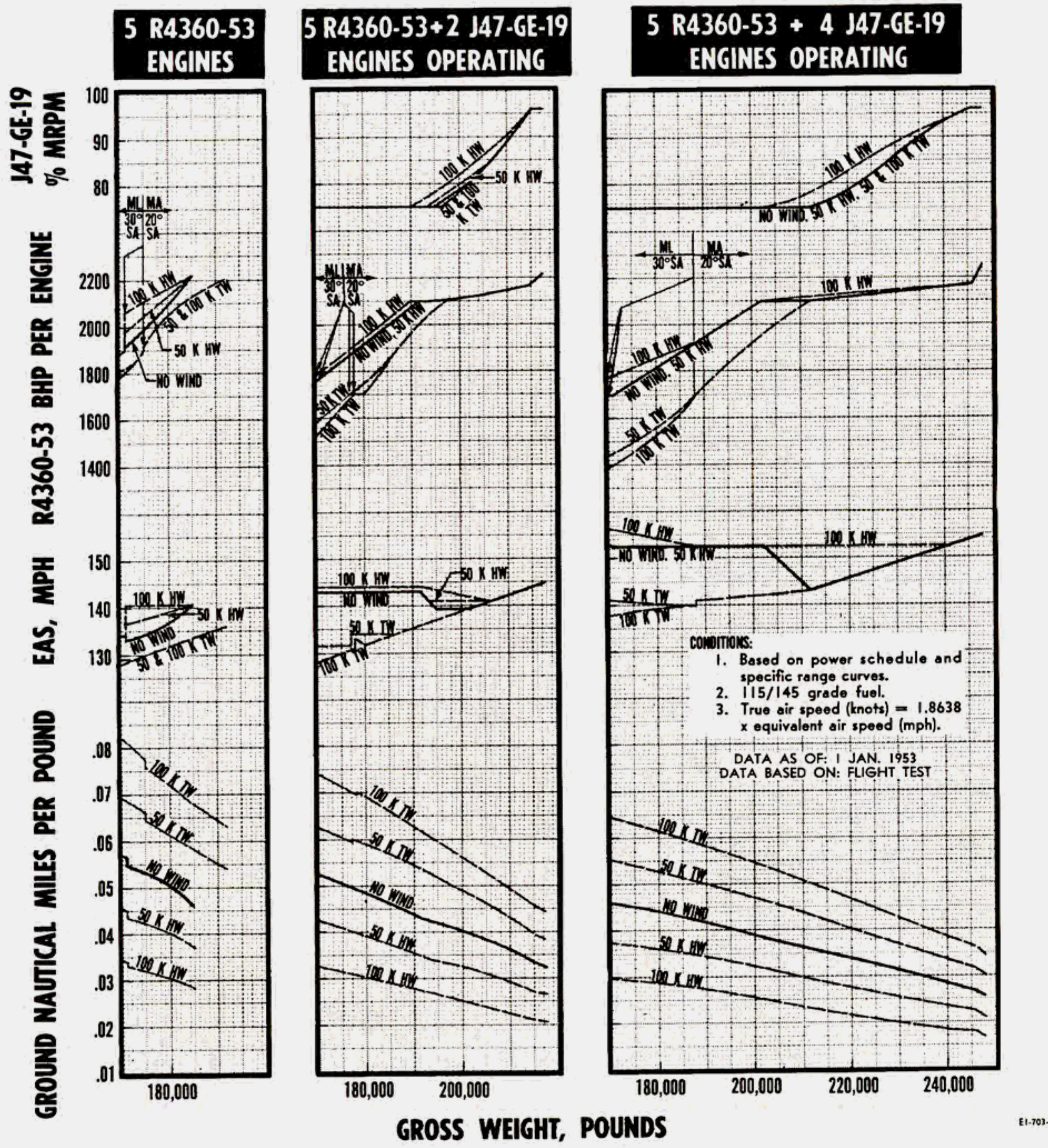

Figure A-226.

LONG RANGE OPERATING CONDITIONS AT 42,500 FEET

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING, OPTIMUM J47-GE-19 ENGINES OPERATING

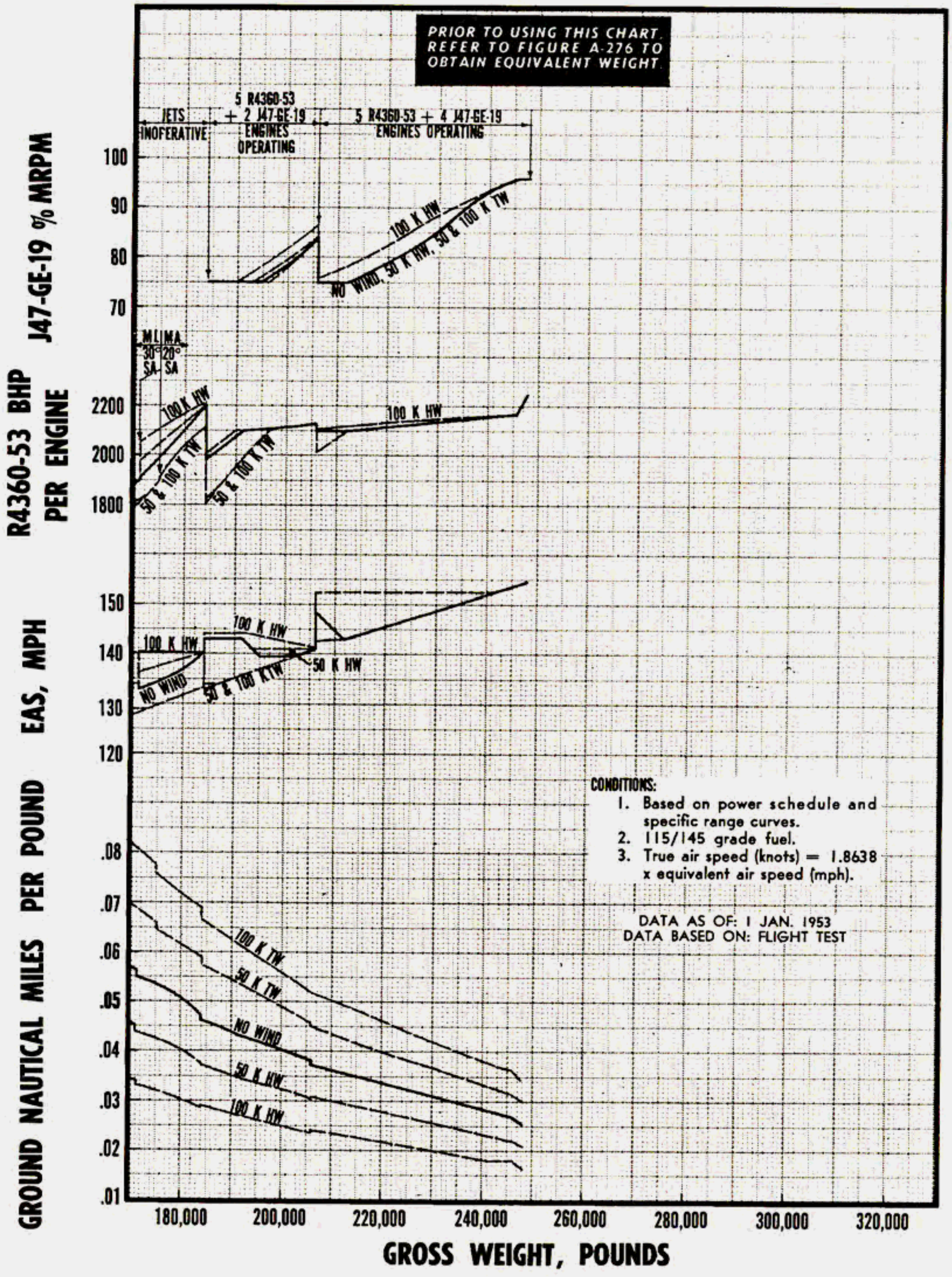

Figure A-227.

LONG RANGE OPERATING CONDITIONS AT 45,000 FEET

STANDARD ATMOSPHERE

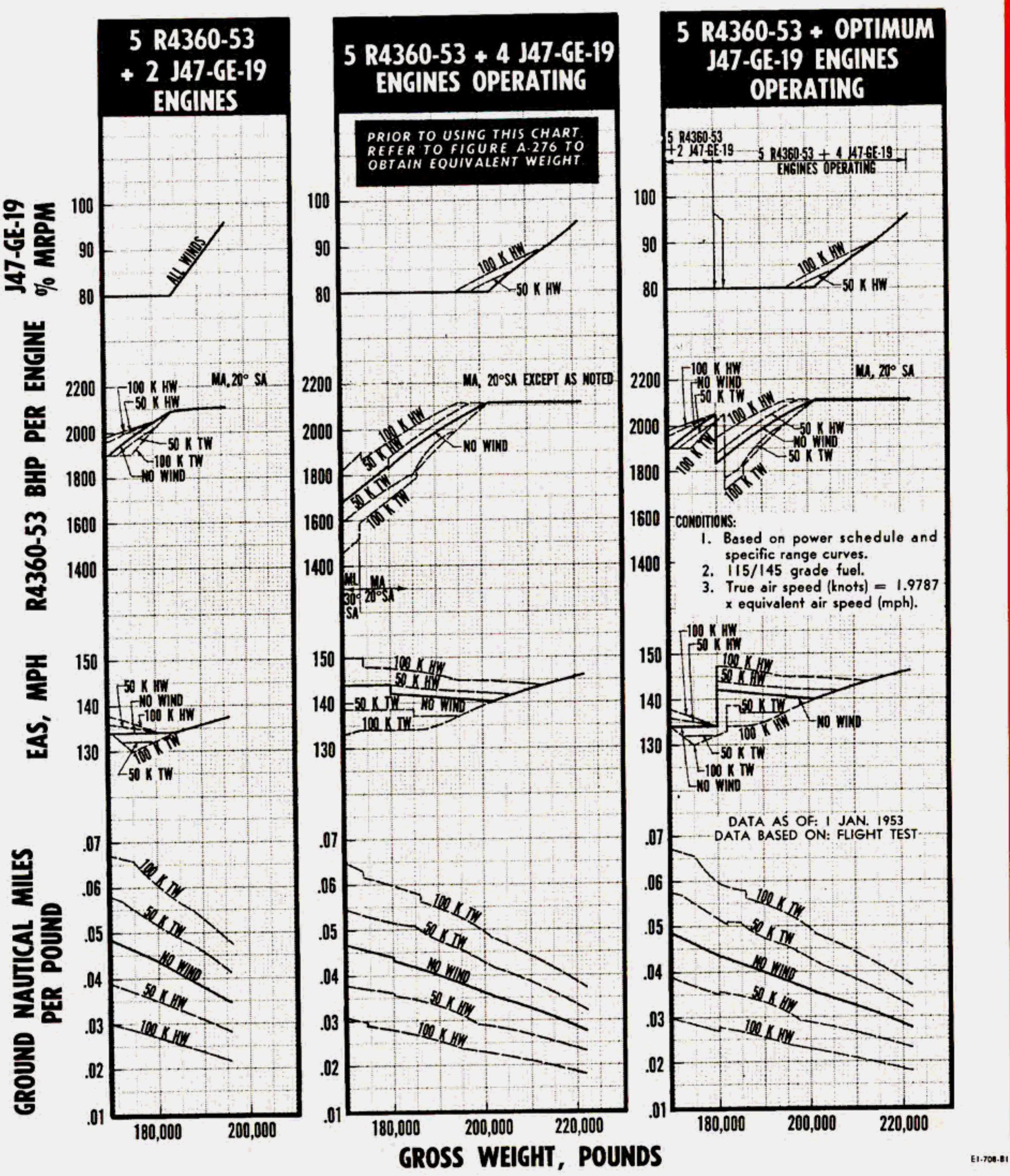

Figure A-228.

LONG RANGE DISTANCE PREDICTION

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING

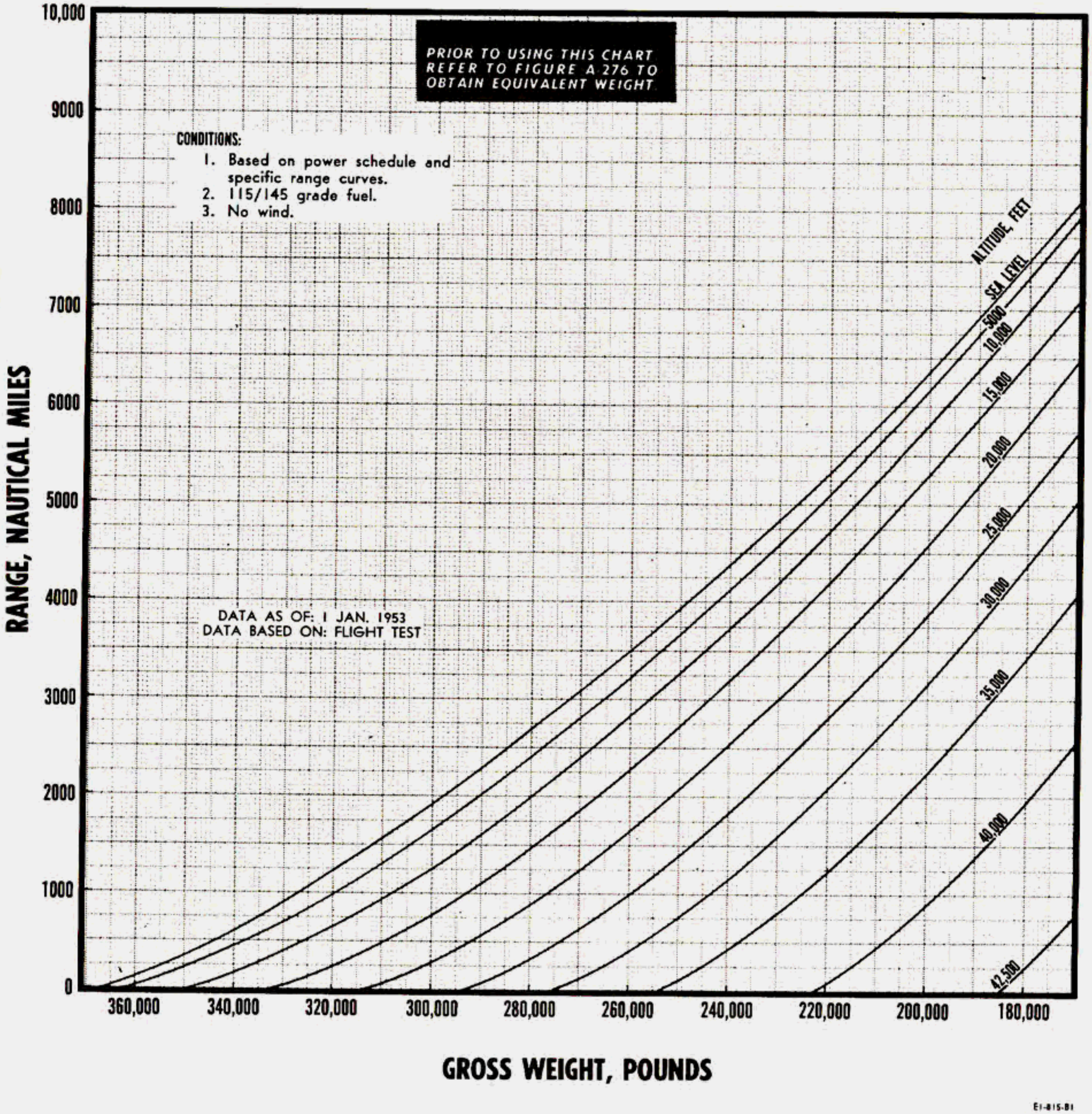

Figure A-229.

LONG RANGE TIME PREDICTION

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING

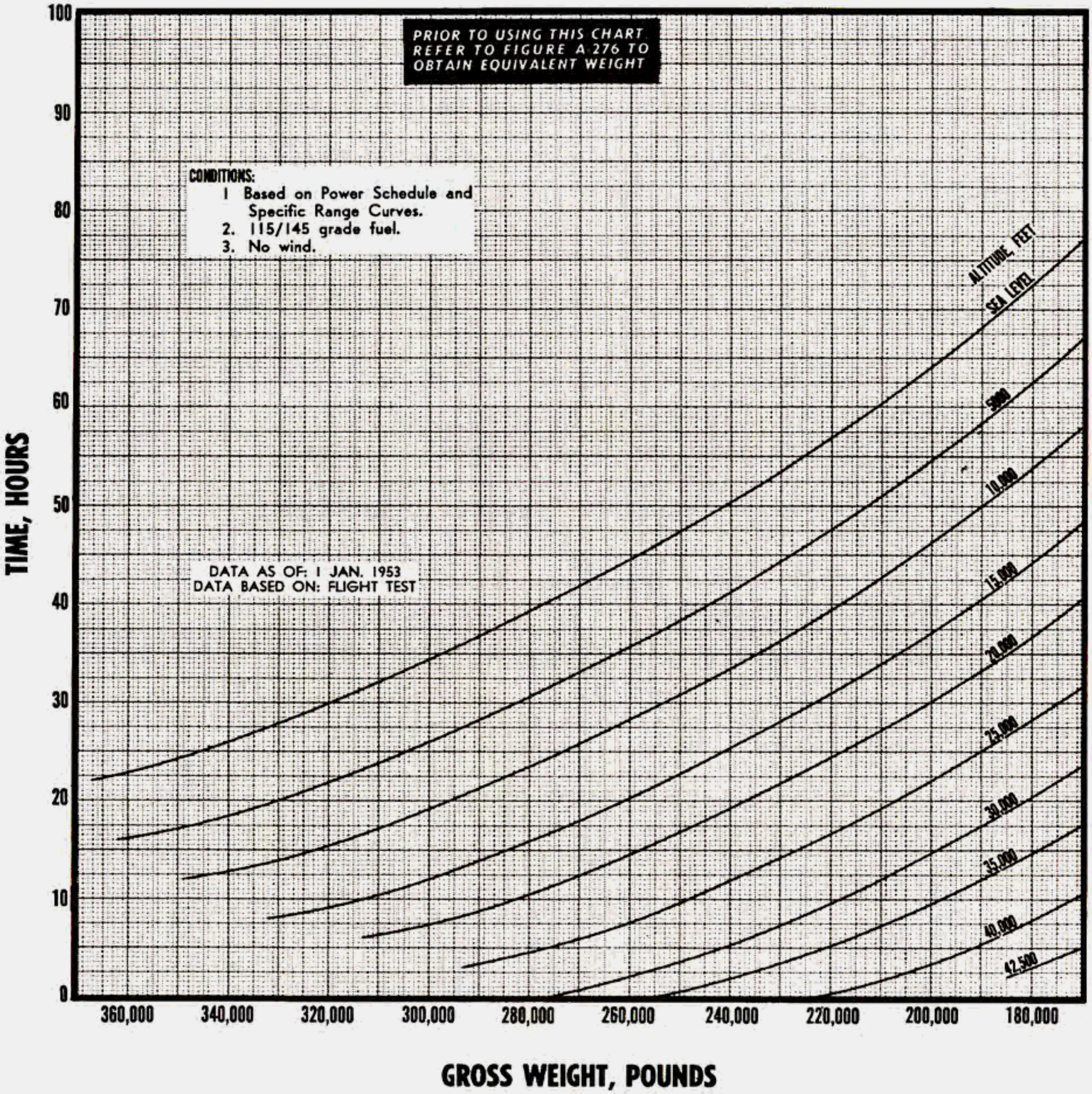

Figure A-230.

LONG RANGE DISTANCE PREDICTION

STANDARD ATMOSPHERE

5 R4360-53 + NOTED J47-GE-19 ENGINES OPERATING

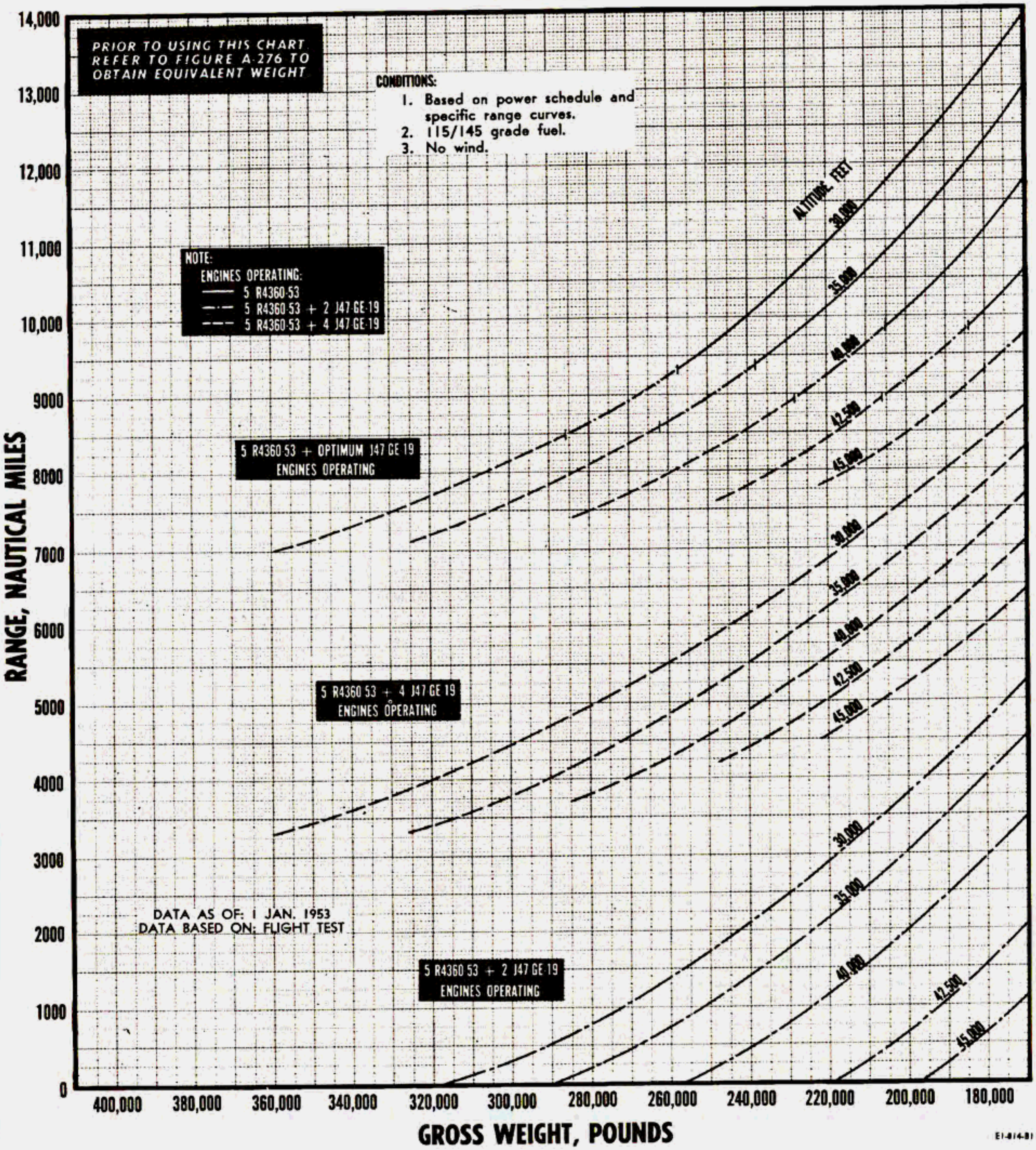

Figure A-231.

LONG RANGE TIME PREDICTION

STANDARD ATMOSPHERE

5 R4360-53 + NOTED J47-GE-19 ENGINES OPERATING

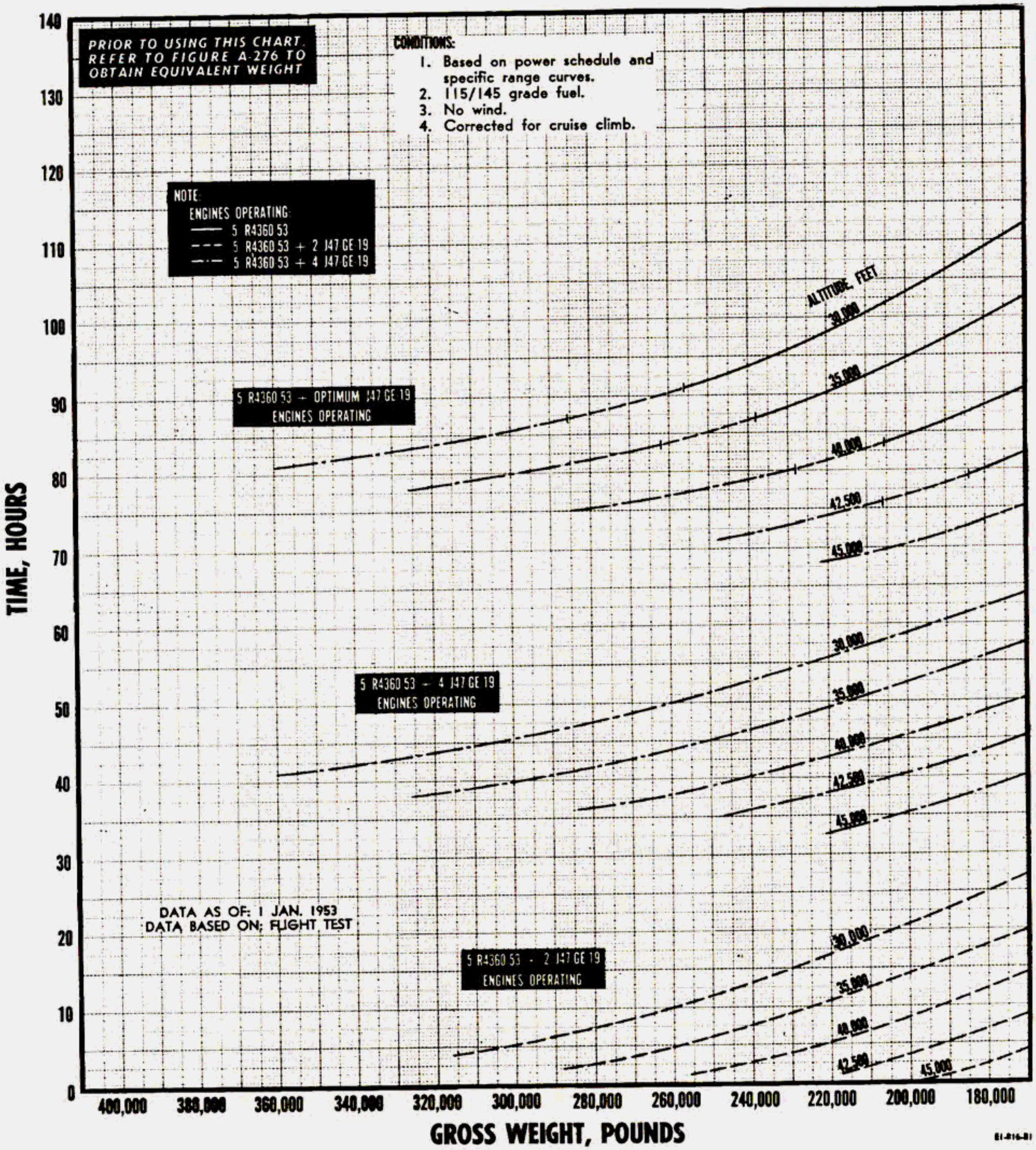

Figure A-232.

LONG RANGE OPERATING CONDITIONS AT SEA LEVEL

STANDARD ATMOSPHERE

4 R4360-53 ENGINES OPERATING

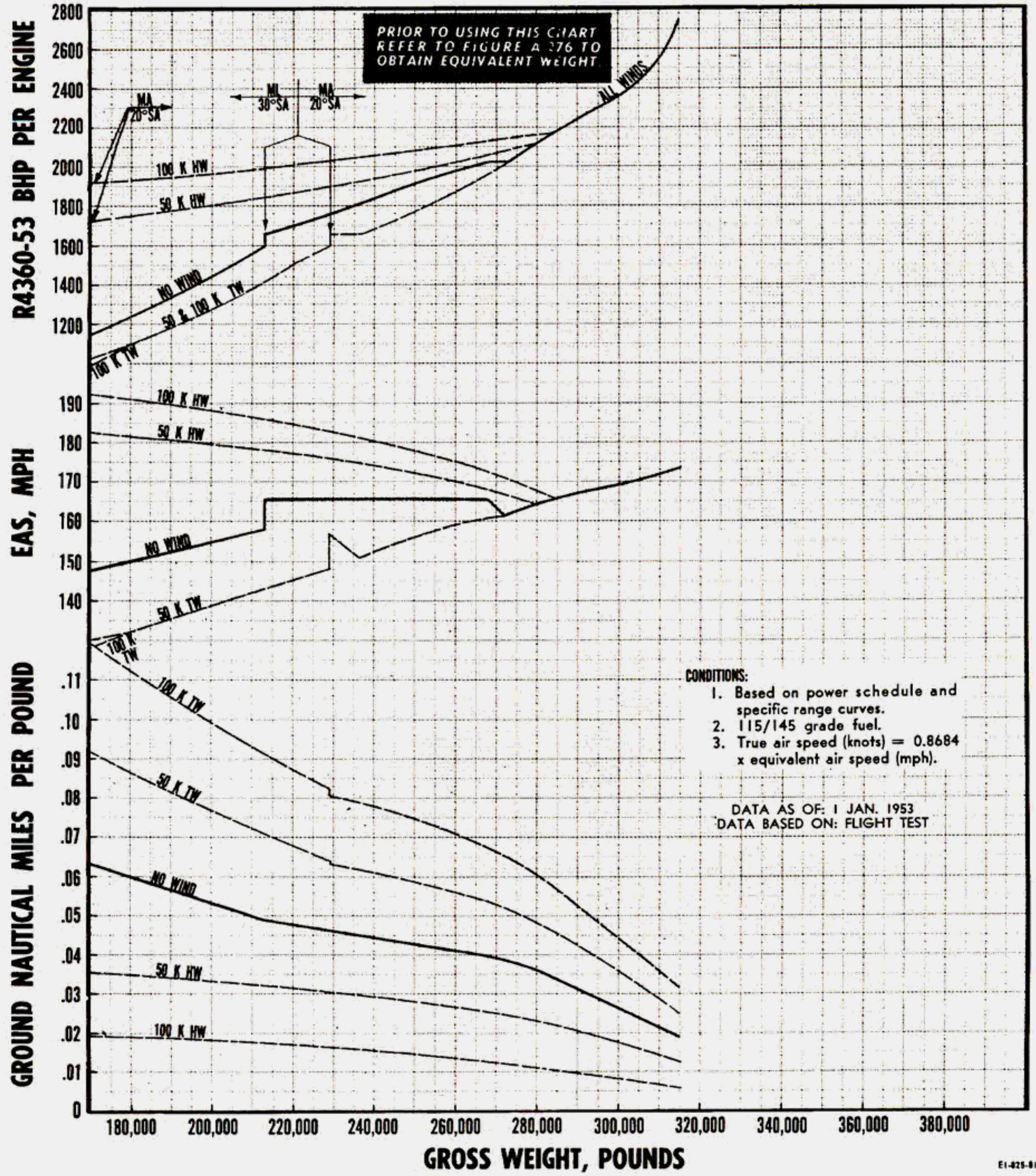

Figure A-233.

LONG RANGE OPERATING CONDITIONS AT 5000 FEET

STANDARD ATMOSPHERE

4 R4360-53 ENGINES OPERATING

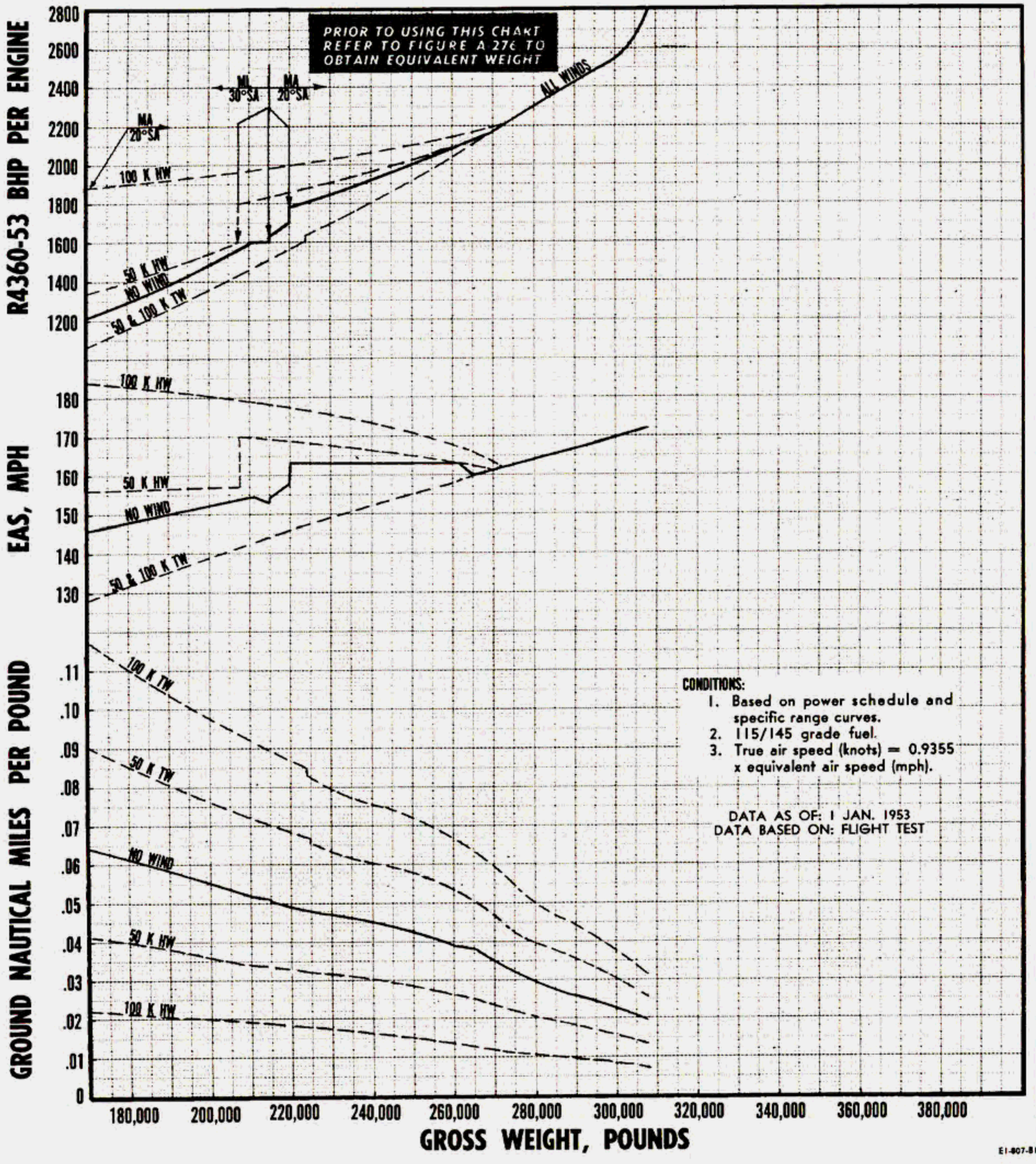

Figure A-234.

LONG RANGE OPERATING CONDITIONS AT 10,000 FEET

STANDARD ATMOSPHERE

4 R4360-53 ENGINES OPERATING

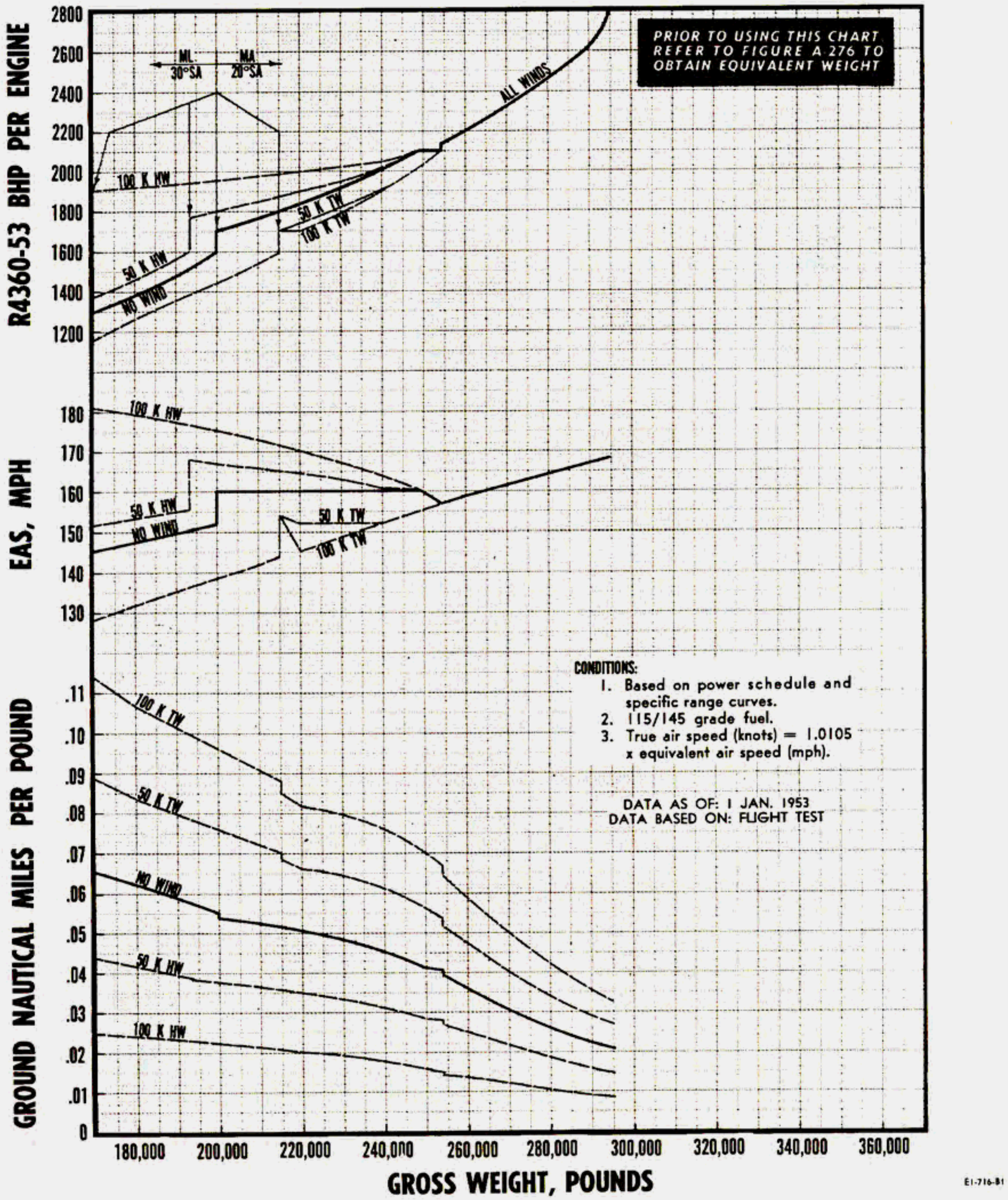

Figure A-235.

LONG RANGE OPERATING CONDITIONS AT 15,000 FEET

STANDARD ATMOSPHERE

4 R4360-53 ENGINES OPERATING

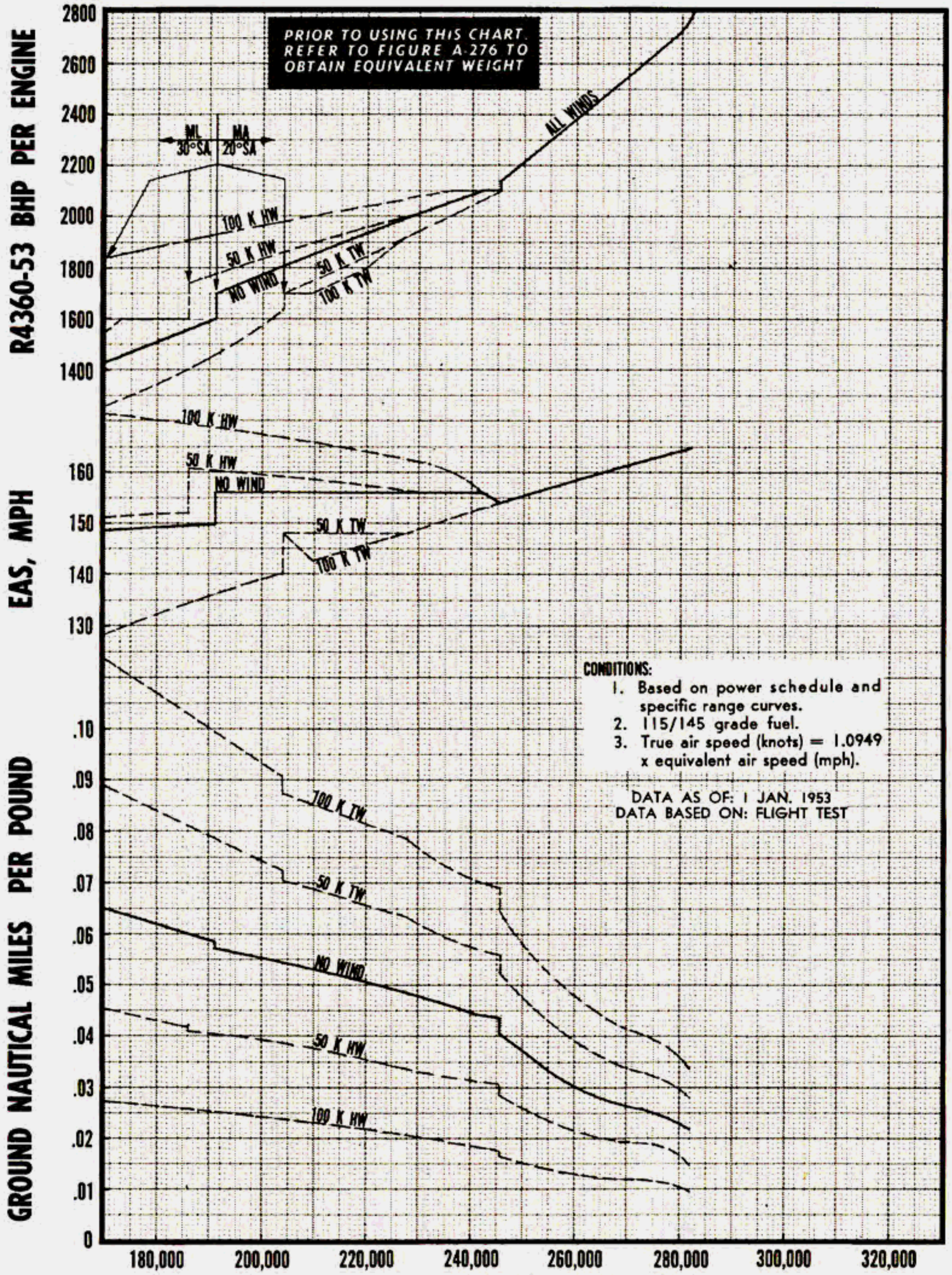

Figure A-236.

LONG RANGE OPERATING CONDITIONS AT 20,000 FEET

STANDARD ATMOSPHERE

4 R4360-53 ENGINES OPERATING

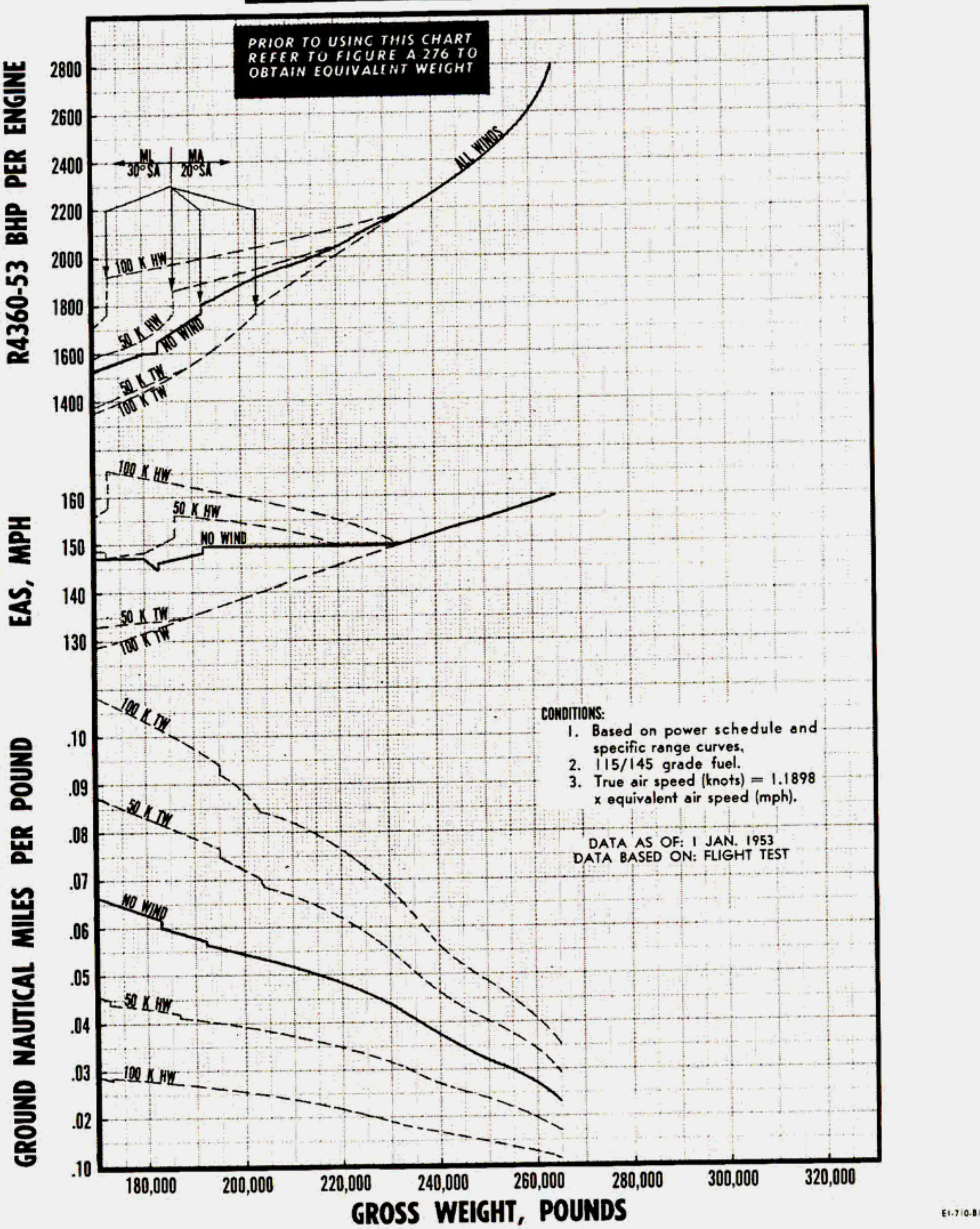

Figure A-237.

LONG RANGE OPERATING CONDITIONS AT 25,000 FEET

STANDARD ATMOSPHERE

4 R4360-53 ENGINES OPERATING

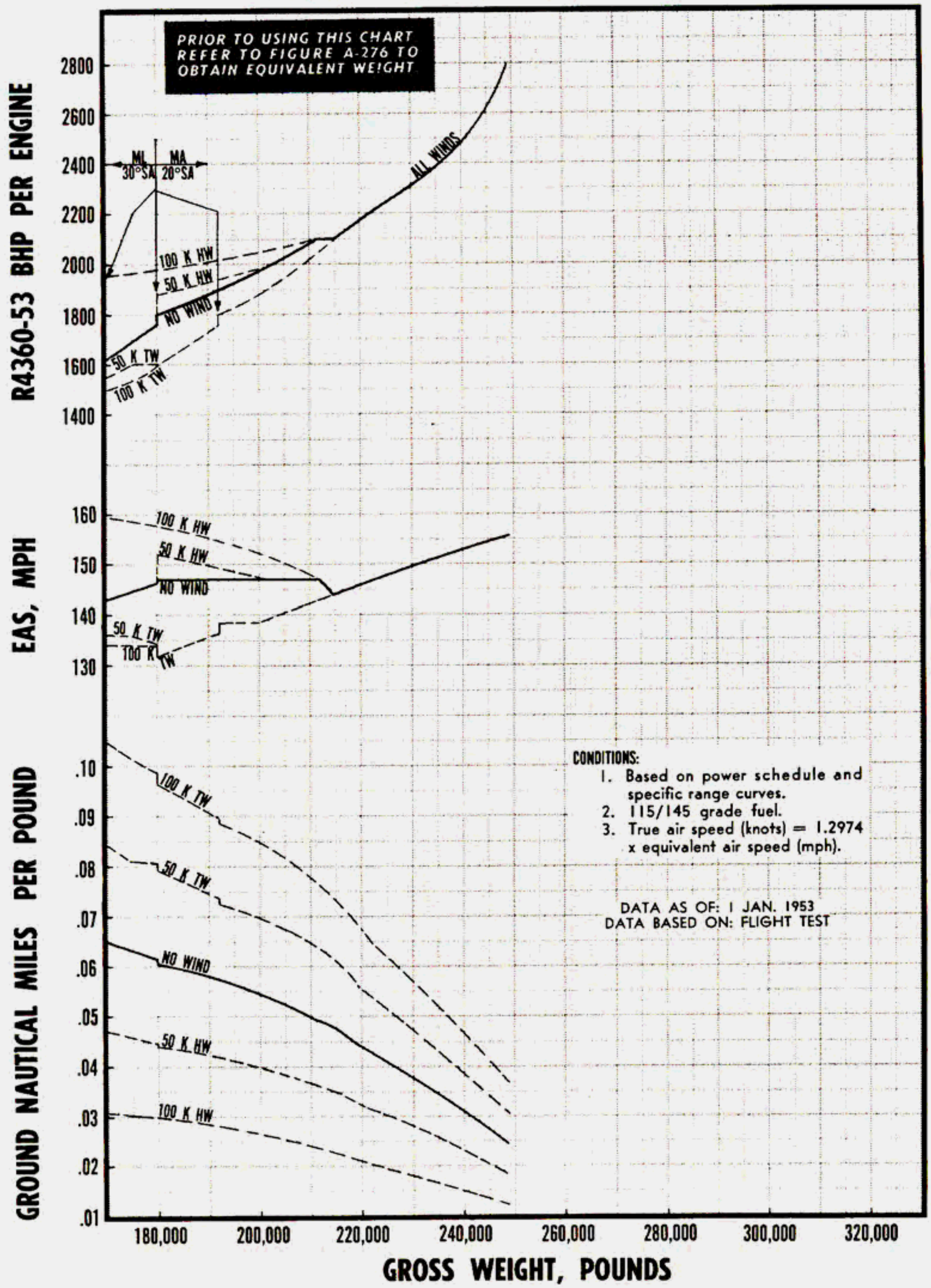

Figure A-238.

LONG RANGE OPERATING CONDITIONS AT 30,000 FEET

STANDARD ATMOSPHERE

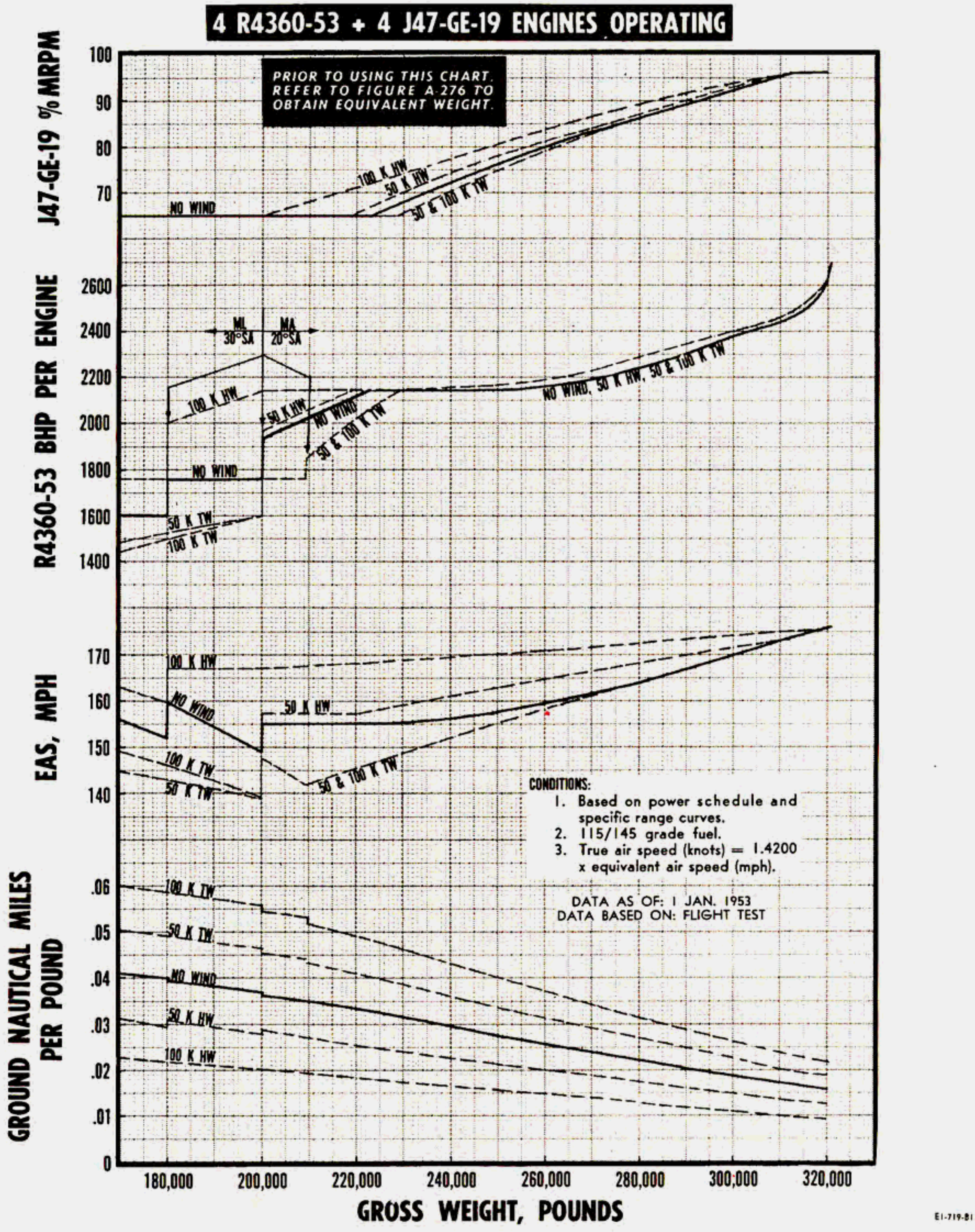

Figure A-239.

LONG RANGE OPERATING CONDITIONS AT 30,000 FEET

STANDARD ATMOSPHERE

4 R4360-53 ENGINES OPERATING

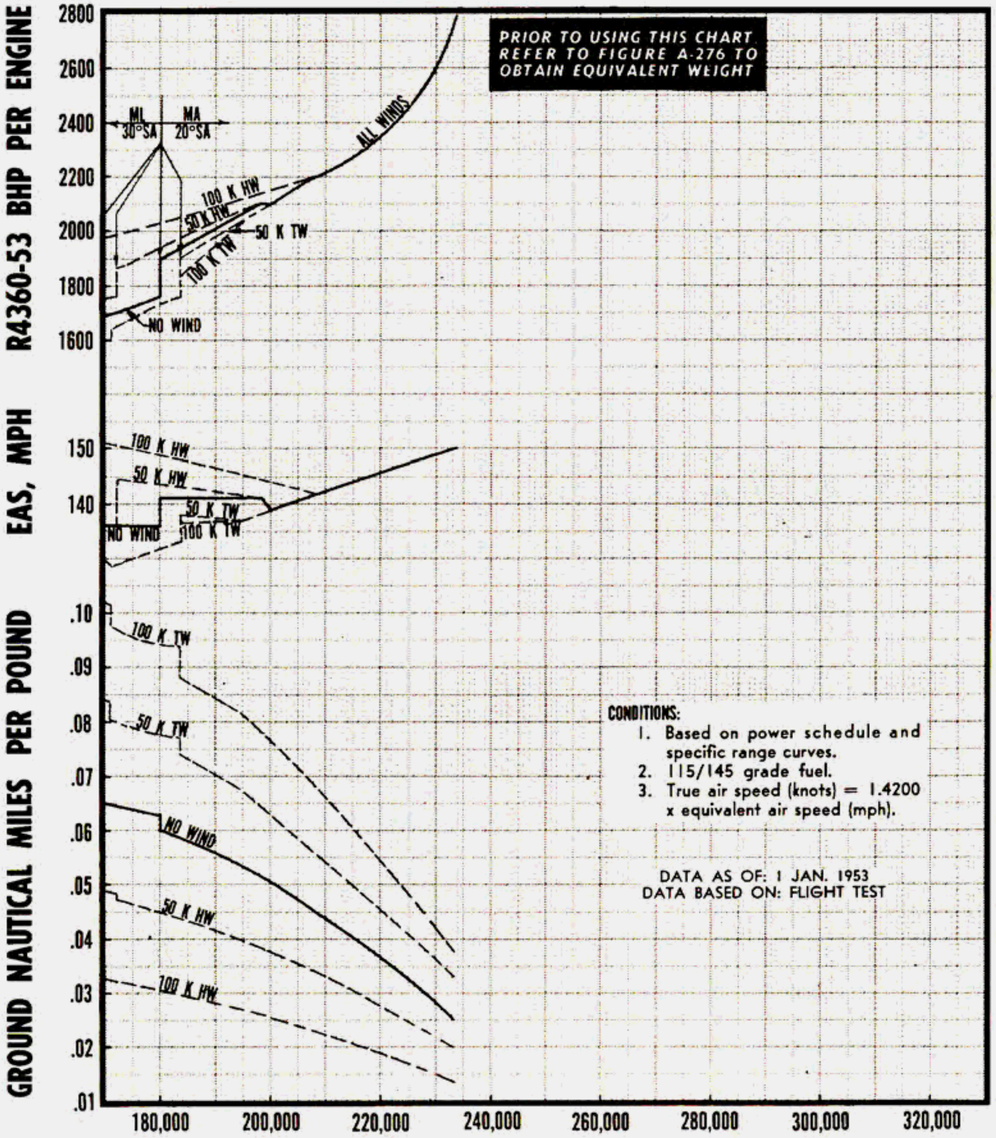

Figure A-240.

LONG RANGE OPERATING CONDITIONS AT 35,000 FEET

STANDARD ATMOSPHERE

4 R4360-53 + 4 J47-GE-19 ENGINES OPERATING

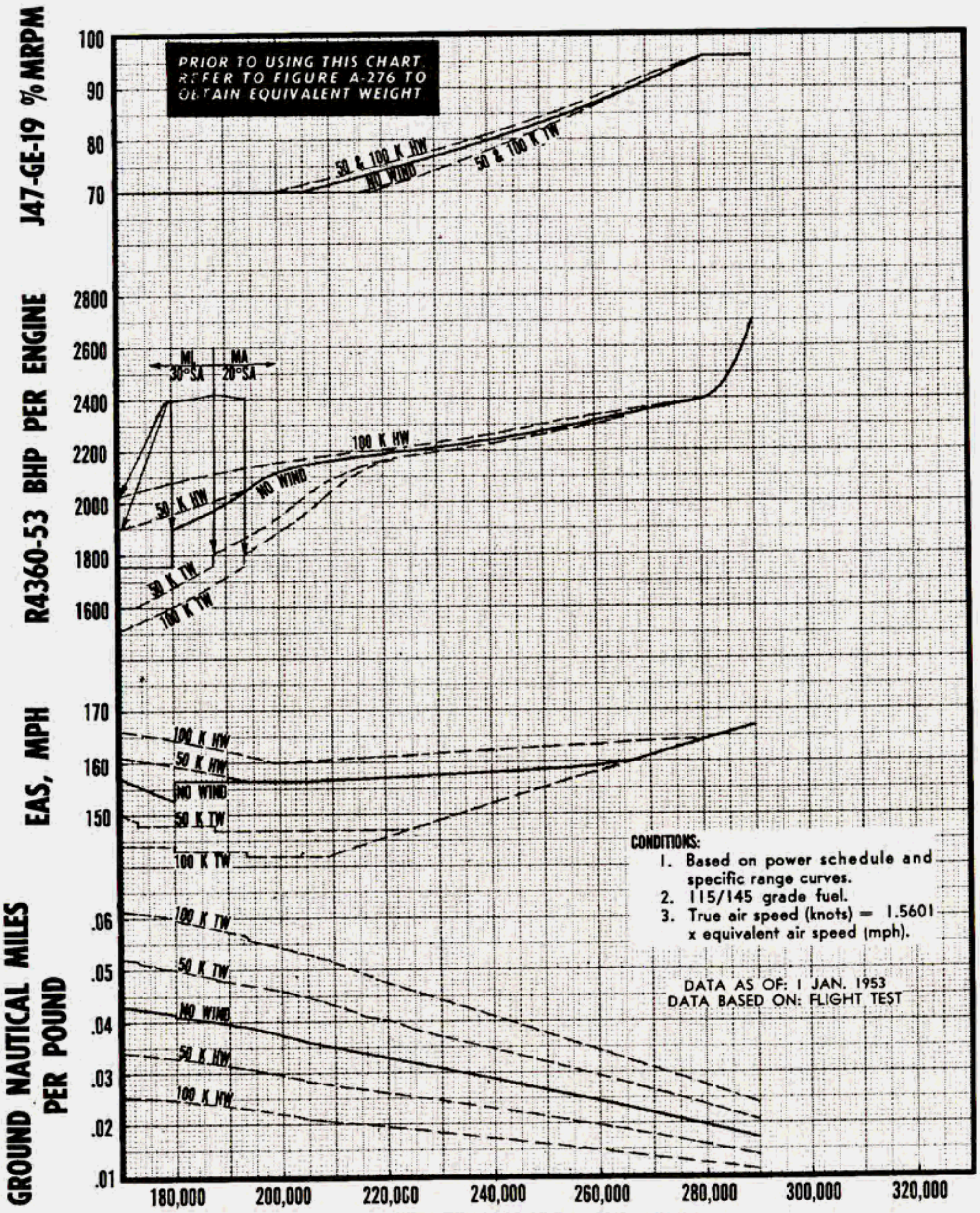

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Figure A-241.

LONG RANGE OPERATING CONDITIONS AT 35,000 FEET

STANDARD ATMOSPHERE

4 R4360-53 ENGINES OPERATING

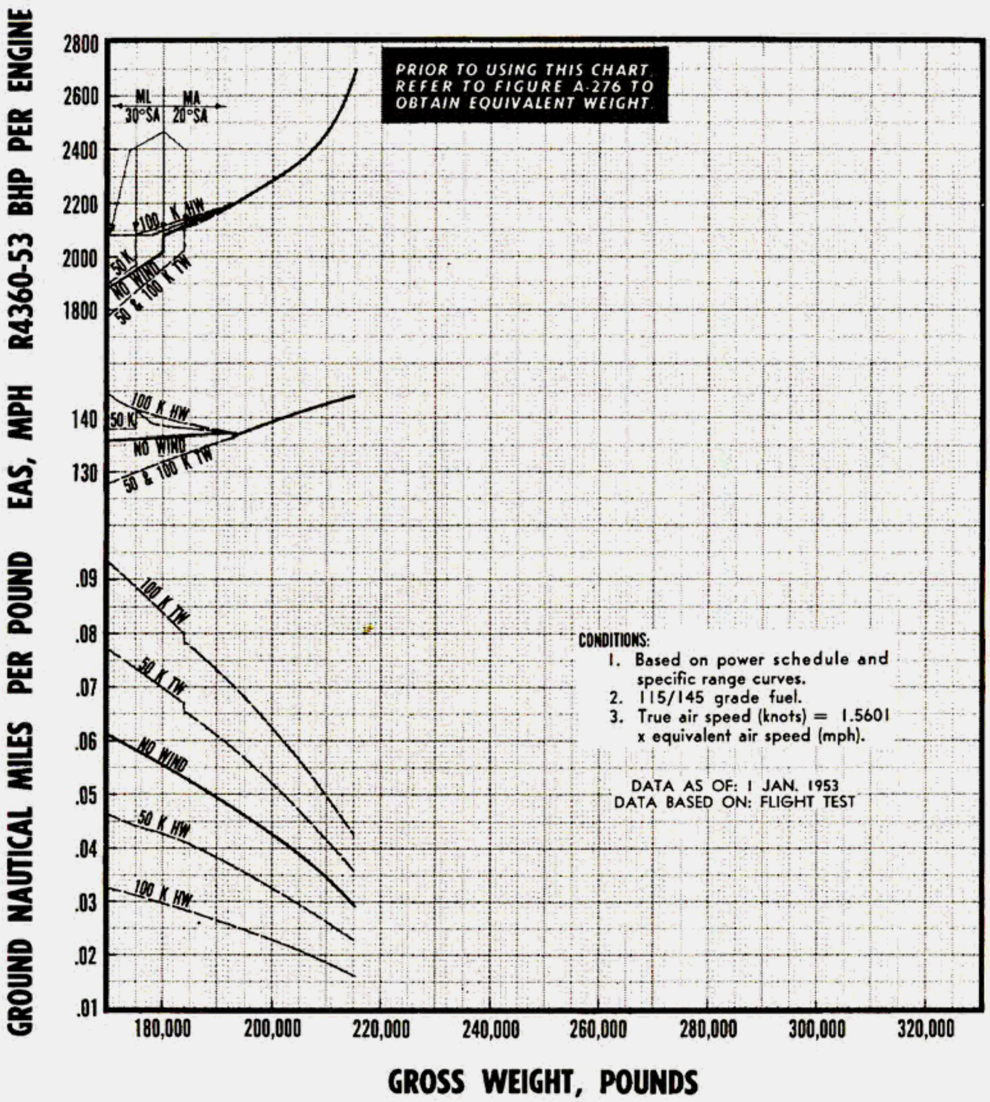

Figure A-242.

LONG RANGE OPERATING CONDITIONS AT 40,000 FEET

STANDARD ATMOSPHERE

4 R4360-53 + 4 J47-GE-19 ENGINES OPERATING

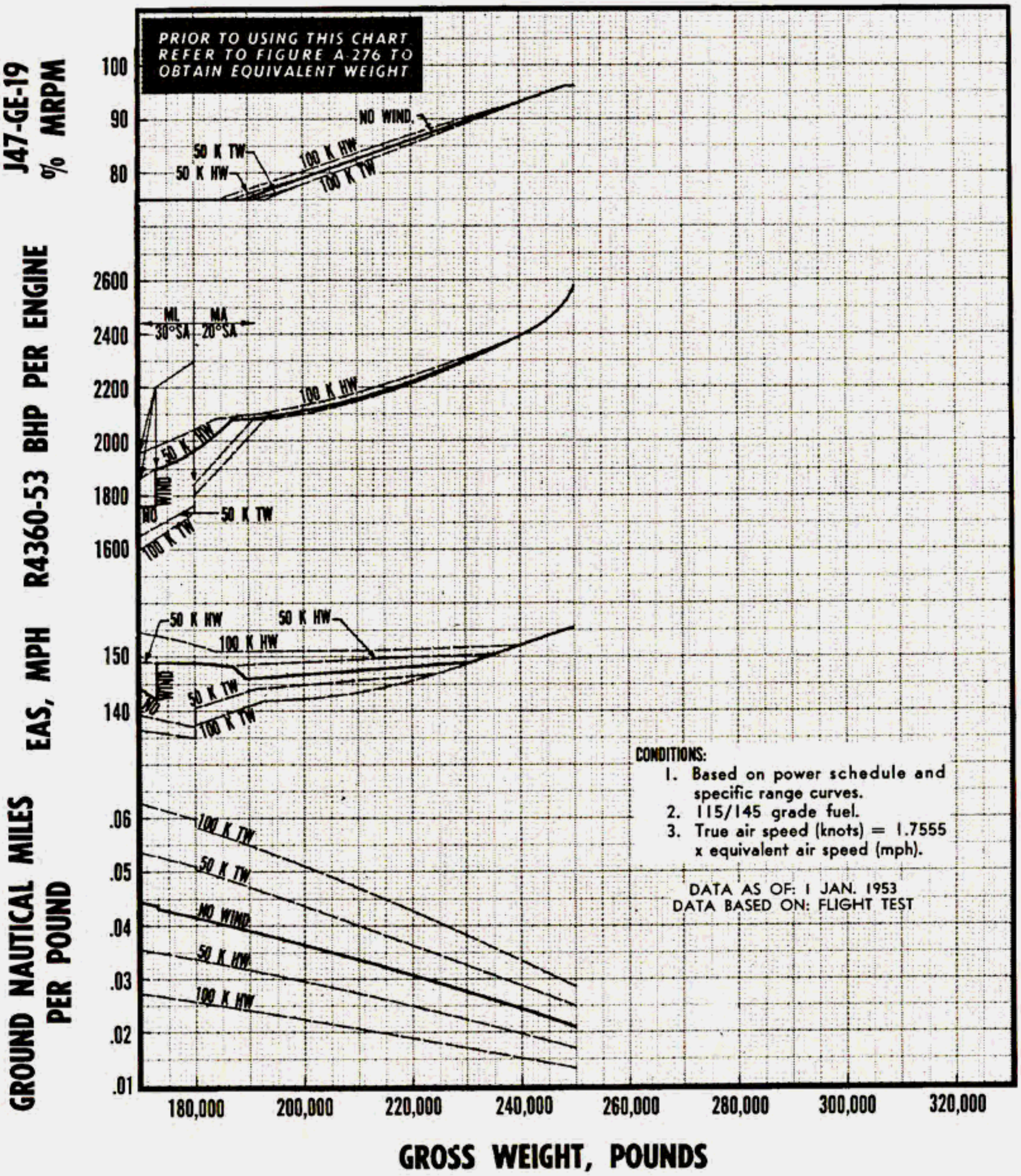

Figure A-243.

LONG RANGE OPERATING CONDITIONS AT 42,500 FEET

STANDARD ATMOSPHERE

4 R4360-53 + 4 J47-GE-19 ENGINES OPERATING

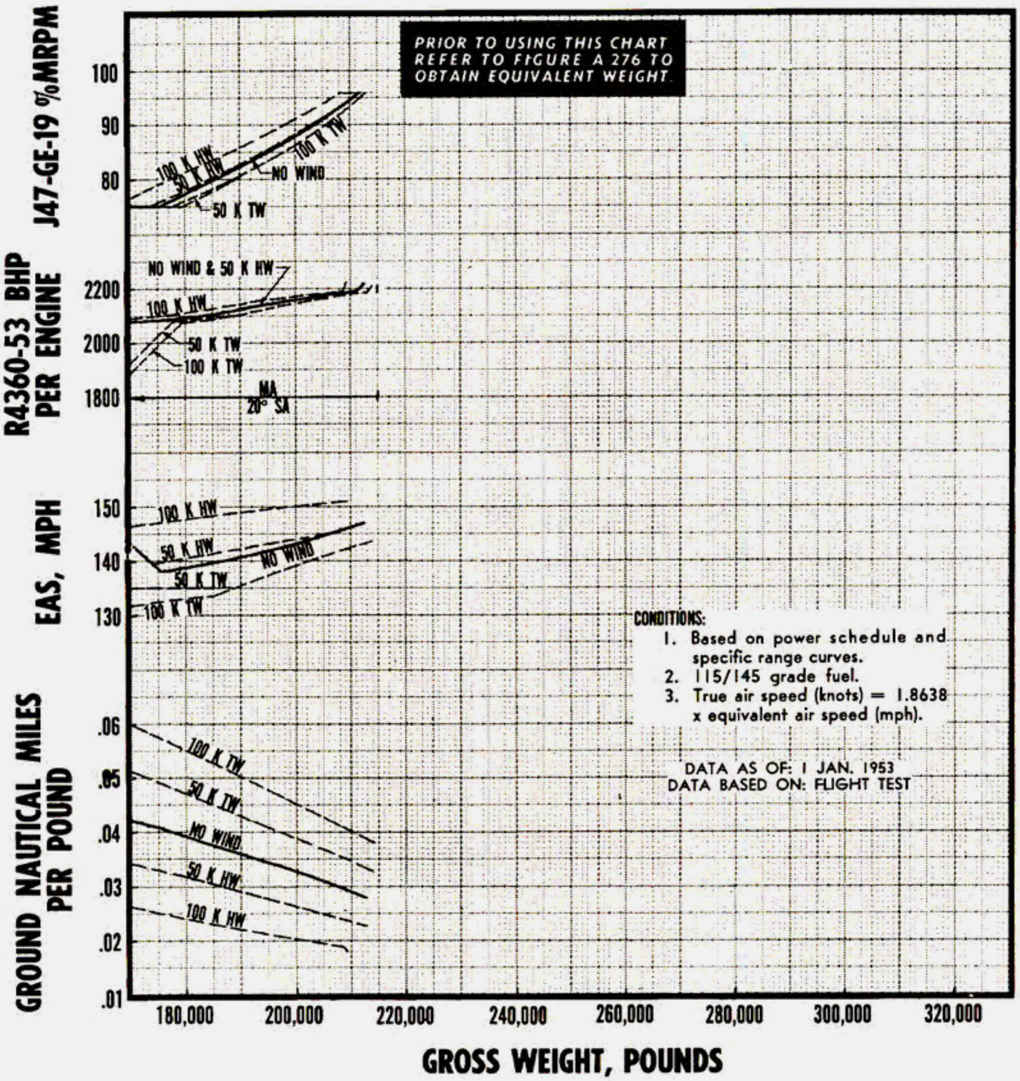

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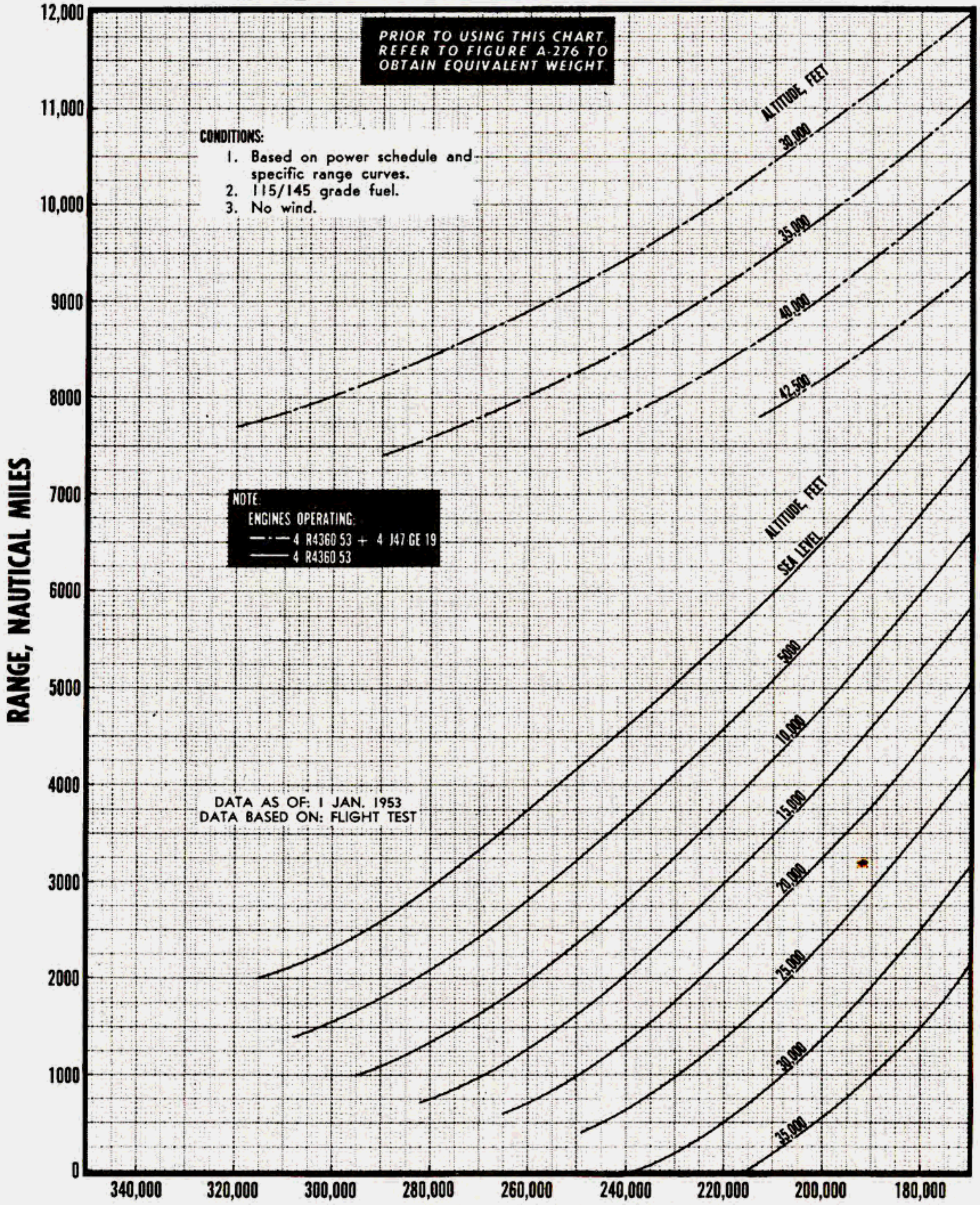
Figure A-244.

LONG RANGE DISTANCE PREDICTION

STANDARD ATMOSPHERE

4 R4360-53 + NOTED J47-GE-19 ENGINES OPERATING



E1-821-81

LONG RANGE TIME PREDICTION
STANDARD ATMOSPHERE

4 R4360-53 + NOTED J47-GE-19 ENGINES OPERATING

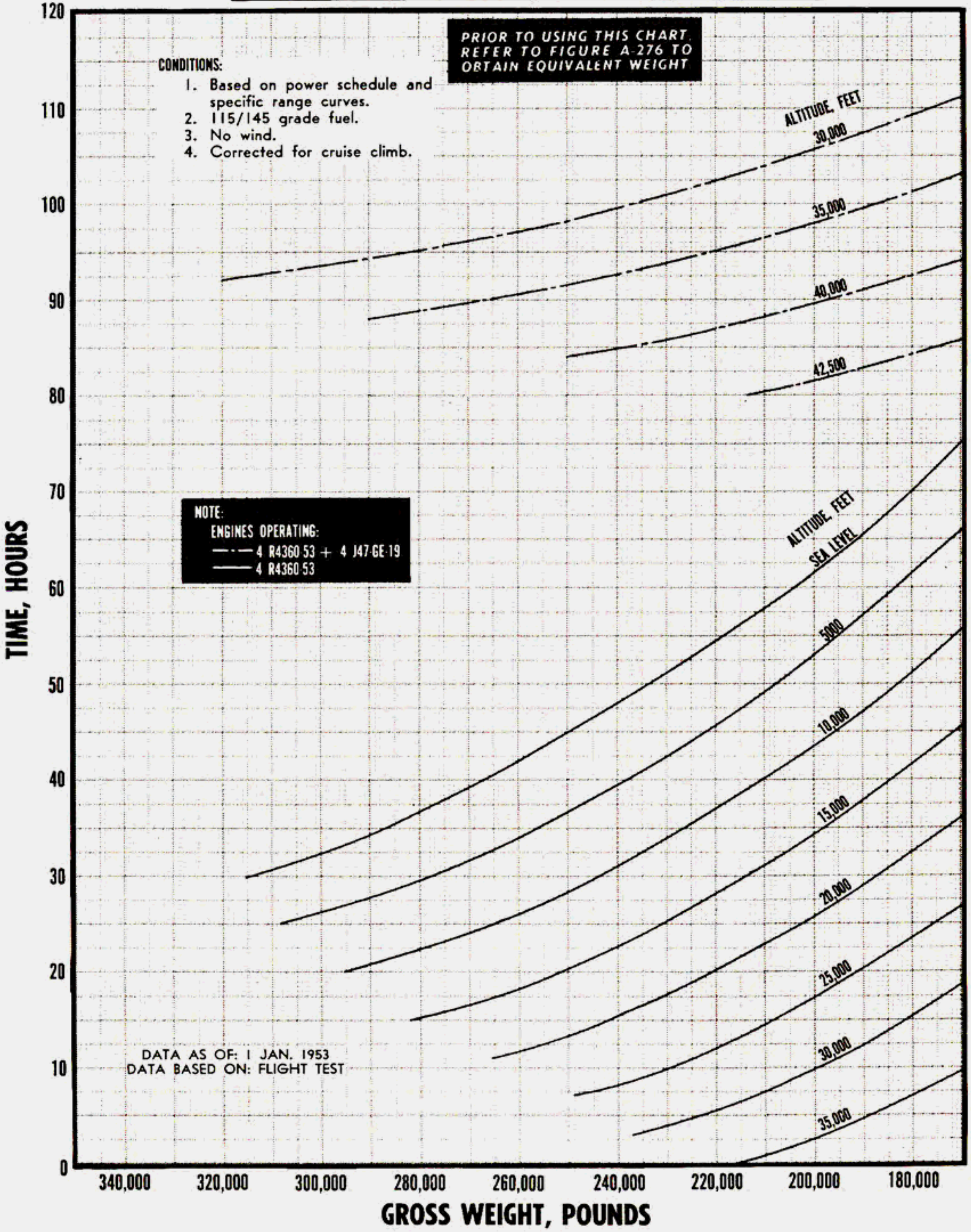


Figure A-246.

LONG RANGE OPERATING CONDITIONS AT 10,000 FEET

STANDARD ATMOSPHERE

3 R4360-53 + 2 J47-GE-19 ENGINES OPERATING

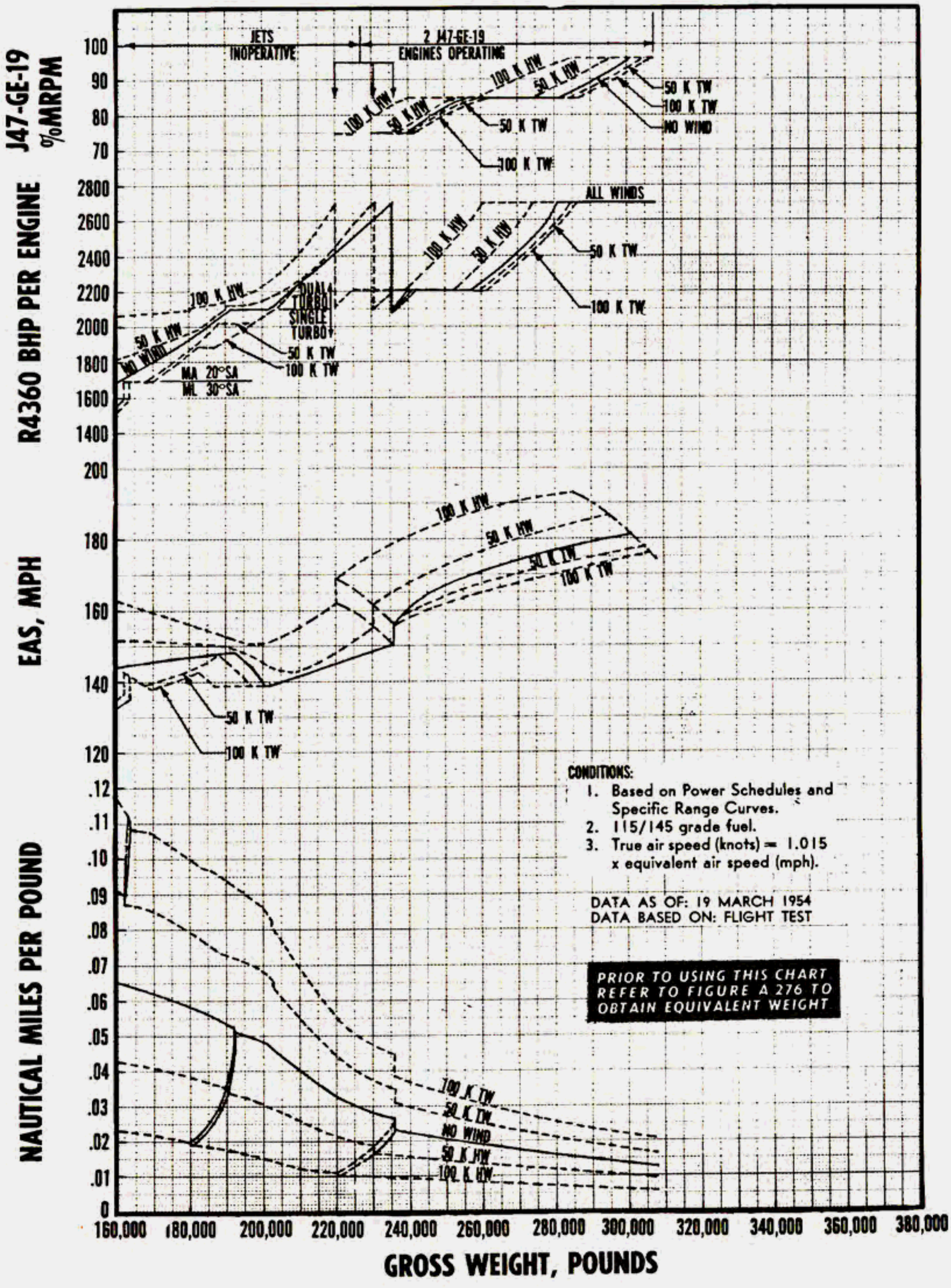


Figure A-247.

SPECIFIC RANGE SUMMARY.

The specific range summary charts are presented to show the variation of nautical miles per pound with gross weight and altitude for long range operation.

Gross weights are given in 10,000-pound increments. The charts are intended primarily for use in evaluation of the engineers' logs but are also useful in flight planning. The charts are presented for 6 + 0, 6 + 2, and 6 + 4 engine operation only. The altitudes on these charts are presented as $1/\sqrt{\sigma}$, this being a more useful term than density altitude; however, a conversion scale for reading density altitude from $1/\sqrt{\sigma}$ is provided on each chart.

EXAMPLE.

Find the nautical miles per pound for a gross weight of 240,000 pounds at a $1/\sqrt{\sigma}$ of 1.85 (density altitude of 36,000 feet) for six engine operation.

Enter figure A-248 at $1/\sqrt{\sigma}$ of 1.85 (A) and move vertically to the 240,000 pound gross weight line (B). On the scale at the left, read a nautical miles per pound of .0468 (C).

SPECIFIC RANGE SUMMARY

6 R4360-53 ENGINES OPERATING

NOTES: 1. Based on Long Range Operating Conditions.
2. Standard atmosphere.

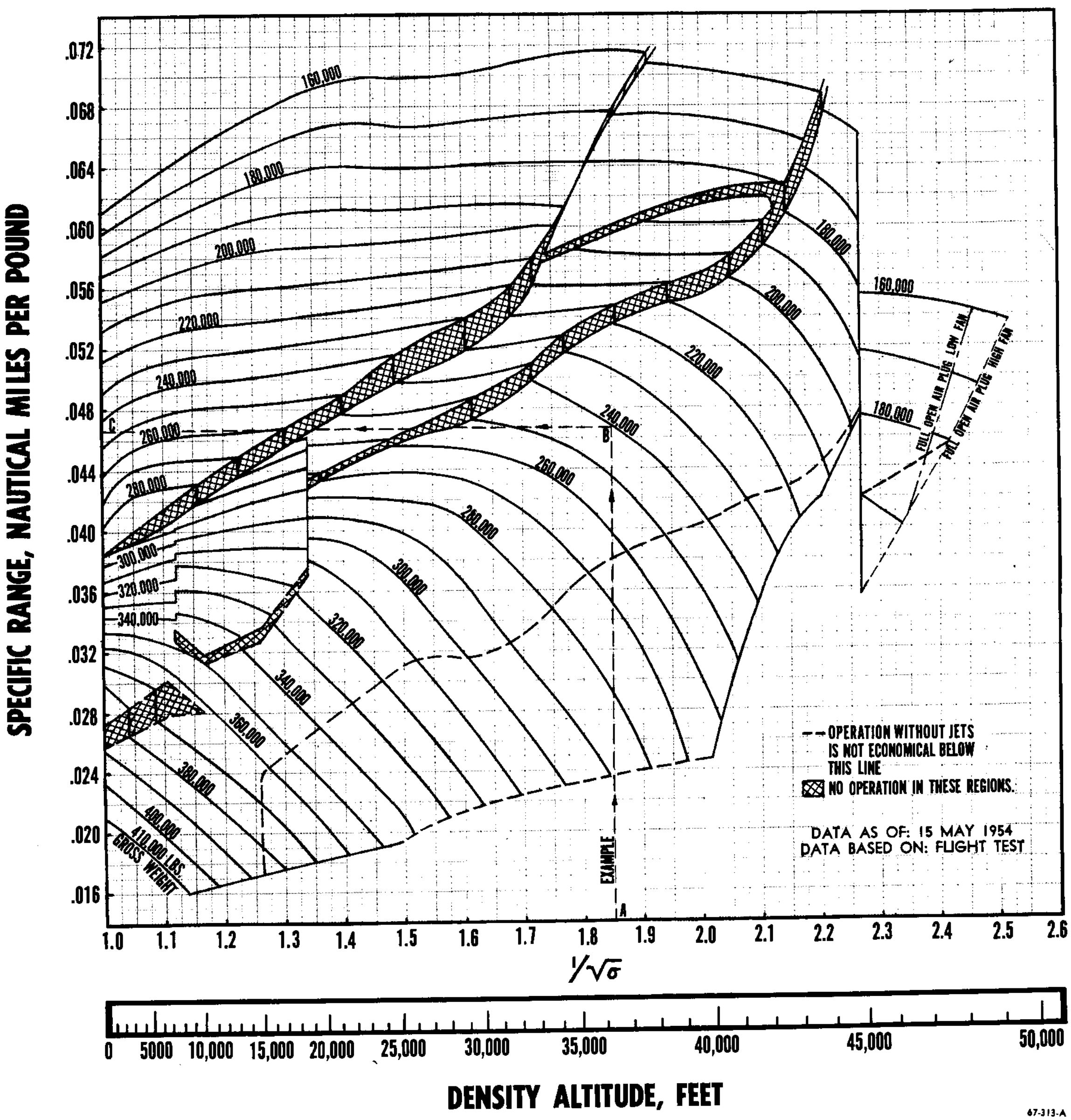
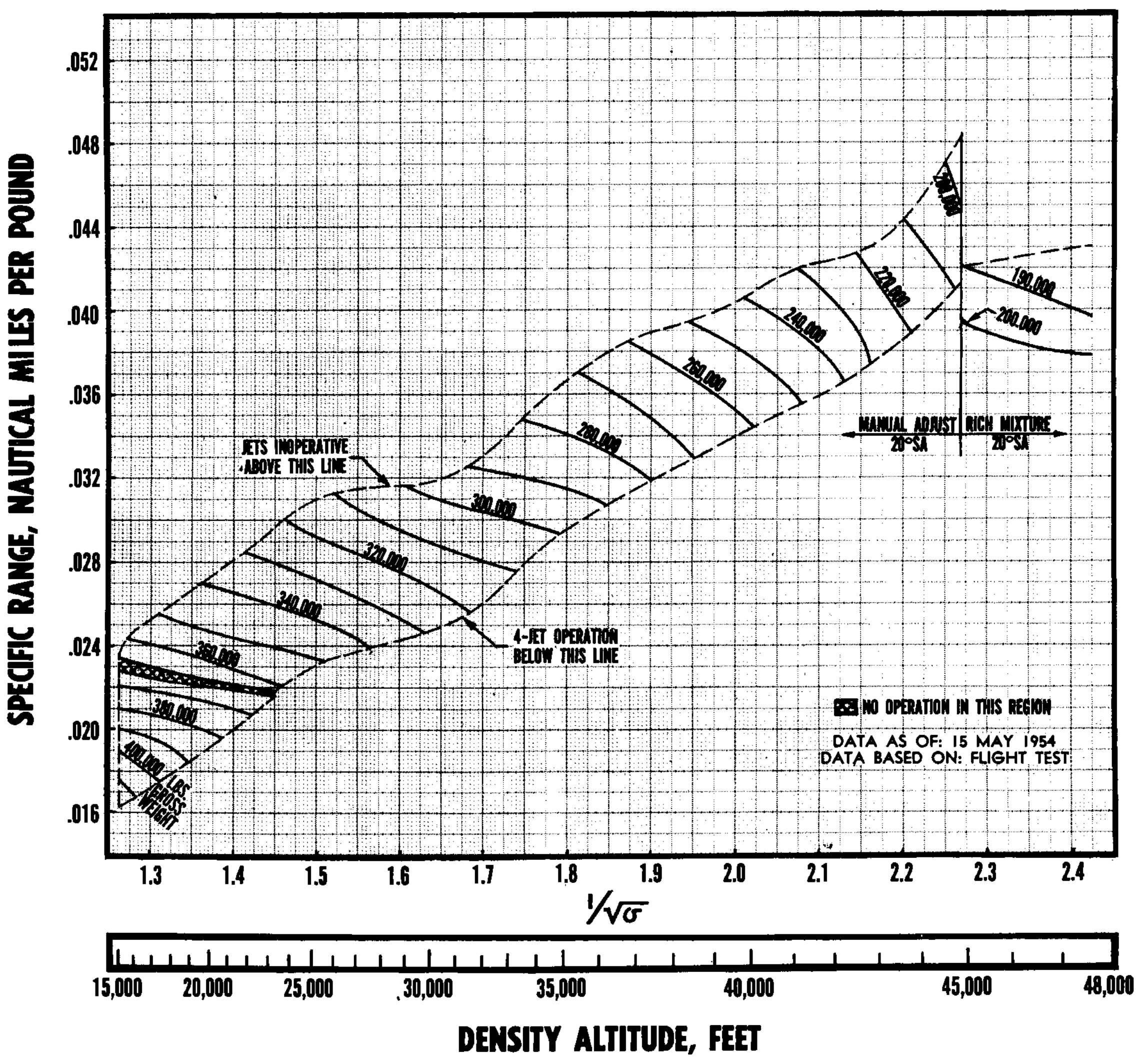


Figure A-248.

SPECIFIC RANGE SUMMARY

6 R4360-53 + 2 J47-GE-19 ENGINES OPERATING

NOTES: 1. Based on Long Range Operating Conditions.
2. Standard atmosphere.



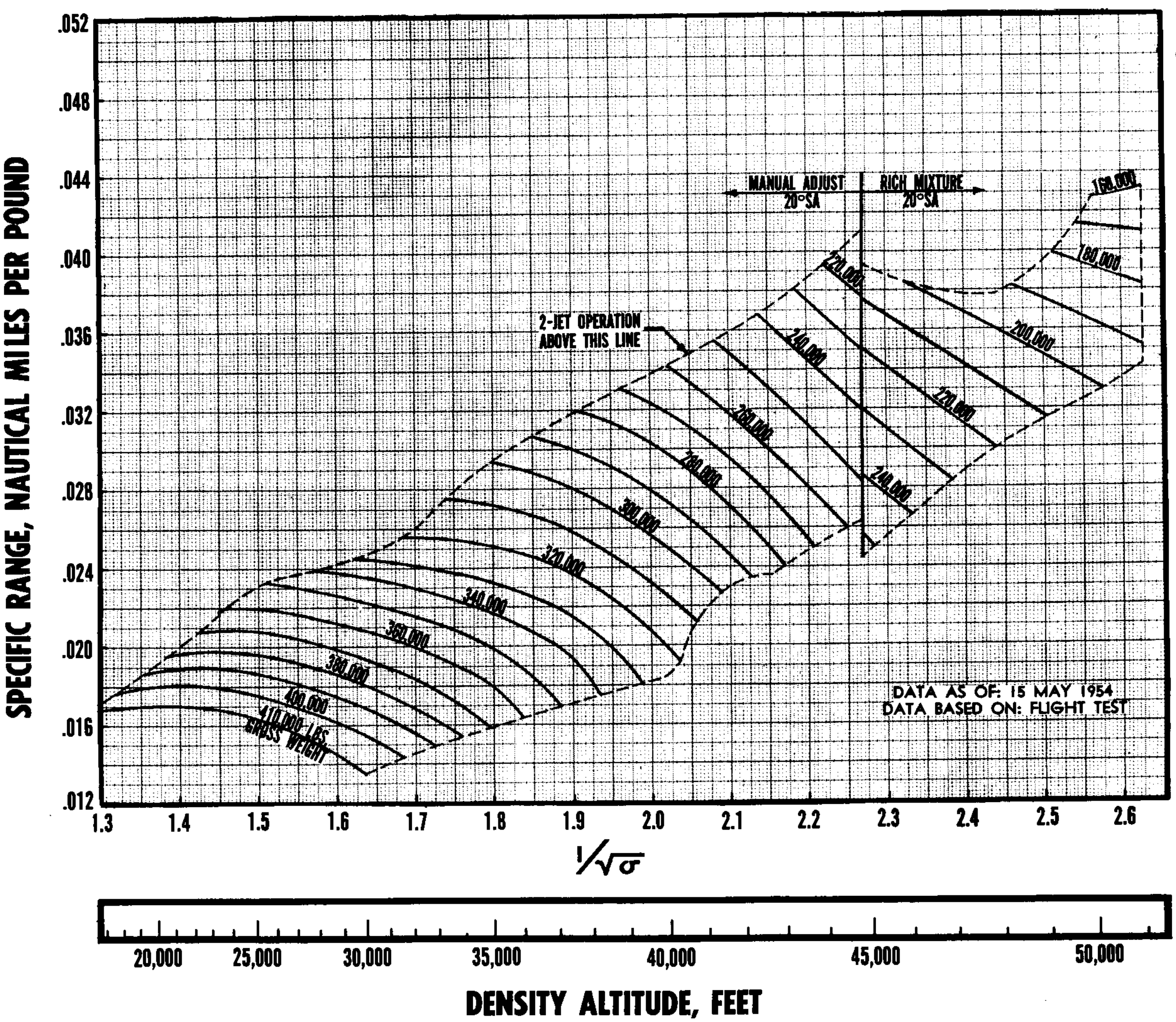
67-324-A

Figure A-249.

SPECIFIC RANGE SUMMARY

6 R4360-53 + 4 J47-GE-19 ENGINES OPERATING

CONDITIONS:
1. Based on Power Schedules and Specific Range Curves.
2. 115/145 grade fuel.
3. Standard atmosphere.
4. Clean airplane configuration.



67-312-A

Figure A-250.

LONG RANGE OPERATION SUMMARY.

These charts (figures A-251 through A-253) have been prepared to show the variation of reciprocating engine brake horsepower, jet engine per cent military rpm, and EAS with altitude for long range operation. The charts are presented for 6 + 0, 6 + 2, and 6 + 4 engine operation only.

EXAMPLE.

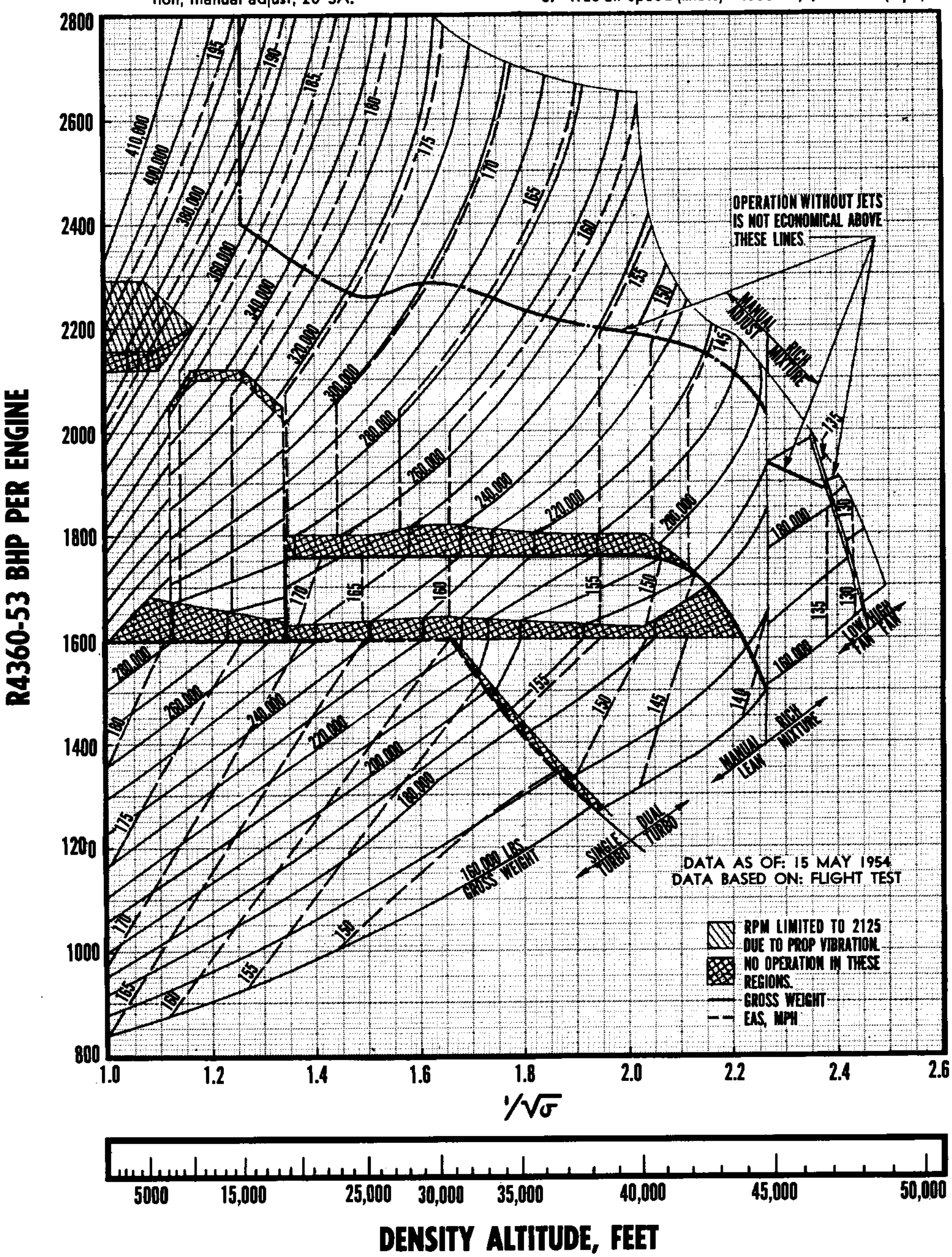
Determine the power setting and EAS for a gross weight of 310,000 pounds at a $1/\sqrt{\sigma}$ of 1.85 (density altitude = 36,000 feet).

On examination of figures A-251, A-252 and A-253 it is noted that figure A-253 must be used. Entering figure A-253 at $1/\sqrt{\sigma}$ of 1.85 (A), move vertically to the 310,000 pound gross weight line (B) (jet data portion of the chart). Project horizontally from (B) and read a per cent military rpm at 82 per cent (C). Continue the vertically projection from $1/\sqrt{\sigma} = 1.85$ to the upper chart (reciprocating engine data) and intersect the 310,000 pound line (D). Project horizontally to the left and read 2190 bhp (E). To obtain the air speed, interpolate between the dashed lines at point (D) and obtain 173 mph.

LONG RANGE OPERATION SUMMARY

6 R4360-53 ENGINES OPERATING

1. Based on Power Schedule and Specific Range Curves.
2. Manual lean, 30°SA, below heavy lines. Rich mixture, 20°SA, above 44,800 feet. All other operation, manual adjust, 20°SA.
3. 115/145 grade fuel.
4. Single turbo operation below heavy dashed line. All other operation in dual turbo.
5. Low fan operation except where noted.
6. True air speed (knots) = .868 x $1/\sqrt{\sigma}$ x EAS (mph).



67-314-A

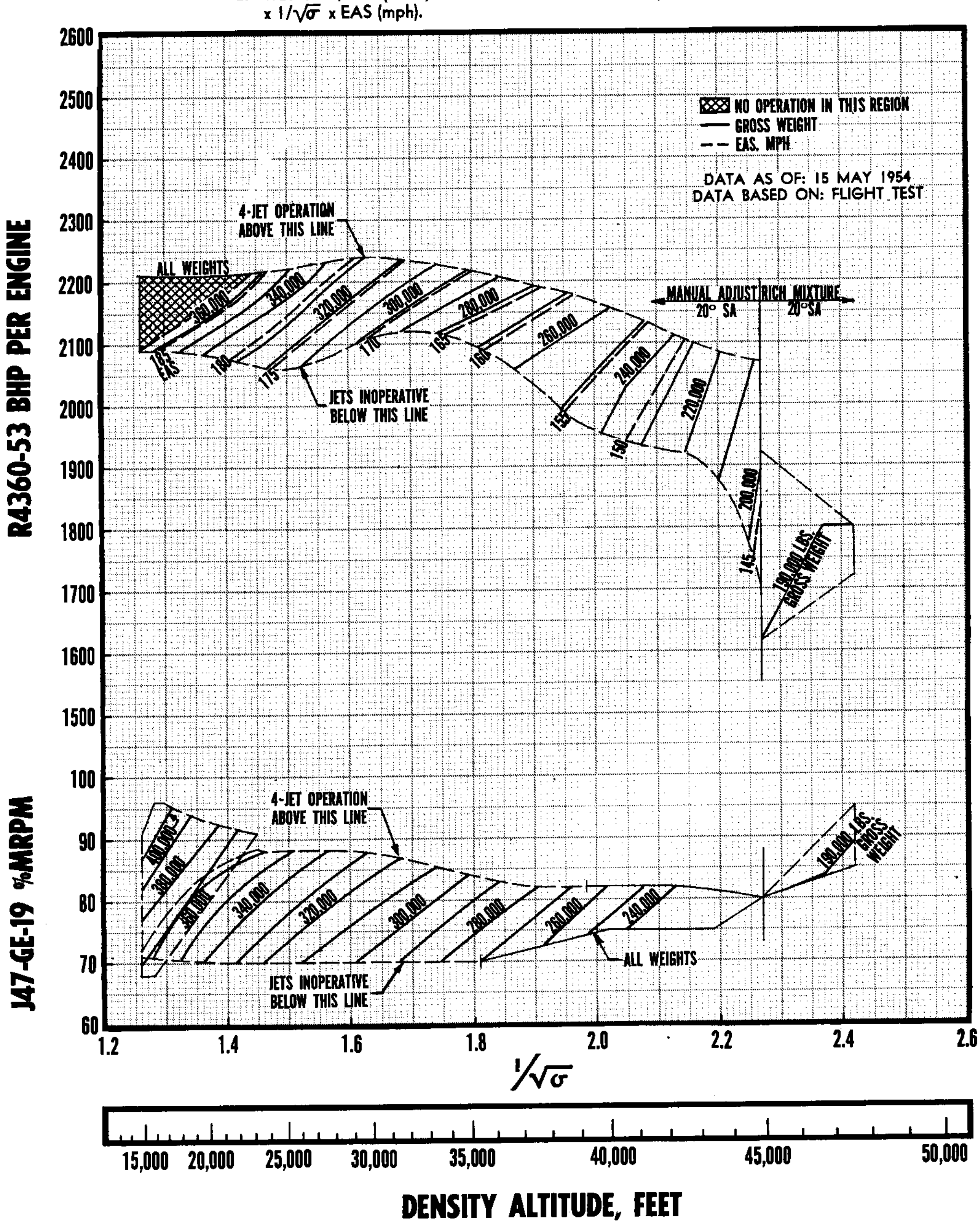
Figure A-251.

LONG RANGE OPERATION SUMMARY

STANDARD ATMOSPHERE

6 R4360-53 + 2 J47-GE-19 ENGINES OPERATING

CONDITIONS:
1. Based on Power Schedule and Specific Range Curves.
2. True air speed (knots) = .868 x $1/\sqrt{\sigma}$ x EAS (mph).
3. 115/145 grade fuel.
4. Clean airplane configuration.
5. All dual turbo operation.



67-307-A

Figure A-252.

LONG RANGE OPERATION SUMMARY

STANDARD ATMOSPHERE

6 R4360-53 + 4 J47-GE-19 ENGINES OPERATING

CONDITIONS:
1. Based on Power Schedule and Specific Range Curves.
2. 115/145 grade fuel.
3. Clean airplane configuration.
4. True air speed (knots) = .868 x I $\sqrt{\sigma}$ x EAS (mph).
5. All dual turbo operation.

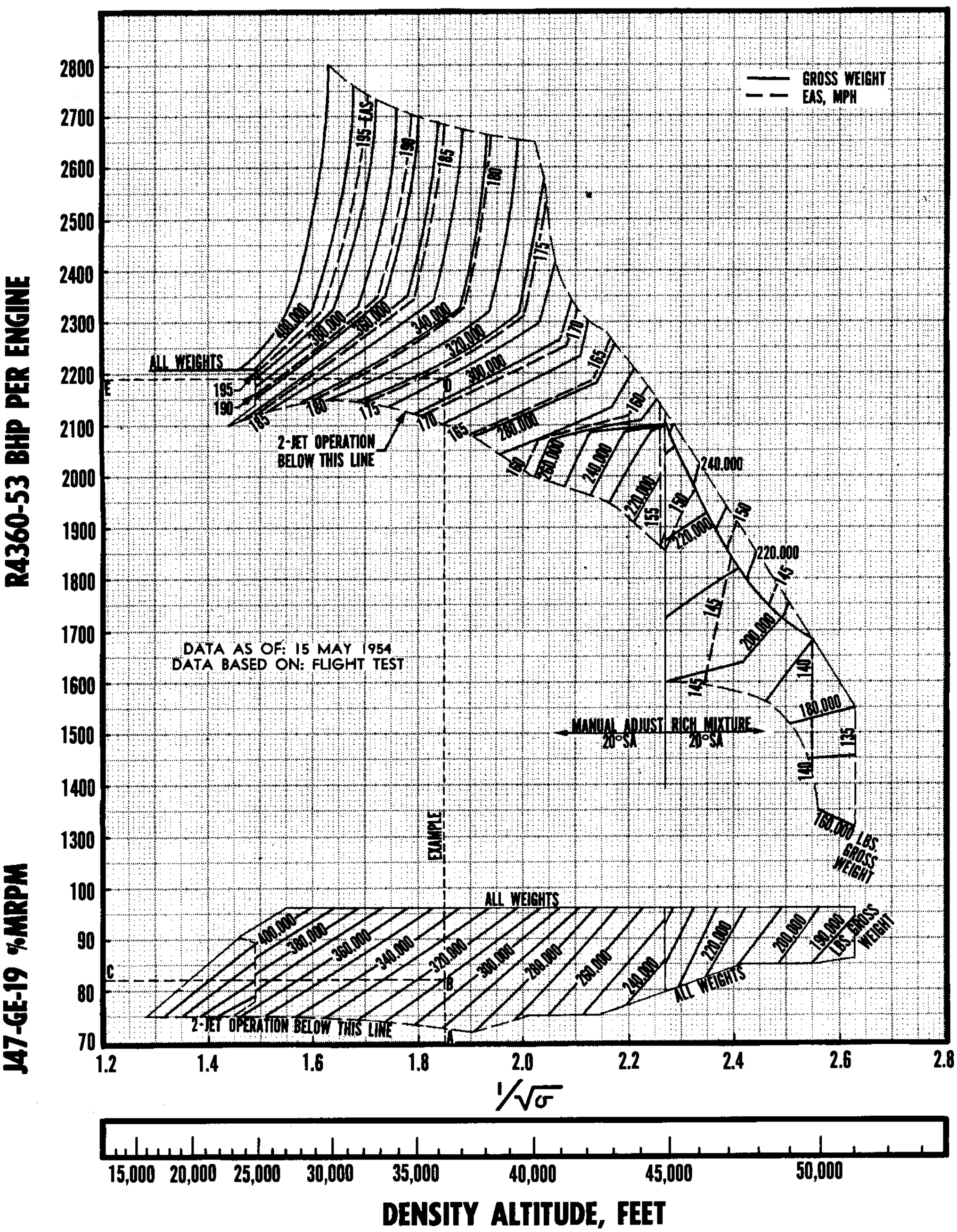


Figure A-253.

OPERATING CONDITIONS FOR MAXIMUM ATTAINABLE ALTITUDE.

To obtain the maximum attainable altitude capabilites of the airplane, it is necessary to fly a climbing flight path. The operating conditions for this flight path are shown in figure A-255. Since it is necessary to make frequent power changes during the stages of a high altitude cruise, the recommended power schedules of figures A-255 and A-119 must be rigidly followed.

Note

> Four J47-GE-19 jets operating at 96 per cent military rpm are required for all operation at maximum attainable altitude.

EXAMPLE.

On a combat mission over water it is desired to arrive at enemy coast-in at 40,000 feet at the highest gross weight possible and remain on the maximum attainable altitude flight path for 600 nautical miles. Determine the initial gross weight and reciprocating engine power, and the gross weight, engine power, and altitude attained at the end of the 600 nautical miles.

Enter figure A-255 at 40,000 feet and obtain an initial gross of 330,800 pounds and a reciprocating engine power of 2500 bhp at 2410 rpm: Enter figure A-256 at 330,800 pounds and obtain a reference distance of 1100 nautical miles. To this reference distance add 600 nautical miles and obtain a new reference distance of 1700 nautical miles. At the 1700 reference point of figure A-256 obtain a gross weight of 299,500 pounds. With this gross weight enter figure A-255 and obtain the final altitude of 41,700 feet and a reciprocating engine power of 2320 bhp.

OPERATING CONDITIONS FOR MAXIMUM ATTAINABLE ALTITUDE

6 R4360-53 + 4 J47-GE-19 ENGINES OPERATING

CONDITIONS: 1. NACA day.
2. No wind.
3. 115/145 grade fuel.
4. Based on Power Schedule Curves.

ALTITUDE (ft)	GROSS WEIGHT (lbs)	EAS (mph)	PILOTS' IAS‡ (mph)	R4360-53 ENGINE					J47-19 ENGINE	
				BHP	RPM	T.P. (psi)	APP. MAP (in. of Hg)	F.F. (lbs/hr/eng)	% MIL RPM	F.F. (lbs/hr/eng)
31,000	410,000	171.2	180.7	2780	2580	200	54.6	2010	96	2125
31,500	405,000	170.1	180.0	2770	2570	200	54.3	1995	96	2100
32,100	400,000	169.1	178.9	2760	2560	200	54.1	1980	96	2080
32,700	395,000	167.9	178.0	2745	2545	200	54.0	1960	96	2045
33,300	390,000	167.0	176.5	2730	2540	200	53.8	1955	96	1995
33,900	385,000	165.9	176.0	2720	2530	200	53.5	1940	96	1940
34,500	380,000	164.9	174.2	2710	2520	200	53.3	1925	96	1890
35,100	375,000	163.8	173.6	2700	2510	200	53.1	1915	96	1825
35,300	373,000	163.4	172.9	2695	2505	200	53.0	1905	96	1790
35,300	372,500	163.3	172.9	2695	2505	200	53.0	1905	96	1790
35,600	370,000	162.8	172.6	2685	2500	200	52.9	1900	96	1755
36,200	365,000	161.9	171.7	2675	2490	200	52.7	1875	96	1745
36,700	360,000	160.8	170.8	2660	2480	200	52.6	1860	96	1705
37,300	355,000	160.0	170.0	2650	2470	200	52.5	1855	96	1670
37,800	350,000	159.0	169.1	2640	2460	200	52.3	1840	96	1620
38,400	345,000	158.0	168.0	2630	2450	200	52.1	1825	96	1590
39,000	340,000	157.2	167.1	2620	2440	201	51.9	1800	96	1580
39,500	335,000	156.3	166.0	2605	2430	201	51.7	1785	96	1525
40,100	330,000	155.7	165.1	2600	2420	201	51.6	1770	96	1495
40,400	327,500	155.2	164.6	2595	2415	201	51.5	1765	96	1480
40,500	325,000	155.0	164.3	2565	2390	201	50.6	1725	96	1450
40,700	320,000	154.7	163.8	2515	2345	201	50.2	1655	96	1385
41,000	315,000	154.1	163.3	2470	2300	201	49.3	1580	96	1370
41,200	310,000	153.9	162.8	2420	2255	202	48.7	1510	96	1350
41,500	305,000	153.3	161.9	2370	2205	202	47.9	1415	96	1345
41,700	300,000	152.9	161.5	2320	2160	202	47.3	1330	96	1340
41,800	297,500	152.8	161.3	2300	2140	202	47.1	1290	96	1340
41,800	294,300	152.8	161.1	2300	2140	202	47.1	1290	96	1340
42,200	290,000	151.8	160.4	2270	2140	200	46.4	1245	96	1335
42,700	285,000	150.8	159.5	2235	2140	197	45.5	1195	96	1330
43,100	280,000	150.0	158.6	2200	2140	193	44.9	1140	96	1330
43,600	275,000	149.2	157.9	2175	2140	191	44.0	1110	96	1300
44,100	270,000	148.3	157.0	2145	2140	188	43.2	1085	96	1265
44,600	265,000	147.7	156.0	2110	2140	185	42.2	1040	96	1260
44,600	265,000	137.2	146.0	2110	2140	179	42.2	1260	96	1305
45,100	260,000	135.8	144.5	2080	2140	177	41.4	1235	96	1240
45,500	255,000	134.2	142.8	2045	2140	174	40.7	1190	96	1205
46,000	250,000	132.9	141.4	2010	2140	171	39.6	1155	96	1165
46,500	245,000	131.3	139.7	1975	2140	160	39.0	1120	96	1140
46,900	240,000	130.0	138.3	1935	2140	164	38.3	1090	96	1110

NOTES: 1. Manual adjust, 20° SA, low fan, above heavy line; rich mixture, high fan, below heavy line.
2. 110°C oil-in temperature limit.
3. 38°C CAT.
4. All operation in dual turbo.
5. ‡Assuming no instrument error.

67-322-A

Figure A-254. (Sheet 1)

OPERATING CONDITIONS FOR MAXIMUM ATTAINABLE ALTITUDE

6 R4360-53 + 4 J47-GE-19 ENGINES OPERATING

CONDITIONS: 1. NACA day. 2. No wind. 3. 115/145 grade fuel. 4. Based on Power Schedule Curves.

ALTITUDE (ft)	GROSS WEIGHT (lbs)	EAS (mph)	PILOTS' IAS‡ (mph)	R4360-53 ENGINE					J47-19 ENGINE	
				BHP	RPM	T.P. (psi)	APP. MAP (in. of Hg)	F.F. (lbs/hr/eng)	% MIL RPM	F.F. (lbs/hr/eng)
47,400	235,000	128.7	137.0	1900	2140	161	37.4	1065	96	1080
47,800	230,000	127.2	135.5	1860	2140	158	36.7	1025	96	1070
48,200	225,000	125.8	134.1	1825	2140	155	36.0	1000	96	1050
48,700	220,000	124.3	132.6	1790	2140	152	35.0	970	96	1045
49,100	215,000	123.0	131.4	1750	2140	148	34.3	945	96	1020
49,600	210,000	121.7	129.9	1710	2140	145	33.4	930	96	990
50,000	205,000	120.2	128.2	1665	2140	141	32.6	900	96	985
50,500	200,000	118.9	126.8	1620	2140	137	31.7	875	96	980
50,900	195,000	117.7	125.5	1565	2140	133	31.0	845	96	975
51,100	193,000	116.9	123.8	1545	2140	131	30.6	840	96	965
51,300	190,000	116.1	123.0	1510	2130	128	30.2	825	96	950
51,800	185,000	114.8	121.6	1450	2120	123	29.2	795	96	925
52,200	180,000	113.3	120.1	1385	2100	114	28.5	760	96	900
52,700	175,000	112.0	118.7	1320	2080	112	27.5	730	96	860
53,100	170,000	110.8	117.5	1240	2055	105	26.7	710	96	820

NOTES: 1. Rich mixture, high fan.
2. 110°C oil-in temperature limit.
3. 38°C CAT.
4. All operation in dual turbo.
5. ‡Assuming no instrument error.

67-320-A

Figure A-254.(Sheet 2)

MAXIMUM ATTAINABLE ALTITUDE OPERATING CONDITIONS

STANDARD ATMOSPHERE

6 R4360-53 + 4 J47-GE-19 ENGINES OPERATING*

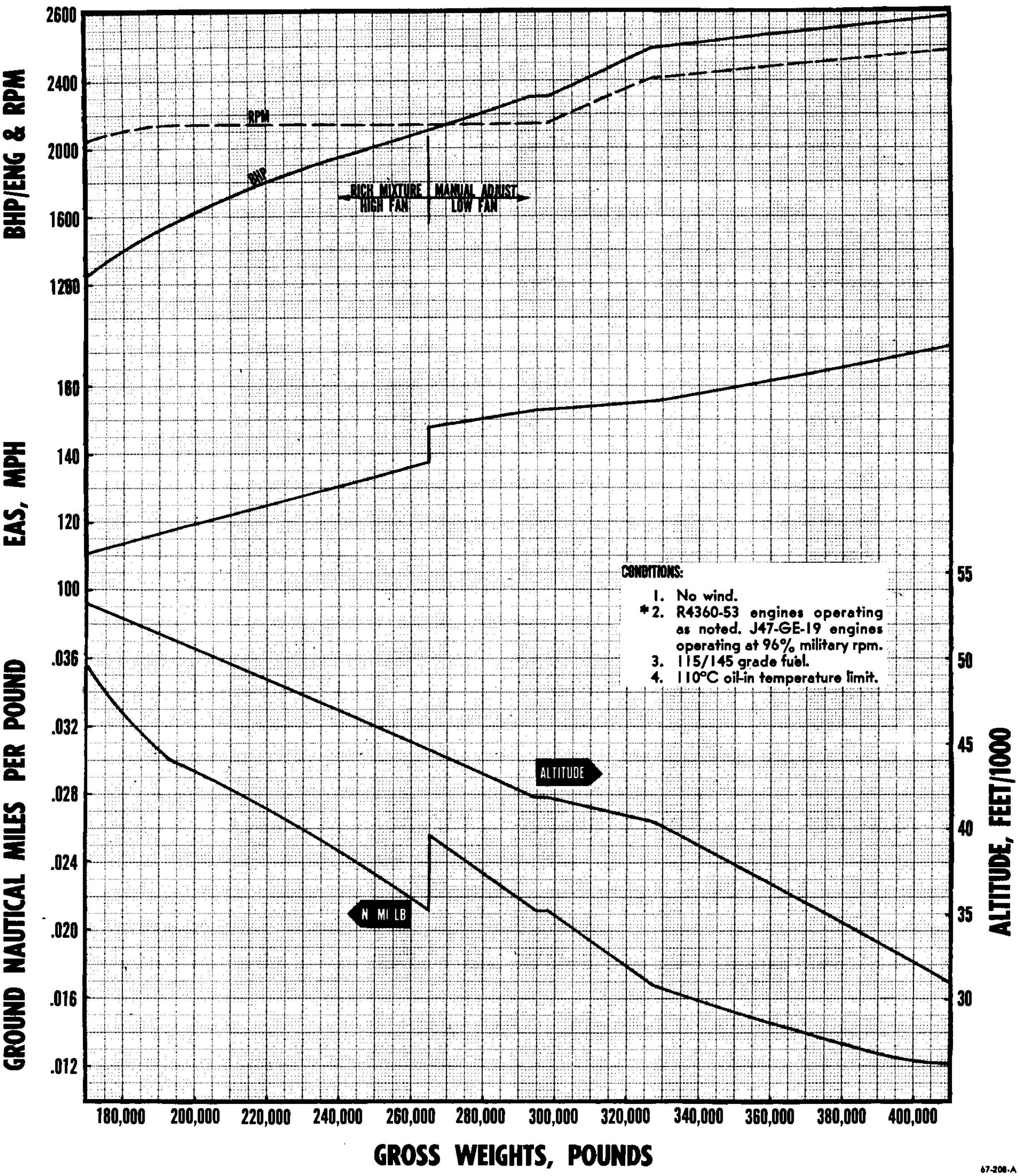
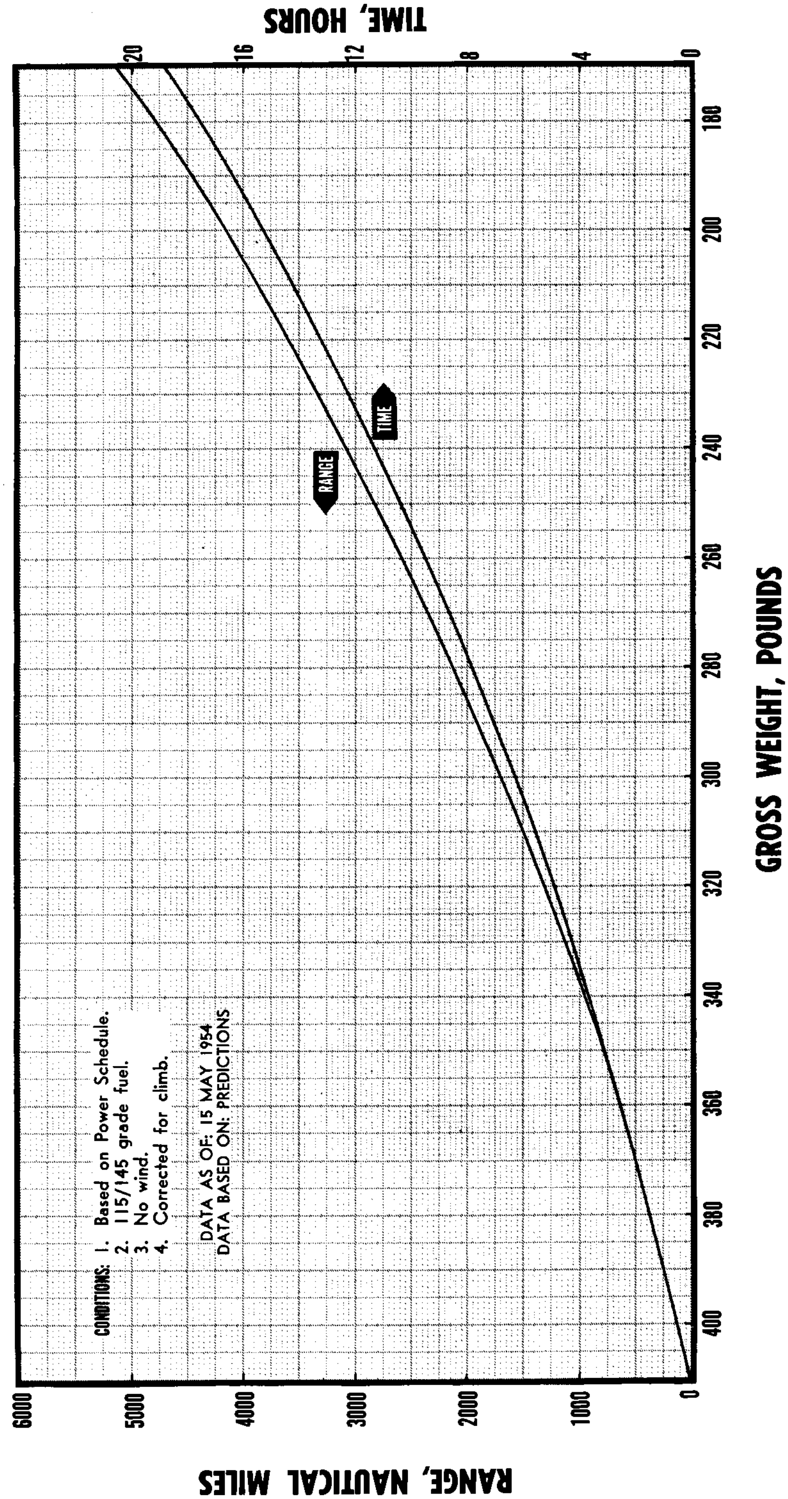


Figure A-255.

TIME AND RANGE PREDICTION AT MAXIMUM ATTAINABLE ALTITUDE

STANDARD ATMOSPHERE



67-190-A

Figure A-256.

LONG RANGE OPERATION AT OPTIMUM ALTITUDE.

It is necessary to fly a climbing flight profile to obtain the maximum long range capabilities of the airplane. These optimum altitude long range operating conditions are shown in figures A-258, A-260, and A-263.

Cruising speeds were selected in the same manner as those for long range operation at constant altitude. Since operation at extremely low altitudes is often not feasible, operating conditions for a minimum altitude of 5000 feet have been added to optimum altitude data for the high gross weights.

Optimum altitude long range time and distance predictions are presented in figures A-258A, A-261, and A-264.

These curves include time and range predictions for a minimum altitude of 5000 feet and are used in the same manner as the constant altitude time and distance predictions.

Note

Prior to using any of the partial reciprocating engine optimum altitude long range operating data, equivalent weight corrections from figure A-276 must be made.

LONG RANGE OPERATING CONDITIONS AT OPTIMUM ALTITUDE

6 R4360-53 ENGINES OPERATING

CONDITIONS:
1. NACA day.
2. No wind.
3. 115/145 grade fuel.
4. Based on Power Schedule and Specific Range Curves.

ALTITUDE (ft)	GROSS WEIGHT (lbs)	EAS (mph)	PILOTS' IAS‡ (mph)	R4360-53 ENGINE BHP	RPM	T.P. (psi)	APP. MAP (in. of Hg)	F.F. (lbs/hr/eng)
5,000	410,000	198.8	203.3	2550	2360	196.8	50.0	1695
5,000	405,000	197.7	202.2	2485	2305	196.8	49.0	1600
5,000	400,000	196.4	200.7	2420	2245	196.8	48.0	1505
5,000	395,000	195.2	199.6	2365	2190	197.8	47.0	1400
5,000	390,000	193.9	198.3	2310	2145	197.6	47.0	1315
5,000	387,800	193.4	197.7	2295	2125	198.3	46.0	1275
5,000	385,000	192.7	197.1	2270	2125	196.0	46.0	1240
5,000	380,000	191.4	195.7	2230	2125	192.5	46.0	1190
5,000	375,000	190.2	194.6	2180	2125	187.8	45.0	1120
5,000	372,000	189.4	193.8	2150	2125	185.4	44.0	1080
5,000	372,000	189.4	193.8	2115	1960	199.0	44.0	990
5,000	370,000	189.0	193.3	2105	1950	199.0	44.0	975
5,000	365,000	189.0	193.2	2085	1935	199.0	44.0	955
5,000	360,000	189.0	193.1	2060	1910	199.0	43.0	935
5,000	355,000	189.0	193.0	2035	1890	199.0	43.0	915
5,000	350,000	189.0	192.9	2010	1880	197.5	42.0	895
5,000	345,000	189.0	192.8	1985	1880	195.0	42.0	880
5,000	340,000	189.0	192.7	1960	1880	192.4	41.0	865
5,000	336,800	189.0	192.6	1940	1880	190.4	41.0	855
5,000	336,800	181.0	185.0	1940	1880	190.4	41.0	855
7,600	330,000	179.9	184.1	1955	1880	192.3	41.0	860
7,600	330,000	179.9	184.1	1930	1880	189.8	43.0	850
9,300	325,000	179.0	183.1	1920	1880	189.1	43.0	845
10,900	320,000	177.8	182.0	1910	1880	188.3	43.0	840
12,400	315,000	176.8	181.2	1900	1880	187.4	43.0	835
13,800	310,000	175.9	180.3	1895	1880	187.1	43.0	830
15,200	305,000	175.0	179.4	1885	1880	186.2	43.0	825
16,500	300,000	174.0	178.0	1875	1880	185.5	43.0	820
18,500	295,000	173.2	177.3	1865	1880	184.5	43.0	815
18,500	292,500	172.8	176.8	1860	1880	184.2	43.0	810
18,500	292,500	176.0	180.0	1860	1880	184.2	43.0	810
18,500	285,000	176.0	179.6	1805	1880	178.6	42.0	790
18,500	280,000	176.0	179.5	1780	1880	176.1	41.0	780
18,500	275,000	176.0	179.4	1755	1880	173.5	40.0	770
18,500	270,000	176.0	179.3	1735	1880	171.5	40.0	760
18,500	265,000	176.0	179.2	1720	1880	170.0	39.0	750
18,500	260,000	176.0	179.1	1705	1880	168.5	39.0	745
18,500	260,000	167.7	171.6	1600	1820	163.4	43.0	700

NOTES:
1. Manual adjust, 20°SA, above heavy line; Manual lean, 30° SA, below.
2. All operation in low fan.
3. 38°C CAT.
4. Single turbo operation below dashed line.
5. ‡Assuming no instrument error.

67-234-A

Figure A-257. (Sheet 1)

LONG RANGE OPERATING CONDITIONS AT OPTIMUM ALTITUDE

6 R4360-53 ENGINES OPERATING

CONDITIONS: 1. NACA day.
2. No wind.
3. 115/145 grade fuel.
4. Based on Power Schedule and Specific Range Curves.

ALTITUDE (ft)	GROSS WEIGHT (lbs)	EAS (mph)	PILOTS' IAS‡ (mph)	R4360-53 ENGINE				
				BHP	RPM	T.P. (psi)	APP. MAP (in. of Hg)	F.F. (lbs/hr/eng)
20,000	255,000	166.6	170.5	1600	1820	163.4	43.0	700
21,300	250,000	165.5	169.4	1600	1820	163.4	43.0	700
22,650	245,000	164.5	168.3	1595	1800	165.4	43.0	695
24,000	240,000	163.4	167.5	1590	1790	166.0	43.0	690
25,200	235,000	162.2	166.1	1580	1780	166.0	43.0	685
26,500	230,000	160.8	165.0	1570	1760	166.0	43.0	675
27,750	225,000	159.5	163.7	1555	1750	166.0	43.0	670
29,000	220,000	158.2	162.3	1535	1735	166.0	43.0	665
30,100	215,000	157.1	161.3	1515	1720	166.0	43.0	660
31,100	210,000	156.1	160.4	1505	1710	166.0	43.0	655
32,000	205,000	155.3	159.5	1500	1700	166.0	43.0	650
32,800	200,000	154.7	158.9	1485	1690	166.0	43.0	650
33,500	195,000	154.1	158.4	1480	1680	166.0	43.0	645
34,100	190,000	153.8	158.0	1475	1670	166.0	43.0	640
34,800	185,000	153.5	157.6	1465	1665	166.0	43.0	640
35,000	180,000	153.4	157.0	1460	1660	166.0	43.0	635
35,000	177,000	152.0	156.0	1410	1600	166.0	42.0	615
35,000	175,000	151.2	155.1	1380	1600	162.6	41.0	600
35,000	170,000	149.0	152.8	1300	1600	153.1	39.0	570

NOTES: 1. Manual lean, 30° SA.
2. All operation in low fan.
3. 38°C CAT.
4. Single turbo operation
5. ‡Assuming no instrument error.

67-319-A

Figure A-257. (Sheet 2)

OPTIMUM ALTITUDE LONG RANGE OPERATING CONDITIONS

STANDARD ATMOSPHERE

6 R4360-53 ENGINES OPERATING

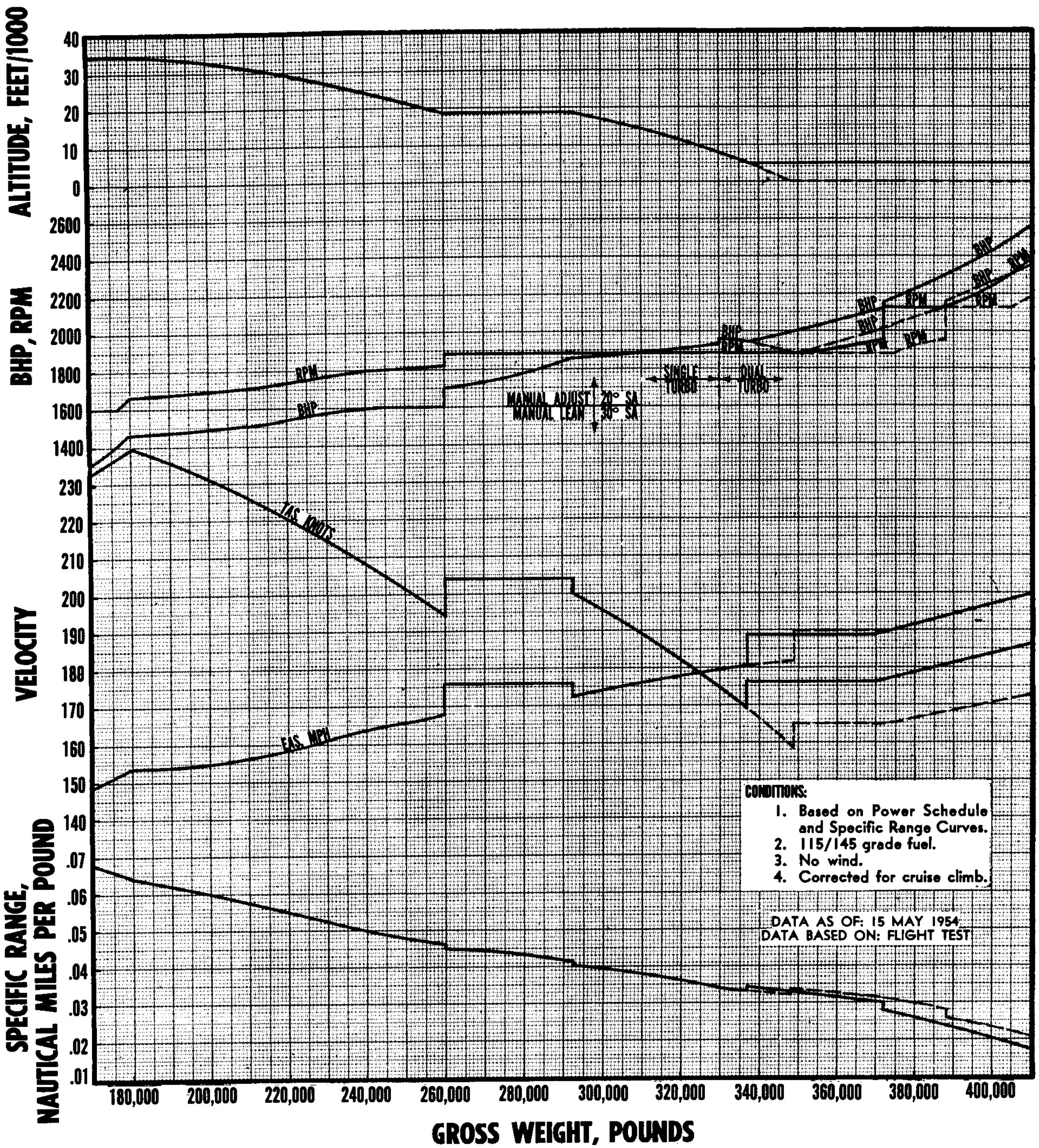


Figure A-258.

OPTIMUM ALTITUDE LONG RANGE AND TIME PREDICTION

STANDARD ATMOSPHERE

6 R4360-53 ENGINES OPERATING

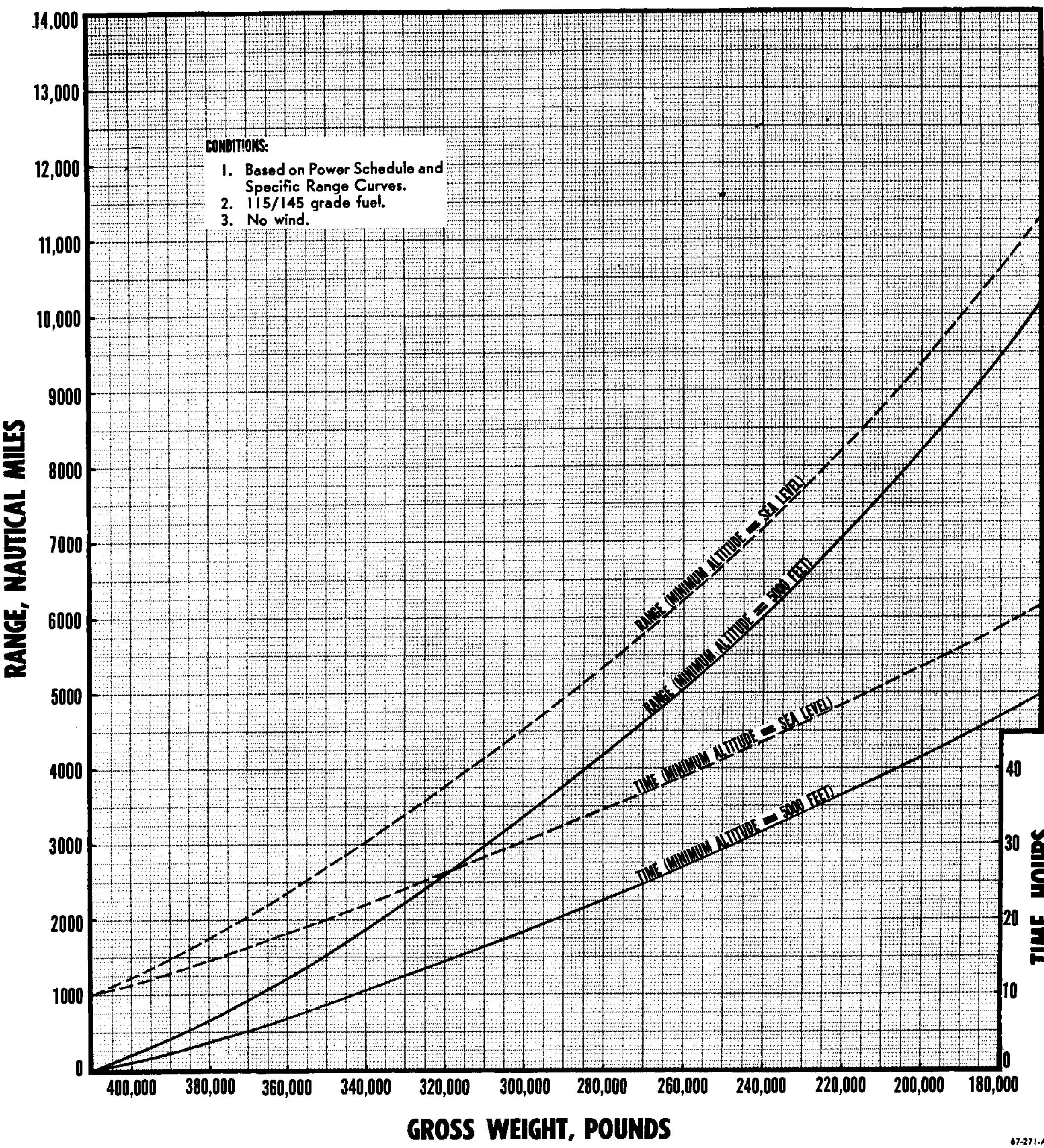


Figure A-258A.

LONG RANGE OPERATING CONDITIONS AT OPTIMUM ALTITUDE

PRIOR TO USING THIS CHART REFER TO FIGURE A-276 TO OBTAIN EQUIVALENT WEIGHT

5 R4360-53 ENGINES OPERATING

CONDITIONS:
1. NACA day.
2. No wind.
3. 115/145 grade fuel.
4. Based on Power Schedule and Specific Range Curves.

ALTITUDE (ft.)	GROSS WEIGHT (lbs)	EAS (mph)	PILOTS' IAS‡ (mph)	R4360-53 ENGINE				
				BHP	RPM	T. P. (psi)	APP MAP (in. of Hg)	FF (lbs/hr/eng)
5000	362,000	186.0	190.0	2800	2600	195.0	54.0	2040
5000	360,000	186.0	190.0	2700	2510	196.0	52.4	1910
5000	355,000	185.6	189.6	2640	2455	196.5	51.6	1825
5000	350,000	185.0	189.0	2580	2390	196.5	50.6	1740
5000	345,000	184.0	188.4	2500	2320	197.0	49.4	1625
5000	340,000	183.0	186.9	2415	2240	197.5	48.1	1495
5000	335,000	181.5	185.3	2340	2165	198.0	47.1	1360
5000	330,000	180.0	183.9	2280	2110	198.5	46.2	1255
5000	325,000	178.2	182.1	2225	2060	199.0	45.6	1140
5000	320,000	176.5	180.2	2185	2020	199.5	44.9	1080
5000	316,000	175.0	178.8	2160	2000	199.5	44.5	1045
5000	310,000	175.0	178.7	2105	1955	199.5	43.8	980
5000	305,000	175.0	178.6	2060	1915	200.0	43.2	940
5000	300,500	175.0	178.5	2025	1880	200.0	42.7	910
5000	295,000	175.0	178.4	1975	1880	194.5	41.7	875
5000	290,000	175.0	178.3	1940	1880	190.5	41.0	855
5000	285,000	175.0	178.2	1900	1880	186.5	40.2	835
5000	280,000	175.0	178.1	1865	1880	183.0	39.5	815
5000	280,000	168.0	171.4	1865	1880	183.0	39.5	815
7500	275,000	167.0	170.8	1865	1880	184.0	42.2	815
9500	270,000	166.0	169.5	1860	1880	183.5	42.0	815
11,000	265,000	165.3	169.0	1855	1880	183.0	42.0	810
12,500	260,000	165.0	168.7	1845	1880	182.0	41.8	805
13,500	255,000	164.6	168.4	1840	1880	182.0	41.8	805
14,250	250,000	164.4	168.0	1825	1880	181.0	41.5	800
15,000	245,000	164.2	167.7	1805	1880	178.5	41.0	795
15,500	240,000	164.0	167.5	1785	1880	176.0	40.5	785
16,250	235,000	163.1	166.6	1760	1880	174.0	39.9	775
17,000	230,000	161.5	165.0	1730	1880	171.0	39.0	765
18,000	226,000	159.5	162.8	1700	1880	168.0	38.2	750
18,000	226,000	156.2	159.7	1700	1930	164.0	39.8*	745
20,000	220,000	153.1	156.7	1640	1860	164.0	38.8*	720
20,000	220,000	155.2	158.6	1600	1815	164.0	38.3*	700
20,000	216,000	157.8	161.1	1600	1815	164.0	38.3*	700
20,000	216,000	157.0	160.2	1600	1815	164.0	42.9	700
21,000	210,000	153.8	157.2	1560	1775	164.5	42.5	680
22,000	205,000	151.8	155.2	1535	1740	164.5	42.3	670
23,000	200,000	150.0	153.4	1510	1720	165.0	42.1	655
24,000	195,000	149.0	152.4	1495	1695	165.0	42.0	650
25,000	190,000	148.0	151.3	1480	1680	165.0	41.9	640
26,000	185,000	147.5	150.7	1470	1670	165.5	41.9	635
27,250	180,000	147.0	150.3	1465	1660	165.5	42.0	635
28,500	175,000	147.0	150.2	1460	1660	166.0	42.1	630
29,750	170,000	147.0	150.1	1460	1660	166.0	42.2	630

NOTES:
1. Manual adjust, 20°SA above heavy line; manual lean, 30°SA, below.
2. All operation in low fan.
3. 38°C CAT. except where noted,
   * 20°C CAT.
4. Single turbo operation within dashed lines.
5. ‡ Assuming no instrument error.

E1-427-81

Figure A-259.

OPTIMUM ALTITUDE LONG RANGE OPERATING CONDITIONS

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING

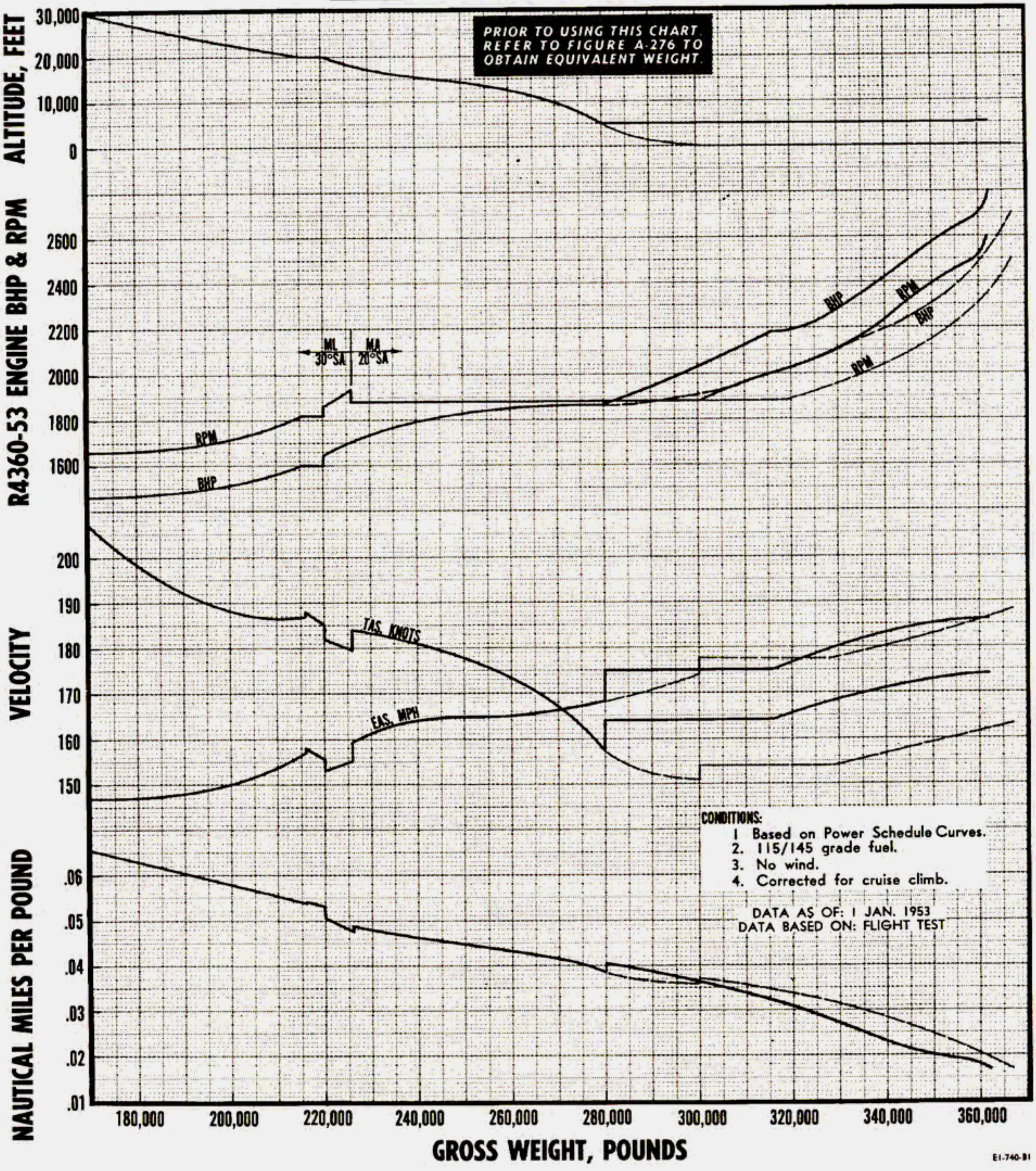


Figure A-260.

OPTIMUM ALTITUDE LONG RANGE AND TIME PREDICTION

STANDARD ATMOSPHERE

5 R4360-53 ENGINES OPERATING

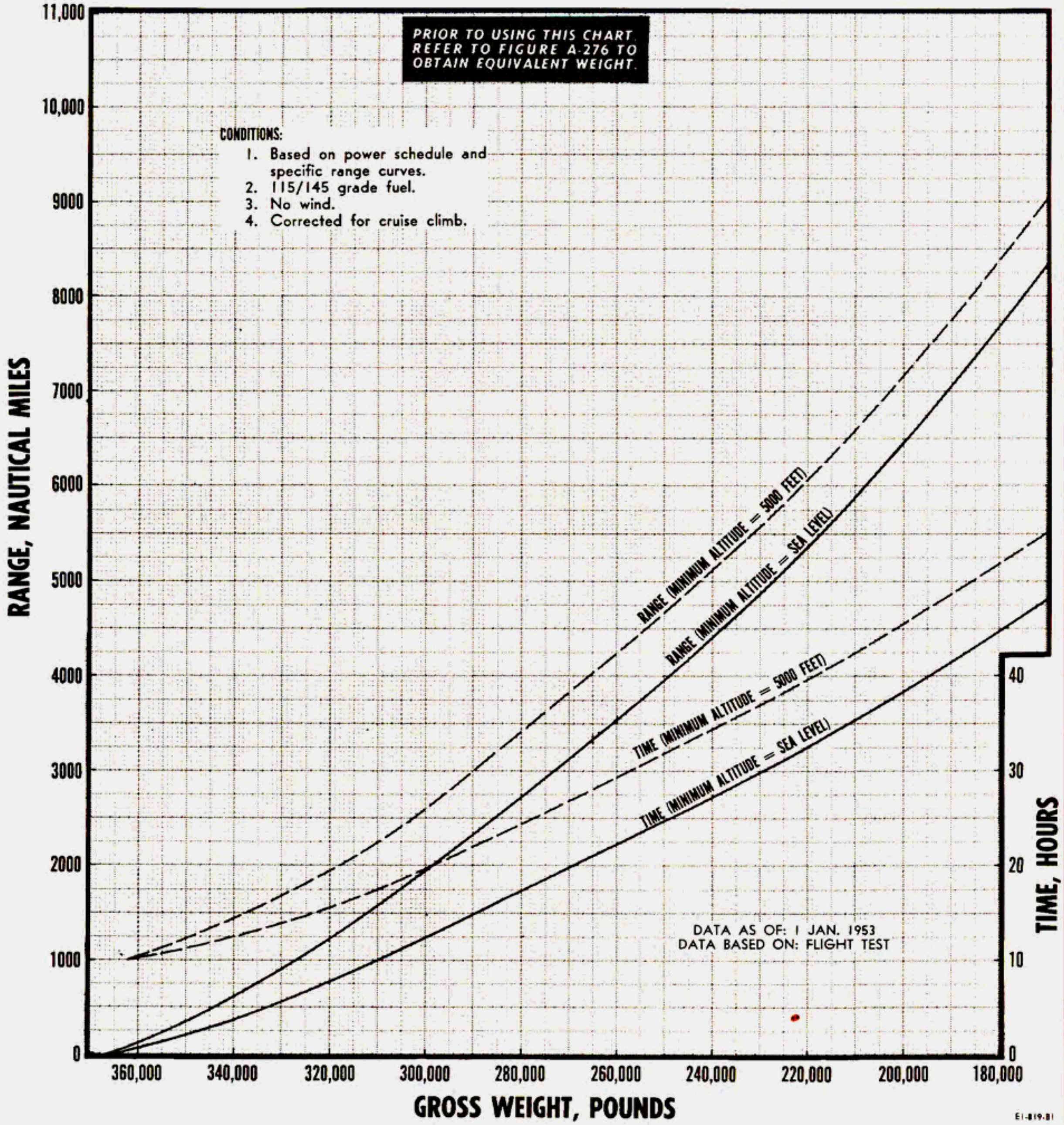


Figure A-261.

LONG RANGE OPERATING CONDITIONS AT OPTIMUM ALTITUDE

PRIOR TO USING THIS CHART. REFER TO FIGURE A-276 TO OBTAIN EQUIVALENT WEIGHT.

4 R4360-53 ENGINES OPERATING

CONDITIONS:
1. NACA day.
2. No wind.
3. 115/145 grade fuel.
4. Based on Power Schedule and Specific Range Curves.

ALTITUDE (ft.)	GROSS WEIGHT (lbs)	EAS (mph)	PILOTS' IAS‡ (mph)	R4360-53 ENGINE BHP	RPM	T. P. (psi)	APP MAP (in. of Hg)	FF (lbs/hr/eng)
5000	308,000	172.0	176.2	2800	2600	194.5	54.0	2040
5000	305,000	170.8	175.0	2655	2465	196.0	51.8	1850
5000	300,000	169.5	173.5	2550	2365	196.5	50.2	1700
5000	295,000	168.5	172.5	2485	2305	197.0	49.2	1605
5000	290,000	167.5	171.4	2425	2250	197.5	48.3	1510
5000	285,000	166.3	170.1	2360	2190	198.0	47.3	1400
5000	280,000	165.0	169.0	2300	2135	198.0	46.5	1290
5000	275,000	163.5	167.3	2235	2075	198.5	45.6	1170
5000	270,000	161.5	165.2	2170	2010	199.5	44.7	1060
5000	265,000	160.0	163.8	2100	1950	199.5	43.7	970
5000	262,000	163.0	166.5	2100	1950	199.5	43.7	970
5000	260,000	163.0	166.4	2090	1935	199.5	43.6	960
5000	255,000	163.0	166.3	2045	1895	200.0	42.9	920
5000	253,000	163.0	166.3	2025	1880	200.0	42.7	910
5000	253,000	157.0	160.8	2025	1880	200.0	42.7	910
6500	250,000	156.9	160.3	2025	1880	199.5	46.3	910
8500	245,000	156.5	159.8	2025	1880	199.5	46.3	910
10,000	242,000	156.2	159.6	2025	1880	199.5	46.3	910
10,500	240,000	156.0	159.5	2020	1880	199.0	46.3	905
12,000	235,000	155.5	159.2	2010	1880	198.5	46.1	900
13,000	230,000	154.6	158.2	2000	1880	198.0	45.9	890
14,500	225,000	153.5	157.3	1980	1880	196.0	45.6	880
16,500	220,000	152.0	155.4	1970	1880	195.0	45.3	875
18,000	215,000	150.6	154.2	1955	1880	193.5	44.9	865
19,500	210,000	149.0	152.5	1940	1880	192.5	44.6	855
21,000	205,000	147.8	151.5	1920	1880	191.0	39.1	840
22,000	200,000	147.0	150.6	1900	1880	189.0	38.6	830
23,000	195,000	146.2	149.5	1875	1880	186.0	38.0	820
24,000	190,000	146.0	149.4	1855	1880	184.5	37.3	810
24,500	185,000	146.0	149.3	1830	1880	182.5	36.6	795
25,000	180,000	146.0	149.2	1800	1880	179.0	35.7	790
25,000	180,000	144.2	147.5	1760	2000	164.0	40.2*	780
26,000	175,000	142.0	145.0	1720	1950	164.5	39.9*	760
27,500	170,000	139.6	142.6	1680	1905	165.0	39.6*	740

NOTES:
1. Manual adjust, 20° SA, above heavy line; manual lean, 30°SA, below.
2. All operation in low fan.
3. 38°C CAT. except where noted, * 20°C CAT.
4. Single turbo operation within dashed lines.
5. ‡ Assuming no instrument error.

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Figure A-262.

OPTIMUM ALTITUDE LONG RANGE OPERATING CONDITIONS

STANDARD ATMOSPHERE

4 R4360-53 ENGINES OPERATING

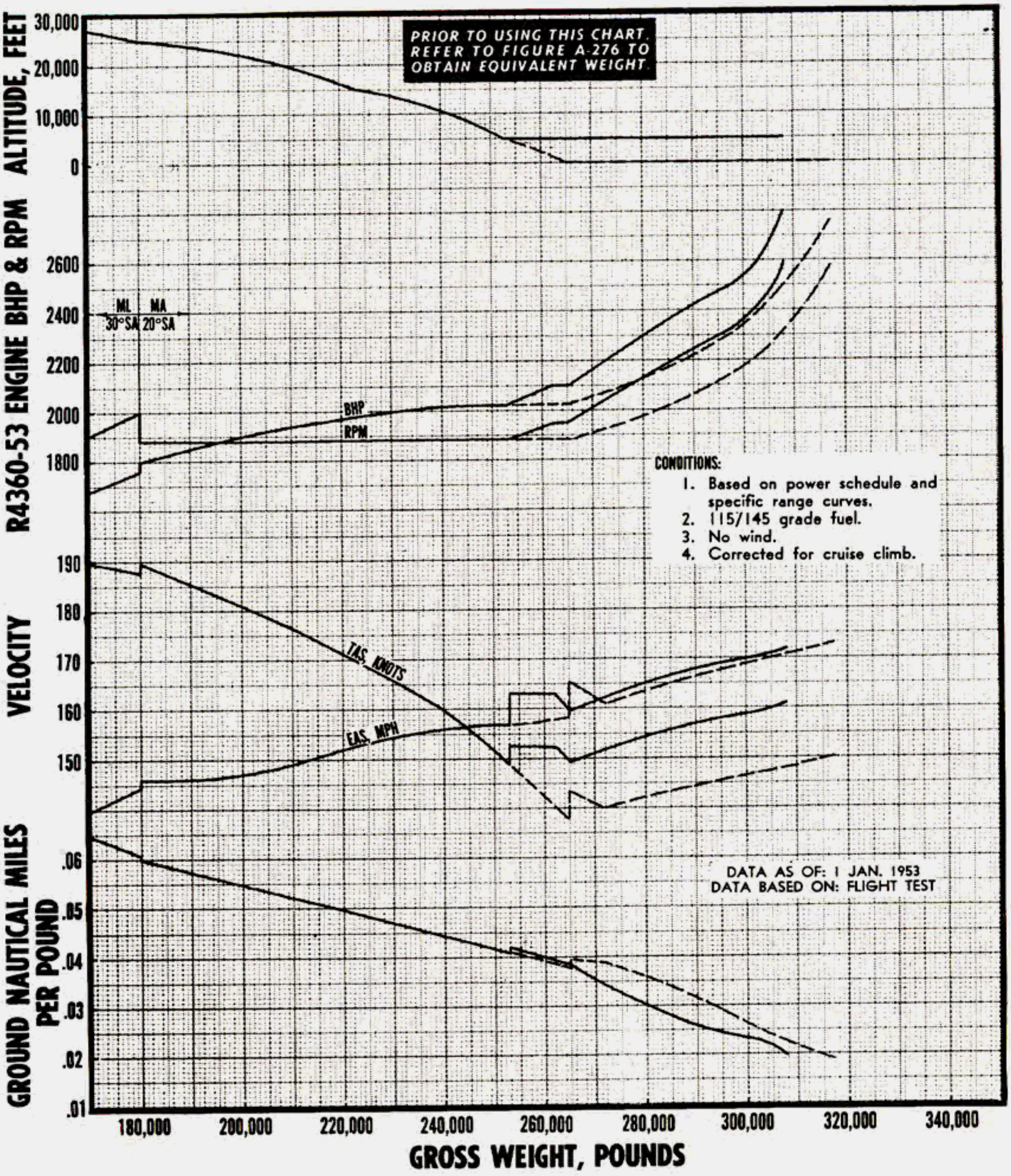

Figure A-263.

OPTIMUM ALTITUDE LONG RANGE AND TIME PREDICTION

STANDARD ATMOSPHERE

4 R4360-53 ENGINES OPERATING

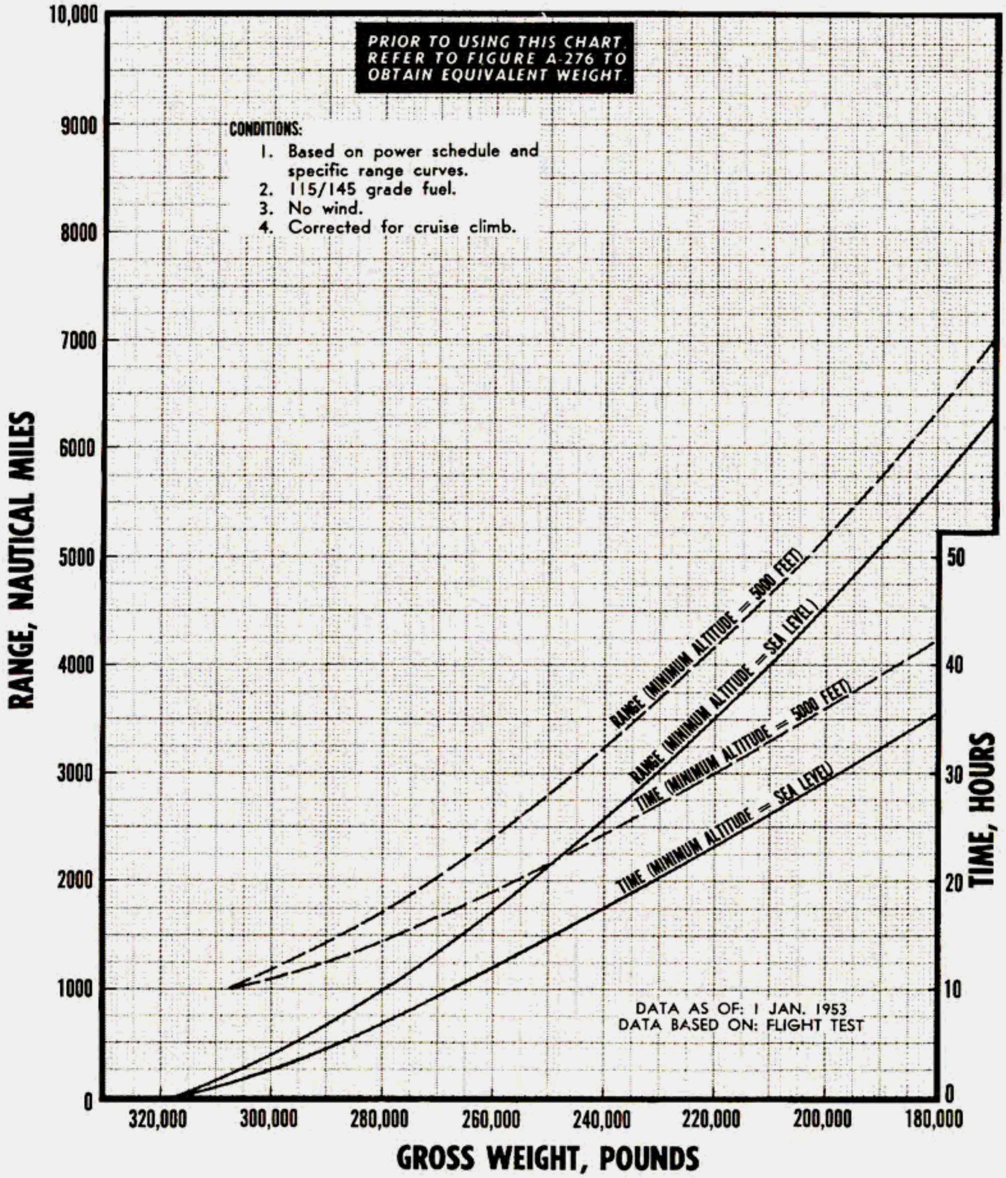

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Figure A-264.

DESCENT CONTROL.

The descent performance curves predict time used, fuel consumed and horizontal distance covered during long range and high speed descents, respectively. Both types of descent are presented for a clean airplane configuration and incorporate a practical schedule for power settings and air speeds tabulated in figures A-265 and A-267. No operational limits will be exceeded when these schedules are followed.

Long range descent control, which results in an average rate of descent of 300 fpm, should be used on all missions.

The high-speed type of descent may be used in training or in emergencies when safe rapid descent is desired and range is of no cercern.

Note

This high speed descent control will not result in the maximum rate of descent available. In the event of extreme emergency, the procedure discussed in "Emergency Descent," Section III, should be used.

EXAMPLE.

Determine performance for long range descent from 35,000 feet to 10,000 feet altitude at an initial gross weight of 275,000 pounds.

Enter figure A-266 at 275,000 pounds (A) and move vertically to 35,000 feet (B) and read reference values of 126 minutes (C) and 420 nautical miles (interpolated). Follow parallel to guide lines to 10,000 feet (D) and read reference values of 34 minutes (E) and 92 nautical miles (interpolated). Project vertically from (D) to (F) and read a gross weight of 270,500 pounds. The difference between the two reference times (126 and 34) and the two distances (420 and 92) yields a time for descent of 92 minutes and a distance traveled of 328 nautical miles. The estimate of fuel consumed during descent is 275,000 — 270,000 or 5000 pounds.

The schedule of operating conditions to be maintained during descent is tabulated in figure A-265. For a more accurate determination of fuel consumption, use the fuel flows presented in this table and the time increments involved to obtain 5320 pounds consumed. Using the calculated fuel consumed in descent results in a gross weight of 269,680 pounds after descent.

For high speed descent use the same procedure as outlined for long range descent performance. Figures A-267 and A-268 must be used for high speed descent and performance determination.

LONG RANGE DESCENT CONTROL SCHEDULE

NOTES:
1. 6 R4360 engines operating as noted.
2. Operation above 45,000 feet in rich mixture.
3. Operation below 45,000 feet; manual lean, 30° spark advance to left of heavy line, manual adjust to right of heavy line.
4. Single turbo operation to left of dotted line; dual turbo operation to right of dotted line.
5. Low RPM fan drive ratio.
6. J47-GE-19 engines inoperative, nose shutoff doors closed.
7. The air plug is fully closed for all operation below 25,000 feet.
8. 115/145 grade fuel.
9. NACA standard day.
10. Interpolate operating conditions for intermediate gross weights.

DENSITY ALTITUDE FEET	OPERATING CONDITIONS	GROSS WEIGHT, POUNDS											
		180,000	200,000	220,000	240,000	260,000	280,000	300,000	320,000	340,000	360,000	380,000	400,000
52,500 TO 50,000	EAS (mph)	130	130										
	BHP	1400	1465										
	RPM	2200	2400										
	TP (psi)	120	115										
	APP. MAP (in. of Hg.)	28.3	28.4										
	FF (lbs/hr/eng)	777	825										
	APO*	1/2	1/2										
	ICO†	1/2	1/2										
50,000 TO 45,000	EAS (mph)	135	140	140	140	140							
	BHP	1350	1660	1660	1660	1660							
	RPM	2090	2155	2155	2155	2155							
	TP (psi)	122	146	146	146	146							
	APP. MAP (in. of Hg.)	28.4	32.7	32.7	32.7	32.7							
	FF (lbs/hr/eng)	741	902	902	902	902							
	APO*	1/2	Full Open	Full Open	Full Open	Full Open							
	ICO†	1/4	1/2	1/2	1/2	1/2							
45,000 TO 40,000	EAS (mph)	145	145	149	156	156	156	156	156				
	BHP	‡1220	1300	1500	1900	2100	2100	2100	2100				
	RPM	1860	1895	1940	2075	2200	2200	2200	2200				
	TP (psi)	124	130	146	173	180	180	180	180				
	APP. MAP (in. of Hg.)	26.8	28.2	32.0	38.9	41.8	41.8	41.8	41.8				
	FF (lbs/hr/eng)	560	590	673	860	1050	1050	1050	1050				
	APO*	1/4	1/4	1/2	3/4	3/4	3/4	3/4	3/4				
	ICO†	0	0	1/4	3/4	3/4	3/4	3/4	3/4				
40,000 TO 35,000	EAS (mph)	154	147	150	156	163	169	175	175	175	175	175	
	BHP	‡1100	‡1100	1300	1500	1800	2100	2400	2600	2600	2600	2600	
	RPM	1700	1700	1860	1905	1940	2030	2225	2415	2415	2415	2415	
	TP (psi)	122	122	131	148	175	195	203	202	202	202	202	
	APP. MAP (in. of Hg.)	31.1	31.1	33.2	37.0	36.9	43.4	48.7	51.7	51.7	51.7	51.7	
	FF (lbs/hr/eng)	505	505	591	670	799	995	1462	1784	1784	1784	1784	
	APO*	0	1/4	1/4	1/4	1/4	1/4	1/2	3/4	3/4	3/4	3/4	
	ICO†	1/4	1/4	1/4	1/4	1/4	1/2	3/4	Full Open	Full Open	Full Open	Full Open	
35,000 TO 30,000	EAS (mph)	164	159	154	156	163	169	175	180	186	190	190	190
	BHP	‡1160	‡1160	‡1160	1200	1450	1600	1900	2090	2300	2700	2700	2700
	RPM	1600	1600	1600	1600	1635	1860	1880	1940	2135	2505	2505	2505
	TP (psi)	136	136	136	141	167	162	191	203	202	186	186	186
	APP. MAP (in. of Hg.)	34.8	34.8	34.8	36.0	42.7	39.8	40.4	44.5	47.1	53.1	53.1	53.1
	FF (lbs/hr/eng)	520	520	520	585	628	705	832	965	1286	1906	1906	1906
	APO*	0	0	0	0	0	0	1/4	1/4	1/4	1/2	1/2	1/2
	ICO†	1/2	1/2	1/2	1/2	Full Open	1/4	1/4	1/4	1/4	1/2	1/2	1/2
30,000 TO 20,000	EAS (mph)	173	170	166	160	163	169	175	180	186	192	197	197
	BHP	‡1160	‡1160	‡1160	‡1160	1250	1450	1650	1875	2075	2300	2600	2700
	RPM	1500	1500	1500	1500	1500	1640	1865	1880	1925	2135	2415	2505
	TP (psi)	145	145	145	145	157	166	166	187	202	202	201	200
	APP. MAP (in. of Hg.)	34.2	34.2	34.2	34.2	37.0	42.0	39.1	40.0	43.8	47.1	51.9	53.3
	FF (lbs/hr/eng)	510	510	510	510	565	630	720	820	950	1285	1770	1906
	APO*	0	0	0	0	0	0	0	1/4	1/4	1/4	1/4	1/4
	ICO†	0	0	0	0	1/4	1/2	1/4	0	1/4	1/4	1/4	1/4
20,000 TO 10,000	EAS (mph)	185	184	182	179	175	169	175	180	186	191	197	202
	BHP	‡1120	‡1120	‡1120	‡1120	‡1120	‡1120	1275	1400	1600	1760	1950	2125
	RPM	1440	1440	1440	1435	1425	1420	1440	1590	1815	2050	1880	2050
	TP (psi)	145	145	145	146	147	148	166	165	164	159	194	193
	APP. MAP (in. of Hg.)	34.6	34.6	34.6	34.6	34.6	34.6	38.5	40.3	42.9	40.3	40.0	43.0
	FF (lbs/hr/eng)	495	495	495	495	493	493	555	605	700	778	861	1025
	ICO†	0	0	0	0	0	0	0	0	1/4	0	0	0
10,000 TO S. L.	EAS (mph)	179	177	175	172	168	169	175	180	186	191	197	202
	BHP	800	800	800	800	800	860	1000	1100	1250	1350	1500	1685
	RPM	1410	1405	1400	1400	1400	1400	1400	1410	1420	1525	1700	1920
	TP (psi)	105	106	106	106	106	114	133	146	165	165	164	162
	APP. MAP (in. of Hg.)	26.5	26.5	26.5	26.5	26.5	28.0	31.3	33.9	37.4	38.9	41.0	39.7
	FF (lbs/hr/eng)	375	375	375	375	375	396	445	483	545	585	650	740
	ICO†	0	0	0	0	0	0	0	0	0	0	0	0

† Average approximate intercooler opening—fraction of full open. Maintain limit CAT.
* Average approximate air plug opening—fraction of full open. Maintain limit CHT.
‡ Minimum power required to maintain cabin pressurization.

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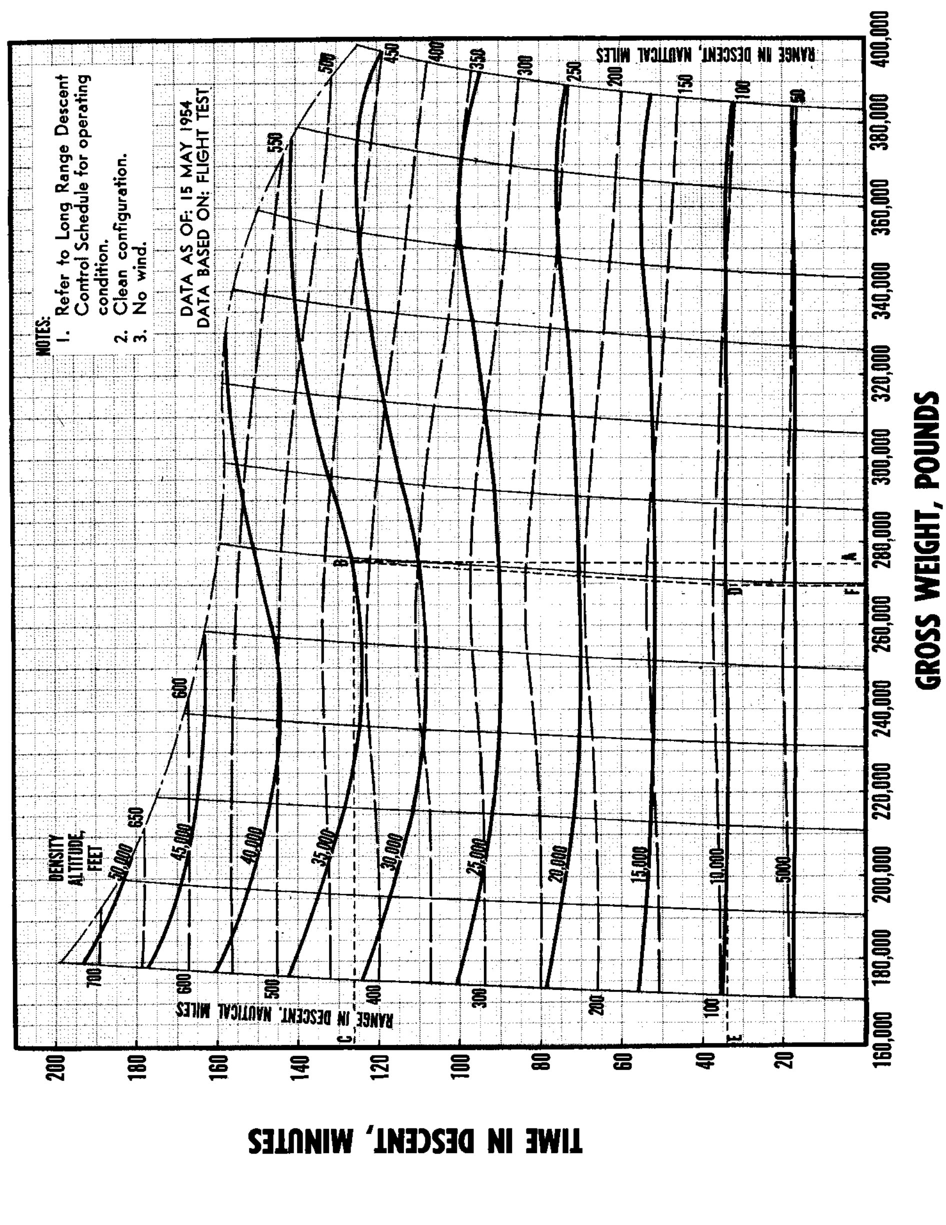
Figure A-265.

LONG RANGE DESCENT PERFORMANCE

STANDARD ATMOSPHERE

6 R4360-53 ENGINES OPERATING



67-279-A

Figure A-266.

HIGH SPEED DESCENT CONTROL

STANDARD ATMOSPHERE

CONDITIONS:
1. All engines operating in manual adjust, 20° spark advance.
2. Low fan drive ratio at all altitdues.
3. Air plugs and intercoolers closed at all altitudes.
4. All J47-GE-19 engines inoperative, nose shutoff doors closed.
5. 115/145 grade fuel.
6. Clean configuration.
7. No wind.

DENSITY ALTITUDE (ft)	(4) R4360-53 ENGINES BHP	RPM	T P (psi)	(2) R4360-53 ENGINES BHP	RPM	T P (psi)	EAS (mph) 220,000 Lb OR LESS	220,000 Lb to 280,000 Lb	280,000 Lb to 320,000 Lb	320,000 Lb OR OVER	6-ENGINE FUEL FLOW (lb/min)
52,500	1218	2055	113	600	1550	73	154	149	144	125	59.1
50,000	1220	1990	116	600	1550	73	167	162	157	150	59.1
47,500	1230	1930	120	600	1550	73	179	175	171	166	59.1
45,000	1250	1875	126	600	1550	73	192	188	185	182	59.1
45,000	920	1550	112	600	1550	73	192	188	185	182	46.5
42,500	960	1550	117	600	1550	73	205	202	200	197	41.5
40,000	1050	1550	128	660	1550	80	219	217	215	213	44.2
35,000	1150	1560	139	870	1560	105	248	246	240	220	47.8
30,000	1190	1590	141	910	1590	107	266	266	245	225	49.2
25,000	1190	1550	144	940	1550	113	266	266	250	230	49.4
20,000	1170	1560	140	940	1560	112	266	266	255	236	49.2
15,000	1120	1560	134	940	1560	112	266	266	260	241	47.5
10,000	1080	1550	129	940	1550	112	266	266	264	245	46.5
5,000	920	1550	108	920	1550	108	266	266	266	248	42.0
Sea Level	910	1550	107	910	1550	107	266	266	266	250	41.7

NOTE: Single turbo operation below dashed line.
Dual turbo operation above dashed line.

67-137-A

Figure A-267.

HIGH SPEED DESCENT CONTROL

STANDARD ATMOSPHERE

NOTES:
1. Refer to High Speed Descent Control Schedule for operating conditions.
2. Clean configuration.
3. No wind.

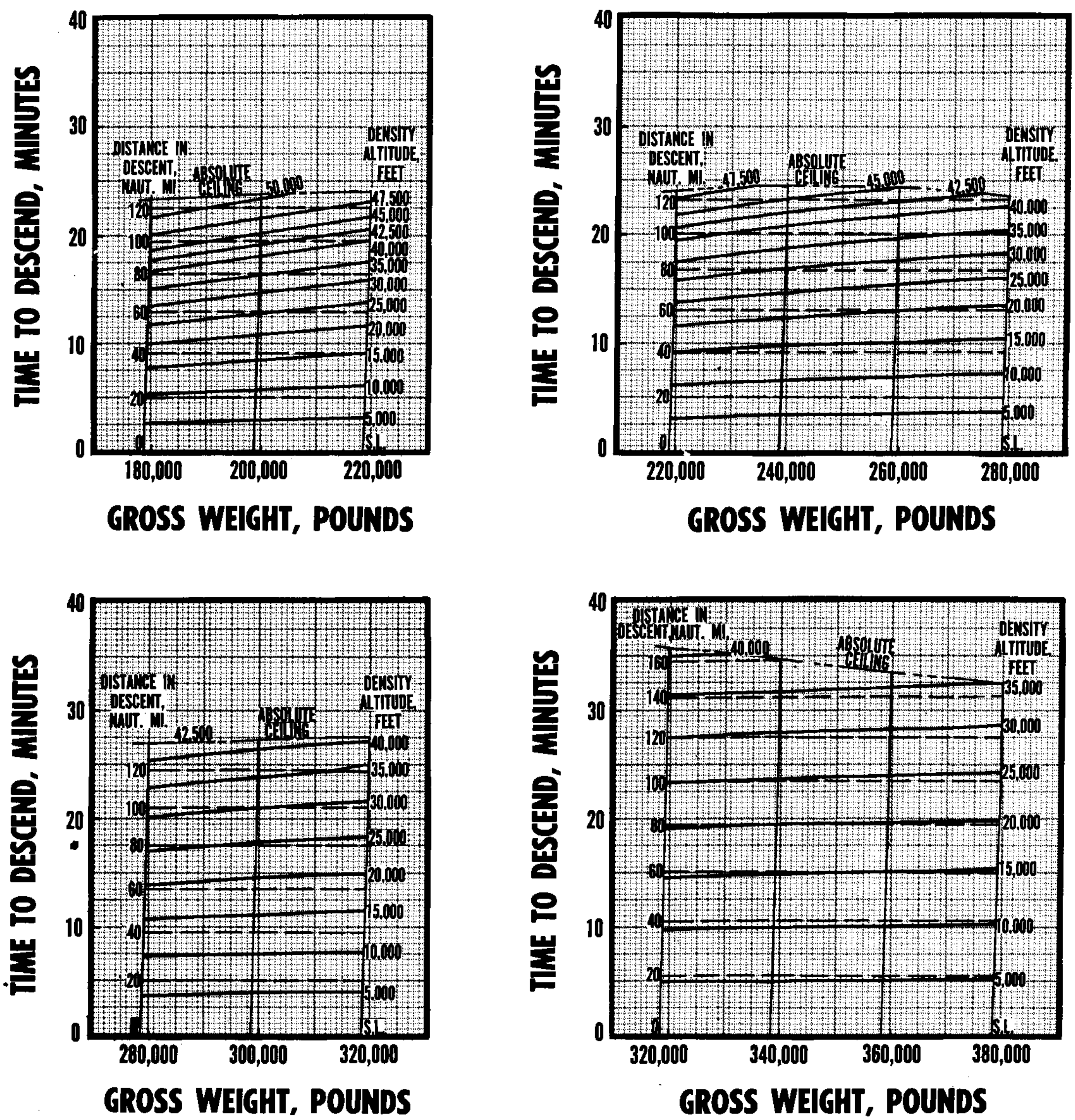


Figure A-268.

SAFE APPROACH WEIGHT.

Figure A-269 presents the maximum gross weight for a refused landing and safe go-around. These weights afford an emergency rate of climb of 100 fpm in the landing configuration (gear down, flaps deflected 30 degrees) when maximum allowable power is pulled at the approach rpm. Limit go-around weights may be determined for normal and emergency engine operating configurations and any practical atmospheric condition.

EXAMPLE.

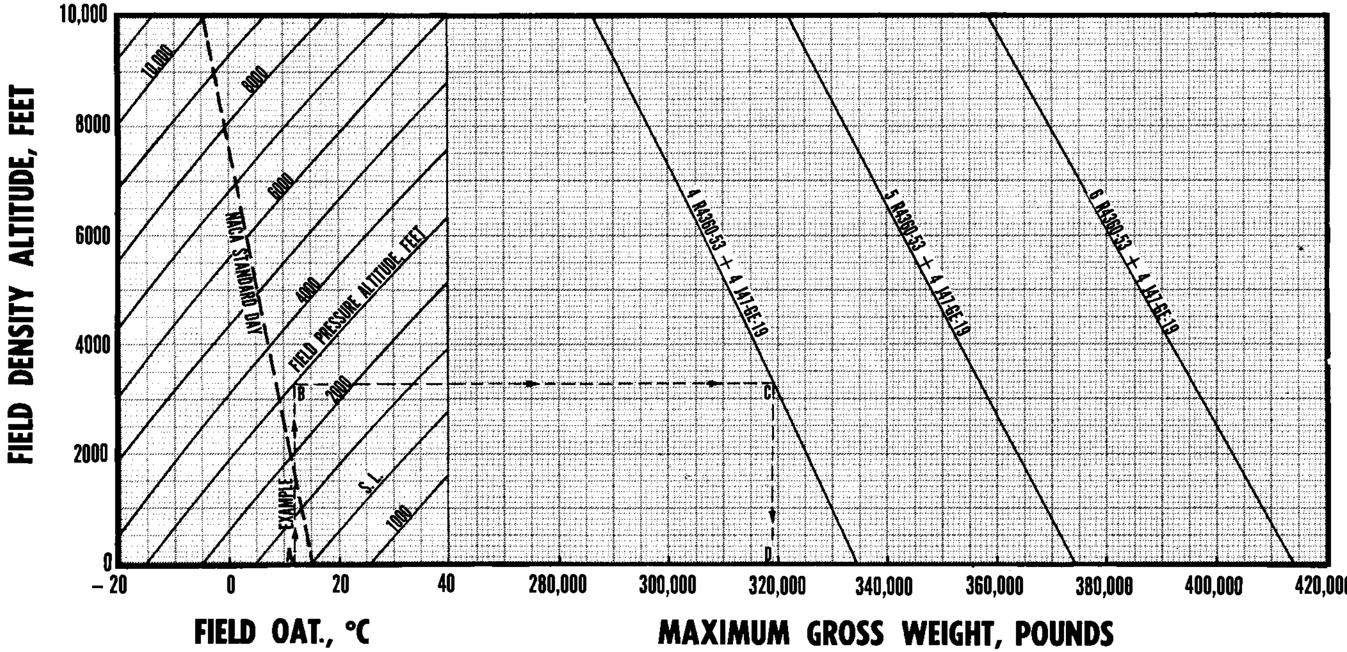
Determine maximum safe approach gross weight for the following landing conditions:

4 R4350-53 engines operating
4 J47-GE-19 engines operating
3000 feet field pressure altitude
12°C field OAT.

Enter figure A-269 at a field air temperature of 12°C (A), and move vertically to 3000 feet field pressure altitude (B) to establish field density altitude. Move horizontally at this density altitude to the limit line for the prescribed engine operating condition (C) and read a maximum gross weight of 317,500 (D).

LIMIT APPROACH WEIGHTS

CONDITIONS:
1. Approach limit weights based on power available for 100 fpm rate of climb with flaps 30°, gear down at 135 per cent of stalling speed.
2. R4360-53 engines operating at 3250/2600 (BHP/RPM); J47-GE-19 engines operating at 100% military RPM.
3. 115/145 grade fuel.
4. No wind.



67-160-A

Figure A-269.

LANDING DISTANCE.

These curves present landing ground roll and total distance to clear a 50-foot obstacle. Landing performance can be determined for any gross weight and any practical atmospheric condition.

Individual charts (figures A-270 and A-271) are presented for total landing distance and ground roll for the maximum stopping condition of six propellers in reverse pitch plus brake. Ground roll and total distance are presented on composite charts for the following additional stopping conditions: four propellers reversed + brakes, two propellers reversed + brakes, brakes only, and six propellers reversed only.

Data is based on the standard landing configuration (flaps 30 degrees) for high performance approach speeds (125 per cent power-off stall velocity) and touch-down at 110 per cent stall speed. Brakes are applied at instant of touch-down and maximum braking held to complete stop. Jets used to supplement reciprocating engines during approach are throttled upon touch-down. Reciprocating engines not used for reversed thrust are at idle.

Note

The latest procedure requires approach at 135 per cent power-off stall speed. Charted landing distances should be increased by 25 per cent for normal landing procedure.

EXAMPLE.

Determine landing distances for approach at 135 per cent stall velocity with maximum braking (six propellers reversed + brakes) for:

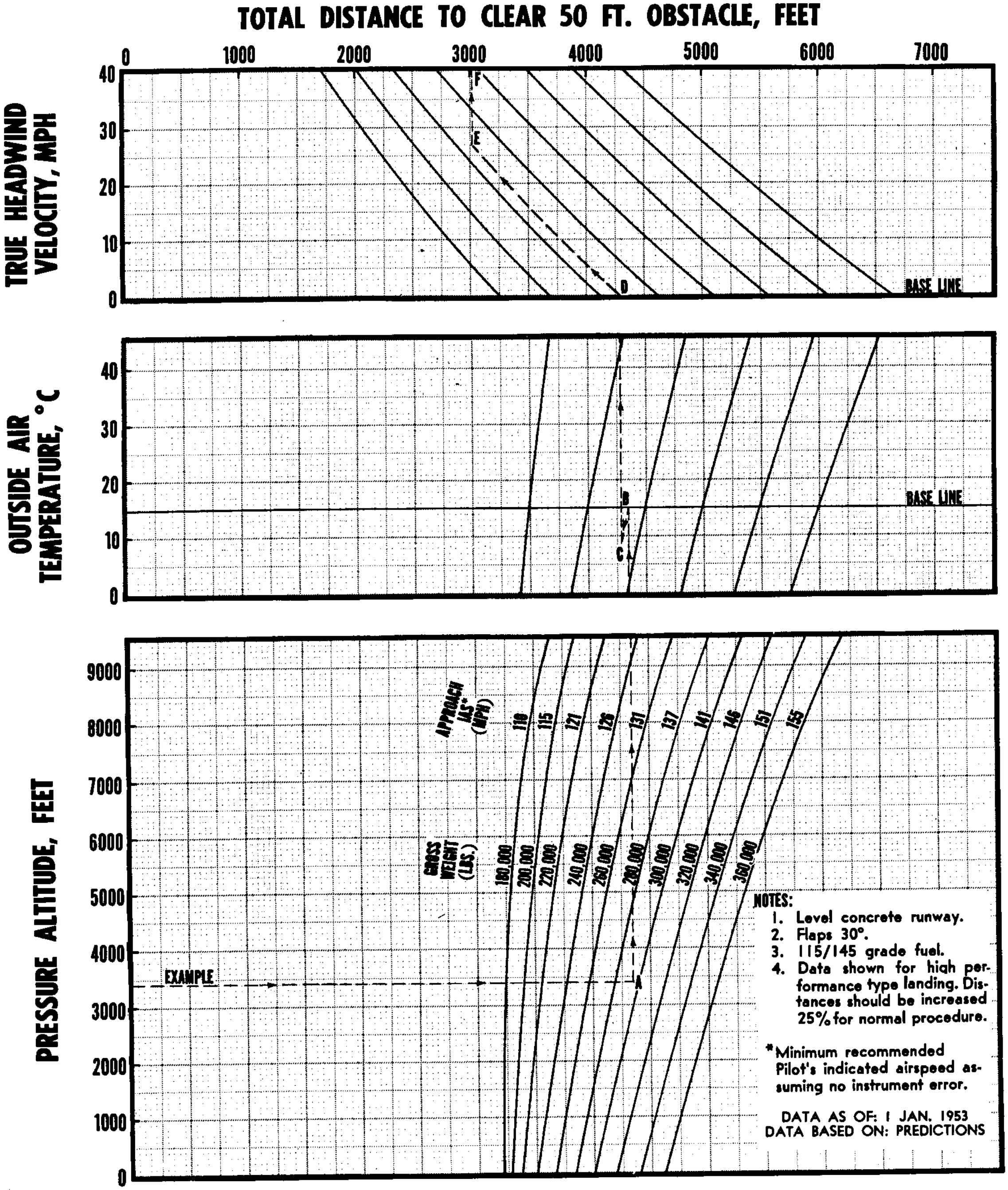
295,000 pounds gross weight
3400 feet pressure altitude
8°C OAT.
27 mph head wind

Enter figure A-270 at a pressure altitude of 3400 feet and a gross weight of 295,000 pounds (A), move vertically to base line on OAT. chart (B). Follow parallel to guide lines to OAT. of 8°C (C). Move vertically to base line of head wind chart (D), and follow guide lines to 27 mph (E). Read 3020 feet to clear a 50-foot obstacle (F). From figure A-319, using the same procedure, determine a ground roll distance of 1700 feet.

Increase these values by 25 per cent to obtain 3775 feet for total distance and 2125 feet for landing ground roll. These figures apply for normal landing technique at 135 per cent stall speed.

LANDING DISTANCE

BRAKES APPLIED AND SIX PROPELLERS IN REVERSE PITCH DURING GROUND ROLL



NOTES:
1. Level concrete runway.
2. Flaps 30°.
3. 115/145 grade fuel.
4. Data shown for high performance type landing. Distances should be increased 25% for normal procedure.

*Minimum recommended Pilot's indicated airspeed assuming no instrument error.

DATA AS OF: 1 JAN. 1953
DATA BASED ON: PREDICTIONS

E1-731-B1

Figure A-270.

LANDING GROUND ROLL DISTANCE
BRAKES APPLIED AND SIX PROPELLERS IN REVERSE PITCH DURING ROLL

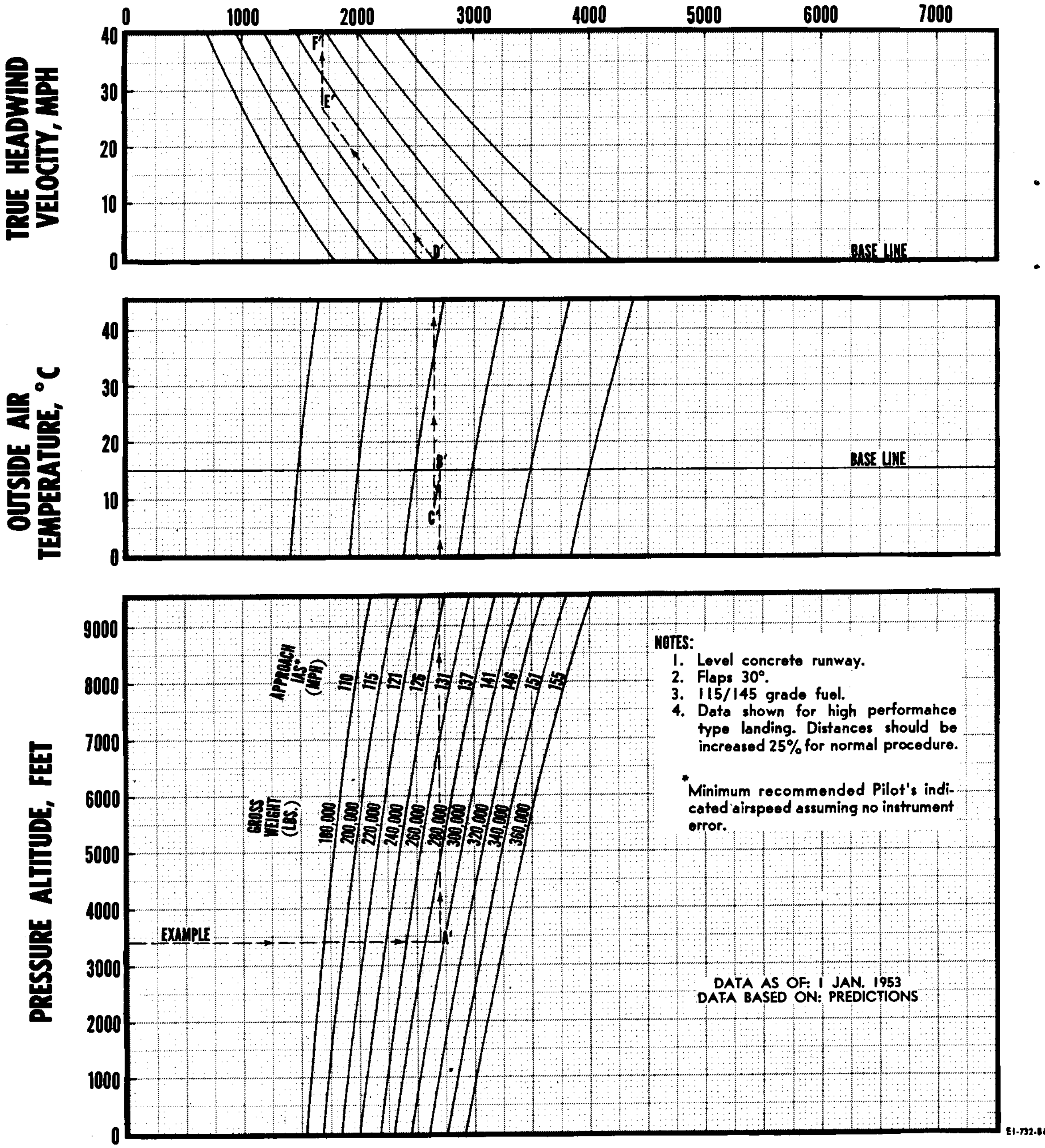


Figure A-271.

LANDING DISTANCE

BRAKES APPLIED AND FOUR PROPELLERS IN REVERSE PITCH DURING GROUND ROLL

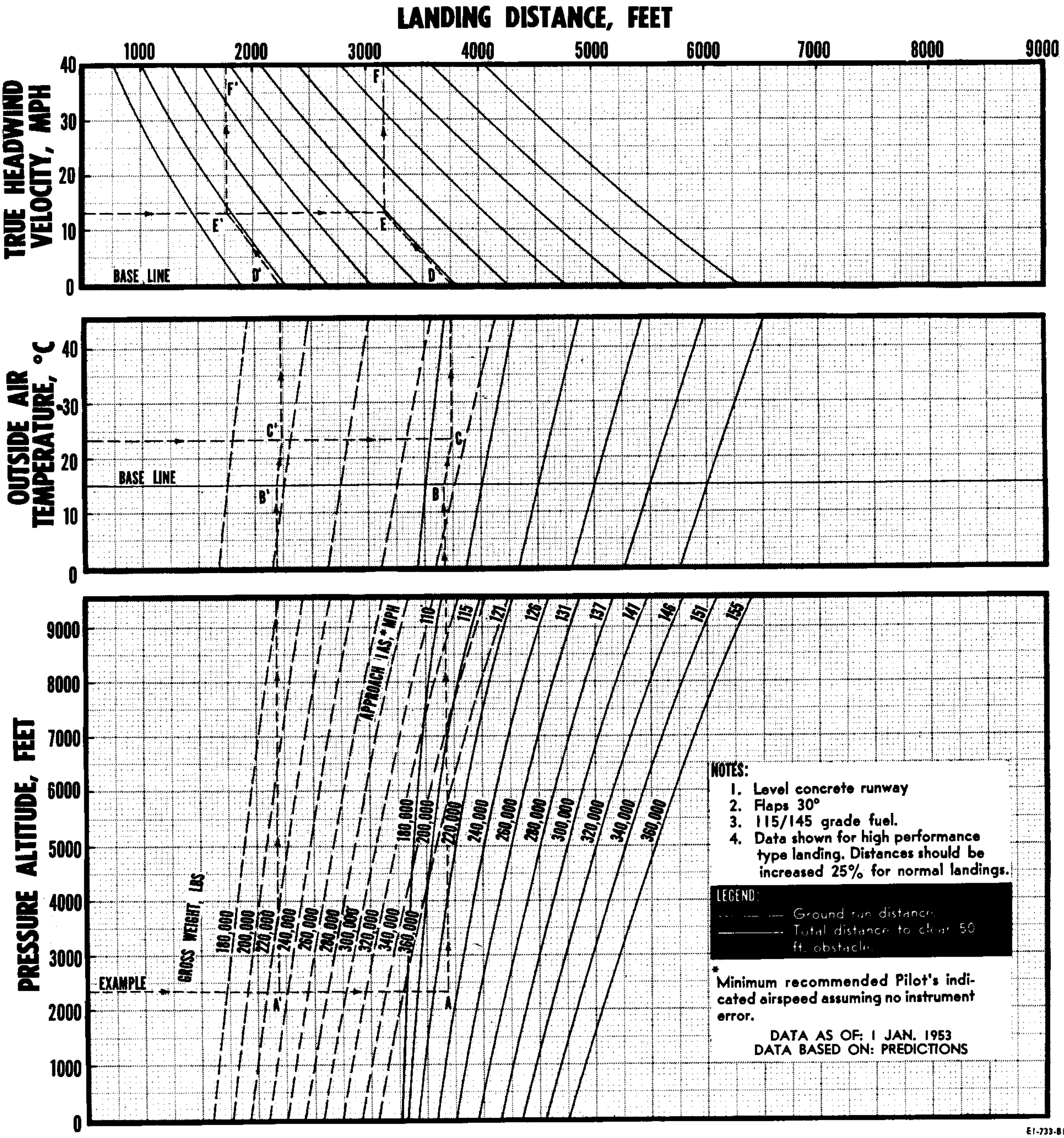


Figure A-272.

LANDING DISTANCE
BRAKES APPLIED AND TWO PROPELLERS IN REVERSE PITCH DURING GROUND ROLL

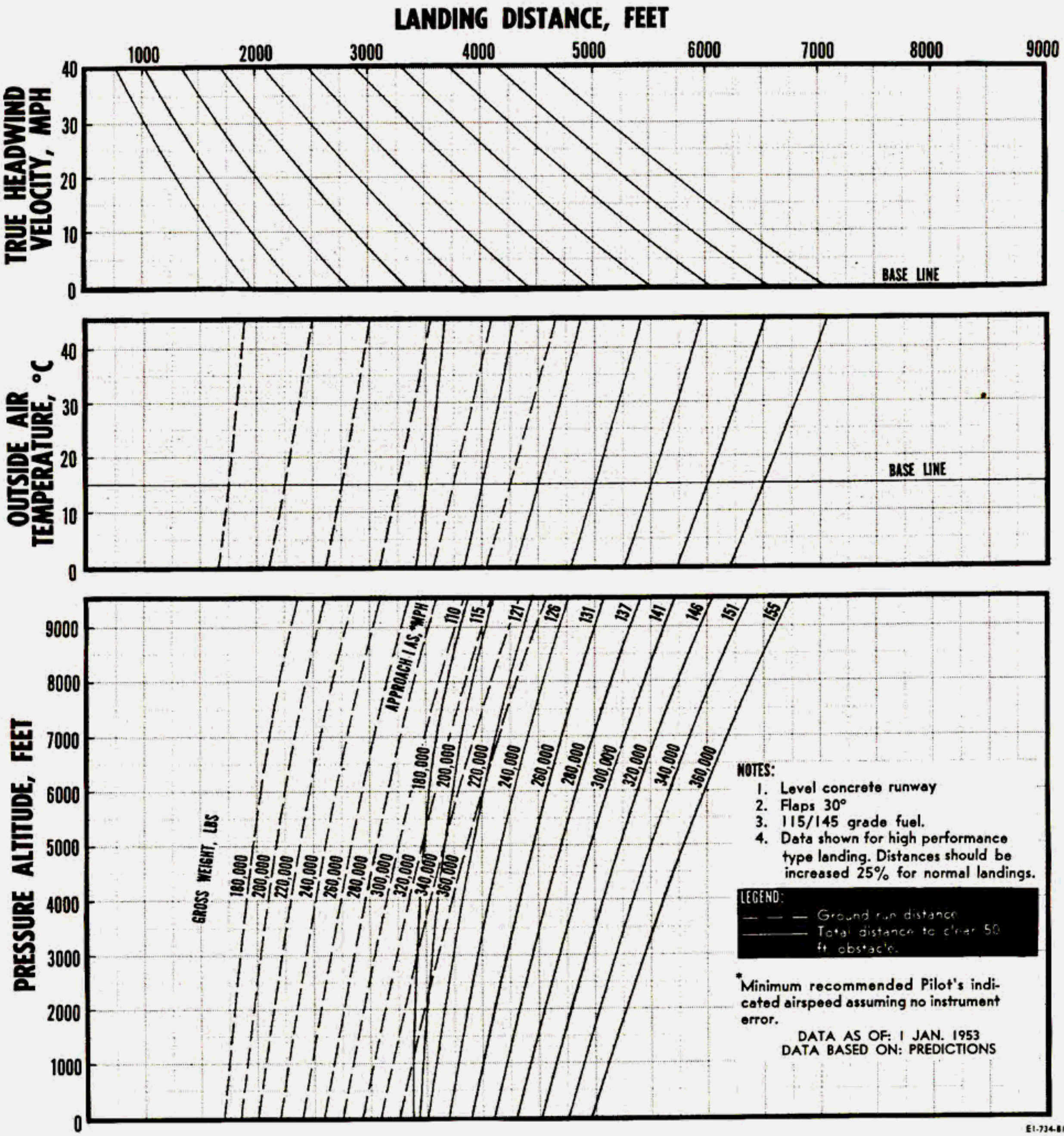


Figure A-273.

LANDING DISTANCE
BRAKES ONLY APPLIED DURING GROUND ROLL

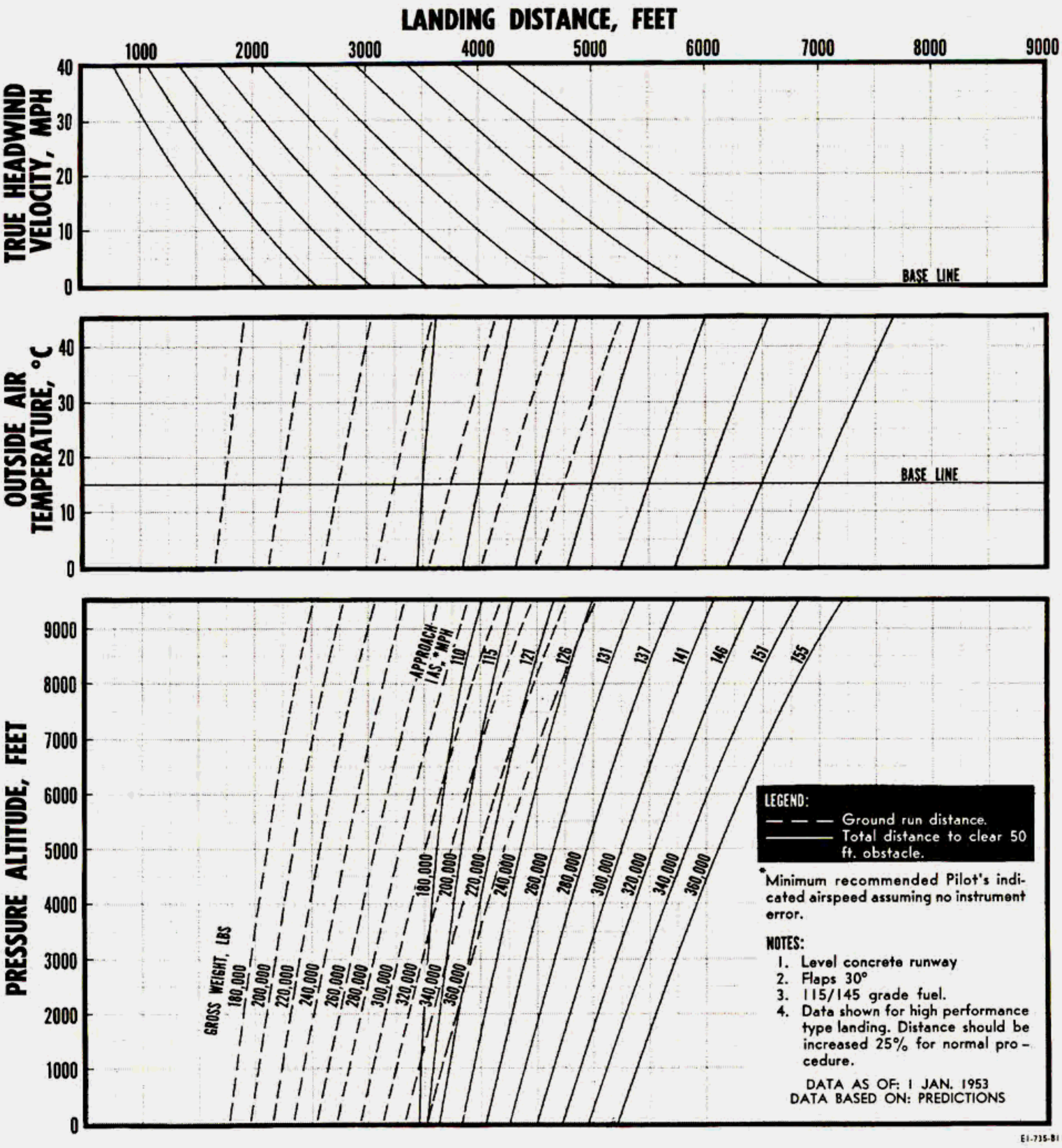


Figure A-274.

LANDING DISTANCE

SIX PROPELLERS IN REVERSE PITCH DURING GROUND ROLL (NO BRAKES)

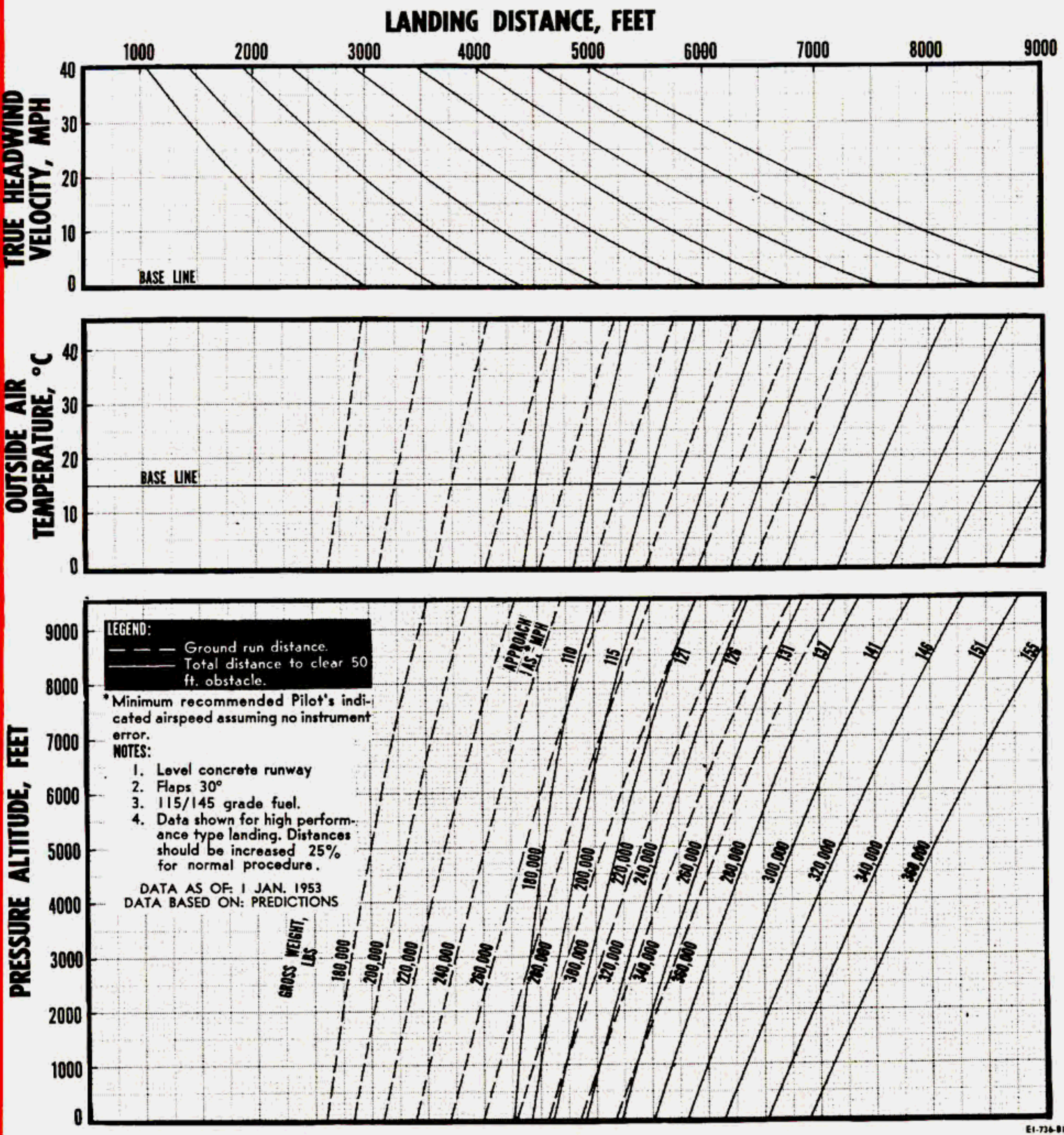


Figure A-275.

ALTERNATE CONFIGURATION DATA.

SPECIFIC RANGE AND LONG RANGE OPERATING PERFORMANCE DETERMINATION FOR PARTIAL RECIPROCATING ENGINE CONFIGURATIONS.

The specific range and long range operating performance data for partial reciprocating engine operation presented in this appendix is based on the former external configuration of this model. To validate this data for the present external configuration, corrections must be applied to these curves to compensate for the change in drag resulting from the removal of the astrodome, the sighting blisters, the nose turret, and the hand chaff dispenser chute. Figure A-276 presents equivalent weight corrections which, when applied to the specific range and long range operating curves for partial reciprocating engine operation, validates this data for the external configuration of the airplane described in this handbook.

EXAMPLE.

It is desired to set up power for a long range cruise of 300 nautical miles at 20,000 feet operating with five reciprocating engines. Initial cruise weight is 280,000 pounds and the distance is 300 nautical miles. Determine power setting, recommended EAS, amount of fuel used, and time in cruise.

Enter figure A-161 at 280,000 pounds gross weight and obtain a recommended EAS of 164 mph. Next, enter figure A-276 at 280,000 pounds (A) and project vertically to 164 EAS (B) (interpolated). From this point move horizontally to the left and read an incremental weight of 8100 pounds (C). The equivalent gross weight is 280,000 minus 8100 or 271,900 pounds. Using the equivalent gross weight, re-enter figure A-161 and read 1990 bhp (interpolated) and .041 nautical miles per pound. Engine operation is in single turbo with 20-degree SA in manual adjust. The average fuel used in flying 300 nautical miles is 300 ÷ .041, or 7320 pounds. Time for cruise is 300 ÷ [164 × (1.370 ÷ 1.152)], or 1.55 hours.

PERFORMANCE DETERMINATION FOR ALTERNATE EXTERNAL CONFIGURATIONS.

Any alteration of the external configuration of the airplane caused by opening the bomb bay doors, etc., results in a change of total airplane drag. If the altitude and air speed are to remain constant, this change in drag must be compensated for by a change in power. Since the "Specific Range" and "Long Range Operating Conditions Curves" presented in this appendix apply to a "clean" airplane only, a correction factor must be applied when other external configurations are used. This correction factor results in obtaining an "equivalent gross weight" for the alternate configuration—i.e., a gross weight for the altered airplane which will have the identical performance of an airplane with the standard external configuration.

The curves in figure A-277 are presented in order to obtain the equivalent gross weight for two external configurations. The use of the curve is dependent upon gross weight, desired air speed, and the drag change (referred to as flat plate area) for the particular airplane external configuration. The summary of flat plate area is shown in figure A-277.

EXAMPLE.

An airplane with six reciprocating engines operating and weighing 300,000 pounds is to fly at a density altitude of 35,000 feet and at an EAS of 170 mph. Find the power required to fly the airplane for these conditions with the bomb bay doors open.

Enter figure A-277 at a gross weight of 300,000 pounds (A) and move vertically to an equivalent flat plate area of 20.1 square feet (B). Now move horizontally to the base line (C). From (C), follow a line similar to the guide lines to 170 mph (D). Proceed horizontally to the scale on the left and read a weight increment of 34,000 pounds (E). The equivalent gross weight is the algebraic sum of the actual gross weight and the weight increment, 300,000 + 34,000, or 334,000 pounds.

Since the EAS, altitude, and equivalent gross weight are now known, it is necessary to enter the applicable "Specific Range Curve" (figure A-142) to obtain the new power setting. From this curve the power required is found to be 6 reciprocating engines operating at 2220 bhp and 4 jets operating at 85 per cent military rpm.

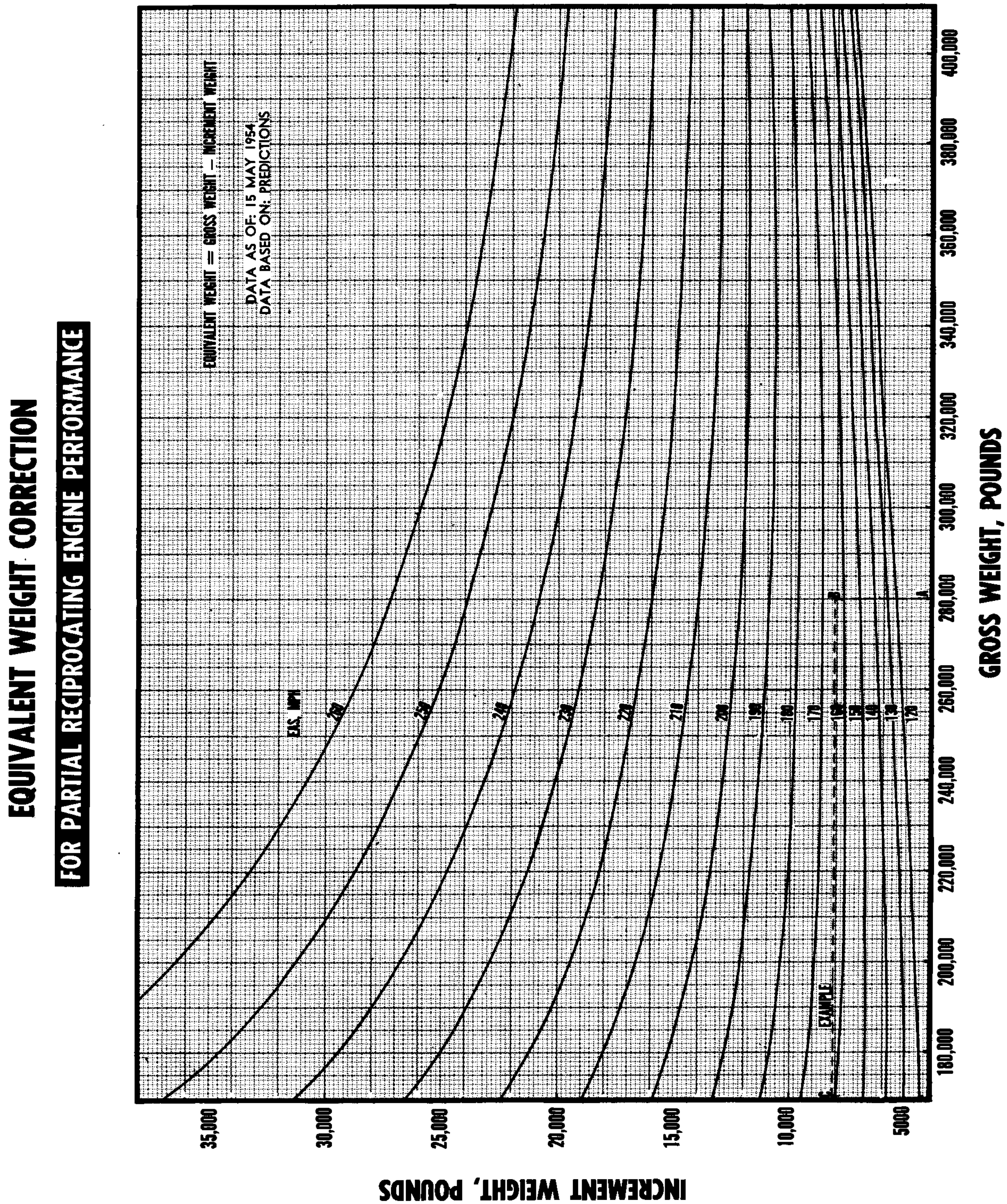


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Figure A-276.

EQUIVALENT WEIGHT DETERMINATION
FOR DRAG CHANGE

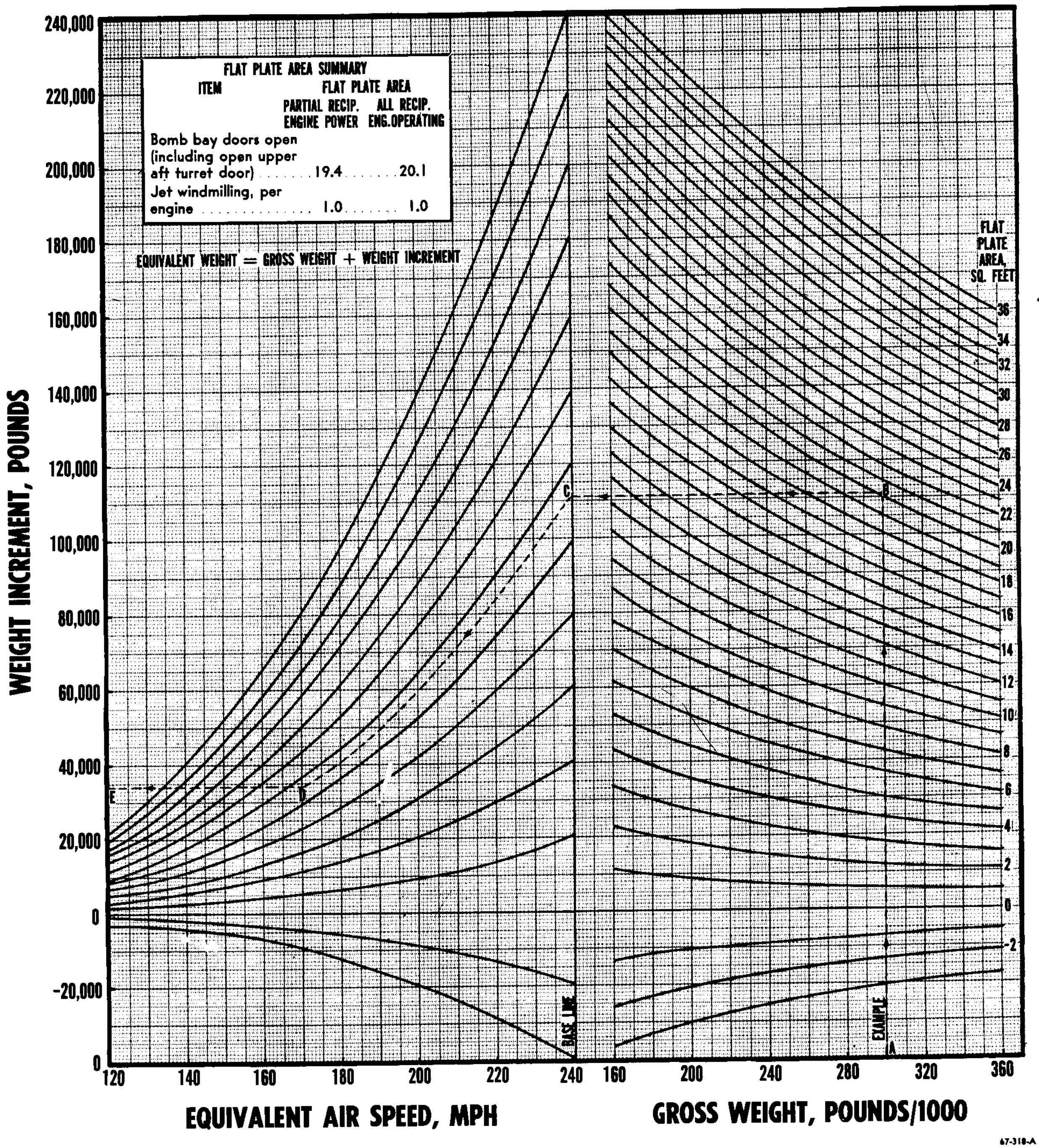

Figure A-277.

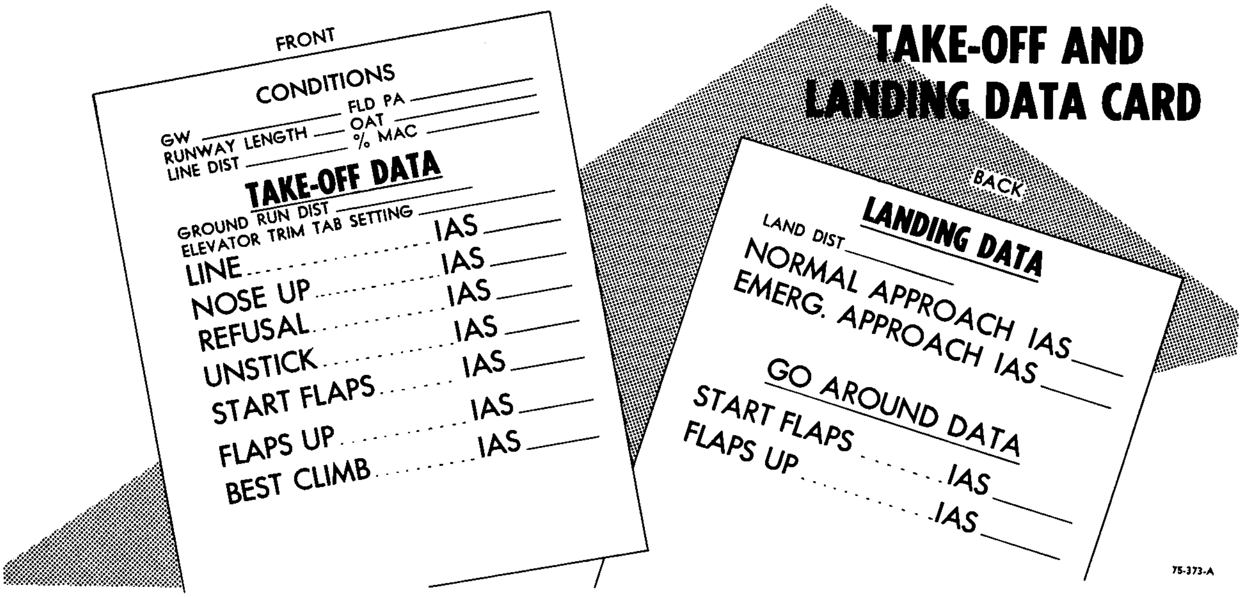

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Figure A-278.

MISSION PLANNING.

TAKE-OFF AND LANDING DATA CARD.

Prior to each take-off and before each landing, the aircraft performance engineer will compute and record all data contained on the take-off and landing data card. This recorded data will be checked by the aircraft commander and returned to the pilot. The pilot will call off pertinent data to the aircraft commander prior to and during take-off and prior to all landings.

Note

Completion of both take-off and landing data prior to take-off is necessary in the event a condition necessitating emergency landing occurs shortly after take-off.

Definitions.

The take-off and landing card definitions are as follows:

1. CONDITIONS.

a. GW (Gross Weight). Gross weight of the airplane in pounds at start of take-off roll, or at start of final approach whichever is applicable.

b. RUNWAY LENGTH. Usable length of runway in feet.

c. LINE DIST (Line Distance). Distance from start of take-off roll to runway acceleration-check marker.

d. FLD PA (Field Pressure Altitude). Altimeter reading in feet or dial setting of 29.92 inches Hg.

e. OAT. (Outside Air Temperature). Runway air temperature in °F.

f. % MAC. Airplane center of gravity location in per cent of mean aerodynamic chord.

2. TAKE-OFF DATA.

a. GROUND RUN DISTANCE. Distance in feet from start of acceleration to unstick speed.

b. ELEVATOR TRIM TAB SETTING. Elevator trim tab setting in degrees for take-off.

c. LINE IAS. Indicated airspeed in mph that aircraft accelerates to at the line distance.

d. NOSE-UP IAS. Indicated airspeed in mph at which nose wheel should be lifted from the runway.

e. REFUSAL IAS. Indicated airspeed in mph that the airplane can attain during normal acceleration and stop within the confines of the remaining runway using brakes and four engines reversed.

f. UNSTICK IAS. Indicated airspeed in mph at which the main gear leaves the ground.

g. START FLAPS IAS. Indicated airspeed in mph at which retraction of flaps is begun after take-off is completed.

h. FLAPS UP IAS. Indicated airspeed in mph at which retraction of flaps is completed.

i. BEST CLIMB IAS. Indicated airspeed in mph for start of climb to cruising altitude, gear and flaps up, and climb power adjusted.

3. LANDING DATA.

a. LAND DIST (Landing Distance). The horizontal distance in feet from point of touchdown.

b. NORMAL APPROACH IAS. Indicated airspeed in mph for normal final approach.

c. EMERGENCY APPROACH IAS. Indicated airspeed in mph for final approach with partial engine operation.

4. GO-AROUND DATA.

a. START FLAPS IAS. Indicated airspeed in mph at which retraction of flaps is begun after take-off is completed.

b. FLAPS UP IAS. Indicated airspeed in mph at which retraction of flaps is completed.

MISSION EXAMPLES.

Mission A.

An airplane has landed at an advance base for emergency repairs and must be ferried to a base 4000 nautical miles away with one reciprocating engine inoperative. The minimum altitude for the first 2000 miles is 5000 feet, while the minimum altitude for the remainder of the flight is 15,000 feet. A high speed descent to base is to be made at the end of the flight. Cruise distances and fuel consumed in climb are to be increased by five per cent to cover adverse operating conditions. The wind is negligible. The airplane weight less fuel load is 170,100 pounds and the total reserve fuel load is to be 20,000 pounds.

In this sample mission it is necessary to begin planning with the known landing gross weight and work backwards along the flight to arrive at a take-off gross weight. Therefore, the first step is to determine the landing gross weight. Add the basic weight (170,100 lbs) and the reserve fuel load (20,000 lbs) to obtain a landing gross weight of 190,100 pounds (H).

First, it is necessary to determine the gross weight at the beginning of the high speed descent (G). Since a quick inspection of the "High Speed Descent Curve" (figure A-268) shows that the fuel consumption during a high-speed descent is very small, assume a gross weight of 190,500 pounds for the beginning of the high-speed descent (G). An inspection of the long range chart for five-engine operation at 20,000 feet (figure A-213) and the equivalent weight correction chart figure A-276) shows that the equivalent air speed at the point 4000 miles from take-off (G) is 150 mph. Enter figure A-276 at 190,500 pounds and determine an incremental weight of —6700 pounds at 150 mph.

The equivalent weight is 190,500 — 6700, or 183,800 pounds. On figure A-213 at 183,800 pounds check the equivalent air speed to be 150 mph and determine a specific range of 0.0621 ground nautical miles per pound. The long range charts for five-engine operation at 25,000 and 30,000 feet (figures A-214 and A-215) and the equivalent weight chart (figure A-276) give the following equivalent gross weight, equivalent air speeds and ground nautical miles per pound.

Altitude	*Equivalent Gross Weight*	*EAS*	*Ground N.Mi./ Lb.*
20,000	183,800	150	0.0621
25,000	184,000	148	0.0627
30,000	183,000	152	0.0626

This indicates that the best operating conditions are at 25,000 feet; therefore, the high speed descent will begin at 25,000 feet at a gross weight which must be determined from the "High Speed Descent Curve" (figure A-156). Entering the curve with an assumed gross weight of 190,500 pounds and at an altitude of 25,000 feet, note that the total time to descend, as read from the scale on the left is 10.25 minutes. Using the fuel flow for the average altitude, 47.0 pounds per minute at 12,500 feet, determine the fuel loss to be 10.25 minutes x 47.0 pounds per minute or 482 pounds. Multiplying this by 5/6 to obtain five-engine fuel flow, results in 401 pounds of fuel consumed during the high speed descent. Therefore, the gross weight at start of high speed descent is 190,100 pounds plus 401 pounds = 190,501 pounds (G). A check of the "High Speed Descent Chart" shows that the time to descend from 25,000 feet to sea level at a gross weight of 190,500 pounds is still 10.25 minutes. Therefore the original assumption of 190,500 pounds is in agreement with the gross weight of 190,501 pounds. Assume no range gained during high speed descent.

The next step is to determine the gross weight at the point 3000 nautical miles from take-off (F). Using the best nautical miles per pound at the 4000-nautical mile point, the approximate gross weight for the 3000-nautical mile distance from take-off is found to be

$$\frac{1000 \times 1.05}{0.0627} + 190{,}501, \text{ or } 207{,}247 \text{ pounds.}$$

The equivalent gross weight, equivalent air speed and specific range at various altitudes at this distance for a gross weight of 207,247 pounds are:

Altitude	*Equivalent Gross Weight*	*EAS*	*Ground N.Mi./ Lb.*
20,000	200,150	154.3	0.0576
25,000	200,250	152.8	0.0576
30,000	200,650	149.0	0.0573

The specific range values for the 4000-nautical mile point (G) and the 3000-nautical mile point (F) indicate the best cruising altitude to be 25,000 feet. The average ground nautical miles per pound between these two points is $\frac{0.0627 + 0.0576}{2}$ or 0.0601. Using this

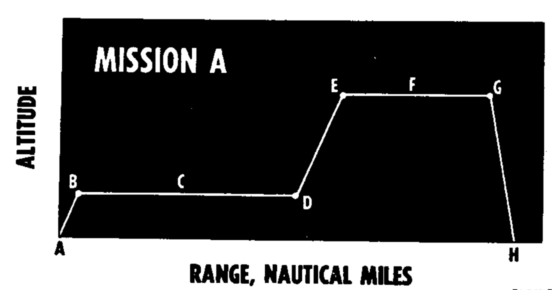

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Figure A-279.

value, the gross weight at the 3000-nautical mile distance (F) is then $\frac{1000 \times 1.05}{0.0601} + 190{,}501$, or 207,972.

This weight compared with the first approximation of 207,247 pounds is too much in error, so a gross weight of 207,972 pounds will be used as a second approximation. Using the second approximation for gross weight the specific range at 25,000 feet is seen to be 0.0571 miles per pound. The average specific range for the 3000-4000 nautical mile portion of the flight (FG) is then 0.0599 which gives a gross weight at the 3000-nautical mile distance (F) of 208,030 pounds. This value compares favorably with the second approximation so it will be used as the actual gross weight.

For the 2000-nautical mile distance from take-off (E) the gross weight is approximated as $\frac{1000 \times 1.05 +}{0.0571}$ 208,030, or 226,419 pounds. For this gross weight, the equivalent air speed, equivalent gross weight, and specific range at various altitudes are:

Altitude	*Equivalent Gross Weight*	*EAS*	*Ground N. Mi./ Lb.*
15,000	218,800	160	0.0529
20,000	219,300	155	0.0530
25,000	219,400	154	0.0521

The value of the best ground nautical miles per pound is seen to be at 20,000 feet. However, the difference between the nautical miles per pound at 20,000 feet and that at 25,000 feet is small, and the climb from 20,000 feet at the 2000-nautical mile distance (E) to 25,000 feet at the 3000-nautical mile distance (F) is much too gradual to make this flight plan practicable, so the entire 2000-4000 nautical mile portion of the flight (EG) will be flown at 25,000 feet. The average specific range for the 2000-3000 nautical mile portion of the flight (EF) is 0.0546, making the gross weight at the 2000 nautical mile distance (E) equal to 227,260 pounds. This weight compared with the first approximation of 226,419 pounds is too much in error, so a gross weight of 227,260 pounds will be used as a second approximation. Using the second approximation for gross weight the specific range at 25,000 feet is seen to be 0.0511 miles per pound. The average specific range for the 2000-3000 nautical mile portion of the flight (EF) is then 0.0541 which gives a gross weight at the 2000-nautical mile distance (E) of 227,440 pounds. This value compares favorably with the second approximation so it will be used as the actual gross weight.

For the first leg of the flight (BD) the altitude for the maximum range (best ground nautical mile per pound) for the approximate equivalent gross weight range of this portion of the flight, as shown in figure A-260, is approximately 15,000 feet; therefore, the first leg (BD) will be flown at 15,000 feet.

Since the gross weight at the beginning of the last 2000 nautical miles (E) is known (277,440 pounds), the climb from 15,000 feet to 25,000 feet (DE) can be determined. Enter the "Long Range Climb Curve" (figure A-119) at 229,740 pounds (2300 pounds added to 227,-440 to obtain climb performance with one engine inoperative) and 25,000 feet altitude. Determine an equivalent gross weight (not corrected to cover adverse conditions) at start of climb (15,000 feet) (D) to be 231,800 pounds. Increasing the fuel consumed in climb by 5 per cent increases this weight to 231,900 pounds. The actual gross weight is 231,900 — 2300 or 229,660 pounds, the air distance in climb in 72 nautical miles, and the time to climb is 23.6 minutes. The power setting given for 6-engine climb (2085 bhp) must be increased by 20 per cent (2500 bhp) for 5-engine operation in order to maintain an equivalent climb performance.

The remainder of the effective ground distance to be flown in the second 1000 nautical miles from take-off (CD) is approximately (1000×1.05) —72 or 974 nautical miles. For a weight at (D) of 229,600 pounds the equivalent weight chart (figure A-276) and the long range operation curve at 15,000 feet (figure A-212) give an equivalent weight of 222,000 pounds, an equivalent air speed of 160.3 mph, and a specific range of 0.052 nautical miles per pound; hence the weight 1000 nautical miles from take-off (C) will be approximately 974/0.0520 + 229,600 or 248,330 pounds. With this approximation, it is seen that the value of the specific range at the 1000-nautical mile distance (C) at 15,000 feet is 0.0478 nautical miles per pound. The average ground nautical miles per pound for the 1000-2000 nautical mile portion (CD) will be 0.0499 making the gross weight at the 1000-nautical mile point (C) equal 249,120 pounds. This weight compared with the first approximation of 248,330 pounds is too much in error, so a gross weight of 249,120 pounds will be used as a second approximation. Using a gross weight of 249,120 pounds the specific range is seen to be 0.0476 nautical miles per pound; the average specific range is $\frac{0.0520 + 0.0476}{2}$ or 0.0498; and the gross weight at the 1000-nautical mile distance (C) is 249,158 pounds. This value compares favorably with the second approximation so it will be used as the actual gross weight.

For the start of the first leg of the flight (B) the gross weight is approximated in the same manner as above to be 270,242 pounds. The ground nautical miles per pound is found to be 0.0433. For the distance of (1000 × 1.05) —33 = 1017 nautical miles (33 nautical miles assumed in climb to 15,000 feet) the average ground nautical miles per pound is 0.0454. The gross weight at the end of climb to 15,000 feet is 271,560 pounds. This gross weight compared with the first approximation is too much in error, so a gross weight of 271,560 pounds will be used as a second approximation. Using the second approximate gross weight (271,560 pounds) the specific range is found to be 0.0430. The average nautical miles per pound is 0.0453 and the actual gross beginning of the cruise (B).

To find the time to climb from sea level to 15,000 feet weight is $\frac{1017}{.0453}$ + 249,158 or 271,606 pounds at the (AB) enter the "Climb Performance Curve" (figure A-125) with 271,606 + 32,000 = 303,606 pounds (32,000 pounds added to gross weight to obtain climb performance with one engine inoperative) at 15,000 feet altitude and obtain 12.3 minutes for the time to climb and 33 nautical miles for the distance in climb from sea level, which compares with the assumed value. Following parellel to the climb guide lines to sea level determine the gross weight to be 309,500 — 32,000 or 277,500 pounds. Increasing the fuel consumed in climb by 5 per cent gives a gross weight at the beginning of climb of 283,688 pounds.

The initial gross weight before warm-up and take-off will be 283,688 + 4200 or 287,888 pounds.

The time of flight for each leg of the mission is determined by dividing the ground distance by the average ground speed. Hence, the time to climb from sea level to 15,000 feet (AB) is 0.205 hours; the time for the leg (BC) is 5.36 hours; for leg (CD) it is 5.19 hours. The time to climb to 25,000 feet (DE) is 0.39 hours; the time for the leg (EF) is 5.01 hours; and for the remaining portion (FG), it is 5.13 hours. The time for the high speed descent is 0.17 hours. The total flight time is then 21.455 hours.

The take-off gross weight is 287,888 pounds; the advance base runway length is 6000 feet; the pressure altitude is 2000 feet; the ambient air temperature is 80°F; and the effective headwind is 5 mph. Enter figures A-82 and A-83 to obtain a ground run distance of 3220 feet and a take-off distance to clear a 50-feet obstacle of 4075 feet. For no-wind condition these distances would be 3480 feet and 4350 feet, respectively, making operations from the advance base safe at this take-off gross weight.

Mission B.

A bomb load of 10,000 pounds is to be dropped from 40,000 feet on a target 3000 nautical miles from the take-off and landing point. A take-off gross weight of 370,000 pounds has been authorized, and the landing gross weight, including fuel reserve, is 193,191 pounds. The combat zone, which is to be as long as possible, will be flown at an altitude of 40,000 feet under long range operating conditions. The outbound cruise altitude will be 25,000 feet while the inbound cruise altitude will be 25,000 feet. The wind is negligible. Mission range is to be increased 5% to cover adverse operating conditions and no credit will be taken for range gain in descent. Fuel used in warm-up and take-off is 4200 pounds, which includes 300 pounds of ADI fluid.

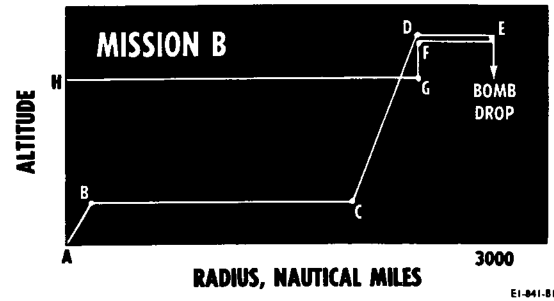

Figure A-280.

By making various assumptions, this mission may be worked out starting from the take-off gross weight. However, some estimating and re-estimating may be omitted by starting with the landing weight and working backward in the following manner. Assume a combat zone of 600 nautical miles. The inbound cruise leg at 25,000 feet (GH) will then be 2400 nautical miles. When increased by 5 per cent, GH becomes 2520 nautical miles and the combat zone will be 630 nautical miles. To determine the gross weight at start of inbound cruise (G) enter the "Long Range Distance Prediction Chart" (figure A-207) at 193,191 pounds and 25,000 feet and read a reference range of 8360 nautical miles. Re-enter figure A-207 at 5840 miles (8360-2520) and 25,000 feet and read the gross weight of 238,600 pounds. This is the gross weight at G and, since no credit is taken for descent, it is also the gross weight at the end of the combat zone (F). Re-enter the same chart at 40,000 feet at a gross weight of 238,600 pounds and read a reference range of 2500 nautical miles. Move along the curve a distance equal to the combat zone to 2500 — 630 or 1870 miles and obtain the gross weight after bomb drop which is 255,800 pounds. The gross weight prior to bomb drop (E) will now be 255,800 + 10,000, or 265,800 pounds. Again using figure A-207 enter at 40,000 feet and 265,800 pounds and read the reference range to be 1520 nautical miles. Subtract the combat zone distance (630 miles) and read the gross weight at 890 miles to be 286,300 pounds. This is the gross weight at D prior to the combat zone.

To determine the gross weight at the end of the outbound cruise at 5000 feet, enter the "Long Range Climb Performance Chart" (figure A-121) at 40,000 feet and at a gross weight of 286,300 pounds and read a reference distance of 429 miles. Move parallel to the nearest guide line to 5000 feet and read the reference distance of 11 miles and the gross weight of 306,500 pounds at start of climb (C). The distance required for the climb is 429 —11, or 418 nautical miles. The distance to climb to 5000 feet after take-off is approximately 14 miles. Thus, the 5000 foot cruise leg is 2520 —14 —418, or 2088 nautical miles. Enter figure A-207 at 306,500 pounds to obtain a reference distance of 5585 miles. Re-entering at 5585 —2088, or 3497 miles will establish the gross weight at the start of cruise at 5000 feet to be 366,500 pounds. To determine the gross weight at sea level, enter the "Maximum Continuous Power Climb Performance Chart" (figure A-125) at 5000 feet and 366,500 pounds. The distance required for the climb is seen to be 14 nautical miles, and by moving parallel to the nearest guide line to sea level the gross weight prior to climb is read at 369,500 pounds. The warm-up, taxi, and take-off allowance of 4200 pounds is added to the 369,500 pounds to give an initial gross weight of 373,700 pounds.

Since this weight is higher than the allowable initial weight of 370,000 pounds, we will assume a shorter combat zone and rework the mission as we have just done. By assuming a combat zone of 500 nautical miles and working from the landing weight of 193,191 pounds back to the starting weight we will establish the initial gross weight to be 368,000 pounds. Now we have bracketed the actual initial weight of 370,000 pounds and by interpolation the correct combat zone may be approximated quite closely. The figures as they stand are as follows:

Assumed Combat Zone	*Take-off Gross Weight*
600	373,700
500	368,000

The interpolation is as follows:

$$\text{The corrected combat zone} = 600 - \frac{(373{,}700 - 370{,}000)}{(373{,}700 - 368{,}000)} \times 100$$
$$= 535 \text{ nautical miles}$$

This corrected combat zone will now be used and the mission again followed through from the landing gross weight to the starting gross weight. Since the procedure is identical to that followed in our first assumption, it will be omitted here and only the distances and gross weights will be recorded.

Gross weight at H = 193,191 pounds
Cruise leg HG = (3000 — 535) × 1.05 = 2,588 nautical miles.
Gross weight at G = 239,600 pounds
Gross weight at F = 239,600 pounds
Combat zone DE and EF = 535 × 1.05 = 561 nautical miles
Gross weight at E (after bomb drop) = 254,700 pounds
Gross weight at E (before bomb drop) = 264,700 pounds
Gross weight at D = 282,300 pounds
Climb distance CD = 382 nautical miles
Gross weight at C = 301,300 pounds
Cruise leg BC = 2192 nautical miles
Gross weight at B = 362,800 pounds
Climb distance AB = 14 nautical miles
Gross weight at A = 365,700 pounds
Take-off gross weight = 365,700 + 4200 = 369,900 pounds.

The small discrepancy between this take-off gross weight and the allowable take-off gross weight makes another approximation unnecessary.

Mission C.

A 10,000-pound bomb is to be dropped from 40,000 feet altitude on a target 3600 nautical miles from the take-off base. The airplane is to land at a base 2000 nautical miles from the target. The first 2600 nautical miles are to be flown at 5000 feet or above, the next 500 nautical miles at 20,000 feet or above, and the last 500 nautical miles to target at 40,000 feet. The airplane will fly at maximum continuous power for 15 minutes prior to bomb drop and for 10 minutes after bomb drop. The airplane is to remain at 40,000 feet after bomb drops and the final 1500 nautical miles to the base are to be flown above 20,000 feet. The mission range is to be increased 5 per cent to cover adverse operating conditions. An emergency fuel reserve of 6000 pounds plus fuel for 30 minutes cruise at sea level is also to be considered. A 25 knot head wind is predicted for the portion of the flight at 40,000 feet. The take-off gross weight, mission time, distance in climb, etc., may be determined by working backwards along the flight path, starting with the landing gross weight. The landing gross weight is obtained by summing up all the known weights of the airplane, less fuel and bombs, from the "Weight and Balance Handbook" and then adding in the weight of crew, oil, ammunition, reserve fuel, etc.

The landing weight for this sample mission is 175,871 + 6000 or 181,871 pounds plus fuel for 30 minutes cruise at sea level. The fuel for 30 minutes cruise at sea level may be determined by first entering the "Long Range Operating Conditions at Sea Level" (figure A-194) at approximately 183,000 pounds and obtaining the bhp which is 925 in manual lean. Now enter the "Engine Power Schedule at Sea Level" table (figure

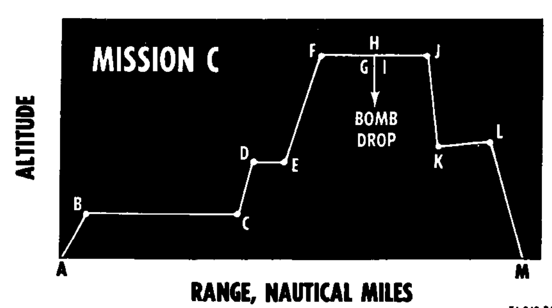

Figure A-281.

A-19) and determine the fuel flow to be 418 pounds per hour per engine. The fuel for 30 minutes cruise is 418 × 6 × .5 × 1.05, or 1320 pounds. Therefore, the landing weight is 181,871 plus 1320, or 183,191 pounds. Working backward along the mission, the next step is to determine the range gained (LM) during descent to the landing base. Neither altitude nor gross weight is known at the end of optimum altitude cruise (L); therefore, they must be found by trial and error. Reference to the "Opitmum Altitude Long Range Operating Conditions" (figure A-258) will indicate the optimum altitude prior to descent to be approximately 34,500 feet for our landing gross weight. Using this assumption and entering the "Long Range Descent Curve" (figure A-266) at the landing weight (183,191 pounds) at sea level and moving parallel to the nearest guide line to the predicted altitude (34,500 feet), the gross weight is determined to be 189,600 pounds. If the initial assumption were correct, this gross weight and altitude should be in agreement with the optimum altitude cruise chart. If there should be a disagreement, other assumptions should be made and the above steps repeated. A check will show our figures to be in agreement. At this condition, a range of 460 nautical miles and a time of 1.58 hours are read from the long range descent curve. This is the range (LM) and time required to descend to sea level, since working backwards, the time and range at sea level are zero.

The range traversed during the optimum altitude cruise leg (KL) plus the range gained during descent to base, (460 miles, LM) plus the range to descend from 40,000 feet (JK) equals 1575 nautical miles (1500 × 1.05). Therefore, the descent (JK) and the cruise leg (KL) have a total range of 1115 nautical miles (1575 —460).

The range of leg (KL) is determined by trial and error. Estimate a gross weight of 206,600 pounds at beginning of cruise (K) and determine the optimum altitude to be 32,000 feet from the "Optimum Altitude Curve" (figure A-258). Enter the "Optimum Altitude Long Range and Time Prediction" chart (figure A-258A) for 5000 feet minimum altitude, at the gross weight established for the end of cruise (189,600 pounds) and get a reference range of 8820 nautical miles and a reference time of 44.2 hours. Re-enter the chart at the estimated gross weight of 206,600 pounds and get a reference range of 7820 nautical miles and a reference time of 39.8 hours. The range and time for the optimum altitude cruise leg are 8820 —7820 or 1000 nautical miles and 44.2 — 39.8 or 4.4 hours. To get the descent conditions from 40,000 feet to optimum altitude (32,000 feet) enter the "Long Range Descent Chart" (figure A-266) at 32,000 feet and the estimated gross weight of 206,600 pounds and read a reference range of 404 miles and a reference time of 2.02 hours (K). Parallel the nearest guide line to 40,000 feet and read a gross weight of 208,000 pounds, a reference range of 519 miles and a reference time of 2.48 hours (J). The range and time for descent (JK) are 519 —404 or 115 nautical miles and 2.48 —2.02 or .46 hours. The range for the descent (JK) and the cruise leg (KL) is then 115 plus 1000 or 1115, which is the desired range (JKL). If this range did not agree with the desired range, another gross weight has to be assumed at (K) until the desired range is obtained.

The total distance at 40,000 feet after target is 500 × 1.05 or 525 nautical miles (HJ). This distance includes 10 minutes of high speed after bomb drop. Estimate the gross weight at the end of this 10-minute period (HI) to be 216,500 pounds. Enter figure A-146 at 2650 bhp for the reciprocating engines and 96 per cent for the jets and read a true air speed of 369.5 knots at a gross weight of 216,500 pounds. Correcting this speed for the 25-knot headwind results in a true ground speed of 344.5 knots during the 10-minute period and the distance covered is 57 nautical miles (HI). The cruise distance (IJ) is 525 —57 or 468 nautical miles. Enter the "Long Range Operating Conditions at 40,000 Feet" (figure A-202) to determine the average specific range between 208,000 pounds and the estimated 216,500 pounds for the 25 knot headwind condition to be .048 miles per pound. The gross weight consumed in cruising from I to J is 468 divided by .048 or 9750 pounds. Thus the gross weight at I is 208,000 + 9750 or 217,750 pounds.

To determine the time required for the cruise (IJ) it will be necessary to re-enter figure A-202 to get the average cruise speed which is 153 mph, EAS. Converted to ground speed, this is (153 × 1.7555) — 25 (headwind) or 243 knots. Thus the time increment (IJ) is 468÷243 or 1.9 hours. To determine the fuel used in 10 minutes at high speed, obtain a fuel flow of 184 pounds per minute (1840 pounds per hour per engine at 2650 bhp) for the reciprocating engines from figure A-34. From figures A-63 and A-64 obtain a fuel flow of 107 pounds per minute (1599 pounds per hour per engine) for the jets at 96 per cent military rpm, 40,000 feet (NACA day), and 210 mph EAS (369.5 knots). The total fuel flow is 184 + 107 or 291 pounds per minute. In 10 minutes 2910 pounds would be consumed; therefore, the weight after bomb drop would be 217,750 plus 2910, or 220,660 pounds. The weight prior to bomb drop would be 220,660 plus 10,000 or 230,660 pounds. In 15 minutes at maximum continuous power the fuel used is 15 × 291 or 4365 pounds and the weight prior to high speed (G) is 230,660 plus 4365 or 235,025 pounds. At an average gross weight of 232,842 pounds, read a true air speed of 366 knots from figure A-146, as before. The ground speed is 366 —25 or 341 knots and is in the average velocity during the 15 minutes of high speed (GH); the range traveled is 85 nautical miles. The cruise at 40,000 feet prior to target run (FG) would be 525 —85, or 440 nautical miles. Estimate the gross weight at F to be 246,750 pounds. Enter figure A-146 at an average gross weight of 240,-875 pounds and a headwind condition of 25 knots and read the average ground miles per pound to be .0375.

The gross weight required for cruise (FG) is then 440 ÷ .0375, or 11,720 pounds. Thus the gross weight prior to cruise (FG) is 235,025 + 11,720, or 246,745 pounds which corresponds to the estimate. Re-enter figure A-146 at 240,875 pounds and read the average EAS for cruise (FG) to be 152. The ground speed is then (1.7555 × 152) — 25 or 241 knots, and the time required is 440 ÷ 241 or 1.8 hours.

Enter the "Long Range Climb Curve" (figure A-120) at 40,000 feet and 246,745 and determine the gross weight at start of climb to be 253,700 pounds (E). The climb distance (EF) is 171 nautical miles and the time in climb is .8 hours. The distance to be flown at 20,000 feet (DE) is 525 —171, or 354 nautical miles. Enter the "Long Range Distance Prediction" chart (figure A-207) at 20,000 feet and 253,700 pounds to obtain a reference range of 5810 nautical miles. Move down at constant altitude to a range of 5810 —354 or 5456 nautical miles to obtain a gross weight of 261,200 pounds. This is the gross weight at D. By entering the "Long Range Time Prediction" chart (figure A-208) at gross weights of 253,700 pounds and 261,200 pounds and noting the corresponding reference times, the time for cruise (DE) is found to be 1.7 hours. Re-enter the "Long Range Climb" curve (figure A-120) at 20,000 feet and 261,200 pounds to determine the gross weight at start of climb from 5000 feet (C). The gross weight is found to be 265,100 pounds. The range gained during climb (CD) is 116 nautical miles and the time for climb is 0.7 hours. Since the distance for climb to 5000 feet (AB) at normal rated power is approximately 12 nautical miles, the distance to be traveled at 5000 feet (BC) is (2600 — 12 — 116) × 1.05, or 2595 nautical miles. The weight change and elapsed time may be determined from figures A-207 and A-208. Using the same method as before, the gross weight (B) is determined to be 329,700 pounds and the cruise time at 5000 feet (BC) is 14.8 hours. From the climb performance curves for maximum continuous power (figure A-125) the weight at the beginning of climb to 5000 feet (AB) is found to be 325,200 pounds, the distance covered is 12 nautical miles and the time for climb is 0.1 hours. The warm-up, taxi, and take-off allowance of 4200 pounds is added to the 325,200 pounds to give an initial gross weight of 329,400 pounds.

The total fuel load will be take-off gross weight minus bomb load minus mission basic weight (329,400 —183,191 —10,000 = 136,209 pounds).

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