OPERATING LIMITAT[illegible]

SECTION V
operating limitations

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INTRODUCTION.

This section includes the engine and aircraft limitations which must be observed during normal operation. Cognizance must be taken of instrument markings, since the limitations stated thereon are not repeated in the text (figure 5-1).

MINIMUM CREW REQUIREMENT.

The minimum crew consists of a pilot, a copilot, and a flight mechanic. Additional crewmembers, as required, will be added at the discretion of the commander.

INSTRUMENT MARKINGS.

ENGINE POWER INSTRUMENTS.

Refer to figure 5-1 for engine power limitations.

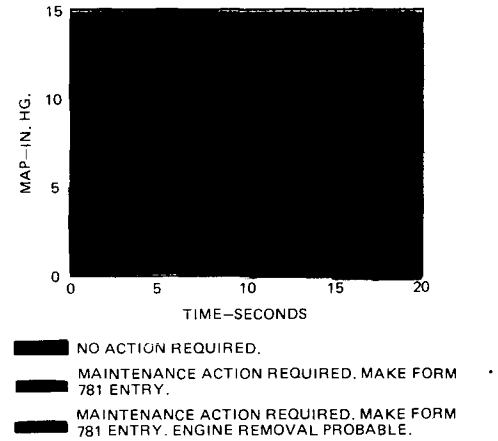
ENGINE LIMITATIONS.

If an engine overspeed condition occurs and the engine exceeds 2950 rpm the engine must be inspected upon landing. If overspeed is in excess of 3400 rpm, the engine must be replaced.

EXCESSIVE MANIFOLD PRESSURE (OVERBOOSTING).

When overboost occurs, combustion temperatures rise. If overboost of sufficient magnitude exists, detonation and pre-ignition may result and cause physical damage to the engine, possibly in a matter of seconds. If at takeoff rpm (2800), any MAP above the maximum MAP is an overboost. If at METO power rpm (2600) or below, any MAP above METO power MAP is an overboost. To determine if an entry is required in Form 781 or maintenance is required, refer to the overboost chart.

OVERBOOST CHART



CAUTION

If overboost conditions represented by the yellow and red areas of the Overboost Chart occur, do not take off, or if airborne, land as soon as practicable. Should mission requirements and flight safety dictate,continue operation of overboost engine, consideration should be given to reduce power and a close surveillance maintained.

NOTE

The above overboost limits are not intended in any way to allow or condone operation of the engine at any combination of horsepower, rpm, MAP in excess of those authorized in the Power Performance Charts of the App 1, Part II (T.O. 1C-118A-1-1).

ENGINE POWER TIME LIMITATIONS.

The engines are approved for five minutes of operation at maximum power during takeoff and climb at takeoff speed. There is no time limitation in the use of METO power.

CARBURETOR AIR TEMPERATURE LIMITATIONS.

LOW BLOWER - Max allowable CAT. (preheat applied) 38°C.

HIGH BLOWER - Maximum allowable CAT. 15°C.

NOTE

When preventive preheat is applied, the maximum carburetor air temperature limit in low blower is 38°C. In high blower the maximum CAT is 15°C; however, this limit has been extended to 30°C for cruise up to 1200 brake horsepower at mixture settings of 12 BMEP drop from best power mixture. It is mandatory that these higher CAT limits in high blower, along with the specified BHP, BMEP, and CHT (204°C) limits, not be exceeded. If any of these limits are exceeded, the maximum CAT limit reverts to 15°C.

PROPELLER LIMITATIONS.

See figure 5-1 for normal propeller limitations.

AIRSPEED LIMITATIONS.

Maximum dive speed (V_{ne}) sea level to 12,000 feet...... 329 KIAS; above 12,000 feet, reduce speed 5 KIAS per 1000 feet

Maximum speed for normal operation (V_{no}) - sea level to 17,000 feet .... 246 KIAS; above 17,000 feet, reduce speed 5 KIAS per 1000 feet

Landing gear extended .... 170 KIAS

Flaps extended 30 degrees or less.. 170 KIAS

Flaps extended more than 30 degrees...................... 150 KIAS

Landing light extended............ 150 KIAS

Propeller unfeathering .... 140 KIAS

Fuel dumping..................... 185 KIAS

Window or exit open............... 195 KIAS

Over-the-wing exit open........... 220 KIAS

Cockpit window open .... 260 KIAS

Hardover signal for autopilot....... 210 KIAS

Maximum propeller feathered speed........................... 190 KIAS

Maximum tire rotation speed....... 139 KIAS

For flight in severe turbulence, indicated speeds of 165 KIAS are recommended for weights under 100,000 pounds and speeds of 175 KIAS for weights above 100,000 pounds.

MANEUVERS.

The following maneuvers are permitted:

Bank angles up to but not in excess of 60 degrees. Slipping or skidding as required for asymmetric power conditions or for landing approaches, at indicated airspeeds up to but not in excess of 225 KIAS.

CENTER OF GRAVITY (CG) LIMITATIONS.

Aft limit .... 33 percent MAC

Forward limits (landing gear up)

Up to 83,200 pounds .... 9 percent MAC

83,200 to 103,000 pounds..... 13 percent MAC

103,000 to 107,000 pounds.... 13.8 percent MAC

Forward limits (gear down)

Up to 85,600 pounds .... 11 percent MAC

85,600 to 102,200 pounds .... 14.1 percent MAC

102,200 to 103,000 pounds.... 14.6 percent MAC

103,000 to 107,000 pounds.... 16.9 percent MAC

NOTE

MAC limits given may be computed linearly in order to determine the correct limit for a specific gross weight.

Refer to Handbook of Weight and Balance, T.O. 1-1B-40.

OPERATING LIMITS—NORMAL FUEL GRADE.

The normal operating limits on grade 115/145 fuel are as follows:

Condition	RPM	BHP	MAX MAP. (In. Hg)	(1) Critical Altitude	BMEP	MAX CHT.	MAX CAT.	Mixture
Maximum Wet Low Blower (5 Minutes	2800 (±25)	2500	62.0 at SL (9) 61.5 at 3800 feet	2600 feet (MAP-61.0)	253	260°C	38°C (10)	AUTO RICH
Maximum Wet High Blower (5 Minutes)	2600	1900	49.0 (9) 50.5 at 10,000 feet	15,700 feet	207	260°C	15°C	AUTO RICH
Maximum Dry Low Blower (5 Minutes)	2800 (±25)	2300	63.0 at SL (9) 62.5 at 3300 feet	3300 feet (MAP-62.5)	232	260°C	38°C (10)	AUTO RICH
Maximum Dry High Blower (5 Minutes)	2600	1750	49.5 51.5 at 10,000 feet	15.000 feet	191	260°C	15°C	AUTO RICH
METO Low Blower	2600	1900	51.5 at SL 50.0 at 7200 feet	7200 feet (MAP-48.0)	207	232°C (2)	38°C (10)	AUTO RICH (3)
METO High Blower	2600	1700	50.0 at 10,000 feet 47.5 at 15,900 feet	15,400 feet (MAP-46.7)	185	232°C (2)	15°C	AUTO RICH (3)
Maximum Cruise Low Blower	2300	1240	37.3 at SL 33.3 at 14,000 feet	(4)	153 (5)	204°C (8)	38°C (10)	12 BMEP Drop (7)
Maximum Cruise High Blower	2300	1200	35.1 at 10,000 feet 34.6 at 18,800 feet	(4)	147 (6)	204°C (8)	15°C (11)	12 BMEP Drop (7)

(1) Critical altitude in climb as determined by flight test.

(2) 260°C allowed for 30 minutes.

(3) Fuel flows may be leaned to minimum values shown in Appendix.

(4) Function of gross weight.

(5) Maximum cruise low blower -- 155 BMEP (except when at 1240 BHP and 2300 rpm -- 153 BMEP).

(6) Maximum cruise high blower -- 150 BMEP (except when at 1200 BHP and 2300 rpm -- 147 BMEP).

(7) With reference to "Best Power" mixtures.

(8) 232°C Maximum CHT for continuous operation.

NOTE

204°C is the desired maximum CHT for continuous operation.

(9) Maximum MAP for takeoff may be increased by existing vapor pressure up to 1.5 In. Hg (refer to Part 2 Appendix).

(10) +38°C maximum allowable CAT with preheat applied.

(11) Maximum cruise high blower CAT may be 30°C under certain condition, see CARBURETOR AIR TEMPERATURE LIMITATIONS.

OPERATING LIMITS—ALTERNATE FUEL GRADE.

When an aircraft has been serviced with 100/130 GRADE AVGAS, the power charts for ALTERNATE GRADE 100/130 fuel shall be used until the following conditions are accomplished:

(a) After one full load of 115/145 GRADE AVGAS has been incrementally added to tank/tanks, NORMAL GRADE 115/145 limits apply except that take-off power will be limited to "WET" power only and High Blower METO power will not be used.

(b) After two full loads of 115/145 GRADE AVGAS has been incrementally added to tank/tanks, NORMAL GRADE 115/145 limits apply.

NOTE

In cases of aircraft or engines which do not have operative water injection (ADI), it is mandatory to adhere to the "two full loads" rule prior to using NORMAL GRADE 115/145 power schedules.

The operating limits on grade 100/130 fuel are as follows:

Condition	RPM	BPH	MAX MAP. (In. Hg)	(1) Critical Altitude	BMEP	MAX CHT.	MAX CAT.	Mixture
Maximum Wet Low Blower (5 Minutes)	2800 (±25)	2400	59.5 at SL (9) 59.0 at 5000 feet	3500 feet (MAP-59.0)	242	260°C	38°C (10)	AUTO RICH
Maximum Wet High Blower (5 Minutes)	2600	1850	48.0 (9) 49.5 at 10,000 feet	16,500 feet	201	260°C	15°C	AUTO RICH
Maximum Dry Low Blower (5 Minutes)	2800 (±25)	1950	53.0 at SL (9) 51.0 at 9800 feet	8200 feet (MAP-50.1)	197	260°C	38°C (10)	AUTO RICH
Maximum Dry High Blower (5 Minutes)	2600	1700	47.5 49.0 at 10,000 feet	16,250 feet	185	260°C	15°C	AUTO RICH
METO Low Blower	2600	1800	48.5 at SL 46.5 at 9200 feet	8700 feet (MAP-45.2)	196	232°C (2)	38°C (10)	AUTO RICH (3)
METO High Blower	2600	1700	49.0 at 10,000 feet 47.5 at 16,250 feet	15,400 feet (MAP-46.7)	185	232°C (2)	15°C	AUTO RICH (3)
Maximum Cruise Low Blower	2300	1240	37.3 at SL 33.3 at 14,000 feet	(4)	153 (5)	204°C (8)	38°C (10)	12 BMEP Drop (7)
Maximum Cruise High Blower	2300	1200	35.1 at 10,000 feet 34.6 at 18,800 feet	(4)	147 (6)	204°C (8)	15°C (11)	12 BMEP Drop (7)

(1) Critical altitude in climb as determined by flight test.

(2) 260°C allowed for 30 minutes.

(3) Fuel flows may be leaned to minimum values shown in Appendix.

(4) Function of gross weight.

(5) Maximum cruise low blower -- 155 BMEP (except when at 1240 BHP and 2300 rpm -- 153 BMEP).

(6) Maximum cruise high blower -- 150 BMEP (except when at 1200 BHP and 2300 rpm -- 147 BMEP).

(7) With reference to "Best Power" mixtures.

(8) 232°C Maximum CHT for continuous operation.

NOTE

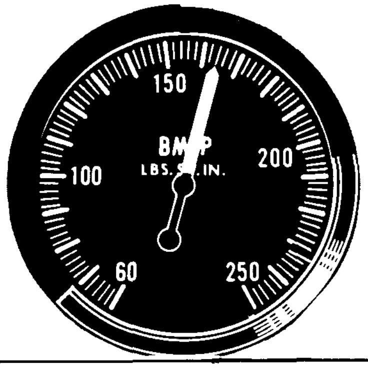
204°C is the desired maximum CHT for continuous operation.

(9) Maximum MAP for takeoff may be increased by existing vapor pressure up to 1.5 In. Hg (refer to Part 2 Appendix).

(10) +38°C maximum allowable CAT with preheat applied.

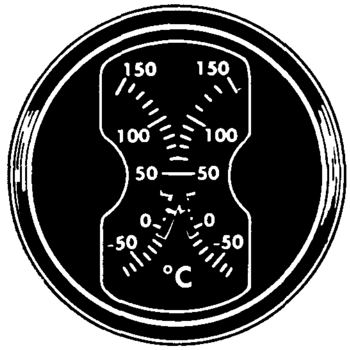
(11) Maximum cruise high blower CAT may be 30°C under certain conditions, see CARBURETOR AIR TEMPERATURE LIMITATIONS.

INSTRUMENT LIMIT MARKINGS FUEL GRADE 115/145



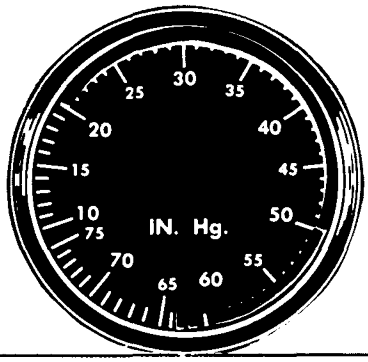
BMEP GAGE

- 70 TO 155 PSI MANUAL LEAN PERMITTED
- 155 TO 207 PSI AUTO RICH OR MANUALLY ADJUST
- 207 PSI METO (OPERATION ABOVE THIS PRESSURE) LIMITED TO 5 MINUTES AT MAXIMUM POWER
- 232 PSI MAXIMUM (DRY)
- 253 PSI MAXIMUM (WET)



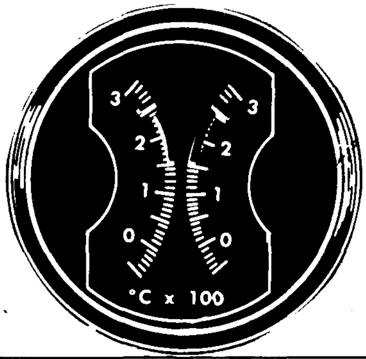
CARBURETOR AIR TEMPERATURE INDICATOR

- +38°C MAXIMUM OPERATING LIMIT WITH PREHEAT APPLIED
- −10°C TO +15°C (CAUTIONARY RANGE; DANGER OF ICING)
- +15°C TO +38°C NORMAL OPERATION RANGE



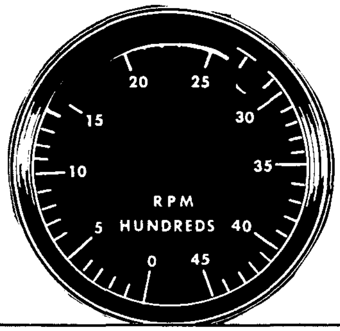
MANIFOLD PRESSURE GAGE

- LONG 62 IN HG MAXIMUM OPERATING LIMIT (WET)
- SHORT 63 IN HG MAXIMUM OPERATING LIMIT (DRY)
- 50 TO 60 IN HG LIMITED OPERATION (CAUTION RANGE)
- 20 TO 50 IN. HG NORMAL CONTINUOUS OPERATION



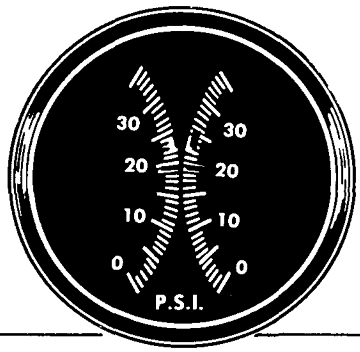
CYLINDER HEAD TEMPERATURE INDICATOR

- 260°C MAXIMUM OPERATING LIMIT
- 150°C TO 232°C CONTINUOUS OPERATION
- 190°C TO 200°C DESIRED FOR CRUISE



TACHOMETER

- 2800 (±25) RPM MAXIMUM TAKEOFF LIMIT
- 2600 TO 2800 RPM LIMITED OPERATION
- 1400 TO 2600 RPM NORMAL CONTINUOUS OPERATION

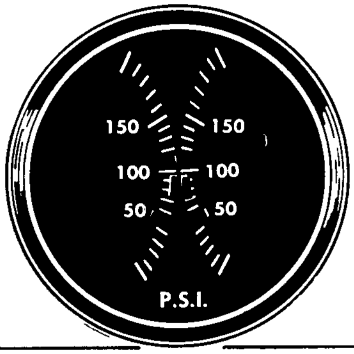


WATER PRESSURE INDICATOR (ADI)

- 22 TO 24 PSI NORMAL OPERATING RANGE
- 18 PSI MINIMUM ALLOWABLE

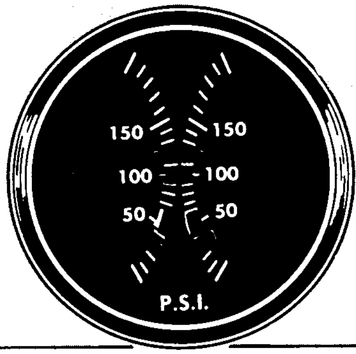
Figure 5-1 (Sheet 1 of 5)

INSTRUMENT LIMIT MARKINGS FUEL GRADE 115/145



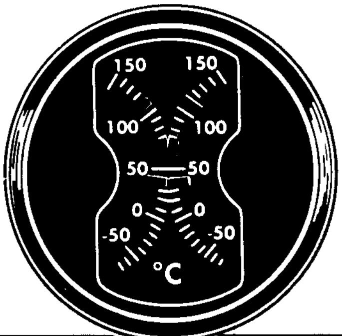
OIL PRESSURE INDICATOR

- 110 PSI MAXIMUM ALLOWABLE
- 75 TO 95 PSI NORMAL OPERATING RANGE
- 50 PSI MINIMUM ALLOWABLE (FOR 1400 RPM ONLY)



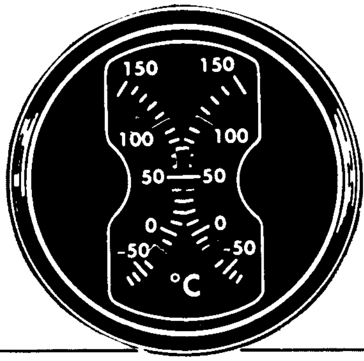
SUPERCHARGER OIL PRESSURE

- 120 PSI MAXIMUM ALLOWABLE
- 45 TO 65 PSI NORMAL
- 30 PSI MINIMUM



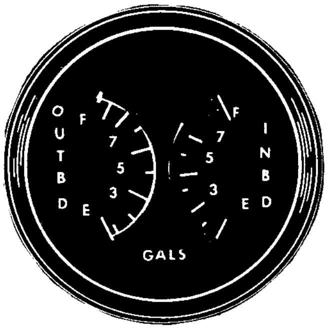
OIL TEMPERATURE INDICATOR

- 100°C MAXIMUM OPERATING LIMIT
- 60°C TO 75°C NORMAL CONTINUOUS OPERATION
- 40°C MINIMUM OPERATING LIMIT



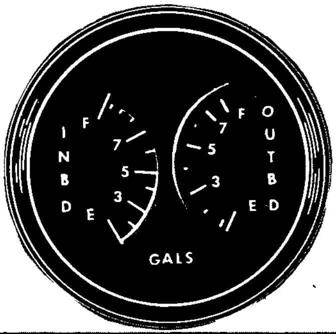
SUPERCHARGER OIL TEMPERATURE INDICATOR

- 110°C MAXIMUM OPERATING LIMIT
- −23°C MINIMUM OPERATING LIMIT
- 60°C TO 80°C NORMAL CONTINUOUS OPERATION



WATER QUANTITY INDICATOR ENGINES 1 AND 2

- OUTBOARD 9.4
- INBOARD 10.24

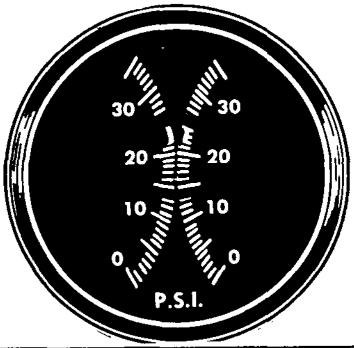


WATER QUANTITY INDICATOR ENGINES 3 AND 4

- OUTBOARD 9.4
- INBOARD 10.24

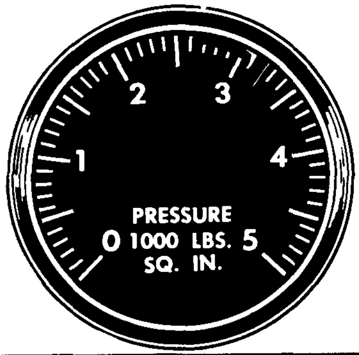
Figure 5-1 (Sheet 2 of 5)

INSTRUMENT LIMIT MARKINGS FUEL GRADE 115/145



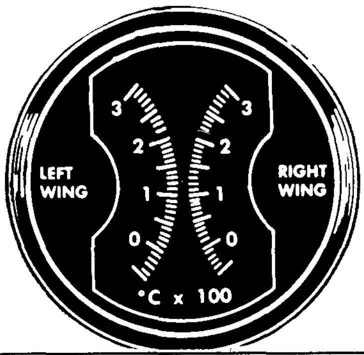
FUEL PRESSURE INDICATOR

- 25 1/2 PSI MAXIMUM ALLOWABLE
- 22 TO 24 PSI NORMAL OPERATING RANGE
- 14 PSI MINIMUM ALLOWABLE, IDLING



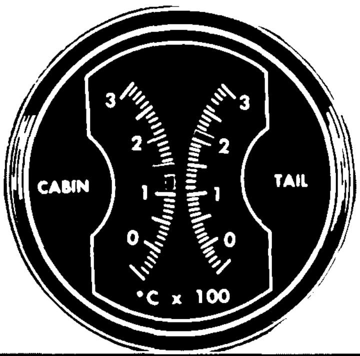
HYDRAULIC PRESSURE GAGE

- 3200 PSI MAXIMUM ALLOWABLE
- 2650 TO 3100 PSI NORMAL OPERATING RANGE



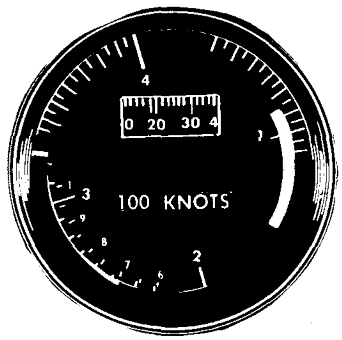
WING HEATERS TEMPERATURE INDICATOR

- 210°C MAXIMUM OPERATING LIMIT



CABIN AND TAIL HEATERS TEMPERATURE INDICATOR

- CABIN HEATER 150°C MAXIMUM OPERATING LIMIT
- 115°C TO 135°C NORMAL (CABIN)
- TAIL HEATER 210°C MAXIMUM OPERATING LIMIT



AIRSPEED INDICATOR

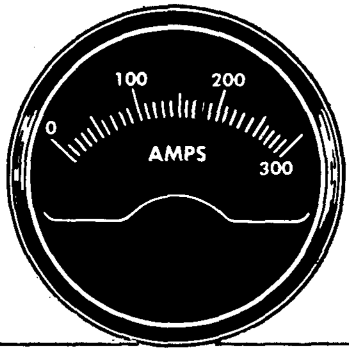
- 329 KNOTS (IAS) - MAXIMUM PERMISSIBLE INDICATED AIRSPEED
- 246 TO 329 KNOTS (IAS) — CAUTION RANGE
- 115 TO 246 KNOTS (IAS) — NORMAL OPERATING RANGE
- 150 KNOTS (IAS) — MAXIMUM PERMISSIBLE INDICATED AIRSPEED WITH FLAPS EXTENDED MORE THAN 30 DEGREES

Figure 5-1 (Sheet 3 of 5)

INSTRUMENT LIMIT MARKINGS

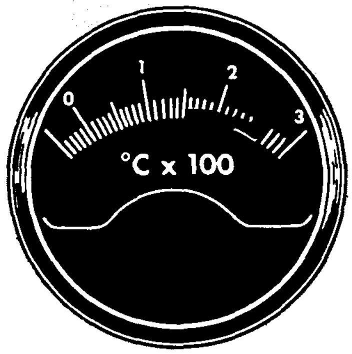
FUEL GRADE 115/145

D2



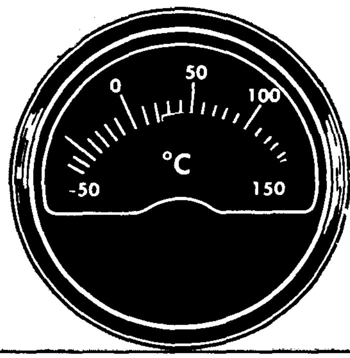
AUXILIARY POWER PLANT AMMETER

175 AMPS MAXIMUM OPERATING LIMIT



AUXILIARY POWER UNIT CYLINDER HEAD TEMPERATURE GAGE

255°C MAXIMUM OPERATING LIMIT
220°C TO 255°C LIMITED OPERATION (CAUTIONARY RANGE)
160°C TO 220°C NORMAL CONTINUOUS OPERATION



AUXILIARY POWER UNIT OIL TEMPERATURE GAGE

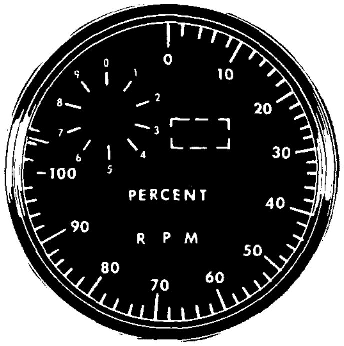
146°C MAXIMUM OPERATING RANGE
21°C TO 146°C NORMAL CONTINUOUS OPERATING RANGE

Figure 5-1 (Sheet 4 of 5)

INSTRUMENT LIMIT MARKINGS

FUEL GRADE 115/145

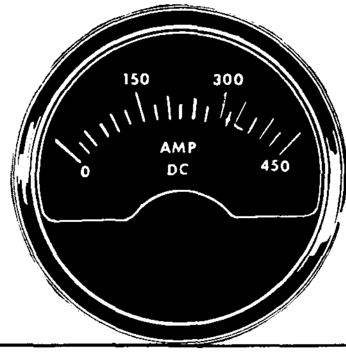
GTP/70



APU TACHOMETER

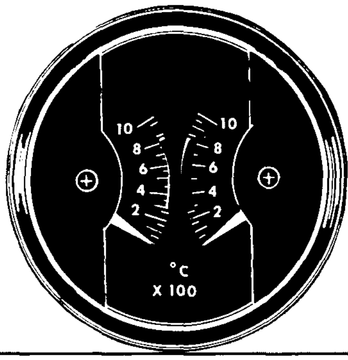
99 TO 101% LOADED CONDITION

99 TO 103% NO LOAD CONDITION



AMPERE INDICATOR

MAXIMUM - 350 AMPS

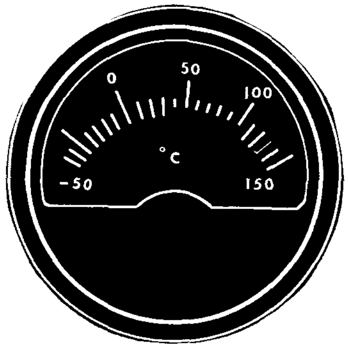


COMBUSTION CHAMBER INDICATOR

300°C TO 843°C NORMAL OPERATING RANGE

NOTE
300°C MAXIMUM TEMPERATURE DIFFERENTIAL COMBUSTION CHAMBER

865°C MAXIMUM



AUXILIARY POWER UNIT OIL TEMPERATURE GAGE

124°C MAXIMUM OPERATING RANGE

30° TO 100°C NORMAL RANGE

Figure 5-1 (Sheet 5 of 5)

OPERATIONAL WEIGHT LIMITATIONS.

Weight has an important effect on the capability and performance of the aircraft. In designing aircraft, weight has always been a primary restrictive factor. Aircraft are designed with sufficient strength to accomplish a certain basic mission without undue allowance for overloading or improper weight distribution. Every effort is made to eliminate unneccessary weight; however, the weight penalty for making an aircraft foolproof is prohibitive. Weight limitations, therefore, are necessarily involved in operation of the aircraft. If these limitations are exceeded, a loss in performance is inevitable and structural failure is quite probable. When the aircraft is loaded beyond the established limits, the ceiling and range are decreased, control forces and stalling speeds become higher, and the rate of climb falls off rapidly as the maximum gross weight is exceeded. The takeoff and landing rolls increase appreciably with an increase in gross weight. Likewise, the brakes may become insufficient to brake the forward momentum of the aircraft, and the wings will become more vulnerable to airloads during maneuvers or flight through turbulent air. These resultant effects can reach serious proportions when the weight limitations are disregarded. In cargo aircraft, the effect produced by weight is much greater than that encountered in aircraft of other types because the cargo itself adds a considerable amount to the weight at which the aircraft is operated. In order that cargo of various sizes may be accommodated, the cargo hold is of such proportions that space is not a restrictive factor; consequently, overloading is entirely possible. Weight limitations must be complied with if the aircraft is to be operated efficiently, economically, and safely. The maximum recommended gross weights for normal operation are as follows:

Takeoff .... 107,000 pounds

Landing...................... 88,200 pounds

Zero wing fuel................ 83,200 pounds

War emergency gross weights are as follows:

Takeoff .... 112,000 pounds

Landing...................... 107,000 pounds

Zero wing fuel................ 89,900 pounds

The zero wing fuel weight is the gross weight minus the weight of the fuel, oil and water-alcohol carried in the wings and nacelles. The zero wing fuel determines the maximum weight which can be carried in the fuselage in order to have strength available for the corresponding permissible accelerations. Since the permissible accelerations are a function of the weight and distribution of fuel, the fuel must be loaded and used as described in figure 7-1. There are no structural minimum fuel requirements for this aircraft.

WEIGHT AND LOADS.

Due to the effect of gravity on its mass, the aircraft possesses weight. More exactly, this weight is a force which gravity exerts on the material used in the fabrication of the aircraft and which pulls it toward the earth. In any condition of static equilibrium, during straight and level flight or at rest on the ground, the aircraft is subjected to this pull of gravity, the strength of which is called **1.0 g.** As fuel, cargo, crewmembers, and additional equipment are added in order that the aircraft may accomplish a specific mission, the weight of the aircraft correspondingly increases and the additional weight constitutes a force acting on the aircraft structure. The weight of the aircraft, or the force which gravity imposes on it, may also be considered as a load. On the ground, this load must be sustained by the landing gear; in flight, by the wings. There is a limit to the load which the landing gear is capable of supporting during taxi, takeoff, and landing operations; there is likewise a limit to the load which the wings can sustain in flight.

During maneuvering and flight through turbulent air, additional loads are imposed. These loads, caused by the acceleration of the aircraft, are the result of forces which, in addition to that of gravity, act upon the total mass of the loaded aircraft. Both these forces tend to produce undesirable and potentially dangerous loads on the aircraft structure and its members. This is particularly true of the wings, which must sustain the aircraft in flight. When the weight of the aircraft is increased, the wings become more and more vulnerable to the loads imposed by sudden changes in air currents or manipulation of the controls. The ultimate strength of the aircraft structure is eventually exceeded by the combined forces of weight and airloads. When this condition occurs, structural failure results. The maximum weight which the aircraft can safely carry is dependent upon distribution of the weight throughout the aircraft and its capacity to sustain airloads in accelerated flight.

LOAD FACTORS.

A load factor is the ratio of the load imposed on the aircraft when accelerated in any direction as compared with the load imposed by gravity in any condition of static equilibrium. The load factor denotes the strength of the forces acting on the aircraft because of sudden changes in air currents and manipulation of the controls, and is expressed by the term g, which is the gravitational force. By definition, then, all aircraft at rest on the ground or in straight and level flight possess a load factor of 1.0 g, because the force acting upon the aircraft under either of these conditions is merely that of gravity. When the aircraft enters a region of turbulent air or the pilot elects to maneuver the aircraft, additional forces are imposed on the structure. The additional load on the wings resulting from these forces is expressed in relation to the gravitational force and is referred to as 0.5 g, 2.0 g, 3.0 g, etc, which means that the forces exerted on the wing structure and its members are half, two, or three times the force exerted by gravity. For example, if the normal weight of the aircraft is 60,000 pounds and the load factor at some given moment of accelerated flight is 3.0 g's, the total force which the wings must sustain is 180,000 pounds, or three times the normal weight of the aircraft in straight and level flight. (Refer to Distribution of Load, this section.)

CAUTION

The aircraft must have the load distributed so that the wings can safely withstand a load factor of at least 2.0 g's, as structural damage to the wings may result if the aircraft encounters a situation whereby more than 2.0 g's are imposed. Aircraft with combinations of payload and fuel which limit the load factor capability to 2.5 g's must be flown with caution, especially in turbulent air or during turns and pullouts.

MARGIN OF SAFETY.

The margin of safety is the range of forces which exist between two points, one of which is the load factor the aircraft is sustaining at any given moment, and the other the load factor at which structural damage will occur. If, for example, the aircraft is incapable of sustaining a load factor greater than 2.5 g's and during flight through turbulent air is subjected to a force of 1.5 g's, the margin of safety at this particular moment is 1.0 g. When fuel and cargo loads are increased, the margin of safety decreases. This increase in weight actually becomes a component of the forces acting on the aircraft, and, as such, lessens the capacity of the aircraft to sustain further loads due to accelerated flight. For this reason, it is advisable in loading aircraft to maintain a margin of safety which will never be exceeded during any period of flight.

WARNING

If the combined weight of cargo and fuel is such that the aircraft is incapable of sustaining a force of 2.5 g's, turns and pullouts should be made with caution to minimize the resulting airloads.

EXPLANATION OF CHART.

The Weight Limitations Chart (figure 5-2) shows graphically the weight-carrying capabilities of the aircraft as defined by the various criteria which provide limits for safe and efficient operation. Through the use of these charts, the flight planner is aided in recognizing the weight limitations which will restrict operation on a specific mission and in determining what margin of safety may be established.

NOTE

Although the chart indicates the limitations involved in the loading of the aircraft, the authority for operating it at a given gross weight remains the responsibility of the local authority.

GROSS WEIGHTS.

The data in the chart (figure 5-2) is based on an initial operating weight of the aircraft exclusive of fuel and cargo. The zero point of the chart at the junction of the fuel and cargo loads axes represents an operating weight of 60,000 pounds. As individual operating weights may vary, it is necessary to adjust the chart for the specific aircraft involved. The operating weight plus the fuel and cargo as required in a mission can be shown by gross weight lines which slope at a 45-degree angle to the axis of the chart. These diagonal lines also indicate various structural and performance limitations. However, any gross weight line may be plotted to obtain a graphic representation of the limitations involved in the fuel-weight combination which a mission may require.

NOTE

The gross weight of the aircraft should never exceed that required for the mission, since unnecessary risk and wear of the equipment will otherwise result. Takeoff gross weights must also be considered with respect to available runways, surrounding terrain, altitude, atmospheric conditions, mission requirements, and the urgency of the mission.

DISTRIBUTION OF LOAD.

The maximum load that the aircraft can carry is dependent on the way the load is distributed. The weight of an aircraft in flight is supported by the wings; therefore, the more load that is carried in the fuselage, the greater will be the bending moment on the wings. This means that an aircraft might safely carry 30,000 pounds if 12,000 pounds were carried in the fuselage and 18,000 pounds were in the wings. But the same 30,000 pounds might become an unsafe load if the weight distribution were 25,000 pounds in the fuselage and 5000 pounds in the wings, the unsafe condition resulting from the excessive bending moment imposed on the wings by the 25,000 pounds in the fuselage. When carrying cargo, load factor capabilities below 2.5 g's, are not considered desirable because the cargo distribution may be critical enough to overload the floor and/or the fuselage shell.

CARGO LOAD.

In any mission, range and fuel consumption directly determine the fuel which must be carried and indirectly the cargo which can be transported. With the

WEIGHT LIMITATIONS CHART

BASED UPON 60,000 POUNDS
BASIC OPERATING WEIGHT
(INCLUDES OIL)

MODEL: C-118A

ENGINES: R2800-52W
FUEL GRADE 115/145
ALTERNATE FUEL GRADE 100/130

Note:
For gross weight limited by performance refer to appendix.
*Total wing fuel capacity at 6 pounds per gallon.

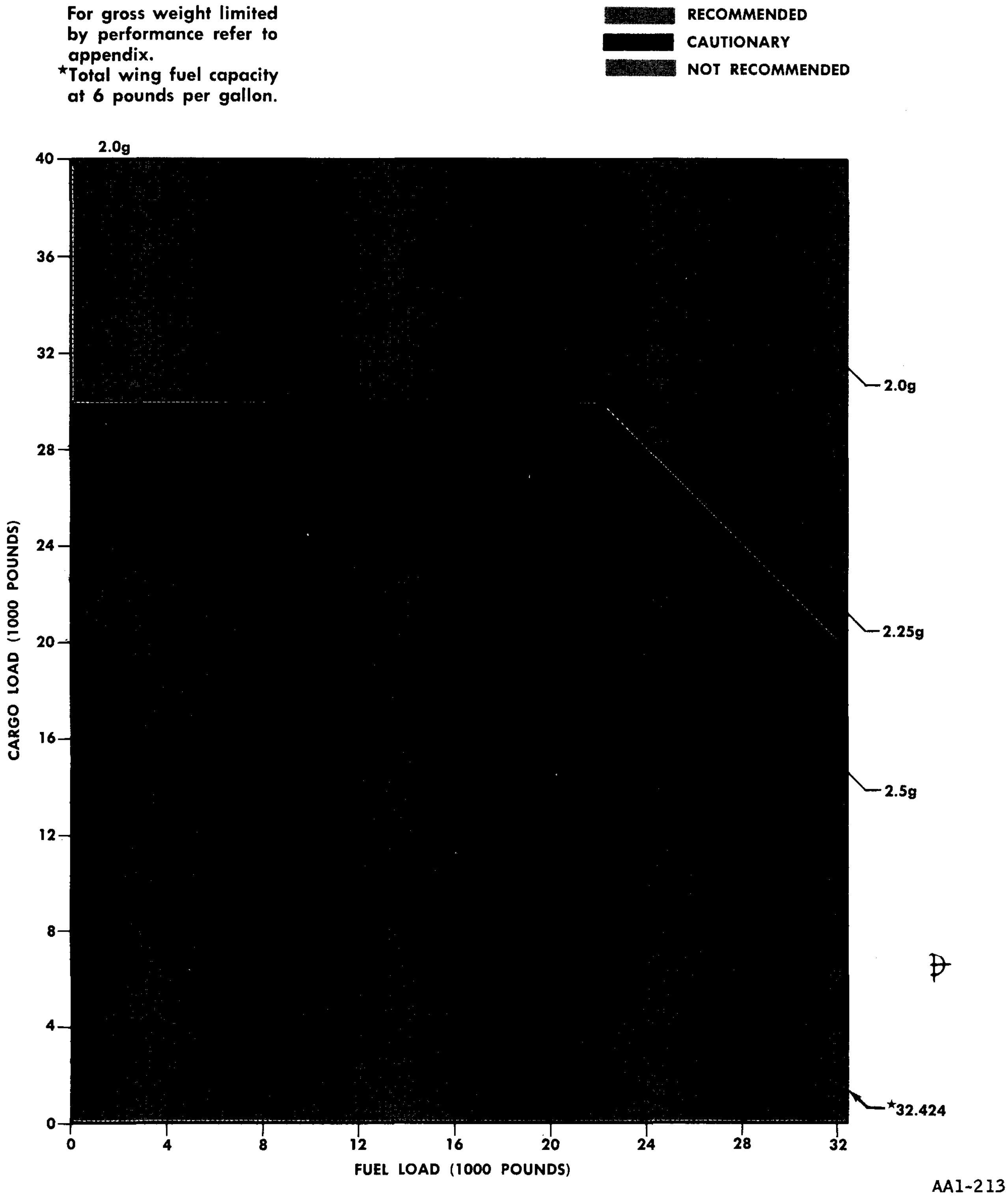


Figure 5-2

necessary fuel for the mission established, cargo loading is variable within the limits established by the strength and performance of the aircraft. The payload, as carried in the cargo compartment, appears in thousands of pounds along the vertical axis of the chart. When fuselage fuel is utilized to increase the range of the aircraft, the combined weight of the fuel and tanks is computed as cargo load.

WING FLIGHT LOAD FACTORS.

Wing flight load factors of 2.0, 2.25, and 2.5 g's are represented. The load factor 2.0 line represents an absolute minimum which should never be violated because of the dangerously small margin of safety; the load factors of 2.25 and 2.5 g's are included for comparative purposes. Notice that the effect of weight distribution is clearly illustrated by the shape of these lines. If the aircraft has a basic operating weight of 60,000 pounds, a load factor in excess of 2.0 g's may result in structural damage in each of the following instances:

At 100,000 pounds, when no load is carried in the wings.

At 107,000 pounds, when 7000 pounds of fuel is carried in the wings.

At 123,800 pounds, when 23,800 pounds of fuel is carried in the wings.

The aircraft will safely withstand a load factor of 2.5 g's in each of the following instances:

At 83,200 pounds, when no load is carried in the wings.

At 88,200 pounds, when 5000 pounds of fuel is carried in the wings.

At 107,000 pounds, when 23,800 pounds of fuel or above is carried in the wings.

Refer to Cautionary Loading Area, this section.

CRUISE SPEEDS.

Caution must also be exercised in selecting the cruise speeds for operation. Load factors result not only from maneuvers instituted by the pilot, but also by encountering atmospheric gusts. At any given speed and gross weight, the larger the gust the higher the load factor. Similarly, at any given gross weight and stated gust intensity, the higher the speed the larger the load factor. The aircraft is basically designed to be able to safely withstand the load factors resulting from a gust of 30 feet per second at 251 KIAS per hour with 23,200 pounds of cargo. From the chart, it can be seen that, as the cargo weight is increased, the load factor made good is decreased. If a gust of 30 feet per second is also to be made good, then the speed likewise must be decreased.

LANDING GEAR LIMITATIONS.

The landing gear structure is designed for landing during routine operation at a gross weight of 88,200 pounds at a maximum contact sinking speed of 10 feet per second (figure 5-3). This is the maximum recommended landing weight for normal operation. In case of emergency, landings may be made up to 107,000 pounds at a maximum contact sinking speed of 5 feet per second.

PERFORMANCE LIMITATIONS.

In the case of four-engine aircraft, it is generally inherent that structural rather than performance limitations restrict the weight which the aircraft can carry. Obviously, the gross weight must necessarily be limited by the ability of the aircraft to take off within available runway length and clear any obstacles. But the primary consideration is the ability of the aircraft to fly with partial power. Performance with one engine out is not generally a restrictive factor in the normal loading of the aircraft. Note the gross weight lines on the chart, particularly those which separate the loading areas. Each of these lines defines a specific limitation and several of the lines are performance limitations, but the gross weights are sufficiently high for normal operation. These performance limitations are based on the gross weight at which an adequate rate of climb can be maintained under various conditions of power, temperature, and configuration.

POWER LOSS AND PERFORMANCE.

The loss of one engine results in an asymmetric power condition and a decrease in the rate of climb. However, a rate of climb of 50 feet per minute with three engines operating can be maintained with gross weights up to 113,900 pounds on a standard day at sea level with maximum power, wing flaps at the takeoff position, gear down, and inoperative engines windmilling. Power losses due to temperature, humidity, and engine deficiency exert a considerable influence on the rate of climb even when all the engines are operating. It is not difficult to visualize the effect which engine failure will produce on the rate of climb, but is is interesting to note the marked difference in aircraft performance resulting from a rise in temperature and a corresponding fall in air density. The gross weight difference to provide a rate of climb of 50 feet per minute on a hot day as compared to a standard day at sea level is 6,600 pounds, resulting in a maximum gross weight of 107,300 pounds, in order to maintain a rate of climb of

MAXIMUM SINKING SPEED CHART

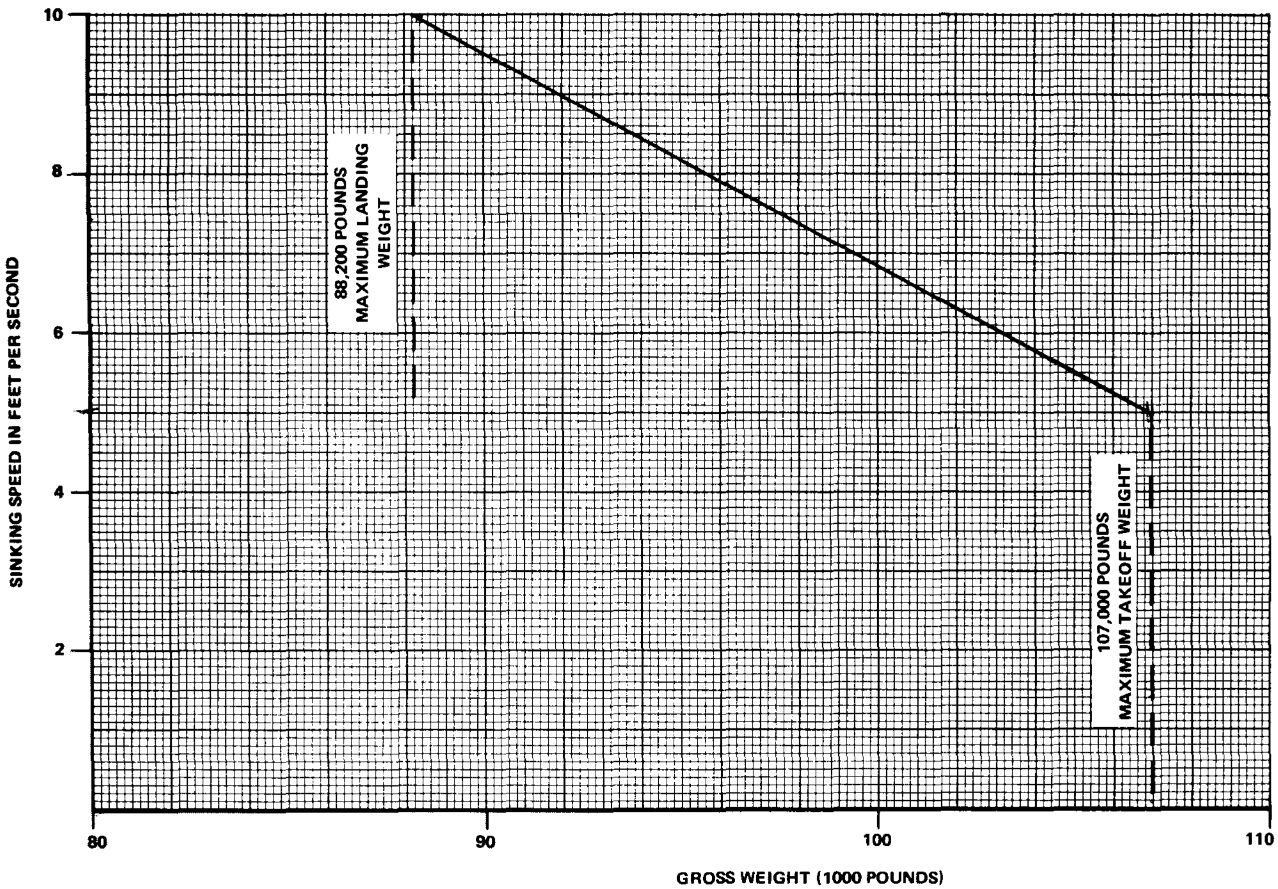


Figure 5-3

50 feet per minute at sea level on a hot day. For purpose of standardization, the temperature of a standard day is 15°C and that of a hot day, 38°C at sea level. Naturally, variations of temperature and altitude within this range will give similarly graduated values in brake horsepower and rate of climb. The effect of humidity and engine deficiency on brake horsepower, and ultimately the gross weight at which the aircraft may be operated, has not been included in the weight limitations chart because of the extreme number of variable conditions involved. However, the effect of humidity on brake horsepower is shown in the Appendix, part 2.

CONFIGURATION AND PERFORMANCE.

The configuration of the aircraft also imposes a penalty on performance. In other than clean configurations, the increase in drag produces a decrease in the rate of climb and requires a readjustment of the gross weight at which the aircraft may be operated. As with power losses, this condition is most critical at takeoff when of necessity, the landing gear is extended, and the cowl flaps and oil cooler flaps are open. The drag created by a windmilling propeller and the extended landing gear during the takeoff roll is such that no attempt to take off should be made unless the critical engine failure airspeed for the gross weight of the aircraft has been attained or exceeded.

RECOMMENDED LOADING AREA.

The green area on the charts represents the loading conditions that present no particular problem in regard to strength or performance of the aircraft. Operation of the aircraft at weights outside this recommended loading area should be avoided unless the mission requires it. The green area is bounded by the 2.5 g's wingload factor line and the landing gear limitation.

CAUTIONARY LOADING AREA.

The yellow area on the charts represents loadings of progressively increasing risk as the red area is approached. Be extremely careful because (1) performance with one engine out at these gross weights is marginal depending upon configuration, altitude, and ambient air temperature and (2) the maximum safe load factor is decreased.

LOADING NOT RECOMMENDED.

NOTE

Whenever flights are conducted at weights shown in the red area of the chart, entry of this fact in Form 781 is required.

The red area represents loadings which are not recommended because of loss of the margin of safety from the standpoint of both performance and structural limitations. Under conditions of extreme emergency when safety of flight is of secondary importance, the commanding officer will determine if the degree of risk warrants operation of the aircraft at gross weights appearing in the red zone.

USE OF WEIGHT LIMITATIONS CHART.

The sample problems shown below may be used to determine the exact position of a loaded aircraft on the Weight Limitation Chart (figure 5-2).

Problem:

Requiring 2000 gallons of fuel to reach a base, what is the maximum cargo that can be carried?

Solution:

Presume that the aircraft weights 65,000 pounds before the fuel and cargo are added. Enter the chart at a fuel weight of 12,000 pounds (based on fuel weight of six pounds per gallon). By moving vertically up the chart to the maximum loading (limit of the yellow area), it is determined that a maximum cargo load of 30,000 pounds may be carried. The additional operating weight of 5,000 pounds (65,000 - 60,000 = 5,000) is simply considered as added alternate cargo, which reduces the maximum cargo load first determined. Thus, the maximum allowable cargo load becomes 25,000 pounds (30,000 - 5,000 = 25,000). If, for instance, the aircraft weighed 58,000 pounds rather than the 65,000 pounds presumed above, the alternate cargo would be 60,000 - 58,000 or 2,000 pounds, and would allow a 2,000 pound increase in the maximum cargo load first determined. By adding the operating fuel and cargo weights, it is found that the aircraft would weigh 65,000 + 12,000 + 25,000 or 102,000 pounds, which does not exceed the normal maximum takeoff gross weight of 107,000 pounds.

Problem:

Requiring a 22,000 pound cargo load, what is the maximum amount of fuel that can be carried?

Solution:

Presume that the aircraft weighs 60,000 pounds before the fuel and cargo are added. Since the basic operating weight is 60,000 pounds, the chart can be entered at a cargo weight of 22,000 pounds and the maximum amount of fuel can be read directly from the chart. By moving horizontally across the chart to the maximum fuel load (limit of the green area), it is determined that the maximum fuel that can be carried is 25,000 pounds, or, 25,000 ÷ 6 = 4167 gallons.

HEATER NOZZLE FUEL PRESSURE

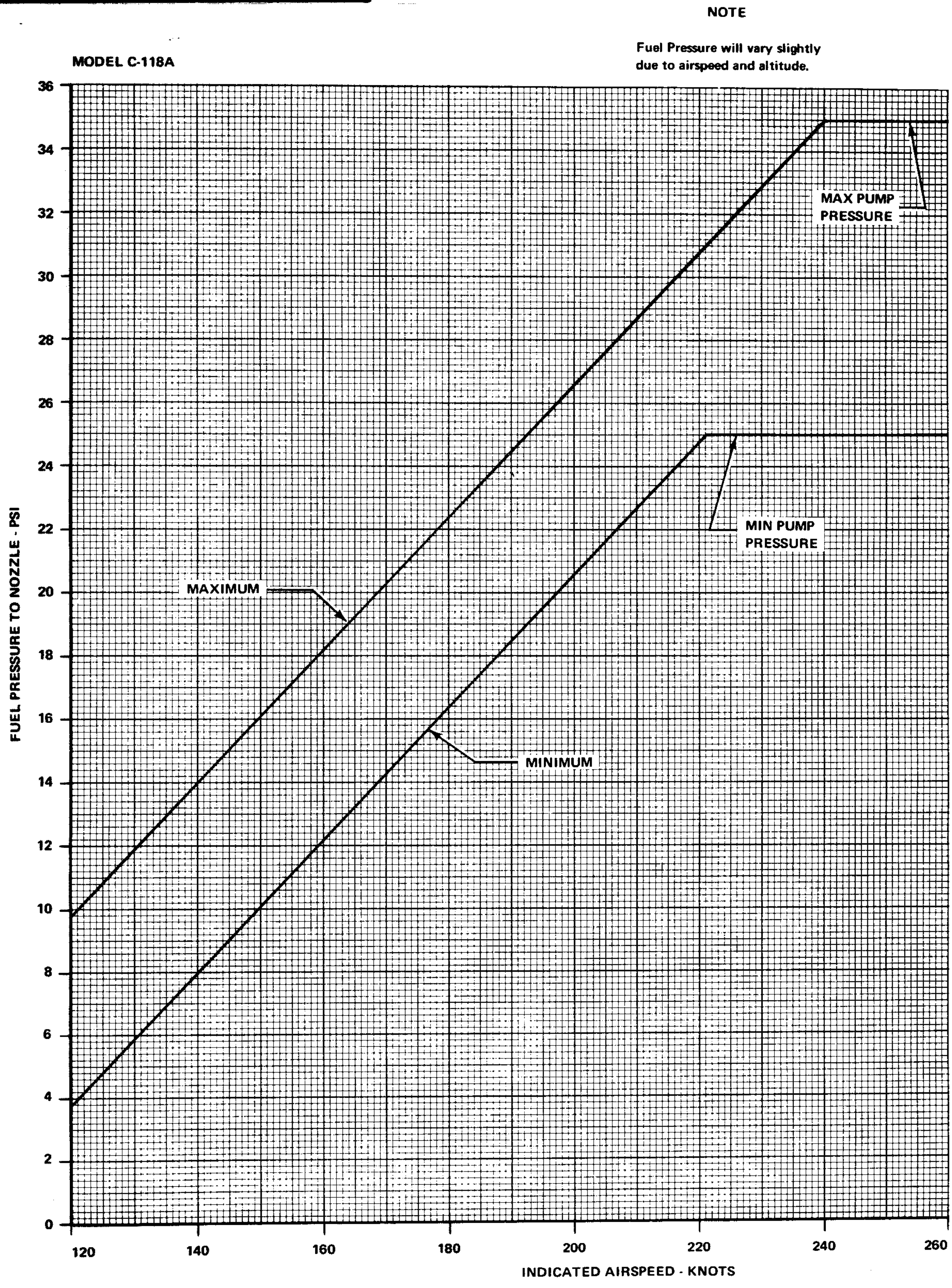


Figure 5-4

TABLE OF TOLERANCES

FUEL PRESSURES

1. ENGINE PUMPS - BOOST PUMPS OFF

   a. Minimum (below 1200 rpm) .... 14 psi

   b. Minimum (flight) .... 18 psi

   c. Normal .... 22 to 24 psi

   d. Maximum .... $25\frac{1}{2}$ psi

2. TANK BOOSTER PUMPS - PUMPS ON
   MAIN TANKS - HIGH BOOST - ENGINES OFF

   a. Minimum .... 21 psi

   b. Maximum .... 33 psi

   MAIN TANKS - LOW BOOST - ENGINES OFF

   a. Minimum .... 12 psi

   b. Maximum .... 18 psi

   ALTERNATE TANKS - HIGH BOOST - ENGINES OFF

   a. Minimum .... 21 psi

   b. Maximum .... 33 psi

   ALTERNATE TANKS - LOW BOOST - ENGINES OFF

   a. Minimum .... 12 psi

   b. Maximum .... 18 psi

   Fuel warning light comes on any time pressure drops below 18 psi.

   Low boost ON any time fuel pressure drops below 22 psi or fluctuates.

   Crossfeed system thermal-relief valve opens at 65 to 85 psi.

   Internal fuel tank pressure-relief valve opens at 2.5 psi.

3. CABIN HEATER

   GROUND OPERATION - GROUND BLOWER ON - ENGINES OFF

   a. Minimum .... 3 psi

   b. Normal .... 7 psi

   c. Maximum .... 10 psi

4. WING HEATERS

   GROUND OPERATION

   a. Minimum .... 3 psi

   b. Normal .... 5 psi

   c. Maximum .... 7 psi

5. TAIL HEATER

   GROUND OPERATION

   a. Minimum .... 3 psi

   b. Normal .... 5 psi

   c. Maximum .... 7 psi

   Cabin heater fuel supplied from No. 2 main tank. Wing and tail heater fuel supplied from No. 3 main tank.

   A crossfeed arrangement makes it possible to operate all heaters from either tank.

OIL SYSTEM PRESSURES

1. ENGINES

   a. Minimum

      (1). Ground idle only .... 25 psi

      (2). Above 1400 rpm .... 50 psi

   b. Normal .... 75 to 95 psi

   c. Maximum .... 110 psi

   Separate oil pressure warning lights (each engine) set to come on at 50 $\pm$5 psi.

2. CABIN SUPERCHARGER

   a. Minimum .... 30 psi

   b. Normal .... 45 to 65 psi

   c. Maximum .... 120 psi

   Warning light comes on at 30 $\pm$5 psi.

   NOTE

   Ground operation only, oil pressure may be 25 psi at 1000 rpm.

3. AUXILIARY POWER UNIT
   - a. Below Minimum............. Warning light on
   - b. Normal .... Warning light off

OPERATING TEMPERATURES

ENGINES

1. CYLINDER HEAD
   - a. Minimum (ground operation)........... ---
   - b. Maximum operating limit .... 260°C
   - c. Normal operating limit .... 150° to 232°C
   - d. Desired for cruise .... 190° to 200°C
   - e. Maximum cruise...................... 232°C
   - f. For engines shutdown cooling..... below 200°C

2. OIL
   - a. Minimum operating limit.............. 40°C
   - b. Normal operating limits .... 60° to 75°C
   - c. Maximum operating limit .... 100°C

SUPERCHARGER

3. OIL
   - a. Minimum operating limit............ - 23°C
   - b. Normal operating limits .... 60° to 80°C
   - c. Maximum operating limit .... 110°C

HEATERS

4. CABIN HEATER
   - a. Minimum operating limit .... 110°C
   - b. Normal operating limits .... 115° to 135°C
   - c. Maximum operating limit .... 150°C

5. WING HEATERS
   - a. Maximum operating limit .... 210°C

6. TAIL HEATER
   - a. Maximum operating limit .... 210°C

AUXILIARY POWER UNIT—GTP70 (See Placards)

7. COMBUSTION CHAMBER
   - a. Normal Operating Limits..... 300°C to 843°C
   - b. Maximum Operating Limits .... 865°C
   - c. Maximum Operating Temperature differential combustion chamber ...... 300°C

8. OIL
   - a. Minimum operating limit............. 20°C
   - b. Normal operating limits.........30° to 110°C
   - c. Maximum operating limit .... 124°C

CARBURETOR

9. AIR TEMPERATURE - NO CARB HEAT
   - a. Normal operating limits..........15° to 38°C
   - b. Cautionary range (possible icing)..-10°to 15°C
   - c. Maximum operating limit in low blower and no carburetor heat .... 55°C

   To prevent throttle icing, avoid carburetor air temperatures of - 10°C to + 15°C.

10. CARBURETOR AIR TEMPERATURE LIMITS - WITH CARB HEAT LOW BLOWER
    - a. Minimum carburetor air temperature .. ---
    - b. Maximum carburetor air temperature .. 38°C

    HIGH BLOWER (above 1200 BHP)
    - a. Minimum carburetor air temperature...
    - b. Maximum carburetor air temperature .. 15°C (except maximum power wet).......... 20°C

    HIGH BLOWER (below 1200 BHP)
    - a. Minimum carburetor air temperature .. ---
    - b. Maximum carburetor air temperature .. 30°C

MANIFOLD PRESSURES

1. ENGINES
   - a. Normal continuous .... 20 to 50 in. hg
   - b. Caution range............... 50 to 60 in. hg
   - c. Maximum (dry) .... 63 in. hg
   - d. Maximum (wet) .... 62 in. hg

ADI SYSTEM

1. WATER-ALCOHOL ANTIDETONATION
   - a. Static (System OFF) .... 8 to 12 psi
   - b. No-flow condition
     - (1). Inboard Engines .... 27 to 29 psi
     - (2). Outboard Engines .... 29 to 32 psi
   - c. Minimum .... 18 psi
   - d. Normal .... 22 to 24 psi

   Water-alcohol supply adequate for 5 minutes operation at takeoff power. Supply warning lights come on when water-alcohol pressure drops below 18 psi.

HYDRAULIC SYSTEM PRESSURES

1. MAIN SYSTEM PRESSURE
   - a. Minimum .... 2650 psi
   - b. Normal .... 3100 psi
   - c. Maximum .... 3200 psi
   - d. Normal System Relief (Valve)
     - (1). Minimum .... 3300 psi
     - (2). Maximum .... 3400 psi
2. EMERGENCY PUMP RELIEF
   - a. Minimum .... 3000 psi
   - b. Maximum .... 3050 psi
3. NOSEWHEEL STEERING SNUBBING PRESSURE
   - a. Minimum .... 150 psi
   - b. Maximum .... 170 psi
4. BRAKE SYSTEM BRAKE CONTROL VALVE
   - a. Minimum .... 1750 psi
   - b. Maximum .... 1850 psi

   BRAKES
   - a. Minimum .... 615 psi
   - b. Maximum .... 645 psi
5. ANTISKID BRAKING
   - a. Minimum .... 615 psi
   - b. Maximum .... 645 psi

ACCUMULATOR AIR PRESSURES

1. MAIN HYDRAULIC SYSTEM
   - a. Minimum .... 1000 psi
   - b. Maximum .... 1200 psi
2. NOSEWHEEL STEERING
   - a. Minimum .... 50 psi
   - b. Maximum .... 55 psi
3. ANTISKID BRAKING
   - a. Minimum .... 300 psi
   - b. Normal .... 325 psi
   - c. Maximum .... 350 psi
4. EMERGENCY AIRBRAKE
   - a. Minimum .... 950 psi
   - b. Normal .... 1000 psi
   - c. Maximum .... 1050 psi

OXYGEN SYSTEM

1. GASEOUS - FULL CYLINDERS SYSTEM PRESSURE
   - a. Minimum .... 400 psi
   - b. Maximum .... 425 psi

SYSTEMS OPERATING TIMES

1. LANDING GEAR
   - a. Normal retraction .... 7 to 10 sec
   - b. Emergency retraction .... 2-5 min
   - c. Normal extension .... 10 to 12 sec
   - d. Average freefall .... 20 sec
   - e. Maximum freefall .... 60 sec

2. WING FLAPS

   a. Extension (@ 105 KIAS) .... 10 to 15 sec

   b. Retraction (50^{o} to 20^{o})........... 7 to 11 sec

   c. Retraction (20^{o} to UP)........... 11 to 15 sec

3. ENGINE STARTER

   Maximum cranking time during engine start is one minute. If engine fails to start, allow one minute for cooling. If engine fails to start on second attempt, allow five minutes for cooling.

NOTE

Maximum cranking time using aircraft battery is 30 seconds.

COLD WEATHER ENGINE OPERATION

1. EXTERNAL HEAT APPLICATION TO ENGINES NO WIND - 25 PERCENT OIL DILUTION

   a. Temperature - 6^{o} to - 18^{o}C......... $\frac{1}{2}$ hour

   b. Temperature - 18^{o} to - 32^{o}C..... $\frac{1}{2}$ to 1 hour

   c. Temperature - 32^{o} to - 40^{o}C.... 1 to 2 hours

   d. Temperature - 40^{o} to - 54^{o}C...$1\frac{1}{2}$ to $2\frac{1}{2}$ hours

   Oil temperatures must be below 50^{o}C for effective oil dilution.

   Oil dilution is required whenever ambient air temperature will drop below 2^{o}C before next start.

2. OIL DILUTION TIMES NO WIND - 25 PERCENT OIL DILUTION

   a. Temperature 2^{o} to - 12^{o}C......... 3 minutes

   b. Temperature - 12^{o} to - 29^{o}C...... 6 minutes

   c. Temperature - 29^{o} to - 40^{o}C...... 9 minutes

   d. Temperature - 40^{o} to - 54^{o}C...... 12 minutes

   Set fuel boost pump switch on LOW for oil dilution Engine rpm 1000 to 1200.

ELECTRICAL SYSTEM

AC VOLTAGE AND FREQUENCY

1. MAIN INVERTERS

   a. Minimum......................... 110 vac

   b. Maximum .... 120 vac

   c. Minimum......................... 380 cps

   d. Maximum .... 420 cps

2. EMERGENCY INVERTERS

   a. Minimum......................... 110 vac

   b. Maximum .... 120 vac

   c. Minimum......................... 380 cps

   d. Maximum .... 420 cps

   One emergency (3-phase) inverter is installed on both early and late model aircraft.

NOTE

A phase allowable tolerance for aircraft equipped with G-2 compass system is 110 to 130 Volts.

3. ENGINE INSTRUMENT POWER - NORMAL OR STANDBY

   a. Minimum......................... 26 vac

   b. Maximum .... 26 vac

DC VOLTAGE AND AMPERAGE

4. ENGINE DRIVEN GENERATORS

   a. Minimum......................... 27.5 vdc

   b. Maximum .... 30 vdc

   c. Maximum

      (1). Above 0^{o}C................. 350 amps

      (2). Below 0^{o}C................. 400 amps

   Reverse current relay set to trip at 10-35 amps on early model aircraft and at 20-35 amps on late model aircraft. Both generator types interchangeable between early and late model aircraft. The regulators maintain a constant generator voltage of 28 vdc at approximately 1000 rpm.

5. APU GENERATORS EARLY MODEL

   a. Minimum......................... 26 vdc

   b. Maximum .... 30 vdc

c. Maximum .... 195 amps

Not designed to operate at altitudes above 5000 feet.

Receives fuel from No. 2 main tank.

LATE MODEL

a. Minimum........................ 26 vdc

b. Maximum .... 30 vdc

c. Maximum .... 350 amps

Designed to operate at all flight altitudes.

Receives fuel from No. 3 main tank.

6. EXTERNAL POWER SOURCE

a. Minimum........................ 18 vdc

b. Maximum .... 30 vdc

7. PITOT, STATIC, AND AIRSCOOP DEICING

Cabin heater, Comb. air scoop.... 13-17 Amps

Belly scoop...................... 17-28 Amps

Wing scoop....................... 23-27 Amps

Pitot and Static .... 15-20 Amps

FLIGHT CHARACTERISTICS

SECTION VI

flight characteristics

TABLE OF CONTENTS

GENERAL FLIGHT CHARACTERISTICS.

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

AERODYNAMIC CHARACTERISTICS.

The aircraft is dynamically stable about all axes; that is, if an oscillation is induced about the roll, pitch, or yaw axis of the airplane, it will damp out. Static stability is the tendency of the aircraft to return to its original trimmed condition following a displacement from that condition. From the point of view of control forces, an aircraft is statically stable in pitch (longitudinally) if a push force is required to maintain a speed above trim speed, and a pull force is required to maintain a speed below trim speed. Spiral stability is approximately neutral. As an example, when the aircraft is properly trimmed for a standard rate turn in the instrument approach configuration (gear up, flaps 20 degrees), it will tend to remain in that attitude. Dihedral effect will cause the aircraft to bank automatically into the turn as rudder is applied. This effect is helpful in obtaining maximum maneuverability.

CONTROL FORCE AND EFFECTIVENESS.

Due to the characteristics of the aerodynamic boost system, the control forces and movements required vary throughout the speed range of the aircraft. At high speed, a given rate of roll can be developed with a small force applied to the controls and with a small control movement. To develop the same rate of roll at low speed, both a greater force and movement must be applied to the controls.

The ratio of rudder to aileron displacement required to accomplish a coordinated turn varies with speed. At high speeds, turns may be made primarily with the ailerons, very little rudder being required. As speed decreases, and/or gear and flaps are extended, a greater portion of rudder to aileron displacement is required. This should be taken into consideration when making approaches in gusty air conditions, or with one or more engines inoperative.

At high speed, the elevator is extremely effective and, therefore, requires a small amount of force and movement to maneuver the aircraft. At low speed such as during the landing approach, elevator effectiveness decreases, requiring a greater movement to maneuver the aircraft. Control force increases with elevator displacement; therefore, both a greater movement and a greater force are required at low speed, as compared to cruising flight.

During landing, the center of gravity position greatly affects the amount of elevator required. The further aft the cg, the less elevator required; the further forward the cg, the more elevator required. If the aircraft is loaded aft of the aft cg limit, it will be unstable; if loaded forward of the forward limit, the amount of elevator control available will probably be insufficient to properly flare the aircraft.

Elevator requirements vary with power. As an example, as power is applied during an overshoot, down elevator is required to counteract for nose-up pitching; conversely, as power is cut during the landing flare, up elevator is required.

EQUIVALENT PARASITE DRAG AREAS.

The following table of drag items is given in square feet of equivalent flat plate area:

Item	Drag of Item (Square Feet)
Basic Aircraft	27.3
Landing Gear	38.6
20-Degree Wing Flaps	26.8
30-Degree Wing Flaps	46.3
50-Degree Wing Flaps	83.6
Windmilling Propeller	13.6
+4-Degree Cowl Flaps	5.4
+2-Degree Cowl Flaps	3.5
+-Degree Cowl Flaps	1.7

WING FLAP CHARACTERISTICS.

Wing flaps of the double-slotted type provide the additional lift required for takeoff, and both extra lift and drag for approach and landing. At small angles (20 to 25 degrees), the flaps act primarily as an added lift device, and at large angles (40 to 50 degrees), as both an added lift and drag device. High drag at maximum flap extension is obtained primarily from the amount of extra surface exposed to the airstream. In effect, as the flaps are extended the camber of the wing is increased, giving it a higher lift at any given angle of attack. This explains the ballooning of the aircraft as the flaps are extended. Conversely, the opposite occurs as flaps are retracted and the aircraft settles. Extension of the flaps also reduces the stalling speed of the aircraft. Changes resulting from flap extensions are included in the following table:

Flap Position (Degrees	Wing Flap Drag Area (Square Feet)	Lift Increase (Percent)	Indicated Stall Speed at 88,200 lb (KIAS)
0	0	0	112
10	12.8	7.5	104
20	26.8	26.7	95
30	46.3	46.1	90
40	58.7	56.5	88
45	66.8	60.5	88
50	83.6	64.5	87

Two-speed flap retraction is provided. The faster retraction rate from 50 to 20 degrees (9 seconds) is provided for rapid elimination of high drag present at high flap angles. The slower retraction rate from 20 degrees to up (13 seconds) is provided so that the flight path during takeoff can remain relatively constant as flaps are retracted. This is the result of lift increase due to increasing airspeed balancing lift loss due to flap retraction. At a given speed, the flight path can remain constant during flap extension or retraction, provided the angle of attack is changed to counteract for the lift changes which are taking place in the wing-flap combination, or the speed is changed to compensate for the change in lift at a constant angle of attack.

STALLS.

Stall characteristics of the aircraft are excellent. The aircraft is fully controllable up to the stall. At the stall, the nose of the aircraft pitches down gently without rolling, allowing stall recovery to be effected with a minimum manipulation of the controls and loss of altitude. Acceleration increases stalling speed. A 15-feet-per-second gust encountered in level flight will raise the stalling speed from 114 to 130 knots IAS. This gust is equivalent to an acceleration of 1.30g's which can be developed in a coordinated turn at a bank angle of 40 degrees.

WARNING

Stalls may be encountered with little or no warning.

Figure 6-1 is based on the effect of acceleration and gives the change in stalling speed for various gross weights, flap positions and for all bank angles up to 60 degrees. The use of figure 6-1 is illustrated in the following example:

Given: Configuration - Flap angle - 20 degrees
Gross weight - 79,000 pounds

Find: Stalling speed in coordinated turn for bank angle of 30 degrees.

Enter chart at gross weight of 79,000 pounds (A) and read up to flap angle 20 degrees (B), and across to baseline (C). Follow guide lines to a bank angle of 30 degrees (D), and read across to find airspeed of 97 knots (E). Figure 6-1 tabulates the changes in stalling speed based on zero thrust (V_S) for varying gross weights and flap positions. Due to the slipstream effect over the wing, power-on stalling speeds are lower than zero thrust stalling speeds by approximately 5 to 10 knots at approach power, and 10 to 15 knots at maximum power. This difference is not taken into consideration in calculating performance speeds based on stalling speeds, but instead is available as an extra margin of safety.

STALLING SPEED IN COORDINATED TURN

MODEL: C-118A
DATE: 7 JUNE 1972
DATA BASIS: FLIGHT TEST

ENGINES: (4) R2800-52W

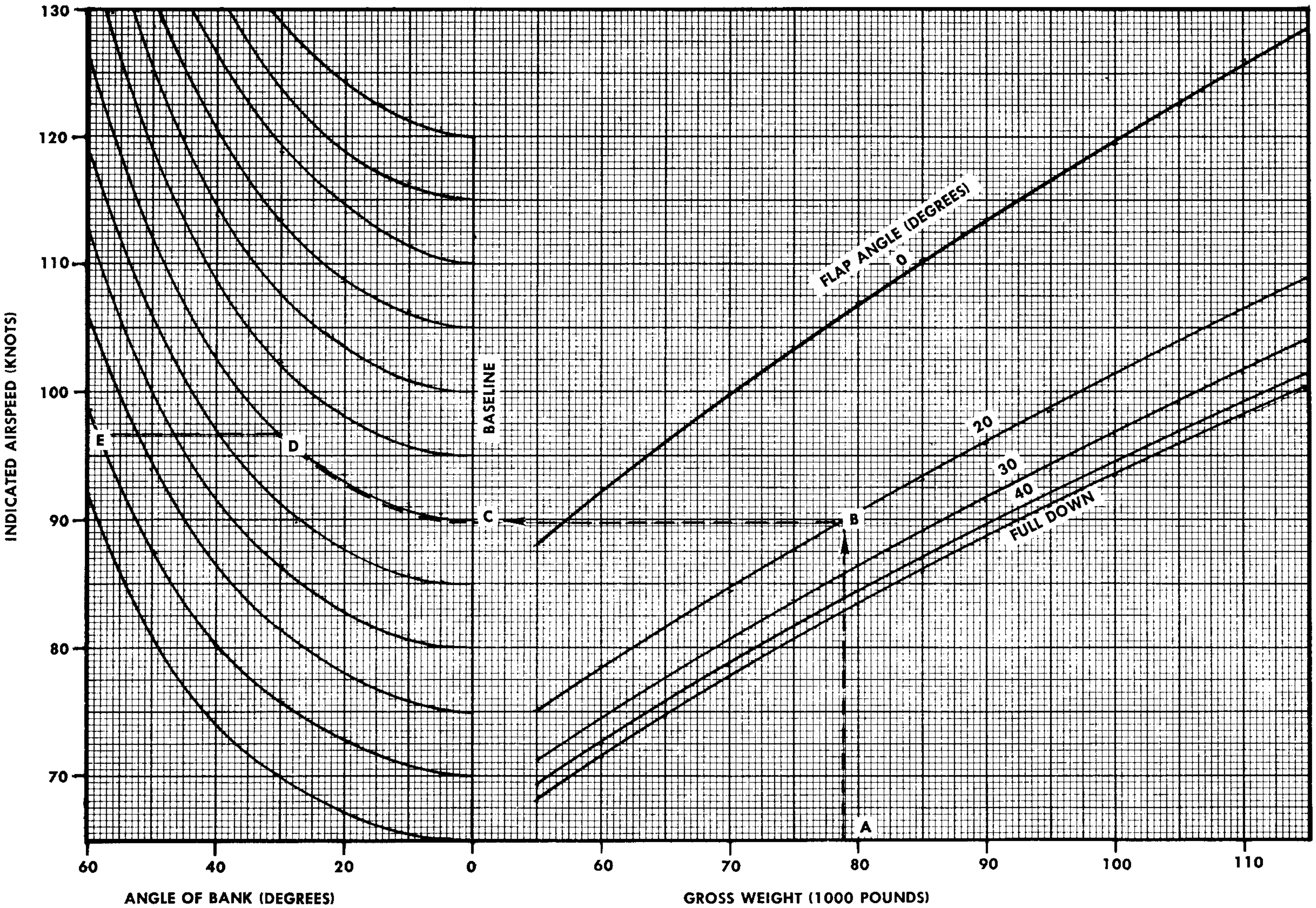


Figure 6-1

RECOVERY FROM STALL.

When the aircraft is stalled, recovery should always be made by nosing the aircraft slightly down, and applying power as required. At all times, abrupt pull-outs should be avoided so as to eliminate the possibility of excessive g forces and resultant secondary stall.

SPINS.

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

FLIGHT CONTROLS.

The flight controls are very effective under all conditions of flight, and there is no unusual reaction to the flight controls under any flight condition.

DIVING.

Diving speed is limited as mentioned in Section V. Avoid abrupt pullouts at any time. Do not allow the IAS pointer to exceed the limit marking on the airspeed indicator (figure 5-1).

LIMITING DESIGN SPEEDS.

The criteria for establishing the limiting speeds of the aircraft from a structural standpoint may be explained as follows:

a. The load exerted on a body in a moving stream of air depends on the density of the air and on the speed of the air with respect to that body.

b. Mach number effect is caused by changes in airflow around an aircraft which may result in control force, control effectiveness and stability irregularities. For this reason, a maximum Mach number limitation is established.

The maximum speed demonstrated is based on two design limits of the aircraft; first, the ability to withstand a 15-foot-per-second gust at the maximum permissible indicated airspeed with no permament deformation; and second, no control force, control effectiveness, or stability abnormalities. The aircraft has been demonstrated to a maximum Mach number of 0.65. At Mach numbers at or below the maximum demonstrated value, no undesirable flight characteristics occur.

At the maximum normal operating speed (V_{no}) and at any combination of gross weight and fuel weight within the stated limitations, the aircraft is designed to withstand the gust load factors resulting from at least a 30-foot-per-second gust with no permanent deformations.

SECTION VII

systems operation

TABLE OF CONTENTS

FUEL SYSTEM MANAGEMENT.

All takeoffs, landings, and ground operations should be made with each engine receiving fuel from its respective main tank. A vapor vent return line connected to each carburetor returns all vapor plus fuel to the No. 2 main tank for engines No. 1 and 2, and to the No. 3 main tank for engines No. 3 and 4. The normal return flow is less than two gallons per engine per hour; however, if the vent float sticks or is damaged, it is possible to obtain a maximum flow of 20 to 30 gallons per engine per hour. For this reason, the fuel levels of No. 2 and 3 main tanks must be checked periodically to avoid overflowing. When selecting a new fuel supply for an engine, the new supply should be selected before shutting off the old supply or before the old supply is depleted, to minimize fuel surge to the carburetor (which can result in ruptured diaphragms or collapsed vapor vent floats), and the fuel booster pump should be turned to LOW. If a fuel [redacted] depleted before selecting a new source, retar[redacted]rottle of the affected engine before selecting a new supply to prevent fuel surge [redacted] also to prevent the possibility of overspeeding, which can result from the sudden resumption of power following a momentary power loss. Figures 7-1 and 7-2 graphically show the fuel flow and the control lever positions for various combinations of fuel system management. See figure 7-3 for fuel quantity data.

[redacted]

Maximum wing strength must be maintained by using fuel as recommended in the Fuel System Management Table (figure 7-1). After selecting alternate fuel tanks, the main fuel tank fuel quantity indicator should be monitored to prevent possible overfilling of the main tanks through the vapor vent return system in case of malfunctioning carburetors. The maximum unbalanced fuel load permissible, without restriction on speed or gross weight, is 1050 pounds between inner wing tanks and 450 pounds between outer wing tanks. These cross ship fuel unbalances must not occur simultaneously, as the structural safety margin for gusts and maneuvering will become critical.

TABLE
UNBALANCED FUEL LOAD LIMITATIONS

Tank Location	Cumulative Unbalance Between Tanks	Gallons	Weight
Outer Wing	No. 1 Main and No. 4 Main	75	450
Center Wing	No. 2 Main and No. 3 Main	175	1050
Center Wing	No. 1 Alt. and No. 4 Alt.	175	1050
Center Wing	No. 2 Alt. and No. 3 Alt.	175	1050

FUEL SYSTEM CHECK.

1. Fuel tank selectors - OFF.
2. Crossfeed selectors - OFF.
3. Alternate fuel boost pump switches - LOW.

NOTE

Fuel pressure indication is evidence of selector valve leakage.

4. Alternate fuel boost pump switches - OFF.
5. Main fuel boost pump switches - LOW.

NOTE

Fuel pressure indication is evidence of selector valve leakage.

6. Fuel tank selectors - MAIN (Check low boost pressure within limits). Wait for pressure to stabilize before selecting high boost position.
7. Main fuel boost pump switches - HIGH (high boost pressure within limits and warning light off).
8. Select low boost position No. 1 main - Warning light should come on at approximately 18 psi - return boost pump switch to high - light off.
9. Repeat step 8 for No. 2 and No. 3.
10. Select low boost No. 4 main - Warning light should come on at approximately 18 psi.
11. No. 1, 2, and 3 main boost pumps - LOW.
12. Fuel tank selectors - Alternate (fuel pressure should drop to zero).
13. Alternate fuel boost pump switches - LOW. (Check low boost pressure within limits) wait for pressure to stabilize before selecting high boost position.
14. Alternate fuel boost pump switches - HIGH. (High boost pressure within limits.)
15. Left crossfeed selector - Engine No. 1 and No. 2.

    Right crossfeed selector - Engine No. 3 and No. 4.
16. No. 2 and 3 tank selectors - OFF.
17. No. 2 and 3 alternate boost pumps - LOW.
18. No. 1 alternate boost pump - LOW. (No. 1 and 2 fuel pressure should drop to low boost pressure - No. 3 and 4 unchanged.) Reselect high boost No. 1 alternate
19. Crossfeed selectors - All engines.
20. No. 4 fuel tank selector - OFF.
21. No. 1 alternate boost pump - LOW (fuel pressure should drop to low boost pressure all engines.
22. No. 4 alternate boost pump - LOW.
23. Fuel tank selectors - Main.

NOTE

Fuel systems controls will remain in this position until visual inspection of the fuel system for leaks has been completed.

24. No. 1 main boost pump - HIGH BOOST.

    Remaining boost pumps to LOW.

RECOMMENDED USE OF FUEL BOOSTER PUMPS.

It is recommended that the electric fuel booster pumps be operated in LOW boost under the following conditions:

a. For engine start.

b. For takeoff/landing.

c. When climbing.

d. When selecting a new fuel supply source.

e. For fuel conditioning.

f. When fuel pressure drops below 22 psi or fluctuates.

g. For oil dilution.

[redacted]

[redacted]

Since the boiling point characteristics of fuel vary with each production run, and each run varies with age and the conditioning the fuel receives, it is difficult to predict the exact moment and condition under which booster pumps should be applied. Conditioning the fuel for one and one-half hours by booster pump agitation covers most of the critical fuel conditions that may occur in the fuel system. It is realized that this one and one-half hour period will be extremely liberal in a great many instances. With OAT below 24°C (75°F), it should be remembered that, with high altitudes and/or high OAT , it will be necessary to condition the fuel for longer periods. Therefore, make the following test for fuel stability:

a. After the aircraft has been stabilized at the cruise altitude, momentarily turn one of the selected booster pumps off and at the same time watch the fuel pressure.

b. If the fuel pressure drops or fluctuates, leave the booster pump in operation for a longer period.

c. If the pressure remains steady, the booster pump may be turned off.

d. Repeat this procedure for the remaining booster pumps.

USE OF HIGH BOOST PUMP PRESSURE.

In the event of engine fuel pump failure or an extreme cold weather start, where LOW boost does not supply sufficient pressure, HIGH boost may be used, provided LOW boost is first used to pressurize the system up to the carburetor. When shifting from LOW boost to HIGH boost, make the switch as rapidly as possible.

PRECAUTIONS.

a. Crossfeed valves should be in their OFF positions unless flow of fuel is expected through them.

[redacted]

[redacted]

[redacted]

NOTE

[redacted]

FERRYING OF AIRCRAFT WITH ONE OR MORE ALTERNATE FUEL TANKS INOPERATIVE.

The following procedure allows deviations from prescribed FUEL SYSTEM MANAGEMENT TABLE, this Section, to permit ferrying of aircraft with one or more alternate fuel tanks inoperative, when authorized and directed by the major command concerned.

[redacted]

The fuel booster pump switches and corresponding fuel booster pump circuit breakers for the affected alternate fuel tanks must be placed in the OFF position.

a. Ascertain that the reason for the inoperative tank(s) in no way impairs the structural or operational integrity of the aircraft.

b. Do not fuel the corresponding tank(s) on the opposite side of the aircraft.

c. All fuel must be loaded about the centerline of the aircraft.

d. All takeoffs, initial climbs, and landings must be made with each engine receiving fuel from its respective main tank.

e. If the takeoff weight does not exceed the maximum zero fuel weight, fuel may be loaded in and used symmetrically from any tank(s) in any order, except for the conditions in steps B and D.

f. If the takeoff weight exceeds the maximum zero fuel wieght:

(1). The main tanks must be filled equally first; additional fuel may be loaded in any or all of the remaining usable tanks within the limitations of steps B and C.

(2). The takeoff gross weight must not exceed the maximum zero fuel weight plus weight of fuel in the main tank.

(3). Except for the conditions in step D, all fuel in the tanks other than the mains must be used first, symmetrically about the aircraft centerline, then fuel must be used from all the mains simultaneously.

HEATER FUEL MANAGEMENT.

The amount of fuel used by the heaters varies with the heater cycling due to altitude and temperature. The three airfoil heaters, one for each wing and one for the tail, use approximately five gallons per hour per heater. The cabin heater uses approximately two or four gallons per hour. When all heaters are operating, they will use a total of approximately 17 to 19 gallons per hour.

FUEL SYSTEM

EIGHT-TANK SYSTEM
TOTAL USABLE FUEL - 5404 GALLONS
(Fuel Weight Computed at 6 Pounds Per Gallon)

FUEL LOAD GALS	FUEL LOAD LBS	Tanks: 1 AND 4 MAIN GALS	1 AND 4 MAIN LBS	1 AND 4 ALTERNATE GALS	1 AND 4 ALTERNATE LBS	2 AND 3 MAIN GALS	2 AND 3 MAIN LBS	2 AND 3 ALTERNATE GALS	2 AND 3 ALTERNATE LBS	*USAGE
1200	7200	300	1800			300	1800			4
1300	7800	325	1950			325	1950			4
1400	8400	350	2100			350	2100			4
1500	9000	375	2250			375	2250			4
1600	9600	400	2400			400	2400			4
1700	10200	425	2550			425	2550			4
1800	10800	450	2700			450	2700			4
1900	11400	475	2850			475	2850			4
2000	12000	500	3000			500	3000			4
2100	12600	525	3150			525	3150			4
2200	13200	550	3300			550	3300			4
2300	13800	575	3450			575	3450			4
2400	14400	600	3600			600	3600			4
2500	15000	625	3750			625	3750			4
2600	15600	650	3900			650	3800			4
2700	16200	675	4050			675	3950			4
2800	16800	695	4170			625	3750	80	480	1-3-4
2900	17400	695	4170			675	4050	80	480	1-3-4
3000	18000	695	4170			675	4050	130	780	1-3-4
3100	18600	695	4170			675	4050	180	1080	1-3-4
3200	19200	695	4170			675	4050	230	1380	1-3-4
3300	19800	695	4170			675	4050	280	1680	1-3-4
3400	20400	695	4170			719	4314	286	1716	1-3-4
3500	21000	695	4170			719	4314	336	2016	1-3-4
3600	21600	695	4170	200	1200	719	4314	186	1116	1-2-4
3700	22200	695	4170	218	1308	719	4314	218	1308	1-2-4
3800	22800	695	4170	243	1458	719	4314	243	1458	1-2-4
3900	23400	695	4170	268	1608	719	4314	268	1608	1-2-4
4000	24000	695	4170	293	1758	719	4314	293	1758	1-2-4
4100	24600	695	4170	318	1908	719	4314	318	1908	1-2-4
4200	25200	695	4170	343	2058	719	4314	343	2058	1-2-4

Figure 7-1 (Sheet 1 of 2)

MANAGEMENT

FUEL LOAD GALS	FUEL LOAD LBS	1 AND 4 MAIN GALS	1 AND 4 MAIN LBS	1 AND 4 ALTERNATE GALS	1 AND 4 ALTERNATE LBS	2 AND 3 MAIN GALS	2 AND 3 MAIN LBS	2 AND 3 ALTERNATE GALS	2 AND 3 ALTERNATE LBS	*USAGE
		Tanks								
4300	25800	695	4170	368	2208	719	3414	368	2208	1-2-4
4400	26400	695	4170	393	2358	719	3414	393	2358	1-2-4
4500	27000	695	4170	418	2508	719	3414	418	2508	1-2-4
4600	27600	695	4170	443	2658	719	3414	443	2658	1-2-4
4700	28200	695	4170	468	2808	719	3414	468	2808	1-2-4
4800	28800	695	4170	493	2958	719	3414	493	2958	1-2-4
4900	29400	695	4170	526	3156	719	3414	510	3060	1-2-4
5000	30000	695	4170	526	3156	719	3414	560	3360	1-2-3-4
5100	30600	695	4170	526	3156	719	3414	610	3660	1-2-3-4
5200	31200	695	4170	526	3156	719	3414	660	3960	1-2-3-4
5300	31800	695	4170	526	3156	719	3414	710	4260	1-2-3-4
5404	32424	695	4170	526	3156	719	3414	762	4572	1-2-3-4
Undumpable		116	696	0	0	108	648	54	324	
Unstickable		140	840	160	960	140	840	80	480	

*Usage Code 1

1. Main tanks to respective engines (switch to next step after 75 gallons (450 pounds) are used from each main tank or at completion of initial climb (cruise altitude or 15 minutes after start of takeoff).
2. Alternate tanks to respective engines until 100 pounds remain.
3. No. 2 and 3 alternate tanks to respective sides (crossfeed) until 100 pounds remain.
4. Main tanks to respective engines.

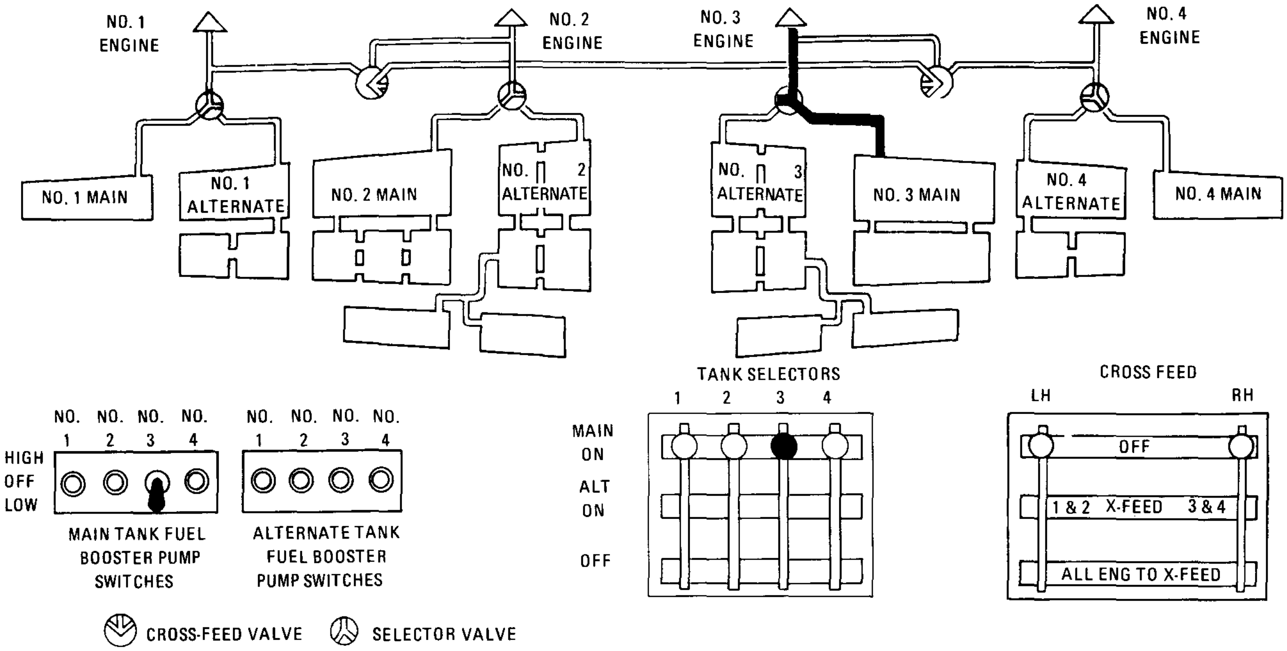
FOR FUEL LOADS OF 5100 GALLONS AND ABOVE

*Usage Code 2

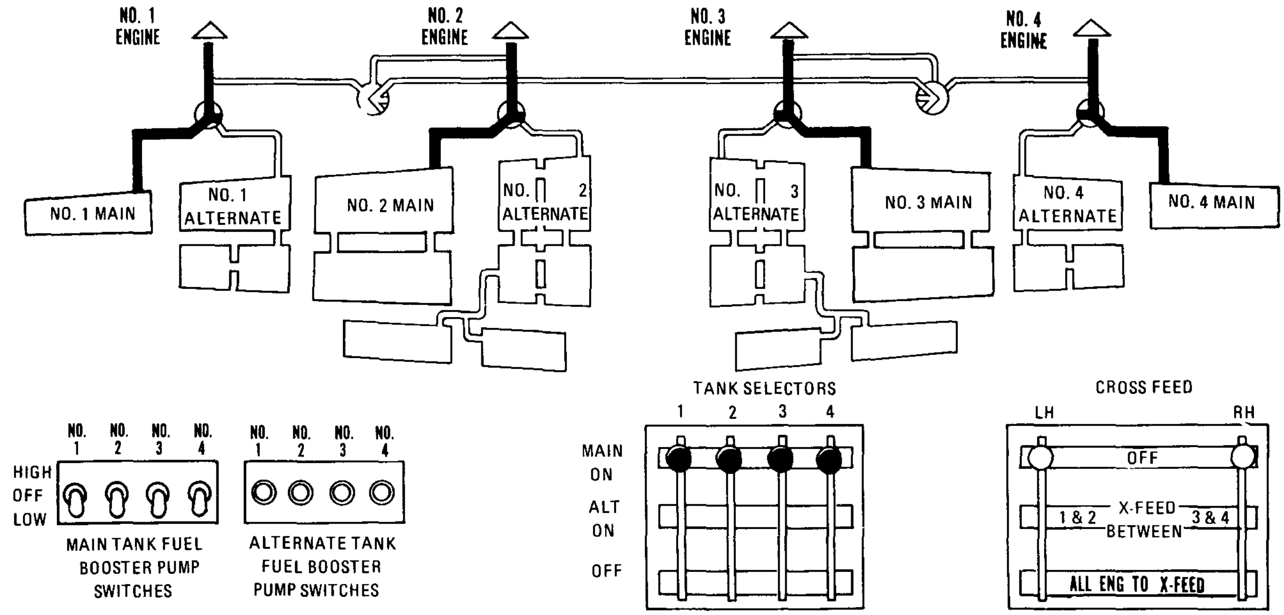
1. Main tanks to respective engines (switch to next step after 75 gallons (450 pounds) are used from each main tank or at completion of initial climb (cruise altitude or 15 minutes after start of takeoff).
2. No. 2 and 3 alternate tanks to respective sides (crossfeed) until fuel remaining is equal to fuel in No. 1 and 4 alternate tanks.
3. Alternate tanks to respective engines until 100 pounds remain; if any unbalance occurs, use crossfeed until 100 pounds remain in all alternate tanks.
4. Main tanks to respective engines.

Figure 7-1 (Sheet 2 of 2)

FUEL SYSTEM



NORMAL ENGINE STARTING, FUEL FLOW "MAINS" FOR ALL ENGINES; BOOSTER PUMP "LOW" TO ENGINE NO. 3

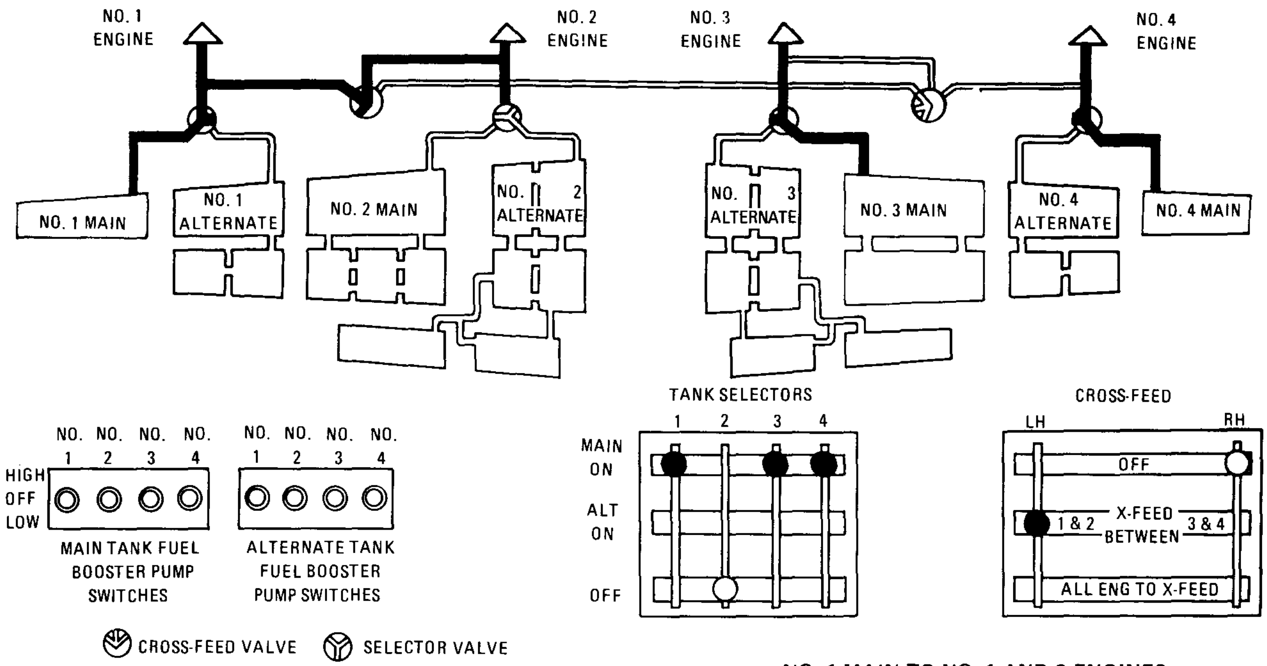


CROSS-FEED VALVE SELECTOR VALVE

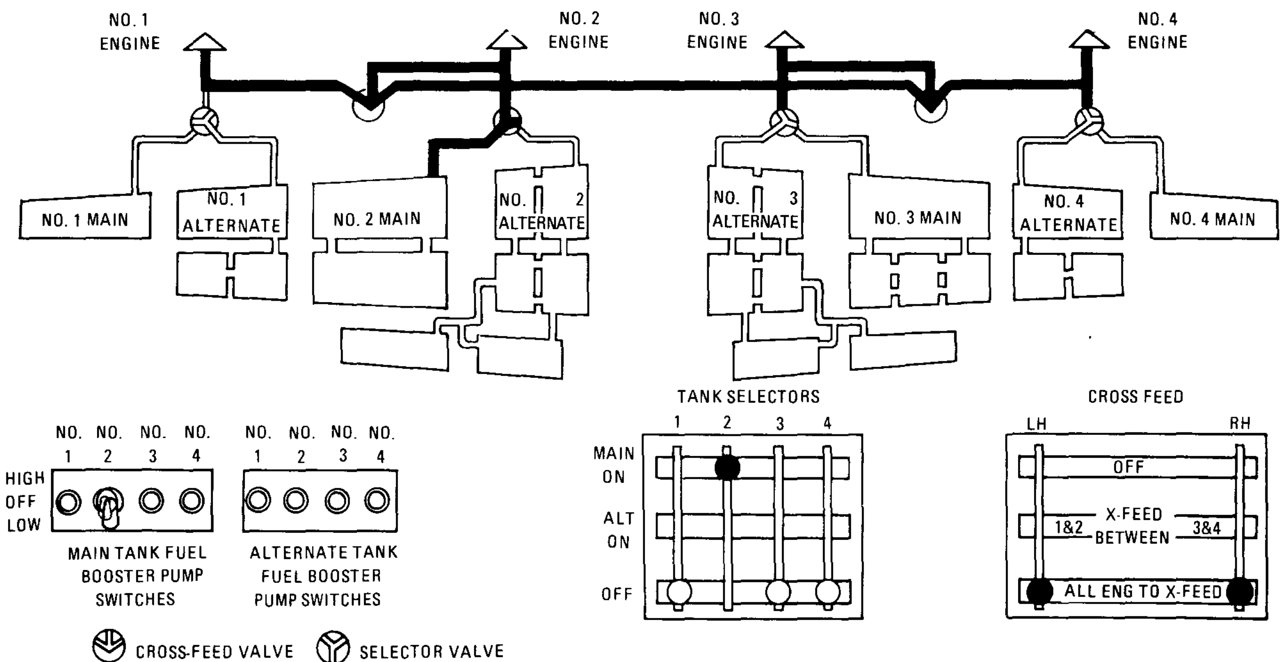
MAIN TANKS ON FOR ALL GROUND MANEUVERING, TAKEOFFS AND LANDINGS. BOOSTER PUMPS "ON" FOR TAKEOFFS AND LANDINGS AND WHENEVER NECESSARY TO MAINTAIN PRESSURE.

Figure 7-2 (Sheet 1 of 3)

MANAGEMENT



NO. 1 MAIN TO NO. 1 AND 2 ENGINES NO. 3 AND NO. 4 MAIN TO RESPECTIVE ENGINES, BOOSTER PUMPS "OFF" UNLESS NECESSARY TO MAINTAIN PRESSURE



NO. 2 MAIN TO ALL FOUR ENGINES THROUGH CROSS FEED SYSTEM BOOSTER PUMP "ON" TO MAINTAIN PRESSURE

Figure 7-2 (Sheet 2 of 3)

FUEL SYSTEM MANAGEMENT

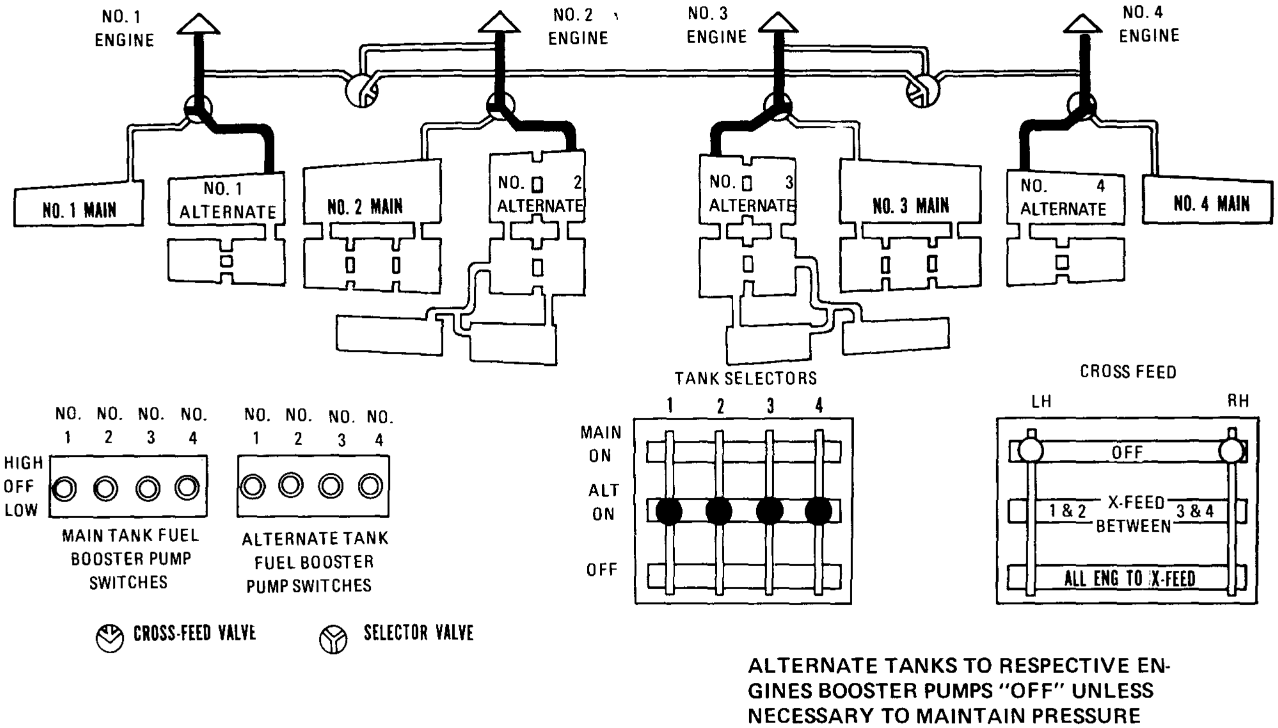


Figure 7-2 (Sheet 3 of 3)

CABIN HEATER CHECK.

1. Cabin heater ground blower operation - Checked.
2. Windshield heat selector switch - 0° C to -40° C.
3. Heater fuel and ignition selector switch - System No. 2.
4. Heater ignition selector switch - Check (single ignition).
5. Cabin heater master switch - ON.
6. Fuel pressure and temperature - Check for rise.
7. Cabin heater master switch - OFF.
8. Cockpit temperature rheostat - HOT.
9. Windshield heat selector - OFF.
10. Heater fuel and ignition selector switch - System No. 1 (wait 30 seconds before turning heater master switch ON).
11. Cabin heater master switch - ON.
12. Fuel pressure and temperature - Check for rise.
13. Cabin heater master switch - OFF.
14. Heater ignition selector switch - NORMAL (dual ignition).

NOTE

Do not turn cockpit temperature rheostat to normal until the cabin heater temperature has cooled.

AIRFOIL HEATER AND PROPELLER DEICER CHECK.

Use the following procedure to check heaters and deicer:

1. Heater fuel crossfeed - NORMAL SYSTEM.
2. Heater fuel and ignition selector switch - System No. 2.
3. Heater ignition selector switches - Check (single ignition).

FUEL QUANTITY DATA TABLE

FUEL AT 6 POUNDS PER GALLON

TANK	NO.	USABLE FUEL LEVEL FLIGHT (EACH TANK)		TOTAL FUEL GROUND ATTITUDE (EACH TANK)	
		GALLONS	POUNDS	GALLONS	POUNDS
1 AND 4 MAIN	2	695	4170	700.3	4201.8
2 AND 3 MAIN	2	719	4314	722.6	4335.6
1 AND 4 ALTERNATE	2	526	3156	531.0	3186.0
2 AND 3 ALTERNATE	2	762	4572	773.7	4642.2
TOTAL		5404	32,424	5455.2	32,731.2

AA1-178

Figure 7-3

4. Master heater switch - ON.
5. Fuel pressure and temperature - Check for rise.
6. Master heater switch - OFF.
7. Heater fuel and ignition selector switches - System No. 1. (Wait 30 seconds before turning master heater switch to ON.)
8. Master heater switch - ON.
9. Fuel pressure and temperature - Check for rise.

Note

For airfoil/and cabin heater operation, the No. 2, 3, and 4 engines (No. 2 and 3 for cabin and No. 2 and 4 for airfoil) must be operating at rpm above generator cut-in speed. This will provide the required ram air and electrical power for these systems. The cabin heater mav be operated by ground power or APU/GTPU.

10. Master heater switch - OFF.

CAUTION

Prolonged ground checking of airfoil heaters can cause a tail heater fire warning indication after heater is turned off. This is due to residual heat in heater and lack of purging air from ground blower. If the tail heater warning light comes on after a heater check, turn off the five amp tail airfoil heater circuit breaker on the main junction box and turn the airfoil heater switch to ON. This will cut off fuel and ignition to the airfoil heaters and will permit continued ground blower operation. If the warning light goes off within 10 seconds, turn master heater switch to OFF and visually inspect tail heater for possible damage. If warning light remains on, execute emergency procedures for tail heater fire and record on Form 781.

11. Heater ignition selector switches - NORMAL (Dual ignition).

The propeller deicing switch should be turned to ON and the propeller deicing ammeter checked for a 20-second cycle for each propeller. The

FUEL DENSITY TABLE

FUEL TEMPERATURE		FUEL DENSITY (LB/GAL)	
DEGREES C	DEGREES F	GRADE 100/130	GRADE 115/145
−50 to −45	−58 to −49	6.34	6.27
−45 to −40	−49 to −40	6.30	6.23
−40 to −35	−40 to −31	6.27	6.19
−35 to −30	−31 to −22	6.23	6.16
−30 to −25	−22 to −13	6.20	6.12
−25 to −20	−13 to −4	6.16	6.08
−20 to −15	−4 to 5	6.12	6.04
−15 to −10	5 to 14	6.09	6.00
−10 to −5	14 to 23	6.05	5.97
−5 to 0	23 to 32	6.02	5.93
0 to 5	32 to 41	5.98	5.90
5 to 10	41 to 50	5.94	5.86
10 to 15	50 to 59	5.91	5.82
15 to 20	59 to 68	5.87	5.78
20 to 25	68 to 77	5.84	5.75
25 to 30	77 to 86	5.80	5.71
30 to 35	86 to 95	5.77	5.67
35 to 40	95 to 104	5.73	5.63
40 to 45	104 to 113	5.69	5.60
45 to 50	113 to 122	5.66	5.56

Figure 7-4

switch should then be placed in the OFF position. The desired ammeter reading is placarded in the cockpit near the ammeter. A variation of more than 10 percent of the reading during the deicing operation will indicate possible presence of a deicing circuit abnormality.

OIL SYSTEM MANAGEMENT.

The capacity of each nacelle oil tank is 35 usable gallons plus 2.5 gallons in reserve for propeller feathering. In addition, the auxiliary oil tank located in the left fillet has a total capacity of 26 gallons. This oil is normally diluted in accordance with the following table. Auxiliary oil is transferred to a selected engine nacelle tank by means of a transfer system. Transfer oil pressure is provided by a motor and pump combination, controlled by a momentary contact switch on the upper overhead panel. Adjacent to the oil transfer pump switch is a tank selector switch which positions the four-way selector valve and directs auxiliary oil to the desired nacelle oil tank. Oil temperature is controlled by four switches on the aft overhead panel with the positions OPEN, CLOSE, OFF, and AUTOMATIC.

NOTE

It is recommended that no takeoff be made with less than 110 pounds in any nacelle tank.

TABLE
VISCOSITY/TEMPERATURE
TRANSFER LIMITATIONS*

OIL	FUEL	TEMP
100%	0	+1.7°C
80%	20%	-33°C
65%	35%	-38°C
50%	50%	-60°C

*Typical oil and fuel dilution proportions for low temperature ranges, for preventing congealed oil in auxiliary tank and lines.

It is desirable but not necessary that auxiliary oil be transferred to a nacelle tank when the level of oil drops to 110 pounds. The procedure should be as follows:

a. Position the tank selector switch to the required nacelle tank.

b. Depress the auxiliary oil tank pump switch. Release the switch when the desired amount of oil has been transferred, as indicated by the oil tank quantity indicator.

c. After oil has been transferred, the transfer system lines should be evacuated by reversing the pump actuating switch (approximately one minute) to avoid the possibility of oil congealing in the transfer line.

NOTE

Nacelle oil tanks must not be filled above the 150-pound level by use of the oil transfer system due to excessive foaming when the diluted oil enters the tank. In the event of an emergency condition, the engine can be continuously operated down to 35 pounds of oil (15 percent of normal quantity). When operating with a low oil quantity, the oil temperature and oil pressure should be monitored closely.

CAUTION

Due to the effect of diluted oil on engine components, inflight oil transfer shall be held to a minimum and used only when required to insure an adequate supply of oil in the nacelle tank for normal operation.

d. The oil temperature normally is regulated automatically. However, if automatic oil temperature control becomes inoperative, the oil cooler door can be positioned manually by using the oil cooler door air exit switch on the aft overhead panel in either the OPEN or CLOSE positions, as required. These are momentary positions. When the switch is centered, a brake keeps the door locked in position. Refer to Section V for Operation Limits.

CYLINDER HEAD TEMPERATURE MANAGEMENT.

Minimum cylinder head temperatures, within limits, should be secured prior to takeoff for the following reasons:

a. Increasing temperatures are conducive to common types of spark plug fouling, which can be reduced through control of maximum CHT.

b. [redacted]. Minimum CHT can be maintained by making a brief engine runup to perform the necessary checks and by keeping cowl flaps fully open until ready to apply takeoff power. [redacted]

ADI SYSTEM MANAGEMENT.

When ADI is used during a takeoff, the ADI system pressure, fuel flow, manifold pressure, and BMEP must be monitored by the flight mechanic, and any discrepancies must be reported to the pilot immediately. As throttles are advanced beyond 38 to 42 inches manifold pressure, the ADI pressure should drop to a normal flow of from 22 to 24 psi as a result of ADI flow. If the drop in pressure should fail to occur on any water pressure indicator, change power to the maximum dry manifold pressure and turn ADI switch OFF for the respective engine.

During takeoff, if the ADI pressure drops below 18 psi (light on) and carburetor enrichment is in excess of 1800 pph, it is possible that a fuel, oil, or ADI leak exists within the engine nacelle. If this malfunction occurs prior to refusal speed, takeoff should be discontinued and the cause of the pressure drop investigated. If failure of the ADI system can be attributed to an electrical malfunction, a takeoff may be made with the affected ADI system OFF, provided performance requirements are met. If malfunction occurs after refusal speed, takeoff must be continued. [redacted]

ENGINE BLOWERS.

ENGINE BLOWER SHIFT CHECK.

When making an engine blower shift check, pilots should make absolutely certain that blowers are back in low before takeoff. Should the blower shift actuator fail to shift from high back to low, and a takeoff be made in high blower, severe detonation caused by high compression and high temperature of the mixture might result in engine failure. To determine whether or not blowers have actually shifted, pilots may observe two indications: manifold pressure and oil pressure. When shifting from high back to low, a drop in manifold pressure and a fluctuation of BMEP indicate that the blower has actually gone back into low position.

ENGINE BLOWER SHIFT OPERATION.

The altitudes for shifting blowers are given in the Power Schedule Tables in T.O. 1C-118A-1-1. These altitude values are determined from engine operating curves and comparative fuel consumption for each blower ratio at the same engine power output. They are based on use of low blower whenever the desired power can be maintained at the selected rpm with full throttle. Carburetor air temperature as related to blower operation is of critical importance. Carburetor air temperature is measured before fuel is injected and before the fuel-air mixture passes into the blower section. Due to the compressor action of the blower and other factors, considerable heat rise occurs in the fuel-air mixture before the charge is admitted to the cylinders. By controlling the carburetor air temperature to certain maximums, it is therefore possible to preclude detonation that originates from excessive carburetor heat. The low blower critical altitude (full throttle) for normal climb BHP is usually reached in the range of 12,000 to 15,000 feet, depending upon existing atmospheric conditions and variations in engine condition.

BLOWER SHIFT PROCEDURE.

The shock associated with a blower shift will be minimized by reducing the pumping load on the supercharger through a momentary manifold pressure reduction to approximately 25 in. Hg while effecting the shift from low to high ratio. The shift from high to low ratio may be effected without reduction in manifold pressure as this shift reduces the pumping load on the supercharger. The use of auto-rich mixture during the engine blower shift operations is beneficial because the change in fuel/air ratio obtained in moving from manual lean to auto-rich, changes the temperature pattern within the combustion chambers and causes lead and carbon deposits to be carried out the exhaust, thus prolonging spark plug life. Use the following applicable procedure when shifting from low to high blower.

Procedure A.

a. Reduce power on symmetrical engines (No. 1 and 4) to 25 in. Hg MAP and place No. 1 and 4 engine blower switches to HIGH.

b. Establish high blower climb power on engines No. 1 and 4.

c. Reduce power on symmetrical engines (No. 2 and 3) to 25 in. Hg MAP and place No. 2 and 3 engine blower switches to HIGH.

d. Establish high blower climb power on engines No. 2 and 3.

Procedure B.

a. Reduce power on all engines to 25 in. Hg MAP and place all engine blower switches to HIGH.

b. Establish high blower climb power on all engines.

CAUTION

In the event electrical power is lost or temporarily disrupted during high blower operation, the blowers will automatically shift to the low ratio. To prevent inadvertent shift back to high blower, place the blower switches in LOW position before restoring power. Refer to ELECTRICAL SYSTEM FAILURE, Section III.

NOTE

All throttle movements should be smooth and equal during blower shift procedure.

SPARK PLUG ANTIFOULING PROCEDURES.

GENERAL.

Spark plug fouling is a principal cause of ignition trouble, which in turn is one of the most common engine maintenance and operating problems with aircraft engines using 115/145 or 100/130 grade fuel. These grades of fuel may contain a relatively high lead content, up to 4.5 cc per gallon. Fouling might be defined as an accumulation of deposits which cause misfiring or prevent firing across the spark plug electrodes. The most common types of fouling are lead fouling and carbon fouling, with lead fouling the main troublemaker. Cause, prevention, and cure of spark plug fouling are all linked to the chemistry and physics of the combustion cycle, which in turn are subject to wide variation under different ground and flight engine operating conditions. A logical treatment of the problem involves a separate discussion of each aspect of typical engine operation including ground running, takeoff, cruise, and descent. Prevention is the most profitable line of attack to the problem.

IMPORTANT FACTORS.

Tetraethyl lead is the most important basic cause of lead fouling. Scavenger agents such as bromine in the tetraethyl lead are provided to combine with the lead during combustion, removing it with the exhaust gases. However, under certain conditions of temperature and pressure, the lead will condense out on the spark plug insulator as lead oxide or lead bromide. In the presence of excess carbon as a reducing agent, these may form metallic lead particles. All such deposits can prevent ignition or firing. Other pertinent factors which influence plug misfiring include the type of ignition system, spark plug characteristics and age, water injection operation (dry or wet takeoffs) general engine conditioning including the care and handling of spark plugs, the operating requirements and characteristics of the particular engine installation, and the specific engine operating conditions.

In general, spark plug fouling involves a buildup of deposits through prolonged operation under a fixed set of conditions. Therefore, prevention and remedy for plug fouling depend on taking action to vary these conditions which includes upsetting the chemistry of the fouling cycle and thereby restoring proper ignition.

IDLE MIXTURE CHECK.

Idle mixture adjustment is one of the most important factors to be considered in providing protection against fouled spark plugs. When performing a postflight check, the flight mechanic must check the idle mixture at minimum idle rpm and at the most commonly used ground idle rpm for a rise not to exceed 20 rpm. Too much emphasis cannot be placed on slow movement of the manual mixture lever during the check. Best power mixture must be obtained and held for at least five seconds. Best power is when a maximum rise in rpm is noted. Any further movement past this point will cause a drop in rpm; therefore, the flight mechanic should move the mixture lever slowly until he has obtained maximum rpm and the rpm has started to decrease. The mixture lever should then be moved very slowly back to the point where the maximum rpm rise was obtained. After ascertaining that the best power mixture has been obtained and maximum rpm rise has been noted, return the mixture control to the appropriate setting. If no rpm rise was noted when slowly moving the mixture lever toward IDLE CUT-OFF, the mixture is too lean. If over a 10 rpm rise is noted, the mixture is too rich and the mixture should be manually leaned to obtain best power or maximum rpm. If the rpm rise was less than 10 rpm the mixture control may be placed in either the AUTO LEAN or AUTO RICH position. It must be remembered that cylinder head temperature has a direct bearing upon the results obtained; therefore, the engine must have a cylinder head temperature between 160° and 180°C when performing an idle mixture check. When the aircraft is at the home station and the idle mixture is found to be out of adjustment, it is recommended that corrective maintenance be performed prior to releasing the aircraft for flight.

Idle mixture strength does change with altitude changes. Therefore, when an aircraft is operating away from its home station, the idle mixture could be too rich and cause fouling of the spark plugs. Naturally, this will be noted by the flight mechanic when he performs the idle mixture check. This will not be cause for rejection of the aircraft, as the mixture will be correct when the aircraft is returned to the home station. In these cases, the flight mechanic will manually lean the mixture for any extended periods of ground operation. The mixture will be manually leaned to obtain maximum rpm, which will be the best power mixture. Further, a minimum of 150°C cylinder head temperature should be maintained. The most critical fouling range for the R-2800 engine is between 900 and 1100 rpm.

SPARK PLUG FOULING PREVENTION, CLEANOUT AND GROUND DEFOULING PROCEDURE.

Spark plug fouling prevention:

During extended periods of ground idling it is recommended that mixtures be manually leaned to obtain maximum rpm rise.

Spark plug cleanout:

After each 10 minutes of ground operation at low rpm, the throttles should be advanced slowly (three to five seconds per 100 rpm) to manifold pressure five inches above field barometric pressure, with a concurrent scan of combustion patterns on the ignition analyzer. This power shall be held for one minute; however, maximum ground operating cylinder head temperatures (232°C) will not be exceeded. If a fouled pattern appears on the ignition analyzer, proceed with ground defouling procedure.

Ground defouling procedure:

1. Props - Full INCREASE rpm.
2. ADI - OFF.
3. Mixture - AUTO RICH.
4. Decrease power to a manifold pressure one inch below that manifold pressure at which the spark plug resumes firing and operate for at least 10 seconds.
   a. Advance throttles slowly (three to five seconds per 100 rpm) to five inches above field barometric pressure.
   b. Scan ignition analyzer during power increase for proper combustion patterns.
   c. Hold this power for one minute.
   d. If satisfactory patterns appear on ignition analyzer, reduce power to field barometric pressure and continue with engine runup check.
   e. If after performing steps a. through e. twice and fouled pattern(s) appear on the analyzer, proceed as follows:
5. Operate engine(s) at field barometric pressure until CHT reaches 180 to 190°C.

NOTE

In colder temperatures it is permissible to place mixture control in AUTO LEAN until desired CHT is reached, then return to AUTO RICH.

6. Advance power slowly to 40 in. Hg and scan analyzer and check BMEP output. If some combustion is present in all cylinders, advance power to 45 in. Hg for a maximum of 30 seconds (do not exceed CHT of 232°C). If the analyzer is inoperative, compare actual BMEP against that which a normal engine would produce under existing conditions of temperature, humidity and altitude.
7. If after performing the above procedure twice and spark plugs are not defouled, corrective maintenance must be performed.

INFLIGHT PREVENTION.

A periodic change in engine conditions will usually prevent lead fouling during cruise. The engine analyzer should be used to check ignition patterns at least once each hour and, after each hour at cruise settings, one of the following procedures should be used to prevent fouling:

a. The use of auto-rich mixture for a two minute period.

b. Engine blower shift.

c. A change in power of three to five inches of manifold pressure or a change of 100 rpm. A reduction in the power level followed by an increase in the power level appears to be the most effective approach to prevention of fouled spark plugs.

INFLIGHT DEFOULING.

If spark plug fouling occurs in flight the rich-mixture method of correction should be tried first. If this is not effective, reduce manifold pressure slowly until plugs resume firing and maintain this power for approximately one minute. Slowly increase power, while scanning analyzer and repeating the previous process until all plugs have resumed firing and manifold pressure has been increased to the desired cruise setting. Plugs that cannot be cleared should be recorded for corrective maintenance after landing.

DESCENT.

Best power mixture is favorable to clean ignition and provides minimum tendency for plug fouling.

CAUTION

When flying conditions require a large reduction in power, reduce rpm as well as manifold pressure. It is important to cushion the high inertial loads on the master rod bearings which occur under these conditions. As a rule of thumb, each 100 rpm requires at least one inch Hg. manifold pressure (for example, 23 inches Hg at 2300 rpm). Operation at high rpm and low manifold pressure should be kept at a minimum.

ENGINE DISCREPANCIES IN FLIGHT.

A positive procedure cannot be established to cover all possible situations requiring engine shutdown. Although many considerations will influence this decision, a guide for feathering is offered here. Serious consideration should be given to shutting the engine down when one or more of the following conditions occur and spark plug lead fouling is determined not to be a factor:

a. An extreme or abnormal engine vibration occurs.

b. An excessive or uncontrollable power loss occurs.

c. A sudden or uncontrollable rise in oil temperature occurs.

d. A sudden uncontrollable drop in oil pressure occurs.

e. A sudden and uncontrollable rise of cylinder head temperature occurs.

f. When symptoms of impending mechanical failure exist in any one cylinder (two shorted-secondary patterns in one cylinder).

CAUTION

If both spark plugs of any cylinder show shorted secondary patterns, consideration should be given to shut the engine down unless it is needed to sustain flight. Often both spark plugs showing shorted secondary patterns are the result of piston or valve failure which may be followed by engine failure.

g. A heavy discharge of oil is seen to emit from the engine breather or exhaust system or a sudden decrease in oil quantity indication.

h. The oil temperature or cylinder head temperature cannot be maintained within the published limits.

i. An engine fire occurs.

AIRCRAFT BRAKING.

Effective aircraft braking - both dynamic and aerodynamic - requires full consideration of several operational and environmental variables. Consistent use of approved braking techniques will assure maximum safety, reliability, and deceleration force. Professional pilots know from experience that careless use of brakes can produce totally unexpected results.

Dynamic braking includes deceleration force of the wheelbrake system and wheel rolling-drag. Aerodynamic braking is a function of airspeed control, flaps, touchdown attitude, wheel rolling-drag (as related to gross landing weight and wing lift remaining) and reverse thrust.

Braking efficiency is a function of the following factors: type of aircraft, gross landing weight, proper tire inflation and adequate tread depth, wind, runway slope and length, runway condition reading (RCR), antiskid system efficiency, aerodynamic braking efficiency, dynamic braking efficiency and taxiing technique for existing airport and weather conditions.

On all landings maximum aerodynamic braking commensurate with runway length and slope should be used, with minimum wheel brake action. Such technique will conserve the brakes and assure top system performance, particularly in the case of emergency.

To obtain maximum deceleration, full aircraft weight must be on the wheels. This is achieved by placing the nosewheel on runway, by flap retraction and the application of reverse thrust. If brake pressure is applied too soon after touchdown, the wheels will lock more readily than if applied after full weight is on the landing gear. A wheel once locked by too early use of brakes will not unlock as weight increases until brake pressure is released. With full weight on the wheels, a gradual increase of braking pressure to the required maximum can usually be made without skidding the tires.

For very short landing rolls a single, smooth application with progressively increasing pedal pressure is recommended. Such procedure is effective for all emergency braking also.

SKIDS.

Brakes can only stop the wheels from turning. Stopping an aircraft depends upon positive traction (friction coefficient) between tires and runway surface. Mechanical braking action must be transmitted to the runway surface through the wheel for satisfactory braking results.

Braking efficiency decreases as wheels begin to skid. If one wheel locks, there is a strong tendency for the aircraft to turn away from the locked wheel. Further application of brake pressure at the locked wheel provides no corrective action. Since the friction coefficient decreases proportionally as a skid increases, once locked, a wheel will not recover its normal roll until brake pressure is released.

There are two reasons for loss of normal traction and braking efficiency during skids. First, the immediate affect is to scuff the tread, tearing off small pieces of rubber which act like rollers under the tires. Second, the heat generated starts to melt the rubber - molten rubber acts as a lubricant. In some situations, there may be a little or no indication to the pilot of skidding until a tire has blown out. If skidding is even suspected, as evidenced by any unusual ground-steering feel, release brake pressure immediately and reapply. Also, with the antiskid system inoperative, skids can be expected if brakes are applied before full aircraft weight is down on the wheels.

It has been determined that optimum braking requires a 15 to 20 percent rolling-skid factor. The wheels continue to rotate, but must have some slippage between the tires and runway for proper braking action. In other words, wheel rotational speed is limited to 80 - 85 percent of that during free roll. As the amount of skid increases beyond this optimum, the friction coefficient decreases rapidly. During a 75 percent skid, for example, friction efficiency drops to 60 percent of optimum.

In most situations, wheel lock and the resulting wheel skid is less likely during landing rollout if full aircraft weight is distributed evenly on the main wheels.

ANTISKID SYSTEM.

The antiskid system functions in conjunction with the regular wheel brakes, assisting the pilot by automatically preventing skids. This system is designed to prevent skidding at higher speeds under light wheel loads, and operates each time a main landing wheel approaches a skid condition. Therefore, brake systems equipped with the antiskid feature can be applied immediately after touchdown if required.

Although the antiskid system considerably reduces the rollout distance on wet or dry runways, its not intended for use as a full-time automatic braking system. Such indiscriminate braking will cause excessive brake wear due to extreme heating. Instead, pilots should continue to make minimum use of wheel brakes by utilizing a full landing rollout with maximum aerodynamic braking.

If maximum braking is required with the antiskid system inoperative, first decrease remaining wing lift by raising flaps and placing all wheels firmly on the runway before applying brakes. This technique will place full aircraft weight on the wheels and runway, providing maximum rolling-drag. Thrust reversal is then used if required. Avoid brake application any time that noticeable wing lift remains.

HYDROPLANING.

Hydroplaning is a form of wheel skidding caused by heavy precipitation on the runway, and can suddenly reduce traction between tires and runway surface to zero with or without the presence of water puddles. An aircraft might feel to the pilot to be making a firm landing, until suddenly normal wheel braking proves ineffective. The aircraft may even accelerate slightly at this point as the tires ride up on top of the water film.

Aircraft become more susceptible to hydroplaning if rain suddenly increases in intensity during touchdown and rollout. At such times the plane may be practically obscured by spray. Hydroplaning can also cause excessive cycling of the antiskid system, forcing the pilot to rely upon aerodynamic braking. In extreme hydroplaning situations, a complete absence of tire marks has been noted after the aircraft had skidded off the end of the runway.

There are three known types of hydroplaning related to aircraft wheel braking. All the types can occur singly or simultaneously, under nosewheel and main wheels. Such hydroplaning can also occur at any point throughout the gross weight range of an aircraft.

a. Dynamic Hydroplaning: This type can occur when about one-tenth of an inch or more of water covers the runway. The water reacts to lift the tires and wheels off the runway surface - the aircraft supported by a water film.

b. Viscous Hydroplaning: This type is the result of the viscosity properties of water and slush films. In such situations a very thin film of water (one-thousandths of an inch, for example) cannot be penetrated by the tire tread. As a result, the tire rolls along on top of the film. Such interface reaction is most likely to occur at runway touchdown areas impregnated with relatively large deposits of rubber particles scrubbed from the tires of landing aircraft. Tires fail to gain effective traction during wet weather due to viscous hydroplaning - skidding results.

c. Rubber Reversion Hydroplaning: This type of hydroplaning requires a prolonged locked-wheel skid, skid-generated heat and damp-to-wet runway conditions. Rubber reversion is that condition where tire rubber reverts to its original uncured state - becomes sticky and tacky - due to excessive heat generated by friction between the tire footprint and wet runway surface. It is theorized that reverted rubber acts as a seal between the tire and runway surface, trapping and delaying water escape from under the tire footprint area. The trapped water is heated and converted to steam by the skidding friction. The resulting steam pressure lifts and holds the tire off the runway surface.

FRICTION COEFFICIENT.

The term friction coefficient describes the ability to resist skidding under various operational and environmental conditions. Friction coefficient equals average tractional force at the tread and runway interface, divided by individual wheel load. The braking coefficient decreases when a wheel begins to skid. As stated, mechanical braking action at the wheel must be transmitted to the runway surface in order to attain an acceptable braking coefficient.

RUNWAY SURFACE CONDITION.

Landing aircraft are susceptible to skidding whenever standing water or slush begins to exceed one-tenth of an inch in depth. The problem of water accumulation under the wheels during rollout in moderate to torrential downpours is important enough to give a pilot cause to consider a go-around and landing delay until runway surface conditions are improved. This alternative becomes increasingly important if final approach speed or altitude is excessive. Limited runway length is also a factor to be considered.

Pilots should request and receive an accurate report of anticipated runway surface conditions at the time of landing. Such report should be based upon an actual visual runway surface inspection by authorized ground personnel. If doubt exists, the pilot should request another RCR just prior to estimated arrival time. Any report of standing water or moderate to heavy precipitation on the runway should be cause for extra caution and possible landing delay.

TIRE CONDITION.

The following factors concerning tire condition, as related to skidding, are also of importance when planning landings in moderate to heavy precipitation:

a. Tire Inflation: Tire inflation pressures are very important. Make certain that tires remain inflated within recommended tolerances, particularly during rain and slush seasons.

b. Tread Depth: Tread depth also contributes to braking efficiency. If standing water depth exceeds tread depth, such tires will react as smooth tires above the aircraft's hydroplaning speed. See Figure 7-5 for hydroplaning ground speeds as a function of tire pressure. A gross weight scale is included on the right side of figure 7-5. Enter chart with tire pressure of 97 psi proceed to curve line and out to ground speed line of approximately 89 kts.

NOTE

Hydroplanning ground speed will be good only if tire pressure is maintained in accordance with Tire Pressure Chart.

c. Taxiing and Brake Cooling: Minimum braking action while taxiing contributes to safety, reliability and reduced maintenance. Taxi accidents due to brake failure are thus minimized. Excessive heat is the most serious adverse factor resulting from improper braking technique. Minimum brake use and frequent cooling intervals will relieve the heat problem.

Peak temperatures occur in wheel and brake assemblies five to 15 minutes after heavy and emergency braking, as well as after some high wind taxiing. Pilots should allow for final brake cooling while approaching the parking area when possible. An aircraft should not be taxied into a crowded ramp area or have the parking brake set with hot brakes. Sufficient cooling time must be provided. Such safety precautions will prevent hazardous brake fires and wheel and tire assembly explosions due to heat.

INVERTER OPERATIONAL CHECK.

1. Radar inverter - NORMAL.
2. Radio-electric inverter - STANDBY.
3. Instrument switch - STANDBY.
4. With the inverter warning lights off, check voltage output with the ac voltmeter and selector switch in the following positions:
   - a. Radio Elect Flt Inv 115V.
   - b. Phase A.
   - c. Phase C.
   - d. Eng Inst 26V.
   - e. Radar Inv 115.
   - f. Phase A.
   - g. Phase C.
   - h. Check frequency - 380 to 420 cycles per second on both Radio Elec Flt Inv 115V and Radar Inv 115V positions.
5. Radar inverter - STANDBY.
6. Electrical Radio inverter - NORMAL.
7. Instrument switch - NORMAL.
8. Repeat procedures for step 4 in reverse order.
9. Radar inverter - NORMAL.

HYDROPLANING

GROUND SPEED VS TIRE PRESSURE FOR SMOOTH TIRES

NOTE: GROUND SPEED MUST BE CONVERTED TO KIAS - CORRECT FOR WIND, DENSITY ALT., AND POSITION ERROR

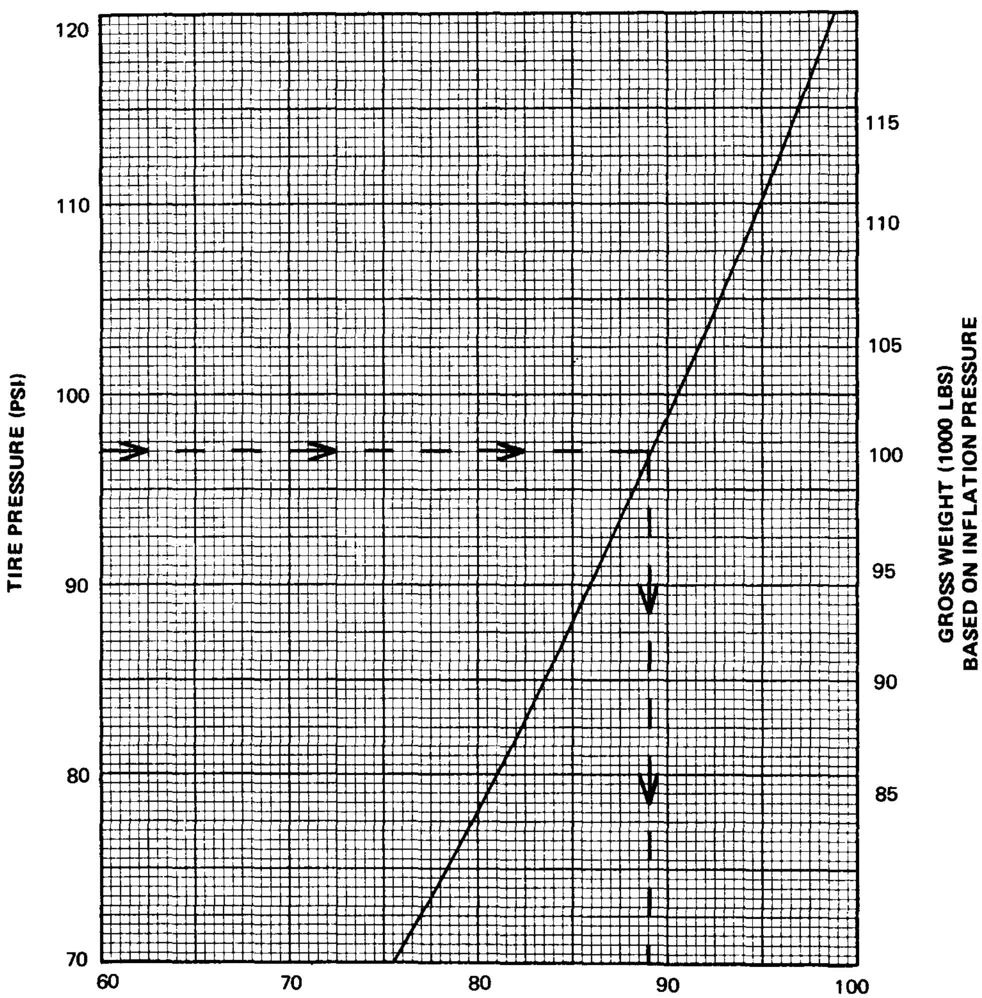


Figure 7-5. Hydroplaning Ground Speed (KNOTS)

SECTION VIII
crew duties

TABLE OF CONTENTS

INTRODUCTION

This section contains those functions of the crew which are in addition to the primary responsibilities of a crewmember. It is assumed that each individual crewmember is fully aware of the primary responsibilities of his job.

PILOT.

It will be the responsibility of the pilot to assure that a thorough inspection of the aircraft and all equipment is properly conducted in sufficient time prior to departure to permit correction of discrepancies without incurring delays. The inspection checklists are covered in detail in Sections II and III.

COPILOT.

The copilot will aid the pilot as directed in order to accomplish the assigned mission.

FLIGHT MECHANIC.

The flight mechanic shall perform the aircraft preflight inspection as outlined in Section II and report aircraft conditions to the pilot. In flight he will operate and monitor the various systems to ensure the successful completion of the mission.

NAVIGATOR.

The navigator will aid the pilot in all matters pertaining to flight planning and will perform any other duties assigned.

NAVIGATOR'S EXTERIOR INSPECTION.

Nose to Belly Scoop.

1. Driftmeter (if installed) - Checked.

   Check lens and lens housing for cleanliness, condition, and security.

2. Antenna - Checked.

INTERIOR INSPECTION - POWER OFF.

1. Equipment - Stowed.
2. Form 781 - Checked.
3. MK-59 AP radar pressurizing system - NORMAL ON.
4. APS-42 radar control panel - OFF.

   Check all switches OFF, counterclockwise or down. Insure scope intensity controls (Pilot's and navigator's)are full counterclockwise.

5. SCR-718 altimeter receiver gain - OFF.
6. APN-70 LORAN power switch - OFF.
7. ARN-6 automatic radio compasses - OFF.

   Check function selector switch is OFF.

8. Interphone selector switch.- INTERPHONE.
9. Circuit breakers and fuses - Checked.

   Check all navigation equipment circuit breakers and fuses are closed.

10. Oxygen mask - Checked and set.

    Check oxygen mask, oxygen regulator and system pressure; set regulator to 100%.

    NOTE

    Insure emergency knob (red) is safety wired in the CLOSED position.

11. Very pistol and flares - Secured.

    Ensure flares and very pistol are stored in proper location.

12. Drift flare chute (if applicable) - Closed.

13. Navigator's table - Stowed.

INTERIOR INSPECTION - POWER ON.

1. External power - ON.

   a. Battery selector switch - GROUND POWER.

   b. Battery master switch - BATT, GND PWR.

   c. Electrical radio and radar inverters - NORMAL.

      Check for 115 ± 5 vac and 400 ± 20 cps.

2. Sextant and mount - Checked.

   Check sextant operation and mount alignment. Set 180.4 degrees in the mount and azimuth window and read 360 degrees on the vertical stabilizer. Caution should be exercised not to sight on the VHF antenna.

3. Interphone power - Checked.

4. Lights - Checked.

5. APS-42 radar - STANDBY.

6. SCR-718 altimeter - OFF

   CAUTION

   Except in emergencies, the SCR-718 altimeter equipment will be used only over broad ocean areas starting not less than 50 miles off shore unless restrictions are specifically waivered by HQ USAF.

7. APN-70 LORAN - Checked.

8. APS-42 radar - Check operation.

   After 3 minutes antenna tilt meter needle will deflect indicating set is warmed up. Turn ON and check. Both pilot's and navigator's scopes should be checked for proper operation.

9. APS-42 radar - OFF.

10. Heading indicators, RMI's and magnetic compass - Checked.

    Check RMI's and S-2 compass heading indicators for proper operation. Cross reference should be made using the B-21 magnetic compass. The magnetic compass must agree with the approximate heading of the parked aircraft. If the magnetic compass does not agree, the navigator should take a heading shot and this should be used as the cross reference.

11. HF radio time hack - As required.

12. Clocks - Checked and set.

STARTING ENGINES.

1. Interphone - Monitor (UHF and VHF).

   Monitor UHF and VHF for aircraft clearance.

BEFORE TAXI.

1. Radar - STANDBY.

2. Radios - Monitor clearance.

3. Altimeters and radio altimeter - "Set." P, CP, N

TAXI.

1. Radios - Monitor.

2. Radar - SEARCH (after 3 minutes warmup).

3. Flight instruments - "Checked." P, CP, N

   The navigator checks the S-2 heading indicator and RMI card for proper operation. Checks should be made during turns insuring that all indicators follow through the turns and recover.

ENGINE RUNUP.

1. Flight instruments - "Checked." P, CP, N, FM

   Navigator will compare magnetic compass heading with the RMI and S-2 compass to insure these instruments are within tolerance.

BEFORE TAKEOFF.

1. Safety belt - Fastened.
2. Radios and radar - Monitor.

   Navigator should also insure that he knows the radio setup for departure. Navigator checks his bearing pointers, and radar for proper setting.

AFTER TAKEOFF AND CLIMB.

1. Takeoff time - Record.
2. Departure and climb - Monitor.

   Navigator will monitor radio calls, altitude, restriction, heading changes and terrain clearance during climb out.

3. Altimeters - Set.

   Altimeters will be set to 29.92 in. Hg passing the transition altitude. Below transition altitude, altimeters will be set to local altimeter setting.

4. Crew exit door safety strap - Fastened.

CRUISE.

1. Altimeters - Set.

DESCENT AND BEFORE LANDING.

1. Sextant - Removed and stowed.
2. Crew briefing - Monitored.

   Insure navigation radio setup is monitored and crosschecked.

3. Altimeters - "Set". P, CP, N
4. Navigator's table - Stowed.
5. Door safety strap - Unfastened.
6. Safety belt - Fastened.
7. Descent and approach - Monitor.

   Monitor descent, traffic pattern entry and final approach with search radar. When flying under the guidance of radar, advise the pilot immediately if instructions will result in a hazardous condition, or if it appears that radar approach control is not tracking the airplane. Place the interphone selector switch on INTER and monitor command radios.

8. All navigation equipment not required for letdown - Set. Turn off after landing is assured.
9. SCR-718 altimeter - OFF.

   Turn altimeter OFF prior to reaching 50 mile limit.

AFTER LANDING AND ENGINE SHUTDOWN.

1. Radar - "OFF."
2. Radio compasses - OFF.
3. Navigator's light controls - OFF.
4. Logs and form - Completed.

BEFORE LEAVING AIRCRAFT.

1. Radios and radio altimeters - "OFF." P, CP, N
2. Form 781 - Completed.

FLIGHT TRAFFIC SPECIALIST/LOADMASTER.

NOTE

Items marked with a black symbol (●) will be accomplished for loading nuclear weapon cargo in addition to the general loading checklist.

BEFORE INTERIOR INSPECTION.

1. Wheel chocks - In place.
2. Electrical ground - Connected.
3. External power - As required.
4. Landing gear downlocks - Installed.

INTERIOR INSPECTION.

1. Form 781 - Checked.
2. Cabin lights - Checked/As required.
3. Lavatories; cleanliness, water supply, additional equipment and supplies - Checked.

   Inspect lavatories for neatness and cleanliness. Check inspection window on pressure bulkhead for security. Check that wingnuts on pressure bulkhead are secured. Check water flow from lavatory faucets.

4. Washwater tank valve - Checked.

   Check that valve is on NORMAL position.

5. First aid kits - Checked.

   Check that first aid kits are installed and that seals are unbroken.

6. Buffet - Checked.

   Inspect buffet for cleanliness. Check that electrical connector behind buffet is plugged in and secured. Check operation of hotcup receptacle by operation of switches on buffet panel. Amber lights on panel indicate power to receptacle.

   Check water heater and toilet lights. Buffet ceiling light will dim noticeably when water heater is turned on. Check that release pins on buffet are installed and secured.

7. Water tanks - Checked.

   Check that the aft 10-gallon water tank is properly secured.

8. Liferafts and vests - Checked.

   Check for sufficient rafts and life vests to accommodate all personnel aboard aircraft. Check condition of all rafts and make sure they are secured. Number of rafts will vary with configuration.

9. Emergency slide - Checked.

   Check for installation, storage, and condition, insure color code hookup compatability.

10. Emergency exit ropes - Secured.

    Check that ditching rope at main cabin door has red ribbon securely attached and is fastened to snap securely.

11. Seats and safety belts; seats secured and inspected - Checked.

12. Portable oxygen bottles, smoke masks, and oxygen masks. Inspect for quantity, capacity, dates of inspection and stowage - Checked and stowed.

13. General condition of cabin, cleanliness - Checked.

    Check cleanliness and security, and passenger information and ditching card installed.

14. Emergency exits - Checked.

15. Crash axe stowed forward and aft - Stowed.

16. Survival equipment, quantity and type - Checked.

17. Cabin windows clean condition, and protected - Secured.

18. Protective clothing, quantity checked and stowed - Checked.

19. Cargo doors forward and aft, operation and security - Checked.

20. Fire extinguishers, quantity and inspection date - Checked.

21. Public address system - Checked.

22. Litter stanchions, quantity stowed - Checked.

23. Cargo tie down equipment, condition and amount - Checked.

24. Emergency evacuation ladder stowed - Checked.

25. Nameplates (if required) - Installed.

PRIOR TO LOADING.

NOTE

Refer to T.O. 1C-118A-9, T.O. 1C-118A-16, AFM 71-4 and other appropriate publications for loading and handling instructions.

1. Load planning - Completed.

●2. Aircraft parked in designated loading area; separation maintained - Checked and completed.

3. Aircraft in level attitude and grounded, main gear chocked - Checked.

●4. Fire department - Notified.

●5. Assure two-way tower communication if fire fighting vehicle is not standing by at the aircraft during loading - As required.

●6. Two 50-lb CO_2 or one 10-gallon CB fire extinguishers - In place.

●7. Placard aircraft - As required.

●8. Loading crew - Briefed.

●9. Security guards - Posted.

10. Cargo and manifests - Checked.

AFTER LOADING.

1. Cargo doors - Closed.
2. Loose equipment - Stowed.
3. Cargo leakage - Checked.

   Check for any fumes or leaks and dents in containers.
4. Load tiedown - Completed and checked.
5. Cargo placards - Installed (if required).
6. Manifests, Form 365F, and jettison plan - Submit to pilot.
7. Inflight lunches and beverages - Aboard and inventoried.
8. Passenger briefing and seating - Completed.

   Brief passengers and check that safety belts are fastened.
9. Report to pilot that passengers are loaded and secure, cargo loaded and tied down.

BEFORE TAXI.

1. Tiedowns - Tight and secure.
2. Breather plugs - Removed and retain (if required).
3. Loose equipment - Secured.
4. Passengers - Secured.

   Check passengers and advise them to prepare for takeoff.
5. Cabin - Secured.
6. Safety belt - Fastened.

AFTER TAKEOFF/CLIMB.

1. Wing scan - Completed.

   Report any unusual conditions observed.
2. Pressurization check - Completed.

   Check alignment of bayonets on all doors, report any unusual conditions.
3. Cabin door safety straps - Fastened.

CRUISE.

1. Tiedowns - Tight.

   Check tiedowns periodically.
2. Cargo leakage - Checked.

   Check for any fumes or leaks periodically.
3. Preplanning - Complete.
4. Equipment status - Written up.

   Report to pilot and write up in Form 781 any equipment that malfunctions.

DESCENT.

1. Tiedowns - Tight.
2. Passengers - Seated, safety belts fastened, and briefed.
3. Lavatories - Checked.
4. Perishables - Collected (as applicable).
5. Cabin door safety straps - Removed.
6. Cabin - Secured.
7. Safety belt - Fastened.

PREFLIGHT (INTERMEDIATE STOP - NO LOADING OR OFFLOADING).

1. Escape hatches - Checked.
2. Cargo tiedowns - Checked.
3. Manifests Form 365F - Submit to pilot.
4. Inflight lunches and beverages - Aboard and inventoried.
5. Passenger briefing and seating - Completed.

   Brief passengers and check that safety belts are fastened.

NORMAL LANDING (INTERMEDIATE STOP OR DESTINATION).

1. Offloading of passengers - Completed.

   Supervise offloading of passengers.
2. Manifests (copy) - Retained.

3. Cargo and passenger manifest and mission report - Checked and completed.
4. Aircraft electrically grounded - Checked.
●5. Fire department - Notified.
●6. Assure two-way tower communication if fire fighting vehicle is not standing by at the aircraft during loading/offloading - As required.
●7. Two 50-pound CO_2 or one 10-gallon CB fire extinguishers - In place.
8. Placard aircraft - As required.
9. Offloading crew - Briefed; ●Security guards - Posted.
10. Cargo doors - As required.
11. Offloading of cargo and baggage - Completed.

 Check aircraft to ensure that all cargo and baggage is offloaded. Obtain receipt for all registered mail, pouches, and special cargo.

12. Aircraft - Clean.
13. Customs - As required.
14. Equipment status - Check and enter discrepancies on Form 781.

RADIO OPERATOR.

RADIO OPERATOR'S PREFLIGHT CHECKLIST.

NOTE

On aircraft without the services of a radio operator, these items will be checked by a crewmember designated by the pilot.

EXTERIOR INSPECTION.

Nose toBelly Scoop.

1. VHF and/or UHF antennas - Check security and condition.
2. ADF loop housings - Check security and condition.
3. ADF sensing antennas - Check security and condition.

Right Wing Fillet and Root-to-Tail Right Side Check.

1. HF antenna (liaison) - Condition/security.
2. Antennas - Checked.

 All antennas for tautness and security. AIMS/IFF antenna. Check cover over marker beacon antenna for cracks and make sure it is not painted.

INTERIOR INSPECTION.

Main Cargo Compartment.

1. Interphone and public address system - Checked.

 Check telephone, interphone, and public address system for operation.

2. Emergency radio - Checked.

 Ensure that the emergency radios are properly secured. Type, number, and location will vary with configuration and mission.

3. AIMS/IFF - Checked/Set.

Crew Compartment.

1. Emergency transmitter - Checked.

 Emergency transmitter(s) installed and properly secured, (if applicable).

PASSENGER BRIEFING CHECKLIST.

NOTE

The Passenger Briefing checklist will be performed by crewmember as designated by the pilot.

PREDEPARTURE BRIEFING.

1. Briefing crewmember's name.
2. Aircraft commander's name.
3. Destination.
4. Flight altitude.
5. Estimated time enroute.
6. Brief on observing the FASTEN SEAT BELT and NO SMOKING signs.
7. Demonstrate use of parachute (if applicable).
8. Use of seat belts.
9. Indicate the location of emergency equipment.
10. Describe warning signals and indicate the location of EMERGENCY EXITS (figure 8-1). Caution passengers not to open or move handles on doors or emergency exits unless directed by a crew member.

EMERGENCY HATCHES AND EXITS

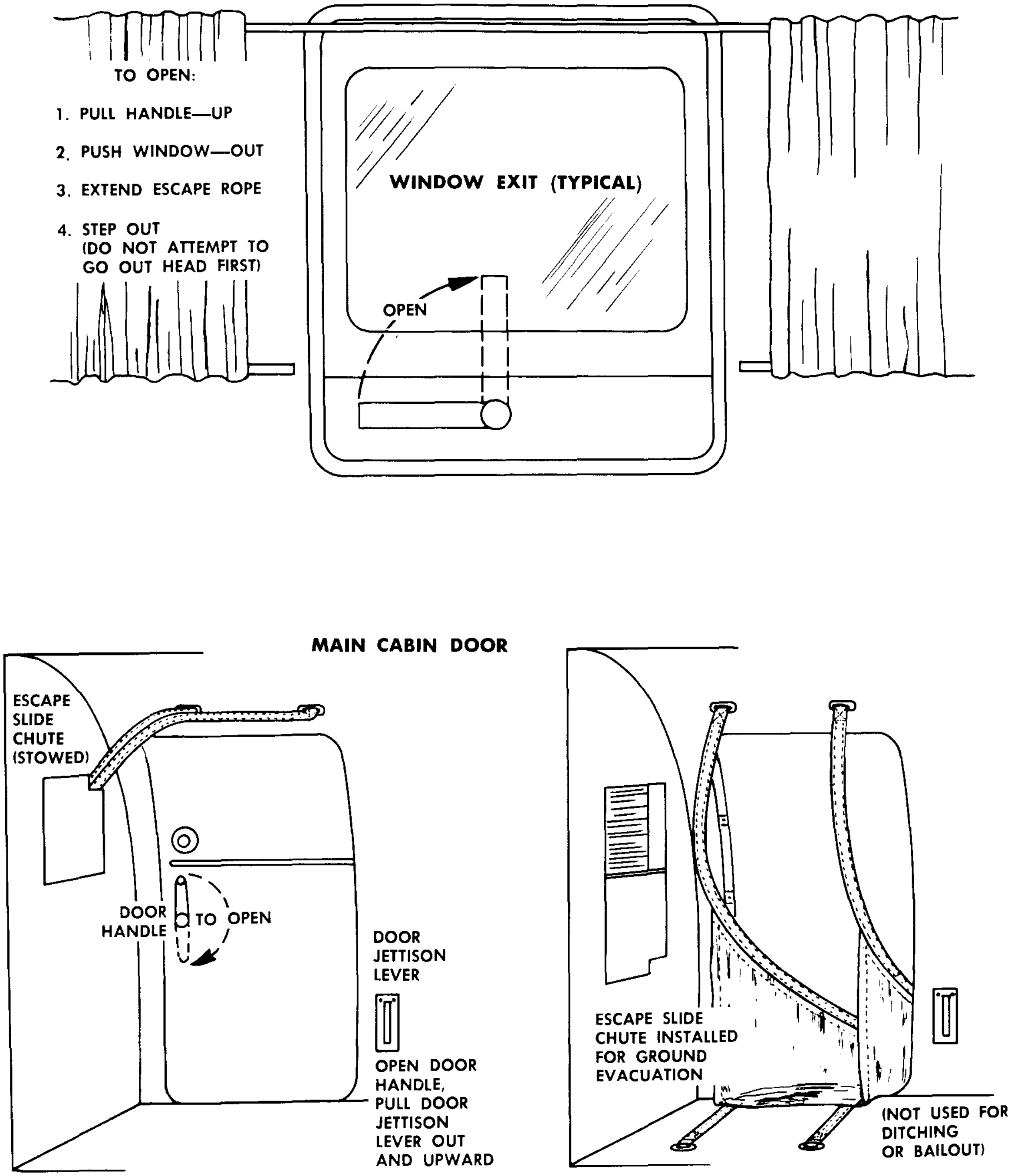


Figure 8-1

BRACE POSITIONS

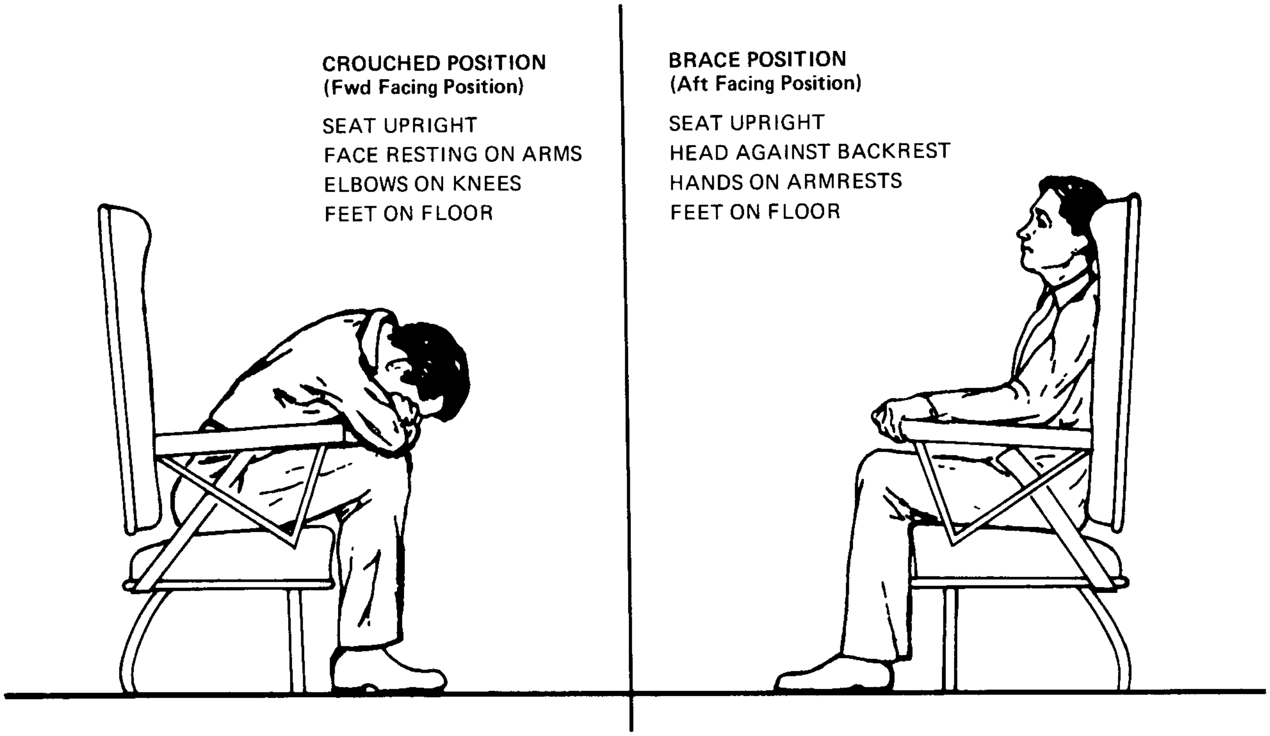


Figure 8-2

11. Caution passengers against the use of electronic equipment (portable radios, recorders, etc.)

12. Advise passengers of information cards.

OVERWATER BRIEFING.

1. Describe applicable emergency equipment.

2. Demonstrate use of life vest.

3. Describe ditching procedures.

ARRIVAL BRIEFING.

1. Announce arrival time

2. Caution passengers to observe FASTEN SEAT BELT and NO SMOKING signs.

3. Provide any additional information as applicable.

PASSENGER INFORMATION.

NOTE

The remaining pages, in this section, contain passenger information and may be removed for local reproduction without destroying the continuity of this manual.

1. Please observe seat belt and no smoking signs. Seat belts will be fastened during takeoff and landing and at anytime during flight as instructed by the pilot. Smoking is prohibited during all ground operations, during and immediately after takeoff and before landings, and at anytime during flight as instructed by the pilot.

2. In the event of an inflight emergency, remain seated with the seat belt fastened and follow the pilot's or crewmember's instructions.

3. Emergency exits are shown in figure 8-1.

CRASH LANDING OR DITCHING (Figure 3-4).

1. If a crash landing or ditching situation has developed, the pilot will alert the crew and passengers with an announcement over the public address system.
2. Fasten seat belt securely.
3. Remove cords, ties, straps; loosen collar, and parachute harness (if applicable), don life vest (if applicable) but do not inflate. Do not smoke. Place your seat to the upright position. Secure all loose objects, such as food trays, etc., in the seat pouch ahead of you. Remove high-heel shoes.

   Remove all things from your person that could obviously hurt you - such as glasses, false teeth, etc.
4. A crewmember will advise passengers which escape routes to use and aid in adjusting life vests.
5. If blankets or pillows are available, use to protect face.
6. Just prior to impact, if conditions permit, the pilot will alert the crew and passengers with an announcement over the public address system.
7. Brace for impact.
8. Hold crash landing positions until after the aircraft has stopped moving.
9. Remove seat belt and follow the crew's instruction for evacuation.

BRACE POSITION.

Refer to figure 8-2.

ALL WEATHER PROCEDURES

SECTION IX
all weather operation

TABLE OF CONTENTS

INTRODUCTION.

This section contains only those procedures which differ from, or are in addition to, the normal operating instructions covered in Section II, except where repetition is necessary for emphasis, clarity, or continuity of thought. Operation of the various aircraft systems is described in Section VII.

NOTE

This is an approach category-C aircraft.

NIGHT FLYING.

Night flying procedure is conventional and there is no special technique required in the use of any of the aircraft equipment. However, it is recommended that landing lights be turned off prior to retraction.

OPERATION UNDER INSTRUMENT FLIGHT CONDITIONS.

The aircraft has excellent qualities in regard to instrument flying. Stability in all axes is excellent, and the aircraft can be trimmed to fly "hands off." Takeoff characteristics are satisfactory. Maneuverability on GCA and ILS is excellent. Before attempting an instrument flight, check that all radios and flight instruments are operating properly.

INSTRUMENT TAKEOFF.

Use Normal Takeoff Procedures in Section II.

INSTRUMENT CLIMB.

Climbing airspeed and attitude are easily maintained and the aircraft handles satisfactorily up to and during maximum rate of climb. Climbing turns should be limited to bank angles of 30 degrees.

CRUISING UNDER INSTRUMENT CONDITIONS.

The aircraft should be handled in the same manner as during VFR flight. Refer to the Appendix for cruising speeds. In addition, the following checks should be made periodically:

a. Check heading indicators and attitude indicators for proper indication, cross-checking all flight instruments.

b. Check pitot heaters and surface deicing equipment for proper operation during icing conditions.

SNOW, RAIN, ICE CRYSTAL, OR CORONA RADIO STATIC.

When radio static is encountered enroute, turn the radio volume down until conditions improve. When nearing the destination, the following may improve reception:

Reduced airspeed.

Lowered radio volume.

Keying the transmitter.

Radio compass in LOOP (wingtip position).

Changing rpm.

DESCENT.

To descend from altitude, use the same procedure as during VFR flight down to the minimum safe altitude for the approach being used and in accordance with instructions received from the airway traffic controller.

HOLDING PROCEDURE.

Holding is normally accomplished by using the traffic pattern configuration (rpm 2100, flaps 20 degrees, 140 KIAS). However, if prolonged holding is expected, or fuel is considered critical, fly the aircraft clean in accordance with Maximum Endurance Power Charts.

TACAN, VOR, ADF, AND RANGE APPROACH-FOUR-ENGINE PROCEDURE.

See figure 9-1 for typical approaches.

a. Just prior to initial approach fix (IAF), pilot reduces airspeed to 140 KIAS and calls for rpm 2100, flaps 20 degrees, and the phase II Descent Checklist.

b. Maintain 140 KIAS and flaps 20 degrees from initial approach fix (IAF) throughout procedure turn. If necessary, 2400 rpm may be used.

c. Just prior to final approach fix (FAF), pilot may extend flaps to 30 degrees. At final approach fix (FAF), rpm 2400, gear down, flaps 30 degrees and complete Before Landing checklist (see Section II). Maintain 125 KIAS until runway is in sight.

TACAN, VOR, ADF, AND RANGE APPROACH-THREE-ENGINE PROCEDURE.

a. Just prior to IAF, pilot reduces speed to 140 KIAS and calls for rpm 2400, flaps 20 degrees and the phase II Descent checklist.

b. Maintain 140 KIAS and flaps 20 degrees from initial approach fix (IAF) throughout procedure turn. If necessary, 2600 rpm may be used.

c. Just prior to FAF, pilot may extend flaps to 30 degrees. At FAF, rpm 2600, gear down, flaps 30 degrees, ADI-ON, and complete Before Landing checklist. Maintain 125 KIAS until runway is in sight.

TACAN, VOR, ADF, AND RANGE APPROACH-TWO-ENGINE PROCEDURE.

a. Just prior to the IAF, pilot reduces airspeed to 140% Vs and calls for rpm 2600 and the phase II Descent checklist.

b. Maintain 140% Vs, flaps up, from initial approach fix (IAF) throughout procedure turn. If necessary, 2800 rpm may be used.

c. Over FAF, rpm 2800, flaps 20 degrees, ADI-ON. Maintain an airspeed of 140 KIAS.

NOTE

When the distance from the final approach fix to the airfield prohibits immediate descent, the flaps should remain UP until starting descent. This will prevent using prolonged high power when the fix is a considerable distance from the airfield.

WARNING

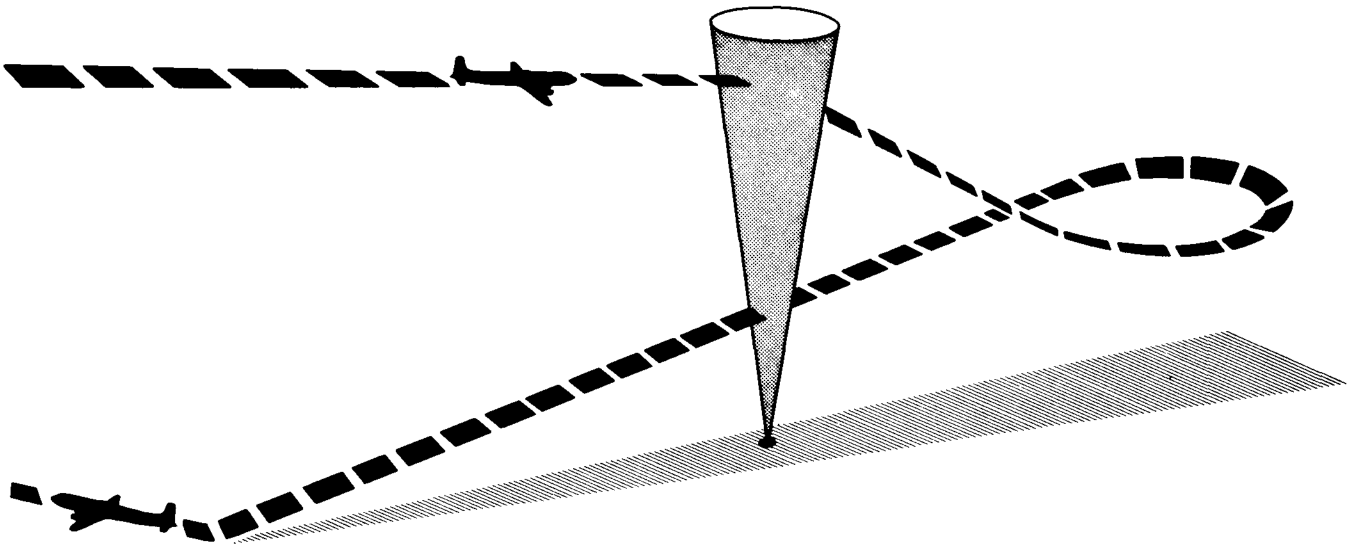
When landing with gross weight in excess of 95,000 lbs., compute final approach speed at 140% Vs.

d. Do not extend gear or wing flaps beyond 20 degrees until certain that landing will be completed. Complete Before Landing checklist.

NOTE

At normal landing gross weights, it is impossible to maintain altitude even with maximum power on two engines with either the gear down and zero flaps or the flaps down and gear up. Maintain a speed of 140 KIAS during approach until certain that a landing will be accomplished (Refer to Go-Around With Two Engines Inoperative, Section III). The pilot must remember that considerably more power will be required on the good engines during the two-engine approach. It is important to remember that normal relationships of power, trim, and control do not apply with two engines out on one side. During approach with two engines inoperative on one side, it is better to control manually, at least in part, the directional and lateral attitudes of the aircraft, rather than to apply full trim tab to rudder and aileron. This will obviate a drastic trim change and/or reduce the forces necessary to maintain control when power is reduced for landing.

TACAN, VOR, ADF AND RANGE-Typical



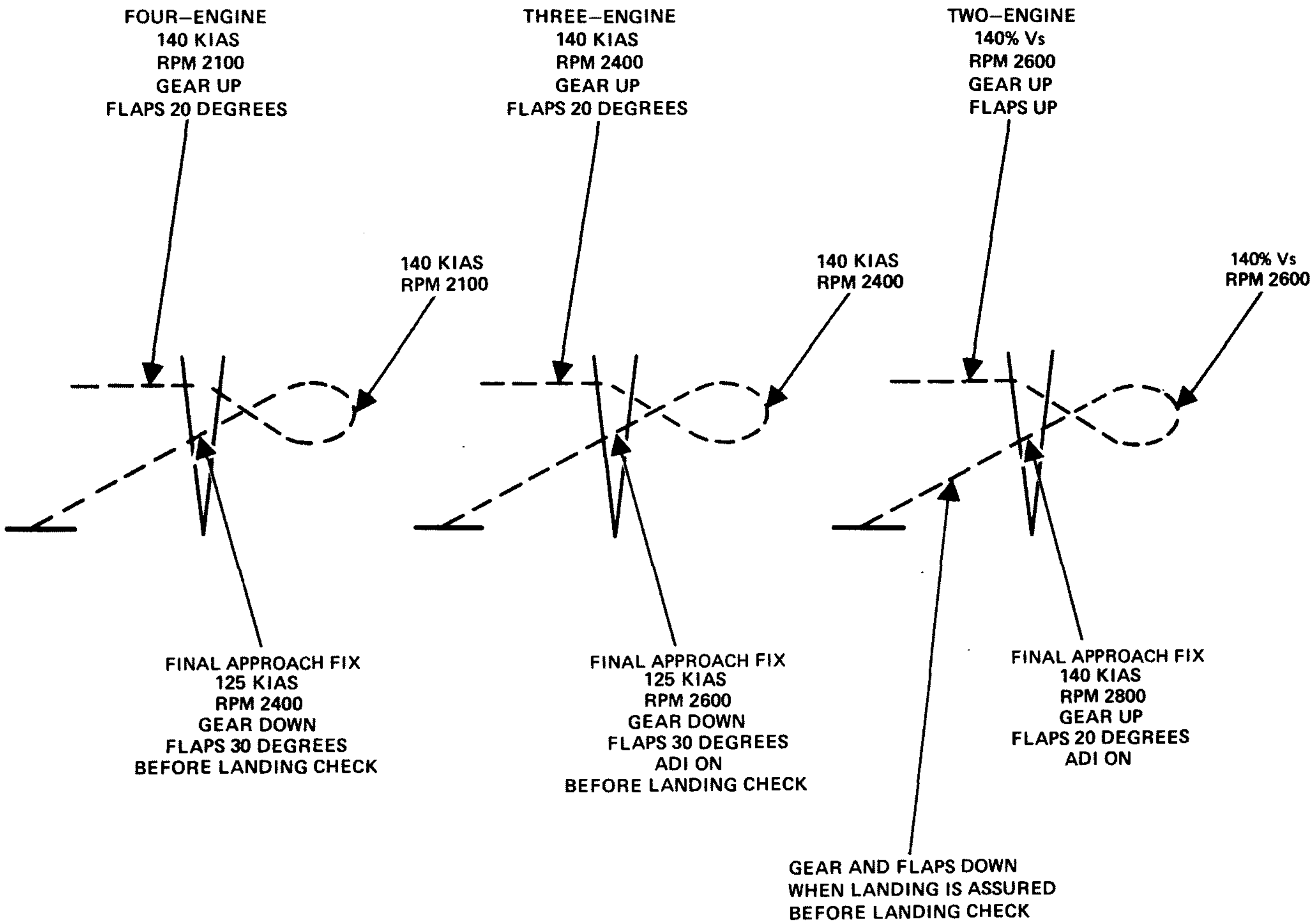


Figure 9-1

CIRCLING APPROACHES.

Circling approaches should be conducted in strict observance of circling approach minimums. A circling approach in the maneuvering configuration takes a radius of turn of approximately 1.5 miles.

MANEUVERING CONFIGURATION.

The maneuvering configuration for four-engine circling approaches will normally be rpm 2100, flaps 20 degrees, and airspeed 140 KIAS.

TACAN, VOR, ADF, AND RANGE APPROACH - (CIRCLING FINAL) - FOUR-ENGINE PROCEDURE.

a. Just prior to the IAF, pilot reduces airspeed to 140 KIAS and calls for rpm 2100, flaps 20 degrees, and the Phase II Descent checklist.

b. Rpm 2400 may be used if necessary.

c. After turning base leg, pilot calls for rpm 2400, gear down, flaps 30 degrees, and the Before Landing checklist.

TACAN, VOR, ADF, AND RANGE APPROACH - (CIRCLING FINAL) - THREE-ENGINE PROCEDURE.

a. Just prior to the IAF, pilot reduces airspeed to 140 KIAS and calls for rpm 2400, flaps 20 degrees, and the Phase II Descent checklist.

b. Rpm 2600 may be used if necessary.

c. After turning base leg, pilot calls for rpm 2600, gear down, flaps 30 degrees, ADI-ON. and the Before Landing checklist.

TACAN, VOR, ADF, AND RANGE APPROACH - (CIRCLING FINAL) - TWO-ENGINE PROCEDURE.

a. Just prior to the IAF, pilot reduces airspeed to 140% Vs and calls for rpm 2600 and phase II Descent checklist.

b. Rpm 2800 may be used if necessary.

c. When certain that landing can be completed, pilot calls for rpm 2800, gear down, flaps set, ADI-ON, and the Before Landing Checklist.

GCA AND ILS APPROACH - FOUR-ENGINE PROCEDURE.

See figures 9-2 and 9-3 for typical approaches.

a. Just prior to reaching the fix used in conjunction with radar or ILS, the pilot reduces airspeed to 140 KIAS and calls for rpm 2100, flaps 20 degrees, and the phase II Descent checklist.

b. Maintain 140 KIAS, flaps 20 degrees, and rpm 2100 on radar downwind leg or outbound on ILS.

c. Just prior to glide path interception (approximately 30 seconds or one mile) extend flaps to 30 degrees, allowing airspeed to taper to 125 KIAS at glide path interception. When flaps are set 30 degrees, rpm may be advanced to 2400 for stabilization, if desired. Upon glide path interception, rpm 2400, gear down, Before Landing checklist; maintain 125 KIAS.

GCA AND ILS APPROACH - THREE-ENGINE PROCEDURE.

a. Just prior to reaching the fix used in conjunction with radar or ILS, the pilot reduces airspeed to 140 KIAS and calls for rpm 2400, flaps 20 degrees, and the Phase II Descent checklist.

b. Maintain 140 KIAS, flaps 20 degrees, and rpm 2400 on radar downwind leg or outbound on ILS.

c. Just prior to glide path interception (approximately 30 seconds or one mile), extend flaps to 30 degrees, allowing airspeed to taper to 125 KIAS at glide path interception. When flaps are set 30 degrees, rpm may be advanced to 2600 for stabilization if desired. Upon glide path interception, rpm 2600, gear down, ADI-ON, and complete Before Landing checklist; maintain 125 KIAS.

GCA AND ILS APPROACH - TWO-ENGINE PROCEDURE.

a. Just prior to reaching the fix used in conjunction with radar or ILS, the pilot reduces airspeed to 140% Vs and calls for rpm 2600 and the phase II Descent checklist.

b. Maintain 140% Vs FLAPS UP, and rpm 2600 on radar downwind leg or outbound on ILS.

c. When intercepting the glide path on radar or ILS, pilot calls for rpm 2800 and flaps 20 degrees, ADI-ON, and maintains 140 KIAS.

WARNING

When landing with gross weight in excess of 95,000 lbs., compute final approach speed at 140% Vs.

d. When certain that the landing can be completed, pilot calls for gear down, ADI-ON, flaps set, and the Before Landing checklist.

GCA PROCEDURE

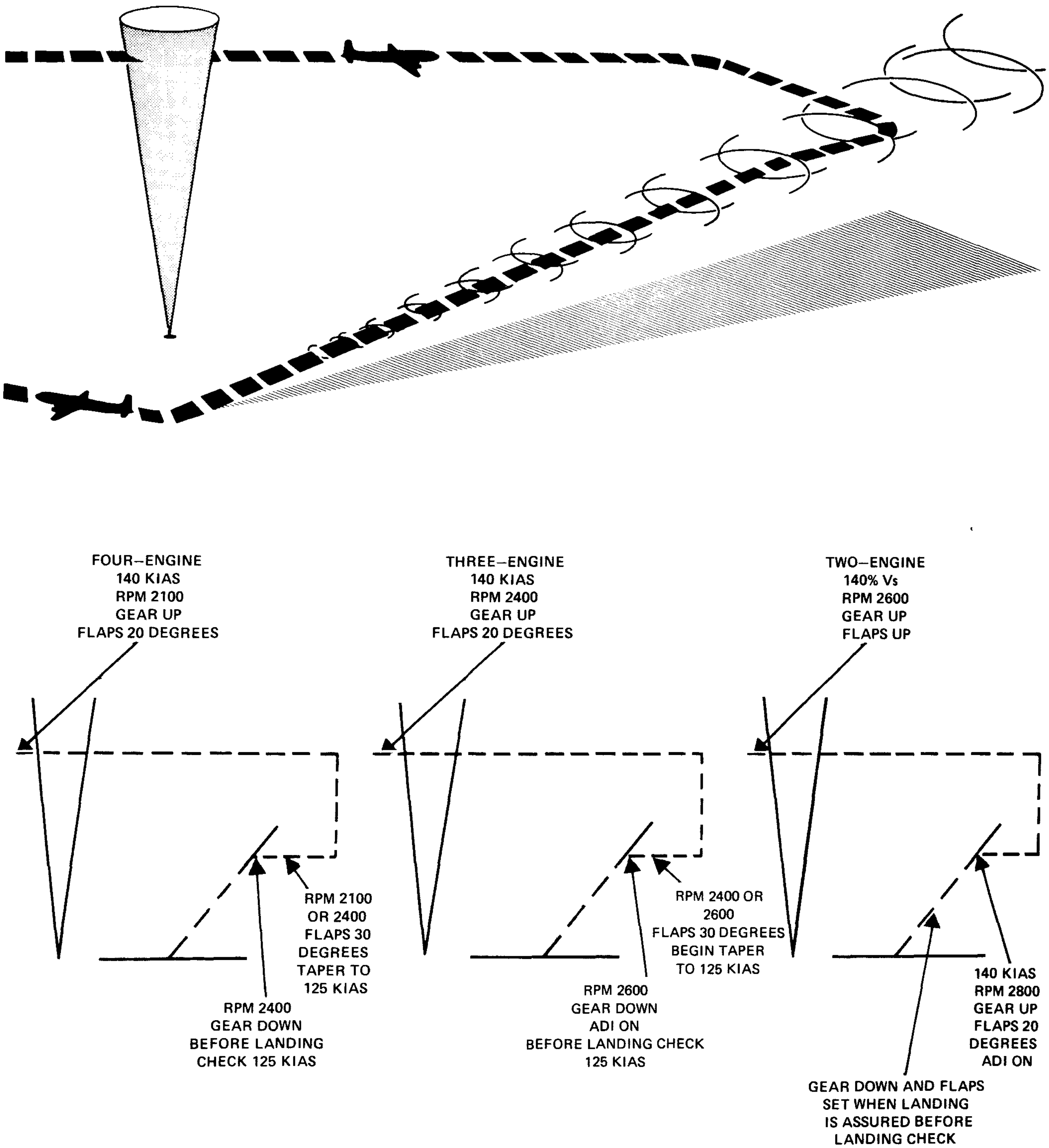
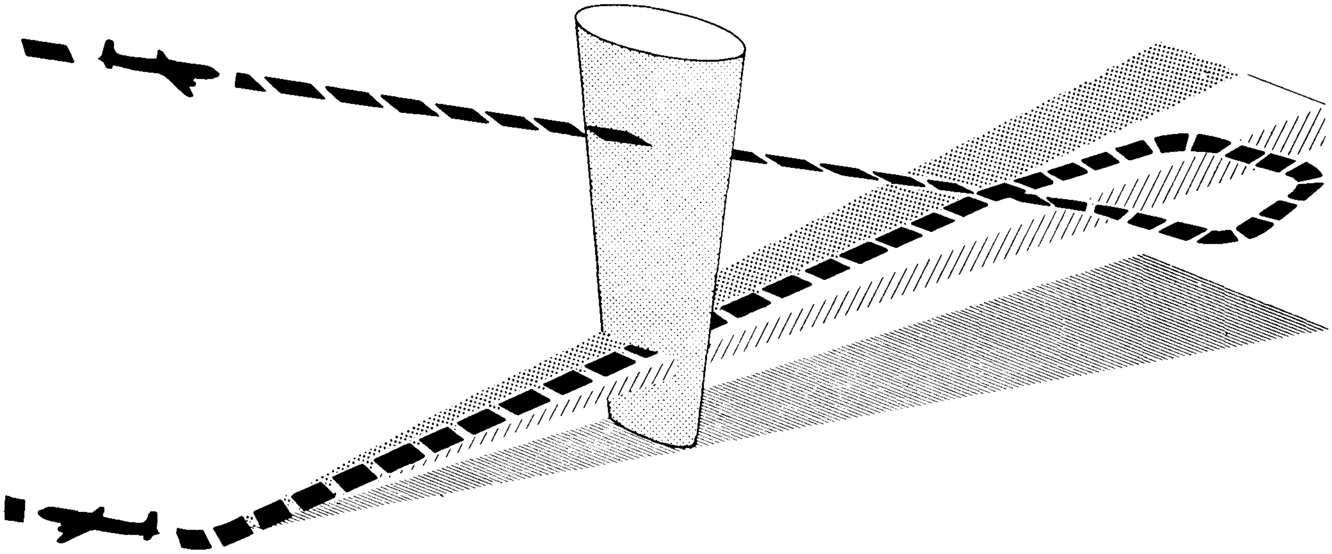


Figure 9-2

ILS PROCEDURE



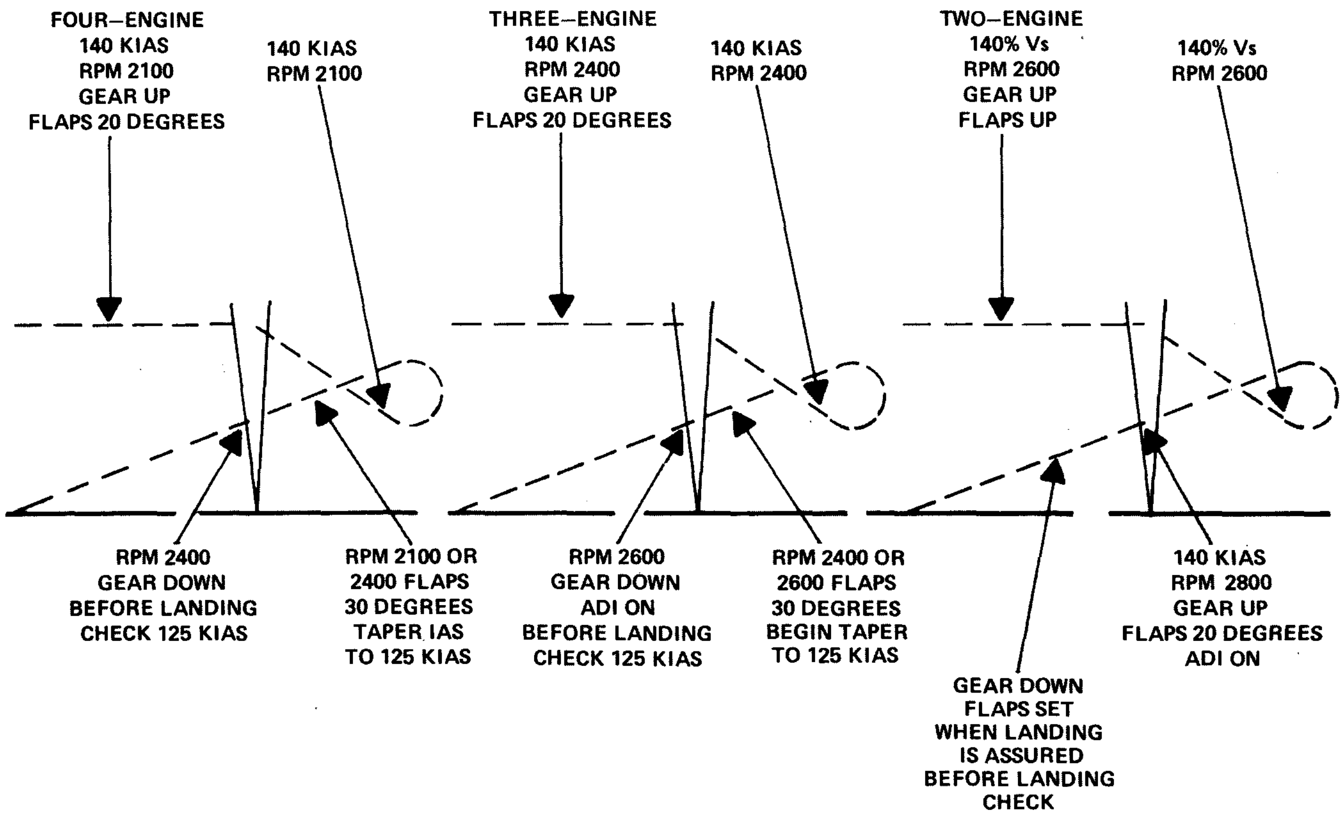


Figure 9-3

ILS AUTOMATIC APPROACH (Figure 9-3).

The procedure to be used when flying an automatic approach is as follows:

a. Automatic approach selector switch - AUTO-PILOT.

b. Autopilot - Engaged.

c. Altitude control switch - ON.

d. Prior to or when over outer marker outbound, reduce airspeed to 140 KIAS and call for phase II Descent checklist.

e. On the inbound heading, turn the automatic approach selector switch to LOCALIZER when the CDI of the course indicator leaves the stops.

f. When steady on the localizer, the glide slope indicator should be monitored. Just prior to glide path interception (approximately 30 seconds or one mile) extend wing flaps to 30 degrees and allow airspeed to taper the approach airspeed. Set rpm at 2400. When the glide slope indicator shows one-half to one dot above center, extend the landing gear and complete the Before Landing checklist.

g. When the glide slope indicator centers, turn the automatic approach selector switch to APPROACH position. (Check that approach-ready light remains on.)

h. Adjust power as necessary to maintain 125 KIAS. Just prior to reaching minimum approach altitude, the pilot depresses autopilot release switch on his control wheel, states "Servos Out," and assumes control of the aircraft to complete the landing or missed approach as applicable. Flight mechanic disengages autopilot servos on pilot's command.

FLIGHT IN TURBULENCE AND THUNDERSTORMS.

CAUTION

Flights through thunderstorms or other areas of extreme turbulence must be avoided whenever possible. Maximum use of weather forecast facilities, and air or ground radar to aid in avoiding thunderstorms and turbulence is essential.

If a thunderstorm or turbulence cannot be avoided, the following procedures should be followed:

The key to proper flight techniques through turbulence is attitude. Both pitch and bank should be controlled by reference to the attitude indicator. Do not change trim after the proper attitude has been established. Extreme gusts will cause large attitude changes. Use smooth and moderate elevator and aileron inputs to reestablish the desired attitude. To avoid overstressing the airplane, do not make large or abrupt attitude changes.

Adjust power to establish a speed of 165 KIAS below 100,000 pounds and 175 KIAS over 100,000 pounds. Trim the airplane for level flight at the proper airspeed. Severe turbulence will cause large and rapid variations in indicated airspeed. Do not chase the airspeed.

Severe vertical gusts may cause appreciable altitude deviations. Allow altitude to vary. Sacrifice altitude to maintain the desired attitude. Do not chase the altimeter.

NOTE

If possible, do not operate on fuel tanks that have less than 1000 pounds; return each engine to its own fuel supply. When operating in icing or severe cold, mixtures may be adjusted to best power to maintain cylinder head temperature within limits. For night operations, the cockpit lights may be turned to full bright to minimize the blinding effects of the lightning.

a. Autopilot altitude control switch - OFF.

b. Power - Set to obtain penetration speed.

c. Hydraulic bypass lever - DOWN.

d. Gear lever - UP.

e. Mixture controls - AUTO RICH.

f. Booster pumps - LOW.

g. Carburetor heat - Set.

h. Heater and de-icers or anti-icers - ON.

i. Gyro instruments - Checked.

j. Safety belts - Tightened.

k. Cockpit lights - Set.

l. Seat belt light - ON.

WARNING

The aircraft is capable of withstanding higher accelerations (gusts) with the wing flaps retracted; therefore, it is necessary that all cruising and descent operations be with the flaps retracted during flight in turbulent air conditions.

COLD WEATHER PROCEDURES.

Most cold weather operating difficulties are encountered on the ground. The most critical periods in the operation of the aircraft are the preflight and postflight periods. Proper diligence on the part of crewmembers concerning ground operation is the most important factor in successful arctic operation. In addition to normal preflight check outlined in Section II, the following actions should be taken when temperatures reach -18°C and lower.

PREPARATION FOR FLIGHT.

a. Apply external heat to the engines and accessory sections. An extra heater duct should be directed to the auxiliary power unit if the unit is to be used. The following list of time requirements for engine heating at various temperatures gives rough estimates which will vary with wind velocities and percentage of engine oil dilution. The tabulation is based on an oil dilution of approximately 25 percent and no wind.

-6° to -18°C . . . . 1/2 hour (approximately)

-18° to -32°C . . . . 1/2 to 1 hour

-32° to -40°C . . . . 1 to 2 hours

-40° to -54°C . . . . . . 1 1/2 to 2 1/2 hours

b. Check the oil tank drains for oil flow. If no oil flow is obtainable, apply external heat to the drains and oil tanks. In addition to external heating, oil immersion heaters may be used. If the immersion heaters are to be effective in keeping the oil warm during the night, they should be placed in the oil tanks immediately after engine shutdown.

c. Start the cabin heater as soon as possible to heat the flight instruments, defrost the windshields, and warm the radios, dynamotors, inverters, and other equipment within the aircraft. At -54°C, the cabin heater may not operate unless radome heat is turned ON first. If the cabin heater still fails to operate, check for a frozen fuel solenoid in the landing gear well. Cabin superchargers should be preheated at temperatures below -40°C.

d. Check for engine stiffness periodically to determine when sufficient heat has been applied. Generally, if an engine is stiff enough to require more than three men to move a propeller, it is considered too stiff to start.

NOTE

If operation of the cargo doors is required, it may be necessary to apply heat to the actuating cylinders and seals at temperatures below -29°C.

WARNING

Remove all frost, snow, and ice accumulation before flight.

BEFORE STARTING ENGINES.

Before starting the engines, perform the following:

a. Remove the oil immersion heaters, if used.

b. Remove the ground heater ducts.

c. Remove all covers.

STARTING ENGINES.

Start the engine by the normal procedure (Section II), except for the following variations:

a. Rather than short, rapid actuation of the primer switch, hold the switch in the PRIME position for a longer period to provide effective priming.

NOTE

High boost may be used if necessary, provided low boost is used first.

b. Oil may be diluted (figure 9-4) slightly if pressure is too high for a prolonged period.

c. If the oil pressure gage does not indicate minimum pressure within 30 seconds, shut down the engine and check for a frozen oil pressure transmitter. If the transmitter is frozen, apply heat as necessary.

d. Check all instruments for proper operation.

e. Carburetor heat should be applied immediately after starting, to assist vaporization and combustion. Do not exceed a carburetor air temperature of 38°C (100°F).

f. Operate wing flaps through at least one cycle.

g. Check the movement of the control surfaces.

WARMUP AND GROUND TESTS.

Use the procedure outlined in Section II.

NOTE

When warming up an engine after oil dilution, allow the oil temperature to rise above 60°C and to increase the engine speed during the runup to dissipate as much of the dilutant fuel as possible and allow the oil to return to its normal viscosity. Oil dilution burnoff should be three minutes 20 seconds for every one minute of oil dilution. Below this temperature, and at low engine speeds, very little gasoline will be driven out of the oil. Run the propellers to full increase and decrease at least three times to heat the oil in the propeller domes. Reverse the propellers at least once during the warmup period. Engine oil quantity indicators must be closely monitored during runup, takeoff, and climb for excessive drop in quantity indication.

TAXI INSTRUCTIONS.

Use the same procedure outlined in Section II, only taxi more slowly and use more caution when applying brakes.

BEFORE TAKEOFF.

Make a thorough check for ease and proper operation of all controls important to cold weather takeoff. These controls include carburetor heat, cowl flaps, oil cooler, cabin heater, and trim tabs.

TAKEOFF.

a. A cabin heating system should be operating, and the windshield anti-icing system should be utilized during takeoff.

b. Pitot heaters and propeller and airfoil deicers should be ON if precipitation is encountered or if icing conditions are anticipated immediately after takeoff.

c. The pilot should be cognizant of the fact that the flight indicators are not very reliable at temperatures below -20°C (-4°F). Also, all flight instruments should be cross-checked.

NOTE

When the landing gear lever is placed in NEUTRAL at temperatures below -7°C, the landing gear may extend due to failure of the uplocks to engage.

DURING FLIGHT.

Adjust the cowl flaps as required to maintain proper cylinder head temperatures. Cross-check all flight instruments and be alert for any erroneous indication.

CARBURETOR PREHEAT.

When icing conditions are anticipated, carburetor preheat should be used. A carburetor air temperature of 15°C will prevent severe power loss when entering heavy precipitation if preheat is applied several minutes in advance. The automatic mixture control requires up to five minutes to adjust to large changes in temperature, and may tend to overcompensate for temperatures appreciably above standard. It is therefore desirable to enrich mixtures prior to the application of carburetor preheat, and then delay resetting the chart brake mean effective pressure (BMEP) drop until five minutes after the throttles have been opened up or rpm has increased to the new chart value. At any fixed position of the carburetor preheat control, carburetor air temperature (CAT) will fluctuate with power, airspeed, cowl flap opening, and air moisture content. It will be necessary to monitor the CAT so that sufficient heat for ice prevention be maintained, and that the maximum temperature limits of 38°C in low ratio and 15°C in high ratio not be exceeded, except as noted in the following paragraph.

Should carburetor icing occur, it is usually first indicated by a loss of BMEP and fuel flow, not necessarily accompanied by engine instability or loss of manifold pressure. The indication is the same as would be obtained by moving the mixture control toward IDLE CUTOFF. Corrective action for this most common type of icing (the presence of which is confirmed by loss of both BMEP and fuel flow) consists of AUTO RICH mixture, full carburetor heat for 30 seconds, and then slowly reduced heat to 15°C when it is established that cooler CAT increases fuel flow and BMEP, thus indicating that ice has been eliminated. When advanced stages of leanness have occurred, full prime may be of assistance in restoring power. The addition of carburetor preheat reduces BMEP, and this is not to be construed as further icing. When ice has been thoroughly eliminated and the CAT stabilized for five minutes, the mixture may be reset to chart BMEP drop. It is possible in some circumstances for ice to form in the airscoop, on the carburetor upper deck screen, or in the supercharger intake throat in such a manner as to restrict airflow and therefore cause a loss of manifold pressure, as well as fuel flow and BMEP. Corrective action is the same as above, with the addition of rpm and/or high blower ratio, if necessary to generate the required heat.

Another less common type of carburetor icing may be encountered when descending through warm moist air with cold fuel in the tanks. The fuel, acting as a refrigerant, may cause ice to form and create a restriction between the air chambers of the carburetor, thus inducing excessive fuel flow, with resultant BMEP loss. Full carburetor preheat should be applied, but the mixtures in this case should be leaned to best power as indicated by BMEP. Monitor both BMEP and fuel flow in this condition, since mixtures will lean out rapidly as ice is dispelled. Restore normal CAT and mixture as before. With the -16 carburetor, this type of icing is more likely to occur under other conditions, but it can be dispelled much more readily. Carburetor deicing alcohol has been helpful in ice elimination, particularly ice of the latter type; however, preheat is a more effective remedy.

Because of the reaction time required by the automatic mixture control to large temperature changes, the sudden removal of carburetor heat will cause mixture to lean severely. For this reason, the mixture controls should be placed in AUTO RICH and CAT reduced in increments. Allow temperatures to stabilize for five minutes before adjusting mixture to desired value.

CARBURETOR ALCOHOL DEICING.

If the presence of ice is still suspected after applying carburetor preheat or if the carburetor preheat is inoperative, return the carburetor air temperature controls to full COLD position, and operate the carburetor alcohol deicing system for a period of one minute.

NOTE

As a last resort, backfire the engine by manually leaning.

PROPELLER DEICING.

Ice is removed from the propeller blades by electrical heating elements mounted on the blade leading edge. The propeller deicing system is controlled by a single ON-OFF master switch on the heater control panel. Operation of the system is either automatic or manual. When the system is operated automatically, each propeller, one at a time, receives electrical current for a period of 20 seconds. Each propeller is heated once every 80 seconds. For manual operation, position the individual propeller selector switches to MANUAL and rotate the ammeter selector switch in sequence to the four ON positions. When manually deicing, it is recommended that the time period for each propeller not exceed 60 seconds ON and 180 seconds OFF.

When ice accumulation is observed, turn the propeller deicing system ON. Generally, automatic operation will be sufficient to keep the propeller blades free of ice.

NOTE

The lack of cooling airstream over the propeller blade surfaces, when the engines are inoperative, is the limiting factor for ground operation. One complete cycle should be sufficient for ground checks. Any one propeller may be isolated from the automatic system by turning its manual switch ON and keeping the selector switch OFF. This may be desirable if any one propeller vibrates, because one blade is not receiving proper heating. Electric heating is available when any propeller is in the feathered position.

When making a ground check, the propeller deicing switch should be turned ON and the propeller deicing ammeter checked for a 20-second cycle for each propeller. The switch should then be placed in the OFF position. The desired ammeter reading is placarded in the cockpit near the ammeter. A variation of more than 10 percent of the reading during the deicing operation will indicate possible presence of a deicing circuit abnormality.

WINDSHIELD HEAT.

By setting the windshield heat selector switch to the temperature range in which the aircraft is flying, the windshield will remain at a temperature which will probably melt any ice that is encountered. In the event of severe icing, the windshield heat selector can be turned to the ANTI-ICING position to supply the maximum amount of heat from the cabin heater directly to the windshield.

WINDSHIELD ALCOHOL DEICING.

If the windshield heat does not keep the windshield clear, apply windshield deicing fluid. Normally, this can be delayed until the aircraft is out of the icing zone, since the ice will usually evaporate or melt during descent.

AIRFOIL ANTI-ICING.

Turn ON the airfoil anti-icing heater switch three to five minutes prior to entering icing conditions to allow time for the airfoil leading edges to heat to maximum temperature. If unable to anticipate icing, turn system ON when first accumulation of ice is noted. Accumulated ice should melt and blow off. Leave the airfoil anti-icing heaters ON continuously when flying in and out of intermittent icing conditions.

It is permissible to operate the airfoil anti-icing heaters on the ground prior to and during takeoff, when climbing into known icing conditions. The heaters should be manually turned OFF after landing, rather than depending upon the automatic controls. If one wing airfoil heater fails to operate, turn both heaters OFF to maintain wing symmetry. If the tail airfoil heater is inoperative, it is permissible to continue operation of the wing airfoil heaters for anti-icing. Normal cruising speed is permissible in trace icing conditions, provided that long duration in the icing does not result in accumulations in excess of 1 inch on the engine cowling, propeller domes, and antennas. Fragments of ice, 1 inch or more in thickness, may cause appreciable damage to the horizontal stabilizer after breaking loose from the inboard engine cowling at high speeds.

If moderate icing conditions are encountered, a percentage of the water striking the leading edge will not evaporate because of insufficient heat and will run back along the airfoil a few inches and refreeze over the fuel tank area where the local temperature is below $0^{o}C$. Runback will usually be observed first in the nacelle-to-nacelle wing sections and the horizontal stabilizers, in the wing sections outboard of the outer-engines, and progressively approaching the wingtips as the severity of the icing increases.

ALTIMETER ERROR.

There has been considerable discussion regarding the altimeter error due to mountain top vortices, caused by upper winds of high velocity over mountain ranges or other rough terrain. There are several different lines of thought as to the magnitude of this error. It is known that altimeter errors do exist from this source, and there is enough evidence to justify maintenance of altitudes of not less than 2000 feet above the highest terrain during periods of high wind velocities and turbulence.

WARNING

The altimeter should be checked closely to assure that the 10,000-foot pointer is reading correctly. Due to previous settings of the altimeter, the setting knob could have been rotated until eventually the numbers reappeared at the barometric scale window from the opposite side, thus indicating a 10,000-foot error.

APPROACH AND LANDING.

During descent for landing, monitor engine temperatures closely. Temperature inversions are common in winter, and ground temperature may be 15^{o} to $30^{o}C$ colder than at altitude. Therefore, it is desired to keep cylinder head temperatures above $150^{o}C$ by maintaining sufficient power and closing cowl flaps. This will assure good fuel vaporization, thus minimizing the danger of backfiring and cutting out. The oil temperature should be maintained over $50^{o}C$. Stalling speed will increase when ice has formed on the aircraft; therefore, higher approach speeds will be required. Maintain shallow angles of bank when making an approach with an iced-up aircraft.

a. Prior to initiating an approach, it is advisable to exercise propellers through the range of 1900 to 2300 rpm at least twice.

NOTE

At low temperature, inadvertent asymmetrical propeller reversing is possible, and an alternate procedure must be used if the propellers do not reverse or will not reverse together.

b. Upon completion of landing roll, the oil cooler doors should be opened so that the oil will cool sufficiently while taxiing to the ramp and permit oil dilution.

c. Emergency airbrake pressure should be visually checked to ascertain whether or not the system will function, if needed.

CLEARVIEW WINDOW.

In the event that windshield heat has been inoperative and alcohol supply exhausted, it may be necessary to open the clearview window to provide adequate visibility for landing. Proceed as follows:

a. Depressurize.

b. Compute a minimum final approach speed in accordance with the degree of icing on airfoils and aircraft surface.

c. Make all turns shallow.

d. Commands will not be audible in the cockpit after the clearview window has been opened. Therefore, plan to give and receive all instructions by use of the interphone system.

e. Perform a thorough crew briefing before opening the window. The briefing should include the copilot calling airspeeds and altitude over the interphone during final approach, leaving enough interval to allow the pilot to interpose commands for manifold pressure adjustments.

f. Accurate depth perception will be more difficult than normal. Therefore, do not attempt to touch down in a nose-high attitude.

g. The tendency will be to land in a slight crab to the right due to leaning the body slightly to the left to look through the window opening.

STOPPING OF ENGINES.

Oil dilution is required if the expected minimum temperature is below 2°C.

OIL DILUTION PROCEDURE.

The aircraft is equipped with a system of oil dilution to facilitate cold weather starting. When a cold weather start is anticipated, the engine oil should be diluted with fuel before stopping the engines, provided that the engine oil temperature is maintained below 50°C. Above this temperature, dilution may not be effective, since the fuel introduced into the system will vaporize. When the oil temperature exceeds 50°C during the dilution period, stop the engine and wait until oil temperatures have fallen below 40°C before again starting the engine and resuming the dilution operation. During conditions of extremely low OAT., it may be necessary to break the dilution period up into two or more short periods. If it is necessary to service the engine section oil tanks, the oil dilution period must be divided so that part of the dilution is accomplished before the oil tanks are serviced and the remainder after the tanks are services. To allow for addition of the fuel, the oil tanks should not be completely filled.

Perform the oil dilution operation as follows (operation of the oil dilution system is indicated by a slow drop in oil pressure):

a. Turn the fuel booster pump switches to LOW to supply adequate fuel pressure.

b. Operate each engine at approximately 1200 rpm.

c. Maintain oil temperature below 50°C, stopping any engine for a short period if the temperature exceeds this limit.

d. Operate the oil dilution switches for the periods and temperatures shown on figure 9-4.

e. Exercise the propellers from 1200 to 1500 rpm at least three times to dilute the oil in propeller system. Reverse propellers at least once during oil dilution. When dilution is complete, shut engine down in normal manner while continuing to hold the oil dilution switch ON until engine has stopped.

f. If, after engine shutdown, an engine is started and operated on the ground, the engine oil should be rediluted. If the engine is operated with oil temperature below 50°C, replace 25 percent of the dilutent for each 10 minutes of ground operation. Do not exceed 90 percent replacement. If the engine is operated with oil temperature above 50°C, replace 25 percent of the dilutent for each five minutes of ground operation. Do not exceed 90 percent replacement.

WARNING

Do not allow oil pressure to decrease below specified minimum limit (Section V). If oil pressure decreases below minimum limit during use of dilution system, stop diluting.

Example: Aircraft engine diluted three mintues and subsequently operated for 15 minutes, with five minutes of this operation with oil temperature above 50°C. Ten minutes operation below 50°C requires 25 percent replacement of dilutent. Five minutes operation above 50°C requires 25 percent replacement of dilutent. Total replacement required is 50 percent or 1 1/2 minutes dilution.

DESERT PROCEDURES.

Windblown sand is the main concern of operation in the desert. Many of the malfunctions which occur will be found to originate because of improper care on the ground. Since most of the procedures given in Section II apply, as well to Desert Procedures, only specific information for care of the aircraft during ground and flight operation will be given in this section.

GROUND OPERATION.

The aircraft must be given special treatment when based in the desert if the operation is to be successful. To minimize costly maintenance, adhere to the following instructions:

a. Hold ground operation of the aircraft to a minimum.

b. Cover all air intakes and ducts as soon as possible after engine shutdown to prevent entrance of blowing sand.

c. Keep all equipment free of sand, dirt, or moisture.

d. Keep the aircraft dispersed as much as possible. The engines of one aircraft can add hours to maintenance problems to another when proper precautions are not followed during taxiing or ground operation.

ANTICIPATED OUTSIDE AIR TEMPERATURE FOR OIL DILUTION

NOTES:

1. For partially filled oil tanks, dilution time will be lowered by the same ratio as the percentage of oil in the tanks.
2. Do not dilute engine oil until oil temperature has fallen below 50° C.
3. Record oil pressure before dilution and when completed. During warmup, pressure will return to normal before takeoff.

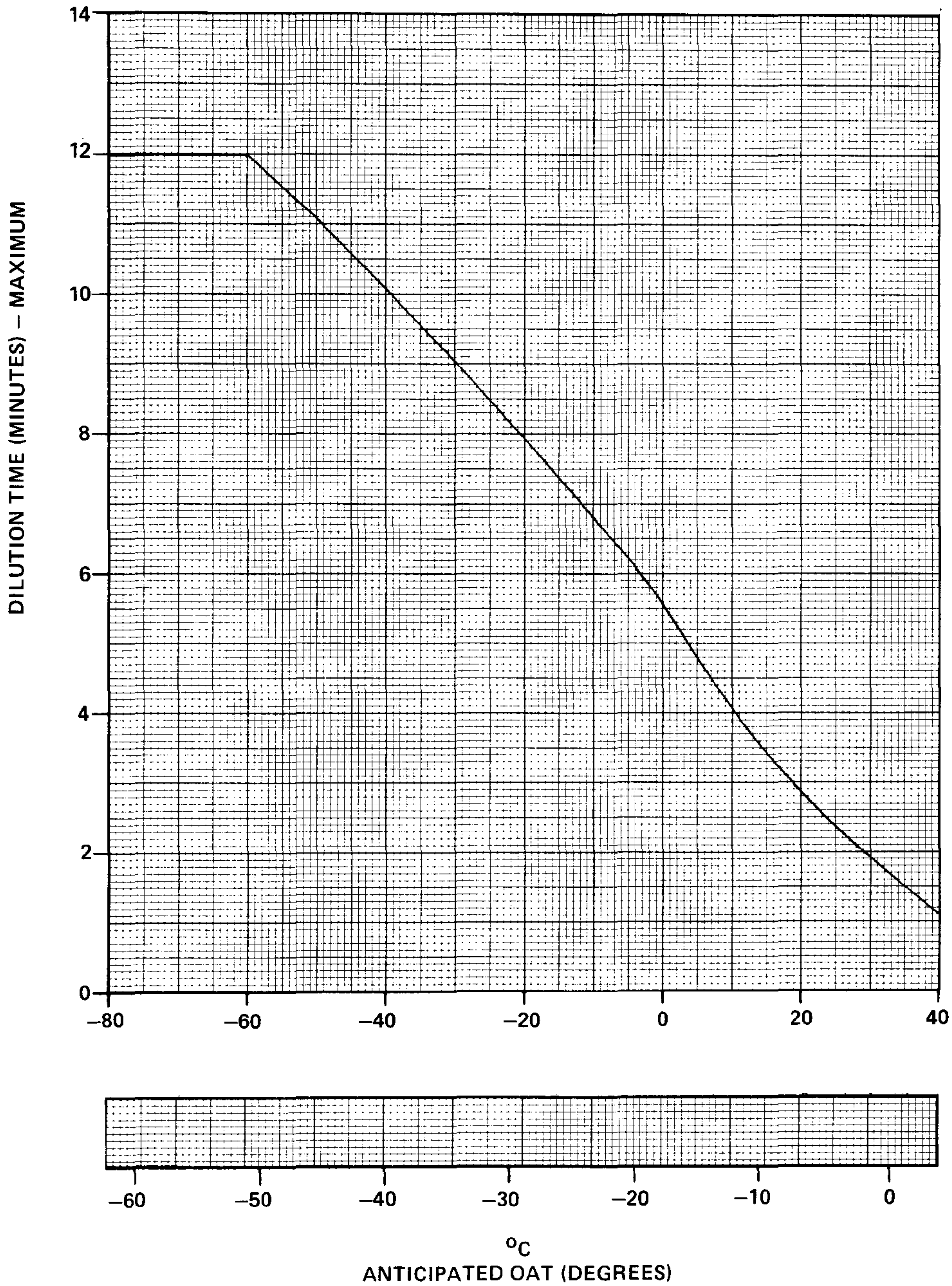


Figure 9-4

FLIGHT OPERATIONS.

When operating in hot weather, remember that hot weather operation requires that you be more cautious of stalling speeds and temperature limitations.

NOTE

> If CAT limit must be exceeded, reduce manifold pressure limit 1 inch Hg for each 6^{o} above normal CAT limit.

a. Keep cylinder head temperatures as low as possible before takeoff.

b. Longer takeoff distances are required.

c. Use the brakes sparingly.

d. Climb at not less than the speed shown in the climb charts (Performance Data T.O. 1C-118A-1-1.)

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S. Sullivan
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FLIGHT MANUAL

PERFORMANCE DATA

USAF SERIES

C-118A AND VC-118A

AIRCRAFT

AF 09(603)-67-C-0519
F09603-72-D-1406-0189

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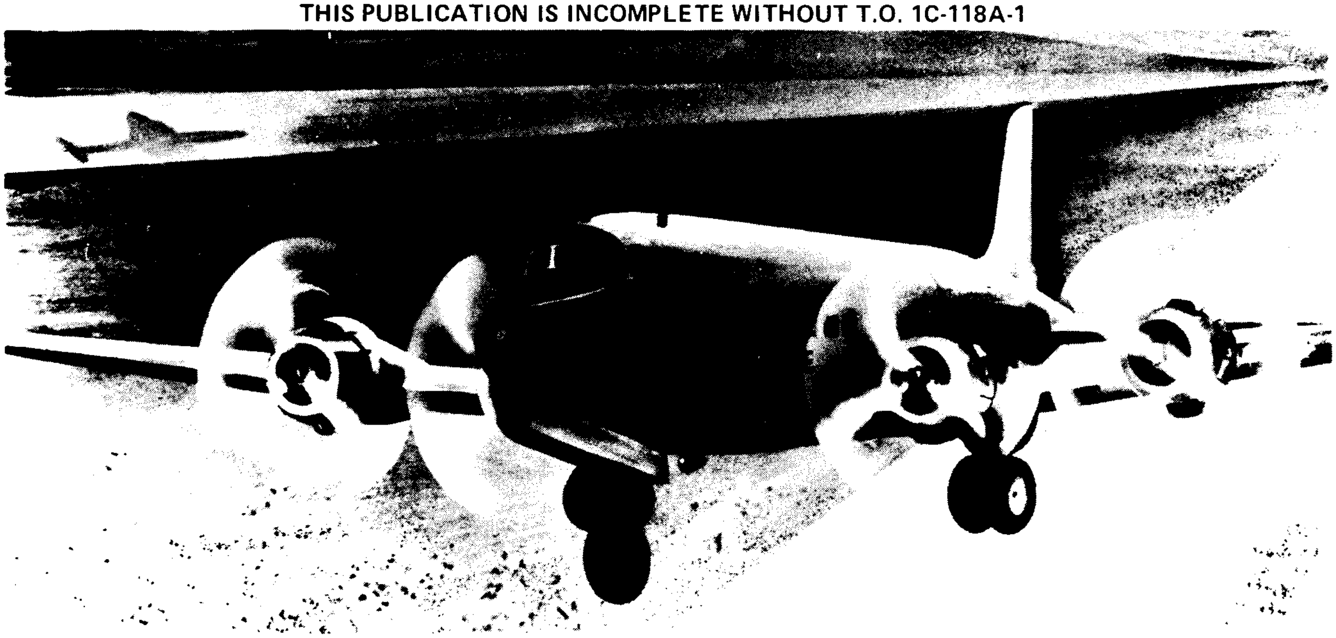

COMMANDERS ARE RESPONSIBLE FOR BRINGING THIS PUBLICATION TO THE ATTENTION OF ALL AIR FORCE PERSONNEL CLEARED FOR OPERATION OF SUBJECT AIRCRAFT.

This change incorporates Interim Safety Supplement TO 1C-118A-1-1SS-9 dated 13 June 1974.

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LIST OF EFFECTIVE PAGES

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Total number of pages in this manual is 214 consisting of the following:

Page No.	# Change No.
Title	3
A	3
i	0
ii	2
A1-1 — A1-5	0
A1-6	2
A1-7 — A1-20	0
A2-1 — A2-6	0
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A3-1 — A3-6	0
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A6-5 — A6-12	0
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A7-10 Blank	0
Index 1 — Index 3	0
Index 4 Blank	0

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T.O. 1C-118A-1-1

FLIGHT MANUAL

PERFORMANCE DATA

USAF SERIES

C-118A AND VC-118A

AIRCRAFT

AF 09(603)-67-C-0519
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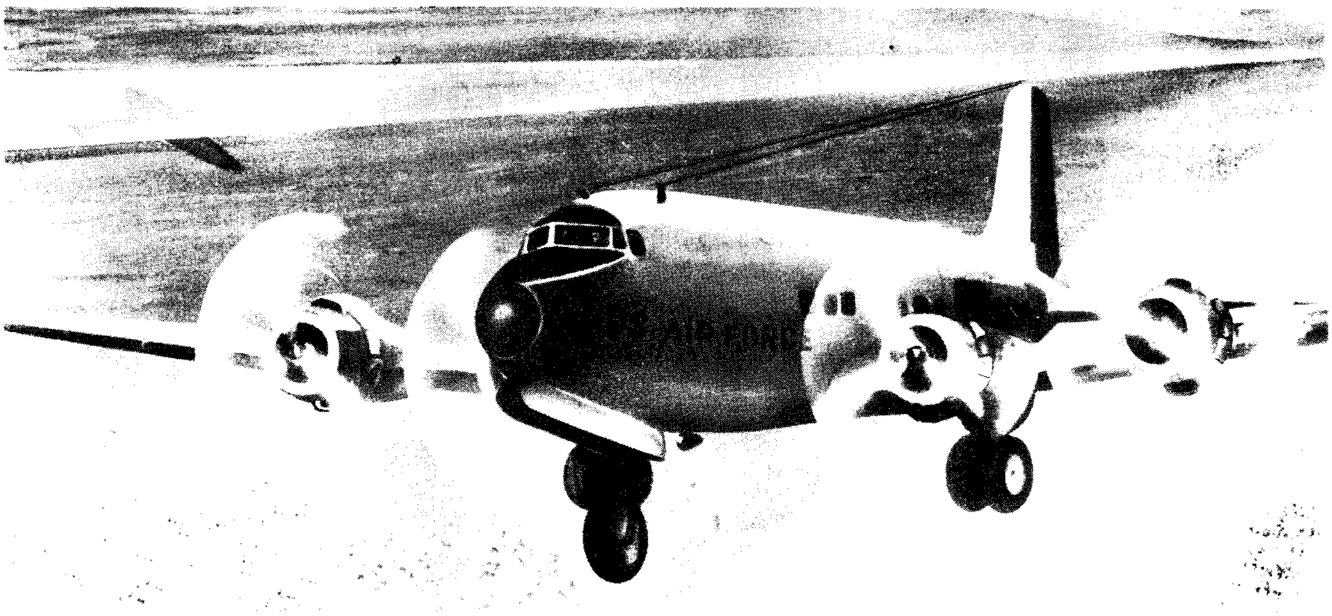

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LIST OF EFFECTIVE PAGES

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NOTE: On a changed page, the portion of the text affected by the latest change is indicated by a vertical line, or other change symbol, in the outer margin of the page. Changes to illustrations are indicated by miniature pointing hands. Changes to wiring diagrams are indicated by shaded areas.

Total number of pages in this manual is 214 consisting of the following:

Zero in this column indicates an original page.

performance data

APPENDIX I

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NOTE

The illustrations in this appendix are applicable to both the C-118A and the VC-118A.

Introduction

SCOPE. This manual contains instructions that will provide you with a general knowledge of the aircraft, its characteristics, and specific normal and emergency operating procedures. Your flying experience is recognized; therefore, basic flight principles are avoided. It provides the most acceptable operating instructions under most circumstances; however, conditions existing in multiple emergencies, adverse weather and terrain, or extenuating circumstances may require modification of any procedure(s).

PERMISSIBLE OPERATIONS. The Flight Manual takes a "positive approach" and normally states only what you can do. Unusual operations or configurations (such as assymetrical loading) are prohibited unless specifically covered herein. Clearance must be obtained from the Flight Manual Manager (Warner Robins Air Materiel Area, Robins AFB Georgia 31098 ATTN: MMEAH) before any questionable operation is attempted which is not specifically permitted in this manual.

HOW TO BE ASSURED OF HAVING LATEST DATA.

Refer to T.O. 0-1-1-3 which lists all current Flight Manuals, Safety Supplements, Operational Supplements, and Checklists. Its frequency of issue assures an accurate and up-to-date listing of these publications.

STANDARDIZATION AND ARRANGEMENT.
Standardization assures that the scope and arrangement of all Flight Manuals are identical. The manual is divided into nine fairly independent sections to simplify reading it straight through or using it as a reference manual. Performance data is contained in T.O. 1C-118A-1-1.

SAFETY SUPPLEMENTS. Information involving safety will be promptly forwarded to you by Safety Supplements. Supplements covering loss of life will get to you in 48 hours by TWX, and those concerning serious damage to equipment will reach you within 10 days by mail. The title page of the Flight Manual and the title block of each Safety Supplement should be checked to determine the effect they may have on existing supplements. You must remain constantly aware of the status of all supplements; current supplements must be complied with, but there is no point in restricting your operation by complying with a replaced or rescinded supplement.

OPERATIONAL SUPPLEMENTS. Information involving operations will be promptly forwarded to you by Operational Supplements. Supplements covering urgent operational information will get to you in 48 hours by TWX, and those concerning essential information, but of a less urgent nature, will get to you within 10 days by mail. The title page of the Flight Manual and the title block of each Operational Supplement should be checked to determine the effect they have on existing supplements. You must remain constantly aware of the status of all supplements; current supplements must be complied with, but there is no point in restricting your operation with a replaced or rescinded supplement.

CHECKLISTS. The Flight Manual contains only amplified procedures; flight crew and scroll checklists have been issued as separate technical orders; refer to T.O. 0-1-1-3 for current status of these checklists. Line items in the Flight Manual and checklists are identical with respect to arrangement and item numbers.

HOW TO GET PERSONAL COPIES. Each flight crewmember is entitled to personal copies of the Flight Manual, Safety and Operational Supplements, and Checklists. The required quantities should be ordered before you need them to assure their prompt receipt. Check with your supply personnel; it is their job to fulfill your Technical Order requests. Basically, you must order the required quantities on the Publication Requirements Table (T.O. 01-1-3). Technical Orders 00-5-1 and 00-5-2 give detailed information for properly ordering these publications. Make sure a system is established at your base to deliver these publications to flight crews immediately upon their delivery to supply.

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

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

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

CAUTION —Operating procedures, techniques, etc., which will result in damage to equipment if not carefully followed.

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

DEFINITIONS. The following definitions apply to the words indicated:

The words "shall or will" are to indicate a mandatory requirement. The word "should" indicates a nonmandatory desire, or preferred method of accomplishment. The word "may" indicates an acceptable or suggested means of accomplishment.

YOUR RESPONSIBILITY TO LET US KNOW. Every effort is made to keep the Flight Manual current. Review conferences with operating personnel and a constant review of accident and flight test reports assure inclusion of the latest data in the manual. However, we cannot correct an error unless we know of its existance. In this regard, it is essential that you do your part. Comments, corrections, and questions regarding this manual or any phase of the Flight Manual program are welcomed. These should be submitted in accordance with AFR 60-9 and forwarded through your Command Headquarters to Warner Robins Air Logistic Center, Robins AFB Georgia 31098 (ATTN: MMEA).

part 1
introduction

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LIST OF ILLUSTRATIONS

ABBREVIATIONS.

Abbreviation	Definition
ADI	Anti-detonation injection
Alt.	Altitude
BHP	Brake horsepower
BMEP	Brake mean effective pressure
°C	Degrees centigrade
CAS	Calibrated airspeed
CAT	Carburetor air temperature
CBR	California Bearing Ratio
CHT	Cylinder head temperature
Comp.	Component
Crit.	Critical
EAS	Equivalent airspeed
Eng.	Engine
ESWL	Equivalent single wheel load
°F	Degrees Fahrenheit
Fld.	Field
FPM	Feet per minute
Ft.	Feet
F.T.	Full throttle
Hg	Mercury
IAS	Indicated airspeed
ICAO	International Civil Aviation Organization
In.	Inch
Kts.	Knots
LCN	Load classification number
Lbs.	Pounds
lb/hr	Pounds per hour (fuel flow)
LD	Lift drag ratio
MAP	Manifold absolute pressure
MAX	Maximum (power)
METO	Maximum except takeoff
Min.	Minute
OAT	Outside air temperature
PSI	Pounds per square inch
Pt.	Point
RCR	Runway condition reading
RPM	Revolutions per minute
S.L.	Sea Level
Std.	Standard
T	Absolute temperature
TAS	True airspeed
UCI	Unit Construction Index
V_A	Acceleration check speed
V_{CO}	Climbout speed
V_{CRIT}	Critical engine failure speed
V_D	Decision speed
$V_{L/D}$	Speed for maximum lift to drag ratio
V_{MC}	Minimum control speed
V_{NE}	Maximum dive speed
V_{NO}	Maximum speed for normal operation
V_R	Refusal speed
V_S	Stalling speed
V_{SO}	Stalling speed with zero thrust and wing flaps in landing configuration
V_{TO}	Takeoff speed
Wt.	Weight
δ	Delta: ratio of ambient air pressure to standard sea level air pressure
σ	Sigma: ratio of ambient air density to standard sea level air density

DEFINITION OF TERMS.

AIRSPEED – the speed of the aircraft relative to the air through which it is moving

AMBIENT CONDITIONS – conditions of the air surrounding the aircraft at any given time under consideration

AUTO-LEAN – the mixture control lever at the lean detent

AUTO-RICH – the mixture control lever at the rich detent

BEST ECONOMY MIXTURE – the fuel-air mixture which results in the most power for a given fuel flow

BEST POWER MIXTURE – the fuel-air mixture which results in the most power for a given manifold pressure

BMEP DROP – a loss in BMEP due to a manual adjustment of the mixture control

CALIBRATED AIRSPEED – indicated airspeed corrected for instrument and position error

CALIFORNIA BEARING RATIO – an index used to indicate the strength of runways, generally applied to sod and unsurfaced runways.

CLIMBOUT FACTOR – a factor used to determine the maximum gross weight allowable for climbout over a given obstacle on three engines, based on the height of the obstacle and distance of the obstacle from brake release

COMPRESSIBILITY ERROR – an error in the airspeed indicator reading and the outside air temperature indicator reading caused by air being slightly compressed by the moving aircraft

CRITICAL ENGINE FAILURE SPEED – the speed at which engine failure permits acceleration to takeoff speed in the same distance that the aircraft may be decelerated to a stop

CRITICAL FIELD LENGTH – the total length of runway required to accelerate on all engines to the critical engine failure speed, experience an engine failure, then continue to takeoff or stop

DENSITY ALTITUDE – the altitude obtained from a standard density altitude chart (such as figure A1-9) for any given pressure altitude and temperature or for any density ratio factor ($1/\sqrt{\sigma}$)

DEWPOINT – the temperature at which condensation occurs in a cooling mass of air

DRY BULB TEMPERATURE – the air temperature as indicated by a thermometer with a dry bulb (true air temperature)

DRY POWER – engine power being developed without the aid of water injection (ADI switch OFF)

EFFECTIVE WIND (HEADWIND OR TAILWIND) – The component of the existing wind condition which acts opposite to or in the direction of travel. For takeoff or landing, this component will be computed from the takeoff and landing crosswind chart

EQUIVALENT AIRSPEED – calibrated airspeed corrected for compressibility

EQUIVALENT BMEP – BMEP for high blower operation at 2600 RPM adjusted for use on takeoff performance charts and emergency climb charts that are based on BMEP values for 2800 RPM

EQUIVALENT SINGLE WHEEL LOAD – the runway loading applied by each single wheel, adjusted for the mutual action of two or more single wheels in close proximity. Used in determining runway load-bearing capabilities

ACCELERATION SPEED – the minimum acceptable speed at the acceleration checkpoint

ACCELERATION CHECK POINT – a predetermined point, based on time/distance, at which the acceleration check speed should be attained

GROUND EFFECT – the reduction in induced drag when the aircraft is near the ground

HIGH BLOWER – the engine supercharger in high gear ratio

INCHES HG – a measure of air pressure which compares it to the weight of a column of mercury

INDICATED AIRSPEED – airspeed indicator reading uncorrected (assuming the mechanical error in the instrument is negligible)

LOAD CLASSIFICATION NUMBER – an index used to indicate strength of a runway, usually applied to concrete and flexible surface (macadam) runways

LOW BLOWER – the engine supercharger in low gear ratio

MANUAL LEAN – fuel-air mixture on the lean side of best power mixture, adjusted manually to give a prescribed BMEP drop from best power mixture

MANUAL RICH – fuel-air mixture on the rich side of best power mixture, adjusted manually to reduce fuel flow to the prescribed minimum shown on figure A2-13

MAXIMUM (MAX) POWER – the brake horsepower available for takeoff corrected for atmospheric conditions

NAUTICAL MILES PER POUND – the number of nautical miles traveled while consuming a pound of fuel

OPERATING WEIGHT EMPTY – the weight of the aircraft and its contents, not including payload, fuel, or regular engine oil, when the aircraft is loaded with all provisions necessary to complete a mission

POSITION ERROR – the error in the airspeed indicator reading and the altimeter reading caused by the inability of the static orifices to experience the true ambient air pressure

POWER FACTOR – BMEP corrected for density altitude, used as a correction factor to obtain rate of climb on the emergency climb charts

PRESSURE ALTITUDE – the altitude obtained from a standard atmosphere table, such as figure A1-10, for any given value of air pressure (measured in inches Hg). This is the altitude that an altimeter will show (after correcting for position error) when the barometric setting is at 29.92

RAM – the increase in air pressure at the entrance to an airscoop due to the speed of the aircraft

RECOMMENDED LONG RANGE CRUISE SPEED – the speed at which it is recommended to fly the aircraft when long range is of more concern than high speed. For the C-118A, recommended long range cruise speed is the same at 110 percent of the speed of maximum lift to drag ratio

REFUSAL DISTANCE – the distance required to accelerate to the refusal speed

REFUSAL SPEED – maximum speed to which the aircraft can accelerate and then stop in the available runway length

RELATIVE HUMIDITY – the ratio of the amount of water vapor in a given mass of air to the maximum amount of water vapor that the mass of air could hold at the same temperature

RUNWAY CONDITION READING – a number indicating the relative slickness or coefficient of friction of the runway surface, as measured by the brake decelerometer, is used to correct stopping distances for landing on other than a dry hard surface runway

SPECIFIC HUMIDITY – the ratio of the amount of water vapor in a given mass of air to the mass of dry air, measured in pounds

STANDARD ATMOSPHERIC CONDITIONS – an arbitrarily selected set of atmospheric conditions chosen to approximate the average atmosphere of the world

STANDARD DAY – a day on which standard atmospheric conditions are assumed to exist

TAKEOFF FACTOR – a factor used to determine takeoff performance, based on available BMEP corrected for pressure altitude and temperature

THRESHOLD SPEED – the speed at which the aircraft crosses the end of the runway during a normal landing (130 percent of the stall speed for wing flaps in the landing position)

TOUCHDOWN SPEED – the speed at which the aircraft comes in contact with the runway during a normal landing (120 percent of the stall speed for wing flaps in the landing position)

TRUE AIRSPEED – the true speed of the aircraft relative to the air through which it is moving (equal to EAS times $1/\sqrt{\sigma}$)

TRUE ALTITUDE – altitude above sea level

UNIT CONSTRUCTION INDEX – an index used to indicate strength of a runway, usually applied to concrete and flexible surface (macadam) runways

VAPOR PRESSURE – the partial pressure of water vapor existing in the air

V_D – DECISION SPEED; the highest speed at which the pilot may elect either to continue takeoff or to stop should an engine fail. At higher speeds the aircraft is committed to takeoff

$V_{L/D}$ – the speed for maximum lift to drag ratio

V_{MC} – the slowest safe indicated airspeed at which adequate control surface response remains for maintaining directional, lateral, and vertical control of the aircraft.

V_{SO} – the zero thrust stalling speed with wing flaps in the landing configuration

V_{TO} – takeoff speed 115 percent of the stalling speed with wing flaps in takeoff configuration (or 110 percent of the air minimum-control speed, whichever is greater).

WET BULB TEMPERATURE – the temperature indicated by a thermometer whose bulb has been kept moist with water and which has been circulated in the air. This temperature, along with the dry bulb temperature, is used in conjunction with a psychrometric chart to determine the degree of humidity.

WET POWER – the power developed by an engine with the aid of water injection (ADI fluid)

WIND GRADIENT – the change in windspeed with altitude. Because of friction between the air and the ground surface, the windspeed generally diminishes as one nears the ground.

INTRODUCTION.

The data shown in this Appendix are provided to aid the flight crews in achieving maximum utilization of the aircraft consistent with safety. In most cases data are included to permit missions to be planned with allowances for more than 1 degree of safety. This is done so that the importance of the mission may be weighed against safety requirements. For example, the charts in Part 3 allow takeoff distance to be determined based on the engines developing 100 percent of the predicted power or 95 percent of the predicted power, or even less, if desired. Furthermore, this takeoff distance may be based on all four engines operating all the way, or may allow for an engine failure at the most critical time. Similarly, rates of climb and cruise performance are shown for two, three, or four engines operating, and landing distances are provided for brakes only or for either two engines or four engines operating at full reverse thrust.

It should be stressed that these charts show the optimum performance expected from the aircraft when flown with careful pilot technique under stable atmospheric conditions. There are several factors (mechanical imperfections, improper pilot technique, turbulent air, etc.) which adversely affect performance, whereas very few factors can improve performance. This is one of the reasons for allowing performance margins when planning a mission.

FUEL GRADES.

The standard fuel grade is 115/145. The alternate fuel grade is 100/130. Take-off and climb data may be determined for both standard and alternate fuel grades. Cruise data is applicable to either fuel grade, except as noted.

INSTRUMENT ERRORS.

All instruments have some degree of mechanical error. Ordinarily this may be assumed to be negligible since the instruments are maintained within specified tolerances. However, the airspeed indicator, altimeter and outside air temperature indicator have other sources of error which, under certain circumstances, are great enough to require corrections to be made to the instrument readings. One of these errors, known as the position error, arises from the requirement that the airspeed indicator and altimeter must measure the ambient air pressure. This is done through the static orifices on the side of the fuselage for the pilot's and the copilot's alternate system and through static orifices on the fuselage mounted pitot-static probes for the pilot's and copilot's normal system. Because of the rapid motion of the aircraft through the air neither of these locations transmit the true ambient pressure at all speeds and angles of attack. The correction for this error is included in the Airspeed Position Error Correction charts (figures A1-1 through A1-3) and the Altimeter Position Error Correction charts (figures A1-5 through A1-6). The Airspeed Position Error Correction charts also include a correction for a smaller error due to the position of the pitot tubes which measure the impact pressure. There is zero position error correction for the pilot's and copilot's normal system in ground effect.

Another error in the airspeed system is due to the behavior of air striking the pitot tubes at high velocities. This is called the compressibility error. The markings on the airspeed indicator have been spaced so that this error is automatically accounted for at sea level. At higher altitudes, however, corrections for this error should be applied to the instrument reading. These corrections appear on the Calibrated Airspeed Correction for Compressibility chart (figure A1-4).

The outside air temperature indicator also has an error known as the compressibility error. This error arises from the fact that the outside air passes the temperature sensing element at a speed approximately equal to the speed of the aircraft. However, the very thin layer of air in immediate contact with the sensing element has been brought almost to rest (relative to the element). In doing this, its temperature has risen due to a combination of compression and friction. The correction for this error appears on the Temperature Correction for Compressibility chart (figure A1-7).

AIRSPEED TERMINOLOGY.

Airspeed terminology used in this Appendix is defined as follows:

Term	Abbreviation	Definition
Indicated Airspeed	IAS	*Airspeed Indicator reading uncorrected.
Calibrated Airspeed	CAS	Indicated airspeed corrected for position error.
Equivalent Airspeed	EAS	Calibrated airspeed corrected for compressibility.
True Airspeed	TAS	TAS = EAS $1/\sqrt{\sigma}$

*IAS is used in this Appendix as though the mechanical error in the instrument is zero.

All airspeeds of importance in takeoff and landing procedures are shown in this Appendix as indicated airspeed (IAS).

PROCEDURE TO CONVERT INDICATED AIRSPEED (IAS) TO TRUE AIRSPEED (TAS).

Charts and tables are provided to convert indicated airspeed to true airspeed. This is done in three steps as follows:

SAMPLE PROBLEM.

GIVEN:	Indicated Airspeed	=	185 knots
	Pressure Altitude	=	15,000 feet
	Outside Air Temperature	=	-30 °C
FIND:	True Airspeed		

INDICATED AIRSPEED (IAS) TO CALIBRATED AIRSPEED (CAS).

1. Find applicable position error correction chart, noting static source reference. For example, figure A1-1, Airspeed Position Error Correction chart - Pilot's and Co-pilot's Normal System.
2. Enter chart at 185 KIAS and project to the right to curve.
3. Project down to the calibrated airspeed scale and read 186 knots CAS.

CALIBRATED AIRSPEED (CAS) TO EQUIVALENT AIRSPEED (EAS).

1. To obtain equivalent airspeed, correct calibrated airspeed for compressibility error, which varies with airspeed and pressure altitude.
2. Use chart, figure A1-4, Calibrated Airspeed Correction for Compressibility.
3. Enter chart on calibrated airspeed scale at 186 knots (CAS). Project vertically to intersection with 15,000 feet pressure altitude curve.
4. Project horizontally to scale on left edge of chart. Read correction 1.45 knots. Round off to one knot.
5. Subtract correction from calibrated airspeed to obtain equivalent airspeed.

   186 KCAS - 1 knot = 185 KEAS.

EQUIVALENT AIRSPEED (EAS) TO TRUE AIRSPEED (TAS).

True airspeed may be found by multiplying the equivalent airspeed by the quantity $1/\sqrt{\sigma}$, where σ (sigma) is the density ratio of ambient air to standard sea level air. The quantity $1/\sqrt{\sigma}$ is sometimes referred to as the "Smoe factor."

1. Correct OAT for compressibility by use of figure A1-7. For 15,000 feet pressure altitude and 186 KCAS, read 3.6 °C correction. Round off to 4 °C.

   -30 °C OAT – 4 °C correction = -34 °C OAT.
2. Enter Density Altitude chart, figure A1-9, with -34 °C and project vertically to 15,000 feet pressure altitude line.
3. Project horizontally to right edge of chart. Read $1/\sqrt{\sigma}$ = 1.213.
4. Another method of obtaining $1/\sqrt{\sigma}$ is to project horizontally to the density altitude scale at the left. Read 12,600 feet density altitude. Then, by using the ICAO Standard Atmosphere Table (figure A1-10, sheet 2), read $1/\sqrt{\sigma}$ = 1.2127 opposite 12,600 feet.
5. EAS × $1/\sqrt{\sigma}$ = TAS.

   185 KEAS x 1.213 = 224 KTAS.

DISCUSSION OF CHARTS.

AIRSPEED POSITION ERROR CORRECTION CHARTS.

These charts (figure A1-1 through A1-3) contain the corrections for changing calibrated airspeed (CAS) to indicated airspeed (IAS) and vice versa. Corrections are shown for the pilot's and copilot's normal and alternate static systems.

Two of the charts are for in-flight use, while the third is for use during the takeoff ground run.

CALIBRATED AIRSPEED CORRECTION FOR COMPRESSIBILITY CHART.

This chart (figure A1-4) shows the correction that must be subtracted from calibrated airspeed to determine equivalent airspeed. It will be noted that there is no correction at sea level and that the amount of the correction increases with increasing altitude.

ALTIMETER POSITION ERROR CORRECTION CHARTS.

These charts (figures A1-5 and A1-6) show the corrections that must be applied to the altimeter reading to obtain the true altitude. If the barometric setting is at 29.92 the result will be true pressure altitude. If, instead, the barometric setting is at the local sea level value the result will be approximate true altitude.

NOTE

> The appropriate altimeter correction (position error) for the current aircraft configuration must be used to fly corrected altitude for traffic separation.

Corrections are shown for the pilot's and copilot's normal and alternate systems.

On figures A1-6 through A1-8 chase-around lines illustrate the following sample problem.

GIVEN: Airspeed = 185 KIAS.
Altimeter reading =

14,977 feet, pilot's and copilot's normal static source.

14,940 feet, pilot's and copilot's alternate static source.

FIND: True altitude

1. Enter the indicated airspeed scale at 185 knots.
2. Proceed vertically to appropriate altimeter reading.
3. Go horizontally to the left-hand scale and read the correction:

23 feet, pilot's and copilot's normal static source (figure A1-5);

60 feet, pilot's and copilot's alternate static source (figure A1-6).

TEMPERATURE CORRECTION FOR COMPRESSIBILITY CHART.

This chart (figure A1-7) shows the correction that must be subtracted from the outside air temperature indicator reading to determine the true outside air temperature (see next under "INSTRUMENT ERRORS"). For example, assume that the aircraft is cruising at 185 KCAS (point A) at an altitude of 15,000 feet (point B). The chart shows that the correction is 3.5°C (point C). This amount must be subtracted from the indicated air temperature to determine the outside air temperature. If the instrument reads 6°C, then the outside air temperature would be 6 -3.5, or 2.5°C. If the instrument reads -12°C, then the outside air temperature would be -12 -3.5, or -15.5°C.

DENSITY ALTITUDE CHART.

A Density Altitude Chart (figure A1-9) has been included so that the density altitude and the reciprocal of the square root of the density ratio ($1/\sqrt{\sigma}$) may be determined for any pressure altitude under non-standard conditions. Sheet 1 covers a range of density altitudes from -8000 feet to 18,000 feet, and sheet 2 extends from 14,000 feet to 40,000 feet.

ICAO STANDARD ATMOSPHERE TABLE.

The ICAO Standard Atmosphere Table (figure A1-10) shows values of the various atmospheric properties for a standard day as defined by the International Civil Aviation Organization. Sheet 1 lists the density ratio (σ), the reciprocal of the square root of the density ratio ($1/\sqrt{\sigma}$), the temperature, speed of sound, pressure and pressure ratio (δ) for every 1000 feet of altitude from sea level to 45,000 feet. Sheet 2 lists only the reciprocal of the square root of the density ratio ($1/\sqrt{\sigma}$) for every 100 feet of altitude from 100 feet to 30,000 feet.

The standard atmosphere defined by ICAO represents an approximation to the average atmosphere of the world. It is based on a temperature of 15°C(59°F) and a pressure of 29.92 inches Hg for sea level conditions. The temperature variation with height is uniform from 15°C (59°F) at sea level to -56.5°C (-69.7°F) at 36,089 feet. This altitude is assumed to be the beginning of the isothermal region or stratosphere. For all practical purposes, the temperature will remain constant as altitude is increased above 36,089 feet. ICAO standard atmosphere values have been used in preparation of all performance charts in this Appendix.

PSYCHROMETRIC CHART.

The Psychrometric Chart (figure A1-11) graphically relates the various measures of water vapor in the atmosphere. Although it is the dew point that is commonly furnished the pilot, occasionally humidity may be available as wet and dry bulb temperatures, and less often, as relative humidity. To meet all such situations the psychrometric chart provides a means of converting from one variable to another.

Three examples for obtaining specific humidity are given below that differ as to which quantities are known.

EXAMPLE 1:

GIVEN: Pressure altitude = 5000 ft.
Dew point = 54.5°F

FIND: Specific humidity

1. Locate 54.5°F dew point temperature on curved line for 100 percent relative humidity (point B). This point can be found either by interpolation between 50° and 60°F along curved line or by entering at 54.5°F on dry bulb temperature scale (point A) and projecting vertically upward to curved line for 100 percent relative humidity.

2. From point B, proceed horizontally to left to base line and then follow along curved path interpolated between guide lines to 5000 ft. pressure altitude (point C).

3. Project horizontally to specific humidity scale at extreme left (point D) and read 0.0108.

4. If vapor pressure is desired, project horizontally from point B to extreme right (point E) and read 0.425 inches Hg.

EXAMPLE 2:

GIVEN: Pressure altitude = 5000 ft.

Wet bulb temperature = 17°C

Dry bulb temperature = 26°C

FIND: Dew point and specific humidity

1. Enter with 26°C dry bulb temperature (point F) and proceed vertically upward to intersection with imaginary slant line for 17°C wet bulb temperature (point G). Note that the 17°C wet bulb temperature line can be located by interpolation between the 15° and 20°C wet bulb lines for 5000 ft. altitude. To assist interpolation, the upper end of this line can be located by entering the dry bulb temperature scale at 17°C (point H) and projecting vertically upward to the 100 percent relative humidity line (point I). Draw slant line through point I parallel to 5000 ft. wet bulb dashed lines to intersection (point G) with vertical projection of point F.

2. From point G, project horizontally to left to dew point scale (point B) and read dew point, 54.5°F.

3. Continue left as in Example 1 (points C and D) to obtain a specific humidity of 0.0108.

4. From point G, project horizontally to right to obtain 0.425 inches Hg vapor pressure (point E).

EXAMPLE 3:

GIVEN: Relative humidity = 43%

Dry bulb temperature = 26°C

FIND: Dew point and specific humidity

1. Enter dry bulb temperature scale at 26°C (point F) and proceed vertically upward to intersection with 43 percent relative humidity line, interpolated between 40 percent and 60 percent (point G).

2. Project horizontally to the left to the dew point scale (point B) and read dew point, 54.5°F.

3. To obtain specific humidity project horizontally to left base line and continue as in example 1 (points C and D) to read 0.0108.

4. From point G project horizontally to right to obtain 0.425 inches Hg vapor pressure (point E).

TEMPERATURE CONVERSION CHART.

A Temperature Conversion chart is provided (figure A1-8) to facilitate the conversion of either Fahrenheit temperatures to Centigrade or Centigrade temperatures to Fahrenheit. The appropriate scale is entered at the known temperature. The corresponding value may then be read from the other scale as indicated by the oblique line. For example, the chart shows that 50 degrees Fahrenheit is the same temperature as 10 degrees Centigrade.

AIRSPEED POSITION ERROR CORRECTION – FLIGHT
PILOT'S AND COPILOT'S NORMAL STATIC SOURCE

MODEL: C-118A
DATA AS OF: NOV 1971
DATA BASIS: FLIGHT TEST

NOTE: THIS CHART APPLIES TO ALL FLAP AND LANDING GEAR CONFIGURATION.

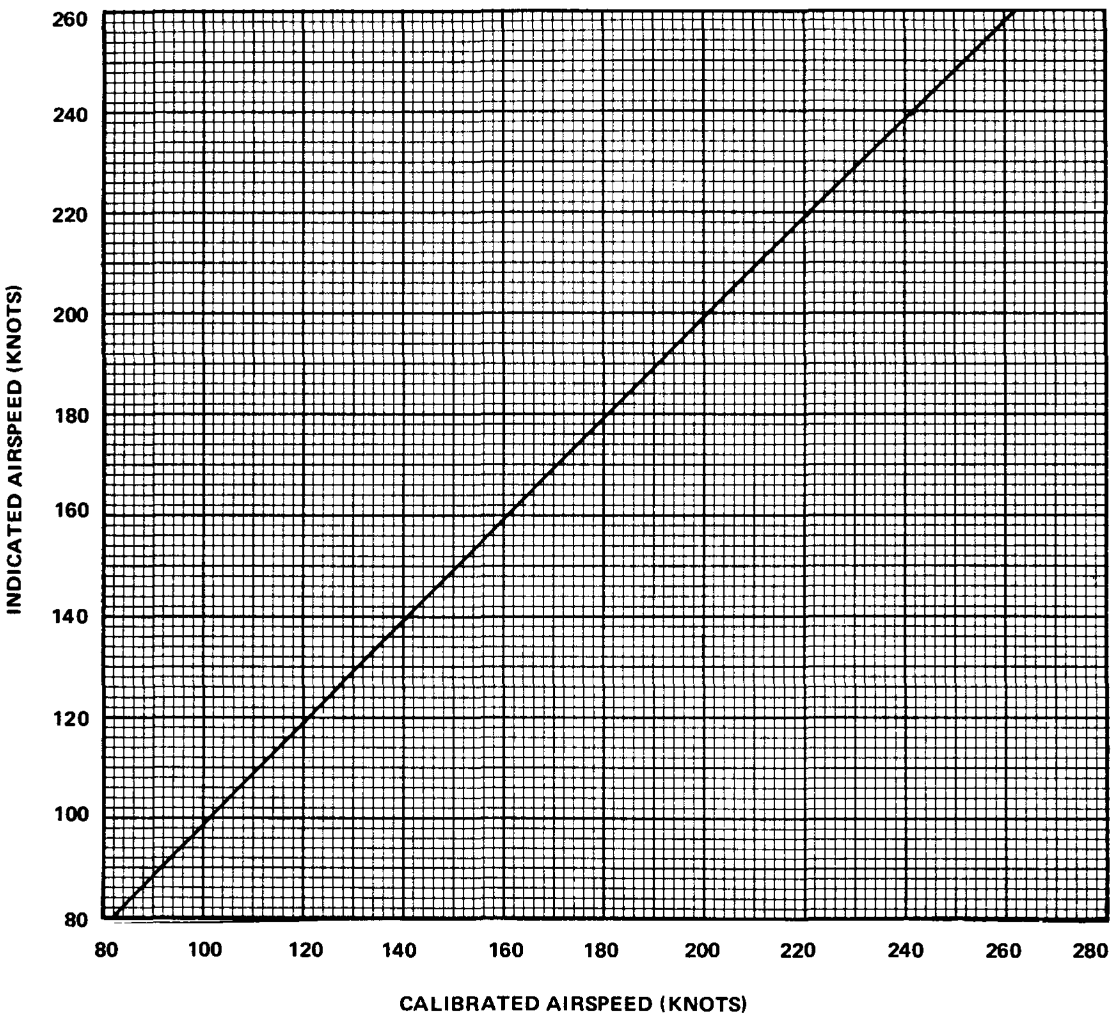


Figure A1-1. Airspeed Position Error Correction - Flight - Pilot's and Copilot's Normal Static Source

AIRSPEED POSITION ERROR CORRECTION – FLIGHT
PILOT'S AND COPILOT'S ALTERNATE STATIC SOURCE

MODEL: C-118A
DATA AS OF: NOV 1971
DATA BASIS: FLIGHT TEST

NOTE: THIS CHART APPLIES TO ALL FLAP AND LANDING GEAR CONFIGURATION.

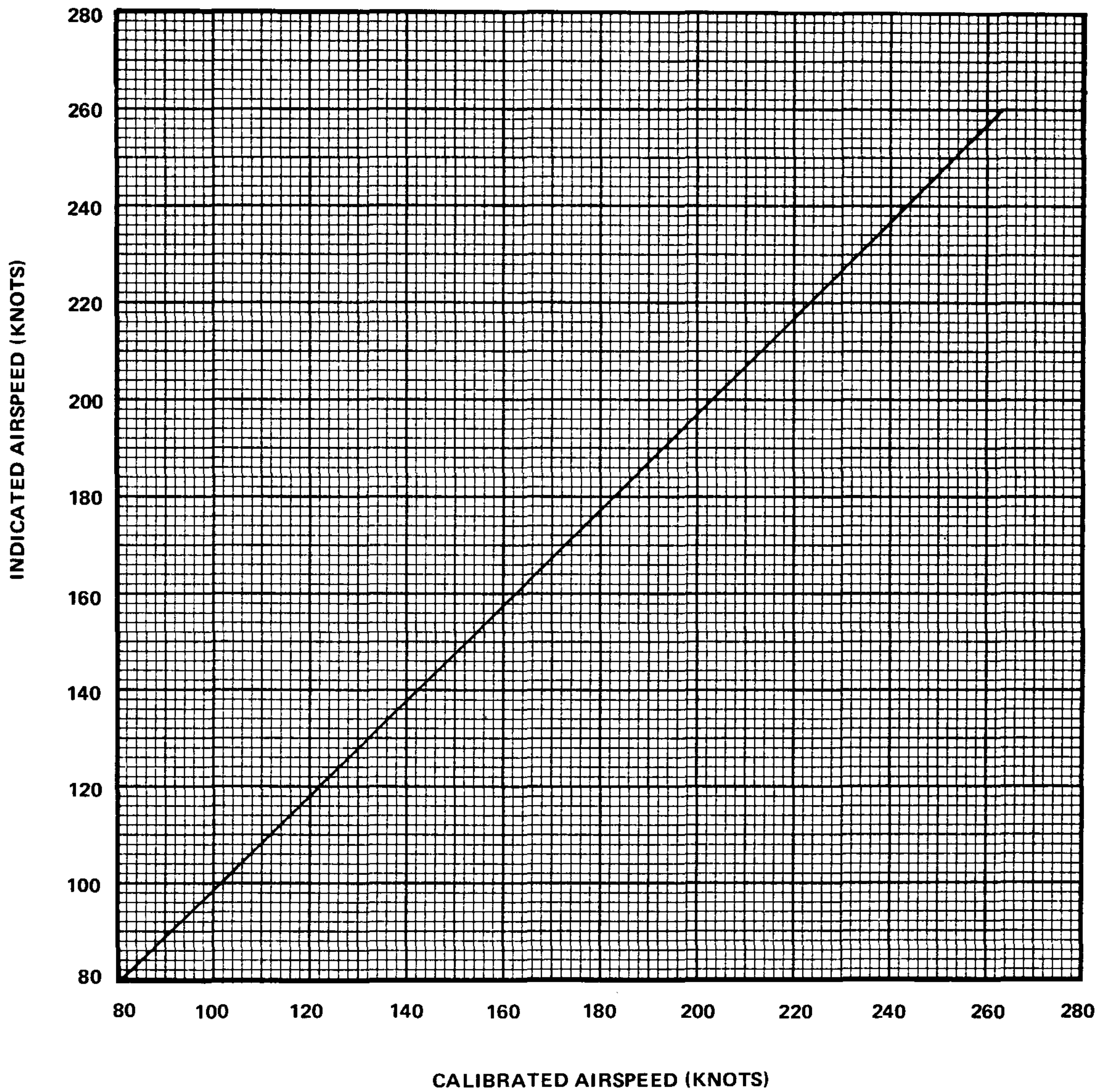


Figure A1-2. Airspeed Position Error Correction - Flight - Pilot's and Copilot's Alternate Static Source

AIRSPEED POSITION ERROR CORRECTION – GROUND RUN
PILOT'S AND COPILOT'S ALTERNATE STATIC SOURCE

MODEL: C-118A
DATA AS OF: NOV 1971
DATA BASIS: FLIGHT TEST

NOTES:

1. FLAPS 20°, GEAR DOWN
2. THE PILOT'S AND COPILOT'S NORMAL SYSTEM HAS ZERO POSITION ERROR IN GROUND EFFECT.

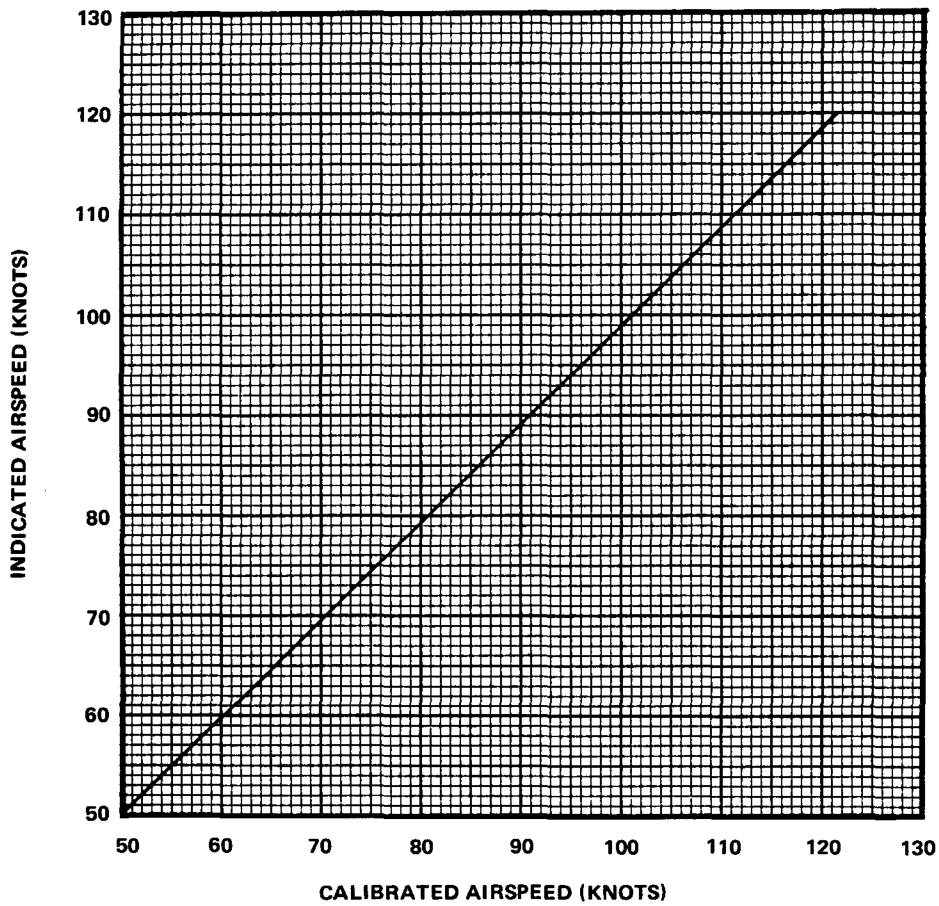
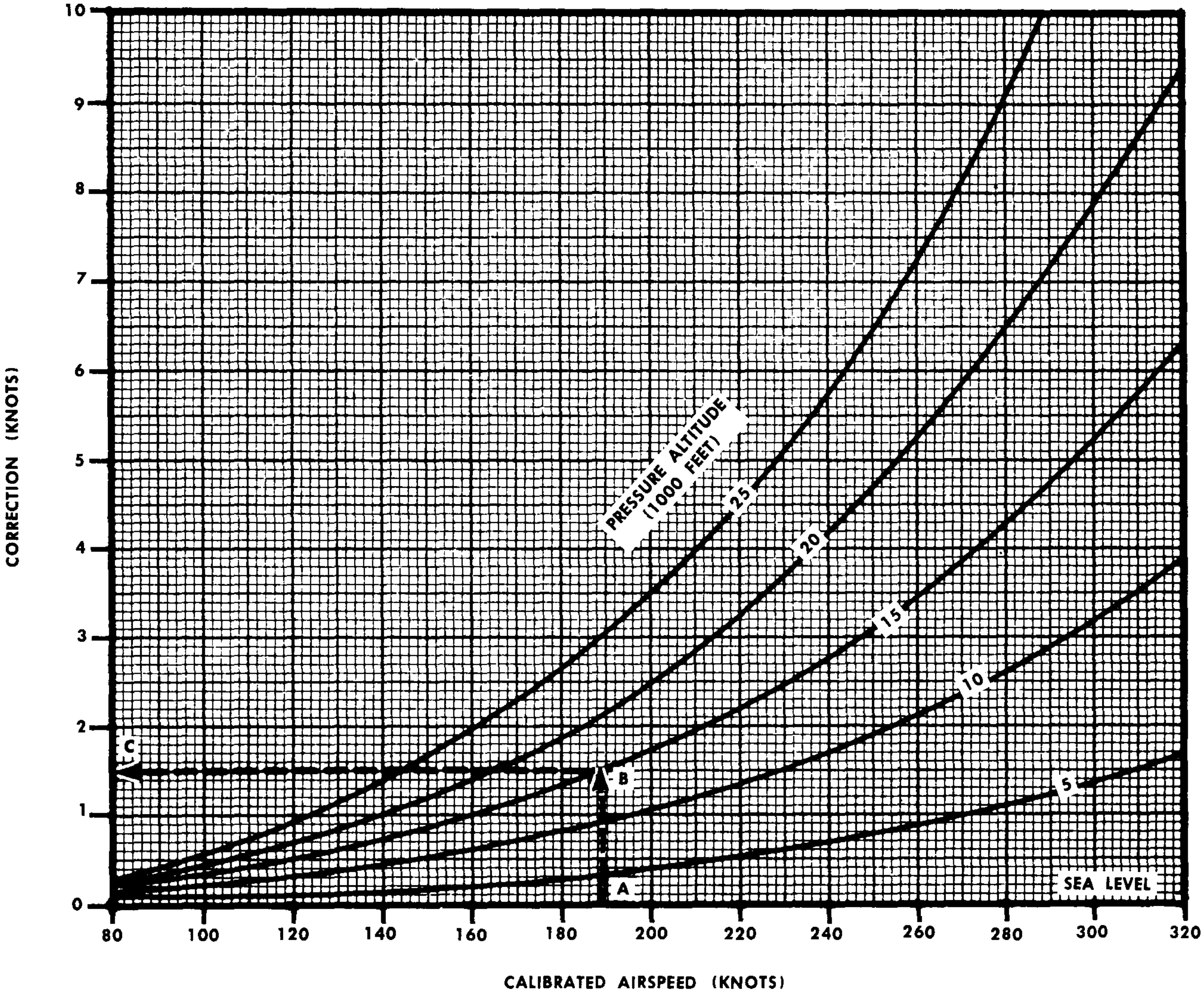


Figure A1-3. Airspeed Position Error Correction - Ground Run - Pilot's and Copilot's Alternate Static Source

CALIBRATED AIRSPEED CORRECTION FOR COMPRESSIBILITY

MODEL: C-118A
DATA AS OF: 2-15-59

Note:
Subtract correction from calibrated airspeed to obtain equivalent airspeed.



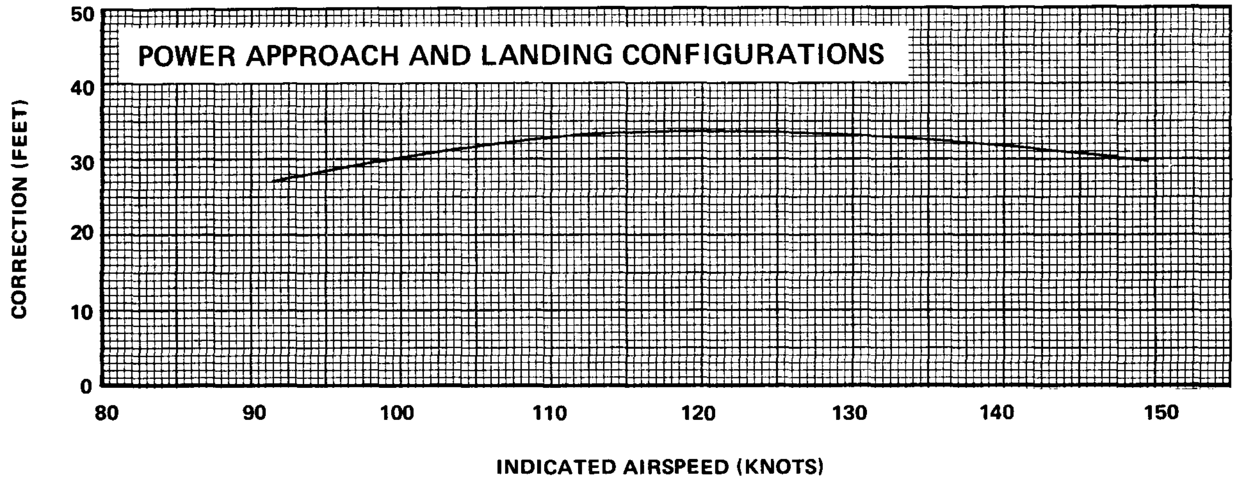
SAMPLE PROBLEM:
Given: Pressure altitude = 15,000 feet
calibrated airspeed = 189 knots
A. Enter graph at 189 knots CAS
B. At 15,000 feet read correction
C. Correction = 1.5 knots (round off to 2 knots).
D. 189 knots CAS — 2 knots = 187 knots EAS.

Figure A1-4. Calibrated Airspeed Correction for Compressibility

ALTIMETER POSITION ERROR CORRECTION
PILOT'S AND COPILOT'S NORMAL STATIC SOURCE

MODEL: C-118A
DATA AS OF: NOV 1971
DATA BASIS: FLIGHT TEST

NOTE:
ADD CORRECTION TO ALTIMETER READING TO OBTAIN ALTITUDE.



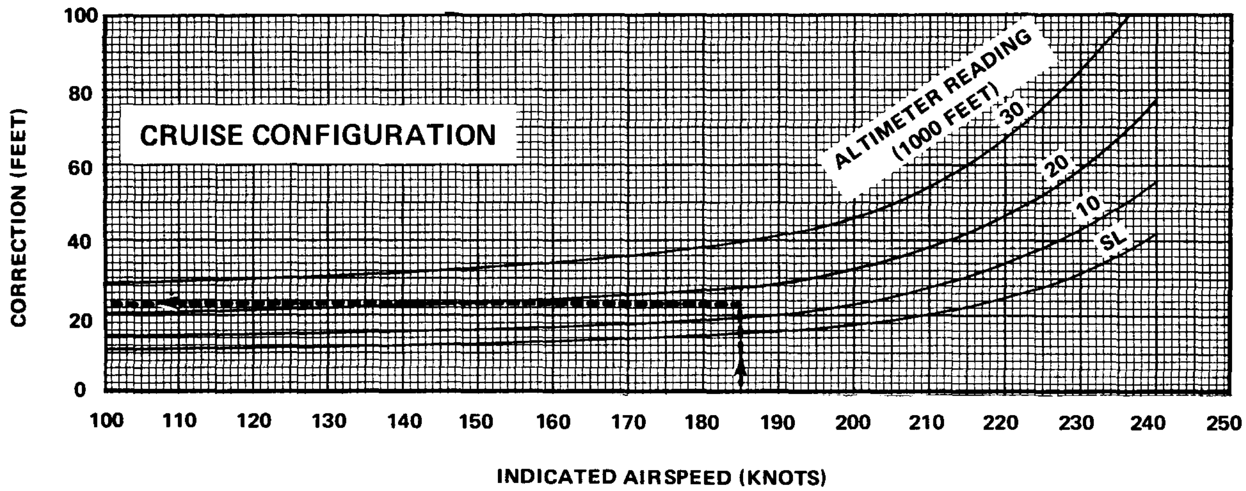


Figure A1-5. Altimeter Position Error Correction - Pilot's and Copilot's Normal Static Source

ALTIMETER POSITION ERROR CORRECTION
PILOT'S AND COPILOT'S ALTERNATE STATIC SOURCE

THIS CHART APPLIES TO ALL FLAP AND LANDING GEAR CONFIGURATIONS

MODEL: C-118A
DATA AS OF: 2-15-59
DATA BASIS: FLIGHT TEST

Note:
Add correction to altimeter reading to obtain altitude.

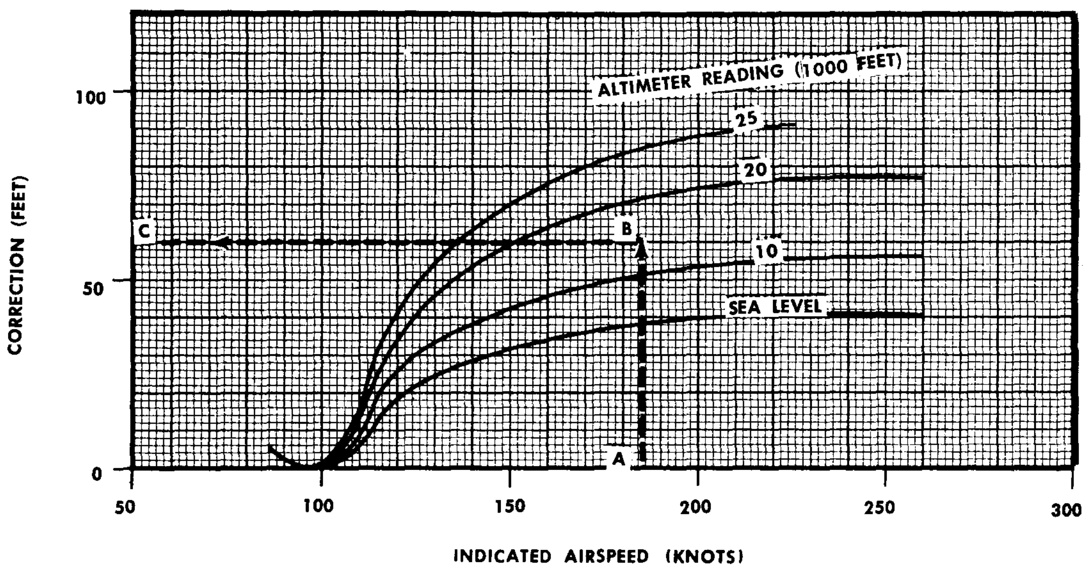


Figure A1-6. Altimeter Position Error Correction - Pilot's and Copilot's Alternate Static Source

TEMPERATURE CORRECTION FOR COMPRESSIBILITY

MODEL: C-118A
DATA AS OF: 2-15-59
DATA BASIS: FLIGHT TEST

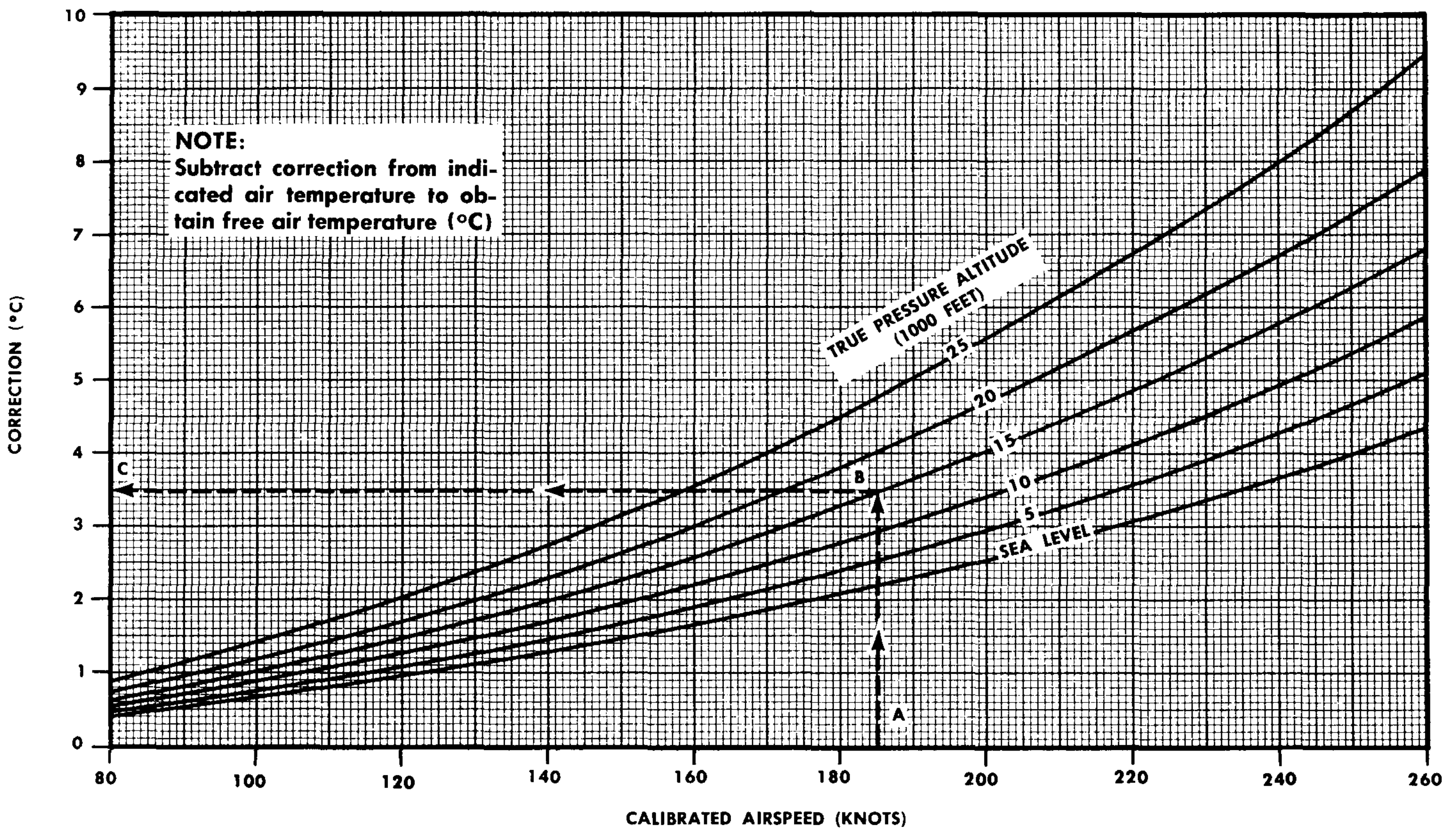


Figure A1-7. Temperature Correction for Compressibility

TEMPERATURE CONVERSION CHART
CENTIGRADE VS FAHRENHEIT

TEMPERATURE CONVERSION:
Centigrade = 5/9 (F −32)
Fahrenheit = 9/5 C +32

SAMPLE PROBLEM:
A. Centigrade = 10°
B. Fahrenheit = 50°

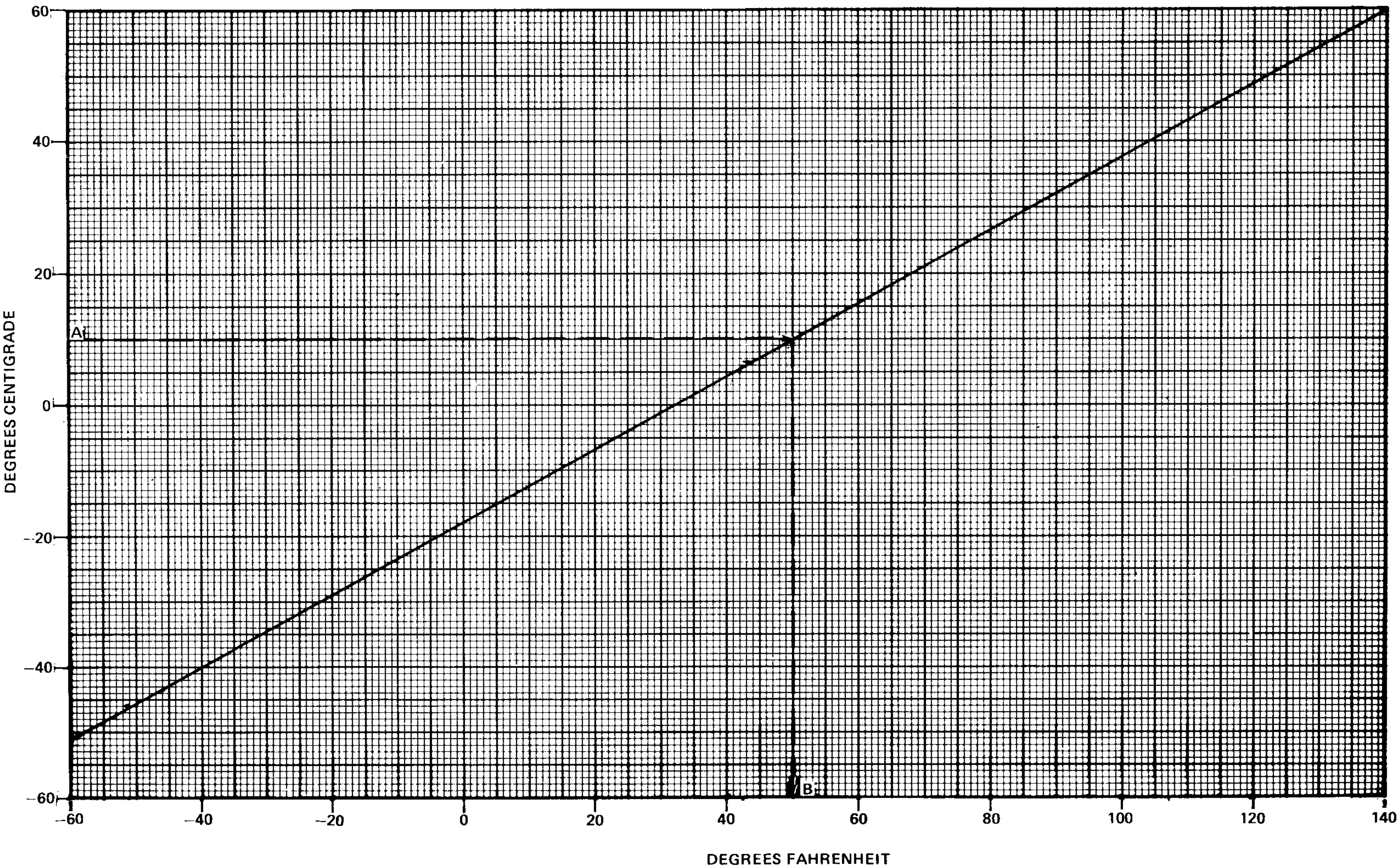


Figure A1-8. Temperature Conversion Chart

DENSITY ALTITUDE CHART

SAMPLE PROBLEM:

A. OUTSIDE AIR TEMPERATURE = 25°

B. PRESSURE ALTITUDE = 1500 FEET

C. $\frac{1}{\sqrt{\sigma}}$ = 1.045

D. DENSITY ALTITUDE = 3000 FEET

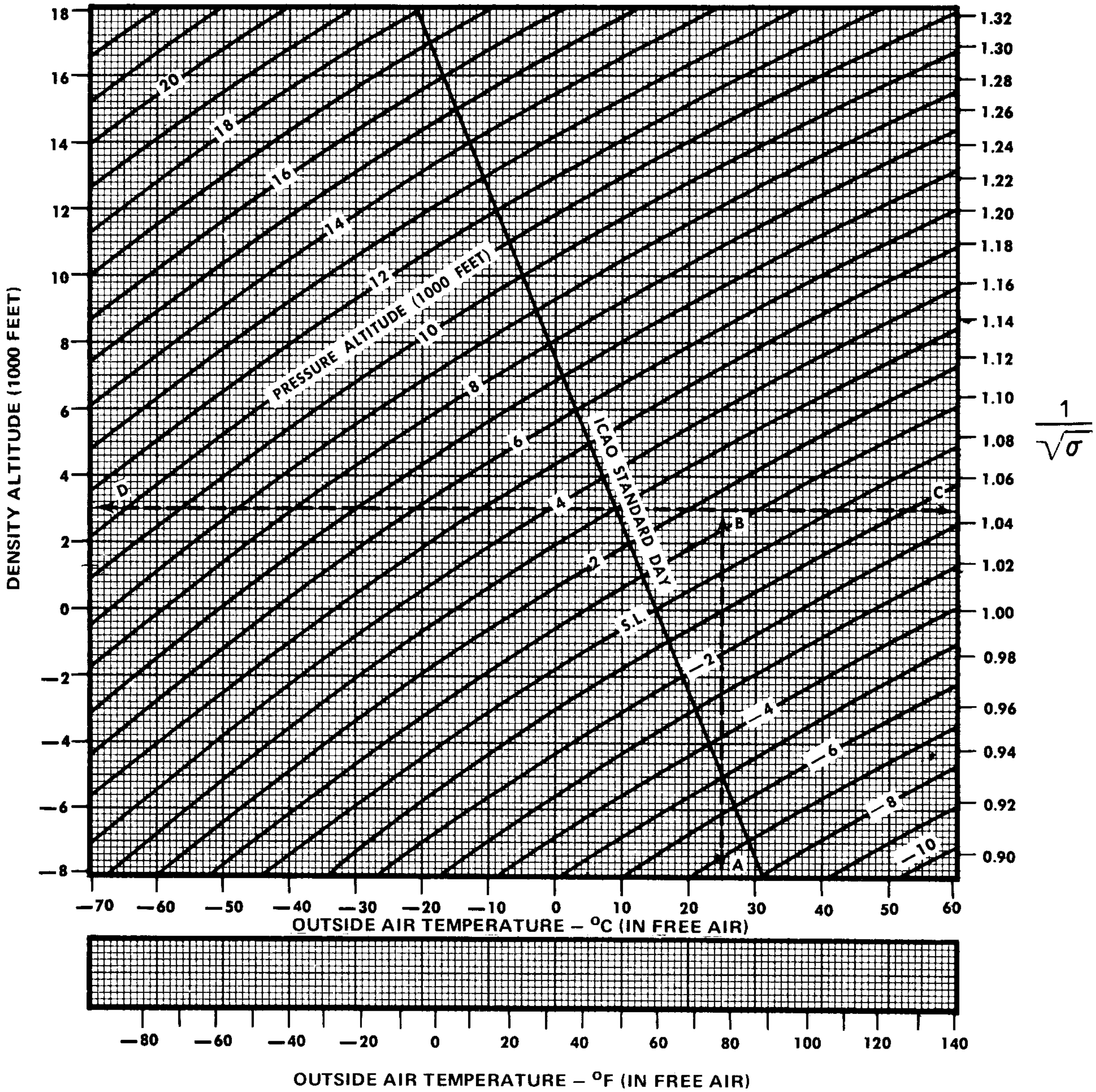


Figure A1-9. Density Altitude Chart (Sheet 1 of 2)

DENSITY ALTITUDE CHART

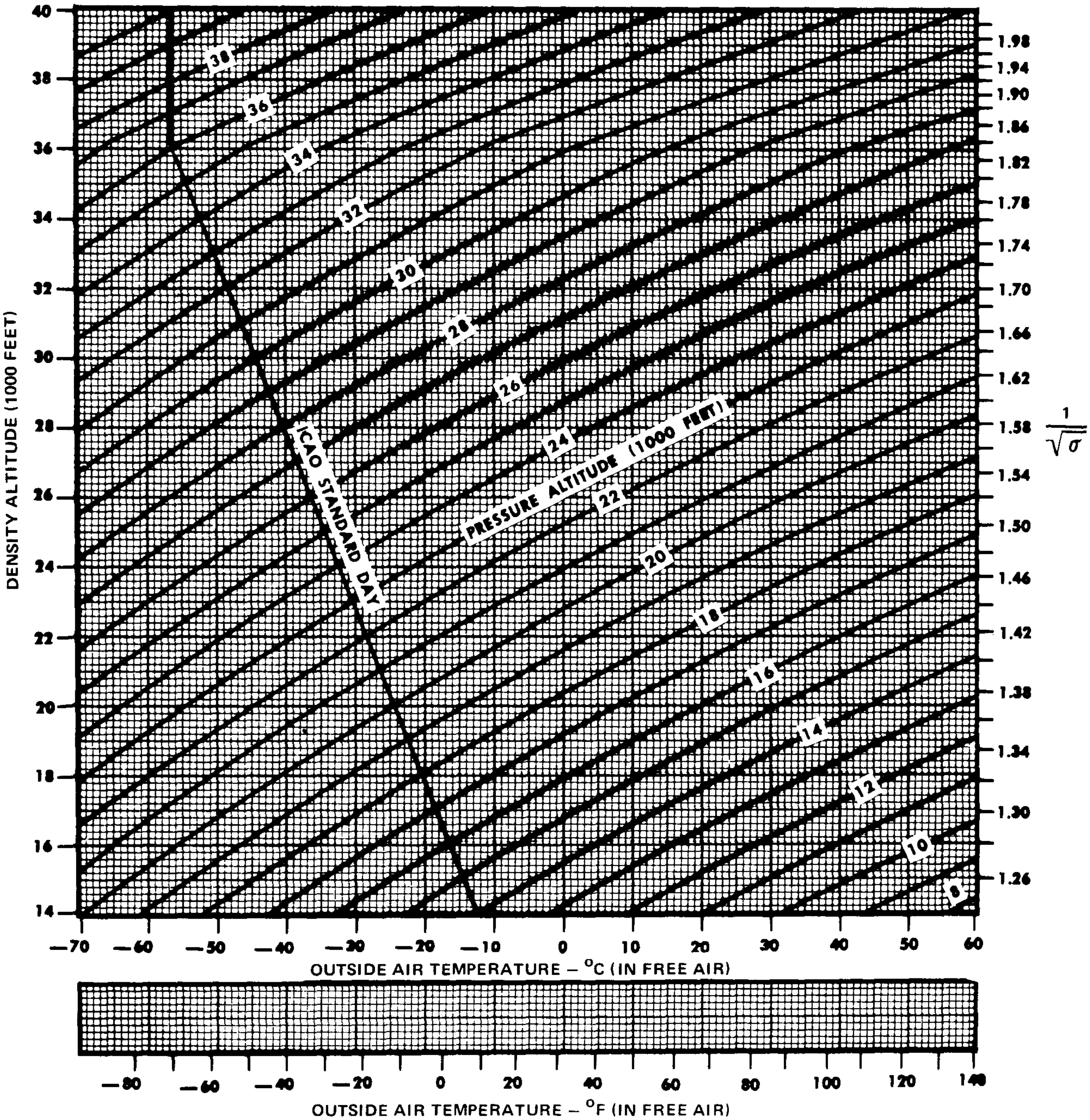


Figure A1-9. Density Altitude Chart (Sheet 2 of 2)

ICAO STANDARD ATMOSPHERE TABLE

STANDARD SEA LEVEL CONDITIONS:

Temperature = 15°C (59°F)
Pressure = 29.921 in. Hg (2116.216 lb/sq. ft.)
Density = .0023769 slugs/cu. ft.
Speed of sound = 1116.89 ft/sec. (661.7 knots)

CONVERSION FACTORS:

1 in. Hg = 70.727 lb/sq. ft.
1 in. Hg = 0.49116 lb/sq. in.
1 Knot = 1.151 mph
1 Knot = 1.688 ft./sec.

Altitude (Feet)	*Density Ratio σ*	$\frac{1}{\sqrt{\sigma}}$	*Temperature* °C	°F	*Speed of Sound (Knots)*	*Pressure (In. Hg)*	*Pressure Ratio δ*
0	1.000	1.0000	15.000	59.000	661.7	29.921	1.0000
1000	.9711	1.0148	13.019	55.434	659.5	28.856	.9644
2000	.9428	1.0299	11.038	51.868	657.2	27.821	.9298
3000	.9151	1.0454	9.056	48.302	654.9	26.817	.8962
4000	.8881	1.0611	7.076	44.735	652.6	25.842	.8637
5000	.8617	1.0773	5.094	41.169	650.3	24.896	.8320
6000	.8359	1.0938	3.113	37.603	648.7	23.978	.8014
7000	.8106	1.1107	1.132	34.037	645.6	23.088	.7716
8000	.7860	1.1279	− 0.850	30.471	643.3	22.225	.7428
9000	.7620	1.1456	− 2.831	26.905	640.9	21.388	.7148
10,000	.7385	1.1637	− 4.812	23.338	638.6	20.577	.6877
11,000	.7155	1.1822	− 6.793	19.772	636.2	19.791	.6614
12,000	.6932	1.2011	− 8.774	16.206	633.9	19.029	.6360
13,000	.6713	1.2205	−10.756	12.640	631.5	18.292	.6113
14,000	.6500	1.2403	−12.737	9.074	629.0	17.577	.5875
15,000	.6292	1.2606	−14.718	5.508	626.6	16.886	.5643
16,000	.6090	1.2815	−16.699	1.941	624.2	16.216	.5420
17,000	.5892	1.3028	−18.680	− 1.625	621.8	15.569	.5203
18,000	.5699	1.3246	−20.662	− 5.191	619.4	14.942	.4994
19,000	.5511	1.3470	−22.643	− 8.757	617.0	14.336	.4791
20,000	.5328	1.3700	−24.624	−12.323	614.6	13.750	.4595
21,000	.5150	1.3935	−26.605	−15.889	612.1	13.184	.4406
22,000	.4976	1.4176	−28.587	−19.456	609.6	12.636	.4223
23,000	.4800	1.4424	−30.568	−23.022	607.1	12.107	.4046
24,000	.4642	1.4678	−32.549	−26.588	604.6	11.597	.3876
25,000	.4481	1.4938	−34.530	−30.154	602.1	11.103	.3711
26,000	.4325	1.5206	−36.511	−33.720	599.6	10.627	.3552
27,000	.4173	1.5480	−38.492	−37.286	597.1	10.168	.3398
28,000	.4025	1.5762	−40.474	−40.852	594.6	9.725	.3250
29,000	.3881	1.6052	−42.455	−44.419	592.1	9.297	.3107
30,000	.3741	1.6349	−44.436	−47.985	589.5	8.885	.2970
31,000	.3605	1.6654	−46.417	−51.551	586.9	8.488	.2837
32,000	.3473	1.6968	−48.398	−55.117	584.4	8.106	.2709
33,000	.3345	1.7291	−50.379	−58.683	581.8	7.737	.2586
34,000	.3220	1.7623	−52.361	−62.249	579.2	7.382	.2467
35,000	.3099	1.7964	−54.342	−65.816	576.6	7.041	.2353
36,000	.2981	1.8315	−56.323	−69.382	574.0	6.712	.2243
36,089	.2971	1.8347	−56.500	−69.700	573.7	6.683	.2234
37,000	.2843	1.8753	−56.500	−69.700	573.7	6.397	.2138
38,000	.2710	1.9209	−56.500	−69.700	573.7	6.097	.2038
39,000	.2583	1.9677	−56.500	−69.700	573.7	5.811	.1942
40,000	.2462	2.0155	−56.500	−69.700	573.7	5.538	.1851
41,000	.2346	2.0645	−56.500	−69.700	573.7	5.278	.1764
42,000	.2236	2.1148	−56.500	−69.700	573.7	5.030	.1681
43,000	.2131	2.1662	−56.500	−69.700	573.7	4.794	.1602
44,000	.2031	2.2189	−56.500	−69.700	573.7	4.569	.1527
45,000	.1936	2.2728	−56.500	−69.700	573.7	4.355	.1455

Figure A1-10. 1CAO Standard Atmosphere Table (Sheet 1 of 2)

ICAO STANDARD ATMOSPHERE TABLE

ALTITUDE IN 100-FOOT INCREMENTS AND $\frac{1}{\sqrt{\sigma}}$

Altitude (Feet)	$\frac{1}{\sqrt{\sigma}}$	*Altitude (Feet)*	$\frac{1}{\sqrt{\sigma}}$	*Altitude (Feet)*	$\frac{1}{\sqrt{\sigma}}$	*Altitude (Feet)*	$\frac{1}{\sqrt{\sigma}}$	*Altitude (Feet)*	$\frac{1}{\sqrt{\sigma}}$
100	1.0015	6100	1.0955	12100	1.2030	18100	1.3269	24100	1.4704
200	1.0029	6200	1.0971	12200	1.2049	18200	1.3291	24200	1.4729
300	1.0044	6300	1.0988	12300	1.2069	18300	1.3313	24300	1.4755
400	1.0059	6400	1.1005	12400	1.2088	18400	1.3335	24400	1.4781
500	1.0074	6500	1.1022	12500	1.2107	18500	1.3358	24500	1.4807
600	1.0088	6600	1.1039	12600	1.2127	18600	1.3380	24600	1.4833
700	1.0103	6700	1.1056	12700	1.2146	18700	1.3403	24700	1.4860
800	1.0118	6800	1.1073	12800	1.2166	18800	1.3425	24800	1.4886
900	1.0133	6900	1.1090	12900	1.2185	18900	1.3448	24900	1.4912
1000	1.0148	7000	1.1107	13000	1.2205	19000	1.3470	25000	1.4938
1100	1.0163	7100	1.1124	13100	1.2224	19100	1.3493	25100	1.4965
1200	1.0178	7200	1.1141	13200	1.2244	19200	1.3516	25200	1.4991
1300	1.0193	7300	1.1158	13300	1.2264	19300	1.3539	25300	1.5018
1400	1.0208	7400	1.1175	13400	1.2284	19400	1.3561	25400	1.5045
1500	1.0223	7500	1.1193	13500	1.2303	19500	1.3584	25500	1.5071
1600	1.0238	7600	1.1210	13600	1.2323	19600	1.3607	25600	1.5098
1700	1.0253	7700	1.1227	13700	1.2343	19700	1.3630	25700	1.5125
1800	1.0269	7800	1.1245	13800	1.2363	19800	1.3653	25800	1.5152
1900	1.0284	7900	1.1262	13900	1.2383	19900	1.3677	25900	1.5179
2000	1.0299	8000	1.1279	14000	1.2403	20000	1.3700	26000	1.5206
2100	1.0314	8100	1.1297	14100	1.2423	20100	1.3723	26100	1.5233
2200	1.0330	8200	1.1314	14200	1.2444	20200	1.3746	26200	1.5260
2300	1.0345	8300	1.1332	14300	1.2464	20300	1.3770	26300	1.5287
2400	1.0360	8400	1.1350	14400	1.2484	20400	1.3793	26400	1.5315
2500	1.0376	8500	1.1367	14500	1.2504	20500	1.3817	26500	1.5342
2600	1.0391	8600	1.1385	14600	1.2525	20600	1.3840	26600	1.5370
2700	1.0407	8700	1.1403	14700	1.2545	20700	1.3864	26700	1.5397
2800	1.0422	8800	1.1420	14800	1.2565	20800	1.3888	26800	1.5425
2900	1.0438	8900	1.1438	14900	1.2586	20900	1.3911	26900	1.5453
3000	1.0454	9000	1.1456	15000	1.2606	21000	1.3935	27000	1.5480
3100	1.0469	9100	1.1474	15100	1.2627	21100	1.3959	27100	1.5508
3200	1.0485	9200	1.1492	15200	1.2648	21200	1.3983	27200	1.5536
3300	1.0501	9300	1.1510	15300	1.2668	21300	1.4007	27300	1.5564
3400	1.0516	9400	1.1528	15400	1.2689	21400	1.4031	27400	1.5592
3500	1.0532	9500	1.1546	15500	1.2710	21500	1.4055	27500	1.5620
3600	1.0548	9600	1.1564	15600	1.2731	21600	1.4079	27600	1.5649
3700	1.0564	9700	1.1582	15700	1.2752	21700	1.4103	27700	1.5677
3800	1.0580	9800	1.1600	15800	1.2773	21800	1.4128	27800	1.5705
3900	1.0595	9900	1.1618	15900	1.2794	21900	1.4152	27900	1.5734
4000	1.0611	10000	1.1637	16000	1.2815	22000	1.4176	28000	1.5762
4100	1.0627	10100	1.1655	16100	1.2836	22100	1.4201	28100	1.5791
4200	1.0643	10200	1.1673	16200	1.2857	22200	1.4225	28200	1.5819
4300	1.0659	10300	1.1692	16300	1.2878	22300	1.4250	28300	1.5848
4400	1.0676	10400	1.1710	16400	1.2899	22400	1.4275	28400	1.5877
4500	1.0692	10500	1.1729	16500	1.2921	22500	1.4299	28500	1.5906
4600	1.0708	10600	1.1747	16600	1.2942	22600	1.4324	28600	1.5935
4700	1.0724	10700	1.1766	16700	1.2963	22700	1.4349	28700	1.5964
4800	1.0740	10800	1.1784	16800	1.2985	22800	1.4374	28800	1.5993
4900	1.0757	10900	1.1803	16900	1.3006	22900	1.4399	28900	1.6022
5000	1.0773	11000	1.1822	17000	1.3028	23000	1.4424	29000	1.6052
5100	1.0789	11100	1.1840	17100	1.3049	23100	1.4449	29100	1.6081
5200	1.0806	11200	1.1859	17200	1.3071	23200	1.4474	29200	1.6110
5300	1.0822	11300	1.1878	17300	1.3093	23300	1.4499	29300	1.6140
5400	1.0838	11400	1.1897	17400	1.3115	23400	1.4525	29400	1.6170
5500	1.0855	11500	1.1916	17500	1.3136	23500	1.4550	29500	1.6199
5600	1.0871	11600	1.1935	17600	1.3158	23600	1.4576	29600	1.6229
5700	1.0888	11700	1.1954	17700	1.3180	23700	1.4601	29700	1.6259
5800	1.0905	11800	1.1973	17800	1.3202	23800	1.4627	29800	1.6289
5900	1.0921	11900	1.1992	17900	1.3224	23900	1.4652	29900	1.6319
6000	1.0938	12000	1.2011	18000	1.3246	24000	1.4678	30000	1.6349

Figure A1-10. 1CAO Standard Atmosphere Table (Sheet 2 of 2)

PSYCHROMETRIC CHART

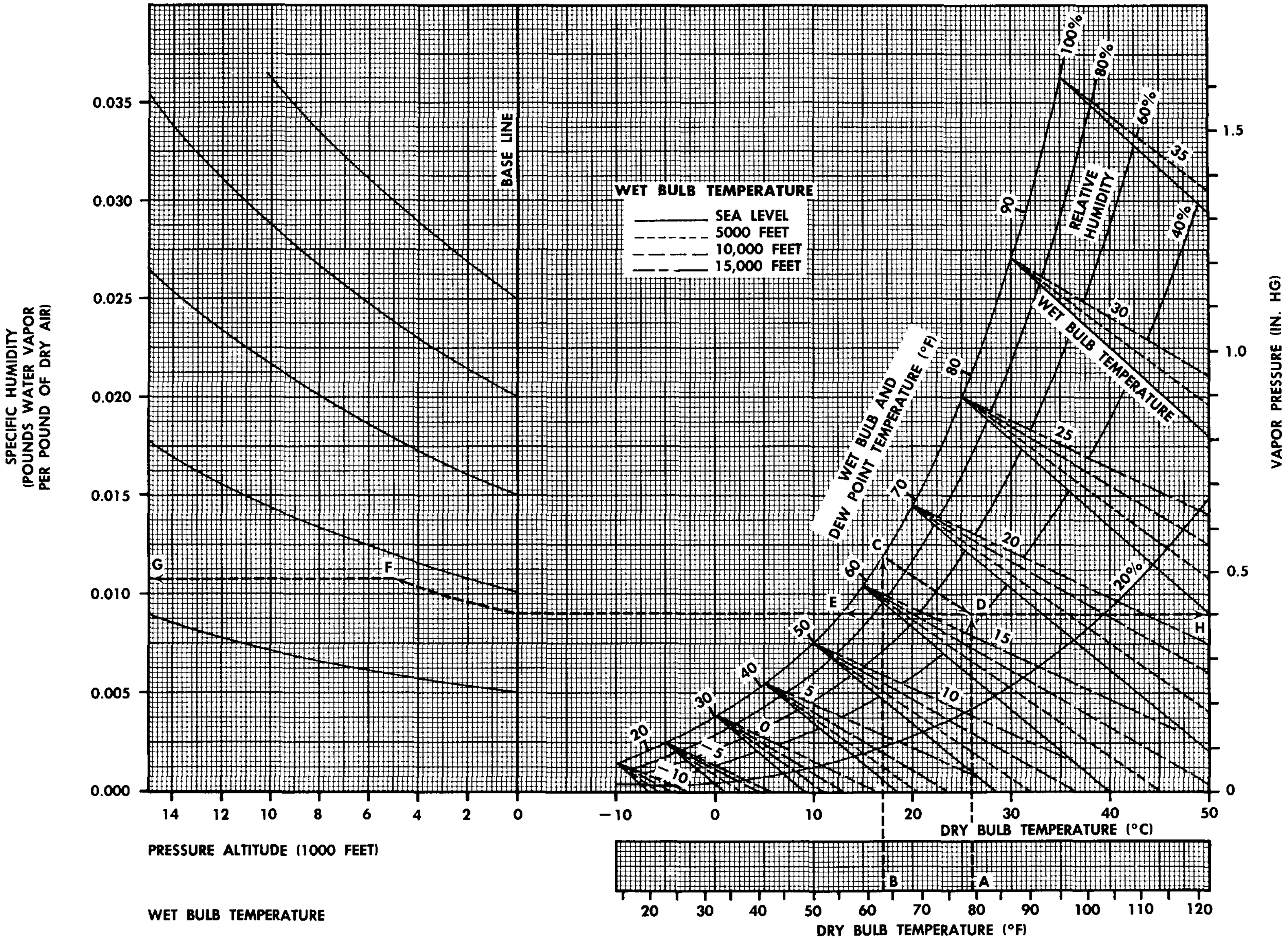


Figure A1-11. Psychrometric Chart

part 2
engine data

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LIST OF ILLUSTRATIONS

INTRODUCTION.

The engine data shown in this part are provided to aid the prediction of takeoff, climb and cruise performance, and to supply the information necessary for maximum and safe utilization of the engine. The individual charts are described in detail below.

The words "wet" or "dry" describing the power used for takeoff refer to whether or not water injection (ADI fluid) is used.

The engine torquemeters are connected to gages, which are calibrated in terms of BMEP (brake mean effective pressure). If the BMEP and RPM are known it is possible to determine the brake horsepower by the following equation:

$$BHP = (BMEP \times RPM)/283$$

THE EFFECT OF TEMPERATURE ON ENGINE POWER.

The effect of temperature on engine power is accounted for by correction grids on many of the charts. If it is desirable to determine this effect for conditions not shown it may be approximated by the following equations:

$$BHP = BHP_{std}\sqrt{T_{std}/T}$$ For part throttle, constant manifold pressure operation,

$$BHP = BHP_{std}\,(T_{std}/T)$$ For full throttle operation,

where T and T_{std} are absolute temperature. Absolute temperature is equal to the temperature in degrees Centigrade plus 273. A 10°C temperature increase above standard results in approximately 1.7 percent power loss for part throttle, constant manifold pressure operation, and approximately 3.5 percent power loss for full throttle operation.

THE EFFECT OF HUMIDITY ON ENGINE POWER.

The effect of humidity on engine power is accounted for by correction grids on the applicable charts.

THE BMEP DROP METHOD OF SETTING CRUISE MIXTURES.

Considerable experience with the R-2800 engines indicate that the most efficient method of setting cruise mixtures is the BMEP drop method. With this method it is possible to operate the engine much closer to the optimum fuel to air ratio than would result from the use of auto-lean. This, in turn, permits more range for a given amount of fuel.

The BHP-RPM Schedules and BHP-MAP Schedules (figures A2-18 through A2-21) and the Power Settings for Cruise Charts (the even numbered figures from A5-36 through A5-58 and A5-61 through A5-63) are based on a given BMEP drop (usually 12 PSI) from best power mixture. Observe either the BMEP or MAP limit, whichever is more limiting.

Upon reaching cruise altitude, climb power should be maintained until the indicated airspeed anticipated for the particular altitude, gross weight and cruise power is reached. This higher airspeed will afford a cushion so that the airspeed dissipation incurred during trim and power adjustments will not result in an airspeed at the start of cruise less than that anticipated for cruise.

From the charts referenced above for the selected brake horsepower, determine the appropriate manifold pressure, RPM, blower ratio, and BMEP drop. Cruise power will then be set in this sequence:

1. Set cruise power.
2. Shift blower, if required.

3. Set cowl flaps to the angle anticipated to yield 190° to 200°C cylinder head temperature when stabilized.

4. Adjust throttle to selected manifold pressure, allowing for any known gage error.

NOTE

For initial cruise setting after climb, maintain climb mixture setting, or auto rich setting, as necessary, for 5 minutes to allow stabilization prior to manual adjustment.

5. Manually lean the mixture for each engine individually as follows:

   a. Determine best power mixture by slowly leaning the mixture while carefully observing the BMEP until maximum BMEP is reached. Since the transport carburetor has been specifically designed to facilitate manual leaning, a rise of BMEP should be noted during the initial leaning process, indicating that the mixture is providing the maximum power output for the MAP and RPM setting used. If the initial rise is not observed, but instead an immediate drop of BMEP is noted, the carburetor is at or slightly on the lean side of best power even though the mixture is in the auto-rich position. If the carburetor is lean, return the mixture control to auto-rich and determine best power by applying intermittent prime and observing the BMEP. If a drop in BMEP is noted when using prime, the mixture is at best power. If a rise in BMEP is noted when using prime, the mixture is leaner than best power. With the use of prime, adjust the mixture control lever to find best power. When best power is found with the use of prime, manually lean to the prescribed BMEP drop. If best power cannot be found with the use of prime, do not lean beyond the auto-lean position.

   b. When the BMEP is stabilized with the mixture at best power setting (maximum BMEP), manually lean the mixture to the prescribed BMEP drop. Check manual lean BMEP drop by intermittent use of prime after each manual leaning. If 12 BMEP rise is not indicated, repeat manual leaning procedure. Since the BMEP drop setting is based on a constant manifold pressure, it is essential that airspeed and altitude be held constant during this step. A change in airspeed at constant throttle affects ram and therefore manifold pressure and BMEP to the extent that an airspeed change of 10 knots can result in as much as a 5 BMEP change. If loss of manifold pressure is experienced due to loss of ram, reset manifold pressure to original value.

6. Readjust cowl flaps to provide the desired CHT, 190° to 200°C. When stabilized, cross check engine RPM. With equal manifold pressure, RPM, carburetor air and cylinder head temperatures, equal engine airflow is normally obtained. With identical BMEP drop settings, fuel/air ratio and therefore fuel flows will also be equal, regardless of the condition of the ignition system. Any difference in fuel flow under these conditions must be due to instrument inaccuracy, either flowmeter or manifold pressure, or to a mechanical malfunction, such as a stuck valve or broken pushrod, which affects mixture flow. BMEP differences will be due entirely to unequal accessory loads, instrument inaccuracy and/or mechanical discrepancies.

7. Once cruise power has been set and stabilized, the maximum difference in indicated BMEP, including that due to unequal accessory loading, should not exceed 8 BMEP. If a greater discrepancy is noted, it should be recorded in the log with as complete a description as possible to assist in troubleshooting.

Mixtures adjusted in this manner should remain substantially the same regardless of small throttle adjustments necessary to counteract small changes in airspeed, altitude, and/or CAT. Mixtures, however, should be periodically checked during cruise and adjusted as required. Power should be reset after appreciable change in CAT or altitude. If power change is excess of 50 BHP from original power setting, reset mixtures as outlined in step 5. Mixture strength or BMEP drop can be quickly checked by applying prime in varying amounts to determine best power or peak BMEP.

This procedure affords the simplest and quickest adjustment to cruise power since it involves the fewest control movements. Another advantage is that by setting equal airflow (RPM, MAP, CAT and CHT) and fuel/air ratio (BMEP drop) on all engines, any discrepancies are in greater evidence and in flight troubleshooting is facilitated.

SETTING MANUAL RICH MIXTURES.

When operating in the power ranges where the cruise performance charts require manual rich mixture settings, set the cruise mixture as follows:

NOTE

Maximum BMEP for manual rich mixture setting will not exceed 207 BMEP at 2600 RPM.

1. From the appropriate charts (figure A5-61, A5-62, or A5-63) determine manifold pressure, rpm, and blower ratio for the selected power.

2. Set RPM, blower ratio (if required), cowl flaps, and manifold pressure as outlined in steps 1 through 4 for manual lead adjustment.

NOTE

For initial cruise setting after climb maintain rich mixture setting for 5 minutes to allow stabilization prior to manual adjustment.

3. Determine the desired fuel flow from the Minimum Fuel Flow chart (figure A2-15).

4. If fuel flows exceeds chart values, manually lean the mixture to charted fuel flow.

5. Readjust cowl flaps to provide the desired CHT, 190° to 200°C. When stabilized, cross check engine instruments (step 6, manual lead adjustments).

6. Check mixture periodically during cruise and adjust as required, particularly after appreciable changes in CAT, power or altitude.

DISCUSSION OF CHARTS.

ENGINE OPERATING LIMITS CHART.

A chart has been included (figure A2-1) tabulating the engine operating limits for maximum, METO, and maximum cruise powers. These limits have been established by the engine manufacturer to permit maximum utilization of the engine consistent with a reasonable long engine life. If any of these limits are exceeded, excessive engine wear, and even engine failure, may result.

It will be noted that for several power conditions both a MAP limit and a BMEP limit are shown. In these cases observe whichever limit is reached first. On cold days the BMEP limit will be most restrictive, while on warm days the MAP limit will be most restrictive.

For maximum cruise powers there are no MAP limits as such; however, the Power Setting for Cruise charts in Part 5 or the BHP-RPM Schedules and BHP-MAP Schedules (figures A2-18 through A2-21) list the RPM and MAP required to develop a given brake horsepower at a given altitude and temperature. Each MAP listed is to be considered as the MAP limit for that particular set of conditions.

To partially offset the loss of power due to humidity, the MAP limits for the takeoff powers may be increased by the existing water vapor pressure up to a maximum of 1. 5 inches Hg.

BRAKE HORSEPOWER AVAILABLE FOR TAKEOFF CHARTS.

Charts are provided showing the power available for takeoff in low blower with standard fuel grade, wet (figure A2-2), standard fuel grade, dry (figure A2-3), alternate fuel grade, wet (figure A2-4), and alternate fuel grade, dry (figure A2-5); and in high blower with standard grade fuel, wet (figure A2-6), and standard fuel grade, dry (figure A2-7). The powers determined from these charts are used to determine takeoff performance in Part 3. Results may be read in the form of predicted brake horsepower, predicted BMEP (corresponding to the predicted brake horsepower) or 95 percent of predicted BMEP. For takeoff planning, 95 percent of predicted BMEP will be used to determine takeoff performance.

The high blower charts (figure A2-6 and A2-7) are included for use at high altitudes where maximum power available in low blower is less than that obtainable in high blower at 2600 RPM. A curve is included on the chart to indicate the altitude and CAT where high blower maximum power is equal to low blower maximum power. Reference to this line eliminates the necessity for checking both the high blower and low blower charts to determine the maximum power available for the given conditions, however, under conditions where power available in high blower is equal to or slightly less than that obtained in low blower, the low blower charts should be checked, and the use of high or low blower determined by power required for takeoff and climbout, low blower critical altitude, obstacle clearance, etc. A conversion scale is included on the charts to convert high blower BMEP to an equivalent low blower BMEP for use in computing takeoff and climb performance.

These charts allow corrections to be made for altitude, carburetor air temperature and humidity. Because the carburetor air temperature is seldom known at the time these charts are used, assume that it is 5 degrees Centigrade above the outside air temperature. To prevent overboosting the engines when the carburetor air temperature is below standard, a correction scale, showing the amount by which the MAP limit should be reduced, is included on the applicable charts.

In allowing for the effect of humidity one scale corrects the power downward for the effect of humidity alone. Another scale corrects the power upwards to account for the allowable increase in MAP equal to the existing water vapor pressure up to 1. 5 inches Hg. This later correction may only be made when the combination of pressure altitude and carburetor air temperature indicate that takeoff power may be developed with less than full throttle setting.

For takeoff ground run, with full throttle operation, the chart values for BMEP are based on ram available at approximately 70 KIAS. At the start of the ground run, with no ram air, manifold pressures approximately 1 in. Hg below charted values may be expected. In part throttle operation, when manifold pressures are set at the start of ground run, an overboost of approximately 1 in. Hg MAP may be expected at climbout speeds unless the throttles are adjusted during the ground run.

When planning a takeoff with ADI inoperative on one or more engines, determine the reject BMEP of 95 percent BMEP for both wet and dry power for the given conditions. Compute BMEP for determining takeoff factor, gross weight limited by three-engine climb performance, and emergency climb performance as follows: With ADI inoperative on one engine, take the average of the BMEP for two wet and one dry engine; for example, for given conditions producing a wet BMEP of 240, the dry BMEP will be 211, the average will be (240 + 240 + 211) ÷ 3 = 230 BMEP. Use 230 BMEP for computing performance from the charts. This method allows sufficient margin of safety in the event that engine failure occurs on an engine with ADI operating, leaving only two wet engines. To compute the average BMEP with ADI inoperative on two engines, take the average of one wet and two dry engines. If ADI is inoperative on three engines, compute performance for dry power on all engines.

Equivalent BMEP

The BMEP values used on the Takeoff Factor, Takeoff Gross Weight Limited By Three-Engine Climb Performance, and the Emergency Climb charts are based on operation in low blower at 2800 RPM. To compute takeoff or climb data for high blower operation at 2600 RPM, the BMEP obtained in high blower must be converted to an equivalent BMEP before entering the charts. The Brake Horsepower Available For Takeoff charts for high blower operation include a conversion scale for converting high blower BMEP to Equivalent BMEP. Equivalent BMEP may also be obtained by applying the following formula: Equivalent BMEP = High Blower BMEP x 0.93. In cases where equivalent BMEP for high blower operation is not equal to the BMEP obtainable in low blower, the decision to use high blower should be based on power requirements, such as reaching low blower critical altitude immediately after takeoff, clearance of obstructions, etc.

A sample problem has been included on each of the low blower charts illustrating a range of operating conditions. The high blower charts are worked in the same manner, except that an additional scale is used to show equivalent BMEP.

ENGINE CALIBRATION—LOW BLOWER—BRAKE HORSEPOWER VS MANIFOLD PRESSURE CHART.

This chart (figure A2-10) shows the relationship between brake horsepower, manifold pressure and RPM at sea level on a standard day. From this chart it may easily be determined how a given change in manifold pressure or RPM will affect brake horsepower. Although the actual values on the chart apply only to sea level, standard day, the relative picture remains approximately the same at higher altitudes and other atmospheric conditions. For example, the chart shows that for a given manifold pressure, decreasing the RPM from 1500 to 1400 decreases the power output by 60 brake horsepower. This approximate loss in power will occur regardless of altitude or temperature.

This chart may also be used with the Brake Horsepower vs Altitude chart to determine the engine settings required to develop a given power at higher altitudes (see text under Engine Calibration – Low Blower, Brake Horsepower vs Altitude Chart).

ENGINE CALIBRATION—LOW BLOWER—BRAKE HORSEPOWER VS ALTITUDE CHART.

This chart (figure A2-11) shows the relationship between brake horsepower, RPM, and altitude for low blower operation with standard atmospheric conditions. Each curve is for a single RPM and shows how engine power decreases with increasing altitude when operating at full throttle. The curves for takeoff RPM wet and dry, and for METO RPM are for auto-rich operation. The curves for 1400 RPM to 2300 RPM are for manual lean operation.

A line labeled "Limited by Maximum Recommended Cruise BMEP" has been drawn across the manual lean curves to show the maximum power which may be developed at any given RPM during normal cruise operation. The same line also shows the maximum altitude at which that power may be obtained with that RPM (in low blower). For example, the chart shows that the maximum cruise power for 2000 RPM is 1100 brake horsepower. Furthermore, the maximum altitude at which 1100 brake horsepower may be obtained with 2000 RPM is 12,800 feet. At lower altitudes 1100 brake horsepower may be obtained by using 2000 RPM and varying degrees of throttle. To obtain 1100 brake horsepower at altitudes above 12,800 feet it is necessary to increase the RPM. Once 2300 RPM has been reached, with full throttle, it will be necessary to use high blower to gain more altitude.

The manifold pressures shown on the chart are for full throttle only (with the exception of the values indicated on the takeoff and METO RPM part-throttle lines). However, manifold pressures for part throttle operation may be determined by use of the guide lines as illustrated in the following example.

SAMPLE PROBLEM:

GIVEN: Cruise altitude = 10,000 feet.
Cruise power = 1040 brake horsepower per engine.

FIND: RPM and manifold pressure.

1. Enter BHP scale at selected power, 1040 RPM (Point A).
2. Enter pressure altitude scale at cruise altitude, 10,000 feet (Point B).
3. Locate BHP - altitude point (Point C).
4. Find intersection of 1040 BHP and the line limited by maximum recommended cruise BMEP. This determines the minimum RPM at which 1040 BHP may be obtained for cruise operation, 1900 rpm.
5. Extend a line parallel to the guide lines from point C to the 1900 RPM line. Read the MAP required to develop 1040 BHP at 10,000 FEET with 1900 RPM, 30.8 inches Hg.
6. As an alternate method to step 5, extend a line parallel to the guide lines from point C to the left hand scale (point F). Read the power, 900 BHP, with which to enter the BHP vs MAP chart (figure A2-10) for determining the required MAP.

ENGINE CALIBRATION — HIGH BLOWER — BRAKE HORSEPOWER VS MANIFOLD PRESSURE CHART.

This chart (figure A2-12) is similar to the low blower brake horsepower vs manifold pressure chart described above. It differs in that it is based on high blower operation at an altitude of 10,000 feet. It is used in the same manner as described for the low blower chart.

ENGINE CALIBRATION — HIGH BLOWER — BRAKE HORSEPOWER VS ALTITUDE CHART.

This chart (figure A2-13) shows data for high blower operation corresponding to the low blower brake horsepower vs altitude chart described above. It differs in that there are no takeoff RPM's shown, and the chart starts at 10,000 feet (to correspond to the facing high blower brake horsepower vs manifold pressure chart) rather than sea level. In other respects the chart may be used in the same manner as described for the low blower chart.

ENGINE CALIBRATION — ALTERNATE FUEL GRADE CHART.

This chart (figure A2-14) shows the brake horsepower vs altitude calibration for takeoff RPM, wet and dry, in low blower and for METO RPM in both low blower and high blower with alternate fuel grade. For cruise power calibrations the auto-lean curves on figures A2-10 through A2-13 may be used; however, never exceed the power limited by maximum recommended cruise BMEP for any given RPM.

MINIMUM FUEL FLOW CHART — AUTO RICH OPERATION.

The Minimum Fuel Flow chart (figure A2-15) shows the expected fuel flow for auto rich operation in both low blower ratio and high blower ratio. If fuel flows substantially exceed those shown on the chart a loss in power may result. In such a case it is permissible to manually lean the mixture to the fuel flow determined from the chart. In no case should the mixture be leaned to less than the chart fuel flows.

It is important that fuel flow be monitored to ascertain that it is within prescribed limits. The minimum fuel flow limit is not an engine limit at normal climb power or auto rich cruise powers. It is, however, a carburetor limit designed to obviate damage which might otherwise result at higher power, where margin between a safe fuel flow and engine detonation is diminishing. At these powers, therefore, it is considered safe to continue operation when the fuel flow is at or 50 pounds per hour below the minimum fuel flow shown on figure A2-15, providing CHT and CAT. limits are observed. If the fuel flow falls more more than 50 pounds per hour below published minimum, power should be reduced by increments of 100 BHP until the fuel flow is not more than 50 pounds per hour below the limit for that particular reduced power. CHT and CAT. limits must still be monitored. For a carburetor whose fuel flow is below published minimums, a complete writeup should be made in the log and corrective maintenance accomplished at the next landing.

The chase-around lines on the chart illustrate the example.

SAMPLE PROBLEM:

GIVEN: Engine power = 1300 BHP.
RPM = 2300.

FIND: Minimum fuel flow (low blower).

1. Enter the brake horsepower scale at 1300 BHP (A) and proceed vertically upwards.
2. Enter the left-hand scale at 2250 RPM (B) and continue to the right to 1300 BHP.
3. At the intersection of 2250 RPM and 1300 BHP (C) read the minimum fuel flow per engine, 800 pounds per hour.

ESTIMATED FUEL CONSUMPTION FOR CRUISE POWERS CHARTS.

These two charts show the estimated fuel flows for cruise operation in low blower (figure A2-16) and high blower (figure A2-17) when using the BMEP drop method of cruise control. The charts are based on best economy mixture setting; however, an auxiliary graph is included so that the fuel flow may be determined when operating at any given BMEP drop from best power mixture setting.

SAMPLE PROBLEM:

GIVEN: Engine power = 1150 BHP.
RPM = 2200.
BMEP Drop = 12.
Blower Range = Low blower.

FIND: Estimated fuel consumption.

1. Enter the chart (figure A2-16) at 1150 BHP (A).
2. Read vertically to the 2200 RPM curve (B).
3. Read across to find fuel flow of 520 pounds per hour per engine (C).
4. To find fuel flow increment for BMEP drop, enter the auxiliary graph at 12 BMEP (D) and read up to 2200 RPM (E).
5. Read across to find fuel flow increment of 2 pounds per hour (F).
6. Fuel flow for each engine is 520 + 2 = 522 pounds per hour per engine. Total fuel flow for all four engines is 522 x 4 = 2088 pounds per hour.

BHP-RPM SCHEDULE CHARTS.

These two charts show the RPM necessary to develop a given brake horsepower when cruising either in low blower (figure A2-18) or high blower (figure A2-20). The charts are based on operating at 12 BMEP drop from best power mixture. Corrections are provided for carburetor air temperature and pressure altitude.

Within a certain range of conditions part throttle operation is indicated on each chart. In such cases the manifold pressure required to develop the given brake horsepower may be determined from the facing BHP-MAP Schedule chart. When full throttle operation is indicated it is not necessary to know the manifold pressure. Correction for ram effect of 180 KCAS is included in the chart.

It may also be noted that carburetor air temperature only affects RPM when operating at full throttle. For example, figure A2-18 shows that at 6000 feet pressure altitude the RPM required to develop 1000 BHP is 1855 for any carburetor air temperature from 20°C to -60°C. This is because part throttle operation is indicated. However, at 14, 000 feet pressure altitude any change in carburetor air temperature affects the RPM required to developed 1000 BHP because, for these conditions, full throttle operation is required. The chart shows that an increase in carburetor air temperature increases the RPM required.

SAMPLE PROBLEM:

GIVEN: Carburetor air temperature = -10°C.
Blower operation = Low blower.
Pressure altitude = 10, 000 feet.
Desired power = 1050 BHP.

FIND: RPM required to produce 1050 BHP.

1. Enter the low blower chart (figure A2-18) at carburetor air temperature of -10°C (A) and read across to pressure altitude of 10, 000 feet (B).
2. Read up to desired power of 1050 BHP (C).
3. Read across to find required RPM of 1945 (D). Since power setting is in the part throttle range at this altitude, the manifold pressure for this power setting must be obtained from the BHP-MAP Schedule chart (figure A2-19).

BHP-MAP SCHEDULE CHARTS.

These two charts show the manifold pressure required to develop a given brake horsepower when cruising in either low blower (figure A2-19) or high blower (figure A2-21). They are to be used with the RPM's determined from the facing BHP-RPM Schedule charts, and are based on 12 BMEP drop from best power mixture. The corrections shown for carburetor air temperature are applicable only for part throttle operation. Although manifold pressures are also shown for full throttle operation they are approximately correct only for standard atmospheric conditions and are not required for setting up engine powers.

Sample problems are included on both charts to illustrate the method of computing for temperatures below standard (figure A2-19) and for temperatures above standard (figure A2-21).

OPERATING LIMITS—NORMAL FUEL GRADE.

The normal operating limits on grade 115/145 fuel are as follows:

Condition	RPM	BHP	MAX MAP. (In. Hg)	(1) Critical Altitude	BMEP	MAX CHT.	MAX CAT.	Mixture
Maximum Wet Low Blower (5 Minutes	2800 (±25)	2500	62.0 at SL (9) 61.5 at 3800 feet	2600 feet (MAP-61.0)	253	260°C	38°C (10)	AUTO RICH
Maximum Wet High Blower (5 Minutes)	2600	1900	49.0 (9) 50.5 at 10,000 feet	15,700 feet	207	260°C	15°C	AUTO RICH
Maximum Dry Low Blower (5 Minutes)	2800 (±25)	2300	63.0 at SL (9) 62.5 at 3300 feet	3300 feet (MAP-62.5)	232	260°C	38°C (10)	AUTO RICH
Maximum Dry High Blower (5 Minutes)	2600	1750	49.5 51.5 at 10,000 feet	15,000 feet	191	260°C	15°C	AUTO RICH
METO Low Blower	2600	1900	51.5 at SL 50.0 at 7200 feet	7200 feet (MAP-48.0)	207	232°C (2)	38°C (10)	AUTO RICH (3)
METO High Blower	2600	1700	50.0 at 10,000 feet 47.5 at 15,900 feet	15,400 feet (MAP-46.7)	185	232°C (2)	15°C	AUTO RICH (3)
Maximum Cruise Low Blower	2300	1240	37.3 at SL 33.3 at 14,000 feet	(4)	153 (5)	204°C (8)	38°C (10)	12 BMEP Drop (7)
Maximum Cruise High Blower	2300	1200	35.1 at 10,000 feet 34.6 at 18,800 feet	(4)	147 (6)	204°C (8)	15°C (11)	12 BMEP Drop (7)

(1) Critical altitude in climb as determined by flight test.

(2) 260°C allowed for 30 minutes.

(3) Fuel flows may be leaned to minimum values shown in Appendix.

(4) Function of gross weight.

(5) Maximum cruise low blower -- 155 BMEP (except when at 1240 BHP and 2300 rpm -- 153 BMEP).

(6) Maximum cruise high blower -- 150 BMEP (except when at 1200 BHP and 2300 rpm -- 147 BMEP).

(7) With reference to "Best Power" mixtures.

(8) 232°C Maximum CHT for continuous operation.

NOTE

204°C is the desired maximum CHT for continuous operation.

(9) Maximum MAP for takeoff may be increased by existing vapor pressure up to 1.5 In. Hg (refer to Part 2 Appendix).

(10) +38°C maximum allowable CAT with preheat applied.

(11) Maximum cruise high blower CAT may be 30°C under certain condition, see CARBURETOR AIR TEMPERATURE, Part 5.

Figure A2-1. Operating Limits - Normal Fuel Grade (Sheet 1 of 2)

OPERATING LIMITS—ALTERNATE FUEL GRADE.

The operating limits on grade 100/130 fuel are as follows:

Condition	RPM	BPH	MAX MAP. (In. Hg)	(1) Critical Altitude	BMEP	MAX CHT.	MAX CAT.	Mixture
Maximum Wet Low Blower (5 Minutes)	2800 (±25)	2400	59.5 at SL (9) 59.0 at 5000 feet	3500 feet (MAP-59.0)	242	260°C	38°C (10)	AUTO RICH
Maximum Wet High Blower (5 Minutes)	2600	1850	48.0 (9) 49.5 at 10,000 feet	16,500 feet	201	260°C	15°C	AUTO RICH
Maximum Dry Low Blower (5 Minutes)	2800 (±25)	1950	53.0 at SL (9) 51.0 at 9800 feet	8200 feet (MAP-50.1)	197	260°C	38°C (10)	AUTO RICH
Maximum Dry High Blower (5 Minutes)	2600	1700	47.5 49.0 at 10,000 feet	16,250 feet	185	260°C	15°C	AUTO RICH
METO Low Blower	2600	1800	48.5 at SL 26.5 at 9200 feet	8700 feet (MAP-45.2)	196	232°C (2)	38°C (10)	AUTO RICH (3)
METO High Blower	2600	1700	49.0 at 10,000 feet 47.5 at 16,250 feet	15,400 feet (MAP-46.7)	185	232°C (2)	15°C	AUTO RICH (3)
Maximum Cruise Low Blower	2300	1240	37.3 at SL 33.3 at 14,000 feet	(4)	153 (5)	204°C (8)	38°C (10)	12 BMEP Drop (7)
Maximum Cruise High Blower	2300	1200	35.1 at 10,000 feet 34.6 at 18,800 feet	(4)	147 (6)	204°C (8)	15°C (11)	12 BMEP Drop (7)

(1) Critical altitude in climb as determined by flight test.

(2) 260°C allowed for 30 minutes.

(3) Fuel flows may be leaned to minimum values shown in Appendix.

(4) Function of gross weight.

(5) Maximum cruise low blower -- 155 BMEP (except when at 1240 BHP and 2300 rpm -- 153 BMEP).

(6) Maximum cruise high blower -- 150 BMEP (except when at 1200 BHP and 2300 rpm -- 147 BMEP).

(7) With reference to "Best Power" mixtures.

(8) 232°C Maximum CHT for continuous operation.

NOTE

204°C is the desired maximum CHT for continuous operation.

(9) Maximum MAP for takeoff may be increased by existing vapor pressure up to 1.5 In. Hg (refer to Part 2 Appendix).

(10) +38°C maximum allowable CAT with preheat applied.

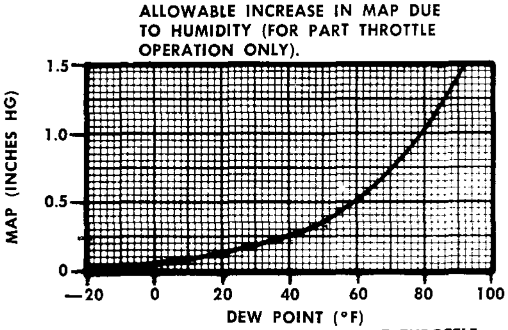
(11) Maximum cruise high blower CAT may be 30°C under certain conditions, see CARBURETOR AIR TEMPERATURE, Part 5.

Figure A2-1. Operating Limits - Alternate Fuel Grade (Sheet 2 of 2)

BRAKE HORSEPOWER AVAILABLE FOR TAKEOFF— STANDARD FUEL GRADE – WET LOW BLOWER, 2800 RPM

MODEL: C-118A
DATA AS OF: 10-15-64
DATA BASIS: FLIGHT TEST

ENGINES: (4) R2800-52W
FUEL GRADE: 115/145



NOTES:

1. **Assume that the carburetor air temperature (CAT) is 5°C above the outside air temperature (OAT).**

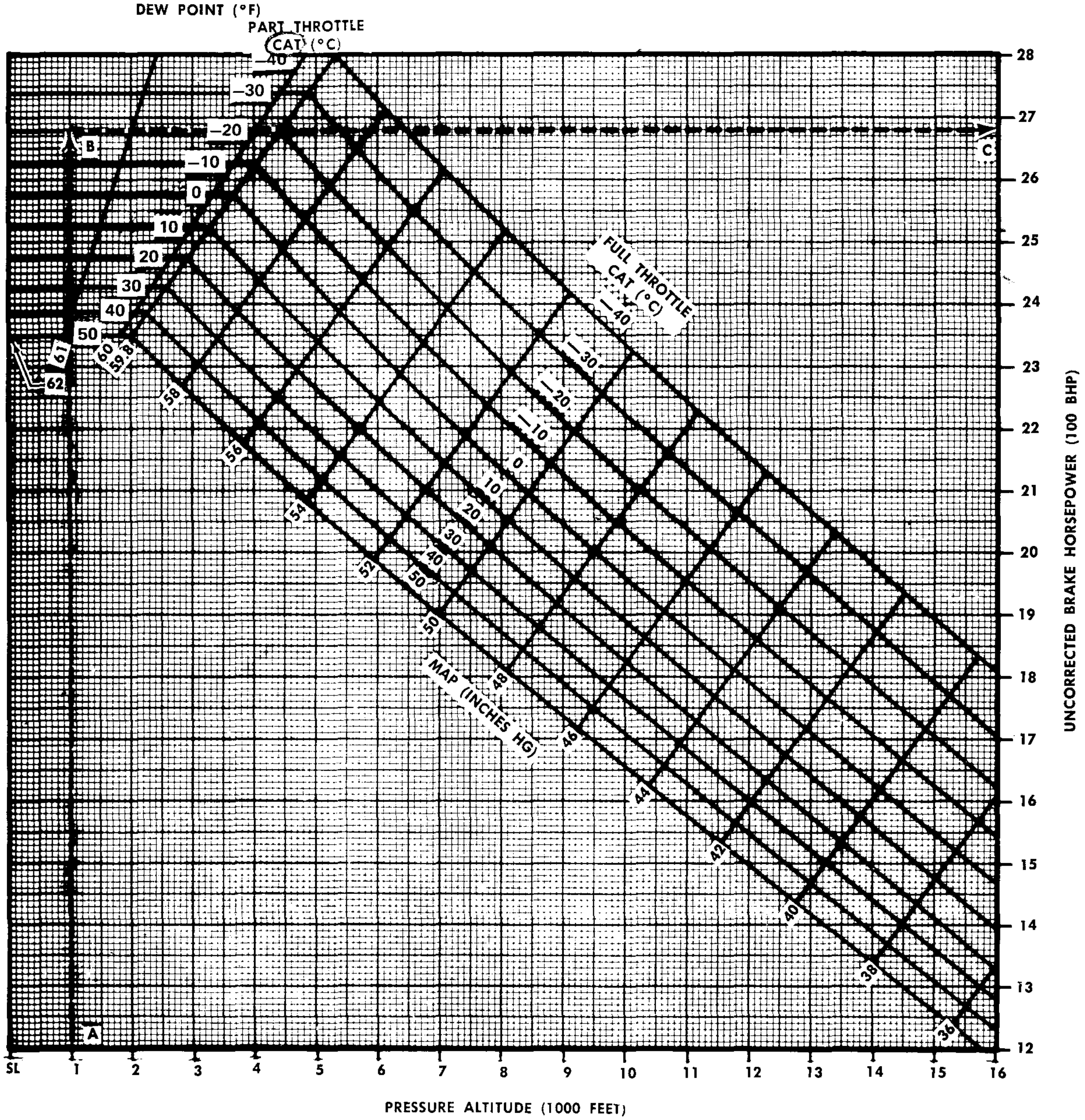


Figure A2-2. Brake Horsepower Available for Takeoff - Standard Fuel Grade - Wet - Low Blower, 2800 Rpm (Sheet 1 of 2)

MODEL: C-118A
DATA AS OF: 10-15-64
DATA BASIS: FLIGHT TEST

BRAKE HORSEPOWER AVAILABLE FOR TAKEOFF–STANDARD FUEL GRADE – WET LOW BLOWER, 2800 RPM

ENGINES: (4) R2800-52W
FUEL GRADE: 115/145

SAMPLE PROBLEM:

A. Pressure altitude = 1000 feet.
B. CAT = –20°C (5° above OAT of –25°C).
C. Uncorrected brake horsepower = 2680.
D. No correction for humidity because dew point is –20°C.
E. Predicted power per engine = 2500 BHP.
F. Map reduction for low CAT = 3.6 inch. Hg. (MAP for takeoff = 61.5 inch. Hg –3.6 inch. Hg, or 57.9 inch. Hg).
G. Predicted BMEP = 253 PSI.
H. 95 percent predicted BMEP = 240 PSI.

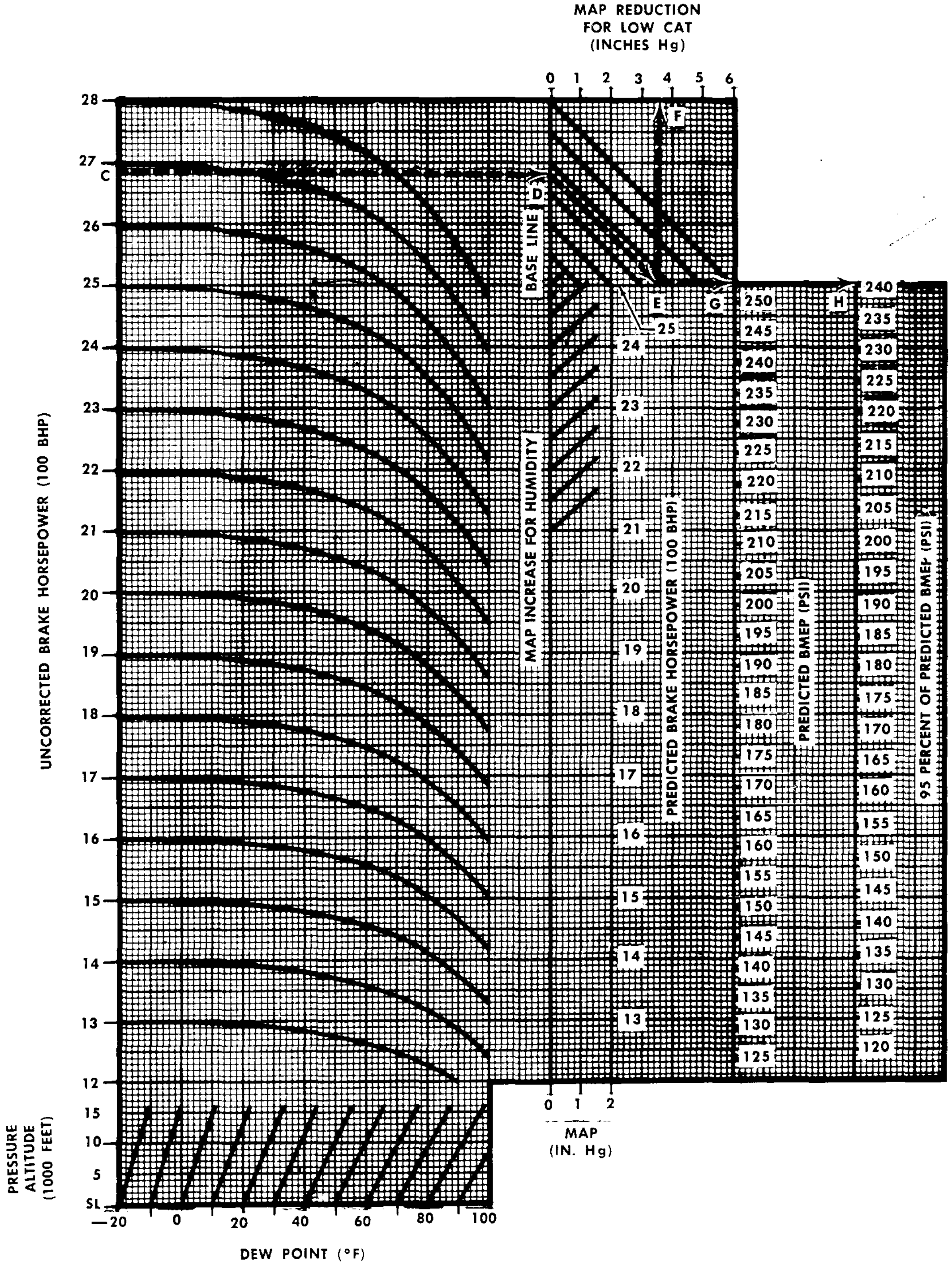
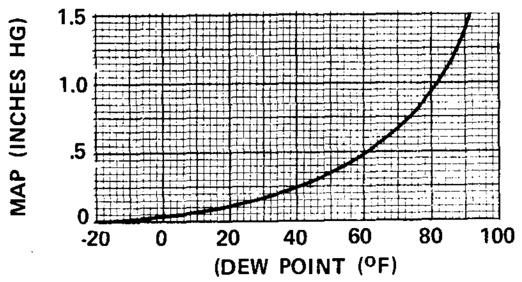


Figure A2-2. Brake Horsepower Available for Takeoff - Standard Fuel Grade - Wet - Low Blower, 2800 Rpm (Sheet 2 of 2)

BRAKE HORSEPOWER AVAILABLE FOR TAKEOFF STANDARD FUEL GRADE – DRY LOW BLOWER, 2800 RPM

ALLOWABLE INCREASE IN MAP TO HUMIDITY (FOR PART THROTTLE OPERATION ONLY)



NOTE

1. CAT EQUALS OAT +5°C

MODEL: C118A
DATA AS OF: 11-27-67
DATA BASIS: P&W OI 115 22 DEC 65
ENGINES: (4) R2800-52W
FUEL GRADE: 115/145

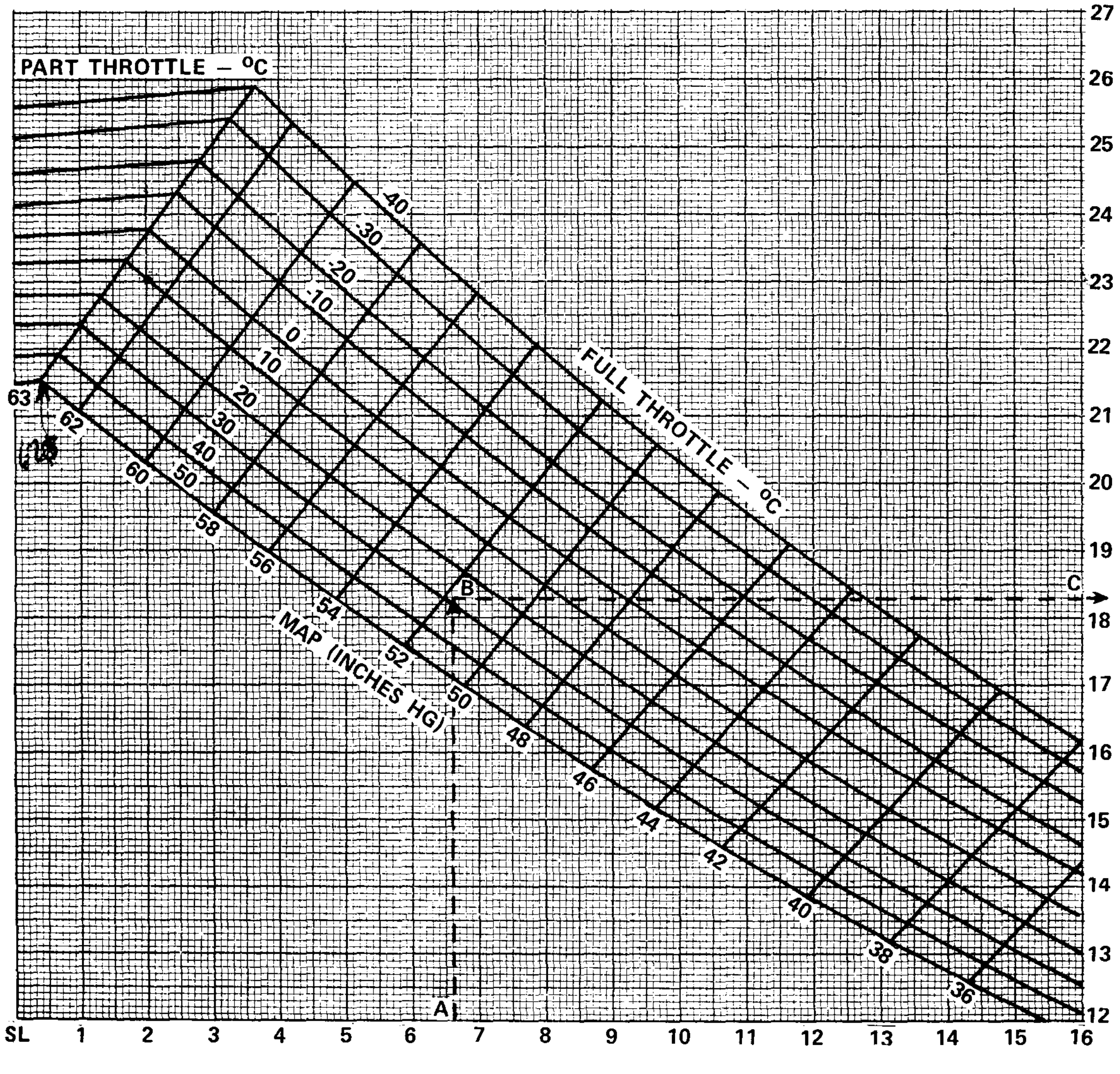


Figure A2-3. Brake Horsepower Available for Takeoff - Standard Fuel Grade - Dry - Low Blower, 2800 Rpm (Sheet 1 of 2)

MODEL: C118A
DATA AS OF: 27-11-67
DATA BASIS: P&W OI 115

BRAKE HORSEPOWER AVAILABLE FOR TAKEOFF
STANDARD FUEL GRADE – DRY
LOW BLOWER 2800 RPM

ENGINES: (4) R2800-52W
FUEL GRADE: 115/145

SAMPLE PROBLEM:

A. Pressure Altitude = 6600 Feet
B. CAT = 30°C MAP = 51.6 Inches HG
C. Uncorrected Brake Horsepower = 1830 BHP
D. Dew Point = 54°F
E. Pressure Altitude = 6600 Feet
F. Power Corrected for Humidity
G. No Increase in MAP for Humidity Because Full Throttle Operation is Required (Point B)
H. Predicted Power for Engine = 1762 BHP
I. Predicted BMEP = 178.1 PSI
J. 95 Percent of Predicted BMEP = 169.2 PSI

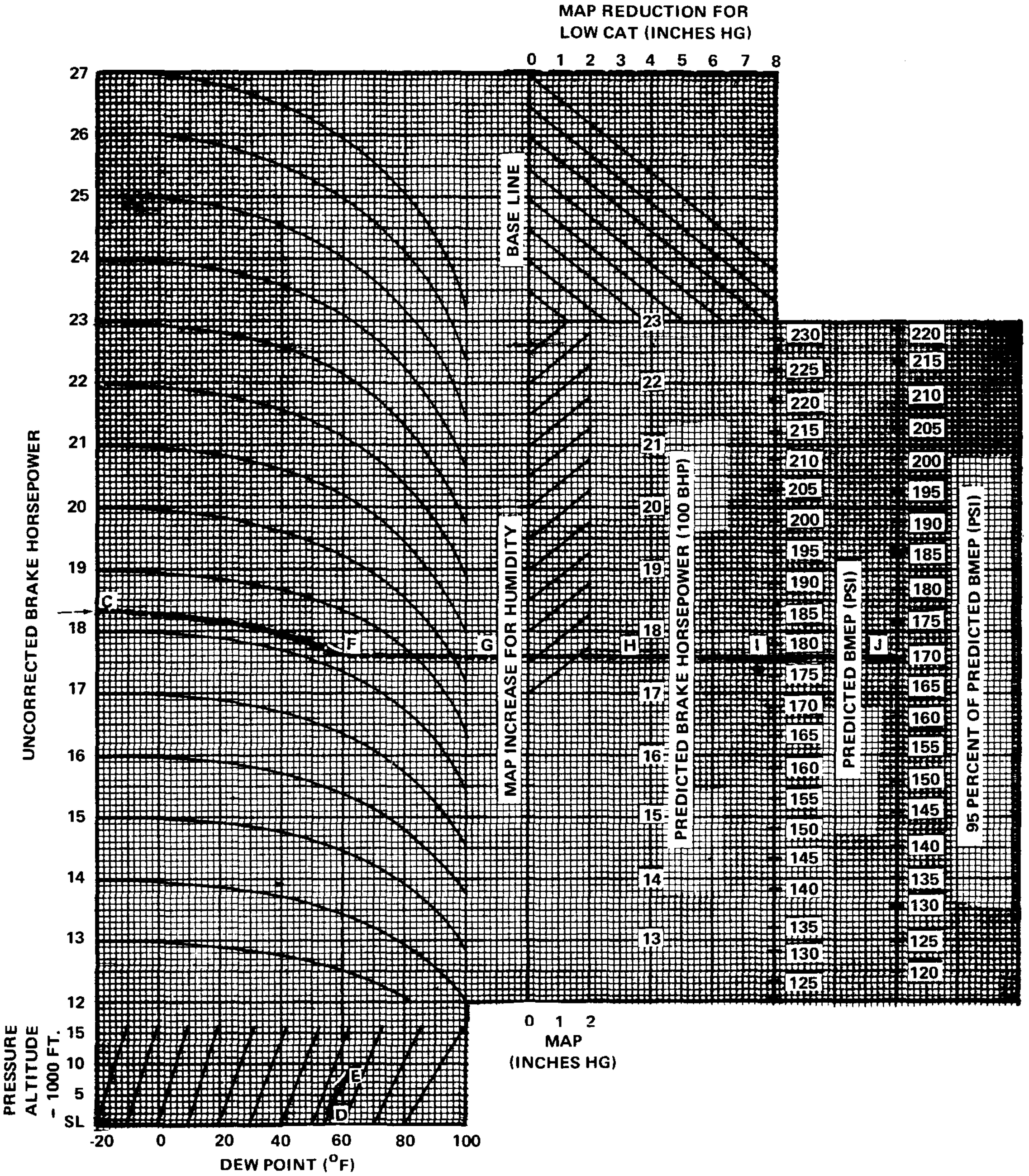
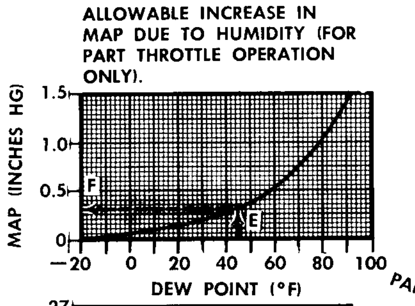


Figure A2-3. Brake Horsepower Available for Takeoff - Standard Fuel Grade - Dry - Low Blower, 2800 Rpm (Sheet 2 of 2)

BRAKE HORSEPOWER AVAILABLE FOR TAKEOFF – ALTERNATE FUEL GRADE – WET
LOW BLOWER, 2800 RPM

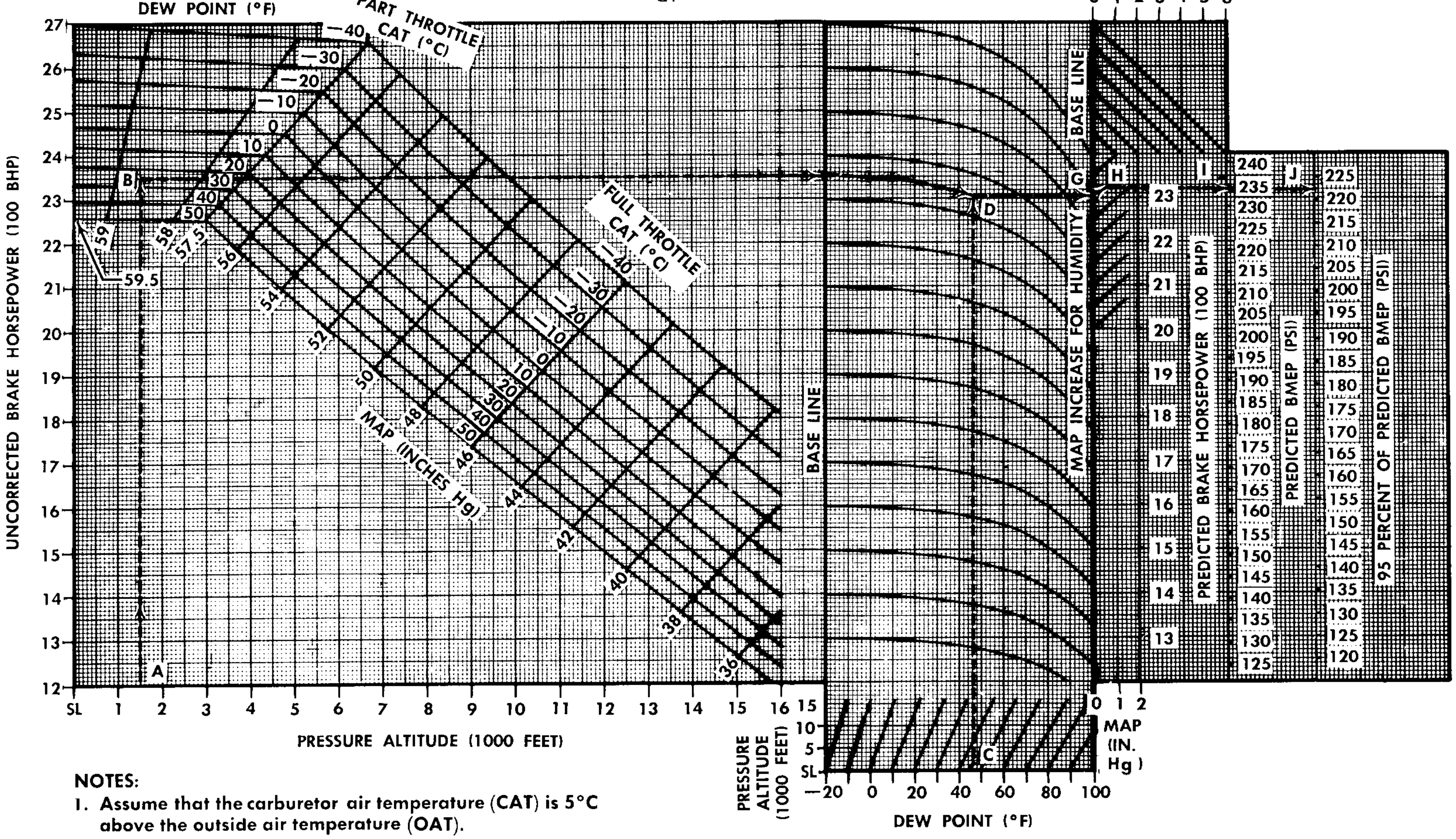
MODEL: C-118A
DATA AS OF: 10-15-64
DATA BASIS: FLIGHT TEST

ENGINES: (4) R2800-52W
FUEL GRADE: 100/130



SAMPLE PROBLEM:

A. Pressure altitude = 1500 feet.
B. CAT = 25°C (5° above OAT of 20°C) MAP = 58.7.
C. Dew point = 45°F at 1500 feet altitude.
D. Power correction for humidity.
E. Enter auxiliary graph at the dew point of 45°F.
F. Read the allowable increase in MAP due to humidity, 0.3 inches of Hg (MAP for takeoff will be 58.7 + 0.3 or 56.8 inches Hg).
G. Correct power for 0.3 inch Hg increase in MAP.
H. Predicted power per engine = 2322 BHP.
I. Predicted BMEP = 234 PSI.
J. 95 percent of predicted BMEP = 222.3 PSI.



NOTES:

1. Assume that the carburetor air temperature (CAT) is 5°C above the outside air temperature (OAT).

Figure A2-4. Brake Horsepower Available for Takeoff - Alternate Fuel Grade - Wet - Low Blower, 2800 Rpm

BRAKE HORSEPOWER AVAILABLE FOR TAKEOFF – ALTERNATE FUEL GRADE – DRY
2800 RPM

MODEL: C-118A
DATA AS OF: 10-15-64
DATA BASIS: FLIGHT TEST

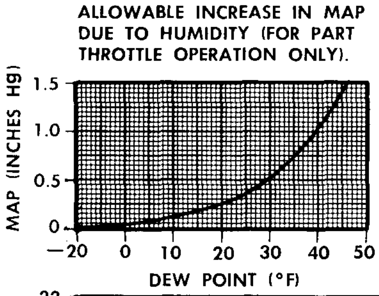
ENGINES: (4) R2800-52W
FUEL GRADE: 100/130

SAMPLE PROBLEM:

A. Pressure altitude = 4000 feet.
B. CAT = −25°C (5°C above OAT of −30°C) 51.6 inches Hg.
C. There is no correction for humidity because the dew point is less than −20°C.
D. There is no increase in MAP because the dew point is less than −20°.
E. Predicted power per engine = 1950 BHP.
F. MAP reduction for low CAT = 3.9 inches Hg (MAP for takeoff = 51.6 inches Hg −3.9 inches Hg = 47.7 inches Hg).
G. Predicted BMEP = 196.7 PSI.
H. 95 percent of predicted BMEP = 186.9 PSI.

NOTES:

1. Assume that the carburetor air temperature (CAT) is 5°C above the outside air temperature (OAT).



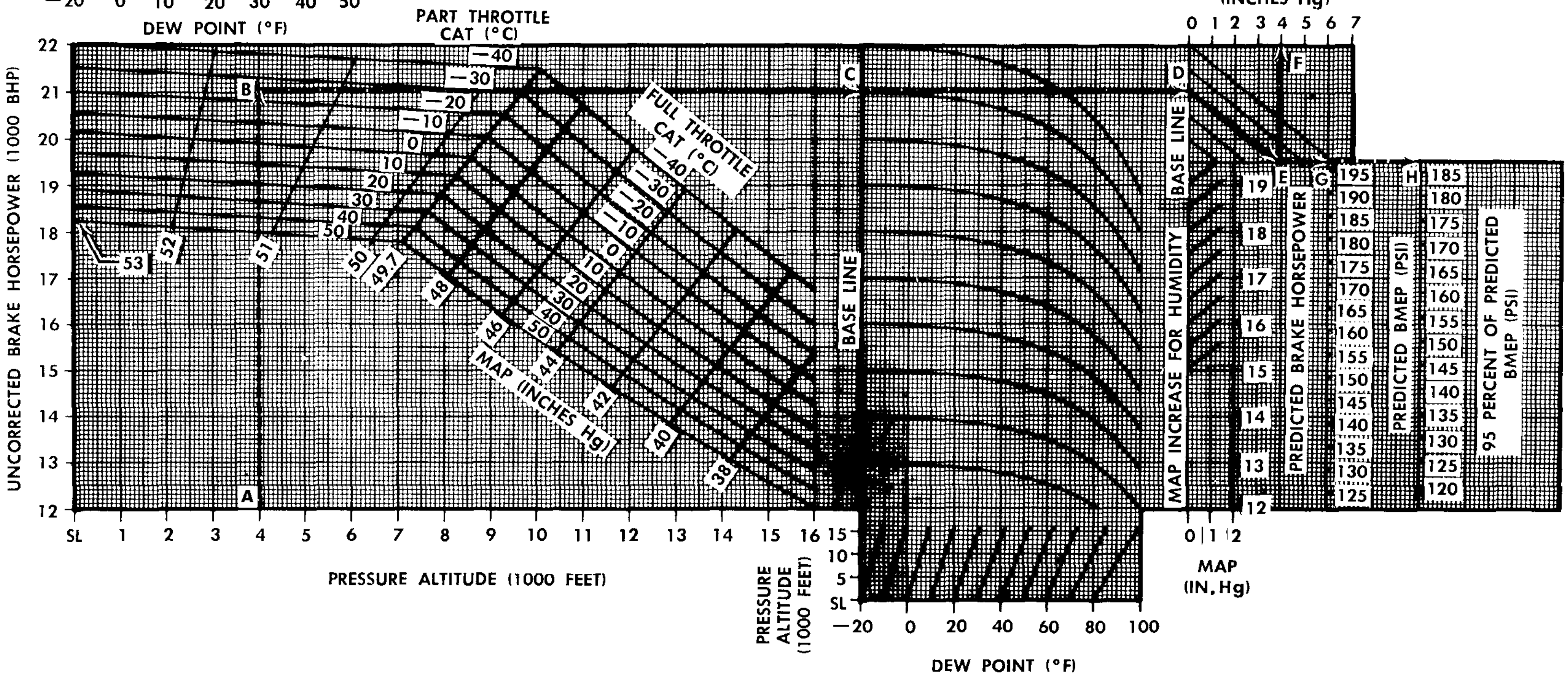
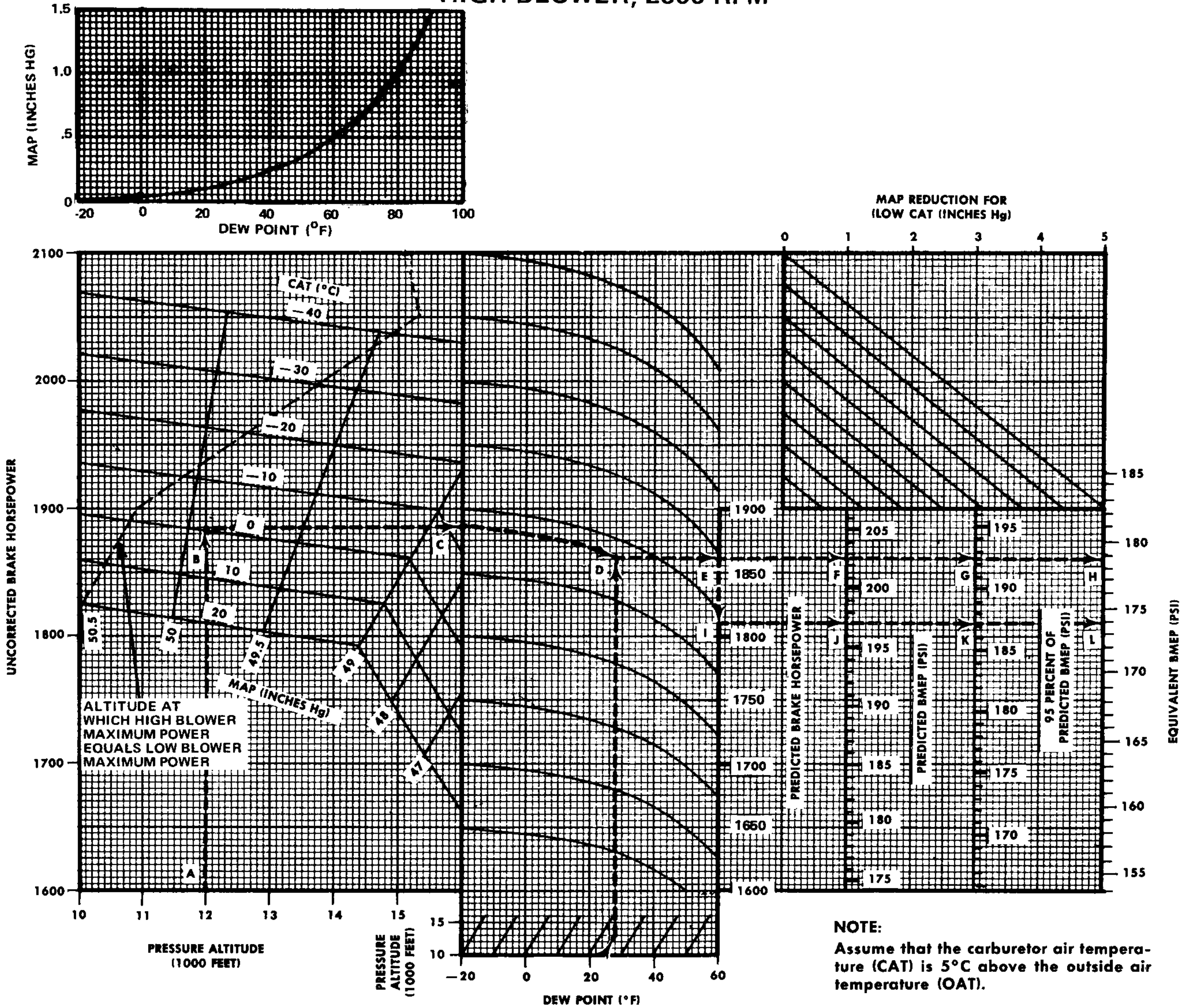


Figure A2-5. Brake Horsepower Available for Takeoff - Alternate Fuel Grade - Dry - Low Blower, 2800 Rpm

BRAKE HORSEPOWER AVAILABLE FOR TAKEOFF
STANDARD FUEL GRADE – WET
HIGH BLOWER, 2600 RPM

MODEL: C-118A
DATA AS OF: 10-15-64
DATA BASIS: P&W O.I.113

ENGINES: (4) R2800-52W
FUEL GRADE: 115/145



NOTE:
Assume that the carburetor air temperature (CAT) is 5°C above the outside air temperature (OAT).

SAMPLE PROBLEM:

A. Pressure altitude = 12,000 feet.
B. CAT = 0°C. (MAP = 49.9 inches Hg.)
C. Baseline.
D. Dewpoint = 25°F.
E. Predicted brake horsepower = 1860 BHP.
F. Predicted BMEP = 202 PSI.
G. 95 percent predicted BMEP = 192 PSI.
H. Equivalent BMEP = 179 PSI.

For alternate grade fuel, 100/130, subtract 1 inch MAP and 50 BHP.

MAP = 48.9 inches Hg.

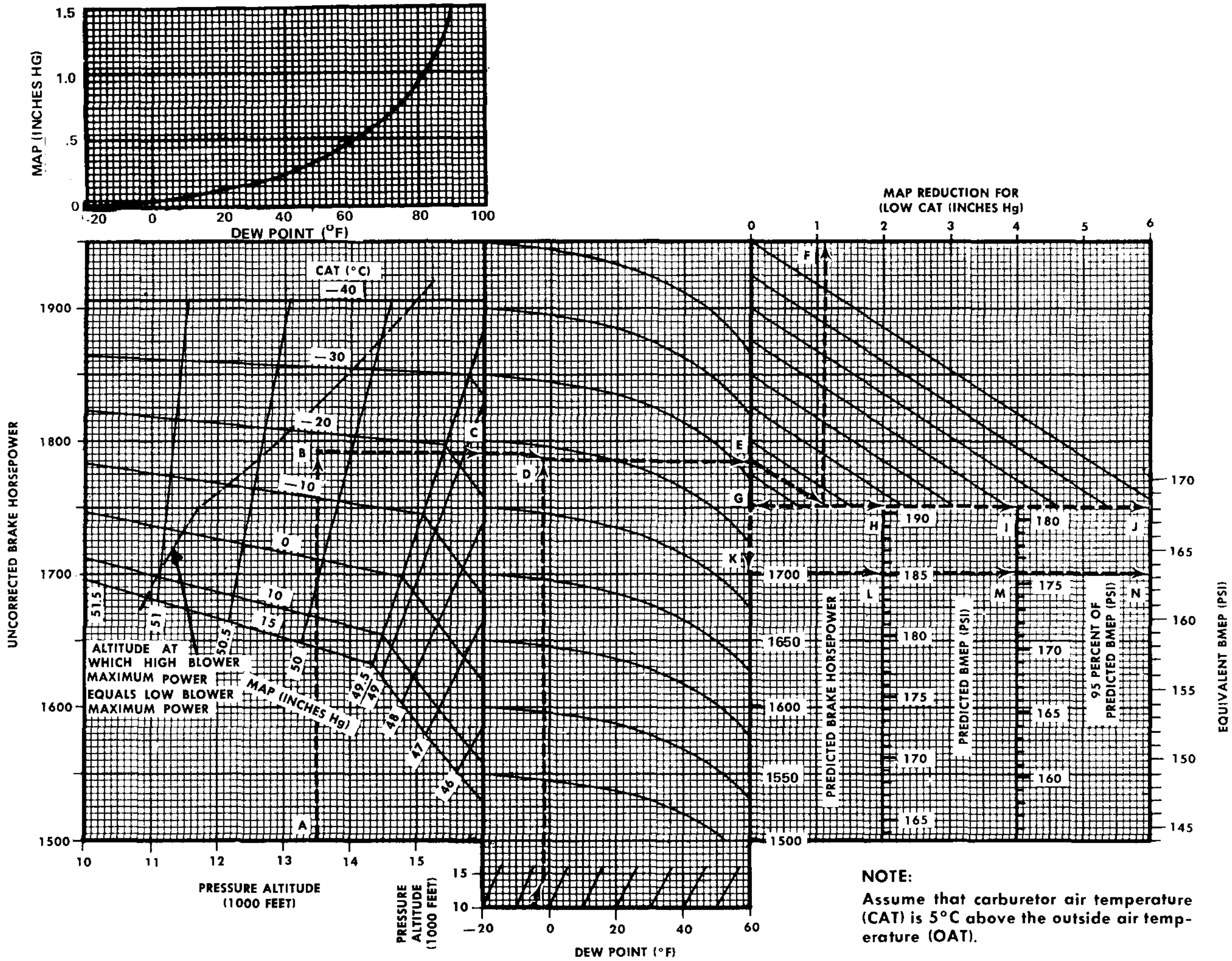
I. Predicted brake horsepower = 1810 BHP.
J. Predicted BMEP = 197 PSI.
K. 95 percent predicted BMEP = 187 PSI.
L. Equivalent BMEP = 174 PSI.

Figure A2-6. Brake Horsepower Available for Takeoff - Standard Fuel Grade - Wet - High Blower, 2600 Rpm

BRAKE HORSEPOWER AVAILABLE FOR TAKEOFF
STANDARD FUEL GRADE – DRY
HIGH BLOWER, 2600 RPM

MODEL: C-118A
DATA AS OF: 10-15-64
DATA BASIS: P&W O.I.113

ENGINES: (4) R2800-52W
FUEL GRADE: 115/145



NOTE:
Assume that carburetor air temperature (CAT) is 5°C above the outside air temperature (OAT).

For alternate grade fuel, 100/130, subtract 1.5 inches MAP and 50 BHP. MAP = 48.7 – 1.1 = 47.6 inches Hg.

SAMPLE PROBLEM:

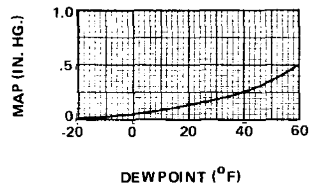
A. Pressure altitude = 13,500 feet.
B. CAT = – 17°C. MAP = 50.2 inches Hg.
C. Baseline.
D. Dewpoint = – 5°F.
E. Baseline.
F. MAP reduction for low CAT = 1.1 inches Hg (MAP = 50.2 – 1.1 = 49.1 inches Hg).
G. Predicted brake horsepower = 1750 BHP.
H. Predicted BMEP = 190 PSI.
I. 95 percent predicted BMEP = 181 PSI.
J. Equivalent BMEP = 168 PSI.
K. Predicted brake horsepower = 1700 BHP.
L. Predicted BMEP = 185 PSI.
M. 95 percent predicted BMEP = 176 PSI.
N. Equivalent BMEP = 163 PSI.

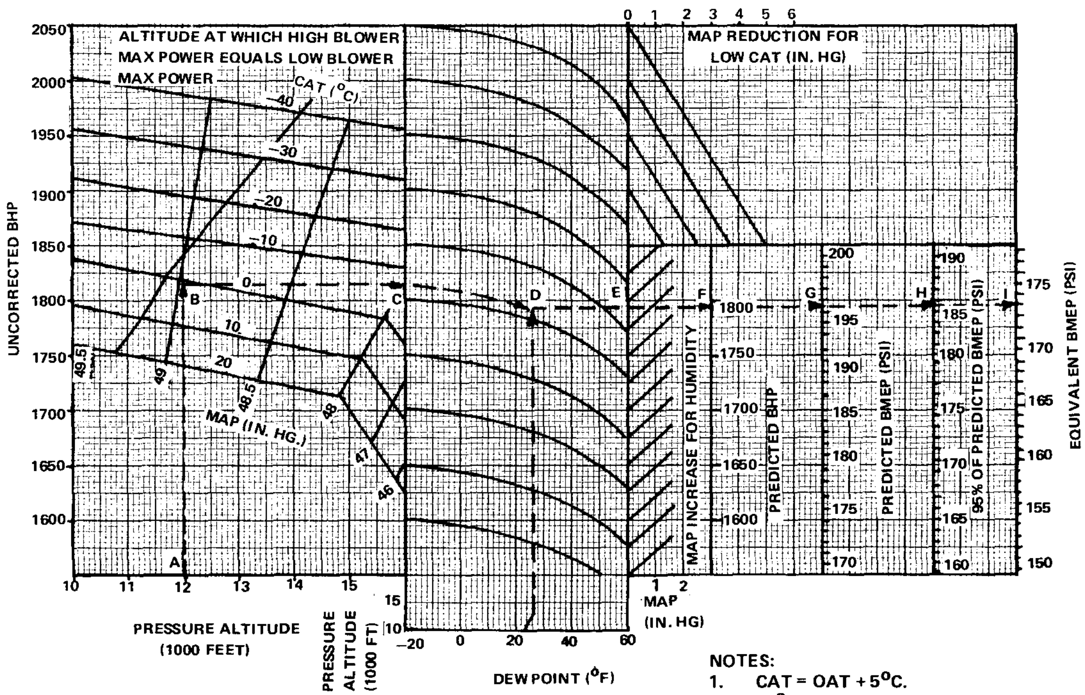
Figure A2-7. Brake Horsepower Available for Takeoff - Standard Fuel Grade - Dry - High Blower, 2600 RPM

MODEL: C-118A
DATA BASIS: P & W O.I. 113

BRAKE HORSEPOWER AVAILABLE FOR TAKEOFF ALTERNATE FUEL GRADE – WET HIGH BLOWER, 2600 RPM

ENGINES: (4) R2800–52W
FUEL GRADE: 100/130





NOTES:
1. CAT = OAT + 5°C.
2. 20°C CAT Maximum High Blower Wet.

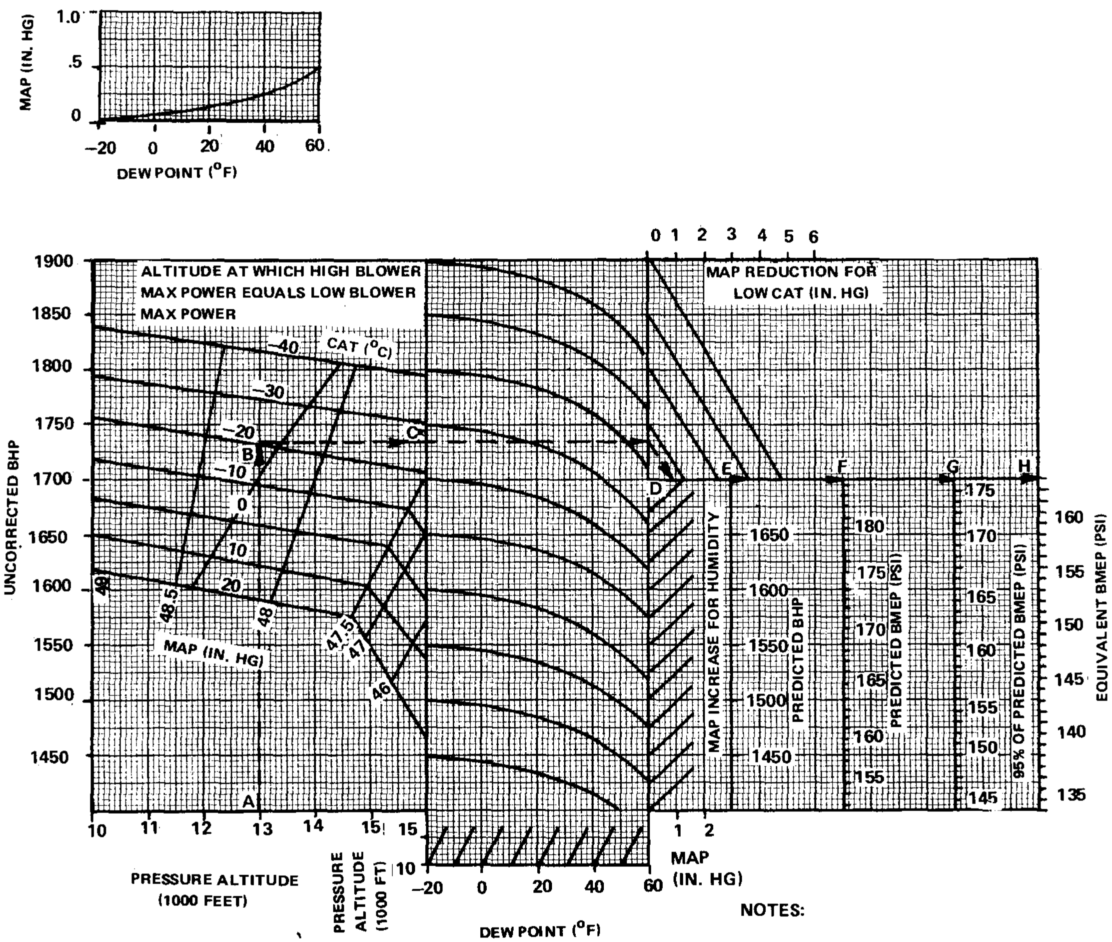
SAMPLE PROBLEM:
A. Pressure Altitude = 12,000 Ft.
B. CAT = 0°.
C. Base Line.
D. Dew Point = 25°F.
E. MAP Increase for Humidity = .2.
F. Predicted BHP = 1795.
G. Predicted BMEP = 195.5 PSI.
H. 95% Predicted BMEP 186 PSI.
I. Equivalent BMEP 173 PSI.

Figure A2-8. Brake Horsepower Available for Takeoff - Alternate Fuel Grade - Wet - High Blower, 2600 RPM

MODEL: C-118A
DATA BASIS: P & W O.I. 113

BRAKE HORSEPOWER AVAILABLE FOR TAKEOFF ALTERNATE FUEL GRADE – DRY HIGH BLOWER, 2600 RPM

ENGINES: (4) R2800–52W
FUEL GRADE: 100/130



NOTES:

1. CAT – OAT + 5°C.
2. 15°C CAT Maximum High Blower Dry.

SAMPLE PROBLEM:

A. Pressure Altitude = 13,000 feet.
B. CAT = 20°C.
C. Base Line (Dew Point Not Applicable when Below -20°F).
D. MAP Reduction for Low CAT = .8 Inch Hg.
E. Predicted BHP = 1700.
F. Predicted BMEP = 185 PSI.
G. 95% Predicted BMEP = 176 PSI.
H. Equivalent BMEP = 163 PSI.

Figure A2-9. Brake Horsepower Available For Takeoff - Alternate Fuel Grade - Dry - High Blower, 2600 RPM

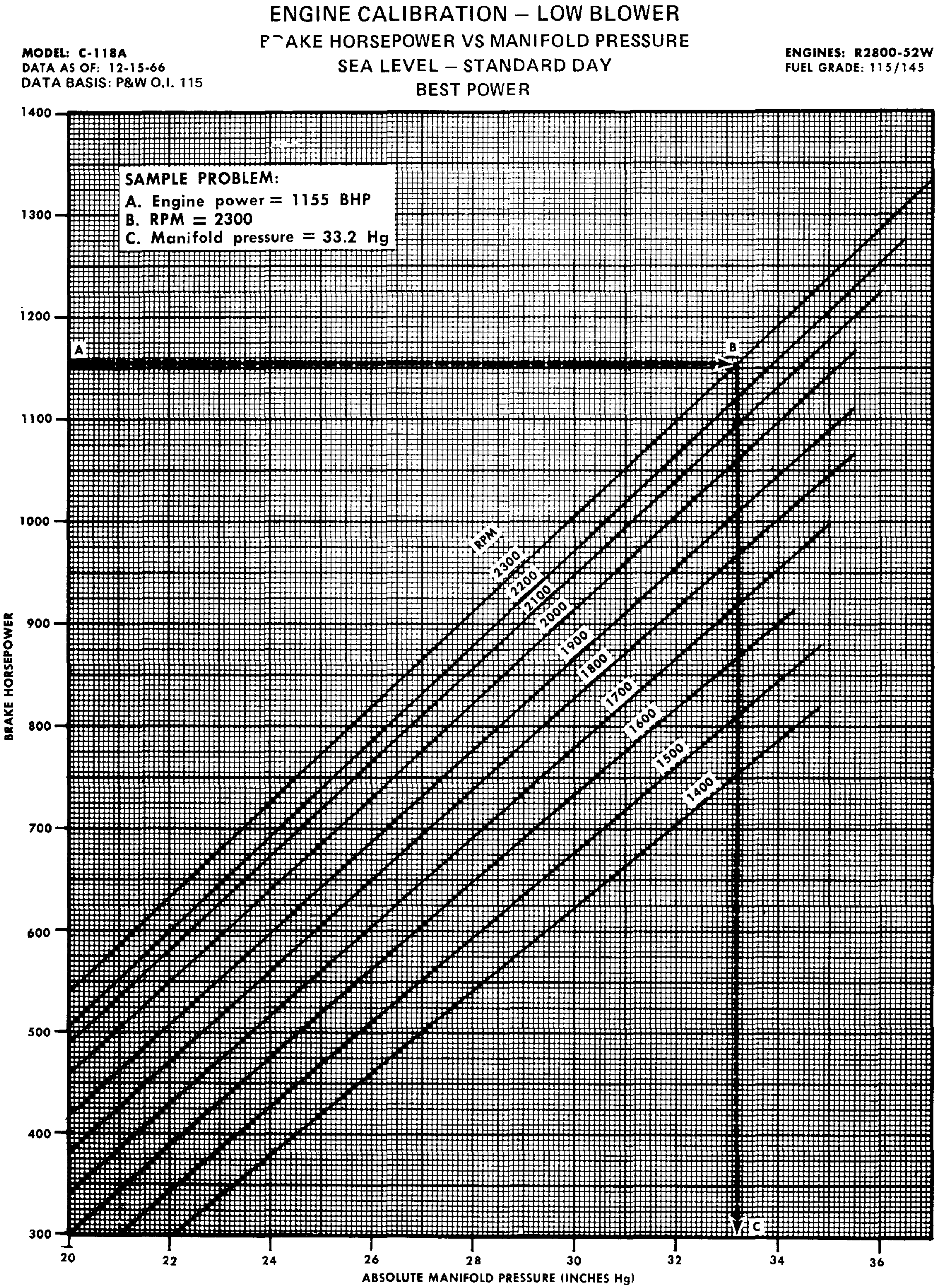


Figure A2-10. Engine Calibration - Low Blower - Brake Horsepower Vs Manifold Pressure (Sheet 1 of 2)

ENGINE CALIBRATION – LOW BLOWER
BRAKE HORSEPOWER VS MANIFOLD PRESSURE
SEA LEVEL – STANDARD DAY
AUTO RICH MIXTURE

MODEL: C-118A
DATA AS OF: 12-15-66
DATA BASIS: P&W O.I. 115

ENGINES: R2800-52W
FUEL GRADE: 115/145

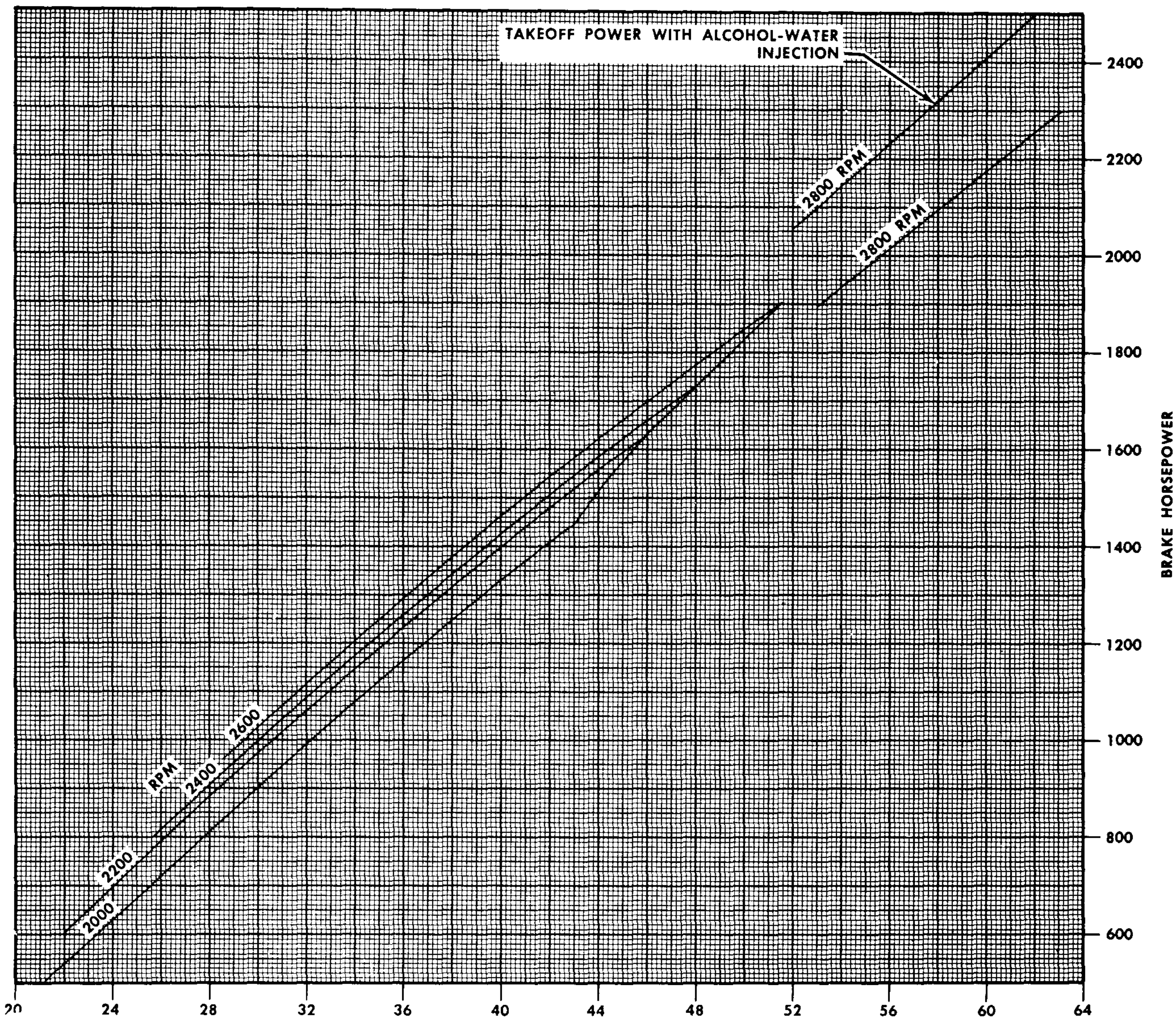


Figure A2-10. Engine Calibration - Low Blower - Brake Horsepower Vs Manifold Pressure (Sheet 2 of 2)

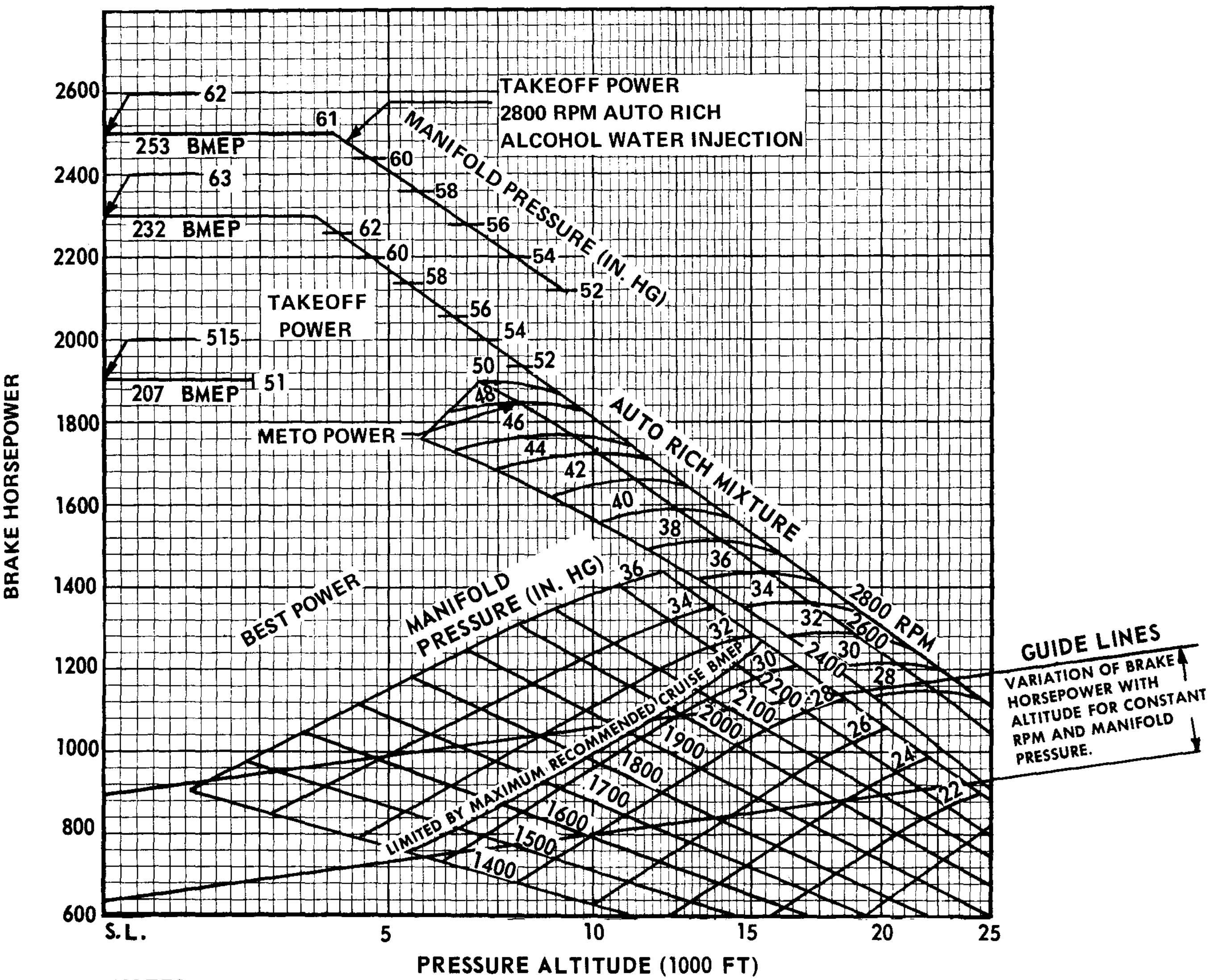
ENGINE CALIBRATION – LOW BLOWER

BRAKE HORSEPOWER VS ALTITUDE

NACA STANDARD DAY

MODEL: C-118A
DATA AS OF: 11-27-67
DATA BASIS: Pratt & Whitney 0.1.115

ENGINES: R2800–52W
FULL GRADE: 115/145



NOTES:

1. Values given in this chart are based on engine calibration curve no. Inst. 16472-1B and 16472-2 in Pratt and Whitney 0.1.115 dtd April 1951, revised Dec. 1965. All predicted BHP values are available from the altitude, RPM intersection, back to sea level, at that RPM, by maintaining constant BMEP.

2. Effect of ram air not included.

Figure A2-11. Engine Calibration - Low Blower - Brake Horsepower Vs Altitude

ENGINE CALIBRATION – HIGH BLOWER

BRAKE HORSEPOWER VS MANIFOLD PRESSURE

10,000 FEET – STANDARD DAY

BEST POWER

MODEL: C-118A
DATA AS OF: 12-15-66
DATA BASIS: P&W O.I. 115

ENGINES: R2800-52W
FUEL GRADE: 115/145

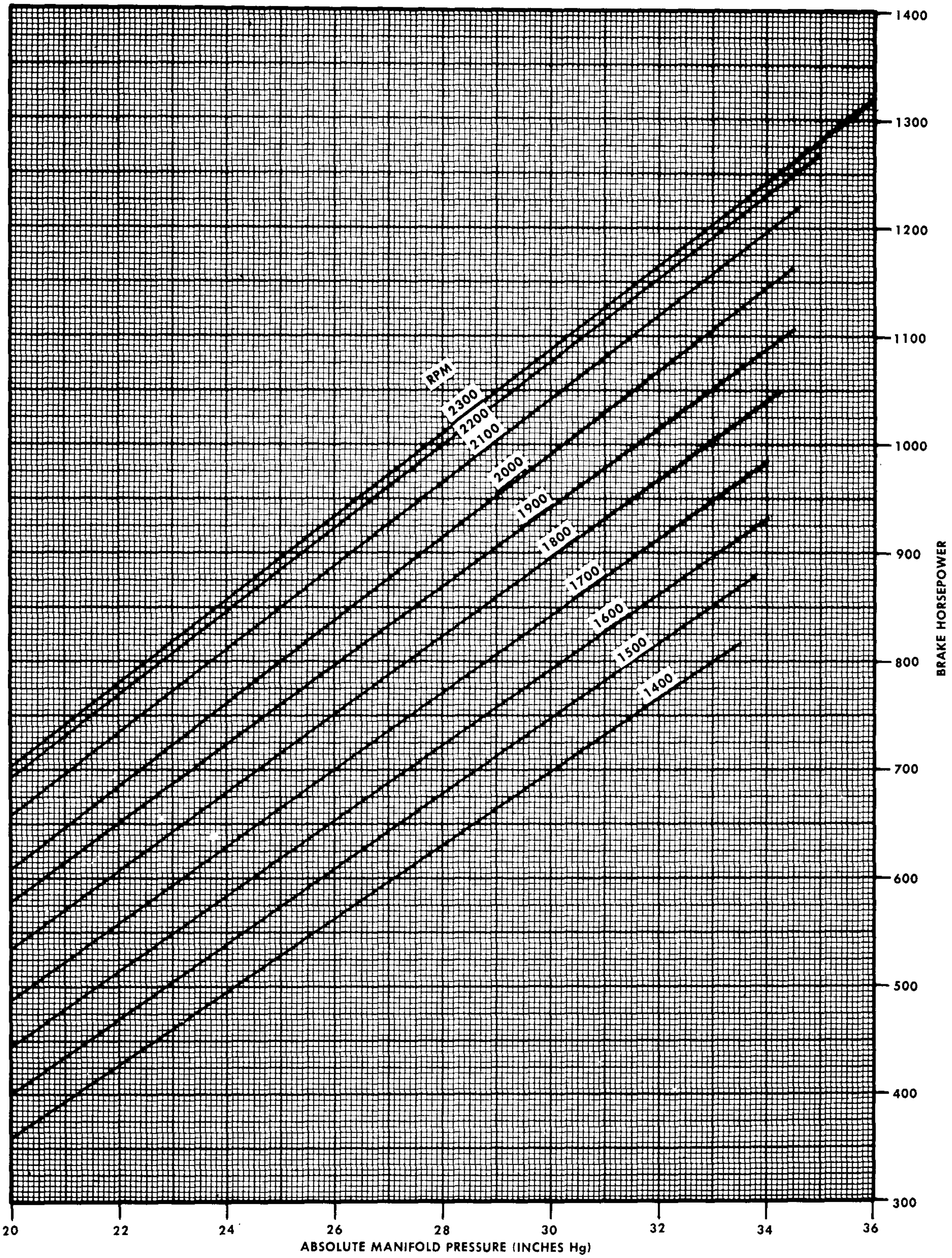


Figure A2-12. Engine Calibration - High Blower - Brake Horsepower Vs Manifold Pressure (Sheet 1 of 2)

ENGINE CALIBRATION – HIGH BLOWER

MODEL: C-118A
DATA AS OF: 12-15-66
DATA BASIS: P&W O.I. 115

BRAKE HORSEPOWER VS MANIFOLD PRESSURE
10,000 FEET – STANDARD DAY
AUTO RICH MIXTURE

ENGINES: R2800-52W
FUEL GRADE: 115/145

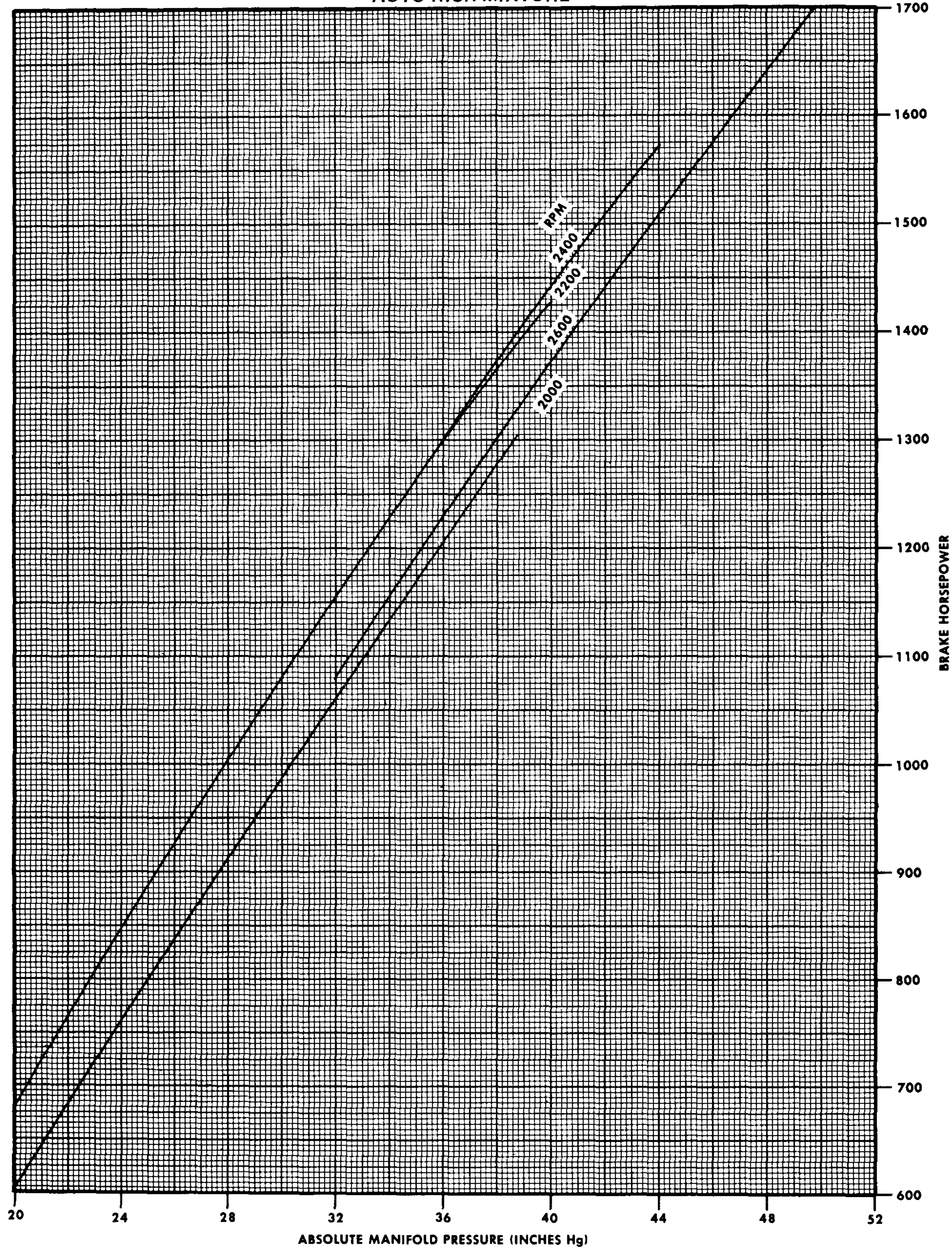
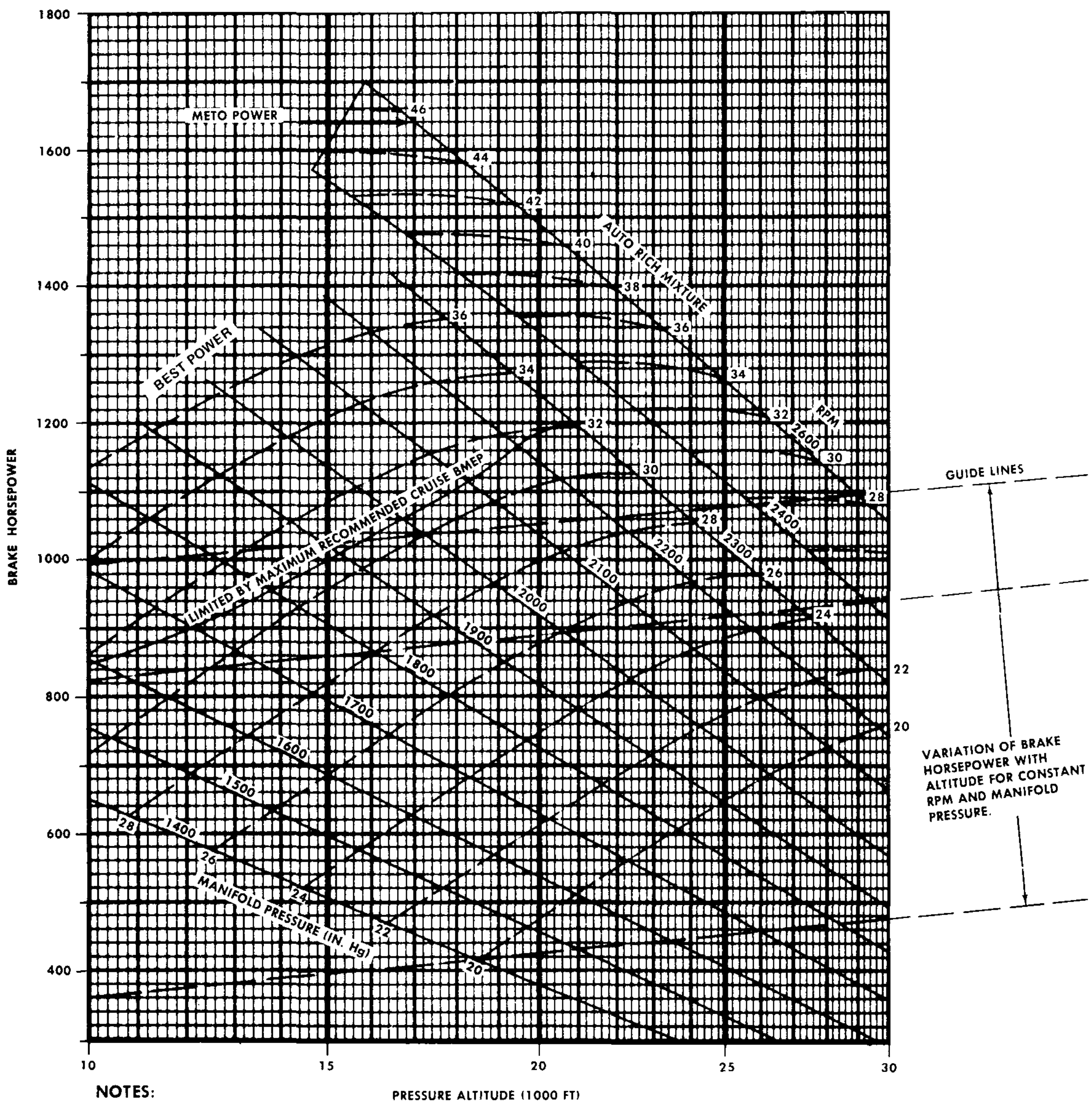


Figure A2-12. Engine Calibration. - High Blower - Brake Horsepower Vs Manifold Pressure (Sheet 2 of 2)

ENGINE CALIBRATION – HIGH BLOWER
BRAKE HORSEPOWER VS ALTITUDE
STANDARD DAY

MODEL: C-118A
DATA AS OF: 12-15-66
DATA BASIS: PRATT & WHITNEY O.I. 115

ENGINES: R2800-52W
FUEL GRADE: 115/145



NOTES:

1. Values given in this chart are based on engine calibration curves No. Inst. 16472-3 and 16472-4 in Pratt and Whitney O.I. 115 dated April 1951, revised Dec. 1965.
2. Do not use high blower if carburetor air temperature exceeds 15°C (approximately 60°F).
3. Effect of ram air not included.

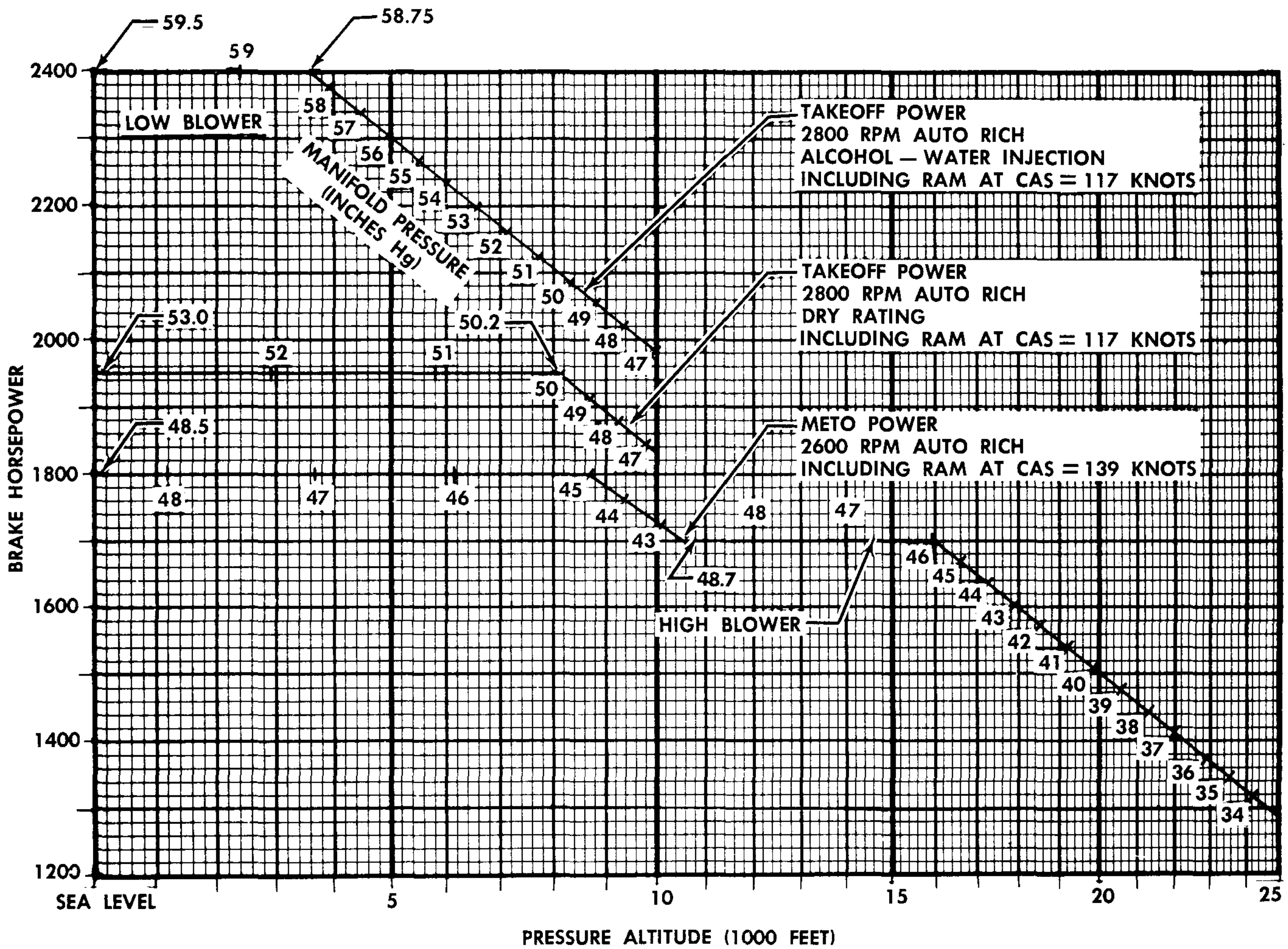
Figure A2-13. Engine Calibration Chart - High Blower - Brake Horsepower Vs Altitude

ENGINE CALIBRATION CURVE – ALTERNATE FUEL GRADE

NACA STANDARD DAY

MODEL: C-118A
DATA AS OF: 10-15-64
DATA BASIS: FLIGHT TEST

ENGINE(S): R2800-52W
FUEL GRADE: 100/130



NOTES:

1. Do not use high blower if carburetor air temperature exceeds 15°C (approximately 60°F).
2. Cruise powers are the same as for 115/145 grade fuel.

CAUTION

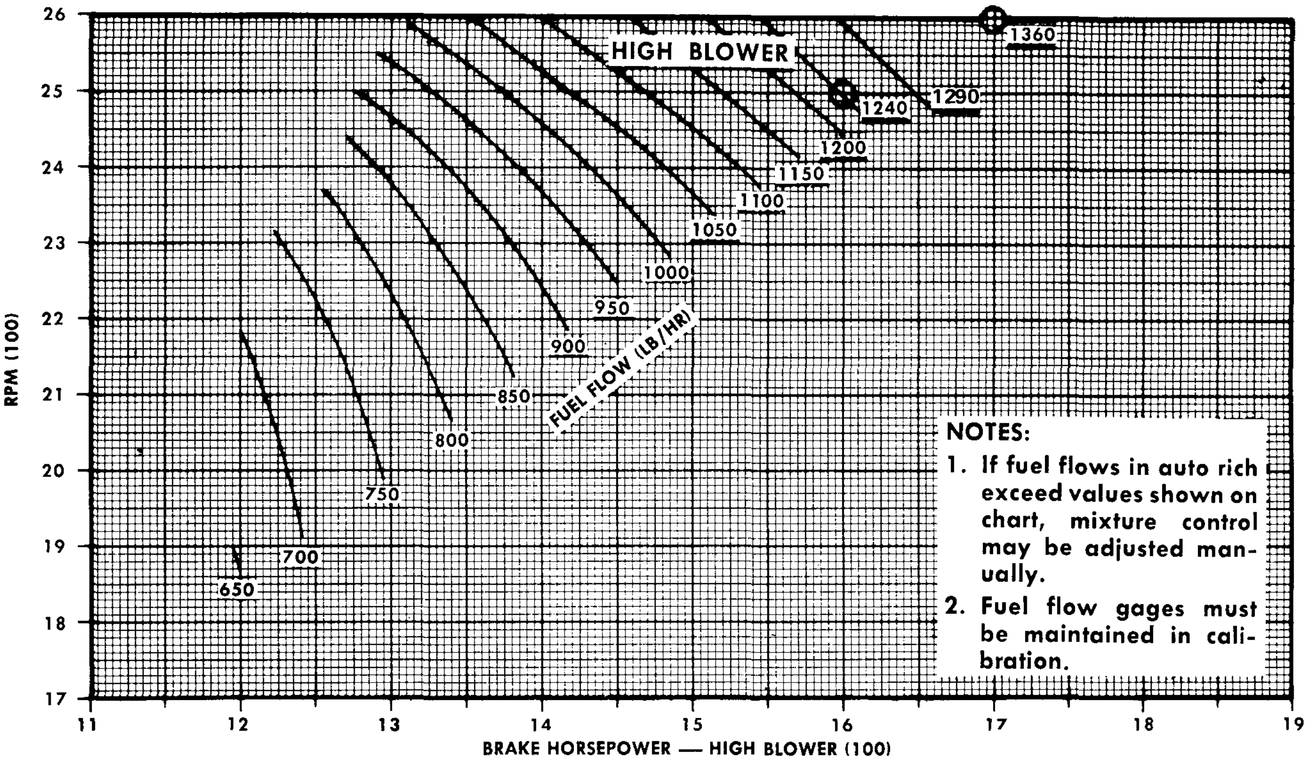
Use of this alternate grade fuel for takeoff is not desired for normal operation.

Figure A2-14. Engine Calibration Curve - Alternate Fuel Grade

MINIMUM FUEL FLOW – AUTO RICH OPERATION

MODEL: C-118A
DATA AS OF: 12-15-66
DATA BASIS: PRATT & WHITNEY O.I. 115

ENGINES: (4) R2800-52W



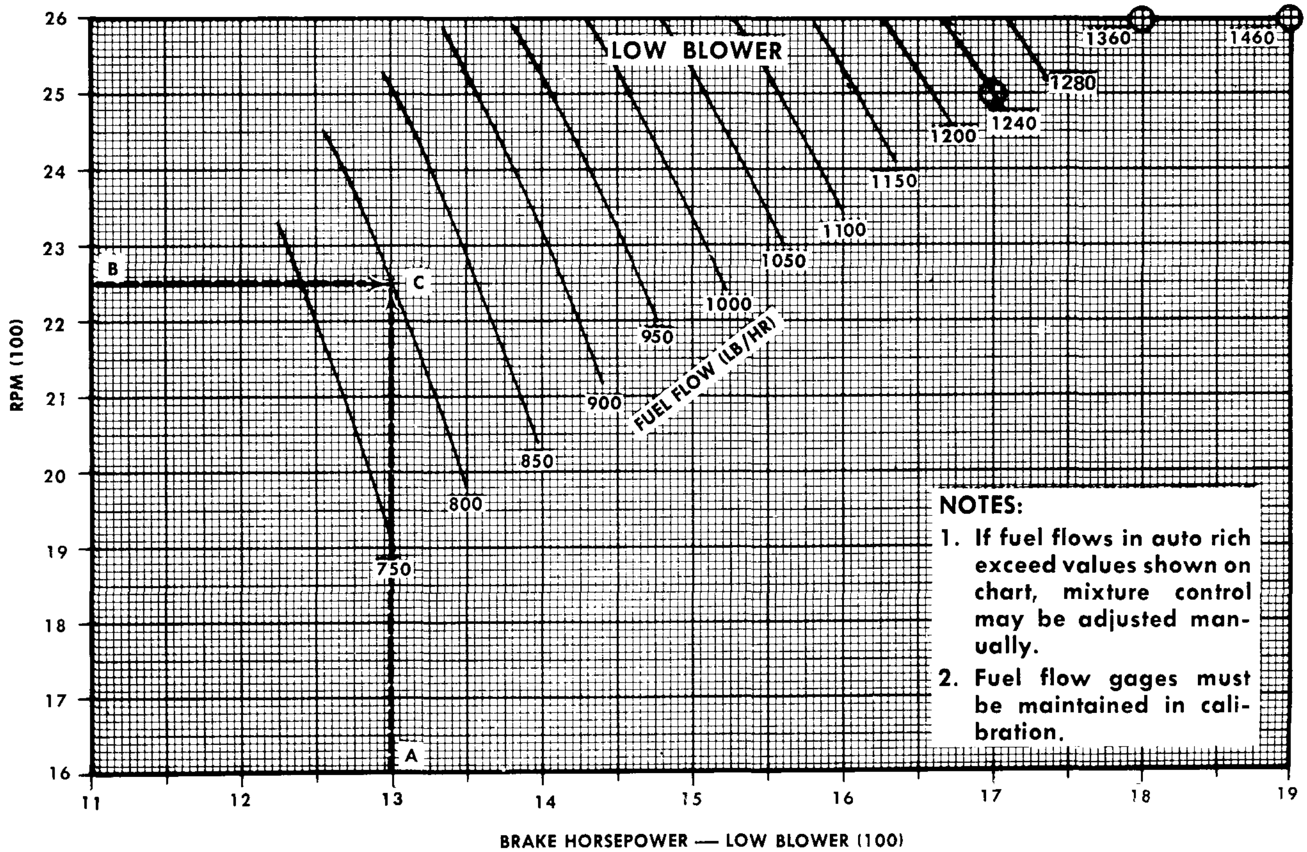


Figure A2-15. Minimum Fuel Flow - Auto Rich Operation

ESTIMATED FUEL CONSUMPTION FOR CRUISE POWERS – LOW BLOWER

MODEL: C-118A
DATA AS OF: 10-15-64
DATA BASIS: ESTIMATED

ENGINES: (4) R2800-52W
FUEL GRADE: 115/145
ALTERNATE FUEL GRADE: 100/130

NOTE:
Fuel flow increments to be added to fuel flow for best economy, when operating at a given BMEP drop.

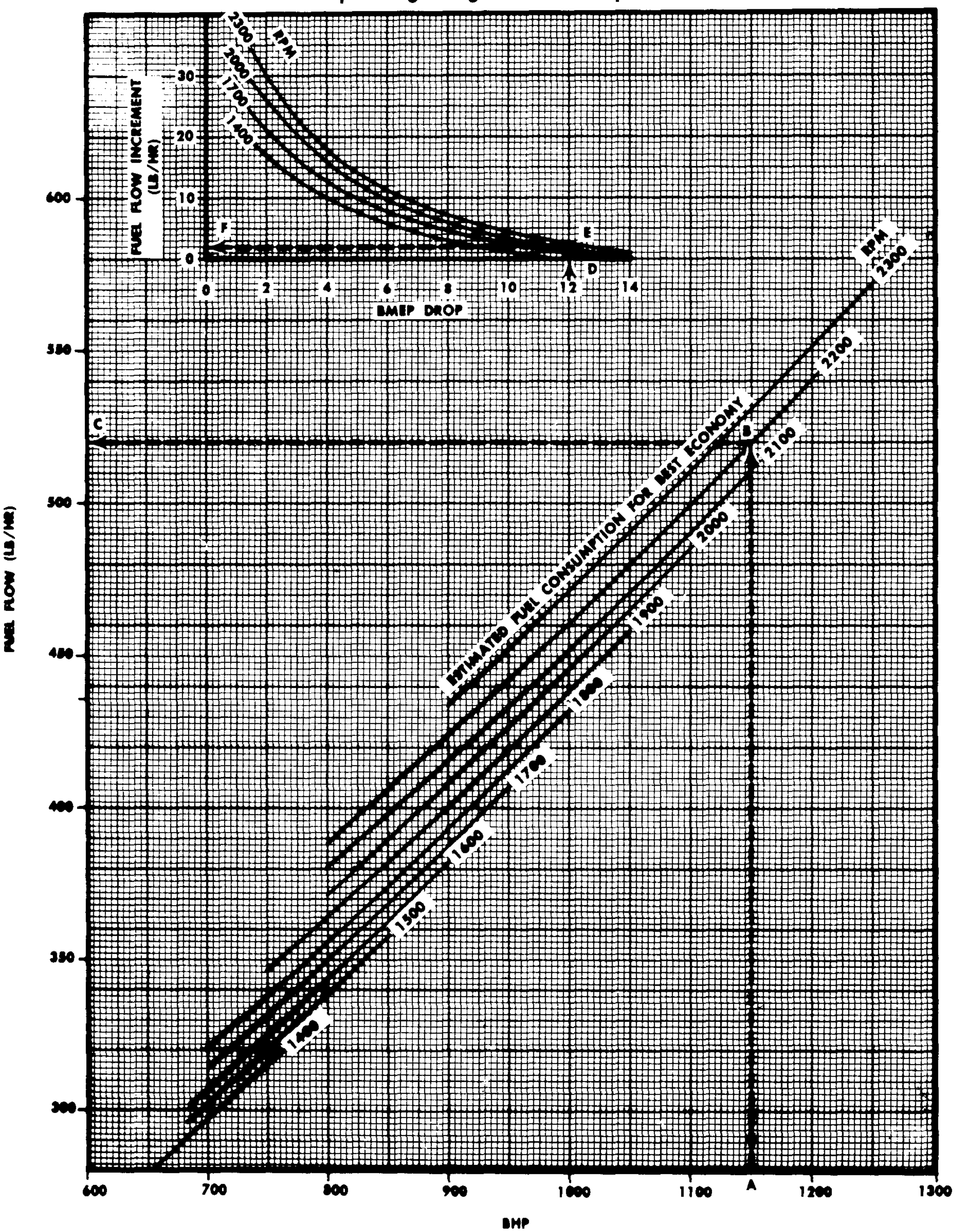


Figure A2-16. Estimated Fuel Consumption for Cruise Powers - Low Blower

ESTIMATED FUEL CONSUMPTION FOR CRUISE POWERS HIGH BLOWER

MODEL: C-118A
DATA AS OF: 10-15-64
DATA BASIS: ESTIMATED

ENGINES: (4) R2800-52W
FUEL GRADE: 115/145
ALTERNATE FUEL GRADE: 100/130

NOTE:
Fuel flow increment to be added to fuel flow for best economy, when operating at a given BMEP drop.

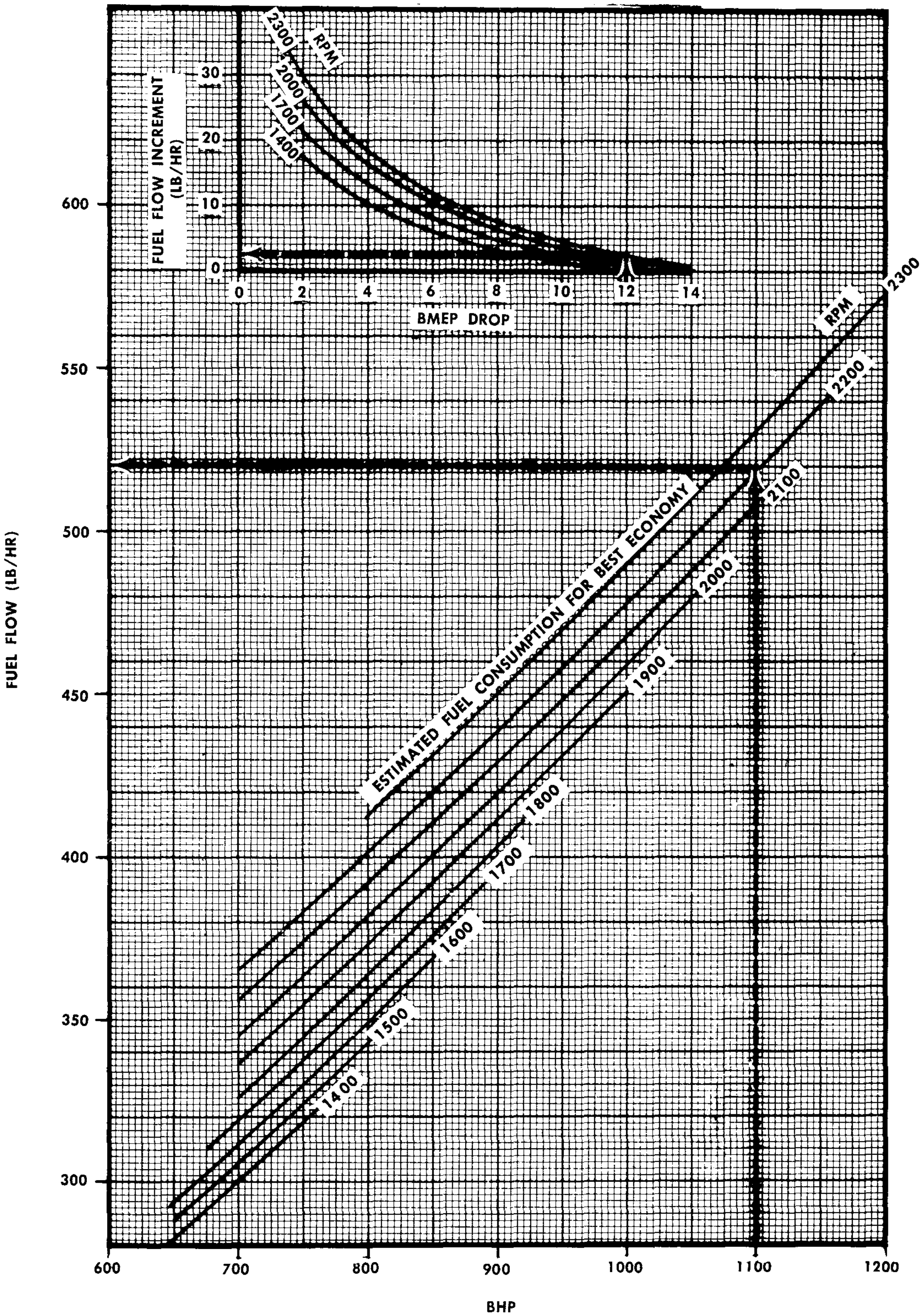


Figure A2-17. Estimated Fuel Consumption for Cruise Powers - High Blower

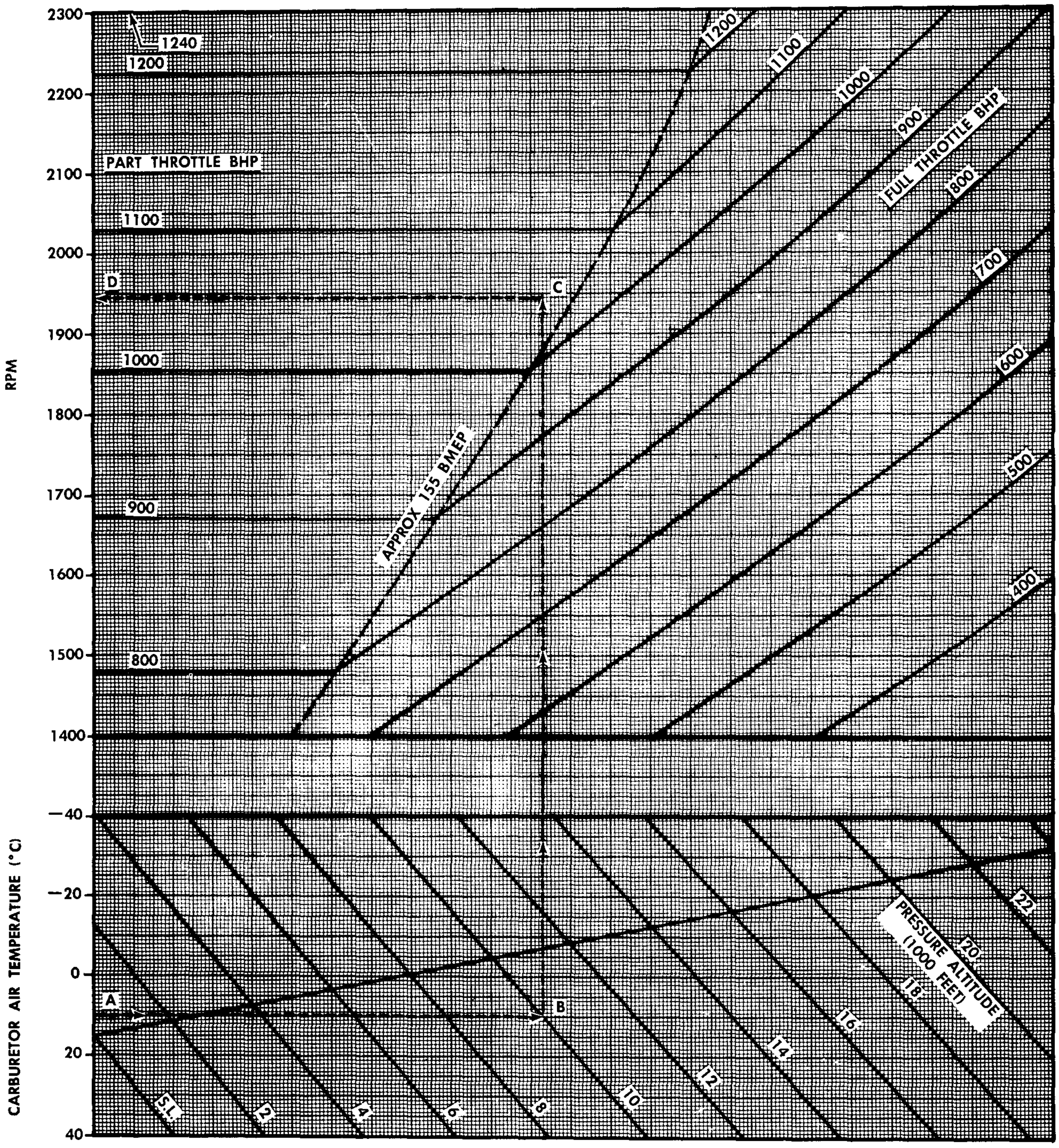
BHP-RPM SCHEDULE — LOW BLOWER

MANUAL MIXTURE ADJUSTMENT

12 BMEP DROP FROM BEST POWER MIXTURE

MODEL: C-118A
DATA AS OF: 6-15-62
DATA BASIS: CALCULATED DATA

ENGINES: (4) R2800-52W
FUEL GRADE: 115/145
ALTERNATE FUEL GRADE: 100/130



NOTE:
For part throttle BHP's the manifold pressure must be obtained from the BHP-manifold pressure schedule.

SAMPLE PROBLEM:
A. Carburetor air temperature = 10°C.
B. Pressure altitude = 10,000 feet.
C. Desired power = 1050 BHP.
E. Required RPM = 1945.

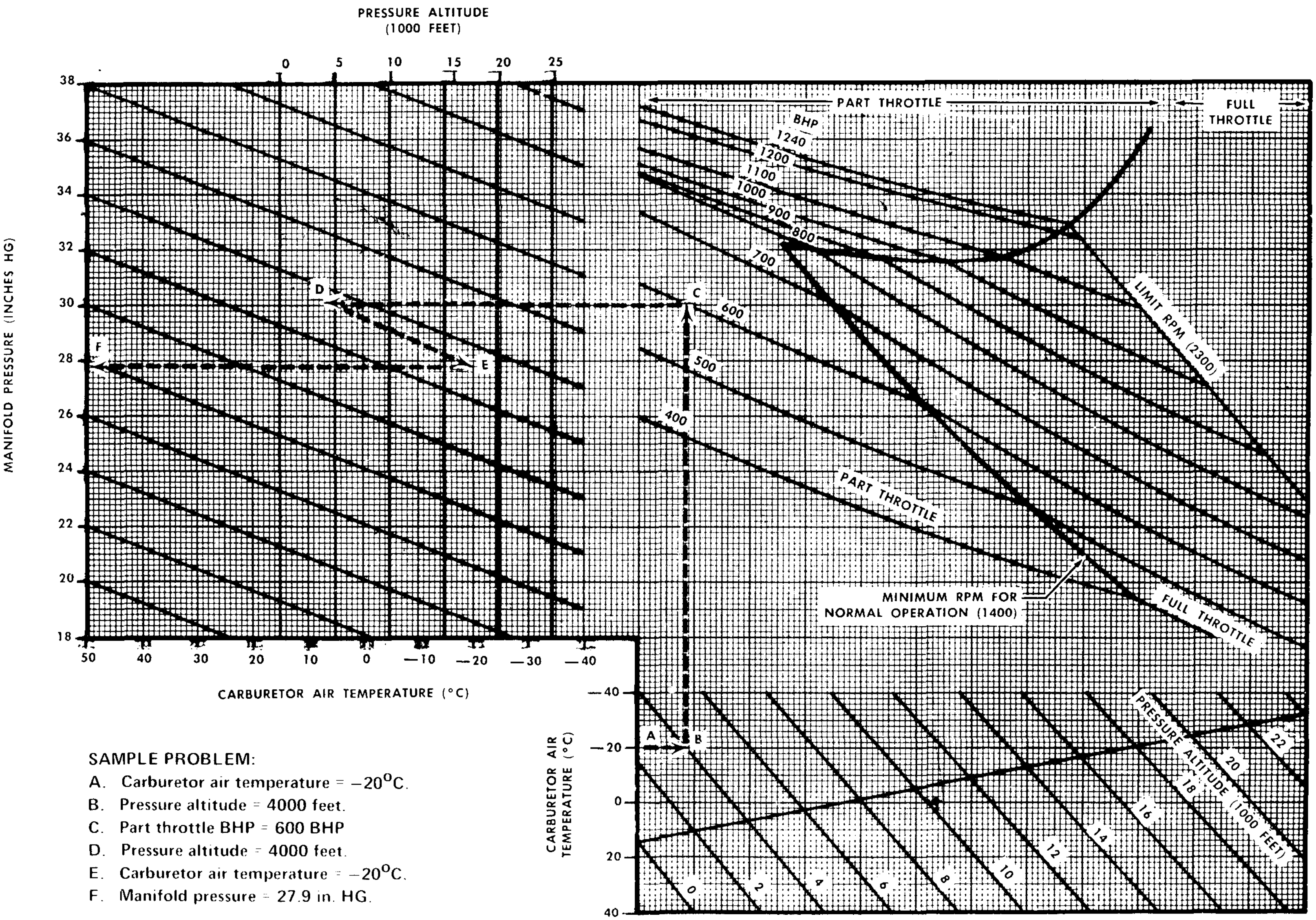
Figure A2-18. BHP - RPM Schedule - Low Blower

SHOULD BE NEAR 155 BMEP

BHP-MAP SCHEDULE – LOW BLOWER
MANUAL MIXTURE ADJUSTMENT
12 BMEP DROP FROM BEST POWER MIXTURE

MODEL: C-118A
DATA AS OF: 6-15-62
DATA BASIS: FLIGHT TEST

ENGINES: (4) R2800-52W
FUEL GRADE: 115/145
ALTERNATE FUEL GRADE: 100/130



SAMPLE PROBLEM:

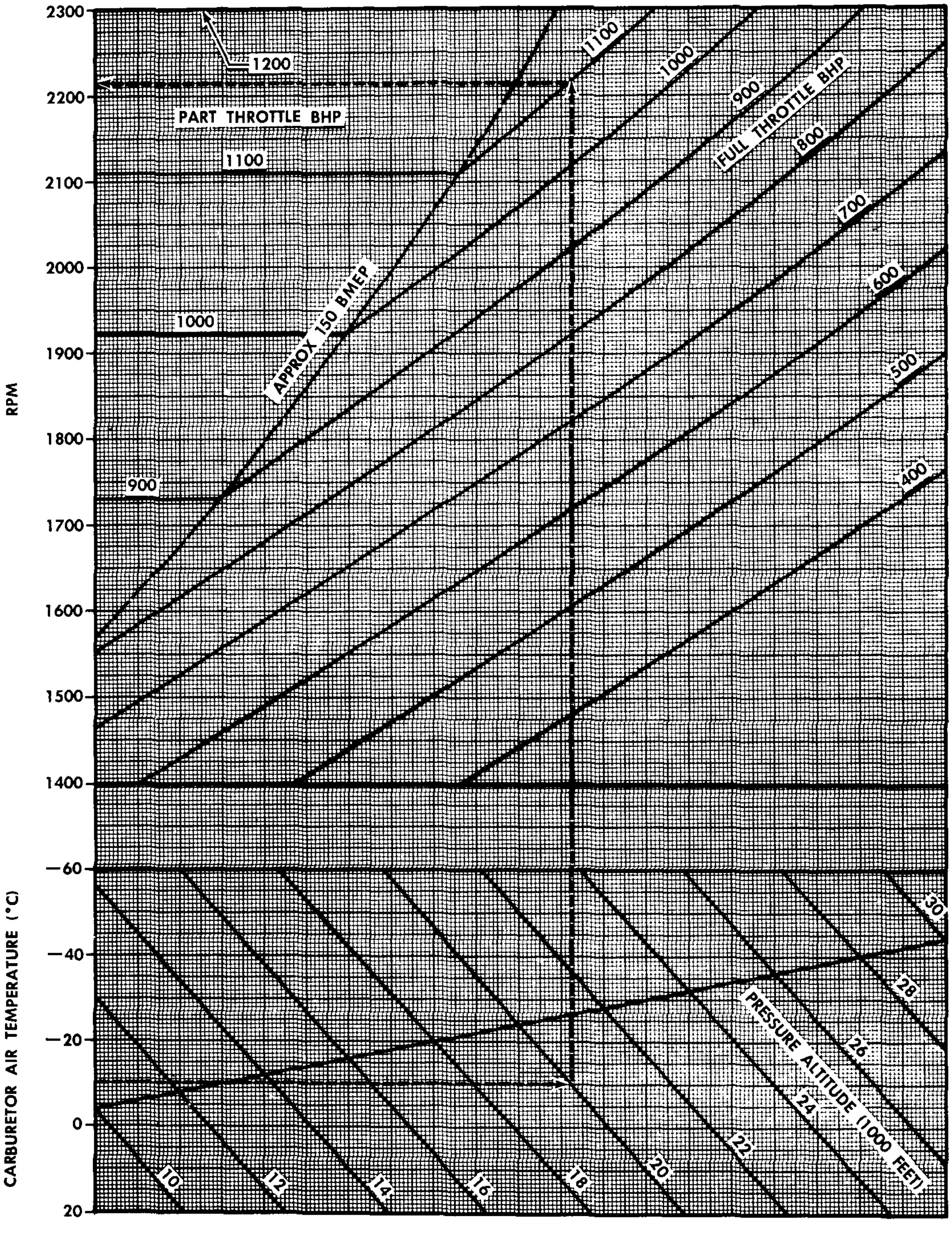
A. Carburetor air temperature = −20°C.
B. Pressure altitude = 4000 feet.
C. Part throttle BHP = 600 BHP
D. Pressure altitude = 4000 feet.
E. Carburetor air temperature = −20°C.
F. Manifold pressure = 27.9 in. HG.

Figure A2-19. BHP-MAP Schedule - Low Blower

BHP-RPM SCHEDULE – HIGH BLOWER
MANUAL MIXTURE ADJUSTMENT
12 BMEP DROP FROM BEST POWER MIXTURE

MODEL: C-118A
DATA AS OF: 6-15-62
DATA BASIS: CALCULATED DATA

ENGINES: (4) R2800-52W
FUEL GRADE: 115/145
ALTERNATE FUEL GRADE: 100/130



NOTE:
For part throttle BHP's the manifold pressure must be obtained from the BHP-manifold pressure schedule.

Figure A2-20. BHP - RPM Schedule - High Blower

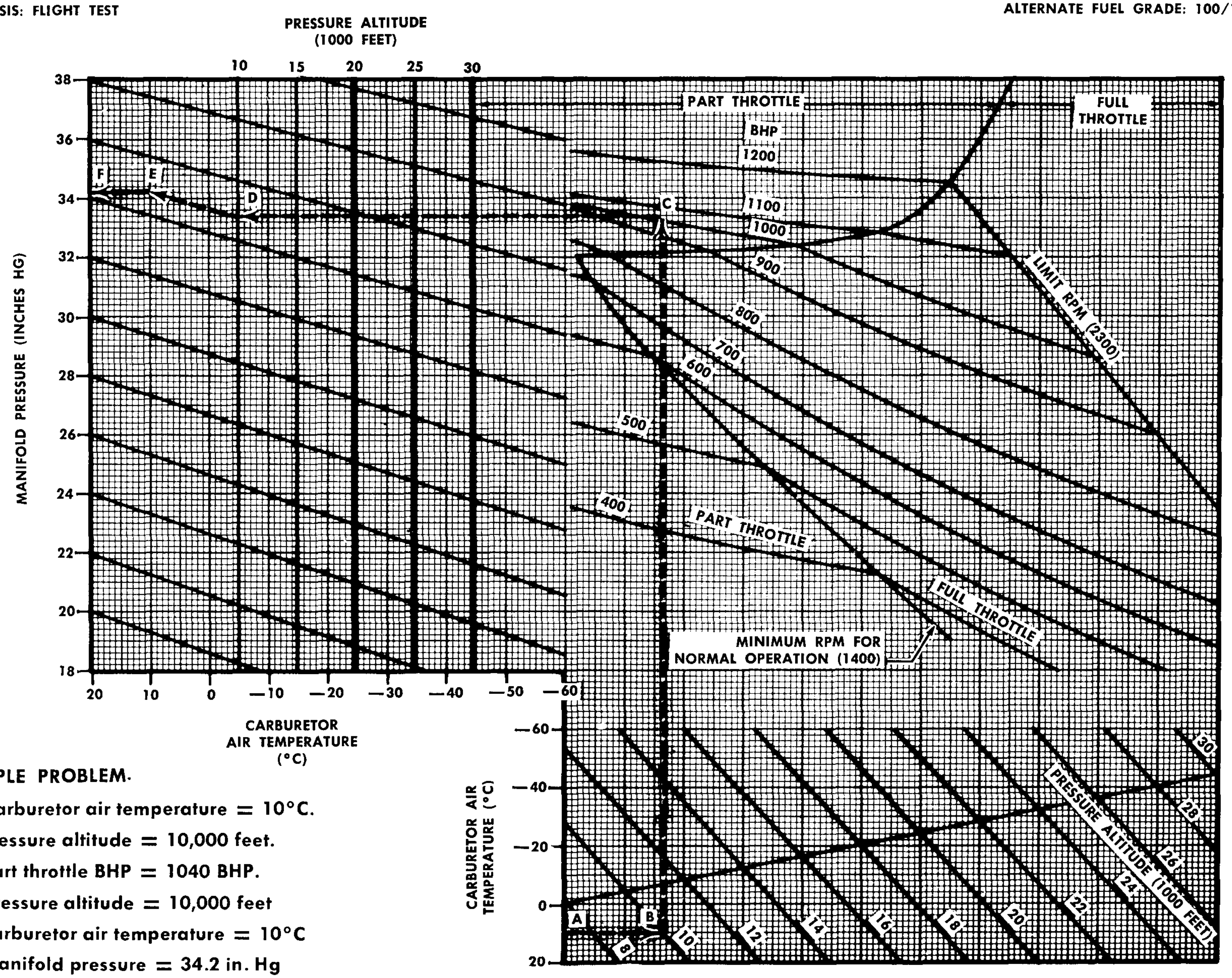
BHP-MAP SCHEDULE —HIGH BLOWER

MANUAL MIXTURE ADJUSTMENT

12 BMEP DROP FROM BEST POWER MIXTURE

MODEL: C-118A
DATA AS OF: 6-15-62
DATA BASIS: FLIGHT TEST

ENGINES: (4) R2800-52W
FUEL GRADE: 115/145
ALTERNATE FUEL GRADE: 100/130



SAMPLE PROBLEM.

A. Carburetor air temperature = 10°C.
B. Pressure altitude = 10,000 feet.
C. Part throttle BHP = 1040 BHP.
D. Pressure altitude = 10,000 feet
E. Carburetor air temperature = 10°C
F. Manifold pressure = 34.2 in. Hg

AA1-246A

Figure A2-21. BHP-MAP Schedule - High Blower