TABLE OF CONTENTS

GENERAL.

With normal and full military loads, the airplane is stable at all normal speeds. In two-engine flying there is no noticeable torque effect, and the airplane is easily controlled in single-engine flight. Very little change in elevator and rudder trim is necessary for changes in power and speed. At low airspeeds the efficiency of the ailerons decreases, and rudder correction should be used to assist in keeping the wings level.

SPINS.

Spinning in this airplane is prohibited. However, if an unintentional spin should occur, use the conventional procedure for recovery from the spin.

MANEUVERING FLIGHT.

The stick forces per G are comparatively low for this class airplane. It is impossible to encounter stick reversal. Although stick force gradient in accelerated flight is within allowable specification limits, the effectiveness of the elevator for one pilot effort is such that the allowable load factor limit of the airplane can easily be exceeded. Extreme maneuvering flight is prohibited.

DIVING.

Refer to the Instrument Range Markings, Section V, for maximum speeds permitted during flight. Do not allow the airspeed to exceed the limit marking on the airspeed indicator. Use conventional methods for recovery from a dive, avoiding abrupt pull-outs to prevent structural damage.

CAUTION

Elevator forces are so designed for maneuvering and formation flight that with one arm, it is possible for pilot to exceed the maximum allowable acceleration limits.

FLIGHT WITH CARGO DOORS OFF.

The flight characteristics of the airplane, when flying with the cargo loading doors off, are practically the same as those experienced with an airplane with the cargo doors attached, up to take-off flap settings. Buffeting is most noticeable and objectionable at speeds of 104 knots IAS and above, with take-off or greater flap settings, and decreases as airspeed is decreased. Equipment may be dropped at slow speeds as long as the take-off flap setting is not exceeded.

POWER ON STALL SPEEDS (CAS - knots)*

	FLAPS UP				FLAPS TAKE-OFF				FLAPS LANDING			
	Angle of Bank				Angle of Bank				Angle of Bank			
GROSS WEIGHT	0°	10°	20°	30°	0°	10°	20°	30°	0°	10°	20°	30°
44,000	77	78	80	83	72	72	74	77	68	68	70	73
50,000	82	83	85	89	77	77	79	82	72	73	75	78
56,000	87	88	90	94	81	82	84	87	77	77	79	82
62,000	92	92	94	99	85	86	88	92	81	81	83	87
68,000	96	97	99	103	89	90	92	96	85	85	87	91
74,000	100	101	103	108	93	94	96	100	88	89	91	95
77,000	102	103	105	110	95	96	98	102	90	91	93	97

POWER OFF STALL SPEEDS (CAS - knots)

GROSS WEIGHT	FLAPS UP 0°	FLAPS UP 10°	FLAPS UP 20°	FLAPS UP 30°	FLAPS TAKE-OFF 0°	FLAPS TAKE-OFF 10°	FLAPS TAKE-OFF 20°	FLAPS TAKE-OFF 30°	FLAPS LANDING 0°	FLAPS LANDING 10°	FLAPS LANDING 20°	FLAPS LANDING 30°
44,000	80	80	82	86	76	77	79	82	73	74	76	79
50,000	85	86	88	92	81	82	84	87	78	79	81	84
56,000	90	91	93	97	86	87	89	92	83	84	85	89
62,000	95	95	98	102	91	91	93	97	87	88	90	94
68,000	99	100	102	107	95	95	98	102	91	92	94	98
74,000	103	104	107	111	99	100	102	106	95	96	98	102
77,000	106	106	109	113	101	102	104	108	97	98	100	105

**Based on power for 1.2 x the power-off stall speed in the landing configuration (gear and flaps down).*

Figure 6–1

The use of flaps during approach and landing should be restricted to a minimum to avoid objectionable buffeting. When buffeting is encountered, maneuvering in a tight turn or flying through extremely turbulent air should, if possible, be avoided.

Note

Do not lower flaps at IAS above 122 knots with doors removed, as severe buffeting will be encountered.

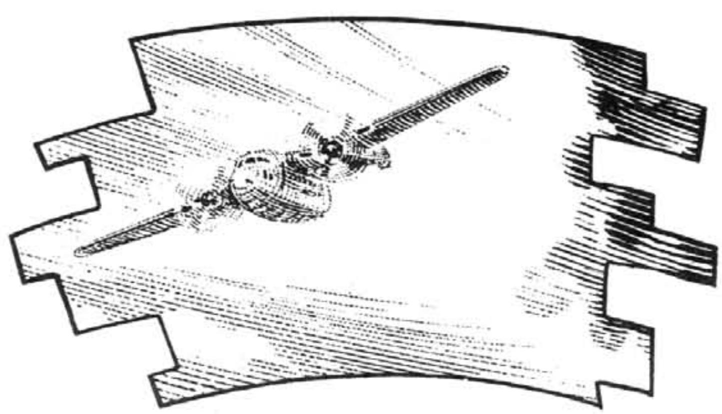
The take-off speeds chart and stall chart for flight with cargo doors off are identical to those computed for the cargo-doors-on configuration of the airplane. Additional charts containing maximum glide distances and safe single-engine airspeeds are provided to reflect airplane performance in both cargo-door configurations. A separate series of cargo-doors-off operating data charts are included in Appendix I.

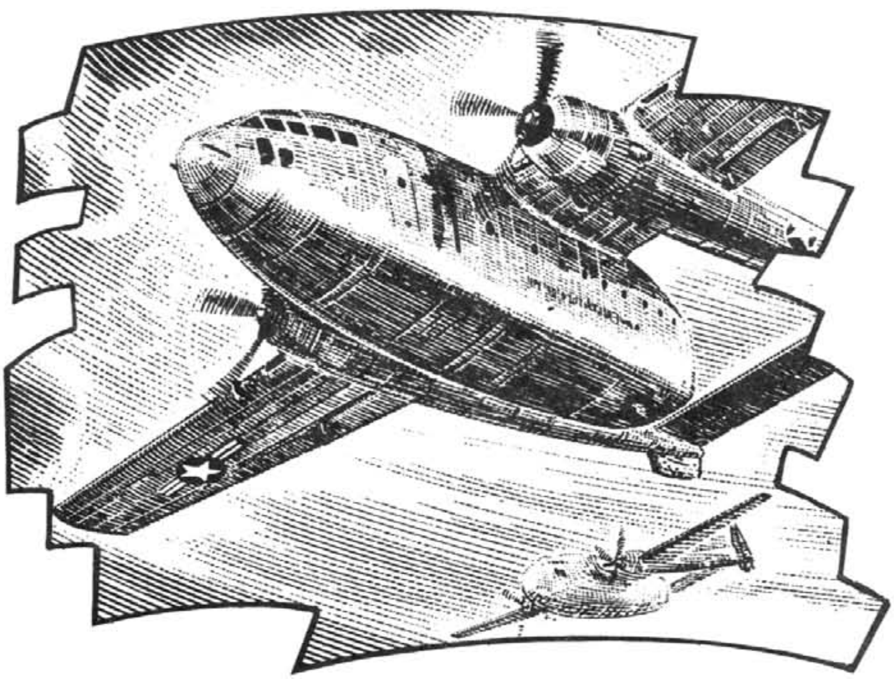
FLIGHT WITH FLIGHT OPERABLE DOOR OPEN.

On airplanes with flight operable door, buffeting may be encountered at 130 knots IAS and above when the flight operable door is open.

STALLS.

The airplane stall warning appears as aileron nibble or flutter and buffeting throughout the airplane which increases in intensity as a complete stall is approached. With landing gear and flaps extended, stall warning is encountered 5-10 knots lower than in clean configuration. With cargo doors off, elevator vibration precedes the aileron nibble normally encountered as the stall speed is approached. To prevent a complete stall or enable a safe recovery from one, the normal procedure of regaining airspeed and neutralizing controls should be employed as this airplane has no abnormal characteristics during stall recovery. Refer to stall charts, this section, for air speeds at which stalls are calculated to occur.





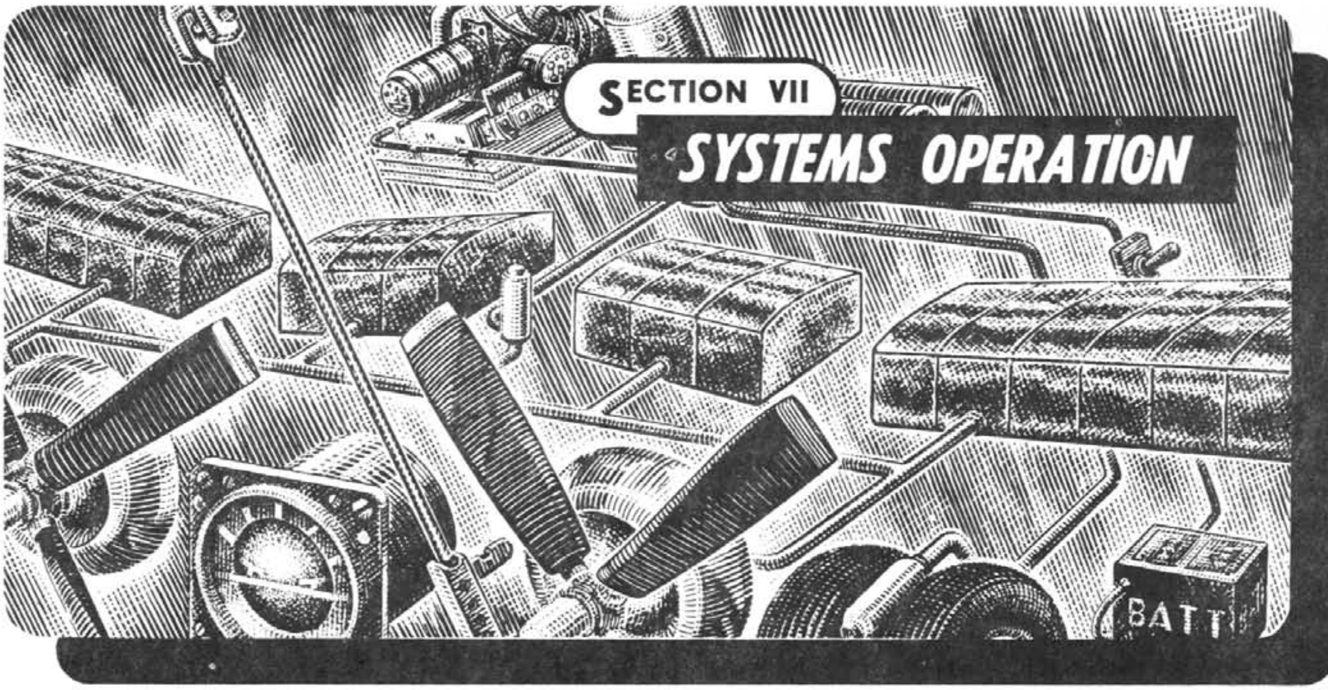


TABLE OF CONTENTS

ENGINES.

OVERBOOSTING.

As the airplane engine is not equipped with an automatic pressure regulator, power settings must be exactly obtained by manual operation of the throttle. Consequently, it is possible to overboost the engine if caution is not observed. Overboosting of the engine is a condition arising from too great a manifold pressure. Detonation, rather than normal combustion, will result, causing an abrupt pressure rise, violent pressure fluctuations, and a rapid rise in cylinder head temperatures. These conditions combine to produce destruction of the engine in a variety of ways. In order that the engine may not be overboosted, neither the manifold nor the torque pressure should be permitted to exceed the limits as prescribed in Engine Power Schedule, Appendix I.

COWL FLAP OPERATION AND CYLINDER HEAD TEMPERATURE.

The cowl flaps on the airplane, when fully open, present high drag which reduces the load-carrying capability of the airplane, as well as requires high power to maintain the desired cruise speed. Cowl flap controls are categorized as to OPEN, CLOSED, and TRAIL positions. It should be noted that the TRAIL setting of the cowl flaps is largely one of convenience and that variations from the TRAIL position during normal flight operation are not only permissible but recommended. In most conditions of flight the best result will be obtained with the cowl flaps at a setting between the TRAIL and CLOSED positions. Naturally, the reduction of the cowl flap opening will be reflected in the increased performance of the airplane as the drag is lessened. Every effort, therefore, should be made to maintain the desired balance in the relationship of cylinder head temperatures and cowl flap settings as recommended below.

It is desirable to allow as wide a range of cylinder head temperature operation as possible to facilitate temperature control. An optimum cylinder head temperature for cruise power operation has been established at 180°C. Operation at this temperature will result in maximum cylinder durability. In the event that the cylinder head temperature drops below 140° accompanied by engine instability and visible engine roughness, it is recommended that carburetor heat be used. The most important variable as far as cold weather engine instability is concerned is carburetor air temperature since most of the fuel vaporization takes place in the induction system; hence the recommendation to use carburetor heat in cold weather operation to correct cold weather engine instability. Low cylinder head temperature with a smooth running engine is not considered detrimental to the operation of the engine.

CYLINDER HEAD TEMPERATURE LIMITS.

Basically, the cylinder head temperature limit is established from two sources; namely, the physical properties of the material used in the manufacture of the cylinder head and the detonation characteristics of the cylinder head involved. It should be understood thoroughly that the temperature observed on the cylinder head temperature gage and sensed by the thermocouple is an entirely relative temperature which is used for convenience. Thus, if the cylinder head temperature, as measured by the cylinder head thermocouple, reads 200°C, there may be points in the cylinder head which are much hotter, and conversely, other points which are much cooler. It is very probable that the local hot and cool spots of a given cylinder will vary with the engine baffling and the cowl cooling ability. Thus, the temperature distribution probably varies with each installation. With these factors in mind, it is apparent that the cylinder temperature, as measured in the conventional manner, is only a very rough approximation of the actual temperature condition. The cylinder head limits are established with this in view, and if they appear low, it is only because it is desirable to have the hottest spot in the cylinder well within safe operating limits. As a further amplification of this, it is very important that ground running of the engines be limited to an absolute minimum because the air cooling, in general, is so poor that the temperature distribution over the cylinder will be very wide, and actual engine damage may be done with little or no indication from the cylinder head temperature gage.

CRUISING MIXTURE CHECK.

CAUTION

Under no circumstances should this check be made at a power setting above 2200 rpm and a torque pressure of 95 psi (manifold pressure limits not exceeded) or when alternate fuel is used.

After setting up straight and level flight for cruise at some altitude within the low blower range, accomplish the following procedure:

1. Mixture—RICH.
2. Supercharger switches—LOW.
3. Carburetor air control switches—COLD.
4. Set 2200 rpm and 95 psi torque (not to exceed the manifold pressure limits).
5. Move the mixture control to best power (maximum rise in torque pressure or the point at which the torque pressure just begins to fall off).
6. If a rise occurs, reset torque pressure to 95 psi with the throttles.

Note

With carburetor air and cylinder head temperatures the same on both engines, the manifold pressure spread between engines should not vary more than 2 in. Hg. If a greater spread exists, it should be investigated at the first opportunity.

7. Move the mixture control slowly to the NORMAL notch and note that the torque pressure drop does not exceed 10% (9.5 psi lean limit) nor is less than 5% (5 psi rich limit). Should the torque pressure drop exceed 10% when the mixture control is moved into the NORMAL notch, the mixture control may be placed at the point of the 10% drop for cruise operation.

CAUTION

The mixture control will not be moved below the NORMAL notch at any time during this check.

8. If the torque pressure drop is not within the 5%-10% limits outlined in the above step, this condition should be noted in Form 1, Part II.

CHEMICALLY CORRECT MIXTURE.

At a point somewhere between the NORMAL and RICH mixture control positions, a chemically correct fuel/air mixture is obtained. The mixture at this point is leaner than Best Power and richer than Best Economy. While chemically correct for the production of power, this mixture results in maximum cylinder head and exhaust gas temperatures because the temperature of the gases in the combustion chamber lacks the cooling effect of either an excess of air or fuel. Operation in this chemically correct mixture can be detrimental to cylinder, spark plug, exhaust valve, exhaust valve seat, and power recovery turbine unit life and should be avoided.

The actual temperature difference of the cylinder head between Best Power and chemically correct mixture operation is not very great. However, the difference is significant in that operation at Best Power (leaner than the chemically correct mixture) will result in a lowering of the cylinder head temperature and thereby will decrease the cowl flaps angle required under critical cooling conditions. At Best Power less air is required because of the leaner mixture strength; the excess air passes through the combustion chamber and aids in cooling.

TORQUE PRESSURE GAGE FLUCTUATIONS.

Torque pressure fluctuation occurs predominantly in the cruise range or up to the point at which automatic carburetor enrichment occurs. A torque pressure gage fluctuation of $\pm$ 3 psi should be no cause for concern if engine operation is smooth as determined by visual inspection and feel, since this type of fluctuation is generally caused by engine torque impulses which become more noticeable as the mixture control is leaned from Best Power toward the NORMAL notch. Under fluctuating conditions, the mean reading of the torque pressure gage should be used. The mixture control should not be moved out of the NORMAL notch merely to stop torque pressure gage fluctuations because the cylinder head and exhaust gas temperatures reach their maximum values in the vicinity of the chemically correct mixture. Refer to CHEMICALLY CORRECT MIXTURE above.

Fluctuation of the torque pressure gage is sustained because of insufficient damping of the gage. However, heavy or improper damping sufficient to eliminate the fluctuation could result in an undesirable gage sluggishness.

Marginal ignition wiring (coils, distributors, and leads), two or three weak spark plugs, and weak compression in one or more cylinders can cause torque pressure fluctuations greater than $\pm$ 3 psi fluctuations noted above, but this fluctuation is generally accompanied by engine roughness. With an engine operating normally, however, it has been proven conclusively by tests that torque pressure fluctuation is increased only by extremely lean mixture strengths. Any marginal leanness accompanied by marginal ignition wiring, etc., will produce unwarranted fluctuation of the torque pressure gage and, perhaps, engine roughness.

Torque pressure fluctuations accompanied by a slightly rough engine can occur without a fluctuation in rpm. Thus a fluctuation in rpm, alone, is not always indicative of engine roughness.

REVERSE LOW-FLOW TORQUEMETER (On R-3350-89A Engines).

On R-3350-89A engines, a reverse low-flow type torquemeter is installed. Inasmuch as the torque pressure lines differ slightly from those installed on R-3350-85 and -89 engines, torque pressure readings on -89A engines are normally approximately 3 psi higher. During ground operation, all torque pressure readings taken below 1600 RPM should be disregarded, provided satisfactory indications are observed above 1600 RPM.

SPARK PLUG FOULING.

During prolonged periods of ground engine operation, spark plugs may become fouled. Should this occur, as indicated by magneto check, the following procedure is recommended:

1. Adjust throttles to 1200 rpm.
2. Lean toward IDLE CUT OFF to establish Best Power (maximum rpm for minimum manifold pressure) and run for two minutes.

Note

A very gradual movement of the mixture control is essential. If the lever is moved too rapidly, it is possible to lean past the point of Best Power without noticing it.

3. Return mixture control to RICH and repeat magneto check.

Note

This procedure is known as "Low Burn Out" and is recommended to prevent fouled plugs from acting as glow plugs. There is also less chance of damaging the plugs by excessive temperatures. A fouled plug rendered incandescent by excessive heat acts as a glow plug and usually will not be detected in a magneto check.

CAUTION

If prolonged idling is anticipated, place mixture control at Best Power to eliminate possibility of spark plug fouling.

CALCULATION OF BRAKE HORSEPOWER.

The basic formula for calculating horsepower may be stated as follows:

$$HP = \frac{FT\text{-}LBS/MIN}{33{,}000}$$

In discussing aircraft engines, however, the term brake horsepower is used, which means the power required to brake the shaft at a particular RPM. In this case the formula is stated differently in order to permit the use of RPM and TORQUE in calculating engine power output.

First of all consider torque (FT-LBS) as the product of a braking force (LBS) applied to a shaft, times the radius (r) of the shaft:

$$TORQUE = force \times radius$$
$$= (LBS \times (r)$$

Now consider the distance through which the force acts during one revolution of the shaft:

$$distance = (2\pi) \times (r)$$

It is now possible to calculate the work performed by the brake during one revolution:

$$work/rev. = force \times distance$$
$$= (LBS) \times (2\pi) \times (r)$$

However, since TORQUE is equal to force (LBS) x radius (r), the expression becomes:

$$work/rev. = TORQUE \times 2\pi$$

Now by forming the product of work/rev. and RPM, it is possible to determine the work/min. or power developed by the shaft (absorbed by the brake):

$$power = TORQUE \times 2\pi \times RPM\ (FT\text{-}LBS/MIN)$$

This power, expressed in ft-lbs/min. may now be converted to brake horsepower by the basic formula:

$$BHP = \frac{FT\text{-}LBS/MIN}{33{,}000} \text{ or } \frac{TORQUE \times 2\pi \times RPM}{33{,}000}$$

Where TORQUE is expressed in ft-lbs. developed at propeller shaft, and RPM is the propeller speed. Since the torque is measured hydraulically (psi on the torque-meter) it must be converted to ft-lbs. before it can be used in the formula. Likewise, engine speed (RPM on the tachometer) must be converted to propeller speed before it can be used in the formula. If the horsepower constant, 33,000, and the constant factor 2π are combined with the constants used to convert torque oil pressure to ft-lbs. and engine speed to propeller speed, one constant can be determined to simplify the formula. This constant is calculated by the engine manufacturer and is known as the torque-meter constant. The formula then becomes:

$$BHP = \frac{TOP \times RPM}{K}$$

where TOP is torque oil pressure read directly from the torquemeter; RPM is engine speed read directly from the tachometer; and K is the torquemeter constant (142 in this case).

HOT FUEL PRIME SYSTEM.

The primary cause of difficulties in starting reciprocating engines at low temperatures is the poor vaporization of fuel. Although special fuels have been developed with vapor pressure high enough for satisfactory vaporization at very low temperatures, the attendant disadvantages of carrying two types of fuel and employing two different priming systems are at once apparent. However, tests have proven that engine starting in extreme cold weather is much less difficult if the fuel normally used is heated prior to priming.

COMPONENTS.

The hot fuel priming system installed by compliance with T.O. 1C-119-549 is installed in series with the normal engine priming system. The installation in each nacelle is complete in itself; the two are in no way connected. A Janitrol hot fuel priming unit is mounted on the firewall of each nacelle; a control switch and two fuel temperature gages are installed in the crew compartment. The hot fuel priming unit basically consists of a blower assembly, ignition unit, burner, heater exchanger and controls for automatic regulation of fuel flow and fuel pressure as well as temperature. The blower is a motor-driven axial vane type blower which supplies air to support combustion inside the burner and to lower surface temperatures of the unit. The ignition unit converts 28-volt dc to high voltage oscillating current capable of producing a continuous spark at the gap between the spark plug and the ground electrode, both of which are mounted in the burner section. The burner provides an area for combining fuel and air and igniting this combustible mixture. The fuel spray nozzle, spark plug and ground electrode are mounted in the wall of the burner in such a manner that ignition of the fuel/air mixture is assured. Air for combustion enters the burner through a series of perforations in the burner wall. The heat exchanger consists of two stainless steel coils of .25 inch diameter tubing which are connected in parallel and through which the fuel for priming is heated. The heat exchanger extends through the burner. A reservoir with a capacity of approximately 1 pint is welded to the outlet end of the heat exchanger coils. Two thermal switches, one a cycling switch and the other a limit switch, are submerged in the fuel in the reservoir. Each thermal switch controls the operation of its respective solenoid valve in the fuel line to the burner and automatically regulates the temperature of the fuel. A temperature sensing device also installed in the reservoir transmits the temperature of the fuel to a temperature gage on the instrument panel. Control of the fuel pressure and fuel flow to the burner is provided by a regulator which reduces fuel pressure to 22 psi.

OPERATION.

Complete operation of the hot prime equipment in each nacelle is controlled by use of the hot prime switch on the overhead panel. When, for example, the switch is placed in the R position, the primer

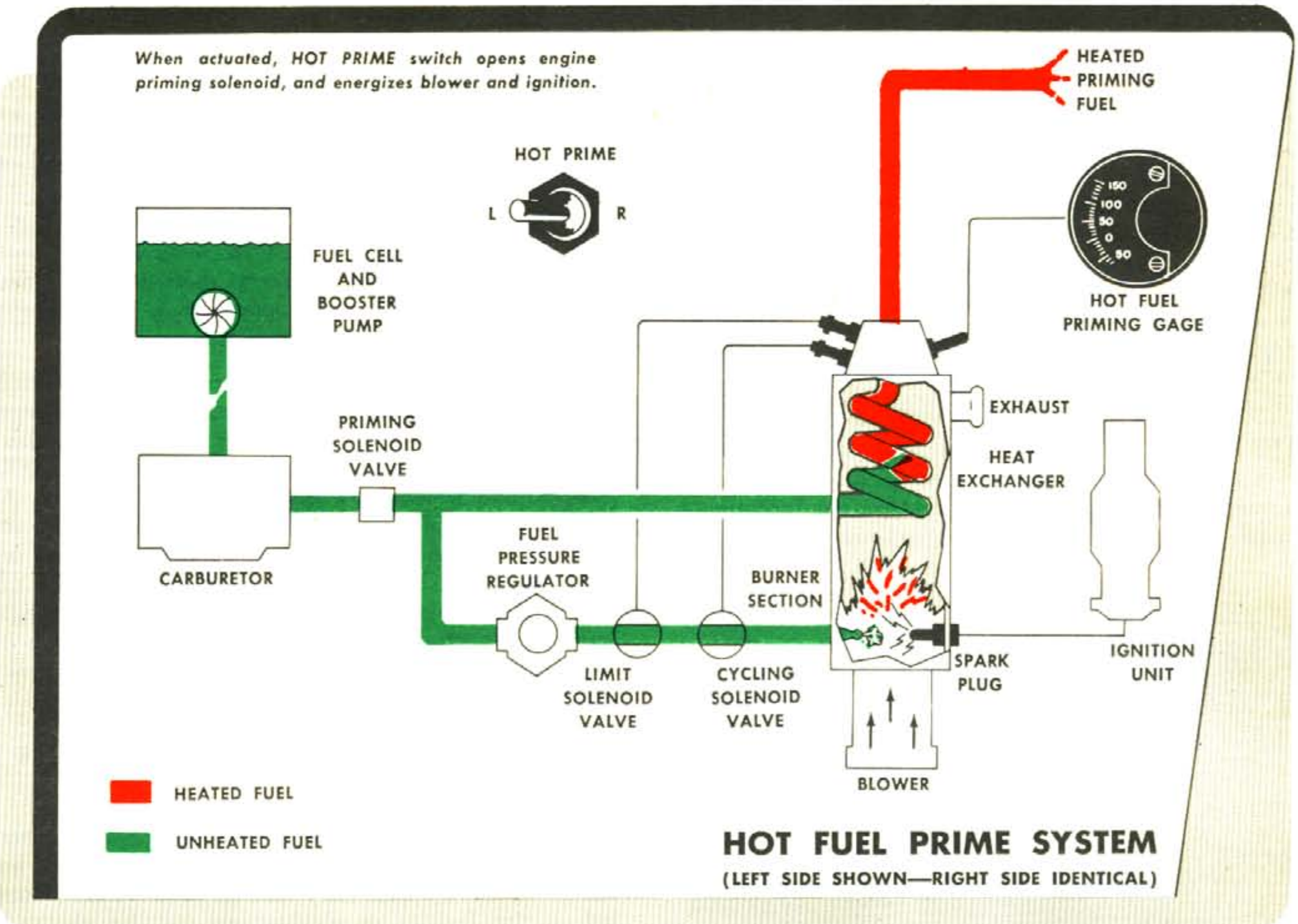


Figure 7–1

solenoid valve on the right engine carburetor opens and the blower of the right hot fuel priming unit operates to supply air for combustion and cooling. The blower and solenoid valve remain energized as long as the switch is held in the R position. Fuel under boost pump pressure flows into the heat exchanger coils and into the burner. The spark produced by the ignition unit ignites the fuel in the burner; heating of the priming fuel in the heat exchanger coils is almost instantaneous since the rate of heat transfer through the stainless steel coils is very rapid. The heated fuel then flows into the reservoir at the outlet end of the heat exchanger coils and to the three priming nozzles around the supercharger rear housing. Automatic regulation of the fuel temperature is provided by the two thermal switches in the reservoir. When the fuel temperature reaches 180°F (84°C), the cycling switch closes which, through the action of a relay, causes the cycling solenoid valve in the burner fuel supply line to close. The ignition unit remains operative and as the temperature of the fuel in the reservoir drops to the opening temperature of the cycling switch, the switch breaks contact and a circuit is completed through the relay to the cycling solenoid valve. Fuel again flows to the burner and the above cycling sequence occurs as long as the hot prime switch is held in the R position. Should the temperature of the fuel in the reservoir reach 220°F (104°C), the limit thermal switch closes, causing a second relay to open which de-energizes the ignition unit as well as the cycling and limit solenoid valves. The blower continues to operate to provide cooling. Although the ignition and fuel supply to the burner are cut off, fuel flow for priming continues. As the temperature in the reservoir drops to the opening setting of the limit thermal switch, the switch opens and heater operation resumes. Exhaust gases are ducted from the exhaust well of the hot fuel prime unit to an exhaust port in the secondary cowling panel.

PROPELLERS.

PROPELLER REVERSING.

The reversible pitch propeller is a valuable feature which, when properly used, increases safety and utility of the airplane. However, it is important to point out the undesirable consequences which result from improper use of this device. When the throttles are lifted over the stop and placed in the reverse pitch range, the engine continues normal operation, but with this significant exception: the direction of airflow to the engine cooling passages is reversed, the cowl flaps no longer regulate the airflow through the engine as effectively as in forward thrust operation, and increased temperatures develop around the engine.

The undesirable effects of continued propeller operation in reverse pitch, unfortunately, do not show up immediately and are not indicated on the instrument panel. The cylinder head temperatures do not rise alarmingly as the reserve heat capacity permits the bulkier portions of the engine to absorb heat without appreciable temperature increase. The damage is done to smaller parts which do not have this capacity and are formed of rubber or rubber compounds. The use of the propeller to brake the landing roll does not result in critical temperature conditions. The cooling-off during approach, the forward motion of the airplane, and the relatively short interval of reverse pitch operation serve to keep temperatures below the damaging level. The type of reverse pitch operation that is damaging to the engine is that which sustains an unfavorable condition over an extended period. This includes backing of the airplane, maneuvering, or continued operation in reverse pitch for checks, instructional purposes, or demonstrations. It is recommended that reverse thrust be employed for braking and only such other conditions as is absolutely required.

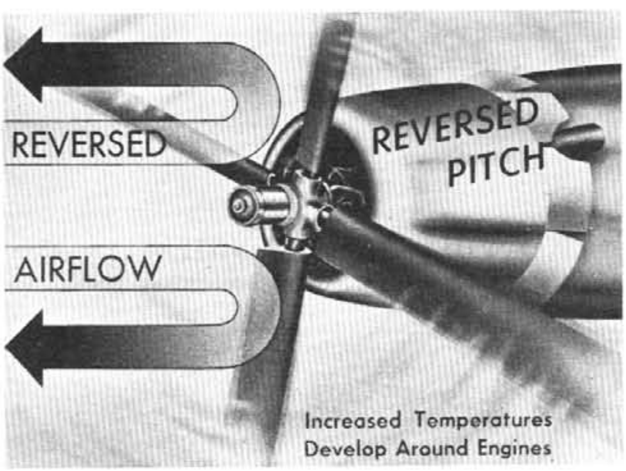


Figure 7–2

PROPELLER CHECK FOR REVERSE PITCH OPERATION.

It has been noted that reversible pitch propellers do not always return to forward pitch after reversing. In some instances it is not evident that the propellers are still in reverse pitch until oil temperatures and cylinder head temperatures go overboard. As oil and cylinder head temperature gages are very slow to indicate that propellers are still in reverse pitch and engine damage is possible due to sustained heat conditions during reverse pitch operation, it is important to recognize reverse pitch operation.

To insure that the propellers have returned to forward pitch after reverse thrust operation, watch for a surge in rpm as propellers are unreversed. As a further check, move the propeller controls to the FEATHER position and watch for a drop on the tachometers. A rise in rpm indicates that the propeller is still in reverse pitch. As soon as the rpm begins to rise or fall, the propeller levers should be moved out of FEATHER position. This check should be made immediately after reverse pitch operation if there is any doubt that the propeller did not return to forward thrust.

HYDRAULICALLY CHARGING THE PROPELLER ACCUMULATOR.

If the propeller blades do not move toward the feather position during the static feathering check, it will be necessary to hydraulically charge the accumulator before the feathering mechanisms can be checked. The following procedure should be employed to charge the accumulator:

1. Start the engine and allow temperature and pressures to reach desired ranges (minimum operating range).

2. With propeller control lever in INCREASE RPM, adjust throttle to 1800 rpm.

3. Rapidly move propeller control lever into full FEATHER position and hold only until rpm reaches approximately 1200 rpm. Immediately return propeller control lever to INCREASE RPM position. Repeat this step 3 times.

4. With the propeller control lever in INCREASE RPM position, reverse the propeller and adjust throttle to obtain 1700-1800 rpm. Hold this power for not less than 15 seconds.

CAUTION

Do not run propeller in reverse for an extended period as extremely high engine temperatures may result.

5. Return propeller to forward thrust operation. System will be purged of air and accumulator will be hydraulically charged.

FUEL MANAGEMENT.

The sequence of fuel tank usage during normal operation depends on fuel first being used from the tanks to which the carburetor vapor return line is routed. On some airplanes the vapor return lines return fuel from the carburetors to the outboard tanks. On airplanes AF53-7840 thru 53-7884, AF53-8153 thru 53-8156 and IK450 thru IK466, the vapor return lines were rerouted at the time of production to return fuel to the inboard tanks. Compliance with T. O. 1C-119-538 also will route the vapor return lines to the inboard tanks. These two configurations of the vapor return lines necessitate the different fuel management sequences outlined below.

MAIN FUEL SYSTEM.

NORMAL OPERATION.

The fuel, oil and hydraulic shut off switches are turned to the NORM position to open the shut off valves at the firewall. The fuel booster pump switches are placed in NORMAL ON for starting, climb, all crossflow operation, heater operation (engines not operating) and whenever required to reduce fuel pressure oscillation. The EMERG. ON position of booster pump switches is utilized for take-offs, landings, and during operation with an engine-driven fuel pump inoperative.

Note

> To pressurize the fuel system when the engines are not running, first turn fuel booster pump switches to NORMAL to allow pressure to stabilize; then turn to EMERG. ON if additional pressure is required.

On airplanes with vapor return lines routed to the inboard tanks, the sequence of tank selection is as follows: place fuel selector switches in INBOARD position at the time of starting the engines and continue using the fuel from the inboard tanks until that supply is depleted. Then switch to OUTBOARD for the remainder of the flight.

On airplanes with vapor return lines to the outboard tank, sequence of tank operation is as follows: place fuel selector switches in OUTBOARD position for warm-up, take-off and climb. By doing so, space is provided in the outboard tanks for fuel return from the carburetor. After the initial climb, selector switches are switched to INBOARD and fuel used from inboard tanks until supply is depleted. Flight then is completed on outboard fuel with selector switches in OUTBOARD.

CROSSFLOW OPERATION.

Either engine can be supplied from any one of the tanks by use of crossflow lines, but fuel cannot be transferred from one tank to another in flight. Either tank may be used to supply both engines by placing selector switch of empty tank to CROSSFLOW and selector switch of full tank to OUTBOARD or INBOARD. In case of engine failure, fuel in dead engine tanks may be used by placing selector switch of dead engine in OUTBOARD or INBOARD; fuel, oil and hydraulic shut-off switch of dead engine in SHUT; and selector switch of live engine in CROSSFLOW.

Note

> Turn the booster pump switches to NORMAL ON during all crossflow operations.

AUXILIARY FUEL SYSTEM.

SEQUENCE OF OPERATION (On Airplanes With Vapor Return Lines to the Inboard Tanks.)

When the auxiliary fuel system is used, the sequence of operation should be warm-up, take-off, and climb to altitude on the inboard tanks to provide space for vapor return from the carburetor; then use auxiliary fuel supply. When this supply is depleted, revert to main fuel system using inboard tanks first, then outboard tanks.

SEQUENCE OF OPERATION (On Airplanes With Vapor Return Lines to the Outboard Tanks.)

When the auxiliary fuel system is used, the sequence of operation should be warm-up, take-off, and climb on the outboard tanks to provide space for vapor return from the carburetor, then use auxiliary fuel supply. When this supply is consumed, revert to main fuel system using inboard tanks first, then outboard tanks.

TO OBTAIN AUXILIARY FUEL.

To make transition from the main fuel system, turn auxiliary fuel booster pump switch to ON and open both auxiliary fuel shut-off valves. (The valve in the cargo compartment ceiling should already be in the open position). The right engine will then be using fuel from both the auxiliary fuel tanks and either the right inboard or right outboard tank, depending upon the position of the right fuel selector switch. The right fuel selector switch should then be placed in CROSSFLOW position. This switch movement shuts off fuel flow from the right main tank and opens the crossflow valve, thus permitting the engines to operate on both auxiliary fuel and the main tank indicated by the position of the left fuel selector switch. Transition is then completed by movement of the left fuel selector switch to CROSSFLOW, which shuts off fuel flow from the left main tank. To properly purge air from auxiliary fuel system lines when switching to auxiliary fuel, the main fuel system booster pump switches should be in the OFF position.

J-8 ATTITUDE INDICATION

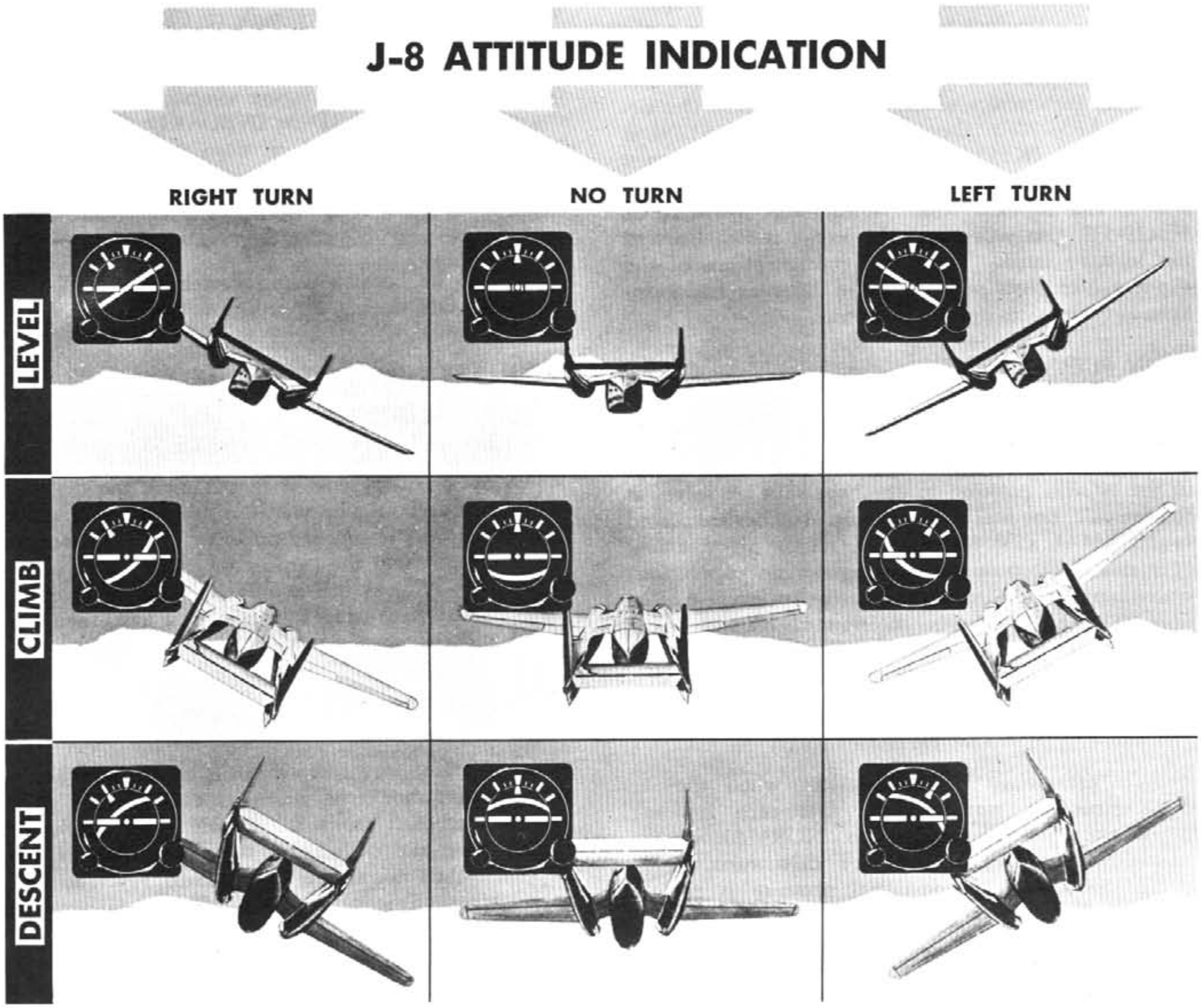


Figure 7–3

TO SWITCH FROM AUXILIARY FUEL.

Should the use of auxiliary fuel be continued until the supply is depleted, there is a possibility of the engine-driven pumps drawing air into the fuel lines which could cause engine stoppage. To prevent this, the auxiliary fuel supply should be checked periodically, using the dipstick attached to the filler cap. When almost empty, transition to the main fuel system should be made.

To make transition from auxiliary tank operation to main fuel system, turn left and then right selector switches to INBOARD pausing for approximately one minute after each selection to insure proper operation.

Then turn the auxiliary fuel booster pump switch OFF and close the auxiliary fuel tank shut-off valve located at the aft end of the rear tank. Leave the auxiliary fuel system shut-off valve in the cargo compartment ceiling OPEN; this will prevent possible damage in the valve and lines from thermal expansion of the trapped fuel. Run engines up to normal rated power for two minutes as a final check to assure that complete transition has been made.

INSTRUMENTS.

ATTITUDE INDICATOR.

The type J-8 attitude indicator (gyro horizon, vertical gyro) installed in the airplane, provides constant visual indication of the flight attitude of the airplane in pitch and roll, with a minimum amount of attention from the pilot. Power for the instrument gyros is from the 115-volt alternating current supply. The instrument has freedom of rotation of 360 degrees about the roll axis and effective freedom of 360 degrees about the pitch axis.

The degree of climb or dive, up to 27 degrees, is indicated by the displacement of the horizon bar with respect to the adjustable miniature airplane. Should the degree of climb or dive exceed 27 degrees, the increased angle is indicated by reference of the miniature airplane to graduations on the sphere and also by the word CLIMB or DIVE which will appear on the sphere. Aircraft attitude about the roll axis is shown by the angle between the miniature airplane and the horizon bar and also by the bank pointer relative to the degree markings.

CAGING.

The J-8 attitude indicator may be caged manually by pulling the pull-to-cage knob which operates a gyro centering device. The knob should be pulled smoothly away from the face of the instrument since a violent or hard pull may damage the instrument. A momentary stop will be felt when the bank caging mechanism is engaged; as the knob is pulled further out, the pitch caging mechanism is engaged. As soon as the knob reaches its limit of travel, it should be quickly released; otherwise an error may be introduced.

Note

To check that caging knob has released completely after pulling, push knob against instrument case after it has been released. If further travel is noticed or if gyro precesses, the caging mechanism is not releasing properly and may result in later tumbling of gyros.

There are only two conditions that necessitate caging of the instrument by the pilot.

1. After power is applied, allow 30 seconds for the gyros to gain speed. However, the instrument should be caged immediately thereafter to prevent torque stresses on the instrument mechanism.

2. Due to acceleration forces acting on the instrument mechanism during prolonged turns, errors in pitch and bank may be noted upon return to straight and level flight. This error is commonly referred to as "sluggishness" or "lag." Though the instrument will immediately begin to correct this error, the pilot may speed this correction by manually caging the instrument.

Note

It is essential that the pilot realize that the indicator cages to the attitude of the aircraft and not to true vertical. Therefore, the instrument should never be caged to correct in-flight errors unless the aircraft is in straight and level flight by visual reference to a true horizon.

SURFACE CONTROL BOOST TABS.

ELEVATOR SPRING TAB SYSTEM.

The elevator spring tab system is self-contained within the elevator surface and operates automatically with control column movement. The elevator horns, on opposite ends of the elevator, are interconnected through the elevator surface and balanced in neutral by means of a spring cartridge tied into the interconnecting linkage. A push-pull rod also tied into the linkage is connected to the spring tab surface. When the air load on the elevator is less than the spring cartridge preload, the elevator horns and interconnecting linkage is held in neutral and elevator surface movement is accomplished without assistance from the spring tab. When the air load on the elevator surface is greater than the spring cartridge preload, the elevator surface will tend to stay neutralized and pilot effort on the elevator horns will compress the spring through the interconnecting linkage and at the same time move the tab surface in the desired direction to assist in elevator movement.

RUDDER SPRING TAB SYSTEM.

Rudder spring tabs are provided on the lower trailing edge of each rudder. The spring tab actuating mechanisms are located immediately below the rudder surfaces in the boom tail cones. The spring tab surface is attached to the rudder torque tube assembly by a horn and push-pull rod mechanism. When no air load is applied to the rudder surfaces, the spring tab mechanism transmits cable motion from the rudder pedals directly to the rudder surfaces, and the spring tab remains in the neutral position. With an air load on the rudder surfaces, the rudders will resist the motion applied by the cables and the torque tube will be twisted by the opposing forces. However, the tab surface is mechanically linked to the torque tube assembly on the cable side and will be deflected in the proper direction to assist the pilot effort in moving the rudder surfaces. Two pre-loaded spring cartridges are installed on each main rudder horn to return the spring tabs to neutral upon release of rudder pedal pressure.

AILERON FLETTNER TAB SYSTEM.

A flettner tab is incorporated into the trailing edge of each inboard aileron. A push-pull rod extending from the flettner tab horn on the outer wing panel to a bracket located on the inboard leading edge of the tab transmits aileron travel to the flettner tab. When the control wheel is moved, the cable assembly transmits the motion to the ailerons. Movement of the ailerons is transferred to the tab, itself, by the push-pull-rod attached to the flettner tab horn off the aileron hinge centering line. Aileron travel in either direction always actuates the flettner tab in an opposite direction, thereby reducing loads placed on the control wheels in flight.

AERIAL DELIVERY SYSTEM.

PRE-TAKE-OFF CHECK.

For missions involving monorail drop, the following checks should be performed in addition to the normal interior checks for all flights. Refer to aerial delivery placard on left hand side of fuselage.

1. Check that the canvas guide curtain has been properly installed to prevent excessive movement of the paratainers.
2. Check that the anchor cable is properly installed and each paratainer static line is attached to the anchor cable.
3. Check that the red arm monorail stop switch is in the six o'clock position.
4. Check that the locking plunger on each trolley is firmly seated in the monorail recess to assure positive locking action when the trolleys are in the loaded position on the monorail.
5. Check that the hinged floor section is sufficiently open to accommodate the largest paratainer to be dropped and that the securing rods are secured in place.

EQUIPMENT DROP SYSTEM.

PRE-TAKE-OFF CHECK.

For heavy drop missions, the following checks should be made in addition to the normal interior checks.

1. Check the position of the load in the airplane and verify the proper location of the center of gravity of the loaded airplane.
2. Check that no individually rigged load violates a minimum weight of 2500 pounds nor a maximum weight of 21,000 pounds.
3. Check that adequate provisions for restraining the cargo within the cargo compartment during take-off and in flight have been provided. When the cargo to be delivered is mounted on metal, load bearing-type platforms, check that the tie-down devices are secured to the tie-down rings incorporated into the platforms and the tie-down fittings in the airplane floor. When the vehicles or cargo are mounted on wooden, non-load bearing, skid-type platforms, check that the tie-down devices are secured directly to the vehicles and cargo being delivered and the tie-down fittings in the cargo compartment floor. When the cargo is to be delivered in aerial delivery containers and platforms are not used, check that the tie-down devices secure the containers in position on the cargo floor. The tie-down devices should not be fastened to the fittings in the cargo floor in such a manner that restraint is applied around the containers.
4. Ascertain that the drop loads are correctly rigged and proper parachutes employed.
5. Check that the wheeled conveyors are properly secured to the tie-down fittings with conveyor clamps and that the forward and side buffer assemblies are correctly installed to prevent damage to either the airplane or the equipment during ejection.
6. Check that the loading jacks have been removed from their normal position at the aft end of the cargo compartment and stowed in a position where no interference with the load being ejected will occur.
7. Make certain that a means of emergency exit is provided for crew and personnel stationed in the cargo compartment.

TABLE OF CONTENTS

PILOT AND COPILOT.

Inasmuch as the whole of this handbook has been directed toward the functions required of the pilot and copilot, any restatement of their duties and responsibilities would tend to be repetitious. It may be noted, however, that command within the plane is held by the pilot upon whom ultimately falls the responsibility for the performance of the plane and crew during any specific mission. Procedures then, are determined by his decisions and executed on his orders. The copilot assists the pilot in flight operation, and undertakes control of the airplane at the command of the pilot. Should the pilot become incapable of executing the mission due to sickness, injury, death, etc., the copilot assumes command and, likewise, the responsibility for the performance of the plane and crew in the accomplishment of the mission.

NAVIGATOR.

The responsibilities of the navigator by virtue of his capacity and station in airplane are as follows:

BEFORE ENTERING AIRPLANE.

1. Review information on mission obtained at briefing.
2. Check personal gear for completeness.
3. Assist in exterior inspection of airplane.

ON ENTERING THE AIRPLANE.

1. Check driftmeter.
2. Check oxygen equipment at his station.
3. Check lights at his station.
4. Check that appropriate and necessary publications are being carried.
5. Check pyrotechnic equipment stowed.
6. Check astrodome hatch secured.
7. Check seat and safety belt for proper adjustment.
8. Check interphone panel at his station.
9. Make necessary pre-flight check of electronic navigational equipment.
10. Report on condition and operation of equipment checked.

BEFORE TAKE-OFF.

1. Take position at station for take-off and tighten safety belt.

DURING FLIGHT.

1. Inform pilot of any equipment at his station which becomes inoperative.

EMERGENCY PROCEDURE.

Refer to ditching and forced landing charts in Section III, this handbook, for navigator's duties and responsibilities during these emergencies. The navigator is also responsible for:

1. Shutting off his equipment in event of electrical system failure.
2. Assistance in emergency operation of landing gear or wing flaps.
3. Assisting in fighting fire.

BEFORE LANDING.

1. Turn off all equipment at his station if its use is not dictated by necessity.
2. Take position at station for landing and tighten safety belt.

AFTER LANDING.

1. Turn off and secure all equipment at his station.
2. Reinform pilot of all inoperative equipment at his station.

RADIO OPERATOR.

The responsibilities of the radio operator by virtue of his capacity and station in the airplane are as follows:

BEFORE ENTERING THE AIRPLANE.

1. Check antennas in exterior inspection for security and cleanliness.
2. Check personal equipment for completeness.

ON ENTERING THE AIRPLANE.

1. Check that emergency axe is stowed.
2. Check operation of oxygen equipment at his station.
3. Check operation of interphone equipment at his station.
4. Check that first aid kits in crew compartment are stowed.
5. Check crew compartment fire extinguisher.
6. Check operation of all radio equipment at his station and insure that it has been checked as required in T. O. 1C-119B-6.
7. Report to pilot on condition and operation of equipment checked.

BEFORE TAKE-OFF.

1. Tighten safety belt and prepare for take-off.

DURING FLIGHT.

1. Report to pilot any equipment at his station which becomes inoperative.
2. Reel in trailing antenna, if installed, before aerial drop.

EMERGENCY PROCEDURES.

Refer to ditching and forced landing charts in Section III, this handbook, for radio operator's duties and responsibilities during these emergencies. The radio operator is also responsible for:

1. Turning off all radio equipment during electrical system malfunctioning or failure.

BEFORE LANDING.

1. Retract trailing antenna, if installed.
2. Turn off all non-essential radio equipment.

AFTER LANDING.

1. Turn off and secure all equipment at his station.
2. Reinform pilot of any inoperative equipment at his station.

FLIGHT MECHANIC.

The responsibilities of the flight mechanic by virtue of his capacity and station in the airplane are as follows:

BEFORE ENTERING THE AIRPLANE.

1. Check personal gear for completeness.
2. Insure that the exterior and interior checks of the airplane have been accomplished as required in T. O. 1C-119B-6.

ON ENTERING THE AIRPLANE.

1. Check operation of cargo compartment interphone stations.

2. Check for stowage and availability of cargo compartment first aid kits.

3. Check that all hatches, doors, and entrance ladder are secured.

4. Check cargo tied down properly, or paratroops, if carried, are seated and prepared for take-off.

5. Check hand fire extinguishers in cargo compartment for location and pressure.

6. Report to pilot on condition of equipment checked.

BEFORE TAKE-OFF.

1. Start APP, if required.

2. Take position at station and tighten safety belt.

DURING FLIGHT.

1. Stop APP, if used, after take-off and subsequent climb has been completed.

2. Conduct periodic inspections of cargo to insure proper tie-down is maintained.

3. Conduct hourly inspections of the engines.

4. Regulate cargo heat and lighting as required.

5. Report to pilot the failure of any equipment for which he is responsible.

6. Operate emergency pressure release valve to depressurize the hydraulic system (as directed by the pilot).

EMERGENCY PROCEDURE.

Refer to ditching and forced landing charts in Section III, this handbook, for flight mechanics' duties and responsibilities during these emergencies. Flight mechanic is also responsible for:

1. Starting APP in case of generator failure.

2. Assisting in emergency operation of landing gear and wing flaps.

3. Assisting in fighting fires.

4. Resetting field control relay in cargo compartment if relay cannot be reset by generator control switch.

5. Manual starting of APP if occasion arises.

BEFORE LANDING.

1. Start APP, if required.

2. Check landing gear.

3. Tighten safety belt and prepare for landing.

AFTER LANDING.

1. Shut down APP, if used, when airplane is parked.

2. Reinform pilot of any malfunctioning or inoperative equipment.

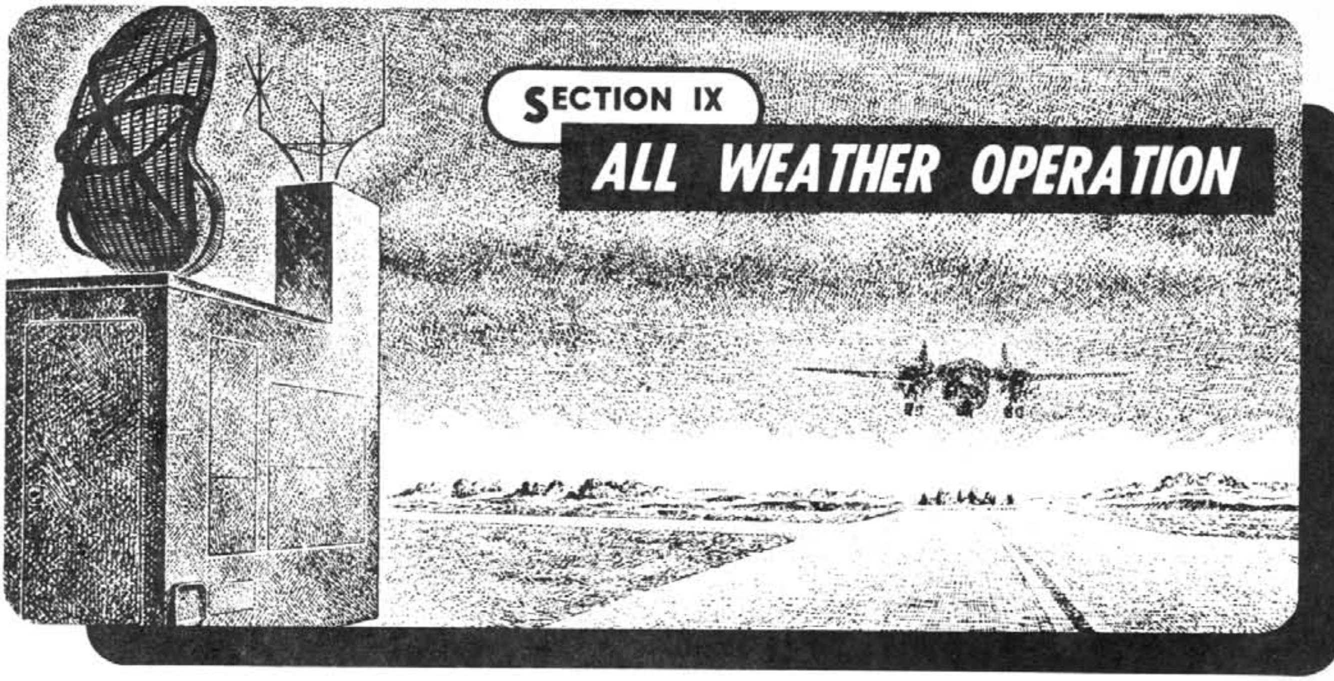


TABLE OF CONTENTS

Note

The function of this section is to set forth the proper techniques and procedure for all weather operation that necessarily supplement rather than differ from those instructions for normal operation covered in Section II, this handbook. Although some repetition is necessary in obtaining emphasis, clarity or continuity of thought, the scope of this section is essentially concerned with operation as it is affected by various weather and climatic conditions.

INSTRUMENT FLIGHT PROCEDURES.

Note

In presenting the various phases of instrument flight, no attempt has been made to set forth a statement of the instrument technique necessary to perform that particular operation. Rather, a check list of specific functions which demand consideration and compliance is supplied. Refer to appropriate Technical Orders and Training Manuals for complete operation of navigational and communicative aids which form the basis of instrument flight.

This airplane is easily adapted to instrument flight in that provisions are made for a pilot and copilot (each with a separate set of flight controls and flight instruments), and a navigator and radio operator, who form a team for the coordination of all information necessary during instrument flight conditions. The airplane is provided with adequate instrumentation and electronic aids to cover practically all conditions of instrument flight; no special technique due to airplane configuration and operation is required.

INSTRUMENT TAKE-OFF.

Prior to instrument take-off, check all lighting facilities, pitot heaters, anti-icing and heating systems.

1. Do not use flaps unless the length of the runway requires that a short field take-off be made.

2. Hold directional control with nose wheel steering up to 60 knots at which time adequate rudder control is available.

3. Lift the nose wheel off with positive action at recommended take-off speed for the gross weight involved, maintaining take-off attitude by reference to attitude gyro.

4. When it becomes certain that airplane will remain airborne, retract landing gear.

5. Upon reaching an altitude which insures obstacle clearance, accelerate to best rate-of-climb speed and reduce power to normal rated. Make certain that airplane continues to climb during this transition.

INSTRUMENT CLIMB.

Use normal climbing speeds and attitudes that have been found to be satisfactory under visual flight operations.

INSTRUMENT CRUISING FLIGHT.

During cruising flight no unusual discomforts should be experienced by the crew. Use of the automatic pilot, if conditions permit, will lessen pilot strain. By alternately assuming control of the airplane at half-hour intervals, the pilot and copilot will experience less fatigue and greater concentration of effort necessary for instrument flight will be possible.

RADIO AND NAVIGATIONAL EQUIPMENT.

During instrument flight, radio and navigational equipment may be affected to some degree by precipitational crash static. The radio compass is, perhaps, more vulnerable to rain static than the other equipment.

DESCENT.

Employ the same technique as previously outlined for descents under visual flight conditions in Section II, this handbook.

HOLDING.

For holding patterns keep gear and flaps up and power for level flight at 30-40 knots above power-off stall speed.

INSTRUMENT APPROACHES.

The airplane is equipped and capable of performing any type of instrument approach now in common use. No unusual or special techniques are required in adapting the airplane to permit utilization of these devices. Refer to Radio Range, GCA, and ILS approach diagrams, figures 9–1, 9–2, and 9–3.

ICE, SNOW, AND RAIN.

The problem presented by the occurrence of ice, snow or rain during operation is such that it demands provisions be incorporated into the airplane to reduce and eliminate the adverse effects produced by each. Engine power output and response of flight control surfaces are particularly vulnerable. Given the performance of a particular engine or flight control system, the index of their sensitivity to control and work output, when there are no malfunctioning elements in the system, is largely that of the atmospheric conditions in which they are operated. As these two components and their allied systems are ultimately responsible for flight, it is imperative that operation of each for maximum effectiveness be maintained. Although the presence of ice, snow, or rain constitutes an undesirable effect on operation, the counter-measures and procedures provided are adequate to permit the continuance of approximately normal flight. Emergencies encountered during flight operation in ice, snow, or rain are almost solely confined to failure or malfunctioning of the de-icing and anti-icing equipment and/or necessary operation under extremely hazardous atmospheric conditions.

RADIO RANGE LETDOWN

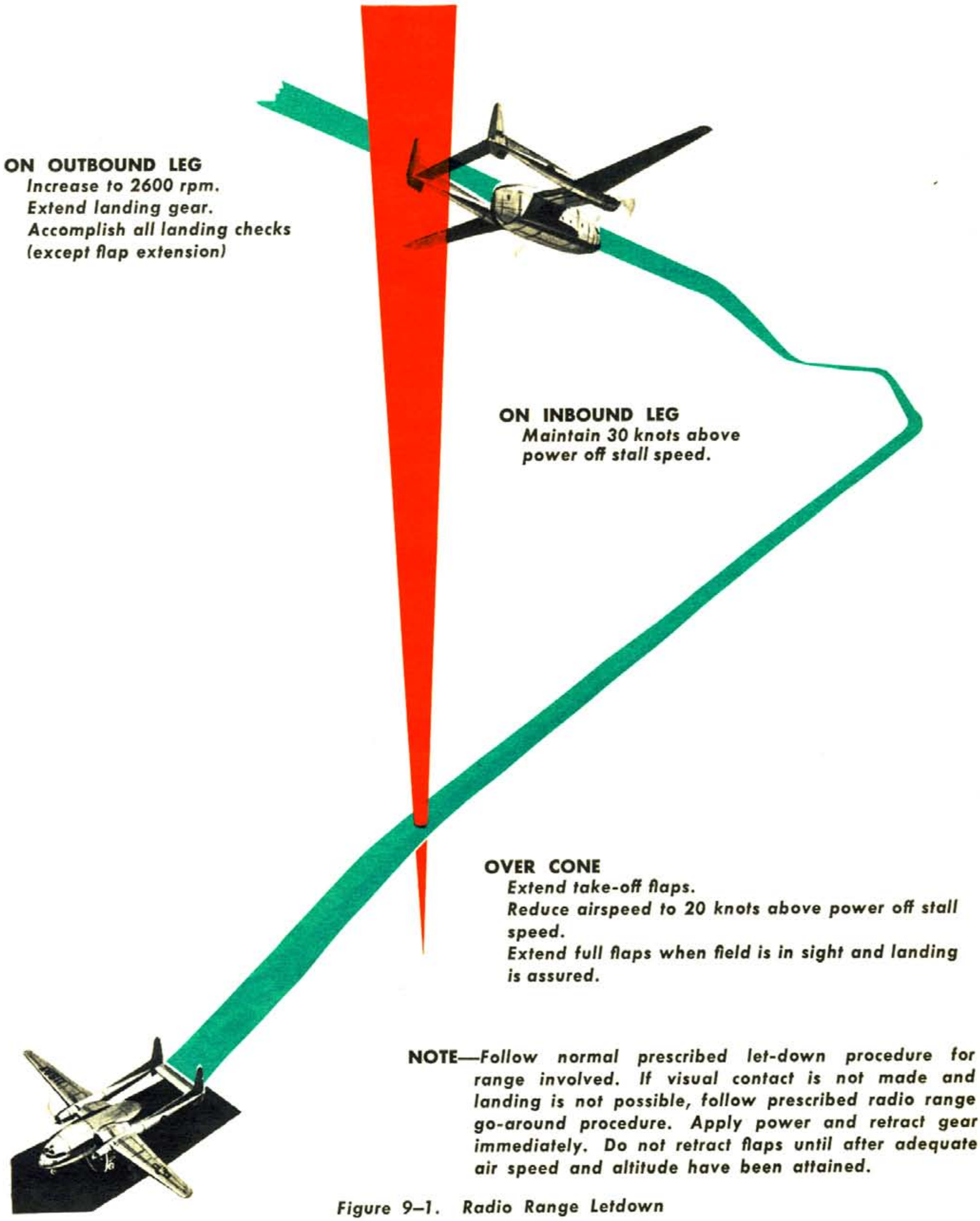
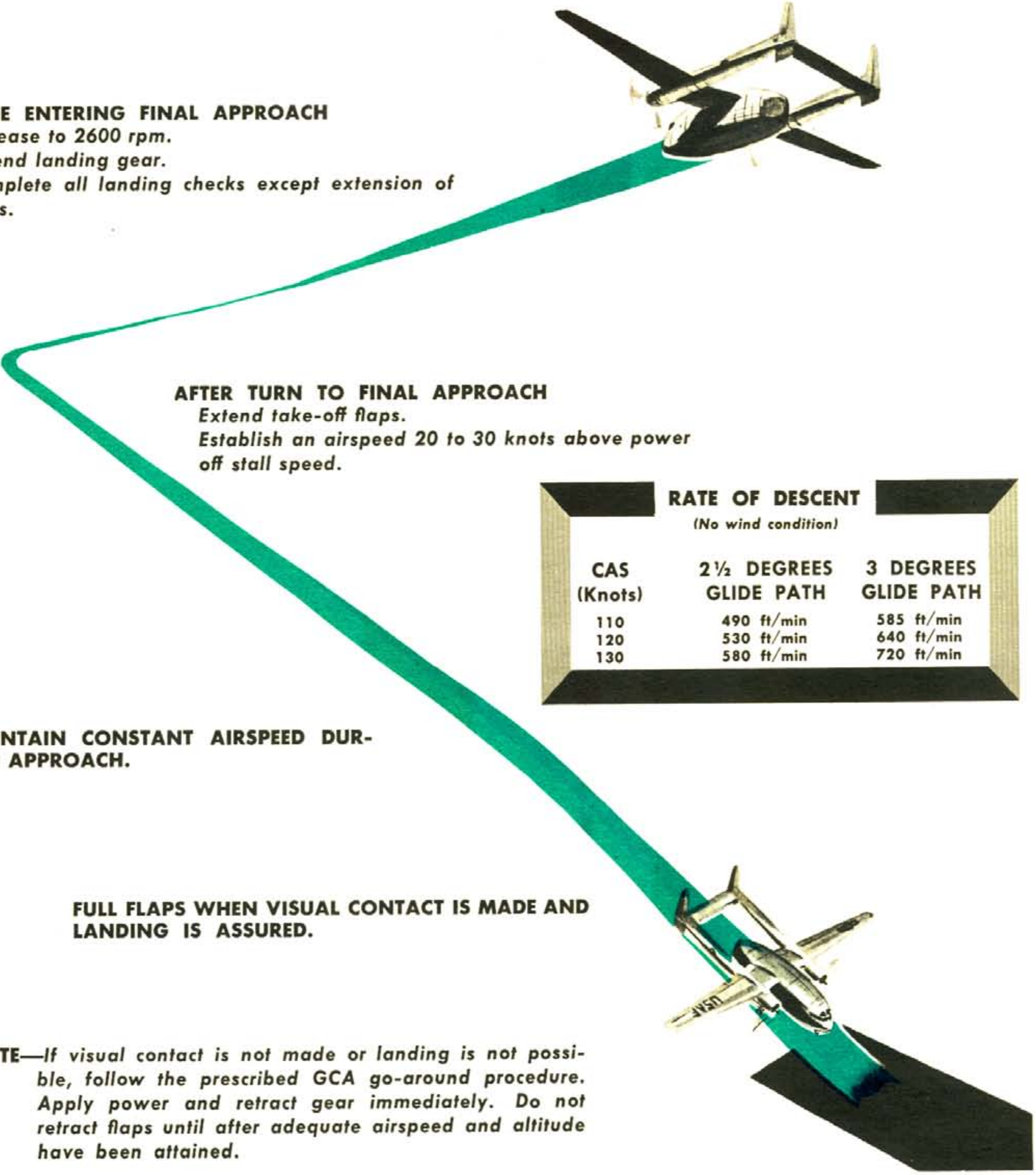


Figure 9–1. Radio Range Letdown

GROUND CONTROL APPROACH

NOTE—*GCA patterns will vary and will not necessarily be flown as shown here. However, patterns will usually provide for interception of final approach at not less than five miles from the approach end of the runway.*



BEFORE ENTERING FINAL APPROACH

Increase to 2600 rpm.
Extend landing gear.
Complete all landing checks except extension of flaps.

AFTER TURN TO FINAL APPROACH

Extend take-off flaps.
Establish an airspeed 20 to 30 knots above power off stall speed.

RATE OF DESCENT
(No wind condition)

CAS (Knots)	2½ DEGREES GLIDE PATH	3 DEGREES GLIDE PATH
110	490 ft/min	585 ft/min
120	530 ft/min	640 ft/min
130	580 ft/min	720 ft/min

MAINTAIN CONSTANT AIRSPEED DURING APPROACH.

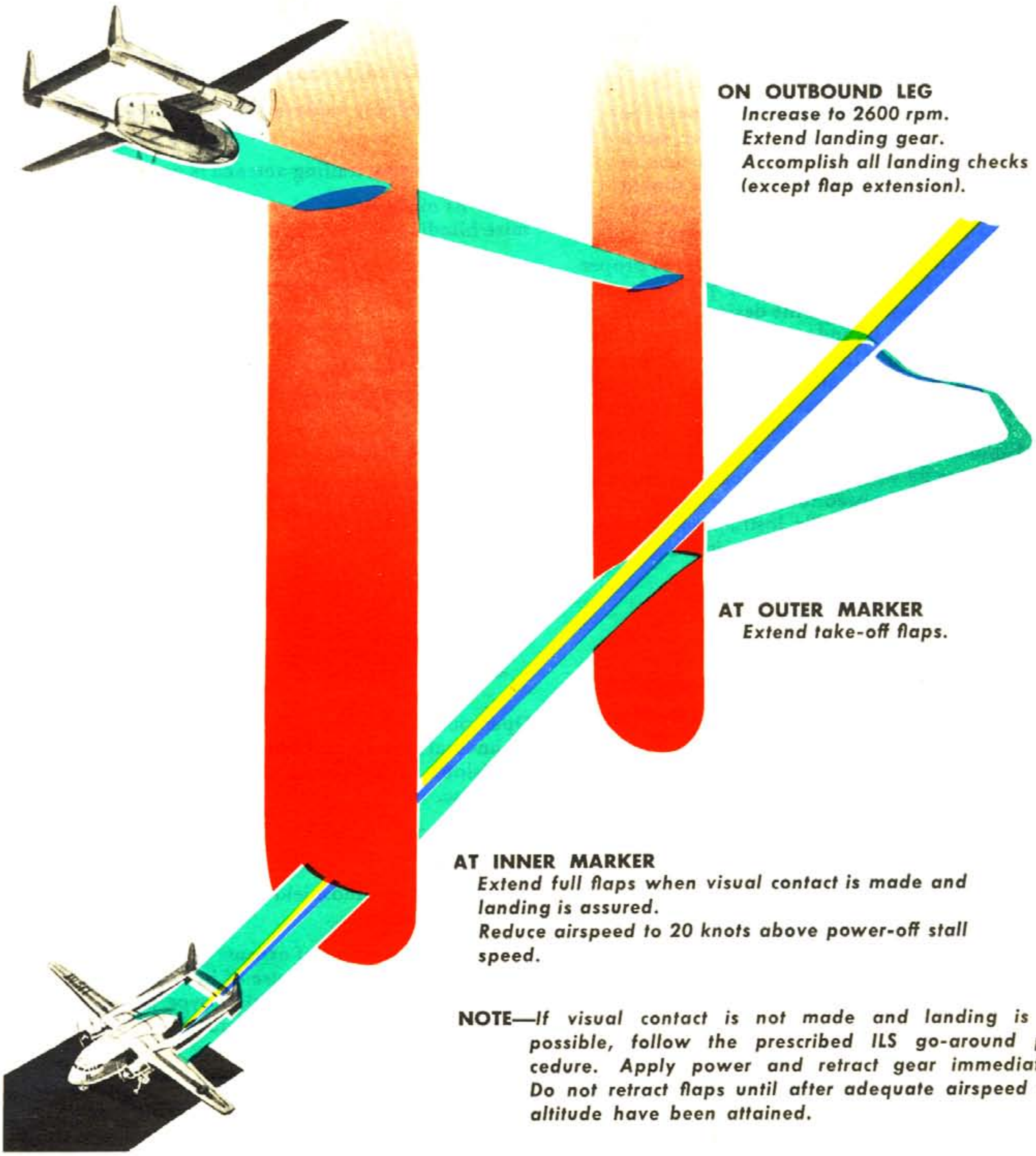
FULL FLAPS WHEN VISUAL CONTACT IS MADE AND LANDING IS ASSURED.

NOTE—*If visual contact is not made or landing is not possible, follow the prescribed GCA go-around procedure. Apply power and retract gear immediately. Do not retract flaps until after adequate airspeed and altitude have been attained.*

Figure 9-2. Ground Control Approach (GCA)

INSTRUMENT LANDING SYSTEM

NOTE—*Maintain airspeed of 30 knots above power-off stall speed throughout ILS pattern until inner marker is reached.*



ON OUTBOUND LEG

Increase to 2600 rpm.
Extend landing gear.
Accomplish all landing checks (except flap extension).

AT OUTER MARKER

Extend take-off flaps.

AT INNER MARKER

Extend full flaps when visual contact is made and landing is assured.
Reduce airspeed to 20 knots above power-off stall speed.

NOTE—*If visual contact is not made and landing is not possible, follow the prescribed ILS go-around procedure. Apply power and retract gear immediately. Do not retract flaps until after adequate airspeed and altitude have been attained.*

Figure 9–3. Instrument Landing System (ILS)

TURBULENT AIR AND THUNDERSTORM FLYING.

Note

Flight through a thunderstorm should be avoided if it is at all possible. However, since circumstances may force you at some time to enter a zone of severe turbulence, you should be familiar with the techniques recommended for flying under such conditions.

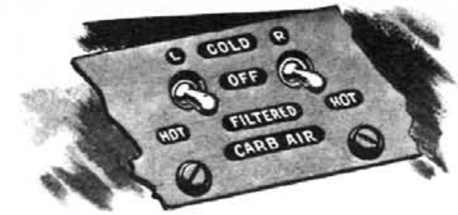
Power setting and pitch attitude are the keys to proper flight technique in turbulent air. The power setting and pitch attitude required for the desired penetration airspeed (see figure 9–4), and established before entering the storm will, if maintained throughout the storm, result in a constant airspeed, regardless of any false readings of the airspeed indicator. Do not attempt to change power settings every time your airspeed indicator fluctuates. Rapid changes in horizontal gust velocity or heavy rain clogging the pitot tube may cause the airspeed to fluctuate momentarily as much as 60 knots. Specific instructions for preparing to enter a storm and flying in it are given in the following paragraphs:

APPROACHING THE STORM.

It is imperative that you prepare the airplane prior to entering a zone of turbulent air. If the storm cannot be seen, its proximity can be detected by radio crash static. Prepare the airplane as follows:

1. Disengage auto pilot.

2. Adjust propeller controls for approximately 2000 rpm for gyroscopic stability.
3. Mixture controls........................RICH.
4. Pitot heater switch........................ON.
5. Carburetor air controls HOT as required.



6. Throttles adjusted as necessary to obtain penetration speed—*60 knots above the power-off stall.*
7. Check gyro instruments for proper settings.
8. Safety belt tightened (check with crew members).
9. Turn off any radio equipment rendered useless by static.
10. Make sure trailing antenna is not extended.
11. At night, turn cockpit lights full bright to minimize blinding effect of lightning.

CAUTION

Do not lower flaps or gear as this will result in a loss of aerodynamic efficiency.

NIGHT FLYING.

Operation of the airplane at night involves no unique or unusual techniques: however, these are aids and provisions to meet several minor problems which may arise.

1. Turn on exterior and interior lights as required to insure adequate lighting.
2. To reduce windshield reflection, dim crew compartment lights.
3. The effectiveness of exhaust glare may be appreciably lowered by proper use of interior lights in the crew compartment. Use of slide type shades on the crew compartment windows will also eliminate exhaust glare.

Emergencies occurring during flight demand special consideration. It is imperative that flashlights be stowed aboard the airplane and be immediately available for use on such an occasion. It is equally important that crew members familiarize themselves with

IN THE STORM

NOTE

Normally, the least turbulent area in a thunderstorm will be at an altitude of less than 6000 feet. Altitudes between 10,000 feet and 20,000 feet are usually the most turbulent.

1. MAINTAIN POWER SETTING AND PITCH ATTITUDE (AS ESTABLISHED BEFORE THE STORM) THROUGHOUT THE STORM.

Hold these constant and your airspeed will be approximately constant, regardless of your airspeed indicator.

2. DEVOTE ALL YOUR ATTENTION TO FLYING THE AIRPLANE.

3. EXPECT TURBULENCE, PRECIPITATION, AND LIGHTNING.

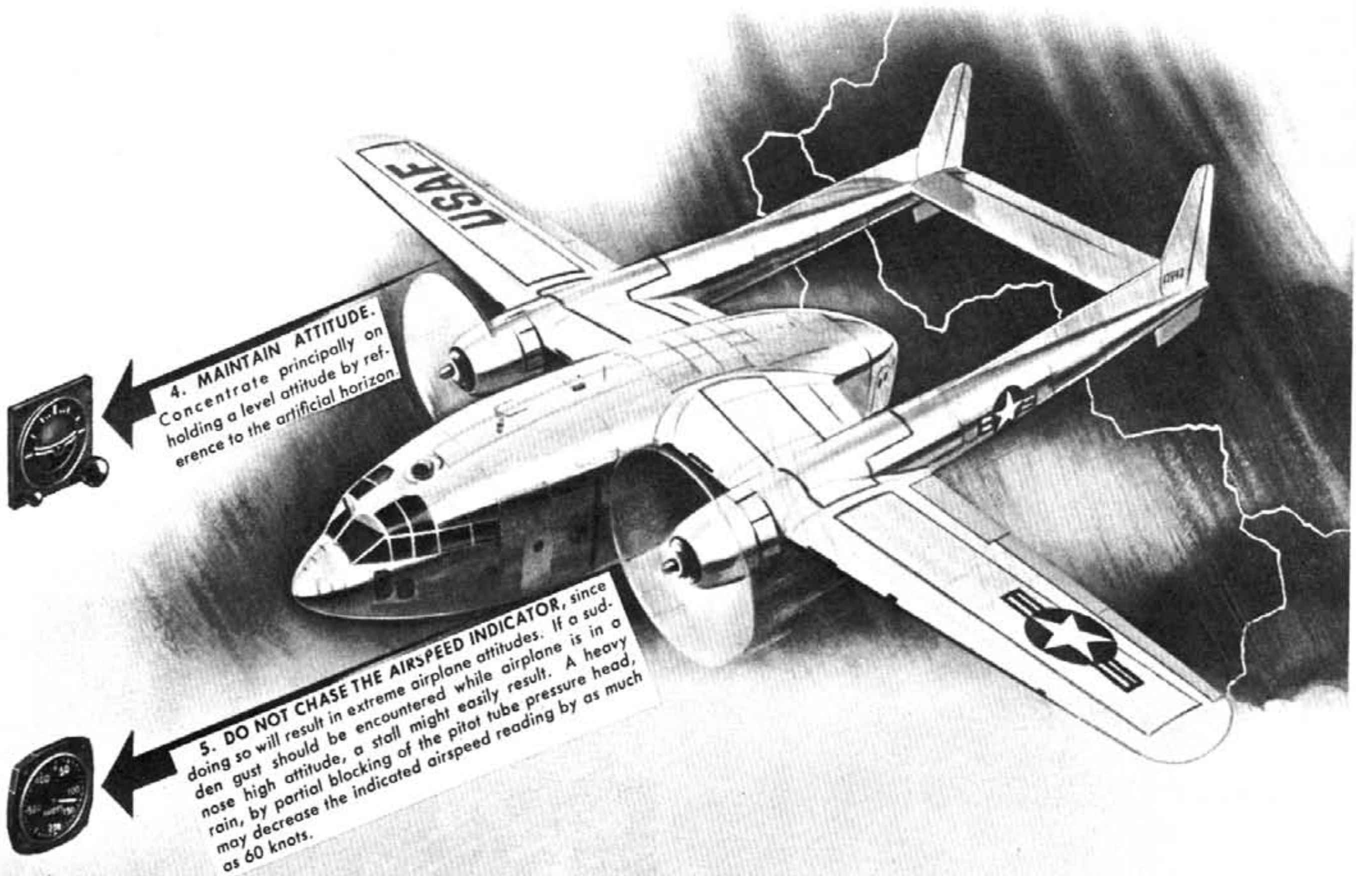
6. USE LITTLE ELEVATOR AND SUDDEN CONTROL AS POSSIBLE. *This minimizes the stresses imposed on the airplane.*

7. OPERATE DE-ICING AND ANTI-ICING CONTROLS AS NECESSARY.

This prevents formation of ice on propellers and lifting surfaces.

8. THE ALTIMETER IS UNRELIABLE IN THUNDERSTORM FLYING BECAUSE OF DIFFERENTIAL BAROMETRIC PRESSURES WITHIN THE TURBULENT AREA.

A gain or loss of several thousand feet may be expected. Make allowance for this error in determining minimum safe altitude.



Optimum turbulent air penetration speed is 60 Knots above power-off stall speed.

Figure 9–4

the location and controls of all equipment so that emergency counter measures and procedures may be accomplished with an absolute minimum of false starts, mistakes, and consequent loss of time. Ready knowledge and accomplishment of procedures during emergencies enhance the chance of continued safe operation and, in a larger sense, remove the element of finality.

COLD WEATHER OPERATION.

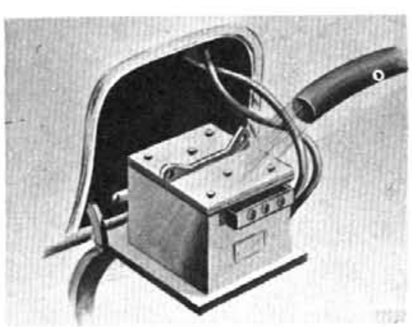
The following operating instructions should be complied with when temperatures of 20° F (−7° C) or below are encountered. The success of cold weather operation depends greatly on the preparation made during engine shutdown and post flight procedures. The success of the next day's operation depends upon the proper application of preparatory procedures.

BEFORE ENTERING THE AIRPLANE.

1. Oil screens must be checked and cleaned before each flight during the early part of the cold weather period to remove sludge which has been washed down by frequent oil dilution.

2. Ascertain that dust and/or snow excluders are installed on the main landing gear wheels.

3. Install warm battery or heat cold battery if it was not removed after preceding flight.



4. Install engine nose shields or covers on the nacelles and remove protective covers from the wing, empennage, astrodome, crew compartment and pitot tubes.

5. Although the airplane incorporates an integral engine and engine accessory preheat system, ground heaters may be utilized prior to especially cold starts to facilitate this process. Preheating the engine cylinders and intake manifolds on all cold starts assure good fuel vaporization and prevents spark plug changes due to frosted electrodes.

6. On each engine, check the firewall fitting drain and oil tank sump drain, and apply heat if flow is unsatisfactory. Preheat should never be considered adequate until fluid oil will flow from the firewall fitting drain.

7. Check the oil tanks for oil flow. If no oil flow is obtainable, apply heat to the drains and oil tank. In addition, oil immersion heaters may be used.

8. Check all fuel and oil tank vent lines and crankcase breathers for freedom from frozen condensate. Apply heat if necessary.

CAUTION

Freezing of any water droplets in the vent line may collapse the tanks.

9. Check the primer shut-off valve for open passage to allow free flow.

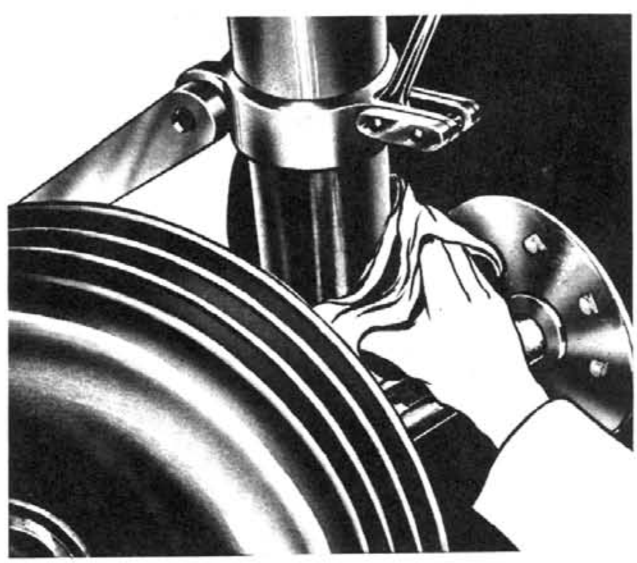
10. Check fuel system for leaks and all fuel drains for free flow. Apply heat when necessary to obtain flow.

11. Check flight surfaces, control surface hinges, propellers, pitot tubes, and the wing air ducts for freedom from frost, snow, or ice. Brush off all light snow and frost. Remove any accumulation of ice by direct flow of air from a portable ground heater. Wing and tail anti-icing system may be used to remove light frost from the leading edges of the flight surfaces.

Note

Do not chip away ice as this may damage airplane.

12. Clean the landing gear shock struts of dirt and ice, also check for proper inflation. Wipe the shock struts with a hydraulic oil-soaked cloth after they are cleaned.



13. Check the tires for proper inflation.

14. Carefully inspect all openings in the airplane for accumulation of snow.

15. At temperatures below −30° F (−34° C) apply preheat directly to the propeller dome and oil reservoir.

ON ENTERING THE AIRPLANE.

1. Start the auxiliary power plant. Apply external preheat directly to auxiliary power plant before attempting to start if the outside air temperature is below −10° F (−23° C).

2. By means of the airplane's engine accessory heating system, preheat the engine accessory section if outside air temperature is below 8° F (−18° C) and oil dilution was accomplished at shut down. Preheat if outside air temperature has fallen below 35° F (2° C), and oil dilution was not accomplished at previous shut down.

3. The engine preheat schedule given below is based on utilizing engine shields or covers, ground heaters (one per engine) and the airplane's preheaters simultaneously, wind velocity of zero and assuming appropriate oil dilution was previously accomplished.

PREHEAT CHART

OUTSIDE AIR TEMPERATURE °F	OUTSIDE AIR TEMPERATURE °C	PREHEAT TIME (MINUTES)
0 to −25	−18 to −32	20
−25 to −40	−32 to −40	30
−40 to −50	−40 to −45	45
−50 to −65	−45 to −54	60

Figure 9–5

4. Start the crew compartment and the cargo compartment heaters to heat the flight instruments, defrost the windshields, and warm the radios, the dynamotors, the inverters, and other equipment within the airplane.

5. Check functioning of those instruments that can be checked without engine operation.

WARNING

In cold weather, make sure all instruments have warmed-up sufficiently to insure normal operation. Check for sluggish instruments during taxiing.

6. Exert light pressure on the brake pedals several times before setting parking brake.

CAUTION

Do not use foot brakes when applying parking brake as damage to the parking brake control system may result.

BEFORE STARTING ENGINES.

1. After both engines are preheated sufficiently, remove the engine nose shields or covers, oil immersion heaters, wheel snow excluders, and any external ground preheat discharge duct that may have been used.

2. Use external power source for engine starting and ground checking electrical equipment. (If external power source is not available, the APP may be used.)

STARTING ENGINES.

1. Shut-off the supply of internal preheat to the engine nacelles.

2. Place carburetor air control in COLD position.

3. The throttle setting should be slightly less than that for a normal start.

4. To ascertain that the engine has been sufficiently preheated, make a crankability test by holding the starter switch ON (fuel and ignition OFF) until the engine will turn over at least 50 rpm. After reaching this speed, turn the ignition switch ON and continue starting procedure.

5. Priming. More than normal priming will be required at low temperatures during the starting cycle of the engine and immediately after combustion until smooth operation is obtained. It is not considered harmful to prime continuously (when necessary), during the entire starting period. However, prime only

after the engine has commenced turning to avoid liquid locks which might result in bent connecting rods.

Note

If no oil pressure is obtained within 30 seconds, shut down engine immediately and investigate. This will usually be caused by congealed oil or ice in the oil drain, congealed oil in supply line or pressure line from engine to the oil pressure transmitter.

6. If the engine has not started after one minute of cranking, allow the starter to cool for one minute or more before attempting another start.

Note

Moisture forms quickly on spark plugs during cold starts. After three or four unsuccessful attempts, remove at least one spark plug from each of the engine cylinders and heat to dry points. Attempt to start engine immediately after replacing the spark plugs.

WARNING

Dilution solenoid may stick in the open position subsequent to diluting. If this occurs, dilution will continue when the engines are started again. Observe the fuel and oil pressures closely when starting engines, and before take-off to be sure that dilution solenoid is closed. If any spewing of oil, low oil pressure, or high cylinder head temperatures are noted after take-off, land and investigate the cause of trouble.

7. Apply carburetor heat as soon as possible after engine is started to assist in fuel vaporization and reduce back-firing or after-firing.

ENGINE GROUND OPERATION.

1. If cylinder head temperature of 100°C or more cannot be maintained, place cowl flaps in TRAIL position.
2. Place propeller control levers in INCREASE RPM position.
3. Continue use of carburetor heat as required to improve fuel vaporization and to prevent the engine from backfiring.
4. Place oil cooler exit flap switches in AUTO position.
5. Set throttle to maintain 1200 RPM.
6. Place the mixture control in RICH position.
7. Set fuel booster pump switch in OFF position.
8. When warming up an engine after an oil dilution operation, it is preferable to allow the oil temperature to rise above 140° F (60° C) and to increase the engine speed during the run-up to dissipate as much of the dilutant fuel as possible to allow the oil to return to its normal viscosity. Below this temperature, and at low engine speeds, very little fuel will be evaporated from the oil.
9. Operate all the flight control surfaces through full travel three or four times to check ease of operation.
10. Check operation of the windshield wipers.
11. Check operation of the pitot-static tube heaters. (Indicated by ammeter fluctuation.)
12. Check all instruments to ascertain they are within operating limits.
13. Operate the wing flaps through one cycle.
14. Check the operation of the wing and tail anti-icing system.
15. Check propeller de-icing system.

BEFORE TAKE-OFF.

1. When carburetor air temperature is below 0° F (−18° C) carburetor heat may be applied to prevent rough engine operation and improve vaporization and distribution of fuel.

Note

At temperatures below −40° F (−40° C) it may become necessary to trail the cowl flaps in order to raise the cylinder head and carburetor air temperatures high enough to obtain full power output for take-off.

2. If cylinder head temperature of 100°C or more cannot be maintained, place cowl flaps in TRAIL position.

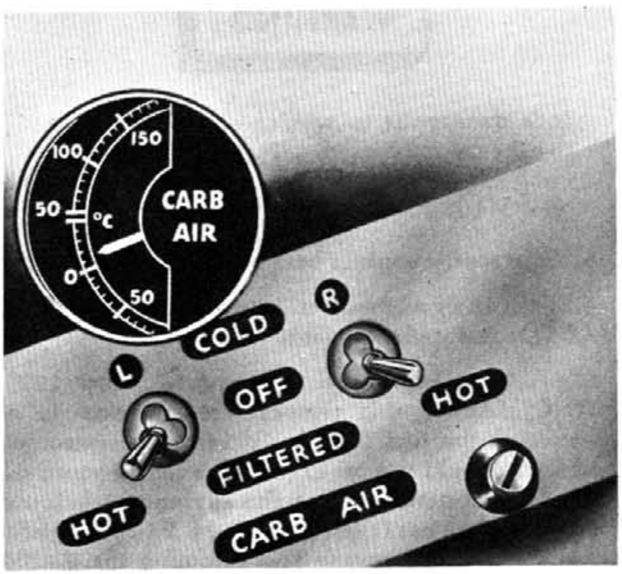
Note

Prior to take-off, the engine must be warmed up sufficiently so that oil pressures are stabilized within established limits. Oil temperatures must rise at least 6° C above pre-starting oil temperatures. As a further check, open throttles to obtain not more than 30″ manifold pressure; if the oil pressure drops or fluctuates as engine speed is increased, the warm-up period should be extended.

TAKE OFF.

1. At subzero temperatures, full take-off power may be reached at a reduced manifold pressure, due to the increase in air density.

2. Line up airplane on the runway and apply power holding the brakes until engines are operating smoothly. Maintain carburetor air temperatures between 15° C and 20° C during the take-off run, or higher, if smoother engine operation is obtained.



Note

> Proper use of cowl flaps and carburetor heat will materially assist in normal engine performance and safe take-off. At temperatures below −40° F (−40° C) the cowl flaps will probably have to be fully closed.

3. Carburetor heat must be applied so that the fuel will vaporize properly at subzero temperature. Regulate the carburetor heat to maintain carburetor air temperatures within the proper limits throughout engine run-up, take-off, climb, and cruise. It would be wise to have the co-pilot regulate the carburetor heat controls as the carburetor heat available will not only vary with engine power changes, but will also vary too quickly for the pilot to watch while preoccupied with other controls. At temperatures below −40° F (−40° C), this becomes an important and critical item.

4. If oil discharge from engine breathers is noted during take-off, reduce RPM as quickly as practicable and operate engines at reduced power. If oil discharge cannot be prevented, a landing should be effected immediately.

CRUISE.

1. After take-off from a snow or slush-covered field, operate the landing gear and the wing flaps through several complete cycles to preclude their freezing in the UP position.

2. If precipitation is encountered or if icing conditions are anticipated immediately after take-off, turn ON the pitot tube heaters, wing and tail anti-icing and propeller de-icing system.

3. Stop the auxiliary power plant unless its use is desirable due to instrument and/or icing conditions.

4. Under icing conditions apply carburetor heat, as required, to prevent formation of ice. When cruising under severe icing conditions, use at least 75 percent of rated engine power with mixture control NORMAL. Under all icing conditions operate engines with carburetor heat between 15° C and 40° C.

Note

> At low-power settings, low cylinder head and carburetor air temperatures will result in poor fuel vaporization and distribution, causing engine roughness and back-firing. Sufficient carburetor heat should be applied to obtain smooth engine operation. Placing mixture control in RICH will also correct rough engine operation but proper use of carburetor heat is preferable to operation in RICH since a decrease in fuel consumption is obtained.

5. Adjust the cowl flaps, as required, to maintain proper cylinder head temperatures.

6. Cross-check all flight instruments and be alert for any erroneous indications.

APPROACH.

1. Start the auxiliary power plant approximately five minutes before landing.

2. All unnecessary electrical equipment and heaters should be turned OFF.

3. When letting down for landing, watch engine temperatures closely. Atmospheric temperature changes are common in winter, and ground temperatures may be 15° C to 30° C colder than at altitude. Therefore maintain cylinder head temperatures above 100° C and oil temperatures above 30° C.

4. Cowl flaps should be CLOSED and carburetor heat ON as required. At extremely low temperatures below −55° F (−48° C), it would be wise to effect a long, low approach for landing so as to necessitate the use of engine power, thus aiding in keeping cylinder head temperatures from becoming critically low.

WARNING

Do not fail to use sufficient carburetor heat during approach and landing. If this is not done, engine may miss or die when power is applied.

5. Lower the flaps and reduce airspeed while descending, but use enough power to maintain a safe marginal engine temperature.

6. Pump brake pedals several times during the approach and check hydraulic pressure gage for desired pressure.

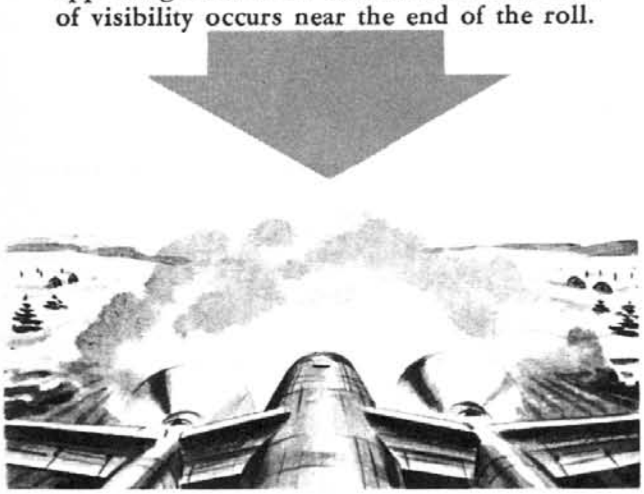
LANDING.

1. Immediately after landing, the oil cooler exit flaps should be opened so that the oil will cool sufficiently while taxiing to the ramp to permit oil dilution.

2. Carburetor air control in HOT position while taxiing.

CAUTION

Upon reversing propellers, apply only enough power to decelerate the airplane without obstructing vision by blowing snow. Although presenting no serious control problem, the use of reverse pitch to shorten the landing roll will invariably cause a temporary loss of visibility even on runways appearing to have no loose snow. This loss of visibility occurs near the end of the roll.



STOPPING ENGINES.

1. When a cold weather start is anticipated, the engine oil should be diluted with fuel while the engines are still warm.

2. If it is necessary to service the oil tanks, divide the oil dilution period so that half dilution is accomplished before servicing the oil tank and the remainder is accomplished after the oil tank is serviced.

WARNING

It is dangerous to service and not dilute as the heavy undiluted oil collects, and may congeal, on the tank bottom and block the flow of oil.

3. Operate the engines between 1000 and 1100 rpm.

4. Turn the fuel booster pump switches to NORMAL ON to supply adequate fuel pressure.

5. Maintain engine oil temperature below 122° F (50° C). Above this temperature, dilution is not effective as the fuel introduced into the system will vaporize. Should the oil exceed this temperature during the dilution period, stop the engine and wait until oil temperature has fallen below 104° F (40° C) before again starting the engine and resuming the dilution operation. If engine is shut down, the total time for two or more dilution periods shall be that time indicated on the chart.

6. Watch oil pressure carefully when diluting. If oil pressure falls below 15 psi, shut down engine and allow to cool before diluting again.

7. Dilute oil, as required by the lowest anticipated temperature for the time indicated in the following table: Operation of the oil dilution is indicated by a substantial fuel pressure drop and rise in fuel flow when dilution switch is energized.

OIL DILUTION CHART

ANTICIPATED TEMPERATURE	TIME TO DILUTE	% DILUTION RESULTING
+20 to −10°F − 7 to −23°C	1 Min	10%
−10 to −35°F −23 to −37°C	2⅔ Min	20%
−35°F & Below −37°C & Below	4 Min	30%

Figure 9–6

8. A short acceleration period of approximately 10 seconds at the end of the dilution run will usually clear the spark plugs of any fouling condition resulting from prolonged idling.

9. When the dilution is complete, shut the engine down in a normal manner, continuing to hold the oil dilution switch ON until the engine has stopped. This is important, because only diluted oil must be circulated through the engine oil system.

10. Leave brakes off. If brakes are allowed to remain on, the formation of ice may lock the control so that it cannot be operated.

BEFORE LEAVING THE AIRPLANE.

1. Complete refueling of the airplane should be accomplished at this point to minimize the accumulation of condensation in the fuel tanks, lines and drains.

2. Drain condensation from fuel tank drains before moisture in them freezes.

3. The oil tank sumps and firewall fitting must be drained of condensate before moisture in them freezes or non-diluted oil at these areas congeals. Drainage of moisture and small amount of oil at these areas will move diluted oil into these areas.

4. Inspect vents, and crankcase breathers, and remove any existing ice.

5. Install protective covers to guard against possible collection of snow, frost and ice.

6. Approximately thirty minutes after stopping engines, turn each propeller at least twelve blades.

7. It is advisable to keep the landing gear shock struts exceptionally clean as the slightest scarring of the "O" ring seals in the struts will result in leakage due to low temperature. Therefore clean the shock struts of dirt and ice and then wipe them carefully with a hydraulic oil-soaked cloth.

8. When the airplane is parked for the night, leave some aperture, such as a window, partly open. If this is not done, lack of air circulation within the compartment will cause frosting of the windows.

9. When placing the airplane into, or removing from a hangar, open as many windows as possible to aid in equal warming or cooling of the interior. Rapid cooling or heating will cause sufficient differential contraction of the transparent areas to cause cracking.

10. If the airplane is to remain outside for a period of more than four hours at below freezing temperatures, remove battery after flight and stow it in a heated room.

TROPIC OPERATION.

Operation in the tropics, because of periods of excessive heat and moisture, poses a two-fold problem. In general, when temperatures hover about 100° F or higher, procedures for hot weather operation should be instituted. Structural surface temperatures are dependent upon the heating effect of the sun and whatever cooling effect the wind may exert. Low-wind velocities will result in skin temperatures 1.4 to 1.5 times free-air temperatures, which may be well over 130° F (54° C). Interior temperatures will generally remain between free air and skin temperatures. Improvised cover will alleviate excessive skin temperatures. Wing, empennage, or fuselage interiors may rise to 1-1/2 times free-air temperature. It is highly important that lubrication, hydraulic systems, cable tension, and life of materials such as rubber and hydraulic equipment be checked frequently. Bungee cords, hatch seals, tires, etc., should be inspected for blisters and other signs of deterioration. Metal surfaces become burning hot; gloves and mitts should be used when touching metal surfaces which have been exposed to the sun. Slide type shades on the side and overhead windows of the crew compartment should be drawn, and canvas or matting thrown over the windshield to protect equipment from the sun. Although the temperature may be from 10 to 20 degrees lower with the windows, doors and hatches open, the risk of absorbing excessive amounts of moisture must not be discounted. However, it is recommended that the airplane be ventilated when the wind is calm and the humidity not excessive as a means of guarding against heat warping of the instruments. The exclusion of strong sunlight also protects the luminous numerals and letters on the instruments.

BEFORE ENTERING THE AIRPLANE.

1. Cool the crew and cargo compartment with portable coolers. The refrigerant lines which attach the evaporator assembly to each cooler make it possible to carry the evaporator into the cargo compartment through the rear cargo doors.

2. Check that filters are free of corrosion and fungi.

3. Check all fabric surfaces and control surface hinge points for freedom from fungi. If fungi are present, remove them from all surfaces except the fabric surfaces with a stiff brush or compressed air. Use a clean soft cloth for fabric surfaces.

4. Check tire pressure, as wide changes in temperature cause corresponding changes in air pressure.

5. Inspect shock struts, and use a cloth moistened in hydraulic oil to wipe the shock struts clean.

6. Inspect all safety and limit switches for moisture and if necessary, heat them with warm airflow to eliminate moisture.

7. Remove engine covers, shields, or other protective covers.

ON ENTERING THE AIRPLANE.

1. Operate all movable surfaces.

2. If necessary, warm electrical instruments with an external source of heat until all moisture is eliminated.

3. Check for leaks in the hydraulic system; valves and packings will swell under hot and moist atmospheric conditions.

4. Check wing, empennage, fuselage ventilation and drain holes.

5. Check that the equipment is free from corrosion.

STARTING ENGINES.

Refer to starting procedure under DESERT OPERATION.

ENGINE GROUND OPERATION.

1. Keep time required for engine warm up and tests to a minimum, with engine headed into the wind for better cooling as cylinder head temperatures will rise very rapidly during warm weather.

2. Watch cylinder head and carburetor air temperatures. Do not exceed limits.

3. Do not over-prime the engine.

BEFORE TAKE OFF.

1. In taxiing prior to take-off, use the brakes as infrequently as possible; in hot weather they are difficult to cool.

TAKE OFF.

1. Remember that the take-off distances will be longer because the air is less dense in warm weather.

2. Maximum cylinder head and carburetor air temperature must be within limits for take-off.

3. Retract wing flaps, if used for take-off, with caution.

CLIMB.

1. Do not climb the airplane at less than flying speeds specified in Climb Charts, Appendix I, as low flying speed will result in higher than normal cylinder head temperatures.

2. Adjust the cowl flaps, as required, to maintain proper cylinder head temperatures.

LANDING.

1. True airplane stalling speed will be greater and additional distance for landing will be required because hot air is less dense than cold.

2. Use the brakes as infrequently as possible; in hot weather, they are difficult to cool.

STOPPING ENGINES.

1. Shut down engines as soon as practicable to avoid overheating.

BEFORE LEAVING THE AIRPLANE.

1. After engines have cooled, install engine covers or shields.

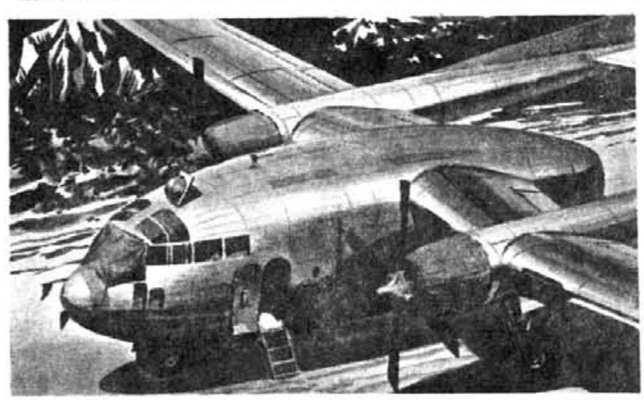
2. If heat is excessive, close shades and cover windshield.

3. If moisture or blowing dust does not constitute a hazard, open windows, doors and hatches slightly to aid in air circulation and reduction of adverse temperatures.

4. If moisture is excessive and the means are available, keep sensitive equipment warmer than ambient temperature by approximately 10° F (6° C). If heating cannot be accomplished, circulation of air over this equipment will be helpful.

INSTALL ———

ENGINE AND CREW COMPARTMENT COVERS



——— and VENTILATE

DESERT OPERATION.

The life of the airplane, and its parts is unbelievably short when sand, dust, and heat are permitted to act upon them uncontrolled. The abrasive qualities of dust and sand upon cylinder walls, valves and moving parts of the airplane, and the destructive effect of heat upon airplane instruments will require endless cleaning, inspection, and hours of hard work to keep the airplane serviceable if certain basic preventive measures are ignored. Even in flight the hazards of dust and sand will be difficult to escape, for dust clouds over a desert may be found at altitudes as high as 10,000 feet.

BEFORE ENTERING THE AIRPLANE.

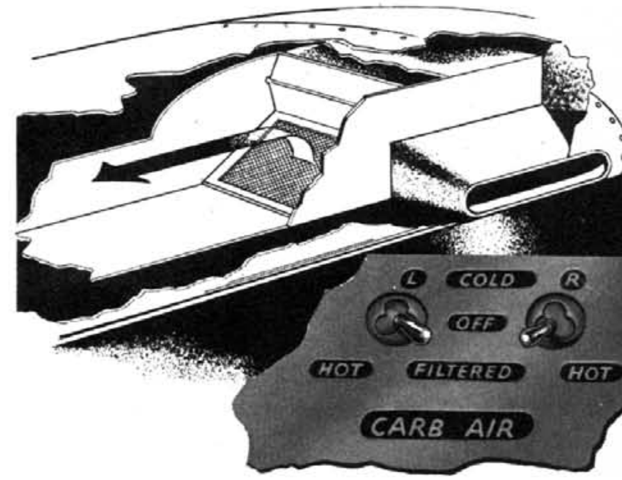
1. Cool the crew and cargo compartments with portable coolers. The refrigerant lines, which attach the evaporator assembly to each cooler, make it possible to carry the evaporator into the cargo compartment through the rear cargo doors.
2. Check to see that hatch seals and tires are not blistered or show other evidences of deterioration.
3. Inspect the shock struts and tires for proper inflation.
4. Use a clean dry cloth to wipe the landing gear shock struts free of dust and sand.
5. Check that limit switches are free of sand and dust.
6. Remove ground cooling ducts, engine shields and airplane covers.

ON ENTERING THE AIRPLANE.

1. Operate all movable flight control surfaces.
2. Wipe instrument panel with a lint-free cloth to remove any dust or sand.
3. Check operation of carburetor air intake filters.

STARTING ENGINES.

1. Use the normal starting procedure outline in Section II, supplemented by the following:
2. If on sandy or dusty ground, conduct engine starts and warm-up with the airplane on landing mats or any hard natural surface swept clean of sand and dust. This will help avoid sand pitting of the propellers and airplane surfaces. Do not operate engine windward of other airplanes parked on the ground. Causing sand and dust to be blown in the vicinity of other airplanes increases the problem of ground maintenance and decreases the life of the airplanes.
3. During all ground operations in sandy or dusty regions, keep carburetor air control in FILTERED position.



4. Do not over-prime as fuel vaporization is more rapid at high temperatures.

ENGINE WARM-UP.

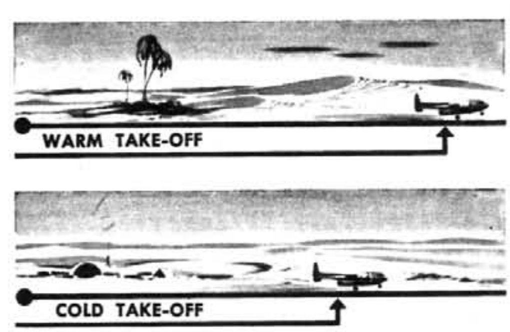
1. Keep time of warm-up and engine tests to a minimum, with engines headed into the wind for better cooling, as cylinder head temperatures will rise very rapidly during warm weather.
2. Watch cylinder head and carburetor air temperatures. Do not exceed limits.

BEFORE TAKE-OFF.

Unless absolutely necessary, do not take-off during sand or dust storms. Head the airplane cross-wind, close cowl flaps, and stop engines.

TAKE-OFF.

1. Remember that take-off distances will be longer because the air is less dense during warm weather.



2. If the ground is sandy or dusty, avoid taking off in the wake of another airplane.

3. Carburetor air control in the FILTERED position.

4. Maximum cylinder head and carburetor air temperature for take-off must be within limits.

5. As high temperatures cause variations in stalling speeds, it is imperative that the pilot be capable of detecting pre-stall conditions and be cognizant of the necessary corrective measures to employ.

6. Retract wing flaps, if used for take-off, with caution.

CRUISE.

1. Do not climb the airplane at less than the flying speed specified in the Climb Chart, Appendix I, as low flying speed will result in higher than normal cylinder head temperatures.

2. Adjust the cowl flaps, as required, to maintain proper cylinder head temperatures.

LANDING.

True airplane stalling speed will be greater and additional distance will be required for landing, because hot air is less dense than cold air.

STOPPING ENGINES.

Shut down engines as soon as practicable to avoid over-heating.

BEFORE LEAVING THE AIRPLANE.

1. After engines have cooled, install engine covers or shields.

2. If operating in sandy country, close and cover all openings to keep sand out, particularly pitot tubes and engines, including carburetor intakes, oil cooler ducts and flaps, breathers, and engine and heater exhaust ports. Cover windshield and all the windows to prevent sand scratching.

3. Handle high octane fuels with care. Be sure that all fueling equipment and airplane are well grounded.

4. Exercise care to avoid letting sand or dust enter the engine fuel and oil tanks while servicing.

5. Clean the engine induction air filters after each flight. Replace any that are in questionable condition.

6. If blowing sand does not present a hazard, keep main entrance door, cargo doors and crew compartment hatches open to permit air circulation. Close during sand or dust storms.

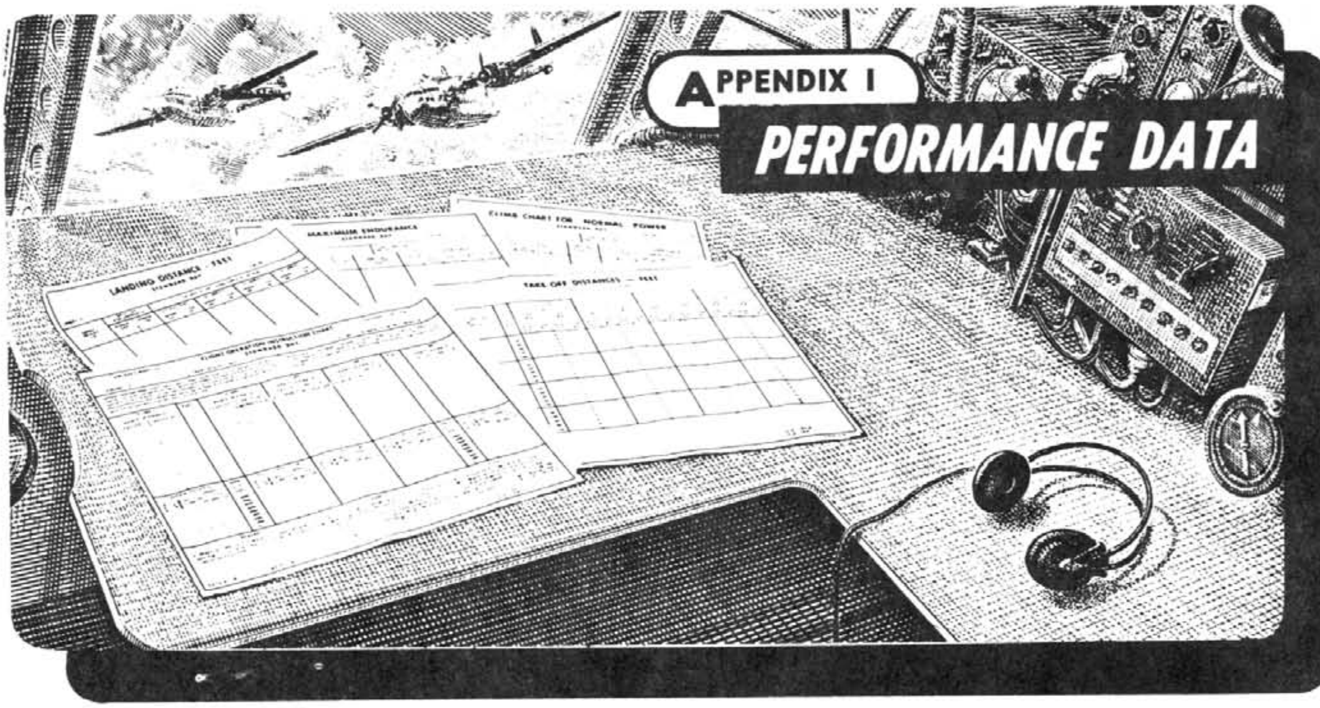


TABLE OF CONTENTS

CARGO DOORS OFF OPERATION.

GLOSSARY OF TERMS AND ABBREVIATIONS.

MAXIMUM POWER (DRY)—The maximum power available from the engine without using the water-alcohol injection system. Use NORMAL mixture and 2900 RPM for low blower or 2600 RPM for high blower. Time limit is 30 minutes.

TAKE-OFF POWER (DRY)—The same as maximum power (dry) except RICH mixture is used and the time limit is 5 minutes.

MAXIMUM POWER (WET)—The maximum power available from the engine utilizing the water-alcohol injection system. Use NORMAL mixture and 2900 RPM (low blower only). Time limit is 30 minutes or until water is consumed.

TAKE-OFF POWER (WET)—The same as maximum power (wet) except RICH mixture is used and the time limit is 5 minutes.

NORMAL POWER—The maximum power available from the engine for continuous operation. Use NORMAL mixture and 2600 RPM. No time limit.

FAT—Free air temperature.

CAT—Carburetor air temperature (for the speed range of the C-119, CAT is essentially equal to FAT).

PRESSURE ALTITUDE—Standard pressure altitude.

DENSITY ALTITUDE—Altitude based on standard air density scale, see figure A-6.

DEW POINT—A temperature related to the specific humidity of the air, from which BHP correction for humidity is taken, see figures A-4 and A-5.

MP—Engine absolute manifold pressure, in.Hg.

RPM—Engine speed, revolutions per minute.

BHP—Engine brake horsepower.

TP—Torque pressure is a measure of the engine brake horsepower. $BHP = \frac{(TP)\ (RPM)}{142}$ for the R3350-85-89 engines.

EXPECTED TORQUE—The torque pressure the engine will develop if the engine is functioning correctly, see figures A-4 and A-5.

REJECT TORQUE—95% of expected torque. If less than 95% of expected torque is realized, engine malfunction is indicated.

% DEVIATION—Deviation from standard day sea level BHP, for use in predicting take-off distance and limit take-off gross weight, see figures A-4 and A-5.

LIMIT TAKE-OFF GROSS WEIGHT—The highest weight for safe take-off in event of an engine failure (based on 100 fpm rate of climb with critical engine inoperative, propeller feathered and landing gear up), see figures A-9 through A-12 and A-51 through A-54.

IAS—Indicated airspeed corrected for instrument error.

CAS—Calibrated airspeed, IAS corrected for installation, see figure A-1.

EAS—Equivalent airspeed, CAS corrected for compressibility error; essentially no correction for C-119 airspeeds.

TAS—True airspeed; EAS corrected for relative density.

PERFORMANCE DATA CHARTS.

A series of charts is provided on the following pages to furnish the pilot with sufficient data to make an intelligent and safe flight plan. The charts include data on take-off, climb, and landing, and operating instructions for cruising flight from maximum endurance through 99% best economy to Normal Power (maximum continuous power) and Maximum Power —Dry (for combat operation). Because the number of variables involved makes precise predictions impossible, the emphasis in these charts has been on conservatism. For example, all fuel flows are increased 5% over flight test values for conservatism; range values, therefore, are reduced. No allowance has been made for wind (except take-off distances), navigational error, combat or formation flight, or other contingencies. Appropriate allowances for these items should be dictated by local regulations and should be accounted for when the fuel available for cruise is determined. The charts are arranged to give maximum facility of use for pre-flight and in-flight planning.

When the airplane is operated with the rear cargo doors removed for heavy equipment drops, the performance of the airplane is lessened because of the marked increase in drag. A separate series of charts is provided for operation in this configuration following the series of charts with cargo doors on. When airplanes with flight operable doors are used for heavy equipment drops, the "doors-on" tables should be employed.

Use of the alternate grade (100/130) fuel, as outlined in ALTERNATE FUEL GRADE LIMITATIONS, Section V, also results in a loss in airplane performance because of the necessary reduction in power. As this is most critical at take-off, a series of limit take-off gross weight charts and brake horsepower correction charts is included.

STANDARD DAY TEMPERATURE TABLE.

A Standard Day Temperature Table is included to give standard day temperature at each 1000-foot altitude increment from sea level to 25,000 feet.

AIRSPEED INSTALLATION CORRECTION TABLE.

Airpseed Installation Correction Tables are provided to correct the indicated airspeed for installation error with rear cargo doors on and off respectively.

BRAKE HORSEPOWER CORRECTION CHARTS.

Brake Horsepower Correction Charts are presented for Maximum Power (Wet) and Maximum Power (Dry) which predict the brake horsepower expected torque pressure, reject torque pressure, and deviation from sea level standard brake horsepower for probable atmospheric condition encountered at take-off. These data are strictly engine performance and apply to both cargo doors on and off operation.

DENSITY ALTITUDE CORRECTION AND TEMPERATURE CONVERSION CHART.

Density Altitude Correction Chart and Temperature Conversion Chart is presented for determination of the density altitude for free air temperature and pressure altitude combinations. All airplane performance charts are based on density altitude rather than pressure altitude to compensate for temperature variations at any altimeter reading. These data are strictly atmospheric conditions and apply to both doors on and off operation.

BRAKE HORSEPOWER ADJUSTMENT CHARTS.

Brake Horsepower Adjustment Charts for low blower and high blower operation, present additional power setting data for obtaining the required engine brake horsepower quoted in the Flight Operation Instruction Charts, Long Range Cruise and Cruise Control Charts, and Maximum Endurance Charts if atmospheric and/or engine conditions prevent the obtaining of the required brake horsepower with the power settings presented in the chart.

LIMIT TAKE-OFF GROSS WEIGHT CHARTS.

Limit Take-Off Gross Weight Charts show the highest gross weight at which a 100 fpm rate of climb can be maintained at various density altitudes with one engine inoperative, landing gear retracted and the propeller of the inoperative engine feathered. These data are presented for both "flaps UP" and "flaps 14°," for maximum wet and maximum dry powers and configurations and should be used in conjunction with the corresponding take-off flap setting.

STANDARD TAKE-OFF DISTANCES CHARTS.

Standard Take-Off Distances Charts present distances for ground run and fifty-foot obstacle clearance with zero and 30-knot headwind for deviations from sea level standard brake horsepower at density altitudes from −4000 to +8000 feet in 2000-foot increments at four gross weights which bracket the operating weight band. These data are presented for "flaps UP" and "flaps down 14°" for maximum wet (Take-Off Power—Wet) and maximum dry powers (Take-Off Power—Dry).

MAXIMUM PERFORMANCE TAKE-OFF DISTANCES CHART.

Maximum Performance Take-Off Distances Chart gives distances for ground run and fifty-foot obstacle clearance with zero and 30-knot headwind for four deviations from sea level standard brake horsepower at density altitudes from −4000 to +8000 feet in 2000-foot increments at four gross weights which bracket the operating weight band. These data are for "flaps down 14°," Maximum Power (Wet), and rear cargo doors on only, and are to be used only with extreme caution as they represent the minimum take-off distances for the airplane as justified by Air Force flight test.

CLIMB CURVES AND CHARTS.

Separate Climb Curves and Charts are presented for two-engine operation at Maximum (Dry) and Normal Power and for single-engine operation at Maximum (Wet) and Maximum (Dry) Power. These charts give rate-of-climb, time-to-climb, range-in-climb, best climb speed, power settings, and fuel used in warm-up, take-off and climb to various density altitudes in 5000-foot increments. Also presented are climb curves for single-engine Normal Power with standard free air temperatures, and Maximum (Wet) and Maximum (Dry) Power with NACA "hot day" temperatures.

Speeds quoted on Climb Curves are sea level CAS.

LANDING DISTANCE CHARTS.

Landing Distance Charts show distances for fifty-foot obstacle clearance and landing ground roll distances for landing with brakes only and with brakes plus reverse thrust. These data are given for four gross weights at density altitudes of −4000, sea level, 4000 and 8000 feet.

MAXIMUM ENDURANCE CHARTS.

Maximum Endurance Charts present speeds and power settings for obtaining maximum endurance at −4000 feet and at 5000-foot density altitude increments from sea level to 20,000 feet for two-engine operation and −4000 to 15,000 feet for single-engine operation. The Brake Horsepower Adjustment Charts are to be used in conjunction with these maximum endurance charts to obtain the required brake horsepower if, because of atmospheric and/or engine conditions, the power settings quoted do not produce the required brake horsepower.

LONG RANGE CRUISE CONTROL CHARTS.

Long Range Cruise and Cruise Control Charts show integrated ranges for "gross weights to start cruise" of 60,000 pounds up to 76,000 pounds, or to the highest cruise weight applicable, in 4000-pound increments. These range values are realized only by religiously following the cruise control data and adjusting the power settings for 2000-pound weight reduction as fuel is used. Speed, BHP, torque pressure, manifold pressure, RPM and fuel flow are presented for gross weights of 44,000 pounds to the top weight to start cruise in 2000-pound increments. The Brake Horsepower Adjustment Charts are to be used in conjunction with these Long Range Cruise and Cruise Control Charts if, because of atmospheric and/or engine conditions, the power settings quoted do not produce the required horsepower.

COMBAT ALLOWANCE CHART.

The Combat Allowance Chart gives power settings and fuel flows for Maximum Power (Dry) operation at 2000-foot density altitude increments from −4000 feet to 30,000 feet.

FLIGHT OPERATION INSTRUCTION CHARTS.

Flight Operation Instruction Charts cover the various gross weight brackets from the limit take-off gross weight to the minimum flying weight and a full range of practical fuel loadings are entered in each chart. Column I is based on maximum continuous power, Normal Power for two-engine operation or Maximum Power (Dry) in case of emergency single-engine operation, and therefore shows least range; while Column V, which shows maximum range, is based on 99% best economy and therefore shows considerably lower power and speeds. Columns II, III and IV give intermediate range-speed relationships for interpolation purposes. Range values shown on any chart are integrated values which automatically take into account the changes in power and speed with changes in weight as shown on the succeeding charts for lighter weights. It is most essential that, as the airplane gross weight diminishes, the power should be reset for each different weight band if the range values quoted are to be realized.

Note

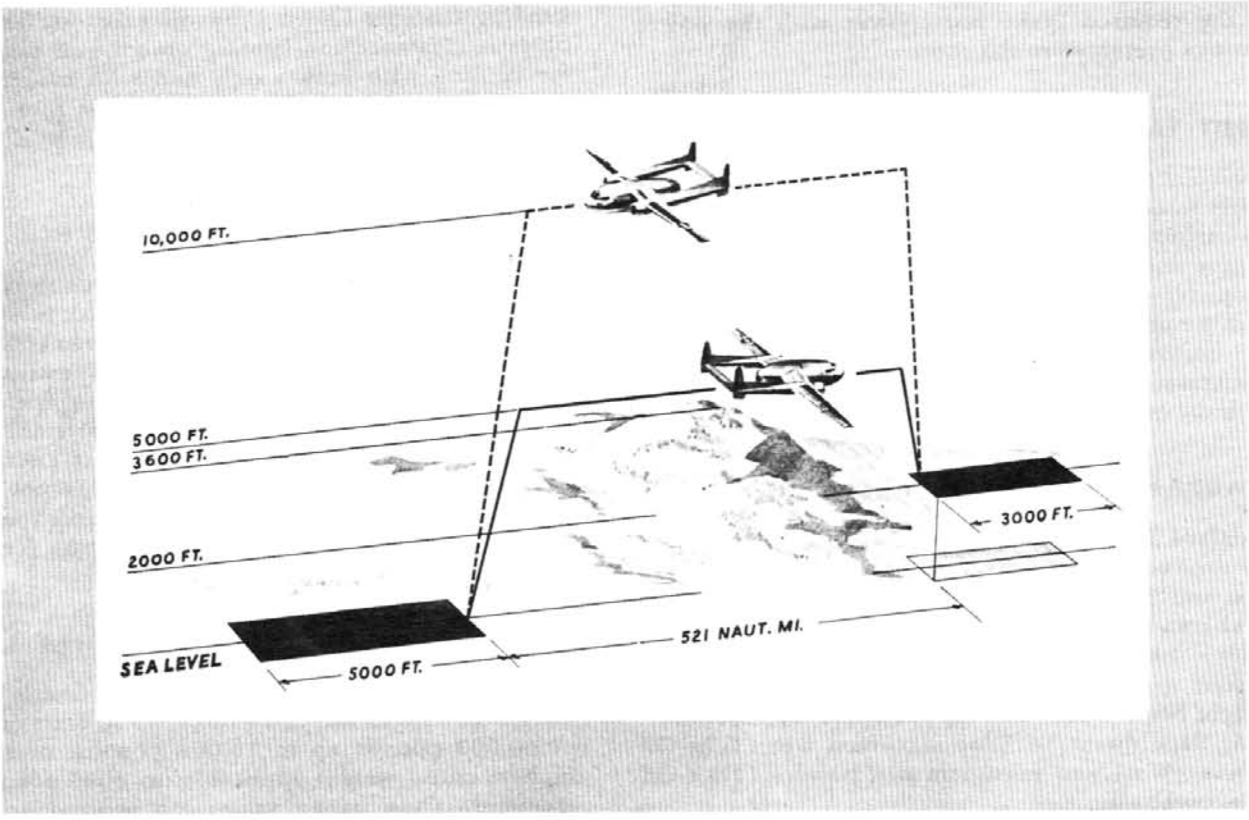
> All power settings in the Flight Operation Instruction Charts presuppose the use of low blower operation at altitudes of 15,000 feet or less. High blower operation is assumed above 15,000 feet.

The Brake Horsepower Adjustment Charts are to be used in conjunction with the Flight Operation Instruction Charts to obtain the required brake horsepower if, because of atmospheric and/or engine conditions, the power settings quoted do not produce the required horsepower.

USE OF CHARTS.

The following two sample problems based on typical missions and using actual chart values demonstrate how the charts should be used.

GENERAL RADIUS MISSION.



REQUIREMENT.

Fifteen thousand pounds of equipment are to be landed at a forward airhead located 521 nautical miles from the home airfield.

DATA KNOWN.

1. The home airfield is at sea level with a 5000-foot runway.

2. Forward airhead is at 2000 feet altitude with a 3000-foot runway.

3. Intervening terrain contains mountains of 3,600 feet altitude.

4. Weather at base is CAVU; FAT, 59°F; Dew Point, 30°F; pressure altitude, sea level.

5. Winds are: 26 knots tailwind at sea level for cruise out.
   35 knots tailwind at 5,000 feet for cruise out.
   26 knots tailwind at 10,000 feet for cruise out.

6. Airplane weight (less fuel and cargo) is 43,498 pounds.

FIRST—A GENERAL FLIGHT PLAN.

The general flight plan which will fulfill the various requirements of the mission is: take-off at sea level from a 5,000-foot runway, climb to 5,000 feet at normal power and speed for best climb, cruise out 521 nautical miles, descend to 2,000 feet and land in less than 3,000 feet; then after unloading the 15,000 pounds of cargo at forward airstrip, take-off at 2000 feet in less than 3,000 feet, climb to 10,000 feet to take advantage of lower headwinds, cruise back 521 nautical miles, descend to sea level and land at the home airbase in less than 5,000 feet. Inasmuch as the weight of the airplane and the cargo is 58,498 pounds (43,498 + 15,000 = 58,498 pounds), the cruise out, obviously, will be made at a gross weight of approximately 70,000 pounds when fuel required and general fuel reserves are considered. To obtain the amount of fuel required for cruise, refer to Column V of the Flight Operation Instruction Chart for 70,000-60,000 pounds, figure A-27, which indicates that a 1135 nautical mile range may be obtained with 9,000 pounds of fuel. However, additional fuel will be required for the warm-up, take-off and climb step at the home airbase as well as at the forward airfield. Moreover, some allotment of fuel for wind reserves on the return trip and for general fuel reserve is necessary. The Climb Chart for normal power, figure A-21, indicates that the initial warm-up, take-off and climb to 5,000 feet will require 960 pounds of fuel at an airplane gross weight of 77,000 pounds. Similarly, the allowance for warm-up, take-off and climb to 10,000 feet from the forward airstrip is obtained from the same chart. If the second take-off gross weight is assumed to be 55,000 pounds, which is the gross weight on the climb chart nearest the airplane's gross weight when 15,000 pounds of cargo have been unloaded, the fuel allowance for the warm-up, take-off and climb to 10,000 feet is 1,005 pounds. These allowances, together with the airplane, cargo and estimated fuel for cruise, but not including allowances for wind or general reserves, will total 69,463 pounds (43,498 + 15,000 + 9,000 + 960 + 1,005 = 69,463 pounds). If a take-off gross weight of 71,000 pounds is assumed, this will allow 1,537 pounds of fuel for wind and general reserves, which appears adequate especially since an additional conservative factor is introduced when the cargo is unloaded at the forward airhead.

From the Brake Horsepower Correction Chart of figure A-4 for maximum power wet: the corrected BHP = 3483, expected torque pressure + 170 psi, reject torque pressure = 161 psi, deviation from sea level standard BHP = 1%. From the Density Altitude Correction Chart and Temperature Conversion Chart of figure A-6, the density altitude is 0 feet or sea level.

Reference to the Take-Off Distances Chart, figure A-13, shows that, with zero flap deflection, a gross weight of 71,000 pounds, sea level density altitude, and one percent deviation, an initial take-off can be made in less than 4000 feet with (3239 feet to clear a 50-foot obstacle with a 30-knot headwind) take-off being made into the wind.

Note

> To take advantage of the 5000-foot runway at the base airfield, the take-off is accomplished with a 0° wing flaps setting. Therefore, less risk is involved should an engine failure occur during take-off. From the maximum power wet Limit Take-Off Gross Weight Chart of figure A-9 at 1% deviation and sea level density altitude a limit gross weight for single-engine, 100-foot per minute rate-of-climb is 79,500 pounds. (However, the landing gear limits take-off gross weight to 77,000 pounds.)

The take-off from the forward outstrip will be made at an approximate gross weight of 55,000 pounds. Assuming standard temperature at 2000 feet pressure altitude and no humidity correction, the Brake Horsepower Correction Chart (figure A-4) shows zero deviation from sea level standard brake horsepower. From figure A-6 the density altitude is 2,000 feet and from the Take-Off Distances Chart of figure A-14, the take-off will require 2460 feet to clear a 50-foot obstacle with no wind and 14° flap deflection.

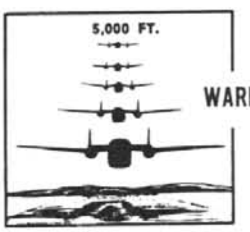
Note

> Due to the shortness of the runway at the forward airstrip, take-off (14°) flaps and maximum power wet are used to get off within the available distance.

To estimate the first landing weight, start with the assumed take-off weight of 71,000 pounds; subtract the fuel for warm-up, take-off and climb, 960 pounds; and enter the Flight Operation Instruction Chart for 70,000-60,000 pounds, figure A-27, and read 4200 pounds of fuel at a range of 530 nautical miles in column V. Thus the first landing weight would be approximately 65,840 pounds (71,000 − 960 − 4200 = 65,840 pounds). Assume 67,000 pounds for conservatism. By referring to the Landing Distances Chart for brakes and reverse thrust, figure A-23, it is found by interpolation that, for 67,000 pounds at 2,000 feet density altitude, the ground roll will be 2037 feet, while the required distance to clear a 50-foot obstacle will be 3,118 feet. Since this latter distance is greater than the 3000-foot runway at the forward field, the mission can be accomplished only if there are no obstacles at the runway approach or if sufficient headwind exists.

FINALLY—A DETAILED FLIGHT PLAN.

In order to determine the power settings and to insure that the mission will be flown in a sufficiently safe manner, it is necessary to make a detailed analysis of the problem as a check on the general flight plan. Determine the detailed flight plan as follows:



WARM-UP, TAKE-OFF AND CLIMB TO 5000 FEET.

LEG 1					
Plane Weight (lbs)	Fuel (lbs)	Condition	Altitude (feet)	Power Setting	Fuel Used (lbs)
71,000	12,502	Climb	5000	2600 RPM 142 psi 48 in. Hg	960

PLANE WEIGHT: 71,000 pounds as estimated in general flight plan.

FUEL WEIGHT: 12,502 pounds of which 9,000 pounds is fuel for cruise out and back; 960 pounds, the fuel for initial warm-up, take-off and climb; 1,005 pounds, the fuel for second warm-up, take-off and climb, and 1,537 pounds, the fuel allowance for wind and general reserve.

CONDITION: Climb to cruising altitude.

ALTITUDE: Choice of 5,000 feet is made to take advantage of more favorable tailwind and to clear intervening terrain.

POWER SETTING: Power setting of 2600 RPM, 142 psi torque pressure and 48 inches mercury manifold pressure is taken directly from the Climb Chart for normal power, figure A-21.

FUEL USED: Fuel (960 pounds) used in warm-up, take-off and climb to 5,000 feet is read directly from the climb chart for normal power, A-21.

Note

> Time consumed and distance covered in the climb are considered negligible in this instance. Should the climb be to high altitudes, the time consumed and the distance covered may be taken directly from the Climb Charts.

CRUISE OUT AT 5,000 FEET.

LEG 2							
Plane Weight (lbs)	Fuel (lbs)	Power Setting	TAS (kn)	Ground Speed (kn)	Time (hrs)	Distance (n.mi.)	Fuel Used (lbs)
70,040	11,542	1580 BHP 2220 RPM 101 psi 32.5 in. Hg	176	* 176	2.96	521	4200

The cruise out to the forward airbase should be made at speed for maximum range. Column V conditions of the Flight Operation Instruction Chart are used throughout.

PLANE WEIGHT: The weight of the airplane at the start of the cruise is 70,040 pounds which is the original weight of the airplane (71,000 pounds) less the fuel (960 pounds) used for warm-up, take-off and climb to 5,000 feet.

FUEL WEIGHT: The fuel weight at the start of the cruise is 11,542 pounds which is the original fuel weight (12,502 pounds) less the fuel (960 pounds) used for warm-up, take-off and climb to 5,000 feet.

POWER SETTING: The initial cruise power setting of 2220 RPM, 32.5 inches of manifold pressure, 1580 brake horsepower and 101 psi torque pressure is read directly from the 5000-foot density altitude entry in Column V of the Flight Operation Instruction Chart for an airplane gross weight of 70,000-60,000 pounds, figure A-27.

TAS: The true airspeed of 176 knots is read from the Flight Operation Instruction Chart, figure A-27.

*GROUND SPEED: Although a 35-knot tailwind exists at 5000 feet altitude, ground speed is considered the same as TAS to introduce further conservatism.

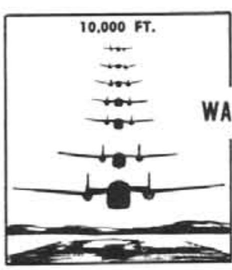
DISTANCE: The distance is 521 nautical miles as given in the general flight plan.

TIME: The duration of the cruise, 2.96 hours, is the distance of 521 nautical miles divided by the ground speed of 176 knots.

FUEL USED: The fuel used, 4200 pounds, is read from Column V of the Flight Operation Instruction Chart for 70,000-60,000 pounds, figure A-27, for a conservative range of 530 nautical miles.

LANDING AT FORWARD AIRBASE.

The landing weight at the forward airbase will be the airplane gross weight (70,040 pounds) at the beginning of the cruise less the fuel (4,200 pounds) used during the cruise. This indicates that the landing gross weight will be 65,840 pounds which is less than the 67,000 pounds assumed. But because of the cruise tailwind and other conservative factors in the Flight Operation Chart Data, this landing weight could be as high as 66,500 pounds. Therefore, to be conservative, the orginal estimate of 67,000 pounds will hold true and this weight will be too great to land at the forward base if there are obstacles at the runway approach.



WARM-UP, TAKE-OFF AND CLIMB TO 10,000 FEET.

LEG 3					
Plane Weight (lbs)	Fuel (lbs)	Condition	Altitude (feet)	Power Setting	Fuel Used (lbs)
50,840	7,342	Climb	10,000	2600 RPM 142 psi 48 in. Hg	1005

PLANE WEIGHT: The airplane gross weight (50,840 pounds) at take-off from the forward airbase is the landing gross weight (65,840 pounds) less the cargo (15,000 pounds) unloaded.

FUEL WEIGHT: The fuel weight (7,342 pounds) at take-off is the weight of fuel (11,542 pounds) at the start of the cruise less the fuel (4,200 pounds) used during the 521 nautical miles cruise.

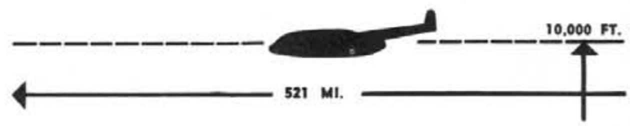
CONDITION: Climb to obtain cruising altitude.

ALTITUDE: An altitude of 10,000 feet is selected for the cruise back because the headwinds are lower at this altitude.

POWER SETTING: Power setting of 2600 RPM, 142 psi torque pressure and 48 inches mercury manifold pressure is taken directly from the Climb Chart for normal power, figure A-21.

FUEL USED: The fuel used for take-off and climb to 10,000 feet is 1,005 pounds as taken from the Climb Chart for normal power, figure A-21. The 55,000-pound chart is used for conservatism.

CRUISE BACK AT 10,000 FEET.



LEG 4							
Plane Weight (lbs)	Fuel (lbs)	Power Setting	TAS (kn)	Ground Speed (kn)	Time (hrs)	Distance (n.mi.)	Fuel Used (lbs)
49,835	6,337	1210 BHP 1730 RPM 99 psi 29 in. Hg	173	147	3.54	521	4200

The cruise back to the home base should be made at speed for maximum range. Column V conditions of the Flight Operation Instruction Charts are used throughout.

PLANE WEIGHT: The cruising gross weight (49,835 pounds) of the airplane is the take-off gross weight (50,840 pounds) less the fuel (1,005 pounds) used in take-off and climb to 10,000 feet.

FUEL WEIGHT: The fuel weight (6,337 pounds) at the start of the cruise back is the fuel weight at take-off (7,342 pounds) less the fuel (1,005 pounds) used in take-off and climb to 10,000 feet.

POWER SETTING: The power setting of 1730 RPM, 29 inches of manifold pressure, 1210 BHP and 99 psi torque pressure is read directly from the 10,000-foot density altitude entry in column V of the Flight Operation Instruction Chart for an airplane gross weight of 50,000-40,000 pounds, figure A-29.

TAS: The true airspeed of 173 knots is read from the Flight Operation Instruction Chart, figure A-29.

GROUND SPEED: The ground speed of 147 knots is the true airspeed (173 knots) less the 26-knot headwind prevailing at 10,000 feet.

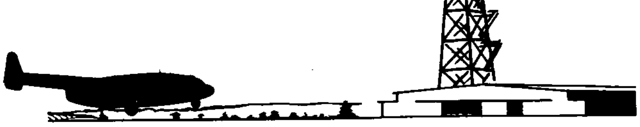
DISTANCE: The distance is 521 nautical miles as given in the general flight plan.

HOURS: The duration of the cruise back (3.54 hours) is the distance of the return leg (521 nautical miles) divided by the ground speed (147 knots). Note that the actual nautical air mile distance to be flown on the return leg is 612 nautical air miles which is the duration of the return flight (3.54 hours) multiplied by the TAS (173 knots).

FUEL USED: The fuel (4,200 pounds) used on the cruise back is obtained from Column V, Flight Operation Instruction Chart, figure A-29, for a distance of

665 nautical air miles which is the next distance shown above 612 nautical air miles.

LANDING AT HOME AIRBASE.



Descent is made to sea level and a landing made at the home airfield. The landing gross weight is 45,635 pounds which is the weight at the start of the cruise (49,835 pounds) less the fuel consumed during the cruise back (4,200 pounds). The landing distance over a 50-foot obstacle is 2094 feet. The fuel remaining when the mission has been accomplished is 2,137 pounds—the fuel weight at the start of the return cruise (6,337 pounds) less the fuel used during the cruise (4,200 pounds).

ADDITIONAL CONSIDERATIONS.

Certain changes may occur during flight which would affect the original flight plan, and which would necessitate re:erence to the charts. Assume, for example, that after climbing to an altitude of 10,000 feet for the return cruise, an engine failure should occur. It is seen from previous computations that, at this point, the airplane gross weight is 49,835 pounds, and that 6,337 pounds of fuel remain. By referring to the Flight Operation Instruction Chart for single-engine operation for 50,000 to 40,000 (figure A-47), it is seen that 655 nautical miles can be flown on single engine with 4,200 pounds of fuel. This would leave 2,137 pounds of fuel for reserve.

Or suppose that the airplane is to rendezvous with another at 10,000 feet and make the return trip together. However, the other plane arrives 15 minutes late. Circling, while waiting, should be flown at speed and power for maximum endurance, which may be taken from figure A-24, Maximum Endurance Chart. The fuel used during this delay, which is also taken from the same chart, reduces the airplane weight and fuel load entries for the return cruise to the home base.

Then, too, if an enemy raid were imminent when take-off from the forward field was made, the climb and thirty minutes of cruise back might be made at maximum power (dry) and combat power settings. The data for climb would then be taken from the Maximum Power (dry) Climb Chart (figure A-19), instead of the Normal Power Climb Chart and the maximum combat power settings taken from the Combat Allowance Chart (figure A-25). The fuel used would be double the amount shown in the fuel-flow-per-engine column and would have to be accounted for in the weight and fuel entries of the final leg of the flight.

MASTER DATA CHART.

After this detailed plan is satisfactorily completed, it should be assembled into a master chart to facilitate the use of the data during flight.

POST FLIGHT ANALYSIS.

Upon the completion of the flight, comparison should be made between the actual and the computed data. This will give the pilot a better idea of the margin of safety afforded by the charts. He should then be able to plan succeeding missions with increased accuracy.

MASTER DATA CHART (FOR USE IN FLIGHT)

CONDITION	PLANE WEIGHT (LB)	FUEL WEIGHT (LB)	FUEL USED	POWER SETTINGS	ALT.	TAS (KN)	GROUND SPEED (KN)	HRS.	NAUT. MILES
TAKE-OFF AND CLIMB TO 5,000 FEET	71,000	12,502	960	2600 RPM 142 PSI 48 in HG	5,000				
CRUISE OUT	70,040	11,542	4,200	1580 BHP 2220 RPM 101 PSI 32.5 in HG	5,000	176	176	2.96	521
TAKE-OFF AND CLIMB TO 10,000 FEET	50,840	7,342	1,005	2600 RPM 142 PSI 48 in HG	10,000				
CRUISE BACK	49,835	6,337	4,200	1210 BHP 1730 RPM 99 PSI 29 in HG	10,000	173	147	3.54	521
AFTER LANDING	45,635	2,137							

NOTES: 1. FORWARD AIRBASE IS AT 2,000 FEET ALTITUDE WITH 3,000-FOOT RUNWAY.
2. INTERVENING TERRAIN IS 3,600 FEET.
3. WINDS: 26 KNOTS TAILWIND AT SEA LEVEL FOR CRUISE OUT.
35 KNOTS TAILWIND AT 5,000 FEET FOR CRUISE OUT.
26 KNOTS TAILWIND AT 10,000 FEET FOR CRUISE OUT.

CRUISE CONTROL RANGE MISSION.

To illustrate the use of the Brake Horsepower Correction Charts, Density Altitude Correction Chart, Limit Take-Off Gross Weight Charts and Long Range Cruise Charts, the following example is presented.

REQUIREMENT.

That 15,000 pounds or more of cargo is to be flown to a distant airfield located 1343 nautical miles from the home airfield.

DATA KNOWN.

1. Home airfield is at 2000-feet altitude with a 5000-foot runway.

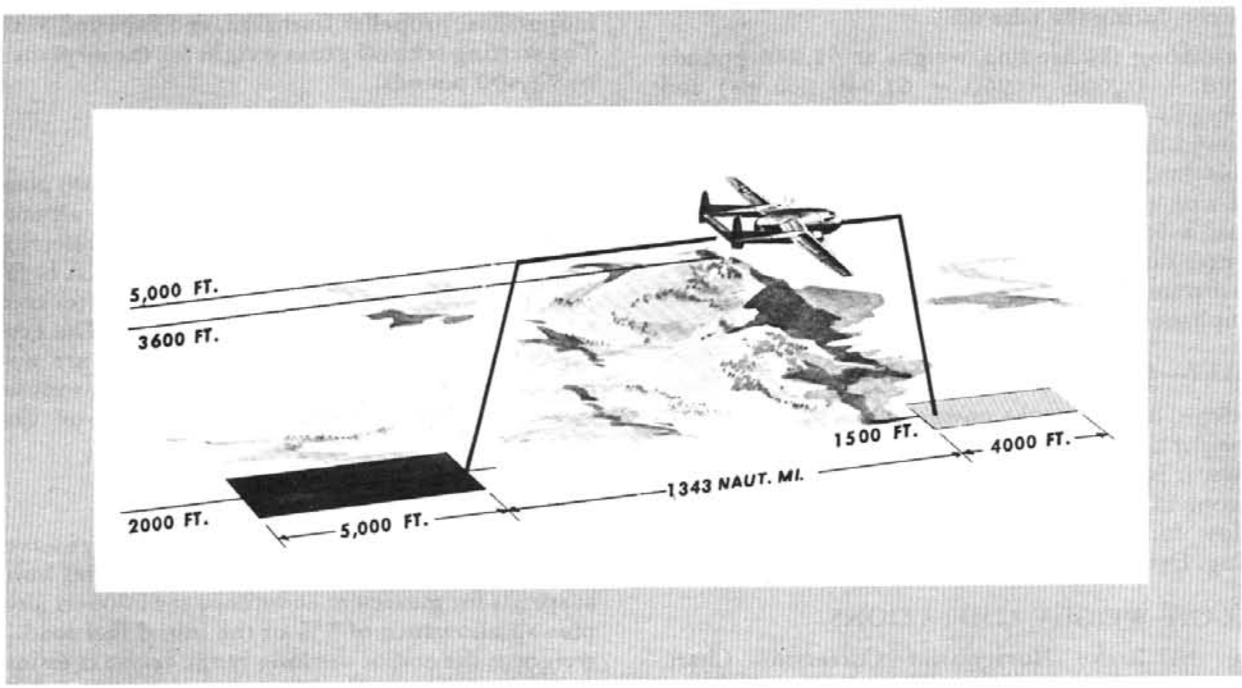
2. Distant airfield is at 1500-feet altitude with a 4000-foot runway.

3. Intervening terrain reaches 3,600 feet.

4. Weather at home airfield is CAVU, FAT—90°F, Dew Point—60°F, pressure altitude—2,000 feet.

5. Winds are: 26 knots tailwind at 2,000 feet for cruise out.
   35 knots tailwind at 5,000 feet for cruise out.
   26 knots tailwind at 10,000 feet for cruise out.

6. Airplane weight (less fuel and cargo) is 43,498 pounds.



FIRST—A GENERAL FLIGHT PLAN.

The general flight plan which will fulfill the various requirements of the mission is: take-off at 2000 feet from a 5,000-foot runway, climb to 5,000 feet at normal power and speed for best climb, cruise out 1343 nautical miles, descend to 1,500 feet, land in less than 4,000 feet and unload the cargo.

Inasmuch as the weight of the airplane and the cargo is 58,498 pounds (43,498 + 15,000 = 58,498 pounds), the cruise out will be made at a gross weight of approximately 72,000 pounds when fuel required and general fuel reserves are considered. To obtain the amount of fuel required for cruise, refer to the Long Range Chart at 5,000 foot altitude for 72,000 pounds, figure A-31, which indicates that a 1,345 nautical mile range may be obtained with 10,000 pounds of fuel. However, additional fuel will be required for the warm-up, take-off and climb step. The Climb Chart for normal power, figure A-21, indicates that the initial warm-up, take-off and climb from sea level to 5,000 feet will require 960 pounds of fuel at an airplane gross weight of 77,000 pounds. This allowance, together with the airplane, cargo and estimated fuel for cruise, but not including allowances for wind or general reserves, will total 69,458 pounds (43,498 + 15,000 + 10,000 + 960 = 69,458 pounds). If a take-off gross weight of 72,000 pounds is assumed, this will allow 2,542 pounds of fuel for wind and general reserves, which appears adequate since an additional conservation factor is introduced when no credit is taken for the fact that the home airfield is at 2000 feet altitude, for range covered in climb to 5000 feet and for the tailwind.

Reference to the Take-Off Distance Chart, figure A-13, shows that, with a gross weight of 77,000 pounds—which is the first weight shown above the estimated gross weight of 72,000 pounds—an initial take-off can be made in less than 5000 feet (4,510 feet to clear a 50-foot obstacle with a 30-knot wind at a 2000-foot density altitude with zero deviation from sea level standard brake horsepower.

Note

To take advantage of the 5,000-foot runway at the home airfield, the take-off is accomplished with a 0° wing flaps setting. Therefore less risk is involved should an engine failure occur during the take-off.

By estimating the landing weight at 61,040 pounds (72,000 − 10,000 − 960 = 61,040 pounds) and referring to the Landing Distance Chart, figure A-23, it is found through interpolation that the ground roll for this landing at 1,500 feet altitude with reverse thrust will be 1,818 feet, while the required distance to clear a 50-foot obstacle will be 2,825 feet. Since this latter distance is less than the 4,000-foot runway at the distant airfield it appears that the mission can be accomplished even if no wind exists during landing.

FINALLY—A DETAILED FLIGHT PLAN.

In order to determine the power settings and to insure that the mission will be flown in a sufficiently safe manner, it is necessary to make a detailed analysis of the problem as a check on the general flight plan and to allow for the atmospheric conditions as actually existing. Determine the detailed flight plan as follows:

TAKE-OFF WEIGHT LIMITATIONS.

Using the Brake Horsepower Correction Chart, figure A-4, and knowing the atmospheric conditions at the home airfield, the correction to brake horsepower can be determined as a percent deviation from standard sea level BHP for Take-Off Power (Wet). These curves also indicate expected torque and reject torque.

Known: 2000-foot Pressure Altitude
90°F—FAT—CAT
60°F—Dew Point
Read: 159 psi Expected Torque
151 psi Reject Torque
7.4% Deviation

Note

If it is impossible to obtain "reject torque" during the engine run up to full power, or in the take-off run itself; the take-off should be discontinued as this indicates a probable engine malfunction.

Now use Figure A-6, the Density Altitude Correction Chart, to determine the temperature in degrees centigrade and the density altitude at home airfield.

Known: FAT—90°F
Pressure Altitude—2000 feet
Read: FAT—32°C
Density Altitude—4300 feet

Now knowing density altitude and percent deviation in power use figure A-9, Limit Take-Off Gross Weight Chart, for a zero flap deflection and Take-Off Power (Wet) to determine the limit take-off gross weight.

Known: Percent Deviation—7.4%
Density Altitude—4300 feet
Read: 72,400

This limit take-off gross weight is the highest gross weight at which the airplane can maintain a rate of climb of 100 feet per minute with the critical engine inoperative, propeller feathered, and flaps and gear up. The starting take-off gross weight for the airplane will be 72,400 pounds.

TAKE-OFF DISTANCE.

Using the take-off weight limitation of 72,400 pounds, the 7.4% deviation in power, the density altitude of 4,300 feet and head wind of 26 knots, and referring to the Take-Off Distance Chart, figure A-13, it is found through interpolation that the distance to clear a 50-foot obstacle will be about 5409 feet. The ground run is interpolated as 2777 feet. If there are no 50-foot obstacles at the end of the 5000-foot runway or in the area beyond the runway, the take-off can be made at 72,400 pounds gross weight.

FUEL RESERVE.

For this example the wind and general fuel reserve has been selected as fuel required for 30 minutes holding at speeds for maximum endurance at 5000 feet altitude plus an allowance of 5% of the initial fuel load. The weight at the end of the long range cruise is estimated to be 61,440 pounds (72,400 − 10,000 − 960 = 61,440 pounds). Using the Maximum Endurance Chart, figure A-24, and interpolating for a gross weight of 61,440 pounds the fuel required is 442 pounds. Fuel weight is now 11,402 pounds (10,000 + 960 + 442 = 11,402 pounds). The initial fuel load including the allowance of 5% of the initial fuel is 12,002 pounds (11,402 ÷ .95) and 5% of the initial fuel is 600 pounds.

Note

To obtain the 30 minutes maximum endurance at 5000 feet altitude, the power settings shown in the Maximum Endurance Chart of figure A-24 must be observed.

PAYLOAD.

The payload that can be carried is 16,900 pounds. (72,400 − 43,498 − 600 = 16,900 pounds).

WARM-UP, TAKE-OFF AND CLIMB TO 5,000 FEET.

LEG 1						
Plane Weight (lbs)	Fuel (lbs)	Condition	Altitude (feet)	Power Setting	Fuel Used (lbs)	CAS/TAS (kn)
72,400	12,002	Climb	5000	2600 RPM 142 psi 48 in. Hg	960	129/129

PLANE WEIGHT: 72,400 pounds as estimated in the take-off weight limitation section.

FUEL WEIGHT: The fuel weight is 12,002 pounds (10,000 + 960 + 442 + 600 = 12,002 pounds).

CONDITION: Climb to cruising altitude.

ALTITUDE: Choice of 5,000 feet is made to take advantage of more favorable tailwind and to clear intervening terrain.

POWER SETTING: Power setting of 2600 RPM, 142 psi torque pressure and 48 in. Hg manifold pressure is taken directly from the Climb Chart for Normal Power of figure A-21.

FUEL USED: Fuel (960 pounds) used in warm-up, take-off and climb to 5,000 feet is read directly from the Climb Chart for normal power, figure A-21. Since the home airfield is at 2000 feet altitude, this gives a conservative value for fuel used.

CAS/TAS: Speeds for best climb are read directly from the Climb Chart for Normal Power of figure A-21.

Note

Time consumed and distance covered in the climb are considered negligible in this instance. Should the climb be to higher altitudes, the time consumed and the distance covered may also be taken directly from the Climb Charts.

LONG RANGE CRUISE AT 5,000 FEET.

FIRST POWER SETTING—START OF CRUISE

LEG 2								
Plane Weight (lb)	Fuel (lb)	Power Setting	Fuel Flow (lb/hr)	CAS/TAS (kn)	Ground Speed (kn)	Time (hrs)	Distance (n.mi.)	Fuel Used (lb)
71,440	11,042	2170 RPM 1520 BHP 100 psi 32.5 in. Hg	1320	156/168	203	1.091	221	1440

The cruise to the distant airfield should be made at the speeds and power settings shown in the Long Range Cruise Chart at 5000 feet altitude, figure A-31. At the start of cruise, the first power setting corresponding to a 72,000-pound gross weight is used. In addition, credit is taken for the 35-knot tailwind which is assumed to be the same all the way to the distant airfield.

PLANE WEIGHT: The weight of the airplane at the start of the cruise is 71,440 pounds which is the original weight of the airplane (72,400 pounds) less the fuel (960 pounds) used for warm-up, take-off and climb to 5000 feet.

FUEL WEIGHT: The fuel weight at the start of the cruise is 11,042 which is the original fuel weight (12,002 pounds) less the fuel (960 pounds) used for warm-up, take-off and climb to 5000 feet.

POWER SETTING: The first power setting of 2170 RPM, 32.5 in. Hg. manifold pressure, 1520 BHP and 100 psi torque pressure is read at the 72,000 pounds gross weight line of the Long Range Cruise Chart at 5000-foot altitude, figure A-31.

FUEL FLOW: The fuel flow of 1,320 pounds per hour is read at the 72,000 pound gross weight line of the Long Range Cruise Chart at 5000-foot altitude, figure A-31.

CAS/TAS: The calibrated airspeed of 156 knots and the true airspeed of 168 knots are read at the 72,000 pound gross weight line of the Long Range Cruise Chart at 5000-foot altitude, figure A-31.

GROUND SPEED: The 35-knot tailwind is assumed to be the same all the way to the distant airfield. In this example credit is taken for the tailwind which gives a ground speed of 203 knots (168 + 35 = 203 knots).

FUEL USED: The fuel used during the first power setting is 1,440 pounds which is determined by subtracting the gross weight line of 70,000 pounds from the cruise starting gross weight of 71,440 pounds.

TIME: The time required to get down to the next lower gross weight is 1.091 hours, which is determined by dividing the fuel used during the first power setting by the fuel flow (1,440 ÷ 1,320 = 1.091 hours).

DISTANCE: The distance covered with the first power setting is 221 nautical miles and is determined by multiplying the ground speed by the time for the first power setting (203 x 1.091 = 221 nautical miles).

SECOND POWER SETTING—AT START OF THIS SEGMENT

LEG 2								
Plane Weight (lb)	Fuel (lb)	Power Setting	Fuel Flow (lb/hr)	CAS/TAS (kn)	Ground Speed (kn)	Time	Distance (n.mi.)	Fuel Used (lb)
70,000	9,602	2100 RPM 1460 BHP 99 psi 32.0 in. Hg	1,275	154/166	201	1.569	315	2,000

For the second power setting enough fuel has been consumed for the airplane to have a gross weight of 70,000 pounds. Therefore, the Long Range Cruise Chart at 5000 feet altitude, figure A-31, is again used for determining the power settings for 70,000 pounds gross weight. All of the information appearing in the table above is calculated in the same manner as that described for the first power settings. This process of changing the power setting of the airplane for each 2,000-pound increment change in gross weight is continued until the final power setting is obtained and the distant airfield is reached.

The next two power settings are shown in the Master Data Chart at the end of this example:

FINAL POWER SETTING—AT START OF THE SEGMENT

LEG 2								
Plane Weight (lb)	Fuel (lb)	Power Setting	Fuel Flow (lb/hr)	CAS/TAS (kn)	Ground Speed (kn)	Time	Distance (n.mi.)	Fuel Used (lb)
64,000	3,603	1870 RPM 1290 BHP 98 psi 31.0 in Hg	1,140	149/160	195	.779	152	888

The final power setting is shown in the table above and is used until the distant airfield is reached. Necessary calculations are made as previously described except as follows:

DISTANCE: Distance covered with the final power setting is 152 nautical miles which is determined by subtracting the total distance covered in preceding segments from the distance to be flown from the home airfield to the distant airfield (1343 − 221 − 315 − 321 − 334 = 152 nautical miles).

TIME: Time required is .779 hours which is determined by dividing the distance remaining by the ground speed (152 ÷ 195 = .779 hours).

FUEL USED: Fuel used is 888 pounds and is determined by multiplying the fuel flow by the time (1,140 × .779 = 888 pounds).

Note

Nautical miles per pound of fuel are substantially lower for single-engine operation; therefore, if at any time during the cruise, an engine failure occurs, the range that can be obtained at that gross weight with the fuel remaining for cruise, can be checked from the Single-Engine Long Range Cruise Charts (Figure A-49 at 5000 feet density altitude). This check should be made immediately after engine fails and single-engine procedure is completed.

LANDING AT DISTANT AIRFIELD.

Before landing, the pilot contacts the distant airfield and gets the following information about the atmospheric conditions:

1. Weather at distant airfield is CAVU, FAT = 84°F, Dew Point = 70°F, pressure altitude = 1,800 feet.

2. Wind on the landing runway is a 22-knot headwind.

With the above information the pilot then determines the density altitude of 3,700 feet from the Density Altitude Correction Chart figure A-6. The landing weight at the distant airfield will be 63,112 pounds which is determined by subtracting the fuel used during the final power setting segment from the gross weight at the start of the final power setting segment (64,000 − 888 = 63,112 pounds landing gross weight). Then, referring to the Landing Distance Chart, figure A-23, and interpolating for gross weight and density altitude, the ground roll is 2,015 feet and the total distance over a 50-foot obstacle is 3,087 feet. Since the landing runway at the distant airfield is 4000 feet long, the airplane has ample runway distance.

MASTER DATA CHART.

As in the first problem, after this detailed plan is satisfactorily completed, it should be assembled into a master chart to facilitate use of data during flight.

MASTER DATA CHART

LEG	CONDITION	PLANE WEIGHT (LB)	FUEL (LB)	POWER SETTING	FUEL FLOW (LB/HR)	CAS/TAS (KN)	GROUND SPEED (KN)	TIME (HR)	DISTANCE (N. MI.)	FUEL USED (LB)
1	CLIMB TO 5,000 FT.	72,400	12,002	2600 RPM 142 psi 48 in HG		129/129				960
2	CRUISE 1ST POWER SETTING	71,440	11,042	2170 RPM 1520 BHP 100 PSI 32.5 in HG	1,320	156/168	203	1.091	221	1,440
	CRUISE 2ND POWER SETTING	70,000	9,602	2100 RPM 1460 BHP 99 PSI 32 in HG	1,275	154/166	201	1.569	315	2,000
	CRUISE 3RD POWER SETTING	68,000	7,602	2020 RPM 1400 BHP 98 PSI 31.5 in HG	1,240	153/164	199	1.613	321	2,000
	CRUISE 4TH POWER SETTING	66,000	5,602	1940 RPM 1340 BHP 98 PSI 31.5 in HG	1,180	151/162	179	1.695	334	2,000
	CRUISE FINAL POWER SETTING	64,000	3,602	1870 RPM 1290 BHP 98 PSI 31 in HG	1,140	149/160	195	.779	152	888
3	LANDING	63,112	2,714							

NOTES: 1. DISTANT AIRFIELD IS AT 1,500 FEET ALTITUDE WITH 4,000-FOOT RUNWAY.
2. INTERVENING TERRAIN IS 3,600 FEET.
3. WINDS: 26 KNOTS TAILWIND AT 2,000 FEET.
35 KNOTS TAILWIND AT 5,000 FEET.
26 KNOTS TAILWIND AT 10,000 FEET.

AIRSPEED INSTALLATION CORRECTION TABLE

REAR CARGO DOORS ON

I. A. S.	CORRECTION
82	Add 6 Knots
95	Add 5 Knots
109	Add 4 Knots
123	Add 3 Knots
139	Add 2 Knots
155	Add 1 Knot
178	No Correction Necessary
199	Subtract 1 Knot
206	Subtract 1 Knot
229	No Correction Necessary
240	Add 1 Knot

REAR CARGO DOORS OFF

I. A. S.	CORRECTION
90	Add 5 Knots
105	Add 4 Knots
125	Add 3 Knots
156	Add 2 Knots
200	Add 1 Knot

EXAMPLE:

Find CAS when IAS = 123 Knots (rear cargo doors on)

CAS = 123 + 3 = 126 Knots

Figure A-1. Airspeed Installation Correction Table

STANDARD DAY TEMPERATURES VERSUS ALTITUDE		
ALTITUDE	TEMPERATURES	
FEET	DEGREES F	DEGREES C
0	59.000	15.000
1,000	55.434	13.019
2,000	51,868	11.038
3,000	48.301	9.056
4,000	44.735	7.075
5,000	41.169	5.094
6,000	37.603	3.113
7,000	34.037	1.132
8,000	30.471	— 0.850
9,000	26.904	— 2.831
10,000	23.338	— 4.812
11,000	19.772	— 6.793
12,000	16.206	— 8.774
13,000	12,640	— 10.756
14,000	9.074	— 12.737
15,000	5.507	— 14.718
16,000	1.941	— 16.699
17,000	— 1.625	— 18.680
18,000	— 5.191	— 20.662
19,000	— 8.757	— 22.643
20,000	— 12.323	— 24.624
21,000	— 15.890	— 26.605
22,000	— 19.456	— 28.586
23,000	— 23.022	— 30.568
24,000	— 26.588	— 32.549
25,000	— 30.154	— 34.530

Figure A-2. Standard Day Temperature at Altitude

ENGINE POWER SCHEDULE

STANDARD DAY—NO RAM—FUEL 115/145

ENGINE: R3350-85-89 **SUPERCHARGER RATIO:** Low

POWER RATING	BHP at Sea Level	MIXTURE	RPM	ALTITUDE—FEET											
				Sea Level		2000		4000		6000		8000		10000	
				MAP (in. Hg)	TOP (psi)	MAP (in. Hg)	TOP (psi)	MAP (in. Hg)	TOP (psi)	MAP (in. Hg)	TOP (psi)	MAP (in. Hg)	TOP (psi)	MAP (in. Hg)	TOP (psi)
Take-off Wet	3500	RICH	2900	57.5	171	57.0	171	56.5	171						
Military Wet (Maximum Wet)	3500	NORMAL	2900	57.5	171	57.0	171	56.5	171						
Take-off Dry	3250	RICH	2900	59.5	159	58.5	159	57.5	159						
Military Dry (Maximum Dry)	3250	NORMAL	2900	59.5	159	58.5	159	57.5	159						
Normal	2600	NORMAL	2600	48.0	142	47.5	143	47.0	144	46.5	145				
Cruise	1980	NORMAL	2400	39.0	117	38.5	118	38.0	119	37.5	120	37.0	121	36.5	122
Cruise	1720	NORMAL	2300	37.0	106	36.5	107	36.5	109	36.0	110	35.5	111	35.5	112
Cruise	1500	NORMAL	2200	35.5	97	35.0	98	34.5	99	34.0	100	33.5	101	33.0	102
Cruise	1435	NORMAL	2100	35.0	97	34.5	97	34.0	98	33.5	99	33.0	100	32.5	100
Cruise	1350	NORMAL	2000	34.5	96	34.0	97	33.5	98	33.0	98	32.5	99	32.0	99
Cruise	1285	NORMAL	1900	34.5	96	34.0	96	33.5	97	33.0	98	32.5	98		
Cruise	1200	NORMAL	1800	34.0	95	33.5	96	32.5	96	32.0	97	31.5	97		
Cruise	1135	NORMAL	1700	34.0	95	33.5	96	32.5	96	32.0	97				
Cruise	1070	NORMAL	1600	34.0	95	33.0	95	32.0	96	31.5	96				
Cruise	1000	NORMAL	1500	33.5	95	33.0	95	32.0	95						
Cruise	925	NORMAL	1400	33.0	94	32.5	94								

REMARKS: (1) Do not exceed the torque pressure or manifold pressure listed, whichever comes first. Do not exceed a 2.0 in. Hg difference in manifold pressure between engines when operating at the same power.

(2) Operation at take-off power is limited to 5 minutes; at military power 30 minutes.

(3) Cruise MAP limits (2400 rpm and below) may be increased 0.5 in. Hg for each 12°C carburetor air difference above standard temperature but must be decreased 0.5 in. Hg for each 12°C below standard.

(4) This schedule extends from sea level to the full throttle limit at zero ram. Power settings beyond this limit may be experienced because of in-flight, air scoop ram and may be employed if chart full-throttle torque is not exceeded.

DATA BASIS: SP-948A (WAD) **DATA AS OF:** February 1955

Figure A-3. Engine Power Schedule (Low Blower) Sheet 1 of 2

ENGINE POWER SCHEDULE

STANDARD DAY—NO RAM—FUEL 115/145

ENGINE: R3350-85-89

SUPERCHARGER RATIO: High

POWER RATING	BHP at 10,000 feet	MIXTURE	RPM	ALTITUDE—FEET 10000 MAP (in. Hg)	10000 TOP (psi)	12000 MAP (in. Hg)	12000 TOP (psi)	14000 MAP (in. Hg)	14000 TOP (psi)	16000 MAP (in. Hg)	16000 TOP (psi)	18000 MAP (in. Hg)	18000 TOP (psi)	20000 MAP (in. Hg)	20000 TOP (psi)
Military Dry (Maximum Dry)	2500	NORMAL	2600	51.5	137	51.0	138	50.5	138	50.0	139				
Normal	2400	NORMAL	2600	49.5	131	49.0	132	48.5	132	48.0	133				
Cruise	1780	NORMAL	2400	39.0	105	38.0	106	38.0	106	37.5	107	37.0	108	36.5	109
Cruise	1600	NORMAL	2300	36.0	99	36.0	99	35.0	100	35.0	100	35.0	101	34.5	101
Cruise	1500	NORMAL	2200	36.0	98	36.0	99	35.0	99	35.0	100	35.0	101		
Cruise	1420	NORMAL	2100	36.0	96	35.5	97	35.0	97	34.5	98	34.0	99		
Cruise	1350	NORMAL	2000	35.5	96	35.0	96	34.0	97	33.5	97				
Cruise	1270	NORMAL	1900	34.0	95	34.5	96	33.0	96	32.5	97				
Cruise	1190	NORMAL	1800	33.0	94	32.0	94	32.0	95	31.0	95				
Cruise	1115	NORMAL	1700	32.0	93	31.0	93	30.5	94						
Cruise	1035	NORMAL	1600	31.0	92	30.0	92	29.5	92						
Cruise	960	NORMAL	1500	30.0	91	29.0	92	28.0	92						
Cruise	900	NORMAL	1400	29.0	91	28.0	91								

REMARKS: (1) Do not exceed the torque pressure or manifold pressure listed, whichever comes first. Do not exceed a 2.0 in. Hg difference in manifold pressure between engines when operating at the same power.

(2) Operation at military power is limited to 30 minutes.

(3) Cruise MAP limits (2400 rpm and below) may be increased 0.5 in. Hg for each 12°C carburetor air difference above standard temperature but must be decreased 0.5 in. Hg for each 12°C below standard.

(4) This schedule extends from sea level to the full throttle limit at zero ram. Power settings beyond this limit may be experienced because of in-flight, air scoop ram and may be employed if chart full-throttle torque is not exceeded.

DATA BASIS: SP-938B (WAD)

DATA AS OF: February 1955

Figure A-3. Engine Power Schedule (High Blower) Sheet 2 of 2

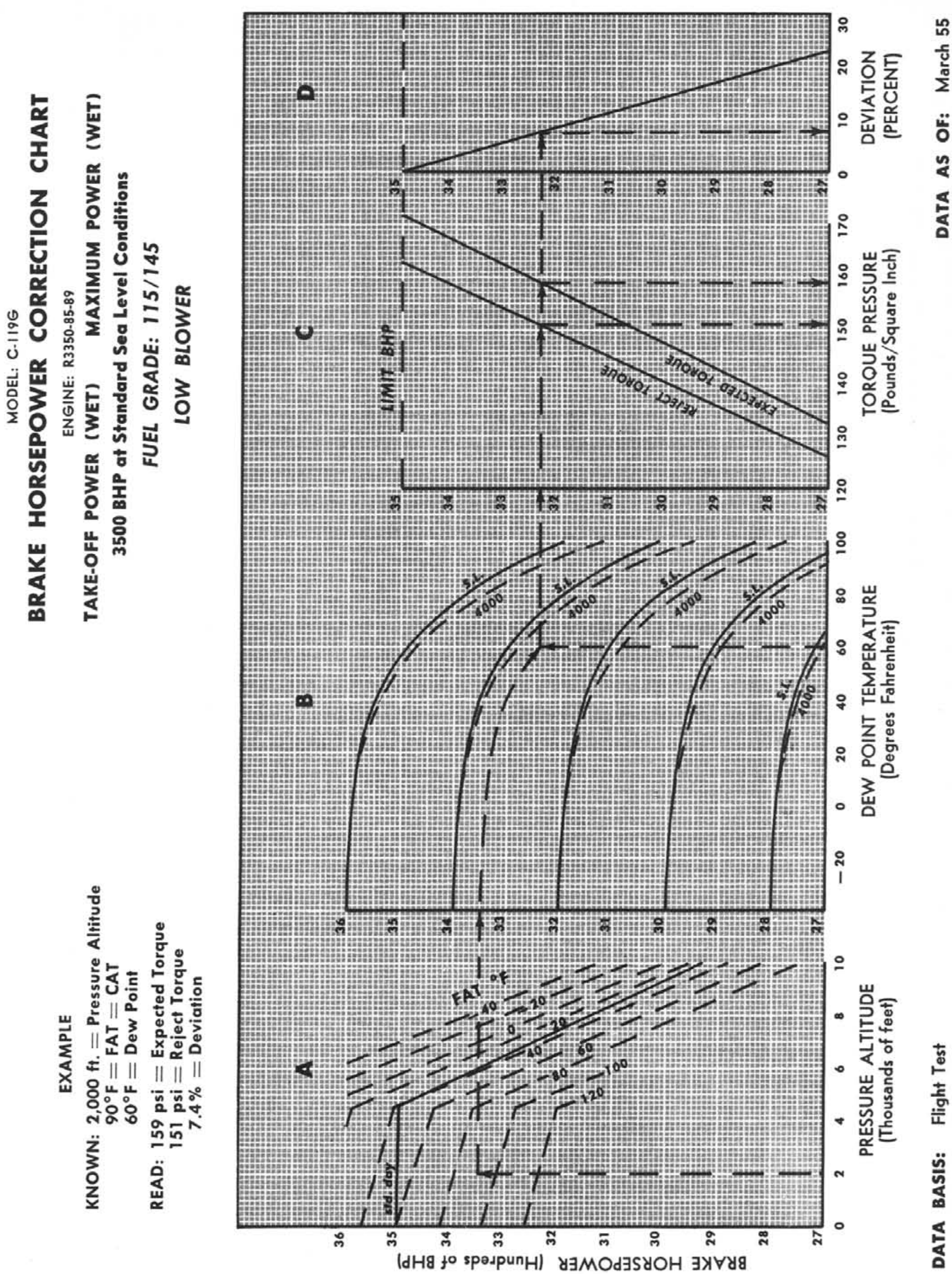


Figure A-4. Brake Horsepower Correction Curve (Wet Power)

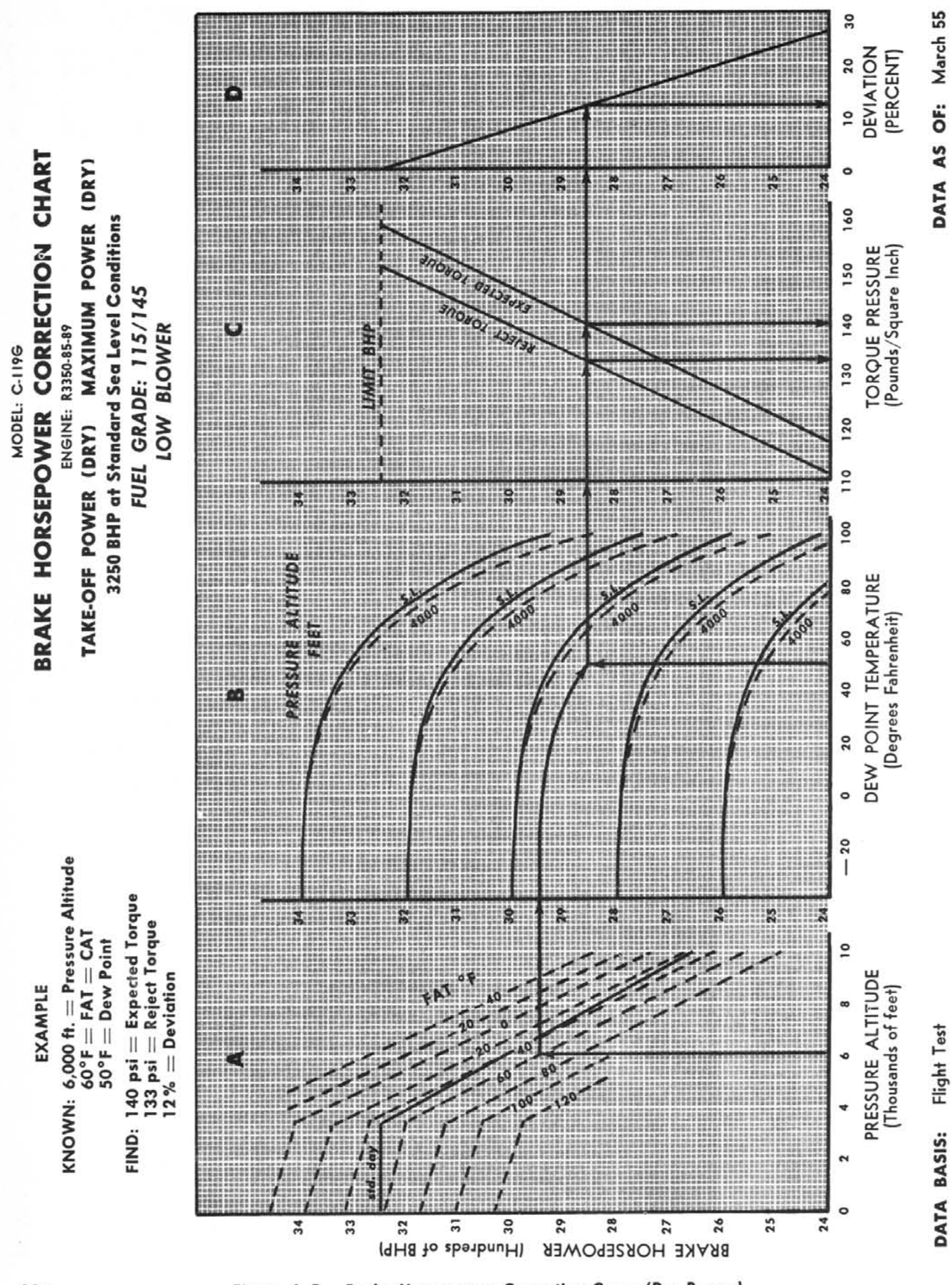


Figure A-5. Brake Horsepower Correction Curve (Dry Power)

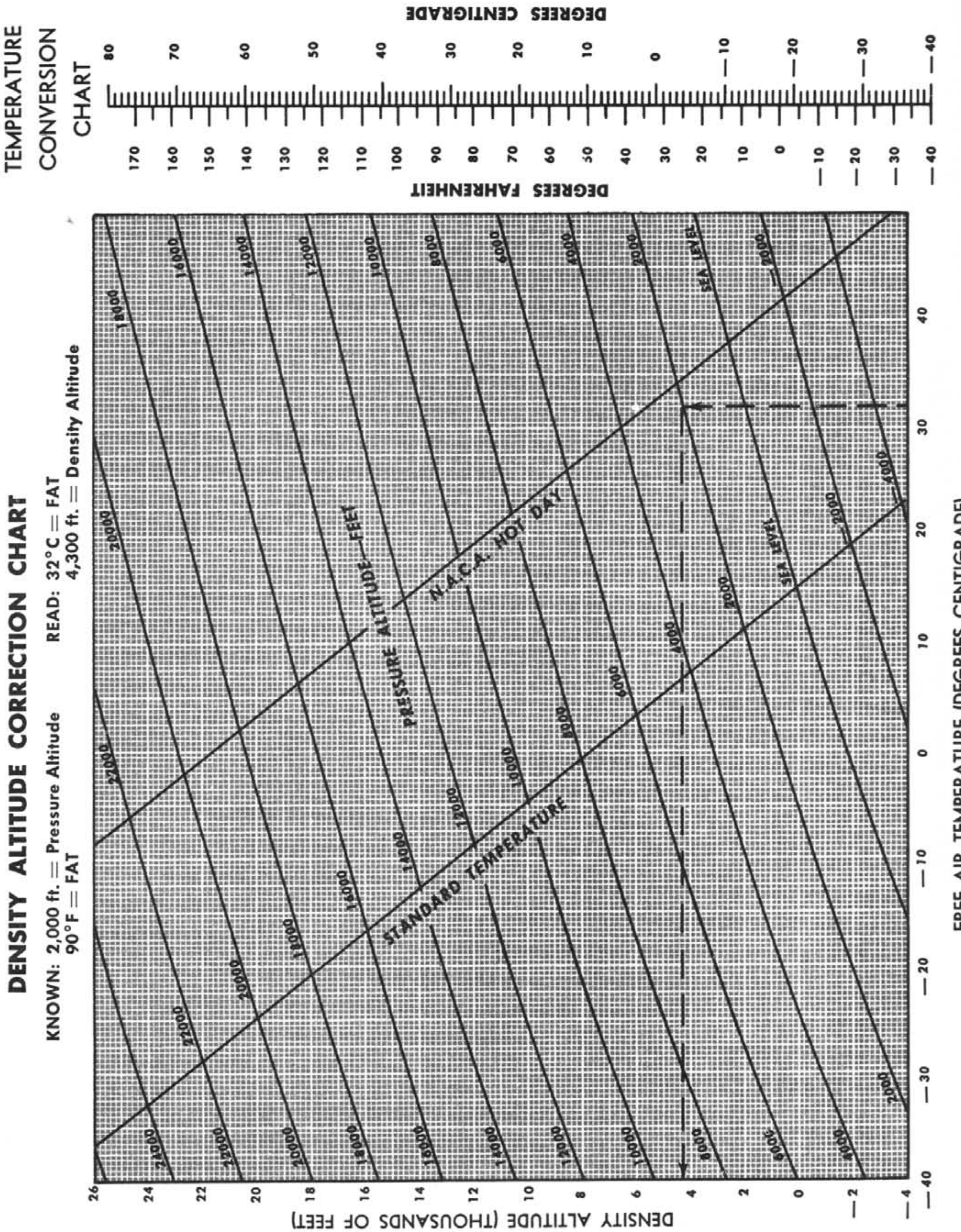


Figure A-6. Density Altitude Correction and Temperature Conversion Chart

MODEL: C-119G

BRAKE HORSEPOWER ADJUSTMENT CHART

ENGINES: R3350-85-89

FUEL GRADE: 115/145
LOW BLOWER

EXAMPLE

Pressure altitude—Sea level
Set 40.5 in. Hg and 2440 rpm

A-2100 BHP; 122 psi expected

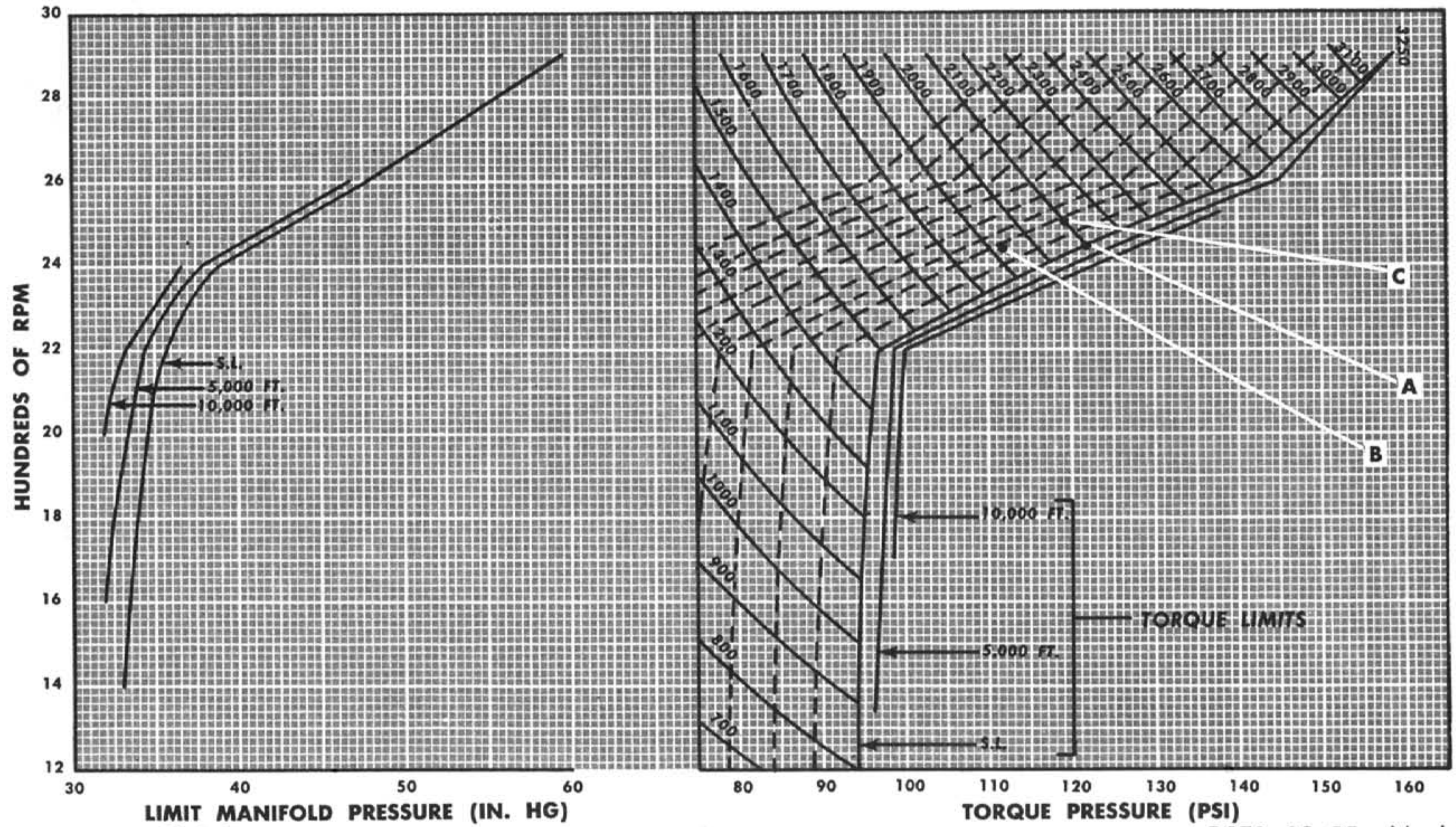
B-112 psi actual torque

Move parallel to dashed line to desired BHP at point C (2100 BHP)

C-2500 rpm, 119 psi and 43.5 in. Hg.—adjusted setting for 2100 BHP desired

NOTES

1. **This curve is used only for adjusting cruise and maximum endurance power settings.**
2. **At 2400 rpm and below, MAP limits may be increased 0.5 in. Hg for each 12°C air temperature difference above standard day but must be decreased 0.5 in. Hg for each 12°C below standard day.**



DATA BASIS: Flight Test

DATA AS OF: March 55

Figure A-7. Brake Horsepower Adjustment Curve (Low Blower)

MODEL: C-119G

BRAKE HORSEPOWER ADJUSTMENT CHART

ENGINE: R3350-85-89

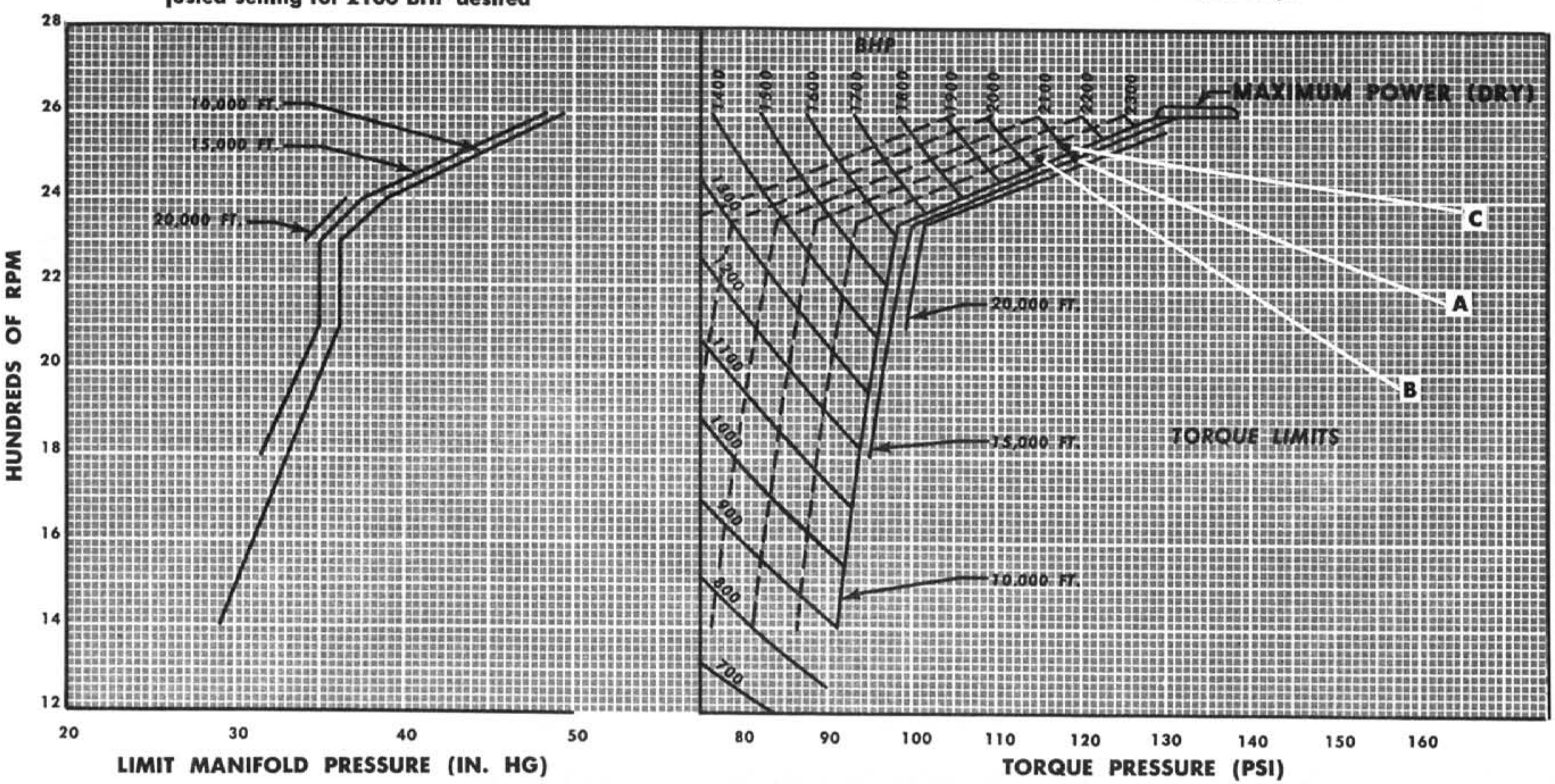
FUEL GRADE: 115/145 HIGH BLOWER

EXAMPLE

Pressure altitude—15,000 ft.
Set 43.0 in. Hg and 2500 rpm
A—2100 BHP; 119 psi expected
B—115 psi actual torque
Move parallel to dashed lines to desired BHP at point C (2100 BHP)
C—2520 rpm, 118 psi and 44.0 in. Hg—adjusted setting for 2100 BHP desired

NOTES

1. **This curve is used only for adjusting cruise and maximum endurance power settings.**
2. **At 2400 rpm and below, MAP limits may be increased 0.5 in. Hg for each 12°C air temperature difference above standard day but must be decreased 0.5 in. Hg for each 12°C below standard day.**



DATA BASIS: Flight Test

DATA AS OF: March 55

Figure A-8. Brake Horsepower Adjustment Chart (High Blower)

MODEL: C-119G

LIMIT TAKE-OFF GROSS WEIGHT CHART

ENGINE: R3350-85-89

TAKE-OFF POWER (WET) MAXIMUM POWER (WET)

3500 BHP at Standard Sea Level Conditions

WING FLAPS 0°

CARGO DOORS ON

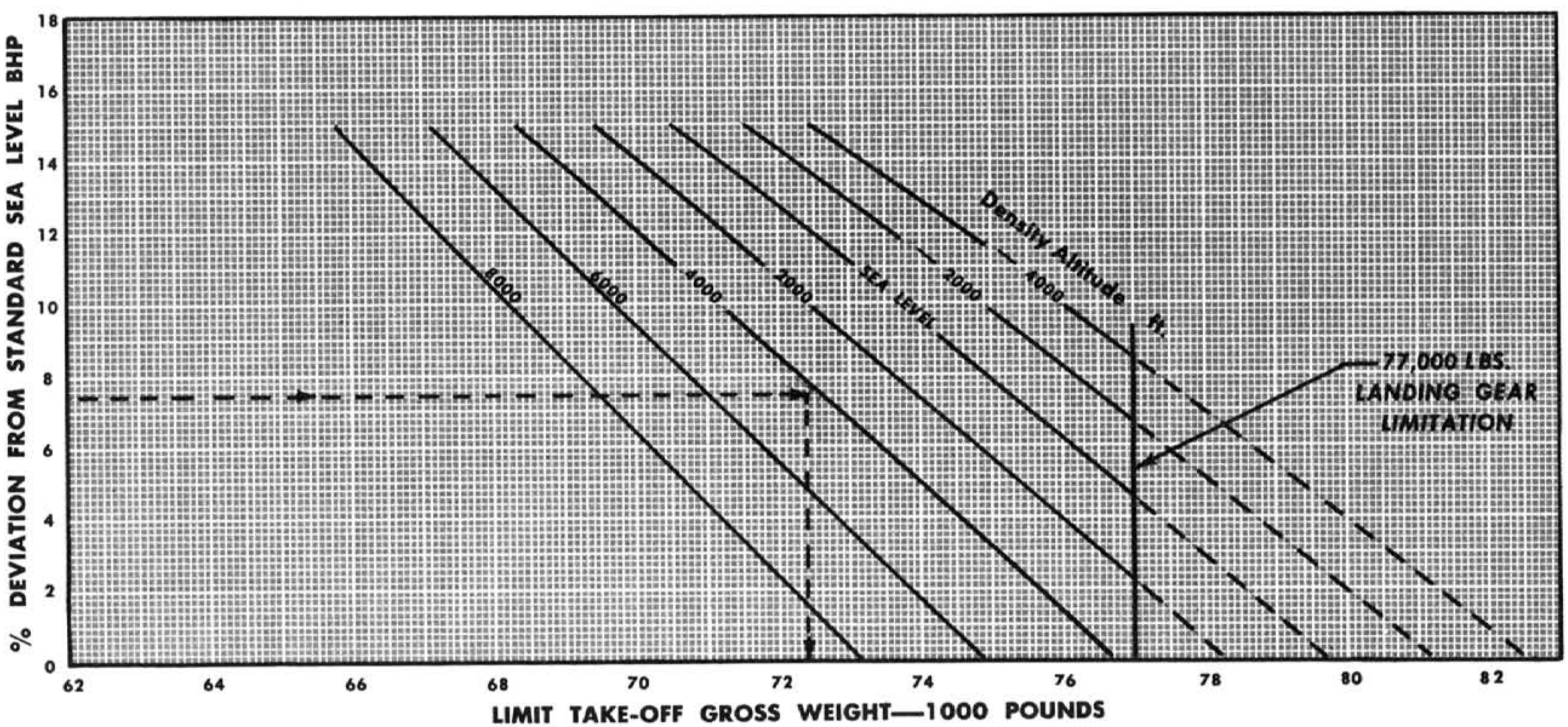
EXAMPLE

KNOWN: Deviation = 7.4%
Density Altitude = 4300 ft.

FIND: Limit Take-off Gross Weight = 72,400 lbs.

NOTES

1. This curve based on a single-engine rate-of-climb of 100 fpm.



DATA BASIS: Flight Test

DATA AS OF: March 55

Figure A-9. Limit Take-off Weight Curve (Take-off Wet Power—Flaps 0°)

MODEL: C-119G

LIMIT TAKE-OFF GROSS WEIGHT CHART

ENGINE: R3350-85-89

TAKE-OFF POWER (WET) MAXIMUM POWER (WET)

3500 BHP at Standard Sea Level Conditions

WING FLAPS 14°

CARGO DOORS ON

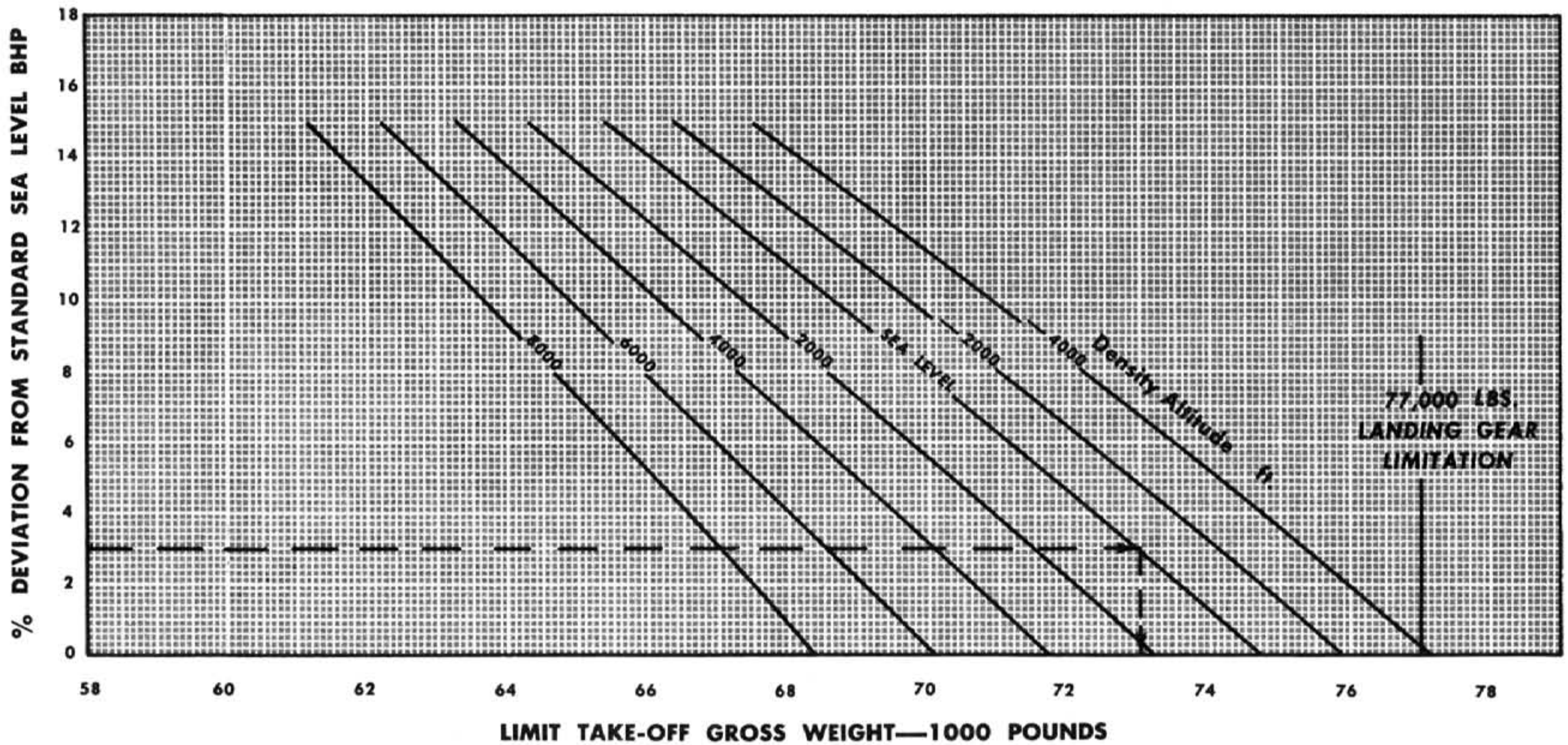
EXAMPLE

KNOWN: Deviation = 3%
Density Altitude = Sea Level

FIND: Limit Take-off Gross Weight = 73,000 lbs.

NOTES

1. This curve based on a single-engine rate-of-climb of 100 fpm.



DATA BASIS: Flight Test

DATA AS OF: March 55

Figure A-10. Limit Take-off Weight Curve (Take-off Wet Power—Flaps 14°)

MODEL: C-119G

LIMIT TAKE-OFF GROSS WEIGHT CHART

ENGINE: R3350-85-89

TAKE-OFF POWER (DRY) MAXIMUM POWER (DRY)

3250 BHP at Standard Sea Level Conditions

WING FLAPS 0°

CARGO DOORS ON

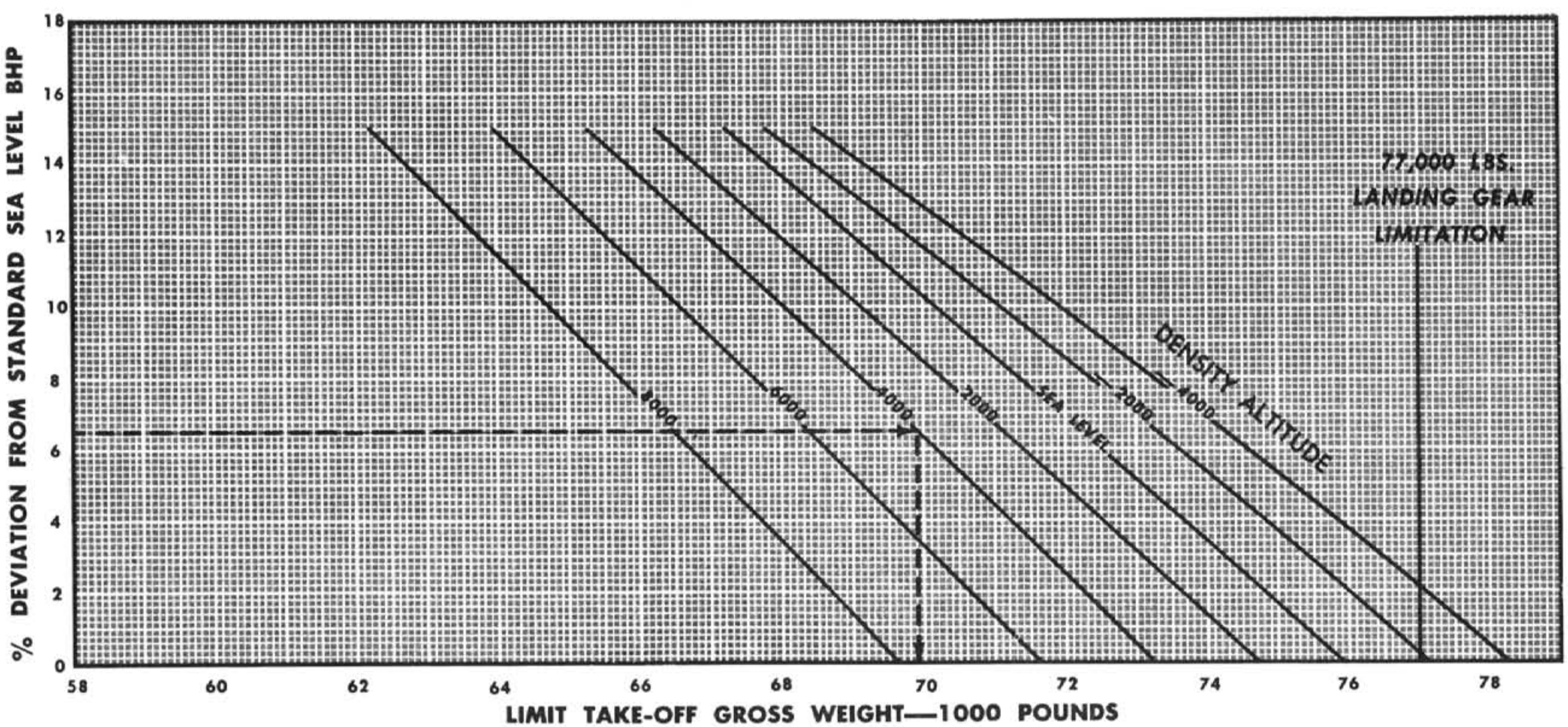
EXAMPLE

KNOWN: Deviation = 6.5%
Density Altitude = 4,000 ft.

FIND: Limit Take-off Gross Weight = 69,900 lbs.

NOTES

1. This curve based on a single-engine rate-of-climb of 100 fpm.
2. Add 0.5% deviation for every 10°F increase in FAT above standard temperature to compensate for additional cooling drag.



DATA BASIS: Flight Test

DATA AS OF: March 55

Figure A-11. Limit Take-off Weight Curve (Take-off Dry Power—Flaps 0°)

MODEL: C-119G

LIMIT TAKE-OFF GROSS WEIGHT CHART

ENGINE: R3350-85-89

TAKE-OFF POWER (DRY) MAXIMUM POWER (DRY)

3250 BHP at Standard Sea Level Conditions

WING FLAPS 14°

CARGO DOORS ON

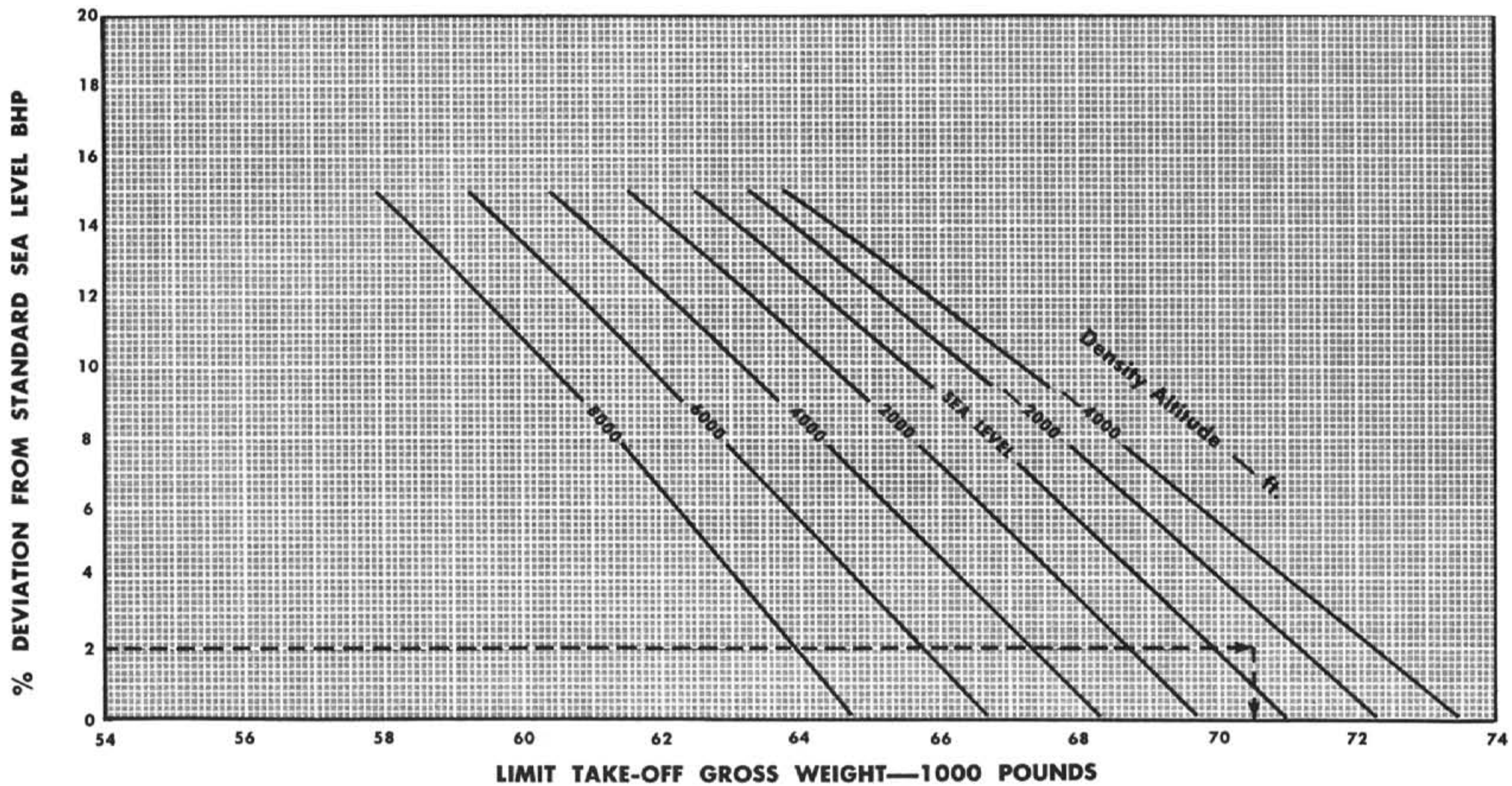
EXAMPLE

KNOWN: Deviation = 2%
Density Altitude = —1,000 ft.

FIND: Limit Take-off Gross Weight = 70,500 lbs.

NOTES

1. **This curve based on a single-engine rate-of-climb of 100 fpm.**
2. **Add 0.5% deviation for every 10°F increase in FAT above standard temperature to compensate for additional cooling drag.**



DATA BASIS: Flight Test

DATA AS OF: March 55

Figure A-12. Limit Take-off Weight Curve (Take-off Dry Power—Flaps 14°)

STANDARD TAKE-OFF DISTANCES—FEET

TAKE-OFF POWER (WET)

0° FLAPS HARD SURFACE RUNWAY

MODEL: C-119G

ENGINES: (2) R3350-85-89

GROSS WEIGHT	DENSITY ALTITUDE	0% DEVIATION FROM SEA LEVEL STANDARD BHP				5% DEVIATION FROM SEA LEVEL STANDARD BHP				10% DEVIATION FROM SEA LEVEL STANDARD BHP				15% DEVIATION FROM SEA LEVEL STANDARD BHP			
		ZERO WIND		30-KNOT WIND		ZERO WIND		30-KNOT WIND		ZERO WIND		30-KNOT WIND		ZERO WIND		30-KNOT WIND	
		GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′
77,000	−4000	3080	5190	1710	3280	3300	5700	1830	3620	3570	6250	1960	3990	3800	6960	2120	4480
	−2000	3350	5650	1900	3630	3580	6210	2050	4000	3860	6880	2180	4450	4180	7800	2380	5090
V_S = 106 KN. CAS	S.L.	3660	6190	2110	4020	3920	6820	2280	4450	4220	7600	2440	5000	4600	8760	2660	5800
	2000	4030	6830	2360	4510	4320	7580	2550	5000	4660	8500	2740	5680	5100	9820	3000	6600
$V_{T.O.}$ = 116 KN. CAS	4000	4420	7590	2650	5100	4760	8450	2850	5670	5150	9530	3090	6460	5600	11,030	3350	7520
	6000	4830	8570	3000	5850	5260	9530	3200	6510	5670	10,720	3450	7400	6150	12,420	3750	8620
V_{50} = 127 KN. CAS	8000	5230	9780	3400	6790	5780	10,810	3600	7540	6210	12,170	3870	8540	6720	14,050	4180	9930
66,000	−4000	2060	3380	1090	2040	2200	3640	1160	2200	2350	3900	1230	2360	2500	4240	1320	2570
	−2000	2230	3660	1200	2250	2390	3950	1300	2420	2540	4240	1370	2630	2750	4650	1470	2870
V_S = 98 KN. CAS	S.L.	2440	3970	1350	2480	2600	4300	1430	2660	2780	4650	1530	2920	2990	5100	1650	3210
	2000	2680	4350	1490	2730	2860	4720	1600	2960	3050	5120	1720	3270	3290	5670	1850	3620
$V_{T.O.}$ = 108 KN. CAS	4000	2940	4760	1680	3050	3130	5160	1790	3300	3350	5640	1910	3640	3610	6260	2070	4060
	6000	3230	5260	1890	3420	3450	5660	2000	3700	3680	6200	2160	4050	3950	6850	2320	4520
V_{50} = 118 KN. CAS	8000	3550	5830	2130	3870	3770	6220	2250	4130	4030	6780	2410	4520	4300	7500	2570	5020
55,000	−4000	1300	2150	640	1230	1380	2290	670	1310	1470	2440	720	1390	1560	2580	760	1480
	−2000	1420	2310	710	1350	1500	2480	750	1430	1580	2650	800	1530	1710	2800	850	1610
V_S = 90 KN. CAS	S.L.	1540	2490	790	1470	1630	2670	830	1560	1730	2850	890	1680	1850	3050	950	1800
	2000	1680	2720	890	1620	1780	2890	940	1740	1890	3090	990	1860	2020	3320	1050	1980
$V_{T.O.}$ = 98 KN. CAS	4000	1840	2950	990	1800	1950	3130	1050	1920	2070	3360	1110	2060	2190	3600	1180	2200
	6000	2020	3220	1100	1990	2140	3420	1170	2120	2270	3670	1250	2280	2400	3910	1310	2410
V_{50} = 107 KN. CAS	8000	2220	3540	1240	2230	2340	3750	1310	2350	2480	3980	1390	2510	2620	4250	1470	2670
44,000	−4000	770	1360	330	730	810	1410	350	760	850	1480	370	790	900	1560	390	830
	−2000	820	1450	370	790	870	1510	390	820	920	1590	410	860	980	1690	440	900
V_S = 80 KN. CAS	S.L.	900	1550	420	860	950	1620	440	900	1000	1710	460	940	1070	1800	490	1000
	2000	980	1670	470	950	1030	1750	500	980	1090	1820	520	1040	1170	1930	550	1100
$V_{T.O.}$ = 88 KN. CAS	4000	1070	1790	520	1020	1130	1890	560	1080	1190	1990	580	1140	1260	2090	610	1200
	6000	1170	1950	590	1140	1240	2030	630	1200	1300	2140	650	1260	1380	2270	690	1320
V_{50} = 96 KN. CAS	8000	1280	2110	660	1260	1350	2200	700	1300	1420	2330	730	1380	1500	2460	770	1460

REMARKS: (1) V_S = Stall speed based on power-off $C_{L_{MAX}}$.
(2) $V_{T.O.}$ = Take-off speed = 1.1 times V_S.
(3) V_{50} = 50-foot obstacle clearance speed = 1.2 times V_S.

DATA AS OF: March 1955

DATA BASIS: Flight Test

FUEL GRADE: 115/145

FUEL DENSITY: 6 Lb/Gal

Figure A-13. Standard Take-off Distances (Take-off Wet Power—Flaps 0°)

STANDARD TAKE-OFF DISTANCES—FEET
TAKE-OFF POWER (WET)
14° FLAPS *HARD SURFACE RUNWAY*

MODEL: C-119G

ENGINES: (2) R3350-85-89

GROSS WEIGHT	DENSITY ALTITUDE	0% DEVIATION FROM SEA LEVEL STANDARD BHP				5% DEVIATION FROM SEA LEVEL STANDARD BHP				10% DEVIATION FROM SEA LEVEL STANDARD BHP				15% DEVIATION FROM SEA LEVEL STANDARD BHP			
		ZERO WIND		30-KNOT WIND		ZERO WIND		30-KNOT WIND		ZERO WIND		30-KNOT WIND		ZERO WIND		30-KNOT WIND	
		GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′
77,000	−4000	2740	4690	1480	2900	2940	5160	1580	3200	3150	5670	1700	3540	3390	6340	1820	3980
	−2000	3000	5120	1640	3220	3200	5630	1750	3550	3440	6280	1880	3980	3730	7150	2040	4560
Vs = 101 KN. CAS	S.L.	3280	5630	1820	3590	3490	6170	1950	3950	3770	6940	2100	4470	4100	8000	2280	5200
	2000	3590	6180	2040	3980	3850	6830	2200	4440	4140	7730	2360	5060	4520	8970	2590	5910
VT.O. = 111 KN. CAS	4000	3940	6840	2300	4500	4220	7600	2460	5020	4560	8640	2660	5750	4980	10,130	2900	6810
	6000	4350	7680	2580	5140	4640	8520	2760	5730	5000	9700	2980	6550	5460	11,680	3260	8010
V50 = 121 KN. CAS	8000	4810	8730	2910	5940	5110	9650	3090	6600	5530	10,970	3350	7550	6010	13,820	3630	9670
66,000	−4000	1830	3040	930	1790	1960	3290	990	1930	2080	3530	1060	2080	2230	3840	1130	2270
	−2000	2000	3300	1020	1970	2140	3560	1090	2130	2280	3850	1170	2300	2450	4200	1250	2520
Vs = 93 KN. CAS	S.L.	2180	3590	1140	2180	2330	3860	1220	2350	2480	4200	1300	2550	2670	4620	1410	2820
	2000	2390	3910	1290	2410	2550	4240	1380	2600	2720	4610	1450	2860	2930	5120	1590	3160
VT.O. = 103 KN. CAS	4000	2610	4280	1450	2680	2780	4620	1540	2910	2980	5070	1650	3200	3210	5620	1780	3560
	6000	2880	4700	1640	3020	3050	5090	1730	3260	3260	5560	1850	3570	3500	6160	1990	3940
V50 = 112 KN. CAS	8000	3180	5250	1830	3400	3350	5610	1930	3650	3580	6080	2070	3960	3830	6720	2210	4390
55,000	−4000	1170	1970	540	1090	1240	2080	580	1150	1310	2210	610	1220	1390	2370	650	1310
	−2000	1270	2100	600	1190	1350	2230	650	1250	1420	2360	680	1350	1510	2570	730	1440
Vs = 86 KN. CAS	S.L.	1380	2270	680	1310	1470	2400	720	1380	1560	2570	760	1480	1650	2790	810	1590
	2000	1510	2460	760	1440	1610	2610	810	1510	1700	2800	850	1650	1800	3010	910	1750
VT.O. = 94 KN. CAS	4000	1650	2690	850	1600	1760	2840	900	1680	1850	3050	950	1820	1960	3280	1010	1940
	6000	1800	2910	950	1750	1910	3090	1000	1870	2000	3310	1070	2000	2140	3560	1150	2130
V50 = 102 KN. CAS	8000	1950	3150	1060	930	2070	3360	1120	2070	2200	3580	1190	2210	2330	3840	1280	2360
44,000	−4000	680	1220	290	630	720	1270	300	660	760	1370	320	700	810	1440	340	740
	−2000	730	1300	330	690	780	1370	340	720	820	1460	350	760	870	1520	380	800
Vs = 76 KN. CAS	S.L.	800	1390	370	750	850	1470	370	780	890	1560	390	830	940	1630	420	860
	2000	880	1500	400	840	930	1580	410	850	960	1680	440	900	1040	1740	460	930
VT.O. = 84 KN. CAS	4000	960	1630	450	910	1010	1700	470	940	1050	1800	490	990	1120	1880	520	1040
	6000	1050	1770	510	1000	1100	1850	540	1050	1150	1940	550	1100	1230	2040	590	1170
V50 = 92 KN. CAS	8000	1150	1930	570	1120	1200	2020	600	1170	1260	2130	630	1240	1350	2260	660	1310

REMARKS: (1) Vs = Stall speed based on power-off $C_{L_{MAX}}$.
(2) VT.O. = Take-off speed = 1.1 times Vs.
(3) V50 = 50-foot obstacle clearance speed = 1.2 times Vs.

DATA AS OF: March 1955
DATA BASIS: Flight Test

FUEL GRADE: 115/145
FUEL DENSITY: 6 Lb/Gal

Figure A-16. Standard Take-off Distances (Take-off Wet Power—Flaps 14°)

STANDARD TAKE-OFF DISTANCES—FEET

TAKE-OFF POWER (DRY)

0° FLAPS HARD SURFACE RUNWAY

MODEL: C-119G

ENGINES: (2) R3350-85-89

GROSS WEIGHT	DENSITY ALTITUDE	0% DEVIATION FROM SEA LEVEL STANDARD BHP				5% DEVIATION FROM SEA LEVEL STANDARD BHP				10% DEVIATION FROM SEA LEVEL STANDARD BHP				15% DEVIATION FROM SEA LEVEL STANDARD BHP			
		ZERO WIND		30-KNOT WIND		ZERO WIND		30-KNOT WIND		ZERO WIND		30-KNOT WIND		ZERO WIND		30-KNOT WIND	
		GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′
77,000	−4000	3400	5930	1890	3780	3640	6530	2030	4170	3890	7280	2170	4690	4170	8360	2320	5450
	−2000	3710	6480	2100	4200	3980	7210	2270	4700	4270	8190	2430	5340	4590	9430	2600	6230
V_s = 106 KN. CAS	S.L.	4050	7140	2350	4680	4360	8000	2520	5280	4710	9160	2720	6090	5070	10,650	2930	7160
	2000	4470	7930	2640	5280	4810	8900	2840	5980	5200	10,250	3070	6940	5610	12,120	3290	8290
$V_{T.O.}$ = 116 KN. CAS	4000	4930	8880	2950	5980	5300	10,000	3180	6800	5720	11,570	3430	7940	6170	13,850	3690	9630
	6000	5440	10,020	3310	6900	5850	11,340	3550	7840	6290	13,240	3850	9190	6800	16,080	4150	11,390
V_{50} = 127 KN. CAS	8000	5950	11,500	3700	8060	6400	12,990	3990	9150	6920	15,290	4300	10,870	7520	18,930	4680	13,620
66,000	−4000	2250	3740	1190	2260	2400	4030	1270	2440	2550	4360	1340	2650	2720	4810	1430	2950
	−2000	2440	4050	1330	2500	2620	4400	1420	2690	2790	4800	1490	2970	2980	5380	1620	3350
V_s = 98 KN. CAS	S.L.	2670	4420	1470	2760	2850	4780	1570	2990	3060	5290	1680	3340	3260	5920	1800	3760
	2000	2940	4850	1650	3090	3140	5280	1760	3350	3330	5830	1880	3750	3560	6520	2010	4200
$V_{T.O.}$ = 108 KN. CAS	4000	3230	5330	1850	3440	3440	5830	1970	3770	3610	6440	2100	4180	3900	7150	2230	4680
	6000	3540	5860	2070	3840	3770	6410	2200	4200	3970	7080	2350	4650	4290	7880	2500	5210
V_{50} = 118 KN. CAS	8000	3870	6450	2310	4290	4110	6990	2450	4660	4400	7740	2630	5180	4730	8650	2820	5850
55,000	−4000	1420	2340	690	1340	1500	2490	730	1420	1600	2660	780	1520	1700	2860	830	1640
	−2000	1540	2540	780	1470	1620	2710	830	1560	1740	2900	870	1680	1850	3110	930	1820
V_s = 90 KN. CAS	S.L.	1670	2750	860	1620	1770	2940	920	1720	1900	3130	980	1860	2020	3390	1040	2010
	2000	1820	2960	970	1780	1940	3200	1020	1910	2070	3400	1090	2050	2190	3680	1150	2500
$V_{T.O.}$ = 98 KN. CAS	4000	2000	3200	1070	1950	2120	3460	1140	2100	2260	3700	1210	2270	2380	3990	1280	2440
	6000	2180	3490	1200	2160	2320	3770	1270	2330	2470	4020	1350	2520	2600	4340	1430	2720
V_{50} = 107 KN. CAS	8000	2390	3830	1340	2410	2520	4090	1420	2580	2680	4430	1500	2800	2850	4750	1590	3030
44,000	−4000	810	1420	350	760	860	1500	370	800	920	1600	400	850	990	1690	430	900
	−2000	880	1530	400	840	940	1630	420	880	1000	1720	450	940	1070	1800	480	980
V_s = 80 KN. CAS	S.L.	960	1650	450	920	1030	1770	480	970	1090	1870	510	1030	1160	1950	540	1070
	2000	1050	1800	500	1020	1110	1900	530	1060	1190	2000	580	1120	1250	2100	600	1160
$V_{T.O.}$ = 88 KN. CAS	4000	1150	1940	560	1120	1200	2050	590	1170	1280	2150	630	1220	1350	2280	660	1270
	6000	1250	2100	640	1230	1320	2220	670	1300	1400	2330	700	1360	1480	2460	750	1400
V_{50} = 96 KN. CAS	8000	1370	2240	710	1340	1450	2410	750	1430	1520	2530	790	1500	1610	2670	830	1590

REMARKS: (1) V_s = Stall speed based on power-off $C_{L_{MAX}}$.
(2) $V_{T.O.}$ = Take-off speed = 1.1 times V_s.
(3) V_{50} = 50-foot obstacle clearance speed = 1.2 times V_s.

DATA AS OF: March 1955
DATA BASIS: Flight Test

FUEL GRADE: 115/145
FUEL DENSITY: 6 Lb/Gal

Figure A-15. Standard Take-off Distances (Take-off Dry Power—Flaps 0°)

STANDARD TAKE-OFF DISTANCES—FEET

TAKE-OFF POWER (DRY)

14° FLAPS *HARD SURFACE RUNWAY*

MODEL: C-119G **ENGINES:** (2) R3350-85-89

GROSS WEIGHT	DENSITY ALTITUDE	0% DEVIATION FROM SEA LEVEL STANDARD BHP				5% DEVIATION FROM SEA LEVEL STANDARD BHP				10% DEVIATION FROM SEA LEVEL STANDARD BHP				15% DEVIATION FROM SEA LEVEL STANDARD BHP			
		ZERO WIND		30-KNOT WIND		ZERO WIND		30-KNOT WIND		ZERO WIND		30-KNOT WIND		ZERO WIND		30-KNOT WIND	
		GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′
77,000	−4000	3020	5370	1630	3340	3210	5870	1730	3670	3470	6600	1870	4160	3750	7680	2020	4890
	−2000	3290	5870	1810	3700	3540	6550	1930	4160	3820	7430	2090	4780	4130	8690	2260	5610
V_S = 101 KN. CAS	S.L.	3600	6470	2010	4150	3880	7290	2170	4710	4200	8360	2340	5460	4530	9820	2530	6460
	2000	3950	7190	2260	4700	4280	8110	2430	5330	4630	9390	2640	6240	5000	11,060	2860	7410
$V_{T.O.}$ = 111 KN. CAS	4000	4370	8030	2550	5320	4700	9040	2740	6040	5090	10,580	2970	7120	5520	12,560	3220	8570
	6000	4800	9000	2860	6070	5150	10,130	3050	6890	5590	11,930	3330	8160	6110	14,600	3630	10,090
V_{50} = 121 KN. CAS	8000	5290	10,170	3200	6970	5680	11,480	3440	7920	6170	13,530	3720	9430	6770	17,200	4100	12,160
66,000	−4000	2010	3380	1020	1990	2130	3620	1080	2140	2280	3950	1160	2340	2470	4340	1240	2590
	−2000	2200	3650	1120	2200	2340	3960	1200	2370	2500	4330	1300	2600	2710	4760	1380	2900
V_S = 93 KN. CAS	S.L.	2390	3970	1250	2420	2540	4330	1340	2640	2730	4740	1440	2900	2960	5250	1550	3250
	2000	2610	4360	1400	2700	2790	4750	1490	2950	2990	5220	1610	3270	3240	5830	1740	3680
$V_{T.O.}$ = 103 KN. CAS	4000	2850	4790	1580	3010	3040	5200	1680	3290	3270	5750	1810	3650	3520	6490	1930	4160
	6000	3120	5250	1770	3370	3330	5700	1890	3670	3570	6320	2030	4080	3950	7140	2170	4650
V_{50} = 112 KN. CAS	8000	3430	5790	1990	3770	3660	6280	2120	4090	3930	6940	2270	4550	4230	7840	2450	5170
55,000	−4000	1260	2130	590	1180	1330	2250	620	1250	1430	2430	660	1350	1540	2600	720	1450
	−2000	1370	2300	650	1290	1450	2380	700	1380	1570	2640	750	1480	1680	2800	800	1620
V_S = 86 KN. CAS	S.L.	1480	2460	730	1410	1580	2570	780	1520	1680	2850	830	1630	1820	3050	890	1770
	2000	1630	2640	820	1520	1730	2830	880	1670	1840	3090	930	1800	1980	3310	980	1960
$V_{T.O.}$ = 94 KN. CAS	4000	1770	2850	920	1670	1890	3090	980	1840	2000	3350	1030	2000	2150	3610	1100	2160
	6000	1940	3120	1020	1870	2050	3360	1100	2020	2180	3610	1150	2200	2340	3940	1240	2400
V_{50} = 102 KN. CAS	8000	2130	3420	1150	2100	2240	3650	1210	2250	2380	3900	1290	2410	2550	4310	1380	2670
44,000	−4000	740	1270	310	680	780	1350	320	700	830	1470	350	760	890	1560	370	810
	−2000	800	1370	350	740	850	1450	350	770	900	1560	380	830	950	1660	400	870
V_S = 76 KN. CAS	S.L.	860	1480	390	790	920	1560	400	840	970	1680	420	890	1020	1790	450	940
	2000	950	1610	440	880	1000	1700	450	920	1060	1800	470	980	1120	1910	510	1030
$V_{T.O.}$ = 84 KN. CAS	4000	1030	1750	490	970	1090	1840	510	1020	1150	1930	540	1070	1200	2070	570	1160
	6000	1130	1880	550	1070	1200	1980	570	1120	1250	2090	610	1190	1320	2250	640	1300
V_{50} = 92 KN. CAS	8000	1220	2020	610	1180	1310	2130	640	1230	1370	2280	680	1320	1450	2460	720	1450

REMARKS: (1) V_S = Stall speed based on power-off $C_{L_{MAX}}$.
(2) $V_{T.O.}$ = Take-off speed = 1.1 times V_S.
(3) V_{50} = 50-foot obstacle clearance speed = 1.2 times V_S.

DATA AS OF: March 1955
DATA BASIS: Flight Test

FUEL GRADE: 115/145
FUEL DENSITY: 6 Lb/Gal

Figure A-14. Standard Take-off Distances (Take-off Dry Power—Flaps 14°)

MAXIMUM PEFORMANCE TAKE-OFF DISTANCES—FEET

TAKE-OFF POWER (WET)

14° FLAPS HARD SURFACE RUNWAY

MODEL: C-119G

ENGINES: (2) R3350-85-89

GROSS WEIGHT	DENSITY ALTITUDE	0% DEVIATION FROM SEA LEVEL STANDARD BHP				5% DEVIATION FROM SEA LEVEL STANDARD BHP				10% DEVIATION FROM SEA LEVEL STANDARD BHP				15% DEVIATION FROM SEA LEVEL STANDARD BHP			
		ZERO WIND		30-KNOT WIND		ZERO WIND		30-KNOT WIND		ZERO WIND		30-KNOT WIND		ZERO WIND		30-KNOT WIND	
		GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′
77,000	−4000	1710	2580	800	1380	1820	2750	850	1460	1930	2900	900	1550	2060	3090	960	1650
	−2000	1850	2760	880	1500	1970	2930	940	1590	2100	3090	1000	1680	2240	3330	1070	1800
V_S = 92 KN. CAS	S.L.	2020	2970	990	1630	2150	3150	1050	1730	2290	3330	1120	1840	2440	3610	1190	1980
	2000	2210	3210	1110	1800	2350	3390	1180	1910	2500	3610	1260	2020	2670	3920	1350	2190
$V_{T.O.}$ = 94 KN. CAS	4000	2430	3480	1250	1990	2590	3680	1340	2100	2740	3920	1410	2230	2930	4250	1520	2420
	6000	2680	3780	1420	2190	2840	3990	1500	2320	3000	4260	1590	2470	3210	4600	1700	2670
V_{50} = 94 KN. CAS	8000	2950	4100	1600	2410	3100	4320	1680	2550	3280	4630	1770	2730	3510	4970	1900	2940
66,000	−4000	1160	1900	500	970	1230	1990	530	1020	1290	2080	560	1060	1370	2170	590	1110
	−2000	1250	2010	550	1040	1320	2110	580	1090	1390	2200	610	1140	1490	2310	650	1190
V_S = 85 KN. CAS	S.L.	1360	2150	620	1130	1430	2250	650	1190	1520	2350	690	1240	1610	2480	730	1300
	2000	1490	2310	700	1240	1570	2410	740	1300	1660	2530	780	1360	1760	2660	830	1430
$V_{T.O.}$ = 87 KN. CAS	4000	1630	2490	790	1370	1720	2600	830	1430	1810	2720	880	1490	1930	2870	940	1580
	6000	1790	2690	890	1510	1890	2810	930	1570	1980	2940	990	1640	2110	3100	1050	1730
V_{50} = 87 KN. CAS	8000	1960	2900	1000	1660	2060	3030	1050	1720	2170	3170	1110	1800	2310	3350	1190	1890
55,000	−4000	760	1390	300	670	810	1450	320	700	850	1500	330	720	900	1550	350	750
	−2000	820	1470	330	720	870	1530	340	750	910	1580	360	780	960	1650	380	800
V_S = 77 KN. CAS	S.L.	890	1570	370	790	940	1630	390	820	990	1690	410	850	1050	1760	430	870
	2000	980	1680	420	860	1030	1740	440	890	1080	1800	470	920	1140	1880	490	950
$V_{T.O.}$ = 79 KN. CAS	4000	1070	1800	470	940	1120	1860	500	970	1180	1930	530	1010	1250	2010	560	1040
	6000	1170	1930	550	1030	1230	1990	570	1060	1290	2070	590	1100	1370	2150	630	1130
V_{50} = 79 KN. CAS	8000	1280	2070	600	1120	1350	2130	640	1150	1410	2210	660	1200	1500	2290	700	1230
44,000	−4000	450	970	150	440	470	1010	160	450	500	1040	170	470	530	1070	180	480
	−2000	490	1030	170	470	510	1060	180	490	540	1090	190	500	570	1130	200	520
V_S = 69 KN. CAS	S.L.	530	1090	190	510	560	1130	200	530	580	1160	210	540	610	1190	220	560
	2000	580	1160	220	560	610	1200	230	570	640	1230	240	590	670	1270	250	610
$V_{T.O.}$ = 71 KN. CAS	4000	630	1240	240	610	660	1280	260	620	700	1310	270	640	730	1360	290	660
	6000	690	1320	280	660	720	1360	290	680	760	1400	310	700	800	1450	330	720
V_{50} = 71 KN. CAS	8000	750	1400	320	720	780	1440	330	740	820	1490	350	760	870	1540	360	780

REMARKS: (1) V_S — Stall speed based on $C_{L_{MAX}}$ including power effects for 3200 BHP.
(2) $V_{T.O.}$ — Take-off speed — 1.026 times V_S (95% $C_{L_{MAX}}$).
(3) V_{50} — 50-foot obstacle clearance speed — 1.026 times V_S (95% $C_{L_{MAX}}$).
(4) This take-off procedure to be used with caution and only when maximum performance is necessary as V_S quoted is absolute minimum stall speed.

DATA AS OF: March 1955
DATA BASIS: Flight Test

FUEL GRADE: 115/145
FUEL DENSITY: 6 Lb/Gal

Figure A-17. Maximum Performance Take-off Distances (Take-off Wet Power—Flaps 14°)

MODEL: C-119G

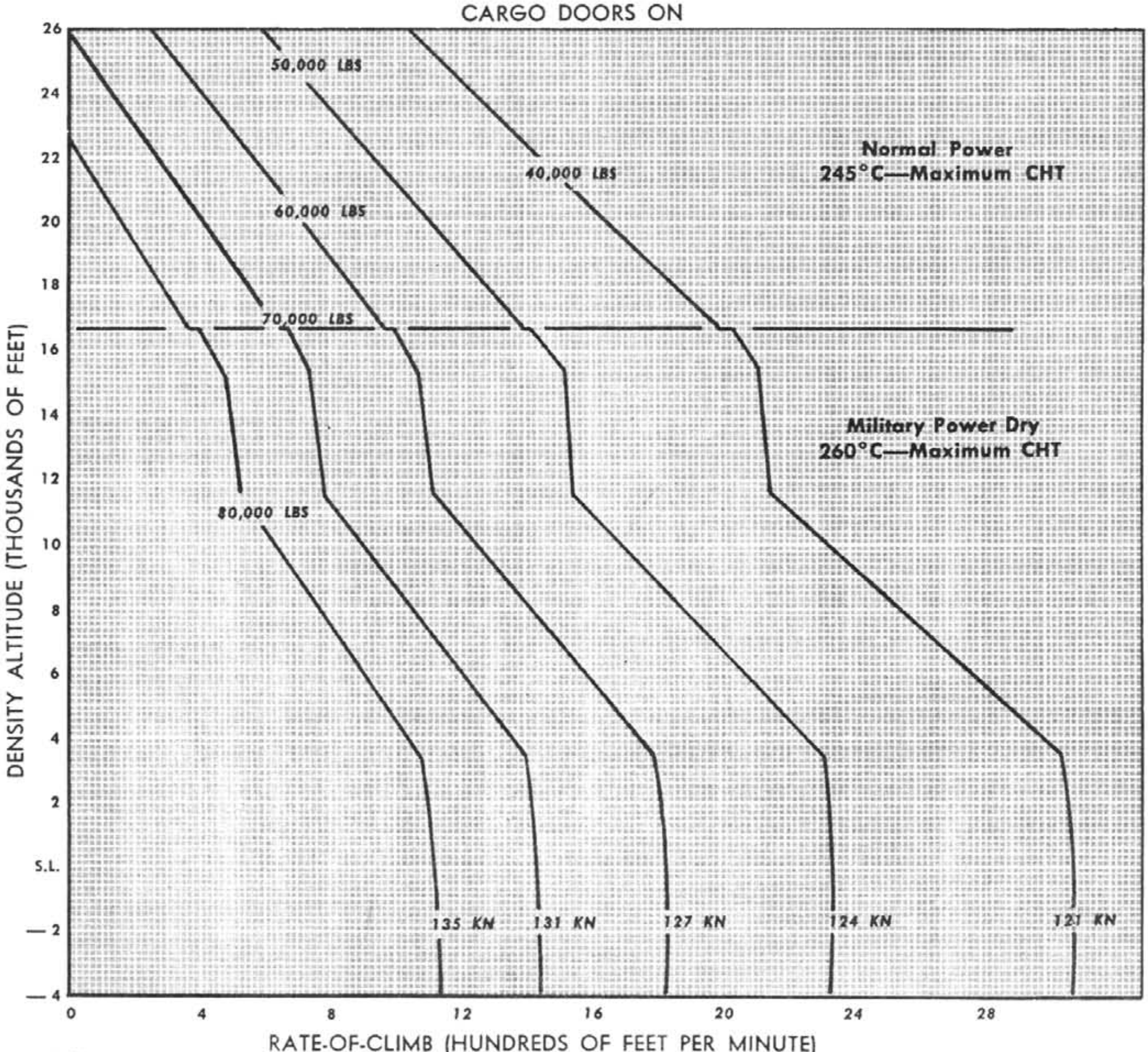
CLIMB CURVE FOR MAXIMUM POWER (DRY)

ENGINES: R3350-85-89

TWO-ENGINE OPERATION

STANDARD DAY TEMPERATURES

CARGO DOORS ON



REMARKS:

(1) Climb speeds quoted are sea level CAS.

(2) 2900 rpm and NORMAL mixture.

(3) Each temperature variation of 5.6°C (10°F) from standard day temperature produces a 1.1% variation in the BHP of each engine. This 1.1% multiplied by the propeller efficiency at best climb speed (approximately 80%) gives a variation of .88% (.0088) in the thrust horsepower. The resulting change in the rate-of-climb values, then, may be obtained from the following formulae:

$$\Delta R/C = \Delta THP \times \frac{33000}{W}$$

$$\Delta THP = .0088\ BHP_{Std} \times N$$

BHP_{Std} = Brake horsepower per engine (standard day)

N = Number of engines operating

W = Gross weight of the airplane

DATA BASIS: Flight Test **DATA AS OF:** March 55

Figure A-18. Climb Curve For Maximum Dry Power

CLIMB CHART FOR MAXIMUM POWER (DRY)
STANDARD TEMPERATURES
TWO-ENGINE OPERATION

MODEL: C-119G **ENGINES:** (2) R-3350-85

CONFIGURATION: Cargo Doors On **WEIGHT:** 77,000 Lbs. (left) — **CONFIGURATION:** Cargo Doors On **WEIGHT:** 66,000 Lbs. (right)

APPROXIMATE RATE OF CLIMB	FROM SEA LEVEL DIST.	FROM SEA LEVEL TIME	FROM SEA LEVEL FUEL	M.P. IN. HG	TORQUE PSI	RPM	CAS KN	TAS KN	DENSITY ALTITUDE FEET	TAS KN	CAS KN	RPM	TORQUE PSI	M.P. IN. HG	FROM SEA LEVEL FUEL	FROM SEA LEVEL TIME	FROM SEA LEVEL DIST.	APPROXIMATE RATE OF CLIMB
1220					159	2900	133	126	−4,000	122	129	2900	159					1590
1205	0	0	585 (1)	59.5	159	2900	134	134	S.L.	129	129	2900	159	59.5	585 (1)	0	0	1590
1060	10	4.3	920	54.5	152	2900	134	144	5,000	138	128	2900	152	54.5	840	3.4	7	1420
605	24	10.0	1295	45.5	130	2900	131	152	10,000	144	124	2900	130	45.5	1105	7.5	17	1040
545	46	18.0	1735	50.0	138	2600	128	162	15,000	153	121	2600	138	50.0	1415	12.5	31	870
220	81	31.6	2460	42.0	120	2600	126	173	20,000	163	119	2600	120	42.0	1850	20.0	49	520

CONFIGURATION: Cargo Doors On **WEIGHT:** 55,000 Lbs. (left) — **CONFIGURATION:** Cargo Doors On **WEIGHT:** 44,000 Lbs. (right)

APPROXIMATE RATE OF CLIMB	FROM SEA LEVEL DIST.	FROM SEA LEVEL TIME	FROM SEA LEVEL FUEL	M.P. IN. HG	TORQUE PSI	RPM	CAS KN	TAS KN	DENSITY ALTITUDE FEET	TAS KN	CAS KN	RPM	TORQUE PSI	M.P. IN. HG	FROM SEA LEVEL FUEL	FROM SEA LEVEL TIME	FROM SEA LEVEL DIST.	APPROXIMATE RATE OF CLIMB
2065					159	2900	126	119	−4,000	117	123	2900	159					2740
2065	0	0	585 (1)	59.5	159	2900	125	125	S.L.	122	122	2900	159	59.5	585 (1)	0	0	2750
1895	5	2.7	775	54.5	152	2900	123	133	5,000	128	119	2900	152	54.5	725	2.1	4	2550
1465	12	5.5	970	45.5	130	2900	118	137	10,000	130	112	2900	130	45.5	875	4.0	8	2050
1290	22	9.2	1210	50.0	138	2600	114	144	15,000	134	106	2600	138	50.0	1040	6.5	14	1850
905	33	13.8	1500	42.0	120	2600	111	152	20,000	145	106	2600	120	42.0	1220	9.8	21	1410
490	53	21.0	1790	34.0	99	2600	109	163	25,000	151	101	2600	99	34.0	1410	13.8	32	940

REMARKS:

(1) Taxi and take-off allowance.
(2) 2900 rpm and NORMAL mixture.
(3) Each temperature variation of 5.6°C (10°F) from standard day temperature produces a 1.1% variation in the BHP of each engine. This 1.1% multiplied by the propeller efficiency at best climb speed (approximately 80%) gives a variation of .88% (.0088) in the thrust horsepower. The resulting change in the rate-of-climb values, then, may be obtained from the following formulae:

$$\Delta R/C = \Delta THP \times \frac{33000}{W}$$

$$\Delta THP = .0088\ BHP_{Std} \times N$$

BHP_{Std} = Brake horsepower per engine (standard day)
N = Number of engines operating
W = Gross weight of the airplane

LEGEND

Rate of Climb: Feet Per Min
Distance: Nautical Miles
Time: Minutes
Fuel: Lb
M.P.: Manifold Pressure
Torque: Torque Pressure
RPM: Rev Per Min
CAS: Calibrated Airspeed
TAS: True Airspeed

DATA AS OF: March 1955
DATA BASIS: Flight Test

FUEL GRADE: 115/145
FUEL DENSITY: 6 Lb/Gal

Figure A-19. Climb Chart For Maximum Dry Power