SECTION V
OPERATING LIMITATIONS

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MINIMUM CREW REQUIREMENTS.

The minimum crew requirements for this aircraft under normal non-tactical conditions are pilot, copilot, and flight mechanic. Additional crew members may be added at the discretion of the Commander.

INSTRUMENT RANGE MARKINGS.

The instrument range markings are shown pictorially in Figure 5-1 as they appear on the aircraft. Since they are not necessarily repeated in the text, particular attention should be paid to this illustration. Those markings, however, which require amplification are covered in the text under the appropriate headings.

ENGINE LIMITATIONS.

RECIPROCATING ENGINE POWER LIMITS DATA.

In the Power Schedule Curves, Appendix I, values of manifold pressure, torque and rpm are given for the power limits of the engine. Note that for a given power, the manifold pressure and torque pressure values are set according to whichever occurs first. Other engine operating data is given in Figure 5-1. These engine instrument range markings should give the pilot complete criteria for safe operation. Particular attention should be given to the engine take-off limits.

Reciprocating Engine Power Time Limits.

METO Power is the maximum power at which the engine may be operated continuously. At engine ratings above METO Power, a specific time limit is imposed. Operation at Maximum Power is limited to five minutes, except in emergencies. It should be noted that the engine can be run continuously under overload conditions of power and speed for a much longer period. By imposing a time limit, the cumulative effect of the overloads is distributed evenly over the period between engine overhauls, and the useful life of the engine is lengthened accordingly. When the use of Maximum Power is required for longer than five minutes, a notation of this action should be made on Form 781.

RECIPROCATING ENGINE TAKE-OFF LIMITS.

Inasmuch as this engine installation is not equipped with an automatic power control unit, it is possible to overboost the engine at take-off unless caution is exercised. Full forward position of the throttles will give a condition which exceeds engine take-off limits at altitudes below 3800 feet on a standard day.

EXCESSIVE MANIFOLD PRESSURE (OVERBOOSTING).

When overboost occurs, combustion temperatures rise. If overboost of sufficient magnitude exists, detonation and pre-ignition may result and cause physical damage to the engine, possibly in a matter of seconds. If at maximum, except take-off (METO) rpm or below, any MAP above METO power MAP limit (see Overboost Chart) is considered an overboost. If at take-off rpm (2800 ± 25), any MAP above the take-off MAP limit (see Overboost Chart) is considered an overboost. The time limits for METO or take-off overboost are the same and are shown in the Overboost Chart. Overboost conditions represented by the yellow and red areas of the Overboost Chart require maintenance actions and must be carefully recorded on AFTO Form 781 noting (if possible) the manifold pressure, rpm, carburetor air temperature, mixture setting, altitude, and duration of the overboost.

instrument . . RANGE

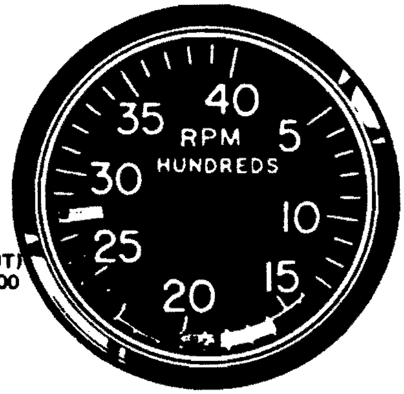
FUEL GRADE 100/130

TORQUE PRESSURE

- 50 TO 87 PSI AUTO LEAN (Except 130 bhp)
- 87 TO 110 PSI RICH
- 110 PSI MAXIMUM CONTINUOUS
- 120 PSI TAKE-OFF DRY (2700 RPM)
- 135 PSI TAKE-OFF WET

NOTES

1. ALL OPERATIONS (GROUND AND FLIGHT) REQUIRED IN THE 1600 TO 1850 RPM RANGE SHOULD BE ACCOMPLISHED AS QUICKLY AS POSSIBLE.
2. THE RPM RANGE OF 2650 TO 2800 ±25 SHOULD BE AVOIDED EXCEPT WHEN REQUIRED DURING ENGINE RUN-UP, TAKE-OFF AND LANDING.



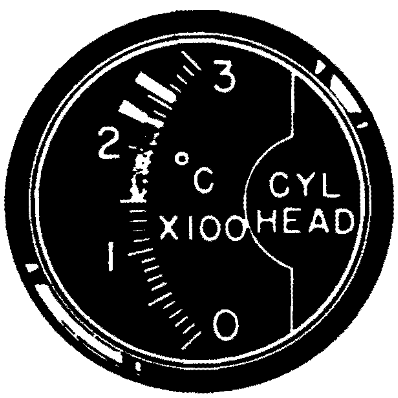
TACHOMETER

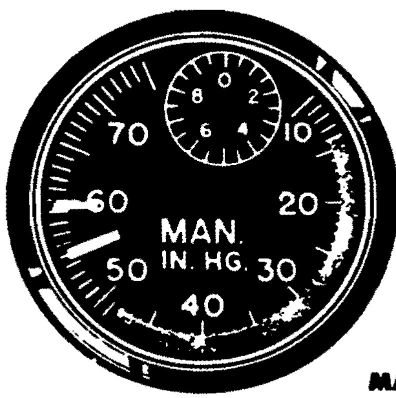
- 1400 TO 2300 RPM AUTO LEAN OR MANUAL LEAN
- 1600 TO 1850 RPM HIGH STRESS AREA ON PROPELLER
- 2300 TO 2600 RPM RICH
- 2600 RPM MAXIMUM CONTINUOUS
- 2800 RPM MAXIMUM

SEA LEVEL | **STANDARD DAY** | **LOW BLOWER**

CYLINDER HEAD TEMPERATURE

- 150° TO 232°C AUTO LEAN OR MANUAL LEAN OPERATION
- 232°C MAXIMUM AUTO LEAN OR MANUAL LEAN
- 260°C MAXIMUM RICH





MANIFOLD PRESSURE

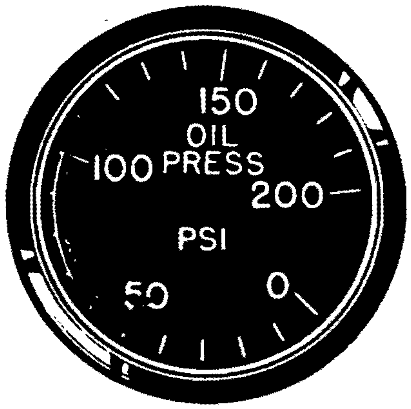
- 14.0 TO 38.5 IN Hg AUTO LEAN OR MANUAL LEAN (Except 1300 bhp)
- 38.5 TO 48.5 IN Hg RICH
- 48.5 IN Hg MAXIMUM CONTINUOUS
- 59.5 IN Hg TAKE-OFF WET
- 55.0 IN Hg TAKE-OFF DRY (2700 RPM)

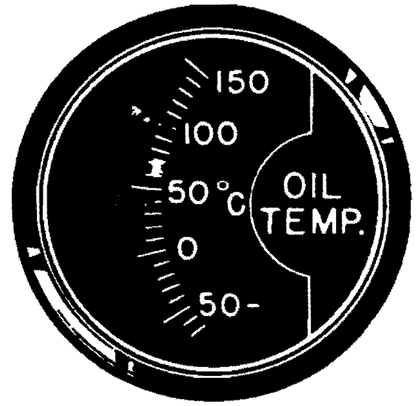
Figure 5-1 *(Sheet 1 of 4 sheets)*

MARKINGS

OIL PRESSURE

- 50 PSI MINIMUM AT 1400 RPM
- 60 TO 100 PSI NORMAL OPERATION (MINIMUM FOR TAKE-OFF 80 PSI)
- 110 PSI MAXIMUM





OIL TEMPERATURE

- 40°C MINIMUM FOR FLIGHT
- 60° TO 75°C NORMAL OPERATION
- 100°C MAXIMUM

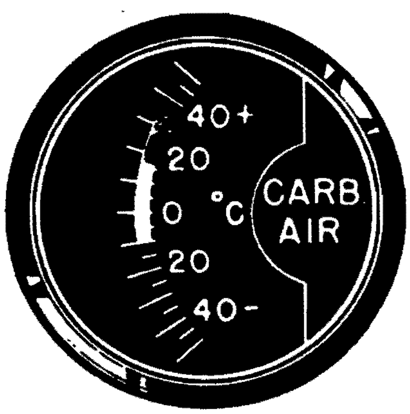
Note

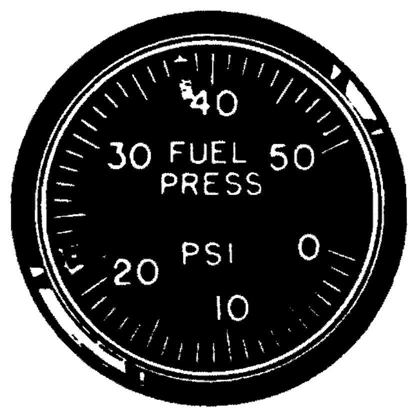
100°C TEMPERATURES PERMITTED DURING CLIMB

SEA LEVEL | **STANDARD DAY** | **LOW BLOWER**

CARBURETOR AIR TEMPERATURE

- −10° TO +15°C DANGER OF ICING
- +15° TO +38°C NORMAL OPERATION
- +38°C MAXIMUM WITH HEAT





FUEL PRESSURE

- 21 PSI MINIMUM FOR FLIGHT
- 21 TO 23 PSI NORMAL OPERATION
- 38 PSI MAXIMUM

PUMP TYPE	BOOST RANGE
HI PRESS. PUMP	LO 10 TO 17 PSI HI 26 TO 38 PSI
LOW PRESS. PUMP	LO 8 TO 16 PSI HI 20 TO 27.5 PSI

NOTE

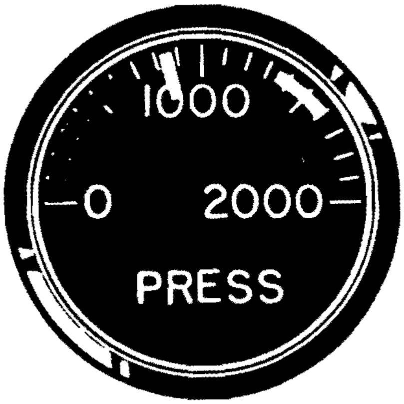
WHEN CHECKING BOOST PUMP PRESSURE, AT LEAST 27 VOLTS IS REQUIRED TO OBTAIN 20 PSI FUEL PRESSURE.

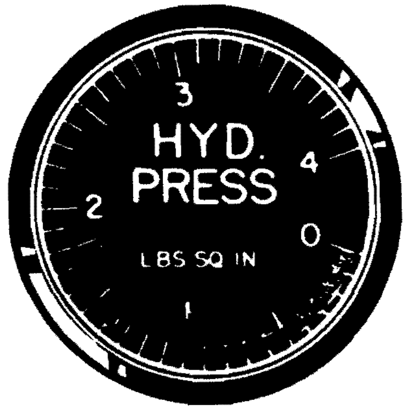
(Sheet 2 of 4 sheets)

instrument . . RANGE

BRAKE ACCUMULATOR

- 600 PSI AIR PRELOAD
- 850 PSI MINIMUM PRESSURE FOR BRAKING
- 1350 TO 1600 PSI NORMAL RANGE
- 1750 PSI MAXIMUM



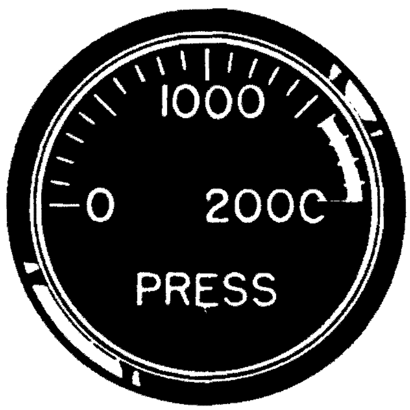


MAIN HYDRAULIC SYSTEM ACCUMULATOR

- 1000 PSI AIR PRELOAD
- 1350 TO 1600 PSI NORMAL RANGE
- 1750 PSI MAXIMUM

HYDRAULIC PRESSURE

- 1350 PSI MINIMUM
- 1350 TO 1600 PSI NORMAL RANGE
- 1750 PSI MAXIMUM

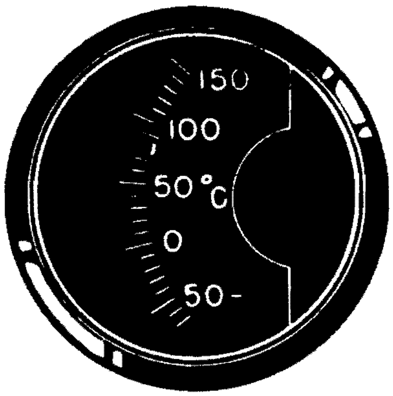


AIR BRAKE PRESSURE

- 1600 TO 2000 PSI NORMAL RANGE
- 2000 PSI MAXIMUM

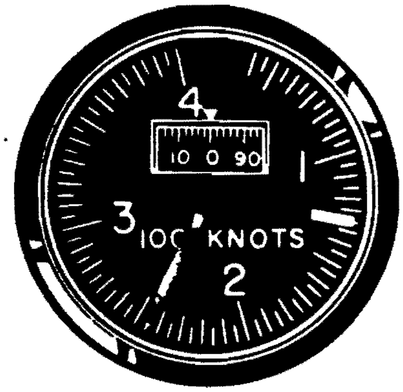
Figure 5-1 *(Sheet 3 of 4 sheets)*

MARKINGS



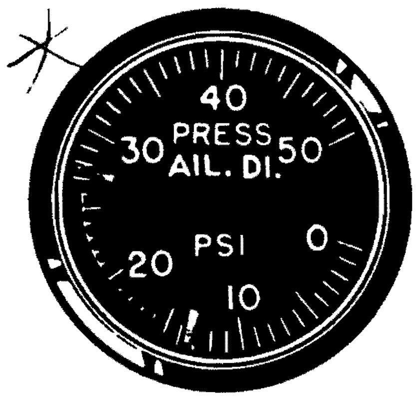
HOT FUEL PRIME

76°C TO 85°C NORMAL RANGE



AIR SPEED

130 KNOTS MAXIMUM WITH CARGO DOOR OPEN
245 KNOTS MAXIMUM DIVING SPEED

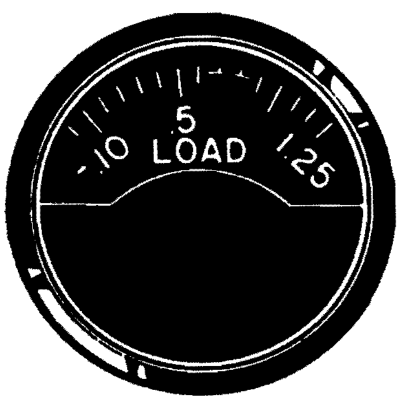


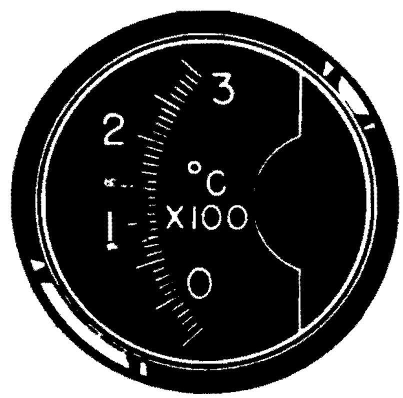
AILERON DEICING PRESSURE

13 PSI MINIMUM
15 TO 26 PSI AUTOMATIC OPERATION RANGE
28 PSI MAXIMUM

DEICING AMMETER

0.65 TO 0.85 NORMAL DEICING



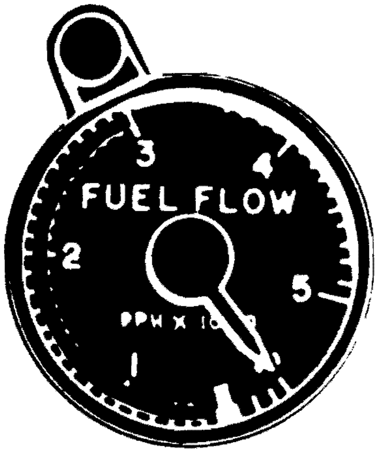


ANTI-ICING AIR TEMPERATURE

76°C MINIMUM
76° TO 150°C NORMAL RANGE
150°C OVERHEAT

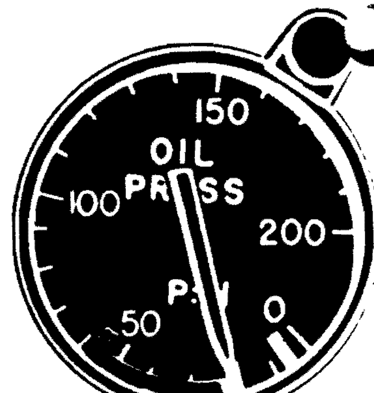
(Sheet 4 of 4 sheets)

JET ENGINE INSTRUMENT RANGE MARKINGS



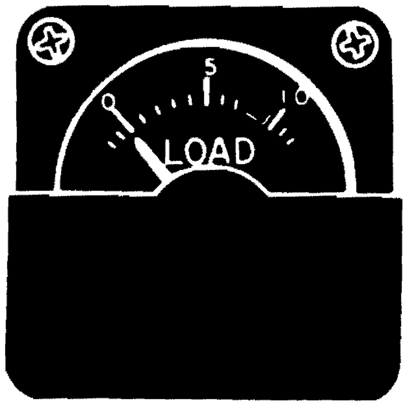
FUEL FLOW

- 350 PPH MINIMUM FOR IDLE. MAXIMUM FOR LIGHT-OFF
- 500 TO 3000 PPH NORMAL OPERATION



OIL PRESS.

- 5 PSI MINIMUM FOR IDLE
- 20 PSI MINIMUM FOR TAKEOFF
- 20 TO 55 PSI NORMAL OPERATION
- 55 PSI MAXIMUM CONTINUOUS OPERATION (MAY BE EXCEEDED FOR FIVE MINUTES IMMEDIATELY AFTER STARTING BUT NOT TO EXCEED 185 PSI)

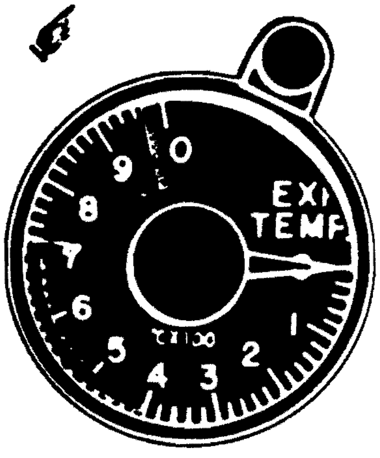


DEICE LOADMETER

- .70 TO .95 NORMAL OPERATION

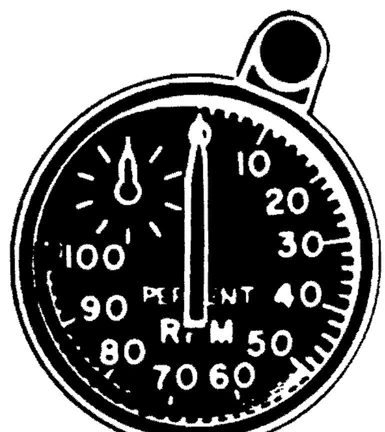
FUEL PRESS.

- 5 TO 50 PSI NORMAL OPERATION 50 PSI MAXIMUM



EXHAUST GAS TEMP.

- 400 TO 676°C NORMAL OPERATION
- 692°C MAXIMUM OPERATING (TIME LIMIT 30 MINUTES)
- 982°C MAXIMUM FOR START (TIME LIMIT 1 SECOND)

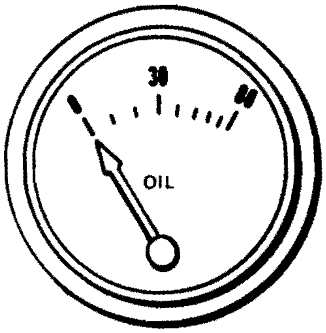


TACHOMETER

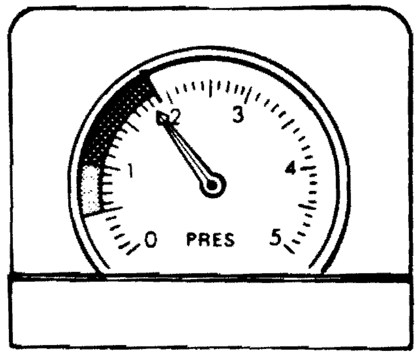
- 100% MAXIMUM RPM (30 MIN. LIMIT)
- 97.9 TO 50 ± 1.5% NORMAL OPERATING (CONTINUOUS)

Figure 5-2

IMPROVED PESTICIDE SPRAY SYSTEM INSTRUMENT RANGE MARKINGS (B)



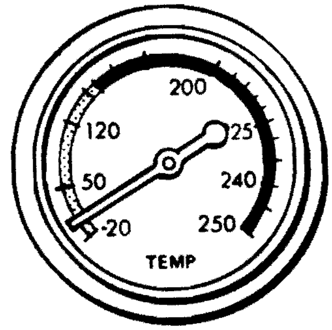
OIL PRESSURE GAUGE



AIR PURGE - BOTTLE PRESSURE

YELLOW

GREEN

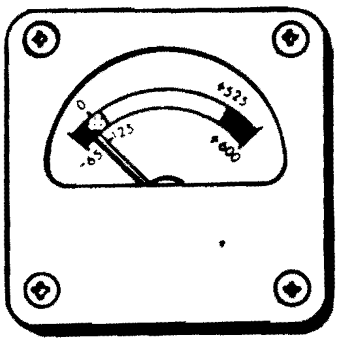


OIL TEMPERATURE GAUGE

RED

ORANGE

GREEN

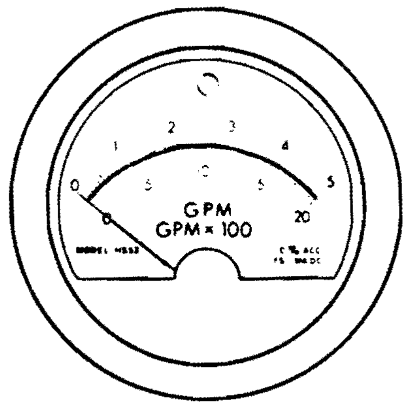


CYLINDER HEAD TEMPERATURE GAUGE

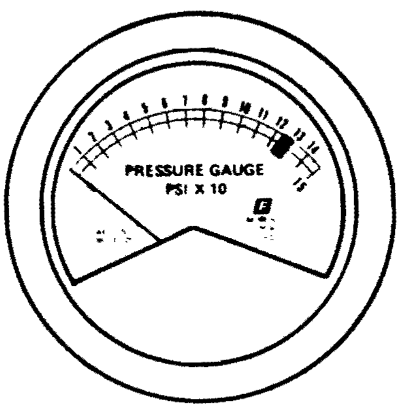
RED

ORANGE

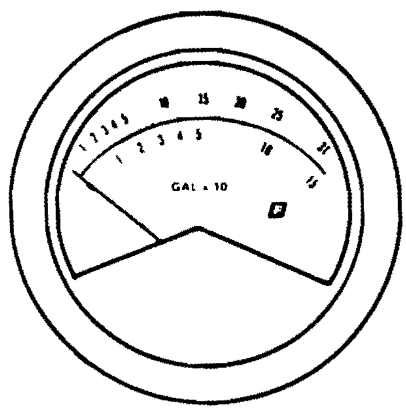
GREEN



FLOWMETER GAUGE



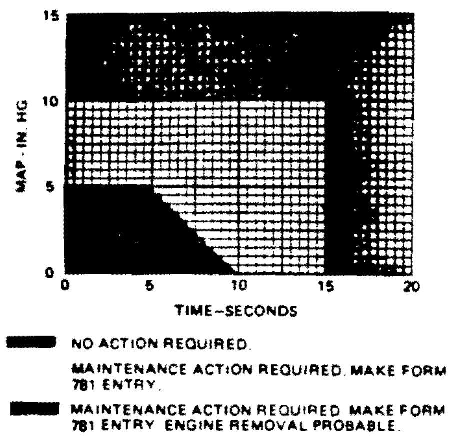
SYSTEM PRESSURE GAUGE



QUANTITY INDICATING GAUGE

Figure 5-3

OVERBOOST CHART



CAUTION

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

Note

The above overboost limits are not intended in any way to allow or condone operation of the engine at any combination of horsepower, rpm, MAP in excess of those authorized in the Power Performance Charts of the Appendix 1, Part II.

MAXIMUM RECIPROCATING ENGINE OVERSPEED.

The maximum engine overspeed is 3350 rpm. If overspeeding occurs, land at nearest suitable landing field. Note all conditions of overspeeding on Form 781. If engine rpm was between 3100 to 3350 rpm, the engine must be inspected before further flight. If engine rpm exceeds 3350 rpm, the engine must be changed. The maximum engine speed permitted during a dive is 3100 rpm.

RECIP STARTER LIMITATIONS.

In order to avoid overheating the starter, do not crank the engine continuously for more than one minute. Following each minute of continuous cranking, the starter should be allowed to cool for one minute.

CARBURETOR AIR TEMPERATURE LIMITS.

In order to avoid detonation which may result from high carburetor air temperatures, the carburetor air temperature during low blower operation is limited to 38°C when carburetor heat is being used. There is no maximum limit during low blower operation when heat is not used. During high blower operation, the following carburetor air temperature limits are applicable with or without carburetor heat:

a. At 1200 bhp or less, +30°C.

b. Above 1200 bhp, +15°C.

SUPERCHARGER LIMITS.

Shifting from low to high blower operation may be accomplished at any normal engine power setting provided the carburetor air temperature does not exceed the limits for high blower operation as set forth in CARBURETOR AIR TEMPERATURE LIMITS.

CYLINDER HEAD TEMPERATURE LIMITS.

In addition to the cylinder head temperature limits as indicated in INSTRUMENT RANGE MARKINGS, Figure 5-1, the following limits apply:

a. 260°C - Maximum permitted during climb at METO Power.

b. 232°C - Maximum permitted during ground operation.

c. 232°C - Maximum permitted during manual lean or auto lean operation.

d. 200°C - Maximum permitted at time of shutdown.

Desired Operational Temperatures.

The following cylinder head temperatures are desirable:

a. 200°C - during cruise or operation at METO Power.

b. 170°C - Maximum desired prior to the application of power at start of take-off. Refer to HOT WEATHER AND DESERT PROCEDURES, Section IX.

c. 150°C - Minimum desirable during descent.

JET ENGINE.

Note

Engine starts should be considered normal so long as starting temperature and fuel flow limits are not exceeded and the engine attains normal idle operation.

JET ENGINE OPERATING TIME LIMITS.

The jet engines can be operated continuously at any rpm between idle and 97.9%. Maximum power of 100% rpm is limited to 30 continuous minutes duration.

MAXIMUM JET ENGINE OVERSPEED.

The maximum engine overspeed for the J85-GE-17 engines is 106.7% for 10 seconds which should occur only during throttle transient or 104% during steady state operations.

JET ENGINE EXHAUST GAS TEMPERATURE LIMITS.

Maximum permissible exhaust gas temperature limits are listed below. Temperatures above 692°C may be encountered only during starting or acceleration.

temperature (°C)	time
1010	max.
982	1 sec.
850	5 sec.
780	10 sec.
704	60 sec.
692	30 min.
676	continuous

JET ENGINE STARTER LIMITATIONS.

Note

Engine starts should be considered normal so long as starting temperature and fuel flow limits are not exceeded and other engine operational characteristics such as idle to military accelerations are normal.

Duty cycle limitations for the jet engine starter are:

1. A 3-minute wait after the first motoring run of not more than 20 seconds.

2. A 5-minute wait after the second motoring run of not more than 20 seconds.

3. Not more than three 20-second cranks in a 30-minute period.

CAUTION

Motoring for more than 20 seconds can cause severe damage to the starter.

JET ENGINE OPERATING TIME LIMITS.

The jet engines can be operated continuously at any rpm between idle and 97.9%. Maximum power of 100% rpm is limited to 30 continuous minutes duration.

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temperature (°C)	time
1010	max.
982	1 sec.
850	5 sec.
780	10 sec.
704	60 sec.
692	30 min.
676	continuous

JET ENGINE STARTER LIMITATIONS.

Note

Engine starts should be considered normal so long as starting temperature and fuel flow limits are not exceeded and other engine operational characteristics such as idle to military accelerations are normal.

Duty cycle limitations for the jet engine starter are:

1. A 3-minute wait after the first motoring run of not more than 20 seconds.

2. A 5-minute wait after the second motoring run of not more than 20 seconds.

3. Not more than three 20-second cranks in a 30-minute period.

CAUTION

Motoring for more than 20 seconds can cause severe damage to the starter.

JET ENGINE AIR INLET DOOR ACTUATOR LIMITATIONS (INFLIGHT)

A ten-minute wait is required between complete operating cycles of the pod air inlet door to permit adequate cooling of the actuator. A complete cycle is defined as door opened and closed or door closed and opened.

FUEL QUANTITY LIMITATIONS.

ASSAULT TAKE-OFF.

The minimum fuel quantity permitted in each nacelle tank for assault take-off is 2200 pounds with jet engines operating and 1050 pounds with reciprocating engines only. This is generally considered adequate to avoid uncovering of the fuel boost pump inlet during the initial acceleration. If uncovering of the fuel boost pump inlet should occur, and abrupt drop in fuel pressure will result and the engine may stop for want of fuel.

ALTERNATE FUEL GRADE LIMITATIONS.

Alternate grade fuel for the aircraft is grade 115/145. There are no limitations imposed with the use of this fuel. All performance calculations are the same as when using normal grade fuel. There are no limitations imposed when the aircraft is serviced with a mixture of 115/145 and 100/130 fuels.

PROPELLER LIMITATIONS.

All checks required in the 1600 to 1850 rpm should be accomplished as quickly as possible. The RPM range of 2650 to 2800 should be avoided except when required during ENGINE RUN-UP, TAKE-OFF and LANDING. When operating on the ground, the propellers should remain in increase RPM at all times except for engine and propeller operational checks.

BRAKE LIMITATIONS.

After maximum braking at high gross weight (assault landings), the following cooling time should be adhered to if time and operational conditions permit.

Brake-On Speed	Inflight Cooling Time (Gear Extended)	On-Ground Cooling Time
Up to 84 knots	15 min.	30 min.
85 to 94 knots	25 min.	45 min.
95 knots and above	30 min.	60 min.

CAUTION

Use of brakes before expiration of recommended cooling time will result in shorter brake life and possible brake failure.

CARGO DOOR AND RAMP LIMITATIONS.

RAMP WEIGHT LIMITATIONS.

When the ramp is supported by the hydraulic actuators alone, the maximum weight which may be placed on the end of the ramp is 2500 pounds. However, the ramp is capable of supporting up to 8000 pounds when the positioning links are installed. Refer to Ramp Positioning Links, Section IV.

CAUTION

When the ramp is not on the ground, the aircraft must be supported by jacks to prevent tipping when loading more than 6,000 pounds on the ramp.

DOOR OPERATION IN FLIGHT.

When the aircraft is operated with the aft troop doors removed and the flaps down more than 20°, hydraulic pressure is insufficient to open the cargo door because of the negative air pressures created about the door by the flaps-down airflow. If the opening of the cargo door as well as the use of flaps is anticipated when the aft troop doors are removed, it is recommended that the cargo door be opened prior to the lowering of the wing flaps. Hydraulic operation of the door can also be accomplished, provided the airspeed is below 100 knots and the flaps setting does not exceed 45°, by first lowering the ramp to the full down position. Door operation is not adversely affected by flaps setting when the aft troop doors are closed.

WARNING

Do not allow the ramp to free fall without the links installed inflight. Do not lower the ramp below horizontal position without first advising the pilot.

AIRSPEED LIMITATIONS.

To avoid excessive airloads on the aircraft structure, the following airspeed limits should not be exceeded:

130 knots - when opening cargo door or ramp

132 knots - when extending wing flaps

135 knots - when extending landing gear

Note

The airspeed limits stated above are equally applicable after the door or ramp has been opened, the wing flaps extended, or the landing gear extended.

Observe the following maximum airspeed limitations when jettisoning fuel tanks:

115 knots - when jettisoning nacelle tank

120 knots - when jettisoning drop tank

Observe the following limitation on take-off and landing.

139 knots - maximum tire rotation speed

WARNING

Maximum tire rotation speed is 139 knots ground speed, not indicated airspeed. To determine ground speed, compute the true airspeed and apply winds.

Refer to Instrument Range Markings, Figure 5-1, and Turbulence And Thunderstorms, Section IX, for additional airspeed limitations.

PROHIBITED MANEUVERS.

No acrobatics or power-on stalls allowed. The maximum angle of bank is 60 degrees (level turn) to avoid overstressing the aircraft. Avoid asymmetric loading at high airspeed or with G forces such as rolling pullouts.

CENTER-OF-GRAVITY LIMITATIONS.

The forward center-of-gravity limit for take-off is 20.6% MAC. The most forward c.g. for inflight loading is 18% MAC; the aft limit is 32% MAC. Refer to T.O. 1-1B-40 for cargo centroid limitations at various operating weights.

WARNING

Particular attention should be given to proper loading when take-offs are necessary from runways of marginal lengths. Avoid taking off at maximum gross weight and most forward center-of-gravity since the nose cannot be lifted off the ground at minimum take-off speeds under these conditions. Then, too, after take-off, the consumption of fuel will move the center-of-gravity even further forward.

WEIGHT LIMITATIONS.

Weight, more than any other single factor, will determine the capability and performance of the aircraft. In the designing of the aircraft, weight has always been a primary restrictive factor as it has a direct effect on an aircraft's configuration, power and range. An aircraft is designed with sufficient strength to accomplish a certain basic mission without undue allowance for overloading or improper weight distribution. Every effort is made to eliminate unnecessary weight; on the other hand, the weight penalty for making an aircraft foolproof is prohibitive. Weight limitations, therefore, are necessarily involved in the operation of the aircraft. If these limitations are exceeded, a loss in the performance of the aircraft is inevitable and structural failure is quite probable. When an aircraft is loaded beyond the established limits, ceiling and range are decreased, control forces and stalling speeds become higher, and the rate-of-climb falls off rapidly as the maximum gross weight is exceeded. The take-off and landing rolls increase appreciably with an increase in gross weight. Likewise, the brakes are less efficient in braking the forward momentum of the aircraft, and the wings are more vulnerable to air loads during maneuvers or flight through turbulent air. These resultant effects can reach serious proportions when the weight limitations of a specific aircraft are disregarded. In a cargo aircraft, the effect produced by weight is much greater than that encountered in aircraft of other types because the cargo, itself, adds a considerable amount to the weight at which the aircraft is operated. In order that cargo of various sizes may be accommodated, the cargo hold is of such proportions that space is not a restrictive factor; consequently, overloading is entirely possible and weight limitations must be complied with if the aircraft is to be operated efficiently, economically and safely. A consideration of the weight factors involved, particularly as they apply to this aircraft, appears in the succeeding paragraphs.

Landing Weight Versus Rate of Sink.

Gross weight limitations of the C-123 aircraft are normally determined by take-off performance. However, the additional power provided by the jet engines on the C-123K aircraft increases performance capability to the point where it is no longer a limiting factor. Therefore, with jet engines operating, aircraft gross weight is limited only by structural considerations. The structural limitations become extremely important, since short range missions may result in landings being performed at higher gross weights than previously experienced with C-123 aircraft. Particular attention must therefore be given to the structural loads imposed on the aircraft during landing. The landing gear structure is designed to withstand landing loads at a gross weight of 51,350 pounds, with the c.g. at 18-32% MAC, at a sink rate of 660 fpm (11 fps). With the c.g. limited 20.1-32% MAC, landings may be made at 54,000 pounds gross weight at a sink rate of 660 fpm (11 fps). Landings may be made at higher gross weights, by adjusting the aircraft sink rate in accordance with the Landing Weight vs Rate of Sink chart (figure 5-6). As shown on the chart, the aircraft may be landed safely at gross weights up to the gear structural limits of 59,000 or 60,000 pounds if the rate of sink does not exceed the limits shown.

Note

The rate of sink indicated is predicated on landing on both main gear and tracking straight down the runway. If landing is made on one main gear the rate of sink must be reduced further.

WEIGHT AND LOADS.

Gravity Effects.

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

Maneuvering.

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

LOAD FACTORS.

A load factor is the ratio of the load imposed on the aircraft when accelerated in any direction as compared with the load imposed on the aircraft by gravity in any condition of static equilibrium. The load factor denotes the strength of the forces acting on the aircraft due to sudden changes in air currents and manipulation of the controls, and is expressed by the term g, which is the gravitational force. By definition then, all aircraft at rest on the ground or in straight and level flight possess a load factor of 1.0g because the force acting upon the aircraft under either of these conditions is merely that of gravity. When the aircraft enters a region of turbulent air or the pilot elects to maneuver the aircraft, additional forces are imposed on the structure. The additional load on the wings resulting from these forces is expressed in relation to the gravitational force and referred to as 0.5g, 2.0g, 3.0g, etc., which means that the forces exerted on the wing structure and its members are 0.5, 2, or 3 times the force exerted by gravity. For example, if the normal weight of the aircraft is 50,000 pounds and the load factor at some given moment of accelerated flight is 3.0g, the total force which the wings must sustain is 150,000 pounds or three times the normal weight of the aircraft in straight and level flight.

MARGIN OF SAFETY.

The margin of safety is the range of forces which exist between two points, one of which is the load factor the aircraft is sustaining at any given moment, and the other is the load factor at which structural damage will occur. If, for example, the aircraft is incapable of sustaining a load factor greater than 3.0g and, during flight through turbulent air is subjected to a force of 1.5g, the margin of safety at this particular moment is 1.5g. When fuel and cargo loads are increased, the margin of safety decreases. This increase in weight actually becomes a component of the forces acting on the aircraft, and, as such, lessens the capacity of the aircraft to sustain further loads due to accelerated flight. For this reason, it is advisable in loading an aircraft to maintain a margin of safety which will never be exceeded during any period of flight. Experience has shown that an aircraft should never be overloaded to the point where it cannot make good a load factor of 2.0g because almost any mission, even with ideal conditions, will subject the aircraft at one time or another to load factors of at least 2.0g.

WARNING

If the combined weight of cargo and fuel is such that the aircraft is incapable of sustaining a force of 3.0g, turns and pull-outs should be made with caution to minimize the resulting air loads.

EXPLANATION OF THE CHARTS

The Structural Weight Limitations chart is intended to present graphically the weight-carrying capabilities of the aircraft as defined by the various structural

WING LOAD FACTORS...

+3.0g,-1.5g Design Wing Load Factor

+2.5g Marginal Wing Load Factor

FUEL GRADE...100/130

MAXIMUM NACELLE FUEL	**8,478 LB**
DROP TANK FUEL	**5,292 LB**
TOTAL FUEL	**13,770 LB**

WEIGHTS	CRITERIA
51,350 lb	. . . Maximum landing gross weight at a contact sinking speed of 11 ft/sec ultimate and a c.g. location within 18% - 20.1% MAC.
54,000 lb	. . . Maximum landing gross weight at a contact sinking speed of 11 ft/sec ultimate and a c.g. location within 20.1% - 32% MAC.
54,000 lb	. . . Design gross weight (this is not a limiting factor).
60,000 lb	. . . Landing gear strength limitations for taxiing and ground handling conditions.
60,000 lb	. . . Maximum landing gross weight at a contact sinking speed of 9.2 ft/sec ultimate and a c.g. location within 18% - 32% MAC.
72,500 lb	. . . Maximum landing gross weight at a contact sinking speed of 8 ft/sec ultimate and a c.g. location within 18% - 32% MAC.

limitations to permit safe and efficient operation. Through the use of the Chart, the flight planner is aided in recognizing the structural weight limitations which may restrict operation in a specific mission and in determining what margin of safety may be established.

Note

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

The Take-Off Gross Weight Limit Curves in Appendix I supplement the criteria presented on the Structural Weight Limitations chart by providing limiting gross weights throughout the whole range of altitudes and atmospheric conditions which might conceivably be encountered.

Gross Weight.

The data in the Structural Weight Limitations chart is based on the operating weight of the aircraft exclusive of the cargo and the fuel required for the mission but including the following items: crew; full oil and water; trapped fuel, oil, and water; and standard equipment. Any special equipment such as loading ramps, jacks, troop seats, litters, tie-down devices, wheel chocks, tool boxes, etc., are considered to be special load items and, when carried, should be computed as part of the cargo load. The zero point of the chart at the junction of the fuel and cargo load axes represents an operating weight of 39,100 pounds for aircraft with external drop tanks installed. As individual operating weights may vary, it will be necessary to adjust the chart of the specific aircraft involved. The operating weight plus the fuel and cargo required in a mission can be shown by gross weight lines which slope across the chart. The diagonal lines also indicate various structural limitations. However, any gross weight line may be plotted, by interpolation, to obtain a graphic representation of the limitations involved in the fuel-weight combination which a mission may require.

Note

> The gross weight of the aircraft should never exceed that required for the mission since unnecessary risk and wear of the equipment will otherwise result. Take-off gross weights must also be considered in light of available runways, surrounding terrain, altitude, atmospheric conditions, mission requirements, and the urgency of the mission.

STRUCTURAL WEIGHT LIMITATIONS

AUXILIARY JETS ON OR OFF
DROP TANKS AND TANK PYLONS OFF
BASIC OPERATING WEIGHT—41,521 LBS.

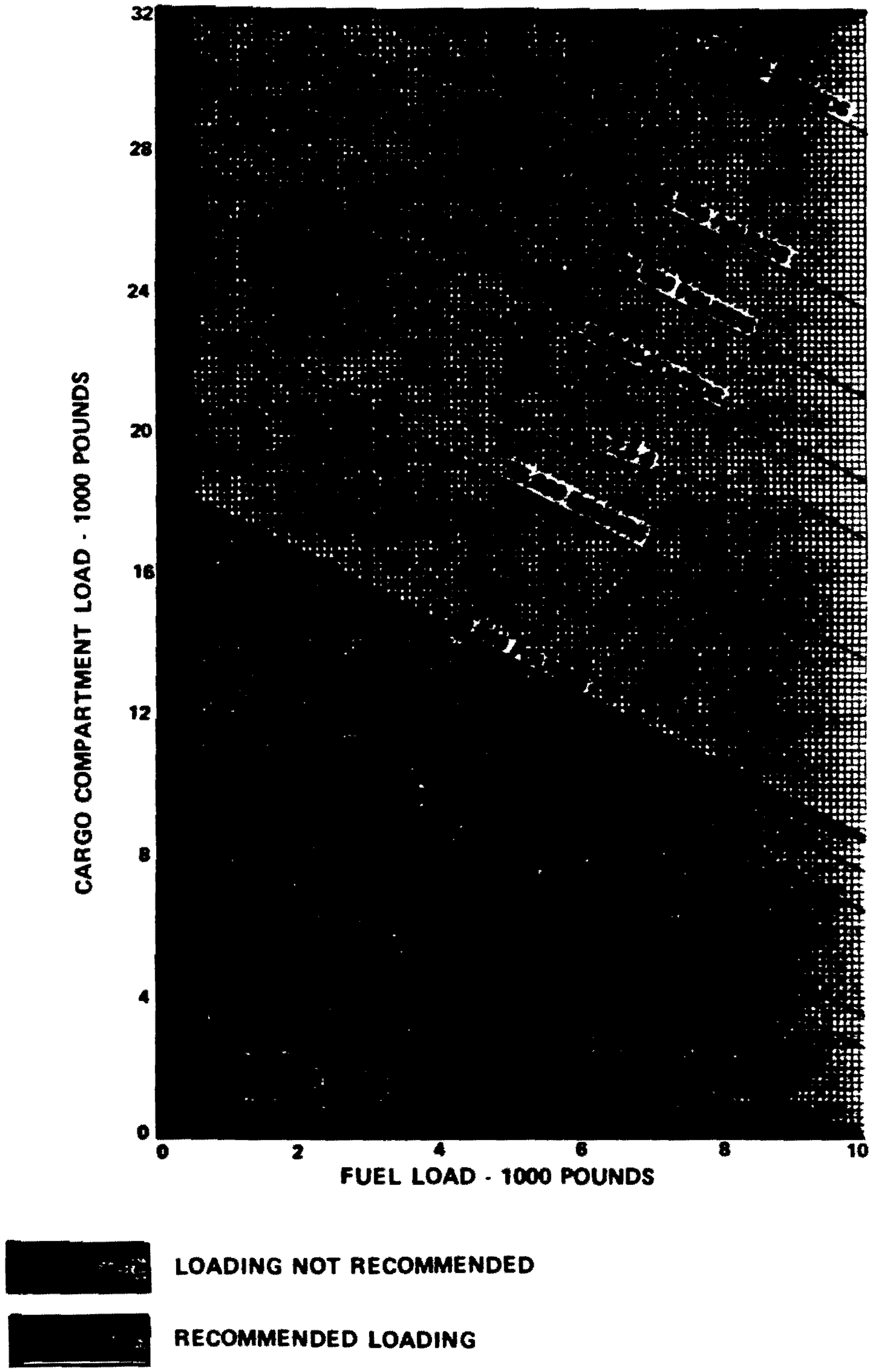


Figure 5-5

WING LOAD FACTORS...

+3.0g,-1.5g Design Wing Load Factor

+2.5g Marginal Wing Load Factor

FUEL GRADE... 100/130

MAXIMUM NACELLE FUEL 8,478 LB

WEIGHTS	CRITERIA
51,350 lb	. . . Maximum landing gross weight at a contact sinking speed of 11 ft/sec ultimate and a c.g. location within 18% - 20.1% MAC.
54,000 lb	. . . Maximum landing gross weight at a contact sinking speed of 11 ft/sec ultimate and a c.g. location within 20.1% - 32% MAC.
54,000 lb	. . . Design gross weight.
60,000 lb	. . . Landing gear strength limitations for taxiing and ground handling conditions.
60,000 lb	. . . Maximum landing gross weight at a contact sinking speed of 9.2 ft/sec ultimate and a c.g. location within 18% - 32% MAC.
72,500 lb	. . . Maximum landing gross weight at a contact sinking speed of 8 ft/sec ultimate and a c.g. location within 18% - 32% MAC.

Wing Fuel Load.

At the base of the chart along the horizontal axis, the weight of the fuel normally carried in the wing fuel tanks is indicated in thousands of pounds. Although the maximum fuel loadings with and without the drop tanks are shown, any amount of fuel may be carried within the range of loadings indicated.

Cargo Load.

In any mission, range and fuel consumption directly determine the fuel which must be carried, and indirectly, the cargo which can be transported. With full fuel load, cargo loading is variable within the limits established by the strength and performance of the aircraft. The payload, as carried in the cargo compartment, appears in thousands of pounds along the vertical axis of the chart.

WING STRENGTH.

The loads which the wing will sustain under different weight and fuel loading conditions are represented by the wing load factor lines on the chart. Under most loading conditions, which are normally limited by engine-out performance or landing gear strength, the margin of safety provided by the strength of the wing is adequate. However, when flight through turbulent air is anticipated, the highest practical wing load factor is desirable. It should be noted that the wing load factor lines on the chart remain valid regardless of a difference in the operating weight from that on which the chart is based. The wing load factor lines are based on the gross weight of the aircraft and the fuel load; no adjustment of the lines as they appear on the chart is required when the operating weight changes.

Wing Strength With External Fuel Tanks.

The structural strength of the wing with nacelle and external fuel tanks fully serviced has been checked for a dynamic landing condition based on an ultimate sinking speed of 12 fps and a gross weight of 54,000 pounds. Extrapolation of this data indicates that, at an ultimate sinking speed of 8 fps, it is structurally satisfactory to land at 60,000 pounds with both nacelle and drop tanks full.

LANDING GEAR STRENGTH LIMITATIONS.

Taxiing And Ground Handling.

The maximum gross weight for taxiing and ground handling conditions with zero wing lift acting is

60,000 lbs. The design of the nose gear axles is such that the axles are capable of sustaining loads imposed in turning at this gross weight. Likewise, nose gear strength is adequate to sustain loads imposed by asymmetrical braking at the taxiing and ground handling limit weight.

Landing.

The landing gear structure is designed for normal landings at a gross weight of 51,350 pounds, the center of gravity location within 18%-32% MAC, and a contact sinking speed of 11 fps ultimate. However, if the center-of-gravity location at landing falls within 20.1%-32% MAC, the landing may be accomplished at 54,000 pounds. Moving the center-of-gravity location aft of 20.1% MAC effectively reduces the loads which the nose gear must sustain in landing and permits the increase in gross weight. Extrapolation of the above data indicates the landing gear will withstand a landing gross weight of 72,500 pounds at a contact sinking speed of 8 fps ultimate. The 72,500 pounds landing weight is considerably higher than the limitations imposed by the maximum overload take-off conditions. In view of the fact that a normal landing is accomplished at an average contact sinking speed of approximately 2-3 fps, the strength of landing gear will allow the landing to be accomplished safely even in the case of an aborted mission at maximum overload take-off gross weight.

BRAKING.

The wheel brakes are satisfactory for normal expected service life with reverse thrust at 54,000 pounds. In a refused take-off situation, a one-time emergency stop can be made at a gross weight of 60,000 pounds without the benefit of reverse thrust.

LOADING AREAS.

Some idea of the direct relationship between weight limitations and structural limitations may be obtained from the discussion of the loading areas in the paragraphs which follow.

Recommended Loading Area.

The green area on the charts represents the loading conditions that present no particular problem in regard to strength of the aircraft. Operation of the aircraft at weights outside this recommended loading area should be avoided unless the dictates of the mission require it. The green area of the chart is defined by the landing gear strength limitation for taxiing and ground handling conditions as defined under LANDING GEAR STRENGTH LIMITATIONS. As seen from the Structural Weight Limitations charts, the 2.5g wing load factor line exceeds the above landing gear strength limitations and is never a restriction for the recommended loading area.

Loading Not Recommended.

The red area represents loadings which are not recommended because the margin of safety from the standpoint of structural limitations is something less than the most desirable or the best practical. Under conditions of extreme emergency when safety of flight is of secondary importance, the Commander will determine if the degree of risk warrants operation of the aircraft at gross weights appearing in the red zone.

Note

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

USING THE CHART.

Two sample problems, the solution of which are obtained through the use of the Structural Weight Limitations (Drop Tanks On) chart, figure 5-4, appear below. Note that in Problem No. 1 the basic operating weight of the aircraft is assumed to be 39,100 pounds. Should the basic operating weight of a specific aircraft under consideration differ from the basic operating weight of the chart, refer to Problem No. 2 which has been designed to illustrate the solution of just such a problem. In each case the problems below have been based on arbitrarily-selected loads that have been selected for the sake of convenience to illustrate the use of the Structural Weight Limitations charts.

Problem No. 1:

For initial planning purposes, what is the cargo load which can be transported if a preliminary fuel estimate indicates that 10,000 pounds of fuel will be required to complete the mission at a maximum gross take-off weight of 54,000 pounds as determined from Take-off Gross Weight Limit Chart in Appendix I?

Solution.

Locate the 10,000-pound fuel load along the horizontal axis of the Structural Weight Limitations chart and proceed vertically from that point until the diagonal defining the maximum gross weight of the aircraft (54,000 pounds) is reached. From this point move directly across to the horizontal axis of the chart and note that a cargo load of 4,900 pounds may be carried in the cargo compartment.

Problem No. 2:

For initial planning purposes, what is the cargo load which can be transported if a preliminary fuel estimate indicates that 12,000 pounds of fuel will be required to complete the mission at a maximum gross take-off weight of 54,000 pounds as determined from Appendix I, Take-off Gross Weight Limit Chart, and the basic operating weight of the aircraft is 40,100 pounds?

Solution.

If the addition of crew members or equipment should raise the basic operating weight of the aircraft to 40,100 pounds, the problem is solved in the same manner as the first problem by considering the increase in operating weight as an increase in the cargo load. Enter the chart at the fuel load of 12,000 pounds and proceed vertically until the 54,000-pound diagonal is intersected. A resulting cargo load of 2,900pounds is indicated. However, when the sum of the aircraft basic operating weight (40,100 pounds), fuel load (12,000 pounds) and the cargo load (2,900 pounds) is obtained, the total weight (55,000) exceeds that of the maximum gross weight (54,000 pounds). As the basic operating weight and the fuel load are fixed because of the requirements of the mission, a suitable adjustment in the cargo load is necessary to bring the gross weight to a figure commensurate with the required gross weight of the aircraft. A reduction of 1,000 pounds in the cargo load is obviously the solution. In effect, when the basic operating weight of the aircraft exceeds that on which the weight limitations chart is based, the additional weight is designated as cargo load and must be subtracted from that cargo load value derived from the chart for any given fuel load.

PERFORMANCE LIMITATIONS.

In the case of two-engine aircraft, it is generally inherent that performance rather than structural limitations restrict the weight which the aircraft can carry; however, with the additional thrust available from the jet engine, performance is not the limiting factor in the operation of the aircraft. Obviously, the gross weight must necessarily be limited by the ability of the aircraft to take off within available runway length and clear any obstacles. But, if the runway length is sufficient, the aircraft may be loaded as required using the Structural Weight Limitation Charts.

Note

Reference to the various charts in the Appendix will indicate the performance of the aircraft as affected by altitude, and non-standard atmospheric conditions.

Power Loss and Performance.

In two-engine aircraft, the effect of an engine failure on aircraft performance is immediate. The loss of half the total thrust normally developed by both reciprocating engines and the asymmetric power condition which results produce a marked decrease in the rate-of-climb. The significance of gross weight and configuration immediately becomes apparent, for the aircraft with partial power is unable to maintain an adequate rate-of-climb at high gross weights or in a configuration with the landing gear and wing flaps extended. Power losses due to altitude, temperature, humidity, and engine deficiency exert a considerable influence on the rate-of-climb even when both engines are operating. It is not difficult to visualize the effect which engine failure will produce on the rate-of-climb, but it is interesting to note the remarkable difference in aircraft performance resulting from a rise in temperature and a corresponding fall in air density. The difference between a standard day (15°C at sea level) and a hot day (38°C at sea level) requires a considerable reduction in the cargo load to maintain a 100-fpm rate-of-climb. This reduction reflects the loss in power output of the engine (due to the increase in carburetor air temperature) and the reduction in lift resulting from the decrease in air density. Naturally, variations of temperature and altitude within this range will give similarly graduated values in brake horsepower and rate-of-climb. The effect of altitude and non-standard conditions is thoroughly examined in the Brake Horsepower Available Curves and Take-off Gross Weight Limit Curve, Appendix I. With the additional thrust available the loss of power due to a reciprocating engine failure is not as critical as without jet thrust.

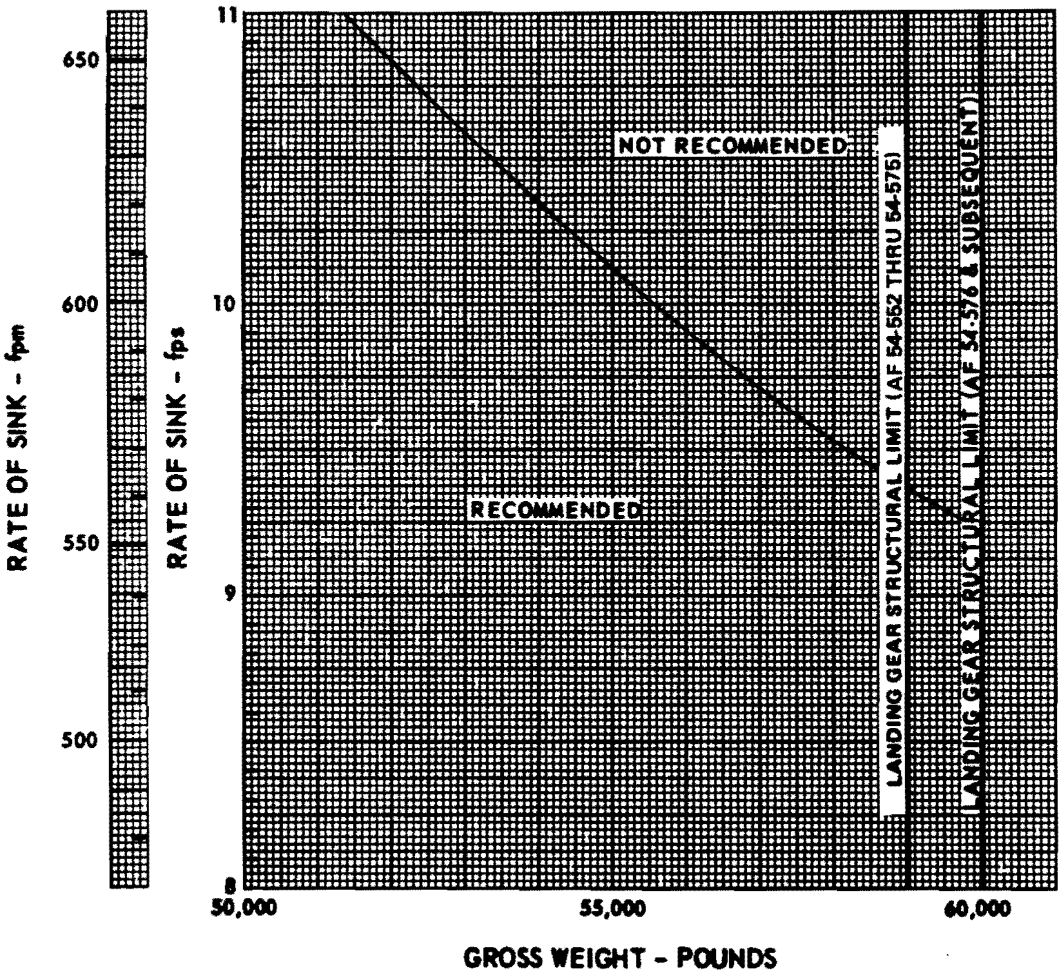
Configuration And Performance.

The configuration of the aircraft also imposes a penalty on performance. In other than clean configurations, the increase in drag produces a decrease in the rate-of-climb and requires a readjustment of the gross weight at which the aircraft may be operated. As with power losses, this condition is most critical at take-off when, of necessity, the landing gear is extended, the cowl flaps and oil cooler flaps are open, and the wing flaps at a 20° deflection. The effect of the drag produced by the wing flaps is indicated on the Take-off Gross Weight Limit Curve, Appendix I. Note that a considerable reduction in the gross weight is required to maintain the 100 fpm rate-of-climb when the wing flaps are used. Operation with and without external drop tanks installed, likewise, affects performance. The "tanks-off" configuration includes the effect of drag produced by the pylons since the pylons are not easily removable.

C-123K/UC-123K

LANDING WEIGHT VERSUS RATE OF SINK

(With c.g. located at 18-32 %MAC)



NOTE: WITH LIMITED c.g. RANGE OF 20.1 - 32% MAC, MAXIMUM RATE OF SINK OF 660 FEET PER MINUTE (11 fps) IS ALLOWABLE AT A GROSS WEIGHT OF 54,000 POUNDS.

Figure 5-6

SECTION VI
FLIGHT CHARACTERISTICS

table of contents

STALLS.

An artificial stall warning device is installed to provide adequate stall warning in all configurations. This warning appears as a shaking of the pilot's control column and visual indication on the angle of attack indicator. Shaker actuation is initiated at 110% of power-off stall speed (1.1V_S on the angle of attack indicator) in all configurations.

WARNING

Intentional power-on stalls are prohibited in the C-123 series aircraft. If a power-on stall is inadvertantly encountered, all power should be reduced and a power-off stall recovery should be accomplished.

If a complete stall is encountered with power off, warning will appear as a longitudinal buffet and stall characteristics are normal. A complete stall in all power-on configurations is not preceded by an aerodynamic warning and an abrupt roll and downward pitching of the aircraft will result. To prevent a complete stall or to recover from one, the normal procedure of neutralizing controls and regaining airspeed should be employed as the aircraft has no abnormal characteristics during stall recovery. Refer to stall charts, this section, for air speeds at which stalls are calculated to occur.

Note

- The power-on stall speeds listed in Figure 6-1 are the stall speeds of the aircraft with maximum wet power.
- The stall speeds listed in Figures 6-2, 6-3, and 6-4 are based on a power setting to deliver zero propeller thrust. As an example, an appropriate power setting for zero thrust at a gross weight of 45,000 pounds is 16 inches of manifold pressure at 2400 rpm. This power setting will vary slightly with gross weight.
- The stall speeds listed in Figure 6-5 are based on a power setting with the throttles closed.

SPINS.

Intentional spins are prohibited; however, in the event of an unintentional spin the following recovery procedures are recommended:

1. Retard power to idle.
2. Retract flaps and landing gear.
3. Push forward on the control column until the nose of the aircraft is below the horizon, then neutralize the control column.
4. Apply rudder opposite the direction of spin rotation. The rudder should be applied at a slow rate (2 to 3 seconds for full deflection).
5. Neutralize the rudder as soon as rotation stops.
6. Recover to a normal flight attitude.

CAUTION

Avoid abrupt pull out during recovery to prevent structural damage to the aircraft.

MODEL: C-123K/UC-123K

POWER-ON STALL SPEEDS

BASED ON WET TAKEOFF POWER
IN GROUND EFFECT
TAKEOFF

DATA AS OF: SEPTEMBER 15, 1973
DATA BASIS: FLIGHT TEST

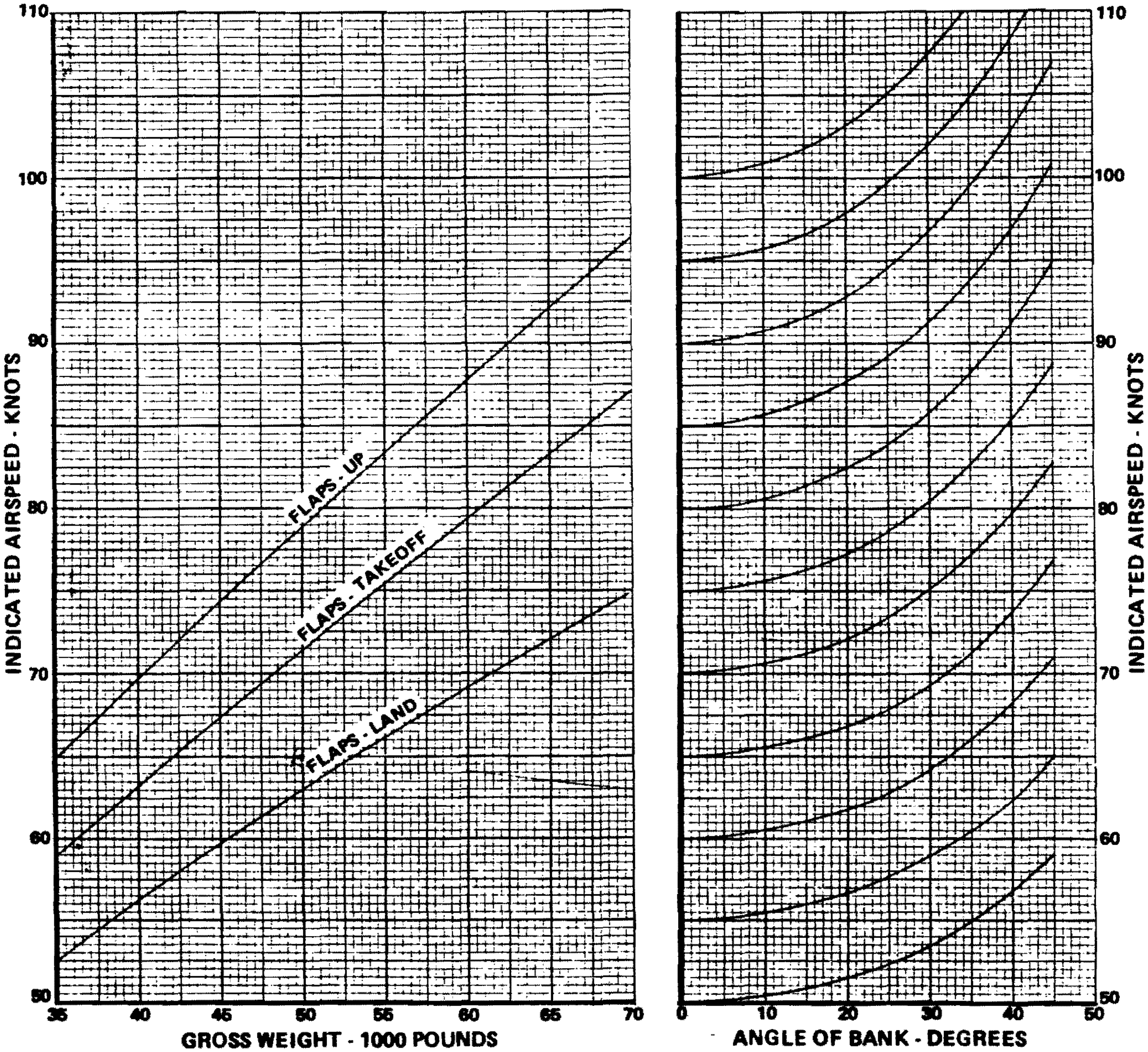


Figure 6-1.

MODEL: C-123K/UC-123K

ZERO THRUST STALL SPEEDS

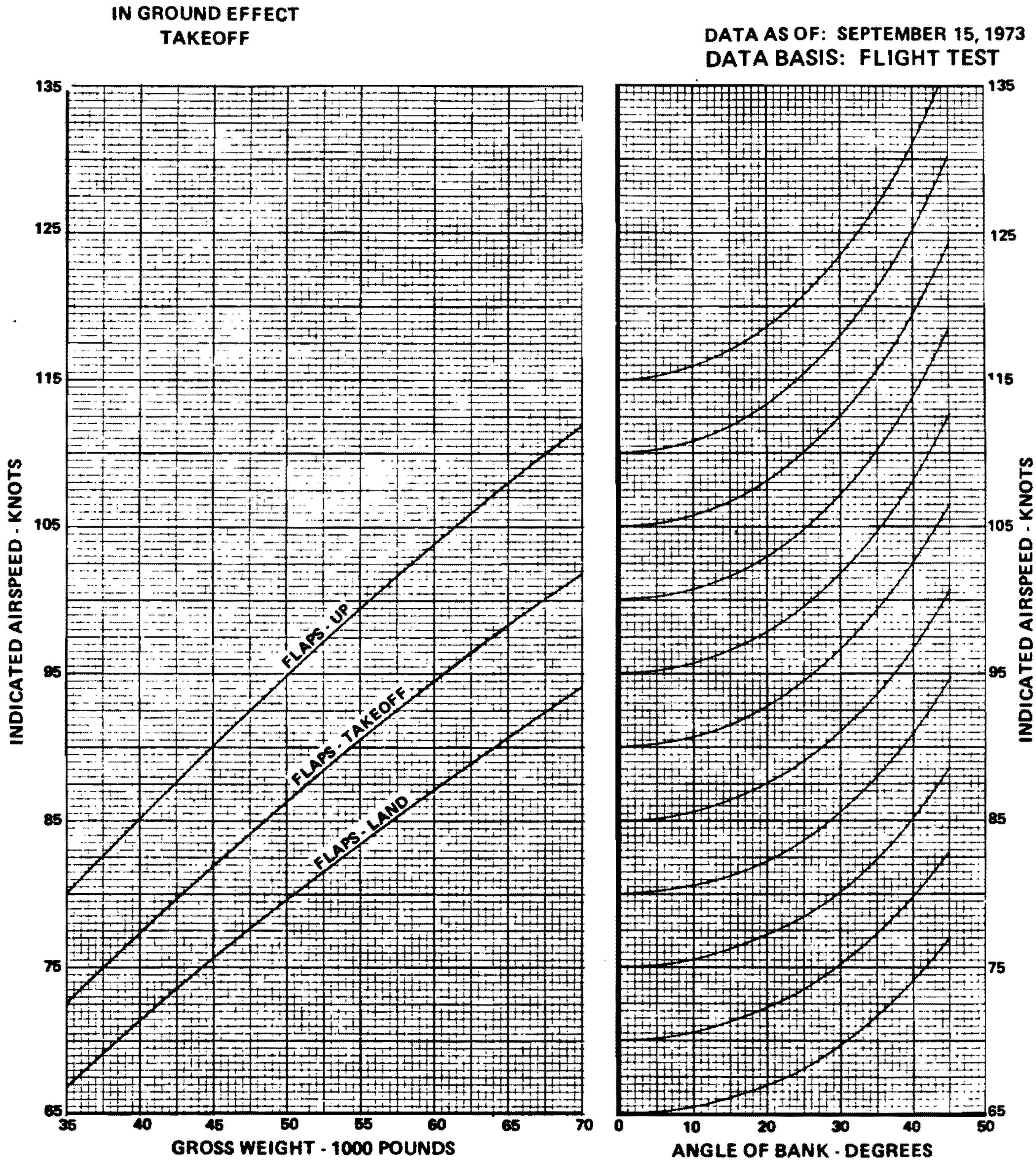


Figure 6-2.

MODEL: C-123K/UC-123K

ZERO THRUST STALL SPEEDS

IN GROUND EFFECT
LANDING

DATA AS OF: SEPTEMBER 15, 1973
DATA BASIS: FLIGHT TEST

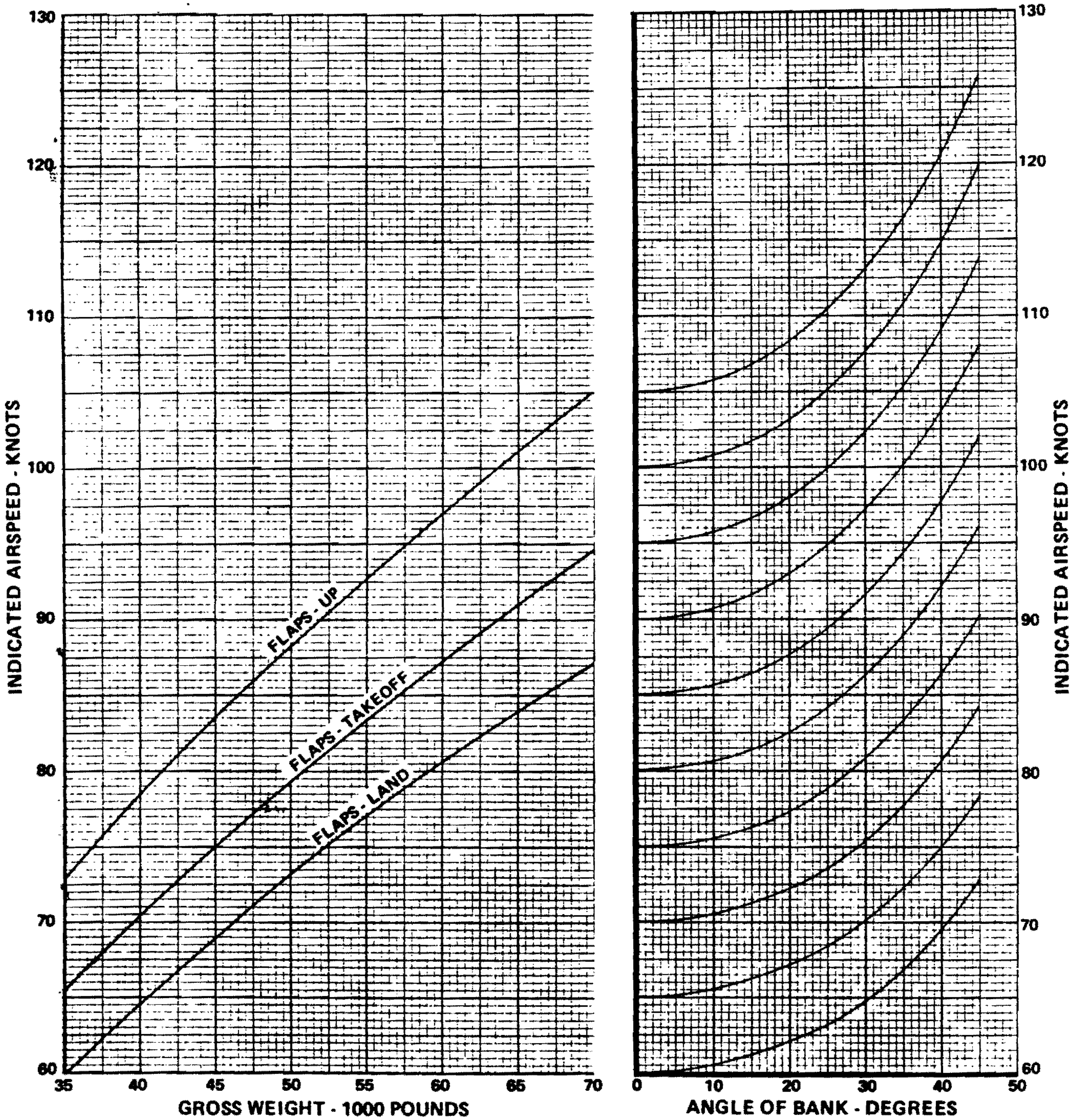


Figure 6-3.

MODEL: C-123K/UC-123K

ZERO THRUST STALL SPEEDS

OUT OF GROUND EFFECT

DATA AS OF: SEPTEMBER 15, 1973

DATA BASIS: FLIGHT TEST

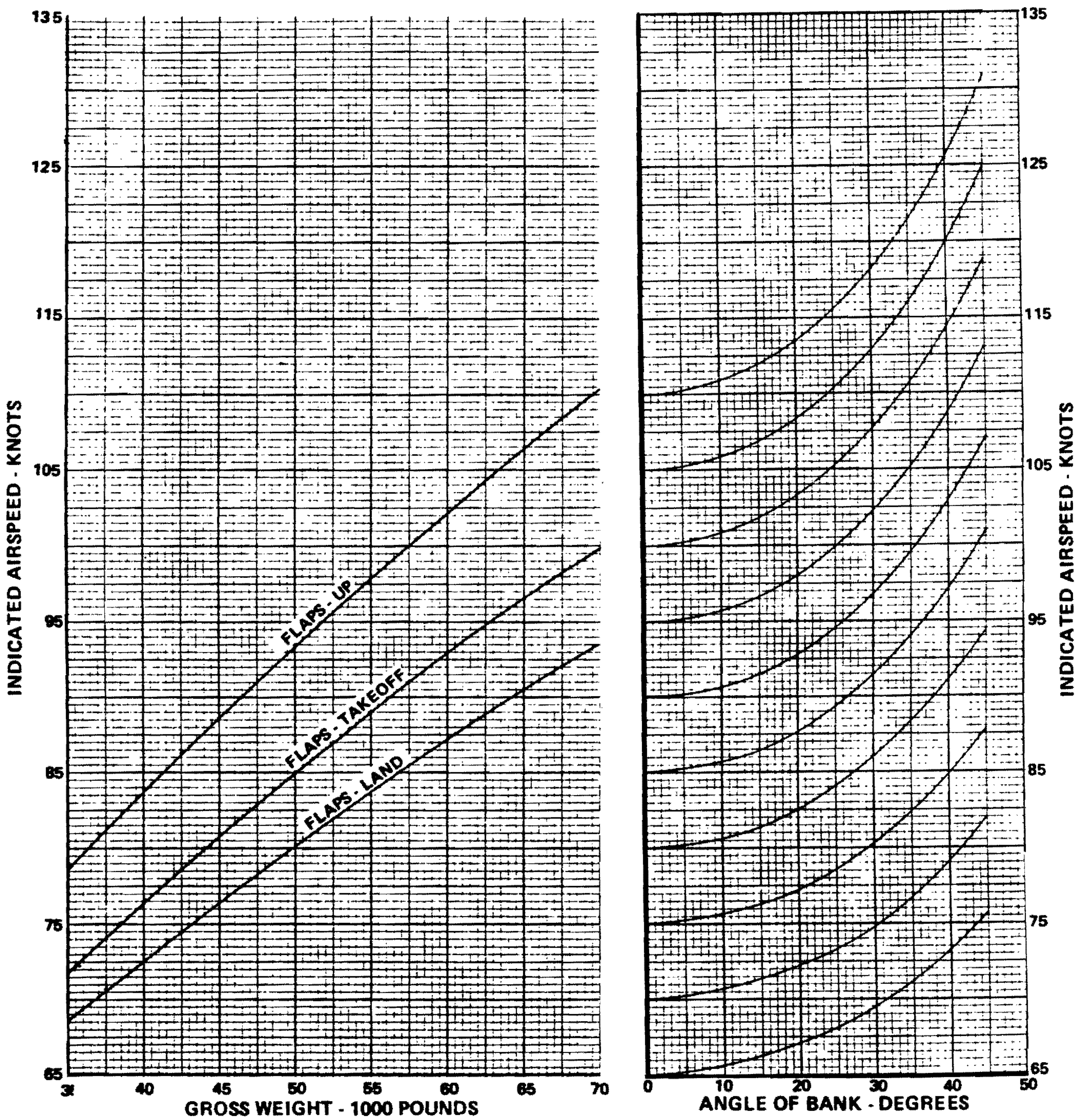


Figure 6-4.

MODEL: C-123K/UC-123K

POWER- OFF STALL SPEEDS

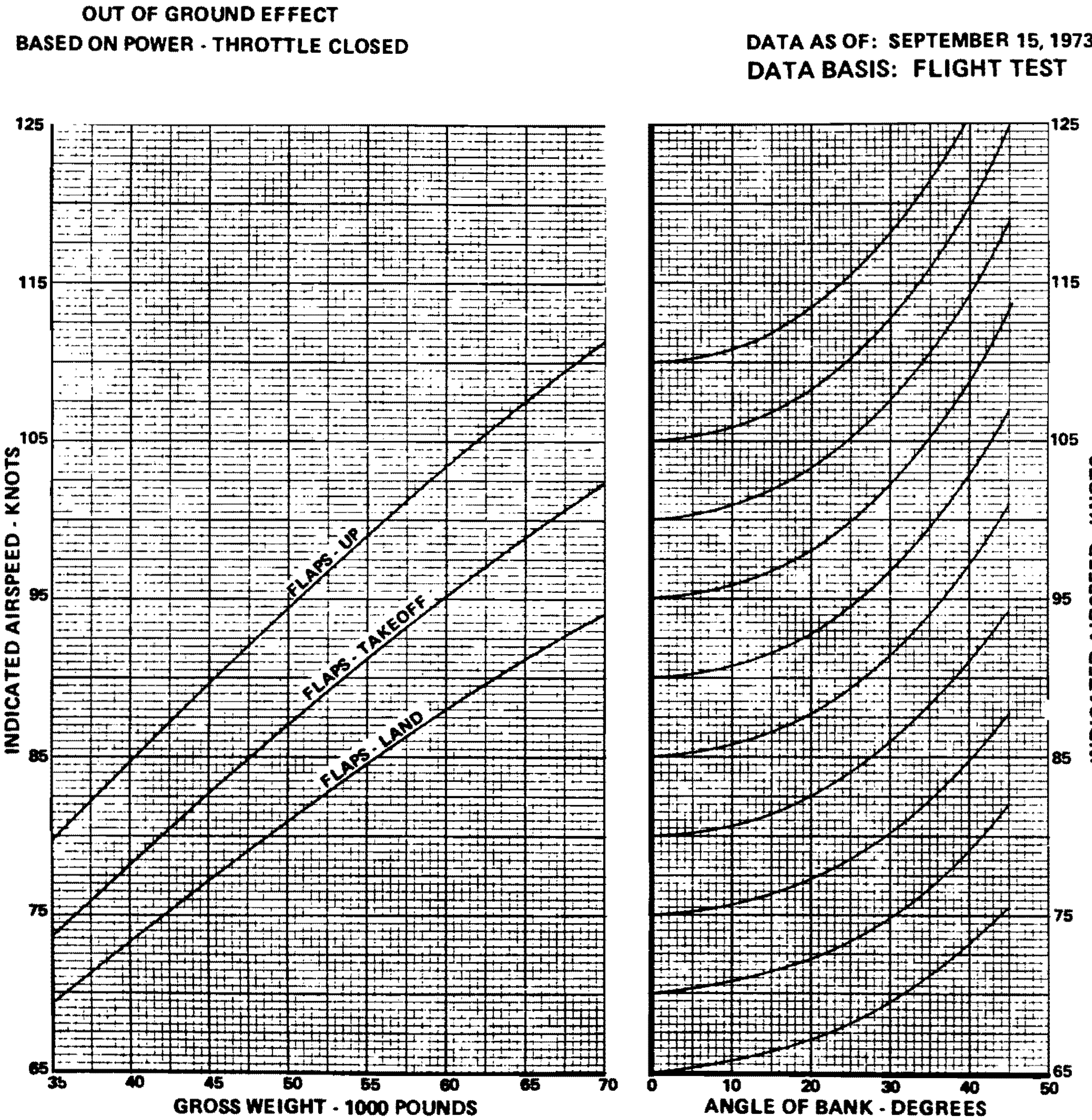


Figure 6-5.

DIVING.

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

WARNING

Elevator forces are so designed for maneuvering and formation flight that, with one pilot effort, the allowable load factor limit of the aircraft can be easily exceeded. Extreme maneuvering flight is prohibited.

CONTROL FORCES AND GLIDE ANGLE.

With normal and full military loads, the aircraft is stable at all normal speeds. Control forces are balanced and coordinated to provide ease of control in both two-engine and engine-out flight. Control forces are such that the aircraft is easily controlled with changes in airspeed, flap setting, and center-of-gravity location. Because the aircraft was designed for minimum take-off and landing distances, the glide angle with gear and flaps extended is exceptionally steep. For normal landings, the LAND (45°) setting of the wing flaps is recommended.

MANEUVERING FLIGHT.

The stick forces per g are comparatively low for this class aircraft. Although stick force gradient is within allowable specification limits, the effectiveness of the elevator for one pilot effort is such that the allowable load factor limit of the aircraft can easily be exceeded. Extreme maneuvering flight is prohibited.

FLIGHT CHARACTERISTICS VERSUS CONFIGURATION.

A discussion of the flight characteristics of the aircraft in other than the normal configuration appears in the following paragraphs. The specific configurations discussed are: cargo door and ramp open, one or both nacelle tanks off, and one or both external drop tanks installed.

FLIGHT WITH CARGO DOOR AND RAMP OPEN.

Extension of the cargo ramp during flight creates a mild nose-up pitching moment which is easily trimmed out. Extension or retraction of the cargo ramp and door causes no other significant handling changes except an empennage buffet which increases from light to moderate with increasing speed up to maximum allowable airspeed. Refer to Airspeed Limitations, Section V, for the maximum airspeed permitted with the cargo door and ramp open.

FLIGHT WITH NACELLE TANKS OFF.

The flight characteristics of the aircraft vary when one or both nacelle tanks are jettisoned. Refer to Airspeed Limitations, Section V, for the maximum airspeed at which the nacelle tanks may be jettisoned.

One Nacelle Tank Jettisoned.

If either nacelle tank is jettisoned during an emergency, significant change in lateral trim will occur, depending on the amount of fuel contained in the remaining tank. See emergency procedures Section III. The buffet experienced during flight with one nacelle tank off is comparable to that produced by the cowl flaps fully open. Should either nacelle tank be inadvertently released during flight or intentionally jettisoned because it has been set afire by any means other than an engine emergency, the engine in that nacelle may be supplied fuel by the use of the crossfeed procedures. However, before the crossfeed procedures are employed, the engine, in all probability, will stop for want of fuel and have to be restarted. This, of course, does not apply if the nacelle tank has been intentionally jettisoned because of an engine fire or a similar engine emergency; restarting of the engine in this case could prove hazardous.

Both Nacelle Tanks Jettisoned.

Both nacelle tanks may be jettisoned for crash landings or other emergencies without seriously impairing the power-off handling characteristics of the aircraft. Jettisoning may be accomplished on the approach at altitudes as low as 50 feet without danger of fire caused by fuel splashing from the tank on ground impact. It should be noted that the power-off glide ranges in Maximum Glide, Section III, do not reflect the nacelle-tanks-off configuration and, because the loss of both nacelle tanks materially increases the drag of the aircraft, the glide ranges quoted are in excess of those obtainable with the nacelle tanks off.

FLIGHT WITH DROP TANKS.

The flight characteristics of the aircraft equipped with drop tanks vary with the conditions outlined below. Refer to Airspeed Limitations, Section V, for the maximum airspeed at which the drop tanks may be jettisoned.

Both Drop Tanks Installed.

The flight characteristics of the aircraft are not adversely affected by the addition of a drop tank on the underside of each wing outer panel. Unsymmetrical fuel loading of the drop tanks, however, is a matter of some concern. Differences in fuel loading greater than one-half tank capacity are considered hazardous for take-off or landing and require caution in ground handling to avoid wing tip contact with the ground. It is highly improbable that any pilot would attempt a take-off with an unsymmetrical fuel loading but this condition could conceivably result from a failure of the fuel transfer equipment during flight. Refer to Fuel System Emergency Operation, Section III, for the procedure to employ should a failure of the transfer equipment occur. At cruise speeds, the effect of the unsymmetrical fuel loading is not particularly pronounced; however, when speed is reduced for the approach and landing, it is extremely difficult to hold the wings level if one tank is full and the other empty. With one tank empty and the other half-full or less, no difficulty will be experienced in executing the approach and landing.

One Drop Tank Installed.

No attempt to take off with only one fully-serviced drop tank installed should be made. However, if it becomes necessary to jettison a drop tank during flight, the resulting effect on the flight characteristics of the aircraft is similar to that caused by unsymmetrical fuel loading discussed above. Refer to Jettisoning of Fuel Tanks, Section III, for the procedure to employ when jettisoning a drop tank.

Drop Tank Icing.

When light or moderate icing conditions are anticipated, flight with drop tanks installed is not recommended since a build-up of ice may occur on the unheated drop tanks and pylons. If icing conditions are encountered in flight and an excessive build-up of ice on the drop tanks and pylons results, a drop in airspeed will be experienced as will a moderate aileron buffeting and a general sluggishness of the controls. As soon as the build-up is detected, the pilot should attempt to locate an ice-free altitude.

FLIGHT WITH BAIL-OUT HATCH REMOVED.

During flight with the outer bail-out hatch removed, prior to opening the inner hatch the following precautions will be observed:

a. Personnel will remain forward of fuselage station 120 or aft of fuselage station 225 unless a properly fitted safety retention harness is worn.

b. All personnel in the cargo compartment not involved in operations requiring movement in the vicinity of the bail-out hatch will be seated in troop seats with seat belt fastened while the inner hatch is open.

c. During all take-off and landing, the inner hatch will be closed.

SECTION VII

SYSTEMS OPERATION

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ENGINES.

OVERBOOSTING.

Overboosting of the engine is a condition arising from too great a manifold pressure. Detonation, rather than normal combustion can result, causing an abrupt pressure rise, violent pressure fluctuations, and possibly 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 pressure nor torque should be permitted to exceed the limits. Refer to Instrument Range Markings, Figure 5-1, and Power Schedules, Appendix I.

LOW MANIFOLD PRESSURE.

If the nature of flying conditions requires a large reduction in power, reduce rpm as well as manifold pressure. For descents or other low power maneuvers, it is important to cushion the high inertia loads on the master rod bearings which occur at conditions of high rpm and low manifold pressure. As a rule of thumb, it is well to remember that each hundred rpm requires at least one inch Hg manifold pressure. For example, 23 inches Hg at 2300 rpm. Operation at high rpm and low manifold pressure should be kept to a minimum.

MANUAL LEANING.

Since it has been recognized that automatic carburetor operation will not permit attaining the maximum precision in the control of fuel flow and mixture strength, and since the lean automatic position is not set for stable engine operation at various altitudes, some method of manually setting the cruise mixture is desired on most transport type aircraft. The recognized method is the so-called torque pressure drop method.

The torque pressure drop method of setting cruise mixture is a procedure keyed to the fundamental relationship between fuel-air ratio and power. Experience has indicated that it gives uniform cruise mixtures, simplified cruise control procedure, and is a satisfactory interpretation of the procedures outlined by the engine manufacturer. The method eliminates reliance upon the quantitative accuracy of torquemeter systems, using torque oil pressure (TOP) gages only for relative measurement.

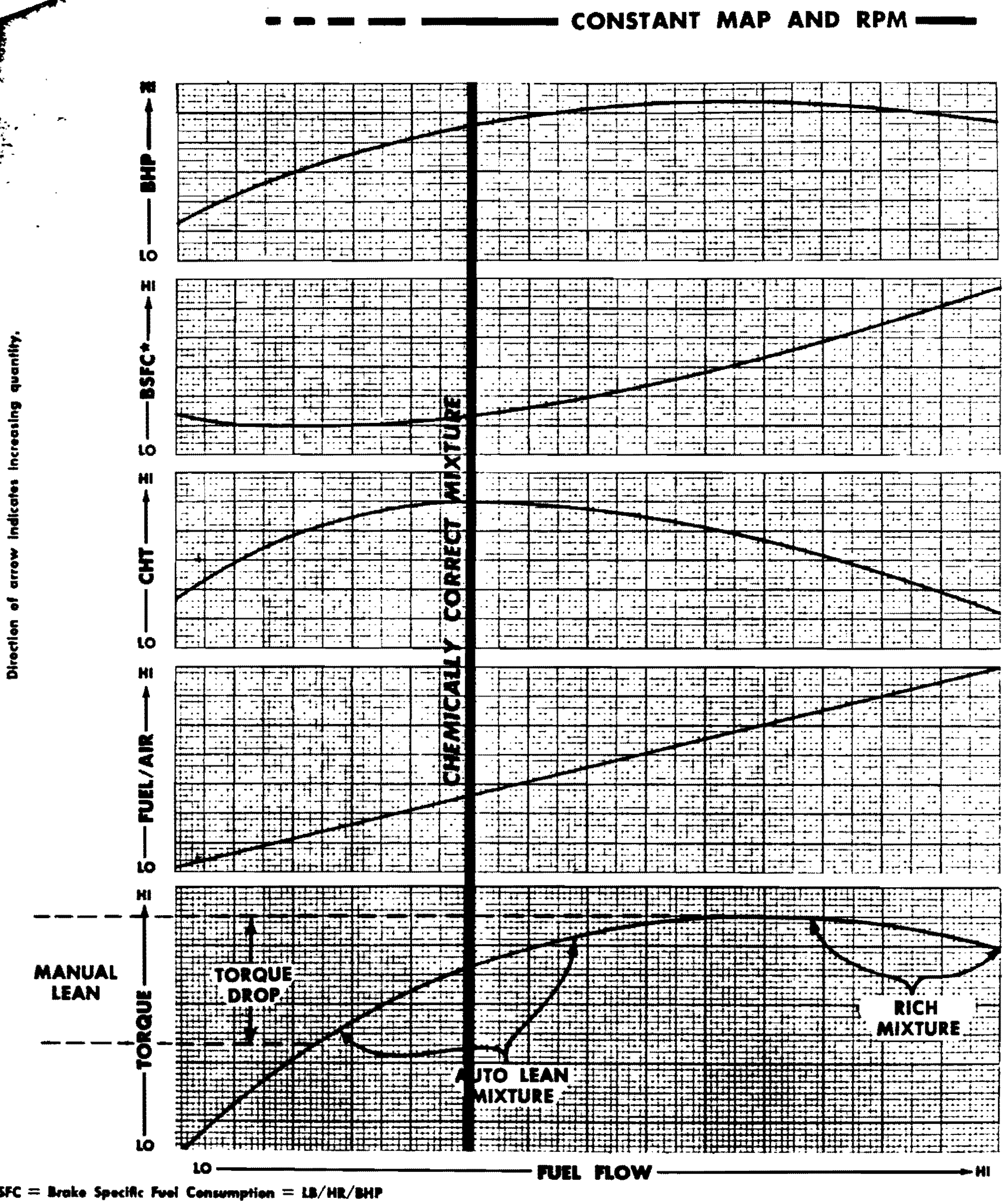
Note

> When cruise is contemplated for long periods of time at a constant power setting, cruise mixture will be manually selected since a combination of allowable carburetor and engine tolerances may cause detonation when operating in AUTO LEAN. Therefore, AUTO LEAN will not arbitrarily be used for cruise operation.

Use of the torque pressure drop method will insure that all engines are operating at the same mixture strength. With all engines set to a single manifold pressure and assuming equal accessory loads and engine condition, all torquemeter readings and cylinder head temperatures (CHT) will be close together. While the mixture control levers may be at different positions on the quadrant, the greater uniformity of engine performance, mixture strength, and fuel consumption should result in savings of fuel and improved engine condition. In addition, the torque pressure drop method is the simplest method to use. Basically, the procedure provides for establishing the desired fuel-air ratio with as many factors as possible held constant, including air flow, CHT, carburetor air temperature (CAT), manifold pressure (MAP), and RPM. Only fuel flow is varied, and resulting changes of power follow closely to the fundamental relationship between fuel-air ratio and power. Thus the torque pressure drop method is a locked throttle procedure for setting cruise mixture with reference to best power. Best power fuel-air ratios define the mixture range at which the engine develops maximum

ENGINE PERFORMANCE VS MIXTURE

(TYPICAL FOR ALL RECIPROCATING ENGINES AT CRUISE POWERS)



*BSFC = Brake Specific Fuel Consumption = LB/HR/BHP

Figure 7-1

17647

power at a fixed throttle setting. As the mixture is leaned or enriched from best power, the power will fall off at a very consistent rate and this power loss can be measured directly with the TOP gage. Knowing the ralationship of mixture strength to power, the desired cruise mixture can be obtained with certain drop in torque pressure which can be indicated as TOP, from the best power peak. This procedure is outlined, step by step, as follows:

CAUTION

Manual leaning is not permitted above 1300 bhp in low blower and 1200 bhp in high blower.

a. After reaching cruise altitude and leveling off, establish the desired cruise values of RPM and MAP (corrected for CAT) but with the mixture control in RICH. Allow flying conditions (indicated airspeed (IAS), CHT, CAT, etc.) to stabilize for about five minutes with the aircraft trimmed for cruise flight. Set the mixture for each engine in turn.

b. Note the TOP obtained in RICH. RICH is usually at, or slightly richer than, best power at cruise brake horsepower, particularly with transport type carburetor settings.

c. Manually lean the mixture from RICH. It is probable that the peak TOP will occur at RICH or as the mixture control is leaned slightly from RICH. Fix in mind the peak TOP observed in steps (a) and (b). Then, continue leaning the mixture until a seven-pound TOP drop is observed below the maximum TOP reading.

d. After setting mixture, recheck MAP and TOP readings. Because of variables, such as accessory loadings and instrument tolerances, there may be considerable spread of TOP for a given MAP on both engines.

As previously noted, the TOP drop method requires only the use of the torquemeter instrumentation in a qualitative sense. This results from the fact that throttle settings are made to a single manifold pressure which, with small accessory loads and proper mixture strength, should result in proper engine air consumption to give the desired power. Thus, engines in good condition should all show close to the same torquemeter readings. To permit operators to determine the manifold pressure required for any power and operating condition, refer to charts in Appendix I.

Note

When the above procedure is attempted, it may be necessary to use prime to establish best power. A suitable procedure is as follows:

Use of Prime to Establish Best Power Peak.

On normal engine with a proper metering carburetor, RICH should be at, or close to, best power mixture. When prime is applied with the mixture control in RICH, the following relationships apply:

a. If the TOP drops, RICH is at, or richer than, best power. If it is richer than best power, the TOP will rise as the mixture is manually leaned from RICH.

b. If the TOP does not change, either RICH is near the lean end of the best power mixture range or the primer is inoperative. To check for possible primer malfunction, manually lean the mixture until a perceptible drop in TOP occurs, then apply prime; if the primer is working, there will be an immediate rise in TOP.

c. If the TOP rises and then falls when prime is used, RICH is leaner than best power.

d. Because of differences in primer installation, variable fuel pressure and variable primer capacity, the effect of prime enrichment will vary, depending on whether prime is applied continously or by intermittent shots. Experience will soon show which is the preferable method of using prime to determine best power TOP.

Apply prime to establish best power peak as follows:

After reaching cruise altitude and leveling off, establish the desired cruise values of RPM and MAP (corrected for CAT) with the mixture in RICH. Allow flying conditions (IAS, CHT, CAT, etc.) to stablize for five minutes with the aircraft trimmed for cruise flight. Set the mixture for each engine in turn as follows:

a. Note the TOP obtained in RICH. RICH is usually at, or close to, best power at cruise brake horsepower.

b. Engage the primer and watch the TOP gage for a rise, drop, or steady indication. Note the maximum TOP reading.

c. Manually lean the mixture from RICH. It is possible that the peak TOP will occur as the mixture control is leaned from RICH. Fix in mind the peak TOP, lean the mixture until a seven-pound drop is observed below the maximum TOP reading.

d. After setting mixture, recheck MAP and TOP readings. Because of variables, such as accessory loadings and instrument tolerances, there may be a considerable spread in TOP for a given MAP on both engines.

CHEMICALLY CORRECT MIXTURE.

At approximately a three psi torque drop from best power, a chemically correct fuel/air mixture is obtained (Figure 7-1). 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 the life of cylinders, spark plugs, exhaust valves, and exhaust valve seats and should therefore be avoided. The actual temperature difference of the cylinder head between Best Economy and chemically correct mixture operation is not very great. However, the difference is significant in that operation at Best Economy (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 Economy less air is required because of the leaner mixture strength; the excess air passes through the combustion chamber and aids in cooling.

CARBURETOR AIR CONTROL.

System Components.

The entire carburetor air ducting, which is built into the engine cowling, consists of a main duct extending from the leading edge of the top cowling panel to the carburetor, and a short duct in each side cowling panel. Both short ducts connect to the main duct when the cowling panels are in the normal closed position. An air filter is installed in the intake duct opening of each side cowling panel. The main duct has five openings: a cold air inlet, a hot air inlet, two inlets that connect to the side cowling filtered air ducts, and an outlet that connects to the rubber air intake duct on the carburetor. Two controllable doors, a filtered air door and a hot air door, are installed within the main duct. Both doors are linked mechanically to a bellcrank, located further aft in the nacelle, by push-pull cable assemblies. The bellcrank is linked to its respective carburetor air control lever on the pilots' control panel (pedestal) by cables.

Operation.

Operation of the carburetor air control system is controlled manually by the selection of the HOT, COLD or FILTERED positions of the control levers in the cockpit. Refer to CARBURETOR AIR CONTROL, Figure 7-2. With a lever in the COLD position, the filtered air door is open, the hot air door is closed and unfiltered cold air flows through the main duct into the carburetor. Placing a lever to HOT opens the hot air door and so positions it in the duct that the cold air flow is blocked off; only full hot air as collected from the engine exhaust manifold area is admitted to the carburetor. Movement of a control lever to any intermediate setting between HOT and COLD so positions the hot air door that a varying selection of carburetor air temperature is available. When a lever is placed in the FILTER position, both the hot air and filtered air doors close, blocking off the cold air and hot air inlets. Air then enters through the filter unit in each side cowling panel and flows through the main duct to the carburetor. Use of the filters restricts airflow sufficiently to reduce MAP as much as 2 to 2.5 inches Hg at full throttle.

CARBURETOR ICING.

Icing Conditions.

Depending upon the atmospheric conditions contributing to ice formation, carburetor icing may occur as induction ice, internal ice within the air passages of the carburetor (impact tube icing or mixture control bleed icing) or a combination thereof. Induction icing is apt to occur in the airscoop on the carburetor air screen and throttles when visible moisture at near-freezing temperatures exists, either in the form of clouds or precipitation. The conditions favorable for the formation of impact tube ice are the same as those for induction ice. Bleed icing is caused by a combination of extremely low fuel temperatures (below 0°C) and flight through a relatively warm and humid air-mass.

Icing Indications.

When operating in icing conditions without carburetor heat, there may be little warning that icing has occurred until it has progressed sufficiently to impair engine performance seriously. For this reason it is important to recognize the various forms of carburetor icing so that the proper deicing procedures may be employed. In all cases, some indication of engine power change is evident, the primary indication being a change in torque pressure. If there is no accompanying decrease in manifold pressure, the power change is probably due to leaning or enrichment of

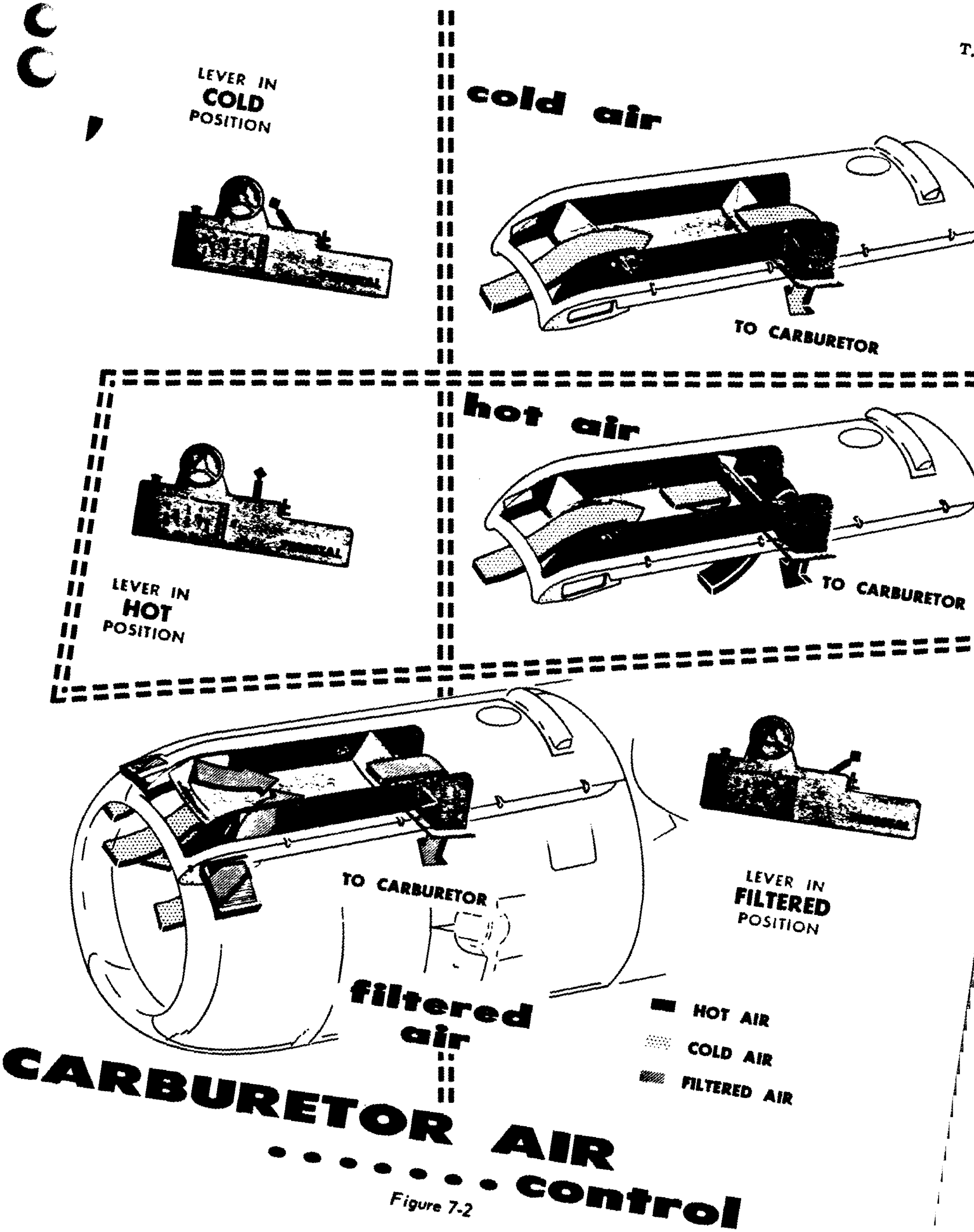

LEVER IN
COLD
POSITION
cold air
TO CARBURETOR
hot air
LEVER IN
HOT
POSITION
TO CARBURETOR
TO CARBURETOR
LEVER IN
FILTERED
POSITION
filtered
air
HOT AIR
COLD AIR
FILTERED AIR
CARBURETOR AIR
...... control

Figure 7-2

the mixture, depending upon the location of ice in the carburetor. Should this condition become severe, a power loss will result and may be accompanied by rough or erratic engine operation. If a decrease in manifold pressure is also observed, the power loss is probably due to restricted airflow through the induction system. Depending upon the location of the ice, this might also result in backfiring or rough running of the engine. Another method of checking for induction icing is to note the response of manifold pressure to movements of the throttle lever.

The information presented in figure 7-3 is given to show the effect of various types of ice on carburetor metering. The fuel flow changes are responsible for the resulting power changes. (Refer to figure 7-1.)

Prevention Of Icing.

The use of carburetor heat for prevention of ice is most effective when applied considerably in advance of encountering icing conditions. Thus it is preferable to use carburetor heat at least 15 minutes before entering an area in which carburetor icing is likely to occur. If operating in the low blower range, attempt to maintain at least 15°C carburetor air temperature (38°C maximum). In high blower, at cruise power setting or less, maintain 15° -30°C. Refer to CARBURETOR AIR TEMPERATURE LIMITS, Section V.

a. Advance mixture lever to RICH.

b. Adjust carburetor heat to maintain desired carburetor air temperature.

c. After carburetor air temperature and engine operation have stabilized, adjust mixture to desired setting.

Note

Carburetor heat may be necessary to avoid carburetor icing during take-off, climb, cruise, and descent. If the carburetor air temperature is -10° to +15°C and icing conditions exist, carburetor air temperature should be maintained above 15°C prior to entering icing conditions.

Induction Icing Procedure.

If induction icing should occur before any preventive measures are taken, use the following procedure.

a. Shift to RICH mixture and apply maximum carburetor heat. Hold heat for 30 seconds.

Note

If appreciable engine icing develops, the loss in power will be accompanied by a loss in preheat capacity, sharply reducing the effectiveness of full preheat in eliminating ice. In such cases it may be necessary to apply full preheat for a longer period of time.

b. Check to see if manifold pressure and torque pressure have been restored by moving the carburetor air levers toward COLD a little at a time.

c. Adjust carburetor air levers to maintain 15°C minimum carburetor air temperature.

Internal Icing Procedure.

If internal icing should occur before preventive measures are taken, use the following procedure. Inasmuch as internal ice may cause either leaning (impact tube ice) or enrichment (bleed ice) of the mixture, it is sometimes difficult, without the aid of fuel flowmeters, to determine which effect has occurred.

a. Adjust the carburetor air levers to obtain the maximum permissible carburetor air temperature. (Refer to CARBURETOR AIR TEMPERATURE LIMITS, Section V.) This type of icing may require constant application of maximum permissible heat for a

MIXTURE SETTING	LEANER THAN BEST POWER			RICHER THAN BEST POWER		
TYPE OF ICING	FUEL FLOW	TOP	MAP	FUEL FLOW	TOP	MAP
INDUCTION	DECREASE	DECREASE	DECREASE	DECREASE	DECREASE	DECREASE
IMPACT TUBE	DECREASE	DECREASE	NO CHANGE	DECREASE	INCREASE THEN DECREASE	NO CHANGE
BLEED ICE	INCREASE	INCREASE THEN DECREASE	NO CHANGE	INCREASE	DECREASE	NO CHANGE

EFFECT OF ICE ON CARBURETOR METERING

Figure 7-3

SPARK PLUG DEFOULING PROCEDURES.

The most important factor to be considered in providing protection against carbon spark plug fouling is the correct idle mixture setting. Manual leaning on the ground is permissible to compensate for temperature and altitude variations. However, clearing of plugs or controlling of spark plug fouling due to oil or excessive rich idle mixture may be accomplished by the following procedure.

a. When unacceptable spark plug performance is encountered during the reciprocating engine runup, reduce engine speed to 1000 rpm. Operate the engine at this rpm for two minutes with mixture slightly leaner than Best Power. Best Power is obtained by slowly manually leaning the mixture until maximum rpm is obtained. Further lean the mixture until 25 rpm decrease from Best Power is noted which will result in a mixture slightly leaner than Best Power. The leaning procedure will increase oxygen to fuel ratio within the cylinder to support chemical oxidation removal of carbon material from the spark plug core tip. After two minutes at this power setting, return the mixture lever to RICH and check the engine performance. If engine performance is still unsatisfactory, repeat the spark plug defouling procedure. In the event the second attempt to clear the spark plugs fails to produce the desired results, the mission should be aborted.

Note

Too much emphasis cannot be placed on slow movement of the mixture lever which is necessary to obtain the Best Power mixture. "Slowly" may be defined as the rate of movement which would require 12 to 15 seconds to move the mixture lever from RICH TO OFF.

b. In advancing the throttles for take-off, slowly increase manifold pressure to field barometric pressure which will increase the core tip temperatures and decrease the possibility of marginal spark plug performance during take-off.

c. An aircraft form entry should be made whenever the aircraft is at its home station and the idle mixture is noted out of adjustment. However, when the aircraft is operating away from its home station, no form entry should be made since the mixture strength may be correct when the aircraft returns. Changes in altitude as well as climatic conditions may alter the idle mixture strength. In either case, the mixture will be manually leaned at idle to produce a mixture 25 rpm leaner than Best Power. Normally idle is 650 RPM ± 25 RPM and slightly richer than best power (10 RPM rise when manually leaned).

d. After each ten minutes of ground operation, slowly advance the throttles to field barometric pressure. Hold this power for one minute but not to exceed the CHT for ground operation.

IN-FLIGHT FOULING PROTECTION.

Fouling Prevention.

A periodic change in engine conditions will usually forestall lead fouling. Here again, prevention is preferable to cure. A reduction in power followed by an increase appears to be the best approach to prevention. The desired results will be obtained by using the following procedure hourly during cruise operation below 875 bhp:

a. Retard throttle slightly.

b. Set mixture control to AUTO LEAN.

c. Establish rpm setting for 1100 bhp (three to five seconds per 100 rpm change).

d. Move throttle slowly (three to five seconds per inch MAP change) until manifold pressure for 1100 bhp is established.

e. Maintain 1100 bhp for five minutes.

f. Reset desired cruise power.

Note

Periodic fouling protection is not required when operating at or above 875 bhp.

Cure of Fouling.

Cure is less certain and includes a wider variety of procedures than prevention. If fouling is detected soon enough, however, it can usually be eliminated or held to a minimum. Generally, plugs which are misfiring or completely fouled are apt to resume firing at lower power settings. Therefore, it is preferable to reduce power and then restore it, rather than attempt to reach a high power setting with malfunctioning plugs. High power burnout procedures, either with or without water, could chemically change the fouling deposits to the extent that there could be no inflight remedy and the only cure would be to change spark plugs. High power burnout procedures also introduce the possibilities of destructive backfiring during the application of power. If rough engine operation is experienced due to misfiring spark plugs, the following procedure should be accomplished.

a. Set mixture control to AUTO LEAN.

b. Reduce power until smooth engine operation is obtained and operate at this power for at least one minute.

c. Establish rpm setting for 1100 bhp (three to five seconds per 100 rpm change).

d. Move throttle slowly (three to five seconds per inch MAP change) until manifold pressure for 1100 bhp is established.

e. Maintain 1100 bhp for five minutes.

f. Reset desired cruise power.

Descent.

Prior to descent, perform the above spark plug Cure of Fouling procedure, if cruising at less than 875 BHP.

CAUTION

Cylinder head temperatures will be maintained above 150°C during letdown and approach whenever possible.

HOT FUEL PRIME SYSTEM.

The primary cause of difficulty 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, if the standard fuel normally used is heated before priming, the necessary vaporization for smooth engine starting may be obtained.

System Components.

The hot fuel priming system 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 installed in each nacelle on the engine mount tube structure. The associated control switch and temperature gages are installed in the crew compartment. The hot fuel priming unit basically consists of a blower assembly, ignition unit, burner, heat exchanger, and controls for automatic regulation of burner fuel flow and pressure, as well as heated fuel temperature. The blower is a motor-driven axial-vane type blower which supplies air for combustion and cooling of the burner unit. The burner is a perforated can with a fuel spray nozzle, spark plug, and ground electrode mounted in such a way as to assure positive ignition of the combustible mixture. Air for combustion enters through the perforated wall of the burner and mixes with the fuel spray. The heat exchanger is mounted within the burner and consists of two coils of 1/4-inch stainless steel tubing, connected in parallel. The outlet end is welded to a small reservoir of approximately 1-pint capacity. 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, thus automatically regulating the temperature of the fuel. A temperature sensing device also installed in the reservoir transmits the temperature of the heated fuel to a temperature gage on the engine starting panel. A fuel pressure regulator controls fuel pressure to the burner. Refer to Figure 7-4.

System Operation.

Complete operation of the hot prime equipment in each nacelle is controlled by the hot prime switch on the engine starting panel. When the switch is placed in the ENG. NO. 1 position, the primer solenoid valve on the left engine carburetor opens and the blower on the left 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 ENG. NO. 1 position. Fuel under boost pump pressure flows into the heat exchanger coils and the burner. The spark produced by the ignition unit ignites the portion of fuel that entered the burner causing rapid heating of the fuel in the heat exchanger coils. The heated fuel flows into the reservoir at the outlet end of the coils and on to the primer discharge nozzles of the carburetor. Automatic regulation of the fuel temperature is provided by the two thermal switches in the reservoir. When the fuel temperature reaches 85°C, the cycling switch begins to operate and holds the temperature of the fuel at approximately 90°C by alternately opening and closing a relay in the electrical circuit of the cycling solenoid valve. The ignition unit remains operative as long as the cycling switch has control of the unit, and the hot prime switch is held in the ENG. NO. 1 position. Should the temperature of the fuel in the reservoir reach 107°C (approx.), the limit thermal switch closes, causing a second relay to open which deenergizes the ignition circuit as well as the cycling and limit solenoid valves. The blower continues to operate and provide cooling air. Although the ignition and fuel supply to the burner are cut off, fuel

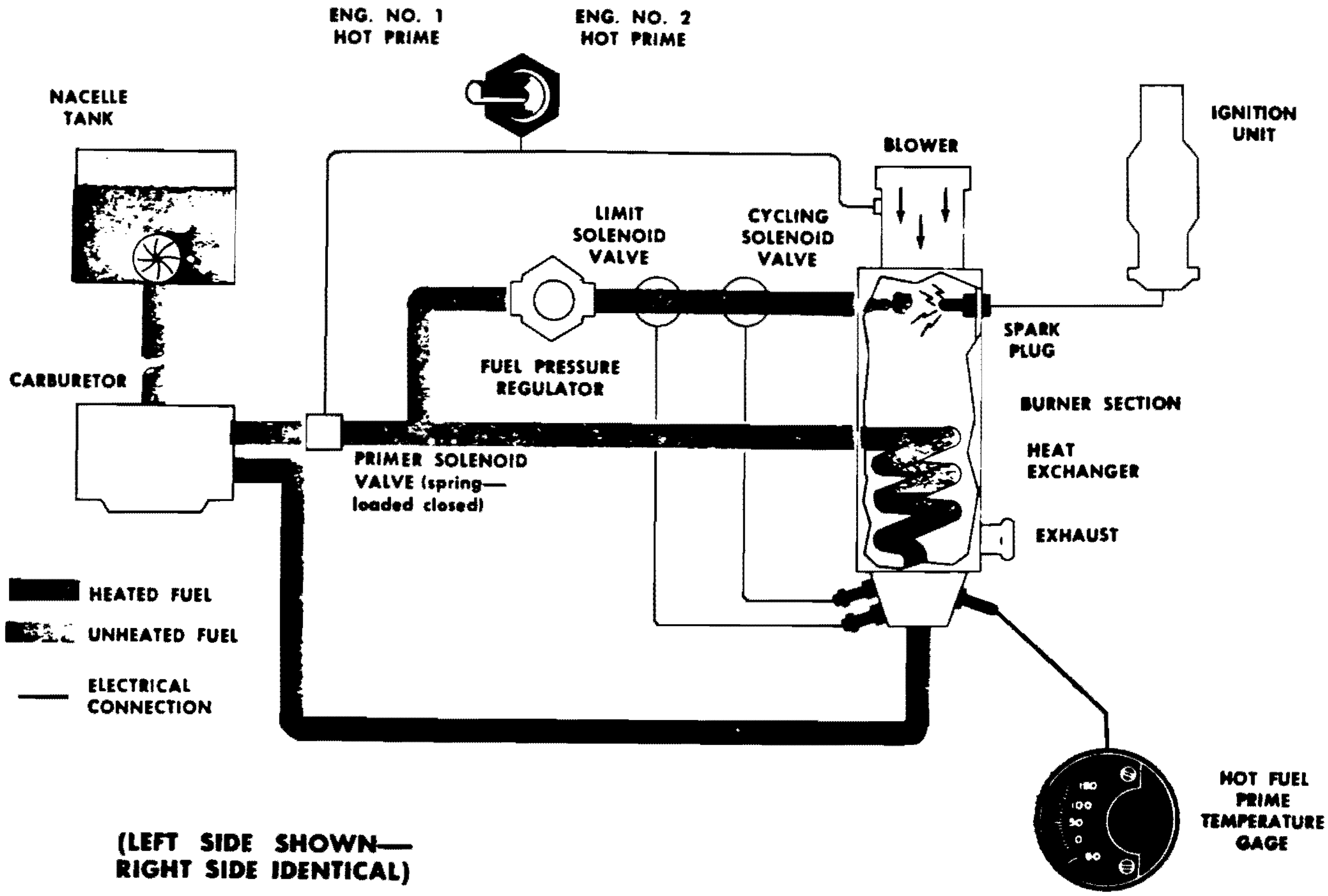


Figure 7-4

flow for priming continues. When the temperature in the reservoir drops sufficiently, the limit switch opens and heater operation resumes. Exhaust gases are ducted from the exhaust well of the burner to an exhaust port in the engine fireseal diaphragm.

SUPERCHARGER SHIFT DURING CLIMB.

The precise point at which to shift must be determined from the operating curves, taking into account the combinations of rpm and manifold pressure used with both low and high impeller ratio. A satisfactory rule which will give reasonable accuracy, if the same combination of rpm and manifold pressure is used in both low and high ratio, is as follows:

a. After passing the low blower critical altitude, continue climbing with full throttle until the manifold pressure has fallen off about five inches Hg.

b. Adjust throttle to reduce manifold pressure an additional four inches Hg.

c. Shift to HIGH. Do not exceed 103.5 TOP.

CAUTION

To avoid detonation, do not shift to HIGH if carburetor air temperature exceeds the limits noted in CARBURETOR AIR TEMPERATURE LIMITS, Section V.

d. Adjust throttle to the desired manifold pressure.

COWL FLAP OPERATION AND CYLINDER HEAD TEMPERATURE.

The cowl flaps on the aircraft, when fully open, present high drag which reduces the load-carrying capability of the aircraft and requires higher power to maintain the desired cruise speed. Cowl flap controls are marked OPEN, OFF, CLOSED, and TAKE-OFF. It should be noted that the TAKE-OFF setting of the cowl flaps is largely one of convenience and that variations from the TAKE-OFF position diuring 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 TAKE-OFF and CLOSED positions. Naturally, the reduction of the cowl flap opening will be reflected in the increased performance of the aircraft as the drag is lessened. Every effort, therefore, should be made to maintain the desired balance in the relationship of cylinder head temperature and cowl flap settings are 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 range for cruise power operation has been established at 170°-200°C. Operation within this range will result in maximum cylinder durability. Cylinder head temperatures below 170°C are not desirable as instability and spark plug fouling may result.

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 engine 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 cylinders will be very wide, and actual engine damage may be done with little or no indication from the cylinder head temperature gage.

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:

$$\begin{aligned} torque &= force \ X \ radius \\ &= (lbs) \ X \ (r) \end{aligned}$$

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

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

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

$$\begin{aligned} work/rev &= force \ X \ distance \\ &= (lbs) \ X \ (2\pi) \ X \ (r) \end{aligned}$$

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

$$work/rev = torque \ X \ 2\pi$$

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):

$$power = torque \ X \ 2\pi \ X \ rpm$$

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

$$bhp = \frac{ft\text{-}lbs/min}{33{,}000} \ or \ \frac{torque \ X \ 2\pi \ X \ rpm}{33{,}000}$$

where torque is expressed in ft-lbs developed at the propeller shaft, and rpm is the propeller speed. Since the torque is measured hydraulically (psi on the torquemeter), 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 torquemeter constant. The formula then becomes:

$$bhp = top \times rpm \times k$$

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 (.00632 in this case).

This formula may also be solved by using an E6-B type computer with a torquemeter constant of 158. The formula becomes:

$$\frac{TOP}{158} = \frac{BHP}{RPM}$$

PROPELLERS.

PROPELLER REVERSING.

The reversible pitch propeller is a valuable feature which, when properly used, increases safety and utility of the aircraft. 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 disrupted, 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 aircraft, and the relatively short interval of reverse pitch operation tend 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 aircraft, 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 are absolutely required.

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 or carburetor air temperatures exceed normal limits. 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 operation, watch for a surge of rpm as propellers are unreversed. As a further check, depress the feathering buttons momentarily and watch for a drop in rpm on the tachometers. Then return the feathering buttons to neutral. A rise in rpm indicates that the propeller is still in reverse pitch. This check should be made immediately after reverse pitch operation if there is any doubt that the propeller did not return to forward thrust. On some aircraft, (modified in accordance with T. O. 1C-123-593) propeller reverse pitch indicating lights are installed on the copilot's instrument panel. The lights illuminate when the propeller blades move into the reverse pitch range and remain illuminated until the propeller blades are returned to the forward pitch position, this affords the crew a quick accurate check on the position of the propeller blades.

OIL SYSTEM.

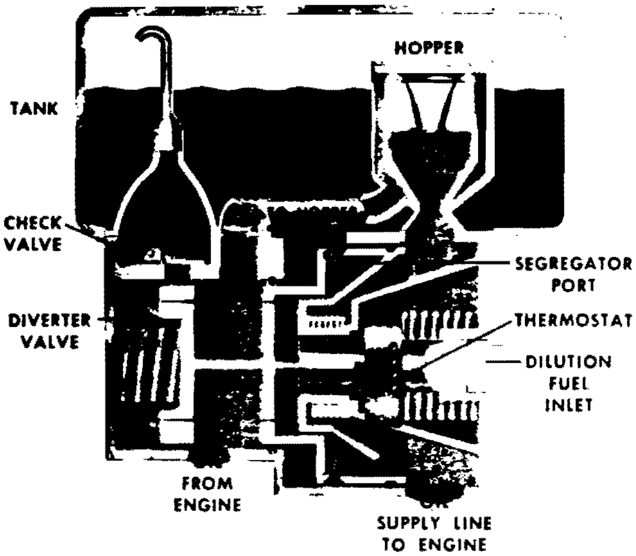
DIVERTER-SEGREGATOR VALVE.

A diverter-segregator valve is installed in the sump of the oil tank to provide thermostatically controlled isolation of the oil in the hopper from the oil in the main portion of the tank during the warm-up period and to segregate diluted oil from undiluted oil following the oil dilution procedure. As a result, only a limited amount of the total oil supply is circulated to and from the engine until the oil remaining in the tank becomes sufficiently decongealed to flow freely. In order to hasten the decongealing process, the diverter-segregator valve directs the warm oil returning from the engine to a space between the double walls of the hopper (Figure 7-5), so that some of its heat may be transferred to the oil in the surrounding tank. While the tank oil is decongealing, the hopper oil supply lubricates the engine, and scavenging pump pressure (return oil) opens the segregator port in the valve so that oil from the tank may flow to the engine as it decongeals. When the temperature of the return oil reaches 54°C (130°F), a thermostat within the valve begins to expand and opens the "to tank" port

oil diverter . . . SEGREGATOR VALVE

COLD CONGEALED OIL — WARM OIL (dilution fuel boiled off)

DILUTED OIL — FUEL

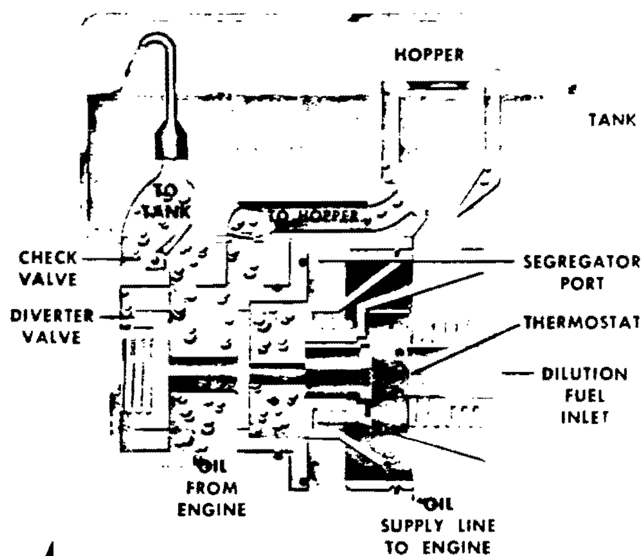


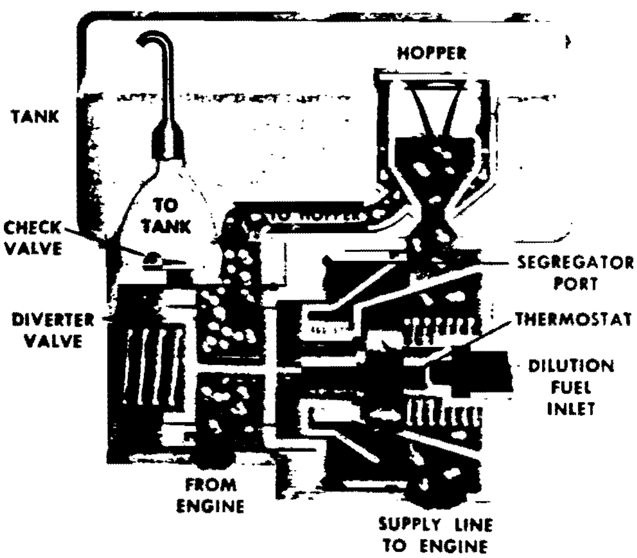
COLD START CONDITION

1. Diluted oil flows from hopper to engine.
2. Scavenging pump pressure (return oil) drives segregator valve to right, opening segregator port for flow of congealed oil. However, no flow of congealed oil occurs until heated by double-walled hopper.
3. Return oil from engine is diverted to double-walled hopper.

NORMAL OPERATING CONDITION

1. Warm oil has expanded thermostat, causing diverter valve to move left, diverting return oil flow to tank.
2. Small amount of return oil still flows to hopper to prevent entrance of air at hopper outlet.





OIL DILUTION BEFORE SHUTDOWN

1. Dilution switch ON. Cold fuel causes thermostat to contract, causing diverter valve to close (move to right). Diluted oil flow is through hopper circuit only.
2. When engine is shut down, drop in return oil pressure allows segregator valve to move to the left, closing segregator port. This segregates diluted hopper oil supply from tank oil supply until next start.

Figure 7-5

diverting part of the return oil to the tank rather than the hopper. As the temperature of the oil increases, the thermostat diverts more and more oil to the tank until, at a temperature of 71°C (160°F), maximum diversion is reached. Excessive slow rise in oil temperature may be caused by the "to tank" port being stuck. This item should be checked by maintenance personnel. The valve is so designed that complete diversion of return oil flow is never accomplished; approximately 10% is returned to the hopper under all operating conditions in order to preclude any possibility of the hopper being pumped dry with resultant introduction of air into the engine oil supply line. However, certain malfunctions can cause oil starvation and loss of oil pressure. If malfunction is suspected, check oil quantity in the hopper.

Oil Dilution.

During cold weather operation, dilution of the oil with fuel is necessary to reduce its viscosity and insure sufficient flow for adequate lubrication. Since the system is designed to recirculate only the hopper oil supply during warm-up, it is not necessary to dilute the entire oil tank, provided positive segregation of the diluted oil is maintained. The fuel enters the oil system through a connection on one end of the diverter-segregator valve, and passes through a hood surrounding the thermostat. As the temperature of the fuel is considerably lower than that of the oil circulating through the engine, the thermostat is chilled rapidly. This causes the thermostat to actuate the valve to the cold position, regardless of the temperature of the oil, and all the diluted oil returning from the engine is diverted to the hopper. After diluting for the recommended length of time (refer to Oil Dilution Table, Figure 9-3), the engine is shut down and oil flow ceases. Reheating of the thermostat may now occur due to the residual heat in the system, and may even be sufficient to cause the thermostat to open the "to tank" port in the valve assembly. However, since the engine is shut down, oil flow has ceased and no diluted oil is diverted to the tank. Oil flow from the tank into the oil supply line is prevented because scavenging pump pressure is not available to hold open the segregator port between the tank and the supply line. In this manner, positive segregation of diluted from undiluted oil is maintained.

MANUAL OPERATION OF OIL COOLERS.

If loss of engine oil occurs during cruising operation, oil temperature has a tendency to rise gradually since less oil is circulated more frequently between the engine and the tank. Normally, however, if the oil coolers are operated automatically, this condition will not be detected immediately since the oil coolers will open gradually in an attempt to maintain constant oil temperature. But if the oil temperature switches are kept in the OFF position, the rising oil temperature will probably be detected in the pilot's normal scan of the instruments. Consequently, if loss of oil or other malfunction in the oil system is suspected, manual operation of the oil coolers will give a more accurate diagnosis of the situation than continuing to operate with the oil temperature switches in the AUTO position. This will also reduce wear of the oil cooler actuators due to minor fluctuations in oil temperature. The following procedure should be used to adjust the oil cooler doors during cruise configuration:

a. After level-off at cruise altitude, place oil temperature switches to OFF.

b. After visually scanning the oil cooler door position, adjust doors to a streamline configuration (approximately 4 to 5 inches open).

c. Place switches OFF.

d. Maintain oil temperatures as desired.

This procedure reduces drag as oil cooler doors will stabilize in a more streamlined configuration.

FUEL MANAGEMENT.

NACELLE TANK BOOST PUMP OPERATION.

The nacelle tank boost pump switches are turned to the LO position for starting engines, climb, all crossfeed operations, heater operation (when engines are not operating) and as necessary to eliminate fluctuation during cruise. The HI position of the boost pump switches is utilized for take-offs, landings, oil dilution and during operation with one engine-driven pump inoperative. To pressurize the fuel system when the engines are not running, first turn the nacelle tank boost pump switches to LO to allow pressure to stabilize; then turn to Hi if additional pressure is required.

RECIPROCATING ENGINE CROSSFEED OPERATION.

Either reciprocating engine can be supplied from either of the nacelle tanks by use of the crossfeed line, but fuel cannot be transferred from one tank to another. Either tank may be used to supply either reciprocating engine by turning the crossfeed switches to ON.

Note

During normal crossfeed operations turn the boost pump switch (for the tank from which fuel is being used) to LO. For high power application, turn the boost pump to HI. When changing from crossfeed operation to normal fuel management, turn both boost pump switches to the applicable position to preclude fuel pressure fluctuations.

JET BOOST PUMP OPERATION.

The jet engine fuel boost pumps are energized by placing jet engine fuel boost pump switches to ON. By using the desired boost pump switch in conjunction with the jet fuel crossfeed switch, either or both jet engines can be supplied by the corresponding tank.

JET CROSSFEED OPERATION.

Either nacelle tank can be used to supply fuel to either or both jet engines, but fuel cannot be transferred from one tank to another. Placing the jet fuel crossfeed switch to the ON position, opens the crossfeed valves. In the event of engine or boost pump failure, it will be possible to maintain a balanced fuel load by using both the reciprocating and jet fuel crossfeed systems.

USE OF EXTERNAL DROP TANK FUEL.

When the external drop tanks are carried to increase the fuel supply, fuel is used first from the nacelle tanks to permit replenishing from the drop tanks. Then, as the level of fuel drops in the nacelle tanks, a float-type valve opens permitting fuel from the external drop tanks to flow as soon as sufficient air pressure is built up. The time required to develop sufficient air pressure for the transfer of fuel varies, depending upon the initial quantity of fuel in the drop tanks, and the existing pressure in the tanks when the air pump switches are turned ON.

Note

Positive pressure in the drop tanks, which usually develops during a climb, will tend to shorten the time required for transfer to begin. Negative pressure, usually developed during a descent, will tend to increase the time required. Altitude has little or no effect on the time to begin transfer, or on the rate of transfer.

Note

During fuel transfer from the external drop tanks to the nacelle tanks, press to test the fuel flow indicator lights each 30 minutes and check the nacelle fuel quantity indicators for an equal distribution of fuel. Also be alert for any significant change in aileron trim possibly indicating an unbalanced wing load. Both the switch which turns on the air pump in the external drop tank and the fuel flow indicator light are protected by the same circuit breaker. If the circuit breaker should open during fuel transfer operations, the only indication would be a light which would not press to test, an uneven fuel quantity in the nacelle tanks, or a noticeable change in aileron trim. Failure to closely monitor this system could result in the necessity to jettison the external drop tanks prior to landing.

The approximate times required for the air pump to develop sufficient pressure to begin fuel transfer are as follows:

Full Tank	2 minutes
1/2 Tank	7 minutes
1/3 Tank	10 minutes

Since the float-type valves in the nacelle tanks automatically prevent overfilling, you may turn ON the external drop tank air pump switches immediately after take-off and climb. By so doing, fuel transfer is accomplished as quickly as possible, and there is no danger of running the nacelle tanks dry with insufficient air pressure in the drop tanks for immediate transfer. Once the flow is established, fuel is transferred from each tank at a rate equal to the fuel requirements of the engines served by the tank. However, the maximum capability of the transfer system is approximately 1800 pounds per hour, a rate well in excess of the highest expected cruising fuel consumption. Therefore, a float valve malfunction may cause loss of fuel through overflow. If this procedure is followed, a watch for overflow must be maintained. When the fuel supply in the drop tanks is exhausted, the fuel flow indicator lights on the fuel selector panel illuminate, indicating that the transfer of fuel is complete. The external drop tank air pump switches should then be turned OFF.

Fuel Transfer Check.

In order to check for actual transfer of fuel from the external drop tanks, it is necessary that the level of fuel in the nacelle tanks be low enough to open the float-type valves controlling the flow of drop tank fuel. Otherwise, the most that can be checked is the functioning of the external drop tank air pumps and the fuel flow indicator lights. If the external drop tanks are sufficiently pressurized when the nacelle float valves open, the fuel quantity indicated on the fuel selector panel should remain substantially constant, indicating that the valves are cycling open and closed properly. On the other hand, if the nacelle tank fuel level is below that required to open the valves, a definite increase in nacelle tank fuel quantity should be observed (up to the level at which the float-type valves close).

Note

The indicated fuel quantity at which the float-type valves open will vary slightly, depending upon aircraft attitude and fuel density. Normally, however, the valves should have opened by the time the indicated fuel quantity reads 4000 pounds or less.

As a normal pre-flight item, the complete check for actual fuel transfer cannot be made unless the flight is commenced with partially empty nacelle tanks. However, operation of the external drop tank air pumps and fuel flow indicator lights may be checked as follows:

a. Turn ON the external drop tank air pump switches.

b. Observe the amber fuel flow indicator lights on the fuel selector panel. Glowing of the lights indicates that the transfer line has not yet filled with fuel.

c. After allowing sufficient time for air pressure to build up, check that the indicator lights go out.

d. Turn OFF the external drop tank air pump switches.

Shortly after completing a normal warm-up, take-off and climb, nacelle tank fuel quantity should be low enough to complete the fuel transfer check:

a. Turn ON the external drop tank air pump switches.

b. Check that the amber fuel flow indicator lights go out.

c. Observe the fuel quantity gages for indication of fuel transfer.

NOTE

When transfer of external drop tank fuel is commenced with nacelle tank fuel near the 4000-pound level, some overflow of fuel may occur. Normally, the float-type valves in the nacelle tanks automatically prevent over-filling; however, it is advisable to observe the nacelle tanks for evidence of overflow. In doing so, fuel overflow should not be confused with leakage of water that has accumulated in the nacelle structure around the nacelle tanks. In general, water is apt to present the appearance of coarse spray or droplets, whereas fuel overflow more nearly resembles vapor.

AUXILIARY FUEL LONG RANGE SYSTEM. (A/A45Y-1 SPRAY SYSTEM) (A)

The UC-123K aircraft utilizes the 1000-gallon spray tank as an auxiliary fuel tank on long range ferry missions. Fuel can be transferred from the spray tank to either nacelle tank by selecting the desired nacelle tank with the manual fuel selector valve, located on the fuel transfer panel. The manual drain valve is opened and the fuel pump switch, on the fuel transfer panel (figure 1-15) is positioned to ON. Fuel enters the nacelle tanks through the float-type valves.

CAUTION

The manual line valve (in the line to the spray pump) should not be opened or the pumping engine started when fuel is carried in the spray tank.

WARNING

Tank lines will be purged whenever switching from fuel to chemicals or chemicals to fuel.

MODEL: C-123K

T.O. and L. Data

T.O. CONDITIONS

(30° at max)

FAT 73 °F 23 °C CAT. 22° C

DP 61 °F PA SL ft DA 900 ft

Wind 220 °M 15 kt

Gross Wt. 57,850 lbs Rwy. Lgth. 3500 ft

H Wind Comp 10 kt

X Wind Comp 12 kt

SAMPLE

T.O. DATA

	WET		DRY	
MAP	62	in. Hg	63	in. Hg
Exp. TOP	132.3	psi	122	psi
Min. Perf. TOP	126.1	psi	116	psi
T.O. GW Limit	60,000	lbs	60,000	lbs
T.O. Dist.	2350	ft		ft

T.O. Speed 102 kt IAS

Gross Weight Limited by Critical Field Length GREATER THAN 57,850 lbs

E.O. Best Climb 124 kt IAS

E.O. R/C 980 ft/min 895 ft/min

E.O. Serv. Ceil.-Max. Dry GREATER THAN 20,000 ft
(Jets at 100% RPM)

LANDING IMMED. AFTER T.O. DATA

Final App. Speed ______ kt IAS
(E.O. - 115 kts min. until landing assured)

Land. Dist. (Brakes only) 3925 ft

N-21

MODEL: C-123K

LAND. CONDITIONS

Fld. Elev. 1000 (PA) ft Rwy. Lgth. 4500 ft

Gross Wt. 52,713 lbs

FAT 61 °F 16 °C

PA 1000 ft

DA ft

Wind NOT AVAILABLE °M °C

H Wind Comp — kt

X Wind Comp — kt

SAMPLE

LAND. DATA

Final App. Speed 99 kt IAS

T/D Speed 83 kt IAS

Land. Dist. (Brakes only) 3925 ft

N-22

HYDRAULIC BRAKE SYSTEM.

It is absolutely necessary that aircraft brakes be treated with respect. Such practices as stopping short (failure to utilize all available runway space), excessive use of the brakes for turning, and dragging of the brakes while taxiing increases brake wear unnecessarily and contributes to maintenance difficulties and accidents.

SKIDDING.

Brakes, themselves, can merely stop the wheel from turning, but stopping the aircraft is dependent upon the friction of the tires on the runway. For this purpose it is easier to think in terms of coefficient of friction (frictional force divided by the load on the wheel). It has been found that optimum braking occurs with approximately a 15-20% rolling skid; i.e., the wheel continues to rotate but has approximately 15-20% slippage on the surface so that the rotational speed is 80-85% of the speed which the wheel would have were it in free roll. As the amount of skid increases beyond this amount, the coefficient of friction decreases rapidly so that with a 75% skid, the friction is approximately 60% of the optimum and, with a full skid, becomes even lower. There are two reasons for this loss in braking effectiveness with skidding. First, the immediate action is to scuff the rubber, tearing off little pieces which act almost like rollers under the tire. Second, the heat generated starts to melt the rubber and the molten rubber acts as a lubricant. NASA figures have shown that for an incipient skid with an approximate load of 10,000 pounds per wheel, the coefficient of friction on dry concrete is as high as .8, whereas the coefficient is of the order of .5 or less with a 75% skid. Therefore, if one wheel is locked during application of brakes, there is a very definite tendency for the aircraft to turn away from that wheel and further application of brake pressure will offer no corrective action. Since the coefficient of friction goes down when the wheel begins to skid, it is apparent that a wheel, once locked, will never free itself until brake pressure is reduced so that the braking effect on the wheel is less than the turning moment remaining with the reduced frictional force.

ANTI-SKID SYSTEM.

The anti-skid system is provided to permit maximum use of the hydraulic brakes without danger of locking the wheels in a skid. Each main wheel is equipped with a separate, independent unit consisting of a wheel-driven dc generator, an anti-skid controller unit, and a brake control valve. As the main wheels touch down and begin to spin, the rotary motion is converted to electrical energy by the wheel-driven generator, which is applied to the deceleration detector and locked wheel detector circuits in the anti-skid controller unit. During normal wheel deceleration due to braking action, the electrical energy produced by the wheel-driven generator is dissipated by the deceleration detector circuits. When the deceleration rate increases too fast, indicating an impending skid, the electrical energy dissipates in excess of a preset threshold and produces a signal that, when amplified, opens the brake control valve and reduces brake pressure in proportion to the electrical signal. An auxiliary circuit, called a locked wheel prevention circuit, relieves brake pressure whenever the wheel speed goes below 12.9 knots while the aircraft speed is above 22.5 knots. When the aircraft speed is below 22.5 knots, the locked wheel prevention circuit is deenergized to allow normal taxiing and parking. A touchdown protection circuit is provided to prevent the application of brakes while the aircraft is still airborne if anti-skid is on.

Wheel-driven Generators.

A wheel-driven generator is mounted in the outboard axle of each main landing gear assembly. The body of the generator is attached to, and prevented from rotating by, the axle. The generator rotor shaft protrudes and is coupled to, and is rotated by, the wheel. As the wheel rotates during a landing roll, the wheel-driven generator produces a dc voltage output which is proportional to the wheel speed. The generator output voltages from both generators are connected through wires to the anti-skid controller unit.

Controller.

The anti-skid controller unit is mounted in the right-hand side of the aircraft fuselage, just forward of the landing gear wheel well. Signal voltages from both the left and right main landing gear wheel-driven generators are applied to the unit. Power to operate the controller unit is obtained from the 28-volt dc flight emergency bus through the landing gear handle, lock and brake circuit breaker. The controller unit output is applied to the left and right brake control valves.

Control Valve.

A brake control valve is mounted on a bracket attached to each main landing gear strut. The control valves are electrically connected to the anti-skid controller. When the controller senses an impending skid, its circuits apply a voltage to the control valve which reduces the brake pressure in proportion to the voltage.

BRAKING TECHNIQUES.

After Touchdown.

Since the anti-skid system automatically prevents skidding, braking technique for optimum performance is very simple. All that is required is steady application of the pedals in accordance with the braking requirement. For shortest landing roll, brakes and reverse thrust should be applied simultaneously immediately after the nose gear is lowered.

CAUTION

If indications of excessive cycling or skidding occurs reduce braking pressure immediately and reapply with caution.

Taxiing.

Use the brakes as lightly as possible when taxiing; take advantage of nose wheel steering and engine power to facilitate turning. Avoid excessive speed and any unnecessary maneuvering.

Cooling.

It is recommended that a minimum of 15 minutes elapse between maximum braking landings when the landing gear remains extended in the slip stream, and a minimum of 30 minutes between landings when the landing gear has been retracted. This will allow sufficient time for cooling between brake application. Additional time should be allowed for cooling if brakes are used for steering, crosswind taxiing, or when a series of landings is performed. After the brakes have been used excessively for an emergency stop and are in the heated condition, the aircraft should not be taxied into a crowded parking area. Peak temperatures occur in the wheel and brake assembly from 5 to 15 minutes after a maximum braking operation. When hot brakes are suspected, have fire department inspect brakes and tires for a possible fire. Record brake overheating in Form 781.

WARNING

All personnel, except fire fighters, should evacuate the immediate area. The area will be cleared of personnel and equipment for a distance of at least 300 feet to the sides of the wheels. Depart area in a forward or aft direction. Personnel required to be near a suspected hot brake (to insert chocks, fight fire, etc) will approach from forward or aft only.

CAUTION

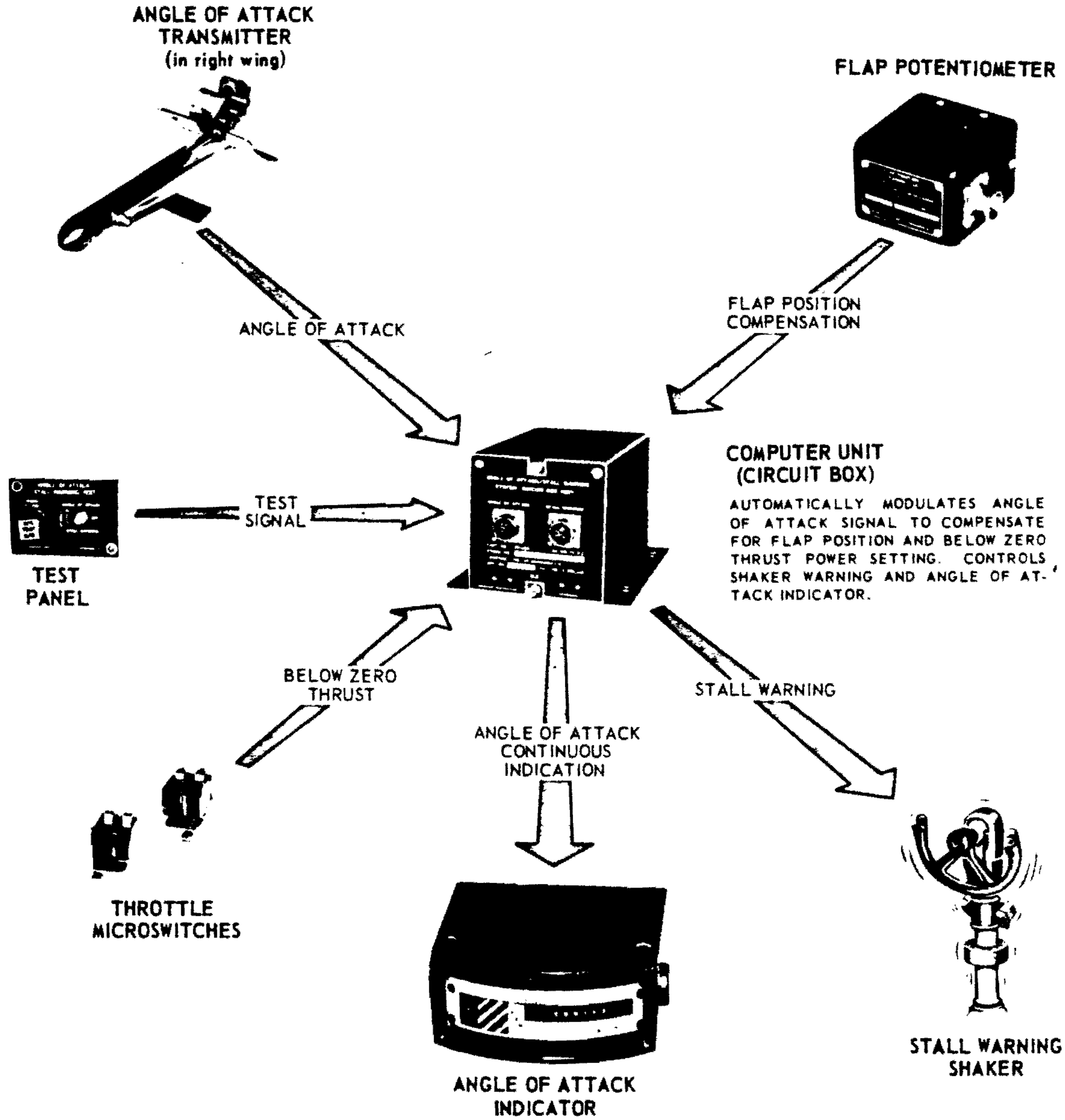
After maximum braking at high gross weight (assault landings), extreme caution should be exercised to prevent brake failure due to overheating. Subsequent braking should be accomplished by use of propeller reversing. Turns should be made using nose gear steering. Cooling times noted in Section V should be adhered to if time and operational conditions permit.

ANGLE OF ATTACK/STALL WARNING SYSTEM.

The angle of attack/stall warning system is installed to give the pilots visual and physical warning of impending stall, and a visual indication of the aircraft angle of attack as an increment of stall speed. The system includes the transmitter, computer unit (circuit box), flap potentiometer, indicators, test switch, and control column shaker. The system is powered from the 28-volt dc primary bus.

SYSTEM OPERATION.

The principal source of intelligence for operation of the angle of attack/stall warning system is provided by the transmitter, mounted in the leading edge of the right wing. The transmitter includes a vane, located ahead of the leading edge, to sense airflow direction, which is dependent on wing angle of attack. The vane positions two potentiometers to provide separate signals for stall warning and angle of attack indication. Vane position signals are fed to the computer unit (circuit box) where they are modulated by signals from the flap potentiometer and throttle-actuated microswitches. The flap potentiometer is connected directly to the flap torque tube and provides correction for changes in stall angle of attack with varying flap position. The throttle-actuated microswitches provide a shift of stall warning and angle of attack signals when either throttle is retarded below power for zero thrust. Retarding the throttles below zero thrust in flight decreases the lift of the wing behind the propellers and increases stalling speed by 4-7 knots in all configurations. The modulated angle of attack (vane position) signals are displayed on indicators mounted on each pilot's glare shield. These indicators provide a visual presentation of angle of attack. The horizontal dial is calibrated from 0.9 to 1.4 times V_S in the low speed range and with a linear scale in the cruise speed range. The dial is color coded to provide quick reference for particular flight requirements. The indicator pointer is damped to reduce major oscillations of the pointer when flying in turbulent air. No damping factor is incorporated in the stall warning circuit so that an impending stall pro-



ANGLE OF ATTACK / STALL WARNING SYSTEM

Figure 7-6

vides an immediate indication. Stall warning is initiated at 1.1 V_s and the control column shaker is energized to provide physical warning that the angle of attack, flap position and power are of such values that the aircraft is very near, though slightly above, a stall. Deicing of the vane is controlled by the pitot heat switch.

FLIGHT OPERATION.

The system is preset on the basis of a desired angle of attack for cruise, approach and landing configurations as determined by performance of the aircraft. The required angle of attack is not affected by gross weight, bank angle, load factor, sideslip, center-of-gravity, or density altitude. In cruising flight the pointer will be positioned in the green cruise band. When used to set up approach speed prior to landing, control of the aircraft should be maintained so that the pointer indicates the desired angle of attack displayed as an increment of the stall speed (V_s). This can be accomplished by using the elevator control and/or the throttle as necessary. As long as the pointer remains at the selected speed, the desired angle of attack for approach is being made. If the pointer moves toward the left from the selected speed, the approach is too slow; if to the right, too fast.